

**GEOPHYSICAL SURVEY  
REPORT G1506**

**Culverhouse Cross to  
Cardiff International Airport / St  
Athan Enterprise Zone Link:  
Geophysical Survey**

**Client:**

**PARSONS  
BRINCKERHOFF**

**On behalf of:**

**Llywodraeth Cymru  
Welsh Government**

**G S B**  
**PROSPECTION Ltd**

*Celebrating over 25 years at  
the forefront of  
Archaeological Geophysics*



# GSB Survey Report No. G1506

## Culverhouse Cross to Cardiff International Airport/St Athan Enterprise Zone Link: Geophysical Survey

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### Archive CD Content

- Minimally Processed Greyscale Images and XY Trace Plots in DWG format 1:500
- DWG Viewer
- Digital Copies of Report Text and Figures (both PDF and native formats)

### Survey Personnel

Field Co-ordinator: Graeme Attwood MSc

Report Author: Graeme Attwood MSc

Project Assistants: Alistair Galt BA MSc

### Dates

Fieldwork: 2 - 6 February 2015

Report: 23 February 2015

**Report Approved:** Dr John Gater MCIFA FSA

## Background Project Details

<b>NGR</b>	ST 081 706 approximate centre
<b>Location</b>	The site is located northwest of Barry along the A4226
<b>HER/SMR</b>	Glamorgan – Gwent HER
<b>District</b>	Vale of Glamorgan
<b>Topography</b>	See General Considerations
<b>Current Land Use</b>	Mostly pasture, some areas wooded
<b>Soils</b>	Bromyard (571b): well drained reddish fine silty soils over shale and siltstone. Some similar soils with slowly permeable subsoils and slight seasonal waterlogging. Some well drained coarse loamy soils over sandstone. Denchworth (712b): Slowly permeable seasonally waterlogged clayey soils with similar fine loamy over clayey soils. Some fine loamy over clayey soils with only slight seasonal waterlogging and some slowly permeable calcareous clayey soils. (SSEW 1983)
<b>Geology</b>	Bedrock geology consists of Lias Group - mudstone, siltstone, limestone and sandstone. No superficial deposits have been recorded (BGS 2015).
<b>Archaeology</b>	There is a range of archaeology known to be located in the study area; this consists of a number of ring ditches, a Roman villa (Whitton Lodge - a site of national importance) and inhumation burials which could be part of a larger cemetery site (Parsons Brinckerhoff 2014).
<b>Survey Methods</b>	Detailed magnetometer survey (fluxgate gradiometer)

## Aims

To locate and characterise any anomalies of possible archaeological interest within the study area. The work forms part of a wider archaeological assessment being carried out by **Parsons Brinckerhoff** on behalf of the **Welsh Government**.

## Summary of Results

The survey has identified a complex of anomalies of clear archaeological interest in Area 15 immediately south of Whitton Lodge Roman villa. The results include rectilinear enclosures, ring ditches and other features of interest, including two possible kiln-like features. While some of the responses are likely to be associated with the villa, others may be of an earlier date. Another enclosure has been recorded in Area 17 to the north of the villa.

Elsewhere, there are clusters of responses which have been classified as having an uncertain origin; in these instances an archaeological interpretation cannot be ruled out but other explanations - natural, agricultural or recent activity, are equally likely.

## Method

All survey data points had their position recorded using Trimble R10 Real Time Kinematic (RTK) VRS Now GNSS equipment. The geophysical survey area is georeferenced relative to the Ordnance Survey National Grid.

Technique	Instrument	Traverse Interval	Sample Interval
Magnetometer	CartEasy <sup>N</sup> cart system (Bartington Grad 601 sensors)	0.75m	0.125m

All survey work is carried out in accordance with the current English Heritage guidelines (EH 2008).

## Data Processing

Data processing was performed as appropriate using an in-house software package (CartEasy<sup>N</sup>)

Zero Mean Traverse, Gridding

## Interpretation

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 very specific known features documented in other sources, this is done (for example: *Abbey Wall*, *Roman Road*). For the generic categories levels of confidence are indicated, for example: *Archaeology* – *?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 *?Archaeology*. Details of the data plot formats and interpretation categories used are given in the Appendix: Technical Information at the end of the report.

## General Considerations

Survey conditions were generally good, the survey areas being largely of pasture except Areas 6, 18 and 19 which consisted of a short cereal crop. Area 19 was wet and it was difficult to pull the cart. Area 3 was particularly steep sloping down from northwest to southeast. A stream in the centre of Area 3 rendered some land too wet for survey while a number of temporary fences in the same area slightly slowed survey. Area 4 consisted entirely of very soft land around a cattle feeder. Deep vehicle ruts were present in Area 6, although the cart could traverse over the ruts, they have created an effect much like weak ferrous anomalies. The easternmost end of Area 18 was boggy and not surveyable.

With the exception of Area 6, any poor ground conditions did not adversely affect the data quality.

Access to Area 21 was not available at the time of survey while Area 20 was wooded and overgrown.

## 1.0 Survey Results - Magnetometer Survey

### Areas 1, 2 and 3

- 1.1 Apart from a few trends and responses of uncertain origin, there is little in the data of specific interest. While the uncertain responses could be archaeological they are more likely to be agricultural or natural geological effects; the responses lack any clear definition and are unlike the archaeological responses elsewhere in the dataset.
- 1.2 There is an old field boundary (OS 2015) visible in Area 3 and ploughing trends are recorded which stop at this former division.

