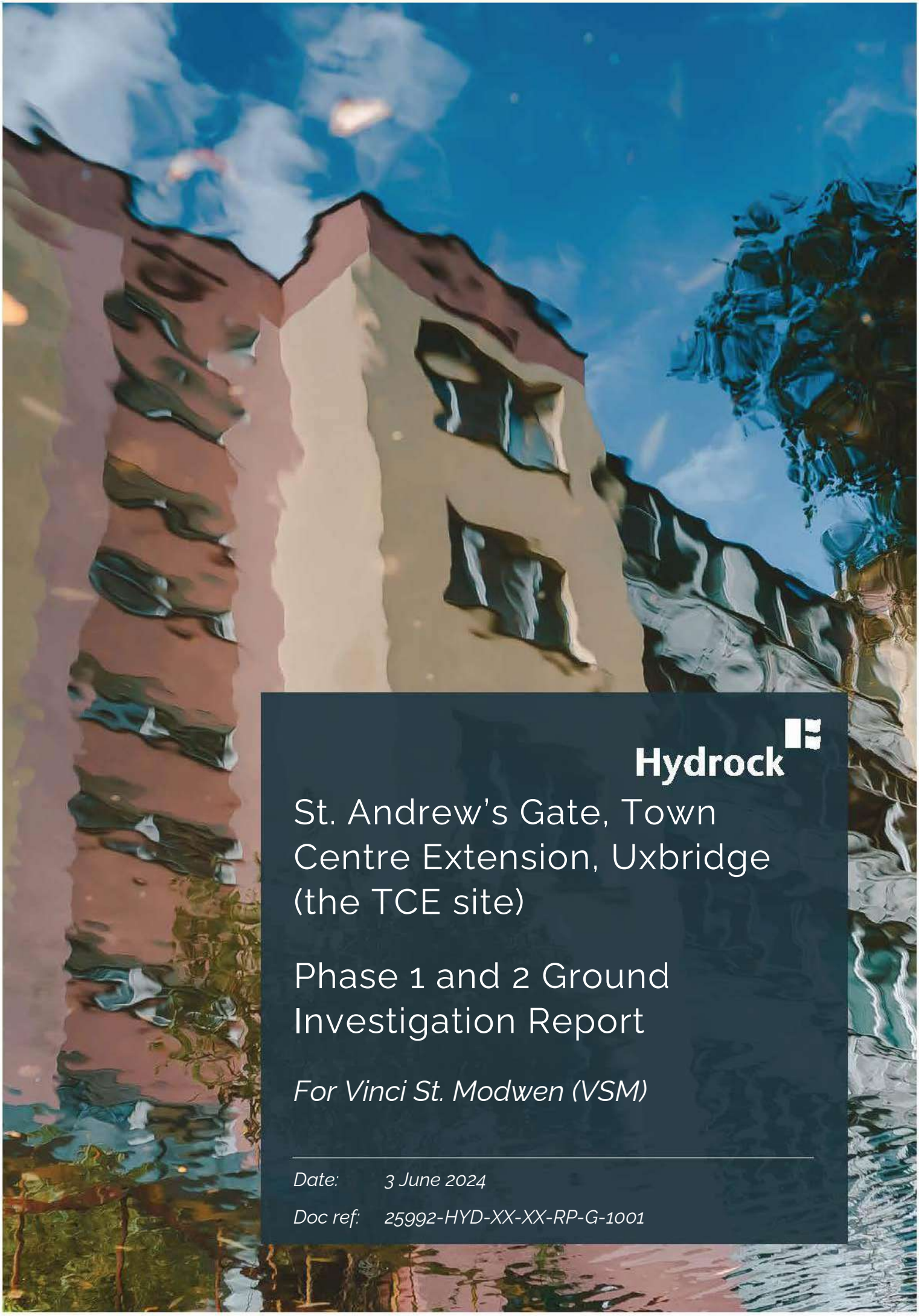
St. Andrew's Gate, Town Centre Extension, Uxbridge
Hybrid Planning Application

Contamination: Phase 1 and 2 Ground Investigation Report

ST. ANDREW'S PARK
UXBRIDGE

VINCI PLC | ST. MODWEN



Hydrock

St. Andrew's Gate, Town Centre Extension, Uxbridge (the TCE site)

Phase 1 and 2 Ground Investigation Report

For Vinci St. Modwen (VSM)

Date: *3 June 2024*

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Issued by	Hydrock Consultants Limited 5-7 Tanner Street London SE1 3LE United Kingdom	T +44 (0)203 8468456 E london@hydrock.com hydrock.com
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Prepared by		Kurt Gilmore BSc FGS
Checked by		Simon Calkin BEng MSc and Wayne Lewis BSc FGS
Approved by		Adam Linnell MSci CSci FGS

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Objectives	The works have been commissioned to support the planning application and to assist with the design of the development.
Client	VSM (Uxbridge)
Site name and location	St. Andrew's Gate, Town Centre Extension, Uxbridge (the TCE site).
Proposed development	Hydrock understands that the proposed development is to comprise •Creation of up to no. 356 residential dwellings (Class C3) within three new build blocks, of up to 10 storeys; with up to 1,100sqm GIA of flexible commercial space (Use Classes E(a), E(b), E(c), E(e), E(g)(i) and E(g)(ii)) at ground floor level, which will include a convenience store of up to 440sqm (GIA) located in Building Zone C and other flexible commercial floorspace at ground floor level in Building Zones B and C (outline application). Change of use of the former cinema building for a gym (E(d)) and café (E(b)); is proposed in the full application.
Site description	The site is irregular in shape and has an area of approximately 1.80Ha. The site is contained within the wider St Andrew's Park development area and is bounded by Hillingdon Road to the west, Burton Road to the south and the wider development to the east.
Desk study summary	
Topography	The site gently slopes from roughly 45m OD in the south to 49m OD in the North.
Hydrology	The River Pinn is located 196m to the east.
Site History	The site was previously part of the RAF Uxbridge Station from 1938 – 2010 when many of the site structures were demolished.
Geology	Made Ground is present across the site associated with historic construction and demolition activities. The Black Park Gravel Member is present sporadically across the site underlying the Made Ground and has both granular and cohesive components. A large degree of mixing has occurred between this strata and the overlying Made Ground. The London Clay Formation is present across the site to depths of approximately 20m bgl comprising grey silty clay with local lenses of sand in places. The top of this unit shows evidence of natural mixing with the overlying Black Park Gravel Formation where this is present. The Lambeth Group was encountered underlying the London Clay at depths >20m bgl. The base of the Lambeth group was not proven.
Natural geological hazards	» »Soft / loose compressible ground (low strength and high settlement potential). » Shrinkage / swelling of the clay fraction of soils under the influence of vegetation.

	» Variable lateral and vertical changes in ground conditions. » Attack of buried concrete by aggressive ground conditions. » Earthworks – unsuitability of site won material to be reused as fill.
Anthropomorphic geotechnical hazards	» Uncontrolled Made Ground (variable strength and compressibility) » Loose Made Ground, leading to difficulty with excavation and collapse of side walls. » Obstructions. » Existing below ground structures to remain.
Hydrogeology	The Black Park Gravels are designated as a Secondary (A) Aquifer. The London Clay Formation is considered to be an unproductive stratum.
UXO risk	A specialist UXO assessment indicates a low bomb risk at the site.
Preliminary conceptual site model based on desk study	
Potential contaminant sources	Made Ground, associated with historical construction activities and imported fill, possibly including elevated concentrations of metals, metalloids, asbestos fibres, Asbestos Containing Materials, PAH and petroleum hydrocarbons (S01). Ground gases (carbon dioxide and methane) from organic materials in the Made Ground / Black Park Gravel Formation (S02).
Potential contaminant linkages (for receptors for which there is or will be a pathway)	» Humans– residential with/without plant uptake » Controlled waters – River Pinn / groundwater in Secondary (a) Aquifer » Plant life » Buildings
Ground model proven by investigation	
Ground and groundwater conditions encountered by investigation	The ground conditions as proven by the investigation undertaken at the site comprise: » Made Ground to depths of between 0.4m and 2.5m, with an average thickness of around 1.0m. Comprises a mixture of sandy / gravelly clay, with fragments of brick, concrete, asphalt, wood and metal. » The Black Park Gravel Member was encountered underlying the Made Ground at the site, although in some locations (CP03A, TP01.) it was entirely absent. Although the boundaries are somewhat blurred; the Black Park Gravel Member is considered to be encountered to depths of between 1.55m and 3.1m, with an average thickness of 1.45m. It comprises mostly of a mixture of soft becoming firm sandy / gravelly clay and locally a clayey / sandy gravel. » The London Clay Formation was encountered underlying the Made Ground or Black Park Gravel Member across the site. The London Clay Formation is between 16.20m and 17.0m thick, with an average thickness of 16.56m. » The Lambeth Group was encountered underlying the London Clay Formation in CP02 at 20.20m bgl. The base of the Lambeth Group was not proven. Perched water was encountered in the Made Ground and Black Park Gravel Member during the post fieldwork monitoring; however, it has been noted that the site has seen heavy snow and rainfall during the monitoring period, with rainwater pooling at the site surface.

	Given the locally granular nature of some shallow soils and presence of underlying London Clay, it can be expected that localised pockets of perched water exist on site. One small seepage of groundwater was detected deep in the shelly beds of London Clay in CP02 whilst subsequent monitoring of deep installations with CP01 & 02 have detected ingress of groundwater within previously dry bore holes.
Summary of geotechnical conclusions	
Groundwork	Demolition of the former site structures has largely already taken place. Buried obstructions were encountered during this investigation associated with foundations of old buildings and there is a possibility of further such obstructions being encountered. Excavation to proposed founding depth generally should be readily achievable with standard excavation plant. Excavations during investigation were generally stable, although slight spalling should be expected from the Made Ground and within the sands and gravels below the water table. Water seepages into excavations are likely to be adequately controlled by sump pumping.
Foundations	The Made Ground is considered unsuitable in its present condition for use as founding soils on the basis of its unpredictable nature and likely deposition in an uncontrolled manner and should be fully penetrated by all new foundations or excavated, screened, processed and re-engineered to create the development platform. Unless improved in stiffness by the insertion of stone columns, the Black Park Gravel is also considered unsuitable in its present condition for use as founding soils on the basis of its low and often variable strength and should be fully penetrated by all new foundations. On the basis of the ground conditions indicated from the current and previous investigations, the foundations will likely comprise piled foundations due to the unsuitability of the shallow soils and anticipated loads from the 3-10 storey blocks. Certainly, for the higher loaded buildings. As mentioned, ground improvement with stone columns could be used to stiffen and unify the ground. In combination with re-engineered shallow fill materials and raft foundations atop, such a solution could be used to support 3 storey housing in some areas. Otherwise piled foundations should be implemented. Depending on column loads and layouts, piles should extend through the Made Ground and River Terrace Deposits and to a suitable depth into the underlying London Clay Formation.
Roads and pavements	Based on the test results and subject to in situ testing during construction, a CBR of <2.5% should be used for design.
Buried concrete	» DC-1 for the shallow soils (Made Ground and River Terrace Deposits); » DC-4 for the deeper soils (clays of the London Clay Formation); and » DC-4 for piles.

Summary of geo-environmental assessment	
Human Health	• Hotspot of PAH in the Made Ground at WS06.
Potable water supply pipes	• Brownfield site with organic contamination and barrier pipe is considered suitable for this site. However, confirmation should be sought from the water supply company at the earliest opportunity.
Ground gases or vapours:	• Low to risk from ground gases and CS1 conditions apply.
Enabling works	
Proposed mitigation measures	The mitigation measures proposed to remove unacceptable risks include: • The excavation and replacement of the PAH hotspot at Ws06. • The installation of a 450mm cover system in public open space, comprising subsoil beneath a topsoil thickness of between 150mm and 300mm (PL1). • Installation of Protectaline pipework. The methodology for the remediation should be presented in a Remediation Strategy, which will need to be submitted to the warranty provider and the regulatory authorities for approval. Verification reports by a competent independent geo-environmental specialist will be required following completion of any remedial works.
Earthworks	In order to undertake the cut to fill earthworks and use of excavated materials in earthworks a site specific Earthwork Specification will be required to allow reuse of suitable materials along with the production of a Materials Management Plan and its approval by a Qualified Person. Verification reports by competent independent geotechnical specialists will be required following completion of any earthworks.
Waste management	Excavated soils to be disposed of as waste, are likely to be classed as non-hazardous.
Future considerations	
Further work	Following the ground investigation works undertaken to date, the following further works will be required: • specialist UXO/UXB risk assessment in accordance with CIRIA Report C681 with regard to construction risk; • discussion and agreement with utility providers regarding the materials suitable for pipework; • discussions with regulatory bodies and the warranty provider regarding the conclusions of this report; • assessment of tree influence on foundations and design of foundations; • discussions with piling Contractors regarding conclusions of this report and design of the piles; • provision of geotechnical design for the Category 2 structures (earthworks, floor slabs, foundations etc.); • production of a Remediation Strategy and Verification Plan (and agreement with the regulatory bodies and the warranty provider); • production of a Materials Management Plan relating to reuse of soils at the site; • remediation and mitigation works; and • verification of the earthworks, remediation and mitigation works.

This Executive Summary forms part of Hydrock Consultants Limited report number 25992-HYD-XX-XX-RP-G-1001 and should not be used as a separate document.

1. Introduction

1.1 Terms of reference

In October 2022, Hydrock Consultants Limited (Hydrock) was commissioned by Vinci St. Modwen (VSM) (the Client) to undertake site investigation, comprising a Phase 1 desk study and Phase 2 supplementary ground investigation at St Andrew's Gate, Uxbridge. The site is located east of Hillingdon Road, Uxbridge and is a former military (RAF) station site.

Hydrock understands that the proposed development is to comprise • Creation of up to no. 356 residential dwellings (Class C3) within three new build blocks, of up to 10 storeys; with up to 1,100sqm GIA of flexible commercial space (Use Classes E(a), E(b), E(c), E(e), E(g)(i) and E(g)(ii)) at ground floor level, which will include a convenience store of up to 440sqm (GIA) located in Building Zone C and other flexible commercial floorspace at ground floor level in Building Zones B and C (outline application).

Change of use of the former cinema building for a gym (E(d)) and café (E(b)); is proposed in the full application.

The investigation works have been undertaken in accordance with Hydrock's proposal referenced (St Andrew's Gate-FP-GE-0001 and August 2022) and the Client's instructions to proceed (Ref PO number 129812).

1.2 Objectives

The works have been commissioned to support the planning application and to assist with the design of the development.

The objectives of the Phase 1 Desk Study are to formulate a preliminary Ground Model and an Initial Conceptual Site Model of the site to identify and make a preliminary assessment of any potential geo-environmental and geotechnical risks to the proposed development.

The objectives of the Phase 2 Ground Investigation are:

- to resolve any geotechnical and geo-environmental uncertainties identified in the Phase 1 Desk Study by refining and updating the preliminary Ground Model, based on the conditions met in accordance with the principles of Environment Agency (EA) 'Land Contamination: Risk Management' (LCRM) (2020);
- to identify any geo-environmental mitigation requirements to enable development to progress; and
- to provide preliminary geotechnical recommendations for design.

1.3 Scope

The site investigation includes a Phase 1 Desk Study and a Phase 2 Ground Investigation.

The scope of the Phase 1 Desk Study comprises:

- a field reconnaissance (walkover) to determine the nature of the site and its surroundings including current and former land uses, topography and hydrology;
- acquisition and review of:
  - historical Ordnance Survey maps, to identify any; former potentially contaminative uses shown at the site and immediately surrounding it, and an assessment of the associated contamination risks;

  - a third-party environmental report to identify any; flooding warning areas, local landfills, pollution incidents, abstractions, environmental permits etc. All of which may have had the potential to have environmental impact on the site;
  - topographical, geological and hydrogeological maps;
  - British Geological Survey (BGS) archive records;
  - regional UXB risk maps;
- a review of previous investigations carried out at the site;
- development of a preliminary Ground Model representing ground conditions at the site;
- development of an initial Conceptual Site Model (iCSM), including identification of potential contaminant linkages;
- a qualitative assessment of any geo-environmental risks identified; and
- identification of any plausible geotechnical hazards.

The scope of the Phase 2 Ground Investigation comprises:

- a ground investigation including trial pitting, windowless sampling, cable percussive boring, to:
  - obtain data on the ground and groundwater conditions of the site;
  - allow collection of samples for geotechnical and chemical laboratory analysis;
  - allow geotechnical field tests to be undertaken;
  - install gas and groundwater wells;
- gas concentration and groundwater level monitoring;
- groundwater sampling;
- geotechnical and chemical laboratory analysis;
- updating of the preliminary Ground Model;
- preparation of a geotechnical risk register;
- presentation of an initial geotechnical design recommendations;
- formulation of an updated Conceptual Site Model (CSM), including identification of any plausible contaminant linkages;
- completion of a generic quantitative risk assessment of any identified chemical contaminants to establish 'suitability for use' under the current planning regime;
- discussion of any potential environmental liabilities associated with land contamination (soil, water and gas); and
- identification of outline mitigation requirements to ensure the site is 'suitable for use'.

1.4 Available information

The following documents, reports etc have been provided to Hydrock by the Client for use in the preparation of this report:

- Ian Farmer Associates April 2015. 'ST ANDREW'S PARK PHASES 5, 6 & RIFLE RANGE UXBRIDGE– Factual Ground Investigation Report', Ref: 21311);
- Atkins. June 2015. 'St Andrew's Park - Phase 6 – Remediation and Reclamation Strategy',); and
- VSM. St Andrew's Gate Illustrative Masterplan

It is understood that the Client defined in Section 1.1 commissioned assignment of the above documents and Hydrock has assumed full reliance can be placed upon their contents. Should this not be the case, Hydrock should be informed at the earliest opportunity.

1.5 Regulatory context and guidance

The investigation work has been carried out in general compliance with recognised best practice, including (but not limited to) BS 5930:2015, BS 10175:2011+A2:2017 and the AGS (2006) 'Good Practice Guidelines for Site Investigations'.

The geo-environmental section of this report is written in broad accordance with BS 10175:2011+ A2:2017, EA LCRM), (2021) and the AGS (2006) 'Good Practice Guidelines for Site Investigations'.

The methods used follow a risk-based approach, the first stage of which is a Phase 1 desk study and field reconnaissance, with any potential geo-environmental risks assessed qualitatively. This is done using the 'source-pathway-receptor contaminant linkage' concept to assess risk as introduced in the Environmental Protection Act 1990 (EPA, 1990). Any potential geotechnical risks are also assessed from the Phase 1 desk study and site reconnaissance stage.

Phase 2 comprises intrusive ground investigation work and testing. The factual information from the desk study and the ground investigation are used to develop the Conceptual Site Model (CSM). This CSM is based on a ground model of the site physical conditions and an exposure model of the possible contaminant linkages. The CSM forms the basis for Generic Quantitative Risk Assessment (GQRA) in accordance with current guidelines. This GQRA might lead to more Detailed Quantitative Risk Assessment (DQRA).

Professional judgement is then used to evaluate the findings of the risk assessments and to provide recommendations for the development.

The geotechnical section of this report is prepared in general accordance with BS EN 1997-1+A1: 2013, BS EN 1997-2:2007 and BS 8004:2015. This report constitutes a Ground Investigation Report (GIR) as described in Part 2 of Eurocode 7 (BS EN 1997-2) (EC7). However, it is not intended to fulfil the requirements of a Geotechnical Design Report (GDR) as specified in EC7.

Where relevant the relevant requirements of the current edition of NHBC Standards have also been applied.

The geo-environmental and geotechnical aspects are discussed in separate sections. Throughout the report the term 'geotechnical' is used to describe aspects relating to the physical nature of the site (such as foundation requirements). The term 'geo-environmental' is used to describe aspects relating to ground-related environmental issues (such as potential contamination). However, it should be appreciated that this is an integrated investigation and these two main aspects are inter-related. Designers should take all aspects of the investigation into account.

Remaining uncertainties and recommendations for further work are listed in Section 9 and Section 10.

2. Desk study (and field reconnaissance)

2.1 Data

A number of desk study sources have been used to assemble the following information. These are presented in Appendix C and include:

- Third-party environmental report (Groundsure report, reference HYD-9293976);
- Historical Ordnance Survey mapping;
- BGS Archive Records;
- Zetica UXB Risk Maps (https://zeticauxo.com/downloads-and-resources/risk-maps/);

As part of the desk study, a number of previous ground investigations undertaken at the site have been reviewed (see Section 1.4). Whilst these provide useful information with regard to planning the current investigation, chemical information from these has not been considered during the preparation of this report due to the age of the reports. Historical information regarding the physical condition of the ground has however been used where it is considered pertinent to foundation & infrastructure design.

2.2 Site referencing

Table 2.1: Site referencing information

Item	Brief Description
Site name	St. Andrew's Gate, Town Centre Extension, Uxbridge (the TCE site)
Site address	St. Andrew's Gate, Town Centre Extension, Uxbridge (the TCE site) The nearest postcode is UB8 1LE.
Site location and grid reference	The site is located east of the A4020 Hillingdon Road and west of Hornchurch Road. The National Grid Reference of the approximate centre of the site is 506084E, 183829N. The site is 1.80 Ha in area.
Site boundaries	The site is contained within the wider St Andrew's Park development area, and is bounded by Hillingdon Road to the west, Burton Road to the south and the wider development to the east.

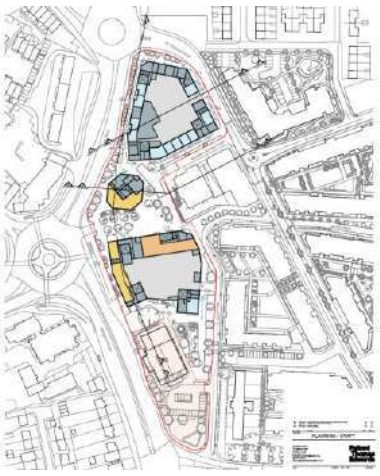


Figure 2.1: Site location (Illustrative Masterplan)

Figure 2.2: Site Location Plan

2.3 Site description

A description of the site is presented in Table 2.2.

Table 2.2: Site description

Item	Brief Description
Site access	The wider site was accessed from Burton Road.
Site area	The site is irregular in shape and has an area of approximately 1.80Ha.
Elevation, topography and any geomorphic features	The site gently slopes from roughly 45m OD in the south to 49m OD in the North.
Site boundaries and surrounding land	The site is bounded by Hillingdon Road to the west, St Andrew's Road to the north and Burton Road to the south. The wider development is to the east.
Present land use	All previous site structures have been demolished (with the exception of the retained cinema in south).
Vegetation	None.
General site sensitivity	The site is within a generally residential / commercial area 150m south east of Uxbridge town centre.

2.4 Site history

A study of historical Ordnance Survey maps (Appendix C) has been undertaken to identify any former land uses at the site and surrounding areas which may have geotechnical or geo-environmental implications for the proposed development. The key findings are summarised in Table 2.3.

It should be noted that it is common for military sites not to be shown on Ordnance Survey maps and so details of sites with military or security significance may not be picked up in this review.

Table 2.3: Site history review

Reference	Key features on site	Key features off-site
OS Map[1] 1881: 1:2,500	Undeveloped / open fields.	Hillingdon House located to the east. St Andrew's Church near western site boundary.

[1] Ordnance Survey Historical Map Information provided by Groundsure.

