



Land at Penn Hill, Calne

Desk Study and Ground Investigation Report

For Castlewood Properties Ventures Limited

Date: 9 November 2022

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Executive Summary

SITE INFORMATION AND SETTING	
Objectives	The works have been commissioned to support the planning application and to assist with design.
Client	Castlewood Properties Ventures Limited
Site name and location	Land at Penn Hill, Calne, located at Oxford Road, Calne, Wiltshire. The nearest postcode is SN11 8RR.
Proposed development	The proposed site development is to comprise residential housing within the south-western and north-western fields, a commercial area towards the centre of the site and Public Open Space (POS) across the south-eastern and north-eastern fields. Existing hedgerows are to be retained where possible and the existing Public Rights of Way will be set within green corridors, which are to run through the development.
Site description	The site is irregular in shape and has an area of approximately 15.3 ha. The site primarily consists of un-developed, agricultural fields split across the majority of the site, with the exception of the central area. The central area of the site consists of an industrial area, with associated buildings including a vehicle repair workshop, waste oil burner, garages and a coach depot.
DESK STUDY SUMMARY	
Topography	A spot height, situated towards the south of the central site area, is shown to be 106m above Ordnance Datum (AOD). This generally corresponds with the rest of the central section, and northern section, of the site, including that of Penn Hill Farm and the industrial estate The site slopes steeply downwards from the central area to the east, to approximately 90 - 85m AOD, to the south to approximately 95m AOD and to the west to approximately 90m AOD, based upon contour lines as shown in the historical maps.
Hydrology	Abberd Brook, flowing roughly north-east to south-west, is situated 300m south-east of the site.
Site History	- The site has largely remained unchanged since the earliest available OS map (1885). A large proportion of the site consists of undeveloped fields with sporadic trees. Penn Hill Farm is situated towards the centre of the site area. - Between 1986 and 1994, 2 no. additional buildings, as-well as an area of likely hardstanding, were constructed immediately to the north of Penn Hill Farm.
Geology	Superficial: No natural superficial deposits recorded. Solid: Lower Greensand Group and Kimmeridge Clay Formation.
Natural geological hazards	N/A
Anthropomorphic geotechnical hazards	Made Ground is likely to be present within the central industrial area of the site. There is the potential for localised Made Ground in the surrounding agricultural fields. Quarrying: there is no evidence from available records of mineral extraction at the site and, as such, Hydrock believes it is unlikely that sand extraction has taken place.
Hydrogeology	The Lower Greensand Group comprises a Secondary A Aquifer. The site is not within a Source Protection Zone.
Site Zoning	For Contam assessment, the following zones apply: Zone A – proposed residential area. Zone B – proposed commercial area. Zone C – proposed Public Open Space area.

	The geo-environmental risk assessment has been undertaken based upon the current proposed site development layout. Should the proposed layout change, the data will need to be re-assessed based upon the updated applicable land use scenarios.
UXO Risk	A non-specialist UXO assessment indicates a low bomb risk.
Other	N/A
PRELIMINARY CONCEPTUAL SITE MODEL BASED ON DESK STUDY	
Potential contaminant sources	Made Ground, associated with historical construction activities and imported fill (S01) Hydrocarbon fuels, lubricants, oils and solvents from the operation of the vehicle repair workshop, waste oil burner and garages within the industrial area, situated towards the centre of the site.(S02). Coal tar, potentially present in the bituminous bound pavements present in the form of roads and car parks (S03). Ground gases (carbon dioxide and methane) from organic materials in the Made Ground (S04). Hydrocarbon vapours from potential VOC and petroleum hydrocarbon spillages/leaks (S05). Asbestos within existing buildings (S06). Ground gases (carbon dioxide and methane) from materials in the historical landfill (Calne Sand Pit), located 5m to the north of the site (S07).
Potential contaminant linkages (for receptors for which there is or will be a pathway)	People (neighbours, site end users) (R01). Development end use (buildings, utilities and landscaping) (R02). Groundwater: Secondary A aquifer status of the Lower Greensand Group (R03). Surface water: Abberd Brook, situated 300m to the south-east of the site and the potential pond, if to be retained, in the north-east corner of the site (R04).
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 – between 0.00m and 1.50m below ground level (bgl), encountered only within the central industrial area. • Topsoil - between 0.00m and 0.40m bgl, generally comprising dark brown silty sand; the amount of sand / silt varied per locality. • Lower Greensand Group, underlying the Topsoil at a number of locations to a maximum depth of 2.40m bgl. This generally comprised brown slightly clayey / slightly silty sand. In those areas that encountered deeper deposits, the material was encountered as a light grey to grey, mottled orangish brown and reddish brown, slightly silty sand. • Kimmeridge Clay Formation - encountered from 0.10m to 2.40m bgl, generally comprising stiff desiccated brown to greyish brown locally slightly sandy clay in its uppermost part, from between 0.10 - 0.30m bgl to a maximum depth of 1.00m bgl. Underlying the above was generally noted to consist of firm grey mottled brown and orangish brown clay, with varying amounts of selenite crystals, shell fragments and locally relict rootlets. This represents the weathered layer, and generally becomes stiff with depth, and dark grey mottled brown. Groundwater was encountered at depths between 0.30m bgl and 3.50m bgl during the investigation. Water levels recorded post-fieldwork ranged from 0.20m bgl to 4.57m bgl (103.19m OD to 91.89m OD), subject to on-going monitoring. There is shallow groundwater in the Made Ground. Perched groundwater was encountered within the Kimmeridge Clay Formation.
SUMMARY OF GEOTECHNICAL CONCLUSIONS	
Groundwork	Obstructions associated with former including foundations, floor slabs and services, should be anticipated.

	Excavation to proposed founding depth generally should be readily achievable with standard excavation plant. Heavy duty excavation plant/breaking equipment may be required to excavate intact rock quality strata; however, this is not envisaged. Excavations during investigation were generally stable, although slight spalling should be expected from the Made Ground and within the sands below the water table. Water seepages into excavations are likely to be adequately controlled by sump pumping. Alternative methods of dewatering may be required in areas.
Foundations	Foundations are recommended to comprise: • Strip/trench fill foundations or pad foundations, from a minimum depth of 1.50m bgl. • Piled foundations. Allowable net bearing pressure of 150 kN/m² should be available for shallow foundations. Deepening of foundations/heave protection is likely to be required to allow for the effects of trees. If shallow soft spots are encountered which, during the site works, were locally encountered from a minimum depth of 1.00m bgl to a maximum depth of 2.90m bgl, foundation depth will be required to be deepened until a suitable firm clay is reached. Suspended floor slabs are recommended due to the presence of high shrinkage potential clay soils. Suspended over a void where within the influencing distance of trees.
Roads and pavements	For road / pavement design, a design CBR of 2.5 % is recommended.
Sustainable drainage	Soakaway drainage is considered unsuitable for this site.
Buried concrete	Design Sulfate Class - DS-3 and ACEC Class AC-3. Equivalent to Design Chemical Class DC-3 for a 50-year design life.
SUMMARY OF GEO-ENVIRONMENTAL ASSESSMENT	
Human Health	• Arsenic in the Topsoil. • PAH in the Made Ground. • Asbestos in the Made Ground.
Phytotoxicity	• Boron, copper and zinc in the Made Ground.
Controlled waters	Groundwater samples exceed the EQS for cadmium, copper, manganese, nickel, ammoniacal nitrogen and sulfate.
Radon:	The site is not in a Radon Affected Area.
Construction materials:	Plastic or bitumastic products may be at risk from high concentrations of VOC.
Potable water supply pipes	• Standard pipework is envisaged for the greenfield area. However, confirmation should be sought from the water supply company at the earliest opportunity. • Brownfield located within the industrial area, so barrier pipe is considered suitable for this area. However, confirmation should be sought from the water supply company at the earliest opportunity.
Ground gases or vapours:	• Low risk from ground gases (subject to additional and on-going monitoring) and CS1 conditions apply.
ENABLING WORKS	
Proposed mitigation measures	The mitigation measures proposed to remove unacceptable risks include: • Exceedances of arsenic are present in the natural ground. Further assessment will be required using bio accessibility testing in consultation with the regulatory authorities (PL1). • Hydrock understands that the current industrial estate is designated as 'commercial' in the current masterplan. Should there be areas of proposed landscaping, these areas will

	require an engineered clean cover system so that site users will not come into contact with the Made Ground soils. It is anticipated the rest of the commercial area will comprise hardstanding or buildings, restricting any point of contact. This will also serve to mitigate the risk to, and provide a suitable growing medium for, plant life (PL2, 3 and 4). Asbestos demolition survey and removal by a specialist contractor, if asbestos is present (PL5). 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 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	The natural soils are likely to be classified as non-hazardous waste, for disposal at an 'inert' landfill site, subject to confirmation by WAC testing. The Made Ground encountered within the central industrial area is generally likely to be classified as non-hazardous waste. However, a couple of samples of the Made Ground, collected from WS09 and WS10, are likely to be classified as hazardous waste.
FUTURE CONSIDERATIONS	
Further work	Following the ground investigation works undertaken to date, the following further works will be required: - demolition asbestos survey if asbestos is identified within the buildings within the industrial area; - completion and reporting of the ongoing gas monitoring, hence the conclusions in this report are provisional, subject to the completion of monitoring; - supplementary ground investigation for detailed design, including soft spots; - further assessment for exceedances of Arsenic using bio accessibility testing; - supplementary ground investigation and assessment in accordance with ADEPT & CWF Guidance (August 2019) to fully assess potential bituminous bound pavement arisings with regards to the presence of coal tar and waste disposal; - 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 piles (where required); - provision of geotechnical design for the Category 2 and / or 3 structures (earthworks, retaining, 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 and import of soils to the site; - writing of a Materials Management Strategy relating to reuse of soils at the site; - remediation and mitigation work; and

- verification of the earthworks, remediation and mitigation works.

This Executive Summary forms part of Hydrock Consultants Limited report number 24863-HYD-XX-XX-RP-GE-1000 and should not be used as a separate document.

1. INTRODUCTION

1.1 Terms of reference

In July 2022, Hydrock Consultants Limited (Hydrock) was commissioned by Turley Associates Ltd on behalf of Castle Properties Ventures Ltd to undertake a Phase 1 desk study and Phase 2 ground investigation at the land at Penn Hill, Calne, Wiltshire.

The site currently consists primarily of a series of agricultural fields. A number of industrial buildings are also located towards the centre of the site, as well as a private residential property; it should be noted that the private residential property is not within the proposed development area. Two Public Rights of Way run through the centre of the site.

Hydrock understands that the proposed development is to comprise residential housing within the south-western and north-western fields, a commercial area towards the centre of the site and Public Open Space (POS) across the south-eastern and north-eastern fields. Existing hedgerows are to be retained where possible and the existing Public Rights of Way will be set within green corridors, which are to run through the development. A proposed development layout (Pegasus Group Drawing P21-3061_04), is presented in Appendix A.

The works have been undertaken in accordance with Hydrock's proposal referenced (24863-HYD-XX-XX-FP-GE-1001, dated 1st July 2022) and the Client's instructions to proceed (email from Peter Davis on 22 July 2022).

1.2 Objectives

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

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) (2021);
- to identify any geo-environmental mitigation requirements to enable development to progress; and
- to provide preliminary geotechnical recommendations for design.

1.3 Scope

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;
- 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 preliminary ground investigation including trial pitting, windowless sampling, soakaway testing and TRL DCP testing 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 Turley Associates Ltd for use in the preparation of this report:

- Pegasus Group. August 2022. 'Concept Masterplan', Ref: Version 2
- Turley Associates Ltd. Undated. 'Vision Statement RevE'
- Turley Associates Ltd. June 2020. 'Site Location Plan', Ref: 1000

The Client has commissioned or obtained assignment of the above documents and Hydrock and Hydrock is entitled to full reliance upon their contents.

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+A1:2020, 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, 'Land Contamination: Risk Management' (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 risk assessed qualitatively using the 'source-pathway-receptor contaminant linkage' concept. This assesses risk as introduced in the Environmental Protection Act 1990 (EPA, 1990). Any potential geotechnical risks are also assessed.

Phase 2 comprises intrusive ground investigation work and testing. The factual information from Phase 1 and Phase 2 are used to develop the Conceptual Model (CM). This CM is based on a ground model of the site physical conditions and an exposure model of the possible contaminant linkages. The CM 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 NHBC Standards (2022) 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). 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 D and include:

- Third-party environmental report (Groundsure report, Ref: 8964750);
- Historical Ordnance Survey mapping;
- BGS Archive Records; and
- Zetica UXB Risk Maps (<https://zeticauxo.com/downloads-and-resources/risk-maps/>).

2.2 Site referencing

Table 2.1: Site referencing information

Item	Brief Description
Site name	Land at Penn Hill, Calne
Site address	Penn Hill Farm, Oxford Road, Calne, Wiltshire. The nearest postcode is SN11 8RR.
Site location and grid reference	The site is located to the east of Oxford Road and north of Sand Pit Road. The site is approximately 9.5km to the south-east of Chippenham, located on the eastern edge of Calne. The National Grid Reference of the approximate centre of the site is 400800E, 172012N.
Site boundaries	The site boundary has been understood to fall within the fences, trees, hedgerows and associated vegetation that runs along each field boundary. With regards to the private property located towards the centre of the site, the buildings and all surrounding associated land have not been included within the site area, at the request of the client.



Figure 2-1: Site location
(Reproduced with permission from Groundsure)



Figure 2-2: Extract from the Ordnance Survey Map.
(OS licence 100023353).

A site location plan (Turley Associates Ltd. June 2020. 'Site Location Plan', Ref: 1000) is presented in Appendix A.

2.3 Site description and field reconnaissance survey

A field reconnaissance survey was undertaken on 13 September 2022 to visually identify assess potential geotechnical hazards, contaminant sources for future investigation and identification of possible source-pathway-receptor linkages. The weather during the field reconnaissance survey was overcast and heavy rain. It should be noted that in the months preceding this, a prolonged period of dry and hot weather was in effect.

A description of the site is presented in Table 2.2 selected photographs are presented in Figure 2-3 to Figure 2-6. Additional photographs are presented in Appendix B.

Table 2.2: Site description

Item	Brief Description
Site access	The site can be accessed from the west, through a new housing estate situated to the east of Oxford Road. The site can also be accessed from the south off Sand Pit Road.
Site area	The site is irregular in shape and has an area of approximately 15.3 ha.
Elevation, topography and any geomorphic features	A spot height, situated towards the south of the central site area, is shown to be 106m above Ordnance Datum (AOD). This generally corresponds with the rest of the central section, and northern section, of the site, including that of Penn Hill Farm and the industrial estate. The site slopes steeply downwards from the central area to the east to approximately 90 - 85m AOD, to the south to approximately 95m AOD and to the west to approximately 90m AOD based upon contour lines as shown in the historical maps.
Site boundaries and surrounding land	The site is bound to the south by Sand Pit Road and, beyond that, residential properties. To the west the site is bound by a housing development under construction, with the development towards the north-west recently being completed. Agricultural land lies to the east of the site whilst Calne Sand Pit, an historical landfill, borders the site to the north.
Present land use	The site primarily consists of un-developed, agricultural fields split across the majority of the site, with the exception of the central area. Two private roads, accessed via Sand Pit Road and Oxford Road respectively, give access to the central area. The fields have been used for grazing animals, as noted by the troughs located around the fields. The central area of the site consists of an industrial estate, with associated buildings including a vehicle repair workshop, waste oil burner, garages and a coach depot. Penn Hill Farm, a private residential property not included within the site area, is also present adjacent to the south of the industrial estate. A stockpile was noted in the central field area, located to the south of Penn Hill Farm, which was covered with vegetation. A pond obscured with overgrown vegetation and a mature tree, is present in the north-eastern corner of the site. A public footpath, roughly trending north - south, runs from the southern border of the south-western field to the north-eastern corner of the north-western field. Two high voltage overhead electrical services were noted, roughly trending south-west to north-east throughout the western fields, and south-east to north-west throughout the eastern fields respectively. Visible services were also identified within the central industrial area.
Vegetation	Field areas are covered with grass / vegetation. Surface desiccation cracks were noted towards the south-eastern corner of the site. Mature trees are present predominantly along the field boundaries, along with hedgerows and dense vegetation.

Item	Brief Description
	Sporadic trees are also present across the wider site area.
General site sensitivity	Whilst the centre of the site is an industrial area, the wider site area is located on the eastern edge of Calne in a generally rural area.



Figure 2-3: South-western field area, with overhead high voltage cables trending roughly north-south and a slope towards the west.



Figure 2-4: Industrial area located towards the centre of the site.



Figure 2-5: Surface desiccation crack present in the south-eastern corner of the site.



Figure 2-6: North-eastern field area, with overhead high voltage cables trending roughly south-east to north-west.

2.4 Site history

A study of historical Ordnance Survey maps (Appendix D) 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.

Table 2.3: Site history review

Reference	Key features on site	Key features off-site
OS Map ¹ 1885 (1:10,560) 1886 (1:2,500)	A large proportion of the site consists of undeveloped fields with sporadic trees. Penn Hill Farm, comprising approximately 6 buildings, is situated towards the centre of the site area. A number of small ponds are present, located: • North east corner • Western site boundary • Central northern site section • Southern site section A potential small building is noted to be present in the north-western corner. An access road, trending east to west, is present across the central section of the site, linking up to Penn Hill Farm.	Small pond noted adjacent to the south-west corner of the site. Brickworks, and an associated clay works, are present approximately 85m to the south-west. A number of wells are shown on the mapping: 285m south-west, 310m south-west, 130m, west, 210m west, 235m west and 285m north-west. Area of marshes present approximately 110m to the north-west of the site. Small number of residential properties located 200m to the west. Abberd Brook, roughly trending south-west to north-east, approximately 300m to the south-east.
1899 (1:10,560) 1900 (1:2,500)	No significant change.	Abberd Brook flow direction shown to be towards the south-west. Four ponds shown associated with the previously noted brickworks. Well present 85m to the north. Large sand pit noted approximately 750m to the south-east.
1922 - 1925 (1:10,560) 1924 (1:2,500)	No significant change.	Brickworks, and associated clay pit / ponds are no longer shown. Well present 10m from the north-east corner of the site. Further sand pit present approximately 600m to the south-east of the site.
1938 (1:10,560)	No significant change.	No significant change.
1956 (1:10,560)	No significant change.	Previously noted sandpit 600m to the south-east has been expanded significantly to the north-east of its former position. Residential development within 300m of the south-western corner of the site.
1970 (1:2,500)	No significant change.	Builder's Yard present 55m to the south-west of the site. Scrap metal yard present 210m to the south-west. A number of factories, warehouses and an engineering works noted approximately 250m to the south-west.
1980 - 1982 (1:10,000) 1986 (1:2,500)	No significant change.	Field boundaries to the immediate north of the site no longer shown (this is inferred to be Calne Sand Pit as described in the site description [Section 2.3]). Further residential development has occurred to the south of the site.

¹ Ordnance Survey Historical Map Information provided by Groundsure.

Reference	Key features on site	Key features off-site
1994 (1:2,500)	2 no. additional buildings, as-well as an area of likely hardstanding, have been constructed immediately to the north of Penn Hill Farm. An access road to this area is also shown.	A number of factories are shown approximately 250m to the west of the site. 'Works', most likely associated with the previously noted sand pit to the south-east of the site, present with associated pond and electricity substation, approximately 380m to the south-east.
2001 (1:10,000)	Only the ponds in the north-eastern corner and western central site boundary are shown.	Sand Pit Road has been constructed running adjacent to the southern site boundary.
2001 Aerial Photograph ²	An access road, roughly trending north to south, is shown from Sand Pit Road to the central site area. Surrounding agricultural fields are undeveloped. Trees and hedgerows appear to run along the field boundaries.	No significant change.
2010 (1:10,000)	No significant change.	No significant change.
2022 (1:10,000)	No significant change.	Large residential development has occurred within the immediate vicinity of the southern site boundary. Further residential development noted within 50m of the north-western corner of the site.

2.5 Geology

The general geology of the site area is shown on the 1:50,000 British Geological Survey (BGS) map extract reproduced as part of the Groundsure report and is summarised in Table 2.4. Extracts from the map are shown in Figure 2-7 and Figure 2-8 .

Table 2.4: Geology

Ref. for Figures	Location	Stratigraphic Name	Description
Superficial Deposits (Figure 2-7)			
1	290m east	Alluvium	Soft to firm consolidated, compressible silty clay. Can contain layers of silt, sand and basal gravel.
Solid Geology (Figure 2-8)			
1	On site.	Lower Greensand Group	Mainly sands and sandstones, with silts and clays in some intervals.
3	On site.	Kimmeridge Clay Formation	Pale to medium grey mudstone, mainly smooth or silty, with argillaceous limestone nodules. Some alternations of dark grey mudstone.

² Historical Aerial photograph, provided as part of the historical map Information provided by Groundsure.



Figure 2-7: Superficial deposits.
(Reproduced with permission from Groundsure)



Figure 2-8: Solid geology.
(Reproduced with permission from Groundsure)

Reference to British Geological Mapping (BGS) Sheet 266 - Marlborough, shows the Lower Greensand Formation to be underlain by the Kimmeridge Clay Formation. This is subsequently followed by Upper Calcareous Grit, Coral Rag, Lower Calcareous Grit and the Oxford Clay Formation with Kellaway's Beds.

There is the potential for localised Made Ground to be present within the vicinity of the existing industrial buildings and private residential property, as-well as potentially infilled ponds that were shown to be present on the historical maps.

Whilst there are none within the immediate vicinity of the site, a number of borehole logs from the BGS archive have been reviewed, with the closest to the site being 600m. Selected records are summarised below:

- SU07SW223, located 750m to the south-east of the site (NGR 401610E, 171450N), drilled to a depth of 11.0m and recorded:
 - » Firm brown crumbly silty sand, between ground level and 0.60m below ground level (bgl);
 - » Firm multicoloured sandy clayey silt, between 0.60m and 0.90m bgl;
 - » Soft dark brown clayey silt, between 0.90m and 2.30m bgl;
 - » Dense medium grained sand, with small lumps of soft clay, between 2.30m and 6.50m bgl (probable Lower Greensand Formation);
 - » Dense, well graded medium grained sand, between 6.50m and 10.40m bgl (probable Lower Greensand Formation); and
 - » Stiff dark blueish grey clay with shell fragments, between 10.40m and 11.00m (probable Kimmeridge Clay Formation).
- SU07SW242, located 600m to the west of the site (NGR 400011E, 172242N), excavated to a depth of 3.20m and recorded
 - » Topsoil, between ground level and 0.25m bgl;

- » Stiff orangish brown slightly gravelly clay, with the gravel comprising limestone, between 0.25m and 1.85m bgl (probable Kimmeridge Clay Formation); and
- » Stiff mottled grey yellow clay with fine sand partings and gypsum crystals, between 1.85m and 3.20m bgl (probable Kimmeridge Clay Formation).

2.6 Hydrogeology

2.6.1 Aquifer designations

Based on the inferred geological sequence presented in Section and the Environment Agency's interactive aquifer designation map, the aquifer system presented in Table 2.5 applies.

Table 2.5: Aquifer system

Stratum	Aquifer Designation	Comments
Solid Geology		
Lower Greensand Formation	Secondary A Aquifer	Some storage potential due to the porous nature of the rock. Water movement likely to occur through fractures.
Kimmeridge Clay Formation	Unproductive	Low permeability. Negligible significance on river base flow or water supply.

2.6.2 Groundwater abstraction

There are no active licensed groundwater abstractions within 1km of the site. However, there is an historical abstraction, for the purposes of process water, at Aggregate Industries UK Ltd, situated just off site to the north (i.e., Calne Sand Pit). This was for 'excavated pit and storage lagoon' with the original start date noted to be June 1990, potentially indicating when the pit was finished being excavated.

2.6.3 Groundwater source protection zones and groundwater vulnerability

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

With regard to the Secondary A Aquifer beneath the site, the groundwater vulnerability reported in the environmental report is high.

2.6.4 Groundwater levels, recharge, and flow

There is the potential for shallow groundwater to be present within the underlying sandstone of the Lower Greensand Group and mudstone of the Kimmeridge Clay formation, if present. Vertical migration of groundwater is likely to be limited by the high clay content in the Kimmeridge Clay Formation. Groundwater will be concentrated in fractures within the rock, as the rock mass itself will be of low-moderate porosity and permeability. It is considered likely that the clays that overly the rock mass itself and, in parts, underly the Lower Greensand Group, will act as an aquitard.

Due to the covering of relatively impermeable clay, it is considered that there will be limited local recharge to groundwater within the bedrock, with the flow of groundwater following the natural gradient of the topography.

Groundwater was encountered in BGS boreholes located in the surrounding area:

- SU07SW223 - at 7.30m bgl (87.37m AOD), within the Lower Greensand Group.

- SU07SW242 - at 3.20m bgl (76.10m bgl), within the Kimmeridge Clay Formation.

2.6.5 Groundwater quality

There is no designated groundwater body beneath the site.

The nearest designated groundwater body is 450m to the south-west of the site (Corallian Limestone [Calne to Swindon]) and is currently (2019 Cycle 2) classified under the Water Framework Directive as 'good'.

2.6.6 Groundwater flooding

The environmental data report indicates a negligible 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
Potential Pond (identified during site walkover)	North-east corner of the site.
Abberd Brook	Approximately 300m south-east.
Wilts and Berks Canal	1.5km south-west.
River Marden	2.5km south-west.

2.7.2 Surface water abstractions and discharges

There are no active licensed surface water abstractions or discharges within 500m of the site.

2.7.3 Surface water quality

Reference to the Environment Agency web site shows the site is located within the catchment of the Severn River Basin District, with the specific river water body being the Abberd Brook - source to confluence River Marden. The current (2019 cycle 2) overall status under the Water Framework Directive is 'moderate'.

The water body is currently 'moderate' status due to mercury and PBPE levels, as well as high phosphate concentrations, amongst others. Objectives to reach good status range between 2027 and 2063, the main reasoning for chemical conditions to recover naturally.

2.7.4 Surface water flooding

The desk study information indicates the proposed development is in Flood Zone 1 (with a low probability of flooding from rivers or the sea).

No further consideration of flood risk is undertaken in this report. Specialist flood risk advice should be sought with regard to drainage and flooding.

2.8 Mining and mineral extraction

The Kimmeridge Clay Formation in the area has been quarried for brick manufacture but there is no evidence on the historical plans of any brick pits or brick and tile works having existed within the site boundary. The nearest historical brickwork to the site is shown to be approximately 85m to the south-west which ceased operations by 1925.

The environmental report and historical mapping indicate that sand quarrying has also been undertaken in the wider area, to the north of the site (Calne Sand Pit) and to the south-east. This is due to the presence of sand deposits associated with the Lower Greensand Group. However, there is no evidence from available records of mineral extraction at the site and, as such, Hydrock believes that there is a low likelihood for surface sand extraction to have taken place.

2.9 Natural ground instability

The Natural Ground Subsidence Report indicates that the hazard ratings for dissolution, compressible deposits and running sands are negligible. It also indicates that the hazard rating for collapsible deposits is very low.

There are cohesive soils underlying the site with the potential for volume change. Trees and hedges are present at the site, which will need to be taken into consideration for foundation design in relation to shrink-swell as a result of changes in moisture content from removal, or growth, of trees.

There is the potential for slope instability problems along the eastern site boundary, as well in the north-eastern and south-eastern corners of the site.

2.10 Waste management

There are six waste management sites recorded within 500m of the site, as listed in Table 2.7.

