Symmetrys Ltd
Structural Engineers

BASEMENT IMPACT ASSESSMENT

12 Lyndhurst Gardens
London
NW3 5NR

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Structural Engineers

REVISIONS AND ADDITIONAL MATERIAL

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1.0 NON-TECHNICAL SUMMARY

1.1.1 The site location is 12 Lyndhurst Gardens, London, NW3 5NR.

1.1.2 The current site arrangement is a five-storey residential building, with a converted loft and no existing basement. The existing structure is load-bearing masonry with timber floors spanning from front to back of the house.

Figure 1 - Front Elevation

1.1.3 The proposed development comprises the refurbishment of the ground floor and includes:

- Demolition of the existing rear bay window at ground floor
- Construction of a new single storey rear extension at ground floor
- Constructing a new basement towards the rear half of the property, extending into the garden
- Reconfiguration of the internal walls

The new basement will extend below the rear garden to form lightwells whilst not extending more than 50% of the existing garden area.

1.1.4 The following assessments are presented:

- Desk Study
- Screening
- Scoping
- Additional evidence/assessments
- Site investigation
- Ground movement assessment
- Surface water drainage strategy/SUDS assessment
- Others
- Impact Assessment

1.1.5 The authors and reviewers of these assessments are listed below in Clause 2.1.

1.1.6 The ground conditions beneath the site are made ground overlying Head deposits, with firm London Clay formation at 3.0m BGL. Ground water was recorded at a depth of 4.31m BGL during monitoring but is not considered to form a laterally continuous aquifer unit.

1.1.7 The construction methods proposed are to form the new basement by using sequential reinforced concrete underpins. Existing masonry walls will be underpinned with reinforced concrete retaining walls that bear upon mass concrete strip footings and are formed in hits no greater than 1m long. The basement slab shall be formed by a reinforced concrete slab that will tie into and act as prop to the base of the retaining walls. Prior to the excavation of the basement, all existing load bearing walls will be propped and supported off steelwork in the temporary condition.

1.1.8 A structural monitoring strategy to control the works and impacts to neighbouring structures will comprise a series of targets (points) set on the existing front, rear, and party walls of the neighbouring property from ground level to roof level at intervals not exceeding 3m centres horizontally and vertically.

1.1.9 The Contractor shall monitor the position and movements of the elevations of the adjacent properties around the perimeter of the proposed excavation. The monitoring shall be undertaken by a specialist survey company.

1.1.10 The BIA has assessed land stability and the impacts of the proposed development on neighbouring structures will be comprised within Category 1 of the Burland Scale Impacts.

1.1.11 The BIA has identified no potential slope stability impacts.

1.1.12 The BIA has identified no potential hydrogeological impacts to the existing site and surroundings.

1.1.13 The BIA has identified low flood risk from the proposed development.

2.0 INTRODUCTION

The purpose of this assessment is to consider the effects of a proposed basement development at 12 Lyndhurst Gardens, London, NW3 5NR on the local hydrology, geology and hydrogeology and potential impacts to neighbours and the wider environment. The site location is presented in Figure 1.

Figure 2 - Site Location

The BIA approach follows current planning procedure for basements and lightwells adopted by LB 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

2.1.1 The BIA Report has been authored by Ahmed Kolia (MEng), a Structural Engineer at Symmetrys, and the SuDS Strategy Report has been authored by Maddy Wright (BEng(Hons)), a Civil Engineer at Symmetrys.

2.1.2 It has been reviewed by Ashwin Halaria (BEng, MSc), an Associate at Symmetrys with 16 years of experience; Braedan Beggs (BEng BCom), a Structural Engineer at Symmetrys with 9 years of experience; and Mark Barnikel (BEng(Hons)), a Civil & Structural Engineer at Symmetrys.

2.1.3 The Geotechnical Site Investigation Report was prepared and authored by Christopher Hall (MSc), Environmental Consultant at LMB; and Philip Lewis (BSc, MSc, CGeol, FGS), the Managing Director of LMB Geosolutions.

2.1.4 The Ground Movement Assessment Report was prepared by Amir Abbasi (MSc BSc CGeol FGS), Steve Morgan (MSc BSc CGeol FGS RoGEP QP), and Ian Marychurch (MSc BSc CEng MICE CGeol FGS CMgr MCMI MIoD Dip IoD) of Card Geotechnics Limited.

2.1.5 The Flood Risk Assessment was prepared by Jessica Bayliff (MESci), Consultant at GeoSmart; checked by Alan White (BSc, MSc), Principle Consultant at GeoSmart; and reviewed by Dr Paul Ellis (PhD, BSc, CGeol), Principle Consultant at GeoSmart.

2.1.6 This BIA has been reviewed and approved by Chris Atkins (CEng, MIStructE), managing director of Symmetrys with 28 years of experience in Structural Engineering; and Philip Lewis (BSc, FGS, CGeol), Director of LMB Geosolutions Ltd.

2.2 Sources of Information

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

- Site walkover
- Current/historical mapping
- Geological mapping
- Hydrogeological data
- Current/historical hydrological data
- LB Camden, Strategic Flood Risk Assessment (produced by URS, 2014);
- LB Camden, Floods in Camden, Report of the Floods Scrutiny Panel (2013);
- LB Camden, Planning Guidance (CPG) – Basements (March 2018);
- LB Camden, Camden Geological, Hydrogeological and Hydrological Study – Guidance for Subterranean Development (produced by Arup, 2010);
- LB Camden, Local Plan Policy A5 Basements (2017);
- LB Camden's Audit Process Terms of Reference;

2.3 Existing and Proposed Development

2.3.1 The Application site is located on Lyndhurst Gardens, approximately 450 metres from Belsize Park Underground Station.

2.3.2 A Network Rail Tunnel (Belsize Tunnel) is located under the rear garden, at approximately 2.5m beyond the proposed footprint of the new basement and approximately 28m below existing ground level. In addition to this, the next closest tunnel (TFL Northern Line) is located approximately 240m north of the property.

2.3.3 The site slope angle is estimated between 0 and 5 degrees.

2.3.4 The existing structure is a 5-storey load-bearing masonry detached house with an existing bay window extension at the rear of the house. The current property shows no significant signs of deformation.

2.3.5 The property is converted into flats, and the basement development is proposed beneath Flat 2 only. Both neighbouring buildings, at No.10 and No.14, are of the same age and the same style as 12 Lyndhurst Gardens. It is understood that those neighbouring buildings do not have basements.

2.3.6 Lyndhurst Gardens comprises several Grade II listed buildings on the street, including No.12.

2.3.7 Neighbouring gardens are present at the rear of the properties, and will be protected in accordance with the Camden Local Plan from 2017.

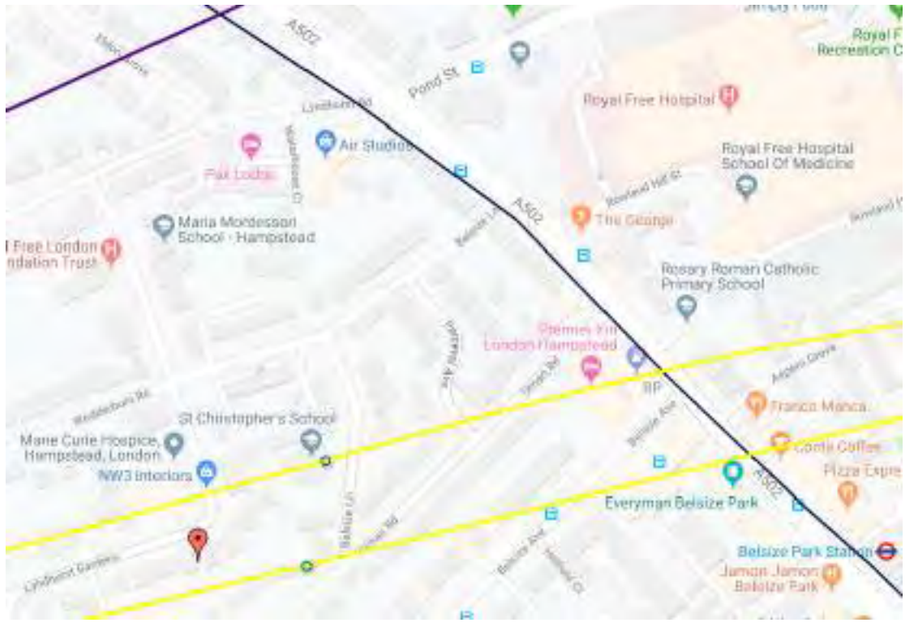


Figure 3 - Site location relative to railway lines

2.3.8 Existing and Proposed development drawings are presented in Appendix 1.

2.3.9 The proposed development will utilise the following construction techniques to form the new basement floor:

Sequential reinforced concrete underpins will be used to form the new level of the basement. The use of temporary propping will ensure that the basement does not cause any local ground movements whilst construction is taking place.

The underpinning sequence is proposed to be carried out in maximum 1.0m width bays to avoid undermining the adjoining properties.

The new floor will be formed with a reinforced concrete slab that will support potential heave efforts.

The basement will extend below the rear garden to form lightwells. It will occupy less than 50% of the existing site area. As for the main basement construction, the walls forming the basement will be formed using L-shaped concrete retaining walls built in an underpinned sequence.

2.3.10 The outline construction programme for the proposed development is*:*

The works are expected to be completed over 8-9 months program split in the three phases below:

- 2 months excavation
- 4 months construction
- 3-4 months fit-out.

3.0 DESK STUDY

3.1 Site History

3.1.1 A Desktop Study has been undertaken and can be found in Appendix 3.

3.2 Geology

3.2.1 According to the *British Geological Survey (BGS)* map, the site has London Clay Formation underlying soils, with no superficial deposits. The site is close to the boundary where the underlying soils are Claygate Member with no superficial deposits.

3.2.2 The BGS map of the area indicates that the site has underlying Stiff brown CLAY as per the borehole results of TQ28SE2342 towards the South-West of the site.

Figure 4 - Extract of BGS map

3.2.3 Refer to Preliminary Risk Assessment Desk Study in Appendix 3 for details of the local Geology.

3.2.4 It is also mentioned that ground investigation works have previously been carried out at the neighbouring property – 10 Lyndhurst Gardens – with the following ground conditions encountered:

Strata	Depth Range to Top (m bgl)	Depth Range to (Base (m bgl)	Summary Description
Made Ground	Ground Level	2.10 – 3.50	The ground surface was found to comprise grass. The Made Ground soils were typically found to comprise gravelly to slightly gravelly and locally sandy clay with varying proportions of brick, chalk, carbonaceous material and roots.
Possible Made Ground	2.10	2.80	Possible Made Ground was observed in BH1 and was found to comprise soft sandy clay.
London Clay Formation (1)	2.80 – 3.50	10.00 – 10.45	The London Clay was typically found to comprise an upper (c.5.50-6.00m) more weathered sequence of soft becoming firm clay with occasional silty fine sand partings and selenite crystals. The less weathered London Clay was typically found to comprise a sequence of stiff fissured clay.

Figure 5 - Extract from LMB Report showing ground conditions at neighbouring property

It should be noted that the results from the Geotechnical Site Investigation at 12 Lyndhurst Gardens are almost identical to those from the neighbouring property.

3.3 Hydrogeology

Refer to Desktop Study in Appendix 3 for details of the local Hydrogeology.

3.4 Hydrology, Drainage and Flood Risk

3.4.1 The site is located at approximately 800 from the closest surface water features in Hampstead Heath.

Figure 6 - Extract of Camden Surface Water Features map

3.4.2 The site is located approximately 250 metres from the River Tyburn historical watercourse.

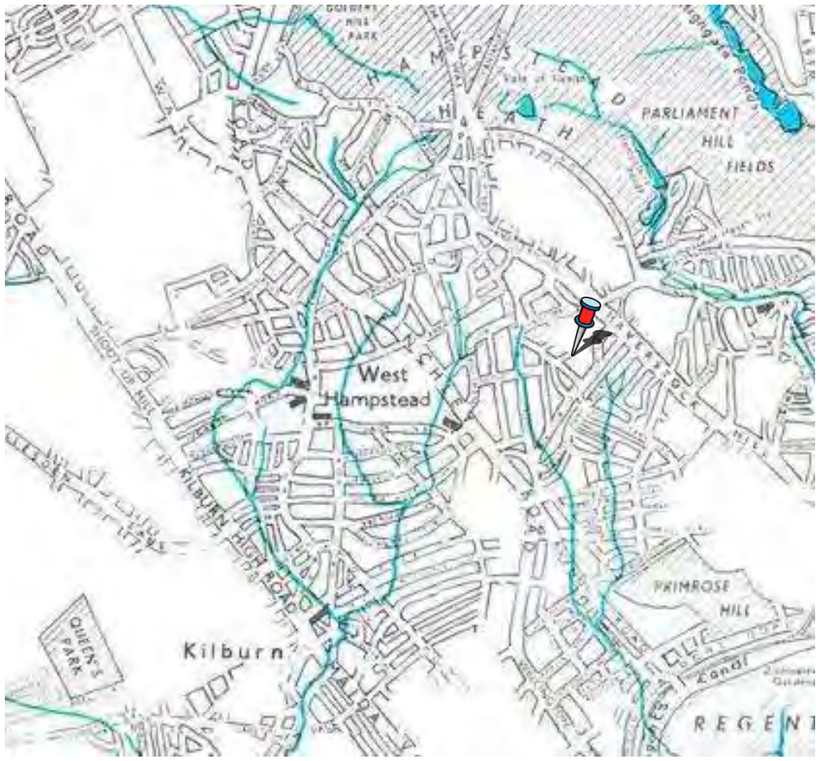


Figure 7 - Extract from the “Lost Rivers of London” by Nicholas Barton

3.4.3 The site is not within the catchment of the Hampstead Heath Pond Chain.

3.4.4 The existing site is approximately 47% impermeable area.

3.4.5 The proposal includes approximately 9% increase in impermeable area at the site. It is proposed to utilise a rainwater attenuation tank in order to decrease the volume and velocity of the surface water runoff entering the combined system. The rear roof and hardstand runoff will be collected and released at a controlled rate of 1L/s with an overflow for large storm events.

3.4.6 The site is classified as “very low risk” of flooding due to rivers or the sea.

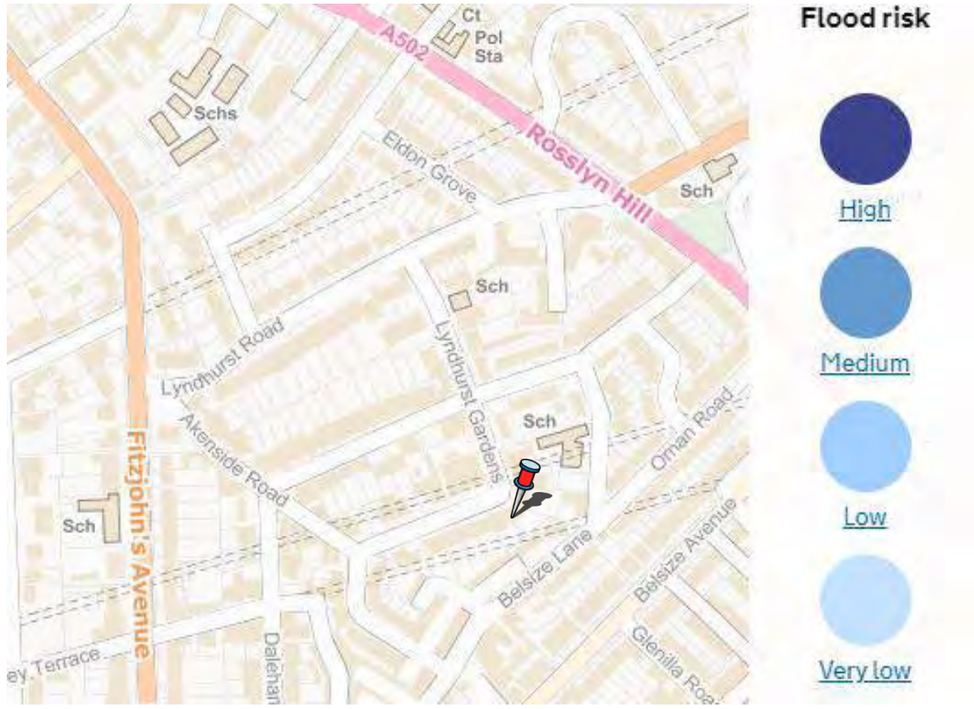


Figure 8 - Extract of long-term flood risk map due to rivers or the sea from gov.uk website

3.4.7 The site is classified as “high risk” of flooding due surface water.

Figure 9 - Extract of long-term flood risk map due to surface water from gov.uk website

4.0 SCREENING

4.1 Subterranean ground water flow

4.1.1 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	No Groundwater was recorded during the site investigation. Groundwater was recorded during monitoring visits but would unlikely represent a continuous aquifer. Refer to LMB report in Appendix 3.
1b. Will the proposed basement extend beneath the water table surface?	No	Groundwater was recorded at a depth of 4.31m BGL during monitoring visits. The new basement is to be founded at 3.8m BGL. Groundwater was recorded during monitoring visit but would unlikely represent a continuous aquifer. Refer to LMB report in Appendix 3.
2. Is the site within 100m of a watercourse, well (used / disused) or potential spring line?	No	No – Refer to 3.4.2. Groundwater was not recorded during the site investigation. During monitoring visits, it was recorded at a deeper level than new formation level. Refer to LMB report in Appendix 3.
3. Is the site within the catchment of the pond chains on Hampstead Heath?	No	Refer to 3.4.1
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	Yes	The impermeable area will increase by 9%. Refer to SuDS Strategy report in Appendix 5
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	Rainwater attenuation tanks will be utilised in order to decrease the volume and velocity of water runoff, and released at a controlled rate of 1L/s. Refer to SuDS Strategy report in Appendix 5.
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	Groundwater was recorded at depth 4.31m BGL during monitoring visits. The new basement to be founded at 3.8m BGL.

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)?	No	Refer to 2.3.3
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	There are be no proposed changes in slope. The majority of the garden will remain as existing except for less than 50% of the rear garden.
3. Does the development neighbour land, including railway cuttings and the like, have a slope greater than 7 degrees (approximately 1 in 8)?	No	Proposed development drawings are presented in Appendix 1
4. Is the site within a wider hillside setting in which the general slope is greater than 7 degrees (approximately 1 in 8)?	No	The site is not located on a wider hillside with slope greater than 7 degrees.
5. Is the London Clay the shallowest strata at the site?	Yes	Soil investigation reveals 2m of made ground with possible Head deposits. However, these are above the formation level of the proposed basement, which will be founded on London Clay. Refer to 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	Refer to 4.4.1, below
7. Is there a history of seasonal shrink-swell subsidence in the local area and/or evidence of such effects at the site?	No	No significant cracks were identified on the walls.
8. Is the site within 100m of a watercourse or a potential spring line?	No	Refer to 3.4.2
9. Is the site within an area of previously worked ground?	No	Refer to 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?	No	No Groundwater was recorded during the site investigation. Groundwater was recorded during monitoring visit but would unlikely represent a continuous aquifer. Refer to LMB report in Appendix 3.
11. Is the site within 50m of the Hampstead Heath Ponds?	No	Refer to 3.4.1
12. Is the site within 5m of a highway or pedestrian right of way?	Yes	The existing site is within 5m of Lyndhurst Gardens, but the extent of the proposed basement is not within 5m.

13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Yes	The proposed new basement, which will extend from party wall to side elevation, will be formed at a level approximately 3.4-3.9m deeper than the neighbouring properties.
14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	Yes	Refer to 2.3.2. Belsize tunnel is roughly 2.5m beyond proposed basement, at approximately 28m depth below existing ground level.

4.3 Surface Water and Flooding

Question	Response	Details
1. Is the site within the catchment of the pond chains on Hampstead Heath?	No	Refer to 3.4.1
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	Drainage routes within the site have been altered to suit the works. The surface water from the rear of the site will be collected into an attenuation tank and released at a controlled rate of 1L/s, resulting in a decrease in peak run-off. This will result in a betterment as the surface water currently drains to the public network with no SuDS measures in place.
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?	Yes	The proposal includes approximately 9% increase in impermeable area of the site.
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?	Yes	There will be a decrease in peak inflow to the downstream watercourses due to the attenuation and controlled release of the runoff from the rear of the dwelling.
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 in the quality of surface water received by neighbouring properties of downstream watercourses.
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	This has been taken into consideration and managed through the inclusion of an attenuation tank which will decrease the peak runoff volume. Refer to 3.4.5, 3.4.7, and the SuDS Strategy report in Appendix 5.

4.4 Non-Technical Summary of Screening Process

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

- The site is located within 5m of highway or pedestrian right of way, but the extent of the proposed basement is not within 5m;
- The proposed basement will significantly increase the differential depth of foundations relative to neighbouring properties;
- The shallowest stratum is the London Clay formation;
- There will be a change in the proportion of hard surfaced area within the site;
- Two trees in the rear garden are to be felled. The proposed works are also close to or within the protection zone for a third tree (being retained) that is within the surrounding gardens;
- The site is over (or within the exclusion zone of) tunnels.

4.4.2 The other potential concerns considered within the screening process have been demonstrated to be not applicable or insignificant 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 The site is located within 5 metres of highway or pedestrian right-of-way

5.1.1 The site is located on the southern side of Lyndhurst Gardens, with direct access to this road.

5.1.2 It is proposed to construct a new basement towards the rear of the property; however, this will be set back approximately 5.5m from the existing lightwell that is approximately 1.7m wide. The front wall of the lightwell is set back by approximately 3.5m and the level of the lightwell is 2.2m lower than the highway and pedestrian right-of-way.

5.1.3 Therefore, the carriageway of Lyndhurst Gardens has a relative location greater than 5m from the proposed basement extension, and can therefore be considered to be subject to negligible movements associated with the proposed construction development works.

5.2 The proposed basement will significantly increase the differential depth of foundations relative to neighbouring properties

5.2.1 The new basement construction will extend below part of the existing building and the rear garden of 12 Lyndhurst Gardens. This will require underpinning of some load-bearing walls and the party wall shared with the other flats within 12 Lyndhurst Gardens.

5.2.2 It is proposed to lower the existing foundations with a reinforced concrete wall built in an underpinned sequence. Although this is a frequently used technique to build basement that will limit potential ground movements, the effects of the works on the ground stability and the neighbouring properties need to be considered.

5.2.3 A Ground Movement Impact Assessment has been undertaken for the other flats within 12 Lyndhurst Gardens, and the neighbouring properties immediately on either side. The 'Critical sections' that have been identified are denoted as 'B-B'' with 14 Lyndhurst Gardens and 'C-C'' with Flat 1 of 12 Lyndhurst Gardens.

5.2.4 14 Lyndhurst Gardens is roughly 2m to the east of the proposed basement boundary and does not share a party wall. The assessment for this property has demonstrated that potential damage will be within Category 0 (Negligible) of the Burland scale.

5.2.5 Flat 1 is approximately 8m width along the front elevation, is assumed to have shallow foundations, and shares a party wall with Flat 2. The assessment for this flat has demonstrated that potential damage will be within Category 1 (Very Slight) of the Burland scale.

5.2.6 10 Lyndhurst Gardens is greater than 10m to the west from the site, and is considered to be subject to negligible movements associated with the proposed construction development.

5.2.7 Refer to the Ground Movement Assessment in Appendix 4 for further details.

5.3 The shallowest stratum is the London Clay formation

5.3.1 A ground investigation has been undertaken, refer to Appendix 3, and the findings reveal a thin layer of possible Head Deposits overlaying London Clay where the proposed basement will be founded.

5.3.2 London Clay has a medium-high potential volume change. The expected heave forces can cause short- and long-term deformation. Short-term heave deformation occurs instantaneously and can be remediated by removing the expanded ground during the excavation. Long-term heave will be addressed by designing the slab to take potential heave forces.

5.3.3 A Ground Movement Assessment has been undertaken, to predict the potential heave and settlement actions on the proposed structure. The basement slab has been designed to withstand the local heave pressures and to transfer the forces to the perimeter retaining walls. These uplift forces would be resisted by the significant dead load of the existing building.

5.4 There will be a change in the proportion of hard surfaced area within the site

5.4.1 There is a small increase in impermeable area at the site of approximately 9%. The runoff from the existing rear roof and new extension roof/hardstand areas is to be collected into a surface water attenuation tank.

5.4.2 The runoff will be released at a controlled rate of 1L/s in order to decrease both the volume and velocity of the surface water entering the combined public network.

5.4.3 As both the extension and existing rear roof are to be collected, this scheme will create an improvement to the site as no SuDS measures are currently included within the network.

5.5 Two trees in the rear garden are to be felled. The proposed works are also close to or within the protection zone for a third tree (being retained) that is within the surrounding gardens.

5.5.1 All trees have protection status. However, refer to the Arboricultural Report for clarification and justification. The necessary planning permissions shall be obtained prior to the removal of any trees.

5.5.2 The proposed basement structure and Construction Methodology have been designed in accordance with requirements from the Arboricultural Report, to comply with any applicable tree protection zones.

5.5.3 According to the site investigation report, the London Clay has medium-high plasticity index and volume change potential. Removal of the trees will potentially cause localised soil expansion and heaving. The basement slab has been designed to withstand the local heave pressures and to transfer the forces to the perimeter retaining walls. These uplift forces would be resisted by the significant dead load of the existing building.

5.6 The site is over (or within the exclusion zone of) tunnels.

5.6.1 The Belsize tunnel is located beneath the garden at the rear of the site, and runs in an east-west direction that is almost parallel with the rear façade of the building.

5.6.2 The tunnel is located at a lateral distance approximately 2.5m beyond the rear wall of the proposed basement extension, and the tunnel crown is approximately 28m below the existing ground level.

5.6.3 It is proposed to lower the existing foundations with a reinforced concrete wall built in an underpinned sequence. Although this is a frequently used technique to build basement that will limit potential ground movements, the effects of the works on the ground stability and any underlying infrastructure need to be considered.

5.6.4 A Ground Movement Impact Assessment has been undertaken for the Belsize Tunnel, and the movements along the tunnel crown axis are deemed to be of negligible consequence to the structure of the tunnel, given the tunnel's depth.

6.0 SITE INVESTIGATION / ADDITIONAL ASSESSMENTS

6.1 Site Investigation

6.1.1 A complete Site Investigation has been undertaken by LMB; refer to Appendix 3.

6.2 Ground Movement Assessment

6.2.1 Following the results of the screening and scoping process, a Ground Movement Assessment has been undertaken by Card Geotechnics Limited (CGL); refer to Appendix 4.

7.0 CONSTRUCTION METHODOLOGY / ENGINEERING STATEMENTS

7.1 Outline of Underground Utilities and Obstructions

7.1.1 A full survey will be carried out prior to works beginning on site to map all existing underground utilities in and around the site. A full UXO Survey should also be carried out as this area was heavily bombed during WWII, with roughly 10 bombs falling within 250m, and the closest falling roughly 30m to the north of the site.

7.2 Outline of Geotechnical Design Parameters

7.2.1 The following geotechnical design parameters are reasonably conservative, based on the site investigation data presented in Appendix 3 and relevant technical guidance (as referenced in paragraph 2.2 of this BIA).

7.3 Outline Temporary and Permanent Works Proposals

7.3.1 The works proposals include the construction of a new basement, the demolition of the existing rear extension including the conservatory, and the construction of a new rear extension at ground floor.

7.4 Design Proposals

To form the new basement, sequential reinforced concrete underpins will be used, which is a well-known and frequently used technique to form sub-terranean structures. The use of temporary propping will ensure that the basement does not cause any local ground movements whilst construction is taking place.

The underpinning sequence is proposed to be carried out in maximum 1.0m width bays to avoid undermining the adjoining properties.

Below the existing house

The existing masonry walls are to be underpinned to the proposed new basement floor level with new reinforced concrete slab, working as a permanent prop at the base. To form the extension, new RC retaining walls are to be constructed at an underpinned sequence in a similar way than shown on Symmetrys Drawings attached to this report in Appendix 1. The retaining walls are designed to resist both vertical and horizontal loads such as surcharge and soil pressure with the basement reinforced concrete slab designed to resist potential soil pressure due to heave, hydrostatic pressure and buoyancy forces.

The expected heave forces cause short and long-term deformation. Short term heave deformation occurs instantaneously and can be remediated by removing the expanded ground during the excavation.

The structural calculations attached to this report in Appendix 2 also demonstrate that the existing structure can be safely supported on the proposed retaining wall structure within parameters contained within the report by LMB Geosolutions for ground bearing capacity.

To ensure continuity between the RC retaining walls and the masonry walls, dowels will be drilled into the underside of the masonry walls and cast in with the RC walls.

Rear Garden

The basement will extend below the rear garden only, and will occupy less than 50% of the existing site area. As for the main basement construction, the walls forming the basement will be formed using L-shaped concrete retaining walls built in an underpinned sequence. The remaining garden will be landscaped as per architect's drawings. The proposed works shall also comply with the Arboricultural Report's requirements.

Waterproofing

BS8102 sets out guidance for the waterproofing of basement structures according to their use. With this in mind the use of tanked, integral and/or drained methods of waterproofing will have to be considered. These items will be considered once a tanking specialist has been employed.

7.4.1 Proposed Sequence of Works

The structural method statement provided, (see Appendix 1), is for the purpose of the design team's design development and for the purpose of the client's planning application. The appointed contractor will be responsible for all temporary supports and for the stability of the structure during the works.

The method of construction adopted minimises the need for temporary works. However, propping during the underpinning sequencing will be required to minimise the risk of ground movement occurring.

Construction Methodology shall also be in accordance with the Arboricultural Report to suit requirements for any tree protection zones that overlap with the proposed development.

To ensure that the retained engineer's intent is correctly interpreted by the contactor, they will be required to submit all temporary works proposals to review a minimum of 7 working days prior to commencing excavation. The contractor should also submit a dewatering strategy to ensure a strategy is agreed should water be encountered.

Below Existing Building

The existing steelwork at ground floor will be needled and supported off a series of beams which in turn would be supported off a section of basement slab that would be cast ahead of the needling works. This would produce an unhindered area for the basement to be excavated and formed. Once the central load bearing wall has been supported, the remaining perimeter walls can be underpinned as per the drawings in Appendix 1.

Temporary propping to the newly formed retaining walls will be required until the ground floor has been formed. For further details please see Appendix 1 for Construction Sequence and Method Statements.

De-watering Strategy

As the site does not lie above an aquifer and no watercourse has been identified in close vicinity of the property, a dewatering strategy is not necessary.

7.4.2 Stability of Neighbouring Structures

Due to the robust engineering principles and construction method applied, the extent of movement is limited in accordance with British and European codes. We can confirm that the proposed structural design and method of construction of the basement has been developed with a view to ensuring structural safety, and that if constructed in accordance with this document the works will be completed without any adverse impact on the structural stability of the neighbouring properties, other adjacent structures, adjoining land and gardens or the adjoining Public Highway.

The reinforced concrete structure will be designed to accommodate surcharges from the neighbouring property, public highway and ground pressures. The structure will have adequate stiffness to ensure that the lateral deflections do not exceed the appropriate limits recommended by British Standards Codes of Practice in order to ensure that potential ground movements be kept to acceptable limits. The structures will be designed to withstand any uplift due to hydrostatic pressures as well as being designed to transfer vertical loads into the ground safely. Refer to Structural calculations in Appendix 2

7.5 Ground Movement and Damage Impact Assessment

7.5.1 A Ground Movement Assessment (GMA) has been carried out in accordance with CIRIA publication C760 'Guidance on embedded retaining wall design' and takes into account the construction methodology and site-specific ground and groundwater conditions presented in this report. This assessment is attached to this report in Appendix 4.

7.5.2 The results presented in this report describe the predicted ground movement to fall within Burland Category 1 (Very Slight) or less. Refer also to Clause 5.2 of this report.

Category of damage	Description of typical damage	Approximate crack width (mm)	Limiting tensile strain ε_{lim} (per cent)
0 Negligible	Hairline cracks of less than about 0.1 mm are classed as negligible	<0.1	0.0-0.05
1 Very slight	Fine cracks that can easily be treated during normal decoration. Perhaps isolated slight fracture in building. Cracks in external brickwork visible on inspection	<1	0.05-0.075
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. Doors and windows may stick slightly.	<5	0.075-0.15
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. Doors and windows sticking. Service pipes may fracture. Weathertightness often impaired.	5-15 or a number of cracks > 3	0.15-0.3
4 Severe	Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Windows and frames distorted, floor sloping noticeably. Walls leaning or bulging noticeably, some loss of bearing in beams. Service pipes disrupted.	15-25 but also depends on number of cracks.	>0.3

Figure 10 – Burland Damage Category Chart (CIRIA C580)

7.6 Control of Construction Works

It is proposed that the structural stability of the surrounding/adjacent properties is safeguarded by a system of movement monitoring.

The Contractor shall monitor the position and movements of the elevations of the adjacent properties around the perimeter of the proposed excavation. The monitoring shall be undertaken by a specialist survey company. The monitoring system will have at least the following characteristics:

1. The existing facades of the neighbouring properties as well as the flank wall of the neighbouring building will be monitored near ground level and at roof level, at intervals not exceeding 3m centres horizontally and vertically.

2. Monitoring points (targets) shall be firmly attached, to allow 3D position measurement, for the duration of the work, to a continuous and uninterrupted accuracy of -/+ 1mm. A suitable remote reference base/datum unaffected by the works will be adopted, one located at least 50m from the site.

3. Points/targets shall be measured for 3D positioning on, at not less than the following intervals:

    - Before any works commence (base reading)
    - Weekly during the period of basement excavation/construction
    - Monthly during the course of the remainder of the works.
    - Six months after the completion of all construction works.

4. All measurements shall be plotted graphically, to clearly indicate the fluctuation of movement with time. The survey company shall submit the monitoring results to the Engineer (Symmetrys Ltd) and to the Adjoining Owners Party Wall Surveyors/Engineer within 24 hours of measurement, graphically and numerically.

5. The following trigger levels for movement are proposed for agreement. In the event of a trigger value being reached the Contractor will immediately stop any work that might cause further movement, assess the situation and propose alternative methods for proceeding, with definitive further movement limits for those later steps.

6. Trigger movement limits are proposed as follows:

    A) Facades Horizontal/Vertical Movement

Amber:	+/-5mm	All parties notified
Red:	+/-8mm	Works stop and reviewed

    B) Garden Walls and Excavation:

Amber:	+/-5mm	All parties notified
Red:	+/-8mm	Works stop and reviewed

    C) Cracks to Party Walls:

Amber:	+/-2mm	All parties notified
Red:	+/-4mm	Works stop and reviewed

8.0 BASEMENT IMPACT ASSESSMENT

8.1.1 A Conceptual Site Model (CSM) is presented in Appendix 4.

8.2 Land Stability/Slope Stability

8.2.1 The site investigation has identified the London Clay formation to be the founding stratum.

8.2.2 The risk of movement and damage to this development due to shrink and swell of the London Clay is manageable with the design of a new substructure sufficiently stiff to withstand the actions of the heave.

8.2.3 A Ground Movement Assessment has concluded that the Damage Impact to surrounding structures within the zone of influence will be within Category 1 in accordance with the Burland Scale.

8.2.4 The BIA has concluded that there will be no risks or stability impacts to the development and/or adjacent sites due to slope.

8.3 Hydrogeology and Groundwater Flooding

8.3.1 The BIA has concluded there is a low risk of groundwater flooding.

8.3.2 The BIA has concluded there are no impacts to the wider hydrogeological environment.

8.4 Hydrology, Surface Water Flooding and Sewer Flooding

8.4.1 The BIA has concluded there is low risk of flooding from sewers and surface water.

8.4.2 The BIA has concluded there are no impacts to the wider hydrological environment.

9.0 SUMMARY

9.1 It is essential that a thorough review of all temporary works, contractors' method statements and calculations for these works is undertaken by a suitable qualified structural engineer prior to works starting. The permanent works will also be submitted to Building Control and the necessary Party Wall Surveyors for approval prior to the works commencing on site.

9.2 The proposed basement at 12 Lyndhurst Gardens has been designed with robust structural principles and methods of construction that are widely used and known. This will ensure the integrity of neighbouring structures and roadways are not compromised during its construction.

9.3 This assumed Method Statement and Structural report has been completed by Symmetrys Limited and checked by Christopher Atkins who is the Managing Director of Symmetrys Limited.

Report Prepared by:	*Report Reviewed by:*			
Ahmed Kolia Meng (Hons)	Christopher Atkins CEng MIStructE	John Strawson MICE	Ashwin Halaria MSc BEng	Philip Lewis BSc (Hons) FGS CGeol
Structural Engineer at Symmetrys	Managing Director of Symmetrys	CAD Manager at Symmetrys	Associate At Symmetrys	Director of LMB Geosolutions Ltd

Symmetrys Ltd
Structural Engineers

APPENDIX 1

PROPOSED DEVELOPMENT DRAWINGS

QD A1 STANDARD

REFER TO ARCHITECTS DRAWINGS FOR DETAILS OF ALL LEVELS AND SETTING OUT.

THE CONTRACTOR IS RESPONSIBLE FOR THE DESIGN, INSTALLATION, SEQUENCING, AND MAINTENANCE OF ALL TEMPORARY WORKS. ENSURE THE STRENGTH AND STABILITY OF THE BUILDING IS NOT COMPROMISED THROUGHOUT THE WORKS.

LEGEND

- DENOTES EXISTING MASONRY OR TIMBER WALLS
- DENOTES NEW MASONRY WALLS BUILT IN 20N/mm² COMPRESSIVE STRENGTH BRICKWORK AND GRADE iii MORTAR
- DENOTES NEW MASONRY WALLS BUILT IN 7.3N/mm² COMPRESSIVE STRENGTH BLOCKWORK AND GRADE iii MORTAR
- DENOTES NEW NON LOAD BEARING STUD WALL BY ARCHITECT
- DENOTES REINFORCED CONCRETE RETAINING WALL
- DENOTES NEW 350mm THICK RC RAFT SLAB
- (4) DENOTES SEQUENCE OF PROPOSED UNDERPINS. THE CONTRACTOR WILL HAVE TO PROVIDE HIS OWN SEQUENCE OF WORKS AND ALL METHOD STATEMENTS ONCE APPOINTED

CONTRACTOR/SPECIALIST DESIGN ELEMENTS

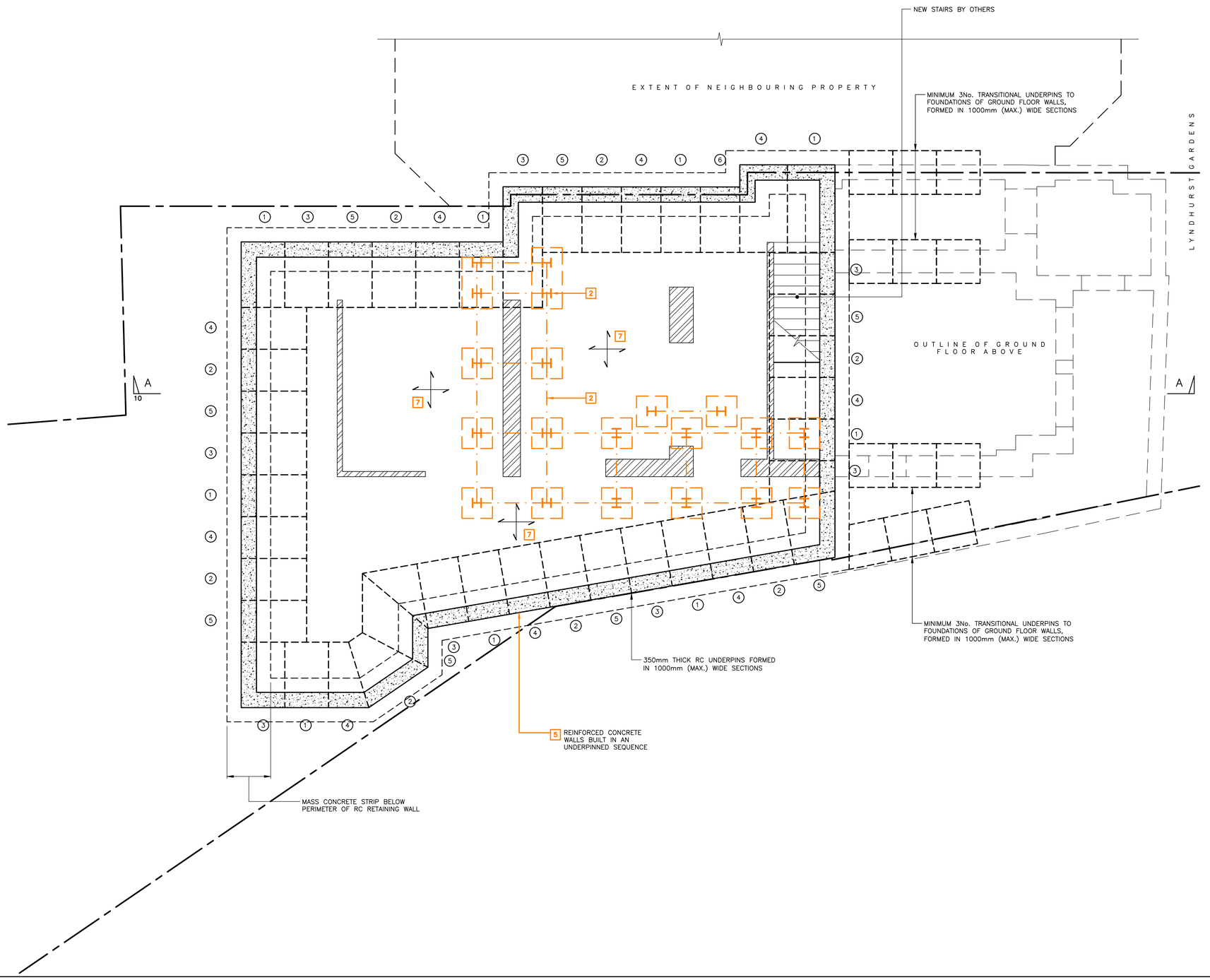
1. ALL TEMPORARY WORKS
2. ALL TANKING DETAILS
3. ALL REINFORCEMENT DRAWINGS AND BAR BENDING SCHEDULES
4. DESIGN OF ALL STEELWORK CONNECTIONS. THE FABRICATOR WILL HAVE TO SUBMIT THEIR CALCULATIONS TO BUILDING CONTROL FOR APPROVAL
5. STEEL FABRICATION DRAWINGS

NOTES

- ALL STEELWORK IN THE EXTERNAL WALLS IS TO BE GALVANISED (125 MICRONS)
- ALL STEELWORK TO BE ENCASED IN CONCRETE IS TO BE UN-PAINTED
- LOCATION OF EXISTING AND PROPOSED DRAIN RUNS ARE TO BE CONFIRMED BY THE SERVICE ENGINEER
- PLEASE REFER TO ARCHITECTS DRAWINGS FOR ALL SETTING OUT DETAILS, INSULATION AND VENTILATION DETAILS, DAMP PROOF COURSES AND ALL TANKING DETAILS
- FOR ALL FIRE WORK PROTECTION TO STEELWORK REFER TO THE ARCHITECTS DRAWINGS
- CONTRACTOR SHOULD ALSO REVIEW MECHANICAL ENGINEERS DRAWINGS FOR EXACT LOCATION OF SERVICE PENETRATION PRIOR TO CUTTING

PROPOSED METHOD STATEMENT – SUGGESTED SEQUENCE OF WORKS

1. LOCALLY BUILD THE CONCRETE PAD BELOW THE TEMPORARY STEEL COLUMNS AT LOWER GROUND FLOOR
2. INSTALL TEMPORARY STEELS TO PICK UP THE INTERNAL LOAD BEARING WALLS BY NEEDLING THE WALL AT 1200CTS USING 152X30UC SUPPORTED ON A 203UC MAIN BEAM SUPPORTED ON PADSTONES AND TEMPORARY COLUMNS/ SLIMSHORES
3. DEMOLISH ALL NON LOAD BEARING WALLS AT GROUND FLOOR AND REAR CONSERVATORY
4. DEMOLISH LOWER GROUND FLOOR
5. INSTALL ALL TEMPORARY PROPS AND FORM THE NEW CONCRETE UNDERPINS AND PERIMETER FOUNDATIONS IN AN UNDERPINS SEQUENCE. SEE DRAWINGS SK04 FOR PROPOSED PROPPING TO UNDERPINS
6. EXCAVATE BASEMENT
7. INSTALL ALL DRAINAGE AND THEN FORM BASEMENT SLAB
8. BUILD STRIP FOUNDATION ALONG BOUNDARY WALL IN AN UNDERPINNED SEQUENCE
9. KEEPING IN POSITION ALL TEMPORARY WORKS INSTALL ALL GROUND FLOOR AND FIRST FLOOR PERMANENT STEEL WORK AND THEN INSTALL COMPOSITE FLOOR DECKING AT GROUND FLOOR
10. FORM SUSPENDED REINFORCED CONCRETE SLABS
11. REMOVE ALL TEMPORARY WORKS IN REVERSE ORDER OF INSTALLATION
12. INSTALL WATERPROOFING



Notes

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS & ENGINEERS DRAWINGS AND SPECIFICATIONS
2. DO NOT SCALE FROM THIS DRAWING

Rev	Date	Chkd	Amendments
P1	03.06.19	AK	ISSUED FOR PLANNING

Drawing Status: PLANNING

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Job Title

12 LYNDHURST GARDENS LONDON, NW3

Drawing Title

BASEMENT FLOOR PLAN

Job No.	Drawing No.	Revision
19050	01	P1

Scales 1:50 AT A1 — Original Size A1

Drawn By NF Date MAY 2019

Company No. 5873122
VAT Registration No. 894 2993 61
Registered In England And Wales

QD A1 STANDARD

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LEGEND

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- DENOTES NEW MASONRY WALLS BUILT IN 20N/mm² COMPRESSIVE STRENGTH BRICKWORK AND GRADE iii MORTAR
- DENOTES NEW MASONRY WALLS BUILT IN 7.3N/mm² COMPRESSIVE STRENGTH BLOCKWORK AND GRADE iii MORTAR
- DENOTES NEW NON LOAD BEARING STUD WALL BY ARCHITECT
- SEE DETAIL FOR TYPICAL RESTRAINT
- DENOTES WALL TO BE DEMOLISHED
- DENOTES NEW FLOOR JOISTS 200x50mm C24 TIMBER AT 300mm CENTRES
- DENOTES EXISTING TIMBER FLOOR JOISTS
- PS — DENOTES 440 LONG x 100 WIDE x 215mm HIGH MASS CONCRETE C20/25 PADSTONE UNLESS NOTED OTHERWISE
- DENOTES JOISTS DOUBLED UP UNDER NEW PARTITIONS AND BATHTUBS TYPICALLY, OR WHERE SHOWN ON PLAN. BOLT TOGETHER VIA TOOTHPLATE CONNECTIONS USING M12 BOLTS AT 400mm CENTRES STAGGERED.

CONTRACTOR/SPECIALIST DESIGN ELEMENTS

1. ALL TEMPORARY WORKS
2. ALL TANKING DETAILS
3. ALL REINFORCEMENT DRAWINGS AND BAR BENDING SCHEDULES
4. DESIGN OF ALL STEELWORK CONNECTIONS. THE FABRICATOR WILL HAVE TO SUBMIT THEIR CALCULATIONS TO BUILDING CONTROL FOR APPROVAL
5. STEEL FABRICATION DRAWINGS

NOTES

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2. INSTALL TEMPORARY STEELS TO PICK UP THE INTERNAL LOAD BEARING WALLS BY NEEDLING THE WALL AT 1200CTS USING 152X30UC SUPPORTED ON A 203UC MAIN BEAM SUPPORTED ON PADSTONES AND TEMPORARY COLUMNS/ SLIMSHORES
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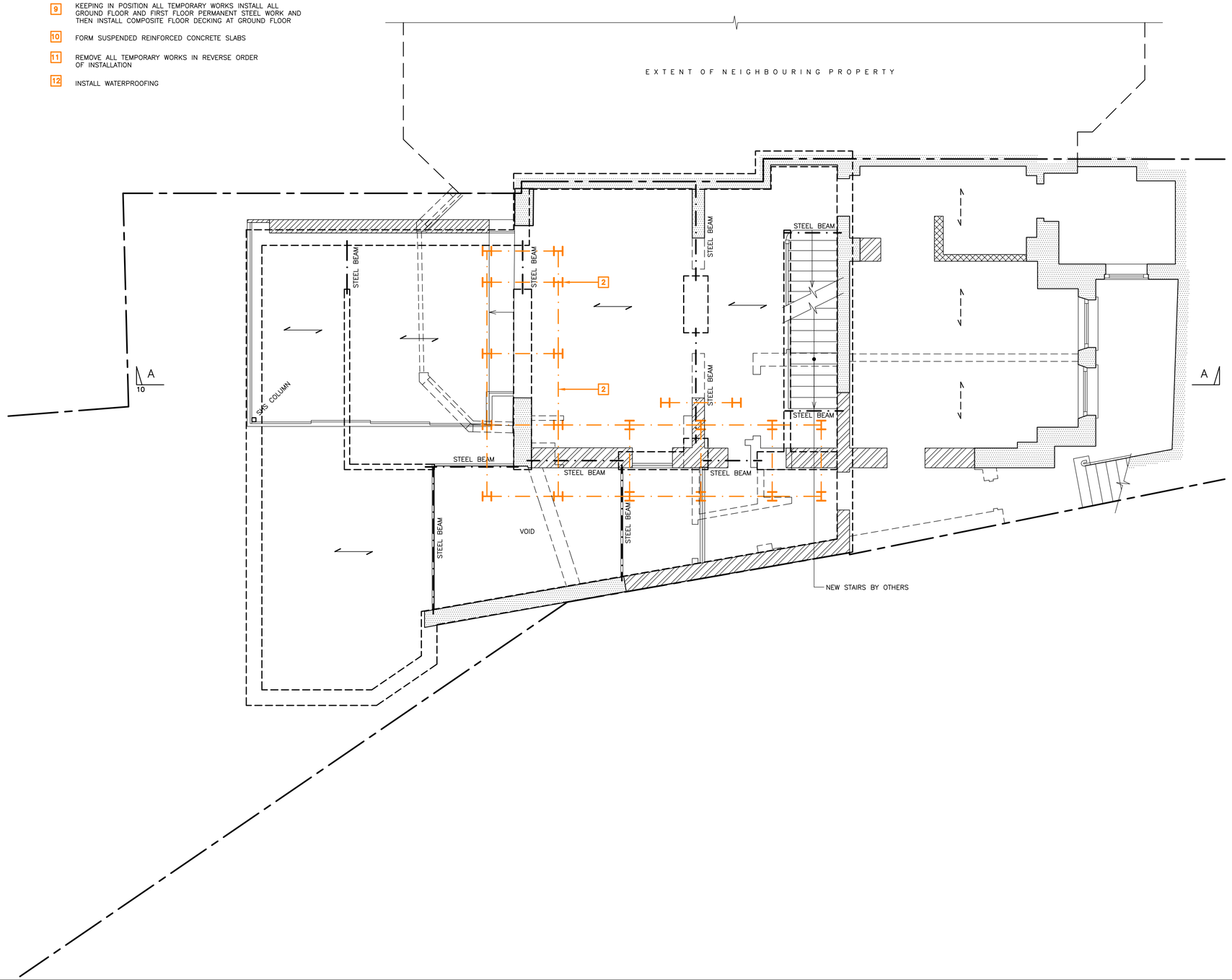

Notes

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Rev	Date	Chkd	Amendments
P1	03.06.19	AK	ISSUED FOR PLANNING

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Job Title: 12 LYNDHURST GARDENS LONDON, NW3

Drawing Title: GROUND FLOOR PLAN

Job No.	Drawing No.	Revision
19050	02	P1

Scales: 1:50 AT A1 — Original Size A1

Drawn By: NF — Date: MAY 2019

Company No. 5873122
VAT Registration No. 894 2993 61
Registered In England And Wales

QD A1 STANDARD

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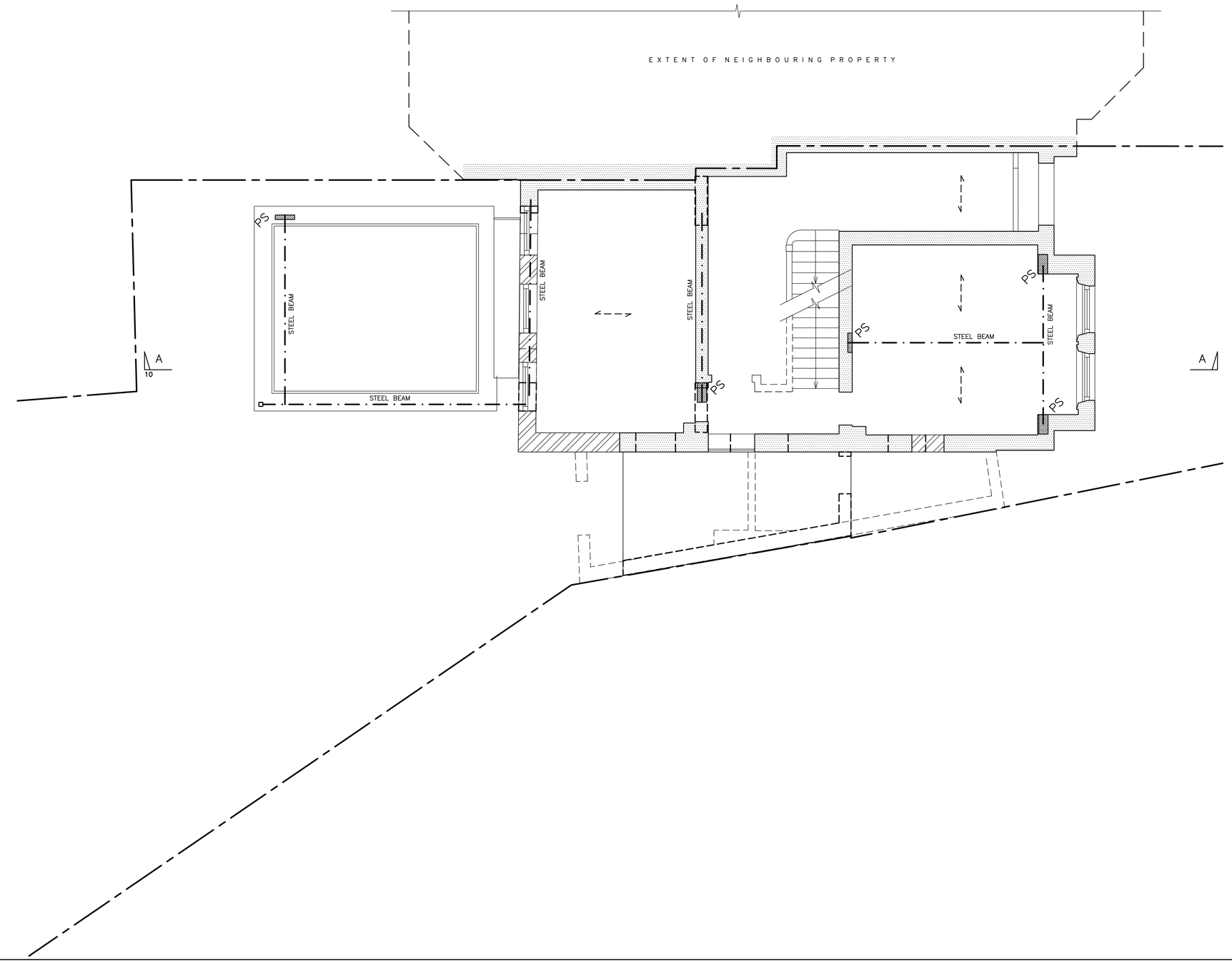

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P1	03.06.19	AK	ISSUED FOR PLANNING

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Job Title: 12 LYNDHURST GARDENS LONDON, NW3

Drawing Title: FIRST FLOOR PLAN

Job No.	Drawing No.	Revision
19050	03	P1

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Company No. 5873122
VAT Registration No. 894 2993 61
Registered In England And Wales

QD A1 STANDARD

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- DENOTES WALL TO BE DEMOLISHED
- DENOTES TEMPORARY BEAMS

CONTRACTOR/SPECIALIST DESIGN ELEMENTS

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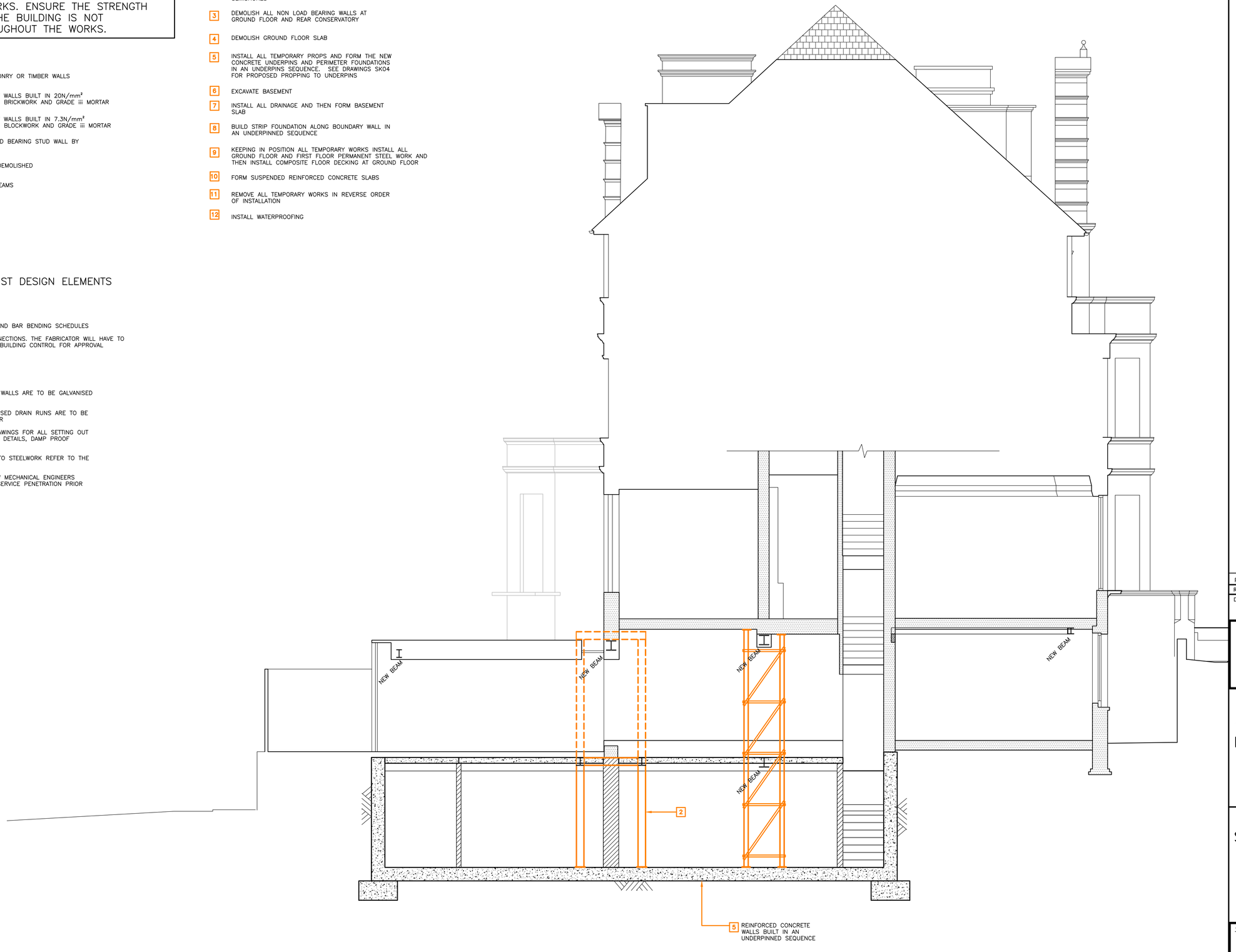

Notes

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P1	03.06.19	AK	ISSUE FOR PLANNING

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Job Title: 12 LYNDHURST GARDENS LONDON, NW3

Drawing Title: SECTION A–A

Job No.	Drawing No.	Revision
19050	10	P1

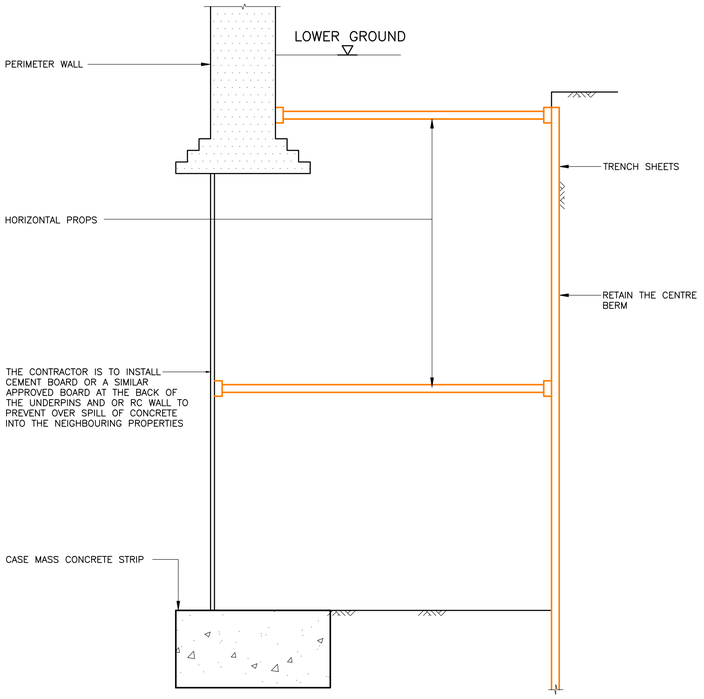
Scales 1:50 AT A1 | Original Size A1

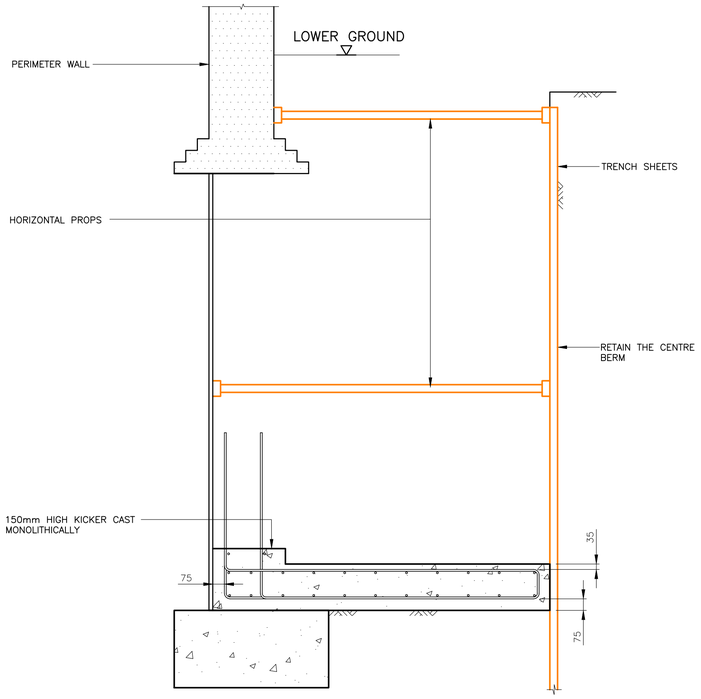
Drawn By NF Date MAY 2019

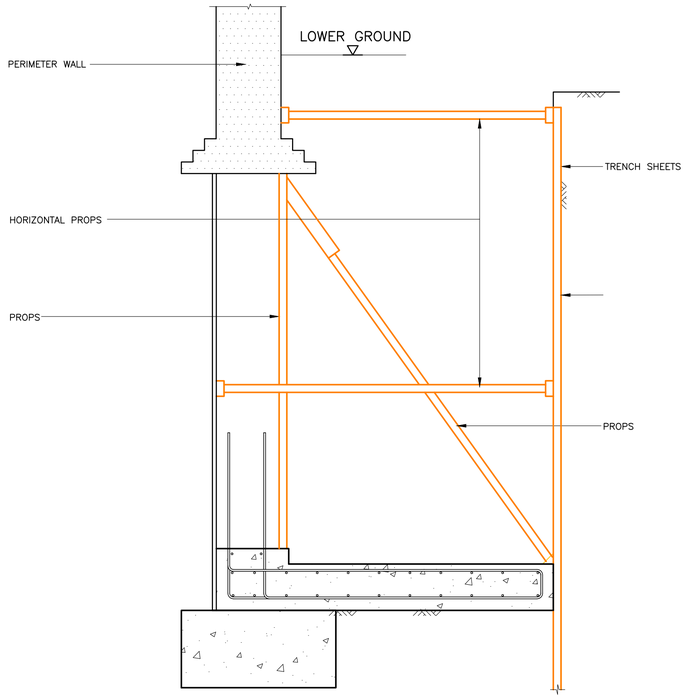
Company No. 5873122
VAT Registration No. 894 2993 61
Registered In England And Wales

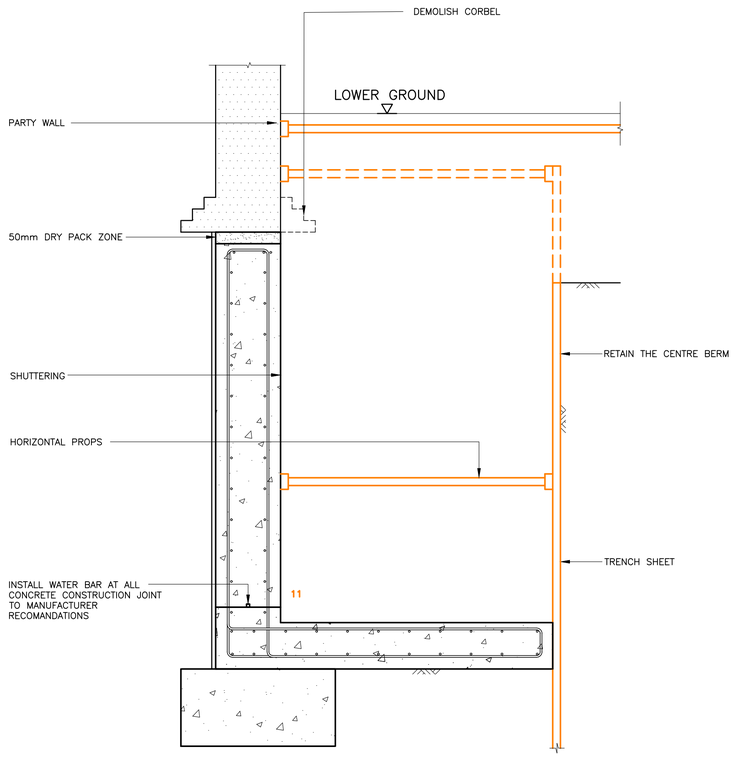
QD A1 STANDARD

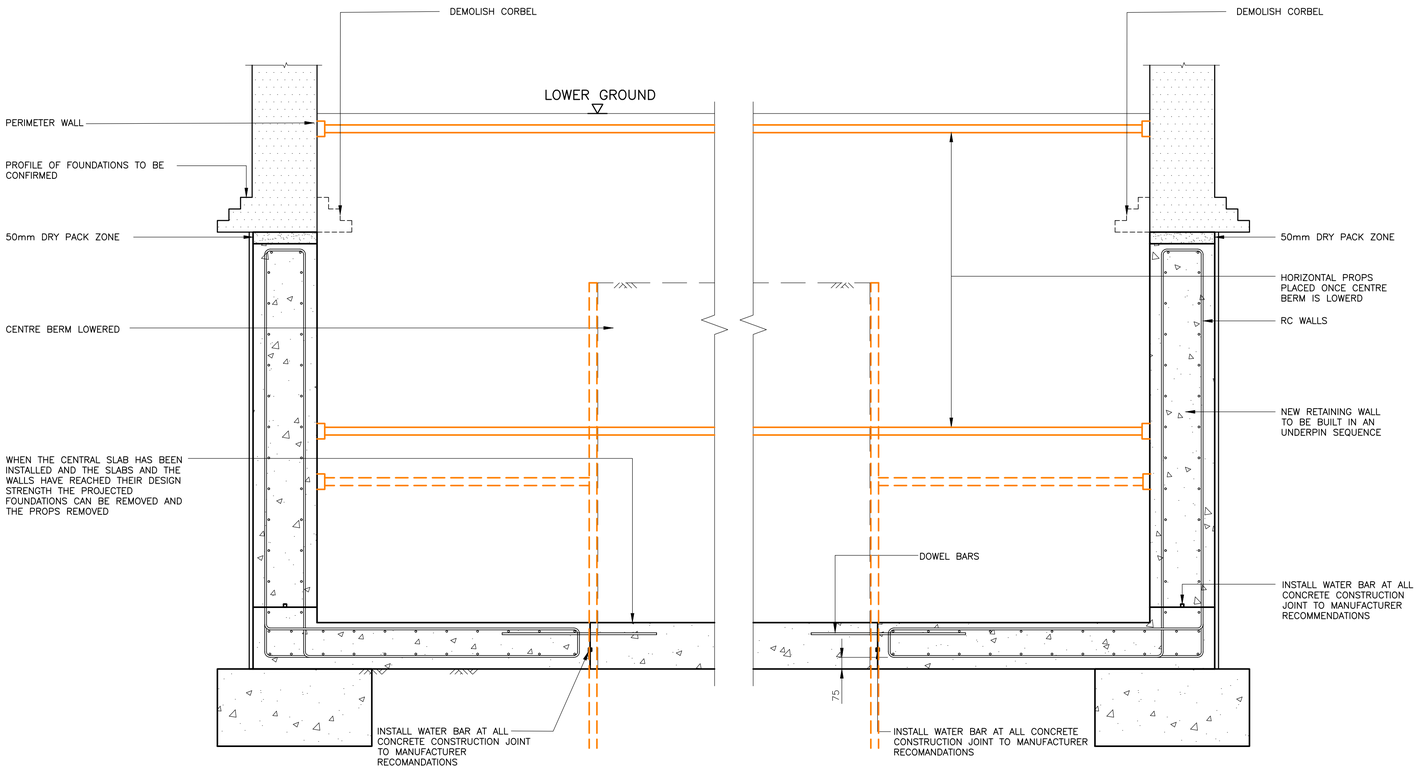
NOTE:
UNDERPINS TO BE DOWELLED INTO EACH OTHER WITH 6No. MIN H20 DOWELS WITH 400mm MIN. EMBEDMENT











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Rev	Date	Chkd	Amendments
P2	03.03.20	AK	UPDATED UNDERPINNING
P1	03.06.19	AK	ISSUE FOR PLANNING

Drawing Status
PLANNING

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E: info@symmetrys.com

Job Title
12 LYNDHURST GARDENS LONDON, NW3

Drawing Title
TYPICAL UNDERPINNING SEQUENCE

Job No.	Drawing No.	Revision
19050	11	P2

Scales 1:50 AT A1
Original Size A1
Drawn By NF Date MAY 2019

QD A1 STANDARD

REAR ELEVATION

MONITORING

IT IS PROPOSED THAT THE STRUCTURAL STABILITY OF THE SURROUNDING/ADJACENT PROPERTIES IS SAFEGUARDED BY A SYSTEM OF MOVEMENT MONITORING.

