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Ground Investigation Report and Basement Impact Assessment

252 Sheen Lane, Richmond, London, SW14 8RL

On behalf of Alison and David Harwood

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EXECUTIVE SUMMARY	
PROPOSED DEVELOPMENT	At the time of reporting, August 2024, the proposed development was understood to comprise the extension of the existing basement and a single-storey side extension in place of the existing garage. The proposed foundation depth of the basement understood to be 3.50m bgl.
GEOLOGY	The BGS Solid and Drift Geological Map for the South London Area (Sheet Number 270) revealed that the site was underlain by the superficial Taplow Gravel Member, underlain by the London Clay Formation bedrock. No superficial deposits, outcrops of other bedrock deposits or areas of Made/Worked Ground were noted within a 250m radius of the site.
HYDROGEOLOGY	The DEFRA online maps indicated that the site was located on Secondary A Aquifer associated with the superficial Taplow Gravel Member, underlain by Unproductive Strata associated with the London Clay Formation. From analysis of hydrogeological and topographical maps the groundwater table was anticipated to be encountered at shallow to moderate depth within the Taplow Gravel Member capping the impermeable London Clay Formation. Perched water was also likely to be found within the Made Ground, especially after periods of intense or prolonged rainfall. It was considered that the groundwater was flowing to the North, towards the River Thames and in alignment with local topography. The nearest surface water feature was observed to be Adams Pond ~325m southeast of the site and Beverley Brook ~680m east of the site. Further afield the River Thames was noted 1.30km north of the site.

FOUNDATION DESIGN	Foundations should be taken through any Topsoil/Made Ground and extend 300mm below root penetrated soils, before founding onto competent, moisture stable soils. Therefore a proposed foundation depth for the proposed basement of ~3.5m bgl is considered to be suitable. Foundations constructed at ~3.5m bgl will be founded within the Taplow Gravel Member and should be designed based on an allowable bearing capacity of 250kN/m^2.
SUB-SURFACE CONCRETE	The water soluble sulphate concentration ranged between 8.56 – 17.1mg/l, with a pH range of 7.6-8.1. According to BRE Special Digest 1, 2005, 'Concrete in Aggressive Ground' a Sulphate Design Class of DS-1 could be used for sub-surface concrete in contact with the Taplow Gravel Member. Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-1. It is not expected that the basement will be constructed within soils of the London Clay Formation, which are potentially present from ~5.30m bgl. If this is the case, then samples will need to be obtained and tested, as a higher class will be most likely required.
CONTAMINATION	Laboratory analysis for contamination was outside of the remit of this investigation.

1.0 INTRODUCTION

1.1 General

Ground and Water Limited were instructed by Alison and David Hardwood on the 23rd July 2024 to conduct a Ground Investigation Report on the site referred to as 252 Sheen Lane, Richmond, London, SW14 8RL. The scope of the investigation was detailed within the Ground and Water Limited fee proposal (reference: QU-0686).

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 proposed development includes a basement. A Basement Impact Assessment, including screening and detailed comment on surface water flooding/management or combined flooding (sourced from SFRA or similar sources) was part of the remit of the report.

The requirements of the following reports were reviewed with respect to this project:

- The London Borough of Richmond Upon Thames, Planning Advice Note: Good Practice Guide on Basement Developments (May 2015).
- The London Borough of Richmond Upon Thames: Further Groundwater Investigations (March 2021).
- The London Borough of Richmond Upon Thames: Strategic Flood Risk Assessment Level 1 (March 2021).
- The London Borough of Richmond Upon Thames: Basement Assessment User Guide (March 2021).

In addition, a Ground Movement Assessment for the impact of the proposed development on surrounding properties and assets was not in the remit of the report.

An Environmental Desk Study and Contamination Assessment including a gas, vapour, groundwater or soils risk assessment were not part of the remit of this report.

The techniques adopted for the investigation were chosen considering the requirements of the client, anticipated ground conditions, 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.

1.4 Technical Glossary

Generic technical terms can be viewed within the glossary provided within Appendix B.

2.0 SITE SETTING

2.1 Site Location

The site comprised a 400m^2 rectangular shaped plot of land, located along the western side of Sheen Lane. The site was located within Richmond, a mainly residential suburb in inner south-west London. A Site Location Plan is provided within Figure 1 and a plan showing the site development area is given within Figure 2.

2.2 Site Description

At the time of site works, July 2024, the existing development comprised a two-storey terraced residential building with attic and cellar occupying a section of the property. The site was noted to be relatively flat and level. A hardstanding driveway was noted to the front of the site with a soft-landscaped garden to the rear. An aerial view of the site showing an approximate site boundary is given within Figure 3.

2.3 Site Topography

The existing on-site property contained a partial basement. The site and surrounding area were noted to be generally flat. A contour map has been provided within Figure 4.

2.4 Historical Map Review

The site formed part of a larger undeveloped area from the earlier available map (1840). A road was noted adjacent to the eastern boundary running north to south. The surrounding area was generally undeveloped. The site and surrounding area remained generally unhanged up to 1913 with residential development noted ~75m northeast and from ~190m northeast. The site becomes developed with a singular terraced property from the 1933 mapping. The surrounding area has also undergone residential development in all directions. The site and surrounding area remained generally unchanged throughout the remainder of the mapping and to present day. Historical maps, obtained from GroundSure, can be viewed within Appendix C.

2.5 Nearby Assets and Subterranean Developments

No railway cuttings were noted within a 250m radius of the site. No London Underground tunnels were noted within a 250m radius of the site. The site is not in close proximity to any National Rail lines. The site was considered to be not sufficiently close to underground transport services, in order for these to affect the property and there are no approved proposals for any TfL services in the vicinity that would affect the development.

The properties along Sheen Lane, and surrounding roads Stonehill Road and Vicarage Gardens, were mainly 2-to-3 storey, terraced and semi-detached residential properties. It is understood that the property at 256 Sheen Lane has an existing basement.

2.6 Proposed Development

At the time of reporting, August 2024, the proposed development was understood to comprise the extension of the existing basement and a single-storey side extension in place of the existing garage. The proposed foundation depth of the basement understood to be 3.50m bgl.

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

7. A plan view of the proposed development can be viewed within Figure 5 with a cross-section of the proposed development provided within Figure 6.

2.7 Geology

The BGS Solid and Drift Geological Map for the South London Area (Sheet Number 270) revealed that the site was underlain by the superficial Taplow Gravel Member, underlain by the London Clay Formation bedrock. No superficial deposits, outcrops of other bedrock deposits or areas of Made/Worked Ground were noted within a 250m radius of the site.

2.8 Hydrogeology and Hydrology

The DEFRA online maps indicated that the site was located on Secondary A Aquifer associated with the superficial Taplow Gravel Member, underlain by Unproductive Strata associated with the London Clay Formation.

From analysis of hydrogeological and topographical maps the groundwater table was anticipated to be encountered at shallow to moderate depth within the Taplow Gravel Member capping the impermeable London Clay Formation. Perched water was also likely to be found within the Made Ground, especially after periods of intense or prolonged rainfall. It was considered that the groundwater was flowing to the North, towards the River Thames and in alignment with local topography.

The nearest surface water feature was observed to be Adams Pond ~325m southeast of the site and Beverley Brook ~680m east of the site. Further afield the River Thames was noted 1.30km north of the site.

2.9 BGS Borehole Records

A BGS borehole record in similar geology ~240m south-west of the site (ref.: TQ27SW237) noted fill over sandy CLAY to 0.60m bgl, overlying brown sand and gravel to 7.0m bgl. Grey CLAY was then proven to the base of the borehole at 10.0m bgl. Groundwater was encountered at 1.20m bgl.

Another BGS borehole record in similar geology ~1.29km southeast of the site (ref.: TQ27SW310), noted 1.0m of Topsoil underlain by drift silt to 1.50m bgl over yellow sandy CLAY to reddish CLAY up to 7.0m bgl. Dark grey London CLAY was then recorded to 101m bgl over the Reading Beds to 119m bgl. Thanet Sand was then recorded to 120m bgl underlain by CHALK to the base of the borehole at 122m bgl. No groundwater was encountered.

2.10 Flooding

A summary of the risk of various flooding types has been summarised in the following table.

Summary of Flood Risk			
Type of Flooding	**Figure Reference**	**On-site Flood Risk**	**Nearby records**
Rivers and Seas	Figure 7	Low risk – Flood Zone 1	Not Within 50m
Reservoir	Figure 8	No	Not Within 50m
Surface Water Flooding	Figure 9	Low	Low Within 20m

Summary of Flood Risk			
Type of Flooding	**Figure Reference**	**On-site Flood Risk**	**Nearby records**
Flood Defences	Figure 10	No	Not Within 50m. However, flood defences are present along River Thames, with the site most likely benefitting from it.
Groundwater Flooding	Figure 11	Yes – Superficial Deposits flooding between 50% and 75%	Same within 50m
Throughflow Flooding	Figure 12	No throughflow catchment area	Not Within 50m
Sewer Flooding	Figure 13	1No. Thames Water record of indoor incidents. 0No outdoor incident.	Wider Area where 0 – 10 incidents were reported
Critical Drainage Areas	Figure 14	No the site is not positioned within a critical drainage area.	N/A

2.11 Radon

A review of the freely available UK Health Security Agency radon database, UK Radon, indicated that the site was located within a 1km grid square, where the maximum radon potential of less than 1% was recorded. Basic radon protection measures are required in areas where more than 3% of houses are at or above the Action Level.

The site was in an area where a risk assessment was not required.

It is recommended however that due to the proposed development including a basement, to upgrade the waterproofing system into combining protection against radon.

2.12 Unexploded Ordnance Review

A review of the data available on www.zeticauxo.com/ revealed the site was located within the London high-risk area associated with unexploded ordnance (UXO). The London area is further separated into 25No. categories based on bombing densities, where green is indicated for areas having <10 bombs dropped per km^2 and red is indicated for areas having >150 bombs dropped per km^2. The site is situated within the light orange area, ~one third through the spectrum.

3.0 BASEMENT IMPACT ASSESSMENT

A scoping and screening assessment was undertaken for the proposed development based on the supplementary planning document (SPD) for the London Borough of Richmond. This stage should identify any areas of concern and therefore focus efforts on further investigation.

3.1 Stage 1: Screening

The screening questions/fields for three distinct topics (surface water/flooding, groundwater, and stability) have been summarised within this section of the report.

Questions relating to surface water and flooding, as well as discussion and conclusions, can be viewed within the following table.

Subterranean Characteristics Screening Flowchart		
Question	**Discussion**	**Conclusion**
Does the recorded water table extend above the base of the proposed subsurface structure?	**Potentially:** From analysis of hydrogeological and topographical maps, the groundwater table was anticipated to be encountered within the Taplow Gravel Member, capping the underlying London Clay Formation. Perched water was also likely to be found within the Made Ground and underlying strata where silty/sandy/gravelly bands are noted, especially after periods of intense or prolonged rainfall.	**Take forward to scoping**
Is the proposed subsurface development structure within 100m of a watercourse or spring line?	With reference to mapping, the nearest surface water feature was identified to be a Pond ~325m southeast of the site.	No further action required
Are infiltration methods proposed as part of the site's drainage strategy?	A SUDs strategy is being produced for the site.	No further action required
Does the proposed excavation during the construction phase extend below the local water table level or spring line (if applicable)?	**Maybe:** From analysis of hydrogeological and topographical maps the groundwater table was anticipated to be encountered at shallow to moderate depth within the Taplow Gravel member capping the impermeable London Clay Formation. Perched water was also likely to be found within the Made Ground, especially after periods of intense or prolonged rainfall. It was considered that the groundwater was flowing north, towards the River Thames and in alignment with local topography. The proposed development was understood to comprise the construction of the basement which could extend below the groundwater depth. However, this will need confirming by site investigation and groundwater monitoring.	**Take forward to scoping**
Is the shallowest geological strata at the site London Clay?	**No:** The BGS Solid and Drift Geological Map for the Richmond Area (Sheet No.270) highlighted the site was underlain by the superficial Taplow Gravel Member with the bedrock deposits of the London Clay Formation recorded below.	No further action required
Is the site underlain by an aquifer and/or permeable geology?	**Yes:** The BGS Solid and Drift Geological Map for the Richmond Area (Sheet No.270) highlighted the site was underlain by the secondary A Aquifer associated with the Taplow Gravel member with the bedrock deposits of the London Clay Formation recorded below which is classified as unproductive strata.	**Take forward to scoping**

Questions relating to groundwater, as well as discussion and conclusions, can be viewed within the following table.

Land Stability Screening Flowchart		
Question	**Discussion**	**Conclusion**
Does the site, or neighbouring area, topography include slopes that are greater than 7˚?	**No:** The site was noted to have no major slopes and/or undulations. No significant slopes, natural or man-made, were noted within close proximity to the site. No deep failures were expected due to the geology and the depth of the basement.	No further action required
Will changes to the site's topography result in slopes that are greater than 7˚?	**No:** The gradients on-site were considered to remain similar to the existing.	No further action required
Will the implementation of the proposed subsurface structure require any trees to be felled or uprooted?	**No:** It was understood that no trees will be felled to accommodate the development.	No further action required
Has the ground at the site been previously worked?	**No:** With reference to the BGS Solid and Drift Geological Map for the South London Area (Sheet No.270), no Made Ground/Worked Ground was noted within a 250m radius of the site.	No further action required
Is the site within the vicinity of any tunnels or railway lines?	No railway lines or underground lines are noted within a 250m radius of the site.	No further action required

Questions relating to ground stability, as well as discussion and conclusions, can be viewed within the following table.

Flood Risk and Drainage Screening Flowchart		
Question	**Discussion**	**Conclusion**
Will the proposed subsurface development result in a change in impermeable area coverage on the site?	**Yes** The amount of soft landscaping is to reduce, but not massively. A SUDs strategy is being produced for the site.	**Take forward to scoping**
Will the proposed subsurface development impact the flow profile of throughflow, surface water or groundwater to downstream areas?	**Not expected**. Because of the permeable soils below, any increased levels of groundwater will be able to flow through the sides and under the basement. Cumulative effects are not expected, as the site is not within a throughflow catchment area and due to the small size and depth of the basement, together with the granular soils below.	SI is required to confirm and will be further discussed in scoping and report.
Will the proposed subsurface development increase throughflow or groundwater flood risk to neighbouring properties?	**No:** Given the relatively small size of the structure it was unlikely to form a significant barrier to cause an increased risk to flooding of neighbouring properties. The site was not located within an Throughflow Catchment and/or potential throughflow catchment area. The above should be supported by the results of a ground investigation and the depth to impermeable strata.	No further action required, but will be further discussed in scoping and report.

3.2 Stage 2: Scoping

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

- **Perched Water and Groundwater:** It was considered likely that groundwater may be encountered within the Taplow Gravel Member, capping the underlying London Clay

Formation. Perched water may be present within the Made Ground and any sandy/silty layers of the London Clay Formation encountered. Given the proposed basement depth and the anticipated geology/hydrogeology underlying the site, it was possible that the basement may encounter some perched water/groundwater during construction. **This is to be taken forward for further assessment through a ground investigation and the installation of a monitoring well. This is to be taken forward for further assessment through a ground investigation and the installation of a monitoring well.**

- **Seasonal Soil Moisture and Volume Change Potential:** Anticipated geology considered the presence of Taplow Gravel Member, which is unlikely to be subject to shrinkage-swelling; however, any clay/silt bands within the formation may be subject to shrinkage-swelling. The underlying London Clay Formation is very likely to have volume change potential and therefore would be subject to subsidence due to shrinkage-swelling. **The depth and volume change potential of the underlying Kempton Park Gravel Member and London Clay Formation should be investigated.**

- **Pressure Induced Settlement and Heave:** Given the overburden pressure release following excavation of soil, as well as the loading of retaining wall foundations, the pressure across the basement is likely to cause differential settlement and heave. **Regarding the bulk basement construction, care will need to be taken to ensure that the slab is protected through accommodating heave (primarily) and any seasonal if applicable.**

- **Hydrostatic Uplift:** As the basement may be constructed below the water table, hydrostatic pressure may create an uplift force on the basement. Care will need to be taken to ensure that the basement is protected from buoyancy forces.

- **Retaining Wall Design:** Given the design of basements, retaining walls should be appropriately designed to withstand the horizontal pressure of adjacent strata. **Retaining walls should be appropriately designed**.

- **Instability During Excavation:** Stability issues may arise during the excavation through natural soils and Made Ground. **Specific measures to be undertaken throughout excavation and construction will be discussed within this report, and more specifically the construction method statement.**

- **Ground Movement and Nearby Assets:** Various buildings and structures were noted in close proximity to the site, with some having basements/lower ground floors evident, and others not; therefore, differential foundation depths would cause potential damage to the walls of nearby buildings, due to soil displacement following the excavation/installation of the basement. This may also cause damage to nearby roads, pavements and utilities. **A Ground Movement Assessment (GMA) is recommended to assess the soil displacement and damage to nearby buildings, roads, pavements and utilities during the detailed design stage/prior to construction.**

- **Sub-Surface Concrete in Aggressive Ground Conditions:** Concrete may corrode if unsuitable concrete is used. A suitable concrete class should be used for all sub-surface concrete used for all foundations, based on the levels of sulphates and the pH within the ground it is being constructed on/through. **Testing in accordance with BRE Special Digest is required to be undertaken and a concrete specification is to be provided.**

- **Surface Water Flooding and Site Drainage:** Data from the Environment Agency website indicated that the site, and the majority of the surrounding area, was at very low risk of surface water flooding. The amount of hardstanding is likely to increase following the construction of the proposed development, leading to less areas for surface water to infiltrate into the ground, however not massively. **The effect the proposed development will have on surface water flooding and the requirements to prevent surface water flooding and site drainage is to be discussed further within this report.**

- **Groundwater Flooding and Flow:** As the site was underlain by a Secondary (A) Aquifer, underlain by Unproductive Strata, there was considered to be a risk of groundwater flooding. **A groundwater monitoring well should be installed as part of the site investigation, as well as groundwater dip measurements following the site works, to investigate groundwater levels.**

- **Sewer Flooding:** Given their subterranean position, basements can be susceptible to flooding from sewers. 1No. indoor incident and 0No. outdoor incidents within the postcode area. **The effect the basement will have on the risk of sewer flooding and the requirements to prevent sewer flooding is to be discussed further within this report.**

A site-specific ground investigation has been undertaken to inform design, including provision of information on the existing foundations. The results of this investigation and subsequent engineering considerations are provided within this report.

The submission of a drainage scheme will be required. It is understood this will form part of the overall Structural Scheme and will be included in the Structural Engineers report, during the detailed design stage/prior to construction.

A qualified arboriculturist should be consulted for advice on the impact of nearby trees to the construction of the basement.

4.0 SITE WORKS

4.1 Scope of Works

Site works were undertaken on the 29th July 2024 and comprised the drilling of 2No. Windowless Sampler Boreholes (WS1 – WS2) to depths of between 2.00 – 4.40m bgl with Standard Penetration Tests at 1.00m intervals. Boreholes were terminated early due to density of strata. Super Heavy Dynamic Probes (DP1 – DP2) were undertaken through the base of boreholes to final depths of between 2.0 – 8.0m bgl. A combined ground-gas/groundwater monitoring standpipe, with an internal diameter of 50mm, was installed to 4.00m bgl within WS2, with a response zone between 1.00 – 4.00m bgl. The installation details can be viewed within the table below.

Combined Ground-gas and Groundwater Monitoring Well Construction

Trial Hole	Type of Installation	Depth of Installation (m bgl)	Thickness of slotted piping with gravel filter pack (m)	Depth of plain piping with bentonite seal (m bgl)	Response Zone (m bgl)	Piping internal diameter (mm)
WS2	Standpipe	4.00	3.00	1.00	1.00 – 4.00	50

The site investigation also comprised 3no. hand dug foundation exposures (TP1-TP3) and 1no. hand dug trial pit (TP4) to 1.20m bgl.

The approximate location of the trial hole locations can be seen within Figure 15.

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, the exploratory position was relocated away from these areas.

As a further precautionary measure, the borehole was hand excavated to 1.00m below the local ground level (bgl) and scanned with a Cable Avoidance Tool (CAT scanner) to minimise the risk to services.

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

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.

5.0 ENCOUNTERED GROUND CONDITIONS

5.1 Soil Conditions

The trial holes were logged by a Ground and Water Limited representative, generally in accordance with BS EN 14688 'Geotechnical Investigation and Testing – Identification and Classification of Soil'.

The ground conditions encountered within the trial holes constructed on the site did generally conform to that anticipated from examination of the geology map. A capping of Made Ground or Topsoil was noted to overlie the superficial Taplow Gravel Member.

The succession of conditions and description of soils encountered in the trial holes in descending order is tabulated below.

Summary of Strata Encountered (BH1)			
Strata	**Top Depth (m bgl)**	**Base Depth (m bgl)**	**Thickness (m)**
TOPSOIL (TP4): A dark brown very sandy slightly gravelly CLAY. Sand was fine and gravel comprised fine to medium sub-angular to sub-rounded flint.	GL	0.30	0.30
MADE GROUND: Dark brown to orangish brown sandy gravelly CLAY to clayey gravelly SAND. Sand was medium and gravel comprised fine to coarse sub-angular to sub-rounded flint, brick and concrete.	GL	0.30 - 0.85	0.30 - 0.85
TAPLOW GRAVEL MEMBER: An orangish brown slightly clayey gravelly SAND to sandy GRAVEL. Sand was medium and gravel comprised fine to coarse sub-angular to sub-rounded flint.	0.30 – 0.50	2.00 – 4.20	1.70 – 3.70

For details of the composition of the soils encountered at particular points, reference must be made to the individual trial hole logs within Appendix E of this report. A trial hole location plan can also be viewed within Figure 15.

5.2 Roots Encountered

Roots were proven to between 0.20- 0.50m bgl within WS2 and TP1-TP4 however no roots were noted within WS1.

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.

5.3 Foundation Exposures

The hand excavation of 3No. Foundation Exposures (TP1 – TP3) was undertaken. A tabulated summary showing the depth and width of each foundation can be viewed below, as well as the bearing stratum. Diagrams of each foundation exposure can be viewed within Figures 16 to 19.

Summary of Foundations Encountered			
Trial Hole	**Depth of Foundation (m bgl)**	**Width at the Base of Foundation (mm)**	**Bearing Stratum**
TP1 (West wall)	1.10	0.20	Taplow Gravel Member
TP1 (South wall)	1.10	0.20	Taplow Gravel Member
TP2	0.60	0.22	Taplow Gravel Member
TP3	Below 1.20	Not identified	Taplow Gravel Member

5.4 Groundwater Conditions

A groundwater strike was encountered within WS2 at 3.25m bgl. Groundwater was not encountered within the remaining exploratory holes.

Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage. The investigation was undertaken in July 2024 when groundwater levels are likely to be approaching their annual minimum (lowest elevation). Exact groundwater levels may only be determined through long term measurements from monitoring wells installed on-site.

Groundwater monitoring was undertaken on two occasions to date. The results can be seen tabulated below.

Groundwater Observations			
Date	**Trial Hole**	**Water Level (m bgl)**	**Final Well Depth (m bgl)**
14/08/2024	WS2	2.80	3.40
19/08/2024	WS2	2.90	3.40

It is recommended that groundwater measurement is also undertaken during the winter season and before construction begins.

5.5 Obstructions

The boreholes were terminated early (WS1 at 2.0m and WS2 at 4.40m bgl) due to density of underlying sands and gravels. Super Heavy Dynamic Probes (DP1 – DP2) were undertaken through the base of boreholes to final depths of between 2.0 – 8.0m bgl.

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

6.0 IN-SITU AND LABORATORY TESTING

6.1 In-Situ Strength Testing

Standard Penetration Tests (SPTs) and Super Heavy Dynamic Probes (SHDPs) were undertaken as part of the site investigation. The results of the SPT's have not been amended to consider hammer efficiency, rod lengths and overburden pressure in accordance with Eurocode 7. The test results are presented on the borehole logs within Appendix E. An interpretation of the in-situ geotechnical testing results is given in the table below.

Interpretation of In-situ Geotechnical Testing Results

Strata	SPT "N" Blow Counts/Equivalent SPT "N Value from DP	Equivalent Undrained Shear Strength (Cu) (kPa)	Soil Type		Trial Hole/s
			Granular (Density)	Cohesive (Cu)	
Taplow Gravel Member **(Granular)**	8 – 50	-	Medium Dense to Very Dense	-	WS1/0.30 – 2.0m bgl WS2/0.50-4.20m bgl
Assumed Taplow Gravel Member **(Granular)**	16 – 61		Medium Dense to Extremely Dense		DP1/2.0m bgl DP2/4.3-5.20m bgl
Assumed London Clay Formation (Cohesive)	8 – 14	40 – 70		Medium	DP2/5.30-8.0m bgl

It must be noted that field measurements of undrained shear strength (Cu) are dependent on a number of variables including disturbance of sample, method of investigation and also the size of specimen or test zone. It should also be noted that dynamic probing can underestimate the strength of the soils.

It has been assumed based off the changes in blow counts encountered during the dynamic probing that the London Clay Formation was encountered from ~5.30m bgl.

6.2 Geotechnical Laboratory Testing

A programme of geotechnical laboratory testing, scheduled by Ground and Water Limited and carried out by an accredited geotechnical testing laboratory was undertaken on samples recovered. Details of the specific tests used in each case are given below.

Standard Methodology for Laboratory Geotechnical Testing

Test	Standard	Number of Tests
Particle Size Distribution Tests	BS1377:2016:Part 2:Clause 9	5
Water Soluble Sulphate and pH Test	BS1377:2018:Part 3:Clause 5	1
BRE Special Digest 1 Tests	BRE Special Digest 1 “Concrete in Aggressive Ground (BRE, 2005).	2

6.2.1 Particle Size Distribution Testing

The results of particle size distribution (PSD) testing undertaken show that the shallower deposits of the Taplow Gravel Member have volume change potential in accordance with BRE240 but not in accordance with NHBC Standards Chapter 4.2. The deeper deposits over 2.00m bgl do not have volume change potential in accordance with BRE240 or in accordance with NHBC Standards Chapter 4.2 The results of the PSD testing can be viewed within Appendix F.

Particle Size Distribution Tests Results Summary

Stratum	Range Passing 63µm Sieve (%)	Volume Change Potential	
		BRE	NHBC
Taplow Gravel Member (WS1/2.00m bgl, WS2/3.00m bgl and WS2/4.00m bgl)	4 - 14	No	No
Taplow Gravel Member (WS1/1.00m bgl, WS2/1.50m bgl,	16 - 20	Yes	No

- **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).**
- **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%.**

6.3 Chemical Laboratory Testing

Laboratory analysis for contamination was outside of the remit of this investigation.

7.0 ENGINEERING CONSIDERATIONS

7.1 Soil Characteristics and Foundation Considerations

A summary of the soil characteristics following the intrusive site investigation and laboratory testing and the relevant foundation considerations has been provided below. The following information from the ground investigation was considered pertinent to the design of foundations.

- Foundations should be taken through any Made Ground and either into, or onto a suitable underlying natural stratum of adequate bearing characteristics.
- The design and construction of the basement and associated structural elements would need to take into account the volume change potential of the respective soils.
- The loads of proposed foundations should not exceed the allowable bearing capacity of the soils they are founding upon.
- Foundations must not be placed within fresh root penetrated and/or desiccated soils with volume change potential. It is recommended that foundations are taken at least 300mm into non-fresh root penetrated strata if the soils have volume change potential, or into soils of no volume change potential.
- The influence of trees on or surrounding the site will need to be taken into account in final design (NHBC Standards Chapter 4. 2) (tree rings).
- Any water ingress must be prevented from entering foundation trenches and excavations must be kept dry and either concreted or blinded as soon after excavation as possible. If water were allowed to accumulate within the excavation for even a short period of time, an increase in heave may occur. The shear strength will also be reduced, resulting in lower bearing capacities, resulting in increased settlements. Instability issues may arise within the foundation trenches, in case of perched water being present.
- Final designs for the foundations should be carried out by a suitably qualified Engineer based on the findings of this investigation and with reference to the anticipated loadings, serviceability requirements for the structure and the developments proximity to former, present, and proposed trees.

7.2 Geotechnical Analysis

This section of the report states suitable geotechnical parameters for the soils encountered as well as comments on the bearing capacity of the soils. A settlement/heave analysis was undertaken following the construction of the proposed development using Pdisp from Oasys.

7.2.1 Geotechnical Parameters for Modelling

Following a literature review from well documented publications, the short-term and long-term Young’s Modulus (E short term and E’) has been produced. The parameters, shown below, were used when undertaking the settlement/heave analysis within Pdisp.

