# Land at Swainsea Lane
# Pickering
# North Yorkshire

## Geophysical Survey



*Summary*

*A geophysical (magnetometer) survey covering approximately 0.8 hectares was undertaken off Swainsea Lane, Pickering as part of pre-determination evaluation works in advance of the development of the site. Linear anomalies indicative of ditched features perhaps forming part of a former field system or enclosure have been located to the west of the development area. Discrete anomalies across the survey area may also be indicative of archaeological features although a geological origin for these anomalies cannot be discounted. Some of these anomalies are just beyond the proposed development area.*

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## Report Information

| | |
|---|---|
| Client: | MAP Archaeological Consultancy Limited, Showfield Lane, Malton, North Yorkshire YO17 6BT |
| Report Type: | Geophysical Survey |
| Location: | Swainsea Lane, Pickering |
| County: | North Yorkshire |
| Grid Reference: | SE 793 849 |
| Period(s) of activity represented: | Romano-British/Iron Age? |
| Report Number: | 2013 |
| Project Number: | 3515 |
| Site Code: | SWP09 |
| Planning Application No.: | Pre-determination |
| Museum Accession No.: | - |
| Date of fieldwork: | December 2009 |
| Date of report: | December 2009 |
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| Report: | Alistair Webb |
| Illustrations: | Sam Harrison |
| Photography: | n/a |
| Research: | n/a |
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# 1 Introduction

Archaeological Services WYAS (ASWYAS) was commissioned by Paula Ware of MAP Archaeological Consultancy Limited to undertake a geophysical (magnetometer) survey at a site bordering Swainsea Lane in Pickering (see Fig. 1), as part of pre-determination evaluation works to accompany a planning application.

### Site location and topography

The site, centred at SE 793 849, is located on the northern edge of Pickering and is bordered by Swainsea Lane to the east, an agricultural centre to the south-east and fields to the north and west (see Fig. 2). The land was relatively flat at 40m above Ordnance Datum and the survey covered approximately 0.8 hectares.

### Soils, geology and land-use

The solid geology comprises Upper Calcareous Grit overlain with soils classified in the Rivington 1 soil association. These soils are characterised as well drained coarse loams.

The land was under permanent pasture at the time of survey although there had been some fly tipping adjacent to Swainsea Lane which slightly reduced the area available for survey.

# 2 Archaeological and Historical Background

No specific archaeological information on the site was available although it is understood that there are no known archaeological features or remains within the site boundary. However, the site is located within a landscape of known archaeological potential with a multi-period occupation site at Newbridge Quarry less than 1km to the north.

# 3 Aims and Objectives

The general aim of the geophysical survey was to establish and clarify the potential for archaeological features within the development boundary as part of pre-determination evaluation works.

Specifically the survey sought to provide information about the nature and possible interpretation of magnetic anomalies identified during the survey and thereby determine the likely extent, presence or absence of any buried archaeological remains within the proposed development area. These aims were to be achieved by undertaking detailed (recorded) magnetometer survey across the whole of the proposed development site.

## 4 Methodology

A Bartington Grad601 magnetic gradiometer was used to take readings at 0.25m intervals on zig-zag (east-west) traverses 1m apart within 30m by 30m grids so that 3600 readings were recorded in each grid. These readings were stored in the memory of the instrument and later downloaded to computer for processing and interpretation. Geoplot 3 (Geoscan Research) software was used to process and present the data. Further details are given in Appendix 1. Detailed (recorded) survey allows the visualisation of weaker anomalies that may not have been readily identifiable by alternative evaluation techniques such as magnetometer (magnetic) scanning.

### Reporting

A general site location plan, incorporating the 1:50000 Ordnance Survey mapping, is shown in Figure 1. Figure 2 shows the processed greyscale magnetometer data at a scale of 1:1000. The processed and 'raw' (unprocessed) magnetometer data from the survey, together with interpretations of the identified magnetic anomalies, are presented at a scale of 1:500 in Figures 3, 4 and 5.

The geophysical survey methodology, report and any recommendations comply with guidelines outlined by English Heritage (David *et al.* 2008) and by the IfA (Gaffney *et al.* 2002). All figures reproduced from Ordnance Survey mapping are with the permission of the controller of Her Majesty's Stationery Office (© Crown copyright).

Technical information on the equipment used, data processing and magnetic survey methodology is given in Appendix 1. Appendix 2 details the survey location information and Appendix 3 describes the composition and location of the survey archive.

***The figures in this report have been produced following analysis of the data in 'raw' and processed formats and over a range of different display levels. All figures are presented to most suitably display and interpret the data from this site based on the experience and knowledge of Archaeological Services staff.***

## 5 Results and Discussion

'Iron spike' anomalies have been identified across the whole of the survey area. These anomalies are caused by ferrous material in the upper soil horizons and although they could be caused by archaeological artefacts they are more likely to be caused by modern ferrous debris. There is a preponderance of such anomalies towards the eastern edge of the site which reflects the presence of fly tipped material around the eastern periphery of the site. In places the tipping was extensive accounting for the more general areas of magnetic disturbance and the unsuitability for survey of part of the site bordering Swainsea Lane.

To the west of the site a strong linear anomaly aligned south-west/north-east crosses the survey area. This anomaly is indicative of an infilled linear ditch-type feature. Perpendicular to it is a second linear ditch-type anomaly. It should be noted that this second anomaly is outside the development area (see Fig. 2). These anomalies are interpreted as archaeological in origin, probably forming part of a field system or perhaps the corner of an enclosure. The second linear anomaly appears to terminate just before the point at which the two ditches would have intersected possibly suggesting an entranceway between fields/enclosures.

