GEOPHYSICAL SURVEY REPORT

SUMO Survey

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Land at Blythe Bridge, Stoke on Trent, Staffordshire

Client

Staffordshire University, Centre of Archaeology

Survey Report

13462

Date

October 2018

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GEOPHYSICAL SURVEY REPORT

Project name:
Land at Blythe Bridge, Stoke on Trent, Staffordshire

SUMO Job reference:
13462

Client:
Staffordshire University, Centre of Archaeology

Survey date:
17 - 18 September 2018

Report date:
8 October 2018

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1 SUMMARY OF RESULTS

A detailed magnetometer survey was conducted over approximately 5 ha of pasture land at Blythe Bridge, near Stoke on Trent. No definite archaeological anomalies have been identified. Evidence of agricultural activity can be seen across the site, and includes ridge and furrow, plough effects, land drains and a former fence line. Areas of natural variation have been mapped while the remaining responses are modern and are a result of nearby ferrous metal objects.

2 INTRODUCTION

2.1 Background synopsis

SUMO Geophysics Ltd were commissioned to undertake a geophysical survey of an area outlined for development. This survey forms part of an archaeological investigation being undertaken by **Staffordshire University, Centre of Archaeology**.

2.2 Site details

NGR / Postcode	SJ 965 407 / ST11 9ND
Location	The site is located to the south-east of Blythe Bridge, Forsbrook, Staffordshire, approximately 11km south-east of Stoke on Trent. The A521 forms the northern boundary of the site with the A50 to the west.
HER/SMR	Staffordshire
District	Staffordshire Moorlands
Parish	Forsbrook CP
Topography	Mostly level
Current Land Use	Pasture
Geology	Solid: Tarporley Siltstone Formation - siltstone, mudstone and sandstone. Superficial: Till, Devensian - diamicton (BGS 2018).
Soils	Clifton Association (711n) - slowly permeable seasonally waterlogged reddish fine and coarse loamy soils (SSEW 1983).
Archaeology	Based on current evidence, this assessment has identified that the study site has a moderate theoretical potential for previously undiscovered Roman evidence due to its proximity to the course of a Roman road c.100m to the north. Such evidence (if present) is likely to comprise unstratified finds related to peripheral roadside activity. The study site is located away from the Medieval and later settlement foci and would have formed part of the agricultural hinterland of Forsbrook and Draycott in the Moors (CgMs 2017).
Survey Methods	Magnetometer survey (fluxgate gradiometer)
Study Area	*c.* 5 ha

2.3 Aims and Objectives

To locate and characterise any anomalies of possible archaeological interest within the study area.

3 METHODS, PROCESSING & PRESENTATION

3.1 Standards & Guidance

This report and all fieldwork have been conducted in accordance with the latest guidance documents issued by Historic England (EH 2008) (then English Heritage), the Chartered Institute for Archaeologists (CIfA 2014) and the European Archaeological Council (EAC 2016).

3.2 Survey methods

Detailed magnetic survey was chosen as an efficient and effective method of locating archaeological anomalies.

Technique	Instrument	Traverse Interval	Sample Interval
Magnetometer	Bartington Grad 601-2	1.0m	0.25m

More information regarding this technique is included in Appendices A and B.

3.3 Data Processing

The following basic processing steps have been carried out on the data used in this report:

De-stripe; de-stagger; interpolate

3.4 Presentation of results and interpretation

The presentation of the results includes a 'minimally processed data' and a 'processed data' greyscale plot. Magnetic anomalies are identified, interpreted and plotted onto the 'Interpretation' drawings.

When interpreting the results, several factors are taken into consideration, including the nature of archaeological features being investigated and the local conditions at the site (geology, pedology, topography etc.). Anomalies are categorised by their potential origin. Where responses can be related to other existing evidence, the anomalies will be given specific categories, such as: *Abbey Wall* or *Roman Road*. Where the interpretation is based largely on the geophysical data, levels of confidence are implied, for example: *Probable*, or *Possible Archaeology*. The former is used for a confident interpretation, based on anomaly definition and/or other corroborative data such as cropmarks. Poor anomaly definition, a lack of clear patterns to the responses and an absence of other supporting data reduces confidence, hence the classification *Possible*.

