Nordens Barn Farm

Geophysical Survey Report

One Planet Developments

April 2023

Ecus Ltd

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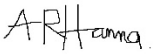

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1. Summary

Ecus Ltd carried out a geophysical survey for One Planet Developments in April 2023 at Nordens Barn Farm, Selby, North Yorkshire. A single agricultural field covering c.24ha was surveyed.

The survey produced good data and confirmed the presence of a trackway identified on historic mapping, labelled 'Markam Line'. An area of possible archaeology was identified. This corresponds to historic map data indicating a small building adjacent to a relict field boundary.

The possible remains of an enclosure to the northwest which is likely medieval in date have also been identified. Another anomaly was also identified to the southwest which could also indicate the presence of a pit. Several undetermined linear anomalies were also detected throughout the field. These have some potential to evidence unrecorded trackways or enclosures.

Evidence of ridge and furrow cultivation is noted in the south-eastern area of the survey data with further evidence of more recent agricultural activity along the eastern boundary. A complex field drain system is also noted as are previous field boundaries which correspond with historic map data.

2. Introduction

2.1 Project Background

2.1.1 Ecus Ltd was commissioned by One Planet Developments to undertake a geophysical survey to inform a forthcoming planning application for a proposed solar farm at Nordens Barn Farm in Selby, North Yorkshire. The Site is centred on National Grid Reference 451320 432060 (Figure 1). The survey was carried out in accordance with the written scheme of investigation (ECUS, 2023) submitted to North Yorkshire County Council for approval.

2.2 Location, Topology and Geology

2.2.1 The Site lies c. 1.1km northeast of the village of South Milford, and c. 1.3km southeast of Sherburn-in-Elmet. The Site is *c.* 24ha in extent and comprises a single agricultural field. The immediate field boundaries are demarcated by vegetation and mature trees and an area of woodland, with Sherburn Aero Club to the north beyond the vegetation, Gascoigne Wood Mine to the east, and Sherburn Curve trainline to the south.

2.2.1 The surrounding landscape is characterised by agricultural fields interspersed with villages, as well as an industrial distribution site to the north.

2.2.2 The landscape within the Site is very level, lying at c. 8m above Ordnance Datum (aOD). The underlying geology of the site is recorded as mostly dolomitic Limestone of the Brotherton Formation. The northwest and southeast corners are recorded as calcareous Mudstone of the Roxby Formation. The Site is overlain by superficial deposits comprising clay and silty Hemingbrough Glaciolacustrine Formation (British Geological Survey 2023).

3. Archaeological and Historical Background

3.1 Introduction

3.1.1 The following summary has been prepared using a desk-based assessment (DBA) currently being produced by Ecus (2023).

3.2 Archaeological Investigations

3.2.1 No previous archaeological investigations are known to have been undertaken within the Site. The HERs record seven previous archaeological investigations within the study area of the DBA. These include both non-intrusive and intrusive works.

3.2.2 The closest investigation to the Site comprises an archaeological desk-based assessment for the Former Gascoigne Wood Colliery, done by Cotswold Archaeology. The conclusions were that:

A medieval moated complex is within the site but this was thought to be poorly preserved. It was levelled during construction of the railway lines at the colliery. There is some potential for prehistoric and medieval remains within the site.

3.2.3 A nearby geophysical survey has recorded possible archaeological anomalies in the form of linear trends, modern agriculture and drainage, former field boundaries, and medieval ridge and furrow.

3.2.4 Any relevant results of other investigations previously undertaken in the study area are discussed in further detail below in Section 3.3.

3.3 Historic Background and Archaeological Baseline

3.3.1 There is evidence of Prehistoric activity in the study area, including one findspot of an Early Bronze Age axe hammer c. 980 m north-east of the Site. In addition, there are multiple areas of prehistoric earthworks to the south of the Site – specifically, a ring ditch c. 925 m south-east of the site, and a cluster of ring ditches and rectilinear cropmarks c. 835 m south-west of the site.

3.3.2 As well as the identified and dated earthworks there are multiple undated earthworks, including;

- A cropmark indicative of a possible enclosure.
- A ditched enclosure.
- An enclosure.
- An undated trackway.

- An enclosure.
- Unclassified cropmarks.
- A trackway.

3.3.3 It is probable that some or all these features date from the Prehistoric period.

3.3.4 There is one possible feature dating from the Romano-British period, which is a cropmark enclosure north of Milford Common Drain. This could relate to a field system.

Early medieval and Medieval

3.3.5 Sherburn in Elmet is recorded in Domesday Book as having 233 households, suggesting it was a substantial settlement in 1086.

3.3.6 A medieval moated site is located between Common Lane and Gascoigne Wood Mine, c. 900m to the south-east of the site, which has a possible date of the twelfth to the thirteenth centuries. This was shown as an earthwork on the 1907 OS map but has now been ploughed out, as it was demolished for the building of the railway. Aerial photography shows it was once part of a larger complex. It was labelled as Reygate Shaw on an enclosure map and was presumably at some point the home of the Reygate family who held the land in the fourteenth century. There are related medieval features to the south which include fishponds and enclosures.

