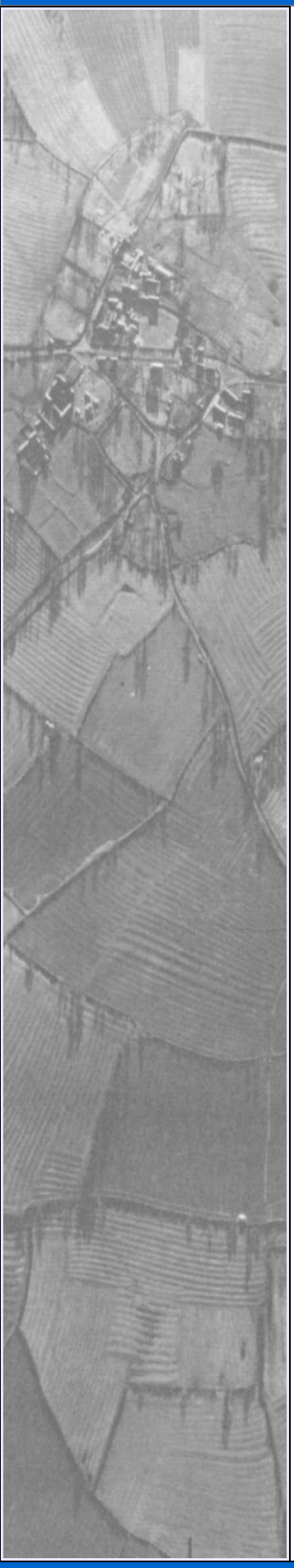

Land adjacent to Shipston High School Shipston-on-Stour Warwickshire

MAGNETOMETER SURVEY REPORT

for

Archaeology Warwickshire

David Sabin and Kerry Donaldson

March 2015

Ref. no. 598

ARCHAEOLOGICAL SURVEYS LTD

Land adjacent to Shipston High School Shipston-on-Stour Warwickshire

Magnetometer Survey Report

for

Archaeology Warwickshire

Fieldwork by David Sabin (Hons) MCIfA
Report by Kerry Donaldson BSc (Hons)
Report checked by David Sabin
Primary archive location - Archaeological Surveys Ltd, Yatesbury, Wiltshire

Survey dates – 20th March 2015
Ordnance Survey Grid Reference – **SP 24985 40810**

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SUMMARY

A detailed magnetometer survey was carried out by Archaeological Surveys Ltd, at the request of Archaeology Warwickshire, on an area of land adjacent to Shipston High School, Shipston-on-Stour, Warwickshire. The site has been outlined for a potential solar farm and the survey forms part of an archaeological assessment. The site was very overgrown with numerous saplings and areas of brambles that prevented collection of a complete data set. The results demonstrate the presence of a number of very weakly positive responses of uncertain origin and at least two land drains or services. Positive anomalies may relate to former cut features, although their archaeological potential cannot be determined.

1 INTRODUCTION

1.1 Survey background

1.1.1 Archaeological Surveys Ltd was commissioned by Archaeology Warwickshire, to undertake a magnetometer survey of an area of land adjacent to Shipston High School, Shipston-on-Stour, Warwickshire. The site has been outlined for a potential solar farm and the survey forms part of an archaeological assessment of the site.

1.1.2 The geophysical survey was carried out in accordance with a Written Scheme of Investigation (WSI) produced by Archaeology Warwickshire (2015).

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 a single land parcel immediately west of Shipston High School. It slopes down from the north western corner at 115m AOD to 92m AOD at the south eastern corner. It is centred on Ordnance Survey National Grid Reference (OS NGR) SP 24985 40810, see Figures 01 and 02.

1.3.2 The geophysical survey covered approximately 1.5ha of scrub land within a single field that had been left unmanaged. The area contained patches of grass, briar, thistles, thorn and saplings. Parts of the site were also waterlogged.

Plate 1: Survey area looking towards the west

1.3.3 The conditions across the site were very poor resulting in a fragmented dataset representing approximately 50% of the field; however, the limited sample is widespread across the site and may well be representative. The data are collected from numerous small patches of grass but survey was prevented by dense thickets of briar, tall saplings and thorn bushes. Weather conditions during the survey were sunny and warm.