4 RESULTS

The survey has been divided into six survey areas (Areas 1-6).

4.1 ***Probable / Possible Archaeology***

4.1.1 No magnetic responses have been recorded that could be interpreted as being of archaeological interest.

4.2 ***Uncertain***

4.2.1 A single weak curvilinear trend in the north of Area 2 is of uncertain origin, though an archaeological explanation is thought unlikely. The response is probably of natural or modern origin.

4.3 ***Agricultural – Ploughing / Land Drains / Former Fence***

4.3.1 Widely spaced, slightly curved parallel linear anomalies are visible in Area 3 and are indicative of ridge and furrow cultivation.

4.3.2 Evidence of modern ploughing activity is visible in Areas 5 and 6 in the form of magnetically weak, closely spaced linear anomalies.

4.3.3 Linear anomalies comprising positive and negative components are visible across Area 4. These responses are typical of those associated with modern land or field drains.

4.3.4 A weak bipolar linear anomaly forming a part-rectilinear feature in Area 6 is thought to be of modern origin and is probably associated with the line of a former fence.

4.4 ***Natural / Geological / Pedological / Topographic***

4.4.1 Sinuous bands of enhanced magnetic response can be seen in Areas 3, 4 and 5. These are likely to be a result of localised variations in the underlying geology and / or superficial deposits.

4.5 ***Ferrous / Magnetic Disturbance***

4.5.1 Ferrous responses close to boundaries are due to adjacent fences and gates. Smaller scale ferrous anomalies ("iron spikes") are present throughout the data and are characteristic of small pieces of ferrous debris (or brick / tile) in the topsoil; they are commonly assigned a modern origin. Only the most prominent of these are highlighted on the interpretation diagram.

5 DATA APPRAISAL & CONFIDENCE ASSESSMENT

5.1 Historic England guidelines (EH 2008) Table 4 states that the average magnetic response on siltstone, mudstone and sandstone is variable. The results from this survey indicate the presence of ridge and furrow, ploughing and land drains. As a consequence, the technique is likely to have detected any archaeological features, if present.

6 CONCLUSION

6.1 The survey at Blythe Bridge has not revealed any anomalies of definite archaeological origin. Evidence of ridge and furrow, modern ploughing and land drains have been identified, along with a former fence line, areas of natural magnetic variation and disturbance from nearby ferrous objects.

7 REFERENCES

BGS 2018 British Geological Survey, Geology of Britain viewer [Accessed 08/10/2018] *website*: (http://www.bgs.ac.uk/opengeoscience/home.html?Accordion1=1#maps)

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EH 2008 *Geophysical Survey in Archaeological Field Evaluation.* English Heritage, Swindon https://content.historicengland.org.uk/images-books/publications/geophysical-survey-in-archaeological-field-evaluation/geophysics-guidelines.pdf/