OS Map 1920 – 1:10,000	Undeveloped / open fields.	Metropolitan Railway 400m to the north of site.
OS Map 1938 – 1:10,000	Undeveloped / open fields.	Residential properties along site boundary.
OS Map 1960 – 1970 1:10,000	Unspecified RAF Station buildings located on site. Cinema building marked.	Surrounding site area occupied by the RAF Station.
OS Map 1966 1:2,500	Tennis court marked in south east of the site.	Wider area used for residential accommodation for RAF Station.
OS Map 1990 – 1:10,000	No significant change.	No significant change.
OS Map 2001 1:10,000	Several Ancillary structures in the north of the site have been demolished.	No significant change.

2.5 Geology

The geology of the site area is shown on the 1:10,000 British Geological Survey (BGS) map extract reproduced as part of the Groundsure report and is summarised below:

Table 2.4: Geology

Ref. for Figures	Location	Stratigraphic Name	Description
Superficial Deposits (Figure 2.3)			
1	On site	Black Park Gravel Member	Sand and Gravel
3	118m west	Langley Silt Member	Variable silt to clay.
2	99m south west	Lynch Hill Gravel Member	Sand and gravel.
Solid Geology (Figure 2.4)			
1	On site.	London Clay Formation	Poorly laminated, blue-grey or grey-brown, slightly calcareous, silty to very silty clay, clayey silt and sometimes silt, with some layers of sandy clay

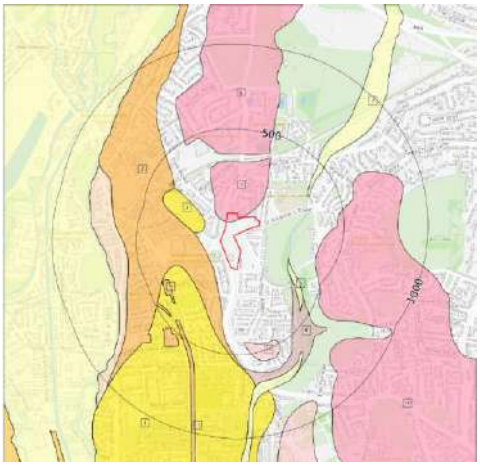


Figure 2.3: Superficial deposits.

(Reproduced with permission from Groundsure)

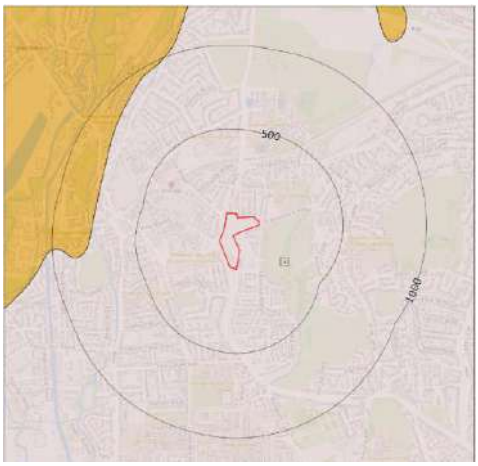


Figure 2.4: Solid geology.

(Reproduced with permission from Groundsure)

The ground conditions at the wider site proven by previous investigation (Ian Farmer Associates, 2015,), comprise:

- Made Ground to between 0.3m and 3.2m bgl, comprising both cohesive and granular elements, described as black grey / grey brown, clayey gravelly sand / sandy gravel and brown / orange brown, silty gravelly sandy clay. The gravel component comprises quartz, flint, brick, concrete, ash, clinker, coal, quartzite, limestone and timber.
- River Terrace Deposits (The Black Park Gravel Member) recorded at 15 out of 30 locations at depths of between 1.3m and 2.3m bgl the deposits are generally firm to stiff / medium dense to dense, orange brown / grey brown / brown, clayey sand and gravel / sandy gravelly clay and gravelly clayey sand. Gravel is flint and quartz with occasional calcareous inclusions.
- London Clay Formation was recorded all but 5 of the 64 exploratory holes which penetrated the Made Ground and Superficial Deposits. It was encountered at depths of between 0.3m and 3.1mbgl and its base was proven within CP806 at 19.5mbgl, overlying the Lambeth Group.
- The Lambeth Group was encountered within CP806 underlying and London Clay at 19.5m but was not proven beyond 20.45mbgl. The Lambeth Group at this location was described as stiff grey silty gravelly very sandy clay with occasional silt and fine sand lenses. Gravel is fine to coarse sub-angular to sub-rounded of green-blue siltstone and purple mudstone.

2.6 Hydrogeology

Based on the inferred geological sequence presented in Section 2.5 and the Environment Agency's interactive aquifer designation map, the aquifer system presented in Table 2.5 applies. Additional information on the hydraulic characteristics of the geological units has been abstracted from Allen et al (1997) and Jones et al (2000).

Table 2.5: Aquifer system

Stratum	Aquifer Designation	Comments
Made Ground	Unclassified/unproductive	Artificial ground not included in the classification system. Likely to be moderate to high porosity because of unconsolidated nature, but permeability is likely

		to be constrained to low, or low to moderate because of poor sorting and clay content.
Superficial Deposits		
Black Park Gravel Member	Secondary A Aquifer	Intergranular permeability. Dominated by moderate to high permeability layers of sand and gravel, interbedded with low permeability clay. Overall, this unit is likely to be relatively anisotropic in nature with horizontal permeability similar to vertical permeability (i.e. $k_h > k_v$).
Solid Geology		
London Clay Formation	Unproductive Strata	Predominantly clay of low permeability, interbedded with occasional layers of sand and gravel, of moderate to high permeability. Overall, this unit is likely to be anisotropic in nature with horizontal permeability greater than vertical permeability ((i.e. $k_h > k_v$).
Chalk (underlying the site at depth)	Principal Aquifer	Fractured. Overall, this unit is likely to be anisotropic in nature with horizontal permeability similar to vertical permeability (i.e. $k_h > k_v$).

2.6.1 *Groundwater abstraction*

There are no active licensed groundwater abstractions within 1000m of the site.

2.6.2 *Groundwater source protection zones and groundwater vulnerability*

The site is not within a groundwater Source Protection Zone (SPZ).

2.6.3 *Groundwater flooding*

The environmental data report indicates a low risk of groundwater flooding.

2.7 Hydrology

2.7.1 *Surface water system and drainage*

The surface water features in the vicinity of the site are listed in Table 2.6.

Table 2.6: Surface water features

Feature	Location Relative to Site
River Pinn	196m to the east

2.7.2 *Surface water flooding*

The desk study information indicates the proposed development is in a low flood risk area (a chance of flooding between 1 in 1000 (0.1%) and 1 in 100 (1%)).

No further consideration of flood risk is undertaken in this report. A Flood Risk Assessment has been undertaken by VSM's appointed Engineers and forms part of the supporting technical reports that accompanies the outline planning application.

2.8 Natural ground instability

Trees and hedges are present in the southern site area. Cohesive deposits of the London Clay Formation may be affected by potential for shrink-swell ground movements in clays as a result of changes in moisture content from removal or growth of trees.

2.9 Waste management

There are no current or historical waste management sites recorded within 250m of the site.

2.10 Regulatory Information

Information in the GroundSure Report (Appendix C), relating to various regulatory controls has been reviewed, with a summary presented below in Table 2.7.

Table 2.7: Regulatory information within 500m of the site

Regulatory Data	Distance from Site	Details	Potential Risk	Comment
Pollution Incidents	410m north east	July 2001, Oils and fuel, Category 3 – minor incident	No	Due to its distance from the site.
Trade Directory Entries	108m west	Active Car repairs and servicing	No	Due to its distance from the site.
Electricity Sub Station	On site	Open	No	Know to have been removed.
Electricity Sub Station	65m North	Open	No	Due to distance from site.

2.11 Natural soil chemistry

Information contained within the environmental report (Appendix C) gives indicative (estimated) concentration values for the natural soils at the site for a selection of Contaminants of Potential Concern (CoPC). These have been reproduced in Table 2.8.

Table 2.8: Natural soil chemistry

Element	Arsenic	Cadmium	Chromium	Lead	Nickel
Concentration (mg/kg)	-	<1.8	-	100 -200	-

The data in Table 2.8 is considered within the geo-environmental assessment.

2.12 Evidence of contamination

Previous ground investigations at the wider site area indicate:

- Concentrations of lead and arsenic above the GAC are recorded in several soil samples taken in the Made Ground;
- Concentrations of polyaromatic hydrocarbons (PAH) above the Generic Assessment Criteria (GAC) and the presence of asbestos (fibres and Asbestos Containing Material) are present in soil samples from the Made Ground.

2.13 Radon

The guidance indicates that the site is not in a Radon Affected Area and no radon protection measures are required.

2.14 Unexploded ordnance (UXO)

A specialist UXO screening exercise was carried out at the site in 2010 by Planit on behalf of Halcrow Group Limited (HGL). This assessment was included in the 2015 Atkins report provided to Hydrock by the client.

Based upon the findings of the assessment undertaken by Planit, it was determined that the wider site lies within an area considered to present a low risk from the threat of unexploded ordnance (UXO) and explosive ordnance (EO). The risk levels associated with EO are in part due to the inherently dangerous nature of EO and the high risk involved in any encounter. However, as a former RAF facility of strategic importance, the site would have been subjected to thorough and expert postraid bomb surveys.

As the records clearly indicate that bombs fell only in the west side of the facility Planit zoned the site in terms of Ordnance Threat Level. Planit considered there to be an EO risk predominantly to the west of the site.

Based on historical data, no former rifle ranges are recorded within the site.

3. Initial conceptual site model

3.1 Introduction

The initial Conceptual Site Model (iCSM) incorporates evidence from the site walkover, the Desk Study and previous investigations carried out at the site. The formulation of an initial Conceptual Site Model is a key component of the LCRM methodology. The iCSM incorporates a ground model of the site physical conditions and an exposure model of the possible contaminant linkages; it forms the basis for Generic Quantitative Risk Assessment (GQRA) in accordance with current guidelines.

3.2 Ground model

The preliminary ground model presented in Section 2 provides an understanding of the ground conditions and is the basis for preparing the preliminary geotechnical hazard assessment (Section 3.3) and the preliminary geo-environmental exposure model (Section 3.4).

3.3 Geotechnical hazard identification

3.3.1 Context

The preliminary geotechnical hazard identification has been undertaken in accordance with the general requirements of ICE/DETR Document 'Managing Geotechnical Risk' and CD 622.

The following section sets out the identified geotechnical hazards and the development elements potentially affected (see Table I.1 in Appendix I for further information).

3.3.2 Plausible geotechnical hazards

Plausible geotechnical hazards identified at the site are:

- Uncontrolled Made Ground (variable strength and compressibility).
- Soft / loose compressible ground (low strength and high settlement potential).
- Shrinkage / swelling of the clay fraction of soils under the influence of vegetation.
- Variable lateral and vertical changes in ground conditions.
- Attack of buried concrete by aggressive ground conditions.
- Obstructions.
- Existing below ground structures to remain.
- Loose Made Ground, leading to difficulty with excavation and collapse of side walls.
- Earthworks – unsuitability of site won material to be reused as fill.

3.3.3 Potential development elements affected

Development elements potentially affected by geotechnical hazards are:

- Buildings – foundations.
- Buildings – floor Slabs
- Roads and pavements.
- Services.
- Gardens.
- Construction staff, vehicles and plant operators.
- Concrete below ground.

» Insufficient fill to complete earthworks.

Health and safety risks to site Contractors and maintenance workers have not been assessed during these works and will need to be considered separately during design.

The above plausible geotechnical hazards and development elements affected have been carried forward for investigation and assessment. The investigation is presented in Section 5 and the assessment is presented in Section 6.

3.4 Geo-environmental exposure model

3.4.1 Context

The preliminary exposure model is used to identify geo-environmental hazards and to establish potential contaminant linkages, based on the source-pathway-receptor (SPR) approach.

A viable contaminant linkage requires all the components of an SPR to be present. If only one or two are present, there is no linkage and no further assessment is required.

3.4.2 Potential contaminants

For the purpose of this assessment the potential contaminants have been separated according to whether they are likely to have originated from an on-site or off-site source.

3.4.2.1 Potential on-site sources of contamination

» Made Ground, associated with historical construction activities and imported fill, possibly including elevated concentrations of metals, metalloids, asbestos fibres, Asbestos Containing Materials, PAH and petroleum hydrocarbons (S01).

» Ground gases (carbon dioxide and methane) from organic materials in the Made Ground / Black Park Gravel Member (S02).

3.4.2.2 Potential off-site sources of contamination

No potential off-site sources of contamination have been identified.

3.4.3 Potential receptors

The following potential receptors in relation to the proposed land use have been identified.

» People (neighbours, site end users) (R01).

» Development end use (buildings, utilities and landscaping) (R02).

» Groundwater: Secondary A aquifer status of the Black Park Gravel Member (R03).

» Surface water: The River Pinn 196m to the east (R04).

3.4.4 Potential pathways

The following potential pathways have been identified.

» Ingestion, skin contact, inhalation of dust and outdoor air by people (P01).

» Methane ingress via permeable soils and/or construction gaps (P02).

» Root uptake by plant (P03).

» Migration of contaminant via leachate migration through the unsaturated zone in the River Terrace Deposits (P04).

» Surface water via base flow from groundwater (P05).

Health and safety risks to site development contractors and maintenance workers have not been assessed as part of this study and will need to be considered separately.

The above sources, pathways and receptors have been considered as part of the Preliminary Risk Assessment in accordance with LCRM (2021), are considered to be plausible in the context of this site and have been carried forward for investigation and assessment. The investigation is presented in Section 5 and the assessment is presented in Section 7 An assessment of the Source – Pathway – Receptor linkages is undertaken following the assessment (Section 7) and is presented in Appendix J (Table J.1).

3.4.5 *Potential implications of climate change*

Climate change has the potential to change the risk profile for conceptual site models and associated contaminant linkages. The impact of climate change on the CSM is site-specific, and a qualitative assessment of the potential impact of climate change on the CSM for this site is summarised below. The assessment has primarily utilised the guidance in Environment Agency (2010)[2] and SoBRA (2022)[3] which set out the UK context to climate change and land contamination. Both guidance documents advocate a "what if" scenario approach in the context of changes in ambient temperatures, an increase in the frequency of extreme rainfall/storm events and heatwaves/droughts, and long-term changes in groundwater and sea levels.

Those "what if" scenarios that are relevant to this CSM are:

- Increased long-term rainfall leading to increased infiltration and seasonally higher groundwater and water levels in surface waters.
- Increased frequency and/or magnitude of extreme rainfall events leading to short-term surface flooding, surface water run-off, groundwater flooding, and/or land-based erosion.
- Long-term decrease in rainfall leading to lower infiltration and fall in groundwater and surface water levels.

[2] Environment Agency, 2010. Guiding Principles for Land Contamination. Part 2. FAQs, technical information, detailed advice and references, March 2010.

[3] SoBRA, 2022. Guidance on Assessing Risk to Controlled Waters from UK Land Contamination Under Conditions of Future Climate Change, Society of Brownfield Risk Assessment, August 2022.

4. Ground investigations

4.1 Site works

The ground investigation works, including the rationale which was based on the findings of the preliminary risk assessment is summarised in Table 4.1. For the investigation rationale of the historical investigations, please refer to the historical reports in Appendix C.

The fieldwork took place between 31/10/22 and 11/11/22. The ground investigation locations were surveyed in using a topographic survey quality GPS and are shown on the Exploratory Hole Location Plan (Hydrock Drawing 25992-HYD-XX-ZZ-DR-GE-1001) in Appendix A.

The logs, including details of ground conditions, soil sampling, in situ testing and any installations, are also presented in Appendix D.

The weather conditions during the Hydrock fieldwork and for the previous week were wet.

Table 4.1: Summary of site works

Activity	Method	No.	Name	Depth Range (m bgl)	In situ tests	Rationale
Drilling, Pitting and Probing						
Ian Farmer Associates (2015)						
Boreholes	Cable percussive	4	CP803-805 CP807	20.00-20.45	SPT	See Appendix C
	Windowless sampler	7	WS801 WS807-811 WS814	2.00-5.45	SPT	See Appendix C
Trial pits	Machine	26	TP801 TP804 TP819 TP820 TP823-838 TP845-850	2.30 - 4.30	Hand shear vane (HSV) PID	See Appendix C
	Hand-excavated	13	HP801-813	0.35-0.80		See Appendix C
Hydrock (2022)						
Boreholes	Cable percussive	4	CP01-03A	20.00-20.45	SPT	Installed to monitor groundwater.

						To investigate strength profile of the London Clay Formation.
	Windowless sampler	6	WS01 – 06	4.00 – 5.00	SPT	Installed to monitor ground gas. To investigate thickness of Made Ground and collect samples for contamination testing.
Trial pits	Machine (JCB 3CX)	8	TP01 – TP08	0.50 – 4.00		For general site coverage and collection of samples

Wells for monitoring groundwater levels and ground gas concentrations, and to facilitate the sampling of leachate and / or groundwater, were installed in six of the windowless sampler and three of the cable percussion boreholes. A summary of the monitoring well installations is presented in Table 4.2.

Table 4.2: Summary of monitoring installations

Location	Ground level (m OD)	Standpipe / piezometer diameter	Screen top and base depth (m bgl)	Screen top and base elevation (m OD)	Strata targeted
CP01	50.46	50	2.50 to 23.80	47.96 to 26.66	London Clay
CP02	45.52	50	3.10 to 18.00	42.42 to 27.52	London Clay
CP03A	49.08	50	3.10 to 25.00	45.98 to 24.08	London Clay
WS01	50.49	50	1.00 to 4.00	49.49 to 46.49	Made Ground / Black Park Gravel
WS02	50.44	50	2.00 to 2.70	48.44 to 47.74	Made Ground
WS03	45.79	50	1.00 to 5.00	44.79 to 40.79	Black Park Gravel
WS04	45.39	50	1.20 to 3.00	44.19 to 42.39	Black Park Gravel Member
WS05	49.98	50	1.45 to 5.00	48.53 to 44.98	London Clay
WS06	49.15	50	1.45 to 5.00	47.70 to 44.15	London Clay

4.2 Geo-environmental testing

4.2.1 Sampling strategy and protocols

Exploratory hole positions were determined by reference to the site conditions and uncertainties identified in the Initial Conceptual Model, targeting gaps in the previous investigations.

Samples were taken, stored and transported in general accordance with BS 10175:2011+A2:2017.

4.2.2 Geo-environmental monitoring

Gas monitoring boreholes have been monitored on six occasions. The results are presented in Appendix F Monitoring is ongoing and this report will be updated on completion of the monitoring.

4.2.3 Geo-environmental laboratory analyses

The chemical test certificates for testing undertaken as part of Hydrock's investigation are provided in Appendix G and summarised in the table below. Wherever possible, UKAS and MCERTS accredited procedures have been used.

The chemical test certificates for testing undertaken as part of historical investigations are provided in the relevant reports in Appendix C.

The geo-environmental analyses undertaken on soils in the Hydrock investigation are summarised in Table 4.3.

Table 4.3: Geo-environmental analyses of soils

Determinand Suite	Made Ground	Black Park Gravel	London Clay
Hydrock minimum suite of determinands for solids*	22	6	0
Speciated aliphatic and aromatic banding Total petroleum hydrocarbons by HS-GC/MS and GC/FID (Hydrock Tier 2 TPH Suite)	20	3	-
Asbestos quantification	1	-	-

*Hydrock minimum soil suite comprises: As, B (water soluble), Be, Cd, Cr (total), Cr (VI), Cu, Hg, Ni, Pb, S (elemental), Se, V, Zn, cyanide (total), sulfide, pH, asbestos fibres, speciated polynuclear aromatic hydrocarbons (PAH, by GC-FID), total phenols and fraction of organic carbon

The soils chemical test data are interpreted and assessed in Sections 7.3 and 7.4.

The geo-environmental analyses undertaken as part of Hydrock's investigation on waters, are summarised in Table 4.4.

Table 4.4: Geo-environmental analyses of waters

Determinand Suite	Groundwater
Hydrock minimum suite of determinands for waters	2
Speciated aliphatic and aromatic banding Total petroleum hydrocarbons by HS-GC/MS and GC/FID (Hydrock Tier 2 TPH Suite)	2

The groundwater chemical test data are interpreted and assessed in Section 7.5.

4.3 Geotechnical testing

4.3.1 Geotechnical laboratory testing

The geotechnical tests undertaken are summarised in Table 4.5 and the test certificates are provided in Appendix E. Wherever possible, UKAS accredited procedures have been used.

The geotechnical tests undertaken as part of historical investigations are provided in the relevant reports in Appendix C.

Table 4.5: Summary of sample numbers for geotechnical tests

Test	Made Ground	Black Park Gravel Member	London Clay Formation
Ian Farmer Associates (2015)			
Natural moisture content	5	6	33
Sieved moisture content	2	1	5
Atterberg limits	5	2	33
Particle size distribution (sieve)	5	5	14
Hand Vane Test	-	-	9
Single stage undrained triaxial compressive strength	-	-	8
One dimensional oedometer consolidation	-	-	5
Optimum Moisture Content / Maximum Dry Density Relationship (2.5kg rammer)	15	2	5
Remoulded California Bearing Ratio at natural moisture content (soaked)	13	3	7
Hydrock (2022)			
Natural moisture content	1	3	3
Atterberg limits	-	1	4
Particle size distribution (sieve)	-	2	-
Water soluble sulfate and pH	3	3	1
Single stage undrained triaxial compressive strength	-	-	12
One dimensional oedometer consolidation	-	-	3
Remoulded California Bearing Ratio at natural moisture content (soaked)	2	1	-

The geotechnical test data (including both Hydrock and historical data) are summarised in Section 5.5 and interpreted in Section 6.

5. Ground investigation records and data

5.1 Physical ground conditions

5.1.1 Summary of strata encountered

The following presents a summary of the properties of the ground and groundwater conditions encountered, based on field observations, interpretation of the field data and laboratory test results, taking into account drilling, excavation and sampling methods, transport, handling and specimen preparation.

All relevant data from the Hydrock investigation discussed in Section 4 as well as any reliable data from previous investigations noted in Section 1.4 are used from this point forward.

Details of the Hydrock ground investigation works are provided in the logs in Appendix D, previous data are provided in Appendix C , a summary of the ground model is presented in Table 5.1 and the individual strata are described in the sections below.

Table 5.1: Strata encountered

Stratum	Depth to top (m bgl)	Depth to base (m bgl)	Thickness (m) (range)	Thickness (m) (average)
Ian Farmer Associates (2015)				
Topsoil	0	0.1	0.1	0.1
Made Ground	0	0.4 - 2.1	0.4 - 2.1	1.2
Black Park Gravel Member	0.4 - 2.1	1.3 - 3.0	0.5 - 2.6	0.9
London Clay Formation	0.5 - 2.5	Not Proven	Not Proven	Not Proven
Hydrock (2022)				
Surface Cover – Asphalt hardstanding	0.00	0.10 - 0.30	0.10 – 0.30	0.20
'General' Made Ground	0.0 – 0.30	0.40 - 2.50	0.40 - 2.50	1.11
Black Park Gravel Member	0.40 – 1.20	1.55 - 3.10	0.60 - 2.35	1.45
London Clay Formation	0.40 – 3.10	Not proven	Not proven	Not proven
Lambeth Group	20.20	Not proven	Not proven	Not proven

5.1.2 Surface covering

Asphalt surfacing was encountered in the areas of the site currently in use as car parking, ranging between 0.10m to 0.30m in thickness.

5.1.3 Made Ground

Below the surface covering, Made Ground was recorded across the entire site.