### Areas 5, 6, 7, 8 and 9

- 1.3 Straddling Areas 6 and 7 are three linear anomalies which appear to form an open-sided ditched enclosure with definite archaeological potential; it is unclear whether the features extend to the east, beyond the survey limits.
- 1.4 To the south of this 'enclosure', there are numerous uncertain responses in the data. For example, approximately 75m to the south of the 'enclosure' is a small 5m rectilinear feature and a similar sized irregular arc; their close proximity to the recorded archaeological features adds weight to their potential interest. Similarly in Area 7 there are several weak trends which appear to form rectilinear patterns which could be of interest, though in this instance they could easily be the result of ploughing.
- 1.5 In Area 6 there are well-defined linear anomalies which correspond to former boundaries visible on historic mapping (OS 2015). The narrow band of disturbance following a north-south alignment equates with vehicle ruts leading to a test borehole. There is a scatter of responses close to the corners of Areas 5 and 6 and these are thought to simply reflect the removal of the old boundaries.
- 1.6 Ploughing effects are visible in the data in most of the fields, though they are less prominent in Areas 7 – 9.

### Areas 10, 11, 12, 13 and 14

- 1.7 There are three clusters of anomalies which are difficult to interpret. In Area 11 there are linear responses and trends on differing alignments to the ploughing, in Area 12 are some strong anomalies immediately adjacent to the A4226, and in Area 13 there is a group of pit-like responses. In the absence of a known context an archaeological interpretation is perhaps unlikely but the responses do not appear strictly agricultural or natural in origin. Some anthropological explanation is therefore probable, but perhaps of a recent (modern) date.
- 1.8 Once again differing ploughing practices are visible in the data. Two pipes cross diagonally through Area 10.

### Area 15 (see also Figure 11)

- 1.9 There is a marked contrast between the results from this area compared with any of the other fields surveyed. There is a complex of responses associated with a number of features of archaeological interest. Ring ditches, some complete and some partial, are interspersed amongst rectilinear features and enclosures which clearly extend beyond the limits of the survey area. A few pits are also visible. Many of the anomalies appear to intersect with others and the results suggest multi-period activity. In the north of the field there may be two kiln-like features; a lime kiln is recorded in the field to the north. Given the known Roman villa in this field (Area 16 which

had previously been surveyed - GSB 2010 & 2010a) it is likely that many of the features are associated, though the ring ditches may be of an earlier date.

### **Areas 17, 18 and 19**

- 1.10 There is a clear rectilinear anomaly in Area 17 which presumably relates to the villa in Area 16 to the south. It extends beyond the survey area and apart from a few ferrous type anomalies there do not appear to be any concentrations of features within the western half of the enclosure.
- 1.11 There are several uncertain responses in both survey areas. The anomalies are not as well-defined as the archaeological responses and the limited width of the survey area hinders a wider view. As such it is likely that the data indicate natural variations in the local soils, with the possible exception of the responses closest to the enclosure in Area 17.
- 1.12 A band of magnetic disturbance / enhancement crosses Area 18; it is thought to be recent as it is not visible in data collected in the 2010 survey (GSB).
- 1.13 There is little of interest in the data from Area 19. A large pipe runs along the eastern edge of the survey; there is a small zone of increased magnetic response and a few uncertain trends but neither are thought to be of any archaeological significance.

## **2.0 Conclusions**

- 2.1 The survey has helped to identify areas of archaeological potential along the line of the proposed road improvements. Areas to the north and particularly immediately south of Whitton Lodge villa have revealed a complex of features, including possible pre-Roman archaeology. Additionally the survey has highlighted some responses which have an uncertain origin and in the wider context of the overall results their archaeological potential cannot be ignored.

## **References**

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<http://mapapps.bgs.ac.uk/geologyofbritain/home.html>  
1:50,000 scale geology, centred on ST 081 706. Accessed 16/02/2015
- EH 2008            *Geophysical Survey in Archaeological Field Evaluation*. English Heritage,  
Portsmouth.
- GSB 2010            *A4226 Five Mile Lane Improvements, Barry*, GSB Prospection Ltd., Thornton
- GSB 2010a          *A4226 Five Mile Lane Improvements: North of Whitton Cross, Vale of Glamorgan*,  
GSB Prospection Ltd, Thornton
- OS 2015            <http://www.old-maps.co.uk>  
centred on ST 081 706. Accessed 16/02/2015
- SSEW 1983          *Soils of England and Wales. Sheet 2, Wales*. Soil Survey of England and Wales,  
Harpenden.



