ground&water

GROUND INVESTIGATION AND BASEMENT IMPACT ASSESSMENT REPORT

for the site at

16 ROSECROFT AVENUE, HAMPSTEAD, LONDON, NW3 7QB

on behalf of

MRS APPLETON C/O 5D ARCHITECTS AND VINCENT AND RYMILL

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1.0 INTRODUCTION

1.1 General

Ground and Water Limited were instructed by Mrs Appleton c/o 5D Architects and Vincent and Rymill, on the 14th May 2018, to undertake a Ground Investigation and Basement Impact Assessment on a site at 16 Rosecroft Avenue, Hampstead, London, NW3 7QB. The scope of the investigation was detailed within the Ground and Water Limited fee proposal ref: GWQ3854, dated 14th May 2018.

1.2 Aims of the Investigation

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

The investigation was to be undertaken to provide parameters for the design of foundations by means of in-situ and laboratory geotechnical testing undertaken on soil samples recovered from trial holes.

The requirements of the Camden Planning Guidance Basements and Lightwells (CPG4), July 2015, and London Borough of Camden, Camden Geological, Hydrogeological and Hydrological Study, Guidance for Subterranean Development (November 2010) was reviewed with respect to this report.

A Desk Study and full scale 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/GEOTECHNICAL DESK STUDY

2.1 Site Location

The site comprised a ~661m^2 rectangular shaped plot of land, orientated in an approximately east to west direction, located on the eastern side of Rosecroft Avenue. The site was located ~100m north-east of Hollycroft Avenue. The site was located in Child's Hill/Hampstead, north-west London, within the London Borough of Camden.

The national grid reference for the centre of the site was approximately TQ 25507 86205 A site location plan is given within Figure 1. A plan showing the site area is given within Figure 2.

2.2 Site Description

A Site Walkover was undertaken in June 2018. The site comprised a three-storey semi-detached brick built residential dwelling with roof accommodation, set in a southerly/south-westerly slope. A lower floor ground floor garage was noted beneath the front of the site, with a sloping concrete driveway. A paved front garden with steps, was noted to front the property, the ground level of the property was ~2.0m higher than Rosecroft Avenue.

The driveway at the front of the property was at 107.45m AOD and sloped upwards away from the property, to 108.87m AOD where it joins Rosecroft Avenue. The front doorway accessed via raised via steps at a level of 109.46m AOD. The front garden is located at approximately 109.44. Stepped patio/decking areas to the rear of the property range between 109.83m AOD to 111.22m AOD, increasing to approximately 111.79m AOD within the soft landscaped garden area.

An aerial view of the site is given within Figure 3. A section view of the existing development can be viewed within Figure 4, with a plan view provided in Figure 5. A topographic survey of the site can be viewed in Figure 6.

2.3 Proposed Development

At the time of reporting, July 2018, the proposed development was understood to comprise the excavation of a basement below the entire footprint of the ground floor (between ~109 – 112m AOD), including construction of lightwells, as well a single storey rear extension. The basement will be excavated ~3.40m below first floor level (formed at 106.40m AOD). The retaining wall foundation of the basement is to be formed at ~2.00m below driveway level (floor level of front garage) (bdl) and ~4.20m below patio level (bpl) at the rear garden. A section view of the proposed development can be viewed within Figure 7, with a proposed plan view provided in Figure 8.

The proposed development fell within Geotechnical Design Category 2 in accordance with Eurocode 7.

The proposed development was understood not to involve any re-profiling of the site and its immediate environs. It was understood that no trees will be removed to facilitate the construction of the basement.

2.4 Site History

The object of this search was to report on the history of the site and its environs from available County Series, Ordnance Survey and Aerial Photography Maps dating from the 1870 to the 1994 and downloaded from Groundsure Environmental Insight. In the following sections dealing with individual maps, only features considered to have a potential impact on the site and usually within a notional 250 metre radius of the site boundaries are discussed. Any distances quoted for features remote from the site have been scaled from the maps and are only approximate. The north point and approximate extent of the site are indicated on each figure. The historical maps referred to are given within Appendix B. The implications of the map search are discussed later within this report. The historic map review can be seen tabulated overleaf.

Table 1: Environmental Significance of Data From Historical Maps

Date	Scale	Site	Environs
1870	1:2,500	The site was occupied by undeveloped farmland and woodland. A circular pond was noted within the south-western corner of the site.	Agricultural buildings were present ~100m north, ~80-90m north-east and ~250m west and north-west of the site. A well was present ~90m north-east of the site. Childs Hills Lane was present ~120m north-west of the site. The rest of the sites environs were occupied by undeveloped farmland and woodland. A historic well was noted ~90m north-east of the site.
1896	1:1,056	The pond within the south-western corner was no longer noted. As previous map.	The historic well noted ~90m north-east of the site was no longer noted. Remainder as previous map.
1896	1:2,500	As previous map.	The well ~90m north-east of the site was no longer present. A road had been constructed, joining Childs Hill Lane, ~250m north-west of the site. Sunnyfield had been constructed ~250m north of the site. Agricultural buildings had been constructed ~250m west of the site Redington Road had been constructed ~80m east of the site. A reservoir had been constructed ~250m south-west of the site. Remainder as previous map.
1915	1:2,500	A residential house had been constructed within the site boundaries. The po	The area surrounding the site had undergone complete residential development apart from farmland still remaining ~100-250m north-west of the site. The reservoir was still present ~250m south-west of the site
1953	1:1,250	As previous map.	Residential development had occurred ~100-20m north-west of the site. Remainder as previous map. Embanked land ~200m north was noted, associated with Child Hill House.
1953	1:2,500	As previous map.	As previous map.
1955	1:1,250	As previous map.	As previous map.
1962-1966	1:1,250	As previous map.	As previous map.
1969	1:1,250	As previous map.	As previous map.
1974	1:1,250	As previous map.	The embanked land ~200m to the north of the site was no longer noted. As previous map.
1979	1:1,250	As previous map.	As previous map.
1979-1981	1:1,250	As previous map.	As previous map.
1981-1986	1:1,250	As previous map.	As previous map.
1991	1:1,250	As previous map.	As previous map.
1993-1994	1:1,250	As previous map.	As previous map.
1993-1994	1:1,250	As previous map.	As previous map.

2.5 Geology

The geology map of the British Geological Survey for the North London area (Sheet No. 256) revealed the site was located on the bedrock deposits of the Bagshot Formation. These were found to overly the bedrock deposits of the Claygate Member of the London Clay Formation. Worked Ground was noted ~300m south-west of the site.

Figure 4 of the Camden Geological, Hydrogeological and Hydrological Study indicated that an area of Worked Ground was present ~280m south-west of the site (see Figure 9 of this report).

Worked Ground

Worked Ground is where natural materials are known to have been remove, for example in quarries and pits, excavations for roads and railways and in general landscaping.

Bagshot Formation

Bagshot Beds comprise mainly fine to medium grained yellow, pink and brown sand with ferruginous concretions. Beds of grey clay "pipe clay" occur frequently as do beds of black flint gravel.

Claygate Member of the London Clay Formation
The Claygate Member of the London Clay Formation comprises alternating layers of clayey sand and sandy clays. The sands usually overlie the clays. The clays are typically brown to mauve mottled and are overconsolidated. The bed is transitional and overlays the undivided London Clay Formation. It has been used extensively for brick making.

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 record ~330m south-west of the site (TQ28/NE421) revealed 1.10m of Made Ground overlying a stiff to very stiff brown to dark grey clay with selenite crystals and silt pockets for the remaining depth of the borehole, a depth of 20.0m bgl.

2.6 Summary of the basement impact assessment report of 14 Rosecroft Avenue, Hampstead (Ref.: GWPR1540/GIR/March 2016)

The site comprised a ~520m^2 rectangular shape plot of land, orientated in a west to east direction, located on the eastern side of Rosecroft Avenue, ~70m north of its junction with Hollycroft Avenue. The site was located in the Childs Hill/Hampstead area of north-west London.

The site comprised a semi-detached two storey brick-built structure, with roof accommodation, set into a southerly slope. A lower ground floor garage structure was noted beneath the front of the southern portion of the site with a concrete driveway onto Rosecroft Avenue. A paved front garden, with steps, was noted to front the property, with the ground floor level of the property ~2.0 – 2.5m higher than Rosecroft Avenue.

The site investigation and impact assessment were undertaken based on a proposed basement similar in depth to the one proposed for No. 14.

Siteworks were undertaken on the 22nd January 2016 and the 1st February 2016 and comprised the drilling of 1No. Terrier Windowless Sampler Borehole (WS1) to a depth of 6.00m below lower ground level (blgl), the drilling of 1No. Hand Held Window Sampler Borehole (WS2) to a depth of 6.00m below ground level (bgl) and the hand excavation of two trial pit foundation exposures (TP/FE1 and TP/FE2) to a depth of 0.70m – 1.20m bgl. Standard Penetration Testing was undertaken in WS1 at 1.00m intervals. A Super Heavy Dynamic Probe (SHDP) (DP1) was undertaken through the base of WS1 to a depth of 10.00m blgl.

WS1 was drilled from the level of the driveway located to the front of the property, ~2.40m below the ground floor of the existing property. WS2 was drilled to the rear of the property at ground level.

A small diameter combined bio-gas and groundwater monitoring well was installed within WS1 to 5.00m blgl. The construction of the well installed can be seen tabulated below.

Ground Conditions
Made Ground was encountered from ground level to 0.20m - >1.20m bgl/blgl.

Soils described as representative of Head Deposits were encountered underlying the Made Ground to a proved depth of 1.40m blgl/bgl within WS1 and WS2 and for the remaining depth of TP/FE2, a maximum of 1.20m bgl. The Head Deposits were noted to comprise a red/orange brown and grey brown mottled sandy gravelly silty clay. The sand was fine to medium grained. The gravel was occasional, fine to coarse, sub-angular to rounded flint. The Head Deposits were likely to have low to medium volume change potential in accordance with BRE240 and NHBC Standards Chapter 4.2.

Deposits of the Bagshot Formation were encountered underlying the Head Deposits within WS1 and WS2 to a proved depth of 2.20m blgl/bgl. The soils were noted to comprise a light to orange brown very sandy clay to clayey sand. The sand was fine grained. Cohesive soils of the Bagshot Formation are likely to have low to medium volume change potential in accordance with BRE240 and NHBC Standards Chapter 4.2. Granular soils of the Bagshot Formation are likely to have no volume change potential in accordance with NHBC Standards Chapter 4.2 and volume change potential in accordance with BRE240.

From 2.20m blgl/bgl and for the remaining depth of WS1 and WS2, a maximum of 6.00m blgl/bgl, soils described as representative of the Claygate Member of the London Clay Formation were encountered. The deposits were described as orange brown, with local grey brown mottling, alternating layers of very sandy silty clay and clayey medium dense sand. The sand was fine grained. The granular soils of the Claygate Member of the London Clay Formation were shown to be medium dense. The cohesive soils of the Claygate Member of the London Clay Formation was shown to have a medium undrained shear strength (45kPa). Geotechnical testing revealed the cohesive soils of the Claygate Member of the London Clay Formation to have low to medium volume change potential in accordance with both BRE240 and NHBC Standards Chapter 4.2. Consistency Index calculations indicated these soils to be firm to stiff. The cohesive deposits of the Claygate Member of the London Clay Formation were shown to be overconsolidated to heavily overconsolidated soils. The granular soils of the Claygate Member of the London Clay Formation were shown to have a volume change potential in accordance with BRE240 and no volume change potential in accordance with NHBC Standards Chapter 4.2 Based on the results of the dynamic probing, cohesive soils of the Claygate Member of the London Clay Formation were assumed to be present within DP1 from 6.00m blgl to the base of the probe at 10.00m blgl. The assumed Claygate Member of the London Clay Formation was shown to have a medium to high undrained shear strength (50 – 145kPa).

Information supplied by 5D architects confirmed that no damage was noted to No.14 during the basement construction at No.16 Rosecroft Avenue.

2.7 Slope Stability and Subterranean Developments

The site was situated within an area where a natural or man-made slope of greater than 7^{o} and less than 10^{o} was present (Figure 16 Camden Geological, Hydrogeological and Hydrological Study, Figure 10 of this report).

Figure 17 of the Camden Geological, Hydrogeological and Hydrological Study indicated the site was not situated within an area prone to landslides (see Figure 11 of this report).

Figure 18 of the Camden Geological, Hydrogeological and Hydrological Study indicated that no major subterranean infrastructure (including existing and proposed tunnels) was noted within close proximity to the site (see Figure 12 of this report).

2.8 Hydrogeology and Hydrology

A study of the aquifer maps on the DEFRA website and Figure 8 of the Camden Geological, Hydrogeological and Hydrological Study (see Figure 13 of this report) revealed the site to be located on a **Secondary A Aquifer** comprising the Bagshot Formation and the underlying Claygate Member of the London Clay Formation. No designation was given for any superficial deposits due to their likely absence.

Secondary aquifers include a wide range of drift deposits with an equally wide range of water permeability and storage capacities. Secondary (A) Aquifers consist of deposits with permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as Minor Aquifers.

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.

Examination of the Environment Agency records and Figure 8 of the Camden Geological, Hydrogeological and Hydrological Study (see Figure 13 of this report) showed that the site did **not** fall within a Groundwater Source Protection Zone as classified in the Policy and Practice for the Protection of Groundwater.

There were no surface water features within a close proximity of the site in accordance with Figure 12 of the Camden Geological, Hydrogeological and Hydrological Study (see Figure 14 of this report).

Figure 11 of the Camden Geological, Hydrogeological and Hydrological Study revealed a tributary of the "Lost" Westbourne River immediately to the east of the site. (see Figure 15 of this report).

Figure 14 of the Camden Geological, Hydrogeological and Hydrological Study revealed the site was not located within the catchment of Hampstead Ponds (see Figure 16 of this report).

From analysis of hydrogeological and topographical maps groundwater was anticipated to be encountered at moderate depth (3 - 6m below existing ground level (bgl)) and it was considered that the groundwater was flowing in a south-westerly direction in accordance with the local topography.

Examination of the Environment Agency records showed that the site was not situated within a floodplain or flood warning area. Figure 15 of the Camden Geological, Hydrogeological and Hydrological Study revealed that Platts Lane (~130m west) and Ferncroft Avenue (~130m south-west) suffered surface water flooding in 2002 and 1975 respectively (see Figure 17 of this report).

A plan showing the location of the site with respect to Environment Agency Flood Maps can be seen in Figure 18.

2.9 Radon

BRE 211 (20015) Map 5 of London, Sussex and West Kent revealed the site **was not** located within an area where mandatory protection measures against the ingress of Radon were required. The site **was not** located within an area where a risk assessment was required.

2.10 Geotechnical Conceptual Site Model

The following geotechnical concerns have been formulated by this desk based review and should be analysed investigated further.

- Soils with the potential for volume change potential are likely to be encountered under the site. Soils volume change potential to be determined along with depth of root penetration

with reference to proximity of nearby trees;
- Potential for low undrained shear strength in shallow soils;
- Potential for Made Ground due to construction activities in site history and backfilling of pond.
- Basement excavation and land stability given neighbouring properties and roads;
- Land stability with respect to slope;
- Potential for shallow groundwater to be encountered perched within shallow Made Ground; or within sand/silty bands of the Bagshot Formation and Claygate Member of the London Clay Formation. Proximity of lost tributary;
- Presence of a Secondary Aquifer and whether basement will affect saturated Aquifer;
- Temporary works whilst underpinning;
- Surface Water Run-off due to an increase of the area or proposed hardstanding;
- Heave of soils following overburden pressure release.

3.0 BASEMENT IMPACT ASSESSMENT

This stage should identify any areas of concern and therefore focus efforts on further investigation.

3.1 Stage 1: Screening

3.1.1 Subterranean (Groundwater) Screening Flowchart

Question 1a. Is the site located directly above an aquifer?

Yes. A study of the aquifer maps on the DEFRA website, and Figure 8 of the Camden Geological, Hydrogeological and Hydrological Study, revealed the site to be located on a **Secondary A Aquifer** relating to the bedrock of the Bagshot Formation as well as the Claygate Member of the London Clay Formation (see Figure 13 of this report). **Take forward to scoping.**

Question 1b. Will the proposed basement extend beneath the water table surface?

Maybe. From analysis of hydrogeological and topographical maps groundwater was anticipated to be encountered at moderate depth (3 - 6m below existing ground level (bgl)). Perched water migrating through the Bagshot Formation, Claygate Member of the London Clay Formation and Made Ground is also likely. **Take forward to scoping.**

Question 2. Is the site within 100m of a watercourse, well (used/disused) or potential spring line?

No. There were no surface water features within a close proximity of the site in accordance with Figure 12 of the Camden Geological, Hydrogeological and Hydrological Study (see Figure 14 of this report).

Figure 11 of the Camden Geological, Hydrogeological and Hydrological Study revealed a tributary of the "Lost" Westbourne River immediately to the east of the site. (see Figure 15 of this report). **Take forward to scoping.**

3. Is the site within the catchment of the pond chains on Hampstead Heath?

No. Figure 14 of the Camden Geological, Hydrogeological and Hydrological Study revealed the site was not located within the catchment of Hampstead Ponds (see Figure 16 of this report).

Question 4. Will the proposed development result in a change in the proportion of hard surface/paved areas?

YEs. The proposed development includes the construction of lightwells and a rear single storey extension, the amount of hardstanding is expected to increase by ~34m^2. **Take forward to scoping.**

Question 5. As part of the 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)?

Marginally. At the time of reporting, July 2018, a slight increase in the amount of surface water discharged into the ground was anticipated. The proposed lightwell and rear story single extension should be appropriately drained. **Take forward to scoping.**

6. Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to, or lower than, the mean water level in any local pond (not just the pond chains on Hampstead Heath) or spring line?

No. The site not located within the catchment of Hampstead Heath Ponds and is located topographically lower. Any groundwater is not in hydrogeological continuity with the pond chains of Hampstead Heath. There were no surface water features within a close proximity of the site in accordance with Figure 12 of the Camden Geological, Hydrogeological and Hydrological Study (see Figure 14 of this report). **No further action**

3.1.2 Land Stability Screening Flowchart

Question 1. Does the existing site include slopes, natural or manmade, greater than 7 degrees (approximately 1 in 8)?

