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Description	Basement Impact Assessment & Ground Movement Assessment & Predicted Damage Category.
Site	73 Goldhurst Terrace NW6 3HA
Reference	A704.21
Status	Final rev n.1
Client	Basement Consulting Ltd
Issue date	28/10/2021

Prepared and reviewed by		
Name	Mr Paolo Pitasi CEng MICE	Paolo Pitasi
Position	Director	
Date	23/11/2021	

- ## 1. Introduction.

1.1 Basement Consulting Limited commissioned this Basement Impact Assessment as a supporting document to the planning application for the proposed basement at 73 Goldhurst Terrace NW6 3HA. The local planning authority is the London Borough of Camden.

1.2 The Basement Impact Assessment will include the following items:
• Screening.
• Scoping.
• Site investigation and study.
• Impact assessment and Review and decision making.
The purpose of these items should be to assess the impact of the proposed development on surface water flow, flooding, groundwater flow and structural stability, as well as the cumulative effect on the surrounding area, to identify suitable construction methods and mitigation measures, and a method for monitoring local ground conditions, water movement, subsidence, and drainage.

2. Site context

- ### 2.1 Topographic setting.

The new residential redevelopment is in an area relatively flat, with no significant topographical features located within the district of Camden which is part of the London Borough of Camden.
The surrounding areas were found to be generally residential or commercial.
The new property has the entrance from the road which is Goldhurst Terrace in a consisting mostly of terraced properties of similar design.
The site location plan is given in Figure below.

- **2.2 Site Description and neighbouring Properties**

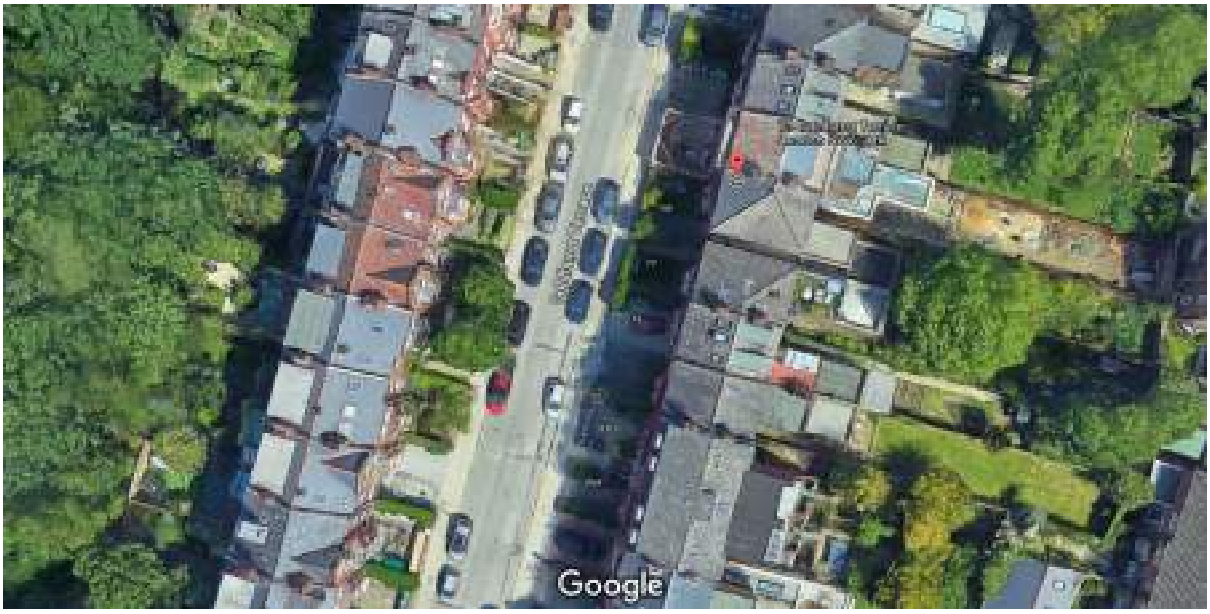
The site comprised a 2-storey terraced property, which was positioned approximately east to west. The property extended out to the rear (west) at a lower roof level than the main house, with garden following on it. There was a small front garden on the eastern side which adjoined to the Goldhurst Terrace Road.

There was an existing basement of ~26m2 located below the main house.

The property shared a party wall on its northern side with the building No. 71 Goldhurst Terrace Road and a party wall on its southern side with the building No. 75E Goldhurst Terrace Road.

There were no known basements below these two neighbouring properties.

An aerial photograph of the site has been included in the figure below.



- **2.3 Proposed Development**

The proposed development comprised the extending of the existing basement below the footprint of the main house, into the front garden to create a lightwell, into a portion of the rear garden and with a small single-story extension to the house's rear.
The proposed basement extension had an area of ~110m2 and extended to a depth of ~3.25m below ground level (BGL) and for which satisfying these main requirements of the Camden Planning Guidance (Basements):

- to be no more than one storey deep and
- to not exceed 50% of the garden of the property.

The extended basement would include a games and cinema rooms, toilet, utility, storage, home gym below the main house, a new lightwell at the rear with steps leading up to the front door and a new lightwell at the front.
In compiling this report reliance was placed on architectonic drawings that are attached at the end of this report.

- **2.4 Planning searches (Historical maps).**

The site history has been researched by reference to historical OS maps obtained from the Groundsure Insights database reference GS-8317459 of 06/11/2021 that are attached at the end of this report.
The earliest map studied, dated between 1871 and 1872, shows the site to be undeveloped, comprising part of an open field.
However, by 1896 the site had been developed and the existing road network established, although the map is not of sufficient resolution to determine the exact nature of the building present on site. The neighbouring properties have also been established by this time.
The site and surrounding area have remained essentially unaltered from this time. The key apparent features noted on site and the surrounding area are summarised below.

Year	Map scale	Site description
1871-1872	1:2500	Site to be undeveloped comprising part of an open field
1896	1:2500	The site had been developed and the existing road network established
1915	1:2500	The building outline is maintained which proves not change to the property
1935	1:2500	The building outline is maintained which proves not change to the property
1953	1:2500	The building outline is maintained which proves not change to the property
1955	1:2500	The building outline is maintained which proves not change to the property
1960-1962	1:2500	The building outline is maintained which proves not change to the property
1967-1971	1:2500	The building outline is maintained which proves not change to the property
1979-1983	1:2500	The building outline is maintained which proves not change to the property
1991	1:2500	The building outline is maintained which proves not change to the property
2003	1:2500	The building outline is maintained which proves not change to the property

- **2.5 Planning searches: Bomb damage maps.**

The London bomb map shown in attached figure (extracted from website www.bombsight.org) shows no bombs were dropped directly in the immediate vicinity of the proposed site. The nearest bomb was recorded about more than 100m away in the south-west direction of the property
The properties within 150m of 73 Goldhurst Terrace NW6 3HA did not suffer any bomb damage.

- **2.6 General information.**

The following document: Groundsure Geo Insight report ref. GS-8317458 of 06/11/2021 which provides high quality geo-environmental information of the site will be used as reference for drafting the Basement Impact assessment.
This document is attached at the end of this report.

- **2.7 Site investigation and study.**

The proposed intrusive investigation was designed to provide information on the ground conditions and to aid the design of foundations for the proposed residential development.
The FACTUAL GROUND INVESTIGATION REPORT performed by Ground & Water Report Reference: GWPR3316/GIR/October 2019 includes the following contents:

- Introduction
- Site setting
- Fieldwork
- Encountered ground conditions.
- In -situ and laboratory geotechnical testing.

This document provides detailed geo-environmental information of the site and will be used as reference for drafting this Basement Impact assessment.
This document is attached at the end of this report.

- **2.8 Geological setting.**

2.8.a The published BGS Geological mapping 1:50000 and the Geo Insight reference: GS-8317458 of 06/11/2021 attached at the end of this report indicate the site to be located directly upon the bedrock London Clay Formation with no overlying superficial deposits.

2.8.b The London Clay Formation is well documented (e.g., Ellison et al., 2004) as consisting of over-consolidated, firm to very stiff, grey to blueish grey, fissured, bioturbated, slightly calcareous, silty to very silty clay. It contains well-graded beds of clayey silt to fine silty sand, pyrite, and various sized carbonate concretions (claystone).

2.8.b Examining the BGS Borehole Records, it is possible to state that an exploratory borehole (BGS Reference: TQ28SE276) was carried out in the neighbouring area of the site. The mentioned document is attached below.

TQ28SE/ 276
2623.8410
256

GROUND EXPLORATIONS LIMITED

BOREHOLE SECTION SHEET

Date........December..................19..55

CONTRACT NAME	Swiss Cottage.	ORDER No.	
Bored for :	Messrs. Goodhart-Rendel & Partners.		
Address :	Kirkland House, Whitehall S.W1.		
Address of Site :	Colridge Gardens		
District or Town :	Swiss Cottage	County :	London
Standing Water Level :	- below surface	Dia. of Borehole :	6 Inches
Water Struck (1)	None (2) (3)		
Boring Commenced :	5.12.55	Boring Completed :	6.12.55
Special Remarks :			

Jar Samples : 2871 2'0"; 2872 5'0"; 2879 9'0"; 2876 13'0"; 2878 17'0"; 2880 22'0";

Core Samples : 2873 5'6" - 7'0"; 2875 10'0" - 11'6"; 2877 14'6" - 16'0"; 2879 18'6" - 20'0"; 2881 23'6" - 25'0";

Sand/Gravel Samples :

DESCRIPTION OF STRATA	Thickness Feet	Thickness Inches	Depth Below Surface Feet	Depth Below Surface Inches
The descriptions are given in accordance with the Civil Engineering Code of Practice No. 1 "Site Investigations." No responsibility is accepted for these descriptions and clients should examine the samples submitted.				
No. 1 Boring				
Topsoil	1	6	(0.46) 1	6
Loamy clay	3	6	(1.52) 5	0
Brown clay	20	0	(7.62) 25	0
TOTAL FROM SURFACE ...	25	0	25	0.

This form is to be returned to Head Office immediately the borehole is finished.

Foreman's Signature.. *Date*..................................

P. & R. Ltd.—175

2.8.c Detailed information on the soil condition are illustrated in the FACTUAL GROUND INVESTIGATION REPORT (performed by Ground & Water Report Reference: GWPR3316/GIR/October 2019) at the section 4.0 ENCOUNTERED GROUND CONDITIONS.

- **2.9 Hydrological setting and surface water flooding.**

2.9.a There were no surface water features within a 250m radius of the site location. The nearest surface water feature was the Regent's Canal, ~1.52km south-east of the site.

2.9.b The Environment Agency (EA) published a new map of 'Risk of Flooding from Surface Water' on their website in January 2014; This map identifies four levels of risk (high, medium, low, and very low.

2.9.c The EA's definitions of the categories are:
'Very low' risk: Each year, these areas have a chance of flooding of less than 1 in 1000 (0.1%).
'Low' risk: Each year, these areas have a chance of flooding of between 1 in 1000 (0.1%) and

1 in 100 (1%)
'Medium' risk: Each year, these areas have a chance of flooding of between 1 in 100 (1%) and 1 in 30 (3.3%).
'High' risk: Each year, these areas have a chance of flooding of greater than 1 in 30 (3.3%).

2.9.d This modelling indicates that the area at 73 Goldhurst Terrace NW6 3HA has very low risk of flooding from rivers or sea and the related flood risks map is attached below:

Low risk from surface water or reservoirs and the related flood risks map is attached below.

For these reasons, the flood risk assessment is not necessary.

- **2.10 Hydrological setting and ground water flooding.**

This section was already expounded in the FACTUAL GROUND INVESTIGATION REPORT performed by Ground & Water Report Reference: GWPR3316/GIR/October 2019 at the section 2.4.
On the basis of this report the site was situated within a Flood Zone 1, i.e., an area with low probability of flooding. Therefor the probability of finding an aquifer in the area where the basement is built, will be very low.

- **2.11 Shrinking /swelling clays and impact with existing trees.**

The results from Atterberg Limits Tests at the section 5.2 of the FACTUAL GROUND INVESTIGATION REPORT performed by Ground & Water Report Reference: GWPR3316/GIR/October 2019 classify the soil as: CV, CH: medium and high plasticity clays and high shrinkage potential.
Also, the Geo Insight reference: GS-8317458 of 06/11/2021 gives a hazard rating for potential shrink-swell problems on the building as moderate.
As a result, the clays undergo considerable volume changes in response to variations in natural moisture content (they shrink on drying and swell on subsequent rehydration). These changes can occur seasonally in response to normal climatic variations to depths of up to 1.5m, and much greater depths in the presence of trees whose roots abstract moisture from the clays.
The BRE Digest 240 suggests: “Two courses of action are open:

- Estimate the potential for swelling or shrinkage and try to avoid large changes in the water content, for example by not planting trees near the foundations.

- Accept that swelling or shrinkage will occur and take account of it. The foundations can be designed to resist resulting ground movements, or the superstructure can be designed to accommodate movement without damage.

Thus, the foundation must be designed to withstand movements due to this phenomenon.

- **2.12 Railways, tunned and underground structure.**

2.12.a Railways, tunnels and underground structure for transport do not pass below or close (Within 180m) to the site. See the Geo Insight reference GS-8317458 of 06/11/2021 sections n.5 and n.8

1.12.b Other underground infrastructure as human-made cavities under the main drainage, sewers, cables, or communications might be present within the zone of influence of the proposed basement, so an appropriate services/utility search should be undertaken before carrying out the construction of the basement. If any such infrastructure is identified, then its potential influence on the proposed basement must be assessed.

- **2.13 Landslides.**

The topography of the site and the surrounding land is relatively flat for which slope instability problems are unlikely to be present and no actions required to avoid problems due to landslides.
The Geo Insight reference GS-8317458 of 06/11/2021 section n.4.5 a hazard rating for potential landslides as very low.

3 Screening.

3.a Introduction.

Paca Geotechnical Engineering ltd has adopted a screening process to meet the requirements of the London Borough of Camden to identify potential risks to the ground, groundwater/surface water, land stability to be further investigated in the other stages

3.b Surface Flow and Flooding Screening Assessment.

The response to the Surface Flow and Flood Screening Assessment is given in table below:

Question	Response
As part of the proposed site drainage, will surface water flows (e.g., volume of rainfall and peak run-off) be materially changed from the existing route?	**No** – The anticipated geology was the London Clay Formation, which as unproductive strata and would provide very limited capacity to store rainfall. The proposed basement would therefore not materially change the existing route. Thus, it will not be necessary to carry forward to the next stages.
Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	**Yes** –The proposed development comprised extending the existing basement below the footprint of the main house, into the front garden to create a lightwell and into a portion of the rear garden, with a small single-story extension to the house’s rear.

	it will be necessary to carry forward to the next stages.
Will the proposed basement development 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** –The proposed basement would not result in changes to the profile of water inflows. Thus, it will not be necessary to carry forward to the next stages.
Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	**No –** The quality of surface water would not be affected. Thus, it will not be necessary to carry forward to the next stages.
Is the site in an area known to be at risk from surface water flooding (Rivers, sea, surface water or reservoirs)?	**No –** No risk on surface water flooding onsite from EA maps. In fact, the site is located within an area of very low risk. Very low means that each year, this area has a chance of flooding of less than 1 in 1000 (0.1%). Thus, it will not be necessary to carry forward to the next stages.

3.c Subterranean (Groundwater) Screening Assessment

The response to the Subterranean (Groundwater) Screening Assessment is given in the table below:

Question	**Response**
Is the site located directly above an aquifer?	**No –** Anticipated geology of the London Clay Formation classified as unproductive strata. Thus, it will not be necessary to carry forward to the next stages.
Is the site within 100 m of a watercourse, well (used/ disused) or potential spring line?	**No –** The nearest permeant water body was ~1.52km south-east of the site. Thus, it will not be necessary to carry forward to the next stages.
As part of the site drainage, will more surface water (e.g., rainfall and run-off) than at present be discharged to the ground (e.g., via soakaways and/or SUDS)?	**No –** An increase of surface water discharging to the ground was considered unlikely, due to the current very low permeability of the London Clay Formation. Thus, it will not be necessary to carry forward to the next stages.
Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to or lower than, the mean water level in any local pond or spring line?	**No –** The nearest permanent surface water feature was ~1.52km south-east of the site. Thus, it will not be necessary to carry forward to the next stages.

Is the site within a Source Protection Zone?	**No –** The site is not located within a Source Protection Zone. Thus, it will not be necessary to carry forward to the next stages.

3.d Stability Screening Assessment.

The response to the Stability Screening Assessment is given in Table below:

Question	**Response**
Does the existing site include slopes, natu-ral or manmade, greater than 7°?	**No –** On-site topography was <1°. Thus, the site is flat. Thus, it will not be necessary to carry for-ward to the next stages.
Will the proposed re-profiling of landscap-ing at the site change slopes at the prop-erty boundary to more than 7°?	**No –** The proposed development would not alter the existing site landscaping eleva-tions. Thus, it will not be necessary to carry for-ward to the next stages.
Does the development neighbour land, in-cluding railway cuttings and the like, with a slope greater than 7°?	**No –** The topography within neighboring land was substantially flat and level**.** Thus, it will not be necessary to carry for-ward to the next stages.
Is the site within a wider hillside setting in which the general slope is greater than 7°?	**No –** The wider area was sloping in gener-ally <7°. **Thus, it will not be necessary to carry for-ward to the next stages.**
Is the London Clay the shallowest strata at the site?	**Yes-** Thus, it will be necessary to carry forward to the next stages.
Will any tree/s be felled as part of the pro-posed development and/or are any works proposed within any tree protection zones where trees are to be retained?	**Yes –** there are tree located in the gardens at the rear. **Thus, it will be necessary to carry for-ward to the next stages.**
Is there a history of seasonal shrink-swell subsidence in the local area and / or evi-dence of such effects at the site?	**Unknown –** No known history or evidence of subsidence. Anticipated geology of the London Clay Formation would have shrink-swell potential. **Thus, it will be necessary to carry for-ward to the next stages.**
Is the site within 100 m of a watercourse or potential spring line?	**No –** The nearest permanent surface water feature was ~1.52km south-east of the site. Thus, it will not be necessary to carry for-ward to the next stages.
Is the site within an area of previously worked ground?	**No -** The relevant geological map did not show any Made Ground or Worked Ground within or near the site.

	Thus, it will not be necessary to carry for-ward to the next stages.
Is the site within an aquifer?	**No –** Anticipated geology of the London Clay Formation classified as unproductive strata. Thus, it will not be necessary to carry for-ward to the next stages.
Is the site within 5 m of a highway or pe-destrian right of way?	**No –** but there is a street parking within 5m of the site **Thus, it will be necessary to carry for-ward to the next stages.**
Will the proposed basement significantly increase the differential depth of founda-tions relative to neighboring properties?	**Unknown** – Review of available infor-mation, indicated no evidence that the neighboring properties to the north and south had basements. **Thus, it will be necessary to carry for-ward to the next stages.**
Is the site over (or within the exclusion zone of) any tunnels, e.g., railway lines?	**No –**Underground structures were not an-ticipated within the area of influence of the proposed development. Thus, it will not be necessary to carry for-ward to the next stages.

4 Scoping, impact assessment, review, and mitigation of adverse effects.

4.a Introduction

The purpose of scoping is to assess in more detail the issues of concern identified in the screening process to be investigated in the impact assessment. Potential hazards are as-sessed for each of the identified potential impact factors.

The scoping stage is furthermore to assist in defining the nature of the investigation re-quired to assess the impact of the issues of concern identified in the screening process. The scope of the investigation must comply with the guidance issued by the London Borough of Camden Council and be a suitable basis on which to assess the potential impacts.

4.b Potential Impacts

The following potential impacts were identified in Table below.

Potential Impacts (Surface Flow and Flooding)

Screening Flowchart: Question	Potential Impacts	Discussion and mitigation of ad-verse effects.
Will the proposed base-ment development result in a change in the propor-tion of hard surfaced / paved areas?	Increasing the hard stand-ing area could affect the way rainfall and surface water are transmitted away from the property.	The basement was to extent into the front garden providing a lightwell and the rear to have an enlargement of it. The anticipated geology of the Lon-don Clay Formation would have a very low permeability. The existing

		inflow of rainfall and surface water would be limited. Therefore, the proposed basement would have limited impact. Additional mitigation measures in the form of Sustainable Drainage Systems (SuDs) would be used to aid surface water drainage.

Potential Impacts (Groundwater)

Screening Flowchart: Question	**Potential Impacts**	**Discussion and mitigation of adverse effects.**
Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	Increasing the hard standing area could affect the way rainfall and surface water are transmitted away from the property.	Design of drainage to account for any increase of surface water inflow and prevent increase of inflow of surface water into the ground. Given the anticipated geology of the London Clay Formation which had a very low permeability the proposed basement would have limited impact. Possible water ingress must be prevented by dewatering during construction, either by exclusion, extraction, or combination.

Potential Impacts (Stability)

Screening Flowchart: Question	**Potential Impacts**	**Discussion and mitigation of adverse effects.**
Is the London Clay the shallowest strata at the site?	The London Clay Formation is prone to seasonal shrink-swell if moisture conditions are changed	Design of foundations to account for the volume change potential of the London Clay Formation. This item will be exposed in detail in the sections 2.10 and 8 of this BIA.
Will any trees be felled as part of the proposed development and / or are any works proposed within any tree protection zones where trees are to be retained?	Moisture deficit associated with felled trees will gradually recover leading to swelling in cohesive soils. This can reduce soil strength and affect slope stability.	No slopes greater than 1o on-site. The impact of trees on the proposed basement and the related precautions were explained on the sections 2.10 and 8 of this BIA.
Is there a history of seasonal shrink-swell subsidence in the local area and / or evidence of such effects at the site	Changes to moisture content in soils with a shrink-swell potential can cause damage to structures.	An instructive investigation was performed to confirm ground conditions.

		The section: 5.0 IN-SITU AND LABORATORY GEOTECHNICAL TESTING of FACTUAL GROUND INVESTIGATION REPORT performed by Ground & Water Report Reference: GWPR3316/GIR/October 2019 gives all the information about the moisture content of the clay. The precautions to be considered during the construction of the proposed basement were exposed on the sections 2.10 and 8 of this BIA.
Is the site within 5 m of a street parking?	Basement construction could cause damage to the street parking.	Design of adequate temporary and permanent support and use of best practice construction and the impact of the proposed development on the adjacent properties will be examined on the section n. 5 of this BIA
Will the proposed basement significantly increase the differential depth of foundations relative to neighboring properties?	Basement construction could cause damage to neighboring properties	Design of adequate temporary and permanent support, use of best practice construction and the impact of the proposed development on the adjacent properties will be examined on the section n. 5 of this BIA

5.Ground Movement Assessment & Predicted Damage Category

5.aGround movement assessment.

This assessment covers both short term and long-term movements relating to the construction and the performance of the permanent works.

The design and construction methodology aims to limit damage to the existing building on the site and to all adjoining buildings to Category 2(max.) as set out in Table 2.5 of CIRIA report C 580.

This assessment has used empirical means as set out in CIRIA2 C 580 Embedded Retaining Walls: Guidance for Economic Design.

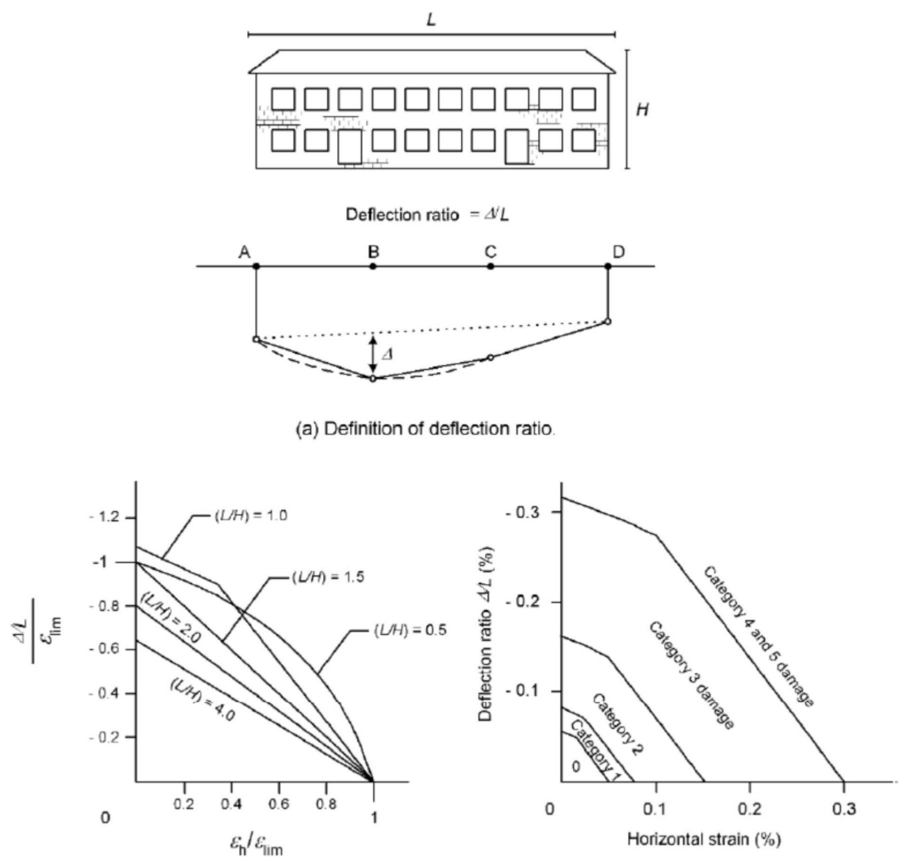
Movement:

Neighboring structure	
Width=L=	5.60m
Height=H	11.00m
L/H=	0.51
Basement depth, Hb=	2.75m
Ground movement assessment Ciria C580 due to the installation of the basement walls;	
Ground horizontal Surface Movement (Table 2.2 C580)	-0.05%

max δh (maximum horizontal surface movement)	-0.05% x2.75=		-1.375 mm
Distance behind wall to negligible movement (multiple of wall depth)			1.5
L=	2.75m	1.5	4.125m (distances are measured from underpinned wall)
Horizontal movement gradient due to the installation			1.375/4125=-0.3mm/m
L=0			δh =-1.375mm
L1=3.75m			$\delta h1$ =0mm
The difference $\Delta hi=\delta h-\delta h1$			1.375mm
The horizontal strain beneath the front of the wall due to the installation			εhi=-1.375mm/4125mm=-0.033%
Ground vertical surface movement / Wall Depth (Table 2.2 C580)			-0.05
max δv (maximum vertical surface movement or vertical deflection) =	-0.05% x 2.75=		-1.375 mm
Distance behind foundation to negligible movement (multiple of wall depth = (Table 2.2 C580))			1.5
xv1= 2.75 x 1.5 =			4.125m
Vertical movement gradient due to the installation			=1.375/4125=-0.33 mm/m
For xv=0			δv = -1.375mm
x1=4.1255m			$\delta v1$ = 0.0 mm
The difference $\delta v-\delta v1$=			Δv=-1.375mm
The vertical strain beneath the front of the wall due to the installation:			$\varepsilon v=\Delta v/L$=-1.375/4125=-0.033%
Ground movement assessment Ciria C580 due to the excavation of the basement walls;			
Ground horizontal Surface Movement at the wall = (Table 2.4 C580)			-0.15%
max δhs (maximum horizontal surface movement) =	-0.15% x 2.75=		-4.125mm
Distance behind foundation to negligible movement (multiple of wall depth = (Table 2.4 C580)			4
x1s= 2.75 x 4 =			11mm
Horizontal movement gradient due to the excavation			=-4.125/11=-0.375mm/m
For xs=0			δhs =-4.125mm
For x1s=11.0m			$\delta h1s$ = 0.0 mm
The difference $\Delta he=\delta hs-\delta h1s$=			-4.125mm

The horizontal strain beneath the front of the wall due to the excavation	εhe=-4.125mm/11000=-0.0375%
Ground vertical surface movement / Wall Depth (Table 2.4 C580)	-0.1
max δvs (maximum vertical surface movement) =	-0.1*2.75=-2.75mm
Distance behind foundation to negligible movement (multiple of wall depth = (Table 2.4 C580)	3.5
xv1s=	3.5 x 2.75=9.625m
Vertical movement gradient due to the excavation	=-2.75/9.625=-0.285mm/m
For xvs=0	δvs =-2.75mm
For xv1s=9.625m	δv1s = 0.0 mm
The difference δvs-δv1s=	Δvs=-2.75mm
The vertical strain beneath the front of the wall due to the excavation	εvs=Δvs/L=-0.033%
The total movement and strain at wall location (excavation and installation)	
The total Horizontal Movement (excavation and installation) =Δhi+Δhe	Δht=-1.365-4.125=-5.5mm
The total horizontal strain beneath the front of the wall=εhi+εhe	εht=-0.0705%
The total vertical movement excavation and installation=Δv+Δvs	Δvt=-4.125mm
The total vertical strain beneath the front of the wall=Δvt/L=εv+εvs	εvt=0.0578%

5.b Predicted damage category and conclusion; The calculated ground movements reported in previous section were used to determine the potential damage category, which could be induced to the neighbouring structures by the construction of the foundation. The assessment was carried out considering the method described in CIRIA Special Publication 200 (Burland et al., 2001) and CIRIA C580 (Gabbart al., 2003), based upon the method proposed by Burland et al. (2001) and considering the works by Burland and Wroth (1974) and Boscardin and Cording (1989).



(a) Definition of deflection ratio.

(b) Influence of horizontal strain on Δ/L / ε_{lim} (after Burland, 2001)

(c) Relationship between damage category and deflection ratio and horizontal tensile strain for hogging for (L/H) = 1.0 (after Burland, 2001)

The ratio L/H for the neighbouring buildings was assumed equal to 0.51
The general categories of damage are summarised in Table below:

Damage category	Description of degree of damage	Description of typical damage and likely forms of repair for typical masonry buildings	Approx. crack width (mm)	Max. tensile strain %
0	Negligible	Hairline cracks.		< 0.05
1	Very slight	Fine cracks easily treated during normal redecoration. Perhaps isolated slight fracture in building. Cracks in exterior visible upon close inspection.	0.1 to 1.0	0.05 to 0.075
2	Slight	Cracks easily filled. Redecoration probably required. Several slight fractures inside building. Exterior cracks visible; some repainting may be required for weather-tightness. Doors and windows may stick slightly.	1 to 5	0.075 to 0.15
3	Moderate	Cracks may require cutting out and patching. Recurrent cracks can be masked by suitable linings. Tuck pointing and possible replacement of a small amount of exterior brickwork may be required. Doors and windows sticking. Utility services may be interrupted. Weather tightness often impaired.	5 to 15 or a number of cracks > 3	0.15 to 0.3
4	Severe	Extensive repair required involving removal and replacement of walls especially over doors and windows. Window and door frames distorted. Floor slopes noticeably. Walls lean or bulge noticeably. Some loss of bearing in beams. Utility services disrupted.	15 to 25 but also depends on number of cracks	> 0.3
5	Very severe	Major repair required involving partial or complete reconstruction. Beams lose bearing, walls lean badly and require shoring. Windows broken by distortion. Danger of instability.	Usually > 25 but depends on number of cracks	
Note: Please refer LU Civil Engineering - Common Requirements S1050[4]				

Table 2: Building damage classification

Buildings are generally considered to be at low risk if the predicted degree of damage falls into categories 0 to 2. The damage within these categories would not be structural and can be repaired readily and economically.

For which the ε_{lim} will be assumed equal to 0.12%.