3.3.7 Approximately 660m south of the Site, and c. 945m to the south-west of Reygate Shaw, is a possible medieval drove way with integrated enclosures. These likely represent the medieval agricultural use of the land around Reygate Shaw.

3.3.8 The only other recorded medieval feature is ridge and furrow which is located near Sherburn Aero Club, c. 850 m north-east of the site. This further demonstrates that the study area was largely used for agricultural purposes during the medieval period.

Post medieval and Twentieth Century

3.3.9 Sherburn in Elmet Airfield is directly north of the Site, it was originally used in WWI as a Royal Air force aircraft acceptance park, by 1918 it covered 177 acres. It is still used as an airfield today. Within the airfield there are multiple crash sites, all dated to the twentieth century.

3.3.10 Directly to the west of the airfield is the Sherburn in Elmet Aircraft Factory, with multiple hangars, and a possible aircraft factory in the south-west.

3.3.11 The other medieval features within the study area are the Gascoigne Wood Boundaries, dating from the post-medieval period to the twentieth century, the former township boundary and dyke for

Sherburn in Elmet, dating from the eighteenth to the nineteenth centuries, and a bridge over the North Trans-Pennine railway line.

3.3.12 The Site is recorded on the 1885-1900 OS map as one agricultural field, which is updated in the 1888-1913 OS Six Inch to a group of small agricultural areas, possibly including a trackway running from the north to the south labelled as 'Markam Lane'. In the 1949-1972 OS map this is clearly labelled as a path. There is another possible trackway recorded on the western boundary of the Site from the 1885-1900 map onwards.

3.3.13 The railway is present on the 1885-1900 OS map, with 'Gascoign Wood Junction' labelled directly east of the Site. This is recorded up until the 1949-1972 map, with the addition of a marshalling yard.

LiDAR Imagery

3.3.14 Environment Agency LiDAR imagery was obtained and processed in order to determine whether any buried archaeology survives within the Site. No earthworks of archaeological interest were identified within the Site from the available LiDAR data. The presence of agricultural boundaries is confirmed by faint features within the data.

Aerial Photography

3.3.15 Aerial photographs held at Historic England were reviewed for the purpose of this HEDBA. The composition and layout of the Site in the photographs (dated from 1949 and 2018) correlated with available OS mapping and illustrated the Site in agricultural use. No archaeological features were identified within the Site from available imagery.

4. Geophysical Survey Methodology

4.1.1 All survey work was completed to appropriate standards, as outlined by existing guidelines (CIfA 2014a, revised 2021; 2014b, updated 2020; Schmidt et al. 2015).

4.1.2 The gradiometer survey was completed using Bartington Grad601-2 dual magnetic gradiometer systems with a data logger. Readings were recorded at a resolution of 0.01nT and data collected with a traverse interval of 1m and a sample interval of 0.25m (further details are available in Appendix A).

4.1.3 The survey data was collected on site by traversing in c.300m increments - utilising a cart system to achieve the best possible results. Real Time Kinematic (RTK) differential GPS equipment was used to accurately determine the position of the survey equipment and monitor data. Sensors were left to acclimatise outdoors for c.30 minutes prior to balancing at the start of each day's survey.

4.1.4 The post-survey processing was undertaken using TerraSurveyor software and consisted of standard processing procedures. Illustrations were created using QGIS software.

4.1.5 Interpretation of identified anomalies was achieved through analysis of anomaly patterning and increases in magnetic response and was aided by examining the available supporting information. The interpretations follow Ecus colour coding and categorisations of anomalies and attempt, where possible, to suggest the nature of the buried feature.

5. Mitigation Factors

5.1.1 Field boundaries comprised of fences and drainage ditches. At the time of survey, site conditions were particularly wet, however this is not thought to have had a negative impact on the data. Where necessary, a 2m-buffer was observed along metal fences, farmyard waste, metallic debris, and machine parts. A 2m-buffer was observed to minimise the effects or magnetic interference on the survey and to help to reduce any masking of potential buried features. Two areas in the south-eastern area of the site were omitted due to obstructions in the field.

5.1.2 Whilst there are areas of magnetic interference within the data set, this in mainly localised to the southern boundary of the field. The site has otherwise produced good usable data.

5.1.3 The results of geophysical survey may not reveal all potential archaeology within a survey area, and geological, agricultural, and modern features may mask weaker archaeological responses.

6. Interpretation of Survey Data

6.1.1 Anomalies found within the survey data are listed in Table 1.

Table 1: Survey Anomalies

Anomaly Number	Anomaly Type	Description	Interpretation
1.	Possible Archaeology	A large irregular anomaly (c.133m x c.23m) along the northwest boundary running east – west.	The anomaly likely represents a medieval enclosure. Though no previous activity has been reported on the site, HER records indicate nearby medieval activity in the surrounding area.
2.	Possible Archaeology	An area of increased magnetic response (c.46m x c.26m) in the south-eastern area of the site.	The anomaly is likely the demolished remains of a small building which is visible in the historic OS maps 1888-1913 along a previous field boundary.
3.	Possible Archaeology	A small, positive anomaly (c.12m x c.7m) in the south-western area of the site.	This anomaly represents a possible pit. However, could be natural in origin.
4.	Historic trackway	A linear anomaly (c.256m x c.20m) in the eastern area of the site running north to south.	This anomaly represents a historic trackway known as 'Markam Lane' and corresponds to the historic OS maps 1888-1913.
5.	Historic field boundary	A large curvilinear anomaly (c.248m) in the western area of the site running north-east to south-west.	This anomaly represents an historic field boundary which corresponds to historic OS maps 1888-1913.