Table 2.7: Waste management sites

Site Name and Location	Details
Calne Sandpit, 10m to the north	Status: Closed. Operational dates: 1978 - 1990 Wastes accepted: inert, commercial, household and industrial wastes.
Scrap Metal Yard, 200m to the west	Status: Closed. Operational dates: 1968 - 1986
Abberd Lane Transfer Centre, 170m to the south	Status: Open. Operational dates: 1993 - Present Day Size: medium (>25,000t, <75,000t/annum). Wastes accepted: commercial and industrial wastes.
R F Wood and Waste Recycling Limited, 265m to the east	Status: Open Operational dates: 2018 - Present Day Size: medium (>25,000t, <75,000t/annum). Type of Site: 75kte HCl waste TS and treatment.
Units 3-5, No 2, Porte Marsh Road, 305m to the west	Status: Closed Operational dates: 2011 - 2021 Size: (>25,000t, <75,000t/annum). Type of Site: 75kte materials recycling facility.
Sands Farm Quarry, 440m to the south-east	Status: Open Operational dates: 2011 - Present Day Size: 25,000t Type of Site: Management of inert or extractive waste at mine / material recycling treatment facility.

2.11 Regulatory Information

Information in the GroundSure Report (Appendix D), relating to various regulatory controls has been reviewed, with a summary presented below in **Error! Reference source not found..**

Table 2.8: Regulatory information within 500m of the site

Regulatory Data	Distance from Site	Details	Potential Risk	Comment
Local Authority Pollution Prevention and Controls	N/A	N/A	No	-
Pollution Incidents	5m east	April 2003, sewage materials, Category 3 – minor incident	No	Due to the Category 3 classification if the incident.
	50m south	September 2001, specific waste materials, Category 3 - minor incident.	No	Due to the Category 3 classification if the incident.
	240m west	February 2003, inorganic chemicals / products, Category 3 - minor incident.	No	Due to its distance to the site and the Category 3 classification of the incident.
	275m north-west	February 2002, organic chemicals / products, Category 3 - minor incident	No	Due to its distance to the site and the Category 3 classification of the incident.
Trade Directory Entries	On site	Active Furniture	No	Due to the materials involved in the manufacturing process.
	On site	Active Vehicle hire & rental	Yes	Due to its location on the site.
	On site	Active Vehicle repair, testing and servicing	Yes	Due to its location on the site.
	55m south	Active Vehicle repair, testing and servicing.	No	It is down gradient of site.
	105m south-west	Active Electricity Sub Station	No	Due to its distance to the site.
	205m west	Active Factory	No	Due to its distance to the site.
	215m west	Active Electrical components	No	Due to its distance to the site.
	220m north-west	Active Distribution and haulage	No	Due to its distance to the site.
	240m north-west	Active Electricity Sub Station	No	Due to its distance to the site.
	250m north-west	Active Electricity Sub Station	No	Due to its distance to the site.

Regulatory Data	Distance from Site	Details	Potential Risk	Comment
Fuel Station Entries	200m south-west	Open Petrol station	No	Due to its distance to the site.
Control of major accident hazards sites (COMAH)	435m north-west	Historical NIHHS Site	No	Due to being historical and its distance to the site.
Registered radioactive substances	N/A	No entries on registered radioactive substances were recorded within 500m of the site.	No	-
Notification of installations handling hazardous substances	N/A	No entries on notification of installations handling hazardous substances were recorded within 500m of the site.	No	-
Part A and Part B Activities and Enforcements (within 250m of the site).	On site	Waste Oil Burner, New Legislation, Part B	Yes	Due to being on site.
	250m north-west	Medium Combustion Plant, New Legislation, Part A	No	Due to its distance from the site.

2.12 Natural soil chemistry

Information contained within the environmental report (Appendix D) 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 2.9.

Table 2.9: Natural soil chemistry

Element	Arsenic	Cadmium	Chromium	Lead	Nickel
Concentration (mg/kg)	15 - 25	1.8	60 - 90	100	15 - 30

Reference to the UK Soil Observatory (UKSO) map viewer shows that whilst arsenic levels are consistent (19.3 - 22.6 mg/kg) with those in the environmental report, they are in fact elevated when compared to the surrounding area, as shown in Figure 2-9.

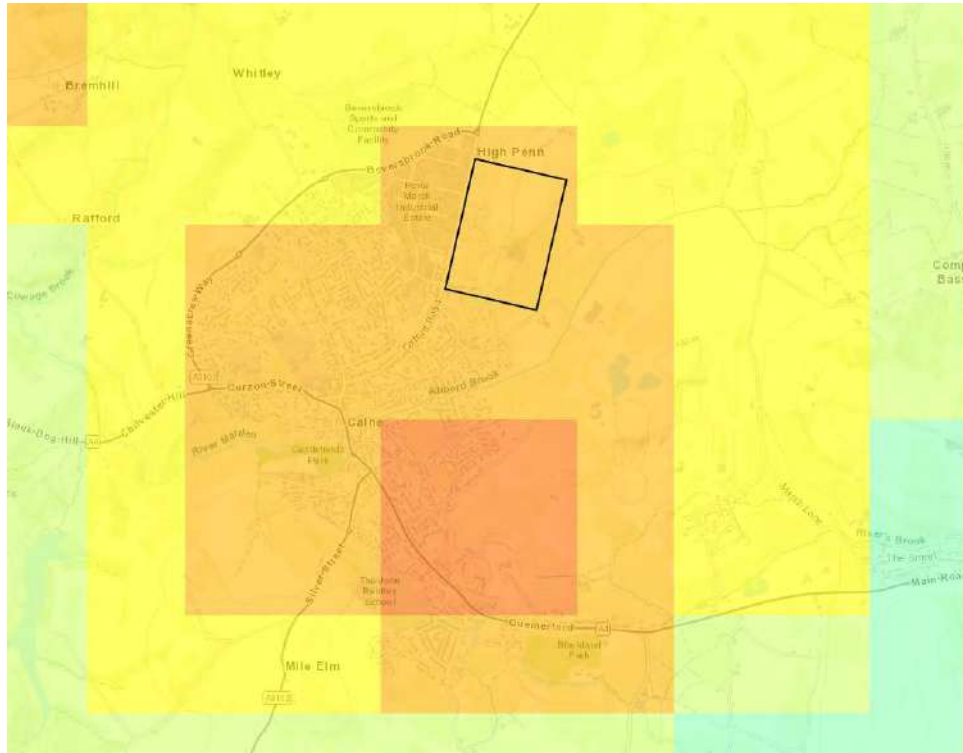


Figure 2-9: Extract from UK Soil Observatory (UKSO) map viewer for arsenic concentrations at, and within the surrounding area, of the site.

2.13 Radon

The radon risk is reported in the environmental report. This indicates that the site is not in a Radon Affected Area and no radon protection measures are required.

2.14 Unexploded ordnance (UXO)

In general accordance with CIRIA Report C681 (Stone et al 2009) a non-specialist UXO screening exercise has been undertaken for the purposes of ground investigation and is presented in Table 2.10.

Table 2.10: Non-specialist UXO screening (for the purposes of ground investigation)

Data	Comment	Further Assessment Required
Site History	There is no indication of former military use from the desk study.	No
Post War Development	The majority of the site has not been developed upon.	Yes
Geology Type	The ground conditions indicate sandstone and mudstone are present at shallow depths. It is unlikely UXO would remain un-detected.	No
Surface Cover during WWI	The surface cover during WWII comprised open fields. There is the potential that UXO, if present, would remain undetected.	Yes
Indicator of Aerial Delivered UXO	Screening against the regional bomb risk map (Wiltshire) in Appendix D indicates the site to be in an area where the bomb risk is low. The map shows a UXO find approximately 1km to the north-west of the site.	No

The non-specialist UXO screening exercise has indicated that whilst there is the potential for UXO to remain undetected due to the presence of open fields at the site during WWII and no further development on site since then, no further assessment is required with regard to UXO in relation to ground investigation due to the site history, the geology present and the overall risk level being designated as 'low'. Further assessment may be considered prudent for construction activities.

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 the HE documents HD 41/15 and CD 622.

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

3.3.2 Plausible geotechnical hazards

Plausible geotechnical hazards identified at the site are:

- Uncontrolled Made Ground (variable strength and compressibility) likely to be present underlying the industrial area, located towards the centre of the site.
- Soft / loose compressible ground (low strength and high settlement potential) associated with the weathered deposits of the Kimmeridge Clay Formation.
- Shrinkage / swelling of the clay fraction of soils under the influence of vegetation due to the likely presence of cohesive soils at the site.
- Variable lateral and vertical changes in ground conditions due to the presence of two different geological formations, as well as the potential for variation in the weathering profile of the Kimmeridge Clay Formation.
- Attack of buried concrete by aggressive ground conditions due to the fact that the Kimmeridge Clay Formation is understood to be a high sulfate bearing stratum.
- There is the potential for obstructions to be encountered within the industrial area, as a result of previous development.
- Existing below ground structures to remain (foundations, basements, and adjacent sub-structures of the industrial area and private residential house in the centre of the site).
- Shallow groundwater within the Lower Greensand Group / Kimmeridge Clay Formation.
- Changing groundwater conditions due to the seasonal changes.

- Running sands and / or loose Made Ground, leading to difficulty with excavation and collapse of side walls where either the Lower Greensand Group, or Made Ground, is encountered.
- Slope stability issues – general slopes and retaining walls.
- Earthworks – settlement, poor bearing capacity of fill or 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 and ground floor slabs.
- Roads and pavements.
- Services.
- General slopes.
- Retaining walls.
- Gardens.
- Construction staff, vehicles and plant operators.
- Concrete below ground.
- Earthworks control, inability to place and compact fill.
- 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).

- Hydrocarbon fuels, lubricants, oils and solvents from the operation of the vehicle repair workshop, waste oil burner and garages within the industrial area, situated towards the centre of the site, including leakage from fuel storage tanks, the pipework between tanks and pumps, and general spillage, together with uncontrolled disposal and spillage from waste receptacles (S02).
- Coal tar, potentially present in the bituminous bound pavements present in the form of roads and car parks (S03).
- Ground gases (carbon dioxide and methane) from organic materials in the Made Ground (S04).
- Hydrocarbon vapours from potential VOC and petroleum hydrocarbon spillages/leaks (S05).
- Asbestos within existing buildings (S06).

3.4.2.2 *Potential off-site sources of contamination*

- Ground gases (carbon dioxide and methane) from materials in the historical landfill (Calne Sand Pit), located 5m to the north of the site (S07).

3.4.3 *Potential receptors*

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

- People (site end users, neighbours) (R01).
- Development end use (buildings, utilities and landscaping) (R02).
- Groundwater: Secondary A aquifer status of the Lower Greensand Group (R03).
- Surface water: Abberd Brook, situated 300m to the south-east of the site and the potential pond, if to be retained, in the north-east corner of the site (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).
- Ground gas ingress via permeable soils and/or construction gaps (P02).
- VOC and petroleum hydrocarbon vapour ingress via permeable soils and/or construction gaps (P03).
- Root uptake by plant (P04).
- Migration of contaminant via leachate migration through the unsaturated zone in the Lower Greensand Group (P05).
- Surface run-off (P06).

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 K (Table K.1). A preliminary conceptual site model (Hydrock Drawing 24863-HYD-XX-XX-DR-GE-1004) is presented in Appendix A.

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.

The fieldwork took place between 20th and 29th September 2022. The ground investigation locations were surveyed in using a Total Station GPS survey instrument and are shown on the Exploratory Hole Location Plan (Hydrock Drawing 24863-HYD-XX-XX-DR-GE-1003) in Appendix A.

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

The weather conditions during the Hydrock fieldwork and for the previous week were generally overcast with sporadic showers, following a long period (three months) of drought conditions.

Table 4.1: Summary of site works

Activity	Method	No.	Name	Depth Range (m bgl)	In situ tests	Rationale
Drilling, Pitting and Probing						
Boreholes	Windowless sampler	11	WS01-WS11	0.70 - 5.00	SPT	For general site coverage and collection of samples. Installation of ground gas and groundwater monitoring and sampling wells.
Trial pits	Machine (JCB 3X)	39	TP01-TP39	0.55 - 3.75	Hand shear vane (HSV)	For general site coverage and collection of samples.
Probes	TRL dynamic cone penetrometer	8	TRL01-TRL08	0.44 - 0.83	California Bearing Ratio (CBR)	To allow the derivation of CBR values in the shallow soil profile.
Other in situ testing or monitoring						
Infiltration	Indicative	4	SA01-SA04	1.90 - 2.00	-	To enable infiltration testing.

Wells for monitoring groundwater levels and ground gas concentrations, and to facilitate the sampling of groundwater, were installed in a number of the windowless sampler 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	Screen top and base depth (m bgl)	Screen top and base elevation (m OD)	Strata targeted
WS01	103.98	50	1.00 to 5.00	102.98 - 98.98	Natural ground.
WS03	96.30	50	1.00 to 5.00	95.30 - 91.30	Natural ground.
WS05	97.66	50	1.00 to 5.00	96.66 - 92.66	Natural ground.
WS07	97.61	50	1.00 to 5.00	96.61 - 92.61	Natural ground.
WS10	103.39	50	2.00 to 5.00	101.39 - 98.39	Natural ground.

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.

Certain specific features, such as the industrial area situated towards the centre of the site and the historical landfill situated 5m to the north of the site, were targeted for specific investigation. A reasonably even spacing was used for the remainder of the site.

No specific sampling statistics or grid were utilised in this instance.

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 two occasions. The results are presented in Appendix G. 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 H and summarised in the table below. Wherever possible, UKAS and MCERTS accredited procedures have been used.

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

Table 4.3: Geo-environmental analyses of soils or other solids

Determinand Suite	Made Ground	Topsoil	Lower Greensand Group	Kimmeridge Clay Formation
Hydrock minimum suite of determinands for solids*	6	15	1	3
Speciated aliphatic and aromatic banding Total petroleum hydrocarbons by HS-GC/MS and GC/FID (Hydrock Tier 2 TPH Suite)	3	-	-	-
WAC Inert Solid Suite	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

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

4.3 Geotechnical testing

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

Table 4.5: Summary of sample numbers for geotechnical tests

Test	Lower Greensand Formation	Kimmeridge Clay Formation
Natural moisture content	-	10
Atterberg limits	-	9
Particle size distribution (dry sieve)	2	-
Particle size distribution (wet sieve)	-	1
Sulfate and aggressive chemical environment classification for buried concrete classification (full BRE SD1 suite)	-	5

The geotechnical test data are summarised in Section 5.5 and interpreted in Section 6.

4.4 Constraints

The footprints of the buildings within the industrial area could not be investigated as most buildings were still in use, preventing intrusive ground investigation. Furthermore, due to this area being active, access was limited as to not obstruct any entrances to workshops, due to the presence of parked cars and storage areas adjacent to buildings.

The presence of high-voltage overhead electrical services through the fields meant that, in line with Hydrock's safe digging practices, a 9-metre stand-off zone from the electrical services was kept throughout the investigation. As such, no ground investigation was undertaken within these zones.

A few drainage pipes associated with the land's agricultural use were encountered across the site. In those locations where they were encountered and not broken through trial pits were terminated in order to preserve them.

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 are used from this point forward.

Details of the Hydrock ground investigation works are provided in the logs in Appendix E, 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)
'General' Made Ground (industrial area only)	0.00	0.60 - 1.50	0.60 - 1.50	1.07
Topsoil	0.00	0.10 - 0.40	0.10 - 0.40	0.23
Lower Greensand Group	0.15 - 0.40	0.45 - 2.40	0.30 - 2.15	0.74
Kimmeridge Clay Formation	0.10 - 2.40	>5.00	>4.40	Not proven

5.1.2 Surface covering

The following surface cover was identified during the field reconnaissance and the fieldworks:

- Structures (workshops, buildings, storage areas) and hardstanding, covering the central industrial area of the site, along with roads that trend approximately N-S along the eastern site boundary and E-W through the centre of the site.
- Vegetation (grass, trees, brambles, hedgerows), covering the agricultural fields that surround the central industrial area.

5.1.3 Bituminous bound pavement

Bituminous bound pavement was encountered at one locality, WS10; this is in the vicinity of the industrial area. This was noted to be 0.05m thick, and underlain by a dark brown sandy gravel sub-base.

5.1.4 Made Ground

Made Ground was present at all localities undertaken within the central industrial area; it was not encountered in the surrounding agricultural fields. The Made Ground was encountered from the surface (i.e., 0.00m) to a maximum depth of 1.50m below ground level (bgl).

Made Ground was generally encountered as a sandy gravel in its uppermost part, to between 0.30m and 0.70m bgl, with gravel constituents varying per locality. Gravel was noted to include: chalk, flint, limestone, brick, concrete and sandstone. This was underlain by soft to firm brown clay / clayey sand, interpreted to be reworked natural material.

5.1.5 Topsoil

Where the Made Ground was not encountered (i.e., those not within the industrial area), the exploratory holes encountered topsoil.

Topsoil was recorded between 0.10m and 0.40m thick, with an average thickness of 0.23m. The topsoil generally comprised dark brown silty sand; the amount of sand / silt varied per locality, whilst some Topsoil was locally encountered primarily as a clay.

For the purposes of this report, topsoil is defined as the upper layer of an in-situ soil profile, usually darker in colour and more fertile than the layer below (subsoil), which is a product of natural chemical, physical, biological and environmental processes, but does not imply compliance with BS 3882:2015. Reuse of topsoil as a growing medium at the site should be determined by the landscape architect or the landscape Contractors.

5.1.6 Lower Greensand Group

The Lower Greensand Group was encountered underlying the Topsoil in a number of locations across the site. Whilst deposits associated with the Lower Greensand Group were expected, and encountered, across the central section of the site as shown in Section 2.5, deposits were also present along the western boundary of the site and in the north-eastern corner. The Lower Greensand Group is between 0.30m and 2.15m thick, with an average thickness of 1.07m.

This generally consisted of a brown, with occasional reddish-brown mottling, slightly clayey or slightly silty sand. In those areas that encountered deeper deposits, the material was encountered as a light grey to grey, mottled orangish brown and reddish brown, slightly silty sand.

5.1.7 Kimmeridge Clay Formation

The Kimmeridge Clay Formation was encountered across the entirety of the site, underlying either the Made Ground, Topsoil or the Lower Greensand Formation. The base was unproven.

This generally consisted of stiff desiccated brown to greyish brown locally slightly sandy clay in its uppermost part, from between 0.10 - 0.30m bgl to a maximum depth of 1.00m bgl. Underlying the above was generally noted to consist of firm grey mottled brown and orangish brown clay, with varying amounts of selenite crystals, shell fragments and locally relict rootlets. This represents the weathered layer, and generally becomes stiff with depth, and dark grey mottled brown, generally between 1.70m to 3.40m bgl.

It should be noted that, locally, the transition from firm to stiff was not noted at all localities due to the presence of perched groundwater within the stratum. Soft / soft to firm clay was encountered in these horizons from a minimum depth of 1.00m bgl to a maximum depth of 2.90m bgl, with thickness ranging from 0.50m - 0.90m. This is attributed to the water softening the clay.

Potentially moderately weak mudstone was encountered between 2.60 - 3.20m bgl in a couple of locations along the western side of the site, recovered as clayey gravel and cobbles of mudstone. The base of which was found in one locality (TP25) and was noted to be underlain by very stiff dark grey clay.

5.2 Visual and olfactory evidence of contamination (soil)

In addition to the more common man-made constituents (concrete, clinker, brick, etc), described above in Section 5.1.4, visual and olfactory evidence of contamination was noted in a few localities, summarised in Table 5.2.

Table 5.2: Visual and olfactory evidence of contamination - soils

Stratum	Location	Depth (m bgl)	Description
Made Ground	WS09	0.30 - 0.70	Slight hydrocarbon odour
Made Ground	WS10	0.30 - 0.60	Material stained black.
Made Ground	WS10	0.40	Potential asbestos containing material.

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	Groundwater observation (m bgl)	Comment
Kimmeridge Clay Formation	20/09/22	TP03	3.50	Minor ingress.
	20/09/22	TP04	3.20	Minor ingress.
	21/09/22	TP06	1.60	Minor ingress.
	21/09/22	TP06	2.50	Minor ingress.
	21/09/22	TP06	3.70	Minor ingress.
	21/09/22	TP07	3.00	Minor ingress.
	21/09/22	TP10	2.70	Minor ingress.
	21/09/22	TP11	2.30	Minor ingress.
	21/09/22	TP12	3.30	Minor ingress.
	23/09/22	TP15	1.55	Significant ingress.
	23/09/22	TP17	2.10	Minor ingress.
	23/09/22	TP17	2.90	Minor ingress.
	23/09/22	TP17	3.60	Moderate ingress.
	23/09/22	TP19	3.20	Moderate ingress.
	23/09/22	TP20	2.90	Minor ingress.
	23/09/22	TP20	3.70	Minor ingress.
	27/09/22	TP24	2.40	Minor ingress.
	27/09/22	TP24	3.20	Moderate ingress.
	27/09/22	TP25	2.25	Minor ingress.
	27/09/22	TP25	2.60	Moderate ingress.
	28/09/22	TP28	2.20	Minor ingress.
	29/09/22	TP34	2.70	Minor ingress.

Stratum	Date	Location	Groundwater observation (m bgl)	Comment
	29/09/22	TP37	2.40	Minor ingress.
	28/09/22	WS10	4.60	Moderate ingress.
Made Ground	28/09/22	WS09	0.30	Minor ingress.

Groundwater levels recorded during post-fieldwork monitoring 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)
Kimmeridge Clay Formation	06/10/22 - 18/10/22	WS01	1.81 - 1.90	102.17 - 102.08
		WS03	4.21 - 4.41	92.09 - 91.89
		WS05	4.27 - 4.43	93.39 - 93.23
		WS07	4.44 - 4.57	93.17 - 93.04
		WS10	0.20	103.19

5.3.2 Infiltration tests

The results of the infiltration testing undertaken are summarised in Table 5.5. The results sheets are presented in Appendix E.

Testing was carried out in accordance with Hydrock's 1-day assessment methodology. This is in general accordance with BRE Digest 365 (BRE DG 2016) where infiltration rates allow three test runs during a working day (or where there is no infiltration), but where low infiltration rates were encountered the available time may not have been sufficient to fully comply with the BRE test method (i.e., three runs of the test).

Table 5.5: Infiltration test results

Stratum	Location	Depth to base of pit (m bgl)	Infiltration rate (m/s)			
			Run 1	Run 2	Run 3	Range
Kimmeridge Clay Formation	SA01	2.00	No infiltration over 4 hours.			-
	SA02	1.90	No infiltration over 3 hours.			
	SA03	1.90	No infiltration over 4 hours.			
	SA04	1.90	No infiltration over 3 hours.			

5.3.3 Groundwater summary

In general, groundwater encountered during the ground investigation was generally as a minor seepage within the Kimmeridge Clay Formation, except for those localities in which potentially moderately weak mudstone was present (moderate ingress). This groundwater is likely indicative of perched groundwater within the cohesive soils.

Post fieldwork groundwater monitoring has indicated the presence of groundwater between 4.21m and 4.57m bgl within those wells located in the western section of the site. WS10, in the industrial area, and WS01, located within the central field adjacent to the farm, have recorded higher groundwater levels of 0.20m bgl and 1.81 - 1.90m bgl respectively. This is also likely to be indicative of perched groundwater collecting within the wells.

It should be noted that monitoring has been undertaken in October (i.e., during periods of heavy rainfall), and changes in groundwater conditions are likely across the seasons.

It should be assumed that groundwater within the Kimmeridge Clay Formation is predominantly present in the mudstone fissure network that likely exists at depth. The cohesive clays that overlie the mudstone across the site are generally impermeable and will restrict any leaching from shallow soils.

5.4 Ground gases (carbon dioxide and methane)

Records from the gas monitoring boreholes are presented in Appendix G and summarised in Table 5.6.

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

Table 5.6: Range of ground gas data

Stratum	Methane (%)	Carbon dioxide (%)	Oxygen (%)	Steady flow rate (l/hr)	Comment
'General' Made Ground	-	-	-	-	No monitoring possible due to high groundwater level recorded within WS10.
Kimmeridge Clay Formation	0.0 – 0.1	0.1 – 0.6	20.5 – 21.2	0.0 – 0.2	All carbon dioxide and methane readings below 1%.

5.5 Geotechnical data

5.5.1 Introduction

Laboratory test results are contained in Appendix F with *in situ* test results shown on the relevant exploratory hole log or datasheet in Appendix E. 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 5.7.

Table 5.7: Volume change potential

Stratum	No. of tests	Plasticity Index			Modified Plasticity Index			Plasticity designation	Volume Change Potential
		Min.	Max.	Av.	Min.	Max.	Av.		
Kimmeridge Clay Formation	8	31	50	42	31	50	41.8	High to Very High	Medium to High
Kimmeridge Clay Formation (Desiccated)	1	-	-	52	-	-	51.5	Very High	High

5.5.3 Particle size distribution

Particle Size Distribution test (PSDs) results are summarised in Table 5.8 and summary descriptions and PSD plots of the material analysed are presented in Appendix F.

Table 5.8: PSD results summary

Stratum	No. of tests	Silt/Clay %	Sand %	Gravel %	General description
Lower Greensand Group	2	0 - 2	97 - 99	1	Slightly clayey sand / sand.
Kimmeridge Clay Formation	1	91	7	2	Slightly gravelly slightly sandy clay.

5.5.4 Soil strength

Table 5.9 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. A shear strength versus depth profile is summarised in Figure 5-1, whilst an SPT 'N' value versus depth profile is summarised in Figure 5-2.

Table 5.9: Soil strength results and derived values

Stratum	No. of tests	SPT (N-value) (range)	c _u (kPa)	Method
Made Ground	1	12	54	SPT – windowless sampler boreholes.
Kimmeridge Clay Formation	49	5 - 36	23 - 162	SPT – windowless sampler boreholes.
	136	-	46 - 233	Hand shear vane.

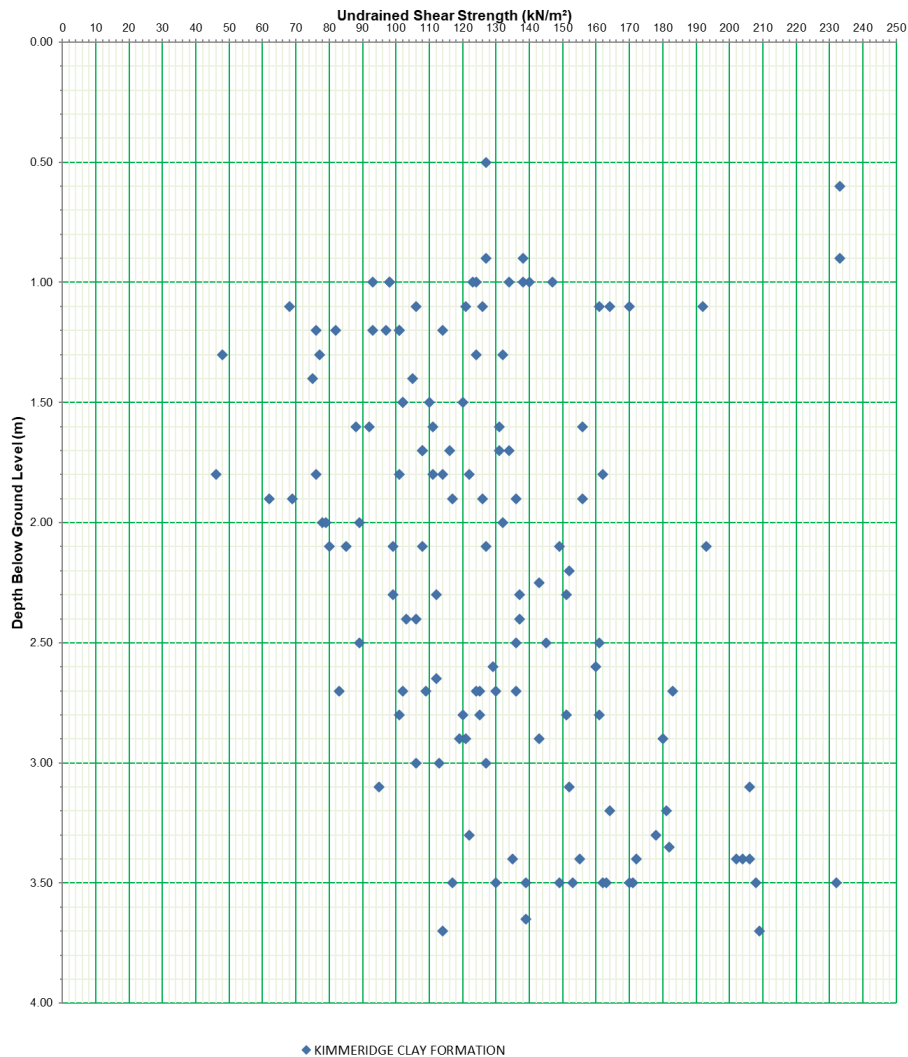


Figure 5-1 Undrained shear strength (kPa) vs Depth (m bgl).