1.4 Site history and archaeological potential

1.4.1 The site lies immediately north east of a Romano-British settlement (MWA13172) which was subject to a geophysical survey (Stratascan, 2012). A number of rectilinear and curvilinear enclosures, linear ditches, a possible trackway and pits were located. Subsequent archaeological evaluation (Cotswold Archaeology, 2012) identified that these features related to a Roman agricultural settlement site. Later ridge and furrow and more modern agricultural practices had truncated much of the archaeological features. The results indicate that there was some possibility for the archaeological features to continue to the south; however, a geophysical survey to the south of the Campden Road, located linear anomalies that may indicate linear boundary ditches, rather than enclosures or settlement related features (Archaeological

Surveys, 2015).

1.4.2 The site lies outside the medieval core of Shipston-on-Stour and is believed to have been within the agricultural hinterland. It is likely that the site contains ridge and furrow.

1.5 Geology and soils

1.5.1 The underlying geology is mudstone from the Charmouth Mudstone Formation (BGS, 2015).

1.5.2 The overlying soil across the survey area is from the Denchworth association and is a pelo-stagnogley. It consists of a slowly permeable, seasonally waterlogged, clayey soil (Soil Survey of England and Wales, 1983).

1.5.3 Magnetometry carried out over similar geology and soil has produced good results, although at times there can be poor contrast between the fill of cut features and the material into which they were cut. The site is, therefore, considered suitable 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 20 Hz. The gradiometers have a range of recording data between 0.1nT and 10,000nT. The system 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.

2.2.3 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.

2.3.2 The data are collected between limits of ±10000nT and clipped for display at ±2nT. Data are interpolated to a resolution of effectively 0.5m between tracks and 0.13m 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 high pass filter is also applied to remove survey tracks and spurious data caused by very poor ground conditions.

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 processed greyscale plot.

2.3.5 The raster images are combined with base mapping using ProgeCAD Professional 2014, creating DWG 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 offered 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. 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.

2.3.7 A digital archive is produced with this report, see Appendix D below. The main archive is held at the offices of Archaeological Surveys Ltd.

3 RESULTS

3.1 General assessment of survey results

3.1.1 The detailed magnetic survey was carried out over approximately 1.5ha within a 3ha field.

3.1.2 Magnetic anomalies located can be generally classified as positive and negative anomalies of an uncertain origin, anomalies associated with land management and strong discrete dipolar anomalies relating to ferrous objects. Anomalies located within the survey area have been numbered and are described in 3.4 below.

3.2 Statement of data quality

3.2.1 Data are considered representative of the magnetic anomalies present within the site. The survey was very fragmented due to the nature of the ground cover within the site. Survey was attempted across all accessible areas.

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.

Report sub-heading CAD layer names and plot colour	Description and origin of anomalies
Anomalies with an uncertain origin AS-ABST MAG POS LINEAR UNCERTAIN AS-ABST MAG NEG LINEAR UNCERTAIN AS-ABST MAG POS DISCRETE UNCERTAIN AS-ABST MAG POS UNCERTAIN	The category applies to a range of anomalies where there is not enough evidence to confidently suggest an origin. Anomalies in this category may well be related to archaeologically significant features, but equally relatively modern features, geological/pedological features and agricultural features should be considered. 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. Negative anomalies are produced by material of comparatively low magnetic susceptibility such as stone and subsoil.
Anomalies relating to land management AS-ABST MAG LAND DRAIN	Land drains can appear in a classic herringbone pattern of interconnected multiple dipolar linear anomalies, or as parallel linear anomalies. The multiple dipolar response indicates a ceramic land drain.
Anomalies associated with magnetic debris AS-ABST MAG STRONG DIPOLAR	Strong discrete dipolar anomalies are responses to ferrous objects within the topsoil.

Table 1: List and description of interpretation categories

3.4 List of anomalies

Area centred on OS NGR 424985 240810, see Figures 03 & 04.

Anomalies with an uncertain origin

(1) – A short, positive linear within the northern central part of the survey area. It is possible that this relates to a cut feature, but the response is weak (<1nT) and there is a lack of definable associated features.

(2) – A discrete positive response is located towards the south eastern corner of the site. It appears as a pit-like response (2nT) but it is possible that it is associated with a weakly positive linear anomaly that may extend across it, oriented east to west.

