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# BASEMENT IMPACT ASSESSMENT

## 192 GOLDHURST TERRACE
## LONDON, NW6 3HN

| | |
|---|---|
| Ref: | MES/2207/DSA002 |
| Rev: | 03 |
| Date: | July 2022 |
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# 1.0 Non-Technical Summary

At the request of D'Soto Architects, on behalf of Chirag Sachdev, a Basement Impact Assessment (BIA) has been carried out at 192 Goldhurst Terrace, London NW6 3HN in support of a planning application for a proposed new basement development to an existing three-storey end of terrace house. The proposed basement is to share the Party Wall with the existing basement to 190 Goldhurst Terrace. Basement retaining walls will be formed using underpinning techniques.

The assessments have been undertaken by appropriately qualified professionals, including a Chartered Hydrogeologist (CGeol FGS) and Chartered Civil Engineer (CEng MICE).

The British Geological Survey (BGS) map of the area indicates that the site is underlain by the London Clay Formation. The London Clay formation typically comprises firm to stiff clay of medium to high strength and is a suitable bearing stratum for the proposed development's foundations, confirmed by the site investigation.

The London Clay has potential to shrink and swell with moisture variation, which may cause movement and damage to structures bearing upon it. The risk of movement and damage to this development due to moisture variation is negligible, considering the proposed depth of the basement.

The London Clay is designated Unproductive Strata. There is a very low risk of groundwater flooding or potential for impacting the wider hydrogeological environment.

The site and the adjacent properties have not been impacted by flooding. The SuDS proposals are to attenuate surface water discharge flow off-site, in accordance with best practice. There is a very low risk of flooding to the proposed development and the development will not impact on the wider hydrological environment.

There will be no impact to slopes due to the proposed development. The main site is level and is not situated in a wider hillside environment of slopes of 7° or more.

Ground movements caused by the excavation and construction of the proposed development will be minimal. Damage impact to adjacent structures is assessed to be a maximum of Very Slight (Category 1 in accordance with the Burland Scale) with impact to the highway and underlying utilities assessed to be negligible.

It is recommended that structural movement monitoring is undertaken and mitigation actions implemented if movement trends indicate structural tolerances could be exceeded.

The BIA demonstrates that the proposed development will not cause adverse impacts relating to land stability, groundwater and surface water flow, and is at very low risk of flooding.

## 2.0 Introduction

At the request of D'Soto Architects, on behalf of Chirag Sachdev, the following assessments have been carried out at 192 Goldhurst Terrace, London NW6 3HN in support of a planning application for a proposed new basement development to an existing three-storey end of terrace house:

- a Desk Study;
- Screening and Scoping;
- a Site Investigation;
- a Ground Movement Assessment (GMA);
- a Flood Risk Assessment (FRA);
- a Drainage Strategy;
- and a Basement Impact Assessment (BIA).

The proposed basement is to share the Party Wall with the existing basement to 190 Goldhurst Terrace. Basement retaining walls will be formed using underpinning techniques, cast in a traditional hit and miss sequence.

### 2.1 Purpose and Methodology of Assessment

The purpose of this assessment is to consider the impacts of the proposed basements on the local hydrological, geological and hydrogeological environments, including potential impacts on neighbouring properties and the wider area.

The information contained within this BIA has been produced specifically to meet the requirements set out by Camden Planning Guidance - Basements (CPG, January 2021) and the Local Plan 2017: Policy A5 Basements in order to assist the London Borough (LB) of Camden with their decision-making process.

The BIA approach follows current planning procedure for basements and lightwells adopted by LB Camden and comprises the following elements:

- Desk Study;
- Screening;
- Scoping;
- Site Investigation and additional assessments identified during Scoping;
- Impact Assessment.

### 2.2 Authors

The assessment has been reviewed and approved by Chartered Civil Engineer Corrado Candian, MEng CEng MICE and Chartered Hydrogeologist Philip Lewis, BSc CGeol FGS, who both have more than 20 years' relevant experience of design and assessment of residential and commercial developments including basements.

The Supervising Engineer for the scheme is DVP Structures in conjunction with Piledesigns Ltd, specifically Val Pseneac CEng MIStructE and Mike Johnson CEng MIStuctE CSSW, who have reviewed the relevant geo-structural information and provided confirmation of the suitability and buildability of the scheme, within the guidelines provided by LB Camden, as presented in their Construction Method Statement (CMS).

## 2.3 Sources of Information

The following baseline data have been referenced to complete the BIA in relation to the proposed development:

- Site walkover (June 2022).
- Ordnance Survey Mapping;
- British Geological Survey, Geology of Britain Viewer (online);
- Groundsure Mapping Report (ref GS-2879065), Historical Mapping Data;
- Groundsure Enviro + Geo Insights Report (ref GS-2879063 and GS-2879064), Geology and Subsurface Structure (Infrastructure and Utilities) Data;
- D'Soto Architects Drawings of Existing and Proposed Development, July 2022;
- Construction Method Statement (DVP Structures / Piledesigns Ltd), July 2022;
- BIA 190 Goldhurst Terrace (ref: GGC16550/R4, Gabriel Geo-Consulting Ltd), December 2021;
- LB Camden, Planning Guidance: Basements, January 2021;
- LB Camden, The Local Plan 2017: Policy A5 Basements;
- LB Camden, Strategic Flood Risk Assessment (produced by URS), 2014;
- Barton, The Lost Rivers of London, 1992;
- LB Camden, Camden Geological, Hydrogeological and Hydrological Study - Guidance for Subterranean Development (produced by Arup), 2010;
- CIRIA, C760 Embedded retaining walls - Guidance for Economic Design, 2017;
- Tomlinson, M.J. (2001) Foundation Design and Construction;
- ASUC, Guidelines for Safe and Efficient Basement Construction Directly Below or Near to Existing Structures, 2nd Edition, 2016.

## 2.2 Existing and Proposed Development

The site location and recent aerial photograph are presented in Figures 1 and 2, Appendix 1 and Appendix 3. Existing and proposed development plans are presented in Appendix 2.

The Application site fronts Goldhurst Terrace, which forms the southern site boundary, and comprises a 3-storey end of terrace residential property with associated driveway and garden areas. The site occupies an area of 0.04 hectares and is roughly rectangular. Survey data and the site walkover indicates that the site is largely on relatively flat ground at an elevation of 45.00m OD. Goldhurst Terrace carriageway falls gently eastwards within the vicinity of No.192, towards a low point located between the curve in Goldhurst Terrace, and the junction of Goldhurst Terrace with Fairhazel Gardens (approximately 300m from No.192). To the east of this junction, Goldhurst Terrace falls southwards (from Finchley Road) at gradients which ease from approximately 3.0° at its north-eastern end, to less than 1° near the junction with Fairhazel Gardens.

Across the wider area of Goldhurst Terrace and adjoining streets, the slopes are less than 7°. This is confirmed by LB Camden mapping data (Appendix 3, Figure 7) and OS data.

The front of the site is largely paved over with a tree nearest to the house and shrubs in limited border areas fronting the pavement and road. A pedestrian access side passage runs from the street to the rear garden which is paved. The house is typically >8.0m from the footway (>10.0m from the highway), with the ground floor bay window at the eastern edge of the house being 7.0m from the footway, 10.0m from the highway. The rear garden is laid to astroturf which appears to be laid directly onto a previous patio area and extends approximately 8.0m from the house. The borders are fenced on all sides.

To the east and west the immediate neighbours are residential buildings of three storeys (Nos. 190 and 194 Goldhurst Terrace respectively). The rear garden of No.196 Goldhurst Terrace bounds the site to the north with Goldhurst Terrace carriageway forming the southern boundary.

The proposed development comprises the construction of a single storey basement beneath the full footprint of the existing house which is to share a Party Wall with the proposed basement to No.190 Goldhurst Terrace (pending Planning Permission).

The basement will be formed at approximately 3.50m below ground level (bgl) by reinforced concrete retaining walls, underpinning the existing building's foundations, which are currently at approximately 1.00m bgl (as demonstrated by the site investigation, see Section 6).

The proposed structural arrangements are described in detail in the Construction Method Statement (CMS). In summary, the basement retaining walls will be cast and stiffly propped by the basement slab. At ground level, steel beams in conjunction with a timber floor will be designed to act as a diaphragm such that it can stiffly prop the basement wall in the permanent condition.

The temporary works methodology also includes stiff propping of the retaining walls to ensure ground movements are limited to within the minimum practicable.

The development will be founded upon thickened edges to the basement wall underpin stem bases, which will transfer the loads into ground in conjunction with the ground bearing basement slab. Internal slab thickening is to be adopted where steel columns are proposed to be supported by the basement slab. The slab is intended to be sized such that the heave and hydrostatic pressures are resisted without heave protection measures.

Formation level is within the underlying natural London Clay of suitable bearing capacity.

One tree, currently within the flower border immediately adjacent to the front door, will be removed as part of the proposed works.

