GEO-ENVIRONMENTAL ASSESSMENT
LYDDEN
DOVER
QUINN ESTATES LTD
GEA-21929A-19-451
OCTOBER 2019

IDOM

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EXECUTIVE SUMMARY

A Geo-Environmental Assessment was requested by Quinn Estates Ltd. The purpose of the assessment was to identify any contaminative or geotechnical issues associated with former land use at *Lydden, Dover* which might impact on the site's purchase and redevelopment.

SITE DETAILS	
Approximate site area	1.93 ha
Current/previous use	The site has been open grassland since 1872 and is currently in use as grazing land for cattle.
Proposed use	The proposed development is expected to include domestic homes with private gardens and public open space.
PHASE 1 NON-INTRUSIVE INVESTIGATION	
Expected geology	The expected geology comprises superficial Head deposits running north-south through the centre of site overlying a bedrock of Lewes Nodular Chalk Formation.
Groundwater	The underlying Head deposits are Secondary A Aquifers. The bedrock is a Principal Aquifer. The site is in a Source Protection Zone one. Groundwater abstraction has been undertaken at five locations within 1 km. Two at 559 m and 605 m east and three at 910 m, 968m and 975 m south west.
Surface water	There are ponds 40 m west and 40 m north east. There are no surface water abstraction licences within 1 km. There is a low flood risk rating with high confidence.
Other	The site lies within a Radon Affected Area (5 – 10 % of homes are above the action level). Basic Radon protection measures will be necessary.
PHASE 2 EXPLORATORY INVESTIGATION	
Ground Conditions	Consistent with the published geology, superficial deposits were located in the centre of site comprising Head deposits of very soft to soft brown slightly gravelly sandy clay with gravels of flint as well as pale grey slightly clayey gravelly sand with gravels of flint and chalk. The underlying bedrock was Lewes Nodular Chalk Formation comprising a moderate strength creamish white slightly sandy chalk with fine to cobble sized flints.
Contamination	No visual, olfactory or chemical contamination was encountered on site. No herbicides or pesticides were encountered above the detection limit of testing.
Geotechnical issues	Soft superficial clays exist across the majority of the site, whilst superficial sand/gravel is locally loose in nature.

RECOMMENDATIONS	
Geotechnical	Traditional strip/trench footings considered feasible towards the south-eastern boundary, whilst piles or rafts will be required across the majority of the site. CBR values of < 2 % should be assumed for shallow clay, whilst for sand/gravel or chalk, a CBR value of 5 % will apply. Buried concrete classes DS-1 and AC-1s will apply to new foundation concrete.
Remediation	Basic Radon protection measures will be necessary. No further remedial measures are recommended.
Waste classification	Soils on site are assumed to be classified as inert non-hazardous.
Re-use of site-won materials	Natural site won materials are chemically suitable for reuse. Topsoil will require BS3882:2015 testing for re-use onsite.

SECTION 1 INTRODUCTION

1.1 Quinn Estates Ltd proposes to purchase an area of land located to the east of Church Lane, Lydden for residential development purposes. No proposed development has been put forward, therefore this report assumes that the most sensitive development will take place, a development with private gardens that can facilitate the growth of homegrown produce. IDOM Merebrook Limited (IDOM) has been commissioned by Quinn Estates Ltd to undertake preliminary site investigation works and to advise on the geo-environmental implications of the purchase and redevelopment of the site for the proposed end use.

1.2 The objectives of the investigation are to:

i. Assess surface and sub-surface ground conditions present at the site;

ii. Identify hazards associated with ground contamination which may place constraints on the site and the proposed development;

iii. Evaluate the risks associated with any identified hazards;

iv. Provide preliminary recommendations for the mitigation of any significant risks identified; and

v. Provide preliminary geotechnical recommendations.

1.3 A Phase 1 (Non-intrusive Investigation) and a Phase 2a (Preliminary Exploratory Investigation) have been undertaken for the subject site.

1.4 This report presents the findings of the geo-environmental investigation and provides an interpretation of the geo-environmental conditions that exist at the site. The contaminative status of the site and the implications with respect to development have been interpreted in accordance with the current government guidance on source-pathway-receptor risk assessment. This report uses a Tier 1 risk assessment to ascribe a conservative qualitative appraisal of the hazards associated with the site.

1.5 This report has been prepared for Quinn Estates Ltd for the sole purpose described above and no extended duty of care to any third party is implied or offered. Third parties making reference to the report should consult Quinn Estates Ltd and IDOM Merebrook as to the extent to which the findings may be appropriate for their use.

SECTION 2 PHASE 1 (NON-INTRUSIVE INVESTIGATION)

2.1 INTRODUCTION

2.1.1 The non-intrusive investigation has been conducted with reference to the documents and sources detailed in Table 1 below:

Table 1: Published Data and Information Sources

SOURCE DATA	GROUNDSURE DATA
BGS 1:50,000 Series Geological Sheet 289	Ordnance Survey (OS) historical maps scaled at 1:10,560, 1:10,000, 1:2,500 and 1:1,250 dated 1872 - 2014
BGS Geology of Britain 1:50,000 online maps	Water abstraction, discharge and pollution data
Radon: guidance on protection measures for new dwellings	Registered waste management sites
Environment Agency (EA) online data maps	Mining records and natural ground stability data
UK National Air Quality Archive, online	Protected areas of environmentally sensitive land use or conservation
Other relevant designations and/or authorisations and Trade Directory entries	

2.1.2 The above sources are all authoritative and it is believed that they are reasonably reliable. However, independent verification of the information supplied has not necessarily been carried out and IDOM cannot be held liable for inaccuracies or deficiencies in the information.

2.2 SITE LOCATION AND SETTING

2.2.1 The site is a field of open grassland located east of Church Lane in Lydden (CT15 7JP). It is adjacent to a garage, farm buildings and residential homes.

2.2.2 The site is private land but remains in use by the public as a recreational field.

2.2.3 The site occupies an area of approximately 1.93 hectares located at National Grid Reference [6]26187, [1]45461 and indicated on drawing 21929a-304-001 presented in Appendix 1 of this report.

2.2.4 The site is enclosed by a fence and farm gates. The boundaries of the site are as follows:

i. To the north is another field of open grassland used for cattle grazing;

ii. To the east there is a residential building as well as more open grassland;

iii. To the south there are residential buildings followed by Canterbury Road; and

iv. To the west there are the buildings associated with the site, buildings from Lydden Farm and beyond that runs Church Lane.

2.2.5 The site is currently used as grazing land. During the site walkover there were no contaminative issues noted. There is an underground sewage pipe running north east to south west across site.

2.2.6 Adjacent to the south west corner is Lydden Garage. This is a small garage used for local car service and maintenance. No fuel storage tanks were identified. The site appeared to be in good order with proper waste management and well maintained hard standing surfaces.

2.2.7 The south and eastern boundaries have trees running along the edge.

2.2.8 There is a small number of disused cars kept on the western edge of site.

2.2.9 The site forms a valley running north to south with a steep rise in topography on the eastern section and a shallower rise on the western section.

2.3 SITE HISTORY

2.3.1 The site history, based on a review of the historic and current maps, dating from 1872 to 2014 is summarised below. Potentially contaminative land uses are shown in **bold**. Copies of key maps used in this review are provided in Appendix 2.

Table 2: Summary of the key features shown on historic maps

DATA SOURCE	SITE / SURROUNDINGS
1872 (1:2,500 scale).	Site: The site is open grassland.
	Surroundings: There is a **pond** 40 m south west and a school adjacent to the south east corner.
1937 - 1939 (1:2,500 scale).	Site: The site is unchanged.
	Surroundings: **Lydden Court Farm** has been built adjacent to the north of site and a house has been built adjacent to the west of site which is attached to the property. There is a **railway** 700 m north east and **Lyoak Pumping Station** 1250 m south west. **Stonehall Colliery**, a disused mine, is 550 m north east with an associated **tank** and **mine shafts**.
1956 - 1957 (1:2,500 scale).	Site: The site remains unchanged.
	Surroundings: The south eastern school is no longer labelled. **Bell Farm** has been built 60 m south west and a **garage** has opened adjacent to the south west corner.
1974 – 1975 (1:2,500 scale).	Site: The site remains unchanged.
	Surroundings: There is a **pond** in Lydden Court Farm 40 m to the north east.
	Site: The site remains unchanged.

DATA SOURCE	SITE / SURROUNDINGS
2002 (1:10,000 scale).	Surroundings: Stonehall Colliery to the north east has been redeveloped as **Broadfield Farm** and a **cricket ground**.

2.3.2 In summary, historic plans show that the site has remained as open grassland since 1872. It is currently in use as grazing land.

2.3.3 The surrounding area has seen three farms being built with a small amount of residential development occurring along the adjacent roads. A potentially significant contamination issue is from Stonehall Colliery, a disused mine identified 550 m north (1937).

2.3.4 The historic maps show potentially contaminative uses at the following:

i. Lydden Garage – waste and heavy metals, hydrocarbons;

ii. Stonehall Colliery – landfill, heavy metals, slurry, asbestos; and

iii. Onsite farmland – pesticides and herbicides.

2.3.5 Whilst Stonehall Colliery presents a potential contamination source, the distance between the site and Stonehall Colliery is significant (550 m) and Stonehall Colliery has since been redeveloped to a farm and cricket ground. Therefore, Stonehall Colliery will no longer be considered as a significant contamination risk.

2.3.6 Given the nature of the historical mapping process (scale, representation of conditions at discrete time intervals frequency *etc.*), any such maps and plans may not provide a comprehensive account of a site's history. Identification of pertinent land uses and associated potentially contaminative activities, may therefore be absent from mapping records.

2.4 GEOLOGY

2.4.1 The published geological map indicates the presence of head deposits running along the onsite depression running north to south through the centre of site comprising silt and gravels.

2.4.2 The underlying bedrock geology comprises Lewes Nodular Chalk Formation. This is composed of hard to very hard nodular chalks with interbedded soft to medium hard chalks and marls with regular seams of flints.

2.4.3 There are three relevant historical borehole logs as follows:

i. TR24NE11 (1970) – encountered 1.00 m of soft and firm brown becoming reddish brown slightly clayey silt with flints at the base followed by a medium strong slightly weathered yellow white chalk with some flints for a further 2.00 m until the borehole ended at 3.00 m. No groundwater was encountered;

ii. TR24NE10 (1970) – encountered 0.50 m of made ground as weak chalk fragments in a loose brown silt followed by 0.50 m of angular flint fragments and chalk in a matrix of loose and medium dense light brown silt until the borehole ended at 1.00 m. No groundwater was encountered;

iii. TR24NE34 (1974) – encountered drift deposits for 3.35 m, followed by chalk with flint until 18.29 m, firm chalk with flint layers until 83.52 m and finally a base of hard chalk rock and chalk marl until the base of the borehole at 106.68m. Groundwater was encountered at a depth of 36.57 m bgl.

2.4.3.2 Following the identification of Stonehall Colliery 550 m to the north east, Geological sheets 289 and 290 have been used to ascertain the depths of the underlying coal measures:

i. Sheet 289 contains a section line from grid reference $^{1}38525$ to $^{2}11600$ and identifies the shallowest coal seam at about 310 m bgl,

ii. Sheet 290 contains a section line from grid reference $^{1}51100$ to $^{2}32100$ and identifies the shallowest coal seam at about 160 m bgl.

2.4.3.3 At these depths, coal mining legacy associated with the underlying coal seams is considered unlikely to affect the development.

2.4.4 The historical borehole logs are located in Appendix 3 of this report.

2.4.5 The groundsure database contains no references to made ground within 50 m of the site.

2.5 HYDROGEOLOGY

2.5.1 The Groundsure database has identified the head deposits as a Secondary A Aquifer whilst the underlying Lewes Nodular Chalk Formation is identified as a Principal aquifer.

2.5.2 The site is within groundwater *Source Protection Zone 1 – inner catchment* relating to potable water supplies approximately 600 m east of the site (groundwater abstraction by Veolia Water Southeast Limited 559 m and 605 m east).

2.5.3 There are three additional abstraction licences operated by Affinity Water Ltd 910 m, 968 m and 975 m south west.

2.6 HYDROLOGY

2.6.1 There are two ponds, one 40 m west and the other 40 m north east. There are no other minor surface water features within 250 m of the site or major surface water features within 1000 m of the site.

2.6.2 There are no surface water abstraction licences within 1 km of the site.

2.6.3 A risk of clearwater flooding is identified on site, the risk is classified as limited by the Groundsure database with a high confidence in this classification.

2.6.4 The risk of flooding from rivers and the sea (RoFRaS) is very low.

2.7 CURRENT SITE ISSUES

2.7.1 Potentially significant environmental issues have been investigated within relevant distances of the site, based on the database of records supplied by Groundsure. These relate to the following searches:

i. Water discharge or pollution incidents within 250 m of the site;

ii. Waste management sites within 250 m of the site;

iii. Statutory authorisations within 50 m of the site;

iv. Trade directory entries of possible contaminative use within 50 m of the site;

v. Special protection or conservation areas within 50 m of the site; and

vi. Any other relevant issues.