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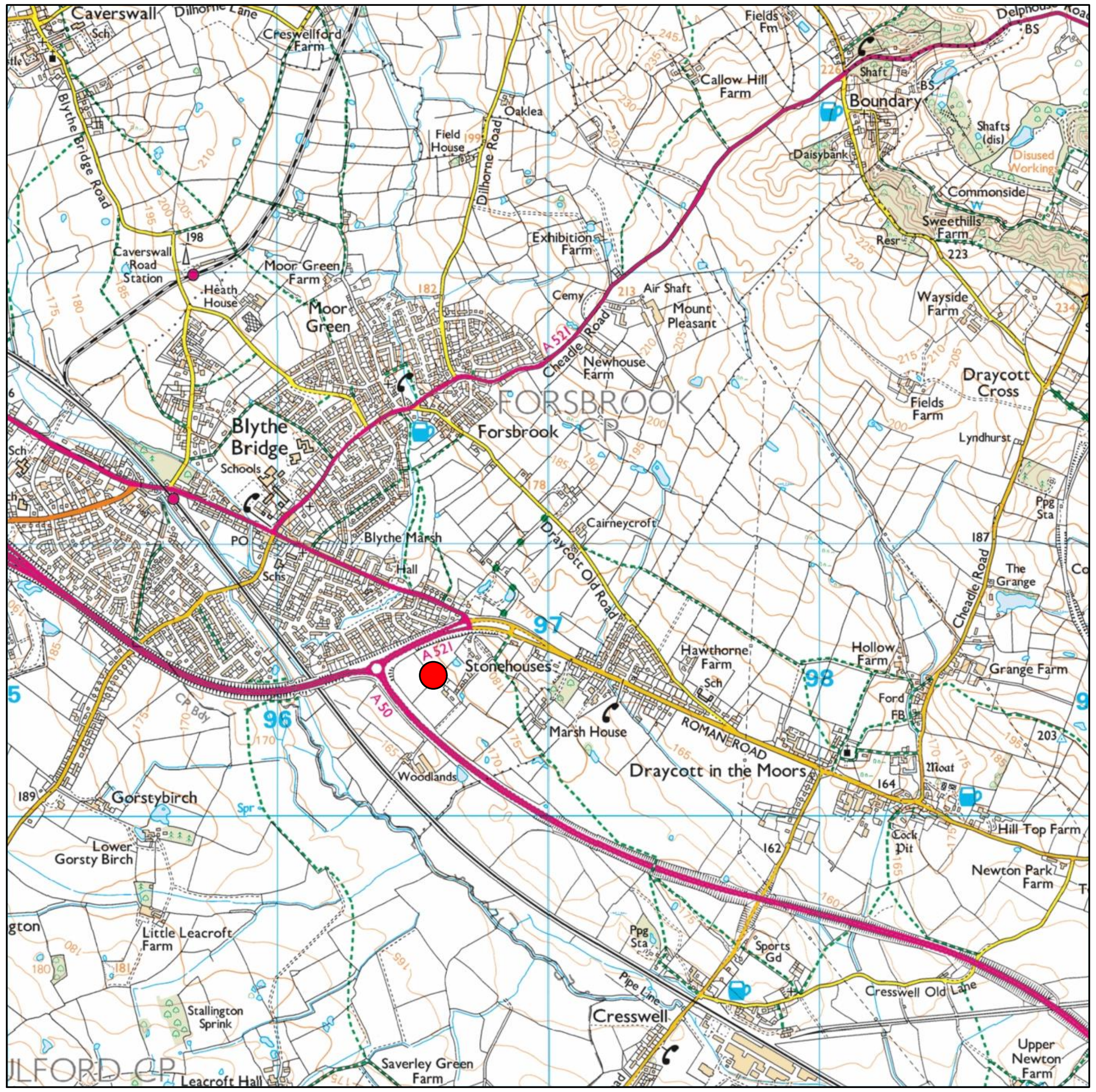

N

Site Location

Reproduced from Ordnance Survey's 1:25 000 map of 1998 with the permission of the controller of Her Majesty's Stationery Office.