Summary of Geotechnical Parameters							
Geological Strata	Depth (m bgl)		Short-term Young's Modulus (Eu short term) (kPa)		Long-term, Young's Modulus (E' long term) (kPa)		Poisson's Ratio
	Top	Base	Top	Base	Top	Base	
Made Ground	0.00	0.50	10,000	10,000	10,000	10,000	0.45
Taplow Gravel Member	0.50	1.20	22,000	22,000	22,000	22,000	0.30
	1.20	2.20	22,000	76,000	22,000	76,000	0.30
	2.20	3.20	76,000	96,000	76,000	96,000	0.30
	3.20	4.20	96,000	100,000	96,000	100,000	0.30
	4.20	5.30	100,000	100,000	100,000	100,000	0.30
London Clay Formation	5.30	101.0	37,500	611,700	28,125	458,775	0.45

Made Ground

Made Ground was modelled between ground level and 0.50m bgl. A short-term and long-term Young Modulus (Eu and E') of 10MPa was suitable and on the conservative side, regarding Made Ground encountered on site. A Poisson's Ratio of 0.45 was considered suitable for these soils, given their variable nature.

Taplow Gravel Member

Given the granular soils are permeable, no significant long-term draining of the soil was anticipated to occur and therefore the short and long-term modulus was considered sensible to remain the same. The widely accepted relationship between recorded SPTs within granular soils and E values of 2000* SPT "N" values was used for this consideration. The value was cross-referenced with representative published data (Obrzud & Truty 2012), showing a range of between 50 – 320MPa for the Young Modulus for dense sands and gravels. This also aligns with the drained modulus (30 – 160MPa) for River Terrace Gravels included in *"Burland JB, Standing, JR, and Jardine, FM (2001) Building response to tunnelling, case studies from construction of the Jubilee Line Extension CIRIA Special Publication 200".* A Poisson's Ratio of 0.30 was considered suitable for the granular soils.

London Clay Formation

Cohesive soils of the London Clay Formation were assumed to have been encountered from 5.30m bgl based off the dynamic probe results. It is inferred from nearby BGS borehole records that the London Clay would be extending to 101m bgl.

The design line taken from "*Burland JB, Standing, JR, and Jardine, FM (2001) Building response to tunnelling, case studies from construction of the Jubilee Line Extension CIRIA Special Publication 200*" was used to model how Cu changed with depth. This was considered a more reliable data source than the limited SHDP data from site works, which may have also underestimated soil strength. The equation was undrained shear strength = (depth into the LCF x 8) + 50.

The relationship between Eu and Cu is generally dependent on strain levels. For small strains, a ratio of 750 can be adopted based on well documented publications. This is also reflected for the London Clay Formation, after extensive research, within graphs depicting strains and Eu/Cu ratios included in *"Burland JB, Standing, JR, and Jardine, FM (2001) Building response to tunnelling, case studies from construction of the Jubilee Line Extension CIRIA Special Publication 200".* A Poisson's Ratio of 0.45 was considered suitable for these soils, given their cohesive nature.

Long-Term Conditions

A ratio of E’ to Eu of ~0.75 was considered a sensible approach for this stage in the design, for cohesive soils. For Made Ground, it was considered suitable for E’ and Eu to be equal, given that these soils are more permeable and to limit the level of anticipated Young Modulus at a representative value.

7.2.2 Bearing Capacity

Foundations should be taken through any Topsoil/Made Ground and extend 300mm below root penetrated soils, before founding onto competent, moisture stable soils. Therefore a proposed foundation depth for the proposed basement of ~3.5m bgl is considered to be suitable. Foundations constructed at ~3.5m bgl will be founded within the Taplow Gravel Member and should be designed based on an allowable bearing capacity of 250kN/m^2.

7.2.3 Settlement/Heave Analysis

Analyses of vertical ground movements, using the Mindlin analysis method within Pdisp software, was undertaken to assess the potential movements resulting from changes of net vertical pressure changes. Geotechnical parameters noted in the previous section of this report were used for the model. A rigid boundary at depth was considered at 101.00m bgl, for calculation purposes. The inputs and outputs of this analysis can be viewed within Appendix I.

Five representative stages of construction, in terms of the net change in vertical pressure, have been modelled. These were considered to adequately approximate the movements rising from the basement construction.

- **Stage 1:** Excavation of the retaining wall voids, with short-term conditions;
- **Stage 2:** Loads associated with the construction of the retaining walls, with short-term conditions;
- **Stage 3:** Stage 2 loads and loads associated with the mass excavation of the basement footprint, with short-term conditions;
- **Stage 4:** Stage 3 loads, as well as loads associated with the construction of the basement slab, with short term conditions. The basement is fully constructed from this stage onwards;
- **Stage 5:** Stage 4 loads, for long-term conditions.

As the proposed development did not comprise the demolition of the existing building, the existing loads of the property were not anticipated to change throughout the development.

Given the overall rectangular shape of the basement, the excavation was based on a rectangle using the maximum length and width of the basement. This was considered conservative and will ensure accurate results.

The overburden pressure release following the excavation and removal of soils was based on a specific weight of soil of 19kN/m. Based on a proposed basement depth of 3.50m bgl, an overburden pressure release of 66.5kN/m^2. The overburden pressure release was modelled at 3.50m bgl.

Retaining wall loads were modelled as extending 1.00m towards the centre of the basement and as having a representative uniform load of 30.00kN/m^2 throughout construction, increasing to 60.00kN/m^2 once fully constructed. This was selected in order not to underestimate the heave and overestimate any settlement. The load of the basement slab was unknown at the time of reporting and was assumed to be 10kN/m^2. All loads were modelled at 3.50m bgl.

A tabulated summary of all applied loads, at each stage/model, can be viewed below.

Summary of Net Bearing Pressure Changes for PDisp Analysis				
Description	**Applied Load (+ive)/ Load Removal (-ive) (kN/m^2)**			
	Stage 1	**Stage 2**	**Stage 3**	**Stage 4**
Excavation of Retaining Wall Voids	-66.50			
Construction of Retaining Walls		30.00	30.00	60.00
Mass Excavation Void			-66.50	-66.50
Construction of Basement Slabs				10.00

The method stated above was considered to comprise a comprehensive and reasonably conservative approach, in order to estimate the maximum potential heave and settlements.

A tabulated summary concluding the amount of soil displacement shown at the basement depth (3.50m bgl) within the contour plots can be viewed below. It should be noted that the soil displacement between models are not cumulative values; therefore, the amount of soil displacement between models should not be added together as each model shows each construction stage individually.

Settlement/Heave Analysis	
Model	**Soil Displacement**
Model 1	1.24-2.23mm heave. No settlement
Model 2	0.558 – 1.01mm settlement. No heave
Model 3	0.45-4.62mm heave. No settlement
Model 4	0.565mm settlement. 3.28mm heave.
Model 5	0.900mm settlement. 4.14mm heave.
Diagrammatic representation can be viewed within Appendix I. **Please note that the above figures should not be added together (or be superimposed) and that they represent anticipated movements at different accumulated stages of construction, in order to approach and test all expected combinations of loading regimes (models).**	

A maximum amount of heave of 4.89mm was noted for the long term conditions (Model 5) however the maximum amount during the construction phase was following the mass excavation of the basement void (Model 3) at 3.28mm. Once constructed, the maximum amount of heave increased from 3.84mm for short term conditions (Model 4), to 4.14mm for long term conditions (Model 5); therefore, the highest risk of movement will likely occur during the construction of the basement and later through long-term heave of the constructed basement.

7.2.4 Buoyancy

Given the soil is constructed through granular soils and there is the potential for groundwater to rise above the basement formation level, buoyancy should be accounted for in structural design.

7.2.5 Additional Comments

Regarding the bulk basement construction, care will need to be taken to ensure that the slab is protected through accommodating heave resulting from unloading.

Final designs for the foundations should be carried out by a suitably qualified Engineer based on the findings of this investigation and with reference to the anticipated loadings, serviceability requirements for the foundations. A Structural Engineer will also need to review the anticipated ground movements and assess their potential impact on the existing structure and neighbouring properties. It must be noted that finalised construction will aid the structural stability of the neighbouring party walls, reducing the risk of the seasonal movements noted during the structural works.

7.3 Retaining Walls, Excavations and Stability

Shallow excavations in the Made Ground are likely to be marginally stable at best. Long, deep excavations, through these strata and into the underlying London Clay Formation are likely to become unstable.

Appropriate propping and support should be incorporated during construction of the basement.

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 the soils encountered with an appropriate angle of shear resistance (Φ') and effective cohesion (C') for the ground conditions encountered, regarding long-term considerations, as well using an appropriate undrained shear strength Cu for short-term considerations.

The overlying Made Ground needs to be considered in the design of the basement.

Based on the ground conditions encountered within the boreholes the following parameters tabulated below could be used in the design of retaining walls, for a long-term consideration. These have been designed based on the in-situ strength testing profile recorded, results of geotechnical classification tests and reference to literature.

Retaining Wall/Basement Design Parameters					
Strata	**Unit Volume Weight (kN/m^3)**	**Cohesion Intercept (c') (kPa)**	**Angle of Shearing Resistance (°)**	**Ka (Rankine)**	**Kp (Rankine)**
Made Ground	~19	0	12	0.66	1.52
Taplow Gravel Member (granular)	~19 – 20	0	32 – 40	0.22 – 0.31	3.25 – 4.60
London Clay Formation	~20 – 22	0 – 5	24 – 28	0.36 – 0.42	2.37 – 2.77

It should be noted that the Ka and Kp values presented in the table, are shown for guidance and they are derived from the Rankine theory for soil pressures. The values for angles of internal friction provided are considered to be characteristic values of the soils encountered.

According to C760, a design method (e.g. EC7) should be adopted and followed through the whole design process. In addition, the following considerations should be considered during the design process:

- Appropriate consideration of groundwater levels.
- Surcharge pressure equivalent to the pressures of any adjacent buildings.
- Surcharge pressures from potential piling work platforms and heavy plant traffic.

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.

Ground Instability Recommendations

Specific measures should be included in a competent Construction Method Statement for the works on this site by the structural engineer and the contractor. If instability is noted, the following could be applied for good workmanship and mitigation of any risk. It should be noted that these are indicative.

- Where soft/loose spots are encountered, trench sheets should be left in. Alternatively, a back prop with precast lintels or sacrificial boards should be installed. If the soil support to the ends of the lintels is insufficient, brace the ends of the PC lintels with 150x150 C24 timbers and prop with Acrows diagonally back to the ground.
- Where voids are present, trench sheeting with 75mm diameter holes should be installed, to allow the concrete to flow behind the trench sheeting thereby filling any voids encountered in soils behind.
- Prior to casting, a layer of DPM should be installed between trench sheeting (or PC lintels) and new concrete. The lintels should be cut into the soil by 150mm either side of the pin. A site stock of a minimum of 10 lintels should be present to prevent delays due to ordering.

7.4 Sub-Surface Concrete Design

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'* considering the pH of the soils. For the classification given below, the “mobile” and “natural” case was adopted given the geology encountered and the residential use of the site.

Made Ground

No samples of the Made Ground were analysed for sulphates and pH.

Taplow Gravel Member

According to Box C6 of BRE Special Digest 1, 2005, 'Concrete in Aggressive Ground' the Taplow Gravel Member did not fall within a list of UK geological formations known to contain pyrite. Consequently, it was not required to consider the levels of total potential sulphate in the classification process.

The water soluble sulphate concentration ranged between 8.56 – 17.1mg/l, with a pH range of 7.6-8.1. According to BRE Special Digest 1, 2005, 'Concrete in Aggressive Ground' a Sulphate Design Class of DS-1 could be used for sub-surface concrete in contact with the Taplow Gravel Member. Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-

1.

It is not expected that the basement will be constructed within soils of the London Clay Formation, which are potentially present from ~5.30m bgl. If this is the case, then samples will need to be obtained and tested, as a higher class will be most likely required.

7.5 Hydrogeological Effects, Flooding and Surface Water Disposal

Basements have potential to greatly impact hydrological and hydrogeological regimes. Numerous comments and considerations reflecting on the relationship between the basement and groundwater/surface water have been discussed below.

7.5.1 Basement Construction & Groundwater

If the construction works take place during the winter months, when the groundwater level is expected to be at its higher elevation, water could accumulate thus dewatering could be required to facilitate the construction and prevent the base of the excavation blowing before the slab was cast. **The lower ground floors must be suitably tanked to prevent ingress of groundwater and also surface water run-off. A dewatering or permitting grout contingency plan should be included within the Construction Method Statement and considered in the final design. As there will be potential for groundwater to collect behind the retaining walls, the basement should be waterproofed and designed to withstand hydrostatic pressures in accordance with BS8102:2009: Code of Practice for the Protection of Below Ground Structures against Water from the Ground.**

Should groundwater/perched water be encountered across the site, dewatering from sumps introduced into the floor of the excavation may be required. Consideration could be given to creating a coffer dam using contiguous piled or sheet piled walls to aid construction below the perched water table if groundwater becomes a significant issue. **The advice of a reputable dewatering company should be sought.**

7.5.2 Site Drainage

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.

The principles of SUDS and the requirements of the London Plan Policy 5.13 Sustainable Drainage 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 London Plan Policy 5.13 Sustainable Drainage the surface water run-off should be managed as close to its source as possible in line with the following drainage hierarchy.

- Rainwater use as a resource (for example rainwater harvesting, blue roofs for irrigation)
- Rainwater infiltration to ground at or close to source
- Rainwater attenuation in green infrastructure features for gradual release (for example green roofs, rain gardens)
- Rainwater discharge direct to a watercourse (unless not appropriate)
- Controlled rainwater discharge to a surface water sewer or drain

- Controlled rainwater discharge to a 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.

Soakage testing in accordance with BRE365 was beyond the scope of this investigation.

Any soakaways should be located sufficiently away from buildings and infrastructure, in order to prevent undermining of foundations. Additional drainage may be considered should significant amounts of water be encountered.

The submission of a Sustainable Urban Drainage Scheme (SUDS) is likely to be required for this site due to the proposed development increasing the amounts of hardstanding (however not massively).

Consultation with the Environment Agency must be sought regarding any use that may have an impact on groundwater resources, abstractions and surface water features/watercourses.

7.5.3 Additional Hydrogeological comments, throughflow, flooding

The site itself has the potential to flood from groundwater, due to a Secondary Aquifer underlain by Unproductive Strata. Perched water may be encountered within the Made Ground and the underlying geological formations, especially after periods of prolonged or intense rainfall. **This should be considered in final design.**

Due to the relatively low permeability rates of the cohesive soils, groundwater is more likely to flow through the more granular deposits of the Taplow Gravel Member. The proposed basement is not expected to extend into the cohesive London Clay Formation, so when groundwater is elevated to above basement level, it can flow beneath the basement as well as around; therefore, groundwater flow direction is not expected to be affected.

Cumulative effects are not expected, as the site is not within a throughflow catchment area and due to the small size and depth of the basement, together with the granular soils below.

Given the relatively small size of the structure it was unlikely to form a significant barrier to cause an increased risk to flooding of neighbouring properties.

Given their subterranean position, lower ground floors can be susceptible to flooding from sewers. In order to minimise the risk of sewer flooding to the development, all subterranean development must be connected to the sewerage network, installed with a positively pumped non-return valve device.

Consultation with the Environment Agency must be sought regarding any use that may have an impact on groundwater resources, abstractions and surface water features/watercourses.

7.6 Discovery Strategy

A full contamination assessment was beyond the scope of this investigation, where targeted sampling was not undertaken. There may be areas of contamination that have not been identified during the course of the intrusive investigation (e.g. underground storage tanks). Such occurrences may be discovered during the 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 and then the Local Authority will need to be informed.

7.7 Waste Disposal

The excavation of foundations and other soils 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 (WM3) 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.

7.8 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 would be 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.

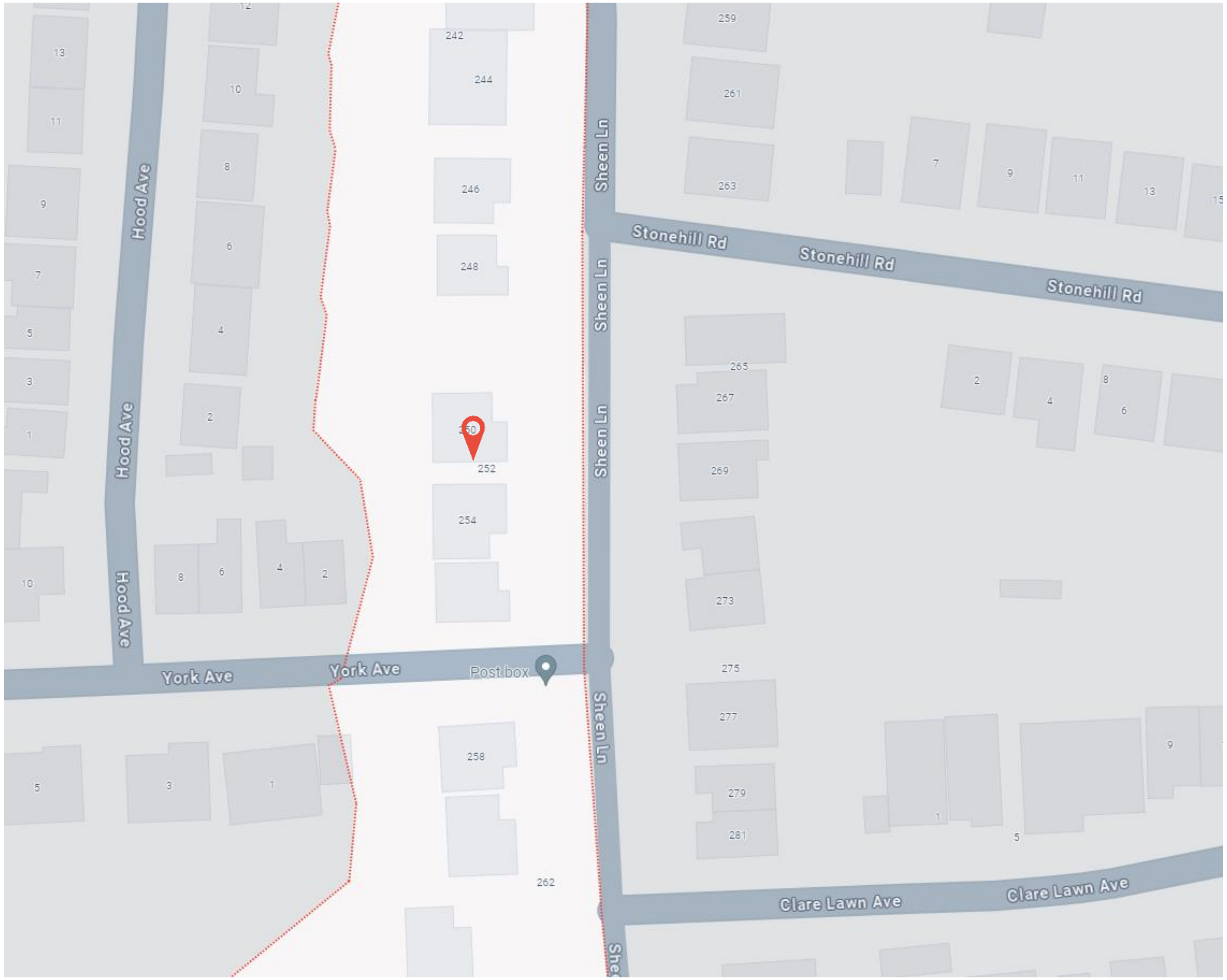
FIGURES

📍 Site Location

252 Sheen Lane, Richmond, London, SW14 8RL

Alison and David Harwood	**September 2024**
Figure 1: Site Location Plan	**GWPR6137**

ground&water



● Site Location

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Figure 2: Site Development Area	**GWPR6137**

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🔴 Site Location

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Figure 3: Aerial Site View	**GWPR6137**

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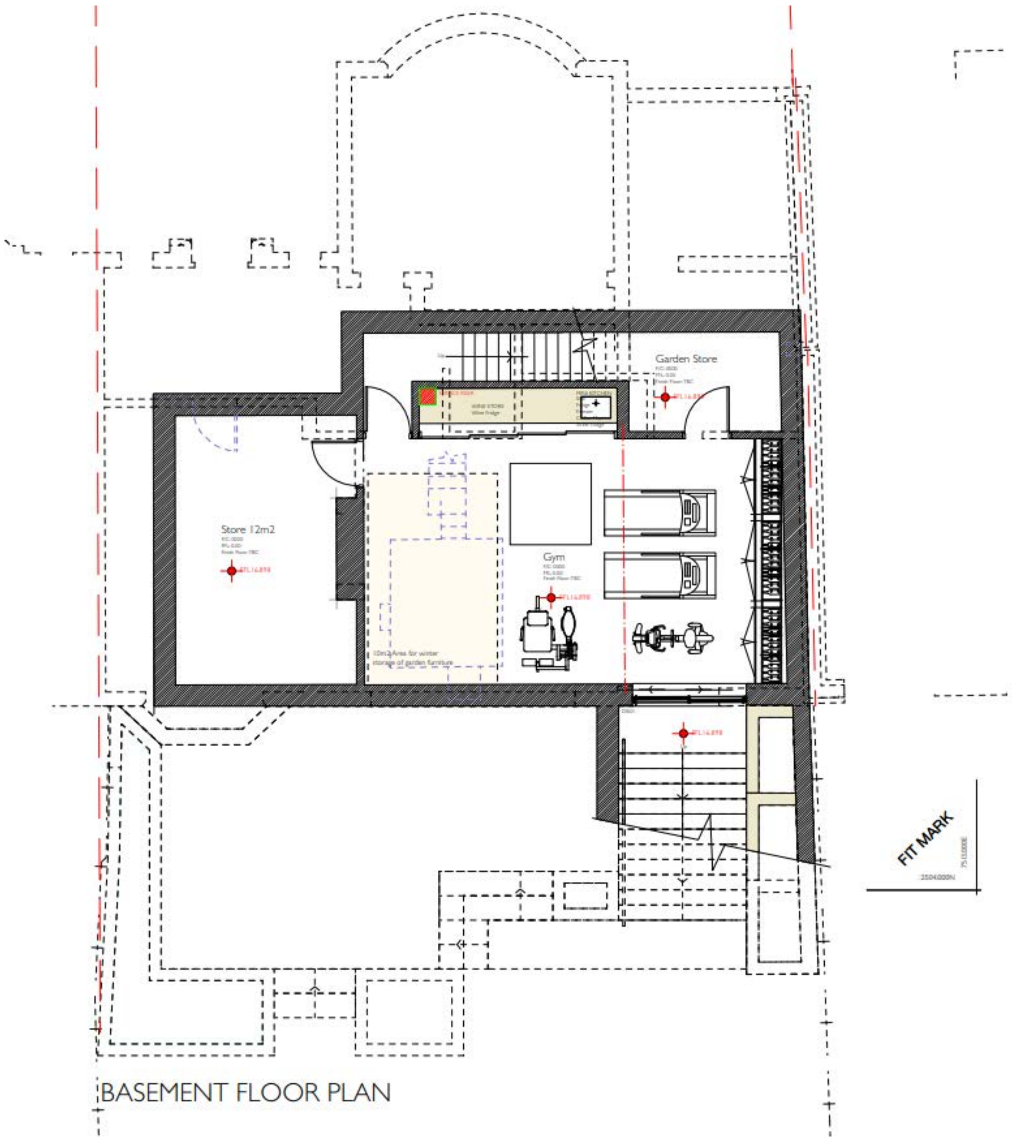
Figure 4: Topographical Contour Map	**GWPR6137**



▯ Site Boundary

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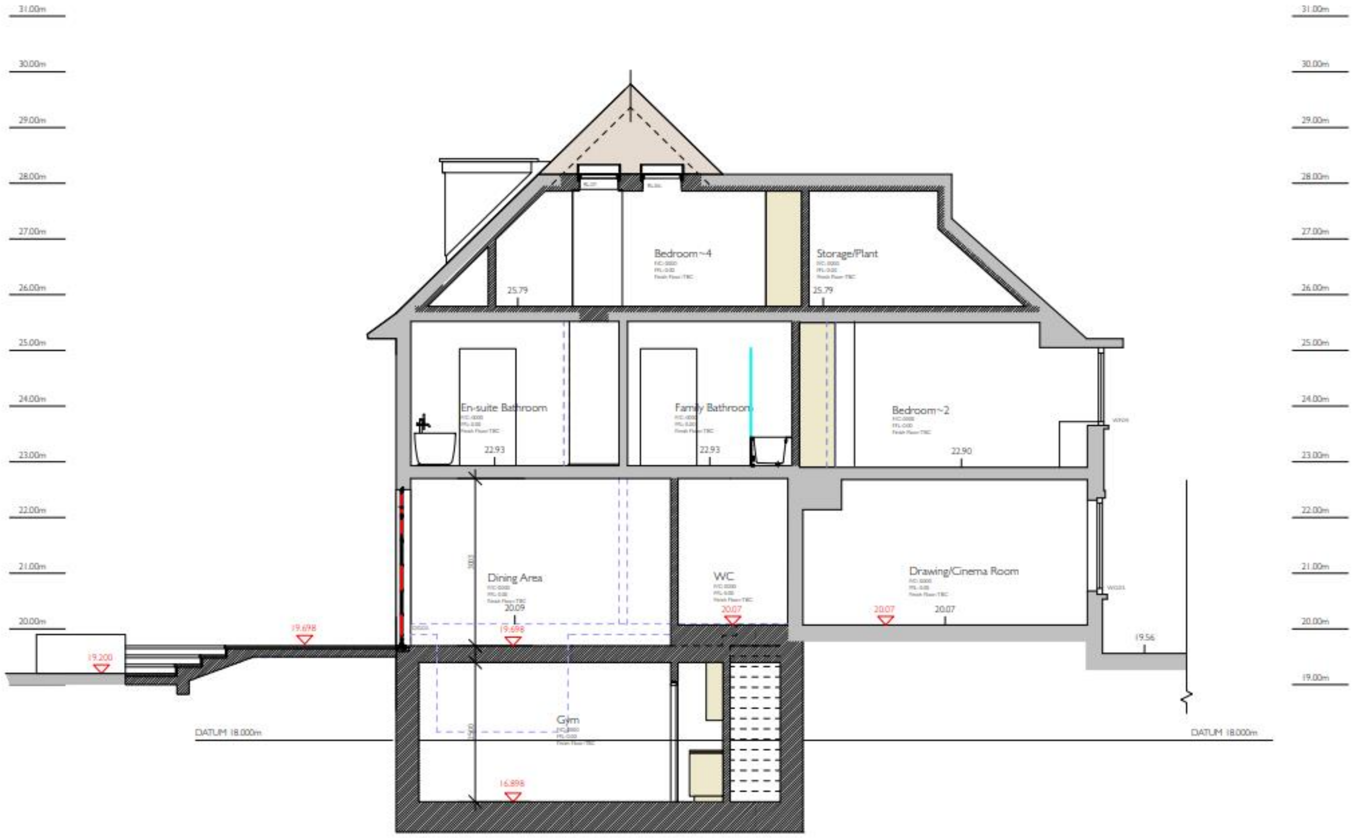
Figure 5: Proposed Development – Basement Floor Plan	**GWPR6137**



SECTION A-A

▯ Site Boundary

252 Sheen Lane, Richmond, London, SW14 8RL

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Figure 6: Proposed Development Section	**GWPR6137**

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Figure 7: EA Flooding From Rivers and Seas

