magnitude surveys

Geophysical Survey Report

Grange Farm – Phase 3, Areas P, Q & R

Mid Suffolk

For

HCUK Group

On Behalf Of

PACE Nano Energy Limited

Magnitude Surveys Ref: MSTM1114A

OASIS Number: TBC

Parish Code: PAL075

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Abstract

Magnitude Surveys was commissioned to access the subsurface archaeological potential of a c. 21.5ha area of land at Grange Farm, Mid Suffolk. A fluxgate gradiometer survey was successfully completed across the survey area, of which c.1.4ha was not surveyed due to difficult ground conditions. Possible archaeological activity has been identified, with anomalies of curvilinear morphology suggestive of a ring ditch present. Agricultural features including former mapped and unmapped field boundaries, and modern ploughing have been identified. Some anomalies classified as 'Undetermined' were detected within the survey area and archaeological interpretations for these cannot be excluded. The impact of modern activity on the site is limited to magnetic interference around field perimeters and that caused by pylons and overhead cables.

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1. Introduction

1.1. Magnitude Surveys Ltd (MS) was commissioned by HCUK Group on behalf of PACE Nano Energy Limited to undertake a geophysical survey over a c. 21.5ha area of land at Grange Farm, Mid Suffolk (TM 10831 77565).

1.2. The geophysical survey comprised cart-mounted 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 (Chmielowska, 2022).

1.5. The survey commenced on 14/2/22 and took four days to complete.

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 west of Palgrave (Figure 1). Gradiometer survey was undertaken across 3 fields under arable cultivation. The survey area was bordered to the north by Lion Road, to the south by Old Bury Road, and to the east and west by hedges (Figure 2). Around 1.4ha of the survey area was not surveyed due to difficult ground conditions.

4.2. Survey considerations:

Survey Area	Ground Conditions	Further Notes
1	The ground consisted of a muddy field with harvested stubble of corn in the eastern half, open unplanted land in the west, and grass to the northwest. The land sloped down to the bottom of the field.	The area was surrounded by trees and hedges on all sides and Old Bury Road to the south. Overhead telephone lines ran from the southern boundary across the field to the north-west. An electric pylon was located in the southeastern corner of the survey area.
2	The survey area consisted of a recently planted arable field. The field featured areas of mud and water that were unsurveyable. The field had a small slope across the middle sloping down to the southern end.	The area was surrounded by trees and hedges on all borders. The western edge of the field was also bordered by unharvested corn. The eastern border comprised long grass. A metal fence ran the length of the northern boundary, beyond which was Lion Road.
3	The field consisted of an agricultural field that was unplanted. A slope ran across the field from the middle, sloping down to the southern border.	The area was surrounded by trees and hedges on the southern and western boundaries. An area of unharvested corn ran along the western boundary. The eastern boundary was open to the remainder of the field. A public footpath ran along the northern boundary, which comprised a series of hedges and beyond this was Lion Road. An electric pylon was located outside the survey area and the overhead cables ran across the northeastern corner of the area.

4.3. The underlying geology comprises chalk from the Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation and Portsdown Chalk Formation across the whole survey area. Superficial deposits consist of diamicton from the Lowestoft Formation across the north of Areas 2 & 3, and sand and gravel from Croxton Sand and Gravel Member across Area 1 and the remainder of Areas 2 & 3 (British Geological Survey, 20222022).

4.4. The soils consist of slightly acid, loamy and clayey soils with impeded drainage in Area 1 and the south of Areas 2 & 3 and freely draining, slightly acid, sandy soils in the north of Areas 2 & 3 (Soilscapes, 20222022).

5. Archaeological Background

5.1. The following is a summary of a heritage and archaeological assessment produced and provided by HCUK Group (Vallance and Jones, 2022).

5.2. An evaluation and excavation were carried out 350m to the west of the survey at St John's House Hospital, Lion Road. An excavation identified scattered prehistoric finds and evidence of activity on the site throughout the Roman period, with a series of ditches, a possible palisade or fence line and a substantial rubbish pit. Evidence for an Early Saxon burial was also found as well as features relating to a post-medieval range of ancillary buildings and yards.

5.3. Several prehistoric finds have been recorded around the survey area including Mesolithic flint found approximately 300m to the north of the survey area; a possible Mesolithic hut site or ditch with cut deer antlers and flint flakes found under a road in a peaty deposit approximately 500m to the east, and a scatter of Late Neolithic/Early Bronze Age flints have been found approximately 700m to the southwest. Findspots from the around the survey area include a partly polished flint axe head, a polished flint axe, a flaked flint axe and a grooved axe, hammer or maul from Palgrave.

5.4. A possible small round-barrow from the bronze age, measuring 10 metres in diameter with visible surrounding ditch is recorded approximately 900m northwest from the survey area.

5.5. Roman finds include, scatters of flint-tempered pottery, a widespread scatter of occasional sherds 1km northwest from the survey area, and sherds of pottery recovered from a large field approximately 500m north east from the survey area.