0 metres 2000

1:50,000 @ A4



Site Location

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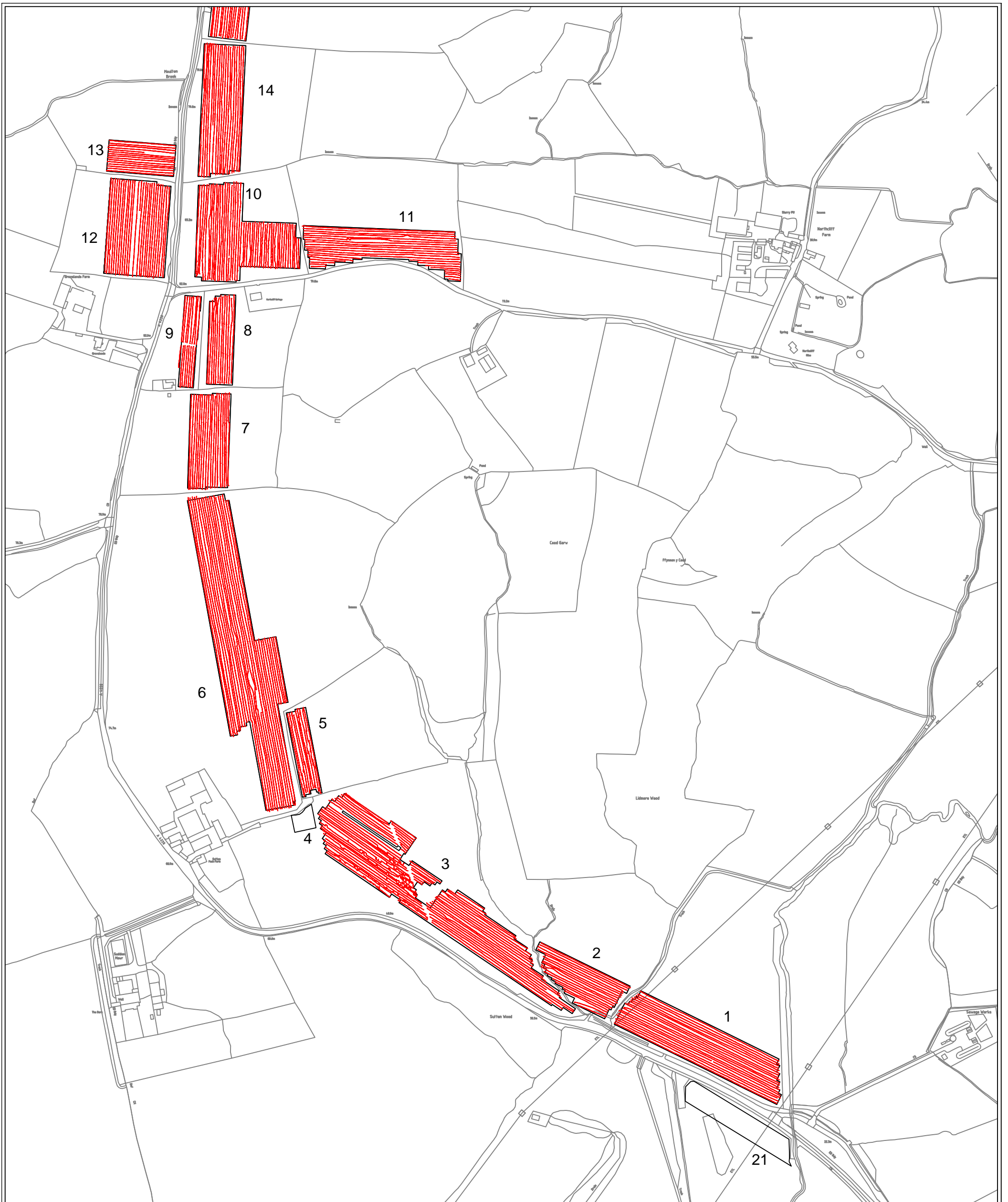
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**Title:** Site Location Diagram

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**Figure 1**



0 metres 200  
1:5000 @ A3

 GNSS Trace

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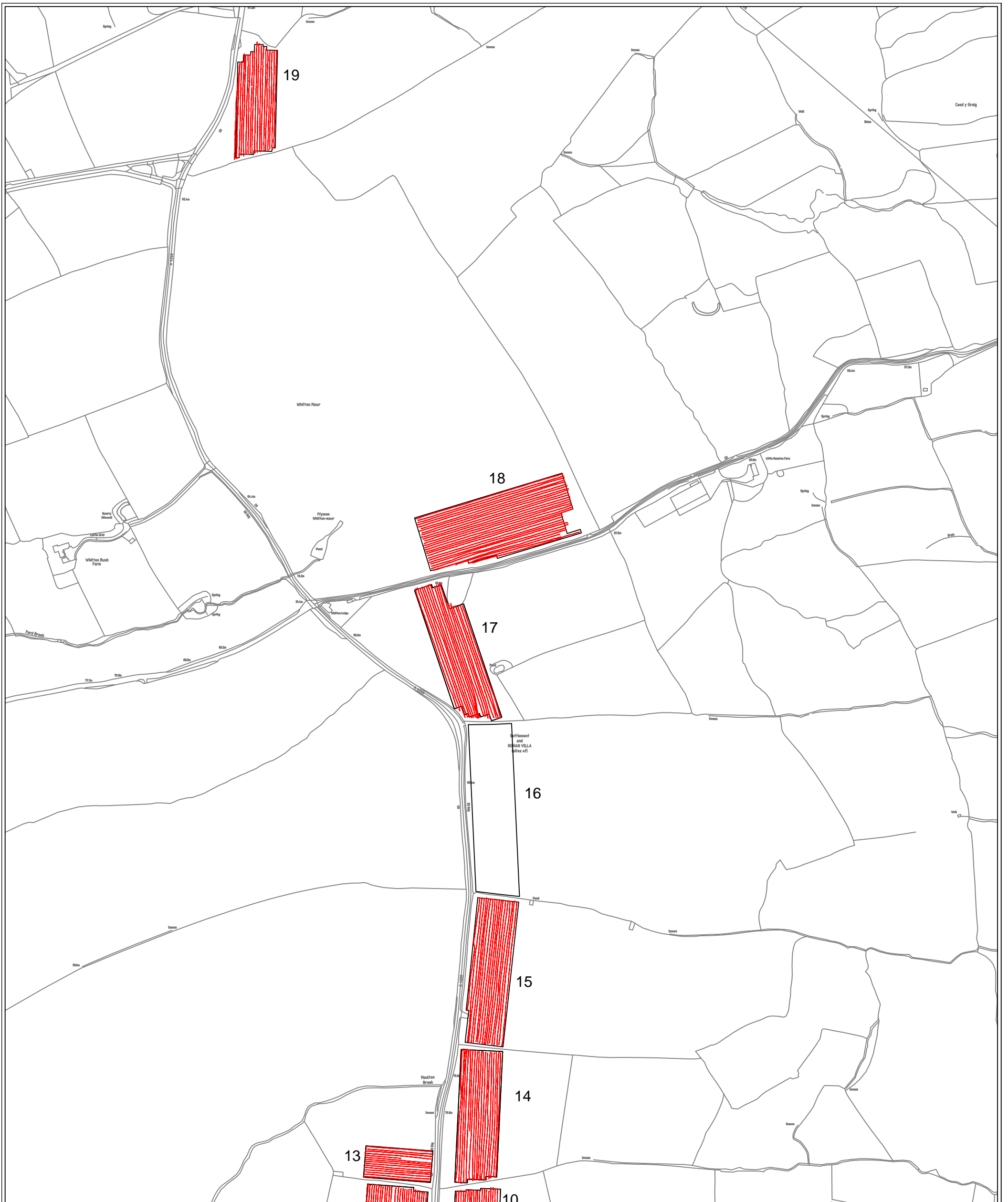
**Title:** Location of Survey Areas (South)

