Geophysical Survey Report

on

Land North of Kenninghall Road and South of Quidenham Road East Harling, Norfolk

For

Pre-Construct Archaeology

Magnitude Surveys Ref: MSTL1174

HER Event Number: ENF152098

Consultation Number: CNF48585

OASIS Number: magnitud1-504210

Museum Accession Code: NWHCM: 2022.73

April 2022

Unit 17, Commerce Court

Challenge Way

Bradford

BD4 8NW

01274 926020

info@magnitudesurveys.co.uk

Report By:

India Terry BA (Hons)

Vesna Kozinc BSc (Hons) MSc

Report Approved By:

Finnegan Pope-Carter BSc (Hons) MSc FGS

Issue Date:

26 April 2022

Abstract

Magnitude Surveys was commissioned to assess the subsurface archaeological potential of a 6.9ha area of land North of Kenninghall Road and South of Quidenham Road, East Harling, Norfolk. A fluxgate gradiometer survey was successfully completed across 6.5ha of the survey area with 0.4ha not being surveyed due to dense scrub. No archaeological anomalies have been identified in the survey area. Anomalies related to agricultural use were found across the survey area and have been interpreted as agricultural trends and possible field boundaries. Natural variations in the underlying soil and chalk geology have also been identified. Linear anomalies have been recorded in the survey area and have been classified as “Undetermined”; these could have an archaeological, agricultural, or natural origin. The impact of modern activity is limited to a service pipeline in the eastern part of the survey area and interference from the housing and fences along the boundary.

Contents

List of Figures

1. Introduction

1.1. Magnitude Surveys Ltd (MS) was commissioned by Pre-Construct Archaeology on behalf of CLIENT'S CLIENT to undertake a geophysical survey over a c. 6.9ha area of land North of Kenninghall Road and South of Quidenham Road, East Harling (TL 99960 86464). An area of 0.4ha was not surveyed due to dense scrub.

1.2. The geophysical survey comprised quad-towed and hand-carried GNSS-positioned fluxgate gradiometer survey. Magnetic survey is the standard primary geophysical method for archaeological applications in the UK due to its ability to detect a range of different features. The technique is particularly suited for detecting fired or magnetically enhanced features, such as ditches, pits, kilns, sunken featured buildings (SFBs) and industrial activity (David *et al*., 2008).

1.3. The survey was conducted in line with the current best practice guidelines produced by Historic England (David *et al*., 2008), the Chartered Institute for Archaeologists (CIfA, 2020) and the European Archaeological Council (Schmidt *et al.,* 2015).

1.4. It was conducted in line with a WSI produced by MS (Turner, 2022).

1.5. The survey was undertaken over 2 days between 3/3/2022 and 10/3/2022.

2. Quality Assurance

2.1. Magnitude Surveys is a Registered Organisation of the Chartered Institute for Archaeologists (CIfA), the chartered UK body for archaeologists, and a corporate member of ISAP (International Society for Archaeological Prospection).

2.2. The directors of MS are involved in cutting edge research and the development of guidance/policy. Specifically, Dr Chrys Harris has a PhD in archaeological geophysics from the University of Bradford, is a Member of CIfA and is the Vice-Chair of the International Society for Archaeological Prospection (ISAP); Finnegan Pope-Carter has an MSc in archaeological geophysics and is a Fellow of the London Geological Society, as well as a member of GeoSIG (CIfA Geophysics Special Interest Group); Dr Paul Johnson has a PhD in archaeology from the University of Southampton, is a Fellow of the Society of Antiquaries of London, has been a member of the ISAP Management Committee since 2015, and is currently the nominated representative for the EAA Archaeological Prospection Community to the board of the European Archaeological Association.

2.3. All MS managers, field and office staff have degree qualifications relevant to archaeology or geophysics and/or field experience.

3. Objectives

3.1. The objective of this geophysical survey was to assess the subsurface archaeological potential of the survey area.

4. Geographic Background

4.1. The survey area was located c. 550m north-east of East Harling (Figure 1). Gradiometer survey was undertaken across one field under scrub and grassland. The survey area was bordered by other fields to the north and east and by housing to the south and west. Quidenham road ran along the northern boundary (Figure 2). A small area in the south of the field has not been surveyed due to dense vegetation.

4.2. Survey considerations:

Survey Area	Ground Conditions	Further Notes
1	The area consisted of flat scrub and grassland. Earth mounds, dense scrub areas, and a pile of burnt material were present in the south of the survey area that were unable to be surveyed.	The survey area was bordered by a tree line in the north and east sides, housing and wooden fences in the west and south sides and a metal fence in the south.
2	The area consists of flat scrub and grassland.	There was no physical boundary in the north and east sides of the survey area and a treeline in the west and south sides.