THE CONTRACTOR SHALL MONITOR THE POSITION AND MOVEMENTS OF THE BASEMENT EXCAVATION PERIMETER, AND THE ELEVATIONS OF THE ADJACENT PROPERTIES AROUND THE PERIMETER OF THE PROPOSED EXCAVATION. THE MONITORING SHALL BE UNDERTAKEN BY A SPECIALIST SURVEY COMPANY. THE MONITORING SYSTEM WILL HAVE AT LEAST THE FOLLOWING CHARACTERISTICS: MONITORING POSITIONS (TARGETS) WILL BE ESTABLISHED WITHIN THE PROPOSED EXCAVATION AND ON THE ADJACENT STRUCTURES THEMSELVES.

1) THE PERIMETER TEMPORARY/PERMANENT WORKS WILL BE MONITORED AT GROUND LEVEL, AT INTERVALS NOT EXCEEDING 3–4M CENTRES, MEASURED FROM THE TARGETS INSTALLED ON THE FIRST LEVEL ON THE UNDERPIN RETAINING WALL.

2) THE EXISTING FACADES WILL BE MONITORED NEAR GROUND LEVEL AND AT ROOF LEVEL, AT INTERVALS NOT EXCEEDING 3M CENTRES.

3) MONITORING POINTS (TARGETS) SHALL BE FIRMLY ATTACHED, TO ALLOW 3D POSITION MEASUREMENT, FOR THE DURATION OF THE WORK, TO A CONTINUOUS AND UNINTERRUPTED ACCURACY OF –/+ 2MM. A SUITABLE REMOTE REFERENCE BASE/DATUM UNAFFECTED BY THE WORKS WILL BE ADOPTED, ONE LOCATED AT LEAST 50M FROM THE SITE.

4) POINTS/TARGETS SHALL BE MEASURED FOR 3D POSITIONING, AT NOT LESS THAN THE FOLLOWING INTERVALS:

   FOR THE EXISTING FAÇADE, BEFORE ANY WORKS COMMENCE (BASE READING) AND THEN WEEKLY DURING THE PERIOD OF BASEMENT EXCAVATION/CONSTRUCTION AND MONTHLY DURING THE COURSE OF THE REMAINDER OF THE WORKS. A FINAL READING IS TO BE UNDERTAKEN 6 MONTHS AFTER THE COMPLETION OF ALL CONSTRUCTION WORKS. FOR THE NEW BASEMENT PERIMETER, AT THE TIME OF COMPLETION OF THE FIRST LEVEL OF UNDERPINNING BEFORE EXCAVATING (BASE READING) AND THEN WEEKLY DURING THE PERIOD OF BASEMENT EXCAVATION/CONSTRUCTION AND MONTHLY DURING THE COURSE OF THE REMAINDER OF THE WORKS.

5) ALL MEASUREMENTS SHALL BE PLOTTED GRAPHICALLY, TO CLEARLY INDICATE THE FLUCTUATION OF MOVEMENT WITH TIME. THE SURVEY COMPANY SHALL SUBMIT THE MONITORING RESULTS TO THE ENGINEER (SYMMETRYS LTD) AND TO THE ADJOINING OWNERS PARTY WALL SURVEYORS/ENGINEER WITHIN 24 HOURS OF MEASUREMENT, GRAPHICALLY AND NUMERICALLY.

6) THE FOLLOWING TRIGGER LEVELS FOR MOVEMENT ARE PROPOSED FOR AGREEMENT. IN THE EVENT OF A TRIGGER VALUE BEING REACHED THE CONTRACTOR WILL IMMEDIATELY STOP ANY WORK THAT MIGHT CAUSE FURTHER MOVEMENT, ASSESS THE SITUATION AND PROPOSE ALTERNATIVE METHODS FOR PROCEEDING, WITH DEFINITIVE FURTHER MOVEMENT LIMITS FOR THOSE LATER STEPS.

7) TRIGGER MOVEMENT LIMITS ARE PROPOSED AS FOLLOWS:

   A) FACADES HORIZONTAL MOVEMENT/FACADES VERTICAL MOVEMENT

      AMBER +/–5MM
      – ALL PARTIES NOTIFIED.

      RED +/–8MM
      – WORKS STOP AND REVIEWED
      – CONSULTATION BETWEEN THE PARTY WALL SURVEYORS

   B) THE GARDEN WALLS AND EXCAVATION

      AMBER +/–5MM
      – ALL PARTIES NOTIFIED.

      RED +/–8MM
      – WORKS STOP AND REVIEWED
      – CONSULTATION BETWEEN THE PARTY WALL SURVEYORS

   C) CRACKS TO PARTY WALLS
      AMBER 2MM
      RED 4MM

NOTE

THE TARGETS ARE SHOWN ON THE 1:50 SECTION DRAWINGS SHOWN THUS

Notes

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS & ENGINEERS DRAWINGS AND SPECIFICATIONS
2. DO NOT SCALE FROM THIS DRAWING

Rev	Date	Chkd	Amendments
P1	03.06.19	AK	ISSUE FOR PLANNING

Drawing Status

PLANNING

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Job Title

12 LYNDHURST GARDENS
LONDON, NW3

Drawing Title

MOVEMENT MONITORING
ELEVATIONS

Job No.	Drawing No.	Revision
19050	20	P1

Scales 1:50 AT A1 — Original Size A1

Drawn By NF Date MAY 2019

Company No. 5873122
VAT Registration No. 894 2993 61
Registered In England And Wales

Symmetrys Ltd
Structural Engineers

APPENDIX 2
STRUCTURAL ENGINEER'S STATEMENT AND CALCULATIONS

Symmetrys Ltd
Structural Engineers

Structural Calculation Package

12 Lyndhurst Gardens
London
NW3 5NR

19050-CAL-001
29th May 2018
Rev. A

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12 Lyndhurst Gardens

1.0 Introduction

1.1 Symmetrys were instructed by Daniel Burbridge to design a single storey basement and rear extension below the existing house at 12 Lyndhurst Gardens.

1.2 The structural works consisted of the following:

- Design of single storey rear extension
- Design of new basement

2.0 Design Codes

2.1 The following design codes/guidance were used to carry out the design:

- BS 648: 1964 – Weights of Building Materials
- BS 5268: Pt 2: 2002 – Structural Timber
- BS 5628: Pt 1: 2005 – Masonry
- BS 5950: Pt 1: 2008 – Structural Steel
- BS 6399: Pt 1: 1998 – Design Loads
- BS 8110: Pt 1: 1997 – Structural Use of Concrete

3.0 Ground Conditions

3.1 Design assumes London Clay with an allowable bearing pressure of 120kPa based on the findings of the soil investigation provided to Symmetrys by the Architect.

4.0 Substructure Design

4.1 The full footprint basement underpin consists of reinforced concrete underpin retaining walls with a ground bearing reinforced concrete slab. Although no ground water was encountered during the ground investigation, the water table is conservatively assumed to be 1m below ground level.

5.0 Loading

5.1 Floor Loadings - Existing:

Level	Load type	Description	Distributed Load (kN/m^2)	or Point Load (kN)
Existing Ground floor	Dead 'G'	200 thick RC slab	6.00	
	Live 'Q'	Residential private (Cat A1)	1.50	2.00
	Live 'Q'	Lightweight partitions (no greater than 2kN/m)	1.00	
Existing 1st / 2nd / 3rd / 4th floors	Dead 'G'	Timber joists floor + Ceiling + Finishes	1.25	
	Live 'Q'	Residential private (Cat A1)	1.50	2.00
	Live 'Q'	Lightweight partitions (no greater than 2kN/m)	1.00	
Existing Roofs	Dead 'G'	Timber joists roof + Ceiling + Finishes	1.25	
	Live 'Q'	Access for maintenance only (Cat H)	0.75	0.90

5.2 Floor Loadings – Proposed:

Level	Load type	Description	Distributed Load (kN/m²)	or Point Load (kN)
Proposed Basement	Dead 'G'	350 thick RC slab	10.50	
	Live 'Q'	Residential private (Cat A1)	1.50	2.00
	Live 'Q'	Lightweight partitions (no greater than 2kN/m)	0.80	
Proposed new Ground floor	Dead 'G'	Composite slab floor	6.25	
	Live 'Q'	Residential private (Cat A1)	1.50	2.00
	Live 'Q'	Lightweight partitions (no greater than 2kN/m)	0.80	
New Roofs	Dead 'G'	New timber flat roofs	1.25	
	Live 'Q'	Access for maintenance only (Cat H)	0.60	0.90

5.3 Wall Loadings:

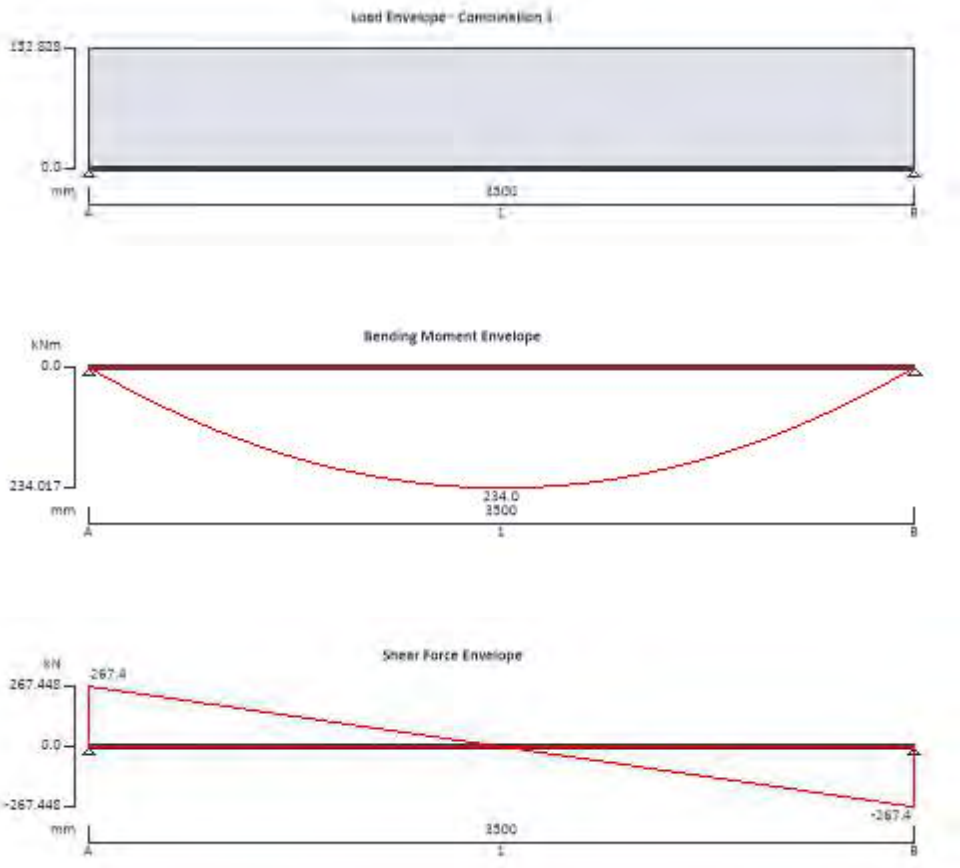
Level	Wall height (m)	Description	Distributed Load (kN/m²)	Wall line Load (kN/m)
Various	3.00	Timber stud partition	0.60	1.80
		Brick & Block cavity wall	4.50	13.50
		Solid 102.5 thick wall	2.25	6.75
		Solid 215 thick wall	4.50	13.50
		Solid 335 thick wall	6.75	20.25

Symmetrys Structural Engineers	Project: 12 Lyndhurst Gardens				Job no.: 19050	
	Calcs for: Beam				Start page no./Revision: 4 A	
	Calcs by: AK	Calcs date: 29/05/2019	Checked by: BB	Checked date: 29/05/2019	Approved by: AH	Approved date: 29/05/2019

STEEL BEAM ANALYSIS & DESIGN (EN1993-1-1:2005)

In accordance with EN1993-1-1:2005 incorporating Corrigenda February 2006 and April 2009 and the UK national annex

TEDDS calculation version 3.0.13



Support conditions

Support A	Vertically restrained
	Rotationally free
Support B	Vertically restrained
	Rotationally free

Applied loading

Beam loads	Permanent self weight of beam × 1
	12m 215mm brick - Permanent full UDL 54 kN/m
	5 floors, 1.25kPa - Permanent full UDL 25 kN/m
	5 floors, 1.5kPa - Variable full UDL 30 kN/m

Load combinations

Load combination 1	Support A	Permanent × 1.35
		Variable × 1.50
		Permanent × 1.35
		Variable × 1.50
	Support B	Permanent × 1.35

Variable × 1.50

Analysis results

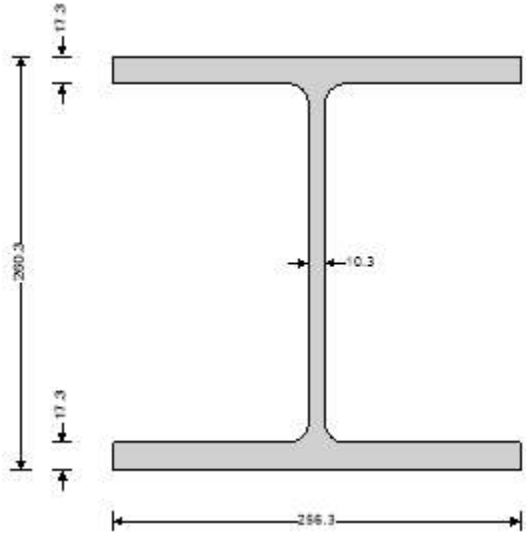
Maximum moment	M_{max} = **234** kNm	M_{min} = **0** kNm
Maximum shear	V_{max} = **267.4** kN	V_{min} = **-267.4** kN
Deflection	δ_{max} = **7.2** mm	δ_{min} = **0** mm
Maximum reaction at support A	R_{A_max} = **267.4** kN	R_{A_min} = **267.4** kN
Unfactored permanent load reaction at support A	$R_{A\_Permanent}$ = **139.8** kN	
Unfactored variable load reaction at support A	$R_{A\_Variable}$ = **52.5** kN	
Maximum reaction at support B	R_{B_max} = **267.4** kN	R_{B_min} = **267.4** kN
Unfactored permanent load reaction at support B	$R_{B\_Permanent}$ = **139.8** kN	
Unfactored variable load reaction at support B	$R_{B\_Variable}$ = **52.5** kN	

Section details

Section type	**UKC 254x254x89 (Tata Steel Advance)**
Steel grade	**S275**

EN 10025-2:2004 - Hot rolled products of structural steels

Nominal thickness of element	t = max(t_f, t_w) = **17.3** mm
Nominal yield strength	f_y = **265** N/mm^2
Nominal ultimate tensile strength	f_u = **410** N/mm^2
Modulus of elasticity	E = **210000** N/mm^2



Partial factors - Section 6.1

Resistance of cross-sections	γ_{M0} = **1.00**
Resistance of members to instability	γ_{M1} = **1.00**
Resistance of tensile members to fracture	γ_{M2} = **1.10**

Lateral restraint

Span 1 has full lateral restraint

Effective length factors

Effective length factor in major axis	K_y = **1.000**
Effective length factor in minor axis	K_z = **1.000**
Effective length factor for torsion	$K_{LT.A}$ = **1.000**
	$K_{LT.B}$ = **1.000**

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Classification of cross sections - Section 5.5

$\varepsilon = \sqrt{[235\ N/mm^2 / f_y]} =$ **0.94**

Internal compression parts subject to bending - Table 5.2 (sheet 1 of 3)

Width of section: $c = d =$ **200.3** mm

$c / t_w = 20.7 \times \varepsilon <= 72 \times \varepsilon$ Class 1

Outstand flanges - Table 5.2 (sheet 2 of 3)

Width of section: $c = (b - t_w - 2 \times r) / 2 =$ **110.3** mm

$c / t_f = 6.8 \times \varepsilon <= 9 \times \varepsilon$ Class 1

Section is class 1

Check shear - Section 6.2.6

Height of web: $h_w = h - 2 \times t_f =$ **225.7** mm

Shear area factor: $\eta =$ **1.000**

$h_w / t_w < 72 \times \varepsilon / \eta$

Shear buckling resistance can be ignored

Design shear force: $V_{Ed} = \max(abs(V_{max}), abs(V_{min})) =$ **267.4** kN

Shear area - cl 6.2.6(3): $A_v = \max(A - 2 \times b \times t_f + (t_w + 2 \times r) \times t_f, \eta \times h_w \times t_w) =$ **3081** mm^2

Design shear resistance - cl 6.2.6(2): $V_{c,Rd} = V_{pl,Rd} = A_v \times (f_y / \sqrt{[3]}) / \gamma_{M0} =$ **471.4** kN

PASS - Design shear resistance exceeds design shear force

Combined bending and shear - Section 6.2.8

Reduction factor - cl.6.2.8(3): $\rho_v = [(2 \times V_{Ed} / V_{pl,Rd}) - 1]^2 =$ **0.018**

Check bending moment major (y-y) axis - Section 6.2.5

Design bending moment: $M_{Ed} = \max(abs(M_{s1\_max}), abs(M_{s1\_min})) =$ **234** kNm

Design bending resistance moment - eq 6.13: $M_{c,Rd} = M_{pl,Rd} = [(W_{pl,y} - t_w \times h^2 / 4) + (t_w \times h^2 / 4) \times (1 - \rho_v)] \times f_y / \gamma_{M0} =$ **323.5** kNm

PASS - Design bending resistance moment exceeds design bending moment

Check vertical deflection - Section 7.2.1

Consider deflection due to permanent and variable loads

Limiting deflection: $\delta_{lim} = L_{s1} / 360 =$ **9.7** mm

Maximum deflection span 1: $\delta = \max(abs(\delta_{max}), abs(\delta_{min})) =$ **7.165** mm

PASS - Maximum deflection does not exceed deflection limit

RETAINING WALL ANALYSIS

In accordance with EN1997-1:2004 incorporating Corrigendum dated February 2009 and the UK National Annex incorporating Corrigendum No.1

Tedds calculation version 2.9.08

Retaining wall details

Stem type	Cantilever
Stem height	h_{stem} = **3250** mm
Stem thickness	t_{stem} = **350** mm
Angle to rear face of stem	α = **90** deg
Stem density	γ_{stem} = **25** kN/m^3
Toe length	l_{toe} = **2000** mm
Base thickness	t_{base} = **350** mm
Base density	γ_{base} = **25** kN/m^3
Height of retained soil	h_{ret} = **3250** mm
Angle of soil surface	β = **0** deg
Depth of cover	d_{cover} = **0** mm
Height of water	h_{water} = **2250** mm
Water density	γ_w = **9.8** kN/m^3

Retained soil properties

Soil type	Firm clay
Moist density	γ_{mr} = **18** kN/m^3
Saturated density	γ_{sr} = **18** kN/m^3
Characteristic effective shear resistance angle	$\phi'_{r.k}$ = **22** deg
Characteristic wall friction angle	$\delta_{r.k}$ = **11** deg

Base soil properties

Soil type	Firm clay
Soil density	γ_b = **18** kN/m^3
Characteristic effective shear resistance angle	$\phi'_{b.k}$ = **22** deg
Characteristic wall friction angle	$\delta_{b.k}$ = **11** deg
Characteristic base friction angle	$\delta_{bb.k}$ = **22** deg
Presumed bearing capacity	$P_{bearing}$ = **120** kN/m^2

Loading details

Variable surcharge load	$Surcharge_Q$ = **10** kN/m^2
Vertical line load at 2175 mm	P_{G1} = **90** kN/m
	P_{Q1} = **40** kN/m

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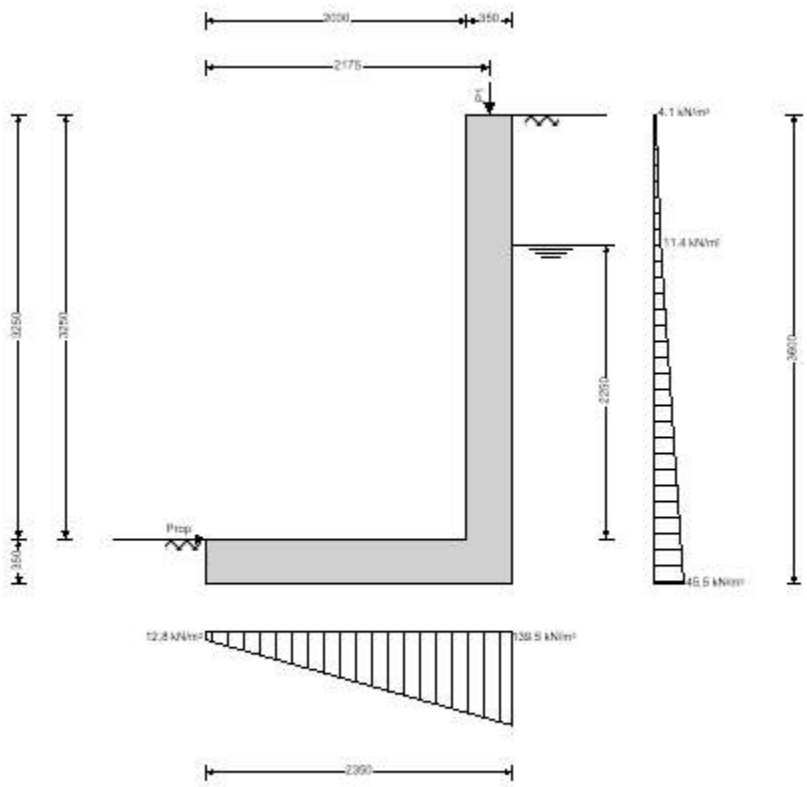


General arrangement

Calculate retaining wall geometry

Base length	$l_{base} = l_{toe} + t_{stem}$ = **2350** mm
Saturated soil height	$h_{sat} = h_{water} + d_{cover}$ = **2250** mm
Moist soil height	$h_{moist} = h_{ret} - h_{water}$ = **1000** mm
Length of surcharge load	$l_{sur} = l_{heel}$ = **0** mm
- Distance to vertical component	$x_{sur\_v} = l_{base} - l_{heel} / 2$ = **2350** mm
Effective height of wall	$h_{eff} = h_{base} + d_{cover} + h_{ret}$ = **3600** mm
- Distance to horizontal component	$x_{sur\_h} = h_{eff} / 2$ = **1800** mm
Area of wall stem	$A_{stem} = h_{stem} \times t_{stem}$ = **1.138** m^2
- Distance to vertical component	$x_{stem} = l_{toe} + t_{stem} / 2$ = **2175** mm
Area of wall base	$A_{base} = l_{base} \times t_{base}$ = **0.823** m^2
- Distance to vertical component	$x_{base} = l_{base} / 2$ = **1175** mm

Using Coulomb theory

Active pressure coefficient	$K_A = \sin(\alpha + \phi'_{r.k})^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta_{r.k}) \times [1 + \sqrt{[\sin(\phi'_{r.k} + \delta_{r.k}) \times \sin(\phi'_{r.k} - \beta) / (\sin(\alpha - \delta_{r.k}) \times \sin(\alpha + \beta))]}]^2)$ = **0.413**
Passive pressure coefficient	$K_P = \sin(90 - \phi'_{b.k})^2 / (\sin(90 + \delta_{b.k}) \times [1 - \sqrt{[\sin(\phi'_{b.k} + \delta_{b.k}) \times \sin(\phi'_{b.k}) / (\sin(90 + \delta_{b.k}))]}]^2)$ = **2.958**

Bearing pressure check

Vertical forces on wall

Wall stem	$F_{stem} = A_{stem} \times \gamma_{stem}$ = **28.4** kN/m
Wall base	$F_{base} = A_{base} \times \gamma_{base}$ = **20.6** kN/m

Line loads	$F_{P\_v} = P_{G1} + P_{Q1} =$ **130** kN/m
Total	$F_{total\_v} = F_{stem} + F_{base} + F_{P\_v} + F_{water\_v} =$ **179** kN/m

Horizontal forces on wall

Surcharge load	$F_{sur\_h} = K_A \times \cos(\delta_{r.k}) \times Surcharge_Q \times h_{eff} =$ **14.6** kN/m
Saturated retained soil	$F_{sat\_h} = K_A \times \cos(\delta_{r.k}) \times (\gamma_{sr} - \gamma_w) \times (h_{sat} + h_{base})^2 / 2 =$ **11.2** kN/m
Water	$F_{water\_h} = \gamma_w \times (h_{water} + d_{cover} + h_{base})^2 / 2 =$ **33.2** kN/m
Moist retained soil	$F_{moist\_h} = K_A \times \cos(\delta_{r.k}) \times \gamma_{mr} \times ((h_{eff} - h_{sat} - h_{base})^2 / 2 + (h_{eff} - h_{sat} - h_{base}) \times (h_{sat} + h_{base})) =$ **22.6** kN/m
Base soil	$F_{pass\_h} = -K_P \times \cos(\delta_{b.k}) \times \gamma_b \times (d_{cover} + h_{base})^2 / 2 =$ **-3.2** kN/m
Total	$F_{total\_h} = F_{sur\_h} + F_{sat\_h} + F_{water\_h} + F_{moist\_h} + F_{pass\_h} =$ **78.4** kN/m

Moments on wall

Wall stem	$M_{stem} = F_{stem} \times x_{stem} =$ **61.9** kNm/m
Wall base	$M_{base} = F_{base} \times x_{base} =$ **24.2** kNm/m
Surcharge load	$M_{sur} = -F_{sur\_h} \times x_{sur\_h} =$ **-26.3** kNm/m
Line loads	$M_P = (P_{G1} + P_{Q1}) \times p_1 =$ **282.8** kNm/m
Saturated retained soil	$M_{sat} = -F_{sat\_h} \times x_{sat\_h} =$ **-9.7** kNm/m
Water	$M_{water} = -F_{water\_h} \times x_{water\_h} =$ **-28.7** kNm/m
Moist retained soil	$M_{moist} = -F_{moist\_h} \times x_{moist\_h} =$ **-35.4** kNm/m
Total	$M_{total} = M_{stem} + M_{base} + M_{sur} + M_P + M_{sat} + M_{water} + M_{moist} =$ **268.6** kNm/m

Check bearing pressure

Propping force	$F_{prop\_base} = F_{total\_h} =$ **78.4** kN/m
Distance to reaction	$\bar{x} = M_{total} / F_{total\_v} =$ **1501** mm
Eccentricity of reaction	$e = \bar{x} - l_{base} / 2 =$ **326** mm
Loaded length of base	$l_{load} = l_{base} =$ **2350** mm
Bearing pressure at toe	$q_{toe} = F_{total\_v} / l_{base} \times (1 - 6 \times e / l_{base}) =$ **12.8** kN/m²
Bearing pressure at heel	$q_{heel} = F_{total\_v} / l_{base} \times (1 + 6 \times e / l_{base}) =$ **139.5** kN/m²
Factor of safety	$FoS_{bp} = P_{bearing} / \max(q_{toe}, q_{heel}) =$ **0.86**

FAIL - Maximum applied bearing pressure exceeds allowable bearing pressure

1.2m wide mass concrete strip footing to be provided below the retaining wall to spread the this load and decrease bearing pressure: 139.5 / 1.2 = 116.25kN/m² < 120kN/m² Therefore okay

RETAINING WALL DESIGN

In accordance with EN1992-1-1:2004 incorporating Corrigendum dated January 2008 and the UK National Annex incorporating National Amendment No.1

Tedds calculation version 2.9.08

Concrete details - Table 3.1 - Strength and deformation characteristics for concrete

Concrete strength class	C30/37
Characteristic compressive cylinder strength	$f_{ck} =$ **30** N/mm²
Characteristic compressive cube strength	$f_{ck,cube} =$ **37** N/mm²
Mean value of compressive cylinder strength	$f_{cm} = f_{ck} + 8$ N/mm² = **38** N/mm²
Mean value of axial tensile strength	$f_{ctm} = 0.3$ N/mm² $\times (f_{ck} / 1$ N/mm²$)^{2/3} =$ **2.9** N/mm²
5% fractile of axial tensile strength	$f_{ctk,0.05} = 0.7 \times f_{ctm} =$ **2.0** N/mm²
Secant modulus of elasticity of concrete	$E_{cm} = 22$ kN/mm² $\times (f_{cm} / 10$ N/mm²$)^{0.3} =$ **32837** N/mm²
Partial factor for concrete - Table 2.1N	$\gamma_C =$ **1.50**
Compressive strength coefficient - cl.3.1.6(1)	$\alpha_{cc} =$ **0.85**
Design compressive concrete strength - exp.3.15	$f_{cd} = \alpha_{cc} \times f_{ck} / \gamma_C =$ **17.0** N/mm²
Maximum aggregate size	$h_{agg} =$ **20** mm

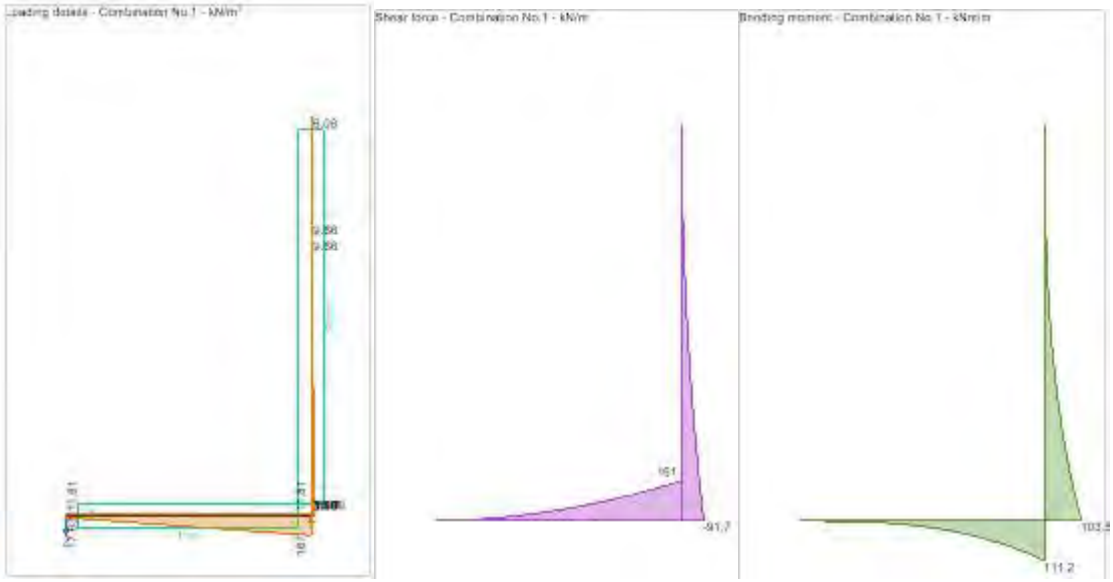
Ultimate strain - Table 3.1	ε_{cu2} = **0.0035**
Shortening strain - Table 3.1	ε_{cu3} = **0.0035**
Effective compression zone height factor	λ = **0.80**
Effective strength factor	η = **1.00**
Bending coefficient k_1	K_1 = **0.40**
Bending coefficient k_2	$K_2 = 1.00 \times (0.6 + 0.0014/\varepsilon_{cu2})$ = **1.00**
Bending coefficient k_3	K_3 =**0.40**
Bending coefficient k_4	$K_4 = 1.00 \times (0.6 + 0.0014/\varepsilon_{cu2})$ =**1.00**

Reinforcement details

Characteristic yield strength of reinforcement	f_{yk} = **500** N/mm^2
Modulus of elasticity of reinforcement	E_s = **200000** N/mm^2
Partial factor for reinforcing steel - Table 2.1N	γ_S = **1.15**
Design yield strength of reinforcement	$f_{yd} = f_{yk} / \gamma_S$ = **435** N/mm^2

Cover to reinforcement

Front face of stem	c_{sf} = **40** mm
Rear face of stem	c_{sr} = **50** mm
Top face of base	c_{bt} = **50** mm
Bottom face of base	c_{bb} = **75** mm



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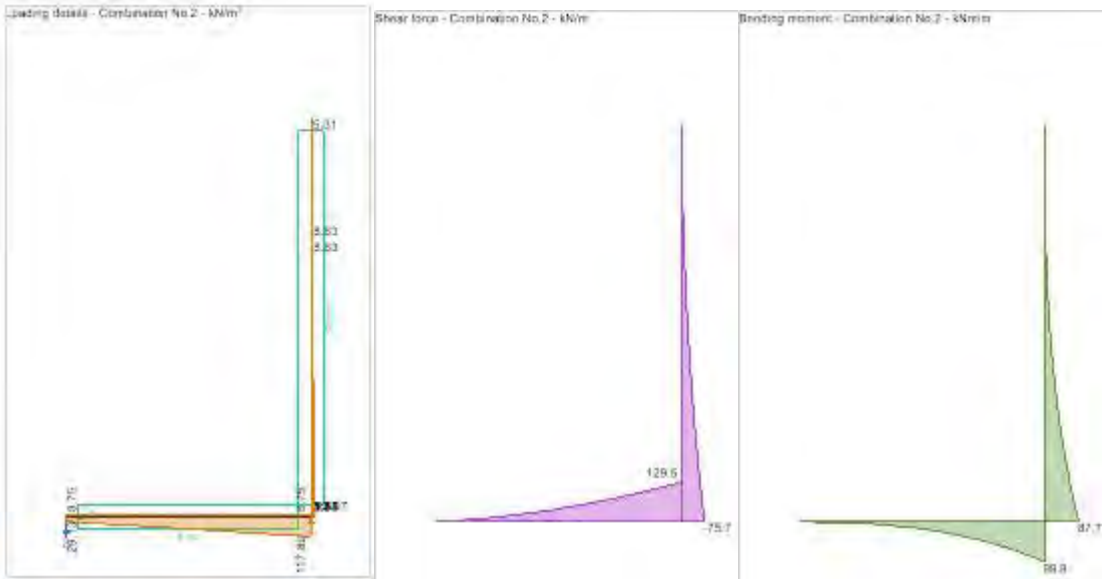

Check stem design at base of stem

Depth of section — h = **350** mm

Rectangular section in flexure - Section 6.1

Design bending moment combination 1 — M = **103.5** kNm/m

Depth to tension reinforcement — $d = h - c_{sr} - \phi_{sr} / 2$ = **292** mm

$K = M / (d^2 \times f_{ck})$ = **0.040**

$K' = (2 \times \eta \times \alpha_{cc}/\gamma_c) \times (1 - \lambda \times (\delta - K_1)/(2 \times K_2)) \times (\lambda \times (\delta - K_1)/(2 \times K_2))$

K' = **0.207**

K' > K - No compression reinforcement is required

Lever arm — $z = \min(0.5 + 0.5 \times (1 - 2 \times K / (\eta \times \alpha_{cc} / \gamma_c))^{0.5}, 0.95) \times d$ = **277** mm

Depth of neutral axis — $x = 2.5 \times (d - z)$ = **37** mm

Area of tension reinforcement required — $A_{sr.req} = M / (f_{yd} \times z)$ = **858** mm²/m

Tension reinforcement provided — 16 dia.bars @ 150 c/c

Area of tension reinforcement provided — $A_{sr.prov} = \pi \times \phi_{sr}^2 / (4 \times s_{sr})$ = **1340** mm²/m

Minimum area of reinforcement - exp.9.1N — $A_{sr.min} = \max(0.26 \times f_{ctm} / f_{yk}, 0.0013) \times d$ = **440** mm²/m

Maximum area of reinforcement - cl.9.2.1.1(3) — $A_{sr.max} = 0.04 \times h$ = **14000** mm²/m

$\max(A_{sr.req}, A_{sr.min}) / A_{sr.prov}$ = **0.64**

PASS - Area of reinforcement provided is greater than area of reinforcement required

Library item: Rectangular single output

Deflection control - Section 7.4

Reference reinforcement ratio — $\rho_0 = \sqrt{(f_{ck} / 1\ N/mm^2)} / 1000$ = **0.005**

Required tension reinforcement ratio — $\rho = A_{sr.req} / d$ = **0.003**

Required compression reinforcement ratio — $\rho' = A_{sr.2.req} / d_2$ = **0.000**

Structural system factor - Table 7.4N — K_b = **0.4**

Reinforcement factor - exp.7.17 — $K_s = \min(500\ N/mm^2 / (f_{yk} \times A_{sr.req} / A_{sr.prov}), 1.5)$ = **1.5**

Limiting span to depth ratio - exp.7.16.a — $\min(K_s \times K_b \times [11 + 1.5 \times \sqrt{(f_{ck} / 1\ N/mm^2)} \times \rho_0 / \rho + 3.2 \times \sqrt{(f_{ck} / 1\ N/mm^2)} \times (\rho_0 / \rho - 1)^{3/2}], 40 \times K_b)$ = **16**

Actual span to depth ratio — h_{stem} / d = **1.1**

PASS - Span to depth ratio is less than deflection control limit

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Crack control - Section 7.3

Limiting crack width	w_{max} = **0.3** mm
Variable load factor - EN1990 – Table A1.1	ψ_2 = **0.6**
Serviceability bending moment	M_{sls} = **65.7** kNm/m
Tensile stress in reinforcement	$\sigma_s = M_{sls} / (A_{sr.prov} \times z)$ = **176.7** N/mm^2
Load duration	Long term
Load duration factor	k_t = **0.4**
Effective area of concrete in tension	$A_{c.eff} = \min(2.5 \times (h - d), (h - x) / 3, h / 2)$
	$A_{c.eff}$ = **104500** mm^2/m
Mean value of concrete tensile strength	$f_{ct.eff} = f_{ctm}$ = **2.9** N/mm^2
Reinforcement ratio	$\rho_{p.eff} = A_{sr.prov} / A_{c.eff}$ = **0.013**
Modular ratio	$\alpha_e = E_s / E_{cm}$ = **6.091**
Bond property coefficient	k_1 = **0.8**
Strain distribution coefficient	k_2 = **0.5**
	k_3 = **3.4**
	k_4 = **0.425**
Maximum crack spacing - exp.7.11	$s_{r.max} = k_3 \times c_{sr} + k_1 \times k_2 \times k_4 \times \phi_{sr} / \rho_{p.eff}$ = **382** mm
Maximum crack width - exp.7.8	$w_k = s_{r.max} \times \max(\sigma_s - k_t \times (f_{ct.eff} / \rho_{p.eff}) \times (1 + \alpha_e \times \rho_{p.eff}), 0.6 \times \sigma_s) / E_s$
	w_k = **0.202** mm
	w_k / w_{max} = **0.675**
	PASS - Maximum crack width is less than limiting crack width

Rectangular section in shear - Section 6.2

Design shear force	V = **91.7** kNm/m
	$C_{Rd,c} = 0.18 / \gamma_C$ = **0.120**
	$k = \min(1 + \sqrt{(200 \text{ mm} / d)}, 2)$ = **1.828**
Longitudinal reinforcement ratio	$\rho_l = \min(A_{sr.prov} / d, 0.02)$ = **0.005**
	v_{min} = 0.035 N$^{1/2}$/mm $\times k^{3/2} \times f_{ck}^{0.5}$ = **0.474** N/mm^2
Design shear resistance - exp.6.2a & 6.2b	$V_{Rd.c} = \max(C_{Rd.c} \times k \times (100 \text{ N}^2/\text{mm}^4 \times \rho_l \times f_{ck})^{1/3}, v_{min}) \times d$
	$V_{Rd.c}$ = **153.5** kN/m
	$V / V_{Rd.c}$ = **0.598**
	PASS - Design shear resistance exceeds design shear force

Horizontal reinforcement parallel to face of stem - Section 9.6

Minimum area of reinforcement – cl.9.6.3(1)	$A_{sx.req} = \max(0.25 \times A_{sr.prov}, 0.001 \times t_{stem})$ = **350** mm^2/m
Maximum spacing of reinforcement – cl.9.6.3(2)	s_{sx_max} = **400** mm
Transverse reinforcement provided	12 dia.bars @ 200 c/c
Area of transverse reinforcement provided	$A_{sx.prov} = \pi \times \phi_{sx}^2 / (4 \times s_{sx})$ = **565** mm^2/m
	PASS - Area of reinforcement provided is greater than area of reinforcement required

Check base design at toe

Depth of section	h = **350** mm

Rectangular section in flexure - Section 6.1

Design bending moment combination 1	M = **111.2** kNm/m
Depth to tension reinforcement	$d = h - c_{bb} - \phi_{bb} / 2$ = **265** mm
	$K = M / (d^2 \times f_{ck})$ = **0.053**
	$K' = (2 \times \eta \times \alpha_{cc}/\gamma_C) \times (1 - \lambda \times (\delta - K_1)/(2 \times K_2)) \times (\lambda \times (\delta - K_1)/(2 \times K_2))$
	K' = **0.207**
	K' > K - No compression reinforcement is required

Lever arm	$z = \min(0.5 + 0.5 \times (1 - 2 \times K / (\eta \times \alpha_{cc} / \gamma_C))^{0.5}, 0.95) \times d =$ **252** mm
Depth of neutral axis	$x = 2.5 \times (d - z) =$ **33** mm
Area of tension reinforcement required	$A_{bb.req} = M / (f_{yd} \times z) =$ **1016** mm²/m
Tension reinforcement provided	20 dia.bars @ 150 c/c
Area of tension reinforcement provided	$A_{bb.prov} = \pi \times \phi_{bb}^2 / (4 \times s_{bb}) =$ **2094** mm²/m
Minimum area of reinforcement - exp.9.1N	$A_{bb.min} = \max(0.26 \times f_{ctm} / f_{yk}, 0.0013) \times d =$ **399** mm²/m
Maximum area of reinforcement - cl.9.2.1.1(3)	$A_{bb.max} = 0.04 \times h =$ **14000** mm²/m
	$\max(A_{bb.req}, A_{bb.min}) / A_{bb.prov} =$ **0.485**

PASS - Area of reinforcement provided is greater than area of reinforcement required

Library item: Rectangular single output

Crack control - Section 7.3

Limiting crack width	$w_{max} =$ **0.3** mm
Variable load factor - EN1990 – Table A1.1	$\psi_2 =$ **0.6**
Serviceability bending moment	$M_{sls} =$ **80** kNm/m
Tensile stress in reinforcement	$\sigma_s = M_{sls} / (A_{bb.prov} \times z) =$ **151.8** N/mm²
Load duration	Long term
Load duration factor	$k_t =$ **0.4**
Effective area of concrete in tension	$A_{c.eff} = \min(2.5 \times (h - d), (h - x) / 3, h / 2)$
	$A_{c.eff} =$ **105625** mm²/m
Mean value of concrete tensile strength	$f_{ct.eff} = f_{ctm} =$ **2.9** N/mm²
Reinforcement ratio	$\rho_{p.eff} = A_{bb.prov} / A_{c.eff} =$ **0.020**
Modular ratio	$\alpha_e = E_s / E_{cm} =$ **6.091**
Bond property coefficient	$k_1 =$ **0.8**
Strain distribution coefficient	$k_2 =$ **0.5**
	$k_3 =$ **3.4**
	$k_4 =$ **0.425**
Maximum crack spacing - exp.7.11	$s_{r.max} = k_3 \times c_{bb} + k_1 \times k_2 \times k_4 \times \phi_{bb} / \rho_{p.eff} =$ **426** mm
Maximum crack width - exp.7.8	$w_k = s_{r.max} \times \max(\sigma_s - k_t \times (f_{ct.eff} / \rho_{p.eff}) \times (1 + \alpha_e \times \rho_{p.eff}), 0.6 \times \sigma_s) / E_s$
	$w_k =$ **0.194** mm
	$w_k / w_{max} =$ **0.647**

PASS - Maximum crack width is less than limiting crack width

Rectangular section in shear - Section 6.2

Design shear force	$V =$ **161** kN/m
	$C_{Rd,c} = 0.18 / \gamma_C =$ **0.120**
	$k = \min(1 + \sqrt{(200 \text{ mm} / d)}, 2) =$ **1.869**
Longitudinal reinforcement ratio	$\rho_l = \min(A_{bb.prov} / d, 0.02) =$ **0.008**
	$v_{min} = 0.035 \text{ N}^{1/2}/\text{mm} \times k^{3/2} \times f_{ck}^{0.5} =$ **0.490** N/mm²
Design shear resistance - exp.6.2a & 6.2b	$V_{Rd.c} = \max(C_{Rd.c} \times k \times (100 \text{ N}^2/\text{mm}^4 \times \rho_l \times f_{ck})^{1/3}, v_{min}) \times d$
	$V_{Rd.c} =$ **170.7** kN/m
	$V / V_{Rd.c} =$ **0.943**

PASS - Design shear resistance exceeds design shear force

Secondary transverse reinforcement to base - Section 9.3

Minimum area of reinforcement – cl.9.3.1.1(2)	$A_{bx.req} = 0.2 \times A_{bb.prov} =$ **419** mm²/m
Maximum spacing of reinforcement – cl.9.3.1.1(3)	$s_{bx\_max} =$ **450** mm
Transverse reinforcement provided	12 dia.bars @ 200 c/c
Area of transverse reinforcement provided	$A_{bx.prov} = \pi \times \phi_{bx}^2 / (4 \times s_{bx}) =$ **565** mm²/m

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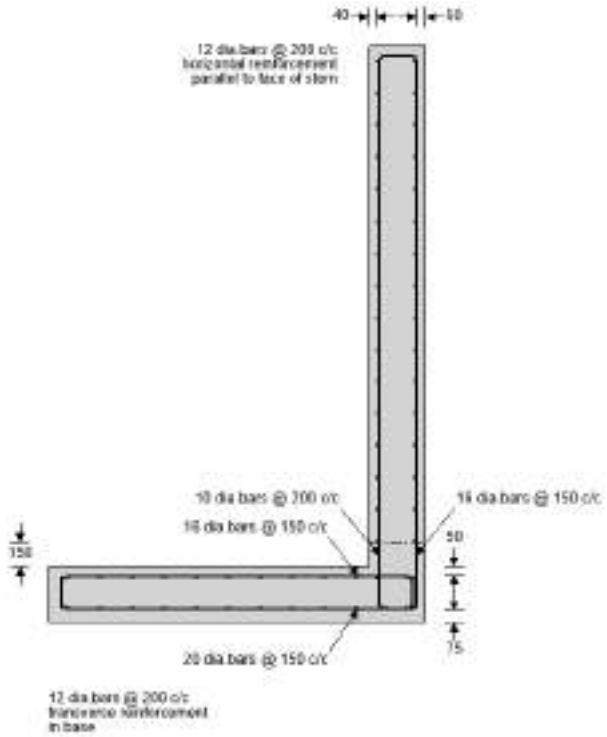
PASS - Area of reinforcement provided is greater than area of reinforcement required



SCI	Tata Steel		v9.0.34.24751
Job Reference:	12 Lyndhurst Gardens	Date:	29/5/2019
Deck Reference:	CF60/1.2_350	Job No:	19050
Company Name:	Symmetrys	Calcs By:	AK
Checked By:	AH		

Full Output

Note: Section Designed to Eurocodes, United Kingdom National Annex

Construction Stage:	PASS	**Max Unity Factor:**	0.37
Normal Stage:	PASS	**Max Unity Factor:**	0.29
Fire Condition:	PASS	**Max Unity Factor:**	0.57
Serviceability:	SATISFACTORY	**Max Unity Factor:**	0.51

***** Section Adequate *****

Floor Plan Data (propped composite construction with ComFlor 60/1.2/S350 decking)

Beam centres	3.60 m	Profile span type	Single
Beam or wall width	200 mm	Propping	Single (at 1/2 span)
Prop width	100 mm		
		Concrete span type	End

Profile Data (ComFlor 60/1.2/S350 decking.)

Depth	60 mm	Pitch of deck ribs	300 mm
Trough width	120 mm	Crest width	130.7 mm
Nominal sheet thickness	1.20 mm	Design sheet thickness	1.16 mm
Deck weight	0.14 kN/m²	Yield strength	350 N/mm²

Concrete Slab (Normal Weight Concrete ; Grade C30/37; Mesh : A393)

Overall slab depth	150 mm		
Concrete characteristic strength	30 N/mm²	Concrete wet density	2550 kg/m³
Modular ratio	10	Concrete dry density	2450 kg/m³
Bar reinforcement :			
Diameter	10 mm	Yield strength	500 N/mm²
Distance from slab soffit	30 mm		
Mesh reinforcement :			
Mesh	A393	Yield strength	500 N/mm²
Cover to Mesh	30 mm	Mesh Layers	Single
Account for End Anchorage	No	Shear connectors per rib	N/A
Diameter of Shear Connectors	N/A		
Screed depth	75 mm	Screed density	2000 kg/m³

Section Properties

*** Note - 1: All values of inertia are expressed in steel units
*** Note - 2: Average inertia is used for deflection calculations for the composite stage
*** Note - 3: Cracked dynamic inertia is used for natural frequency calculations

Deck Profile

Sagging Inertia, Iy	132.910 cm4/m	Area of profile (Net), Ap	1721 mm²/m
Hogging Inertia, Iy	121.600 cm4/m	Effective area of profile	1576.00 mm²/m

Composite

Inertia, Iy - Uncracked	2495 cm4/m	Inertia, Iy - Cracked	1430 cm4/m
Average inertia	1963 cm4/m	Cracked inertia (dynamic)	1625 cm4/m
Shear bond coefficients - Mr	178.39	Kr	0.099400
Concrete volume	0.117 m³/m/m		

Loads Acting on Slab (Actions)

*** Note: Slab subjected to uniformly distributed loads (UDL) ONLY

Imposed (occupancy)	1.50 kN/m²	Partitions	1.00 kN/m²
Ceilings and services	0.50 kN/m²	Finishes	0.50 kN/m²
Self weight of concrete slab (wet)	2.94 kN/m²	Self weight of decking	0.14 kN/m²
Self weight of concrete slab (dry)	2.82 kN/m²	Self weight of screeds	1.47 kN/m²
Construction load	1.50 kN/m²		

Line Loads Perpendicular to Deck Span (Actions)
None

Line Loads Parallel to Deck Span (Actions)
None

Fire Data

Design method	Bar Method	Fire resistance period	60 mins
Non-permanent imposed loads	N/A		

Partial Safety Factors

Actions		Materials	
Permanent, gamma G	1.35	Structural steel - elastic, gamma M0	1.00
Permanent - accidental, gamma GA	N/A	Structural steel - buckling, gamma M1	1.00
Variable, gamma Q	1.50	Concrete, gamma C	1.50
Combination factor - Fire, psi 1	0.70	Reinforcement, gamma S	1.15
Combination factor, psi 0	0.70	Combination factor, psi 2	0.60

Construction Stage

Loadings	@ SLS (kN/m²)	@ ULS (kN/m²)
Self weight of decking	0.14	0.18
Self weight of concrete slab (wet)	2.94	4.41
Reinforcement	0.09	0.13
Total weight of slab	3.17	4.72
Construction live load	0.75	1.13
Construction live load patch	0.75	1.13

Effective Span of Deck
Effective span Le, is the smaller of

1) c/c of supports	= 3.60 m
2) clear span + deck depth	= 1.65 + 60.0 / 1000
	= 1.71 m
Therefore Le	= 1.71 m

Shear Resistance Check (BS EN 1993-1-3 Clause 6.1.5 and 6.1.7.3)

Applied shear	7.30 kN/m			
Web shear resistance, Pv	100.15 kN/m	Unity Factor	0.07	PASS
Applied reaction	14.58 kN/m			
Web crushing resistance, Pw	51.93 kN/m	Unity Factor	0.28	PASS

Bending Resistance Check (BS EN 1993-1-3 Clause 6.1.4.1)

Sagging

Max applied moment	1.97 kNm/m			
Moment resistance	15.21 kNm/m	Unity Factor	0.13	PASS

Hogging

Applied moment	2.33 kNm/m			
Moment resistance	13.07 kNm/m	Unity Factor	0.18	PASS

Combined Effects
Bending and Web Crushing (BS EN 1993-1-3 Clause 6.1.11)

Design unity factor is the worst case of
1. Maximum hogging:
(14.58 / 51.93 + 2.33 / 13.07) / 1.25 = 0.37
2. Maximum reaction:
(14.58 / 51.93 + 2.33 / 13.07) / 1.25 = 0.37
Design unity factor 0.37 PASS

Bending and Shear (BS EN 1993-1-3 Clause 6.1.10)

*** Note: Low shear - This check is not required

Support Interaction Check at Serviceability Limit State (BS EN 1993-1-3 Clause 7.2)

Design unity factor is the worst case of
1. Maximum hogging:
(9.80 / 51.93 + 1.59 / 13.07) / (0.9 * 1.25) = 0.28
2. Maximum reaction:
(9.80 / 51.93 + 1.59 / 13.07) / (0.9 * 1.25) = 0.28
Design unity factor 0.28 PASS

Deflection

Allowable deflection is the lesser of

1) Effective span / deflection limit without ponding	9.50 mm
2) Deflection limit without ponding, absolute maximum value	20.00 mm
3) Slab depth / 10	15.00 mm

Max self weight deflection = 0.55mm <= 9.50mm SATISFACTORY

Normal Stage

Span

The effective composite span is 3.52 m

Loadings	@ SLS (kN/m²)	@ ULS (kN/m²)
Dead (Profile, concrete, reinforcement)	3.05	4.12
Imposed	2.50	3.75
Superimp (Ceiling, services, screed, finishes)	2.47	3.34
Total	8.02	11.21

All line and point described above in 'Loading Details' are applied at the Normal stage

Shear Resistance Check

Vertical Shear (Proprietary Method)

Maximum applied shear 18.72 kN/m
Shear resistance of end diaphragm (ComFlor 225 only) 0.00 kN/m ***test value
Vertical shear resistance in the troughs is the greater of:
1. (0.54 * 282.17 * 120.00) / 1000
2. (0.12 * 2.00 * (100 * 0.01 * 30.00)^1/3) * 282.17 * 120.00) / 1000
= 23.18 kN/m
Vertical shear resistance above the ribs is the greater of:
1. (0.54 * 217.83 * 35.00) / 1000
2. (0.00 * 2.00 * (100 * 0.02 * 30.00)^1/3) * 217.83 * 35.00) / 1000
= 7.16 kN/m
Vertical shear resistance of the decking is:
(1000 / 120.00) * 2 *14953.75 * Cos(22.73) / 1000= 91.95 kN/m
Total vertical shear resistance is:= 122.29 kN/m
Unity Factor = 18.72/122.29 = 0.15 < 1 PASS

Punching Shear (BS EN 1994-1-1 Clause 9.7.6)

N/A - no concentrated loads have been applied

Bending Resistance Check (BS EN 1994-1-1 Clause 9.7.2)

Applied bending moment	15.14 kNm/m	
Depth of concrete stress block	33.28 mm	
Lever arm	100.18 mm	
Compression in concrete	452.55 kN/m	
Moment Resistance	51.74 kNm/m	
Unity Factor = 15.14/51.74 = 0.29 < 1		PASS

Fire Resistance

Effective span in fire	3.45 m	
Fire total UDL	7.28 kN/m²	
Fire free moment	10.84 kNm/m	
Moment resistance	11.68 kNm/m	
Total moment resistance	19.09 kNm/m	
Unity Factor	0.57	PASS

Deflection

Properties

Modular ratio	10.00	
Uncracked section inertia	24952490.00 mm4	
Cracked section inertia	14301820.00 mm4	

Deflection Checks

Imposed load deflection	1.20 mm	
Allowable deflection (20 mm max)	20.00 mm	SATISFACTORY
Total deflection	5.01 mm	
Allowable deflection	9.77 mm	PASS

Dynamic Sensitivity

Dynamic inertia (cracked section)	1625.46 cm4	
Maximum deflection	3.34 mm	
Frequency	9.85 Hz	
Unity Factor = 5.00/9.85 = 0.51 < 1		PASS

Temporary work design

Design of props to top of basement.

Prop force = 55.1 kN/m

Ultimate = 1.6 x 55.1 = 88.2 kN/m

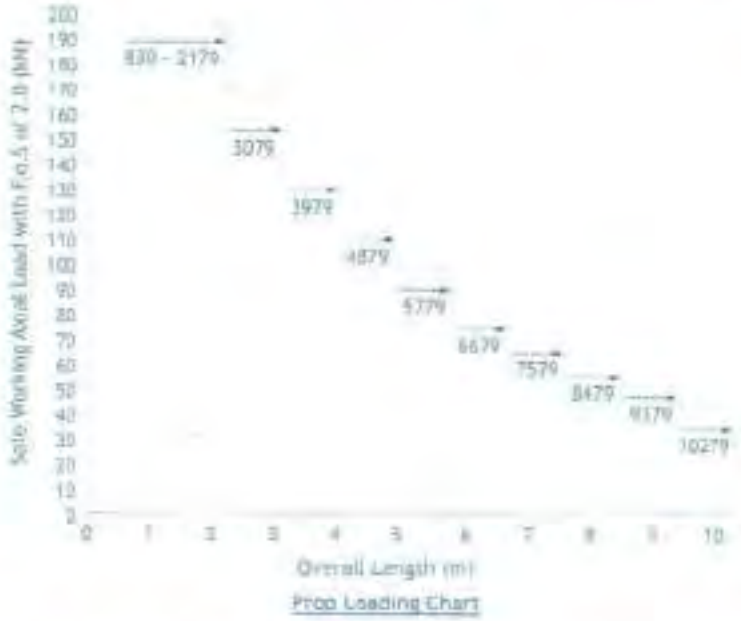
Provide S31KP19 Mayberg Preps (L = 5.7m)

Capacity = 80 kN/m (FoS = 2.0)

Provide props @ 850mm

$80/0.850$ = 94 kN/m > 88.2 → OK.

push pull props - lengths and capacities



Prop Loading Chart

Head of prop will comprise S3/10 or S3/10A used viz:
S3/10 Use A - To prop Mk3 soldiers
S3/10A Use B - To prop vertical members other than soldiers
S3/10A Use C - To prop Mk2 soldiers

For general use a Factor of Safety of 2 is recommended. However, for controlled situations where the loading is predictable a Factor of Safety of 1.7 may be used.

The safe working loads shown in the table are for props used in compression either vertically or horizontally. In horizontal applications, the props should always be used with the soldier webs/tightening holes in the vertical plane.

When used in tension the safe working load should not exceed 120kN.

Mabey tubular props are an alternative to Mk3 Soldiers for any of the applications shown. Tubular props and soldiers should not be combined in any single prop.

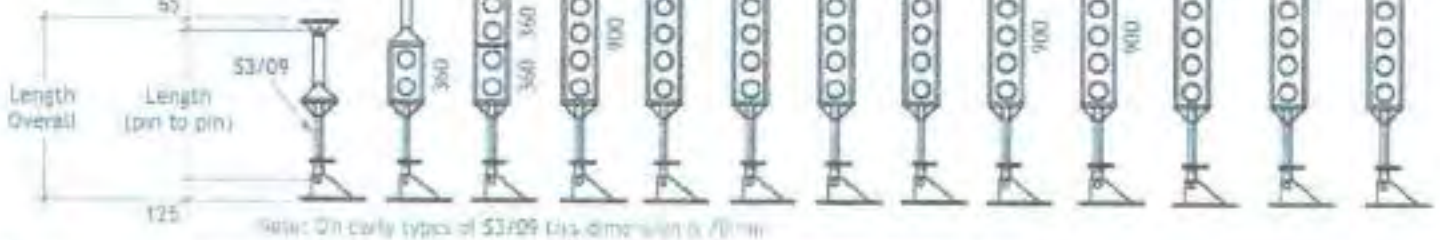
For props a recommended straightness tolerance is given below, indicated by Max Offset Dim (mm). Should the prop fall outside the range shown, the components should be checked for local damage to end plates.

All bolted joints require 6 No. S3/22 bolts.

Intermediate lengths may be obtained by adding 1 or 2 360mm Units (S3/1-360 or S3/24), or in some cases screw jacks can be fixed at each end.

Allowance to be made for elastic shortening of Push Pull Prop = 0.05mm/tonne/metre.

A kit assembly reference is given to assist in ordering the props. The kit includes all parts and bolts necessary depending upon the manner in which the prop is used. The kit assembly reference number must be followed by the A, B or C suffix i.e. a Type 9 Prop to support Mk2 soldiers would be called off as S3/KP/9C.



Note: On early types of S3/09 this dimension is 70 mm

PROP	1	2	3	4	5	6	7	8	9	10	11	12	13
KIT ASSEMBLY REF	S3/KP/1	S3/KP/2	S3/KP/3	S3/KP/4	S3/KP/5	S3/KP/6	S3/KP/7	S3/KP/8	S3/KP/9	S3/KP/10	S3/KP/11	S3/KP/12	S3/KP/13
MAX LENGTH Overall (mm)	1279	1639	1999	2179	3079	3979	4879	5779	6679	7579	8479	9379	10279
MIN LENGTH Overall (mm)	830	1190	1550	1730	2630	3530	4430	5330	6230	7130	8030	8930	9830
WEIGHT (kg)	50	69	87	95	90	113	131	151	182	201	213	231	257
LOAD CAPACITY (FOS 2.0) (kN)	200	200	200	200	170	140	120	100	80	70	60	50	45
LOAD CAPACITY (FOS 1.7) (kN)	200	200	200	200	200	165	140	118	94	82	70	59	53
MAX OFFSET DIM (mm)	2.0	3.0	3.5	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0	22.0

APPENDIX 3

GEOTECHNICAL SITE INVESTIGATION – LMB GEOSOLUTIONS LTD

LMB GEOSOLUTIONS LTD

GROUND INVESTIGATION & ASSESSMENT

12 LYNDHURST GARDENS, LONDON, NW3

May 2019

DOCUMENT RECORD

Document Title	Ground Investigation & Assessment
Site	12 Lyndhurst Gardens, London NW3 5NR
Document Date	3rd May 2019
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	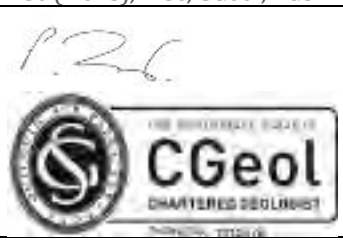

LMB

Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

Company No. 8303397
LMB Home

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EXECUTIVE SUMMARY

Executive Summary

Site Details	12 Lyndhurst Gardens, London NW3 5NR
Proposed Development	The development proposals comprise a new two storey house with partial single storey basement.
Ground & Groundwater Conditions	Made Ground overlying possible Head Deposits and London Clay Formation. Groundwater was recorded at a depth of 4.31m during monitoring but is not considered to form a laterally continuous aquifer unit.
Preliminary Risk Assessment	Very low to Moderate risk rating.
Geotechnical Advice	For traditional strip foundations placed on the competent London Clay at a depth of c. 4.00m a net safe bearing pressure of 120kN/m^2 should be available. The above advice is based on NHBC/BRE guidance and assumes that the proposed basement development and in particular foundations would not be within the influence of any trees or tree routes. Given the nearby structures, it is considered likely that temporary or permanent support will be needed for construction. Coefficient of active earth pressure: Made Ground: 0.30. Possible Head Deposits: 0.30. London Clay: 0.40. Coefficient of passive earth resistance: Made Ground: 3.2. Possible Head Deposits: 3.2. London Clay: 2.7. Buried concrete: DS-1, AC-1s.
Recommendations	The full set of recommendations should be reviewed, but in summary the following are provided: • It is recommended that maintenance and construction workers involved in below ground works adopt appropriate management procedures to mitigate potential risks. • It is recommended that movement monitoring is undertaken as part of basement construction. • It is recommended that the potential for heave and uplift due to groundwater pressure are considered within basement design.
This executive summary is not a stand alone document and should be read in conjunction with the full report text, including conclusions and recommendations.	

INTRODUCTION

Introduction

AUTHORISATION

LMB Geosolutions Ltd (LMB) was instructed by Symmetrys Ltd (Consultant Engineers) on behalf of Mr Daniel Burbidge (the Client) in March 2019 to undertake ground investigation and assessment works in relation to the proposed basement development at 12 Lyndhurst Gardens, London NW3 5NR (the Site).

PROJECT AND SITE DETAILS

Site Address	12 Lyndhurst Gardens, London NW3 5NR (the Site). A Site Location Plan is provided as **Figure 1**.
Proposed Development	The site currently comprises part of the lower ground floor and first floor and rear garden area of a four-storey semi-detached residential property. It is understood that the client wishes to construct a new single storey basement beneath part of the footprint and rear garden of the lower ground floor. A development schematic is provided in **Appendix A**.
Background	The scope of works and requirements of this report were based on the information provided by Symmetrys (Consultant Engineers) within the following document: • Site Investigation Specification 12 Lyndhurst Gardens, London NW3 5NR (ref. 19050, 1st March 2019) and associated site investigation plan

AIMS & OBJECTIVES

This report aims to provide information sufficient to meet the requirements of the specification provided by the Consultant Engineers.

SCOPE OF WORKS

The following scope of works has been completed:

Desk Study (Preliminary Risk Assessment)

- Completion of a site reconnaissance survey to make a preliminary assessment of the site and immediately surrounding area;
- Review of information on the planning portal for records pertaining to development on the site and in the neighbouring area;

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- Acquisition of a Groundsure enviro insight report and review of data for the area to assess historical land uses on and immediately surrounding the site;
- Assessment of the 'sensitivity' of the site location as determined by factors such as hydrogeology, proximity of watercourses, neighbouring land use, ecologically sensitive uses and geology detailed on British Geological Survey (BGS) maps; and
- Completion of an interpretive report (included within the main ground investigation report) that includes:
    - Details of current site conditions based on the reconnaissance survey;
    - Production of a preliminary conceptual site model; and
    - Provision of a Preliminary Risk Assessment outlining potential land contamination issues associated with the proposed development.

Ground Investigation & Assessment

- Site set up including liaison with Consultant Engineers, Client and appointment of sub-contractors;
- Mobilisation to site and transport of the rig to the proposed location;
- Completion of 1No. dynamic (windowless) sampler boreholes to a depth of 10.0m below ground level (bgl) with insitu testing and collection of disturbed samples for laboratory testing;
- Completion of 2no. hand excavated trial pits to expose and record existing building foundations and enable collection of soil samples for laboratory testing;
- Supervision and geological logging of the soil arisings in accordance with BS5930 by an appropriately experienced geo-environmental engineer;
- Installation of 1no. monitoring well to depths of 5.0m bgl and return monitoring of groundwater levels on 1no. occasion;
- Geotechnical laboratory testing of the soil samples for an appropriate suite of determinands (including pH, sulphate, atterberg limits, and moisture content);
- Chemical analysis of 2no. sample of Made Ground, including Waste Acceptance Criteria (WAC);
- Completion of a factual and interpretive report that includes;
    - Details of the ground and groundwater conditions encountered;
    - Schematic sections of exposed foundations;
    - Presentation of chemical analytical results;
    - Geotechnical laboratory testing and provision of advice on the material properties of the shallow soil horizon including parameters to aid in retaining wall design and foundation options; &
    - Conclusions and recommendations.

CONTRIBUTORS

The desk study section of this report has been compiled by Christopher Hall, an environmental consultant with an MSc in Applied Environmental Hydrogeology and over 7 years of experience. Christopher specialises

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in contaminated land and hydrogeology having worked on a wide range of investigations and assessments across a multitude of sectors.

This report has been reviewed and authorised by Philip Lewis, a hydrogeologist and chartered Geologist with over nineteen years experience as a geoscience professional, including over fifteen years experience as a professional adviser (consultant) in hydrogeology, engineering geology and contaminated land.