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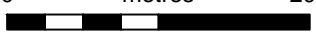
Drawn by: GSA

**Figure 2a**





0 metres 200



1:5000 @ A3



GNSS Trace

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**Title:** Location of Survey Areas (North)

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**Figure 2b**



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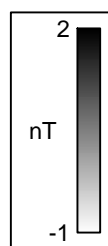
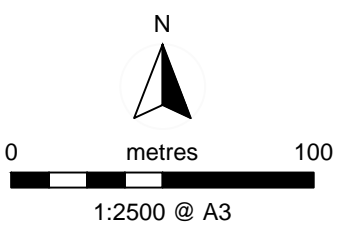
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 International Airport: Geophysical Survey

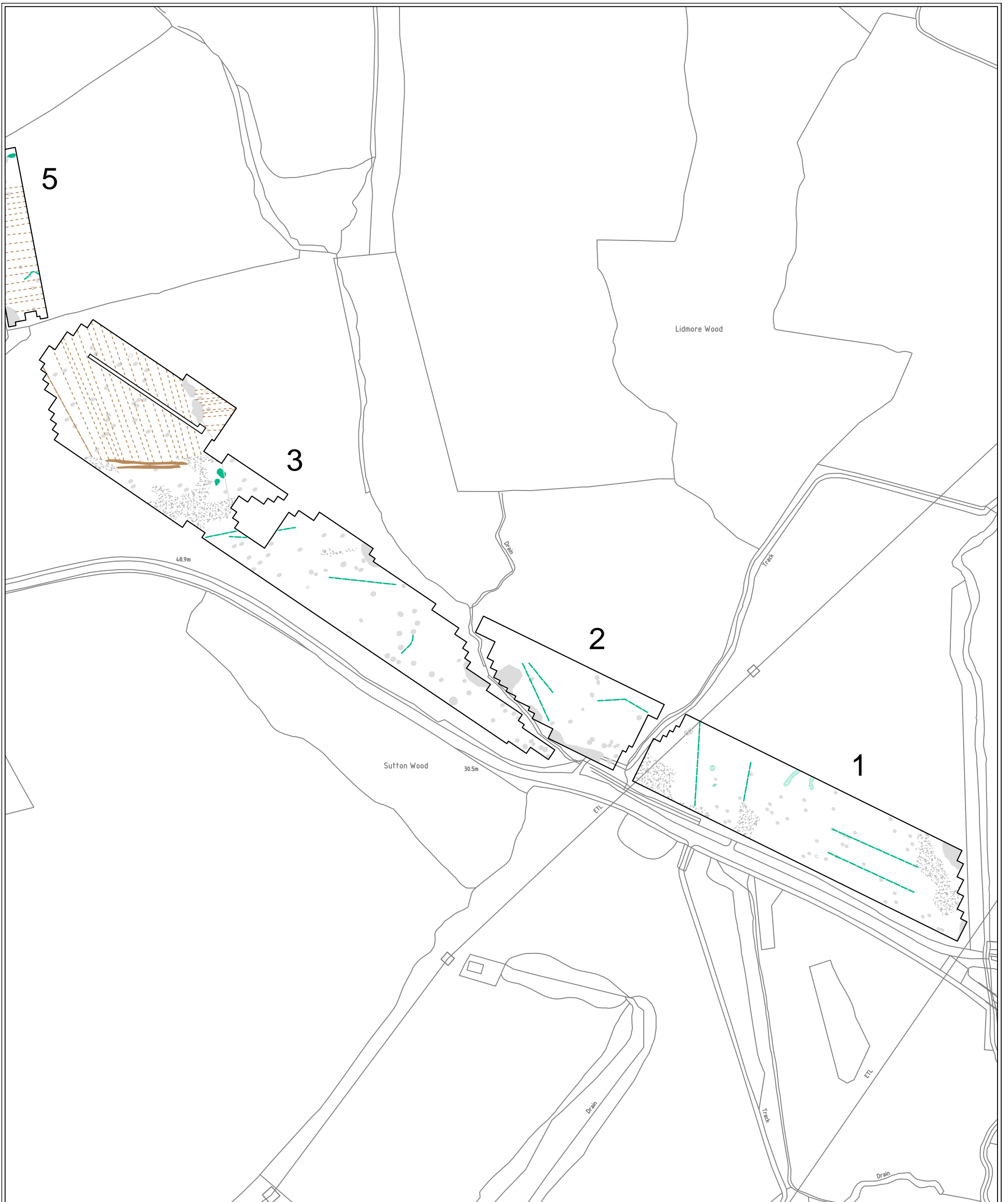
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 (Areas: 1-3)









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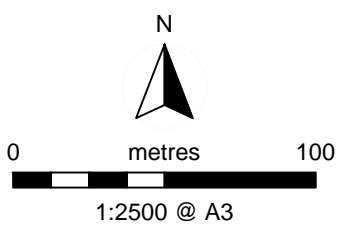
Drawn by: GSA

**Figure 3**





- |   |   |  |  |
|---|---|--|--|
|  | Archaeology<br>(discrete / weak / trend)      |  | Old Field Boundary<br>(discrete anomaly / trend) |
|  | ?Archaeology<br>(weak / trend)                |  | Agricultural<br>(r+f / plough)                   |
|  | ?Burnt - Fired<br>(discrete anomaly)          |  | Magnetic Disturbance<br>(zone)                   |
|  | Uncertain Origin<br>(discrete / weak / trend) |  | Ferrous<br>(discrete anomaly / pipe)             |