4.3. The underlying geology comprises chalk of the Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation and Portsdown Chalk Formation. No superficial deposits have been recorded (British Geological Survey, 2022).

4.4. The soils consist of freely draining shallow lime-rich soils (Soilscapes, 2022).

5. Archaeological Background

5.1. The following is a brief summary of an archaeological evaluation report produced by PreConstruct Archaeology (Mlynarska, 2021) and of the results of a previous geophysical survey undertaken by Magnitude Surveys (Cantarano & Beck, 2020), as well as an HER search from Norfolk County Council (NCC 2022). The report produced by PCA contains the result of a geophysical survey (SUMO, 2020) and of evaluation trenches conducted to the west of the survey area throughout 2020 and 2021 respectively.

5.2. The trial trenching, which was conducted within c. 1km west of the survey area, which identified Middle/Late Iron Age and Romano-British Age activity. This includes quarry pits and a small Roman farmstead. A trackway and associated enclosures were also identified.

5.3. Palaeolithic, Mesolithic and Neolithic activity in the surrounding area is largely evidenced by scattered finds of flints, pottery and animal bones. Bronze Age activity has been identified in the form of cropmarks, particularly to the south and west of the survey area. This includes ditches and barrows c. 750m and c. 800m west of the survey area and a cremation burial identified c. 900m south of the survey area. A possible small prehistoric settlement has been identified ofrom a previous geophysical investigation (SUMO, 2020) to the immediate centre-west of the survey area. A burnt mound and trackway has been identified in the fields immediately to the north of the site (MNF28355), and a second possible burnt mound is

recorded c.750m northeast of the survey area (MNF31961). Possible ring ditches are recorded c. 250m to the east (MNF18461) and c. 300m to the northeast (MNF38841) of the survey area.

5.4. Evidence of Iron Age to Roman activity has been identified in the surroundings of the survey area. To the immediate northeast of the survey area, a middle Iron Age occupation site and possible traces of Iron Age buildings have been identified. Geophysical surveys undertaken during the widening of the M1, c. 600m south of the survey area, detected several enclosures and ditches possibly representing Iron Age to Roman agricultural activity. Extending to the immediate southwest of the survey area is a potentially Iron Age to Roman settlement detected through geophysical investigations (SUMO, 2020; Cantarano & Beck, 2020). This consists of a concentration of numerous rectangular enclosures, trackways, and ring ditches which represent a series of potential roundhouses. Geophysical surveys also identified another possible multiphase settlement located c.600m to the west of the centre of the survey area, dating from the Iron Age and Romano period through to Saxon and possibly into the Medieval period (SUMO, 2020; Cantarano & Beck, 2020). Further Iron Age and Roman activity known in the surrounding area includes the route of Watling Street and scattered artefactual evidence comprising pottery, brooches, coins, and a horse harness.

5.5. Medieval activity is known in the surrounding area including a Saxon cemetery c. 900m west of the survey area and scattered findspots of Saxon pottery. Ridge and furrow agriculture has been detected immediately to the south of the site (MNF63081). Several estates are recorded in the Domesday survey within close vicinity of the survey area; a possible Medieval moat and enclosures are recorded c. 400m to the northwest. During the post-Medieval period the survey area was largely characterised as open agricultural and pastoral fields, though a number of Medieval to post Medieval buildings are recorded in the historical core of East Harling, c. 500m to the west of the survey area. A lime extraction pit and two lime kilns are recorded c. 300m northeast of the survey area (MNF13820).

6. Methodology

6.1. Data Collection

6.1.1. Magnetometer surveys are generally the most cost effective and suitable geophysical technique for the detection of archaeology in England. Therefore, a magnetometer survey should be the preferred geophysical technique unless its use is precluded by any specific survey objectives or the site environment. For this site, no factors precluded the recommendation of a standard magnetometer survey. Geophysical survey therefore comprised the magnetic method as described in the following section.

6.1.2. Geophysical prospection comprised the magnetic method as described in the following table.

6.1.3. Table of survey strategies:

Method	Instrument	Traverse Interval	Sample Interval
Magnetic	Bartington Instruments Grad-13 Digital Three-Axis Gradiometer	1m	200Hz reprojected to 0.125m

6.1.4. The magnetic data were collected using MS' bespoke hand-carried GNSS-positioned system in the east of field 1 and field 2 and quad-towed cart GNSS-positioned system.

