Symmetrys Ltd
Structural Engineers

BASEMENT IMPACT ASSESSMENT

43 Hillfield Road
London
NW6 1QD

17420

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Project Name	43 Hillfield Road
Planning Reference No.	TBC

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Appendices

1.0 NON TECHNICAL SUMMARY

1.1.1. The site location is 43 Hillfield Road, NW6 1QD.

1.1.2. The current site arrangement is a four storey terraced house with an existing lower ground floor under part of the footprint of the house. The existing structure is load bearing masonry with timber floors spanning from front to back of the house.

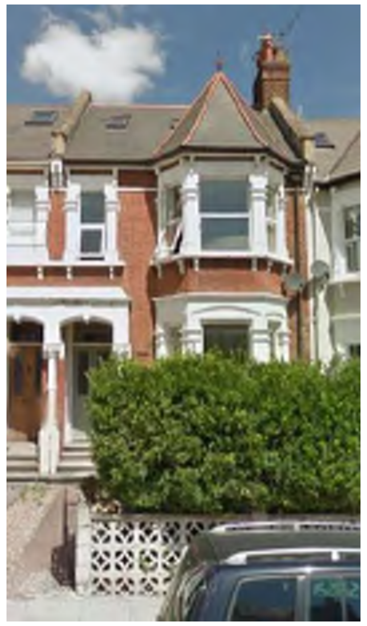

Figure 1: Front Elevation

1.1.3. The proposed development comprises the refurbishment of the lower ground floor and ground floor including:

- Demolition of the existing rear extension at ground floor
- Construction of a new rear extension at ground floor
- Extension and lowering of the existing lower ground floor
- Reconfiguration of the internal walls

The lower ground floor will extend below the front and rear gardens 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 of the assessments are Camille Corvec (MEng), a Structural Engineer at Symmetrys for this Basement Impact Assessment.

To review this report we have consulted Ashwin Halaria (BEng, MSc), associate at Symmetrys with 15 years experience, John Strawson (MICE), Philip Lewis (BSc, MSc, CGeol, FGS), managing director of LMB Geosolutions and Chris Atkins (CEng, MIStructE), managing director of Symmetrys with 27 years of experience in structural engineering.

1.1.6. The ground conditions beneath the site are London Clay. Ground water was recorded during subsequent monitoring visit at depths between 1.64m and 2.06m.

1.1.7. The construction methods proposed are to form the new level of the lower ground floor level by using sequential reinforced concrete underpins. The existing masonry wall will be underpinned with reinforced concrete retaining wall. The basement slab formed by a reinforced concrete slab will act as prop at 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 long term.

1.1.8. A structural monitoring strategy to control the works and impacts to neighbouring structures will comprise a series of targets (points) that will set on the existing facades of the neighbouring properties near ground level and at roof level at intervals not exceeding 3m centres horizontally and vertically.

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.*

1.1.9. 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.

1.1.10. The BIA has identified no *potential slope stability impacts.*

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

1.1.12. The BIA has identified *low flood risk for the proposed development.*

2.0 INTRODUCTION

The purpose of this assessment is to consider the effects of a proposed basement development at 43 Hillfield Road, NW6 1QD, London on the local hydrology, geology and hydrogeology and potential impacts to neighbours and the wider environment. The site location is presented in Figure 1.

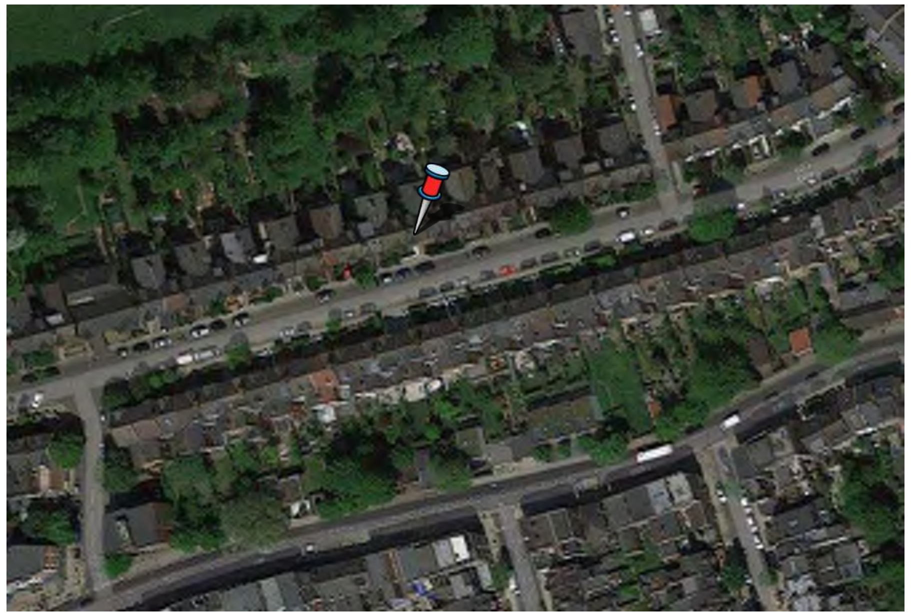

Figure 2: Site Location

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 has been authored by Camille Corvec (MEng), a Structural Engineer at Symmetrys.

2.1.2. It has been reviewed by Ashwin Halaria (BEng, MSc), associate at Symmetrys with 15 years experience, John Strawson (MICE) and Philip Lewis (BSc, MSc, CGeol, FGS), managing director of LMB Geosolutions.

2.1.3. This BIA has been approved by Chris Atkins (CEng, MIStructE), managing director of Symmetrys with 27 years of experience in structural engineering.

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 Hillfield Road at 500 metres from West Hampstead Station. The site is not within a wider hillside setting.

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

2.3.3. The existing structure is a 4 storey load bearing masonry house with an existing conservatory at the rear of the house. The current property shows no significant signs of deformation.

2.3.4. The property is a terraced house. Both neighbouring structure are the same age and the same style as 43 Hillfield Road. It is understood that No.45 has an existing basement. The extent and the depth of this basement will need to be confirmed.

2.3.5. There are no known Listed Properties on Hillfield Road or in the adjacent streets.

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

2.3.7. Adjacent infrastructure includes a railway line along the neighbourhood at approximately 500 metres from the site. A consultation with the London Underground Asset Protection Team has been undertaken to confirm that there are no closer existing assets to the site.

2.3.8. Underground infrastructure present beneath/close to the site includes the Jubilee line's tunnel approximately 600 metres from the site. A consultation with the London Underground Asset Protection Team has been undertaken to confirm that there are no closer existing assets to the site. Refer to Figure 3 for the location of the Jubilee line.

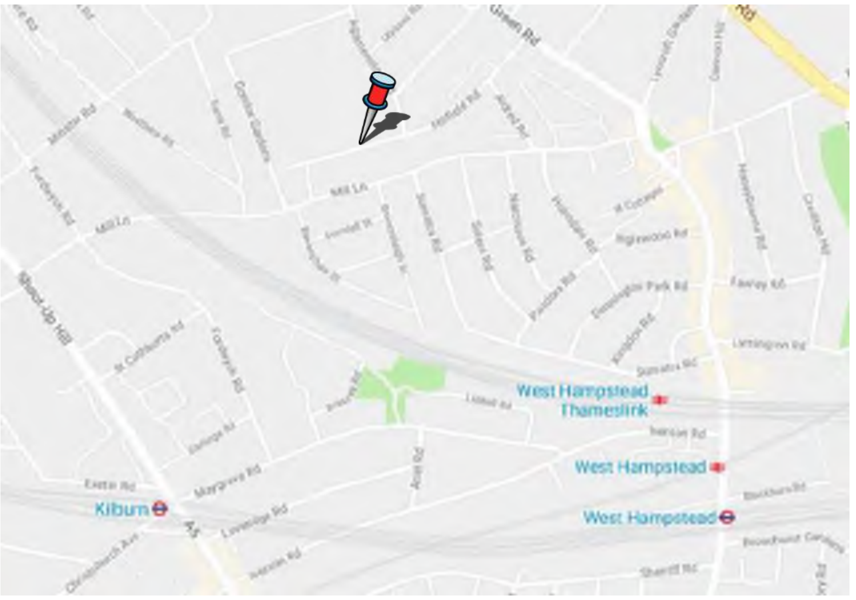

Figure 3: Site location from railway line

2.3.9. Existing and Proposed development drawings are presented in Appendix 2.

2.3.10. The proposed development will utilise the following construction techniques to form the new lower ground floor:

Sequential reinforced concrete underpins will be used to form the new level of the lower ground. 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 and front gardens to form lightwells. It will occupy less than 50% of the existing area. As for the main basement construction, the walls forming the lightwells will be formed using L-shaped concrete retaining walls built in an underpinned sequence.

2.3.11. The outline construction programme for the proposed development is*:*

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

- 2 months excavation

- 3 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 1.

3.2. Geology

3.2.1. The *British Geology Survey (BGS) map* of the area indicates that the site is underlain by hard blue clay as per the borehole results of TQ28SW85 in the South of the site, see Figure 4.

Figure 4: Extract of BGS map

3.2.2 Refer to Desktop Study in Appendix 1 for details of the local Geology.

3.3. Hydrogeology

Refer to Desktop Study in Appendix 1 for details of the local Hydrogeology.

3.4. Hydrology, Drainage and Flood Risk

3.4.1. The site is located at two kilometres from the closest surface water features in Hampstead Heath, see Figure 5.

Figure 5: Extract of Camden Surface Water Features map

3.4.2. The site is located at 500 metres distance from the Westbourne historical watercourse. This is a significant distance therefore it is unlikely to have any impact on the local hydrology, see Figure 6.

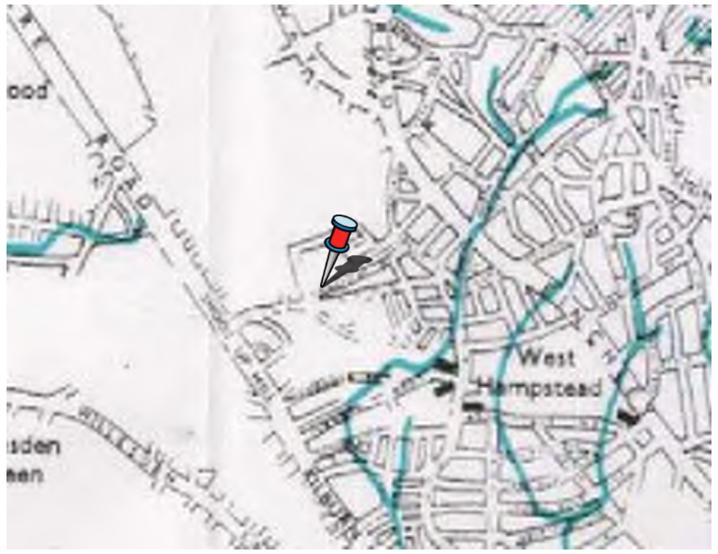

Figure 6: Extract of the “Lost Rivers of London” from Nicholas Barton

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

3.4.4. The percentage of permeable area is currently 18.8% of the total surface of the site.

3.4.5. The proposed surface area will represent 20.2% of the total surface of the site. Therefore there will be no increase in surface water run-off in the site. This will be achieved by new planter areas and permeable paving at the front of the property.

3.4.6. The site is classified is not located in a Local Flood Risk Zone and is at low risk of surface water flooding, see Figure 7 and 8.

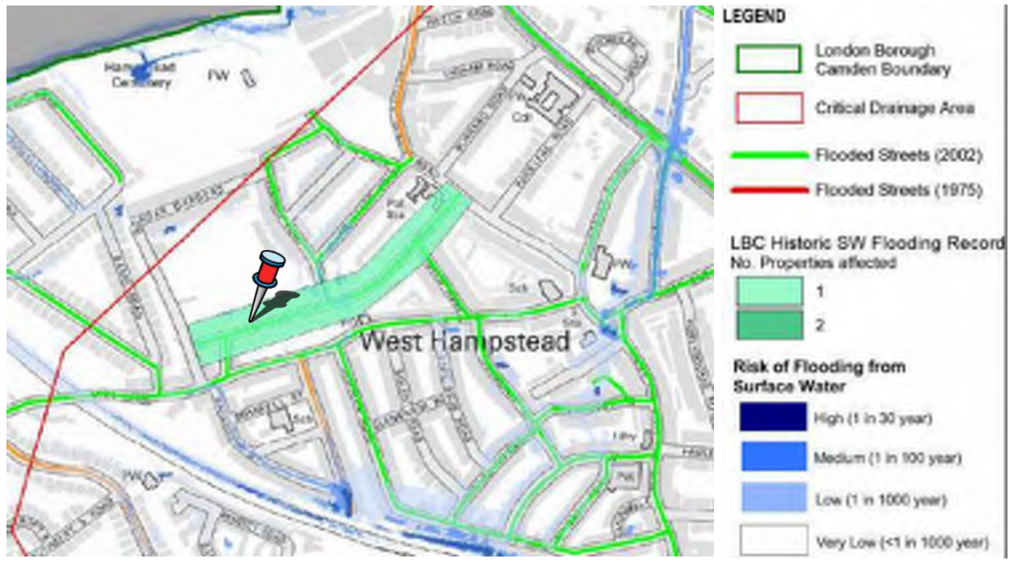

Figure 7: Extract of URS map “Updated Flood Maps for Surface Water Flooding”

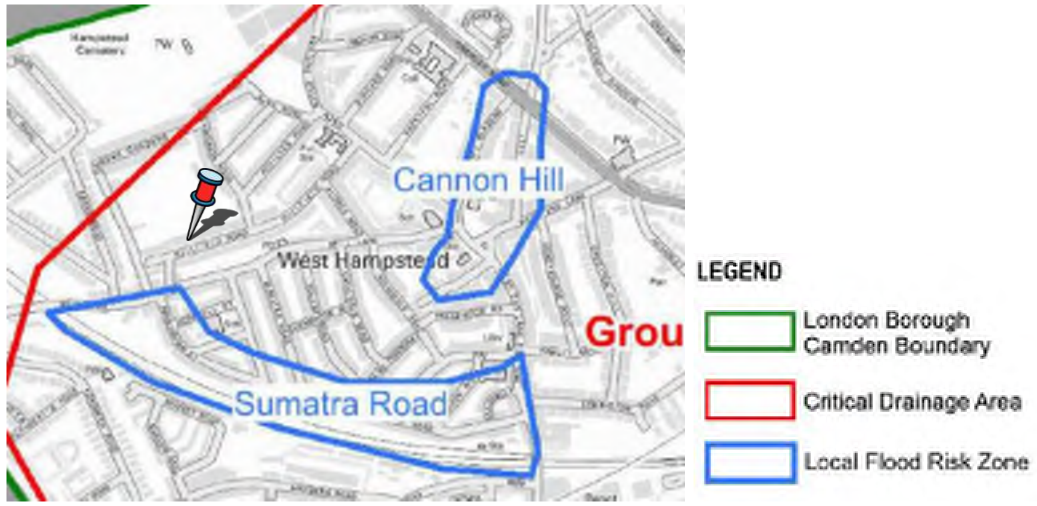

Figure 8: Extract of URS Map “Critical Drainage Area / Local Flood Risk Zones”

3.4.7. The site is within a Critical Drainage Area.

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 visit but would unlikely represent a continuous aquifer. Refer to LMB report in Appendix 1. The London Clay is designated Unproductive Strata.
1b. Will the proposed basement extend beneath the water table surface?	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 1.
2. Is the site within 100mof a watercourse, well (used / disused) or potential spring line?	No	Refer to 3.4.1 and 3.4.2
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 proportion of hard surfaced area will be decreased.
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)?	**Yes**	More surface water will be discharged to the ground, refer to 3.4.5 and 3.4.6
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	Refer to 3.4.1

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 2.3.2
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 the front and rear courtyards.
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7 degrees (approximately 1 in 8)?	No	Refer to 2.3.7
4. Is the site within a wider hillside setting in which the general slope is greater than 7 degrees (approximately1 in 8)?	No	The site is not located on a wilder hillside
5. Is the London Clay the shallowest strata at the site?	**Yes**	Refer to results of the ground investigation in Appendix 1.
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?	No	There are existing trees within the property and in the surrounding gardens however they are at a considerable distance from the property.
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 3.4.1
9. Is the site within an area of previously worked ground?	No	Refer to Appendix 1
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 1.
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 site is located on Hillfield Road.
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	**Yes**	It is proposed to lower the existing lower ground floor that will extend from party wall to party wall
14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	No	Refer to 2.3.8

4.3. Surface Water and Flooding

Question	Response	Details
1. Is the site within the catchment of the ponds 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	There will be no changes in the surface water flow route.
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?	**Yes**	The proportion of hard surfaced area will be decreased.
4. Will the proposed basement result in changes to the profile of the inflows (instantaneous and long-term) of surface water being received by adjacent properties or downstream watercourses?	No	There will be no changes in the profile of the inflows received by neighbouring properties or downstream watercourses as there will be no changes in the surface water flow route.
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.	No	Refer to 3.4.6

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 within 5m of highway or pedestrian right of way
- The site will significantly increase the differential depth of foundations relative to neighbouring properties.
- The London Clay formation is the shallowest strata
- There will be a change in the proportion of hard surfaced area within the site.

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

5.0 SCOPING

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

5.1. The site is located within 5 metres of highway of pedestrian right of way

5.1.1. The site is located on Hillfield Road with direct access to this road. It is proposed to extend the lower ground floor to below the front courtyard to a distance of 3.3 metres to the pedestrian pathway on Hillfield Road.

5.1.2. The ground movements occurring during and after the extension of the lower ground floor needs to be considered.

5.1.3 A Ground Movement Assessment has been undertaken, refer to Appendix 1. The assessment demonstrates that potential damage will be within Category 1 of the Burland scale (Very slight).

5.2. The site will significantly increase the differential depth of foundations relative to neighbouring properties

5.2.1. The existing lower ground floor will be lowered and extended below part of the front and rear courtyard. This will require underpinning some of the party walls with No. 41 and No.45 Hillfield Road.

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 Assessment has been undertaken, refer to Appendix 1. The assessment demonstrates that potential damage will be within Category 1 of the Burland scale (Very slight).

5.3. The London Clay formation is the shallowest strata

5.3.1 A ground investigation has been undertaken, refer to Appendix 1, and the findings reveal that the proposed basement will be founded on London Clay.

5.3.2 London Clay has a 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.

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 forced 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 The existing rear garden will not be affected by the proposed works. However there are existing planters around the property that will be removed to form the basement. It is proposed to replace these planters with new ones

5.4.2 It is proposed to replace these planters by new ones and to install permeable paving in the front courtyard. As a result, there will be an increase of permeable area of 4.2 m².

5.4.3 Scoping: As it is proposed to increase the permeable surface of the site which will provide attenuation to the surface water run-off, no further assessment will be required.

6.0 SITE INVESTIGATION / ADDITONAL ASSESSMENTS

6.1. Site Investigation

A complete Site Investigation has been undertaken, refer to Appendix 1.

6.2 Ground Movement Assessment

Following the results of the screening and scoping process, a ground movement assessment has been undertaken, refer to Appendix 1.

7.0 CONSTRUCTION METHODOLOGY / ENGINNERING STATEMENTS

7.1. Outline Geotechnical Design Parameters

7.1.1. The following outline, reasonably conservative geotechnical parameters have been determined, based on the site investigation data presented in Appendix 1 and relevant technical guidance (as referenced in para 2.2 of this BIA).

7.2. Outline Temporary and Permanent Works Proposals

7.2.1. The works proposals include the lowering and the extension of an existing lower ground floor, the demolition of the existing rear extension including the conservatory and the construction of a new rear extension at ground floor.

7.2.2 Design Proposals

To form the new level of the lower ground floor level sequential reinforced concrete underpins will be used which is a well-known and frequently used technique to form subterranean 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 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 2. 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 3 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 and Front Gardens

The basement will extend below the rear and front gardens to form lightwells. It will occupy less than 50% of the existing area. As for the main basement construction, the walls forming the lightwells 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.

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.

7.2.3 Proposed Sequence of Works

The structural method statement provided, (see Appendix 2), 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.

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 2.

Temporary propping to the newly formed retaining walls will be required until the ground floor has been formed. For further details please see Appendix 2 for construction sequence and method statements.

Dewatering Strategy

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

7.2.4 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 able to 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 3.

7.3. Ground Movement and Damage Impact Assessment

7.3.1 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 1.

7.3.2 The results presented in this report describe the predicted ground movement to fall within Burland Category 1 (Very Slight.)

7.4. 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:

Existing Buildings Horizontal/Vertical movement

Amber	+/-8mm	All parties notified.
Red	+/-10mm	Works reviewed

8.0 BASEMENT IMPACT ASSESSMENT

8.1.1. A Conceptual Site Model (CSM) is presented in Appendix 1.

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 surface water/sewer flooding.

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

APPENDIX 1

GROUND INVESTIGATION AND ASSESSMENTS

LMB GEOSOLUTIONS LTD

GROUND INVESTIGATION & ASSESSMENT

FLAT 1, 43 HILLFIELD ROAD, LONDON, NW6 1QD

August 2018

DOCUMENT RECORD

Document Title	Ground Investigation & Assessment
Site	Flat 1, 43 Hillfield Road, London, NW6 1QD
Document Date	29th August 2018
Document Version	Issue 1
Document Authorisation	Philip Lewis BSc (Hons), MSc, CGeol, FGS

Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

Company No. 8303397
LMB Home

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Executive Summary

Site Details	Flat 1, 43 Hillfield Road, London, NW6 1QD
Proposed Development	The development proposals comprise lowering and extending the existing basement/cellar to form a single storey basement.
Ground & Groundwater Conditions	Made Ground overlying London Clay Formation. Groundwater was recorded during monitoring but is not considered to form a laterally continuous aquifer unit and the recorded groundwater level will most likely be reflective of the pore water pressures within discrete features (e.g. thin sand partings).
Preliminary Risk Assessment	Very low to Moderate/Low risk rating.
Assessment of Soil Analytical Results	Elevated Lead (front garden soils) and elevated concentrations of certain PAHs (rear garden area) were recorded. However, the results of the GQRA indicate that no plausible pollutant linkages are considered to exist. As such it is considered unlikely that the recorded concentrations of Lead and PAHs will pose a risk to future site users but should be considered by maintenance and construction workers.
Geotechnical Advice	For traditional strip foundations placed on the competent firm clay at a depth of 3.00m bgl a net safe bearing pressure of 115kN/m^2 should be available. This advice assumes that the proposed basement development and in particular foundations would not be within the influence of any trees or tree routes. Given the size of the excavation and the adjacent and nearby structures, it is considered likely that temporary support (sheet/secant piles or similar) will be needed for construction. Coefficient of active earth pressure: Made Ground: 0.35. London Clay: 0.42. Coefficient of passive earth resistance: Made Ground: 3.5. London Clay: 2.7. Buried concrete: Made Ground: DS-1, AC-1s. London Clay DS-3, AC-2s.
Ground Movement Assessment	The ground movement assessment undertaken indicates that damage to surrounding properties will generally be within Burland Category 1 (Very Slight).
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 Andras Cserep (the Client) in July 2018 to undertake ground investigation and assessment works in relation to the proposed basement development at Flat 1, 43 Hillfield Road, London NW6 1QD (the Site).

PROJECT AND SITE DETAILS

Site Address	Flat 1, 43 Hillfield Road, London NW6 1QD (the Site). A Site Location Plan is provided as **Figure 1**.
Proposed Development	The site currently comprises the lower ground floor flat of a three storey (including roof) residential terrace property with an existing partial basement/cellar. It is understood that the Client wishes to deepen and extend the partial basement/cellar to create a single storey basement beneath the footprint of the existing building.
Background	The scope of works and requirements of this report were based on the information provided by Symmetrys (Consultant Engineers) within the following documents: • Email specification from Camille Corvec (Symmetrys) to Philip Lewis (LMB) 25th June 2018; & • Site Investigation Plan.

AIMS & OBJECTIVES

This report aims to provide information sufficient to meet the requirements of the email 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 potential sources of contamination;
- Review of information on the planning portal for records pertaining to basement development in the neighbouring area;

- Review of historical plans 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;
- Completion of an interpretive report (to be included within the main ground investigation report) that will include:
    - Details of current site conditions based on the reconnaissance survey;
    - Production of a preliminary conceptual site model;
    - 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. continuous flight auger borehole and 1No. dynamic (windowless) sampler borehole to depths of 8.00m bgl with insitu testing and collection of disturbed samples for laboratory testing;
- Completion of 5no. hand excavated trial pits to a maximum depth of 1.20m bgl to expose and inspect existing building foundations;
- Supervision and geological logging of the soil arisings in accordance with BS5930 by an appropriately experienced geo-environmental engineer;
- Installation of 2no. monitoring well to depths of 5.0m bgl and return monitoring of groundwater levels on 2no. occasion;
- Geotechnical laboratory testing of the soil samples for an appropriate suite of determinands (dependent on ground conditions encountered could include pH, sulphate, PSD, triaxial testing, atterberg limits, and moisture content, as appropriate);
- Chemical analysis of 1no. 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.

INTRODUCTION

Ground Movement Assessment (GMA)

Completion of GMA calculations in accordance with the CIRIA publication C760 'Guidance on embedded retaining wall design' and provision of an interpretive report section (to be incorporated into the main report) that includes:

- A summary of any assumptions and findings;
- Provides estimates of any predicted damage/impact based upon the Burland scale; and
- Provides recommendations for additional works and/or mitigation measures.

CONTRIBUTORS

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.

The Ground Movement Assessment has been completed by Corrado Candian (CEng, MICE).

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);
- Barton, N.J. (1982). Lost Rivers of London.
- Groundsure Enviro Insight Report (ref. GS-5263871, 24th July 2018).

SITE RECONNAISANNCE

A representative of LMB completed a site walkover survey on Friday 27th August 2018 that included internal and external areas. A photographic record is provided as **Appendix B**.

The site currently comprises the lower ground floor flat of a three storey (including roof) residential terrace property with an existing partial basement/cellar (see Plates 1 to 4).

The site is located on a relatively flat lying residential road with an existing basement in the neighbouring property (see Plates 5 to 7).

During the survey no obvious signs of structural damage such as cracked bricks were observed on the property.

ENVIRONMENTAL SETTING

Published Geology & Aquifer Designations	Reference to British Geological Survey (BGS) Digital Map (1:50,000) and accessible information contained on the Environment Agency (EA) website and within the Groundsure report (ref. GS-5263871) indicates that the site is directly located over the London Clay Formation. No superficial deposits are anticipated at the site based on available sources of information.

	The London Clay Formation is designated 'Unproductive Strata' and in this area is likely to be approximately 50m in thickness.
Local Hydrology	Reference to information on local mapping, the Groundsure Enviro Insight Report (ref. GS-5263871) indicates that there are no surface water features within 250m of the site. However, reference to the *Lost Rivers of London* (Barton, N.J, 1982) suggests that the site is located approximately 500m west of the former course of a tributary of the River Westbourne, which has now been adopted into the local drainage/sewage system. The nearest known surface water feature are ponds located at Hampstead Heath, located approximately 1500m northwest. In addition, a covered reservoir is believed to be present to the north 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. Publicly accessible information contained on the EA website, gov.uk website and in the Groundsure Enviro Insight Report (ref. GS-5263871) indicates that the site is located in an area at very low risk of flooding from rivers and sea and at a low risk from surface water flooding. Information in the Groundsure Enviro Insight Report (ref. GS-5263871) indicates that site is not in an area considered prone to groundwater flooding.
Resource Potential & Ecological Quality	**Surface Water**: N/A there are no surface water courses within 500m 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).
Surrounding Land Use	Surrounding land uses are primarily residential.
Local Designations	Reference to information contained on the Groundsure Enviro Insight Report (ref. GS-5263871) indicates that a designated Local Nature Reserve (Westbere Copse) is located approximately 420m west of the site. No other designations (e.g. Sites of Special Scientific Interest) are located within 500m of the site.

BELOW GROUND ASSETS

As part of the assessment the following organisations were contacted to ascertain if they held any below ground assets below or in close proximity to the site:

- Network Rail;
- Crossrail;
- London Underground Ltd / Transport for London.

Responses have been received from Network Rail and London Underground confirming they do not hold any below ground assets in the vicinity of the site. A response from Crossrail is pending but based on experience of nearby sites below ground assets in the vicinity of the site are not anticipated.