Yes. The site was situated within an area where a natural or man-made slope of greater than 7^o and less than 10^o was present (Figure 18 Camden Geological, Hydrogeological and Hydrological Study, Figure 12 of this report).

Figure 17 of the Camden Geological, Hydrogeological and Hydrological Study indicated the site was not situated within an area prone to landslides (see Figure 11 of this report). **Take forward to scoping.**

Question 2. Will the proposed re-profiling of landscaping at site change slopes at the property boundary to more than 7deg (approximately 1 in 8)?

No. No significant re-profiling of the slope is anticipated to occur; however, the rear basement extension retaining wall would need to be properly designed given its being cut into an existing slope. **No further action.**

Question 3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7deg (approximately 1 in 8)?

Yes. The site was situated within an area where a natural or man-made slope of greater than 7^o and less than 10^o was present. An area with a natural or man-made slope of greater than 10^o was located immediately north-west of the site (Figure 16 Camden Geological, Hydrogeological and Hydrological Study, Figure 10 of this report). **Take forward to scoping**.

Figure 17 of the Camden Geological, Hydrogeological and Hydrological Study indicated the site was not situated within an area prone to landslides (see Figure 11 of this report).

No railway cuttings or similar were noted within a close proximity of the site. **No further action.**

Question 4. Is the site within a wider hillside setting in which the general slope is greater than 7degrees (approximately 1 in 8)?

Possibly. The site was situated within an area where a natural or man-made slope of greater than 7^o and less than 10^o was present but is not within a wide hillside setting.

However, the site is sloping down from a topographic high ~100m north-east of the site.

An area with a natural or man-made slope of greater than 10^o was located immediately north-west of the site (Figure 16 Camden Geological, Hydrogeological and Hydrological Study, Figure 10 of this report). However these are fairly localised along Rosecroft Avenue and do not represent the general slope of the site's environs.

Figure 17 of the Camden Geological, Hydrogeological and Hydrological Study indicated the site was not situated within an area prone to landslides (see Figure 11 of this report). **Take forward to scoping**

Question 5: Is the London Clay the shallowest strata at the site?
No, the geological map (sheet 256) indicates that the site is underlain by the Bagshot Formation overlying the Claygate Member of the London Clay Formation. **No further action.**

Question 6: Will any tree/s 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? (Note that consent is required from LB Camden to undertake work to any tree/s protected by a Tree Protection Order or to tree/s in a Conservation Area if the tree is over certain dimensions).
No. It was understood that no trees would be removed to facilitate the excavation of the basement **No further action**.

Question 7: Is there a history of seasonal shrink-swell subsidence in the local area, and/or evidence of such effects at the site?
None known. However, the Bagshot Formation and Claygate Member of the London Clay Formation is indicated as being present at the property, which have the potential for volume change. **Take forward to scoping.**

8. Is the site within 100m of a watercourse or a potential spring line?
No. There were no surface water features within a close proximity of the site in accordance with Figure 12 of the Camden Geological, Hydrogeological and Hydrological Study (see Figure 14 of this report). Figure 11 of the Camden Geological, Hydrogeological and Hydrological Study revealed a tributary of the "Lost" Westbourne River immediately to the east of the site. (see Figure 15 of this report) **No further action.**

9. Is the site within an area of previously worked ground?
No. Figure 4 of the Camden Geological, Hydrogeological and Hydrological Study indicated that an area of Worked Ground was present ~280m south-west of the site (see Figure 9 of this report). **No further action.**

10. Is the site within an aquifer? If so, will the proposed basement extent beneath the water table such that dewatering may be required during construction?
Yes. Site overlies Secondary (A) Aquifer of the Bagshot Formation and Claygate Member of the London Clay Formation. **Maybe.** From analysis of hydrogeological and topographical maps groundwater was anticipated to be encountered at moderate depth (3 - 6m below existing ground level (bgl)). Perched water migrating through the Bagshot Formation, Claygate Member of the London Clay Formation and Made Ground is also likely. **Take forward to scoping.**

11. Is the site within 50m of the Hampstead Heath Ponds?
No. Figure 14 of the Camden Geological, Hydrogeological and Hydrological Study revealed the site was not located within the catchment of Hampstead Ponds (see Figure 16 of this report). **No further action.**

Question 12: Is the site within 5m of a highway or pedestrian right of way?
No. The nearest highway and pedestrian right of way was noted 7.8m west. **No further**

action.

Question 13: Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties? Possibly. It was understood that the proposed basement will be constructed at the same depth as the basement recently formed under the neighbouring property, No.14 Rosecroft Avenue. It is also understood that No. 14 and No. 16 Rosecroft Avenue will be sharing underpinnings. Therefore, differential foundation depths will not be an issue at this property.

It was not known if No.12 or No.18 Rosecroft Avenue have existing basements. Given the properties to the west appear a sufficient distance away from the proposed development, it was likely a Ground Movement Analysis (GMA) will only be required on these two properties. **Take forward to scoping.**

14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?
No. Figure 18 of the Camden Geological, Hydrogeological and Hydrological Study indicated that no major subterranean infrastructure (including existing and proposed tunnels) was noted within close proximity to the site (see Figure 12 of this report). **No further action.**

3.1.3 Surface Water and Flooding Screening Flowchart

1. Is the site within the catchment of the pond chains of Hampstead Heath?
No. Figure 14 of the Camden Geological, Hydrogeological and Hydrological Study revealed the site was not located within the catchment of Hampstead Ponds (see Figure 16 of this report). **No further action.**

2. As part of the of the proposed site drainage, will surface water flows be materially changed from the existing route?
No. The existing surface water routes will be not changed by the development. **No further action**.

3. Will the proposed basement development result in a change to the hard surfaces/paved external areas?
Marginally. The proposed development includes the construction of lightwells and a rear single storey extension and is expected to increase the amount of hardstanding in the area by $34m^2$. **Take forward to scoping.**

4. Will the proposed basement result in changes to the inflows (instantaneous and long term) of surface water being received by adjacent properties or downstream watercourses?
No. Surface water that is received by adjacent properties and downstream watercourses is not from the site. This will remain the case with the proposed development. **No further action**.

5. Will the proposed basement result in a change to the surface water being received by adjacent properties or downstream watercourses?
No. Collected surface water will be from building roofs and paving, as before. The quality of the water received downstream will therefore not change. **No further action**.

6. Is the site in an area identified to have surface water flood risk according to either the Local Flood Risk Management Strategy or the Strategic Flood Risk Assessment or is it at risk from flooding, for example, because the basement is below the static water level of a nearby surface water feature?

No.

Please see table below:

Flood Risks Overview		
Potential Source	**Potential Flood Risk at Site?**	**Justification**
Fluvial Flooding	No	EA Flood Mapping shows site was not located within a Flood Zone. No surface water features within a close proximity of the site.
Tidal Flooding	No.	EA Flood Mapping shows site was not located within a Flood Zone.
Flooding from Rising/High Groundwater	No.	From analysis of hydrogeological and topographical maps groundwater was anticipated to be encountered at moderate depth (3 - 6m below existing ground level (bgl)).
Surface Water (Pluvial) Flooding	No	Figure 12 the Camden Geological, Hydrogeological and Hydrological Study revealed that whilst the site was not subject to surface water flooding (See Figure 14 of this report).
Flooding From Infrastructure Failure	No	Figure 12 the Camden Geological, Hydrogeological and Hydrological Study revealed that whilst the site was not subject to surface water flooding (See Figure 14 of this report).
Flooding from Reservoirs, Canals and other artificial sources	No.	The study of historic maps revealed a covered reservoir was present ~250m south-west of the site. The reservoir was down groundwater gradient. Data from the Environment Agency website indicated that Rosecroft Avenue was at very low risk of flooding from reservoirs.

3.2 Stage 2: Scoping

3.2.1 Conceptual Site Model & Matters of Concern

There are nine areas of concerns that the Screening process have highlighted.

1. **Perched water within the Made Ground or Groundwater within the Bagshot Formation and Claygate Member of the London Clay Formation** – The basement may encounter groundwater, associated with the saturated aquifer of the Bagshot Formation and Claygate Member of the London Clay Formation, during construction. Perched water may also be encountered. This is to be taken forward for further assessment to confirm depth of the saturated Aquifer and the effect of the basement on any saturated aquifer, if appropriate;

2. **Soil Moisture** – There is potential for soil moisture content to affect the development. This is to be taken forward for further assessment;

3. **Bagshot Formation Shrink and Swell** – The basement was anticipated to be founded in the Bagshot Formation. The soils are likely to have medium plasticity and volume change potential. The concrete mix design should take appropriate account of sulphate levels (testing to BRE Special Digest). Heave on removal of overburden pressure may be a risk.

4. **Differential Foundation Depths** – It was understood that the proposal is to excavate a 3.40m lower ground floor beneath the footprint of the property, potentially creating differential depths between the foundation of No.12 and No.18 Rosecroft Avenue. Therefore, further assessment through Ground Movement Analysis (GMA) is required.

   It was understood that the proposed basement will be constructed at the same depth as the basement recently formed under the neighbouring property, No.14 Rosecroft Avenue. It is also understood that No. 14 and No. 16 Rosecroft Avenue will be sharing underpinnings. Therefore, differential foundation depths will not be an issue at this property.

5. **Overall Slope Stability –** The site was situated within an area where a natural or man-made slope of greater than 7^{o} and less than 10^{o} was present but is not within a wider hillside setting. The site was sloping down from a topographic high to the north of West Heath.

   An area with a natural or man-made slope of greater than 10^{o} was located immediately north-east of the site (Figure 16 Camden Geological, Hydrogeological and Hydrological Study, Figure 10 of this report). However, these are fairly localised along Rosecroft Avenue and do not represent the general slope of the site's environs.

   Figure 17 of the Camden Geological, Hydrogeological and Hydrological Study indicated the site was not situated within an area prone to landslides (see Figure 11 of this report).

   The stability of the slope and its environs should be reviewed with respect to the proposed development.

6. **Retaining Walls** should be appropriately designed**;**

7. **Tree and Bushes.** No trees or to be removed for the proposed development. Care should be taken to minimise root damage during construction works. Should bushes be removed there is potential for the soils to swell as a result which may affect this and neighbouring properties and this should be accounted for in design and further assessed;

8. **Surface Water/Drainage.** The proposed development is expected to increase the amount of hardstanding by 34m^2. The design should ensure both lightwell and extension are appropriately drained.

9. **Historic Well ~80m south-west.**
   A historic well was noted ~90m north-east of the site from the earliest historic maps (1870) through to the 1896 historic map. No further wells were noted on subsequent historic maps and a study of BGS borehole records indicated no private water abstraction boreholes in a close proximity of the site.

   Given the distance of the feature from the site, its absence from historic maps dating from the 1896 map, the absence of BGS borehole abstractions within a close proximity, and the proposed development (single storey basement), the historic well ~90m north-east of the site was not considered to be at risk.

10. **Shallow Groundwater Levels**
    Figure 11 of the Camden Geological, Hydrogeological and Hydrological Study revealed a

tributary of the “Lost” Westbourne River immediately to the east of the site. (see Figure 15 of this report).

11. **Deep Made Ground.**
    In the 1870 historic map, a circular pond was noted within the south-western corner of the site. By the 1896 historic map, the pond was no longer noted and consequentially was potentially infilled. Therefore, there is a risk of deep Made Ground within the site.

A site-specific ground investigation should be undertaken to inform design. The scope of the investigation can be seen within Section 4 of this report. The results of the investigation are given within Sections 5 and 6 with the conclusions and recommendations provided within Section 7 of this report.

A ground movement assessment should be undertaken. The results of ground movement assessments undertaken on the neighbouring properties to the site can be seen within Section 7.7 of this report.

The stability of the slope and its environs should be reviewed with respect to the proposed development. This is discussed within Section 7.6 of this report.

4.0 FIELDWORK

4.1 Scope of Works

Site works were undertaken on the 23rd and 25th May 2018 and comprised the drilling of one 1No. Dart Windowless Sampler Borehole (BH1) at driveway level (107.45m AOD), to a depth of 7.00m below driveway level (bdl), and 2No. Hand Held Window Sampling Rigs (WS2-WS3). WS2 was drilled within the patio area at 109.83m AOD, to 4.80m below patio level (bpl). WS3 was drilled within the upper rear garden at 111.72m AOD, to 3.30m below rear garden level (brgl).

Standard Penetration Tests (SPTs) were carried out in BH1 at 1.00m intervals. A Super Heavy Dynamic Probe (DP1) was undertaken through the base of BH1 to a depth of 13.10m below driveway level.

Site works also comprised the excavation of one trial pit foundation exposure (TP2/FE2) at 110.72m AOD, to a depth of 0.80m below rear garden wall level (brgwl).

The trial holes and their elevations can be seen tabulated below. These elevations have been taken from the topography survey, prior to demolition.

Trial Hole Elevations in Relation to the Base level of the Proposed Basement	
Trial Hole	**Elevation (m AOD)**
BH1 (driveway level)	107.45
WS2 (patio level)	109.83
WS3 (upper rear garden level)	111.72
TP2/FE2 (rear garden wall level)	110.72

A 50mm combined ground-gas and groundwater monitoring well was installed in BH1 to 5.00m bdl. The construction of the well installed can be seen tabulated below.

Combined Ground-gas and Groundwater Monitoring Well Construction				
Trial Hole	**Depth of Installation (m below driveway level (mAOD))**	**Thickness of slotted piping with gravel filter pack (m)**	**Depth of plain piping with bentonite seal (mAOD))**	**Piping external diameter (mm)**
BH1	5.00m (102.45)	4.00m	1.00m below driveway level (106.45)	50mm

The approximate locations of the trial holes can be seen within Figure 20.

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.

4.2 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. In addition, one soil sample was sent off for analysis for a broad range of contaminants in accordance with DEFRA/CLEA methodologies.

4.3 Obstruction/Limitations

Due to limited access, the proposed trial pit foundation exposure TP/FE1 was not able to be excavated.

5.0 ENCOUNTERED GROUND CONDITIONS

5.1 Soil Conditions

All exploratory holes were logged by Harry Brock 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 holes drilled on the site generally conformed to that anticipated from examination of the geology map. A capping of Made Ground was noted to overlie the soils of the Bagshot Formation which were found to overlie soils of the Claygate Member 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, the Bagshot Formation and the Claygate Member of the London Clay Formation at particular points, reference must be made to the individual trial hole logs within Appendix C.

The trial hole location plan can be viewed in Figure 20.

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

Made Ground
Bagshot Formation
Claygate Member of the London Clay Formation (BH1 only)

Made Ground

Made Ground was encountered from their relative ground levels to depths of 0.08 – 1.00m below the top of the boreholes in BH1, WS1-WS2 and TP2/FE2. From each trial holes relative ground level (bgl) to depths of between 0.08 – 0.15m bgl the Made Ground comprised a capping of lean concrete/concrete slab and slab/sand. A brown stone sub-base was then encountered in TP2/FE2 to a depth of 0.20m brgwl.

From the upper rear garden level in WS3, and underlying the brown stone sub-base in TP2/FE2, the Made Ground comprised a brown/orange-brown gravelly sandy silty clay/gravelly silty clayey sand. The sand was fine to coarse grained. The gravel was rare to occasional, fine, sub-angular to sub-rounded brick and ash. Pockets of sand were noted in WS3 from upper rear garden level to 0.70m brgl and the Made Ground became more sandy with depth.

Bagshot Formation

Soils described as the Bagshot Formation were encountered underlying the Made Ground in all trial hole to depths of between 0.80 – 4.80m bgl. The soils comprised a brown/brown-orange clayey silty sand/sandy silty clay/silty sandy clay. The sand was fine to medium grained. Within WS3 the soils became more sandy with depth. Pockets of sand were observed from 0.08 – 1.00m and 2.00 – 4.80m below patio level within WS2, and from 0.48 – 0.80m below rear garden wall level within TP2/FE2.

Claygate Member of the London Clay Formation
Soils described as the Claygate Member of the London Clay Formation were encountered underlying the Bagshot Formation, from 2.20m below driveway level for the remaining depth of BH1. The soils comprised interbedded layers of brown/brown-orange mottled silty very sandy clay/silty sandy clay with clayey silty sand/silty very clayey sand. The sand was fine to medium grained.

5.2 Foundation Exposures

A description of the foundation layout and ground conditions encountered within the hand dug trial pit/foundation exposures are given within this section of the report. The Foundation Exposures plan can be seen in Figure 20.

TP2/FE2
Trial pit foundation exposure TP2/FE2 was hand excavated on the north-eastern wall, rear wall at its northern end, of the existing property. The exact location of the trial hole can be seen in Figure 20, with a section drawing of the foundation encountered in Figure 21.

From rear ground level to a depth of 0.17m bgl a brick and render block was noted. The block was noted to be resting upon a brick step, which stepped out by 0.04m and was 0.07m in thickness. The step was noted to rest upon a black ash/clinker footing, which stepped out by 0.30m and was 0.25m in thickness. The footing was noted to rest upon soils of the Bagshot Formation. which were described as orange-brown sandy silty clay. The sand was fine to medium grained. Pockets of sand were observed.

5.3 Roots Encountered

Roots were noted to depths of 1.50m – 1.80m bgl within BH1, WS2-WS3 and for the full depth of TP2/FE2, a depth of 0.80m bgl. The depths of roots in each trial hole is tabulated below.

Borehole	Depths of Roots (m bgl)
BH1	1.50m below driveway level
WS2	1.50m below patio level
WS3	1.80m below upper rear garden level
TP2/FE2	0.80m below rear garden wall level (full depth of trial hole)

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.

5.4 Groundwater Conditions

Groundwater strikes were noted from 3.70 – 3.80m bgl within BH1 & WS2. No groundwater was observed in WS3 or TP2/FE2. The drilling process may have obscured further groundwater strikes. The groundwater conditions are tabulated below.