Made Ground was encountered to depths of between 0.4m and 2.5m (in CP03A), with an average thickness of around 1.0m. The Made Ground comprises a mixture of sandy / gravelly clay, with fragments of brick, concrete, asphalt, wood and metal.

5.1.4 Black Park Gravel Member

The Black Park Gravel Member was encountered underlying the Made Ground at the site, although in some locations (CP03A, TP01) it was entirely absent. Whilst BGS mapping identified the Black Park Gravel Member as only being present in the north of the site, flint gravels were also encountered in the south, although significant mixing between the Black Park Gravel Member and the Made Ground appeared to have taken place at the site, likely as a result of historic construction activities. Natural historical mixing of flint gravels within the top horizon of the London Clay due to past erosive processes also seems to have occurred., These processes make it difficult to determine both the natural composition of this strata and the true transitions between strata above and below.

Although the boundaries are somewhat blurred; the Black Park Gravel Member is considered to be encountered to depths of between 1.55m and 3.1m, with an average thickness of 1.45m. It comprises mostly of a mixture of soft becoming firm sandy / gravelly clay and locally a clayey / sandy gravel.

5.1.5 London Clay Formation

The London Clay Formation was encountered underlying the Made Ground or Black Park Gravel Member across the site. The London Clay Formation is between 16.20m and 17.0m thick, with an average thickness of 16.56m.

This generally consisted of firm orangish brown mottled grey silty clay, becoming stiff dark grey fissured silty clay with depth.

5.1.6 Lambeth Group

The Lambeth Group was encountered underlying the London Clay Formation in CP02 at 20.20m bgl. The base of the Lambeth Group was not proven.

This generally consisted of stiff dark grey fissured silty clay with frequent white fragmented shells throughout becoming very stiff light green mottled light grey and purple slightly sandy silty clay.

5.2 Obstructions

Obstructions were encountered in a number of trial pits and boreholes during the investigation. These intrusive locations are summarised in Table 5.2.

Table 5.2: Obstructions encountered

Stratum	Location	Depth (m bgl)	Description
Made Ground	CP03	0.90	Concrete
Made Ground	TP04	0.50	Concrete

5.3 Groundwater

5.3.1 Groundwater observations and levels

Groundwater encountered during the investigation is listed in Table 5.3. A groundwater observation represents the depth at which groundwater was first observed and is likely to be deeper than the actual water table level at that location.

Table 5.3: Groundwater occurrence

Stratum	Date	Location	Fieldwork		Comment
			Groundwater observation (m bgl)	Rose to after 20 mins (m bgl)	
Lambeth Group	04/11/22	CP02	19.50	19.50	Seepage

Groundwater levels recorded during post-fieldwork monitoring (6 visits) are summarised in Table 5.4.

Table 5.4: Groundwater level data summary

Stratum	Date range	Location	Post-fieldwork monitoring	
			Depth to groundwater (range) (m bgl)	Groundwater elevation (range) (m OD)
London Clay Formation	19/12/22-10/01/23	CP01	14.32 – 14.41	36.05 - 36.14
		CP02	8.87 – 9.00	36.51 - 36.64
		CP03	13.48 – 13.60	35.48 - 35.60

5.3.2 *Groundwater summary*

Perched water was encountered in the Made Ground and Black Park Gravel member during the post fieldwork monitoring; however, it has been noted that the site has seen heavy snow and rainfall during the monitoring period, with rainwater pooling at the site surface.

Given the locally granular nature of some shallow soils and presence of underlying London Clay, it can be expected that localised pockets of perched water exist on site.

One small seepage of groundwater was detected deep in the shelly beds of London Clay in CP02 whilst subsequent monitoring of deep installations with CP01 & 02 have detected ingress of groundwater within previously dry bores.

5.4 Ground gases (carbon dioxide and methane)

Records from the gas monitoring boreholes are presented in Appendix F and summarised in Table 5.5.

To date four monitoring visits have been undertaken, with a further two visits to be undertaken as part of the current commission. The data are assessed in Section 7.6.

Table 5.5: Range of ground gas data

Stratum	Methane (%)	Carbon dioxide (%)	Oxygen (%)	Steady flow rate (l/hr)	Comment
'General' Made Ground	0.00	0.3 -8.7	7.9 -19.3	0 -9.60	All five out of six readings taken in WS06 have c02 >5%. High flow rates in WS06 are likely due to incursion of perched groundwater (due to heavy snow / rainfall over the monitoring period) leading to artificially high internal borehole pressures.

5.5 Geotechnical data

5.5.1 Introduction

Laboratory test results are contained in Appendix E with *in situ* test results shown on the relevant exploratory hole log or datasheet in Appendix D. The following sections summarise the main findings and provide interpretation where appropriate.

5.5.2 Plasticity

The volume change potentials in terms of NHBC Standard (Chapter 4.2) with respect to building near trees have been determined from the results of plasticity index tests on samples of soil. These are summarised in Table 5.6.

Table 5.6: Volume change potential

Stratum	No. of tests	Plasticity Index			Modified Plasticity Index			Plasticity designation	Volume Change Potential
		Min.	Max.	Av.	Min.	Max.	Av.		
Ian Farmer Associates (2015)									
Made Ground	5	24	43	32.4	6.2	34.3	14.4	Low	Low to medium
Black Park Gravel Member	2	37	51	44	13.3	49.9	30.1	Intermediate	Medium to high
London Clay Formation	27	21	50	43	11.4	50	35.8	Intermediate to high	Medium to high
Hydrock (2022)									
Made Ground	1	49	49	49	16.2	16.2	16.2	Low	Low

London Clay Formation	4	30	43	40	7.5	40	27.5	Intermediate	Medium to high

5.5.3 *Particle size distribution*

Particle Size Distribution test (PSDs) results are summarised in Table 5.7 and summary descriptions and PSD plots of the material analysed are presented in Appendix E.

Table 5.7: PSD results summary

Stratum	No. of tests	Silt/Clay %	Sand %	Gravel %	General description
Ian Farmer Associates (2015)					
Made Ground	5	39 - 82	4 - 18	5 - 51	Sandy gravelly CLAY
Black Park Gravel Member	5	6 - 34	13 - 42	26 - 78	Sandy gravel
London Clay Formation	14	74 - 100	0 - 25	0 - 12	Slightly gravelly sandy CLAY
Hydrock (2022)					
Made Ground	1	20	25	55	Clayey sandy gravel.
London Clay Formation	3	60 - 97	2 -7	0 - 33	Slightly sandy silty clay.

5.5.4 *Soil strength*

Table 5.8 summarises information pertaining to the shear strength of the soils according to geological stratum. Factual results are summarised for laboratory tests, field tests (e.g. hand shear vane) and uncorrected Standard Penetration Tests (SPT). Where the SPT is used to infer shear strength by published correlation, this is also tabulated.

Table 5.8: Soil strength results and derived values

Stratum	No. of tests	SPT (N-value) (range)	c_u (kPa)	Method
Ian Farmer Associates (2015)				
Made Ground	2	8	36*	SPT – cable percussion.
	4	5 - 10	22.5 - 45*	SPT – windowless sampler boreholes.
	1	8	36	CPT correlation
London Clay Formation	36	10 - 35	45 – 157.5*	SPT – cable percussion.
	21	6 - 50	27 – 225*	SPT – windowless sampler boreholes.
	9		9 - >140	Hand shear vane
	7	12-30	54 - 135	CPT correlation
	8		87 - 178	Triaxial compression test
Hydrock (2022)				
Made Ground	1	9	41.5	SPT – cable percussion.
London Clay Formation	30	13 - 38	58.5 - 171	SPT – cable percussion.
	11	-	39 - 196	Triaxial compression test

5.5.5 *Relative density*

Table 5.9 summarises information pertaining to the effective angle of shearing resistance of the granular soils according to geological stratum. Factual results are summarised for laboratory tests, field tests (e.g. SPT, CPT, dynamic probe correlation).

Table 5.9: Relative density results and derived values

Stratum	No. of tests	Method	SPT (N-value) (Range)	phi' (°)
Ian Farmer Associates (2015)				
Black Park Gravel Formation	1	CPT Correlation	11	30
	4	SPT – windowless sampler boreholes (Peck et. al. (1967).	9 - 50	29 - 41

Hydrock (2022)				
Made Ground	3	SPT – cable percussion (Peck et. al. (1967).	14 - 17	31 - 32

Figure 5.1: SPT 'N' Value versus depth summary

5.5.6 Compressibility

Table 5.10 presents a summary of the derived parameters for coefficient of consolidation and compressibility. The data indicates that the material is generally of medium to high compressibility over the pressure ranges tested.

Table 5.10: Summary of compressibility

Stratum	No. of tests / results	Method	Pressure range (kN/m²)	Coefficient of volume compressibility (m_v) (m²/MN)	Coefficient of consolidation (C_v) (m²/yr)
Ian Farmer Associates (2015)					
London Clay Formation	2	One Dimensional Oedometer Testing	0 - 70	Swelling	Swelling
	2		70 - 140	0.121 - 0.138	0.609 - 1.973
	2		140 - 280	0.104 - 0.110	0.417 - 1.272
	2		280 - 560	0.073 - 0.076	0.394 - 0.814
	2		Unload	0.067 - 0.071	0.291 - 0.428
Hydrock (2022)					
London Clay Formation	3	One Dimensional Oedometer Testing	0 - 100	Swelling	Swelling
	3		100 -200	0.32	51
	3		200 - 400	0.23	1.1
	3		Unload	0.072	-

5.5.7 Compaction and moisture content

Table 5.11 presents a summary of the moisture content tests and compaction studies undertaken at the site.

Table 5.11: Compaction study results

Stratum	No. tests	Method	Natural moisture content (%) (range)	Optimum moisture content (%) (range)	Particle density (Mg/m^3) (range)	Maximum dry density (Mg/m^3) (range)
Ian Farmer Associates (2015)						
Made ground	5	2.5kg Rammer	26 - 37	12 - 24	2.1 - 2.65	1.55 - 1.84
Black Park Gravel Member	6	2.5kg Rammer	8.5 - 29	11 - 16	2.65	1.75 - 1.97
London Clay Formation	33	2.5kg Rammer	22-32	11 - 27	2.65	1.5 - 1.76

5.5.8 Subgrade stiffness

The subgrade stiffness (CBR and Modulus of Subgrade Reaction) results are summarised in Table 5.12.

Table 5.12: CBR results and derived values

Stratum	No. tests	Method	Modulus of Subgrade Reaction k ($MN/m^2/m$) (Range)	CBR (%) (Range)
Hydrock (2022)				
Made Ground	2	Laboratory remoulded sample at Natural Moisture Content (NMC)	0.73 – 41.33	1.2 - 11
London Clay Formation	1	Laboratory remoulded sample at Natural Moisture Content (NMC)	0.37	0.5

Where using the IAN method, 'k' has been back calculated from the Equivalent CBR.

5.5.9 *Sulfate content*

In accordance with BRE (Special Digest 1), the Design Sulfate (DS) classification and the Aggressive Chemical Environment for Concrete (ACEC) classification are presented in Table 5.13. The assessment summary sheets are presented in Appendix E.

Table 5.13: Aggressive chemical environment concrete classification

Stratum	No. tests	DS	ACEC
Made Ground / River Terrace Deposits	5	DS-1	AC-1
London Clay Formation	2	DS-2	DS-2

6. Geotechnical assessment

6.1 Geotechnical categorization of the proposed development

Eurocode 7, Section 2 advocates the use of geotechnical categorization of the proposed structures to establish the design requirements.

The proposed development is the creation of up to no. 356 residential dwellings, within three new build blocks, of up to 10 storeys.

Based on the above, for the purposes of this investigation, the proposed structures have been classed as Geotechnical Category 2.

For Category 2 structures, the Geotechnical Category should be re-assessed at the design stage and specific geotechnical design (in addition to this investigation), is required.

Following ground investigation and as part of the assessment provided in the following section, the preliminary geotechnical hazard identification undertaken in Section 3.3 has been updated.

Assessment has been undertaken in accordance with the general requirements of ICE/DETR Document 'Managing Geotechnical Risk' and the HE documents HD 41/15 and CD 622. The preliminary Geotechnical Risk Register following investigation is provided in Appendix I (Table J.3) and will need to be updated during future design works.

6.2 Characteristic design values

In accordance with BS EN ISO 1997-1 (EC 7), Hydrock consider the proposed structures would be classified as Category 2 structures. As part of the separate geotechnical design, the designer should determine the geotechnical design values.

Table 6.1 provides characteristic geotechnical values to assist the designer. These are based on laboratory testing, *in situ* testing and by professional judgement using published data together with knowledge and experience of the ground conditions. Care should be exercised in using these assumed soil strength parameters for any purpose beyond the scope of this report because it may be that additional sampling and testing are required for certain purposes. The reader should refer to the original test results summarised in Section 5 and provided in Appendix D and Appendix E.

Table 6.1: Characteristic geotechnical values

Parameter Stratum	Bulk unit weight kN/m³ γ [a]	Effective angle of internal friction ° ϕ' [b c]	Effective cohesion kN/m² c' [d]	Undrained shear strength kN/m² c_u [e]	Coefficient of compressibility m²/MN m_v [f]	Modulus of subgrade reaction (IAN73/06) MN/m²/m k [g]
Made Ground	17.00	-	-	-	-	<30
Granular Black Park Gravel	18.00	38	-	-	0.1	50
Cohesive Black Park Gravel	17.00	25	1	35	0.19	<30
London Clay Formation	20.00	23	2.5	45 - 150	0.11 – 0.033	N/a

a. Measured as part of the triaxial strength test and estimated based on the recommendations of BS 8004-2015.

b. Internal friction (φ') values for the granular in situ *material derived from SPT data following the recommendations of Peck et al., (1967).*

Parameter Stratum	Bulk unit weight kN/m³ γ [a]	Effective angle of internal friction ° ϕ' [b c]	Effective cohesion kN/m² c' [d]	Undrained shear strength kN/m² c_u [e]	Coefficient of compressibility m²/MN m_v [f]	Modulus of subgrade reaction (IAN73/06) MN/m²/m k [g]

c. BS 8002:1994 Code of practice for Earth retaining structures, British Standards institution.
d. Site measurements and laboratory data.
e. Laboratory data.
f. Based upon the equilibrium long term CBR from DMRB IAN 73/06 Rev 1 Table 5.1.

6.3 Groundwork

6.3.1 Site preparation

Demolition of the former site structures has largely already taken place.

Buried obstructions were encountered during this investigation associated with foundations of old buildings and there is a possibility of further such obstructions being encountered.

6.3.2 Groundworks

Following breaking out of hardstanding and obstructions, excavation of shallow soils should be readily undertaken by conventional plant and equipment. However, excavation through any buried construction may require heavy-duty excavation plant/ the use of specialist breaking equipment.

Trial pit faces were noted to remain generally vertical without collapse. The faces of shallow, near vertically sided excavations put down at the site are likely to remain stable for short periods of time.

Temporary trench support, or battering of excavation sides, is recommended for all excavations that are to be left open for any length of time and will definitely be required where man entry is required. Particular attention should be paid to excavation at, or close to, site boundaries/adjoining existing roads/structures/buildings, where collapse of excavation faces could have a disproportionate effect.

A risk assessment of the stability of any open excavation should be undertaken by a competent person and appropriate measures adopted to ensure safe working practise in and around open excavations. Further guidance on responsibilities and requirements for working near, and in, excavations can be obtained from the Construction Design and Management Regulations (2015); Construction Information Sheet 47: Inspections and Reports (2005) and HSG47: Avoiding Danger from Underground Services.

To ensure no loads are imposed on the sides of the excavation, spoil should not be placed immediately adjacent to the excavation. Spoil should be placed a suitable distance from the side of the excavation (as assessed by a competent person).

Based on site observations, the rate of water ingress to the proposed excavations is likely to be slow. In these circumstances, groundwater control by sump pumping is likely to be sufficient.

However, it should be recognised that groundwater levels may vary from those at the time of the investigation, for example in response to seasonal fluctuations and the timing of construction may dictate the extent of groundwater control required.

6.3.3 *Earthworks/reuse of site-won materials*

Whilst no specific earthworks testing has been undertaken, it is understood limited cut to fill will be required. Review of geotechnical data (see Section 5.5 and Appendix E) coupled with Hydrock's experience, indicates that:

- following processing to remove oversize and deleterious material the Made Ground should be suitable for reuse as general fill. Note that re-engineered materials are likely to yield SSMs of 3% or more;
- London Clay derived soils are likely to be Class 2 (Cohesive) General Fill and are likely to be 'wet' of Optimum Moisture Content; and
- the majority of soils of the Black Park Gravel Formation are likely to be Class 2C (Stoney Cohesive) - General Fill;

If earthworks are proposed, additional earthworks testing and Specification will be required as a supplementary stage of works.

The earthworks may need to be undertaken under a Materials Management Plan (see Section 8.3).

Where it is proposed to reuse site won materials as an engineered fill it will be necessary to develop an appropriate Site Specific Earthworks Specification. The basis for the Specification should be BS 6031:2009 and the latest version of the SHW, Series 600 Earthworks. Once site proposals have been further defined more specific consideration will need to be given to the reuse of materials and reference should be made back to Hydrock.

6.4 Foundation recommendations

In accordance with EC7, BS EN 1997-1+A1 (2013), the proposed structures are considered to be Geotechnical Category 2. As such, foundation recommendations are presented to aid development proposals only and separate geotechnical design will be required.

6.4.1 *Foundation Type*

The Made Ground is considered unsuitable in its present condition for use as founding soils on the basis of its unpredictable nature and likely deposition in an uncontrolled manner and should be fully penetrated by all new foundations or excavated, screened, processed and re-engineered to create the development platform.

Unless improved in stiffness by the insertion of stone columns, the Black Park Gravel is also considered unsuitable in its present condition for use as founding soils on the basis of its low and often variable strength and should be fully penetrated by all new foundations.

On the basis of the ground conditions indicated from the current and previous investigations, the foundations will likely comprise piled foundations due to the unsuitability of the shallow soils and anticipated loads from the 3-10 storey blocks. Certainly, for the higher loaded buildings.

As mentioned, ground improvement with stone columns could be used to stiffen and unify the ground. In combination with re-engineered shallow fill materials and raft foundations atop, such a solution could be used to support 3 storey housing in some areas. Otherwise piled foundations should be implemented.

6.4.2 *Piled foundations*

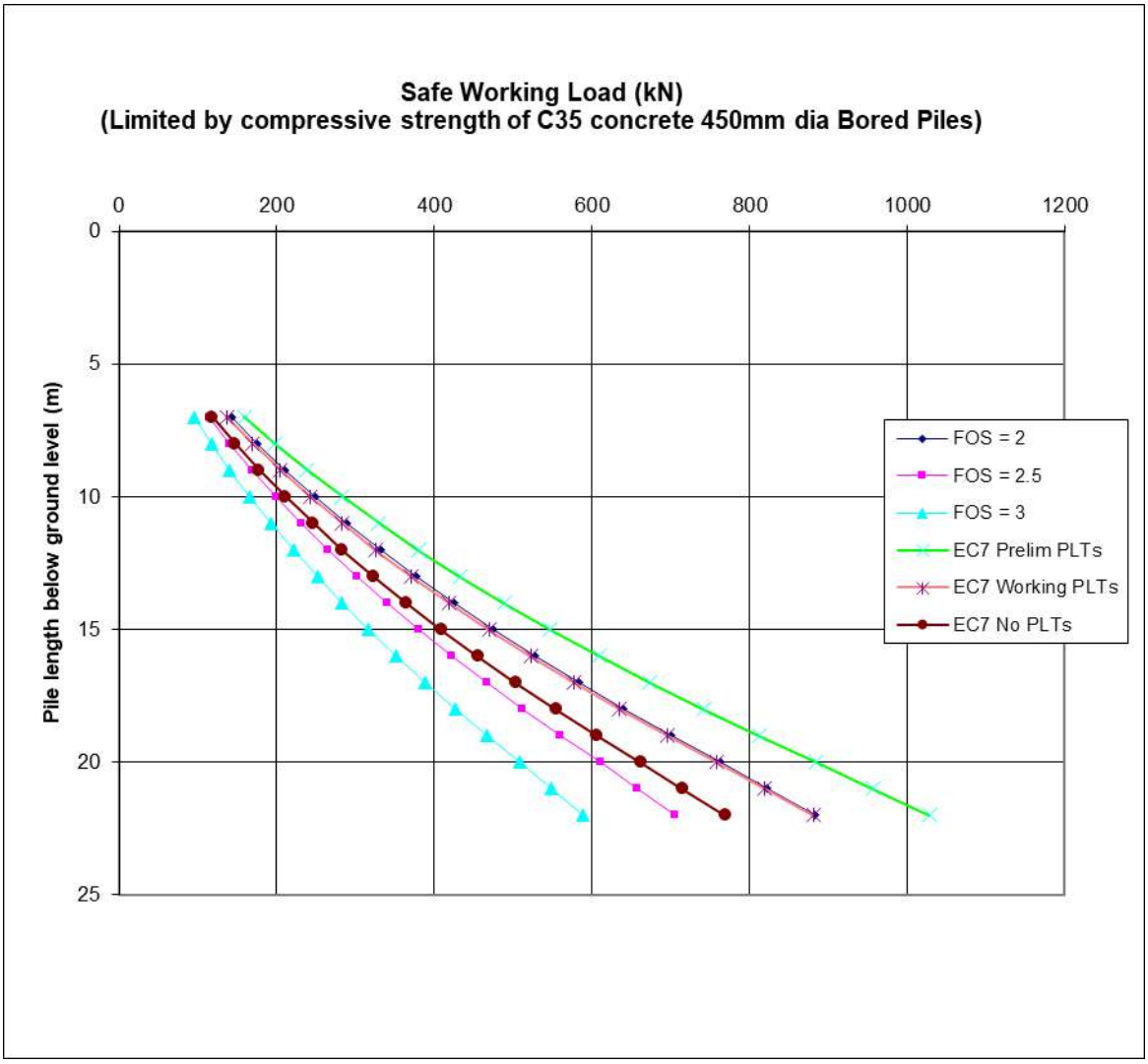
Depending on column loads and layouts, piles should extend through the Made Ground and River Terrace Deposits and to a suitable depth into the underlying London Clay Formation.

Driven piles / bored piles with the use of casing / CFA piles should be suitable to support the foundations for the structures. However, the choice of piling system should be undertaken by a

specialist piling Contractor and the design of piles is beyond the scope of this report. The decision on pile type and design should take into account the following factors relevant to the site:

- Obstructions in the ground are expected from the previous structures, which could cause piles to stop shallower than the design depths, or to deviate from the vertical, thereby reducing their capacity. In some circumstances, obstructions can lead to pile breakage.
- Pile installation can create preferential pathways for the migration of contaminants to the groundwater.
- Boring of piles through coarse soils can result in loosening of the material, with resultant risk of shaft collapse prior to concreting and reduced shaft friction.
- Groundwater levels are at roughly 36m OD and temporary casing may be required to depths of approximately 20m bgl for bored piles. If CFA piles are used, concrete is placed as the auger is withdrawn, which can balance the water pressure if the operation is undertaken carefully.
- Depending on the working loads involved, piles should extend a minimum of five pile diameters into the bearing stratum to mobilise sufficient shaft friction and end-bearing resistance to carry the required loads without unacceptable settlement.
- Consideration for the potential down-drag effects of negative skin friction on piles from the secondary consolidation of the shallow superficial soils may be needed if ground levels are to be raised.
- Collapse of the pile shaft can be caused by 'necking' of the pile in running sand conditions, leading to pile failure. Such conditions do not, however, appear to have been detected on the site.
- Where foundations are constructed on clay soils within the influencing distance of trees design should include for the upper section of the pile to be sleeved or additional length allowed for to resist stresses from clay swelling or shrinkage. In addition, heave protection may be required on the inside faces and underside of the ground beams.