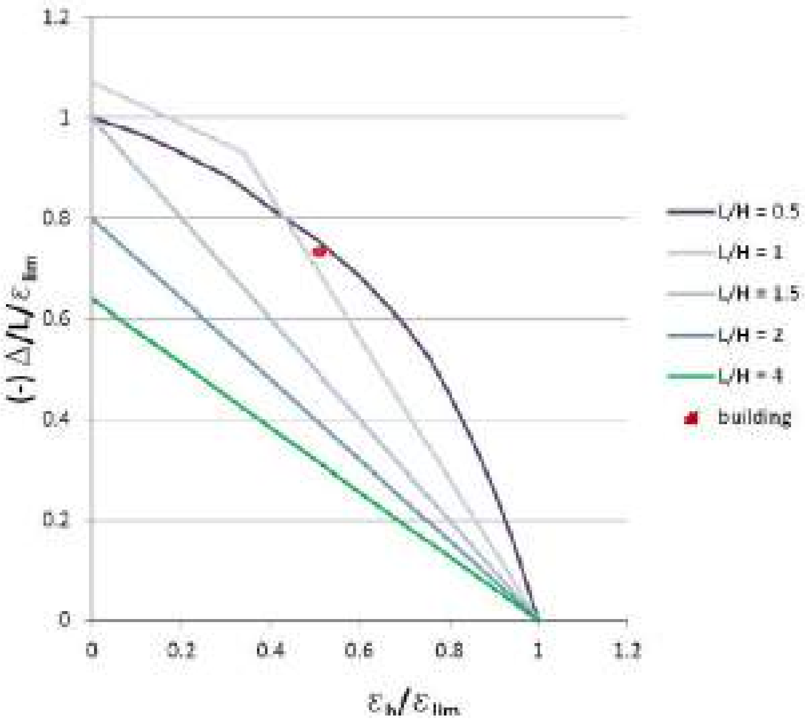
The results reported below defines the expected damage category on neighboring structures according to the classification by Burland (2001).

Being: ε_{lim}=0.12%

Then Being L/H=0.51 and ε_{ht}=0.0705% then $\varepsilon_{ht}/\varepsilon_{lim}$=0.58

By the figure 2.18b from Ciria C580 shown below it is possible to determine the value of $\Delta/L/\varepsilon_{lim}$ that is equal to 0.78

Fig 2.18b from CIRIA C580



Being the value of Δvt/L=Δ/L=0.0578% then the limit Tensile strain εlim=0.0578/0.78=0.074%

Thus:

Δ/L/εlim	Limit Tensile strain (εlim) %	Damage Category
0.05%	0.074	1

The results show an expected Damage Category 1 (very slight damage) that is acceptable for the neighbouring structures. It must be emphasised that the calculations were determined for the considered specific case and can be invalidated if changes in the proposed layout will be applied. In addition, inadequate workmanship and poor construction control are particularly significant to invalidate this assessment of the ground movements.

In addition, it is recommended to provide recommendations able to reduce the expected damage to a more sustainable category of 0 (Negligible); See section n.7 of this report.

6.Monitoring

Condition surveys of the neighboring properties are recommended before the works commence, in order to provide a factual record of any pre-existing damage. Such surveys are usually carried out while negotiating the Party Wall Award and are beneficial to all parties concerned.

Precise movement monitoring should be undertaken weekly throughout the period during which the basement walls and slab are constructed, with three sets of initial readings taken

before excavation of the basement starts in order to assess the degree of existing movement.
Readings may revert to fortnightly once the basement structure has been completed.
This monitoring should be undertaken with a total station instrument and targets attached at a minimum of two levels at the following.
The accuracy of this system of monitoring is usually quoted as +/- 2mm. Thus, if recorded movements in either direction reach 5mm, then the frequency of readings should be increased as appropriate to the severity of the movement, and consideration should be given to installing additional targets. If the recorded movements in either direction reach 8mm, then work should stop until new method statements have been prepared and approved by the appointed structural engineer.
If any structural cracks appear in the main loadbearing walls, then those cracks should be monitored using the Demec system (or similar) on the same frequency as the target monitoring.

•7.0 Construction method and construction stages.
7.aThe scheme of the proposed basement will comprise shallow reinforced concrete (RC) underpinning with mass concrete heels, at a founding depth below the level of the existing foundation to get a final height equal to 2.75m.
RC underpinning will be required beneath the party walls of the buildings and the rear and at the front of the existing building to create the proposed basement extension of the property.
Underpinning method involves the excavation of the ground in short lengths (pins length less than 1m) by hand underneath the existing foundation and sequentially to enable the stresses in the ground to 'arch' onto the ground or completed underpinning on both sides of the excavation, together with the ability of stiff homogenous clays to stand un-supported for a limited period. Loads from the structure above will similarly arch across the excavation, provided that the structure is in good condition.
When the basement base level will be reached, then the reinforced concrete wall section will be erected and kept for curing before next excavation starts.
These bays with the following dimension: variable depth and length less than 1.0m, are dug out individually and concreted as short as possible.
The boxes are staggered so that the building remains structurally sound always.
Between these bays of reinforced concrete retaining walls, steel reinforcing bars are placed to tie them together to function as one solid structure when completed.

7.b Some ground movements are inevitable when an underground structure is constructed, and the magnitude of the movement depends on:
- the geology.
- the adequacy of temporary support that will be used during the underpinning excavations.
- the quality of workmanship when constructing the permanent structure.

In any case, the possible ground movement will not create any damage to the adjacent structures as it will be discussed in the next section.

7.c It would be prudent to undertake a structural condition survey of adjacent properties on both sides of the site before work commences. This should be covered by the Party Wall Surveyor.

7.d Temporary horizontal supports will be required when the mentioned retaining wall pins will be built and must be maintained until the pins have been completed, including al-lowing time for the concrete to gain adequate strength.
Under UK standard practice, the contractor is responsible for designing and implementing the temporary works, so it is considered essential that the contractor em-ployed for these works should have completed similar schemes successfully.
Full details of the temporary works should be provided in the contractor's method state-ments. By conforming to normal health and safety good practice, the requirements for tem-porary support of any excavation must be assessed by a competent person at the start of every shift, and at each significant change in the geometry of the excavations as the work progresses.

7.e The unloaded clays at/beneath formation level will readily absorb any available water which would lead to softening and loss of strength. It will, therefore, be essential to ensure that the clays at formation level (onto which the underpin/retaining wall bases and the basement slab will bear) are protected from all sources of water, with suitable channeling to sumps for any groundwater seeping into the excavations. The formation clays should be inspected and then blinded with concrete immediately after completion of final excavation to grade. Any unacceptably soft/weak areas must be excavated and replaced with concrete.

7.f The time between excavation and placing of concrete to be kept as short as possible, but no longer than 24 hours unless by prior agreement. The excavations are to be protected from collapse, are to be kept clean and dry, and must be inspected by the competent person. The concrete is to be placed immediately after this inspection. Any collapse of the trench, standing water or softened trench base is to be removed and cleaned out before the placement of the concrete.

7.g After constructing a concrete RC wall 'pin', allow a minimum of 48 hours min for the concrete to cure before excavating an adjacent pin.

7.h It needs to incorporate mild steel dowel bars diam.10mm and length=600mm between each pin (300mm embedment into each pin). For safety and access reasons and if they are returned to straight when casting, these bars may be bent out of the way during excavation. Mini-mum cover to all reinforcement to be 75mm. After that, the pin of the reinforced con-crete wall has cured, any gap between undersides of existing foundation and underpinning block to be filled with 1:2 cement/sharp sand, mixed as dry as possible with "Conbex 100" cement additive and then consolidated by ramming with a suitable blunt instrument until the space is filled. In this way, it is assured that the building load is transferred to the new pin.
Summarizing below the proposed sequence of the works:
•Stage n.1: Excavating a bay as specified above over full height to line with back of existing foundation to reach the basement base level.
•Stage n.1a: Providing any temporary trench sheeting as may be necessary to stabilise the excavations.
•Stage n.2: Casting the lean mix concrete at the bottom of trench.
•Stage n.2.a: Installing formwork to prevent overspill and the reinforcement of steel bars.

•Stage 2.b: Casting new mass concrete underpin using the proposed Class concrete to no more than half height of full underpin.
•Stage 2.c: Once concrete has lost fluidity; second lift can be cast.
•Stage n.3: Dry pack.
•Stage n.4: Once each section of wall is installed, placing temporary shore during the excavation to ensure stability until permanent concrete slab at the basement base will be cast.
•Stage n.5: casting the concrete slab at the bottom of the new basement.

8.0 **Basement scheme and geotechnical parameters.**
8.aThe section 4.3 of the FACTUAL GROUND INVESTIGATION REPORT performed by Ground & Water Report Reference: GWPR3316/GIR/October 2019 states the presence of fresh roots at the front and the back until a depth less than 3.00m
Thus, if roots are encountered during the basement construction, its foundations must not be placed within any live root penetrated or desiccated cohesive soils or those with a volume change potential. If the foundation excavations should reveal such materials, the excavations must be extended to greater depth in order to bypass these unsuitable soils.
Excavations must be checked by a suitable person prior to concrete being poured.
As the proposed development included a basement with a depth of ~ -3.3m BGL,
the basement foundation would be expected to pass through any live root penetrated or desiccated cohesive soils, for which it should not be affected by this phenomenon.

8.b The allowable bearing capacity has been calculated for the London Clay Formation from a depth > 3.30 BGL.
Being the average SPT's >20, then Cu = undrained shear strength of the soil=f1*N where f1=5 because PI> 40% (Clayton Ciria report 143, SPT method’s and use 1995 and stroud and Butter 1975), for which Cu>100KPa and applying the Brinch Hansen equation
Qlim=(1+0.2*B/L) *5.14*Cu= (1+0.2*5.7/24.1) *5.14*100=538KPa
A factor of safety equal =3 is applied to calculate the allowable bearing capacity that will be=179KPa.
A cautious value of allowable bearing capacity equal to 100KPa will be assumed for our calculation in such way to reduce the total settlement (both elastic and consolidation) of the basement foundation that will be less than 25mm
In addition, the proposed basement will be founded on reinforced concrete raft connected with the reinforced concrete walls at the side forming a monolithic structure which should support well the soil movements that could occur due to this phenomenon and to reduce the possibility of differential settlement affecting the foundations.
For the allowable bearing value given above, settlements should not exceed the presented values, provided that excavation bases are carefully bottomed out and blinded or concreted as soon after excavation as possible and kept dry. Foundations must not be constructed over former structures and other hard spots. The foundations design must be suitable for the conditions present at the site.

8.cThe angle of shearing resistance (Ø’cv/ Ø’pk) at long term condition or drained condition to be used for the calculation of the retaining walls basement pins will 24°

9.Anticipated Heave.
Given the anticipated volume of soil being excavated and loads applied, long term heave would be minimal, anticipated to be <5mm. Immediate heave is likely to have a minimal effect as it would take place soon after excavation and any immediate heave is likely to be removed during the excavation of the basement slab in order to achieve the correct dig level prior to casting the slab.
It must be mentioned that it was assumed that excavations will be kept dry and either concreted or blinded as soon after excavation. If water is allowed for even a short time to enter excavations, not only will a greater heave be experiencing owing to the soil increasing in volume by taking up water, but the shear strength, and hence the bearing capacity, will also be reduced.

10.0 Underground Concrete.
One sample from London Clay Formation were submitted for water soluble sulphate (2:1) and pH testing in accordance with Building Research Establishment Special Digest 1, 2005, 'Concrete in Aggressive Ground'.
The test recorded water-soluble sulphate 0.64 g/l with pH values of 7.38.
For which the concrete to be placed in contact with soil or groundwater must be designed in accordance with the recommendations of Building Research Establishment Special Digest 1 2005, 'Concrete in Aggressive Ground' taking into account any possible exposure of potentially pyrite bearing natural ground and the pH of the soils.

11.0Drainage system.
Drainage systems has been designed to operate under 'surcharge' at times of peak rainfall, which means that the level of effluent in the sewers may rise to ground level. Non-return valves and pumped above ground loop systems must, therefore, be fitted on the drains serving the basement, courtyard and lightwell, to ensure that water from the mains sewer system cannot enter the basement when the adjacent sewer is operating under surcharge. All drains which discharge via the same outfall as the basement must be protected, including those carrying foul water and roof/surface water. A battery powered reserve pump should be fitted to ensure that the system remains functional during power cuts.
The pumped above-ground loop must rise high enough above ground level to create sufficient pressure head to open the non-return valve when the sewer flow is surcharged to ground level. Otherwise, the basement would once again be vulnerable to flooding while the surcharged flow continues. If it is not possible to achieve a sufficient rise of the loop above ground level, then temporary interception storage should be provided as recommended above.

12.0 Waterproofing.
12.aThe proposed basement will need to be fully waterproofed to provide adequate long- term control of moisture ingress from the groundwater. Detailed recommendations for the waterproofing system are beyond the scope of this report although it is noted that, as a minimum, it would be prudent for the system to be designed in compliance with the requirements of BS8102:2009.

12.b The waterproofing measures must include sealing of all services which pass through the perimeter walls and floor of the basement, including the sumps for the drainage systems.

12.cThe National House Building Council published new guidance on the waterproofing of basements in November 2014 (NHBC Standards, Chapter 5.4). Compliance would be compulsory if an NHBC warranty is required. Otherwise, it may provide a useful guide to best practice.

13.DESIGN STANDARDS

13.1 The works shall be designed in accordance with all current prevailing British Standard Codes of Practice and current best practice including but not limited to:

- Loading: BS6399
- Concrete: BS8110
- Steel: BS5950
- Timber: BS5268
- Masonry: BS5628
- Temporary Works: BS5975

13.2 Design of the basement retaining walls must take into consideration:
- Earth pressures from the surrounding ground.
- Dead and live loads from the structures above, including loads from the adjoining properties.
- Surcharge load.
- A provisional design groundwater level at ground level.

- **14.0 Assessment methodology**

14.a The evaluation will be carried out at short term at long terms after the construction of the reinforced concrete retaining wall pin.
According to the BS codes, the retaining wall must be checked against the ultimate limit state and serviceability limit state.
For the ultimate limit, it needs to verify that relevant potential collapse mechanisms will occur and to check the external stability:

a) Bearing capacity failure.
b) Overturning.
c) Forward sliding.
d) Overall, rotational, or global slip surface stability.

14.b For the serviceability limit state, it needs to verify that during working condition, the structure will retain its characteristics without the need for abnormal maintenance and to check the internal stability:

a) Settlement.

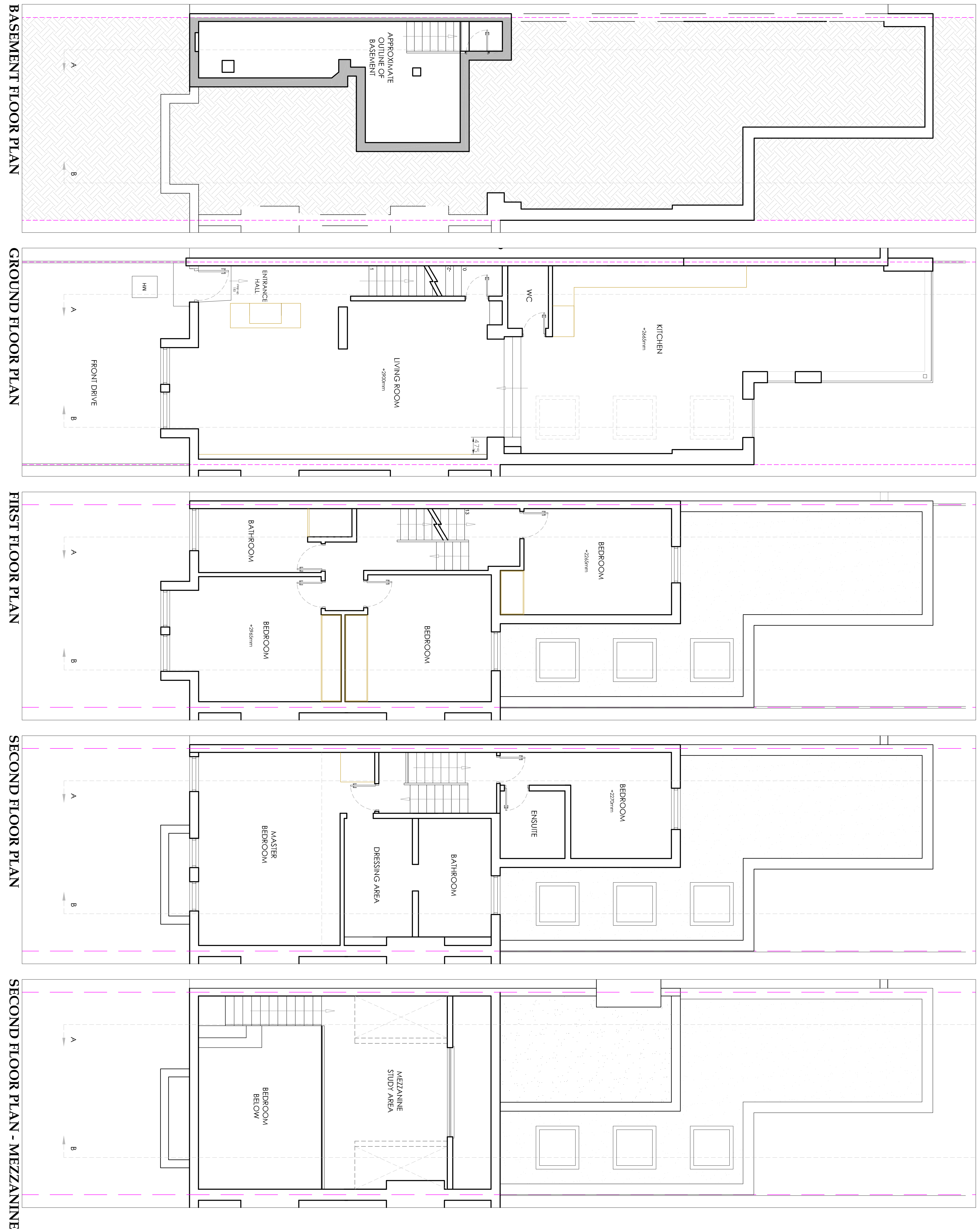
15.Recommendations.

15.a The development of the basements is unlikely to impact on groundwater, surface water or flooding, unlikely to impact on drainage or ground infiltration of rainwater.
15.bUse of sulphate resisting cement in underground concrete.
15.c Watertight design to the basement.
15.d Check on foundations to adjacent properties before construction.
15.e Monitoring of any ground movements to ensure they are within expectations.
15.f Use of compressible material beneath floor slab to accommodate any future heave in London Clay.
15.g Construction of underpinned or other foundations on the unweathered London Clay.
This may be achieved by ensuring best practice engineering and design of the proposed scheme by competent persons and in full accordance with the Construction (Design and Management) Regulations.
This will include:

• Determination of the most appropriate methods of construction of the proposed basement.
• Undertake pre-condition surveys of adjacent structures.
• Establishment of contingencies to deal with adverse performance.
• Ensuring quality of workmanship by competent persons.

16.Biography.

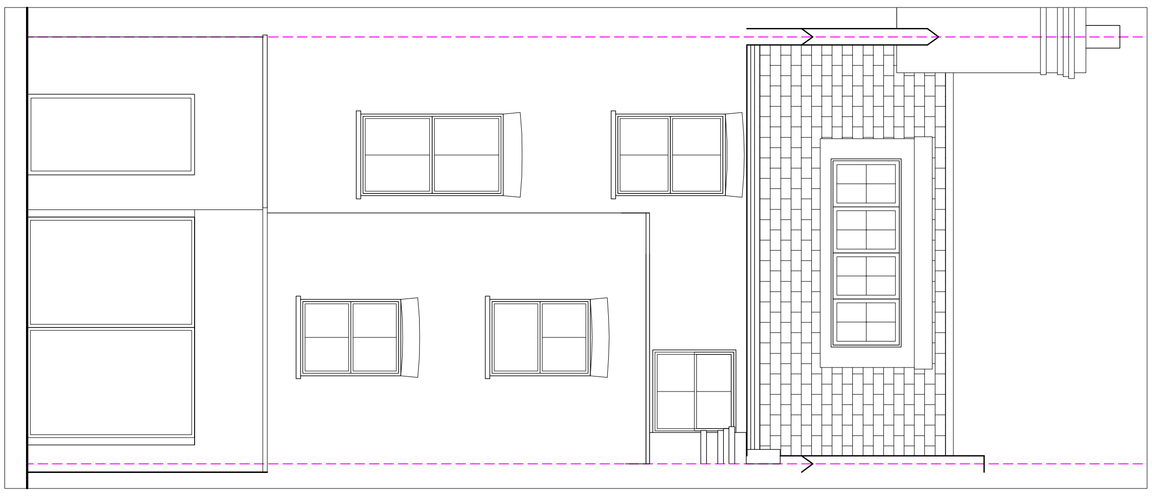
- CIRIA2 C 580 Embedded Retaining Walls: Guidance for Economic Design.
- Foundation design and construction Mj Tomlinson.

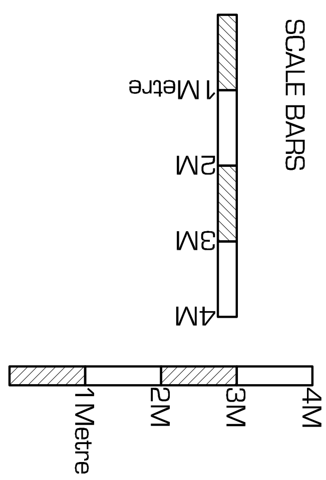


BASEMENT CONSULTING LTD 758-760 GREAT CAMBRIDGE ROAD ENFIELD, MIDDLX, EN1 3GN Tel: (020) 8443 7099	EXISTING FLOOR PLANS	drawn: --	chk: --	date: 21.10.2021
		council: Camden		scale: 1:100 @ A3
	customer name & site address: Mr. & Mrs. Chen 73 Goldhurst Terrace London, NW6 3HA works: Basement Conversion	reference: ---	rev: ---	Dwg no. GOLD-21-01

FRONT ELEVATION

REAR ELEVATION





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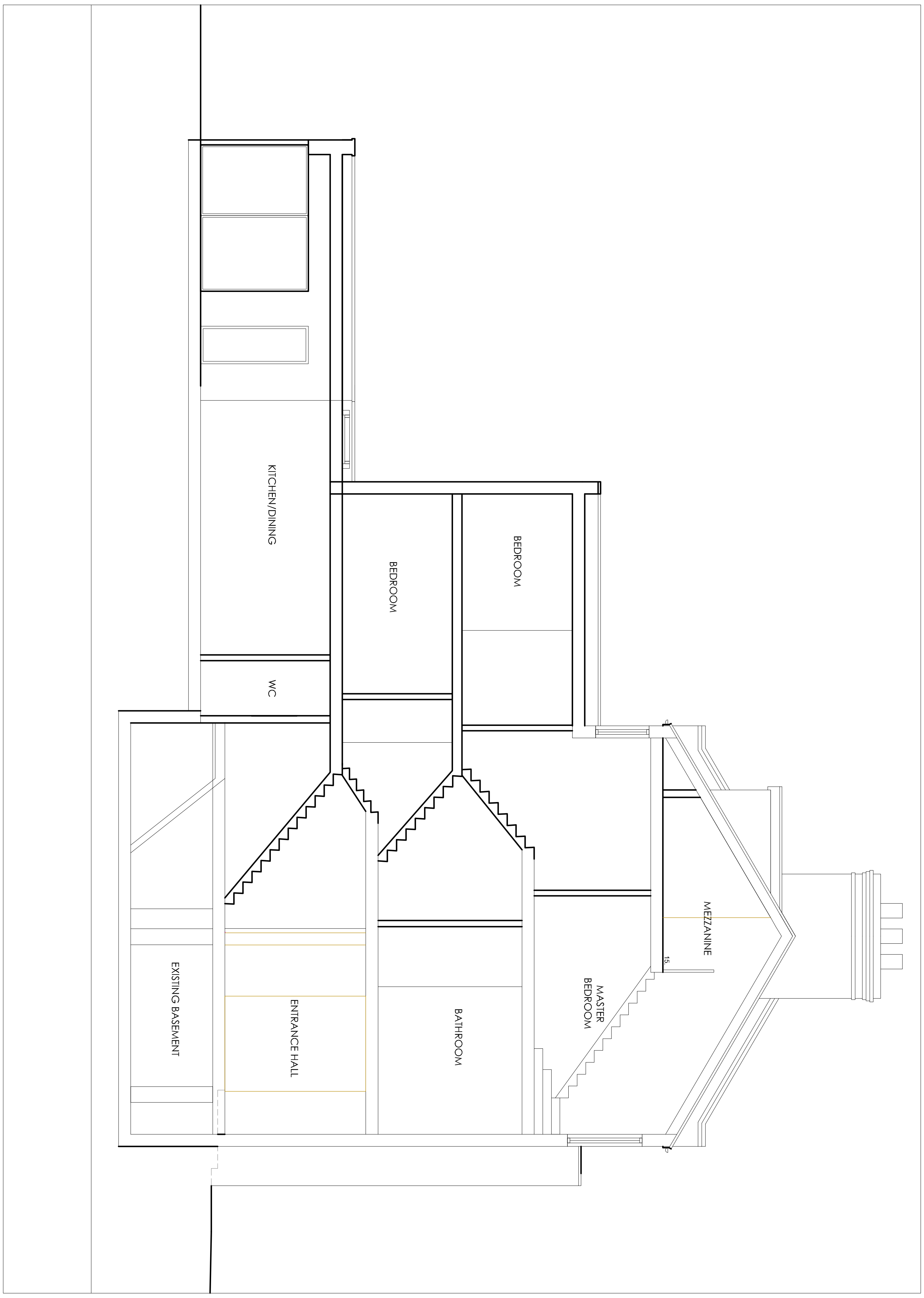
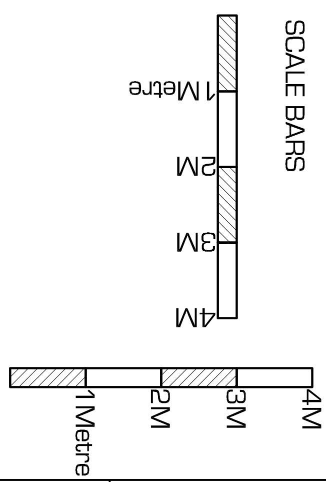
EXISTING SECTION A





BASEMENT CONSULTING LTD

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customer name & site address:
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works:
Basement Conversion

drawn: --
chk: --
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council: Camden
scale: 1:100 @ A3
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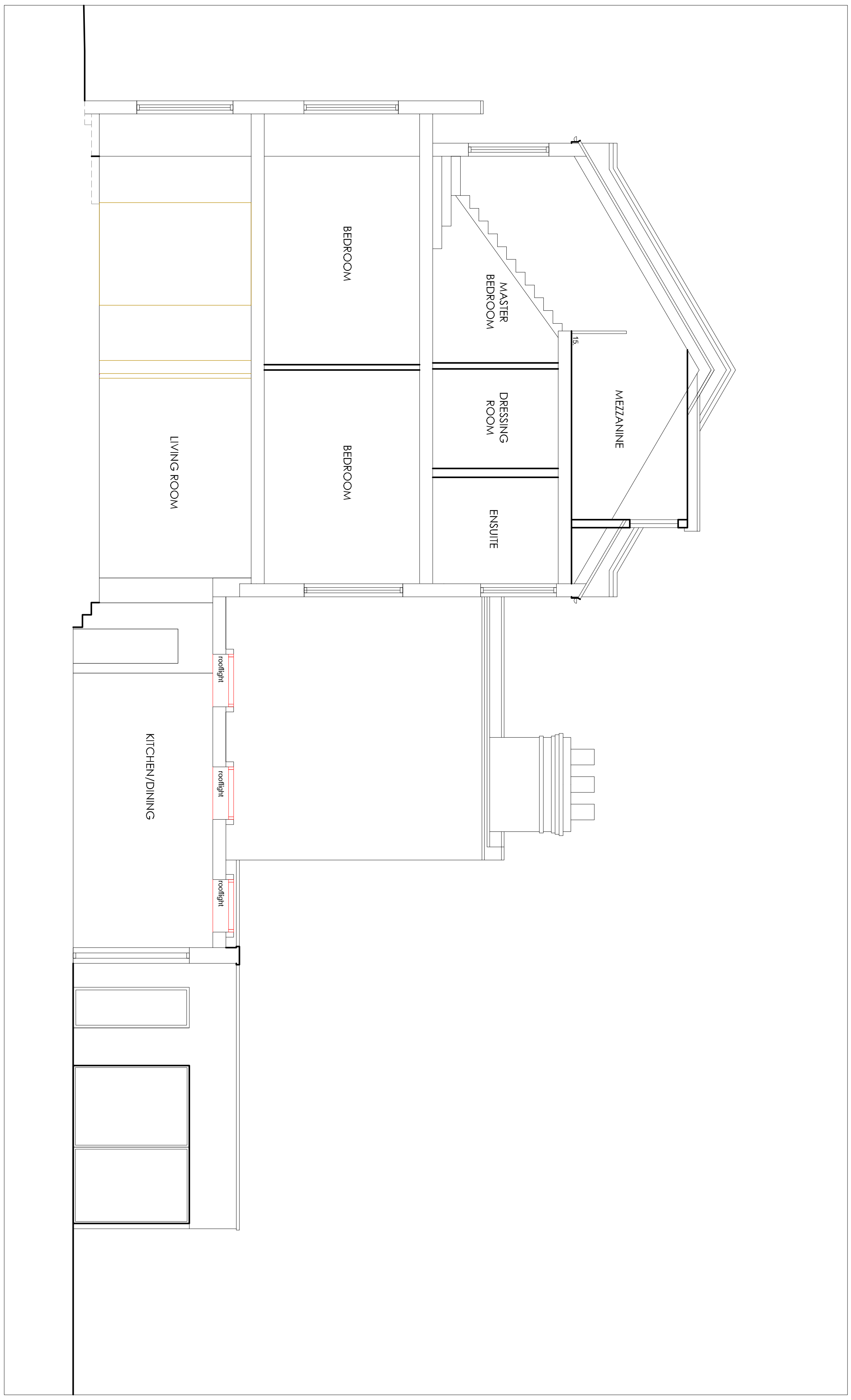
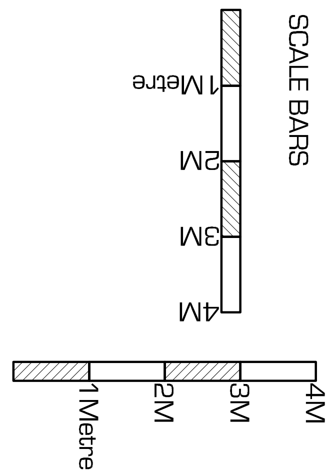
rev: ---
Dwg no. GOLD-21-03