Borehole	Groundwater Conditions
BH1	Groundwater strike at 3.80m below driveway level (103.65m AOD)
WS2	Groundwater strike at 3.70m below patio level (106.13m AOD)
WS3	N/A
TP2/FE2	N/A

A return visit to monitor the combined gas and groundwater monitoring well installed in BH1 by a Ground and Water Limited Engineer on the 20th June 2018. Groundwater was noted to be resting at 4.09m bdl (103.36mAOD) in the 4.30m deep well (103.15mAOD).

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

The site investigation was conducted in May and June 2018, when groundwater levels should be falling from their annual maximum (highest elevation). The long-term groundwater elevation might increase 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.

5.5 Obstructions

No artificial or natural sub-surface obstructions were noted during construction of the trial holes.

6.0 INSITU AND LABORATORY GEOTECHNICAL TESTING

6.1 In-Situ Geotechnical Testing

Standard Penetration Testing (SPT's) was undertaken at 1.00m intervals in BH1. 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. In addition, a Super Heavy Dynamic Probe (DP1) was undertaken through the base of BH1 to a depth of 13.10m bdl. The test results are presented on the trial hole 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 150 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".

Dynamic Probing involves the driving of a metal cone into the ground via a series of steel rods. These rods are driven from the surface by a hammer system that lifts and drops a 63.5kg (SHDP) hammer onto the top of the rods through a set height, thus ensuring a consistent energy input. The number of hammer blows that are required to drive the cone down by each 100mm increment are recorded. These blow counts then provide a comparative assessment from which correlations have been published, based on dynamic energy, which permits engineering parameters to be generated. *(The 'Super Heavy' (SHDP) Tests were conducted in accordance with BS 1377; 1990; Part 9, Clause 3.2).*

The cohesive soils of the Bagshot Formation were classified based on the table below.

Undrained Shear Strength from Field SPT/Equivalent 'SPT's derived from DP Results for 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	-

The granular soils of the Bagshot Formation and Claygate Member of the London Clay Formation were classified based on the table below.

Correlation between SPT/Equivalent 'SPT's derived from DP results and granular classification	
Classification	**Equivalent SPT Blow Counts (N1)**
Extremely Dense	>58
Very Dense	42 – 58
Dense	25 – 42
Medium Dense	8 – 25
Loose	3 – 8
Very Loose	0 – 3

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

In-Situ Geotechnical Testing Results Summary					
Strata	SPT "N" Blow Counts/ equivalent 'SPT's derived from SHDP results	Undrained Shear Strength kPa (Based on Stroud, 1974)	Soil Type		Trial Hole
			Cohesive	Granular	
Bagshot Formation (Cohesive)	12	60	Medium	-	BH1 (1.10 – 2.20m bdl)
Claygate Member of the London Clay Formation (Granular)	8 – 15	-	-	Loose/Medium Dense-Medium Dense	BH1 (2.20 – 7.00m bdl)
Claygate Member of the London Clay Formation (Cohesive)	10 – 13	50 – 65	Medium	-	BH1 (2.20 – 7.00m bdl)
Assumed Claygate Member of the London Clay Formation* (Granular)	20 – 30			Medium Dense to Dense	DP1 (7.10 – 8.10m bdl)
Assumed Claygate Member of the London Clay Formation* (Cohesive)	9 – 27	45 – 135	Medium to High/Very High	-	DP1 (8.10 – 13.10m bdl)

*Assumed based upon the results of the "super heavy" dynamic probing

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.

The test results are presented on the trial hole logs within Appendix C.

6.2 Laboratory Geotechnical Testing

A programme of geotechnical laboratory testing, scheduled by Ground and Water Limited and carried out by K4 Soils Laboratory and QTS Environmental Limited, was undertaken on samples recovered from the Bagshot Formation and Claygate Member of the London Clay Formation. The results of the tests are presented in Appendix D and Appendix E.

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 overleaf:

Standard Methodology for Laboratory Geotechnical Testing		
Test	Standard	Number of Tests
Atterberg Limit Tests	BS1377:2016:Part 2:Clauses 3.2, 4.3 & 5	4
Particle Size Distribution	BS1377:2016:Part 2:Clause 9	2
Water Soluble Sulphate & pH	BS1377:2016:Part 3:Clause 5	2
BRE Special Digest 1 (incl. Ph, Electrical Conductivity, 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

6.2.1 Atterberg Limit Tests

A précis of Atterberg Limit Tests undertaken on two samples of the Bagshot Formation and two samples of Claygate Member of the London Clay Formation can be seen tabulated overleaf.

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**
Bagshot Formation	20-23	100	22.00 – 23.00	CL	0.61 – 0.77 (Firm to Stiff)	**Medium**	**Medium**
Claygate Member of the London Clay Formation	30-34	100	24.00 – 28.00	CL	0.25 – 0.50 (Soft to Firm)	**Medium**	**Medium**

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.

6.2.2 Comparison of Soil's Moisture Content with Index Properties

6.2.2.1 Liquidity Index Analyses

The results of the Atterberg Limit tests undertaken on two samples of the Bagshot Formation and two samples of Claygate Member 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 below.

The test results are presented within Appendix D.

Liquidity Index Calculations Summary					
Stratum/Trial Hole/Depth	**Moisture Content (%)**	**Plastic Limit (%)**	**Modified Plasticity Index (%)**	**Liquidity Index**	**Result**
Bagshot Formation (WS3/1.50m bgl) Orangish brown slightly mottled grey silty sandy CLAY.	20	15	22	0.23	Overconsolidated
Bagshot Formation (WS2/2.50m bgl) Orangish brown slightly mottled grey silty sandy CLAY.	23	14	23	0.39	Overconsolidated
Claygate Member of the London Clay Formation (BH1/3.50m bgl) Orangish brown slightly mottled grey silty sandy CLAY.	30	16	28	0.50	Overconsolidated
Claygate Member of the London Clay Formation (BH1/6.50m bgl) Orangish brown slightly mottled grey silty sandy CLAY.	34	16	24	0.75	Overconsolidated

Liquidity Index testing revealed no evidence for moisture deficit within the overconsolidated samples of the Bagshot Formation and the Claygate Member of the London Clay Formation tested.

6.2.2.2 Liquid Limit

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

Moisture Content vs. Liquid Limit				
Strata/Trial Hole/Depth/Soil Description	**Moisture Content (MC) (%)**	**Liquid Limit (LL) (%)**	**40% Liquid Limit (LL)**	**Result**
Bagshot Formation (WS3/1.50m bgl) Orangish brown slightly mottled grey silty sandy CLAY.	20	37	14.8	MC > 0.4 x LL (No significant moisture deficit)
Bagshot Formation (WS2/2.50m bgl) Light orangish brown slightly mottled grey silty sandy CLAY.	23	37	14.8	MC > 0.4 x LL (No significant moisture deficit)
Claygate Member of the London Clay Formation (BH1/3.50m bgl) Orangish brown slightly mottled grey silty sandy CLAY.	30	44	17.6	MC > 0.4 x LL (No significant moisture deficit)
Claygate Member of the London Clay Formation (BH1/6.50m bgl) Orangish brown slightly mottled grey silty sandy CLAY.	34	40	16.0	MC = 0.4 x LL (No significant moisture deficit)

The results in the table above indicated that the samples of the overconsolidated Bagshot Formation and Claygate Member of the London Clay Formation tested showed no evidence of a significant moisture deficit.

5.2.3 Particle Size Distribution (PSD) Tests

The results of PSD testing undertaken on one sample of the Bagshot Formation and one sample of the Claygate Member of the London Clay Formation are tabulated below.

PSD Test Results Summary			
Trial Hole/Depth/Strata Description	**Volume Change Potential Range**		**Passing 63µm sieve range (%)**
	BRE	**NHBC**	
Bagshot Formation (WS2/1.00m bgl) Orangish brown mottled grey silty sandy CLAY.	**YES**	**YES**	40
Claygate Member of the London Clay Formation (BH1/4.50m bgl) Orangish brown slightly silty SAND.	NO	NO	3

NB Volume Change Potential refers to BRE Digest 240 (based on Grading test results).
Shrinkability refers to NHBC Standards Chapter 4.2 (based on Grading test results).

Volume Change Potential – BRE 240 states that a soil has a volume change potential when the clay fraction exceeds 15%. Only the silt and clay combined fraction are determined by sieving therefore the volume change potential is estimated from the percentage passing the 63µm sieve.

NHBC Standards Chapter 4.2 states that a soil is shrinkable if the percentage of silt and clay passing the 63µm sieve is greater than 35% and the Plasticity Index is greater than 10%.

6.2.4 Sulphate and pH Tests

A sulphate and pH test was undertaken on one sample from the Claygate Member of the London Clay Formation (BH1/3.50m bgl). The sulphate concentration was 150mg/l with a pH of 7.70.

6.2.5 BRE Special Digest 1

In accordance with BRE Special Digest 1 'Concrete in Aggressive Ground' (BRE, 2005) one sample Bagshot Formation (BH1/0.80m bgl) and one sample of the Claygate Member of the London Clay Formation (BH1/7.00m bgl) were scheduled for laboratory analysis to determine parameters for concrete specification.

The results are given within Appendix E and a summary is tabulated below.

Summary of Results of BRE Special Digest Testing			
Determinand	**Unit**	**Minimum**	**Maximum**
pH	-	4.8	6.3
Ammonium as NH_4	mg/kg	1.1	2.0
Sulphur	%	<0.02	<0.02
Chloride (water soluble)	mg/kg	45	55
Magnesium (water soluble)	mg/l	1.9	3.1
Nitrate (water soluble)	mg/kg	4	14
Sulphate (water soluble)	g/l	0.08	0.09
Sulphate (total)	%	0.02	<0.02

5.3 Chemical Laboratory Testing – Human Health Risk Assessment

A programme of chemical laboratory testing, scheduled by Ground and Water Limited, and carried out by DETS Environmental Limited, was undertaken on one sample of Made Ground (W3/0.25m bgl).

A Desk Study and full-scale contamination assessment were not part of the remit of this report. However, one soil sample was sent off for analysis for a broad range of contaminants in accordance with DEFRA/CLEA methodologies. The sample tested and the reasons for testing can be seen tabulated below.

Methodology for Sampling Locations and Chemical Laboratory Testing			
Trial Hole	**Sampling Strategy/ Trial Hole purpose**	**Depth (m bgl)**	**Anticipated Proposed End-use**
WS3	Representative sample of Made Ground	0.25	Area of soft landscaping within the raised rear garden

The site comprised a rectangular shaped plot of land, 665m^2 in area with four sampling locations, given an unknown hotspot shape, the sampling density means that a hotspot with an area of approximately 997.5m^2 and a radius of approximately 17.82m would be encountered (CLR 4).

Soil sampling depths were chosen to reflect the receptors of concern, human health, and typically comprised a surface or near surface sample and then at approximately 0.50m depth increments thereafter, extending into the underlying natural soils. The receptors relevant to the sampling depths can be seen below:

Near surface samples	Direct ingestion, dermal contact and dust inhalation. Protection of end-users and maintenance workers e.g. Landscape Gardeners. Protection of shallow rooted plants Perched Water/Surface Water Run-off
>0.5m below each relative ground level	Protection of deep rooted plants. Perched Water/Surface Water Run-off Aquifers as potential receptors

The depth of soil sampling can be seen within the trial hole logs presented in Appendix B.

The analysis suite is presented overleaf and comprised:

- Semi-metals and heavy metals incl. Arsenic, Cadmium, Chromium (incl. Hexavalent Chromium), Copper, Lead, Mercury, Nickel, Selenium, Vanadium, Zinc (WS3/0.25m below upper rear garden level);
- Asbestos screen (WS3/0.25m below upper rear garden level);
- Polycyclic Aromatic Hydrocarbons (PAH's) incl. Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene, Dibenz(a,h)anthracene, Benzo(ghi)perylene: (WS3/0.25m below upper rear garden level);
- Fuel Oils – Speciated TPH including full aliphatic/aromatic split: (WS3/0.25m below upper rear garden level);
- BTEX compounds (Benzene, Toluene, Ethylbenzene, Xylene) and MTBE – used as marker compounds for Volatile Organic Compounds (VOCs): (WS3/0.25m below upper rear garden level)

The chemical laboratory results are presented in Appendix E.

5.3.1 Soil Assessment Criteria

The derivation of Soil Assessment Criteria used within this report can be seen within Appendix F.

5.3.2 Determination of Representative Contamination Concentration

At the time of reporting, July 2018, the proposed development was understood to comprise the excavation of a basement below the entire footprint of the ground floor (between ~109 – 112m AOD), including construction of lightwells, as well a single storey rear extension. The basement will be excavated ~3.40m below first floor level (formed at 106.40m AOD). The retaining wall foundation of the basement is to be formed at ~2.00m below driveway level (floor level of front garage) (bdl) and ~4.20m below patio level (bpl) at the rear garden. A section view of the proposed development can be viewed within Figure 7, with a proposed plan view provided in Figure 8.

The proposed development fell within Geotechnical Design Category 2 in accordance with Eurocode 7.

The proposed development was understood not to involve any re-profiling of the site and its immediate environs. It was understood that no trees will be removed to facilitate the construction of the basement.

Therefore, the results of the chemical laboratory testing were compared to the LQM/CIEH Suitable 4 Use Levels (S4UL), for a ***'Residential with Home Grown Produce'*** land-use scenario, as this was considered the most appropriate land-use scenario. The C4SL LLTC for Lead was compared to a ***"Residential with home-grown produce (RwoHP)"*** land-use scenario.

Where no LQM/CIEH S4UL/C4SL LLTC was available for a particular determinant then preliminary reference was made to the laboratory detection limit of the determinant. If a positive concentration was noted then further risk assessment was undertaken.

For Cyanide, where no SGC/GAC or C4SL LLTC was available a Site Specific Assessment

Criteria of 10mg/kg was adopted. This is based on ICRCL 59/83, TCL, ATRISK (SOIL) Screening Value and Dutch Intervention Value (ranging from 20 – 34mg/kg). Therefore, a SSAC of ~10mg/kg is considered conservative.

Where a contaminant of concern's LQM/CIEH S4UL/C4SL LLTC varies according to the Soil's Organic Matter (SOM), the SOM recorded for the soil sample was used to derive the appropriate SGV/GAC. An SOM of 1.40% was noted.

The results of the comparison of the representative contaminants concentrations are presented in the table below.

Substance	Sample Location Where available LQM/CIEH S4UL/, CSL4 LLTC or GAC were exceeded for relevant land-use scenario
	“Residential with Homegrown Produce” Land-Use Scenario
Arsenic	None
Boron	None
Cadmium	None
Chromium (III)	None
Hexavalent Chromium (VI)	None
Lead	None
Mercury (Elemental)	None
Nickel	None
Selenium	None
Vanadium	None
Copper	None
Zinc	None
Boron	None
Cyanide (Total)	None
Phenol	None
TPH C5 – C6 (aliphatic)	None
TPH C6 – C8 (aliphatic)	None
TPH C8 - C10 (aliphatic)	None
TPH C10 - C12 (aliphatic)	None
TPH C12 - C16 (aliphatic)	None
TPH C16 - C21 (aliphatic)	None
TPH C21 - C34 (aliphatic)	None
TPH C5 – C7 (aromatic)	None
TPH C7 – C8 (aromatic)	None
TPH C8 - C10 (aromatic)	None
TPH C10 - C12 (aromatic)	None
TPH C12 - C16 (aromatic)	None
TPH C16 - C21 (aromatic)	None
TPH C21 - C35 (aromatic)	None
Naphthalene	None
Acenapthylene	None
Acenapthene	None
Fluorene	None
Phenanthrene	None
Anthracene	None
Fluoranthene	None
Pyrene	None
Benzo(a)anthracene	None
Chrysene	None
Benzo(b)fluoranthene	None
Benzo(k)fluoranthene	None
Indeno(1,2,3-cd)pyrene	None
Benzo(ghi)perylene	None
Benzo(a)pyrene	None
Dibenz(a,h)anthracene	None
Benzene	None
Toluene	None
Ethylbenzene	None
Xylene (o, m & p)	None
MTBE	None
Asbestos Screen	None

Chemical laboratory testing of the Made Ground revealed no elevated levels of contaminants above the guideline levels for a ‘***Residential with home grown produce***’ land-use scenario.

In addition, the intrusive investigation did **not** reveal any visual or olfactory evidence to suggest any hydrocarbon-type contamination in the trial holes excavated on the site. The chemical laboratory results have verified that no elevated concentrations of aliphatic/aromatic hydrocarbons (C_5-C_{35}) or BTEX compounds are present in the soils underlying the site.

5.3.3 Groundwater Risk Assessment

A study of the aquifer maps on the DEFRA website revealed the site to be located on a **Secondary A Aquifer** comprising the Bagshot Formation and the Claygate Member of the London Clay Formation.

Examination of the Environment Agency records showed that the site did not fall within a Groundwater Source Protection Zone as classified in the Policy and Practice for the Protection of Groundwater.

Examination of the Environment Agency records and Figure 8 of the Camden Geological, Hydrogeological and Hydrological Study (see Figure 13 of this report) showed that the site did **not** fall within a Groundwater Source Protection Zone as classified in the Policy and Practice for the Protection of Groundwater.

There were no surface water features within a close proximity of the site in accordance with Figure 12 of the Camden Geological, Hydrogeological and Hydrological Study (see Figure 14 of this report). Figure 11 of the Camden Geological, Hydrogeological and Hydrological Study revealed a tributary of the “Lost” Westbourne River immediately to the east of the site. (see Figure 15 of this report)

Figure 14 of the Camden Geological, Hydrogeological and Hydrological Study revealed the site was not located within the catchment of Hampstead Ponds (see Figure 17 of this report).

From analysis of hydrogeological and topographical maps groundwater was anticipated to be encountered at moderate depth (3 - 6m below existing ground floor level (bgl)) and it was considered that the groundwater was flowing in a south-westerly direction in accordance with the local topography.

Examination of the Environment Agency records showed that the site was not situated within a floodplain or flood warning area. Figure 15 the Camden Geological, Hydrogeological and Hydrological Study revealed that Platts Lane (~130m west) and Ferncroft Avenue (~130m south-west) suffered surface water flooding in 2002 and 1975 respectively (see Figure 17 of this report).