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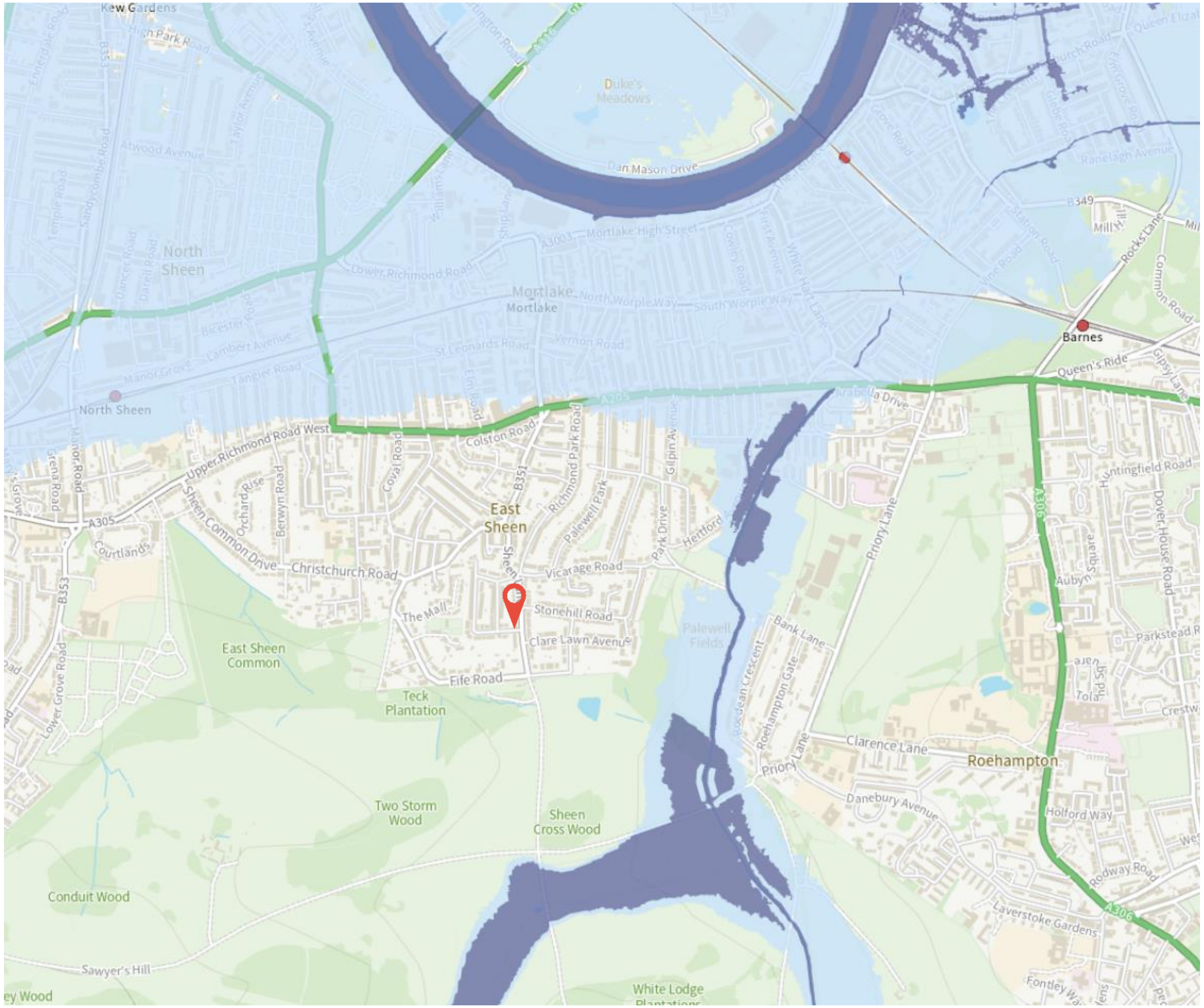

📍 Site Location

■ When river levels are normal

□ When there is also flooding from rivers

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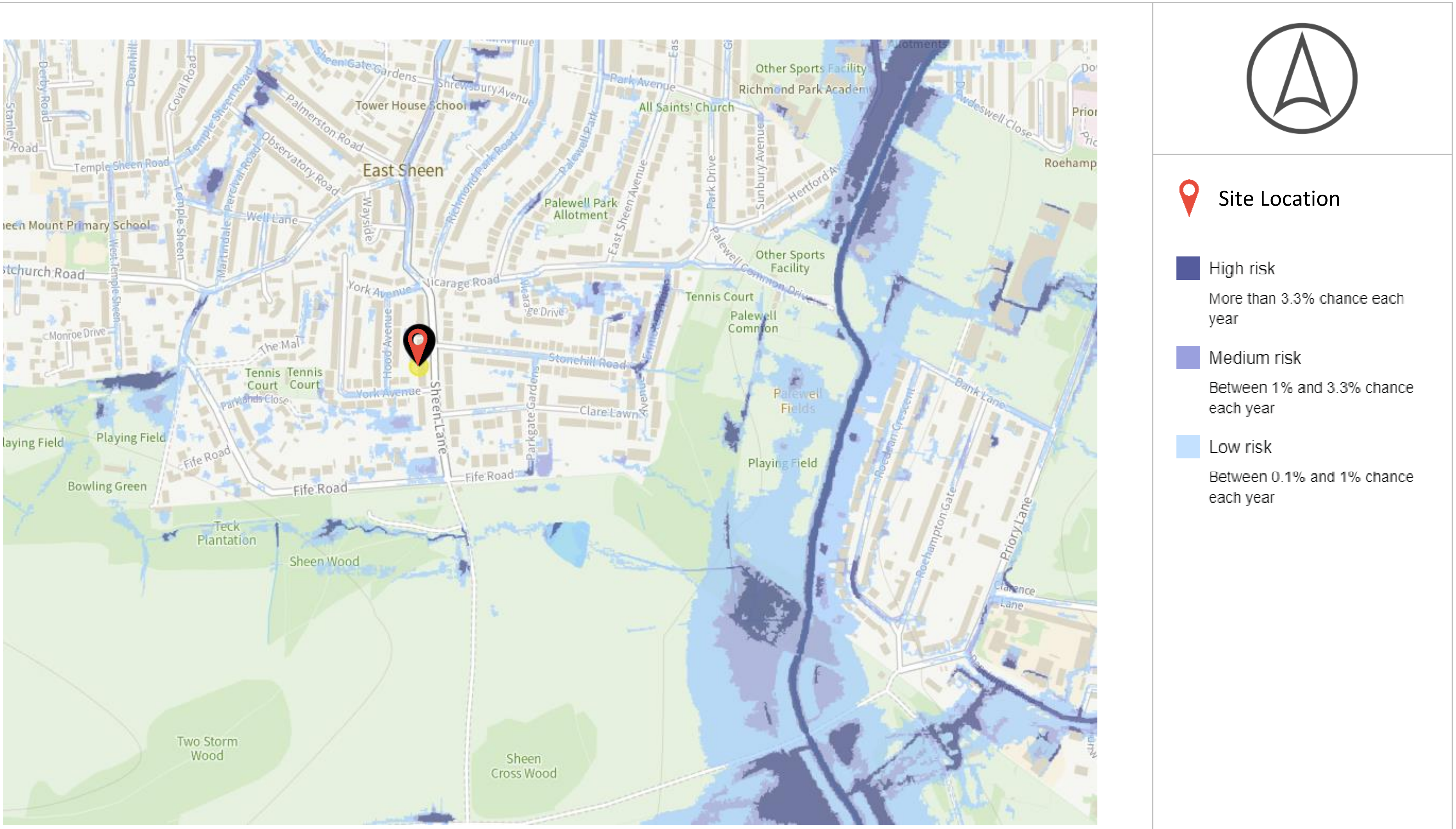
Figure 8: EA Reservoir Flooding	**GWPR6137**



📍 Site Location

▇ High risk

More than 3.3% chance each year

▇ Medium risk

Between 1% and 3.3% chance each year

▇ Low risk

Between 0.1% and 1% chance each year

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Figure 9: Surface Water Flooding	**GWPR6137**

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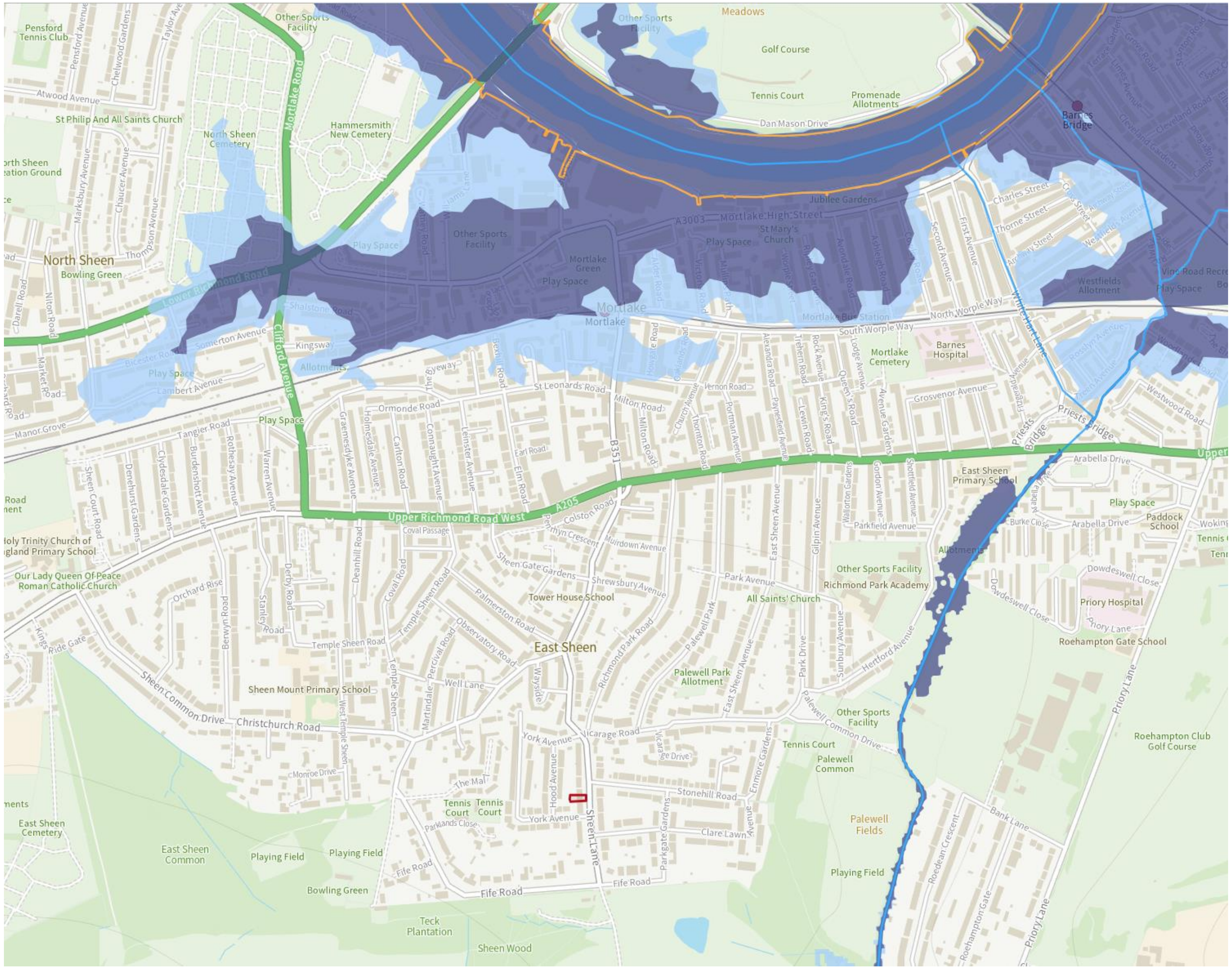

🟥 Your site boundary

■ Flood zone 3

■ Flood zone 2

☐ Flood zone 1

▬ Flood defence

〜 Main river

▦ Water storage area

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Figure 10: Flood Defence

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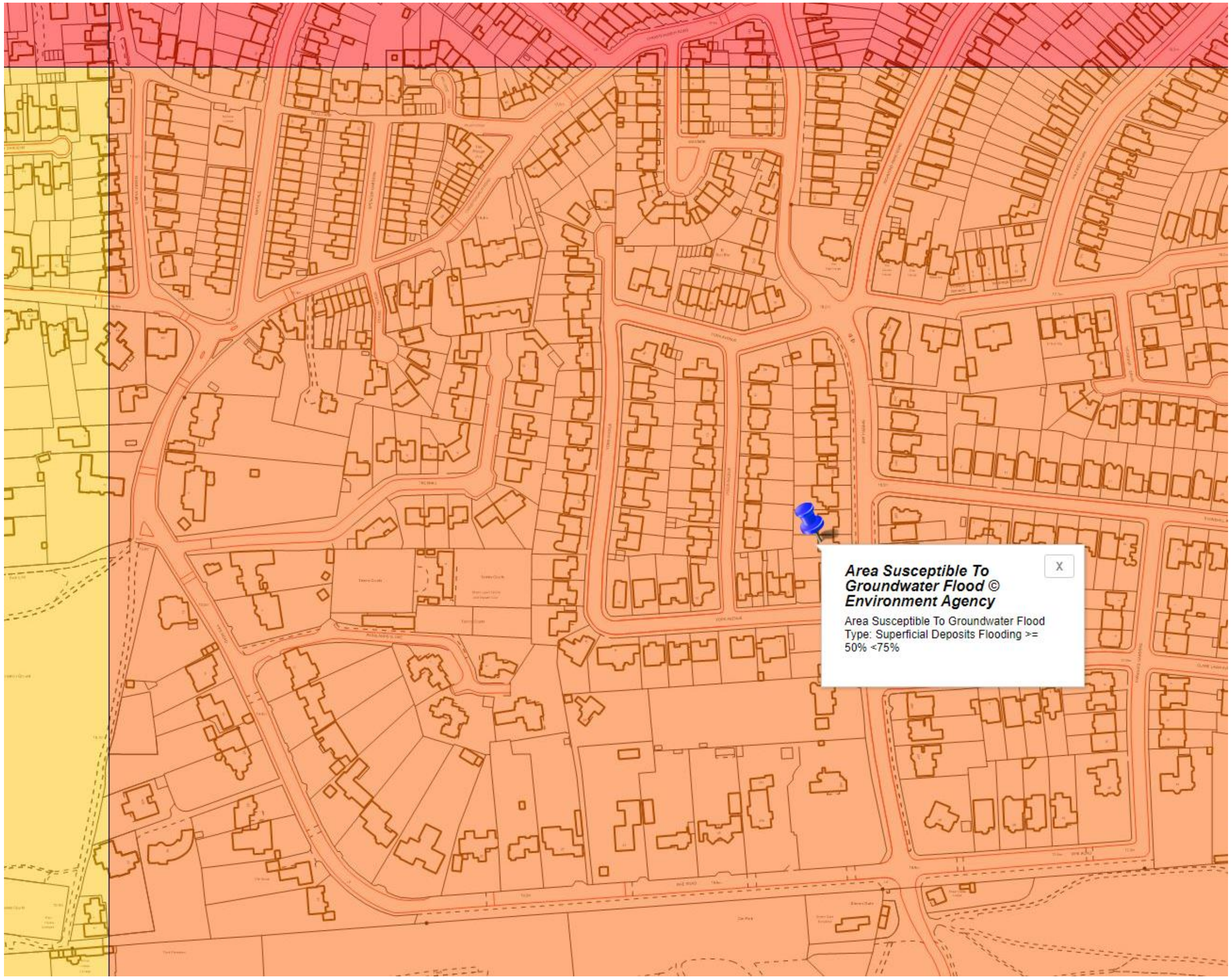

Area Susceptible To Groundwater Flood © Environment Agency

Area Susceptible To Groundwater Flood Type: Superficial Deposits Flooding >= 50% <75%

Area Susceptible To Groundwater Flood © Environment Agency

- 🟩 less than 25%
- 🟨 between 25% and 49.9%
- 🟧 between 50% and 74.9%
- 🟥 75% or more

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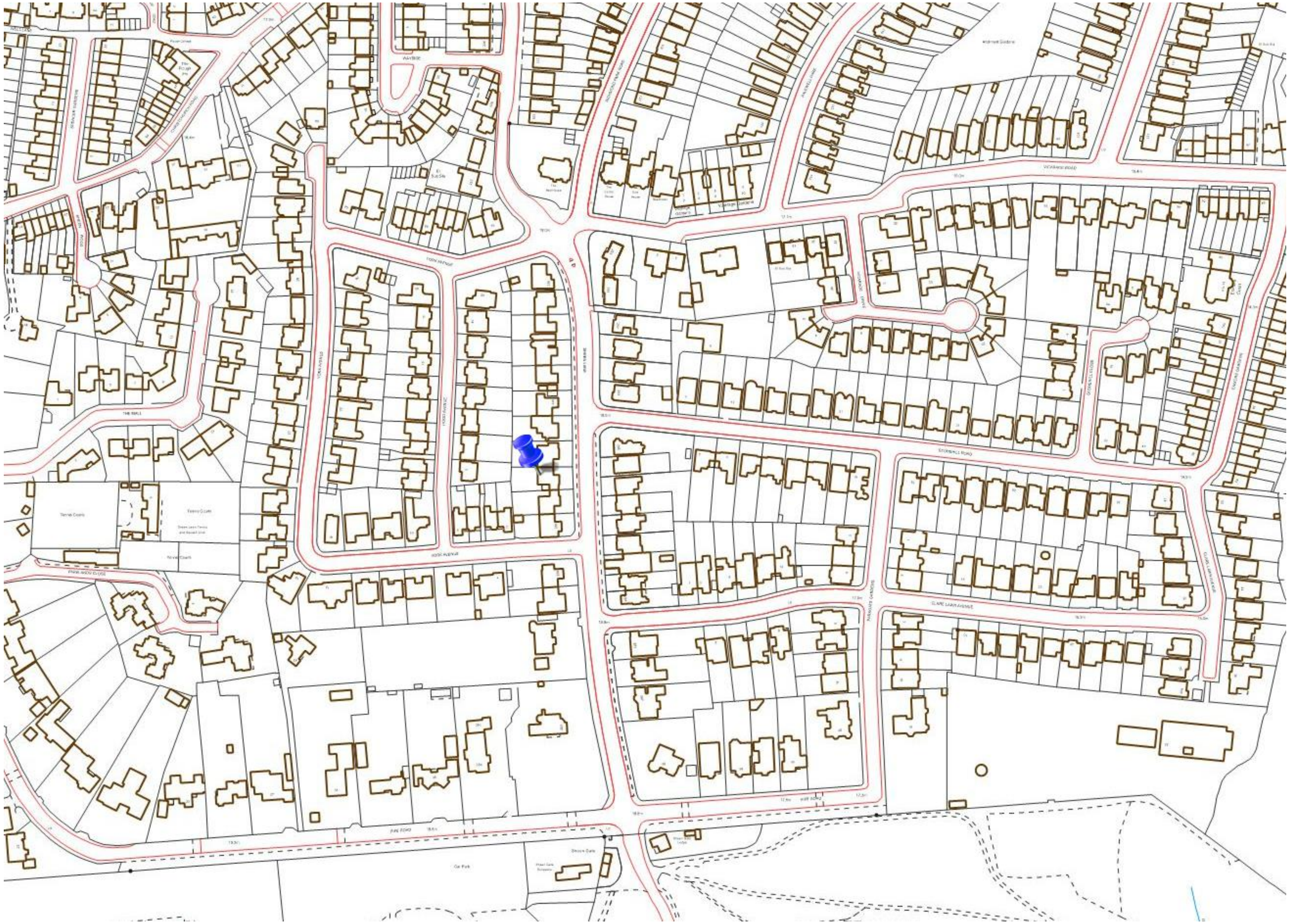
Figure 11: Groundwater flooding	**GWPR6137**



▨ Throughflow Catchment Area (Throughflow and Groundwater Policy Zone)

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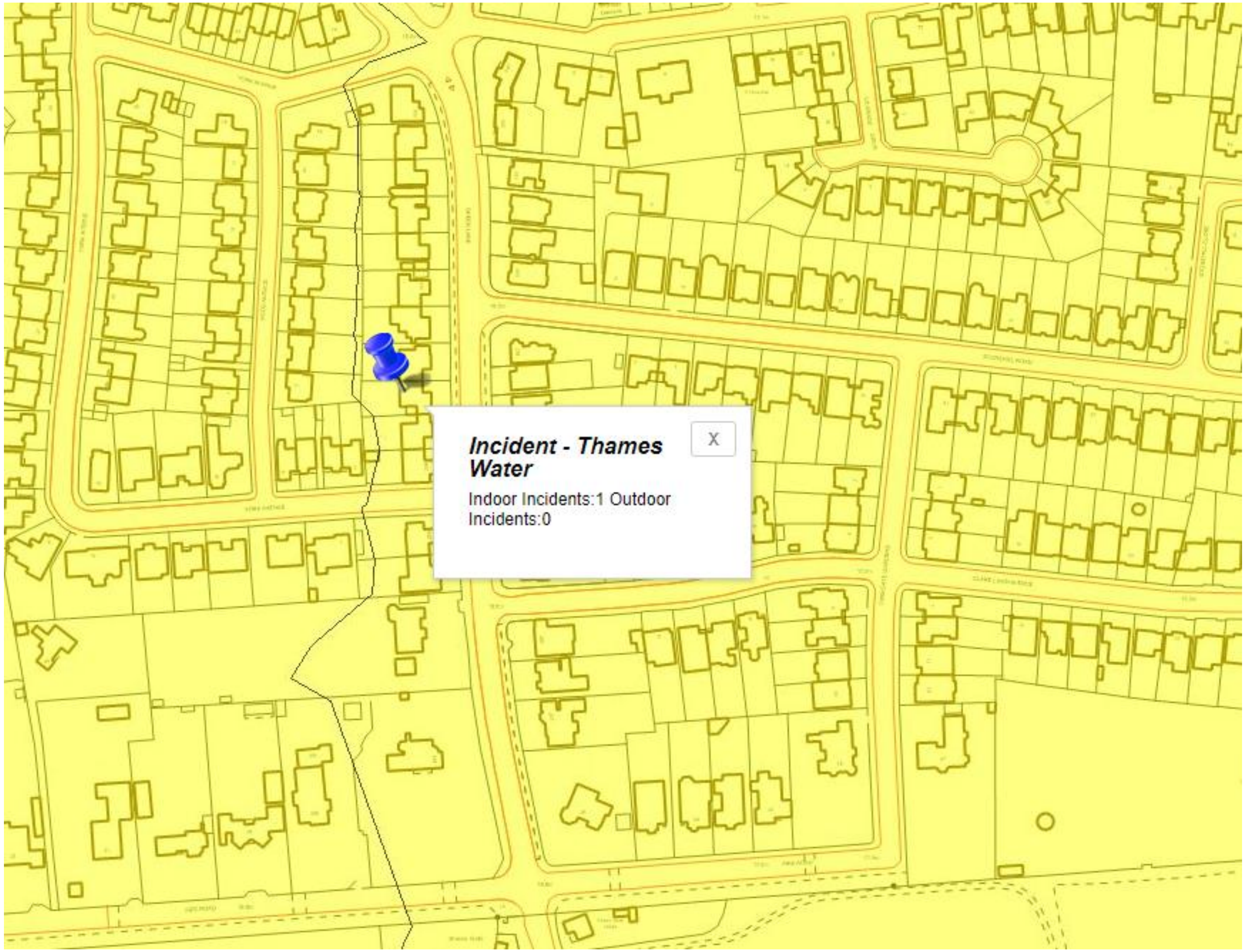
Figure 12: Throughflow flooding	**GWPR6137**



Incident - Thames Water

Indoor Incidents:1 Outdoor Incidents:0

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Figure 13: Sewer Flooding

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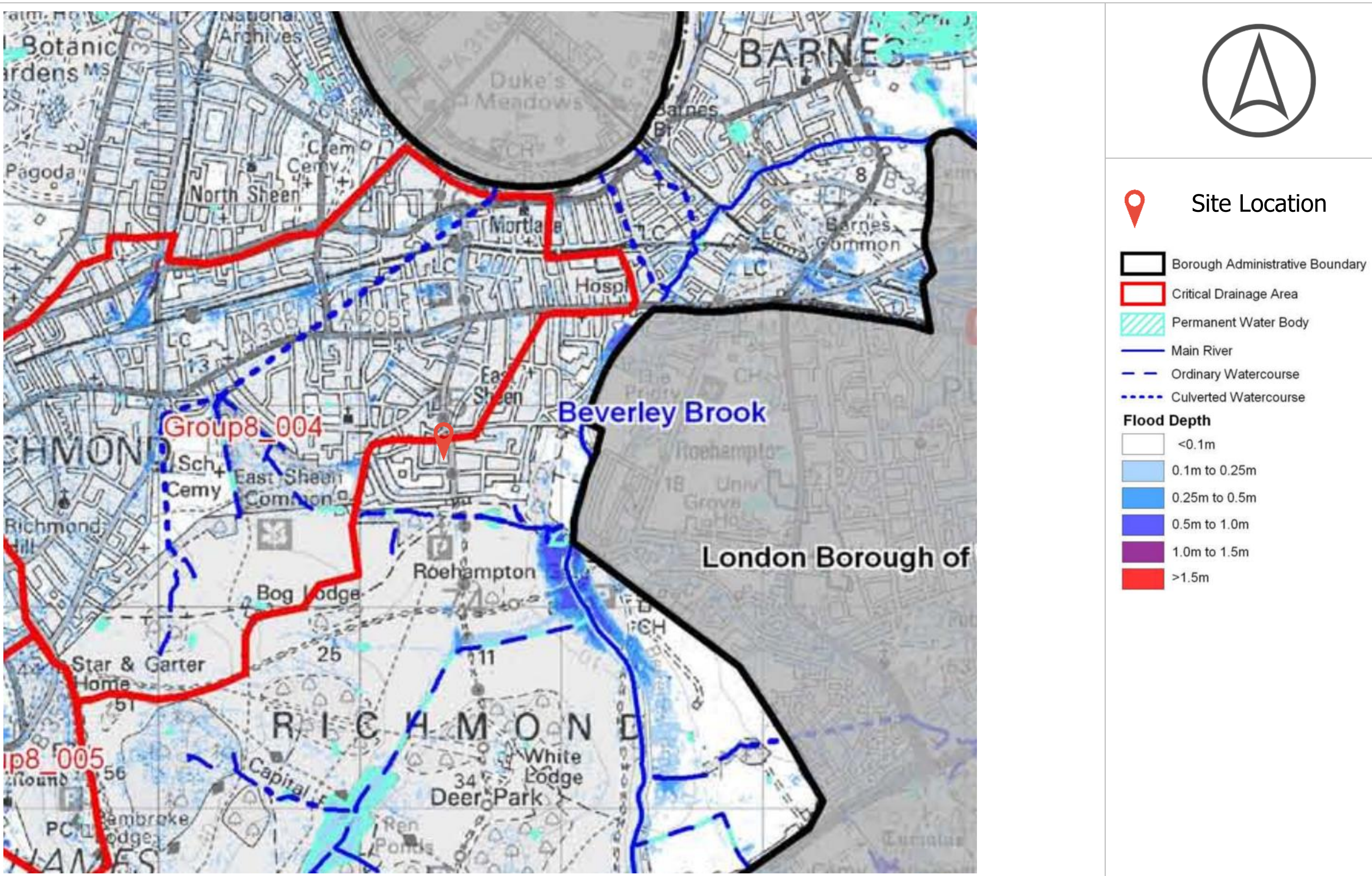

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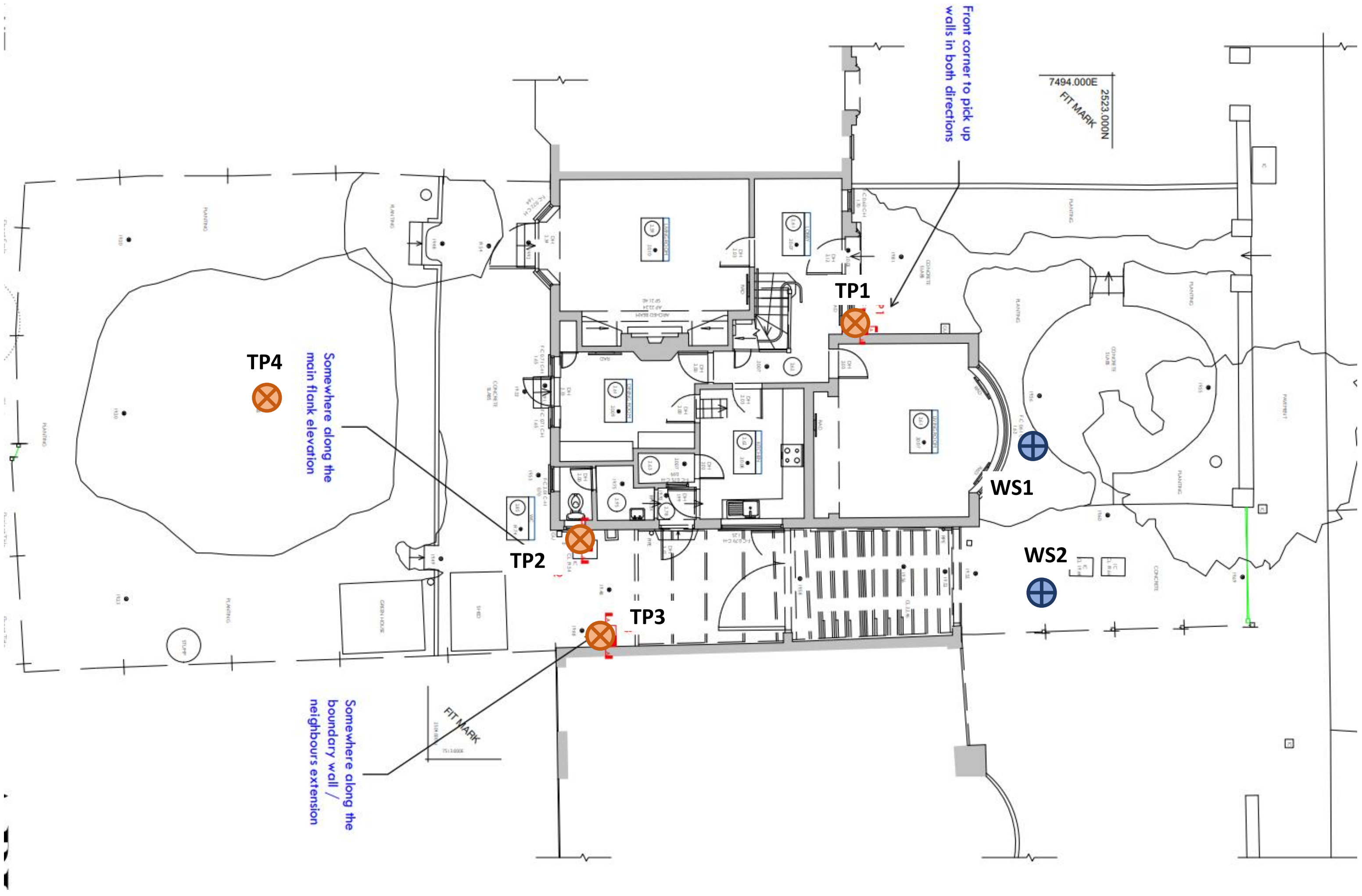
Figure 14: Critical Drainage Areas	**GWPR6137**