2.7.2 Potentially significant environmental issues identified by the above searches are summarised in Table 3 below.

Table 3: Potentially significant environmental issues

ENVIRONMENTAL CATEGORY	DESCRIPTION
Water discharge or pollution incidents within 250 m	None.
Waste management sites within 250 m	None.
Statutory authorisations within 50 m	None.
Trade directory entries of possible contaminative use within 50 m	**Lydden Garage** is adjacent to the south west corner of site. Whilst this is a potential source of pollution, it is unlikely to impact the site as the garage is covered in hardstanding and a walkover showed a small-scale local service with no examples of poor waste management.
Special protection or conservation areas within 50 m	None.
Other relevant issues.	The site is underlain at depth by the Kent Coalfield and a coal mining report will be required to accompany the planning application for development.

2.8 INDICATIVE GROUND STABILITY HAZARDS

2.8.1 The Groundsure database was used to assess ground stability hazards for the site. The results are as follows:

i. The risk of compressible ground is negligible;

ii. The risk of shrink-swell clays, collapsible rocks and running sands is very low.

iii. The risk of landslides is classified as low meaning there is a possibility of landslides after a major change in ground conditions. Consideration should be given to stability if changes to drainage or excavations take place.

iv. Soluble rocks are classified as low risk. Whilst soluble rocks are present on site, there is a low possibility of natural subsidence. High surface water flow could cause dissolution of the underlying rocks. Consideration should be given to stability changes when new drainage or construction is planned. Care should be taken with local drainage into the Lewes Nodular Chalk Formation.

2.9 RADON GAS

2.9.1 The site lies within a Radon Affected Area as defined by the former Health Protection Agency, now Public Health England as 5 – 10 % of houses are above the action level). Guidance issued by the Buildings Research Establishment (BRE-211) indicates that basic radon protective measures are necessary.

2.10 AIR QUALITY

2.10.1 The site does not lie within a designated Air Quality Management Area (AQMA).

2.11 ECOLOGY

2.11.1 Information from environmental and ecological datasets was obtained from a review of the MAGIC (Multi-Agency Geographic Information for the Countryside) website and the Groundsure report in order to identify any ecological receptors that might be relevant to the contamination risk assessment for the site. There are no species or habitats considered to be potentially relevant ecological receptors.

2.12 PREVIOUS INVESTIGATIONS

2.12.1 No known previous investigation data exists for the site.

2.13 PRELIMINARY CONCEPTUAL SITE MODEL AND RISK ASSESSMENT

2.13.1 From the Phase 1 assessment a preliminary site conceptual model and risk assessment have been produced using the framework established in Part IIA of the *Environmental Protection Act 1990* and detailed in Contaminated Land Report *CLR11 - Model Procedures for the Management of Land Contamination.*

2.13.2 Risk from contamination has been assessed using the source-pathway-receptor and pollutant linkage methodology, whereby a risk can only exist if all elements of: source, pathway and receptor, are present.

2.13.3 The potential sources for onsite contamination are:

i. Limited potential for localised made ground with anthropogenic contamination (heavy metals, PAH and asbestos);

ii. The adjacent Lydden Garage;

iii. Potential for historical onsite usage of herbicides and pesticides although any contamination is likely to be very low level;

iv. Whilst desk study does not suggest any significant ground gas sources in the area, the underlying chalk can give rise to low concentrations of carbon dioxide ground gas..

2.13.4 Potential pathways for onsite contamination to reach receptors are considered to be:

i. Interaction with soils through dermal contact or ingestion/inhalation of soil and generated dust,

ii. Ingestion of homegrown produce by residents with private gardens,

iii. Vertical and horizontal migration of contamination,

iv. Construction generated dust.

2.13.5 Potential receptors to contamination include:

i. Future residents with private gardens,

ii. Construction workers,

iii. Future users of public open space,

iv. The underlying aquifers,

v. The nearby surface water ponds,

vi. Surrounding residential homes and adjacent fields.

2.13.6 From the Phase 1 assessment a preliminary site conceptual model has been produced as Table 4 which identifies the potential pollutant linkages. These have been used to inform the Phase 2 intrusive investigation presented in the subsequent sections.

Table 4: Preliminary Conceptual Model

POSSIBLE POLLUTANT LINKAGE			RISK CHARACTERISATION
POTENTIAL SOURCES	**PATHWAYS**	**RECEPTORS**	
Heavy metals and hydrocarbons (made ground)	Contact with contaminated soil	Human health (current users)	**Low risk identified** Very limited potential for made ground which can contain elevated metals and hydrocarbons. The site is private land with a small number of users interacting with the soil infrequently.
	Ingestion and inhalation of contaminated soil and dust	Human health (current users)	
Heavy metals and hydrocarbons (made ground)	Contact with contaminated soil	Human health (future residents)	**Low risk identified** Very limited potential for made ground which can contain elevated metals and hydrocarbons however exposure is likely.
	Ingestion and inhalation of contaminated soil and dust	Human health (future residents)	
Heavy metals and hydrocarbons (made ground)	Contact with contaminated soil	Human health (construction workers)	**Low risk identified** Very limited potential for made ground which can contain elevated metals and hydrocarbons however exposure is likely.
	Ingestion and inhalation of contaminated soil and dust	Human health (construction workers)	
Asbestos (made ground)	Ingestion and inhalation of contaminated soil and dust	Human health (future residents and construction workers)	**Low risk identified** Potential for localised made ground which could contain asbestos.
Contamination (all forms)	Vertical migration to aquifer	Controlled waters	**Low risk identified** Limited potential for contamination that would affect the underlying aquifers.
Contamination (all forms)	Horizontal migration to surface water	Controlled waters	**Low risk identified** Very limited potential for contamination to affect the nearby ponds.
Hydrocarbons	Direct contact	Plastic water pipes	**Low risk identified** There is Lydden Garage adjacent to the south west corner and derelict cars onsite.
Hazardous Gas/Vapours In soil	Ingress into buildings and voids	Human health (future residents and construction workers)	**Low risk identified** Limited potential for made ground which could act as source of hazardous gas. Chalk can act as a low-level producer of CO^2.
Adjacent land	Lateral migration in vapour or groundwater phase	Subject site	**Low risk identified** Adjacent garage does not appear to have had associated fuel storage and potential for mobile contaminants in low.

SECTION 3 SITE INVESTIGATION RATIONALE

3.1 INTRODUCTION

3.1.1 A site investigation rationale has been devised in accordance with the findings of the Phase 1 investigation and the resultant preliminary conceptual site model and risk assessment. Priority contaminants were identified as:

i. The potential onsite use of herbicides and pesticides,

ii. Potential for localised made ground with heavy metals, asbestos and hydrocarbons,

iii. Limited potential for the adjacent garage to act as a source of hydrocarbons,

iv. Very limited potential for hazardous gas generation from the underlying chalk.

3.1.2 Intrusive sampling locations were chosen on the basis of providing broad spatial coverage of the site and excavating areas that are linked to the priority contaminant sources.

3.2 SITE INVESTIGATION METHODS

3.2.1 An intrusive investigation was carried out by IDOM on 24th – 26th September 2019 and comprised the following scope of work:

i. Two cable percussion boreholes (MBH01 and MBH02) to 15 metres below ground level (m bgl);

ii. Ten machine-dug trial holes (MTP01 to MTP10) to a depth of 3 m bgl;

iii. Four soakage pits (MSP01 to MSP04) to a depth of 3 m bgl.

3.2.2 Exploratory hole locations are indicated on drawing 21929a-304-001 in Appendix 1. Logging of exploratory holes was undertaken by an IDOM Merebrook Officer. Exploratory hole logs are contained in Appendix 3.

3.2.3 Light cable percussion equipment was used to advance boreholes MBH01 and MBH02. Standard Penetration Tests (SPTs) were performed at approximate 1 metre intervals. The tests involved driving a steel cone tipped series of rods into the ground over a distance of 450 mm using the repeated blows of a 63.5 kg weight allowed to free fall over a distance of 760 mm. The total number of blows required for the final 300 mm penetration (the 'N' value) is recorded on the logs.

3.2.4 The two boreholes were installed with slotted pipe within gravel to form a response zone in the underlying natural ground and plain pipe topped by bentonite was used to form a seal. MBH01 was installed to 5 m bgl with 3 m of plain pipe followed by 2 m of slotted pipe. MBH02 was installed to 15 m with 5 m of plain pipe followed by 10 m of slotted pipe. The installations were subsequently used to detect groundwater and monitor the natural ground gas conditions.

3.2.5 Representative soil samples were taken from various depths and strata to assess the contaminative status of the site. Soil samples were submitted to an MCERTS/ UKAS accredited laboratory for chemical analysis of a broad suite of potential contaminants including herbicide and pesticide testing of the topsoil. The results are provided in Appendix 4.

3.2.6 A programme of geotechnical laboratory testing was performed on selected soil samples obtained from the boreholes, comprising classification tests. Chemical testing was also undertaken to assess the aggressiveness of the ground with respect to buried concrete. The test results are presented in Appendix 5.

SECTION 4 GROUND CONDITIONS

4.1 SURFACE GROUND CONDITIONS

4.1.1 The site was a grassed field with only minor variation in the vegetation.

4.2 SUB-SURFACE GROUND CONDITIONS

4.2.1 The subsurface ground conditions were consistent with those identified by the published geology.

4.2.2 A summary of the ground conditions encountered is presented in Table 5, whilst a more detailed assessment of the strata is contained in the following sections of the report.

Table 5: Summary of Sub-surface Ground Conditions

STRATA	DEPTH TO TOP RANGE (m bgl)	THICKNESS RANGE (m)
Topsoil	0.00	0.10 – 0.50
Head deposits	0.10 – 0.50	0.30 – 3.60
Lewes Nodular Chalk Formation	0.40 – 3.80	Base not proven

4.2.3 Topsoil

4.2.3.1 The topsoil consisted of soft greyish brown clayey fine sand with abundant organic material and occasional gravels of fine to medium sub-angular to sub-rounded flint.

4.2.3.2 There was no visual or olfactory evidence of contamination.

4.2.3.3 There were no examples of perched water encountered.

4.2.4 Head deposits

4.2.4.1 Head deposits were encountered at the topographically lower areas of site running north to south.

4.2.4.2 Head deposits comprised very soft to soft dark brown slightly gravelly sandy clay with gravels of fine to medium, sub-angular to sub-rounded flints and occasional fine to medium, sub-angular chalks. Underlying this were Head deposits of pale grey slightly clayey gravelly fine to coarse sand with gravels of fine to medium, sub-angular chalk and occasional fine, angular to sub-rounded flints.

4.2.4.3 There was no visual or olfactory evidence of contamination.

4.2.4.4 No groundwater was encountered.

4.2.4.5 Atterberg limit tests carried out on four samples of superficial clay indicate that the soil can be classified as clay of low to high plasticity. The plasticity index of the soil was found to range between 10 and 20 %, and in accordance with NHBC guidelines, this soil is of low and medium volume change potential. Moisture contents were also determined and ranged from 16 to 21 %.

4.2.4.6 An SPT performed in MBH01 at 1.2 m bgl, within cohesive Head recorded an 'N' value of 5, indicating soft low strength ground conditions, whilst at 2.2 m bgl an 'N' value of 6 was obtained in sand, indicative of loose conditions. An SPT carried out at a depth of 3.2 m bgl was met with refusal and this is considered likely to be due to the presence of a chalk or flint cobble. SPT 'N' values of 15 and 19 recorded within sand encountered in MBH02 are indicative of medium dense ground conditions.

4.2.5 Lewes Nodular Chalk Formation

4.2.5.1 Lewes Nodular Chalk Formation was encountered below the Head deposits in the centre depression of site at depths of around 3 m bgl. At higher topographies the Lewes Nodular Chalk Formation was encountered at much shallower depths (0.40 m bgl).

4.2.5.2 Lewes Nodular Chalk Formation comprised a moderate strength creamy white fine-grained gravelly chalk. The gravels were fine to cobble sub-angular to sub-rounded flints.

4.2.5.3 There was no visual or olfactory evidence of contamination.

4.2.5.4 No groundwater was encountered.

4.2.5.5 SPT 'N' values in MBH01 ranged from 7 to 8 in the upper 2 m (depths of 4.2 and 5.2 m bgl, respectively) indicating low strength conditions, whilst 'N' values of 14 to 34 below indicate the presence of more competent conditions. In MBH02, SPT 'N' values ranged between 15 and 30, indicative of competent ground conditions. An SPT performed at 15.0 m bgl was met with refusal.