Given the hydrogeological setting of the site, the groundwater (Secondary A Aquifer) directly underlying the site was considered to be a sensitive receptor. However, given the low level of determinants noted in the soils and the likely limited mobility of determinants, the Made Ground encountered onsite was unlikely to pose a risk to groundwater.

7.0 ENGINEERING CONSIDERATIONS

7.1 Impact Assessment

There were no apparent major issues which should seriously affect the viability of the construction of the new basement and single storey rear extension. However, the assessment of the geological environment of 16 Rosecroft Avenue and the screening exercise indicate some areas for further discussion in this report with suggested mitigation where appropriate.

1. **Bagshot Formation/Shrink and Swell** - The basement will be founded in the Bagshot Formation. The cohesive soils were of medium plasticity and medium volume change potential. The extension of the basement will be founded at ~2.00m below driveway level and ~4.20m below patio level; therefore, below any seasonal shrink and swell. The basement will also be constructed beyond the depth of any root penetrated soils. **It is possible that the removal of overburden may cause heave to occur.**

2. **Trees and Bushes –** Multiple trees are located in the rear garden and a number of bushes in the gardens and adjacent gardens. The nearest tree is noted to be ~6.00m to the north-east of the front retaining wall of the basement; therefore, the basement is not noted to be extending below the tree canopy. Care should be taken to minimise root damage during construction works. Should vegetation be removed, there is potential for the soils to swell as a result which may affect this and neighbouring properties and this should be accounted for in design.

3. **Basement Depth –** It was understood that the proposed basement will be constructed at the same depth as the basement recently formed under the neighbouring property, No.14 Rosecroft Avenue. It is also understood that No. 14 and No. 16 Rosecroft Avenue will be sharing underpinnings. Therefore, differential foundation depths will not be an issue at this property.

   No. 18 Rosecroft Avenue, on visual inspection, was noted to not have an existing basement. It was not known if No.12 Rosecroft Avenue had an existing basement. Given the properties to the west appear a sufficient distance away from the proposed development it was considered that only these two properties would require a Ground Movement Analysis (GMA).

   Take forward to scoping. A Ground Movement Analysis and individual assessment will be carried out for the neighbouring properties.

   Ground movement analysis and assessment was carried out for both neighbouring properties. The GMA is detailed later in this report.

4 **Surface Water Flood Risk and Surface Water Drainage** – The proposed development was expected to increase the amount of hardstanding by ~34m^2.

   The submission of a Sustainable Urban Drainage Scheme (SUDS) may be required for the proposed development to mitigate increased surface water flow.

5 **Made Ground –** The ground investigation encountered Made Ground to 0.08 – 1.00m bgl. The Made Ground was likely to be associated with the construction of the existing house.

The basement extension will be founded in natural ground (Bagshot Formation), by-passing the Made Ground.

6 **Groundwater** – Groundwater was encountered at 3.80m bdl (103.65m AOD) within BH1 located at the driveway of the property (107.45m AOD), and at ~3.70m bpl (106.13m AOD) within WS2, located at the rear of the property (110.25m AOD).

A return visit to monitor the combined gas and groundwater monitoring well installed in BH1 by a Ground and Water Limited Engineer on the 20th June 2018. Groundwater was noted to be resting at 4.09m bdl (103.36mAOD) in the 4.30m deep well (103.15mAOD).

The structural Design will need to take this into account. The potential for the rear retaining wall to encountered groundwater needs to be taken into account in final design.

It must be noted that no groundwater was encountered during the Ground Investigation at No.14 Rosecroft Avenue (Ref.: GWPR1540/GIR/March 2016).

7.1 Soil Characteristics and Geotechnical Parameters

Based on the results of the intrusive investigation and geotechnical laboratory testing the following interpretations have been made with respect to engineering considerations.

- Made Ground was encountered from each trial holes relative ground level to depths of between 0.08 -1.00m bgl within BH1, WS2-WS3 & TP2/FE2, ranging between 107.30 – 110.72m AOD.

  As a result of the inherent variability of Made Ground, it is usually unpredictable in terms of bearing capacity and settlement characteristics. Foundations should, therefore, be taken through any Made Ground and either into, or onto a suitable underlying natural stratum of adequate bearing characteristics.

  Made Ground may be found to deeper depth at other locations on the site, especially close to former structures/foundations and service runs.

- Soils described as the Bagshot Formation were encountered underlying the Made Ground in all trial hole to depths of between 0.80 – 4.80m below the top of the boreholes. The soils comprised a brown/brown-orange interbedded layers of clayey silty sand with layers of sandy silty clay/silty sandy clay of medium undrained shear strength (60kPa). The sand was fine to medium grained. Within WS3 the soils became more sandy with depth. Pockets of sand were observed from 0.08 – 1.00m and 2.00 – 4.80m bpl within WS2 and from 0.48 – 0.80m brgwl within TP2.

  The cohesive soils of the Bagshot Formation were shown to have **MEDIUM** volume change potential in accordance both BRE240 and NHBC Standards Chapter 4.2.

  Consistency Index Calculations indicated the cohesive soils of the Bagshot Formation to be firm to stiff. Geotechnical analysis revealed the soils to be overconsolidated with no potentially significant moisture deficits.

  The deposits of the Bagshot Formation were therefore likely to be a suitable stratum for the proposed traditional strip or mat foundations associated with the basement. The settlements induced on loading are likely to be low to moderate.

- Soils described as the Claygate Member of the London Clay Formation were encountered underlying the Bagshot Formation for the remaining depth of BH1. The soils comprised interbedded layers of brown/brown-orange mottled silty very sandy clay/silty sandy clay of medium undrained shear strength (50-65kPa) with loose/medium to medium dense clayey silty sand/silty very clayey sands. The sand was fine to medium grained.

  The granular soils of the Claygate Member of the London Clay Formation were shown to have **NO** volume change potential in accordance with BRE240 and NHBC Standards Chapter 4.2.

  The cohesive soils of the Claygate Member of the London Clay Formation were shown to have **MEDIUM** volume change potential in accordance both BRE240 and NHBC Standards Chapter 4.2.

  Consistency Index Calculations indicated the cohesive soils of the Claygate Member of the London Clay Formation to be soft to firm. Geotechnical analysis revealed the soils to be overconsolidated with no potentially significant moisture deficits.

The final design of foundations will need to take into account the volume change potential of the soil, the depth of root penetration and/or moisture deficit and the likely serviceability and settlement requirements of the proposed structure. These parameters for design are discussed in the next section of this report.

- The groundwater levels encountered appear to dip in line with tomography, being at 3.7 – 3.8m below their relative ground levels. The groundwater levels was deemed to be at ~106.13m AOD to the rear of the property and at 103.36 – 103.65m AOD at the front.

- Roots were noted to depths of 1.50m – 1.80m bgl within BH1, WS2-WS3 and for the full depth of TP2/FE2 at 0.80m brgwl.

The geotechnical parameters, tabulated below, have been used when modelling settlements and bearing capacities for spread foundation design.

Summary of Geotechnical Parameters (Based on BH1)							
Layer (m bdl)	Unit Volume Weight (kN/m³)	Saturated Unit Volume Weight (kN/m³)	Cohesion (kN/m²)	Undrained Cohesion (kN/m²)	Angle of Friction (◦)	Elastic Modulus (kN/m²)	Odeometric Modulus (kN/m²)
0.00 – 0.50	1.49	1.88	0.00	0.00	28.20	4695.42	5472.11
0.50 – 1.00	1.73	1.92	0.00	0.00	29.99	11732.60	8087.54
1.00 – 1.50	2.04	2.24	0.00	63.74	0.00	12709.40	12709.40
1.50 – 2.00	2.05	2.25	0.00	68.65	0.00	13690.00	13690.00
2.00 – 2.40	1.87	1.95	0.00	0.00	31.34	17016.50	10050.80
2.50 – 3.00	1.78	1.93	0.00	0.00	30.44	13497.80	8743.61
3.00 – 3.50	1.73	1.92	0.00	0.00	29.99	11732.60	8087.54
3.50 – 4.00	1.92	2.11	0.00	41.19	0.00	8306.23	10383.20
4.00 – 4.50	1.69	1.91	0.00	0.00	29.69	10555.80	7650.17
4.50 – 5.00	1.69	1.91	0.00	0.00	29.69	10555.80	7650.17
5.00 – 5.50	1.98	2.18	0.00	50.99	0.00	10267.50	10267.50
5.50 – 6.00	2.03	2.23	0.00	60.80	0.00	12219.00	12219.00
6.00 – 6.50	2.08	2.29	0.00	83.36	0.00	16622.20	16622.20
6.50 – 7.00	2.11	2.19	0.00	117.68	0.00	23467.30	23467.30
7.00 – 7.50	2.14	2.32	0.00	139.25	0.00	27860.60	27860.60
7.50 – 8.00	2.10	2.31	0.00	98.07	0.00	19554.40	19554.40
8.00 – 8.50	2.05	2.25	0.00	68.65	0.00	13690.00	13690.00
8.50 – 9.00	1.98	2.18	0.00	50.99	0.00	10267.50	10267.50
9.00 – 9.50	1.94	2.13	0.00	44.13	0.00	8796.56	10996.20
9.50 – 10.00	2.02	2.22	0.00	58.54	0.00	11728.70	11728.70
10.00 – 10.50	2.08	2.29	0.00	83.36	0.00	16622.20	16622.20
10.50 – 11.00	2.11	2.17	0.00	112.78	0.00	22486.60	22486.60
11.00 – 11.50	2.11	2.18	0.00	114.74	0.00	22976.90	22976.90
11.50 – 12.00	2.12	2.22	0.00	122.58	0.00	24438.10	24438.10
12.00 – 12.50	2.12	2.22	0.00	122.58	0.00	24438.10	24438.10
12.50 – 13.00	2.12	2.24	0.00	124.54	0.00	24928.50	24928.50
13.00 – 13.50	2.12	2.25	0.00	127.49	0.00	25148.80	25148.80

7.2 Spread and Basement Foundations

At the time of reporting, July 2018, the proposed development was understood to comprise the excavation of a basement below the entire footprint of the ground floor (between ~109 – 112m AOD), including construction of lightwells, as well a single storey rear extension. The basement will be excavated ~3.40m below first floor level (formed at 106.40m AOD). The retaining wall foundation of the basement is to be formed at ~2.00m below driveway level (floor level of front garage) (bdl) and ~4.20m below patio level (bpl) at the rear garden. A section view of the proposed development can be viewed within Figure 7, with a proposed plan view provided in Figure 8.

The proposed development fell within Geotechnical Design Category 2 in accordance with Eurocode 7.

The proposed development was understood not to involve any re-profiling of the site and its immediate environs. It was understood that no trees will be removed to facilitate the construction of the basement.

The proposed development fell within Geotechnical Design Category 2 in accordance with Eurocode 7. The proposed foundation loads were not known to Ground and Water Limited at the time of reporting but are likely to range from 75 – 150kN/m^2.

Foundations should be designed in accordance with soils of **medium** volume change potential in accordance with BRE Digest 240 and NHBC Chapter 4.2.

Given the volume change potential of the soils, foundations must therefore not be placed within cohesive root penetrated and/or desiccated soils and the influence of the trees surrounding the site must be taken into account (NHBC Standards Chapter 4.2). It is recommended that foundations are taken at least 300mm into non-root penetrated strata.

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. Should trees be removed from the footprint of the proposed building then an alternative foundation system, such as piles or isolated pads should be considered.

Roots were noted to depths of 1.50m – 1.80m bgl within BH1, WS2-WS3 and for the full depth of TP2/FE2 at 0.80m brgwl. The depth of root penetration is tabulated below.

Borehole	Depths of Roots (m bgl)
BH1	1.50
WS2	1.50
WS3	1.80
TP2/FE2	0.80 (full depth of trial hole)

The basement formation level must be carefully inspected for the presence of fresh/live roots. Should live roots be noted at basement formation level then the basement formation level should be extended at least 300mm into non-root penetrated soils. The void should be backfilled to the proposed slab level using a granular engineered fill.

A minimum foundation depth of 2.00m below driveway level and 4.20m from the patio level is proposed.

It is considered likely the proposed basement will be constructed with load bearing concrete retaining walls with semi-ground bearing concrete floors. The following bearing capacities could be adopted for 5.0m long by 0.75m and 1.00m wide footings or a 1.50m by 1.50m pad a depth of 2.00m bdl from the front of the property and a depth of 4.20m bpl from the rear garden.

Due to the ground conditions encountered within BH1 (interbedded clays and sands), both drained and undrained conditions have been used for calculating bearing capacities at 2.00m and 4.20m bgl. **The allowable bearing capacity has been based on a figure between these two values.**

Limit State: Bearing Capacities Calculated (Bases on BH1)		
Depth	**Foundation System**	**Limit Bearing Capacity (kN/m²)**
2.00m bdl (Undrained conditions)	5.00m by 0.75m Strip	13.35
	5.00m by 1.00m Strip	13.53
	1.50m by 1.50m Pad	13.53
2.00 bdl (Drained conditions)	5.00m by 0.75m Strip	236.09
	5.00m by 1.00m Strip	243.35
	1.50m by 1.50m Pad	308.76
4.20 bpl (Undrained conditions)	5.00m by 0.75m Strip	23.26
	5.00m by 1.00m Strip	29.66
	1.50m by 1.50m Pad	60.11
4.20 bpl (Drained conditions)	5.00m by 0.75m Strip	381.43
	5.00m by 1.00m Strip	389.65
	1.50m by 1.50m Pad	148.34

Serviceability State: Settlement Parameters Calculated (Based on BH1)			
Depth	**Foundation System**	**Limit Bearing Capacity (kN/m²)**	**Settlement (mm)**
2.00m bdl	5.00m by 0.75m Strip	150	22.29
	5.00m by 1.00m Strip	140	24.45
	1.50m by 1.50m Pad	150	23.71
4.20m bpl	5.00m by 0.75m Strip	200	19.50
	5.00m by 1.00m Strip	200	23.00
	1.50m by 1.50m Pad	100	5.30

The actual settlement which will occur will be a function of the structural loading. Therefore, foundations and loading profiles should be examined by a structural engineer.

Based on the groundwater conditions encountered, if foundations were taken to ~2.00m bdl and 4.20m bpl (~106.40m AOD), it was considered **unlikely** that the retaining wallls near the front driveway will encounter groundwater and **possible** that the retaining walls near the rear garden patio will encounter groundwater. Keeping the retaining walls shallow to the rear may mean groundwater ingress is avoided, the groundwater level was measured at 0.27m shallower than the proposed basement.

No groundwater was encountered during the Ground Investigation at No.14 Rosecroft Avenue (Ref.: GWPR1540/GIR/March 2016).

The rear basement slab and retaining walls may need to take into account potential boyancy effects of groundwater in final design.

The structural engineer will be required to account for this in the final design.

Foundations to this depth would require dewatering to facilitate the construction and prevent the base of the excavation blowing before the slab was cast. The advice of a reputable dewatering contractor, familiar with the type of ground and groundwater conditions encountered on this site, should be sought prior to finalising the design of the excavation for the basement.

6.2.1 Basement Slab

An equivalent basement slab, measuring ~19.0m by ~9.6m, with a self-weight of 10kN/m2, may experience an immediate heave on overburden pressure relief of ~6.53mm constructed at 2.00m bdl and ~17.84mm constructed at ~4.20m bpl.

It is estimated that 30 - 50% of the total heave will be immediate. Therefore, the total heave may reach up to 1.96 – 3.27mm at a depth of 2.00m bdl and 5.35 – 8.92mm at a depth of 4.20m bpl. **The structural engineer will be required to account for this in the final design. Use of clayboard beneath partially suspended slab may be required.**

6.2.2 General Advice for Basement Foundations

Excavations must be kept dry and either concreted or blinded as soon after excavation as possible. If water were allowed to accumulate on the formation for even a short time not only would an increase in heave occur resulting from the soil increasing in volume by taking up water, but also the shear strength and hence the bearing capacity would also be reduced

It was considered possible that the basement excavations may encounter some perched water within the Made Ground or and silty/sandy beds of Bagshot Formation and Claygate Member of the London Clay Formation, especially after period of prolonged rainfall. The structural engineer will be required to account for this in the final design.

Consideration could be given to shallowing of the basement level to the rear of the structure in order to avoid interaction with groundwater.

If the construction works take place during the winter months, when the groundwater level is expected to be at its higher elevation, perched water may be encountered thus dewatering could be required to facilitate the construction and prevent the base of the excavation blowing before the slab was cast.

In the context of this report groundwater is classed as part of the saturated aquifer, with perched water being a finite volume of water trapped at shallower depth above the saturated aquifer, possibly due to anthropogenic reasons (i.e. Made Ground).

The advice of a reputable dewatering contractor, familiar with the type of ground and groundwater conditions encountered on this site, should be sought prior to finalising the design of the excavation for the basement. It would also be recommended to check the standing groundwater level again in the monitoring standpipe installed on-site immediately prior to commencing the build to ensure adequate precautions are in place in the event of groundwater levels being higher than previously recorded.

The basement must be suitably tanked to prevent ingress of groundwater and also surface water run-off.

7.3 Piled Foundations

Given the results of the investigation, a piled foundation scheme was considered unlikely to be required at this site.

7.4 Basement Excavations & Stability

Shallow excavations in the Made Ground, Bagshot Formation and the Claygate Member of the

London Clay Formation are likely to be marginally stable at best. Long, deep excavations, through both of these strata are likely to become unstable.

The excavation of the basement must not affect the integrity of the adjacent structures beyond the boundaries. The excavation must be supported by suitably designed retaining walls. It is considered unlikely that battering the sides of the excavation, casting the retaining walls and then backfilling to the rear of the walls would be suitable given the close proximity of the party walls.

The retaining walls for the basement will need to be constructed based on cohesive soils with an appropriate angle of shear resistance (*Ф'*) for the ground conditions encountered.

Based on the ground conditions encountered within the boreholes the following parameters could be used in the design of retaining walls. These have been designed based on the SPT profile recorded, results of geotechnical classification tests and reference to literature.