▯ Site boundary

⊗ Hand Excavated Trial Pit/FE

⊕ Windowless Sampler Borehole

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Figure 15: Trial Hole Location Plan

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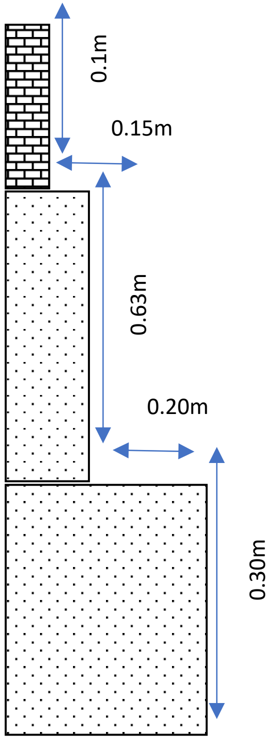
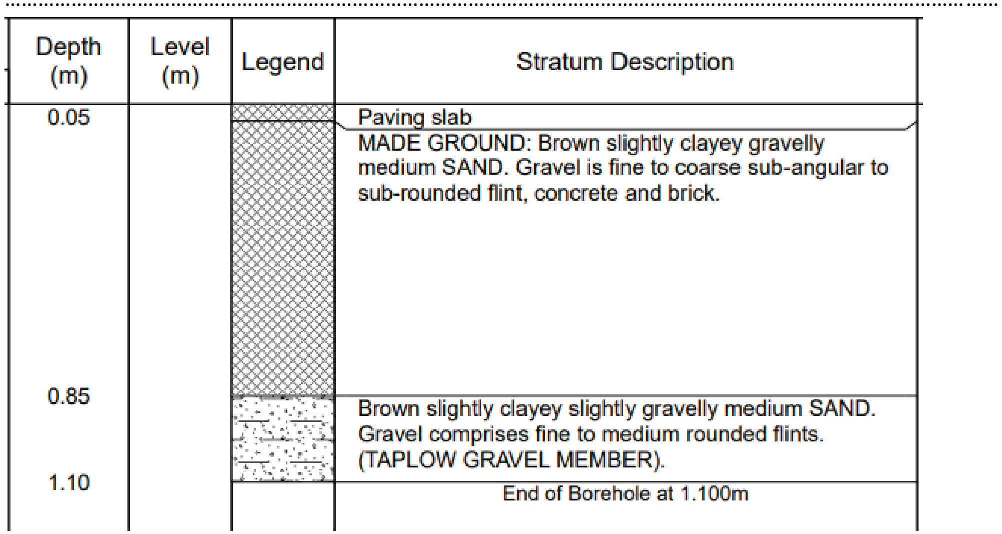




Depth (m)	Level (m)	Legend	Stratum Description
0.05		▨	Paving slab
		▨	MADE GROUND: Brown slightly clayey gravelly medium SAND. Gravel is fine to coarse sub-angular to sub-rounded flint, concrete and brick.
0.85		░	Brown slightly clayey slightly gravelly medium SAND. Gravel comprises fine to medium rounded flints. (TAPLOW GRAVEL MEMBER).
1.10			End of Borehole at 1.100m

The base of the foundation was proven to 1.10m bgl onto the Taplow Gravel Member.

Legend

▦ Brickwork

░ Concrete

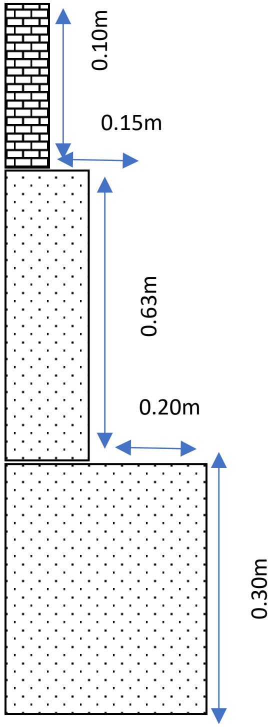
252 Sheen Lane, London, SW14 8RL

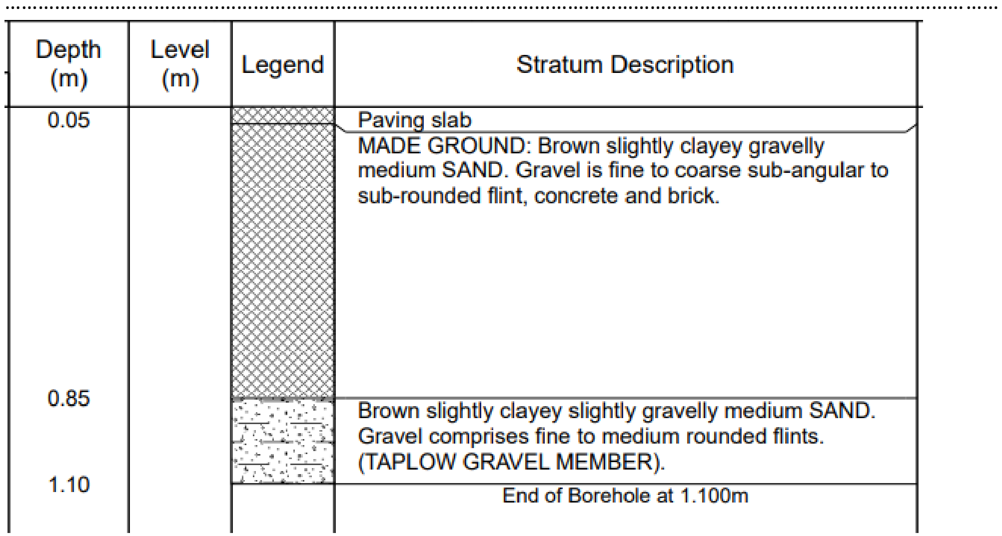
Alison and David Harwood

September 2024

Figure 16: Foundation Exposure TP1 – West Wall

GWPR6137





Depth (m)	Level (m)	Legend	Stratum Description
0.05		▨	Paving slab
		▨	MADE GROUND: Brown slightly clayey gravelly medium SAND. Gravel is fine to coarse sub-angular to sub-rounded flint, concrete and brick.
0.85		░	Brown slightly clayey slightly gravelly medium SAND. Gravel comprises fine to medium rounded flints. (TAPLOW GRAVEL MEMBER).
1.10			End of Borehole at 1.100m

The base of the foundation was proven to 1.10m bgl onto the Taplow Gravel Member.

Legend

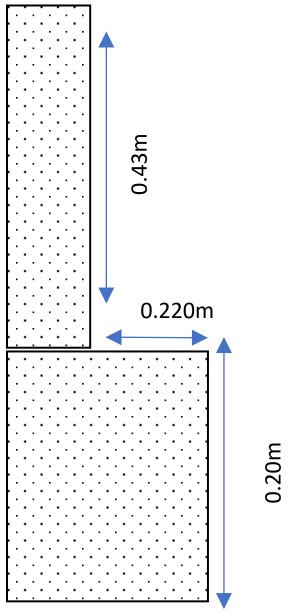
▦ Brickwork

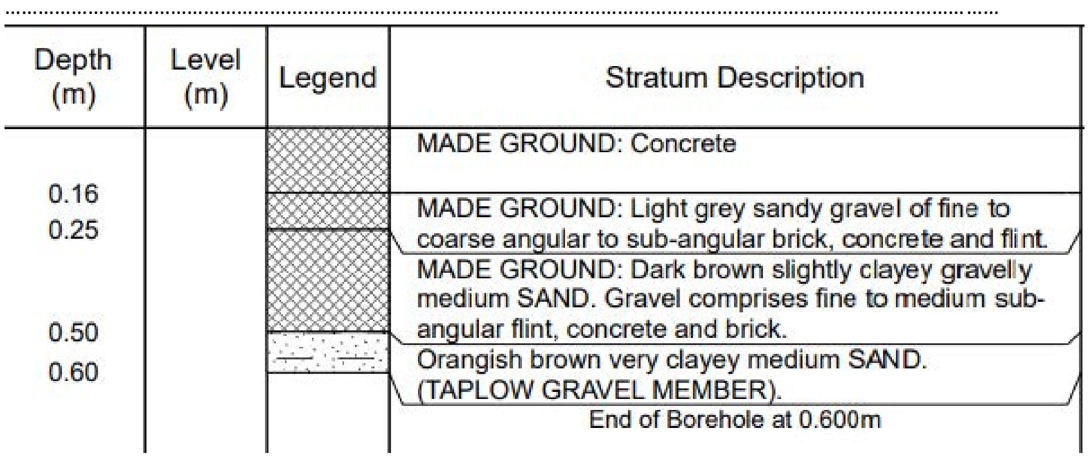
░ Concrete

252 Sheen Lane, London, SW14 8RL

Alison and David Harwood | **September 2024**

Figure 17: Foundation Exposure TP1 – South Wall | **GWPR6137**





Depth (m)	Level (m)	Legend	Stratum Description
0.16		▨	MADE GROUND: Concrete
0.25		▨	MADE GROUND: Light grey sandy gravel of fine to coarse angular to sub-angular brick, concrete and flint.
0.50		▨	MADE GROUND: Dark brown slightly clayey gravelly medium SAND. Gravel comprises fine to medium sub-angular flint, concrete and brick.
0.60		░	Orangish brown very clayey medium SAND. (TAPLOW GRAVEL MEMBER).
			End of Borehole at 0.600m

The base of the foundation was proven to 0.60m bgl onto the Taplow Gravel Member

Legend

▦ Brickwork

░ Concrete

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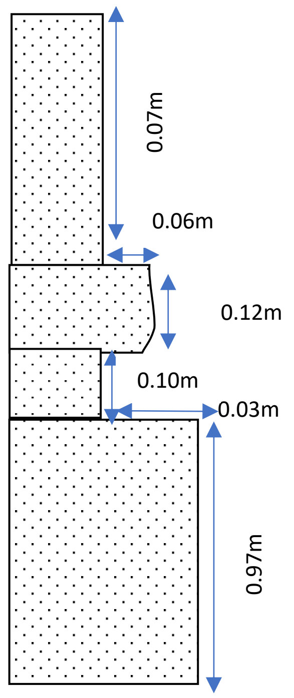
Alison and David Harwood

September 2024

Figure 18: Foundation Exposure TP2

GWPR6137

ground&water



Depth (m)	Level (m)	Legend	Stratum Description
0.12		▨	Concrete
0.60		▨	MADE GROUND: Dark brown very sandy gravelly CLAY. Sand is medium and gravel comprises fine to medium sub-angular to sub-rounded flint, brick and concrete.
1.20		░	Orangish brown very clayey slightly gravelly medium SAND. Gravel comprises fine to coarse angular sandstone and flint. (TAPLOW GRAVEL MEMBER).
			End of Borehole at 1.200m

The base of the foundation was proven to extend beyond 1.20m bgl into the Taplow Gravel Member.

Legend

▦ Brickwork

░ Concrete

252 Sheen Lane, London, SW14 8RL	
Alison and David Harwood	**September 2024**
Figure 19: Foundation Exposure TP3	**GWPR6137**

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 252 Sheen Lane, Richmond, London, SW14 8RL

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: Technical Glossary

TECHNICAL GLOSSARY

The list of possible definitions within the report may be seen below. Please note that some definitions may not be relevant to this report.

HYDROGEOLOGY:

A **Principal Aquifer** is a layer of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer.

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.

Secondary (B) Aquifers consist of deposits with predominantly lower permeability layers with may stoke and yield limited amounts of groundwater due to localised features such as fissures, think permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers.

Secondary Aquifers (Undifferentiated) are assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both a minor aquifer and non-aquifer in different locations due to the variable characteristics of the rock type.

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

FLOOD ZONES:

Environment Agency Flood Zone 2, defined as; land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding.

Environment Agency Flood Zone 3 shows the extent of a river flood with a 1 in 100 (1%0 or greater chance of occurring in any year or a sea flood with a 1 in 200 (0.5%) or greater chance of occurring in any year.

Environment Agency Flood Zone 3 area that benefits from flood defences, defined as; land and property in this flood zone would have a high probability of flooding without the local flood defences. These protect the area against a river flood with a 1% chance of happening each year, or a flood from the sea with a 0.5% chance of happening each year.

GROUNDWATER SOURCE PROTECTION ZONES (SPZS):

Inner Zone (SPZ1): This zone is 50 day travel time of pollutant to source with a 50 metres default minimum radius.

Outer Zone (SPZ2): This zone is 400 day travel time of pollutant to source. This has a 250 or 500 metres minimum radius around the source depending on the amount of water taken.

Total Catchment (SPZ3): This is the area around a supply source within which all the groundwater ends up at the abstraction point. This is the point from where the water is taken. This could extend some distance from the source point.

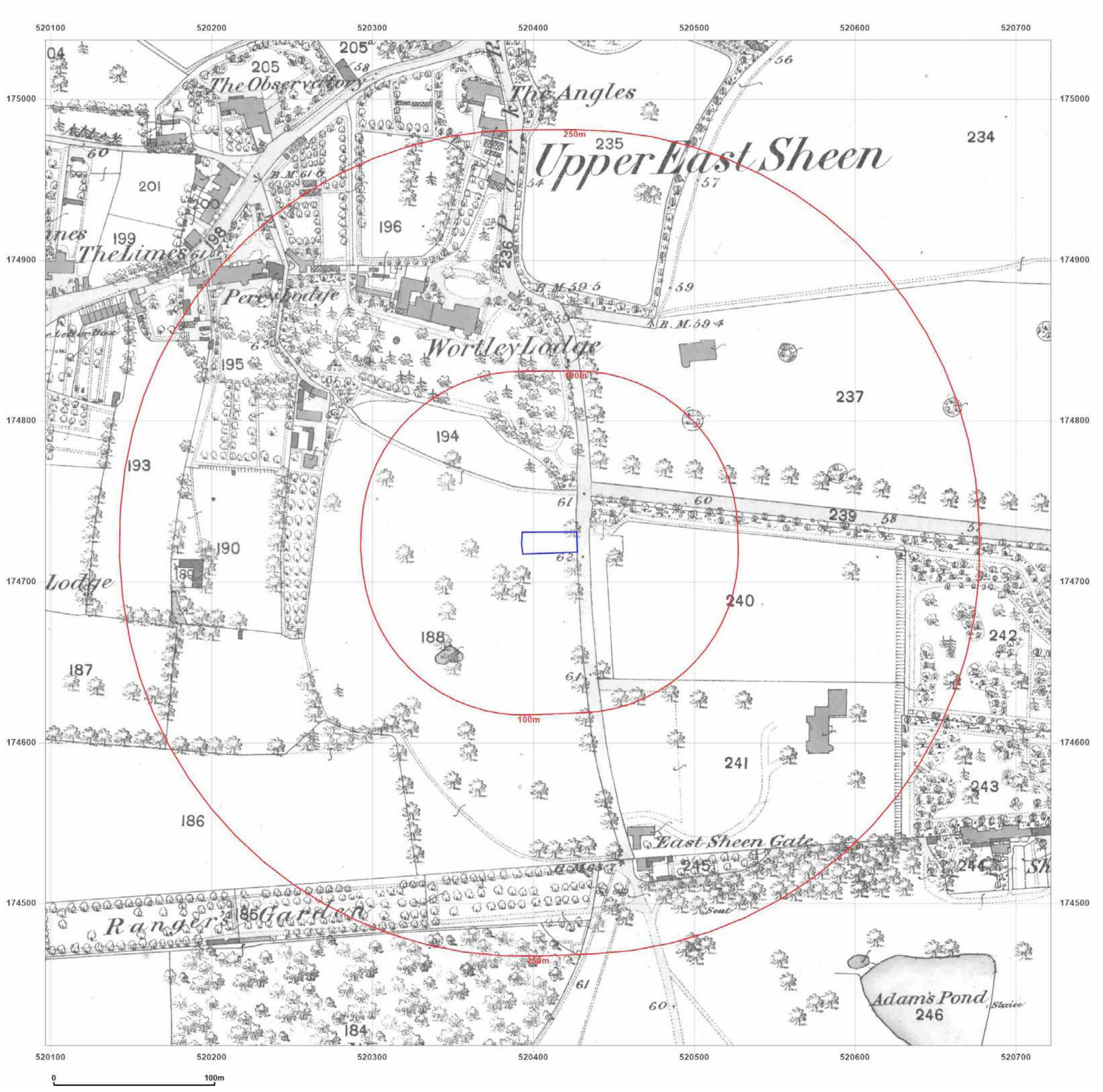
Zone of Special Interest (SPZ4): This zone is where local conditions require additional protection.

IN-SITU STRENGTH GEOTECHNICAL TESTING:

Windowless Sample and/or Cable Percussion and/or Rotary 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 50mm and an inside diameter of 35mm, 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 63.5kg falling through a distance of 760mm. The sample tube is driven 150mm into the ground and then the number of blows needed for the tube to penetrate each 75mm up to a depth of 450mm 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 Dynamic Probe ‘Super Heavy’ (SHDP) Tests were conducted in accordance with BS 1377; 1990; Part 9, Clause 3.2).

APPENDIX C: GroundSure Historical Mapping



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Printed at:	1:2,500

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Revised 1840
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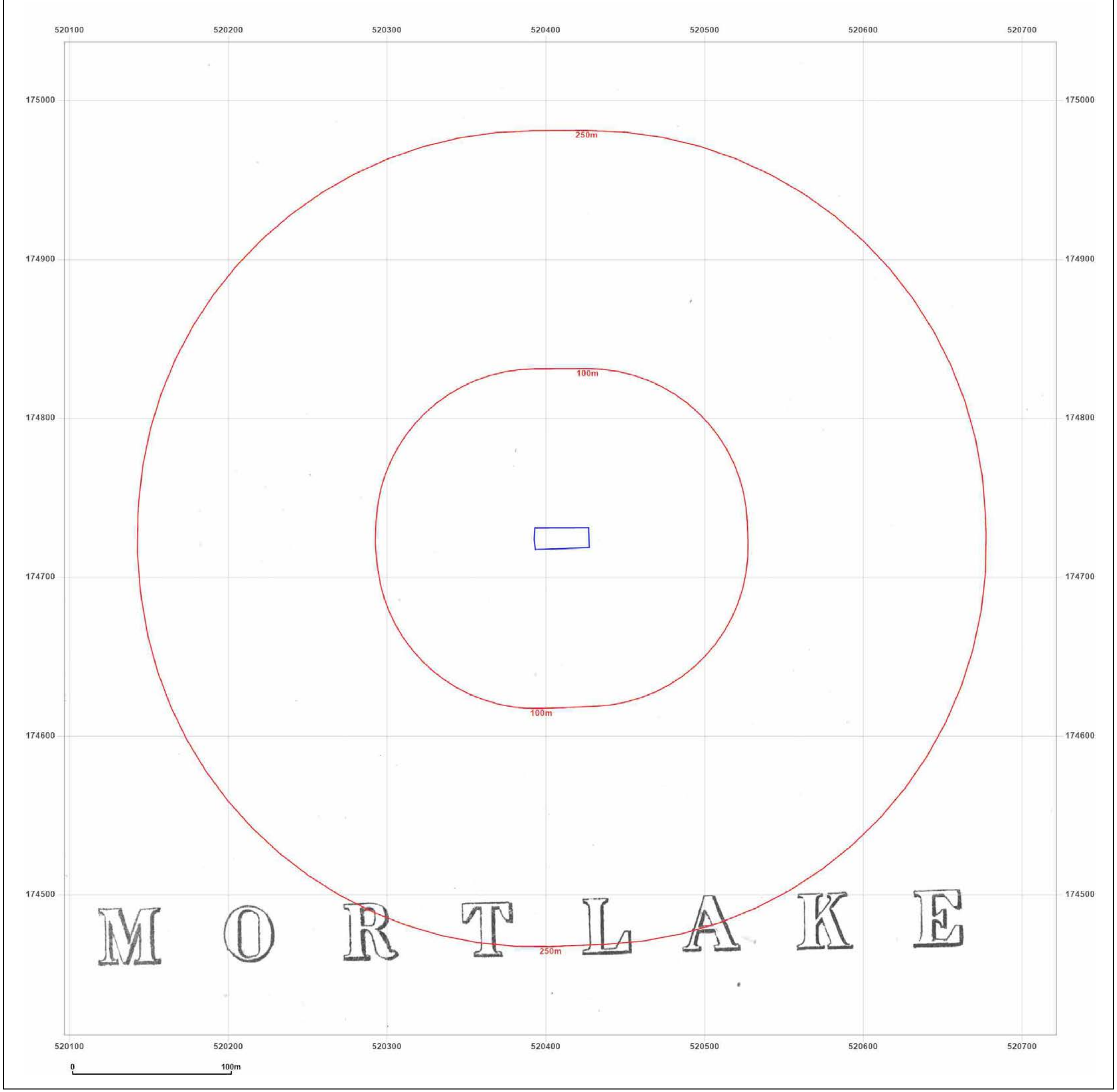

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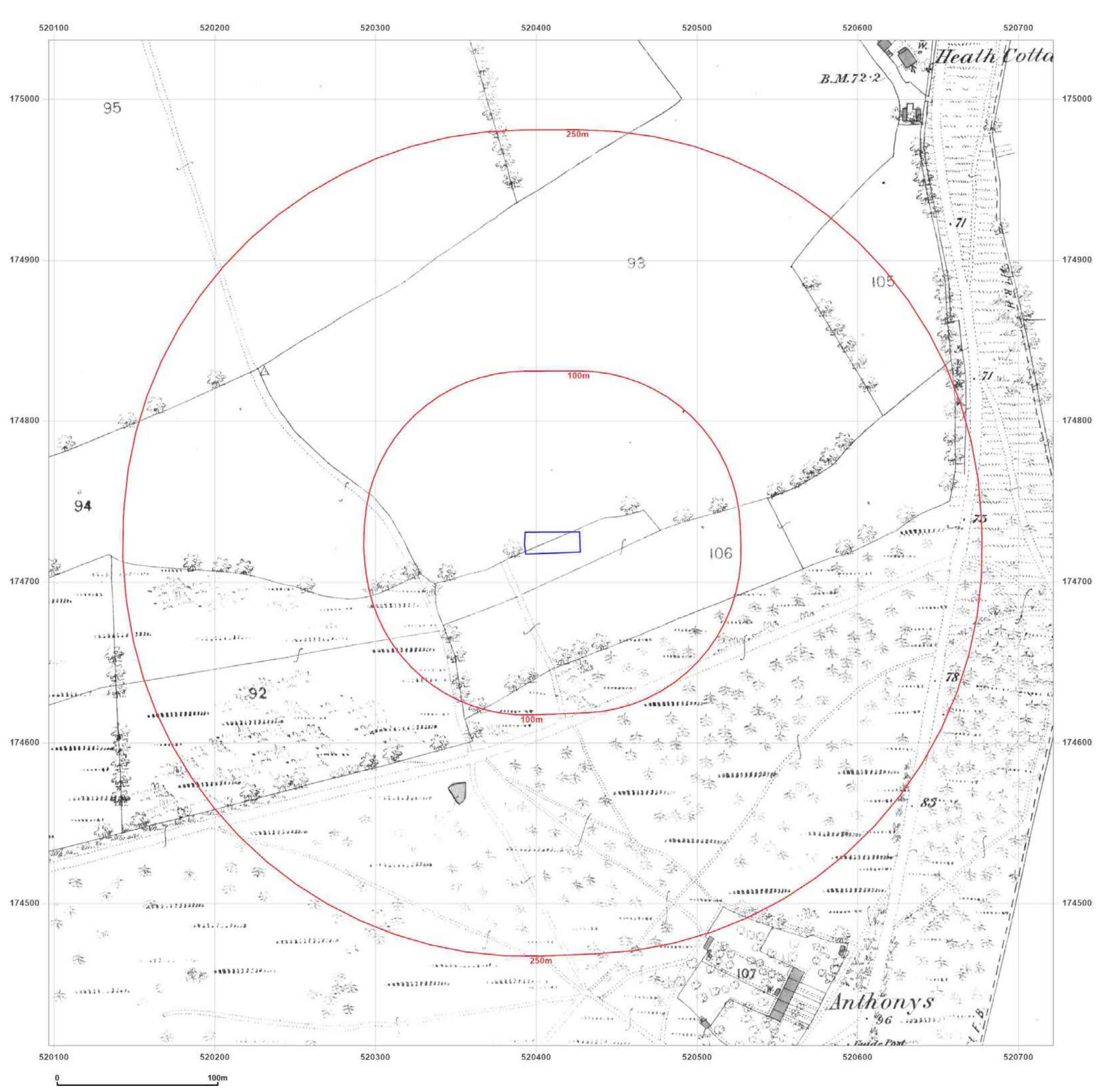

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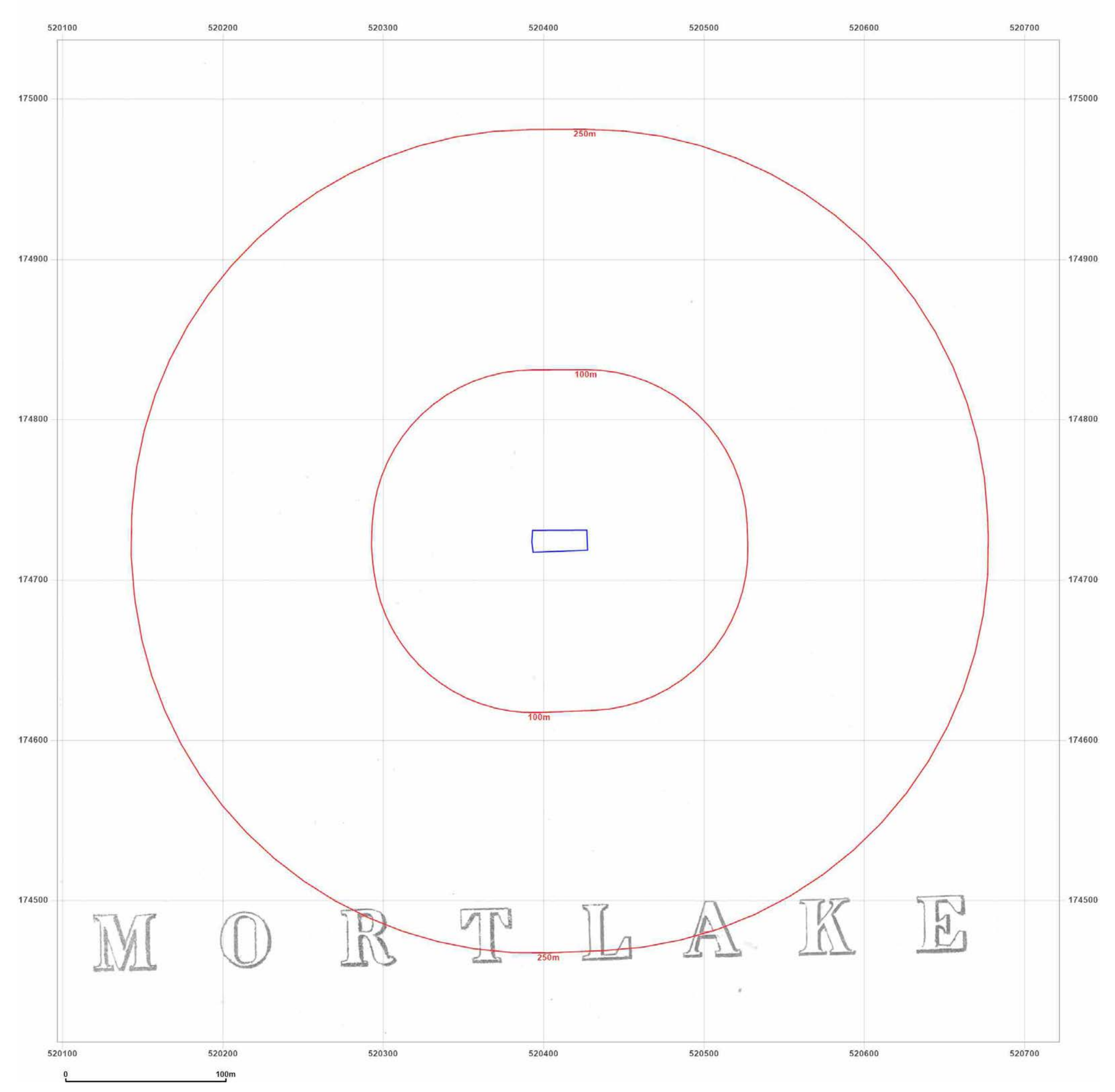