(3) – In the south western part of the survey area is a broad, weakly positive response (0.5nT). This type of response may indicate a cut feature, former bank feature or ridge and furrow, but there are no other parallel responses, and the origin of the anomaly is uncertain.

(4) – In the centre of the site is a weakly positive response (0.6nT). Other weakly positive linear anomalies appear in the vicinity. There is no coherent morphology to the anomalies and their origin is uncertain.

(5) – A positive and parallel negative linear anomaly is located in the western part of the survey area. It is not possible to determine the origin of the responses.

(6) – A small number of positive anomalies can be seen to the north of anomaly (5). They have a east north east to west south west orientation. It is possible that they are associated with agriculture, but they are so weak, short and indistinct that their origin is uncertain.

Anomalies associated with land management

(7) – Two weakly multiple dipolar linear anomalies can be seen in the northern and southern parts of the survey area. This type of anomaly would indicate terracotta land drains.

Anomalies associated with magnetic debris

(8) - The survey area contains widespread and numerous strong, discrete, dipolar anomalies that relate to buried ferrous objects within the topsoil.

4 CONCLUSION

4.1.1 The detailed magnetometer survey located a number of very weak responses within the site. However, the low magnitude response of the anomalies, and fragmented nature of the survey, prevent confident interpretation. Weak positive anomalies may represent former cut features, but their archaeological potential cannot be determined.

5 REFERENCES

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Aspinall, A., Gaffney, C. and Schmidt, A., *Magnetometry for Archaeologists*. Lanham (US), AltaMira Press.

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

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Stratascan, 2012. *Geophysical Survey Report, Shipston-on-Stour.* Ref J3004. Unpublished typescript document.

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 thermoremnant 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.

Thermoremnant 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. Thermoremnant features include ovens, hearths, and kilns. In addition thermoremnant 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 ±20nT and ±10nT 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

COMPOSITE
Filename: J598-mag.xcp
Description: Imported as Composite from: J598-mag.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 30U
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 424900.695285513, 240916.28269215 m
Southeast corner: 425066.185285513, 240719.59269215 m
Collection Method: Randomised
Sensors: 5
Dummy Value: 32702

Source GPS Points: 623500

Dimensions
Composite Size (readings): 1273 x 1513
Survey Size (meters): 165 m x 197 m
X Interval: 0.13 m
Y Interval: 0.13 m

Stats
Max: 2.00
Min: -2.00
Std Dev: 0.56
Mean: 0.00
Median: 0.00
Composite Area: 3.255 ha
Surveyed Area: 1.1644 ha

PROGRAM
Name: TerraSurveyor
Version: 3.0.23.0

Processes: 3
1 Base Layer
2 Clip from -3.00 to 3.00 nT
3 Clip from -2.00 to 2.00 nT

GPS based Proce6
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 DeStripe Median Traverse:
4 Clip from -10.00 to 10.00 nT
5 Clip from -3.00 to 3.00 nT
6 High pass Uniform (median) filter: Window dia: 350

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.

Three printed copies of the report and a PDF copy will be supplied to the Warwickshire Historic Environment Record. The report will also be uploaded to the Online AccesS to the Index of archaeological investigationS (OASIS).

Archive contents:

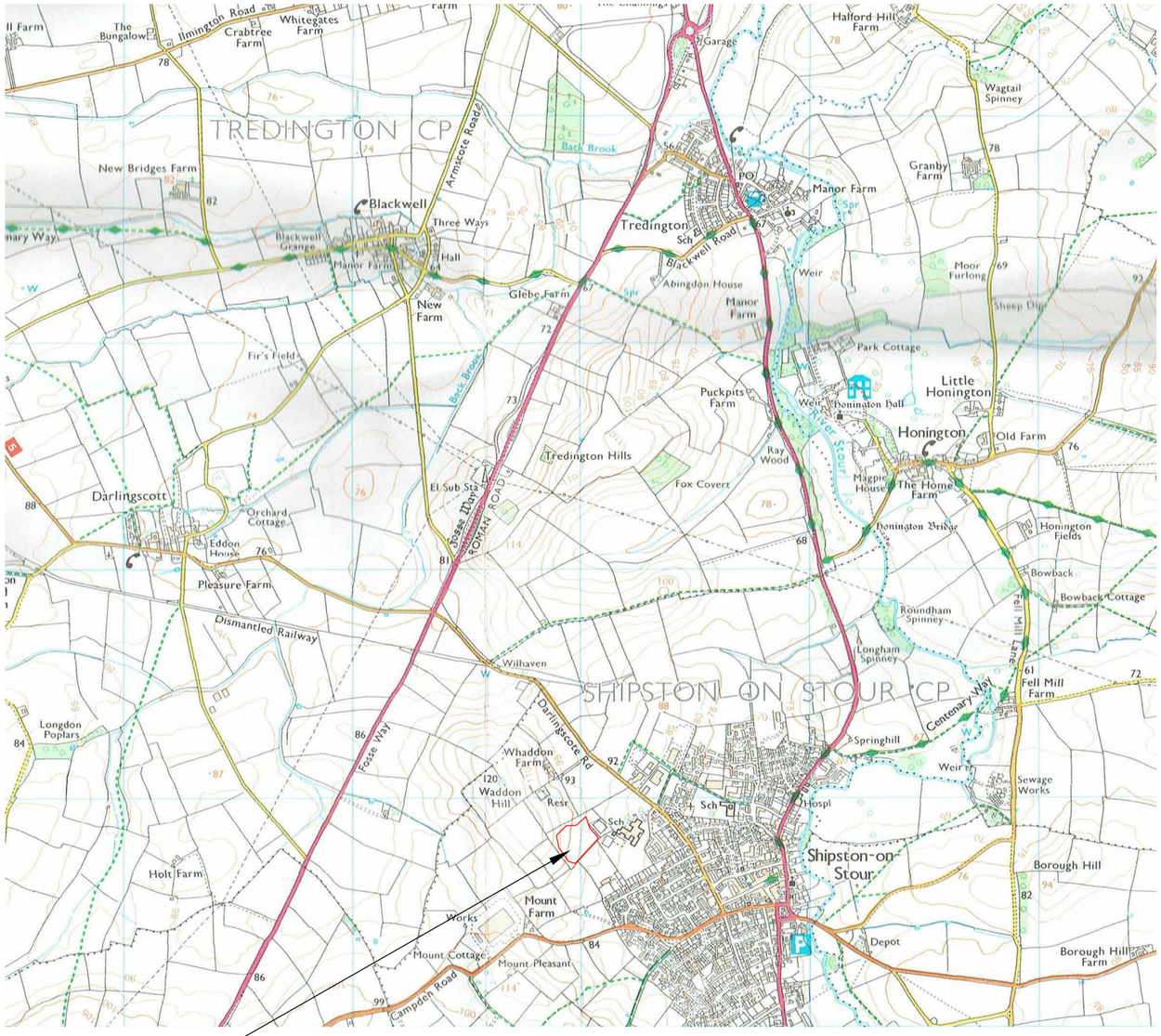
Geophysical data Area 1 - path: J598 Shipston-on-Stour\Data				
Path and Filename	**Software**	**Description**	**Date**	**Creator**
shpsch1\MX\ .prm .dgb .disp	Sensys MXPDA	Proprietary data formats representing magnetometer survey traverses logged to a PDA.		D.J.Sabin
shpsch1\MX\J598-mag.asc	Sensys DLMGPS	ASCII CSV (tab) file representing survey area in eastings, northings (UTM Z30N), magnetic measurement, traverse file and sensor number.		D.J.Sabin
Mag\comps\J598-mag.xcp	TerraSurveyor 3.0.23.0	Composite data file derived from ASCII CSV.		D.J.Sabin
Mag\comps\J598-mag-proc.xcp	TerraSurveyor 3.0.23.0	Processed composite data file (zmt, high pass filter and clipping to ±2nT).		D.J.Sabin
Graphic data - path: J598 Shipston-on-Stour\Data				
Mag\graphics\ J598-mag-proc.tif	TerraSurveyor 3.0.23.0	TIF file showing a minimally processed greyscale plot clipped to ±2nT.		K.T.Donaldson
Mag\graphics\ J598-mag-proc.tfw	TerraSurveyor 3.0.23.0	World file for georeferencing TIF to OSGB36.		K.T.Donaldson
CAD data - path: J598 Shipston-on-Stour\CAD				
J598 version 1.dwg	ProgeCAD 2014	CAD file for creating plots of greyscales, abstraction, interpretation and mapping. Grid coordinates as OSGB. AutoCAD 2010 format.		K.T.Donaldson
Text data - path: J598 Shipston-on-Stour\Documentation				
J598 report.odt	OpenOffice.org 3.0.1 Writer	Report text as an Open Office document.		K.T.Donaldson

Appendix E – copyright and intellectual property

Archaeological Surveys Ltd

Geophysical Survey
Land adjacent to Shipston High School
Shipston-on-Stour
Warwickshire

Map of survey area



Survey location

Survey location

Site centred on OS NGR
SP 24985 40810

SCALE 1:25 000

0m 500m 1000m

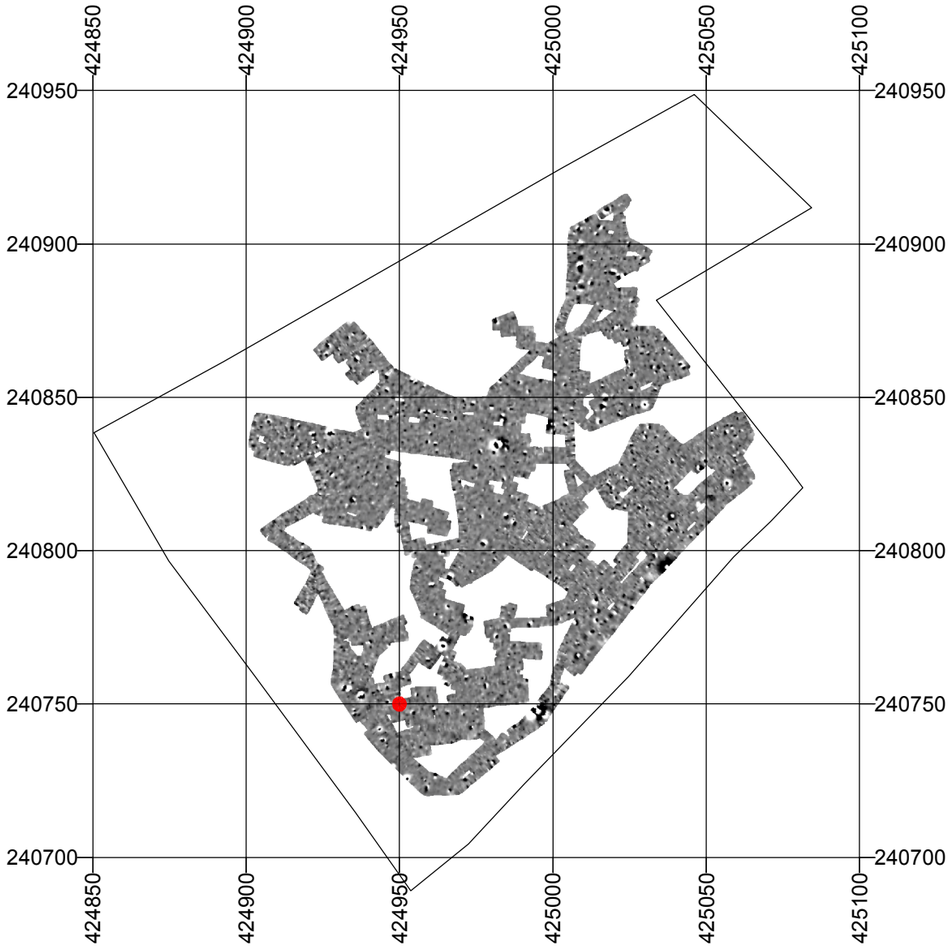
SCALE TRUE AT A3

FIG 01

Archaeological Surveys Ltd

Geophysical Survey
Land adjacent to Shipston High School
Shipston-on-Stour
Warwickshire

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

● 424950 240750

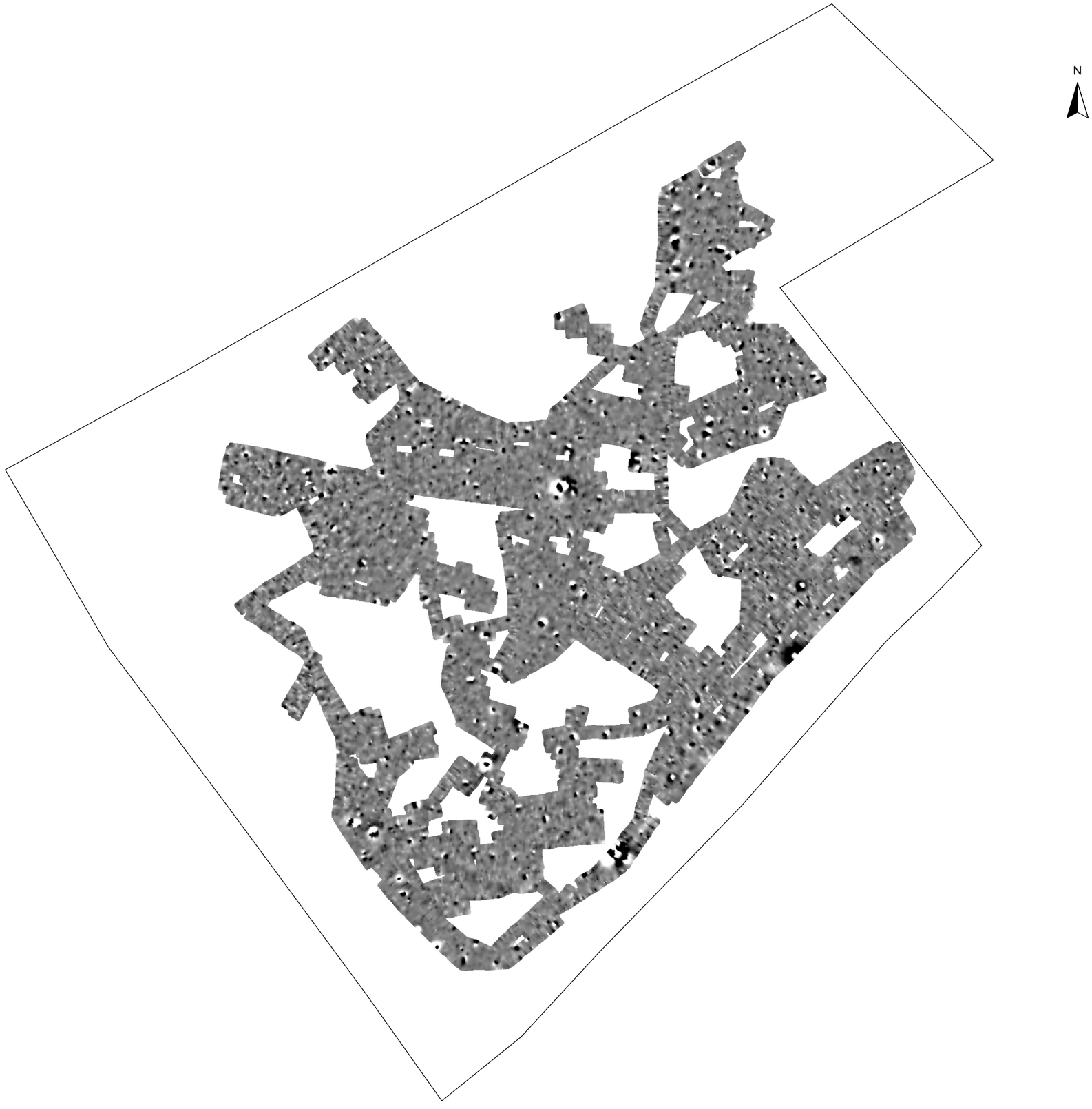
Gaps in data caused by patches of brambles and other dense overgrown vegetation

SCALE 1:2000

0m 20 40 60 80 100m

SCALE TRUE AT A3

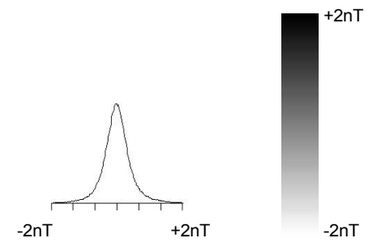
FIG 02



Archaeological Surveys Ltd

Geophysical Survey
Land adjacent to
Shipston High School
Shipston-on-Stour
Warwickshire

Greyscale plot of minimally processed magnetometer data



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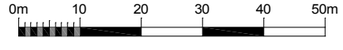


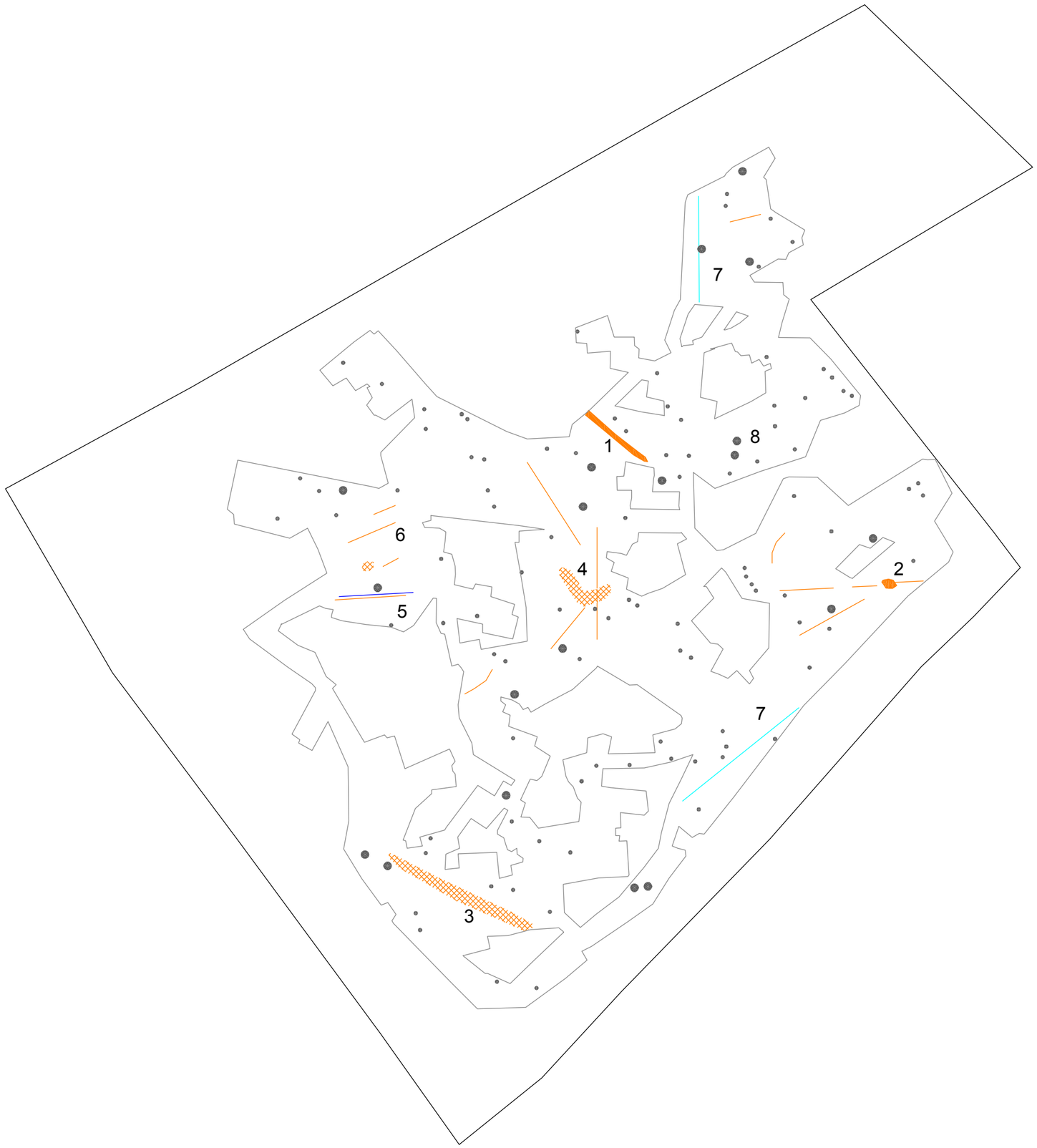
SCALE TRUE AT A3

FIG 03

Archaeological Surveys Ltd

Geophysical Survey
Land adjacent to Shipston High School
Shipston-on-Stour
Warwickshire

Abstraction and interpretation of magnetometer anomalies



- Positive linear anomaly - possible ditch-like feature
- Positive linear anomaly - possible land drain
- Negative linear anomaly - material of low magnetic susceptibility
- Discrete positive response - possible pit-like feature
- Positive anomaly - magnetically enhanced material
- Strong dipolar anomaly - ferrous object

SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

FIG 04