Retaining Wall/Basement Design Parameters					
Strata	**Unit Volume Weight (kN/m³)**	**Cohesion Intercept (c') (kPa)**	**Angle of Shearing Resistance (Ø)**	**Ka**	**Kp**
Made Ground	~13 - 15	0	12	0.66	1.52
Bagshot Formation (Granular)	~21	0	32	0.31	3.25
Bagshot Formation (Cohesive)	~20-22	0	24	0.42	2.37
Claygate Member of the London Clay Formation (Cohesive)	~20-22	0	24	0.42	2.37
Claygate Member of the London Clay Formation (Granular)	~21	0	32	0.31	3.25

Unsupported earth faces formed during excavation may be liable to collapse without warning and suitable safety precautions should therefore be taken to ensure that such earth faces are adequately supported before excavations are entered by personnel.

No groundwater was encountered during the Ground Investigation at No.14 Rosecroft Avenue (Ref.: GWPR1540/GIR/March 2016). Based on the groundwater conditions encountered, if foundations were taken to ~2.00m bdl and 4.20m bpl (~106.40m AOD), it was considered **unlikely** that the retaining walls near the front driveway will encounter groundwater and **possible** that the retaining walls near the rear garden patio will encounter groundwater. Keeping the retaining walls shallow to the rear may mean groundwater ingress is avoided, the groundwater level was measured at 0.27m shallower than the proposed basement.

Foundations to this depth would require dewatering to facilitate the construction and prevent the base of the excavation blowing before the slab was cast. The advice of a reputable dewatering contractor, familiar with the type of ground and groundwater conditions encountered on this site, should be sought prior to finalising the design of the excavation for the basement.

It was considered possible that the basement excavations may encounter some perched water at shallower depths within the Made Ground and the silty/sandy beds of the Bagshot Formation and Claygate Member of the London Clay Formation, especially after prolonged periods of rainfall. The structural engineer will be required to account for this in the final design. Given the depth of the groundwater strike, the actual groundwater table is unlikely to be intercepted by the construction of the basement.

Shallower groundwater levels may be experienced if winter construction is to take place.

7.6 Hydrogeological Effects

A study of the aquifer maps on the Environment Agency website, and Figure 8 of the Camden Geological, Hydrogeological and Hydrological Study (see Figure 113 of this report), revealed the site to be located on **Secondary A Aquifer** relating to the bedrock of the Bagshot Formation and the Claygate Member of the London Clay Formation**.** No designation was given for any superficial deposits due to their likely absence.

The ground conditions encountered generally comprised a capping of Made Ground over interbedded cohesive and granular soils of the Bagshot Formation overlying interbedded cohesive and granular soils of the Claygate Member of the London Clay Formation. Based on visual appraisal of the soils of the Bagshot Formation and Claygate Member of the London Clay Formation beds were likely to have a low permeability.

Groundwater was encountered at 3.80m bdl (103.65mAOD) within BH1, located at the front of the property, and at ~3.70m bpl (106.13mAOD) within WS2, located at the rear of the property (110.25m aOD).

This groundwater was considered to represent the underlying saturated aquifer or the downward migration of perched water from the overlying Made Ground. A return visit to monitor the combined gas and groundwater monitoring well installed in BH1 by a Ground and Water Limited Engineer on the 20th June 2018. Groundwater was noted to be resting at 4.09m bdl (103.36mAOD) in the 4.30m bdl (103.15mAOD) deep well.

No groundwater was encountered during the Ground Investigation at No.14 Rosecroft Avenue (Ref.: GWPR1540/GIR/March 2016). Based on the groundwater conditions encountered, if foundations were taken to ~2.00m bdl and 4.20m bpl (~106.40m AOD), it was considered **unlikely** that the retaining wallls near the front driveway will encounter groundwater and **possible** that the retaining walls near the rear garden patio will encounter groundwater. Keeping the retaining walls shallow to the rear may mean groundwater ingress is avoided, the groundwater level was measured at 0.27m shallower than the proposed basement.

Dewatering may be required and the advice of a reputable dewatering contractor, familiar with the type of ground and groundwater conditions encountered on this site, should be sought prior to finalising the design of the excavation for the basement.

Perched water may encountered during construction in the Made Ground especially after a period of excessive rainfall.

As the basement is constructed on the slope of a hill, it will need to permit groundwater flow downslope. It was considered unlikely that the basement will significantly block groundwater flow as it was likely that groundwater will be able to percolate downward and under the basement into the sand bands present in the Bagshot Formation and Claygate Member of the London Clay Formation. Consideration should be given to additional drainage to help facilitate this process.

7.6 Slope Stability Analysis

Although the site is located on a slope to the north-west, the construction of basements in similar nearby properties, such as the adjacent 14 Rosecroft Avenue, the stability of the slope is not considered a significant risk.

There has been no evidence of a historic slope instability risk on site and the neighbouring property (No. 14 Rosecroft Avenue (Ref:, GWPR1540/GIR/March 2018)) did not encounter any similar issues. The installation of the current lower ground floor box structure should increase overall factors of safety. It is considered that there is no general slope instability issues based on the reviewed profile. The retaining walls will need to be designed appropriately in order to withstand the forces from the retained ground, including potentially groundwater. Therefore, no further slope stability analysis was considered necessary or applicable.

7.7 Assessment of Ground Movement

At the time of reporting, July 2018, the proposed development was understood to comprise the excavation of a basement below the entire footprint of the ground floor (between ~109 – 112m AOD), including construction of lightwells, as well a single storey rear extension. The basement will be excavated ~3.40m below first floor level (formed at 106.40m AOD). The retaining wall foundation of the basement is to be formed at ~2.00m below driveway level (floor level of front garage) (bdl) and ~4.20m below patio level (bpl) at the rear garden. A section view of the proposed development can be viewed within Figure 7, with a proposed plan view provided in Figure 8.

The proposed development fell within Geotechnical Design Category 2 in accordance with Eurocode 7.

The proposed development was understood not to involve any re-profiling of the site and its immediate environs. It was understood that no trees will be removed to facilitate the construction of the basement.

An assessment of potential ground movements was therefore necessary to determine whether there would be any detrimental effects on the neighbouring properties from the extension of the basement.

The site was surrounded by two/three-storey brick built residential detached/semi detached properties to the north, south and east.

Based on the maximum depth of excavation, structures within a 16.8m radius of the proposed basement were considered likely to be influenced by the proposed development.

It is understood that No.14 will be sharing a underpin with No.16 Rosecroft associated with their respective basement. Therefore, differential foundation depths will not be an issue and a Ground Movement Analysis has not been undertaken at this property.

Parameters of Surrounding Properties			
Property	**Approximate Distance to Closest Wall/Corner (m)**	**Approximate Length (m)**	**Approximate Height (m)**
18 Rosecroft Avenue	1.60	20.00	12
12 Rosecroft Avenue	13.40	20.80	12

- The magnitude of ground movements has been assessed for the excavation of the traditional underpinned retaining wall structures.
- It is important to note that CIRIA Report C580/760 was written for embedded retaining walls. Therefore, movement calculations for the excavation of soil and installation of the underpinnings does not strictly apply to C580/760.

The following parameters have been used to inform this assessment:

- The maximum excavation depth is approximately 4.20m bpl.
- The method of basement construction for the basement will be traditional underpinning
- **A high wall stiffness has been assumed in the temporary condition;**
- In the permanent case the wall will always be propped at high level;

Based on reference to CIRIA Report C760 the following ground movements have been developed based on of the excavation of soils to form the basement.

The ground movement analysis was conducted using soft to firm clay, sand and stiff clay ground conditions due to the presence of soft to stiff soils and sands of the Bagshot Formation and Claygate Member of the London Clay Formation.

Ground Movement Analysis - Excavation (Soft to Firm Clay)								
Property	**Assessed Excavation Depth**	**Approx. Horizontal Ground Movement at Closest Wall/Corner (mm)**	**Approx. Horizontal Ground Movement at Furthest Wall/Corner (mm)**	**Horizontal Strain (%)**	**Approx. Vertical Ground Movement at Closest Wall/Corner (mm)**	**Approx. Vertical Ground Movement at Furthest Wall/Corner (mm)**	**Vertical Deflection Ratio (%)**	**Category of Damage**
Conservative Line								
18 Rosecroft Avenue	4.20	5.70	0.00	0.03750	18.90	0.00	0.053571	**Slight**
12 Rosecroft Avenue	4.20	1.28	0.00	0.03750	0.00	0.00	0.00	**Negligible**
Moderate Line								
18 Rosecroft Avenue	4.20	5.70	0.00	0.03750	10.50	0.00	0.030952	**Very Slight**
12 Rosecroft Avenue	4.20	1.28	0.00	0.03750	0.00	0.00	0.00	**Negligible**
Realistic Line								
18 Rosecroft Avenue	4.20	5.70	0.00	0.03750	6.30	0.00	3.20	**Negligible**
12 Rosecroft Avenue	4.20	1.28	0.00	0.03750	0.00	0.00	0.00	**Negligible**

Ground Movement Analysis – Excavation (Sand)					
Property	**Assessed Excavation Depth**	**Approx. Vertical Ground Movement at Closest Wall/Corner (mm)**	**Approx. Vertical Ground Movement at Furthest Wall/Corner (mm)**	**Vertical Deflection Ratio (%)**	**Category of Damage**
18 Rosecroft Avenue	4.20	5.88	0.00	0.018452	**Negligible**
12 Rosecroft Avenue	4.20	0.00	0.00	0.00	**Negligible**

Ground Movement Analysis – Excavation in Stiff Clay								
Property	**Assessed Excavation Depth**	**Approx. Horizontal Ground Movement at Closest Wall (mm)**	**Approx. Horizontal Ground Movement at Furthest Wall (mm)**	**Horizontal Strain (%)**	**Approx. Vertical Ground Movement at Closest Wall (mm)**	**Approx. Vertical Ground Movement at Furthest Wall (mm)**	**Vertical Deflection Ratio (%)**	**Category of Damage**
18 Rosecroft Avenue	4.20	6.30	0.00	0.008929	1.68	0.00	0.03750	**Negligible**
12 Rosecroft Avenue	4.20	1.28	0.00	0.027228	0.37	0.00	0.01262	**Negligible**

The Ground Movement Spreadsheets and Calculations can be seen within Appendix F.

Horizontal contour plots can be seen in Figure 22. Vertical contour plots can be seen in Figures 23 – 25.

In terms of building damage assessment and with reference to Table 2.5 of C580 (after Burland et al, 1977), the 'Description of typical damage' given the calculated movements it is likely that the damage assessment will fall into Category 0, 'Negligible' for all of the properties surrounding the site.

There are a number of key points to note in using this assessment:

- Most ground movement will occur during excavation and construction so the adequacy of temporary support will be critical in limiting ground movements;
- The speed of propping and support is key to limiting ground movements;
- Good workmanship will contribute to minimising ground movements;
- The assessment assumes the wall is in competent clay;
- Larger movements will be expected where soft soils are encountered at, above and below formation;

Ground movement can be minimised by adopting a number of measures, including;

- Ensuring that adequate propping is in place at all times during construction;
- In the permanent and temporary case the wall should be propped at high level;
- Minimise deterioration of the central soil mass by the use of blinding/covering with a waterproof membrane;
- Installation of the first (stiff) support quickly and early in the construction sequence for each underpin panel;
- Control dewatering to minimise fines removal and drawdown;
- Avoid overbreak.

It must be noted that C580 is written for imbedded walls and experience suggests the underpinning method does not result in significant movement. Therefore, the use of C580 in this context could be considered conservative. The stiffness of the wall will render the top 1m of so of the soils present insignificant with respect to movement.

Should the above precautions be included in the Construction Method Statement, best practice and good construction techniques are utilised by a reputable contractor, then this will minimise movements due to underpinning to acceptable limits.

Information supplied by 5D architects confirmed that no damage was noted to No.14 during the basement construction at No.16 Rosecroft Avenue. This proves that the mitigation measures highlighted and good construction practice to limit movements to acceptable limits.

7.8 Sub-Surface Concrete

Sulphate concentrations measured in 2:1 water/soil extracts taken from the Bagshot Formation and Claygate Member of the London Clay Formation, from both the geotechnical and chemical laboratory testing, fell into Class DS-1 of the BRE Special Digest 1, 2005, *'Concrete in Aggressive Ground'.*

Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-1 for foundations within the Claygate Member of the London Clay Formation. For the classification given, the "static" and "natural" case was adopted given the cohesive soils and the residential use of the site.

The sulphate concentration in the samples ranged from 76 - 150mg/l, from chemical and geotechnical testing, with a pH range of 4.8 – 7.7. The total potential sulphate concentration recorded was <0.02 - 0.06%.

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 the pH of the soils.

7.9 Surface Water Disposal

Soakaways constructed within the cohesive/granular soils of the Bagshot Formation and Claygate Formation of the London Clay Formation are unlikely to prove satisfactory due to negligible to low anticipated infiltration rates. Therefore, an alternative method of surface water disposal is required.

Consultation with the Environment Agency must be sought regarding any use that may have an impact on groundwater resources.

The proposed development was expected to increase the amount of hardstanding by 34m^2 and a slight increase in the amount of surface water discharged into the ground was anticipated.

The principles of sustainable urban drainage system (SUDS) and the requirements of the Sustainable Drainage Scheme should be applied to reduce the risk of flooding from surface water ponding and collection associated with the construction of the basement.

In accordance with the Sustainable Urban Drainage System the surface water run-off should be managed as close to its source as possible in line with the following drainage hierarchy:

- Store rainwater for later use;
- use infiltration techniques, such as porous surfaces in non-clay areas;
- attenuate rainwater in ponds or open water features for gradual release;

- attenuate rainwater by storing in tanks or sealed water features for gradual release;
- discharge rainwater direct to a watercourse;
- discharge rainwater to a surface water sewer/drain;
- discharge rainwater to the combined sewer.

Drainage should be designed and implemented in ways that deliver other policy objectives of this Plan, including water use efficiency and quality, biodiversity, amenity and recreation.

The majority of new developments are encouraged to use Sustainable Urban Drainage Systems (SUDS) to manage surface water drainage. This ensures that any volumes and peak flow rates of surface water leaving a developed site are no greater than the rates prior to the proposed development unless specific off-site arrangements are made and result in the same effect.

SUDS techniques include:

- Soakaways and other infiltration devices (where permeability allows);
- Swales and filter strips on sloping areas;
- Ponds, wetlands and basins;
- Filter drains and permeable paving, possibly with storage;
- Green roofs;
- Bioretention areas.

The above methods can be used individually but typically a solution that combines some or all of the above will be more effective.

7.10 Stage 5 Review

The conceptual site model given within Section 3.2.1 identified eight matters of concern for the property. These concerns have been assessed within the report and the conclusions can be seen tabulated overleaf.

Stage 5 Review		
Highlighted Area	**Site Specific Concern**	**Assessment**
Perched water within the Made Ground or groundwater within the Bagshot Formation	The basement may encounter perched water within the Made Ground or silt/sand bands of the Bagshot Formation/Claygate Member of the London Clay Formation during construction.	A groundwater strike was noted at 3.80m bdl (103.65mAOD) within BH1 and at 3.70m bpl (106.13mAOD) within WS2. Further groundwater strikes may have been obscured by the drilling process. A return visit to the groundwater well installed in BH1 by a Ground and Water Limited Engineer on the 20th June 2016. Groundwater was noted to be resting at 4.09m bdl (103.40mAOD) in the 4.30m (103.15mAOD) deep well. Based on the groundwater conditions encountered, if foundations were taken to ~2.00m bdl and 4.20m bpl (~106.40m AOD), it was considered **unlikely** that the retaining wallls near the front driveway will encounter groundwater and **possible** that the retaining walls near the rear garden patio will encounter groundwater. **Structural design will need to take this into account.** The basement may encounter groundwater during periods of wet weather perched within any Topsoil/Made Ground or within sand/silt bands of the Bagshot Formation and Claygate Member of the London Clay Formation. Consideration should be given to the dewatering to facilitate the construction and prevent the base of the excavation blowing before the slab was cast. Consideration could also be given the shallowing of the basement. The structural engineer will need to into account potential buoyancy effects of groundwater in final design.
Soil Moisture/ Trees and Bushes	There is potential for soil moisture content to affect the development.	Geotechnical analysis revealed the soils to be overconsolidated with no potentially root exacerbated moisture deficits. Basement will be formed at moisture stable depth.
Bagshot Member Formation Shrink and Swell	The basement foundations at the front of the property are anticipated to be founded in the cohesive soils of the Bagshot Formation. The soils are likely to have medium plasticity volume change potential. The concrete mix design should take appropriate account of sulphate levels (testing to BRE Special Digest). Heave on removal of overburden pressure may be a risk.	Geotechnical testing revealed the cohesive soils of the Bagshot Formation to have medium volume change potential in accordance with BRE240 and NHBC Standards Chapter 4.2. Sulphate concentrations measured in 2:1 water/soil extracts taken from the Claygate Member of the London Clay Formation from geotechnical analysis fell into Class DS-1 of the BRE Special Digest 1, 2005, 'Concrete in Aggressive Ground'. **Sub-surface concrete specification is discussed further in Section 7.9 of this report. Heave on removal of overburden pressure is discussed within Section 6.2 of this report.**

Cont'd overleaf

Cont'd from previous page

Stage 5 Review – Cont'd		
Highlighted Area	**Site Specific Concern**	**Assessment**
Differential Foundation Depths	It will be important to account for the shallow nature of existing footings at the property and its neighbours. Ground Movement Assessment is required.	Ground movement assessment was carried out on the neighbouring properties within Section 7.7 of this report. In terms of building damage assessment and with reference to Table 2.5 of C580 (after Burland et al, 1977), the 'Description of typical damage' given the calculated movements it falls between "slight" to "negligible" for 18 Rosecroft Avenue, and "negligible" for 12 Rosecroft Avenue. Good construction techniques and mitigated measures adopted in Section 7.7 will limit movements to acceptable limits, as per the approach adopted with No.14 Rosecroft Avenue.
Retaining Walls	Appropriate Design	Based on the groundwater conditions encountered in WS2, it was considered possible that groundwater would be encountered if foundations were taken to 3.70m bpl (106.13m AOD) at the rear of property. Parameters for retaining wall design provided in Section 7.4 of this report. **Structural Design will need to take this into account.**
Overall Slope Stability	The site was situated within an area where a natural or man-made slope of greater than 7_{o} and less than 10_{o} was present but is not within a wider hillside setting. The site is sloping down from a topographic high to the north of West Heath. An area with a natural or man-made slope of greater than 10_{o} was located immediately north-west of the site However, these are fairly localised along Rosecroft Avenue and do not represent the general slope of the site's environs.	It was understood that no existing slope stability problems were present onsite or within the site's environs. Retaining walls should be designed appropriate for the slope. The current lower ground floor box structure may be helping slope stability and should only serve to increase factors of safety. Given the above, an assessment of the slope stability for the development was not considered necessary.
Surface Water/Drainage	The proposed development was expected to increase hardstanding by ~34m^2. A slight increase in the amount of surface water discharged into the ground was anticipated.	The principles of sustainable urban drainage system (SUDS) and the requirements of the Sustainable Drainage Scheme should be applied to reduce the risk of flooding from surface water ponding and collection associated with the construction of the basement.