EXISTING SECTION B





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Camden		1:100 @ A3
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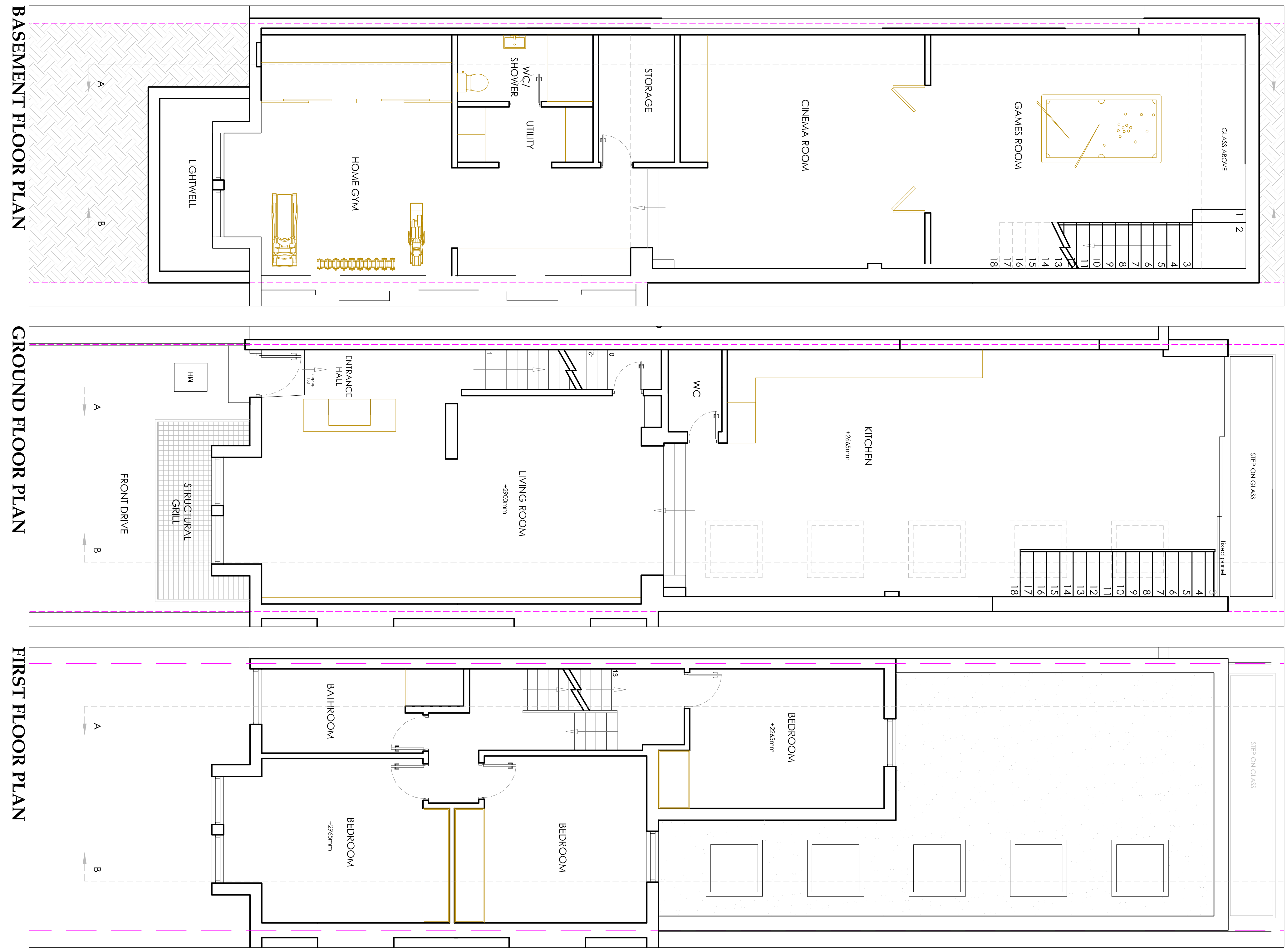

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PROPOSED FLOOR PLANS

drawn: --	chk: --		date: 01.11.2021	
council: Camden			scale: 1:100 @ A3	
reference: ---	rev: ---		Dwg no. GOLD-21-05	

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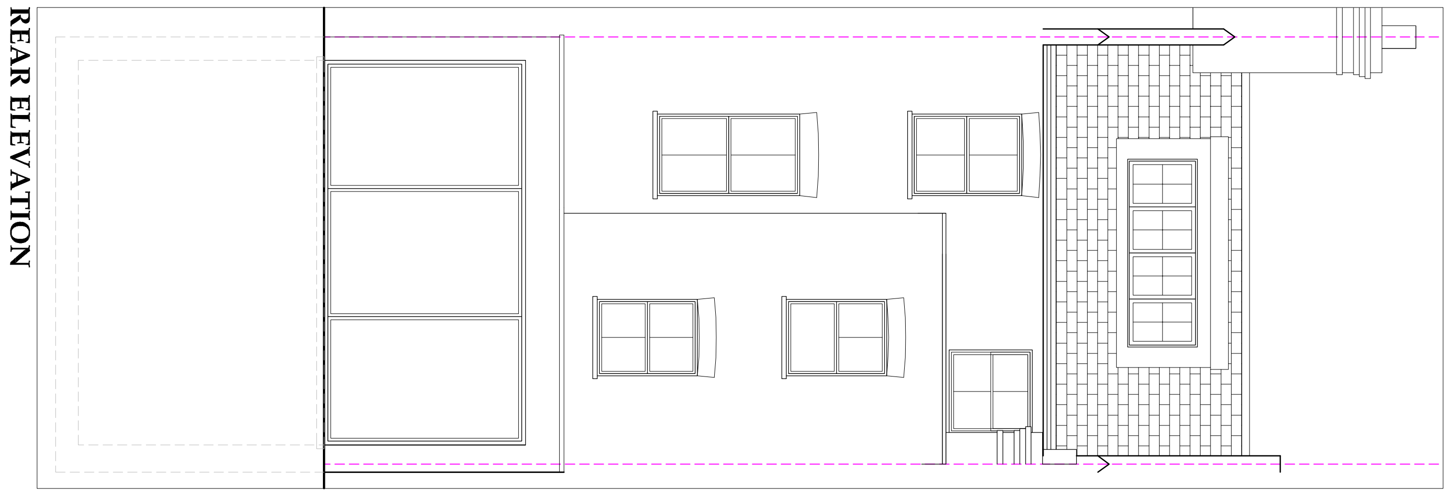

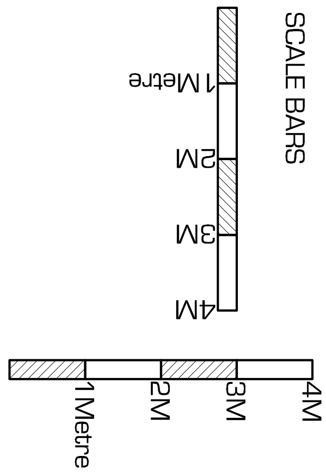

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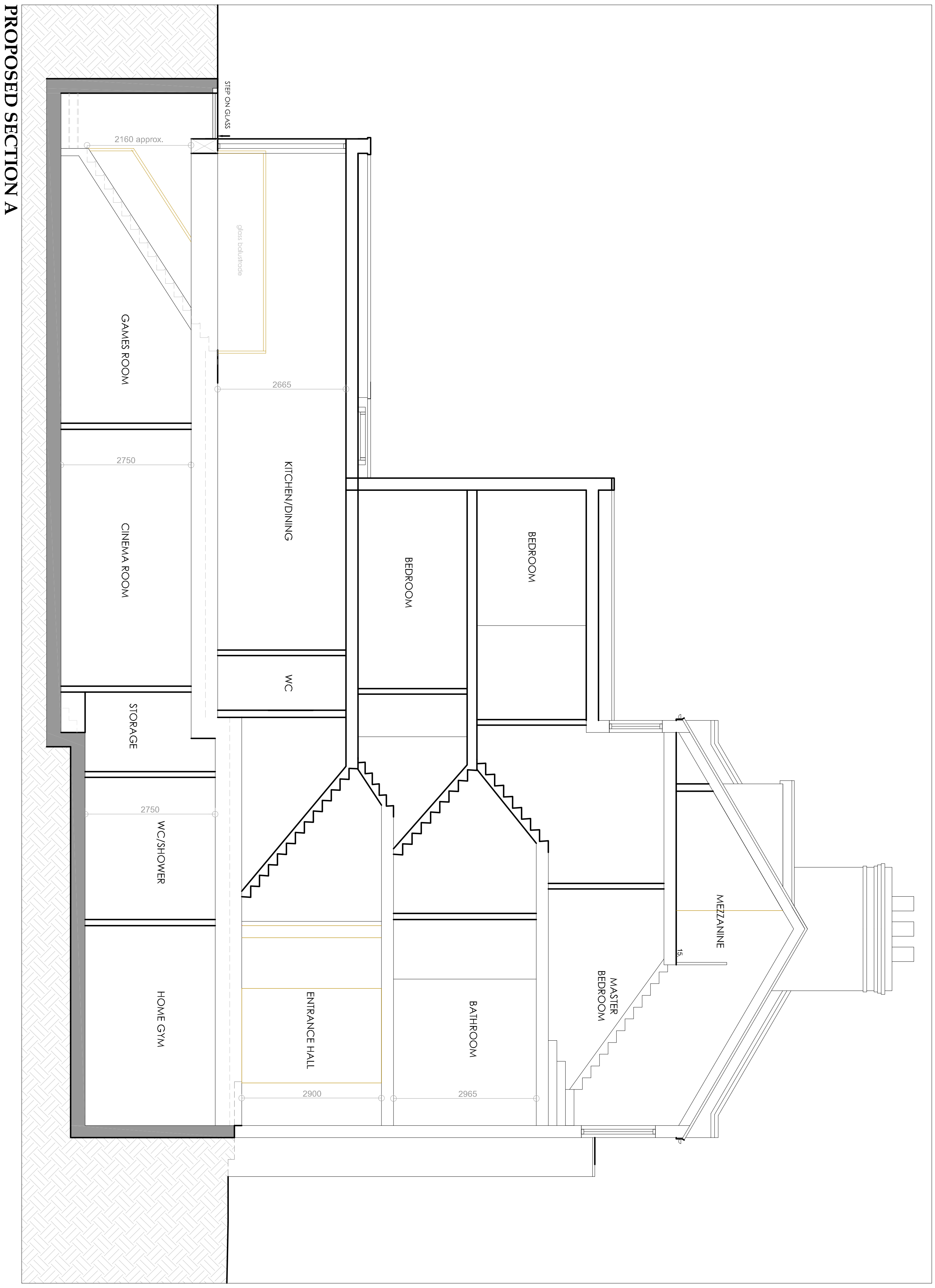
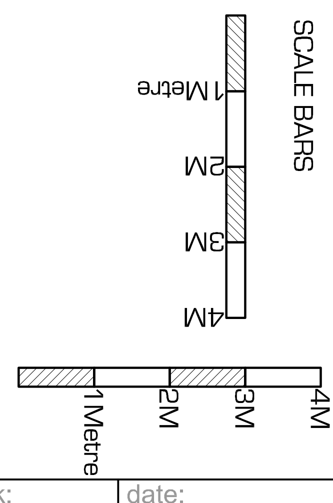
	customer name & site address: Mr. & Mrs. Chen 73 Goldhurst Terrace London, NW6 3HA	works: Basement Conversion	council: **Camden**		scale: 1:100 @ A3
			reference: ---	rev: ---	Dwg no. GOLD-21-06





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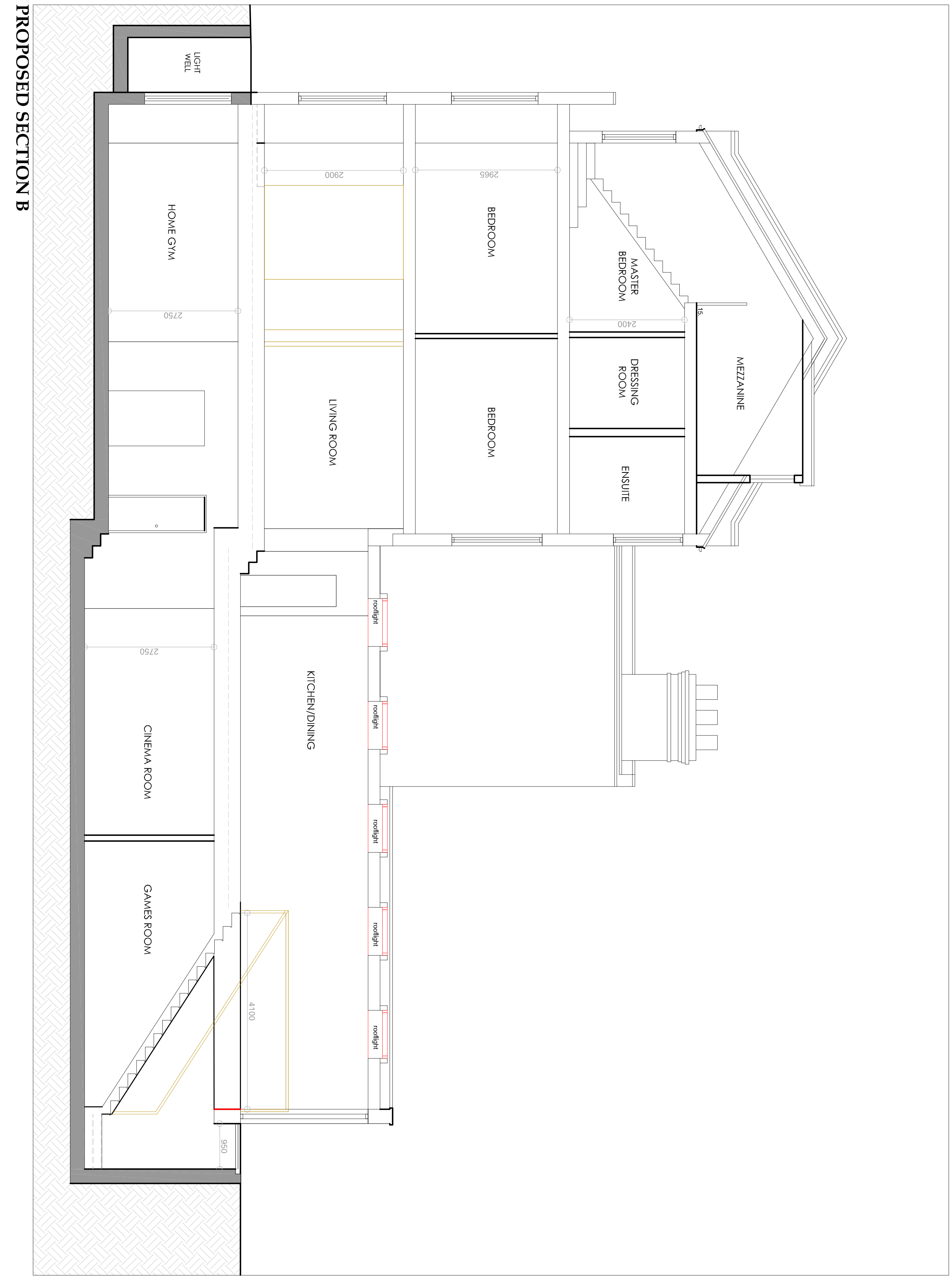
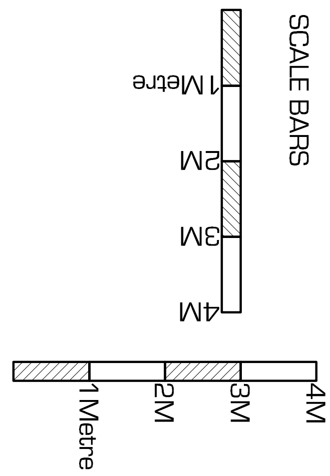
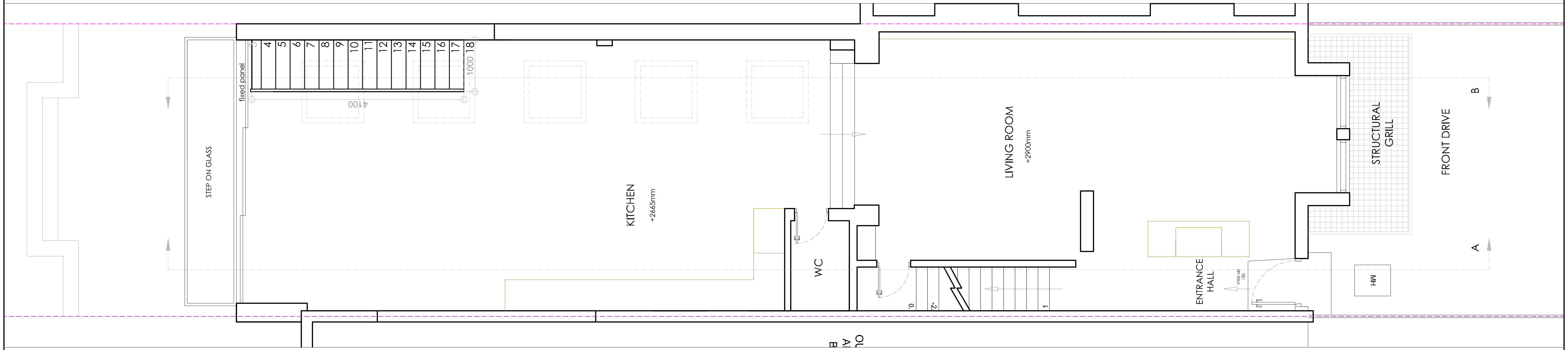
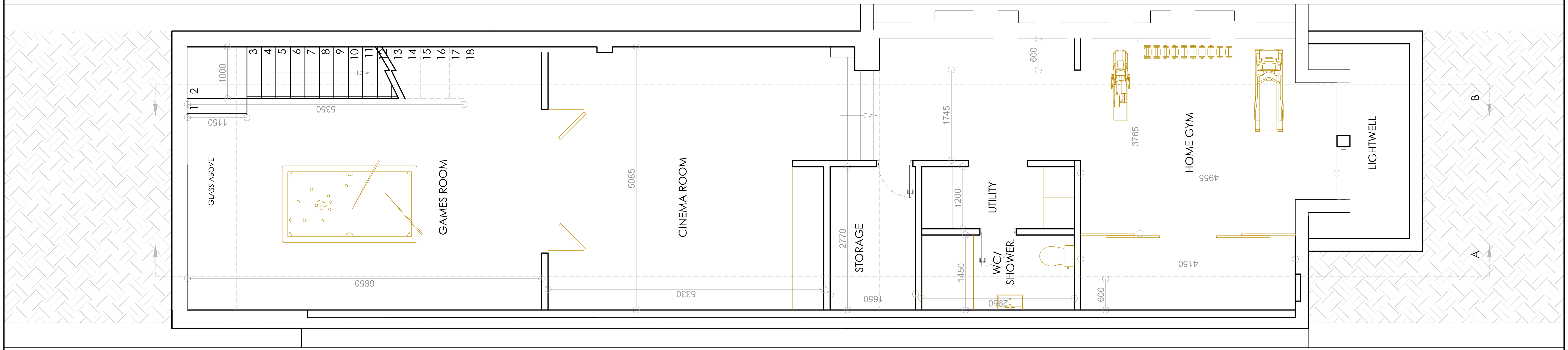




BASEMENT CONSULTING LTD 758-760 GREAT CAMBRIDGE ROAD ENFIELD, MIDDLX, EN1 3GN Tel: (020) 8443 7099	PROPOSED SECTION B		drawn: --	chk: --	date: 01.11.2021
	customer name & site address: Mr. & Mrs. Chen 73 Goldhurst Terrace London, NW6 3HA	works: Basement Conversion	council: Camden		scale: 1:100 @ A3
			reference: ---	rev: ---	Dwg no. GOLD-21-08



PROPOSED GROUND FLOOR PLAN



PROPOSED BASEMENT FLOOR PLAN

SCALE BARS

0.75Metre 1.5M 2.25M 3.0M

BASEMENT CONSULTING LTD

758-760 GREAT CAMBRIDGE ROAD
ENFIELD, MIDDLX, EN1 3GN

Tel: (020) 8443 7099

PROPOSED FLOOR PLANS

customer name & site address:
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works:
Basement Conversion

drawn:	chk:	date:
--	--	01.11.2021
council: **Camden**		scale: 1:75@ A3
reference: ---	rev: ---	Dwg no. GOLD-21-09

Groundsure
LOCATION INTELLIGENCE

Geo
Insight

73, GOLDHURST TERRACE, LONDON, NW6 3HA

Order Details

Date: 06/11/2021

Your ref: A704

Our Ref: GS-8317458

Client: PACA GEOTECHNICAL ENGINEERING

Site Details

Location: 526284 184331

Area: 0.01 ha

Authority: London Borough of Camden

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Contact us with any questions at:
info@groundsure.com
08444 159 000

Summary of findings

Page	Section	Geology 1:10,000 scale	On site	0-50m	50-250m	250-500m	500-2000m
11	1.1	10k Availability	Identified (within 500m)				
12	1.2	Artificial and made ground (10k)	0	0	0	0	-
13	1.3	Superficial geology (10k)	0	0	0	0	-
13	1.4	Landslip (10k)	0	0	0	0	-
14	1.5	Bedrock geology (10k)	1	0	0	0	-
15	1.6	Bedrock faults and other linear features (10k)	0	0	0	0	-
Page	**Section**	**Geology 1:50,000 scale**	**On site**	**0-50m**	**50-250m**	**250-500m**	**500-2000m**
16	2.1	50k Availability	Identified (within 500m)				
17	2.2	Artificial and made ground (50k)	0	0	0	0	-
17	2.3	Artificial ground permeability (50k)	0	0	-	-	-
18	2.4	Superficial geology (50k)	0	0	0	0	-
18	2.5	Superficial permeability (50k)	None (within 50m)				
18	2.6	Landslip (50k)	0	0	0	0	-
18	2.7	Landslip permeability (50k)	None (within 50m)				
19	2.8	Bedrock geology (50k)	1	0	0	0	-
20	2.9	Bedrock permeability (50k)	Identified (within 50m)				
20	2.10	Bedrock faults and other linear features (50k)	0	0	0	0	-
Page	**Section**	**Boreholes**	**On site**	**0-50m**	**50-250m**	**250-500m**	**500-2000m**
21	3.1	BGS Boreholes	0	0	1	-	-
Page	**Section**	**Natural ground subsidence**					
22	4.1	Shrink swell clays	Moderate (within 50m)				
23	4.2	Running sands	Very low (within 50m)				
24	4.3	Compressible deposits	Negligible (within 50m)				
25	4.4	Collapsible deposits	Very low (within 50m)				
26	4.5	Landslides	Very low (within 50m)				
27	4.6	Ground dissolution of soluble rocks	Negligible (within 50m)				

Page	Section	Mining, ground workings and natural cavities	On site	0-50m	50-250m	250-500m	500-2000m
28	5.1	Natural cavities	0	0	0	0	-
29	5.2	BritPits	0	0	0	0	-
29	5.3	Surface ground workings	0	0	0	-	-
29	**5.4**	**Underground workings**	0	0	8	22	39
32	5.5	Historical Mineral Planning Areas	0	0	0	0	-
32	5.6	Non-coal mining	0	0	0	0	0
32	5.7	Mining cavities	0	0	0	0	0
32	5.8	JPB mining areas	None (within 0m)				
33	5.9	Coal mining	None (within 0m)				
33	5.10	Brine areas	None (within 0m)				
33	5.11	Gypsum areas	None (within 0m)				
33	5.12	Tin mining	None (within 0m)				
33	5.13	Clay mining	None (within 0m)				

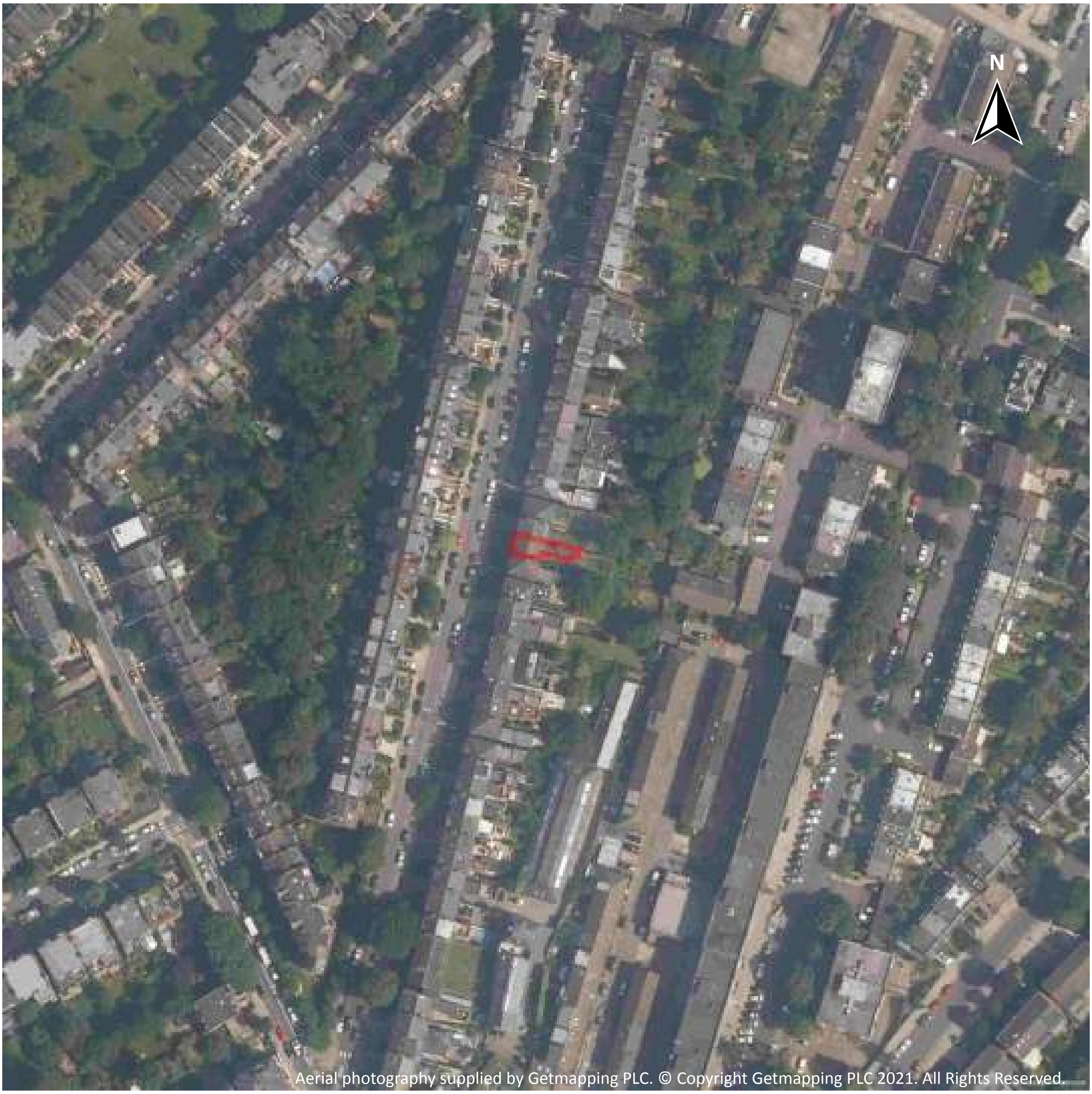
Page	Section	Radon	
34	**6.1**	**Radon**	Less than 1% (within 0m)

Page	Section	Soil chemistry	On site	0-50m	50-250m	250-500m	500-2000m
35	**7.1**	**BGS Estimated Background Soil Chemistry**	1	0	-	-	-
35	**7.2**	**BGS Estimated Urban Soil Chemistry**	1	3	-	-	-
36	**7.3**	**BGS Measured Urban Soil Chemistry**	0	1	-	-	-

Page	Section	Railway infrastructure and projects	On site	0-50m	50-250m	250-500m	500-2000m
37	**8.1**	**Underground railways (London)**	0	0	1	-	-
38	8.2	Underground railways (Non-London)	0	0	0	-	-
38	8.3	Railway tunnels	0	0	0	-	-
38	**8.4**	**Historical railway and tunnel features**	0	0	34	-	-
39	8.5	Royal Mail tunnels	0	0	0	-	-
40	8.6	Historical railways	0	0	0	-	-
40	**8.7**	**Railways**	0	0	6	-	-
40	8.8	Crossrail 1	0	0	0	0	-

41	8.9	Crossrail 2	0	0	0	0	-
41	**8.10**	**HS2**	0	0	0	1	-

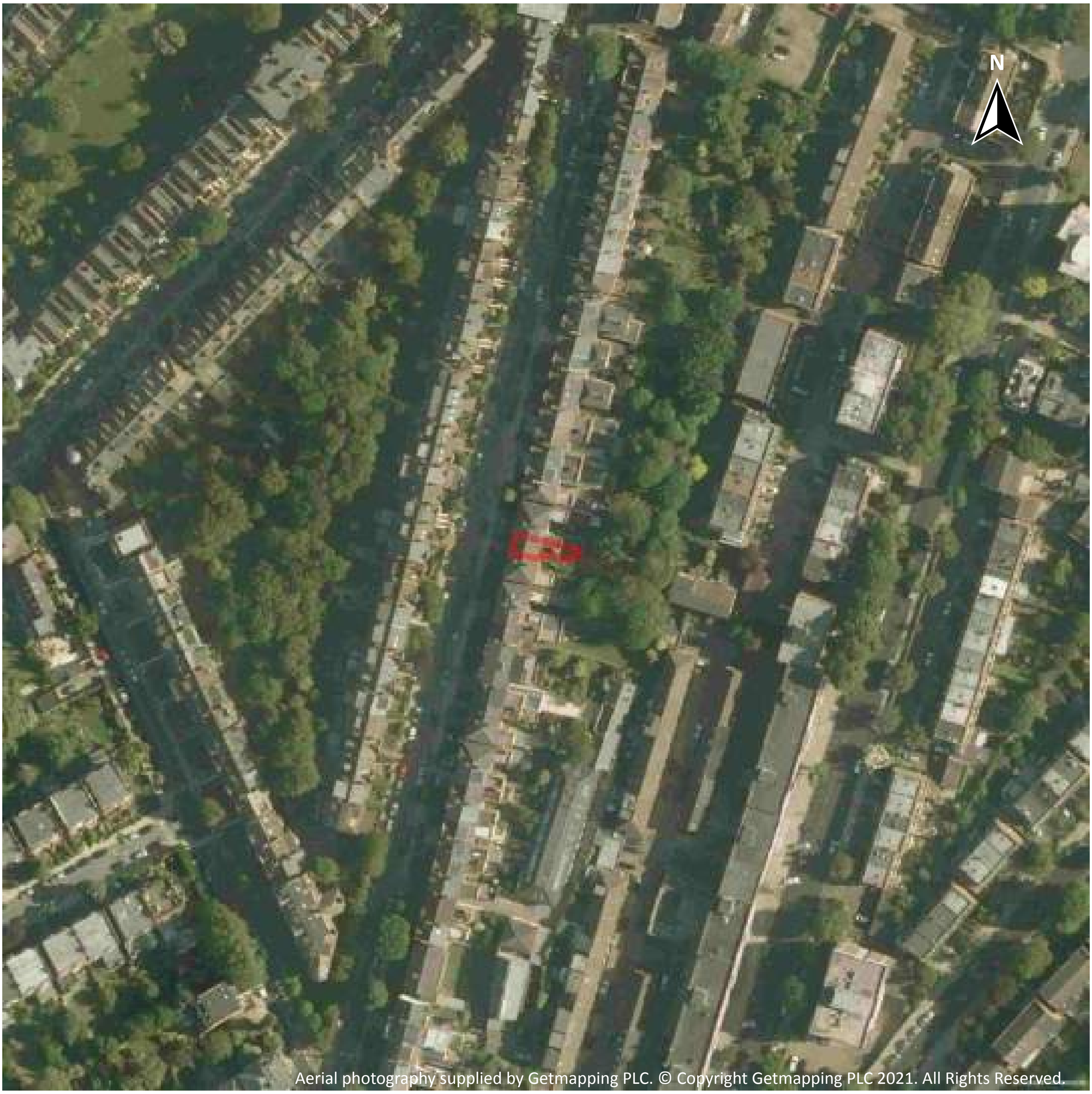
Recent aerial photograph



Capture Date: 29/06/2019

Site Area: 0.01ha

Recent site history - 2015 aerial photograph



Capture Date: 07/06/2015

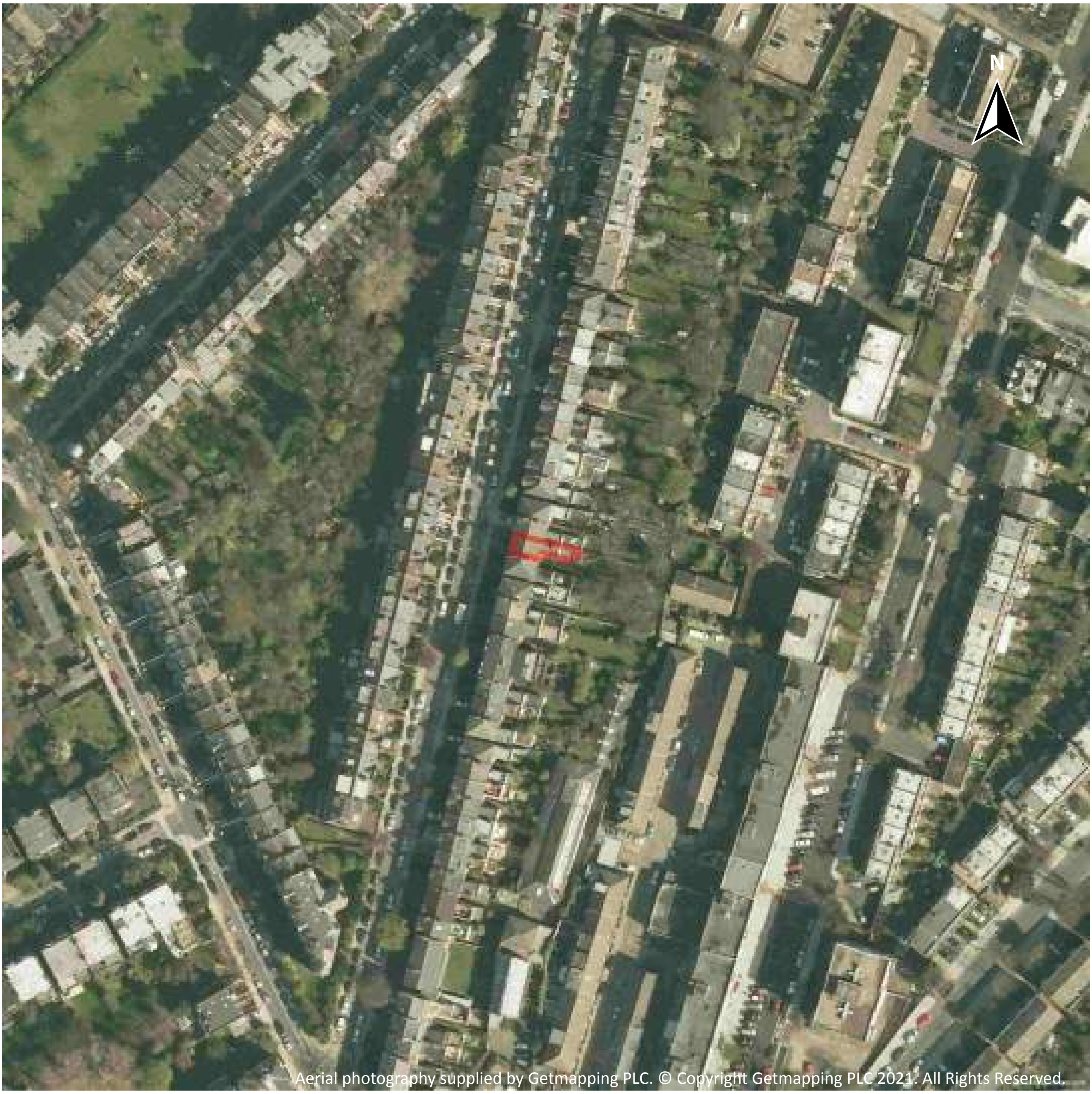
Site Area: 0.01ha

Recent site history - 2013 aerial photograph

Capture Date: 20/04/2013

Site Area: 0.01ha

Recent site history - 2008 aerial photograph



Capture Date: 15/04/2008

Site Area: 0.01ha

Recent site history - 1999 aerial photograph

Capture Date: 04/09/1999

Site Area: 0.01ha

OS MasterMap site plan

Site Area: 0.01ha

1 Geology 1:10,000 scale - Availability

Site Outline

Search buffers in metres (m)

Full coverage

Partial coverage

No coverage

1.1 10k Availability

Records within 500m	1

An indication on the coverage of 1:10,000 scale geology data for the site, the most detailed dataset provided by the British Geological Survey. Either 'Full', 'Partial' or 'No coverage' for each geological theme.