SECTION 5 PRELIMINARY GEOTECHNICAL RECOMMENDATIONS

5.1 FOUNDATIONS

5.1.1 Details of the proposed development have not been finalised at this stage, however it is likely that this will comprise low-rise residential housing with private gardens, parking, soft landscaping and associated infrastructure.

5.1.2 The ground investigation revealed ground conditions consisting of limited thicknesses of topsoil (0.1 – 0.5 m thick) underlain by cohesive and granular Head

Deposits ranging in thickness from 0.3 to 3.6 m. The deeper deposits of Head were encountered in the north-eastern portion of the site and are understood to form an infilled river channel cut into the chalk. Solid geology of the Lewes Nodular Chalk was present below the superficial deposits.

5.1.3 SPTs carried out in borehole MBH01 revealed soft and loose conditions within the Head Deposits, whilst the underlying chalk was initially of low strength, becoming more competent with depth. MBH02 revealed medium dense Head Deposits, above competent chalk.

5.1.4 Based on the information obtained to date, traditional strip/trench footings are considered unlikely to be suitable across the majority of the site due to the 'soft' nature of the superficial clay soils. Towards the south-eastern boundary of the site where chalk has been encountered at shallow depth, strip/trench footings will be feasible. In addition, in the adjacent area where sand/gravel deposits have been encountered, provided these are not loose, strip/trench footings could also be adopted.

5.1.5 Allowable bearing pressures (ABPs) of 175 kN/m^2 are considered to be achievable in the shallow chalk, whilst ABPs of 125 kN/m^2 will apply to the sand/gravel provided medium dense conditions prevail.

5.1.6 Across the majority of the site where the 'soft' superficial deposits occur, a piled foundation solution is considered to be required. Alternatively, consideration could be given to adopting raft foundations. These would allow loads to be distributed over a larger area, thereby limiting total settlements. ABPs of 30 kN/m^2 will apply to rafts founded in the superficial clay soils.

5.1.7 It is envisaged that either driven or bored / Continuous Flight Auger (CFA) piles could be adopted at the site. Driven piles could possibly be utilised as they have the advantage that no arisings are generated, however, the effects of noise / vibrations are likely to be an issue given the proximity of the existing residential development.

5.1.8 The advantage of using bored / CFA piles is the low noise / vibration of the system, however, arisings are generated by bored / CFA piles. Piles would need to be taken through the weak superficial deposits to found within the underlying competent chalk.

5.1.9 It is recommended that the advice of a specialist contractor be sought in order to determine the most appropriate / cost effective system and to advise on pile diameters, depths and safe working capacity. A guide to safe working loads for individual bored / CFA piles of varying diameter is presented in the table below. Pile calculations have been based on assessing skin friction and end bearing resistance in the undisturbed natural strata.

5.1.10 The calculations assume a 12 m long pile penetrating into the competent chalk. A factor of safety of 3.0 has been applied to the calculated ultimate capacities. Greater safe working capacities would be achievable if piles were taken to greater depth thereby benefiting from increased skin friction contribution and possible greater end

bearing resistance. As discussed, these values are for guidance purposes only and should be verified by a specialist contractor. In addition, the safe working loads given are for individual isolated piles. The group effect should be assessed during the design stage.

Table 6: Safe Working Capacities for bored / CFA Piles

Pile Diameter (mm)	Safe Working Capacity (kN)
300	200
450	410
600	685

5.1.11 A preliminary foundation zoning plan, based on the existing information, is included in Appendix 1.

5.1.12 Further investigation will be required to delineate the area of 'soft' clays and confirm the competency of the ground conditions across the remainder of the site.

5.2 EXCAVATIONS AND GROUNDWATER

5.2.1 Based on the ground conditions observed at the site, any shallow excavations have the potential to become unstable in the short term, therefore, if man-entry is required, excavations should be supported by shoring or otherwise battered back to a safe angle in order to protect the workforce from possible collapse.

5.2.2 Groundwater was not encountered during the intrusive investigation. In view of this, it is considered unlikely that groundwater ingress will occur in shallow excavations, however, provision for dewatering during the construction period should still be considered.

5.3 FLOOR SLABS

5.3.1 In view of the presence of cohesive soils at shallow depth across most of the site, it is recommended that suspended floor slabs are adopted for the majority of the proposed development. Where predominantly granular soils are present at shallow depth, consideration could be given to adopting ground bearing floor slabs.

5.4 BURIED CONCRETE

5.4.1 Recommendations given in BRE Special Digest 1:2005 *"Concrete in aggressive ground"* have been followed in order to give recommendations with respect to buried concrete.

5.4.2 Water soluble sulphate analysis was carried out on sixteen soil samples obtained from depths of between 0.1 and 10.5 m bgl with soil pH determination also carried out on these samples. Water soluble sulphate contents ranged between 0.0045 and 0.028 g/l. In accordance with BRE guidelines the characteristic value is calculated by determining the mean of the highest 20 % of results. In this case the characteristic value is 0.02 g/l. On this basis the Design Sulphate Class is DS-1.

5.4.3 The pH values in the soil samples varied between 7.9 and 8.8. The mean of the lowest 20 % of values is 8.0 which represents the characteristic value. Static groundwater conditions have been assumed and on this basis the Aggressive Chemical Environment for Concrete (ACEC) class for the site is AC-1s.

5.5 ROADS AND PAVED AREAS

5.5.1 For preliminary design purposes it is recommended that a California Bearing Ratio (CBR) value of < 2 % is assumed for the shallow clay. Where sand/gravel or chalk is present at shallow depth, provided the formation is proof rolled, a CBR value of 5 % could be assumed.

5.5.2 Once the positions of proposed roads and areas of hardstanding have been finalised, testing could be undertaken to determine an appropriate design CBR value.

5.6 SOAKAWAYS

5.6.1 Four soakage pits were excavated on 26th September 2019 (MSP01 to MSP04). Soakage tests were performed at depths ranging from 1.30 – 2.79 m bgl. MSP01 and MSP03 were tested within the Lewes Nodules Chalk Formation whilst MSP02 and MSP04 were tested within the Head deposits.

5.6.2 Soakage data is included in Appendix 6 and the data sheets show:

i. MSP01 successfully soaked away three times, taking between 27 and 50 minutes to soak;

ii. MSP02 fell by only 0.30 m over 128 minutes;

iii. MSP03 fell by only 0.22 m over 92 minutes; and

iv. MSP04 fell by only 0.49 m over 62 minutes.

5.6.3 The BRE methodology for calculation of soil infiltration rates requires measurement of the volume out flowing from between 75 % and 25 % of the effective depth of the trial pit (height of water in the pit), i.e. three-quarters of the water should soak away. If, due to low levels of infiltration the water level does not fall from between 75 % and 25 % of the total water height, it may be possible to extrapolate the infiltration rate from a curve derived from the plots of actual depth to water against time elapsed.

5.6.4 Data obtained from MSP02, MSP03 and MSP04 was insufficient to allow extrapolation, therefore it is estimated that an infiltration rate in the order of 1.0 $x10^{-7}$ or 1.0 $x10^{-8}$ meters per second would be achieved at these locations. Therefore, it does not appear that the shallow soils at the site are suitable for the use of shallow soakaways.

5.6.5 Data obtained from the successful soakage testing of MSP01 indicated an infiltration rate of 0.134 $x10^{-3}$ to 0.201 $x10^{-3}$ meters per second. This data indicates that the underlying Lewes Nodular Chalk Formation would be suitable for use as a soakage medium, following appropriate consideration of pollution prevention measures due to the site being a source protection zone one and confirmation of the depth of groundwater.

SECTION 6 ENVIRONMENTAL ASSESSMENT

6.1 SOIL QUALITY

6.1.1 A total of 16 soil samples were submitted to the laboratory for chemical analysis, including 10 samples from the topsoil and six samples from the Head deposits. The laboratory chemical analysis certificates are contained in Appendix 4. The results of the analysis are summarised in Table 6.

6.1.2 An initial screening exercise has been undertaken whereby contaminant concentrations recorded in soils have been assessed against *Suitable for Use Levels* (S4ULs) published in 2015 by LQM/CIEH[1]. These precautionary screening levels are designed to be representative of minimal risk to human health in a number of land use scenarios. In this report S4ULs have been selected for a residential land use where the possibility of consumption of homegrown produce exists and assuming a soil organic matter of 1 %. For lead the DEFRA Category 4 Screening Level[2] has been used as this is based on updated toxicological data and a low risk to human health.

6.1.3 An additional set of phytotoxin screening levels have been adopted from 'The Code of Agricultural Practice for the Protection of Soil' Ministry of Agriculture, Fisheries and Food (MAFF), 1993, which are protective of healthy plant growth.

6.1.4 Four samples of topsoil were submitted for testing of herbicide and pesticide concentrations including testing of triazine herbicides, organochloride pesticides (OCP) and organophosphorus pesticides (OPP).

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[1] Nathanail, C. P., McCaffrey, C., Gillett, A. G., Ogden, R. C. and Nathanail, J. F. 2015. *The LQM/CIEH S4ULs for Human Health Risk Assessment*. Land Quality Press, Nottingham. Copyright Land Quality Management Limited reproduced with permission; Publication Number S4UL3100. All rights reserved. Including August 2015 nickel update.

[2] SP1010 *Development of Category 4 Screening Levels Main Report* (Dec 2013) and SP1010 *Policy Companion Document* (Mar 2014).

Table 6: Summary of Soils Chemical Analysis Results

CONTAMINANT	UNITS	MAX	MEAN	No of Tests	SCREENING LEVEL (SL)	No > SL*
HUMAN HEALTH RISK ASSESSMENT						
Asbestos in soil	-	Not detected	Not detected	8	Detected	0
pH	-	8.30	8.09	10	5 – 9	0
Arsenic	$mg.kg^{-1}$	16.00	8.36	10	37	0
Cadmium	$mg.kg^{-1}$	0.70	0.51	10	11	0
Chromium (total)	$mg.kg^{-1}$	31	17.89	10	910	0
Hexavalent Chromium	$mg.kg^{-1}$	4.0	4.00	10	6	0
Lead	$mg.kg^{-1}$	61	29.20	10	200	0
Mercury	$mg.kg^{-1}$	0.30	0.30	10	40	0
Nickel	$mg.kg^{-1}$	21	14.83	10	130	0
Selenium	$mg.kg^{-1}$	1.4	1.04	10	250	0
TPH Aliphatic >EC_5 - EC_6	$mg.kg^{-1}$	0.001	0.001	10	42	0
TPH Aliphatic >EC_6 - EC_8	$mg.kg^{-1}$	0.001	0.001	10	100	0
TPH Aliphatic >EC_8 - EC_{10}	$mg.kg^{-1}$	0.001	0.001	10	27	0
TPH Aliphatic >EC_{10} - EC_{12}	$mg.kg^{-1}$	1.00	1.00	10	130	0
TPH Aliphatic >EC_{12} - EC_{16}	$mg.kg^{-1}$	2.00	2.00	10	1100	0
TPH Aliphatic >EC_{16} - EC_{21}	$mg.kg^{-1}$	8.00	8.00	10	65000	0
TPH Aliphatic >EC_{21} - EC_{35}	$mg.kg^{-1}$	8.00	8.00	10	65000	0
TPH Aromatic >EC_5 - EC_7	$mg.kg^{-1}$	0.001	0.00	10	70	0
TPH Aromatic >EC_7 - EC_8	$mg.kg^{-1}$	0.001	0.00	10	130	0
TPH Aromatic >EC_8 - EC_{10}	$mg.kg^{-1}$	0.001	0.00	10	34	0
TPH Aromatic >EC_{10} - EC_{12}	$mg.kg^{-1}$	1.00	1.00	10	74	0
TPH Aromatic >EC_{12} - EC_{16}	$mg.kg^{-1}$	2.00	2.00	10	140	0
TPH Aromatic >EC_{16} - EC_{21}	$mg.kg^{-1}$	10.00	10.00	10	260	0
TPH Aromatic >EC_{21} - EC_{35}	$mg.kg^{-1}$	10.00	10.00	10	1100	0
Benzene	$mg.kg^{-1}$	0.001	0.001	10	0.087	0
Toluene	$mg.kg^{-1}$	0.001	0.001	10	130	0
Ethylbenzene	$mg.kg^{-1}$	0.001	0.001	10	47	0
Xylene	$mg.kg^{-1}$	0.002	0.002	10	56	0
Acenaphthene	$mg.kg^{-1}$	0.05	0.05	10	210	0
Acenaphthylene	$mg.kg^{-1}$	0.05	0.05	10	170	0
Anthracene	$mg.kg^{-1}$	0.05	0.05	10	2400	0
Benz(a)anthracene	$mg.kg^{-1}$	0.25	0.09	10	7.2	0
Benzo(a)pyrene	$mg.kg^{-1}$	0.24	0.07	10	2.2	0
Benzo(b)fluoranthene	$mg.kg^{-1}$	0.34	0.08	10	2.6	0
Benzo(ghi)perylene	$mg.kg^{-1}$	0.05	0.05	10	320	0
Benzo(k)fluoranthene	$mg.kg^{-1}$	0.16	0.06	10	77	0
Chrysene	$mg.kg^{-1}$	0.33	0.09	10	15	0
Dibenz(ah)anthracene	$mg.kg^{-1}$	0.05	0.05	10	0.24	0
Fluoranthene	$mg.kg^{-1}$	0.56	0.18	10	280	0

CONTAMINANT	UNITS	MAX	MEAN	No of Tests	SCREENING LEVEL (SL)	No > SL*
HUMAN HEALTH RISK ASSESSMENT						
Fluorene	$mg.kg^{-1}$	0.05	0.05	10	170	0
Indeno(123-cd)pyrene	$mg.kg^{-1}$	0.05	0.05	10	27	0
Naphthalene	$mg.kg^{-1}$	0.05	0.05	10	2.3	0
Phenanthrene	$mg.kg^{-1}$	0.2	0.07	10	95	0
Pyrene	$mg.kg^{-1}$	0.5	0.16	10	620	0
Phenol	$mg.kg^{-1}$	1.00	1.00	10	120	0
PHYTOTOXICITY RISK ASSESSMENT						
	Units	**Max**	**Mean**	**No of Test**	**Screening Level (SL)**	**No > SL**
Copper	$mg.kg^{-1}$	98	21.69	10	200	0
Nickel	$mg.kg^{-1}$	21	14.83	10	110	0
Zinc	$mg.kg^{-1}$	86	52.60	10	300	0

Notes: * Number of samples exceeding screening level nd = not detected

6.1.5 In summary, no zootoxic, phytotoxic, organic or inorganic contaminants were found in excess of screening levels, and, no herbicide or pesticide contaminants were found above the detection limit of testing.