LIMITATIONS

LMB has prepared this report solely for the use of the named Client and those parties with whom a warranty agreement and/or assignment has been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from LMB and the Client.

LMB accepts no responsibility or liability for:

a) the consequences of this document being used for any purpose or project other than for which it was commissioned, and

b) issue of this document to any third party with whom an agreement has not been executed.

The risk assessment and opinions provided, among other things, take in to consideration currently available guidance and best available techniques relating to acceptable contamination concentrations and interpretation of these values. No liability can be accepted for the retrospective effects of any future changes or amendments to these value.

Preliminary Risk Assessment

A Preliminary Risk Assessment (PRA) has been undertaken and is presented in this section in order to provide further background and context for the ground investigation and assessment presented in the later sections of this report.

DATA SOURCES

The following data sources have been used to inform the PRA:

- British Geological Survey – 1:50,000 Geological Sheet 256, North London (Solid & Drift);
- British Geological Survey borehole archive records;
- Environment Agency Groundwater Vulnerability Mapping (1:100,000 series) Sheet 40, Thames;
- Information contained on the gov.uk website (https://flood-warning-information.service.gov.uk/long-term-flood-risk/map);
- NERC (2008). UK Hydrometric Register;
- River Basin Management Plan (RBMP). Thames River Basin District (2009); and
- Groundsure Enviro Insight Report (ref. GS-5940803, 11th April 2019).

SITE DESCRIPTION

A representative of LMB completed a site walkover survey on Wednesday 20th February 2019 that included external areas. A photographic record is provided as **Appendix B**.

The site currently comprises a four storey (including existing lower ground floor & roof) semi-detached residential property with steps providing access to the lower ground floor (see Plates 1 & 2). The rear garden area is split level (approximately 1.45m difference) with the southern boundary adjoining the rear gardens of Belsize Lane (see Plates 3 & 4). The neighbouring properties either side of the subject property also include lower ground floor levels/

The site is located on the fairly flat lying, east-west oriented section of Lyndhurst Gardens and opposite the site the road turns approximately north along a gentle slope. The Marie Curie Hospice Hampstead is located opposite the site (see Plates 5 & 6).

No evidence of existing building damage such as cracked bricks was observed during the reconnaissance survey.

PRELIMINARY RISK ASSESSMENT

ENVIRONMENTAL SETTING

Published Geology & Aquifer Designations	Reference to British Geological Survey (BGS) Digital Map (1:50,000) and within the Groundsure report (ref. GS-5940803) indicates the site is directly underlain by the London Clay Formation. No superficial deposits are anticipated at the site based on available sources of information. Available mapping indicates that the Claygate Member (bedrock) overlies the London Clay Formation, approximately 50m north of the site. Available mapping indicates that Head Deposits could potentially be present at the site. The London Clay Formation is designated 'Unproductive Strata' and estimated to be approximately 30m in thickness in this area.
Local Hydrology	According to Groundsure report (ref. GS-5940803) there are no surface water courses within 250m of the site. The nearest main surface water feature are ponds, located within Hampstead Heath, approximately 800m northeast of the site. Reference to *Lost Rivers of London* (Barton, N.J, 1982) and Groundsure report (ref. GS-5940803) indicates that a culverted water course refred to as 'The Fountains' (possibly a tributary of the former River Tyburn) is located approximately 270m east of the site. Information relating to the Thames region within the UK Hydrometric Register indicates that the average annual rainfall in the region is 710mm. Information contained in the Groundsure report (ref. GS-5940803) and on the gov.uk website indicates that the site is located in an area at Very Low risk of flooding from rivers and sea. The site is an area with a low risk of surface water flooding, although the area approximately 15m north is shown to be at a low to high risk from surface water flooding. Information in the Groundsure report (ref. GS-5940803) indicates that the site is located in an area of 'limited potential' to groundwater flooding. It should be noted that this factual information does not constitute an assessment of potential flood risk.
Resource Potential & Ecological Quality	**Surface Water**: There are no surface water features within 250m of the site.
	Groundwater: The groundwater in the London Clay Formation is designated Unproductive Strata and as such is not characterised as a groundwater body within the relevant RBMP. In addition, the site is not located within an EA designated Source Protection Zone (SPZ).

PRELIMINARY RISK ASSESSMENT

Surrounding Land Use	The surrounding land uses are predominantly residential with associated amenities. Royal Free Hospital is located approximately 400m northeast of the site.
Local Designations	Reference to information contained on the Groundsure Enviro Insight Report (ref. GS-5940803) indicates that there are no designations (e.g. Sites of Special Scientific Interest) with 500m of the site.

SUMMARY OF LIKELY GROUND & GROUNDWATER CONDITIONS

The information presented in the following sections is based on review of available BGS borehole logs for the local area and information presented within the Groundsure Enviro Insight Report (ref. GS-5940803).

The interpretation of this information should be considered preliminary pending completion of site specific ground investigation works.

Local Ground Conditions

The nearest BGS borehole log is located approximately 350m east of the site (TQ28NE38). The borehole log did not provide detailed strata descriptions; however, Made Ground was reported to approximately 1.2m bgl, underlain by 'clay', considered to be the London Clay Formation to a proven depth of approximately 6.0m bgl.

LMB have previously completed ground investigation works at the neighbouring property (12 Lyndhurst Gardens) with the following ground conditions encountered:

Strata	Depth Range to Top (m bgl)	Depth Range to (Base (m bgl)	Summary Description
Made Ground	Ground Level	2.10 – 3.50	The ground surface was found to comprise grass. The Made Ground soils were typically found to comprise gravelly to slightly gravelly and locally sandy clay with varying proportions of brick, chalk, carbonaceous material and roots.
Possible Made Ground	2.10	2.80	Possible Made Ground was observed in BH1 and was found to comprise soft sandy clay.
London Clay Formation (1)	2.80 – 3.50	10.00 – 10.45	The London Clay was typically found to comprise an upper (c.5.50-6.00m) more weathered sequence of soft becoming firm clay with occasional silty fine sand partings and selenite crystals. The less weathered London Clay was typically found to comprise a sequence of stiff fissured clay.

(1) Base not determined.

PRELIMINARY RISK ASSESSMENT

POTENTIALLY CONTAMINATIVE HISTORICAL LAND USE

A review of historical data within the Groundsure Enviro Insight Report (GS-5940803) has been completed to identify pertinent potentially contaminative previous land uses on site and within 250m of the site with the results summarised in the table below:

Date	On Site Features	Off Site Features
1866	Tunnel Potential infilling of pond Potential infilling of tunnel	Unspecified pit approximately 40m north Unspecified shaft approximately 160m west Potential infilling of unspecified pit approximately 40m north Potential infilling of unspecified shaft approximately 160m west
1870	-	Unspecified tank approximately 130m north
1871	-	Unspecified tank approximately 80m northwest Unspecified tank approximately 175m east
1896	-	Unspecified tank approximately 220m north
1920	-	Potential infilling of airshaft approximately 195m west
1935	-	Unspecified tank approximately 65m northeast Unspecified tank approximately 170m southeast
1953	-	Electricity substation approximately 165m north Garage approximately 135m southwest Garage approximately 225m northeast
1955	-	Garage approximately 135m southwest
1957	-	Tunnels approximately 245m west Potential infilling of tunnels approximately 245m west
1958	Tunnel Potential infilling of tunnel	Tunnel approximately 25m north Potential infilling of tunnel approximately 25m north
1965	Tunnel	Tunnel approximately 25m north

PRELIMINARY RISK ASSESSMENT

Date	On Site Features	Off Site Features
	Potential infilling of tunnel	Garage approximately 225m northeast Potential infilling of tunnel approximately 25m north
1966	-	Garage approximately 225m northeast
1968	-	Tunnels approximately 245m west Potential infilling of tunnels approximately 245m west
1973	-	Tunnels approximately 245m west Potential infilling of tunnels approximately 245m west
1974	Tunnel Potential infilling of tunnel	Tunnel approximately 25m north Electricity substation approximately 110m east Electricity substation approximately 225m east Potential infilling of tunnel approximately 25m north
1977	-	Electricity substation approximately 95m west
1985	-	Electricity substation approximately 225m east
1986	-	Electricity substation approximately 50m south Electricity substation approximately 95m west
1989	-	Tunnels approximately 245m west Electricity substation approximately 225m east Potential infilling of tunnels approximately 245m west
1991	-	Electricity substation approximately 50m south Electricity substation approximately 55m south Electricity substation approximately 95m west Electricity substation approximately 225m east
1996	Tunnel	Tunnel approximately 25m north

Date	On Site Features	Off Site Features
	Potential infilling of tunnel	Potential infilling of tunnel approximately 25m north

Summary of Site History

A review of historical mapping suggests that from c. 1850 the site comprised open land. Historical mapping indicates that by c. 1895 the site was occupied by the existing building and that there was mass residential development of the surrounding area.

Selected Historical Plans are provided in **Appendix C**.

REVIEW OF PLANNING HISTORY

A search of planning applications on the London Borough of Camden website has been completed to review any existing and proposed development in the vicinity of the site from 2010 onwards. Various granted applications were identified for the site (12 Lyndhurst Gardens), which include applications in 2010 (2010/2580/T for tree works), 2012 (2012/5713/T for tree works), 2014 (2014/4740/P for garden alterations), 2017 (2017/3309/T for tree works) and 2018 (2018/2351/L for window replacements).

Various planning applications have been submitted in the site-wide area which include proposed basement excavations. A planning application was submitted in 2018 (2018/1905/P) at Flat 1, 10 Lyndhurst Gardens, for 'excavation of basement beneath proposed outbuilding and rear curtilage'. The application was refused due to 1) the proposed outbuilding was excessively large, and 2) 'the proposed basement by reason of its scale would form an excessive and unsympathetic addition to the host property, contrary to policy A5 (Basements) of the London Borough of Camden Local Plan (2017)'.

A planning application was submitted in 2016 (2016/1785/P) at 16A Lyndhurst Gardens, for 'additional basement construction information' for the original planning permission (2013/5916/P) for 'erection of a single storey dwelling with two level basement'. The planning application was granted.

ENVIRONMENTAL & PERMITTING DATA

The table below provides a summary of the environmental and permitting data for the site and surrounding area:

Item	On Site	0 – 250m	Description
Part A (2) and Part B Activities	0	1	An active Part B Permit is located approximately 90m southwest of the site for 'dry cleaning'.

PRELIMINARY RISK ASSESSMENT

Item	On Site	0 – 250m	Description
Discharge Consents	0	0	-
Pollution Incidents	0	0	-
Current Industrial Data	0	6	The nearest current industrial land use is an electricity substation located approximately 60m south of the site. Other pertinent activities include further electricity substations located approximately 95m southwest and 115m east of the site.
Local Authority Pollution Prevention Controls	0	0	-
Registered Radioactive Substances	0	0	-
IPC & IPPC Authorisations	0	0	-
Historical & Registered Landfills	0	0	-
Waste Sites	0	0	-

BELOW GROUND ASSETS

The Consultant Engineers consulted Network Rail prior to undertaking the ground investigation works to obtain information regarding the location of the rail tunnels beneath the rear garden of the site.

Exploratory hole locations and in particular the borehole location was positioned by the Consultant Engineers in accordance with the information provided.

ENVIRONMENTAL SENSITIVITY

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

- The site is located in a predominantly residential area;
- The site is underlain by the London Clay Formation, which is designated as Unproductive Strata;

- The site is not located within an SPZ and there are no active licensed groundwater abstractions located within 250m of the site;
- The site is located within an area with Very Low risk of flooding (rivers and sea);
- The site is part located within an area with High risk of surface water flooding;
- The site is located within an area of 'limited potential' to groundwater flooding;
- The nearest surface water feature is located approximately 800m northeast of the site; and
- There are no recorded designated sensitive land uses within 500m of the site.

PRELIMINARY CONCEPTUAL SITE MODEL

The information presented in the previous sections of this report and within the former Environment Agency/DEFRA document; Priority Contaminants for the Assessment of Land (CLR8)[1] have been used to complete a Preliminary Conceptual Site Model (PCSM) that details the potential contaminant sources, pathways and receptors.

The PCSM is presented in the table below:

Potential Contaminant Sources	On-site	• Potential infilling of a pond and tunnel with material of an unknown source and composition.
	Off-site	• Tunnels and infilled land within 25m. • Electricity substation within 50m. • Tanks within 60m. • Dry cleaners within 100m. • Garage within 135m.
Associated Contaminant	On-site	• Contaminants associated with Made Ground including heavy metals, asbestos and organic contaminants.
	Off-site	• Heavy metals and inorganic contaminants (including Polychlorinated biphenyls). • Organic contaminants (including petroleum hydrocarbons). • Bulk ground gases & volatile vapours.
Receptors		• Future Site Users. • Neighbouring residents. • Maintenance and construction workers (acute risk only). • New built development.

[1] This document has been withdrawn but is considered to remain useful in proving technical background for identifying potential sources of contamination and designing ground investigation works.

Pathways to Receptors	• Direct contact, inhalation and ingestion of contaminants within any shallow soils (Acute risk during below ground construction and maintenance). • Migration of ground gas & volatile vapours.

POLLUTANT LINKAGE ASSESSMENT

The likelihood of pollutant linkages being present between the potential contaminant sources, pathways and receptors identified in the PCSM are outlined in the table below:

Pathway Linkage	Likelihood of Pollutant Linkage	Consequences	Risk Rating	Reasoning
Future Site Users (Direct exposure pathway)				
Ingestion/Dermal Contact/Inhalation (Site Users).	Low	Medium	Moderate/Low	Potential on-site sources of contamination have been identified (potential infilling of ponds and tunnels). However, the basement excavation will likely remove a large proportion of Made Ground and potentially impacted soils. Potential exposure for maintenance and construction workers will be acute and it is assumed they will adopt appropriate management procedures to mitigate potential risks.
Ingestion/Dermal Contact/Inhalation (Maintenance and Construction Workers).	Unlikely	Medium	Low	
Future Site Users (Indirect exposure pathway)				
Enclosed space accumulation of ground gas.	Low	Severe	Moderate	Potential sources of ground gas and volatile vapours from on-site (infilling of ponds and

Pathway Linkage	Likelihood of Pollutant Linkage	Consequences	Risk Rating	Reasoning
Outdoor volatile vapour exposure	Low	Medium	Moderate/Low	tunnels) and off-site (infilling of tunnels, historic tanks and garage all within 135m) sources have been identified. Off-site sources of ground gas and volatile vapours are separated from the site by a significant thickness of low permeability London Clay as well as buildings and below ground structures such as existing basements and utility infrastructure. Furthermore, the basement excavation will likely remove a large proportion of Made Ground at the site. However, the potential risk from ground gas and volatile vapours cannot be discounted.
Ingress into potable water supply pipes	Low	Medium	Moderate/Low	Potential on-site sources of contamination have been identified. Confirmation with the statutory undertaker is recommended.
Risks to Buildings via accumulation of ground gas in enclosed spaces and sub-floor voids.	Low	Severe	Moderate	Potential sources of ground gas and volatile vapours from on-site and off-site sources have been identified. Off-site sources of ground gas and volatile vapours are

Pathway Linkage	Likelihood of Pollutant Linkage	Consequences	Risk Rating	Reasoning
				separated from the site by a significant thickness of low permeability London Clay as well as buildings and below ground structures such as existing basements and utility infrastructure. Furthermore, the basement excavation will likely remove a large proportion of Made Ground at the site. However, the potential risk from ground gas and volatile vapours cannot be discounted.
Water Environment				
Contaminant migration on to neighbouring land.	Unlikely	Medium	Low	Potential on-site sources of contamination have been identified (potential infilling of ponds and tunnels). However, the basement excavation will likely remove a large proportion of Made Ground and potentially impacted soils. The site is directly underlain by the London Clay Formation and is considered unlikely to support a groundwater unit capable of significant contaminant migration.
Contaminant migration from neighbouring land.	Unlikely	Medium	Low	
Contamination of groundwater	Unlikely	Medium	Low	

Pathway Linkage	Likelihood of Pollutant Linkage	Consequences	Risk Rating	Reasoning
Contamination of surface water	Unlikely	Medium	Low	The nearest surface water feature is located approximately 800m northeast of the site. Given the distance from the site and that the London Clay Formation is not considered to be capable of supporting a groundwater unit, surface waters have been discounted as a potential receptor.
Foundation Piling				
Creation of a pathway between any near surface contaminants and the underlying aquifers.	Unlikely	Mild	Very Low	Potential on-site sources of contamination have been identified (potential infilling of ponds and tunnels). However, the basement excavation will likely remove a large proportion of Made Ground and potentially impacted soils. If a piled foundation solution is adopted there is a substantial thickness of low permeability London Clay Formation between potential contaminants and sensitive aquifers (e.g. Principal Chalk Aquifer).
Overall Risk Rating			**Very Low to Moderate**	

Ground Investigation & Findings

INTRODUCTION

The ground investigation works were undertaken on 1st April 2019 and comprised the progression of 1no. dynamic (windowless) sampler boreholes to 10.0m below lower ground level (bgl) and 2no. hand excavated trial pits to depths of 1.00m and 1.48m bgl with insitu testing and sampling of soils for laboratory testing (see **Figure 2**).

Groundwater monitoring was undertaken following completion of the fieldworks on 11th April 2019.

Details of the ground investigation completed, along with the findings of the investigation, are provided in the following sections. The exploratory hole logs and laboratory results are presented in **Appendix D, E** and **F** respectively.

Guidance Documents

Details of the best practice guidance documents and reference information used in undertaking the ground investigation and assessment are provided at the end of this report (see REFERENCES & GUIDANCE).

INVESTIGATION STRATEGY

The ground investigation was designed based on the requirements of the Consultant Engineers set out in the Site Investigation Specification 12 Lyndhurst Gardens, London NW3 5NR (ref. 19050, 1st March 2019) and associated site investigation plan.

Soil Chemical Analysis & Laboratory Testing

Soil samples were submitted to the UKAS and MCERTS accredited laboratories of i2 Analytical for chemical analysis and geotechnical testing.

The results of the geotechnical and chemical analysis (including waste acceptance criteria testing) are presented in **Appendix E** and **F** respectively.

GROUND & GROUNDWATER CONDITIONS

Ground Conditions

The table below provides a summary of ground conditions encountered with full descriptions provided in the associated exploratory hole logs provided in **Appendix D**:

GROUND INVESTIGATION & FINDINGS

Strata	Depth Range to Top (m bgl)	Depth to Base (m bgl)	Summary Description
Made Ground(1)	Ground Level	1.00 – 2.00	The Made Ground soils typically comprise gravelly sand and slightly sandy slightly gravelly clay with varying proportions of brick gravel and rare cobbles.
Possible Head Deposits (2)	2.00	2.10	In location BH1 found to comprise CLAY with occasional sub-rounded to rounded medium flint gravel.
London Clay Formation (2)	2.10	10.00	The London Clay Formation was found to comprise a sequence of soft to firm becoming firm to stiff fissured CLAY.

(2) Base not encountered in all locations.

(3) Only encountered in BH1.

(4) Base not determined.

Comparison with Neighbouring Investigation

As outlined, LMB has previously completed ground investigation works in the neighbouring property (10 Lyndhurst Gardens) and a summary of the ground conditions encountered has been provided in the Local Ground Conditions section.

The ground conditions encountered are similar to those recorded in the neighbouring property.

The results of these previous ground investigation works have been appraised for comparative purposes and the data has not been adopted within the current ground investigation and assessment.

Visual and Olfactory Observations

No visual or olfactory evidence of contamination was observed during the ground investigation works. However, Made Ground soils were encountered and can be indicative of the presence of contaminants.

Groundwater Conditions

No groundwater strikes were recorded during the ground investigation works. During return monitoring, groundwater was recorded at a depth of between 4.31m bgl.

Groundwater is commonly recorded within the London Clay Formation during monitoring. However, rather than being representative of a permanent and laterally continuous aquifer unit, the groundwater is present as discrete units within (for example) micro fissures and local mudstone horizons and the recorded groundwater level will most likely be reflective of the pore water pressures within these discrete features.

Characteristic Values of Soil Parameters

A summary of the geotechnical properties of the strata based on the field and laboratory testing is provided in the table below.

Soil Property	**Stratum**		
	Made Ground	Possible Head Deposits	London Clay Formation
Insitu SPT 'N' Value	2	8	10 – 45
Undrained shear strength (kN/m^2) – hand shear vane	-	-	45 – 90
Plasticity Index (%)	-	-	22 – 47
Moisture Content (%)	13 – 14	-	17 – 23
pH	9.7	-	8.0
Water Soluble Sulphate (g/l)	0.033 – 0.090	-	0.40

Geotechnical Advice

INTRODUCTION

The site currently comprises part of the lower ground floor and first floor and rear garden area of a four-storey semi-detached residential property. It is understood that the client wishes to construct a new single storey basement beneath part of the footprint and rear garden of the lower ground floor.

Based on development drawings provided, the following assumptions have been made:

- The formation level for the proposed basement will be at approximately 4.00m bgl.
- The load from the existing four storey structure is in the region of 45-55KN/m^2.
- There will be no significant changes in elevation over the proposed development.
- Foundations will not be eccentrically loaded.

GROUND CONDITIONS SUMMARY

The ground conditions encountered in the exploratory hole comprise Made Ground overlying a thin layer of possible Head Deposits which in turn overlie soft to firm and firm to stiff London Clay Formation.

No groundwater strikes were recorded during the ground investigation works. During return monitoring, groundwater was recorded at a depth of between 4.31m bgl.

Groundwater is commonly recorded within the London Clay Formation during monitoring. However, rather than being representative of a permanent and laterally continuous aquifer unit, the groundwater is present as discrete units within (for example) micro fissures and local mudstone horizons and the recorded groundwater level will most likely be reflective of the pore water pressures within these discrete features.

FOUNDATION OPTIONS

General

Based on the information supplied, the formation level of the basement will be at approximately 4.00m bgl. As such it has been assumed that formation level for foundations will be on the firm London Clay Formation soils.

The London Clay is classified as high plasticity and has a high swelling/shrinkage potential on change of moisture content. In accordance with NHBC and BRE guidance a minimum founding depth of 1.0m is required (before consideration of any other factors such as loads or tree influence). However, laboratory testing does suggest that at presumed formation level the presence of locally more sandy soils results in a medium rather than high plasticity properties, although these conditions may not be extensive across the proposed basement area.

GEOTECHNICAL ADVICE

Structures constructed within influencing distance of trees (whether on or off site and whether to remain or be removed), should be constructed in accordance with NHBC and BRE guidance.

Potential Influence of Trees

Structures constructed within influencing distance of trees (whether on or off site and whether to remain or be removed), should be constructed in accordance with NHBC and BRE guidance.

Reference to an arboriculture survey (ref. AR/MF/038/018, 5th April 2018) provided by the Consultant Engineers suggests that a 12m high Ash tree is present in the rear garden area where the proposed basement will extend.

Reference to the NHBC and BRE guidance indicates that Ash is a broad-leafed moderate water demand tree. Based on the results of the ground investigation, lab testing and on the NHBC/BRE guidance the minimum founding depths due to the presence of this tree would be >2.50m bgl. The formation level of the basement is c. 4.00m bgl and thus foundation should conform with the NHBC/BRE guidance.

Foundations that are carried deep to minimise lateral stresses on existing adjacent foundations/due to tree influence may be stepped up, in accordance with a suitable specification, such as BS8004:1986, as long as a suitable founding stratum is present at shallower depth.

If trees are to be removed, the roots should be grubbed out and foundations extended to below the zone of disturbance created by this activity. Any removal should be undertaken following consultation with a suitably qualified arboriculture consultant.

Spread Foundations

Based on the findings of the ground investigation and the subsequent laboratory testing it has been concluded that for traditional spread foundations (placed on the competent firm London Clay) at the assumed formation level of c.4.00m bgl a net safe bearing pressure of approximately 120kN/m^2 should be available.

The bearing pressure is based on a factor of safety of 3 to ensure that settlement remains within normally acceptable limits. The above advice assumes that the proposed basement development and in particular foundations would not be within the influence of any trees or tree routes.

It is recommended that the undrained shear strength of soils at formation level be confirmed using a hand shear vane and should exceed 60kN/m^2.

Piled Foundations

Based on the proposed development and the ground conditions encountered it is considered unlikely that a piled foundation would be the most feasible solution. However, it is possible that sheet piling (or similar) may be considered as part of the temporary works.

GEOTECHNICAL ADVICE

GROUND STABILITY & RETAINING STRUCTURES

Retaining walls constructed in open cut would be the preferred solution but given the nearby residential structures it is considered likely that temporary support will be needed for construction.

Groundwater was encountered above formation level and as such the stability of unsupported excavations at the site should not be relied upon. Zones loosened by the removal of existing and relict construction may be particularly unpredictable and liable to collapse.

It may be beneficial to install the retaining wall and floor slab sequentially to provide propping and lateral restraint, which could help to minimise deflections. It is likely that this will need to be given particular consideration beneath the party wall of the adjoining properties.

Safe working conditions should be ensured where persons are required to work in excavations. It is recommended that reference be made to CIRIA Report No. 97," Trenching Practice" 1992.

The parameters presented in the table below may be considered to assist in the design of retaining walls.

Strata	**Depth Range (m bgl)**		**Effective Angle of Shear Resistance** (2)	**Coefficient of Active Earth Pressure (Ka)** (2)	**Coefficient of Passive Earth Resistance (Kp)** (2)	**Bulk Density**
	Top	**Base**				
Made Ground	Ground Level	1.00 – 2.00	27	0.30	3.2	1.70(1)
Possible Head Deposits	2.00	2.10	28	0.30	3.2	1.80(1)
London Clay	2.10	10.00	22	0.40	2.7	1.83 – 2.35(3)

(1) Assumed value based on literature information.
(2) Based on soil properties and reference to BS8002 & Tomlinson, M.J. (1986) for a free standing wall.
(3) Literature values taken from Forster (1997).

BURIED CONCRETE

In accordance with BRE Special Digest 1 (2005), the results indicate that the following design sulphate classes and Aggressive Chemical Environment for Concrete (ACEC) classes would apply:

Strata	**Design Sulphate Class**	**ACEC Class**
Made Ground	DS-1	AC-1s
Possible Head Deposits		
London Clay Formation		

GEOTECHNICAL ADVICE

ADDITIONAL CONSIDERATIONS

Existing Structures

It is recommended that any existing buried construction that will underlie the new development is broken out and removed. However, if buried construction (such as existing foundations) are to remain close to the new structure then care should be taken to avoid interaction i.e. to prevent the slab 'breaking its back' over the existing construction.

Potential for Heave, Settlement & Inward Yielding

The laboratory testing on the London Clay Formation suggests that it is typically a high plasticity clay and that the possible Head Deposits are medium plasticity.

The removal of the overburden during the excavation of the partial basement is likely to result in some heave and inward yielding of the soils at formation level and possibly a subsequent settlement of the soils outside the excavation. Based on the ground investigation data, the London Clay at formation level is anticipated to comprise firm clay and so the potential effects maybe limited by their relatively low compressibility (as compared to soft clay soils). Inward yielding in firm to stiff clays is typically in the range of 5-40mm (Tomlinson, M.J. (1986).

The total uplift will be a function of the soil heave pressure and water pressure, it is anticipated that almost half of this will be immediate upon excavation, while the remainder would be long term. The estimated depth of excavation is c. 4.00m below current ground level and assuming an unsaturated unit weight of 20kN/m^3 and accounting for groundwater within the London Clay, the estimated unload due to the excavation would be in the order of 80kN/m^2.

It is anticipated that following excavation and construction of the basement, the load imposed by the new sub-structure will be less than the overburden pressure at formation prior to excavation.

However, it is anticipated the basement slab would not be loaded if strip footings are adopted. In this case a suspended basement floor slab may be appropriate, constructed with suitable compressible void formers that can accommodate the expected ground heave.

Based on the information presented above it is recommended that the basement design takes into account the following:

- The potential for short term and long-term heave and inward yielding during construction and following construction.
- The potential for differential heave that will occur in the areas of the basement beneath the existing building footprint and those beneath the rear garden area.
- The potential for groundwater to cause both lateral and uplift pressure.

GEOTECHNICAL ADVICE

Management of Formation Level

Should pockets of inferior material be present during the inspection of the foundation excavation, they should be removed and replaced with well graded, well compacted hardcore or lean mix concrete. The excavated surface should be protected from deterioration and a blinding layer of concrete used where foundations are not completed without delay. Any surface or perched water should not be allowed to collect in the base of excavations since the clay is prone to rapid deterioration in the presence of water, with loss of their favourable bearing properties.

Groundwater & Groundwater Management

Significant dewatering is not anticipated during the construction of these foundations but some groundwater seepages and/or surface water infiltration into the excavation should be anticipated. It is anticipated that any seepages or rates of inflow of groundwater would be slow and it is recommended that seepages be dealt with by pumping from sumps.

Potential Project Risk

It should be noted that the excavation of the basement may undermine the adjacent property and could lead to settlement in gardens and damage to buildings and below ground services. It is recommended that the contractor should allow for suitable mitigation measures that may include:

- A survey of existing ground levels and buildings;
- A survey of existing below ground services;
- Monitoring of adjacent buildings during construction; and
- Monitoring of adjacent ground levels during construction.

REFERENCES & GUIDANCE

1. Environment Agency/Defra (2002). Model procedures for the Management of Land Contamination (CLR 11).
2. Environment Agency/Defra. Contaminated Land Statutory Guidance (April 2012).
3. BS 10175 (2011) Investigation of Potentially Contaminated Sites. Code of Practice.
4. BS5930 (2007) Code of Practice for Site Investigations.
5. BS 5667-11:2009. Water quality sampling. Part 11: Guidance on sampling of groundwaters.
6. BS 8002 (1994) Code of Practice for Earth Retaining Structures.
7. Tomlinson, M.J. (1986) Foundation Design and Construction.
8. Department of the Environment Industry Profiles.
9. Environment Agency/Defra (2002). Sampling strategies for contaminated land (CLR4)2
10. Environment Agency/Defra (2002). Priority Contaminants for the Assessment of Land (CLR8)3
11. CIRIA (2007). Assessing risks posed by hazardous ground gases to buildings.
12. BS 8485:2007. Code of Practice for the Characterisation and Remediation from Ground Gas in affected Development.
13. NHBC (2007). Guidance on the Evaluation of Development proposals on sites where Methane and Carbon dioxide are present.
14. CL:AIRE (December 2013). Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination.
15. CL:AIRE / CIEH (2008), Guidance on Comparing Soil Contamination Data with a Critical Concentration, May 2008;
16. CL:AIRE / EIC (2009), The Soil Generic Assessment Criteria for Human Health, December 2009.
17. Environment Agency (2003), Review of fate & transport of selected contaminants in the Environment, Report P5-079-TR1;
18. Environment Agency (2004), Model Procedures for the Management of Land Contamination, September 2004, ISBN: 1844322955;
19. Environment Agency (2008a), Compilation of Data for Priority Organic Pollutants, Report SC050021/SR7, November 2008;
20. Environment Agency (2009a), Human Health Toxicological Assessment of Contaminants in Soil, Report SC050021/SR2, January 2009;
21. Environment Agency (2009b), CLEA Software (Version 1.04) Handbook (and Software), Report SC050021/SR4, January 2009;
22. Environment Agency (2009c), Updated Technical Background to the CLEA Model, Report SC050021/SR3, January 2009;

[2] This document has been withdrawn but is considered to remain useful in proving technical background for designing ground investigation works.

[3] This document has been withdrawn but is considered to remain useful in proving technical background for designing ground investigation works.

REFERENCES & GUIDANCE

23. Environment Agency (2009d), A Review of Body Weight and Height Data Used in the CLEA Model, Report SC050021/Final Technical Review 1, January 2009;
24. Nathanial et. al., (2009), The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment (2nd edition), Land Quality Press, Nottingham, ISBN 0-9547474-7-X
25. USEPA (2004), User's Guide for Evaluating Subsurface Vapour Intrusion into Buildings
26. Environment Agency (2013). Groundwater Protection: Principles and Practice (GP3)
27. Water Framework Directive (2000/60/EC)
28. Groundwater Regulations (2009).
29. Drinking Water Quality Standards England & Wales 2000 (Amended 2004, DWS).
30. World Health Organisation (WHO) Petroleum Products in Drinking Water.
31. Environmental Quality Standards (EQS). The River Basin Districts Typology, Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Directions 2010.
32. Environment Agency (2006). Remedial Targets Methodology. Hydrogeological Risk Assessment for Land Contamination.
33. Environment Agency (2013). Technical Guidance WM2 (v3). Interpretation of the definition and classification of hazardous waste.
34. CIRIA C760 - Guidance on embedded retaining wall design, London 2017.
35. CIRIA R143 - The Standard Penetration Test (SPT): Methods and Use, London 1995.
36. Clough, G.W. and Davidson, R.R. Effects of construction on geotechnical performance. Proceedings of the 9th International Conference on Soil Mechanics. Tokyo, Specialty Session, p. 3, 1977.
37. Clough, G.W. et al. Movement control of excavation support systems by iterative design procedure. ASCE Foundation Engineering: current principles and practices. Vol 1, pp. 869-884, 1989.

FIGURES

Key:

Approximate Site Location

IMPORTANT – Please Read

This drawing is for illustrative purposes only and is for use only in conjunction with associated reports relating to the project details below. LMB accepts no liability for the mis-interpretation or use of this illustration by any other parties.

LMB

Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

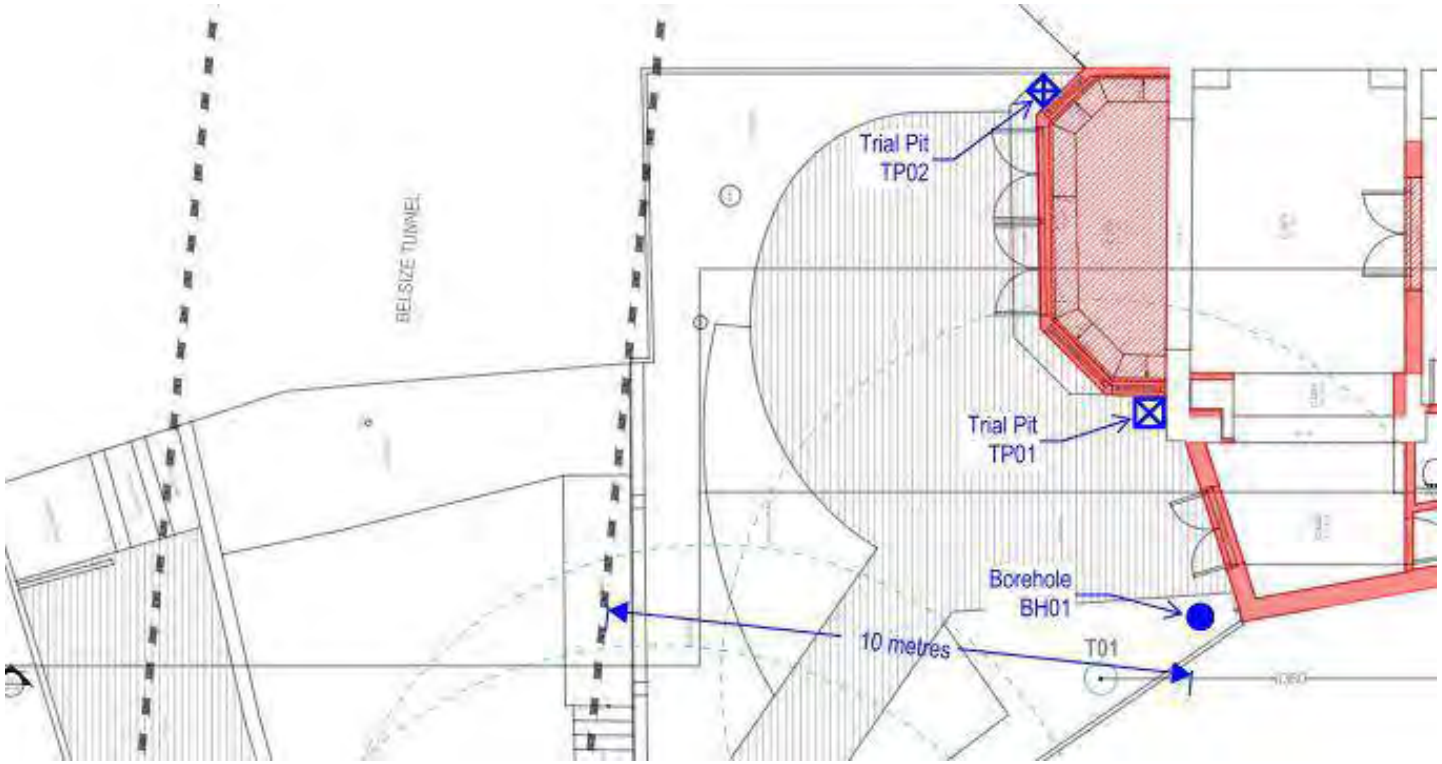
Site: 12 Lyndhurst Gardens, London NW3

Figure Number: Figure 1

Title: Site Location Plan

Project No:	Created By:	Date:
	PIL	April 2019

Client: Daniel Burbidge



Key:

BH — Dynamic (windowless) Sampler Borehole location.

TP — Hand excavated trial pit location.

IMPORTANT – Please Read

This drawing is for illustrative purposes only and is for use only in conjunction with associated reports relating to the project details below. LMB accepts no liability for the mis-interpretation or use of this illustration by any other parties.

LMB
Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

Site: 12 Lyndhurst Gardens, London NW3

Figure Number: Figure 2

Title: Site Location Plan

Project No:	Created By:	Date:
	PIL	April 2019

Client: Daniel Burbidge

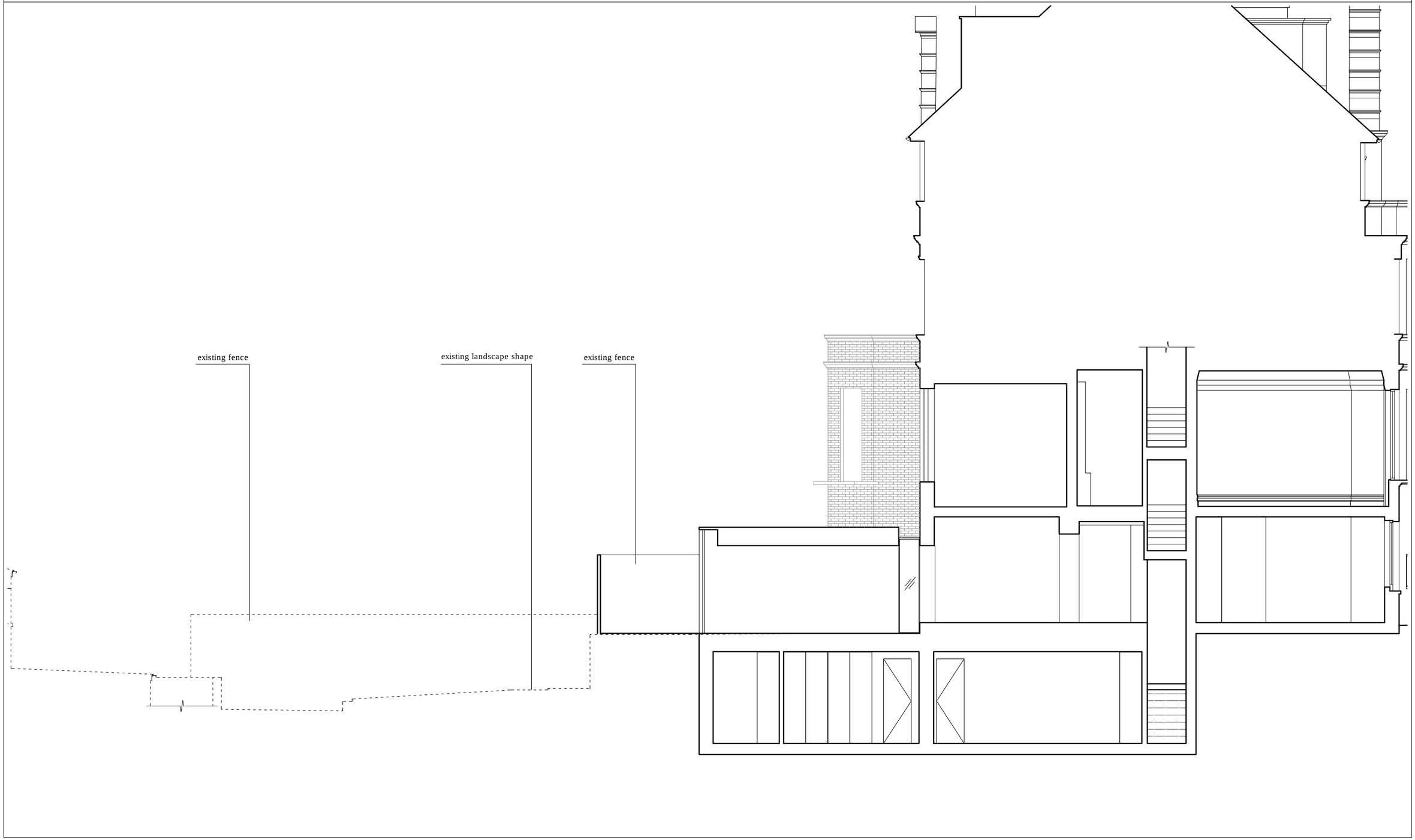
APPENDICES

Appendices

APPENDIX A DEVELOPMENT SCHEMATIC

PROPOSED SECTION 01

SCALE 1:100



LBMV architects

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info@lbmvarchitects.com
www.lbmvarchitects.com

DRAWINGS STATUS: PLANNING PERMISSION | A3

PROJECT TITLE: REAR EXTENSION & BASEMENT

12 Lyndhurst Gardens
NW3 5NR

DRAWN	CHECKED
MC - UG	LM
DATE	SCALE
06.02.2018	1:100@A3

DRAWING TITLE: PROPOSED SECTION 01

JOB NO	DRAWING NO
0066	A2006

GENERAL NOTE
- This drawing should be removed from currency immediately when a revised version is issued.
- All dimensions to be checked on site by the contractor. Discrepancies to be reported before proceeding with the works.
- This drawing is copyrighted.
- All dimensions in mm's.

LEGEND

1.50	0	1	2 m
1.100	0	1	5 m
1.200	0	1	10 m
1:500	0	10	20 m
1:1000	0	10	50 m
1:1250	0	10	50 m

REV	DESCRIPTION	DATE	NAME
04		05/07/2018	
03		24/05/2018	
02		15/03/2018	
01		21/02/2018	

PROPOSED SECTION 02

SCALE 1:100

LBMV architects

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DRAWINGS STATUS: PLANNING PERMISSION | A3

PROJECT TITLE: REAR EXTENSION & BASEMENT

12 Lyndhurst Gardens
NW3 5NR

DRAWN	CHECKED
MC - UG	LM
DATE	SCALE
06.02.2018	1:100@A3

DRAWING TITLE: PROPOSED SECTION 02

JOB NO	DRAWING NO
0066	A2007

GENERAL NOTE
- This drawing should be removed from currency immediately when a revised version is issued.
- All dimensions to be checked on site by the contractor. Discrepancies to be reported before proceeding with the works.
- This drawing is copyrighted.
- All dimensions in mm's.

LEGEND

1.50	0	1	2 m
1.100	0	1	5 m
1.200	0	1	10 m
1:500	0	10	20 m
1:1000	0	10	50 m
1:1250	0	10	50 m

REV	DESCRIPTION	DATE	NAME
04		05/07/2018	
03		24/05/2018	
02		15/03/2018	
01		21/02/2018	

APPENDICES

APPENDIX B PHOTOGRAPHIC RECORD

Plate 1: Existing property.

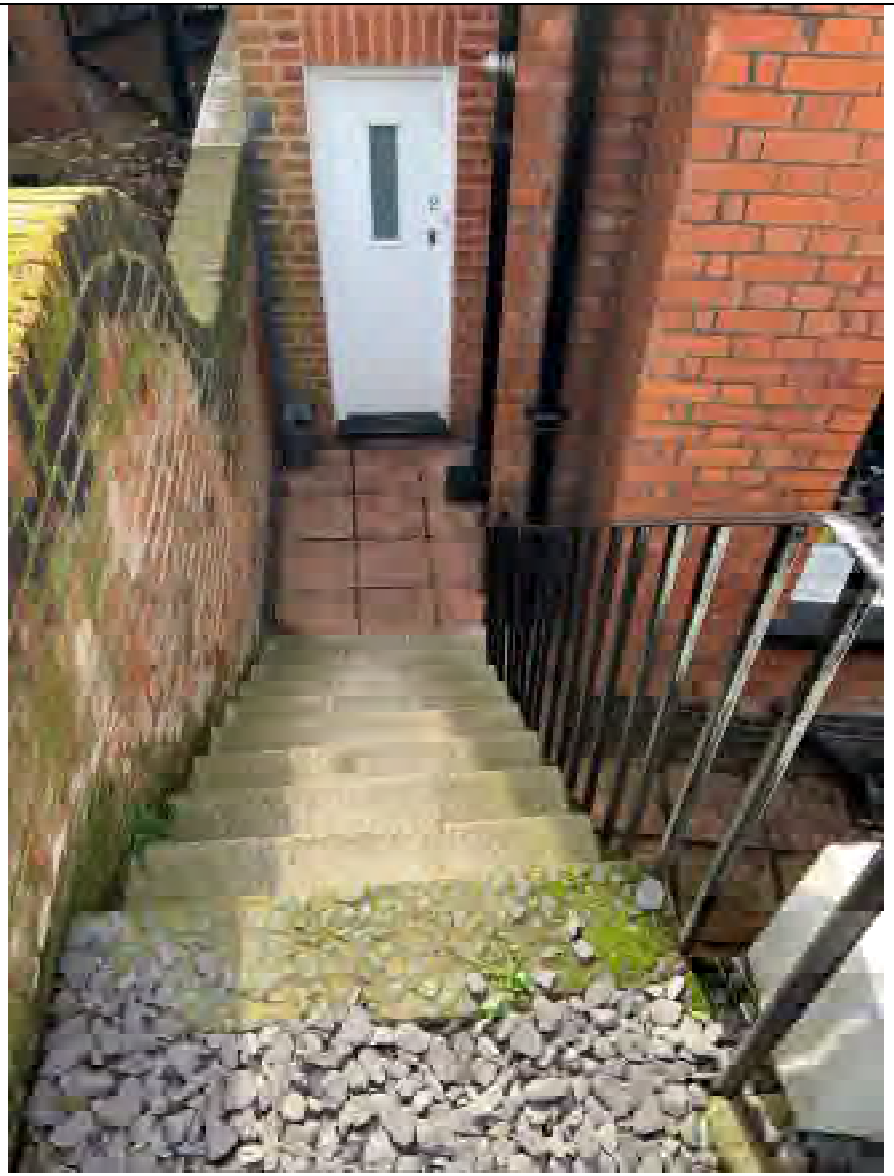


Plate 2: Entrance to lower ground floor.

Photographic Record

Project: 12 Lyndhurst Gardens

Plates 1 & 2

Plate 3: View of upper decked area of rear garden.

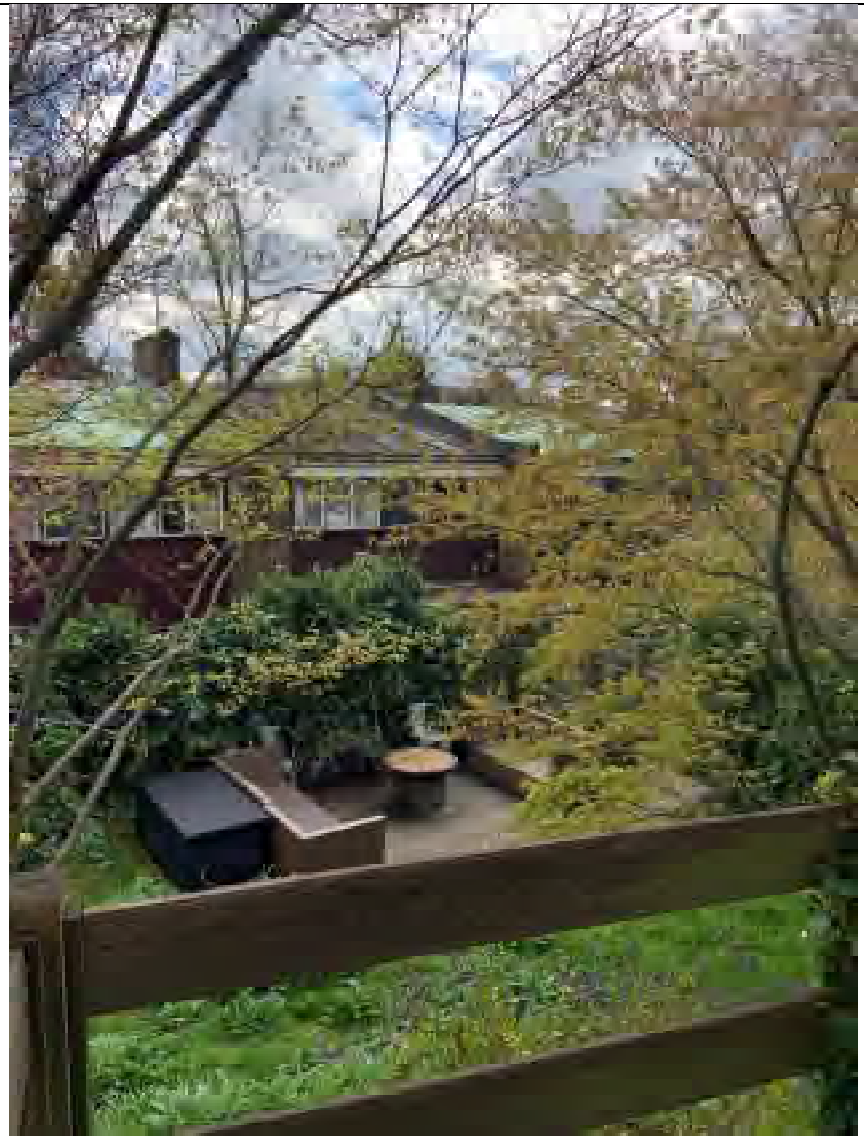


Plate 4: View of lower area of rear garden, neighbouring properties beyond.

LMS Ground Investigation Land Contamination Hydrogeology Engineering Geology	**Photographic Record**	Project: 12 Lyndhurst Gardens Plates 3 & 4

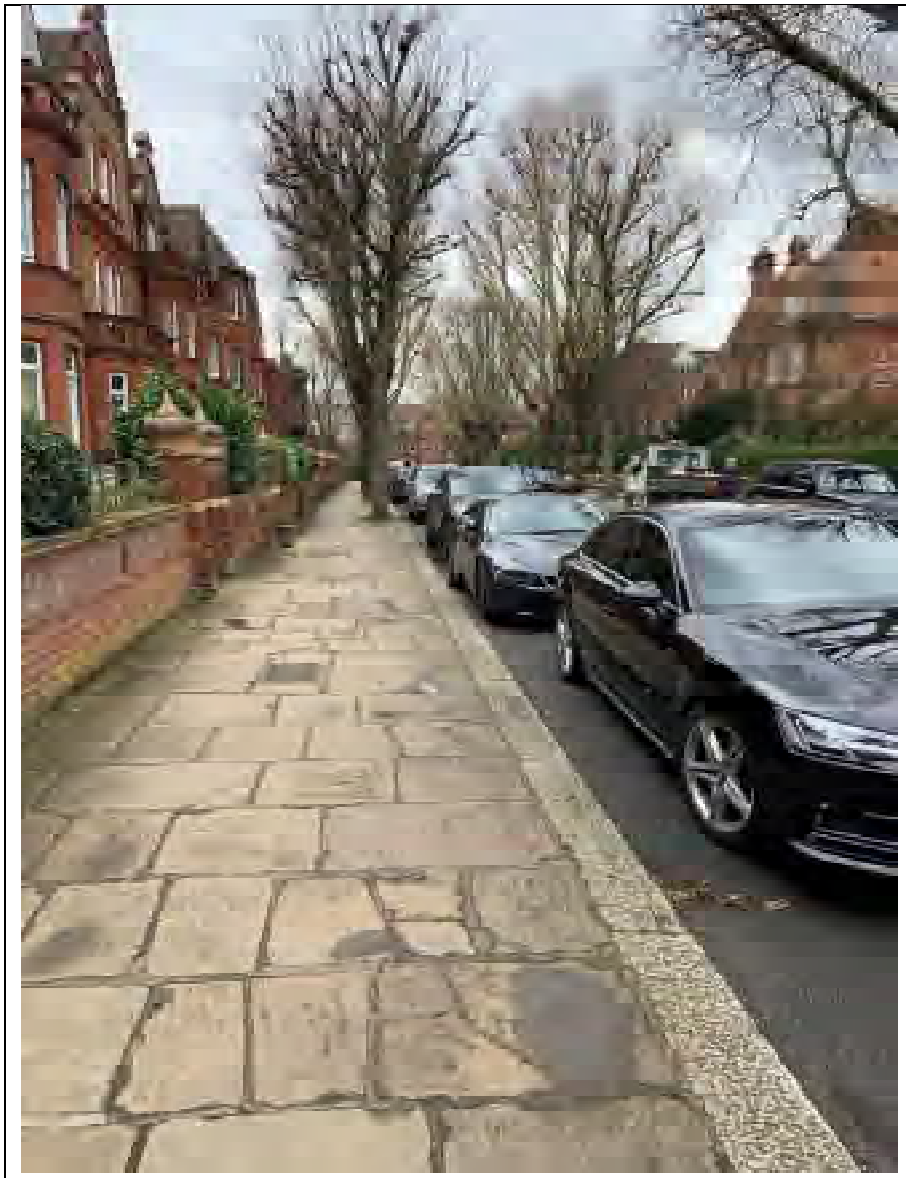


Plate 5: View west along Lyndhurst Gardens

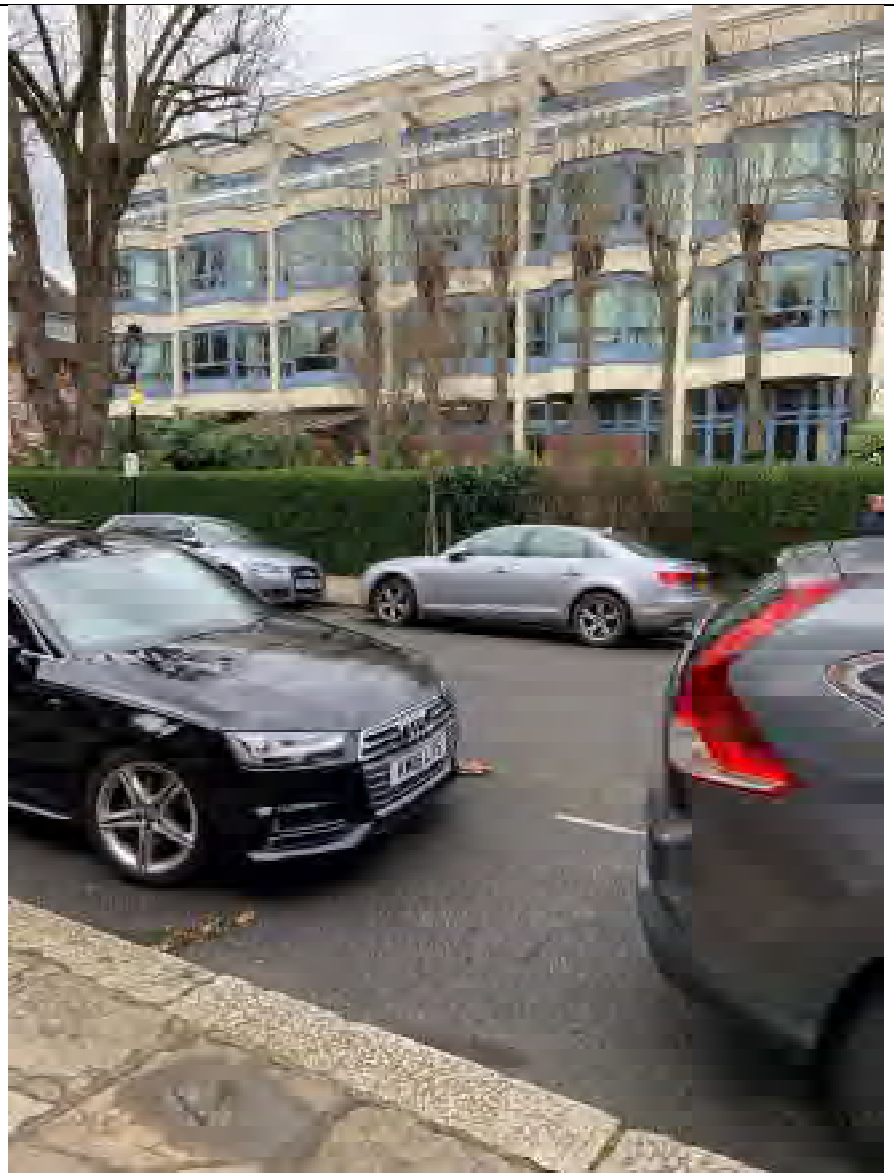
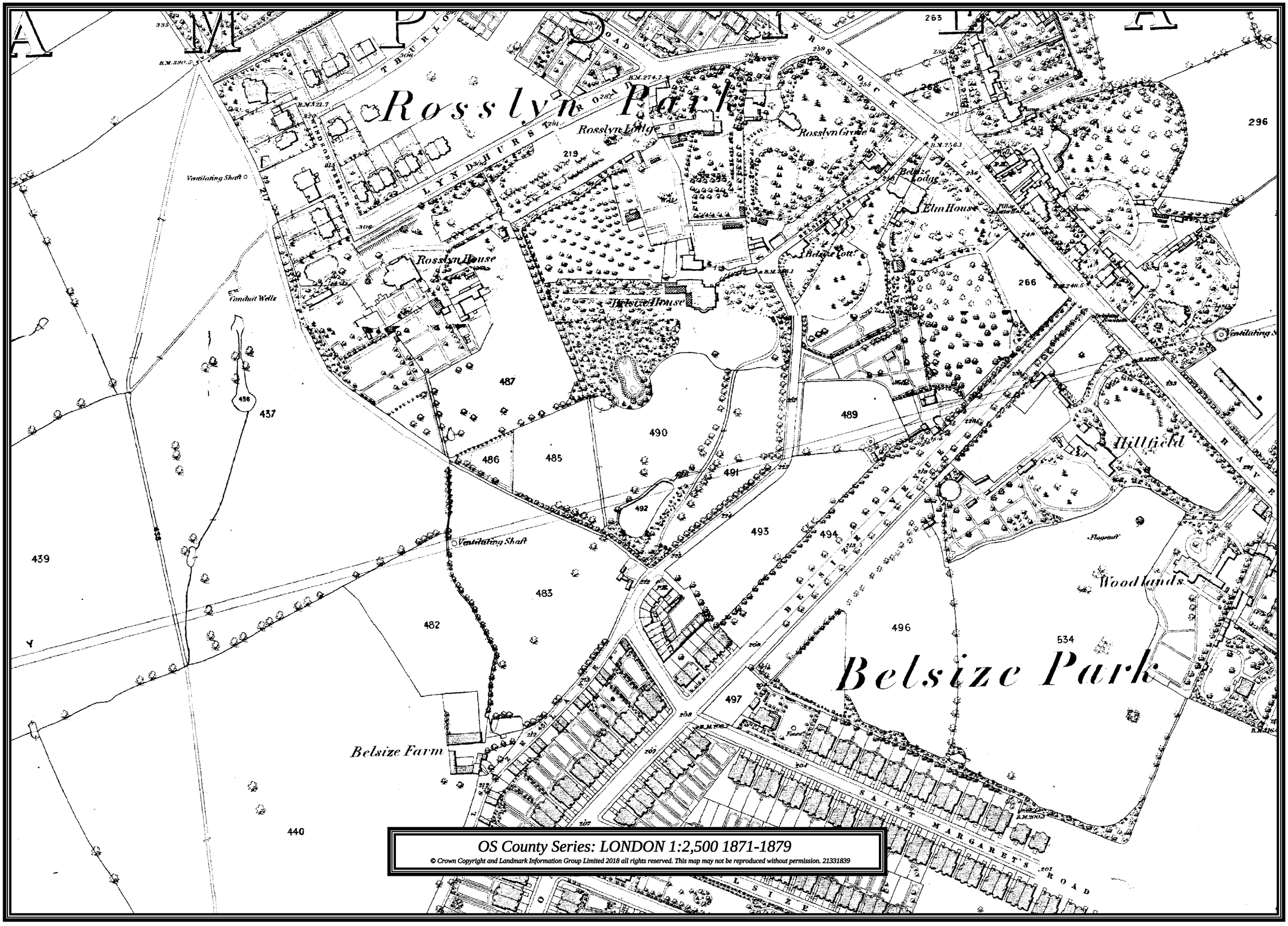


Plate 6: Viwe of hospice to north

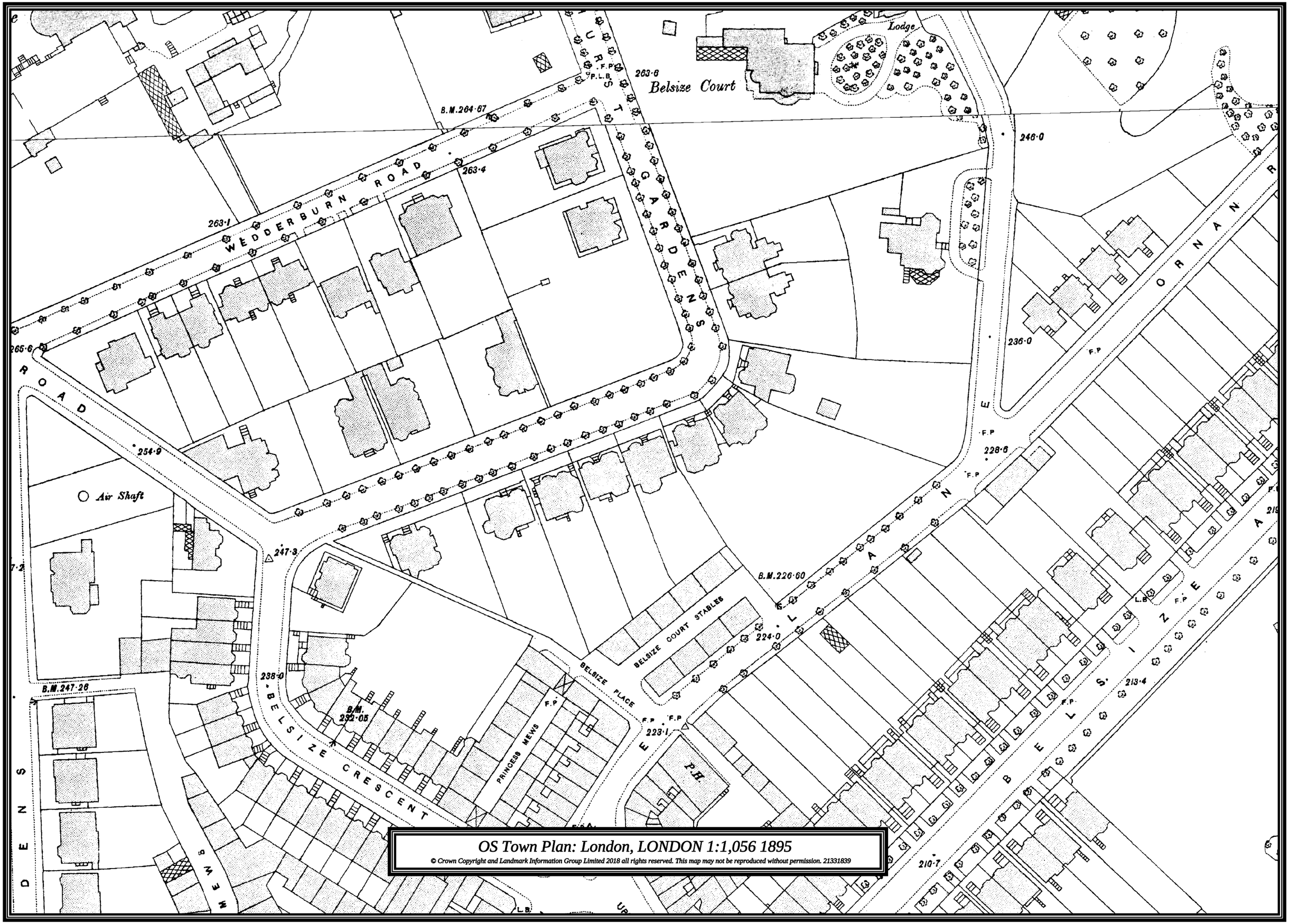
	Photographic Record	Project: 12 Lyndhurst Gardens
		Plates 5 & 6

APPENDICES

APPENDIX C SELECTED HISTORICAL PLANS



OS County Series: LONDON 1:2,500 1871-1879



OS Town Plan: London, LONDON 1:1,056 1895

APPENDICES

APPENDIX D EXPLORATORY HOLE LOGS

Percussion Drilling Log

Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

Project Name: 12 Lyndhurst Gardens	Client: Daniel Burbidge	Date: 01/04/2019
Location: London NW3	Contractor: Smiths Drilling	
Project No. : LMB_12Lyndhurst	Crew Name:	Drilling Equipment:

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
BH1	WLS		PIL	1:50	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.07			Wooden Decking.
					0.18			Concrete screed.
					0.28			MADE GROUND: brown slightly gravelly sand. No recovery (driving brick cobble).
					0.75			MADE GROUND: brown sandy slightly gravelly clay, locally slightly ashy with occasional sub-angular brick cobbles.
		1.00	ES					
		1.00	SPT	N=2 (1,0/1,0,0,1)				
		1.65	D		1.60			MADE GROUND: brown with orange brown mottling slightly sandy clay with rare sub-angular brick gravel and rootlets.
		2.00	D		2.00			
		2.00	SPT	N=8 (1,1/2,2,2,2)	2.10			Soft brown with orange brown and grey mottling CLAY. Occasional sub-rounded to rounded medium flint gravel. (POSSIBLE HEAD DEPOSITS).
		2.60		HVP=45				Soft becoming firm brown with orange brown and grey mottling CLAY. (LONDON CLAY FORMATION).
		3.00	D		3.00			
		3.00	SPT	N=10 (1,2/2,2,3,3)				Firm brown with orange brown mottling locally slightly sandy CLAY. (LONDON CLAY FORMATION).
		3.60		HVP=55				
		4.00	D					
		4.00	SPT	N=10 (2,3/2,2,3,3)				
								4.3m blue/grey veining and closely fissured.
		4.60		HVP=65				
		5.00	D		5.00			
		5.00	SPT	N=14 (3,2/2,4,3,5)				Stiff brown with blue grey veining CLAY. Very closely fissured. (LONDON CLAY FORMATION).
		5.60		HVP=78				
		6.00	D					
		6.00	SPT	N=16 (4,4/4,4,4,4)				
		6.60		HVP=90				
		7.00	D					
		7.00	SPT	N=19 (4,3/4,5,5,5)				
		8.00	SPT	N=28 (4,4/6,7,7,8)				
		8.50	SPT	N=46 (11,11/11,11,12,12)				
		9.00	SPT	N=39 (11,10/9,10,9,11)	9.00			Very stiff dark grey to grey brown CLAY. Very closely fissured. (LONDON CLAY FORMATION).
		9.50	SPT	N=45 (13,11/12,11,12,10)				
					10.00			End of Borehole at 10.000m

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks

AGS

Project: 12 Lyndhurst Gardens

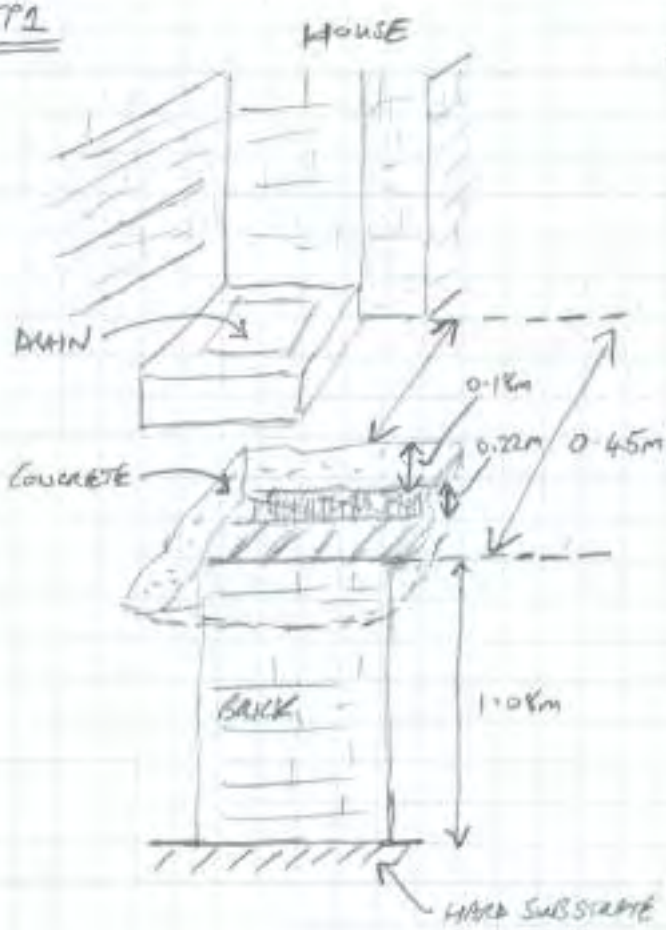
Description: TRIAL PIT SECTION SKETCHES

Mode: PIL

Date: APRIL 2019

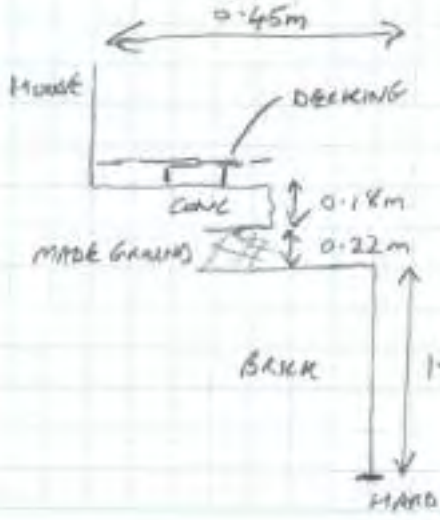
Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

TP1



i) 3D APPROXIMATION

NB. MANHOLE & DRAIN PREVENTED WIDENING OF EXCAVATION.



ii) SECTION

Project: 12 Lyndhurst Gardens

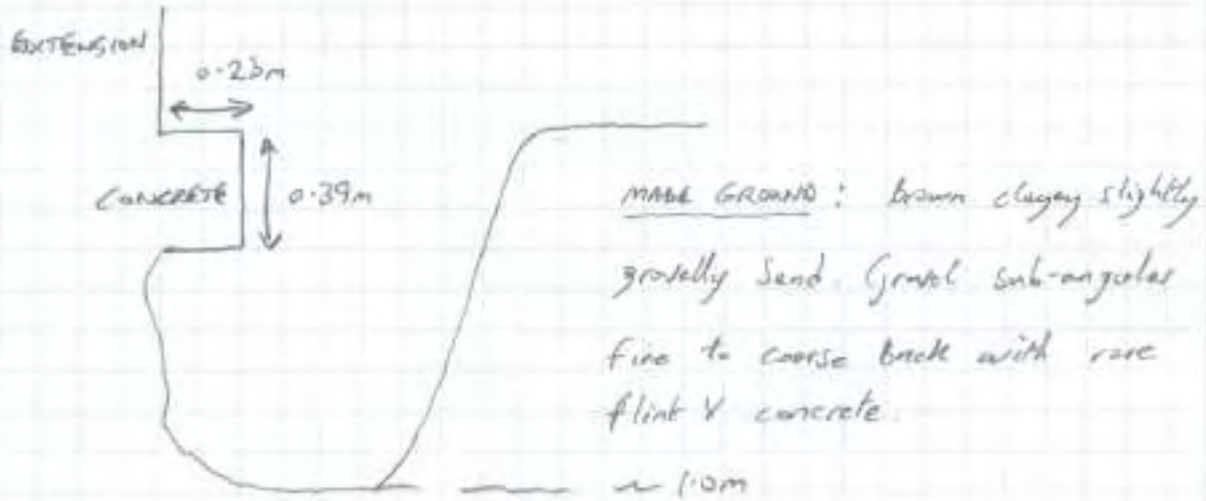
Description:

Made: PIL

Date:

Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

TP2



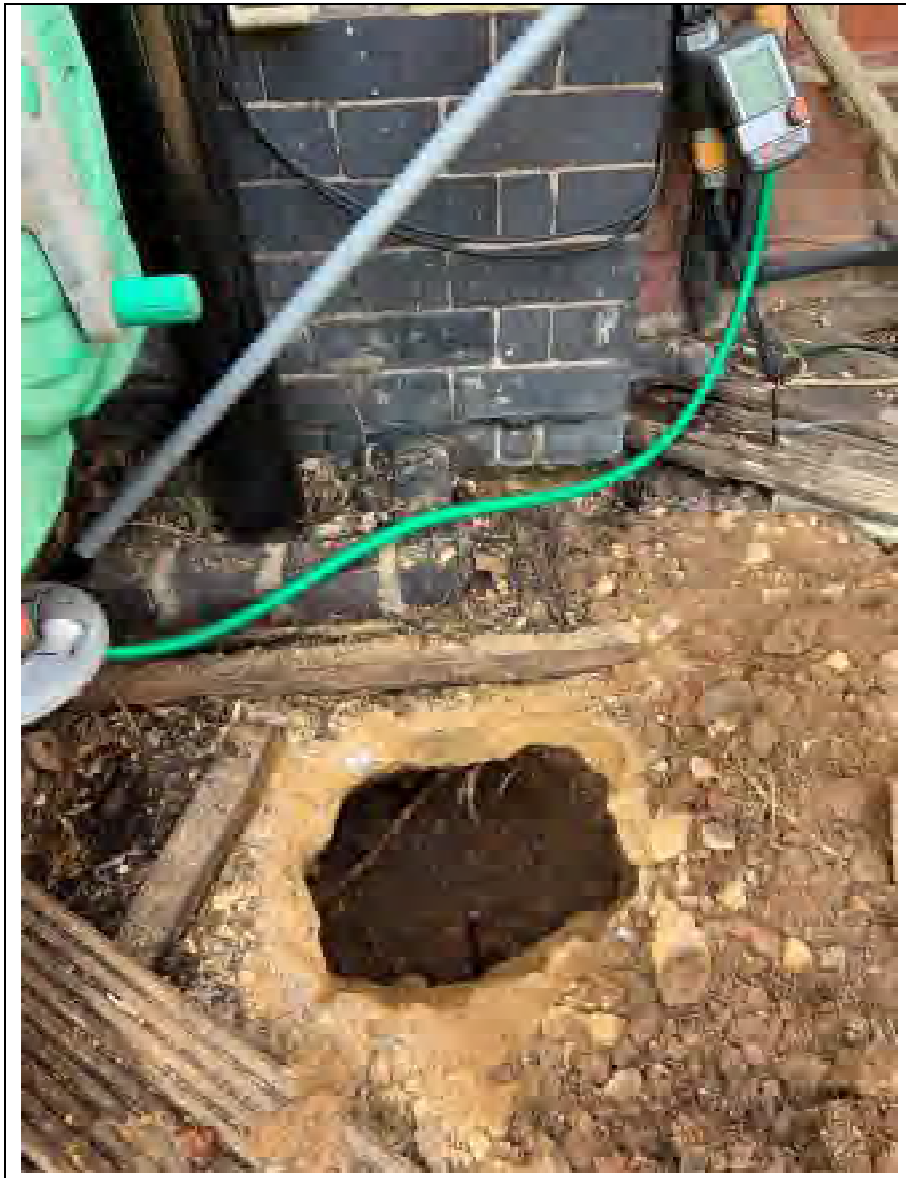


Plate 1: TP1 overview.