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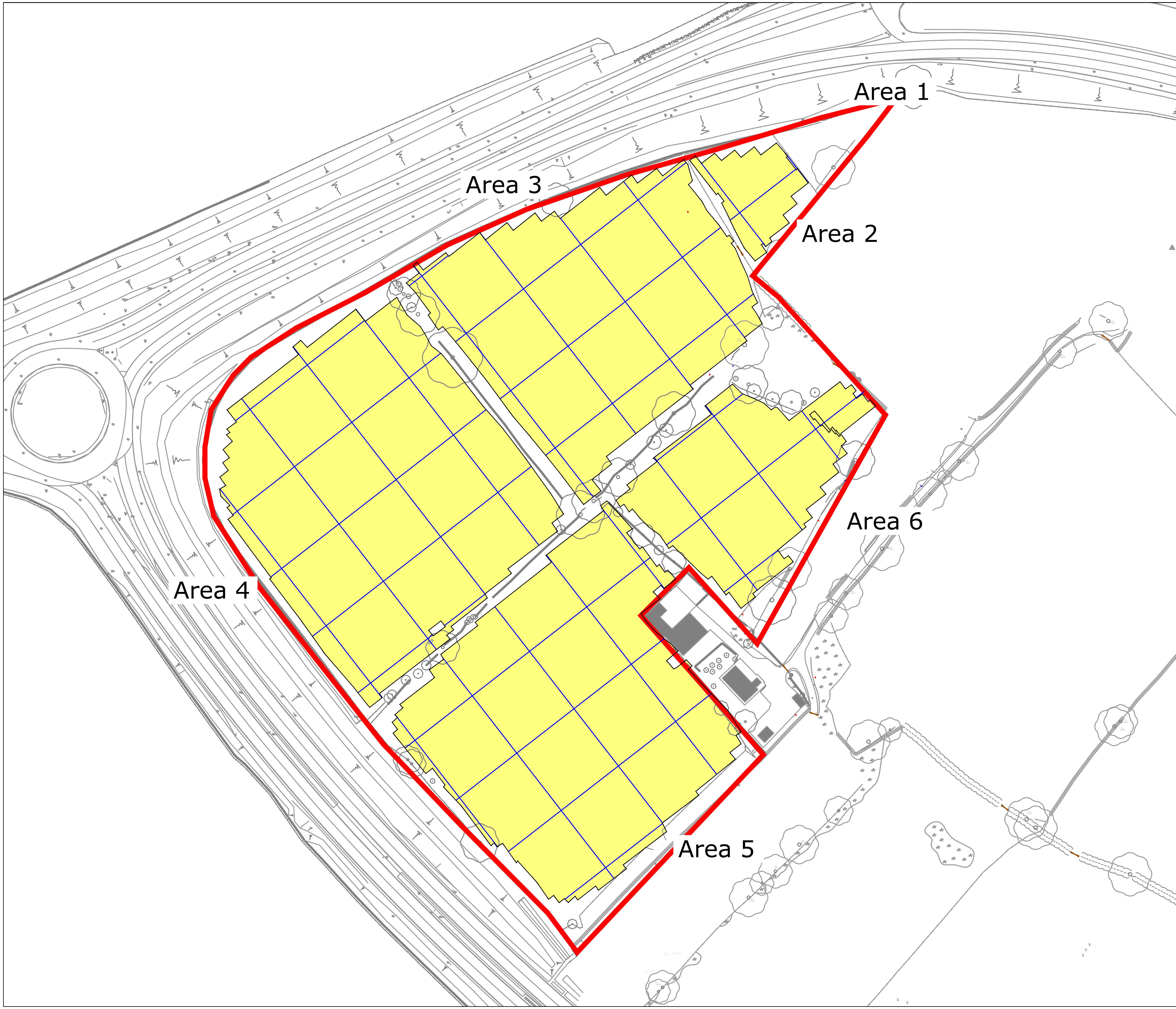
Title:
Site Location Diagram

Client:
Staffordshire University, Centre of Archaeology

Project:
13462 - Land at Blythe Bridge, Stoke On Trent, Staffordshire

Scale:
0 metres 1000
1:25000 @ A3

Fig No:
01



N

Survey Area - showing 30m grid

SUMO Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Location of Survey Areas

