magnitude surveys

Geophysical Survey Report

of

Land at Union Road,

Stowmarket, Suffolk

For

Pegasus Group

On Behalf Of

Endurance Estates

Magnitude Surveys Ref: MSTM448

OASIS Number: magnitud1-343262

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Draft 1.0	Initial internal draft	Alison Langston BA PCIfA	Lauren Bell BSc BSc MSc Alison Langston BA PCIfA	N/A	14 March 2019
Draft 1.1	Initial draft to line manager	Julia Cantarano Ingénieur PCIfA	Alison Langston BA PCIfA	Marta Fortuny BA MA	15 March 2019
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Final 2.1	Appendix added by county archaeologist request	N/A	N/A	Marta Fortuny BA MA	08 May 2019

Abstract

Magnitude Surveys was commissioned to assess the subsurface archaeological potential of a c. 8.5ha area of land at Union Road, Stowmarket, Suffolk. A fluxgate magnetometer survey was successfully completed, and anomalies of probable and possible archaeological origin have been identified. The magnetic enhancement on the site was generally low, with anomalies of possible archaeological origin having a similar contrast to the general variation produced by differences in the soils and geology on the site. Nevertheless, the analysis of the magnetic data for the northern part of the survey, combined with LiDAR and satellite imagery, suggests possible multiple earthwork features enclosing an area of higher ground. Only segments of the earthworks have been covered by the survey. Within the apparently enclosed area, one probable and one possible ring ditch have been identified c. 25m in diameter. There is a further possible ring ditch of similar dimensions in the north eastern corner of the survey, immediately outside a possible entrance complex in the enclosure earthworks. A second possible enclosure has been recorded in the southern part of the site. Anomalies related to recent agricultural activity (ploughing trends and headlands, rubbish dumping) and of undetermined origin have also been identified.

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1. Introduction

1.1. Magnitude Surveys Ltd (MS) was commissioned by Pegasus Group on behalf of Endurance Estates to undertake a geophysical survey on a c.8.5ha area of land at Union Road, Stowmarket, Suffolk (TM 02871 58760).

1.2. The geophysical survey comprised hand-carried GNSS-positioned fluxgate magnetometer survey.

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, 2014) and the European Archaeological Council (Schmidt et al., 2015).

1.4. This survey was conducted under a WSI created by Magnitude Surveys (2019).

1.5. The survey commenced on 25/02/19 and was completed on 07/03/19.

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 of Archaeological Prospection).

2.2. Director Dr. Chrys Harris is a Member of CIfA, has a PhD in archaeological geophysics from the University of Bradford and is the Vice-Chair of ISAP. Director Finnegan Pope-Carter is a Fellow of the London Geological Society, the chartered UK body for geophysicists and geologists, as well as a member of GeoSIG, the CIfA Geophysics Special Interest Group. Reporting Analyst Dr. Kayt Armstrong is a Member of CIfA, has a PhD in archaeological geophysics from Bournemouth University, is the Vice Conference Secretary and Editor of ISAP News for ISAP, and is the UK Management Committee representative for the COST Action SAGA.

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

3. Objectives

3.1. The geophysical survey aimed to assess the subsurface archaeological potential of the survey area.

4. Geographic Background

4.1. The site is located c.1km to the northwest of Stowmarket, Suffolk (Figure 1). Survey was undertaken in two areas of land separated by the B1115 road, each of them bounded on all sides by hedges and treelines. The northern area of the site gradually slopes to the south toward the B1115 road, while the southern area is largely flat (Figure 2).

4.2. Survey considerations:

Survey Area	Ground Conditions	Further Notes
1	Arable land, uneven. Deep furrows throughout. A deep ditch follows the northern and eastern boundary of the area.	Bounded on all sides by thick hedge and a treeline. A small area of uncultivated land lies to the northwest corner. Two service markers are located in this area.
2	Pasture; flat and overgrown.	Bounded by thick hedge and ditch to the west and north and a treelined stream to the south. A large area of unsurveyable overgrowth and debris bounded the eastern edge.

4.3. The underlying geology comprises sand-based sedimentary bedrock of the Crag Group. A Lowestoft Formation superficial deposit composed of sand and gravel overlies Area 1 and the northern part of Area 2. The southern area of Area 2 is composed of alluvial deposits from Rattlesden River (British Geological Survey, 2019).

4.4. The soils consist of lime-rich loam and clay with impeded drainage in Area 1 and alluvial loam and clay with naturally high groundwater in Area 2 (Soilscapes, 2019).

5. Archaeological Background

5.1. The following is a summary of the archaeological background as recorded by the Suffolk Heritage website (2019).

5.2. Prior to the survey, no archaeology was recorded within the survey area. To the immediate east of Area 1, fieldwalking and subsequent excavation revealed a complex of ditches dating from the Late Bronze Age to Early Iron Age. In addition to this, Roman and late medieval finds have surfaced in these fields (ONS 007), including a Roman coin located on the easternmost side (SKT 009). In the field directly to the north of the survey area, geophysical survey and trial trenching identified numerous probable post-medieval enclosures (ONS 012), and other features including a Roman Kiln and a Saxon cemetery (HGH 055).

5.3. C.1km to the west Finsborough Hall (FNG 013) which has a large area of land associated with the post-medieval estate, which extends as close as 130m away from the survey area. The Finsborough Hall and park estate contains find spots associated with Roman metalworking and medieval activity (FNG 043, FNG 044, FNG 046, FNG 051). In a field 250m directly to the south of Area 2, a Late Saxon coin was discovered by metal detecting at Boyton Hall Farm (FNG 018) and a Bronze-Age barbed and tanged flint arrowhead c.330m to the south was found by field walking (FNG 029).

6. Methodology

6.1. Data Collection

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

6.1.2. 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

6.1.3. The magnetic data were collected using MS' bespoke hand-carried GNSS-positioned system.

6.1.3.1. MS' 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.

6.1.3.2. 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.

6.1.3.3. 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 Historic England's standards for "raw or minimally processed data" (see sect 4.2 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 upper and/or 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 at different plotting ranges have been used for data interpretation. Greyscale images should be viewed alongside the XY trace plot (Figure 9). XY trace plots visualise the magnitude and form of the geophysical response, aiding in 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, historic maps, LiDAR data, and soil and geology maps. Google Earth (2019) was consulted as well, to compare the results with recent land usages.

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 will be 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 of further work in order to constantly improve our knowledge and service.

7.2. Discussion

7.2.1. The geophysical results are presented in consideration with satellite imagery (Figure 6), historic maps (Figure 7) and LiDAR (Figure 8).