Plate 2: TP1 detail.

Trial Pit Photographs

Project: 12 Lyndhurst Gardens

Plates 1 & 2

Plate 3: TP2 excavation.

Trial Pit Photographs

Project: 12
Lyndhurst Gardens

Plate 3

APPENDICES

APPENDIX E GEOTECHNICAL LABORATORY RESULTS

TEST CERTIFICATE

Liquid and Plastic Limits

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

UKAS TESTING 4041

Tested in Accordance with: BS 1377-2: 1990: Clause 4.4 and 5

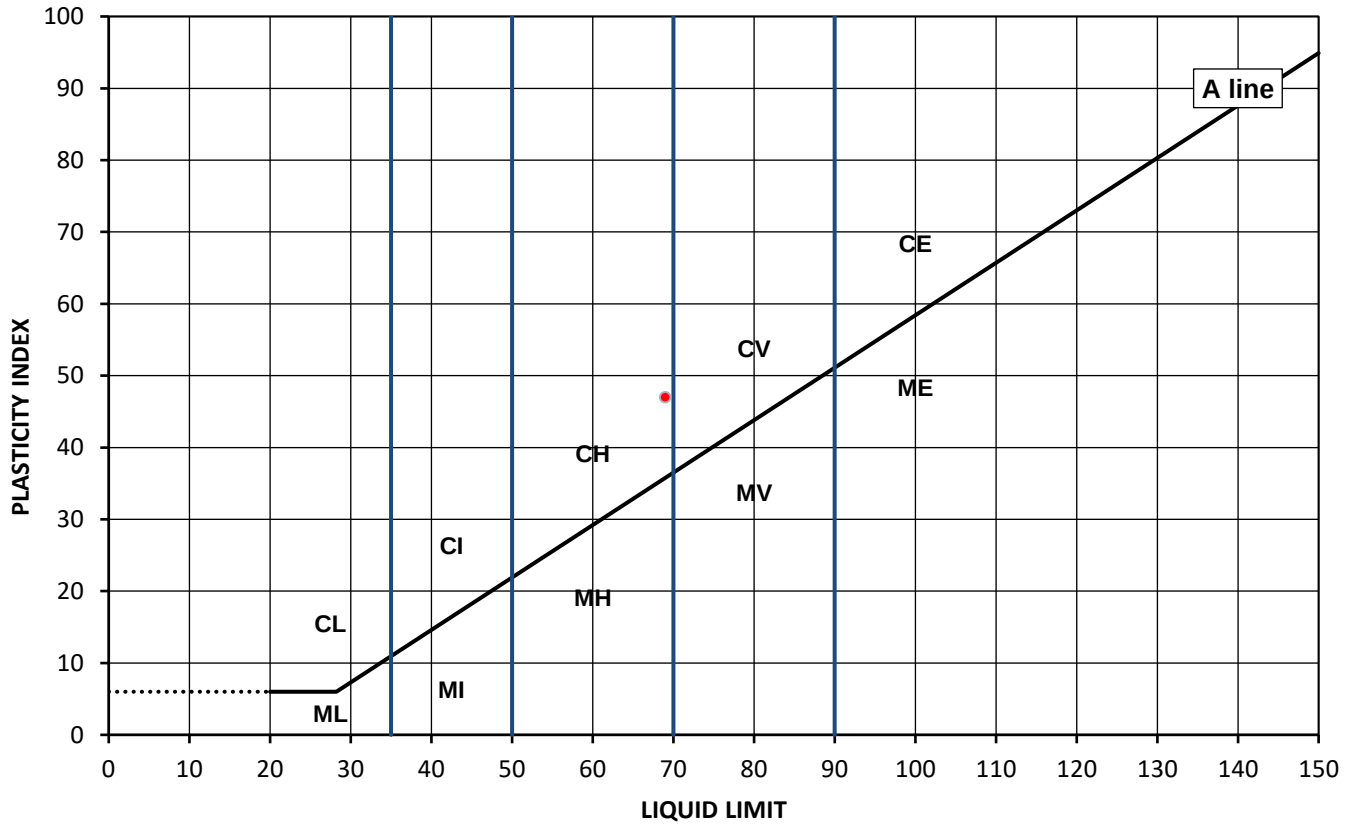
Client:	LMB Geosolutions Ltd	Client Reference:	LMB 12 LYNDHURST
Client Address:	28 Dresden Road, London, N19 3BD	Job Number:	19-36037
		Date Sampled:	19/01/2018
		Date Received:	02/04/2019
Contact:	Philip Lewis	Date Tested:	09/04/2019
Site Name:	12 Lyndhurst Garden	Sampled By:	PIL
Site Address:	Not Given		

Test Results:

Laboratory Reference:	1193482	Depth Top [m]:	3.00
Hole No.:	BH1	Depth Base [m]:	Not Given
Sample Reference:	Not Given	Sample Type:	D
Soil Description:	Brown slightly gravelly CLAY		

Sample Preparation: Tested after >425um removed by hand

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
23	69	22	47	99



Legend, based on BS 5930:2015 Code of practice for site investigations

		Plasticity		Liquid Limit
C	Clay	L	Low	below 35
M	Silt	I	Medium	35 to 50
		H	High	50 to 70
		V	Very high	70 to 90
		E	Extremely high	exceeding 90
	Organic	O	append to classification for organic material (eg CHO)	

Note: Moisture Content by BS 1377-2: 1990: Caluse 3.2

Remarks:

Approved: Dariusz Piotrowski
PL Geotechnical Laboratory Manager
Date Reported: 16/04/2019

Signed: Darren Berrill
Geotechnical General Manager
for and on behalf of i2 Analytical Ltd **GF 232.5**

TEST CERTIFICATE

Liquid and Plastic Limits

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

UKAS TESTING 4041

Tested in Accordance with: BS 1377-2: 1990: Clause 4.4 and 5

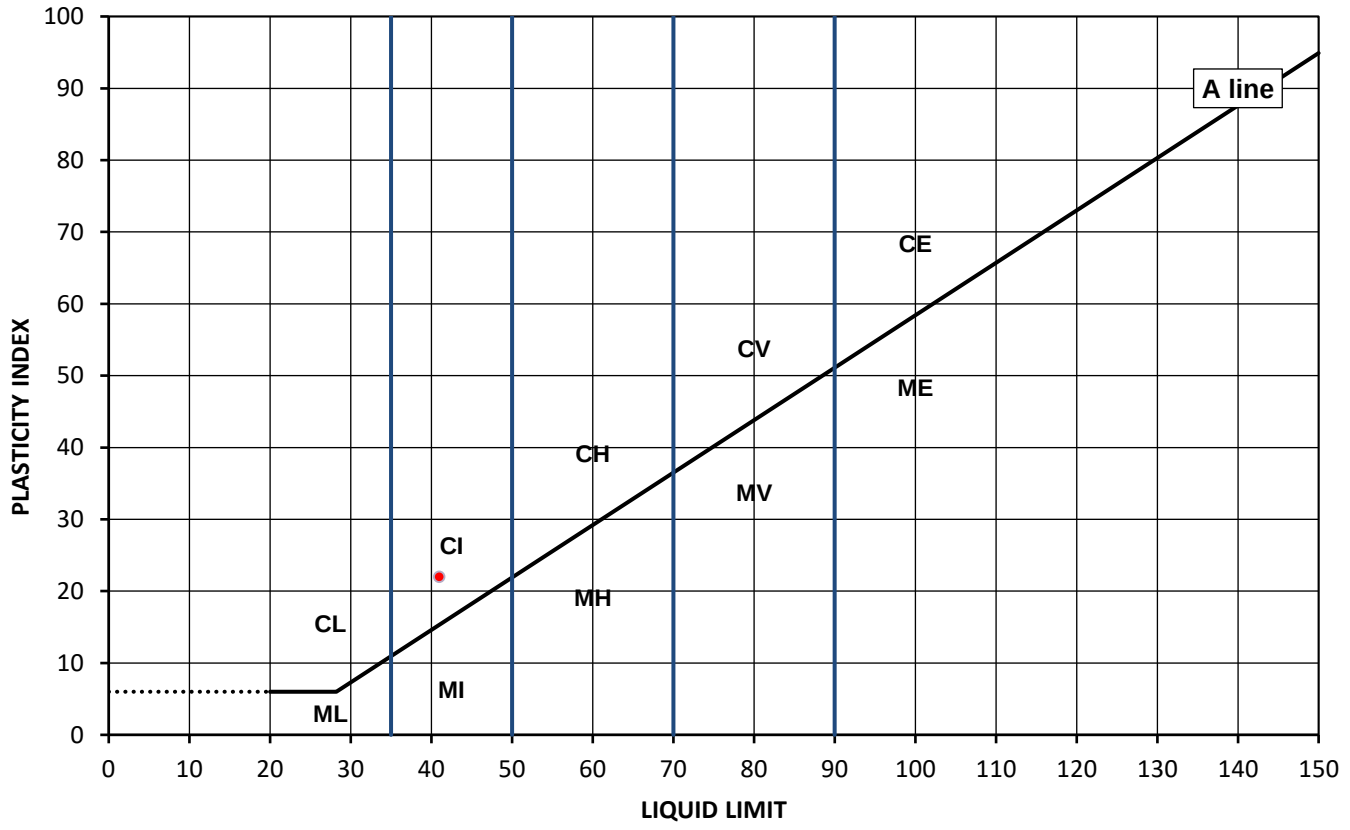
Client:	LMB Geosolutions Ltd	Client Reference:	LMB 12 LYNDHURST
Client Address:	28 Dresden Road, London, N19 3BD	Job Number:	19-36037
		Date Sampled:	19/01/2018
		Date Received:	02/04/2019
Contact:	Philip Lewis	Date Tested:	09/04/2019
Site Name:	12 Lyndhurst Garden	Sampled By:	PIL
Site Address:	Not Given		

Test Results:

Laboratory Reference:	1193483	Depth Top [m]:	4.00
Hole No.:	BH1	Depth Base [m]:	Not Given
Sample Reference:	Not Given	Sample Type:	D
Soil Description:	Brown sandy CLAY		

Sample Preparation: Tested in natural condition

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
17	41	19	22	100



Legend, based on BS 5930:2015 Code of practice for site investigations

		Plasticity		Liquid Limit
C	Clay	L	Low	below 35
M	Silt	I	Medium	35 to 50
		H	High	50 to 70
		V	Very high	70 to 90
		E	Extremely high	exceeding 90
	Organic	O	append to classification for organic material (eg CHO)	

Note: Moisture Content by BS 1377-2: 1990: Caluse 3.2

Remarks:

Approved: Dariusz Piotrowski
PL Geotechnical Laboratory Manager
Date Reported: 16/04/2019

Signed: Darren Berrill
Geotechnical General Manager
for and on behalf of i2 Analytical Ltd **GF 232.5**

SUMMARY REPORT

Summary of Classification Test Results

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

UKAS TESTING 4041

Tested in Accordance with:

MC by BS 1377-2: 1990: Clause 3.2; WC by BS EN 17892-1: 2014; Atterberg by BS 1377-2: 1990: Clause 4.3, Clause 4.4 and 5; PD by BS 1377-2: 1990: Clause 8.2

Client: LMB Geosolutions Ltd

Client Address: 28 Dresden Road, London, N19 3BD

Contact: Philip Lewis

Site Name: 12 Lyndhurst Garden

Site Address: Not Given

Client Reference: LMB 12 LYNDHURST

Job Number: 19-36037

Date Sampled: 19/01/2018

Date Received: 02/04/2019

Date Tested: 09/04/2019

Sampled By: PIL

Test results

Laboratory Reference	Hole No.	Sample				Description	Remarks	MC	WC	Atterberg				Density			Total Porosity#		
		Reference	Depth Top	Depth Base	Type					% Passing 425um	LL	PL	PI	bulk	dry	PD			
			m	m				%	%	%	%	%	%	Mg/m3	Mg/m3	Mg/m3	%		
1193482	BH1	Not Given	3.00	Not Given	D	Brown slightly gravelly CLAY	Atterberg 1 Point	23		99	69	22	47						
1193483	BH1	Not Given	4.00	Not Given	D	Brown sandy CLAY	Atterberg 1 Point	17		100	41	19	22						

Note: # Non accredited; NP - Non plastic

Comments:

Approved: Dariusz Piotrowski
PL Geotechnical Laboratory Manager
Date Reported: 16/04/2019

Signed: Darren Berrill
Geotechnical General Manager
for and on behalf of i2 Analytical Ltd **GF 234.7**

APPENDICES

APPENDIX F CHEMICAL LABORATORY TESTING RESULTS

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e: reception@i2analytical.com

Analytical Report Number : 19-35827

Project / Site name:	12 Lydhurst Gardens	**Samples received on:**	02/04/2019
Your job number:	LMB_12LYDHURST	**Samples instructed on:**	03/04/2019
Your order number:		**Analysis completed by:**	12/04/2019
Report Issue Number:	1	**Report issued on:**	12/04/2019
Samples Analysed:	3 soil samples		

Signed:

Dr Claire Stone
Quality Manager
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

Excel copies of reports are only valid when accompanied by this PDF certificate.

Analytical Report Number: 19-35827

Project / Site name: 12 Lydhurst Gardens

Lab Sample Number				1192546	1192547	1192548		
Sample Reference				BH1	BH1	TP2		
Sample Number				None Supplied	None Supplied	None Supplied		
Depth (m)				1.00	3.00	0.50		
Date Sampled				19/01/2019	19/01/2019	19/01/2019		
Time Taken				None Supplied	None Supplied	None Supplied		
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1		
Moisture Content	%	N/A	NONE	13	16	14		
Total mass of sample received	kg	0.001	NONE	0.10	0.40	0.40		
Asbestos in Soil	Type	N/A	ISO 17025	-	-	Not-detected		
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	-	8.0	9.7		
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.033	0.40	0.090		
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	-	-		
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	-	-		
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	-	-		
Fluorene	mg/kg	0.05	MCERTS	< 0.05	-	-		
Phenanthrene	mg/kg	0.05	MCERTS	0.54	-	-		
Anthracene	mg/kg	0.05	MCERTS	0.12	-	-		
Fluoranthene	mg/kg	0.05	MCERTS	1.5	-	-		
Pyrene	mg/kg	0.05	MCERTS	1.3	-	-		
Benzo(a)anthracene	mg/kg	0.05	MCERTS	0.53	-	-		
Chrysene	mg/kg	0.05	MCERTS	0.71	-	-		
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	0.62	-	-		
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	0.42	-	-		
Benzo(a)pyrene	mg/kg	0.05	MCERTS	0.66	-	-		
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	0.29	-	-		
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	-	-		
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	0.42	-	-		
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	7.02	-	-		
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	34	-	25		
Boron (water soluble)	mg/kg	0.2	MCERTS	2.0	-	1.8		
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	-	< 0.2		
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	25	-	30		
Copper (aqua regia extractable)	mg/kg	1	MCERTS	93	-	63		
Lead (aqua regia extractable)	mg/kg	1	MCERTS	1100	-	570		
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	3.1	-	0.9		
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	27	-	23		
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	-	3.2		
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	120	-	130		
Petroleum Hydrocarbons								
TPH C10 - C40	mg/kg	10	MCERTS	-	-	87		

Analytical Report Number : 19-35827

Project / Site name: 12 Lydhurst Gardens

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1192546	BH1	None Supplied	1.00	Brown loam and clay with gravel and brick.
1192547	BH1	None Supplied	3.00	Brown clay with vegetation.
1192548	TP2	None Supplied	0.50	Brown loam and sand with brick and rubble.

Analytical Report Number : 19-35827

Project / Site name: 12 Lydhurst Gardens

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 2, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests, 2:1 water:soil extraction, analysis by ICP-OES.	L038-PL	D	MCERTS
TPH Banding in Soil by FID	Determination of hexane extractable hydrocarbons in soil by GC-FID.	In-house method, TPH with carbon banding and silica gel split/cleanup.	L076-PL	W	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

Sample ID	Other_ID	Sample Type	Job	Sample Number	Sample Deviation Code	test_name	test_ref	Test Deviation code
BH1		S	19-35827	1192546	c	Speciated EPA-16 PAHs in soil	L064-PL	c
BH1		S	19-35827	1192547	c	pH in soil (automated)	L099-PL	c
TP2		S	19-35827	1192548	c	TPH Banding in Soil by FID	L076-PL	c
TP2		S	19-35827	1192548	c	pH in soil (automated)	L099-PL	c

Key: a - No sampling date b - Incorrect container
c - Holding time d - Headspace e - Temperature

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Analytical Report Number : 19-35828

Project / Site name:	12 Lyndhurst Gardens	**Samples received on:**	02/04/2019
Your job number:	LMB_12LYNDHURST	**Samples instructed on:**	03/04/2019
Your order number:		**Analysis completed by:**	16/04/2019
Report Issue Number:	1	**Report issued on:**	16/04/2019
Samples Analysed:	10:1 WAC Sample		

Signed:

Dr Claire Stone
Quality Manager
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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Waste Acceptance Criteria Analytical Results

Report No:	**19-35828**						
					Client:	**LMBGEOSOL**	
Location	**12 Lyndhurst Gardens**						
Lab Reference (Sample Number)	1192549 / 1192550				**Landfill Waste Acceptance Criteria Limits**		
Sampling Date	19/01/2019				Inert Waste Landfill	Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill	Hazardous Waste Landfill
Sample ID	BH1						
Depth (m)	1.00						
Solid Waste Analysis							
TOC (%)**	1.8				3%	5%	6%
Loss on Ignition (%) **	-				--	--	10%
BTEX (µg/kg) **	-				6000	--	--
Sum of PCBs (mg/kg) **	-				1	--	--
Mineral Oil (mg/kg)	-				500	--	--
Total PAH (WAC-17) (mg/kg)	-				100	--	--
pH (units)**	8.5				--	>6	--
Acid Neutralisation Capacity (mol / kg)	14				--	To be evaluated	To be evaluated
Eluate Analysis	10:1			10:1	Limit values for compliance leaching test		
(BS EN 12457 - 2 preparation utilising end over end leaching procedure)	mg/l			mg/kg	using BS EN 12457-2 at L/S 10 l/kg (mg/kg)		
Arsenic *	0.0225			0.192	0.5	2	25
Barium *	0.0103			0.0877	20	100	300
Cadmium *	< 0.0001			< 0.0008	0.04	1	5
Chromium *	0.0024			0.021	0.5	10	70
Copper *	0.011			0.092	2	50	100
Mercury *	< 0.0005			< 0.0050	0.01	0.2	2
Molybdenum *	0.0039			0.0331	0.5	10	30
Nickel *	0.0045			0.039	0.4	10	40
Lead *	0.036			0.31	0.5	10	50
Antimony *	< 0.0017			< 0.017	0.06	0.7	5
Selenium *	< 0.0040			< 0.040	0.1	0.5	7
Zinc *	0.0097			0.083	4	50	200
Chloride *	2.2			19	800	4000	25000
Fluoride	0.26			2.3	10	150	500
Sulphate *	7.2			62	1000	20000	50000
TDS*	64			550	4000	60000	100000
Phenol Index (Monohydric Phenols) *	< 0.010			< 0.10	1	-	-
DOC	4.51			38.6	500	800	1000
Leach Test Information							
Stone Content (%)	< 0.1						
Sample Mass (kg)	0.51						
Dry Matter (%)	86						
Moisture (%)	14						

Results are expressed on a dry weight basis, after correction for moisture content where applicable.
*= UKAS accredited (liquid eluate analysis only)
Stated limits are for guidance only and i2 cannot be held responsible for any discrepancies with current legislation
** = MCERTS accredited

Landfill WAC analysis (specifically leaching test results) must not be used for hazardous waste classification purposes as defined by the Waste (England and Wales) Regulations 2011 (as amended) and EA Guidance WM3.
This analysis is only applicable for landfill acceptance criteria (The Environmental Permitting (England and Wales) Regulations) and does not give any indication as to whether a waste may be hazardous or non-hazardous.

Analytical Report Number : 19-35828

Project / Site name: 12 Lyndhurst Gardens

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1192549	BH1	None Supplied	1.00	Brown sandy clay with gravel and brick.

Analytical Report Number : 19-35828

Project / Site name: 12 Lyndhurst Gardens

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Acid neutralisation capacity of soil	Determination of acid neutralisation capacity by addition of acid or alkali followed by electronic probe.	In-house method based on Guidance an Sampling and Testing of Wastes to Meet Landfill Waste Acceptance""	L046-PL	W	NONE
BS EN 12457-2 (10:1) Leachate Prep	10:1 (as recieved, moisture adjusted) end over end extraction with water for 24 hours. Eluate filtered prior to analysis.	In-house method based on BSEN12457-2.	L043-PL	W	NONE
Chloride 10:1 WAC	Determination of Chloride colorimetrically by discrete analyser.	In house based on MEWAM Method ISBN 0117516260.	L082-PL	W	ISO 17025
Dissolved organic carbon 10:1 WAC	Determination of dissolved inorganic carbon in leachate by TOC/DOC NDIR Analyser.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L037-PL	W	NONE
Fluoride 10:1 WAC	Determination of fluoride in leachate by 1:1ratio with a buffer solution followed by Ion Selective Electrode.	In-house method based on Use of Total Ionic Strength Adjustment Buffer for Electrode Determination"	L033B-PL	W	ISO 17025
Metals in leachate by ICP-OES	Determination of metals in leachate by acidification followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil""	L039-PL	W	ISO 17025
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 2, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
Monohydric phenols 10:1 WAC	Determination of phenols in leachate by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L080-PL	W	ISO 17025
pH in soil	Determination of pH in soil by addition of water followed by electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L005-PL	W	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate 10:1 WAC	Determination of sulphate in leachate by ICP-OES	In-house method based on MEWAM 1986 Methods for the Determination of Metals in Soil""	L039-PL	W	ISO 17025
Total dissolved solids 10:1 WAC	Determination of total dissolved solids in water by electrometric measurement.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L004-PL	W	NONE
Total organic carbon (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests""	L009-PL	D	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

Sample ID	Other_ID	Sample Type	Job	Sample Number	Sample Deviation Code	test_name	test_ref	Test Deviation code
BH1		S	19-35828	1192549	c	Acid neutralisation capacity of soil	L046-PL	c
BH1		S	19-35828	1192549	c	Organic matter (Automated) in soil	L009-PL	c
BH1		S	19-35828	1192549	c	Total organic carbon (Automated) in soil	L009-PL	c
BH1		S	19-35828	1192549	c	pH in soil	L005-PL	c

Key: a - No sampling date b - Incorrect container
c - Holding time d - Headspace e - Temperature

APPENDIX 4

GROUND MOVEMENT ASSESSMENT – CGL

Providing Ground Solutions

Mr D Burbidge

12 Lyndhurst Gardens, Camden, London

Ground Movement Assessment

Revision 3

March, 2020

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Checked	Steve Morgan, Associate *MSc BSc (Hons) CGeol CMgr FGS MCMI*	
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	Bryn Jones, Director *BSc (Hons) MSc CGeol EurGeol FGS*	

Reference	CG/28992	Revision	0	Issue Date	May 2019
			1		June 2019
			2		September 2019
			3		March 2020

Contents

FIGURES

APPENDICES

1. INTRODUCTION

Card Geotechnics Limited (CGL) have been instructed by Mr D Burbidge (the Client) to produce a Ground Movement Assessment (GMA) to support the planning application for the proposed redevelopment of 12 Lyndhurst Gardens, NW3 5NR, in the Borough of Camden, London. It is understood that a Basement Impact Assessment has previously been completed for the site in accordance with *Camden Planning Guidance: Basements and Lightwells (CPG4)*[1]*,* however, details of this have not been provided. This GMA has been completed to append to the BIA being produced by the Structural Engineer, Symmetrys Limited, for the scheme and have hereafter been referred to as 'the Structural Engineer'

The report includes:

- A description of the site's development history, the underlying geology and groundwater;
- Details of the findings of the ground investigation, in-situ and laboratory geotechnical results; and
- Details of calculations carried out to determine potential ground movements due to the proposed development and their potential effects to neighbouring properties and infrastructure.

This version (Revision 3) of this report has been updated to consider the comments that have been raised by Campbell Reith as part of their Basement Impact Assessment Audit[2] and a revision to proposed underpin construction methodology from two lifts to a single underpins lift.

[1] Camden Planning Guidance – Basements and lightwells (CPG4), July (2015)
[2] Campbell Reith. (2019). Flat 2, 12 Lyndhurst Gardens, NW3 5NR - Basement Impact Assessment Audit – Ref: 12985-62

2. SITE CONTEXT

2.1 Site Location

The site is located at 12 Lyndhurst Gardens (a block of residential flats), London, NW3 5NR in the London Borough of Camden. The National Grid Reference for the approximate centre of the site is 526913, 185091. A site location plan is presented as Figure 1.

2.2 Site Description

The site is broadly rectangular in plan occupying an area of some 900m^2 with dimensions of some 60m by 15.5m with its long axis orientated approximately north to south. The site is currently occupied by a four-storey detached masonry residential property, which has been separated into a series of flats, with a paved area to the front and a private garden area to the rear. Two flats are present at ground floor level, which are Flat 1, and Flat 2. Flat 1 is approximately 8m wide and present in the western part of the structure. Flat 2 is approximately 7m wide and situated within the eastern part of the structure.

The site is bound to the north by Lyndhurst Gardens road, to the west by No. 10 Lyndhurst Gardens, to the east by No. 14 Lyndhurst Gardens (situated 2m to the south) and to the south properties on Belsize Court Garages.

The local planning website has been reviewed and there are no records of neighbouring properties with basements. It is understood that an assessment for a single storey basement beneath No. 10 Lyndhurst Gardens was completed, however the works have not been completed at the time of writing.

The Network Rail Belsize Tunnel is located approximately 2.6m south of the proposed basement, 6.6m from the existing structure, aligned roughly east to west. The tunnel crown level has been provided by the structural engineer and has been taken at 28m below ground level (bgl).

A site layout plan is presented in Figure 2.

2.3 Proposed Development

The proposed development entails the construction of a single storey basement beneath the Flat 2 of the property which extends into the rear garden by some 4m. At this stage, no development is proposed beneath the west of the property beneath Flat 1. Based on the drawings provided the proposed basement extension will be some 3.4mbgl deep across the basement footprint and will be locally deepened around the perimeter to 3.9mbgl. It is assumed that the basement excavation under the building will be enabled through a single underpin lift using a 'hit and miss technique'. It is understood that the proposed basement beneath Flat 2 will share a party wall with Flat 1.

2.4 Site History

The historical development of the site has been traced using historical maps available in the ground investigation report[3] . In summary the site and surrounding area remained undeveloped until the 1890s, since this time the site has remained in its current configuration.

During the 1950s the Belsize *Tunnels* were developed, 230m east and 30m north of the site.

2.5 Unexploded Ordnance

From available bomb damage maps[4], it is indicated that the structure on site or those of its immediate neighbours were not damaged during Second World War bombing. The mapping[5] identifies that 10 high explosive bombs were dropped within 250m of the site, the nearest of which approximately 30m north of the site.

It is recommended that risks from UXO be fully considered by suitably qualified personnel prior to construction.

2.6 Buried Infrastructure

Referencing CGL's in-house archive information and information provided by the Structural Engineer, the Network Rail Belsize Tunnel runs beneath the site at an approximated east-west orientation. The approximate position of the tunnel is presented in Figure 2 and the information provided by the Structural Engineer is presented in Appendix A. It is noted that the tunnel is located some 28mbgl and based on the drawings provided it is located some 2.6m outside of the footprint of the proposed basement excavations.

2.7 Anticipated Ground Conditions

2.7.1 Published Geology

With reference to the British Geological Survey (BGS) website[6] and BGS 1:50,000 map sheet for North London[7], the site is shown to be underlain by the solid geology of the London Clay Formation. Recent superficial deposits are not recorded beneath the site. The descriptions for each stratum provided by the BGS are detailed below:

[3] LMB Geosolutions Limited (May 2019). Ground Investigation and Assessment.
[4] London Topographical Society, 2005. The London County Council bomb damage maps 1939 – 1945.
[5] www.bombsight.org (Accessed 15 May 2019).
[6] http://www.bgs.ac.uk/discoveringGeology/geologyOfBritain/viewer.html (date accessed: 15/05/2019)
[7] British Geological Society (2006). *Geological Survey of England and Wales. Map no. 256 North London – Bedrock and Superficial map.* 1:50,000 scale.

London Clay Formation - Mainly comprises poorly laminated, blue-grey or grey-brown, slightly calcareous, silty clay. The stratum is typically of a firm to stiff consistency near the surface of the stratum, becoming very stiff with depth. Claystones and partings of fine sand or silt may be present. Locally, the London Clay Formation is shown to be approximately 20m to 25m thick.

2.7.2 Unpublished Geology

No freely available BGS borehole records[8] are available within 250m of the site.

2.8 Hydrology and Hydrogeology

The Environment Agency[9] has produced an aquifer designation system consistent with the requirements of the Water Framework Directive. The designations have been set for superficial and bedrock geology and are based on the importance of aquifers for potable water supply, and their role in supporting surface water bodies and wetland ecosystems.

The Environment Agency[10] indicates that the London Clay Formation is classified as *Unproductive Strata*, indicating rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

The nearest surface water body is the Hampstead Heath Ponds, which at their nearest are situated some 750m northeast, upslope of the site. According to CGL's in house records a culverted river, likely a tributary to the former water course of the River Tyburn is situated some 300m east of the site and flows from north to south.

Mapping available on the Environment Agency website[9] indicates that the site is not located within an area at risk of flooding from rivers, sea and reservoirs. The site is however shown to be at low risk from surface water flooding with an area of high risk shown some 25m to the north. The site is not within a groundwater Source Protection Zone, and there are no classified Source Protection Zones within a 250m radius of the site.

[8] http://www.bgs.ac.uk/ (accessed May 2019).
[9] http://www.environment-agency.gov.uk/wiyby (accessed May 2019)

3. GROUND INVESTIGATION

3.1 Current Ground Investigation

A ground investigation report was prepared by LMB Limited[3] in May 2019 on behalf of Symmetrys Limited. The report is contained in Appendix B. The ground investigation comprised the drilling of a single windowless sample borehole to a depth of 10mbgl, and the excavation of 2No. hand excavated trial pits to depths of between 1mbgl and 1.48mbgl.

The sole borehole was installed with a monitoring standpipe on completion. It is understood that a single return monitoring visit was conducted on 11th April 2019.

Soil samples were analysed by i2 Analytical Limited, a UKAS accredited laboratory, for the following geotechnical tests:

- Moisture content; and
- Atterberg Limits.

3.2 Ground Conditions

The ground conditions encountered during the investigation are summarised in Table 1 below. The ground conditions are broadly consistent with the published geology.

Table 1. Summary of Ground Conditions

Strata	***Level to Top of Strata (mbgl)***	***Typical thickness (m)***
Brown gravelly sand with and slightly sandy slightly gravelly clay with varying proportions of brick gravel and rare cobbles **[MADE GROUND]**	0.0	2.0
Soft brown and orange brown grey mottled CLAY with occasional flint gravel **[POSSIBLE HEAD DEPOSITS]** *Encountered in exploratory hole BH1 only.*	2.0	0.1
Soft becoming firm brown with orange brown and grey mottled CLAY **[WEATHERED LONDON CLAY FORMATION]**	2.1	0.9
Firm becoming very stiff brown and blue grey CLAY. **[LONDON CLAY FORMATION]**	3.0	>7.0 (base not proven)

Geotechnical test data, extracted from the LMB Limited Ground Investigation Report, is presented in Table 2 below.

Table 2. Geotechnical Test Data

Uncorrected SPT'N' Data Including Hand Shear Vane Tests						
Strata		***Range (Number of Tests)***		***Equivalent C_u[1] (kN/m^2)***		***Classification[3]***
Made Ground		2 (1)		-		-
Weathered London Clay Formation		8 to 10 (2)		36 to 45		Low to medium strength
London Clay Formation		10 to 46 (7)		45 – 207		Medium to High Strength
Atterberg Limits						
Strata	***Moisture content (%)***	***Liquid Limit (%)***	***Plastic Limit (%)***	***% material <425µm***	***I'_p[1, 2]***	***Volume change potential***
London Clay Formation	17 to 23	41 to 69	19 to 22	99 to 100	22 to 47	Medium to High
Hand Shear Vanes						
Strata	***Undrained shear strength - c_u (kN/m^2) [Depth (m bgl)]***					
London Clay Formation	45 to 90 [2.6 – 6.6]					

Table 2 notes:
1. Based on f1 = 4.5 for London Clay Formation
2. Modified Plasticity Index.
3. Based on British Standards institution. Code of practise for Site Investigations BS 5930:2015

Compiled Plots of the SPT 'N' values and undrained shear strength, c_u (kN/m^2) versus depth (mbgl) are presented in Figure 3 and Figure 4 respectively.

3.3 Groundwater

During the ground investigation water strikes were not recorded. During the return groundwater monitoring visit water was recorded to be present at 4.3m bgl.

The water observed and recorded in borehole BH1 during the return monitoring visit is likely to be representative of perched water in the Made Ground or London Clay Formation rather than a laterally continuous water body.

3.4 Geotechnical Design Parameters

Geotechnical design parameters for the soils encountered on site are summarised in Table 4 below. These are based on the borehole records from the site, the results of the in-situ testing and on published data for the well-studied London geology. The parameters in Table 3 are unfactored (Serviceability Limit State) and are considered to be 'moderately conservative' design values.

Based on the recorded 100mm thickness, the possible 'Head Deposits' strata have been grouped with the Made Ground.

Table 3. Geotechnical Design Parameters

Stratum	***Depth to Top of Stratum (mbgl)[a]***	***Bulk Unit Weight (kN/m^3) [γ_b]***	***Undrained Cohesion, c_u (kN/m^2)***	***Friction Angle (°)***	***Young's Modulus, Eu [E'] (MPa)***
Made Ground (Cohesive) – **including Head Deposits**	0	19[b]	40[c]	25[e]	20[g] [15][h]
Weathered London Clay Formation (Cohesive)	2.10	20[b]	45	23[f]	27[g] [20.25[h]]
London Clay Formation (Cohesive)	3.00	20[b]	45+13z[di]	23[f]	27 + 9.6z[g] [20.25+ 7.2z][h]

***Notes**:*

a. mbgl = metres below ground level

b. BS 8002:1994 Code of practice for earth retaining structures, British Standards institution

c. BS 8004 (1986) Code of practice for foundations; BS 8002:1994 Code of practice for Earth retaining structures; CIRIA C580 Embedded retaining walls – guidance for economic design, Table 5.8 p.154. BS 5930:2015. Code of practise for ground investigations.

d. z = depth below surface of the London Clay Formation

e. BS 8002:1994 (2015) Code of practice for Earth retaining structures, British Standards institution. For the Cohesive Made Ground it has been assumed that PI is 30% (based on log description as gravelly sandy clay), correlating to φ' = 25°.

f. BS 8002:1994 (2015) Code of practice for Earth retaining structures, British Standards institution. For the London Clay Formation it has been assumed that PI is 40% (based on log description and plasticity index tests), correlating to φ' = 23°.

g. Based on Eu = 600 Cu – Burland, Standing J.R., and Jardine F.M. (eds) (2001), Building response to tunnelling, case studies from construction of the Jubilee Line Extension London, CIRIA Special Publication 200.

h. Based on E' = 0.75Eu – Burland, Standing J.R., and Jardine F.M. (eds) (2001), Building response to tunnelling, case studies from construction of the Jubilee Line Extension London, CIRIA Special Publication 200.

i. Strength of London Clay Formation has been limited to 130 kN/m^2

4. GROUND MOVEMENT ASSESSMENT

4.1 Introduction

This section provides details of calculations that have been undertaken to determine ground movements which may result from the construction of the proposed basement and to assess how these may affect the adjacent structures and tunnel beneath the site.

It is understood that the finished floor level (FFL) of the proposed basement, according to available proposed development drawings, will be approximately 3.1m below existing ground floor level. The maximum basement excavation level is at approximately 3.4mbgl across the basement slab area, but locally deepened to 3.9mbgl around the perimeter, to accommodate the 500mm thick mass concrete strip of the underpin. It is understood that the proposed basement beneath Flat 2 will share a party wall with Flat 1.

Proposed development drawings provided by the Structural Engineer are provided in Appendix A.

4.2 Conceptual Site Model and critical sections

A conceptual site model (CSM) of the proposed site conditions has been developed based on the available data to illustrate the conceptual understanding of the ground model and is presented in Figure 5 in section and plan view respectively. Details of the critical sections to be analysed as part of this assessment are discussed below.

4.3 Basement Construction Sequence

This construction sequence has been interpreted from the underpinning noted detailed on structural drawings presented in Appendix A. It is understood that beneath the existing building the new basement is to be constructed using a traditional 'hit and miss' underpin technique, which will involve the excavation in sequence of bays with a maximum 1.2 m width. In is understood the construction of the underpins will be completed in a single lift. The proposed underpinning sequence is presented in Appendix D.

The foundations and basement are to be taken through the Made Ground and weathered London Clay Formation, and founded within the London Clay Formation at depths set out in Section 4.1.

4.4 Critical Sections for Analysis

Based on a review of proposed basement founding depth, its relative location and the likely assumed founding depths of neighbouring properties, the carriageway of Lyndhurst Gardens ,is considered to be subject to negligible movements associated with the proposed construction development works and is

therefore not considered as critical sections for analysis. In addition, No. 10 Lyndhurst Gardens is situated over 10m to the north of the site and, therefore, is considered to be subject to negligible movements associated with the proposed construction development and has also not been included as a critical section.

Three critical sections have been identified for analysis. The locations of critical sections are presented in Figure 2;

- Section A-A' representing the crown of the Belsize Tunnel running across the site approximately east-west;
- Section B-B' representing the eastern wall of the proposed basement through to the far side of neighbouring No. 14 Lyndhurst Gardens;
- Section C-C' representing the western party wall of the proposed basement through to the far side of neighbouring Flat 1, 12 Lyndhurst Gardens; and
- Section D-D' representing the northern party wall of the proposed basement through to the front of the No. 12 Lyndhurst Garden.

4.4.1 Critical Section A-A'

Information regarding the positioning and depth of the Belsize Tunnel with respect to the site have been provided by the Structural Engineer. The position and orientation of the tunnel with respect to the site has been presented in Figure 2. The tunnel is recorded to be situated some 2.6m from the southern basement wall and is aligned roughly east to west. The depth of the outer tunnel crown level has been taken at 28mbgl. Based on this, an assessment has been undertaken to determine the effects of ground movements from the basement excavation and construction on the tunnel.

No further details have been provided.

4.4.2 Critical Section B-B' – No. 14 Lyndhurst Gardens

No.14 Lyndhurst Gardens is located to 2m the east of the proposed basement boundary, and the proposed basement does not form a party wall to this structure. The structure is approximately 15m in width along the front elevation. The depth of the existing foundation has been assumed to be some -1mbgl.

4.4.3 Critical Section C-C' – Flat 1, No. 12 Lyndhurst Gardens

Flat 1, 12 Lyndhurst Gardens is located within the ground floor of the 12 Lyndhurst Garden Structure and shares a party wall with Flat 1. Flat 1 is approximately 8m in width along the front elevation. The depth of the existing foundation has been assumed to be some 1m bgl.

4.4.4 Critical Section D-D' – Front of No. 12 Lyndhurst Gardens

The ground floor of 12 Lyndhurst Gardens to the north of the basement has been assessed. The ground floor is approximately 8m in width. The depth of the existing foundation has been assumed to be some 1m bgl.

4.5 Ground Movements Arising from Basement Excavation

A ground movement assessment has been undertaken using OASYS Limited *PDISP* (*Pressure Induced Soil Displacements*) analysis software version 19.3. *PDISP* assumes that the ground behaves as an elastic material under loading, with movements calculated based on the applied loads and the soil stiffness (E_u and E') for each stratum input by the user. The analysis calculates total settlement, including both short term (undrained) and long-term (total) movements.

The loading information used in the ground movement analysis was provided by Symmetrys Limited, the structural design engineers for the project, and is presented within Appendix A.

It has been assumed that the bulk unit weight of the Made Ground is 19kN/m^3 and the London Clay Formation 20kN/m^3. An unloading of 66 kN/m^2 has been modelled in the PDisp analysis at the underside of the proposed basement level (at 3.4mbgl) to represent the weight of the soil removed during excavation of the basements northern and southern areas respectively. A separate unloading of 78 kN/m^2 has been modelled around the basement perimeter, where the footings are to be locally deepened to 3.9mbgl.

A serviceability limit state (SLS) analysis has been undertaken, using the soil parameters outlined in Section 4.3, which considers the net vertical loading. The data for these plots corresponds to a displacement grid at basement formation level. Displacement lines have been added to the analysis model corresponding to the line and level of the critical constraints outlined above.

4.6 Short Term Heave Due to Excavation

The maximum short-term heave is predicted to be approximately 3mm, which is anticipated to occur in the centre of the proposed basement, located within the east of 12 Lyndhurst Gardens. The predicted heave reduces to approximately 1mm at the basement perimeter of the structure.

A contour plot showing the distribution of ground movements immediately after basement excavation, across the entire lower ground floor footprint and in the vicinity of neighbouring developments, is presented as Figure 6.

4.7 Total Heave Due to Excavation

The maximum total heave is predicted to be approximately 2mm as pore pressures recover within the London Clay Formation, this occurring in the centre of the proposed basement, within the east of 12 Lyndhurst Gardens. A contour plot showing the distribution of net total ground movements across the entire lower ground floor footprint and in the vicinity of neighbouring developments, is presented as Figure 7.

4.8 Settlement

The maximum combined vertical movements predicted for the property are indicated to be in the order of 7mm in the short term, and up to 5mm in the long term (i.e. total settlement of 12mm) beneath the underpins, reducing to approximately 11mm at the basement walls.

4.9 Underpin settlement – Workmanship

In CGL's experience, settlement caused by the construction of underpinning is typically in the order of 2mm to 3mm per stage with good workmanship. This makes allowance for compression of the dry pack concrete on the underside of the foundation as loads are taken up on the new foundations. Where the quality of the workmanship is reduced, a settlement of 5mm per stage could arise from the works. The variations in the quality of workmanship have been adopted in addition to those movement calculated using the PDISP assessment for soil removal and underpin vertical loading at formation.

4.10 Underpin Walls – Lateral Movements

Underpins are large stiff RC concrete inclusions with a very high lateral stiffness to deflation under lateral forces. Lateral ground movement during construction will be primarily dependent on the quality of workmanship of the contractor, particularly in the provision of temporary excavation support for the underpins, use of sacrificial trench sheeting to the rear face of the underpin excavation, dry-packing and timely and accurate installation of temporary propping during construction. Temporary propping of each underpin section during construction will be crucial in controlling horizontal deflection and rotation of the underpins. The detailing and construction of any reinforcement and connections/curing joints between underpin sections and basement slab will also be critical in controlling deflections.

For the purpose of this assessment the maximum deflection ratio of the wall will be determined from the critical ground movement profiles calculated for the adjacent property. This value will be used to

determine the critical allowable lateral deflection of the wall to restrict movements such that predicted Damage Category 1 (very slight damage) is not exceeded in accordance with CPG4. This value should then be considered by the contractor/engineer in the design of a robust lateral propping scheme to the underpins to control deflection to within the limiting values provided.

5. BUILDING DAMAGE ASSESSMENT

The calculated ground movements have been used to assess potential 'damage categories' that may apply to neighbouring properties due to the proposed basement construction and assumed construction sequence. The methodology proposed by Burland and Wroth[10] and later supplemented by the work of Boscardin and Cording[11] has been used, as described in *CIRIA Special Publication 200*[12] and *CIRIA C760*[13].

General damage categories are summarised in Table 4 below:

Table 4. Classification of Damage Visible to Walls (Reproduction of Table 6.4, CIRIA C760)

Category	*Definition*
0 (Negligible)	Negligible – hairline cracks.
1 (Very slight)	Fine cracks that can easily be treated during normal decoration (crack width <1mm).
2 (Slight)	Cracks easily filled; redecoration probably required. Some repointing may be required externally (crack width <5mm).
3 (Moderate)	The cracks require some opening up and can be patched by a mason. Recurrent cracks can be masked by suitable linings. Repointing of external brickwork and possibly a small amount of brickwork to be replaced (crack width 5 to 15mm or a number of cracks > 3mm).
4 (Severe)	Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows (crack width 15mm to 25mm but also depends on number of cracks).
5 (Very Severe)	This requires a major repair involving partial or complete re-building (crack width usually >25mm but depends on number of cracks).

The above assessment criteria are primarily relevant for assessing masonry structures founded on strip footings. The assessment also assumes that the neighbouring properties are fully flexible and deform to follow the profile of the ground i.e. wall stiffness is ignored. This is considered a conservative approach for the purpose of this assessment.

The damage assessment is based on vertical and horizontal ground movements induced by stress changes in the soil (due to basement excavation and application of structural loads) and installation

[10] Burland, J.B., and Wroth, C.P. (1974). *Settlement of buildings and associated damage*, State of the art review. Conf on Settlement of Structures, Cambridge, Pentech Press, London, pp611-654

[11] Boscardin, M.D., and Cording, E.G., (1989). *Building response to excavation induced settlement.* J Geotech Eng, ASCE, 115 (1); pp 1-21.

[12] Burland, Standing J.R., and Jardine F.M. (eds) (2001), *Building response to tunnelling, case studies from construction of the Jubilee Line Extension London*, CIRIA Special Publication 200.

[13] CIRIA C760 (2017) *Guidance on Embedded Retaining Wall Design.*

movements (as described in Section 4.10). Using the resulting ground movement profiles, the deflection ratio and horizontal strain imposed on the structures has been calculated and plotted on the corresponding interaction diagram for the Damage Category to be determined.

5.1 Impact Assessment – No. 14 Lyndhurst Gardens

For the critical section (B-B') of No. 14 Lyndhurst Gardens, the combined impact of drained ground movement and assumed settlement due to workmanship have been used to determine the overall ground movements due to the construction of the basement. The maximum combined vertical movements predicted for No. 14 is to be 6.5mm of settlement at No. 14. The combined (total and installation) movements are presented in Figure 8.

Table 5 summarises the calculation of damage category parameters, namely the deflection ratio and horizontal strain. The method of establishing an appropriate deflection ratio for the neighbouring structure is illustrated graphically in Figure 8.

The span between the footings of the adjacent property has been assumed from development plans to be approximately 15m. These span distances are taken perpendicular and not parallel to the basement footprint.

Table 5. Summary of ground movements and corresponding damage category

Critical Section	*Limiting Horizontal movement [c] (mm)*	*Calculated Maximum deflection (mm)*	*Limiting horizontal Strain ε[a] (%)*	*Deflection ratio Δ/L [b] (%)*	*Damage category*
No. 14 Lyndhurst Gardens	6	2.5	0.04	0.016	0 – Negligible

Notes;

1. See Figure 2.18 (a) CIRIA C580 (2003) Embedded retaining walls guidance for economic design. (L = length of adjacent structure in metres, perpendicular to basement; Δ = relative deflection)
2. See Box 2.5 (v) CIRIA C580 (2003) Embedded retaining walls guidance for economic design. (δ_h = horizontal movement in metres
3. Maximum horizontal movement allowed to ensure Category 1 Damage is not exceeded

Based on the calculated maximum deflection of 3.5mm, a maximum horizontal limiting value of 6mm for the horizontal deflection of the underpins has been calculated to restrict the damage category of adjacent properties to within Category 0 'negligible' damage, as shown on Figure 9.

For Category 1 'Very Slight' damage the limiting horizontal movements increase to 10mm.

The assessment assumes that angular distortion acts over the full width of the structure and that there are no localised higher stress/stiffer/more sensitive areas of No. 14.

5.2 Impact Assessment – Flat 1, No. 12 Lyndhurst Gardens

For the critical sections (C-C' and D-D') assessed for No. 12 Lyndhurst Gardens, the combined impact of drained ground movement and assumed settlement due to workmanship has been used to determine the overall ground movements due to the construction of the basement. The combined (total and installation) movements for the two critical sections are presented in Figures 10a and 10b, which have also taken into account the variations in workmanship quality.

Table 6 summarises the calculation of damage category parameters, namely the deflection ratio and horizontal strain. The method of establishing an appropriate deflection ratio for the neighbouring structure is illustrated graphically in Figure 10.

The span between the footings of the adjacent property has been assumed from development plans to be approximately 8m. These span distances are taken perpendicular and not parallel to the basement footprint.

Table 6. Summary of ground movements and corresponding damage category

Critical Section	*Underpinning Settlement (mm)*	*Limiting Horizontal movement [c] (mm)*	*Calculated Maximum deflection (mm)*	*Limiting horizontal Strain ε_h [a] (%)*	*Deflection ratio Δ/L [b] (%)*	*Damage category*
C-C'	5	3.5	4.0	0.04	0.05	1 – Very Slight
D-D'	5	3.5	4.0	0.04	0.05	1 – Very Slight

Notes;

1. See Figure 2.18 (a) CIRIA C580 (2003) Embedded retaining walls guidance for economic design. (L = length of adjacent structure in metres, perpendicular to basement; Δ = relative deflection)
2. See Box 2.5 (v) CIRIA C580 (2003) Embedded retaining walls guidance for economic design. (δ_h = horizontal movement in metres
3. Maximum horizontal movement allowed to ensure Category 1 Damage is not exceeded

Based on 5mm of underpin settlement a maximum deflection of 4mm, a maximum horizontal limiting value of 2mm for the horizontal deflection of the underpins has been calculated to restrict the damage category of adjacent properties to within Category 1 'Very Slight' damage. The building damage assessments are presented in Figure 11a and 11b.

In CGL's experience of similar works, the lateral deflection of the thick and very stiff RC underpins proposed can be limited such that there is negligible lateral movement of the neighbouring structure. Assuming a robust propping strategy for the underpinning is developed by an experienced underpinning and basement construction Contractor, it is considered the limiting lateral movement values detailed are feasible assuming a high standard of workmanship is adopted. Additionally, a conservative approach has been adopted in the assessment to calculate the vertical displacement to correspond to a deflection ratio, which has then been used to inform the limiting horizontal movement.

The assessment assumes that the neighbouring structure is fully flexible and deforms in accordance with the profile of ground deformation, and conservatively ignores the stiffness of the structure in reality that will further help to limit deflection ratio and reduce angular distortion.

5.3

Short-Term, Long-term and total movements calculated from the analysis of Critical Section A-A' have been presented in Figure 11 with respect to the proposed development. Movements have been calculated at 28mbgl representing the crown level of the Belsize Tunnel.

In summary, in the immediate undrained analysis a maximum heave of 0.05mm is calculated for the crown of the tunnel. In the total drained analysis, a maximum settlement of 0.1mm is predicted. The anticipated ground movements at the crown of the tunnel have been assessed and are shown on Figure 10, the maximum differential movements associated with the basement construction have been calculated at 5m centres with maximum movements of 0.2 mm over 5m.

The results of the PDisp analysis indicate that the proposed basement construction will cause a maximum stress change of 2.4 kN/m^2 on the deep tunnel. The anticipated ground movements at the crown of the tunnel have been assessed and are shown on Figure 12. The maximum stress change associated with the basement construction has been calculated at 5m centres with maximum change in stress of 0.4 kN/m^2 over 5m, this corresponds to a stress increase of approximately <1% assuming the tunnel is at 28mbgl and the weight of the overburden material is 20kN/m^3. The predicted combined short- and long-term stress change profiles along the crown of the tunnel are presented within Figure 13.

The movements calculated along the tunnel crown axis are deemed to be of negligible consequence to the structure of the tunnel and given the tunnel's relative depth.

6. CONSTRUCTION MONITORING

6.1 Adjacent Properties

The results of the ground movement analysis suggest that with good construction control, maximum damage to adjacent structures generated by the assumed construction methods and sequence is likely to be within Category 1 'Very Slight'. This is within the allowable limits specified within London Borough of Camden's basement planning guidance.

A formal monitoring strategy should be implemented on site in order to observe and control ground movements during construction.

The system should operate broadly in accordance with the 'Observational Method' as defined in CIRIA Report 185[14]. Monitoring can be undertaken by installing survey targets to the top of the wall and face of the structure. Baseline values should be established prior to commencement of works. Monitoring of these targets should be carried out at regular time intervals and the results should be analysed to determine if unacceptable horizontal translation of the wall or tilt/settlement of the neighbouring walls is occurring. Regular monitoring of these targets will allow ground movement trends to be detected in a timely manner such that mitigation strategies may be implemented if required.

Monitoring data should be checked against predefined trigger limits and reviewed regularly to assess and manage the damage category of the adjacent buildings as construction progresses.

It is recommended that a condition survey is undertaken on all adjacent walls and property facades prior to the works commencing and ideally when monitoring baseline values are established. Existing cracks or structural defects should be carefully recorded, documented and regularly inspected as construction progresses.

6.1 Tunnels

Predicted displacements on the Belsize tunnel are effectively negligible and it is not proposed to monitor the tunnels.

[14] Nicholson, D., Tse, Che-Ming., Penny, C., The Observational Method in ground engineering: principles and applications, CIRIA report R185, 1999.

7. NON-TECHNICAL SUMMARY

The results of this Ground Movement Assessment are informed by ground investigation data available for the site and BGS records. The analysis is also informed by drawings and loadings provided by the Structural Engineer for the project.

- Based on a numerical assessment, ground movements are anticipated to be of low magnitude in the locale of the adjacent structures and can be mitigated in the structural and temporary works design.

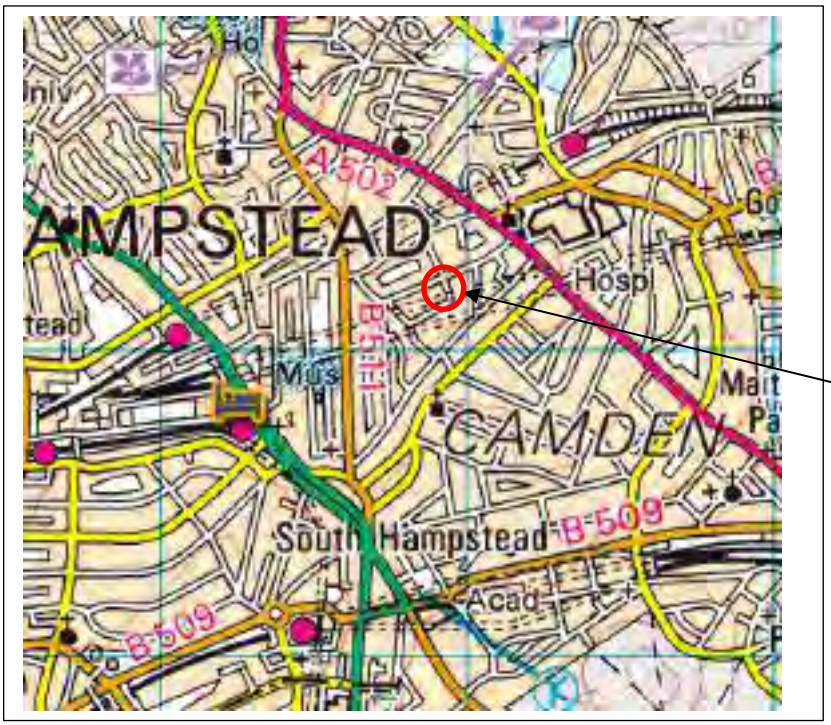
- Assuming high quality workmanship, it is considered that the calculated ground movement would limit building damage to Category 1 'Very Slight'. It should be noted that good workmanship will be critical in controlling ground movements during construction. Reference should be made to the Association of Specialist Underpinning Contractors guidance[15] in this respect.

- Additionally, ground movements predicted along the line of the Network Rail tunnel fall below maintenance standards and the ground movements are unlikely to significantly impact the deep tunnel located to the west of the proposed basement footprint.

- In order to control ground movements to within the predicted range, it is recommended that a formal monitoring strategy is implemented on site in order to observe and control ground movements during construction.

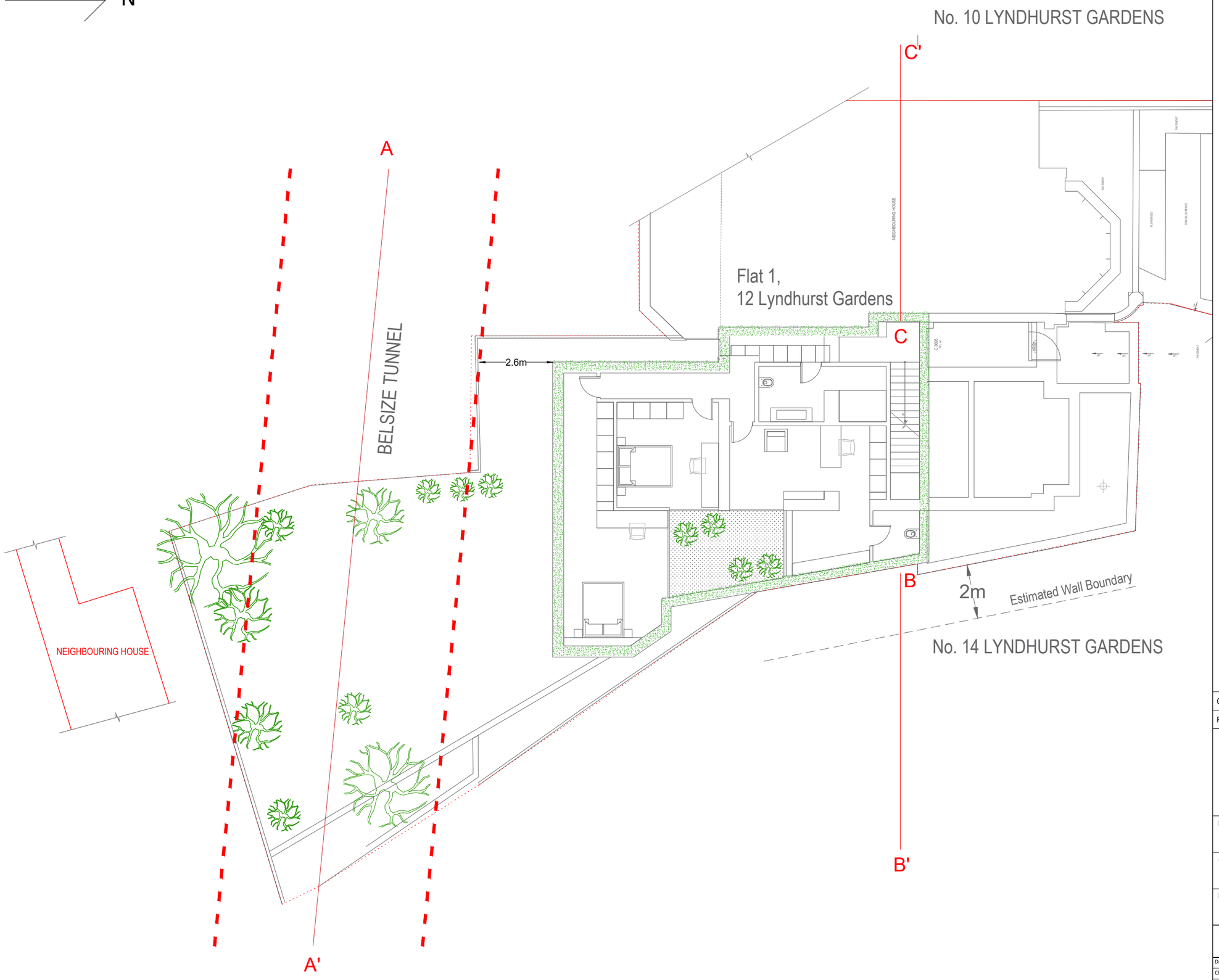
[15] ASUC (October 2013) *Guidelines on safe and efficient basement construction directly below or near to existing structures.*

FIGURES



Client	Project	Job No
Mr D Burbidge	**12 Lyndhurst Gardens, Camden, London**	**CG/28992**
CGL	Title: **Site Location Plan**	**Figure 1**

N



Proposed Basement Outline

Site Boundary

Rev	Date	Comments
01	03/06/1991	Included Section C-C'

Card Geotechnics Ltd
Palatine House
Matford Court
Sigford Road
EX2 8NL
T: 01392 439905

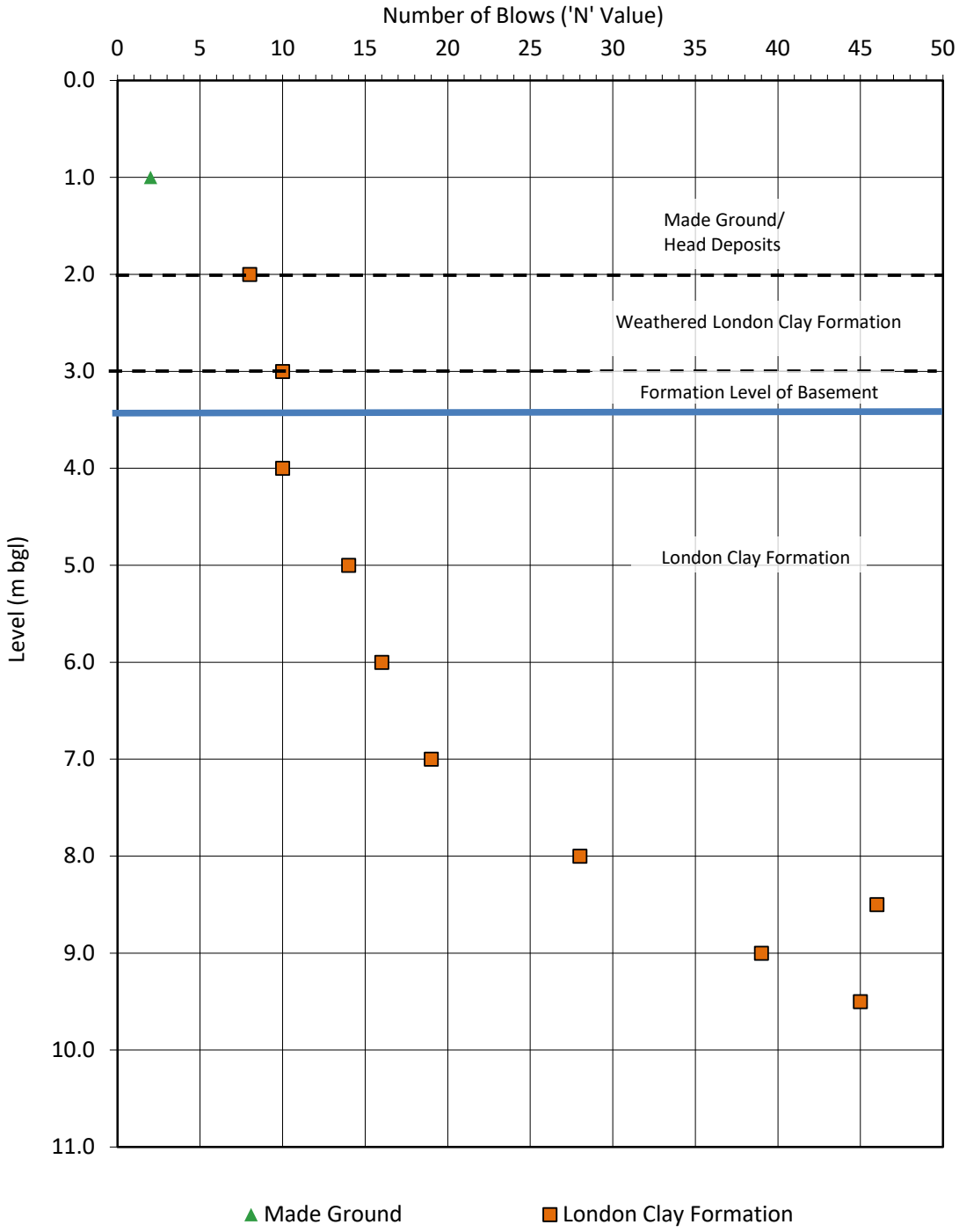
Project
12 Lyndhurst Gardens, Camden, London

Client
Mr D Burbidge

Drawing title
Figure 2 - Site Layout Plan

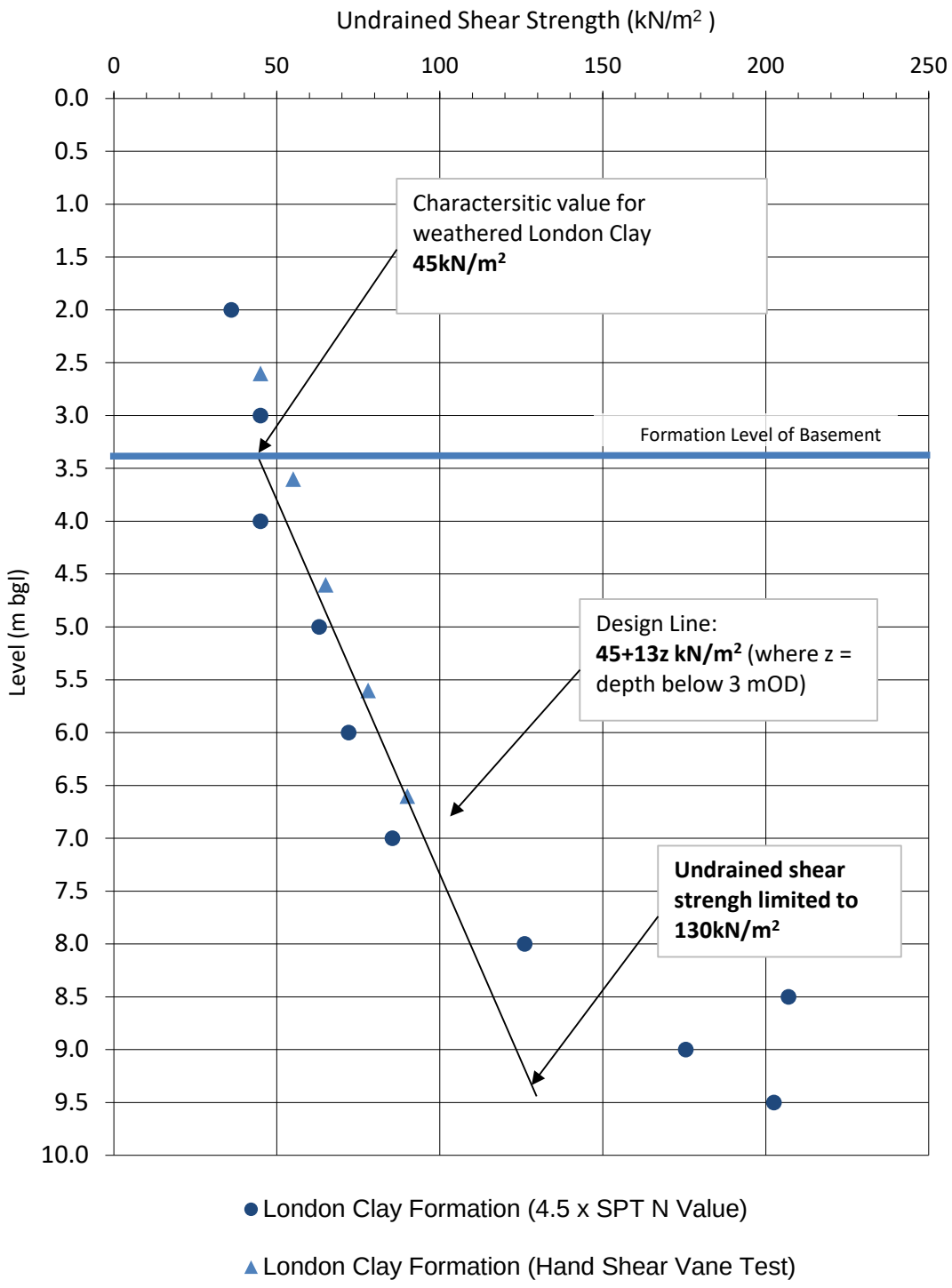
Scale(s)	Job No.
NTS	**CG/28992**

			Dwg No.	Rev.
Drawn	ARA	03/06/19	**CG/28992**	*
Checked	SJM	03/06/19		
Approved				

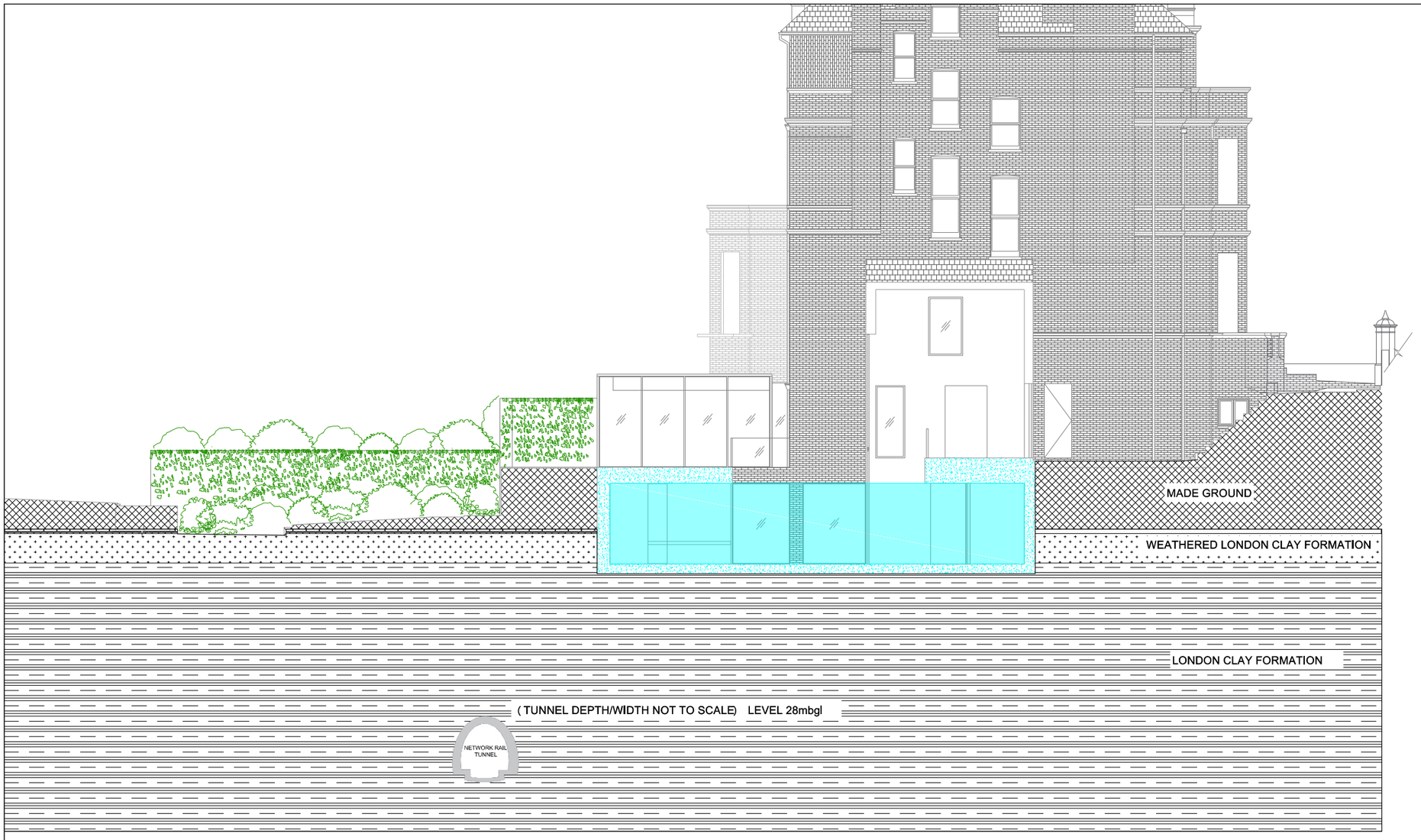


Notes: SPT 'N' values are uncorrected

Client	Project	Job No.
Mr D Burbidge	**12 Lyndhurst Gardens, Camden, London**	**CG/28992**
CGL	Title: **SPT 'N' Value Against Depth Plot**	**Figure 3**



Client	Project	Job No.
Mr D Burbidge	**12 Lyndhurst Gardens, Camden, London**	**CG/28992**
CGL	Title: **Undrained Shear Strength Against Depth Plot**	**Figure 4**



Proposed Basement

Made Ground

Weathered London Clay Formation

London Clay Formation

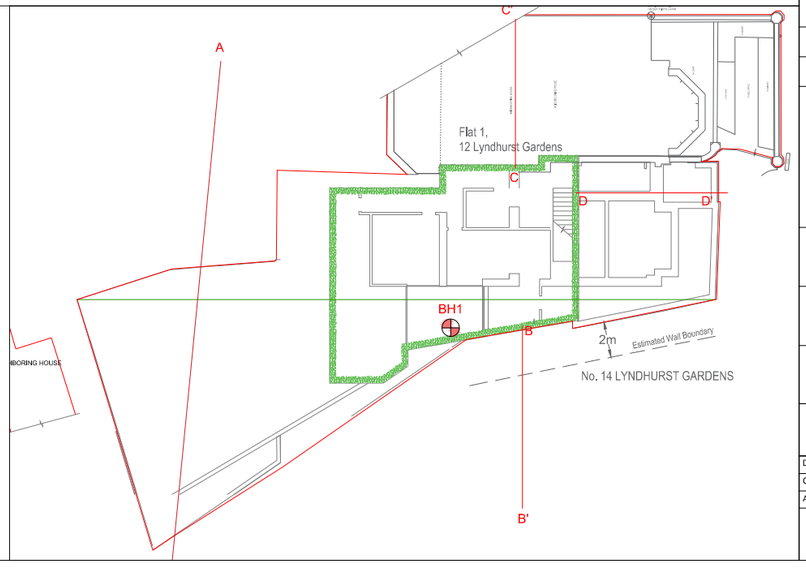
LMB Borehole Location (2019)

Site Boundary

Basement Boundary

Network Rail Tunnel Boundary

Line of Section 1-1



Rev	Date	Comments
*	*	*

Card Geotechnics Ltd
Palatine House
Matford Court
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Project
12 Lyndhurst Gardens, Camden, London

Client
Mr D Burbidge

Drawing title
Figure 5 - Conceptual Site Model

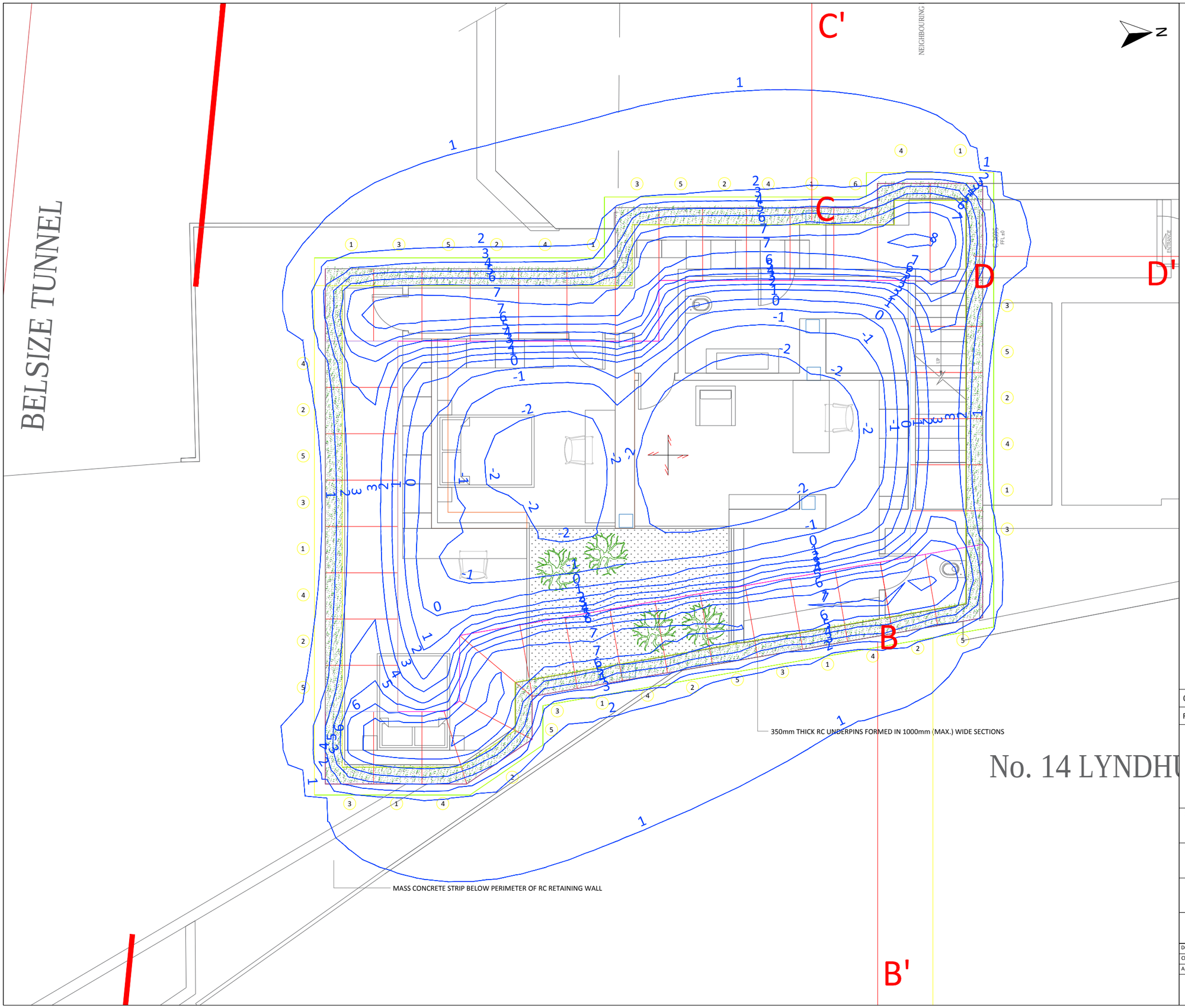
Scale(s)
NTS

Job No.
CG/28992

Drawn	ARA	30/05/19
Checked	SJM	25/09/19
Approved		

Dwg No.
CG/28992

Rev.
*



Notes

1. Contours are in mm.
2. Positive contour values indicate settlement and negative contour values indicate heave.

Rev	Date	Comments
0	31/05/19	

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4 Godalming Business Centre
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Project
12 Lyndhurst Gardens

Client
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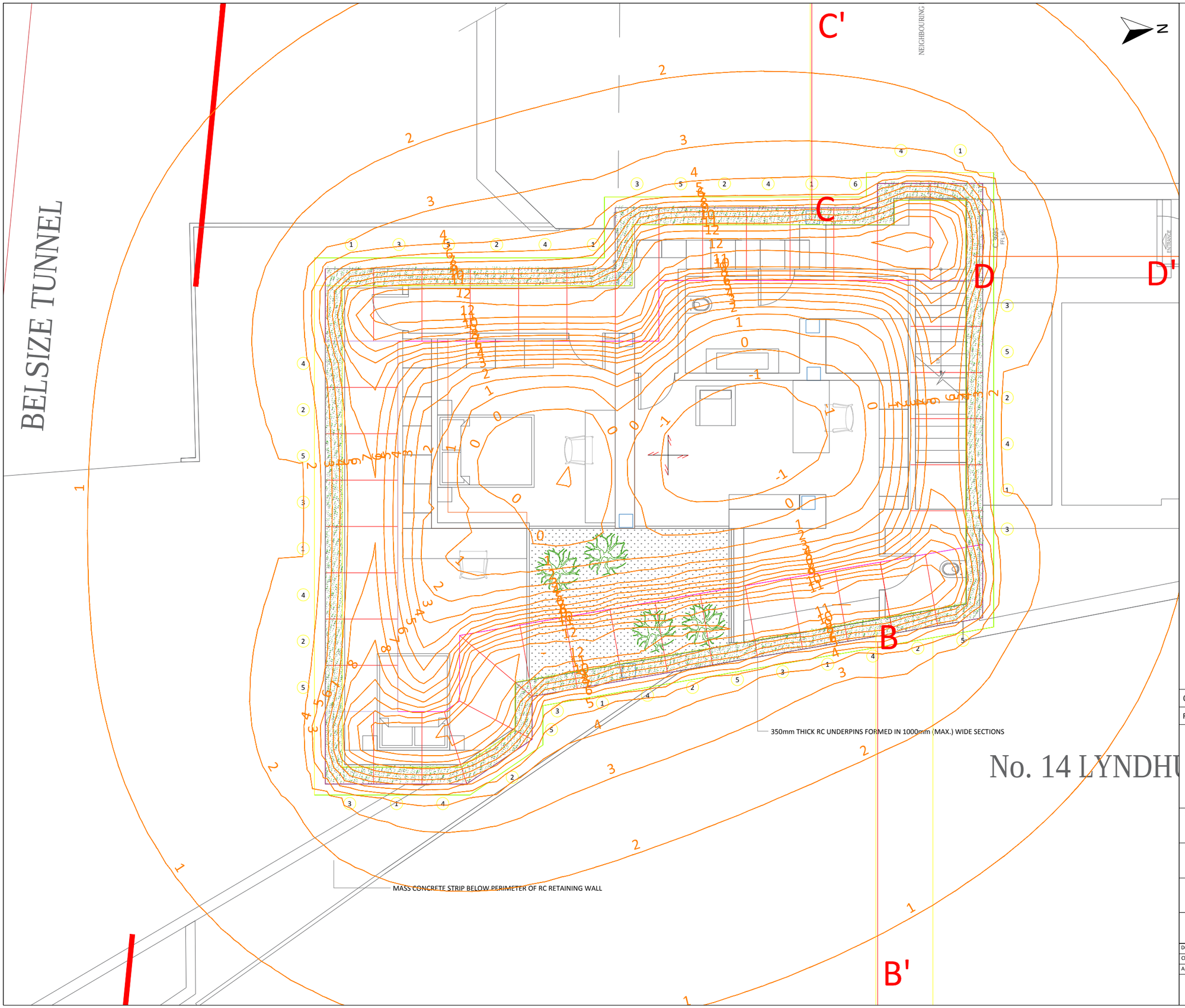
Drawing title
Undrained 'short term' ground movement contours

Scale(s)	Job No.	
NTS	**CG/28992**	
Drawn TSB 31/05/19	Dwg No.	Rev.
Checked SJM 25/09/19	**CG/28992-001**	**0**
Approved		



KEY

Notes

1. Contours are in mm.
2. Positive contour values indicate settlement and negative contour values indicate heave.

Rev	Date	Comments
0	31/05/19	

Card Geotechnics Ltd
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Project
12 Lyndhurst Gardens

Client
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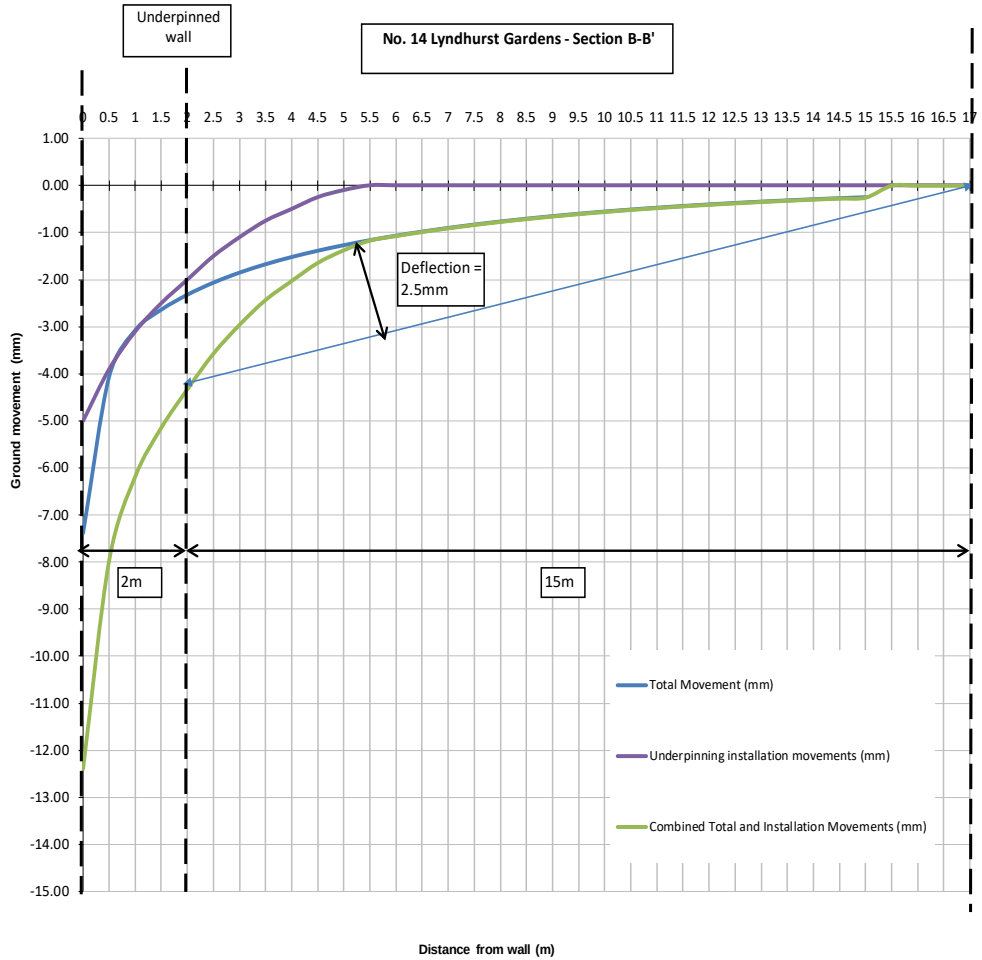
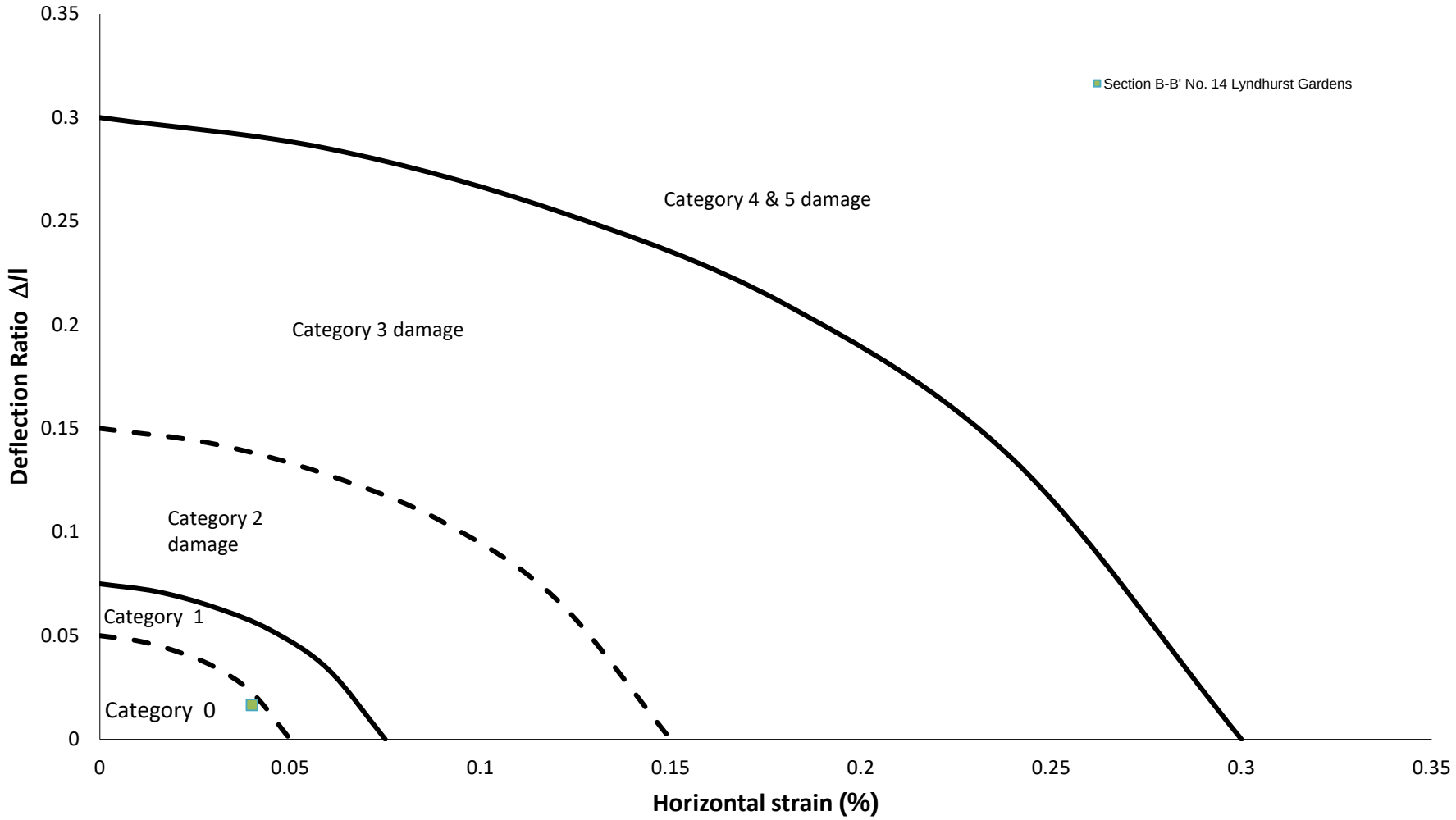
Drawing title
Drained 'Total' ground movement contours

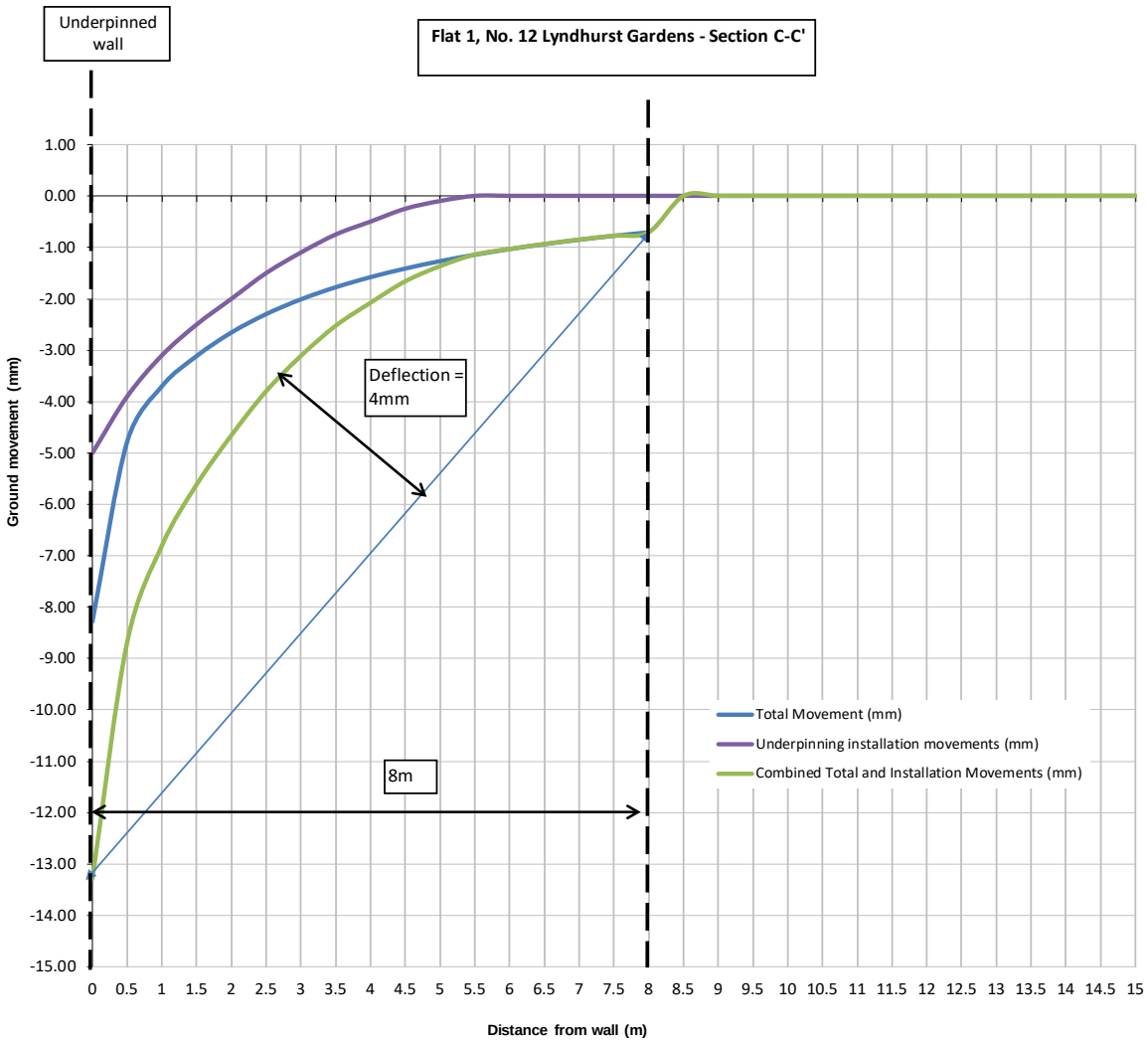
Scale(s)	Job No.	
NTS	**CG/28992**	
Drawn TSB 31/05/19	Dwg No.	Rev.
Checked SJM 25/09/19	**CG/28992-002**	**0**
Approved		



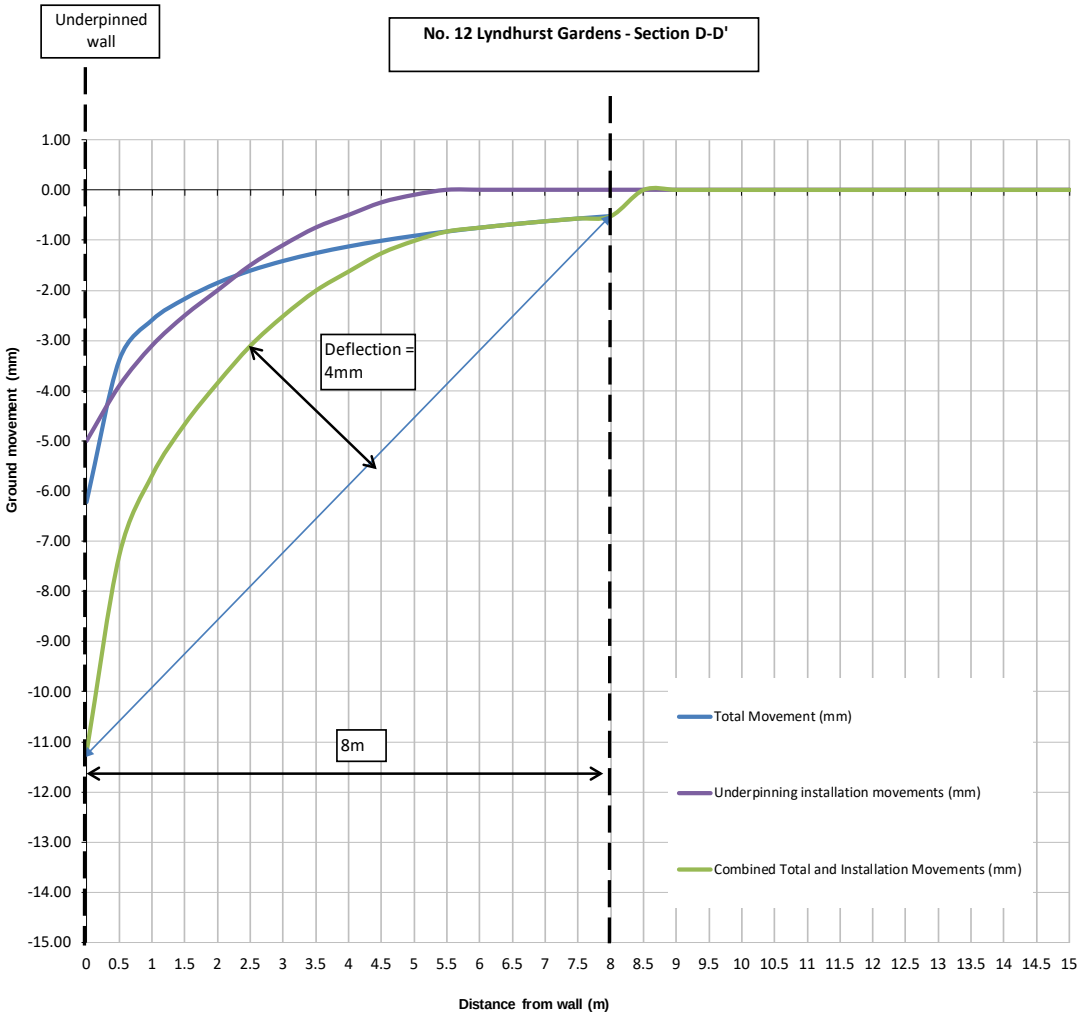
Client	Project	Job No
Mr D Burbidge	**12 Lyndhurst Gardens, Camden, London**	**CG/28992**
CGL	Title **Combined Cumulative Vertical Movement Section B-B'**	**Figure 8**



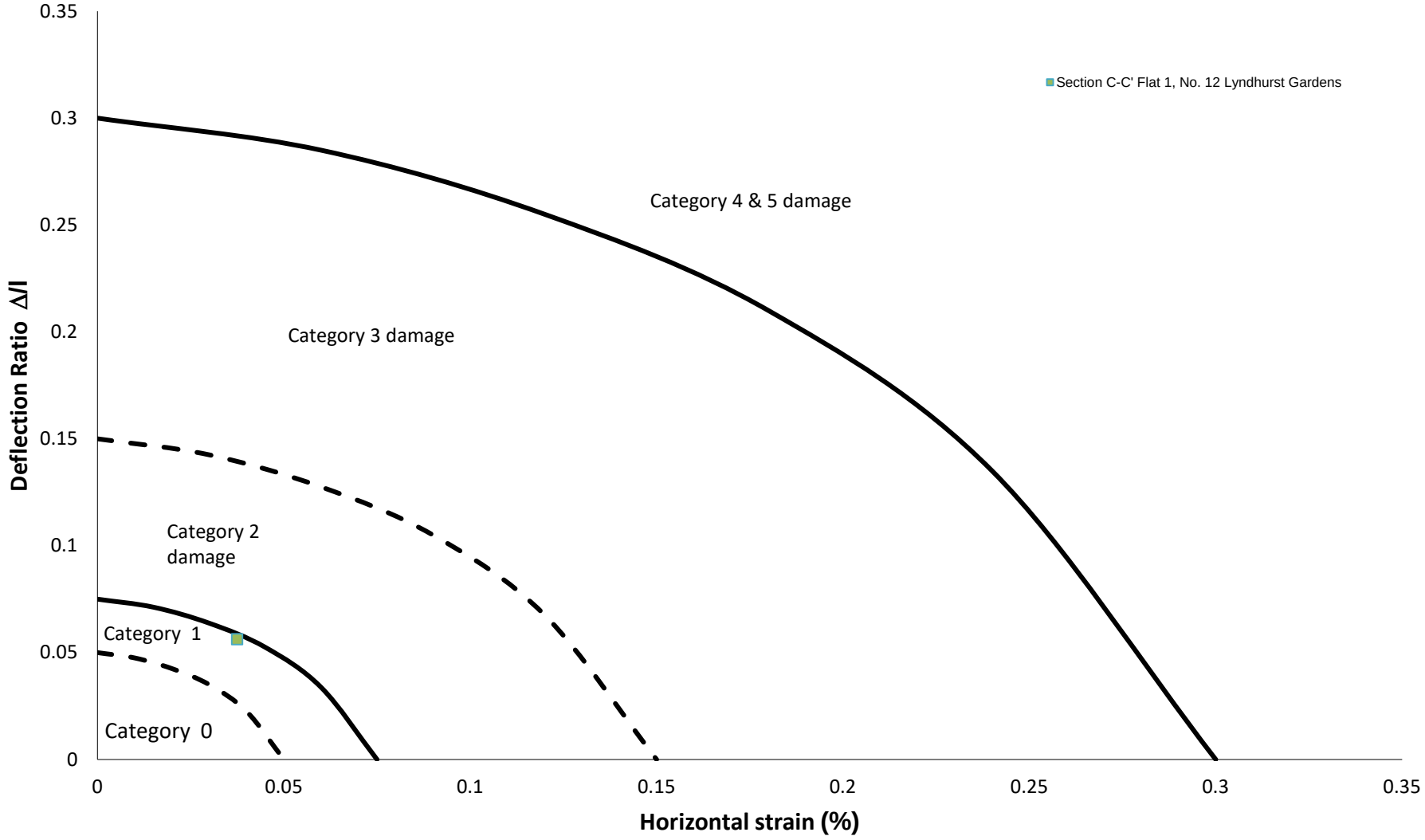
Client	Project	Job No
Mr D Burbidge	**12 Lyndhurst Gardens, Camden, London**	**CG/28992**
CGL	Title **Building Damage Assessment Plot – 14 Lyndhurst Gardens**	**Figure 9**



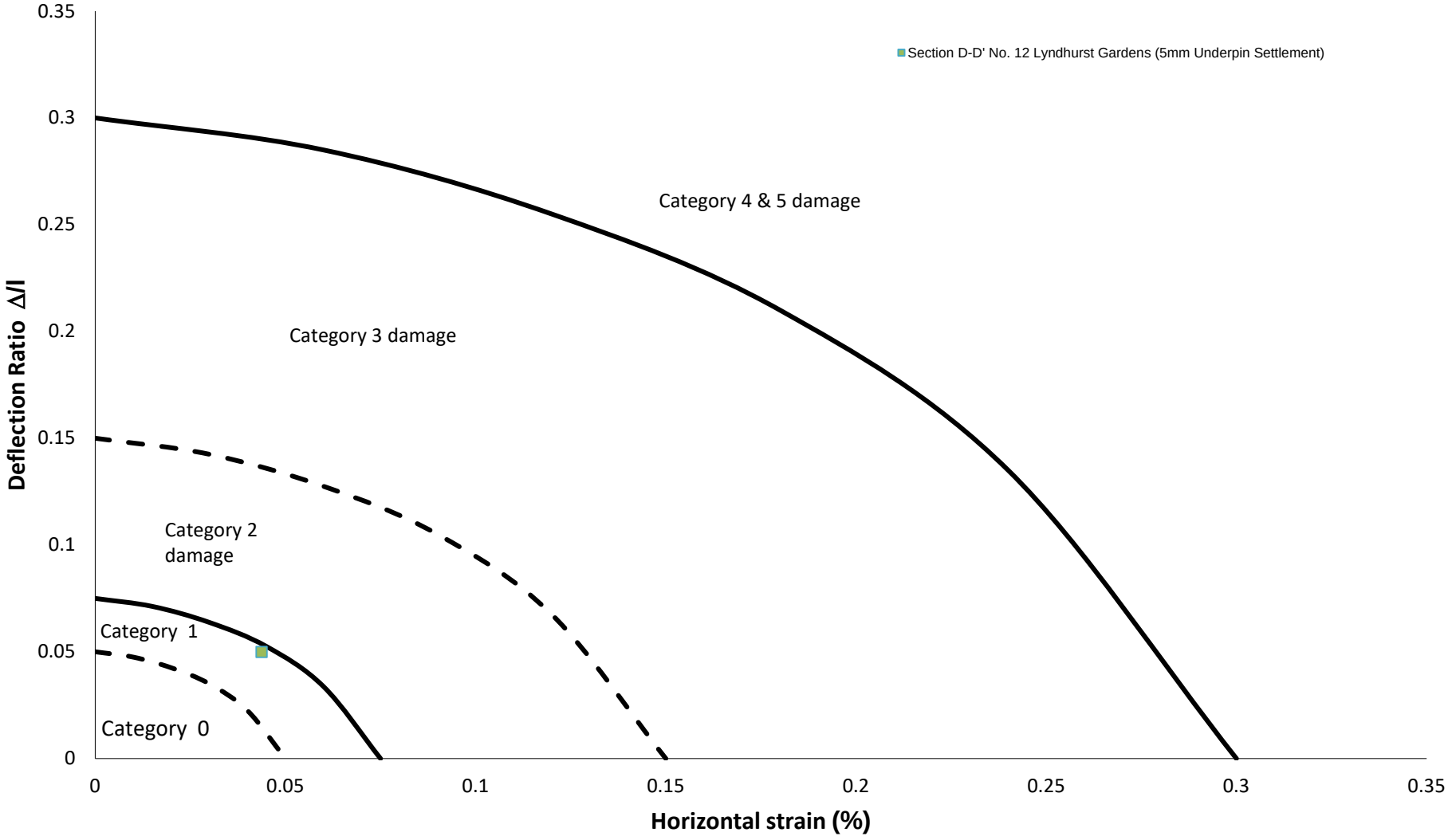
Client	Project	Job No
Mr D Burbidge	**12 Lyndhurst Gardens, Camden, London**	**CG/28992**
CGL	Title **Combined Cumulative Vertical Movement Section C-C'**	**Figure 10a**



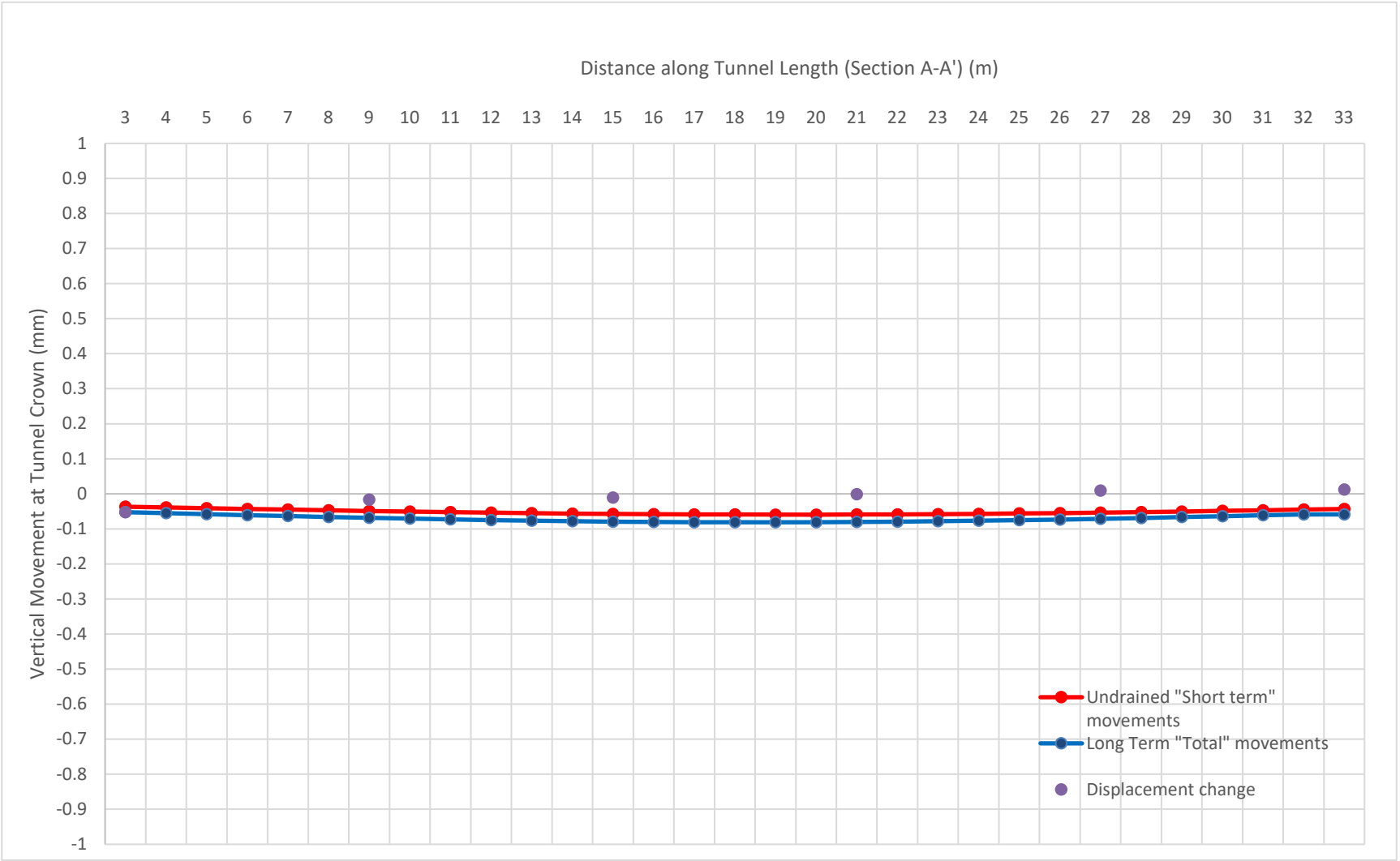
Client	Project	Job No
Mr D Burbidge	**12 Lyndhurst Gardens, Camden, London**	**CG/28992**
CGL	Title **Combined Cumulative Vertical Movement Section D-D'**	**Figure 10b**



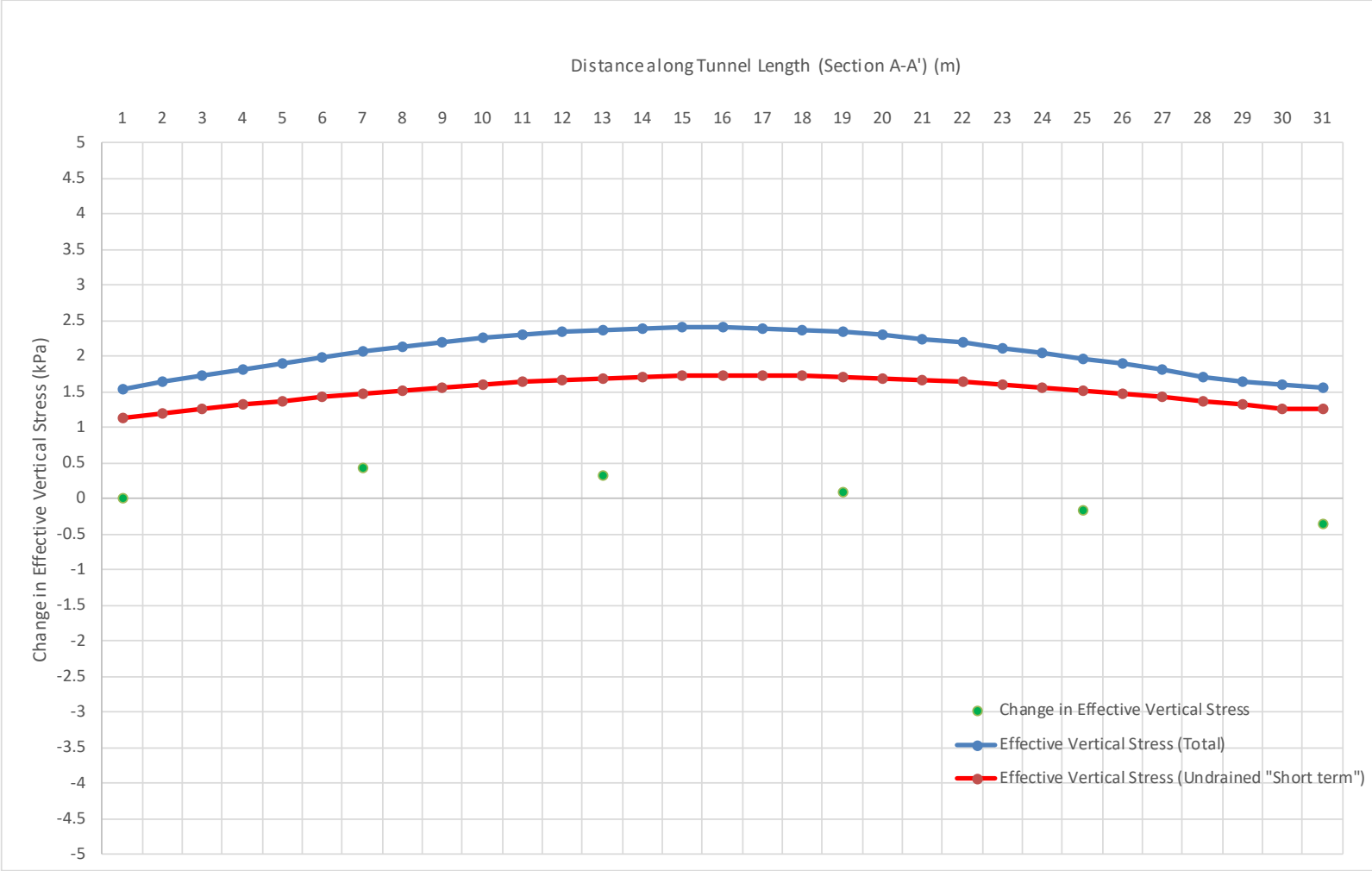
Client	Project	Job No
Mr D Burbidge	**12 Lyndhurst Gardens, Camden, London**	**CG/28992**
CGL	Title **Building Damage Assessment Plot – Flat 1, 12 Lyndhurst Gardens**	**Figure 11a**



Client	Project	Job No
Mr D Burbidge	**12 Lyndhurst Gardens, Camden, London**	**CG/28992**
CGL	Title **Building Damage Assessment Plot – No. 12 Lyndhurst Gardens (Section D-D')**	**Figure 11b**



Client	Project	Job No
Mr D Burbidge	**12 Lyndhurst Gardens, Camden, London**	**CG/28992**
CGL	Title **Belsize Tunnel Vertical Displacement at Tunnel Crown Level (Section A-A')**	**Figure 12**



Client	Project	Job No
Mr D Burbidge	**12 Lyndhurst Gardens, Camden, London**	**CG/28992**
CGL	Title **Belsize Tunnel Change in Effective Stress (Section A-A')**	**Figure 13**

APPENDIX A

Proposed Development Plans

PROPOSED SECTION 02

SCALE 1:100

LBMV architects

Luigi Montefusco Ltd
27 Elizabeth Mews
NW3 4UH London
T+44 (0) 207 483 3880
info@lbmvarchitects.com
www.lbmvarchitects.com

DRAWINGS STATUS: PLANNING PERMISSION | A3

PROJECT TITLE: REAR EXTENSION & BASEMENT

12 Lyndhurst Gardens
NW3 5NR

DRAWN	CHECKED
MC - UG	LM
DATE	SCALE
06.02.2018	1:100@A3

DRAWING TITLE: PROPOSED SECTION 02

JOB NO	DRAWING NO
0066	A2007

GENERAL NOTE
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- This drawing is copyrighted.
- All dimensions in mm's.

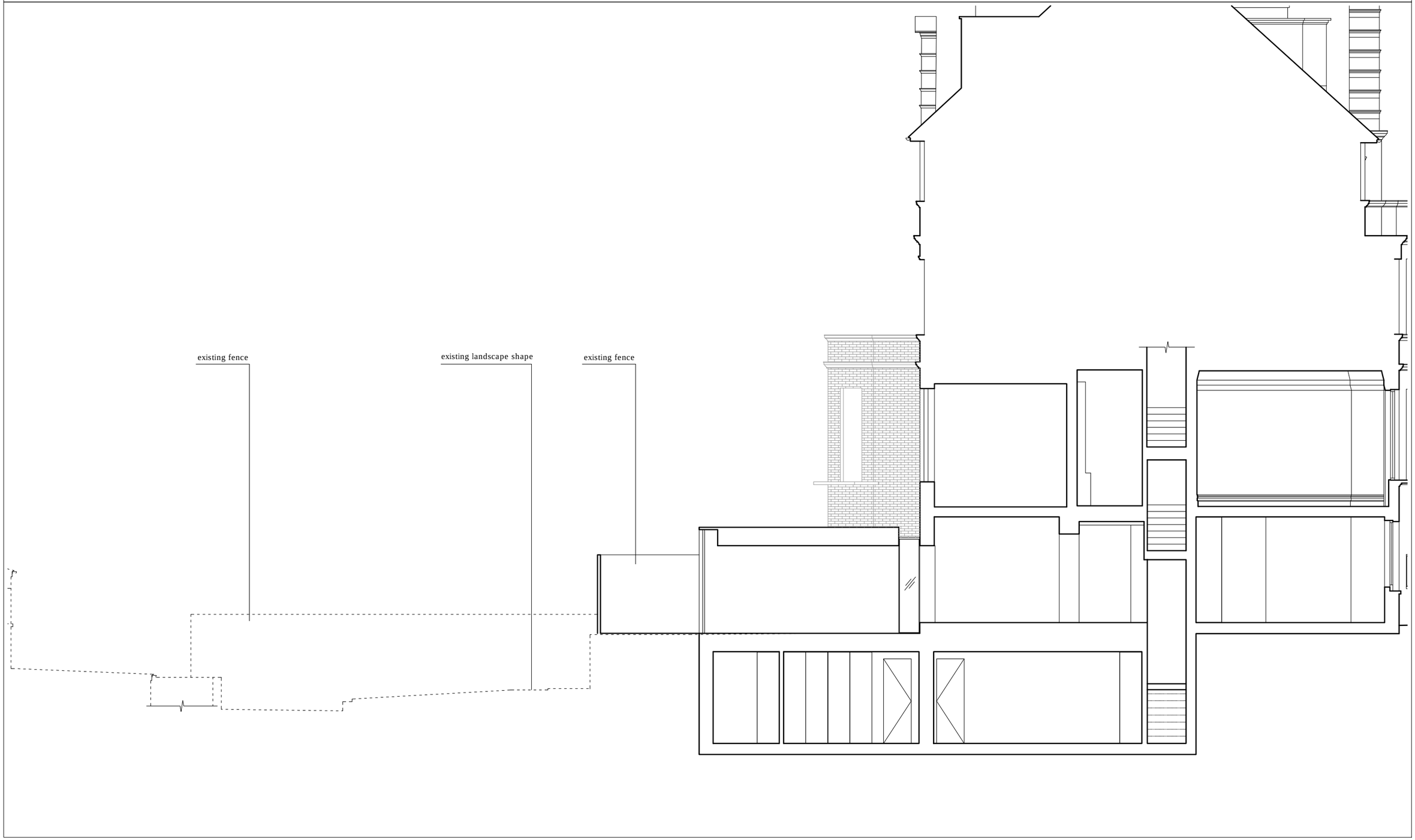
LEGEND

1.50	0	1	2 m
1.100	0	1	5 m
1.200	0	1	10 m
1:500	0	10	20 m
1:1000	0	10	50 m
1:1250	0	10	50 m

REV	DESCRIPTION	DATE	NAME
04		05/07/2018	
03		24/05/2018	
02		15/03/2018	
01		21/02/2018	

PROPOSED SECTION 01

SCALE 1:100



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DRAWINGS STATUS: PLANNING PERMISSION | A3

PROJECT TITLE: REAR EXTENSION & BASEMENT

12 Lyndhurst Gardens
NW3 5NR

DRAWN	CHECKED
MC - UG	LM
DATE	SCALE
06.02.2018	1:100@A3

DRAWING TITLE: PROPOSED SECTION 01

JOB NO	DRAWING NO
0066	A2006

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LEGEND

1.50	0	1	2 m
1.100	0	1	5 m
1.200	0	1	10 m
1:500	0	10	20 m
1:1000	0	10	50 m
1:1250	0	10	50 m

REV	DESCRIPTION	DATE	NAME
04		05/07/2018	
03		24/05/2018	
02		15/03/2018	
01		21/02/2018	

APPENDIX B

Ground Investigation Report

APPENDIX C

Proposed Loadings

Symmetrys Limited
Consulting Structural Engineers

A: Unit 6 The Courtyard, Lynton Road, London, N8 8SL
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E: info@symmetrys.com

		Job No.	Sheet No.	Revision
		19050	11	A
Job Title	12 Lyndhurst Gardens, London NW1	Date	Made By	Checked By
Section	Design Loading Parameters	Apr 2019	BB	AH

Design Loading Parameters

at

12 Lyndhurst Gardens, London NW1

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Consulting Structural Engineers

A: Unit 6 The Courtyard, Lynton Road, London, N8 8SL
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		Job No.	Sheet No.	Revision
		19050	12	A
Job Title	12 Lyndhurst Gardens, London NW1	Date	Made By	Checked By
Section	Design Loading Parameters	Apr 2019	BB	AH

FLOOR LOADINGS - EXISTING

Level	Load type	Description	Distributed Load (kN/m^2)	or Point Load (kN)
Existing Ground floor	Dead 'G'	200 thick RC slab	6.01	
	Live 'Q'	Residential private (Cat A1)	1.50	2.00
	Live 'Q'	Lightweight partitions (no greater than 2kN/m)	1.00	
Existing 1st / 2nd / 3rd / 4th floors	Dead 'G'	Timber joists floor	1.49	
	Live 'Q'	Residential private (Cat A1)	1.50	2.00
	Live 'Q'	Lightweight partitions (no greater than 2kN/m)	1.00	
Existing Roofs	Dead 'G'	Timber joists roof	1.53	
	Live 'Q'	Access for maintenance only (Cat H)	0.75	0.90

FLOOR LOADINGS - PROPOSED

Level	Load type	Description	Distributed Load (kN/m^2)	or Point Load (kN)
Proposed Basement	Dead 'G'	350 thick RC slab	10.50	
	Live 'Q'	Residential private (Cat A1)	1.50	2.00
	Live 'Q'	Lightweight partitions (no greater than 2kN/m)	0.80	
Proposed new Ground floor	Dead 'G'	Composite slab floor	6.23	
	Live 'Q'	Residential private (Cat A1)	1.50	2.00
	Live 'Q'	Lightweight partitions (no greater than 2kN/m)	0.80	
New Roofs	Dead 'G'	New timber flat roofs	1.23	
	Live 'Q'	Access for maintenance only (Cat H)	0.60	0.90

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		Job No.	Sheet No.	Revision
		19050	13	A
Job Title	12 Lyndhurst Gardens, London NW1	Date	Made By	Checked By
Section	Design Loading Parameters	Apr 2019	BB	AH

WALL LOADINGS

Level	Wall height (m)	Description	Distributed Load (kN/m^2)	Wall line Load (kN/m)
Various	3.00	Timber stud partition	0.63	1.86
		Brick & Block cavity wall	4.48	13.48
		Solid 102.5 thick wall	2.47	7.46
		Solid 215 thick wall	4.42	13.30
		Solid 335 thick wall	6.70	20.14

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		Job No.	Sheet No.	Revision
		19050	14	A
Job Title	12 Lyndhurst Gardens, London NW1	Date	Made By	Checked By
Section	Load Take Down	Apr 2019	BB	AH

Load Take Down

at

12 Lyndhurst Gardens, London NW1

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Consulting Structural Engineers

A: Unit 6 The Courtyard, Lynton Road, London, N8 8SL
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E: info@symmetrys.com

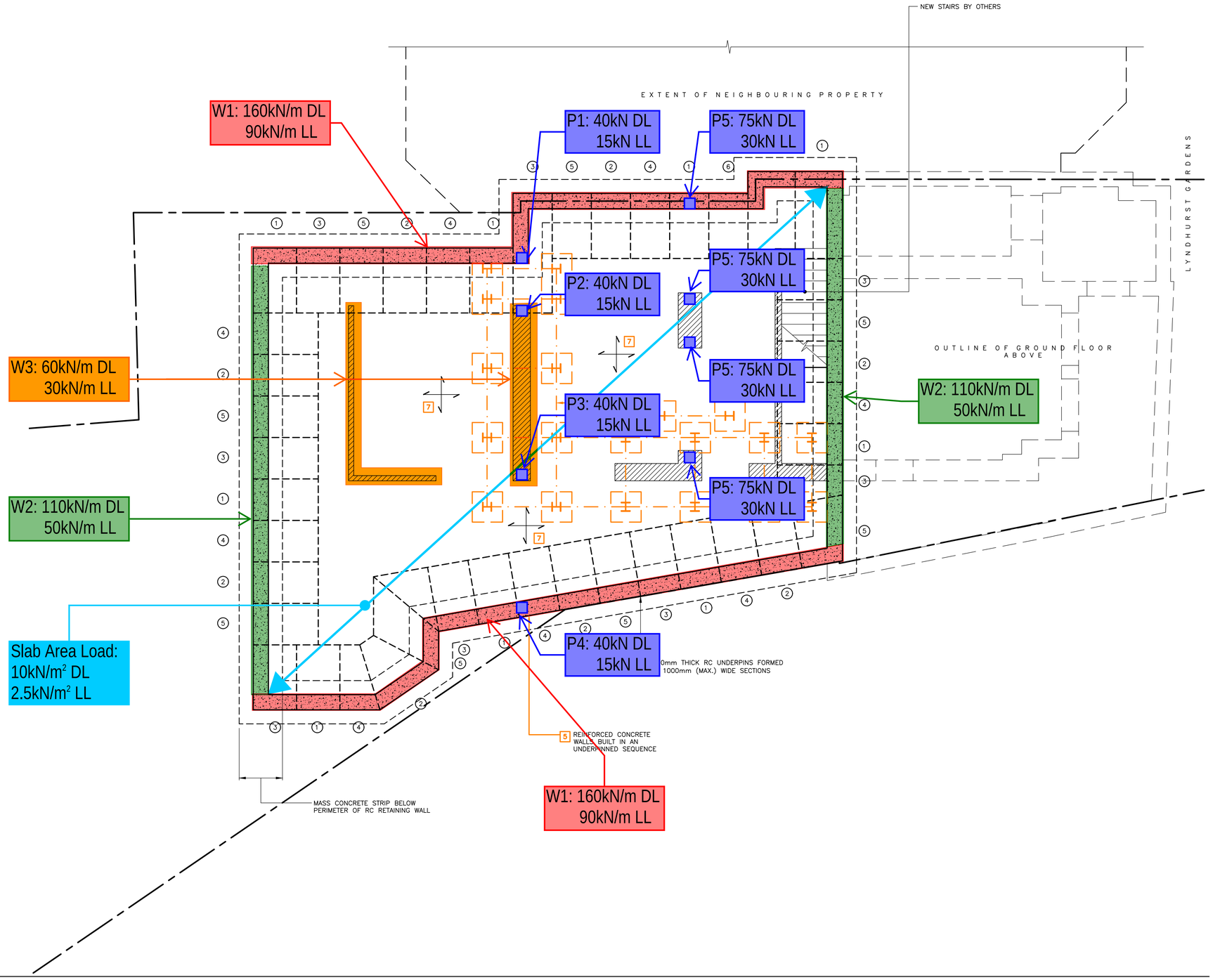
	Job No.	Sheet No.	Revision
	19050	15	A
Job Title 12 Lyndhurst Gardens, London NW1	Date	Made By	Checked By
Section Load Take Down	Apr 2019	BB	AH

LOAD TAKE-DOWN

Storey	No.12 Flat 2 FLW (m)	Neighbour FLW assumed (m)	Perm 'G' load (kN/m^2)	Imp 'Q' load (kN/m^2)	Perm 'G' load (kN/m)	Imp 'Q' load (kN/m)
New Basement	3.3		10.50	2.30	34.6	7.6
New Ground	3.3		6.23	2.30	20.6	7.6
Exist Ground		3.5	2.26	2.50	7.9	8.8
Exist 1st	3.3	3.5	1.49	2.50	10.1	17.0
Exist 2nd	3.3	3.5	1.49	2.50	10.1	17.0
Exist 3rd	3.3	3.5	1.49	2.50	10.1	17.0
Exist 4th	3.3	3.5	1.49	2.50	10.1	17.0
Exist Roof	3.3	3.5	1.53	0.75	10.4	5.1
TOTAL SLS					114.1	97.0

NB: The proposed basement extension is for Flat 2, whereas it is presumed that Flat 1 is the neighbour at ground and first floor, on the other side of the party wall. "FLW" = Floor load width

Storey	Storey height (m)	Perm 'G' load (kN/m^2)	Perm 'G' load (kN/m)
New Basement	3.5	8.75	30.63
Exist Ground	3.5	6.70	23.4
Exist 1st	3.2	6.70	21.4
Exist 2nd	3.2	4.42	14.1
Exist 3rd	3.2	4.42	14.1
Exist 4th	3.0	4.42	13.3
TOTAL SLS			117.0



Symmetrys
Structural Engineers

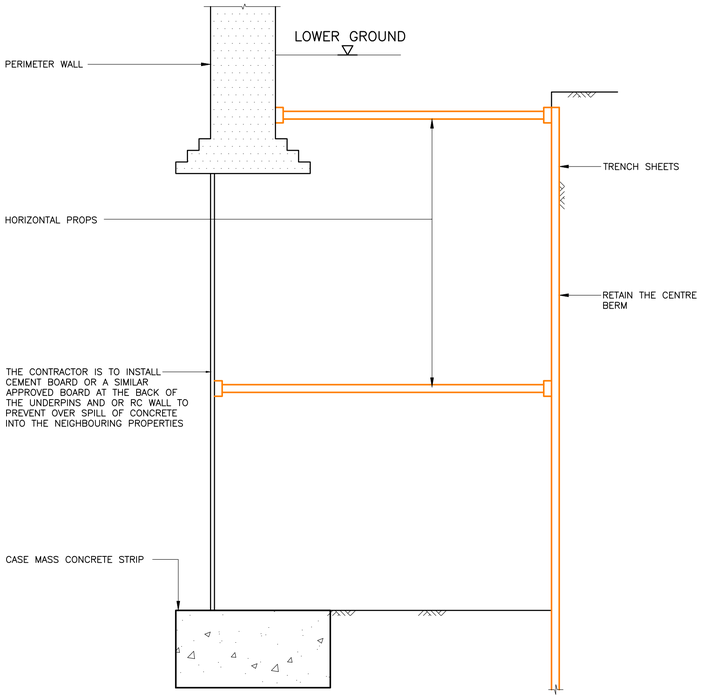
19050-Sk-01 Rev A
Load Take Down
12 Lyndhurst Gardens
AK
30/05/2019

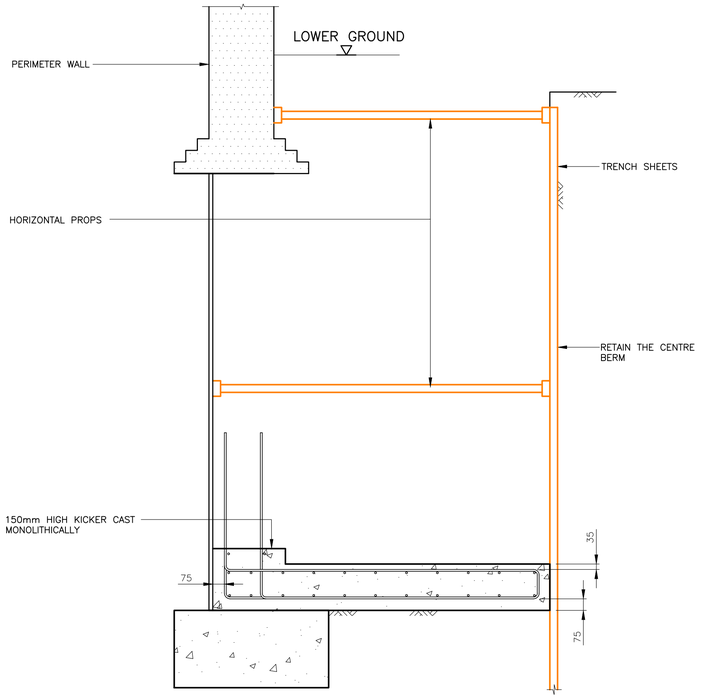
APPENDIX D

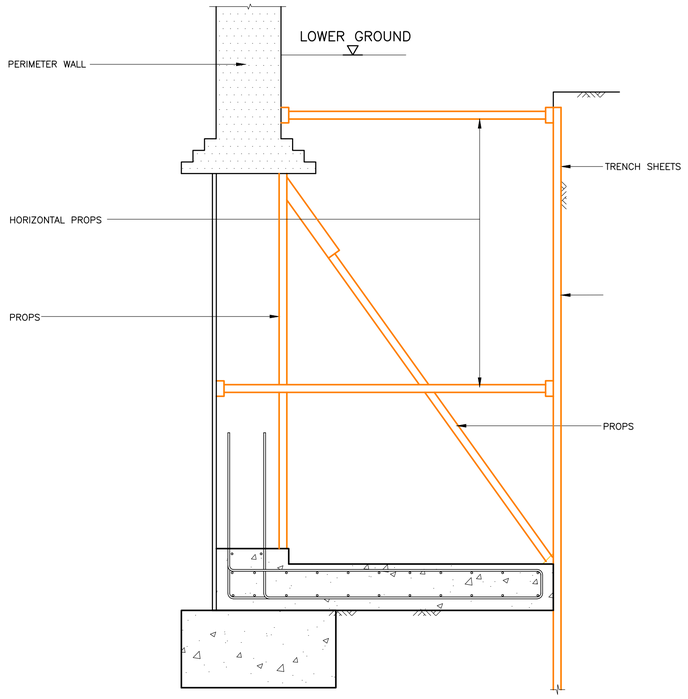
Proposed Underpinning Sequence

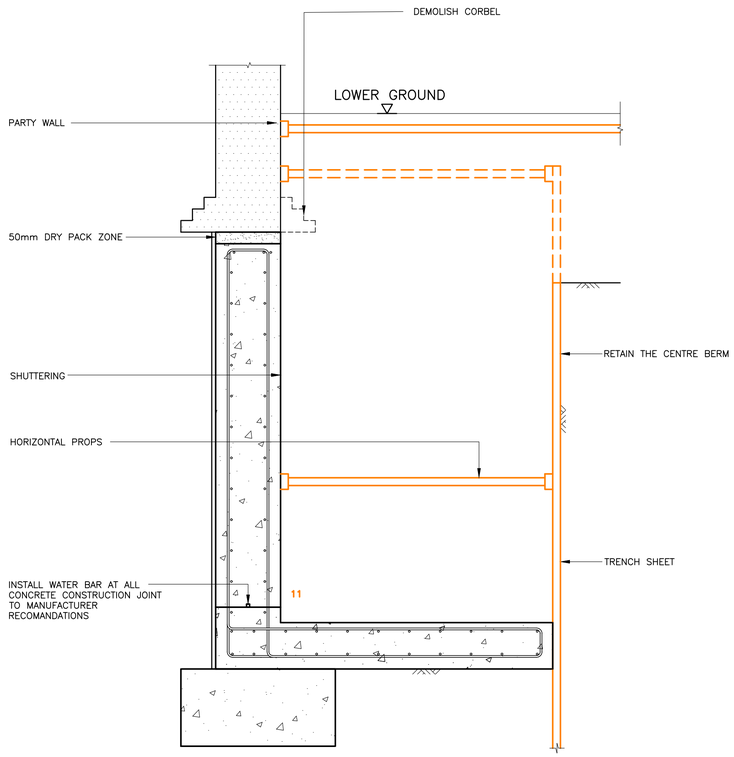
QD A1 STANDARD

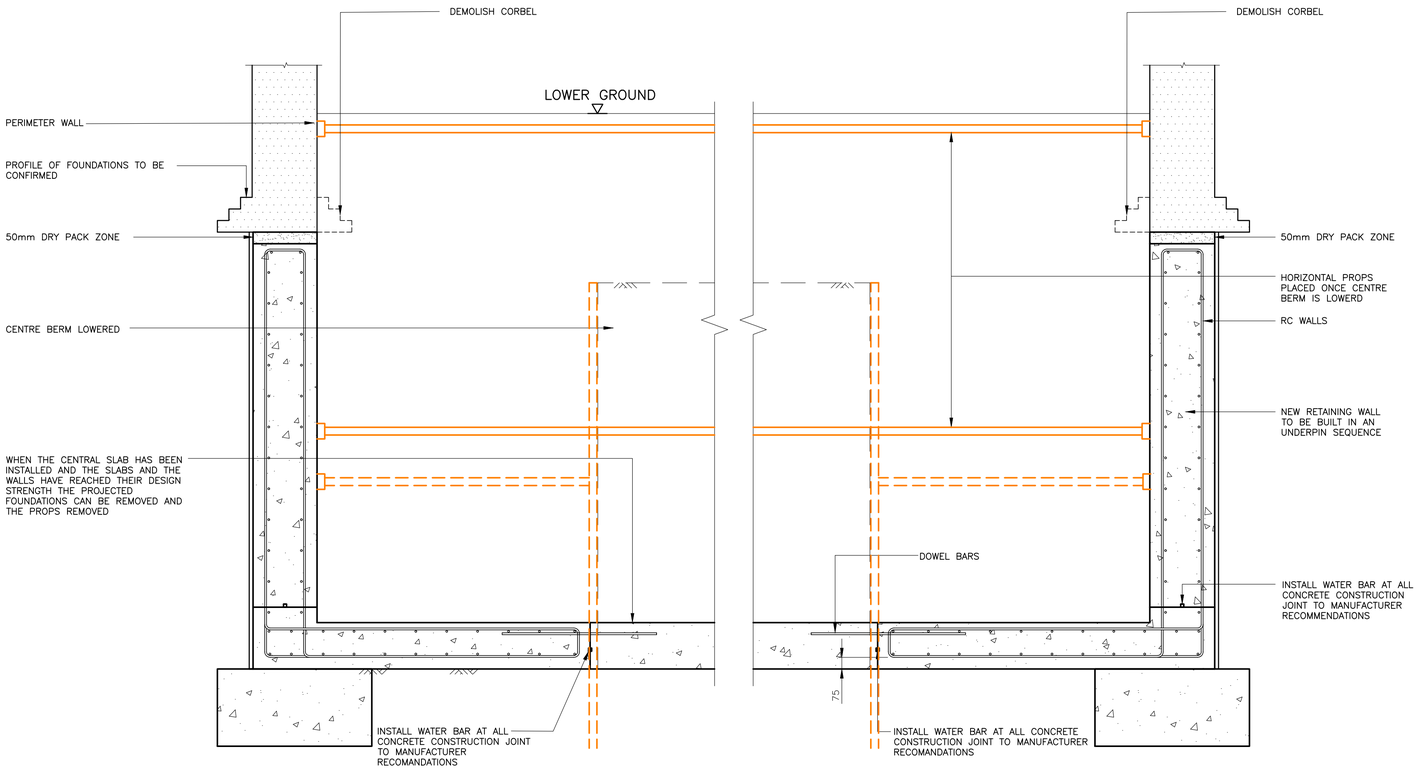
NOTE:
UNDERPINS TO BE DOWELLED INTO EACH OTHER WITH 6No. MIN H20 DOWELS WITH 400mm MIN. EMBEDMENT











Notes

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS & ENGINEERS DRAWINGS AND SPECIFICATIONS
2. DO NOT SCALE FROM THIS DRAWING

Rev	Date	Chkd	Amendments
P2	09.03.20	AK	UPDATED UNDERPINNING
P1	03.06.19	AK	ISSUE FOR PLANNING

Drawing Status
PLANNING

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Consulting Structural Engineers
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Job Title
12 LYNDHURST GARDENS LONDON, NW3

Drawing Title
TYPICAL UNDERPINNING SEQUENCE

Job No.	Drawing No.	Revision
19050	11	P2

Scales 1:50 AT A1 | Original Size A1
Drawn By NF | Date MAY 2019

Company No. 5873122
VAT Registration No. 894 2993 61
Registered In England And Wales

APPENDIX 5
SuDS STRATEGY

Symmetrys Ltd
Structural Engineers

SuDS Strategy

12 Lyndhurst Gardens
London
NW3 5NR

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Symmetrys Limited Consulting Engineers, Registered In England And Wales, Company No. 5873122

24th May 2019
19050 Rev A

Symmetrys Ltd
Structural Engineers

1.0 Executive Summary

1.0 This document has been prepared for planning purposes in order to demonstrate that the proposal will result in a betterment at the site in regards to surface water runoff.

1.1 The existing site consists of a residential dwelling and landscaped areas.

1.2 The proposal involves the construction of a rear extension and basement.

1.3 The Thames Water Asset Plan has not identified any public sewers on the site and has confirmed that there is a combined public network within the street.

1.4 The surface water runoff at the site is understood to drain to the combined sewer system in the road, with no SuDS specific measures in place.

1.5 The proposed drainage scheme involves diverting the assumed existing combined drainage network at the site, through a non-structural, higher level, void in the basement wall, to the front of the site.

1.6 The surface water runoff from the rear of the site will be collected into an attenuation tank and discharged to the combined network at a rate of 1L/s. This will result in a betterment at the site as currently there are no SuDS measures in place.

2.0 Introduction

2.0 This document has been prepared in accordance with the HR Wallingford Method as a preliminary Sustainable Drainage Systems (SuDS) scheme for planning purposes.

2.1 The Objective of the proposed drainage strategy is:

- To demonstrate the proposed development results in a betterment at the site by effectively decreasing the volume and rate of runoff from the site to the public combined sewer network.

3.0 Background

3.1 The site is located in a residential area of London, within the unitary authority of the London Borough of Camden.

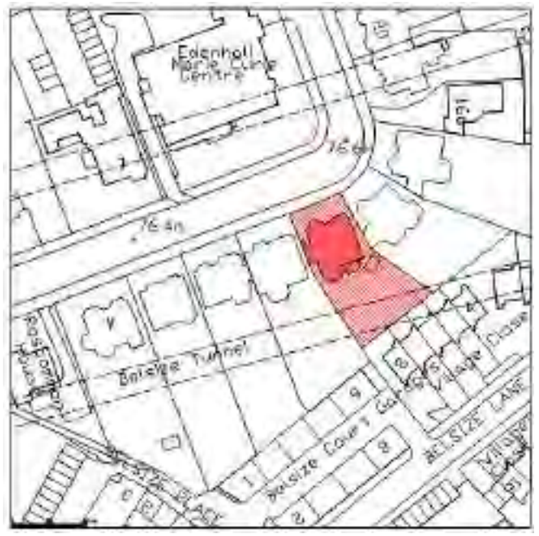


Figure 1: Site location plan

3.2 The local water authority for the area is Thames Water.

3.3 The existing site is approximately 47% impermeable.

3.4 Historical drainage plans indicate that there is a combined pipe passing through the site which has connections from the neighbour within the same curtilage.

3.5 The proposed development at the site involves the refurbishment of the existing dwelling and landscaped areas as well as the construction of a new rear extension and basement.

3.6 The new basement will be constructed from a reinforced concrete basement raft slab tied into reinforced concrete underpin retaining walls.

3.7 Directly underneath the party walls and the majority of the perimeter walls, there will be a mass concrete strip footing founded a minimum of 300mm into the sands and gravels.

4.0 SuDS Requirements

4.1 The surface water drainage arrangements for any development site needs to be such that the peak flow rates and volumes of surface water leaving the developed site are no greater than the rates prior to the proposed development.

4.2 If the site is a greenfield site then the impact of the development will need to be managed so that the runoff from the site replicates the natural characteristics of the predeveloped site.

4.3 The Government's NPPF guidance throughout England required the use of SuDS on all new developments wherever possible. The hierarchy for surface water disposal listed in order of priority is:

- Store rainwater for later use, or where that is not reasonably practical,
- Use infiltration techniques, such as porous surfaces in non-clay areas, or where that is not reasonably practical,
- Attenuate rainwater in ponds or open water features for gradual release,
- Attenuate rainwater by storing in tanks or sealed water features for gradual release,
- Discharge rainwater direct to a watercourse,
- Discharge rainwater to a surface water sewer/drain,
- Discharge rainwater to the combined sewer,

5.0 SuDS Options

5.1 SuDS are a varied collection of techniques designed to manage stormwater in a sustainable manner. SuDS achieve this by seeking to manage surface water from new developments as close to its source as possible and by mimicking the surface water flow regime present on the site prior to development.

5.2 There are two main processes that can be used to manage and control the runoff from development areas. These are;

- Infiltration
- Detention/attenuation – Detention or attenuation aims to stagger surface water flow rates by storing runoff on site and therefore helping to reduce downstream flooding.

6.0 Site Geology

6.1 The British Geological Survey maps show that the site is underlain by the London Clay formation which is known for its very low permeability.

Figure 2: British Geological Survey Map for the site

7.0 Drainage Proposals

7.1 Refer to Appendix A for Proposed Drainage Layout drawings 19050/3000 & 3100 and Appendix B for Surface Water Estimated Storage Calculations.

8.0 Proposed Foul/Combined Water Drainage

8.1 The Thames Water Asset Plan for the site, attached as Appendix C, identifies a 940mm x 610mm public combined sewer within the road, Lyndhurst Gardens.

8.2 There are no records of public drainage networks within the site.

8.3 The proposed development will result in a negligible increase in foul water flow rates from the site.

8.4 The connections from the existing stub stacks at the front of the site, to the drainage network, are expected to remain as is and be verified on site. All new foul water connections that can be connected to the combined network at lower ground floor level, will be. All basement and rear foul connections will be pumped to higher level.

8.5 Refer to Drawing 19050/3000, attached in Appendix A, for the proposed drainage plan which details the proposed private foul water network.

8.6 Due to the proposed basement, all rear drainage networks will be diverted around the southern side of the basement and run in a non-structural void provided within the basement wall, connecting to IC 01. The pipe will be held in place by proprietary clips.

8.7 All redundant pipework is to be grubbed up and removed.

8.8 A CCTV survey is required in order to complete the detailed drainage design at the site.

9.0 Proposed Surface Water Drainage Strategy

9.1 There are no known Thames Water public surface water assets within the site.

9.2 The surface water runoff at the site is understood to drain to the combined network with no SuDS specific measures in place.

9.3 The proposal includes approximately 9% increase in impermeable area at the site.

9.4 Due to the site being underlain by the London Clay formation, SuDS in the form of infiltration is not suitable at this site.

9.5 The existing surface water outfalls were historically approved at the time of construction and are to be verified on site. There is no practical option to add any control or attenuation for these outfalls at the front of the site.

9.6 It is proposed to utilise a rainwater attenuation tank in order to decrease the volume and velocity of the surface water runoff entering the combined system. The rear roof and hardstand runoff will be collected and released at a controlled rate of 1L/s with an overflow for large storm events.

9.7 All cavity drainage and basement level surface water is to be pumped to higher level via a sump pump in the basement lightwell. The sump pump and rising main details are to be confirmed by a specialist manufacturer.

9.8 The proposed paths within the private property are to be laid at slight falls to the soft landscaping.

9.9 The retaining walls will drain via weep holes to the soft landscaping below.

9.10 The channel drain will have a silt bucket and trapped outlet. The collection of silt at source aims to improve the water quality prior to discharging to the public combined sewer.

9.11 In order to provide a detailed drainage plan for the site, a CCTV survey will be required.

9.12 The existing connection to the combined public sewer within the street is to be retained where possible. If a new connection is required, this will be subject to a Thames Water S106 approval.

9.13 The maintenance of the surface water network at the site will be carried out by a suitably qualified management company. This will be confirmed by the developer. The rainwater attenuation tank is to be maintained in accordance with the specialist manufacturers recommendations.

10.0 Maintenance of SuDS

10.1 The long-term responsibility for the maintenance of the SuDS features lies with the home owner.

10.2 All SuDS on site will be installed in accordance with the specialist manufacturers specification.

10.3 The maintenance of any attenuation tank should be in line with Table 21.3 of the the CIRIA SuDS Manual 2015 and include:

Maintenance Schedule	Required Action	Typical frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action.	Monthly for 3 months, then annually
	Remove debris from the catchment surface (where it may cause risk to performance)	Monthly
	For systems where rainfall infiltrates into the tank from above, check surface of filter for blockages by sediment, algae or other matter; remove and replace surface infiltration medium as necessary.	Annually
	Remove sediment from pre-treatment structures and/or internal forebays.	Annually or as required
Remedial actions	Repair/rehabilitate inlets, outlets, vents and overflows.	As required
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed.	Annually
	Survey inside of tank for sediment build-up and remove if necessary.	Every 5 years or as required

11.0 SuDS Summary

11.1 The inclusion of SuDS at this site will reduce the run-off rates and volumes of surface water entering the public combined drainage network in the street. The use of SuDS will create a betterment at the site.

APPENDIX A

PROPOSED DRAINAGE DRAWINGS

QD A1 STANDARD

LEGEND

- APPROXIMATE SITE BOUNDARY
- BOUNDARY OF THE SINGLE CURTILAGE
- DENOTES 100ø PVC–U FOUL WATER DRAINAGE RUNS LAID AT MIN. 1:40 FALLS, UNLESS NOTED OTHERWISE, (WITH JOINTS TO MANUFACTURER'S DETAILS)
- DENOTES 100ø PVC–U SURFACE WATER DRAINAGE RUNS LAID AT MIN. 1:60 FALLS, UNLESS NOTED OTHERWISE (WITH JOINTS TO MANUFACTURER'S DETAILS)
- DENOTES 100ø COMBINED SEWER LAID AT MIN. 1:40 FALLS, UNLESS NOTED OTHERWISE (WITH JOINTS TO MANUFACTURER'S DETAILS).
- EXISTING PIPEWORK TO REMAIN. DETAILS TO BE CONFIRMED VIA CCTV SURVEY.
- DENOTES EXISTING PIPE WORK TO BE GRUBBED UP AND REMOVED.
- DENOTES RISING MAIN FROM SW/CAVITY DRAIN SUMP PUMP (DETAILS AS PER MANUFACTURERS SPECIFICATION)
- DENOTES RISING MAIN FROM FW DRAIN SUMP PUMP (DETAILS AS PER MANUFACTURERS SPECIFICATION)
- EXISTING INSPECTION CHAMBER TO BE REMOVED.
- EXISTING INSPECTION CHAMBER TO REMAIN.
- NEW INSPECTION CHAMBER ON EXISTING COMBINED PUBLIC SEWER MAIN. NEW CHAMBERS TO BE FORMED OF PRECAST CONCRETE 600MM X 450MM AND HAVE A TRAFFICABLE COVER TO MIN LOAD CLASS B125.
- RWP ○ RAINWATER DOWN PIPE (INDICATIVE) – RWP'S TO HAVE TRAPPED OR SEALED OUTLETS WITH RODDING ACCESS EITHER VIA SHOE AND GULLY OR ACCESS PIPE.
- GY ⊠ YARD GULLY.
- SS STUB STACK. TO PROVIDE RODDING ACCESS.
- PROPOSED CHANNEL DRAIN. ACO OR SIMILAR ENGINEER APPROVED PRODUCT. DETAILS BY SPECIALIST MANUFACTURER.

CONTRACTOR/SPECIALIST DESIGN ELEMENTS

1. ALL TEMPORARY WORKS
2. STABILITY OF THE STRUCTURE DURING THE WORKS
3. ALL SUMP PUMP DETAILS/WORKS
4. ALL CHANNEL DRAIN DETAILS
5. ALL TANKING DETAILS

ARCHITECT TO SPECIFY

1. CAVITY DRAINAGE
2. FINAL RWP LOCATIONS
3. IF THRESHOLDS ARE TO BE FLUSH
4. THE TERMINATION POSITION OF ALL VENT PIPES (SVP'S), SS AND AAV.
5. COVER LEVELS ARE INDICATIVE ONLY AND ARE TO BE CONFIRMED BY AND ARCHITECT.
6. PROPOSED GROUND LEVELS AND FFL'S

CONTACT ENGINEER IF ANY OF THE ABOVE DIFFER FROM PLAN BELOW.

PLEASE NOTE:

EXISTING DRAINAGE HAS BEEN APPROXIMATED FROM HISTORICAL INFORMATION. A CCTV SURVEY OF ALL EXISTING DRAINAGE IS REQUIRED TO CONFIRM THE EXISTING CONFIGURATION.

A SEWER DIVERSION APPLICATION MAY BE REQUIRED IF THE NEIGHBOURS DRAINAGE DOES CONNECT THROUGH THE SITE AS SHOWN.

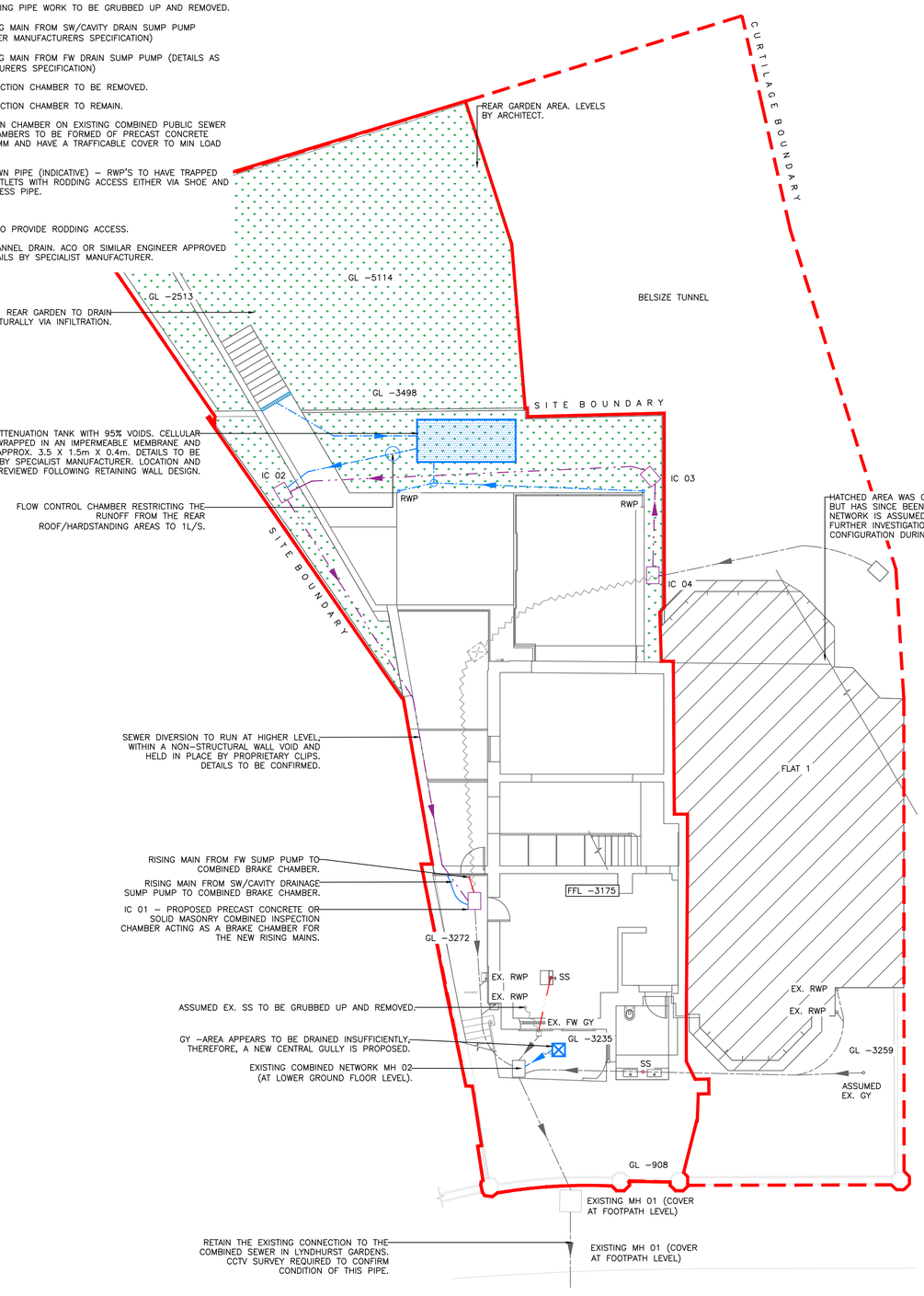
REFER TO THAMES WATER ASSET LOCATION PLAN FOR PUBLIC SEWER NETWORK DETAILS.

RETAINING WALLS TO BE DRAINED VIA WEEP HOLES AND PERFORATED PIPEWORK WITHIN FREE DRAINING PEA SHINGLE SET BELOW CLEAN CRUSHED AGGREGATES.

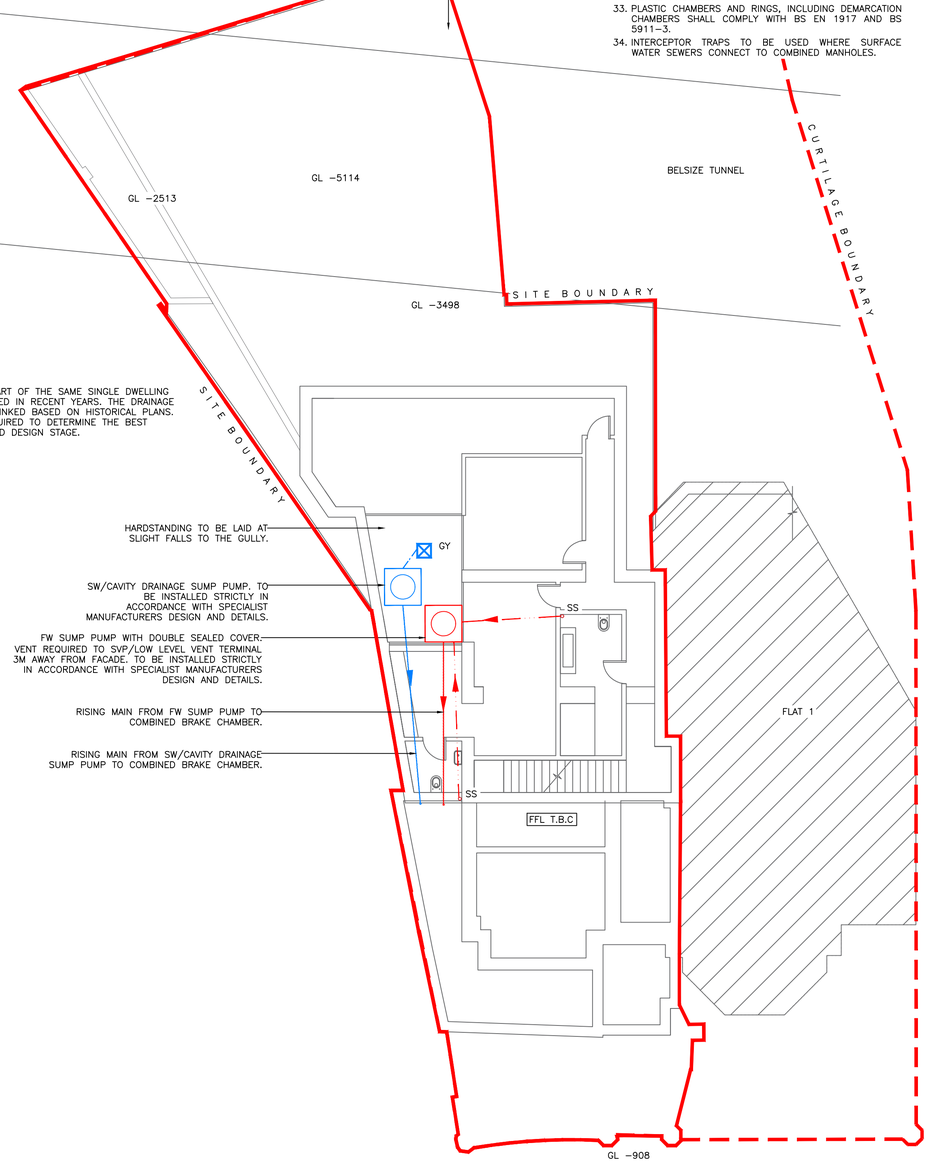
THE GROUND LEVELS ARE TO BE CONVERTED TO A STANDARD DATUM.

ADDITIONAL NOTES:

24. PIPES WITH LESS THAN 0.6M COVER (IN FIELDS) AND 0.9M COVER (IN LIGHT ROADS) REQUIRE PROTECTION IN ACCORDANCE WITH BUILDING REGULATIONS DOCUMENT H.
25. ALL DISUSED, ABANDONED OR REDUNDANT DRAINAGE TO BE REMOVED/SEALED AS STATED IN PART H OF THE BUILDING REGULATIONS 2002 EDITION, APPENDIX H1–B.
26. NON–RETURN VALVES TO BE FITTED TO MANHOLES WHERE SEWER SURCHARGE IS CONSIDERED A RISK TO BUILDING FLOODING.
27. SVPS, STUB STACKS & RWP'S ARE SHOWN INDICATIVE ONLY. REFER TO ARCHITECTURAL DIMENSIONED GA'S FOR ACCURATE LOCATIONS.
28. ALL DRAINAGE WORKS SHOULD COMMENCE AT THE PROPOSED DOWNSTREAM CONNECTION POINT, THE WORKS CONTINUING UPSTREAM FOLLOWING CONFIRMATION OF THE TIE–IN INVERT LEVELS TO THE ENGINEER.
29. CONNECTIONS TO MANHOLES OR LARGER SIZED PIPES TO BE SOFFIT TO SOFFIT UNLESS OTHERWISE INSTRUCTED BY THE ENGINEER. IF THIS IS NOT POSSIBLE, INFORM THE ENGINEER IMMEDIATELY.
30. ALL CEMENT USED FOR CONCRETE DRAINAGE INSTALLATIONS SHALL BE SULPHATE RESISTANT TO CLASS 3 OF BRE DIGEST 363. (GRADE ST5)
31. ALL BENDS IN PIPEWORK SHALL BE LONG RADIUS.
32. ANY DISCREPANCIES BETWEEN THE INFORMATION PROVIDED BY THE ENGINEER AND THAT PROVIDED BY OTHERS MUST BE REFEREED TO THE CONTRACT ADMINISTRATOR/ENGINEER BEFORE THE AFFECTED WORKS PROCEED.
33. PLASTIC CHAMBERS AND RINGS, INCLUDING DEMARCATION CHAMBERS SHALL COMPLY WITH BS EN 1917 AND BS 5911–3.
34. INTERCEPTOR TRAPS TO BE USED WHERE SURFACE WATER SEWERS CONNECT TO COMBINED MANHOLES.



PROPOSED LOWER GROUND FLOOR PLAN
1:100



PROPOSED BASEMENT PLAN
1:100

Notes

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS & ENGINEERS DRAWINGS AND SPECIFICATIONS
2. DO NOT SCALE FROM THIS DRAWING
3. PRELIMINARY AND TENDER DRAWINGS SHALL NOT BE USED FOR CONSTRUCTION OR THE ORDERING OF MATERIALS.
4. ALL DRAINAGE DESIGN AND INSTALLATION TO BE CARRIED OUT IN ACCORDANCE WITH THE FOLLOWING:
   - BS EN 752: DRAIN AND SEWER SYSTEMS OUTSIDE BUILDINGS.
   - BS EN 12056: GRAVITY DRAINAGE SYSTEMS INSIDE BUILDINGS.
   - BUILDING REGULATIONS – PART H
   - SEWERS FOR ADOPTION – 7TH EDITION
   - BS 8000 PT.14 – WORKMANSHIP OF BUILDING SITES
   - LOCAL AUTHORITY REQUIREMENTS
5. REFER TO ARCHITECTS DRAWINGS FOR ALL SETTING OUT DETAILS.
6. ADEQUATELY PROTECT EXISTING DRAINS AND MAINTAIN NORMAL OPERATION DURING CONSTRUCTION.
7. BEFORE COMMENCING ANY SEWER OR DRAINAGE WORKS, THE CONTRACTOR'S GROUND WORKER MUST SATISFY THEMSELVES OF ACTUAL LEVELS AND CONDITIONS OF EXISTING SEWERS. ANY STRUCTURAL DEFECTS SHALL BE REPAIRED USING APPROPRIATE AND APPROVED MEANS.
9. ALL RAINWATER PIPE OUTFALLS SHALL BE 100ø, ALL SOIL VENT PIPES / FOUL CONNECTION OUTFALLS LEAVING BUILDINGS SHALL BE 100ø UNLESS OTHERWISE STATED.
10. WHERE PIPELINES MUST BE CAST IN OR FIXED TO STRUCTURES, INCLUDING MANHOLES AND INSPECTION CHAMBERS, PROVIDE SHORT LENGTH OR ROCKER PIPES NEAR EACH EXTERNAL FACE, WITH FLEXIBLE JOINTS AT EACH END. FOR PIPE SIZE 110MM THE DISTANCE TO THE FIRST JOINT SHALL BE 150MM.
11. WHERE PIPELINES NEED NOT BE CAST IN OR FIXED TO THE STRUCTURE (EG. WALLS TO FOOTINGS) PROVIDE EITHER SHORT LENGTH OR ROCKER PIPES AS SPECIFIED ABOVE, OR OPENINGS IN THE STRUCTURE TO GIVE 50MM MINIMUM CLEARANCE AROUND THE PIPELINE AND CLOSELY FIT A RIGID SHEET TO EACH SIDE OF OPENING TO PREVENT THE INGRESS OF FILL OR VERMIN.
12. PIPES, BENDS AND JUNCTIONS TO BE PVC–U TO BS 4660 OR BS 5481, 110MM DIAMETER WITH FLEXIBLE JOINTS AND KITE–MARK CERTIFIED.
14. EXCAVATE TO FORMATION IMMEDIATELY BEFORE LAYING BEDS OR PIPES. REMOVE MUD, ROCK PROJECTIONS, BOULDERS AND HARD SPOTS AND REPLACE WITH CONSOLIDATED BEDDING MATERIAL.
15. UNLESS SPECIFIED OTHERWISE, BACKFILL FROM TOP OF SPECIFIED SURROUND OF PROTECTIVE CUSHION WITH MATERIAL EXCAVATED FROM THE TRENCH, COMPACTED IN LAYERS NOT EXCEEDING 300MM THICK. DO NOT USE HEAVY COMPACTORS BEFORE THERE IS 600MM OF MATERIAL OVER PIPES.
16. ADEQUATELY PROTECT PIPELINES FROM DAMAGE AND INGRESS OF DEBRIS. SEAL ALL EXPOSED ENDS DURING CONSTRUCTION WITH PROPRIETARY TEMPORARY STOP ENDS. ARRANGE THE WORK TO MINIMISE TIME BETWEEN LAYING AND TESTING. BACKFILL AFTER SUCCESSFUL TESTING.
17. OBTAIN EACH COMPLETE ASSEMBLY OF FITTINGS, TRAPS, ETC. INCLUDING APPROPRIATE COUPLINGS, FROM THE SAME MANUFACTURER, AND CHECK COMPATIBILITY OF COMPONENTS WITH EACH OTHER AND WITH THE PIPE SYSTEM.
18. ACCESS PANELS ARE TO BE PROVIDED TO ALL RAINWATER PIPES A MAXIMUM OF 600MM ABOVE FINISHED GROUND LEVEL.
19. ALL ROAD AND YARD GULLIES ARE TO BE 'TRAPPED' AND FITTED WITH A SILT BUCKET.
20. ALL DRAINAGE TO BE CAST IN CONCRETE WHEN PASSING UNDER FOUNDATIONS.
21. PIPE CONNECTIONS NOT TO INSPECTION CHAMBERS SHALL BE VIA PREFORMED OBLIQUE JUNCTION SWEPT IN THE DIRECTION OF FLOW.
22. ALL RWP AND CHANNEL DRAIN OUTLETS ARE TO BE TRAPPED.
23. MANHOLE COVERS SHALL BE SET TO THE SAME LEVEL AS THE ADJACENT GROUND.

Rev	Date	Chkd	Amendments
P1	24.05.19	MB	PRELIMINARY ISSUE

Drawing Status: PRELIMINARY

Symmetrys Limited
Consulting Structural Engineers
6 The Courtyard, Lynton Road
LONDON, SW1 N8 8SL
T: 020 8340 4041
W: www.symmetrys.com
E: info@symmetrys.com

Job Title

12 LYNDHURST GARDENS
LONDON, NW3 5NR

Drawing Title

BELOW GROUND DRAINAGE PLAN

Job No.	Drawing No.	Revision
19050	3000	P1

Scales 1:100 AT A1 — Original Size A1

Drawn By MW — Date MAY 2019

Company No. 5873122
VAT Registration No. 894 2993 61
Registered In England And Wales

QD A1 STANDARD

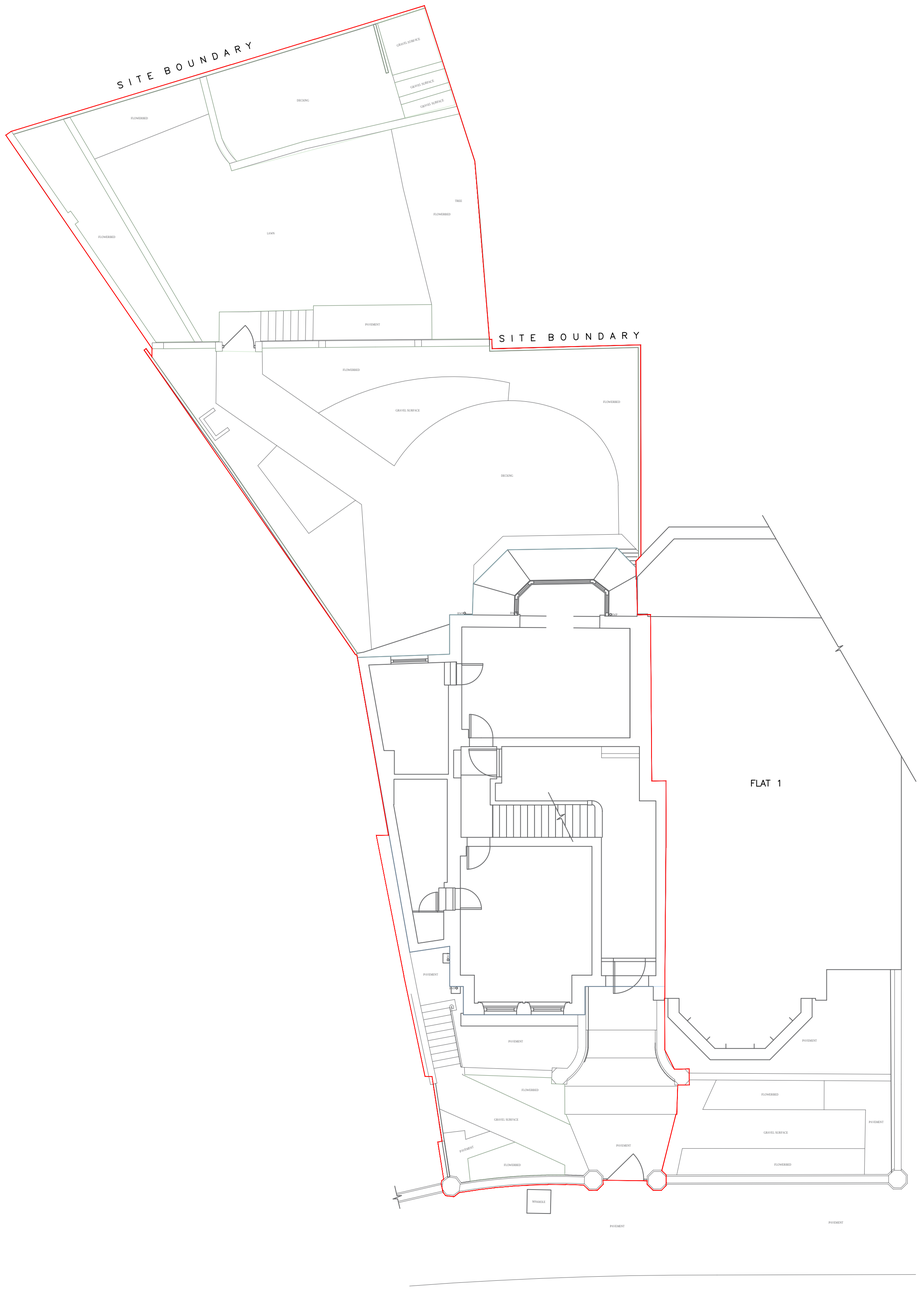
LEGEND

- APPROXIMATE SITE BOUNDARY
- ROOF AREAS
- IMPERMEABLE SURFACES (UNHATCHED AREAS)
- PERMEABLE SURFACES (GARDEN)

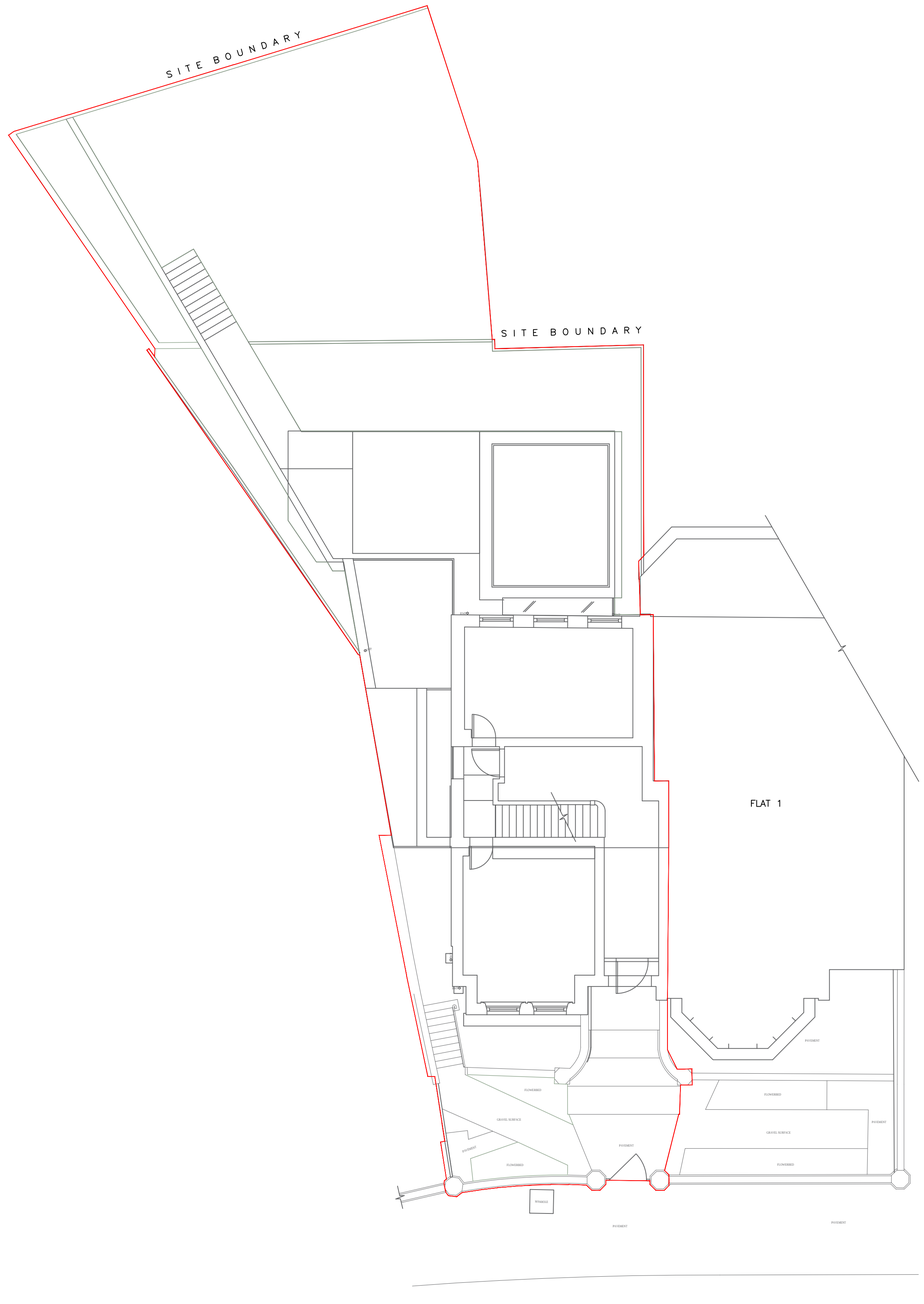
SITE PERMEABILITY, m²			
	IMPERMEABLE SURFACES	PERMEABLE SURFACES	% IMPERMEABLE
EXISTING	188	211	47
PROPOSED	224	176	56

INCREASE IN IMPERMEABLE AREA OF 9%

STORAGE REQUIREMENTS WHEN RESTRICTED TO 1L/s/ha:
- HR WALLINGFORD = 2m3
- PRELIMINARY FLOW CALC = 2-3m3



EXISTING GROUND FLOOR PLAN
1:100



PROPOSED GROUND FLOOR PLAN
1:100

Company No. 5873122
VAT Registration No. 894 2993 61
Registered In England And Wales

Notes

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS & ENGINEERS DRAWINGS AND SPECIFICATIONS
2. DO NOT SCALE FROM THIS DRAWING

Rev	Date	Chkd	Amendments
P1	24.05.19	MB	PRELIMINARY ISSUE

Drawing Status: PRELIMINARY

Symmetrys Limited
Consulting Structural Engineers
6 The Courtyard, Lynton Road
LONDON, SW1 N8 8SL
T: 020 8340 4041
W: www.symmetrys.com
E: info@symmetrys.com

Job Title

12 LYNDHURST GARDENS
LONDON, NW3 5NR

Drawing Title

SITE PERMEABILITY PLAN

Job No.	Drawing No.	Revision
19050	3100	P1

Scales 1:100 AT A1 — Original Size A1

Drawn By MW Date MAY 2019

APPENDIX B

SURFACE WATER ESTIMATED STORAGE REQUIREMENT CALCULATIONS

HR Wallingford
Working with water

Greenfield runoff estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	
Site name:	12 Lyndhurst Gardens
Site location:	London

This is an estimation of the greenfield runoff rate limits that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", W5-074/A/TR1/1 rev. E (2012) and the SuDS Manual, C753 (Ciria, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site coordinates

Latitude:	51.55046° N
Longitude:	0.17263° W

Reference:	
Date:	2019-05-08 08:36

Methodology	IH124

Site characteristics

Total site area (ha)	0.009

Methodology

Qbar estimation method	Calculate from SPR and SAAR
SPR estimation method	Calculate from SOIL type

	Default	Edited
SOIL type	4	4
HOST class	---	---
SPR/SPRHOST	0.47	0.47

Hydrological characteristics

	Default	Edited
SAAR (mm)	650	650
Hydrological region	6	6
Growth curve factor: 1 year	0.85	0.85
Growth curve factor: 30 year	2.3	2.3
Growth curve factor: 100 year	3.19	3.19

Notes:

(1) Is Q_{BAR} < 2.0 l/s/ha?

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consents are usually set at 5.0l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set in which case blockage work must be addressed by using appropriate drainage elements

(3) Is SPR/SPRHOST ≤ 0.3?

Greenfield runoff rates

	Default	Edited
Qbar (l/s)	0.04	0.04
1 in 1 year (l/s)	0.03	0.03
1 in 30 years (l/s)	0.09	0.09
1 in 100 years (l/s)	0.13	0.13

HR Wallingford
Working with water

Surface water storage requirements for sites

www.uksuds.com | Storage estimation tool

Calculated by:	
Site name:	12 Lyndhurst Gardens
Site location:	London

This is an estimation of the storage volume requirements that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", W5-074/A/TR1/1 rev. E (2012) and the SuDS Manual, C753 (Ciria, 2015). It is not to be used for detailed design of drainage systems. It is recommended that hydraulic modelling software is used to calculate volume requirements and design details before finalising the drainage scheme.

Site coordinates

Latitude:	51.55053° N
Longitude:	0.17271° W

Reference:	
Date:	2019-05-08 08:37

Methodology	IH124

Site characteristics

Total site area (ha)	0.009
Significant public open space (ha)	0
Area positively drained (ha)	0.009
Pervious area contribution (%)	30
Impermeable area (ha)	0.009
Percentage of drained area that is impermeable (%)	100
Impervious area drained via infiltration (ha)	0
Return period for infiltration system design (year)	10
Impervious area drained to rainwater harvesting systems (ha)	0
Return period for rainwater harvesting system design (year)	10
Compliance factor for rainwater harvesting system design (%)	66
Net site area for storage volume design (ha)	0.02
Net impermeable area for storage volume design (ha)	0.01

* Where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50 % of the 'area positively drained', the 'net site area' and the estimates of Qbar and other flow rates will have been reduced accordingly.

Design criteria

Volume control approach	Use long term storage

	Default	Edited
Climate change allowance factor	1.4	1.4
Urban creep allowance factor	1.1	1.1
Interception rainfall depth (mm)	5	5
Minimum flow rate (l/s)	1	1

Qbar estimation method	Calculate from SPR and SAAR
SPR estimation method	Calculate from SOIL type

	Default	Edited
Qbar total site area (l/s)	0.04	--
SOIL type	4	4
HOST class	N/A	N/A
SPR	0.47	0.47

Hydrology

	Default	Edited
SAAR (mm)	650	650
M5-60 Rainfall Depth (mm)	20	20
'r' Ratio M5-60/M5-2 day	0.4	0.4
Rainfall 100 yrs 6 hrs	63	
Rainfall 100 yrs 12 hrs	102.41	
FEH/FSR conversion factor	1.33	1.33
Hydrological region	6	
Growth curve factor: 1 year	0.85	0.85
Growth curve factor: 10 year	1.62	1.62
Growth curve factor: 30 year	2.3	2.3
Growth curve factor: 100 year	3.19	3.19

Site discharge rates

	Default	Edited
Qbar total site area (l/s)	0.04	0.04
Qbar net site area (l/s)	0.09	0.09
1 in 1 year (l/s)	1	1
1 in 30 years (l/s)	1	1
1 in 100 years (l/s)	1	1

Estimated storage volumes

	Default	Edited
Interception storage (m^3)	0	0
Attenuation storage (m^3)	2	2
Long term storage (m^3)	0	0
Treatment storage (m^3)	1	1
Total storage *(excluding treatment)* (m^3)	2	2

APPENDIX C
THAMES WATER ASSET PLAN

Asset location search

Property Searches

Symmetrys Limited
Unit 6 The Courtyard Unit 6 The Courtyard

LONDON
N8 8SL

Search address supplied 12
Lyndhurst Gardens
London
NW3 5NR

Your reference 19050

Our reference ALS/ALS Standard/2019_3969499

Search date 15 March 2019

Keeping you up-to-date

Notification of Price Changes

From 1 September 2018 Thames Water Property Searches will be increasing the price of its Asset Location Search in line with RPI at 3.23%.

For further details on the price increase please visit our website: www.thameswater-propertysearches.co.uk
Please note that any orders received with a higher payment prior to the 1 September 2018 will be non-refundable.

Thames Water Utilities Ltd
Property Searches, PO Box 3189, Slough SL1 4WW
DX 151280 Slough 13

searches@thameswater.co.uk
www.thameswater-propertysearches.co.uk

0845 070 9148

Asset location search

Property Searches

Search address supplied: 12, Lyndhurst Gardens, London, NW3 5NR

Dear Sir / Madam

An Asset Location Search is recommended when undertaking a site development. It is essential to obtain information on the size and location of clean water and sewerage assets to safeguard against expensive damage and allow cost-effective service design.

The following records were searched in compiling this report: - the map of public sewers & the map of waterworks. Thames Water Utilities Ltd (TWUL) holds all of these.

This searchprovides maps showing the position, size of Thames Water assets close to the proposed development and also manhole cover and invert levels, where available.

Please note that none of the charges made for this report relate to the provision of Ordnance Survey mapping information. The replies contained in this letter are given following inspection of the public service records available to this company. No responsibility can be accepted for any error or omission in the replies.

You should be aware that the information contained on these plans is current only on the day that the plans are issued. The plans should only be used for the duration of the work that is being carried out at the present time. Under no circumstances should this data be copied or transmitted to parties other than those for whom the current work is being carried out.

Thames Water do update these service plans on a regular basis and failure to observe the above conditions could lead to damage arising to new or diverted services at a later date.

Contact Us

If you have any further queries regarding this enquiry please feel free to contact a member of the team on 0845 070 9148, or use the address below:

Thames Water Utilities Ltd
Property Searches
PO Box 3189
Slough
SL1 4WW

Email: searches@thameswater.co.uk
Web: www.thameswater-propertysearches.co.uk

Waste Water Services

Please provide a copy extract from the public sewer map.

Enclosed is a map showing the approximate lines of our sewers. Our plans do not show sewer connections from individual properties or any sewers not owned by Thames Water unless specifically annotated otherwise. Records such as "private" pipework are in some cases available from the Building Control Department of the relevant Local Authority.

Where the Local Authority does not hold such plans it might be advisable to consult the property deeds for the site or contact neighbouring landowners.

This report relates only to sewerage apparatus of Thames Water Utilities Ltd, it does not disclose details of cables and or communications equipment that may be running through or around such apparatus.

The sewer level information contained in this response represents all of the level data available in our existing records. Should you require any further Information, please refer to the relevant section within the 'Further Contacts' page found later in this document.

For your guidance:

- The Company is not generally responsible for rivers, watercourses, ponds, culverts or highway drains. If any of these are shown on the copy extract they are shown for information only.
- Any private sewers or lateral drains which are indicated on the extract of the public sewer map as being subject to an agreement under Section 104 of the Water Industry Act 1991 are not an ‘as constructed’ record. It is recommended these details be checked with the developer.

Clean Water Services

Please provide a copy extract from the public water main map.

Enclosed is a map showing the approximate positions of our water mains and associated apparatus. Please note that records are not kept of the positions of individual domestic supplies.

For your information, there will be a pressure of at least 10m head at the outside stop valve. If you would like to know the static pressure, please contact our Customer Centre on 0800 316 9800. The Customer Centre can also arrange for a full flow and pressure test to be carried out for a fee.

For your guidance:

- Assets other than vested water mains may be shown on the plan, for information only.
- If an extract of the public water main record is enclosed, this will show known public water mains in the vicinity of the property. It should be possible to estimate the likely length and route of any private water supply pipe connecting the property to the public water network.

Payment for this Search

A charge will be added to your suppliers account.

Further contacts:

Waste Water queries

Should you require verification of the invert levels of public sewers, by site measurement, you will need to approach the relevant Thames Water Area Network Office for permission to lift the appropriate covers. This permission will usually involve you completing a TWOSA form. For further information please contact our Customer Centre on Tel: 0845 920 0800. Alternatively, a survey can be arranged, for a fee, through our Customer Centre on the above number.

If you have any questions regarding sewer connections, budget estimates, diversions, building over issues or any other questions regarding operational issues please direct them to our service desk. Which can be contacted by writing to:

Developer Services (Waste Water)
Thames Water
Clearwater Court
Vastern Road
Reading
RG1 8DB

Tel: 0800 009 3921
Email: developer.services@thameswater.co.uk

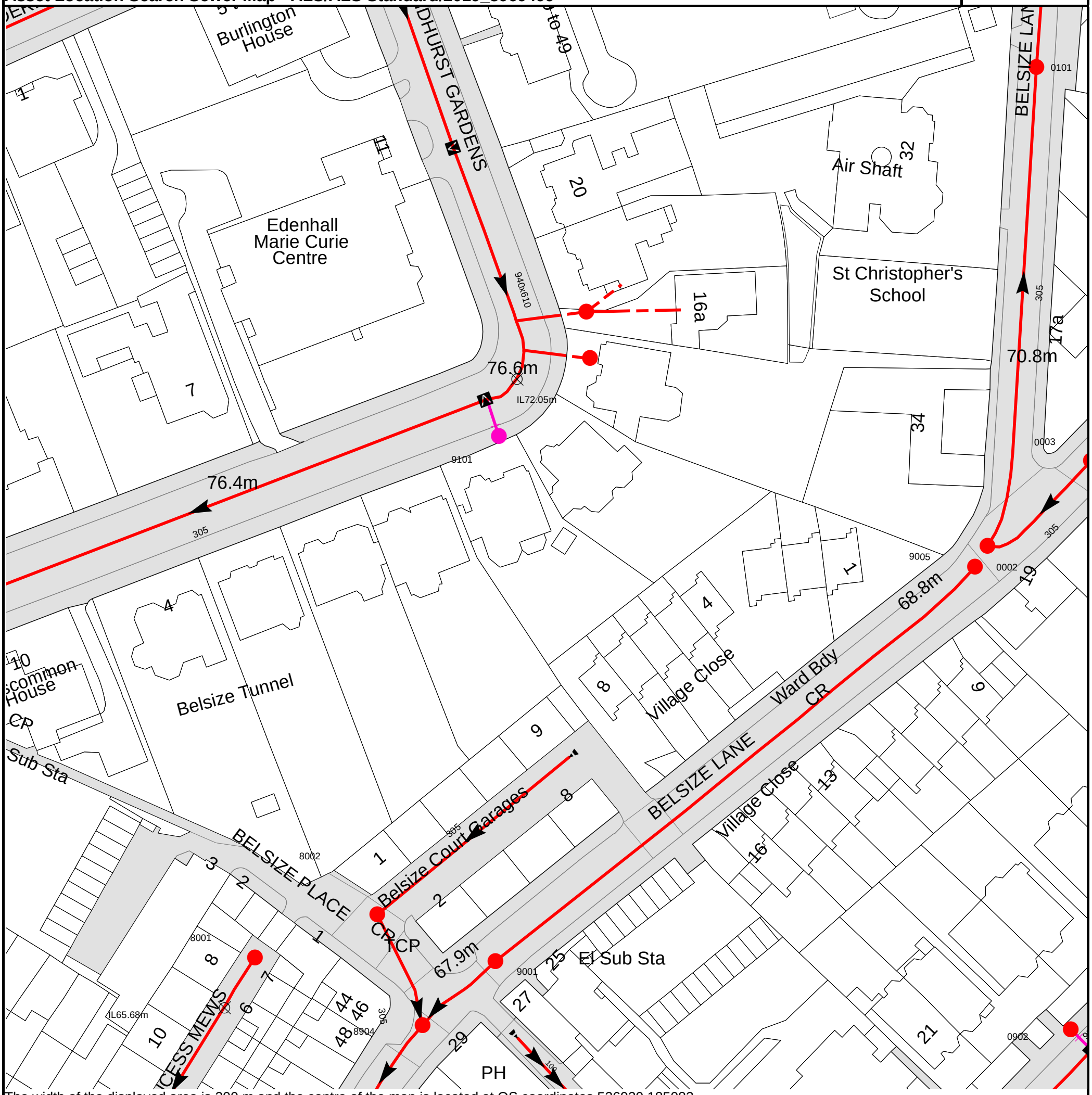
Clean Water queries

Should you require any advice concerning clean water operational issues or clean water connections, please contact:

Developer Services (Clean Water)
Thames Water
Clearwater Court
Vastern Road
Reading
RG1 8DB

Tel: 0800 009 3921
Email: developer.services@thameswater.co.uk

Asset Location Search Sewer Map - ALS/ALS Standard/2019_3969499



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 526920,185083

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

Manhole Reference	Manhole Cover Level	Manhole Invert Level
0101	n/a	n/a
0003	69.82	66.47
9101	n/a	n/a
9106	n/a	n/a
9105	n/a	n/a
8904	67.5	63.1
9001	n/a	n/a
8001	69.28	n/a
8002	68.53	64.49
9005	n/a	n/a
0002	69.2	65.64
0902	n/a	n/a

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

ALS Sewer Map Key

Public Sewer Types (Operated & Maintained by Thames Water)

Foul: A sewer designed to convey waste water from domestic and industrial sources to a treatment works.

Surface Water: A sewer designed to convey surface water (e.g. rain water from roofs, yards and car parks) to rivers or watercourses.

Combined: A sewer designed to convey both waste water and surface water from domestic and industrial sources to a treatment works.

Trunk Surface Water

Trunk Foul

Storm Relief

Trunk Combined

Vent Pipe

Bio-solids (Sludge)

Proposed Thames Surface Water Sewer

Proposed Thames Water Foul Sewer

Gallery

Foul Rising Main

Surface Water Rising Main

Combined Rising Main

Sludge Rising Main

Proposed Thames Water Rising Main

Vacuum

Sewer Fittings

A feature in a sewer that does not affect the flow in the pipe. Example: a vent is a fitting as the function of a vent is to release excess gas.

Air Valve

Dam Chase

Fitting

Meter

Vent Column

Operational Controls

A feature in a sewer that changes or diverts the flow in the sewer. Example: A hydrobrake limits the flow passing downstream.

Control Valve

Drop Pipe

Ancillary

Weir

End Items

End symbols appear at the start or end of a sewer pipe. Examples: an Undefined End at the start of a sewer indicates that Thames Water has no knowledge of the position of the sewer upstream of that symbol, Outfall on a surface water sewer indicates that the pipe discharges into a stream or river.

Outfall

Undefined End

Inlet

Other Symbols

Symbols used on maps which do not fall under other general categories

Public/Private Pumping Station

Change of characteristic indicator (C.O.C.I.)

Invert Level

Summit

Areas

Lines denoting areas of underground surveys, etc.

Agreement

Operational Site

Chamber

Tunnel

Conduit Bridge

Other Sewer Types (Not Operated or Maintained by Thames Water)

Foul Sewer

Surface Water Sewer

Combined Sewer

Gulley

Culverted Watercourse

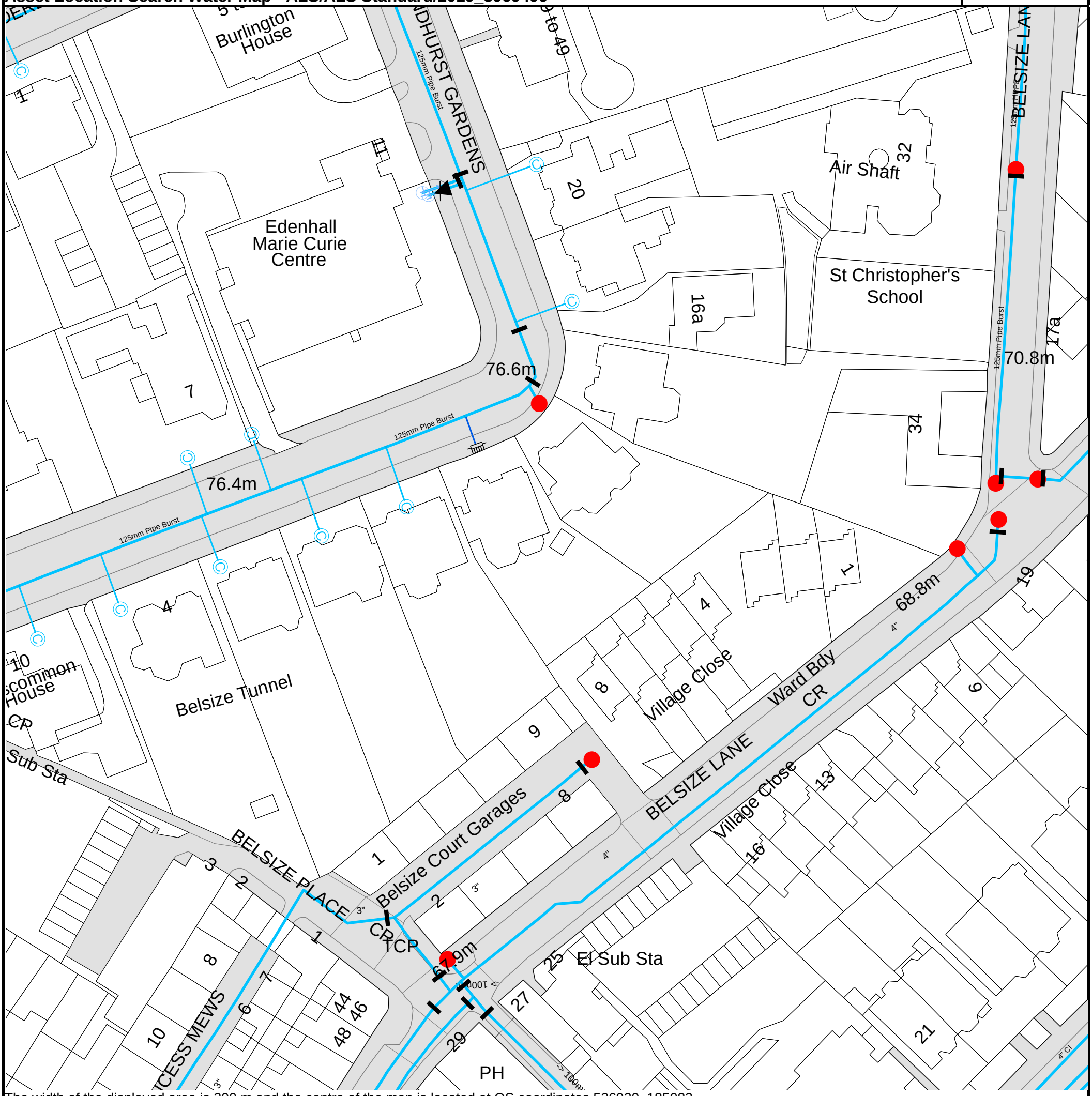
Proposed

Abandoned Sewer

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.
2) All measurements on the plans are metric.
3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate direction of flow.
4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.
5) 'na' or '0' on a manhole level indicates that data is unavailable.
6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in milimetres. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology present on the plan, please contact a member of Property Insight on 0845 070 9148.

Asset Location Search Water Map - ALS/ALS Standard/2019_3969499



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 526920, 185083.

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

ALS Water Map Key

Water Pipes (Operated & Maintained by Thames Water)

4"

Distribution Main: The most common pipe shown on water maps. With few exceptions, domestic connections are only made to distribution mains.

16"

Trunk Main: A main carrying water from a source of supply to a treatment plant or reservoir, or from one treatment plant or reservoir to another. Also a main transferring water in bulk to smaller water mains used for supplying individual customers.

3" SUPPLY

Supply Main: A supply main indicates that the water main is used as a supply for a single property or group of properties.

3" FIRE

Fire Main: Where a pipe is used as a fire supply, the word FIRE will be displayed along the pipe.

3" METERED

Metered Pipe: A metered main indicates that the pipe in question supplies water for a single property or group of properties and that quantity of water passing through the pipe is metered even though there may be no meter symbol shown.

Transmission Tunnel: A very large diameter water pipe. Most tunnels are buried very deep underground. These pipes are not expected to affect the structural integrity of buildings shown on the map provided.

Proposed Main: A main that is still in the planning stages or in the process of being laid. More details of the proposed main and its reference number are generally included near the main.

Valves

- General Purpose Valve
- Air Valve
- Pressure Control Valve
- Customer Valve

Hydrants

- Single Hydrant

Meters

- Meter

End Items

Symbol indicating what happens at the end of a water main.

- Blank Flange
- Capped End
- Emptying Pit
- Undefined End
- Manifold
- Customer Supply
- Fire Supply

Operational Sites

- Booster Station
- Other
- Other (Proposed)
- Pumping Station
- Service Reservoir
- Shaft Inspection
- Treatment Works
- Unknown
- Water Tower

Other Symbols

- Data Logger

PIPE DIAMETER	DEPTH BELOW GROUND
Up to 300mm (12")	900mm (3')
300mm - 600mm (12" - 24")	1100mm (3' 8")
600mm and bigger (24" plus)	1200mm (4')

Other Water Pipes (Not Operated or Maintained by Thames Water)

Other Water Company Main: Occasionally other water company water pipes may overlap the border of our clean water coverage area. These mains are denoted in purple and in most cases have the owner of the pipe displayed along them.

Private Main: Indiates that the water main in question is not owned by Thames Water. These mains normally have text associated with them indicating the diameter and owner of the pipe.

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Credit Card	**BACS Payment**	**Telephone Banking**	**Cheque**
Call **0845 070 9148** quoting your invoice number starting CBA or ADS / OSS	Account number **90478703** Sort code **60-00-01** A remittance advice must be sent to: **Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW.** or email **ps.billing@thameswater.co.uk**	By calling your bank and quoting: Account number **90478703** Sort code **60-00-01** and your invoice number	Made payable to '**Thames Water Utilities Ltd**' Write your Thames Water account number on the back. Send to: **Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW** or by DX to **151280 Slough 13**

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- promotes the best practise and quality standards within the industry for the benefit of consumers and property professionals
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The Property Ombudsman scheme
Milford House
43-55 Milford Street
Salisbury
Wiltshire SP1 2BP
Tel: 01722 333306
Fax: 01722 332296
Web site: www.tpos.co.uk
Email: admin@tpos.co.uk

You can get more information about the PCCB from www.propertycodes.org.uk

PLEASE ASK YOUR SEARCH PROVIDER IF YOU WOULD LIKE A COPY OF THE SEARCH CODE

APPENDIX 6

FLOOD RISK ASSESSMENT - GeoSmart

GeoSmart Information

Environmental Thinking

FloodSmart

Site address	12 Lyndhurst Gardens London NW3 5NR
Site coordinates	526915, 185090
Report prepared for	Daniel Burbidge Flat 2 12 Lyndhurst Gardens London NW3 5NR
Report reference	72205R2
Report status	FINAL
Date issued	2019-11-14
Report author	Jessica Bayliff, MESci. **Consultant**
Report checker	Alan White, MSc., BSc. **Principal Consultant**
Report reviewer	Dr Paul Ellis, PhD, BSc., CGeol. **Principal Consultant**

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1. Executive summary

The National Planning Policy Framework (NPPF) (2019) and National Planning Practice Guidance (NPPG) (2014) requires that flood risk assessments review flooding from all potential sources. A review has been undertaken of national environmental data sets to assess the potential flood risk to the Site. The review is provided within this concise interpretative report written by an experienced GeoSmart consultant.

Site analysis

Source of Flood Risk	Baseline	After Mitigation
River (fluvial) and Sea (coastal/tidal)	Very Low	N/A
Surface water (pluvial) flooding	Very Low to Medium	Very Low
Groundwater flooding	Negligible	N/A
Other flood risk factors present	No	N/A
Is any other further work recommended?	Yes	Yes (see below)

N/A = mitigation not required

The building is currently used within a residential capacity. Development proposals comprise the construction of a single storey basement underneath the rear half of the property.

The flood risks from all sources have been assessed as part of this report and are as follows:

- According to the Environment Agency's (EA) Flood Map for Planning Purposes, the Site is located within a fluvial Flood Zone 1 (Low probability);
- According to the EA's Risk of Flooding from Rivers and Sea (RoFRS) map, which considers the type, condition and crest height of flood defences, the Site has a Very Low risk of flooding from Rivers and the Sea;
- According to the EA's Risk of Flooding from Surface Water (pluvial) flood mapping, the Site has a Very Low to Medium risk of pluvial flooding, and is located within a critical drainage area (Group3_005);
- GeoSmart's Groundwater Flood Risk (GW5) mapping confirms there is a Negligible risk of groundwater flooding at the surface; and
- According to the EA's Risk of Flooding from Reservoir map, the Site is not at risk of Reservoir Flooding.

Recommendations / Next steps

Recommendations for mitigation are provided below, based upon the proposed development and the flood risk to the Site:

The Site has been identified as being at risk of pluvial flooding during the 1 in 100 and 1 in 1000 year events. Although there is the potential for the risk to be lower as the EA surface water (pluvial) data does not take into consideration the presence of the existing drainage network, the following mitigation measures are still recommended to reduce the flood risk to the proposed development:

- Regular maintenance of any drains surrounding/on the Site should be undertaken to reduce the flood risk;
- Consider the use of flood doors and barriers to entrances on the ground and lower ground floor levels;
- A sump and pump system could be fitted within the lowest area of the basement; and
- It is also recommended that the basement is designed and constructed following current best practice and guidance to prevent water ingress. Recommendations presented in the separate Basement Impact Assessment should also be implemented to mitigate the flood risk both on and off-Site.

GeoSmart recommend that mitigation measures that have been discussed within this report are considered as part of the proposed development where possible and evidence of this is provided to the Local Authority as part of the planning application.

2. Introduction

Background and purpose

This assessment has been undertaken by firstly compiling information concerning the Site and the surrounding area. The information gathered was then used to construct a 'conceptual site model', including an understanding of the appropriateness of the development as defined in the NPPF (2019) and the source(s) of any flood risk present. Finally, a preliminary assessment of the steps that can be taken to manage any flood risk to the development was undertaken.

This report has been prepared with reference to the NPPF (2019) and NPPG (2014).

"*The National Planning Policy Framework set out the Government's planning policies for England and how these are expected to be applied*" (NPPF, 2019).

The NPPF (2019) and NPPG (2014) promote a sequential, risk based approach to the location of development.

"This general approach is designed to ensure that areas at little or no risk of flooding from any source are developed in preference to areas at higher risk. The aim should be to keep development out of medium and high risk flood areas (Flood Zones 2 and 3) and other areas affected by other sources of flooding where possible" (NPPG, 2014).

The purpose of this report is to provide clear and pragmatic advice regarding the nature and potential significance of flood hazards which may be present at the Site.

Report scope

A thorough review of a commercially available flood risk report and EA supplied data indicating potential sources of flood risk to the Site from rivers and coastal sources, surface run-off (pluvial), groundwater and reservoirs, including historical flood information and modelled flood extent. Appropriate measures are recommended to manage and mitigate the flood risk to the property.

Information obtained from the EA and a review of the London Borough of Camden Strategic Flood Risk Assessment (SFRA) (URS, 2014), London Borough of Camden Flood Risk Management Strategy (FRMS) (London Borough of Camden, 2013) and London Borough of Camden Surface Water Management Plan (Halcrow, 2011) are used to ascertain local flooding issues and, where appropriate, identify information to support a Sequential and/or Exception test required as part of the NPPF (2019).

Using the available data, the existing and future flood risks to and from the Site from all flood sources will be assessed in line with current best practice. An indication of potential flood risk from the Site to downstream receptors is provided where the proposed development increases flood risk.

Report limitations

It is noted that the findings presented in this report are based on a desk study of information supplied by third parties. Whilst we assume that all information is representative of past and present conditions we can offer no guarantee as to its validity and a proportionate programme of site investigations would be required to fully verify these findings.

The basemap used is the OS Street View 1:10,000 scale, however the Site boundary has been drawn using BlueSky aerial imagery to ensure the correct extent and proportion of the Site is analysed.

This report excludes consideration of potential hazards arising from any activities at the Site other than normal use and occupancy for the intended land uses. Hazards associated with any other activities have not been assessed and must be subject to a specific risk assessment by the parties responsible for those activities.

Datasets

The following table shows the sources of information that have been consulted as part of this report:

Table 1: Datasets consulted to obtain confirmation of sources of flooding and risk

Source of flooding	Datasets consulted				
	Commercial Flood Maps and GW5 Data (Appendix B)	SFRA*	Environment Agency	Thames Water (Appendix C)	OS Data
Historical	X	X	X		
Fluvial/tidal	X	X	X		
Surface water (pluvial)	X	X	X		
Groundwater	X	X			
Sewer		X		X	
Culvert/bridges		X			X
Reservoir		X	X		

*London Borough of Camden Strategic Flood Risk Assessment (SFRA) (URS, 2014), London Borough of Camden Flood Risk Management Strategy (FRMS) (LBC, 2013) and London Borough of Camden Surface Water Management Plan (Halcrow, 2011). Supporting information on the datasets used is provided in the relevant appendix

3. Site analysis

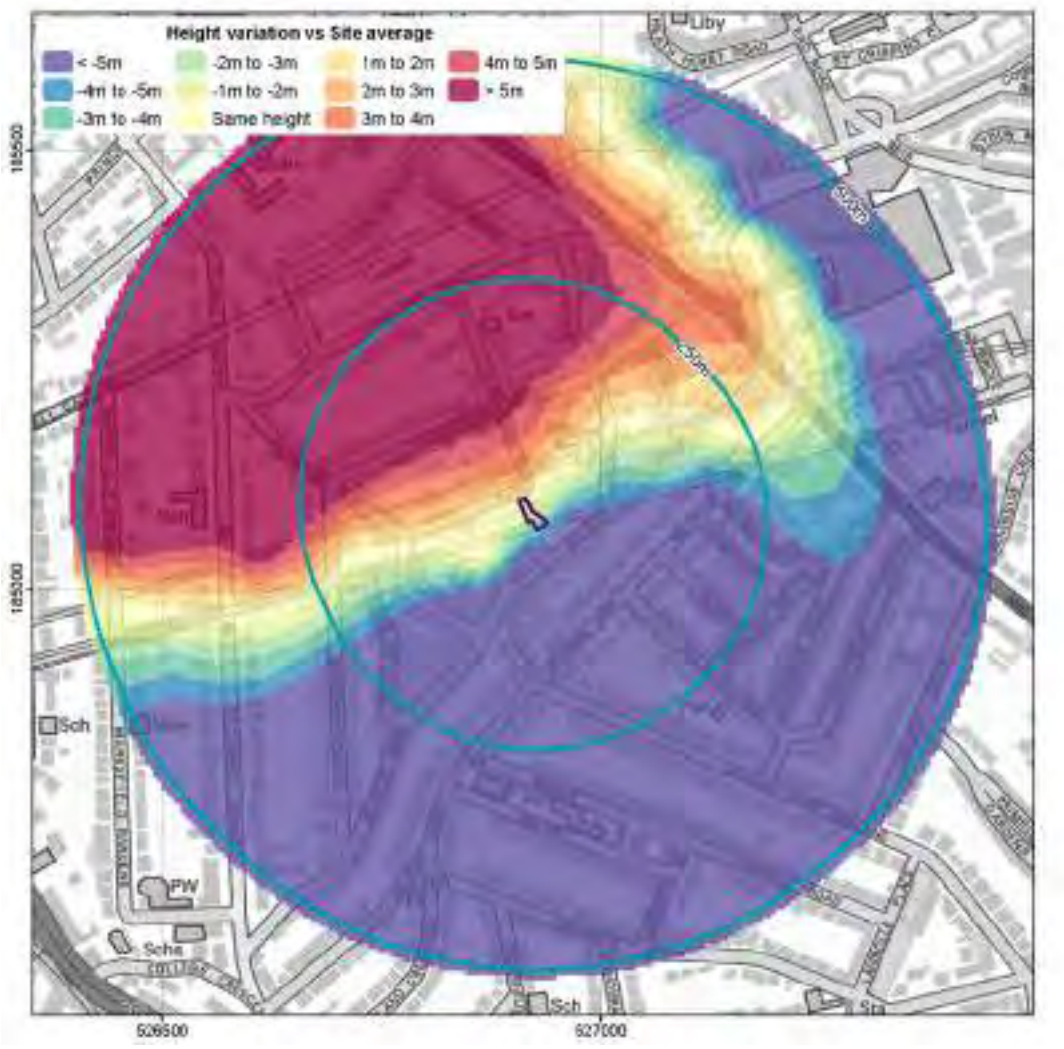
Site information

The Site is located in Camden in a setting of commercial and residential land use at National Grid Reference TQ 26915 85090. Site plans and drawings are provided in Appendix A.

Using a 500 m buffer around the Site, the area is on a slope, falling from north west to south east (Figure 1). It is noted that to the north is a similar level to the Site, whereas the land to the north west land rises to c. 98.4 m above Ordnance Datum (AOD). To the west land rises slightly to c. 78.2 mAOD, to the east land falls slightly to c. 66.2 mAOD and to the south falls to c. 57.4 mAOD.

According to OS data, the general level of the Site is between 76.19 and 69.91mAOD with the Site falling gradually in a south easterly direction. This is based on EA elevation data obtained for the Site to a 1 m resolution with a vertical accuracy of ±150 mm (Appendix D).

Figure 1 Site Location and Relative Elevations



Development

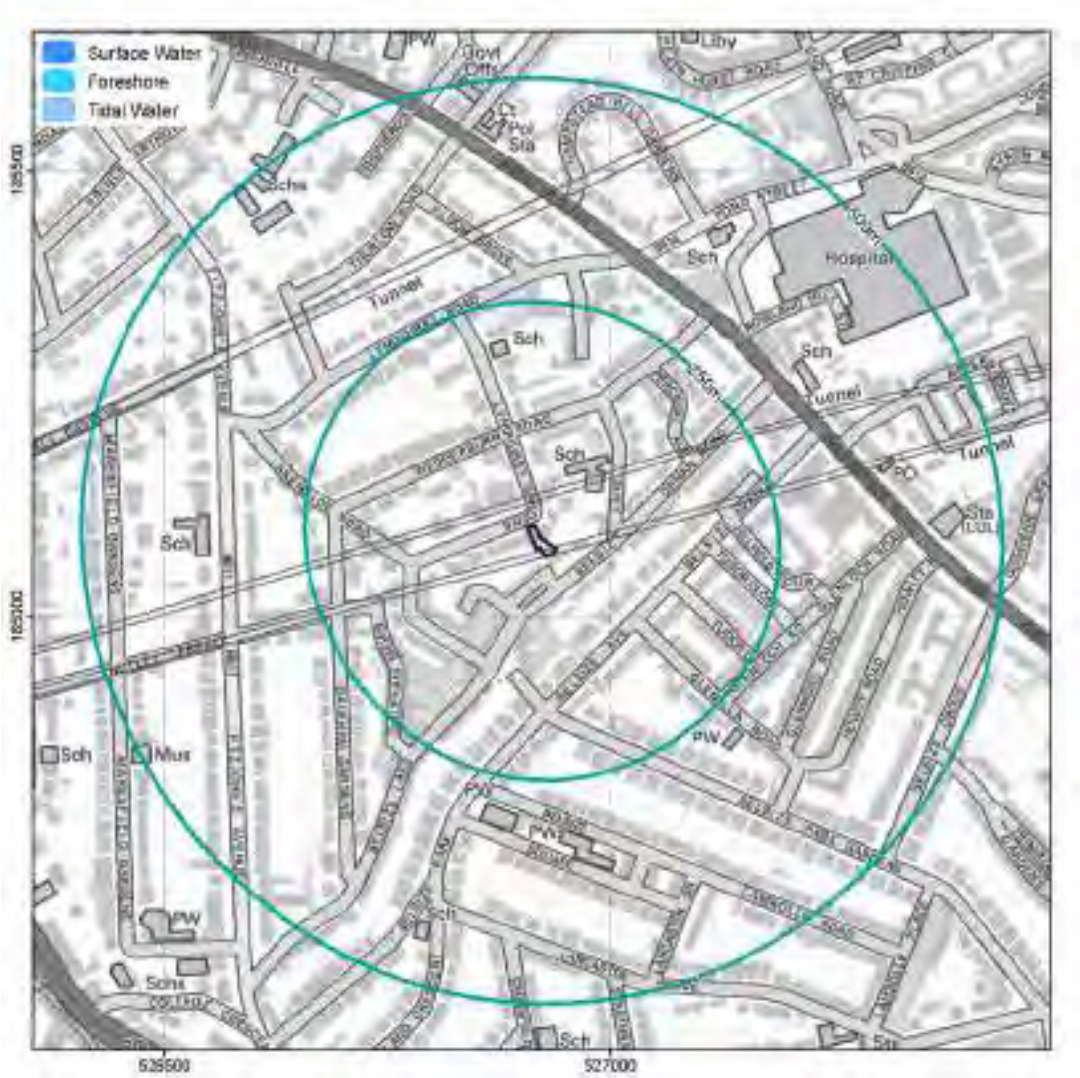
The building is currently used within a residential capacity. Development proposals comprise the demolition of the existing rear bay window at ground floor, construction of a new single storey rear extension at ground floor level and construction of a single storey basement underneath the rear half of the property, extending into the garden (Appendix A). The effect of the overall development may not result in an increase in number of occupants and/or users of the building and will not result in the change of use, nature or times of occupation. The estimated lifespan of the development is 100 years.

Hydrological features

Watercourses/surface water features within 500 m of the Site:

There are no mapped surface water features within 500 m of the Site.

Figure 2 Surface water features



Proximity to relevant infrastructure:

There is no relevant infrastructure relating to potential flood risk located within 500 m of the Site. It is noted on the mapping that a tunnel passes beneath the southern part of the Site. Whilst beyond the scope of this report, it would be advisable to determine the exact location and depth of the tunnel and any associated development constraints.

Hydrogeological features

British Geological Survey (BGS) mapping indicates that there are no underlying superficial deposits (BGS, 2019).

BGS mapping indicates that the underlying bedrock geology consists of the London Clay Formation (BGS, 2019) and is classified as a Unproductive Strata (EA, 2019).

The onsite borehole logs (LMB Geosolutions, May 2019) indicate made ground over London Clay at a depth of 2.1 m below ground level. The report by CGL (2019, pg 9) indicates that '*During the ground investigation water strikes were not recorded. During the return groundwater monitoring visit water was recorded to be present at 4.3 m bgl. The water observed and recorded in borehole BH1 during the return monitoring visit is likely to be representative of perched water in the Made Ground or London Clay Formation rather than a laterally continuous water body.*'

The Site is not located within a groundwater Source Protection Zone (EA, 2019).

4. Flood risk to the development

Historical flood events

No historical flood events have been recorded at the Site (EA, 2019).

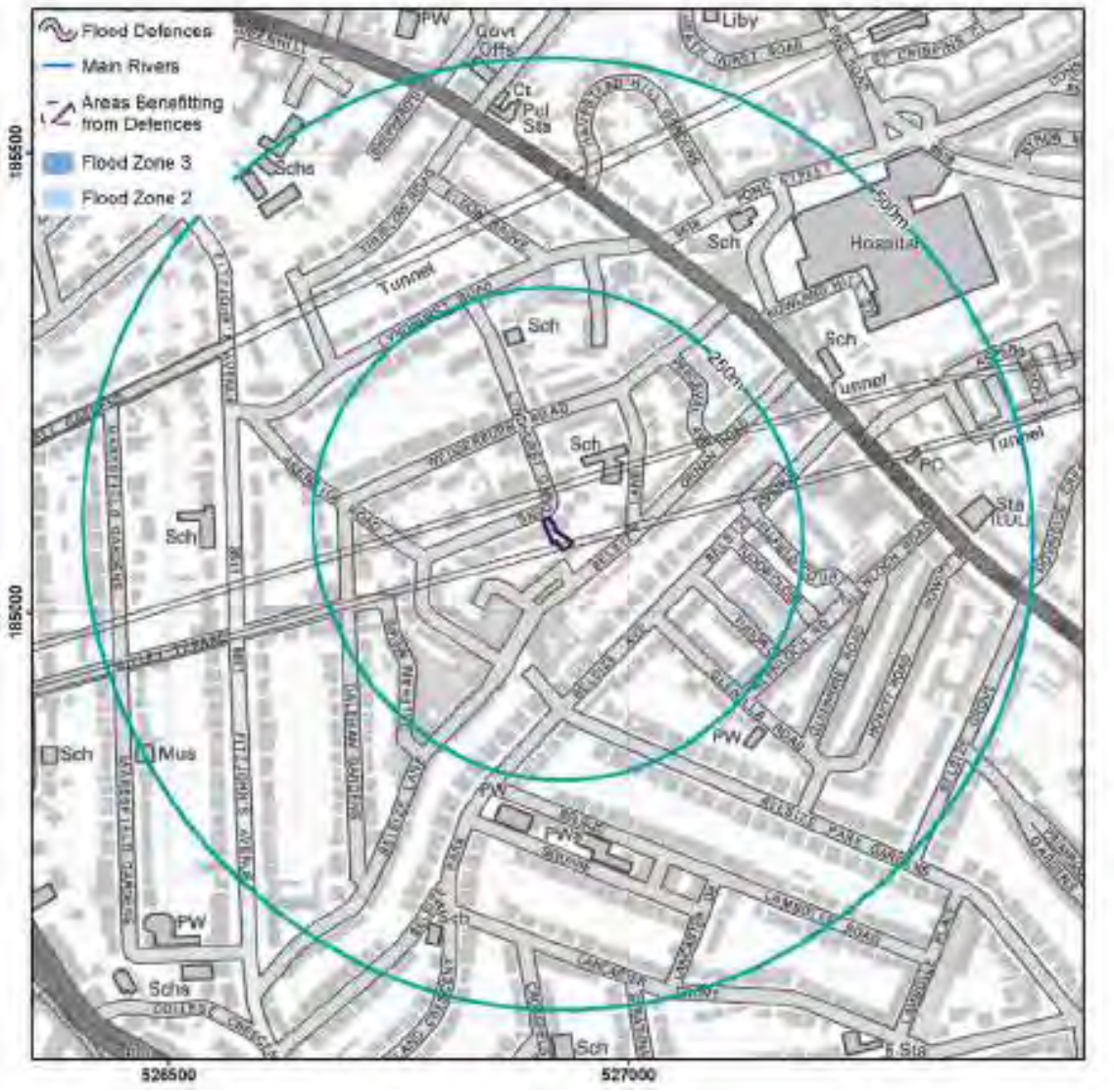
The purpose of historical flood data is to provide information on where and why flooding may have occurred in the past. The absence of any recorded events does not mean flooding has never occurred on Site or that flooding will never occur at the Site.

Rivers (fluvial) / Sea (coastal/tidal) flooding

According to the EA's Flood Map for Planning Purposes (Figure 3), the Site is located within fluvial Flood Zone 1 and is therefore classified as having a Low probability of fluvial flooding.

The Site lies approximately 4.35 km to the south east of the nearest land within a Flood Zone 2 and/or 3.

Figure 3 EA Flood Map for Planning Purposes (EA, 2019)



As defined in the NPPF (2019):

Guidance

Ignoring the presence of any defences, land located in a Flood Zone 1 is considered to have a Low probability of flooding, with less than a 1 in 1000 annual probability of fluvial or coastal flooding in any one year.

Development of all uses of land is appropriate in this zone (see glossary for terminology).

Actual flood risk

The type and condition of the existing flood defences influence the 'actual' risk of fluvial flooding to the Site, albeit the residual risk of flooding should be considered when proposing new development.

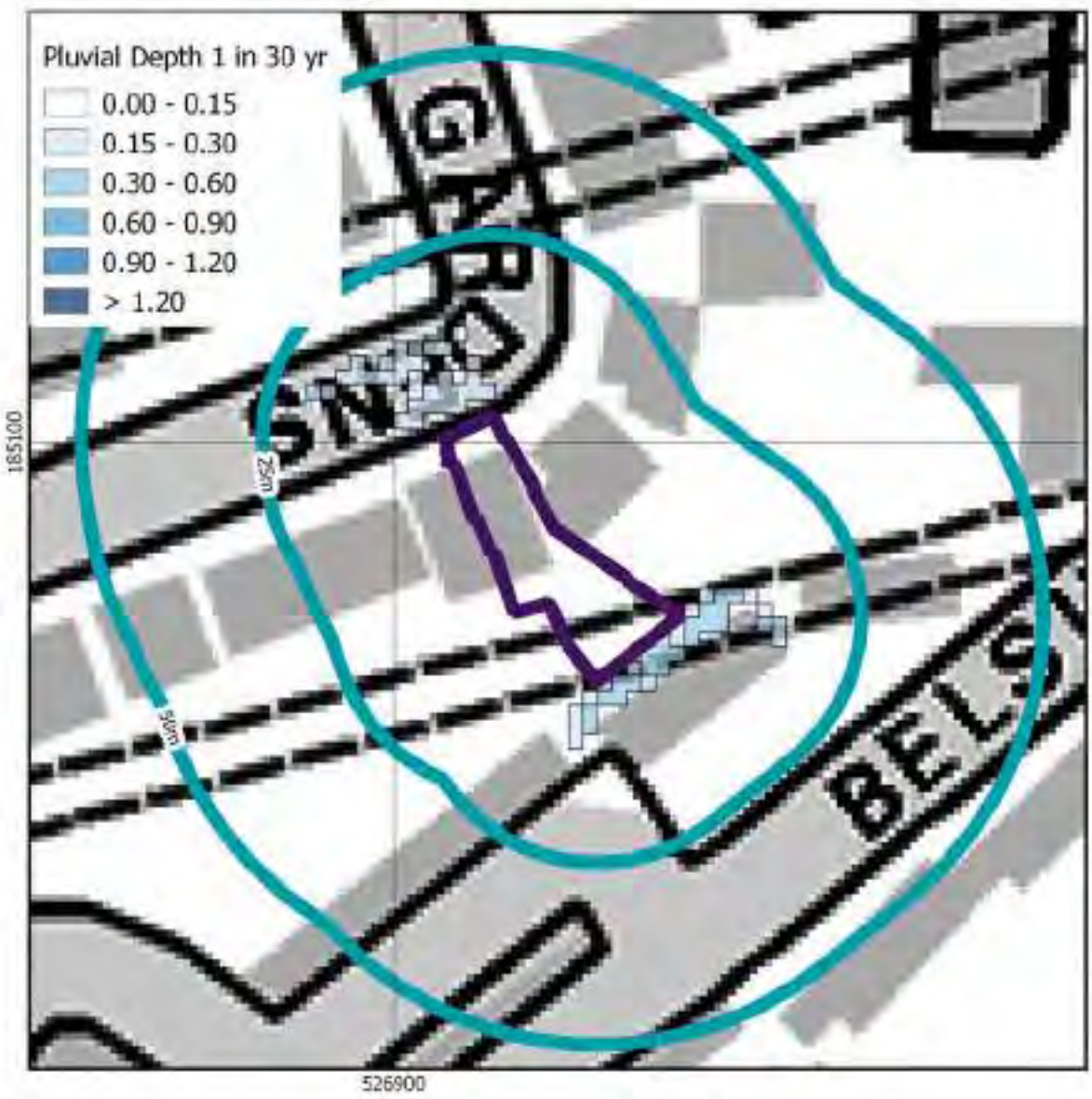
According to the EA's Risk of Flooding from Rivers and the Sea (RoFRS) mapping (Figure 4), which considers the crest height, standard of protection and condition of defences, the flood risk from Rivers and the Sea is Very Low.

Figure 4 EA Risk of Flooding from Rivers and Sea map (EA, 2019)

Surface water (pluvial) flooding

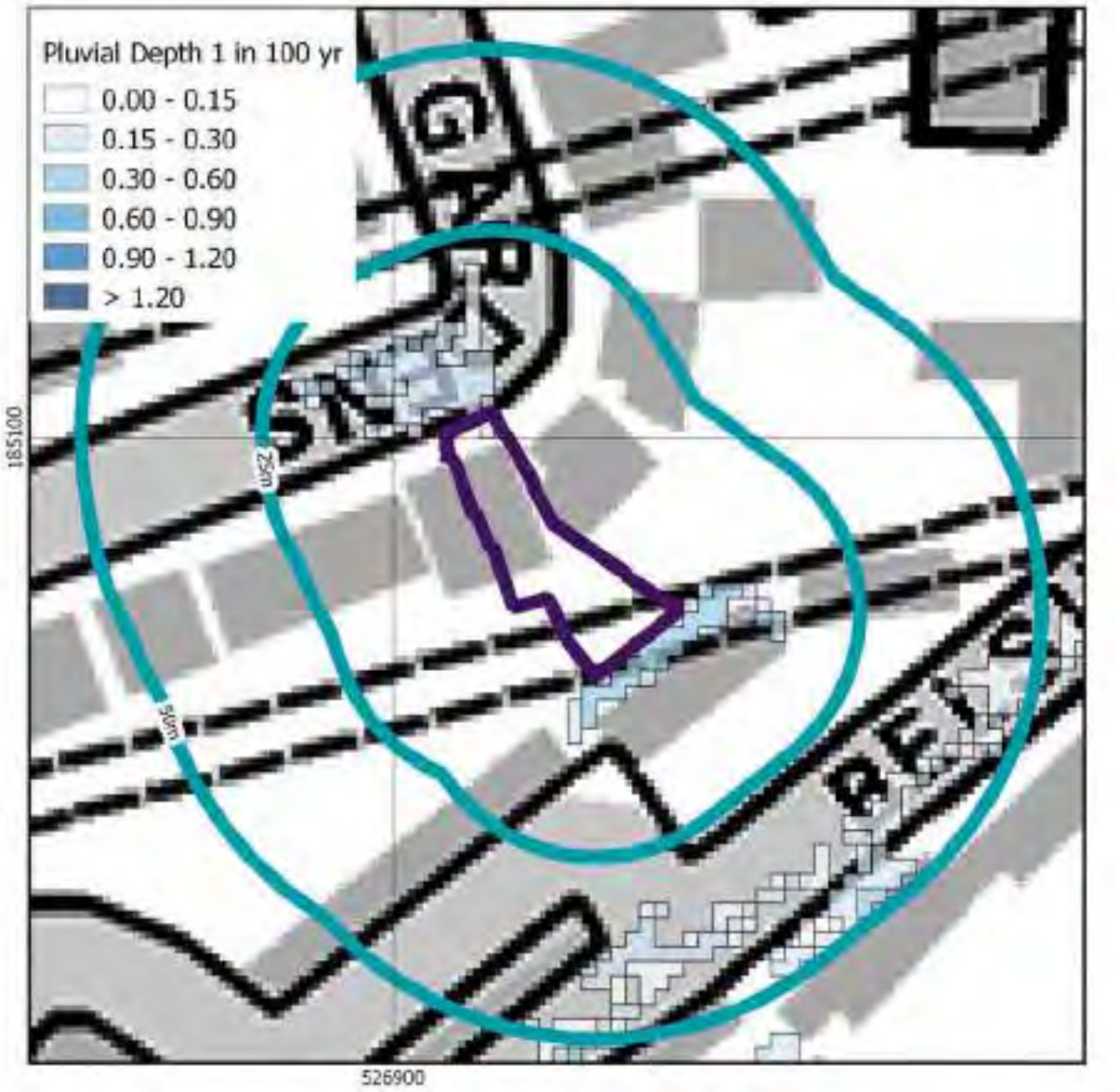
According to the EA's Risk of Flooding from Surface Water (pluvial) mapping (Figures 5-7), there is a Very Low to Medium risk of pluvial flooding across the Site. During the 1in 30 year event (Figure 5), the Site itself is not impacted, however there are areas immediately adjacent at risk, where flood depths range between 0 m and 0.6 m. However, the area of flooding to the north of the Site is likely to be contained within the highway of Lyndhurst Gardens so is unlikely to affect the Site. The flood risk adjacent to the southern Site boundary is considered unlikely to affect the Site and proposed development due to is being located at a lower topography.

Figure 5 Risk of Flooding from Surface Water (pluvial) 1 in 30 year Depth Map (EA, 2019)



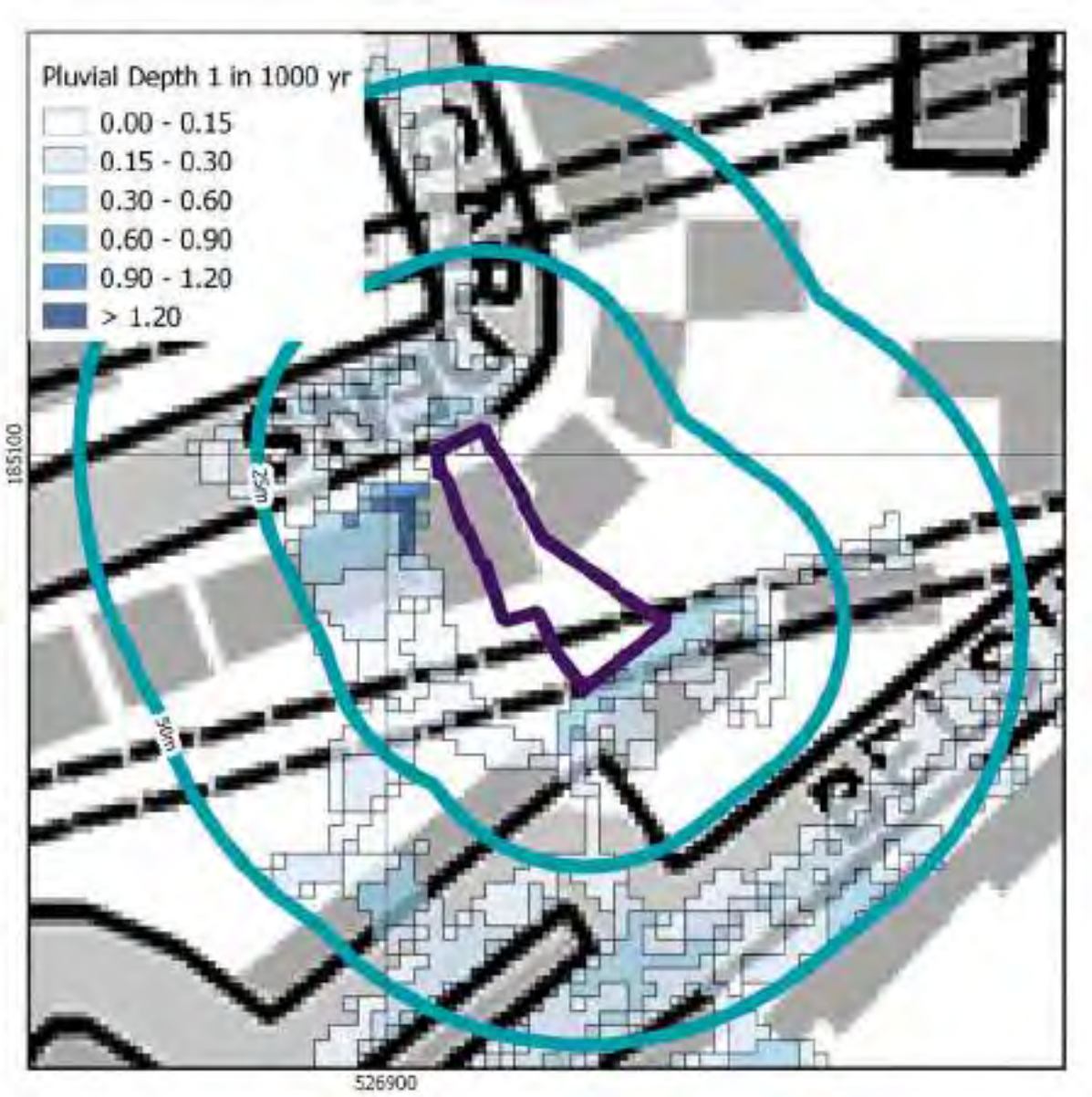
During the 1 in 100 year event (Figure 6), a very small area in the north eastern corner of the Site is mapped as being at risk of surface water flooding, to a depth of 0.3 m.

Figure 6 Risk of Flooding from Surface Water (pluvial) 1 in 100 year Depth Map (EA, 2019)



During the 1 in 1000 year event (Figure 7), the area adjacent to the north west, is mapped as being at risk of surface water flooding, to a depth of 1.20 m. As this area at risk of flooding shares a boundary wall with the Site with a single access point via the gateway in the centre, there is potential for surface waters to be diverted and therefore, the subject Site could be impacted.

Figure 7 Risk of Flooding from Surface Water (pluvial) 1 in 1000 year Depth Map (EA, 2019)



Guidance

According to EA's surface water flood risk map, a site at Very Low risk has a chance of flooding of less than 1 in 1000 (0.1%)

According to EA's surface water flood risk map, a site at Low risk has a chance of flooding of between a 1 in 1000 and 1 in 100 (0.1% and 1%).

According to EA's surface water flood risk map, a site at Medium risk has a chance of flooding of between a 1 in 100 and 1 in 30 (1% and 3.3%).

Analysis EA's pluvial flow route mapping confirm the Site is located on a potential overland flow route during the 1 in 1000 year event and does not contain areas of low topography in relation to the surrounding area.

As the EA surface water (pluvial) data does not take into consideration the presence of the existing drainage network, there is potential for the depth of the surface water flooding shown on the mapping to be exaggerated.

Figure 3V of the SFRA shows the street adjacent to the north of the Site (Lyndhurst Gardens) was affected by flooding in 1975 (URS, 2014). The SFRA confirms the Site is located within a Critical Drainage Area (CDA)(Group3_005)[1], however, the Site is not located within a Local Flood Risk Zone (LRFZ)[2] (URS, 2014).

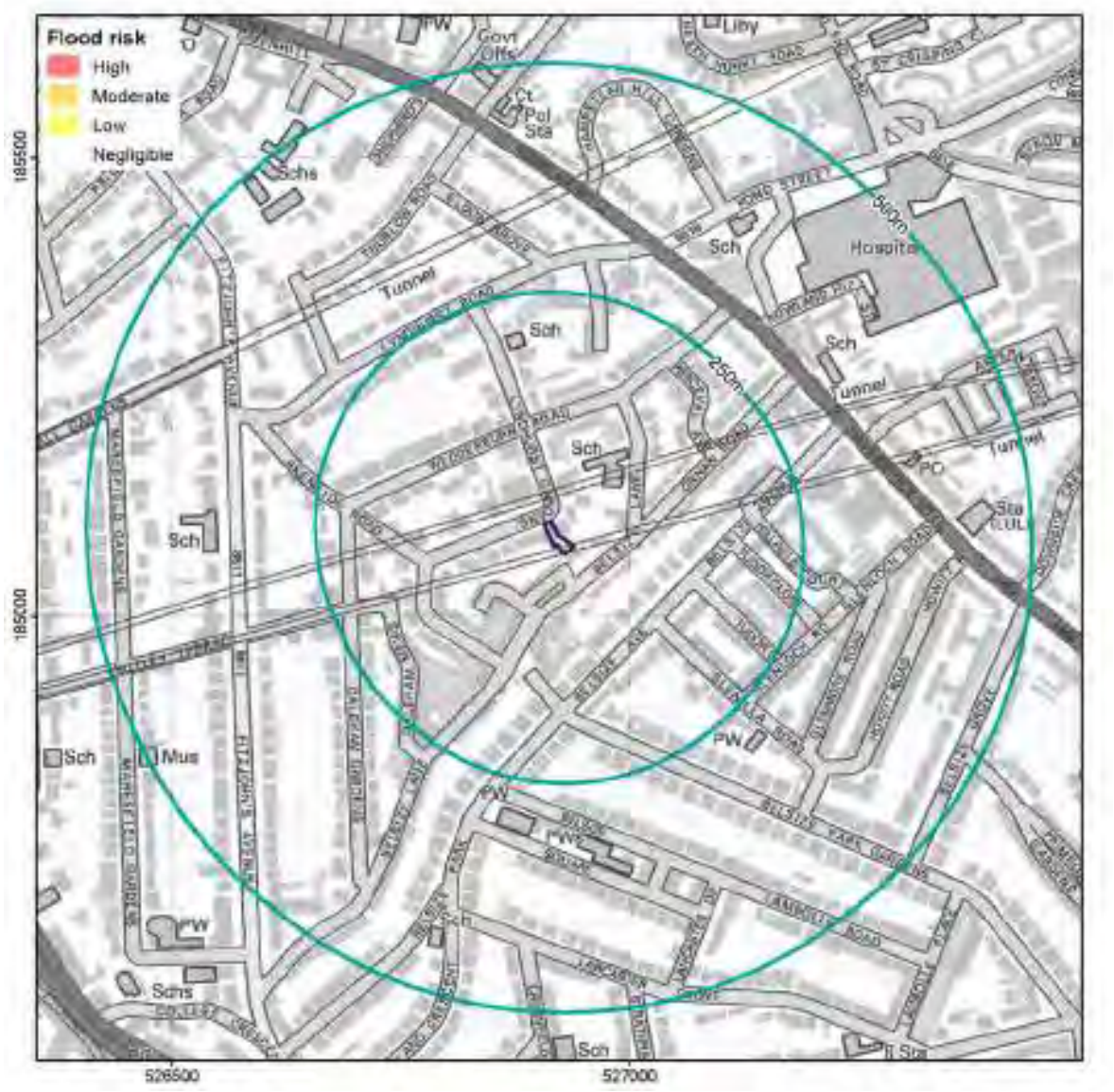
[1] Critical Drainage Areas (CDA) are specific areas in Flood Zone 1 only, where runoff can cause problems downstream, and is not necessarily an area where flooding problems may occur.

[2] A Local Flood Risk Zone (LFRZ) is defined as the actual spatial extent of predicted flooding in a single location

Groundwater flooding

Based on GeoSmart's Groundwater Flood Risk (GW5) Map (Figure 8) the Site is considered to be at Negligible risk of groundwater flooding at the surface. The risk map below confirms the risk of groundwater emergence at the surface during a 1% annual probability (1 in 100 year) event.

Figure 8 GeoSmart GW5 Groundwater Flood Risk Map (GeoSmart, 2019)



The risks may be higher for basements and below ground structures and mitigation measures such as sumps and pumps may be required. Figure 4e of the SFRA, however, does not indicate reported incidents of historical ground water flooding within 100 m of the Site (URS, 2014). The underlying geology (London Clay) is unlikely to hold significant volumes or water, although there is always the possibility of localised sand/silt lenses which could contain groundwater that may affect the development. It has been assumed that the basement construction will incorporate best practice with regards to basement design and tanking to waterproof the below ground structure.

Guidance

According to GeoSmart (2019) there is a Negligible risk of groundwater flooding in this area and any groundwater flooding incidence will be less frequent that 1 in 100 years return period.

Negligible Risk - There will be a remote possibility that incidence of groundwater flooding could lead to damage to property or harm to other sensitive receptors at, or near, this location.

Flooding from Artificial Sources

Sewer flooding

Records held by Thames Water indicate that there have been no incidences of flooding related to the surcharging of public sewers at the Site (Thames Water, 2019; Appendix D). Figure 5a of the SFRA has no records of internal sewer flooding incidences within NW3 5 postcode are. Figure 5b of the SFRA has 1 incident of exterior sewer flooding within NW3 5 postcode area, however, it is not clear where this flood event occurred (URS, 2014).

Guidance

Properties classified as "at risk" are those that have suffered, or are likely to suffer, internal flooding from public foul, combined or surface water sewers due to overloading of the sewerage system either once or twice in the ten year reference period. Records held by the sewage utility company provide information relating to reported incidents, the absence of any records does not mean that the Site is not at risk of flooding.

Canal Failure

According to Ordnance Survey (OS) mapping, there are no canals within 500 m of the Site.

Water supply infrastructure

Water supply infrastructure is comprised of a piped network to distribute water to private houses or industrial, commercial or institution establishments and other usage points.

However, in urban areas, this represents a particular risk of flooding due to the large amount of water supply infrastructure, its condition and the density of buildings. The risks of flooding to properties from burst water mains cannot be readily assessed.

If more information regarding the condition and history of the water supply infrastructure within the vicinity of the Site is required, then it is advisable to contact the local water supplier (Thames Water).

Culverts and bridges

Culverts and bridges have not been identified within 1 km of the Site.

Reservoir flooding

According to the EA's Risk of Flooding from Reservoir mapping the Site is not at risk of flooding from reservoirs (EA, 2019).

Guidance

The risk of reservoir flooding is related to the failure of a large reservoir (holding over 25,000 m^3 of water) and is based on the worst case scenario. Reservoir flooding is extremely unlikely to occur (EA, 2019).

5. Flood risk from the development

Floodplain storage

As the development is located within Flood Zone 1, there would be no losses in floodplain storage as a result of the development. Therefore, compensation for any loss in flood plain storage will not be required.

Drainage and run-off

It is understood a surface water drainage strategy report has been undertaken and included within the Basement Impact Assessment (BIA) produced by Symmetrys Ltd in June 2019.

6. Suitability of proposed development

The information below outlines the suitability of proposed development in relation to national and local planning policy.

National

The aims of the national planning policies are achieved through application of the Sequential Test and in some cases the Exception Test.

Guidance

Sequential test: The aim of this test is to steer new development towards areas with the lowest probability of flooding (NPPF, 2019). Reasonably available sites located in Flood Zone 1 should be considered before those in Flood Zone 2 and only when there are no reasonably available sites in Flood Zones 1 and 2 should development in Flood Zone 3 be considered.

Exception test: In some cases this may need to be applied once the sequential test has been considered. For the exception test to be passed it must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk and a site-specific FRA must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

Suitability of the proposed development, and whether an Exception Test is required, is based on the Flood Zone the Site is located within and the flood risk vulnerability classification of the development proposals. Some developments may contain different elements of vulnerability and the highest vulnerability category should be used, unless the development is considered in its component parts.

This report has been produced to assess all development types, prior to any development. The vulnerability classification and Flood Zones are compared within Table 4 overleaf (Table 3 of the NPPG, 2014).

As the Site is located within Flood Zone 1, all types of development listed within the Table overleaf are acceptable according to National Policy.

Table 4: Flood risk vulnerability and flood zone 'compatibility (taken from NPPG, 2014)

Flood risk vulnerability classification		Essential infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less vulnerable
Flood Zone	Zone 1 – low probability	✓	✓	✓	✓	✓
	Zone 2 – medium probability	✓	✓	Exception test required	✓	✓
	Zone 3a - high probability	Exception test required	✓	X	Exception test required	✓
	Zone 3b – functional flood plain	Exception test required	✓	X	X	X

Local guidance and policy

For this report, the following documents have been consulted for local policy and guidance and relevant information is outlined below:

London Borough of Camden Strategic Flood Risk Assessment (URS, 2014):

- There has been no flooding from fluvial sources within the whole borough.
- The majority of the borough is located within a Critical Drainage Area.
- Specific areas within a CDA are not necessarily at higher risk from surface water than an area outside of a CDA. However, the location of an area within a CDA indicates that it is within a catchment area which contributes to a flooding hotspot. Within CDAs, surface water management should be a particular focus of new developments.
- Historic 'lost rivers' within the borough, were culverted and incorporated into the local sewer network within the 19th century.
- Sustainable drainage systems (SuDS) should be included in new developments unless it is demonstrably not possible to manage surface water using these techniques.

London Borough of Camden Surface Water Management Plan (Halcrow, 2011):

- A Local Flood Risk Zone (LFRZ) is a discrete area of flooding that does not exceed the national criteria for a Flood Risk Area but affects houses, businesses and/or local infrastructure. The boundary is defined as the actual spatial extent of predicted flooding in a single location. Although the Site is located within a CDA, it is not located within a LFRZ.

London Borough of Camden Flood Risk Management Strategy (LBC, 2013):

- The 1975 flood event was caused by a severe storm and caused extensive flooding across the borough, the drainage capacity of the drainpipes, road gillies and sewers were unable to cope with the volume of surface water runoff involved.
- Camden Planning Guidance 4 (CPG4) explains the Council's policies on basements and lightwells. It states that the Council will only permit basement and underground development that does not:
    - Cause harm to the built and natural environment and local amenity;
    - Result in flooding; or
    - Lead to ground instability.

It is understood that a separate Basement Impact Assessment report (as required by Camden Council) has been undertaken, any specific recommendations presented in that report should be incorporated into the design to prevent flooding both on and off-Site.

Guidance

Strategic Flood Risk Assessments are carried out by local authorities, in consultation with the Environment Agency, to assess the flood risk to the area from all sources both now and in the future due to climate change. They are used to inform planning decisions to ensure inappropriate development is avoided (NPPF, 2019).

7. Resilience and mitigation

Based on the available information mitigation measures outlined within this section of the report are likely to help protect the development from flooding.

Rivers (fluvial) / Sea (coastal/tidal) flood mitigation measures

As the Site is located within Flood Zone 1, flooding is unlikely to affect the Site from fluvial and/or tidal sources, therefore mitigation measures are not considered to be required.

Surface water (pluvial) flood mitigation measures

The Site has been identified as being at risk of pluvial flooding during the 1 in 100 and 1 in 1000 year events. Although there is the potential for the risk to be lower as the EA surface water (pluvial) data does not take into consideration the presence of the existing drainage network, the following mitigation measures are still recommended to reduce the flood risk to the dwelling:

- Regular maintenance of any drains surrounding/on the Site should be undertaken to reduce the flood risk;
- Consider the use of flood doors and barriers to entrances on the ground and lower ground floor levels; and
- A sump and pump system could be fitted within the lowest area of the basement.

Groundwater flood mitigation measures

As the Site is not identified as being at risk of groundwater flooding at the surface, mitigation measures are not required. However, the basement level may be at higher risk, although the underlying geology, London Clay, does not usually contain significant quantities of groundwater, but localised pockets may be present. Recommendations presented in the separate Basement Impact Assessment should be implemented to mitigate the flood risk both on and off-Site.

Reservoir flood mitigation measures

The Site is not a risk of flooding from reservoirs; therefore, mitigation measures are not required.

Other flood risk mitigation measures

As the Site is not identified as being at risk from other sources, mitigation measures are not required.

8. Conclusions and recommendations

A VERY LOW fluvial / tidal flood risk has been identified.

A VERY LOW TO MEDIUM surface water (pluvial) flood risk has been identified.

A NEGLIGIBLE groundwater flood risk, at the surface, has been identified.

The Site is not located in an area classified as being at risk of flooding from reservoir failure.

As the Site is located within Flood Zone 1, all types of development listed within the Table 3 of the NPPG (2014) are acceptable according to National Policy.

Providing the recommended mitigation measures are put in place it is likely that flood risk to this Site will be reduced to an acceptable level.

The table below provides a summary of where the responses to key questions are discussed in this report.

Key sources of flood risks identified	Surface Water (pluvial) (see Section 3).
Are standard mitigation measures likely to provide protection from flooding to/from the Site?	Yes (see Section 7).
Is the development likely to satisfy the requirements of the Sequential Test?	N/A (see Section 6).
Is any further work recommended?	
Recommendations for mitigation are provided below, based upon the proposed development and the flood risk to the Site: The Site has been identified as being at risk of pluvial flooding during the 1 in 100 and 1 in 1000 year events. Although there is the potential for the risk to be lower as the EA surface water (pluvial) data does not take into consideration the presence of the existing drainage network, the following mitigation measures are still recommended to reduce the flood risk to the dwelling: • Regular maintenance of any drains surrounding/on the Site should be undertaken to reduce the flood risk; • Consider the use of flood doors and barriers to entrances on the ground and lower ground floor levels; and • A sump and pump system could be fitted within the lowest area of the basement. It is also recommended that the basement is designed and constructed following current best practice and guidance to prevent water ingress. Recommendations presented in the separate Basement Impact Assessment should also be implemented.	

GeoSmart recommend that mitigation measures that have been discussed within this report are considered as part of the proposed development where possible and evidence of this is provided to the Local Authority as part of the planning application.

9. Further information

The following table includes a list of additional products by GeoSmart:

Additional GeoSmart Products		
✓	Additional assessment: SuDSmart Report	The SuDSmart Report range assesses which drainage options are available for a Site. They build on technical detail starting from simple infiltration screening, and work up to more complex SuDS Assessments detailing alternative options and designs. Please contact info@geosmartinfo.co.uk for further information.
✓	Additional assessment: EnviroSmart Report	Provides a robust desk-based assessment of potential contaminated land issues, taking into account the regulatory perspective. Our EnviroSmart reports are designed to be the most cost effective solution for planning conditions. Each report is individually prepared by a highly experienced consultant conversant with Local Authority requirements. Ideal for pre-planning or for addressing planning conditions for small developments. Can also be used for land transactions. Please contact info@geosmartinfo.co.uk for further information.

10. References and glossary

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Environment Agency [EA] (2019b). Long term flood risk assessment for locations in England. Accessed from https://flood-warning-information.service.gov.uk/long-term-flood-risk on 19/09/19.

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URS (2014). London Borough of Camden Strategic Flood Risk Assessment (SFRA). Accessed from: https://www.camden.gov.uk/flooding?inheritRedirect=true#wxbh on 18/09/19.

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National Planning Practice Guidance (2014). Planning Practice Guidance. Flood Risk and Coastal Change. Accessed from http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/ on 19/09/19.

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Survey Open Data (2019). Accessed from: http://www.geostore.com/environment-agency/survey.html#/survey/tandc on 19/09/19.

Thames Water (2019). Thames Water Property Searches – Sewer Flooding History Enquiry. SFH/SFH Standard/2019_4078255.

UK Flood Maps (Ambiental FTP) (2019). UKFloodMap4 Data

Glossary

General terms

BGS	British Geological Survey
EA	Environment Agency
GeoSmart groundwater flood risk model	GeoSmart's national groundwater flood risk model takes advantage of all the available data and provides a preliminary indication of groundwater flood risk on a 5m grid covering England, Wales and Scotland. The model indicates the risk of the water table coming within 1 m of the ground surface for an indicative 1 in 100 year return period scenario.
Dry-Island	An area considered at low risk of flooding (e.g. In a Flood Zone 1) that is entirely surrounded by areas at higher risk of flooding (e.g. Flood Zone 2 and 3)
Flood resilience	Flood resilience or wet-proofing accepts that water will enter the building, but through careful design will minimise damage and allow the re-occupancy of the building quickly. Mitigation measures that reduce the damage to a property caused by flooding can include water entry strategies, raising electrical sockets off the floor, hard flooring.
Flood resistance	Flood resistance, or dry-proofing, stops water entering a building. Mitigation measures that prevent or reduce the likelihood of water entering a property can include raising flood levels or installation of sandbags.
Flood Zone 1	This zone has less than a 0.1% annual probability of river flooding
Flood Zone 2	This zone has between 0.1 and 1% annual probability of river flooding and between 0.1% and 0.5 % annual probability sea flooding
Flood Zone 3	This zone has more than a 1% annual probability of river flooding and 0.5% annual probability of sea flooding
Functional Flood Plain	An area of land where water has to flow or be stored in times of flood.
Hydrologic model	A computer model that simulates surface run-off or fluvial flow. The typical accuracy of hydrologic models such as this is ±0.25m for estimating flood levels at particular locations.
OS	Ordnance Survey
Residual Flood Risk	The flood risk remaining after taking mitigating actions.
SFRA	Strategic Flood Risk Assessment. This is a brief flood risk assessment provided by the local council
SuDS	A Sustainable drainage system (SuDS) is designed to replicate, as closely as possible, the natural drainage from the Site (before development) to ensure that the flood risk downstream of the Site does not increase as a result of the land being developed. SuDS also significantly improve the quality of water leaving the Site and can also improve the amenity and biodiversity that a site has to offer. There are a range of SuDS options available to provide effective surface water management that intercept and store excess run-off. Sites over 1 Ha will usually require a sustainable drainage assessment if planning permission is required. The current proposal is that from April 2014 for more than a single dwelling the drainage system will require approval from the SuDs Approval Board (SABs).

Aquifer Types

Principal aquifer	These are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale.
Secondary A aquifer	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.
Secondary B aquifer	Predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering.
Secondary undifferentiated	Has been assigned in cases where it has not been possible to attribute either category A or B to a rock type due to the variable characteristics of the rock type.
Unproductive Strata	These are rock layers or drift deposits with low permeability that has negligible significance for water supply or river base flow.

NPPF (2019) terms

Exception test	Applied once the sequential test has been passed. For the exception test to be passed it must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk and a site-specific FRA must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.
Sequential test	Aims to steer new development to areas with the lowest probability of flooding.
Essential infrastructure	Essential infrastructure includes essential transport infrastructure, essential utility infrastructure and wind turbines.
Water compatible	Water compatible land uses include flood control infrastructure, water-based recreation and lifeguard/coastal stations.
Less vulnerable	Less vulnerable land uses include police/ambulance/fire stations which are not required to be operational during flooding and buildings used for shops/financial/professional/other services.
More vulnerable	More vulnerable land uses include hospitals, residential institutions, buildings used for dwelling houses/student halls/drinking establishments/hotels and sites used for holiday or short-let caravans and camping.
Highly vulnerable	Highly vulnerable land uses include police/ambulance/fire stations which are required to be operational during flooding, basement dwellings and caravans/mobile homes/park homes intended for permanent residential use.

Appendices

Appendix A

Site plans

QD A1 STANDARD

LEGEND

- APPROXIMATE SITE BOUNDARY
- BOUNDARY OF THE SINGLE CURTILAGE
- DENOTES 100ø PVC–U FOUL WATER DRAINAGE RUNS LAID AT MIN. 1:40 FALLS, UNLESS NOTED OTHERWISE, (WITH JOINTS TO MANUFACTURER'S DETAILS)
- DENOTES 100ø PVC–U SURFACE WATER DRAINAGE RUNS LAID AT MIN. 1:60 FALLS, UNLESS NOTED OTHERWISE (WITH JOINTS TO MANUFACTURER'S DETAILS)
- DENOTES 100ø COMBINED SEWER LAID AT MIN. 1:40 FALLS, UNLESS NOTED OTHERWISE (WITH JOINTS TO MANUFACTURER'S DETAILS).
- EXISTING PIPEWORK TO REMAIN. DETAILS TO BE CONFIRMED VIA CCTV SURVEY.
- DENOTES EXISTING PIPE WORK TO BE GRUBBED UP AND REMOVED.
- DENOTES RISING MAIN FROM SW/CAVITY DRAIN SUMP PUMP (DETAILS AS PER MANUFACTURERS SPECIFICATION)
- DENOTES RISING MAIN FROM FW DRAIN SUMP PUMP (DETAILS AS PER MANUFACTURERS SPECIFICATION)
- EXISTING INSPECTION CHAMBER TO BE REMOVED.
- EXISTING INSPECTION CHAMBER TO REMAIN.
- NEW INSPECTION CHAMBER ON EXISTING COMBINED PUBLIC SEWER MAIN. NEW CHAMBERS TO BE FORMED OF PRECAST CONCRETE 600MM X 450MM AND HAVE A TRAFFICABLE COVER TO MIN LOAD CLASS B125.

- RWP – RAINWATER DOWN PIPE (INDICATIVE) – RWP'S TO HAVE TRAPPED OR SEALED OUTLETS WITH RODDING ACCESS EITHER VIA SHOE AND GULLY OR ACCESS PIPE.
- GY – YARD GULLY.
- SS – STUB STACK. TO PROVIDE RODDING ACCESS.
- PROPOSED CHANNEL DRAIN. ACO OR SIMILAR ENGINEER APPROVED PRODUCT. DETAILS BY SPECIALIST MANUFACTURER.

CONTRACTOR/SPECIALIST DESIGN ELEMENTS

1. ALL TEMPORARY WORKS
2. STABILITY OF THE STRUCTURE DURING THE WORKS
3. ALL SUMP PUMP DETAILS/WORKS
4. ALL CHANNEL DRAIN DETAILS
5. ALL TANKING DETAILS

ARCHITECT TO SPECIFY

1. CAVITY DRAINAGE
2. FINAL RWP LOCATIONS
3. IF THRESHOLDS ARE TO BE FLUSH
4. THE TERMINATION POSITION OF ALL VENT PIPES (SVP'S), SS AND AAV.
5. COVER LEVELS ARE INDICATIVE ONLY AND ARE TO BE CONFIRMED BY AND ARCHITECT.
6. PROPOSED GROUND LEVELS AND FFL'S

CONTACT ENGINEER IF ANY OF THE ABOVE DIFFER FROM PLAN BELOW.

PLEASE NOTE:

EXISTING DRAINAGE HAS BEEN APPRI
OF ALL EXISTING DRAINAGE IS REQU

A SEWER DIVERSION APPLICATION M
CONNECT THROUGH THE SITE AS SH

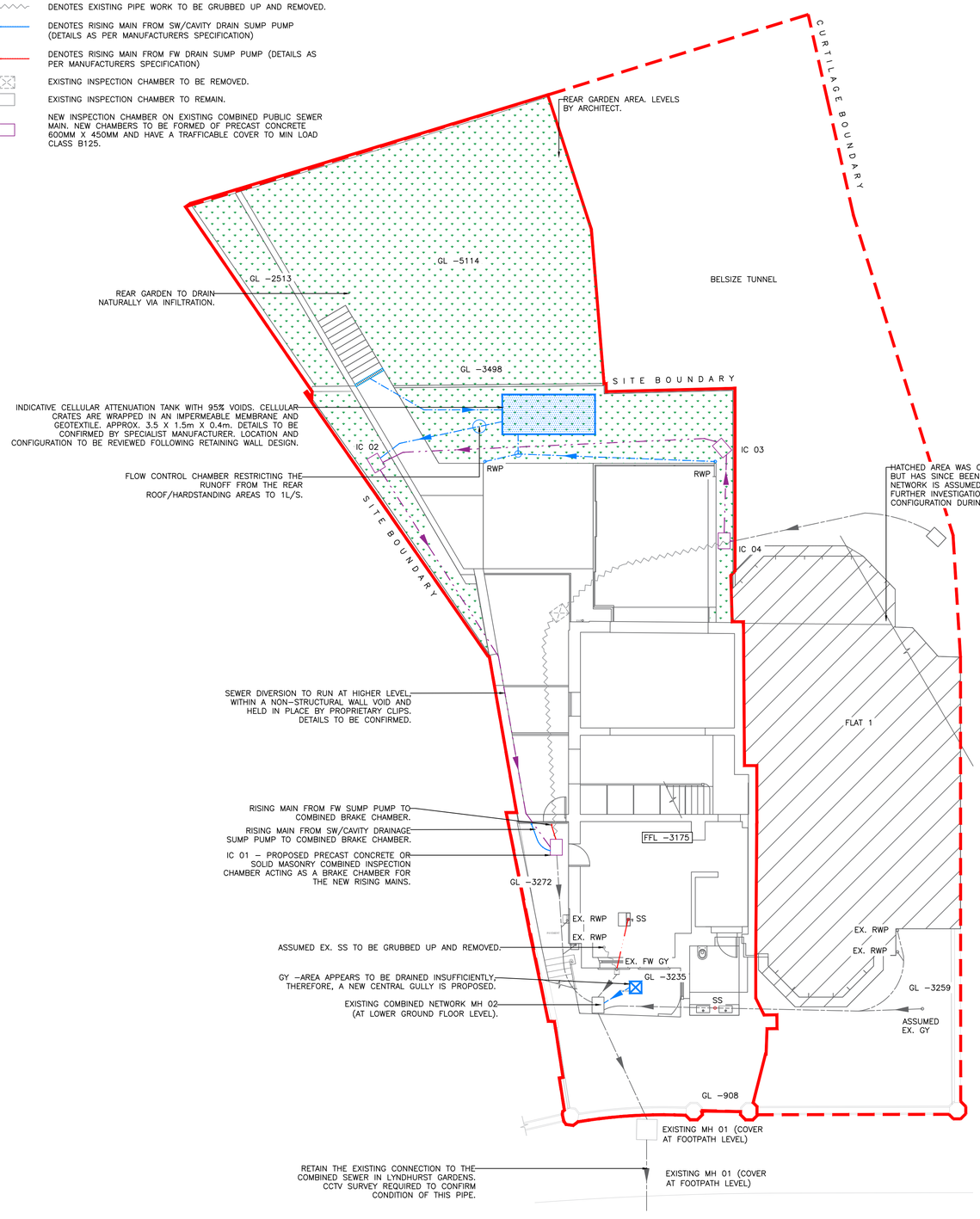
REFER TO THAMES WATER ASSET LO

RETAINING WALLS TO BE DRAINED VI
DRAINING PEA SHINGLE SET BELOW

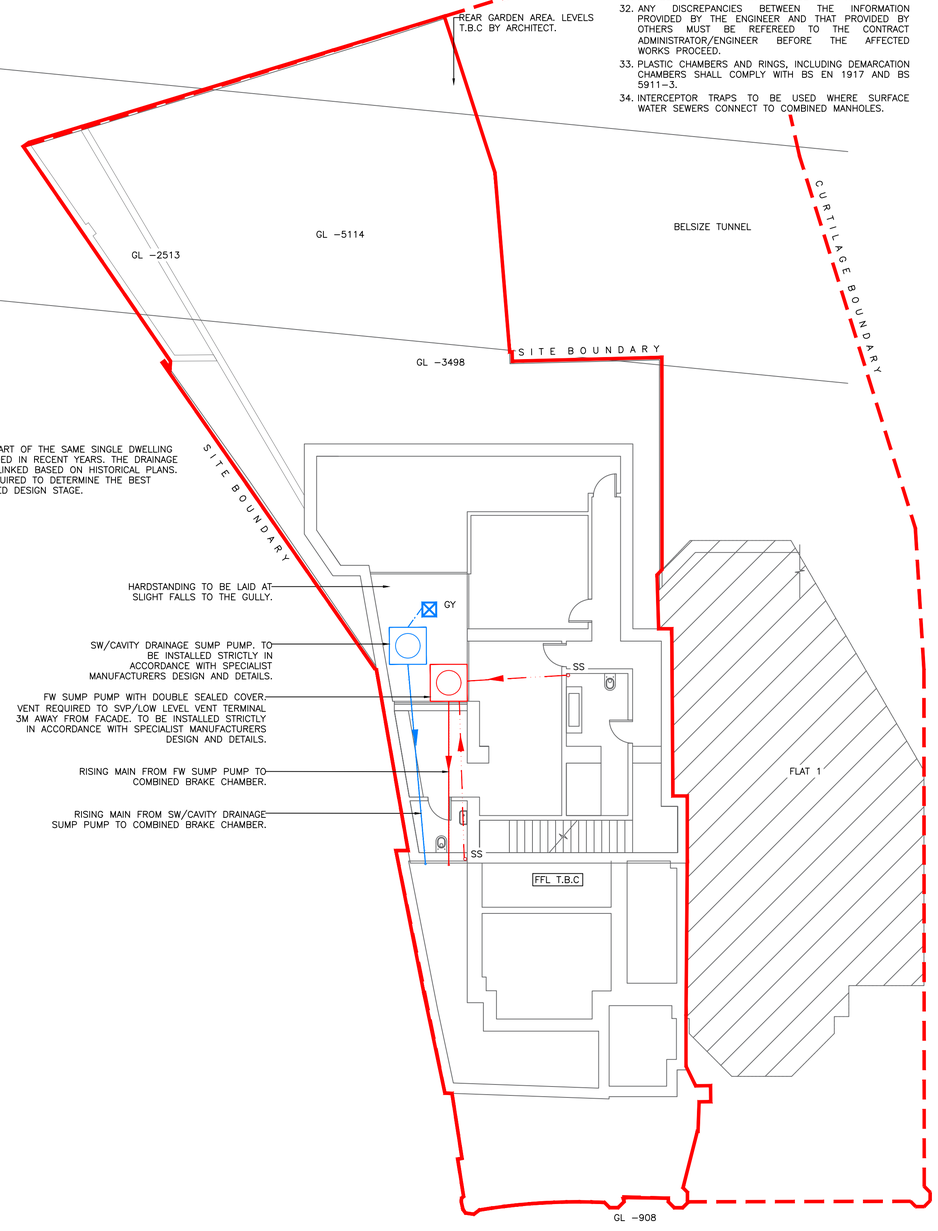
THE GROUND LEVELS ARE TO BE C

ADDITIONAL NOTES:

24. PIPES WITH LESS THAN 0.6M COVER (IN FIELDS) AND 0.9M COVER (IN LIGHT ROADS) REQUIRE PROTECTION IN ACCORDANCE WITH BUILDING REGULATIONS DOCUMENT H.
25. ALL DISUSED, ABANDONED OR REDUNDANT DRAINAGE TO BE REMOVED/SEALED AS STATED IN PART H OF THE BUILDING REGULATIONS 2002 EDITION, APPENDIX H1–8.
26. NON–RETURN VALVES TO BE FITTED TO MANHOLES WHERE SEWER SURCHARGE IS CONSIDERED A RISK TO BUILDING FLOODING.
27. SVPS, STUB STACKS & RWP'S ARE SHOWN INDICATIVE ONLY. REFER TO ARCHITECTURAL DIMENSIONED GA'S FOR ACCURATE LOCATIONS.
28. ALL DRAINAGE WORKS SHOULD COMMENCE AT THE PROPOSED DOWNSTREAM CONNECTION POINT, THE WORKS CONTINUING UPSTREAM FOLLOWING CONFIRMATION OF THE TIE–IN INVERT LEVELS TO THE ENGINEER.
29. CONNECTIONS TO MANHOLES OR LARGER SIZED PIPES TO BE SOFFIT TO SOFFIT UNLESS OTHERWISE INSTRUCTED BY THE ENGINEER. IF THIS IS NOT POSSIBLE, INFORM THE ENGINEER IMMEDIATELY.
30. ALL CEMENT USED FOR CONCRETE DRAINAGE INSTALLATIONS SHALL BE SULPHATE RESISTANT TO CLASS 3 OF BRE DIGEST 363. (GRADE ST5)
31. ALL BENDS IN PIPEWORK SHALL BE LONG RADIUS.
32. ANY DISCREPANCIES BETWEEN THE INFORMATION PROVIDED BY THE ENGINEER AND THAT PROVIDED BY OTHERS MUST BE REFEREED TO THE CONTRACT ADMINISTRATOR/ENGINEER BEFORE THE AFFECTED WORKS PROCEED.
33. PLASTIC CHAMBERS AND RINGS, INCLUDING DEMARCATION CHAMBERS SHALL COMPLY WITH BS EN 1917 AND BS 5911–3.
34. INTERCEPTOR TRAPS TO BE USED WHERE SURFACE WATER SEWERS CONNECT TO COMBINED MANHOLES.