6.1.6 Hydrocarbon testing on the closest exploratory hole (MTP05) to the Lydden Garage showed no hydrocarbon contamination above the detection limit of testing.

6.2 GROUNDWATER

6.2.1 No groundwater was encountered during the site investigation to depths of 15 m bgl (MBH01 and MBH02) or during the subsequent monitoring rounds.

6.3 HAZARDOUS GAS

6.3.1 Gas monitoring has been undertaken on three occasions – 3rd, 10th and 14th October 2019. Levels of methane, carbon dioxide and oxygen were recorded in each standpipe, together with associated parameters including borehole flow and ambient air pressure. The results of these gas monitoring rounds are contained in Appendix 7.

6.3.2 The monitoring rounds were undertaken at low to moderate barometric pressures ranging from 1002 to 1013 mb. Positive flow was not recorded. Over the three monitoring rounds no methane (CH_4) was detected, carbon dioxide (CO_2) was detected to a maximum of 1.6 % v/v with a corresponding depleted oxygen concentration of 18.9 % v/v.

6.4 WASTE CLASSIFICATION, OFF-SITE DISPOSAL OR RE-USE

6.4.1 Waste Considerations

6.4.2 The redevelopment of the site is expected to comprise the construction of several buildings with some private gardens and communal soft landscaping. Arisings from

the construction of the foundations and service trenches are considered for their waste classifications.

6.4.3 Made ground was not encountered during the ground investigation and only natural soils were recorded. No visible asbestos was noted during the ground investigation or encountered during testing of soils.

6.4.4 Chemical testing of the natural soils showed them to be uncontaminated.

6.4.4.1 Natural as-dug arisings (excluding topsoil) could be classed as inert waste without the requirement for WAC testing.

6.4.4.2 On this site it is the case the there is a considerable topsoil resource. The topsoil resource should be fully characterised and then stored and handled appropriately to ensure that its resource status is maintained. Topsoil testing should be undertaken to confirm compliance with the BS3882:2015 specification for topsoil allowing reuse of topsoil onsite.

6.4.4.3 Materials, including waste soils which are not to be retained on site, should be removed and disposed of in accordance with all relevant statues including the *Environmental Protection Act 1990* as amended, *The Controlled Waste Regulations 2012* as amended, *The Waste Regulations 2011* as amended, *The Hazardous Waste Regulations 2005* as amended, *The Waste Management Regulations 2006*, *The Environmental Permitting Regulations 2010* as amended and *The Hazardous Waste (Miscellaneous Amendments) Regulations 2015*.

6.4.4.4 It is a requirement of these regulations that waste sent to landfill should have been subject to measures to reduce the amount of waste, reduce harmful or hazardous properties and facilitate recycling. These requirements may be satisfied by measures such as segregation and screening of wastes to recover suitable fill and material for crushing, segregation of inert materials and putrescible wastes.

6.4.5 Re-use Considerations

6.4.5.1 As a sustainable alternative to off-site disposal, it may be possible to re-use site-won soils provided the following criteria are met:

i. Use of the material will not create an unacceptable risk of pollution to the environment or harm to human health;

ii. The material must be chemically and geotechnically suitable without further treatment;

iii. There must be certainty of use within the scheme;

iv. Material should only be used in the quantity necessary for that use.

6.4.5.2 Provided these criteria are met, the re-use of site-won materials is unlikely to be deemed a waste activity. Production of a *Materials Management Plan* under the

industry *CL:AIRE Code of Practice on the Definition of Waste* represents a robust method of demonstrating that the proposed re-use of material meets the criteria and is not liable for landfill tax.

SECTION 7 RISK ASSESSMENT

7.1 The potential sources of contamination at the site and the implications with respect to development have been interpreted in accordance with the current government guidance on source-pathway-receptor risk assessment.

7.2 The investigations demonstrate that the former and surrounding uses of the site have resulted in no notable contamination issues for the site. No visual, olfactory or chemical contamination issues were encountered during the site investigation.

7.3 The potential impacts of contamination sources have been considered with respect to the following receptors:

i. The general public and present site users,

ii. Residents of future development,

iii. Groundwater,

iv. Surface water,

v. Construction workers,

vi. Adjacent land, and

vii. Infrastructure.

7.4 In each case the existence of a pollutant linkage requires a pathway by which the receptor could be exposed to the source. A qualitative assessment of risk is thus considered in the first instance with respect to the site in its current condition and is summarised in the sections below.

7.5 The general public and present site users

7.5.1 Currently the public do not have access to site, and should they enter site, the interactions with soil will be limited.

7.5.2 The site is in use by the landowners who use the site to graze cattle, however no contamination issues are present and therefore the risk to current site users is low.

7.6 Residents of future development

7.6.1 Soil contamination (chemical)

7.6.1.1 No contamination issues were detected during the site investigation. The risk to future residents with private gardens and homegrown produce is considered to be low.

7.6.2 Asbestos

7.6.2.1 No visible asbestos fragments were encountered, and no asbestos was detected by chemical testing of the soils. Therefore, the risk to future residents from asbestos is considered to be low.

7.6.3 Hazardous Soil Gas/Vapours (including hydrocarbon vapours/radon)

7.6.3.1 No source of hazardous soil gas or vapours was identified during the investigation however chalk has a very limited potential to produce elevated levels of carbon dioxide.

7.6.3.2 Following three rounds of gas monitoring, no elevated carbon dioxide levels were encountered.

7.6.3.3 The NHBC traffic light system and BS8485 Wilson and Card characterisation have been followed to assess the recorded soil gas and flow conditions. Calculations are presented in Appendix 8 which suggest that the site is a Green site / Characteristic Situation 1, meaning no gas protection measures are necessary.

7.6.3.4 The site is within a Radon Affected Area (5 – 10 % of house are above the action level). Guidance issued by the Buildings Research Establishment (BRE-211) indicates that basic radon protective measures are necessary.

7.7 Controlled waters

7.7.1 No groundwater was encountered during the investigation and no continuing source of contamination was identified on site.

7.7.2 The underlying Head deposits are a Secondary A Aquifer and the Lewes Nodular Chalk Formation is a Principal Aquifer. The risk to controlled waters is considered low.

7.7.3 The underlying Lewes Nodule Chalk Formation has the potential for use as a soakaway. Following pollution control measures of onsite drainage, the risk to controlled waters will remain low.

7.8 Construction workers

7.8.1 Potentially, construction workers are initially at the greatest risk from exposure to hazardous contamination due to excavation works and during the handling of materials including imported soils. Providing that dust levels are kept within statutory limits and appropriate health and safety procedures are adhered to during the construction phase, the levels of chemical contamination recorded to date are not considered to present an acute risk to human health.

7.9 Adjacent land

7.9.1 As no contamination issues were encountered on site the risk to adjacent land is considered to be low.

7.9.2 Whilst Lydden Garage is adjacent to the south west corner of site, no visual or olfactory contamination issues were detected, no shallow groundwater is present onsite (thereby allowing attenuation in the unsaturated zone and removing the potential for horizontal migration) and no chemical contamination issues were present onsite. Therefore, the risk to the site from adjacent land is considered to be low.

7.10 Infrastructure

7.10.1 No phytotoxic, herbicide or pesticide chemicals were encountered above the screening level onsite. Therefore, the risk to plant growth is considered to be low.

7.10.2 Contamination with the potential to permeate polymeric services has not been identified by this investigation, however it is recommended that the utility provider is consulted with respect to their requirements for water supply pipes. Utility companies apply strict guideline levels on use of polymeric pipes and may consider all made ground unsuitable for typical plastic pipe materials to be used, however no made ground was encountered during the site investigation. The risk to polymeric services is considered to be low.

SECTION 8 UPDATED CONCEPTUAL MODEL

8.1 Following completion of phases 1 and 2 of the investigation and a qualitative risk assessment, the conceptual model for the site, with relation to pollutant linkages, has been updated. The revised model is presented in Table 9 below.

Table 9: Revised Conceptual Model

POSSIBLE POLLUTANT LINKAGE			RISK CHARACTERISATION
POTENTIAL SOURCES	**PATHWAYS**	**RECEPTORS**	
Heavy metals and hydrocarbons (made ground)	Contact with contaminated soil	Human health (current users)	**Low risk identified** No made ground or natural contamination identified.
	Ingestion and inhalation of contaminated soil and dust	Human health (current users)	
Heavy metals and hydrocarbons (made ground)	Contact with contaminated soil	Human health (construction workers)	**Low risk identified** No made ground or natural contamination identified.
	Ingestion and inhalation of contaminated soil and dust	Human health (construction workers)	
Heavy metals and hydrocarbons (made ground)	Contact with contaminated soil	Human health (future residents)	**Low risk identified** No made ground or natural contamination identified.
	Ingestion and inhalation of contaminated soil and dust	Human health (future residents)	
Asbestos (made ground)	Ingestion and inhalation of contaminated soil and dust	Human health (future residents and construction workers)	**Low risk identified** No made ground or asbestos contamination detected.

POSSIBLE POLLUTANT LINKAGE			RISK CHARACTERISATION
POTENTIAL SOURCES	PATHWAYS	RECEPTORS	
Contamination (all forms)	Vertical migration to aquifer	Controlled waters	**Low risk identified** No contamination encountered onsite, head deposits have a very low infiltration rate.
Contamination (all forms)	Horizontal migration to surface water	Controlled waters	**Low risk identified** No contamination encountered onsite therefore negligible risk of surrounding surface waters being contaminated.
Hydrocarbons	Direct contact	Plastic water pipes	**Low risk identified** No hydrocarbon contamination encountered.
Hazardous Gas/Vapours In soil	Ingress into buildings and voids	Human health (future residents and construction workers)	**Low risk identified** NHBC Guidance classifies the site as Green and BS8485 Wilson and Card guidance classifies the site as Characteristic Situation 1. Basic radon protection measures are necessary.

SECTION 9 PRELIMINARY REMEDIATION STRATEGY

9.1 The identified risks at the site can be mitigated by removal of either the source, pathway or receptor. With reference to the conceptual model for the site a remediation strategy, based on source or pathway removal suggests that no remediation is required as no contamination has been encountered.

9.2 The proposed development is expected to include residential properties with private gardens and public open space.

9.3 The encountered ground conditions comprised of superficial Head deposits of very soft to soft dark brown slightly gravelly sandy clay with gravels of fine to medium sub-angular to sub-rounded flints and occasional fine to medium sub-angular chalks. Underlying this were Head deposits of pale grey slightly clayey gravelly fine to coarse sand with gravels of fine to medium subangular chalk and occasion fine angular to sub-rounded flints.

9.4 The underlying bedrock comprised Lewes Nodular Chalk Formation, a moderate strength creamy white fine-grained gravelly chalk. The gravels were fine to cobble sub-angular to sub-rounded flints.

9.5 Waste soils are likely to be classified as non-hazardous inert for waste disposal.

9.6 There is a significant volume of topsoil at the site. This topsoil is considered suitable for re-use from a contaminant perspective. The texture and nutrient status of this material should be confirmed with the project landscape architect should it be intended for re-use in garden and soft landscaped areas. Testing the topsoil for compliance with BS 3882:2015 specification could allow topsoil to be reused on site. If it is intended to re-use topsoil, then it is recommended that the resource status of this material is clearly defined to ensure compliance with waste legislation. A

Materials Management Plan under the CL:AIRE Code of Practice is a robust way of managing and documenting re-use of resource soils.