As shown by Figure 5-1, there is a desiccated band within the shallow Kimmeridge Clay Formation (represented by high undrained shear strength values between 0.60m and 0.90m bgl). From 0.90m bgl, undrained shear strength becomes more uniform with a general 'increasing with depth trend'; however, there are a number of results that outlie this trend, potentially indicative of softer horizons that are locally influenced by the presence of groundwater.

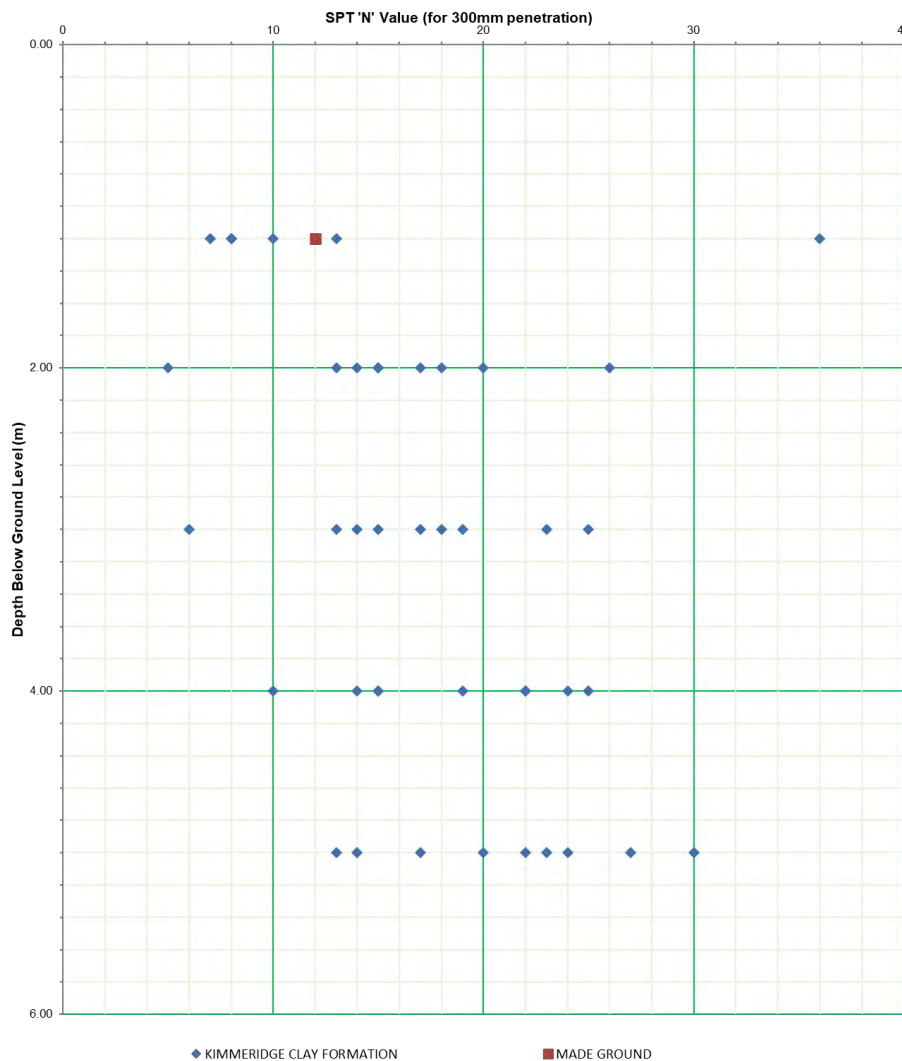


Figure 5-2 SPT 'N' Value vs Depth (m bgl)

Figure 5-2 shows that, with increasing depth below ground, the SPT 'N' value for the Kimmeridge Clay Formation also increases as with the undrained shear strength. It also indicates that desiccation is present at 1.20m bgl within WS04, with an 'N' value of 36 compared with 7 to 13 in the other boreholes.

5.5.5 Subgrade stiffness

The subgrade stiffness (CBR and Modulus of Subgrade Reaction) results are summarised in Table 5.10.

Table 5.10: CBR results and derived values

Stratum	No. tests	Method	CBR (%) (Range)
Topsoil	8	TRL dynamic cone penetrometer	4 - 11
Kimmeridge Clay Formation	6	TRL dynamic cone penetrometer	3 - 23
Lower Greensand Group	4	TRL dynamic cone penetrometer	6 - 19*
*One value of 76 omitted due to being significantly higher than all other values within this range.			

5.5.6 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 5.11. The assessment summary sheet is presented in Appendix F.

Table 5.11: Aggressive chemical environment concrete classification

Stratum	No. tests	DS	ACEC
Kimmeridge Clay Formation	5	3	3

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 understood to comprise low rise (2 to 3 storey) residential dwellings, with associated gardens, Public Open Space and infrastructure. Hydrock is aware that the central area of the site is to be used for commercial purposes; it is not known whether this will involve the site remaining as it currently is, or if re-development will be undertaken. Hydrock understands that, whilst there are no current final development levels, cut to fill or retaining will be required due to current level changes across the site. There is currently no surface water drainage strategy available for review.

Based on the above, for the purposes of this investigation, the proposed structures have been classed as Geotechnical Category 1. The final category classification is subject to the final design. Re-development and construction of commercial/industrial buildings in the central commercial area are likely to be classed as Geotechnical Category 2, subject to final design.

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 J (Table J.3) and will need to be updated during future design works.

6.2 Groundwork

6.2.1 *Site preparation*

The majority of the site is previously undeveloped grassland and no buried obstructions were encountered by this investigation and are not likely to be encountered. Within the central industrial area, the possibility of buried obstructions being encountered remains. Therefore, it is recommended that an allowance be made for breaking out obstructions.

Topsoil should be removed from beneath all building and hardstanding areas.

6.2.2 *Groundworks*

The excavation of shallow soils should be readily undertaken by conventional plant and equipment. However, excavation through any intact rock quality strata may require heavy-duty excavation plant.

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.

However, the Lower Greensand Formation can be subject to spalling and, whilst instability due to spalling was not noted in the short-term trial pit excavations, spalling can cause instability of longer excavations.

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.

Any water pumped from excavations may need to be passed via settlement tanks (to reduce suspended solids) before being discharged to the sewer. Discharge consents may also be required.

6.2.3 *Earthworks/reuse of site-won materials*

Whilst Hydrock has not been provided with the specific requirements for earthworks (cut / fill depths and volumes), it is anticipated earthworks will be required due to the current level differences across the site. The classification of materials depends on both the proposed end use and whether the material will meet the performance requirements of that end use.

If significant earthworks are required, the works may be Category 2 in accordance with BS EN ISO 1997-1 (EC 7) and further geotechnical design may be necessary. 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.

An initial assessment of classification data (see Section 5.5 and Appendix F) has been completed based on Hydrock's understanding of the development and the potential to reuse site-won materials as an engineered fill material. This is summarised in Table 6.1.

Table 6.1: Preliminary earthworks assessment

Stratum	Proposed end use	Preliminary classification (SHW Series 600)	Comment	Suitability for improvement by the inclusion of binders
Made Ground	External Areas	Further testing required to classify material.	Processing to remove oversize and deleterious material required. Can only be used in areas which are not sensitive to settlement.	N/A
Topsoil	Open Space	Class 4 (Landscape Fill)	Unsuitable for General Fill due to high organic content. Can only be used in areas which are not sensitive to settlement.	N/A
Lower Greensand Group	External Areas	Class 1 & Class 6 General Fill	Further testing required if reuse proposed.	Further testing required if reuse proposed.
Kimmeridge Clay Formation	External Areas	Class 2 & Class 7 General Fill	Further testing required if reuse proposed.	Unlikely to be suitable.
Should earthworks be required, supplementary earthworks testing and an earthworks Specification will be necessary to ensure the appropriate management and reuse of the existing soils. If structural fill is required further testing is required to determine the classification of the natural soils.				

The earthworks may need to be undertaken under a Materials Management Plan (see Section 8.4).

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.

6.3 Slope stability

There are a number of significant slopes on site (both steep and / or cover a significant level difference); it is currently not known whether these are to remain as part of the proposed development. However, Hydrock anticipates there will be cut slopes on site which, depending on height, will need to be retained or battered to a suitable angle (see Section 6.4).

As the current investigation is preliminary, it is recommended that supplementary investigation and design be undertaken in the areas of higher risk. This will be dependent on final design levels.

6.4 Retaining walls

With regard to proposed retaining walls, Hydrock understand there is the potential for the requirement of a number of significant retaining walls in areas that are to be cut / filled. However, there are no heights / founding levels currently available.

Any walls in the vicinity of sloping ground below its position shall require a global stability check. Also, where the proposed retaining walls are greater than 2.0m high, they are considered to be Category 2 structures and further geotechnical design will need to be considered.

Any substantial retaining structure could comprise:

- driven sheet piles;
- contiguous or semi-contiguous piled wall;
- preformed concrete retaining wall;
- king posts with concrete or infill panels;
- gabion walls with reinforcement; or
- crib lock walls with reinforcement.

It is recommended that all retaining walls are individually designed using site specific design criteria, assessed as part of the required geotechnical design. Associated as-built records will be required for verification purposes.

Allowance should be made in the design of the retaining walls for adequate drainage behind the structure, or for water seepage through the face of the wall. The overall stability of the retaining wall is not considered in this report. The stability of the retaining wall should be considered in the design process.

Care will need to be taken to ensure that any works close to the site boundaries will not destabilise or cause damage to neighbouring properties including the existing boundary walls and fences. A structural survey is recommended to ensure that existing walls will not be adversely affected.

6.5 Foundation recommendations

This section provides recommendations for the foundations for houses, garages and related buildings as indicated on the proposed development layout (Pegasus Group. August 2022. 'Concept Masterplan', Ref: Version 2) presented in Appendix A.

The recommendations in this report are based on the current NHBC Standards (2022).

The houses proposed for the site are considered to be Geotechnical Category 1. Preliminary foundation recommendations for the foundations for houses and related buildings in this section are based on the geotechnical parameters provided in Section 5.5.

The safe bearing pressures for foundations quoted for Category 1 structures in this report take into consideration traditional factors of safety against the risk of shear failure of the ground and should prevent undue or excessive total and differential settlement from the anticipated structural loadings.

However, there is the potential for the Geotechnical Category to change from 1 to 2, should standard foundations not be suitable. This could be prevalent in areas of soft spots identified during the investigation, where foundations may have to be deepened.

In accordance with EC7, BS EN 1997-1+A1 (2013) rafts and piles are considered to be Geotechnical Category 2. Recommendations for Geotechnical Category 2 structures are presented to aid development proposals only. A separate geotechnical design will be required at the design stage.

Subject to detailed geotechnical design, the safe bearing pressures for foundations in this report take into consideration the risk of shear failure of the ground (ultimate limit state). However, they do not assess acceptable limits of settlement (serviceability limit state). Serviceability limit state assessment will need to be undertaken as part of the separate geotechnical design.

6.5.1 *Foundation types*

On the basis of the ground conditions indicated from the current investigation, the foundations recommended are as follows:

- Strip/trench fill or pad foundations across the majority of the site (deepening due to trees as required) to a maximum depth of 2.5m bgl.
- Piled foundations, where foundations need to be deepened due to tree influence in shrinkable soils to depths in excess of 2.5m bgl; or where soft spots have been encountered.

6.5.2 *Strip / trench fill and pad foundations*

Strip or pad foundations are considered suitable across the majority of the site. They should be below any Made Ground and at least 300mm into the undisturbed natural strata, which comprise firm (or better) clay of the Kimmeridge Clay Formation. If shallow soft spots are encountered which, during the site works, were locally encountered from a minimum depth of 1.00m bgl to a maximum depth of 2.90m bgl, foundation depth will be required to be deepened until a suitable firm clay is reached.

A lower bound safe net bearing pressure of 150kN/m² is considered appropriate for shallow footings due to the presence of deeper softened horizons associated with localised groundwater bearing zones within the Kimmeridge Clay Formation.

If enlarging foundations is considered (e.g., because loads are such that the quoted safe net bearing pressure is inadequate for a standard strip foundation up to 1.0m wide), this could lead to increased settlements and the above recommendations should be reviewed.

Based on the NHBC volume change potential (high) the minimum founding depth for strip or trench fill foundations is 1.50m below final ground level, and to below the base of any Made Ground present, whichever is deeper.

If trees are to be removed, the roots should be grubbed out and foundations extended to below the zone of disturbance created by this activity and to below any remaining root hairs.

Deepening of foundations in accordance with NHBC Standards will be required where foundations are within the zone of influence of existing, removed or proposed trees and proposed shrub planting. A tree survey should be undertaken by an arboriculturist in accordance with BS 5873:2012 to identify the type, and height of existing trees on the site and including any off-site trees, which could have an effect on foundation design.

Where trench fill foundations are within the zone of potential desiccation from trees and are deeper than 1.5m bgl, a suitable compressible material or void former will be required on the inside faces of foundations to external walls and beneath ground bearing floor slabs.

Where foundation depths are stepped, for instance to match changes in depths due to trees or changes in ground conditions, the steps should be designed in accordance with the requirements of the NHBC Standards.

Excavation of strip / trench fill and pad foundations in excess of 2.5m bgl is unlikely to be economical and may be impracticable to undertake. However, if trench fill foundations in excess of 2.5m depth are proposed, they should be designed by a Structural Engineer in accordance with the requirements of the NHBC Standards (Chapter 4.2.8) and NHBC Technical Requirement R5. In addition, Hydrock recommends that the design of foundations deeper than 2.5m should take into account soil desiccation risk from plot specific testing if within the influencing distance of trees.

Foundation formations should be inspected by a geotechnical engineer or other suitably competent person to ensure the founding conditions are suitable and as indicated in this report. Any formation materials deemed as unsuitable should be excavated and replaced with lean mix concrete or deepened to suitable strata. If this is not possible, alternative solutions (such as piling) should be undertaken.

As the ground conditions at formation level are likely to be of variable type and stiffness, for the strip/trench fill foundations, it is recommended that foundation concrete should be reinforced with mesh, installed at the top and bottom of the foundation, across the zone of variable soil conditions.

Foundation excavations should be protected from rainfall, inflow of surface water, frost and freezing conditions. They should also be protected from drying out in hot dry weather.

Groundwater monitoring indicates the presence of a sporadic, low flow groundwater table for the majority of the site. Any water that collects at the base of the foundation excavations should be removed by pumping from a sump in the base.

However, WS01 and WS10 located towards the centre of the site and as such the topographically higher section of the site, have recorded a shallow groundwater table and excavations may be difficult to undertake. Alternative methods of groundwater control may be required as fast groundwater ingress is anticipated, which could result unstable excavations.

6.5.3 *Piled foundations*

Piled foundations may be required where the influence of trees and depth to suitable founding stratum is such that traditional strip foundations become un-economic or impractical to construct. Piled foundations may also be a consideration where house plots coincide with areas where excessive thickness of upfill is to be proposed.

Depending on column loads and layouts, piles should extend through any Made Ground present and to a suitable depth into the underlying Kimmeridge Clay Formation.

Bored piles with the use of casing / CFA piles should be suitable to support the foundations for the houses. 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 may be present, 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.

- If groundwater is encountered, temporary casing is to be required to depths of 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.
- Piles should extend a minimum of five pile diameters into the bearing stratum (Kimmeridge Clay Formation) to mobilise sufficient shaft friction and end-bearing resistance to carry the required loads without unacceptable settlement.
- Where the piles are to be constructed through compressible soils and have fill placed over them, piles should also be designed to cater for the potential down-drag effects of negative skin friction on piles from the secondary consolidation / recently placed fill.
- Collapse of the pile shaft can be caused by 'necking' of the pile in running sand conditions, leading to pile failure.
- Where bored piles extend through very soft ground, bulging of the concrete can occur, leading to lateral pressure on adjacent piles.
- 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.

6.5.4 Foundation works risk assessment

A foundation works risk assessment may be required to determine if piles will result in a significant increase in risk of pollution to Controlled Waters. Due to the low risk the site poses to Controlled Waters and the use of CFA piles into an Unproductive Stratum in this instance, subject to regulatory agreement, Hydrock consider a foundation works risk assessment to be unnecessary.

6.5.5 Working platform

A working platform will be required prior to the arrival on site of any tracked piling plant. This should be designed and installed in accordance with BR470 (BRE 2004) based on data on the specific plant in accordance with an FPS certificate for the rig loadings.

6.6 Ground floor slabs

In accordance with the NHBC standards, as clay soils of high-volume change potential are present at the site, it is recommended that suspended floor slabs with a void be adopted.

Ground floor slabs should be designed to incorporate any gas mitigation measures that may be required, as discussed later within this report.

6.7 Roads and pavements

Based on the test results and subject to *in situ* testing during construction, it is considered likely an equilibrium CBR of 2.5% will be achievable over the majority of the site. This is based on current levels at the site, and is subject to change based on the final design levels and any cut / fill that is recommended across the site.

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.

6.8 Drainage

Indicative infiltration rates for the ground investigation were not able to be calculated due to slow infiltration, as shown in Appendix F and summarised in Table 5.5. Therefore, soakaways are considered unsuitable for the site.

6.9 Buried concrete

Based on guidelines provided in BRE Special Digest 1 (BRE 2005) and the information presented in Section 5.5.6 (Table 5.11) the soils of the Kimmeridge Clay Formation can be classified as Design Sulfate Class DS-3 and ACEC Class AC-3.

As this investigation is preliminary, additional testing is required to confirm that these conditions apply to the whole site area.

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

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 2) 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 removed from, or added to, the exposure model.

7.1.2.2 *Receptors*

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

However, the potential pond, situated in the north-east of the site, has been removed from R04 due to Hydrock anticipating it being infilled as part of the proposed development. If this is not the case, Hydrock will need to be made aware in order to re-assess.

7.1.2.3 *Pathways*

No pathways have been removed from, or added to, the exposure model.

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 4.

In cases where potentially unacceptable risks are indicated and/or the land is potentially unsuitable for its intended use, actions such as more advanced stages of risk assessment (Tier 3, detailed quantitative risk assessment (DQRA)) or remediation are proposed in Section 7.9.

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.

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.

Based on the proposed development, generic assessment criteria (GAC) based on default residential with homegrown produce, commercial / industrial and public open space (park) CLEA land use scenarios have been adopted based on the proposed development layout.

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 H.

The results of the assessment are presented in Appendix H.

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 based on the following site zones, with the data separated into Made Ground, Topsoil and natural soils:

- Proposed commercial area in the centre of the site.
- Proposed residential area in the south-western and north-western fields.
- Proposed area of Public Open Space (POS) across the south-eastern and north-eastern fields.

Should the proposed layout change, the data will need to be re-assessed based upon the updated applicable land use scenarios.

GAC based on a soil organic matter (SOM) of 2.5% for Made Ground and Topsoil and 1.0% for natural soils based on laboratory results has been assessed against. Assessment sheets are presented in Appendix H.

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
<i>Topsoil 'Residential with home-grown produce'</i>						
Arsenic	37	C4SL - CL:AIRE 2014	10	7.6	47	2
<i>Made Ground 'Commercial'</i>						
Benzo(b)fluoranthene	45	Hydrock Derived	6	0.05	49	1
Dibenz(ah)anthracene	3.6	Hydrock Derived	6	0.05	5.40	1

There were no exceedances of the GAC in samples of natural soils when compared to the relevant end use. The presence of arsenic in the Topsoil and PAH species in the Made Ground requires further assessment.

7.3.2 Asbestos

Potential visual evidence of Asbestos Containing Material (ACM) was encountered in WS10 at 0.40m bgl, located within Made Ground in the vicinity of the industrial area. In addition to this, asbestos has been identified by laboratory testing of soil samples from this location as provided in Table 7.2.

Table 7.2: Asbestos in soil samples (laboratory testing)

Location	Depth (m bgl)	% Asbestos (w/w)	Comment
WS10	0.2	0.002	Loose fibres (chrysotile).
	0.5	5.089	Cement type material (chrysotile).

The presence of Asbestos Containing Materials and asbestos fibres in soil requires further consideration.

7.3.3 Risk evaluation

The screening exercise has identified PAH (benzo(b)fluoranthene and dibenz(ah)anthracene) in Made Ground and arsenic in Topsoil at concentrations above the GAC, as well as asbestos within the Made Ground. These are considered further here to assess if the exceedance may be acceptable with respect to the proposed development. The phrase 'further assessment' does not necessarily mean that the soil is 'contaminated' or not fit for use.

7.3.3.1 Arsenic in Topsoil (Proposed Residential Area)

Concentrations of arsenic are elevated above the GAC (47mg/kg vs. the GAC of 37mg/kg) within the Topsoil in locations within the proposed residential area.

There is no evidence of a man-made source of arsenic on the site and, as such, the exceedances are likely coming from a natural source.

Consequently, this exceedance is not considered a significant risk to human health in line with the current Contaminated Land Statutory Guidance, which accepts that there may be natural background levels of substances as a result of the geology, but it is recommended that further assessment be undertaken using bio accessibility testing, in consultation with the regulatory authorities.

7.3.3.2 PAH in Made Ground Soils (Proposed Commercial Area)

Concentrations of benzo(b)fluoranthene are slightly elevated above the GAC (49mg/kg vs. the GAC of 45mg/kg) and dibenz(ah)anthracene slightly elevated above the GAC (5.4mg/kg vs the GAC of 3.6mg/kg) in the Made Ground in WS10 at 0.20m bgl.

Whilst the exceedances are only slightly elevated when compared to the GAC, they still pose a risk which requires mitigation for the proposed end use. However, the proposed end use for the area, designated as 'commercial', means the area will be largely covered with hardstanding and buildings.

If any soft landscaped areas are to be proposed within this area, mitigation will already be required due to the presence of asbestos identified within the Made Ground. As such, the requirement to mitigate the asbestos will also serve to mitigate against the exceedances of PAH in the Made Ground.

7.3.3.3 Asbestos

Asbestos Containing Materials (chrysotile cement) have been identified in a sample of Made Ground, undertaken at WS10 (0.50m bgl). In addition, asbestos fibres (0.002%v/v of chrysotile) have been detected in a sample of Made Ground at the same locality (0.20m bgl).

Hydrock consider it plausible for asbestos to be present in any of the Made Ground soils (central industrial area) and asbestos, (even at low concentrations), represents an unacceptable risk and mitigation measures will be required in this area of the site.

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 of >7 for Made Ground, 7 for natural soils and 5-6 for Topsoil, based on laboratory results.

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

Based on individual test results that exceed the phytotoxic GAC, CoPC which require further assessment are summarised in Table 7.3.

Table 7.3: CoPC which require further assessment (phytotoxic)

CoPC	GAC (mg/kg)	Basis for GAC	No. samples	Min. (mg/kg)	Max. (mg/kg)	No. samples >GAC
<i>Made Ground 'Commercial'</i>						
Boron	5	Nable, et al. 1997	6	0.3	13	2
Copper	135	BS3882 2015	6	9.4	4400	2
Zinc	300	BS3882 2015	6	30	5400	2

7.4.2 Risk evaluation

Within the Made Ground, concentrations of boron, copper and zinc are significantly elevated when compared to the GAC. Whilst detriment to plant life is difficult to quantify as many of the GAC are based on agricultural crop yields rather than harm to particular plant species, the significant exceedance of the GAC indicates the probability of an unacceptable risk to plant life and mitigation may be required.

The requirement for mitigation of risk to human health from the Made Ground encountered in the commercial area (as discussed in Section 7.3.3) will also serve to mitigate risks to plant life. Should soft landscaping areas be proposed in the commercial area, a suitable growing medium will be required for any planting.

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 H. This methodology involves selecting which of several alternative risk scenarios apply in this case. The assessment is presented in Table 7.4 below, with the justification for the scenarios selected explained in the following text:

- The primary natural drainage feature is the Abberd Brook, situated 300m to the south-east of the site, with flow towards the south-west. Recharge to the brook is likely to occur only via overland flow due to the cohesive nature of the underlying Kimmeridge Clay Formation. There is a potential pond located towards the north-eastern corner of the site, however, it is anticipated it will likely be filled as part of the proposed development. It is unlikely to be connected to other water bodies.
- There are no active licensed surface or groundwater abstractions within 500m of the site.
- The site is not within a Source Protection Zone and there is no designated groundwater body beneath the site (the Kimmeridge Clay Formation is classified as 'unproductive').
- The nearest designated groundwater body is 450m to the south-west of the site (Corallian Limestone [Calne to Swindon]), which is currently (2019 Cycle 2) classified under the Water Framework Directive as 'good'.
- Whilst the Lower Greensand Group is also recorded on BGS mapping beneath the site, the ground investigation has encountered this stratum as a sporadic thin layer. No groundwater was encountered within this stratum.

Table 7.4: Summary of water quality risk assessment protocol

Hydrock scenario	Water body receptors	Secondary receptors	Example contaminant linkages	RTM level and data used	Water quality targets
B	Groundwater Surface water	Aquatic ecosystem.	Contaminants from site leach or seep into a groundwater body that feeds inland surface water by base flow. The surface water may be an aquatic ecosystem.	RTM Level 2 - Groundwater.	EQS (inland)

Notes:

Some EQS are water hardness dependent. This is measured either in the receiving surface water or in groundwater (if it is part of the pathway), or is estimated from national maps.

Inland waters EQS applicable to freshwater, 'other' waters EQS applicable to coastal or transitional waters.

This table and the results of the assessment are considered as a first screening for potential risks of pollution of Controlled Waters. More specific requirements may be stipulated by the relevant Agency.

The results of the screening assessment are presented in Appendix H and are summarised in Table 7.5.

In some instances, the reporting limit (or detection limit) quoted by the laboratory may be greater than the WQT that it is being assessed against. As the current exercise is an initial screening assessment, further assessment of these elements has not been undertaken.

Table 7.5: CoPC which require further assessment (controlled waters)

CoPC	WQT (µg/l)	Basis for WQT	No. samples	No. samples above LoD	Min. (µg/l)	Max. (µg/l)	No. samples exceeding WQT and above LoD
Groundwater Data							
Cadmium	0.08	EQS	2	2	0.04	0.11	1
Copper	1	EQS bio†	2	2	3	3.5	2
Manganese	123	EQS bio†	2	2	580	610	2
Nickel	4	EQS bio†	2	2	3.1	7.3	1
Ammoniacal Nitrogen (as N)	300	EQS	2	2	550	5600	2
Sulfate	400000	EQS	2	2	91400	1310000	1

Note: the maximum recorded value is compared with the water quality target.