6.	Historic field boundary	A large linear anomaly (c.288m) in the centre of the site running north-east to south-west.	This anomaly represents an historic field boundary which corresponds to historic OS maps 1888-1913.
7.	Historic field boundary	A large linear anomaly (c.383m) in the centre of the site running north-east to south-west.	This anomaly represents an historic field boundary which corresponds to historic OS maps of the site 1888-1913. However, this area was repurposed as a track between c. 2002 and 2013 visible in aerial imagery.
8.	Historic field boundary	A linear anomaly (c.148m) in the south-eastern area of the site running east to west.	This anomaly represents an historic field boundary which corresponds to historic OS maps 1888-1913.
9.	Historic field boundary	A linear anomaly (c.126m) in the south-eastern area of the site running north-east to south-west.	This anomaly represents an historic field boundary which corresponds to historic OS maps 1888-1913.
10.	Possible archaeology	Linear anomaly (c.147m) in the western area of the site running north-east to south-west.	This anomaly represents a potential, unrecorded trackway though a precise interpretation is not possible currently.
11.	Possible archaeology	Linear anomaly to the north of the site running north-west to south-east.	This anomaly represents a potential, unrecorded ditch feature though a precise interpretation is not possible. It appears to intersect with the possible enclosure (1).

12.	Possible archaeology	Linear anomaly (c.127m) in the western area of the site running north-east to south-west.	This anomaly represents a potential, unrecorded field boundary though a precise interpretation is not possible.
13.	Possible archaeology	Parallel Curvilinear anomaly (c.343m x c.10m) in the western area of the site running north-west to south-east.	This anomaly represents a possible, unrecorded trackway comprised of two parallel ditch features.
14.	Possible archaeology	Linear anomaly (c.210m) in the centre of the site running north-east to south-west.	This anomaly represents a potential, unrecorded field boundary though a precise interpretation is not possible currently.
15.	Possible archaeology	Linear anomaly (c.52m) in the centre of the field running east-west.	This anomaly represents a potential, unrecorded section of field boundary which could be the related to anomaly 17.
16.	Possible archaeology	Linear anomaly (c.255m x 10m) in the eastern area of the field running north-east to south-west.	This anomaly represents a potential, unrecorded ditch or boundary feature parallel to ‘Markam Lane’.
17.	Possible archaeology	Linear anomaly (c.188m) in the eastern area of the field running north-east to south-west.	This anomaly also represents a possible unrecorded ditch or boundary feature parallel to ‘Markam Lane’. It is possible the anomalies at 16 and 17 represent earlier or later iterations of ‘Markham Lane’.

18.	Drainage	Closely spaced, parallel linear anomalies in a ‘herringbone’ pattern.	These anomalies represent agricultural drainage from historic and modern farming. An example of these is noted at 18.
19.	Ridge and Furrow	Parallel linear anomalies in south-eastern area of site.	These anomaly represents likely post-medieval ridge and furrow cultivation.

7. Discussion

7.1.1 The geophysical survey produced usable data of the field under study, though some areas are obscured by the effect of high, ferrous readings.

7.1.2 A single possible pit feature in the south-western area of the field. While this could relate to natural or more recent activity, an earlier archaeological origin cannot be ruled out. In addition a small ditched enclosure is possibly situated to the north of the survey area. However, the enclosure is incomplete due to the extant boundary and therefore a more confident interpretation is not possible.

7.1.3 Both historic and modern agricultural activity is also clearly visible in the data. The field contains several anomalies with possible archaeological potential likely indicating former trackways or boundary features (Figure 3). While these correspond to the historic pattern of land division, the anomalies are do not correspond to features recorded on available historic mapping and so are interpreted as possible archaeology, although a more recent origin cannot be ruled out.

7.1.4 Other anomalies correspond with recorded boundary features on historic OS maps dating to 1888-1913. The historic trackway known as ‘Markam Lane’ (4) which is situated in the eastern area of field. In addition, some evidence ridge and furrow cultivation is noted that appears to respect these boundaries and therefore is likely to be post-medieval in date. Evidence of demolition rubble associated with the location of a small building recorded on historic mapping (1888-1913) is noted in the central portion of the survey area. The origin of this building is not known but could be medieval in date, although a later, post-medieval origin is more probable.

7.1.5 The remaining anomalies are likely to be associated with modern agricultural practices and include numerous field drain systems and modern ploughing activity.

8. Storage and curation

8.1.1 The archive will be prepared in accordance with national guidelines (Brown 2011; CIfA 2020b). The integrity of the primary field record will be preserved. Security copies will be maintained where appropriate. Digital records of the geophysical survey will be held by Ecus.

8.1.2 An OASIS form has been created on the results of the works under the reference number (enter number). Following approval, a pdf version of this final report will be submitted within three months to the Archaeology Data Service via the OASIS form.