Copies of correspondence are included in **Appendix D**.

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, interpretation of BGS mapping and information presented within the Groundsure Enviro Insight Report (ref. GS-5263871).

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

Local Ground Conditions

Available BGS borehole logs for the area surrounding the site is limited to one record approximately 300m southwest of the site (ref. TQ28SW85).

The BGS borehole record suggests that 0.3m of concrete was present underlain by weathered (to 7m bgl) and unweathered (proven depth of 17m bgl) London Clay.

No groundwater or visual or olfactory evidence of contamination was recorded on the BGS borehole log reviewed.

POTENTIALLY CONTAMINATIVE HISTORICAL LAND USE

A review of historical data within the Groundsure Enviro Insight Report (GS-5263871) has been completed to identify potentially contaminative previous land uses on site and within 250m of the site.

Date	On Site Features	Off Site Features
1866	-	Cuttings approximately 230m southwest.
1894	-	Cemetery approximately 220m north. Railway Sidings approximately 240m southwest. Cuttings approximately 240m southwest.

PRELIMINARY RISK ASSESSMENT

Date	On Site Features	Off Site Features
1911	-	Cemetery approximately 220m north. Infilling of reservoir approximately 20m northwest.
1920	-	Cemetery approximately 220m north. Infilling of reservoir approximately 35m northwest.
1938	-	Infilling of reservoir approximately 50m north.
1940	-	Infilling of reservoir approximately 40m north.
1949	-	Cemetery approximately 220m north. Infilling of reservoir approximately 50m northwest.
1953	-	Electricity substation approximately 175m south. Electricity substation approximately 180m north. Electricity substation approximately 185m south. Garage approximately 160m west. Garage approximately 215m south. Garage approximately 235m northeast.
1966	-	Cemetery approximately 220m north.
1973	-	Electricity substation approximately 120m east. Electricity substation approximately 160m east.
1974	-	Police Station approximately 240m northeast. Electricity substation approximately 180m north. Electricity substation approximately 180m west. Electricity substation approximately 185m south.
1976	-	Cemetery approximately 220m north. Infilling of reservoir approximately 50m north.

Date	On Site Features	Off Site Features
1991	-	Electricity substation approximately 120m east. Electricity substation approximately 180m north. Electricity substation approximately 180m west. Electricity substation approximately 185m south.
1992	-	Electricity substation approximately 120m east.
1993	-	Cemetery approximately 220m north. Infilling of reservoir approximately 50m north.
1994	-	Electricity substation approximately 120m east.
1996	-	Police Station approximately 240m northeast.

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. Various granted applications were reviewed within the site-wide area and were predominately related to minor residential conversions and alternations along with minor commercial renovations.

The closest planning decision related to basement construction is as follows:

- 49A Hillfield Road, London, NW6 1QD: Planning permission was granted on 5th March 2012 for excavation to lower floor level basement and to create front and rear lightwells in connection with the ground floor residential flat (Class C3).

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	Dry cleaners approximately 180m east.

Item	**On Site**	**0 – 250m**	**Description**
Discharge Consents	0	0	
Pollution Incidents	0	0	
Current Industrial Data	0	11	The closest current industrial land uses are 'construction and tool hire' and 'vehicle parts and accessories' approximately 90m southeast of the site. Other pertinent land uses include electricity substations (120m east and 180m north, west and south).
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	

ENVIRONMENTAL SENSITIVITY

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

- The Site is located in a predominantly residential land use 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 from rivers and sea and low risk from surface water flooding;
- The site is located within an area which is not prone to groundwater flooding;
- The are no known surface water features within 500m of the site; and

- A Local Nature Reserve is located approximately 410m west of the site. There are no other 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	• None identified, possible Made Ground.
	Off-site	• Infilled land within 50m (believed to be related to a covered reservoir). • Vehicle parts workshop within 90m. • Electricity substation within 120m. • Garage within 160m. • Dry cleaners within 180m.
Associated Contaminant	On-site	• None identified, possible contaminants associated with Made Ground including heavy metals, asbestos and organic contaminants.
	Off-site	• Heavy metals and inorganic contaminants. • Organic contaminants (including petroleum hydrocarbons and volatile organic compounds). • Bulk ground gases & volatile vapours.
Receptors		• Future Site Users; • Neighbouring residents; • Maintenance and construction workers (acute risk only). • New built development.
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.

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[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.

PRELIMINARY RISK ASSESSMENT

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).	Unlikely	Medium	Low	No potential on site contaminant sources have been identified and basement excavation is likely to remove the majority of Made Ground 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	Mild	Very Low	
Future Site Users (Indirect exposure pathway)				
Enclosed space accumulation of ground gas.	Unlikely	Severe	Moderate/Low	Potential sources of ground gas and volatile vapours are limited to off-site locations (such as dry cleaners). They are likely to be separated from the site by buildings and below ground features such as existing basements and utility infrastructure. In addition, the geology comprises low permeability London Clay and as such there is limited potential for ground gas /
Outdoor volatile vapour exposure	Unlikely	Medium	Low	

Pathway Linkage	Likelihood of Pollutant Linkage	Consequences	Risk Rating	Reasoning
				volatile vapour migration on to site.
Ingress into potable water supply pipes	Unlikely	Medium	Low	No on site potential contaminant sources 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.	Unlikely	Severe	Moderate/Low	Potential sources of ground gas and volatile vapours are limited to off-site locations (such as infilled land) and not considered to be significant. They are likely to be separated from the site by buildings and below ground features such as existing basements and utility infrastructure. In addition, the geology comprises low permeability London Clay and as such there is limited potential for ground gas / volatile vapour migration on to site.
Water Environment				
Contaminant migration on to neighbouring land.	Unlikely	Medium	Low	No on-site contaminant sources have been identified and basement development will result in removal of the majority of Made Ground soils. The site is directly underlain by London Clay Formation and
Contaminant migration from neighbouring land.	Unlikely	Medium	Low	

Pathway Linkage	**Likelihood of Pollutant Linkage**	**Consequences**	**Risk Rating**	**Reasoning**
Contamination of groundwater	Unlikely	Medium	Low	is considered unlikely to support a groundwater unit capable of contaminant migration.
Contamination of surface water	Unlikely	Medium	Low	No surface water features have been identified within 500m of the site.
Foundation Piling				
Creation of a pathway between any near surface contaminants and the underlying aquifers.	Unlikely	Mild	Very Low	No on-site contaminant sources have been identified and basement development will result in removal of the majority of Made Ground soils. If a piled foundation solution is adopted there is a substantial thickness of low permeability London Clay between potential contaminants and sensitive aquifers (e.g. Principal Chalk Aquifer).
Overall Risk Rating			**Very Low to Moderate/Low**	

Ground Investigation & Findings

INTRODUCTION

The ground investigation works were undertaken between 27th and 30th July 2018 and comprised the progression of 1No. continuous flight auger borehole and 1No. dynamic (windowless) sampler borehole to depths of 8.00m bgl and 5no. hand excavated trial pits to try and expose existing building foundations, with sampling of soil for laboratory testing (see **Figure 2**).

Groundwater monitoring was undertaken following completion of the fieldworks on 7th August and 22nd August 2018.

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 E, F** and **G** 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 Ground Movement & Construction

The predicted building damage during construction is based on a conservative approach and it is recommended that the contractor gives consideration to the Association of Specialist Underpinning Contractors (ASUC) guidelines which should provide some mitigation and reduce the potential movements.

Ground Movements Monitoring

It is recommended that movement monitoring should be undertaken with surveying points set up prior to commencement of the works and it is recommended that monitoring be undertaken at weekly intervals. It is recommended that trigger values for monitoring are based on the predicted ground movements to ensure conservatism and that they are agreed under the Party Wall Act.

REFERENCES & GUIDANCE).

INVESTIGATION STRATEGY

The ground investigation was designed based on the requirements of the Consultant Engineers set out in the email specification from Camille Corvec (Symmetrys) to Philip Lewis (LMB) 25th June 2017 and associated Site Investigation Plan.

GROUND INVESTIGATION & FINDINGS

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 F** and **G** 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 E**:

Strata	**Depth Range to Top (m bgl)**	**Depth Range to (Base (m bgl)**	**Summary Description**
Made Ground (1)	Ground Level	0.60 – 1.20	The ground surface in the existing basement/cellar area was found to comprise concrete hard standing. In the location BH1 it was found to comprised decorative gravel over concrete and in BH2 decorative gravel. The Made Ground soils were typically found to comprise slightly clayey sand over slightly gravelly clay with varying proportions of brick and concrete.
London Clay Formation (2)	0.60 – 1.20	8.00	Found to comprise firm becoming stiff clay with occasional sand partings and close to very close fissuring.

(1) Base not determined in all locations.

(2) Base not determined.

Visual and Olfactory Observations

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

Groundwater Conditions

No groundwater strikes were recorded during the ground investigation works but the soils were noted. During return monitoring groundwater was recorded in both the monitoring wells at depths of between 1.64m and 2.06m 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	London Clay Formation
Macintosh Probe Results		-	>100/140mm - >100/80mm
SPT 'N' Value		-	9 – 35
Undrained Shear Strength (kN/m^2)	Field	-	45 – >130
	Derived from SPT N Values	-	39 – 150
Bulk Density (mg/m^3)		-	-
Moisture Content (%)		13 – 18	30 – 33
Plasticity Index (%)			35 – 48
pH		7.6 – 8.3	6.6 – 7.6
Sulphate (g/l)		0.024 – 0.10	0.10 – 2.60

Geotechnical Advice

INTRODUCTION

The site currently comprises the lower ground floor flat of a three storey (including roof) residential terrace property with an existing partial basement/cellar.

It is understood that the Client wishes to deepen and extend the partial basement/cellar to create a single storey basement beneath the footprint of the existing building.

On this basis, it the following assumptions have been made:

- The finished floor level of the basement will be approximately 3.00m bgl.
- The load from the existing structure will be in the region of 30-40KN/m^2.
- For the existing structure (including the roof) the wall load is estimated at approximately 60-80kN/m run.
- There will be no significant changes in elevation over the proposed basement development.
- Foundations will not be eccentrically loaded.

GROUND CONDITIONS SUMMARY

The ground conditions encountered in the exploratory hole comprise Made Ground overlying a sequence of firm to stiff locally slightly sandy clays.

Groundwater was recorded at depths ranging between 1.64m and 2.06m bgl during the two monitoring visits.

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 DESIGN

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. 3.00m bgl a net safe bearing pressure of 115kN/m^2 should be available.

The net safe bearing pressure is based on a factor of safety of 3 to ensure that settlement remains within normally acceptable limits. It is recommended that the undrained shear strength of soils at formation level be confirmed using a hand shear vane and should exceed 50kN/m^2.

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.

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.

GROUND STABILITY & RETAINING STRUCTURES

Retaining walls constructed in open cut would be the preferred solution, but given the size of the excavation and the adjacent and nearby residential structures it is considered likely that temporary support (sheet piles or similar) will be needed for construction.

Localised groundwater was encountered above the anticipated excavation depth (c. 1.60-2.00m bgl) and 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 walls 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 within 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	0.60 – 1.20	27	0.35	3.5	1.70(1)
London Clay	0.60 – 1.20	8.00	22	0.42	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
London Clay Formation	DS-3	AC-2s

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 confirms that it is typically a high plasticity clay.

The removal of the overburden during the excavation of the 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 3.00m below current ground level, 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 60kN/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 limited areas outside the building footprint.
- The potential for groundwater to cause both lateral and uplift pressure.

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. This potential is discussed in more detail within the Ground Movement Assessment section.

Assessment of Soil Analytical Results

INTRODUCTION

As outlined, the basement will extend beneath the footprint of the existing property, with the existing front and rear garden areas retained. As such, a large proportion of the Made Ground soils at the site will be removed to facilitate development.

Notwithstanding this a conservative approach has been adopted and a Generic Quantitative Risk Assessment (GQRA) and preliminary waste characterisation have been completed. No statistical analysis has been completed and recorded concentrations have been compared directly to Generic Assessment Criteria (GAC) considering a residential (without plant uptake) end use. Based on the laboratory testing a Soil Organic Matter (SOM) of 1% has been applied.

In addition to the GAC, the provisional Category 4 Screening Levels (pC4SL) developed by CL:AIRE for DEFRA in response to the new definitions within the Contaminated Land Statutory Guidance (ref. DEFRA, April 2012) have also been considered within the assessment.

RISK ASSESSMENT

Assessment of Potential Risks to Future Site Users (Soil Contamination)

Two samples of the Made Ground soils were collected during the ground investigation (BH1 at 0.50m and BH2 at 0.80m) and analysed for a range of determinands including, heavy metals, petroleum hydrocarbons, Polycyclic Aromatic Hydrocarbons (PAH) and asbestos screening.

The majority of the recorded concentrations of determinands were found to either be below the limit of detection for the laboratory method applied or below relevant GAC considering a residential (without plant uptake) end use.

The exceptions are the concentrations of Lead in the shallow soils of the front garden area and concentrations of certain PAHs in the shallow soils of the rear garden area. However, in the rear garden area these soils are contained beneath concrete (beneath decorative gravel) and in the front garden area the soils are likely to be excavated and removed to facilitate basement development.

As such it is considered unlikely that the recorded concentrations of Lead and PAHs will pose a risk to future site users but should be considered by maintenance and construction workers.

Asbestos in Soils

The sample of the Made Ground soils from BH1 was screened for the presence of Asbestos Containing Materials (ACM). No ACM were detected.

ASSESSMENT OF SOIL ANALYTICAL RESULTS

WASTE CHARACTERISATION

The Landfill (England and Wales) Regulations (2002, as amended), the Hazardous Waste (England and Wales) Regulations (2005, as amended) and the Waste (England and Wales) Regulations (2011) have changed the way in which waste materials have traditionally been managed (i.e. landfill disposal). If materials are to be discarded from site, appropriate characterisation and classification are required prior to disposal, to determine whether a waste should be described as either non-hazardous or hazardous. The process of classification is based around the List of Wastes (England) Regulations in conjunction with the Environment Agency Guidance Document WM3 (edition 1, 2015). Waste Acceptance Criteria (WAC) are often confused as a means of classification when, in actuality, they represent criteria that wastes must satisfy for disposal in target landfill types (i.e. non-hazardous waste may be described as inert if it satisfies the appropriate WAC; however, hazardous waste can never be classified as inert even if it satisfies the WAC for an inert landfill).

Certain categories of waste material are termed 'absolute entries' within the List of Wastes Regulations (2005) and are automatically classified as inert or hazardous e.g. glass packaging and acid tars respectively.

Source of Potential Wastes

The waste materials on site are considered to comprise the Made Ground soils that occupy (typically) the upper 1.00m to 2.00m below ground level. In general, the majority of this material could be thought of as 'Construction and Demolition Wastes (including Excavated Soil from Contaminated Sites)' and such soils could be described as inert, non-hazardous or hazardous, dependant on its source and chemical characteristics.

The source of the Made Ground materials is not known but based on the ground conditions encountered it appears to primarily comprise reworked and possible demolition material that is considered to have been derived from historical, local demolition and construction and possibly reworking of the natural soils in the area of the existing property.

BASIC WASTE CHARACTERISATION

Made Ground

On a purely visual basis, the majority of the Made Ground would appear to conform with 'soils and stones' excluding topsoil, peat and excluding soil and stones from contaminated sites (European Waste Catalogue Code 17 05 04), which would be an inert waste material. However, where soil and stones are not automatically classified as inert they will always be treated as so called 'mirror entries' of the List of Waste Regulations (European Waste Catalogue Code 17 05 03 mirror hazardous or 17 05 03 mirror non-hazardous). An assessment of the composition of the soil is required to determine the concentrations of potentially dangerous substances that maybe present in the soils to allow the waste to be classified accordingly.

As such, chemical analysis has been completed on two samples of Made Ground (BH1 & TP2) in general accordance with the Environment Agency document Waste Sampling and Testing for Disposal to Landfill (ref. EBPRI 11507B, March 2013). The results have been used to aid in basic waste characterisation utilising the information presented within the WM3 document for Hazardous wastes.

In addition, a sample of Made Ground (BH1, 0.50m) was tested for the presence of Asbestos Containing Materials with none detected.

Reference to the WM3 document suggests that the majority of the Made Ground materials will be listed as non-hazardous wastes. Any basic waste characterisation will need to be confirmed by the receiving facility.

Natural Ground Deposits

The natural soils (London Clay Formation) are likely to be listed as inert (soils and stones, European Waste Catalogue Code 17 05 04), again this will need to be confirmed by the receiving landfill facility.

In addition, given the scarcity of inert landfill cells it may be more appropriate (depending on timescales and feasibility etc) to source an alternative use for the soils (such as fill materials or daily cover) or to dispose to non-hazardous landfill.

Waste Acceptance Criteria (WAC) Testing

WAC testing has been undertaken on the sample of Made Ground collected from BH1 (0.50m), with the results presented in **Appendix G**.

The results indicate that Made Ground soils would meet the inert waste landfill waste acceptance criteria.

Updated Conceptual Site Model & Pollutant Linkage Assessment

CONCEPTUAL SITE MODEL

Source-Pathway-Receptor Model

Contaminant Sources

Based on the results of the PRA and ground investigation no potential sources of on site contamination are limited to elevated concentrations of Lead (front garden) and PAHs (rear garden area).

Potential off-site sources of contamination include historical surrounding land uses such as possible in-filled reservoirs, an electricity sub-station, dry cleaners and garage.

Contaminant Migration Pathways & Receptors

The potential exposure pathways and receptors described in the Preliminary Risk Assessment section are largely considered to remain valid.

Elevated concentrations of Lead were detected beneath an area of concrete hard standing in the rear garden area, which will remain following development and as such will sever direct contact pathways and should not pose a risk to future site users. Similarly, elevated concentrations of PAHs in the front garden were recorded but will be removed to facilitate development.

However, the recorded concentrations of Lead and PAHs should be considered by maintenance and construction workers

The ground investigation works confirm the presence of low permeability soils beneath the site which along with the presence of local infrastructure and existing basement/lower ground floors will limit the potential for ground gas / volatile vapour migration on to site.

POLLUTANT LINKAGE ASSESSMENT

Based on the information reviewed and GQRA completed, no plausible pollutant linkages are considered to exist.

There is potential for maintenance and construction workers to come into contact with Made Ground soils during construction works. However, it should be noted that this relates to acute and not chronic risk and as such cannot be assessed using the approach described within the statutory guidance (ref. 2).

It is recommended that maintenance and construction workers involved in below ground works adopt appropriate management procedures to mitigate potential risks.

Ground Movement Assessment

INTRODUCTION

There is the potential for ground movements due to the proposed development from the wall installation and from the excavation process. It has been assumed that the excavation will be undertaken using the traditional method of underpinning formed in a 'hit and miss' sequence up to a depth of approximately 3.00m. An appropriate propping system will be utilised.

To provide some basis of estimating likely movements and damage resulting from excavating the basement in front of the underpinning, and in the absence of underpinning specific guidance, the underpinned sections of the new basement have been treated as piles.

The magnitude and extent of ground movements resulting from installation of a piled wall and excavation in front of such a wall are typically estimated based on the guidance given in the CIRIA publication C760 'Guidance on embedded retaining wall design'. The guidance in the CIRIA publication is based on the behaviour of embedded walls at numerous sites in London, which are predominantly walls embedded in London Clay, though typically with some near surface deposits consisting of River Terrace Deposits and Made Ground.

BUILDING DAMAGE ASSESSMENT

CIRIA C760 provides curves estimating horizontal and vertical ground surface movements due to piled wall installation and to excavation in front of wall. Total ground movements resulting from the excavation will be the combination of the installation movements and the excavation movements.

The method provided within Box 6.3 in CIRIA C760 has been used to inform the assessment. CIRIA C760 curves were used to make a prediction of ground movement assuming a high support stiffness wall. Potential corner stiffening effects have not been applied.

Ground Movements – Wall Installation

The movements resulting from excavation in front of the underpins incorporate the movements resulting from the construction (i.e. installation) of the underpins, since, unlike for the piles, the construction process requires an excavation prior to the pins being formed. Therefore CIRIA 760 curves representing ground movements arising from wall installation (Fig. 6.8a and Fig. 6.8b) have not been considered for the underpins.

Ground Movements – Excavation in Front of Wall

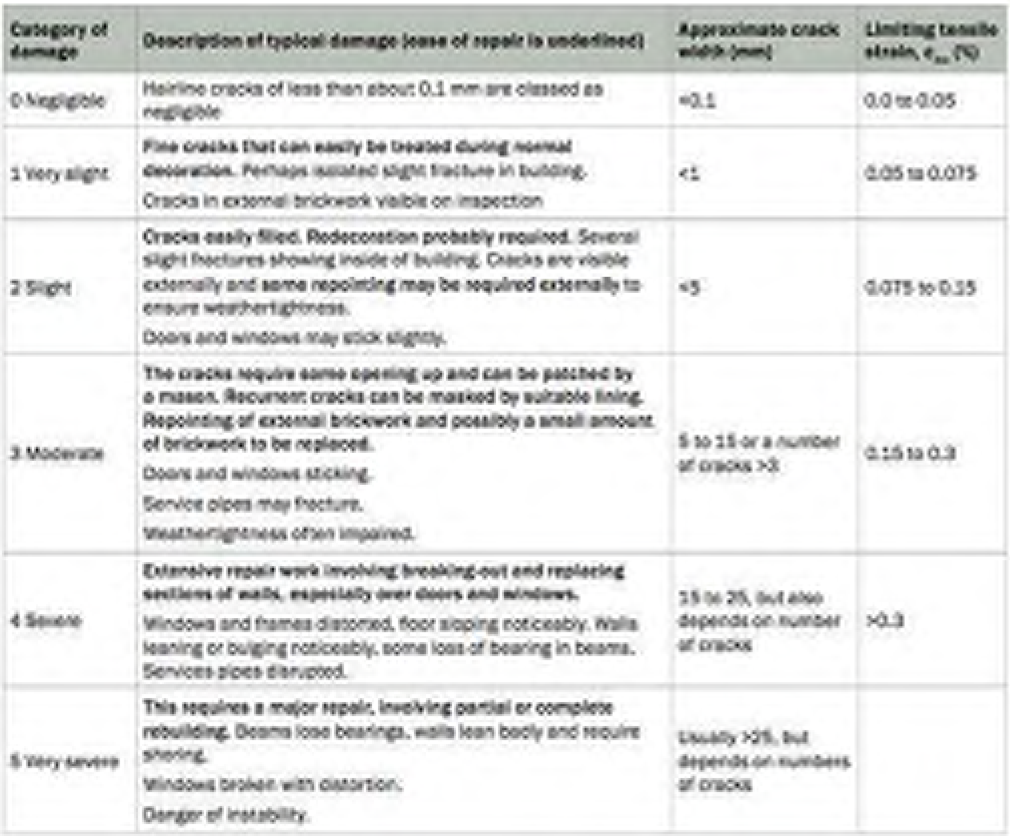
Consideration has been given to account for the nature of the soil to be excavated which comprises Made Ground overlying the London Clay formation. Ground movements arising from excavation in front of wall have been based on Fig. 6.15a and Fig. 6.15b of CIRIA C760 assuming a high support stiffness wall.

GROUND MOVEMENT ASSESSMENT

Damage category

Using these predicted movements, estimates of possible damage have been made for the surrounding structures, based on the Damage Classification Scheme proposed by Burland and Wroth (1974), and later supplemented by the work of Boscardin and Cording. This methodology is described within Box 6.3 in CIRIA C760 (and preceding CIRIA publications).

The ‘Burland Scale’ damage categories are presented in the table below:



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

Damage categories 1 and 2 are generally considered to represent aesthetic damage only.

Summary of Results

Copies of worksheets calculations and graphical representation of the results are presented in **Appendix H** and are summarised in the table below:

GROUND MOVEMENT ASSESSMENT

Nearby Building / Structure	Estimated Damage Category No.	Category of Damage
39 Hillfield Road	1	Very Slight
41 Hillfield Road	1	Very Slight
45 Hillfield Road	1	Very Slight
47 Hillfield Road	1	Very Slight

The ground movement assessment undertaken indicates that damage to surrounding properties will generally be within Burland Category 1 (Very Slight).

Anticipated vertical movements provide a maximum tilt of about 1 in 5000, which is well within generally tolerable differential movement.

The results achieved in the GMA, adopting the C760 empirical assessment approach, are considered to represent an upper bound of theoretical movements, based on historical data. These movements should be reduced by adopting modern techniques, a suitable sequence of works, and a high stiffness propping system. In addition, it should be noted that the presence of existing basements at some of the surrounding buildings has not be considered in the analyses. The presence of such basements would typically reduce the effects of ground movements.

In general, ground movements can be minimised by careful design, sequencing and supervision of the works, ensuring that a high quality of workmanship is maintained.

ADDITIONAL CONSIDERATIONS

Heave

As outlined, an excavation of approximately 3.00m thickness of soil will generate a maximum unloading in the order of 60kN/m^2.

This will result in a measure of short term heave and long term swelling of the underlying London Clay, which theoretically takes a number of years to complete. The new basement slab will be designed to withstand the potential heave forces and movements. About 30 to 50% of soil heave pressure would normally be expected to occur prior to construction of the slab (for a normal construction programme). As such 50% to 70% of potential heave will remain after excavation. Localised groundwater has been recorded at approximately 1.60m to 2.00m bgl. As such the water pressure would need to be considered in the slab design, in addition to the soil heave pressure.

The excavation depth and modest dimensions of the site are such that heave movement associated with unloading of the clay is unlikely to exceed a few millimetres or to have any significant impact on the surrounding structures. Any movement that does occur will be further mitigated by the necessarily slow rate of the excavation and construction.

Ground Movement & Construction

The predicted building damage during construction is based on a conservative approach and it is recommended that the contractor gives consideration to the Association of Specialist Underpinning Contractors (ASUC) guidelines which should provide some mitigation and reduce the potential movements.

Ground Movements Monitoring

It is recommended that movement monitoring should be undertaken with surveying points set up prior to commencement of the works and it is recommended that monitoring be undertaken at weekly intervals. It is recommended that trigger values for monitoring are based on the predicted ground movements to ensure conservatism and that they are agreed under the Party Wall Act.