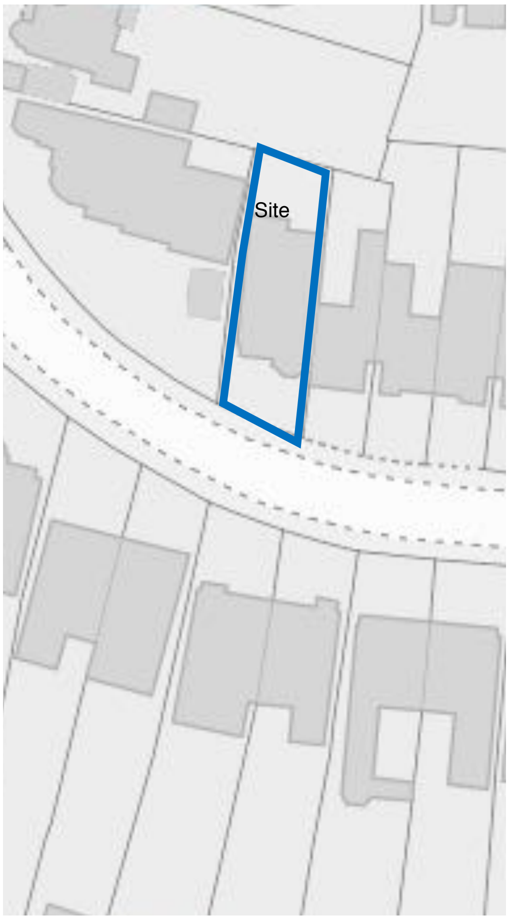


Figure 1: Site Location Plan


Figure 2: Aerial Photograph of the Application Site and Surrounding Area

# 3.0 Desk Study

The desk study has been researched with reference to the Groundsure Enviro + Geo Insight Report and historical mapping, presented in Appendix 3, in addition to other data sources as referenced.

## 3.1 Site History

The historical mapping indicates the site comprised a field from at least 1871. The next available OS map, dated 1896, shows that construction of the Goldhurst Terrace and Aberdare Gardens carriageways had been completed prior to this date; however, only No.196 Goldhurst Terrace had been built at this end of Goldhurst Terrace along with several other houses at the western end of Aberdare Gardens. By the time the 1915 OS map was published, almost all of the properties on Goldhurst Terrace had been completed (including No.192), along with those on Aberdare Gardens and Greencroft Gardens further to the north.

The railway line has been present 200m southeast of the site since at least 1871. Generally, both the large- and small-scale historic OS maps show few significant changes in the area after the above period of major residential development.

No historical tanks are reported on site. Industrial processes are not indicated historically within close proximity of the site. The historical potentially contaminative land uses within the vicinity (250m) relate to railways sidings, electrical substations and garages.

## 3.2 Geology

The British Geological Survey (BGS) map indicates that the site is underlain by the London Clay Formation (see Figure 3). A general stratigraphy of the London Basin is presented in Table 1.

Made Ground would normally be expected above the naturally occurring strata related to the historic development on site. Where present, Made Ground is expected to exhibit a certain degree of heterogeneity and the nature of the material can be expected to vary substantially in both composition and thickness over short distances.

Head Deposits, naturally reworked soils, are common within north London, typically comprising a thin layer of firm sandy gravelly clay.

The London Clay Formation is typically a firm to stiff, high plasticity silty clay, becoming very stiff with depth. Where encountered near surface and in proximity to vegetation, consideration of desiccation and potential for shrink swell movements to impact shallow foundations is required.

The site investigation information from the adjacent No.190 Goldhurst Terrace (Appendix 4) confirms the presence of shallow Made Ground overlying Head Deposits and London Clay. Perched water within the Made Ground and Head Deposits was encountered.

| Period | Series | | Deposits | |
|---|---|---|---|---|
| Quaternary | Holocene | | Made Ground | |
| | | | Alluvium | |
| | Pleistocene | | Langley Silt (Brickearth) | |
| | | | River Terrace Deposits | |
| Palaeogene | Eocene | Thames Group | London Clay Formation | Sub-Divisions A - D |
| | | | Harwich Formation | Swanscombe Member |
| | | | | Oldhaven Member |
| | | Lambeth Group | Woolwich Formation | Upper Shelley Beds |
| | | | Reading Formation | Upper Mottled Beds |
| | | | Woolwich Formation | Laminated Beds |
| | | | | Lower Shelley Beds |
| | Palaeocene | | Reading Formation | Lower Mottled Beds |
| | | | Upnor Formation | |
| | | Thanet Sand Formation | Thanet Sand | |
| | | | Bullhead Beds | |
| Cretaceous | White Chalk Sub-Group | Seaford Chalk Formation | Haven Brow Beds | |
| | | | Cuckmere Beds | |
| | | | Bell Tout Beds | |

Table 1: General Stratigraphy of the London Basin

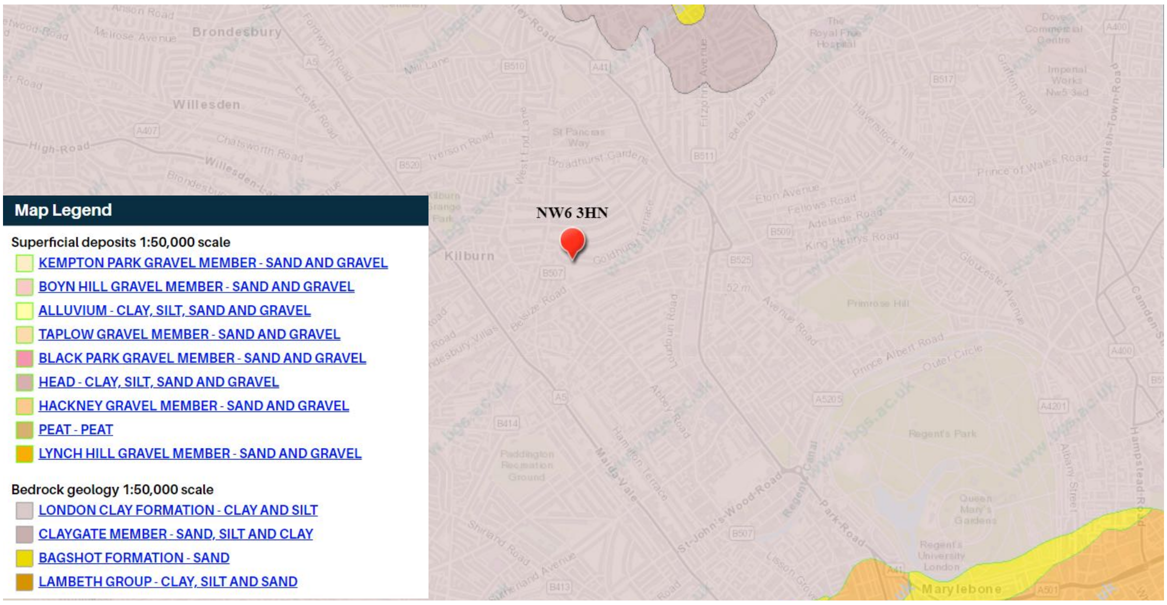


Figure 3: Geological Map of the Site Area (BGS Viewer)

## 3.3 Hydrogeology

The Environment Agency (EA) Groundwater Protection Policy uses aquifer designations that are consistent with the Water Framework Directive. These designations reflect the importance of aquifers in terms of groundwater as a resource (drinking water supply) and also their role in supporting surface water flows and wetland ecosystems:

- Principal Aquifers – layers that have a high permeability and are likely to support water supply and / or river base flow on a strategic scale.

- Secondary Aquifer (A) - permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.

- Unproductive Strata – predominantly impermeable or low permeability layers that have negligible significance for water supply or river base flow.

The aquifer designation beneath the site for the London Clay is Unproductive Strata. The London Clay is not considered likely to be vulnerable to pollutants or capable of supporting the migration of pollutants on or off site, due to its very low permeability.

Perched groundwater would typically be expected in any Made Ground, and possibly also in any Head Deposits which overlie the London Clay, in at least the winter and early spring seasons (and was encountered in the neighbouring site investigation at No. 190). Variations in groundwater levels and pressures will occur in response to seasonal climatic changes and with other man-induced influences.

LB Camden data (Appendix 3, Figure 12) indicates the site is not within a groundwater source protection zone.

## 3.4 Hydrology

Barton's map of the 'lost' rivers of London (Figure 4) indicates that this part of Goldhurst Terrace is situated just to the south-west of the confluence between two branches of one of the former tributaries to the Westbourne. This former tributary of the Westbourne is located approximately 200m east of the site and is not considered to have an impact on the site or the adjacent properties as a result of constructing the proposed development.

There are no current surface water features within 250m of the site.

The site is not within the catchment of the Hampstead Heath Pond Chain. The nearest part of the catchment (Hampstead No. 1 Pond) is approximately 2.2km northeast of the site.

The site surface area immediately to the front and rear (currently astroturf laid on a paved area) of the existing house is currently almost 100% of hardstanding, and therefore infiltration to ground will be limited to cracks / gaps in hard surfacing and leakage from drains, with the remaining rainfall discharged to the local sewer network. The proposed basement beneath the house does not change the impermeable site area.

The site is within a Critical Drainage Area (Group 3_010) and within the Goldhurst Local Flood Risk Zone.

Goldhurst Terrace was subject to surface water flooding in both the 1975 and 2002 flood events.

The following risk of flooding is reported (detailed in Section 8 and Appendix 3) for the proposed development area:

- Very low risk (<1 in 1,000 annual probability) – rivers and seas.
- Very low risk (<1 in 1,000 annual probability) – surface water.
- Very low risk (<1 in 1,000 annual probability) – reservoirs.
- Negligible (no shallow aquifer) – groundwater.
- Negligible (no recorded instances within 100m) – sewer surcharging.