7.11 Discovery Strategy

There may be areas of contamination that have not been identified during the course of the intrusive investigation. For example, there may have been underground storage tanks (UST's) not identified during the Ground Investigation for which there is no historical or contemporary evidence.

Such occurrences may be discovered during the demolition and construction phases for the redevelopment of the site.

Groundworkers should be instructed to report to the Site Manager any evidence for such contamination; this may comprise visual indicators, such as fibrous materials within the soil, discolouration, or odours and emission. Upon discovery advice must be taken from a suitably qualified person before proceeding, such that appropriate remedial measures and health and safety protection may be applied.

Should a new source of contamination be suspected or identified then the Local Authority will need to be informed.

7.12 Waste Disposal

The excavation of foundations is likely to produce waste which will require classification and then recycling or removal from site.

Under the Landfill (England and Wales) Regulations 2002 (as amended), prior to disposal all waste must be classified as;

- Inert;
- Non-hazardous, or;
- Hazardous.

The Environment Agency's Hazardous Waste Technical Guidance (WM2) document outlines the methodology for classifying wastes.

Once classified the waste can be removed to the appropriately licensed facilities, with some waste requiring pre-treatments prior to disposal.

Hazardous waste requires pre-treatment prior to removal. The site may need to be registered as a Hazardous waste producer should such waste be removed from the site.

Based on a risk phrase analysis of the remaining chemical laboratory test results, in accordance with EC Hazardous Waste Directive and undertaken by Ground and Water Limited, one sample of Made Ground tested (WS3/0.25m bgl) was classified as **NON-HAZARDOUS.**

Hazardous waste will require pre-treatment prior to disposal in order to reduce the waste classification.

It is important to note that whilst we consider our in-house assessment tool to be an accurate interpretation of the requirements of WM3, therefore producing an initial classification in accordance with the guidance, landfill operators have their own assessment tools and can often come to different conclusions. As a result, some landfill operators could refuse to take apparently suitable waste. It is recommended that the receiving landfill views the results of this assessment and the chemical laboratory results to determine their own classification.

Following this initial waste hazard assessment a Full WAC Solid Suite Test with single batch leachate was undertaken on a sample of Made Ground (WS3/0.50m bgl) to determine which landfill category the waste conformed to. The results of the WAC test can be seen in Appendix D. All determinants, including cumulative 10:1 leachate concentrations, fell within the **INERT waste category**.

7.13 Imported Material

Any soil which is to be imported onto the site must undergo chemical analysis to prove that it is suitable for the purpose for which it is intended.

The Topsoil must be fit for purpose and must either be supplied with traceable chemical laboratory test certificates or be tested, either prior to placing (ideally) or after placing, to ensure that the human receptor cannot come into contact with compounds that could be detrimental to human health.

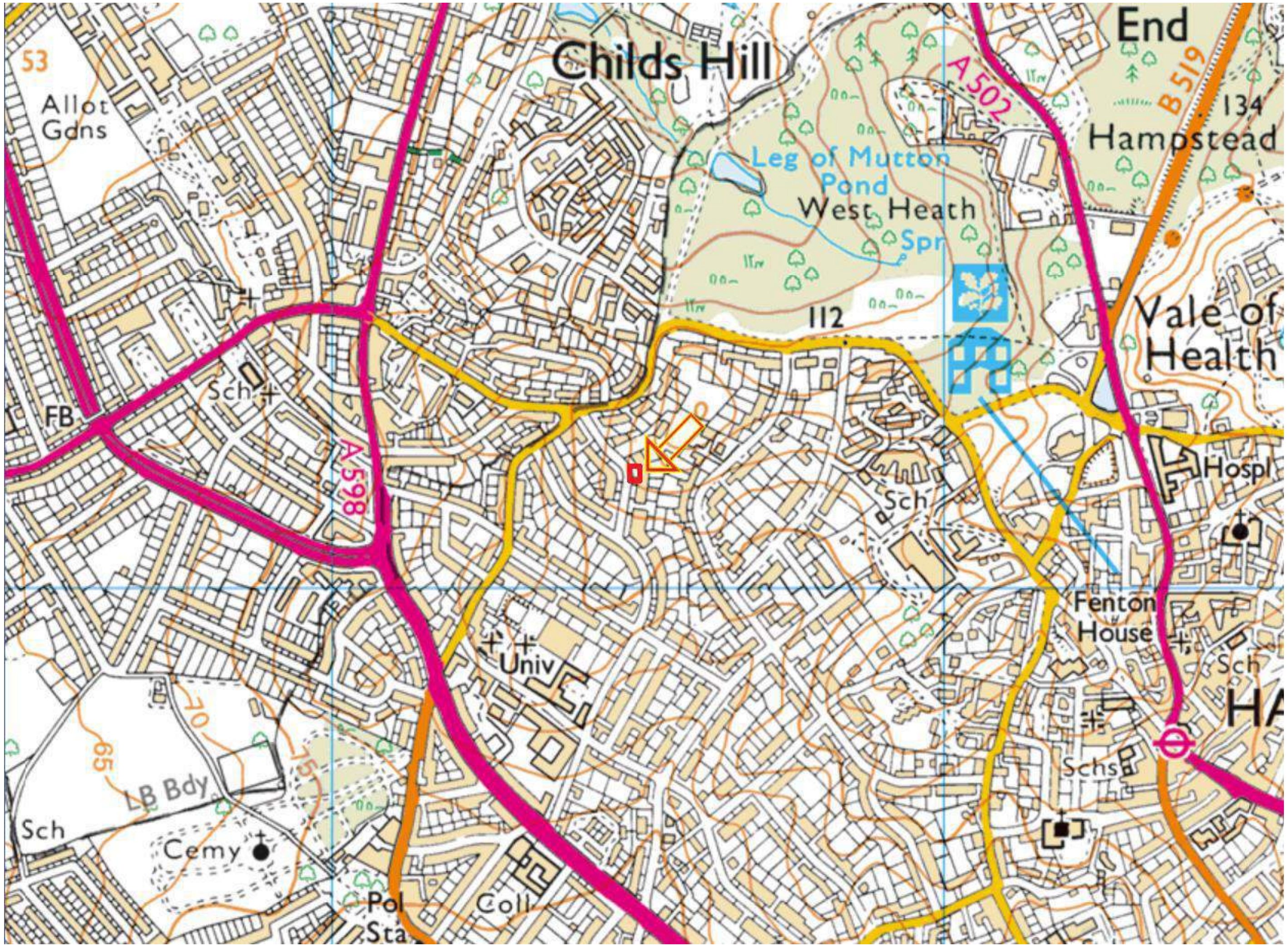
7.14 Duty of Care

Groundworkers must maintain a good standard of personal hygiene including the wearing of overalls, boots, gloves and eye protectors and the use of dust masks during periods of dry weather.

To prevent exposure to airborne dust by both the general public and construction personnel the site should be kept damp during dry weather and at other times when dust were generated as a result of construction activities.

The site should be securely fenced at all times to prevent unauthorised access. Washing facilities should be provided and eating restricted to mess huts.

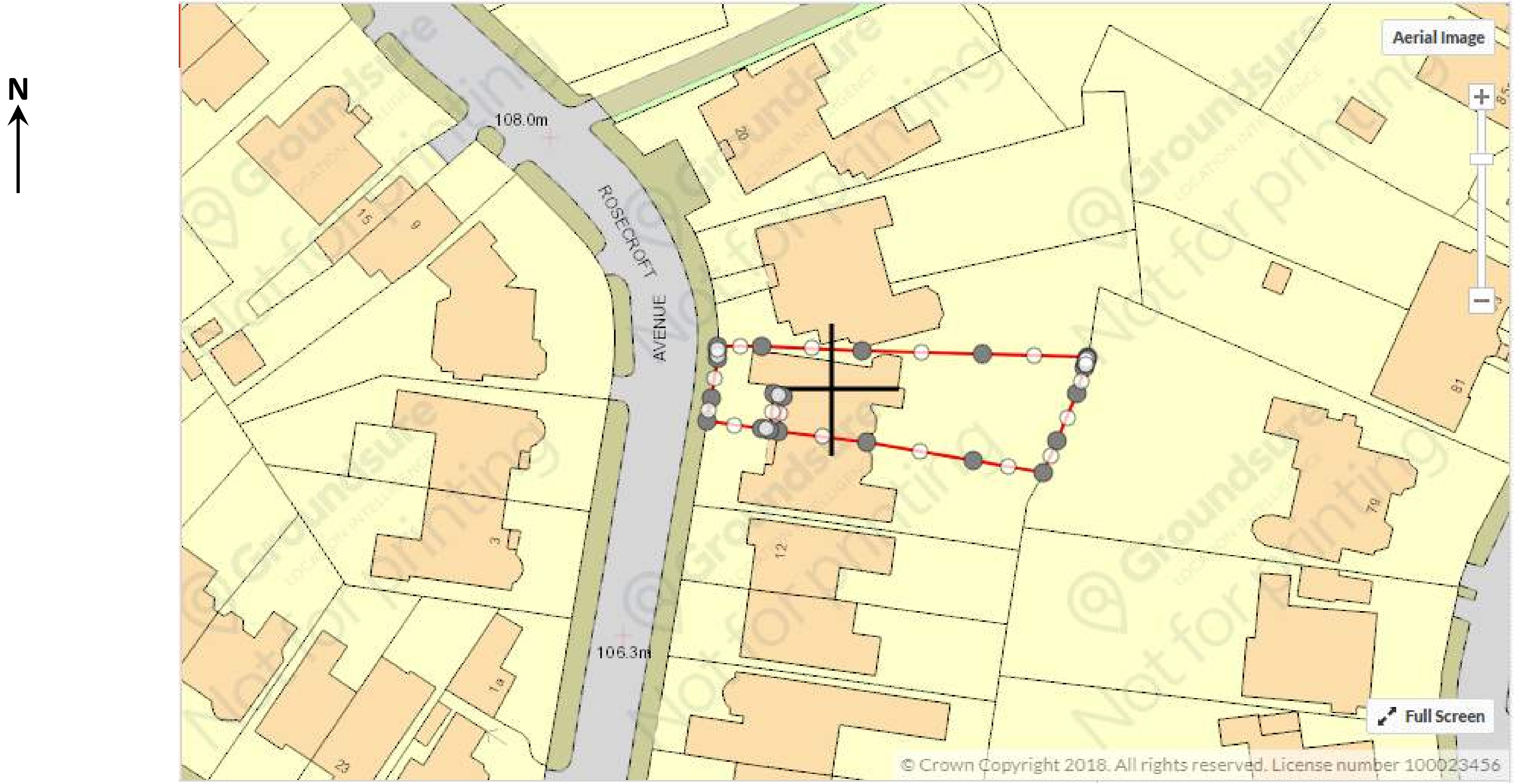
N



APPROXIMATE SITE BOUNDARY

NOT TO SCALE

Project: 16 Rosecroft Avenue, Childs Hill, London, NW3 7QB		**Figure 1**
Client: Mrs Appleton c/o Vincent&Rymill/5D Architects	**Date:** July 2018	ground&water
Site Location Plan	**Ref:** GWPR2630	



APPROXIMATE SITE BOUNDARY

NOT TO SCALE

Project: 16 Rosecroft Avenue, London, NW3 7QB	**Figure 2**
Client: Mrs Appleton c/o Vincent&Rymill/5D Architects — **Date:** July 2018	ground&water
Site Development Area — **Ref:** GWPR2630	

N

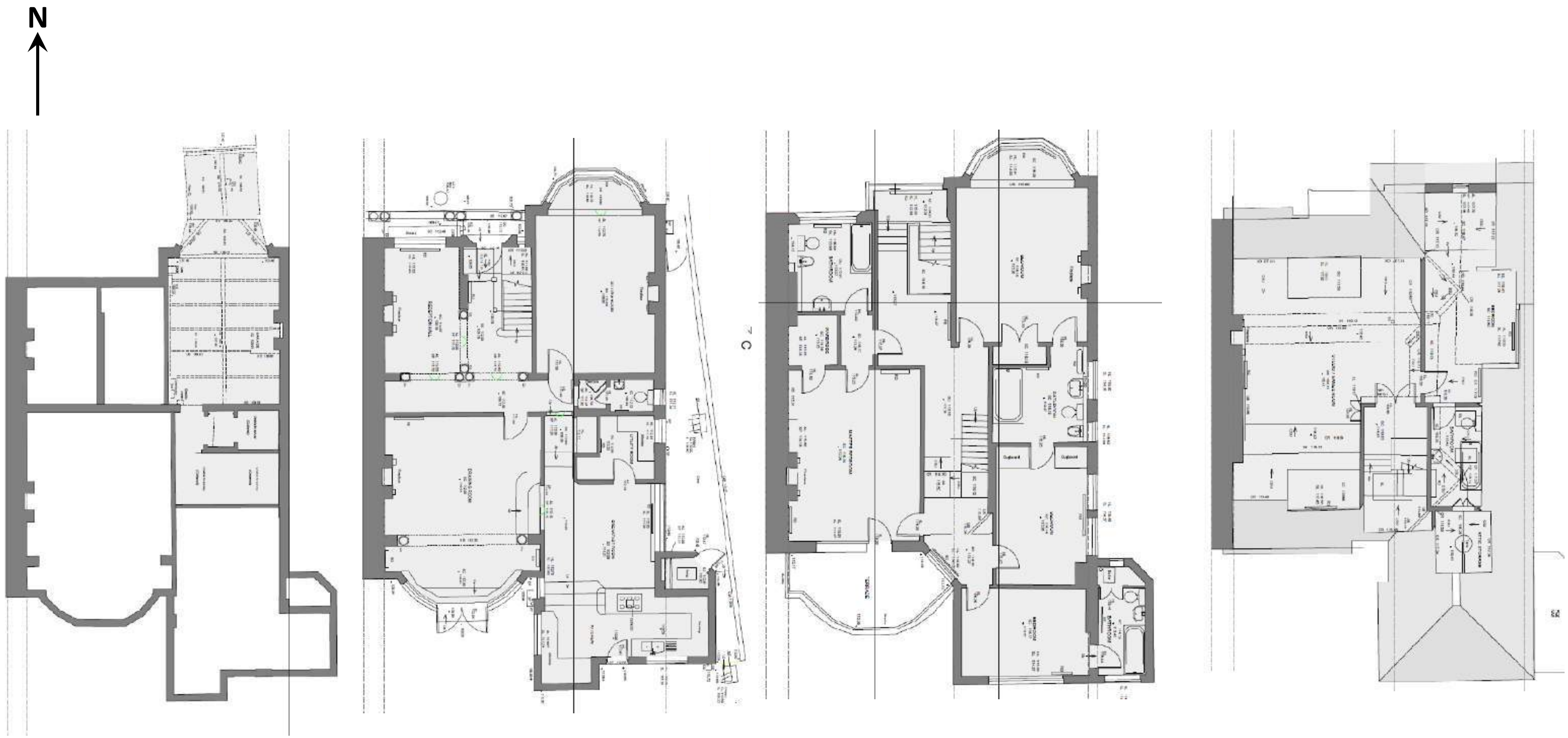
NOT TO SCALE

APPROXIMATE SITE BOUNDARY

Project: 16 Rosecroft Avenue, Childs Hill, London, NW3 7QB		**Figure 3**
Client: Mrs Appleton c/o Vincent&Rymill/5D Architects	**Date:** July 2018	ground&water
Aerial View of Site	**Ref:** GWPR2630	

NOT TO SCALE

Project: 16 Rosecroft Avenue, Childs Hill, London, NW3 7QB		**Figure 4**
Client: Mrs Appleton c/o Vincent&Rymill/5D Architects	**Date:** July 2018	ground&water
Existing Development – Section View	**Ref:** GWPR2630	



Project:

16 Rosecroft Avenue, Childs Hill, London, NW3 7QB

Client:

Mrs Appleton c/o Vincent&Rymill/5D Architects

Date:

July 2018

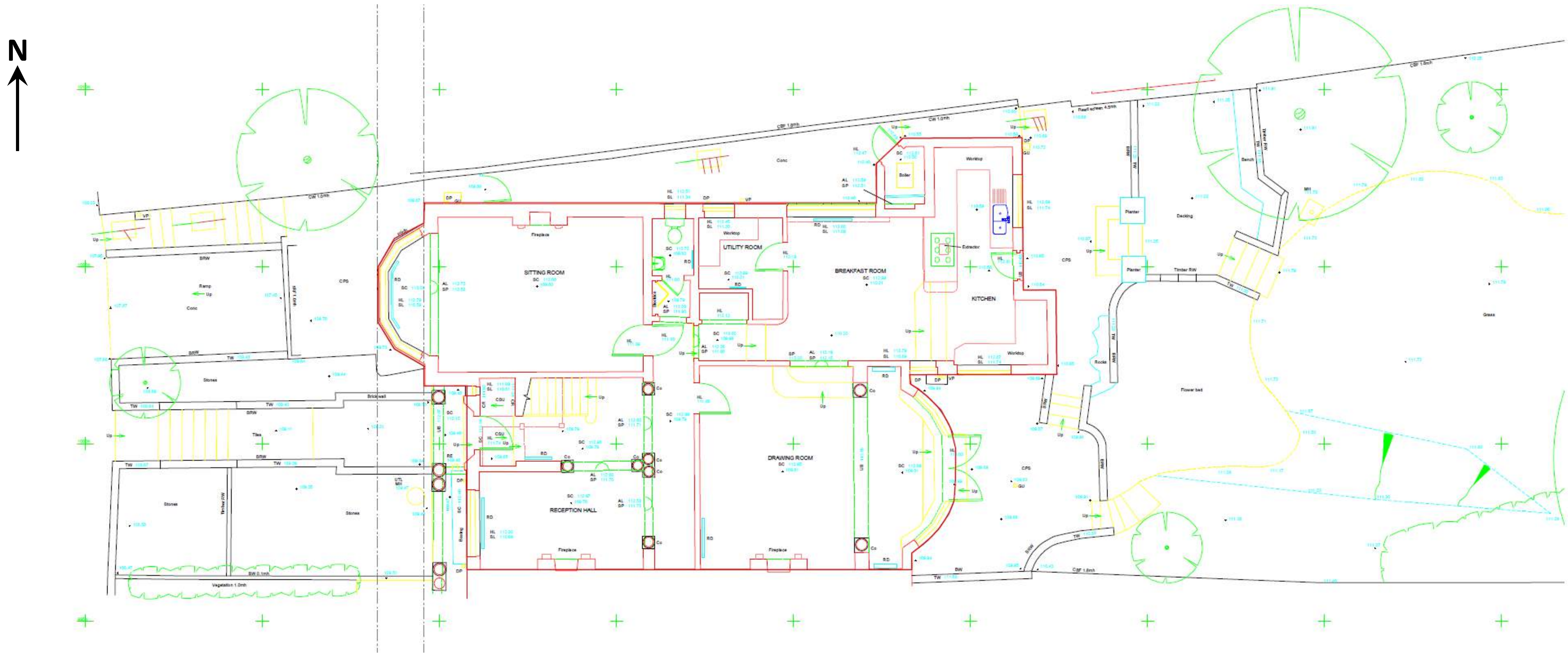
Existing Development – Plan View

Ref:

GWPR2630

Figure 5

ground&water

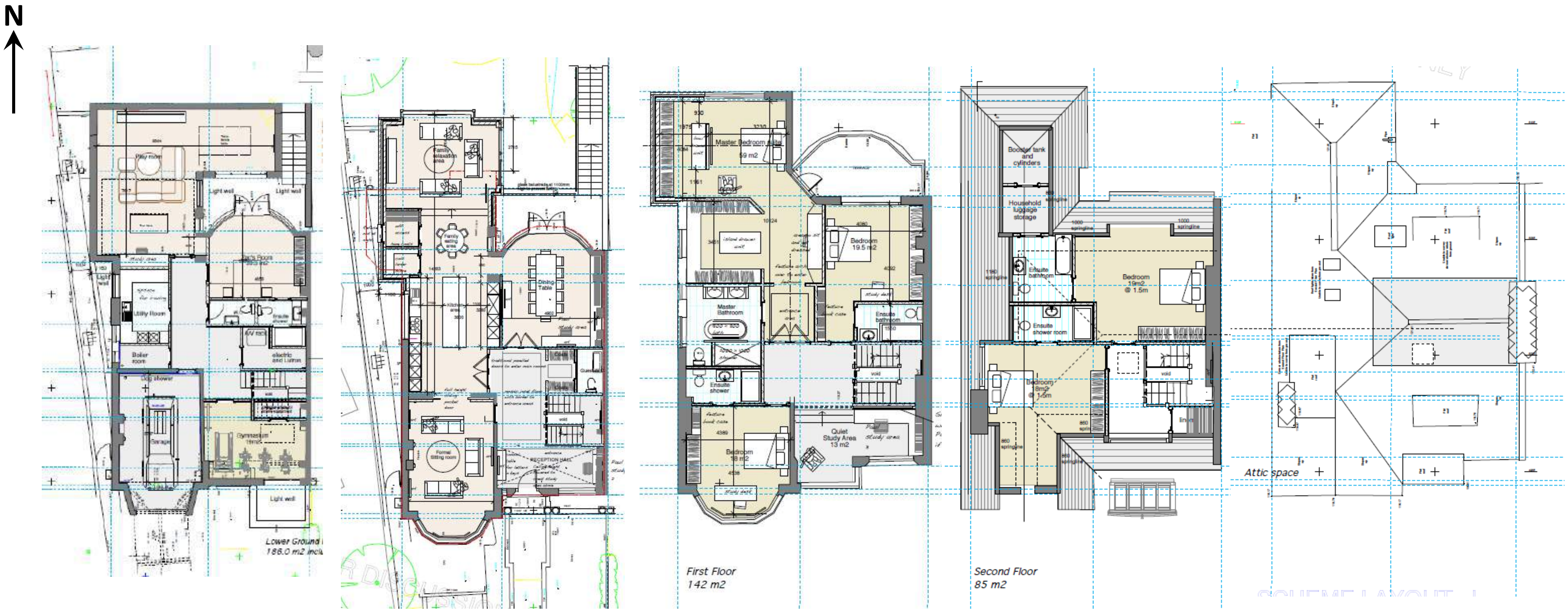


NOT TO SCALE

Project: 16 Rosecroft Avenue, Childs Hill, London, NW3 7QB	**Figure 6**
Client: Mrs Appleton c/o Vincent&Rymill/5D Architects — **Date:** July 2018	ground&water
Topographical Survey — **Ref:** GWPR2630	

NOT TO SCALE

Project: 16 Rosecroft Avenue, Childs Hill, London, NW3 7QB		**Figure 7**
Client: Mrs Appleton c/o Vincent&Rymill/5D Architects	**Date:** July 2018	ground&water
Proposed Development – Section View	**Ref:** GWPR2630	



Lower Ground Floor | Ground Floor | First Floor | Second Floor | Roof

NOT TO SCALE

Project: 16 Rosecroft Avenue, Childs Hill, London, NW3 7QB	**Figure 8**
Client: Mrs Appleton c/o Vincent&Rymill/5D Architects — **Date:** July 2018	ground&water
Proposed Development – Plan View — **Ref:** GWPR2630	

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 16 Rosecroft Avenue, Hampstead, London, NW3 7QB.

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.

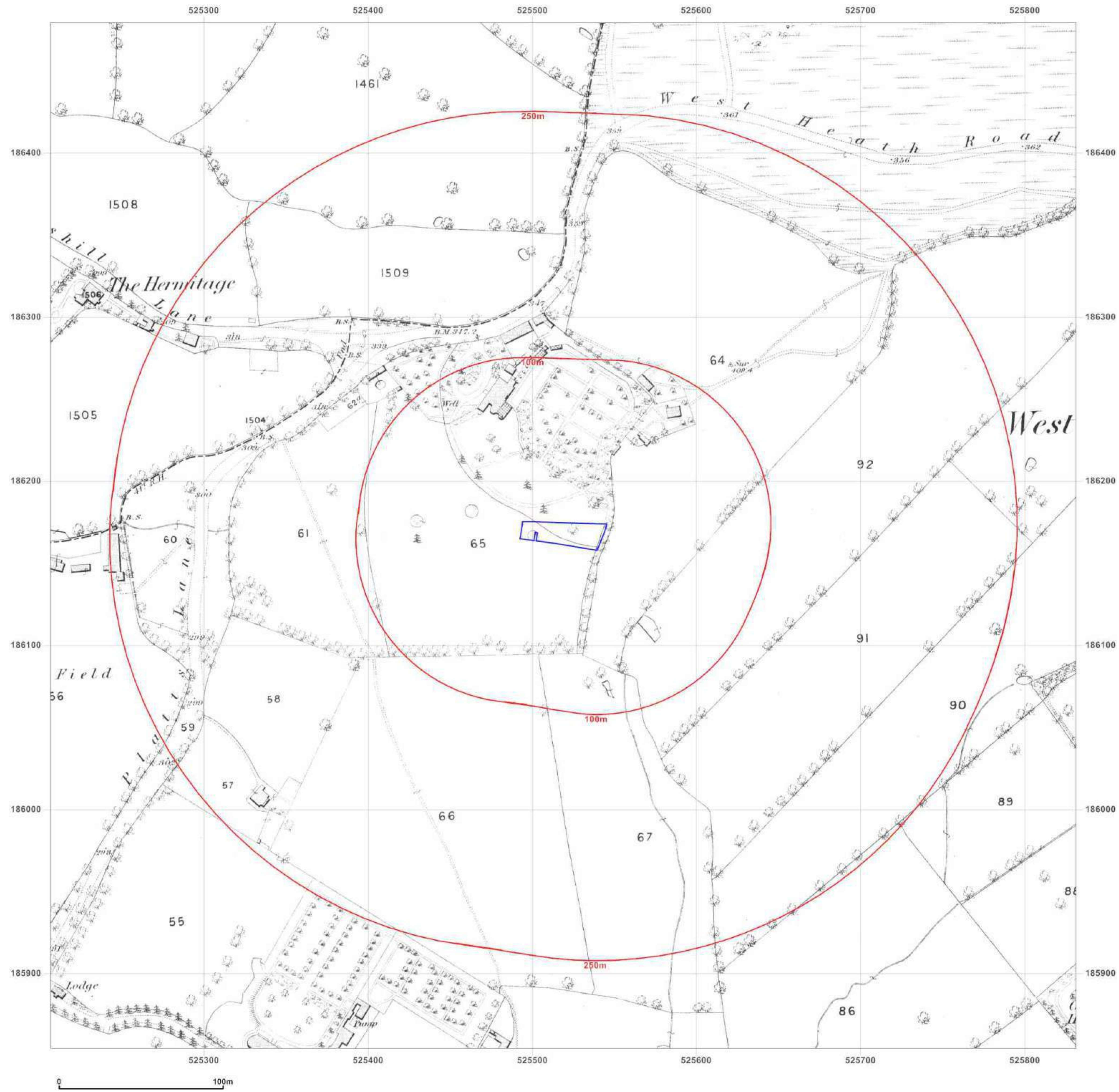
The depth to roots and/or of desiccation may vary from that found during the investigation. The client is responsible for establishing the depth to roots and/or of desiccation on a plot-by-plot basis prior to the construction of foundations. Where trees are mentioned in the text this means existing trees, 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
Historical Maps



Groundsure INSIGHTS

Site Details:

16, ROSECROFT AVENUE,
LONDON, NW3 7QB

Client Ref: GWPR2630_16_Rosecroft_Avenue
Report Ref: HMD-445-5129163
Grid Ref: 525519, 186167

Map Name: County Series

Map date: **1870**

Scale: 1:2,500

Printed at: 1:2,500

N
W E
S

Surveyed 1866
Revised N/A
Edition 1870
Copyright N/A
Levelled N/A

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Groundsure Insights
T: 08444 159000
E: info@groundsure.com
W: www.groundsure.com

Production date: 13 June 2018

Map legend available at:
www.groundsure.com/sites/default/files/groundsure_legend.pdf

Site Details:

16, ROSECROFT AVENUE,
LONDON, NW3 7QB

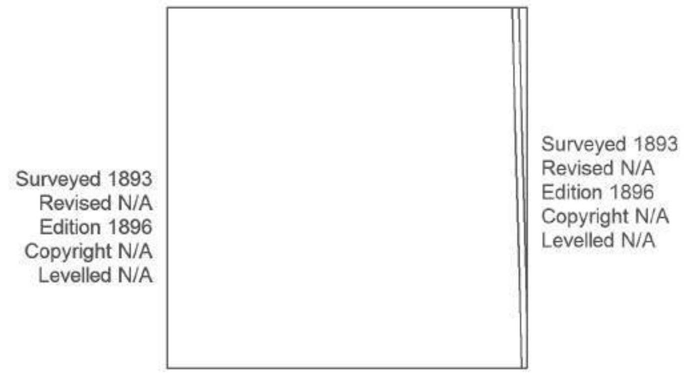
Client Ref: GWPR2630_16_Rosecroft_Avenue
Report Ref: HMD-445-5129163
Grid Ref: 525519, 186167

Map Name: 1056 Scale Town Plan

Map date: **1896**

Scale: 1:1,056

Printed at: 1:1,056



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Production date: 13 June 2018

Map legend available at:
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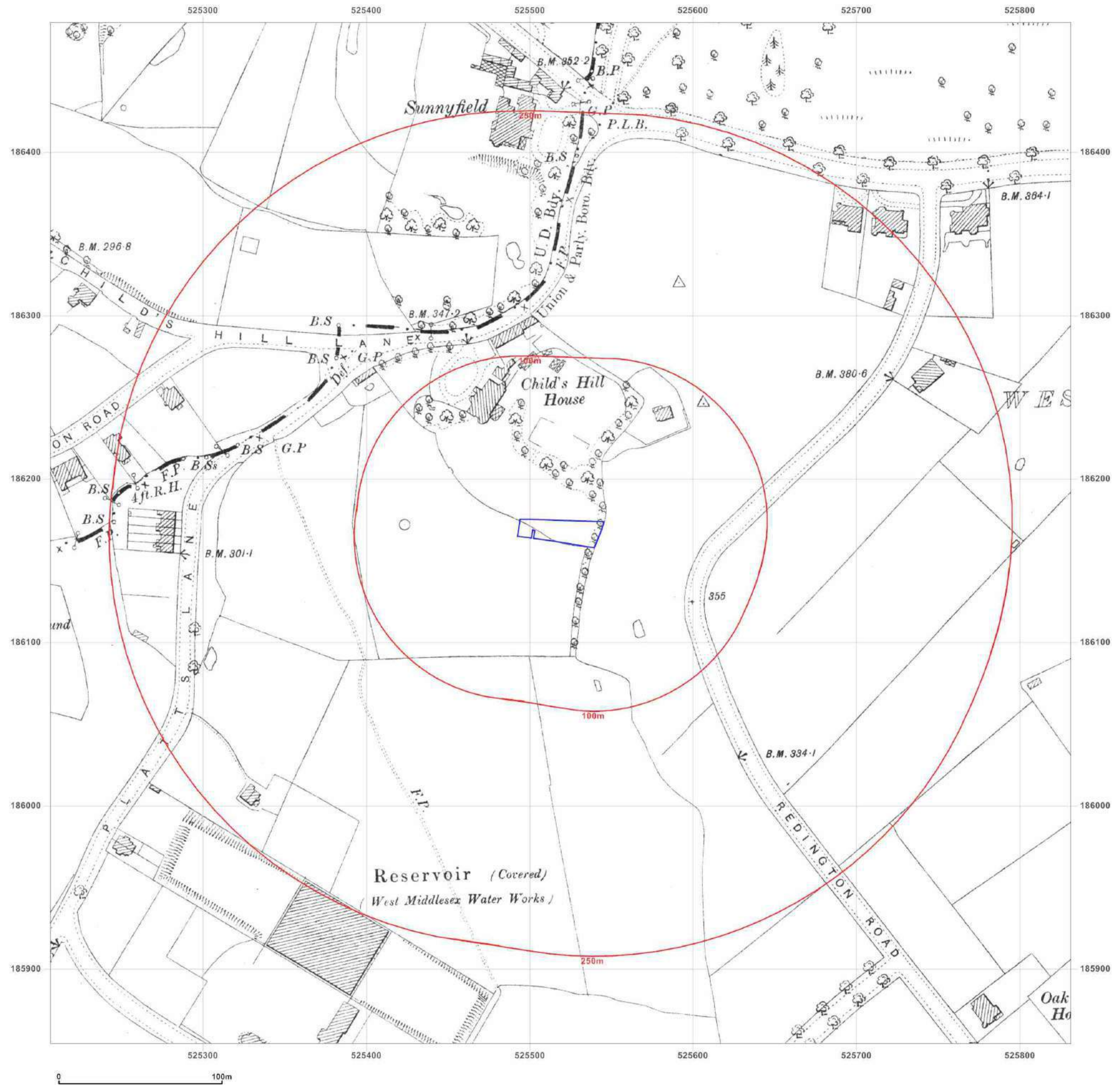

Groundsure INSIGHTS

Site Details:

16, ROSECROFT AVENUE,
LONDON, NW3 7QB

Client Ref: GWPR2630_16_Rosecroft_Avenue
Report Ref: HMD-445-5129163
Grid Ref: 525519, 186167

Map Name: County Series

Map date: **1896**

Scale: 1:2,500

Printed at: 1:2,500

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Surveyed 1896
Revised 1896
Edition N/A
Copyright N/A
Levelled N/A