For the purposes of initial designs, the following indicative range pile working loads can be expected depending on design method and scale of testing undertaken. Ultimately pile designs will need to be undertaken by the specialist contractor.



6.5 Roads and pavements

Based on the test results and subject to *in situ* testing during construction, a CBR of <2.5% should be used for design.

Proof rolling of the formation level will be required and any loose or soft spots should be removed and replaced with an engineered fill, in accordance with a suitable Specification. The formation level will also need to be protected during inclement weather from deterioration; all slopes should be trimmed to falls to shed rain water and the surface sealed to limit infiltration.

Prior to the placement of the founding materials and the construction of the road pavement, the sub-formation and formation will need to be inspected and checked in accordance with a suitable specification to ensure the ground conditions are as expected. All testing should be carried out in accordance with DMRB IAN 73/06 to confirm that the ground conditions at time of construction are consistent with the previous design parameters.

Where the CBR is found to be less than 2.5%, the sub-grade may be unsuitable for both the trafficking of site plant and as support for a permanent foundation, without improvement works being undertaken. Improvement works should be carried out in accordance with DMRB IAN 73/06 Rev 1 Chapter 5. In summary, consideration may be given to the following potential remedial techniques:

» excavation and re-engineering or replacement of weaker soils;

- the inclusion of geosynthetic reinforcement within the unbound layers of the capping and sub-grade;
- where cohesive soils are present and they are deemed suitable for treatment with hydraulic binders, to employ modification and/or stabilisation techniques on the formation; and
- where granular soils are present, de-watering and re-engineering the formation.

6.6 Buried concrete

Based on guidelines provided in BRE Special Digest 1 (BRE 2005) and the information presented in Section 5.5.9 (Table 5.13):

- The shallow soils (Made Ground and River Terrace Deposits) can be classified as Design Sulfate Class DS-1 and ACEC Class AC-1.
- The deeper soils of the London Clay Formation can be classified as Design Sulfate Class DS-2 and ACEC Class AC-2 for strip / trench fill / pad foundations.
- Review of data collected by Ian Farmer Associates suggests the Design Sulfate Class for the London Clay Formation should be more conservatively assigned a value of DS-4 and ACEC Class AC-4 at depth.
- The ring beams of piles, (which will be constructed within the Made Ground and River Terrace Deposits) can be classified as Design Sulfate Class DS-1 and ACEC Class AC-1., whilst the clays of the London Clay Formation are potentially pyritic, piles can be classified as Design Sulfate Class DS-4 and ACEC Class AC-4.

This equates to a Design Chemical Class[4] of:

- DC-1 for the shallow soils (Made Ground and River Terrace Deposits);
- DC-4 for the deeper soils (clays of the London Clay Formation); and
- DC-4 for piles.

The designer should check and confirm the classification of concrete using the information presented in Appendix D and Appendix E during the design.

[4] The calculated ACEC class can be used in accordance with BS 8500-1+A2 (2019), Table A.9 to select the Designated Concrete (DC) class for an intended working life of 50 years. However, the designer is referred to BS 8500-1+A2 (2019), for full details and notes to Table A.9, including any Additional Protective Measures (APMs).

7. Geo-environmental assessment

7.1 Updated conceptual model

7.1.1 Updated ground model

The initial conceptual site model developed from the desk study and field reconnaissance survey (Section 3) has been updated using the findings of the ground investigation and is presented in Section 5. This CSM is the basis for the geo-environmental assessment presented in this section.

7.1.2 Updated exposure model

Following the ground investigation, the plausible contaminant sources, receptors and pathways identified in the preliminary geo-environmental exposure model (Section 3) have been updated or confirmed as follows.

7.1.2.1 Sources

No potential sources have been added to, the exposure model.

The following potential source has been removed from the exposure model.

» Ground gases (carbon dioxide and methane) from organic materials in the Made Ground / River Terrace Deposits). Due to the Made Ground / Black Park Gravel Member having an average TOC of <1%, indicating CS1 conditions.

7.1.2.2 Receptors

No potential receptors have been added to, the exposure model.

The following potential receptors have been removed from the exposure model.

» Groundwater: Secondary A aquifer status of the Black Park Gravel Member.

» Surface water: The River Pinn 196m to the east.

Due to the lack of lateral continuity and an identifiable groundwater body within the Black Park Gravel Member at the site.

7.1.2.3 Pathways

No pathways have been added to, the exposure model.

The following potential pathways have been removed from the exposure model.

» Methane ingress via permeable soils and/or construction gaps. Due to the removal of ground gasses as a potential source.

» Root uptake by plants. Due to a lack of exceedances of the Phytotoxic GAC and current lack of a growing medium at the site, meaning import of subsoil / topsoil will be required.

» Migration of contaminant via leachate migration through the unsaturated zone in the Black Park Gravel Member. Due to lack on lateral continuity within the Black Park Gravel Formation.

» Surface water via base flow from groundwater. Due to lack of a contiguous groundwater body in the shallow soils.

Using the updated ground model and updated exposure model, generic risk assessment is undertaken as presented below.

7.2 Risk assessment approach

Using the updated CSM, a Tier 2 generic quantitative risk assessment (GQRA) for identified receptors based on all media sampled has been undertaken in accordance with the principles of LCRM.

Firstly, the risks associated with the identified potential contaminant linkages have been estimated using standardised methods (typically involving comparison of site data with published 'screening values'). Secondly, where screening values are exceeded, the result has been evaluated in an authoritative review of the findings with other pertinent information to determine whether or not the exceedance is or is not acceptable in the site-specific circumstances.

The data sets used in the assessment comprise the analytical results obtained by Hydrock as listed in Section 5.

7.3 Human health risk assessment

7.3.1 Soils Assessment

7.3.1.1 Generic Assessment Criteria

The soil screening values used are generic assessment criteria (GAC) (i.e. derived in accordance with EA CLEA guidance (2009) using the updated exposure model detailed in Defra SP1010 (2014), with the exception of published C4SLs. The term 'GAC' used in this report is inclusive of all generic soil screening values.

Based on the proposed development, generic assessment criteria (GAC) based on a residential without homegrown produce CLEA land use scenario hase been adopted.

GAC are selected based on the following hierarchy:

- Category 4 Screening Levels (C4SL), where available.
- SoBRA Acute GAC for free cyanide, as acute dose toxicity is the primary risk driver.
- Hydrock GAC, derived by Hydrock as detailed in Appendix G.

The results of the assessment are presented in Appendix G.

7.3.1.2 Data sets

The data set used in this report is based on the conceptual site model and the proposed development, and is taken to be the entire area of the site, with the data separated into Made Ground and natural soils.

GAC based on a soil organic matter (SOM) of 1% have been adopted for all soils based on laboratory results. Assessment sheets are presented in Appendix G.

7.3.1.3 Assessment Results

Based on individual test results that exceed the GAC, the chemicals of potential concern (CoPC) which require further assessment are summarised in Table 7.1.

Table 7.1: CoPC in soils which require further assessment (human health)

CoPC	GAC (mg/kg)	GAC Source	No. samples	Min. (mg/kg)	Max. (mg/kg)	No. samples >GAC
Made Ground						
Benzo(a)pyrene	5.3	C4SL	22	<0.05	7.00	1
Benzo(b)fluoranthene	4.1	Hydrock GAC	22	<0.05	6.30	3
Beryllium	1.7	Hydrock GAC	22	0.71	2.00	1
Dibenz(ah)anthracene	0.32	Hydrock GAC	22	0.05	0.80	4
Black Park Gravel Member						
No Exceedances						

One sample (TP07 – 0.10m) has been removed from the analysis as this sample was taken from asphalt surfacing and is not considered representative of the general Made Ground at the site.

The individual analytical results have been compared with the relevant GAC in the summary table Appendix G. From this, the CoPC in Made Ground are Beryllium (1 out of 22 samples), benzo(a)pyrene (1 out of 22 samples), Benzo(b)fluoranthene (3 out of 22 samples) and Dibenz(ah)anthracene (3 out of 22 samples). The presence of beryllium and PAHs in Made Ground requires further consideration.

All samples submitted for analysis of petroleum hydrocarbons (PHCs), reported concentrations below the GAC and/or laboratory limit of detection.

The phrase 'further assessment required' is used to denote soil concentrations that exceed a GAC. This does not necessarily mean that the soil is 'contaminated' or not otherwise suitable for use. The assessment and any mitigation required are to ensure the site does not pose an 'unacceptable risk' as defined under Planning and Part 2A of EPA 1990.

7.3.2 *Risk evaluation*

Of the three samples showing exceedances for Benzo(b)fluoranthene, two are considered minor (4.2mg/kg and 4.8mg/kg vs a GAC of 4.1mg/kg).

Of the four samples showing exceedances for Dibenz(ah)anthracene, three are considered minor (0.45mg/kg and 0.46mg/kg vs a GAC of 0.32mg/kg).

These exceedances are unlikely to pose a threat to receptors at the site due to the use of conservative screening values which are based on regular soil exposure in residential gardens. This is unlikely to be representative of the current design for the site, which is for commercial / office outlets on the ground floors of the proposed 3-10 storey blocks with residential flats above, Communal Public Open Space at the site is likely to require the import of a suitable subsoil / topsoil growing medium, as no suitable materials currently exist at the site.

An exceedance of the GAC for beryllium (1.2mg/kg vs 2.0mg/kg) has been noted in Made Ground at CP02 (1.5m bgl). A further sample collected at CP02 at 0.5m bgl did not exceed the GAC for beryllium. Due to the depth of the sample and planned design of the development, (inclusive of requirement to import a growing medium for areas of POS) it is considered unlikely that this hotspot poses a risk to the end use receptor, thus no mitigation measures are required.

Significant Exceedances of the GAC for several PAH species have been noted in Made Ground at Ws06 (0.3m bgl). Mitigation measures are required to break this pollutant linkage.

7.3.3 Asbestos

Asbestos has been identified by laboratory testing of soil samples as provided in Table 7.2.

Table 7.2: Asbestos in soil samples (laboratory testing)

Location	Depth (m bgl)	% Asbestos (w/w)	Comment
TP07	0.1	<0.001	Fibres (chrysotile).

A Joint Industry Working Group Assessment has been carried out (Appendix G) and assessed the risks to receptors at the site to be low.
It is also noted that the sample in which asbestos fibres were detected was collected from asphalt surfacing, which is scheduled to be removed as part of the development process.
As such no mitigation measures are required.

7.4 Phytotoxicity risk assessment

7.4.1 Risk estimation

Priority phytotoxic chemical concentrations have been screened against published values to determine the likely risk to plant growth (phytotoxic GAC). Phytotoxic GAC based on a pH >7% have been adopted for all soils based on laboratory results.

As with human health, individual sample test results are compared directly with the phytotoxic GAC.

Results indicate that all CoPC are below the relevant phytotoxic GAC, therefore the contaminant linkage is incomplete.

7.4.2 Risk evaluation

There is no subsoil or topsoil growing medium on the site and this will require import.

7.5 Pollution of controlled waters risk assessment

7.5.1 Risk estimation

The risks to groundwater and surface water from contaminants on site have been assessed in accordance with the Environment Agency (2006) Remedial Targets Methodology (RTM).

Site contaminant loadings are compared with relevant screening values (Water Quality Targets (WQTs), which are linked to the CSM.

Acceptable WQT are defined for protection of human health (based on Drinking Water Standards (DWS)) and for protection of aquatic ecosystems (Environmental Quality Standards (EQS)).

As related specifically to this site, the data are compared with criteria selected in accordance with the methodology presented in Appendix G. This methodology involves selecting which of several alternative risk scenarios apply in this case. The following justification for the scenarios selected is explained in the following text:

- The Black Park Gravels and not laterally contiguous across the site and are unlikely to provide basal flow to the River Pinn 196m east of the site. Any water encountered within the Made

Ground / Black Park Gravels would be considered perched water and as such is not considered as a receiving groundwater body.

- There is a low risk of surface water runoff or contaminants leached from the Made Ground entering the River Pinn to the east of the site due to the distance between the site and the river.
- Groundwater has been detected within the London Clay Formation, however due to the presence of a significant thickness of low permeability clays between this groundwater and the Chalk, there is no viable pathway to groundwater in the underlying Chalk Aquifer and as such this groundwater body has not been assessed.

7.5.2 Risk evaluation

Hydrock believes that the risks to Controlled Waters do not need further consideration.

7.6 Ground gases risk assessment

CL:AIRE RB17 (Card et al 2012) states that where there are natural soils with low organic content and 1m to 5m of Made Ground (average <3m) that comprises general infill and car park construction materials with total organic carbon (TOC) less than 1%, no gas protection is required as this represents CS1. As such, no ground gas protection is required. Total organic carbon (TOC) results have been calculated from soil sampling at the site and are presented in Appendix G.

7.7 Construction materials risk assessment

7.7.1 Water pipelines

A formal water pipe investigation and risk assessment is beyond the scope of this report. However, the findings of this investigation have been compared to the threshold values in Water UK HBF (2014), Table 1 as far as is practicable.

The site is brownfield and organic contamination (PAH) has been identified in exceedance of the threshold values and Hydrock believes barrier pipe is required. However, confirmation should be sought from the water supply company at the earliest opportunity.

7.7.2 Other construction materials

Plastic pipes for drains and sewers are manufactured from unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP) or polyethylene (PE). These materials may be affected by the presence of organic compounds in the soil.

In accordance with the British Plastics Federation Guidance (August, 2018), as the concentrations of petroleum hydrocarbons (TPH) are above 200 mg/kg, the pipework manufacturer should be consulted with regard the suitability of the pipework.

The implications for buried concrete are discussed in Section 6.6.

7.8 Findings of the generic contamination risk assessments

The potential sources, pathways and receptors identified in the desk study (Section 2) have been investigated (Cross ref usually Sections 4 and 5) and assessed (Sections 7.2 to 7.7). A Source-Pathway-Receptor linkage assessment has been undertaken and is presented in Appendix J (Table K.2).

A summary of the Source-Pathway-Receptor (SPR) contaminant linkages for which the risks may be unacceptable and require mitigation (those that are moderate or higher) are discussed in Table 7.3.

Table 7.3 assumes the following SPR linkages which have been discounted (subject to agreement) at the risk evaluation stage are confirmed by the regulators and the warranty provider as not

requiring further consideration (mitigation). If these assumptions are not agreed during regulatory discussions, the conclusions as noted in Table 7.3 will need to be updated:

» Slightly elevated concentrations of PAH at 0.3mbgl in WS06

Table 7.3: Residual risks following risk evaluation

Contaminant Linkage				Comments	
Pollutant Linkage	Sources	Pathways	Receptors	General	Mitigation
PL 1.	Hotspot of PAH in the Made Ground (WS06).	Ingestion, inhalation or direct contact.	Human health.	Moderate exceedances of the GAC.	Mitigation required in the form of excavation, disposal and verification. Clean cover system in areas of Public Open Space.
PL 2.	PAH in soils.	Direct contact	Water supply pipes.	The Made Ground contain contaminants of concern at levels in excess of the GAC.	Installation of "Protectaline" (or similar) pipework.

7.9 Mitigation measures

The outline remediation strategy presented below is provided for guidance only, and does not represent a 'Remediation Options Appraisal', or a 'Remediation Strategy', prepared in accordance with LCRM (2021).

As shown in Table 7.3 (and subject to regulatory (and NHBC) agreement), Hydrock consider the following mitigation is required to ensure the site is suitable for use for the proposed end use. The mitigation measures include:

» The excavation and replacement of the PAH hotspot (PL1).

» The installation of a 450mm cover system in public open space, comprising subsoil beneath a topsoil thickness of between 150mm and 300mm (PL1).

» Installation of Protectaline pipework (PL2).

The methodology for the remediation should be set out in a Remediation Strategy (which will include the 'Implementation Plan', the 'Verification Plan' and the 'Long Term Monitoring and Maintenance Plan'), which will need to be submitted to the warranty provider and the regulatory authorities for approval.

In addition, the production of a Materials Management Plan and its approval by a Qualified Person will be required to allow reuse of suitable material at the site in accordance with waste regulations.

Verification reports by a competent independent geo-environmental specialist will be required following completion of any remedial works.

8. Waste and materials management

8.1 Introduction

The Waste Framework Directive (WFD) (2009/98/EC) defines waste as '*any substance which the holder discards or intends to discard.*' In a geo-environmental context, the waste is most often 'soil' and the two main scenarios are offsite disposal of the material as a waste and/or reuse of the material on site. For cost and sustainability reasons, reuse is preferred to off-site disposal.

Section 8.2 below describes the key issues relating to off-site disposal to landfill and Section 8.3 considers requirements relating to reuse of soils and materials management.

8.2 Waste disposal

8.2.1 Principles

Based on the WFD, any material excavated on site may be classified as waste and it is the responsibility of the producer of a material to determine whether or not it is waste. Where off-site disposal is undertaken, the following guidance applies.

Classification is a staged process:

- A hazardous waste is defined under the WFD as one which possesses one or more of fifteen defined hazardous properties. If a waste is not defined as hazardous, then it is non-hazardous.
- Where the materials are soil, it is then be assigned using the 'List of Waste Codes', which classifies the material as either:
  - hazardous (17-05-03), which is defined as "*soil and stones containing hazardous substances*"; or
  - non-hazardous (17-05-04), which is defined as "*soil and stones other than those mentioned in 17-05-03*".
  - Hydrock utilise the proprietary assessment tool, HazWasteOnline™ to undertake this assessment.
- Waste Acceptance Criteria (WAC) testing is then undertaken if required, and are only applicable following classification of the waste, and only where the waste is destined for disposal to landfill. The WAC are both qualitative and quantitative. The WAC and the associated laboratory analyses (leaching tests) are not suitable for use in the determination of whether a waste is hazardous or non-hazardous.

It should be noted that some non-hazardous wastes may be suitable for disposal at an inert landfill as non-hazardous waste, subject to meeting the appropriate waste acceptance criteria.

It should be noted that classification must be undertaken on the waste produced, by the waste producer. Necessary sampling frequency to adequately characterise a soil population is defined within WM3.

Further discussion with regards to the characterisation process for different scenarios and waste types is provided below.

Topsoil and Peat

Topsoil and peat are biodegradable, therefore if they are surplus to requirements and cannot be re-used in accordance with a Materials Management Plan, they cannot be classified as inert. As such, topsoil and peat need to be classified by a staged assessment and sampling process and would either be classified as hazardous or non-hazardous, depending upon the results of the assessment.

Greenfield sites

Waste from completely greenfield sites may be accepted at a landfill as inert waste if it meets the requirements of paragraph 10 (wastes acceptable without testing at landfills for inert waste) of the Landfill (England and Wales) (Amendment) Regulations (2005) ('the Regulations') can be met. Paragraph 10 of the Regulations states, "*soils may be able to be classified as inert waste without testing, if:*

- *they are single stream waste of a single waste type;*
- *there is no suspicion of contamination and they do not contain other material or substances such as metals, asbestos, plastics, chemicals, etc…..*"

As such, where the site is greenfield and the waste producer is confident about the quality of a soil (i.e. naturally occurring and uncontaminated), further sampling and laboratory testing is not necessary for the Basic Characterisation and this can be undertaken on qualitative Waste Acceptance Criteria testing.

In this instance the waste producer can characterise the waste based on visual assessment and written description of the waste in addition to supporting evidence such as a desk study assessment of the greenfield status. However, it should be noted this characterisation is subject to agreement by the landfill operator who may require testing to be undertaken to confirm classification.

Contaminated or potentially contaminated sites

If the site is brownfield, contaminated or potentially contaminated, the waste must undergo an initial waste classification exercise using background information on the source and origin of the waste and assessment of chemical test data in accordance with Environment Agency Technical Guidance WM3.

If following the initial waste classification exercise, the soils are acceptable for disposal to a non-hazardous landfill, further qualitative Waste Acceptance Criteria (WAC) testing is not required.

However, if soils are potentially able to be disposed to an inert landfill as non-hazardous waste, or require testing to determine if they can be disposed of to a stable non-reactive hazardous or hazardous class of landfill, the next stage of assessment is to undertake qualitative WAC testing. This will determine the Basic Characterisation and the landfill category at which the soils can be accepted.

Hazardous material must be subjected to WAC testing to determine whether it requires treatment before it can be accepted at the hazardous landfill, while non-hazardous material can be tested to determine whether it may be suitable for placement in an inert landfill.

8.2.2 HazWasteOnline™ assessment

As the site is brownfield, in order to inform the preliminary waste characterisation process, Hydrock has undertaken an exercise using the proprietary web-based tool HazWasteOnline™. The output of the HazWasteOnline™ assessment is provided in Appendix H and a summary of the preliminary waste classification is provided below in Section 8.2.3.

It should be noted that some of the soil samples assessed as part of the HazWasteOnline™ are classified as potentially hazardous on account of the designation 'HP3i' (with regards to petroleum hydrocarbons). However, based upon carbon banding of the TPH, the findings of the investigation and the way the petroleum hydrocarbons are distributed within the soil, it is likely that the potential for the soil being hazardous on account of HP3i can be all but discounted and it would be reasonable to assume that the result would indicate that the soil, would be non-hazardous as a result of the TPH content.

8.2.3 Preliminary waste disposal options

The site is brownfield and based on the site history and the HazWasteOnline™ assessment, if suitable segregation of different types of waste is put in place, for soils to be disposed of, it is considered that:

- The natural uncontaminated subsoils are likely to be classified as 'inert' waste and based on the Hazwaste Assessment should be able to be disposed of at an inert landfill.
- The 'General' Made Ground is likely to be classified as non-hazardous waste.
- Any soils containing > 0.1% asbestos or visible asbestos containing materials would be considered as hazardous.

8.2.4 General waste comments

It should be noted that:

- It is the waste producer's responsibility to segregate the waste at source and waste producers must not mix waste materials/streams or dilute hazardous components, for example by mixing with less or non-hazardous waste on site to meet WAC limit values.
- The above preliminary assessment has been made on the basis of the soils tested as part of the ground investigation, using the HazWasteOnline™ assessment. However, the formal classification of waste can only be undertaken on the material to be disposed of, and by the waste producer and the receiving landfill as license conditions vary from landfill to landfill.
- Basic Characterisation should be undertaken in accordance with Environment Agency guidance by the waste producer. Hydrock can assist if required and this report will assist the characterisation. However, Basic Characterisation does not form part of the current commission and would require further assessment and testing on the wastes actually to be disposed.
- Once the waste producer has undertaken an initial Basic Characterisation on each waste stream, they can manage the soils as part of the on-site processing programme (for example, stockpiling, treatment, screening and separation). The waste producer and landfill operator will then need to agree the suite of compliance testing for regularly generated waste to demonstrate compliance with the initial Basic Characterisation prior to disposal.
- At the time of disposal, additional testing on the excavated soils to be disposed of, will likely be necessary.
- Non-hazardous and hazardous soils require pre-treatment (separation, sorting and screening) prior to disposal.
- The costs for disposal of non-hazardous and hazardous soils are significant compared to disposal of inert material.