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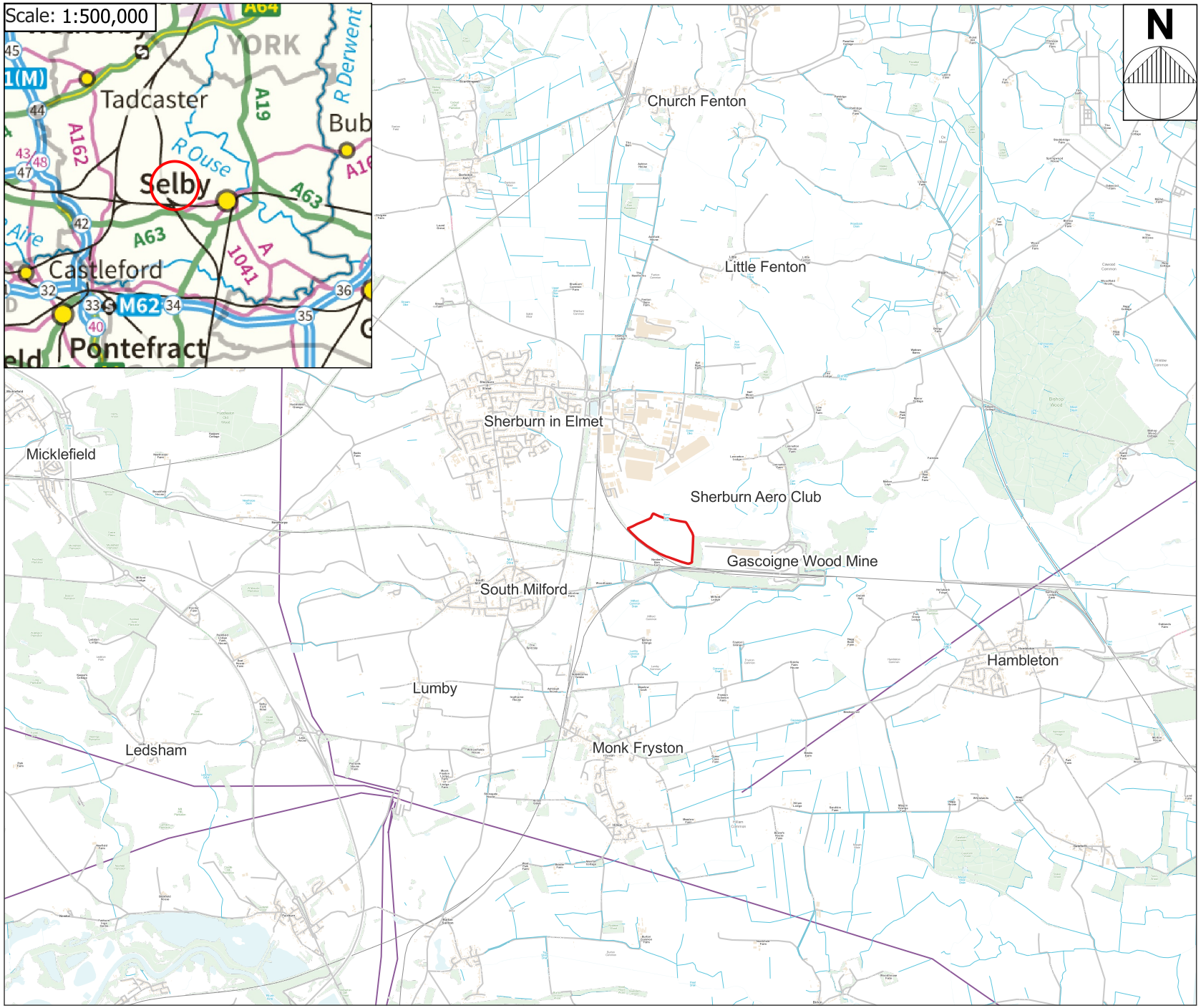