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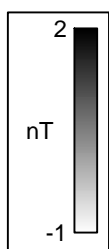
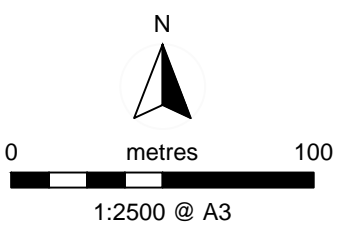
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 International Airport: Geophysical Survey

**Title:** Magnetometer Survey: Interpretation  
 (Areas: 1-3)

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**Figure 4**



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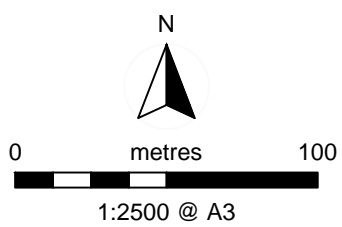
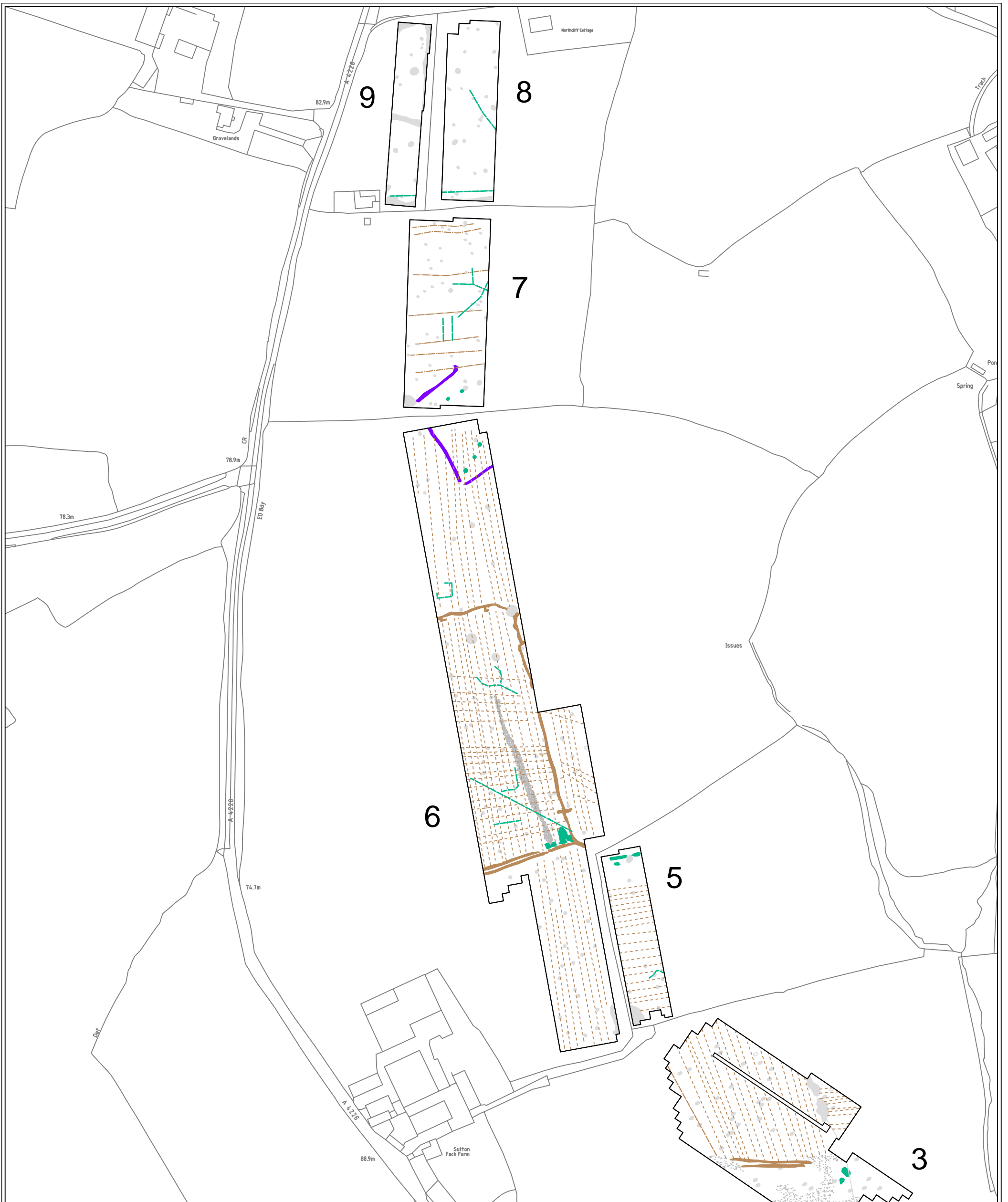
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




**Title:** Magnetometer Survey: Greyscale Plot  
 (Areas: 5 - 9)

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**Figure 5**



- |   |   |  |  |
|---|---|--|--|
|  | Archaeology<br>(discrete / weak / trend)      |  | Old Field Boundary<br>(discrete anomaly / trend) |
|  | ?Archaeology<br>(weak / trend)                |  | Agricultural<br>(r+f / plough)                   |
|  | ?Burnt - Fired<br>(discrete anomaly)          |  | Magnetic Disturbance<br>(zone)                   |
|  | Uncertain Origin<br>(discrete / weak / trend) |  | Ferrous<br>(discrete anomaly / pipe)             |

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**Title:** Magnetometer Survey: Interpretation  
 (Areas: 5 - 9)