- In addition to disposal costs, landfill tax will be applicable. Non-hazardous and hazardous waste will generally be subject to the Standard Rate Landfill Tax. Inert or inactive waste will generally be subject to the Lower Rate Landfill Tax. The landfill tax value changes each April and can be found at https://www.gov.uk/government/publications/rates-and-allowances-landfill-tax/landfill-tax-rates-from-1-april-2013.
- Before a waste producer can move waste to a landfill site for disposal, they need to check the landfill site has the appropriate permit and must have completed the following[5]:
  - Duty of care transfer note / Hazardous Waste consignment note, including comment as to if pre-treatment has been undertaken; and
  - Basic Characterisation of the waste, to include: description of the waste; waste code (using list of wastes); composition of the waste (by testing, if necessary) and; WAC testing (if required).

8.3 Materials management

8.3.1 Introduction

Soils that are to remain on site, should be managed and reused in accordance with a Materials Management Plan (MMP), prepared in accordance with 'The Definition of Waste: Development Industry Code of Practice', Version 2 (CL:AIRE), known as the DoWCoP. Where all aspects of the DoWCoP are followed the soils are considered not to be waste, because they were never discarded in the first place.

Version 2 of the DoWCoP clearly sets out the principles and an outline of the requirements of a MMP. The following compliance criteria must be seen to apply to the MMP for the site:

- Factor 1: Protection of human health and protection of the environment.
- Factor 2: Suitability for use, without further treatment.
- Factor 3: Certainty of Use.
- Factor 4: Fixed Quantity of Material.

The reuse of soils at sites should be considered during the planning and development design process so that compliance with issues such as fixed quantity and certainty of use clearly relate to agreed site levels. Suitability of Use is normally evident from the remediation strategy or the design statement, which form an integral part of a MMP. However, some soils may need to be tested post-excavation to prove they are suitable for use.

Once the MMP is finalised, it must be declared by a Qualified Person (QP). The Declaration is an on-line submission as part of which the QP is required to confirm that the declaration is being made before the relevant works have commenced (i.e. it is not a retrospective application).

Once all material movements have been completed in accordance with the MMP a verification report must be produced, kept for 2 years and provided to the EA on request.

It should be noted that failure to comply with the requirements of the DoWCoP when re-using materials has potentially significant consequences for the waste holder. The risk is that the reused materials are still regarded as a waste that has been illegally deposited. From 1 April 2018, the scope of Landfill Tax has been extended to sites operating without the appropriate environmental disposal permit, and operators of illegal waste sites will now be liable for Landfill Tax. Further

[5] ENVIRONMENT AGENCY. November 2010. Guidance on waste acceptance procedures and criteria. Waste acceptance at landfills. The Environment Agency.

information is available at: https://www.gov.uk/government/publications/landfill-tax-disposals-not-made-at-landfill-sites/landfill-tax-disposals-not-made-at-landfill-sites.

If soils are excavated and reused on sites (or moved to another site) without a MMP, exemption, or appropriate Permit in place, anyone who knowingly facilitates the disposal may be *'jointly and severally liable'* to any assessment of tax, fines or prosecution.

8.3.2 Materials management scenarios

The materials management scenarios present on site are discussed below.

It should be noted that more than one scenario may apply, dependent upon where the soils are proposed for reuse.

8.3.2.1 Clean, naturally occurring materials – transferred to other sites

Where soils are naturally occurring, uncontaminated and are transferred to other sites (i.e. direct transfer), they will not become waste as long as the transfer is undertaken in accordance with the DoWCoP. A MMP must be prepared for the receiving site and the materials movement must be noted in the MMP of the Donor site. This movement must have been declared to CL:AIRE prior to the works commencing.

8.3.2.2 Made Ground and other contaminated soils

On sites where Made Ground or contaminated soils are present, any soils excavated will be a waste as soon as they are excavated (even if they are clean, naturally occurring materials), unless they are subject to reuse in accordance with the DoWCoP. As such, for any brownfield site or a site where Made Ground is present and soils are being moved and reused, the materials could be deemed a waste, subject to either:

- a Materials Management Plan (MMP), to prevent the material being classified as a waste following reuse; or
- an exemption (for limited volumes); or
- an environmental permit, dependant on its status.

Other commonly occurring circumstances are:

8.3.2.3 Made Ground and other contaminated soils

All recycled materials (6F2 etc.) must be produced under the 2013 WRAP 'Quality Protocol: Aggregates from inert waste', whether on site or off-site. If they are not, they will be deemed a waste and can only be used on site under a permit. More information can be found at https://www.gov.uk/government/publications/quality-protocol-production-of-aggregates-frm-inert-waste.

8.3.2.4 Geotechnical improvement requirements

Construction activities carried out on uncontaminated soils solely for the purpose of improving geotechnical properties e.g. lime / cement modification, are not generally regarded as waste treatment operations and do not require a permit.

However, should processing be needed (such as screening, treatment or improvement), that would constitute a waste activity and require a mobile treatment permit. This may be as simple as removing oversize material with an excavator bucket, to using a riddle bucket to remove hardcore to full mechanical screening.

9. Uncertainties and limitations

9.1 General comments

Hydrock Consultants Limited (Hydrock) has prepared this report in accordance with the instructions of Vinci St. Modwen (VSM) (the Client), by e-mail dated October 2022 under the terms of appointment for Hydrock, for the sole and specific use of the Client and parties commissioned by them to undertake work where reliance is placed on this report. Any third parties who use the information contained herein do so at their own risk. Hydrock shall not be responsible for any use of the report or its contents for any purpose other than that for which it was prepared or for use of the report by any parties not defined in Hydrock's appointment.

This report details the findings of work carried out in November 2022. The report has been prepared by Hydrock on the basis of available information obtained during the study period. Although every reasonable effort has been made to gather all relevant information, not all potential environmental constraints or liabilities associated with the site may have been revealed.

Hydrock has used reasonable skill, care and diligence in the design of the investigation of the site and in its interpretation of the information obtained. The inherent variation of ground conditions allows only definition of the actual conditions at the locations and depths of trial pits and boreholes at the time of the investigation. At intermediate locations, conditions can only be inferred.

Groundwater data are only representative of the dates on which they were obtained and both levels and quality may vary.

Plans that provide assessment of foundation types and depths are indicative and subject to further design. This design should incorporate a detailed assessment of the influence of trees, influence of cut to fill proposals and geological conditions.

Unless otherwise stated, the recommendations in this report assume that ground levels will remain as existing. If there is to be any re-profiling (e.g. to create development platforms or for flood alleviation) then the recommendations may not apply.

Information provided by third parties has been used in good faith and is taken at face value; however, Hydrock cannot guarantee its accuracy or completeness.

Where the existing report(s) prepared by others have been provided by the Client, it is assumed that these have been either commissioned by the Client, or can be assigned to the Client, and can be relied upon by Hydrock. Should this not be the case Hydrock should be informed immediately as additional work may be required. Hydrock is not responsible for any factual errors or omissions in the supplied data, or for the opinions and recommendations of others. It is possible that the conditions described may have since changed through natural processes or later activities.

The work has been carried out in general accordance with recognised best practice. Unless otherwise stated, no assessment has been made for the presence of radioactive substances or unexploded ordnance. Where the phrase 'suitable for use' is used in this report, it is in keeping with the terminology used in planning control and does not imply any specific warranty or guarantee offered by Hydrock.

The chemical analyses reported were scheduled for the purposes of risk assessment with respect to human health, plant life and controlled waters as discussed in the report. Whilst the results may be useful in applying the Hazardous Waste Assessment Methodology given in Environment Agency Technical Guidance WM3, they are not primarily intended for that purpose and additional analysis will be required at the time of disposal to fully classify waste. Discussion and comment with regards to waste classification are preliminary and do not form the requirements of 'Basic Characterisation' as required.

Assessment and testing for the presence of coal tar has only been completed at the locations of exploratory holes undertaken for risk assessment purposes. This investigation is not designed to provide a definitive assessment of the risk from coal tar, nor the waste classification for bituminous bound pavement arisings at the site.

Unless otherwise stated, at the time of this investigation the future routes of water supply pipes had not been established. This investigation and sampling strategy may not be fully compliant with UKWIR recommendations. Consequently, a targeted investigation and specific sampling and chemical testing may be required at a later date once the routes of the supply pipes are known. In addition, it is recommended that the relevant water supply company be contacted at an early stage to confirm its requirements for assessment, which may not necessarily be the same as those recommended by UKWIR.

Whilst the preliminary risk assessment process has identified potential risks to construction workers, consideration of occupational health and safety issues is beyond the scope of this report.

Please note that notwithstanding any site observations concerning the presence or otherwise of archaeological sites, asbestos-containing materials or invasive weeds, this report does not constitute a formal survey of these potential constraints and specialist advice should be sought.

Any site boundary line depicted on plans does not imply legal ownership of land.

10. Recommendations for further work

Following the ground investigation works undertaken to date, the following further works will be required:

- specialist UXO/UXB risk assessment in accordance with CIRIA Report C681 with regard to construction risk;
- discussion and agreement with utility providers regarding the materials suitable for pipework;
- discussions with regulatory bodies and the warranty provider regarding the conclusions of this report;
- assessment of tree influence on foundations and design of foundations;
- discussions with piling Contractors regarding conclusions of this report and design of the piles;
- provision of geotechnical design for the Category 2 structures (earthworks, floor slabs, foundations etc.);
- production of a Remediation Strategy and Verification Plan (and agreement with the regulatory bodies and the warranty provider);
- production of a Materials Management Plan relating to reuse of soils at the site;
- remediation and mitigation works; and
- verification of the earthworks, remediation and mitigation works.

11. References

ALLEN, D. L., BREWERTON, L. J., COLEBY, L. M., GIBBS, B. R., LEWIS, M. A., MACDONALD, A. M., WAGSTAFF, S. J. and WILLIAMS, A.T. 1997. The physical properties of major aquifers in England and Wales. British Geological Survey Technical Report WD/97/34. 312pp. Environment Agency R and D Publication 8.

ASSOCIATION OF GROUND INVESTIGATION SPECIALISTS. 2006. Guidelines for Good Practice in Site Investigation. Issue 2. AGS, Beckenham.

ASSOCIATION OF GROUND INVESTIGATION SPECIALISTS. 2019. Waste Classification for Soils – A Practitioners' Guide. AGS, Beckenham.

BRE. 1980. Low-rise buildings on shrinkable clay soils: Part 1. BRE Digest 240. Building Research Establishment, Garston.

BRE. 1999. The influence of trees on house foundations in clay soils. BRE Digest 298. Building Research Establishment, Garston.

BRE. 2016. Soakaway design. BRE DG 365. BRE, Garston.

BRE. 2005. Concrete in aggressive ground. BRE Special Digest 1, 3rd Edition. BRE, Garston.

BRITISH PLASTIC FEDERATION. August 2018. 'Designing Drains and Sewers for Brownfield Sites. Guidance Notes'. BPF Pipes Group (https://www.bpfpipesgroup.com/media/29155/Designing-drains-and-sewers-for-brownfield-sites.pdf)

BRITISH STANDARDS INSTITUTION. 2015. Code of Practice for Foundations. BS 8004. BSI, London.

BRITISH STANDARDS INSTITUTION. 2003. Geotechnical investigation and testing - Identification and classification of rock - Part 1: Identification and description. BS EN ISO 14689-1 Incorporating Corrigendum No.1. BSI, London

BRITISH STANDARDS INSTITUTION. 2015+A2 2019. Concrete – complementary British Standard to BS EN 206-1 – Part 1: Method of specifying and guidance to the specifier. BS 8500-1+A2 2019. BSI, London.

BRITISH STANDARDS INSTITUTION. 2007. Eurocode 7 – Geotechnical design - Part 2: Geotechnical investigation and testing. BS EN 1997-2. BSI, London.

BRITISH STANDARDS INSTITUTION. 2009. Code of practice for earthworks. BS 6031 Incorporating Corrigendum No.1:2010. BSI, London.

BRITISH STANDARDS INSTITUTION. 2011. Code of Practice for Investigation of Potentially Contaminated sites. BS 10175 Incorporating Amendment No. 2:2017. BSI, London.

BRITISH STANDARDS INSTITUTION. 2012. Trees in relation to design, demolition and construction – Recommendations. BS 5837. BSI, London.

BRITISH STANDARDS INSTITUTION. 2004+A1 2013. Eurocode 7 – Geotechnical design - Part 1: General rules. BS EN 1997-1+A1. Incorporating Corrigendum February 2009. BSI, London.

BRITISH STANDARDS INSTITUTION. 2015. Specification for topsoil. BS 3882. BSI, London.

BRITISH STANDARDS INSTITUTION. 2015. Code of practice for ground investigations. BS 5930. BSI, London.

BRITISH STANDARDS INSTITUTION. 2015+A1 2019. Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings. BS 8485:2015 +A1:2019. BSI, London.

CARD, G., WILSON, S. and MORTIMER, S. 2012. A pragmatic approach to ground gas risk assessment. CL:AIRE Research Bulletin RB17. CL:AIRE, London.

CARD, G., LUCAS, J., WILSON, S., 2019. Risk and reliability in gas protection design - 20 years on. Ground Engineering, August/September 2019.

CL:AIRE, 2017. A Pragmatic Approach to Ground Gas Risk Assessment. Research Bulletin 17, CL:AIRE, Buckinghamshire. ISSN 2047-6450.

CL:AIRE, 2020. Professional Guidance: Comparing Soil Contamination Data with a Critical Concentration. CL:AIRE, Buckinghamshire. ISBN 978-1-905046-35-5.

CL:AIRE, 2018. Ground gas monitoring and 'worst-case' conditions. Technical Bulletin 17, CL:AIRE, Buckinghamshire, August 2018.

CL:AIRE, 2021. Good practice for risk assessment for coal mine gas emissions. CL:AIRE, Buckinghamshire. ISBN 978-1-905046-39-3

CLAYTON, C. R. I. 2001. Managing Geotechnical Risk. Improving productivity in UK building and construction. Thomas Telford, London.

CL:AIRE. March 2011. The Definition of Waste: Development Industry Code of Practice, Version 2. Contaminated Land: Applications in the Real Environment (CL:AIRE), London.

CL:AIRE. March 2016. CAR-SOIL™ Control of Asbestos Regulations 2012 - Interpretation for Managing and Working with Asbestos in Soil and Construction and Demolition Materials: Industry guidance. Contaminated Land: Applications in the Real Environment (CL:AIRE), London.

CONCRETE SOCIETY, THE. 2013. Concrete industrial ground floors. A guide to design and construction. Technical Report 34 (4th Ed.). The Concrete Society, Camberley.

DEPARTMENT FOR ENVIRONMENT FOOD AND RURAL AFFAIRS (DEFRA). 2005. 'Landfill (England and Wales) (Amendment) Regulations', (with reference to previous iterations of the regulations).

DEFRA. March 2014. SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document. Defra, London.

ENVIRONMENT AGENCY. June 2001. National Groundwater and Contaminated Land Centre Report NC/99/73: Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention. The Environment Agency, Bristol.

ENVIRONMENT AGENCY. 2006. Remedial Targets Methodology. Hydrogeological Risk Assessment for Land Contamination. The Environment Agency, Bristol.

ENVIRONMENT AGENCY. November 2010. Guidance on waste acceptance procedures and criteria. Waste acceptance at landfills. The Environment Agency.

ENVIRONMENT AGENCY. November 2011. Treatment of waste for landfill. Report – GEHO1111BVDF-E-E 913_11, Version 2 The Environment Agency. http://publications.environment-agency.gov.uk/pdf/GEHO1111BVDF-E-E.pdf

ENVIRONMENT AGENCY. 2021. Waste classification. Guidance on the classification and assessment of waste (1st Edition v1.2.GB) Technical Guidance WM3. The Environment Agency.

ENVIRONMENT AGENCY. 2021. Land Contamination: Risk Management (LCRM). The Environment Agency.

HATANAKA, M, UCHIDA, A, KAKURAI, M, and AOKI, M. 1980. A consideration on the relationship between SPT N-value and internal friction angle of sandy soils. Journal of Structural and Construction Engineering (Transactions of AIJ). 63. 125-129. 10.3130/aijs.63.125_2.

HEALTH and SAFETY EXECUTIVE. December 2005. Construction Information Sheet 47: Inspections and Reports (CIS 47 (Rev 1)). HSE.

HEALTH and SAFETY EXECUTIVE. 2014. HSG47 - Avoiding danger from underground services (Third edition). HSE.

HIGHWAYS AGENCY. 2009. Design Guidance for Road Pavement Foundations (Draft HD25). Interim Advice Note 73/06. Rev 1. Highway Agency, London.

HIGHWAYS AGENCY. 2014. Manual of Contract Documents for Highway Works, Specification for Highway Works: Volume 1, Amendment August 2014. Highway Agency, London.

THE HIGHWAYS AGENCY. 2015. Design Manual, Road and Bridges: Volume 4, Geotechnics and Drainage; Section 1, Earthworks; Part 3, HD 41/15, Maintenance of highway geotechnical assets. HD 41/15.

THE HIGHWAYS AGENCY. 2019. Design Manual for Roads and Bridges. Managing Geotechnical Risk. CD 622 Rev 0. Highway Agency, London.

JONES, H. K., MORRIS, B. L., CHENEY, C. S., BREWERTON, L. J., MERRIN, P. D., LEWIS, M. A., MACDONALD, A. M., COLEBY, L. M., TALBOT, J. C., MCKENZIE, A. A., BIRD, M. J., CUNNINGHAM, J. and ROBINSON, V. K. 2000. The physical properties of minor aquifers in England and Wales. British Geological Survey Technical Report WD/00/04. 234pp. Environment Agency R and D Publication 68.

MILES, J. C. H., APPLETON, J. D., REES, D. M., GREEN, B. M. R., ADLAM. K. A. M. and MYRES. A. H. 2007. Indicative Atlas of Radon in England and Wales. Health Protection Agency and British Geological Survey. Report HPA-RPD-033.

MINISTRY OF HOUSING, COMMUNITIES and LOCAL GOVERNMENT (MHCLG). Internet published Planning practice guidance https://www.gov.uk/government/collections/planning-practice-guidance. MHCLG. London

NATHANAIL P., JONES A., OGDEN, R., AND ROBERTSON A. 2014. Asbestos in soil and made ground: a guide to understanding and managing risks. CIRIA Report C733 Contaminated Land: Applications in Real Environments, London.

NHBC and ENVIRONMENT AGENCY. 2008. Guidance for the safe development of housing on land affected by contamination. R&D Publication 66, 2 Volumes.

NHBC. 2023. NHBC Standards. NHBC, Milton Keynes. https://nhbc-standards.co.uk/

PECK, R.B., HANSON, W.E., AND THORNBURN, T.H., Foundation Engineering, 2nd Edn, John Wiley, New York, 1967, p.310.

RAWLINS, B. G., McGRATH, S. P., SCHEIB, A. J., CAVE, N., LISTER, T. R., INGHAM, M., GOWING, C. and CARTER, S. 2012 .The advanced geochemical atlas of England and Wales. British Geological Survey, Keyworth.

SCIVYER, C. 2015. Radon: Guidance on protective measures for new buildings. Building Research Establishment Report BR 211. BRE, Garston.

STONE, K., MURRAY, A., COOKE, S., FORAN, J. and GOODERHAM, L. 2009. Unexploded ordnance (UXO), a guide to the construction industry. CIRIA Report C681. Contaminated Land: Applications in Real Environments, London.

STROUD, M. A. 1975. The standard penetration test in insensitive clays and soft rocks. Proceedings of the European Symposium on penetration testing, 2, 367-375.

TOMLINSON. M.J. 2001. Foundation Design and Construction (6th Edition and 7th Edition). Prentice Hall Press

WASTE AND RESOURCES ACTION PROGRAMME (WRAP). October 2013. Quality Protocol. Aggregates from inert waste. End of waste criteria for the production of aggregates from inert waste.

WATER UK HBF. January 2014. Contaminated Land Assessment Guidance. Water UK and the Home Builders Federation.

WILSON, S., OLIVER, S., MALLETT, H., HUTCHINGS, H. and CARD, G. 2007. Assessing risks posed by hazardous ground gases to buildings. CIRIA Report C665. Contaminated Land: Applications in Real Environments, London.

WILSON S., ABBOT S., MALLETT H. 2014. Guidance on the use of plastic membranes as VOC vapour barriers. CIRIA Report C748 Contaminated Land: Applications in Real Environments, London

Appendix A Drawings

SETTING OUT NOTES:
All setting out to be confirmed on site prior to construction - any discrepancy must be immediately reported to the Architect.

All setting out to face of structure or to grid. All partitions set out to studwork or structure.

For setting out and specification of M&E services refer to M&E Consultants documents.

For setting out and specification of structure refer to Structural Engineer's documents.