7.2.2. The fluxgate magnetometer survey has responded well to the environment of the survey area. The magnetic data is characterised by a relatively quiet background, and a generally low enhancement, allowing for the detection of anomalies of possible and probable archaeological origin across the site. Magnetic disturbance from modern sources was limited to the edge of the field in the northern part of the site. Debris located in the small area south of the B1115 road may have obscured further anomalies in that part of the site, complicating the interpretation there. Evidence of agricultural activity has been detected as ploughing trends and linear anomalies. Two large dipolar anomalies were identified as modern after the study of the XY traces (Figure 9). Some anomalies were identified which could not be clearly interpreted, and may be of anthropogenic origin; these are marked ‘undetermined’.

7.2.3. Two distinct groups of anomalies interpreted as the remains of banks and ditches have been detected within the northern field. Similarities in the magnetic characteristics and the gently curving shape, and that they appear to be concentric, could indicate these belonged to the same archaeological feature. There is a more ambiguous western single arc that is also possibly part of the same complex. Within this possible bank and ditch enclosure, a distinct circular weakly positive 26m diameter anomaly is interpreted as a probable ring ditch. There are two further, less distinct examples, one within the southern part of the putative enclosure, and one immediately outside the possible entrance in the northern part of the survey. There are also numerous linear and discrete positive anomalies interpreted as further ditches and pits.

7.2.4. In the small area south of the B1115 road, anomalies of possible archaeological origin were also detected. These discrete positive linear anomalies form a discontinuous rectangular enclosure with a possible linear extension to the west. However, the presence of probable buried debris has rendered a more detailed interpretation more

challenging. The gap between the survey areas created by the road means it is not possible to say in the rectilinear enclosure could be linked to the large bank and ditch features detected in the area to the north. Additional small linear anomalies close to the debris spread zone were ambiguous and have been classified as undetermined.

7.2.5. Generally, the anomalies interpreted as being of archaeological origin have been detected across the site with more clarity in the Total Field data set (Figure 3). This is unusual, but can occur in specific circumstances: when the features responsible for the anomalies are large and deeply buried, or when the enhanced material causing the anomaly forms a lens or a layer rather than an infilled volume. It seems likely that the latter is the cause in this instance, possibly suggesting the remaining archaeological layers are thin and somewhat truncated.

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. **Magnetic Disturbance** – The strong anomalies produced by extant metallic structures along the edges of the field and or by services that cross the survey area. These magnetic haloes will obscure the response of any weaker underlying features, should they be present, often over a greater footprint that the structure they are being caused by.

7.3.1.3. **Ferrous (Spike)** – Discrete ferrous-like, dipolar anomalies are likely to be the result of isolated modern metallic debris on or near the ground surface.

7.3.1.4. **Ferrous/Debris (Spread)** – A ferrous/debris spread refers to a concentrated deposition of discrete, dipolar ferrous anomalies and other highly magnetic material. These are often, but not always, related to modern or historical agricultural activity.

7.3.1.5. **Undetermined** – Anomalies are classified as Undetermined when the anomaly origin is ambiguous through the geophysical results and there is no supporting or correlative evidence to warrant 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 not ferrous in nature.

7.3.2. Magnetic Results - Specific Anomalies

7.3.2.1. **Archaeology Possible** – A series of broad, elongated curvilinear anomalies (both positive and negative) have been interpreted as separate sets of banks and ditches in the north, west and south of Area 1 (Figure 5). Two distinct complexes [**1a & 1b**] have a similar magnetic signature characterised by a strongly positive and strongly negative band of measurements, with the polarity varying between the lines rather than along them as seen in modern services and

drains. The northern group of anomalies [**1a**] starts at the eastern boundary forming what we have interpreted as a parallel double ditch running west until their alignment diverges, with the northern one continuing roughly east-west while the other angles to the southwest. This group of anomalies is co-located with a local bank in the topography, as seen in the contours and LiDAR data (figure 8). The group in the south of Area 1 [**1b**] has a southwest-northeast orientation. The anomalies are strong and distinct, with the same alternating lines of positive and negative readings that remain parallel across the surveyed area. Another elongated curvilinear weak anomaly has been identified in the west of Area 1 [**1c**]. It does not show a clear positive and negative part, which might be explained by its proximity to the modern field boundary. Because of this and its location along a contour line (Figure 8) its identification as possible archaeology is less secure than for anomalies **[1a]** and **[1b]**. However, its positioning in relation to them and the overall topography may indicate that they are part of the same archaeological feature. Overall, the combined study of topography, LiDAR (Figure 8), satellite imagery (Figure 6), Gradient (Figure 4) and Total Field (Figure 3) suggests that collectively these anomalies might be part of same archaeological feature: a large (c. 270m) bank-and-ditch enclosure. From the magnetic data alone, it is not possible to assign a date to these anomalies. While this might be related to the probable ring ditches discussed below (7.3.2.2) and thus relate to prehistoric activity, it is also possibly part of the medieval landscape associated with the nearby Hall (5.3 above), such as a park pale or similar.

7.3.2.2. **Archaeology Probable** – Within and immediately outside the possible bank-and-ditch enclosure discussed above (7.3.2.1), several anomalies of probable archaeological origin have been detected. The most remarkable is a distinct positive circular linear, interpreted as ring ditch of c.26m in diameter [**1d**], which is also visible in the satellite imagery (Figure 6). Two further, weaker and discontinuous (but still distinct) circular positive anomalies of similar dimensions have also been identified. One is in the southern part of the possible bank and ditch enclosure **[1e]** and one lies immediately east of the northern bank and ditch complex, outside the possible enclosed area **[1f]**. Further less distinct positive anomalies interpreted as ditches and pits have been identified. A curving line of discrete strongly positive anomalies [**1g**] matches amorphous cropmarks visible in the satellite imagery (Figure 6) and are interpreted as a series of possible pits. Numerous smaller similar pit-like anomalies have been identified in the XY traces across Area 1, but without any apparent pattern or structure.

7.3.2.3. **Archaeology Possible** – A series of weakly positive linear anomalies have been identified in area 2 as being of possible archaeological origin [**2a**], as they form a discontinuous rectilinear enclosure abutting the eastern survey edge, with some internal anomalies. however buried debris has obscured part of the area with strong dipolar anomalies, which has made a more detailed interpretation impossible. It is not possible in the present context to determine if [**2a**] are

linked or related to the potentially archaeological anomalies detected in Area 1.