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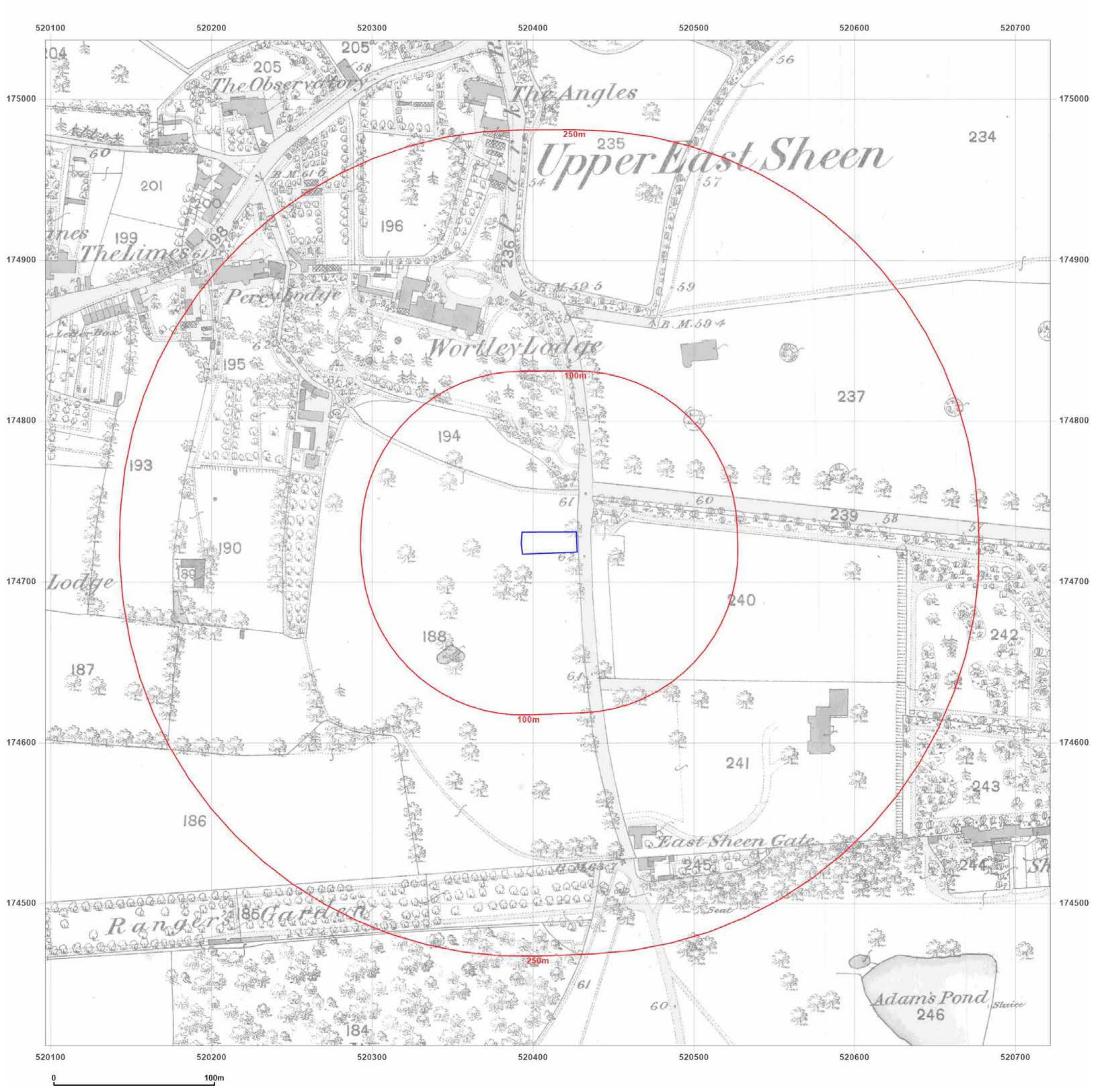

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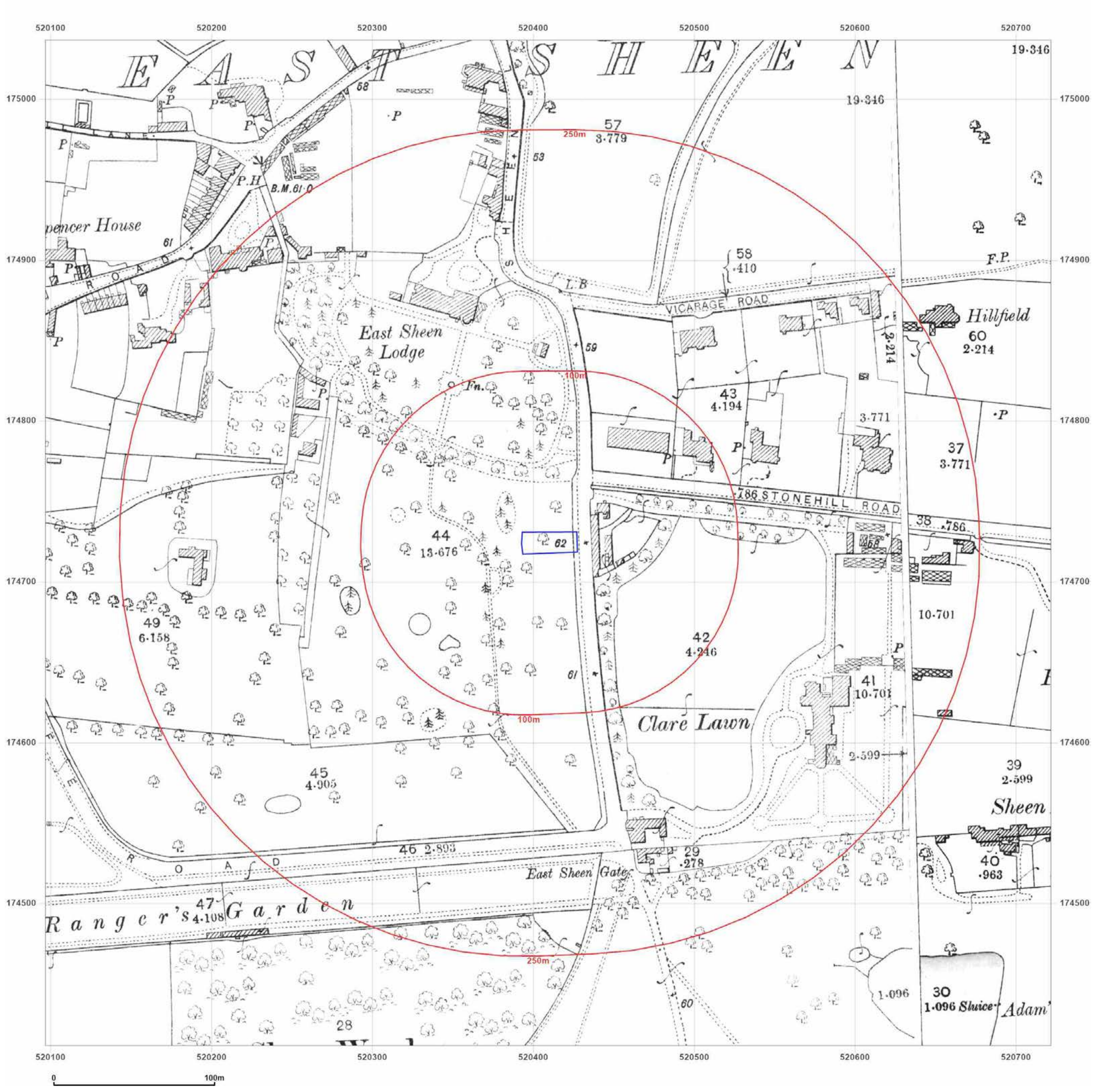

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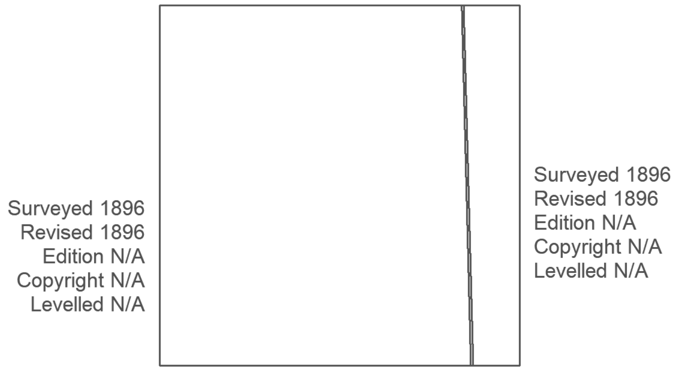

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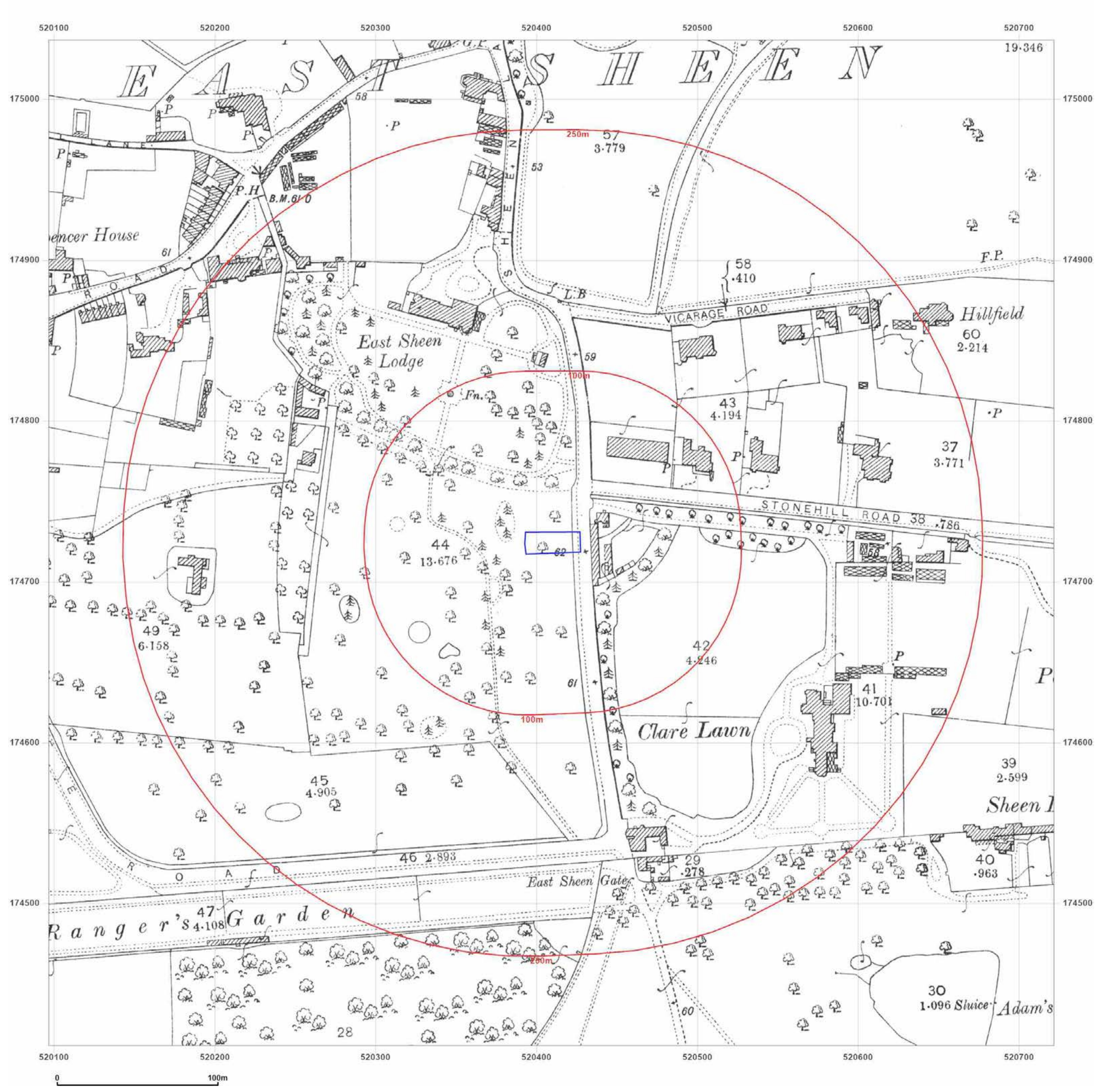

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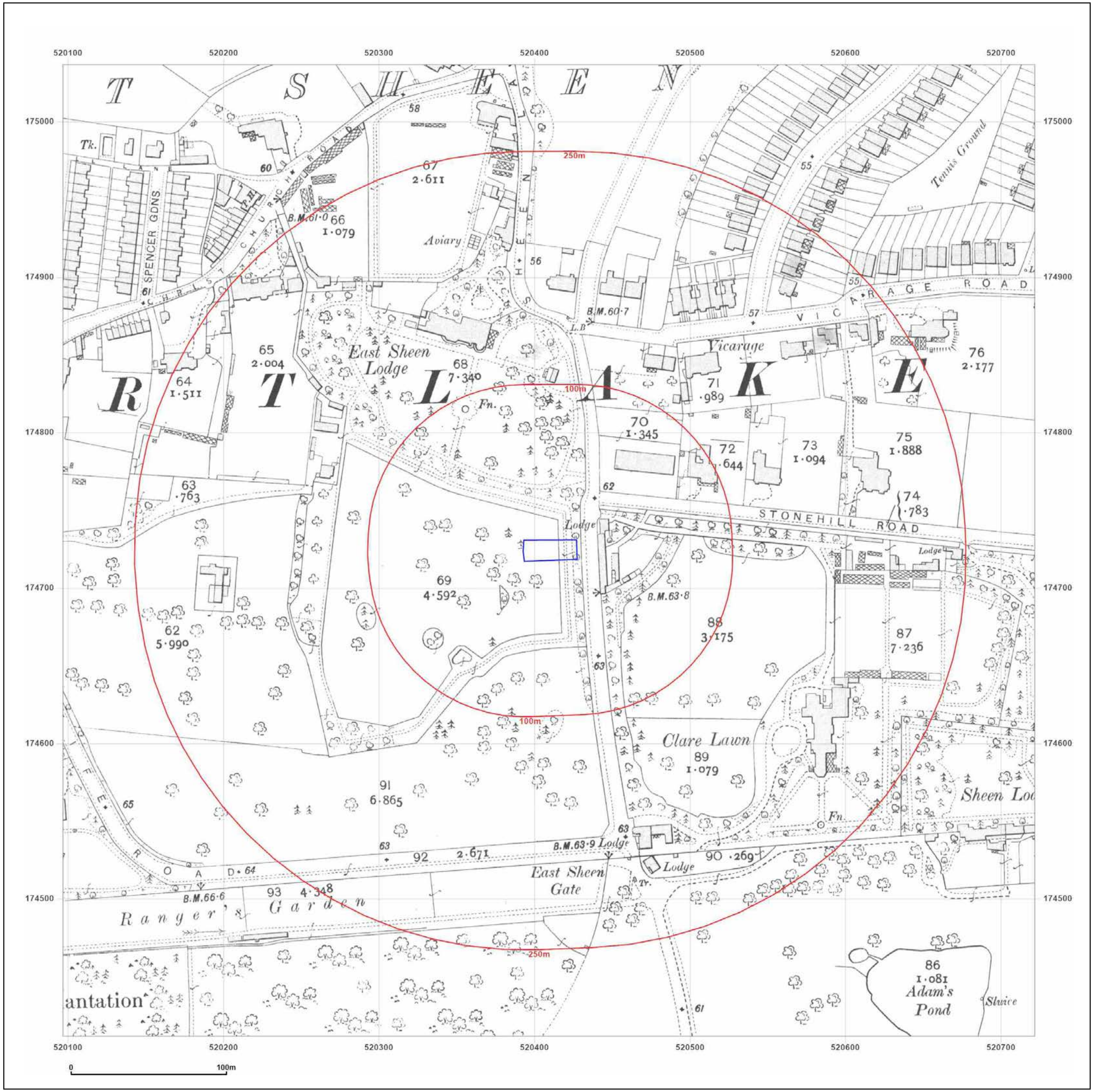

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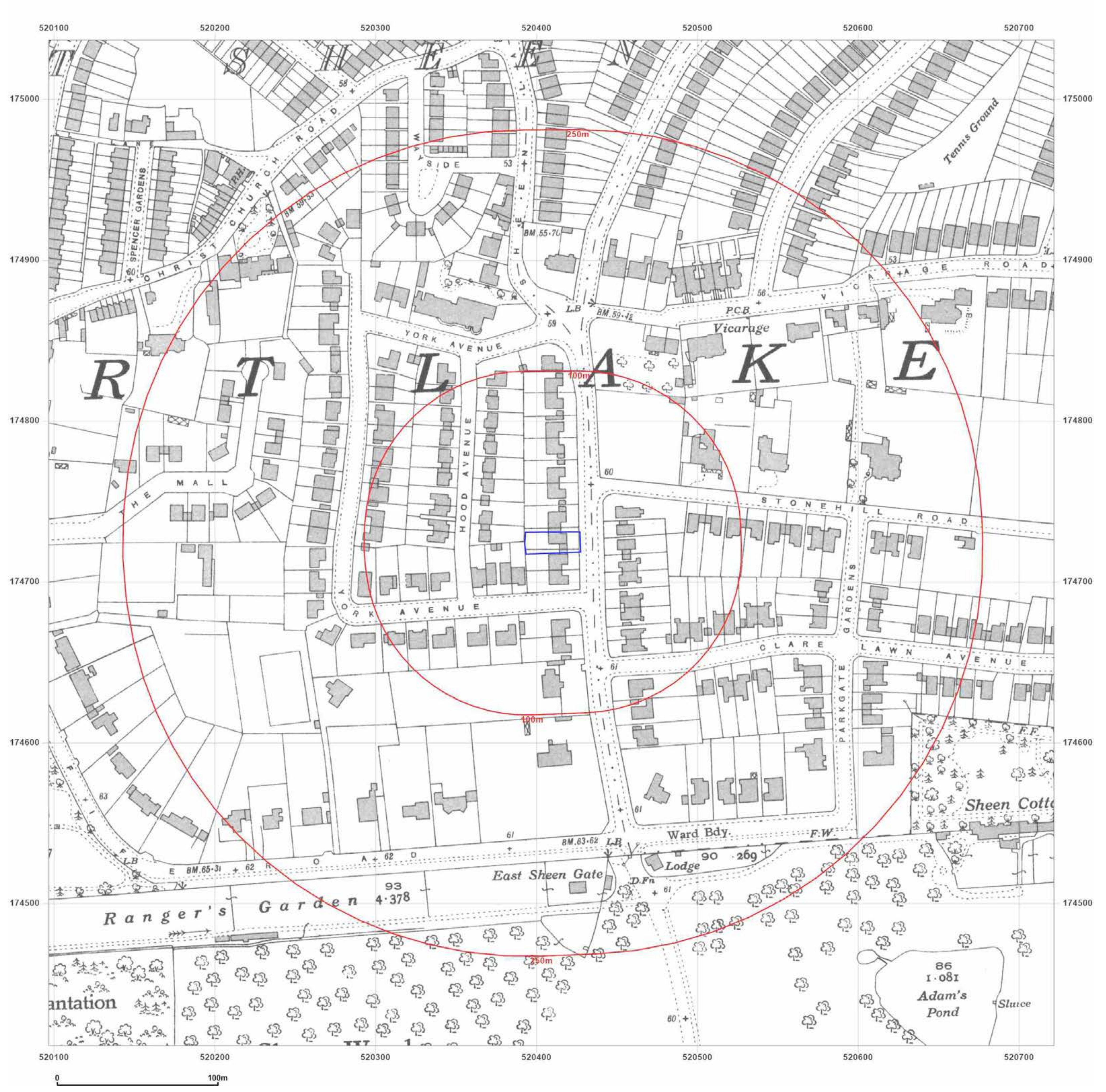

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Revised 1933
Edition N/A
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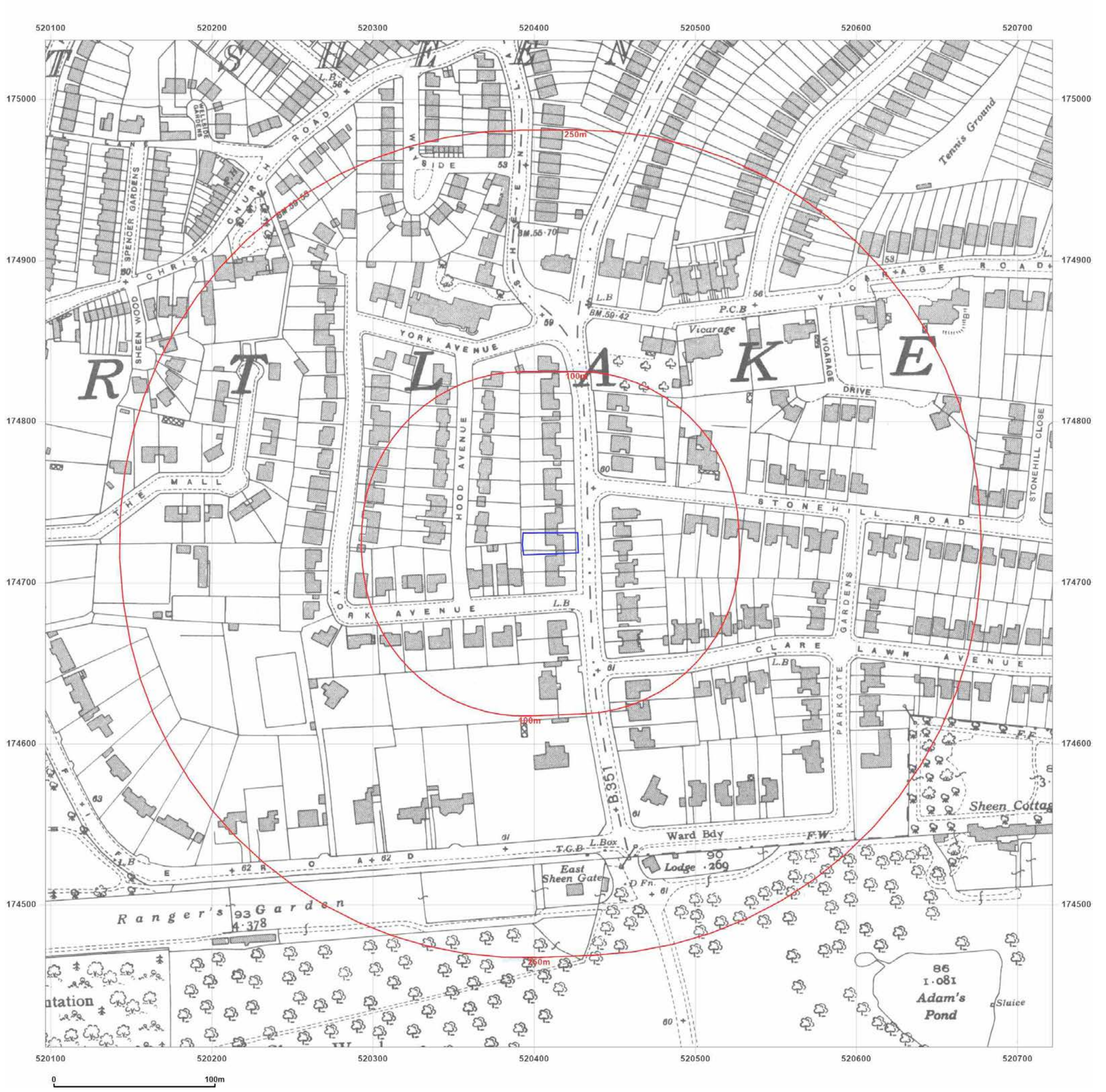

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Edition N/A
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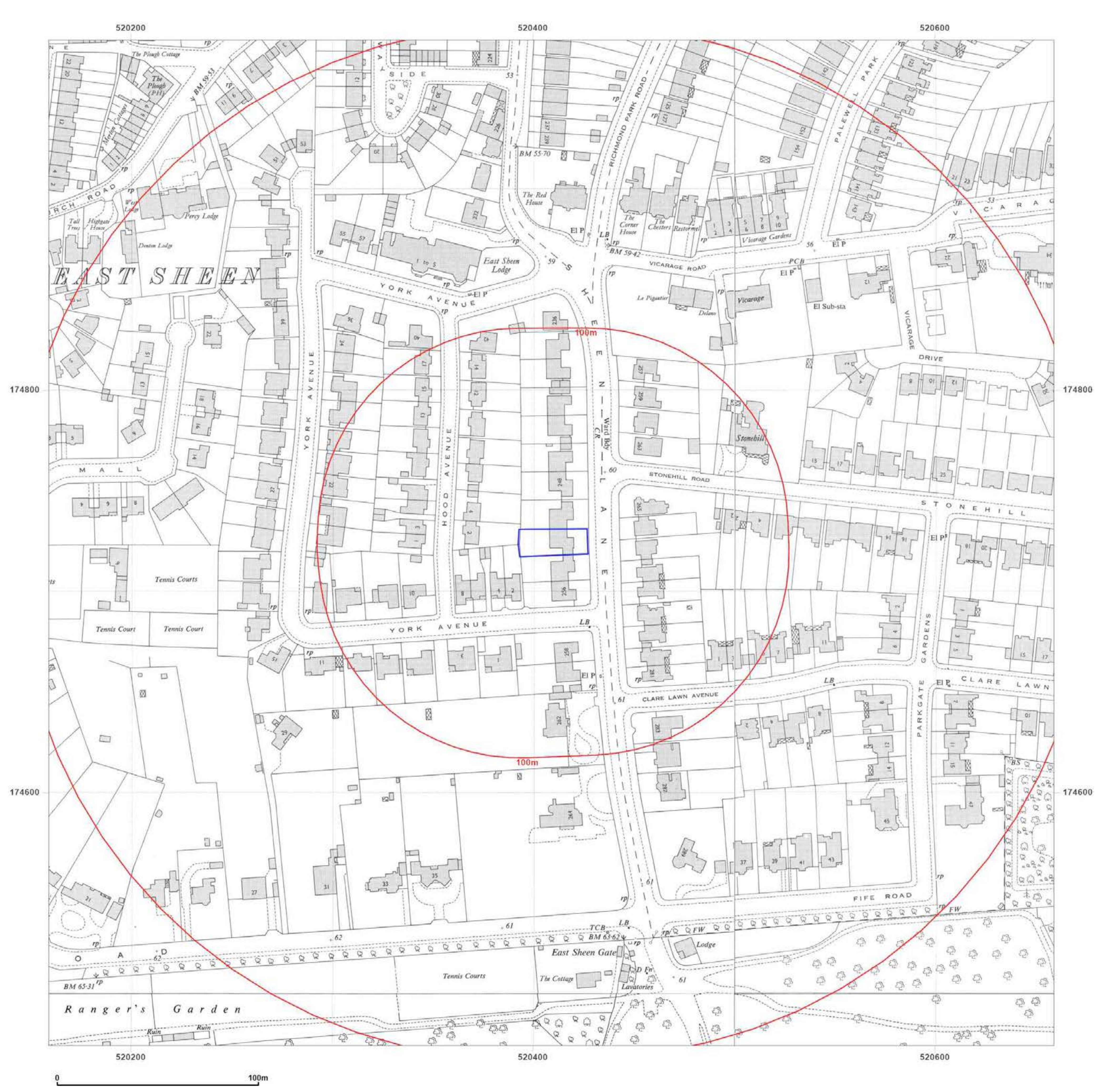