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Key

Site Location

0 1 2 km

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Nordens Barn Farm

Figure 1
Site Location

Brook Holt 3 Blackburn Road Sheffield S61 2DW
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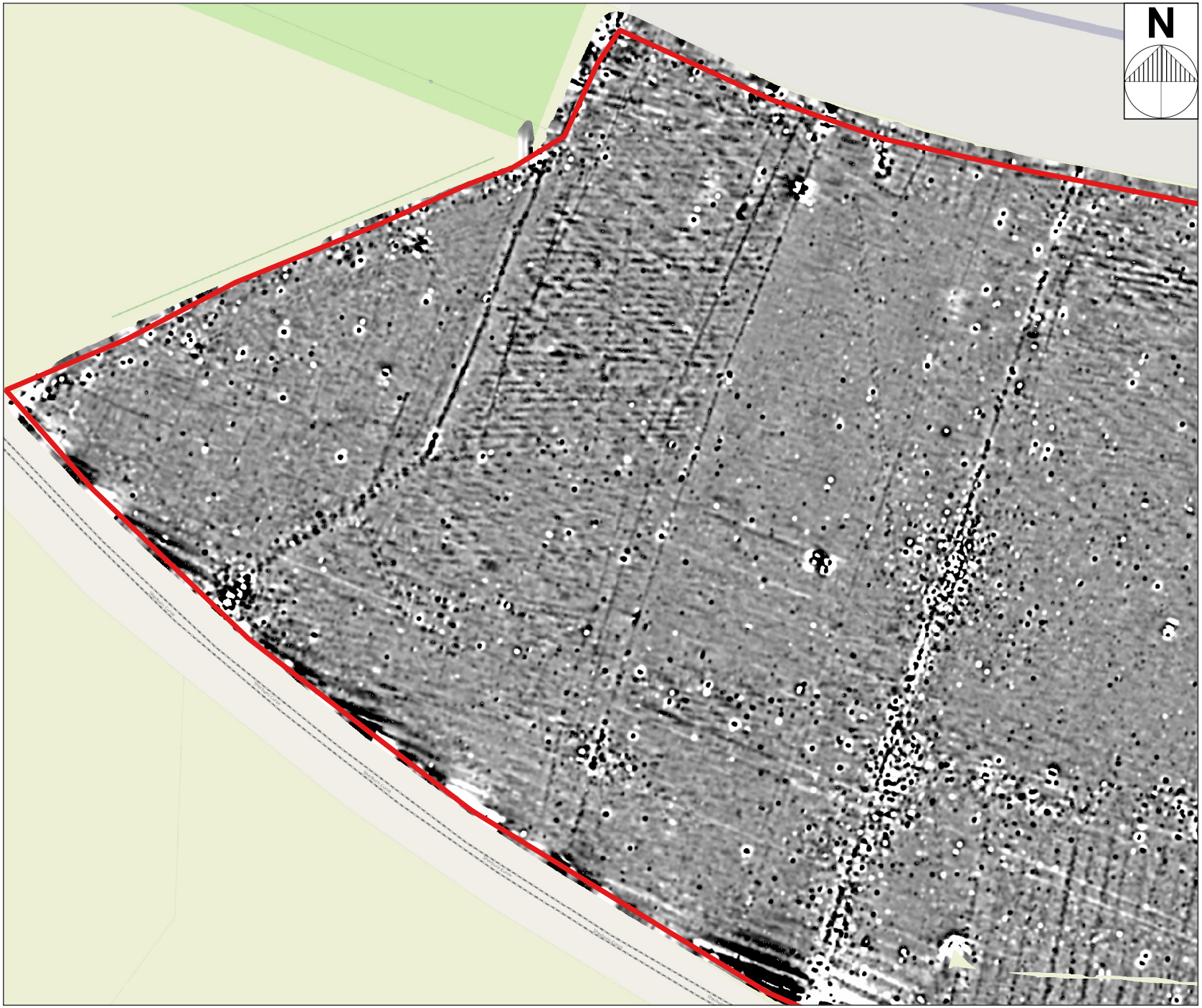

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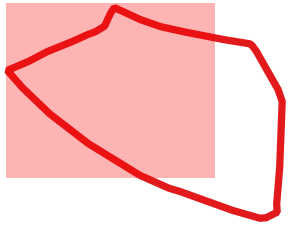
Key

Survey area



0 20 40 60 80 100 m

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Nordens Barn Farm Solar

Figure Number 2
Greyscale plot (west)

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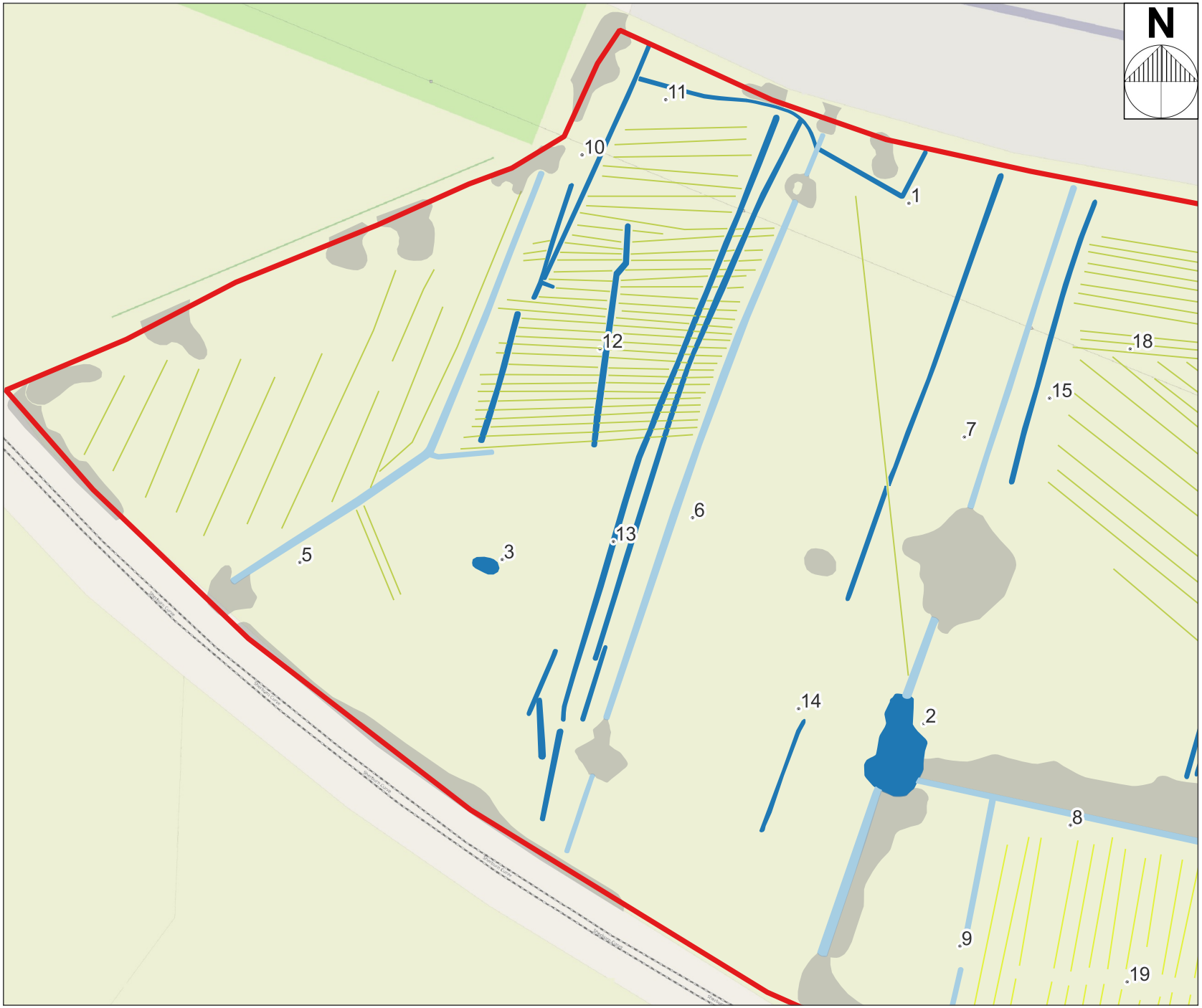