Client:
Staffordshire University, Centre of Archaeology

Project:
13462 - Land at Blythe Bridge, Stoke On Trent, Staffordshire

Scale:
0 metres 75
1:1500 @ A3

Fig No:
02

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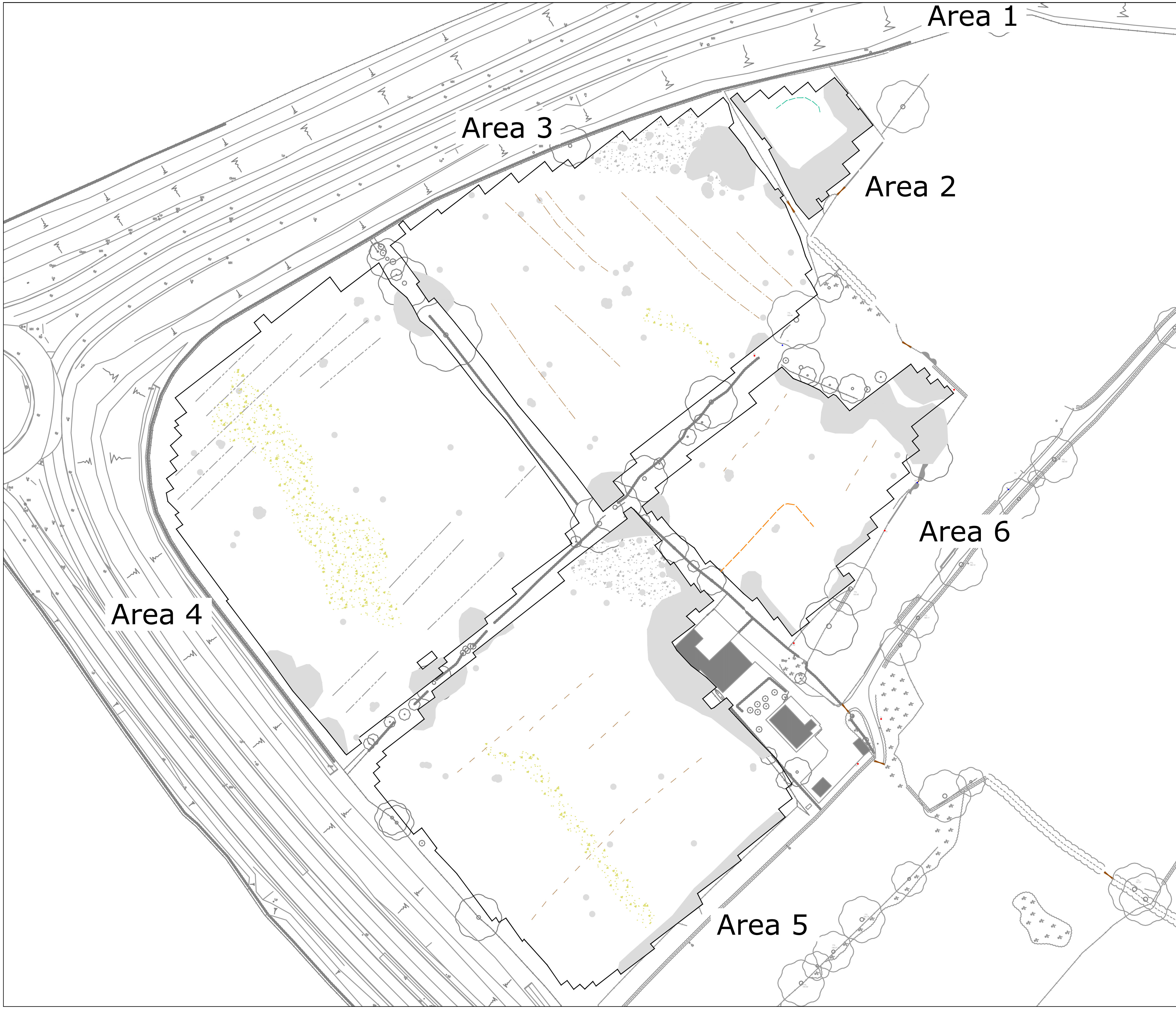
Title:
Magnetometer Survey - Greyscale Plots

Client:
Staffordshire University, Centre of Archaeology

Project:
13462 - Land at Blythe Bridge, Stoke On Trent, Staffordshire

Scale:
0 metres 62.5
1:1250 @ A3

Fig No:
03



Title:
Magnetometer Survey - Interpretation

Client:
Staffordshire University, Centre of Archaeology

Project:
13462 - Land at Blythe Bridge, Stoke On Trent, Staffordshire

Scale: 0 metres 62.5
1:1250 @ A3

Fig No: 04

Title:
Minimally Processed Data - Greyscale Plots

Client:
Staffordshire University, Centre of Archaeology

Project:
13462 - Land at Blythe Bridge, Stoke On Trent, Staffordshire

Scale:
0 metres 62.5
1:1250 @ A3

Fig No:
05

Appendix A - Technical Information: Magnetometer Survey Method

Grid Positioning
For hand held gradiometers the location of the survey grids has been plotted together with the referencing information. Grids were set out using a Trimble R8 Real Time Kinematic (RTK) VRS Now GNSS GPS system.