6.1.5. MS' cart and hand-carried system was comprised of Bartington Instruments Grad 13 Digital Three-Axis Gradiometers. Positional referencing was through a multi-channel, multi-constellation GNSS Smart Antenna RTK GPS outputting in NMEA mode to ensure high positional accuracy of collected measurements. The RTK GPS is accurate to 0.008m + 1ppm in the horizontal and 0.015m + 1ppm in the vertical.

6.1.6. Magnetic and GPS data were stored on an SD card within MS' bespoke datalogger. The datalogger was continuously synced, via an in-field Wi-Fi unit, to servers within MS' offices. This allowed for data collection, processing and visualisation to be monitored in real-time as fieldwork was ongoing.

6.1.7. A navigation system was integrated with the RTK GPS, which was used to guide the surveyor. Data were collected by traversing the survey area along the longest possible lines, ensuring efficient collection and processing.

6.2.Data Processing

6.2.1. Magnetic data were processed in bespoke in-house software produced by MS. Processing steps conform to the EAC and Historic England guidelines for 'minimally enhanced data' (see Section 3.8 in Schmidt *et al.*, 2015: 33 and Section IV.2 in David *et al.,* 2008: 11).

Sensor Calibration – The sensors were calibrated using a bespoke in-house algorithm, which conforms to Olsen *et al*. (2003).

Zero Median Traverse – The median of each sensor traverse is calculated within a specified range and subtracted from the collected data. This removes striping effects caused by small variations in sensor electronics.

Projection to a Regular Grid – Data collected using RTK GPS positioning requires a uniform grid projection to visualise data. Data are rotated to best fit an orthogonal grid projection and are resampled onto the grid using an inverse distance-weighting algorithm.

Interpolation to Square Pixels – Data are interpolated using a bicubic algorithm to increase the pixel density between sensor traverses. This produces images with square pixels for ease of visualisation.

6.3.Data Visualisation and Interpretation

6.3.1. This report presents the gradient of the sensors' total field data as greyscale images, as well as the total field data from the lower sensors. The gradient of the sensors minimises external interferences and reduces the blown-out responses from ferrous and other high contrast material. However, the contrast of weak or ephemeral anomalies can be reduced through the process of calculating the gradient. Consequently, some features can be clearer in the respective gradient or total field datasets. Multiple greyscale images of the gradient and total field at different plotting ranges have been used for data interpretation. Greyscale images should be viewed alongside the XY trace plot

(Figure 6). XY trace plots visualise the magnitude and form of the geophysical response, aiding anomaly interpretation.

6.3.2. Geophysical results have been interpreted using greyscale images and XY traces in a layered environment, overlaid against open street maps, satellite imagery, historical maps, LiDAR data, and soil and geology maps. Google Earth (2022) was also consulted, to compare the results with recent land use.

6.3.3. Geodetic position of results – All vector and raster data have been projected into OSGB36 (ESPG27700) and can be provided upon request in ESRI Shapefile (.SHP) and Geotiff (.TIF) respectively. Figures are provided with raster and vector data projected against OS Open Data.

7. Results

7.1. Qualification

7.1.1. Geophysical results are not a map of the ground and are instead a direct measurement of subsurface properties. Detecting and mapping features requires that said features have properties that can be measured by the chosen technique(s) and that these properties have sufficient contrast with the background to be identifiable. The interpretation of any identified anomalies is inherently subjective. While the scrutiny of the results is undertaken by qualified, experienced individuals and rigorously checked for quality and consistency, it is often not possible to classify all anomaly sources. Where possible, an anomaly source will be identified along with the certainty of the interpretation. The only way to improve the interpretation of results is through a process of comparing excavated results with the geophysical reports. MS actively seek feedback on their reports, as well as reports from further work, in order to constantly improve our knowledge and service.

7.2. Discussion

7.2.1. The geophysical results are presented in combination with satellite imagery and historical maps (Figure 7).

7.2.2. A fluxgate gradiometer survey was successfully carried out over 6.5ha of land North of Kenninghall Road and South of Quidenham Road, East Harling. The gradiometer survey has responded well to the environment of the survey area.

7.2.3. No anomalies suggestive of significant archaeological features have been identified; however agricultural, natural and undetermined anomalies have been interpreted within the survey area. Modern interference from a service pipeline, fencing as well as housing along the field boundary has affected some aeras in the field.

7.2.4. Agricultural activity has been detected as modern ploughing trends and possible ridge and furrow trends. The survey has also identified a weak linear anomaly in the central part of the survey area. The anomaly does not align with the field boundaries visible in the 2nd edition OS Maps, but it does fit in the wider pattern of the boundaries within the landscape and likely reflects further division of the land not mapped or predating the historic maps.