7.3.2.4. **Modern** – A strong anomaly in the north of Area 1 [**1h**] has been classified as modern after studying the XY trace (Figure 9). It does not correspond to anything recorded on the ground at the time on the survey. The magnetic signature suggests possible farm/industrial equipment buried in the near surface, rather than a jumble of small debris.

8. Conclusions

8.1. The geophysical survey responded well to the survey area's environment. Magnetic disturbance is limited to the boundaries of the survey areas, with spreads of debris across parts of Area 2 which have potentially obscured anomalies of different origin. The survey detected a range of anomalies of possible archaeological, agricultural and modern origin.

8.2. The analysis of the magnetic data in correlation with LiDAR derived terrain models, contours and satellite imagery has allowed for the identification of a possible bank-and-ditch enclosure of the hilltop of uncertain date. Within this, two probable ring ditches have been identified, with a further example outside the enclosure to the north east. The central area also contains numerous weaker anomalies interpreted as possible pits and ditches, some of which match cropmarks seen in satellite images of the site.

8.3. A spread of debris made the interpretation of Area 2 more difficult, but a possible rectilinear enclosure with internal features has been identified abutting the eastern survey area boundary.

8.4. Agricultural activity has been identified in the form of modern ploughing trends throughout the northern area, as well as agricultural headlands around the boundaries of the same area. The orientation of the ploughing trends follows the mapped field boundaries. Strong anomalies were also detected in the northern and eastern parts of Area 1 that have been interpreted as substantial modern ferrous debris.

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 the any dictated time embargoes.

10. Copyright

10.1. Copyright and the 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, 2019. Geology of Britain. [Stowmarket, Suffolk]. [http://mapapps.bgs.ac.uk/geologyofbritain/home.html/]. [Accessed 11/03/2019].

Chartered Institute for Archaeologists, 2014. 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, 2019. Google Earth Pro V 7.1.7.2606.

Magnitude Surveys Ltd, 2019. Written Scheme of Investigation for a Geophysical Survey of Land at Union Road Stowmarket, Suffolk. Magnitude Reference MSTM448.

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 ed., 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, 2019. [Stowmarket, Suffolk]. Cranfield University, National Soil Resources Institute [http://landis.org.uk]. [Accessed 11/03/2019].

MSTM448 Land at Union Road, Stowmarket
Figure 1 - Site Location
1:25,000 @ A4

Site Boundary

N

0 0.5 1 km

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Figure 2 - Location of Survey Areas
1:5,000 @ A3

Survey Extent

N

0 250 500 750 m

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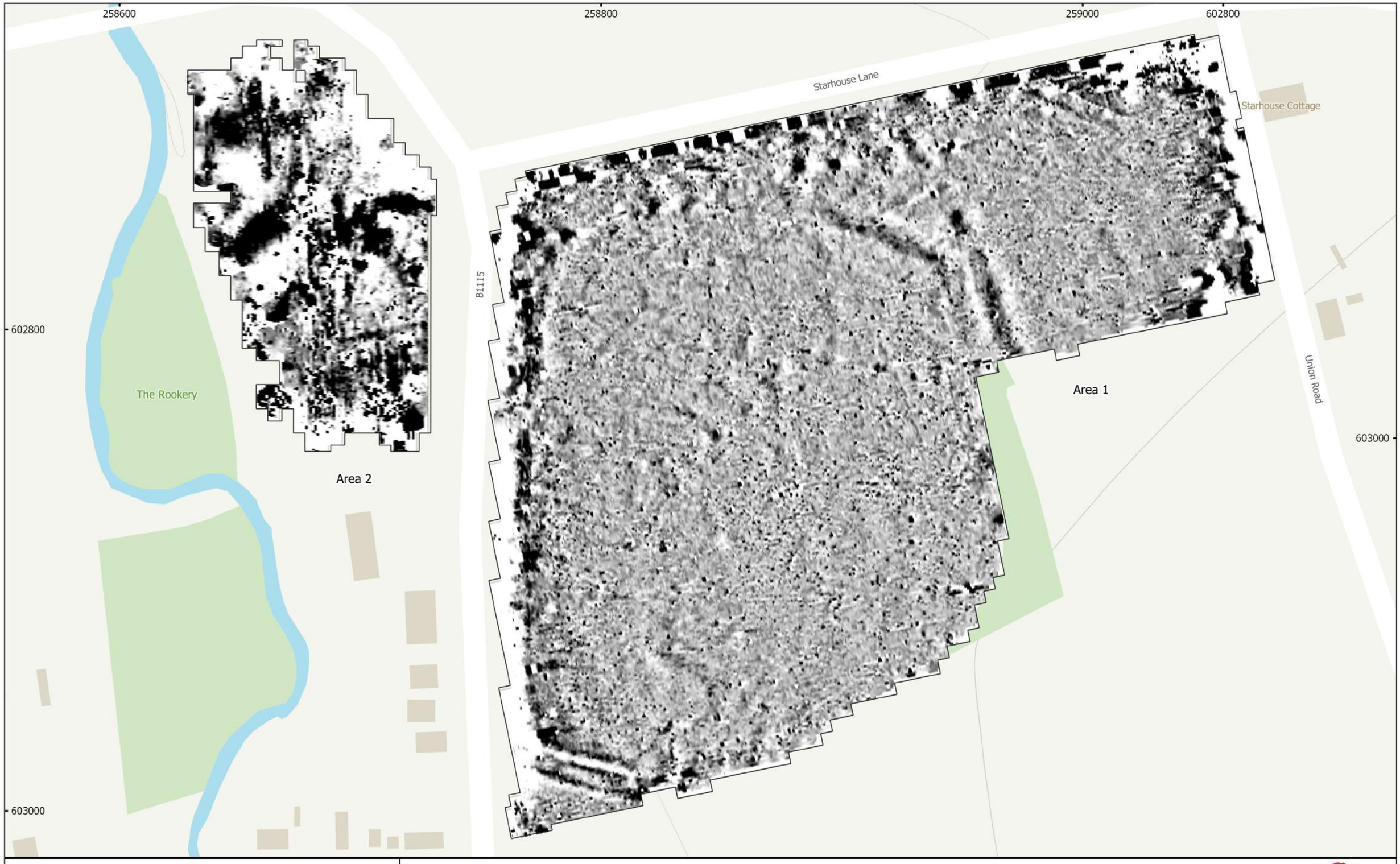

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Figure 3 - Magnetic Total Field (Lower Sensor)
1:1,500 @ A3