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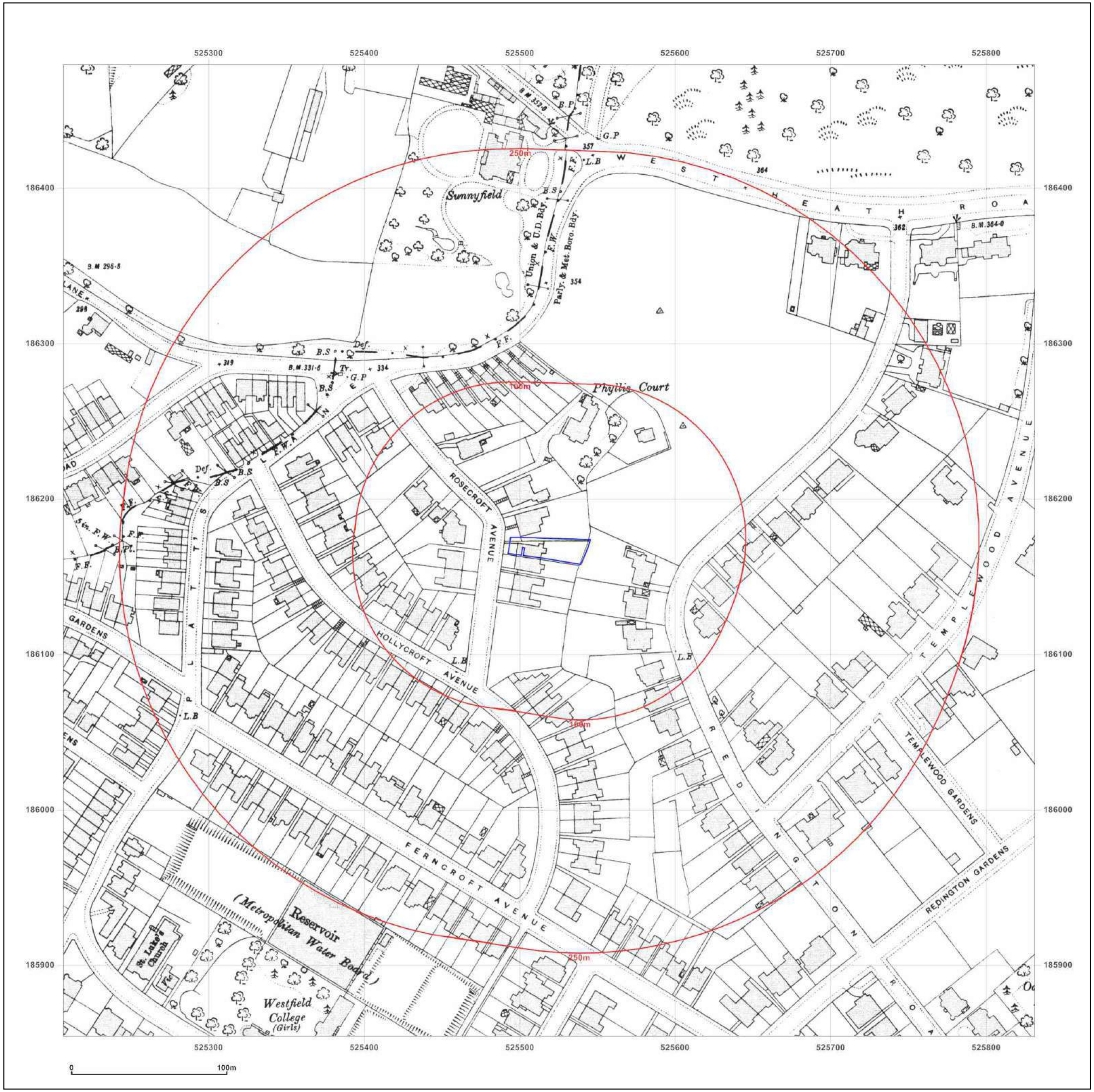
Production date: 13 June 2018

Map legend available at:
www.groundsure.com/sites/default/files/groundsure_legend.pdf



Groundsure INSIGHTS

Site Details:

16, ROSECROFT AVENUE,
LONDON, NW3 7QB

Client Ref: GWPR2630_16_Rosecroft_Avenue
Report Ref: HMD-445-5129163
Grid Ref: 525519, 186167

Map Name: County Series

Map date: **1915**

Scale: 1:2,500

Printed at: 1:2,500

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Surveyed 1915
Revised 1915
Edition N/A
Copyright N/A
Levelled N/A

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T: 08444 159000
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Production date: 13 June 2018

Map legend available at:
www.groundsure.com/sites/default/files/groundsure_legend.pdf

Groundsure INSIGHTS

Site Details:

16, ROSECROFT AVENUE,
LONDON, NW3 7QB

Client Ref: GWPR2630_16_Rosecroft_Avenue
Report Ref: HMD-445-5129163
Grid Ref: 525519, 186167

Map Name: National Grid

Map date: **1953**

Scale: 1:1,250

Printed at: 1:2,000

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Surveyed 1953 Revised 1953 Edition N/A Copyright N/A Levelled 1933	Surveyed 1953 Revised 1953 Edition N/A Copyright N/A Levelled 1933
Surveyed 1953 Revised 1953 Edition N/A Copyright N/A Levelled 1933	Surveyed 1953 Revised 1953 Edition N/A Copyright N/A Levelled 1933

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Production date: 13 June 2018

Map legend available at:
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Groundsure INSIGHTS

Site Details:

16, ROSECROFT AVENUE,
LONDON, NW3 7QB

Client Ref: GWPR2630_16_Rosecroft_Avenue
Report Ref: HMD-445-5129163
Grid Ref: 525519, 186167

Map Name: National Grid

Map date: 1953

Scale: 1:2,500

Printed at: 1:2,500

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Surveyed 1953
Revised 1953
Edition N/A
Copyright 1955
Levelled 1933

Surveyed 1953
Revised 1953
Edition 1955
Copyright N/A
Levelled 1933

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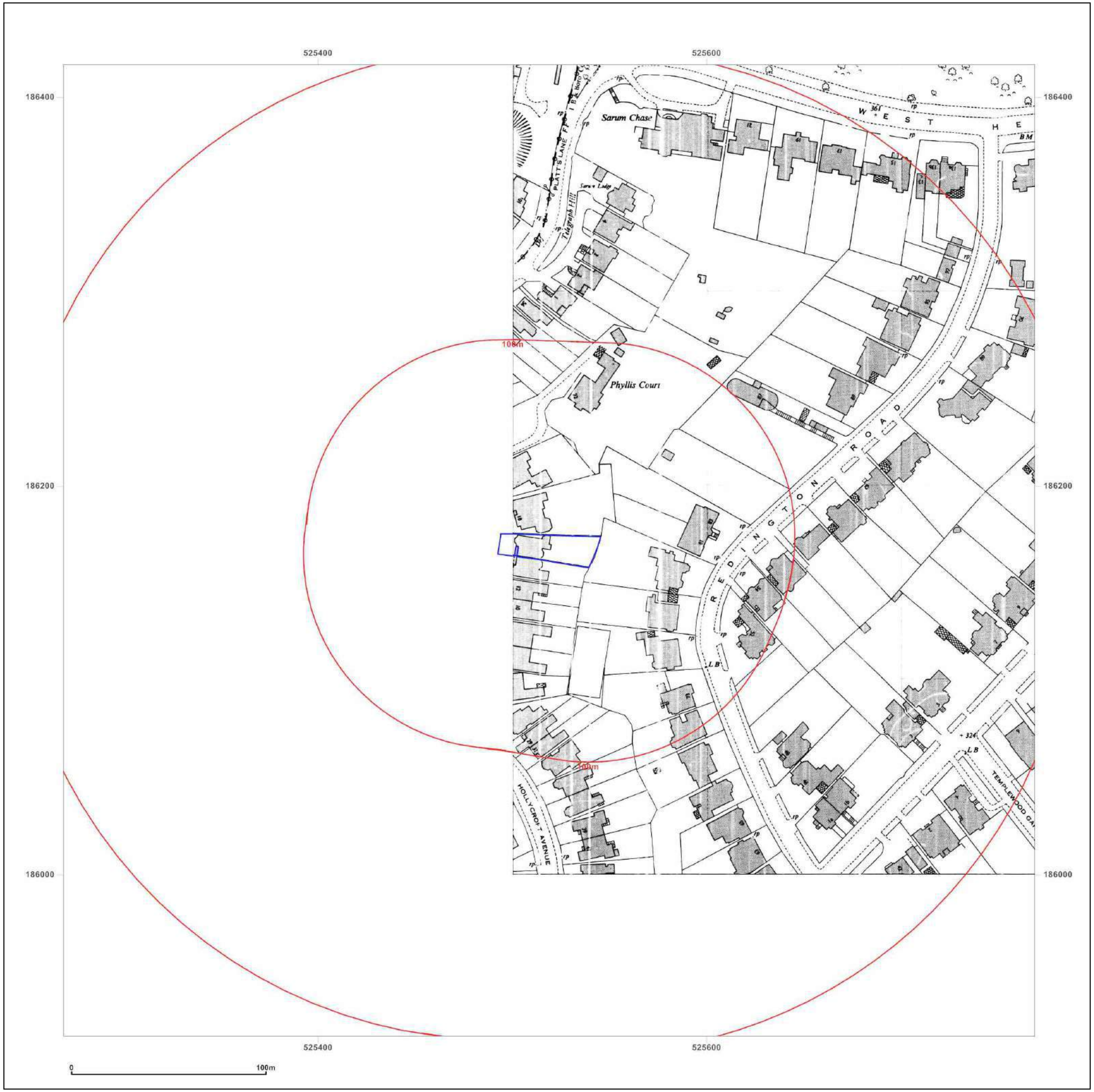
Production date: 13 June 2018

Map legend available at:
www.groundsure.com/sites/default/files/groundsure_legend.pdf



Groundsure INSIGHTS

Site Details:

16, ROSECROFT AVENUE,
LONDON, NW3 7QB

Client Ref: GWPR2630_16_Rosecroft_Avenue
Report Ref: HMD-445-5129163
Grid Ref: 525519, 186167

Map Name: National Grid

Map date: 1955

Scale: 1:1,250

Printed at: 1:2,000

N W E S

Surveyed N/A
Revised N/A
Edition N/A
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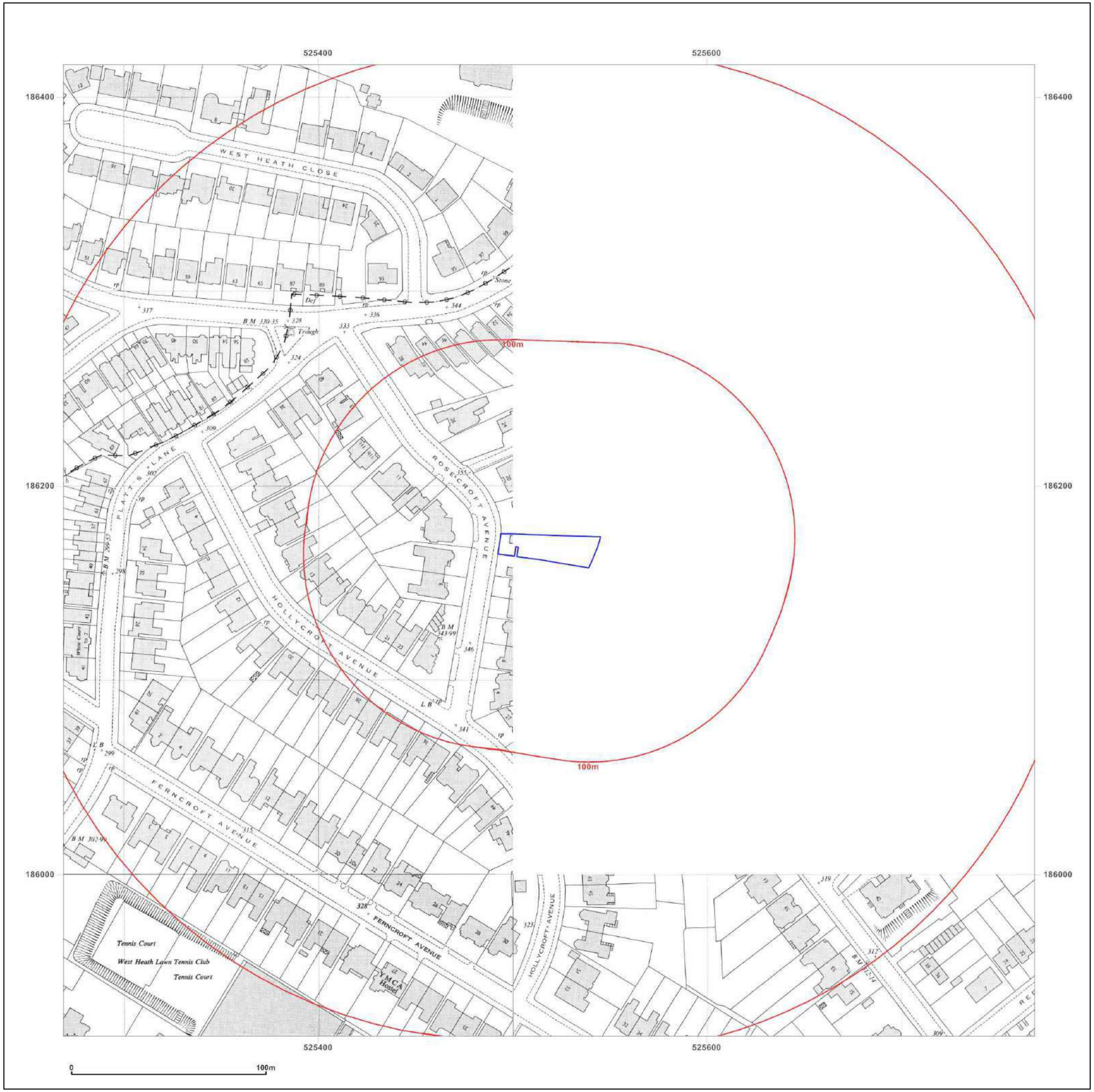
Map legend available at:
www.groundsure.com/sites/default/files/groundsure_legend.pdf



Groundsure INSIGHTS

Site Details:

16, ROSECROFT AVENUE,
LONDON, NW3 7QB

Client Ref: GWPR2630_16_Rosecroft_Avenue
Report Ref: HMD-445-5129163
Grid Ref: 525519, 186167

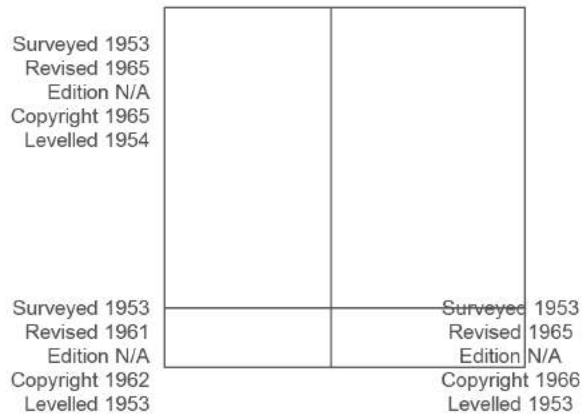
Map Name: National Grid

Map date: **1962-1966**

Scale: 1:1,250

Printed at: 1:2,000

N
W E
S



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Production date: 13 June 2018

Map legend available at:
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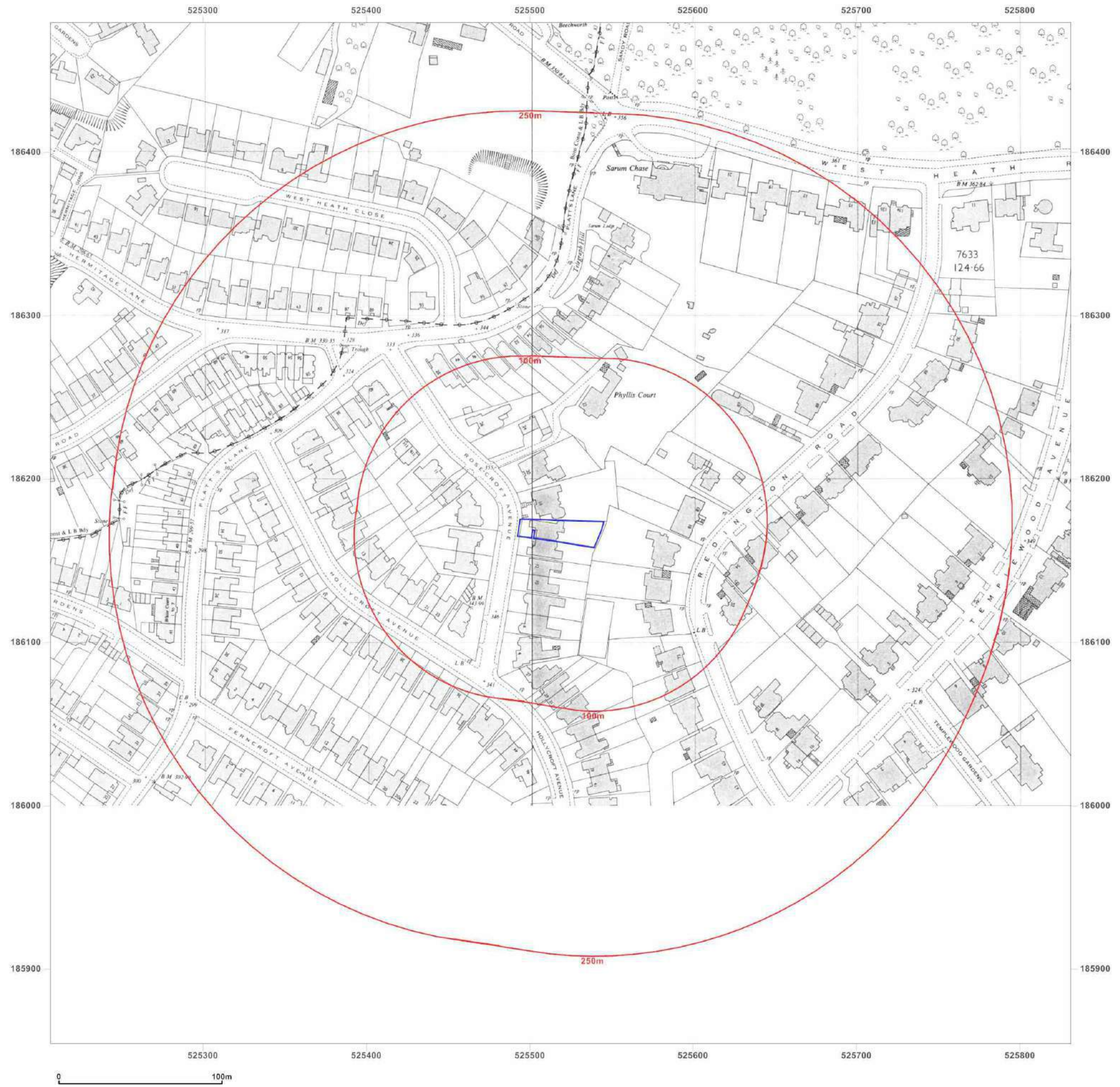

Groundsure INSIGHTS

Site Details:

16, ROSECROFT AVENUE,
LONDON, NW3 7QB

Client Ref: GWPR2630_16_Rosecroft_Avenue
Report Ref: HMD-445-5129163
Grid Ref: 525519, 186167

Map Name: National Grid

Map date: **1969**

Scale: 1:2,500

Printed at: 1:2,500

N
W E
S

Surveyed 1966
Revised 1966
Edition N/A
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