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Surveyed 1951
Revised 1951
Edition N/A
Copyright N/A
Levelled 1932

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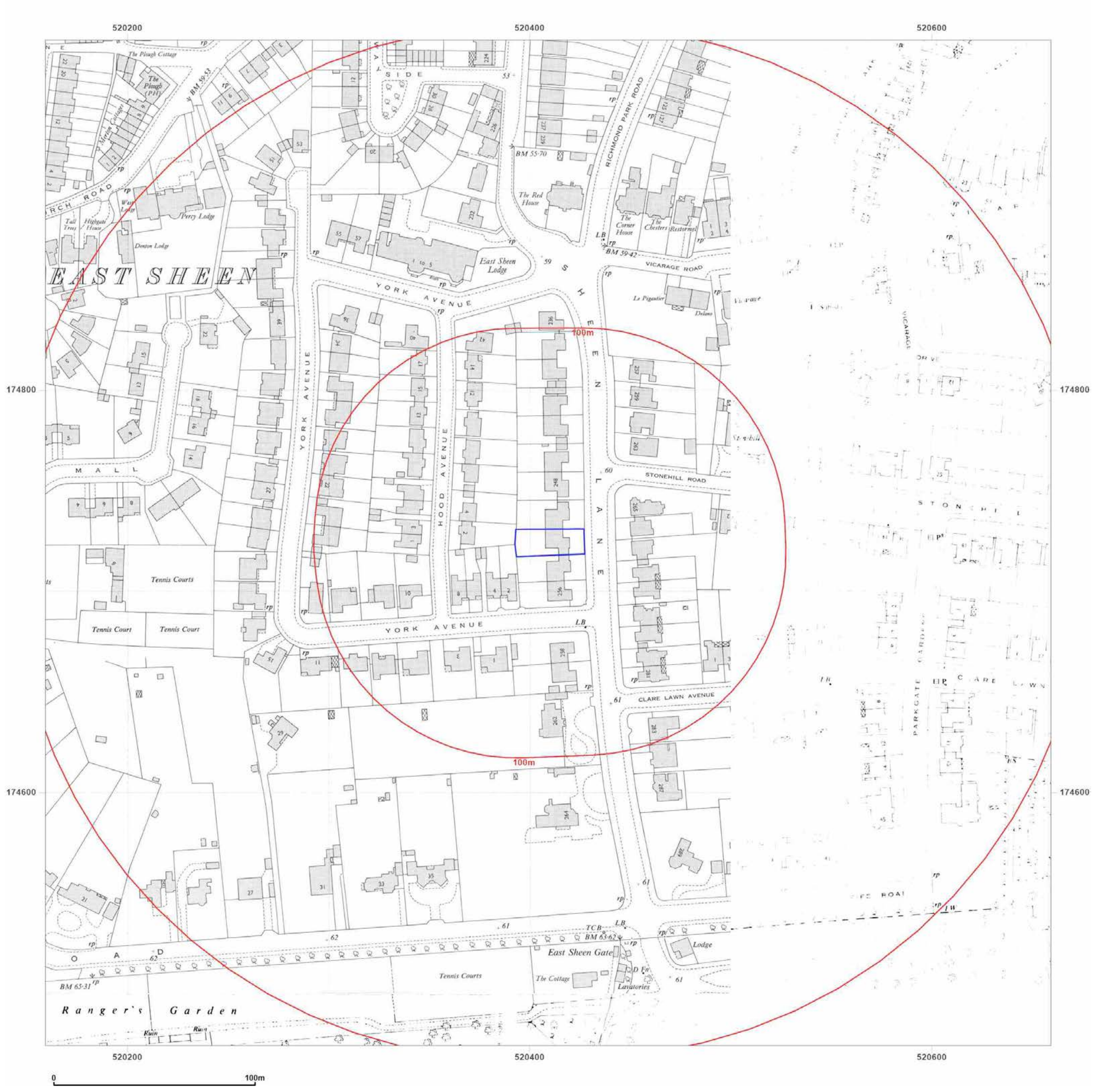

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Revised 1951
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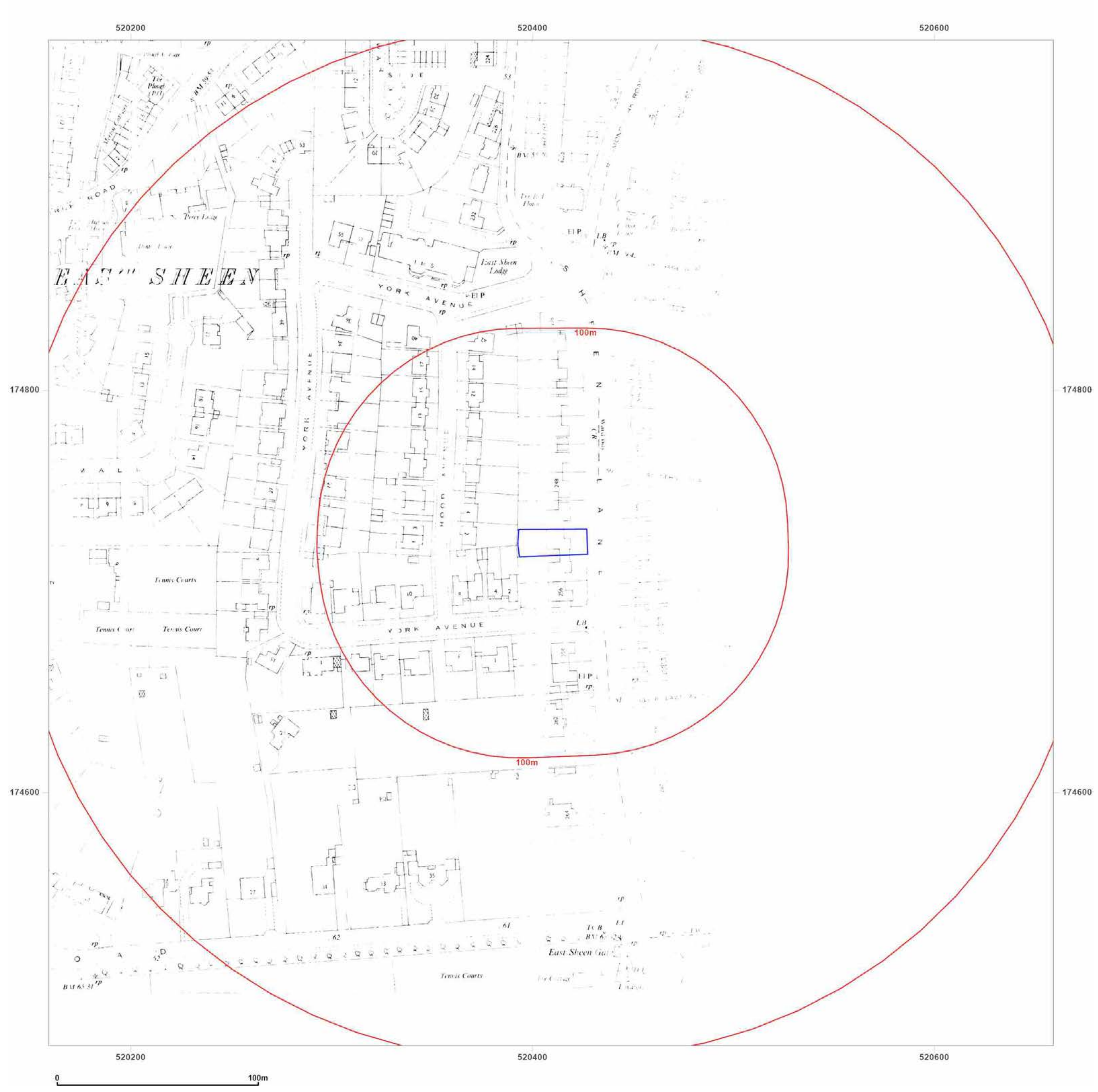

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Map Name:	National Grid
Map date:	**1951-1953**
Scale:	1:2,500
Printed at:	1:2,500

N
W E
S

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

Surveyed 1951
Revised 1951
Edition N/A
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INSIGHTS

Site Details:

252, SHEEN LANE, EAST
SHEEN, LONDON, RICHMOND
UPON THAMES, SW14 8RL

Client Ref:	GWPR6137
Report Ref:	GS-7U6-4V4-RVN-LN6
Grid Ref:	520409, 174724

Map Name:	National Grid
Map date:	**1960**
Scale:	1:2,500
Printed at:	1:2,500

N
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Surveyed 1959
Revised 1959
Edition 1960
Copyright 1960
Levelled 1954

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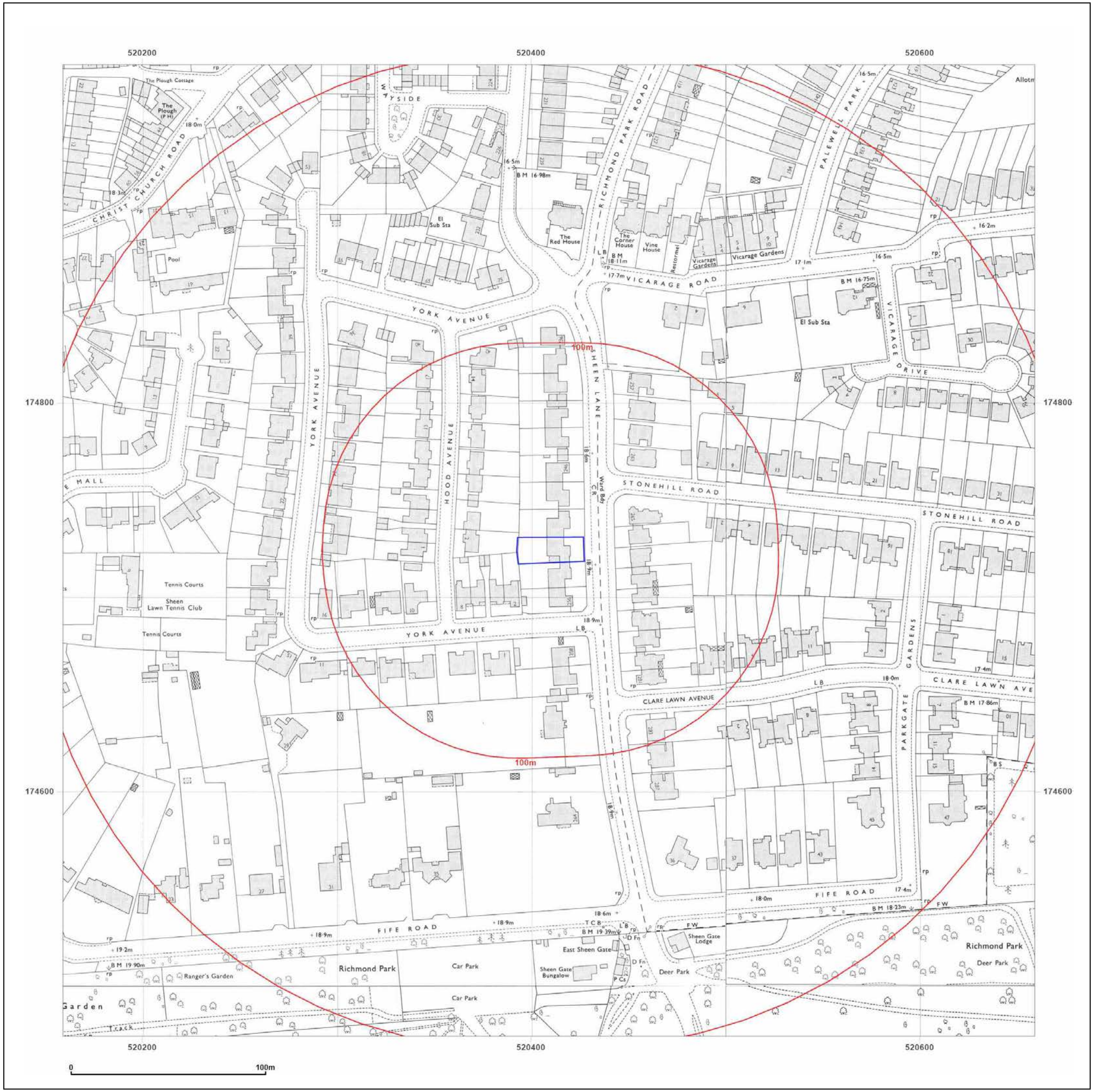

Groundsure
INSIGHTS

Site Details:

252, SHEEN LANE, EAST
SHEEN, LONDON, RICHMOND
UPON THAMES, SW14 8RL

Client Ref: GWPR6137
Report Ref: GS-7U6-4V4-RVN-LN6
Grid Ref: 520409, 174724

Map Name: National Grid

Map date: **1971-1973**

Scale: 1:1,250

Printed at: 1:2,000

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Surveyed 1951 Revised 1972 Edition N/A Copyright 1973 Levelled 1954	Surveyed 1951 Revised 1970 Edition N/A Copyright 1971 Levelled 1954
Surveyed 1951 Revised 1972 Edition N/A Copyright 1973 Levelled 1954	Surveyed 1951 Revised 1972 Edition N/A Copyright 1973 Levelled 1954

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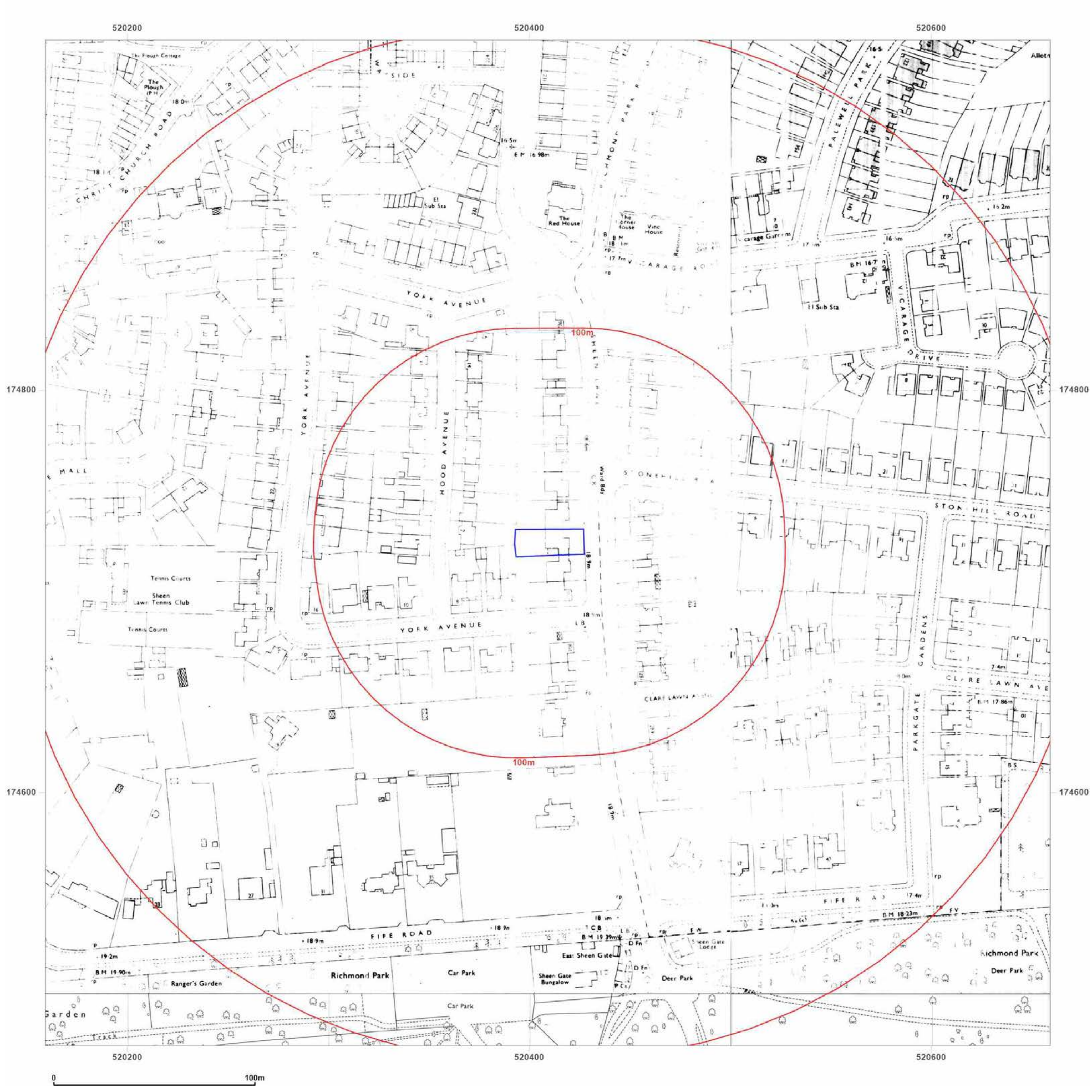

Groundsure
INSIGHTS

Site Details:

252, SHEEN LANE, EAST
SHEEN, LONDON, RICHMOND
UPON THAMES, SW14 8RL

Client Ref: GWPR6137
Report Ref: GS-7U6-4V4-RVN-LN6
Grid Ref: 520409, 174724

Map Name: National Grid

Map date: **1973-1974**

Scale: 1:1,250

Printed at: 1:2,000

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Surveyed N/A Revised N/A Edition N/A Copyright N/A Levelled N/A	Surveyed N/A Revised N/A Edition N/A Copyright N/A Levelled N/A
Surveyed 1951 Revised 1972 Edition N/A Copyright 1973 Levelled 1954	Surveyed 1951 Revised 1972 Edition N/A Copyright 1973 Levelled 1954

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Map legend available at:
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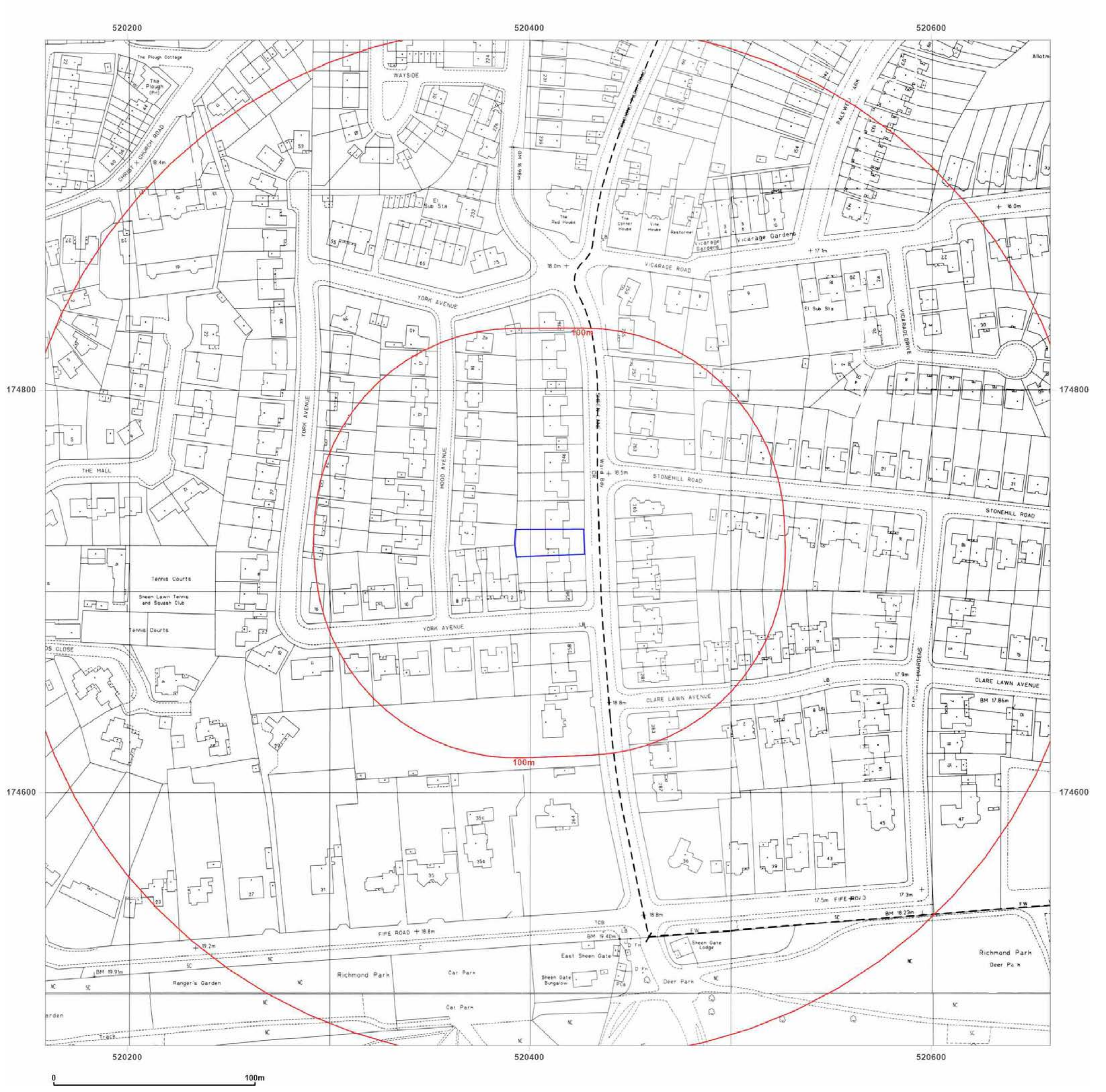

Site Details:

252, SHEEN LANE, EAST
SHEEN, LONDON, RICHMOND
UPON THAMES, SW14 8RL

Client Ref:	GWPR6137
Report Ref:	GS-7U6-4V4-RVN-LN6
Grid Ref:	520409, 174724
Map Name:	National Grid
Map date:	**1991**
Scale:	1:1,250
Printed at:	1:2,000

Surveyed 1991
Revised 1991
Edition N/A
Copyright 1991
Levelled N/A

Surveyed N/A
Revised N/A
Edition N/A
Copyright 1991
Levelled N/A

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Revised 1991
Edition N/A
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Edition N/A
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Map legend available at:
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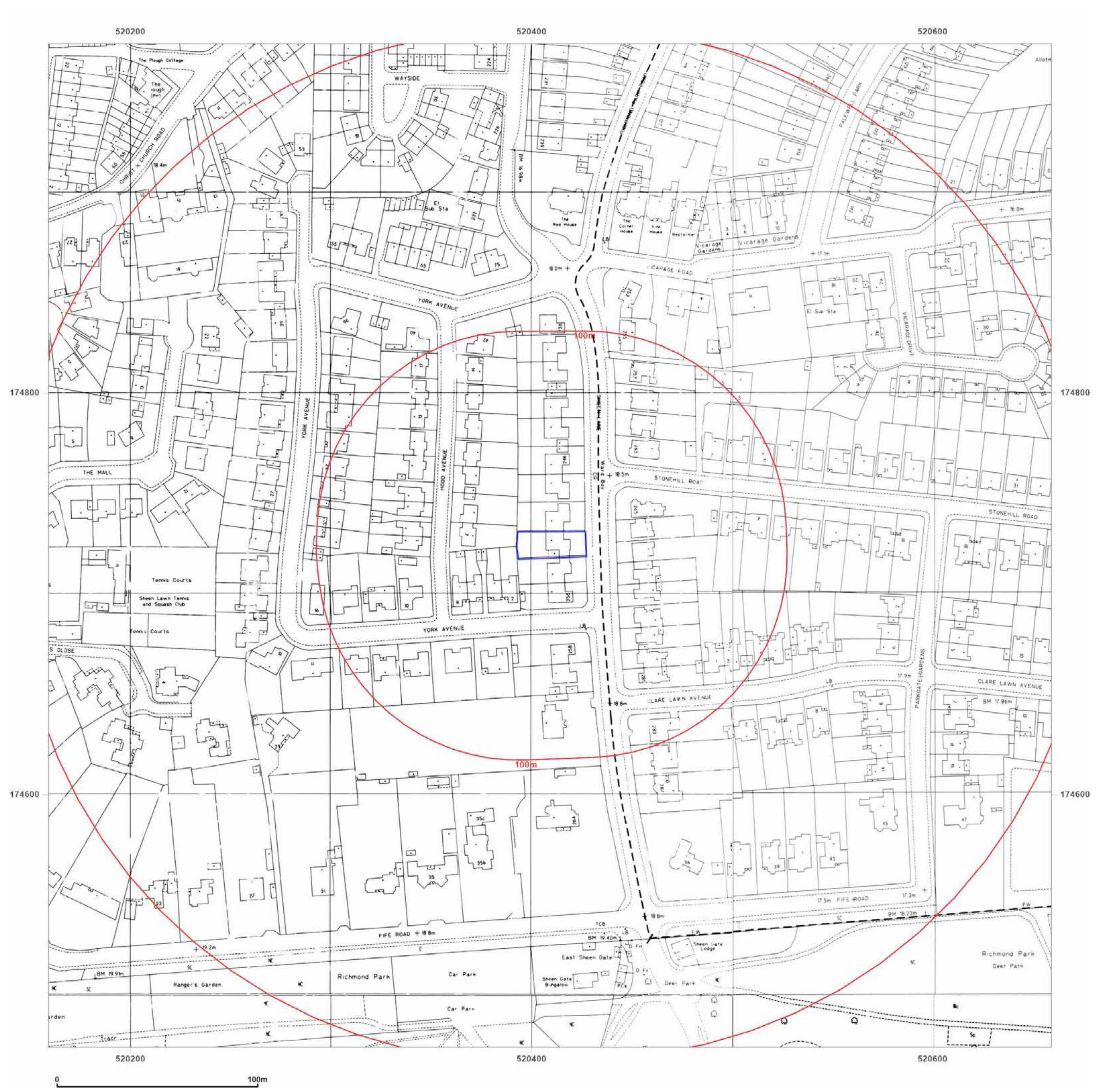

Site Details:

252, SHEEN LANE, EAST
SHEEN, LONDON, RICHMOND
UPON THAMES, SW14 8RL

Client Ref:	GWPR6137
Report Ref:	GS-7U6-4V4-RVN-LN6
Grid Ref:	520409, 174724

Map Name:	National Grid
Map date:	**1991-1993**
Scale:	1:1,250
Printed at:	1:2,000

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Surveyed N/A Revised N/A Edition N/A Copyright 1991 Levelled N/A	Surveyed 1991 Revised 1991 Edition N/A Copyright 1991 Levelled N/A
Surveyed N/A Revised N/A Edition N/A Copyright 1991 Levelled N/A	Surveyed N/A Revised N/A Edition N/A Copyright 1993 Levelled N/A

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Site Details:

252, SHEEN LANE, EAST
SHEEN, LONDON, RICHMOND
UPON THAMES, SW14 8RL

Client Ref:	GWPR6137
Report Ref:	GS-7U6-4V4-RVN-LN6
Grid Ref:	520409, 174724
Map Name:	LandLine
Map date:	**2003**
Scale:	1:1,250
Printed at:	1:1,250

N
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2003

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Production date: 20 August 2024

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APPENDIX D: Trial Hole Logs

Percussion Drilling Log

Project Name: 252 Sheen Lane, London, SW14 8RL	Client: Alison and David Harwood	Date:
Location: 252 Sheen Lane, London, SW14 8RL	Contractor:	
Project No. : GWPR6137	Crew Name:	Drilling Equipment:

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

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.05			Paving slab
					0.06			MADE GROUND: Concrete
					0.30			MADE GROUND: Orangish brown slightly clayey gravelly medium SAND. Gravel comprised fine to medium sub-angular to sub-rounded flints and brick.
		1.20	SPT	N=8 (1,1/2,1,1,4)	1.20			Orangish brown slightly clayey slightly gravelly medium SAND. Gravel comprised occasional fine to medium sub-angular to sub-rounded flints. (TAPLOW GRAVEL MEMBER).
					1.80			Orangish brown slightly clayey gravelly medium SAND. Gravel comprised frequent fine to medium sub-angular to sub-rounded flints. (TAPLOW GRAVEL MEMBER).
		2.00	SPT	0 (50 for 30mm/0 for 0mm)	2.00			Orangish brown sandy GRAVEL. Sand is medium and gravel comprises fine to coarse sub-angular to sub-rounded flint. (TAPLOW GRAVEL MEMBER).
								End of Borehole at 2.000m

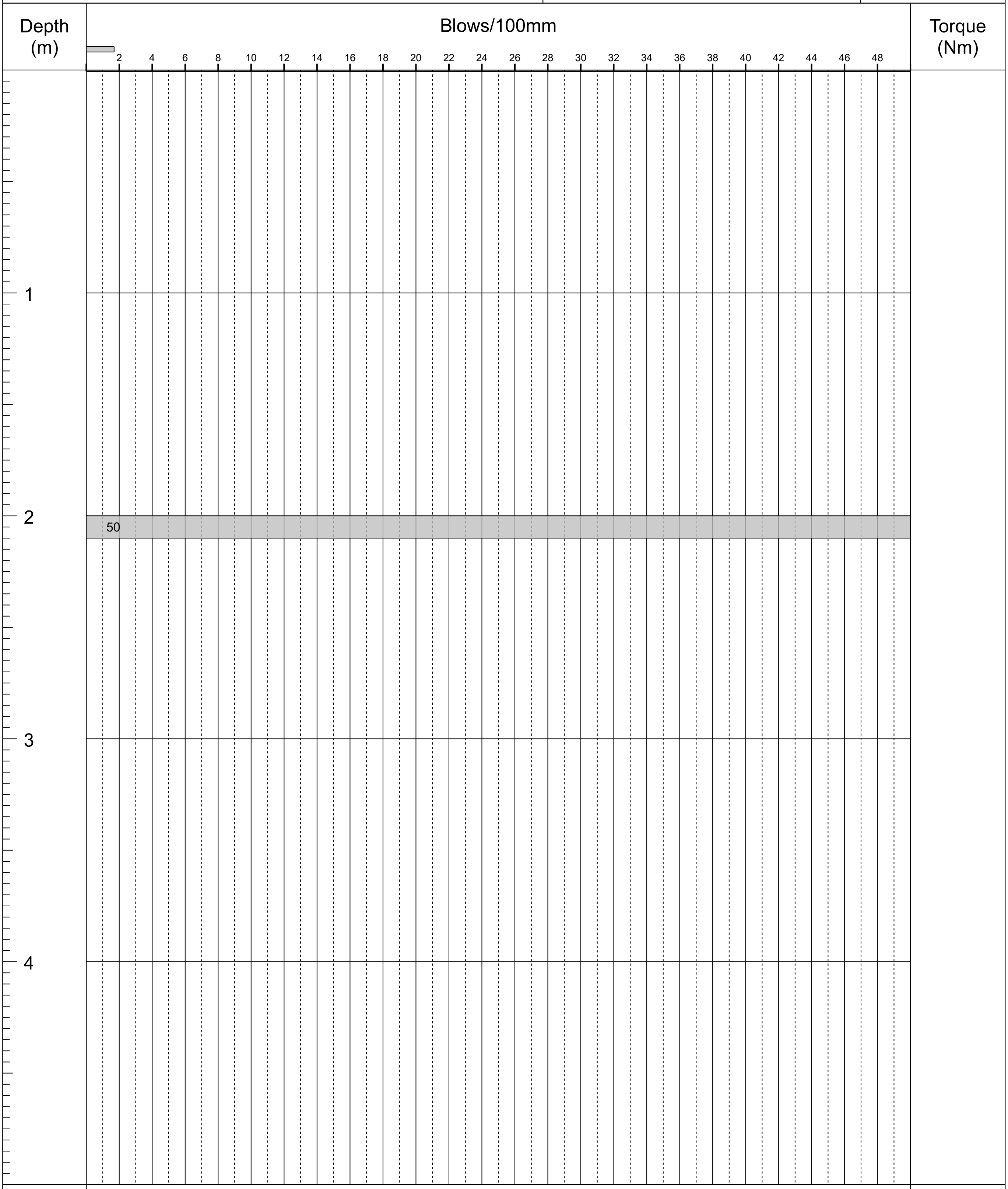
Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks

No groundwater encountered. No roots noted.
Borehole met refusal at 2.0m bgl.