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Key

- Survey area
- Ferrous Disturbance
- Ridge & Furrow
- Drainage
- Historic Boundaries
- Track
- Possible Archaeology
- Undetermined

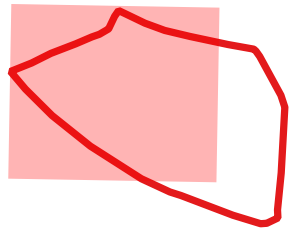

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Figure Number 3
Interpretation plot (west)

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Key

Survey area

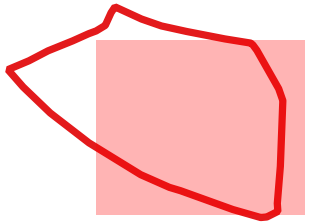

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Figure Number 4
Greyscale plot (east)

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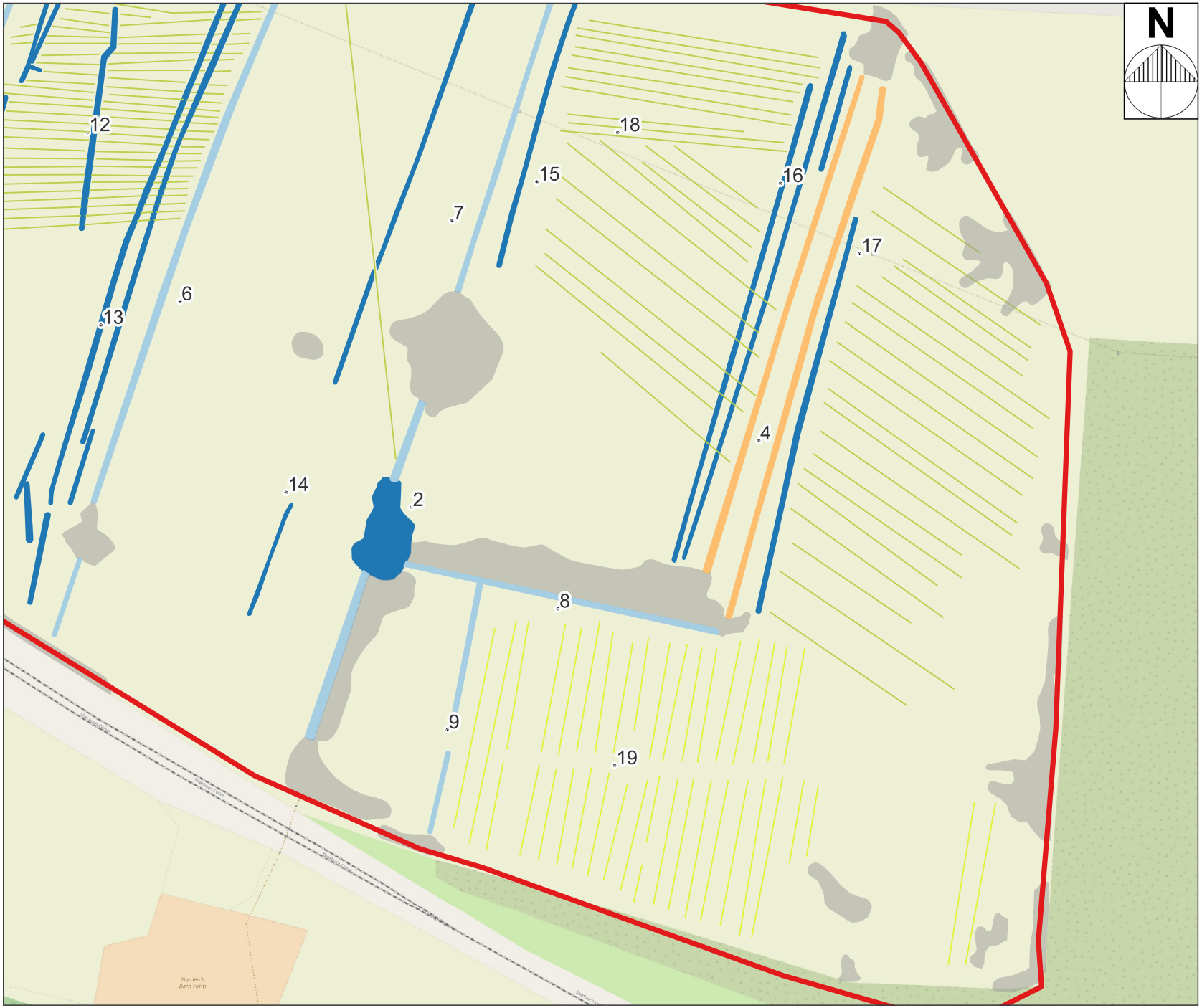

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Key

- Survey area
- Ferrous Disturbance
- Ridge & Furrow
- Drainage
- Historic Boundaries
- Track
- Possible Archaeology
- Undetermined

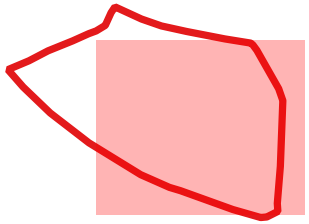

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Figure Number 5
Interpretation plot (east)

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Appendix 1: Technical Information

Gradiometer Survey

Magnetic surveys measure distortions in the earth's magnetic field caused by small magnetic fields associated with buried features (Gaffney and Gater 2003, 36) that have either remnant or induced magnetic properties (Aspinal et al. 2008, 21–26). Human activity and inhabitation often alter the magnetic properties of materials (Aspinal et al. 2008, 21) resulting in the ability for numerous archaeological features to be detected through magnetic surveys. Intensive burning or heating can result in materials attaining a thermoremanent magnetisation; examples of which include kilns, ovens, heaths and brick structures (Aspinal et al. 2008, 27; Gaffney and Gater, 2003, 37). When topsoil rich with iron oxides, fills a man-made depression in the subsoil, it creates an infilled feature, such as a pit or ditch, with a higher magnetic susceptibility compared to the surrounding soil (Aspinal et al. 2008, 37–41; Gaffney and Gater 2003, 22– 26). Magnetic surveys can also detect features with a lower magnetically susceptibility than the surrounding soil, an example of which is a stone wall.

Limitations

Poor results can be due to several factors including short lived archaeological occupation/use or sites with minimal cut or built features. Results can also be limited in areas with soils naturally deficient in iron compounds or in areas with soils overlying naturally magnetic geology, which will produce strong responses masking archaeological features.

Overlying layers, such as demolition rubble or layers of made ground, can hide any earlier archaeological features. The presence of above ground structures and underground services containing ferrous material can distort or mask nearby features.

Particularly uneven or steep ground can increase the processing required or distort results beyond the capabilities of processing. It is also possible in areas containing dramatic topographical changes that natural weathering, such as hill wash, often in combination with intensive modern ploughing, will reduce the topsoil on slopes and towards the peaks of hills and possibly destroy or truncate potential archaeological features. Conversely features at the bottom of slopes may be covered by a greater layer of topsoil and so if buried features are present, they appear faint within the results, if at all.

Over processing of data can also obscure or remove features, especially if there are on the same orientation as the direction of data collection. Consequently, where possible, attempts are made to ensure data is not collected on the same orientation as known potential features and that data quality is sufficient to minimise the required data processing.

Instrumentation

The data will be collected using Bartington Grad 601-2 fluxgate gradiometers, either in a cart configuration with four sensors arranged at one metre intervals or as handheld pairs of sensors. The Bartington 601-2 is a single axis, vertical component fluxgate gradiometer comprising a data logger battery cassette and two sensors. The sensors are Grad-01-1000L cylindrical gradiometer sensors mounted on a rigid carrying frame; each sensor contains two fluxgate magnetometers with 1m vertical separation.

The difference in the magnetic field between the two fluxgates in each sensor is measured in nanoTesla (nT). NAA gradiometer data is recorded with a range of ±100nT, which equates to a resolution of 0.01nT. It should be noted that the actual resolution is limited to 0.03nT because of internal instrumental noise (Bartington Instruments Ltd, n.d., 23).

The gradiometer records two lines of data on each traverse, the grids are walked in a zig-zag pattern amounting to 15 traverses per 30m grid. The gradiometers are calibrated at the start of every day and recalibrated whenever necessary.

Appendix 2: Data Visualisation Information

The data was used to produce a series of images to demonstrate the results of surveys, detailed below:

Greyscale/colour scale plot – This visualised the results as a shaded drawing with highest readings showing as black, running through different shades to lowest showing as white. • Interpreted plot – Through detailed analysis, anomalies have been interpreted and possible features identified. Interpretation drawings are used to show potential features and to reinforce and clarify the written interpretation of the data. Anomalies have been characterised using the terminology detailed in the following section and have been assigned colour coding, which is outlined in keys on figures associated with this report.