Features are displayed on the Geology 1:10,000 scale - Availability map on **page 11**

ID	Location	Artificial	Superficial	Bedrock	Mass movement	Sheet No.
1	On site	Full	Full	Full	No coverage	TQ28SE

This data is sourced from the British Geological Survey.

Geology 1:10,000 scale - Artificial and made ground

1.2 Artificial and made ground (10k)

Records within 500m	0

Details of made, worked, infilled, disturbed and landscaped ground at 1:10,000 scale. Artificial ground can be associated with potentially contaminated material, unpredictable engineering conditions and instability.

This data is sourced from the British Geological Survey.

Geology 1:10,000 scale - Superficial

1.3 Superficial geology (10k)

Records within 500m	0

Superficial geological deposits at 1:10,000 scale. Also known as 'drift', these are the youngest geological deposits, formed during the Quaternary. They rest on older deposits or rocks referred to as bedrock.

This data is sourced from the British Geological Survey.

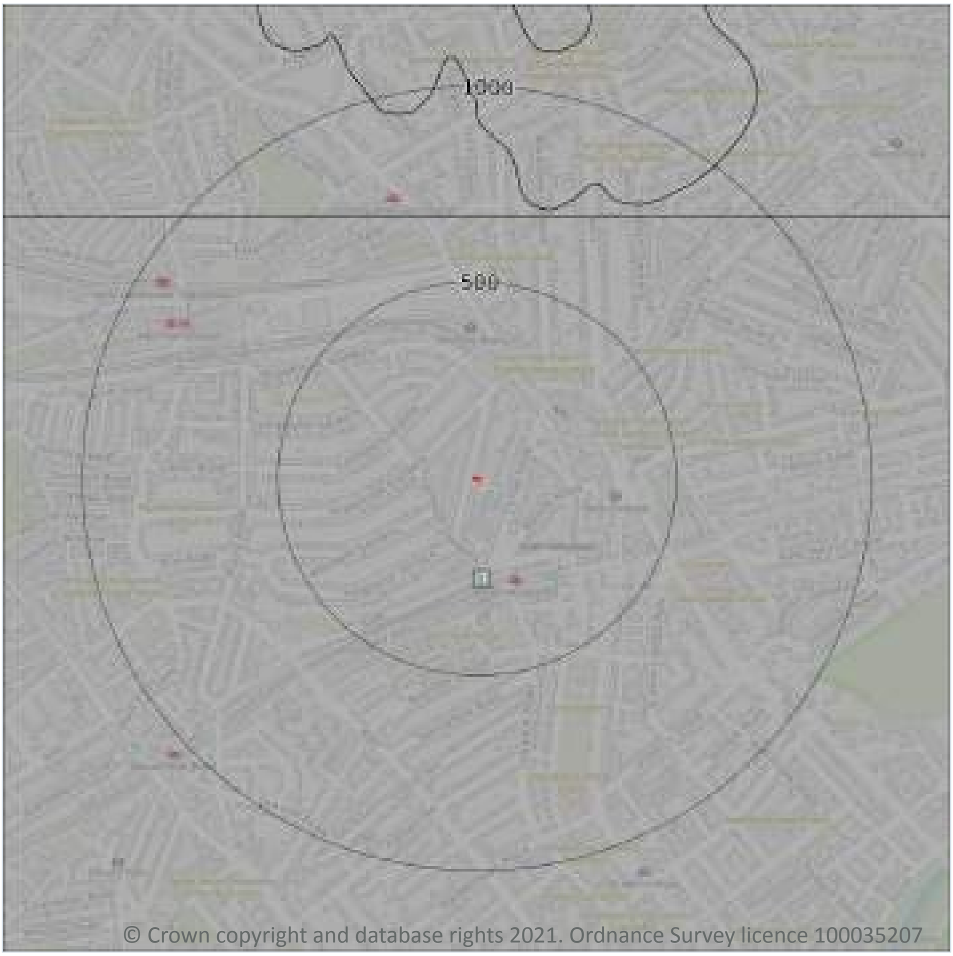
1.4 Landslip (10k)

Records within 500m	0

Mass movement deposits on BGS geological maps at 1:10,000 scale. Primarily superficial deposits that have moved down slope under gravity to form landslips. These affect bedrock, other superficial deposits and artificial ground.

This data is sourced from the British Geological Survey.

Geology 1:10,000 scale - Bedrock



Site Outline

Search buffers in metres (m)

Bedrock faults and other linear features (10k)

Bedrock geology (10k)
Please see table for more details.

1.5 Bedrock geology (10k)

Records within 500m	1

Bedrock geology at 1:10,000 scale. The main mass of rocks forming the Earth and present everywhere, whether exposed at the surface in outcrops or concealed beneath superficial deposits or water.

Features are displayed on the Geology 1:10,000 scale - Bedrock map on **page 14**

ID	Location	LEX Code	Description	Rock age
1	**On site**	**LC-CLAY**	**London Clay Formation - Clay**	**Eocene Epoch**

This data is sourced from the British Geological Survey.

1.6 Bedrock faults and other linear features (10k)

Records within 500m	**0**

Linear features at the ground or bedrock surface at 1:10,000 scale of six main types; rock, fault, fold axis, mineral vein, alteration area or landform. Features are either observed or inferred, and relate primarily to bedrock.

This data is sourced from the British Geological Survey.

2 Geology 1:50,000 scale - Availability

Site Outline

Search buffers in metres (m)

Geological map tile

2.1 50k Availability

Records within 500m	1

An indication on the coverage of 1:50,000 scale geology data for the site. Either 'Full' or 'No coverage' for each geological theme.

Features are displayed on the Geology 1:50,000 scale - Availability map on **page 16**

ID	Location	Artificial	Superficial	Bedrock	Mass movement	Sheet No.
1	**On site**	**Full**	**Full**	**Full**	**Full**	**EW256_north_london_v4**

This data is sourced from the British Geological Survey.

Geology 1:50,000 scale - Artificial and made ground

2.2 Artificial and made ground (50k)

Records within 500m	**0**

Details of made, worked, infilled, disturbed and landscaped ground at 1:50,000 scale. Artificial ground can be associated with potentially contaminated material, unpredictable engineering conditions and instability.

This data is sourced from the British Geological Survey.

2.3 Artificial ground permeability (50k)

Records within 50m	**0**

A qualitative classification of estimated rates of vertical movement of water from the ground surface through the unsaturated zone of any artificial deposits (the zone between the land surface and the water table).

This data is sourced from the British Geological Survey.

Geology 1:50,000 scale - Superficial

2.4 Superficial geology (50k)

Records within 500m	0

Superficial geological deposits at 1:50,000 scale. Also known as 'drift', these are the youngest geological deposits, formed during the Quaternary. They rest on older deposits or rocks referred to as bedrock.

This data is sourced from the British Geological Survey.

2.5 Superficial permeability (50k)

Records within 50m	0

A qualitative classification of estimated rates of vertical movement of water from the ground surface through the unsaturated zone of any superficial deposits (the zone between the land surface and the water table).

This data is sourced from the British Geological Survey.

2.6 Landslip (50k)

Records within 500m	0

Mass movement deposits on BGS geological maps at 1:50,000 scale. Primarily superficial deposits that have moved down slope under gravity to form landslips. These affect bedrock, other superficial deposits and artificial ground.

This data is sourced from the British Geological Survey.

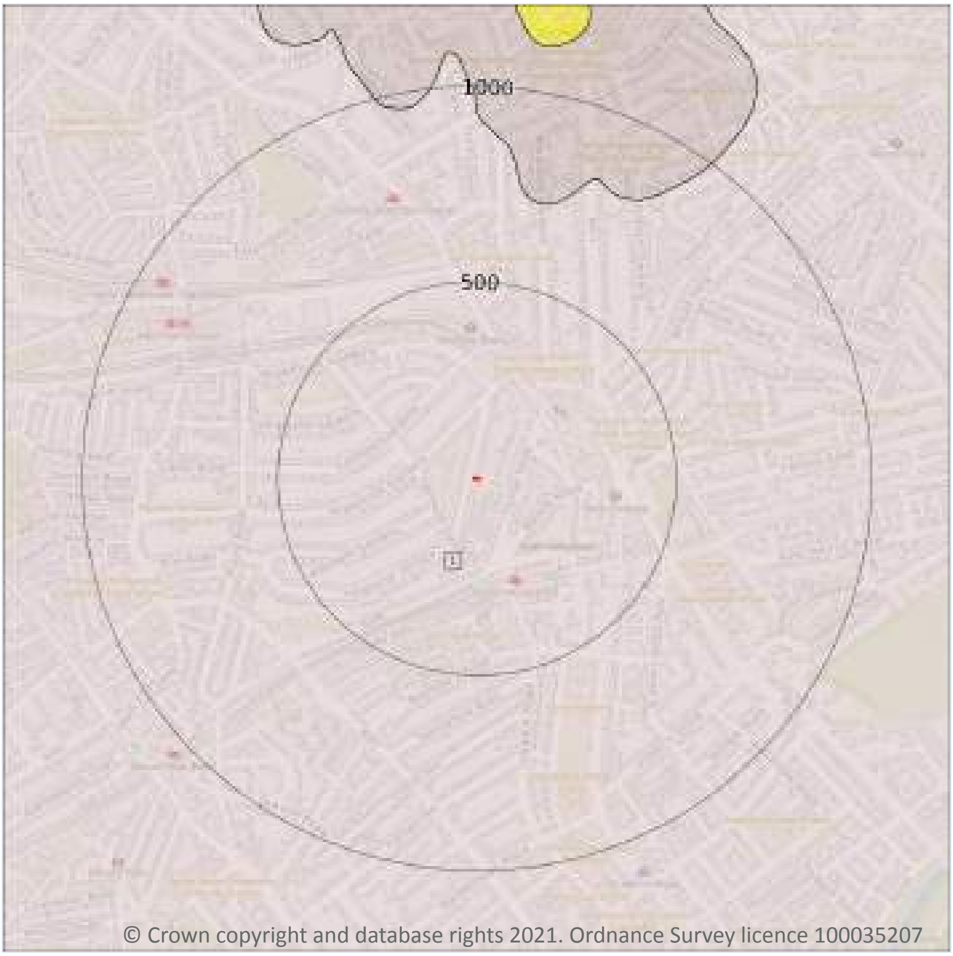
2.7 Landslip permeability (50k)

Records within 50m	0

A qualitative classification of estimated rates of vertical movement of water from the ground surface through the unsaturated zone of any landslip deposits (the zone between the land surface and the water table).

This data is sourced from the British Geological Survey.

Geology 1:50,000 scale - Bedrock



Site Outline
Search buffers in metres (m)
Bedrock faults and other linear features (50k)
Bedrock geology (50k)
Please see table for more details.

2.8 Bedrock geology (50k)

Records within 500m 1

Bedrock geology at 1:50,000 scale. The main mass of rocks forming the Earth and present everywhere, whether exposed at the surface in outcrops or concealed beneath superficial deposits or water.

Features are displayed on the Geology 1:50,000 scale - Bedrock map on **page 19**

ID	Location	LEX Code	Description	Rock age
1	On site	LC-XCZS	LONDON CLAY FORMATION - CLAY, SILT AND SAND	YPRESIAN

This data is sourced from the British Geological Survey.

2.9 Bedrock permeability (50k)

Records within 50m	**1**

A qualitative classification of estimated rates of vertical movement of water from the ground surface through the unsaturated zone of bedrock (the zone between the land surface and the water table).

Location	Flow type	Maximum permeability	Minimum permeability
On site	**Mixed**	**Moderate**	**Very Low**

This data is sourced from the British Geological Survey.

2.10 Bedrock faults and other linear features (50k)

Records within 500m	**0**

Linear features at the ground or bedrock surface at 1:50,000 scale of six main types; rock, fault, fold axis, mineral vein, alteration area or landform. Features are either observed or inferred, and relate primarily to bedrock.

This data is sourced from the British Geological Survey.

3 Boreholes

Site Outline

Search buffers in metres (m)

Confidential

0 - 10m

10 - 30m

30m+

Unknown

3.1 BGS Boreholes

Records within 250m	1

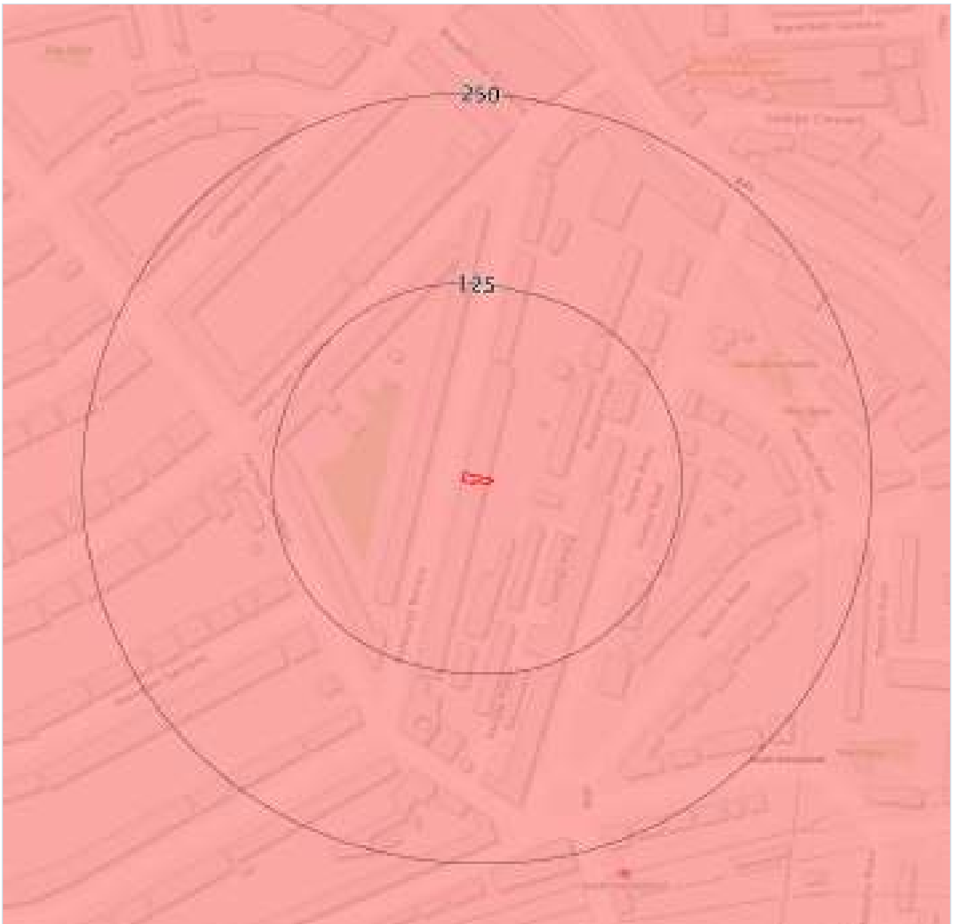
The Single Onshore Boreholes Index (SOBI); an index of over one million records of boreholes, shafts and wells from all forms of drilling and site investigation work held by the British Geological Survey. Covering onshore and nearshore boreholes dating back to at least 1790 and ranging from one to several thousand metres deep.

Features are displayed on the Boreholes map on **page 21**

ID	Location	Grid reference	Name	Length	Confidential	Web link
1	234m S	526230 184100	COLRIDGE GARDENS SWISS COTTAGE	7.62	N	591794

This data is sourced from the British Geological Survey.

4 Natural ground subsidence - Shrink swell clays



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Site Outline

Search buffers in metres (m)

- No data
- Negligible
- Very low
- Low
- Moderate
- High

4.1 Shrink swell clays

Records within 50m	**1**

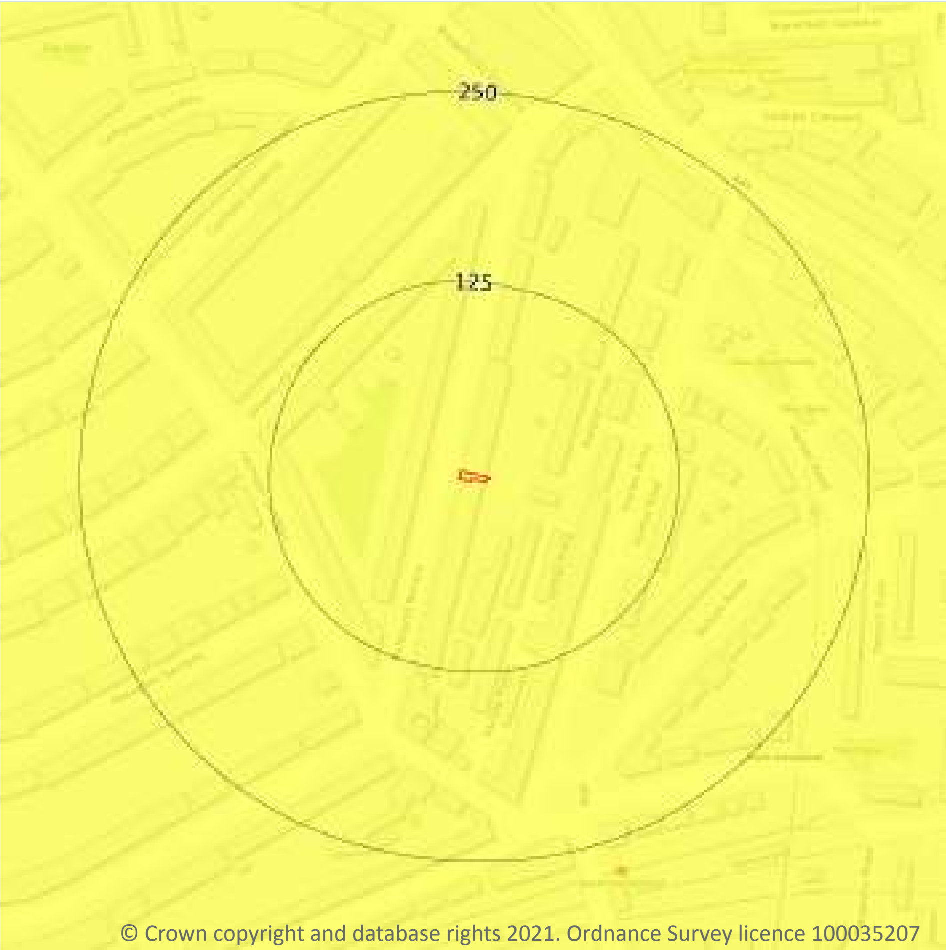
The potential hazard presented by soils that absorb water when wet (making them swell), and lose water as they dry (making them shrink). This shrink-swell behaviour is controlled by the type and amount of clay in the soil, and by seasonal changes in the soil moisture content (related to rainfall and local drainage).

Features are displayed on the Natural ground subsidence - Shrink swell clays map on **page 22**

Location	Hazard rating	Details
On site	**Moderate**	**Ground conditions predominantly high plasticity.**

This data is sourced from the British Geological Survey.

Natural ground subsidence - Running sands



Site Outline
Search buffers in metres (m)

- No data
- Negligible
- Very low
- Low
- Moderate
- High

4.2 Running sands

Records within 50m	1

The potential hazard presented by rocks that can contain loosely-packed sandy layers that can become fluidised by water flowing through them. Such sands can 'run', removing support from overlying buildings and causing potential damage.

Features are displayed on the Natural ground subsidence - Running sands map on **page 23**

Location	Hazard rating	Details
On site	**Very low**	**Running sand conditions are unlikely. No identified constraints on land use due to running conditions unless water table rises rapidly.**

This data is sourced from the British Geological Survey.

Natural ground subsidence - Compressible deposits

Site Outline
Search buffers in metres (m)

- No data
- Negligible
- Very low
- Low
- Moderate
- High

4.3 Compressible deposits

Records within 50m	1

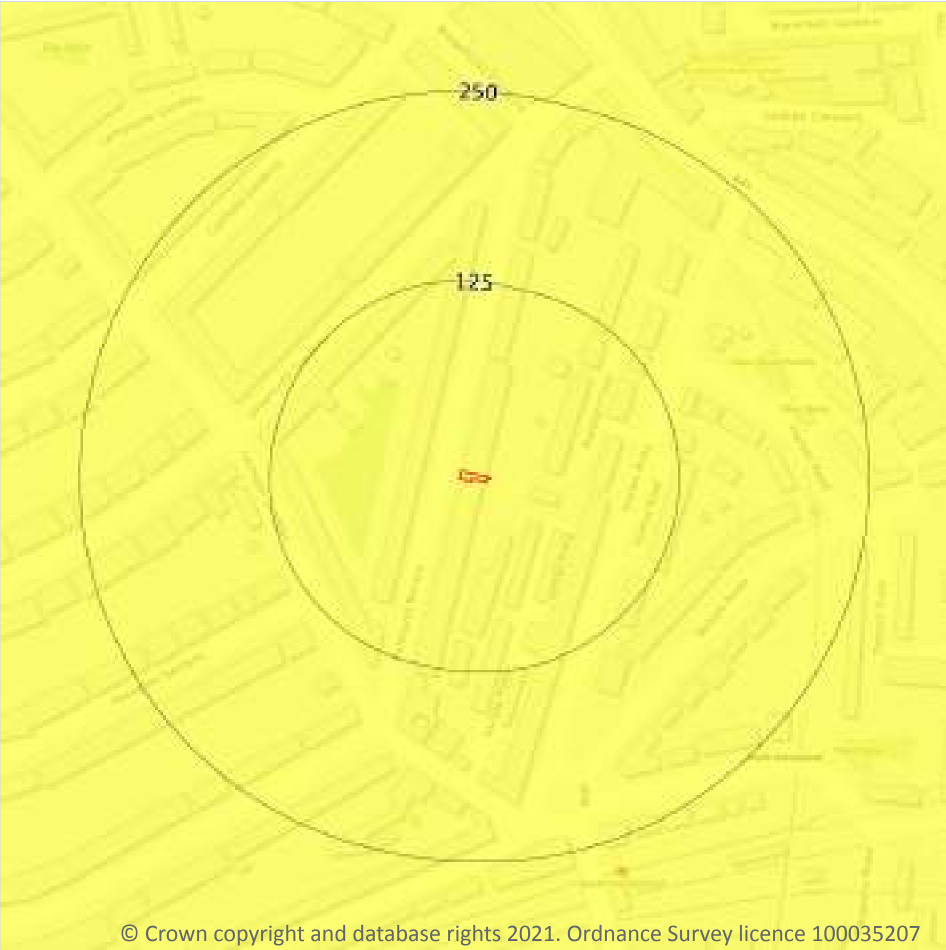
The potential hazard presented by types of ground that may contain layers of very soft materials like clay or peat and may compress if loaded by overlying structures, or if the groundwater level changes, potentially resulting in depression of the ground and disturbance of foundations.

Features are displayed on the Natural ground subsidence - Compressible deposits map on **page 24**

Location	Hazard rating	Details
On site	**Negligible**	**Compressible strata are not thought to occur.**

This data is sourced from the British Geological Survey.

Natural ground subsidence - Collapsible deposits



Site Outline

Search buffers in metres (m)

- No data
- Negligible
- Very low
- Low
- Moderate
- High

4.4 Collapsible deposits

Records within 50m	1

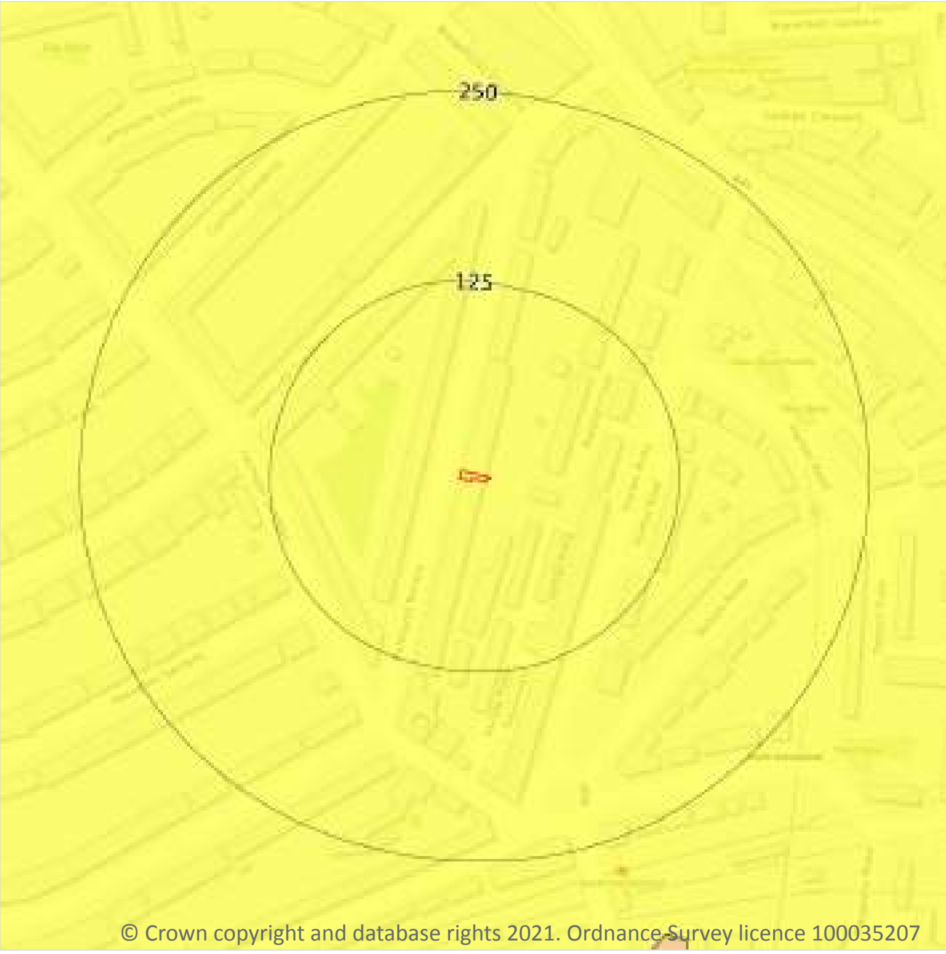
The potential hazard presented by natural deposits that could collapse when a load (such as a building) is placed on them or they become saturated with water.

Features are displayed on the Natural ground subsidence - Collapsible deposits map on **page 25**

Location	Hazard rating	Details
On site	**Very low**	**Deposits with potential to collapse when loaded and saturated are unlikely to be present.**

This data is sourced from the British Geological Survey.

Natural ground subsidence - Landslides



Site Outline
Search buffers in metres (m)

- No data
- Negligible
- Very low
- Low
- Moderate
- High

4.5 Landslides

Records within 50m	1

The potential for landsliding (slope instability) to be a hazard assessed using 1:50,000 scale digital maps of superficial and bedrock deposits, combined with information from the BGS National Landslide Database and scientific and engineering reports.

Features are displayed on the Natural ground subsidence - Landslides map on **page 26**

Location	Hazard rating	Details
On site	**Very low**	**Slope instability problems are not likely to occur but consideration to potential problems of adjacent areas impacting on the site should always be considered.**

This data is sourced from the British Geological Survey.

Natural ground subsidence - Ground dissolution of soluble rocks

Site Outline
Search buffers in metres (m)

- No data
- Negligible
- Very low
- Low
- Moderate
- High

4.6 Ground dissolution of soluble rocks

Records within 50m	1

The potential hazard presented by ground dissolution, which occurs when water passing through soluble rocks produces underground cavities and cave systems. These cavities reduce support to the ground above and can cause localised collapse of the overlying rocks and deposits.

Features are displayed on the Natural ground subsidence - Ground dissolution of soluble rocks map on **page 27**

Location	Hazard rating	Details
On site	**Negligible**	**Soluble rocks are either not thought to be present within the ground, or not prone to dissolution. Dissolution features are unlikely to be present.**

This data is sourced from the British Geological Survey.