Probe Log

Project Name: 252 Sheen Lane, London, SW14 8RL	Project No. GWPR6137	Co-ords:	Probe No DP1 Sheet 1 of 1
			Hole Type DP
Location: 252 Sheen Lane, London, SW14 8RL		Level:	Scale 1:25
Client: Alison and David Harwood		Dates:	Logged By



Remarks:	Fall Height 750	Cone Base Diameter	
	Hammer Wt 64	Final Depth	2.00
	Probe Type DPSH-B		

Percussion Drilling Log

Project Name: 252 Sheen Lane, London, SW14 8RL	Client: Alison and David Harwood	Date:
Location: 252 Sheen Lane, London, SW14 8RL	Contractor:	
Project No. : GWPR6137	Crew Name:	Drilling Equipment:

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
WS2	WS			1:50	Sheet 1 of 1

Well	Water Strikes	**Sample and In Situ Testing** Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.10			MADE GROUND: Concrete
					0.50			MADE GROUND: Dark brown very sandy gravelly CLAY. Gravel comprised fine to coarse sub-angular to sub-rounded flint, concrete and brick.
		1.20	SPT	N=11 (2,1/3,2,2,4)				Light brown clayey slightly gravelly medium SAND. Gravel comprised occasional fine to medium sub-angular to sub-rounded flints. (TAPLOW GRAVEL MEMBER).
		2.00	SPT	N=38 (5,6/8,10,10,10)				
	▼	3.00	SPT	N=48 (9,8/10,12,12,14)				
					3.50			Light brown medium gravelly SAND. Gravel comprises fine to coarse sub-angular to sub-rounded flint. (TAPLOW GRAVEL MEMBER).
		4.00	SPT	42 (11,13/42 for 225mm)				
					4.20			End of Borehole at 4.200m

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

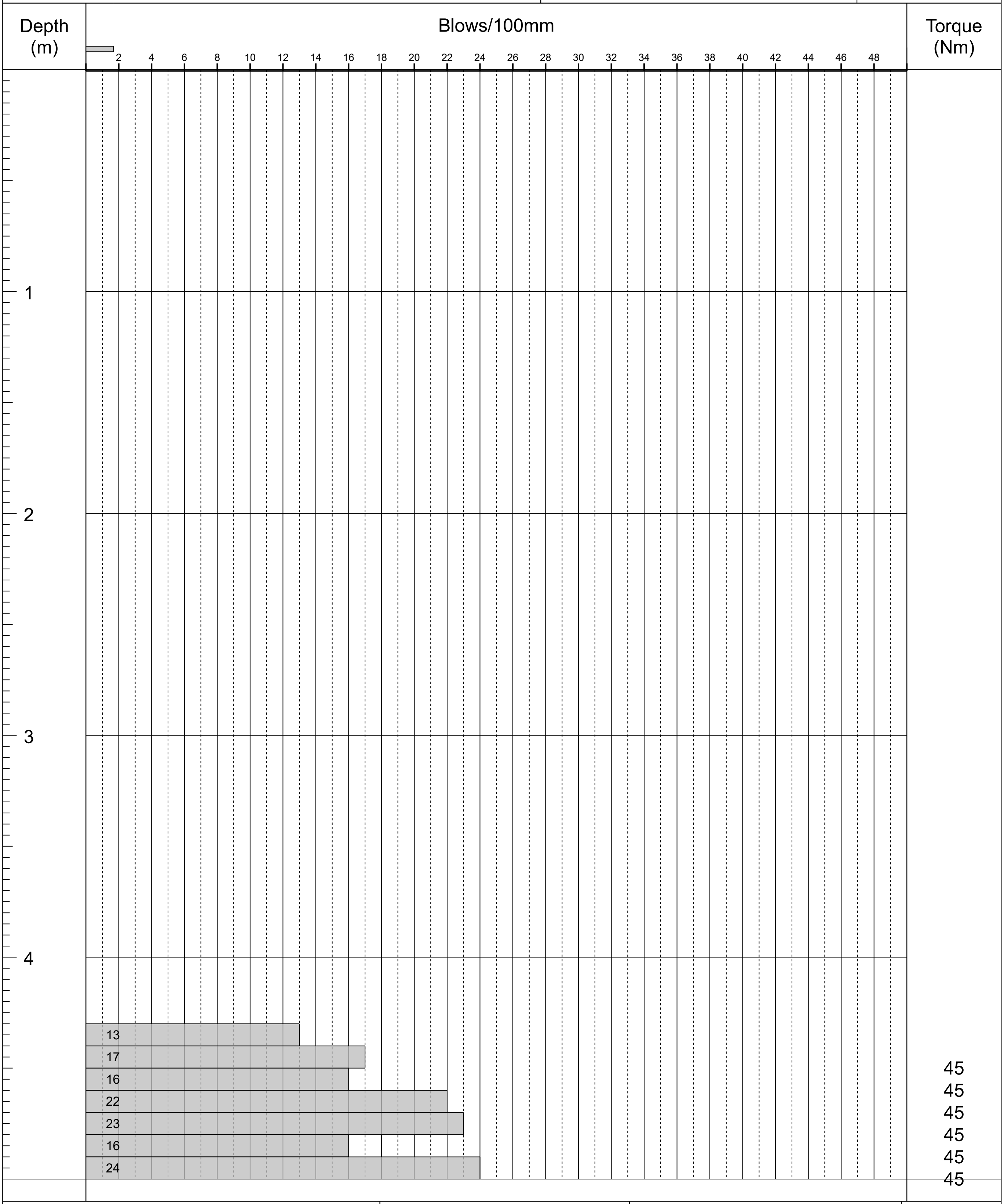
Remarks

Groundwater encountered at 3.25m bgl. Roots noted to 0.50m bgl.
Borehole met refusal at 4.20m bgl.

Probe Log

Probe No
DP2
Sheet 1 of 2

Project Name: 252 Sheen Lane, London, SW14 8RL
Project No. GWPR6137
Co-ords:
Hole Type DP
Location: 252 Sheen Lane, London, SW14 8RL
Level:
Scale 1:25
Client: Alison and David Harwood
Dates:
Logged By



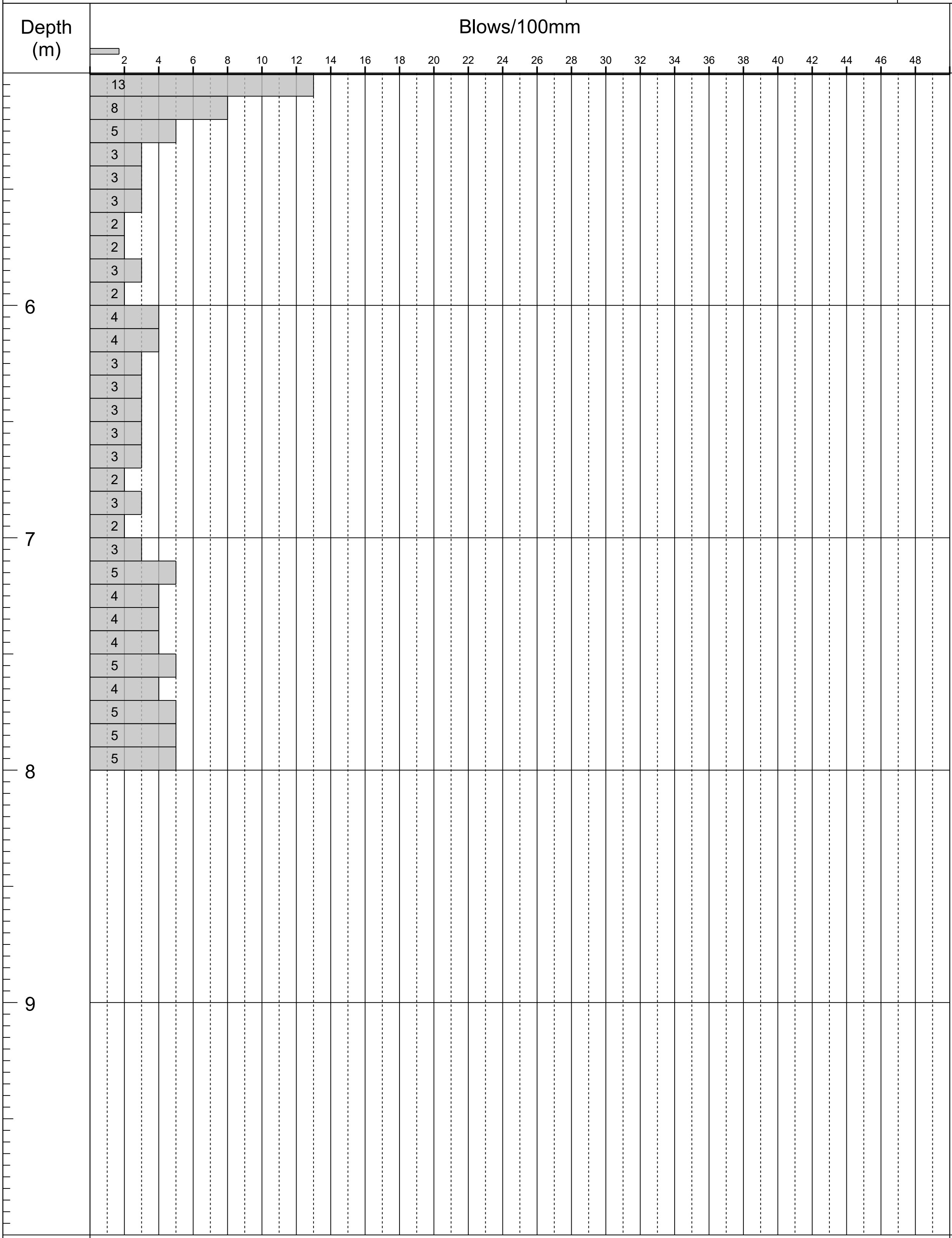
Remarks:

Fall Height 750
Hammer Wt 64
Probe Type DPSH-B
Cone Base Diameter
Final Depth 8.00

Probe Log

Probe No
DP2
Sheet 2 of 2

Project Name:	252 Sheen Lane, London, SW14 8RL	Project No. GWPR6137	Co-ords:	Hole Type DP
Location:	252 Sheen Lane, London, SW14 8RL		Level:	Scale 1:25
Client:	Alison and David Harwood		Dates:	Logged By



Blows/100mm	Torque (Nm)
13	45
8	45
5	45
3	45
3	45
3	45
2	45
2	45
3	45
2	45
4	45
4	45
3	45
3	45
3	45
3	45
3	45
2	45
3	45
2	45
3	45
5	45
4	45
4	45
4	45
5	45
4	45
5	45
5	45
5	

Remarks:

Fall Height	750	Cone Base Diameter	
Hammer Wt	64	Final Depth	8.00
Probe Type	DPSH-B		

Trial Pit Log

Project Name: 252 Sheen Lane, London, SW14 8RL	Client: Alison and David Harwood	Date:
Location: 252 Sheen Lane, London, SW14 8RL	Contractor:	
Project No. : GWPR6137	Crew Name:	Equipment:

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP1	TP			1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
▨					0.05		▨	Paving slab
▨					0.85		▨	MADE GROUND: Brown slightly clayey gravelly medium SAND. Gravel is fine to coarse sub-angular to sub-rounded flint, concrete and brick.
▨					1.10		▨	Brown slightly clayey slightly gravelly medium SAND. Gravel comprises fine to medium rounded flints. (TAPLOW GRAVEL MEMBER).
								End of Borehole at 1.100m

1
2
3
4
5

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks

Remarks

No groundwater encountered. Roots noted to 0.50m bgl.

Trial Pit Log

Project Name: 252 Sheen Lane, London, SW14 8RL	Client: Alison and David Harwood	Date:
Location: 252 Sheen Lane, London, SW14 8RL	Contractor:	
Project No. : GWPR6137	Crew Name:	Equipment:

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP2	TP			1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
▨					0.16		▨	MADE GROUND: Concrete
▨					0.25		▨	MADE GROUND: Light grey sandy gravel of fine to coarse angular to sub-angular brick, concrete and flint.
▨					0.50		▨	MADE GROUND: Dark brown slightly clayey gravelly medium SAND. Gravel comprises fine to medium sub-angular flint, concrete and brick.
▨					0.60		▨	Orangish brown very clayey medium SAND. (TAPLOW GRAVEL MEMBER).

End of Borehole at 0.600m

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks

Remarks

No groundwater encountered. Roots noted to 0.20m bgl.

Trial Pit Log

Project Name: 252 Sheen Lane, London, SW14 8RL	Client: Alison and David Harwood	Date:
Location: 252 Sheen Lane, London, SW14 8RL	Contractor:	
Project No. : GWPR6137	Crew Name:	Equipment:

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP3	TP			1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
▨					0.12		▨	Concrete	
▨					0.60		▨	MADE GROUND: Dark brown very sandy gravelly CLAY. Sand is medium and gravel comprises fine to medium sub-angular to sub-rounded flint, brick and concrete.	
▨					1.20		⁘	Orangish brown very clayey slightly gravelly medium SAND. Gravel comprises fine to coarse angular sandstone and flint. (TAPLOW GRAVEL MEMBER).	1
								End of Borehole at 1.200m	
									2
									3
									4
									5

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks

Remarks

No groundwater encountered. Roots noted to 0.50m bgl.

Trial Pit Log

Project Name: 252 Sheen Lane, London, SW14 8RL	Client: Alison and David Harwood	Date:
Location: 252 Sheen Lane, London, SW14 8RL	Contractor:	
Project No. : GWPR6137	Crew Name:	Equipment:

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP4	TP			1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
▨					0.30		▨	TOPSOIL: Dark brown very sandy slightly gravelly CLAY. Sand is fine and gravel comprises fine to medium sub-angular to sub-rounded flint.
▨					1.20		░	Orangish brown slightly clayey slightly gravelly medium SAND. Gravel comprises fine to coarse sub-angular to angular flint. (TAPLOW GRAVEL MEMBER).
								End of Borehole at 1.200m

Depth scale: 1, 2, 3, 4, 5

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks

Remarks

No groundwater encountered. Roots noted to 0.50m bgl.

APPENDIX E: Geotechnical Laboratory Testing

Laboratory Report

Contract Number: 74007

Client Ref:	**GWPR6137**	Date Received:	**02-08-2024**
Client PO:	**GWPR6137**	Date Completed:	**07-08-2024**
		Report Date:	**07-08-2024**
Client:	**Ground and Water Limited**		
Contract Title:	**GWPR6137**		
For the attention of:	**Libby Bennett**		

This report has been checked and approved by:

B. Evans

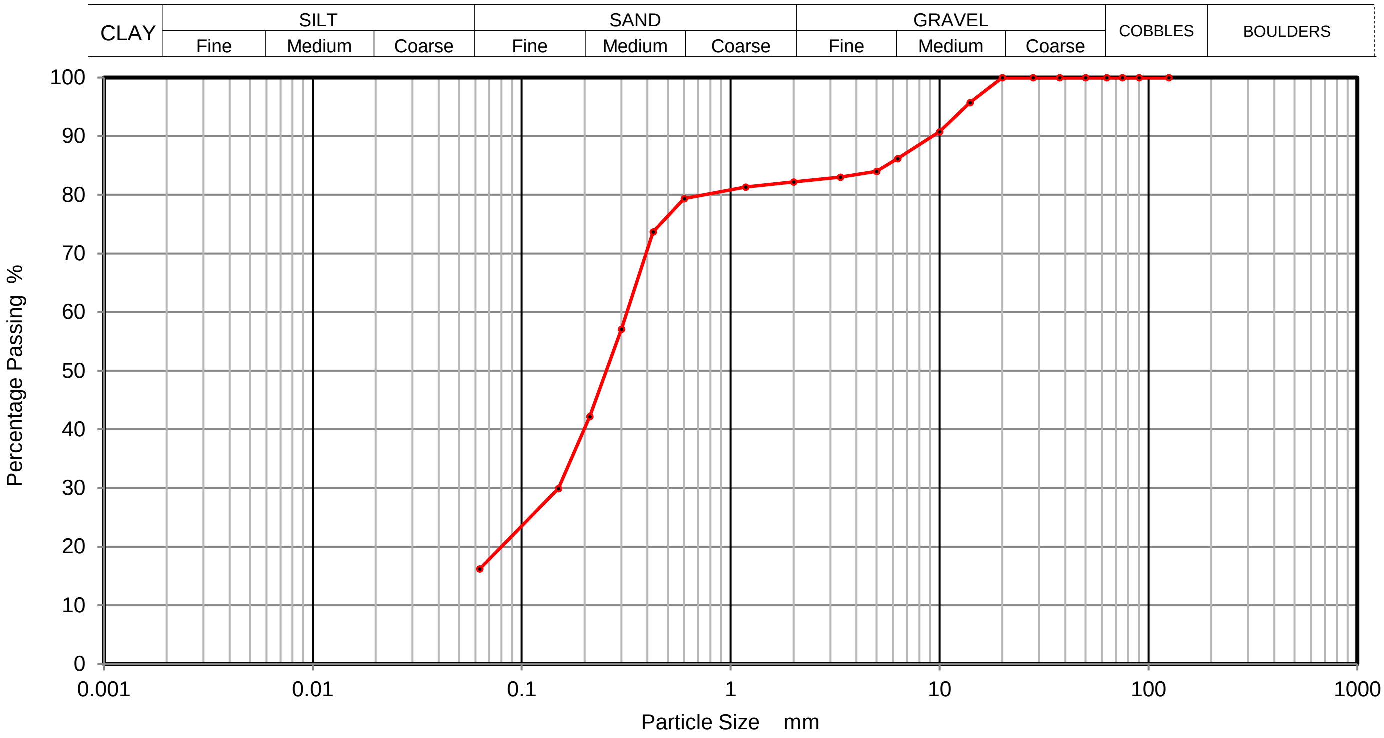
Brendan Evans
Office Administrator

Description	Qty
Particle Size Distribution BS EN ISO 17892-4 : 5.1 - * UKAS	5
Disposal of samples for job	1

Notes: **Observations and Interpretations are outside the UKAS Accreditation**
*** - denotes test included in laboratory scope of accreditation**
 # - denotes test carried out by approved contractor
@ - denotes non accredited tests

Approved Signatories:
Brendan Evans (Office Administrator) - Darren Bourne (Quality Senior Technician) - Paul Evans (Director)
Richard John (Quality/Technical Manager) - Shaun Jones (Laboratory manager) - Shaun Thomas (Site Manager)
Wayne Honey (HR & HSE Manager)

GSTL GEOTECHNICAL SITE & TESTING LABORATORIES	**PARTICLE SIZE DISTRIBUTION BS EN ISO 17892-4:2016 Wet Sieve, Clause 5.2**	Contract Number	**74007**
		Borehole/Pit No.	**WS1**
Project Name	**GWPR6137**	Sample No.	
Sample Description	Brown silty/ clayey fine to medium gravelly fine to coarse SAND	Depth Top	**1.00**
		Depth Base	
Date Tested	06/08/2024	Sample Type	**B**



Sieving		**Sedimentation**	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	96		
10	91		
6.3	86		
5	84		
3.35	83		
2	82		
1.18	81		
0.63	79		
0.425	74		
0.30	57		
0.20	42		
0.15	30		
0.063	16		

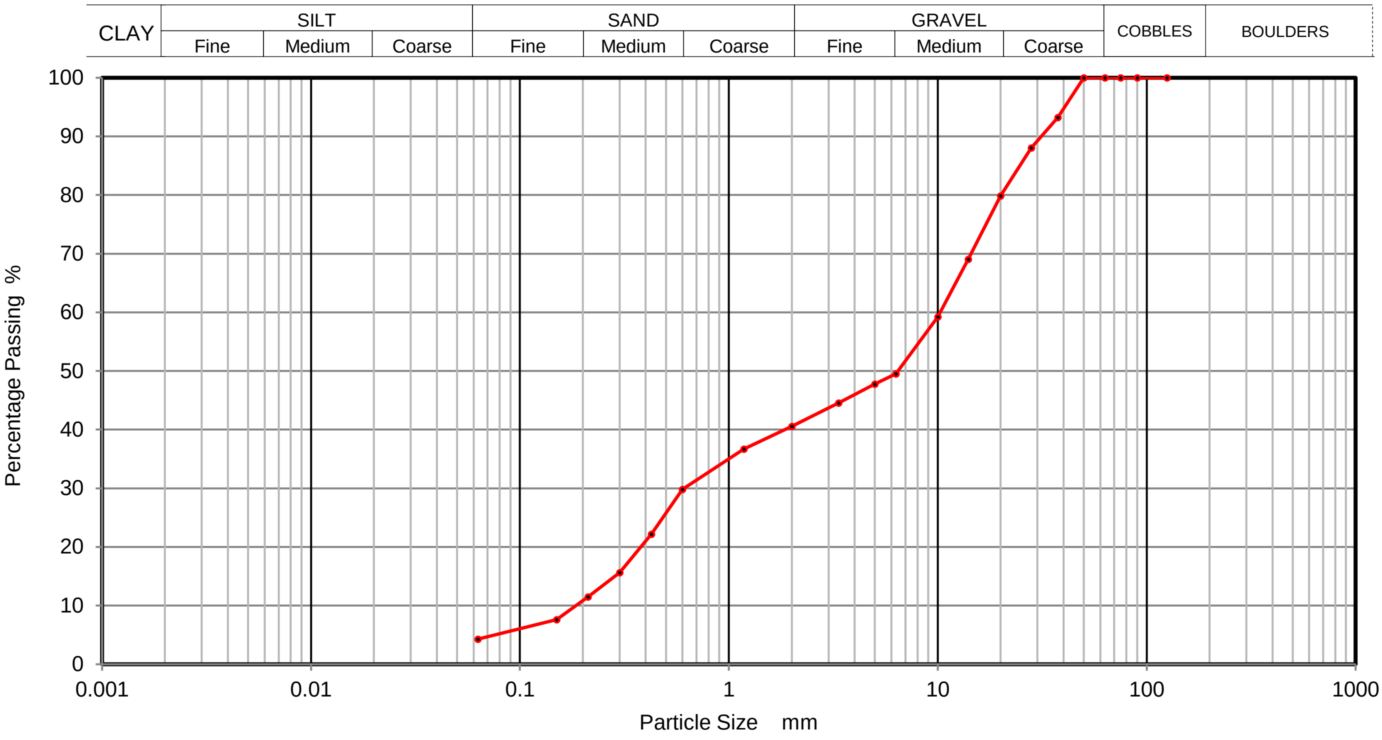
Sample Proportions	% dry mass
Cobbles	0
Gravel	18
Sand	66
Silt and Clay	16

Remarks

Preparation and testing in accordance with BS17892 unless noted below

Operator
David Edwards

GSTL GEOTECHNICAL SITE & TESTING LABORATORIES	**PARTICLE SIZE DISTRIBUTION BS EN ISO 17892-4:2016 Wet Sieve, Clause 5.2**	Contract Number	**74007**
		Borehole/Pit No.	**WS1**
Project Name	**GWPR6137**	Sample No.	
Sample Description	Brown slightly silty/ clayey fine to coarse sandy fine to coarse GRAVEL	Depth Top	**2.00**
		Depth Base	
Date Tested	06/08/2024	Sample Type	**B**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	93		
28	88		
20	80		
14	69		
10	59		
6.3	50		
5	48		
3.35	45		
2	41		
1.18	37		
0.63	30		
0.425	22		
0.30	16		
0.20	12		
0.15	8		
0.063	4		

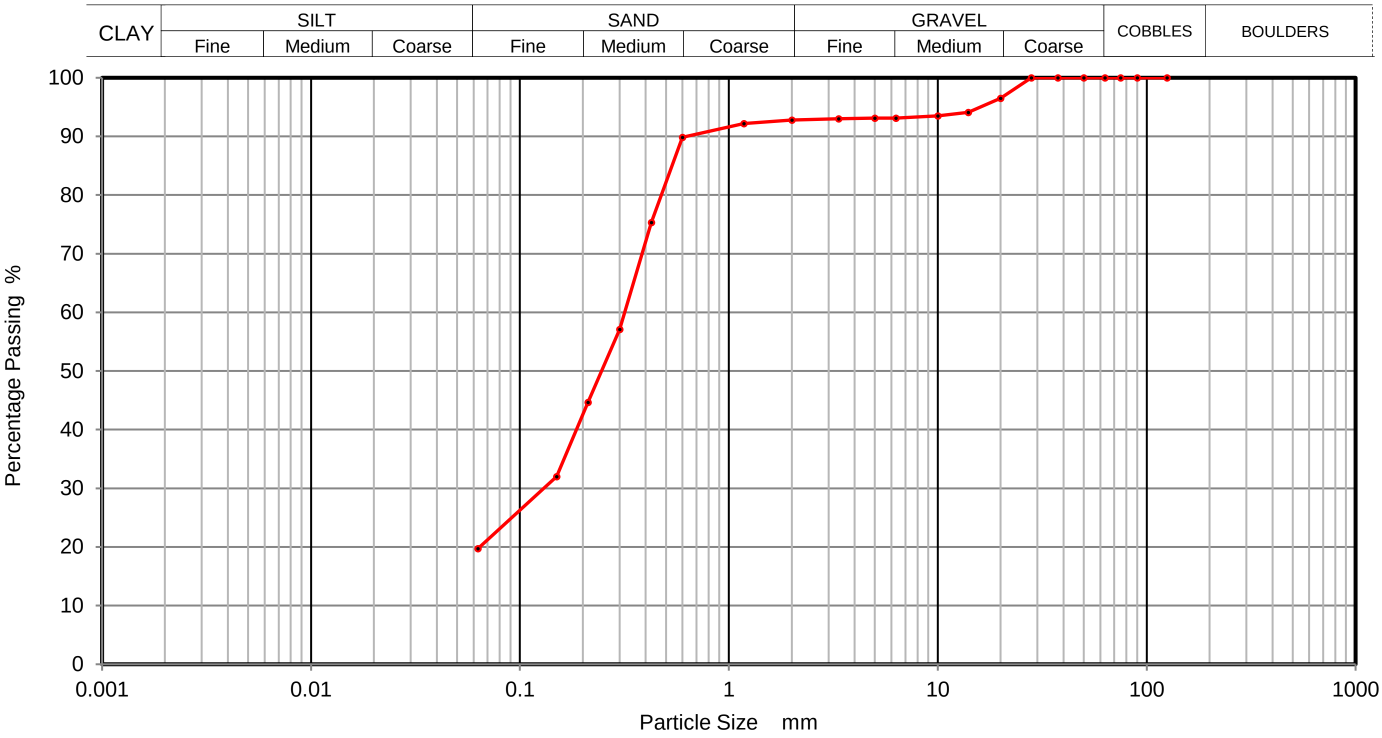
Sample Proportions	% dry mass
Cobbles	0
Gravel	59
Sand	37
Silt and Clay	4