48,998 nT 49,003

N

0 25 50 75 100 m

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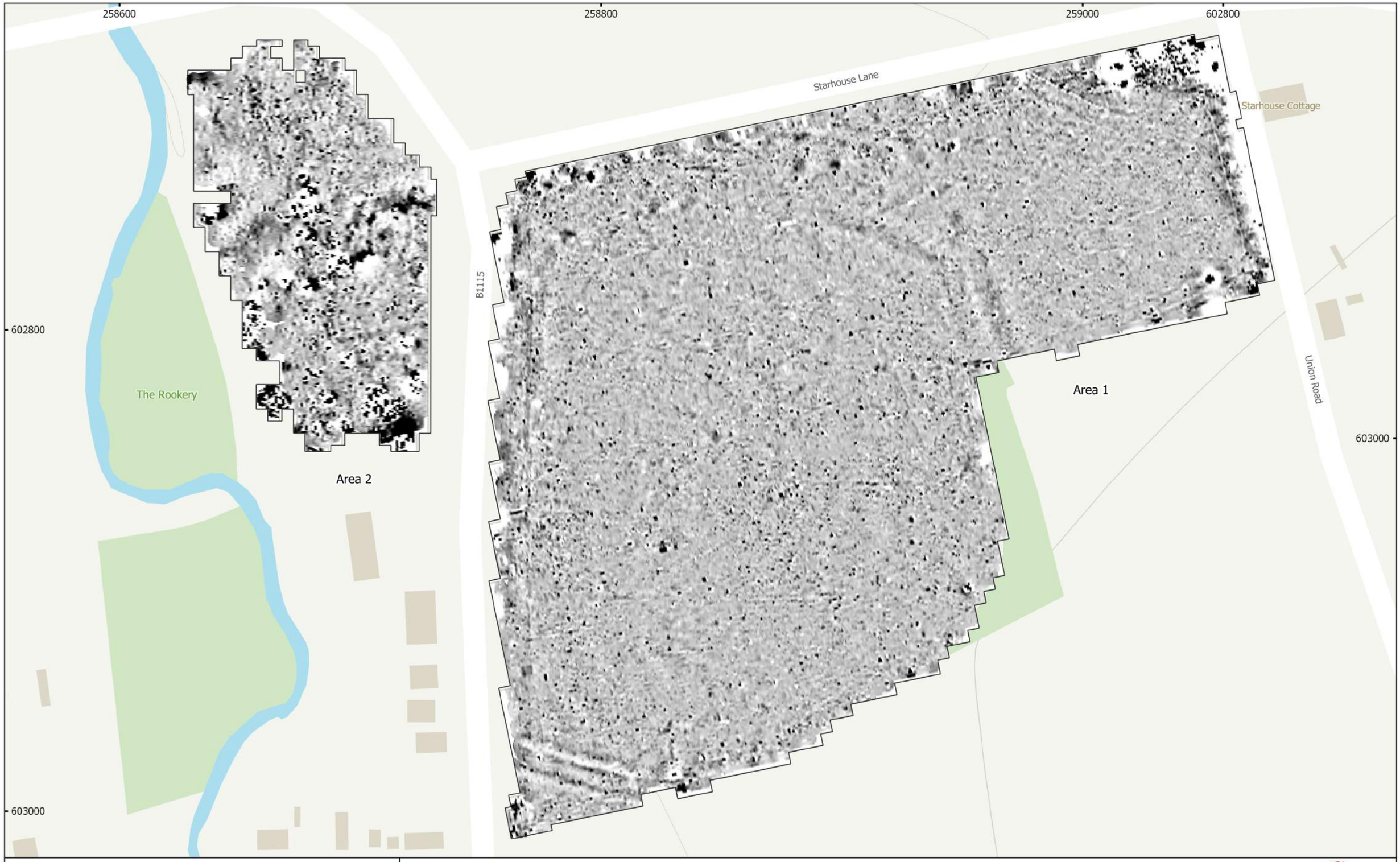

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Figure 4 - Magnetic Gradient
1:1,500 @ A3

-1 nT 2

N

0 25 50 75 100 m

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Figure 5 - Magnetic Interpretation
1:1,500 @ A3

- Archaeology Probable (Strong)
- Archaeology Probable (Weak)
- Archaeology Possible (Strong)
- Archaeology Possible (Weak)
- Agricultural (Weak)
- Magnetic Disturbance
- Ferrous/Debris (Spread)
- Natural (Weak)
- Industrial/Modern (Spread)
- Agricultural (Trend)
- Ferrous (Spike)

N

0 25 50 75 100 m

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Figure 6 - Magnetic Interpretation Over Satellite Imagery
1:2,500 @ A3

- Archaeology Probable (Strong)
- Archaeology Probable (Weak)
- Archaeology Possible (Strong)
- Archaeology Possible (Weak)
- Agricultural (Weak)
- Magnetic Disturbance
- Ferrous/Debris (Spread)
- Natural (Weak)
- Industrial/Modern (Spread)
- Agricultural (Trend)
- Ferrous (Spike)

N

0 40 80 120 160 m

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Figure 7 - Magnetic Interpretation Over Historic Maps
1:2,500 @ A3

Contains historic maps: Ordnance Survey, 6" 2nd edition c. 1882-1913 © National Library of Scotland

- Archaeology Probable (Strong)
- Archaeology Probable (Weak)
- Archaeology Possible (Strong)
- Archaeology Possible (Weak)
- Agricultural (Weak)
- Magnetic Disturbance
- Ferrous/Debris (Spread)
- Natural (Weak)
- Industrial/Modern (Spread)
- Agricultural (Trend)
- Ferrous (Spike)

N

0 40 80 120 160 m

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603000

259000

259000

Area 1

Area 2

603000

259000

259000

Area 1

Area 2

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Figure 8 - Magnetic Interpretation Over LiDAR (Composite DSM)
1:3,000 @ A3

- Archaeology Probable (Strong)
- Archaeology Probable (Weak)
- Archaeology Possible (Strong)
- Archaeology Possible (Weak)
- Agricultural (Weak)
- Magnetic Disturbance
- Ferrous/Debris (Spread)
- Natural (Weak)
- Industrial/Modern (Spread)
- 1m Contour Line