5 Mining, ground workings and natural cavities

Site Outline
Search buffers in metres (m)

- Natural cavities (Area)
- Natural cavities (Point)
- BritPits
- Surface ground workings
- Underground workings
- Historical Mineral Planning Areas
- Mining Cavities

Non Coal Mining

- Sporadic underground mining of restricted extent possible
- Localised small scale underground mining possible
- Small scale mining possible
- Underground mining known or likely within or in close proximity
- Underground mining known within or in very close proximity

5.1 Natural cavities

Records within 500m	0

Industry recognised national database of natural cavities. Sinkholes and caves are formed by the dissolution of soluble rock, such as chalk and limestone, gulls and fissures by cambering. Ground instability can result from movement of loose material contained within these cavities, often triggered by water.

This data is sourced from Stantec UK Ltd.

5.2 BritPits

Records within 500m	0

BritPits (an abbreviation of British Pits) is a database maintained by the British Geological Survey of currently active and closed surface and underground mineral workings. Details of major mineral handling sites, such as wharfs and rail depots are also held in the database.

This data is sourced from the British Geological Survey.

5.3 Surface ground workings

Records within 250m	0

Historical land uses identified from Ordnance Survey mapping that involved ground excavation at the surface. These features may or may not have been subsequently backfilled.

This is data is sourced from Ordnance Survey/Groundsure.

5.4 Underground workings

Records within 1000m	69

Historical land uses identified from Ordnance Survey mapping that indicate the presence of underground workings e.g. mine shafts.

Features are displayed on the Mining, ground workings and natural cavities map on **page 28**

ID	Location	Land Use	Year of mapping	Mapping scale
A	192m NE	Air Shaft	1940	1:10560
A	197m NE	Air Shaft	1957	1:10560
A	200m E	Tunnel	1973	1:10000
A	200m E	Tunnel	1968	1:10560
A	200m E	Tunnel	1957	1:10560
B	220m SE	Air Shaft	1940	1:10560
B	223m SE	Air Shaft	1920	1:10560
B	224m SE	Air Shaft	1957	1:10560
C	310m SE	Tunnel	1973	1:10000
C	310m SE	Tunnel	1968	1:10560
C	310m SE	Tunnel	1989	1:10000
C	310m SE	Tunnel	1957	1:10560

ID	Location	Land Use	Year of mapping	Mapping scale
D	326m SE	Tunnels	1957	1:10560
D	329m SE	Tunnel	1973	1:10000
D	329m SE	Tunnel	1968	1:10560
D	329m SE	Tunnel	1989	1:10000
E	347m SE	Tunnels	1957	1:10560
E	350m SE	Tunnel	1973	1:10000
E	350m SE	Tunnel	1968	1:10560
E	350m SE	Tunnel	1989	1:10000
1	359m SE	Tunnel	1968	1:10560
F	359m SE	Tunnel	1973	1:10000
F	359m SE	Tunnel	1989	1:10000
F	359m SE	Tunnel	1957	1:10560
G	406m SE	Air Shaft	1968	1:10560
G	406m SE	Air Shaft	1957	1:10560
G	406m SE	Air Shaft	1940	1:10560
G	409m SE	Air Shaft	1920	1:10560
H	495m SE	Air Shaft	1973	1:10000
H	495m SE	Air Shaft	1968	1:10560
I	537m N	Tunnels	1957	1:10560
I	537m N	Tunnels	1973	1:10000
I	537m N	Tunnels	1968	1:10560
I	537m N	Tunnels	1989	1:10000
5	544m N	Tunnel	1866	1:10560
7	560m S	Air Shafts	1940	1:10560
J	577m N	Tunnels	1973	1:10000
J	577m N	Tunnels	1989	1:10000
J	577m N	Tunnels	1968	1:10560
J	577m N	Tunnels	1957	1:10560

ID	Location	Land Use	Year of mapping	Mapping scale
8	624m S	Air Shafts	1940	1:10560
-	680m S	Air Shaft	1940	1:10560
-	681m N	Air Shaft	1973	1:10000
-	681m N	Air Shaft	1989	1:10000
-	682m N	Air Shaft	1940	1:10560
-	683m N	Air Shaft	1920	1:10560
-	694m N	Tunnel	1965	1:10560
-	694m N	Tunnel	1974	1:10000
-	694m N	Tunnel	1995	1:10000
-	694m N	Tunnel	1958	1:10560
-	710m E	Air Shaft	1940	1:10560
-	712m S	Tunnel	1968	1:10560
-	736m N	Tunnel	1974	1:10000
-	736m N	Tunnel	1995	1:10000
-	760m NE	Tunnel	1965	1:10560
-	760m NE	Tunnel	1974	1:10000
-	760m NE	Tunnel	1995	1:10000
-	760m NE	Tunnel	1958	1:10560
-	762m N	Tunnel	1958	1:10560
-	764m N	Tunnel	1965	1:10560
-	827m NE	Unspecified Shaft	1866	1:10560
-	845m NE	Air Shaft	1920	1:10560
-	896m E	Air Shaft	1973	1:10000
-	896m E	Air Shaft	1968	1:10560
-	896m E	Air Shaft	1989	1:10000
-	896m E	Air Shaft	1957	1:10560
-	896m E	Air Shaft	1940	1:10560
-	900m E	Air Shaft	1894	1:10560

ID	Location	Land Use	Year of mapping	Mapping scale
-	997m N	Tunnel	1958	1:10560

This is data is sourced from Ordnance Survey/Groundsure.

5.5 Historical Mineral Planning Areas

Records within 500m	**0**

Boundaries of mineral planning permissions for England and Wales. This data was collated between the 1940s (and retrospectively to the 1930s) and the mid 1980s. The data includes permitted, withdrawn and refused permissions.

This data is sourced from the British Geological Survey.

5.6 Non-coal mining

Records within 1000m	**0**

The potential for historical non-coal mining to have affected an area. The assessment is drawn from expert knowledge and literature in addition to the digital geological map of Britain. Mineral commodities may be divided into seven general categories - vein minerals, chalk, oil shale, building stone, bedded ores, evaporites and 'other' commodities (including ball clay, jet, black marble, graphite and chert).

This data is sourced from the British Geological Survey.

5.7 Mining cavities

Records within 1000m	**0**

Industry recognised national database of mining cavities. Degraded mines may result in hazardous subsidence (crown holes). Climatic conditions and water escape can also trigger subsidence over mine entrances and workings.

This data is sourced from Stantec UK Ltd.

5.8 JPB mining areas

Records on site	**0**

Areas which could be affected by former coal and other mining. This data includes some mine plans unavailable to the Coal Authority.

This data is sourced from Johnson Poole and Bloomer.

5.9 Coal mining

Records on site	**0**

Areas which could be affected by past, current or future coal mining.

This data is sourced from the Coal Authority.

5.10 Brine areas

Records on site	**0**

The Cheshire Brine Compensation District indicates areas that may be affected by salt and brine extraction in Cheshire and where compensation would be available where damage from this mining has occurred. Damage from salt and brine mining can still occur outside this district, but no compensation will be available.

This data is sourced from the Cheshire Brine Subsidence Compensation Board.

5.11 Gypsum areas

Records on site	**0**

Generalised areas that may be affected by gypsum extraction.

This data is sourced from British Gypsum.

5.12 Tin mining

Records on site	**0**

Generalised areas that may be affected by historical tin mining.

This data is sourced from Groundsure.

5.13 Clay mining

Records on site	**0**

Generalised areas that may be affected by kaolin and ball clay extraction.

This data is sourced from the Kaolin and Ball Clay Association (UK).

6 Radon

Site Outline
Search buffers in metres (m)

Greater than 30%
Between 10% and 30%
Between 5% and 10%
Between 3% and 5%
Between 1% and 3%
Less than 1%

6.1 Radon

Records on site	1

Estimated percentage of dwellings exceeding the Radon Action Level. This data is the highest resolution radon dataset available for the UK and is produced to a 75m level of accuracy to allow for geological data accuracy and a 'residential property' buffer. The findings of this section should supersede any estimations derived from the Indicative Atlas of Radon in Great Britain. The data was derived from both geological assessments and long term measurements of radon in more than 479,000 households.

Features are displayed on the Radon map on **page 34**

Location	Estimated properties affected	Radon Protection Measures required
On site	**Less than 1%**	**None****

This data is sourced from the British Geological Survey and Public Health England.

7 Soil chemistry

7.1 BGS Estimated Background Soil Chemistry

Records within 50m **1**

The estimated values provide the likely background concentration of the potentially harmful elements Arsenic, Cadmium, Chromium, Lead and Nickel in topsoil. The values are estimated primarily from rural topsoil data collected at a sample density of approximately 1 per 2 km^2. In areas where rural soil samples are not available, estimation is based on stream sediment data collected from small streams at a sampling density of 1 per 2.5 km^2; this is the case for most of Scotland, Wales and southern England. The stream sediment data are converted to soil-equivalent concentrations prior to the estimation.

Location	Arsenic	Bioaccessible Arsenic	Lead	Bioaccessible Lead	Cadmium	Chromium	Nickel
On site	**No data**	**No data**	**No data**	**No data**	**No data**	**No data**	**No data**

This data is sourced from the British Geological Survey.

7.2 BGS Estimated Urban Soil Chemistry

Records within 50m **4**

Estimated topsoil chemistry of Arsenic, Cadmium, Chromium, Copper, Nickel, Lead, Tin and Zinc and bioaccessible Arsenic and Lead in 23 urban centres across Great Britain. These estimates are derived from interpolation of the measured urban topsoil data referred to above and provide information across each city between the measured sample locations (4 per km^2).

Location	Arsenic (mg/kg)	Bioaccessible Arsenic (mg/kg)	Lead (mg/kg)	Bioaccessible Lead (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Nickel (mg/kg)	Tin (mg/kg)
On site	**30**	**5.3**	**693**	**476**	**0.8**	**96**	**129**	**45**	**97**
8m E	30	5.3	660	453	0.9	91	136	44	90
28m S	30	5.3	742	510	0.8	96	134	45	92
30m SE	27	4.7	607	417	0.8	87	123	40	75

This data is sourced from the British Geological Survey.

7.3 BGS Measured Urban Soil Chemistry

Records within 50m	**1**

The locations and measured total concentrations (mg/kg) of Arsenic, Cadmium, Chromium, Copper, Nickel, Lead, Tin and Zinc in urban topsoil samples from 23 urban centres across Great Britain. These are collected at a sample density of 4 per km^2.

Location	Arsenic (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Nickel (mg/kg)	Lead (mg/kg)	Tin (mg/kg)	Sample Type
6m NW	30.4	0.8	95.5	127.7	45.3	688.9	97.0	Topsoil

This data is sourced from the British Geological Survey.

8 Railway infrastructure and projects

- Site Outline
- Search buffers in metres (m)
- Crossrail 1 Stations
- Crossrail 1 Route
- Crossrail 1 Worksites
- Crossrail 2 Stations
- Crossrail 2 Route
- Crossrail 2 Worksites
- Crossrail 2 Safeguarding
- Crossrail 2 Headhouses
- Railway stations
- Active railways
- Active tunnels
- Abandoned railways
- Historic railways
- Historic tunnels
- Underground stations
- Underground Lines
- Royal Mail tunnels
- HS2 optimised route
- HS2 Stations
- HS2 Depots
- HS2 Surface Safeguarding
- HS2 Subsurface Safeguarding

8.1 Underground railways (London)

Records within 250m	1

Details of all active London Underground lines, including approximate tunnel roof depth and operational hours.

Features are displayed on the Railway infrastructure and projects map on **page 37**

Location	Line Name	Line Section	Track Type	Depth (m bgl)	Operational hours
246m NE	Metropolitan Line	Metropolitan Line	Tunnel	7.37	Mon-Sat: Early 0500 Late 0119, Sun: Early 0636 Late 0016

This data is sourced from publicly available information by Groundsure.

8.2 Underground railways (Non-London)

Records within 250m	0

Details of the Merseyrail system, the Tyne and Wear Metro and the Glasgow Subway. Not all parts of all systems are located underground. The data contains location information only and does not include a depth assessment.

This data is sourced from publicly available information by Groundsure.

8.3 Railway tunnels

Records within 250m	0

Railway tunnels taken from contemporary Ordnance Survey mapping.

This data is sourced from the Ordnance Survey.

8.4 Historical railway and tunnel features

Records within 250m	34

Railways and tunnels digitised from historical Ordnance Survey mapping as scales of 1:1,250, 1:2,500, 1:10,000 and 1:10,560.

Features are displayed on the Railway infrastructure and projects map on **page 37**

Location	Land Use	Year of mapping	Mapping scale
200m E	Tunnel	1973	10000
200m E	Tunnel	1968	10560
200m E	Tunnel	1957	10560
202m E	Tunnel	1999	1250
202m E	Tunnel	1974	-
202m E	Tunnel	1983	1250
202m E	Tunnel	1991	1250
202m E	Tunnel	1967	1250
202m E	Tunnel	1953	1250
202m E	Tunnel	1962	1250
203m E	Tunnel	1955	2500
208m E	Tunnel	1967	1250

Location	Land Use	Year of mapping	Mapping scale
208m E	Tunnel	1973	1250
208m E	Tunnel	1953	1250
208m E	Tunnel	1962	1250
208m E	Tunnel	1995	1250
208m E	Tunnel	1978	1250
208m E	Tunnel	1979	1250
208m E	Tunnel	1991	1250
208m E	Tunnel	1984	1250
217m NE	Tunnel	1986	1250
217m NE	Tunnel	1991	1250
218m NE	Tunnel	1960	1250
218m NE	Tunnel	1994	1250
218m NE	Tunnel	1971	1250
218m NE	Tunnel	1953	1250
243m SE	Tunnel	1999	1250
243m SE	Tunnel	1974	-
244m SE	Tunnel	1983	1250
244m SE	Tunnel	1991	1250
245m SE	Tunnel	1967	1250
245m SE	Tunnel	1953	1250
245m SE	Tunnel	1962	1250
250m NE	Tunnel	1896	-

This data is sourced from Ordnance Survey/Groundsure.

8.5 Royal Mail tunnels

Records within 250m	0

The Post Office Railway, otherwise known as the Mail Rail, is an underground railway running through Central London from Paddington Head District Sorting Office to Whitechapel Eastern Head Sorting Office. The line is 10.5km long. The data includes details of the full extent of the tunnels, the depth of the tunnel, and the depth to track level.

This data is sourced from Groundsure/the Postal Museum.

8.6 Historical railways

Records within 250m	**0**

Former railway lines, including dismantled lines, abandoned lines, disused lines, historic railways and razed lines.

This data is sourced from OpenStreetMap.

8.7 Railways

Records within 250m	**6**

Currently existing railway lines, including standard railways, narrow gauge, funicular, trams and light railways.

Features are displayed on the Railway infrastructure and projects map on **page 37**

Location	Name	Type
204m NE	Chiltern Main Line	rail
209m NE	Chiltern Main Line	rail
232m SE	Chiltern Main Line	rail
234m SE	Chiltern Main Line	rail
237m SE	Chiltern Main Line	rail
238m SE	Chiltern Main Line	rail

This data is sourced from Ordnance Survey and OpenStreetMap.

8.8 Crossrail 1

Records within 500m	**0**

The Crossrail railway project links 41 stations over 100 kilometres from Reading and Heathrow in the west, through underground sections in central London, to Shenfield and Abbey Wood in the east.

This data is sourced from publicly available information by Groundsure.

8.9 Crossrail 2

Records within 500m	0

Crossrail 2 is a proposed railway linking the national rail networks in Surrey and Hertfordshire via an underground tunnel through London.

This data is sourced from publicly available information by Groundsure.

8.10 HS2

Records within 500m	1

HS2 is a proposed high speed rail network running from London to Manchester and Leeds via Birmingham. Main civils construction on Phase 1 (London to Birmingham) of the project began in 2019, and it is currently anticipated that this phase will be fully operational by 2026. Construction on Phase 2a (Birmingham to Crewe) is anticipated to commence in 2021, with the service fully operational by 2027. Construction on Phase 2b (Crewe to Manchester and Birmingham to Leeds) is scheduled to begin in 2023 and be operational by 2033.

Features are displayed on the Railway infrastructure and projects map on **page 37**

Location	Track Type	Speed (mph)	Speed (km/h)	Status
326m SE	Tunnel	112mph	180kph	Current preferred consultation route

This data is sourced from HS2 ltd.

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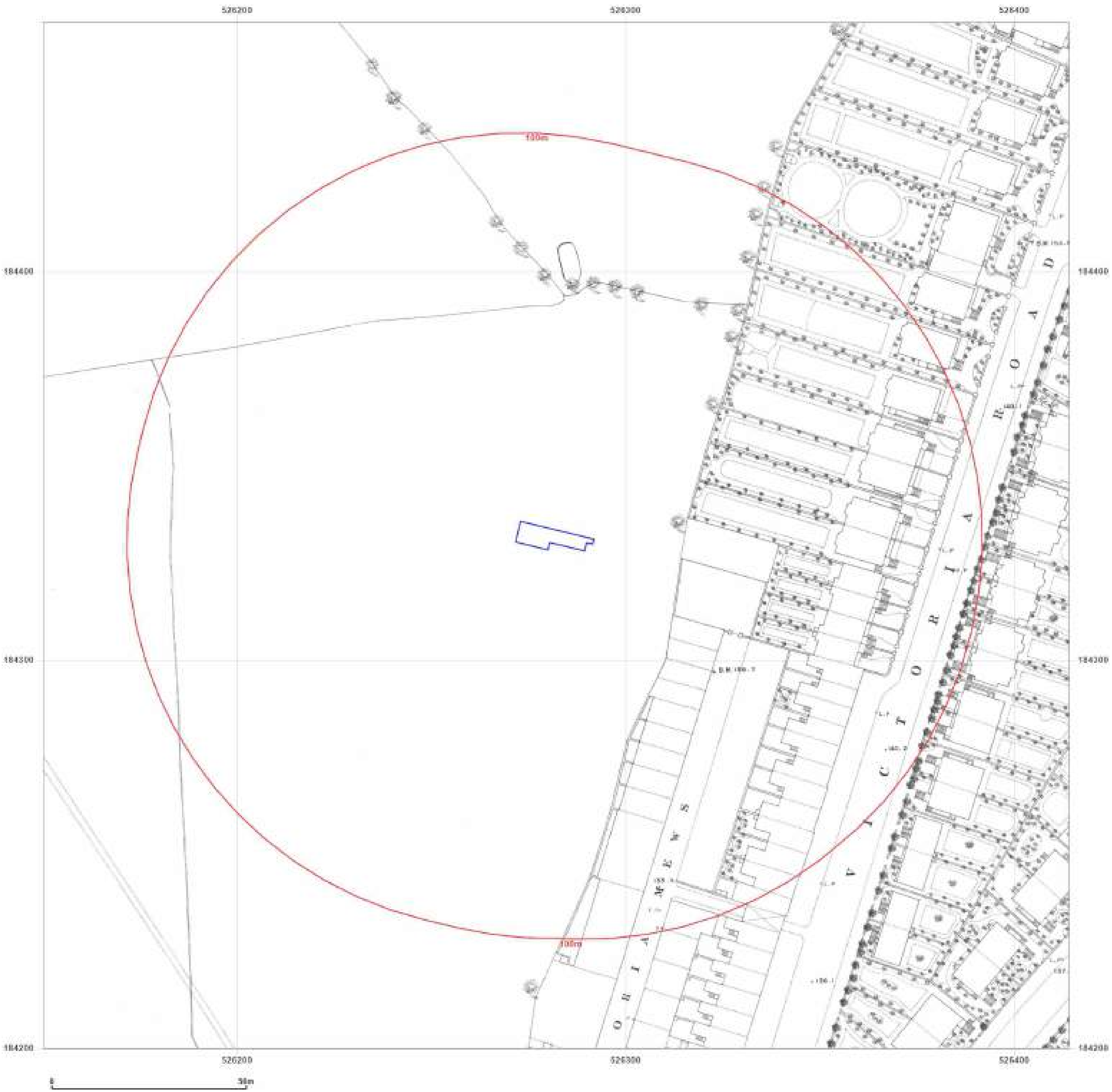

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Site Details:

73, GOLDHURST TERRACE,
LONDON, NW6 3HA

Client Ref: A704
Report Ref: GS-8317459
Grid Ref: 526282, 184332

Map Name: 1056 Scale Town Plan

Map date: **1871**

Scale: 1:1,056

Printed at: 1:1,056

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Revised N/A
Edition 1871
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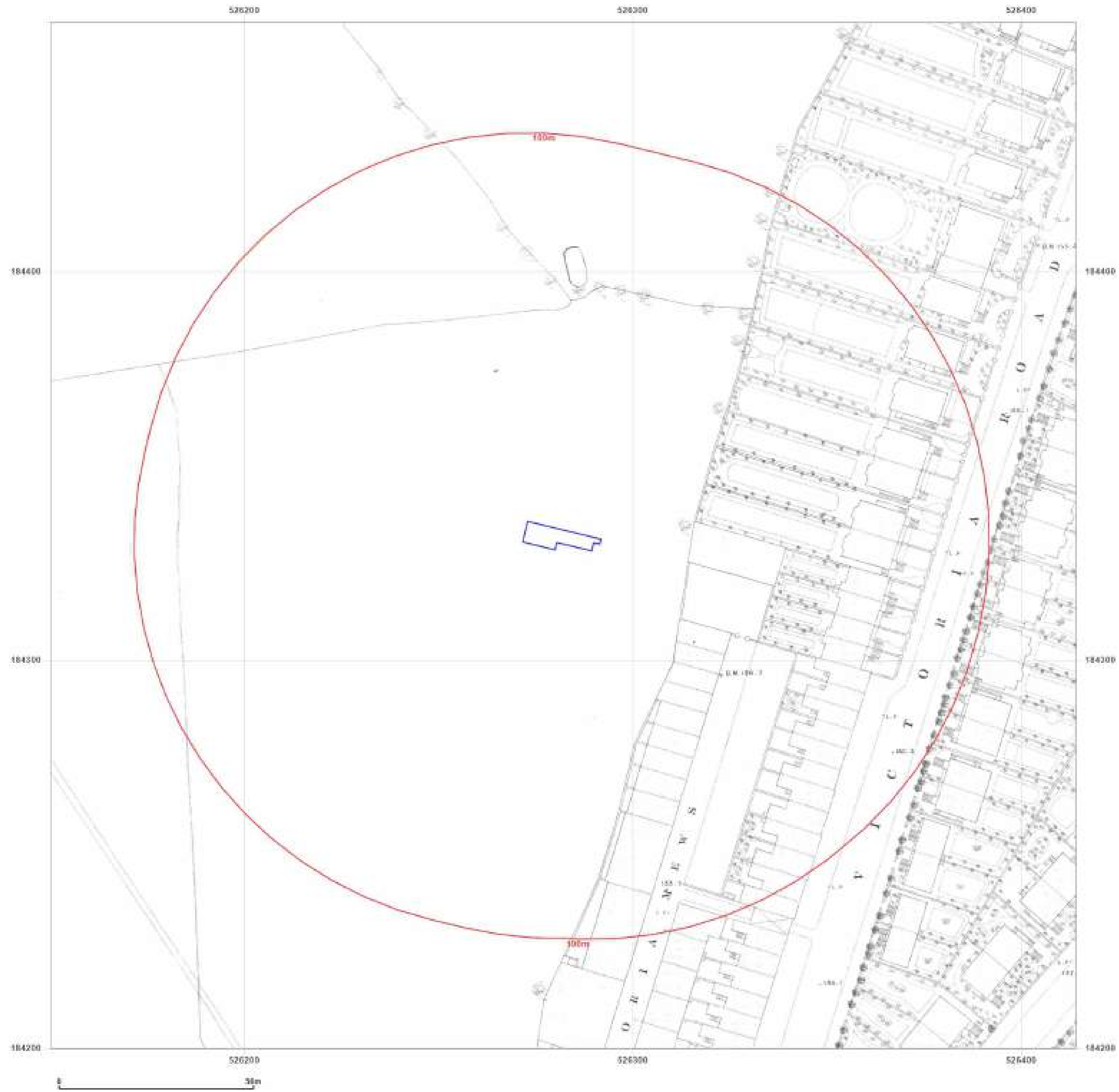

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Client Ref: A704
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Map Name: 1056 Scale Town Plan

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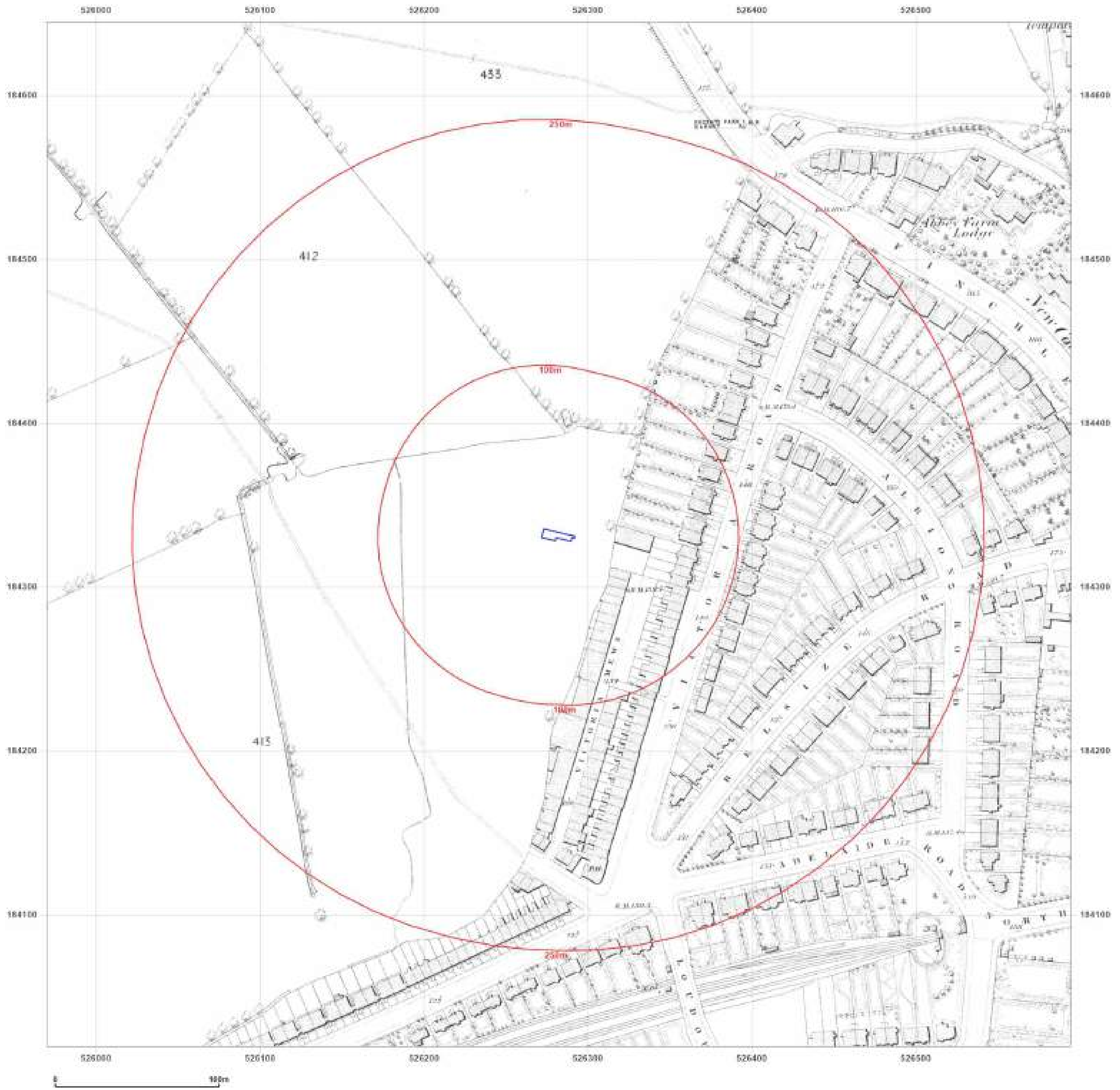

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LONDON, NW6 3HA

Client Ref: A704
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Grid Ref: 526282, 184332

Map Name: County Series

Map date: **1871**

Scale: 1:2,500

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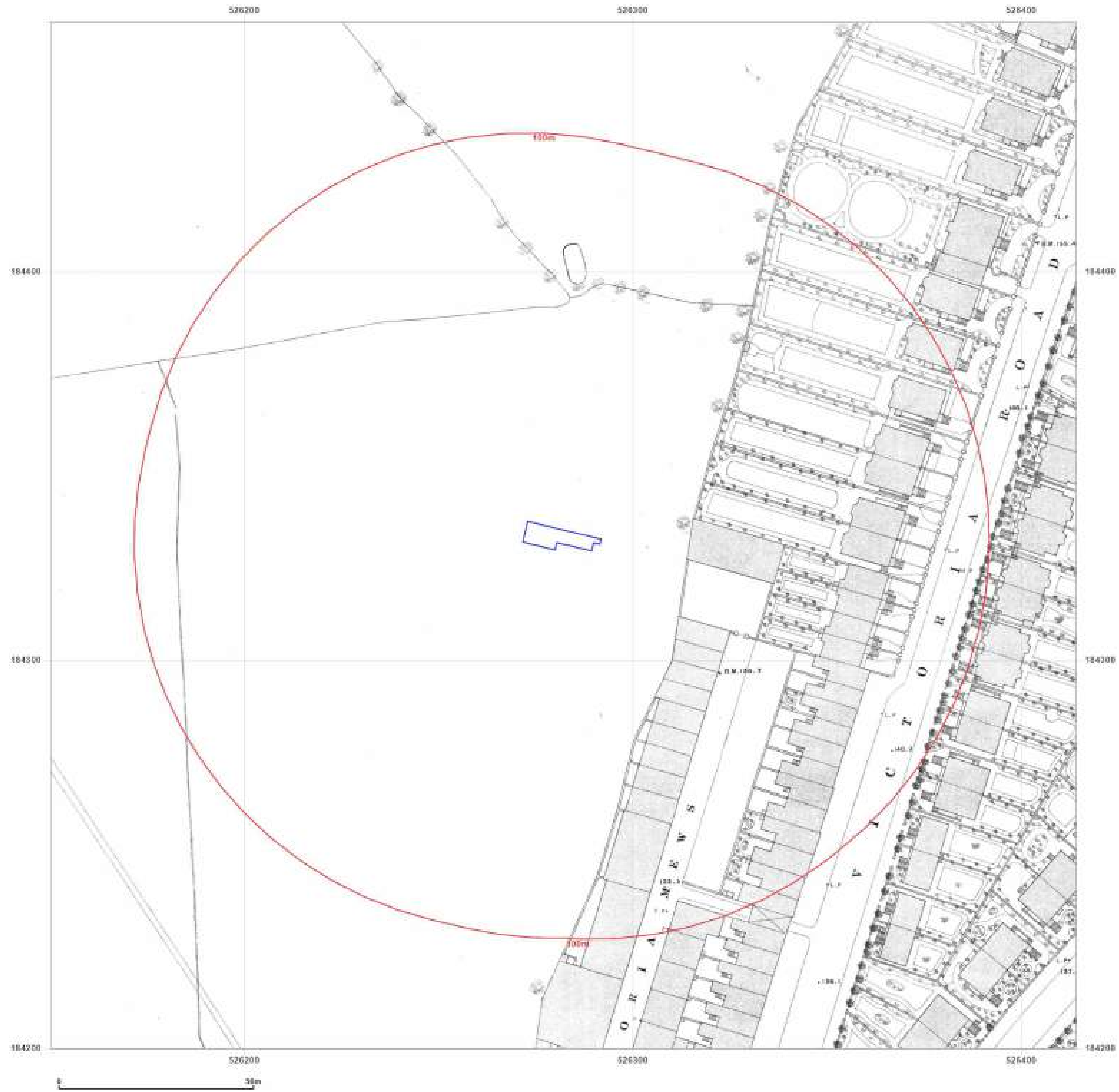

