



**GEOTECHNICAL &  
GEOENVIRONMENTAL CONSULTANCY**

A PHENNA GROUP COMPANY

Verity Trustees Ltd

**Unit 39, Queen Street,  
Tottenham**

*Geotechnical and Geoenvironmental  
Interpretative Report*

April, 2024

Card Geotechnics Limited  
12 Melcombe Place  
London, NW1 6JJ  
Telephone: 02030 967567  
[www.cgl-uk.com](http://www.cgl-uk.com)



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|           |                                                                                       |          |                                                                                       |            |            |
|-----------|---------------------------------------------------------------------------------------|----------|---------------------------------------------------------------------------------------|------------|------------|
| Author    | Madeleine Monnickendam, Senior Engineer<br><i>MSci (Hons) GMICE FGS</i>               |          |  |            |            |
| Checked   | Joseph Birnie, Chartered Senior Engineer<br><i>MSc BSc (Hons) CEng MICE FGS RoGEP</i> |          |  |            |            |
|           | Jessica Whelan, Principal Engineer<br><i>BSc (Hons) CEnv MEnvSc</i>                   |          |  |            |            |
| Approved  | Mark Creighton, Director<br><i>CEng FICE</i>                                          |          |  |            |            |
| Reference | CGL/10175                                                                             | Revision | 0                                                                                     | Issue Date | 22/03/2024 |
|           |                                                                                       |          | 1                                                                                     |            | 12/04/2024 |
|           |                                                                                       |          | 2                                                                                     |            | 18/04/2024 |

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## EXECUTIVE SUMMARY

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Card Geotechnics Limited (CGL) has been commissioned by Verity Trustees Ltd to provide a Geotechnical and Geoenvironmental Interpretative Report following the ground investigation at Unit 39 west on Queen Street in Tottenham, London, N17 8HZ.

- The site is roughly rectangular and comprises of one warehouse between one and two storeys tall. Tarmac car parks are located east and west of the warehouses. A concrete loading bay is located north of the warehouses. Limited area of soft landscaping is present at the north and west boundary of the site. A line of trees runs directly north of the site. A UKPN substation “Lazarus” is located in the south-west corner of the site. The site gently slopes down from the west (+18.3mOD) to the east (+16.3mOD).
- The proposed development comprises of demolition of the existing building and construction of three units housed within one building, which will offer a flexible range of uses falling within the following use classes; Class E(g), (ii), (iii) industrial process, B2 manufacturing and B8 distribution. The development would include ancillary office space, car and cycle parking, service yards and associated soft and hard landscaping.
- The site was historically occupied by fields with a row of trees along the west boundary of the site in the earliest Ordnance Survey map dated 1864-1867. From c. 1935-1936 the site was occupied by a *Furniture Manufactory* in the north area of the site with the UKPN substation “Lazarus” in its present location in the south-west corner of the site. In 1955 a larger warehouse is mapped on site labelled *Engineering Works*. An additional substation is located in the south-west of the site as well as *Tanks*. Additional structures are mapped on the site c.1964-1967. In the map dated 1981-1984, two warehouses are located on site in their current layout. Land use in the surrounding area is residential and industrial with several historical *Works*, and current garages. A gravel pit was mapped west of the site in 1935-1936 is likely to have been infilled since then. Clay may also have been extracted from the pit.
- The ground conditions encountered during the CGL investigation comprised of Made Ground overlying Thames Terrace Deposits and the London Clay Formation. The Made Ground was between 0.20m and 1.80m thick. The Thames Terrace Deposits was encountered between 0.20mbgl and 1.80mbgl (+18.53mOD to +17.27mOD) and was 1.70m thick, proven in BH01 only. The London Clay Formation (including 0.30m thick weathered portion) was encountered at 3.7mbgl (+13.84mOD) and was 20.50m thick (proven in BH01 only). The Lambeth Group was encountered at 24.5mbgl (-6.96mOD) and was >0.5m thick (proven to -7.46mOD in BH01).

- Results of the groundwater monitoring indicate a shallow groundwater table is present in the Thames Terrace Deposits and Made Ground at +17.1mOD. During the ground investigation, the shallowest groundwater strike was at +17.78mOD in WS01 which rose to +17.96mOD. A deep sub-artesian groundwater table is present in the Lambeth Group at 18.1mbgl (-0.50mOD).
- Chemical assessment of Made Ground soil samples indicate that the concentration of contaminants is below human health generic assessment criteria for “commercial” end use, however, asbestos was detected at <0.001% in BH01 at 0.30mbgl, WS02 at 0.30mbgl and WS04 at 1.00mbgl. The risk to construction workers is considered to be moderate and appropriate site practises including good hygiene, dust control and personal protective equipment (PPE) are recommended. The risk to future site users is considered to moderate and clean cover systems are recommended in areas of soft landscaping to mitigate the risks. The risk to off-site users is considered to be low to moderate and implementation of appropriate site practises are recommended.
- A monitoring standpipe was installed in the Thames Terrace Deposits that was flooded above the response zone in every monitoring visit. Due to the flooded response zone, calculation of Gas Screening Values (GSVs) is not considered appropriate. Due to the high groundwater level (~0.5mbgl) it is unlikely that dry gas monitoring wells can be installed in the Made Ground. The Thames Terrace Deposits were granular with no visible organic material and on this basis is not considered to be a source of ground gas. The Made Ground was predominantly granular and visually low in organics, confirmed by laboratory testing which recorded soil organic matter between 0.2% and 1.7%. On this basis, it is likely that the site can be considered to conform to Characteristic Situation 1. This should be confirmed by groundwater monitoring in the summer months to appraise the potential for the groundwater level to drop. If the groundwater table does drop, there is potential for an altered ground gas regime and the recommended characteristic situation may change as a result of further assessment.
- The risk to buried water supply pipes is moderate. Barrier pipes are likely to be required where in contact with Made Ground due to elevated concentrations of hydrocarbons and soil pH readings above 8.
- The risks to plants and vegetation are very low, however, a clean cover system is recommended in areas of soft landscaping due to asbestos (<0.001%) detected in three samples of Made Ground.

- The results of the preliminary waste assessment indicate that five samples of Made Ground would be characterised as “not hazardous”. One would not be acceptable to an inert waste facility due to elevated concentrations of TPH. Three would be suitable for disposal to a non-hazardous waste facility that accepts asbestos waste. One would be classified as non-hazardous and, subject to WAC testing, would be subject to disposal to a non-hazardous waste facility or a licensed inert waste facility.
- The proposed development is likely to be founded on shallow foundations on the Thames Terrace Deposits. Preliminary bearing capacities for pad and strip foundations are provided. The effect of the shallow groundwater table on bearing capacity and floor slabs should be considered. Excavations in the Made Ground and Thames Terrace Deposits are likely to require groundwater control.

## 1. INTRODUCTION

---

Card Geotechnics Limited (CGL) has been commissioned by Verity Trustees Ltd to complete a Geotechnical and Geoenvironmental Interpretative Report following the ground investigation at the site at Unit 39, west of Queen Street in Tottenham, London, N17 8HZ. The site comprises existing warehouses of one and two storeys in height, with no existing basement structures, surrounded by tarmac and concrete car parking spaces and loading bays. The site usage is currently industrial and commercial purposes. There are limited areas of soft landscaping along the north and west boundary of the site.

The proposed development comprises of redevelopment of the site for industrial and warehousing purposes (within Classes E(g) (ii), (iii), B2 and B8, with ancillary office accommodation) along with related access, service yard, car and cycle parking, landscaping, boundary treatment and other related works including demolition.

The current CGL ground investigation completed between 12 February 2024 and 14 February 2024, comprised of one cable percussion borehole to 25mbgl, four windowless sample boreholes to a maximum depth of 3mbgl, and two hand excavated trial pits to a maximum depth of 0.72mbgl. The aim was to investigate the ground conditions beneath the site and inform geotechnical design and geoenvironmental recommendations.

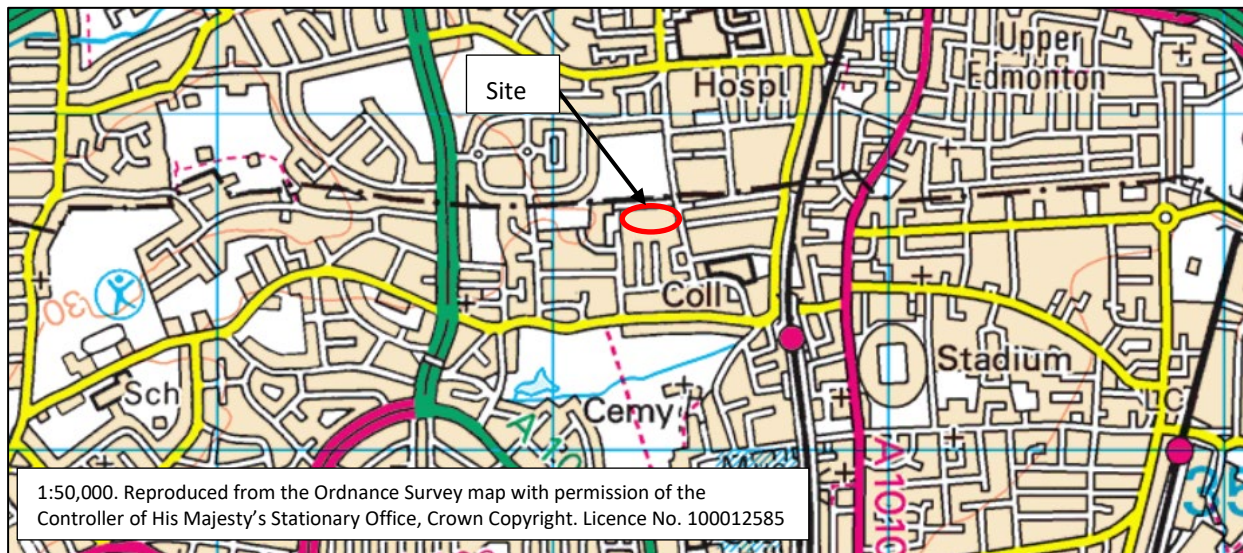
This report includes:

- A summary of the site history, anticipated ground conditions and associated geotechnical and geoenvironmental constraints based on review of the available published and unpublished sources;
- A preliminary qualitative contamination source-pathway-receptor risk assessment based on the available desk study information and the current proposed redevelopment plans; and;
- Provides details on ground conditions encountered on site during the current ground investigation and provide analysis and interpretation of the chemical and geotechnical laboratory testing undertaken on representative soil samples;
- Presents a conceptual site model and revised qualitative risk assessment based on the findings of the ground investigation and chemical testing;
- Provide recommendations regarding mitigation of risks to human health, buildings, structures, plants and vegetation and preliminary waste assessment; and
- Provide recommendations for the geotechnical design aspects of the proposed development including foundations, excavations, groundwater control, drainage and buried concrete.

## 2. SITE LOCATION

The site is located at Unit 39, west of Queen Street in Tottenham, London, N17 8HZ. National Grid coordinates for the approximate centre of the site are 533245E, 191658N. The site is in the Bruce Castle ward of the London Borough of Haringey. The site is approximately 3.06 hectares in area.

**Plate 1: Site Location Plan.**



### 2.1 Site Description

The site is roughly rectangular and comprises of one warehouse. Tarmac car parking spaces are located to the east and west of the warehouse. The ground north of the warehouses is covered in concrete and used a loading bay / for vehicle access. Trees are located at the north perimeter of the site and a row of trees are located immediately outside the site north boundary. The ground level gently slopes from +16.3mOD in the east to +18.2mOD in the western portion of the site. At the west boundary of the site the ground is locally higher at ~18.4mOD compared to the adjacent ground level of +18.0mOD. The ground is retained by a brick wall (~0.4m tall).

With reference to the Groundwise Utility Report<sup>1</sup> and Topographical Survey drawing<sup>2</sup> (included in Appendix A) a UKPN substation “Lazarus” is located in the south-west corner of the site. This is illustrated in the site layout plan, presented in Plate 2 overleaf.

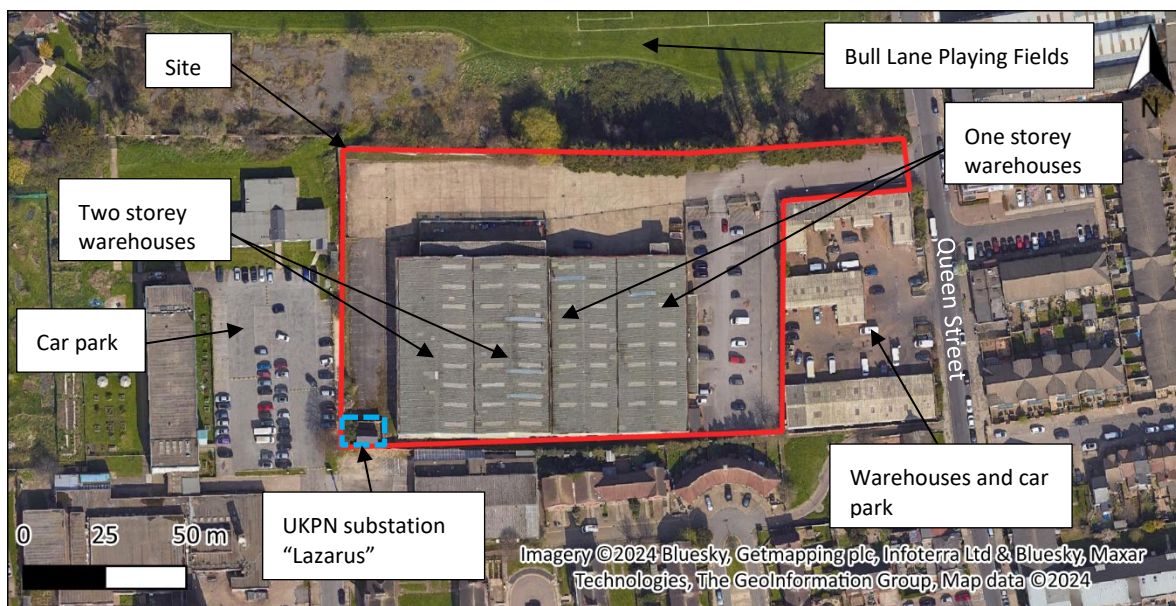
The site is bound to the north by Bull Lane Playing Fields and to the south by residential buildings and a warehouse. The site is bound to the west by a car park and to the east by Queen Street and

<sup>1</sup> Groundwise Searches Ltd (26/01/2024) *Desktop Utility Search* Ref. 34849DM-GWS version 2

<sup>2</sup> Laser Surveys Ltd (March 2022) *Booker Tottenham. Unit 39 Queen Street, London, N17 8HZ* Ref. L10866/1 Revision 0.

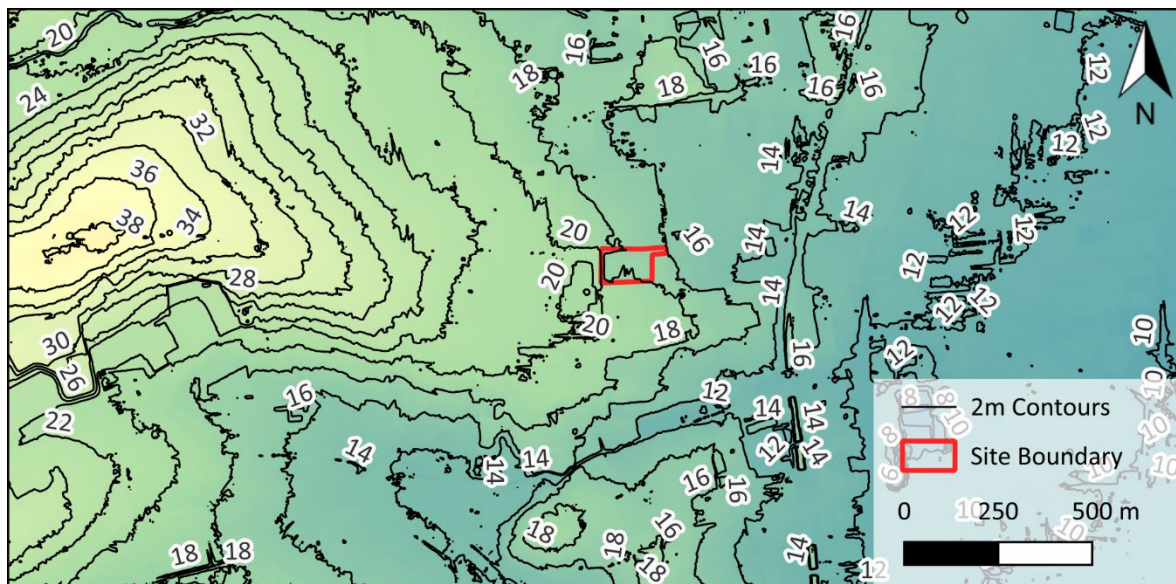
warehouses and car parks for industrial units including a ceramics wholesaler, meat supply company and metal fabrications company.

**Plate 2: Site Layout.**



With reference to publicly available Light Detection and Ranging (LiDAR) data<sup>3</sup>, in the wider area surrounding the site, the ground slopes down to the east and south of the site and slopes up west of the site.

**Plate 3: Topography Surrounding the Site.**



<sup>3</sup> <https://environment.data.gov.uk/DefraDataDownload/?Mode=survey> [Accessed March 2024]

## **2.2 Buried Infrastructure**

With reference to Groundwise Utility Report<sup>1</sup> the following services are located on site:

- UKPN substation “Lazarus” in the south-west corner of the site;
- 90mm polyethylene lower pressure Cadent gas main along the north perimeter of the warehouses and east car park; and
- Three Thames Water assets are shown at the east boundary of the site to connect to other assets running along Queen Street. From satellite imagery of the site many inspection covers are visible on the site and therefore it is likely that private water and sewer pipes are located on site.

## **2.3 Proposed Development**

The proposed development of the site comprises of redevelopment of the site for industrial and warehousing purposes (within Classes E(g) (ii), (iii), B2 and B8, with ancillary office accommodation) along with related access, service yard, car and cycle parking, landscaping, boundary treatment and other related works including demolition. The new warehouses are proposed to be situated in the south and central area of the site and founded on shallow pad foundations. The warehouses are proposed to be surrounded by loading bays and car parking spaces. Limited areas of soft landscaping including new trees are proposed along the north, west and south perimeter of the site. Proposed development plans are included in Appendix B.

### 3. HISTORICAL DEVELOPMENT

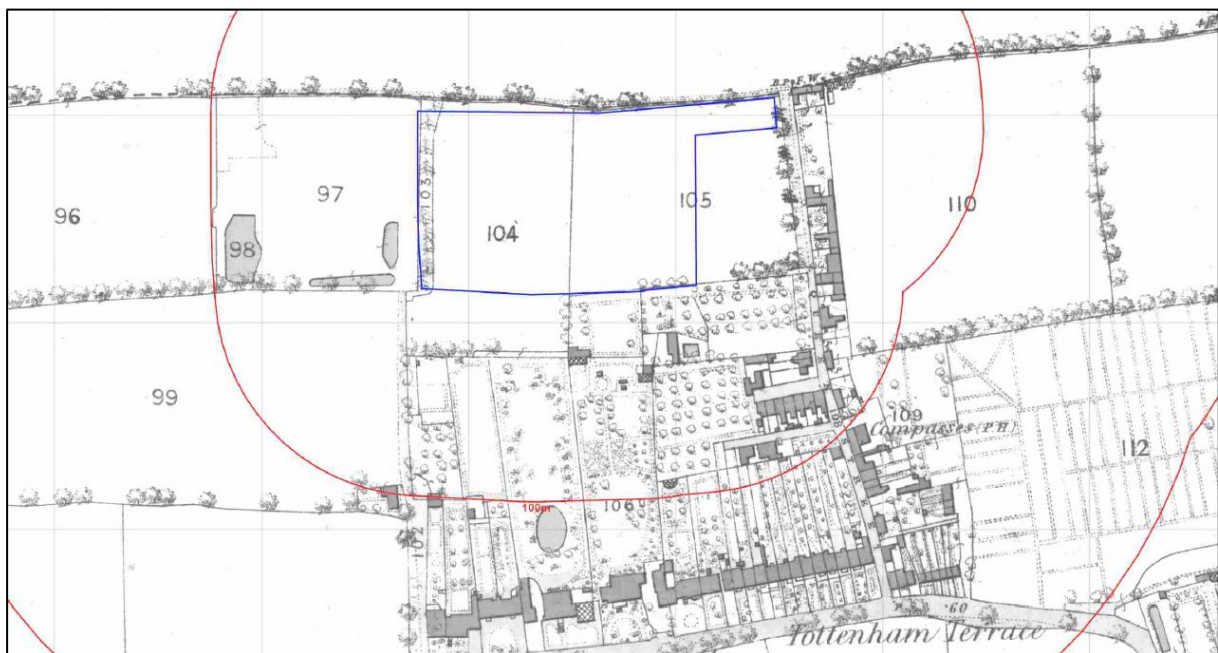
#### 3.1 Sources of Information

The historical development of the site has been traced from Ordnance Survey maps dating between 1864-1867 to 2024 provided by Groundsure. These maps were produced on scales ranging from 1:1,056 to 1:10,560 and are included in Appendix C.

#### 3.2 Site History

With reference to the earliest Ordnance Survey map dated 1864-1867 the site comprises of fields. At the north-east corner of the site *B.P.* is annotated indicated a boundary post. A road is indicated along the north and far east boundary of the site. A row of trees is located along the north and west boundary as well as some of the length of the east and west boundary of the site. The land surrounding the site comprises of fields to the north and west of the site. A row of buildings is located ~50m east of the site and ~150m south of the site labelled *Tottenham Terrace*. Three grey polygons, possibly ponds, are located in the adjacent field west of the site.