DTM over Hillshade

25 m.o.s.l. 65

N

0 70 140 210 m

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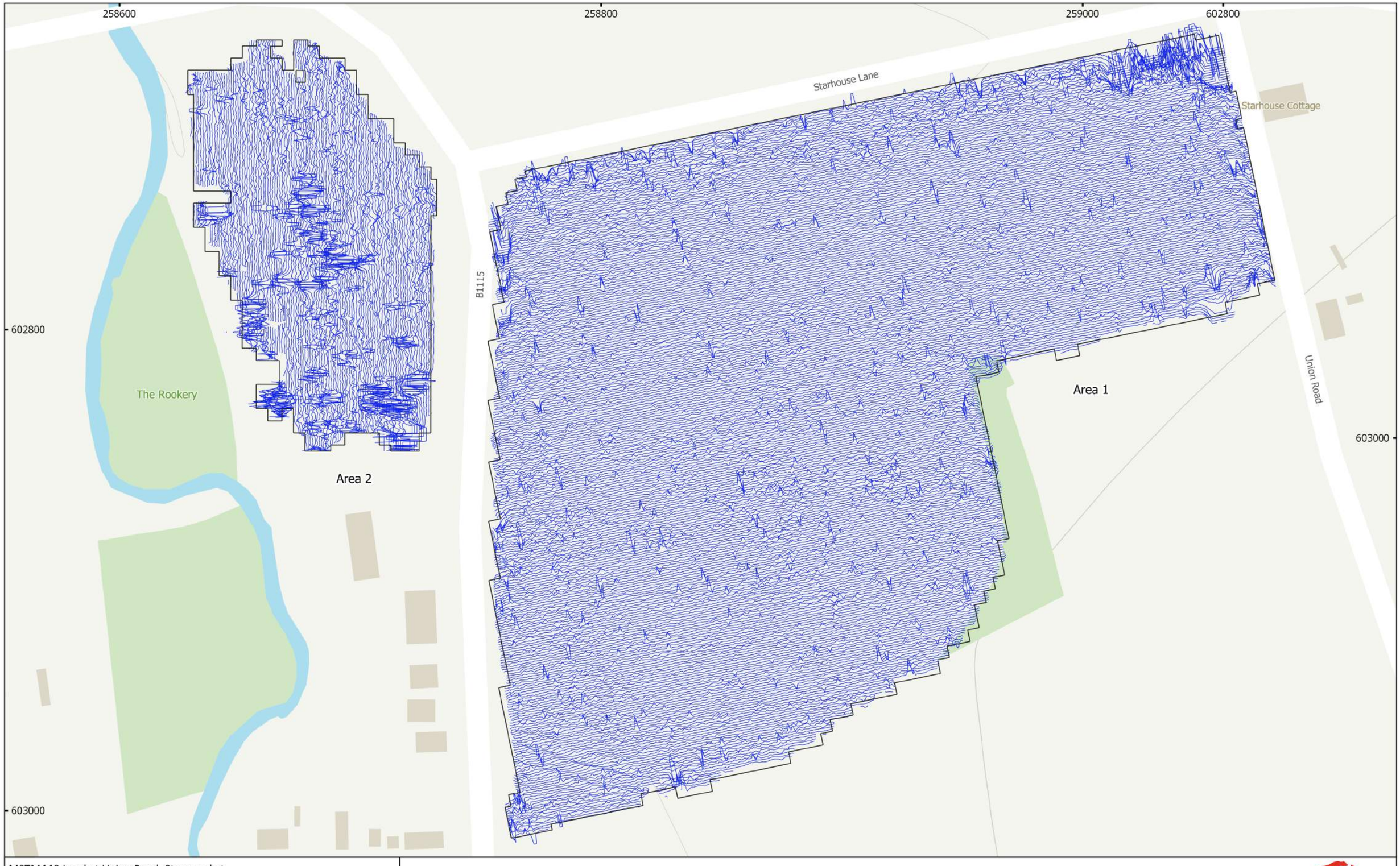

MSTM448 Land at Union Road, Stowmarket
Figure 9 - XY Trace Plot
30nT/cm at 1:1,500 @ A3

N

0 25 50 75 100 m

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Written Scheme of Investigation

For a Geophysical Survey

of

Land at Union Road

Stowmarket, Suffolk

For

Pegasus Group

On Behalf Of

Endurance Estates

Magnitude Surveys Ref: MSTM448

HER Event Number: TBC

OASIS Number: magnitud1-343262

February 2019

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1.0	WSI	Julia Cantarano Ingénieur PCIfA	Julia Cantarano Ingénieur PCIfA	Finnegan Pope-Carter BSc (Hons) MSc FGS	19 February 2019
1.0	Minor Corrections from Client	Julia Cantarano Ingénieur PCIfA	Julia Cantarano Ingénieur PCIfA	Finnegan Pope-Carter BSc (Hons) MSc FGS	20 February 2019

Contents

1. Introduction

1.1. This document details a Written Scheme of Investigation for a geophysical survey by Magnitude Surveys Ltd (MS) for Pegasus Group acting on behalf of Endurance Estates. The survey comprises a c.8.5 ha area of land at Union Road, Stowmarket, Suffolk (TM 02871 58760).

1.2. The geophysical survey will comprise hand-pulled, cart-mounted or hand-carried GNSS-positioned fluxgate gradiometer survey. Magnetic survey is the standard primary geophysical method for archaeological applications in the UK for 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 earth houses, and industrial activity (David *et al*., 2008).

1.3. The survey will be conducted in line with the current best practice guidelines produced by Historic England (David et al., 2008), the Chartered Institute for Archaeologists (2014) and the European Archaeological Council (Schmidt et al., 2015).

2. Objective

2.1. The objective of this geophysical survey is to assess the subsurface archaeological potential of the survey area.

3. Quality Assurance

3.1. Project management, survey work, data processing and report production have been carried out by qualified and professional geophysicists to standards exceeding the current best practice (CIfA, 2014; David *et al*., 2008, Schmidt *et al*., 2015). All MS managers, field and office staff have relevant degree qualifications to archaeology or geophysics and/or field experience.

3.2. 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 of Archaeological Prospection).

3.3. Director Dr. Chrys Harris is a Member of CIfA, has a PhD in archaeological geophysics from the University of Bradford and is the Vice-Chair of ISAP. Director Finnegan Pope-Carter is a Fellow of the London Geological Society, the chartered UK body for geophysicists and geologists, as well as a member of GeoSIG, the CIfA Geophysics Special Interest Group. Reporting Analyst Dr. Kayt Armstrong has a PhD in archaeological geophysics from Bournemouth University, is the Vice Conference Secretary and Editor of ISAP News for ISAP, and is the UK Management Committee representative for the COST Action SAGA.