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Grid Ref: 526282, 184332

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Scale: 1:1,056

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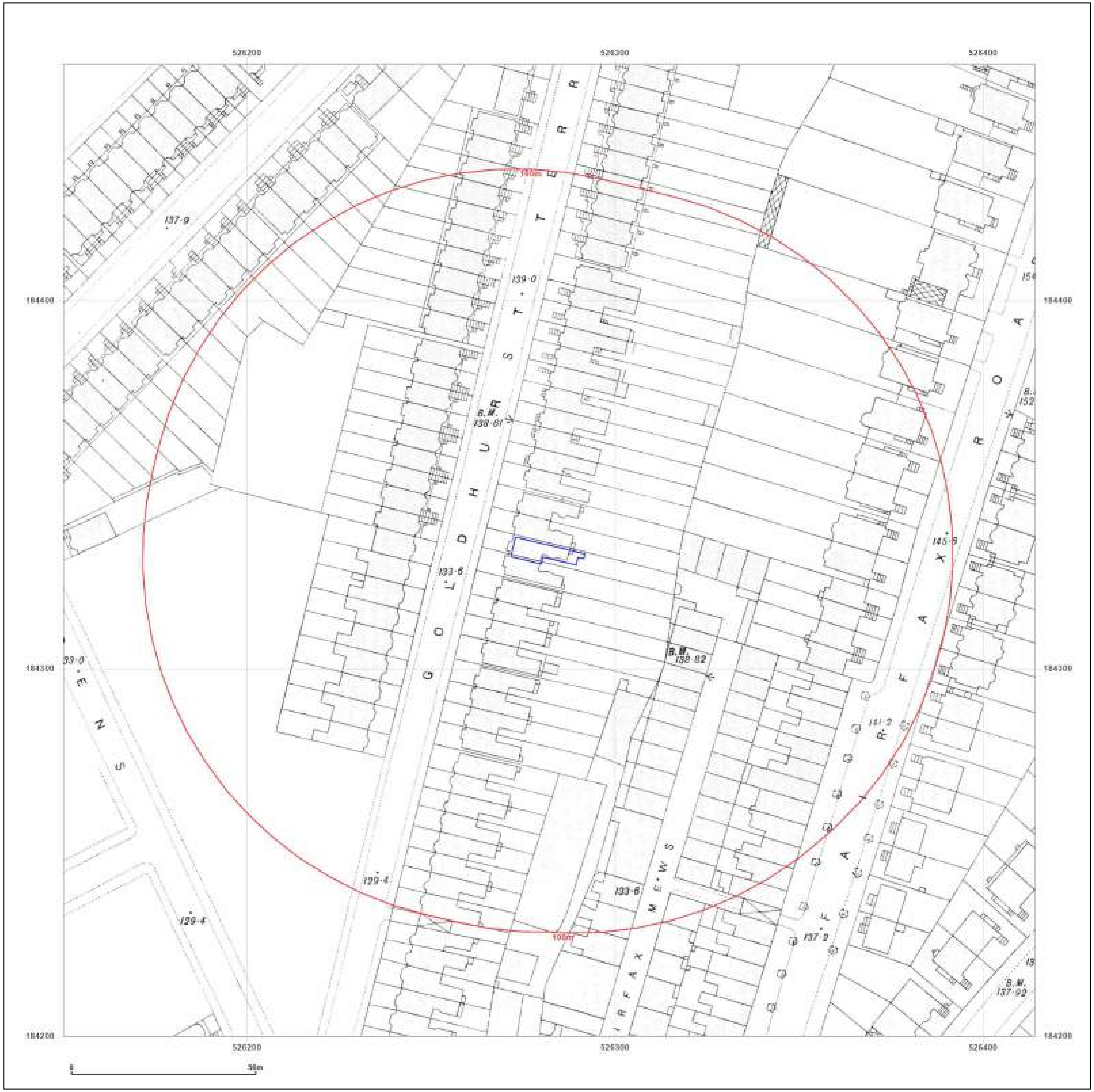

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Client Ref: A704
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Grid Ref: 526282, 184332

Map Name: 1056 Scale Town Plan

Map date: **1896**

Scale: 1:1,056

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Client Ref: A704
Report Ref: GS-8317459
Grid Ref: 526282, 184332

Map Name: County Series

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Client Ref: A704
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Grid Ref: 526282, 184332

Map Name: County Series

Map date: 1915

Scale: 1:2,500

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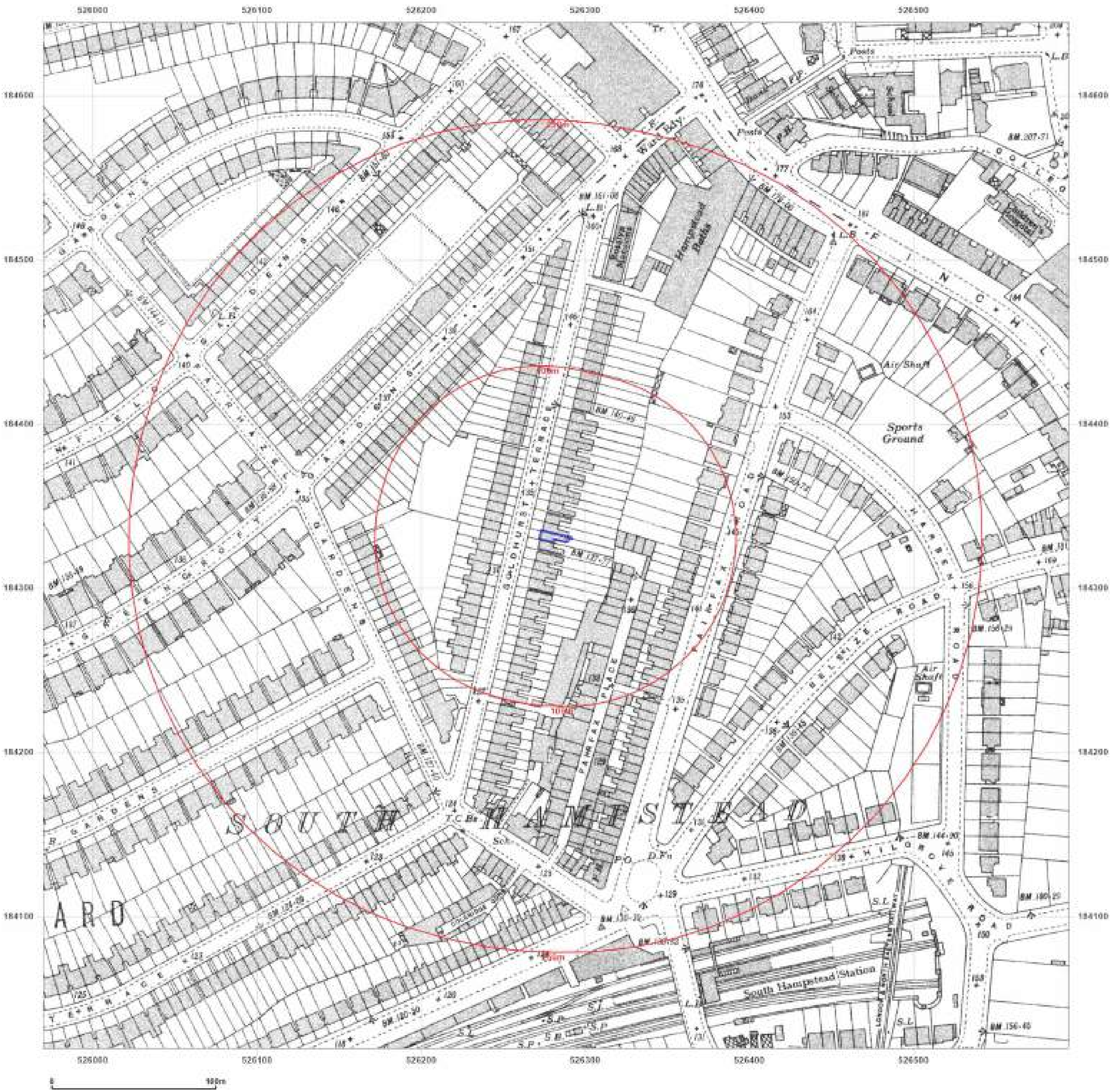

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Map Name: County Series

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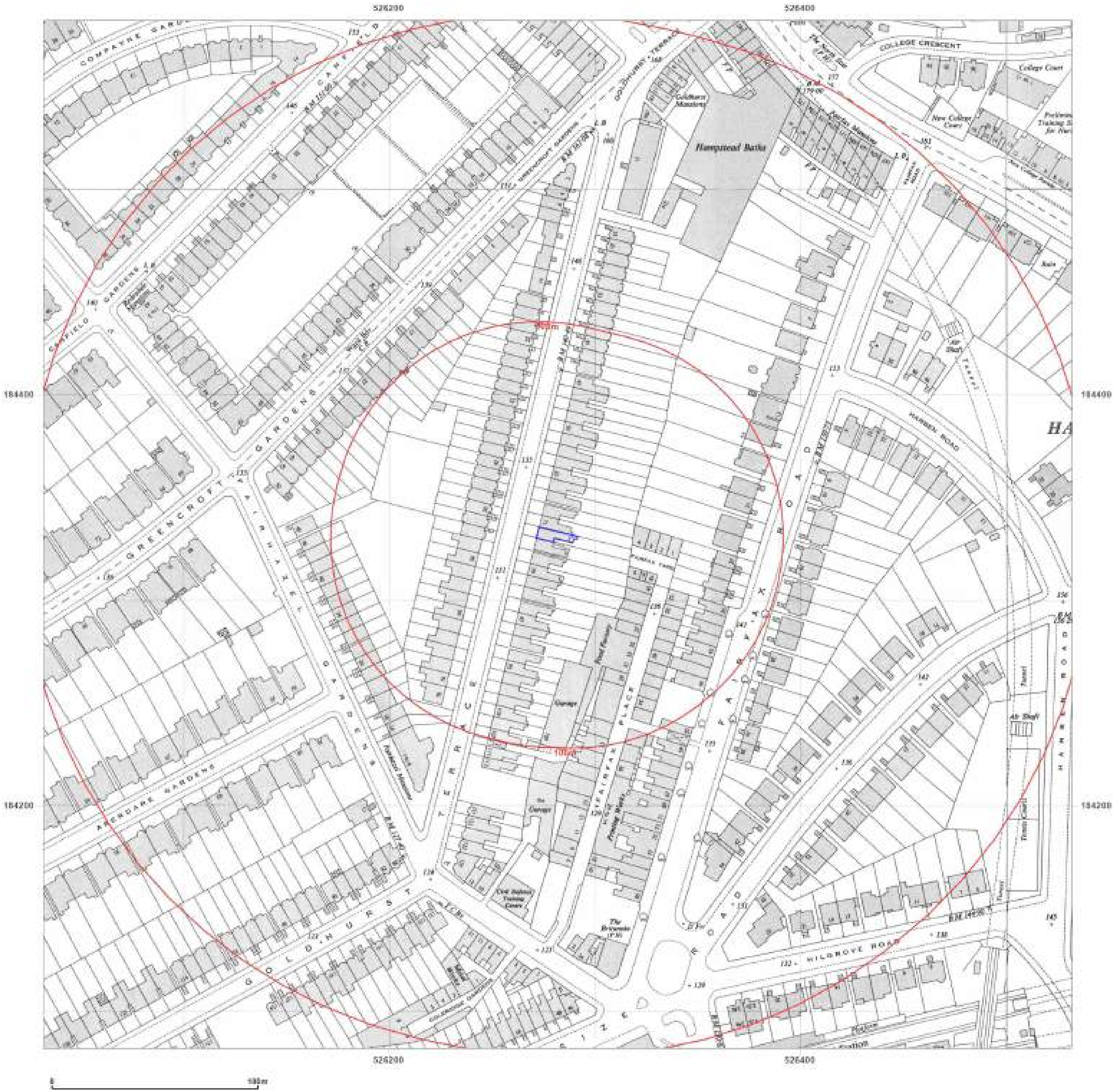

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Site Details:

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LONDON, NW6 3HA

Client Ref: A704
Report Ref: GS-8317459
Grid Ref: 526282, 184332

Map Name: National Grid

Map date: **1953**

Scale: 1:1,250

Printed at: 1:2,000

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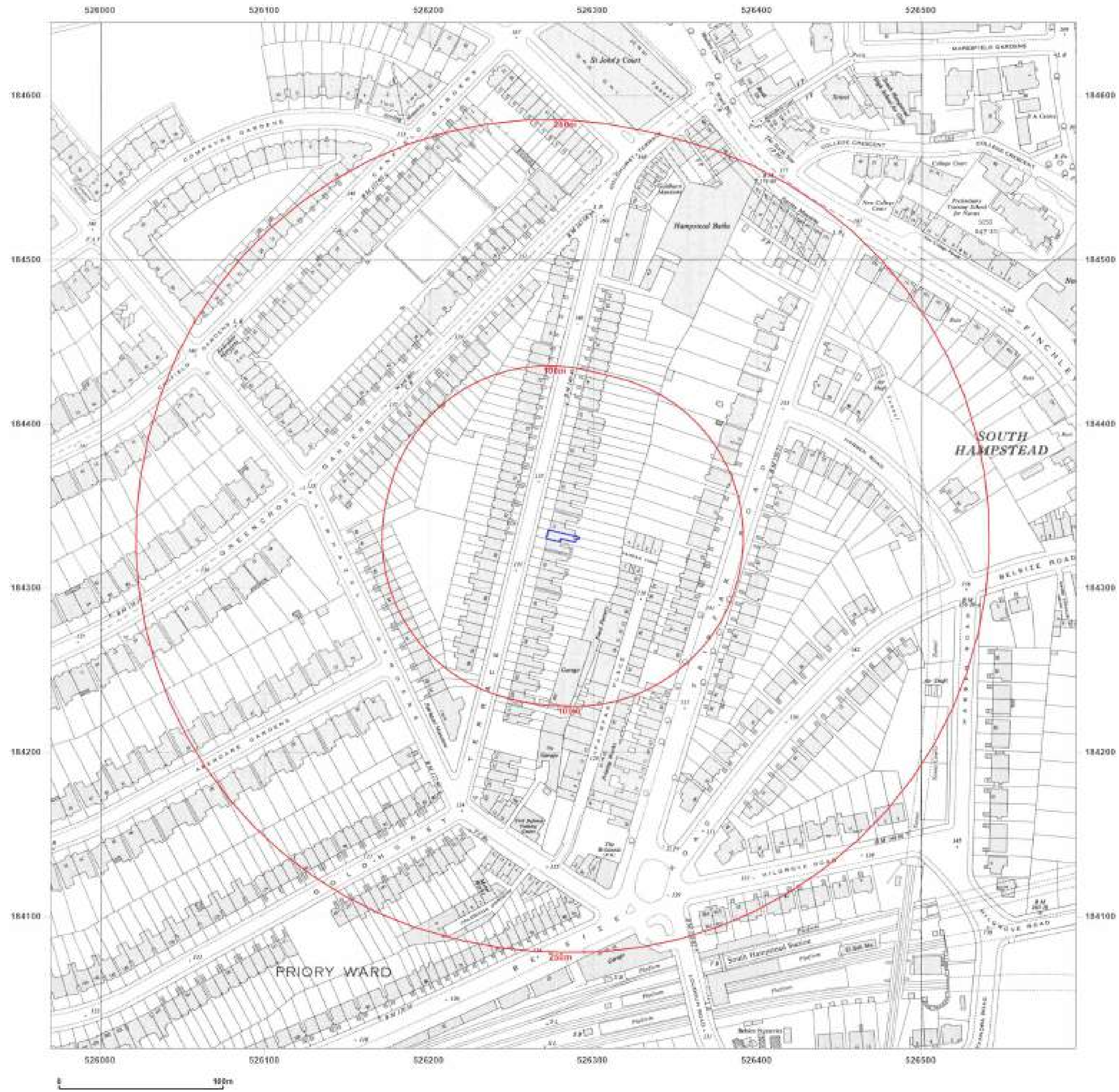

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Site Details:

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Client Ref: A704
Report Ref: GS-8317459
Grid Ref: 526282, 184332

Map Name: National Grid

Map date: **1955**

Scale: 1:2,500

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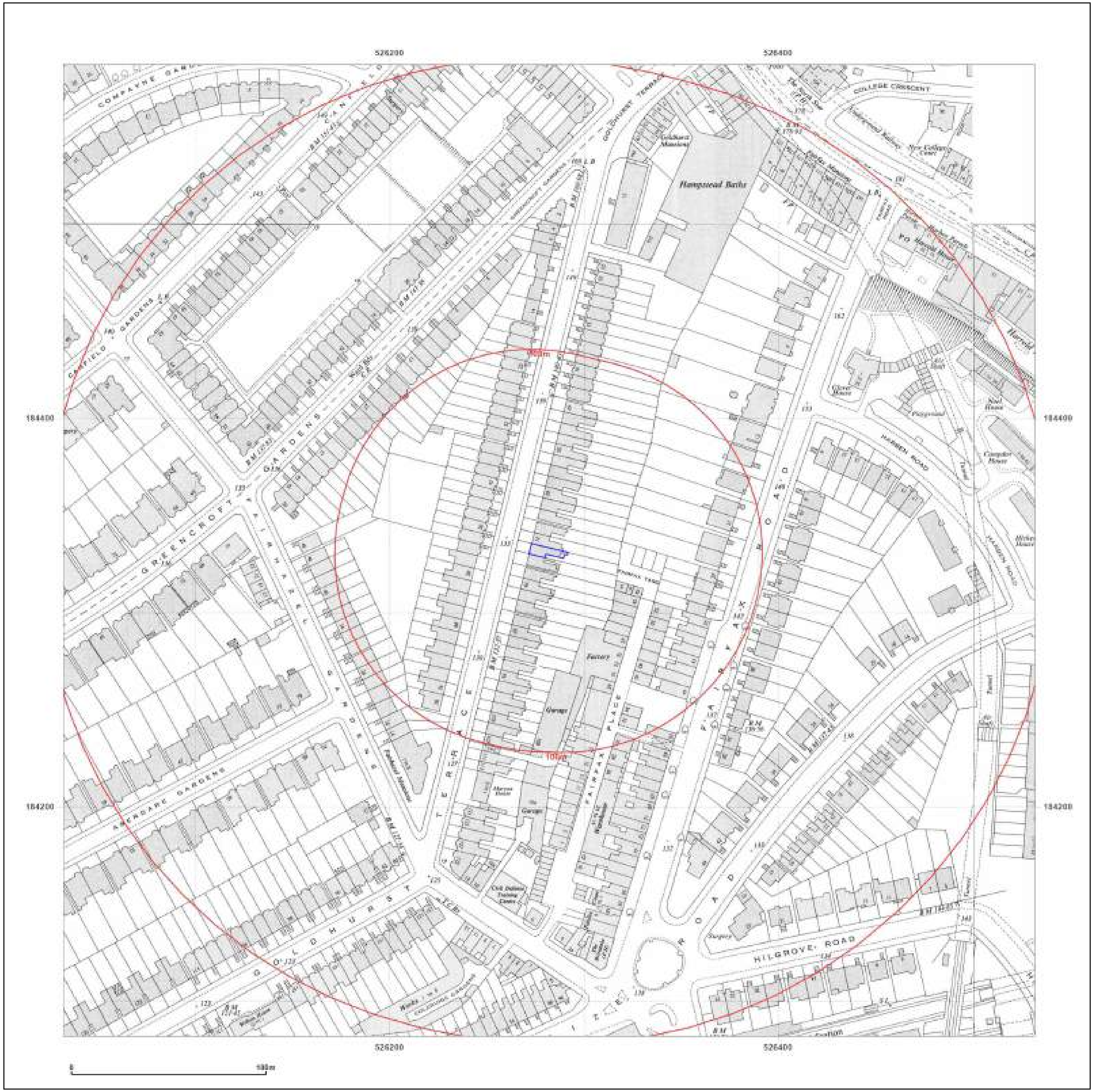

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Report Ref: GS-8317459
Grid Ref: 526282, 184332

Map Name: National Grid

Map date: **1960-1962**

Scale: 1:1,250

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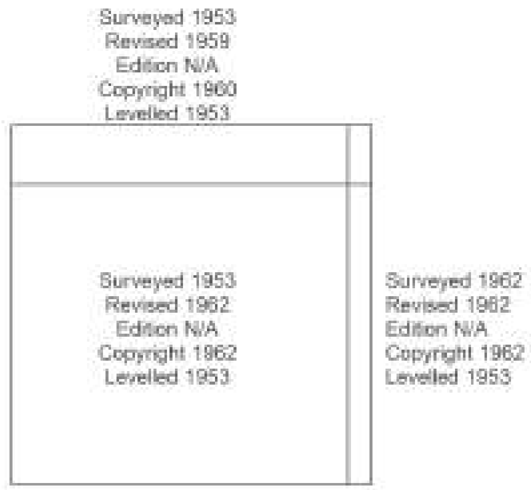

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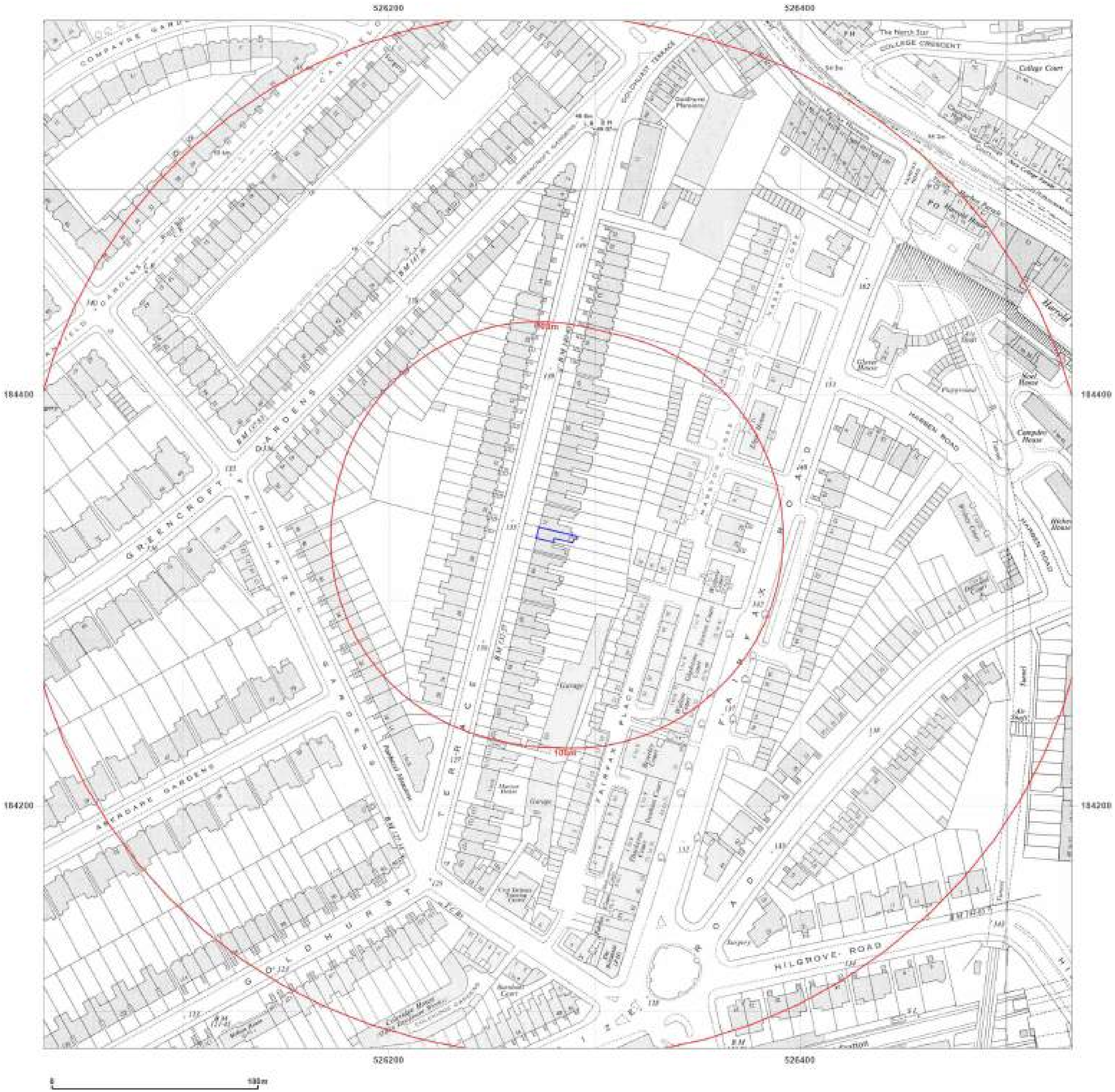

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Client Ref: A704
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Grid Ref: 526282, 184332

Map Name: National Grid

Map date: **1967-1971**

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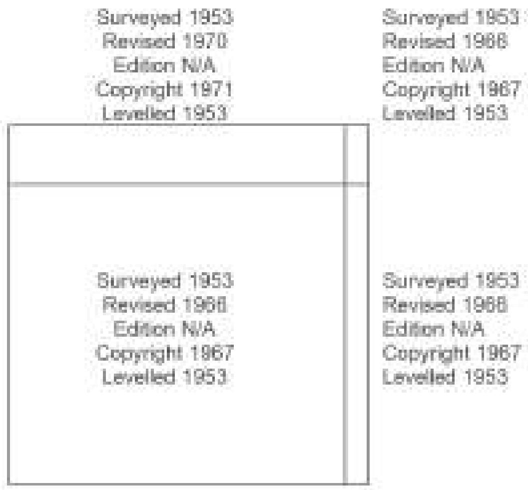

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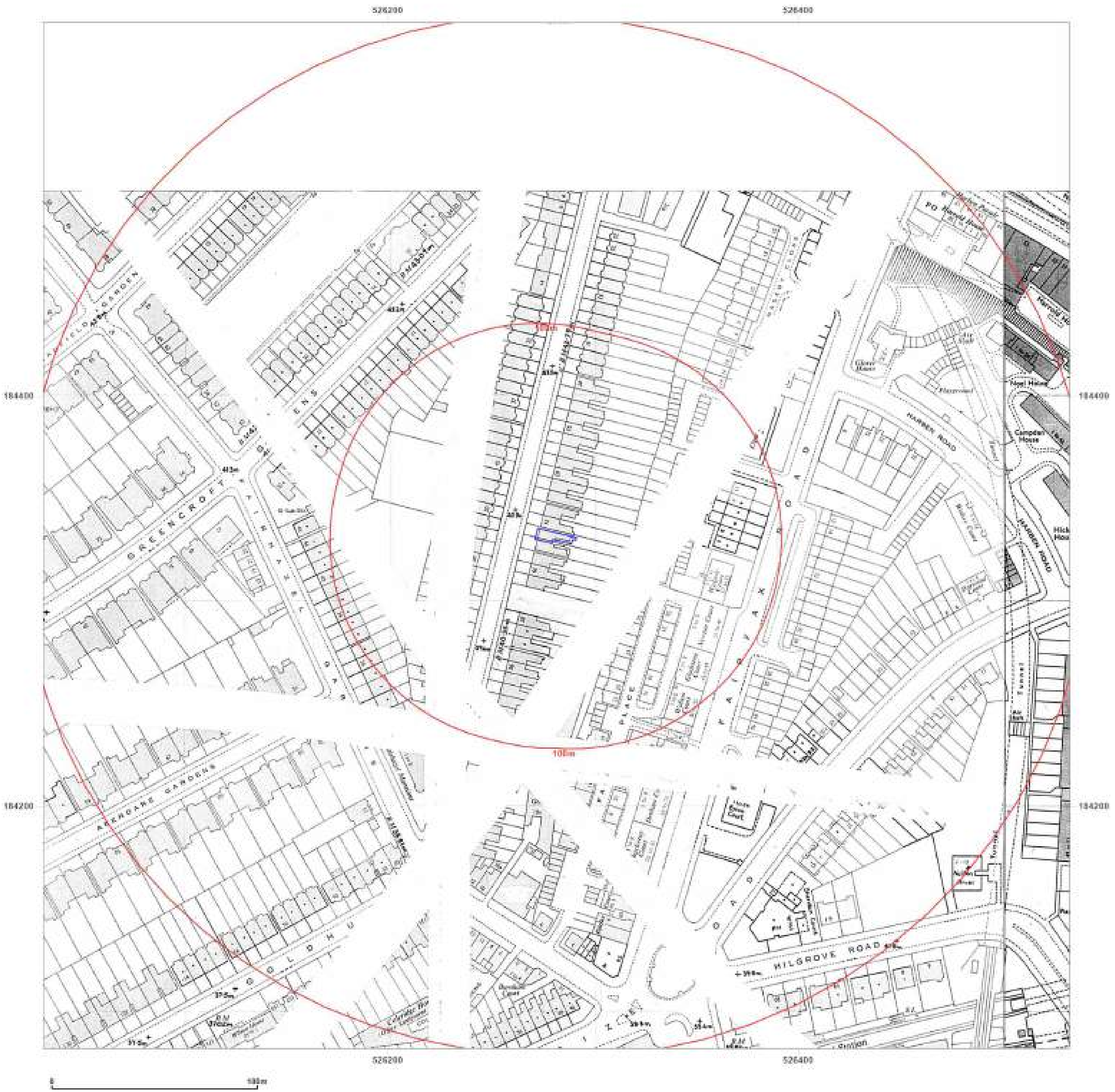

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Client Ref: A704
Report Ref: GS-8317459
Grid Ref: 526282, 184332

Map Name: National Grid

Map date: **1979-1983**

Scale: 1:1,250

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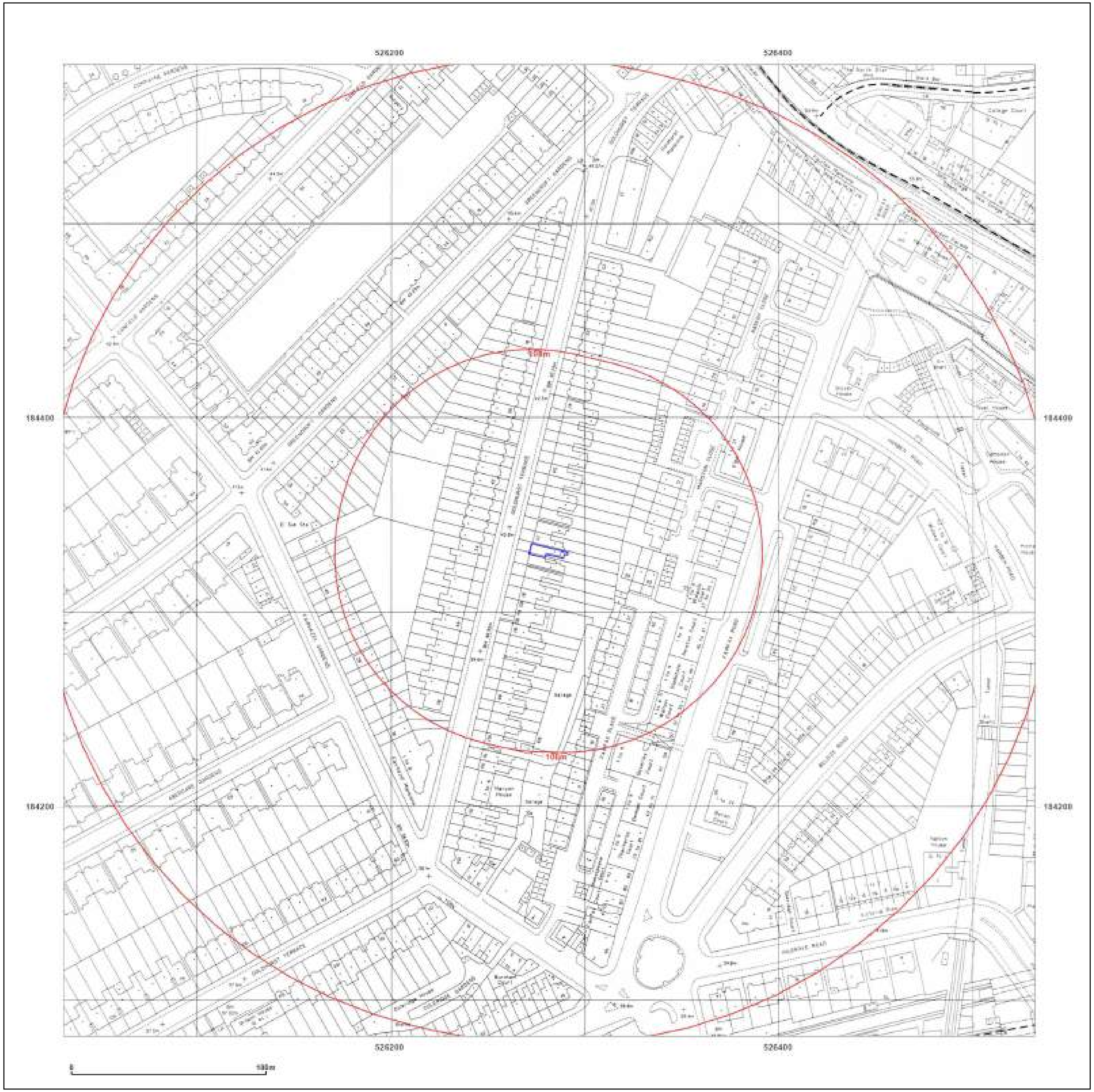