PROPOSED LOWER GROUND FLOOR PLAN
1:100



PROPOSED BASEMENT PLAN
1:100

Notes

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS & ENGINEERS DRAWINGS AND SPECIFICATIONS
2. DO NOT SCALE FROM THIS DRAWING
3. PRELIMINARY AND TENDER DRAWINGS SHALL NOT BE USED FOR CONSTRUCTION OR THE ORDERING OF MATERIALS.
4. ALL DRAINAGE DESIGN AND INSTALLATION TO BE CARRIED OUT IN ACCORDANCE WITH THE FOLLOWING:
   - BS EN 752: DRAIN AND SEWER SYSTEMS OUTSIDE BUILDINGS.
   - BS EN 12056: GRAVITY DRAINAGE SYSTEMS INSIDE BUILDINGS.
   - BUILDING REGULATIONS – PART H
   - SEWERS FOR ADOPTION – 7TH EDITION
   - BS 8000 PT.14 – WORKMANSHIP OF BUILDING SITES
   - LOCAL AUTHORITY REQUIREMENTS
5. REFER TO ARCHITECTS DRAWINGS FOR ALL SETTING OUT DETAILS.
6. ADEQUATELY PROTECT EXISTING DRAINS AND MAINTAIN NORMAL OPERATION DURING CONSTRUCTION.
7. BEFORE COMMENCING ANY SEWER OR DRAINAGE WORKS, THE CONTRACTOR'S GROUND WORKER MUST SATISFY THEMSELVES OF ACTUAL LEVELS AND CONDITIONS OF EXISTING SEWERS. ANY STRUCTURAL DEFECTS SHALL BE REPAIRED USING APPROPRIATE AND APPROVED MEANS.
9. ALL RAINWATER PIPE OUTFALLS SHALL BE 100ø, ALL SOIL VENT PIPES / FOUL CONNECTION OUTFALLS LEAVING BUILDINGS SHALL BE 100ø UNLESS OTHERWISE STATED.
10. WHERE PIPELINES MUST BE CAST IN OR FIXED TO STRUCTURES, INCLUDING MANHOLES AND INSPECTION CHAMBERS, PROVIDE SHORT LENGTH OR ROCKER PIPES NEAR EACH EXTERNAL FACE, WITH FLEXIBLE JOINTS AT EACH END. FOR PIPE SIZE 110MM THE DISTANCE TO THE FIRST JOINT SHALL BE 150MM.
11. WHERE PIPELINES NEED NOT BE CAST IN OR FIXED TO THE STRUCTURE (EG. WALLS TO FOOTINGS) PROVIDE EITHER SHORT LENGTH OR ROCKER PIPES AS SPECIFIED ABOVE, OR OPENINGS IN THE STRUCTURE TO GIVE 50MM MINIMUM CLEARANCE AROUND THE PIPELINE AND CLOSELY FIT A RIGID SHEET TO EACH SIDE OF OPENING TO PREVENT THE INGRESS OF FILL OR VERMIN.
12. PIPES, BENDS AND JUNCTIONS TO BE PVC–U TO BS 4660 OR BS 5481, 110MM DIAMETER WITH FLEXIBLE JOINTS AND KITE–MARK CERTIFIED.
14. EXCAVATE TO FORMATION IMMEDIATELY BEFORE LAYING BEDS OR PIPES. REMOVE MUD, ROCK PROJECTIONS, BOULDERS AND HARD SPOTS AND REPLACE WITH CONSOLIDATED BEDDING MATERIAL.
15. UNLESS SPECIFIED OTHERWISE, BACKFILL FROM TOP OF SPECIFIED SURROUND OF PROTECTIVE CUSHION WITH MATERIAL EXCAVATED FROM THE TRENCH, COMPACTED IN LAYERS NOT EXCEEDING 300MM THICK. DO NOT USE HEAVY COMPACTORS BEFORE THERE IS 600MM OF MATERIAL OVER PIPES.
16. ADEQUATELY PROTECT PIPELINES FROM DAMAGE AND INGRESS OF DEBRIS. SEAL ALL EXPOSED ENDS DURING CONSTRUCTION WITH PROPRIETARY TEMPORARY STOP ENDS. ARRANGE THE WORK TO MINIMISE TIME BETWEEN LAYING AND TESTING. BACKFILL AFTER SUCCESSFUL TESTING.
17. OBTAIN EACH COMPLETE ASSEMBLY OF FITTINGS, TRAPS, ETC. INCLUDING APPROPRIATE COUPLINGS, FROM THE SAME MANUFACTURER, AND CHECK COMPATIBILITY OF COMPONENTS WITH EACH OTHER AND WITH THE PIPE SYSTEM.
18. ACCESS PANELS ARE TO BE PROVIDED TO ALL RAINWATER PIPES A MAXIMUM OF 600MM ABOVE FINISHED GROUND LEVEL.
19. ALL ROAD AND YARD GULLIES ARE TO BE 'TRAPPED' AND FITTED WITH A SILT BUCKET.
20. ALL DRAINAGE TO BE CAST IN CONCRETE WHEN PASSING UNDER FOUNDATIONS.
21. PIPE CONNECTIONS NOT TO INSPECTION CHAMBERS SHALL BE VIA PREFORMED OBLIQUE JUNCTION SWEPT IN THE DIRECTION OF FLOW.
22. ALL RWP AND CHANNEL DRAIN OUTLETS ARE TO BE TRAPPED.
23. MANHOLE COVERS SHALL BE SET TO THE SAME LEVEL AS THE ADJACENT GROUND.

Rev	Date	Chkd	Amendments
P1	24.05.19	MB	PRELIMINARY ISSUE

Drawing Status: PRELIMINARY

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Job Title: 12 LYNDHURST GARDENS LONDON, NW3 5NR

Drawing Title: BELOW GROUND DRAINAGE PLAN

Job No.	Drawing No.	Revision
19050	3000	P1

Scales: 1:100 AT A1 — Original Size A1

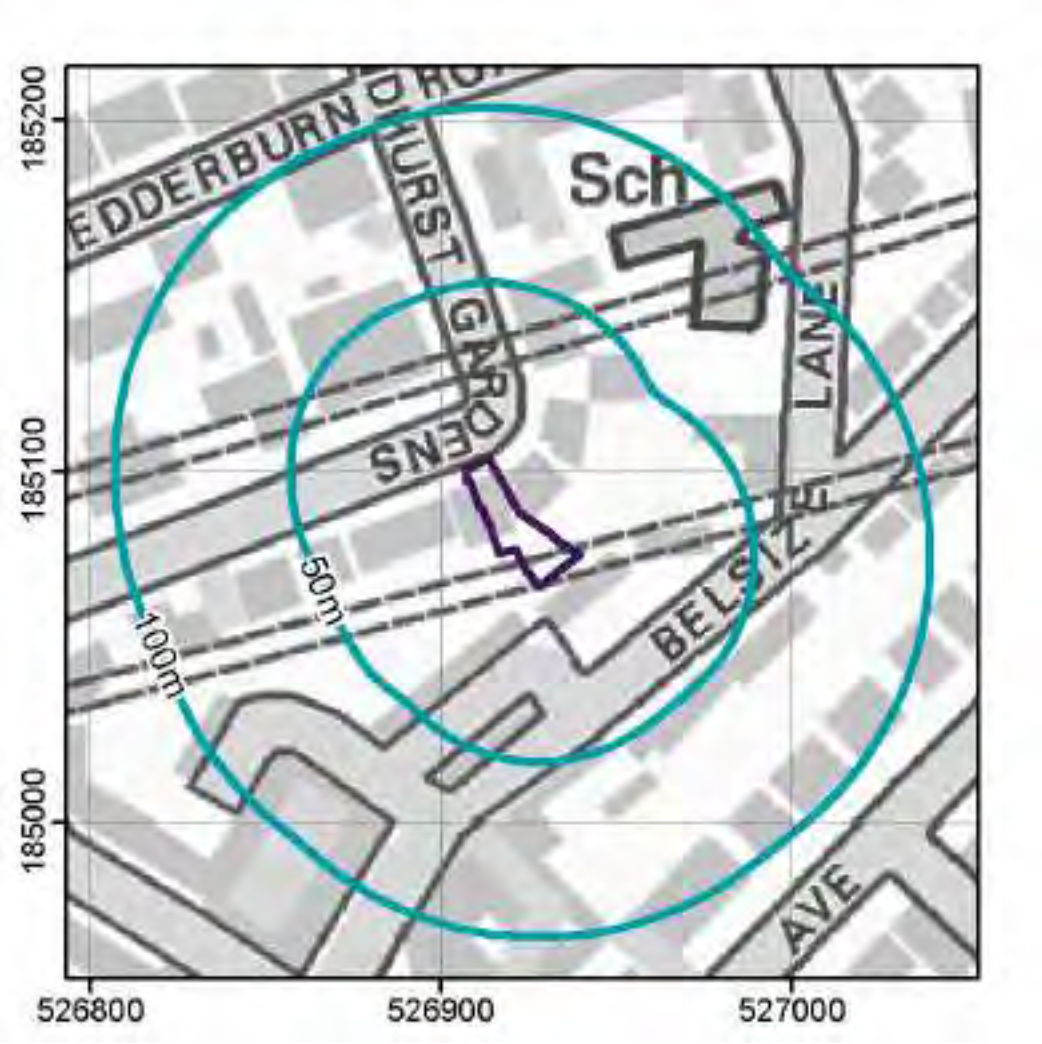
Drawn By: MW — Date: MAY 2019

Company No. 5873122
VAT Registration No. 894 2993 61
Registered In England And Wales

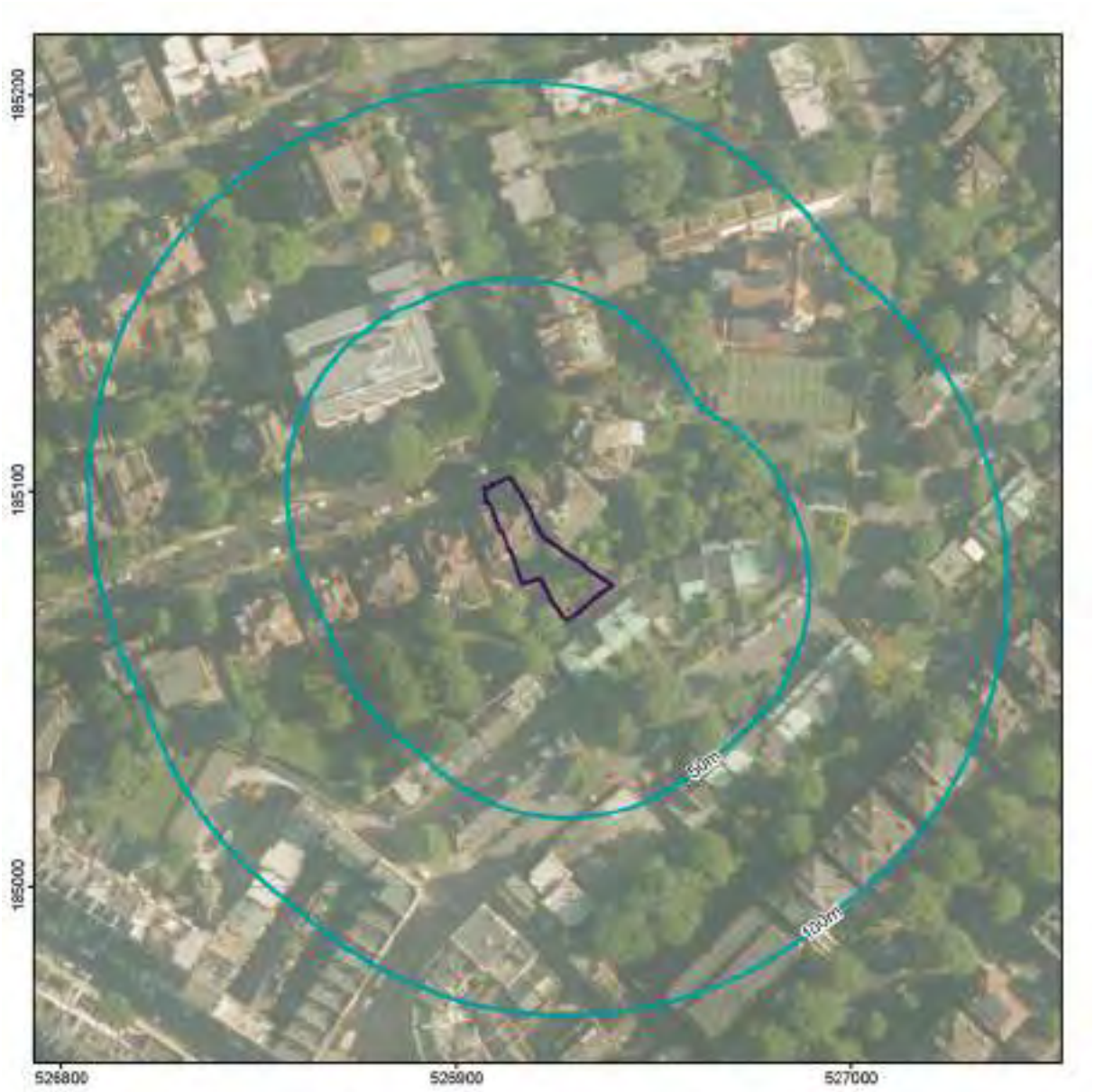
Appendix B

Commercial flood mapping

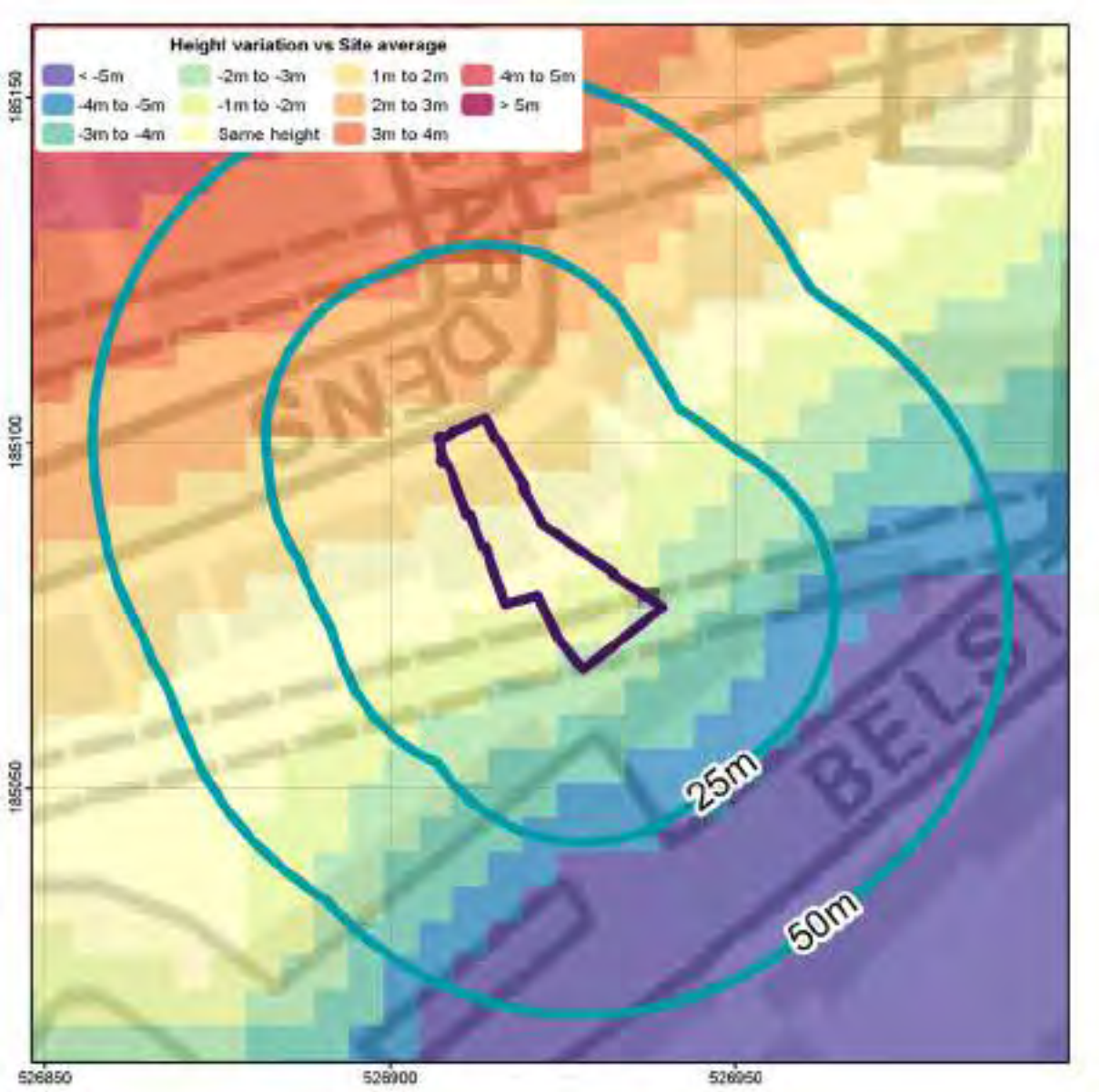
Site Location Plan (OS, 2019)



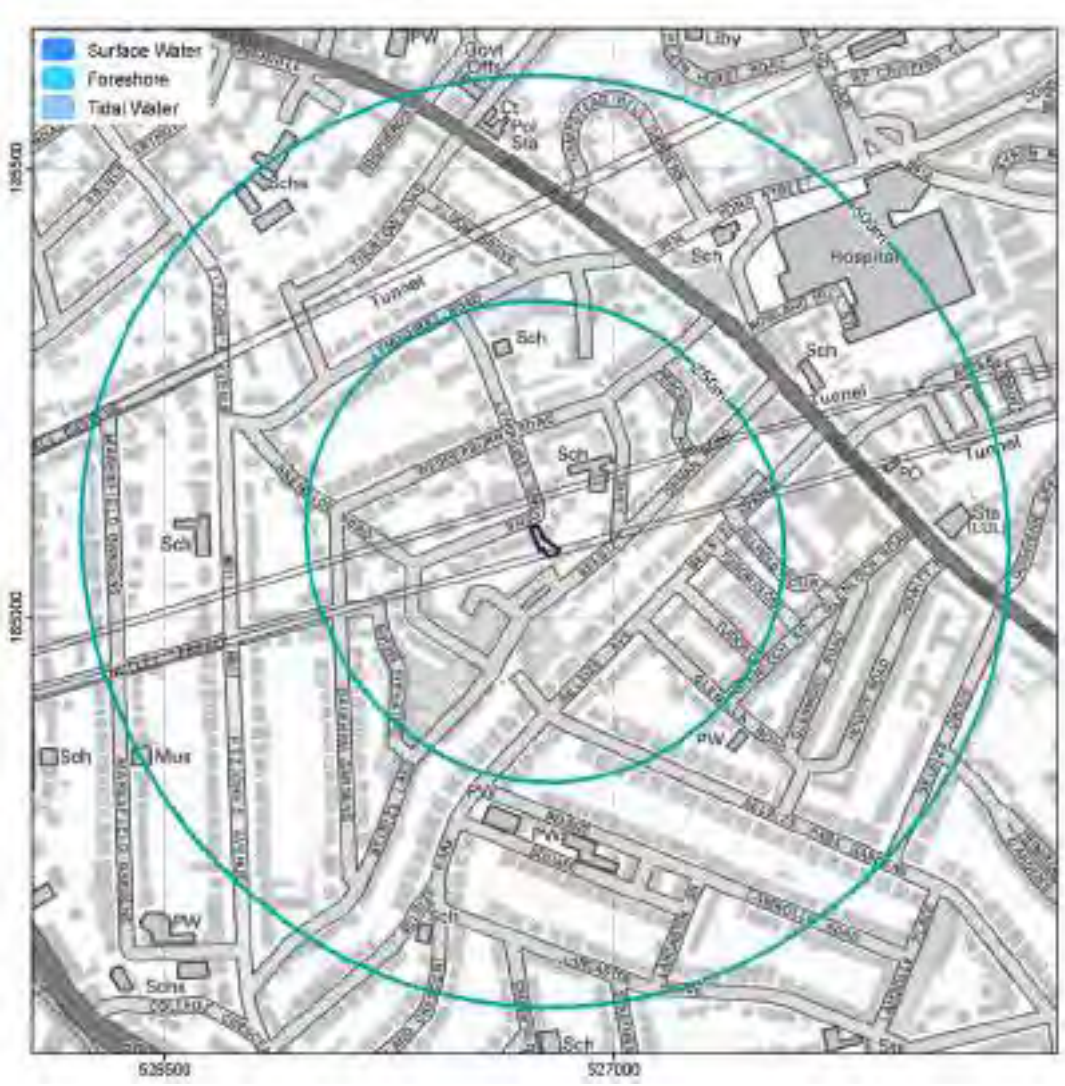
Aerial Photograph (BlueSky, 2019)



GeoSmart DTM5 (5m) map (EA, 2019)

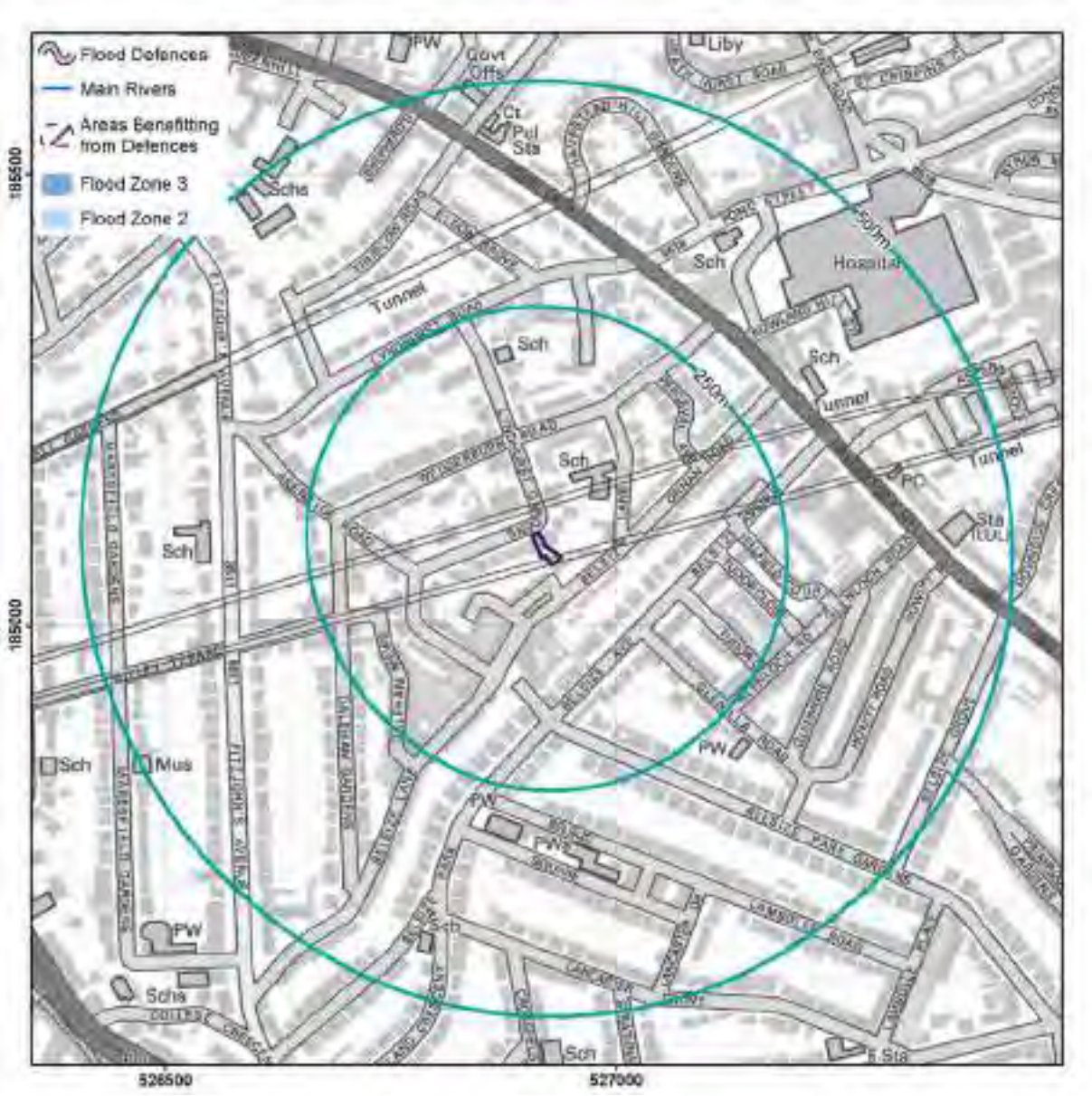


Ordnance Survey Surface Water Feature Vector Map (OS, 2019)

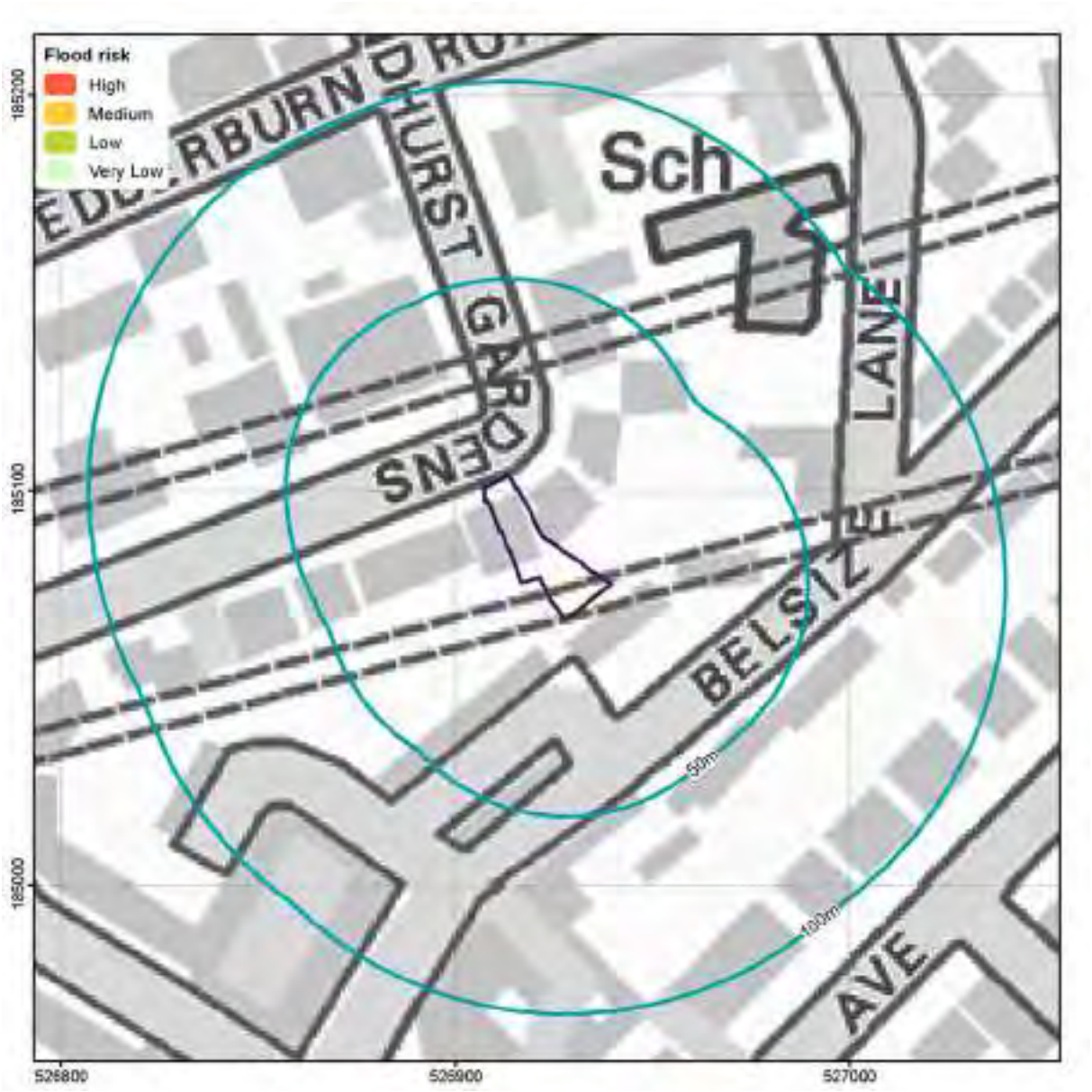


Environment Agency Historic Flood Map (EA, 2019)

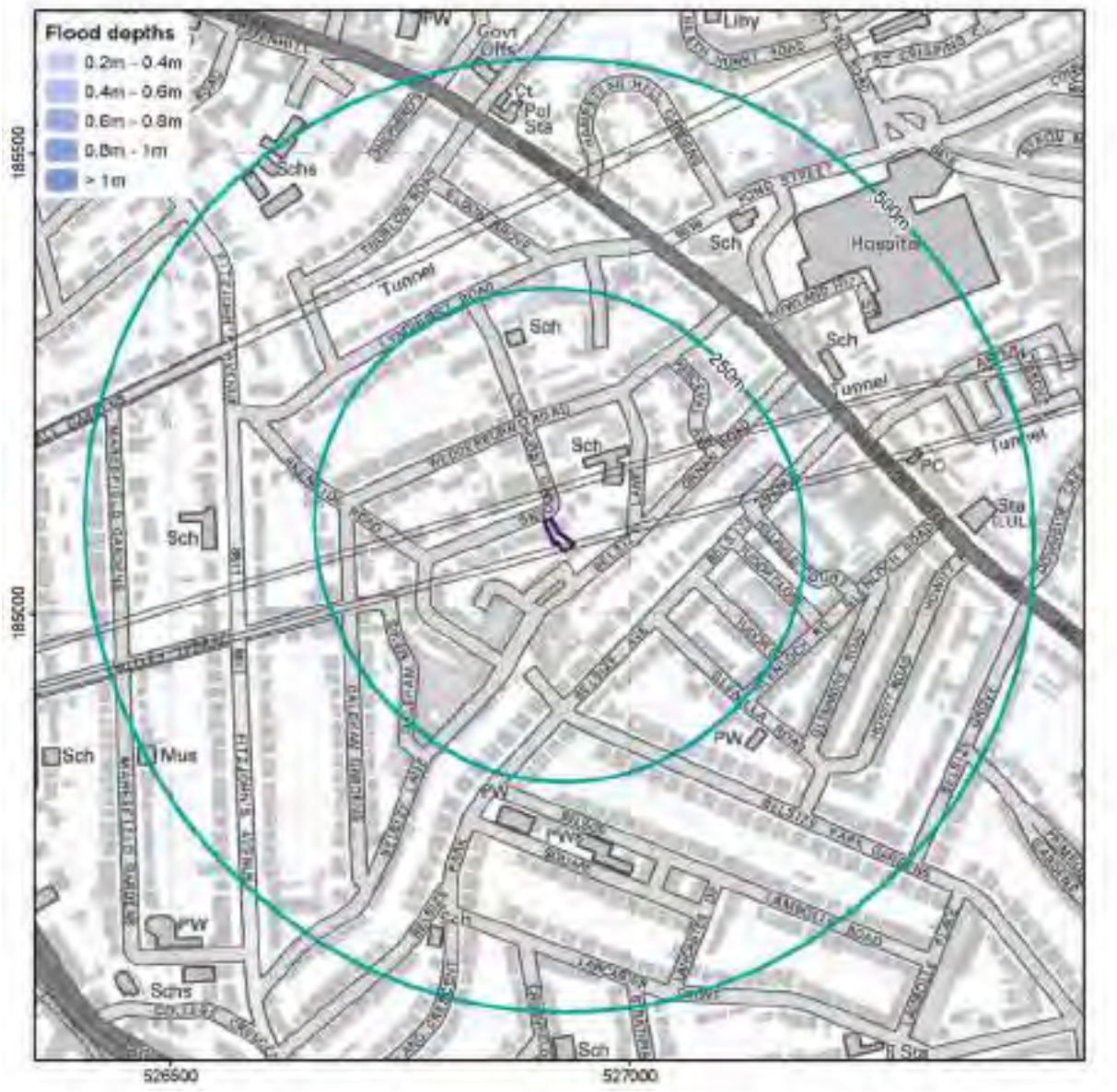
Environment Agency's Flood Map for Planning Purposes (EA, 2019)



Environment Agency's Risk of Flooding from Rivers and Sea Map (RoFRS) (EA, 2019)



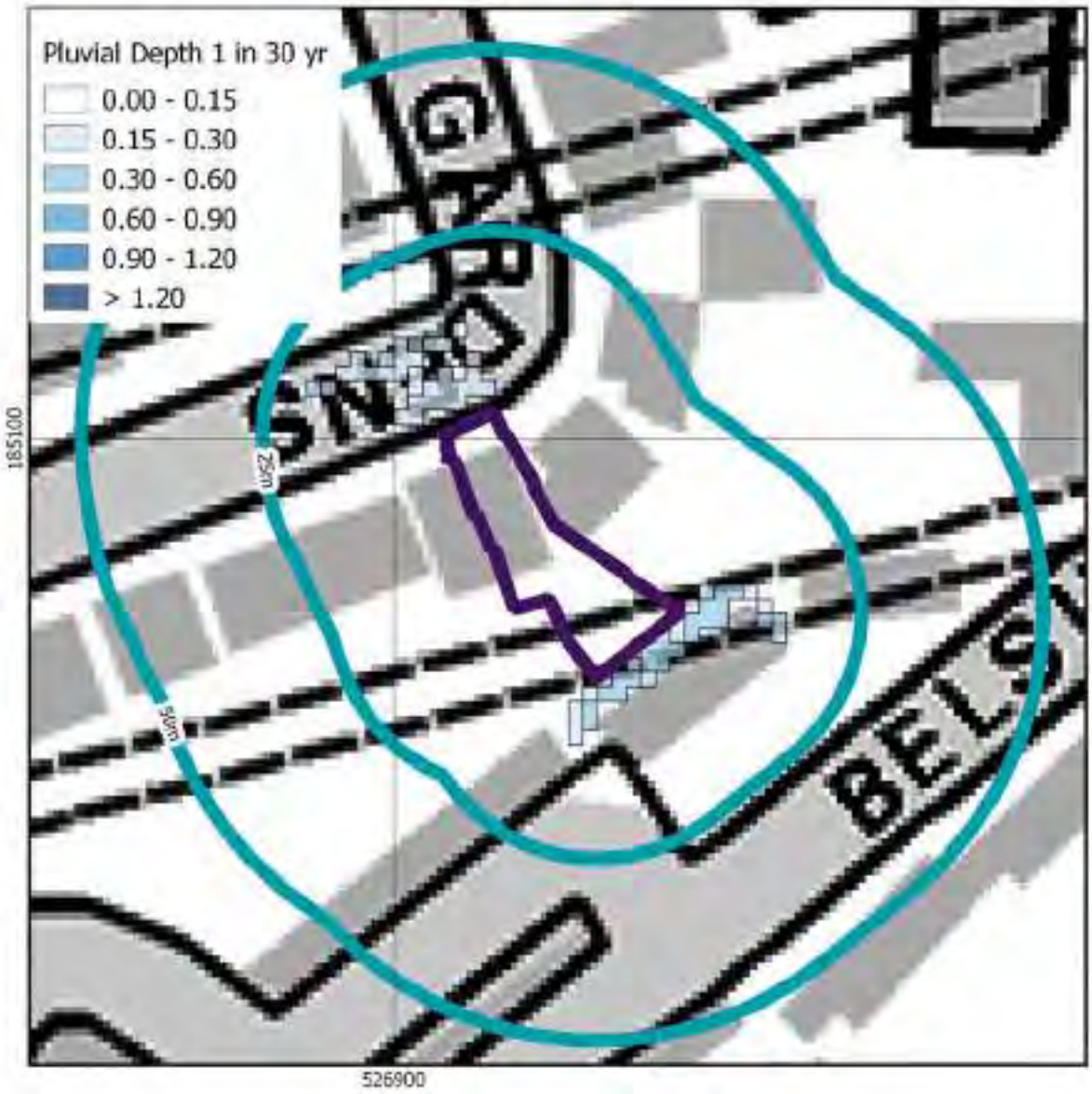
UKFloodMap4TM 1 in 100 year Fluvial/Tidal Flood Depth Map (Ambiental, 2019)



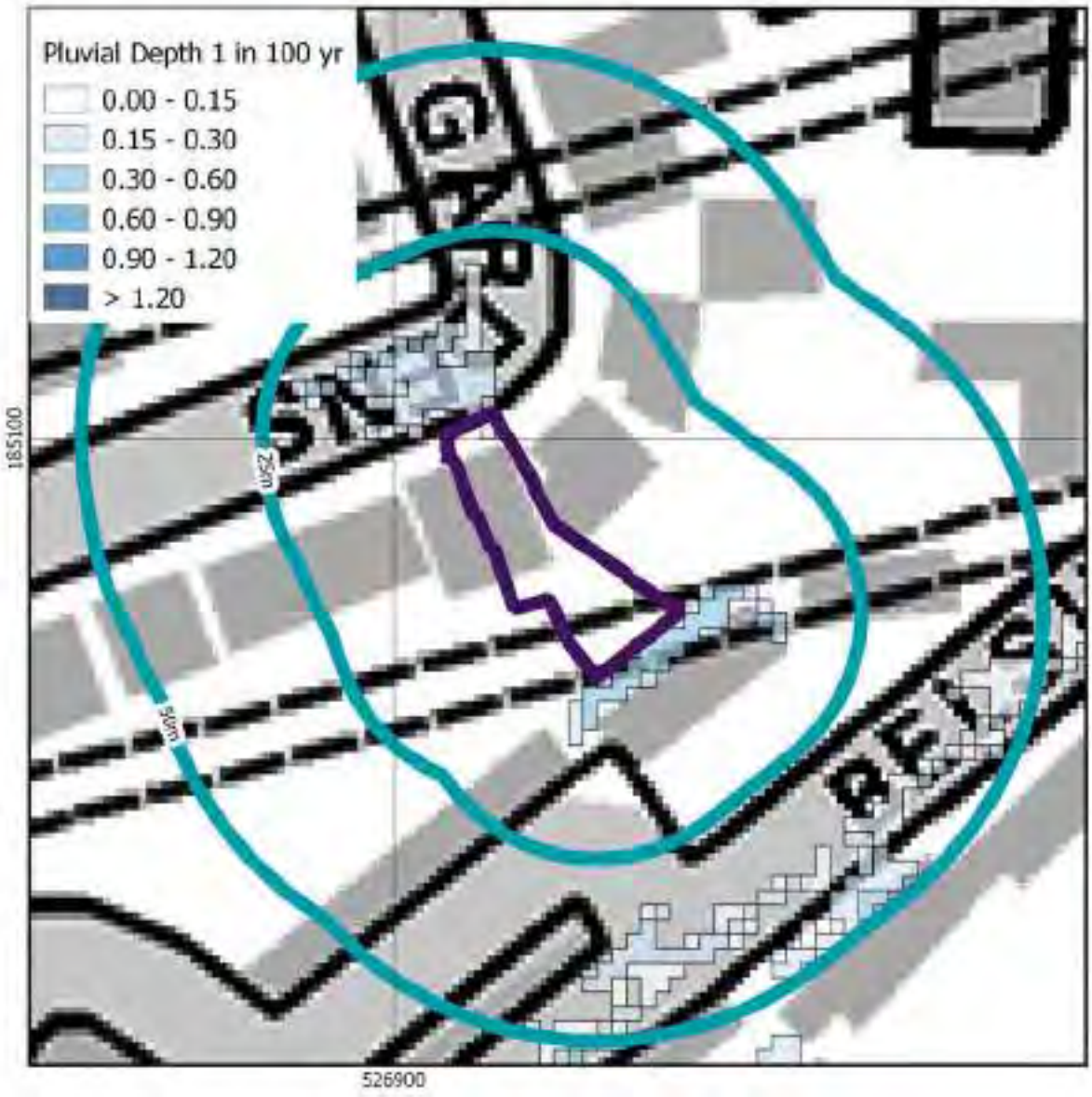
Contains Ordnance Survey data © Crown copyright and database right 2019
Contains Ambiental UKFloodMap4TM data 2019

GeoSmart Groundwater Flood Risk (GW5, v2.2) Map (GeoSmart, 2019)

Risk of Flooding from Surface Water (pluvial) 1 in 30 year Depth Map (EA, 2019)

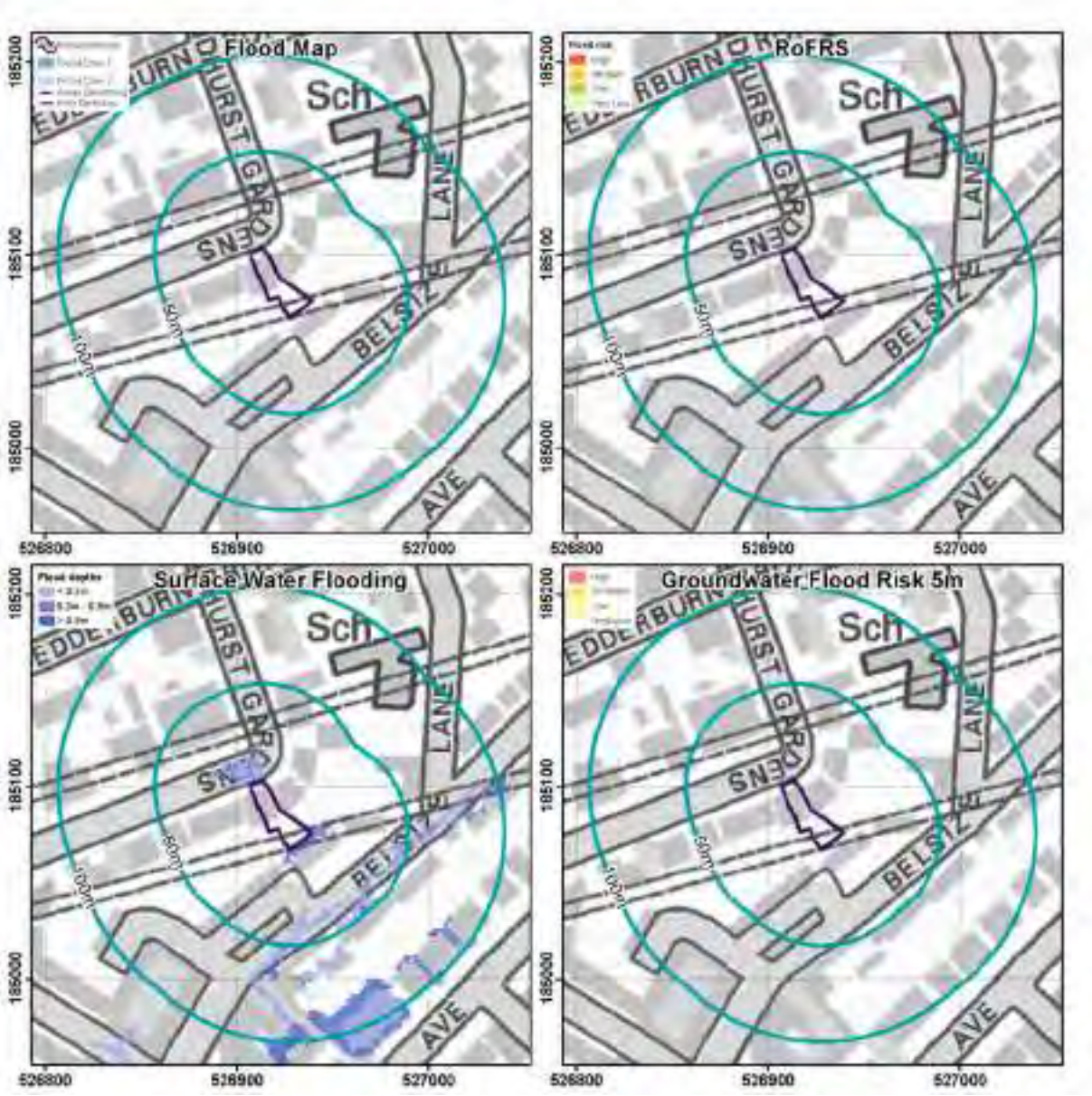


Risk of Flooding from Surface Water (pluvial) 1 in 100 year Depth Map (EA, 2019)



Risk of Flooding from Surface Water (pluvial) 1 in 1000 year Depth Map (EA, 2019)

Quad Map (EA and Ambiental Data, 2019)



Appendix C

Thames Water sewer flooding report

Sewer Flooding
History Enquiry

Property Searches

GeoSmart Information Ltd

Bellstone

Search address supplied	12 Lyndhurst Gardens London NW3 5NR
Your reference	72205
Our reference	SFH/SFH Standard/2019_4078255
Received date	**19 September 2019**
Search date	**19 September 2019**

Thames Water Utilities Ltd
Property Searches, PO Box 3189, Slough SL1 4WW
DX 151280 Slough 13

searches@thameswater.co.uk
www.thameswater-propertysearches.co.uk

0845 070 9148

Sewer Flooding
History Enquiry

Property Searches

Search address supplied: 12,Lyndhurst Gardens,London,NW3 5NR

This search is recommended to check for any sewer flooding in a specific address or area

TWUL, trading as Property Searches, are responsible in respect of the following:-

(i) any negligent or incorrect entry in the records searched;

(ii) any negligent or incorrect interpretation of the records searched;

(iii) and any negligent or incorrect recording of that interpretation in the search report

(iv) compensation payments

Thames Water Utilities Ltd
Property Searches, PO Box 3189, Slough SL1 4WW
DX 151280 Slough 13

searches@thameswater.co.uk
www.thameswater-propertysearches.co.uk

0845 070 9148

Sewer Flooding
History Enquiry

Property Searches

History of Sewer Flooding

Is the requested address or area at risk of flooding due to overloaded public sewers?

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.

For your guidance:

- A sewer is “overloaded” when the flow from a storm is unable to pass through it due to a permanent problem (e.g. flat gradient, small diameter). Flooding as a result of temporary problems such as blockages, siltation, collapses and equipment or operational failures are excluded.
- “Internal flooding” from public sewers is defined as flooding, which enters a building or passes below a suspended floor. For reporting purposes, buildings are restricted to those normally occupied and used for residential, public, commercial, business or industrial purposes.
- “At Risk” properties are those that the water company is required to include in the Regulatory Register that is presented annually to the Director General of Water Services. These are defined as properties that have suffered, or are likely to suffer, internal flooding from public foul, combined or surface water sewers due to overloading of the sewerage system more frequently than the relevant reference period (either once or twice in ten years) as determined by the Company’s reporting procedure.
- Flooding as a result of storm events proven to be exceptional and beyond the reference period of one in ten years are not included on the At Risk Register.
- Properties may be at risk of flooding but not included on the Register where flooding incidents have not been reported to the Company.
- Public Sewers are defined as those for which the Company holds statutory responsibility under the Water Industry Act 1991.
- It should be noted that flooding can occur from private sewers and drains which are not the responsibility of the Company. This report excludes flooding from private sewers and drains and the Company makes no comment upon this matter.
- For further information please contact Thames Water on Tel: 0800 316 9800 or website www.thameswater.co.uk

Thames Water Utilities Ltd
Property Searches, PO Box 3189, Slough SL1 4WW
DX 151280 Slough 13

searches@thameswater.co.uk
www.thameswater-propertysearches.co.uk

0845 070 9148

Appendix D

EA LiDAR ground elevation data

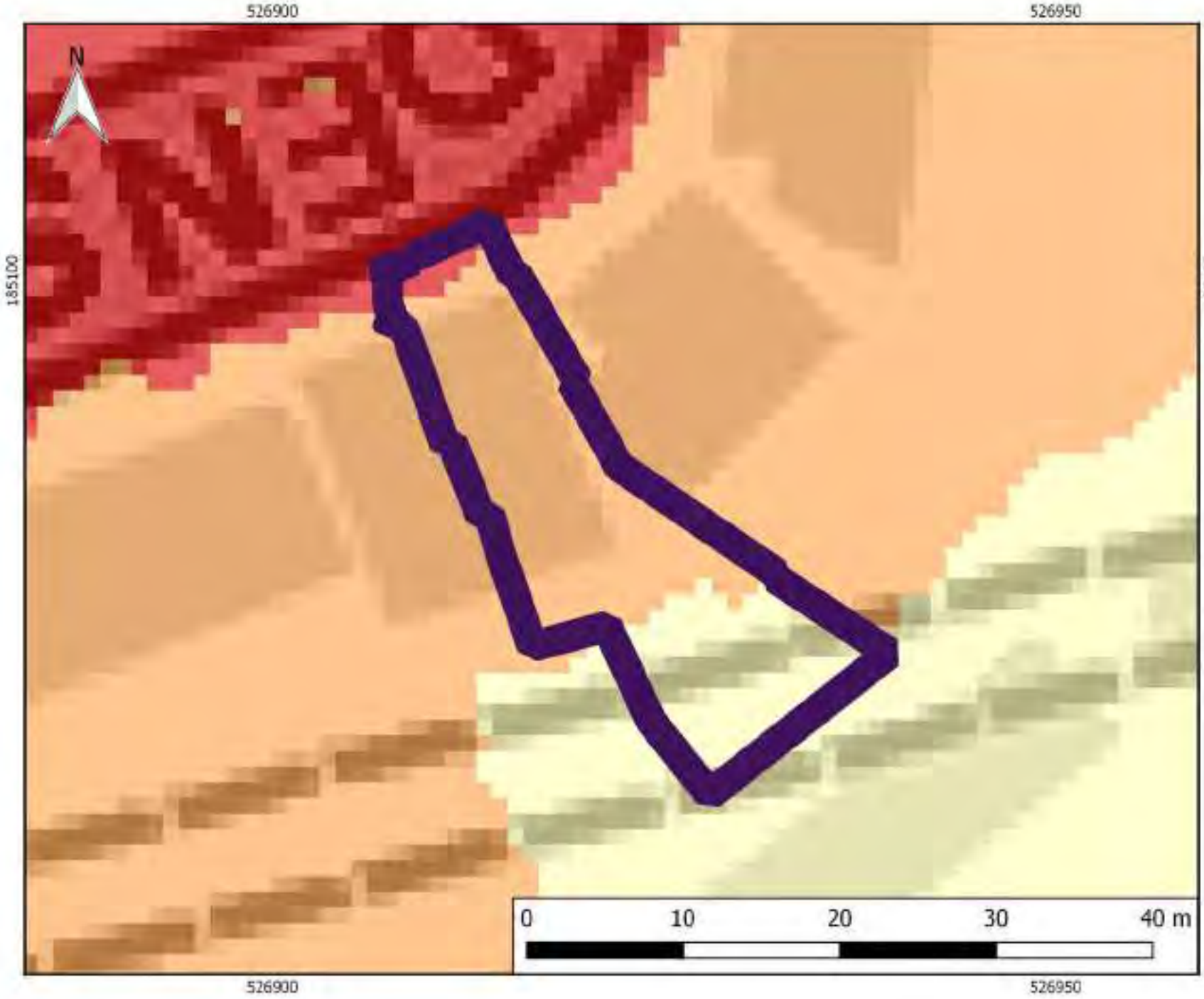


Figure D.1
Elevation on Site (LIDAR Data)

Legend

- Site Boundary
- tq2685_DTM_1M
  - <= 65.98
  - 65.98 - 69.23
  - 69.23 - 72.49
  - 72.49 - 75.74
  - > 75.74

GeoSmart Information
Environmental Thinking

Date 20/09/2019	Drawn
Scale 1:344	Checked
Original	Revision
File Reference	

Disclaimer

This report has been prepared by GeoSmart in its professional capacity as soil, groundwater, flood risk and drainage specialists, with reasonable skill, care and diligence within the agreed scope and terms of contract and taking account of the manpower and resources devoted to it by agreement with its client, and is provided by GeoSmart solely for the internal use of its client.

The advice and opinions in this report should be read and relied on only in the context of the report as a whole, taking account of the terms of reference agreed with the client. The findings are based on the information made available to GeoSmart at the date of the report (and will have been assumed to be correct) and on current UK standards, codes, technology and practices as at that time. They do not purport to include any manner of legal advice or opinion. New information or changes in conditions and regulatory requirements may occur in future, which will change the conclusions presented here.

This report is confidential to the client. The client may submit the report to regulatory bodies, where appropriate. Should the client wish to release this report to any other third party for that party's reliance, GeoSmart may, by prior written agreement, agree to such release, provided that it is acknowledged that GeoSmart accepts no responsibility of any nature to any third party to whom this report or any part thereof is made known. GeoSmart accepts no responsibility for any loss or damage incurred as a result, and the third party does not acquire any rights whatsoever, contractual or otherwise, against GeoSmart except as expressly agreed with GeoSmart in writing.

For full T&Cs see http://geosmartinfo.co.uk/terms-conditions

Important consumer protection information

This search has been produced by GeoSmart Information Limited, Suite 9-11, 1st Floor, Old Bank Buildings, Bellstone, Shrewsbury, SY1 1HU.

Tel: 01743 298 100

Email: info@geosmartinfo.co.uk

GeoSmart Information Limited is registered with the Property Codes Compliance Board (PCCB) as a subscriber to the Search Code. The PCCB independently monitors how registered search firms maintain compliance with the Code.

The Search Code:

- provides protection for homebuyers, sellers, estate agents, conveyancers and mortgage lenders who rely on the information included in property search reports undertaken by subscribers on residential and commercial property within the United Kingdom
- sets out minimum standards which firms compiling and selling search reports have to meet
- promotes the best practice and quality standards within the industry for the benefit of consumers and property professionals
- enables consumers and property professionals to have confidence in firms which subscribe to the code, their products and services.
- By giving you this information, the search firm is confirming that they keep to the principles of the Code. This provides important protection for you.

The Code's core principles

Firms which subscribe to the Search Code will:

- display the Search Code logo prominently on their search reports
- act with integrity and carry out work with due skill, care and diligence
- at all times maintain adequate and appropriate insurance to protect consumers
- conduct business in an honest, fair and professional manner
- handle complaints speedily and fairly
- ensure that products and services comply with industry registration rules and standards and relevant laws
- monitor their compliance with the Code

Complaints

If you have a query or complaint about your search, you should raise it directly with the search firm, and if appropriate ask for any complaint to be considered under their formal internal complaints procedure. If you remain dissatisfied with the firm's final response, after your complaint has been formally considered, or if the firm has exceeded the response timescales, you may refer your complaint for consideration under The Property Ombudsman scheme (TPOs). The Ombudsman can award compensation of up to £5,000 to you if he finds that you have suffered actual loss as a result of your search provider failing to keep to the Code.

Please note that all queries or complaints regarding your search should be directed to your search provider in the first instance, not to TPOs or to the PCCB.

TPOs contact details:

The Property Ombudsman scheme
Milford House
43-55 Milford Street
Salisbury
Wiltshire SP1 2BP
Tel: 01722 333306
Fax: 01722 332296
Email: admin@tpos.co.uk

You can get more information about the PCCB from www.propertycodes.org.uk.

Please ask your search provider if you would like a copy of the search code

Complaints procedure

GeoSmart Information Limited is registered with the Property Codes Compliance Board as a subscriber to the Search Code. A key commitment under the Code is that firms will handle any complaints both speedily and fairly.

If you want to make a complaint, we will:

- Acknowledge it within 5 working days of receipt.
- Normally deal with it fully and provide a final response, in writing, within 20 working days of receipt.
- Keep you informed by letter, telephone or e-mail, as you prefer, if we need more time.
- Provide a final response, in writing, at the latest within 40 working days of receipt.
- Liaise, at your request, with anyone acting formally on your behalf.

If you are not satisfied with our final response, or if we exceed the response timescales, you may refer the complaint to The Property Ombudsman scheme (TPOs): Tel: 01722 333306, E-mail: admin@tpos.co.uk.

We will co-operate fully with the Ombudsman during an investigation and comply with his final decision. Complaints should be sent to:

Jemma Prydderch
Operations Manager
GeoSmart Information Limited
Suite 9-11, 1st Floor,
Old Bank Buildings,
Bellstone,
Shrewsbury,
SY1 1HU
Tel: 01743 298 100
jemmaprydderch@geosmartinfo.co.uk

Terms and Conditions

GEOSMART INFORMATION LIMITED
Conditions of contract for environmental reports

June 2016, Version 1.2

Definitions:

The following words shall have the following meaning:

a) "Client" means the person for whom the Report has been procured either directly or through an Intermediary;

b) "Conditions" means these terms and conditions of sale, the User Guide and the Order;

c) "GEOSMART" means GeoSmart Information Ltd of Suite 9-11, Old Bank Buildings, Bellstone, Shrewsbury, SY1 1HU, registered in England and Wales with company registration number 05475394.

d) "Information" means environmental data, including other third party sources of information;

e) "Intermediary" means the party that places the Order acting on behalf of the Beneficiary, who might be a lawyer, consultant or other party;

f) "Order" means the order for Services sent by a Client or an Intermediary to GEOSMART;

g) "Report" or "Reports" means a report which relates to environmental information (as distinct from opinion) and which is prepared by GEOSMART in respect of a Site;

h) "Services" means the preparation and provision of Report(s) by GEOSMART from the Information;

i) "Site" shall mean the site specified in the Order;

j) "User Guide" means the document (if any) which may be produced from time to time by GEOSMART entitled 'GeoSmart User Guide', which may be requested with the Report by writing to GEOSMART at the above address and will be provided if applicable.

1. Conditions

1.1 Subject to receipt of a valid Order, GEOSMART agrees to supply to the Client or the Intermediary (if the Client has appointed one) the Services subject to these Conditions and the Client or the Intermediary agrees that by placing an Order for the Services it accepts these Conditions. The User Guide applicable to each Report should be read in conjunction with the Report and is incorporated into these Conditions as if it were repeated herein. A Report is sold subject to all information contained in such User Guide

1.2 GEOSMART acknowledges that in the provision of the Report and Services it owes a duty of care to the Intermediary and to the Client.

1.3 In providing search reports and services GEOSMART will comply with Search Code and will take into account the requirements of the Alternative Dispute Resolution for Consumer Disputes (Amendment) Regulations 2015. Further details are provided in the PCCB Bulletin which accompanies GEOSMART Reports.

2. Report

GEOSMART shall use reasonable care, skill and diligence in carrying out the Services and providing the Report to the Intermediary (and the Client). However, the Report is provided to the Intermediary (and the Client) on the express basis that the Intermediary (and the Client) acknowledge and agree to the following:

2.1 information and data supplied in Report(s) is derived from the Information and GEOSMART does not warrant the accuracy or completeness of such Information;

2.2 the sources of information and data supplied in Report(s) are specifically cited in the Report and the User Guide; however, GEOSMART does not claim that these sources represent an exhaustive or comprehensive list of all sources that could or might be consulted; and

2.3 GEOSMART does not guarantee that all environmental risks that are or might be associated with the Site will be identified in the Report; and

2.4 Reports and other services provided by GEOSMART are generally professional business to business services and intended as such for use or interpretation by professional persons skilled in the use of environmental information; and

2.5 GEOSMART shall not be responsible for any error or corruption in a Report resulting from inaccuracy or omission of third party information and data provided by the Intermediary or the Client (as applicable), inaccurate processing of information and data by third parties, computer malfunction or corruption of data whilst in the course of conversion, coding, processing by computer or electronic means, or in the course of transmission by telephone or other communication link.

3. Liability

3.1 As some of the data and information which GEOSMART interprets in Reports is obtained by GEOSMART from third parties, GEOSMART cannot control the accuracy or completeness of such data and information, nor is it within the scope of the Services to verify the data or information by a physical inspection of the Site. Save as provided in Conditions 3.5 and 3.11 GEOSMART will only be liable to the Client or to the Intermediary in respect of the Services:

3.1.1 for loss or damage caused by breach by GEOSMART of these Conditions accordingly save as provided in Condition 3.5 GEOSMART shall not be liable in any other circumstances for any errors, inaccuracies, faults or omissions in the Services;

3.1.2 for any obvious errors or obvious inaccuracies in any information obtained by it where GEOSMART should reasonably have been alerted to such error or inaccuracy;

3.2 GEOSMART has no liability whatsoever for, under or in respect of any insurance policy purchased by the Client or the Intermediary where insurance is made available to the Client or Intermediary following the provision of a Report by GEOSMART issued in accordance with these Conditions. Where such a policy has been purchased, all liability arising from or relating to the Site shall remain exclusively with the insurers. Moreover, GEOSMART is not endorsing any policy recommended by insurers and the Client or the Intermediary is entirely responsible for ensuring the insurance policy offered is suitable for its needs and should seek independent advice.

3.3 GEOSMART does not guarantee that an insurance policy will be available for the environmental risks that may be associated with the Site specified in the Report and the provision of a Report does not constitute any indication by GEOSMART that insurance will be available for the Site.

3.4 GEOSMART has undertaken the Services for use by the Client or the Intermediary and those persons referred to at condition 5.1 and 5.2 and for no other purpose whatsoever and the Services should not be relied upon by any other third party. GEOSMART cannot accept responsibility and will not be liable to any other party for any loss caused as a result of reliance upon the Services. Any other party relying on the Services does so entirely at its own risk, including without limitation, any insurers. Recipients of the Services are to rely on their own skill and judgment in determining the suitability of the Services for their own purpose and use.

3.5 Nothing in these Conditions shall exclude or restrict GEOSMART's liability for death or personal injury resulting from the negligence of GEOSMART or their employees while acting in the course of their employment or arising from a breach of its statutory duty or fraud.

3.6 GEOSMART shall not be liable to any recipient of the Service for loss of profits, loss of contracts, (or other indirect or consequential loss or damage) resulting from any event or default by GEOSMART in the provision of the Services to the fullest extent permitted by law.

3.7 GEOSMART shall make reasonable endeavors to supply the Report on the date agreed with the Intermediary or the Client (as applicable). This date will be taken as a guideline for time planning purposes only. Time shall not be of the essence with respect to the provision of the Services except where it has agreed in writing to a deadline with the Client or Intermediary in which it is stated that time is of the essence.

3.8 GEOSMART shall not be liable for any delay, interruption or failure in performance of its obligations hereunder which is caused by war, flood, riot, Act of God, strike or other labour dispute (including those affecting Government officials), suspension or delay of service at public registries, lack of power, telecommunications failure or overload, or computer malfunction caused by any event beyond the reasonable control of GEOSMART.

3.9 The Client or the Intermediary (as appropriate) shall on receipt of the Services make a reasonable inspection of the Site to satisfy itself that there are no apparent defects or failures with respect to the description of the Site.

3.10 GEOSMART's liability under the Conditions shall cease upon the expiry of six (6) years from the date when the Client, Intermediary or any person making use of the Report in accordance with Condition 5.2 became aware that it may have a claim in respect of a particular Report provided always that there shall be no liability at the expiration of six (6) years from the date of the Report. For the avoidance of doubt, any claims in respect of which proceedings are notified to GEOSMART prior to the expiry of the time periods referred to in this Condition shall survive the expiry of those time periods.

3.11 Subject as otherwise provided in these Conditions, GEOSMART's aggregate liability arising out of the provision or use of the Services, in contract, negligence or in any other way, for damages or loss sustained or incurred by the Intermediary shall be limited to an aggregate amount not exceeding £5,000,000 pounds. For the avoidance of doubt, if multiple parties make use of the Report, the limit referred to above applies to all users of that Report in aggregate.

3.12 GEOSMART undertakes for the duration of the six (6) year period of liability provided for by Condition 3.11 to maintain and renew annually Professional Indemnity Insurance in respect of the Services with a liability limit of not less than £5,000,000 provided that such insurance is available at commercially reasonable rates (and in such case then at the next highest limit which is available in the market at commercially reasonable rates). Details of Professional Indemnity Insurance shall be made available to the Client or Intermediary (as applicable) on request.

3.13 Where GEOSMART procures for the Intermediary, otherwise than as part of a Report, any third party service, including but not limited to, environmental reports, risk models, risk assessments, professional opinions, or any other service, GEOSMART accepts no liability whatsoever for the information contained therein.

3.14 The Client and the Intermediary warrant that they shall: (i) comply with all applicable laws, statutes and regulations relating to anti-bribery and anti-corruption including but not limited to the Bribery Act 2010; (ii) comply with such of GEOSMART 'S anti-bribery and anti-corruption policies as are notified to them from time to time; and (iii) promptly report to GEOSMART any request or demand for any undue financial or other advantage of any kind received by the or on their behalf in connection with these Conditions. Breach of this clause shall be deemed a material breach of these Conditions.

4. Copyright

4.1 The Intermediary, the Client and any recipient of the Report pursuant to the provisions of condition 5.2 acknowledge that the proprietary rights subsisting in copyright, design rights and any other intellectual property rights in respect of the data and information in the Report are and shall remain the property of GEOSMART and these Conditions do not purport to grant, assign, or transfer any such rights in respect thereof.

4.2 Reports may be stored on the Intermediary's server and used on up to ten (10) units (where a "Unit" means a single client personal computer or workstation) on the Intermediary's network and any network of a recipient of the Report pursuant to the provisions of Condition 5.2. Data in Reports is deemed to be in use when it is loaded into the temporary memory (i.e. RAM) or installed onto the permanent memory (i.e. memory chip, hard disc, CDROM) of that computer.

4.3 The Intermediary, the Client and all recipients of the Report pursuant to the provisions of Condition 5.2 are all entitled to make up to five printed copies only of any Report. Copies of the Report may be provided for information purposes for proper and lawful use only to a person who is considering whether to acquire or hold an interest in the Site or to provide funding in relation to the Site. Further copies may not be made in whole or in part without the written permission of GEOSMART who shall be entitled to make a charge for each additional copy.

4.4 The Intermediary and the Client (as applicable) shall (and shall procure that all recipients of the Report pursuant to the provisions of Condition 5.2 shall):

4.4.1 not remove, suppress or modify any trademark, copyright or other proprietary marking belonging to GEOSMART from the Services;

4.4.2 not create any product which is derived directly or indirectly from the data contained in the

Services; save for products documents and advice provided by those acting in a professional or commercial capacity in accordance with 5.2.3;

4.4.3 not combine the Services with or incorporate such Services into any other information data or service;

4.4.4 not re-format or otherwise change (whether by modification, addition or enhancement) data contained in the Services save for those modifications made by those acting in a professional or commercial capacity in accordance with 5.2.3;

4.5 The mapping (if any) contained in any Services is protected by Crown Copyright and must not be used for any purpose outside the context of the Services.

5. Confidentiality and reliance

5.1 Subject to (i) full payment of all relevant Fees and (ii) compliance with this Contract, the Client or the Intermediary is entitled to rely on the report and information provided.

5.2 Subject to Condition 5.3, the Client or the Intermediary (as applicable) may without further charge make the Report available to:

5.2.1 Up to a maximum of three (3) persons who acquire or hold an interest in the Site or an interest in the Client or the entity which holds or acquires an interest in the Site save that nothing shall hereby entitle any such person to recover twice (whether directly or indirectly) in respect of the same loss nor seek recovery in respect of any loss relating to any period after such entity ceases to hold its interest or to have potential liability for the Site(whichever is the later) (unless otherwise agreed by the parties);

5.2.2 Up to a maximum of three (3) persons who provide funding to the Client or to a person at condition 5.2.3;

5.2.3 Up to a maximum of three (3) persons acting in a professional or commercial capacity for the Client in relation to the Site.

5.3 GEOSMART shall have the same duties and obligations to those persons referred to in Conditions 5.2.1, 5.2.2, 5.2.3 in respect of the Services as it has to the Client and the Intermediary , and such persons shall be entitled to rely on the relevant Report as if it was addressed to them and any such person shall be entitled to enforce each of these Conditions as if they were named as joint Client in the Order, provided always that the person to whom the Report is made available accepts these Conditions by writing accordingly to GEOSMART citing the Report and the Site.

5.3 The Report is to be used solely for the benefit of such persons as are set out in Condition 5.1 and 5.2, and GEOSMART exclude all liability to all other persons unless GEOSMART has expressly agreed in writing to a third party taking the benefit of the Report and has been paid reasonable fees for so doing.

5.4 Any information provided by the Intermediary or the Client to GEOSMART in contemplation of the Services to be provided together with the Report will be treated as confidential information.

5.5 GEOSMART agrees not to disclose or publish any statement relating to such confidential information (in whole or in part) to any third party without the prior written consent of the Intermediary save for its provision to GEOSMART 's employees who require access to the confidential information in order to perform their duties to GEOSMART.

5.6 GEOSMART will procure that its employees will maintain the confidential information in strict confidence.

6. GEOSMART's charges

6.1 The Client or the Intermediary (as applicable) shall pay GEOSMART's charges for the Services at the rate set out in the Order.

6.2. Unless otherwise stated all prices are exclusive of Value Added Tax which shall, where applicable, be payable in addition to any sum payable for the Services at the relevant rate in force from time to time, against delivery of an appropriate tax invoice.

6.3 The Client or the Intermediary (as applicable) shall pay the price referred to in Condition 6.1 above for the Services:

6.3.1 without any set off, deduction or counterclaim;

6.3.2 GEOSMART requests upfront payment by debit or credit card (No surcharges for credit cards) or by bank transfer. A credit agreement can be set

up for repeat clients with terms based on 14 days from the date of GEOSMART's invoice.

6.4 GEOSMART shall not be obliged to invoice any party other than the Client or the Intermediary (as applicable) for the provision of Services, but where GEOSMART does so invoice any third party at the written request of the Client Intermediary, and such invoice is not accepted or remains unpaid, GEOSMART shall have the right at any time to cancel such invoice and invoice the Client or the Intermediary (as applicable) direct for such Services. Where the Intermediary 's order comprises a number of Services or separate elements within any one or more Services, any failure by GEOSMART to provide an element or elements of the Services shall not prejudice GEOSMART's ability to require payment in respect of the other Services delivered to the Intermediary or the Client (as applicable).

6.5 If the Intermediary or the Client (as applicable) fails to make any payment on the due date GEOSMART shall be entitled to cancel or suspend any further orders or delivery. In addition, GEOSMART may charge the Intermediary or the Client (as applicable) interest on overdue amounts at 4% over the NatWest plc base rate (as varied from time to time) from the due date until payment in full is made (whether before or after judgment).

7. General

7.1 These Conditions constitute the entire agreement between the parties and no statement given orally or in writing should be deemed incorporated herein unless executed in writing by a director of GEOSMART and countersigned by the Intermediary or the Client (as applicable). Each of the Conditions and Sub-conditions of these Conditions is distinct and severable. If any provision of these Conditions shall be determined to be invalid, illegal or unenforceable, the remainder of these Conditions shall continue to be valid, legal and enforceable to the fullest extent of the law.

7.2 Any time or indulgence granted by GEOSMART or the Client or the Intermediary or delay in exercising any of its rights under these Conditions shall not prejudice or affect GEOSMART's or the Client's or the Intermediary 's rights or operate as a waiver of the same.

7.3 GEOSMART, the Client and the Intermediary shall not be entitled to assign their respective rights or obligations pursuant to these Conditions without the prior written approval of the other parties.

7.4 GEOSMART may suspend or terminate the provision of the Services if the Client or the Intermediary (as applicable) is bankrupt or insolvent or makes any voluntary arrangements with its creditors or become subject to an administration order or has an administrative receiver appointed over any of its assets or GEOSMART has reason to believe that any of foregoing circumstances may come into existence or any amount owing to GEOSMART that is overdue or where the Client or Intermediary (as applicable) has exceeded any credit limit.

7.5 These Conditions shall at all times be governed construed and enforced in accordance with English Law which shall be the proper law of these Conditions, and both parties thereby submit to the exclusive jurisdiction of the English courts.

7.6 Except as otherwise provided in these Conditions a person who is not a party to any contract made pursuant to these Conditions shall have no right under the Contracts (Rights of Third Parties) Act 1999 to enforce any terms of such contract and GEOSMART shall not be liable to any such third party in respect of the Products.