3.4. MS has developed a bespoke geophysical system whereby data is live-streamed from the field back to the office while fieldwork is ongoing. This allows for data to be regularly monitored not only in the field, but by managers in a controlled office environment. Coverage gaps or small errors within the data can be quickly identified and rectified, improving quality control of field survey. The live data streaming allows MS to provide processed data to the client at regular intervals, allowing all parties to be informed of the field survey's progress. Should it become apparent that the survey is being compromised by local conditions, such as the spreading of

green waste, this will be reported back to the client and a mitigation strategy can be devised if necessary.

4. Risk Assessment

4.1. MS' standard magnetic fieldwork risk assessment and site-specific risk assessment have been appended to the end of this document. Before geophysical survey will commence, a brief walkover will be undertaken to identify any additional hazards of an unusual or site-specific nature. If any additional hazards are identified, the site-specific risk assessment will be updated to include these hazards and all surveyors will be informed of the risk. If appropriate mitigation factors cannot be put in place, then the field or part thereof will not be surveyed.

4.2. Field staff will attend a site induction if required. Necessary PPE will be supplied and worn. Wet and cold/hot weather protection is also supplied.

4.3. All surveyors have been issued company mobile phones. Survey teams are expected to make regular contact with the office to keep all parties updated with survey progress. Any change in conditions that may affect the health and safety of the survey team must be reported immediately.

4.4. The survey van contains suitable welfare facilities. Antiseptic hand gel is provided, as is bottled drinking water. A first aid kit is stored in the cab of the van, with a second kit near personnel within the survey area.

4.5. The nearest NHS urgent care centre is at West Suffolk Hospital, Hardwick Lane, Bury St. Edmunds Suffolk, IP33 2QZ. Should toilets be unavailable on site the nearest public accessible toilet is located at 26 Finborough Rd, Stowmarket, IP14 1PR.

5. Methodology

5.1.Data Collection

5.1.1. Geophysical survey will comprise the magnetic method as described in the following table.

5.1.2. Table of survey strategies:

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

5.1.3. Magnitude Surveys employs a modular cart system, which can easily be configured to be pulled by hand, or carried depending on what is most suitable for the site configuration and conditions. Consisting of a cart frame, and backpack system survey can be undertaken should conditions preclude survey with the wheels. The hand carried system retains all of the advantages of a cart system because it is still GNSS positioned and the sensors are maintained at a consistent height.

5.1.4. Magnetic data will be collected using MS' bespoke, hand-pulled cart system or hand-carried GNSS-positioned system. MS' cart or hand-carried system will be comprised of

Bartington Instruments Grad 13 Digital Three-Axis Gradiometers. Positional referencing will be 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.

5.1.5. Magnetic and GPS data will be stored on an SD card within MS' bespoke datalogger. The datalogger is continuously synced, via an in-field Wi-Fi unit, to servers within MS' offices. This allows data collection, processing and visualisation to be monitored in real-time as fieldwork is ongoing (see 3.6).

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

5.2.Data Processing

5.2.1. Magnetic data will be processed in bespoke in-house software produced by MS. Processing steps conform to Historic England's standards for "raw or minimally processed data" (see sect 4.2 in David et al., 2008: 11). Data plots contained within the report conform to Historic England's standards for minimally processed data.

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

Zero Median Traverse – The median of each sensor traverse will be 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 will be 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 will be interpolated using a bicubic algorithm to increase the pixel density between sensor traverses. This produces images with square pixels for ease of visualisation.

5.3.Data Visualisation and Interpretation

5.3.1. The report will present the gradient of the sensors' total field data as greyscale images, as well as the total field data from the upper and/or 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 at different plotting ranges will be used for data interpretation.

5.3.2. Geophysical results will be interpreted using greyscale images and XY traces in a layered environment, overlaid against OS Open Data, satellite imagery, historic maps, LiDAR

data, and soil and geology maps. Google Earth (2019) will be consulted as well, to compare the results with recent land usages.

5.3.3. Geodetic position of results - All vector and raster data will be projected into OSGB36 (ESPG27700) and provided upon request in ESRI Shapefile (.SHP) and Geotiff (.TIF) respectively. Figures will be provided with raster and vector data projected against OS Master Mapping.

6. Reporting

6.1. A detailed report of the survey will be produced after data collection is completed. The Planning Archaeologist will be provided with a draft report for approval, and the approved report will be submitted to the HER. The final report will include as standard:

- Abstract
- Introduction – Details site location and client details.
- Quality Assurance – Details the expertise of Magnitude Surveys and Magnitude Surveys employees undertaking the work.
- Objectives—Details survey objectives.
- Geographic Background – Details the soils and geology of the survey area, as well as providing a general summary of site conditions at time of survey.
- Archaeological Background – Details a brief summary of the archaeological and historical background of the site and its immediate environs. While this will not be an exhaustive assessment of the known sites, it will draw on elements relevant to the results obtained during survey.
- Methodology—Details survey strategy employed, instruments used, data collection strategy, data processing and visualisation methods.
- Survey Considerations – Details specific points of note for each survey area, including topography, upstanding obstructions or neighbouring objects.
- Results—Details the results and interpretation of the geophysical survey, both in a general context and discusses specific anomalies of archaeological interest. Geophysical reports will be discussed in consideration with satellite imagery, historic mapping and LiDAR data—if freely available—as supporting interpretative evidence.
- Conclusions
- Archiving
- Copyright
- References
- Figures—The site location and individual survey areas will be presented. Georeferenced greyscale images of the minimally processed data, XY traces and corresponding interpretations will be displayed at appropriate scales. Interpretations will also be displayed over satellite imagery, historic mapping and LiDAR—as applicable—to provide

further context to the interpretations. All figures will include a detailed scale bar, north arrow and key.

7. Archiving

7.1. MS maintains an in-house digital archive, which is based on Schmidt and Ernenwein (2013). This archive stores the collected measurements, minimally processed data, georeferenced and un-georeferenced images, XY traces and a copy of the final report. A copy of this archive will be included in a disk with the final printed report.

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

7.3. An OASIS form will be filled in on completion of the survey, providing permission from the client.

8. Copyright

8.1. Copyright and the 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.

9. References

Chartered Institute for Archaeologists, 2014. Standards and guidance for archaeological geophysical survey. CIfA.