An RTK GPS (Real-time Kinematic Global Positioning System) can locate a point on the ground to a far greater accuracy than a standard GPS unit. A standard GPS suffers from errors created by satellite orbit errors, clock errors and atmospheric interference, resulting in an accuracy of 5m-10m. An RTK system uses a single base station receiver and a number of mobile units. The base station re-broadcasts the phase of the carrier it measured, and the mobile units compare their own phase measurements with those they received from the base station. This results in an accuracy of around 0.01m.

Technique	Instrument	Traverse Interval	Sample Interval
Magnetometer	Bartington Grad 601-2	1m	0.25m

Instrumentation: Bartington *Grad* 601-2
Bartington instruments operate in a gradiometer configuration which comprises fluxgate sensors mounted vertically, set 1.0m apart. The fluxgate gradiometer suppresses any diurnal or regional effects. The instruments are carried, or cart mounted, with the bottom sensor approximately 0.1-0.3m from the ground surface. At each survey station, the difference in the magnetic field between the two fluxgates is measured in nanoTesla (nT). The sensitivity of the instrument can be adjusted; for most archaeological surveys the most sensitive range (0.1nT) is used. Generally, features up to 1m deep may be detected by this method, though strongly magnetic objects may be visible at greater depths. The Bartington instrument can collect two lines of data per traverse with gradiometer units mounted laterally with a separation of 1.0m. The readings are logged consecutively into the data logger which in turn is daily down-loaded into a portable computer whilst on site. At the end of each site survey, data is transferred to the office for processing and presentation.

Data Processing

Zero Mean Traverse	This process sets the background mean of each traverse within each grid to zero. The operation removes striping effects and edge discontinuities over the whole of the data set.
Step Correction (De-stagger)	When gradiometer data are collected in 'zig-zag' fashion, stepping errors can sometimes arise. These occur because of a slight difference in the speed of walking on the forward and reverse traverses. The result is a staggered effect in the data, which is particularly noticeable on linear anomalies. This process corrects these errors.

Display

Greyscale/ Colourscale Plot	This format divides a given range of readings into a set number of classes. Each class is represented by a specific shade of grey, the intensity increasing with value. All values above the given range are allocated the same shade (maximum intensity); similarly, all values below the given range are represented by the minimum intensity shade. Similar plots can be produced in colour, either using a wide range of colours or by selecting two or three colours to represent positive and negative values. The assigned range (plotting levels) can be adjusted to emphasise different anomalies in the data-set.

Interpretation Categories

In certain circumstances (usually when there is corroborative evidence from desk-based or excavation data) very specific interpretations can be assigned to magnetic anomalies (for example, *Roman Road, Wall,* etc.) and where appropriate, such interpretations will be applied. The list below outlines the generic categories commonly used in the interpretation of the results.