† The EQS for these substances represents a bioavailable concentration, which will be a proportion of the actual dissolved concentrations in water. No site-specific bioavailability testing was able to be undertaken at the site and therefore the EQS bioavailable represents a conservative screening approach.

7.5.2 Risk evaluation

Whilst there are exceedances of the water quality targets, these exceedances are considered not to represent a significant risk of pollution of Controlled Waters from an on-site source as there is no evidence of artificial accumulations of these substances on the site. Either they originate from the natural geology, or, in the case of ammoniacal nitrogen, can likely be attributed to the sites and general surrounding areas agricultural usage.

Furthermore, the inland waters EQSs for copper, manganese and nickel are based on the bioavailable fraction and because bioavailability has not been calculated for these metals the assessment is conservative as it assumes 100% bioavailability.

It would be technically challenging and probably disproportionately costly to remove these natural contaminants from the water or to prevent further infiltration.

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

7.6 Ground gases risk assessment

7.6.1 Data

It is judged from the available evidence that the gas generation potential at the site is moderate (due to the adjacent landfill) and that the sensitivity of the development is high (due to it being a residential development). Consequently, and in accordance with CIRIA C665 (Table 5.5a and 5.5b), an appropriate minimum monitoring regime is 12 readings over 6 months, provided other monitoring requirements are also met, such as prevailing atmospheric pressure conditions (for example, BS 8485:2015 +A1:2019 suggests monitoring should include a period of falling atmospheric pressure).

It is considered that the Kimmeridge Clay Formation present at shallow depths across the site will form an impermeable barrier due to it being a cohesive stratum. As such, the CIRIA guidance is not considered applicable, however, confirmatory monitoring has been undertaken to confirm the risk. An initial monitoring regime of 6 readings over 3 months is scheduled to be undertaken.

Hydrock has undertaken two of the six readings required, including during periods of falling atmospheric pressure, the conclusions presented below are considered interim, pending assessment of the outstanding ground gas monitoring results.

7.6.2 Assessment

The risks associated with the ground gases methane (CH₄) and carbon dioxide (CO₂) have been assessed using BS 8485:2015 +A1:2019, which cites the guidelines published by CIRIA (C655, 2007) (known as Situation A).

The assessment guidelines set out in Table 2 of BS 8485 are based on interpretation of the gas concentrations and the gas flow rates. The quantitative assessment has been carried out by comparing the individual gas concentrations and gas screening values (GSV³) in Appendix D with the published CS thresholds (BS 8485 Table 2), in addition to a worst-case GSV assessment in accordance with section 6.3.7 of BS 8485. The assessment is summarised in Table 7.6 and the full assessment is presented in Appendix G.

³ Note: GSV is synonymous with 'site characteristic hazardous gas flow rate' (Q_{hgs}) of BS 8485:2015 +A1:2019 Table.

Table 7.6: Ground gas risk assessment

	Min	Max	Typical ⁽ⁱ⁾	Comment
Steady Flow Rate (l/hr)	0.0	0.2	<1	-
Methane (%)	0.0	0.1	<1	All methane and carbon dioxide recordings are <1%.
Carbon Dioxide (%)	0.1	0.6	<1	
Oxygen (%)	20.5	21.2	-	-
Carbon Dioxide GSV (l/hr)	0	0.0012	<0.07	CS1
Methane GSV (l/hr)	0	0.0001	<0.07	CS1
⁽ⁱ⁾ Hydrock assume that values are considered to be atypical if 95% or more of the remaining data are less than the value under consideration				

As indicated in Table 7.6, the computed GSV for carbon dioxide and methane indicates CS1 conditions and methane and carbon dioxide at concentrations are ‘typically’ below 1% and 5% respectively. As such, the site is provisionally classified as Characteristic Situation 1 (Situation A) and no mitigation measures are required, subject to outstanding ground gas monitoring results.

Furthermore, no monitoring has been undertaken targeting the Made Ground within the industrial area and therefore this is still considered to be a risk at this time.

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 predominantly previously undeveloped, with a small area of brownfield (industrial area) in the central area of the site. Laboratory testing has not recorded any hydrocarbons in the greenfield area. However, in the industrial area, PAH species have been identified in laboratory testing.

Subject to agreement with the Water Authority, it may be possible for the site to be classified as ‘dual status’, i.e., contaminated and non-contaminated, from the perspective of the water supply pipe requirements, with standard pipework for the greenfield parts of the site and barrier pipework in the area of the landfill. If this is possible, it may be necessary to prepare separate water pipe risk assessments on a plot-by-plot basis in order to demonstrate to the water supply company the suitability of standard polyethylene pipework in greenfield areas.

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 PAH, and BTEX are below 100mg/kg and the concentrations of petroleum hydrocarbons (TPH) are below 200 mg/kg, PVC-U, PP or PE pipework is considered suitable across the greenfield section of the site.

However, within the central industrial area, concentrations of petroleum hydrocarbons (TPH) are above 200 mg/kg and, as such, the pipework manufacturer should be consulted with regard the suitability of the pipework.

The implications for buried concrete are discussed in Section 6.9.

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 (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 K (Table K.2).

The final CSM is illustrated on Hydrock Drawing 24863-HYD-XX-XX-DR-GE-1005 in Appendix A.

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 7.7.

Table 7.7: Residual risks following risk evaluation

Contaminant Linkage				Comments	
Pollutant Linkage	Sources	Pathways	Receptors	General	Mitigation
PL 1.	Arsenic in the Topsoil.	Ingestion, inhalation or direct contact.	Human health.	Exceedance of the GAC.	Further assessment to be undertaken using bio accessibility testing.
PL 2.	PAH in the Made Ground.	Ingestion, inhalation or direct contact.	Human health.	Exceedance of the GAC.	Mitigation required in the form of an engineered cover system in landscaped areas.
PL 3.	Boron, copper and zinc in the Made Ground.	Root uptake.	Plant life.	Significant exceedance of the GAC.	
PL 4.	Asbestos fibres in soil / asbestos-containing materials in the Made Ground	Inhalation of fugitive dust.	Human health.	Made Ground seen to contain asbestos-containing materials. Asbestos fibres measured in soil samples.	
PL 5.	Asbestos fibres from insulation or asbestos-containing materials in the buildings.	Inhalation of fugitive dust.	Human health (site neighbours).	Due to the age of the structures on site, asbestos containing materials (ACM) may be present.	Asbestos demolition survey is required and removal under current legislation rules.

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 7.7 (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:

- Exceedances of arsenic are present in the natural ground. Further assessment will be required using bio accessibility testing in consultation with the regulatory authorities (PL1).
- Hydrock understands that the current industrial estate is designated as 'commercial' in the current masterplan. Should there be areas of proposed landscaping, these areas will require an engineered clean cover system so that site users will not come into contact with the Made Ground soils. It is anticipated the rest of the commercial area will comprise hardstanding or buildings, restricting any point of contact. This will also serve to mitigate the risk to, and provide a suitable growing medium for, plant life (PL2, 3 and 4).
- Asbestos demolition survey and removal by a specialist contractor, if asbestos is present (PL5).

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 below describes the key issues relating to off-site disposal to landfill and Section 8.4 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 a mixture of both brownfield (central industrial area) and greenfield (surrounding agricultural fields), 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 I and a summary of the preliminary waste classification is provided below in Section 8.2.4.

8.2.3 *WAC Testing*

With regards to the greenfield section of the site, quantitative WAC testing has not been undertaken at this stage. Whilst unlikely, if requested, WAC testing may be required during the Basic Characterisation process required by the Landfill operator for the excavated material prior to disposal.

In terms of the central industrial area (i.e., brownfield section of the site), only one WAC test has been undertaken as part of the current ground investigation and is provided in Appendix H. Further WAC testing will be required on the excavated soils that are to be disposed of, to assist with waste disposal options prior to disposal. A summary of the preliminary waste disposal options is provided below in Section 8.2.4.

8.2.4 *Preliminary waste disposal options*

The site can be split between both greenfield and brownfield. Based on the site history, preliminary WAC testing 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 soils are likely to be classified as non-hazardous waste, for disposal at an 'inert' landfill site, subject to confirmation by WAC testing.
- The Made Ground encountered within the central industrial area is generally likely to be classified as non-hazardous waste. However, a couple of samples of the Made Ground, collected from WS09 and WS10, are likely to be classified as hazardous waste due to asbestos, petroleum hydrocarbons and heavy metals.
- Any soils containing > 0.1% asbestos or visible asbestos containing materials would be considered as hazardous.
- Bituminous bound pavement is present; however, no testing has been undertaken.

8.2.5 *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 WAC testing and 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 following⁴:
 - » 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 Re-use of bituminous bound pavement waste containing coal tar

Whilst the site investigation has proven the presence of bituminous bound pavement, no testing has yet been undertaken. In the event that, after testing has been undertaken as part of supplementary ground works at the site some of the bituminous bound pavement waste contains coal tar (otherwise known as, Asphalt Waste Containing Coal Tar (AWCCT)), the following will apply:

If AWCCT is to be re-used on site, it will need to be re-used in accordance with the Environment Agency Regulator Position Statement 075 (EARPS075).

In order to comply with EA RPS075 allowing the re-use of AWCCT in construction operations for hard paving structures, without an environmental permit, the contractor needs to comply with the following items presented in the statement:

“We will not pursue an application for an environmental permit for the use of where:

⁴ ENVIRONMENT AGENCY. November 2010. Guidance on waste acceptance procedures and criteria. Waste acceptance at landfills. The Environment Agency.

- The treated AWCCT meets the requirements of clause 948, ex-situ cold recycled bound material, within the Specification for Highways Works Series 900, or clauses 810 to 880 for cement and other hydraulically bound mixtures within the Specification for Highway Works Series 800.
- The material is used only in bound sub-surface layers e.g., sub-base, base and binder layers. Use in surface applications is not allowed.
- You meet the relevant objectives of the Waste Framework Directive;
 - » ‘... ensuring that waste management is carried out without endangering human health, without harming the environment and in particular: (i) without risk to water, air, soil, plants or animals; (ii) without causing a nuisance through noise or odours; and (iii) without adversely affecting the countryside or places of special interest.’”

The material containing coal tar will need to be placed as part of hardstanding (but cannot be placed below buildings and cannot be placed at the surface), which will break the pathway between the material and the end users of the site. However, it is recommended that the location of the coal tar containing material is recorded in the Health and Safety file to ensure future maintenance workers are aware of the potential risks. The location of the coal tar containing materials should be surveyed in and presented on a plan in the contractor's validation report.

A Controlled Waters Detailed Quantitative Risk Assessment (DQRA) will be required to derive the site-specific remediation target values and comply with the EA regulations. The DQRA should take into account: the transport in the unsaturated zone; dilution upon entering the aquifer; and attenuation within the aquifer pathway. Based on our experience with DQRA and PAH contamination, Hydrock would generally expect such a DQRA to rule out any risk to Controlled Waters primarily based on the travel times of the PAH species. However, the only way this can be proven is by completing the DQRA.

Bench trial testing is likely to be required in order to satisfy the Environment Agency and comply with the Remediation Strategy and Verification Plan. It should be noted that bench trial testing can take a significant period of time and if required, it is recommended this is undertaken early.

8.4 Materials management

8.4.1 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 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.

8.4.2 *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.

8.4.2.1 *Clean, naturally occurring materials – reused on the site of origin*

Where soils are naturally occurring, uncontaminated and are reused on the site they are excavated (i.e. greenfield site with documented site history, with no Made Ground), they will fall outside the Waste Framework Directive (WFD) (i.e. they will not be a waste when reused on the site of origin).

However, there needs to be certainty of that reuse, and evidence is necessary to support this strategy, for example through information provided during the planning process. The onus is on the developer to demonstrate that the materials are not a waste and will never become a waste. As such, a Materials Re-use Strategy is recommended to show certainty. Alternatively, if the volume of material is under 1,000 tonnes, then a U1 waste exemption may be applied for from the Environment Agency.

It may be noted that some ‘clean naturally occurring materials’ may still fail the ‘suitable for use’ test, for example, soils with a naturally high organic content may not be suitable for use because of their propensity to produce ground gases such as methane. Rules regarding other more unusual circumstances such as where natural soils contain an unacceptably high mineral content are described in the DoWCoP.

8.4.2.2 *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.

8.4.2.3 *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:

If Made Ground is being moved between sites, it must be ensured that appropriate permits are in place to ensure the soils are not classified as a waste. Made Ground cannot be moved between sites under DoWCoP alone and would require relevant permits as part of the MMP documentation for the Hub site the material is being treated at.

8.4.2.4 *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>.

8.4.2.5 *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 Site-specific comments

The gas monitoring undertaken to date and included in this report is insufficient to fully characterise the site in accordance with CIRIA Report C665. Monitoring is ongoing and the conclusions of this report will be updated following completion of the scheduled monitoring.

The geo-environmental risk assessment has been undertaken based upon the current proposed site development layout. Should the proposed layout change, the data will need to be re-assessed based upon the updated applicable land use scenarios.

9.2 General comments

Hydrock Consultants Limited (Hydrock) has prepared this report in accordance with the instructions of Castlewood Properties Ventures Limited (the Client), by e-mail dated July 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 September 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 not been undertaken. 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.

The non-specialist UXO screening has been undertaken for the purposes of ground investigation only (i.e., low risk activity in accordance with CIRIA Report C681). Further assessment should be undertaken with regards to other higher risk activities e.g., construction.

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:

- demolition asbestos survey if asbestos is identified within the buildings within the industrial area;
- completion and reporting of the ongoing gas monitoring, hence the conclusions in this report are provisional, subject to the completion of monitoring;
- supplementary ground investigation for detailed design, including soft spots;
- further assessment for exceedances of Arsenic using bio accessibility testing;
- supplementary ground investigation and assessment in accordance with ADEPT & CWF Guidance (August 2019) to fully assess potential bituminous bound pavement arisings with regards to the presence of coal tar and waste disposal;
- 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 piles (where required);
- provision of geotechnical design for the Category 2 and / or 3 structures (earthworks, retaining, 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 and import of soils to the site;
- writing of a Materials Management Strategy relating to reuse of soils at the site;
- remediation and mitigation work; and
- verification of the earthworks, remediation and mitigation works.

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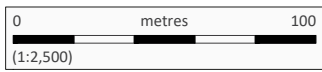
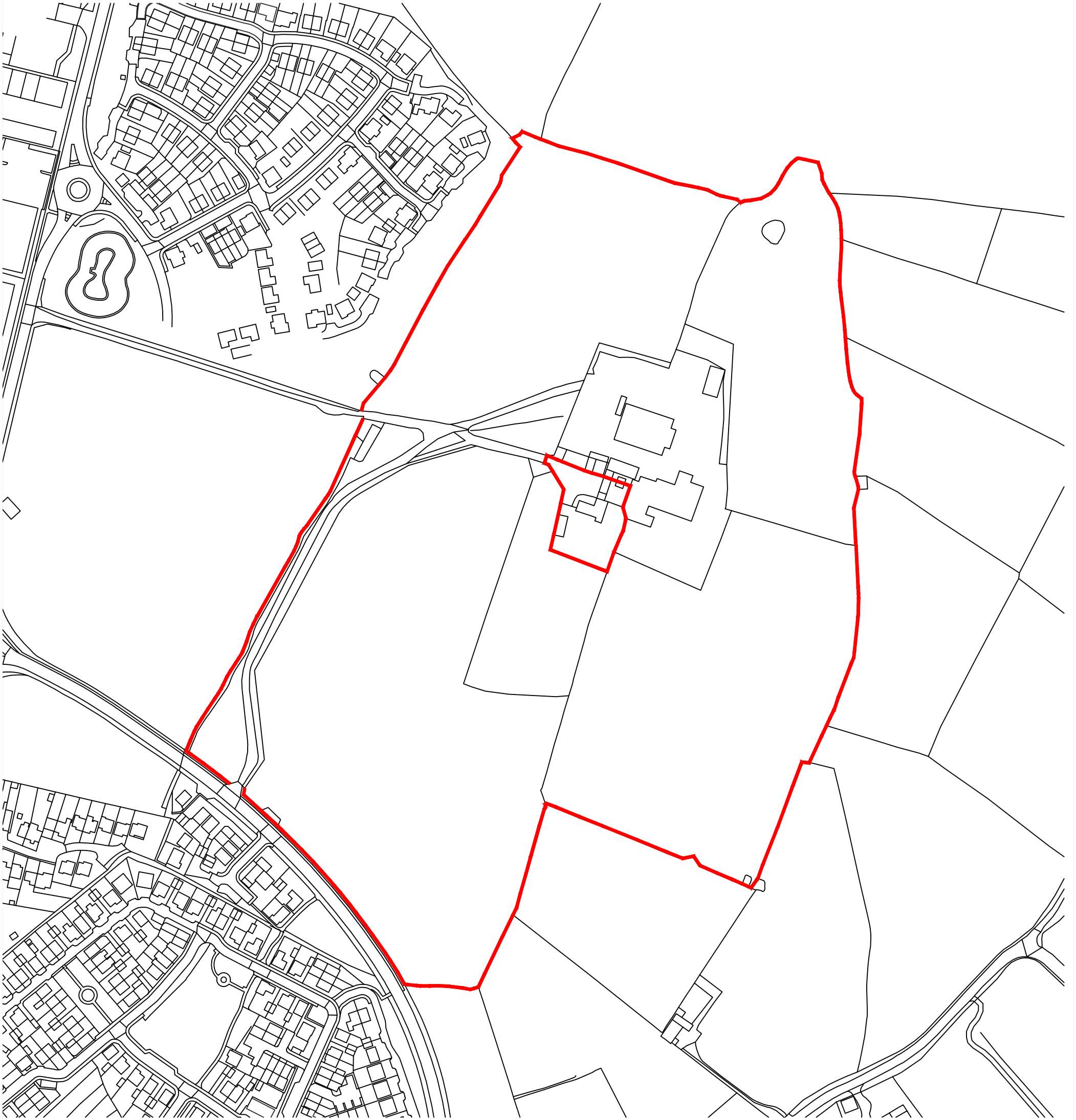
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Appendix A Drawings



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 Redline boundary

CLIENT: Castlewood Properties Ventures Ltd

PROJECT: Penn Hill Farm, Calne

DRAWING: Site Location Plan

PROJECT NUMBER: CASS3002

DRAWING NUMBER: 1000

REVISION: A

DATE: 17/06/2020

CHECKED BY: MR

STATUS: DRAFT

SCALE: 1:2500 @ A3



Concept Masterplan

Creating a Green Network

The masterplan will retain the most valuable hedgerows, where possible, forming a backbone to the green network across the study area and links to its surroundings. Significant trees will be retained and incorporated into public open space. The visually prominent slope within the middle of the study area will be retained as open space integrating the masterplan with the landscape setting. This creates the opportunity for significant biodiversity gain, play and recreation on the doorstep of new homes.

A Connected Neighbourhood

Primary access will be via new junctions from Sand Pit Road. Access to Penn Hill Farmhouse will be retained within the proposed development. The existing Public Rights of Way will be retained and diverted and integrated within the green infrastructure networks of the masterplan. Walking and cycling will be prioritised throughout and link closely to key routes towards the town centre and key destinations.

Delivering Homes & Vibrant Neighbourhood

The study area is available for development now whereby delivery can come forward at pace. Penn Hill can be developed to deliver a vibrant, sustainable new community set within its existing landscape setting, offering new homes, public open space and employment spaces.

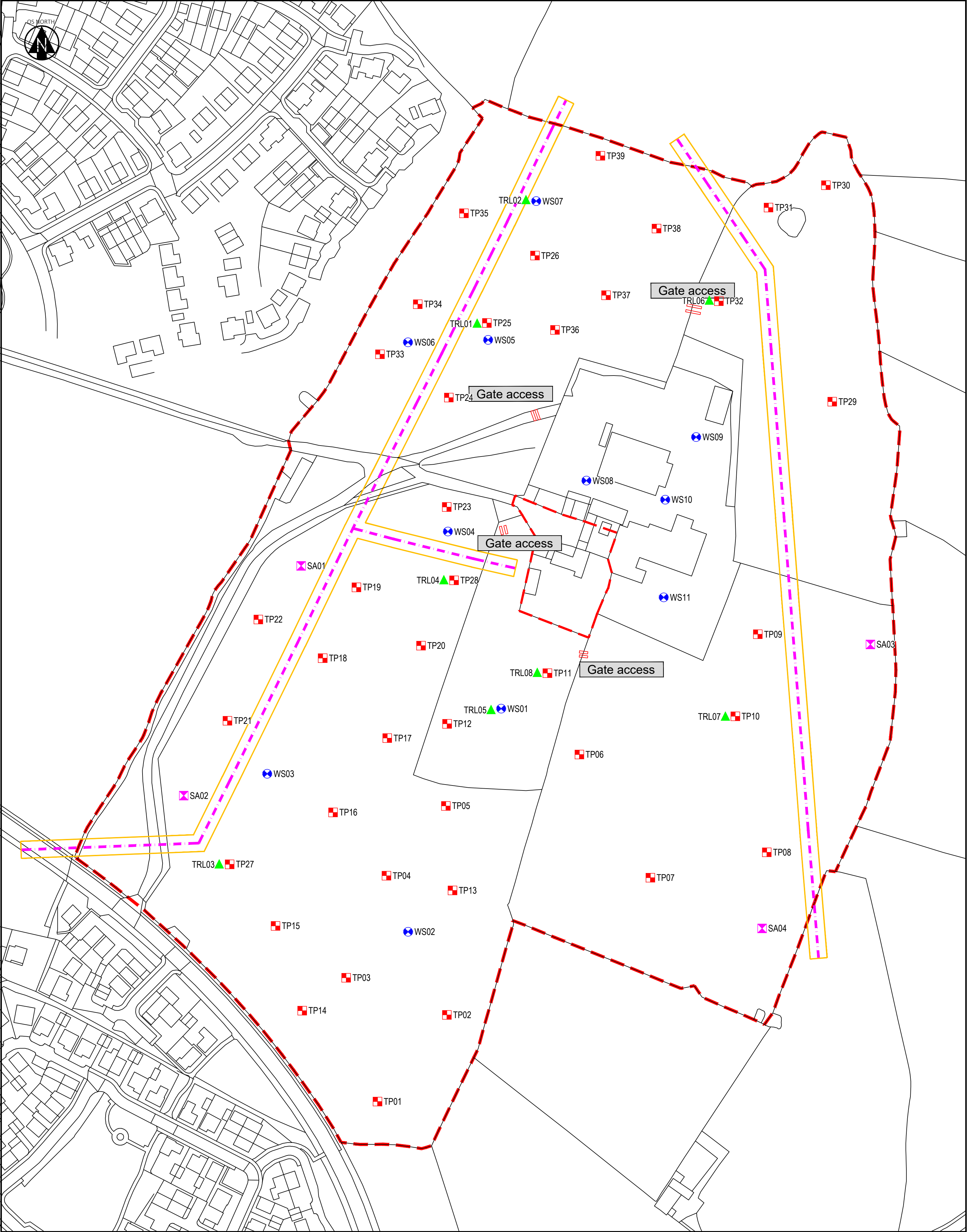
Flood Response

The lower lying land, which slopes to the east and west, would require drainage attenuation features on the corresponding boundaries, excluding development from the flood zone.

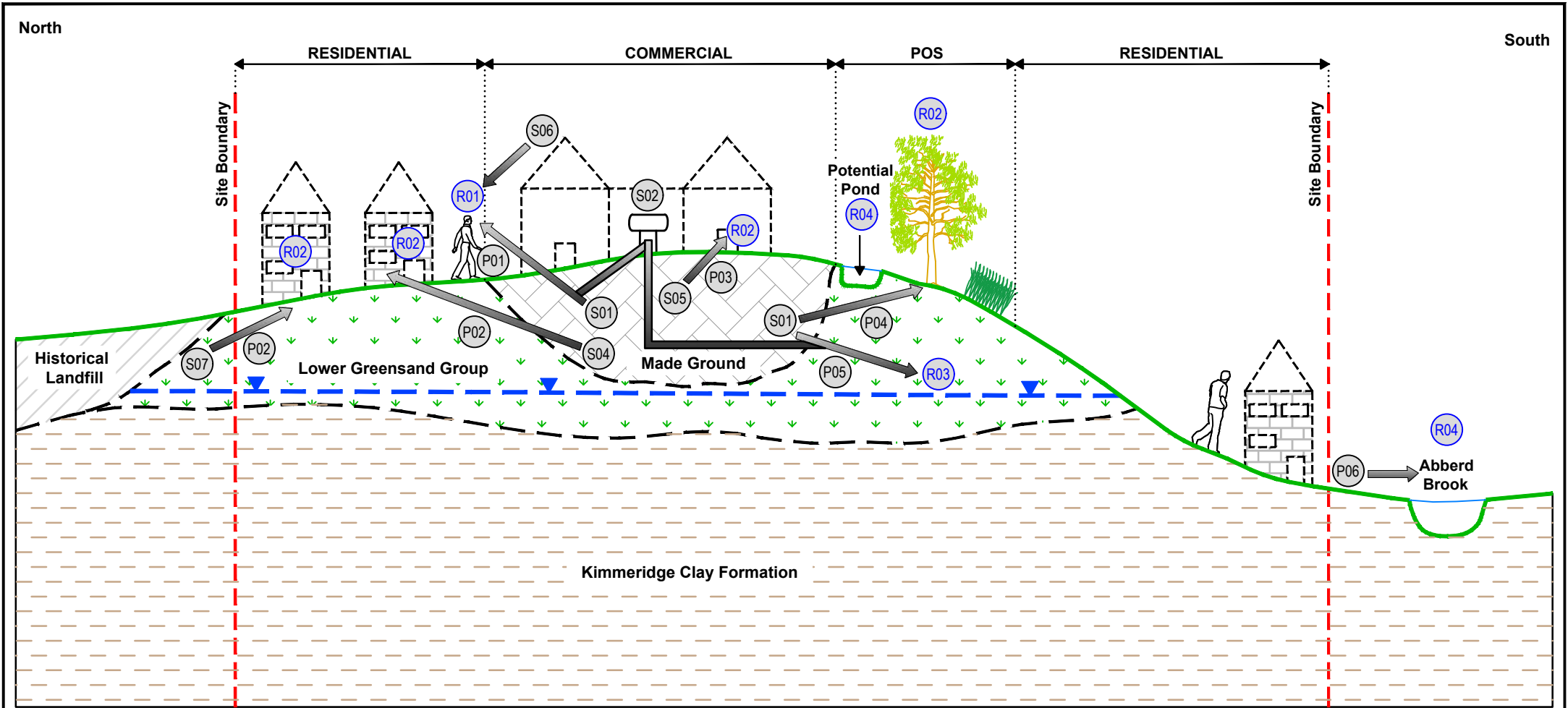
Mixed Employment & Workspaces

Two employment areas have the opportunity for different size workspaces and types of businesses, with the area nearer the farm being suitable for small units integrated within a residential area that might appeal to craft, art or specialist small business whereas the area near Abberd Brook can cater for mid to large units suitable for larger businesses such as distribution, storage or small scale manufacturing.