A Flood Risk Assessment (FRA) and Drainage Strategy is provided in Section 8.

The site is not within the London Management Catchment draining to the Tidal River Thames, which is protected by The Water Framework Directive, an EU-led framework for the protection of inland surface waters, estuaries, coastal waters and groundwater through river basin-level management planning.

## 3.5 Utilities and Underground Infrastructure

As indicated in the search results presented in Appendix 3, there are no reported tunnels or utility infrastructure beneath the site. The standard utilities are present within Goldhurst Terrace and the adjacent residential properties (e.g. mains water, foul and surface water sewers, gas, electricity, telecoms etc). Future development should carefully consider the route of existing utility connections across the site.

## 3.6 Geotechnical Risk / Unexploded Ordnance Risk

Very low or negligible risks relating to dissolution of the ground, slopes, historic mining, or worked ground have been identified from the Desk Study references.

Shrink / swell or subsidence movements to buildings placed on shallow foundations within cohesive deposits (ie London Clay) may occur. Shrink / swell risk to the proposed basement development is considered to be very low due to the depth of the proposed foundations. The site walkover did not indicate any signs of distress to the property which could be linked with existing shrink / swell movements. However, some signs of cracking potentially linked to shrink/ swell have been observed to No. 190 Goldhurst Terrace.

The WW2 bomb map for Hampstead shows that bombs landed 50m northeast of the site, affecting properties on both sides of Aberdare Gardens. This map also shows that bombs landed near the junction between Priory Road and Goldhurst Terrace 150m to the north-west of the site with further bombs landing on Goldhurst Terrace 300m to the east of the site.

The London County Council Bomb Damage Map for this area (London Topographical Society, 2005) shows that No.192 did not suffer any damage. To the north–east of the site, however, No’s 6 and 8 Aberdare Gardens are recorded as having suffered “General blast damage – not structural”, and on the opposite (north) side of Aberdare Gardens, Nos. 17 and 19 are recorded as “Seriously damaged, but repairable at cost”.

It is recommended that a detailed risk assessment and / or appropriate UXO risk mitigation is undertaken prior to intrusive works (e.g. site investigation and subsequent basement construction).

## 3.7 Environmental Database Search

A complete search of environmental registers is presented in Appendix 3. A summary of information is presented in Table 2.

Within 250m from the site, historical contaminative land uses relate to railways sidings, electrical substations and garages.

| Environmental Search | On-Site | Within 50m | Within 250m |
|---|---|---|---|
| Potentially Contaminative Land Uses – historical industrial sites including tanks, energy features, fuel sites, garages, infilled land | 0 | 0 | 34 |
| Environmental Permits, Incidents and Registers – including discharge consents, radioactive substance authorisations, hazardous substance consents and enforcements, site determined as contaminated land | 0 | 0 | 0 |
| Landfill and Waste Sites | 0 | 0 | 0 |
| Current Land Uses – including industrial sites, fuel sites, underground electrical cables, gas transmission pipelines | 0 | 0 | 6 |
| Designated Environmentally Sensitive Sites | 0 | 0 | 0 |
| Mining, Quarrying | 0 | 0 | 0 |

Table 2: Environmental Database Search Summary

## 3.8 Environmental Sensitivity

Overall, the site setting is considered to be of **low** environmental sensitivity, for the following reasons:

- The site is located in an urban, predominantly residential area;
- The final end use of the site will be residential;
- The site is underlain by Unproductive Strata;
- There are no known surface water features in proximity to the site boundary.

## 3.9 Preliminary Conceptual Site Model

The information presented within chapters 2 and 3 of this report has been used to complete a Preliminary Conceptual Site Model (PCSM) that details the potential contaminant sources, pathways and receptors, with regard to:

- Environment Agency/DEFRA; Priority Contaminants for the Assessment of Land (CLR8).

Whilst it is noted that this document has been withdrawn it is still considered pertinent to identifying potential sources of contamination. The PCSM is presented in Table 3.

Potential for off-site sources of contamination (e.g. Made Ground associated with historic development) within soils and groundwater have been identified but with low potential for contaminated groundwater / ground gas / volatile vapours to migrate onto site that could impact future site users, construction and maintenance workers and buildings.

Potential for on-site sources of contamination (e.g. Made Ground associated with historic development) within soils have been identified but with low potential to impact future site users, as the proposed basement will result in the majority of shallow soils being excavated and removed from site, and the permanent concrete basement structure will sever any pathways to receptors. Construction workers should be vigilant for the presence of contamination during development and follow best practice if encountered to mitigate any on-going risks and liabilities, as applicable.

| | | |
|---|---|---|
| **Potential Contaminant Sources** | On-site | • Made Ground associated with historic development.<br>• Potential WW2 unexploded ordnance. |
| | Off-site | • Made Ground associated with historic development.<br>• Potential WW2 unexploded ordnance. |
| **Associated Contaminant** | On-site | • Heavy metals and inorganic contaminants including Asbestos Containing Materials (ACM).<br>• Organic contaminants including hydrocarbons (e.g. diesel, petroleum and PAHs).<br>• Possible generation of bulk ground gases & volatile vapours. |
| | Off-site | • Heavy metals and inorganic contaminants including Asbestos Containing Materials (ACM).<br>• Organic contaminants including hydrocarbons (e.g. diesel, petroleum and PAHs).<br>• Possible generation of bulk ground gases & volatile vapours. |
| **Receptors** | | • Future site users.<br>• Construction workers.<br>• Buildings. |
| **Pathways to Receptors** | | • Site underlain by low permeability London Clay. Migration via groundwater or migration of ground gasses is unlikely. |

Table 3: Preliminary Conceptual Site Model

## 3.10 Preliminary Risk Assessment (PRA)

The Preliminary Risk Assessment (PRA) considers the information provided in the previous sections, including the PCSM. The PRA and risk ratings assigned in Table 4 are based on the qualitative risk assessment matrices presented in CIRIA C552 which are reproduced in Appendix 8.

The likelihood of pollutant linkages being present between the potential contaminant sources, pathways and receptors identified in the PCSM are outlined in Table 4.

Based on the results of the PRA:

- The site is considered to be of **low** environmental sensitivity.
- The potential **low** risks identified are associated with bulk ground gases and volatile vapours from historic infill materials on site.
- The potential for the site to be designated as contaminated land (as defined in Part 2A of the Environmental Protection Act) is considered to be **low**. However, this is on the assumption that any planning conditions related to potential land contamination issues are dealt with to the satisfaction of the Local Authority as part of the development.

| Pathway Linkage | Likelihood of Pollutant Linkage | Consequences | Risk Rating | Reasoning |
|---|---|---|---|---|
| **Future Site Users (Direct exposure pathway)** | | | | |
| **Ingestion / Dermal Contact / Inhalation (Site Users)** | Unlikely | Medium | Low | There will be hardstanding across the proposed development areas; Made Ground will be excavated and removed from site beneath the proposed basement area and as part of site enabling works, as required (e.g. from installation of drainage scheme etc); clean cover may be introduced to landscaped areas, if required.<br>Maintenance and construction workers will adopt appropriate management procedures to mitigate potential risks. Workers will wear proper PPE which will avoid contact and inhalation of any contaminant. |
| **Ingestion / Dermal Contact / Inhalation (Maintenance and Construction Workers)** | Low | Medium | Low | |
| **Future Site Users (Indirect exposure pathway)** | | | | |
| **Enclosed space accumulation of ground gas.** | Unlikely | Severe | Moderate | Migration of any ground gas should be precluded by low permeability London Clay and RC basement floor slab and structure. |
| **Outdoor volatile vapour exposure** | N/A | N/A | N/A | N/A |
| **Ingress into potable water supply pipes** | Low | Mild | Very Low | It is considered unlikely that upgraded water pipe material will be required. However, confirmation with the statutory undertaker is recommended. |
| **Risks to Buildings via accumulation of ground gas and volatile vapours in enclosed spaces and sub-floor voids.** | Unlikely | Severe | Moderate | Migration of any ground gas should be precluded by low permeability London Clay, RC basement floor slab and structure. |

| Pathway Linkage | Likelihood of Pollutant Linkage | Consequences | Risk Rating | Reasoning |
|---|---|---|---|---|
| **Water Environment** | | | | |
| **Contaminant migration on to neighbouring land** | Unlikely | Mild | Very Low | It is considered unlikely that sources of contamination are present beneath the site at concentrations that are likely to impact neighbouring land.<br>The site is underlain by London Clay, a very low permeability soil that should prevent migration of contaminants. |
| **Contaminant migration from neighbouring land** | Unlikely | Medium | Low | |
| **Contamination of groundwater** | Unlikely | Mild | Very Low | It is considered unlikely that sources of contamination are present beneath the site at concentrations that are likely to impact groundwater.<br>The site is underlain by London Clay, a very low permeability soil that should prevent migration of contaminants. |
| **Contamination of surface water** | Unlikely | Mild | Very Low | It is possible that during any construction phase there could be some limited run-off from stockpiles / earthworks. However, it is considered unlikely that such run-off would be contaminated, and control measures would be adopted.<br>There are no immediate surface water features in the vicinity of the site. |
| **Overall Risk Rating** | | | **Low** | |

Table 4: Potential Pollutant Linkages

# 4.0 Screening

A screening process has been undertaken in accordance with the most recent guidance (CPG Basements, 2021) and the findings are described below.