Archaeology / Probable Archaeology	This term is used when the form, nature and pattern of the responses are clearly or very probably archaeological and /or if corroborative evidence is available. These anomalies, whilst considered anthropogenic, could be of any age.
Possible Archaeology	These anomalies exhibit either weak signal strength and / or poor definition, or form incomplete archaeological patterns, thereby reducing the level of confidence in the interpretation. Although the archaeological interpretation is favoured, they may be the result of variable soil depth, plough damage or even aliasing as a result of data collection orientation.
Industrial / Burnt-Fired	Strong magnetic anomalies that, due to their shape and form or the context in which they are found, suggest the presence of kilns, ovens, corn dryers, metal-working areas or hearths. It should be noted that in many instances modern ferrous material can produce similar magnetic anomalies.
Former Field Boundary (probable & possible)	Anomalies that correspond to former boundaries indicated on historic mapping, or which are clearly a continuation of existing land divisions. Possible denotes less confidence where the anomaly may not be shown on historic mapping but nevertheless the anomaly displays all the characteristics of a field boundary.
Ridge & Furrow	Parallel linear anomalies whose broad spacing suggests ridge and furrow cultivation. In some cases, the response may be the result of more recent agricultural activity.
Agriculture (ploughing)	Parallel linear anomalies or trends with a narrower spacing, sometimes aligned with existing boundaries, indicating more recent cultivation regimes.
Land Drain	Weakly magnetic linear anomalies, quite often appearing in series forming parallel and herringbone patterns. Smaller drains may lead and empty into larger diameter pipes, which in turn usually lead to local streams and ponds. These are indicative of clay fired land drains.
Natural	These responses form clear patterns in geographical zones where natural variations are known to produce significant magnetic distortions.
Magnetic Disturbance	Broad zones of strong dipolar anomalies, commonly found in places where modern ferrous or fired materials (e.g. brick rubble) are present. They are presumed to be modern.
Service	Magnetically strong anomalies, usually forming linear features are indicative of ferrous pipes/cables. Sometimes other materials (e.g. pvc) or the fill of the trench can cause weaker magnetic responses which can be identified from their uniform linearity.
Ferrous	This type of response is associated with ferrous material and may result from small items in the topsoil, larger buried objects such as pipes, or above ground features such as fence lines or pylons. Ferrous responses are usually regarded as modern. Individual burnt stones, fired bricks or igneous rocks can produce responses similar to ferrous material.
Uncertain Origin	Anomalies which stand out from the background magnetic variation, yet whose form and lack of patterning gives little clue as to their origin. Often the characteristics and distribution of the responses straddle the categories of *Possible Archaeology* / *Natural* or (in the case of linear responses) *Possible Archaeology* / *Agriculture*; occasionally they are simply of an unusual form.

Where appropriate some anomalies will be further classified according to their form (positive or negative) and relative strength and coherence (trend: weak and poorly defined).

Appendix B - Technical Information: Magnetic Theory

Detailed magnetic survey can be used to effectively define areas of past human activity by mapping spatial variation and contrast in the magnetic properties of soil, subsoil and bedrock. Although the changes in the magnetic field resulting from differing features in the soil are usually weak, changes as small as 0.1 nanoTeslas (nT) in an overall field strength of 48,000 (nT), can be accurately detected.

Weakly magnetic iron minerals are always present within the soil and areas of enhancement relate to increases in *magnetic susceptibility* and permanently magnetised *thermoremanent* material.

Magnetic susceptibility relates to the induced magnetism of a material when in the presence of a magnetic field. This magnetism can be considered as effectively permanent as it exists within the Earth's magnetic field. Magnetic susceptibility can become enhanced due to burning and complex biological or fermentation processes.

Thermoremanence is a permanent magnetism acquired by iron minerals that, after heating to a specific temperature known as the Curie Point, are effectively demagnetised followed by re-magnetisation by the Earth's magnetic field on cooling. Thermoremanent archaeological features can include hearths and kilns; material such as brick and tile may be magnetised through the same process.

Silting and deliberate infilling of ditches and pits with magnetically enhanced soil creates a relative contrast against the much lower levels of magnetism within the subsoil into which the feature is cut. Systematic mapping of magnetic anomalies will produce linear and discrete areas of enhancement allowing assessment and characterisation of subsurface features. Material such as subsoil and non-magnetic bedrock used to create former earthworks and walls may be mapped as areas of lower enhancement compared to surrounding soils.

Magnetic survey is carried out using a fluxgate gradiometer which is a passive instrument consisting of two sensors mounted vertically 1m apart. The instrument is carried about 30cm above the ground surface and the top sensor measures the Earth's magnetic field whilst the lower sensor measures the same field but is also more affected by any localised buried feature. The difference between the two sensors will relate to the strength of a magnetic field created by this feature, if no field is present the difference will be close to zero as the magnetic field measured by both sensors will be the same.

Factors affecting the magnetic survey may include soil type, local geology, previous human activity and disturbance from modern services.

- Archaeological
- Geophysical
- Laser Scanning
- Measured Building
- Topographic
- Utility Mapping

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