REFERENCES & GUIDANCE

REFERENCES & GUIDANCE

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22. Environment Agency (2009c), Updated Technical Background to the CLEA Model, Report SC050021/SR3, January 2009;

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[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;
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FIGURES

Key:

○ Approximate site location

N

IMPORTANT – Please Read

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LMB

Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

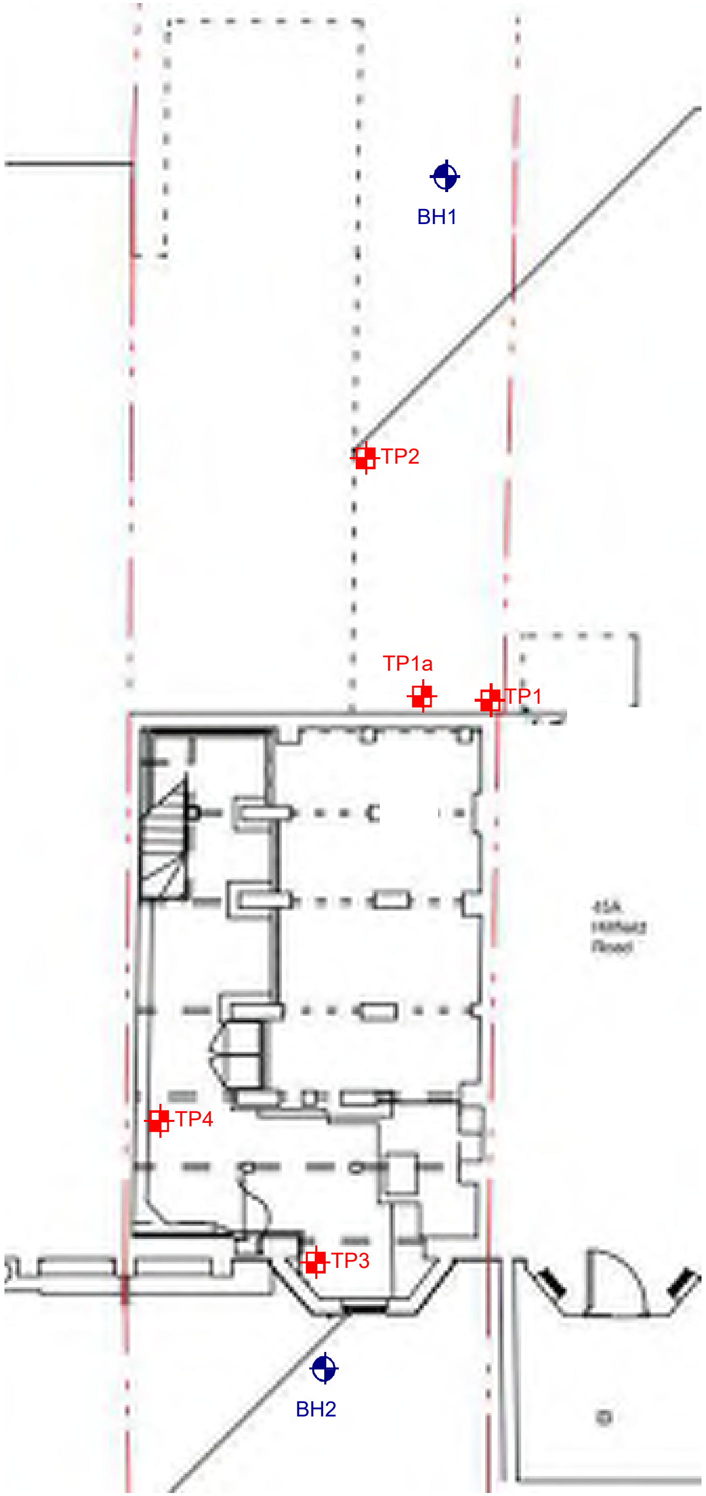
Site:
43 Hillfield Road, London NW6

Figure Number: Figure 1

Title: Site Location Plan

Project No:	**Created By:**	**Date:**
	PIL	August 2018

Client:



Key:

⊕ BH	Borehole location
⊕ TP	Trial Pit location

IMPORTANT – Please Read

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Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

Site:
43 Hillfield Road, London NW6

Figure Number: Figure 2

Title: Exploratory Hole Location Plan

Project No:

Created By: PIL

Date: August 2018

Client:

Key:

▯ 43 Hillfield Road

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LMB

Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

Site:
Hillfield Road, London NW6

Figure Number: Figure 3

Title: Surrounding Properties

Project No:	**Created By:**	**Date:**
	PIL	August 2018

Client:

APPENDICES

Appendices

APPENDIX A DEVELOPMENT SCHEMATIC

QD A1

REFER TO ARCHITECTS DRAWINGS FOR ALL SETTING OUT DETAILS

THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL TEMPORARY SUPPORTS AND RESPONSIBLE FOR STABILITY OF THE STRUCTURE DURING WORKS

LEGEND

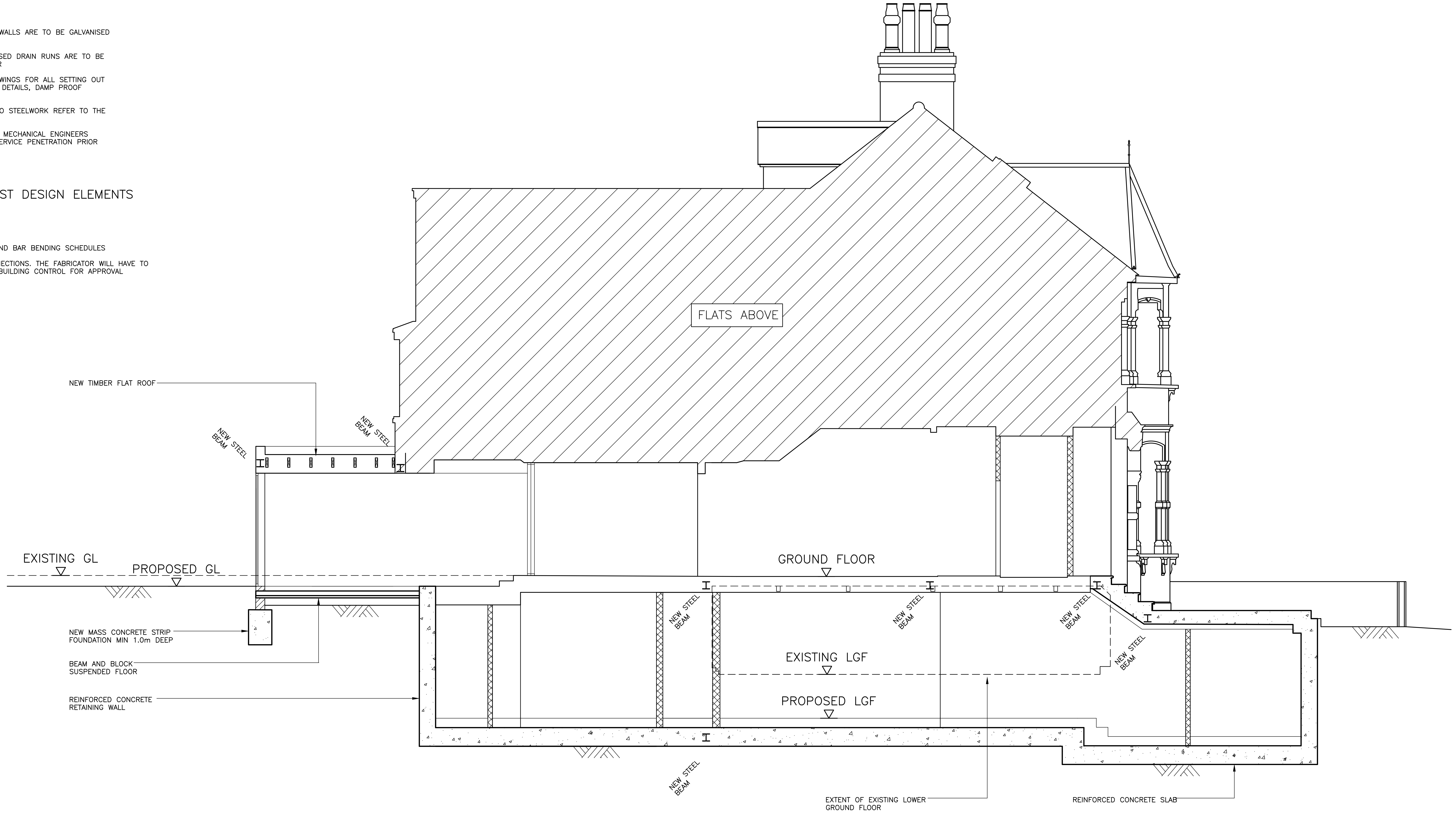
▭	DENOTES EXISTING MASONRY OR TIMBER WALLS
▨	DENOTES NEW MASONRY WALLS BUILT IN $15N/mm^2$ COMPRESSIVE STRENGTH BRICKWORK AND GRADE iii MORTAR
▨	DENOTES NEW MASONRY WALLS BUILT IN $7N/mm^2$ COMPRESSIVE STRENGTH BLOCKWORK AND GRADE iii MORTAR
☒	DENOTES NEW NON LOAD BEARING STUD WALL BY ARCHITECT

NOTES

- ALL STEELWORK IN THE EXTERNAL WALLS ARE TO BE GALVANISED (125 MICRONS)
- 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

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



SECTION A–A

1:50

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
DRAFT	24.07.18	AH	FOR COMMENTS

Drawing Status
PLANNING

Symmetrys Limited
Consulting Structural Engineers

6 The Courtyard, Lynton Road
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T: 020 8340 4041
W: www.symmetrys.com
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Job Title

47 HILFFIELD ROAD
NW6 1QD LONDON

Drawing Title

SECTION A–A

Job No.	Drawing No.	Revision
17420	SK–03	DRAFT

Scales 1:50 AT A1
Original Size A1
Drawn By JNS Date MAY 2018

APPENDICES

APPENDIX B PHOTOGRAPHIC RECORD

Plate 1: Front view of existing property.

Plate 2: Neighbouring Property (no. 41).

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Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

Photographic Record

Project: Flat 1, 43 Hillfield Road

Plates 1 & 2

Plate 3: Existing cellar/basment.

Plate 4: Drain cover within existing basement/cellar.

LMB

Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

Photographic Record

Project: Flat 1, 43 Hillfield Road

Plates 3 & 4

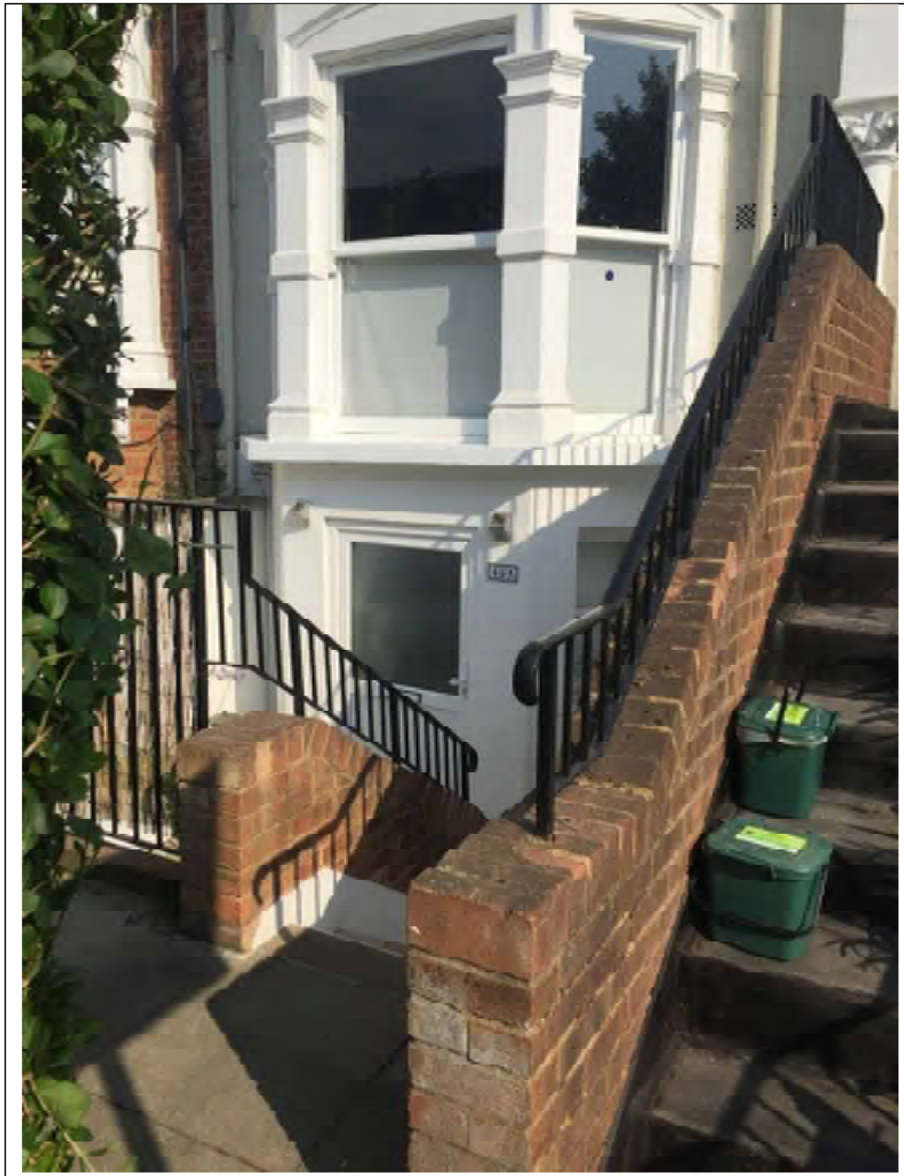


Plate 5: Existing basement in neighbouring property (no. 45).


Plate 6: View east along Hillfiled Road.

Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

Photographic Record

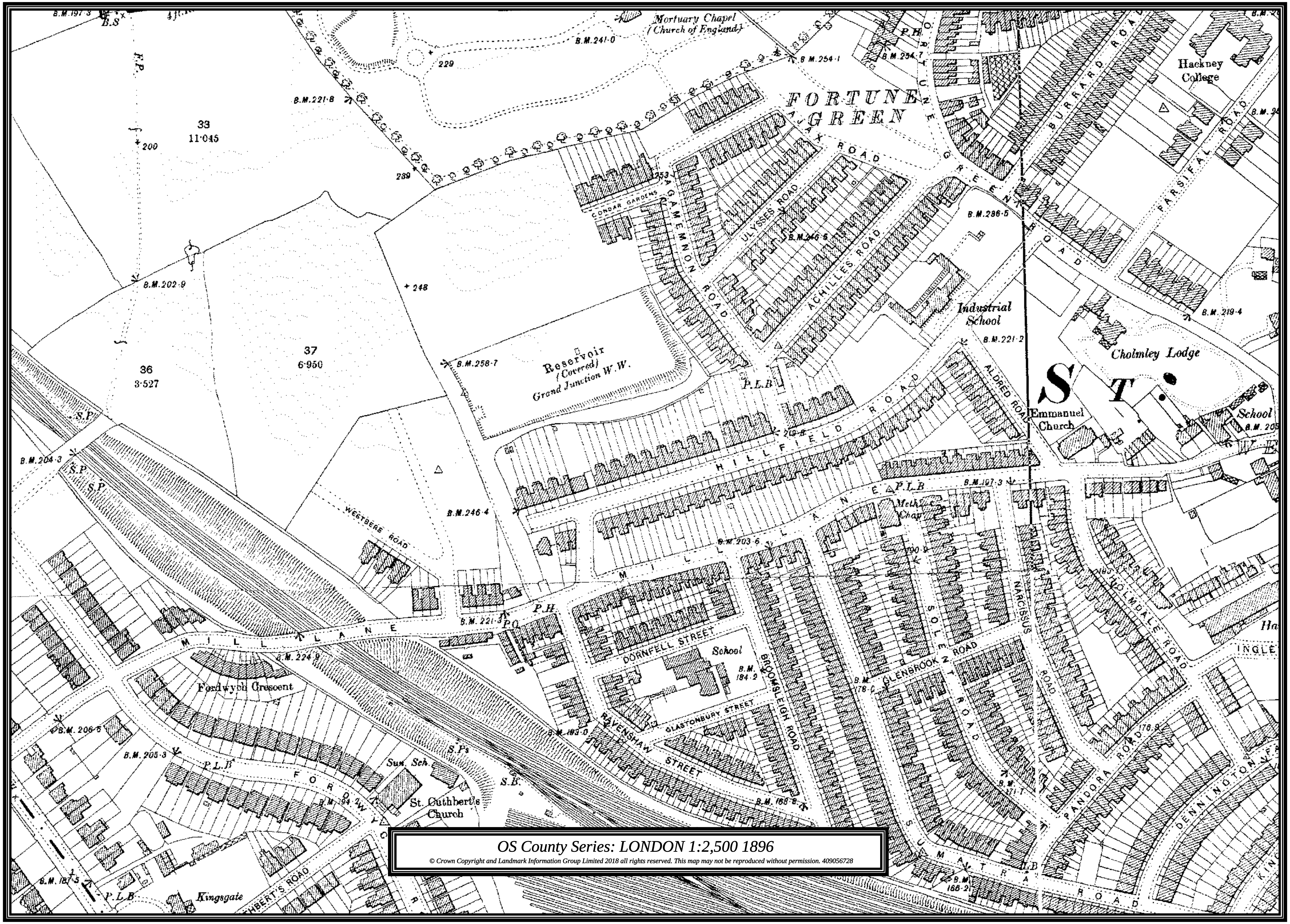
Project: Flat 1, 43 Hillfield Road

Plates 5 & 6

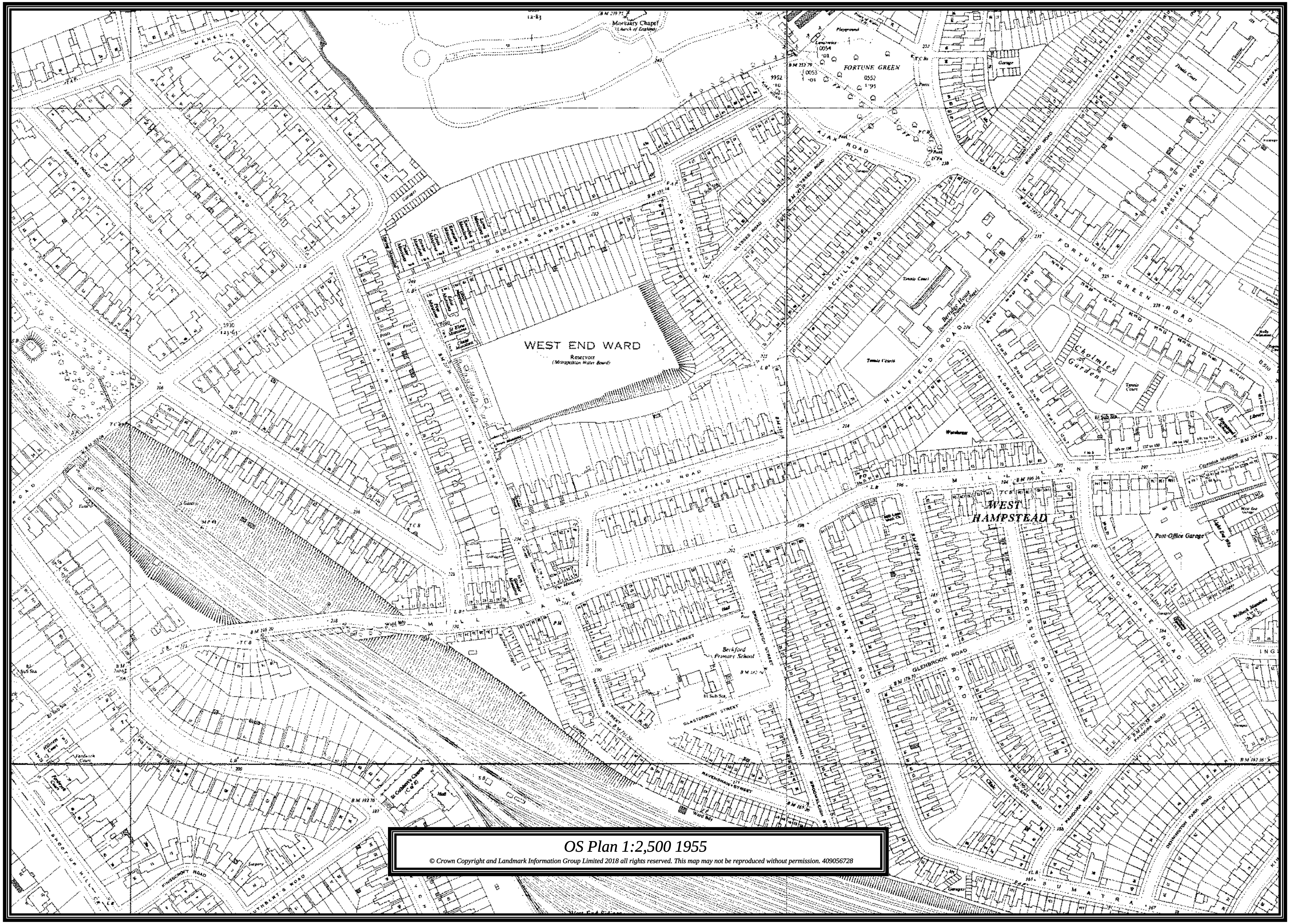
Plate 7: View west along Hillfield Road.

APPENDICES

APPENDIX C SELECTED HISTORICAL MAPS



OS County Series: LONDON 1:2,500 1896



OS Plan 1:2,500 1955

APPENDICES

APPENDIX D RESPONSES FROM BELOW GROUND ASSET HOLDERS

Philip Lewis

From: LULHVpowerassets@tfl.gov.uk
Sent: 24 July 2018 12:41
To: philip@lmbgeosolutions.com
Subject: NRSWA Request Response - Your Reference 43 Hillfield Road

Our Ref: 5IK9927C
Your Ref:43 Hillfield Road
Date:24 July 2018

Name: Philip Lewis
Company Name: LMB Geosolutions Ltd

Dear Sir/Madam

We acknowledge receipt of your Letter / New Roads & Street Works Act Enquiry dated 24/07/18 relating to the following enquiry:

43 Hillfield Road, London NW61QD

We have no H.V. cables or cable duct routes in the immediate area in question. Please note that we only manage High Voltage, Pilot and Fibre Optic Cables for the London Underground distribution network.

Yours sincerely

On Behalf of the H.V. Cables Manager

Title: NRSWA co-ordinator

Email:LULHVpowerassets@tfl.gov.uk

London Underground
Power Distribution

Units 7 & 8,Station Road
Drawing Office
Tufnell Park
London
N19 5UW
Tel: 0203 054 8418

Philip Lewis

From:	Adams Mandy <Mandy.Adams@networkrail.co.uk> on behalf of OP Buried Services Enquiries <OPBuriedServicesEnquiries@networkrail.co.uk>
Sent:	24 July 2018 13:22
To:	Philip Lewis
Subject:	RE: 43 Hillfield Road, London NW61QD

Dear Sir/Madam,

With regards to your enquiry, Network Rail does not believe there is any Network Rail owned apparatus or underground services within the area you have defined. As there is always the possibility that new works could be planned and undertaken in this area by Network Rail this information is valid as at today's date and is supplied for general guidance only.

Please be aware that this response is based on Network Rail's records and knowledge and no guarantee can be given regarding accuracy or completeness. CAT scans, safe digging practices (as contained in HSE publications) and other appropriate investigative techniques should always be carried out.

There may be other apparatus or underground services owned or operated by Utility Companies and accordingly you should contact individual utilities for information.

If, in connection with your investigations and/or work, you become aware of Network Rail apparatus or underground services within your area of work, please ensure these are notified to our Asset Protection team via the following link as a matter of urgency so that appropriate measures for avoidance of risk and damage can be put in place.

http://www.networkrail.co.uk/aspx/1758.aspx?cd=1

If you require any further clarification on any of the information please contact opburiedservicesenquiries@networkrail.co.uk.

Regards

Mandy Adams
Distribution Administrator (NRSWA), Asset Information Services

Asset Information Services: to inspire & enable through the power of data
National Records Centre, Audax Road, Clifton Moor, York, YO30 4US

T: 01904 386391 (int: 35391)
E: mandy.adams@networkrail.co.uk

From: Philip Lewis [mailto:philip@lmbgeosolutions.com]
Sent: 24 July 2018 11:22
To: locationenquiries@tube.tfl.gov.uk; LULHVpowerassets@tfl.gov.uk; OP Buried Services Enquiries; safeguarding@crossrail.co.uk
Subject: RE: 43 Hillfield Road, London NW61QD
Importance: High

Dear Sir/Madame
Our client will be developing the property at the above address including a basement and we would be interested in finding out if you hold any below ground assets in the nearby vicinity.

I have attached a location plan for your information.

Best regards,

Philip Lewis
Bsc (Hons), Msc, FGS, CGeol
Director
LMB Geosolutions Ltd
Tel. +44 7739735097

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Constructionline

worksafe consultant

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****

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London Underground
Infrastructure Protection

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Albany House
55 Broadway
London SW1H 0BD

www.tfl.gov.uk/tube

Your ref:
Our ref: 24211-SI-11-260718

Philip Lewis
LMB Geosolutions Ltd
philip@lmbgeosolutions.com

26 July 2018

Dear Philip,

43 Hillfield Road London NW6 1QD

Thank you for your communication of 24th July 2018.

I can confirm that London Underground has no assets within 50 metres of your site as shown on the plan you provided.

If I can be of further assistance, please contact me.

Yours sincerely

Shahina Inayathusein
Information Manager
Email: locationenquiries@tube.tfl.gov.uk
Direct line: 020 3054 1365

London Underground Limited
trading as London Underground
whose registered office is
55 Broadway
London SW1H 0BD

Registered in England and Wales
Company number 1900907

VAT number 238 7244 46

London Underground Limited is
a company controlled by a local
authority within the meaning of
Part V Local Government and
Housing Act 1989. The controlling
authority is Transport for London.

POSITIVE ABOUT DISABLED PEOPLE

MAYOR OF LONDON

APPENDICES

APPENDIX E EXPLORATORY HOLE LOGS

Borehole Log

Borehole No.	**BH1**	Sheet 1 of 1	
Project Name:	43 Hillfield Road	Project No. LMB_Hillfield	Co-ords: -
Hole Type	RO		
Location:	Hillfield Road, London NW6	Level:	
Scale	1:50		
Client:	Andras Cserep	Dates:	27/07/2018 - 27/07/2018
Logged By	PIL		

Samples and In Situ Testing

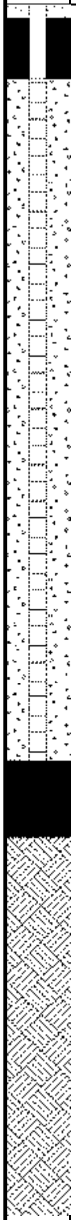
Depth (m)	Type	Results
0.50	ES	
0.75	D	
1.00	D	
		HVP=70
1.50	D	
2.00	D	
		HVP=100
2.50	D	
3.00	D	
		HVP=105
3.50	D	
4.00	D	
		HVP=108
4.50	D	
5.00	D	
		HVP=115
6.00	D	
		HVP=120
7.00	D	
		HVP=130
8.00	D	
		HVP=130

Depth (m)	Level (m)	Stratum Description
0.09		MADE GROUND: decorative gravel and membrane over concrete.
0.12		MADE GROUND: tarmac.
0.18		MADE GROUND: brick.
0.60		MADE GROUND: brown slightly gravelly clay. Gravel sub-angular fine to medium brick and sub-rounded flint.
1.30		Firm brown CLAY with occasional orange/brown mottling. (LONDON CLAY).
4.80		Firm becoming stiff brown CLAY with rare blue/ grey veining. Some fissuring visible. (LONDON CLAY FORMATION).
8.00		Stiff dark brown CLAY. Very closely fissured. (LONDON CLAY FORMATION).
		End of borehole at 8.00 m

Remarks

Borehole Log

Project Name: 43 Hillfield Road	Project No. LMB_Hillfield	Co-ords: -	Borehole No. **BH2** Sheet 1 of 1
Location: Hillfield Road, London NW6		Level:	Hole Type WLS
			Scale 1:50
Client: Andras Cserep		Dates: 30/07/2018 - 30/07/2018	Logged By PIL



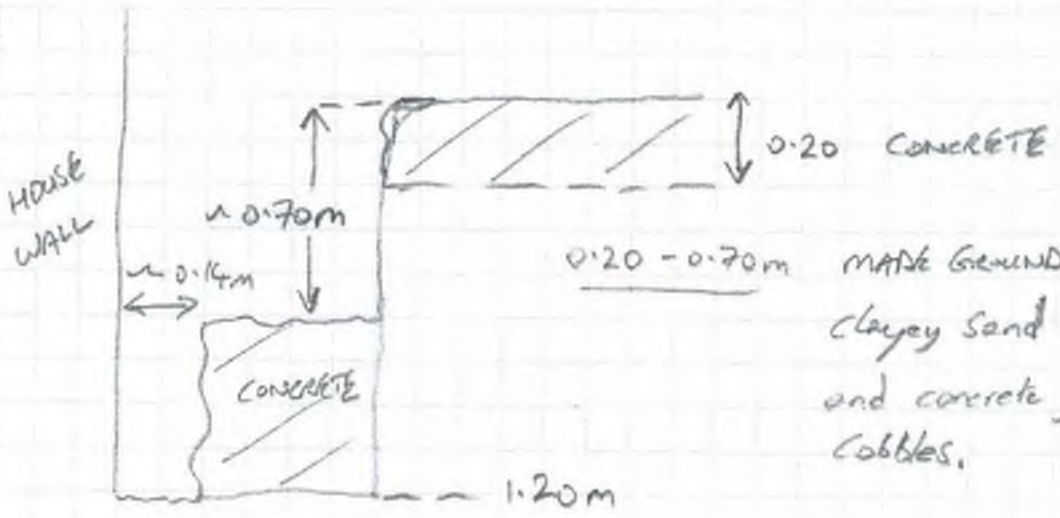
Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Stratum Description
					0.50		MADE GROUND: decorative gravel over brown slightly gravelly slightly clayey sand with brick and concrete gravel.
		0.80	ES		1.10		MADE GROUND: brown slightly gravelly clay. Gravel sub-angular fine to coarse brick. Rootlets throughout and appears desiccated. *0.70m becomes sandy.*
		1.00	D				
		1.00		N=9 (2,3/3,2,2,2)	2.00		Firm brown with orange/brown mottling CLAY with rare rootlets. (LONDON CLAY FORMATION). *1.50m occasional grey mottling.*
				HVP=45			
		2.00	D		3.70		Firm brown with blue/grey veining CLAY. Closely fissured. (LONDON CLAY FORMATION). *2.50m rare orange/brown silty fine sand partings and selenite crystals.*
		2.00		N=9 (1,1/2,2,2,3)			
				HVP=75			
		3.00	D				
		3.00		N=10 (2,2/2,2,3,3)			
				HVP=100	8.00		Stiff brown with grey/blue veining CLAY. Very closely fissured. (LONDON CLAY FORMATION). *5.60m orange/brown sand partings and large selenite crystals.* *6.0m less blue/grey veining.* *6.50m frequent selenite crystals.*
		4.00	D				
		4.00		N=15 (2,3/3,4,4,4)			
				HVP=125			
		5.00	D				
		5.00		N=18 (4,3/4,4,5,5)			
				HVP=125			
		6.00	D				
		6.00		N=19 (4,5/4,5,5,5)			
				HVP=125			
		7.00	D				
		7.00		N=23 (4,4/5,5,6,7)			
		7.50		N=35 (7,8/7,8,10,10)			
							End of borehole at 8.00 m

Remarks

Project: Flat 1, 43 Hillfield Rd

Description: Foundation Excavation Trial Pits
Made: PIL
Date: 23/8/18

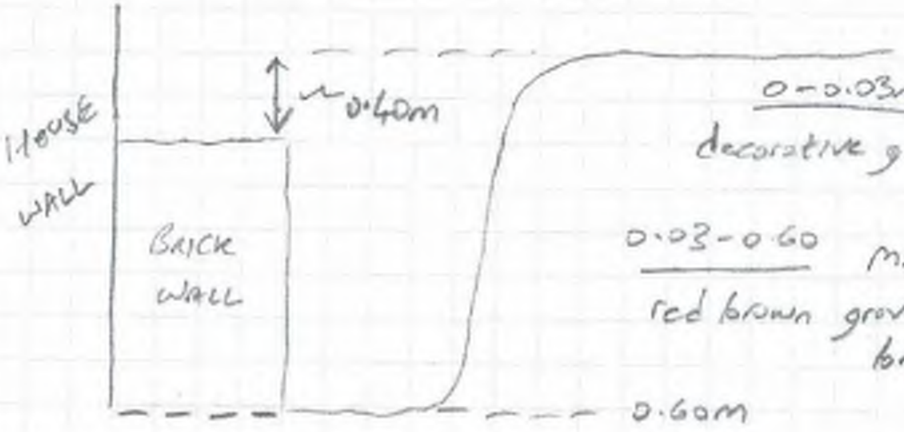
TP1 A



0.20 - 0.70m MADE GROUND: dark brown clayey sand with brick and concrete gravel and cobbles.