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Metres 1:1250

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KEY

Site boundary for hybrid planning application

Site boundary for full element of Hybrid Planning Application (the Former RAF Cinema Building)

rev	date	description	drawn	audited
C01	31.05.2024	Issued for Planning	FS	WT

drawing status

ACCEPTED FOR PLANNING

Diespeker Wharf
38 Graham Street
London N1 8JX
020 7336 7777
forename.surname@ptea.co.uk
@ptearchitects
www.pollardthomasedwards.co.uk

Pollard Thomas Edwards

project	job number	drawn	scale	date created
St Andrew's Gate, Town Centre Extension (TCE), Uxbridge	23-012	FS	1 : 1250@A1	Nov '23

drawing title
Site Location Plan

drawing number: **SAG- PTE- ZZ-00-DR-A-10000**
revision: **C01**
Suitability: **A3**

Appendix B Historical ordnance survey maps

Groundsure INSIGHTS

Site Details:

506087, 183874

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Report Ref: HYD-9293975_Landline_1_1
Grid Ref: 506091, 183710

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Map date: **2003**
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Printed at: 1:1,250

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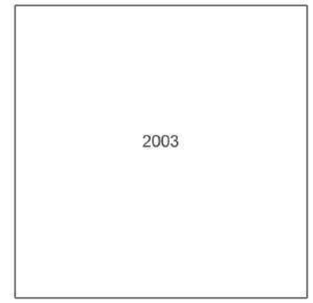

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Produced by
Groundsure Insights
T: 08444 159000
E: info@groundsure.com
W: www.groundsure.com

Production date: 12 January 2023

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

Groundsure INSIGHTS

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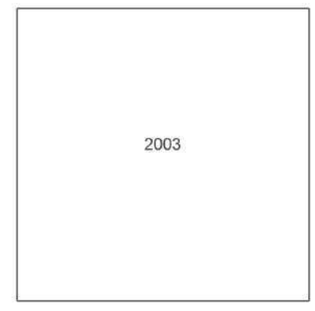

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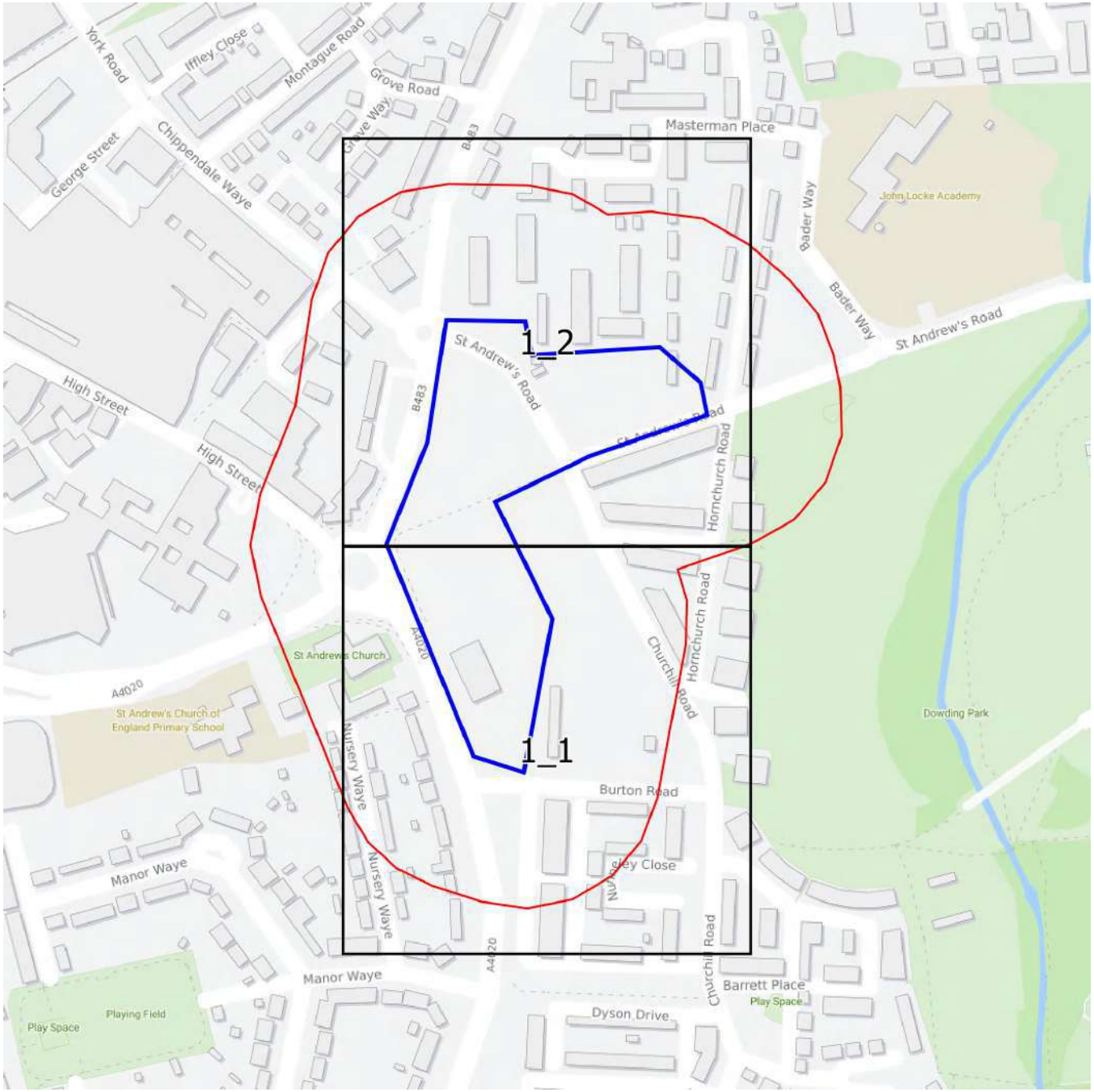

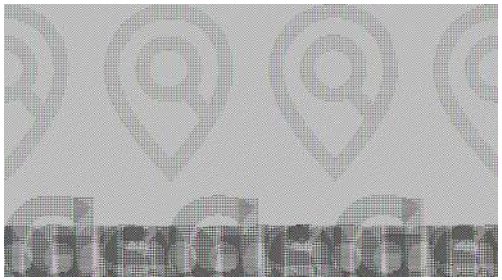

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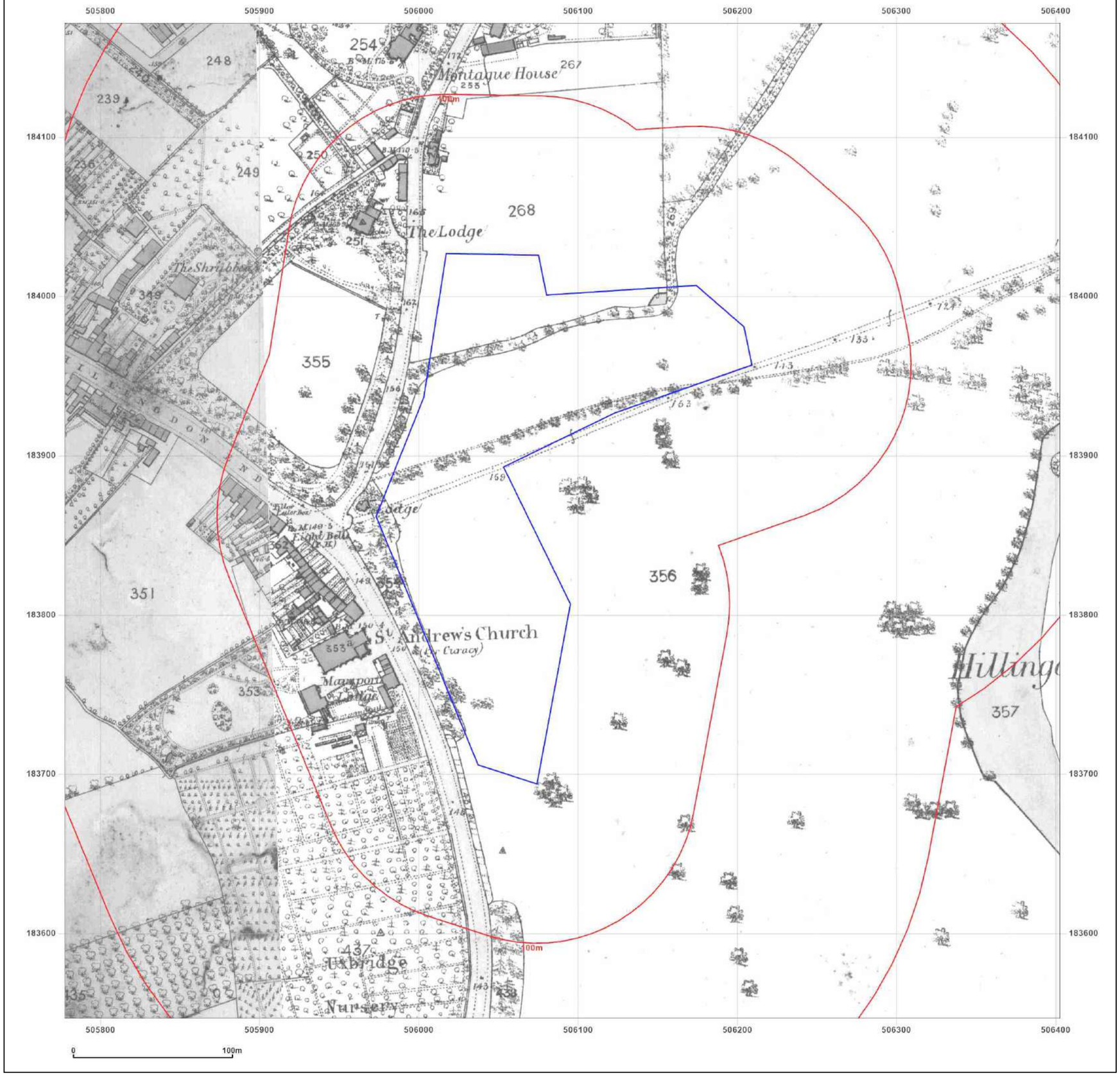

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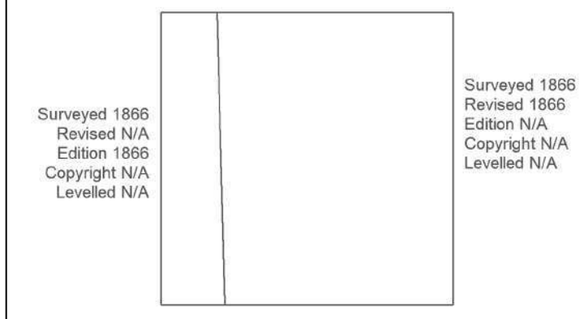

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Produced by
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Production date: 12 January 2023

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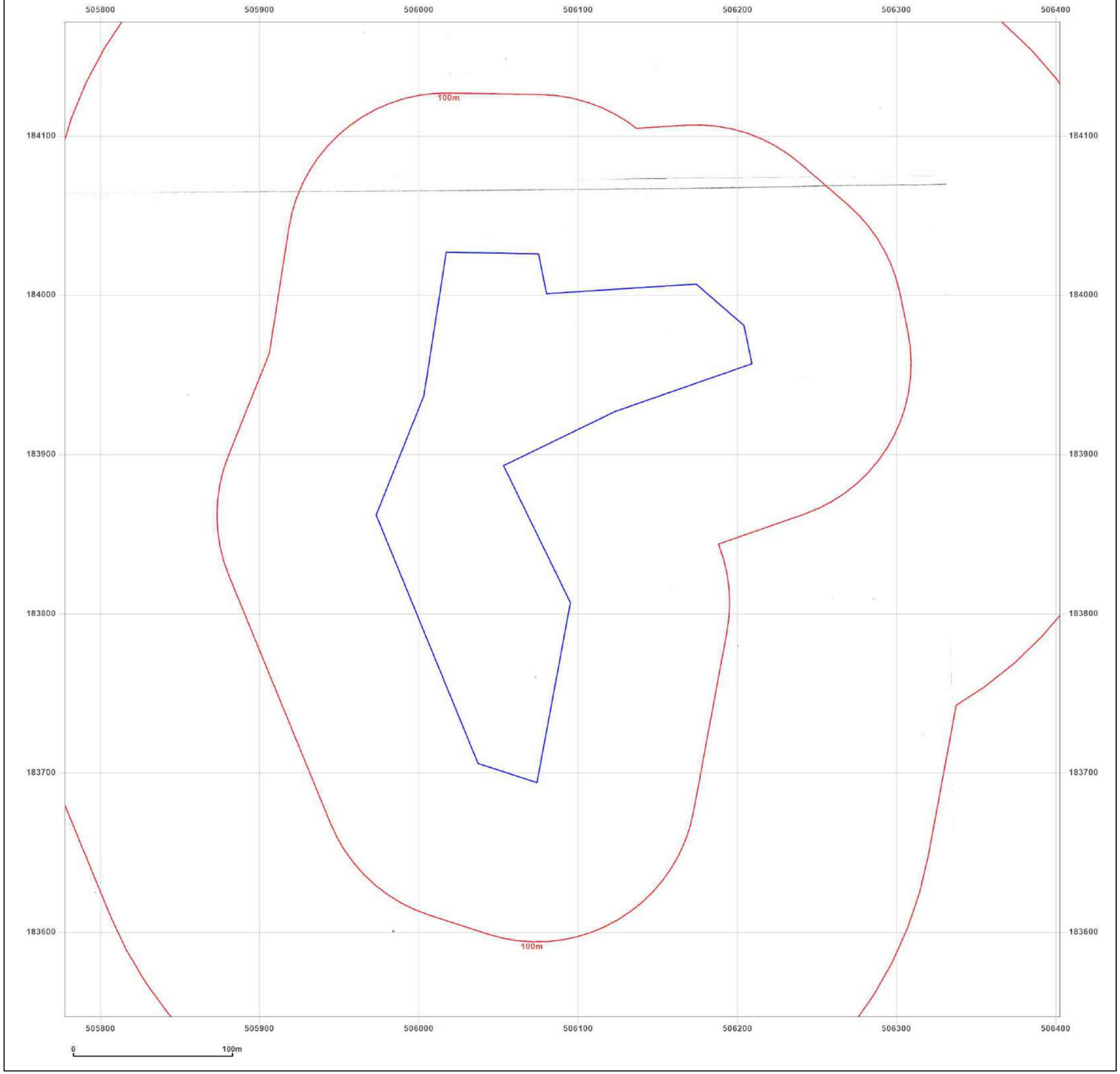

Groundsure INSIGHTS

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506087, 183874

Client Ref: PO23248
Report Ref: HYD-9293975_2500
Grid Ref: 506090, 183859

Map Name: County Series

Map date: **1877-1878**

Scale: 1:2,500

Printed at: 1:2,500

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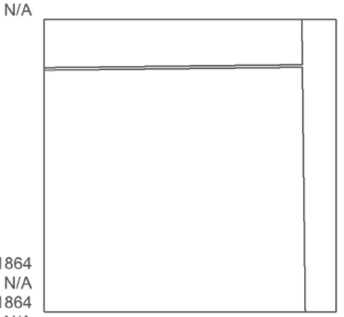
Surveyed 1864
Revised N/A
Edition 1864
Copyright N/A
Levelled N/A



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

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Production date: 12 January 2023

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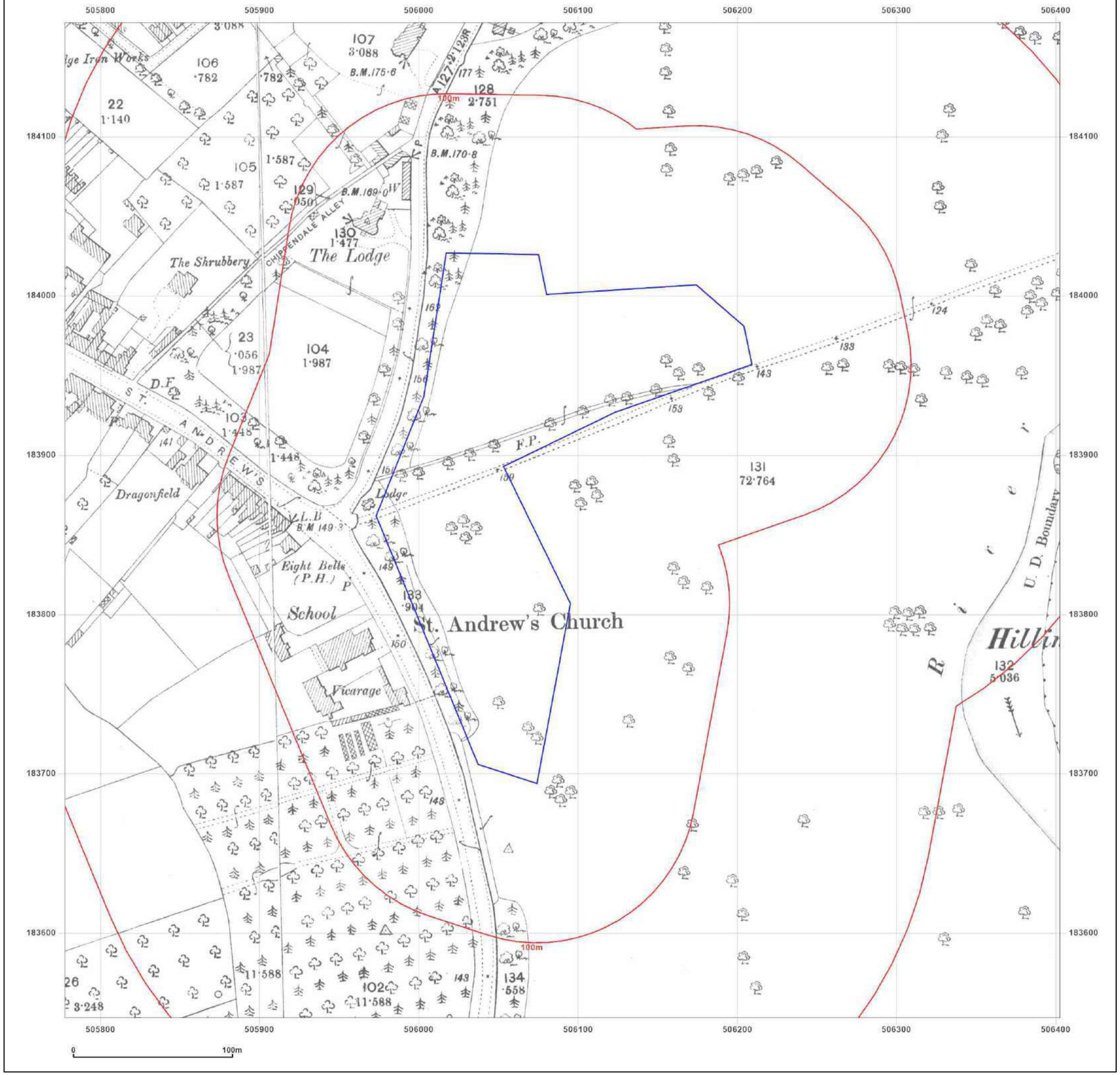

Groundsure INSIGHTS

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506087, 183874

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Report Ref: HYD-9293975_2500
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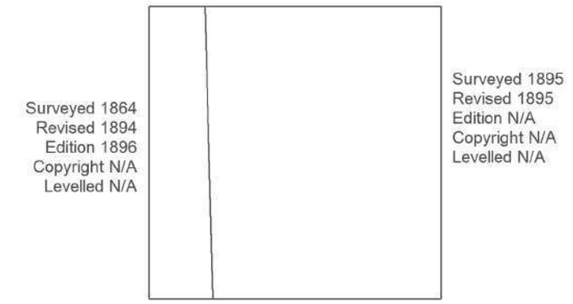

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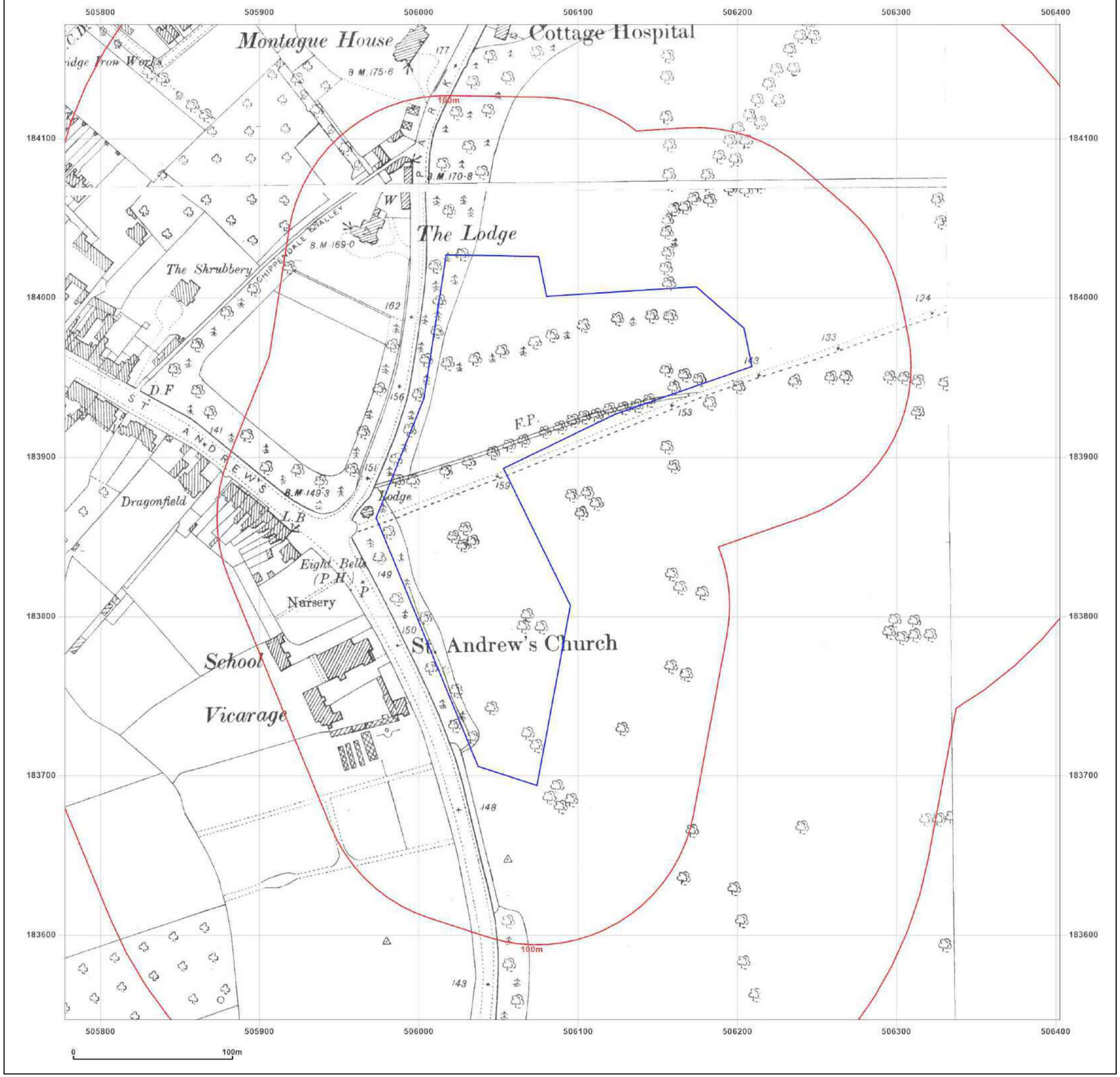
W: www.groundsure.com

Production date: 12 January 2023

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



Groundsure INSIGHTS

Site Details:

506087, 183874

Client Ref: PO23248
Report Ref: HYD-9293975_2500
Grid Ref: 506090, 183859

Map Name: County Series

Map date: **1899**

Scale: 1:2,500

Printed at: 1:2,500

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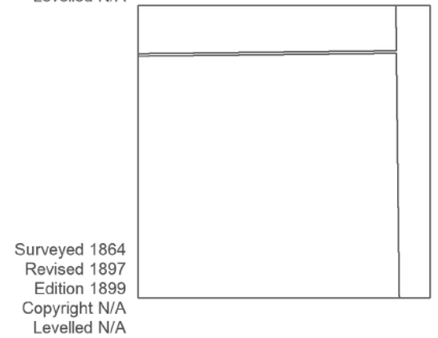

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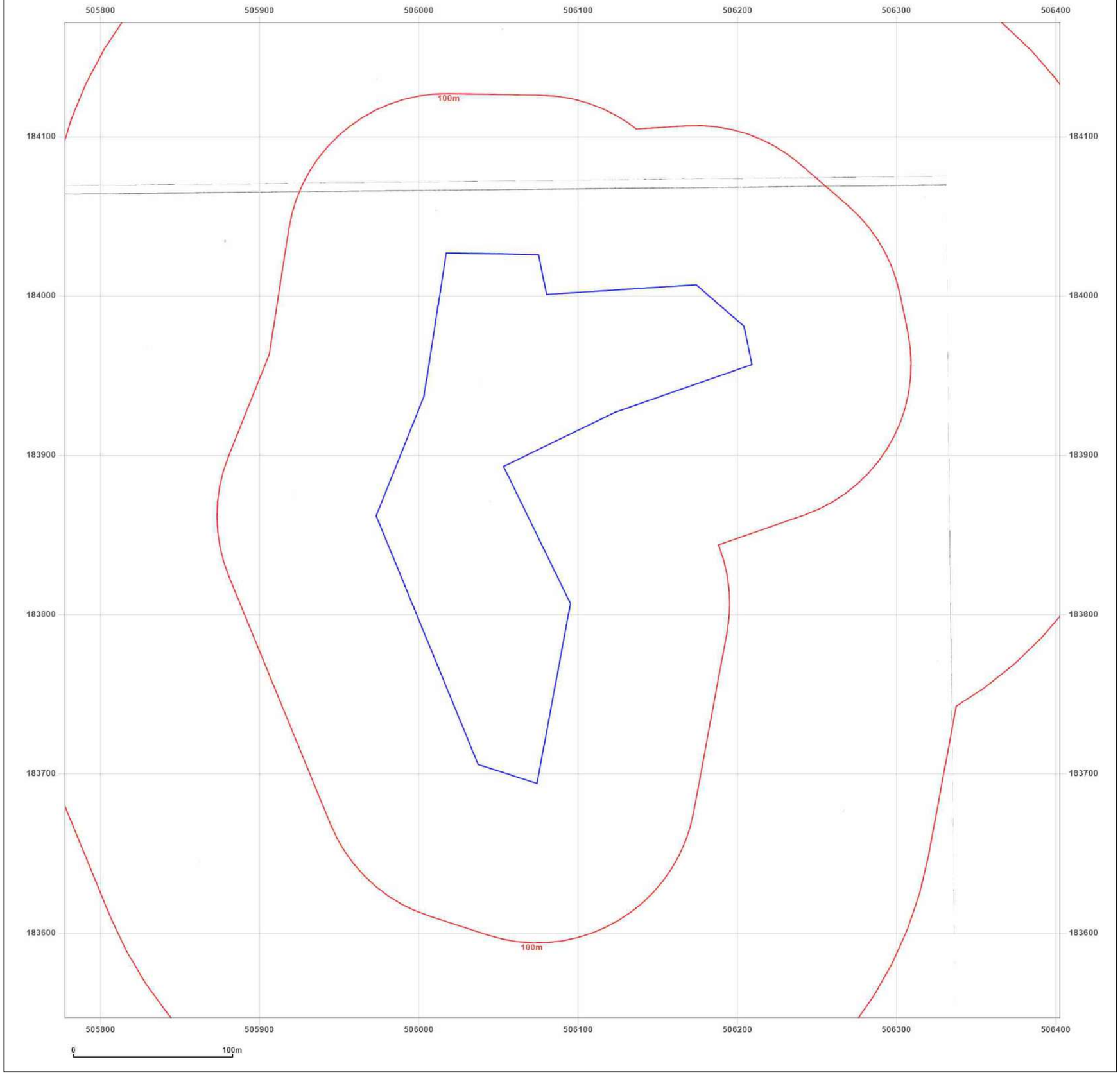
Production date: 12 January 2023