KEY TP Trial Pits SA Soakaways WS Window Sample Boreholes TRL TRL Tests Overhead services 9.00m standoff zone Gate access		NOTES 1. All dimensions are to be checked on site before the commencement of works. Any discrepancies are to be reported to the Architect & Engineer for verification. Figured dimensions only are to be taken from this drawing. 2. This drawing is to be read in conjunction with all relevant Engineers' and Service Engineers' drawings and specifications.		Hydrock Over Court Barns Over Lane Almondsbury, Bristol BS32 4DF TEL: 01454 619 533 FAX: 01454 614 125 E-Mail: bristol@hydrock.com or visit www.hydrock.com CLIENT CASTLEWOOD PROPERTIES VENTURES LTD PROJECT LAND AT PENN HILL, CALNE		TITLE EXPLORATORY HOLE LOCATION PLAN HYDROCK PROJECT NO. C-24863-C SCALE @ A2 1:1250 PURPOSE OF ISSUE SUITABLE FOR INFORMATION STATUS S2 DRAWING NO. (PROJECT CODE-ORIGINATOR-ZONE-LEVEL-TYPE-ROLE-NUMBER) 24863-HYD-XX-XX-DR-GE-1003 REVISION P1	
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Potential on-site sources of contamination

- S01. 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.
- S02. Hydrocarbon fuels, lubricants, oils and solvents from the operation of the vehicle repair workshop, waste oil burner and garages within the industrial area, situated towards the centre of the site, including leakage from fuel storage tanks, the pipework between tanks and pumps, and general spillage, together with uncontrolled disposal and spillage from waste receptacles.
- S03. Coal tar, potentially present in the bituminous bound pavements present in the form of roads and car parks.
- S04. Ground gases (carbon dioxide and methane) from organic materials in the Made Ground.
- S05. Hydrocarbon vapours from potential VOC and petroleum hydrocarbon spillages/leaks.
- S06. Asbestos within existing buildings.

Potential off-site sources of contamination

- S07. Ground gases (carbon dioxide and methane) from materials in the historical landfill (Calne Sand Pit), located 5m to the north of the site.

Potential receptors

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

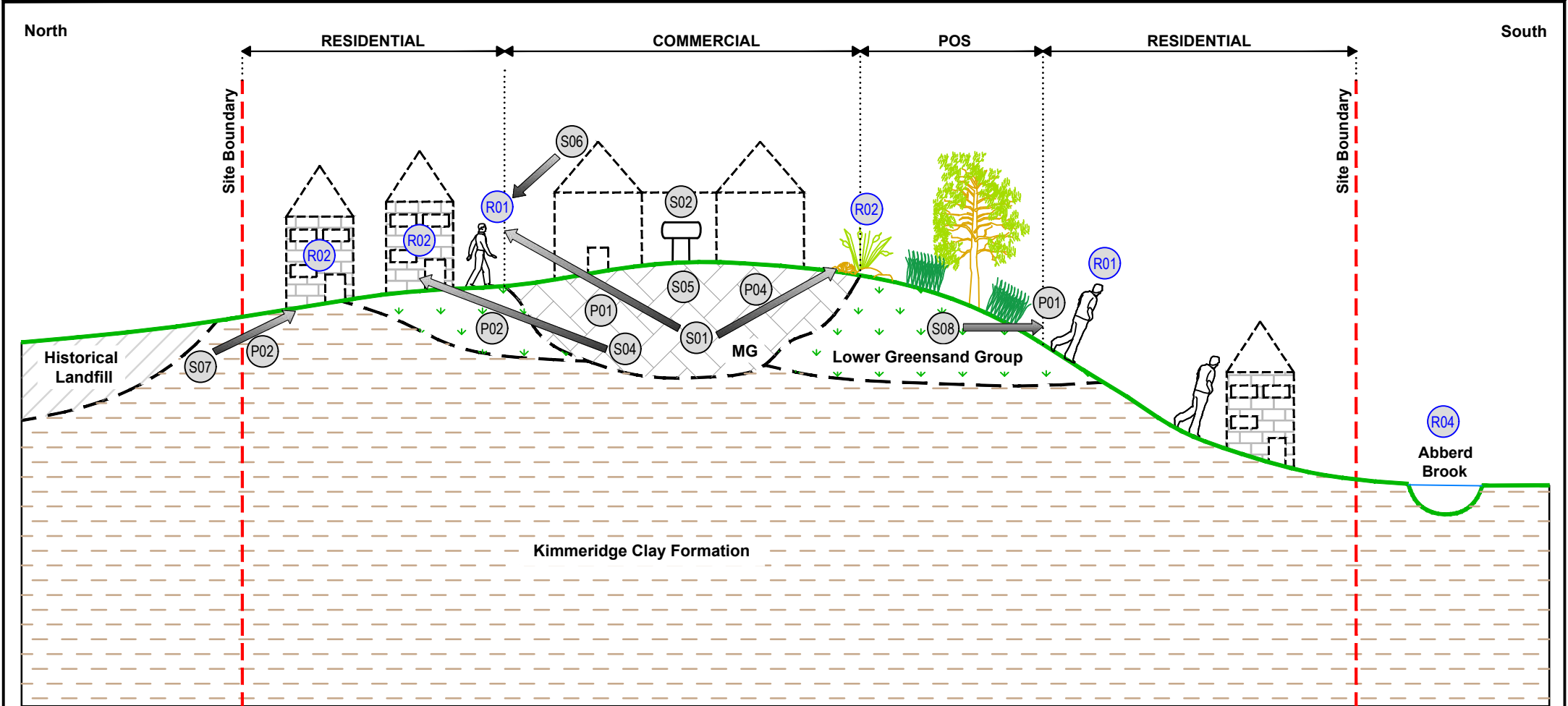
- R01. People (site end users, neighbours).
- R02. Development end use (buildings, utilities and landscaping).
- R03. Groundwater: Secondary A aquifer status of the Lower Greensand Group.
- R04. Surface water: Abberd Brook, situated 300m to the south-east of the site and the potential pond if to be retained, in the north-east corner of the site.

Potential pathways

The following potential pathways have been identified.

- P01.Ingestion, skin contact, inhalation of dust and outdoor air by people.
- P02. Ground gas ingress via permeable soils and/or construction gaps.
- P03. VOC and petroleum hydrocarbon vapour ingress via permeable soils and/or construction gaps.
- P04. Root uptake by plant.
- P05. Migration of contaminant via leachate migration through the unsaturated zone in the Lower Greensand Group.
- P06. Surface run-off.

KEY Existing ground profile Conjectural geological boundary Groundwater elevation Made Ground Historical Landfill Lower Greensand Group Kimmeridge Clay Formation
--



Potential on-site sources of contamination

- S01. 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.
- S02. Hydrocarbon fuels, lubricants, oils and solvents from the operation of the vehicle repair workshop, waste oil burner and garages within the industrial area, situated towards the centre of the site, including leakage from fuel storage tanks, the pipework between tanks and pumps, and general spillage, together with uncontrolled disposal and spillage from waste receptacles.
- S03. Coal tar, potentially present in the bituminous bound pavements present in the form of roads and car parks.
- S04. Ground gases (carbon dioxide and methane) from organic materials in the Made Ground.
- S05. Hydrocarbon vapours from potential VOC and petroleum hydrocarbon spillages/leaks.
- S06. Asbestos within existing buildings.
- S08. Exceedances of arsenic in the natural ground.

Potential off-site sources of contamination

- S07. Ground gases (carbon dioxide and methane) from materials in the historical landfill (Calne Sand Pit), located 5m to the north of the site.

Potential receptors

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

- R01. People (site end users, neighbours).
- R02. Development end use (buildings, utilities and landscaping).
- R03. Groundwater: Secondary A aquifer status of the Lower Greensand Group.
- R04. Surface water: Abberd Brook, situated 300m to the south-east of the site.

Potential pathways

The following potential pathways have been identified.

- P01. Ingestion, skin contact, inhalation of dust and outdoor air by people.
- P02. Ground gas ingress via permeable soils and/or construction gaps.
- P03. VOC and petroleum hydrocarbon vapour ingress via permeable soils and/or construction gaps.
- P04. Root uptake by plant.
- P05. Migration of contaminant via leachate migration through the unsaturated zone in the Lower Greensand Group.
- P06. Surface run-off.

KEY Existing ground profile Conjectural geological boundary Made Ground Historical Landfill Lower Greensand Group Kimmeridge Clay Formation	NOTES 1. All dimensions are to be checked on site before the commencement of works. Any discrepancies are to be reported to the Architect & Engineer for verification. Figured dimensions only are to be taken from this drawing. 2. This drawing is to be read in conjunction with all relevant Engineers' and Service Engineers' drawings and specifications. 3. Text that is light grey and striked through indicates that this risk is less than moderate and therefore considered a low risk.	Hydrock Over Court Barns Over Lane Almondsbury, Bristol BS32 4DF TEL: 01454 619 533 FAX: 01454 614 125 E-Mail: bristol@hydrock.com or visit www.hydrock.com										TITLE			
		CLIENT										FINAL CONCEPTUAL SITE MODEL			
		CASTLEWOOD PROPERTIES VENTURES LTD										HYDROCK PROJECT NO. C-24863-C		SCALE @ A3 NTS	
		PROJECT										PURPOSE OF ISSUE SUITABLE FOR INFORMATION		STATUS S2	
		LAND AT PENN HILL, CALNE										DRAWING NO. (PROJECT CODE-ORIGINATOR-ZONE-LEVEL-TYPE-ROLE-NUMBER) 24863-HYD-XX-XX-DR-GE-1005		REVISION P1	
		P1 FIRST ISSUE EP 08/11/22 DG 08/11/22 DG 08/11/22													
		REV. REVISION NOTES/COMMENTS DRAWN BY DATE CHECKED BY DATE APPROVED BY DATE													

Appendix B Field Reconnaissance Photographs

Desk Study Photograph 1	
Date: 13.09.22	
Direction Photograph Taken: Looking north-eastwards from central section of the site.	
Description: Access roads with overhead services running across.	

Desk Study Photograph 2	
Date: 13.09.22	
Direction Photograph Taken: Looking north-westwards from access road to the industrial estate.	
Description: Gate access to the north-westwards field.	

Desk Study Photograph 3	
Date: 13.09.22	
Direction Photograph Taken: N/A	
Description: Public footpath signage / route.	

Desk Study Photograph 4	
Date: 13.09.22	
Direction Photograph Taken: Looking westwards from north-western field.	
Description: North-western field.	

Desk Study Photograph 5	
Date: 13.09.22	
Direction Photograph Taken: Looking south-eastwards from north-western field.	
Description: Overhead services present in the north-western field.	

Desk Study Photograph 6	
Date: 13.09.22	
Direction Photograph Taken: Looking eastwards from north-western field.	
Description: Gate access from north-western field to the north-eastern field.	

Desk Study Photograph 7		
Date: 13.09.22		
Direction Photograph Taken: Looking north-eastwards from north-eastern field.		
Description: Overhead services present in north-eastern field.		

Desk Study Photograph 8		
Date: 13.09.22		
Direction Photograph Taken: Looking southwards from north-eastern field.		
Description: North-eastern field area with overhead services running through.		

Desk Study Photograph 9	
Date: 13.09.22	
Direction Photograph Taken: Looking south-eastwards from south-eastern field.	
Description: South-eastern field area with overhead services running through.	

Desk Study Photograph 10	
Date: 13.09.22	
Direction Photograph Taken: Looking north-eastwards from south-eastern field.	
Description: South-eastern field area with the central industrial estate in the distance.	

Desk Study Photograph 11	
Date: 13.09.22	
Direction Photograph Taken: Looking westward from south-eastern field.	
Description: Gate access between the central field and the south-eastern field.	

Desk Study Photograph 12	
Date: 13.09.22	
Direction Photograph Taken: Looking southwards from central field.	
Description: Central field area.	

Desk Study Photograph 13	
Date: 13.09.22	
Direction Photograph Taken: Looking northwards from central field.	
Description: Central field area.	

Desk Study Photograph 14	
Date: 13.09.22	
Direction Photograph Taken: Looking south- eastwards from access road to Penn Hill Farm.	
Description: Gate access to the central field area, with an overhead service in the background.	

Desk Study Photograph 15	
Date: 13.09.22	
Direction Photograph Taken: Looking south-westwards from south-western field.	
Description: South-western field area.	

Desk Study Photograph 16	
Date: 13.09.22	
Direction Photograph Taken: Looking westwards from south-western field.	
Description: Overhead services present in the south-western field area.	

Desk Study Photograph 17	
Date: 13.09.22	
Direction Photograph Taken: Looking south-wards from south-western field.	
Description: South-western field area, sloping towards the south.	

Desk Study Photograph 18	
Date: 13.09.22	
Direction Photograph Taken: Looking south-wards from south-western field area.	
Description: Gate access from Sandpit Road into the south-western field area.	

Desk Study Photograph 19	
Date: 13.09.22	
Direction Photograph Taken: Looking north-eastwards from south-western field area.	
Description: South-western field area with overhead services running through.	

Desk Study Photograph 20	
Date: 13.09.22	
Direction Photograph Taken: Looking north-eastwards from access road to the industrial estate.	
Description: Access road with soft landscaping.	

Desk Study Photograph 21	
Date: 13.09.22	
Direction Photograph Taken: Looking north-eastwards from access road to the industrial estate.	
Description: Entrance to the industrial estate.	

Desk Study Photograph 22	
Date: 13.09.22	
Direction Photograph Taken: Looking southwards from central industrial estate.	
Description: Industrial estate with parked cars.	

Desk Study Photograph 23	
Date: 13.09.22	
Direction Photograph Taken: Looking north-eastwards from central industrial estate.	
Description: North-eastern building in central industrial estate.	

Desk Study Photograph 24	
Date: 13.09.22	
Direction Photograph Taken: Looking south-westwards from central industrial estate.	
Description: Central industrial estate.	

Desk Study Photograph 25	
Date: 13.09.22	
Direction Photograph Taken: N/A	
Description: Central industrial estate.	

Desk Study Photograph 26	
Date: 13.09.22	
Direction Photograph Taken: Looking westwards from central industrial estate.	
Description: Central industrial estate.	

Desk Study Photograph 27		
Date: 13.09.22		
Direction Photograph Taken: N/A		
Description: Cover and drainage pipe		

Desk Study Photograph 28		
Date: 13.09.22		
Direction Photograph Taken: Looking westwards from central industrial area.		
Description: Central industrial area.		

Desk Study Photograph 29	
Date: 13.09.22	
Direction Photograph Taken: N/A	
Description: Desiccation crack in the south-western field area.	

Appendix C Historical Ordnance Survey Maps

Site Details:

400800, 172012

Client Ref: 24863
Report Ref: HYD-8964749
Grid Ref: 400758, 172035

Map Name: County Series

Map date: 1885

Scale: 1:10,560

Printed at: 1:10,560



Surveyed N/A
Revised N/A
Edition N/A
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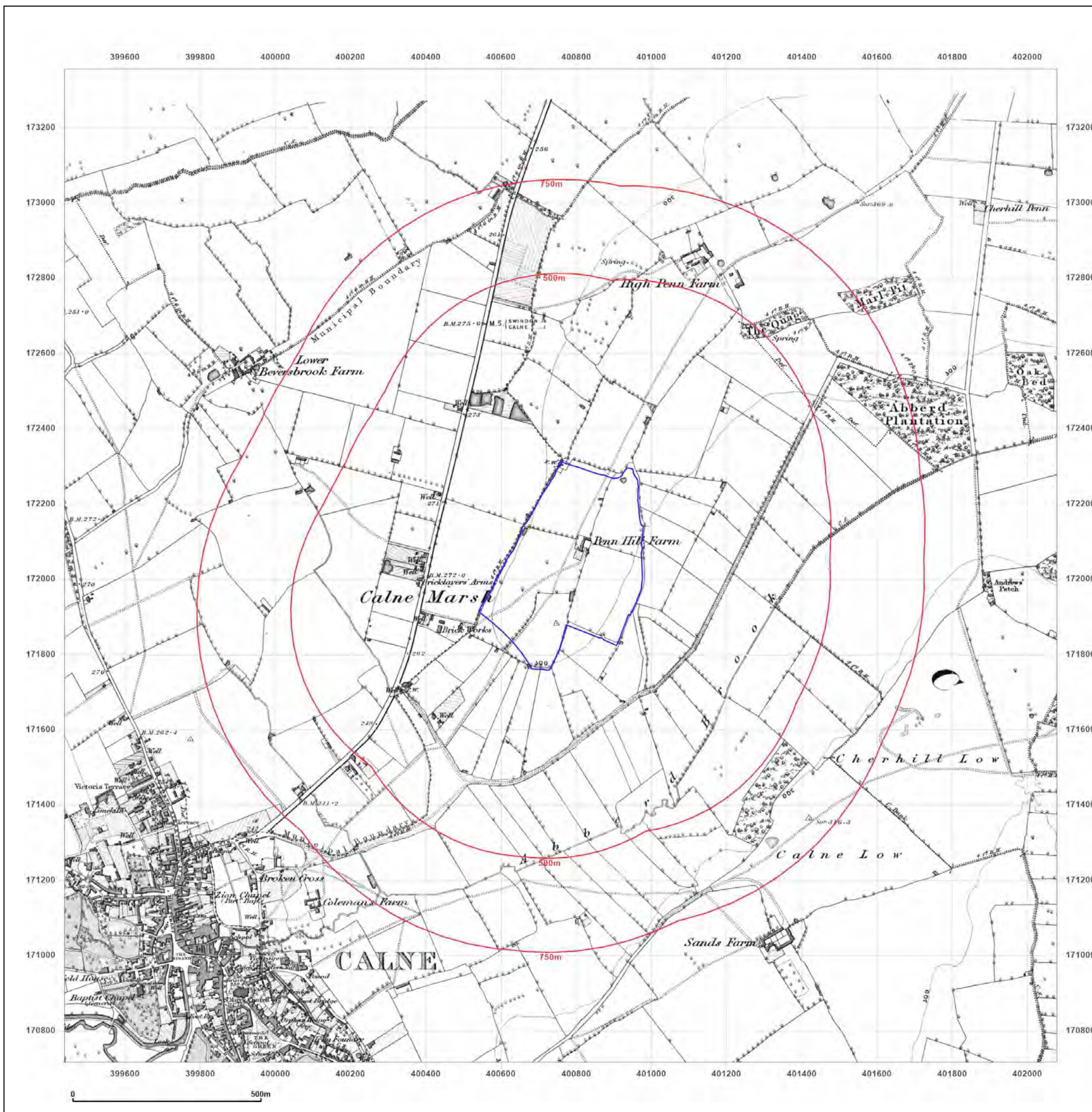


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Site Details:

400800, 172012

Client Ref: 24863
Report Ref: HYD-8964749
Grid Ref: 400758, 172035

Map Name: County Series

Map date: 1885

Scale: 1:10,560

Printed at: 1:10,560



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 Revised 1885
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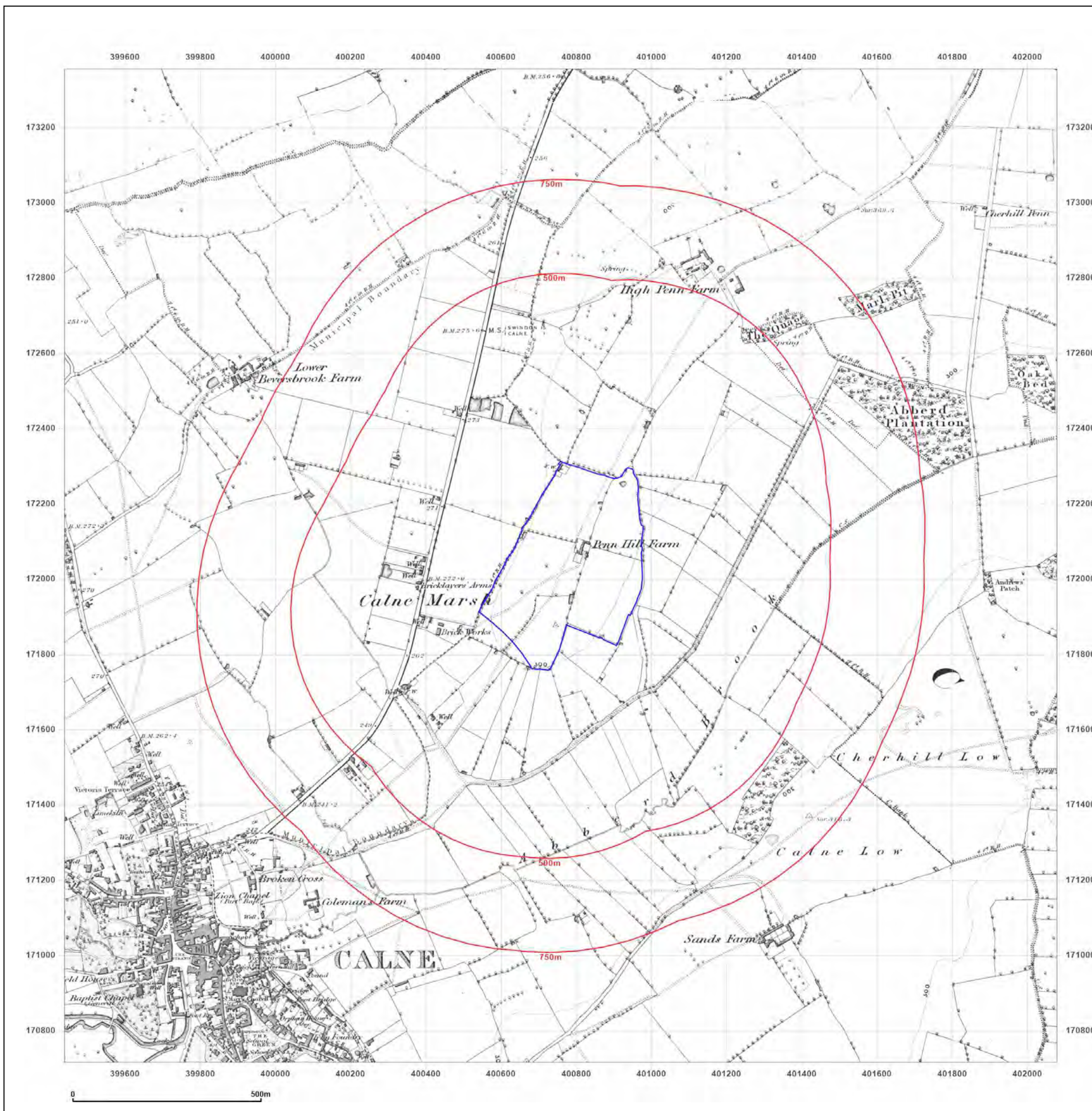


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Site Details:

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Client Ref: 24863
Report Ref: HYD-8964749
Grid Ref: 400758, 172035

Map Name: County Series

Map date: 1899

Scale: 1:10,560

Printed at: 1:10,560



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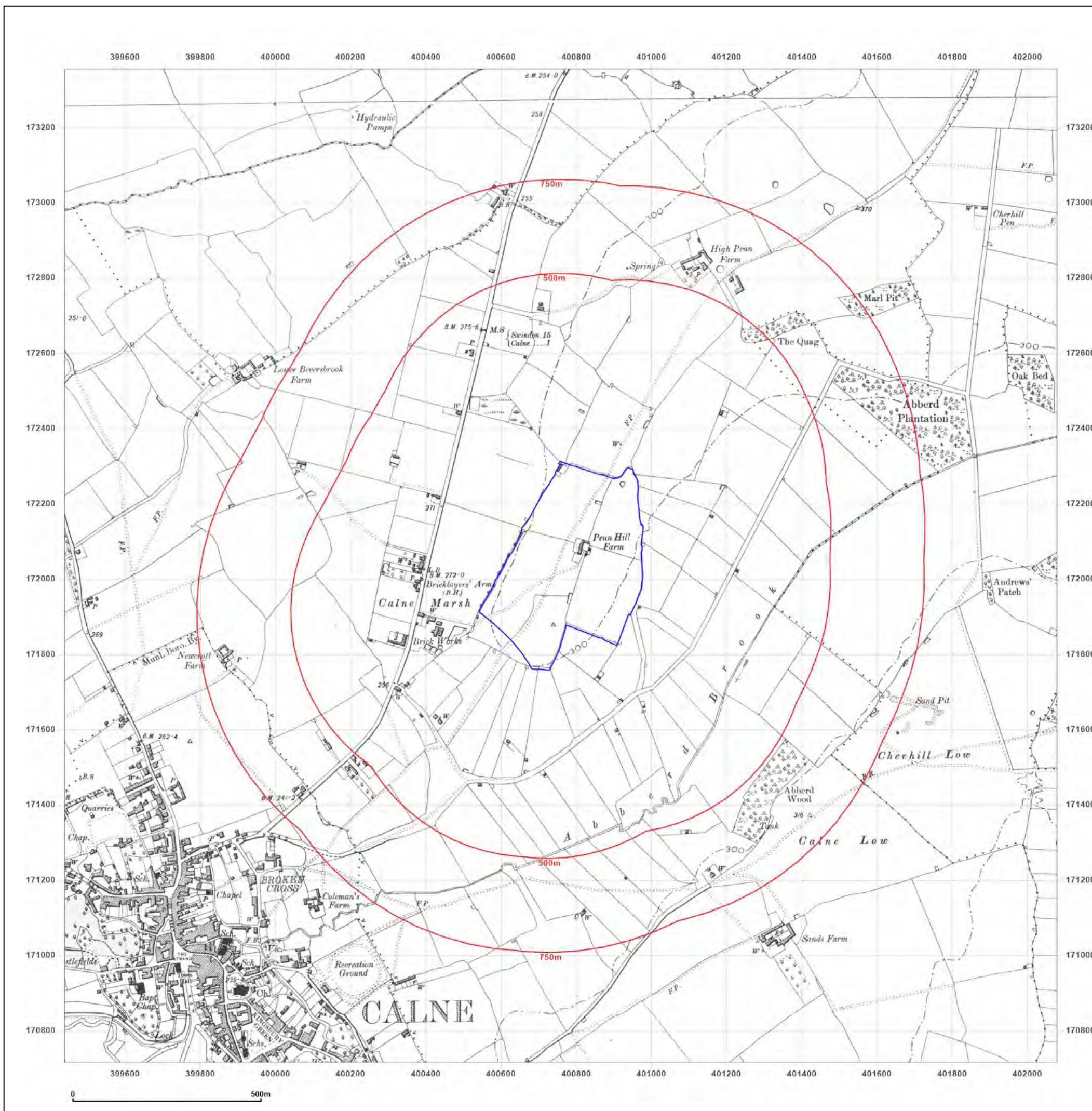


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Site Details:

400800, 172012

Client Ref: 24863
Report Ref: HYD-8964749
Grid Ref: 400758, 172035

Map Name: County Series

Map date: 1922-1925

Scale: 1:10,560

Printed at: 1:10,560



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 Revised 1922
 Edition N/A
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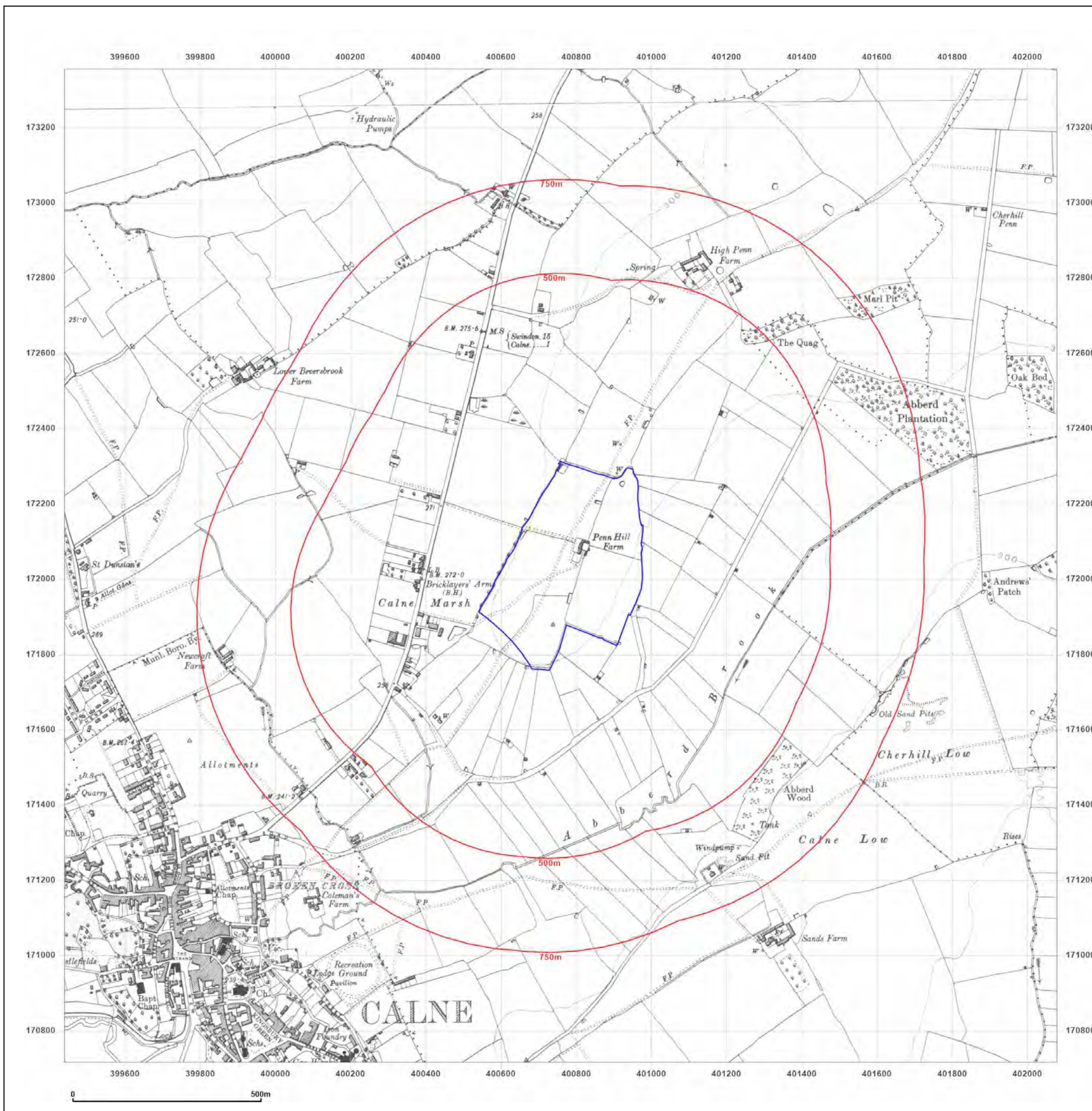


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Site Details:

400800, 172012

Client Ref: 24863
Report Ref: HYD-8964749
Grid Ref: 400758, 172035

Map Name: Provisional

Map date: 1956

Scale: 1:10,560

Printed at: 1:10,560



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Edition N/A
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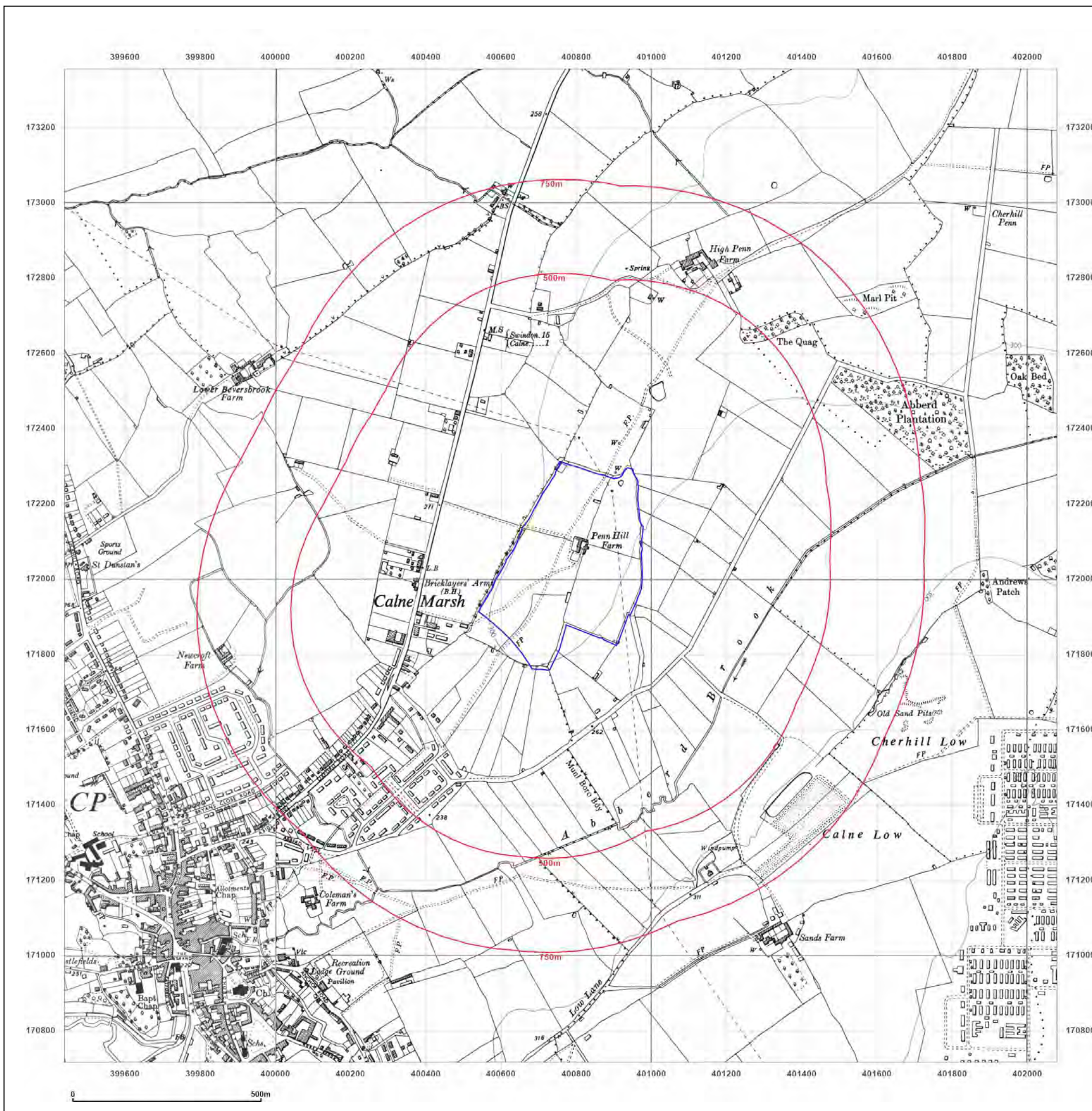


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Site Details:

400800, 172012

Client Ref: 24863
Report Ref: HYD-8964749
Grid Ref: 400758, 172035

Map Name: National Grid

Map date: 1980-1982

Scale: 1:10,000

Printed at: 1:10,000



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 Revised 1980
 Edition N/A
 Copyright 1980
 Levelled 1974

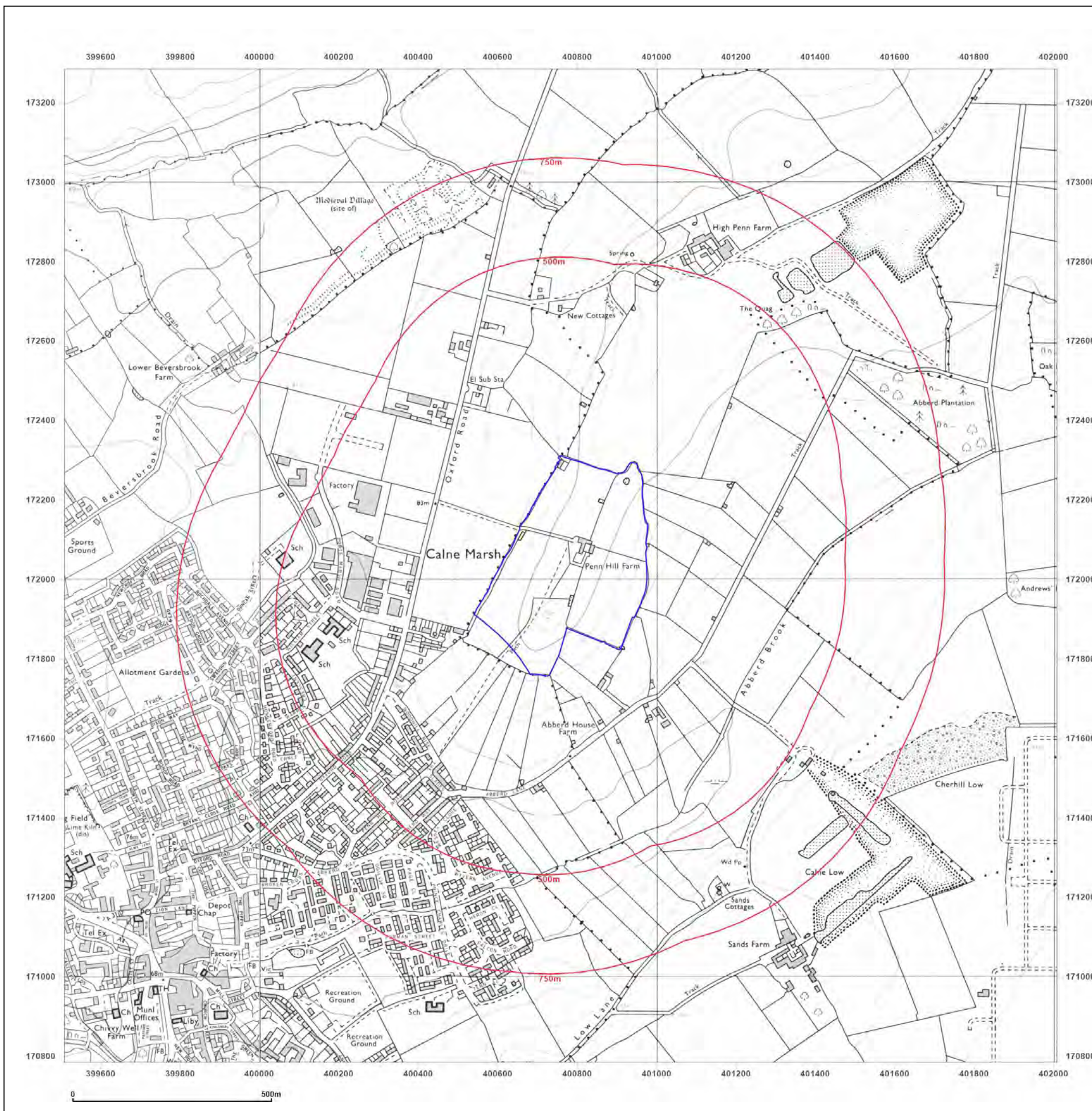


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Site Details:

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Report Ref: HYD-8964749
Grid Ref: 400758, 172035

Map Name: National Grid

Map date: 2010

Scale: 1:10,000

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Site Details:

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Client Ref: 24863
Report Ref: HYD-8964749
Grid Ref: 400758, 172035

Map Name: National Grid

Map date: 2022

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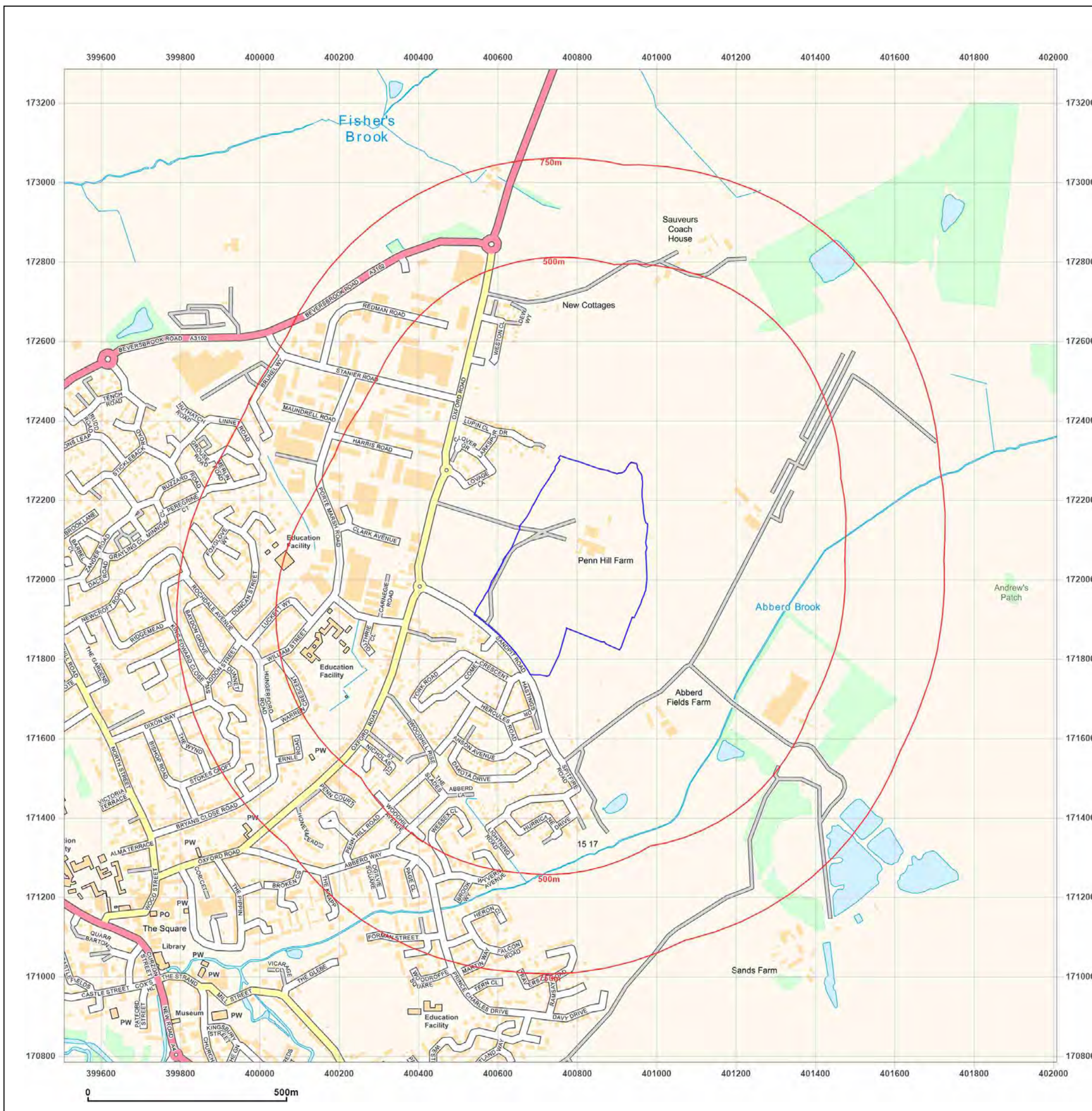


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Site Details:

400800, 172012

Client Ref: 24863
Report Ref: HYD-8964749_LS_1_1
Grid Ref: 400445, 171722

Map Name: County Series

Map date: 1886

Scale: 1:2,500

Printed at: 1:2,500



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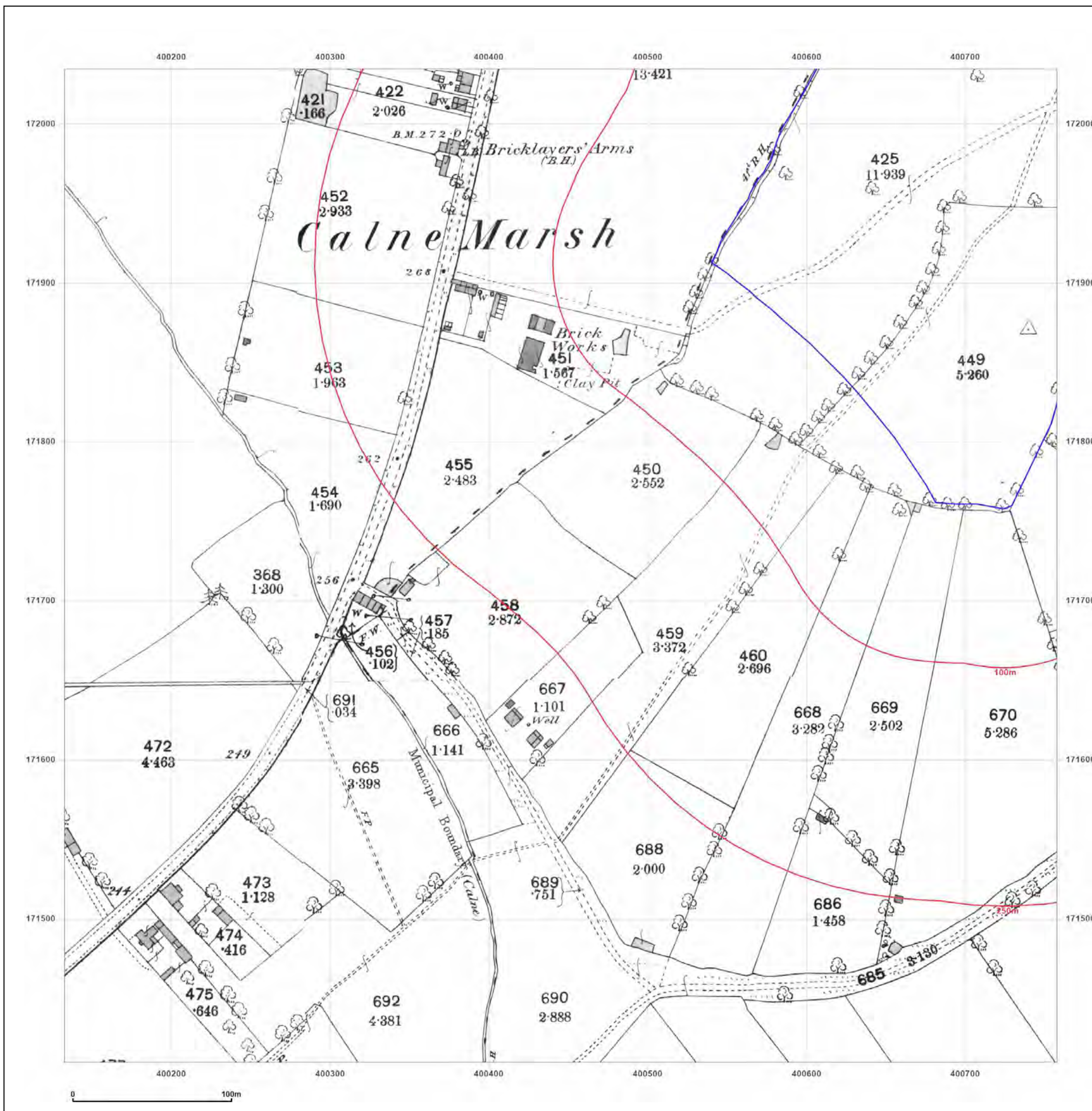


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Site Details:

400800, 172012

Client Ref: 24863
Report Ref: HYD-8964749_LS_1_1
Grid Ref: 400445, 171722

Map Name: County Series

Map date: 1900

Scale: 1:2,500

Printed at: 1:2,500



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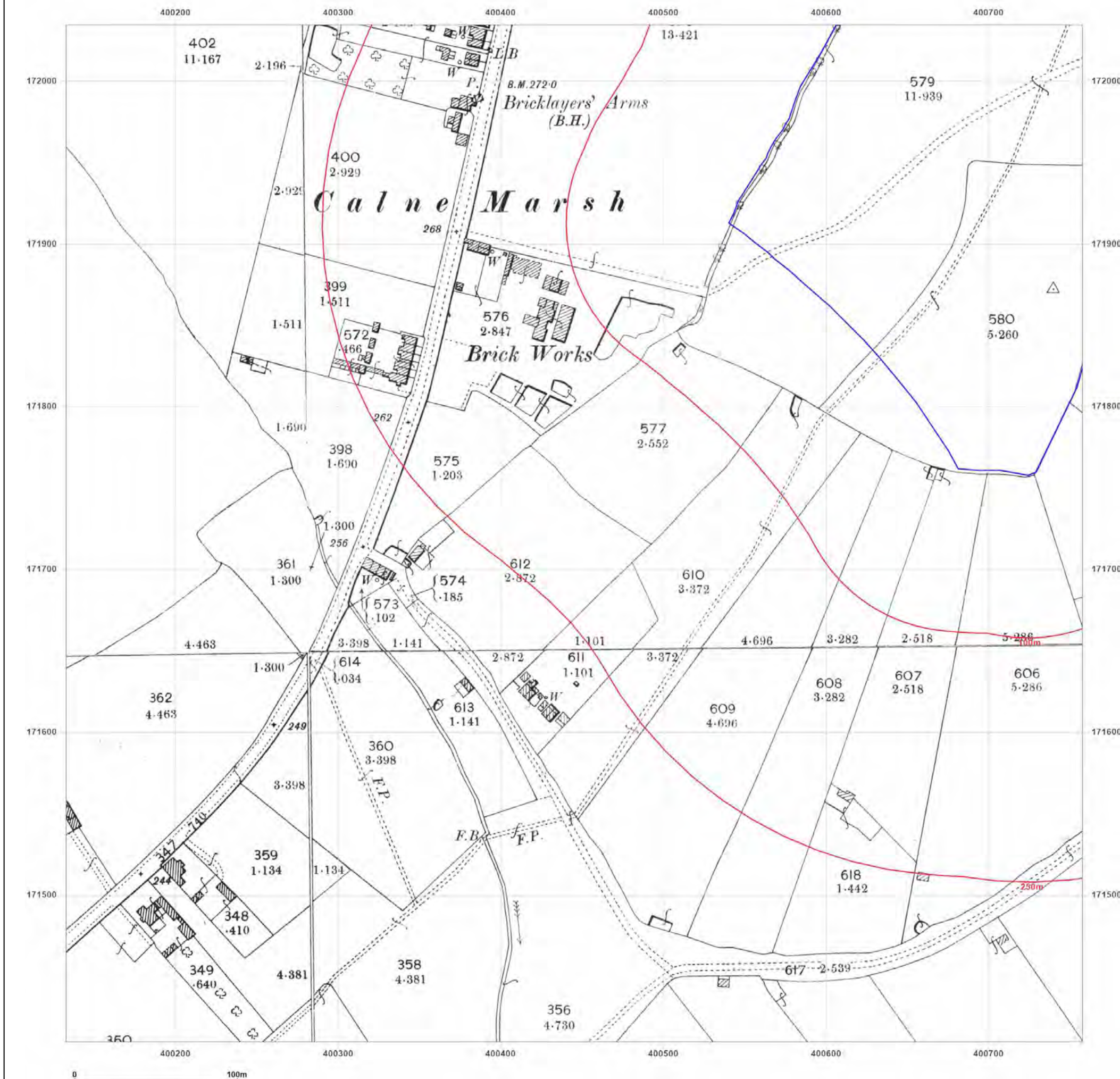


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Site Details:

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Client Ref: 24863
Report Ref: HYD-8964749_LS_1_1
Grid Ref: 400445, 171722

Map Name: County Series

Map date: 1924

Scale: 1:2,500

Printed at: 1:2,500



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 Revised 1924
 Edition N/A
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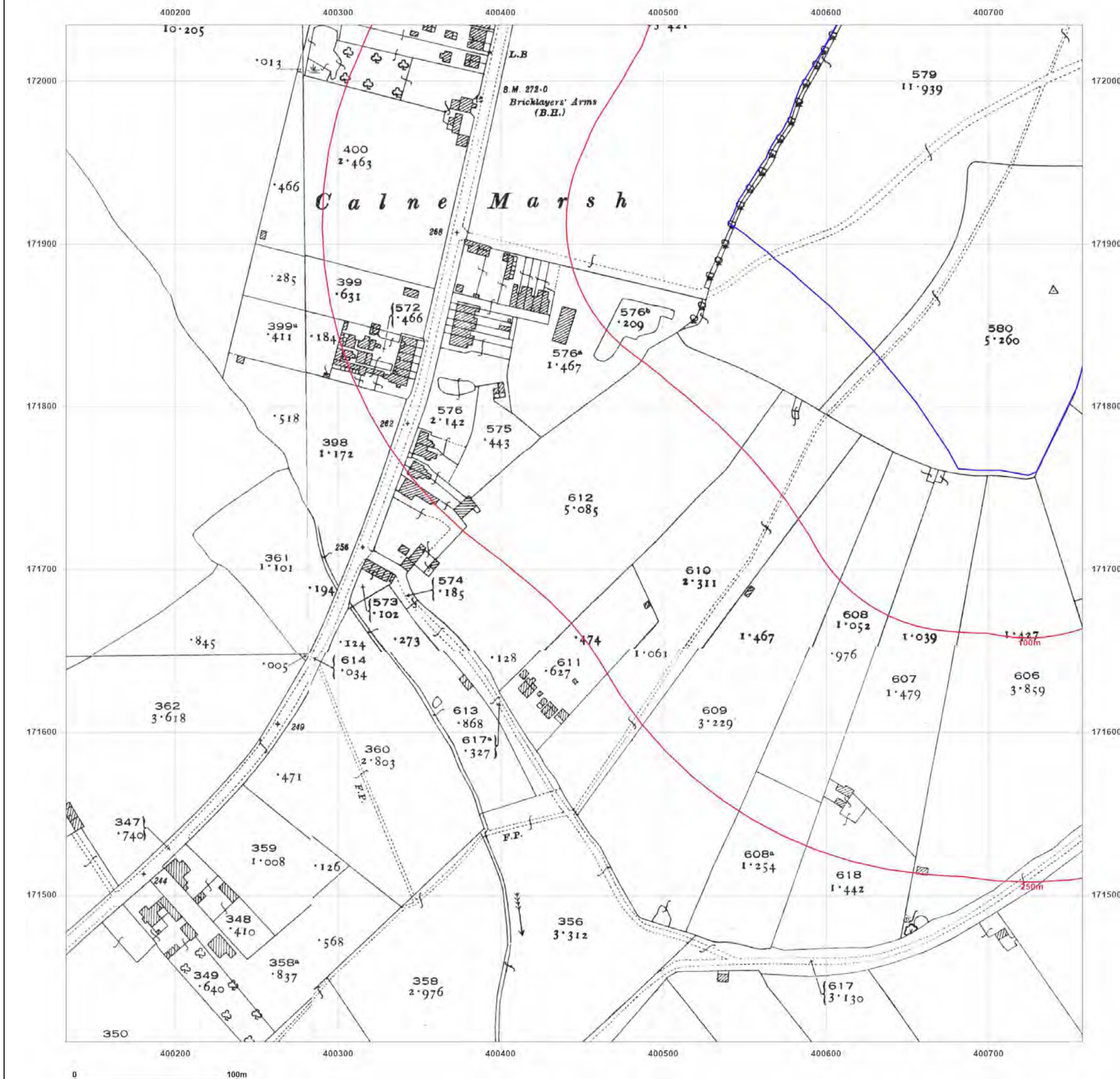


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Site Details:

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Client Ref: 24863
Report Ref: HYD-8964749_LS_1_1
Grid Ref: 400445, 171722

Map Name: National Grid

Map date: 1970

Scale: 1:2,500

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Site Details:

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Client Ref: 24863
Report Ref: HYD-8964749_LS_1_1
Grid Ref: 400445, 171722