5.6. Early Saxon artefact scatters comprising pot sherds and metal work were found by metal detectorists 650m southeast and 450m north east from the survey area.

5.7. The earliest post-medieval map of the survey area shows the area is peppered with small ponds and at least two lanes are shown to follow a course through the southern half of the survey area.

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 quad-towed cart system and hand-carried GNSS-positioned system.

6.1.4.1. 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.

6.1.4.2. 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.

6.1.4.3. 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 (Figures 7 & 10). 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 historical maps (Figure 4).

7.2.2. A fluxgate gradiometer survey was successfully completed across all but c. 1.4ha of the survey area, which could not be surveyed due to difficult ground conditions. The survey has responded well to the environment of the survey area. The geophysical survey has

detected a wide variation of anomalies related to possible archaeological activity, historical and modern agricultural activity as well as natural background. The impact of modern activity on the results is generally limited to magnetic interference from pylons, as well as fencing and metal objects at the edges of survey areas and overhead cables.

7.2.3. Possible archaeology has been identified in Area 3, consisting of an annular ditch-like anomaly surrounding an internal circular anomaly. In the landscape there is known archaeology with similar morphological characteristics, however the magnetic characteristics of this feature only provide a level of confidence supporting an interpretation as possible archaeology.

7.2.4. Evidence of agricultural activity has been detected across the survey area in the form of both mapped and unmapped field boundaries, including traces of what are likely to be older field systems which are not recorded on extant mapping. There is also evidence of ploughing trends.

7.2.5. Broad sinuous bands across parts of the survey area have been interpreted as natural variations, which are best seen in the Total Field data (Figure 3). The banding likely relates to the glaciofluvial conditions under which the superficial deposits were laid down and reflects differences in the composition and texture of said deposits.

7.2.6. Areas of strong magnetic interference have been identified in Areas 1 and 3 and these are related to the presence of modern electricity and telephone pylons.

7.2.7. Throughout most of the survey area anomalies that have been classified as 'Undetermined' have been identified. All of these anomalies have limited context or lack any clear pattern of morphology to enable a confident interpretation. Nevertheless, an archaeological origin cannot be excluded.

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.

7.3.2. Magnetic Results - Specific Anomalies

7.3.2.1. **Possible Archaeology (Weak) –** In the southeast of Area 3, an annular anomaly **[3a]** surrounding a central anomaly has been identified (Figures 5 & 6). These anomalies exhibit a weak, positive magnetic signal, which is indicative of a cut feature. They are not marked on any available historical mapping, nor in satellite imagery. With an exterior diameter of c.13m, and interior diameter of c.10m, this curvilinear morphology is suggestive of a possible ring ditch feature and is therefore classified as being of possible archaeological origin.

7.3.2.2. **Agricultural (Weak & Strong) –** Strong linear anomalies have been identified across the survey area. These anomalies broadly align with field boundaries recorded on Ordnance Survey mapping (Figures 4). Some of the identified anomalies are not associated with any of the boundaries recorded on the historical mapping but are characterized by the same magnetic signal as the above-mentioned. The group of weak, linear anomalies **[2a]** identified in the central section of Area 2 have been interpreted as former unmapped field boundaries that might represent a field pattern pre-dating that depicted on historical maps.

7.3.2.3. **Agricultural (Trend) –** Several strong linear anomalies have been identified crossing Area 2. These anomalies are consistent with agricultural ploughing trends, their date of origin cannot be identified. Some of these correspond with modern ploughing visible on satellite imagery.

7.3.2.4. **Natural (Weak and Spread) –** Across all survey area, weak bands of natural anomalies were identified (Figures 5, 6, 8 & 9). Several diffuse areas in the north of Areas 2 & 3 could be attributed to changes in the superficial deposits in the geology. The banded areas of weak natural anomalies could be correlated with sloping topography identified in the survey area.

7.3.2.5. **Undetermined (Strong/ Weak) –** Several discrete anomalies have been identified that all have similar magnetic signals. These anomalies are all linear in nature. In Area 2 a stronger curvilinear feature has been identified. All of these anomalies have limited context and no distinctive signal or shape, but an archaeological origin cannot be ruled out.

8. Conclusions

8.1. A fluxgate gradiometer survey was successfully completed across all but c. 1.4ha of the c. 21.5ha survey area. Magnetic disturbance was limited to haloes caused by fencing, pylons and service

lines. Natural variations have been identified as sinuous bands and spread zones across the survey area.

8.2. The geophysical results identified an anomaly of possible archaeological origin. These anomalies likely represent the fill of cut features and have been interpreted as a possible ring ditch surrounding a central pit.

8.3. The geophysical results reflect the continued long-term agricultural use of the survey area in the form of former mapped and unmapped field boundaries. Evidence of ploughing was also identified across parts of the survey area.