7.2.5. In the southern part of the survey area, a linear feature has been identified toas part of the drainage system, based on the morphology of the anomaly in the magnetic signal.

7.2.6. In the southern part of the survey area a change in the magnetic background has been interpreted as variation in background geology, possibly as a result of chalk dissolution.

7.2.7. Multiple anomalies scattered across the survey area of an undetermined origin have been detected. These vary in magnetic signal and shape, normally curvilinear or linear but all lack contextual support with which to support a more confident interpretation as they could have an agricultural, archaeological, or natural origin.

7.3.Interpretation

7.3.1. General Statements

7.3.1.1. Geophysical anomalies will be discussed broadly as classification types across the survey area. Only anomalies that are distinctive or unusual will be discussed individually.

7.3.1.2. **Ferrous (Spike)** – Discrete dipolar anomalies are likely to be the result of isolated pieces of modern ferrous debris on or near the ground surface.

7.3.1.3. **Ferrous/Debris (Spread)** – A ferrous/debris spread refers to a concentration of multiple discrete, dipolar anomalies usually resulting from highly magnetic material such as rubble containing ceramic building materials and ferrous rubbish.

7.3.1.4. **Magnetic Disturbance** – The strong anomalies produced by extant metallic structures, typically including fencing, pylons, vehicles and service pipes, have been classified as 'Magnetic Disturbance'. These magnetic 'haloes' will obscure weaker anomalies relating to nearby features, should they be present, often over a greater footprint than the structure causing them.

7.3.1.5. **Undetermined** – Anomalies are classified as Undetermined when the origin of the geophysical anomaly is ambiguous and there is no supporting contextual evidence to justify a more certain classification. These anomalies are likely to be the result of geological, pedological or agricultural processes, although an archaeological origin cannot be entirely ruled out. Undetermined anomalies are generally distinct from those caused by ferrous sources.

7.3.1.6. **Agricultural –** Anomalies are classified as "Agricultural" where they are the result of modern or historical ploughing trends or Ridge and Furrow agriculture, or they result from historical field boundaries that are either recorded on historical mapping, or which fit more generally with extant or recorded field systems.

8. Conclusions

8.1. A fluxgate gradiometer survey was successfully completed across the survey area with 0.4ha unable to be surveyed due to dense scrub in the area. Modern interference was detected from services and housing around the border of the survey area.

8.2. Anomalies related to agricultural use of the survey area have been detected in the western part of the survey area in the form of possible ridge and furrow.

8.3. Natural anomalies produced by variations in the underlying soil and chalk geology have been identified.

8.4. Some anomalies were interpreted and classified as "undetermined" as they could have an archaeological, agricultural, or even natural origin.

9. Archiving

9.1. MS maintains an in-house digital archive, which is based on Schmidt and Ernenwein (2013). This stores the collected measurements, minimally processed data, georeferenced and un-georeferenced images, XY traces and a copy of the final report.

9.2. MS contributes reports to the ADS Grey Literature Library upon permission from the client, subject to any dictated time embargoes.

10. Copyright

10.1. Copyright and intellectual property pertaining to all reports, figures and datasets produced by Magnitude Services Ltd is retained by MS. The client is given full licence to use such material for their own purposes. Permission must be sought by any third party wishing to use or reproduce any IP owned by MS.

11. References

British Geological Survey, 2022. Geology of Britain. East Harling, Norfolk. [http://mapapps.bgs.ac.uk/geologyofbritain/home.html/]. Accessed 11/03/2022.

Chartered Institute for Archaeologists, 2020. Standards and guidance for archaeological geophysical survey. CIfA.

David, A., Linford, N., Linford, P. and Martin, L., 2008. Geophysical survey in archaeological field evaluation: research and professional services guidelines (2nd edition). Historic England.

Google Earth, 2022. Google Earth Pro V 7.1.7.2606.

Mlynarska, J., 2021. Milton Keynes West at Land North-East of Milton Keynes: An Archaeological Evaluation. Pre-Construct Archaeology Ltd.

Norfolk County Council, 2022. NHER enquiry. Accessed 26/04/2022.

Olsen, N., Toffner-Clausen, L., Sabaka, T.J., Brauer, P., Merayo, J.M.G., Jorgensen, J.L., Leger, J.M., Nielsen, O.V., Primdahl, F., and Risbo, T., 2003. Calibration of the Orsted vector magnetometer. Earth Planets Space 55: 11-18.

Schmidt, A. and Ernenwein, E., 2013. Guide to good practice: geophysical data in archaeology (2nd edition). Oxbow Books: Oxford.