9.7 The Gas Risk Assessment carried out in accordance with NHBC guidance and BS8485 Wilson and Card guidance classifies the site as Green and Characteristic Situation 1 respectively. However the site lies in a radon affected area (5 – 10 % of home are above the action level) and basic radon protection measures are required. Refer to BRE publication BR211 (2015) for guidance on basic radon protection measures appropriate for different construction types.

9.8 Material imported for the formation of domestic gardens and landscaped areas should be obtained from a validated source. The validation should incorporate an assessment of the provenance of the material and chemical analysis.

9.9 The adoption of appropriate Health and Safety procedures will ensure that risks to operatives from unexpected hazardous materials at the site are minimised. Operatives should not be allowed to eat, drink or smoke on site except in designated areas and should be required to wash all exposed skin at the end of each shift. Operatives should be required to report any observations of suspect material.

9.10 Materials, including waste soils which are not to be retained on site, should be removed and disposed of in accordance with all relevant statues including the *Environmental Protection Act 1990* as amended, *The Controlled Waste Regulations 2012* as amended, *The Waste Regulations 2011* as amended, *The Hazardous Waste Regulations 2005* as amended, *The Waste Management Regulations 2006, The Environmental Permitting Regulations 2010* as amended and *The Hazardous Waste (Miscellaneous Amendments) Regulations 2015*.

9.11 It is recommended that this report is submitted to the regulators (Local Authority EHO and Planners, Environment Agency Planning Liaison and NHBC) for approval prior to commencement of the works.

9.12 Any observations of ground conditions atypical of those already described should be reported to IDOM immediately so that an assessment of appropriate action can be made.

SECTION 10 CONCLUSIONS

10.1 A Phase 2 Geo-environmental Assessment has been undertaken for the land east of Church Lane, Lydden.

10.2 The site was covered in topsoil overlying Head deposits of very soft to soft brown slightly gravelly sandy clay with flint gravels, followed by pale grey slightly clayey gravelly sand with flint and chalk gravels underlain by a bedrock of Lewes Nodular Chalk Formation.

10.3 In some areas of the site the Head deposit thickness was as much as 3.60 m whilst to the east of site at a topographical high, the Head deposit was only 0.40 m thick.

10.4 Soakage testing indicated that the Head deposits were not suitable for infiltration purposes, whilst the underlying Lewes Nodular Chalk Formation is considered suitable for use as a soakage medium.

10.5 The site lies within the Kent Coal Field with the historical Stonehall Colliery site 550 m north east. Information from the British Geological Survey suggests the coal measures are present at in excess of 150 m depth. Online research also suggests that the shafts at the Stonehall Colliery did not advance to a sufficient depth to intercept the coal measures and the workings were abandoned. As such it is considered very unlikely that coal mining legacy will pose a constraint to development on the subject site. However, for completeness, it is possible that the Local Authority may require a Coal Mining Report to be obtained from the Coal Authority prior to development taking place.

10.6 No visual, olfactory or chemical contamination was encountered during the site investigation. Basic Radon Protection measures will be required and therefore BRE211 (2015) should be consulted. No other remediation measures are recommended.

10.7 Traditional strip/trench footings are considered feasible towards the south-eastern boundary where chalk has been encountered at shallow depth, whilst predominantly granular superficial deposits, provided that medium dense conditions prevail, are also likely to facilitate the use of shallow footings. ABPs of 175 kN/m^2 are considered to be achievable in the shallow chalk, whilst ABPs of 125 kN/m^2 will apply to the sand/gravel.

10.8 In terms of pavement design, CBR values of < 2 % should be assumed for the soft superficial clays, whilst a CBR value of 5 % could be assumed for sand/gravel or chalk.

10.9 Buried concrete classes DS-1 and AC-1s will apply to new foundation concrete.

APPENDIX 1 ▪ Drawings

Legend

- Site boundary
- MBHref — Merebrook borehole with location reference
- MTPref — Merebrook trial pit with location reference
- MSPref — Merebrook soakage test with location reference

First Issue	18-10-2019		-
	SNC	DCE	DCE
Issue Details	Dwn	Chd	App'd

Client/Project

Quinn Estates Ltd
Churhc Lane,
Lyddon

Dwg Title

Undertaken Site Investigation Locations

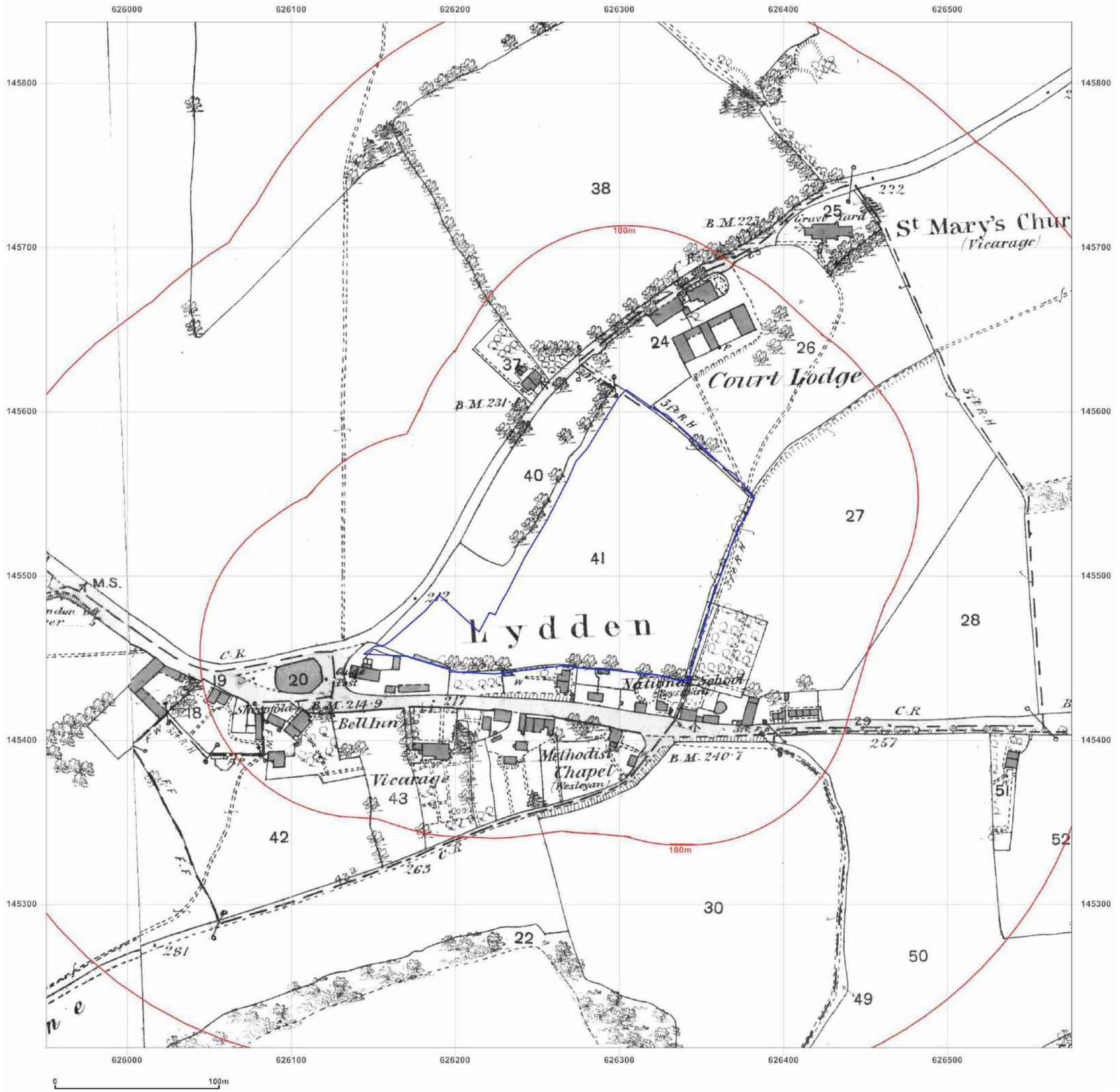
Job No.	Dwg No.	Revision
21929a	304-001	-
Scale: N.T.S	Date: October 2019	Frame Dimensions mm: (A3) 400 x 280
Drawn: SNC	Checked: DCE	Approved: DCE

London
Kent
Derbyshire
Cardiff
Manchester
Stirling
Birmingham

IDOM

Cromford Mills, Mill Lane, Matlock, Derbyshire DE4 3RQ
t: +44(0)1773 829 988 f: +44(0)1773 829 393 e: info.derbyshire@idom.com

APPENDIX 2 ▪ Historical Plans



Groundsure INSIGHTS

Site Details:

CHURCH LANE, LYDDEN

Client Ref: 19-S364-FDO-Lydden
Report Ref: HMD-154-5905365
Grid Ref: 626263, 145525

Map Name: County Series
Map date: 1872
Scale: 1:2,500
Printed at: 1:2,500

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Levelled N/A

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Production date: 27 March 2019

Map legend available at:
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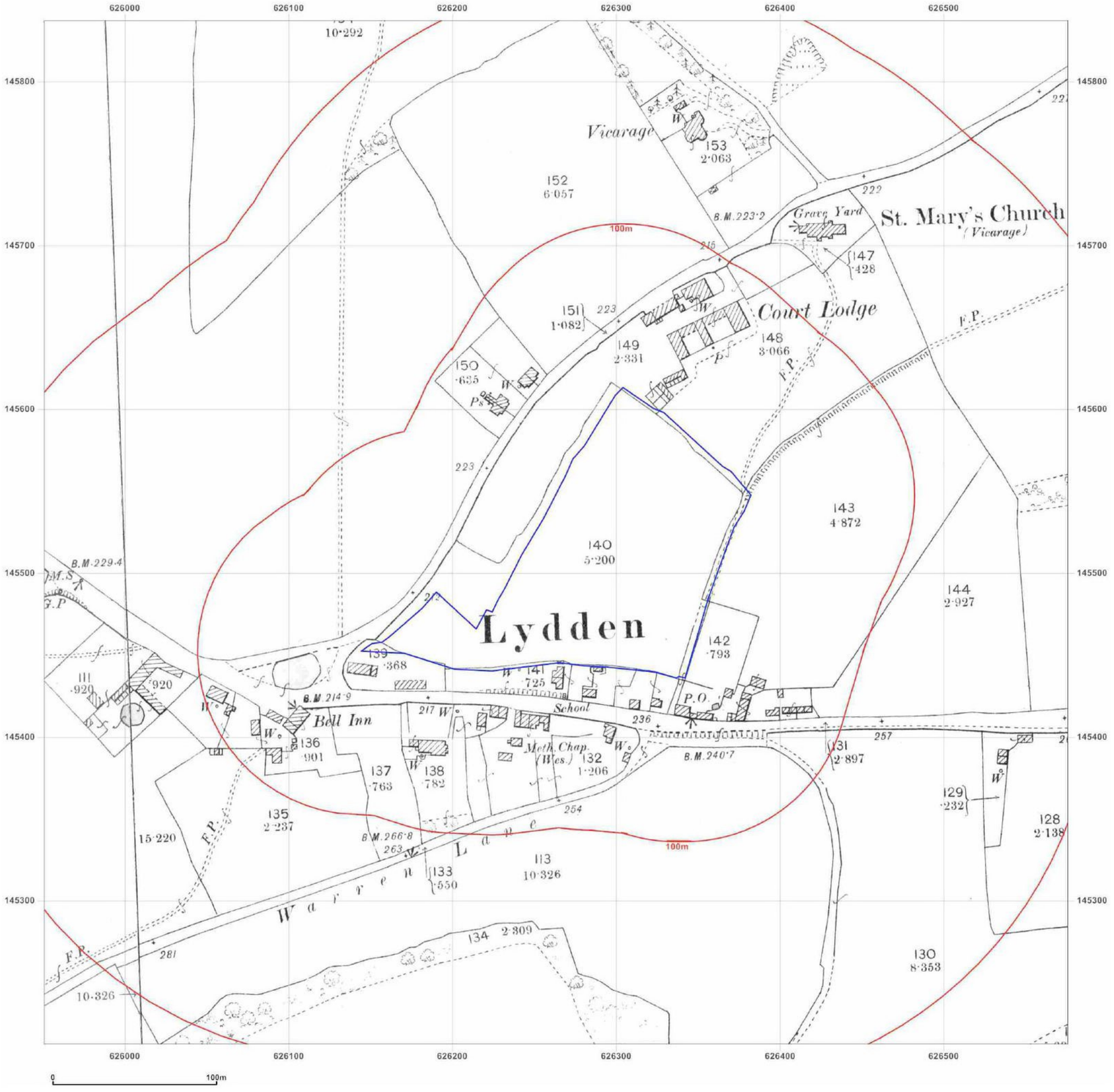