## 4.1 Subterranean (Groundwater) Flow

| Question | Response | Details |
|---|---|---|
| *1a. Is the site located directly above an aquifer?* | No | The site is located over the London Clay Formation, designated as Unproductive Strata. See 3.3 and Appendix 3. |
| *1b. Will the proposed basement extend beneath the water table surface?* | No | A continuous groundwater body is not considered to be present beneath the site. However, perched water is likely to be present within any Made Ground overlying the London Clay. See 3.3, 3.4 and Appendix 3. |
| *2. Is the site within 100m of a watercourse, well (used / disused) or potential spring line?* | No | There are no current watercourses, wells or spring lines within 100m. See 3.4 and Appendix 3. |
| *3. Is the site within the catchment of the pond chains on Hampstead Heath?* | No | Catchment of the pond chains are >2km to the northeast. See 3.4. |
| *4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?* | No | The proposed basement beneath the house will not result in a change to impermeable site area. |
| *5. As part of site drainage, will more surface water (e.g. rainfall and run-off) than a present be discharged to the ground (e.g. via soakaways and/or SUDS)?* | No | There is no increase in impermeable site area. Attenuated drainage will be implemented. See Section 8. |
| *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 or spring line?* | No | No local ponds within the surrounding area to the site. See Appendix 3. |

## 4.2 Slope Stability

| Question | Response | Details |
|---|---|---|
| *1. Does the existing site include slopes, natural or man-made greater than 7° (approximately 1 in 8)?* | No | The overall slope across the site is approximately 1°. |
| *2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7° (approximately 1 in 8)?* | No | See 2.2 and Appendix 2. |
| *3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7° (approximately 1 in 8)?* | No | Maximum overall slope angle in the vicinity of the property is 1°; (and there are no railway cuttings in the vicinity of the site). |
| *4. Is the site within a wider hillside setting in which the general slope is greater than 7° (approximately1 in 8)?* | No | Maximum overall slope angle in the vicinity of the property is 1°; (and there are no railway cuttings in the vicinity of the site). |
| *5. Is the London Clay the shallowest strata at the site?* | Yes | The London Clay Formation is the shallowest natural strata. Made Ground and Head Deposits are anticipated above the London Clay. See 3.1, 3.2 and Appendix 3. |
| *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 2.2, one tree will be removed currently in the front border adjacent the front door. |
| *7. Is there a history of seasonal shrink-swell subsidence in the local area and/or evidence of such effects at the site?* | Yes | In the general area, though these houses appear to have suffered less than others in the area, with only minor cracking observed around some of the windows to No.190. |
| *8. Is the site within 100m of a watercourse or a potential spring line?* | No | There are no current watercourses, wells or spring lines within 100m. See 3.4 and Appendix 3. |
| *9. Is the site within an area of previously worked ground?* | No | See 3.1 and Appendix 3. |
| *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?* | Yes | The site is located on the London Clay Formation, designated Unproductive Strata. However, groundwater control measures during construction may be required if perched water is present. See 3.3, 3.4 and Appendix 3. |
| *11. Is the site within 5m of a highway or pedestrian right of way?* | No | The proposed basement is >5.0m from the pedestrian right of way. |

| | | |
|---|---|---|
| *12. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?* | Yes | The adjacent property at No. 190 is proposed to have a basement. See 2.2. However, assessments have been undertaken in the following sections on the basis that no basement will be present at the time of construction, to be conservative. Shallow foundations assumed to No.194. |
| *13. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?* | No | No tunnels within 250m. No utilities within the site boundary apart from domestic connections to the property. See Appendix 3. |

## 4.3 Surface Water and Flooding

| Question | Response | Details |
|---|---|---|
| *1. Is the site within the catchment of the pond chains on Hampstead Heath?* | No | See 3.4 and Appendix 3. |
| *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 | Proposed SuDS will provide betterment (attenuated discharge). See Section 8. |
| *3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?* | No | See 2.2 and Appendix 2. |
| *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 | Proposed SuDS will provide betterment (attenuated discharge). See Section 8. |
| *5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?* | No | There will be no changes to the quality of the surface water discharged. |
| *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.* | Yes | Goldhurst Terrace was subject to surface water flooding in both the 1975 and 2002 flood events, though the construction in 1994 of the NW Storm Relief Sewer should have been beneficial. The site is within the Goldhurst Local Flood Risk Zone. |

## 4.4 Non-Technical Summary of Screening Process

The screening process identifies the following issues to be carried forward to scoping for further assessment:

- Is the London Clay the shallowest strata at the site?
- Is there a history of seasonal shrink-swell subsidence in the local area and/or evidence of such effects at the site?
- 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?
- Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?
- 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?
- 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?

The other potential concerns considered within the screening process have all been demonstrated to be not applicable or not significant when applied to the proposed development.

# 5.0 Scoping

The following issues have been brought forward from the screening process for further assessment:

## 5.1 Geology / Land Stability

*Shrink Swell*

The London Clay is typically firm to stiff and should provide sufficient bearing capacity for the proposed development. The volume change potential of the London Clay could result in shrink / swell movements impacting foundations, although this is unlikely considering the depth of the proposed basement.

A site investigation is required with appropriate geotechnical assessment to ensure a suitable foundation design, as presented in Sections 6 and 7

*Removal of Trees*

One tree will be removed. Given its existing location, with the bay window between it and the adjacent property, and the existing depth of foundations (see Section 6), the roots are likely to already be obstructed by the existing structure and therefore not underlie No. 190. In addition, No.190 is proposed to construct a basement (pending Planning Permission). Therefore, removal of the tree is not considered likely to impact the foundations / stability of No.190 Goldhurst Terrace.

*Differential Depth of Foundations*

A Party Wall is shared with No. 190 Goldhurst Terrace and No. 194 Goldhurst Terrace is within 2.00m from the proposed basement. No. 190 is proposed to have a basement to the same depth as the proposed basement; the foundation depths of No. 194 are unknown but to be conservative it has been assumed they are conventional, shallow foundations and that the basement construction will result in a differential depth of foundations between the properties. Similarly, for conservative assessment, it has been assumed that the proposed basement to No. 190 will not have been built at the time of construction of the proposed basement on site.

A ground movement assessment is required to assess potential impacts, as presented in Section 9.

## 5.2 Hydrogeology / Groundwater Flow

Considering the hydrogeological properties of the London Clay (i.e. a very low permeability formation, designated as Unproductive Strata) the presence of a continuous groundwater body is discounted. There will be no impacts to groundwater flow or the wider hydrogeological environment as a result of the proposed basement. However, there is potential for perched water to be present within the Made Ground or local seepage within the London Clay which may require groundwater control to be employed during construction to ensure stability is maintained.

A site investigation is required to determine the presence of perched water or groundwater, as presented in Section 6.

## 5.3 Hydrology / Surface Water Flow

The proposed basement beneath the house will not result in any change in impermeable site area. Whilst mitigation measures are not required, in accordance with best practice, considering the site location within a Critical Drainage Area and Local Flood Risk Zone, an attenuated drainage strategy is presented in Section 8.

As the site is within a Local Flood Risk Zone, a Flood Risk Assessment is required, as presented in Section 8.

# 6.0 Site Investigation

## 6.1 Introduction

A ground investigation was undertaken in June 2022, comprising 4no hand excavated trial pits (TP) to a maximum depth of 1.20m bgl. The trial pits were undertaken to observe the existing structure's foundation arrangements.

Site investigation data from the adjacent No.190 Goldhurst Terrace comprising 2no boreholes (BH) to 8.00m bgl is also referenced.

Disturbed samples were generally taken at 0.50m intervals and changes in strata to the base of each exploratory hole. A selection of these were tested in the laboratory for: moisture contents and Atterberg Limits, to assess plasticity; and, pH and sulphate testing to assess a suitable design concrete class for foundations.

The exploratory hole location plans are presented in Appendix 1. Exploratory hole logs and laboratory test results are presented in Appendix 4.

## 6.2 Ground Conditions

The ground conditions encountered were generally as anticipated from the Desk Study. A summary of the encountered ground conditions is presented in Table 5. Interpreted geotechnical parameters are presented in Section 7.

| Exp. Hole No. | Top mbgl | Thickness m | Top mbgl | Thickness m | Top mbgl | Thickness m | Final Depth mbgl |
|---|---|---|---|---|---|---|---|
| | Made Ground | | Head Deposits | | London Clay | | |
| BH1 | 0.00 | 0.90 | 0.90 | 2.10 | 3.00 | >5.00 | 8.00 |
| BH2 | 0.00 | 1.20 | 1.20 | 1.80 | 3.00 | >5.00 | 8.00 |
| TP1 | 0.00 | 1.15 | 1.15 | >0.05 | - | - | 1.20 |
| TP2 | 0.00 | 1.10 | 1.10 | >0.10 | - | - | 1.20 |
| TP3 | 0.00 | 0.90 | 0.90 | >0.10 | - | - | 1.00 |
| TP4 | 0.00 | 1.10 | 1.10 | >0.05 | - | - | 1.15 |

Table 5: Summary of Ground Conditions Encountered

### *Made Ground*

A layer of Made Ground was encountered within all the exploratory holes, typically in the order of 1.00m in thickness. The maximum thickness of Made Ground recorded is 1.20m.