Schmidt, A., Linford, P., Linford, N., David, A., Gaffney, C., Sarris, A. and Fassbinder, J., 2015. Guidelines for the use of geophysics in archaeology: questions to ask and points to consider. EAC Guidelines 2. European Archaeological Council: Belgium.

Soilscapes, 2022. East Harling, Norfolk. Cranfield University, National Soil Resources Institute. [http://landis.org.uk]. Accessed 11/03/2022.

Turner, P., 2022. Written Scheme of Investigation For a Pre-Application Evaluation by Geophysical Magnetometer Survey on Land North of Kenninghall Road and South of Quidenham Road East Harling, Norfolk. Magnitude Surveys.

12. Project Metadata

MS Job Code	MSTL1174
Project Name	Land North of Kenningham Road and South of Quidenham Road, East Harling, Norfolk
Client	Pre-Construct Archaeology
Grid Reference	TL 99950 86464
Survey Techniques	Magnetometry
Survey Size (ha)	6.9ha (Magnetometry)
Survey Dates	2022-03-03 to 2022-03-10
Project Lead	Peter Turner, BSc MSc
Project Officer	Peter Turner, BSc MSc
HER Event No	ENF152098
OASIS No	magnitud1-504210
S42 Licence No	N/A
Report Version	1.0

13. Document History

Version	Comments	Author	Checked By	Date
0.1	Initial draft for Project Lead to Review	IT VK	PT	15 March 2022
0.2	Update following review	VK	FPC	18 March 2022
1.0	Report Issued as Final	PT	PT	26 April 2022

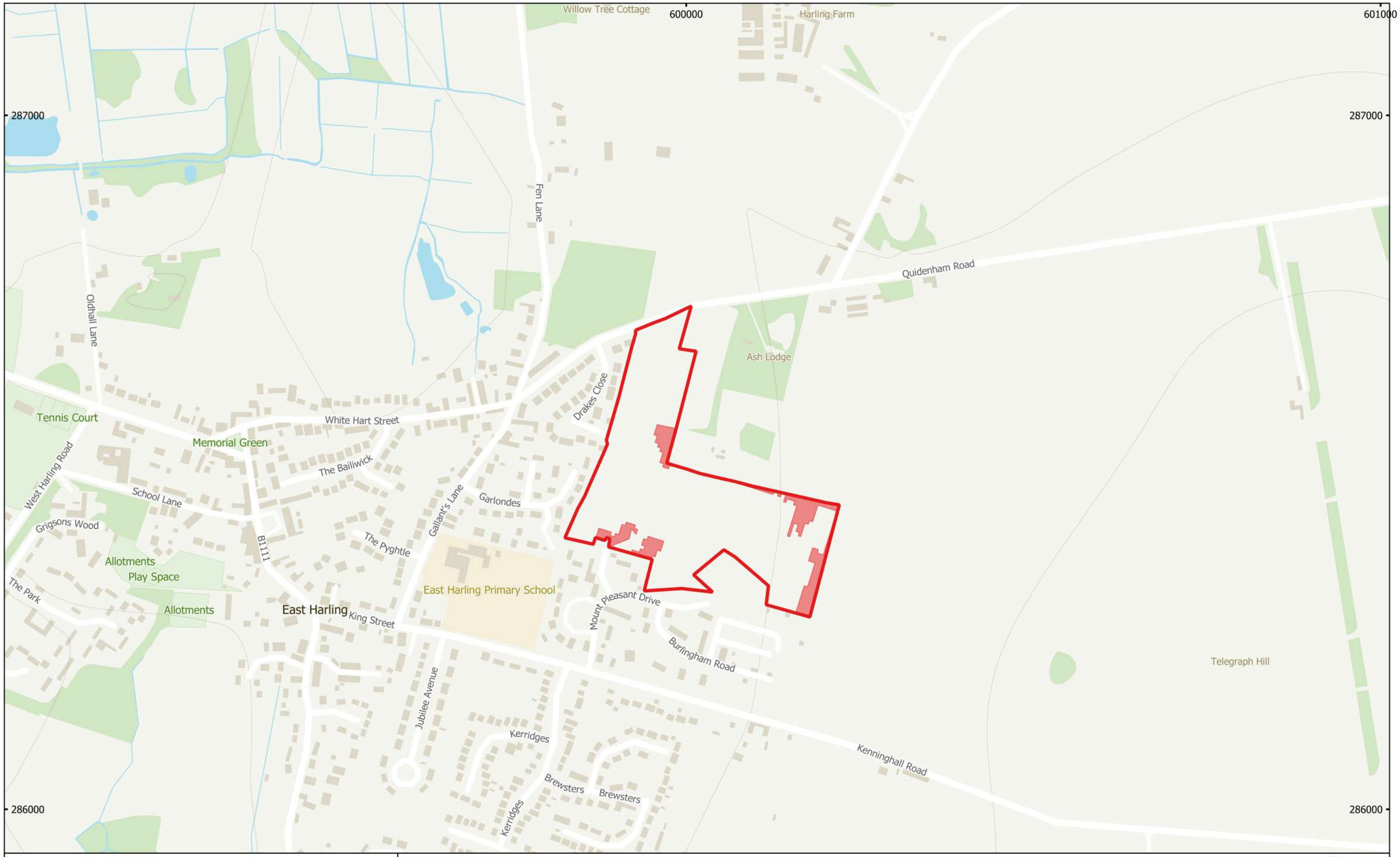
MSTL1174 - Land North of Kenninghall Road and South of Quidenham Road
East Harling, Norfolk
Figure 1 - Site Location
1:25,000 @ A4