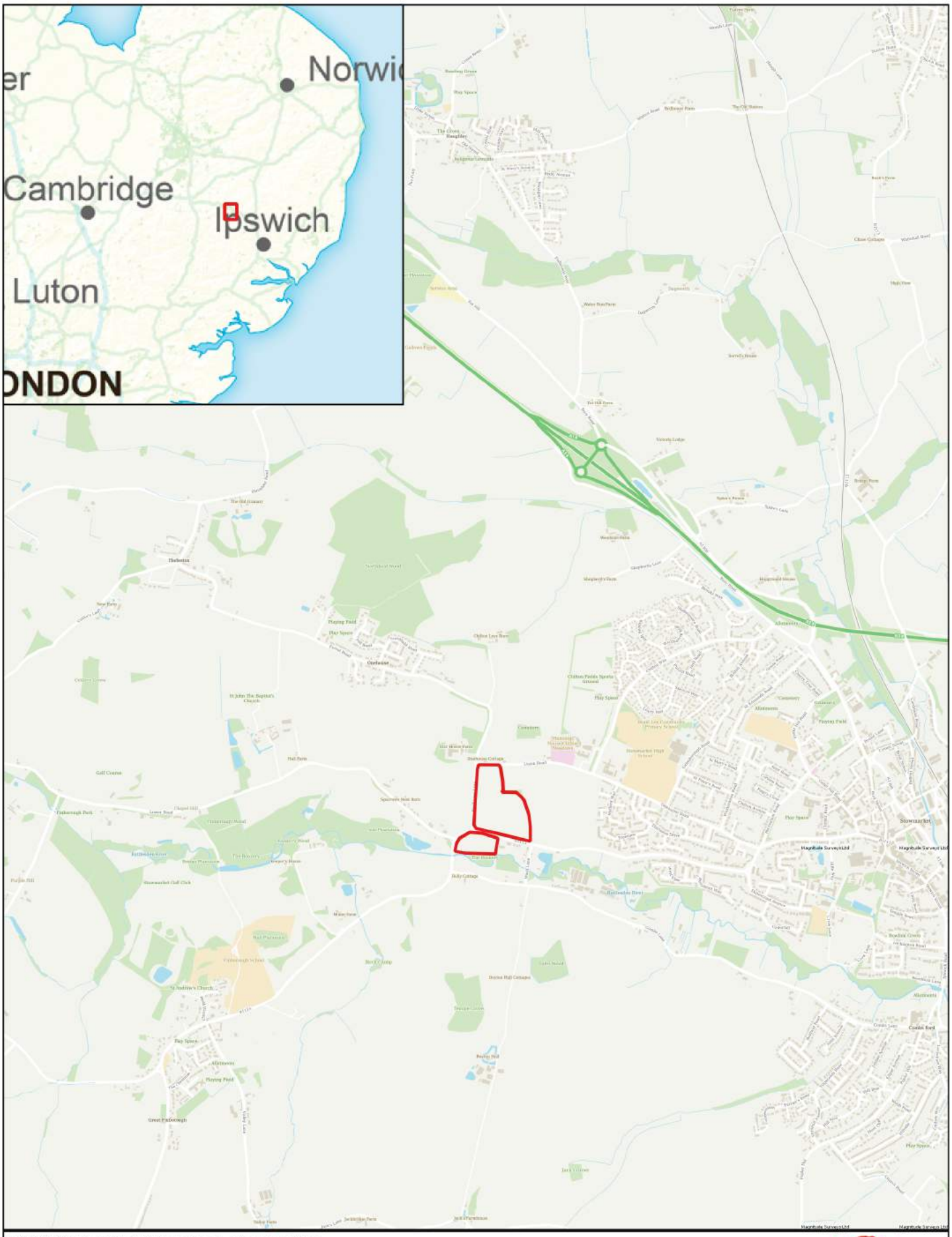
David, A., Linford, N., Linford, P. and Martin, L., 2008. Geophysical survey in archaeological field evaluation: research and professional services guidelines (2nd edition). Historic England.

Google Earth, 2019. Google Earth Pro V 7.1.7.2606.

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 ed., 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.



MSTM448 Land at Union Road, Stowmarket
Figure 1 - Site Location
1:25,000 @ A4

OS

Site Boundary

N

0 0.5 1 km

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602000

603000

604000

259000

259000

MSTM448 Land at Union Road, Stowmarket
Figure 2 - Location of Survey Area
1:6,000 @ A3

Survey Extent

N

0 100 200 300 m

magnitude surveys

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STANDARD MAGNETIC FIELDWORK RISK ASSESSMENT

Likelihood of Accident/Incident Occurring	Severity of Consequences
1. Highly improbable 2. Probable – annually 3. Infrequent – 2-3 times/year 4. Occasional – monthly 5. Frequent – weekly	1. Minor injury minor damage to plant/equipment/buildings 2. Injury (no time lost) damage repair costs are low 3. Injury (time lost) high damage repair costs 4. Major reportable injury very high damage repair costs 5. Fatality major damage and major costs

Details of tasks to be carried out	Potential Hazard	A Likelihood	B Severity Rating	Overall Risk Rating A x B	Control Measures	Action	Revised Risk Rating
Driving company vehicle	Losing control of vehicle, sudden breaking or swerving. Hitting another road user, pedestrian or stationary object.	2 2	5 5	10 Moderate 10 Moderate	Do not drive vehicle if feeling unwell or tired. Take regular breaks on long journeys. Take turns driving when working in groups. Try to avoid driving in adverse weather	If weather is severe pull over. Stay in a hotel if work has been delayed or weather conditions are extreme.	1x5=5 Low 1x5=5 Low
Parking company vehicle	Parking in an unsafe location, such as a blind corner or hidden dip or on the side of a major highway. Pausing while farm gates are opened in order to exit highway.	3 4	5 4	15 High 16 High	Where possible park off-road in car parks, farm yards, fields or lay-bys. If it is not possible to access a survey area in a safe manner, stop and make new arrangements, such as obtaining keys or codes to locked gates. Use vehicle lights, such as dipped headlights, and hazards. Avoid packing or unpacking the vehicles in the dark. When performing reversing procedures while entering or exiting fields, position a colleague in a safe place where they can be seen and heard in order to direct and	Wear high visibility clothing when working around vehicles. Use the floodlight when necessary and safe to do so. Return early during winter months to prevent working in dusk conditions Only stop on highway if safe to do so. Use hazard lights.	1x5=5 Low 1x4=4 Low