The Made Ground typically comprises sandy gravelly clay with fragments of brick and concrete. At ground level paving slabs over granular sub-base was observed.

### *Head Deposits / London Clay Formation*

Probable Head Deposits were recorded to depths of 3.0om in both boreholes, comprising typically firm to stiff clays with variable amounts of rounded flint gravel.

The London Clay was encountered from the base of the probable Head Deposits in the boreholes, proven to >8.00m bgl which was the maximum depth of the boreholes.

The London Clay is characterised as a stiff to very stiff brown becoming mottled blue grey clay, with some sand partings noted. Laboratory testing indicates the deposits to be of very high plasticity.

## 6.3 Groundwater

Groundwater was encountered in BH1 at 0.80m bgl. Subsequent monitoring indicated water at 0.56m bgl in BH1 (rear garden of No. 190 Goldhurst Terrace). No groundwater was encountered in BH2, although subsequent monitoring indicated water at 5.43m bgl in BH2 (front garden of No. 190 Goldhurst Terrace).

No groundwater was encountered during the trial pit excavations on site.

The London Clay is of very low permeability and is not capable of supporting significant groundwater flows, although localised seepages may occur through more permeable sand / silt partings or travel along claystone bands. The Head Deposits would typically be of low permeability, although with a higher proportion of coarse soils than the London Clay, may allow local perched water bodies. Perched water is also common within Made Ground where it overlies lower permeability strata (e.g. Head Deposits / London Clay).

The monitoring data is not attributed to a continuous groundwater body; more likely it represents perched water within Made Ground / Head Deposits or local infiltration into standpipes from surface water drainage. Notwithstanding this, the proposed basement must make allowance for appropriate structural waterproofing and temporary sump pumping during construction.

## 6.4 Existing Building Foundations

Trial Pits were hand excavated to identify the existing building's foundations. The trial pits indicated the foundation depths at between 0.95m to 1.15 m bgl (Table 6).

| Exploratory Hole / Date | Foundation Depth / Notes |
|---|---|
| **TP1** | Masonry wall, corbelled brick footings over concrete strip at 1.08m bgl |
| **TP2** | Masonry wall over concrete strip at 1.15m bgl |
| **TP3a/3b** | Masonry wall, corbelled brick footings over concrete strip at 0.95m bgl |
| **TP4** | Masonry wall over concrete strip at 1.10m bgl |

Table 6: Existing Foundation Depths

The proposed formation level for the basement is 3.50m bgl, therefore underpinning excavations in the order of 2.50m will be required.

# 7.0 Preliminary Geotechnical Assessment

## 7.1 Geotechnical Parameters

A ground model based on the in-situ and laboratory testing is provided in Table 7. Values indicated are characteristic soil parameters. A reasonably conservative ground profile has been adopted for preliminary assessment purposes.

| Stratum | From | To | Thick | γ | $C_u$ | c' | Ø' | $E'_v$ | $E_{u,v}$ |
|---|---|---|---|---|---|---|---|---|---|
| | (mbgl) | (mbgl) | (m) | ($kN/m^3$) | (kPa) | (kPa) | (°) | (MPa) | (MPa) |
| Made Ground | 0.0 | 1.00 | 1.00 | 18 | - | - | 28 | - | - |
| Head Deposits | 1.00 | 3.00 | 2.00 | 19 | 40 | 0 | 25 | $0.8E_{u,v}$ | $400C_u$ |
| London Clay | 3.00 | >8.00 | >5.00 | 19 | 75 | 0 | 23 | $0.8E_{u,v}$ | $400C_u$ |

*z = increase in Cu per m depth.*

Table 7: Geotechnical Parameters

Preliminary foundation options have been assessed, based on the currently proposed building development.

## 7.2 Underpinned Retaining Wall, Strip Foundations

A preliminary assessment of bearing capacity has been undertaken by a number of methods to provide a sensitivity check, in accordance with:

- BS 8004-1986. A factor of safety of 2.5 has been considered.
- BS-EN-1997-1 (Eurocode 7) and National Annex to BS-EN-1997-1 for combinations 1 and 2 of Design Approach 1.

The thickened edges of the underpinned retaining walls will act as strip foundations, to be formed at approximately 3.50m bgl for the basement. The bearing capacity of the London Clay at formation (i.e. >3.00m bgl) is assessed to be 150 kPa.

However, in order to control ground movements foundations should be sized appropriately to limit bearing pressure to 100kPa. This will ensure impacts to neighbouring properties are within the predicted limits (as further discussed in Section 10).

## 7.3 Design Concrete Class

Thirteen soil samples were analysed to determine the design concrete class in accordance with BRE Special Digest 1:2005 (Table C2). Samples were tested from within the Made Ground, Head Deposits and London Clay. The laboratory results are presented in Appendix 4. The preliminary Design Sulphate Class is DS-3, the preliminary ACEC class is AC-3 and the DC class is DC-3. The soil results are summarised in Table 8. It would be prudent to confirm this with sampling from formation level.

| Parameter | Observed Range | Number of Tests | Characteristic Value |
|---|---|---|---|
| Water Soluble Sulphate (mg/l) | 26 to 3,000 | 13 | 3,000 |
| pH | 7.5 to 8.1 | 13 | 7.5 |

Table 8: Laboratory Test Results (Soils)

# 8.0 Flood Risk Assessment and Drainage Strategy

## 8.1 Sources of Flooding

*Fluvial (Rivers and Seas)*

The Environment Agency's Flood Map for Planning (Figure 4) shows the site to be in flood zone 1. This is defined as '*land having a less than 1 in 1,000 annual probability of river or sea flooding*' and the property can therefore be considered to have a low probability of fluvial flooding.

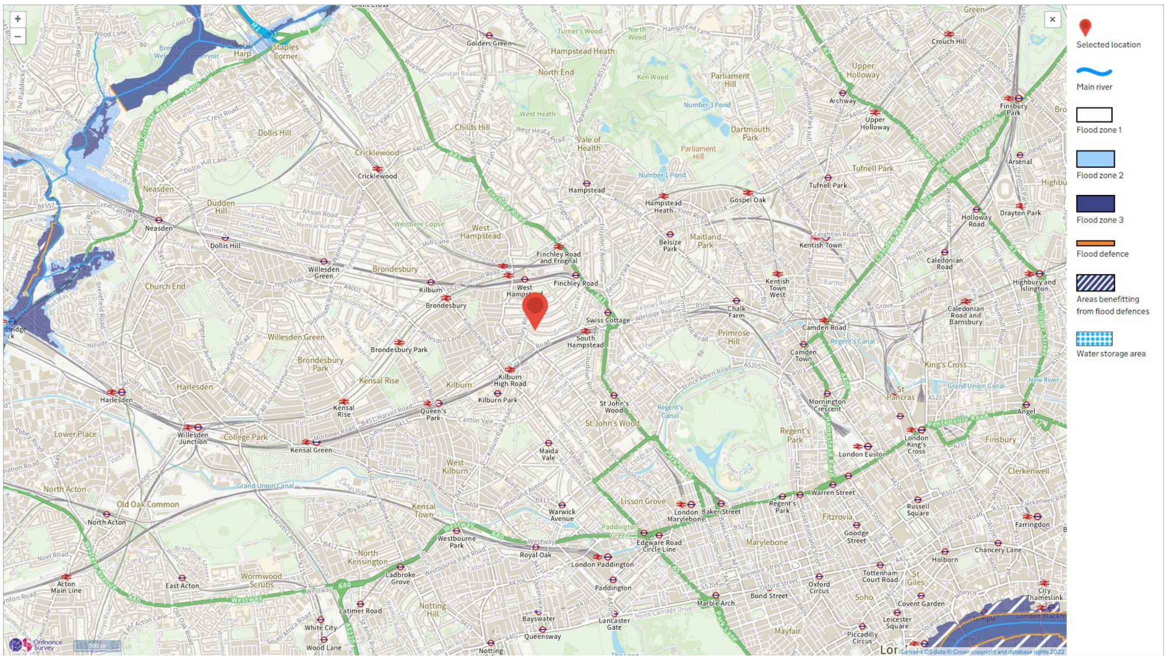


Figure 4: EA Flood Map for Planning[1]

*Pluvial (Surface Water)*

The Long-Term Flood Risk Map for Surface Water (Figure 5) does not show the subject property to be at risk of flooding from surface water. It can therefore be considered to be at very low risk of surface water flooding, meaning that each year the land at the property has a chance of flooding of less than 0.1% (1 in 1,000).

[1] https://flood-map-for-planning.service.gov.uk/confirm-location?easting=525794&northing=184070

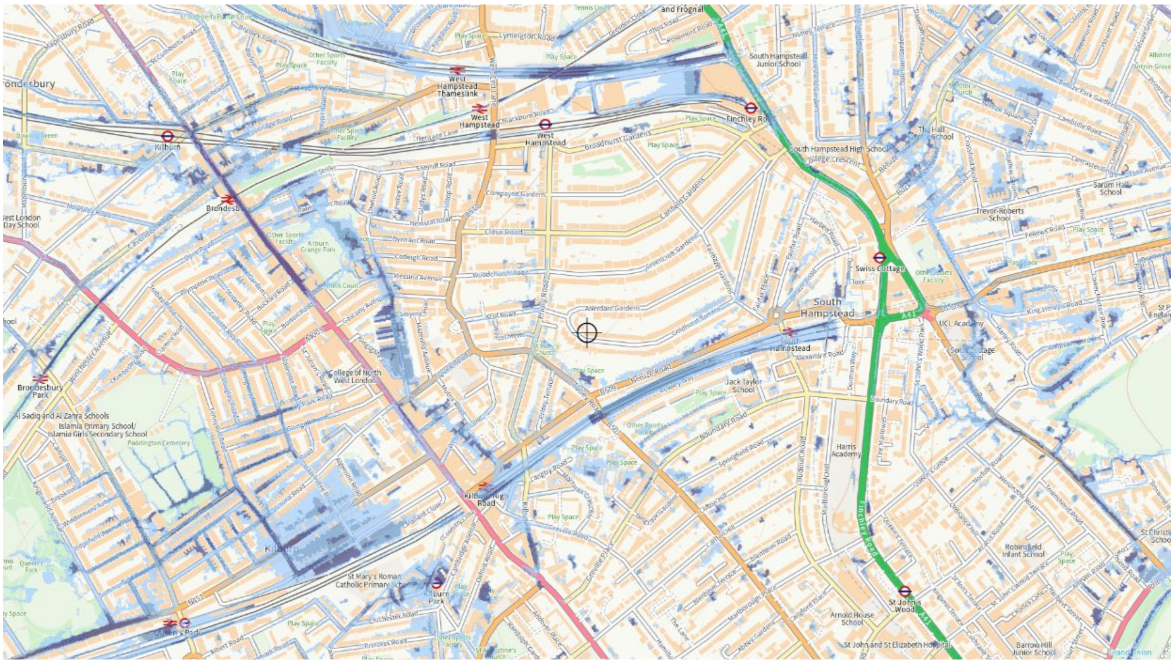

Figure 5: Long-Term Flood Risk Map - Surface Water[2]

*Reservoir*

The Long-Term Flood Risk Map for Reservoir Flooding (Figure 6) does not show the subject property to be in the extent of flooding that could occur in the event of breach failure of a reservoir. This is considered to be the largest area that might be flooded if a reservoir were to fail and release the water it holds. Since this is a prediction of a credible worst-case scenario, it's unlikely that any actual flood would be this large.

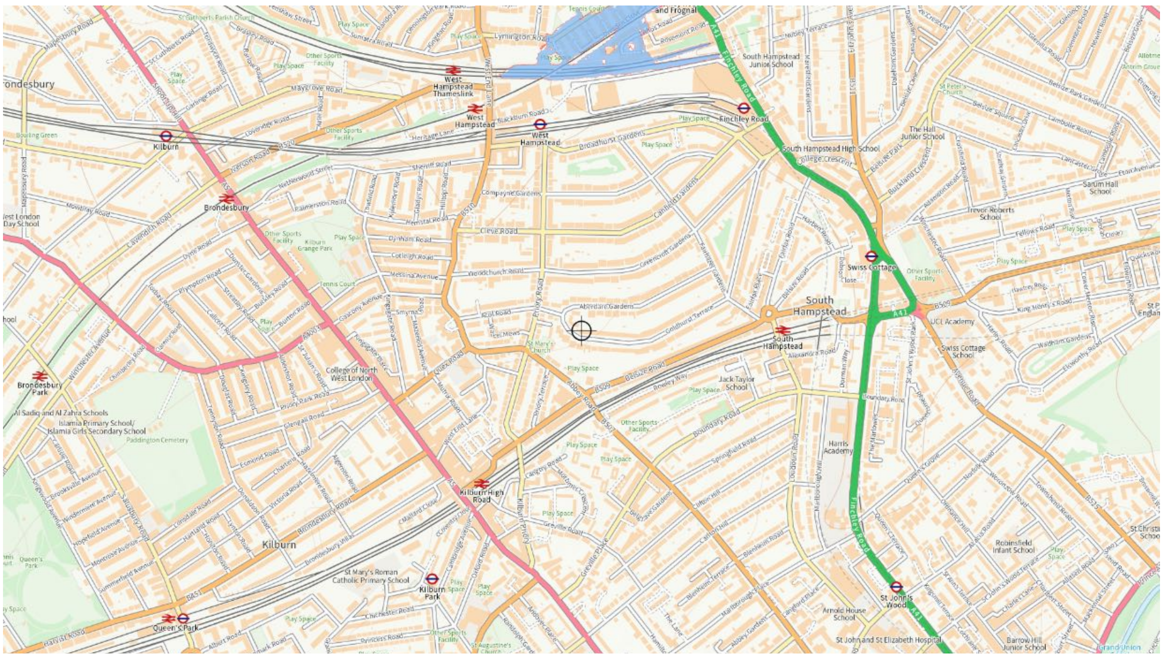

Figure 6: Long-Term Flood Risk Map - Reservoir[3]

[2] https://check-long-term-flood-risk.service.gov.uk/map?easting=525794&northing=184070&map=SurfaceWater

[3] https://check-long-term-flood-risk.service.gov.uk/map?easting=525700&northing=185110&map=Reservoir

### *Groundwater*

A desk top study has been undertaken to review online data sets.

British Geological Survey (BGS) maps do not record superficial deposits at or in the vicinity of the property location but do show bedrock geology to be London Clay Formation comprising Clay, Silt and Sand. The bedrock is designated[4] as '*unproductive*' and so similarly has an aquifer designation status relating to groundwater vulnerability[5] of '*unproductive*'.

The property is not located within a groundwater source protection zone.

Soilscape[6] mapping shows the property to be in an area with '*slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils*' with '*impeded drainage*' to '*stream network*'.

Due to the low permeability and unproductive nature of the underlying bedrock geology, it is considered that there is a negligible risk of ground water egress. The absence of mapped superficial deposits recorded in the area and the site investigation data suggest that near ground soils will therefore not contain groundwater other than in localised granular layers where perched water may accumulate via infiltration of surface water sources.

Figure 4e in the Strategic Flood Risk Assessment (SFRA) for London Borough of Camden (LBC)[7] presents a map showing areas where there is an '*Increased Potential for Elevated Groundwater*'. The property is not located within such an area. The map also shows the locations of historic flooding from groundwater sources and Environment Agency groundwater flood incidents. The property is similarly not in proximity to these areas with the nearest being in the vicinity of Wavel Mews circa 0.23km to the West.

The map also shows that there have been 8no properties affected by groundwater flooding along Canfield Gardens (approx. 0.17km to the north) according to LBC records. It is expected that this is the principal factor to the property being within a Local Flood Risk Zone (LFRZ) as shown on Figure 6 in appendix B of the SFRA

### *Sewer*

Figure 7 is an extract from LBC (2003) Floods in Camden – Report of the Floods Scrutiny Panel. It shows the approximate route of the North-West Storm Relief Sewer in Camden.

The Relief Sewer is located to the east of the subject property, but in the event that its capacity is exceeded such as under a rainfall event similar to that in August 2002, subsequent overland routing of flood water would follow the prevailing terrain. However, from inspection of the RoFSW map (Figure 5), the subject property is not within an overland flood flow route or area where overland flood water flows would accumulate.

It is expected that there will be a local sewer under the main highway adjacent to the property that will take runoff and effluent from the subject building and neighbouring properties.

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[4] https://data.gov.uk/dataset/616469ae-3ff2-41f4-901f-6686feb1d5b6/aquifer-designation-dataset-for-england-and-wales

[5] https://data.gov.uk/dataset/42d7d021-538c-46e2-abbb-644e01c63551/groundwater-vulnerability-maps-2017-on-magic

[6] http://www.landis.org.uk/soilscapes/#

[7] LBC SFRA Report by URS, ref 47070547, Rev 2, dated July 2014

Thames Water were contacted via an enquiry for the adjacent property to establish whether they hold any records of historical flooding in the area of the property address. Their response confirms that '*the flooding records held by Thames Water indicate that there have been no incidents of flooding in the requested area as a result of surcharging public sewers*'.

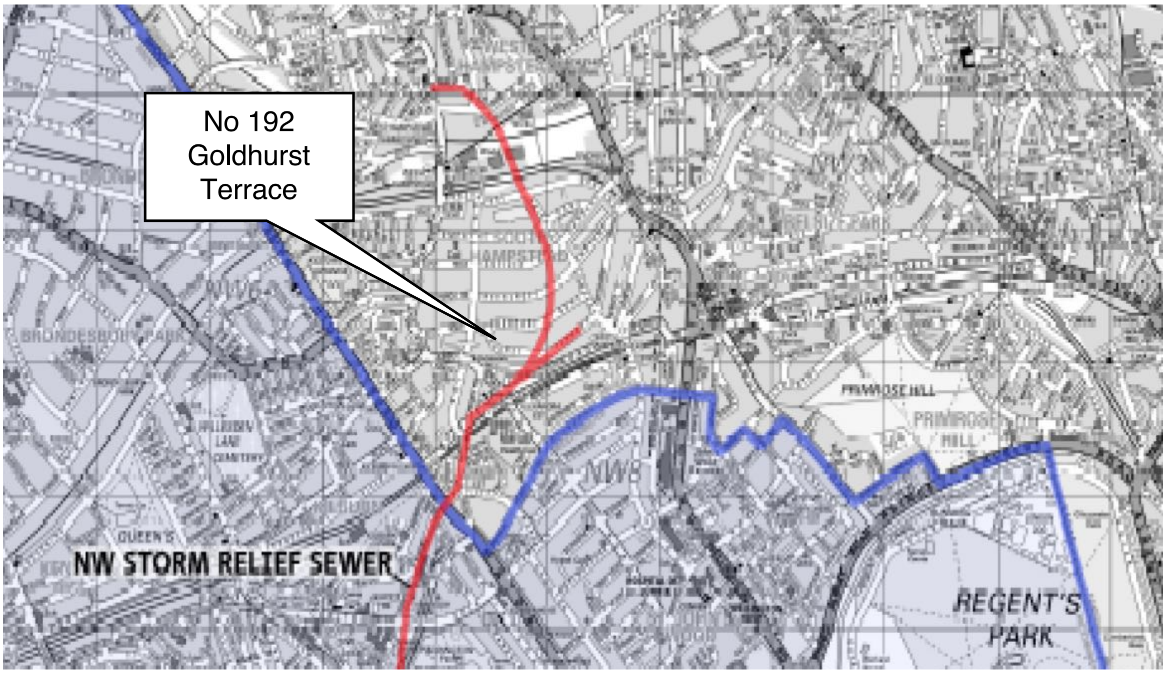


Figure 7: Map of North West Storm Relief Sewer in Camden

## 8.2 Risk of Flooding to and from the Development

From a review of the sources of flooding presented in the foregoing, it is considered that there is a low risk of flooding from all sources.

The predicted effects of climate change generally result in exacerbation of current day flooding due to increases in the rate and volume of flood water that can occur and the reduced frequency of flood events.

However, it is not considered that the effects of climate change will significantly alter the potential for flooding from the sources discussed other than locally in respect of surface water run-off management.

It follows that mitigation measures other than those inherent to standard building practice are not required, but a drainage strategy should be considered to account for the change in run-off areas that will result from the development proposals.

## 8.3 Drainage Strategy

Chapter 9 of The London Plan 2021 includes Policy SI 13 relating to Sustainable Drainage. It presents the following drainage hierarchy:

> *1) rainwater use as a resource (for example rainwater harvesting, blue roofs for irrigation).*
> *2) rainwater infiltration to ground at or close to source.*
> *3) rainwater attenuation in green infrastructure features for gradual release (for example green roofs, rain gardens).*

*4) rainwater discharge direct to a watercourse (unless not appropriate).*
*5) controlled rainwater discharge to a surface water sewer or drain.*
*6) controlled rainwater discharge to a combined sewer.*

The SFRA provides guidance in relation to surface water management. Figure 4c of the SFRA presents a map showing the infiltration potential across the LBC based on BGS data. The property is in an area shaded to signify '*opportunities for bespoke infiltration SuDS*'.

However, given the low permeability soils at and in the vicinity of the property, disposal of surface water runoff to the ground would not be suitable. The increase in building footprint is small, but the predicted effects of climate change are significant and as such the implementation of measures to manage rainfall at source within the property curtilage would be appropriate.

The development proposals do not offer scope to provide green roof areas as there is no change to the main building roof. The change in area on plan occurs at the northeast corner of the property where a patio area is proposed at basement level accesses via an external stair from ground level with a void over both. Two light well areas are also proposed to the southern elevation of the property.

In each case, these areas will allow rainfall directly to the basement level area and so a drainage channel and pump will be required. To mitigate flooding of these well areas, the floor construction could incorporate a void below surface finishes sufficient to accommodate a depth of rainfall associated with 1 in 100 year rainfall, increased to suit climate change effects.

Whilst the main roof areas are unchanged by the proposals, runoff could be diverted into a rainwater harvesting system for re-use in the property, subject to technical and financial considerations. This method of source control would provide good interception of rainfall for regular events but cannot be relied on for management of extreme events where high intensity or prolonged rainfall occurs. Therefore, the need to implement another form of SuDS technique may be required to balance discharge from the property drainage system so that the status quo of existing flow is maintained or ideally reduced.

The drainage system should also be appraised for the effects of climate change over the lifetime of the development. Current guidance[8] for peak rainfall intensity increase allowances states that drainage system should be designed for an upper end allowance so that there is no increase in flood risk elsewhere and the development will be safe from surface water flooding. Planning Practice Guidance[9] for the National Planning Policy Framework assigns a 100 year design life to residential development, which corresponds to development with a lifetime between 2061 and 2125 (2070s epoch). The property is situated in the London Management Catchment where the upper end allowance for the 2070s epoch is 35% and 40% for 1 in 30 year and 1 in 100 year events respectively.

On the basis that the existing drainage is unrestricted, a pre-development discharge rate of approximately 3.5l/s would occur under a rainfall intensity of 50mm/hr. Section 9.13.12 of The London plan 2021 advises that '*development proposals should aim to get as close to greenfield run-off rates as possible depending on site conditions*'. LBC Local Plan Policy CC3

[8] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#peak-rainfall-intensity-allowance

[9] https://www.gov.uk/guidance/flood-risk-and-coastal-change#what-is-lifetime-of-development

also advises that development is required to '*utilise Sustainable Drainage Systems (SuDS) in line with the drainage hierarchy to achieve a greenfield run-off rate where feasible*'.

A greenfield runoff rate of qbar = 3.7l/s/ha has been determined, which for the overall site area of approximately 0.042ha (420sqm) is equivalent to 0.16l/s. This is a very low rate that would not be practical to achieve due to the low size of flow control aperture that would be needed which would be inherently susceptible to blockage.

Therefore, the lowest practical flow rate should be used. For instance, if a geo-cellular tank of 0.8m high and 3m x 4.5m = 13.5sqm plan area is used, it could be sited under the driveway area. A capacity of 10.26m$^3$ would be available (allowing standard 95% void capacity). Allowing 1l/s discharge rate, controlled by a Hydrobrake Optimum unit (ref SHE-0047-1000-0950-1000), the attenuation volume needed to balance runoff from the site area under 1 in 100 year rainfall intensities that have been increased by 40% for the predicted effect of climate change is 10.2m$^3$. Therefore, the tank would be adequate.

In principle, the above is a viable drainage strategy that demonstrates that a crated tank and Hydrobrake flow control can manage runoff for 1 in 100 year + 40% rainfall and restrict discharge to less than 33% of the pre-development peak rate.

### 8.4 FRA and Drainage Strategy, Non-Technical Summary

From a review of the sources of flooding that could influence the proposed works on site, it has been determined that there is a low risk of flooding to the development.

It is not considered that the proposals would result in an increased risk of flooding at the property location or surrounding area or that the effects of climate change will significantly change the current day regime. The surface water management measures to be adopted will provide betterment compared to the existing run-off drained from site.

# 9.0 Ground Movement Assessment

## 9.1 Introduction

Its likely that the proposed basement to No. 190 Goldhurst Terrace will be complete prior to construction of the proposed basement on site. On that basis, by inspection, damage to No. 190 is likely to be Negligible (Category 0 in accordance with the Burland scale). However, in order to undertake a conservative assessment, foundations to all neighbouring buildings have been assumed to be shallow for the purposes of the BIA.

## 9.2 Assessment Methodologies

A ground movement assessment (GMA) has been completed utilising industry standard software (Oasys XDisp). Using the data from the analysis, an assessment has been made of the potential impact on neighbouring buildings in accordance with the Burland Scale. Calculations and GMA outputs are provided in Appendix 6.

## 9.3 Ground Movements Generated by Proposed Development

The following construction processes are likely to give rise to the majority of ground movements:

1. Installation of the underpins.
2. Excavation of the new basement.

Based on the guidance provided in CIRIA C760 for embedded retaining walls, ground movements resulting from installation of underpinned walls and excavation in front of the walls have been estimated. Whilst its noted that the guidance is intended for use with embedded walls, the methodology provides predicted ranges of movement that are consistent with movements generated during underpinning.

In order to be conservative, the depth of existing foundations has been ignored and the depth of underpinning and excavation has been taken from ground level. This approach should over-estimate movements compared to those generated by the actual works.

For movement due to the underpin installations, the magnitudes of the movements are dependent on the total retaining wall depth. Maximum vertical movements occur at the wall itself. C760 indicates movements will be 0.05% of the wall depth, with negligible vertical movement at one and a half times the wall depth from the wall. On this basis, maximum vertical movements due to wall installation of <3mm are predicted with vertical movements extending to a maximum of <7m from the wall.

Anticipated maximum horizontal movements due to wall installation are 0.05% of the wall depth, with negligible horizontal movement one and a half times the wall depth from the wall. Maximum horizontal movements are therefore predicted to be <3mm with horizontal movements extending to a maximum of <7m from the wall.

For movements due to excavation in front of the retaining wall, the magnitudes of the movements are dependent on the excavation depth. Based on the Contractor adopting a stiffly propped method of excavation, C760 indicates maximum vertical movements of 0.10% of excavation depth, with negligible movement three and a half times excavation depth from the wall. Maximum vertical movements due to excavation of <4mm are predicted, extending <13m from the wall.