Site Boundary

N

0 0.5 1 km

magnitude surveys



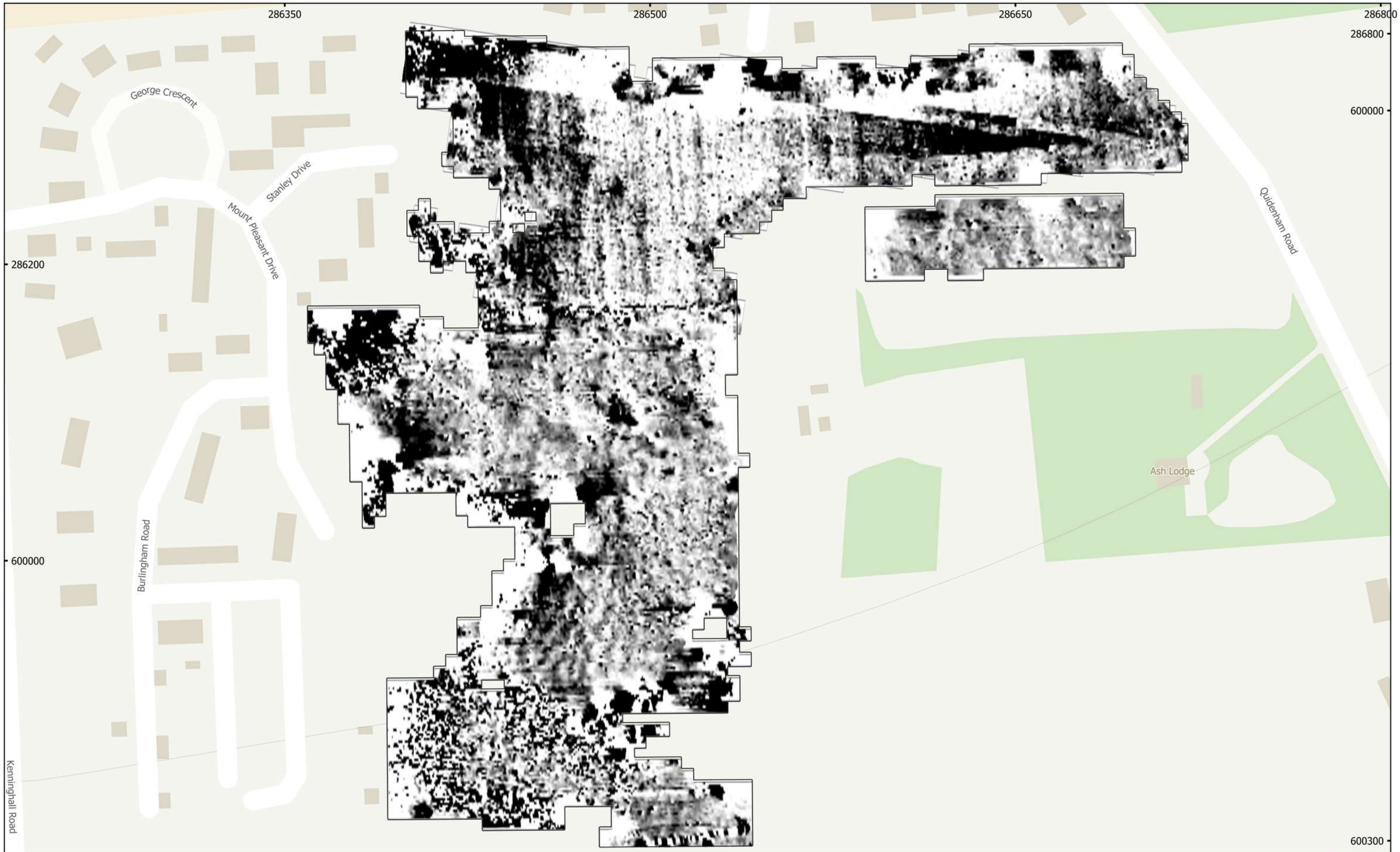
MSTL1174 - Land North of Kenninghall Road and South of Quidenham Road
East Harling, Norfolk
Figure 2 - Location of Survey Area
1:5,000 @ A3

Site Boundary
Unsurveyable Areas

N

0 100 200 300 m

magnitude surveys



MSTL1174 - Land North of Kenninghall Road and South of Quidenham Road
East Harling, Norfolk
Figure 3 - Total Field (Lower Sensor)
1:1,500 @ A3

48,998 nT 49,003

N

0 50 100 150 m

magnitude surveys

MSTL1174 - Land North of Kenninghall Road and South of Quidenham Road
East Harling, Norfolk
Figure 4 - Magnetic Gradient
1:1,500 @ A3

-1 nT 2

N

0 50 100 150 m

magnitude surveys

286350
286500
286650
286800
286800
600000
286200
600000
600300
George Crescent
Stanley Drive
Mount Pleasant Drive
Burlingham Road
Kenninghall Road
Quidenham Road
Ash Lodge

MSTL1174 - Land North of Kenninghall Road and South of Quidenham Road
East Harling, Norfolk
Figure 5 - Magnetic Interpretation
1:1,500 @ A3

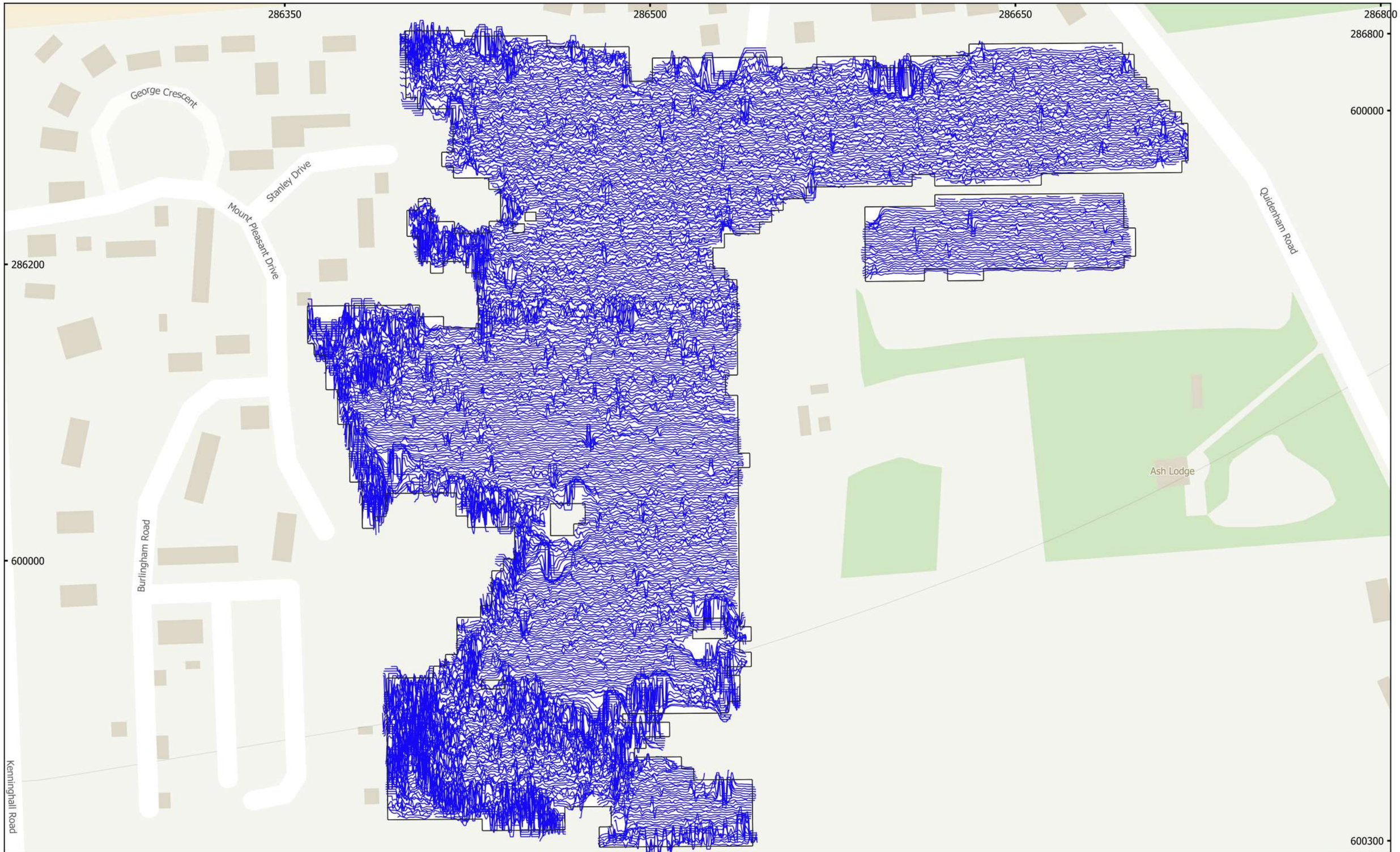
interpretation_poly
- Agricultural (Weak)
- Magnetic Disturbance
- Ferrous/Debris (Spread)
- Natural (Spread)
- Undetermined (Weak)