STANDARD MAGNETIC FIELDWORK RISK ASSESSMENT

Likelihood of Accident/Incident Occurring	Severity of Consequences
1. Highly improbable 2. Probable – annually 3. Infrequent – 2-3 times/year 4. Occasional – monthly 5. Frequent – weekly	1. Minor injury minor damage to plant/equipment/buildings 2. Injury (no time lost) damage repair costs are low 3. Injury (time lost) high damage repair costs 4. Major reportable injury very high damage repair costs 5. Fatality major damage and major costs

					communicate information on the road traffic.		
Loading and unloading the cart	Muscle strain, dropping equipment, slips trips and falls.	4	2	8 Moderate	Work in a pair, never lift the cart in or out on your own. Move the cart to the edge of the van and then lower to the ground. Never step out the van while lowering to the floor. Follow manual handling training.	Clear both the interior and surrounding van area before attempting to lift the cart in or out the van.	2x1=2 Low
Entering and commencing work in a new survey area	Coming into contact with unknown hazards in a new survey area.	4	2	8 Moderate	Where possible, arrange for livestock to be removed from survey areas before work is begun. Liaise with farmer with regard to livestock. Complete a walkover survey and dynamic risk assessment of the survey area to identify any hidden or unusual hazards, remove or reduce the hazard as best as possible and inform all other staff members of both the hazard and the measures that are being implemented to minimise the risk.	Provide a project questionnaire a to be completed by the client before commencement of fieldwork to reduce or eliminate hazards before commencing fieldwork.	2x1=2 Low
Balancing the magnetic sensors	To complete the sensors' calibration requires the cart to be lifted and turned upside down.	4	3	12 Moderate	When the cart must be lifted, ensure it is set up by two people. Before the cart is lifted, a set of steps and commands should be agreed, who will perform each step and when. If either party feels uncomfortable with the procedure, they should immediately let their partner now and safely put the cart down together.		3x2=6 Low

STANDARD MAGNETIC FIELDWORK RISK ASSESSMENT

Likelihood of Accident/Incident Occurring	Severity of Consequences
1. Highly improbable 2. Probable – annually 3. Infrequent – 2-3 times/year 4. Occasional – monthly 5. Frequent – weekly	1. Minor injury minor damage to plant/equipment/buildings 2. Injury (no time lost) damage repair costs are low 3. Injury (time lost) high damage repair costs 4. Major reportable injury very high damage repair costs 5. Fatality major damage and major costs

					The cart should not be lifted in high winds or when the ground is slippery underfoot.		
Surveying with the cart	Slips, trips and falls while walking with instrument. Strains to muscles while pulling cart.	4	3	12 Moderate	Care taken when working in field. Work not to be undertaken where there are poor field conditions, such as heavy plough or thick vegetation - where a clear view of the underfoot condition is not possible.	Safety survey boots to be worn while walking. Warm up/ down in cold conditions.	3x2=6 Low
Working in all weather conditions.	Hypothermia and heat stroke.	3	3	9 Moderate	Stop survey and take shelter in heavy rain and strong wind to avoid accidents and illness. Take regular breaks in hot weather.	Appropriate PPE to be worn, full waterproofs and safety boots are provided. Make use of the provided, water, sun tan lotion and aftersun. Wear a hat.	3x1=3 Low

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SITE SPECIFIC RISK ASSESSMENT

Project Name: Project No:

Client: Assessor:

Date of Survey: Signature:

Description:

Hazard	Who could be harmed?	Mitigation strategies?	Any further action required?	Who should take action? When?	Has the hazard been resolved?

OASIS DATA COLLECTION FORM: England

Printable version

OASIS ID: magnitud1-343262

Project details

Project name	Land at Union Road, Stowmarket
Short description of the project	Magnitude Surveys was commissioned to assess the subsurface archaeological potential of a c. 8.5ha area of land at Union Road, Stowmarket, Suffolk. A fluxgate magnetometer survey was successfully completed, and anomalies of probable and possible archaeological origin have been identified. The magnetic enhancement on the site was generally low, with anomalies of possible archaeological origin having a similar contrast to the general variation produced by differences in the soils and geology on the site. Nevertheless, the analysis of the magnetic data for the northern part of the survey, combined with LiDAR and satellite imagery, suggests possible multiple earthwork features enclosing an area of higher ground. Only segments of the earthworks have been covered by the survey. Within the apparently enclosed area, one probable and one possible ring ditch have been identified c. 25m in diameter. There is a further possible ring ditch of similar dimensions in the north eastern corner of the survey, immediately outside a possible entrance complex in the enclosure earthworks. A second possible enclosure has been recorded in the southern part of the site. Anomalies related to recent agricultural activity (ploughing trends and headlands, rubbish dumping) and of undetermined origin have also been identified.
Project dates	Start: 25-02-2019 End: 18-03-2019
Previous/future work	Not known / Not known
Any associated project reference codes	MSTM448 - Sitecode
Any associated project reference codes	skt 093 - HER event no.
Type of project	Field evaluation
Current Land use	Cultivated Land 4 - Character Undetermined
Current Land use	Grassland Heathland 5 - Character undetermined
Monument type	RING DITCH PROBABLE Uncertain
Monument type	RING DITCH POSSIBLE Uncertain
Monument type	ENCLOSURE Uncertain
Monument type	EARTHWORK Uncertain
Significant Finds	NONE None
Methods & techniques	"Geophysical Survey"
Development type	Not recorded
Prompt	unknown
Position in the	Not known / Not recorded

planning process	
Solid geology (other)	sand-based sedimentary bedrock of the Crag Group
Drift geology	ALLUVIUM
Drift geology (other)	Sand and gravel of Lowestoft Formation
Techniques	Magnetometry

Project location

Country	England
Site location	SUFFOLK MID SUFFOLK ONEHOUSE Land at Union Road, Stowmarket, Suffolk
Postcode	IP14 3BS
Study area	8.5 Hectares
Site coordinates	TM 02871 58760 52.18920596893 0.968276293746 52 11 21 N 000 58 05 E Point
Lat/Long Datum	Unknown
Height OD / Depth	Min: 0m Max: 0m

Project creators

Name of Organisation	Magnitude Surveys Ltd
Project brief originator	Unknown
Project design originator	Magnitude Surveys Ltd
Project director/manager	Finnegan Pope-Carter
Project supervisor	Julia Cantarano
Type of sponsor/funding body	Developer

Project archives

Physical Archive Exists?	No
Digital Archive recipient	Suffolk HER
Digital Archive ID	MSTM448
Digital Contents	"Survey"
Digital Media available	"GIS","Geophysics","Text"
Paper Archive Exists?	No

Project bibliography 1

Publication type	Grey literature (unpublished document/manuscript)
Title	Geophysical Survey Report of Land at Union Road, Stowmarket, Suffolk
Author(s)/Editor(s)	Longston, A.
Author(s)/Editor(s)	Cantarano, J.

Author(s)/Editor(s)	Armstrong, K.
Other bibliographic details	MSTM448
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Issuer or publisher	Magnitude Surveys Ltd
Place of issue or publication	Bradford
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Entered on	8 May 2019

OASIS: