

**Land off B1115
Stowupland
Suffolk
Additional Survey**

MAGNETOMETER SURVEY REPORT

for

New Hall Properties (Eastern) Ltd

Kerry Donaldson & David Sabin

August 2016

Ref. no. J638a

Suffolk County Council HER Parish Code: SUP 033

HER Event No: ESF23302

ARCHAEOLOGICAL SURVEYS LTD

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Stowupland
Suffolk
Additional Survey**

Magnetometer Survey Report

for

New Hall Properties (Eastern) Ltd

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SUMMARY

Detailed magnetometry was carried out within two arable fields on the western edge of Stowupland in Suffolk. The results demonstrate the presence of a number of positive rectilinear anomalies forming two separate complexes of enclosures which contain further fragmented linear, rectilinear, curvilinear and discrete features within both fields. The features appear to have been truncated by phases of development and agricultural activity, and they are generally contained in the eastern parts of both survey areas. Further weakly positive linear, curvilinear and discrete responses can be seen elsewhere. It is possible that away from the main core of former habitation, the fill of cut features is less magnetically enhanced, and so it is possible that the full extent of the archaeological features is not clear in the data. Evidence for six former field boundaries, magnetic debris associated with an infilled pond and widespread discrete dipolar responses has also been located.

1 INTRODUCTION

1.1 *Survey background*

- 1.1.1 Archaeological Surveys Ltd was commissioned by New Hall Properties (Eastern) Ltd to undertake a magnetometer survey of an area of land off the B1115 at Stowupland in Suffolk. An initial survey took place in December 2015 within a single field adjacent to the B1115 with a subsequent survey within a second field immediately to the north. The results of both surveys have been combined into this single report. The site has been outlined for a proposed residential development, and the survey forms part of an archaeological assessment of the site.
- 1.1.2 The geophysical survey was carried out in accordance with two Written Schemes of Investigation (WSI) produced by Archaeological Surveys (2015 & 2016), (Appendix H) and approved by Rachael Abraham, Senior Archaeological Officer for Suffolk County Council Archaeological Service.

1.2 *Survey objectives and techniques*

- 1.2.1 The objective of the survey was to use magnetometry to locate geophysical anomalies that may be archaeological in origin so that they may be assessed prior to development of the site. The methodology is considered an efficient and effective approach to archaeological prospection.
- 1.2.2 The survey and report generally follow the recommendations set out by: English Heritage (2008) *Geophysical survey in archaeological field evaluation*; and Institute for Archaeologists (2002) *The use of Geophysical Techniques in Archaeological Evaluations*. The work has been carried out to the Chartered Institute for Archaeologists (2014) *Standard and Guidance for Archaeological*

Geophysical Survey.

1.3 Site location, description and survey conditions

- 1.3.1 The site is located within an irregularly shaped parcel of land situated between the B1115 to the south, the A14 to the west, Thorney Green Lane to the east and agricultural land to the north. It is centred on Ordnance Survey National Grid Reference (OS NGR) TM 06020 59685, see Figures 01 and 02.
- 1.3.2 The geophysical survey covers approximately 7.3ha within two arable fields. Area 1 to the south contained a young barley crop in December 2015 and Area 2 contained barley stubble in August 2016. The land is generally flat and contained no obstructions.
- 1.3.3 The ground conditions across Area 1 were generally poor due to saturated soil after heavy rain. Traversing was very difficult as a result of thick accumulations of sticky soil on footwear whilst traversing the site. Ground conditions in Area 2 were dry with stubble underfoot. Weather conditions during both surveys were fine.



Plate 1: Area 1 looking south



Plate 2: Area 2 looking south

1.4 Site history and archaeological potential

- 1.4.1 An Archaeological Desk-Based Assessment (DBA) has been carried out for the site by John Newman Archaeological Services (JNAS, 2016). It outlines that there has been no archaeological investigation carried out within the site and there are no designated or undesignated heritage assets recorded within it. It has been under arable cultivation since at least the 19th century, with a barn and pond recorded on 19th century mapping at the north eastern corner. In the wider vicinity, there has been a large amount of archaeological investigations in the area of The Cedars development to the south of the site and these have produced evidence for Bronze Age and Iron Age activity at five sites, Roman activity and settlement at three sites, late Saxon activity at one site and medieval to post-medieval activity in at least a further eight sites, all within a 1km radius of the survey area.
- 1.4.2 A full search of the documentary sources was carried out in preparation of the DBA with a Suffolk County Council Historic Environment Record (SCC HER) search made. The HER monuments map and monuments summary details have been included in Appendix F.
- 1.4.3 The surface conditions within the site were not suitable for the observation of cultural material during the course of the survey. However, some magnetically thermoremnant material (brick/tile fragments) was noted in places and this was considered likely to be relatively modern in origin.

1.5 *Geology and soils*

- 1.5.1 The underlying solid geology across the site is Crag Group - Sand with overlying deposits of Lowestoft Formation - Diamicton (BGS, 2015)
- 1.5.2 The overlying soil across the survey area is from the Beccles 1 association and is a typical stagnogley . It consists of a slowly permeable, seasonally waterlogged, fine, loamy over clayey soil on chalky till (Soil Survey of England and Wales, 1983).
- 1.5.3 Magnetometry survey carried out across similar soils has produced variable results, often with low magnetic susceptibility causing weak or poorly defined anomalies. However, within areas of long term occupation there can be sufficient magnetic contrast for features to be visible within the data. The underlying geology and soils are therefore considered acceptable for magnetic survey.

2 METHODOLOGY

2.1 *Technical synopsis*

- 2.1.1 Magnetometry survey records localised magnetic fields that can be associated with features formed by human activity. Magnetic susceptibility and magnetic thermoremnance are factors associated with the formation of localised fields. Additional details are set out below and within Appendix A.
- 2.1.2 Iron minerals within the soil may become altered by burning and the break down of biological material; effectively the magnetic susceptibility of the soil is increased, and the iron minerals become magnetic in the presence of the Earth's magnetic field. Accumulations of magnetically enhanced soils within features, such as pits and ditches, may produce magnetic anomalies that can be mapped by magnetic prospection.
- 2.1.3 Magnetic thermoremnance can occur when ferrous minerals have been heated to high temperatures such as in a kiln, hearth, oven etc. On cooling, a permanent magnetisation may be acquired due to the presence of the Earth's magnetic field. Certain natural processes associated with the formation of some igneous and metamorphic rock may also result in magnetic thermoremnance.
- 2.1.4 The localised variations in magnetism are measured as sub-units of the Tesla, which is a SI unit of magnetic flux density. These sub-units are nano Teslas (nT), which are equivalent to 10^{-9} Tesla (T).

2.2 *Equipment configuration, data collection and survey detail*

- 2.2.1 The detailed magnetic survey was carried out using a SENSYS MAGNETO®MXPDA 5 channel cart-based system. The instrument has 5

fluxgate gradiometers spaced 0.5m apart with readings recorded at 20Hz. The gradiometers have a range of recording data between 0.1nT and 10,000nT. The sensors are not zeroed in the field, as the vertical axis alignment is fixed using a tension band system. The manufacturer's software uses a compensation process to balance the readings. The system is linked to a Leica GS10 RTK GPS with data recorded by SENSYS MAGNETO®MXPDA software on a rugged computer.

- 2.2.2 Data are collected along a series of parallel survey tracks wherever possible. The length of each track is variable and relates to the size of the survey area and other factors including ground conditions. A visual display aids accurate placing of tracks and their separation.
- 2.2.3 Data are not collected within fixed grids and data points are considered to be random even though the data are collected in a systematic manner covering all accessible areas (Aspinall, Gaffney and Schmidt, 2009).

2.3 Data processing and presentation

- 2.3.1 Magnetic data collected by the MAGNETO®MXPDA cart-based system are initially prepared using SENSYS MAGNETO®DLMGPS software. Survey tracks are analysed and georeferenced raw data (UTM Z30N) are then exported in ASCII format for further analysis and display using TerraSurveyor. In order to fulfil the Suffolk County Council Requirements for a Geophysical Survey (2011), a greyscale image of the raw data has also been displayed without any clipping or compensation, between the limits of the recorded values +1957.60nT and -758.17nT for Area 1 and +2534.431nT and -2522.96nT for Area 2 (Fig 03).
- 2.3.2 Minimal processing is then undertaken using TerraSurveyor, with a zero median traverse function to balance the readings between the sensors and clipping for display at ± 3 nT. This would normally be considered as minimal enhancement of the raw data in order to effectively display it. Data are interpolated to a resolution of effectively 0.5m between tracks and 0.15m along each survey track and displayed as a greyscale image (Fig 04).
- 2.3.3 Appendix C contains metadata concerning the survey and data attributes and is derived directly from TerraSurveyor. Reference should be made to Appendix B for further information on any processes, such as clipping, carried out on the data.
- 2.3.4 A TIF file is produced by TerraSurveyor software along with an associated world file (.TFW) that allows automatic georeferencing (OSGB36 datum) when using GIS or CAD software. The main form of data display used in the report is the minimally processed greyscale plot.
- 2.3.5 The raster images are combined with base mapping using ProgeCAD Professional 2016, creating DWG (2010) file formats. All images are

externally referenced to the CAD drawing in order to maintain good graphical quality. The CAD plots are effectively georeferenced facilitating relocation of features using GPS, resection method, etc.

- 2.3.6 An abstraction and interpretation is also drawn and plotted for all geophysical anomalies located by the survey. Anomalies are abstracted using colour coded points, lines and polygons. All plots are scaled to landscape A3 for paper printing (Fig 05).
- 2.3.7 A brief summary of each anomaly, with an appropriate reference number, is set out in list form within the results (Section 3) to allow a rapid and objective assessment of features within the survey area. Where further interpretation is possible, or where a number of possible origins should be considered, more subjective discussion is set out in Section 4.
- 2.3.8 A digital archive is produced with this report, see Appendix D below. This has been produced under the requirements of the Suffolk County Council Archaeological Service Conservation Team (SCCAS, 2015). The raw data will be archived as proprietary files from the manufacturer's software. Additionally the raw data as well as the minimally processed data will also be archived as CSV files.

3 RESULTS

3.1 *General assessment of survey results*

- 3.1.1 The detailed magnetic survey was carried out within two arable fields covering approximately 7.3ha.
- 3.1.2 Magnetic anomalies located can be generally classified as positive responses of archaeological potential, positive anomalies of an uncertain origin, anomalies associated with land management, linear anomalies of an agricultural origin, areas of magnetic debris and disturbance and strong discrete dipolar anomalies relating to ferrous objects.
- 3.1.3 Anomalies located within each survey area have been numbered and are described below with subsequent discussion in Section 4.






3.2 *Statement of data quality*

- 3.2.1 Data are considered representative of the magnetic anomalies present within the site. There are no significant defects within the dataset. Magnetic disturbance was encountered in the far south western corner of the site and this is likely to relate to very large steel beams within an adjacent road bridge; it appears unlikely to have obscured more significant anomalies. Widespread magnetic debris was also encountered across the site and at high levels in the north eastern corner. The debris is likely to relate to ferrous fragments within ground make-up material and/or spreads of magnetic material within waste

derived from the nearby town.

3.3 Data interpretation

3.3.1 The list of sub-headings below attempts to define a number of separate categories that reflect the range and type of features located during the survey. A basic explanation of the characteristics of the magnetic anomalies is set out for each category in order to justify interpretation, a basic key is indicated to allow cross referencing to the abstraction and interpretation plot. CAD layer names are included to aid reference to associated digital files (.dwg/.dxf). Sub-headings are then used to group anomalies with similar characteristics within the survey area.

Report sub-heading CAD layer names and plot colour	Description and origin of anomalies
<p>Anomalies with archaeological potential</p> <p>AS-ABST MAG POS LINEAR ARCHAEOLOGY AS-ABST MAG POS DISCRETE ARCHAEOLOGY AS-ABST MAG ENCLOSURE DITCH</p> 	<p>Anomalies have the characteristics (mainly morphological) of a range of archaeological features such as pits, ring ditches, enclosures, etc..</p>
<p>Anomalies with an uncertain origin</p> <p>AS-ABST MAG POS LINEAR UNCERTAIN AS-ABST MAG POS DISCRETE UNCERTAIN AS-ABST MAG POS UNCERTAIN</p> 	<p>The category applies to a range of anomalies where <u>there is not enough evidence to confidently suggest an origin</u>. Anomalies in this category <u>may well be related to archaeologically significant features, but equally relatively modern features, geological/pedological features and agricultural features should be considered</u>. Positive anomalies are indicative of magnetically enhanced soils that may form the fill of 'cut' features or may be produced by accumulation within layers or 'earthwork' features; soils subject to burning may also produce positive anomalies.</p>
<p>Anomalies relating to land management</p> <p>AS-ABST MAG BOUNDARY AS-ABST MAG LAND DRAIN</p> 	<p>Anomalies are mainly linear and may be indicative of the magnetically enhanced fill of cut features (i.e. ditches). The anomalies may be long and/or form rectilinear elements and they may relate to topographic features or be visible on early mapping. Associated agricultural anomalies (e.g. headlands, plough marks and former ridge and furrow) may support the interpretation. Land drains can appear in a classic herringbone pattern of interconnected multiple dipolar linear anomalies, or as parallel linear anomalies</p>
<p>Anomalies with an agricultural origin</p> <p>AS-ABST MAG AGRICULTURAL</p> 	<p>The anomalies are often linear and form a series of parallel responses or are parallel to extant land boundaries. Where the response is broad, former ridge and furrow is likely; narrow response is often related to modern ploughing.</p>
<p>Anomalies associated with magnetic debris</p> <p>AS-ABST MAG DEBRIS AS-ABST MAG STRONG DIPOLAR</p> 	<p>Magnetic debris often appears as areas containing many small dipolar anomalies that may range from weak to very strong in magnitude. It often occurs where there has been dumping or ground make-up and is related to magnetically thermoremnant materials such as brick or tile or other small fragments of ferrous material. This type of response is occasionally associated with kilns, furnace structures, or hearths and <u>may therefore be archaeologically significant</u>. It is also possible that the response may be caused by natural material such as certain gravels and fragments of igneous or metamorphic rock. Strong discrete dipolar anomalies are responses to ferrous objects within the topsoil.</p>
<p>Anomalies with a modern origin</p>	<p>The magnetic response is often strong and dipolar indicative of ferrous material and may be associated with extant above</p>


AS-ABST MAG DISTURBANCE		surface features such as wire fencing, cables, pylons etc.. Often a significant area around such features has a strong magnetic flux which may create magnetic disturbance; such disturbance can effectively obscure low magnitude anomalies if they are present. Fluxgate sensors may respond erratically and with hysteresis adjacent to strong magnetic sources.
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Table 1: List and description of interpretation categories

3.4 List of anomalies - Area 1

Area 1 centred on OS NGR 605990 259635, see Figs 06 & 07.

Anomalies of archaeological potential

(1) - A group of positive linear and rectilinear anomalies form a complex of rectilinear enclosures in the eastern part of the survey area. There appears to be several phases of construction or re-cutting and they contain a number of fragmented positive linear, curvilinear and discrete responses (2).

(2) - A number of fragmented positive linear, rectilinear, curvilinear and discrete responses, relating to further cut features, are located primarily within the confines of anomalies (1).

Anomalies with an uncertain origin

(3) - A number of weakly positive linear, curvilinear and discrete anomalies are located within the confines of anomalies (1). However, due to their very weak, short or fragmented response and associated magnetic responses close by, it is not possible to determine if these relate to associated cut features. However, given their location and proximity to anomalies (1) and (2) an archaeological origin should be considered.

(4) - A very weakly positive band extends within the south western part of anomalies (1). It is not possible to determine its origin.

(5) - Located to the south of the south western edge of anomalies (1) is a weakly positive curvilinear anomaly with a diameter of approximately 7.5m. It is possible that this relates to a ring-ditch feature, but this is uncertain.

(6) - The survey area contains a number of very weakly positive, short or fragmented linear and possible rectilinear anomalies. Due to their form and low magnitude response (0.1-0.6nT), it is not possible to determine if they relate to cut features, or if they have an association with agricultural activity or natural features.

(7) - In the western part of the survey area are two weakly positive linear anomalies. They may be parallel with adjacent former field boundaries (11 & 12), possibly relating to agricultural activity, but cut features cannot be completely ruled out.

(8) - The survey area contains a number of isolated, discrete positive responses. These appear pit-like in form, but it is not possible to determine if they have a natural or anthropogenic origin.

(9) - A linear arrangement of discrete positive responses is located to the north west of anomalies (1). These appear pit-like in form, but an association with magnetically thermoremnant objects is possible. It is not possible, however, to determine if they relate to pit-like features with an archaeological origin as they are generally parallel with the line of a removed field boundary (10) located 10m to the north east. An association with the field boundary should be considered.

Anomalies associated with land management

(10, 11 & 12) - Three positive linear anomalies extend across the survey area and relate to former mapped field boundaries. Anomaly (10) is associated with a line of strong, discrete, dipolar anomalies, possibly indicating former fence posts. It also cuts across the archaeological features (1 & 2). They are all depicted on the 1839 Tithe Map, but anomalies (10 & 12) appear to have been removed in the mid 20th century, with anomaly (11) removed prior to 1883.

Anomalies with an agricultural origin

(13) - Parallel linear anomalies are associated with the modern cultivation trend. Not all anomalies have been abstracted.

Anomalies associated with magnetic debris

(14) - In the north eastern corner of the survey area is a zone of strongly magnetic debris. A former structure and a pond are depicted in the 1839 Tithe Map, with removal of the structure by 1883 and the pond infilled more recently. The material relates to ferrous and other magnetically thermoremnant objects used to infill the pond and possibly from demolition material associated with the structure.

(15) - The entire survey area contains widespread and numerous strong, discrete, dipolar anomalies and not all anomalies have been abstracted. These relate to ferrous and other magnetically thermoremnant objects and fragments within the topsoil.

Anomalies with a modern origin

(16) - Magnetic disturbance at the south western corner is a response to a steel bridge. Close to the eastern field boundary is a response to adjacent ferrous material.

3.5 List of anomalies - Area 2

Area 1 centred on OS NGR 606035 259780, see Figs 06 & 07.

Anomalies of archaeological potential

(17, 18 & 19) - Located in the north eastern part of the survey are a number of positive rectilinear, linear and discrete anomalies, with similarities to anomalies (1) and (2) seen in Area 1 to the south. They appear to relate to a group of rectilinear enclosures, linear ditches and pits which relate to a settlement. The majority of the responses have a similar east to west and north to south orientation (17) like (1) and (2); however, there is evidence for other enclosures with a east north east to west south west and north north west to south south east orientation (18), possibly indicating difference phases. Several linear and discrete responses lie on the periphery of the main features and are weak and poorly defined. There appears to have been widespread erosion of the features through agricultural activity.

Anomalies with an uncertain origin

(20) - A possible positive rectilinear anomaly and linear anomaly are located to the west of anomalies (17-19) and have a north east to south west orientation. It is possible that they are associated with a small group of discrete anomalies to the south west. They may relate to cut features and an association with anomalies (17-19) is possible.

(21) - A small number of isolated discrete positive responses and a short positive linear response are located in the central northern part of the survey area. The discrete responses do appear pit-like in form, but it is not possible to determine if they are of archaeological potential.

(22) - Located in the south western corner of the survey area is a weakly positive rectilinear anomaly together with a short, parallel, positive linear anomaly and a small number of discrete responses. It is possible that they relate to cut features, but they lack a coherent morphology preventing confident interpretation.

(23) - The southern part of the survey area contains a number of discrete positive responses. It is not possible to determine if they relate to pit-like features caused by anthropogenic activity, which can include archaeology, but may relate to agricultural practices, or possible naturally formed features. Magnetic debris within the site can also cause similar responses.

Anomalies associated with land management

(24, 25 & 26) - The survey area contains three former field boundaries which were removed during the 20th century. Anomalies (25) and (26) contain very strongly magnetic material and are associated with magnetic debris.

(27) - The western part of the site contains at least two series of land drains. The

response indicates that they are of fired clay (terracotta).

4 DISCUSSION

- 4.1.1 Adjacent to the eastern edge of Area 1 are a number of rectilinear enclosures (1) which contain further linear, rectilinear, curvilinear and discrete features (2). The response ranges from less than 0.5nT to 5nT, but there has been heavy truncation of the features through ploughing and the north western section and parts of the southern edges of the main enclosure are not visible in the data. Together they enclose an area of 0.35ha. There appears to be phases of construction to the enclosures, linear ditches, small rectilinear enclosures and pits. The morphology suggests a possible late prehistoric/Romano-British farmstead. However, the enclosures appear to be parallel with and orthogonal to the adjacent Thorney Green Lane, and an association is possible.
- 4.1.2 Both within the confines of the archaeological features and close to them are a number of weakly positive, short, fragmented positive responses. It appears that some of these may relate to further associated features, but the majority lack a coherent morphology preventing confident interpretation. A positive curvilinear anomaly (5) is located 23m to the south of the enclosures, its very weak response has resulted in classification as uncertain in origin, but a possible ring ditch feature should be considered.
- 4.1.3 A broad, weak response (4) appears to extend towards the south western edge of the enclosures. The response is very weak (0.1nT) and poorly defined, but it does appear to end at the internal edge of the south western rectilinear enclosure. It is not generally parallel with any other archaeological features but it is more parallel with the former field boundaries that cross the site. It is not possible to determine if this relates to an archaeological feature, such as a bank, or to magnetically enhanced material that has been reworked from archaeological features, such as through agricultural activity, or if it has a natural origin.
- 4.1.4 Within the north eastern part of Area 2 further rectilinear, linear and discrete anomalies (17-19) have been found with a similar orientation to those seen 135m to the south in Area 1, indicating a further settlement site encompassing approximately 0.2ha. Other weakly positive linear, rectilinear and discrete responses have also been located in the vicinity, but they are fragmented and poorly defined.
- 4.1.5 Area 2 also contains further evidence for land division, with three land boundaries, two of which enclose zones of magnetic debris. Evidence for land drainage has also been located within the western part of the site.

5 CONCLUSION

- 5.1.1 The detailed magnetometer survey located a number of positive linear, rectilinear, curvilinear and discrete responses that relate to two complexes of enclosures with internal linear and rectilinear ditches and pits within two distinct areas. Within Area 1, the anomalies cover at least 0.35ha appearing parallel with, and possibly bounded by, Thorney Green Road to the east. Within Area 2, there is a second cluster of enclosures, ditches and pits within the north eastern part of the survey area, covering an area of approximately 0.3ha. The features have been truncated through agricultural activity with many of the anomalies are poorly defined.
- 5.1.2 The site also contains a number of very weakly positive, short or fragmented linear anomalies and discrete anomalies both within and adjacent to the archaeological features, and also elsewhere within the site. They lack a coherent morphology and have such a weak response that they are indistinct. It is, therefore, not possible to determine if they relate to further cut features. At least one curvilinear response has been located to the south of the main archaeological features in Area 1, but again its weak response prevents confident interpretation. There are a number of pit-like responses close to the archaeological features, and also several isolated pit-like responses, but their origin is also uncertain.
- 5.1.3 Three formerly mapped field boundaries have also been located in Area 1, together with a zone of magnetic debris in the north eastern corner which relates to an infilled pond and former structure. Within Area 2, three further field boundaries have also been located, as well as at least two series of land drains. The entire site is covered with small, discrete, dipolar responses indicative of ferrous and other magnetically thermoremnant objects.

6 REFERENCES

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Appendix A – basic principles of magnetic survey

Iron minerals are always present to some degree within the topsoil and enhancement associated with human activity is related to increases in the level of magnetic susceptibility and thermoremanent material.

Magnetic susceptibility is an induced magnetism within a material when it is in the presence of a magnetic field. This can be thought of as effectively permanent due to the presence of the Earth's magnetic field.

Thermoremanent magnetism occurs when ferrous material is heated beyond a specific temperature known as the Curie Point. Demagnetisation occurs at this temperature with re-magnetisation by the Earth's magnetic field upon cooling.

Enhancement of magnetic susceptibility can occur in areas subject to burning and complex fermentation processes on biological material; these are frequently associated with human settlement. Thermoremanent features include ovens, hearths, and kilns. In addition thermoremanent material such as tile and brick may also be associated with human activity and settlement.

Silting and deliberate infilling of ditches and pits with magnetically enhanced soil can create an area of enhancement compared with surrounding soils and subsoils into which the feature is cut. Mapping enhanced areas will produce linear and discrete anomalies allowing an assessment and characterisation of hidden subsurface features.

It should be noted that areas of negative enhancement can be produced from material having lower magnetic properties compared to the topsoil. This is common for many sedimentary bedrocks and subsoils which were often used in the construction of banks and walls etc. Mapping these 'negative' anomalies may also reveal archaeological features.

Magnetic survey or magnetometry can be carried out using a fluxgate gradiometer and may be referred to as gradiometry. The SENSYS gradiometer is a passive instrument consisting of two fluxgate sensors mounted vertically 65cm apart. The instrument is carried about 10-20cm above the ground surface and the upper sensor measures the Earth's magnetic field as does the lower sensor but this is influenced to a greater degree by any localised buried field. The difference between the two sensors will relate to the strength the magnetic field created by the buried feature.

There are a number of factors that may affect the magnetic survey and these include soil type, local geology and previous human activity. Situations arise where magnetic disturbance associated with modern services, metal fencing, dumped waste material etc., obscures low magnitude fields associated with archaeological features.

Appendix B – data processing notes

Clipping

Minimum and maximum values are set and replace data outside of the range with those values. Extreme values are removed improving colour or greyscale contrast associated with data values that may be archaeologically significant. It has been found that clipping data to ranges between $\pm 5nT$ and $\pm 3nT$ often improves the appearance of features associated with archaeology. Different ranges are applied to data in order to determine the most suitable for anomaly abstraction and display.

Zero (destripe) Median/Mean Traverse

The median (or mean) of each traverse is calculated ignoring data outside a threshold value, the median (or mean) is then subtracted from the traverse. The process is used to equalise differences between the baseline value of gradiometer sensors.

High Pass Filtering

A mathematical process used to remove low frequency anomalies relating to survey tracks and modern agricultural features.

Appendix C – survey and data information

Raw TerraSurveyor data

COMPOSITE
 Filename: J638-mag-raw.xcp
 Description: Imported as Composite from: J638-mag.asc
 Instrument Type: Sensys DLMGPS
 Units: nT
 UTM Zone: 31U
 Survey corner coordinates (X/Y): OSGB36
 Northwest corner: 605836.125074835, 259761.10821127 m
 Southeast corner: 606171.075074835, 259513.60821127 m
 Collection Method: Randomised
 Sensors: 5
 Dummy Value: 32702

Source GPS Points: 1044600

Dimensions
 Composite Size (readings): 2233 x 1650
 Survey Size (meters): 335 m x 248 m
 Grid Size: 335 m x 248 m
 X Interval: 0.15 m
 Y Interval: 0.15 m

Stats
 Max: 1957.60
 Min: -758.17
 Std Dev: 21.66
 Mean: -17.05
 Median: -21.39
 Composite Area: 8.29 ha
 Surveyed Area: 3.5165 ha

PROGRAM
 Name: TerraSurveyor
 Version: 3.0.23.0

Processes: 1
 1 Base Layer

GPS based Proce2
 1 Base Layer.
 2 Unit Conversion Layer (Lat/Long to OSGB36).

Minimally processed TerraSurveyor data

COMPOSITE
 Filename: J638-mag-proc.xcp
 Description: Imported as Composite from: J638-mag.asc
 Instrument Type: Sensys DLMGPS
 Units: nT
 UTM Zone: 31U
 Survey corner coordinates (X/Y): OSGB36
 Northwest corner: 605836.125074835, 259761.10821127 m
 Southeast corner: 606171.075074835, 259513.60821127 m
 Collection Method: Randomised
 Sensors: 5
 Dummy Value: 32702

Source GPS Points: 1044600

Dimensions
 Composite Size (readings): 2233 x 1650
 Survey Size (meters): 335 m x 248 m
 Grid Size: 335 m x 248 m
 X Interval: 0.15 m
 Y Interval: 0.15 m

Stats
 Max: 3.00
 Min: -3.00
 Std Dev: 0.94
 Mean: 0.04
 Median: 0.01
 Composite Area: 8.29 ha
 Surveyed Area: 3.5165 ha

Processes: 2
 1 Base Layer
 2 Clip from -3.00 to 3.00 nT

GPS based Proce4
 1 Base Layer.
 2 Unit Conversion Layer (Lat/Long to OSGB36).
 3 DeStripe Median Traverse:
 4 Clip from -3.00 to 3.00 nT

Appendix D – digital archive

Archaeological Surveys Ltd hold the primary digital archive at their offices in Wiltshire. Data are backed-up onto an on-site data storage drive and at the earliest opportunity data are copied to CD ROM for storage on-site and off-site.

The geophysical data, CAD, report and graphics will be sent to the Suffolk County Council Archaeological Service (SCCAS) Senior Archaeological Officer Faye Minter for archiving. A SCCAS Archive Data Collection Form will also be sent accompanying the data.

A printed copy of the report and a PDF copy will be supplied to the Suffolk Historic Environment Record. The report will also be uploaded to the Online Access to the Index of archaeological investigationS (OASIS) and a copy of the form included in the final report. The WSI will also be included as an additional appendix.

Archive contents for SCCAS:

CD - path: HER_SUP033\Admin\				
Path and Filename	Software	Description	Date	Creator
SUP033_J638_Stowupland_geophysical_survey_WSI.pdf	Solid PDF creator	Geophysical survey Written Scheme of Investigation in PDF/A format	08/12/15	K.T. Donaldson
SUP033_SCCAS_Archive_Data_Collection_Form_v4.xls	OpenOffice calc	SCCAS Excel Spreadsheet archive data collection form	09/12/15	K.T. Donaldson
CD - path: HER_SUP033\Digital\Data\Raw_data\Sensys_proprietary_files\				
.prm .dgb .disp	Sensys MXPDA	Proprietary data formats with 253 of each file type representing magnetometer survey traverses logged to a PDA .	09/12/15	D.J.Sabin
CD - path: HER_SUP033\Digital\Data\Raw_data\Sensys_magneto_DLMGPS_files\				
SUP033_J638_mag.dlm	Sensys DLMGPS	Proprietary data format for display in Sensys Magneto software	09/12/15	D.J.Sabin
SUP033_J638_mag.prp	Sensys DLMGPS	Proprietary data format composite of survey traverses	09/12/15	D.J.Sabin
CD - path: HER_SUP033\Digital\Data\Raw_data\CSV_file\				
SUP033_J638_mag.csv	Sensys DLMGPS	ASCII CSV (tab) file representing survey area in eastings, northings (UTM Z30N), magnetic measurement, traverse file and sensor number.	10/12/15	D.J.Sabin
CD - path: HER_SUP033\Digital\Data\Processed_data\TerraSurveyor_files\				
SUP033_J638_mag_proc.xcp	TerraSurveyor 3.0.23.0	Processed composite data file (zmt and clipping to $\pm 3nT$).	10/12/15	K.T. Donaldson
SUP033_J638_mag_proc.csv	TerraSurveyor 3.0.23.0	Processed composite data file exported as a CSV file.	10/12/15	K.T. Donaldson
CD - path: HER_SUP033\Digital\Data\Graphics				
SUP033_J638_mag_raw.tif	TerraSurveyor 3.0.23.0	TIF file showing a raw greyscale plot	10/12/15	K.T. Donaldson
SUP033_J638_mag_raw.tfw	TerraSurveyor 3.0.23.0	World file for georeferencing TIF to OSGB36.	10/12/15	K.T. Donaldson
SUP033_J638_mag_proc.tif	TerraSurveyor	TIF file showing a minimally processed greyscale	10/12/15	K.T. Donaldson

	3.0.23.0	plot clipped to $\pm 3nT$.		
SUP033_J638_mag_proc.tfw	TerraSurveyor 3.0.23.0	World file for georeferencing TIF to OSGB36.	10/12/15	K.T. Donaldson
CD - path: HER_SUP033\Digital\CAD				
SUP033_J638_CAD.dwg	ProgeCAD 2016	CAD file for creating plots of greyscales, abstraction, interpretation and mapping. Grid coordinates as OSGB. AutoCAD 2010 format.		K.T.Donaldson
CD - path: HER_SUP033\Report				
SUP033_J638_mag_survey_report.odt	OpenOffice.org 3.0.1 Writer	Report text as an Open Office document.	10/12/15	K.T.Donaldson
SUP033_J638_mag_survey_report.doc	OpenOffice.org 3.0.1 Writer	Report text as an Microsoft Word document		K.T.Donaldson
SUP033_J638_mag_survey_report.rtf	OpenOffice.org 3.0.1 Writer	Report text in Rich Text Format		K.T.Donaldson
SUP033_J638_mag_survey_report.pdf	Solid PDF Creator	Report in PDF/A format		K.T.Donaldson

Appendix E – copyright and intellectual property

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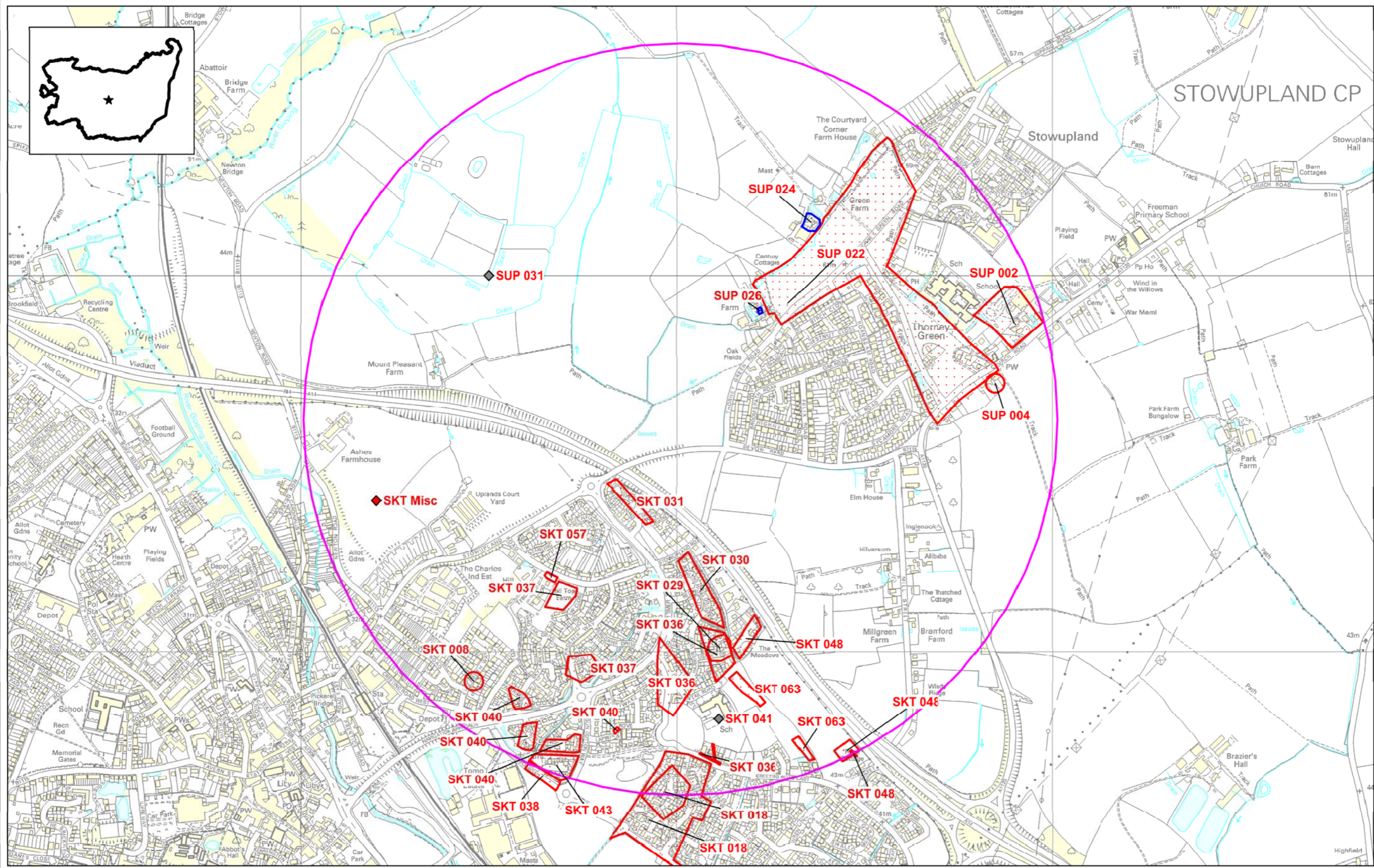
Stowupland

HER monuments

Compiled by James Rolfe on 3 November 2015

Suffolk Historic Environment Record
Suffolk County Council Archaeological Service
9/10 The Churchyard, Shire Hall, Bury St Edmunds, IP33 1RX
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Scale 1:10000



Suffolk County Council Archaeological Service Sites and Monuments Record

03/11/2015

Parish STOWMARKET, MID SUFFOLK,
SUFFOLK

Ref	Site Name	Period	Summary Description	NGR
SKT 008	Victoria Road MSF5395	Rom	Pottery kiln with pierced clay floor.	Centred TM 0546 5892 (10m by 10m)
SKT 018	Phase 3, Roman (Rom)Evaluat MSF14971	Rom	and excavation identified a Roman enclosure, post and slot building, a villa, wells, ovens, field system and burials.	Centred TM 0592 5854 (272m by 351m)
SKT 018	Phase 3, Iron Age (IA)Evaluat MSF26734	IA	and excavation identified a partially enclosed Late Iron Age Settlement with several roundhouses.	Centred TM 0597 5862 (129m by 144m)
SKT 029	Med pottery scatter MSF21073	Med	Med pottery scatter.	TM 0611 5900 (point)
SKT 030	Cedars Park, Phase 7A and 7B, Stowmarket MSF26775		evaluation and monitoring identified two undated ditches, a group of five undated post-holes and a single feature with sparse abraded pottery sherds of possible Roman date.	Centred TM 0606 5916 (121m by 203m)
SKT 031	Phase 8, Cedars Park, Stowmarket, Suffolk MSF26779	PMe	Evaluation identified two parallel ditches aligned NW/SE, one contained post- medieval pottery. These ditches are on the parish boundary.	Centred TM 0587 5939 (125m by 121m)
SKT 036	Cedar's Park phase 4A, Stowmarket, Iron Age (IA) MSF24212	IA	Excavation revealed an Iron Age enclosure two possible round houses and two groups of large pits, one of which formed a circle.	Centred TM 0601 5894 (127m by 226m)
SKT 036	Cedar's Park phase 4A (north East), Stowmarket, medieval (Med) MSF26736	Med	Excavation identified medieval features including, parrallel ditches, an enclosure, a possible structures, field system ditches, quarry pits, a pond and a cobbled surface.	Centred TM 0610 5899 (98m by 147m)
SKT 036	Village centre, Cedars Park, Stowmarket, Suffolk (PMed) MSF26780	PMe	Monitoring of groundworks revealed a NNW-SSE aligned post-medieval drainage ditch that ran into a larger ditch running paralle to the existing road aligned E-W.	Centred TM 0606 5872 (54m by 55m)
SKT 037	Cedars Park phase 6a and 6b MSF23715	IA	Evaluation revealed Iron Age features.	Centred TM 0572 5905 (171m by 281m)
SKT 038	Road Corridor, Cedar's Park, Stowmarket, phase 5c MSF26737	Med	Evaluation and excavation identified pits and ditches of medieval date.	Centred TM 0564 5866 (94m by 80m)
SKT 040	Medieval remains, Cedars Park (Med) MSF25533	Med	Evaluation and excavation identified medieval finds and features, see details.	Centred TM 0574 5876 (215m by 69m)
SKT 040	Undated ditches, Cedars Park (Un) MSF25534	Un	Evaluation recorded a group of undated linear features, likely to represent former field boundaries.	Centred TM 0558 5887 (59m by 60m)

Ref	Site Name	Period	Summary Description	NGR
SKT 040	Post medieval field boundaries, Cedars Park (PMed) MSF25535	PMe	Evaluation recorded a group of ditches of probable post-medieval date.	Centred TM 0560 5877 (52m by 75m)
SKT 041	OUTLINE RECORD: CEDARS PARK - SCHOOL - MON (MS) MSF30518	Un		TM 0611 5882 (point)
SKT 043	Cedars Park Phase 5C, Stowmarket, Suffolk, medieval MSF26738	Med	Excavation identified quarry pits, ditches, gullies, two cobbled surfaces, a well, and refuse pits	Centred TM 0567 5869 (133m by 72m)
SKT 048	Prehistoric features, Cedars Park phase 4B and 4C (Preh) MSF25536	Preh	The earliest activity identified during evaluation was a series of parallel gullies, assigned a tentative prehistoric date.	Centred TM 0645 5873 (66m by 59m)
SKT 048	Early medieval features, Cedars Park phase 4B and 4C (Sax-Med) MSF25537	Sax-	Evaluation revealed a small group of Late Saxon/early medieval features, indicative of domestic activity.	Centred TM 0647 5872 (20m by 19m)
SKT 048	Post medieval field boundaries, Cedars Park phase 4B and 4C MSF25538		Evaluation revealed a number of post-medieval and modern gullies and ditches, representing field boundaries.	Centred TM 0618 5903 (74m by 117m)
SKT 057	Hill Top Farm, Stowmarket MSF25468	PMe	Monitoring identified two ditches and two pits all of probable post-medieval date.	Centred TM 0566 5919 (34m by 28m)
SKT 063	Cedar's Park MSF26527		Evaluation revealed a westward continuation of Late Bronze Age/Early Iron Age activity and Roman ditches observed in the adjacent area, together with three medieval ponds and a medieval ditch.	Centred TM 0625 5882 (229m by 236m)
SKT Misc	Shield shaped harness mount with 3 lions passant on red enamelled background and LMed purse bar fragment. (Med) MSF19783	Med	Shield shaped harness mount with 3 lions passant on red enamelled background and LMed purse bar fragment.	Centred TM 0525 5945 (100m by 100m)
SUP 002	Crown Farm MSF5376	Med	Moat.	Centred TM 0690 5987 (10m by 10m)
SUP 004	The Croft (demolished) MSF5378	C13 Med	Moat.	Centred TM 0684 5971 (10m by 10m)
SUP 022	Thorney Green MSF23691	Med	Thorney Green, as existing, with additional areas where likely Post Medieval encroachment within areas of original green edge ditch.	Centred TM 0629 5992 (659m by 881m)
SUP 024	Farm buildings at Green Farm MSF25359	17th	17th C barn and cartlodge	Centred TM 0635 6014 (50m by 47m)

Ref	Site Name	Period	Summary Description	NGR
SUP 026	Poole's Farmhouse MSF25632	16th-	16th C farmhouse	Centred TM 0622 5990 (13m by 17m)
SUP 031	OUTLINE RECORD: Medieval woods cleared circa 1510 (BACKLOG) MSF34059			TM 0550 6000 (point)

Appendix G - OASIS DATA COLLECTION FORM: England

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OASIS ID: archaeol20-231678

Project details

Project name	Land off B1115, Stowupland, Suffolk, Magnetometer Survey Report
Short description of the project	Detailed magnetometry was carried out within two arable fields on the western edge of Stowupland in Suffolk. The results demonstrate the presence of a number of positive rectilinear anomalies forming two separate complexes of enclosures which contain further fragmented linear, rectilinear, curvilinear and discrete features within both fields. The features appear to have been truncated by phases of development and agricultural activity, and they are generally contained in the eastern parts of both survey areas. Further weakly positive linear, curvilinear and discrete responses can be seen elsewhere. It is possible that away from the main core of former habitation, the fill of cut features is less magnetically enhanced, and so it is possible that the full extent of the archaeological features is not clear in the data. Evidence for six former field boundaries, magnetic debris associated with an infilled pond and widespread discrete dipolar responses has also been located.
Project dates	Start: 09-12-2015 End: 01-08-2016
Previous/future work	Not known / Not known
Any associated project reference codes	SUP033 - Related HER No.
Any associated project reference codes	ESF23302 - HER event no.
Type of project	Field evaluation
Monument type	ENCLOSURE Uncertain
Monument type	DITCH Uncertain
Monument type	PIT Uncertain
Significant Finds	NONE None
Methods & techniques	"Geophysical Survey"
Development type	Housing estate
Prompt	National Planning Policy Framework - NPPF
Position in the planning process	Not known / Not recorded
Solid geology	NORWICH CRAG, RED CRAG AND CHILLESFORD CLAY
Drift geology	CRAG
Drift geology	BOULDER CLAY AND MORAINIC DRIFT
Techniques	Magnetometry

Project location

Country	England
Site location	SUFFOLK MID SUFFOLK STOWUPLAND Land off B1115, Stowupland, Suffolk
Study area	7.3 Hectares
Site coordinates	TM 06020 59685 52.196338167274 1.014844248359 52 11 46 N 001 00 53 E Point

Project creators

Name of Organisation	Archaeological Surveys Ltd
Project brief originator	Archaeological Surveys Ltd
Project design originator	Archaeological Surveys Ltd
Project director/manager	Archaeological Surveys Ltd
Project supervisor	Archaeological Surveys Ltd

Project archives

Physical Archive Exists?	No
Digital Archive recipient	Suffolk County Council Archaeological Service
Digital Contents	"Survey"
Digital Media available	"Geophysics","Text"
Paper Archive Exists?	No

Project bibliography 1

Publication type	Grey literature (unpublished document/manuscript)
Title	Land off B1115, Stowupland, Suffolk, Magnetometer Survey Report
Author(s)/Editor(s)	Donaldson, K and Sabin, D.
Other bibliographic details	Report ref 638
Date	2015
Issuer or publisher	Archaeological Surveys Ltd
Place of issue or publication	Yatesbury

Entered by	Kerry Donaldson (kerry.donaldson@archaeological-surveys.co.uk)
Entered on	19 August 2016



**Land off B1115
Stowupland
Suffolk
Additional Survey**

**GEOPHYSICAL SURVEY
WRITTEN SCHEME OF INVESTIGATION**

for

New Hall Properties (Eastern) Ltd

Kerry Donaldson and David Sabin

June 2016

Ref. no. 638a

Suffolk County Council HER Event No: ESF23302

HER Parish Code: SUP 033

ARCHAEOLOGICAL SURVEYS LTD

**Land off B1115
Stowupland
Suffolk
Additional Survey**

Geophysical Survey Written Scheme of Investigation

Suffolk County Council HER Event No: ESF23302

HER Parish Code: SUP 033



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1 INTRODUCTION

1.1 *Survey background*

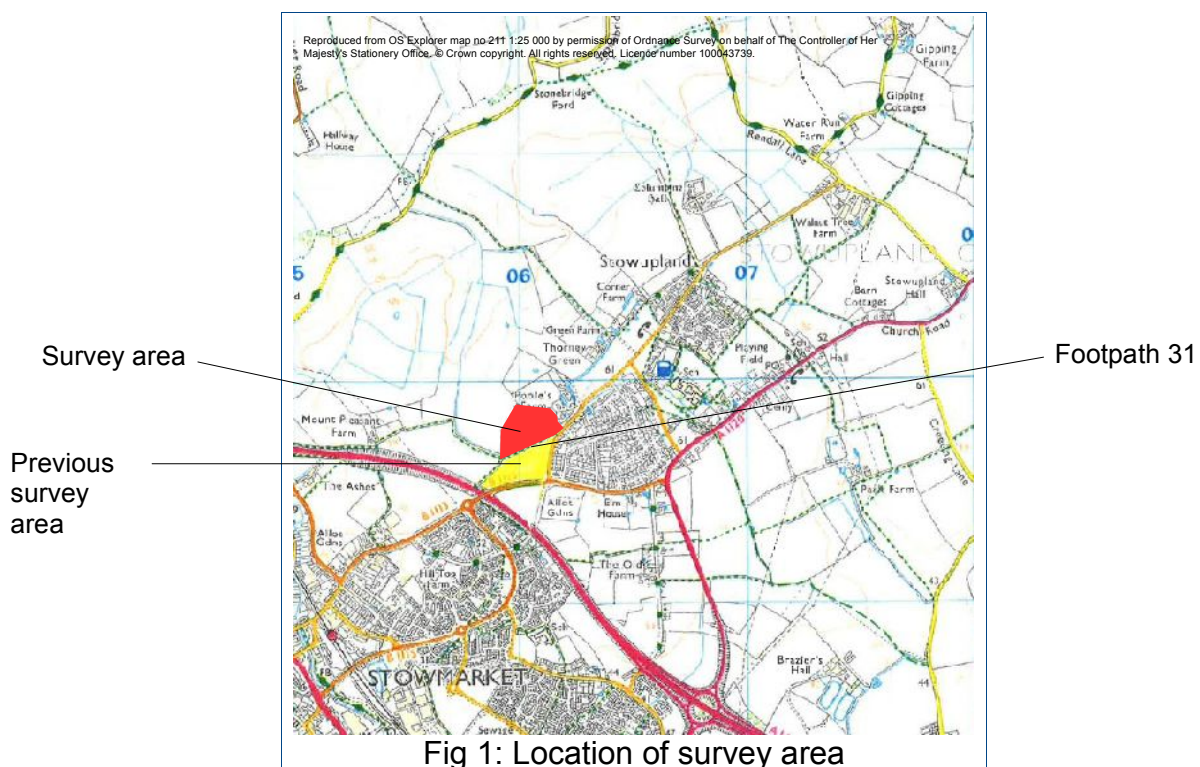
- 1.1.1 Archaeological Surveys Ltd has prepared this Written Scheme of Investigation for New Hall Properties (Eastern) Ltd with regard to a geophysical survey on land to the north west of Thorney Green Road within a single arable field to the north of Footpath 31 at Stowupland in Suffolk see Fig 1. The survey would provide information on the archaeological potential of land likely to be disturbed by a residential development.
- 1.1.2 A previous survey was carried out by Archaeological Surveys Ltd within the southern field in December 2015 and the site has been increased to include the field to the north. Although the survey carried out in the southern field has already been reported on (Archaeological Surveys Ltd, 2015), the results will be combined with the present survey to show the complete site in context. This survey will be represented under the previous Suffolk HER event number ESF23302 and Parish Code SUP 033.
- 1.1.3 Archaeological Surveys Ltd are a small company undertaking specialist geophysical and topographic surveys throughout the UK, Europe and Ireland and is a Registered Organisation with the Chartered Institute for Archaeologists (CIfA). The company directors are David Sabin (Specialised BSc Remote Sensing and Geographic Information Systems, Certificate in Practical Archaeology, Member of the Chartered Institute for Archaeologists) and Kerry Donaldson (BSc Geography, HNC Heritage Management, Certificate in Practical Archaeology). All fieldwork is led by David Sabin.

1.2 *Survey objectives, techniques and standards*

- 1.2.1 The objectives of the survey are to use non-intrusive geophysical techniques to establish the presence/absence, extent, condition, character, quality and date of any archaeological deposits within the proposed development area.
- 1.2.2 The survey and report will generally follow the recommendations set out by English Heritage, 2008: *Geophysical survey in archaeological field evaluation*; and Institute for Archaeologists, 2002, *The use of Geophysical Techniques in Archaeological Evaluations* and Chartered Institute for Archaeologists (2014) *Standard and Guidance for Archaeological Geophysical Survey* and Suffolk County Council Archaeological Service standard *Requirements for a Geophysical Survey* (SCCAS, 2011). Archaeological Surveys Ltd may deviate from the guidelines where it is considered appropriate and justifiable with regard to enhancing the archaeological information that may be derived from the results of the survey.

1.3 Site location, description and survey conditions

1.3.1 The site is located within an irregularly shaped parcel to the north west of Thorney Green Lane, bounded to the south by Footpath 31 and surrounded on most sides by agricultural land and by a dwelling and garden off Thorney Green Road to the east see Fig1 below. The central OS Grid Reference is TM 06030 59780. The area covered by the site is approximately 3.8ha within a single arable field and the survey is due to take place once the crop has been harvested.



1.4 Site history and archaeological potential

1.4.1 The southern field has been subject to a previous geophysical survey (Archaeological Surveys, 2015) and the results of the magnetometry revealed the presence of previously unrecorded archaeology. A series of enclosures, ditches and pits were seen abutting and parallel with Thorney Green Road, which bounds the eastern side of the site.

1.4.2 The site lies close to Thorney Green, which has medieval origins, and a number of possible cropmark and soilmark enclosures are recorded approximately 600m to the north of the site. Roman pottery scatters and metal finds have also been located to the north and east of the site.

1.4.3 There is always potential for the geophysical survey to locate anomalies that

relate to previously unrecorded archaeological features, should they exist within the site.

1.5 *Geology and soils*

- 1.5.1 The underlying solid geology across the site is Crag Group - Sand with overlying deposits of Lowestoft Formation - Diamicton (BGS, 2015). The overlying soils across the survey area are from the Beccles 1 association, which is a typical stagnogley. These consist of slowly permeable seasonally waterlogged, fine loamy over clayey soils on chalky till (Soil Survey of England and Wales, 1983).
- 1.5.2 Magnetometry survey carried out across similar soils has produced variable results, often with low magnetic susceptibility causing weak or poorly defined anomalies. However, within areas of long term occupation there can be sufficient magnetic contrast for features to be visible within the data. The underlying geology and soils are therefore considered acceptable for magnetic survey.

2 METHODOLOGY AND REPORTING

2.1 *Technical synopsis*

- 2.1.1 Magnetometry survey records localised magnetic fields that can be associated with features formed by human activity. Magnetic susceptibility and magnetic thermoremnance influence the formation of localised fields. Additional details are set out below and within Appendix A.
- 2.1.2 Iron minerals within the soil may become altered by burning and the break down of biological material; effectively the magnetic susceptibility of the soil is increased and the iron minerals become magnetic in the presence of the Earth's magnetic field. Accumulations of magnetically enhanced soils within features such as pits and ditches can produce magnetic anomalies that can be mapped during magnetic prospection.
- 2.1.3 Magnetic thermoremnance can occur when ferrous minerals have been heated to high temperatures such as in a kiln, hearth or associated with other industrial processes. On cooling, a permanent magnetisation may be acquired due to the presence of the Earth's magnetic field. Certain natural processes, associated with the formation of some igneous and metamorphic rock, may also result in magnetic thermoremnance.
- 2.1.4 The localised variations in magnetism are measured as sub-units of the Tesla which is a SI unit of magnetic flux density. These sub-units are nano Teslas (nT), which are equivalent to 10^{-9} Tesla (T).

2.2 *Equipment configuration, data collection and survey detail*

- 2.2.1 The survey will be carried out using a SENSYS MAGNETO®MXPDA 5 channel cart based system. The instrument has 5 fluxgate gradiometers spaced 0.5m apart with readings recorded at 20 Hz. It is linked to a Leica GS10 RTK GPS with data recorded by SENSYS MAGNETO®MXPDA software on a rugged PDA computer system.
- 2.2.2 Data are collected along a series of parallel survey transects wherever possible. The length of each transect is variable and relates to the size of the survey area and other factors including ground conditions. A visual display allows accurate placing of transects and helps maintain the correct separation between adjacent traverses.

2.3 *Data processing and presentation*

- 2.3.1 Magnetic data collected by the MAGNETO®MXPDA cart-based system are initially prepared using SENSYS MAGNETO®DLMGPS software. Survey tracks are analysed and georeferenced raw data (UTM Z30N) are then exported in ASCII format for further analysis and display using TerraSurveyor.
- 2.3.2 The data are collected between limits of ± 10000 nT and clipped for display at ± 3 nT. Data are interpolated to a resolution of effectively 0.5m between tracks and 0.15m along each survey track. A zero median traverse function is required in order to remove fixed offset values present within the sensors which do not undergo a zeroing procedure in the field. The approach ensures that the gradiometer sensors are very accurately aligned and fixed to the vertical magnetic field and are not influenced by localised magnetic fields or disturbed by vibration. Although a zero median traverse algorithm can remove anomalies aligned with the survey tracks, in practice this rarely occurs due to the use of long traverses, high resolution measurement and variability within the magnetic susceptibility of long linear features. A TIFF file (UTM ETRS89 Zone 30) is produced by TerraSurveyor software and is reprojected to Ordnance Survey co-ordinates (OSGB36) using the OSTN02 transformation parameters.
- 2.3.3 The main form of data display used in the report will be the minimally processed greyscale plot (clipped and compensated), although a plot of the "raw" data will be shown at absolute values. If further filtering needs to be applied, another greyscale plot will also be shown as filtered data. An abstraction and interpretation plot will outline anomalies using coloured points, polylines and polygons. Plots will be scaled at 1:1000 where suitable, but at other scales if this better defines the context and will include scale bars, scales indicating data range and north arrows (OS Grid North).
- 2.3.4 The raster images will be combined with base mapping using AutoCAD LT 2007 and ProgeCAD 2010 creating DWG file formats. All images will be externally referenced to the CAD drawing in order to maintain good graphical quality. Quality can be compromised by rotation of graphics in order to allow

the data to be orientated with respect to grid north; this is considered acceptable as the survey results are effectively georeferenced allowing relocation of features using GPS, resection method etc.. A digital archive including raster images will be produced with the report allowing separate analysis if necessary, see 2.5 below.

- 2.3.5 An abstraction and interpretation is offered for all geophysical anomalies located by the survey. A brief summary of each anomaly with an appropriate reference number will be set out in list form within the results to allow a rapid assessment of features. Where further interpretation is possible, or where a number of possible origins should be considered, more detailed discussion will follow.

2.4 Reporting

- 2.4.1 Preliminary greyscale results will usually be made available to the client within 1 week of completion of fieldwork. A draft copy of the report is generally submitted to the client within 3 weeks of completion of the fieldwork, depending on complexity of anomalies. A draft copy will also be sent to Rachael Abraham, Senior Archaeological Officer for Suffolk County Council for comment prior to issuing final report to client and Suffolk HER.
- 2.4.2 Although reported on previously (Archaeological Surveys, 2015), the results of the earlier survey will be included to produce a single combined report for the entire proposed development area. This will enable the overall results to be seen in context.
- 2.4.3 Reporting will be carried out in accordance with English Heritage, 2008: *Geophysical survey in archaeological field evaluation*; and Institute for Archaeologists, 2002, *The use of Geophysical Techniques in Archaeological Evaluations* and Chartered Institute for Archaeologists (2014) *Standard and Guidance for Archaeological Geophysical Survey* and Suffolk County Council Archaeological Service standard *Requirements for a Geophysical Survey (SCCAS, 2011)* and will include the following:
- Title page (title of report, authors, contractor, client, reference no. and date)
 - Summary of results
 - Introduction (survey background, survey objectives and techniques, site location, description and survey conditions, site history and archaeological potential, geology and soils)
 - Methodology (technical synopsis, equipment configuration, data collection, survey detail, data processing and presentation)
 - Results (general assessment of survey results, statement of data quality, data interpretation, objective account of anomalies and archaeological interpretation)
 - Discussion
 - Conclusion (assessment of achievement of aims and objectives, results summarised, implications)
 - References

- Appendices (technical details, data processing notes, survey and data information, digital archive)
- Figures (plots in A3 format, location map, referencing layout, greyscale data eg 1:2500 for site and 1:1000 and abstraction and interpretation plot).

2.5 Archive

2.5.1 The main archive is held at the offices of Archaeological Surveys Ltd. Survey results will be produced in hardcopy using A4 for text and A3 for plots (all plots will be scaled for A3). In addition digital data created during the survey can be provided on CD. Further information on the production of the report and the digital formats involved in its creation are set out in 2.5.4 below.

2.5.2 Once payment has been cleared, the geophysical data, CAD, report and graphics will be sent to the Suffolk County Council Archaeological Service (SCCAS) Senior Archaeological Officer Faye Minter for archiving. A SCCAS Archive Data Collection Form will also be sent accompanying the data.

2.5.3 A printed copy of the report and a PDF copy will be supplied to the Suffolk Historic Environment Record. The report will also be uploaded to the Online Access to the Index of archaeological investigations (OASIS) and a copy of the form included in the final report. The WSI will also be included as an additional appendix.

2.5.4 The report will be prepared using the following software on a Windows XP platform:

- TerraSurveyor version 3.0.23.0 (geophysical data analysis),
- SENSYS MAGNETO@ARCH version 1.00-04 (geophysical data analysis),
- AutoCAD LT 2007/ ProgeCAD 2014 (report figures),
- OpenOffice.org 3.0.1 Writer (document text),
- PDF Creator version 0.9 (PDF archive)
- Solid PDF Creator version 8 (PDF archive).

Digital data produced by the survey and report include the following files:

- TerraSurveyor grid and composite files for all geophysical data,
- CSV files for raw composites,
- geophysical composite file graphics as Bitmap images,
- AutoCAD DWG files in 2000 and 2007 versions,
- report text as OpenOffice.org ODT file,
- report text as Word 2000 doc file,
- report text as rich text format (RTF),
- report text as PDF,
- PDFs of all figures.

3 HEALTH AND SAFETY

3.1.1 All work will be carried out under within terms of the Health and Safety at Work Act 1974. Archaeological Surveys Ltd general statement of policy is as follows:

- to provide adequate control of the health and safety risks arising from our work activities;
- to consult with our employees on matters concerning their health and safety;
- to provide and maintain safe equipment;
- to ensure safe handling and use of equipment;
- to provide information, instruction and supervision;
- to ensure all employees are competent to do their tasks and to give them adequate training;
- to prevent accidents and work-related cases of ill health;
- to maintain safe and healthy working conditions;
- to review and revise this policy at regular intervals.

3.1.2 Archaeological Surveys Ltd holds employers liability insurance (£10m), public liability insurance (£5m) and professional indemnity insurance (£2m) and all risk insurance with a reputable UK based insurer, copies of which can be made available on request:

4 INTELLECTUAL PROPERTY RIGHTS

4.1.1 Archaeological Surveys Ltd shall retain intellectual property rights for the materials and records created as part of this project. A non-exclusive, transferable, sub-licensable, perpetual, irrevocable and royalty-free licence shall be granted to the client in order for them to use, reproduce and enhance the reports, documentation, graphics and illustrations produced as part of this project for the purpose for which they were commissioned. Copyright licence will also be granted to the local authority for planning use and within in the Historic Environment Record for public dissemination upon payment by the client. Any document produced to meet planning requirements may be freely copied for planning, development control, research and outreach purposes without recourse to the originator, subject to all due and appropriate acknowledgements being provided and to the terms of the original contract with the client. Archaeological Surveys Ltd shall retain the right to be identified as the author and originator of the material.

4.1.2 The report may contain material that is non-Archaeological Surveys Ltd copyright (eg Ordnance Survey, Crown Copyright) or the intellectual property of third parties, which we are able to provide for limited reproduction under the terms of our own copyright licences, but for which copyright itself is non-transferable by Archaeological Surveys Ltd. Users remain bound by the conditions of the Copyright, Design and Patents Act 1988 with regard to multiple copying and electronic dissemination of this report.

5 REFERENCES

Archaeological Surveys, 2015. *Land off B1115, Stowupland, Suffolk, Magnetometer Survey Report*. Ref 638. Unpublished typescript document.

British Geological Survey, 2015. *Geology of Britain viewer, 1:50 000 scale [online]* available from <http://mapapps.bgs.ac.uk/geologyofbritain/home.html> [accessed 26/11/2015].

Chartered Institute for Archaeologists, 2014. *Standard and Guidance for archaeological geophysical survey*. IfA, University of Reading.

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Institute for Archaeologists, 2002. *The use of Geophysical Techniques in Archaeological Evaluations*. IFA Paper No. 6. IFA, University of Reading.

SCCAS, 2011. *Requirements for a Geophysical Survey*. Suffolk County Council.

Soil Survey of England and Wales, 1983. *Soils of England and Wales, Sheet 4 Eastern England*.

Appendix A – basic principles of magnetic survey

Iron minerals are always present to some degree within the topsoil and enhancement associated with human activity is related to increases in the level of magnetic susceptibility and thermoremanent material.

Magnetic susceptibility is an induced magnetism within a material when it is in the presence of a magnetic field. This can be thought of as effectively permanent due to the presence of the Earth's magnetic field.

Thermoremanent magnetism occurs when ferrous material is heated beyond a specific temperature known as the Curie Point. Demagnetisation occurs at this temperature with re-magnetisation by the Earth's magnetic field upon cooling.

Enhancement of magnetic susceptibility can occur in areas subject to burning and complex fermentation processes on biological material; these are frequently associated with human settlement. Thermoremanent features include ovens, hearths, and kilns. In addition thermoremanent material such as tile and brick may also be associated with human activity and settlement.

Silting and deliberate infilling of ditches and pits with magnetically enhanced soil can create an area of enhancement compared with surrounding soils and subsoils into which the feature is cut. Mapping enhanced areas will produce linear and discrete anomalies allowing an assessment and characterisation of hidden subsurface features.

It should be noted that areas of negative enhancement can be produced from material having lower magnetic properties compared to the topsoil. This is common for many sedimentary bedrocks and subsoils which were often used in the construction of banks and walls etc. Mapping these 'negative' anomalies may also reveal archaeological features.

Magnetic survey or magnetometry can be carried out using a fluxgate gradiometer and may be referred to as gradiometry. The gradiometer is a passive instrument consisting of two fluxgate sensors mounted vertically 0.65m apart. The instrument is carried about 10-20cm above the ground surface and the upper sensor measures the Earth's magnetic field as does the lower sensor but this is influenced to a greater degree by any localised buried field. The difference between the two sensors will relate to the strength the magnetic field created by the buried feature.

There are a number of factors that may affect the magnetic survey and these include soil type, local geology and previous human activity. Situations arise where magnetic disturbance associated with modern services, metal fencing, dumped waste material etc., obscures low magnitude fields associated with archaeological features.

**Geophysical Survey
Land off B1115
Stowupland
Suffolk
Additional Survey**

Map of survey area

Reproduced from OS Explorer map no.211 1:25 000
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Controller of Her Majesty's Stationery Office.
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Licence number 100043739.



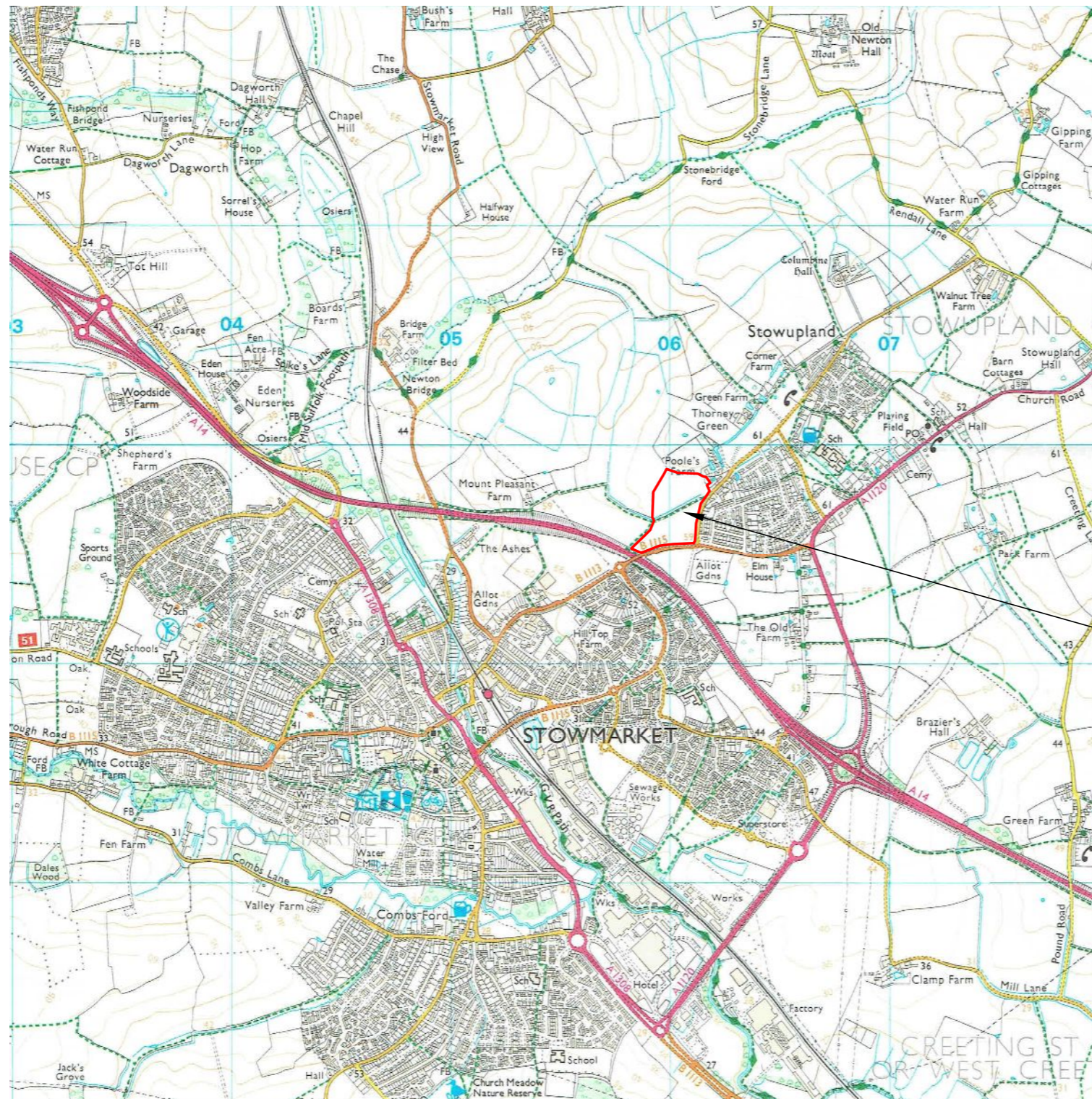
● Survey location

Site centred on OS NGR
TM 06020 59685

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Survey location

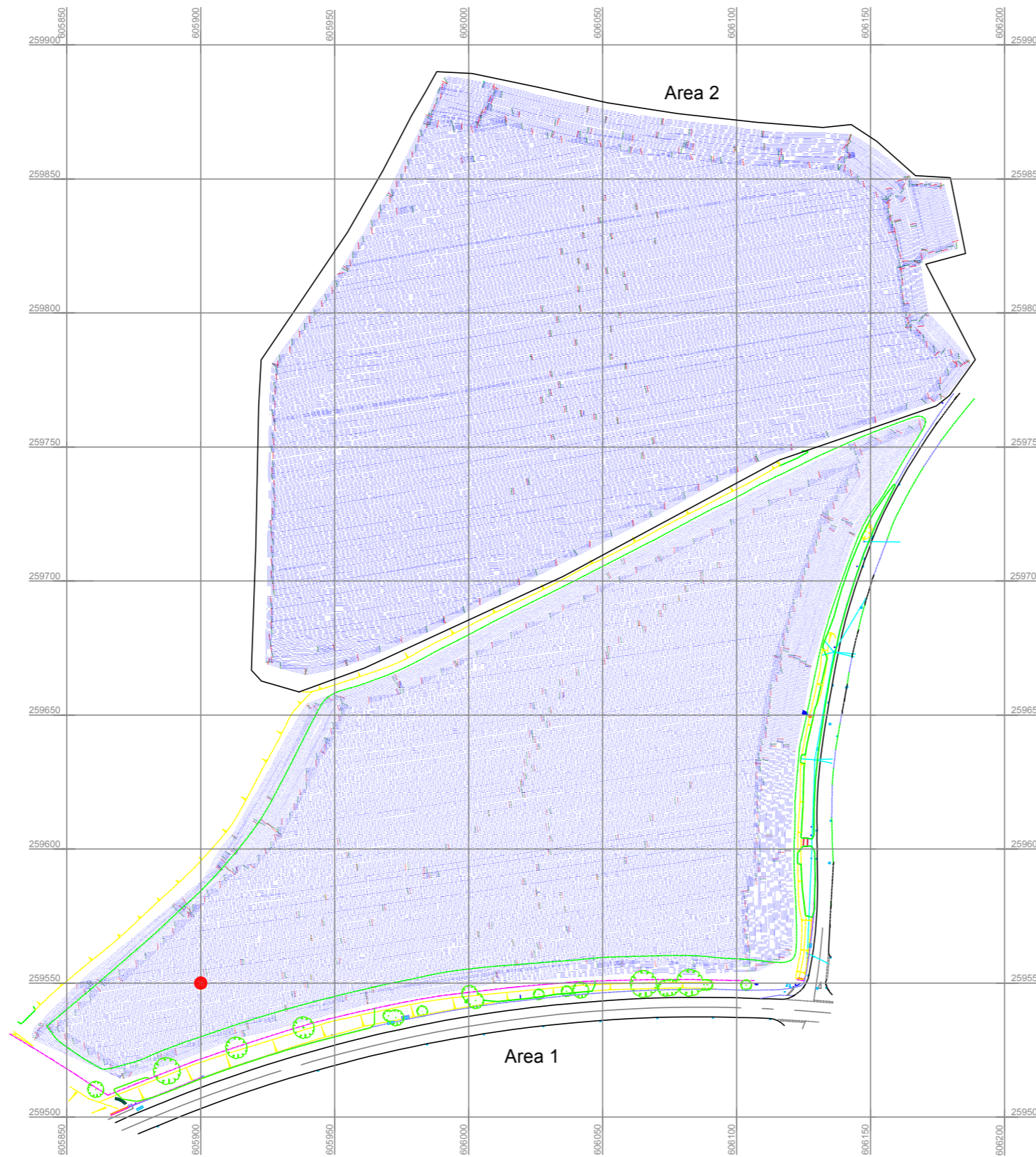
**Geophysical Survey
Land off B1115
Stowupland
Suffolk
Additional Survey**

Referencing information

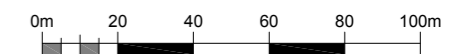
Referencing grid to OSGB36 datum at 50m intervals

Data collected at 20Hz and georeferenced to ETRS89 zone 30 with conversion to OSGB36 using OSTN02

- 605900 259550
- Survey tracks
- ⋯ Survey track start
- ⋯ Survey track stop



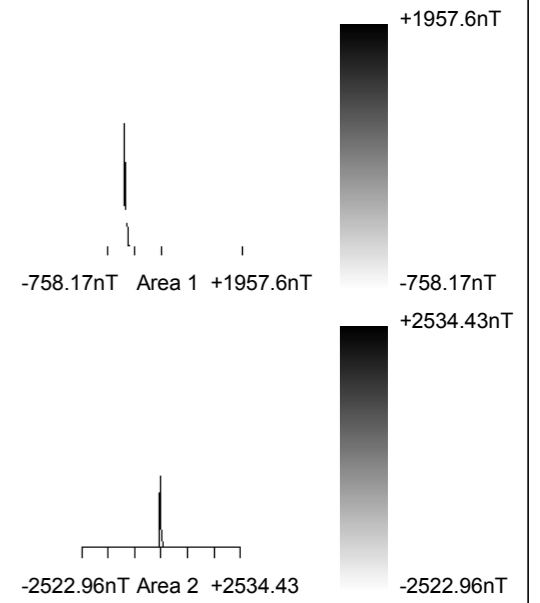
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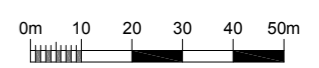
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**Geophysical Survey
Land off B1115
Stowupland
Suffolk
Additional Survey**

**Greyscale plot of raw
magnetometer data**



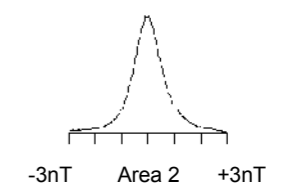
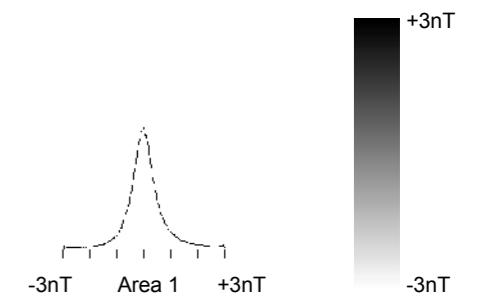
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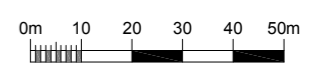
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**Geophysical Survey
Land off B1115
Stowupland
Suffolk
Additional Survey**

**Greyscale plot of minimally
processed magnetometer data**















SCALE 1:1500



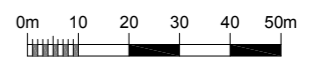
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**Geophysical Survey
Land off B1115
Stowupland
Suffolk
Additional Survey**

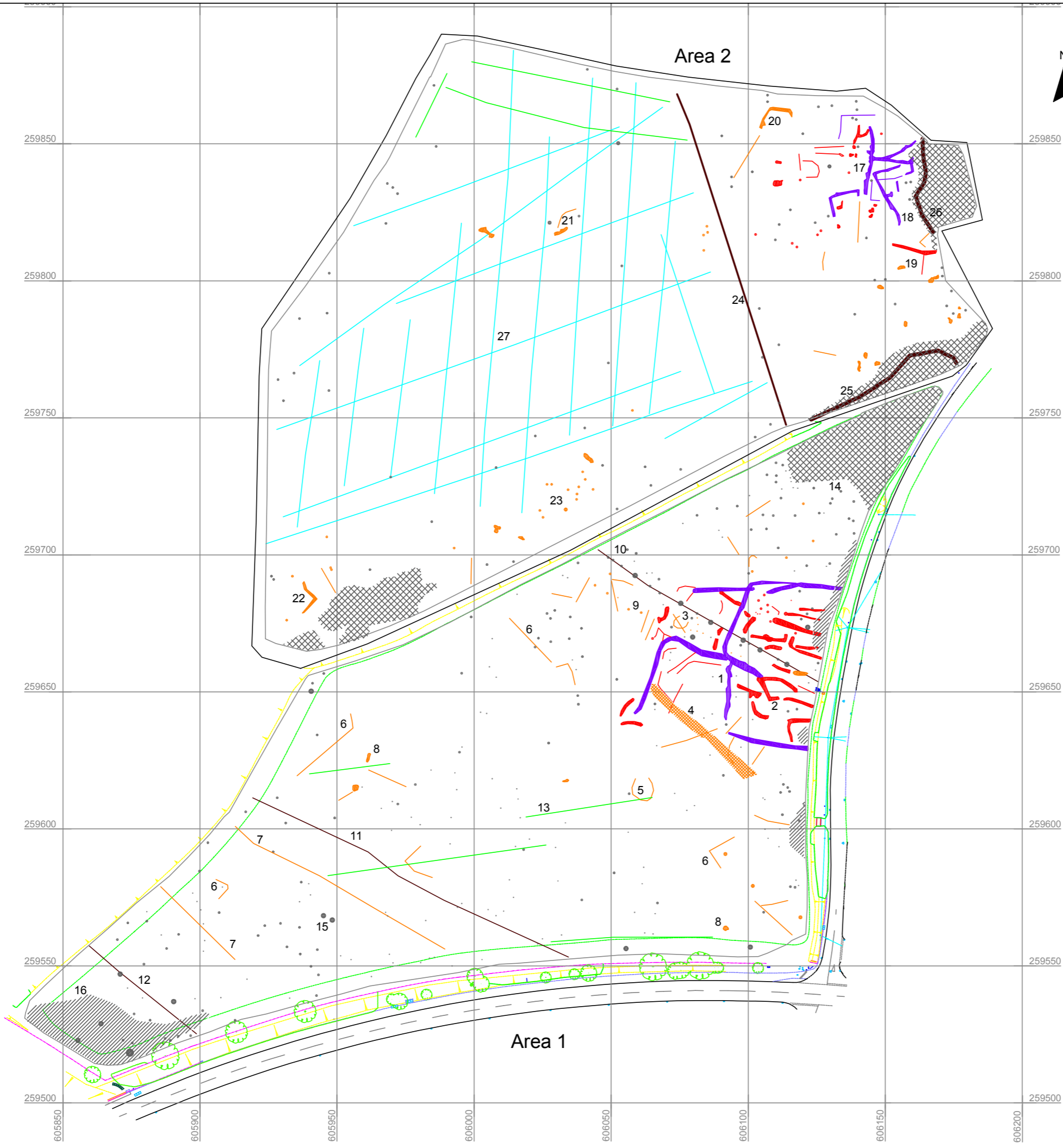
**Abstraction and interpretation of
magnetometer anomalies**

-  Positive linear anomaly - cut feature of archaeological potential
-  Positive rectilinear anomaly - enclosure ditch
-  Positive linear anomaly - possible ditch-like feature
-  Linear anomaly - of agricultural origin
-  Positive linear anomaly - former field boundary
-  Weakly multiple dipolar linear anomaly - land drain
-  Discrete positive response - cut feature of archaeological potential
-  Discrete positive response - possible pit-like feature
-  Positive anomaly - magnetically enhanced material
-  Magnetic debris - spread of magnetically thermoremanent/ferrous material
-  Magnetic disturbance from ferrous material
-  Strong dipolar anomaly - ferrous object

SCALE 1:1500

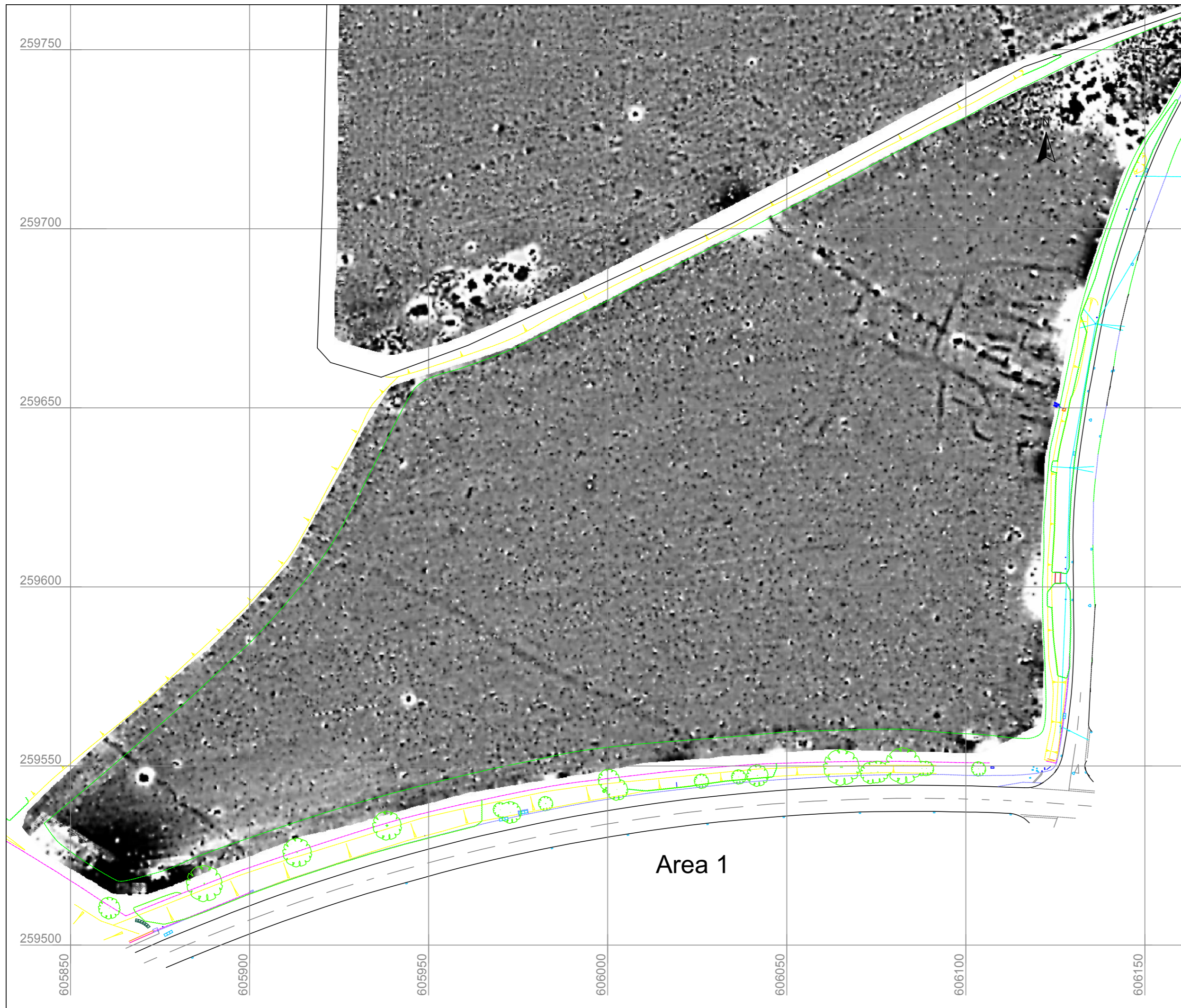
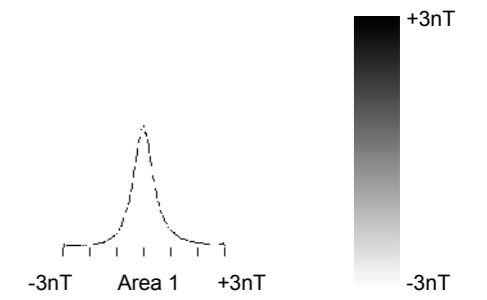


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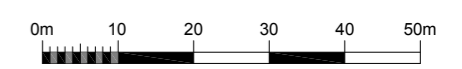
**Geophysical Survey
Land off B1115
Stowupland
Suffolk
Additional Survey**

**Greyscale plot of minimally
processed magnetometer data -
Area 1**



Area 1












SCALE 1:1000



SCALE TRUE AT A3

**Geophysical Survey
Land off B1115
Stowupland
Suffolk
Additional Survey**

**Abstraction and interpretation of
magnetometer anomalies -
Area 1**

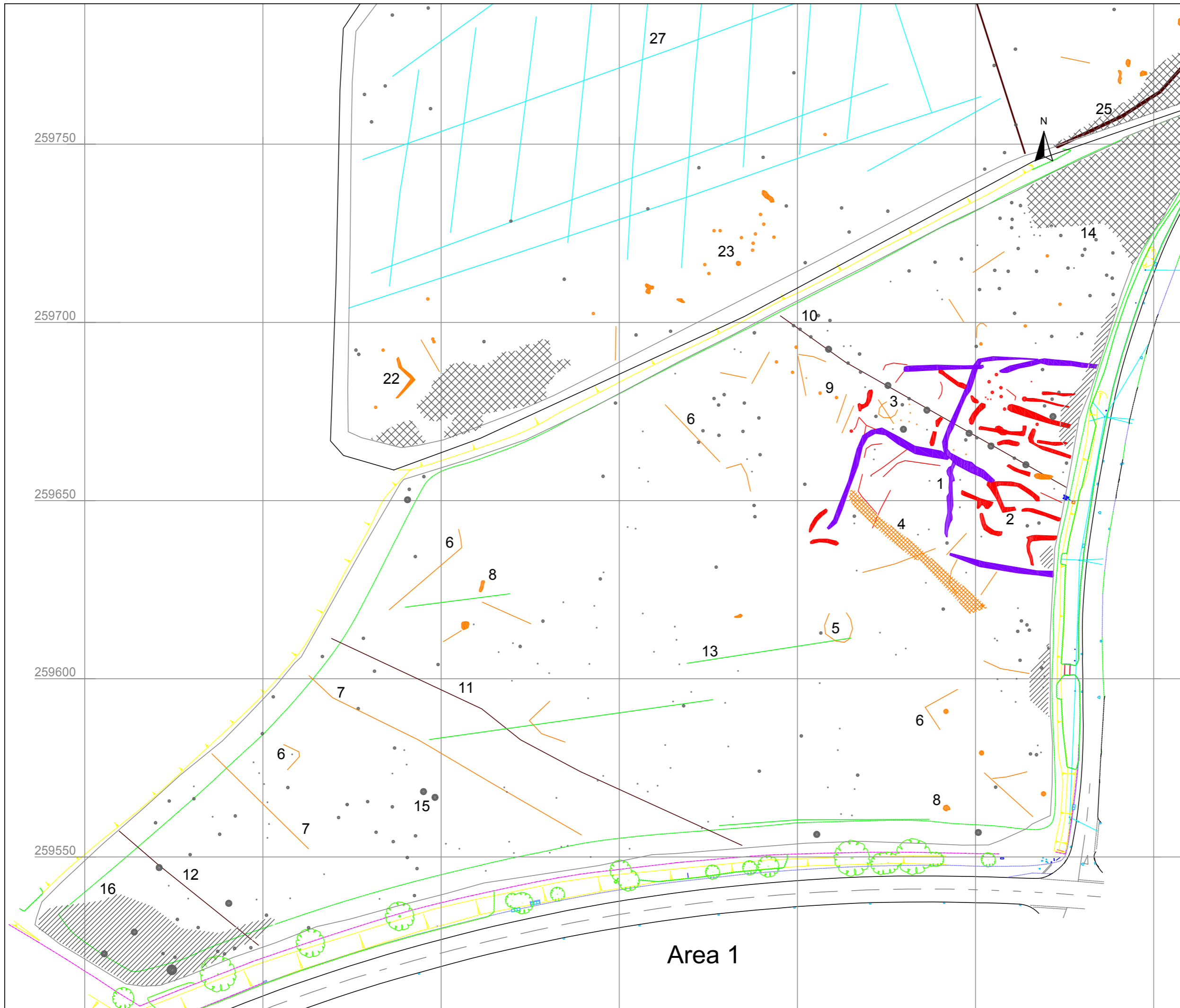
-  Positive linear anomaly - cut feature of archaeological potential
-  Positive rectilinear anomaly - enclosure ditch
-  Positive linear anomaly - possible ditch-like feature
-  Linear anomaly - of agricultural origin
-  Positive linear anomaly - former field boundary
-  Discrete positive response - cut feature of archaeological potential
-  Discrete positive response - possible pit-like feature
-  Positive anomaly - magnetically enhanced material
-  Magnetic debris - spread of magnetically thermoremanent/ferrous material
-  Magnetic disturbance from ferrous material
-  Strong dipolar anomaly - ferrous object

SCALE 1:1000



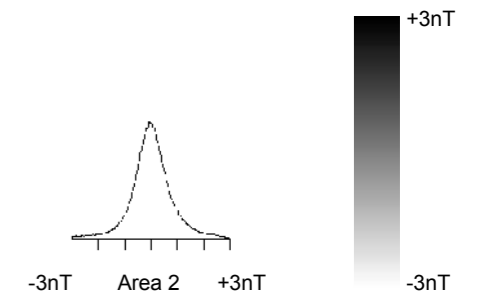
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Area 1



**Geophysical Survey
Land off B1115
Stowupland
Suffolk
Additional Survey**

**Greyscale plot of minimally
processed magnetometer data -
Area 2**



Area 2















SCALE 1:1000



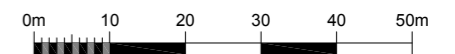
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**Geophysical Survey
Land off B1115
Stowupland
Suffolk
Additional Survey**

**Abstraction and interpretation of
magnetometer anomalies - Area 2**

-  Positive linear anomaly - cut feature of archaeological potential
-  Positive rectilinear anomaly - enclosure ditch
-  Positive linear anomaly - possible ditch-like feature
-  Linear anomaly - of agricultural origin
-  Positive linear anomaly - former field boundary
-  Weakly multiple dipolar linear anomaly - land drain
-  Discrete positive response - cut feature of archaeological potential
-  Discrete positive response - possible pit-like feature
-  Positive anomaly - magnetically enhanced material
-  Magnetic debris - spread of magnetically thermoremanent/ferrous material
-  Magnetic disturbance from ferrous material
-  Strong dipolar anomaly - ferrous object

SCALE 1:1000



SCALE TRUE AT A3