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Map Name: National Grid

Map date: **1991**

Scale: 1:1,250

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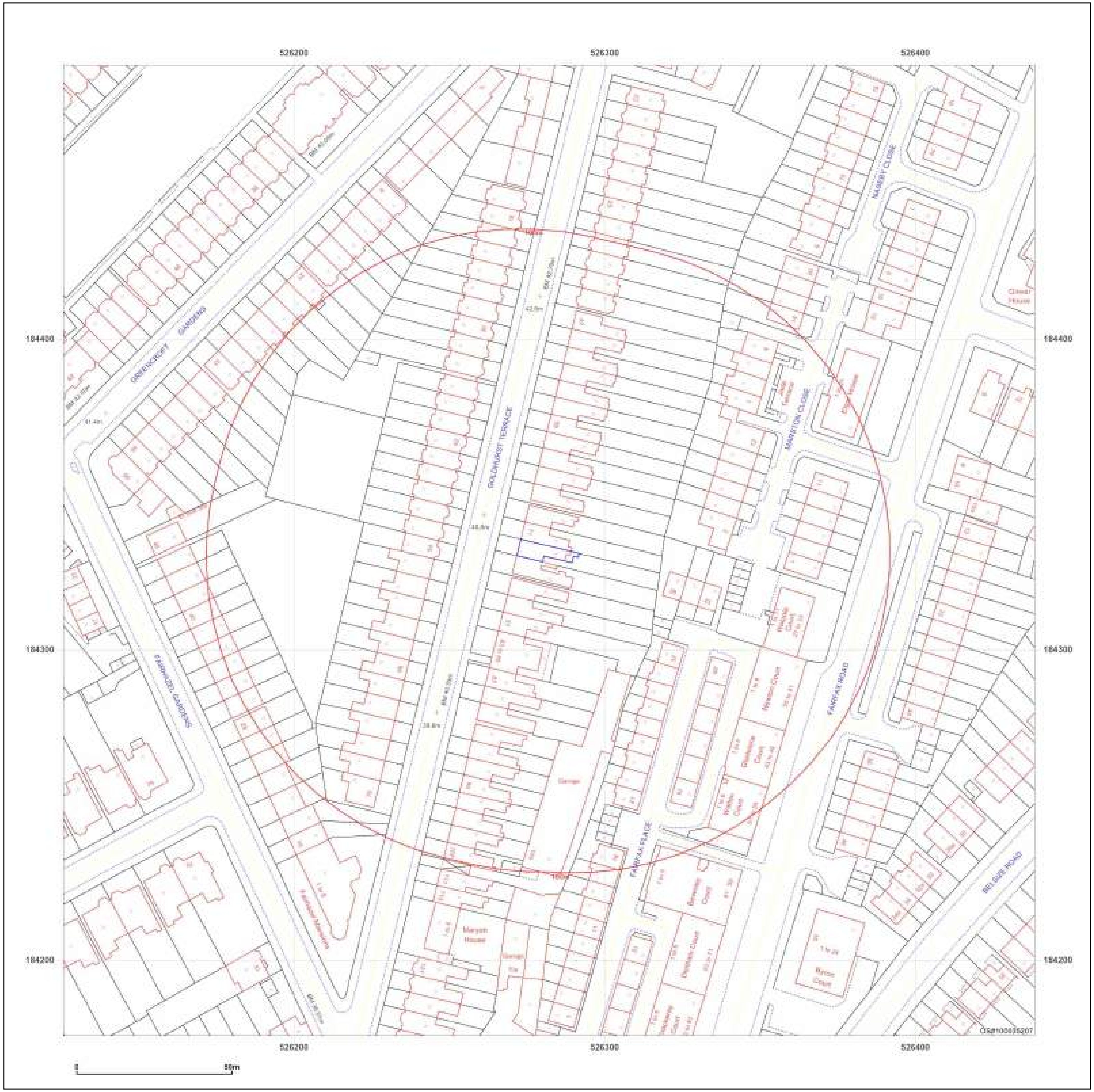

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LONDON, NW6 3HA

Client Ref: A704
Report Ref: GS-8317459
Grid Ref: 526282, 184332

Map Name: LandLine

Map date: **2003**

Scale: 1:1,250

Printed at: 1:1,250

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FACTUAL GROUND INVESTIGATION REPORT

for the site at

73 GOLDHURST TERRACE, LONDON BOROUGH OF CAMDEN, LONDON NW6 3HA

on behalf of

XINCHEN GAO & KAIFENG CHEN C/O CROFT STRUCTURAL ENGINEERS

<table>
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<tr><td rowspan="2">V1.01 October 2019</td><td></td><td></td></tr>
<tr><td>Robin Gledhill MSci (Hons)
Geotechnical & Geo-Environmental Engineer</td><td>Francis Williams M.Geol. (Hons) FGS Cgeol CEnv AGS
Director</td></tr>
<tr><td colspan="3">File Reference: Ground and Water/Project Files/
GWPR3316 73 Goldhurst Terrace, London Borough of Camden, London NW6 3HA</td></tr>
</table>

CONTENTS

FIGURES

APPENDICES

1.0 INTRODUCTION

1.1 General

Ground and Water Limited were instructed by Xinchen Gao & Kaifeng Chen c/o Croft Structural Engineers, on the 10th September 2019, to undertake a Ground Investigation on 73 Goldhurst Terrace, London Borough of Camden, London NW6 3HA. The scope of the investigation was detailed within the Ground and Water Limited fee proposal ref.: GWQ4932 dated 6th September 2017

1.2 Aims of the Investigation

The aim of the investigation was understood to be to supply the client and their designers with factual information regarding the ground conditions underlying the site to assist them in preparing an appropriate scheme for development.

A Desk Study and full-scale geotechnical and contamination assessment were not part of the remit of this report.

The techniques adopted for the investigation were chosen considering the anticipated ground conditions and development proposals on-site, and bearing in mind the nature of the site, limitations to site access and other logistical limitations.

1.3 Conditions and Limitations

This report has been prepared based on the terms, conditions and limitations outlined within Appendix A.

2.0 SITE SETTING

2.1 Site Location

The site comprised a ~300m^2 rectangular shaped plot of land oriented north-west to south-east, located to the east of Goldhurst Terrace, ~170m north of its junction with Fairhazel Gardens. The site was located in South Hampstead area of the London Borough of Camden, north-west London.

The national grid reference for the centre of the site was approximately TQ 26294 84327. A site location plan is given within Figure 1. A plan showing the boundary of the site is provided in Figure 2.

2.2 Site Description

The site comprised a three-storey, terraced residential house with a basement and rear extension. There was noted to be a private rear garden with areas of soft landscaping and a concrete hardstanding driveway at the front of the house with a small amount of soft landscaping planting. An aerial view of the site is provided within Figure 3.

2.3 Proposed Development

At the time of reporting, October 2019, it was understood that the proposed development comprised the further extension to the rear of the building and the conversion of the loft space into a mezzanine floor for use as a study/home-office. There was no proposed change to the basement. The proposed development plan can be seen in Figures 4 and 5.

2.4 Geology

The BGS Geological Map (Solid and Drift) for the area (Sheet no. 256, North London) revealed the site was underlain by bedrock deposits of the London Clay Formation. No superficial deposits were shown to be present onsite. No areas of Made Ground or Worked Ground were noted within a 250m radius of the site.

London Clay Formation

The London Clay Formation comprises stiff grey fissured clay, weathering to brown near surface. Concretions of argillaceous limestone in nodular form (Claystones) occur throughout the formation. Crystals of Gypsum (Selenite) are often found within the weathered part of the London Clay Formation, and precautions against sulphate attack to concrete are sometimes required. The lowest part of the formation is a sandy bed with black rounded gravel and occasional layers of sandstone and is known as the Basement Bed.

A BGS borehole (TQ28SE895) located ~280m east of the site, in similar geology, revealed 0.76m of Made Ground, underlain by a stiff brown clay with sulphate crystals to a depth of 7.62m bgl. A stiff to very stiff grey silty clay was noted for the remaining depth of the borehole, a depth of 12.19m bgl. No groundwater was encountered within the borehole.

2.4 Hydrogeology and Hydrology

A study of the aquifer maps on the DEFRA website revealed the site was underlain by **Unproductive Strata**, associated with the deposits of the London Clay Formation. No designation was given for superficial deposits due to their likely absence**.**

Superficial (Drift) deposits are permeable unconsolidated (loose) deposits, for example, sands and gravels. The bedrock is described as solid permeable formations e.g. sandstone, chalk and limestone.

Unproductive Strata are rock layers with low permeability that have negligible significance for water supply or river base flow. These were formerly classified as non-aquifers.

Examination of the DEFRA website showed that the site **was not** located within a Groundwater Source Protection Zone (SPZ) as classified in the Policy and Practice for the Protection of Groundwater. An **Outer Zone (Zone II)** SPZ was noted ~270m east/south-east of the site.

An Outer Zone (Zone II) Groundwater Source Protection Zone is defined by a 400-day travel time from a point below the water table. The previous methodology gave an option to define SPZ2 as the minimum recharge area required to support 25 per cent of the protected yield. This option is no longer available in defining new SPZs and instead this zone has a minimum radius of 250 or 500 metres around the source, depending on the size of the abstraction.

There were no surface water features within a 250m radius of the site location. The nearest surface water feature was the Regent's Canal, ~1.52km south-east of the site.

From analysis of hydrogeological and topographical maps, groundwater was anticipated to be encountered at depth (>10m bgl). Perched water may be present within any Made Ground and / or within silt and sand pockets of the London Clay Formation.

It was considered that the groundwater was flowing in a easterly/south-easterly direction towards the Zone II Groundwater Source Protection Zone.

Examination of the Environment Agency records showed that the site was situated within a **Flood Zone 1**, i.e. an area with low probability of flooding.

2.5 Radon

BRE 211 (2015) Map 5 of the London, Sussex and west Kent area revealed the site was located within an area where mandatory protection measures against the ingress of Radon were **unlikely to be** required. The site **was not** located within an area where a risk assessment was required.

3.0 FIELDWORK

3.1 Scope of Works

Fieldwork was undertaken on the 13th Sebtember 2019 and comprised the excavation of 3No. Trial Pit Foundation Exposures (TP/FE2 – TP/FE4). TP/FE3 and TP/FE4 were undertaken externally at ground level, and TP/FE2 was undertaken internally within the existing basement. The proposed location of TP/FE1 could not be undertaken due to the presence of an air raid shelter. The foundation exposures were undertkan to depths of between 0.35 – 0.40m bgl (below ground level) in TP/FE3 – TP/FE4 and 0.50 bbl (below basement level) in TP/FE2. Site works also included the drilling of 1No. Windowless Sampler Borehole (WS1) at the front of the property to a depth of 8.45m bgl. The approximate locations of the trial pits and boreholes can be seen within Figures 6 and 7.

The sections of the foundation exposures can be seen within Figures 8 – 10.

Prior to commencing the ground investigation, a walkover survey was carried out to identify the presence of underground services and drainage. Where underground services/drainage were suspected and/or positively identified, exploratory positions were relocated away from these areas.

Upon completion of the site works, the trial holes were backfilled and made good/reinstated in relation to the surrounding area.

3.2 Sampling Procedures

Small disturbed samples were recovered from the trial holes at the depths shown on the trial hole records. Soil samples were generally retrieved from each change of strata and/or at specific areas of concern. Samples were also taken at approximately 0.5m intervals during broad homogenous soil horizons.

A selection of samples were despatched for geotechnical testing purposes.

4.0 ENCOUNTERED GROUND CONDITIONS

4.1 Soil Conditions

All exploratory holes were logged by Robin Gledhill of Ground and Water Limited generally in accordance with BS EN 14688 'Geotechnical Investigation and Testing – Identification and Classification of Soil'.

The ground conditions encountered within the trial pits and boreholes constructed on the site generally did conform to those anticipated from examination of the geology map. A capping of Made Ground was noted to overlie bedrock deposits of the London Clay Formation.

The ground conditions encountered during the investigation are described in this section. For more complete information about the Made Ground and the natural ground at particular points, reference must be made to the individual trial hole logs within Appendix B.

The trial hole location plan can be viewed in Figures 6 and 7.

For the purposes of discussion, the succession of conditions encountered in descending order can be summarised as follows:

Concrete (All Trial Holes)
Made Ground (All Trial Holes)
London Clay Formation (WS1 only)

Made Ground

Made Ground was present within all trail holes, underlying 0.05 – 0.15m of concete, to a proved depth of 0.70m bgl within WS1 and to the base of TP/FE2 – TP/FE4, depths of between 0.30 – 0.40m bgl and 0.60m bbl. The Made Ground comprised a mixture of cohesive and granular soils.

The cohesive soils were encoiuntered within WS1, TP/FE2 and TP/FE4 and comprised mid-brown to grey-brown slightly sandy gravelly silty clay. The sand was fine to coarse grained. The gravel was fine to coarse, angular to rounded flint, concrete, brick and coal fragments.

The granular soils were encountered within TP/FE3 and comprised orange-brown gravelly sand. The sand was fine to coarse grained. The gravel was fine to medium, sub-angular to rounded flint.

London Clay Formation

Soils described as representative of the London Clay Formation were recorded below the Made Ground in WS1 for the remaining depth of the borehole, a depth of 8.45m bgl. The soils generally comprised a mid-brown to grey-brown (locally slightly sandy) silty clay. The sand was fine grained and was concentrated within lenses/partings within WS1 between 2.50 – 4.00m bgl. Rare, fine to medium selenite crystals were noted in WS1 from 2.50m bgl – 8.45m bgl. Claystone nodules were noted at 8.00m bgl.

For details of the composition of the soils encountered at particular points, reference must be made to the individual trial hole logs within Appendix B.

4.2 Foundation Exposures

A description of the foundation layout and ground conditions encountered within the trial pit foundation exposures is given within this section of the report.

TP/FE2

Within Basement – South-East Corner

Trial pit foundation exposure TP/FE2 was excavated internally in the south-western corner of the existing basement (rear wall). The exact location of the trial hole can be seen in Figure 7, and a section drawing of the foundation encountered during TP/FE2 can be seen in Figure 8.

The foundation exposure was measured from basement floor level.

The foundation layout encountered consisted of a concrete wall to basement floor level which continued to 0.35m bbl and rested on a brick footing which extended to a depth of 0.50m bbl. The foundation was resting on soils described as Made Ground, which comprised a mid-brown to grey-brown slightly sandy gravelly silty clay. The sand was fine to coarse grained. The gravel was fine to coarse, angular to sub-rounded, brick, concrete, flint and coal fragments.

The complete ground conditions encountered directly surrounding the foundation are shown in Figure 8.

TP/FE3

Front of building – South-east corner

Trial pit foundation exposure TP/FE3 was excavated by the south-western corner of the front wall of the existing property. The exact location of the trial hole can be seen in Figure 6 and a section drawing of the foundation encountered during TP/FE3 can be seen in Figure 9.

The foundation exposure was measured from ground level.

The foundation layout encountered consisted of a brick wall to ground level which continued to 0.10m bgl and rested on a concrete footing which stepped out by 0.10m and extended to a depth of 0.40m bgl. The foundation exposure could not be extending past 0.40m bgl due to the presence of a concrete obstruction.

The complete ground conditions encountered directly surrounding the foundation are shown in Figure 9.

TP/FE4

Front of building – South-east corner

Trial pit foundation exposure TP/FE4 was excavated by the south-eastern corner of the rear wall of the existing property. The exact location of the trial hole can be seen in Figure 6 and a section drawing of the foundation encountered during TP/FE4 can be seen in Figure 10.

The foundation exposure was measured from ground level.

The foundation layout encountered consisted of a brick wall to ground level which continued to 0.10m bgl, and rested on a concrete foundation which stepped out by 0.20m and extended to a depth of 0.30m bgl. The foundation was resting on soils described as Made Ground, which comprised a mid-brown slightly sandy slightly gravelly silty clay. The sand was fine to coarse grained. The gravel is fine, sub-angular to sub-rounded, flint and brick.

The complete ground conditions encountered directly surrounding the foundation are shown in Figure 10.

4.3 Roots Encountered

The depth of root penetration for each trial hole is tabulated below.

Root Penetration Depth ***Add depth of trial holes?***		
Trial Hole	**Fresh Root Depth (m bgl)**	**Other**
WS1	3.00	Black decaying roots were noted at 3.50m bgl.
TP/FE2	None	None
TP/FE3	None	None
TP/FE4	>0.35	None

It must be noted that the chance of determining actual depth of root penetration through a narrow diameter borehole is low. Roots may be found to greater depths at other locations on the site, particularly close to trees and/or trees that have been removed both within the site and its close environs.

4.4 Groundwater Conditions

No groundwater was encountered within the trial holes.

Exact groundwater levels may only be determined through long term measurements from monitoring wells installed on-site. It should be noted that changes in groundwater level do occur for a number of reasons including seasonal effects and variations in drainage.

The site investigation was conducted in September 2019, when groundwater levels should be close to their annual minimum (i.e. lowest elevation). The long-term groundwater elevation might decrease at some time in the future due to seasonal fluctuation in weather conditions. Isolated pockets of groundwater may be perched within any Made Ground found at other locations around the site.

4.5 Obstructions

The proposed location of TP/FE1 could not be undertaken due to the presence of an air raid shelter, TP/FE3 was refused on a concrete obstruction at 0.40m bgl; it was considered that this may have been the roof of the air raid shelter.

No other artificial or natural obstructions were encountered during the excavation / drilling of the trial holes.

5.0 IN-SITU AND LABORATORY GEOTECHNICAL TESTING

5.1 In-Situ Geotechnical Testing

5.1.1 Standard Penetration Tests (SPTs)

Standard Penetration Testing was undertaken within WS1 at 1.00m intervals to the base of the borehole. The results of the SPT's have not been amended to take into account hammer efficiency, rod lengths and overburden pressure in accordance with Eurocode 7. The test results are presented on the borehole logs within Appendix C.

Windowless Sampler Boreholes provide samples of the ground for assessment but they do not give any engineering data. The standard penetration test (SPT) is an in-situ dynamic penetration test designed to provide information on the geotechnical engineering properties of soil. The test uses a thick-walled sample tube, with an outside diameter of 50 mm and an inside diameter of 35 mm, and a length of around 650mm. This is driven into the ground at the bottom of a borehole by blows from a slide hammer with a weight of 63.5 kg falling through a distance of 760 mm. The sample tube is driven 150 mm into the ground and then the number of blows needed for the tube to penetrate each 75 mm up to a depth of 450 mm is recorded. The sum of the number of blows is termed the "standard penetration resistance" or the "N-value".

The cohesive soils of the London Clay Formation underlying the site were classified based on the table below.

Undrained Shear Strength from Field Inspection/ SPT results Cohesive Soils (EN ISO 14688-2:2004 & Stroud (1974))		
Classification	**Undrained Shear Strength (kPa)**	**Field Indications**
Extremely High	>300	-
Very High	150 – 300	Brittle or very tough
High	75 – 150	Cannot be moulded in the fingers
Medium	40 – 75	Can be moulded in the fingers by strong pressure
Low	20 – 40	Easily moulded in the fingers
Very Low	10 – 20	Exudes between fingers when squeezed in the fist
Extremely Low	<10	-

An interpretation of the in-situ geotechnical testing results is given in the table below.

Interpretation of In-situ Geotechnical Testing Results				
Strata	**SPT "N" Blow Counts**	**Equivalent Undrained Shear Strength (kPa) Cohesive Soils (After Stroud 1974)**	**Soil Type** **Cohesive (Undrained Shear Strength Classification)**	**Trial Hole/s**
London Clay Formation (Cohesive Soils)	6 – 8 13 – 31	30 – 40 65 – 155	Low – Low/Medium Medium – Very High	WS1 (0.70 – 2.50m bgl) WS1 (2.50 – 8.45m bgl)

It must be noted that field measurements of undrained shear strength are dependent on a number of variables including disturbance of sample, method of investigation and also the size of specimen or test zone etc.

5.2 Laboratory Geotechnical Testing

A programme of geotechnical laboratory testing scheduled by Ground and Water Limited and carried out by K4 Soils Laboratory and DETS Limited was undertaken on samples recovered from the London Clay Formation. The results of the tests are presented in Appendix C.

The test procedures used were generally in accordance with the methods described in BS1377:2016.

Details of the specific tests used in each case are given below.

Standard Methodology for Laboratory Geotechnical Testing		
Test	**Standard**	**Number of Tests**
Atterberg Limit Tests	BS1377:2016:Part 2:Clauses 3.2, 4.3 & 5	3
Water Soluble Sulphate & pH	BS1377:2016:Part 3:Clause 5	1
BRE Special Digest 1 (incl. pH, Total Sulphate, W/S Sulphate, Total Chlorine, W/S Chlorine, Total Sulphur, Ammonium as NH4, W/S Nitrate, W/S Magnesium)	BRE Special Digest 1 "Concrete in Aggressive Ground" (BRE, 2005).	2

5.2.1 Atterberg Limit Tests

A précis of Atterberg Limit Tests undertaken on three cohesive samples of the London Clay Formation can be seen tabulated below.

Atterberg Limit Tests Results Summary							
Stratum/Depth	**Moisture Content (%)**	**Passing 425 µm sieve (%)**	**Modified PI (%)**	**Soil Class**	**Consistency Index (Ic)**	**Volume Change Potential**	
						NHBC	**BRE**
London Clay Formation	30 - 33	100	41.0 – 46.0	CH - CV	0.80 – 0.88 (Stiff)	High	High

NB: NP – Non-plastic
BRE Volume Change Potential refers to BRE Digest 240 (based on Atterberg results)
Soil Classification based on British Soil Classification System.
Consistency Index (Ic) based on BS EN IS0 14688-2:2004.

5.2.2 Comparison of Soil's Moisture Content with Index Properties

5.2.2.1 Liquidity Index Analyses

The results of the Atterberg Limit tests undertaken on three samples of the London Clay Formation were analysed to determine the Liquidity Index of the samples. This gives an indication as to whether the samples recovered showed a moisture deficit and their degree of consolidation. The results are tabulated overleaf.

The test results are presented within Appendix C.

Liquidity Index Calculations Summary					
Stratum/Trial Hole/Depth	Moisture Content (%)	Plastic Limit (%)	Modified Plasticity Index (%)	Liquidity Index	Result
London Clay Formation **WS1/1.50m bgl** Lab description: Orangish brown slightly mottled grey silty CLAY.	33	24	46.0	0.20	Overconsolidated / Heavily Overconsolidated (boundary)
London Clay Formation **WS1/3.00m bgl** Lab description: Orangish brown slightly mottled grey silty CLAY with light grey fine sand pockets.	32	26	46.0	0.13	Heavily Overconsolidated
London Clay Formation **WS1/5.00m bgl** Lab description: Orangish brown slightly mottled grey silty CLAY with traces of selenite crystals.	30	25	41.0	0.12	Heavily Overconsolidated

Liquidity Index testing revealed no evidence for moisture deficit within any of the overconsolidated to heavily overconsolidated samples of the London Clay Formation tested.

5.2.2.2 Liquid Limit

A comparison of the soil moisture content and the liquid limit can be seen tabulated below.

Moisture Content vs. Liquid Limit				
Strata/Trial Hole/Depth/Soil Description	Moisture Content (MC) (%)	Liquid Limit (LL) (%)	40% Liquid Limit (LL)	Result
London Clay Formation **WS1/1.50m bgl** Lab description: Orangish brown slightly mottled grey silty CLAY.	33	70	28.0	MC > 0.4 x LL (No significant moisture deficit)
London Clay Formation **WS1/3.00m bgl** Lab description: Orangish brown slightly mottled grey silty CLAY with light grey fine sand pockets.	32	72	28.8	MC > 0.4 x LL (No significant moisture deficit)
London Clay Formation **WS1/5.00m bgl** Lab description: Orangish brown slightly mottled grey silty CLAY with traces of selenite crystals.	30	66	26.4	MC > 0.4 x LL (No significant moisture deficit)

The results in the table above indicated that the three samples of the London Clay Formation tested showed no evidence of a significant moisture deficit.

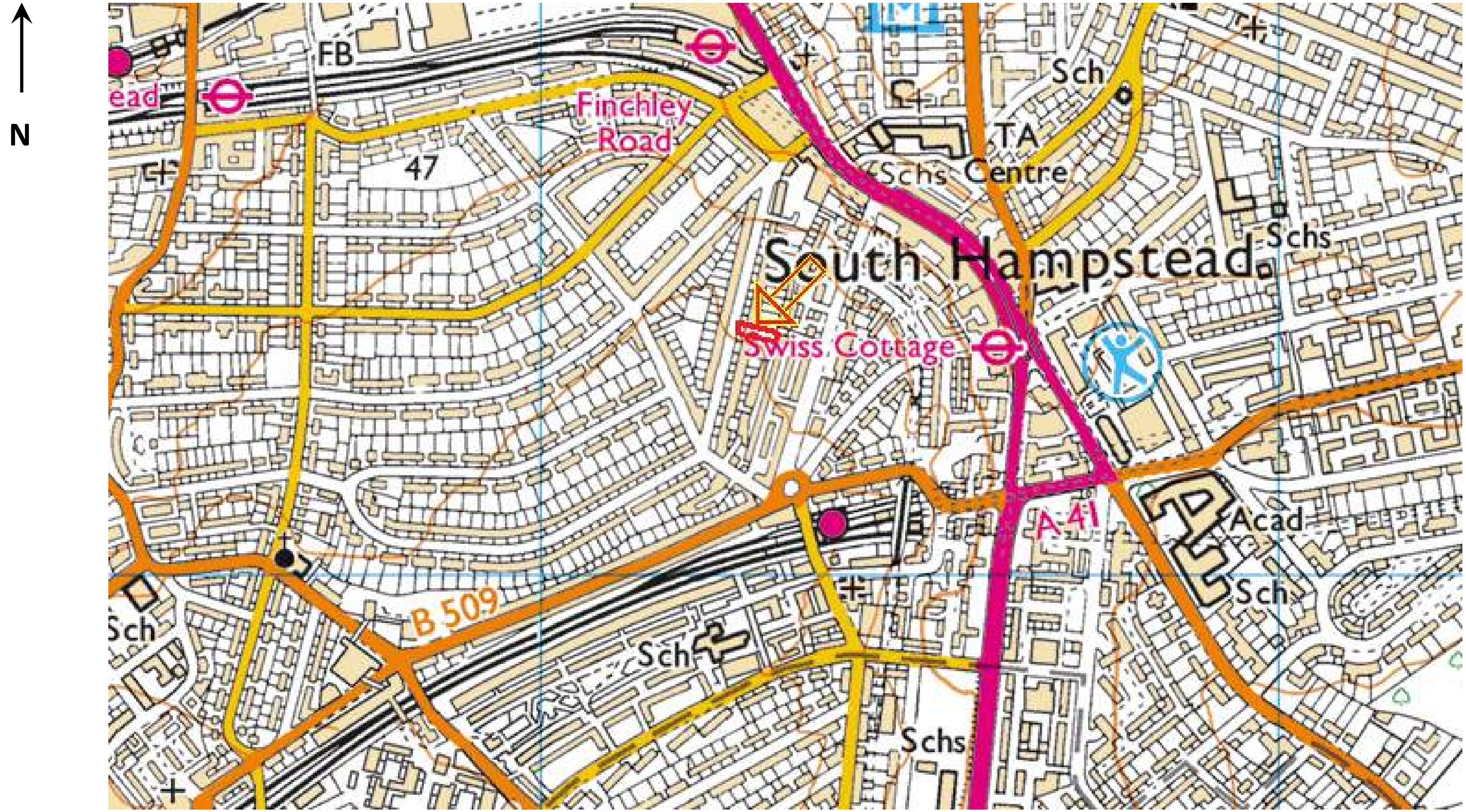
5.2.3 Sulphate and pH Tests

Water soluble sulphate and pH tests were undertaken on one sample of the London Clay Formation (WS1/2.00m bgl). The water-soluble sulphate concentration was found to be 640mg/l, with a pH of 7.38.

5.2.4 BRE Special Digest 1

In accordance with BRE Special Digest 1 ‘Concrete in Aggressive Ground’ (BRE, 2005) two samples of the London Clay Formation (WS1/1.00m bgl & WS1/4.00m bgl) were scheduled for laboratory analysis to determine parameters for concrete specification. The results are given within Appendix C and a summary is tabulated below.