interpretation_line
- Agricultural (Trend)
- Service
- Drainage Feature
- Ferrous (Spike)

N

0 50 100 150 m

magnitude surveys



MSTL1174 - Land North of Kenninghall Road and South of Quidenham Road
East Harling, Norfolk
Figure 6 - XY Trace Plot
30nT/cm at 1:1,500 @ A3

N

0 50 100 150 m

magnitude surveys

286200
286500
286800
599850
599850
600300
285900
EAST HARLING
B.M.74·8
B.M.90·6
B.M.104·7
B.M.101·2
Windmill
Limekiln House
F.P.
G.P
105
103
W

MSTL1174 - Land North of Kenninghall Road and South of Quidenham Road East Harling, Norfolk
Figure 7 - Magnetic Interpretation Over Historical Maps and Satellite Imagery
1:2,500 @ A3

Contains historical mapping © CLS Data 2022: Ordnance Survey, 6" 2nd edition c. 1882-1913
Contains satellite imagery © Bing Satellite 2022

interpretation_poly
- Agricultural (Weak)
- Magnetic Disturbance
- Ferrous/Debris (Spread)
- Natural (Spread)
- Undetermined (Weak)

interpretation_line
- Agricultural (Trend)
- Service
- Drainage Feature
- Ferrous (Spike)

N

0 50 100 150 m

magnitude surveys

Summary for magnitud1-504210

OASIS ID (UID)	magnitud1-504210
Project Name	Geophysical Survey Report on Land North of Kenninghall Road and South of Quidenham Road, East Harling, Norfolk
Sitename	
Activity type	Magnetometry Survey
Project Identifier(s)	MSTL1174
Planning Id	3PL/2019/1076/O
Reason For Investigation	Planning: Pre application
Organisation Responsible for work	Magnitude Surveys Ltd
Project Dates	03-Mar-2022 - 10-Mar-2022
Location	Land North of Kenninghall Road and South of Quidenham Road, East Harling, Norfolk NGR : TM 00009 86457 LL : 52.4394661619589, 0.94115545117073 12 Fig : 600009,286457
Administrative Areas	Country : England County : Norfolk District : Breckland Parish : Harling
Project Methodology	1.2.The geophysical survey comprised quad-towed and hand-carried GNSS-positioned fluxgate gradiometer survey. Magnetic survey is the standard primary geophysical method for archaeological applications in the UK due to its ability to detect a range of different features. The technique is particularly suited for detecting fired or magnetically enhanced features, such as ditches, pits, kilns, sunken featured buildings (SFBs) and industrial activity (David et al., 2008).
Project Results	8.1.A fluxgate gradiometer survey was successfully completed across the survey area with 0.4ha unable to be surveyed due to dense scrub in the area. Modern interference was detected from services and housing around the border of the survey area. 8.2.Anomalies related to agricultural use of the survey area have been detected in the western part of the survey area in the form of possible ridge and furrow. 8.3.Natural anomalies produced by variations in the underlying soil and chalk geology have been identified. 8.4.Some anomalies were interpreted and classified as “undetermined” as they could have an archaeological, agricultural, or even natural origin.
Keywords	Ridge And Furrow - UNCERTAIN - FISH Thesaurus of Monument Types
Funder	
HER	Norfolk HER - unRev - STANDARD
Person Responsible for work	Vesna, Kozinc, India, Terry
HER Identifiers	HER Event No - ENF152098
Archives	