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**Figure 6**



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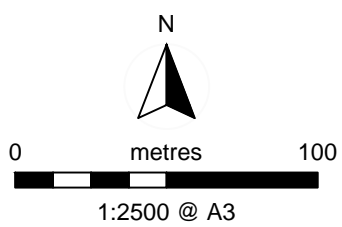
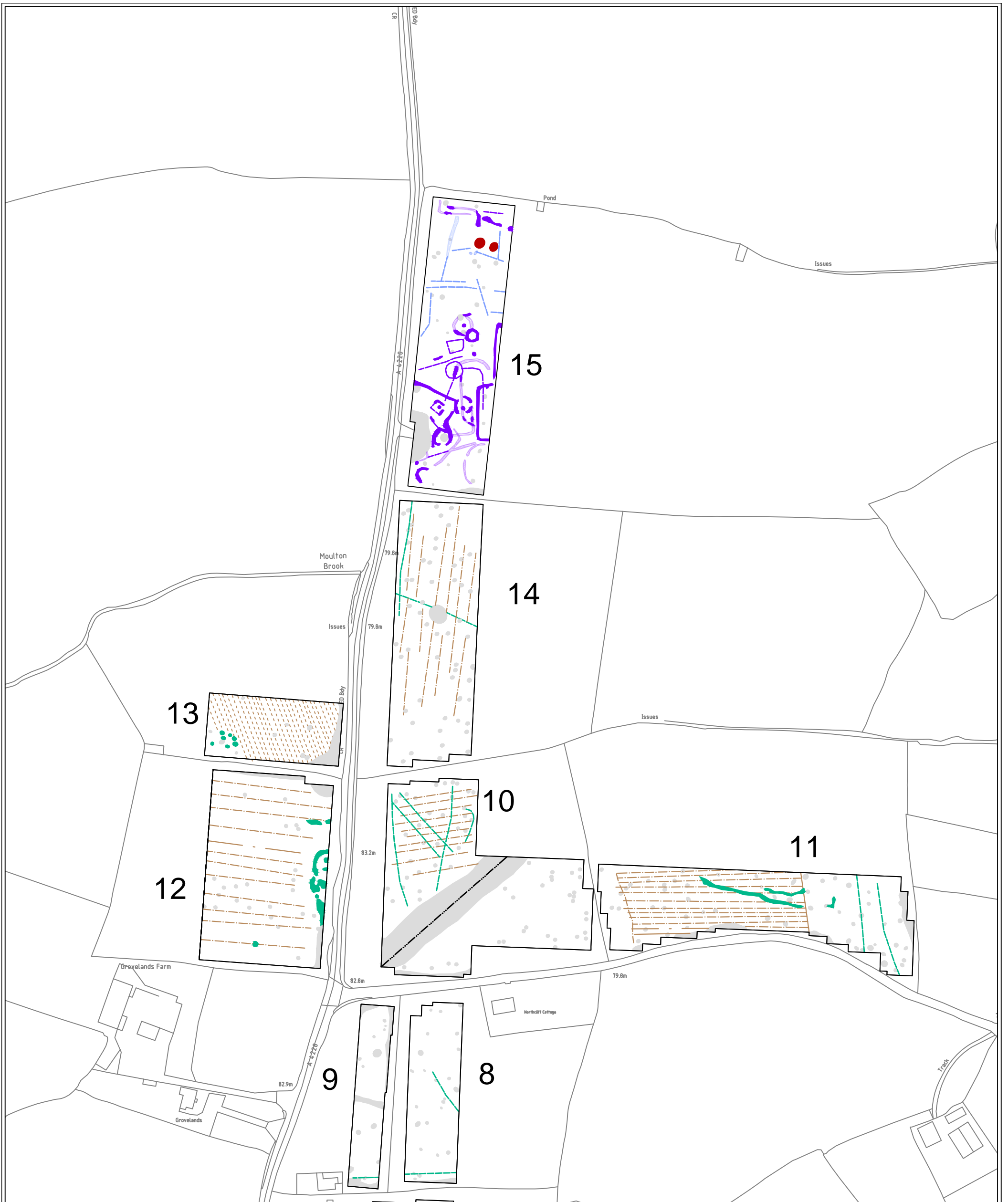
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**Title:** Magnetometer Survey: Greyscale Plot  
 (Areas: 10 - 15)

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**Figure 7**



- |   |   |  |  |
|---|---|--|--|
|  | Archaeology<br>(discrete / weak / trend)      |  | Old Field Boundary<br>(discrete anomaly / trend) |
|  | ?Archaeology<br>(weak / trend)                |  | Agricultural<br>(r+f / plough)                   |
|  | ?Burnt - Fired<br>(discrete anomaly)          |  | Magnetic Disturbance<br>(zone)                   |
|  | Uncertain Origin<br>(discrete / weak / trend) |  | Ferrous<br>(discrete anomaly / pipe)             |

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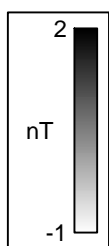
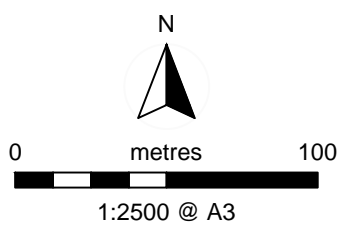
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**Title:** Magnetometer Survey: Interpretation  
 (Areas: 10 - 15)