**Plate 4: Excerpt from 1:2,500 map dated 1864-1867.**

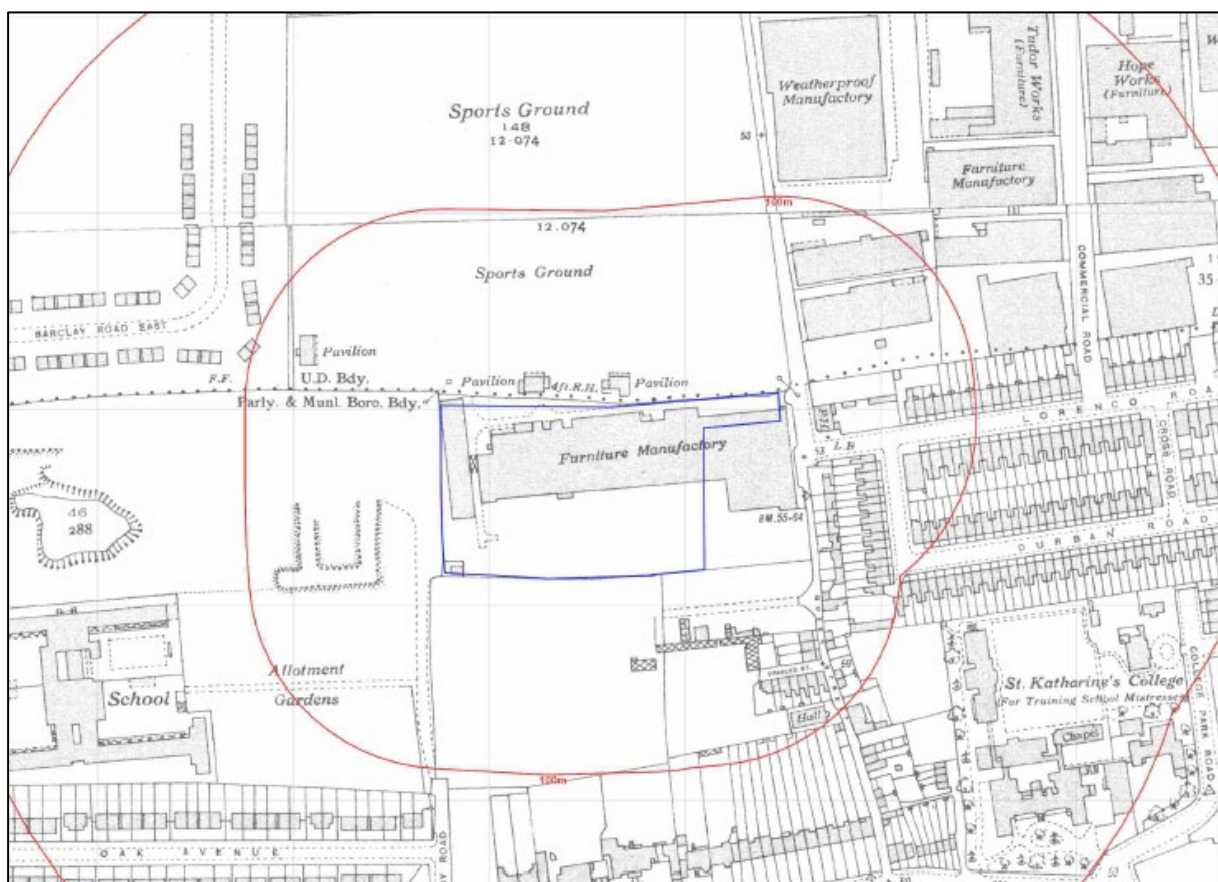


In the map dated 1896 the road east of the site is labelled *Queen Street* and only the row of trees along the west of the site remains. A polygon is annotated in the centre of the site, which is assumed to be a small pond. A *Fn* is labelled ~100m south of the site in the garden of one of the buildings, likely a fountain. In the map dated 1913-1914 the land east of the site is developed into rows of residential buildings and the land south-west of the site is labelled *Allotment Gardens*. A level change is located to

the west of the site with the *Allotment Gardens* at a higher elevation to the field west of the site. A *Kiln* is ~200m north of the site along with a *Brick Field*.

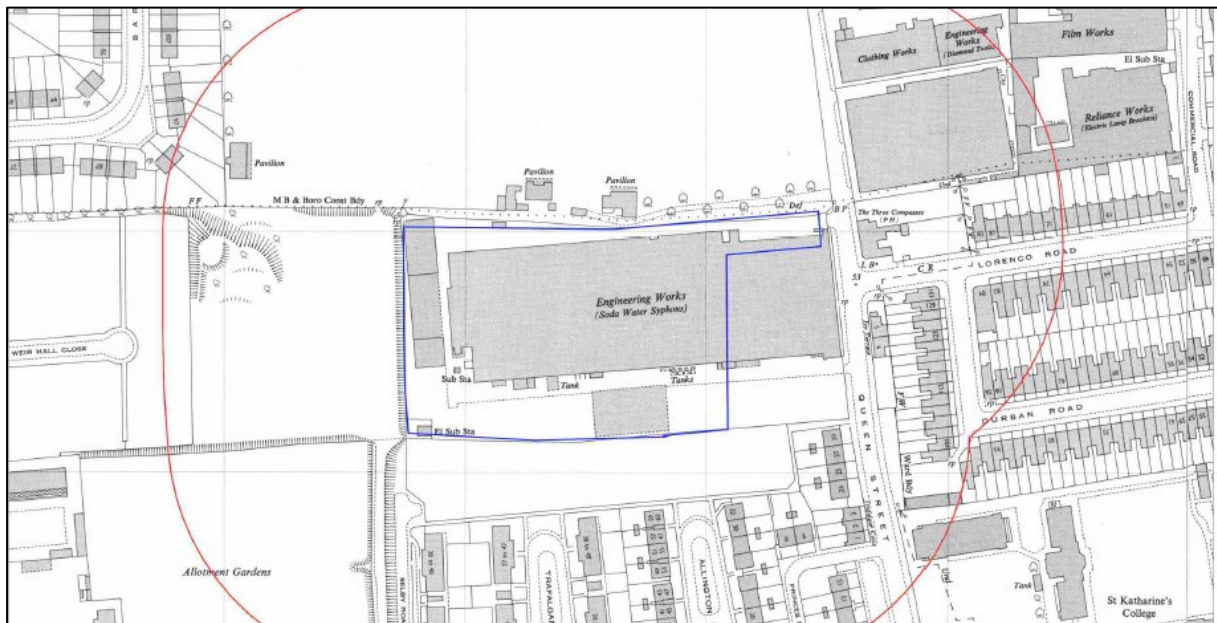
From c. 1935-1936 the site is developed into a *Furniture Manufactory*. The land north of the site is occupied by *Sports Ground* and three *Pavilions*. An area of lowered ground, possible a pond, is noted in the field ~200m west of the site as well as a U-shaped gravel pit. *Brick Fields* are mapped ~500m north and south of the site and it is possible that gravel pit was used as a clay pit / clay extraction as well. Several warehouses are located within 250m north-east of the site including *Weatherproof Manufactory* and *Furniture Manufactory*.

**Plate 5: Excerpt from 1:2,500 map dated 1935-1936.**



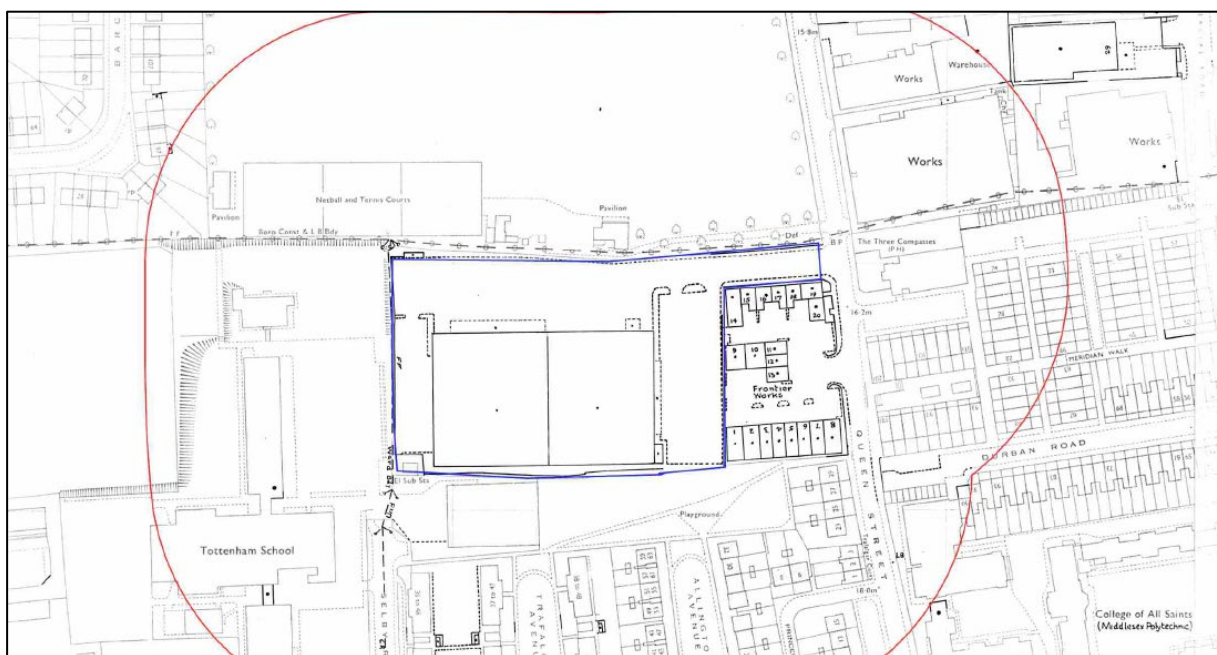
From c. 1955 the warehouse on site is labelled *Engineering Works (Soda Water Syphons)* with a eight *Tanks* south of the main building and two *El Sub Sta* in the south-west of the site area, within the site perimeter. The land south of the site has been developed into residential buildings along *Trafalgar Avenue* and *Allington Avenue*. The warehouses north-east of the site are larger and are labelled *Engineering Works*, *Clothing Works* and *Reliance Works (Electric Lamp Brackets)* among others. The ground level west of the site is raised with a level change at the west boundary of the site.

**Plate 6: Excerpt from 1:1,250 map dated 1955.**



From c. 1964-1967 a larger building of no name is located in the south of the site, and the *Allotment Gardens* are replaced with *Tottenham County Grammar School*. From c. 1981-1984 the *Engineering Works* is no longer located on site and replaced with two warehouses in their current layout. The land immediately east of the site is replaced with warehouses labelled *Frontier Works* in their current layout. The site and surrounding area remains largely the same until c. 2003 when the land south of the site is developed into residential buildings and gardens.

**Plate 7: Excerpt from 1:1,250 map dated 1981-1984.**



### **3.3 Planning History**

A search of the Borough of Haringey<sup>4</sup> website has been carried out which returned no records for the site.

### **3.4 Unexploded Ordnance (UXO)**

A Preliminary Unexploded Ordnance (UXO) Risk Assessment has been carried out for the site by Zetica UXO which concluded that several high explosive (HE) bombs fell in close proximity to the site. The report is included in Appendix D. It is recommended that a detailed UXO risk assessment is carried out to inform the risk and mitigation recommendations that may be required during the demolition and construction phase of works.

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<sup>4</sup> <https://www.haringey.gov.uk/planning-and-building-control/planning/planning-applications/current-planning-applications/view-and-comment-current-applications> [Accessed March 2023]

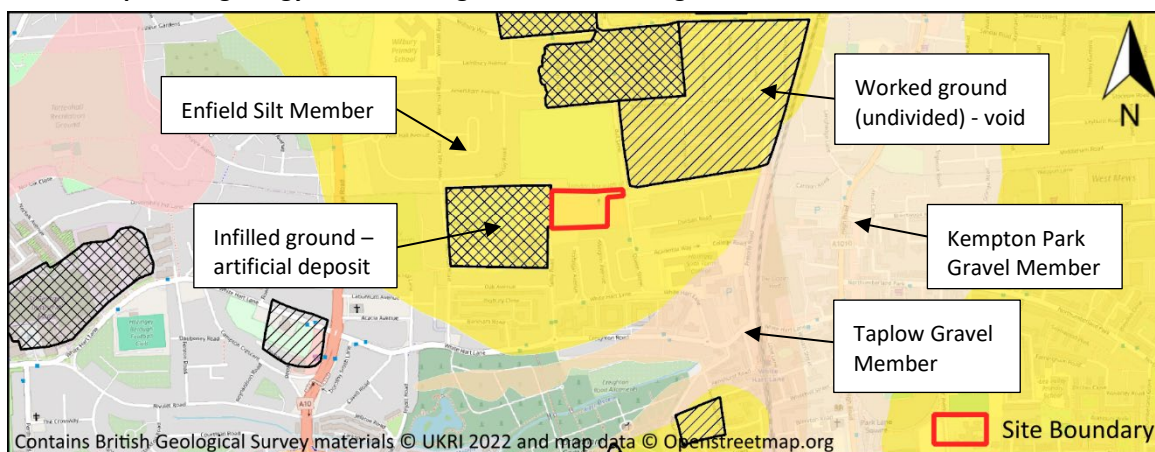
## 4. ANTICIPATED GROUND CONDITIONS

### 4.1 Published Geology

With reference to the British Geological Survey (BGS) GeoIndex<sup>5</sup>, geological map 256<sup>6</sup> and the Groundsure Enviro+Geo Insight Report (included in Appendix E) the site is anticipated to be underlain by the Enfield Silt Member overlying the Taplow Gravel and Kempton Park Gravel Members. These superficial deposits are anticipated to be underlain by the bedrock London Clay Formation and, at depth, the Lambeth Group.

Artificial ground is mapped to directly east of the site and to the north-east of the site. The artificial ground to the east is labelled “infilled ground – artificial deposit”. The artificial ground to the north-east is labelled “worked ground (undivided) – void”. Made Ground may be present on site associated with the construction of the existing warehouses and historical use as *Engineering Works*.

**Plate 8: Superficial geology and artificial ground<sup>7</sup> surrounding the site.**



The following geological descriptions for the above strata are provided based on the BGS lexicon<sup>8</sup>:

- Enfield Silt Member: commonly yellow-brown and massive silt and clay;
- Taplow Gravel and Kempton Park Gravel Members : sand and gravel, locally with lenses of silt, clay or peat; and,
- London Clay Formation: greyish brown stiff to very stiff clay locally sandy clay occasionally with pyrite nodules, selenite crystals, bioturbation and locally with partings of silt and sand.

<sup>5</sup> <https://mapapps2.bgs.ac.uk/geoindex/home.html?> [Accessed March 2024]

<sup>6</sup> Geological Survey of England and Wales 1:63,360/1:50,000 geological map series, New Series. Sheet 256. North London. Bedrock and Superficial. Published 2005. Print code: 2000/2006.

<sup>7</sup> <https://www.bgs.ac.uk/technologies/web-map-services-wms/web-map-services-geology-50k/> [Accessed March 2024]

<sup>8</sup> <https://www.bgs.ac.uk/technologies/the-bgs-lexicon-of-named-rock-units/> [Accessed March 2024]

## 4.2 Unpublished Geology

With reference to the BGS GeoIndex<sup>5</sup>, numerous boreholes records are within 500m of the site. The ten closest borehole records are summarised in *Table 1*. Levels have been provided where available. Some records did not identify the stratum. Soft to firm brown, orangish brown or brown clay to silty clay is considered to be Enfield Silt Member. Descriptions of sand and gravel have not been differentiated into Taplow Gravel Member and Kempton Park Gravel Member, hereafter referred to as “Undifferentiated Thames Terrace Deposits”. Borehole records and a borehole location plan are included in Appendix F.

**Table 1: Summary of BGS borehole records.**

| BGS reference | Grid reference | Distance and Direction | Base of borehole (mbgl) [mOD] | Date | Water Strike (mbgl) | Depth to top of stratum (mbgl) [mOD] |              |                     |                                          |                       |
|---------------|----------------|------------------------|-------------------------------|------|---------------------|--------------------------------------|--------------|---------------------|------------------------------------------|-----------------------|
|               |                |                        |                               |      |                     | Topsoil                              | Made Ground  | Enfield Silt Member | Undifferentiated Thames Terrace Deposits | London Clay Formation |
| TQ39SW116B    | 533190, 191480 | 130m S                 | 13.6 [6.0]                    | 1961 | NE                  | NE                                   | 0.0 [19.6]   | NE                  | 3.0 [16.6]                               | 5.5 [14.1]            |
| TQ39SW116D    | 533190, 191480 | 130m S                 | 12.7 [6.4]                    | 1961 | 3.7                 | NE                                   | 0.0 [19.1]   | NE                  | 3.7 [15.4]                               | 4.9 [14.2]            |
| TQ39SW17/B    | 532980, 191610 | 200m W                 | 11.1                          | 1953 | 4.1                 | 0.0                                  | 0.3          | 4.1                 | 7.2                                      | 8.7                   |
| TW39SW17/F    | 532980, 191610 | 200m W                 | 11.3                          | 1951 | 4.1                 | 0.0                                  | 0.3          | 4.1                 | 7.2                                      | 8.7                   |
| TQ39SW8/A     | 533380, 191410 | 220m S                 | 7.1                           | 1953 | 4.3                 | 0.0                                  | Existing pit | 1.2                 | 1.5                                      | 5.3                   |
| TQ39SW226     | 533720, 191700 | 370m E                 | 6.9                           | 1961 | 2.4                 | NE                                   | 0.0          | 0.8                 | 2.3                                      | 5.6                   |
| TQ39SW486     | 533100, 192100 | 400m N                 | 3.1                           | 1991 | 2.7                 | 0.0                                  | 0.1          | 0.9                 | 1.2                                      | 2.7                   |
| TQ39SW489     | 533280, 192110 | 400m N                 | 4.0                           | 1991 | NE                  | 0.0                                  | 0.1          | 2.8                 | 3.9                                      | NE                    |
| TQ39SW482     | 533190, 192110 | 400m N                 | 3.5                           | 1991 | NE                  | NE                                   | 0.0          | NE                  | 1.4                                      | 2.30                  |
| TQ39SW9/C     | 533910, 191880 | 580m NE                | 15.2                          | 1993 | 5.94                | NE                                   | 0.0          | NE                  | 0.61                                     | 7.6                   |

The borehole records indicate a variable thickness of Made Ground overlies the Enfield Silt Member, sand and gravel and London Clay Formation. The Enfield Silt Member was not encountered in all boreholes. The sand and gravel are generally between 1.5m to 3m thick and was thicker (7m) in TQ39SW9/C. The top of the London Clay Formation varies between 2.3mbgl and 8.7mbgl. Water strikes are recorded in most boreholes, generally in the sand and gravel with some in the Enfield Silt Member.

## 4.3 Mining

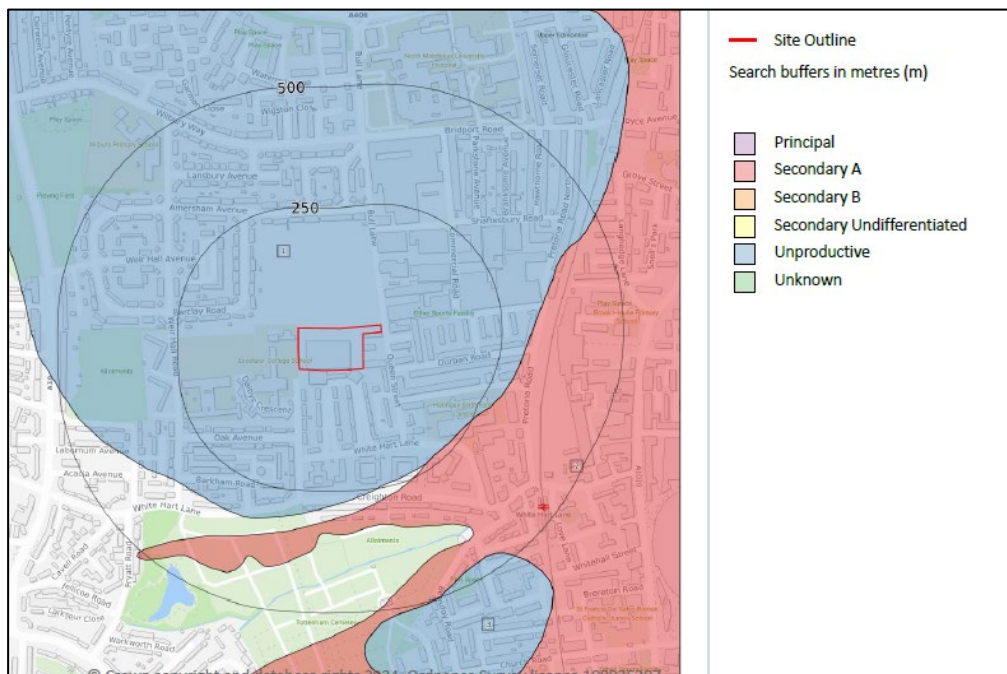
The Groundsure Enviro+Geo Insight Report (see Appendix E) records no natural cavities, BritPits or mining on the site. Surface ground workings are recorded directly west of the site likely associated with the ponds, gravel pit and areas of raised ground mapped in the Ordnance Survey maps (included in Appendix C).

## 4.4 Hydrogeology and Hydrology

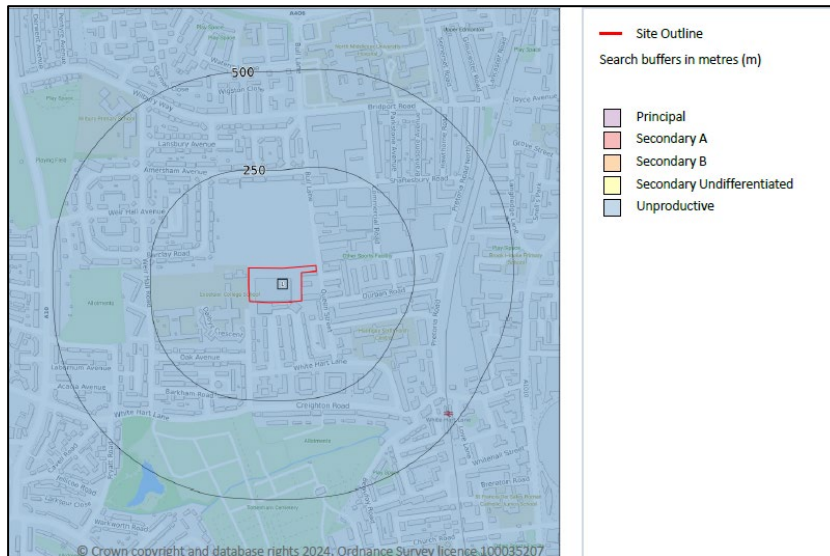
The Environment Agency (EA) has produced an aquifer designation system consistent with the requirements of the Water Framework Directive. The designations have been set for superficial and bedrock geologies and are based on the importance of aquifers for potable water supply and their role in supporting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

The site is not within a Source Protection Zone (SPZ). The Enfield Silt Member is designated Unproductive aquifer. The Kempton Park Gravel Member and Taplow Gravel Member are Secondary A aquifers. The bedrock London Clay Formation is a designated Unproductive aquifer. At depth, the Lambeth Group is a Secondary A aquifer.

**Plate 9: Aquifer status of groundwater within superficial geology (reproduced from Groundsure report in Appendix E).**



**Plate 10: Aquifer status of groundwater within bedrock geology (reproduced from Groundsure report in Appendix E).**

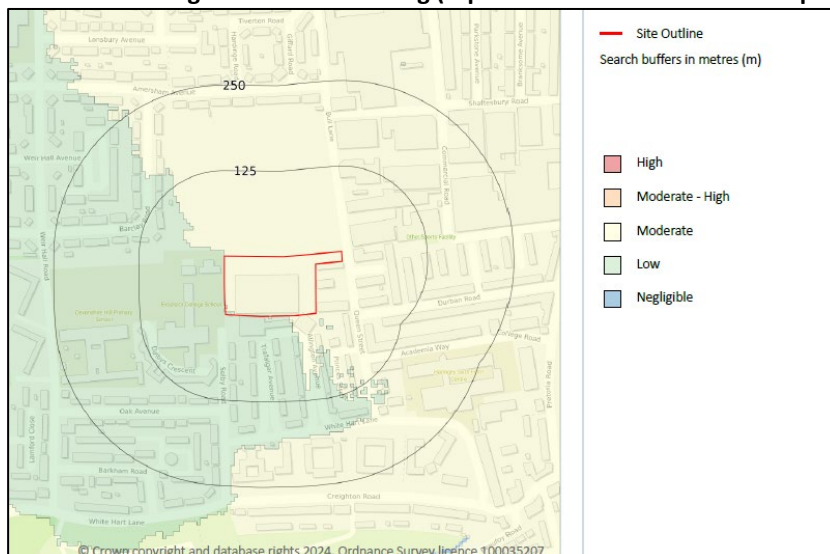


The nearest surface water is the River Moselle 400m south of the site which runs east-west through Tottenham Cemetery. It is noted that most of the river is culverted and only open / exposed to the surface where it runs through the cemetery.

According to the EA<sup>9,10</sup>, the site is not within Flood Zone 2 or 3. With reference to the Groundsure Enviro+Geo Insight Report (see Appendix E) the site is at negligible risk from surface water flooding and flooding from rivers and the sea.

The site is at moderate risk from groundwater flooding.

**Plate 11: Risk of groundwater flooding (reproduced from Groundsure report in Appendix E).**



<sup>9</sup> <https://www.data.gov.uk/dataset/cf494c44-05cd-4060-a029-35937970c9c6/flood-map-for-planning-rivers-and-sea-floodzone-2> [Accessed March 2024]

<sup>10</sup> <https://www.data.gov.uk/dataset/bed63fc1-dd26-4685-b143-2941088923b3/flood-map-for-planning-rivers-and-sea-floodzone-3> [Accessed March 2024]

## 5. ENVIRONMENTAL SETTING

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### 5.1 Environmental Disclosure Report

The Groundsure Enviro+Geo Insight report (see Appendix E) has been obtained to provide information on the environmental setting of the site and assist in identifying possible sources of ground contamination. A summary of the pertinent points is set out below:

- There are three records of historical industrial land uses on the site: *Furniture Manufactory, Engineering Works (Soda Water Syphons)* and *Engineering Works*. Several *Tanks* were also historically mapped on site.
- The electricity substation located in the south-west of the site is a current potentially contaminative land use. Two other substations were historically located in the south-west of the site.
- There are several records of historical industrial land uses within 250m of the site including *Weatherproof Manufactory, Furniture Manufactory, Engineering Works (Die Castings)*, numerous *Works, Gravel Pit* and *Kiln*.
- There are several records of current potentially contaminative land uses within 250m of the site including Ceramatech Ltd and Unique Metal Fabrications Ltd adjacent to the east of the site, several car repair garages, a steel fabricator and several electricity substations within 250m north-east of the site.
- Two waste exemptions are recorded within 250m of the site. One is located 50m south of the site at 40 Trafalgar Avenue for use of waste in construction. The second is 60m south-west of the site at the Selby Centre for uses including use of waste in construction, burning of waste as a fuel in a small appliance, treatment of waste wood and waste plant matter, burning of waste in the open and use of waste to manufacture finished goods.
- One historical record of a licensed pollutant release (Part A(2)/B) within 250m of the site located 120m north-east of the site for coating processes.
- No licensed groundwater abstractions within 250m of the site.
- No licensed potable water abstractions within 250m of the site.

- The site is within the Moselle Brook water body catchment in the Lee Lower Rivers and Lakes operational catchment.
- The site is within a Site of Special Scientific Interest Impact (SSSI) Risk Zone.
- The site is within a Nitrate Vulnerable Zone. The zone is the LEE NVZ for Surface Water with NVZ ID 443.

## **5.2 Radon**

The Groundsure Enviro + Geo Insight report identifies that the site is in an area where less than 1% of properties are above the Radon Action Level. This indicates no radon protective measures are required for new properties. It is noted that if a basement is proposed and planned to be occupied or part occupied, current guidance requires monitoring for radon, irrespective of the initial risk assessment.

## **5.3 Regulatory Enquiries**

The London Borough of Haringey was contacted for information regarding potentially contaminated land within the site and in the surrounding area. To date, a response is awaited from the council. Any pertinent information will be forwarded as an addendum to this report.

## 6. PRELIMINARY RISK ASSESSMENT

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### 6.1 Introduction

Historical contamination of land may present harm to human health and the environment. Current UK legislation stipulates that the risk associated with potential land contamination is assessed and remediated, if necessary. Under the Town and Country Planning Act 1990 (as amended), potential land contamination is a "material planning consideration" together with the National Planning Policy Framework<sup>11</sup> (revised in July 2021, to replace the 2012 version further revised in 2018 and 2019), which means that a planning authority must consider contamination when they prepare development plans or consider individual applications for planning permission. It is the responsibility of the developer to carry out the remediation where it is required and satisfy the Local Authority that the remediation has been carried out as agreed.

Additionally, Part 2A of the Environmental Protection Act 1990 requires that a significant source-pathway-receptor linkage exists to determine a site as contaminated land. This means that there has to be a contaminant present, a receptor that could be harmed by this contaminant, and a pathway linking the two. Part 2A deals with the contamination risk from a site in its current use, however, the planning system requires that the proposed use is considered. Where remediation is carried out under the planning system, it should be ensured that the site is in such a condition that it would still not meet the definition of contaminated land under Part 2A.

### 6.2 Preliminary Conceptual Site Model

A preliminary conceptual model has been compiled for the site with respect to the proposed development to identify the potential sources of contamination and the associated potential contaminant linkages. This model also informs the potential need for further investigation at the site.

#### 6.2.1 Potential Sources

Potential contamination sources can include both current and historical activities on site and in the surrounding area. The following potential sources have been identified at the site.

- On site sources: Made Ground associated with the redevelopment of the site and historical use as a *Furniture Manufactory* and *Engineering Works*. These could be a source of total petroleum hydrocarbons (TPH), polycyclic aromatic hydrocarbons (PAH), semi-volatile and volatile organic compounds (SVOCs and VOCs), heavy metals and potentially asbestos containing material. The

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<sup>11</sup> Ministry of Housing, Communities and Local Government (2021). National Planning Policy Framework.

existing and historical electrical substations could be a source of polychlorinated biphenyls (PCBs).

- Off-site sources: historical off-site activities close to the site include a gravel pit and ground workings west of the site and several *Works, Clothing Works* and *Engineering Works* north-east of the site. Current off-site industrial land uses including metal fabrications and numerous vehicle repair garages (eight within ~200m of the site). These could be a source of similar contaminants to the above.
- Ground gas / vapours: Made Ground and natural superficial deposits can be a source of ground gas where appreciable organic content is present. Hydrocarbon / organic chemicals can also produce organic vapours and ground gases. The infilled ground and gravel pit west of the site may be a source of ground gas if it was used as a pond or backfilled with organic material (e.g. tree leaves).
- Groundwater: Perched water in the Made Ground and shallow groundwater in the Thames Terrace Deposits may be a source of contamination due to the current and previous on and off-site sources. Potential contaminants in perched water would be similar to those present in the soils (TPH, PAH, SVOCs and VOCs and heavy metals) as discussed above.

### **6.2.2 Potential Pathways**

The potential migration pathways that may be present at the site include:

- Ingestion and inhalation: contamination within the Made Ground can result in the ingestion or inhalation of contaminated soils (and asbestos fibres, if present).
- Direct/dermal contact – direct/dermal contact with contaminated soils or shallow groundwater can result in the uptake of contaminants through the skin or permeation of contamination through structures/standard plastic water supply pipes.
- Root uptake – uptake of phytotoxic contamination by plants/vegetation within areas of proposed soft landscaping. It is noted that the existing and proposed basement covers much of the site footprint. It is likely that any proposed plants/vegetation will be planted in planters which would prevent contact with the existing Made Ground.
- Lateral and vertical migration – leaching from potential contamination in the soils may impact the groundwater and nearby surface water features.

- Ground gas/vapour migration – lateral migration of ground gases and/or vapours through the soil matrix could lead to accumulation within buildings and other enclosed spaces such as service and drainage runs, posing a risk of asphyxiation.
- Drainage and services – could provide a preferential pathway for dissolved phase contamination migration and/or ground gases/vapour transport.
- Foundation works – potential creation of contaminant pathway to the Secondary A aquifer in the Undifferentiated Thames Terrace Deposits during construction of shallow foundations.

### **6.2.3 Potential Receptors**

Based on the proposed end use of the site for commercial purposes as warehouses the main receptors at the site are considered to be:

- Future site occupants/users – future warehouse workers and users are primarily at risk from direct contact, inhalation or ingestion if soil is exposed within soft landscaping and from ground gas/vapour accumulation within buildings, arising from contaminated soils and inhalation of asbestos fibres.
- Construction workers – primarily at risk from direct contact, inhalation or ingestion of contaminants and inhalation of asbestos fibres for the duration of the works. Workers will be subject to site-specific health and safety assessments.
- Off-site residents – potential contamination risks are likely to be low assuming appropriate practices during construction.
- Controlled waters – Thames Terrace Deposits, a Secondary A aquifer, is a potential receptor from the presence or migration of contaminants in Made Ground. The nearest surface water is the River Moselle some 400m south of the site and is not considered to be a receptor from lateral migration of contaminants.
- On and off-site building and infrastructure: buried concrete and services, such as water supply pipes, can be at risk from chemically aggressive ground and permeation of organic contaminants into water supply pipes. Elevated hydrocarbon concentrations, including free product, have the potential to influence the curing time of fresh concrete. Ground gases and vapour may also accumulate in buildings, structures and services / service corridors presenting an explosive risk.
- Plants and vegetation: if new vegetation within soft landscaping is proposed, it may be at risk from phytotoxic contaminants such as copper, boron, nickel and zinc.

### **6.3 Preliminary Qualitative Risk Assessment**

A preliminary qualitative risk assessment has been undertaken based on the findings of the preliminary conceptual site model, and the potential contaminant linkages that may exist at the site in accordance with the October 2020 Land Contamination Risk Management Guidance (LCRM)<sup>12</sup> (replacing Contaminated Land Report (CLR) 11<sup>13</sup>). Using criteria broadly based on those presented in CIRIA Report C552<sup>14</sup>, the magnitude of the risk associated with potential contaminant linkages has then been assessed. The risk assessment methodology is presented in Appendix G and the findings of the risk assessment are summarised in Table 2.

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<sup>12</sup> Environment Agency (2020). *Land Contamination Risk Management (LCRM)*.

<sup>13</sup> Environment Agency (2004). *Model Procedures for the Management of Land Contamination (CLR11)*.

<sup>14</sup> CIRIA (2001) Contaminated Land Risk Assessment. A guide to good practice. C552.

Table 2: Preliminary qualitative risk assessment.

| Potential Source/Medium                                                                                                                                   | Potential Exposure Route                                                                                          | Potential Receptor                           | Severity | Probability    | Risk Rating   | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|----------------------------------------------|----------|----------------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Explosive/ asphyxiating gases/vapours from underlying soils (Made Ground) and potential on and off-site sources                                           | Migration of gases and vapours through the surface via permeable soils and drainage & services                    | Internal building spaces & future site users | Medium   | Low likelihood | Moderate/ Low | <p>Made Ground and superficial deposits can be a source of ground gas where appreciable organic content is present. Hydrocarbon / organic chemical can also produce organic vapours and ground gases.</p> <p>The infilled ground and gravel pit west of the site could potentially be a source of ground gas that could laterally migrate to the site. It is noted, however, the ground west of the site is at higher elevation and the ground generally slopes up north-west of the site and ground gas is unlikely to flow downslope towards the site.</p> |
| Organic/ inorganic contaminants such as hydrocarbons, PAH, metals and asbestos within underlying soils (based on historical on-site and off-site sources) | Direct/indirect ingestion of soil and dust, inhalation of particle vapours and asbestos fibres and dermal contact | Construction workers                         | Medium   | Likely         | Moderate      | There is potential for shallow soils to be impacted by asbestos and/or contaminants. Chemical analysis and assessment of shallow soils required to assess risk.                                                                                                                                                                                                                                                                                                                                                                                              |
|                                                                                                                                                           |                                                                                                                   | Future site users                            | Medium   | Low likelihood | Moderate/ Low | Made Ground may be present on site. New areas of soft landscaping are proposed in the development which may provide a pathway to future site users.                                                                                                                                                                                                                                                                                                                                                                                                          |
|                                                                                                                                                           | Direct contact with underground structures and services                                                           | Buildings and structures                     | Mild     | Likely         | Moderate/Low  | Buried concrete to be designed as appropriate for ground conditions. There is potential for contamination within Made Ground where new buried water supply pipes may be laid. Chemical assessment of soils required to assess risk.                                                                                                                                                                                                                                                                                                                          |

| Potential Source/Medium                                                                                                                        | Potential Exposure Route                                 | Potential Receptor                            | Severity | Probability    | Risk Rating    | Comments                                                                                                                                                                                                                                                                                                                                       |
|------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|-----------------------------------------------|----------|----------------|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                | Root uptake                                              | Plants and vegetation                         | Minor    | Likely         | Low            | Limited areas of new soft landscaping are proposed in the development. Chemical analysis and assessment of shallow soils required to assess risk. Imported soils for landscaping are likely to be required in any case, as suitable on-site source of topsoil is unlikely.                                                                     |
|                                                                                                                                                | Vertical migration                                       | Secondary A aquifer (Thames Terrace Deposits) | Medium   | Low likelihood | Moderate / Low | There is potential for shallow soils to be impacted by asbestos and /or contaminants due to historical on and off-site industrial land uses. There is potential for contaminants within the soils to leach to the underlying aquifer in the Thames Terrace Deposits. Analysis and assessment of soils and groundwater required to assess risk. |
| Organic/inorganic contaminants within groundwater (perched groundwater within the Made Ground and groundwater within the Alluvium, if present) | Direct contact and ingestion of contaminated groundwater | Future site users                             | Medium   | Unlikely       | Low            | Construction workers may come into contact with shallow groundwater during excavation works. Future site users are unlikely to come into contact with shallow groundwater due to hardstanding proposed across the majority of the site.                                                                                                        |
|                                                                                                                                                |                                                          | Construction workers                          | Medium   | Likely         | Moderate       |                                                                                                                                                                                                                                                                                                                                                |
|                                                                                                                                                |                                                          | Off-site residents                            | Medium   | Unlikely       | Low            |                                                                                                                                                                                                                                                                                                                                                |
|                                                                                                                                                | Inhalation of vapours                                    | Future site users                             | Medium   | Low likelihood | Moderate/Low   |                                                                                                                                                                                                                                                                                                                                                |
|                                                                                                                                                | Lateral migration                                        | River Moselle                                 | Medium   | Unlikely       | Low            | Shallow groundwater in the Thames Terrace Deposits may present a pathway into the River Moselle. However, is it some 400m                                                                                                                                                                                                                      |

| Potential Source/Medium | Potential Exposure Route                                | Potential Receptor       | Severity | Probability | Risk Rating  | Comments                                                                     |
|-------------------------|---------------------------------------------------------|--------------------------|----------|-------------|--------------|------------------------------------------------------------------------------|
|                         |                                                         |                          |          |             |              | south of the site and on this basis not considered to be a primary receptor. |
|                         | Direct contact with underground structures and services | Buildings and structures | Mild     | Likely      | Moderate/Low | Buried concrete to be designed as appropriate for ground conditions.         |

## 7. CURRENT CGL GROUND INVESTIGATION

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### 7.1 Fieldwork

The ground investigation took place between 12 February 2024 and 14 February 2024 and comprised:

- One cable percussion borehole (BH01) to 25mbgl;
- Four window sample boreholes (WS01 to WS04) to a maximum depth of 3mbgl; and
- Two trial pits (TP01 and TP02) to a maximum depth of 0.72mbgl.

An exploratory hole location plan is included in Figure 1. CGL exploratory hole records, including trial pit plan and sections, are included in Appendix H.

Prior to breaking ground, each exploratory hole was cleared for buried services by a specialist utility contractor. In-situ Standard Penetration Tests (SPTs) and sub-sampling were carried out within boreholes (BH) BH01 and window sample boreholes (WS) WS01 to WS04. The investigation was undertaken in general accordance with the requirements of BS 5930:2015+A1:2020<sup>15</sup> and BS 10175:2011+A2:2017<sup>16</sup>.

### 7.2 Ground Gas and Groundwater Monitoring

Dual installation monitoring standpipes were installed in borehole BH01. Three gas and groundwater monitoring visits were completed on 22 February 2024, 29 February 2024 and 07 March 2024. Gas and groundwater monitoring records are provided in Appendix I.

### 7.3 Laboratory Testing

#### 7.3.1 Chemical Laboratory Analysis

Selected soil samples were submitted to i2 Analytical Limited (a UKAS and MCERTS accredited laboratory) for chemical testing. The analysis included the following determinants:

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<sup>15</sup> British Standards Institution. (2015). Code of practice for site investigations. BS 5930:2015+A1:2020

<sup>16</sup> British Standards Institution. (2017). Investigation of potentially contaminated sites – Code of practice. BS 10175:2011+A2:2017

- Heavy metals / metalloids including antimony, arsenic, barium, beryllium, boron, cadmium, chromium, copper, lead, mercury, nickel, selenium, vanadium and zinc;
- Polycyclic aromatic hydrocarbons (PAH) and total petroleum hydrocarbons (TPH by Criteria Working Group banding);
- Total monohydric phenols;
- BTEX compounds (benzene, toluene, ethylbenzene, xylenes);
- Total cyanide;
- Soil Organic Matter (SOM);
- Total sulphate as SO<sub>4</sub>;
- pH determination; and
- Asbestos screen and identification (Made Ground samples only) and quantification where asbestos was positively identified during screening.

The results of the analysis are included in Appendix J.

### **7.3.2 Geotechnical Laboratory Analysis**

Selected soil samples were submitted to i2 Analytical (a UKAS and MCERTS accredited laboratory) for geotechnical testing.

The following geotechnical laboratory tests were carried out:

- Moisture content;
- Atterberg Limits;
- pH and sulphate to BRE SD1;
- Particle Size Determination (PSD) with sedimentation by pipette on selected samples; and,
- Quick undrained triaxial.

The results of the analysis are included in Appendix K.

## 8. GROUND AND GROUNDWATER CONDITIONS

### 8.1 Ground Conditions

The ground conditions encountered during the CGL ground investigation are summarised in *Table 3*. The natural sand and gravel encountered has not been differentiated into Taplow Gravel Member or Kempton Park Gravel Member and is referred to as 'Undifferentiated Thames Terrace Deposits'.

**Table 3: Summary of ground conditions encountered.**

| Stratum                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Depth to top of stratum (mbgl) [mOD]       | Typical thickness (m)                        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|----------------------------------------------|
| <p>Tarmac, concrete or paving slabs over orangish brown to brown silty gravelly sand to sandy gravel. Gravel is angular to rounded fine to coarse flint, brick and concrete. Occasional gravel of plastic, ceramic and rubber encountered. A layer of soft slightly gravelly clay was encountered in WS04 between 0.90mbgl and 1.30mbgl. A possible service was encountered in WS04 at 1.3mbgl and in TP02. Cobbles of brick and concrete encountered in WS01 between 0.15mbgl and 0.50mbgl. Rare brick cobbles noted in WS04 between 0.40mbgl and 0.90mbgl.</p> <p>Occasional roots and wood fragments noted in WS03 between 0.40mbgl and 0.90mbgl.</p> <p><b>[MADE GROUND]</b><br/>Encountered in all exploratory holes.</p> | <p>0.00<br/>[+18.53 to +17.27]</p>         | <p>0.20 to 1.80</p>                          |
| <p>Very dense greyish brown slightly sandy gravel. Sand is fine to coarse. Gravel is angular to rounded fine to coarse flint and rare concrete.</p> <p><b>[MADE GROUND – POSSIBLE REWORKED THAMES TERRACE DEPOSITS]</b><br/>Encountered in BH01 only.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <p>1.20<br/>[+16.34]</p>                   | <p>0.80</p>                                  |
| <p>Dense to very dense brown and orangish brown sandy gravel to gravelly sand. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse flint.</p> <p><b>[UNDIFFERENTIATED THAMES TERRACE DEPOSITS]</b><br/>Encountered in BH01, TP01, TP02, WS01 and WS03.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <p>0.20 to 2.00<br/>[+17.70 to +15.54]</p> | <p>1.70<br/>(proven in BH01 only)</p>        |
| <p>Soft to firm orangish brown clay.</p> <p><b>[WEATHERED LONDON CLAY FORMATION]</b><br/>Encountered in BH01 only.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <p>3.70<br/>[+13.84]</p>                   | <p>0.30</p>                                  |
| <p>Firm becoming stiff to very stiff dark brown clay. Becoming slightly sandy from 12.5mbgl with rare sand pockets.</p> <p><b>[LONDON CLAY FORMATION]</b><br/>Encountered in BH01 only.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <p>4.00<br/>[+13.54]</p>                   | <p>20.50</p>                                 |
| <p>Very stiff dark brown slightly sandy clay. Sand is fine to medium. Rare pockets of glauconitic fine to medium sand (&lt;35mm) rare gravel of medium rounded flint noted.</p> <p><b>[LAMBETH GROUP]</b><br/>Encountered in BH01 only.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <p>24.50<br/>[-6.96]</p>                   | <p>&gt;0.5 (proven to - 7.46mOD in BH01)</p> |

## 8.2 Groundwater

### 8.2.1 Groundwater Strikes

Groundwater strikes were recorded during the CGL ground investigation, summarised in Table 4.

**Table 4: Groundwater strikes recorded during CGL ground investigation.**

| Borehole | Stratum       | Groundwater Strike (mbgl) [mOD] | Groundwater Depth after 20 mins (mbgl) [mOD] |
|----------|---------------|---------------------------------|----------------------------------------------|
| BH01     | Made Ground   | 0.60<br>[16.94]                 | 0.60<br>[16.94]                              |
| BH01     | Lambeth Group | 24.90<br>[-7.36]                | 23.70<br>[-6.16]                             |
| WS01     | Made Ground   | 0.75<br>[17.78]                 | 0.57<br>[17.96]                              |
| WS02     | Made Ground   | 0.70<br>[17.48]                 | 0.30<br>[17.88]                              |
| WS03     | Made Ground   | 0.85<br>[16.55]                 | 0.72<br>[16.68]                              |
| WS04     | Made Ground   | 1.30<br>[15.97]                 | 0.80<br>[16.47]                              |

### 8.2.2 Groundwater Monitoring

Dual installation monitoring standpipes were installed in borehole BH01. Three gas and groundwater monitoring visits were completed on 22 February 2024, 29 February 2024 and 07 March 2024. Groundwater depths are summarised in Table 5.

**Table 5: Summary of groundwater monitoring.**

| Location | Response zone (mbgl)<br>[Stratum]         | Depth to water (mbgl) [mOD] |                  |                  |
|----------|-------------------------------------------|-----------------------------|------------------|------------------|
|          |                                           | 22/02/24                    | 29/02/24         | 07/03/24         |
| BH01     | 2.0m to 3.5m<br>[Thames Terrace Deposits] | 0.45<br>[17.09]             | 0.55<br>[16.99]  | 0.55<br>[16.99]  |
|          | 23.5m to 25.0m<br>[Lambeth Group]         | 18.10<br>[-0.56]            | 18.10<br>[-0.56] | 18.10<br>[-0.56] |

The depths of the groundwater strikes encountered during the intrusive investigation works and the depths of groundwater recorded during the return ground gas and groundwater monitoring visits indicates a shallow groundwater table is present across the site in the granular Made Ground and Thames Terrace Deposits, likely in hydraulic continuity, at approximately ~0.5mbgl (+17.0mOD). A deeper sub-artesian groundwater level is present in the Lambeth Group at ~18.0mbgl (-0.5mOD), confined by the cohesive London Clay Formation above.

### 8.3 Ground Gas Monitoring

Three gas visits were undertaken 21 February, 29 February and 07 March 2024. The shallow install in BH01 was flooded above the response zone in each of the three visits. Further discussion on the implications of flooded response zones and the likely ground gas regime at the site is presented within Section 9.3.

**Table 6: Summary of Ground Gas Monitoring Results.**

| <b>Location</b> | <b>Response zone [Stratum]</b>            | <b>Maximum flow rate (l/hr)</b> | <b>Minimum O<sub>2</sub> (% volume in air)</b> | <b>Steady CO<sub>2</sub> (% volume in air)</b> | <b>Maximum CH<sub>4</sub> (% volume in air)</b> | <b>Notes</b>                              |
|-----------------|-------------------------------------------|---------------------------------|------------------------------------------------|------------------------------------------------|-------------------------------------------------|-------------------------------------------|
| BH01            | 2.0m to 3.5m<br>[Thames Terrace Deposits] | 120                             | 2.1                                            | 7.2                                            | <0.1                                            | Flooded above response zone in each visit |

### 8.4 Visual and Olfactory Signs of Contamination

Other than the presence of foreign material such as brick, concrete and ceramic fragments noted throughout the Made Ground material, there was no other visual or olfactory evidence of contamination encountered during the works.

### 8.5 Services

A possible service was encountered in TP02, and in WS04 at 1.30mbgl.

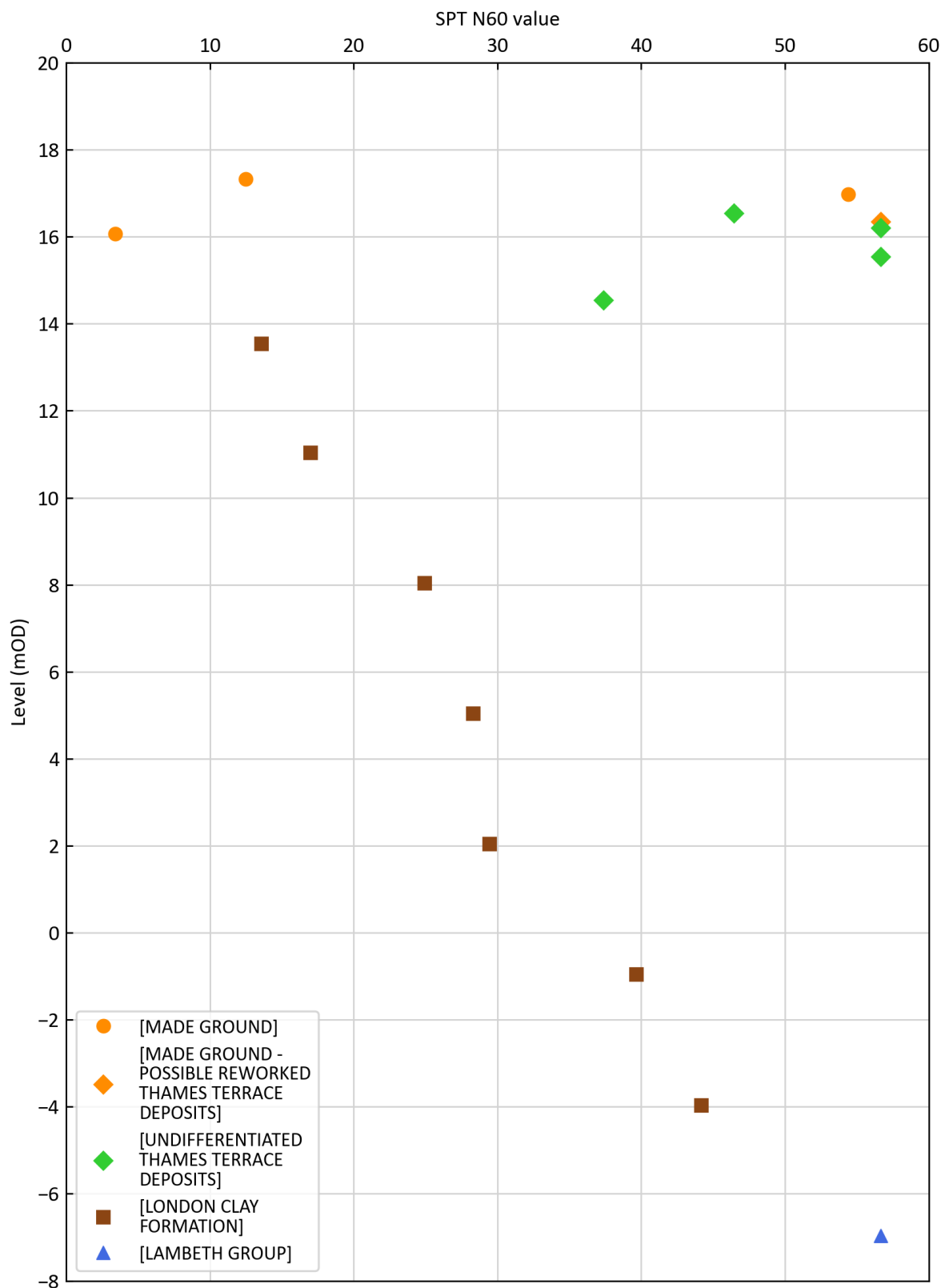
### 8.6 In-situ Geotechnical Tests

The results of the in-situ geotechnical tests are summarised in Table 7. A plot of SPT 'N<sub>60</sub>' value against level is shown in Table 7.

**Table 7: Summary of in-situ geotechnical testing.**

| <b>Stratum</b>                                          | <b>SPT 'N<sub>60</sub>' value</b>   |
|---------------------------------------------------------|-------------------------------------|
| Made Ground                                             | 3 to 54                             |
| Made Ground – Possible Reworked Thames Terrace Deposits | >57                                 |
| Thames Terrace Deposits                                 | 37 to >57                           |
| London Clay Formation                                   | 14 to 44                            |
| Lambeth Group                                           | >57                                 |
| <b>Stratum</b>                                          | <b>Hand shear vane result (kPa)</b> |
| London Clay Formation                                   | >130                                |

Plate 12: SPT 'N<sub>60</sub>' value against level (mOD).



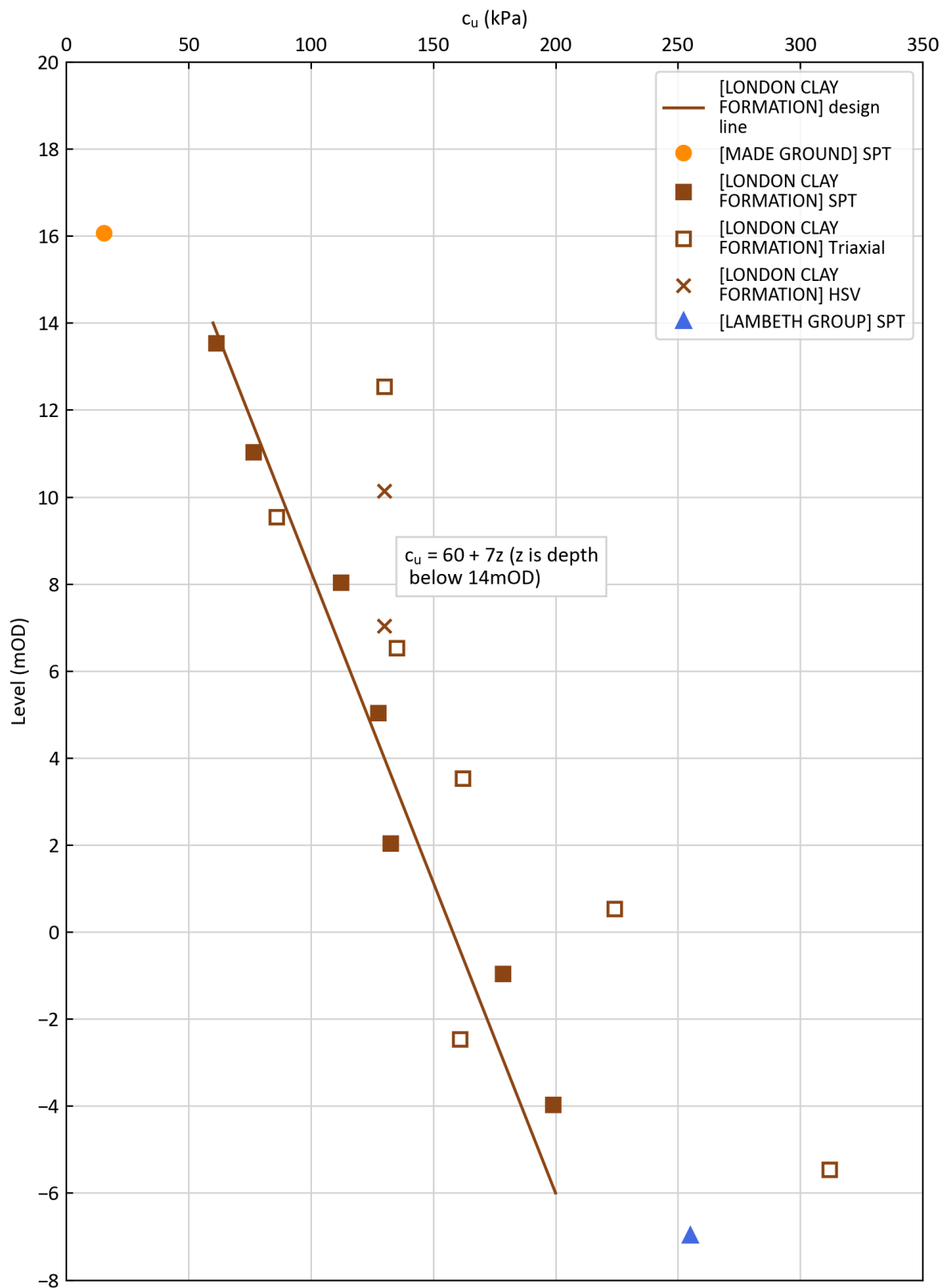
## 8.7 Geotechnical Laboratory Test Results

The results of the geotechnical laboratory analysis are summarised in Table 8. The geotechnical laboratory results are included in Appendix K. A plot of undrained shear strength ( $c_u$ ) versus level in metres above Ordnance Datum (mOD) is illustrated in Plate 13 below.

**Table 8: Summary of geotechnical laboratory tests.**

| Particle size distribution – wet sieve     |                                |                                           |                                                                         |                                                                                |                       |                               |
|--------------------------------------------|--------------------------------|-------------------------------------------|-------------------------------------------------------------------------|--------------------------------------------------------------------------------|-----------------------|-------------------------------|
| Stratum                                    | Very coarse (>63m) (%)         | Gravel (%)                                | Sand (%)                                                                | Fines (<0.063mm) (%)                                                           |                       |                               |
| Made Ground                                | 0                              | 52                                        | 41                                                                      | 7                                                                              |                       |                               |
| Thames Terrace Deposits                    | 0                              | 67 to 80                                  | 18 to 29                                                                | 1 to 4                                                                         |                       |                               |
| Particle size distribution – sedimentation |                                |                                           |                                                                         |                                                                                |                       |                               |
| Stratum                                    | Very coarse (>63m) (%)         | Gravel (%)                                | Sand (%)                                                                | Silt (%)                                                                       | Clay (%)              |                               |
| Lambeth Group                              | 0                              | 1                                         | 22                                                                      | 38                                                                             | 39                    |                               |
| Atterberg limits                           |                                |                                           |                                                                         |                                                                                |                       |                               |
| Stratum                                    | Moisture Content               | Liquid limit (%)                          | Plastic limit (%)                                                       | Plasticity index (%)                                                           | Material <425µm (%)   | Modified plasticity index (%) |
| Weathered London Clay Formation            | 31                             | 67                                        | 29                                                                      | 38                                                                             | 97                    | 37                            |
| London Clay Formation                      | 25 to 30                       | 68 to 78                                  | 26 to 30                                                                | 40 to 49                                                                       | 100                   | 40 to 49                      |
| Shear strength tests                       |                                |                                           |                                                                         |                                                                                |                       |                               |
| Stratum                                    | Undrained shear strength (kPa) |                                           |                                                                         |                                                                                |                       |                               |
| London Clay Formation                      | 86 to 312                      |                                           |                                                                         |                                                                                |                       |                               |
| Sulphate and pH conditions                 |                                |                                           |                                                                         |                                                                                |                       |                               |
| Stratum                                    | pH                             | Total sulphate as SO <sub>4</sub> (mg/kg) | Water soluble sulphate as SO <sub>4</sub> 16hr extraction (2:1) (mg/kg) | Water Soluble SO <sub>4</sub> 16hr extraction (2:1 Leachate Equivalent) (mg/l) | Total sulphur (mg/kg) |                               |
| Made Ground                                | 9.4                            | N/A                                       | 63                                                                      | 32                                                                             | N/A                   |                               |
| Thames Terrace Deposits                    | 8.3                            | N/A                                       | 21                                                                      | 11                                                                             | N/A                   |                               |
| Weathered London Clay Formation            | 7.9                            | 84                                        | 32                                                                      | 16                                                                             | < 50                  |                               |
| London Clay Formation                      | 8.40 to 8.70                   | 280 to 440                                | 140 to 430                                                              | 71 to 214                                                                      | 830 to 3800           |                               |
| Lambeth Group                              | 8.20                           | 1400                                      | 1300                                                                    | 665                                                                            | 15000                 |                               |

Plate 13: Undrained shear strength ( $c_u$ ) against level in metres above Ordnance Datum (mOD).



### 8.7.1 Made Ground

Three SPT 'N<sub>60</sub>' values were recorded in the granular Made Ground between 13 and 57, corresponding to a relative density of medium dense to very dense<sup>17</sup>. One SPT 'N<sub>60</sub>' value of 3 was recorded in cohesive Made Ground corresponding to a correlated  $c_u$  value of 15 ( $f_1 = 4.5^{18}$ ). This was recorded in WS04 at 1.20mbgl. This generally agrees with the engineer's on-site description of soft.

### 8.7.2 Thames Terrace Deposits

Four SPT 'N<sub>60</sub>' values were recorded in the granular Thames Terrace Deposits between 37 and 57, corresponding to a relative density of dense to very dense<sup>17</sup>.

### 8.7.3 London Clay Formation

Seven SPT 'N<sub>60</sub>' values were recorded in the cohesive London Clay Formation between 14 and 44 corresponding to correlated  $c_u$  values between 61kPa and 199kPa ( $f_1 = 4.5^{18}$ ). Seven laboratory unconsolidated undrained triaxial tests reported results between 86kPa and 312kPa corresponding to a strength description of high to very high<sup>19</sup>. Two hand shear vane results of >130kPa were recorded corresponding to a strength description of high strength<sup>19</sup>. The recorded modified plasticity index values (37 to 49, including one value in the Weathered London Clay Formation) indicate medium to high volume change potential.

### 8.7.4 Lambeth Group

One SPT 'N<sub>60</sub>' value was recorded in the Lambeth Group of 57 corresponding to a  $c_u$  value of 255kPa ( $f_1 = 4.5^{18}$ ). This generally agrees with the engineer description as very stiff.

## 8.8 Trial Pits

The findings of trial pits TP01 and TP02 are summarised in Table 9.

Table 9: Summary of trial pit findings.

| Location ID | Top of footing (mbgl) [mOD] | Base of footing (mbgl) [mOD] | Projection from wall (m) | Bearing Stratum                          |
|-------------|-----------------------------|------------------------------|--------------------------|------------------------------------------|
| TP01        | 0.42<br>[+17.48]            | 0.72<br>[+17.18]             | 0.75                     | Undifferentiated Thames Terrace Deposits |
| TP02        | 0.40<br>[+17.53]            | 0.70<br>[+17.23]             | 0.40                     | Undifferentiated Thames Terrace Deposits |

<sup>17</sup> British Standards Institute (2015). BS 5930:2015 Code of Practice for Ground Investigations

<sup>18</sup> Stroud, M. A. (1974). The Standard Penetration Test in Insensitive Clays and Soft Rocks. Proceedings of the European Symposium on Penetration Testing, Stockholm, June 5-7, 1974 2(2): 367-375

<sup>19</sup> British Standards Institute (2015). BS 5930:2015 Code of Practice for Ground Investigations

## 9. CONTAMINATION ASSESSMENT

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### 9.1 General

This section evaluates risks to potential receptors at the site using the results of the chemical analysis of soil samples obtained during the ground investigation and build on the preliminary conceptual site model presented within Section 6.

Potential receptors have been identified with reference to the Part 2A regime and associated DEFRA guidance<sup>20</sup>. As with the Part 2A regime, under the planning regime all receptors (humans, controlled waters, ecology, crops/livestock and buildings) have been considered if there is the potential for them to be adversely affected by exposure to contamination.

CGL's approach and rationale to assessment criteria adoption for this site is presented in Appendix L. A soil organic matter of 1.0% has been used in the Made Ground (measured range 0.20% to 1.70% with an average of 0.7%). A "commercial" end use of the building has been used in the assessment based on the proposed development as warehouses with office space on the first floor.

### 9.2 Risks to Human Health from Soil Contaminants

A total of five soil samples from Made Ground were submitted for chemical analysis. No samples from the Thames Terrace Deposits were tested due to the shallow groundwater table in this stratum.

A review of Table L2 in Appendix L indicates that the concentration of contaminants recorded within Made Ground do not exceed their respective generic assessment criteria (GAC).

Asbestos was tested for in each sample and was detected in three samples as summarised below:

- <0.001% of loose chrysotile fibres detected in BH01 at 0.30mbgl;
- <0.001% of loose chrysotile fibres detected in WS02 at 0.30mbgl; and
- <0.001% of loose chrysotile fibres detected in WS04 at 1.00mbgl.

The risk to future site users is considered to be moderate.

The risks to construction workers from contaminants in Made Ground is considered to be moderate.

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<sup>20</sup> DEFRA (2012) *Environmental Protection Act 1990:Part 2A Contaminated Land Statutory Guidance*

The risks to off-site receptors from construction works from e.g. dust generation is considered to be moderate.

### **9.3 Risks to Human Health from Ground Gas**

Due to the shallow groundwater table across the site, the monitoring install in borehole BH01 with the response zone within the Thames Terrace Deposits, was flooded in each visit. Where monitoring wells are saturated, false or inaccurate flow rate readings can be recorded due to pressure build up within the monitoring wells as a result of the high groundwater level, and limited head space in the monitoring well can result in small volumes of gas recording high concentrations<sup>21</sup>.

In addition, it is noted that no pathways exist for ground gas migration into the BH01 monitoring well due to the saturation of the response zone. Due to the high groundwater level (varied between 0.45mbgl and 0.55mbgl) it is unlikely that dry gas monitoring wells can be installed in the Made Ground with further ground investigation unless the groundwater drops during summer which is discussed at the end of this section.

Based on the ground gas monitoring undertaken to date, calculation of Gas Screening Values (GSVs) is not considered appropriate given the response zones were flooded for the duration, likely giving rise to inaccurate flow rates and unrepresentative ground gas concentrations. Alternative assessment of the available ground investigation data<sup>21</sup> has been undertaken to give an indication of risk.

The Thames Terrace Deposits encountered was granular and generally comprised of clayey sandy gravel to gravelly sand (see logs in Appendix H). The gravel comprised of flint with no organic material visually observed. On this basis the Thames Terrace Deposits is not considered to be a source of ground gas.

The Made Ground was generally described as slightly silty sandy gravel to gravelly sand. The thickness was limited and varied between 0.20m and 1.8m. The gravel typically comprised brick and concrete, and rarely plastic, ceramic, wood and metal fragments. It was visually low in organics, confirmed by laboratory testing where the soil organic matter varied between 0.2% and 1.7% with an average of 0.7% (see chemical laboratory test results in Appendix J). No hydrocarbon odours were recorded during the ground investigation.

Desktop sources do not indicate a likely source of hazardous ground gas on site. Infilled ground and a historic gravel pit is mapped directly west of the site, however, this ground is at higher elevation than the site and the ground surrounding the site slopes up to the north-west and down to the east. Ground

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<sup>21</sup> CL:AIRE (2012) *A Pragmatic Approach to Ground Gas Risk Assessment*. RB17. November 2012.

gas is not considered to flow down slope and therefore any ground gas that may be present in the infilled found is not considered to laterally migrate to the site. The site investigation and laboratory testing identified low organic content in Made Ground. The Thames Terrace Deposits were low visually in organic content.

Based on the above, is it likely that the site can be considered to conform to Characteristic Situation 1 (CS1). This should be confirmed by groundwater monitoring in the summer months to appraise the potential for the groundwater level to drop. If the groundwater table does drop, there is potential for an altered ground gas regime and the recommended characteristic situation may change as a result of further assessment.

#### **9.4 Risks to Secondary A Aquifer from Soil Contaminants in Made Ground**

One groundwater sample from the Thames Terrace Deposits was submitted for chemical analysis. The risks to controlled waters have been assessed against the Freshwater Environmental Quality Standard (EQS) and Drinking Water Values (DWV). The results are summarised in Table L3 in Appendix L.

The assessment indicates that contaminant concentrations are below the EQS and DWV criteria with the exception of elevated ammoniacal nitrogen where a concentration of 3,400µg/l was recorded compared the DWV criteria of 500µg/l. This single exceedance of DWV criteria has been recorded, however, it is unlikely that the shallow groundwater will be a drinking water resource at the site and therefore DWV are considered to be conservative assessment criteria. Additionally, there are no historical uses on the site associated with elevated levels of ammoniacal nitrogen and there are numerous historical and current industrial land uses surrounding the site that may have impacted the shallow groundwater. Furthermore, no exceedances in the concentration of contaminants were recorded in the Made Ground soil. On this basis, it is considered that the source of the ammoniacal nitrogen is off-site and the risk to the Secondary A aquifer in the Thames Terrace Deposits is considered to be low.

The proposed development is anticipated to be founded on shallow foundations and therefore the foundations will not penetrate beyond the London Clay Formation into the Secondary A aquifer in the Lambeth Group. The low permeability London Clay Formation, some 20.5m thick, would act as a barrier from vertical migration of contaminant from shallow soils and groundwater. On this basis, it is considered that the risk to the underlying Secondary A aquifer in the Lambeth Group is low.

#### **9.5 Risks to Vegetation and Plants**

The risks to plant growth from phytotoxic contaminants (copper, boron, nickel and zinc) have been assessed in Table L4 in Appendix L. This indicates that the concentration of contaminants in Made

Ground do not exceed the assessment criteria. On this basis, the risks to plants and vegetation is considered to be very low.

## **9.6 Risks to Buried Water Supply Pipes**

The risk to buried water supply pipes is assessed in Table L5 in Appendix L. The proposed finished floor level and depths of the proposed buried pipes are not known at the time of writing and therefore all shallow soil samples have been assessed.

The risks to buried water supply pipes are considered to be moderate due to elevated concentrations of EC10-EC16 aliphatic and aromatic hydrocarbons in one location, WS02 at 0.30mbgl. Copper pipes are not likely to be suitable due to soil pH readings above 8. Therefore, it is likely that barrier pipes are required. It is recommended that the water supply company is contacted to confirm their requirements for water supply pipes.

## **9.7 Revised Conceptual Site Model**

The qualitative risk assessment has been revised based on the findings of the intrusive investigation and the potential contaminant linkages identified at the site in accordance with the October 2020 Land Contamination Risk Management Guidance (LCRM)<sup>22</sup> (replacing Contaminated Land Report (CRP) 11<sup>23</sup>). This is shown in Table 10 below and presented as a conceptual site model in Figure 2. The risk assessment methodology is presented in Appendix G.

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<sup>22</sup> Environment Agency (2020). Land Contamination Risk Management (LCRM).

<sup>23</sup> Environment Agency (2004). Model Procedures for the Management of Land Contamination (CLR11).

Table 10: Revised qualitative risk assessment.

| Potential Source/Medium                                                                                                                                   | Potential Exposure Route                                                                                          | Potential Receptor                          | Severity | Probability    | Risk Rating    | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|---------------------------------------------|----------|----------------|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Explosive/ asphyxiating gases/vapours from underlying soils (Made Ground) and potential on and off-site sources                                           | Migration of gases and vapours through the surface via permeable soils and drainage & services                    | Internal building spaces & future occupiers | Medium   | Low likelihood | Moderate / Low | The Made Ground and Thames Terrace Deposits was predominantly granular with no visible organic material. This was confirmed by laboratory testing in the Made Ground which recorded values of soil organic matter between 0.2% and 1.7%. As such, it is likely that the site can be considered to conform to Characteristic Situation 1. This should be confirmed by summer groundwater monitoring to constrain the potential for the groundwater level to drop. There is potential that the characteristic situation may change as a result of further monitoring. |
| Organic/ inorganic contaminants such as hydrocarbons, PAH, metals and asbestos within underlying soils (based on historical on-site and off-site sources) | Direct/indirect ingestion of soil and dust, inhalation of particle vapours and asbestos fibres and dermal contact | Construction workers                        | Medium   | Likely         | Moderate       | Asbestos (<0.001%) was detected in three samples of Made Ground. Risk can be mitigated by use of appropriate PPE and appropriate site management practices.                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                                                                                                                                           |                                                                                                                   | Future site users                           | Medium   | Low likelihood | Moderate/ Low  | The majority of the site will be covered by the proposed warehouses or hardstanding, however, new areas of soft landscaping are proposed in the development which provide a potential pathway to future site users from asbestos in Made Ground. Where soft landscaping is proposed a clean cover system will be required to reduce potential exposure.                                                                                                                                                                                                             |
|                                                                                                                                                           | Direct contact with underground structures and services                                                           | Buildings and structures                    | Mild     | Likely         | Moderate/Low   | Buried concrete to be designed as appropriate for ground conditions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

| Potential Source/Medium                                                                                                                        | Potential Exposure Route                                 | Potential Receptor                            | Severity | Probability    | Risk Rating    | Comments                                                                                                                                                                                                                                                                                                                                                    |
|------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|-----------------------------------------------|----------|----------------|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                |                                                          |                                               |          |                |                | Barrier pipes are likely to be required for buried water supply pipes due to elevated concentrations of hydrocarbons in shallow soils.                                                                                                                                                                                                                      |
|                                                                                                                                                | Root uptake                                              | Plants and vegetation                         | Minor    | Unlikely       | Very low       | No exceedances in the concentration of phytotoxic contaminants were recorded in samples of Made Ground. A clean cover system will be required in areas of soft landscaping to limit contact of future site users with the Made Ground.                                                                                                                      |
|                                                                                                                                                | Vertical migration                                       | Secondary A aquifer (Thames Terrace Deposits) | Medium   | Unlikely       | Low            | The concentration of contaminants in the Made Ground did not exceed their respective GACs. An exceedance of the DWV criteria of ammoniacal nitrogen was recorded in the groundwater sample obtained from the Thames Terrace Deposits, however, the shallow groundwater is unlikely to be used as a drinking water source and no EQS criteria were exceeded. |
| Organic/inorganic contaminants within groundwater (perched groundwater within the Made Ground and groundwater within the Alluvium, if present) | Direct contact and ingestion of contaminated groundwater | Future site users                             | Medium   | Unlikely       | Low            | Elevated concentration of ammoniacal nitrogen was recorded above the DWV limits, however no exceedances of EQS limits were recorded and this groundwater is unlikely to be a drinking water resource.                                                                                                                                                       |
|                                                                                                                                                |                                                          | Construction workers                          | Medium   | Low likelihood | Moderate / Low |                                                                                                                                                                                                                                                                                                                                                             |
|                                                                                                                                                |                                                          | Off-site residents                            | Medium   | Unlikely       | Low            |                                                                                                                                                                                                                                                                                                                                                             |
|                                                                                                                                                | Inhalation of vapours                                    | Future site users                             | Medium   | Unlikely       | Low            | Future site users are unlikely to come into contact with shallow groundwater due to hardstanding and warehouses proposed across the majority of the site.                                                                                                                                                                                                   |

| Potential Source/Medium | Potential Exposure Route                                | Potential Receptor       | Severity | Probability | Risk Rating  | Comments                                                                                                                                                                                               |
|-------------------------|---------------------------------------------------------|--------------------------|----------|-------------|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                         | Lateral migration                                       | River Moselle            | Medium   | Unlikely    | Low          | Shallow groundwater in the Thames Terrace Deposits may present a pathway into the River Moselle. However, is it some 400m south of the site and on this basis not considered to be a primary receptor. |
|                         | Direct contact with underground structures and services | Buildings and structures | Mild     | Likely      | Moderate/Low | Buried concrete to be designed as appropriate for ground conditions.                                                                                                                                   |

## 10. GEOENVIRONMENTAL RECOMMENDATIONS

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### 10.1 General

This section provides geoenvironmental recommendations based on information obtained during the ground investigation and the contamination assessments in Section 9. The risk assessment and conceptual site model indicates that contamination within the shallow soils pose a potential risk to human health receptors.

Based on the findings of the contamination assessment, the geoenvironmental recommendations are as follows:

- Further groundwater monitoring rounds during the summer months to constrain the potential of the shallow groundwater table to drop. Based on the shallow groundwater table and lack of organic material encountered in the ground investigation the site is likely to conform to Characteristic Situation 1. However, if the groundwater level drops in summer there is potential for an altered ground gas regime and the characterisation of the site may change.
- Borehole decommissioning (after additional groundwater monitoring rounds are complete);
- Watching brief and implementation of a discovery strategy during enabling works and general earthworks, and to facilitate appropriate waste characterisation of soils for disposal;
- Implementation of appropriate protection of construction workers and mitigation of risks to off-site receptors during construction;
- Provision of a suitable clean cover system in areas of soft landscaping; and
- Selection of appropriate materials for buried water supply pipes. The specification for water supply pipes should be determined by the water supply company.

### 10.2 Borehole Decommissioning

It is recommended that the gas and groundwater monitoring wells are decommissioned after any additional monitoring visits in accordance with EA guidance<sup>24</sup>. The aim is to prevent preferential flow pathways between the surface/Made Ground to the underlying natural soils and shallow aquifer from

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<sup>24</sup> Environment Agency (2012) Good practice for decommissioning redundant boreholes and wells.

being created during the development works. This should be undertaken before significant groundworks take place.

### **10.3 Watching Brief and Discovery Strategy**

It is recommended that a watching brief is carried out during the enabling works, earthworks and construction works by the Contractor. Should areas of unexpected contamination, including asbestos hydrocarbons, and free product, be encountered or suspected, in particular in areas where ground investigation has not been possible (i.e. beneath the existing buildings), a suitably qualified and experienced geoenvironmental engineer should be informed, and the risk associated with the contamination assessed.

Where necessary, an appropriate remediation strategy should be devised and implemented, and the regulators should be informed of additional areas of contamination so identified. The regulators should be provided with the risk assessment and proposed remediation methodology for agreement before undertaking such works. Appropriate verification works to be completed if remedial measures are required should also be identified within the remediation strategy and agreed in advance with the regulators.

During the redevelopment, precautions should be taken to minimise exposure of workers and the general public to potentially harmful substances. Attention should also be paid to restricting possible off-site nuisance such as dust and odour emissions.

### **10.4 Health and Safety and Environmental Controls**

It is recommended that precautions are taken to minimise exposure of workers and the general public to potentially harmful substances during earthworks. The risks to contractors should be controlled through the implementation of site safety procedures and the use of suitable personal protective equipment (PPE). Attention should also be paid to restricting possible off-site nuisance such as dust and odour emissions.

All site works should be undertaken in accordance with the guidelines prepared by the Health and Safety Executive (HSE, 1991)<sup>25</sup> and CIRIA Reports 132<sup>26</sup> and C650<sup>27</sup> and all work should also be carried out in accordance with the Contractor's Construction Health and Safety Plan.

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<sup>25</sup> Health and Safety Executive (1991). *Protection of Workers and the General Public during the development of contaminated land*. Guidance Note HS(G)66, Health and Safety Executive, HMSO, 1991.

<sup>26</sup> CIRIA (1996). *A guide for safe working on contaminated sites*. Steeds JE, Shepherd E & Barry DL. CIRIA Report 132.

<sup>27</sup> CIRIA (2005) *Environmental good practice – Site guide*. 2nd Edition. CIRIA Report C650.

Health and safety precautions that should be taken to limit the exposure of construction workers and potential off-site in contact with the works should include, but not be limited to:

- Personal hygiene, washing and changing procedures, noise and dust;
- Adequate PPE including disposable overalls, gloves and particulate filter masks/vapour respirators, where required;
- Dust and vapour suppression methods, including dampening down, minimising the working face exposed and covering stockpiles, where required;
- Regular cleaning of all site access routes and public area outside;
- Safe storage of fuel and other potentially polluting liquids and the provision of spill control and clean up facilities; and
- Positive collection and disposal of on-site run-off.

Excavations should be planned and inspected regularly by a competent person. No operatives should be permitted to enter unshored or otherwise protected excavations identified as unstable by a competent person, however shallow they may be.

Any stockpiled material and large excavations should be dampened during all earthworks excavation and earth moving activities and vehicles should be washed before leaving site, with washings contained on site and suitably disposed.

#### **10.4.1 Asbestos Control**

Asbestos has been detected during the current site investigation in BH01, WS02 and WS04 and there is potential for undiscovered asbestos fibres and asbestos containing materials (ACMs) during future excavations. It is recommended that, where encountered, asbestos containing material should be handled / removed in accordance with current regulations and guidance<sup>28,29,30,31</sup>.

ACMs, if encountered, should be segregated by hand picking by a trained person utilising the appropriate PPE and implementing necessary precautionary measures to minimise exposure to construction workers and general public during earthworks. The contractor should be responsible for

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<sup>28</sup> HSG247 (2006) *Asbestos: The licensed contractors' guide*

<sup>29</sup> Health and Safety Executive (2006). *Work with materials containing asbestos. Control of Asbestos Regulations 2006*. Approved Code of practice. and guidance, HSE 2006.

<sup>30</sup> Health and Safety Executive (2012). *The Control of Asbestos Regulations*.

<sup>31</sup> Health and Safety Executive (2010). *Asbestos: The Survey Guide*. HSG 264. January 2010.

determining whether the works are notifiable or licensable, and for implementing the appropriate procedures.

Site staff undertaking groundworks should be advised of the potential for asbestos fragments and fibres being present and be trained in basic visual recognition of asbestos. Soils being handled should be dampened, taking care that damping is carried out at the appropriate time and with appropriate amounts of water to suppress dust but not saturate the soils. Soils movement should be minimised, and double handling avoided.

## **10.5 Materials Management and Waste Characterisation**

The Contractor should be responsible for the material management and waste classification at the site. The “waste hierarchy” should be used to rank waste management options according to what is best for the environment. Top priority should be given to preventing waste in the first place, for example, during the pre-construction and planning stages of a new development. However, if waste is created, priority should be given to preparing it for re-use, then recycling, then recovery, and last of all disposal.

### ***10.5.1 Re-use, Recycling and Recovery***

In order to minimise the volumes of soils being disposed to landfill facilities, it is prudent to consider material management options prior to waste disposal. Screening of uncontaminated natural arisings may permit recycling/re-use of the material on site or for other sites under the WRAP protocol<sup>32</sup> (uncontaminated granular soils only) or the CL:AIRE protocol<sup>33</sup> and would lead to a reduction in disposal requirements.

Providing that a Remediation Method Statement, including a Materials Management Plan (MMP) compliant with the CL:AIRE protocol<sup>33</sup>, is produced which details where materials will arise and how they will be used within the limits of that Code of Practice, there is no requirement to seek an environmental permit to re-use materials within the site. However, the process would require sign off by a Qualified Person in advance of works commencing and a final validation report. This process is not applicable to soils that pose harm to human health or the environment.

### ***10.5.2 Preliminary Waste Characterisation***

A preliminary waste characterisation assessment has been carried out on the five soil samples sent for chemical testing, summarised in Table 11.

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<sup>32</sup> WRAP. (n.d.) The Quality Protocol.

<sup>33</sup> CL:AIRE (2011). The Definition of Waste: Development Industry Code of Practice. Version 2.

**Table 11: Summary of the preliminary waste characterisation and WAC testing.**

| <i>Location</i> | <i>Sample Depth (mbbl)</i> | <i>Stratum</i> | <i>Asbestos</i> | <i>Comments</i>                                                                                                                                                                                                                               |
|-----------------|----------------------------|----------------|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| BH01            | 0.30                       | Made Ground    | <0.001          | WM3 preliminary assessment indicates material would be characterised as not hazardous material and would be suitable for disposal to a non-hazardous waste facility that accepts asbestos waste.                                              |
| WS02            | 0.30                       | Made Ground    | <0.001          |                                                                                                                                                                                                                                               |
| WS04            | 1.00                       | Made Ground    | <0.001          |                                                                                                                                                                                                                                               |
| TP01            | 0.15                       | Made Ground    | ND              | WM3 preliminary assessment indicates material would be characterised as not hazardous. Material would be suitable for disposal to a license inert waste facility (subject to WAC testing) or a non-hazardous waste facility.                  |
| TP02            | 0.20                       | Made Ground    | ND              | WM3 preliminary assessment indicates material would be characterised as not hazardous. Material would not be acceptable to an inert waste facility without prior treatment due to elevated concentrations of TPH above the inert waste limit. |

ND: Not detected.

Results of the preliminary WM3 testing indicate that the samples in Made Ground would be characterised as "not hazardous". Asbestos was detected in three of these samples and would require disposal to a non-hazardous waste facility that accepts asbestos waste. One sample would require disposal to a non-hazardous waste facility due to elevated TPH above the inert waste limit.

Uncontaminated natural soils would be acceptable to an inert landfill without the need for additional WAC testing in accordance with current legislation, assuming that the natural material can be effectively segregated from the Made Ground during construction.

In May/June 2012 HMR&C issued Briefs 15/12 and 18/12 clarifying how construction spoil and excess soils will be assessed for landfill tax purposes. Detailed accurate descriptions of waste are required for all wastes to support the landfill tax assessment. Uncontaminated naturally occurring soils will remain inert by default and eligible for the lower rate of landfill tax. Similarly, 'reworked soils' and demolition 'stone' comprising ONLY materials listed in the Schedule of the Landfill Tax (Qualifying Material) Order 2011 (SI 2011/1017) will also be eligible for the lower rate of landfill tax.

However, Made Ground containing soil and foreign objects such as timber, plastic, rubber, metal, paper, plasterboard, asbestos, etc., regardless of the results of chemical analysis for waste classification purposes, will be eligible for the standard (higher) rate of landfill tax. Therefore, to maximise eligibility for lower rate landfill tax on waste construction spoil/ reworked ground, careful waste segregation and controls are necessary.

### **10.5.3 Waste Handling**

All material intended for off-site disposal should be transported and disposed in accordance with the Environmental Protection (Duty of Care) Regulations, 1991 and the Landfill (England and Wales) Regulations, 2002 (as amended). Waste legislation stipulates that hazardous and non-hazardous waste should be pre-treated prior to disposal. Pre-treatment can be undertaken either at the site of origin or may be carried out at a licensed off-site facility and can include selective segregation of soils conducted on site.

### **10.5.4 Asbestos**

Asbestos has been detected in BH01, WS02 and WS04 and there is the potential that further asbestos material may be present in the existing Made Ground soils.

Where asbestos material is present within the soil matrix, this material would not be acceptable for disposal to an inert waste facility and asbestos quantification would be required to determine whether the material would be acceptable to a licensed non-hazardous waste facility or hazardous waste facility that accepts asbestos material.

If asbestos containing materials (ACMs) rather than fibres are encountered, there is the presumption that asbestos is present at greater than 0.1% in elements of the soil and therefore the soil mix is classified as “hazardous” with respect to waste disposal unless appropriate remedial measures are undertaken to segregate the ACMs i.e., hand picking by a suitable qualified person.

Precautions should be taken during groundworks to minimise the risk of fibre release and exposure to the same. It will be necessary to wet the sides/bases of the excavations, particularly in dry weather conditions, and to cover excavated spoil to reduce risk of fibre release. Appropriate control measures will be required to protect groundworkers from potential exposure to asbestos and other harmful contaminants.

## **10.6 Clean Cover System for Areas of Soft Landscaping**

Based on presence of asbestos in the Made Ground in conjunction with the lack of suitable topsoil across the site, it is considered that a clean cover system is required in all areas of soft landscaping to mitigate risks to human health receptors. The extents of the landscaping are likely to be minimal given the proposed commercial land use, and the proposed building footprint and hardstanding will act to cap the remaining areas of the site.

It is recommended that a clean cover system comprising of 450mm of chemically validated soil including a minimum of 150mm topsoil over a geotextile marker layer is installed in areas of proposed soft landscaping.

The depth of the clean cover system may need to be increased for trees/large shrubs which should be specified by the landscape architect.

Where the Made Ground is removed and natural uncontaminated soils are confirmed at formation level by a suitably qualified geoenvironmental engineer, or where soft landscaping not in contact with Made Ground (e.g. rooftop gardens or planters), then a growth medium would likely be required. The thickness of the growth medium would be subject to the requirements of a landscape architect but should comprise a minimum of 150mm of topsoil.

The topsoil/subsoil placed to form the clean cover system/growth medium should be clean imported soil from a known and reputable source and meet the requirements of BS 3882<sup>34</sup> and subsoil the requirements for BS 8601<sup>35</sup>. Chemical certification of the source material and details of source should be provided by the Contractor prior to capping material being brought to site. The results should be inspected by a qualified geoenvironmental engineer to confirm that the material can be accepted at the site.

Once imported and placed, the capping layer construction should be verified by a geoenvironmental engineer. Additionally, representative samples should be taken by the geoenvironmental engineer for chemical laboratory analysis, for each type/source of material imported, at a minimum frequency of one test per 250m<sup>3</sup> of imported material, with a minimum of three samples per source. The results should be compared against the maximum permissible concentrations presented within Appendix N.

## **10.7 Buried Water Supply Pipes**

Based on the available soil analysis and with reference to the UK Water Industry Research Guidance<sup>36</sup>, protective pipe material may be required for the development, although the final specification for water supply pipework at the site should be agreed with the relevant water company.

---

<sup>34</sup> British Standards Institute (2015). Specification for Topsoil and Requirements for Use. BS3882:2015

<sup>35</sup> British Standards Institute (2013). Specification for Subsoil and Requirements for Use. BS8601:2013

<sup>36</sup> Water UK (2014) *Contaminated Land Assessment Guidance*

## **11. GEOTECHNICAL RECOMMENDATIONS**

---

### **11.1 General**

The proposed development comprises the demolition of the existing warehouses and construction of three two storey warehouses surrounded by car parking spaces and loading bays. Limited areas of soft landscaping are proposed around the north, west and east perimeter of the site.

### **11.2 Characteristic Soil Parameters**

Characteristic soil parameters, derived based on the ground investigation, laboratory test results, published information and CGL's experience of similar ground investigations, are summarised in Table 12.

The Made Ground was predominantly granular; however, a layer of cohesive material (soft brown slightly sandy slightly gravelly clay) was encountered in WS04 between 0.90mbgl and 1.30mbgl. Four SPT ' $N_{60}$ ' values were recorded in the Made Ground and varied between 3 and 57. A value of characteristic value of 8 is adopted which is considered to be moderately conservative.

The ground level on site varied between +18.53mOD and +17.27mOD. The shallowest groundwater level encountered during monitoring was +17.09mOD (0.45mbgl) in BH01, however, the shallowest water strike was +17.78mOD in WS01 which rose to +17.96mOD. On this basis a design groundwater level of +18.0mOD is recommended. A sub-artesian water level is present in the Lambeth Group at -0.50mOD.

A drained Young's Modulus of 90MPa is adopted in the Thames Terrace Deposits, however, one lower SPT ' $N_{60}$ ' value of 37 was recorded in BH01 at 3.00mbgl (+14.54mOD).

Only one SPT ' $N_{60}$ ' value was recorded during the ground investigation, and it is understood that the proposed development will be founded on shallow foundations that will not penetrate in the Lambeth Group. Therefore, characteristic soil parameters have not been provided for the Lambeth Group.

**Table 12: Characteristic soil parameters.**

| <b>Stratum</b>                                            | <b>Design Level<br/>[mOD]</b>              | <b>Bulk Unit<br/>Weight<br/><math>\gamma_b</math><br/>(kN/m<sup>3</sup>)</b> | <b>Undrained<br/>Cohesion<br/><math>c_u</math> [c']<br/>(kPa)</b> | <b>Friction<br/>Angle<br/><math>\phi'</math><br/>(°)</b> | <b>Young's<br/>Modulus<br/><math>E_u</math> [E']<br/>(MPa)</b> |
|-----------------------------------------------------------|--------------------------------------------|------------------------------------------------------------------------------|-------------------------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------------|
| Made Ground                                               | Varies between<br>+16.3mOD and<br>+18.2mOD | 18                                                                           | -<br>[0]                                                          | 28 <sup>37</sup>                                         | -<br>[16] <sup>38</sup>                                        |
| Undifferentiated Thames<br>Terrace Deposits               | +16.0                                      | 19                                                                           | -<br>[0]                                                          | 36 <sup>37</sup>                                         | -<br>[80] <sup>38</sup>                                        |
| London Clay Formation<br>(including weathered<br>portion) | +13.8                                      | 20                                                                           | 60+7z <sup>39</sup><br>[5]                                        | 21 <sup>40</sup>                                         | 36 + 4.2z <sup>41</sup><br>[27 + 3.2z] <sup>42</sup>           |

### 11.3 Shallow Foundations

The two storey warehouses are proposed to be founded on shallow foundations bearing on the Thames Terrace Deposits. Allowable bearing capacity considering a factor of safety of 3, pad foundations of dimensions 1.0m x 1.0m, 2.0m x 2.0m and strip foundations of dimensions 0.6m x 4.0m are summarised in Table 13. Bearing capacity calculations are included in Appendix M. Due to the shallow groundwater table, the buoyant unit weight of 10kN/m<sup>3</sup> is used.

The Undifferentiated Thames Terrace Deposits encountered during the ground investigation were granular, however, it is possible that cohesive layers may be present on site. It is recommended that Made Ground and cohesive layers of Undifferentiated Thames Terrace Deposits are removed where present at formation level of the proposed foundations and ground floor slabs to avoid differential settlement.

<sup>37</sup> Peck, R.B., Hanson, W.E., and Thornburn, T.H., Foundation Engineering, 2nd Edition, John Wiley, New York, 1967, p. 310

<sup>38</sup> Based on design SPT x 2MPa

<sup>39</sup> Z is depth below top of stratum

<sup>40</sup> BS 8002:2015 Code of practice for Earth retaining structures, British Standards institution.

<sup>41</sup> Based on 600c<sub>u</sub>

<sup>42</sup> Based on 0.75E<sub>u</sub> - Burland, Standing J.R., and Jardine F.M. (eds) (2001), Building response to tunnelling, case studies from construction of the Jubilee Line Extension London, CIRIA Special Publication 200

**Table 13: Allowable bearing capacity.**

| Foundation Type | Plan Dimensions (mxm) | Embedment into bearing stratum | Bearing Stratum                          | Allowable bearing capacity (kPa) (FoS=3) |
|-----------------|-----------------------|--------------------------------|------------------------------------------|------------------------------------------|
| Pad             | 1mx1m                 | 0m                             | Undifferentiated Thames Terrace Deposits | 60                                       |
|                 |                       | 1m                             |                                          | 260                                      |
|                 | 2mx2m                 | 0m                             |                                          | 125                                      |
|                 |                       | 1m                             |                                          | 320                                      |
| Strip           | 0.6mx4m               | 0m                             |                                          | 50                                       |
|                 |                       | 1m                             |                                          | 185                                      |

- a. The embedment depth used in the calculation conservatively ignores any contribution from the variable Made Ground.

## 11.4 Floor Slabs and Pavements

It is anticipated that floor slabs or new hardstanding will be founded on Made Ground or Thames Terrace Deposits. Based on the known shallow ground conditions, a design California Bearing Ratio (CBR) value of <2.5% is recommended for pavement and roadway design.

All materials within 450mm of the road surface should be non-frost susceptible. The final design values should be determined once a source of fill material is known and verified prior to and during construction. The design subgrade CBR values should be based upon the guidance presented within CD225<sup>43</sup>.

During construction, it is recommended that the sub-grade formation layer be proof rolled prior to placement of the first layer of engineered fill material with any soft spots or loose deleterious area identified during the proof roll removed and replaced with engineered fill. Any soft and/or compressible deposits identified in areas of proposed fill should be excavated and removed prior to the placement of engineered fill. It is recommended that a suitably qualified engineer inspects formation prior to the commencement of any backfill works.

## 11.5 Excavations

A shallow groundwater level of ~0.5mbgl was encountered during the monitoring. This is above the depth of the proposed excavations. Groundwater control is likely to be required which can likely be achieved by adopting a sump pumping system around the perimeter of shallow excavations as well as appropriate temporary supports such as trench boxes / trench sheets.

Excavations should be suitably shored or otherwise supported or battered and should be inspected regularly by a competent person. No operatives should enter un-shored or otherwise unprotected

<sup>43</sup> CD 225 *Design for new pavement foundations* (2020)

excavations identified as unstable by a competent person, however shallow they are, in accordance with the guidelines presented in CIRIA Report 97<sup>44</sup>.

## 11.6 Buried Concrete

Design sulphate (DS) and Aggressive Chemical Environment for Concrete (ACEC) classes for each stratum are summarised in Table 14, based on the results of the sulphate and pH testing.

**Table 14: Design sulphate summary.**

| Stratum                 | WSS DS Class | WSS ACEC Class | TPS DS Class | TPS ACEC Class |
|-------------------------|--------------|----------------|--------------|----------------|
| Made Ground             | DS-1         | AC-1           | N/A          | N/A            |
| Thames Terrace Deposits | DS-1         | AC-1           | N/A          | N/A            |
| London Clay             | DS-1         | AC-1s          | DS-3         | AC-2S          |

For shallow foundations in contact with the Made Ground and Thames Terrace Deposits it is recommended that concrete is designed to DS-1 and AC-1.

For shallow foundations or a raft foundation additionally in contact with the London Clay Formation it is recommended that concrete is designed to DS-3 and AC-2s.

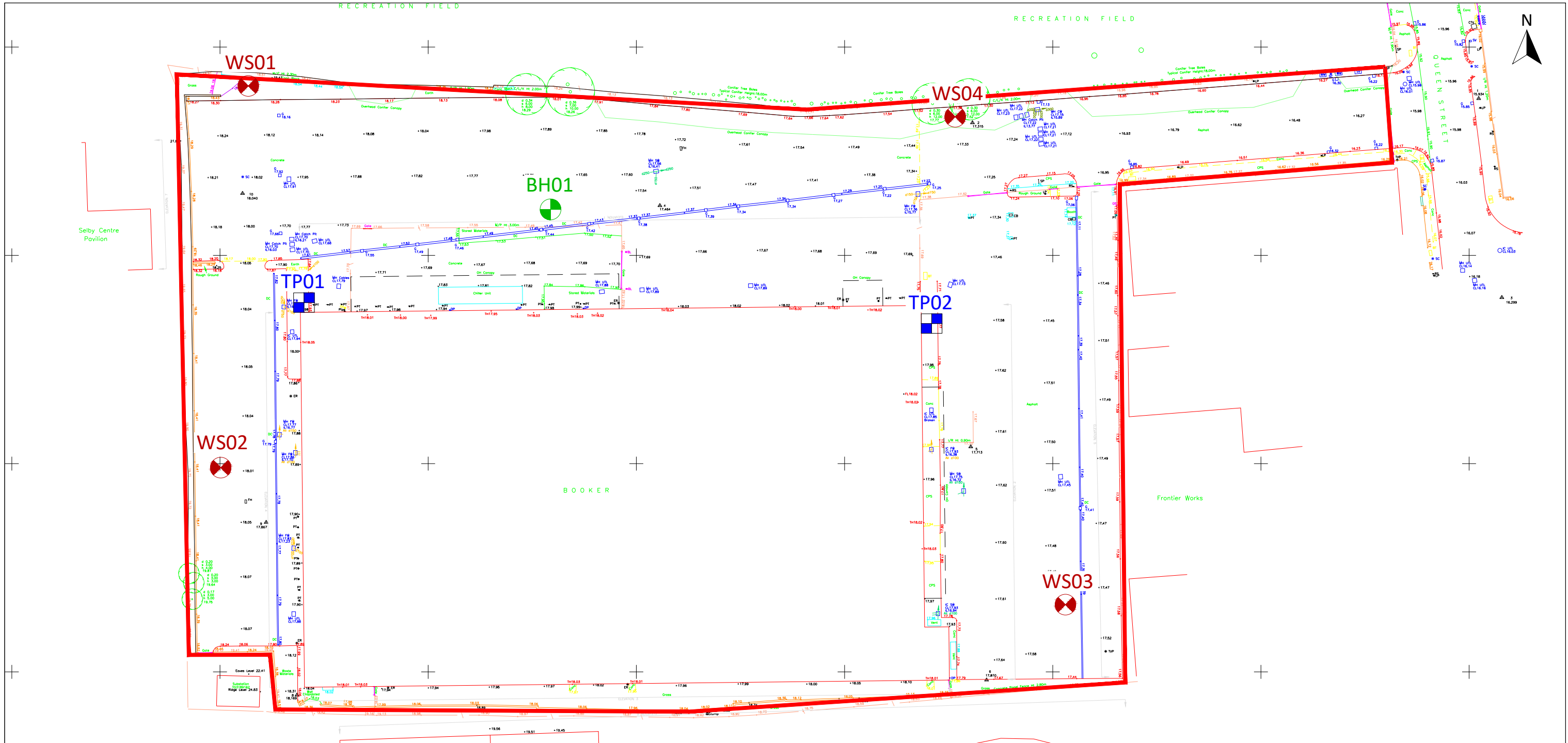
## 11.7 Buried Infrastructure

It is recommended that the impact of the proposed development on the UKPN substation and gas main is assessed by a ground movement analysis and impact assessment. Vibration restriction close to and monitoring of these assets may be required during construction.

---

<sup>44</sup> CIRIA (1992). Trenching Practice (Second Edition). Construction Industry Research and Information Association Report 97.

## FIGURES



KEY



Window sampler borehole



Cable percussion borehole



Trial pit



Site boundary

Notes:

1) Topographical survey taken from drawing "Booker Tottenham. Unit 39 Queen Street, London, N17 8HZ" (drawing no. L10866/1 revision 0).

2) Do not scale from this drawing.

|                                                                                                                                                                                                                                                                                                                               |                                |             |               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|-------------|---------------|
| 0                                                                                                                                                                                                                                                                                                                             | 21/03/2024                     | First Issue |               |
| Rev                                                                                                                                                                                                                                                                                                                           | Date                           | Comments    |               |
| <div><div><div><div><div>GEOTECHNICAL &amp; GEOENVIRONMENTAL CONSULTANCY</div><div>A PREHNA GROUP COMPANY</div></div><div>Card Geotechnics Ltd<br/>12 Melcombe Place<br/>London<br/>NW1 6JJ<br/>T: 020 3096 7567</div></div></div></div> |                                |             |               |
| Project                                                                                                                                                                                                                                                                                                                       | Queen Street, Tottenham        |             |               |
| Client                                                                                                                                                                                                                                                                                                                        | Verity Trustees Ltd            |             |               |
| Drawing title                                                                                                                                                                                                                                                                                                                 | Exploratory Hole Location Plan |             |               |
| Scale(s)                                                                                                                                                                                                                                                                                                                      | NTS                            | Job No.     | CGL/10175     |
| Drawn                                                                                                                                                                                                                                                                                                                         | MEM                            | 15/03/2024  | Dwg No.       |
| Checked                                                                                                                                                                                                                                                                                                                       | JB/JW                          | 20/03/2024  | CGL/10175-001 |
| Approved                                                                                                                                                                                                                                                                                                                      | MPC                            | 21/03/2024  | Rev.          |
|                                                                                                                                                                                                                                                                                                                               |                                |             | 0             |
| <div>© This drawing is the copyright of Card Geotechnics Limited. It may not be reproduced or amended without the written approval of Card Geotechnics</div>                                                                                                                                                                  |                                |             |               |

West

East

Site

Clean cover system required to afford protection to future site users from presence of asbestos. Hardstanding and buildings provide a barrier to future site users across the rest of the site.

Groundwater monitoring visits recommended during summer to constrain potential for groundwater level to drop and to confirm characteristic situation of the site.

Personal Protective Equipment (PPE) and appropriate site practises recommended to mitigate risks to construction workers to afford protection to construction workers from asbestos.

Low risk to controlled waters based on limited contaminant concentrations recorded within groundwater.

Proposed two storey warehouses

Likely to be founded on shallow foundations bearing on to the Undifferentiated Thames Terrace Deposits

Made Ground

Undifferentiated Thames Terrace Deposits

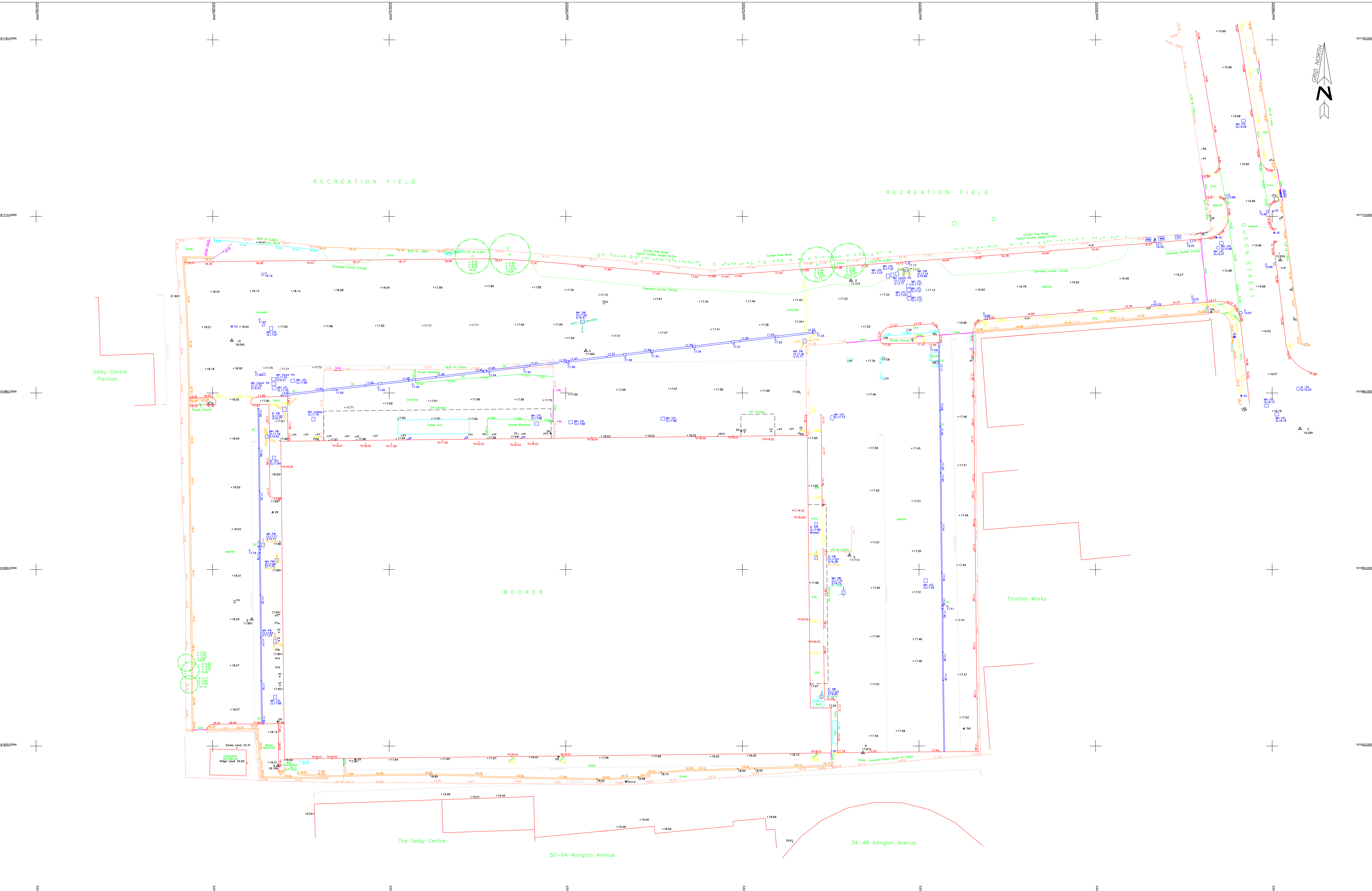
London Clay Formation

Lambeth Group

|                                                                                     |                     |                                      |                         |              |           |
|-------------------------------------------------------------------------------------|---------------------|--------------------------------------|-------------------------|--------------|-----------|
| Client                                                                              | Verity Trustees Ltd | Project                              | Queen Street, Tottenham | Job No       | CGL/10175 |
|  | Title               | Conceptual Site Model (Not to Scale) |                         | Figure 2     |           |
|                                                                                     |                     |                                      |                         | Drafted by:  | MEM       |
|                                                                                     |                     |                                      |                         | Checked by:  | JSB / JW  |
|                                                                                     |                     |                                      |                         | Approved by: | MPC       |

# APPENDIX A

*Topographical Survey*



## **APPENDIX B**

*Proposed Development Plans*

Figured dimensions only are to be used. All dimensions to be checked onsite. Differences between drawings and between drawings and specification or bills of quantities to be reported to the PRC Group.

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Revisions: Drawn/Chkd: Date:

Client:  
VERITY TRUSTEES LTD

Project:  
BOOKER TOTTENHAM

Drawing Title:  
PROPOSED SITE LAYOUT

Scale @ A2: 1:500  
Checked by: ME  
Date: MAR 24

Job No: 11472  
Stage: PL 002  
Drawing No: \*  
Rev:

Issue Status:  
Construction ☐ Preliminary ☐  
Information ☐ Approval ☐  
Tender ☐  
Offices:  
Woking  
London  
Milton Keynes  
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PRC Architecture & Planning



12 Warren Yard,  
Warren Park,  
Milton Keynes,  
MK12 5NW  
01908 305 246  
info@prc-group.com  
www.prc-group.com



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|                     |       |       |       |                |               |     |       |             |
|---------------------|-------|-------|-------|----------------|---------------|-----|-------|-------------|
| SITE AREA           |       |       |       |                |               |     |       |             |
| 3.06 acres          |       |       |       |                |               |     |       |             |
| SITE COVERAGE       |       |       |       |                |               |     |       |             |
| 58% (SITE AREA/GIA) |       |       |       |                |               |     |       |             |
| GEA                 | UNIT  | GF M² | FF M² | TOTAL M² / FT² | TOTAL GIA FT² | FF% | CIH M | CAR PARKING |
| 1.                  | 1,217 | 243   | 1,460 | 15,715         | 14,886        | 20  | 8.5   | 5           |
| 2.                  | 2,124 | 423   | 2,547 | 27,415         | 26,500        | 20  | 8.5   | 9           |
| 3.                  | 2,412 | 839   | 3,251 | 34,993         | 33,486        | 34  | 10    | 13          |
| TOTAL               |       |       | 7,258 | 78,123         | 74,872        |     |       |             |

NOTES:

FLEXIBLE USE CLASSES E(g)(iii), B2 & B8, CAR PARKING PROVIDED AT 1 PER 250², HAUNCH HEIGHT BASED ON DAYLIGHTING OF 25° 1.5M ABOVE GROUND LEVEL ON RESIDENTIAL PROPERTIES TO THE SOUTH.

FIRST FLOOR OFFICES EXTEND OVER LOADING DOORS.

6 ELECTRIC CAR CHARGING SPACES

CYCLE PARKING 10 SHORT STAY NEEDED FOR VISITORS (1 STAND TO UNITS 2, 2 STANDS UNIT 1 & 3)

|     |                                                         |
|-----|---------------------------------------------------------|
| KEY |                                                         |
|     | SITE BOUNDARY                                           |
|     | EXISTING BUILDINGS TO BE DEMOLISHED                     |
|     | BROXAP APOLLO CYCLE SHELTER, SHEFFIELD CYCLE HOOPS      |
|     | BOLLARDS                                                |
|     | ELECTRIC VEHICLE CHARGING POINT (TWO VEHICLES PER POST) |
|     | PROPOSED BUILDINGS                                      |
|     | BLOCK PAVING (VEHICULAR AREAS) CHARCOAL                 |
|     | BLOCK PAVING (PEDESTRIAN AREAS) NATURAL                 |

|  |                                            |
|--|--------------------------------------------|
|  | BRUSHED CONCRETE SERVICE YARD              |
|  | TARMACADAM SURFACING                       |
|  | WELL CONSOLIDATED GRAVEL WITH FINES        |
|  | SOFT LANDSCAPING                           |
|  | GRASSCRETE                                 |
|  | TREES TO BE RETAINED                       |
|  | PROPOSED TREES                             |
|  | 2.4M HIGH WELDMESH FENCE WITH ACCESS GATES |
|  | AMENITY AREAS                              |
|  | CAR SHARE SPACE                            |
|  | PROPOSED SUBSTATION AND SWITCH ROOM        |

|  |                        |
|--|------------------------|
|  | BIRD BOXES             |
|  | BAT BOXES              |
|  | LONG STAY CYCLE SPACE  |
|  | SHORT STAY CYCLE SPACE |
|  | ELECTRIC CYCLE CHARGER |



## **APPENDIX C**

### *Historical Maps*

#### Site Details:

533261 , 191644

**Client Ref:** POP015370  
**Report Ref:** GS-MKV-SNK-9PB-1C3  
**Grid Ref:** 533261, 191660

**Map Name:** County Series

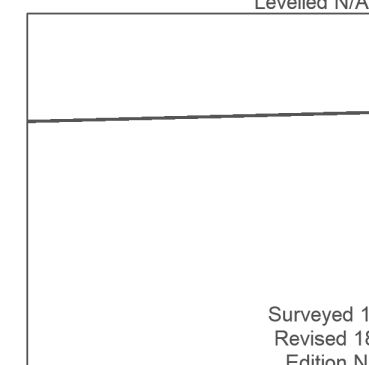
**Map date:** 1864-1867

**Scale:** 1:2,500

**Printed at:** 1:2,500



Surveyed 1867  
 Revised 1867  
 Edition N/A  
 Copyright N/A  
 Levelled N/A



Surveyed 1864  
 Revised 1864  
 Edition N/A  
 Copyright N/A  
 Levelled N/A

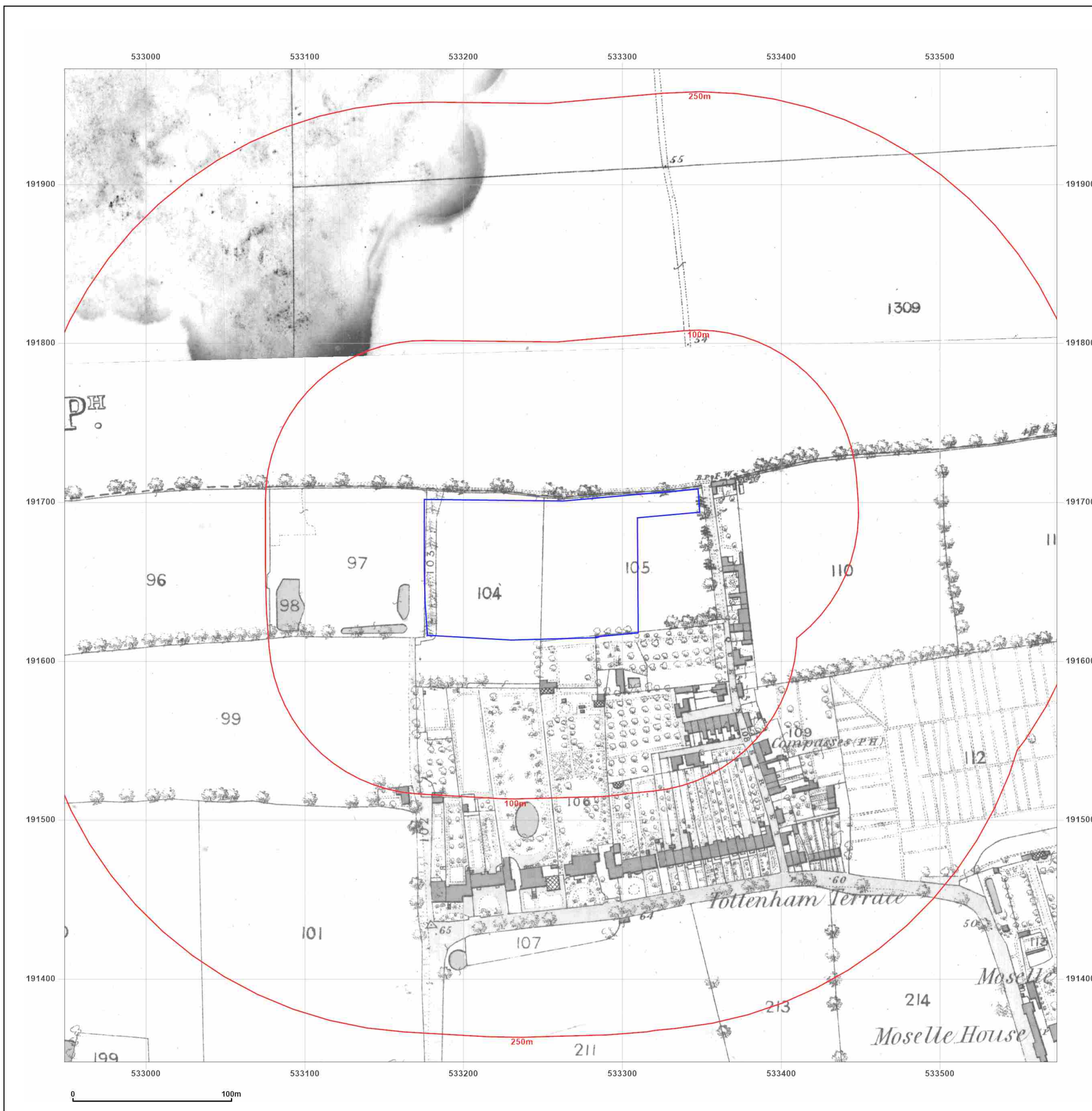


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533261 , 191644

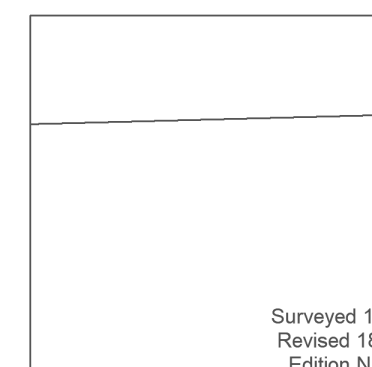
**Client Ref:** POP015370  
**Report Ref:** GS-MKV-SNK-9PB-1C3  
**Grid Ref:** 533261, 191660

**Map Name:** County Series

**Map date:** 1867

**Scale:** 1:2,500

**Printed at:** 1:2,500



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 Revised 1867  
 Edition N/A  
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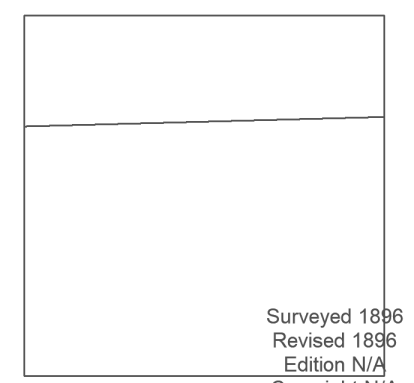
**Client Ref:** POP015370  
**Report Ref:** GS-MKV-SNK-9PB-1C3  
**Grid Ref:** 533261, 191660

**Map Name:** County Series

**Map date:** 1873

**Scale:** 1:2,500

**Printed at:** 1:2,500



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

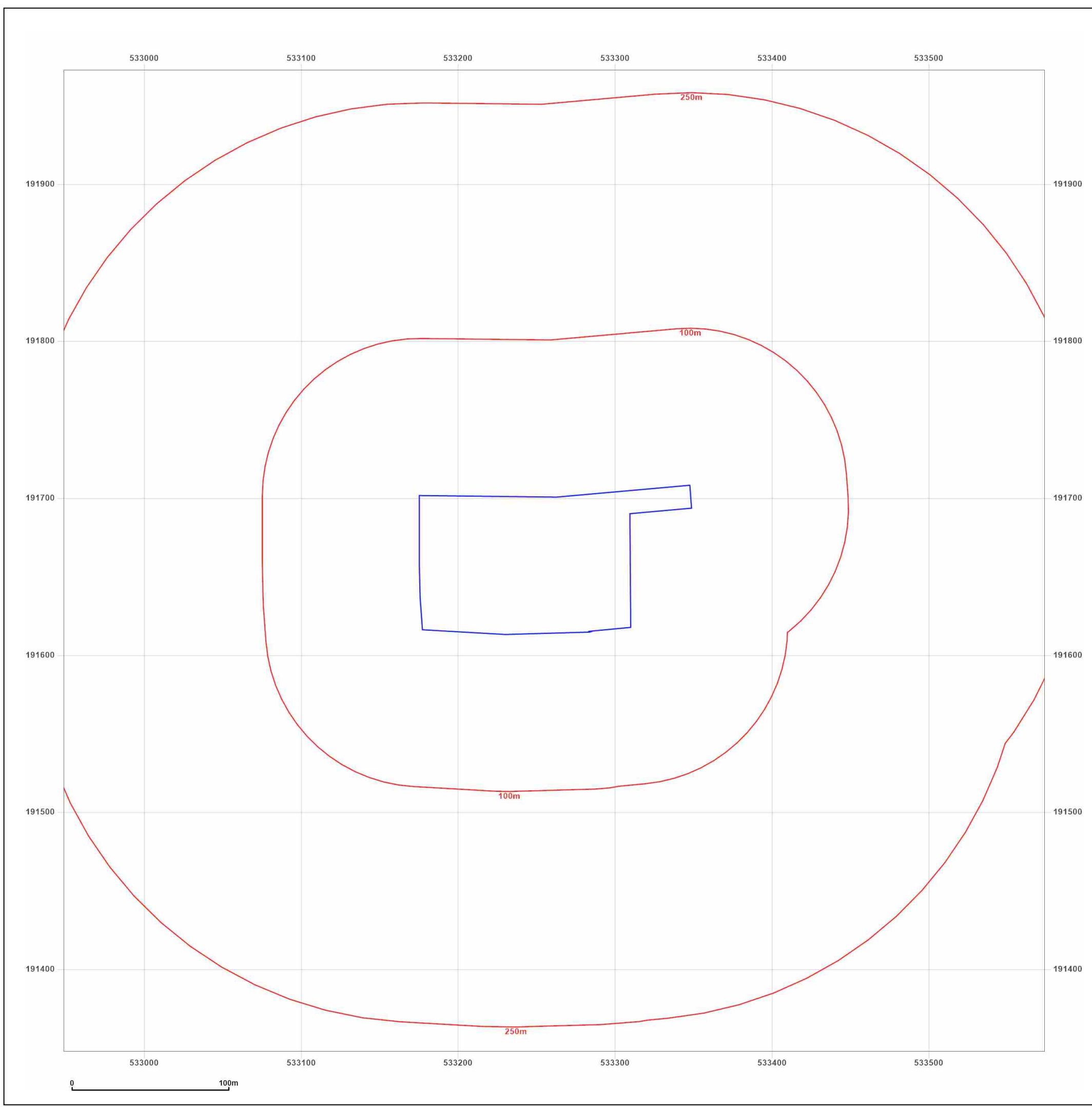


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**Client Ref:** POP015370  
**Report Ref:** GS-MKV-SNK-9PB-1C3  
**Grid Ref:** 533261, 191660

**Map Name:** 1056 Scale Town Plan

**Map date:** 1896

**Scale:** 1:1,056

**Printed at:** 1:1,056



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Surveyed 1894  
 Revised N/A  
 Edition 1896  
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 Levelled N/A

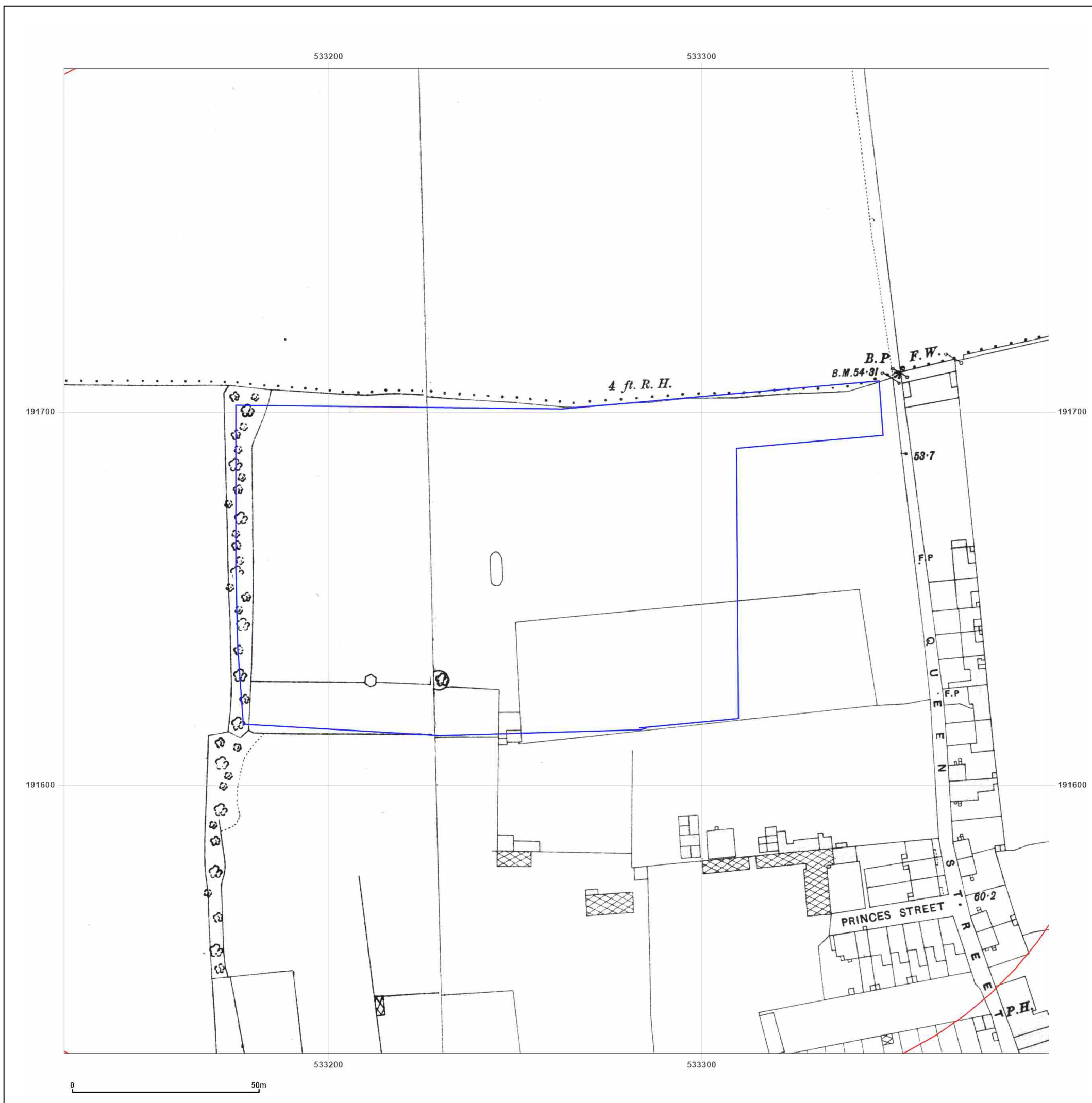


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**Report Ref:** GS-MKV-SNK-9PB-1C3  
**Grid Ref:** 533261, 191660

**Map Name:** County Series

**Map date:** 1896

**Scale:** 1:2,500

**Printed at:** 1:2,500



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

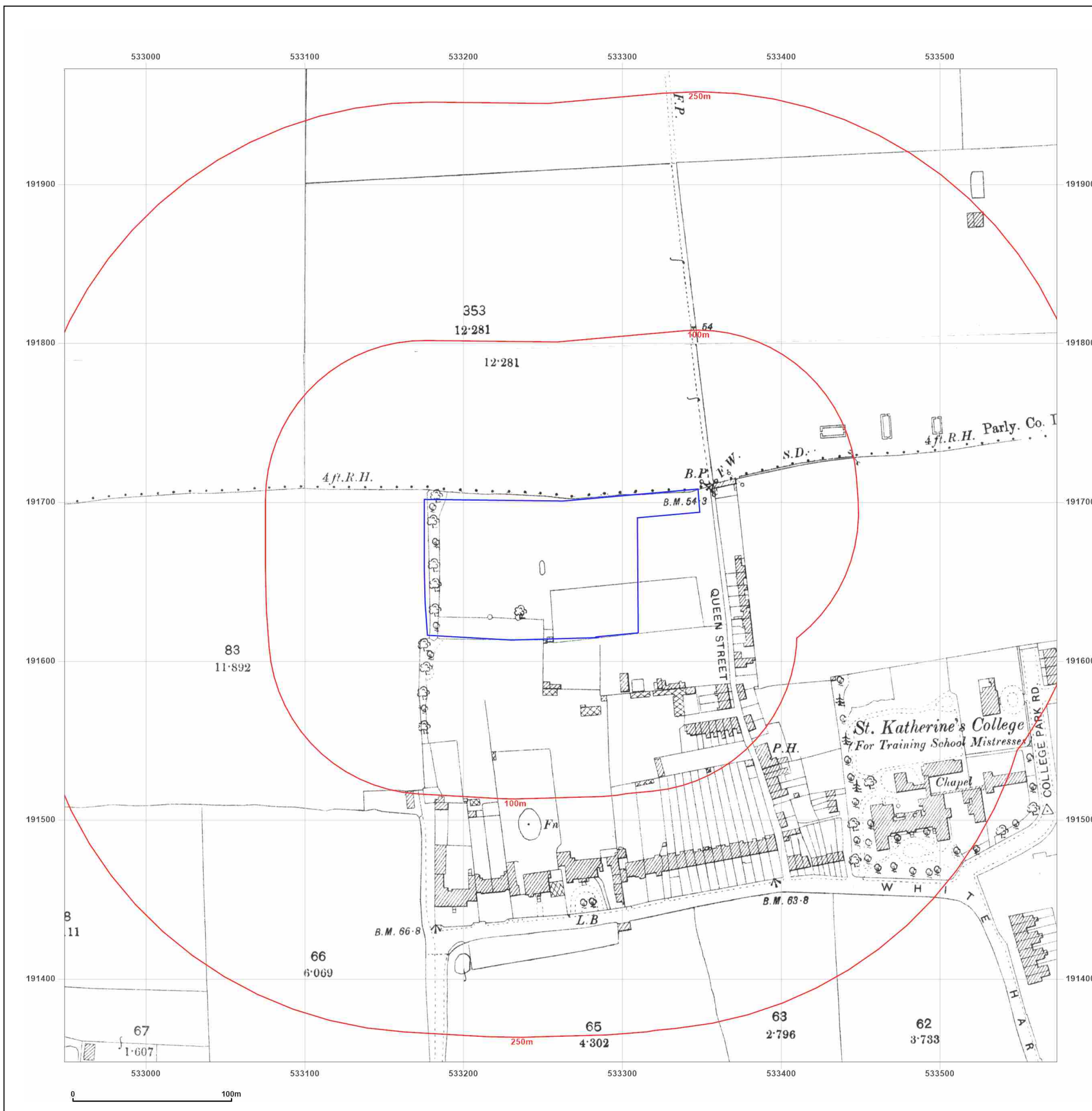


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#### Site Details:

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**Client Ref:** POP015370  
**Report Ref:** GS-MKV-SNK-9PB-1C3  
**Grid Ref:** 533261, 191660

**Map Name:** County Series

**Map date:** 1913-1914

**Scale:** 1:2,500

**Printed at:** 1:2,500



Surveyed 1914  
 Revised 1914  
 Edition N/A  
 Copyright N/A  
 Levelled N/A

Surveyed 1913  
 Revised 1913  
 Edition N/A  
 Copyright N/A  
 Levelled N/A

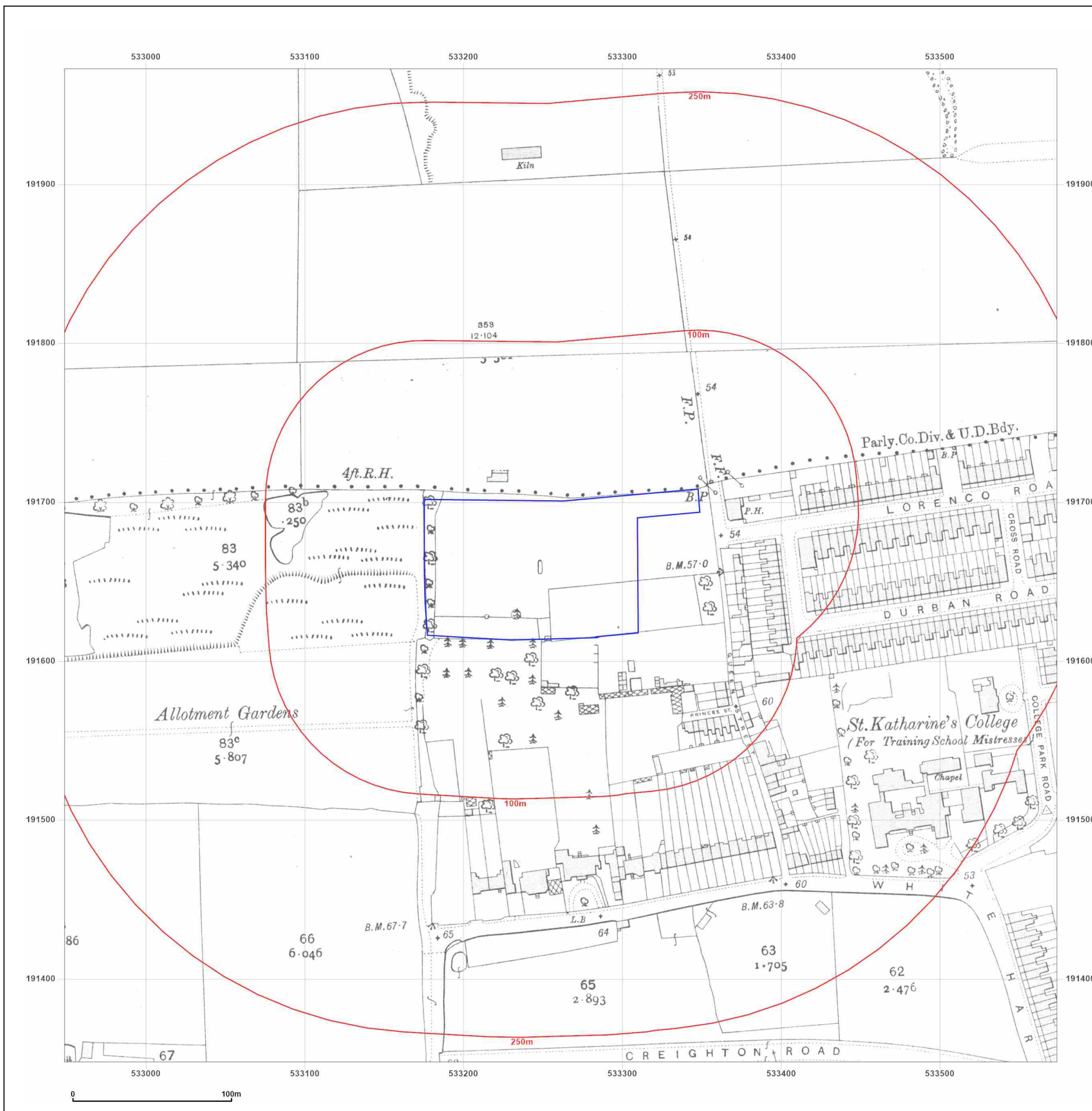


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#### Site Details:

533261, 191644

**Client Ref:** POP015370  
**Report Ref:** GS-MKV-SNK-9PB-1C3  
**Grid Ref:** 533261, 191660

**Map Name:** County Series

**Map date:** 1935-1936

**Scale:** 1:2,500

**Printed at:** 1:2,500



Surveyed 1936  
 Revised 1936  
 Edition N/A  
 Copyright N/A  
 Levelled N/A

Surveyed 1935  
 Revised 1935  
 Edition N/A  
 Copyright N/A  
 Levelled N/A

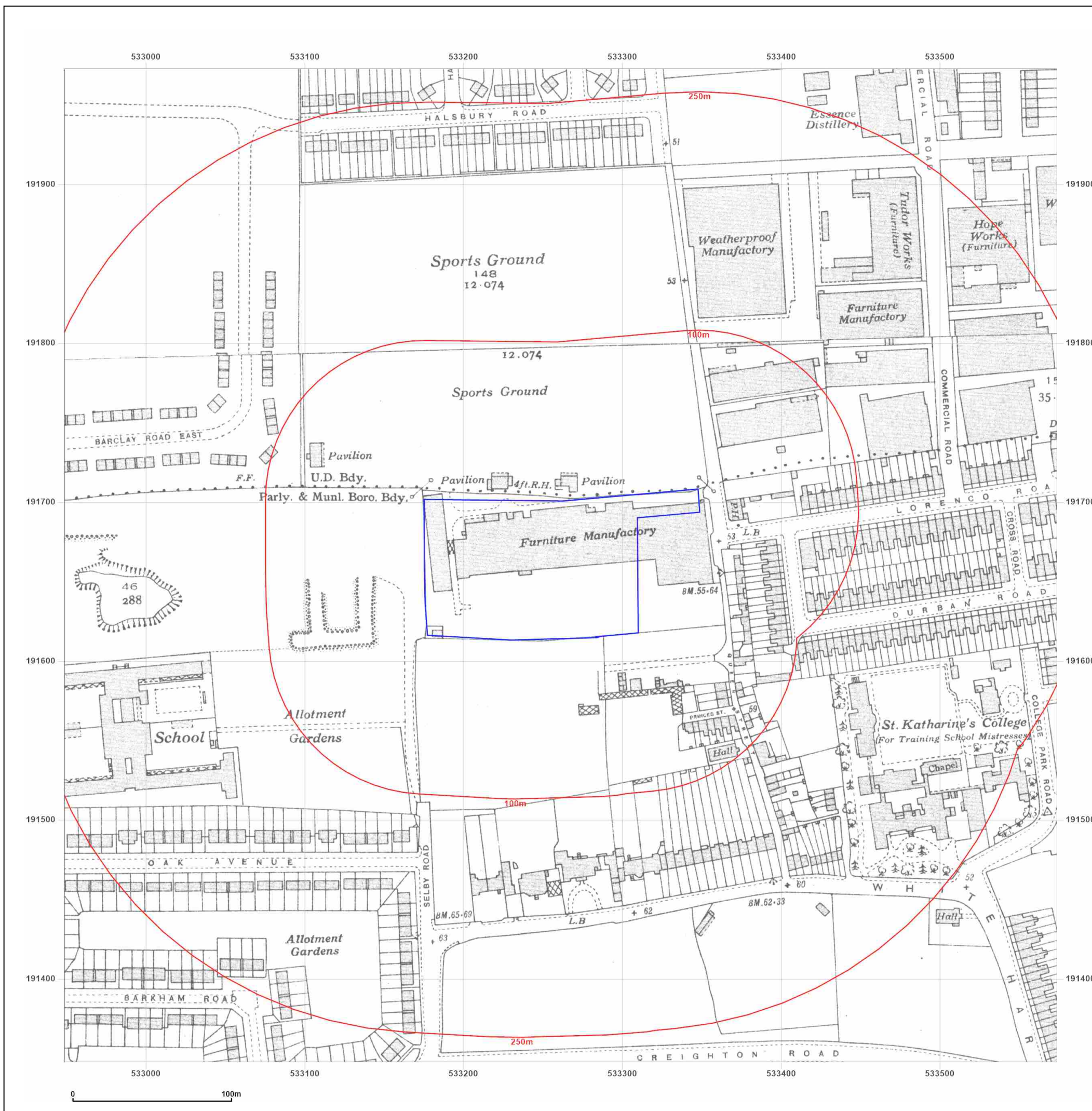


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#### Site Details:

533261 , 191644

**Client Ref:** POP015370  
**Report Ref:** GS-MKV-SNK-9PB-1C3  
**Grid Ref:** 533261, 191660

**Map Name:** County Series

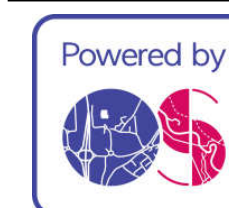
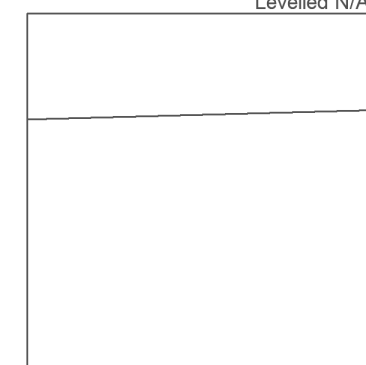
**Map date:** 1938

**Scale:** 1:2,500

**Printed at:** 1:2,500



Surveyed 1938  
 Revised 1938  
 Edition N/A  
 Copyright N/A  
 Levelled N/A

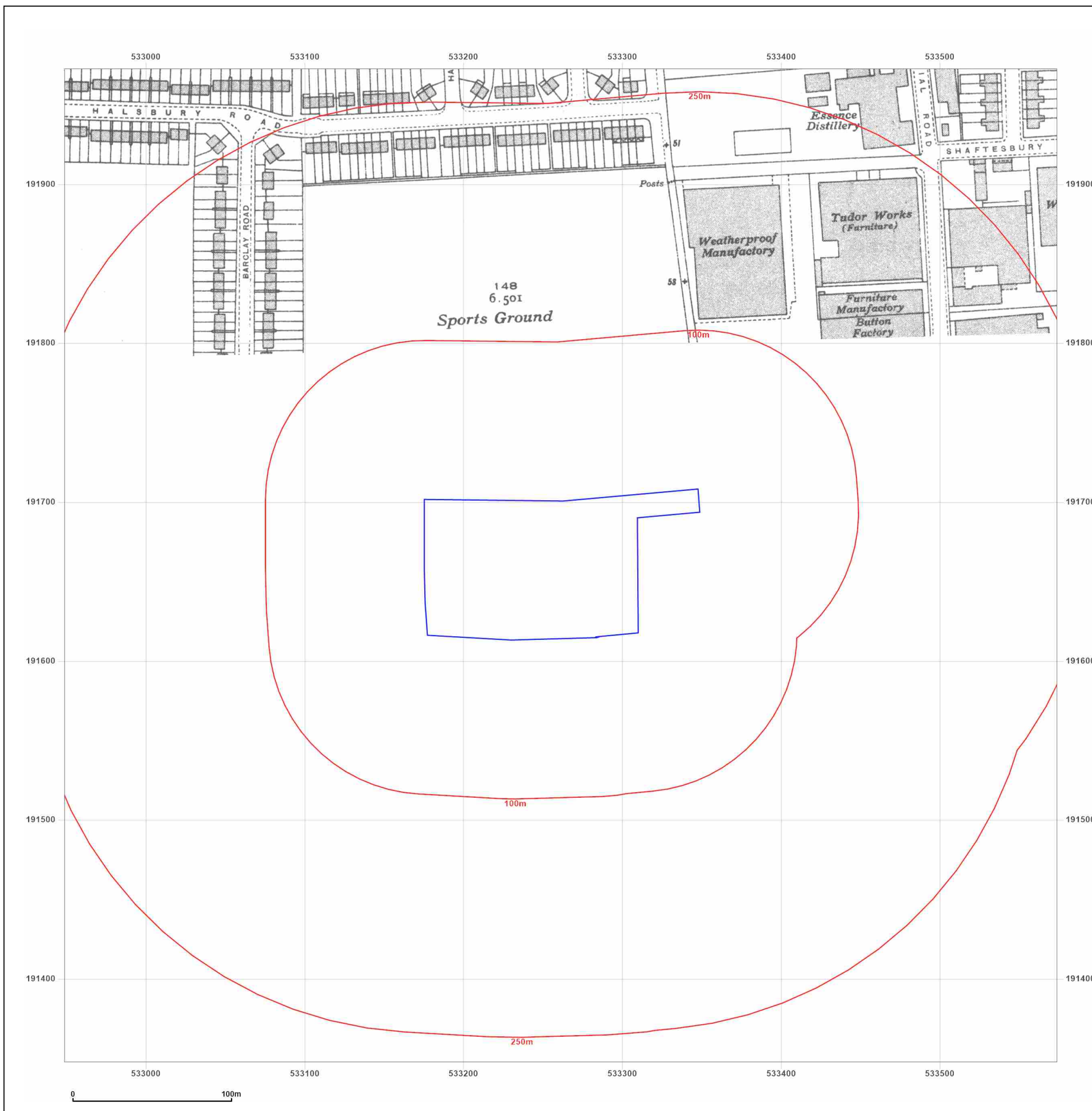


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#### Site Details:

533261 , 191644

**Client Ref:** POP015370  
**Report Ref:** GS-MKV-SNK-9PB-1C3  
**Grid Ref:** 533261, 191660

**Map Name:** National Grid

**Map date:** 1955

**Scale:** 1:1,250

**Printed at:** 1:2,000



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

Surveyed 1955  
 Revised 1955  
 Edition N/A  
 Copyright N/A  
 Levelled 1954

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

Surveyed 1955  
 Revised 1955  
 Edition N/A  
 Copyright N/A  
 Levelled 1954

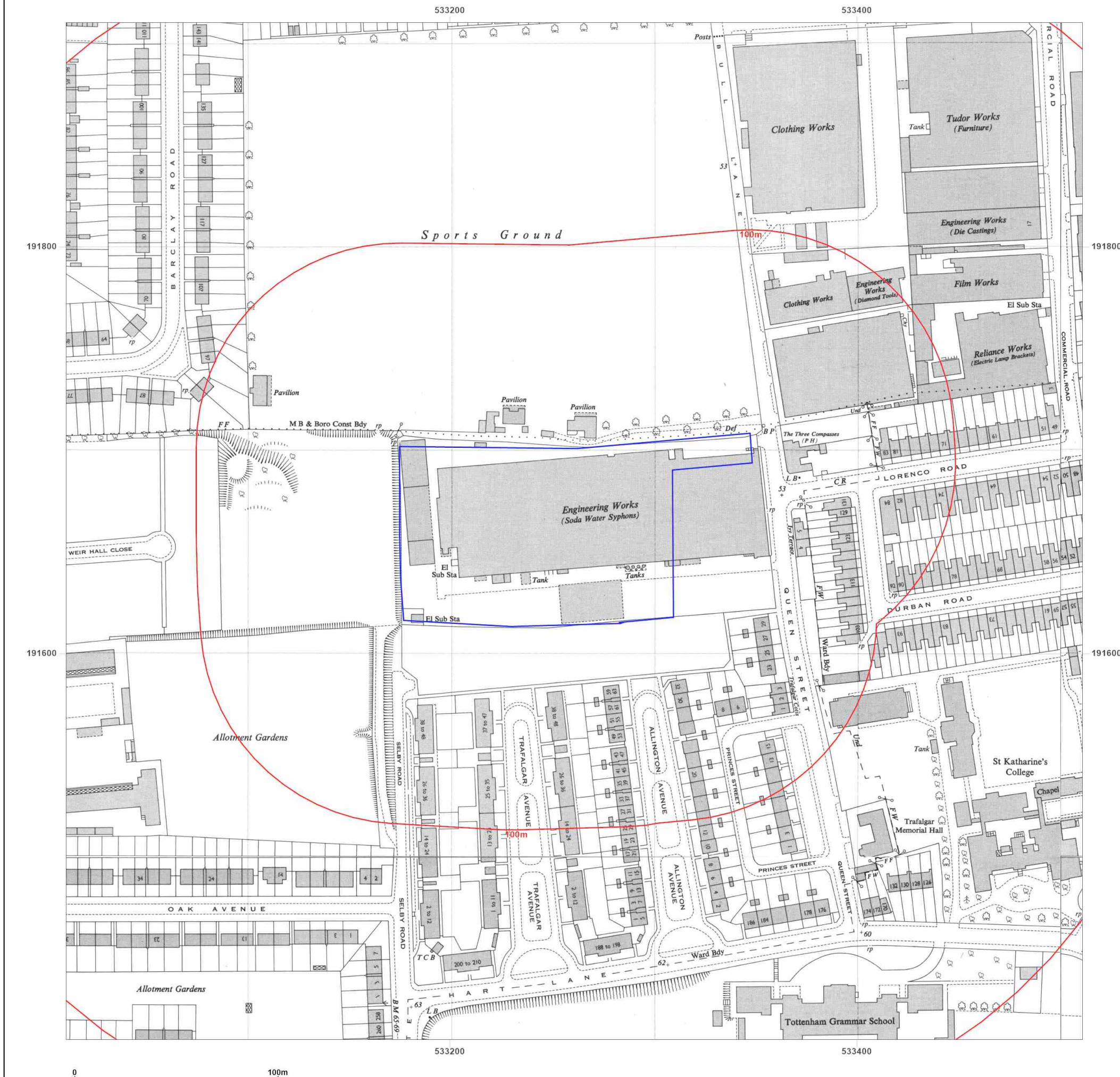


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#### Site Details:

533261, 191644

**Client Ref:** POP015370  
**Report Ref:** GS-MKV-SNK-9PB-1C3  
**Grid Ref:** 533261, 191660

**Map Name:** National Grid

**Map date:** 1955

**Scale:** 1:2,500

**Printed at:** 1:2,500



Surveyed 1955  
 Revised 1955  
 Edition 1957  
 Copyright N/A  
 Levelled 1933

Surveyed 1955  
 Revised 1955  
 Edition 1956  
 Copyright N/A  
 Levelled 1954

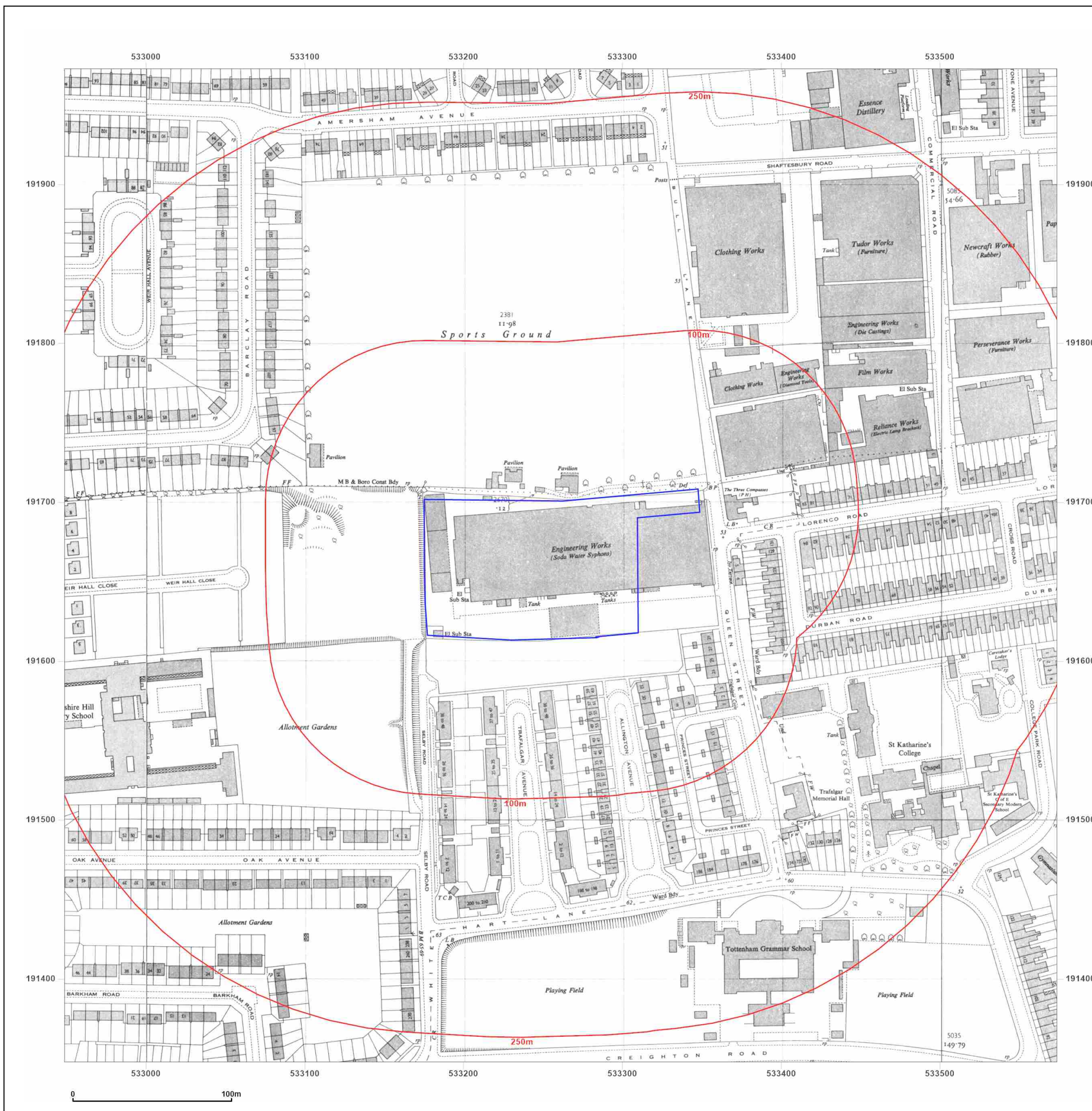


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#### Site Details:

533261, 191644

Client Ref: POP015370  
Report Ref: GS-MKV-SNK-9PB-1C3  
Grid Ref: 533261, 191660

Map Name: National Grid

Map date: 1956

Scale: 1:1,250

Printed at: 1:2,000



Surveyed N/A  
Revised N/A  
Edition N/A  
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Surveyed 1955  
Revised N/A  
Edition 1956  
Copyright N/A  
Levelled 1954

Surveyed 1955  
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Edition 1956  
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#### Site Details:

533261 , 191644

**Client Ref:** POP015370  
**Report Ref:** GS-MKV-SNK-9PB-1C3  
**Grid Ref:** 533261, 191660

**Map Name:** National Grid

**Map date:** 1964-1967

**Scale:** 1:1,250

**Printed at:** 1:2,000



Surveyed 1955  
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 Edition N/A  
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 Levelled 1956

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 Revised 1963  
 Edition N/A  
 Copyright 1964  
 Levelled 1957

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 Revised 1963  
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 Copyright 1964  
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