Remarks

Preparation and testing in accordance with BS17892 unless noted below

Operator
David Edwards

GSTL GEOTECHNICAL SITE & TESTING LABORATORIES	**PARTICLE SIZE DISTRIBUTION** **BS EN ISO 17892-4:2016** **Wet Sieve, Clause 5.2**	Contract Number	**74007**
		Borehole/Pit No.	**WS2**
Project Name	**GWPR6137**	Sample No.	
Sample Description	Brown slightly gravelly silty/ clayey fine to coarse SAND	Depth Top	**1.50**
		Depth Base	
Date Tested	06/08/2024	Sample Type	**B**



Sieving		**Sedimentation**	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	97		
14	94		
10	93		
6.3	93		
5	93		
3.35	93		
2	93		
1.18	92		
0.63	90		
0.425	75		
0.30	57		
0.20	45		
0.15	32		
0.063	20		

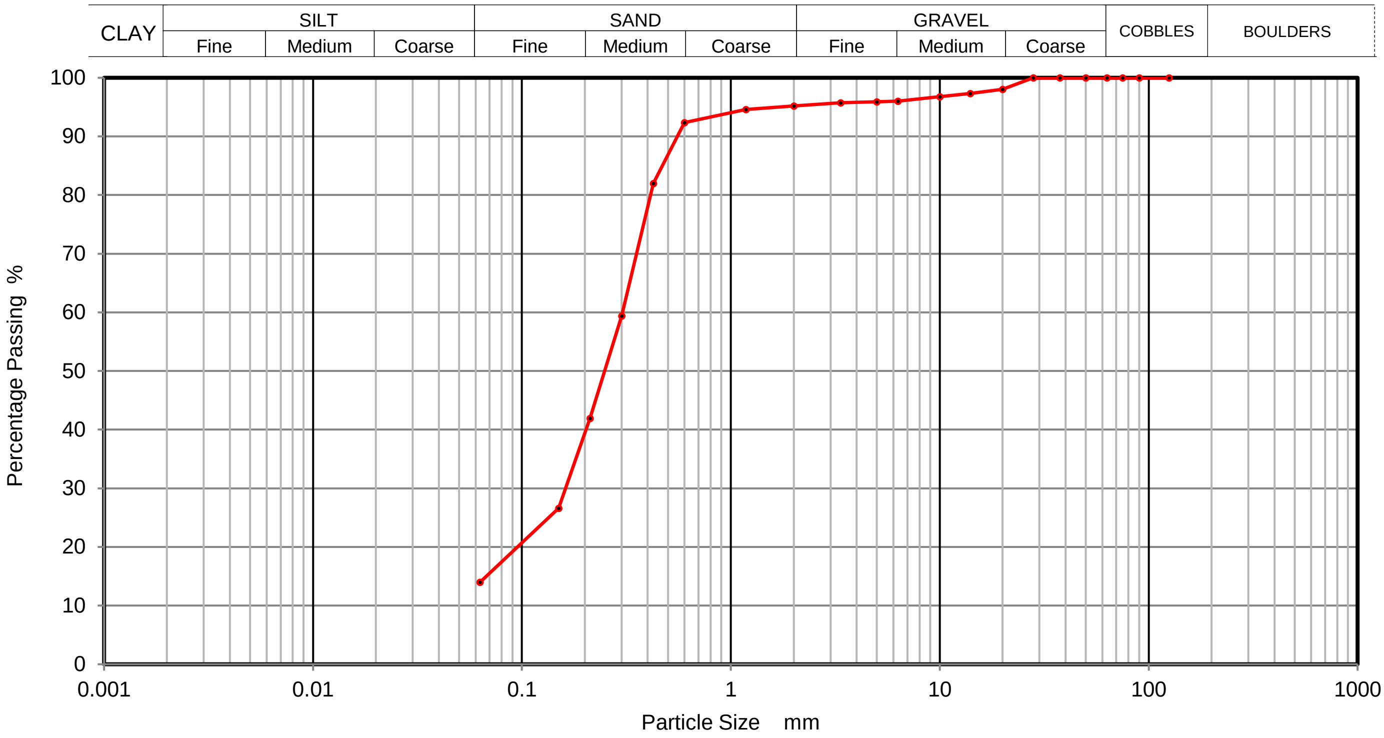
Sample Proportions	% dry mass
Cobbles	0
Gravel	7
Sand	73
Silt and Clay	20

Remarks

Preparation and testing in accordance with BS17892 unless noted below

Operator
David Edwards

GSTL GEOTECHNICAL SITE & TESTING LABORATORIES	**PARTICLE SIZE DISTRIBUTION BS EN ISO 17892-4:2016 Wet Sieve, Clause 5.2**	Contract Number	**74007**
		Borehole/Pit No.	**WS2**
Project Name	**GWPR6137**	Sample No.	
Sample Description	Brown slightly gravelly silty/ clayey fine to coarse SAND	Depth Top	**3.00**
		Depth Base	
Date Tested	06/08/2024	Sample Type	**B**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	98		
14	97		
10	97		
6.3	96		
5	96		
3.35	96		
2	95		
1.18	95		
0.63	92		
0.425	82		
0.30	59		
0.20	42		
0.15	27		
0.063	14		

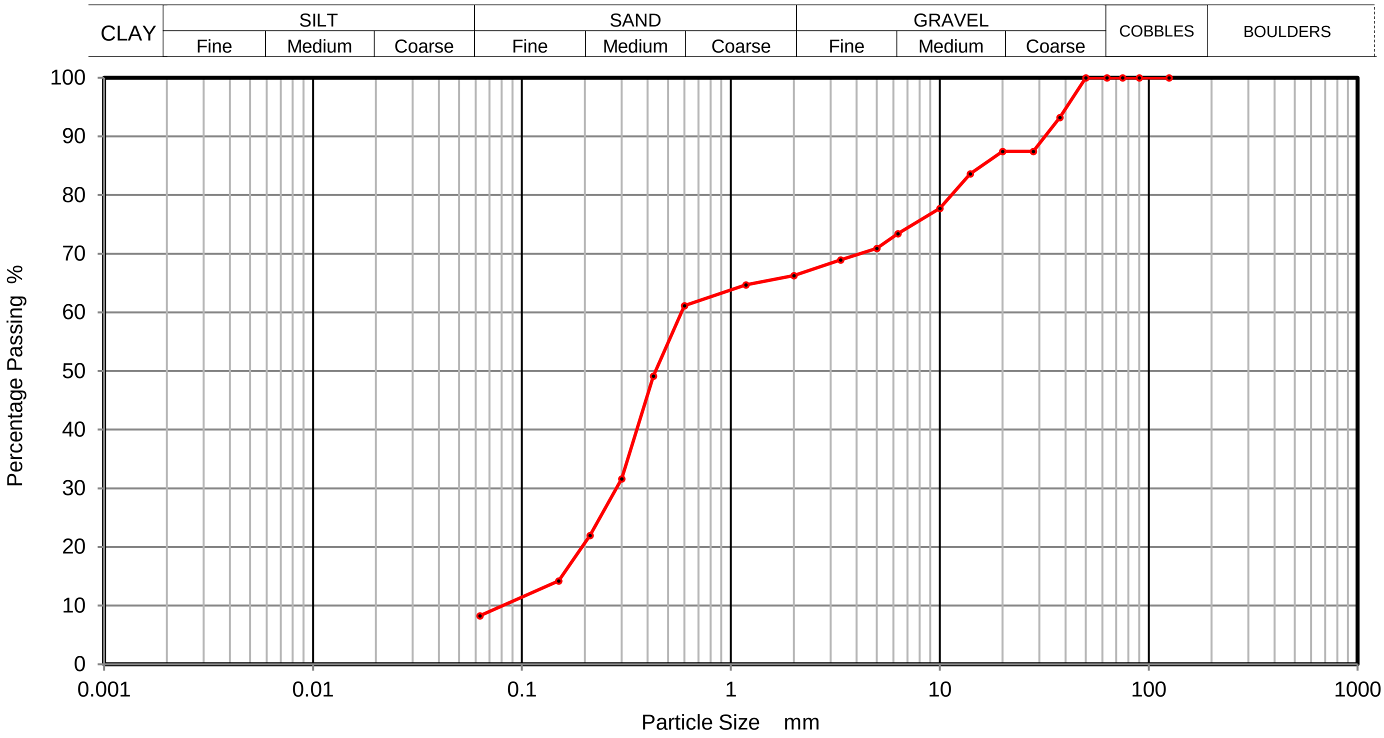
Sample Proportions	% dry mass
Cobbles	0
Gravel	5
Sand	81
Silt and Clay	14

Remarks

Preparation and testing in accordance with BS17892 unless noted below

Operator
David Edwards

GSTL GEOTECHNICAL SITE & TESTING LABORATORIES	**PARTICLE SIZE DISTRIBUTION** **BS EN ISO 17892-4:2016** **Wet Sieve, Clause 5.2**	Contract Number	**74007**
		Borehole/Pit No.	**WS2**
Project Name	**GWPR6137**	Sample No.	
Sample Description	Brown slightly silty/ clayey fine to coarse gravelly fine to coarse SAND	Depth Top	**4.00**
		Depth Base	
Date Tested	06/08/2024	Sample Type	**B**



Sieving		**Sedimentation**	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	93		
28	87		
20	87		
14	84		
10	78		
6.3	73		
5	71		
3.35	69		
2	66		
1.18	65		
0.63	61		
0.425	49		
0.30	32		
0.20	22		
0.15	14		
0.063	8		

Sample Proportions	% dry mass
Cobbles	0
Gravel	34
Sand	58
Silt and Clay	8

Remarks

Preparation and testing in accordance with BS17892 unless noted below

Operator
David Edwards

APPENDIX F: Chemical Laboratory Testing

Ground and Water Ltd
2 The Long Barn
Norton Farm
Selbourne Road
Alton
Hampshire
GU34 3NB

e: libby.bennett@groundandwater.co.uk

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

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

Analytical Report Number : 24-034180

Project / Site name: Sheen Lane

Samples received on: 01/08/2024

Your job number: GWPR6137

Samples instructed on/ Analysis started on: 02/08/2024

Your order number: GWPR6137

Analysis completed by: 08/08/2024

Report Issue Number: 1

Report issued on: 08/08/2024

Samples Analysed: 3 soil samples

Signed:

Joanna Wawrzeczko
Senior Reporting Specialist
For & on behalf of i2 Analytical Ltd.

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

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

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

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

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Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement.
Application of uncertainty of measurement would provide a range within which the true result lies.
An estimate of measurement uncertainty can be provided on request.

Analytical Report Number: 24-034180
Project / Site name: Sheen Lane
Your Order No: GWPR6137

Lab Sample Number				276032	276033	276034
Sample Reference				WS1	WS2	WS2
Sample Number				None Supplied	None Supplied	None Supplied
Depth (m)				1.50	2.00	3.50
Date Sampled				29/07/2024	29/07/2024	29/07/2024
Time Taken				None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Test Limit of detection**	**Test Accreditation Status**			
Stone Content	%	0.1	NONE	41.1	< 0.1	< 0.1
Moisture Content	%	0.01	NONE	3.6	11	12
Total mass of sample received	kg	0.1	NONE	1	1	1

General Inorganics

pH (L099)	pH Units	N/A	MCERTS	7.6	8.1	8.1
Total Sulphate as SO_4	%	0.005	MCERTS	0.012	-	0.008
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	17	21	34
Water Soluble SO_4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	8.56	10.4	17.1
Water Soluble Chloride (2:1) (leachate equivalent)	mg/l	0.5	MCERTS	0.8	-	3.7
Total Sulphur	mg/kg	50	MCERTS	57	-	61
Total Sulphur	%	0.005	MCERTS	0.006	-	0.006
Ammoniacal Nitrogen as NH_4^+	mg/kg	0.5	MCERTS	< 0.5	-	220 $^{\$\$}$
Ammonium as NH_4^+ (10:1 leachate equivalent)	mg/l	0.05	MCERTS	< 0.05	-	15 $^{\$\$}$
Water Soluble Nitrate (2:1) as N	mg/kg	2	NONE	< 2.0	-	2.4
Water Soluble Nitrate (2:1) as N (leachate equivalent)	mg/l	2	NONE	< 2.0	-	< 2.0

Heavy Metals / Metalloids

Magnesium (leachate equivalent)	mg/l	2.5	NONE	< 2.5	-	< 2.5
Magnesium (water soluble)	mg/kg	5	NONE	< 5.0	-	< 5.0

U/S = Unsuitable Sample I/S = Insufficient Sample ND = Not detected

Analytical Report Number : 24-034180
Project / Site name: Sheen Lane

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

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

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
276032	WS1	None Supplied	1.5	Brown loam and sand with gravel and stones
276033	WS2	None Supplied	2	Brown sandy clay
276034	WS2	None Supplied	3.5	Brown sandy clay

Analytical Report Number : 24-034180
Project / Site name: Sheen Lane

Water matrix abbreviations:
Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Moisture Content	Moisture content, determined gravimetrically (up to 30°C)	In-house method	L019B	W	NONE
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight	In-house method based on British Standard Methods and MCERTS requirements.	L019B	D	NONE
Magnesium, water soluble, in soil	Determination of water soluble magnesium by extraction with water followed by ICP-OES	In-house method based on TRL 447	L038B	D	NONE
Total sulphate (as SO4 in soil)	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES	In-house method	L038B	D	MCERTS
Sulphate, water soluble, in soil (16hr extraction)	Sulphate, water soluble, in soil (16hr extraction)	In-house method	L038B	D	MCERTS
Total Sulphur in soil	Determination of total sulphur in soil by extraction with aqua-regia, potassium bromide/bromate followed by ICP-OES	In-house method	L038B	D	MCERTS
Water Soluble Nitrate (2:1) as N in soil	Determination of nitrate by reaction with sodium salicylate and colorimetry	In-house method based on Examination of Water and Wastewatern & Polish Standard Method PN-82/C-04579.08, 2:1 extraction	L078B	W	NONE
Chloride, water soluble, in soil	Determination of Chloride colorimetrically by discrete analyser	In-house method	L082B	D	MCERTS
Ammonium as NH4 in soil	Determination of Ammonium/Ammonia/ Ammoniacal Nitrogen by the colorimetric salicylate/nitroprusside method, 10:1 water extraction.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L082B	W	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement	In-house method	L099	D	MCERTS

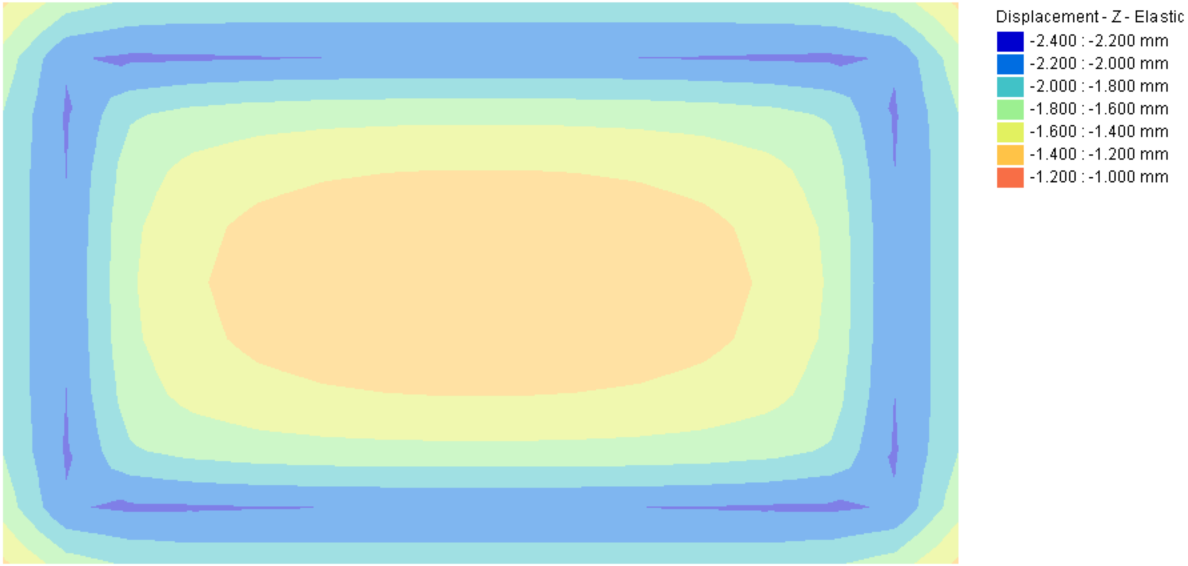
For method numbers ending in 'UK' or 'A' analysis have been carried out in our laboratory in the United Kingdom (Watford).
For method numbers ending in 'F' analysis have been carried out in our laboratory in the United Kingdom (East Kilbride).
For method numbers ending in 'PL' or 'B' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.
Unless otherwise indicated, site information, order number, project number, sampling date, time, sample reference and depth are provided by the client. The instructed on date indicates the date on which this information was provided to the laboratory.

Quality control parameter failure associated with individual result applies to calculated sum of individuals.
The result for sum should be interpreted with caution

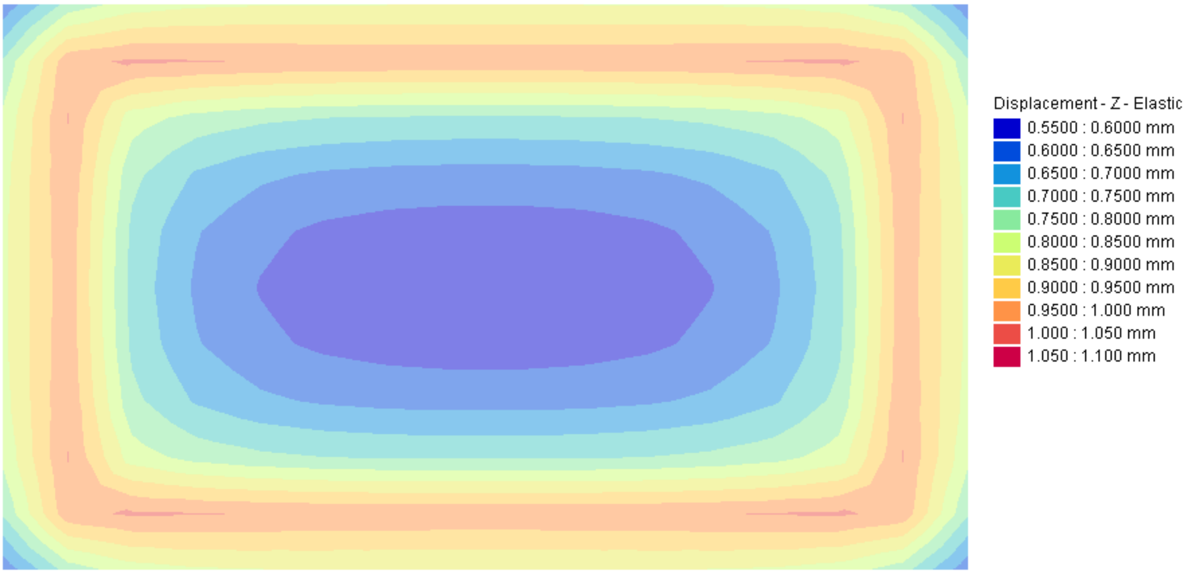
$$ - Result was reported from high dilution. The result should be interpreted with caution.

APPENDIX G: Settlement and Heave Analysis Modelling

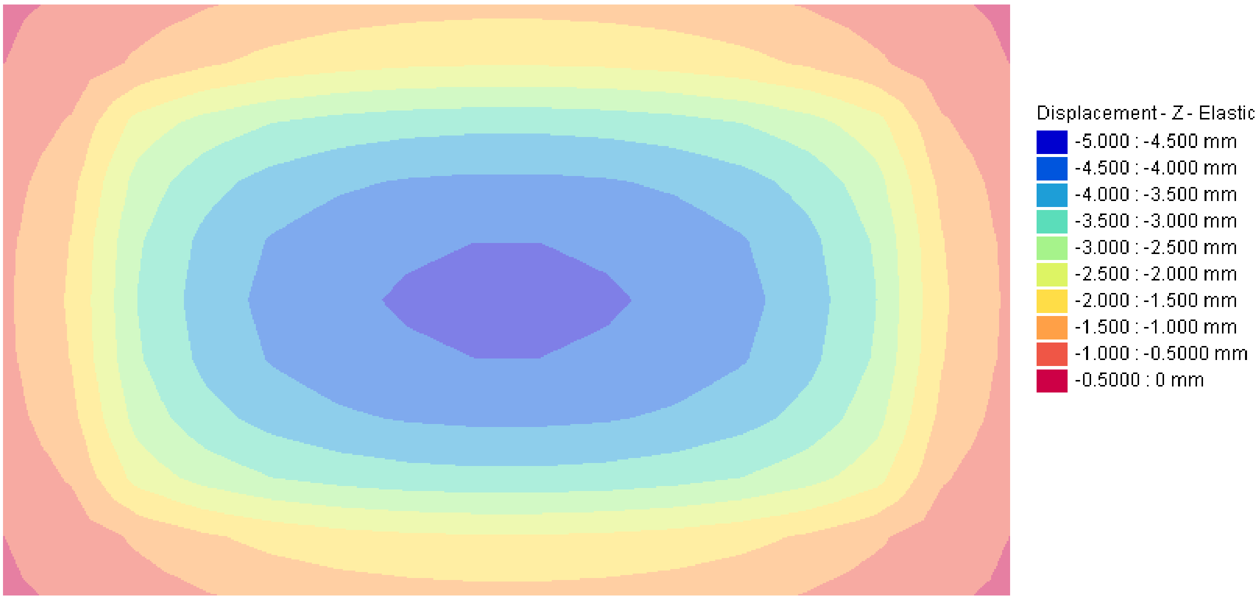
Model 1



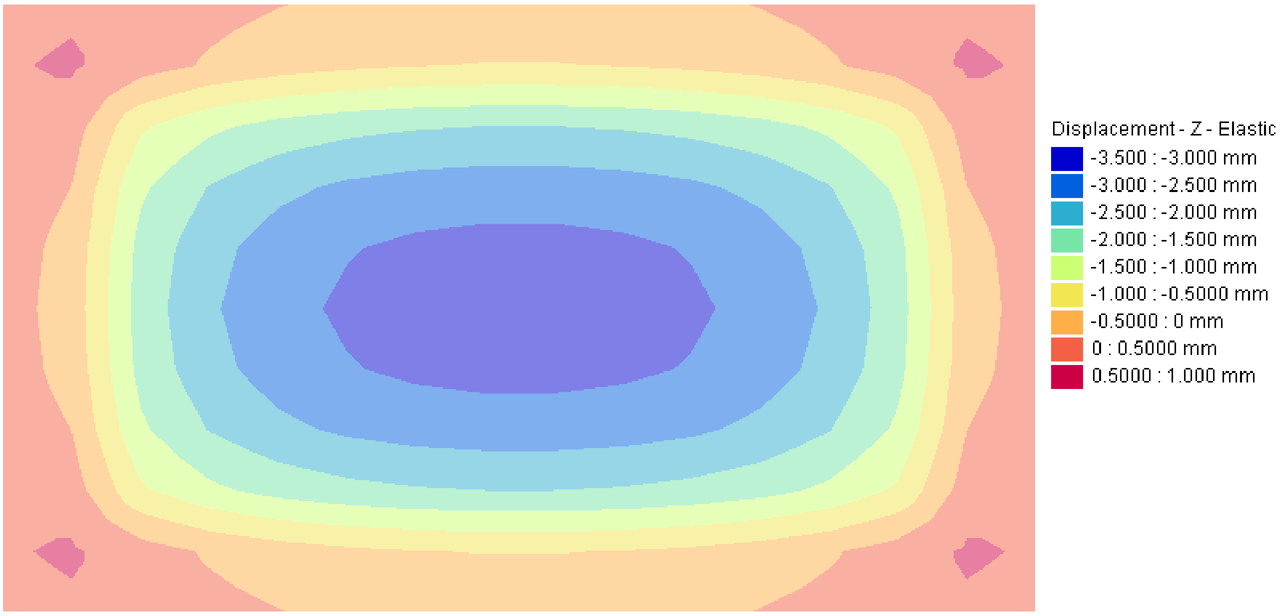
Model 2



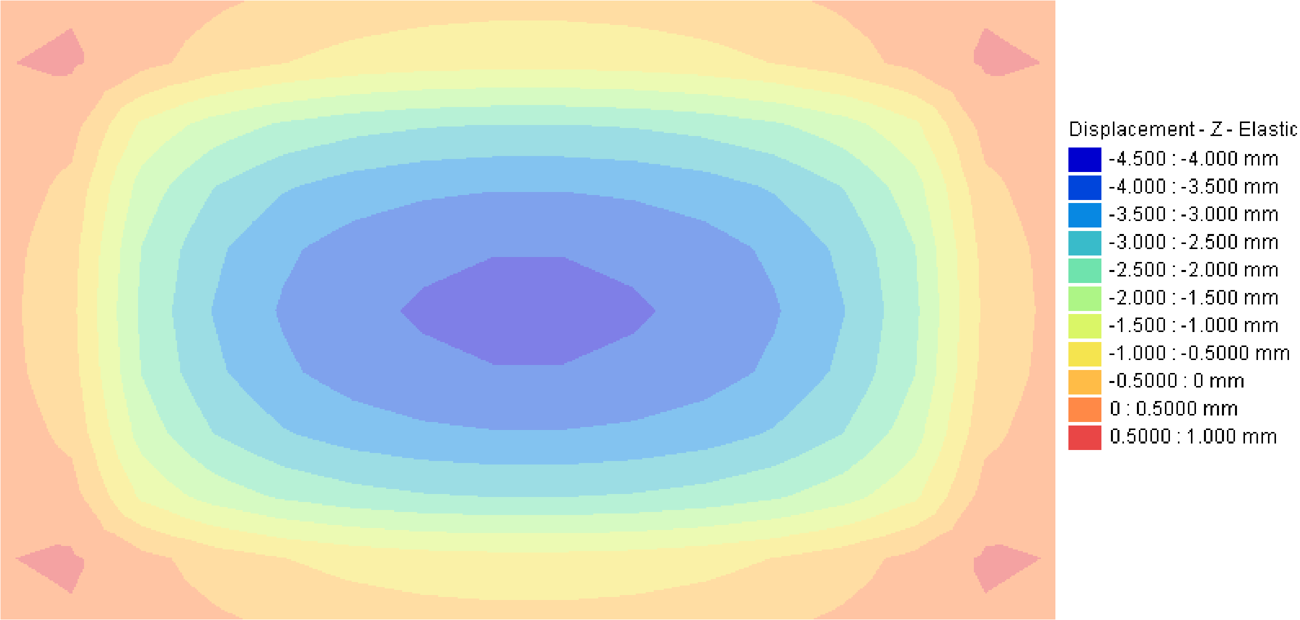
Model 3



Model 4



Model 5


Displacement - Z - Elastic
-4.500 : -4.000 mm
-4.000 : -3.500 mm
-3.500 : -3.000 mm
-3.000 : -2.500 mm
-2.500 : -2.000 mm
-2.000 : -1.500 mm
-1.500 : -1.000 mm
-1.000 : -0.5000 mm
-0.5000 : 0 mm
0 : 0.5000 mm
0.5000 : 1.000 mm