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**Figure 8**



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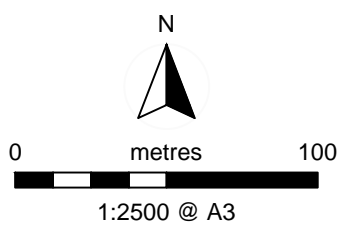
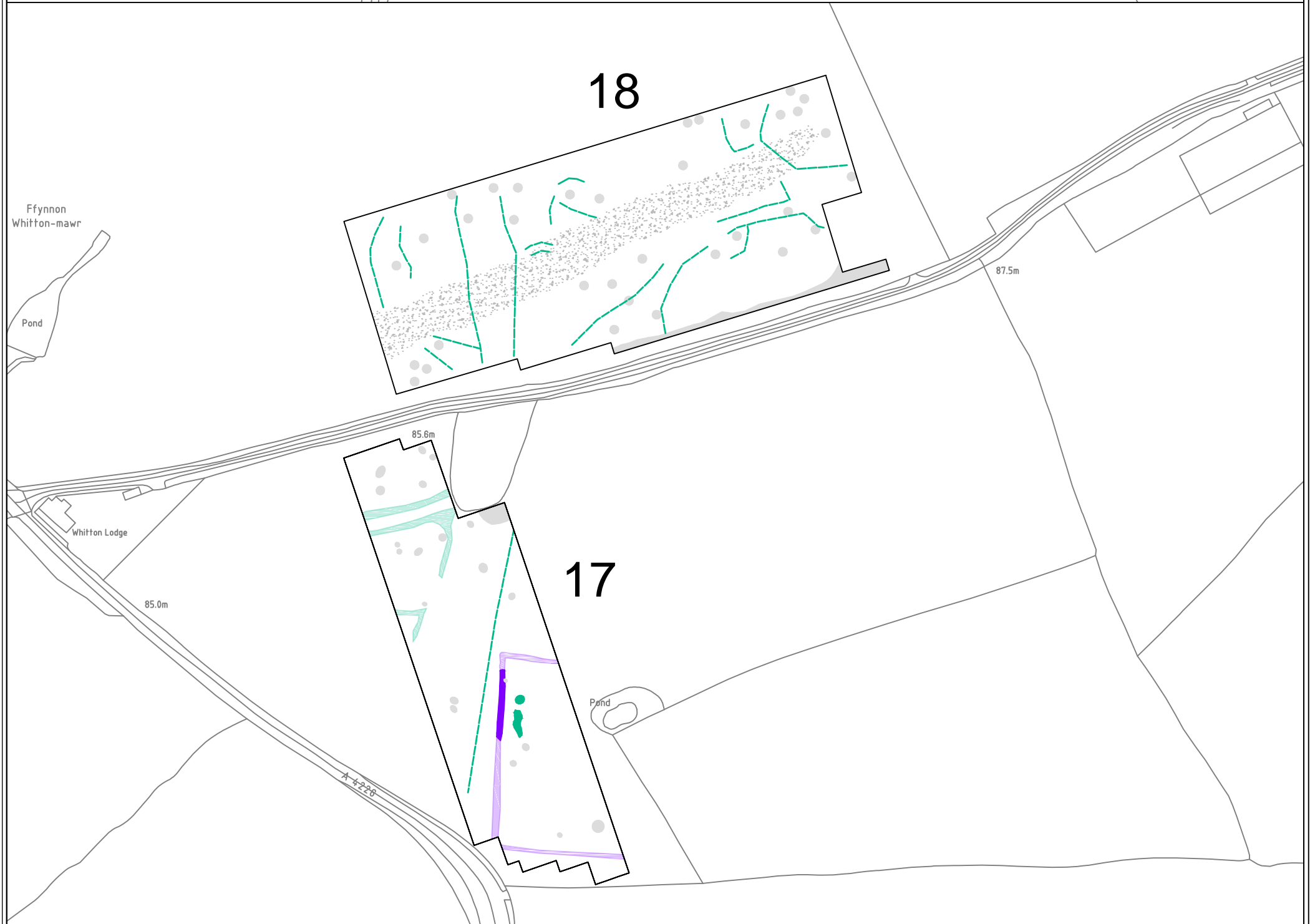
**Title:** Magnetometer Survey: Greyscale Plot (Areas: 17, 18 and 19)








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**Figure 9**





- |   |   |
|---|---|
|  Archaeology<br>(discrete / weak / trend)      |  Old Field Boundary<br>(discrete anomaly / trend) |
|  ?Archaeology<br>(weak / trend)                |  Agricultural<br>(r+f / plough)                   |
|  ?Burnt - Fired<br>(discrete anomaly)          |  Magnetic Disturbance<br>(zone)                   |
|  Uncertain Origin<br>(discrete / weak / trend) |  Ferrous<br>(discrete anomaly / pipe)             |

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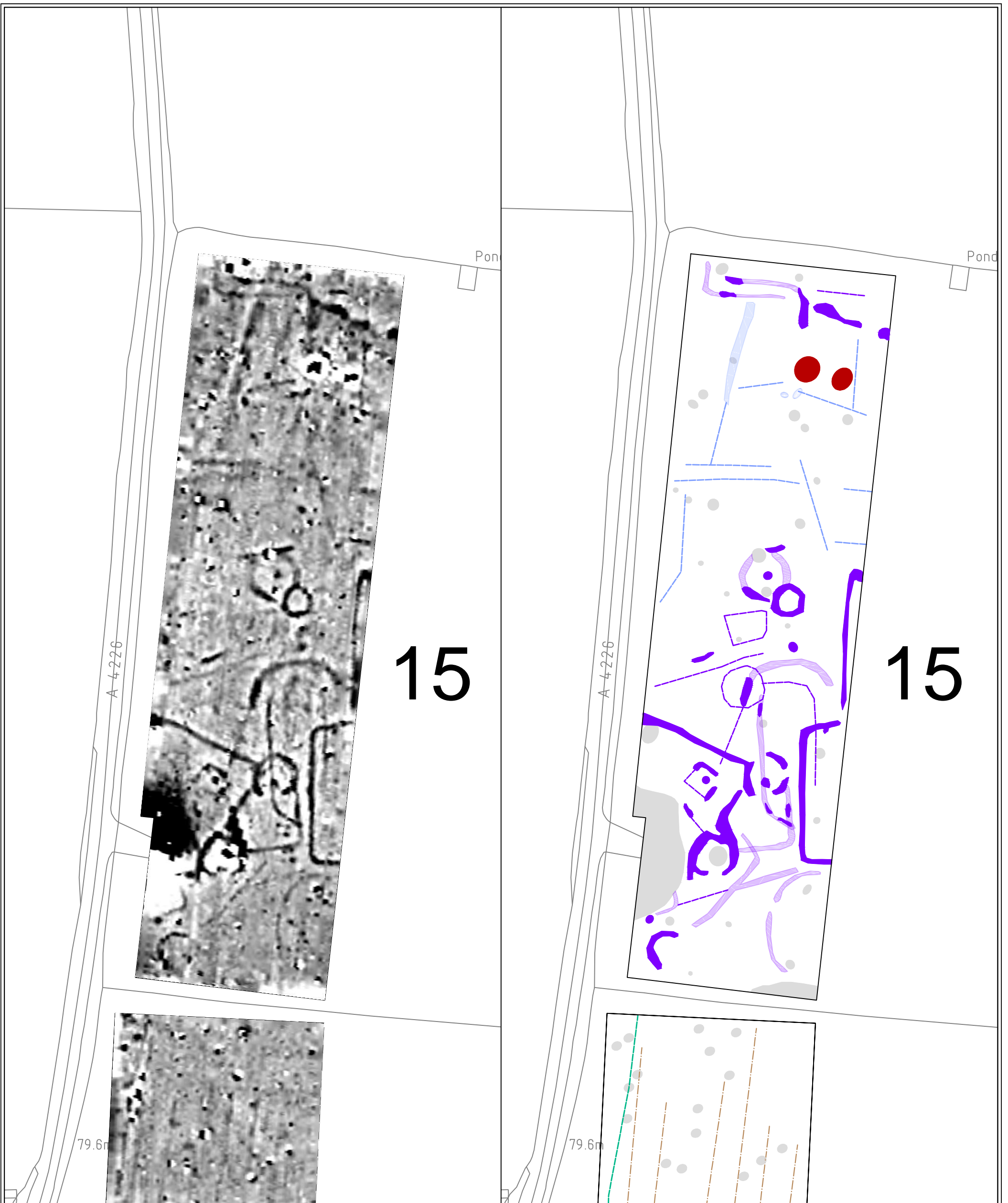
**Project:** G1506 Culverhouse Cross to Cardiff  
 International Airport: Geophysical Survey