8.4. Several anomalies have been classified as undetermined because it was not possible to definitively determine whether these anomalies are the result of archaeological, agricultural, or natural processes.

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

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12. Project Metadata

MS Job Code	MSTM1114A
Project Name	Grange Farm - Areas A, B, C, D, Mid Suffolk
Client	HCUK Group
Grid Reference	TM 10831 77565
Survey Techniques	Magnetometry
Survey Size (ha)	21.5ha (Magnetometry)
Survey Dates	2022-02-14 to 2022-02-17
Project Lead	Dr Anna Chmielowska PCIfA
Project Officer	Dr Anna Chmielowska PCIfA
HER Event No	N/A
OASIS No	TBC
S42 Licence No	N/A
Report Version	0.2

13. Document History

Version	Comments	Author	Checked By	Date
0.1	Initial draft for Project Lead to Review	MS	AC	23 February 2022
0.2	Corrections from Project Lead, draft for Director Approval	MS	PSJ	24 February 22

MSTM1114 - Grange Farm, Mid Suffolk, Areas P, Q, R
Figure 1 - Site Location
1:25,000 @ A4

Site Boundary

N

0 0.5 1 km

magnitude surveys

610000

611000

278000

278000

Palgrave

Crossing Road

Clarke Close

Priory Road

Lion Road

Area 3

Area 2

Area 1

East Cottage

A143

Old Bury Road

New Road

MSTM1114 - Grange Farm, Mid Suffolk, Areas P, Q, R
Figure 2 - Location of Survey Area
1:5,000 @ A3

Survey Extent

Unsurveyable

N

0 100 200 300 m

magnitude surveys

277400 277600 277800 278000 278200 278400

610600

610800

611000

Old Bury Road

A143

Lion Road

Area 1

Area 2

Area 3

MSTM1114 - Grange Farm, Mid Suffolk
Figure 3 - Total Field (Lower Sensor)
1:3,000 @ A3

48,997 nT 49,005

N

0 50 100 150 m

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MSTM1114 - Grange Farm, Mid Suffolk, Areas P, Q, R
Figure46 - Magnetic Interpretation Over Historical Maps and Satellite Imagery
1:3,000 @ A3

Agricultural (Weak)
Archaeology Possible (Weak)
Magnetic Disturbance
Natural (Spread)
Natural (Weak)
Undetermined (Weak)
Overhead Cables
Agricultural (Trend)
Drainage Feature
Ferrous (Spike)

N

0 50 100 150 m

magnitude surveys

278000
610750
611000
278250
278250
Lion Road
277750
Area 3
278000
611250
Area 2
MSTM1114 - Grange Farm, Mid Suffolk, Areas P, Q, R
Figure 5 - Magnetic Gradient (Areas 2 & 3)
1:1,500 @ A3

-1
nT
2
Lion Road
A143
N
0
40
80
120 m
magnitude surveys

278000 610750 Area 1 611000 278250

278250

Lion Road

2a

277750

Area 2

3a

Area 3

278000

611250

MSTM1114 - Grange Farm, Mid Suffolk, Areas P, Q, R
Figure 6 - Magnetic Interpretation (Areas 2 & 3)
1:1,500 @ A3

- Agricultural (Weak)
- Archaeology Possible (Weak)
- Magnetic Disturbance
- Natural (Spread)
- Natural (Weak)
- Undetermined (Weak)
- Overhead Cables
- Agricultural (Trend)
- Drainage Feature
- Ferrous (Spike)

N

0 40 80 120 m

magnitude surveys

278000
610750
611000
278250
278250
Lion Road
277750
Area 3
278000
611250
Area 2

MSTM1114 - Grange Farm, Mid Suffolk, Areas P, Q, R
Figure 7 - XY Trace Plot (Areas 2 & 3)
30nT/cm at 1:1,500 @ A3

N
0
40
80
120 m
magnitude surveys

610750

611000

Area 2

Area 1

277500

277500

A143

MSTM1114 - Grange Farm, Mid Suffolk, Areas P, Q, R
Figure 8 - Magnetic Gradient (Areas 1 & 2)
1:1,500 @ A3

-1 nT 2

N

0 40 80 120 m

magnitude surveys

610750

611000

Area 2

Area 1

277500

277500

A143

MSTM1114 - Grange Farm, Mid Suffolk, Areas P, Q, R
Figure 9 - Magnetic Interpretation (Areas 1 & 2)
1:1,500 @ A3

Agricultural (Weak)
Magnetic Disturbance
Natural (Weak)
Undetermined (Weak)
Agricultural (Trend)
Ferrous (Spike)

N

0 40 80 120 m

magnitude surveys

610750

611000

Area 2

Area 1

277500

277500

A143

MSTM1114 - Grange Farm, Mid Suffolk, Areas P, Q, R
Figure 10 - XY Trace Plot (Areas 1 & 2)
30nT/cm at 1:1,500 @ A3

N

0 40 80 120 m

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