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



Groundsure INSIGHTS

Site Details:

506087, 183874

Client Ref: PO23248
Report Ref: HYD-9293975_2500
Grid Ref: 506090, 183859

Map Name: County Series

Map date: **1932**

Scale: 1:2,500

Printed at: 1:2,500

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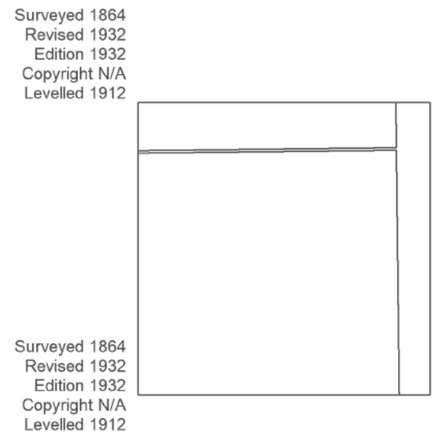

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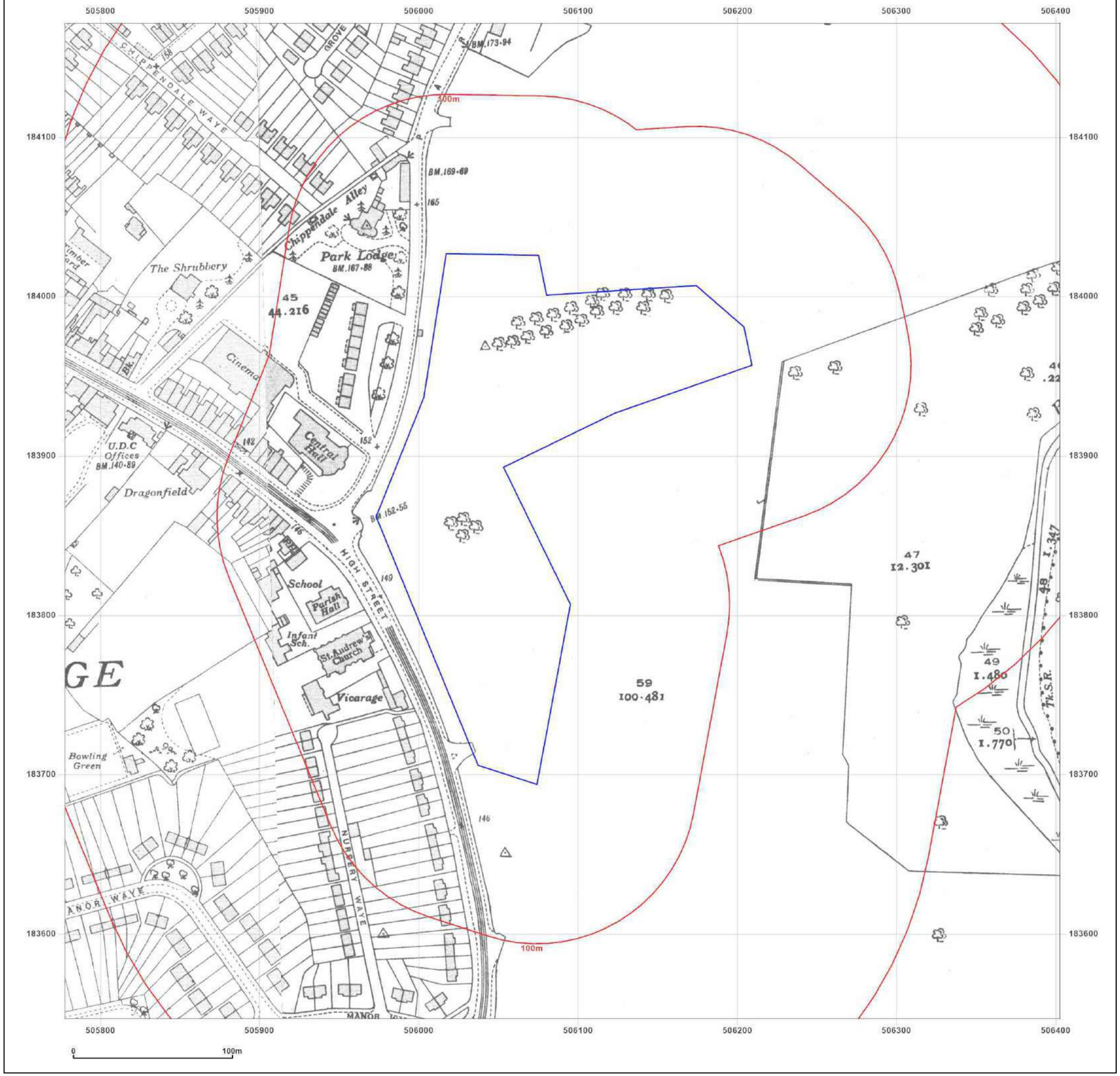

Groundsure INSIGHTS

Site Details:

506087, 183874

Client Ref: PO23248
Report Ref: HYD-9293975_2500
Grid Ref: 506090, 183859

Map Name: County Series

Map date: **1934-1935**

Scale: 1:2,500

Printed at: 1:2,500

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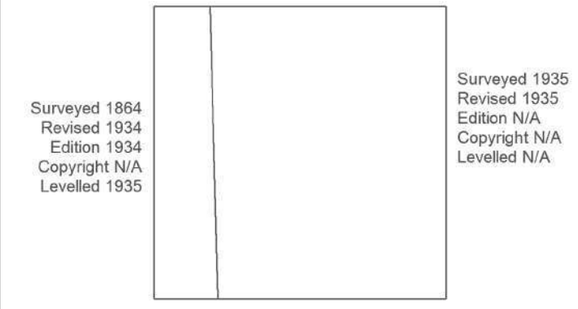

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Groundsure INSIGHTS

Site Details:

506087, 183874

Client Ref: PO23248
Report Ref: HYD-9293975_2500
Grid Ref: 506090, 183859

Map Name: National Grid

Map date: **1966**

Scale: 1:2,500

Printed at: 1:2,500

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

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Production date: 12 January 2023

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Groundsure INSIGHTS

Site Details:

506087, 183874

Client Ref: PO23248
Report Ref: HYD-9293975_2500
Grid Ref: 506090, 183859

Map Name: National Grid

Map date: **1963-1966**

Scale: 1:2,500

Printed at: 1:2,500

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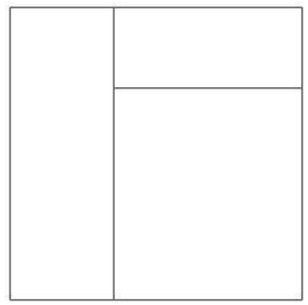
Surveyed 1962
Revised 1962
Edition 1963
Copyright 1963
Levelled 1957



Surveyed 1963
Revised 1963
Edition 1966
Copyright 1966
Levelled 1957

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Production date: 12 January 2023

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Groundsure INSIGHTS

Site Details:

506087, 183874

Client Ref: PO23248
Report Ref: HYD-9293975_2500
Grid Ref: 506090, 183859

Map Name: National Grid

Map date: **1973**

Scale: 1:2,500

Printed at: 1:2,500

N
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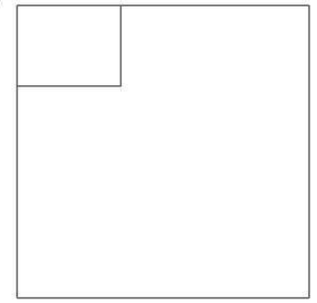
Surveyed 1962
Revised 1971
Edition N/A
Copyright 1973
Levelled 1957



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Groundsure INSIGHTS

Site Details:

506087, 183874

Client Ref: PO23248
Report Ref: HYD-9293975_1250_1_1
Grid Ref: 506090, 183610

Map Name: National Grid

Map date: **1963-1964**

Scale: 1:1,250

Printed at: 1:2,000

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Surveyed 1962 Revised 1962 Edition N/A Copyright 1963 Levelled 1957	Surveyed 1963 Revised 1963 Edition N/A Copyright 1964 Levelled 1957
Surveyed 1962 Revised 1962 Edition N/A Copyright 1963 Levelled 1957	Surveyed 1963 Revised 1963 Edition N/A Copyright 1964 Levelled 1956

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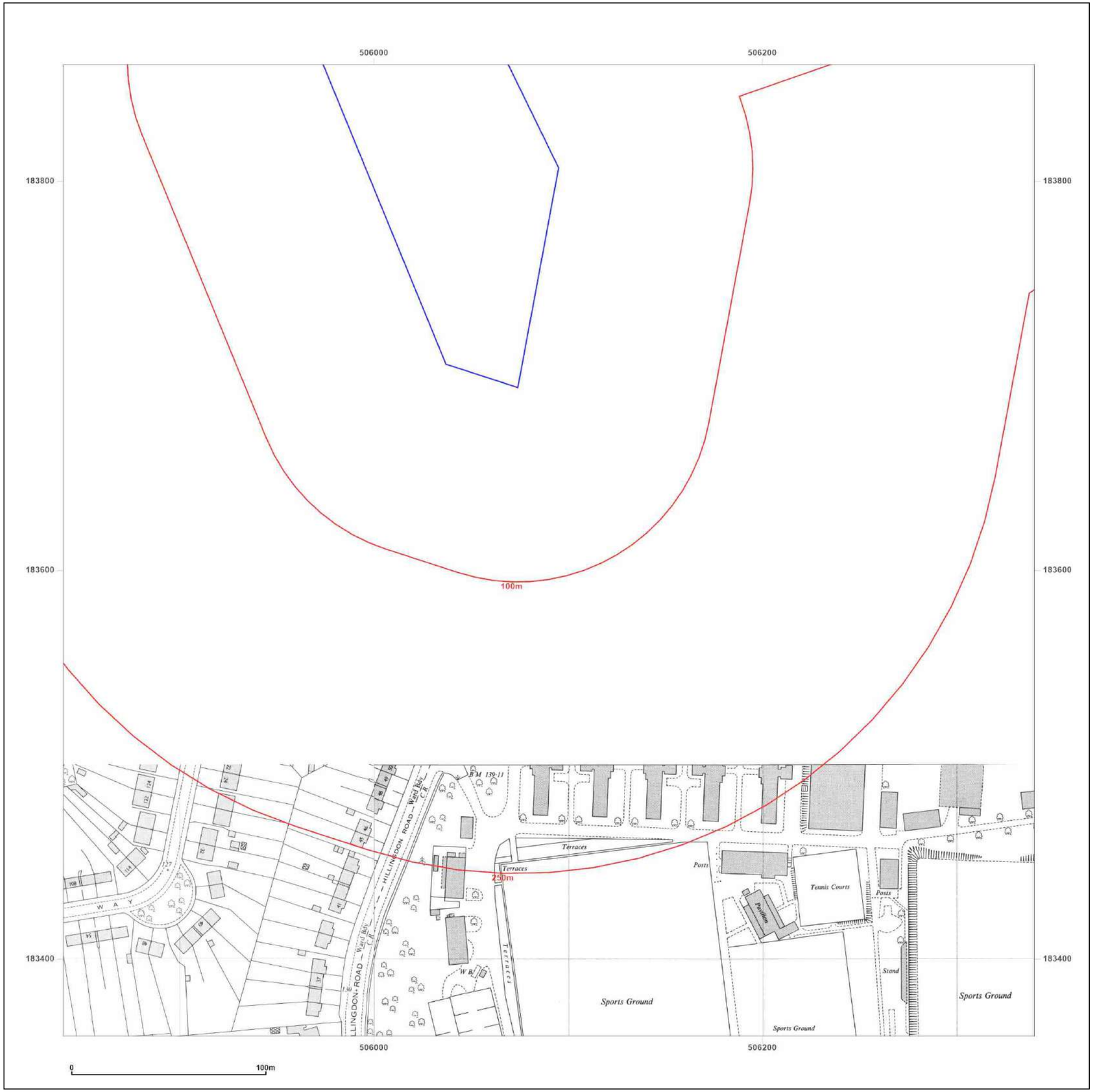

Groundsure INSIGHTS

Site Details:

506087, 183874

Client Ref: PO23248
Report Ref: HYD-9293975_1250_1_1
Grid Ref: 506090, 183610

Map Name: National Grid

Map date: **1963-1967**

Scale: 1:1,250

Printed at: 1:2,000

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Surveyed 1962	Surveyed 1963
Revised 1962	Revised 1966
Edition N/A	Edition N/A
Copyright 1963	Copyright 1967
Levelled 1957	Levelled 1956

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Groundsure INSIGHTS

Site Details:

506087, 183874

Client Ref: PO23248
Report Ref: HYD-9293975_1250_1_1
Grid Ref: 506090, 183610

Map Name: National Grid
Map date: **1973-1977**
Scale: 1:1,250
Printed at: 1:2,000

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Surveyed N/A Revised N/A Edition N/A Copyright N/A Levelled N/A	Surveyed N/A Revised N/A Edition N/A Copyright N/A Levelled N/A
Surveyed 1962 Revised 1972 Edition N/A Copyright 1973 Levelled 1957	Surveyed 1963 Revised 1974 Edition N/A Copyright 1975 Levelled 1956

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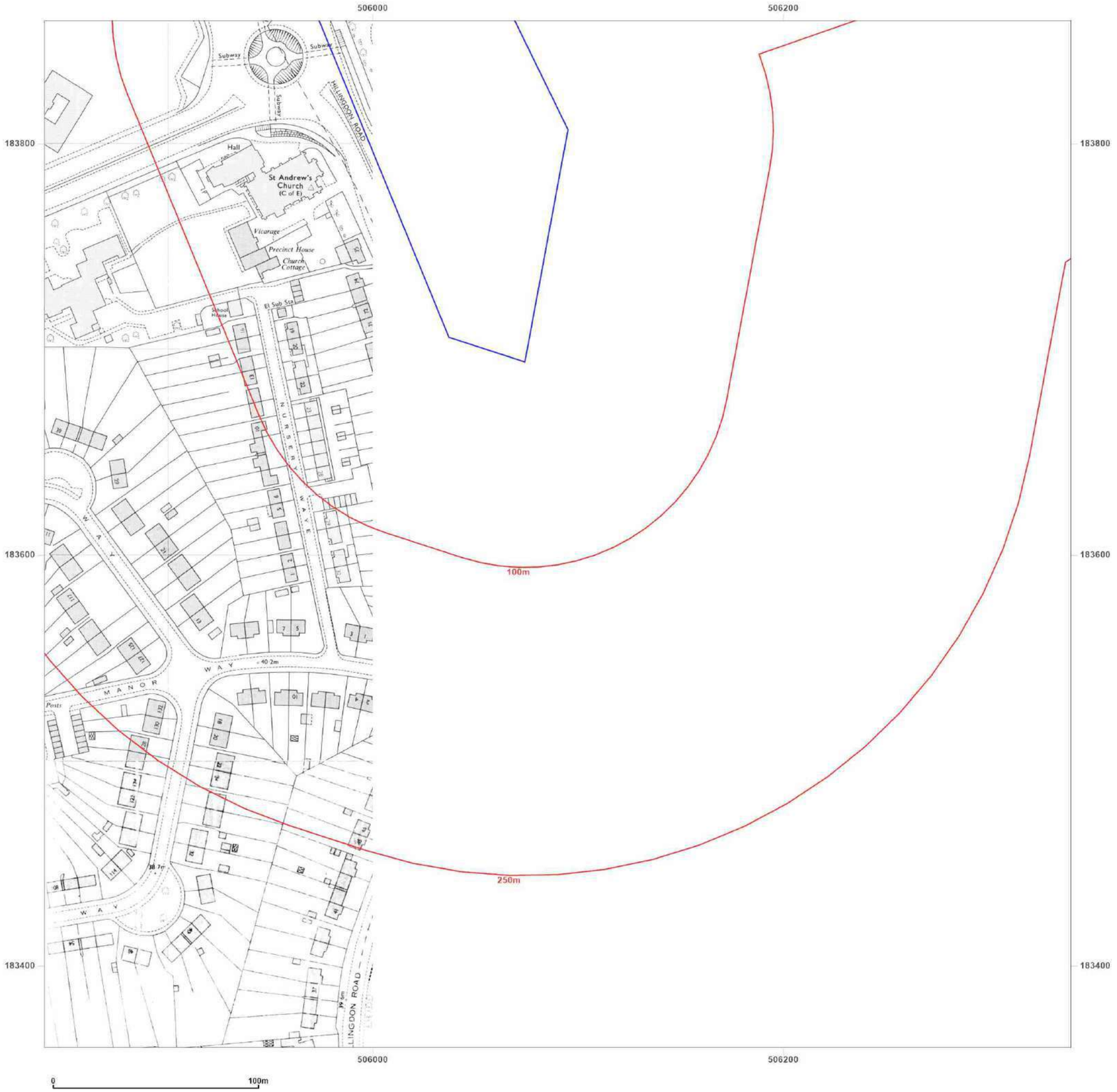

Groundsure INSIGHTS

Site Details:

506087, 183874

Client Ref: PO23248
Report Ref: HYD-9293975_1250_1_1
Grid Ref: 506090, 183610

Map Name: National Grid

Map date: **1976-1977**

Scale: 1:1,250

Printed at: 1:2,000

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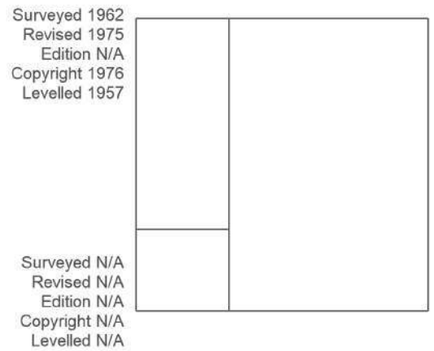

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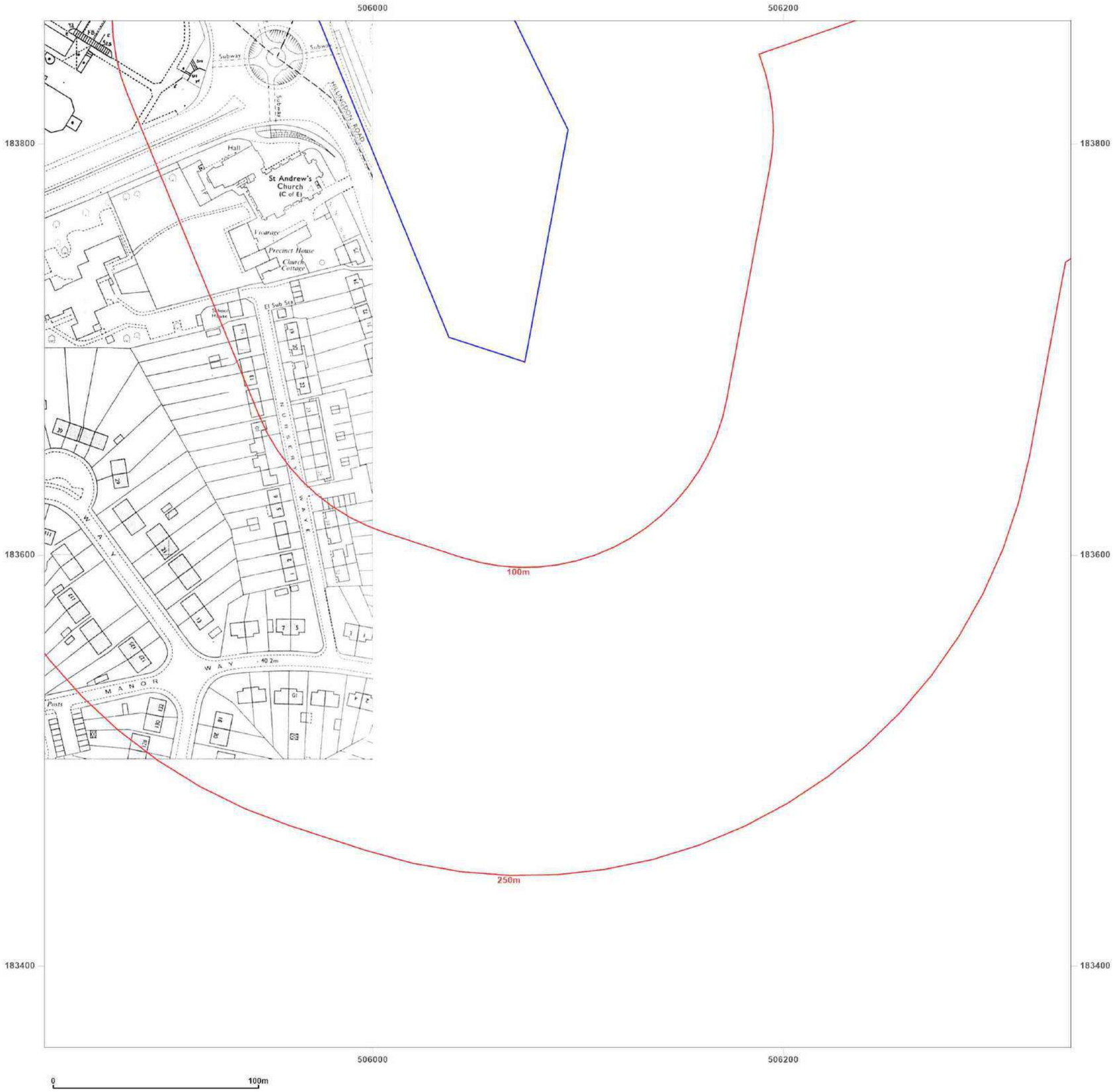

Groundsure INSIGHTS

Site Details:

506087, 183874

Client Ref: PO23248
Report Ref: HYD-9293975_1250_1_1
Grid Ref: 506090, 183610

Map Name: National Grid

Map date: **1978**

Scale: 1:1,250

Printed at: 1:2,000

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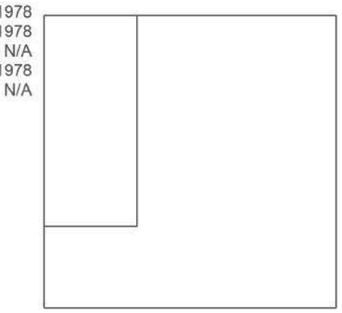
Surveyed 1978
Revised 1978
Edition N/A
Copyright 1978
Levelled N/A