Anticipated maximum horizontal movement due to excavation are 0.15% of the excavation depth, with negligible horizontal movements four times the excavation depth from the wall. Maximum horizontal movements are predicted to be <6mm, extending 14m from the wall.

A summary of ground movement predictions obtained using Oasys XDisp are reported in Appendix 6, presented as contour plots. The calculations take account of the combined vertical and horizontal movements from both installation and excavation. The predicted ground movements are at ground level.

## 9.4 Adjacent Structures, Highway and Utility Assets

Three buildings are identified as being within the potential zone of influence from the proposed basement construction works:

- 188 Goldhurst Terrace
- 190 Goldhurst Terrace
- 194 Goldhurst Terrace

In addition, the flats in the subject building have been assessed.

The potential damage impacts to the buildings within the zone of influence have been assessed.

The footway (with underlying utilities) is located >7.00m from the proposed basement at the closest point; the highway with underlying utilities is located 8.00m from the proposed basement at its closest point.

Although not integral to the purpose of this assessment, it should be noted that during the construction works the adjacent structures will be monitored for movements as required by Party Wall Agreements and any highway or utility asset protection agreements. The results of this monitoring provide a comprehensive feedback loop to the assessment models. This will allow contingency actions to be undertaken, if necessary, to limit movements.

## 9.5 Sensitivity Analysis

To provide a sensitivity check of the methodology adopted, the movement values predicted have been compared with:

- the typical range of movements reported by underpinning contractors, which is between 5mm and 10mm vertical / horizontal for an underpin constructed in a single lift;
- consideration of a 'low stiffness' construction methodology (i.e. without the use of temporary propping to restrain movements), which indicates approximately 16mm to 18mm vertical / horizontal movements (if ignoring the depth of existing foundations). The conservative 'low stiffness' range of movements could be considered a worst-case scenario, if propping was omitted for instance.

## 9.6 Estimates of Ground Movement using Oasys XDisp

Whilst the CIRIA C760 approach is considered conservative, it has been adopted as the underlying method of analysis precisely for this reason: the actual ground movements generated during the works should be less onerous than those predicted. The geometries of the site have been imported into XDisp and ground movements modelled based on C760.

The displacement profiles and damage assessments derived using XDisp assume greenfield movements and predict movements at ground level. In relation to all buildings, the movements derived will be an overestimate of movement both with respect to adjacent foundations and assets, which are located at a depth greater than existing street levels.

## 9.7 Estimates of Movement due to Heave

The excavation of a maximum 3.50m of soil will generate an unloading of around <70kPa (this is conservative, considering the CMS reports a void below the existing suspended ground floor areas). The basement will have a ground bearing slab, locally thickened where required to transfer point and strip loads. It is likely that the ground within the excavation will experience a net unload, rather than load. This will result in a measure of short term heave and long term swelling of the underlying London Clay, which theoretically takes a number of years to complete.

A proportion of the soil heave pressure will be dissipated in the short term / during excavation, before the base slab is cast, due to undrained deformation and other short term effects. In the long term, as the clay swells, the base slab will have a pressure exerted on it.

The magnitude of the long term ground heave pressures exerted on the slab will depend on the magnitude of heave deformation / stress relaxation which occurs prior to the base slab being constructed and how much the slab deflects as a result of the applied heave pressures. If no relaxation occurs before the base slab is cast and the slab is not allowed to deflect (i.e. the base slab is wished in place and fully rigid) then the total heave pressure will be exerted on the slab.

If the ground is allowed to heave / relax prior to casting the base slab, or the slab is flexible, then the soil heave pressure will reduce.

For a normal construction programme, it may be assumed that 50% of soil heave pressure will be dissipated prior to construction of the slab. As such 50% of potential heave will remain after excavation i.e. 35kPa. Given the ground bearing nature of the slab and the transfer of structural loads, the potential long term net heave pressure is likely to be <10 kPa at the centre of the excavation and reduce further around the perimeter of the excavation.

In addition, the slab will be designed to withstand water pressure.

Experience suggests that heave movements tend largely to be restricted to within the basement excavation and it is not anticipated that the changes in loading at basement level will have a significant impact on the neighbouring structures. It should also be noted that CIRIA C760 empirical movement calculations are considered to include short term heave movements and the structure is designed to accommodate long term pressures.

## 9.8 Impact Assessment of Neighbouring Buildings, Highway and Utilities

The ground movements have been used to assess the resultant potential damage that may be experienced by neighbouring structures. The methodology proposed by Burland and Wroth, and later supplemented by the work of Boscardin and Cording, has been used, as described in CIRIA C760 (and preceding CIRIA publications). The 'Burland Scale' damage categories are presented in Table 9.

Based on the ground movements calculated, the following impacts are predicted in accordance with the Burland Scale:

- 188 Goldhurst Terrace – Category 0
- 192 Goldhurst Terrace – Category 1
- 190 Goldhurst Terrace – Category 1
- 194 Goldhurst Terrace – Category 1

The maximum movements predicted to be experienced at the footway are 3mm vertically / 4mm horizontally. This magnitude of movement will cause negligible impact to surfacing or underlying utilities.

It is recommended that structural movement monitoring is undertaken during the works and mitigation actions implemented if movement trends indicate predicted impacts and structural movement tolerances could be exceeded.

| Category of damage | Description of typical damage (ease of repair is underlined) | Approximate crack width (mm) | Limiting tensile strain, $\varepsilon_{lim}$ (%) |
|---|---|---|---|
| 0 Negligible | Hairline cracks of less than about 0.1 mm are classed as negligible | <0.1 | 0.0 to 0.05 |
| 1 Very slight | **Fine cracks that can easily be treated during normal decoration.** Perhaps isolated slight fracture in building.<br>Cracks in external brickwork visible on inspection | <1 | 0.05 to 0.075 |
| 2 Slight | **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.<br>Doors and windows may stick slightly. | <5 | 0.075 to 0.15 |
| 3 Moderate | **The cracks require some opening up and can be patched by a mason. Recurrent cracks can be masked by suitable lining. Repointing of external brickwork and possibly a small amount of brickwork to be replaced.**<br>Doors and windows sticking.<br>Service pipes may fracture.<br>Weathertightness often impaired. | 5 to 15 or a number of cracks >3 | 0.15 to 0.3 |
| 4 Severe | **Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows.**<br>Windows and frames distorted, floor sloping noticeably. Walls leaning or bulging noticeably, some loss of bearing in beams. Services pipes disrupted. | 15 to 25, but also depends on number of cracks | >0.3 |
| 5 Very severe | **This requires a major repair, involving partial or complete rebuilding.** Beams lose bearings, walls lean badly and require shoring.<br>Windows broken with distortion.<br>Danger of instability. | Usually >25, but depends on numbers of cracks | |

Table 9: Damage Categories on the Burland Scale

# 10.0 Basement Impact Assessment

The purpose of this assessment is to consider the potential impacts from basement development on the local hydrology, geology and hydrogeology and any resulting impacts to stability of adjacent structures. The assessments have been undertaken by appropriately qualified professionals in accordance with the guidance.

## 10.1 Geology and Land Stability

The site is underlain by the London Clay Formation. This formation typically comprises firm to stiff clay of medium to high strength and is a suitable bearing stratum for the proposed development's foundations. This has been confirmed by the site investigation.

The risk of movement and damage to this development due to shrink and swell of the London Clay is negligible, considering the depth of the proposed foundations.

Ground movements caused by the excavation and construction of the proposed development have been demonstrated by assessment to be minimal, assuming the adoption of best practice construction methodologies and stiff propping of the basement. Damage Impact to adjacent structures will be limited to a maximum of Very Slight (Category 1 in accordance with the Burland Scale). It is recommended that structural movement monitoring is undertaken and mitigation actions implemented if ground movement trends indicate structural movement tolerances could be exceeded.

Movements to the highway / utilities are considered to be very small, such that they would cause negligible impact. Consultation with relevant asset owners is recommended to ensure that appropriate design and mitigation measures can be provided for the development such that impacts to the highway and utilities are maintained within the agreed limits.

## 10.2 Hydrogeology and Groundwater Flow

The London Clay is designated as Unproductive Strata. There is a very low risk of groundwater flooding or potential for impacting the wider hydrogeological environment.

The Construction Method Statement requires appropriate propping and mitigation measures to be implemented, including the use of sump pumping, which will be controlled by the Contractor and supervised by the Engineer, and there will be no impacts to stability during construction or in the permanent case as a result of encountering shallow perched water.

## 10.3 Hydrology and Surface Water Flow

The site and the adjacent properties have not been impacted by flooding. There is a very low risk of flooding to the proposed development and the proposed development will not impact the wider hydrological environment. The proposed drainage strategy should provide betterment and reduce the risk of surface water flooding or sewer surcharging on site and in the immediate vicinity.

The SuDS proposals allow for a suitable attenuated drainage scheme with off-site discharge flow rates limited to the minimum practicable in accordance with best practice.

## 10.4 Residual Risks and Mitigation

As a contingency, and in accordance with best practice, a structural movement monitoring plan should be set out at design stage. Monitoring should include precise levelling, reflective survey targets or other appropriate instrumentation as determined by the Engineer being