**Title:** Magnetometer Survey: Interpretation  
 (Areas: 17, 18 and 19)

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**Figure 10**











15

15



0 metres 40

1:1000 @ A3

- |   |   |
|---|---|
|  Archaeology<br>(discrete / weak / trend)      |  Old Field Boundary<br>(discrete anomaly / trend) |
|  ?Archaeology<br>(weak / trend)                |  Agricultural<br>(r+f / plough)                   |
|  ?Burnt - Fired<br>(discrete anomaly)          |  Magnetic Disturbance<br>(zone)                   |
|  Uncertain Origin<br>(discrete / weak / trend) |  Ferrous<br>(discrete anomaly / pipe)             |

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**Title:** Magnetometer Survey: (Area: 15 Detailed)  
Greyscale Plot and Interpretation

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Figure 11

## Appendix - Technical Information: Magnetometer Survey

### Instrumentation: Bartington *Grad601-2* / GSB CARTEASY<sup>N</sup> Cart system

Both the Bartington and CARTEASY<sup>N</sup> 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. The Bartington instrument can collect two lines of data per traverse with gradiometer units mounted laterally with a separation of 1.0m. The CARTEASY<sup>N</sup> system has four gradiometer units mounted at 0.75m intervals across its frame – rather than working in grids, the cart uses an on-board survey grade GNSS for positioning. The cart system allows for the collection of topographic data in addition to the magnetic field measurements.

### 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 (Destagger)	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.
Interpolation	When geophysical data are presented as a greyscale, each data point is represented as a small square. The resulting plot can sometimes have a 'blocky' appearance. The interpolation process calculates and inserts additional values between existing data points. The process can be carried out with points along a traverse (the x axis) and/or between traverses (the y axis) and results in a smoother greyscale image.

### Display

XY Trace Plot	This involves a line representation of the data. Each successive row of data is equally incremented in the Y axis, to produce a stacked profile effect. This display may incorporate a hidden-line removal algorithm, which blocks out lines behind the major peaks and can aid interpretation. The advantages of this type of display are that it allows the full range of the data to be viewed and shows the shape of the individual anomalies. The display may also be changed by altering the horizontal viewing angle and the angle above the plane.
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.
3D Surface Plot	This is similar to the XY trace, but in 3 dimensions. Each data point of a survey is represented in its relative position on the x and y axes and the data value is represented in the z axis. This gives a digital terrain, or topographic effect.

## 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.

<i>Archaeology</i>	This term is used when the form, nature and pattern of the response are clearly or very probably archaeological and /or if corroborative evidence is available. These anomalies, whilst considered anthropogenic, could be of any age.
<i>?Archaeology</i>	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.
<i>Increased Magnetic Response</i>	An area where increased fluctuations attest to greater magnetic enhancement of the soils, but no specific patterns can be discerned in the data and no visual indications on the ground surface hint at a cause. They may have some archaeological potential, suggesting damaged archaeological deposits.
<i>Industrial / Burnt-Fired</i>	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.
<i>Old Field Boundary</i>	Anomalies that correspond to former boundaries indicated on historic mapping, or which are clearly a continuation of existing land divisions.
<i>Ridge &amp; Furrow</i>	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.
<i>Ploughing</i>	Parallel linear anomalies or trends with a narrower spacing, sometimes aligned with existing boundaries, indicating more recent cultivation regimes.
<i>Natural</i>	These responses form clear patterns in geographical zones where natural variations are known to produce significant magnetic distortions. Smaller, isolated responses which do not form such obviously 'natural' patterns but which are, nonetheless, likely to be natural in origin may be classified as <i>?Natural</i> .
<i>Uncertain Origin</i>	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 <i>?Archaeology</i> and <i>?Natural</i> or (in the case of linear responses) <i>?Archaeology</i> and <i>?Ploughing</i> ; occasionally they are simply of an unusual form.
<i>Magnetic Disturbance</i>	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.
<i>Ferrous</i>	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.

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).

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