Map Name: National Grid

Map date: 1974

Scale: 1:2,500

Printed at: 1:2,500



Surveyed N/A
Revised 1974
Edition N/A
Copyright N/A
Levelled 1966

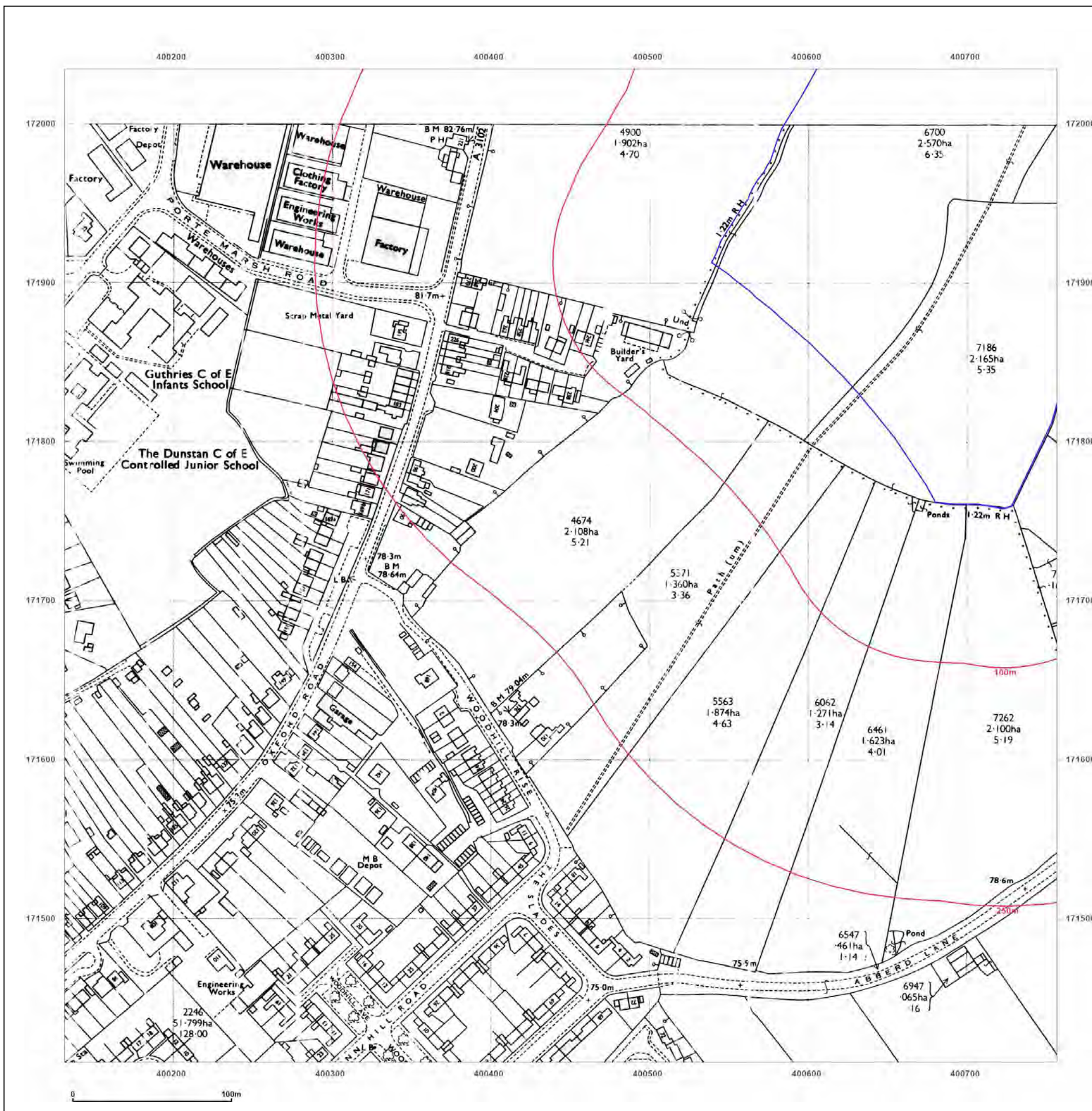


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Site Details:

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Client Ref: 24863
Report Ref: HYD-8964749_LS_1_1
Grid Ref: 400445, 171722

Map Name: National Grid

Map date: 1975

Scale: 1:2,500

Printed at: 1:2,500



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 Edition N/A
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 Levelled 1986

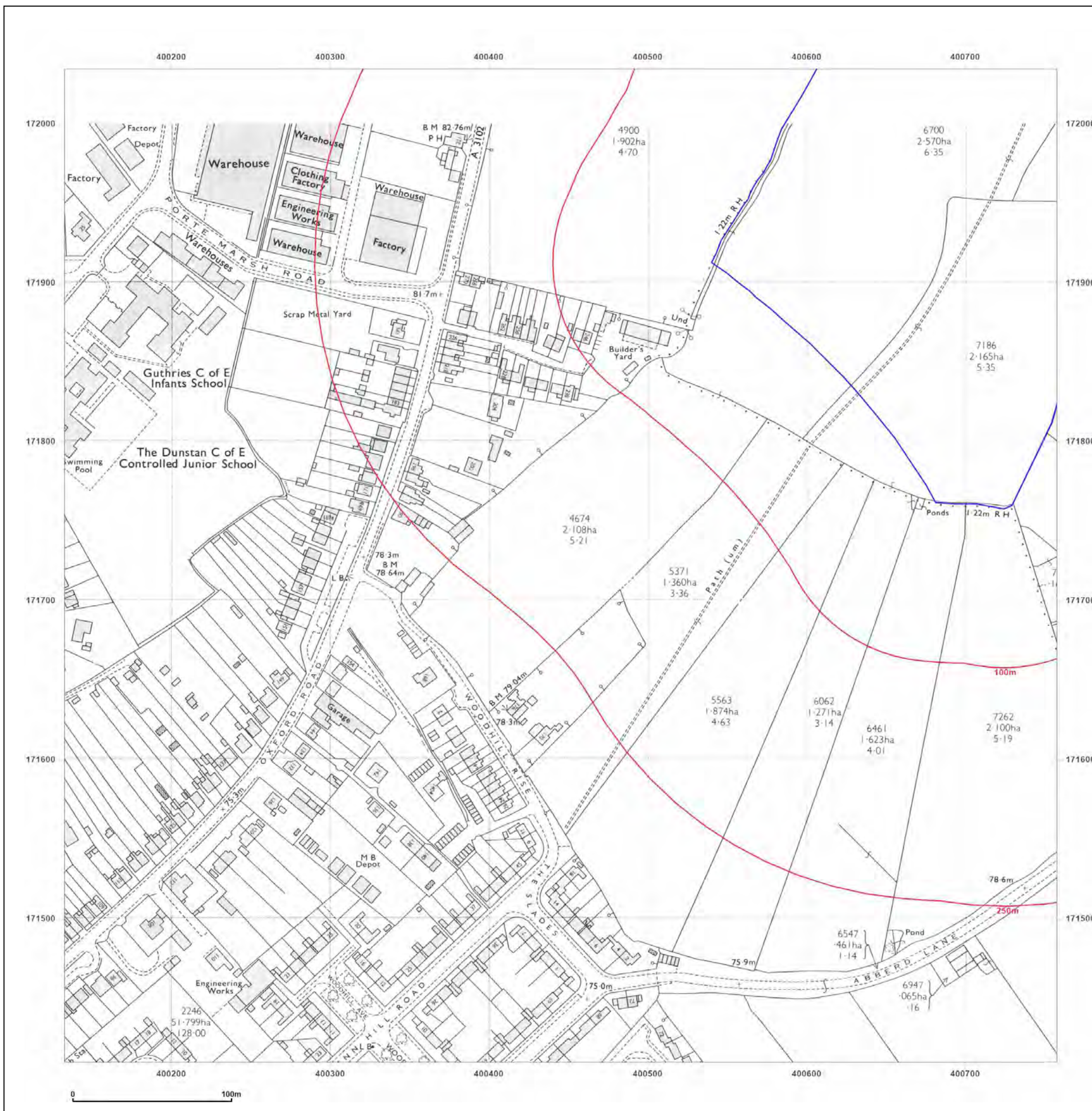


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Client Ref: 24863
Report Ref: HYD-8964749_LS_1_1
Grid Ref: 400445, 171722

Map Name: National Grid

Map date: 1986

Scale: 1:2,500

Printed at: 1:2,500



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Revised N/A
Edition N/A
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Levelled 1966

Surveyed 1966
Revised 1986
Edition N/A
Copyright 1986
Levelled 1966

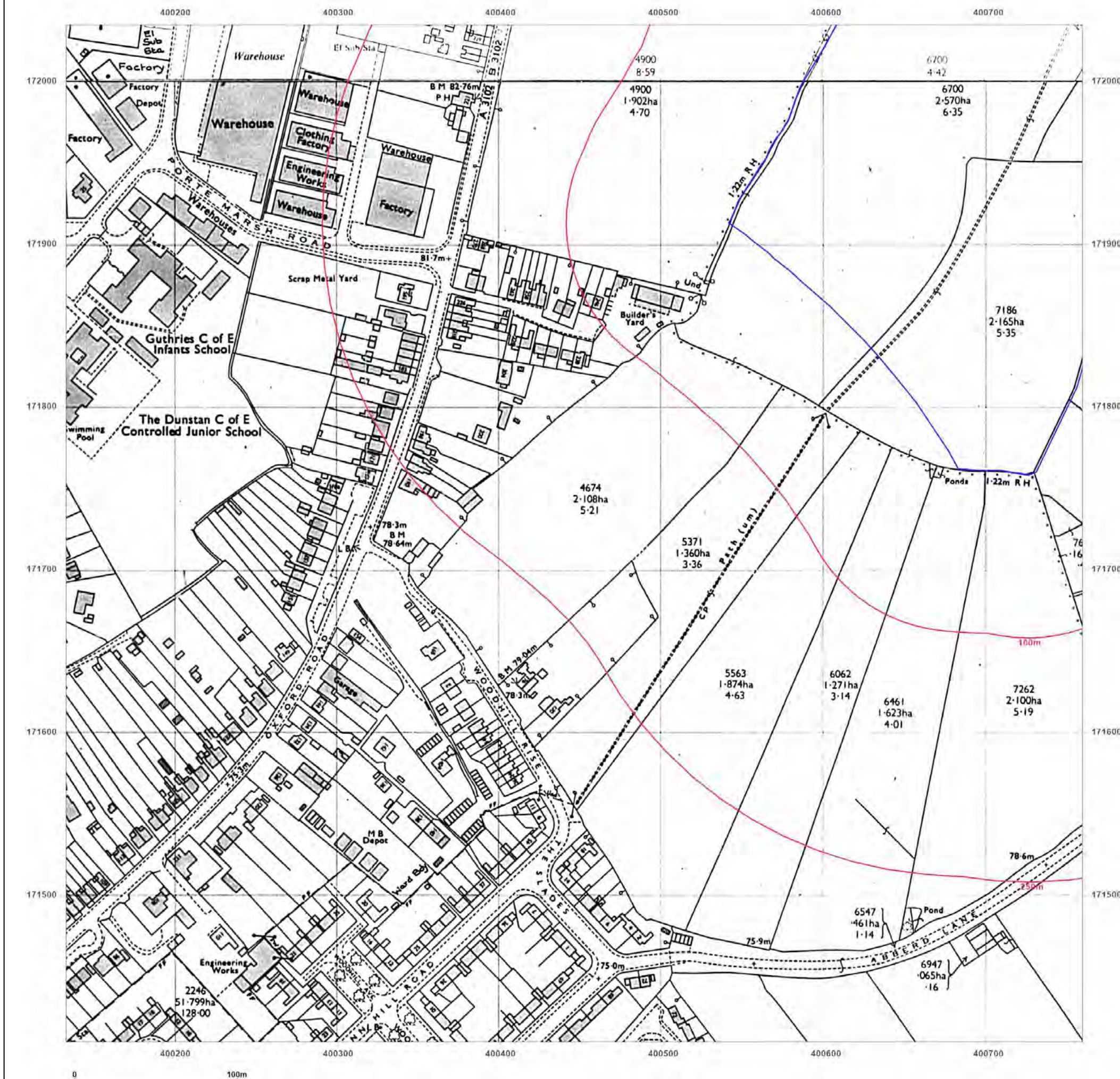


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Site Details:

400800, 172012

Client Ref: 24863
Report Ref: HYD-8964749_LS_1_1
Grid Ref: 400445, 171722

Map Name: National Grid

Map date: 1990-1994

Scale: 1:2,500

Printed at: 1:2,500



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 Edition N/A
 Copyright 1990
 Levelled 1966

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 Revised N/A
 Edition N/A
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Site Details:

400800, 172012

Client Ref: 24863
Report Ref: HYD-8964749_LS_1_2
Grid Ref: 400445, 172347

Map Name: County Series

Map date: 1886

Scale: 1:2,500

Printed at: 1:2,500



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 Revised 1886
 Edition N/A
 Copyright N/A
 Levelled N/A

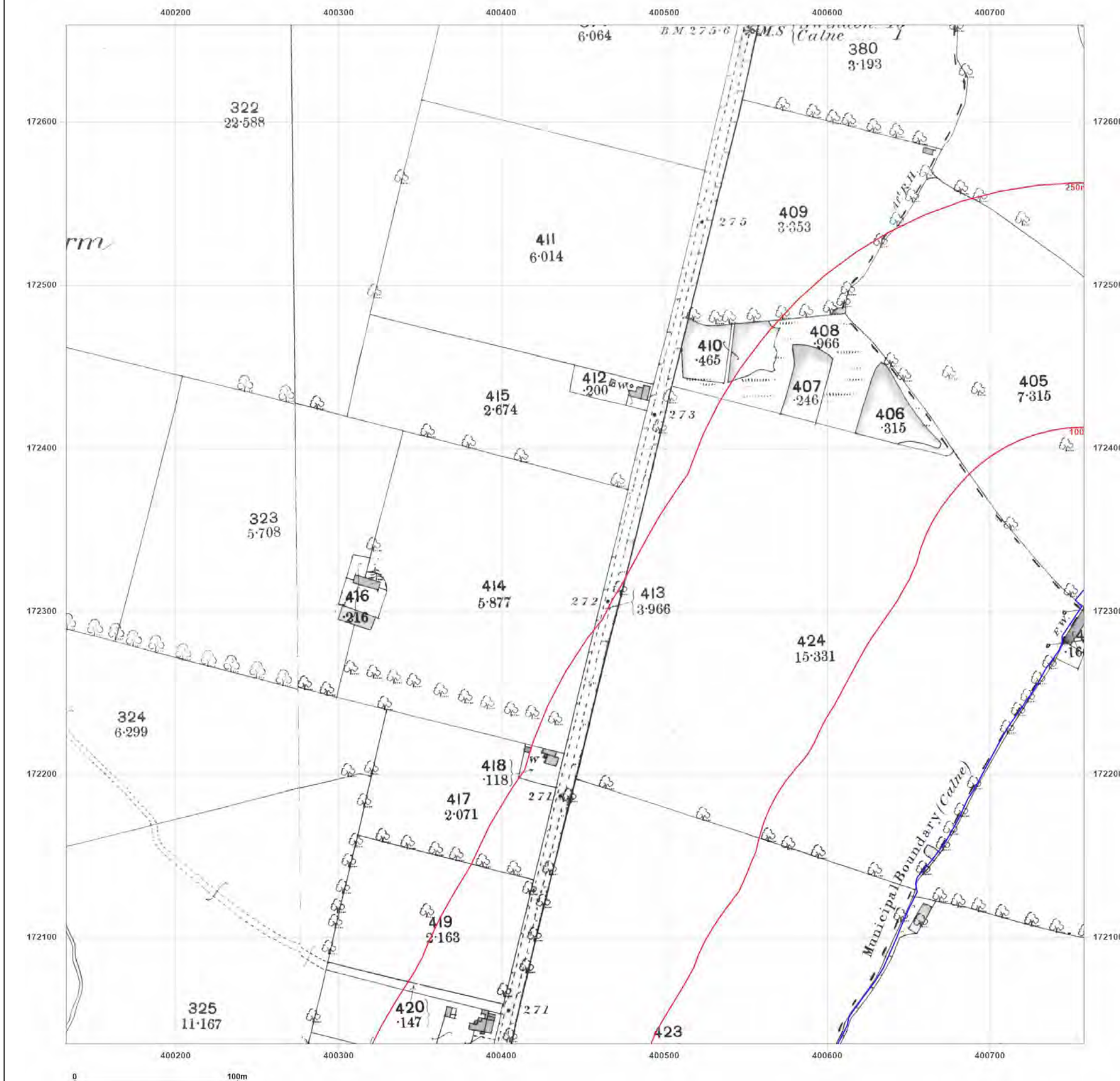


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Site Details:

400800, 172012

Client Ref: 24863
Report Ref: HYD-8964749_LS_1_2
Grid Ref: 400445, 172347

Map Name: County Series

Map date: 1900

Scale: 1:2,500

Printed at: 1:2,500



Surveyed 1900
 Revised 1900
 Edition N/A
 Copyright N/A
 Levelled N/A

Surveyed 1900
 Revised 1900
 Edition N/A
 Copyright N/A
 Levelled N/A

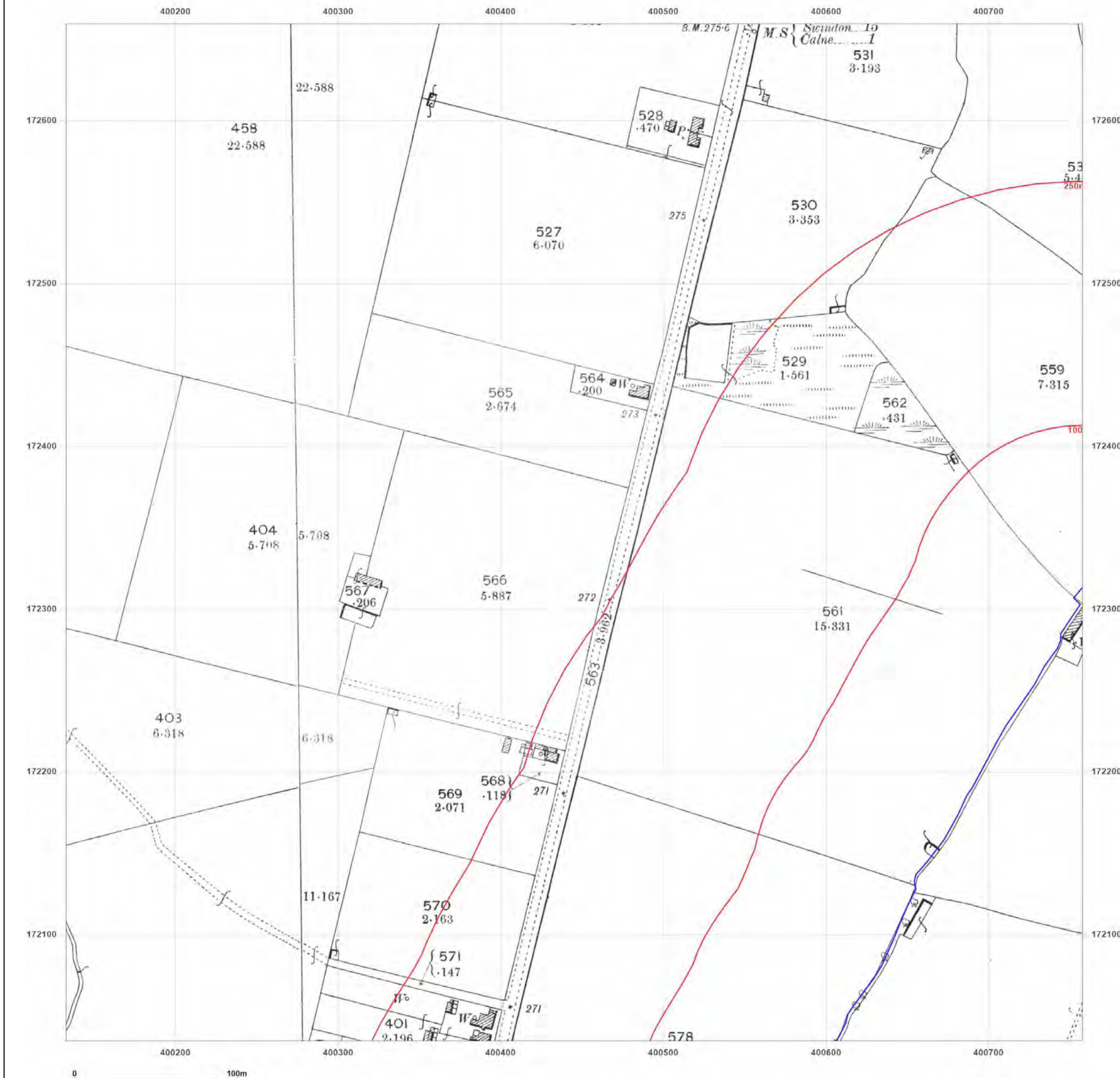


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Site Details:

400800, 172012

Client Ref: 24863
Report Ref: HYD-8964749_LS_1_2
Grid Ref: 400445, 172347

Map Name: County Series

Map date: 1924

Scale: 1:2,500

Printed at: 1:2,500



Surveyed 1924
Revised 1924
Edition N/A
Copyright N/A
Levelled N/A

Surveyed 1924
Revised 1924
Edition N/A
Copyright N/A
Levelled N/A

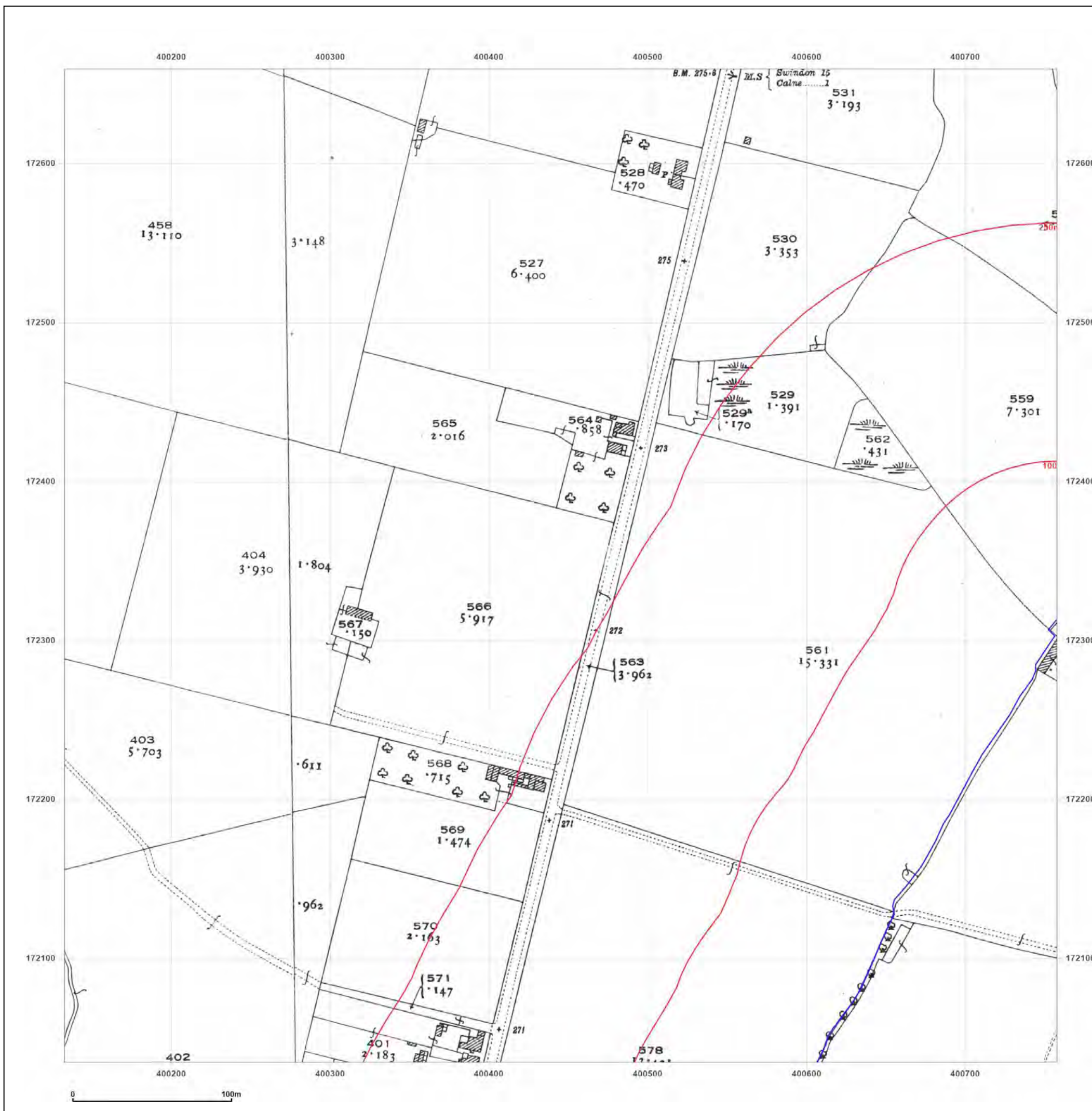


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Site Details:

400800, 172012

Client Ref: 24863
Report Ref: HYD-8964749_LS_1_2
Grid Ref: 400445, 172347

Map Name: National Grid

Map date: 1986

Scale: 1:2,500

Printed at: 1:2,500



Surveyed N/A
 Revised N/A
 Edition N/A
 Copyright 1986
 Levelled 1966



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Site Details:

400800, 172012

Client Ref: 24863
Report Ref: HYD-8964749_LS_1_2
Grid Ref: 400445, 172347

Map Name: National Grid

Map date: 1987

Scale: 1:2,500

Printed at: 1:2,500



Surveyed 1966
Revised 1987
Edition N/A
Copyright 1987
Levelled 1966

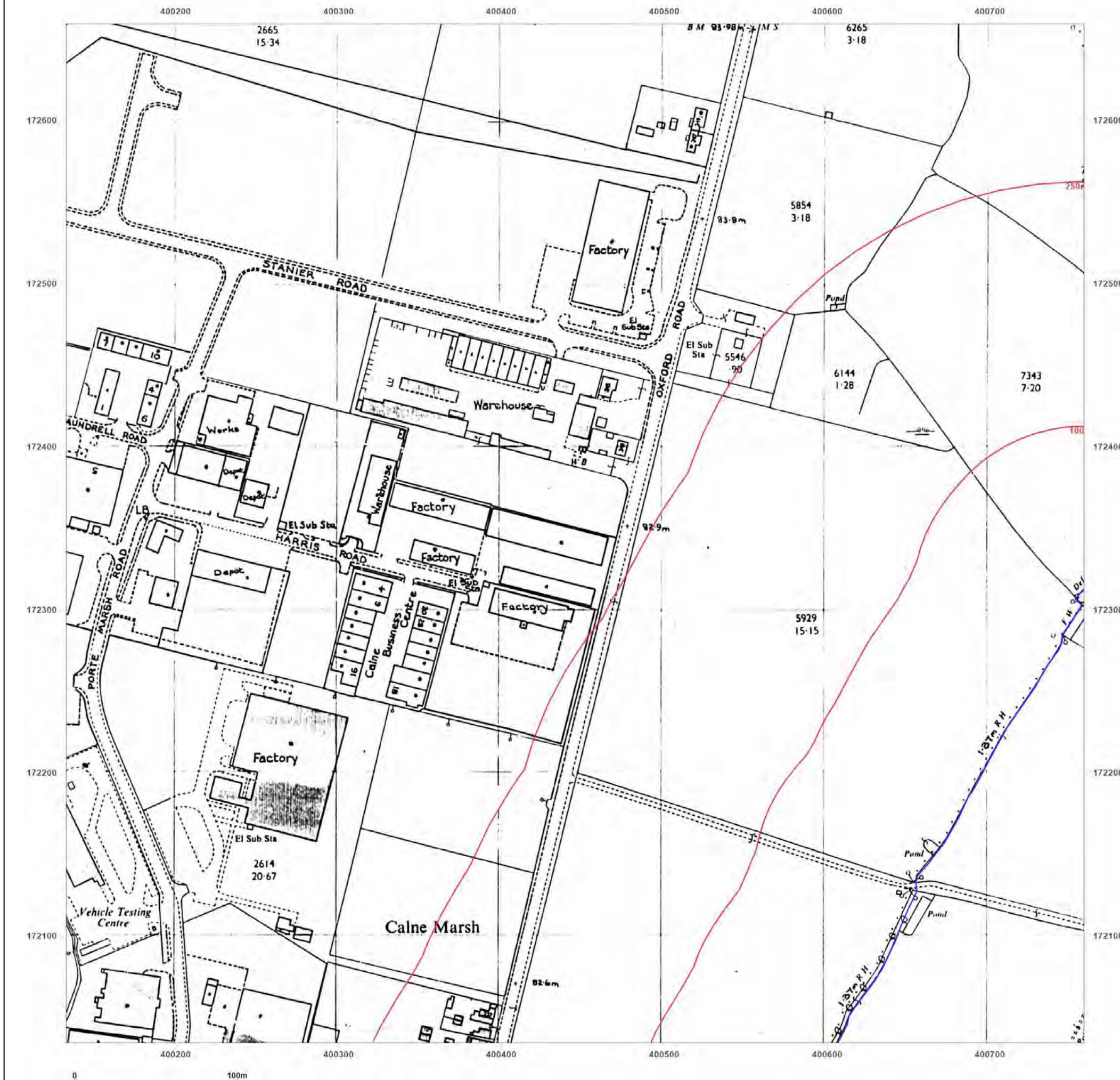


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Site Details:

400800, 172012

Client Ref: 24863
Report Ref: HYD-8964749_LS_1_2
Grid Ref: 400445, 172347

Map Name: National Grid

Map date: 1990

Scale: 1:2,500

Printed at: 1:2,500



Surveyed 1966
 Revised 1990
 Edition N/A
 Copyright 1990
 Levelled 1966



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Site Details:

400800, 172012

Client Ref: 24863
Report Ref: HYD-8964749_LS_1_2
Grid Ref: 400445, 172347

Map Name: National Grid

Map date: 1990

Scale: 1:2,500

Printed at: 1:2,500



Surveyed 1966
Revised 1990
Edition N/A
Copyright 1990
Levelled 1966

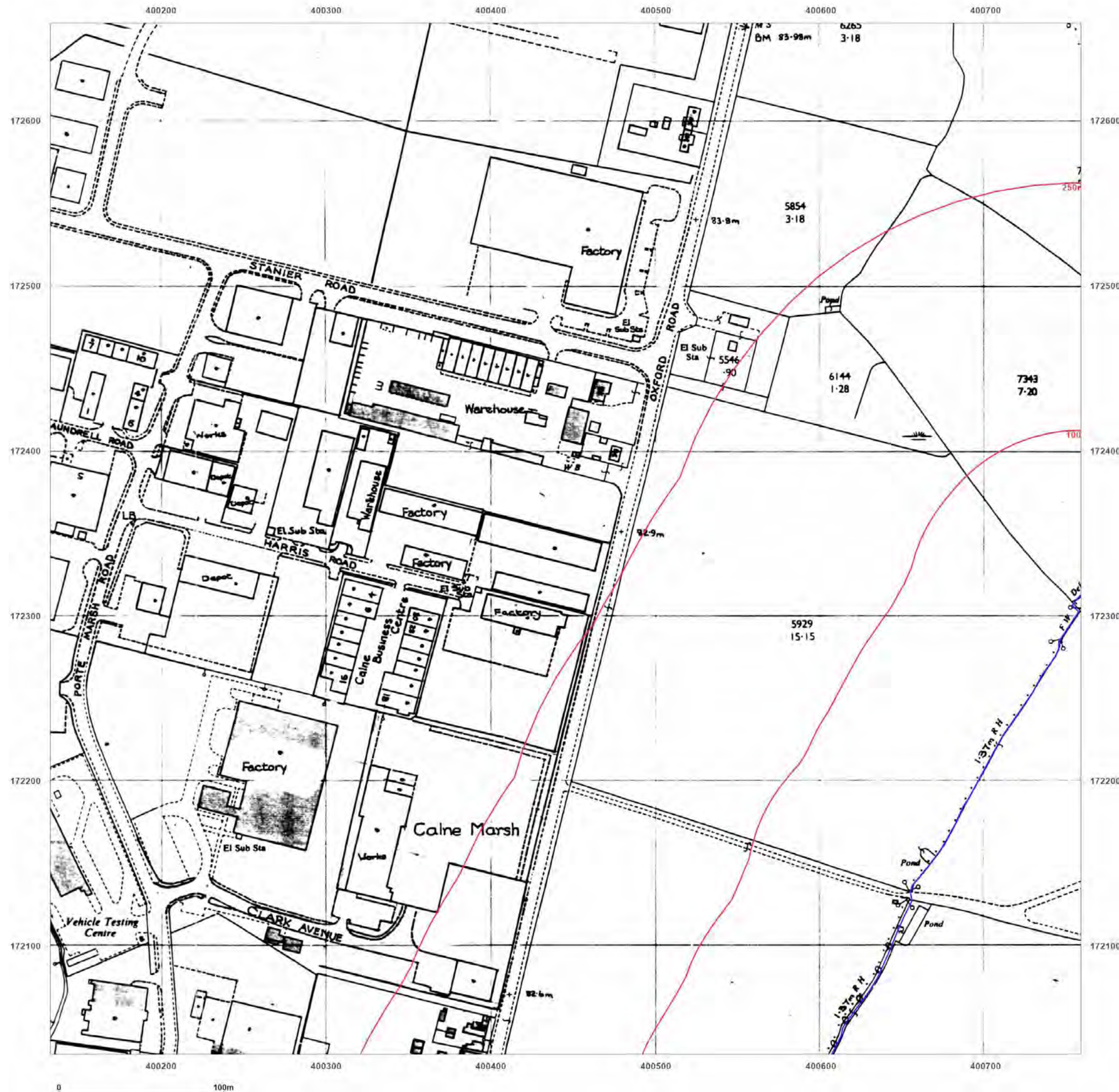


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Site Details:

400800, 172012

Client Ref: 24863
Report Ref: HYD-8964749_LS_1_2
Grid Ref: 400445, 172347

Map Name: National Grid

Map date: 1991

Scale: 1:2,500

Printed at: 1:2,500



Surveyed N/A
 Revised N/A
 Edition N/A
 Copyright 1991
 Levelled 1962



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Site Details:

400800, 172012

Client Ref: 24863
Report Ref: HYD-8964749_LS_1_2
Grid Ref: 400445, 172347

Map Name: National Grid

Map date: 1991

Scale: 1:2,500

Printed at: 1:2,500



Surveyed 1966
Revised 1991
Edition N/A
Copyright 1991
Levelled 1966

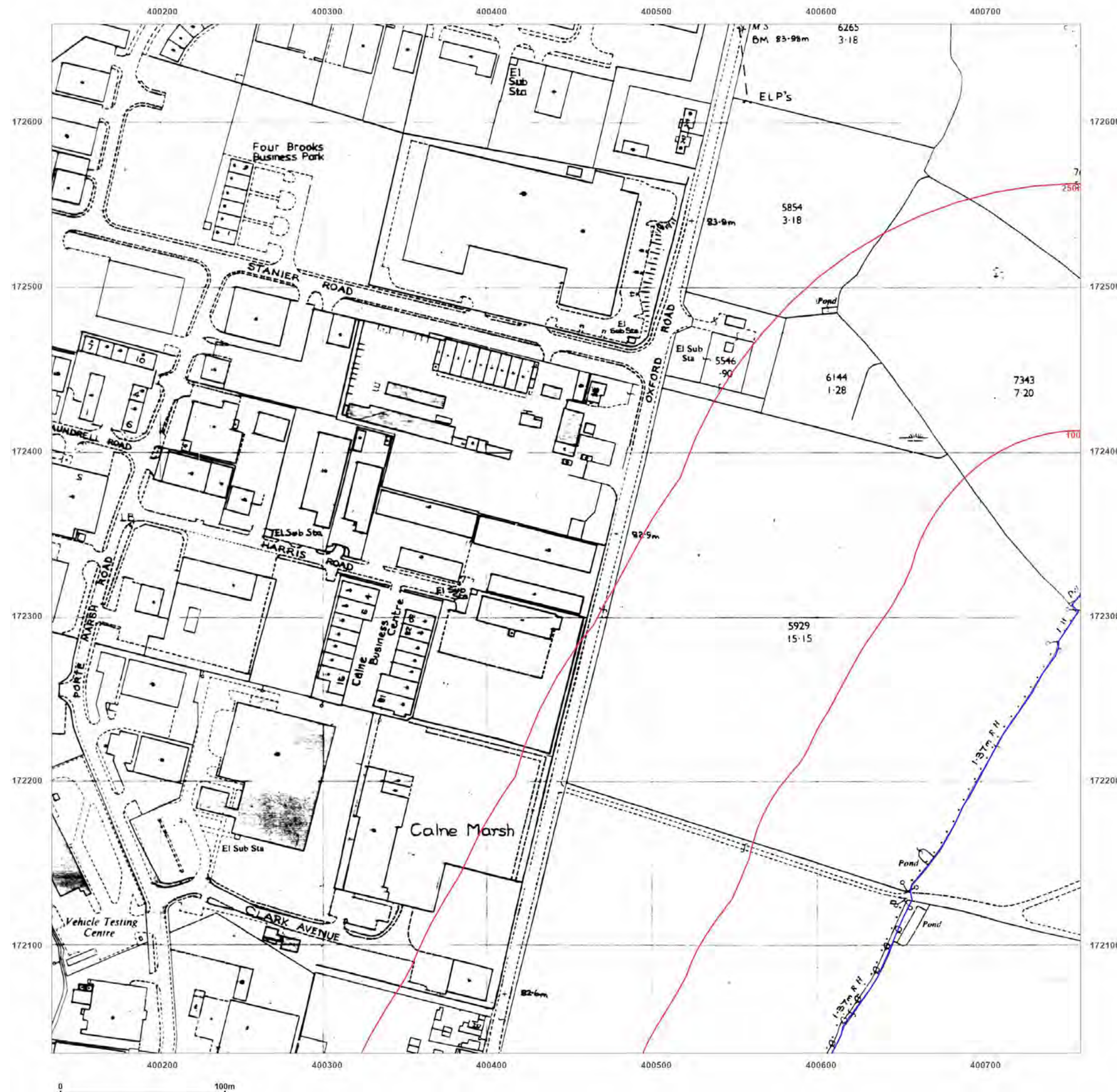


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Site Details:

400800, 172012

Client Ref: 24863
Report Ref: HYD-8964749_LS_1_2
Grid Ref: 400445, 172347

Map Name: National Grid

Map date: 1994

Scale: 1:2,500

Printed at: 1:2,500



Surveyed N/A
 Revised N/A
 Edition N/A
 Copyright 1994
 Levelled N/A



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Site Details:

400800, 172012

Client Ref: 24863
Report Ref: HYD-8964749_LS_2_1
Grid Ref: 401070, 171722

Map Name: County Series

Map date: 1886

Scale: 1:2,500

Printed at: 1:2,500



Surveyed 1886
 Revised 1886
 Edition N/A
 Copyright N/A
 Levelled N/A

Surveyed 1886
 Revised 1886
 Edition N/A
 Copyright N/A
 Levelled N/A

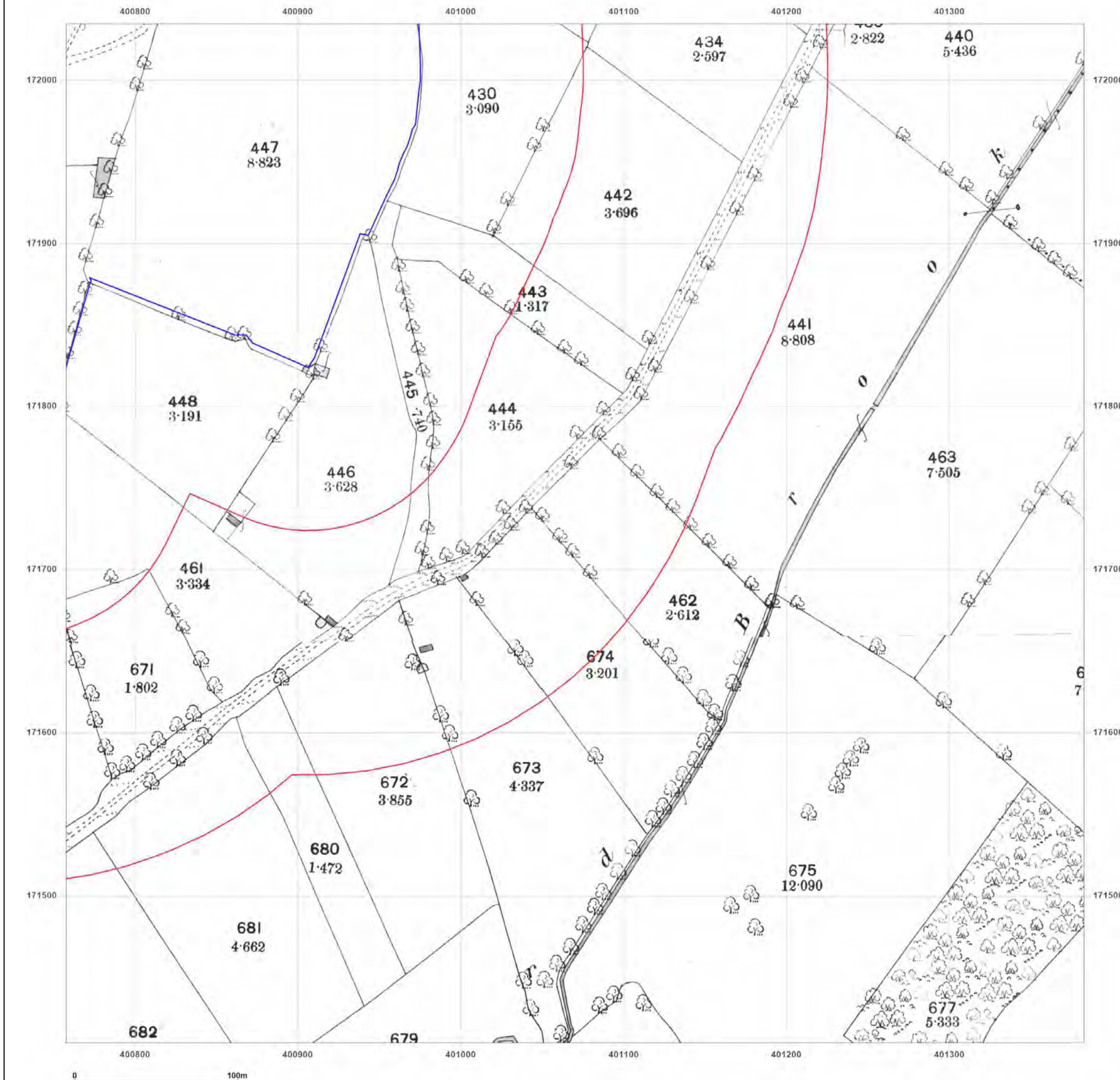


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Site Details:

400800, 172012

Client Ref: 24863
Report Ref: HYD-8964749_LS_2_1
Grid Ref: 401070, 171722

Map Name: County Series

Map date: 1900

Scale: 1:2,500

Printed at: 1:2,500



Surveyed 1900
 Revised 1900
 Edition N/A
 Copyright N/A
 Levelled N/A

Surveyed 1900
 Revised 1900
 Edition N/A
 Copyright N/A
 Levelled N/A

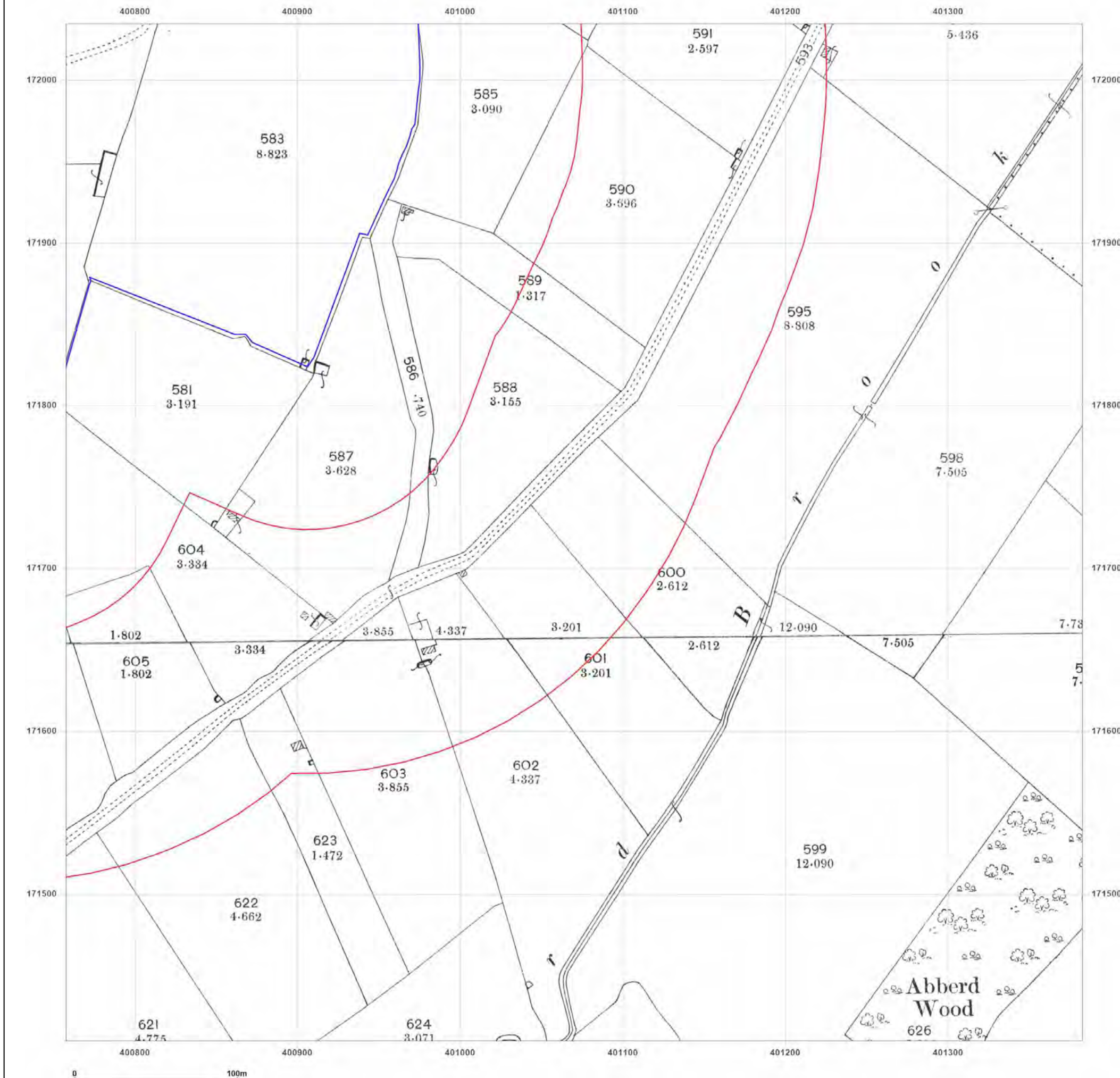


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Site Details:

400800, 172012

Client Ref: 24863
Report Ref: HYD-8964749_LS_2_1
Grid Ref: 401070, 171722

Map Name: County Series

Map date: 1924

Scale: 1:2,500

Printed at: 1:2,500



Surveyed 1924
 Revised 1924
 Edition N/A
 Copyright N/A
 Levelled N/A

Surveyed 1924
 Revised 1924
 Edition N/A
 Copyright N/A
 Levelled N/A

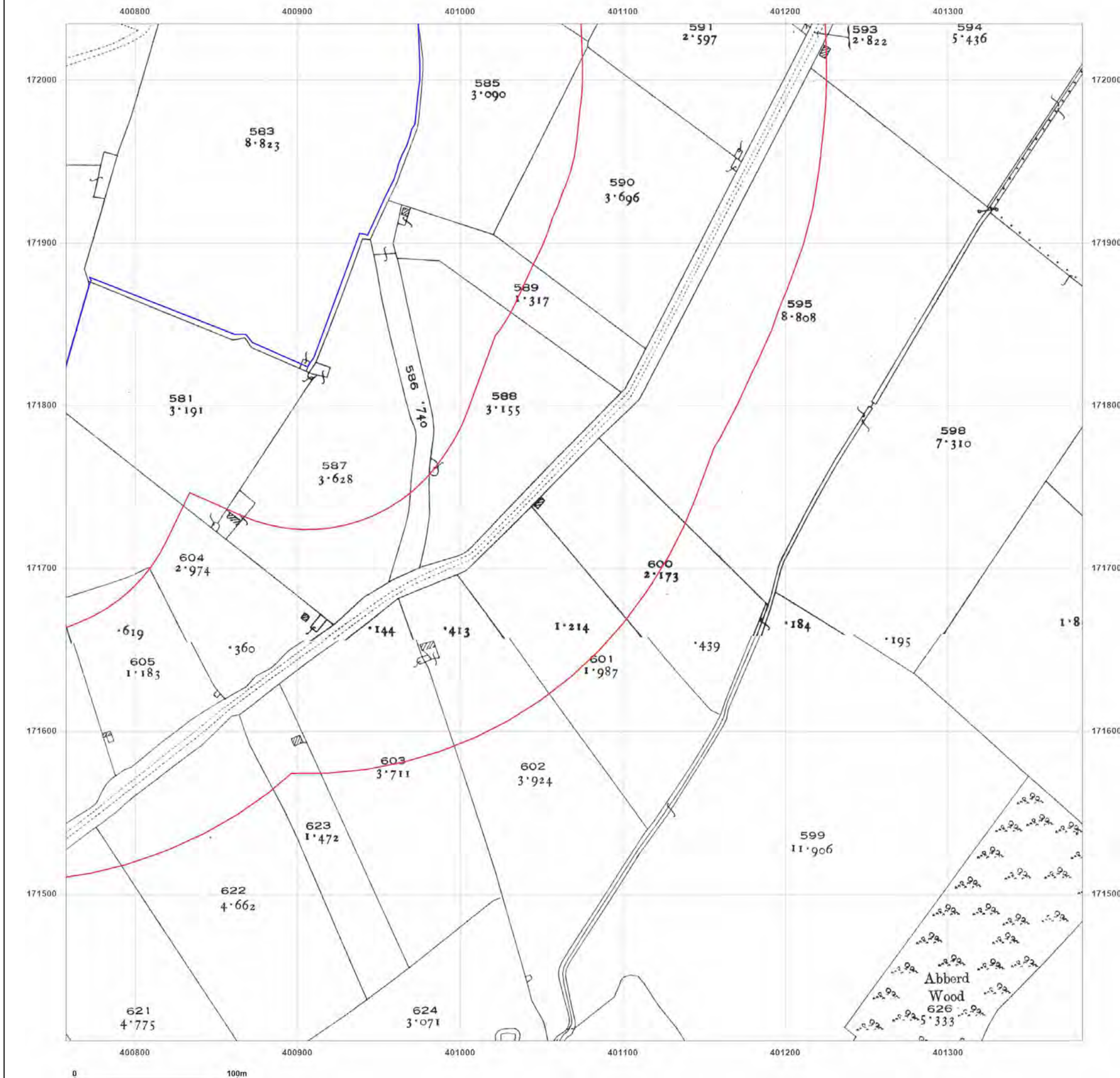


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Site Details:

400800, 172012

Client Ref: 24863
Report Ref: HYD-8964749_LS_2_1
Grid Ref: 401070, 171722

Map Name: National Grid

Map date: 1969-1970

Scale: 1:2,500

Printed at: 1:2,500



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

Surveyed 1968
 Revised 1968
 Edition N/A
 Copyright 1970
 Levelled 1966

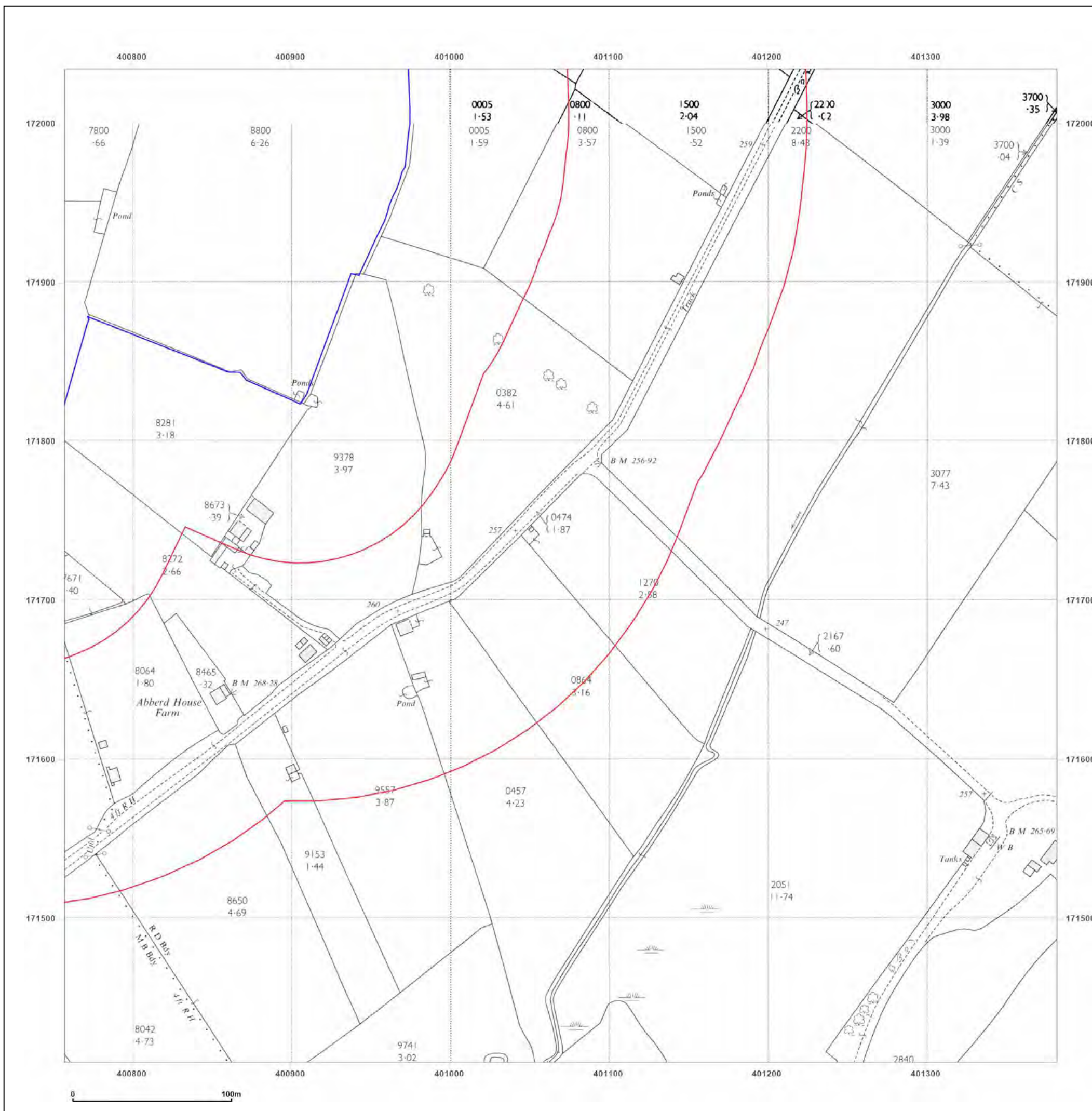


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Site Details:

400800, 172012

Client Ref: 24863
Report Ref: HYD-8964749_LS_2_1
Grid Ref: 401070, 171722

Map Name: National Grid

Map date: 1975

Scale: 1:2,500

Printed at: 1:2,500



Surveyed 1974
 Revised 1974
 Edition N/A
 Copyright 1975
 Levelled 1966



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