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Client Ref: 19-S364-FDO-Lydden
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Grid Ref: 626263, 145525

Map Name: County Series

Map date: **1898**

Scale: 1:2,500

Printed at: 1:2,500

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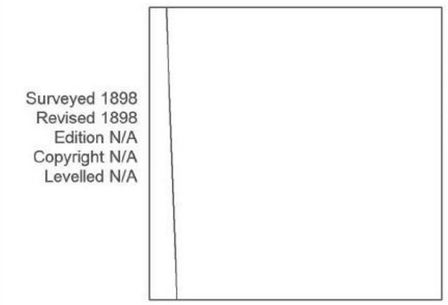

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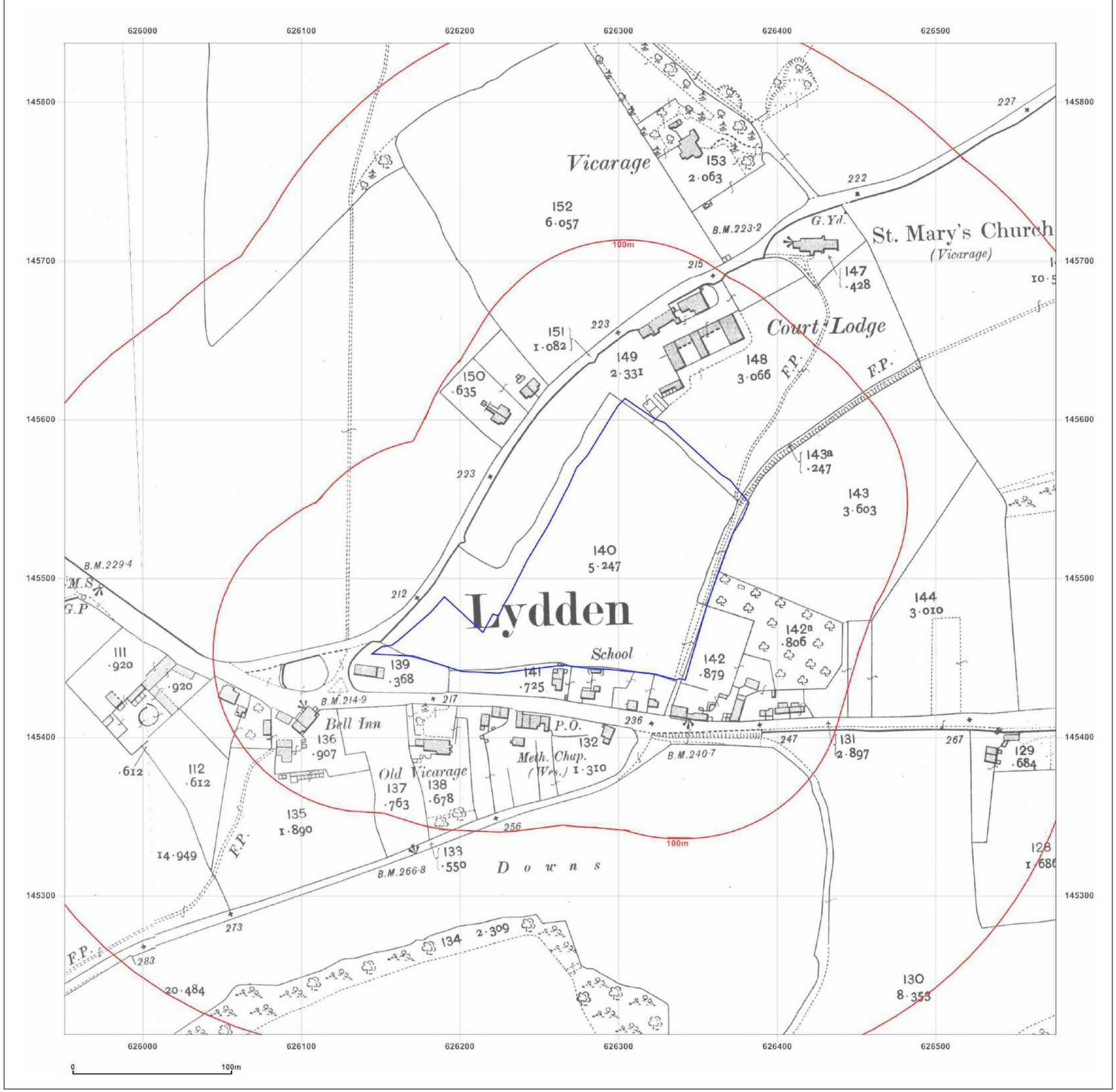

Groundsure INSIGHTS

Site Details:

CHURCH LANE, LYDDEN

Client Ref: 19-S364-FDO-Lydden
Report Ref: HMD-154-5905365
Grid Ref: 626263, 145525

Map Name: County Series
Map date: **1907**
Scale: 1:2,500
Printed at: 1:2,500

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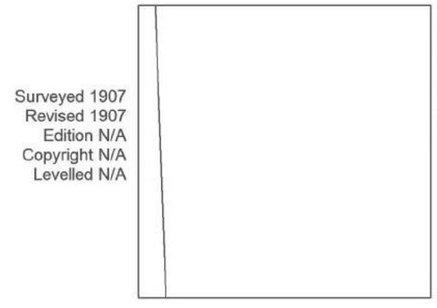

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Production date: 27 March 2019

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Groundsure INSIGHTS

Site Details:

CHURCH LANE, LYDDEN

Client Ref: 19-S364-FDO-Lydden
Report Ref: HMD-154-5905365
Grid Ref: 626263, 145525

Map Name: County Series

Map date: **1937-1939**

Scale: 1:2,500

Printed at: 1:2,500

N
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Surveyed 1939
Revised 1939
Edition N/A
Copyright N/A
Levelled N/A

Surveyed 1937
Revised 1937
Edition N/A
Copyright N/A
Levelled N/A

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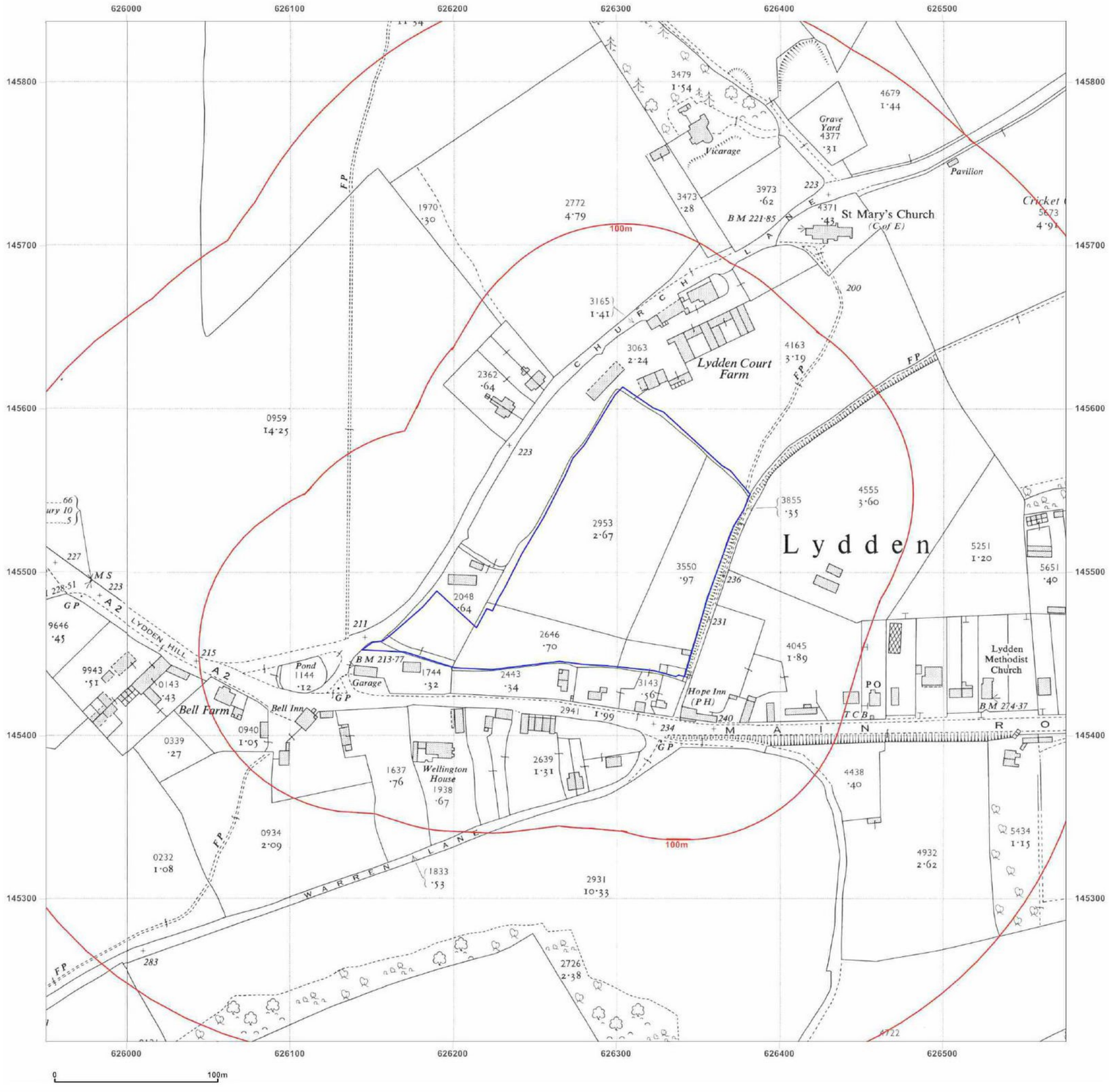

Groundsure INSIGHTS

Site Details:

CHURCH LANE, LYDDEN

Client Ref: 19-S364-FDO-Lydden
Report Ref: HMD-154-5905365
Grid Ref: 626263, 145525

Map Name: National Grid

Map date: **1956-1957**

Scale: 1:2,500

Printed at: 1:2,500

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Surveyed 1957	Surveyed 1956
Revised 1957	Revised 1956
Edition N/A	Edition N/A
Copyright N/A	Copyright N/A
Levelled 1951	Levelled 1951

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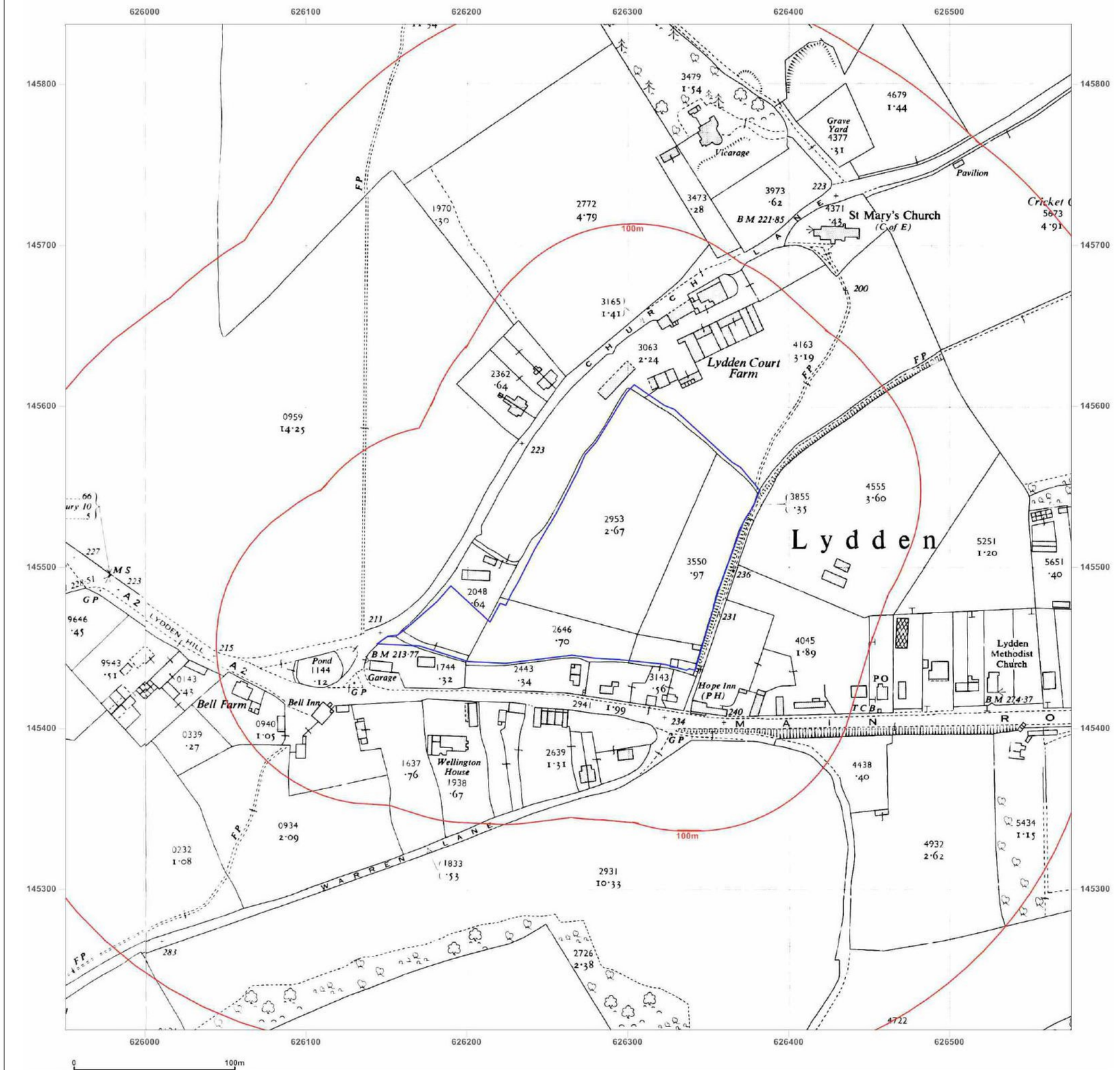