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Groundsure INSIGHTS

Site Details:

506087, 183874

Client Ref: PO23248
Report Ref: HYD-9293975_1250_1_1
Grid Ref: 506090, 183610

Map Name: National Grid

Map date: **1986-1991**

Scale: 1:1,250

Printed at: 1:2,000

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Surveyed 1957 Revised 1987 Edition N/A Copyright 1987 Levelled 1957	Surveyed 1957 Revised 1986 Edition N/A Copyright 1986 Levelled 1957
Surveyed 1957 Revised 1986 Edition N/A Copyright 1986 Levelled 1957	Surveyed N/A Revised N/A Edition N/A Copyright N/A Levelled N/A

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Groundsure INSIGHTS

Site Details:

506087, 183874

Client Ref: PO23248
Report Ref: HYD-9293975_1250_1_1
Grid Ref: 506090, 183610

Map Name: National Grid

Map date: **1987-1992**

Scale: 1:1,250

Printed at: 1:2,000

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Surveyed 1957 Revised 1987 Edition N/A Copyright 1987 Levelled 1957	Surveyed N/A Revised N/A Edition N/A Copyright 1992 Levelled N/A
Surveyed 1962 Revised 1988 Edition N/A Copyright 1988 Levelled N/A	Surveyed N/A Revised N/A Edition N/A Copyright 1992 Levelled N/A

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Groundsure INSIGHTS

Site Details:

506087, 183874

Client Ref: PO23248
Report Ref: HYD-9293975_1250_1_1
Grid Ref: 506090, 183610

Map Name: National Grid

Map date: **1992-1995**

Scale: 1:1,250

Printed at: 1:2,000

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Surveyed N/A Revised N/A Edition N/A Copyright N/A Levelled N/A	Surveyed N/A Revised N/A Edition N/A Copyright 1995 Levelled N/A
Surveyed N/A Revised N/A Edition N/A Copyright N/A Levelled N/A	Surveyed N/A Revised N/A Edition N/A Copyright 1995 Levelled N/A

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Groundsure INSIGHTS

Site Details:

506087, 183874

Client Ref: PO23248
Report Ref: HYD-9293975_1250_1_1
Grid Ref: 506090, 183610

Map Name: National Grid

Map date: **1995**

Scale: 1:1,250

Printed at: 1:2,000

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Surveyed 1995
Revised 1995
Edition N/A
Copyright 1995
Levelled N/A

Surveyed 1995
Revised 1995
Edition N/A
Copyright 1995
Levelled N/A

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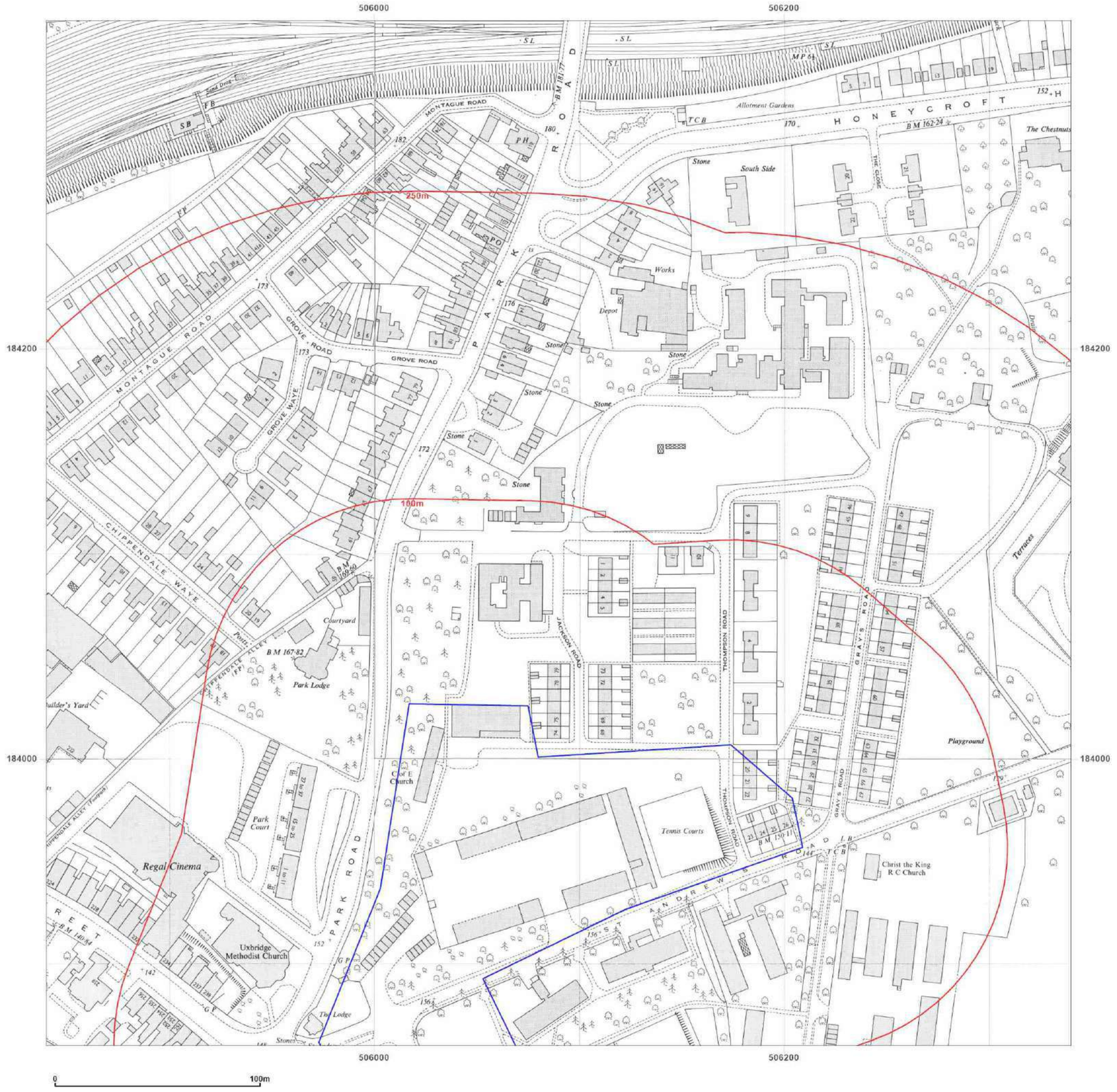

Groundsure INSIGHTS

Site Details:

506087, 183874

Client Ref: PO23248
Report Ref: HYD-9293975_1250_1_2
Grid Ref: 506090, 184110

Map Name: National Grid

Map date: **1962-1964**

Scale: 1:1,250

Printed at: 1:2,000

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Surveyed 1962 Revised 1962 Edition N/A Copyright 1962 Levelled 1957	Surveyed 1962 Revised 1962 Edition N/A Copyright 1962 Levelled 1957
Surveyed 1962 Revised 1962 Edition N/A Copyright 1963 Levelled 1957	Surveyed 1963 Revised 1963 Edition N/A Copyright 1964 Levelled 1957

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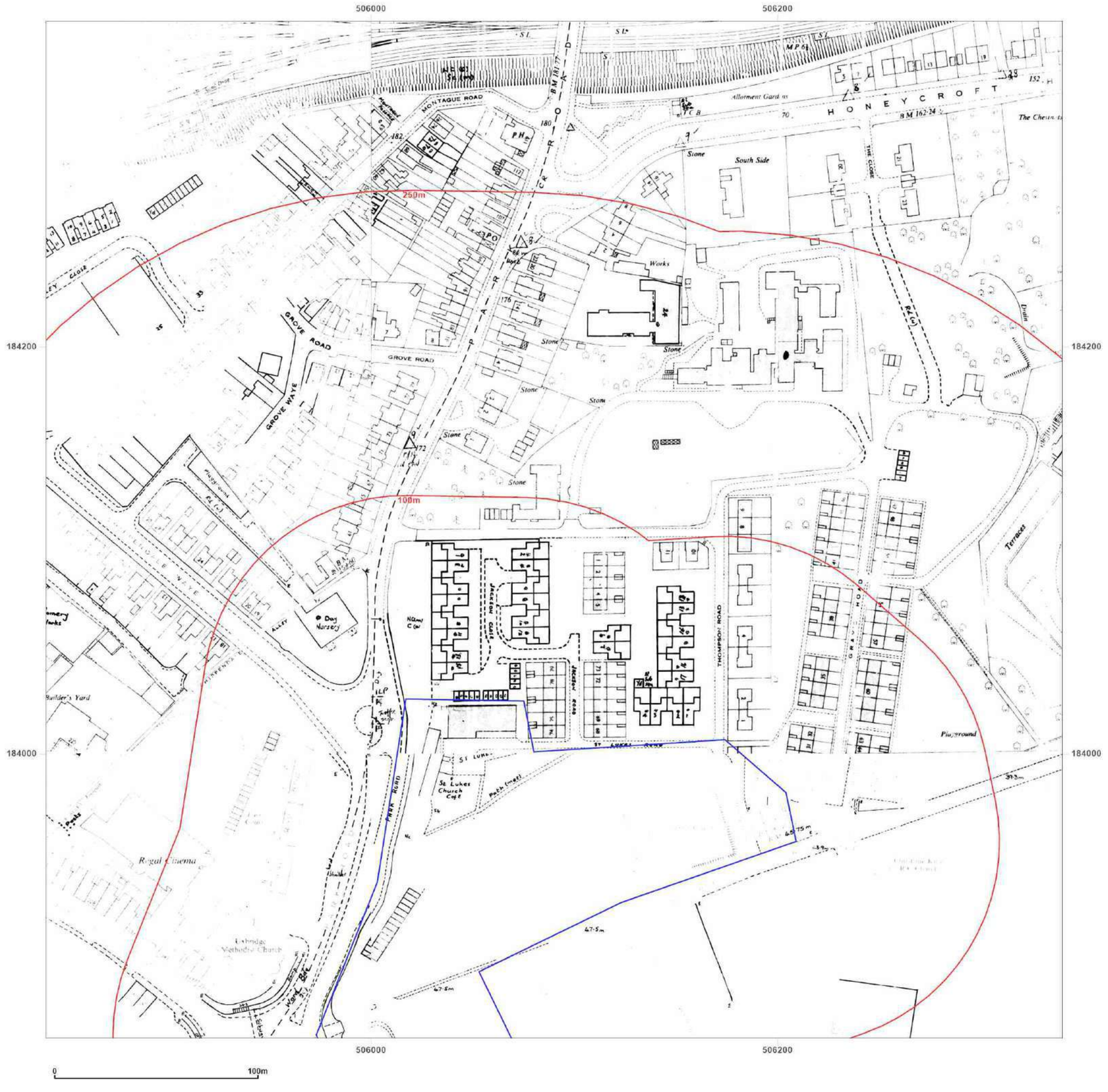

Groundsure INSIGHTS

Site Details:

506087, 183874

Client Ref: PO23248
Report Ref: HYD-9293975_1250_1_2
Grid Ref: 506090, 184110

Map Name: National Grid

Map date: **1974-1977**

Scale: 1:1,250

Printed at: 1:2,000

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

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Groundsure INSIGHTS

Site Details:

506087, 183874

Client Ref: PO23248
Report Ref: HYD-9293975_1250_1_2
Grid Ref: 506090, 184110

Map Name: National Grid

Map date: **1975-1977**

Scale: 1:1,250

Printed at: 1:2,000

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Surveyed 1962 Revised 1974 Edition N/A Copyright 1975 Levelled 1957	Surveyed 1962 Revised 1975 Edition N/A Copyright 1977 Levelled 1957
Surveyed 1962 Revised 1975 Edition N/A Copyright 1976 Levelled 1957	

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Groundsure INSIGHTS

Site Details:

506087, 183874

Client Ref: PO23248
Report Ref: HYD-9293975_1250_1_2
Grid Ref: 506090, 184110

Map Name: National Grid

Map date: **1978-1980**

Scale: 1:1,250

Printed at: 1:2,000

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Surveyed 1980
Revised 1980
Edition N/A
Copyright 1980
Levelled N/A

Surveyed 1978
Revised 1978
Edition N/A
Copyright 1978
Levelled N/A

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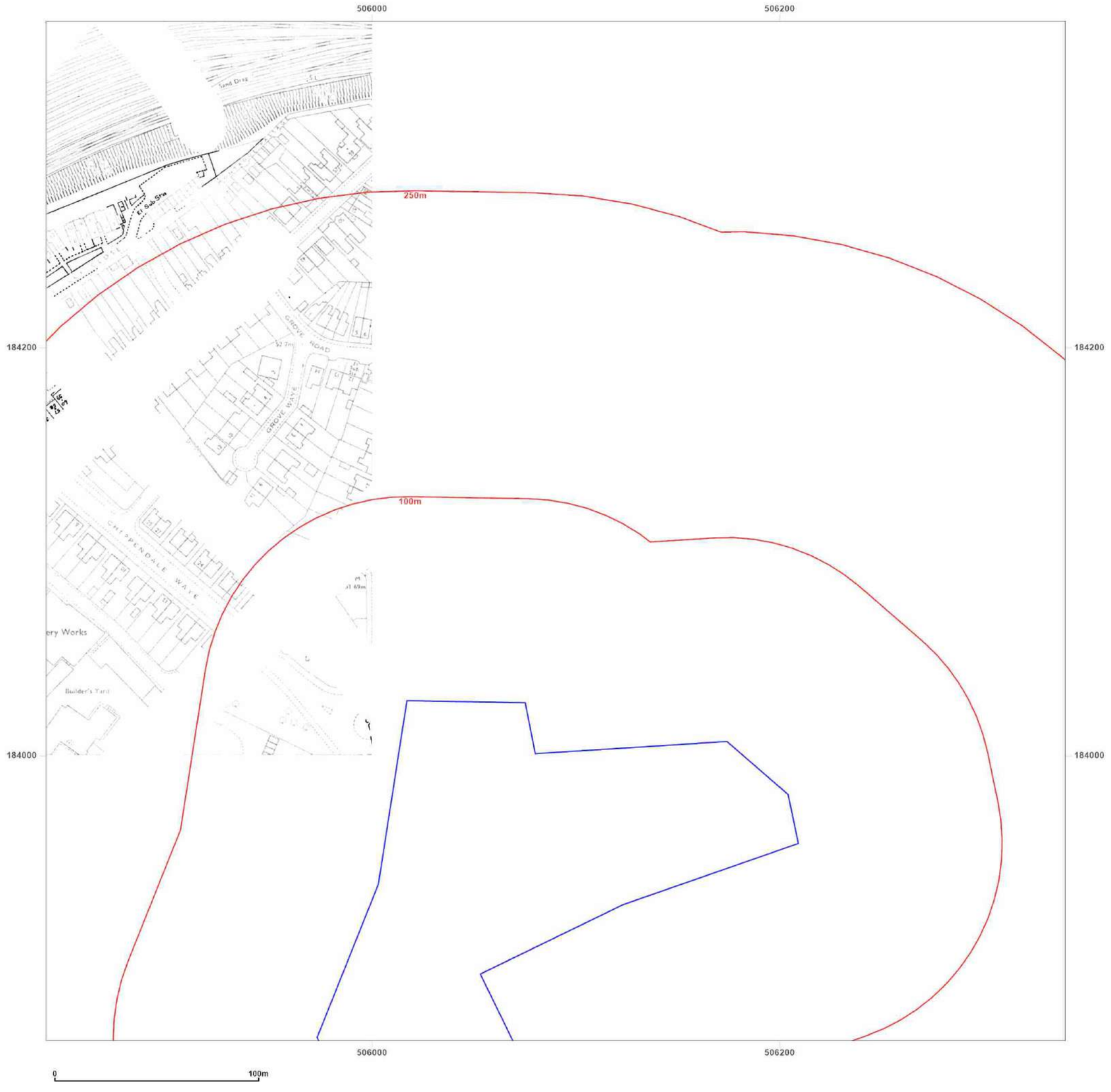

Groundsure INSIGHTS

Site Details:

506087, 183874

Client Ref: PO23248
Report Ref: HYD-9293975_1250_1_2
Grid Ref: 506090, 184110

Map Name: National Grid

Map date: **1980**

Scale: 1:1,250

Printed at: 1:2,000

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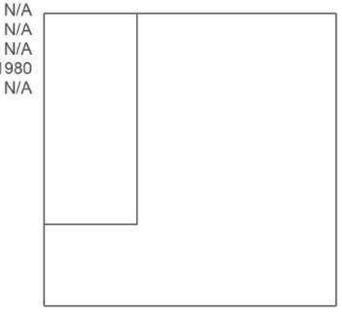
Surveyed N/A
Revised N/A
Edition N/A
Copyright 1980
Levelled N/A



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Groundsure INSIGHTS

Site Details:

506087, 183874

Client Ref: PO23248
Report Ref: HYD-9293975_1250_1_2
Grid Ref: 506090, 184110

Map Name: National Grid

Map date: **1986-1987**

Scale: 1:1,250

Printed at: 1:2,000

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Surveyed N/A Revised N/A Edition N/A Copyright 1986 Levelled N/A	Surveyed 1957 Revised 1987 Edition N/A Copyright 1987 Levelled 1957
Surveyed 1957 Revised 1987 Edition N/A Copyright 1987 Levelled 1957	Surveyed 1957 Revised 1986 Edition N/A Copyright 1986 Levelled 1957

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Revised 1988
Edition N/A
Copyright 1988
Levelled 1957

Surveyed N/A
Revised N/A
Edition N/A
Copyright 1992
Levelled N/A

Surveyed 1957
Revised 1987
Edition N/A
Copyright 1987
Levelled 1957

Surveyed N/A
Revised N/A
Edition N/A
Copyright 1992
Levelled N/A

Groundsure INSIGHTS

Site Details:

506087, 183874

Client Ref: PO23248
Report Ref: HYD-9293975_1250_1_2
Grid Ref: 506090, 184110

Map Name: National Grid

Map date: **1987-1992**

Scale: 1:1,250

Printed at: 1:2,000

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Groundsure INSIGHTS

Site Details:

506087, 183874

Client Ref: PO23248
Report Ref: HYD-9293975_1250_1_2
Grid Ref: 506090, 184110

Map Name: National Grid

Map date: **1995**

Scale: 1:1,250

Printed at: 1:2,000

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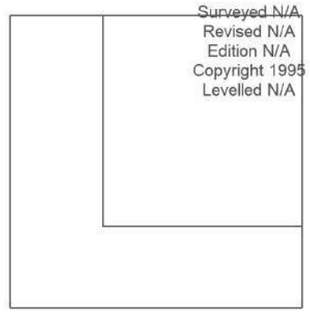

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Site Details:

506087, 183874

Client Ref: PO23248
Report Ref: HYD-9293975_1250_1_2
Grid Ref: 506090, 184110

Map Name: National Grid

Map date: **1995**

Scale: 1:1,250

Printed at: 1:2,000

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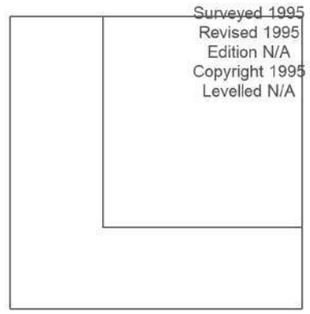

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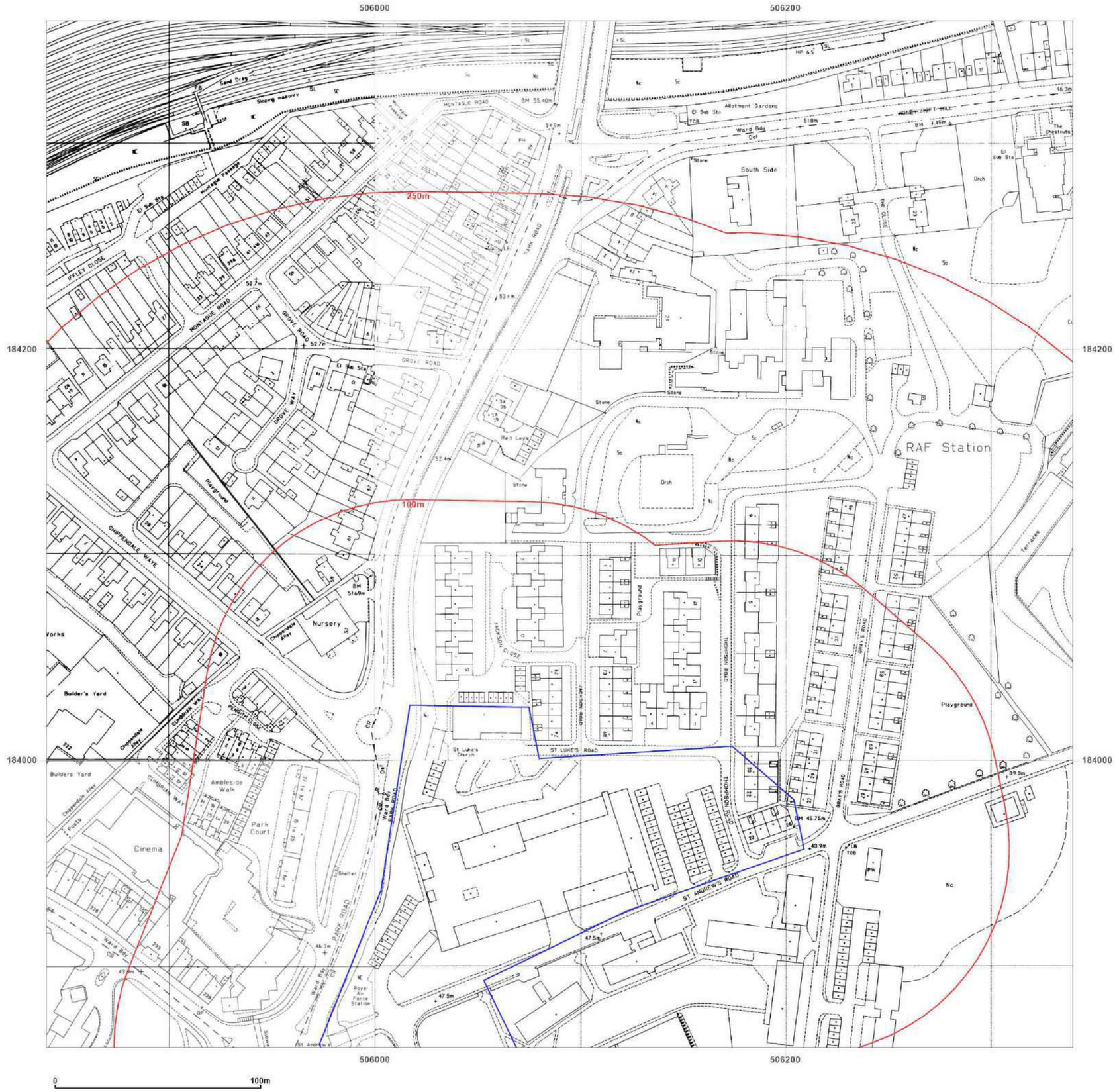

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Site Details:

506087, 183874

Client Ref: PO23248
Report Ref: HYD-9293975_1250_1_2
Grid Ref: 506090, 184110

Map Name: National Grid

Map date: **1992-1995**

Scale: 1:1,250

Printed at: 1:2,000

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Groundsure INSIGHTS

Site Details:

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