NOTE: Unable to progress due to concrete.

TP1B



0 - 0.03m MADE GROUND: decorative gravel over membrane.

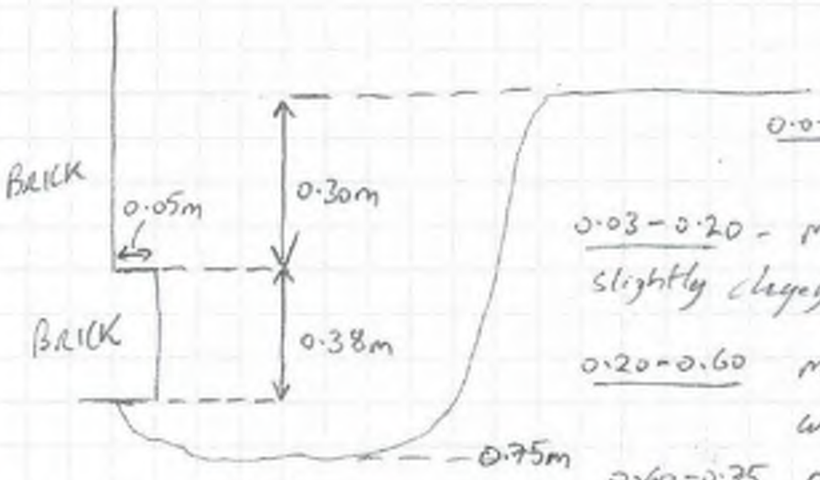
0.03 - 0.60 MADE GROUND: brown to red brown gravelly sand with brick cobbles.

NOTE: Unable to progress due to brick wall - possibly associated with existing basement / cellar.

Project: Flat 1, 43 Hillfield Rd

Description: Foundation Excavation Trial Pits
Made: PIL
Date: 23/8/18

TP2



0.0-0.03 - Decorative gravel over membrane.

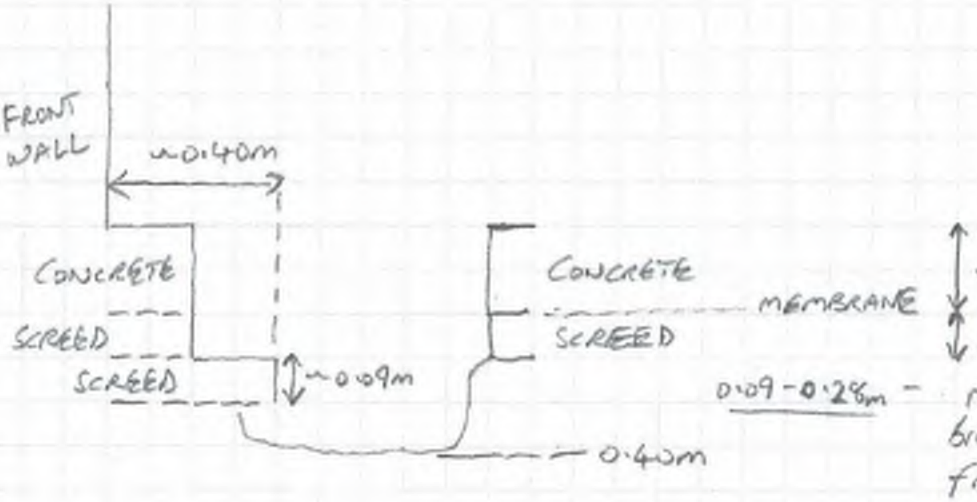
0.03-0.20 - MADE GROUND: black/brown slightly clayey sand with brick fragments.

0.20-0.60 MADE GROUND: brown clay with brick fragments.

0.60-0.75 Firm brown CLAY.

(MSV 55kN/m²)

TP3



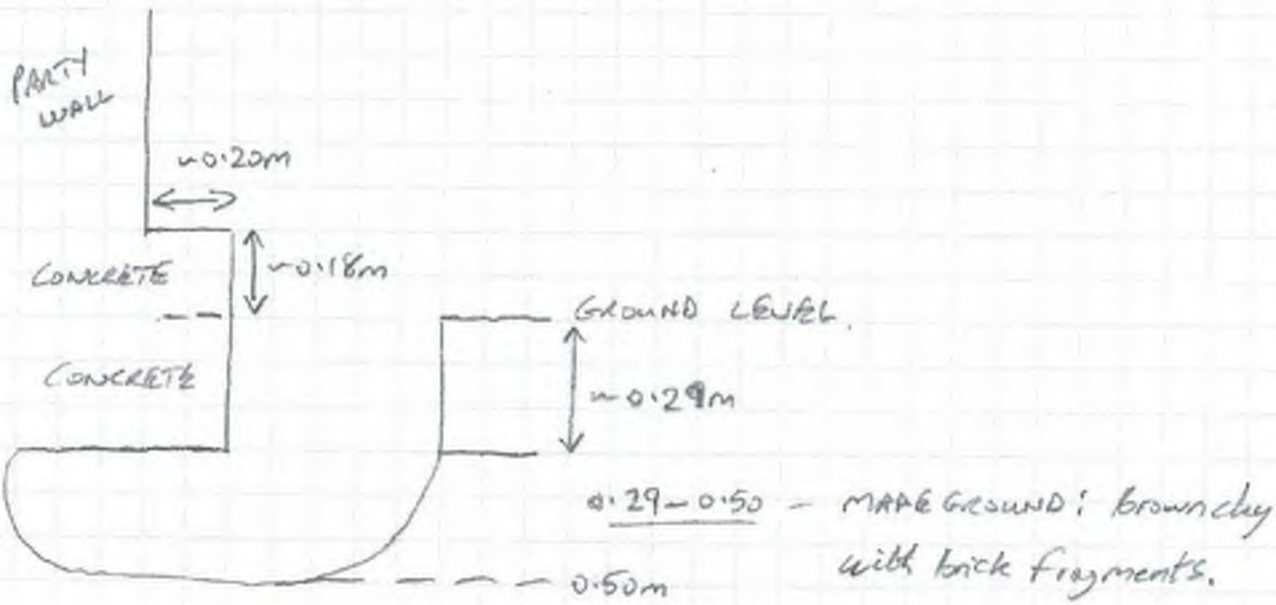
0.09-0.28m - MADE GROUND: brown clay with brick fragments.

0.28-0.40m - Firm brown CLAY.

Project: Flat 1, 43 Hillfield Rd

Description: Foundation Excavation Trial Pits
Made: PIL
Date: 23/8/18

TP4



0·29–0·50 – MADE GROUND: brown clay with brick fragments.

Trial Pit TP1a & 1b

Trial Pit TP1b

Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

Trial Pit Photographs

Project: Flat 1, 43 Hillfield Road

TP 1a & 1b


Trial Pit TP2

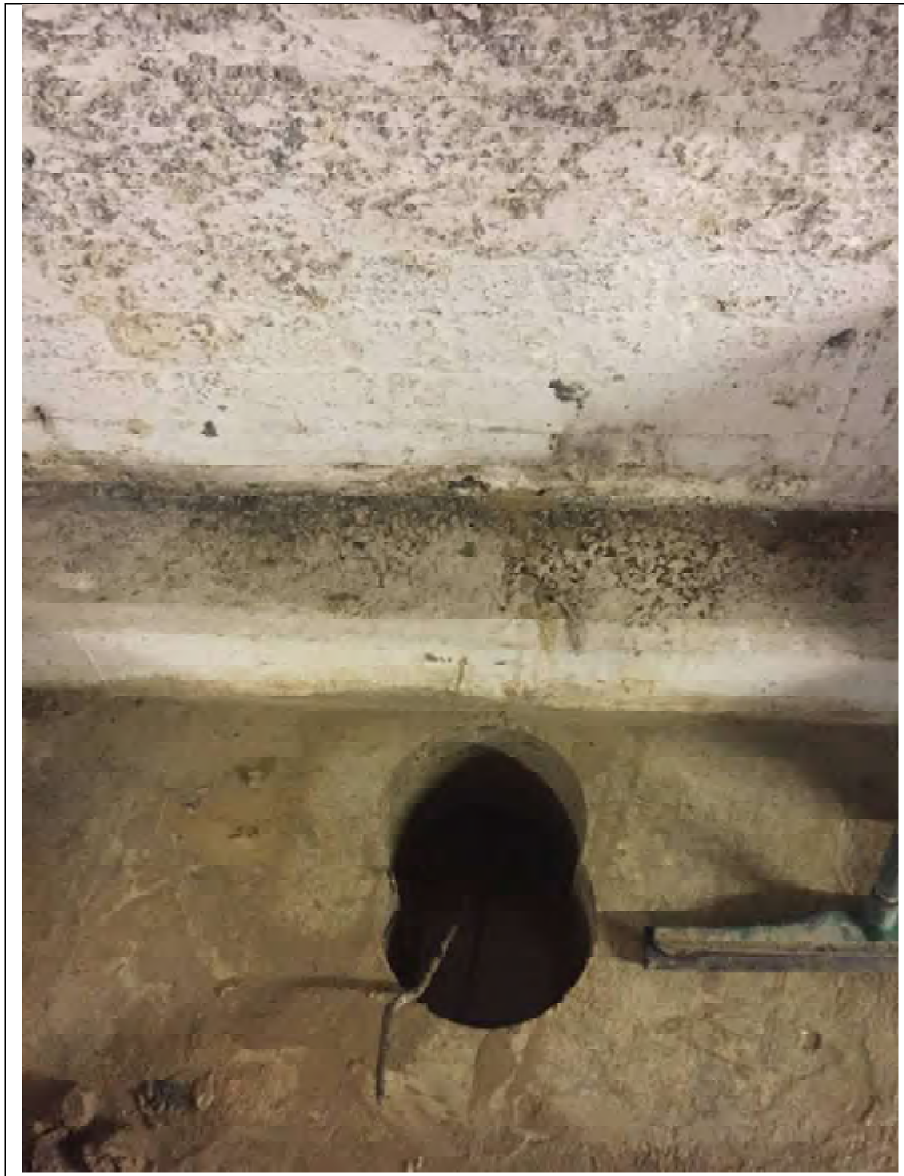

Trial Pit TP3

Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

Trial Pit Photographs

Project: Flat 1, 43 Hillfield Road

TP 2 & 3



Trial Pit TP4

Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

Trial Pit Photographs

Project: Flat 1, 43 Hillfield Road	
TP 4	

APPENDICES

APPENDIX F GEOTECHNICAL LABORATORY RESULTS

4041

TEST CERTIFICATE

Determination of Liquid and Plastic Limits

Tested in Accordance with BS1377-2: 1990: Clause 4.4 & 5: One Point Method

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

Client: LMB Geosolutions Ltd
Client Address: 28 Dresden Road
London
N19 3BD
Contact: Philip Lewis
Site Name: Hillfield Road
Site Address: Not Given

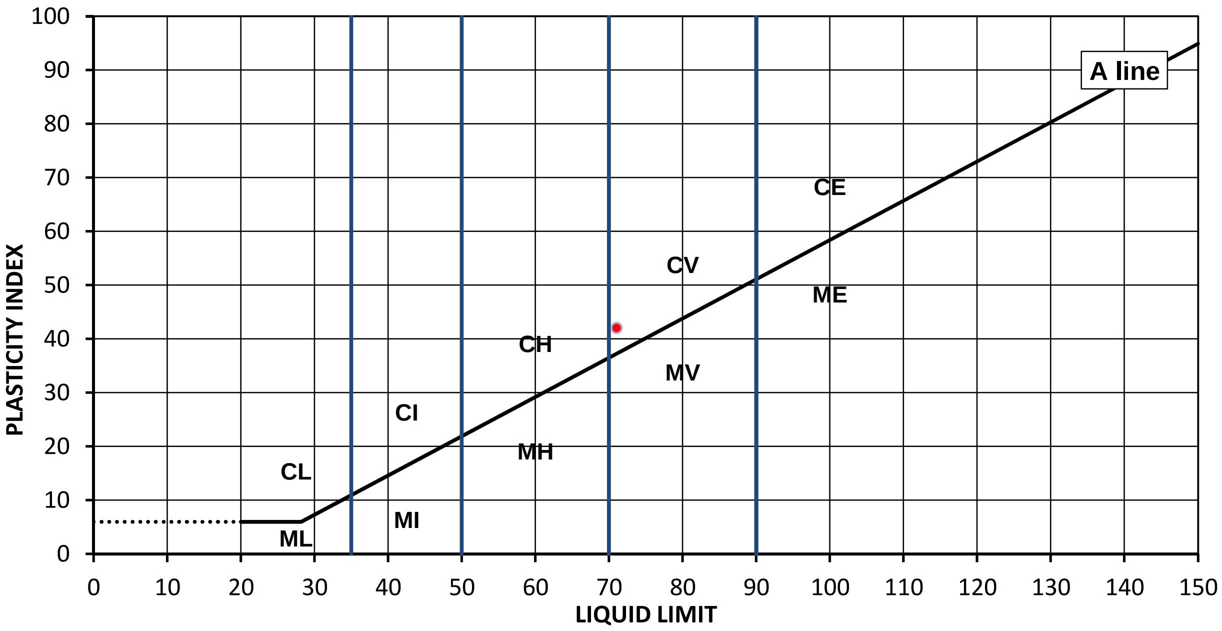
Client Reference: LMB-HILLFIELD
Job Number: 18-94654
Date Sampled: 27/07/2018
Date Received: 30/07/2018
Date Tested: 07/08/2018
Sampled By: PIL

Test Results

Laboratory Reference: 1013213
Hole No.: BH1
Sample Reference: Not Given
Soil Description: Yellowish brown CLAY
Sample Preparation: Tested in natural condition

Depth Top [m]: 3.00
Depth Base [m]: Not Given
Sample Type: D

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
30	71	29	42	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)	

Remarks:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Date Reported: 14/08/2018

Signed:

Darren Berrill
Geotechnical General Manager

for and on behalf of i2 Analytical Ltd

UKAS TESTING 4041

TEST CERTIFICATE

Determination of Liquid and Plastic Limits

Tested in Accordance with BS1377-2: 1990: Clause 4.4 & 5: One Point Method

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

Client: LMB Geosolutions Ltd

Client Address: 28 Dresden Road
London
N19 3BD

Contact: Philip Lewis

Site Name: Hillfield Road

Site Address: Not Given

Client Reference: LMB-HILLFIELD

Job Number: 18-94654

Date Sampled: 27/07/2018

Date Received: 30/07/2018

Date Tested: 07/08/2018

Sampled By: PIL

Test Results

Laboratory Reference: 1013214

Hole No.: BH1

Sample Reference: Not Given

Soil Description: Brown CLAY

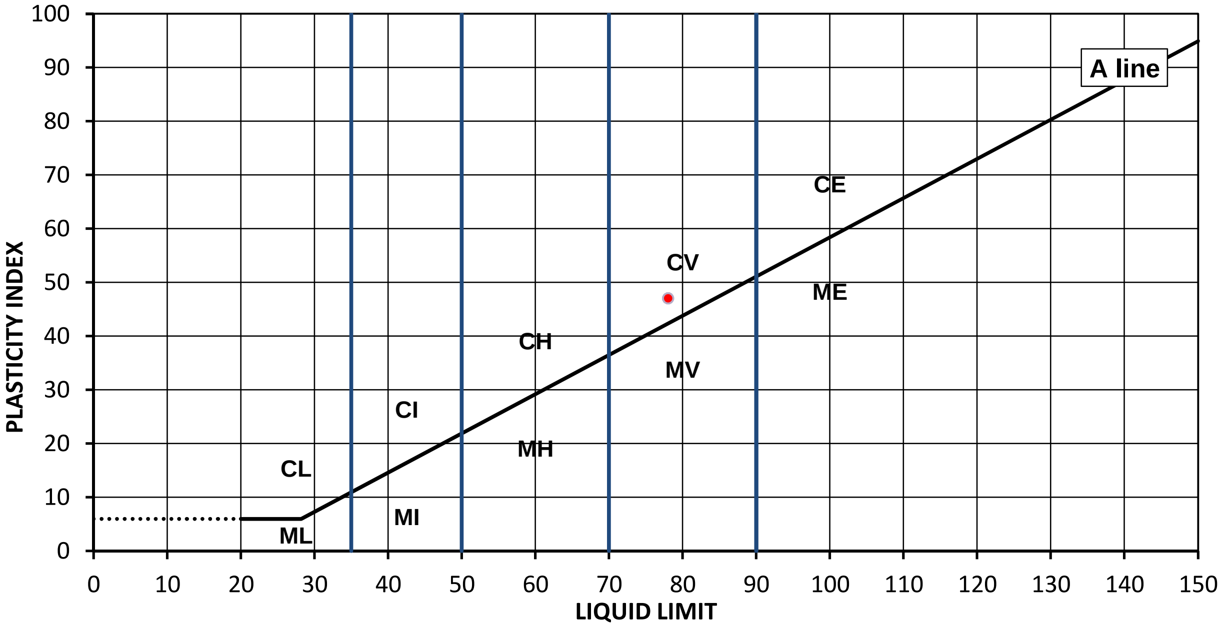
Sample Preparation: Tested in natural condition

Depth Top [m]: 3.50

Depth Base [m]: Not Given

Sample Type: D

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
31	78	31	47	100



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

				Liquid Limit
		Plasticity		
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)	

Remarks:

Approved:

Dariusz Piotrowski
PL Laboratory
Manager

Date Reported: 14/08/2018

Signed:

Darren Berrill
Geotechnical General
Manager

for and on behalf of i2 Analytical Ltd

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The results included within the report are representative of the samples submitted for analysis.
The analysis was carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland."

4041

TEST CERTIFICATE

Determination of Liquid and Plastic Limits

Tested in Accordance with BS1377-2: 1990: Clause 4.4 & 5: One Point Method

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

Client: LMB Geosolutions Ltd
Client Address: 28 Dresden Road
London
N19 3BD
Contact: Philip Lewis
Site Name: Hillfield Road
Site Address: Not Given

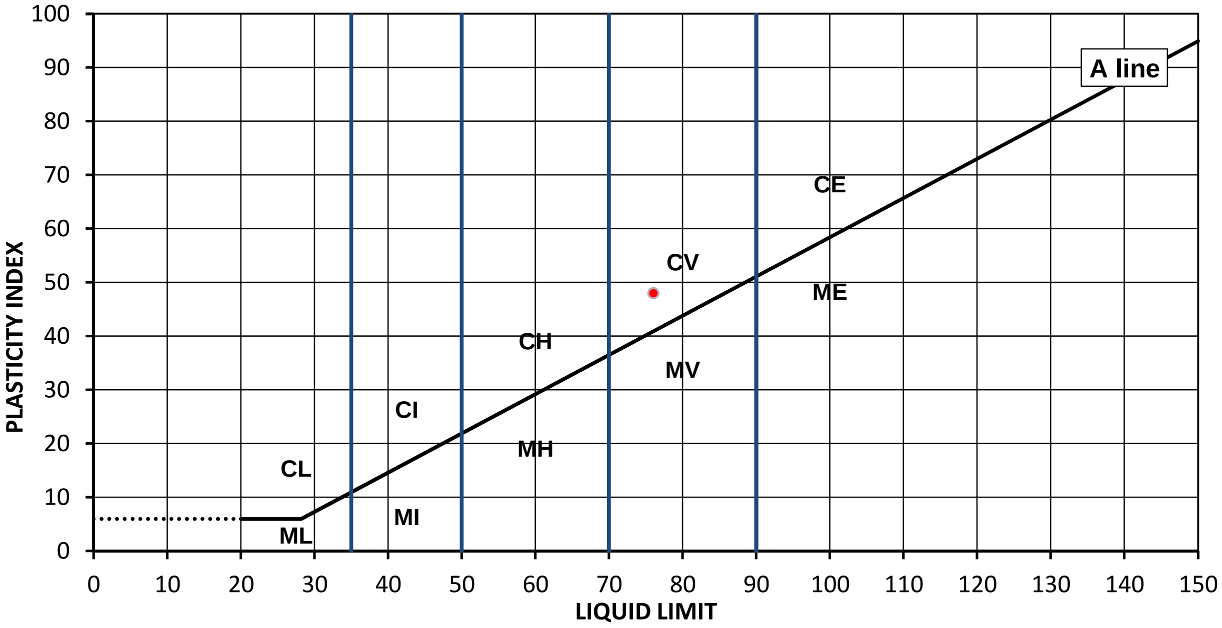
Client Reference: LMB-HILLFIELD
Job Number: 18-94654
Date Sampled: 30/07/2018
Date Received: 30/07/2018
Date Tested: 07/08/2018
Sampled By: PIL

Test Results

Laboratory Reference: 1013216
Hole No.: BH2
Sample Reference: Not Given
Soil Description: Yellowish brown CLAY
Sample Preparation: Tested in natural condition

Depth Top [m]: 3.00
Depth Base [m]: Not Given
Sample Type: D

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
33	76	28	48	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)	

Remarks:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Date Reported: 14/08/2018

Signed:

Darren Berrill
Geotechnical General Manager

for and on behalf of i2 Analytical Ltd

4041

TEST CERTIFICATE

Determination of Liquid and Plastic Limits

Tested in Accordance with BS1377-2: 1990: Clause 4.4 & 5: One Point Method

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

Client: LMB Geosolutions Ltd

Client Address: 28 Dresden Road
London
N19 3BD

Contact: Philip Lewis

Site Name: Hillfield Road

Site Address: Not Given

Client Reference: LMB-HILLFIELD

Job Number: 18-94654

Date Sampled: 30/07/2018

Date Received: 30/07/2018

Date Tested: 07/08/2018

Sampled By: PIL

Test Results

Laboratory Reference: 1013217

Hole No.: BH2

Sample Reference: Not Given

Soil Description: Yellowish brown CLAY

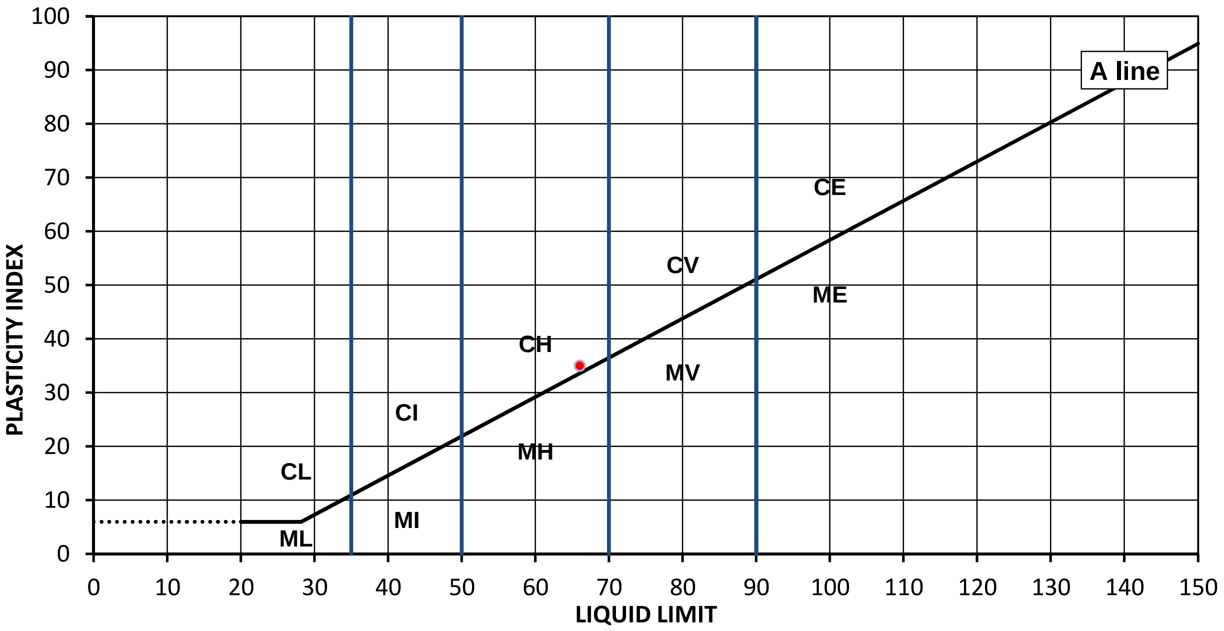
Sample Preparation: Tested in natural condition

Depth Top [m]: 4.00

Depth Base [m]: Not Given

Sample Type: D

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
31	66	31	35	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)	

Remarks:

Approved:

Dariusz Piotrowski
PL Laboratory
Manager

Date Reported: 14/08/2018

Signed:

Darren Berrill
Geotechnical General
Manager

for and on behalf of i2 Analytical Ltd

TEST CERTIFICATE

Summary of Classification Test Results

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

Client: LMB Geosolutions Ltd
Client Address: 28 Dresden Road
London
N19 3BD

Contact: Philip Lewis
Site Name: Hillfield Road
Site Address: Not Given

Client Reference: LMB-HILLFIELD
Job Number: 18-94654
Date Sampled: 27/07 - 30/07/2018
Date Received: 30/07/2018
Date Tested: 07/08/2018
Sampled By: PIL

Test results

		Sample						Atterberg				Density		
Laboratory Reference	Hole No.	Reference	Top depth [m]	Base depth [m]	Type	**Soil Description**	M/C %	% Passing 425um %	LL %	PL %	PI %	bulk Mg/m3	PD Mg/m3	Total Porosity Mg/m3
1013213	BH1	Not Given	3.00	Not Given	D	Yellowish brown CLAY	30	100	71	29	42			
1013214	BH1	Not Given	3.50	Not Given	D	Brown CLAY	31	100	78	31	47			
1013215	BH2	Not Given	2.00	Not Given	D	Yellowish brown CLAY	30							
1013216	BH2	Not Given	3.00	Not Given	D	Yellowish brown CLAY	33	100	76	28	48			
1013217	BH2	Not Given	4.00	Not Given	D	Yellowish brown CLAY	31	100	66	31	35			

Comments:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section

Signed:

Darren Berrill
Geotechnical General Manager

Date Reported: 14/08/2018

for and on behalf of i2 Analytical Ltd

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The results included within the report are representative of the samples submitted for analysis.
The analysis was carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland."

APPENDICES

APPENDIX G CHEMICAL LABORATORY TESTING RESULTS

Philip Lewis
LMB Geosolutions Ltd
28 Dresden Road
London
N19 3BD

e: philip@lmbgeosolutions.com

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

t: 01923 225404
f: 01923 237404
e: reception@i2analytical.com

Analytical Report Number : 18-94895

Project / Site name: Hillfield Road

Samples received on: 30/07/2018

Your job number: LMB_HILLFIELD

Samples instructed on: 31/07/2018

Your order number:

Analysis completed by: 09/08/2018

Report Issue Number: 1

Report issued on: 09/08/2018

Samples Analysed: 4 soil samples

Signed:

Jordan Hill
Reporting 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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Analytical Report Number: 18-94895

Project / Site name: Hillfield Road

Lab Sample Number				1014392	1014393	1014394	1014395	
Sample Reference				BH1	BH1	BH2	BH2	
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	
Depth (m)				0.50	3.00	0.80	2.00	
Date Sampled				27/07/2018	27/07/2018	30/07/2018	30/07/2018	
Time Taken				None Supplied	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	< 0.1	
Moisture Content	%	N/A	NONE	18	19	13	18	
Total mass of sample received	kg	0.001	NONE	0.46	0.45	0.43	0.32	
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	-	-	-	
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	-	6.6	7.6	7.6	
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.10	2.6	0.024	0.10	
Organic Matter	%	0.1	MCERTS	-	-	1.8	-	
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	-	-	-	
Acenaphthylene	mg/kg	0.05	MCERTS	1.6	-	-	-	
Acenaphthene	mg/kg	0.05	MCERTS	0.27	-	-	-	
Fluorene	mg/kg	0.05	MCERTS	1.8	-	-	-	
Phenanthrene	mg/kg	0.05	MCERTS	23	-	-	-	
Anthracene	mg/kg	0.05	MCERTS	5.3	-	-	-	
Fluoranthene	mg/kg	0.05	MCERTS	25	-	-	-	
Pyrene	mg/kg	0.05	MCERTS	18	-	-	-	
Benzo(a)anthracene	mg/kg	0.05	MCERTS	8.9	-	-	-	
Chrysene	mg/kg	0.05	MCERTS	7.6	-	-	-	
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	9.1	-	-	-	
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	3.1	-	-	-	
Benzo(a)pyrene	mg/kg	0.05	MCERTS	7.0	-	-	-	
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	3.5	-	-	-	
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	1.1	-	-	-	
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	3.8	-	-	-	
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	119	-	-	-	

Analytical Report Number: 18-94895

Project / Site name: Hillfield Road

Lab Sample Number				1014392	1014393	1014394	1014395	
Sample Reference				BH1	BH1	BH2	BH2	
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	
Depth (m)				0.50	3.00	0.80	2.00	
Date Sampled				27/07/2018	27/07/2018	30/07/2018	30/07/2018	
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	12	-	16	-	
Boron (water soluble)	mg/kg	0.2	MCERTS	1.9	-	1.7	-	
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	-	< 0.2	-	
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	30	-	42	-	
Copper (aqua regia extractable)	mg/kg	1	MCERTS	23	-	34	-	
Lead (aqua regia extractable)	mg/kg	1	MCERTS	52	-	380	-	
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	-	< 0.3	-	
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	15	-	17	-	
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	-	< 1.0	-	
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	45	-	75	-	
Petroleum Hydrocarbons								
TPH C10 - C40	mg/kg	10	MCERTS	-	-	< 10	-	

Analytical Report Number : 18-94895

Project / Site name: Hillfield Road

* 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 *
1014392	BH1	None Supplied	0.50	Brown clay and sand with gravel and brick.
1014393	BH1	None Supplied	3.00	Brown clay.
1014394	BH2	None Supplied	0.80	Brown clay and sand with gravel.
1014395	BH2	None Supplied	2.00	Brown clay.

Analytical Report Number : 18-94895

Project / Site name: Hillfield Road

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
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	BS1377 Part 3, 1990, Chemical and Electrochemical Tests""	L009-PL	D	MCERTS
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.	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.

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t: 01923 225404
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Analytical Report Number : 18-94896

Project / Site name: Hillfield Road

Samples received on: 30/07/2018

Your job number: LMB_HILLFIELD

Samples instructed on: 31/07/2018

Your order number:

Analysis completed by: 13/08/2018

Report Issue Number: 1

Report issued on: 13/08/2018

Samples Analysed: 1 WAC 10:1 Sample

Signed:

Jordan Hill
Reporting 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.

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Waste Acceptance Criteria Analytical Results

Report No:	**18-94896**						
					Client:	**LMBGEOSOL**	
Location	**Hillfield Road**						
Lab Reference (Sample Number)	1014396 / 1014397				**Landfill Waste Acceptance Criteria** **Limits**		
Sampling Date	27/07/2018				Inert Waste Landfill	Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill	Hazardous Waste Landfill
Sample ID	BH1						
Depth (m)	0.50						
Solid Waste Analysis							
TOC (%)**	1.4				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)**	8.3				--	>6	--
Acid Neutralisation Capacity (mol / kg)	4.7				--	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 *	0.0034			0.0200	0.5	2	25
Barium *	0.0179			0.106	20	100	300
Cadmium *	< 0.0001			< 0.0008	0.04	1	5
Chromium *	0.0075			0.044	0.5	10	70
Copper *	0.017			0.10	2	50	100
Mercury *	< 0.0005			< 0.0050	0.01	0.2	2
Molybdenum *	0.0062			0.0366	0.5	10	30
Nickel *	0.0024			0.014	0.4	10	40
Lead *	0.010			0.061	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 *	0.014			0.084	4	50	200
Chloride *	1.5			8.7	800	4000	25000
Fluoride	0.70			4.1	10	150	500
Sulphate *	9.9			59	1000	20000	50000
TDS*	50			290	4000	60000	100000
Phenol Index (Monohydric Phenols) *	< 0.010			< 0.10	1	-	-
DOC	5.45			32.4	500	800	1000
Leach Test Information							
Stone Content (%)	< 0.1						
Sample Mass (kg)	0.46						
Dry Matter (%)	82						
Moisture (%)	18						
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 : 18-94896

Project / Site name: Hillfield Road

* 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 *
1014396	BH1	None Supplied	0.50	Brown clay and sand with gravel and brick.

Analytical Report Number : 18-94896

Project / Site name: Hillfield Road

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-UK	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	ISO 17025
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.

APPENDICES

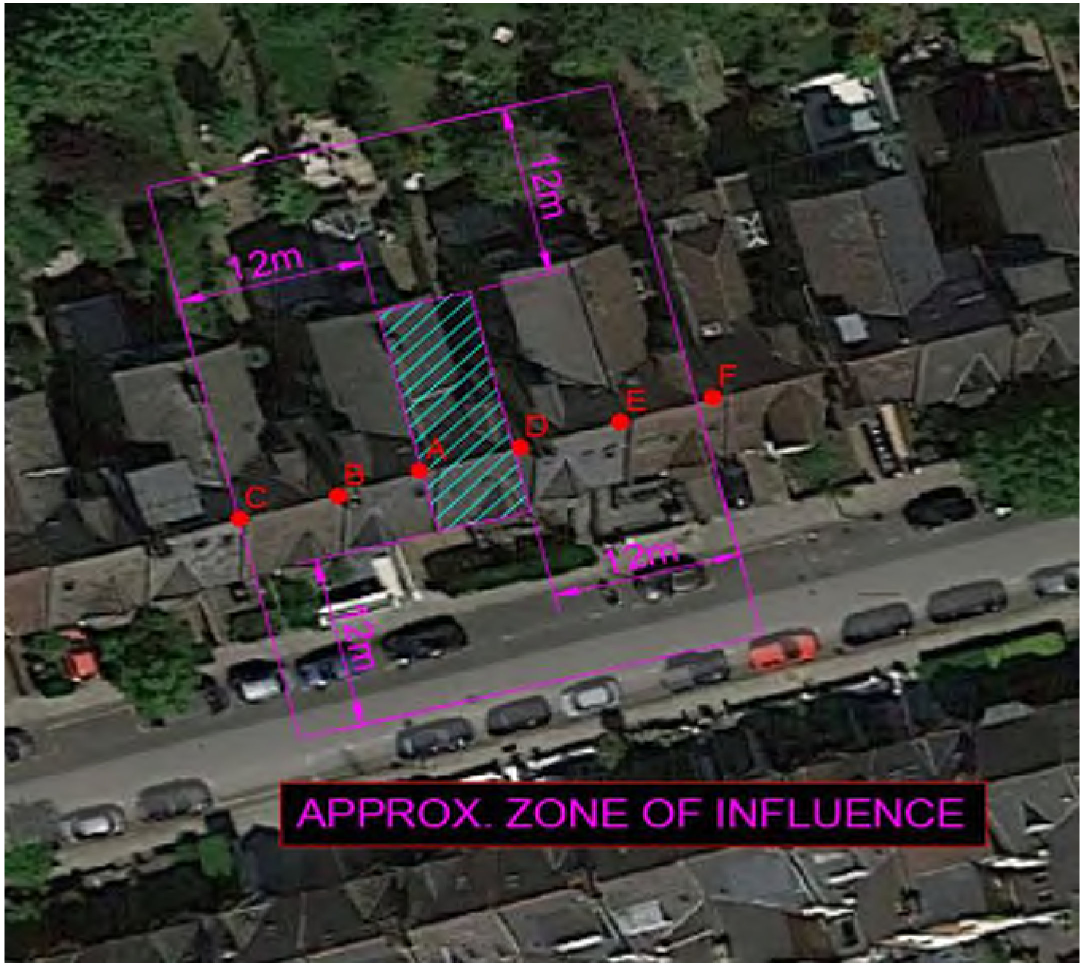
APPENDIX H GMA CALCULATION WORKSHEETS

Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

Calc No.	Sheet No.	Rev
	1	A

Calculation Sheet

Project	Ground Movement Assessment	Made by	CC
Location	43 Hillfield Road - London	Date	28.08.18



LMB

Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

Calc No.	Sheet No.	Rev
	2	A

Calculation Sheet

Project	Ground Movement Assessment	Made by	CC
Location	43 Hillfield Road - London	Date	28.08.18

Assumptions

Propping System will be utilised

Max Excavation Depth 3.00 m

Note:

It has been assumed that ground movements represented in the table include the movements resulting from the installation of the underpins since, unlike for the piles, the construction process requires an excavation prior to the pins being formed.

Nearby Structure	Note	Point	Distance from wall (m)	Ground movements arising from excavation in front of wall				
				Distance from wall / max excavation depth	Horizontal movement / max excavation depth (%)	Horizontal movement (mm)	Settlement / max excavation depth (%)	Vertical movement (mm)
41 Hillfield Road	Underpins	A	0.0	0.0	0.16	4.8	0.05	1.5
		B	6.0	2.0	0.08	2.4	0.04	1.2
39 Hillfield Road	Underpins	B	6.0	2.0	0.08	2.4	0.04	1.2
		C	12.0	4.0	0.00	0.0	0.00	0.0
45 Hillfield Road	Underpins	D	0.0	0.0	0.16	4.8	0.05	1.5
		E	6.0	2.0	0.08	2.4	0.04	1.2
47 Hillfield Road	Underpins	E	6.0	2.0	0.08	2.4	0.04	1.2
		F	12.0	4.0	0.00	0.0	0.00	0.0

Nearby Structure	Total Movements											
	Corner Effect	Total horizontal movement (mm)	Total vertical movement (mm)	L (m)	L_1 (m)	H (m)	L_1/H	Δ (mm)	Tilt (1/x)	M=Δ/L (%)	δh (mm)	εh=δh/L (%)
41 Hillfield Road	N	4.8	1.5	6.0	6.0	10.0	0.6	1.0	6000	0.017	2.4	0.040
		2.4	1.2									
39 Hillfield Road	N	2.4	1.2	6.0	6.0	10.0	0.6	1.2	5000	0.020	2.4	0.040
		0.0	0.0									
45 Hillfield Road	N	4.8	1.5	6.0	6.0	10.0	0.6	1.0	6000	0.017	2.4	0.040
		2.4	1.2									
47 Hillfield Road	N	2.4	1.2	6.0	6.0	10.0	0.6	1.2	5000	0.020	2.4	0.040
		0.0	0.0									

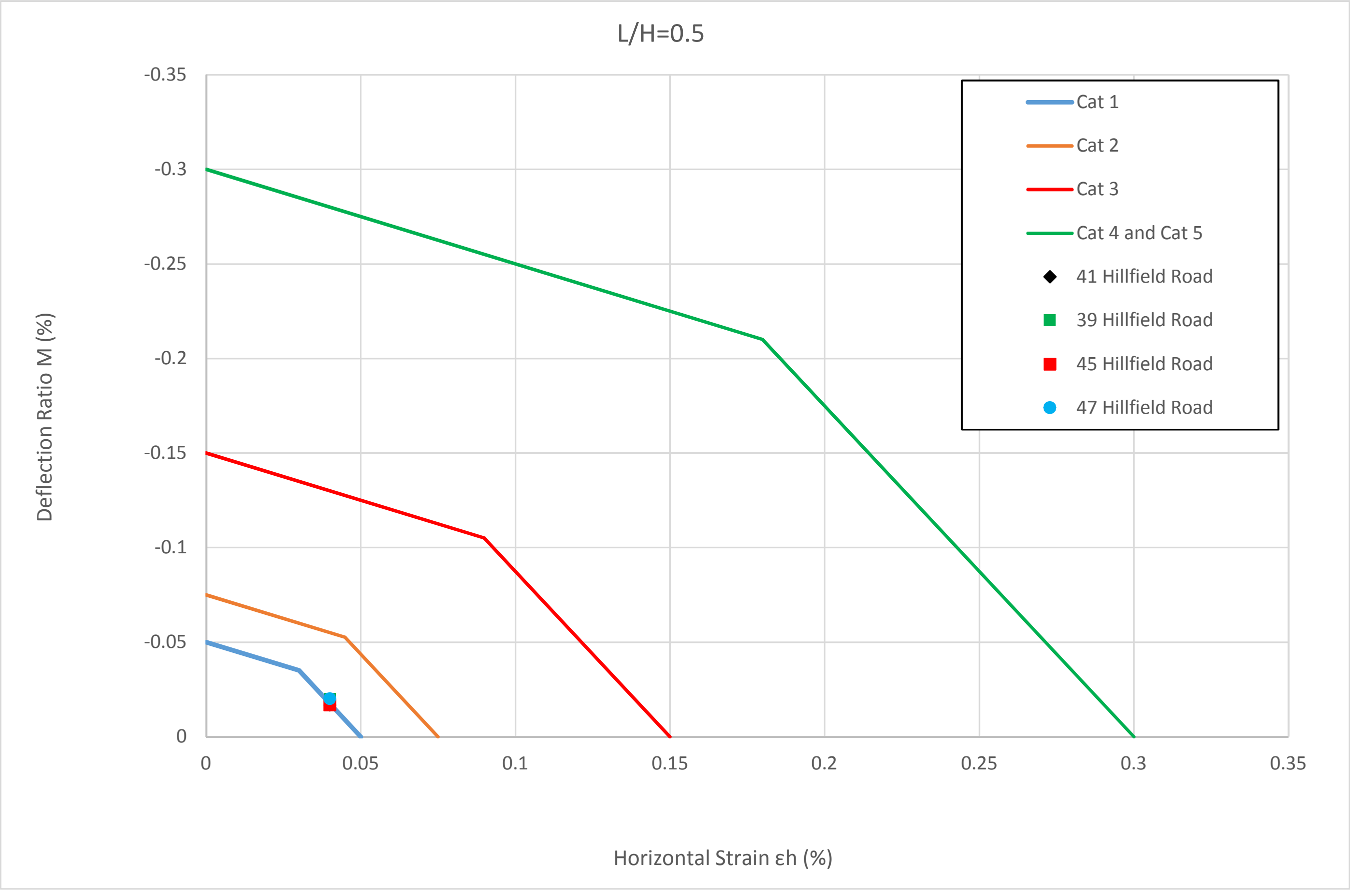
LMB

Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

Calc No.	Sheet No.	Rev
	3	A

Calculation Sheet

Project	Ground Movement Assessment	Made by	CC
Location	43 Hillfield Road - London	Date	28.08.18



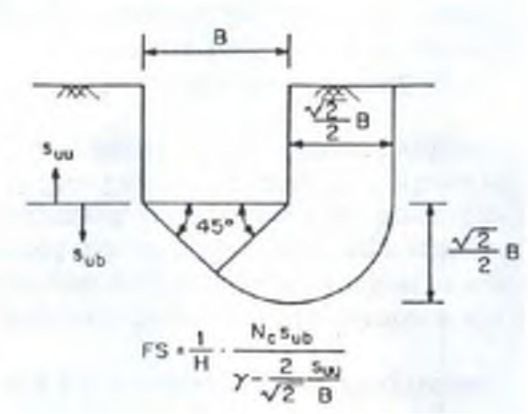
Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

Calc No.	Sheet No.	Rev
	4	A

Calculation Sheet

Project	Ground Movement Assessment	Made by	CC
Location	43 Hillfield Road - London	Date	28.08.18

B	6 m	Excavation Width
H	3 m	Excavation Depth
Nc	5.7	
Sub	50 kPa	Undrained Shear Strength (Stiff Clay)
Suu	40 kPa	Undrained Shear Strength (Firm Clay)
γ_s	20 kN/m³	Bulk Unit Weight of Soil
FoS	9.0	Factor of Safety against Bottom Heave (after Terzaghi, 1943)



Terzaghi's Method to assess Factor of Safety against Bottom Heave (Fig. 6.2 in CIRIA C760).

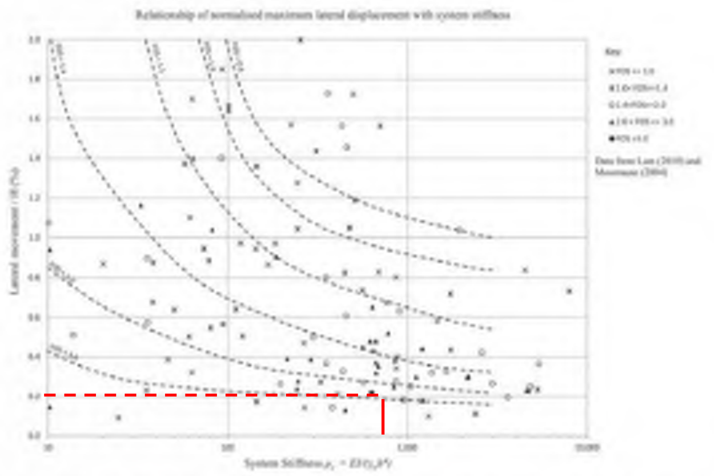


Figure 6.12 Relationship of normalised maximum lateral displacement with system stiffness

E	1.75E+07 kPa	Wall Stiffness (Long Term)
b	0.3 m	Wall Width
I	0.00225 m^4/m	Moment of Inertia
γ_w	10 kN/m³	Bulk Unit Weigth of Water
h	1.5 m	Props Vertical Spacing
ρ_s	778	System Stiffness (after Clough et al, 1989)

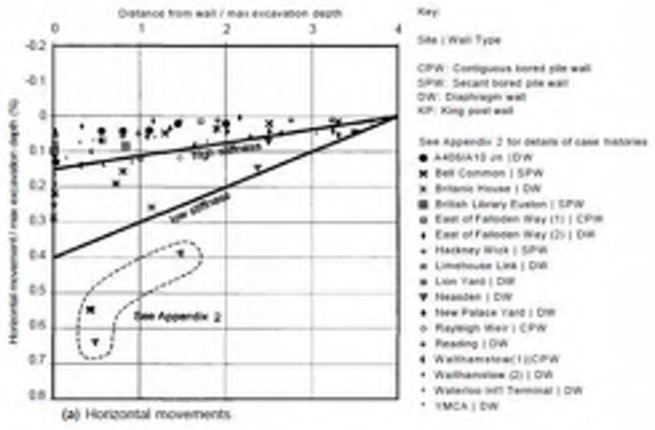


Figure 6.15a

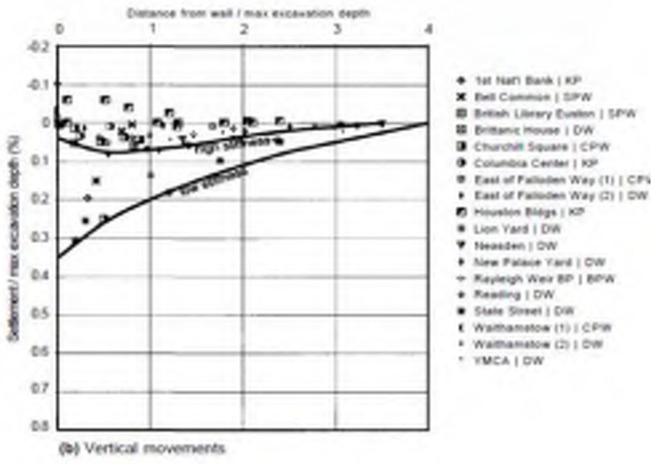


Figure 6.15b

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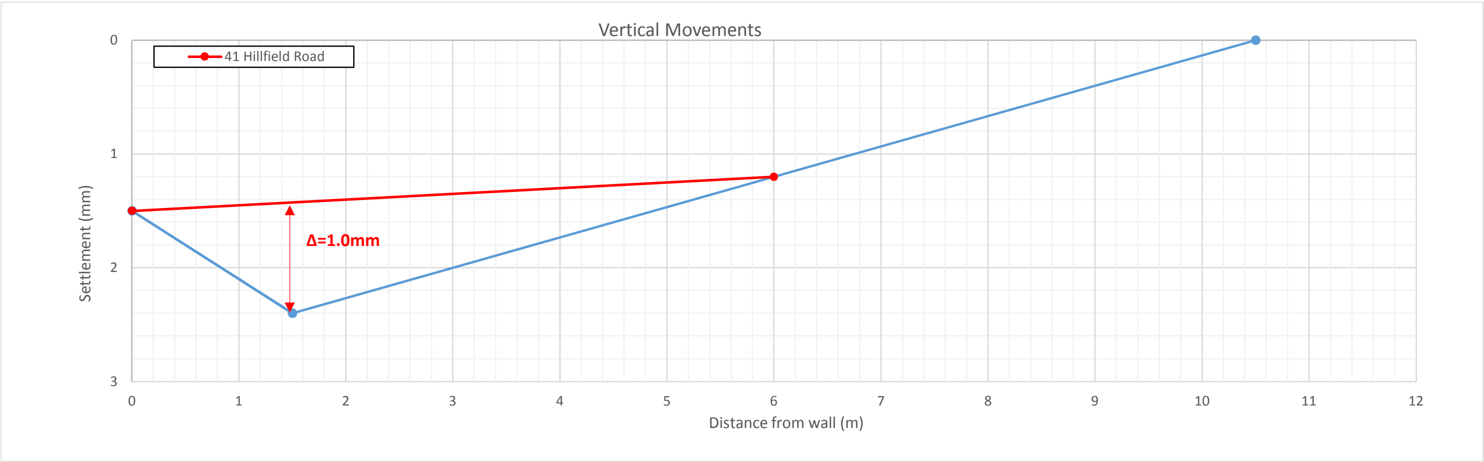
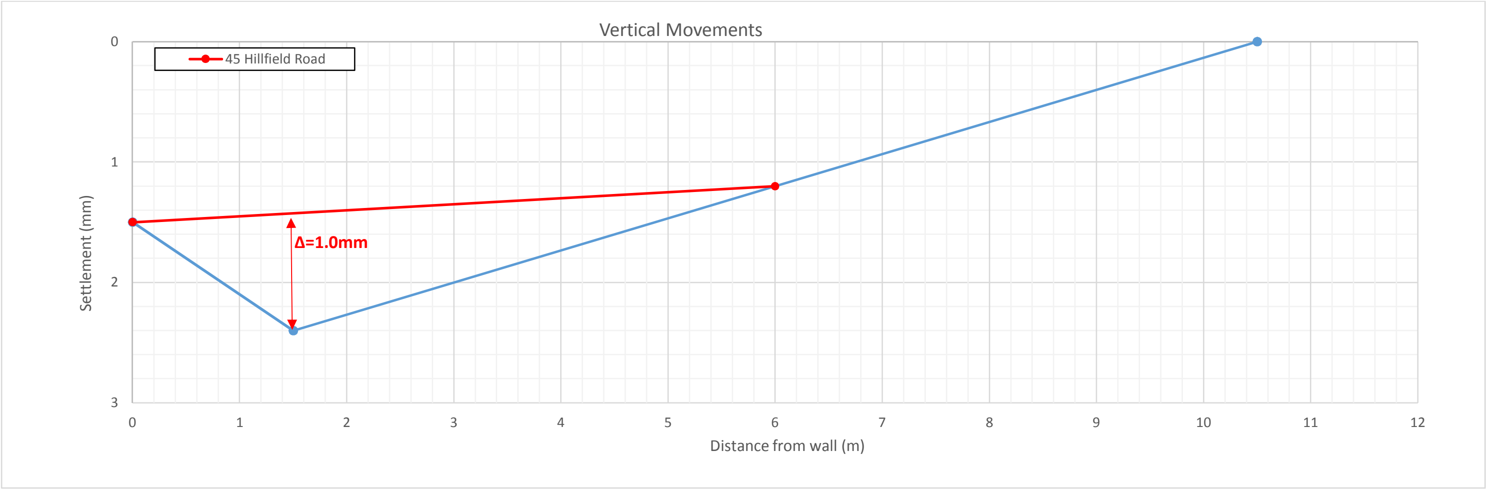
Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

Calc No.	Sheet No.	Rev
	5	A

Calculation Sheet

Project	Ground Movement Assessment	Made by	CC
Location	43 Hillfield Road - London	Date	28.08.18



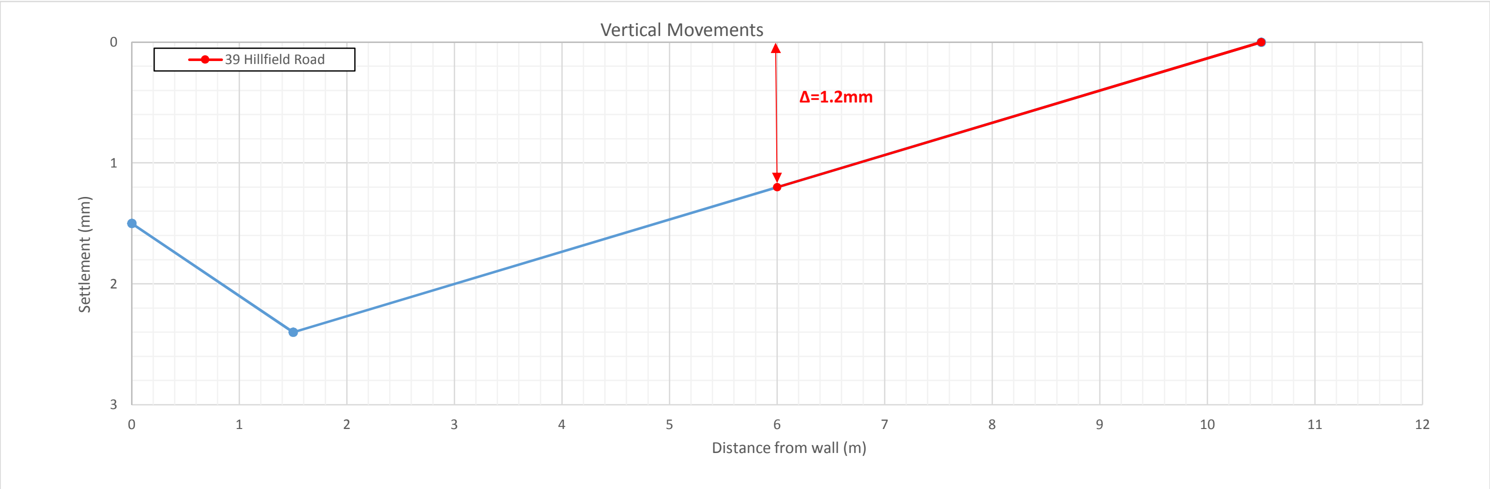


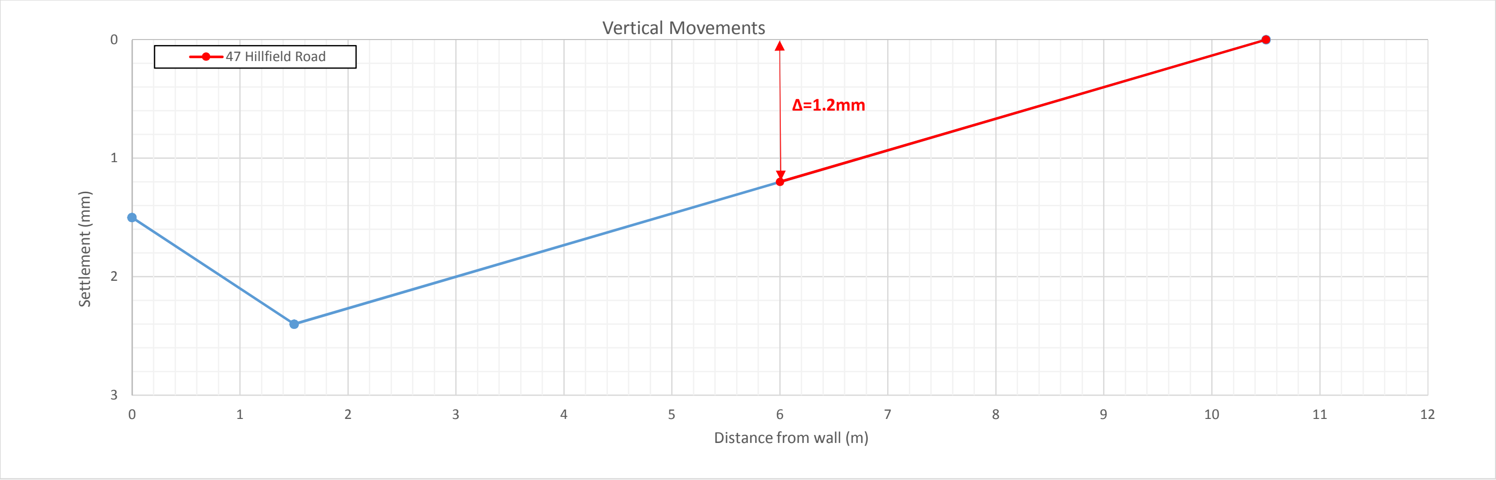
Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

Calc No.	Sheet No.	Rev
	6	A

Calculation Sheet

Project	Ground Movement Assessment	Made by	CC
Location	43 Hillfield Road - London	Date	28.08.18





APPENDIX 2

PROPOSED DEVELOPMENT DRAWINGS

QD A1

FOUNDATIONS HAVE BEEN SIZED BASED ON A SAFE GROUND BEARING PRESSURE OF xxxkN/m² ON XXXX MEMBER (TBC). THE ENGINEER AND LOCAL AUTHORITY BUILDING CONTROL OFFICER ARE TO BE AFFORDED THE OPPORTUNITY OF INSPECTING THE FOUNDATIONS PRIOR TO CONCRETING. THE CONTRACTOR SHOULD ALLOW A SUITABLE CONTINGENCY FOR POURING DEEPER FOUNDATIONS FOLLOWING THE INSPECTION OF THE BUILDING CONTROL OFFICER. THE CONTRACTOR SHOULD ALSO BE AWARE OF THE WATER TABLE AND SOIL CONDITIONS NOTED IN THE SITE INVESTIGATION REPORT

REFER TO ARCHITECTS DRAWINGS FOR ALL SETTING OUT DETAILS

THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL TEMPORARY SUPPORTS AND RESPONSIBLE FOR STABILITY OF THE STRUCTURE DURING WORKS

LEGEND

▭	DENOTES EXISTING MASONRY OR TIMBER WALLS
▨	DENOTES NEW MASONRY WALLS BUILT IN 15N/mm² COMPRESSIVE STRENGTH BRICKWORK AND GRADE iii MORTAR
▨	DENOTES NEW MASONRY WALLS BUILT IN 7N/mm² COMPRESSIVE STRENGTH BLOCKWORK AND GRADE iii MORTAR
▩	DENOTES NEW NON LOAD BEARING STUD WALL BY ARCHITECT
⊠	SEE DETAIL FOR TYPICAL RESTRAINT
✛	DENOTES PROPOSED REINFORCED CONCRETE SLAB
②	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 ARE TO BE GALVANISED (125 MICRONS)

– 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 DEMOLISH EXISTING REAR CONSERVATORY

2 LOCALLY UNDERPIN WALLS AT POSITIONS MARKED TO BE USED TO SUPPORT TEMPORARY WORKS

3 INSTALL TEMPORARY STEELS TO PICK UP THE INTERNAL LOAD BEARING WALLS BY NEEDLING THE WALL AT A MAXIMUM OF 1200mm CENTRES USING 152x30 UC SUPPORTED ON A 203 UC MAIN BEAM SUPPORTED ON PADSTONES AND TEMPORARY COLUMNS/ SLIMSHORES

4 DEMOLISH ALL NON–LOAD BEARING WALLS AT LOWER GROUND FLOOR

5 REMOVE LOWER GROUND FLOOR SLAB

6 INSTALL TRANSITION UNDERPINS

7 INSTALL ALL TEMPORARY PROPS AND FORM THE NEW CONCRETE UNDERPINS AND PERIMETER FOUNDATIONS IN AN UNDERPINNED SEQUENCE. SEE DRAWING SK05 FOR PROPOSED PROPPING TO UNDERPINS

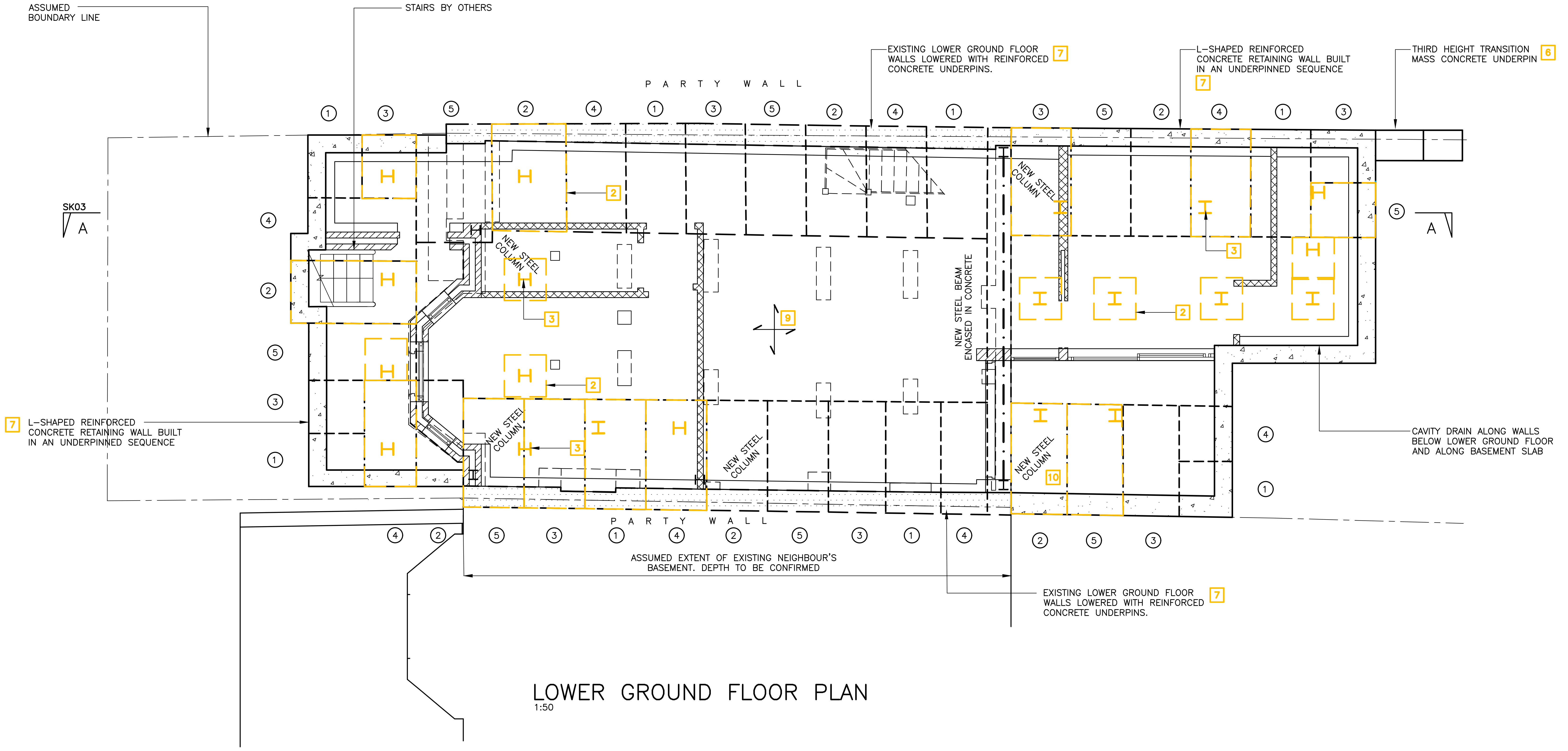
8 EXCAVATE BASEMENT

9 INSTALL ALL DRAINAGE AND THEN FORM BASEMENT SLAB

10 KEEPING IN POSITION ALL TEMPORARY WORKS INSTALL ALL BASEMENT AND LOWER GROUND FLOOR STEEL WORK AND THEN INSTALL FLOOR JOISTS WITH PLY SHEETING AND GROUND BEARING SLAB

11 REMOVE TEMPORARY WORKS IN REVERSE ORDER OF INSTALLATION

12 INSTALL WATERPROOFING



LOWER GROUND FLOOR PLAN
1:50

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
P2	20.09.18	AH	
P1	12.09.18	AH	FOR PLANNING

Drawing Status
PLANNING

Symmetrys Limited
Consulting Structural Engineers

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Job Title
43 HILLFIELD ROAD
NW6 1QD LONDON

Drawing Title
LOWER GROUND
FLOOR PLAN

Job No.	Drawing No.	Revision
17420	SK–01	P2

Scales 1:50 AT A1
Original Size A1
Drawn By JNS
Date MAY 2018

QD A1

REFER TO ARCHITECTS DRAWINGS FOR ALL SETTING OUT DETAILS

THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL TEMPORARY SUPPORTS AND RESPONSIBLE FOR STABILITY OF THE STRUCTURE DURING WORKS

LEGEND

▭	DENOTES EXISTING MASONRY OR TIMBER WALLS
▨	DENOTES NEW MASONRY WALLS BUILT IN 15N/mm² COMPRESSIVE STRENGTH BRICKWORK AND GRADE iii MORTAR
▨	DENOTES NEW MASONRY WALLS BUILT IN 7N/mm² COMPRESSIVE STRENGTH BLOCKWORK AND GRADE iii MORTAR
⊠	DENOTES NEW NON LOAD BEARING STUD WALL BY ARCHITECT
⊠	SEE DETAIL FOR TYPICAL RESTRAINT
✛	DENOTES PROPOSED REINFORCED CONCRETE SLAB
PS ▨	DENOTES NEW MASS CONCRETE PADSTONE
↔	DENOTES PROPOSED SPAN OF NEW TIMBER JOISTS
✛	DENOTES PROPOSED GROUND BEARING SLAB
═	DENOTES DOUBLED UP TIMBERS BOLTED TOGETHER WITH M12 AT 400 CENTRES STAGGERED TOP AND BOTTOM

NOTES

- ALL STEELWORK IN THE EXTERNAL WALLS ARE TO BE GALVANISED (125 MICRONS)
- 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

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
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1 DEMOLISH EXISTING REAR CONSERVATORY

2 LOCALLY UNDERPIN WALLS AT POSITIONS MARKED TO BE USED TO SUPPORT TEMPORARY WORKS

3 INSTALL TEMPORARY STEELS TO PICK UP THE INTERNAL LOAD BEARING WALLS BY NEEDLING THE WALL AT A MAXIMUM OF 1200mm CENTRES USING 152x30 UC SUPPORTED ON A 203 UC MAIN BEAM SUPPORTED ON PADSTONES AND TEMPORARY COLUMNS/ SLIMSHORES

4 DEMOLISH ALL NON-LOAD BEARING WALLS AT LOWER GROUND FLOOR

5 REMOVE LOWER GROUND FLOOR SLAB

6 INSTALL TRANSITION UNDERPINS

7 INSTALL ALL TEMPORARY PROPS AND FORM THE NEW CONCRETE UNDERPINS AND PERIMETER FOUNDATIONS IN AN UNDERPINNED SEQUENCE. SEE DRAWING SK05 FOR PROPOSED PROPPING TO UNDERPINS

8 EXCAVATE BASEMENT

9 INSTALL ALL DRAINAGE AND THEN FORM BASEMENT SLAB

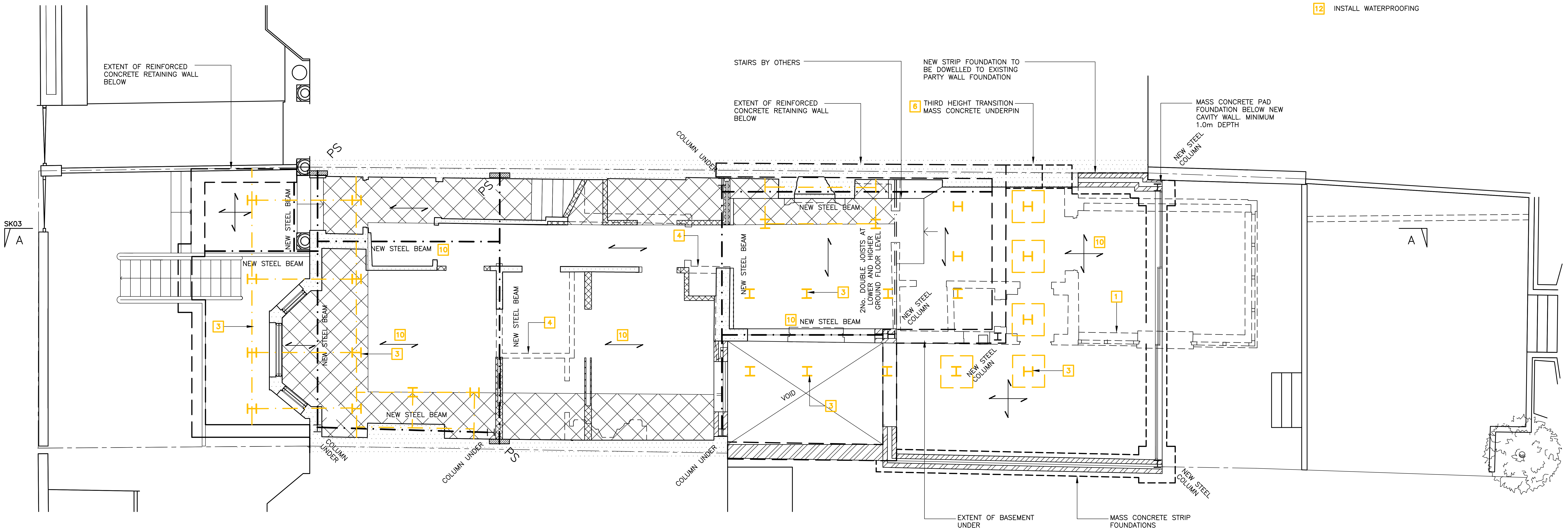
10 KEEPING IN POSITION ALL TEMPORARY WORKS INSTALL ALL BASEMENT AND LOWER GROUND FLOOR STEEL WORK AND THEN INSTALL FLOOR JOISTS WITH PLY SHEETING AND GROUND BEARING SLAB

11 REMOVE 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



GROUND FLOOR PLAN
1:50

Rev	Date	Chkd	Amendments
P2	20.09.18	AH	
P1	12.09.18	AH	FOR PLANNING

Drawing Status
PLANNING

Symmetrys Limited
Consulting Structural Engineers

6 The Courtyard, Lynton Road
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Job Title
43 HILLFIELD ROAD
NW6 1QD LONDON

Drawing Title
GROUND FLOOR PLAN
FLOOR PLAN

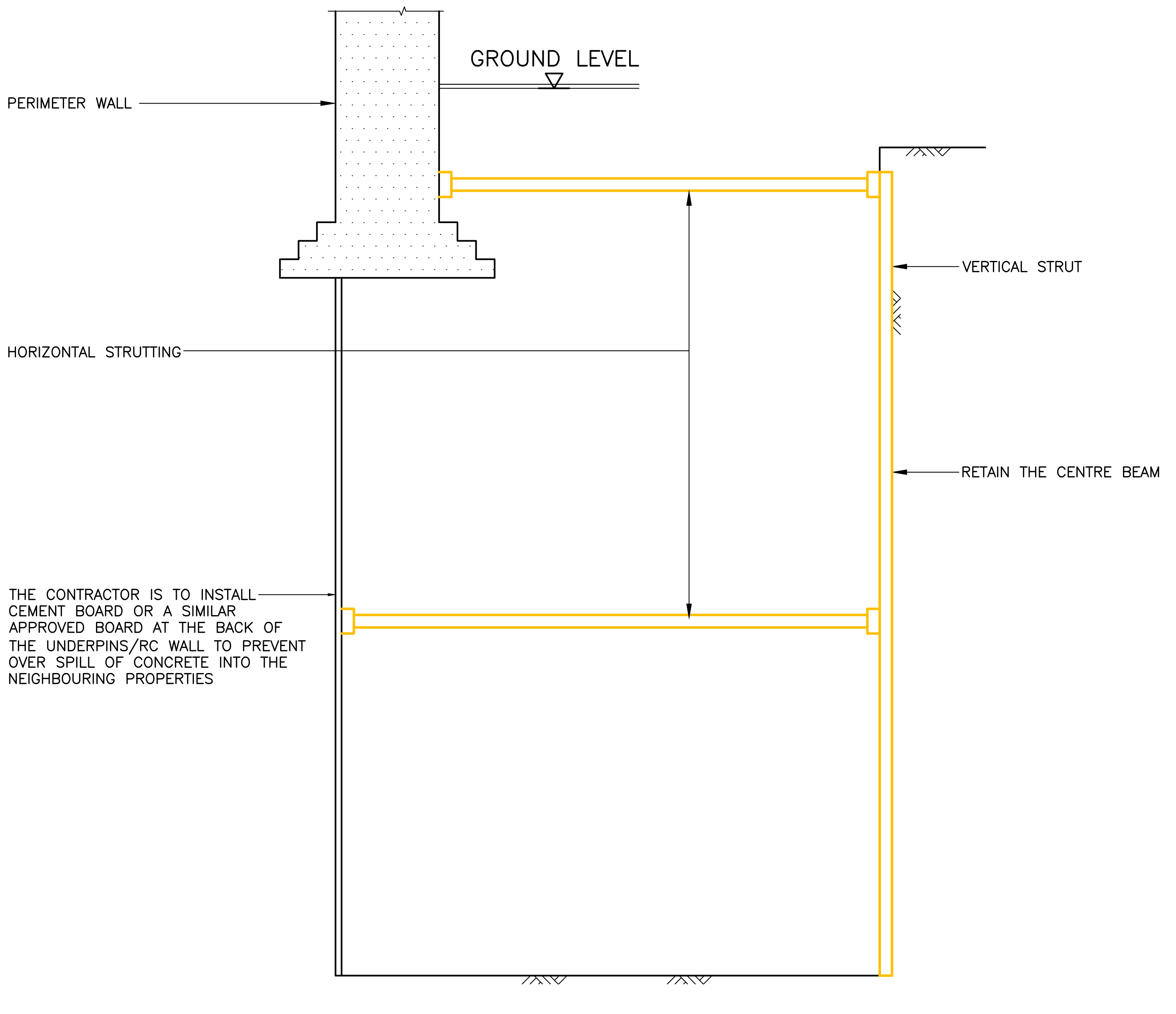
Job No.	Drawing No.	Revision
17420	SK-02	P2

Scales 1:50 AT A1
Original Size A1
Drawn By JNS Date MAY 2018

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

QD A1

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



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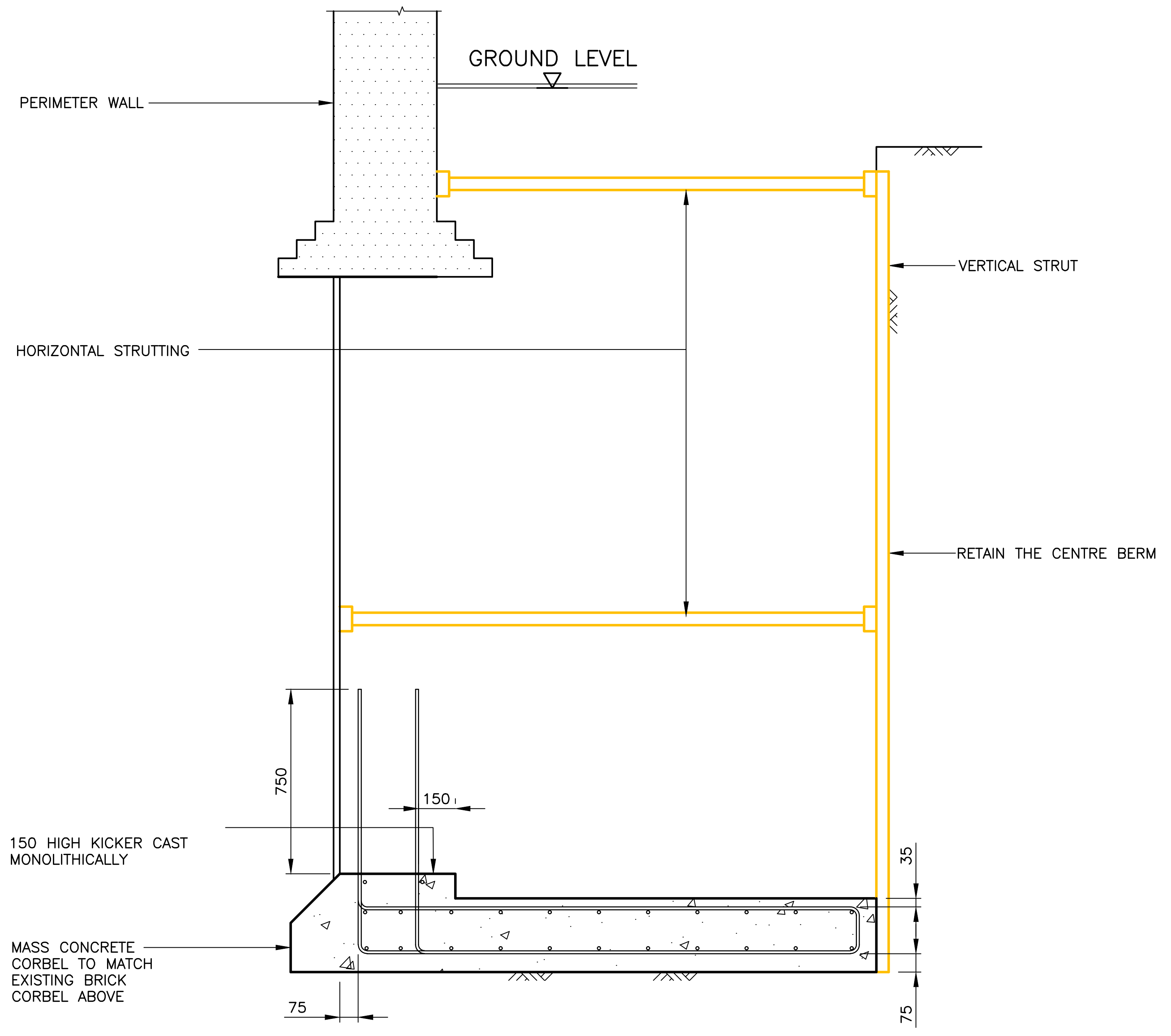

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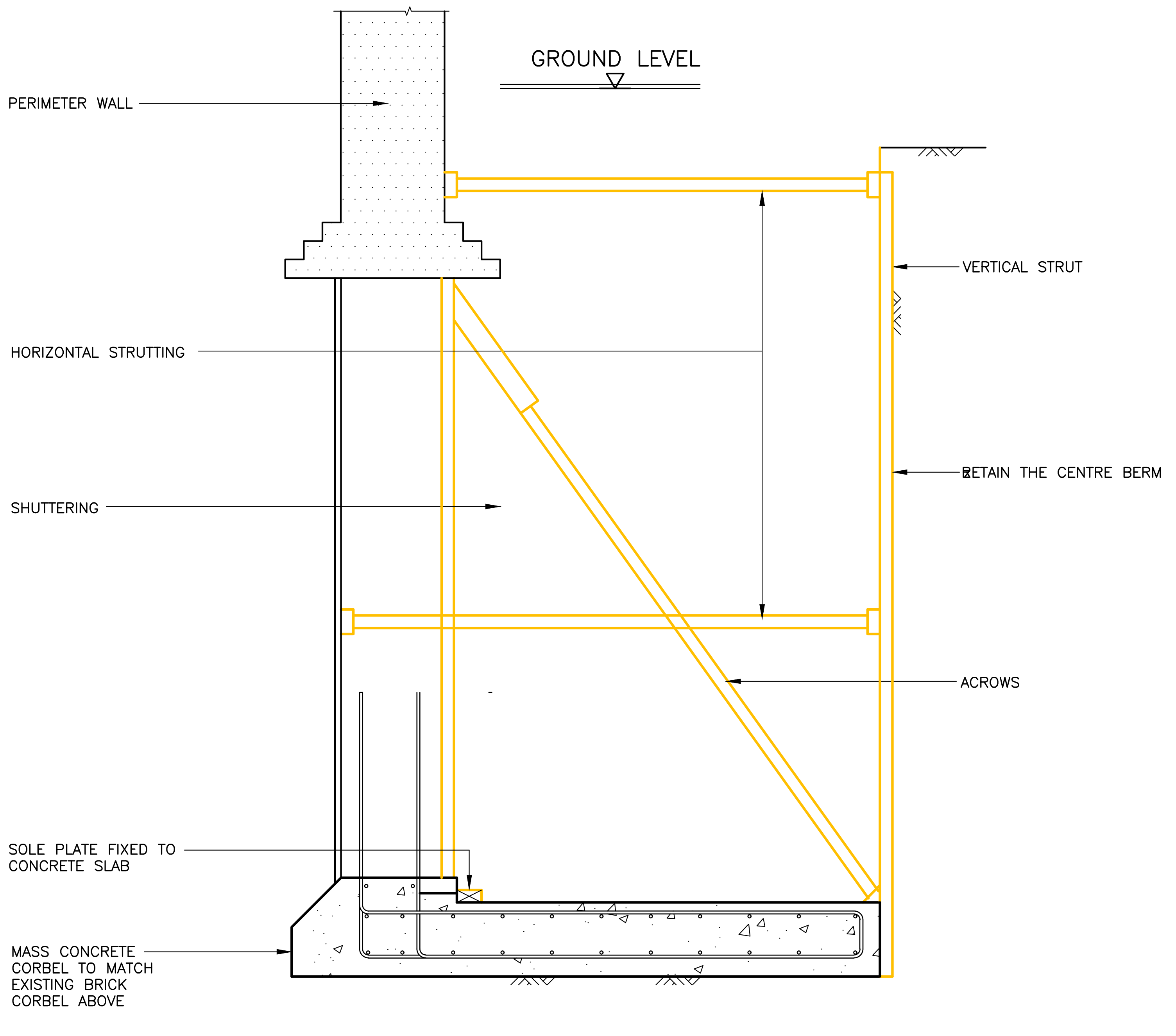
1:20



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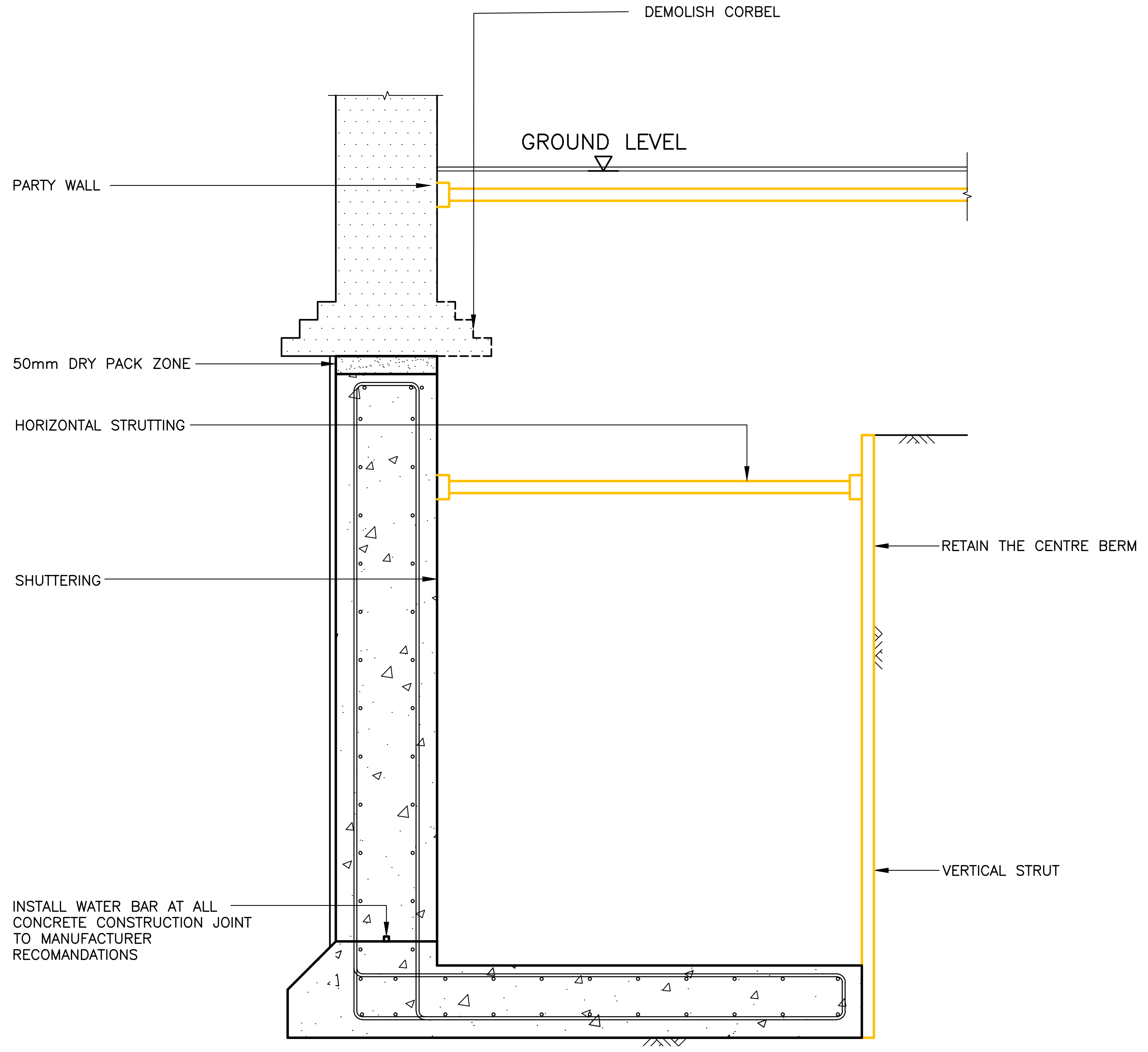

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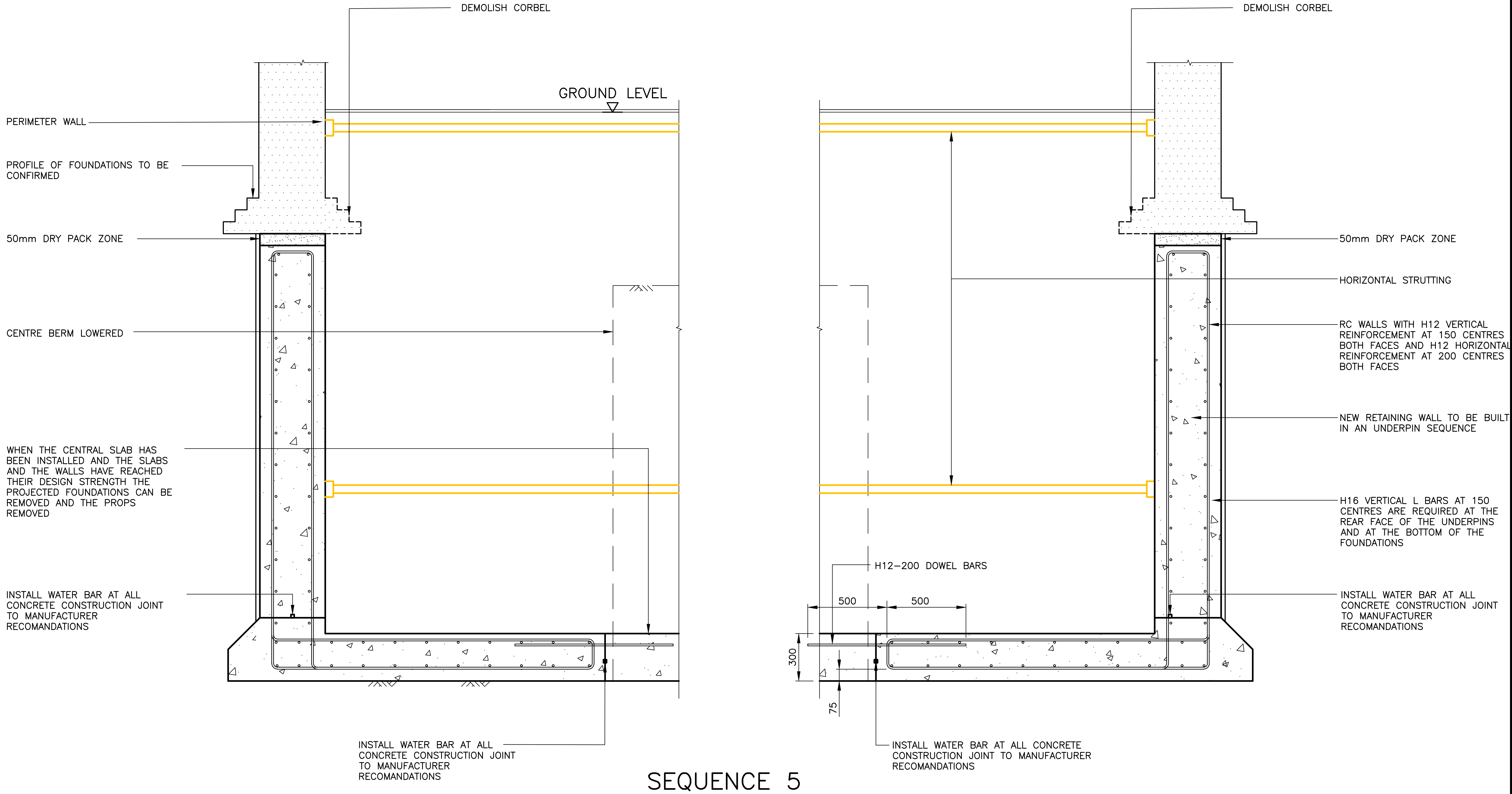

SEQUENCE 5
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Notes

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Rev	Date	Chkd	Amendments
P2	20.09.18	AH	
P1	12.09.18	AH	FOR PLANNING

Drawing Status
PLANNING

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Job Title
43 HILLFIELD ROAD
NW6 1QD LONDON

Drawing Title
TYPICAL UNDERPINNING SEQUENCE

Job No.	Drawing No.	Revision
17420	SK–04	P2

Scales 1:20 AT A1
Original Size A1
Drawn By JNS Date MAY 2018

QD A1

REFER TO ARCHITECTS DRAWINGS FOR ALL SETTING OUT DETAILS

THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL TEMPORARY SUPPORTS AND RESPONSIBLE FOR STABILITY OF THE STRUCTURE DURING WORKS

LEGEND

▭	DENOTES EXISTING MASONRY OR TIMBER WALLS
▨	DENOTES NEW MASONRY WALLS BUILT IN 15N/mm² COMPRESSIVE STRENGTH BRICKWORK AND GRADE iii MORTAR
▨	DENOTES NEW MASONRY WALLS BUILT IN 7N/mm² COMPRESSIVE STRENGTH BLOCKWORK AND GRADE iii MORTAR
▩	DENOTES NEW NON LOAD BEARING STUD WALL BY ARCHITECT

NOTES

– ALL STEELWORK IN THE EXTERNAL WALLS ARE TO BE GALVANISED (125 MICRONS)

– 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

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

PROPOSED METHOD STATEMENT/ SUGGESTED SEQUENCE OF WORKS

1 DEMOLISH EXISTING REAR CONSERVATORY

2 LOCALLY UNDERPIN WALLS AT POSITIONS MARKED TO BE USED TO SUPPORT TEMPORARY WORKS

3 INSTALL TEMPORARY STEELS TO PICK UP THE INTERNAL LOAD BEARING WALLS BY NEEDLING THE WALL AT A MAXIMUM OF 1200mm CENTRES USING 152x30 UC SUPPORTED ON A 203 UC MAIN BEAM SUPPORTED ON PADSTONES AND TEMPORARY COLUMNS/ SLIMSHORES

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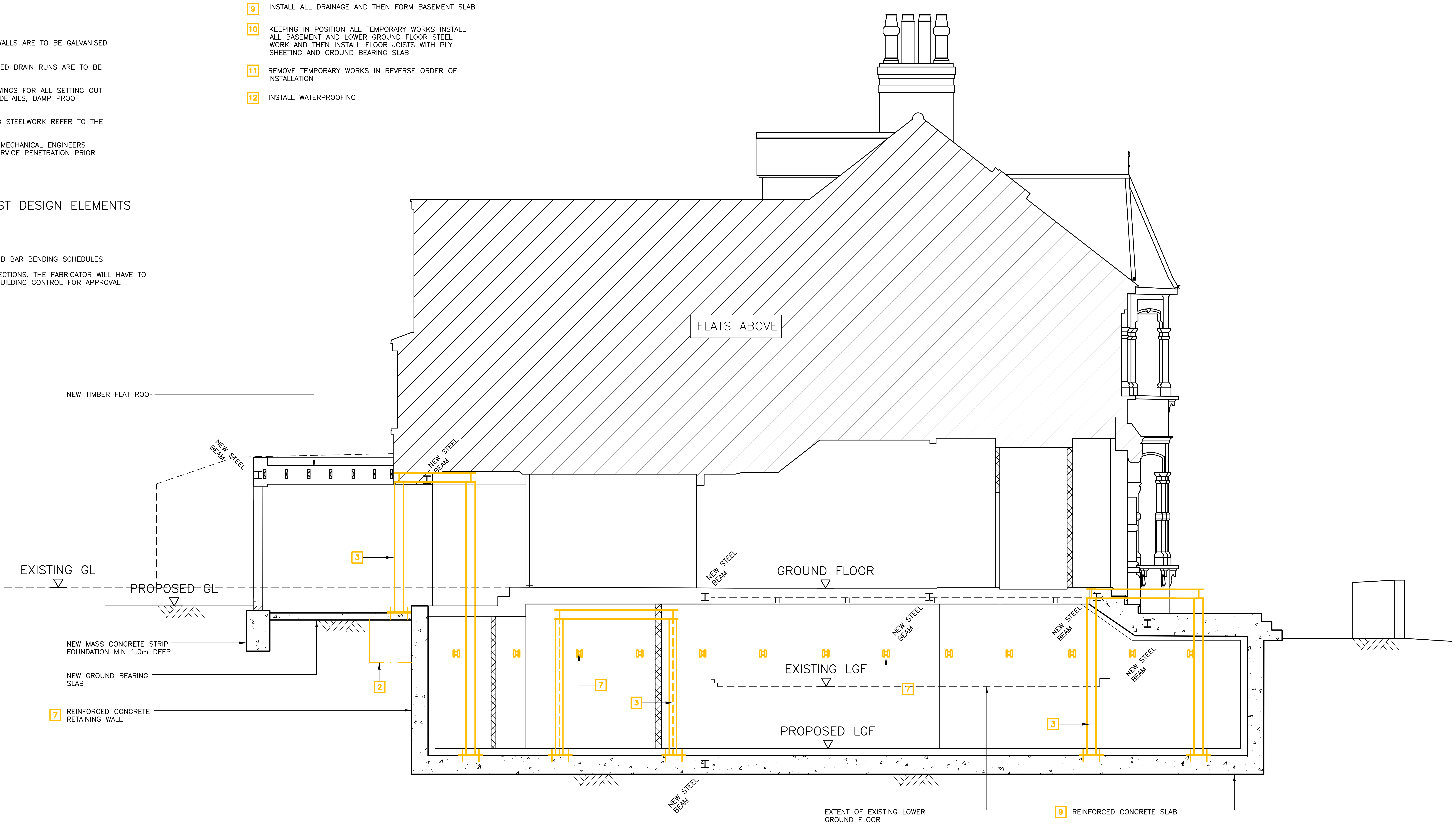

SECTION A–A
1:50

Notes

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Rev	Date	Chkd	Amendments
P1	12.09.18	AH	FOR PLANNING
P1	12.09.18	AH	FOR PLANNING

Drawing Status
PLANNING

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Job Title
43 HILLFIELD ROAD
NW6 1QD LONDON

Drawing Title
SECTION A–A

Job No. 17420
Drawing No. SK–03
Revision P1
Scales 1:50 AT A1
Original Size A1
Drawn By JNS
Date MAY 2018

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

APPENDIX 3

STRUCTURAL ENGINEER’S STATEMENT AND CALCULATIONS

Symmetrys Ltd
Structural Engineers

Structural Calculation Package

43 Hillfield Road
NW6 1QD
London

17420.-CAL-001
04th September 2018
Rev. A

1.0 Introduction

1.1 Symmetrys were instructed by Studio McLeod to design the extension to the single storey basement extension below the existing house at 43 Hillfield Road.

1.2 The structural works consisted of the following:

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: 1991 – Structural Timber
- BS 5628: Pt 1: 1992 – Masonry
- BS 5950: Pt 1: 1990 – Structural Steel
- BS 6399: Pt 1: 1984 – 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 115kPa 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 The loadings used throughout the design are shown in the table below:

Item	DL (kPa)	LL (kPa)
Tiled Roof (With Lining)		
Plain Tiles	0.50	
Felt & Battens	0.05	
Ply deck	0.12	
Rafters & Insulation	0.20	
Plasterboard & Skim	0.12	
	1.00	0.75
Plan load 30º	**1.15**	0.70
Timber Floor		
Ceiling and services	0.15	
Joists	0.20	
Plyboard and finishes	0.25	
	0.60	**1.5**

Solid Masonry 100mm thick 15mm plaster 215mm thick 15mm plaster	 1.9 0.3 **2.2** 4.0 0.3 **4.3**	
Cavity Wall 102 brick 100 block Finishes	 2.1 0.8 0.3 **3.2**	
Timber Stud Wall Plasterboards Skim Coats Studs (75x50 @ 400 c/c)	 0.20 0.15 0.15 **0.5**	

Design of retaining wall

Design of the retaining wall the most heavily loaded.

↳ under party wall with No 41, where there is no basement. → height = 3.6m

Load on Retaining wall

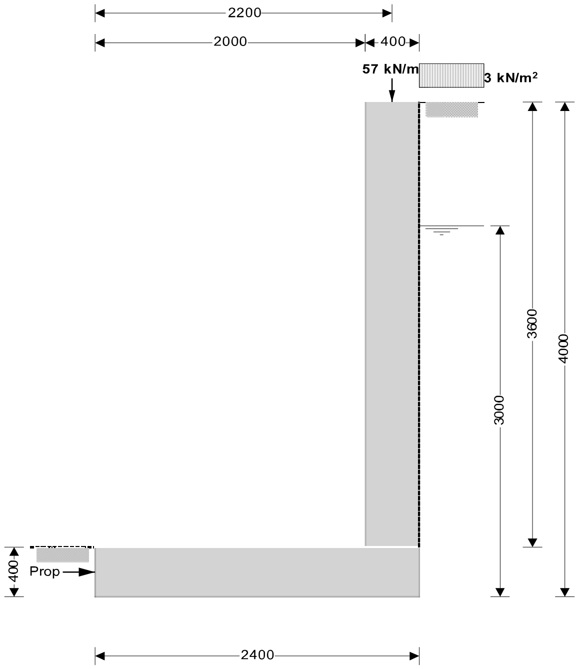
(kN/m)

	DL	LL
• Masonry wall = $8.7m \times 4.44 kN/m^2 = 38.6 kN/m^2$	38.6	
• Timber floor at 1st Floor = $\frac{3.2m}{2} \times \left\| \begin{matrix} 1.0 kN/m^2 \\ 1.5 - \end{matrix} \right. \times 2$	3.2	4.8
• Roof = $2 \times \frac{3.2m}{2} \times \left\| \begin{matrix} 1.15 kN/m^2 \\ 0.75 - \end{matrix} \right.$	3.7	2.4
• New Ground Floor $\frac{3.3m}{2} \times \left\| \begin{matrix} 1.0 kN/m^2 \\ 1.5 - \end{matrix} \right.$ (only @ 43 Hillfield Road (assume GF concrete slab @41.)	1.7	2.5
	47.2	9.7

→ See Tedds output.

RETAINING WALL ANALYSIS (BS 8002:1994)

TEDDS calculation version 1.2.01.06



Wall details

Retaining wall type	**Cantilever propped at base**
Height of retaining wall stem	h_{stem} = **3600** mm
Thickness of wall stem	t_{wall} = **400** mm
Length of toe	l_{toe} = **2000** mm
Length of heel	l_{heel} = **0** mm
Overall length of base	$l_{base} = l_{toe} + l_{heel} + t_{wall}$ = **2400** mm
Thickness of base	t_{base} = **400** mm
Depth of downstand	d_{ds} = **0** mm
Position of downstand	l_{ds} = **1400** mm
Thickness of downstand	t_{ds} = **400** mm
Height of retaining wall	$h_{wall} = h_{stem} + t_{base} + d_{ds}$ = **4000** mm
Depth of cover in front of wall	d_{cover} = **0** mm
Depth of unplanned excavation	d_{exc} = **0** mm
Height of ground water behind wall	h_{water} = **3000** mm
Height of saturated fill above base	$h_{sat} = \max(h_{water} - t_{base} - d_{ds}, 0\text{ mm})$ = **2600** mm
Density of wall construction	γ_{wall} = **23.6** kN/m^3
Density of base construction	γ_{base} = **23.6** kN/m^3
Angle of rear face of wall	α = **90.0** deg
Angle of soil surface behind wall	β = **0.0** deg
Effective height at virtual back of wall	$h_{eff} = h_{wall} + l_{heel} \times \tan(\beta)$ = **4000** mm

Retained material details

Mobilisation factor	M = **1.5**
Moist density of retained material	γ_m = **18.0** kN/m^3

Saturated density of retained material γ_s = **21.0** kN/m^3

Design shear strength ϕ' = **24.2** deg

Angle of wall friction δ = **0.0** deg

Base material details

Stiff clay

Moist density γ_{mb} = **18.0** kN/m^3

Design shear strength ϕ'_b = **24.2** deg

Design base friction δ_b = **18.6** deg

Allowable bearing pressure $P_{bearing}$ = **115** kN/m^2

Using Coulomb theory

Active pressure coefficient for retained material

$$K_a = \sin(\alpha + \phi')^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta) \times [1 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta) / (\sin(\alpha - \delta) \times \sin(\alpha + \beta)))}]^2) = \mathbf{0.419}$$

Passive pressure coefficient for base material

$$K_p = \sin(90 - \phi'_b)^2 / (\sin(90 - \delta_b) \times [1 - \sqrt{(\sin(\phi'_b + \delta_b) \times \sin(\phi'_b) / (\sin(90 + \delta_b)))}]^2) = \mathbf{4.187}$$

At-rest pressure

At-rest pressure for retained material $K_0 = 1 - \sin(\phi')$ = **0.590**

Loading details

Surcharge load on plan Surcharge = **2.5** kN/m^2

Applied vertical dead load on wall W_{dead} = **47.2** kN/m

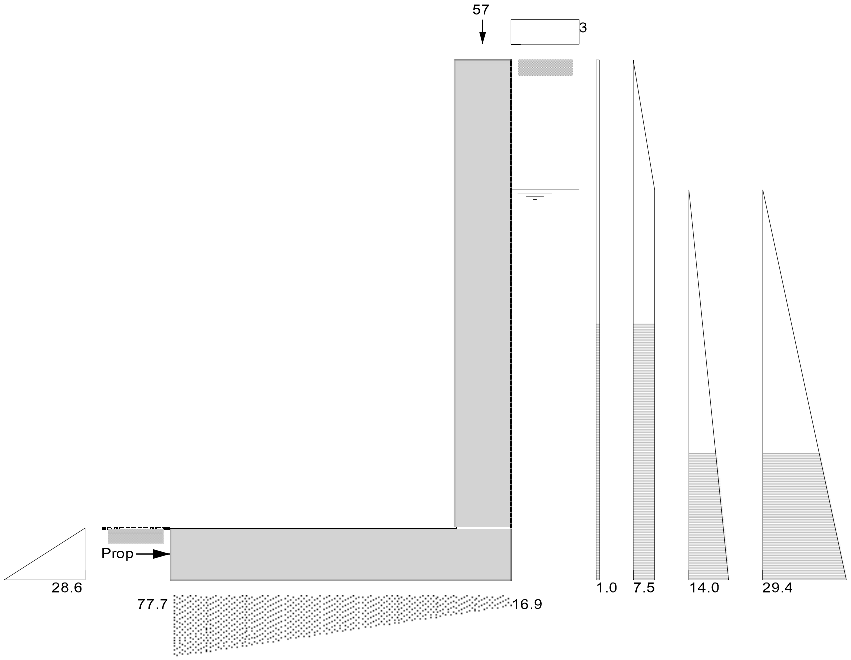
Applied vertical live load on wall W_{live} = **9.7** kN/m

Position of applied vertical load on wall l_{load} = **2200** mm

Applied horizontal dead load on wall F_{dead} = **0.0** kN/m

Applied horizontal live load on wall F_{live} = **0.0** kN/m

Height of applied horizontal load on wall h_{load} = **0** mm



Loads shown in kN/m, pressures shown in kN/m^2

Symmetrys Structural Engineers	Project 43 Hillfield Road				Job no. 17420	
	Calcs for Retaining wall				Start page no./Revision 3	
	Calcs by CC	Calcs date 11/09/2018	Checked by AH	Checked date 11/09/2018	Approved by AH	Approved date 11/09/2018

Vertical forces on wall

Wall stem $w_{wall} = h_{stem} \times t_{wall} \times \gamma_{wall}$ = **34** kN/m

Wall base $w_{base} = l_{base} \times t_{base} \times \gamma_{base}$ = **22.7** kN/m

Applied vertical load $W_v = W_{dead} + W_{live}$ = **56.9** kN/m

Total vertical load $W_{total} = w_{wall} + w_{base} + W_v$ = **113.5** kN/m

Horizontal forces on wall

Surcharge $F_{sur} = K_a \times \text{Surcharge} \times h_{eff}$ = **4.2** kN/m

Moist backfill above water table $F_{m\_a} = 0.5 \times K_a \times \gamma_m \times (h_{eff} - h_{water})^2$ = **3.8** kN/m

Moist backfill below water table $F_{m\_b} = K_a \times \gamma_m \times (h_{eff} - h_{water}) \times h_{water}$ = **22.6** kN/m

Saturated backfill $F_s = 0.5 \times K_a \times (\gamma_s - \gamma_{water}) \times h_{water}^2$ = **21.1** kN/m

Water $F_{water} = 0.5 \times h_{water}^2 \times \gamma_{water}$ = **44.1** kN/m

Total horizontal load $F_{total} = F_{sur} + F_{m\_a} + F_{m\_b} + F_s + F_{water}$ = **95.8** kN/m

Calculate propping force

Passive resistance of soil in front of wall $F_p = 0.5 \times K_p \times \cos(\delta_b) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^2 \times \gamma_{mb}$ = **5.7** kN/m

Propping force $F_{prop} = \max(F_{total} - F_p - (W_{total} - W_{live}) \times \tan(\delta_b), 0\ \text{kN/m})$

F_{prop} = **55.1** kN/m

Overturning moments

Surcharge $M_{sur} = F_{sur} \times (h_{eff} - 2 \times d_{ds}) / 2$ = **8.4** kNm/m

Moist backfill above water table $M_{m\_a} = F_{m\_a} \times (h_{eff} + 2 \times h_{water} - 3 \times d_{ds}) / 3$ = **12.6** kNm/m

Moist backfill below water table $M_{m\_b} = F_{m\_b} \times (h_{water} - 2 \times d_{ds}) / 2$ = **33.9** kNm/m

Saturated backfill $M_s = F_s \times (h_{water} - 3 \times d_{ds}) / 3$ = **21.1** kNm/m

Water $M_{water} = F_{water} \times (h_{water} - 3 \times d_{ds}) / 3$ = **44.1** kNm/m

Total overturning moment $M_{ot} = M_{sur} + M_{m\_a} + M_{m\_b} + M_s + M_{water}$ = **120** kNm/m

Restoring moments

Wall stem $M_{wall} = w_{wall} \times (l_{toe} + t_{wall} / 2)$ = **74.8** kNm/m

Wall base $M_{base} = w_{base} \times l_{base} / 2$ = **27.2** kNm/m

Design vertical dead load $M_{dead} = W_{dead} \times l_{load}$ = **103.8** kNm/m

Total restoring moment $M_{rest} = M_{wall} + M_{base} + M_{dead}$ = **205.8** kNm/m

Check bearing pressure

Design vertical live load $M_{live} = W_{live} \times l_{load}$ = **21.3** kNm/m

Total moment for bearing $M_{total} = M_{rest} - M_{ot} + M_{live}$ = **107.1** kNm/m

Total vertical reaction $R = W_{total}$ = **113.5** kN/m

Distance to reaction $x_{bar} = M_{total} / R$ = **943** mm

Eccentricity of reaction $e = \text{abs}((l_{base} / 2) - x_{bar})$ = **257** mm

Reaction acts within middle third of base

Bearing pressure at toe $p_{toe} = (R / l_{base}) + (6 \times R \times e / l_{base}^2)$ = **77.7** kN/m^2

Bearing pressure at heel $p_{heel} = (R / l_{base}) - (6 \times R \times e / l_{base}^2)$ = **16.9** kN/m^2

PASS - Maximum bearing pressure is less than allowable bearing pressure

RETAINING WALL DESIGN (BS 8002:1994)

TEDDS calculation version 1.2.01.06

Ultimate limit state load factors

Dead load factor $\gamma_{f\_d} = \mathbf{1.4}$

Live load factor $\gamma_{f\_l} = \mathbf{1.6}$

Earth and water pressure factor $\gamma_{f\_e} = \mathbf{1.4}$

Factored vertical forces on wall

Wall stem $w_{wall\_f} = \gamma_{f\_d} \times h_{stem} \times t_{wall} \times \gamma_{wall} = \mathbf{47.6}$ kN/m

Wall base $w_{base\_f} = \gamma_{f\_d} \times l_{base} \times t_{base} \times \gamma_{base} = \mathbf{31.7}$ kN/m

Applied vertical load $W_{v\_f} = \gamma_{f\_d} \times W_{dead} + \gamma_{f\_l} \times W_{live} = \mathbf{81.6}$ kN/m

Total vertical load $W_{total\_f} = w_{wall\_f} + w_{base\_f} + W_{v\_f} = \mathbf{160.9}$ kN/m

Factored horizontal at-rest forces on wall

Surcharge $F_{sur\_f} = \gamma_{f\_l} \times K_0 \times \text{Surcharge} \times h_{eff} = \mathbf{9.4}$ kN/m

Moist backfill above water table $F_{m\_a\_f} = \gamma_{f\_e} \times 0.5 \times K_0 \times \gamma_m \times (h_{eff} - h_{water})^2 = \mathbf{7.4}$ kN/m

Moist backfill below water table $F_{m\_b\_f} = \gamma_{f\_e} \times K_0 \times \gamma_m \times (h_{eff} - h_{water}) \times h_{water} = \mathbf{44.6}$ kN/m

Saturated backfill $F_{s\_f} = \gamma_{f\_e} \times 0.5 \times K_0 \times (\gamma_s - \gamma_{water}) \times h_{water}^2 = \mathbf{41.6}$ kN/m

Water $F_{water\_f} = \gamma_{f\_e} \times 0.5 \times h_{water}^2 \times \gamma_{water} = \mathbf{61.8}$ kN/m

Total horizontal load $F_{total\_f} = F_{sur\_f} + F_{m\_a\_f} + F_{m\_b\_f} + F_{s\_f} + F_{water\_f} = \mathbf{164.9}$ kN/m

Calculate propping force

Passive resistance of soil in front of wall $F_{p\_f} = \gamma_{f\_e} \times 0.5 \times K_p \times \cos(\delta_b) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^2 \times \gamma_{mb} = \mathbf{8}$ kN/m

Propping force $F_{prop\_f} = \max(F_{total\_f} - F_{p\_f} - (W_{total\_f} - \gamma_{f\_l} \times W_{live}) \times \tan(\delta_b), 0\text{ kN/m})$

$F_{prop\_f} = \mathbf{108.0}$ kN/m

Factored overturning moments

Surcharge $M_{sur\_f} = F_{sur\_f} \times (h_{eff} - 2 \times d_{ds}) / 2 = \mathbf{18.9}$ kNm/m

Moist backfill above water table $M_{m\_a\_f} = F_{m\_a\_f} \times (h_{eff} + 2 \times h_{water} - 3 \times d_{ds}) / 3 = \mathbf{24.8}$ kNm/m

Moist backfill below water table $M_{m\_b\_f} = F_{m\_b\_f} \times (h_{water} - 2 \times d_{ds}) / 2 = \mathbf{66.9}$ kNm/m

Saturated backfill $M_{s\_f} = F_{s\_f} \times (h_{water} - 3 \times d_{ds}) / 3 = \mathbf{41.6}$ kNm/m

Water $M_{water\_f} = F_{water\_f} \times (h_{water} - 3 \times d_{ds}) / 3 = \mathbf{61.8}$ kNm/m

Total overturning moment $M_{ot\_f} = M_{sur\_f} + M_{m\_a\_f} + M_{m\_b\_f} + M_{s\_f} + M_{water\_f} = \mathbf{214}$ kNm/m

Restoring moments

Wall stem $M_{wall\_f} = w_{wall\_f} \times (l_{toe} + t_{wall} / 2) = \mathbf{104.7}$ kNm/m

Wall base $M_{base\_f} = w_{base\_f} \times l_{base} / 2 = \mathbf{38.1}$ kNm/m

Design vertical load $M_{v\_f} = W_{v\_f} \times l_{load} = \mathbf{179.5}$ kNm/m

Total restoring moment $M_{rest\_f} = M_{wall\_f} + M_{base\_f} + M_{v\_f} = \mathbf{322.3}$ kNm/m

Factored bearing pressure

Total moment for bearing $M_{total\_f} = M_{rest\_f} - M_{ot\_f} = \mathbf{108.3}$ kNm/m

Total vertical reaction $R_f = W_{total\_f} = \mathbf{160.9}$ kN/m

Distance to reaction $x_{bar\_f} = M_{total\_f} / R_f = \mathbf{673}$ mm

Eccentricity of reaction $e_f = \text{abs}((l_{base} / 2) - x_{bar\_f}) = \mathbf{527}$ mm

Reaction acts outside middle third of base

Bearing pressure at toe $p_{toe\_f} = R_f / (1.5 \times x_{bar\_f}) = \mathbf{159.4}$ kN/m^2

Bearing pressure at heel $p_{heel\_f} = 0\text{ kN/m}^2 = \mathbf{0}$ kN/m^2

Rate of change of base reaction $\text{rate} = p_{toe\_f} / (3 \times x_{bar\_f}) = \mathbf{78.96}$ kN/m^2/m

Bearing pressure at stem / toe $p_{stem\_toe\_f} = \max(p_{toe\_f} - (\text{rate} \times l_{toe}), 0\text{ kN/m}^2) = \mathbf{1.5}$ kN/m^2

Bearing pressure at mid stem $p_{stem\_mid\_f} = \max(p_{toe\_f} - (rate \times (l_{toe} + t_{wall} / 2)), 0\ kN/m^2) = \mathbf{0}\ kN/m^2$

Bearing pressure at stem / heel $p_{stem\_heel\_f} = \max(p_{toe\_f} - (rate \times (l_{toe} + t_{wall})), 0\ kN/m^2) = \mathbf{0}\ kN/m^2$

Design of reinforced concrete retaining wall toe (BS 8002:1994)

Material properties

Characteristic strength of concrete $f_{cu} = \mathbf{40}\ N/mm^2$

Characteristic strength of reinforcement $f_y = \mathbf{500}\ N/mm^2$

Base details

Minimum area of reinforcement $k = \mathbf{0.13}\ \%$

Cover to reinforcement in toe $c_{toe} = \mathbf{30}\ mm$

Calculate shear for toe design

Shear from bearing pressure $V_{toe\_bear} = (p_{toe\_f} + p_{stem\_toe\_f}) \times l_{toe} / 2 = \mathbf{160.9}\ kN/m$

Shear from weight of base $V_{toe\_wt\_base} = \gamma_{f\_d} \times \gamma_{base} \times l_{toe} \times t_{base} = \mathbf{26.4}\ kN/m$

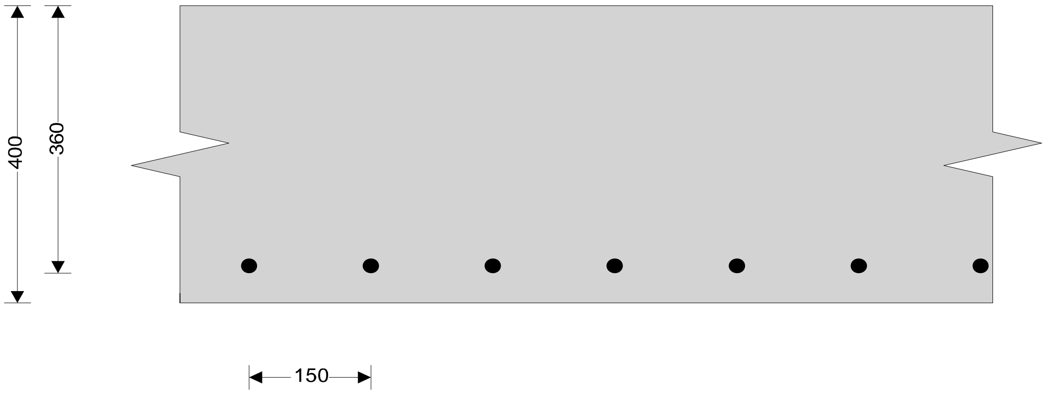
Total shear for toe design $V_{toe} = V_{toe\_bear} - V_{toe\_wt\_base} = \mathbf{134.5}\ kN/m$

Calculate moment for toe design

Moment from bearing pressure $M_{toe\_bear} = (2 \times p_{toe\_f} + p_{stem\_mid\_f}) \times (l_{toe} + t_{wall} / 2)^2 / 6 = \mathbf{257.2}\ kNm/m$

Moment from weight of base $M_{toe\_wt\_base} = (\gamma_{f\_d} \times \gamma_{base} \times t_{base} \times (l_{toe} + t_{wall} / 2)^2 / 2) = \mathbf{32}\ kNm/m$

Total moment for toe design $M_{toe} = M_{toe\_bear} - M_{toe\_wt\_base} = \mathbf{225.2}\ kNm/m$



Check toe in bending

Width of toe $b = \mathbf{1000}\ mm/m$

Depth of reinforcement $d_{toe} = t_{base} - c_{toe} - (\phi_{toe} / 2) = \mathbf{360.0}\ mm$

Constant $K_{toe} = M_{toe} / (b \times d_{toe}^2 \times f_{cu}) = \mathbf{0.043}$

Compression reinforcement is not required

Lever arm $z_{toe} = \min(0.5 + \sqrt{(0.25 - (\min(K_{toe}, 0.225) / 0.9))}, 0.95) \times d_{toe}$

$z_{toe} = \mathbf{342}\ mm$

Area of tension reinforcement required $A_{s\_toe\_des} = M_{toe} / (0.87 \times f_y \times z_{toe}) = \mathbf{1515}\ mm^2/m$

Minimum area of tension reinforcement $A_{s\_toe\_min} = k \times b \times t_{base} = \mathbf{520}\ mm^2/m$

Area of tension reinforcement required $A_{s\_toe\_req} = \mathrm{Max}(A_{s\_toe\_des}, A_{s\_toe\_min}) = \mathbf{1515}\ mm^2/m$

Reinforcement provided **20 mm dia.bars @ 150 mm centres**

Area of reinforcement provided $A_{s\_toe\_prov} = \mathbf{2094}\ mm^2/m$

PASS - Reinforcement provided at the retaining wall toe is adequate

Check shear resistance at toe

Design shear stress $v_{toe} = V_{toe} / (b \times d_{toe}) = \mathbf{0.373}\ N/mm^2$

Allowable shear stress $v_{adm} = \min(0.8 \times \sqrt{(f_{cu} / 1\ N/mm^2)}, 5) \times 1\ N/mm^2 = \mathbf{5.000}\ N/mm^2$

PASS - Design shear stress is less than maximum shear stress

From BS8110:Part 1:1997 – Table 3.8

Design concrete shear stress	v_{c_toe} = **0.634** N/mm^2

$v_{toe} < v_{c\_toe}$ - No shear reinforcement required

Design of reinforced concrete retaining wall stem (BS 8002:1994)

Material properties

Characteristic strength of concrete	f_{cu} = **40** N/mm^2
Characteristic strength of reinforcement	f_y = **500** N/mm^2

Wall details

Minimum area of reinforcement	k = **0.13** %
Cover to reinforcement in stem	c_{stem} = **30** mm
Cover to reinforcement in wall	c_{wall} = **30** mm

Factored horizontal at-rest forces on stem

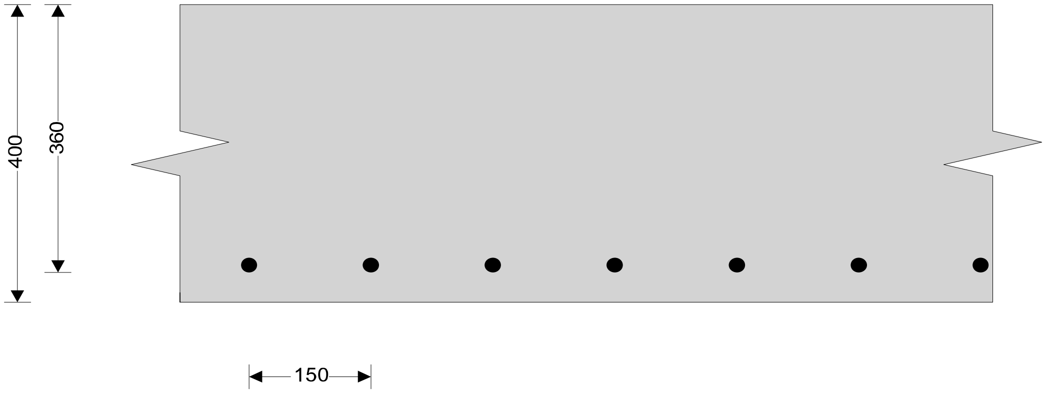
Surcharge	$F_{s\_sur\_f} = \gamma_{f\_l} \times K_0 \times \text{Surcharge} \times (h_{eff} - t_{base} - d_{ds})$ = **8.5** kN/m
Moist backfill above water table	$F_{s\_m\_a\_f} = 0.5 \times \gamma_{f\_e} \times K_0 \times \gamma_m \times (h_{eff} - t_{base} - d_{ds} - h_{sat})^2$ = **7.4** kN/m
Moist backfill below water table	$F_{s\_m\_b\_f} = \gamma_{f\_e} \times K_0 \times \gamma_m \times (h_{eff} - t_{base} - d_{ds} - h_{sat}) \times h_{sat}$ = **38.7** kN/m
Saturated backfill	$F_{s\_s\_f} = 0.5 \times \gamma_{f\_e} \times K_0 \times (\gamma_s - \gamma_{water}) \times h_{sat}^2$ = **31.2** kN/m
Water	$F_{s\_water\_f} = 0.5 \times \gamma_{f\_e} \times \gamma_{water} \times h_{sat}^2$ = **46.4** kN/m

Calculate shear for stem design

Shear at base of stem	$V_{stem} = F_{s\_sur\_f} + F_{s\_m\_a\_f} + F_{s\_m\_b\_f} + F_{s\_s\_f} + F_{s\_water\_f} - F_{prop\_f}$ = **24.3** kN/m

Calculate moment for stem design

Surcharge	$M_{s\_sur} = F_{s\_sur\_f} \times (h_{stem} + t_{base}) / 2$ = **17** kNm/m
Moist backfill above water table	$M_{s\_m\_a} = F_{s\_m\_a\_f} \times (2 \times h_{sat} + h_{eff} - d_{ds} + t_{base} / 2) / 3$ = **23.3** kNm/m
Moist backfill below water table	$M_{s\_m\_b} = F_{s\_m\_b\_f} \times h_{sat} / 2$ = **50.3** kNm/m
Saturated backfill	$M_{s\_s} = F_{s\_s\_f} \times h_{sat} / 3$ = **27.1** kNm/m
Water	$M_{s\_water} = F_{s\_water\_f} \times h_{sat} / 3$ = **40.2** kNm/m
Total moment for stem design	$M_{stem} = M_{s\_sur} + M_{s\_m\_a} + M_{s\_m\_b} + M_{s\_s} + M_{s\_water}$ = **157.9** kNm/m



Check wall stem in bending

Width of wall stem	b = **1000** mm/m
Depth of reinforcement	$d_{stem} = t_{wall} - c_{stem} - (\phi_{stem} / 2)$ = **360.0** mm
Constant	$K_{stem} = M_{stem} / (b \times d_{stem}^2 \times f_{cu})$ = **0.030**

Compression reinforcement is not required

Lever arm	$z_{stem} = \min(0.5 + \sqrt{(0.25 - (\min(K_{stem}, 0.225) / 0.9))}, 0.95) \times d_{stem}$

$z_{stem} = \mathbf{342}$ mm

Area of tension reinforcement required $A_{s\_stem\_des} = M_{stem} / (0.87 \times f_y \times z_{stem}) = \mathbf{1061}\ \text{mm}^2/\text{m}$

Minimum area of tension reinforcement $A_{s\_stem\_min} = k \times b \times t_{wall} = \mathbf{520}\ \text{mm}^2/\text{m}$

Area of tension reinforcement required $A_{s\_stem\_req} = \text{Max}(A_{s\_stem\_des}, A_{s\_stem\_min}) = \mathbf{1061}\ \text{mm}^2/\text{m}$

Reinforcement provided **20 mm dia.bars @ 150 mm centres**

Area of reinforcement provided $A_{s\_stem\_prov} = \mathbf{2094}\ \text{mm}^2/\text{m}$

PASS - Reinforcement provided at the retaining wall stem is adequate

Check shear resistance at wall stem

Design shear stress $v_{stem} = V_{stem} / (b \times d_{stem}) = \mathbf{0.067}\ \text{N/mm}^2$

Allowable shear stress $v_{adm} = \min(0.8 \times \sqrt{}(f_{cu} / 1\ \text{N/mm}^2), 5) \times 1\ \text{N/mm}^2 = \mathbf{5.000}\ \text{N/mm}^2$

PASS - Design shear stress is less than maximum shear stress

From BS8110:Part 1:1997 – Table 3.8

Design concrete shear stress $v_{c\_stem} = \mathbf{0.634}\ \text{N/mm}^2$

$v_{stem} < v_{c\_stem}$ - No shear reinforcement required

Check retaining wall deflection

Basic span/effective depth ratio $\text{ratio}_{bas} = \mathbf{7}$

Design service stress $f_s = 2 \times f_y \times A_{s\_stem\_req} / (3 \times A_{s\_stem\_prov}) = \mathbf{168.9}\ \text{N/mm}^2$

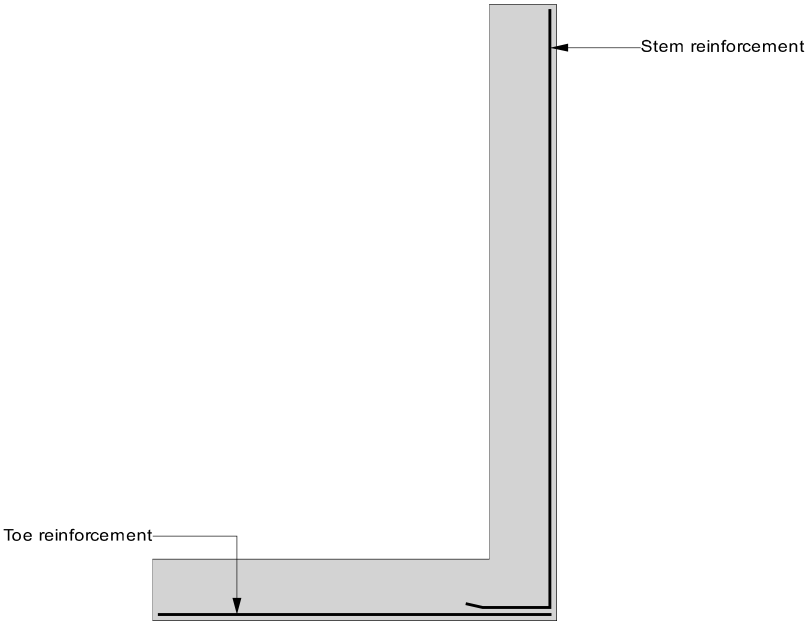
Modification factor $\text{factor}_{tens} = \min(0.55 + (477\ \text{N/mm}^2 - f_s)/(120 \times (0.9\ \text{N/mm}^2 + (M_{stem}/(b \times d_{stem}^2)))),2) = \mathbf{1.76}$

Maximum span/effective depth ratio $\text{ratio}_{max} = \text{ratio}_{bas} \times \text{factor}_{tens} = \mathbf{12.34}$

Actual span/effective depth ratio $\text{ratio}_{act} = h_{stem} / d_{stem} = \mathbf{10.00}$

PASS - Span to depth ratio is acceptable

Indicative retaining wall reinforcement diagram



Toe bars - 20 mm dia.@ 150 mm centres - (2094 mm^2/m)

Stem bars - 20 mm dia.@ 150 mm centres - (2094 mm^2/m)

Design of basement slab

Approximate conservative heave force:

Excavation depth = 3.8m

Hydrostatic pressure = $3.8m \times 10kN/m^3 = 38 kN/m^2$

Overburden pressure = $3.8 \times 18 kN/m^3 = 68.4$ —

Heave = $38 + 0.5 \times (68.4 - 38) = 53.2 kN/m^2$

Basement slab S.W.

SW = $0,4 m \times 24kN/m^3 = 9.6 kN/m^2$

Screed = 0.07×24 — = 1.4 —

Total = $1,4 + 9.6 = 11 kN/m^2$

Uplift:

Overall uplift = $53.2 - 11 = 42.2$ —

Ultimate = $1,6 \times 42.2 = 67.52 kN/m^2$

Design of basement slab:

The basement slab will be designed to transmit forces to the Retaining wall bases.

$$\text{Moment} = \frac{wL^2}{8} = \frac{67.5 \times 2.8m^2}{8} = 66,2 kN.m$$

→ Use 300mm thick RC slab

ELEMENT DESIGN to BS 8110:2005

SOLID SLABS

Originated from RCC11.xls v4.0

INPUT Location Basement slab

Design moment, M 66.2 kNm/m fcu 40 N/mm² γc = 1.50

ßb 1.00 fy 500 N/mm² γs = 1.15

span 2800 mm steel class A

Height, h 300 mm Section location SIMPLY SUPPORTED SP

Bar Ø 16 mm Compression steel SPECIF

cover 50 mm to these bars *(deflection control only)*

ONE or TWO WAY SLAB

OUTPUT Basement slab Compression steel = H10@200(0.162%)

d = 300 - 50 - 16/2 = 242.0 mm

(3.4.4.4) K' = 0.156 > K = 0.028 ok

(3.4.4.4) z = 242.0 [0.5 + (0.25 - 0.028 /0.893)]^½ = 234.1 > 0.95d = 229.9 mm

(3.4.4.1) As = 66.20E6 /500 /229.9 x 1.15 = 662 > min As = 390 mm²/m

PROVIDE H16 @ 300 = 670 mm²/m

(Eqn 8) fs = 2/3 x 500 x 662 /670 /1.00 = 329.4 N/mm²

(Eqn 7) Tens mod factor = 0.55 + (477 - 329.4) /120 /(0.9 + 1.130) = 1.156

(Equation 9) Comp mod factor = 1 + 0.162/(3 + 0.162) = 1.051

(3.4.6.3) Permissible L/d = 20.0 x 1.156 x 1.051 = 24.303

Actual L/d = 2800 /242.0 = 11.570 ok

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

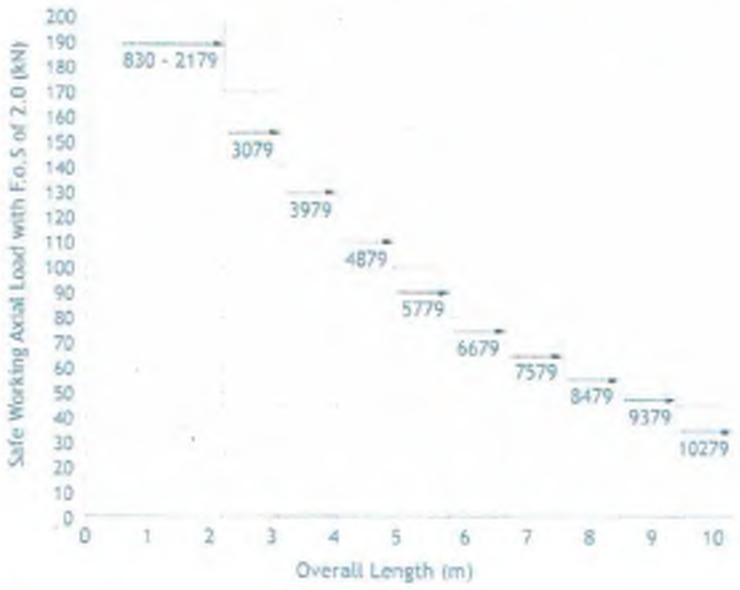
Provide S31/KP/9 Maybey Props (L = 5.7m)

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 **S310A** 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/lightening 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.

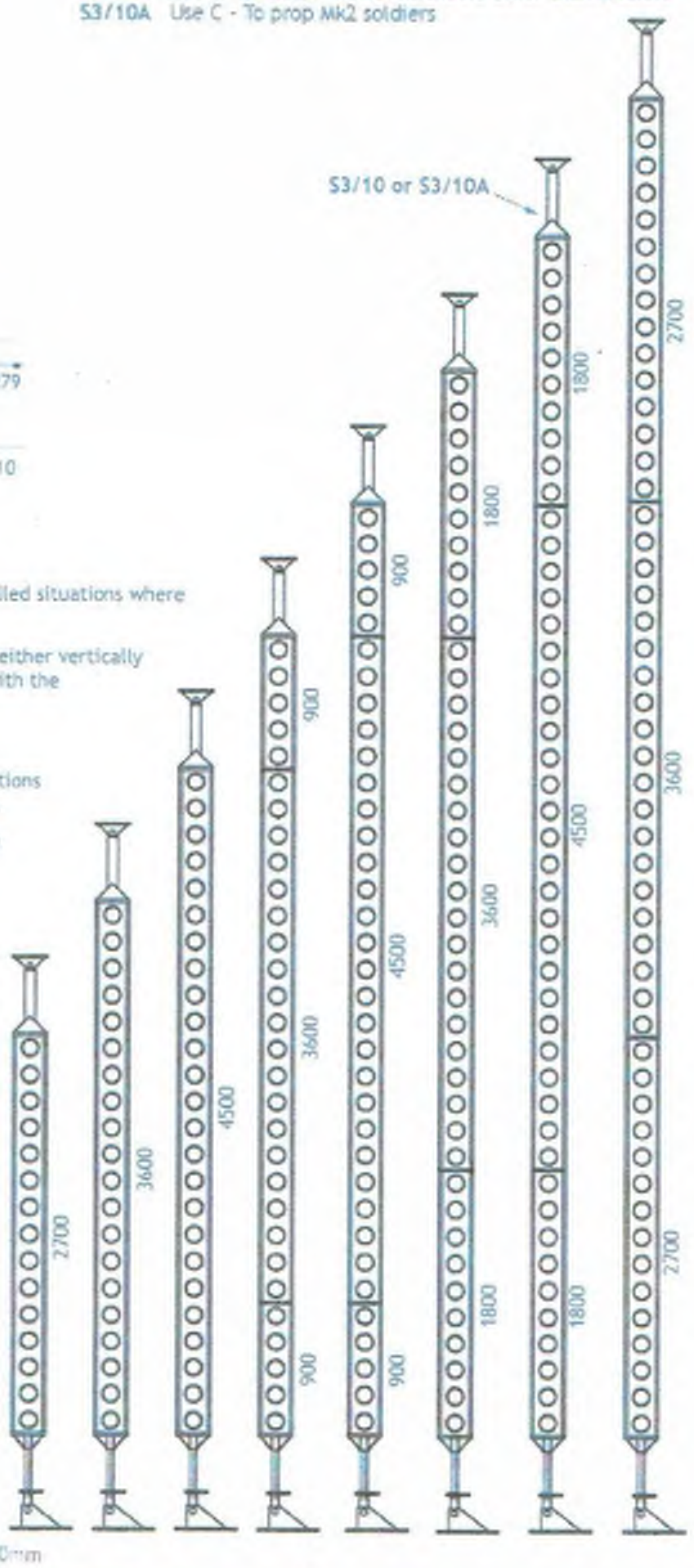
For props a recommended straightness tolerance is given below, indicated by Max Offset Dim (mm). Should the prop fall outside the range shown, the components should be checked for local damage to end plates.

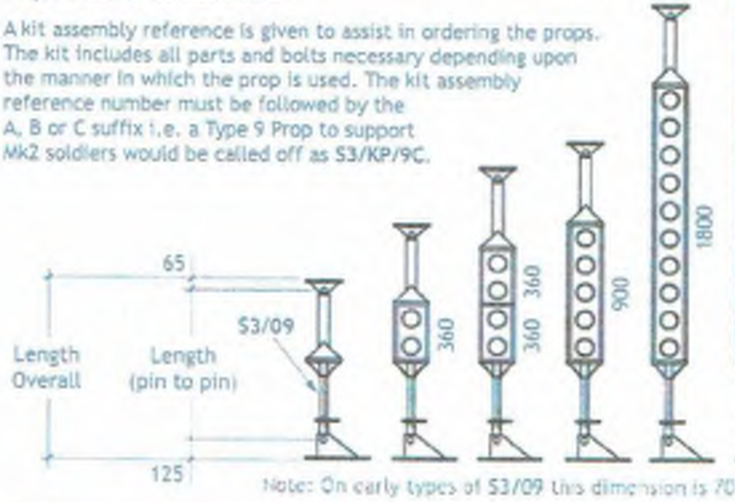
All bolted joints require 6 No. **S3/22** bolts.

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 70mm

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	75	90	113	132	151	182	201	212	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