Groundsure INSIGHTS

Site Details:

CHURCH LANE, LYDDEN

Client Ref: 19-S364-FDO-Lydden
Report Ref: HMD-154-5905365
Grid Ref: 626263, 145525

Map Name: National Grid

Map date: **1957-1958**

Scale: 1:2,500

Printed at: 1:2,500

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

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

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Groundsure INSIGHTS

Site Details:

CHURCH LANE, LYDDEN

Client Ref: 19-S364-FDO-Lydden
Report Ref: HMD-154-5905365
Grid Ref: 626263, 145525

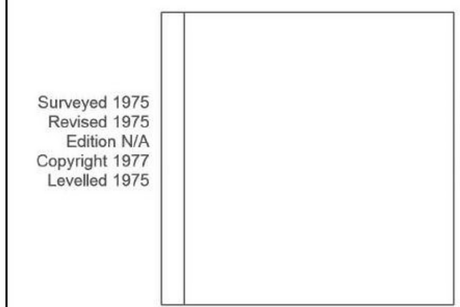
Map Name: National Grid

Map date: **1974-1975**

Scale: 1:2,500

Printed at: 1:2,500

N W E S



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Production date: 27 March 2019

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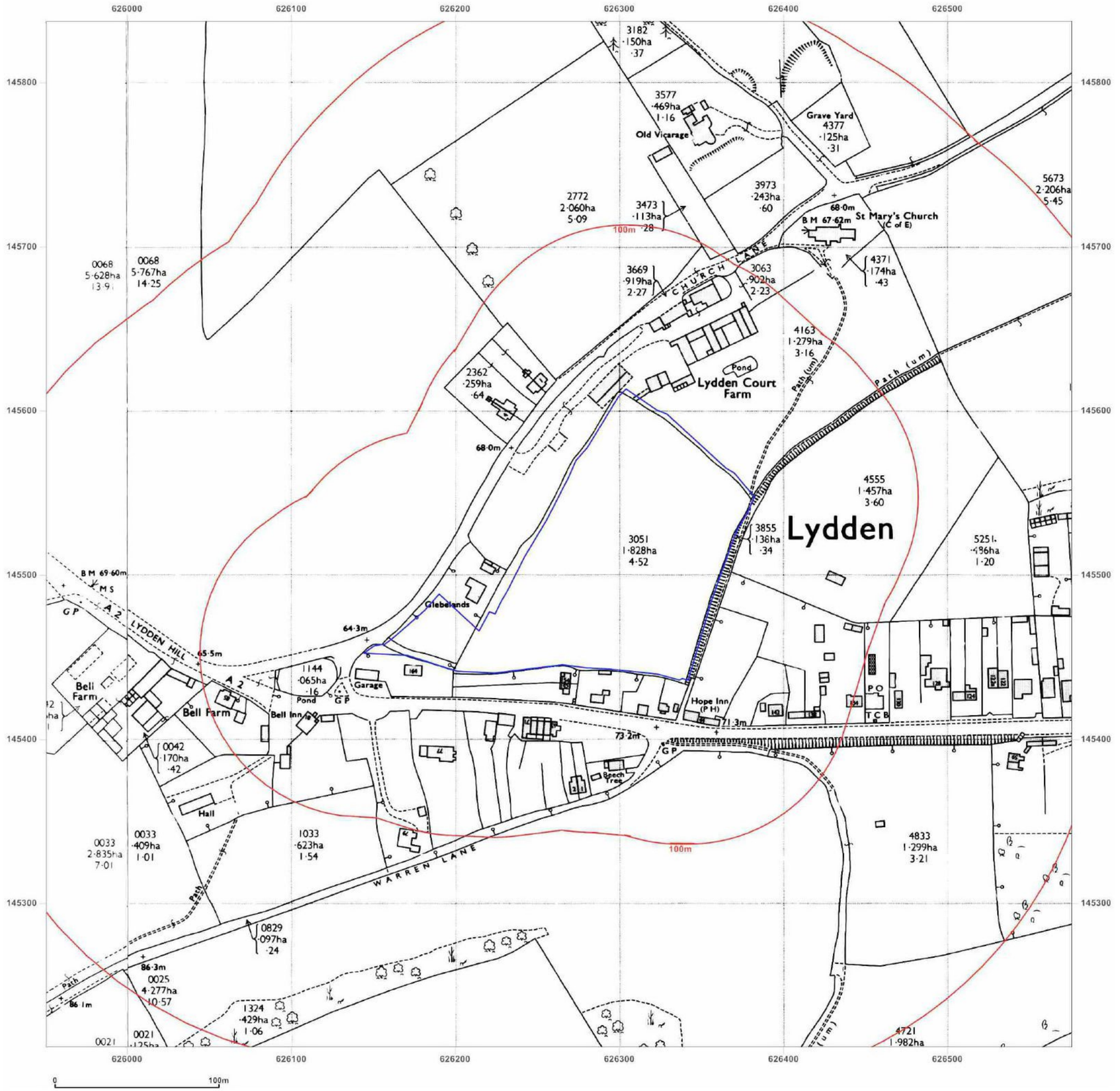

Groundsure INSIGHTS

Site Details:

CHURCH LANE, LYDDEN

Client Ref: 19-S364-FDO-Lydden
Report Ref: HMD-154-5905365
Grid Ref: 626263, 145525

Map Name: National Grid

Map date: **1975-1977**

Scale: 1:2,500

Printed at: 1:2,500

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

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

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Groundsure INSIGHTS

Site Details:

CHURCH LANE, LYDDEN

Client Ref: 19-S364-FDO-Lydden
Report Ref: HMD-154-5905365
Grid Ref: 626263, 145525

Map Name: National Grid

Map date: **1992**

Scale: 1:2,500

Printed at: 1:2,500

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

Surveyed N/A
Revised N/A
Edition N/A
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Groundsure INSIGHTS

Site Details:

CHURCH LANE, LYDDEN

Client Ref: 19-S364-FDO-Lydden
Report Ref: HMD-154-5905365
Grid Ref: 626263, 145525

Map Name: National Grid

Map date: **1992-1994**

Scale: 1:2,500

Printed at: 1:2,500

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

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

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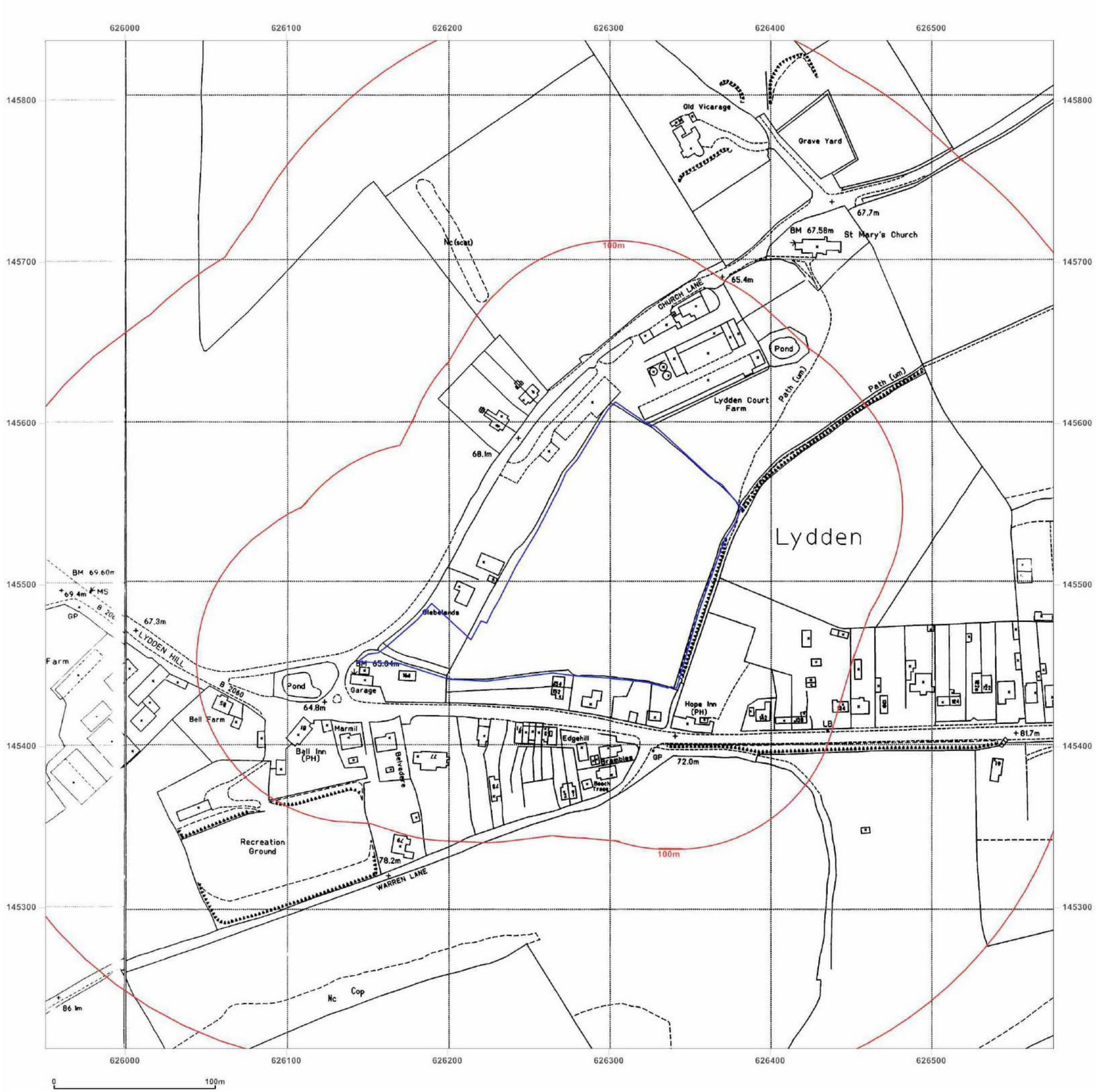

Groundsure INSIGHTS

Site Details:

CHURCH LANE, LYDDEN

Client Ref: 19-S364-FDO-Lydden
Report Ref: HMD-154-5905365
Grid Ref: 626263, 145525

Map Name: National Grid

Map date: **1994**

Scale: 1:2,500

Printed at: 1:2,500

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

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

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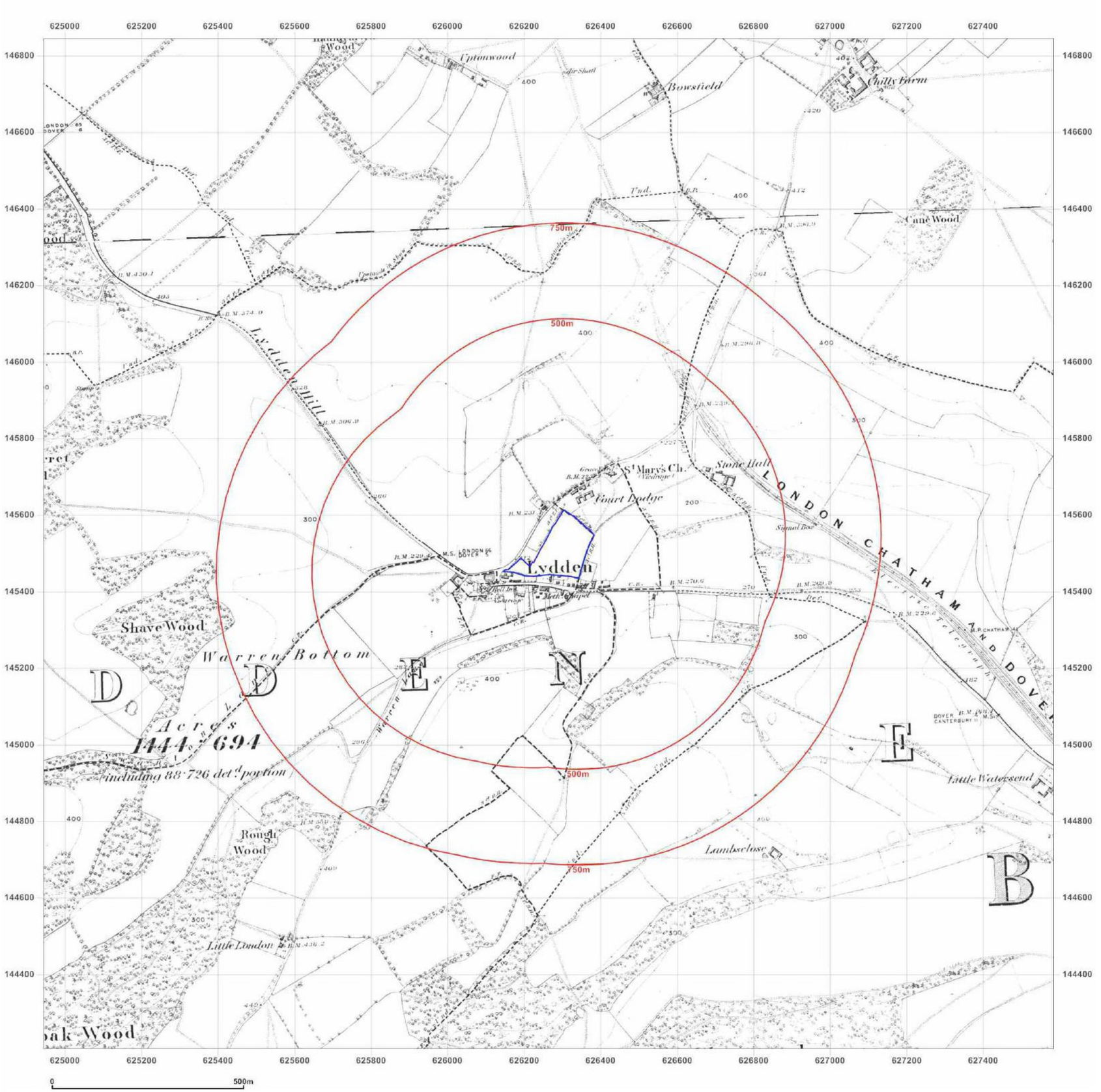

Groundsure INSIGHTS

Site Details:

CHURCH LANE, LYDDEN

Client Ref: 19-S364-FDO-Lydden
Report Ref: HMD-154-5905365
Grid Ref: 626263, 145525

Map Name: County Series

Map date: **1872-1873**

Scale: 1:10,560

Printed at: 1:10,560

N
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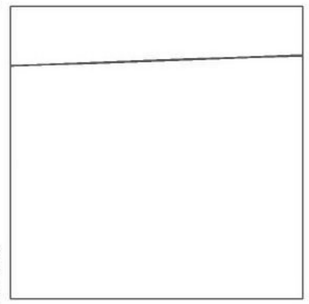
Surveyed 1872
Revised 1872
Edition N/A
Copyright N/A
Levelled N/A



Surveyed 1873
Revised 1873
Edition N/A
Copyright N/A
Levelled N/A

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Production date: 27 March 2019

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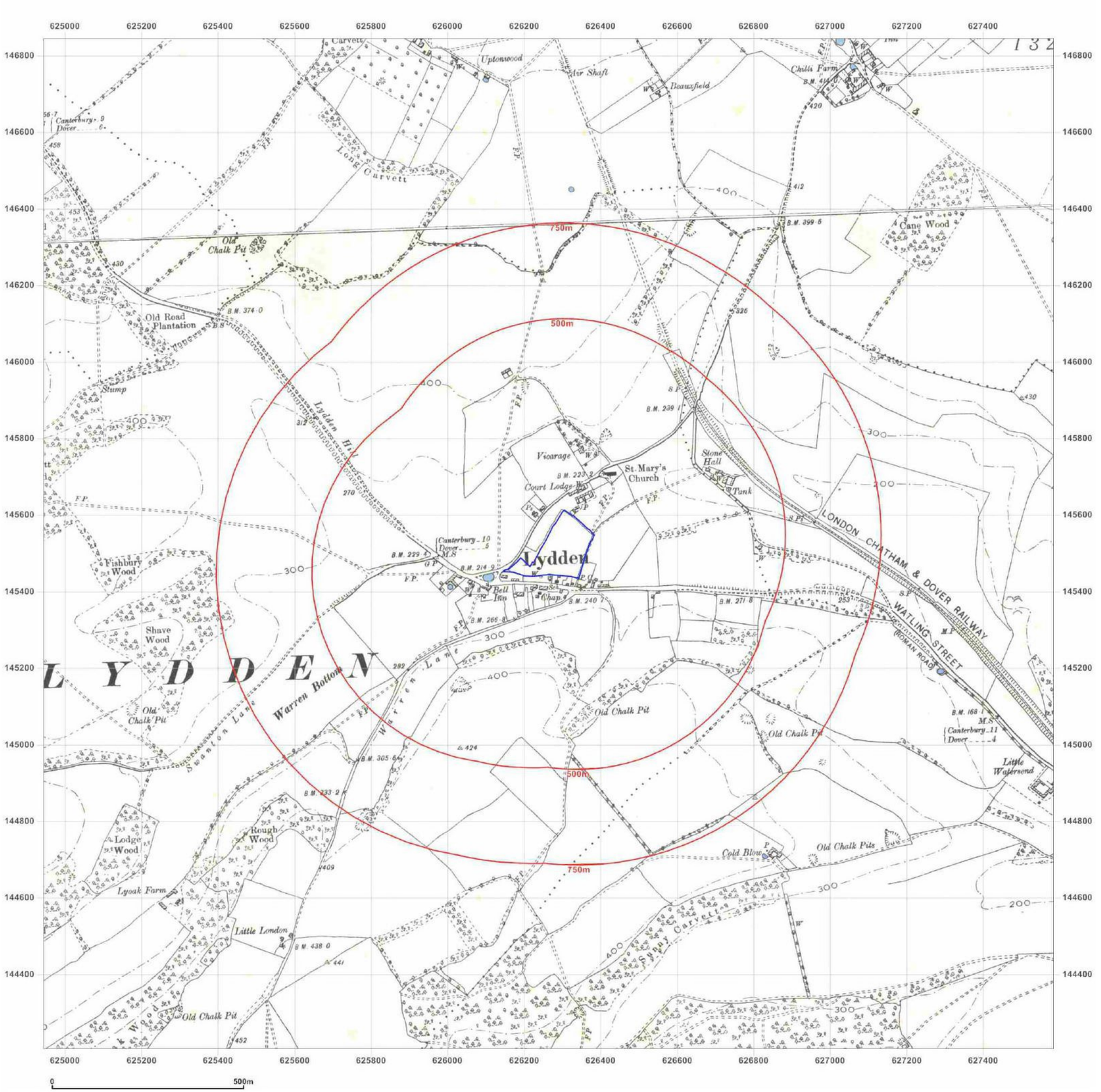

Groundsure INSIGHTS

Site Details:

CHURCH LANE, LYDDEN

Client Ref: 19-S364-FDO-Lydden
Report Ref: HMD-154-5905365
Grid Ref: 626263, 145525

Map Name: County Series

Map date: **1896**

Scale: 1:10,560

Printed at: 1:10,560

N
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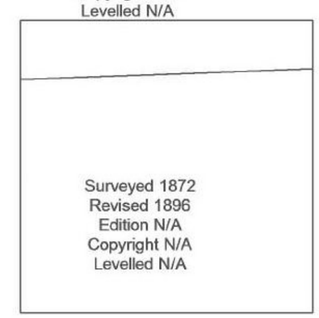
Surveyed 1872
Revised 1896
Edition N/A
Copyright N/A
Levelled N/A



Surveyed 1872
Revised 1896
Edition N/A
Copyright N/A
Levelled N/A

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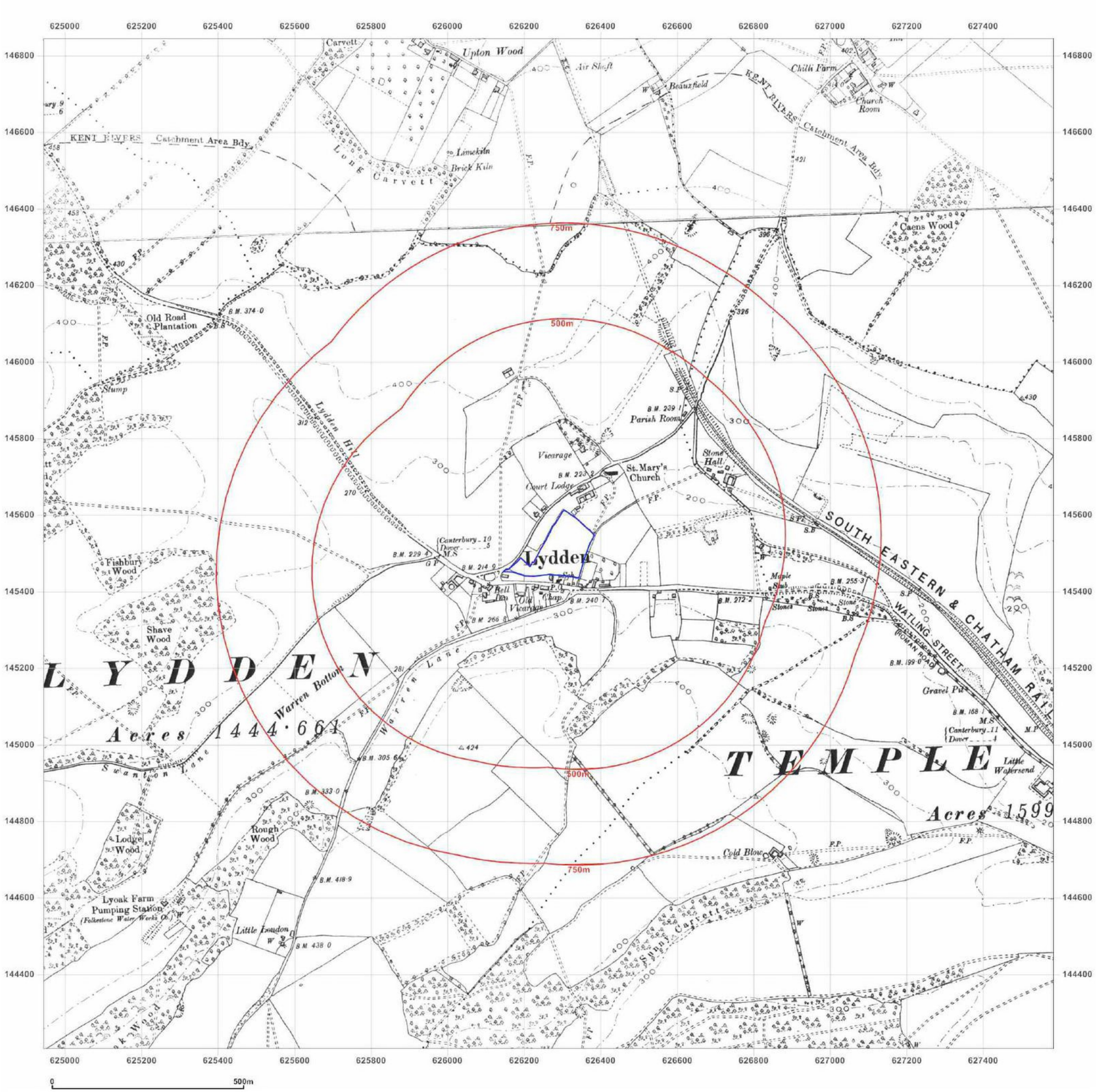

Groundsure INSIGHTS

Site Details:

CHURCH LANE, LYDDEN

Client Ref: 19-S364-FDO-Lydden
Report Ref: HMD-154-5905365
Grid Ref: 626263, 145525

Map Name: County Series

Map date: **1906**

Scale: 1:10,560

Printed at: 1:10,560

N
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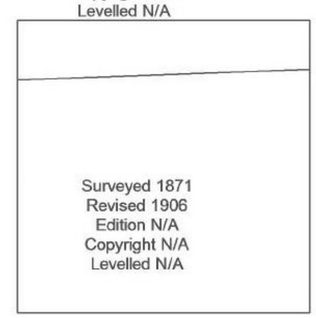
Surveyed 1872
Revised 1906
Edition N/A
Copyright N/A
Levelled N/A



Surveyed 1871
Revised 1906
Edition N/A
Copyright N/A
Levelled N/A

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