Summary of Results of BRE Special Digest Testing			
Determinand	**Unit**	**WS1/1.00m**	**WS1/4.00m**
pH	-	8.1	7.6
Ammonium as NH_4	mg/kg	1.6	3.6
Sulphur	%	0.03	0.75
Chloride (water soluble)	mg/kg	14	62
Magnesium (water soluble)	mg/l	11	200
Nitrate (water soluble)	mg/kg	< 3	< 3
Sulphate (water soluble)	mg/l	164	3170
Sulphate (total)	mg/kg	754	20140



APPROXIMATE SITE BOUNDARY

NOTE: NOT TO SCALE

Project: 73 Goldhurst Terrace, London Borough of Camden, London NW6 3HA	**Figure 1**
Client: Xinchen Gao & Kaifeng Chen c/o Croft Structural Engineers	**Date:** October 2019
Site Location Plan	**Ref:** GWPR3316

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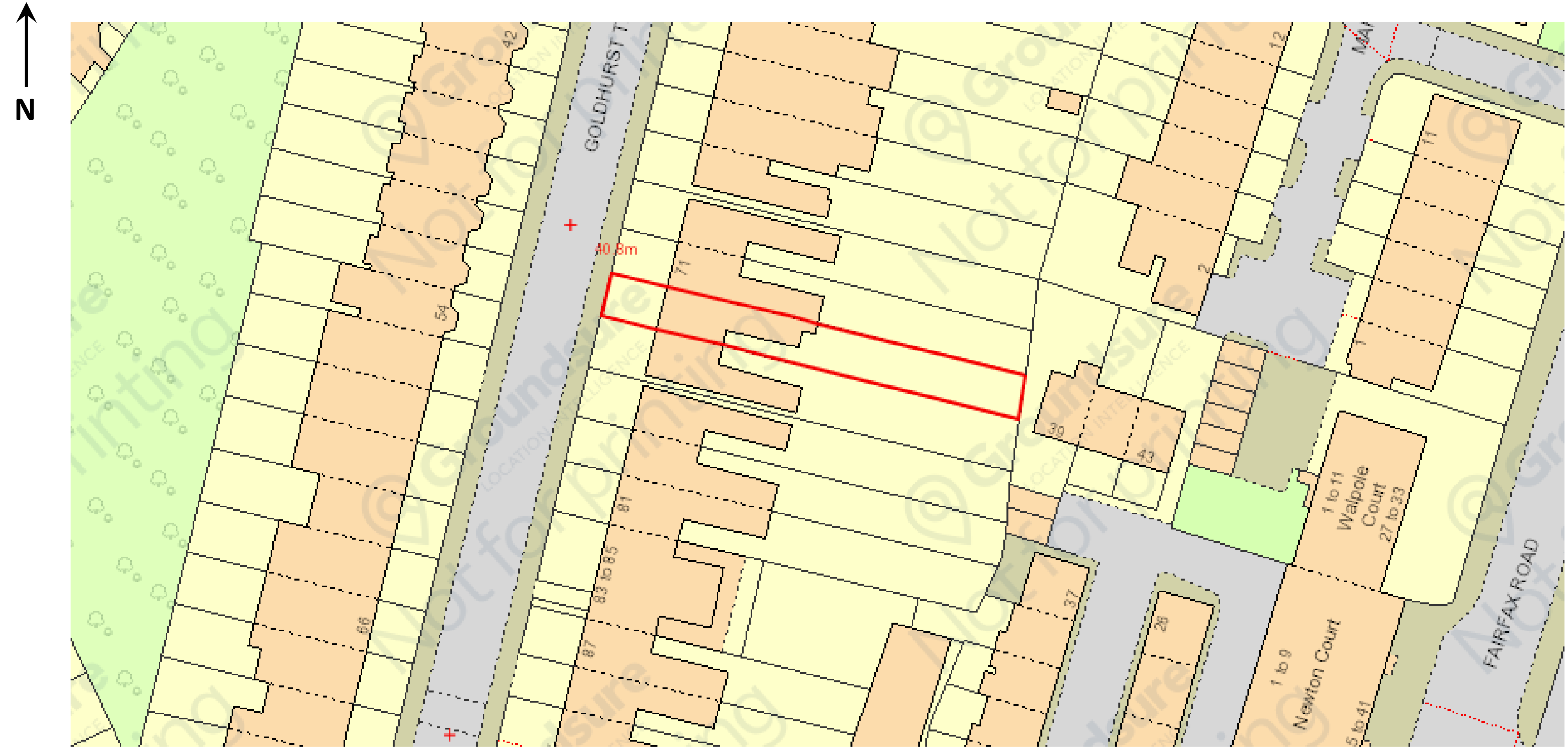


APPROXIMATE SITE BOUNDARY

NOTE: NOT TO SCALE

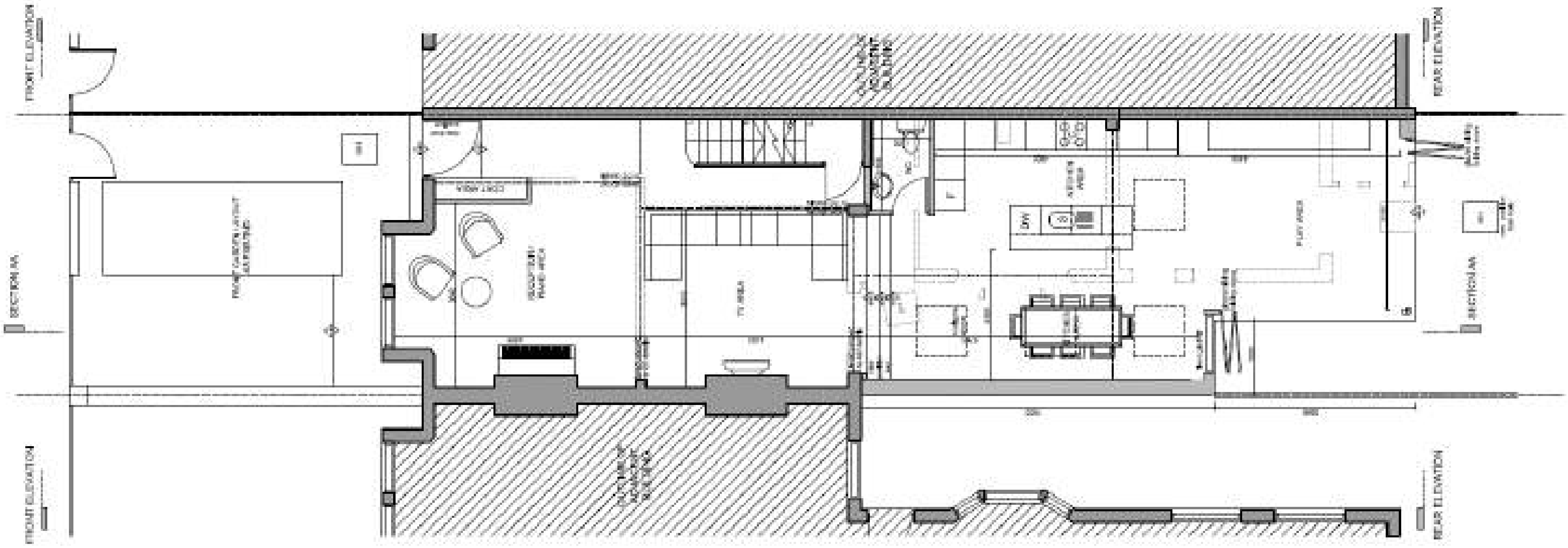
Project: 73 Goldhurst Terrace, London Borough of Camden, London NW6 3HA		Figure 2
Client: Xinchen Gao & Kaifeng Chen c/o Croft Structural Engineers	Date: October 2019	ground&water
Site Development Area	Ref: GWPR3316	

APPROXIMATE SITE BOUNDARY

NOTE: NOT TO SCALE

Project: 73 Goldhurst Terrace, London Borough of Camden, London NW6 3HA		Figure 3
Client: Xinchen Gao & Kaifeng Chen c/o Croft Structural Engineers	Date: October 2019	ground&water
Aerial View of Site	Ref: GWPR3316	

N

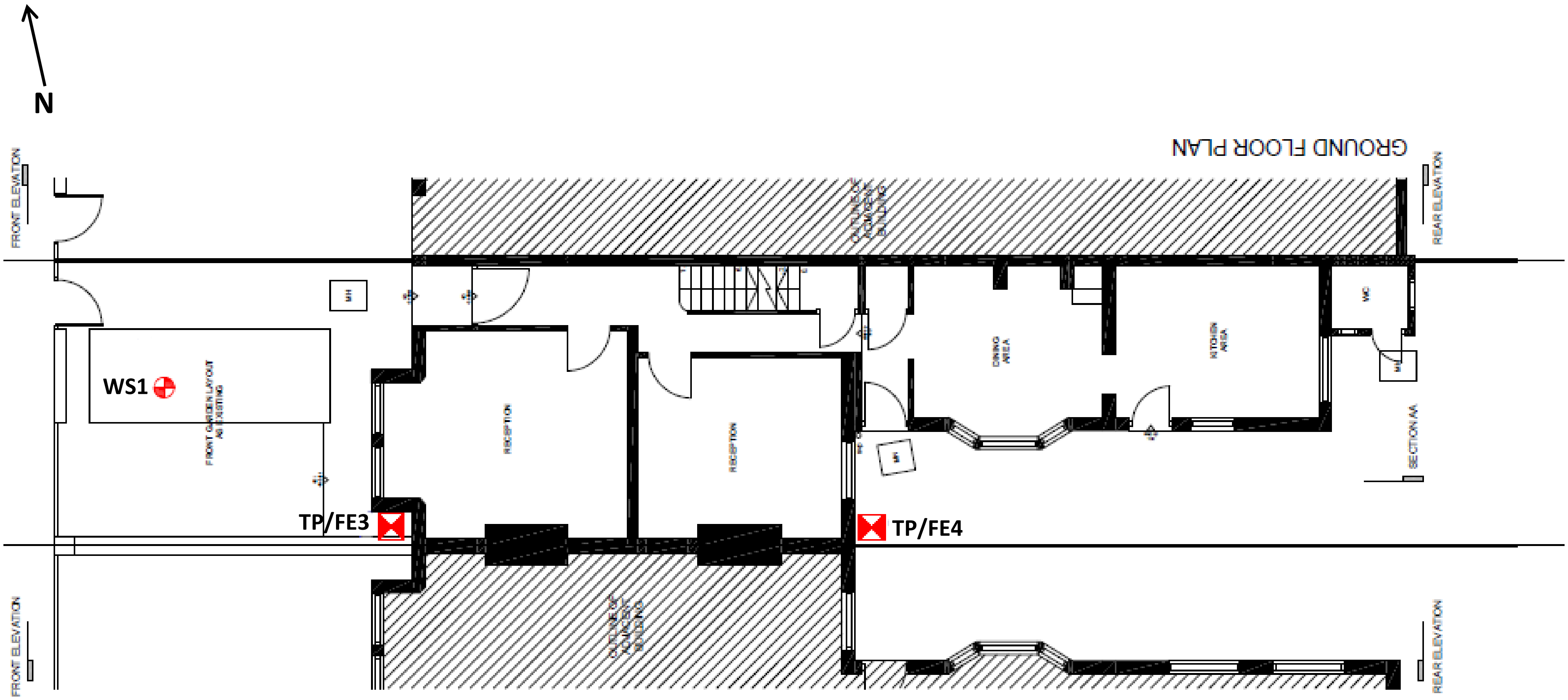


NOT TO SCALE

Project: 73 Goldhurst Terrace, London Borough of Camden, London NW6 3HA	**Figure 4**
Client: Xinchen Gao & Kaifeng Chen c/o Croft Structural Engineers — **Date:** October 2019	ground&water
Proposed Development – Plan View — **Ref:** GWPR3316	

NOT TO SCALE

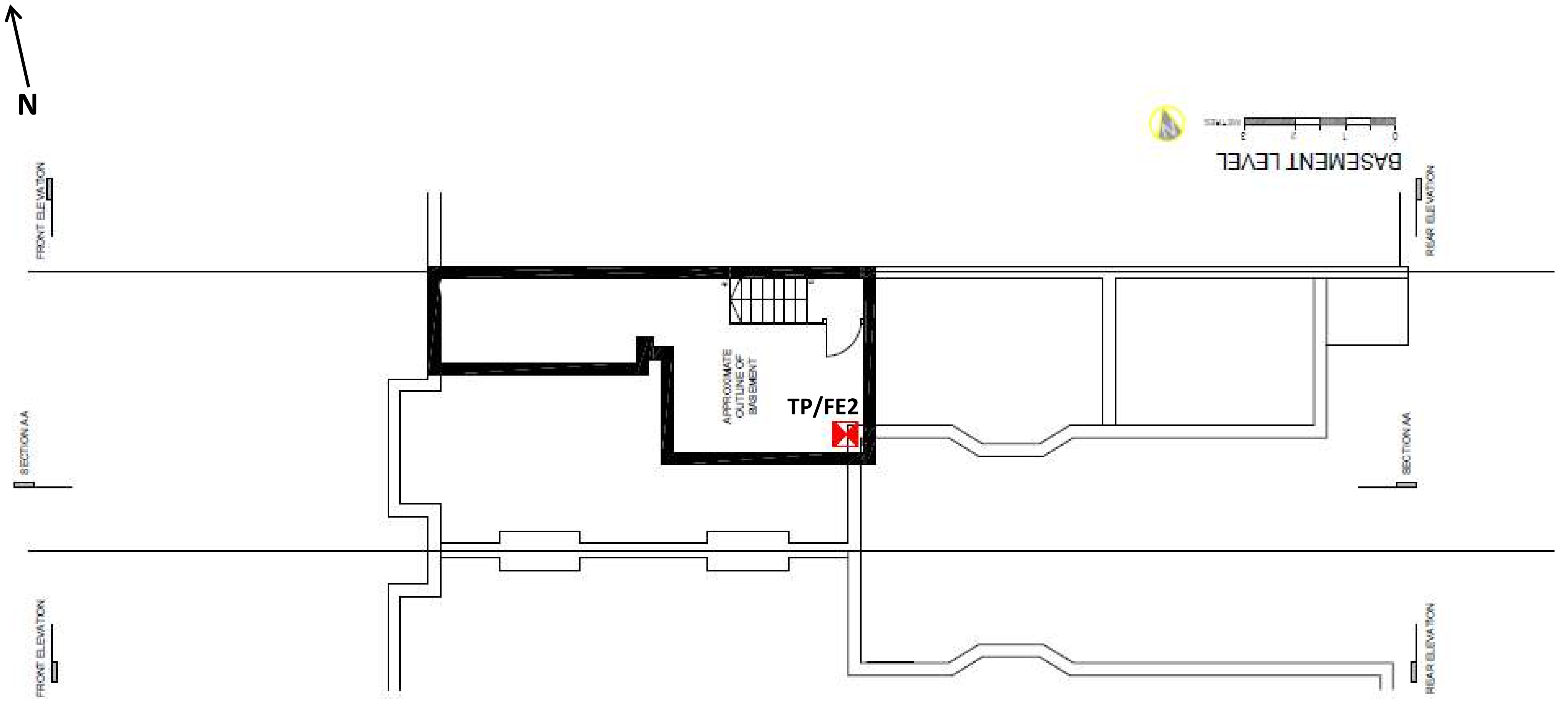
Project: 73 Goldhurst Terrace, London Borough of Camden, London NW6 3HA		**Figure 5**
Client: Xinchen Gao & Kaifeng Chen c/o Croft Structural Engineers	**Date:** October 2019	ground&water
Proposed Development – Section View	**Ref:** GWPR3316	



APPROXIMATE SITE BOUNDARY

NOTE: NOT TO SCALE

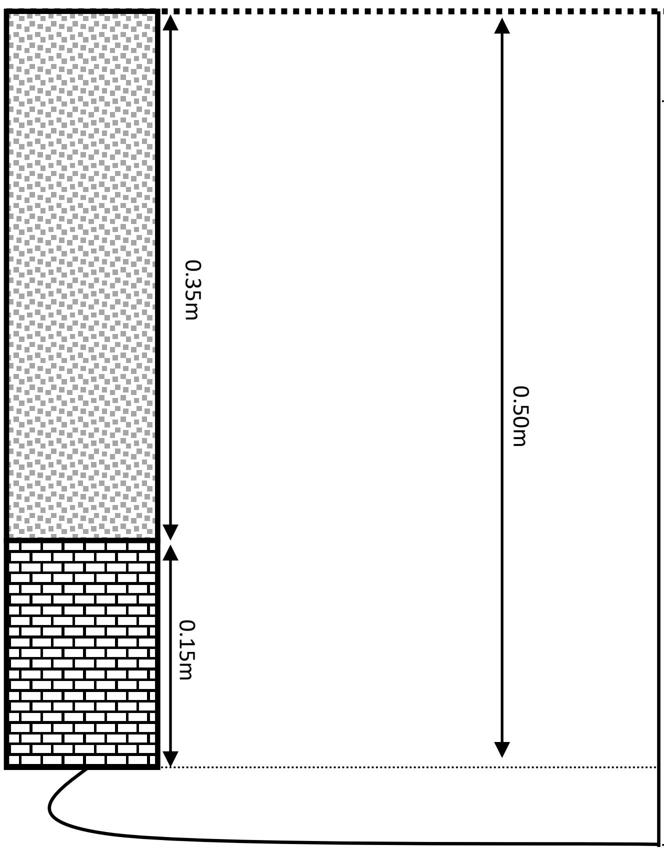
Project: 73 Goldhurst Terrace, London Borough of Camden, London NW6 3HA		Figure 6
Client: Xinchen Gao & Kaifeng Chen c/o Croft Structural Engineers	Date: October 2019	ground&water
Trial Hole Location Plan – Ground Floor	Ref: GWPR3316	



APPROXIMATE SITE BOUNDARY

NOTE: NOT TO SCALE

Project: 73 Goldhurst Terrace, London Borough of Camden, London NW6 3HA		**Figure 7**
Client: Xinchen Gao & Kaifeng Chen c/o Croft Structural Engineers	**Date:** October 2019	ground&water
Trial Hole Location Plan – Basement Level	**Ref:** GWPR3316	



CONCRETE: (GL – 0.05m bbl).

MADE GROUND: (0.05 – 0.60m bbl): Mid-brown to grey-brown slightly sandy gravelly silty clay. Sand is fine to coarse grained. Gravel is fine to coarse, angular to sub-rounded, brick (40%), concrete (20%), flint (19%) and coal fragments (1%).

NOTE: NOT TO SCALE

Concrete

Brick

Project: 73 Goldhurst Terrace, London Borough of Camden, London NW6 3HA	**Figure 8**
Client: Xinchen Gao & Kaifeng Chen c/o Croft Structural Engineers	**Date:** October 2019
Section Drawing: Foundation Exposure TP/FE2	**Ref:** GWPR3316

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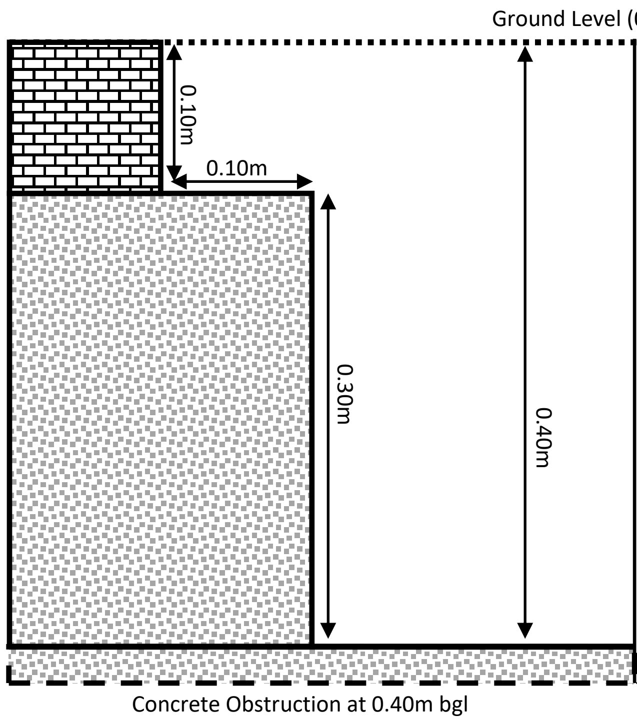


CONCRETE: (GL - 0.05m bgl)

MADE GROUND: (0.05 – 0.40m bgl): Orange-brown gravelly sand. Sand is fine to coarse grained. Gravel is fine to medium, sub-angular to rounded, flint.

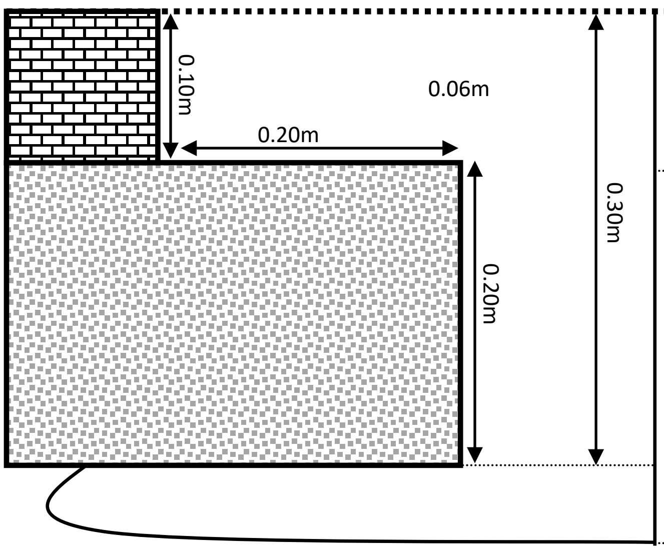
NOTE: NOT TO SCALE

Concrete

Brick

Project: **73 Goldhurst Terrace, London Borough of Camden, London NW6 3HA**		**Figure 9** ground&water
Client: **Xinchen Gao & Kaifeng Chen c/o Croft Structural Engineers**	**Date:** **October 2019**	
Section Drawing: Foundation Exposure TP/FE3	**Ref:** **GWPR3316**	

Ground Level (0.00m)



CONCRETE: (GL - 0.10m bgl)

MADE GROUND: (0.10 – 0.35m bgl): Mid-brown slightly sandy slightly gravelly silty clay. Sand is fine to coarse grained. Gravel is fine, sub-angular to sub-rounded, flint (70%) and brick (30%).

NOTE: NOT TO SCALE

Concrete

Brick

Project: **73 Goldhurst Terrace, London Borough of Camden, London NW6 3HA**		**Figure 10**
Client: **Xinchen Gao & Kaifeng Chen c/o Croft Structural Engineers**	**Date:** **October 2019**	
Section Drawing: Foundation Exposure TP/FE4	**Ref:** **GWPR3316**	

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APPENDIX A
Conditions and Limitations

The ground is a product of continuing natural and artificial processes. As a result, the ground will exhibit a variety of characteristics that vary from place to place across a site, and also with time. Whilst a ground investigation will mitigate to a greater or lesser degree against the resulting risk from variation, the risks cannot be eliminated.

The report has been prepared on the basis of information, data and materials which were available at the time of writing. Accordingly, any conclusions, opinions or judgements made in the report should not be regarded as definitive or relied upon to the exclusion of other information, opinions and judgements.

The investigation, interpretations, and recommendations given in this report were prepared for the sole benefit of the client in accordance with their brief; as such these do not necessarily address all aspects of ground behaviour at the site. No liability is accepted for any reliance placed on it by others unless specifically agreed in writing.

Any decisions made by you, or by any organisation, agency or person who has read, received or been provided with information contained in the report ("you" or "the Recipient") are decisions of the Recipient and we will not make, or be deemed to make, any decisions on behalf of any Recipient. We will not be liable for the consequences of any such decisions.

Current regulations and good practice were used in the preparation of this report. An appropriately qualified person must review the recommendations given in this report at the time of preparation of the scheme design to ensure that any recommendations given remain valid in light of changes in regulation and practice, or additional information obtained regarding the site.

Any Recipient must take into account any other factors apart from the Report of which they and their experts and advisers are or should be aware. The information, data, conclusions, opinions and judgements set out in the report may relate to certain contexts and may not be suitable in other contexts. It is your responsibility to ensure that you do not use the information we provide in the wrong context.

This report is based on readily available geological records, the recorded physical investigation, the strata observed in the works, together with the results of completed site and laboratory tests. Whilst skill and care has been taken to interpret these conditions likely between or below investigation points, the possibility of other characteristics not revealed cannot be discounted, for which no liability can be accepted. The impact of our assessment on other aspects of the development required evaluation by other involved parties.

The opinions expressed cannot be absolute due to the limitations of time and resources within the context of the agreed brief and the possibility of unrecorded previous in ground activities. The ground conditions have been sampled or monitored in recorded locations and tests for some of the more common chemicals generally expected. Other concentrations of types of chemicals may exist. It was not part of the scope of this report to comment on environment/contaminated land considerations.

The conclusions and recommendations relate to 73 Goldhurst Terrace, London Borough of Camden, London NW6 3HA.

Trial hole is a generic term used to describe a method of direct investigation. The term trial pit, borehole or window sampler borehole implies the specific technique used to produce a trial hole.

The depth to roots and/or of desiccation may vary from that found during the investigation. The client is responsible for establishing the depth to roots and/or of desiccation on a plot-by-plot basis prior to the construction of foundations. Where trees are mentioned in the text this means existing trees, recently removed trees (approximately 15 years to full recovery on cohesive soils) and those planned as part of the site landscaping.

Ownership of copyright of all printed material including reports, laboratory test results, trial pit and borehole log sheets, including drillers log sheets, remain with Ground and Water Limited. Licence is for the sole use of the client and may not be assigned, transferred or given to a third party.

Only our client may rely on this report and should this report or any information contained in it be provided to any third party we accept no responsibility to the third party for the contents of this report save to the extent expressly outlined by us in writing in a reliance letter addressed from us to the third party.

Recipients are not permitted to publish this report outside of their organisation without our express written consent.

APPENDIX B
Fieldwork Logs

Percussion Drilling Log

Project Name: 73 Goldhurst Terrace	Client: Xinchen Gao & Kaifeng Chen c/o Croft Structural Engineers	Date: 13/09/2019
Location: London Borough of Camden, London NW6 3HA	Contractor:	
Project No. : GWPR3316	Crew Name:	Drilling Equipment:

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS1	WLS		RG	1:50	Sheet 1 of 1

Depth (m)	Type	Results
0.20	D	
0.50	D	
0.80	D	
1.00	D	
1.00	SPT	N=6 (1,2/2,1,1,2)
1.50	D	
2.00	D	
2.00	SPT	N=8 (1,1/1,2,2,3)
2.50	D	
3.00	D	
3.00	SPT	N=13 (2,3/3,3,4,3)
3.50	D	
4.00	D	
4.00	SPT	N=13 (3,4/4,3,3,3)
4.50	D	
5.00	D	
5.00	SPT	N=15 (3,4/3,4,4,4)
5.50	D	
6.00	D	
6.00	SPT	N=22 (4,5/5,6,5,6)
6.50	D	
7.00	D	
7.00	SPT	N=26 (6,6/7,6,6,7)
7.50	D	
8.00	D	
8.00	SPT	N=31 (6,6/7,7,8,9)

Depth (m)	Level (m)	Stratum Description
0.15		CONCRETE.
0.70		MADE GROUND: Grey-brown slightly sandy gravelly silty clay. Sand is fine to coarse grained. Gravel is fine to coarse, angular to rounded, flint (80%), concrete (10%), brick (9%) and coal fragments (1%).
2.50		LONDON CLAY FORMATION: Mid-brown to grey-brown silty CLAY.
4.00		LONDON CLAY FORMATION: Mid-brown with grey-brown and blue-grey partings/veins, slightly sandy silty CLAY. Sand is fine grained and concentrated into lenses/partings. Rare, fine to medium selenite crystals.
8.45		LONDON CLAY FORMATION: Grey-brown silty CLAY. Rare, fine to medium selenite crystals. Claystone nodules noted at 8.00m bgl.

End of Borehole at 8.450m

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base (m)	Diameter (mm)	Depth Base (m)	Diameter (mm)	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks

Fresh roots noted to a depth of 1.00m bgl. Black decaying roots were noted at 3.50m bgl. No groundwater was encountered.

APPENDIX C
Geotechnical Laboratory Test Results

Summary of Natural Moisture Content, Liquid Limit and Plastic Limit Results

Job No.	Project Name	Programme	
27192	73 Goldhurst Terrace, London	Samples received	23/09/2019
		Schedule received	19/09/2019
Project No.	Client	Project started	24/09/2019
GWPR3316	Ground & Water Ltd	Testing Started	03/10/2019

Hole No.	Sample Ref	Top m	Base m	Type	Soil Description	NMC %	Passing 425µm %	LL %	PL %	PI %	Remarks
WS1	-	1.50	-	D	Orangish brown slightly mottled grey silty CLAY	33	100	70	24	46	
WS1	-	3.00	-	D	Orangish brown slightly mottled grey silty CLAY with light grey fine sand pockets	32	100	72	26	46	
WS1	-	5.00	-	D	Orangish brown slightly mottled grey silty CLAY with traces of selenite crystals	30	100	66	25	41	

Test Methods: BS1377: Part 2: 1990:
Natural Moisture Content : clause 3.2
Atterberg Limits: clause 4.3 and 5.0

Test Report by K4 SOILS LABORATORY
Unit 8 Olds Close Olds Approach
Watford Herts WD18 9RU

Tel: 01923 711 288
Email: James@k4soils.com

Checked and Approved
Initials **J.P**
Date: 04/10/2019

2519

Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

MSF-5-R1(b)

Sulphate Content (Gravimetric Method) for 2:1 Soil: Water Extract and pH Value - Summary of Results
Tested in accordance with BS1377 : Part 3 : 1990, clause 5.3 and clause 9

Job No.	Project Name	Programme	
27192	73 Goldhurst Terrace, London	Samples received	23/09/2019
		Schedule received	19/09/2019
Project No.	Client	Project started	24/09/2019
GWPR3316	Ground & Water Ltd	Testing Started	26/09/2019

Hole No.	Sample Ref	Sample Top (m)	Sample Base (m)	Sample Type	Soil description	Dry Mass passing 2mm (%)	SO3 Content (g/l)	SO4 Content (g/l)	pH	Remarks
WS1	-	2.00	-	D	Light brown slightly yellowish brown silty CLAY	100	0.53	0.64	7.38	

Test Report by K4 SOILS LABORATORY
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MSF-5-R29

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DETS Ltd
Unit 1
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Rose Lane
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t: 01622 850410

DETS Report No: 19-13487

Site Reference:	73 Goldhurst Terrace, London Borough of Camden, London, NW6 3HA
Project / Job Ref:	GWPR3316
Order No:	None Supplied
Sample Receipt Date:	20/09/2019
Sample Scheduled Date:	20/09/2019
Report Issue Number:	1
Reporting Date:	26/09/2019

Authorised by:

Dave Ashworth
Technical Manager

DETS Ltd
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Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

Soil Analysis Certificate						
DETS Report No: 19-13487	**Date Sampled**	13/09/19	13/09/19			
Ground & Water Ltd	**Time Sampled**	None Supplied	None Supplied			
Site Reference: 73 Goldhurst Terrace, London Borough of Camden, London, NW6 3HA	**TP / BH No**	WS1	WS1			
Project / Job Ref: GWPR3316	**Additional Refs**	None Supplied	None Supplied			
Order No: None Supplied	**Depth (m)**	1.00	4.00			
Reporting Date: 26/09/2019	**DETS Sample No**	436222	436223			

Determinand	**Unit**	**RL**	**Accreditation**					
pH	pH Units	N/a	**MCERTS**	8.1	7.6			
Total Sulphate as SO_4	mg/kg	< 200	NONE	754	20140			
Total Sulphate as SO_4	%	< 0.02	NONE	0.08	2.01			
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	**MCERTS**	164	3170			
W/S Sulphate as SO_4 (2:1)	g/l	< 0.01	**MCERTS**	0.16	3.17			
Total Sulphur	%	< 0.02	NONE	0.03	0.75			
Ammonium as NH_4	mg/kg	< 0.5	NONE	1.6	3.6			
Ammonium as NH_4	mg/l	< 0.05	NONE	0.16	0.36			
W/S Chloride (2:1)	mg/kg	< 1	**MCERTS**	14	62			
W/S Chloride (2:1)	mg/l	< 0.5	**MCERTS**	6.8	30.8			
Water Soluble Nitrate (2:1) as NO_3	mg/kg	< 3	**MCERTS**	< 3	< 3			
Water Soluble Nitrate (2:1) as NO_3	mg/l	< 1.5	**MCERTS**	< 1.5	< 1.5			
W/S Magnesium	mg/l	< 0.1	NONE	11	200			

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C
Subcontracted analysis (S)

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Soil Analysis Certificate - Sample Descriptions	
DETS Report No: 19-13487	
Ground & Water Ltd	
Site Reference: 73 Goldhurst Terrace, London Borough of Camden, London, NW6 3HA	
Project / Job Ref: GWPR3316	
Order No: None Supplied	
Reporting Date: 26/09/2019	

DETS Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
436222	WS1	None Supplied	1.00	20	Brown clay
436223	WS1	None Supplied	4.00	18.4	Brown clayey sand

Moisture content is part of procedure E003 & is not an accredited test
Insufficient Sample I/S
Unsuitable Sample U/S

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Soil Analysis Certificate - Methodology & Miscellaneous Information
DETS Report No: 19-13487
Ground & Water Ltd
Site Reference: 73 Goldhurst Terrace, London Borough of Camden, London, NW6 3HA
Project / Job Ref: GWPR3316
Order No: None Supplied
Reporting Date: 26/09/2019

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 – C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received