Magnetic Anomalies and Terminology

Table 2: Lexicon of Terminology

Terminology	Detail
Anomaly	Any outstanding high or low readings forming a particular shape or covering a specific area with the survey results.
Feature	A man-made or naturally created object or material that has been detected through investigation works and has sufficient characteristics or supporting evidence for positive identification.
Magnetic susceptibility	The ability of a buried feature to be magnetically induced when a magnetic field is applied.
Magnetic response	The strength of the changes in magnetic values caused by a buried feature with either a greater or lesser ability to be magnetised compared with the soil around it. Anomalies are considered to either have strong/weak or positive/negative responses. The strength of magnetic response (along with patterning) can be essential in determining the nature of an anomaly, but it should be noted that the size or strength of the magnetic response does not correlate with the size of the buried feature.

Patterning of an anomaly	The shape or form of an individual anomaly.
Thermoremanence	The affect caused when a material has been magnetically altered through a process of heating. Thermoremanent magnetisation occurs when an object or material is heated passed the Curie Point and acquires a permanent magnetisation that is associated with the magnetic field that they cooled within (Gaffney and Gater 2003, 37).

Different anomalies can represent different features created by human occupation, agricultural or modern activity, or natural pedological or geological changes in the substrata. Anomalies interpreted as 'greater' are considered more likely to be of the interpreted characterisation; whereas a 'lesser' categorisation represents a more tentative interpretation applied to those anomalies with weaker increases in magnetic response or if the anomaly has incomplete patterning or irregular form. The strength and size of anomalies can vary depending on the magnetic properties of the feature, the magnetic susceptibility of the soil, the depth at which the feature is buried, and the state of preservation.

Table 3: Characterisation of anomalies

Characterisation	**Detail**
Archaeology and Probable archaeology	Linear anomalies with a positive or negative magnetic responses and composed of a patterning or shape that is suggestive of a buried archaeological feature. These are often indicative of structural remains or infilled features such as ditches. The strength of anomaly signal can be suggestive of the properties of the feature. Negative linear anomalies represent upstanding or infilled features that are less magnetically susceptible than background readings, for example structures or ditches composed of a non-igneous stone material. Bipolar linear anomalies considered to be of an archaeological nature are indicative of material with a high magnetic susceptibility, such as a brick wall. Isolated anomalies or anomalies with a more amorphous form possibly represent infilled features or

	thermomagnetic features such as areas of heating/burning of an archaeological origin. Unless associated with conclusively identified archaeological remains, such as linear anomalies, absolute identification of positive responses can be problematic as it is often not possible to decipher if they are of an archaeological, modern, or agricultural origin. Consequently, isolated positive responses are not shown within the interpretation unless composed of a broad form or belonging to a series of isolated positive responses. Bipolar responses considered likely to be of an archaeological origin are also interpreted as isolated anomaly (archaeology). These are considered to relate to material with a very strong magnetic susceptibility or thermoremanent magnetisation.
Possible archaeology	Weak and diffuse anomalies with an uncertain origin are denoted by trends. It is possible that these belong to archaeological features but given their weak signatures or incomplete patterning it is equally plausible that they relate to agricultural features or natural soil formations.
Recorded field boundary	Linear anomalies, either with positive or negative magnetic responses, that correspond with the location of field boundaries recorded on historic maps, Aerial photos or LiDAR coverage of the site.
Ridge and furrow	Broadly spaced linear anomalies that are likely to be indicative of earlier forms of agriculture, such as ridge and furrow. These often correspond with the location of earthworks visible on the ground or identified on aerial photos or LiDAR survey coverage.
Masking anomalies	
Strongly magnetic bipolar or dipolar.	Positive anomalies with associated negative 'halo' (bipolar) denote features with a strong magnetic response are likely to be of a modern origin.

Service	Isolated bipolar responses of a modern nature are likely to relate to buried ferrous material or objects, such as metallic agricultural debris. If a trend is noted in the alignment or spacing of isolated bipolar responses, it is possible that they are indicative of ferrous fittings or connectors used on buried non-magnetic buried utilities
Magnetic interference	Areas of magnetic disturbance, often along the edges of survey areas are caused by standing metal structures such as fencing and buildings. Also, areas of increased magnetic response denote areas of disturbance containing a high concentration of dipolar or bipolar responses. These are generally considered to be caused by modern debris in the topsoil, although it is possible that the disturbance is in part also caused by isolated archaeological material or geological or pedological changes in the substrata.
Modern Agriculture	
Ploughing trend, land drain	Ploughing trend tends to be regularly spaced linear anomalies, often with a narrower spacing, that conform with ploughing regime at the time of survey, or a recent regime recorded on aerial photos of the site. The response and distribution of land drains varies depending on the composition of the land drain and associated ditch or channel. Consequently, land drains can be composed of weak / strong positive / negative magnetic responses and are identified as a product of either their variance in magnetic values or positioning compared with regularly spaced linear anomalies considered to relate to modern ploughing. Land drains can be located within former agricultural regimes, such as ridge and furrow.

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