Several discrete areas of magnetic enhancement have been identified. These anomalies could also be archaeological in origin, particularly those to the north side of the ditches (the presumed 'inside' of the field/enclosure). However, it should be noted that any of these anomalies could equally be due to geological features or even to modern activity, particularly the two areas of enhancement nearest to Swainsea Lane.

## 6 Conclusion

Anomalies indicative of ditches probably forming part of a field system with a possible enclosure attached have been identified. Additionally discrete anomalies, also possibly indicative of archaeological activity, have been identified. However, it should be noted that some of these anomalies are located outside the proposed development area.

***The results and subsequent interpretation of data from geophysical surveys should not be treated as an absolute representation of the underlying archaeological and non-archaeological remains. Confirmation of the presence or absence of archaeological remains can only be achieved by direct investigation of sub-surface deposits.***

# Appendix 1: Magnetic survey: technical information

## Magnetic Susceptibility and Soil Magnetism

Iron makes up about 6% of the Earth's crust and is mostly present in soils and rocks as minerals such as maghaemite and haemetite. These minerals have a weak, measurable magnetic property termed magnetic susceptibility. Human activities can redistribute these minerals and change (enhance) others into more magnetic forms so that by measuring the magnetic susceptibility of the topsoil, areas where human occupation or settlement has occurred can be identified by virtue of the attendant increase (enhancement) in magnetic susceptibility. If the enhanced material subsequently comes to fill features, such as ditches or pits, localised isolated and linear magnetic anomalies can result whose presence can be detected by a magnetometer (fluxgate gradiometer).

In general, it is the contrast between the magnetic susceptibility of deposits filling cut features, such as ditches or pits, and the magnetic susceptibility of topsoils, subsoils and rocks into which these features have been cut, which causes the most recognisable responses. This is primarily because there is a tendency for magnetic ferrous compounds to become concentrated in the topsoil, thereby making it more magnetic than the subsoil or the bedrock. Linear features cut into the subsoil or geology, such as ditches, that have been silted up or have been backfilled with topsoil will therefore usually produce a positive magnetic response relative to the background soil levels. Discrete feature, such as pits, can also be detected. Less magnetic material such as masonry or plastic service pipes that intrude into the topsoil may give a negative magnetic response relative to the background level.

The magnetic susceptibility of a soil can also be enhanced by the application of heat. This effect can lead to the detection of features such as hearths, kilns or areas of burning.

## Types of Magnetic Anomaly

In the majority of instances anomalies are termed 'positive'. This means that they have a positive magnetic value relative to the magnetic background on any given site. However some features can manifest themselves as 'negative' anomalies that, conversely, means that the response is negative relative to the mean magnetic background. Such negative anomalies are often very faint and are commonly caused by modern, non-ferrous, features such as plastic water pipes. Infilled natural features may also appear as negative anomalies on some geological substrates.

Where it is not possible to give a probable cause of an observed anomaly a '?' is appended.

It should be noted that anomalies interpreted as modern in origin might be caused by features that are present in the topsoil or upper layers of the subsoil. Removal of soil to an archaeological or natural layer can therefore remove the feature causing the anomaly.

The types of response mentioned above can be divided into five main categories that are used in the graphical interpretation of the magnetic data:

*Isolated dipolar anomalies (iron spikes)*

These responses are typically caused by ferrous material either on the surface or in the topsoil. They cause a rapid variation in the magnetic response giving a characteristic 'spiky' trace. Although ferrous archaeological artefacts could produce this type of response, unless there is supporting evidence for an archaeological interpretation, little emphasis is normally given to such anomalies, as modern ferrous objects are common on rural sites, often being present as a consequence of manuring.

*Areas of magnetic disturbance*

These responses can have several causes often being associated with burnt material, such as slag waste or brick rubble or other strongly magnetised/fired material. Ferrous structures such as pylons, mesh or barbed wire fencing and buried pipes can also cause the same disturbed response. A modern origin is usually assumed unless there is other supporting information.

*Linear trend*

This is usually a weak or broad linear anomaly of unknown cause or date. An agricultural origin, either ploughing or land drains is a common cause.

*Areas of magnetic enhancement/positive isolated anomalies*

Areas of enhanced response are characterised by a general increase in the magnetic background over a localised area whilst discrete anomalies are manifest by an increased response (sometimes only visible on an XY trace plot) on two or three successive traverses. In neither instance is there the intense dipolar response characteristic exhibited by an area of magnetic disturbance or of an 'iron spike' anomaly (see above). These anomalies can be caused by infilled discrete archaeological features such as pits or post-holes or by kilns. They can also be caused by pedological variations or by natural infilled features on certain geologies. Ferrous material in the subsoil can also give a similar response. It can often therefore be very difficult to establish an anthropogenic origin without intrusive investigation or other supporting information.

*Linear and curvilinear anomalies*

Such anomalies have a variety of origins. They may be caused by agricultural practice (recent ploughing trends, earlier ridge and furrow regimes or land drains), natural geomorphological features such as palaeochannels or by infilled archaeological ditches.

**Methodology: Magnetic Susceptibility Survey**

There are two methods of measuring the magnetic susceptibility of a soil sample. The first involves the measurement of a given volume of soil, which will include any air and moisture that lies within the sample, and is termed volume specific susceptibility. This method results in a bulk value that it not necessarily fully representative of the constituent components of the sample. The second technique overcomes this potential problem by taking into account both the volume and mass of a sample and is termed mass specific susceptibility. However, mass specific readings cannot be taken in the field where the bulk properties of a soil are usually unknown and so volume specific readings must be taken. Whilst these values are not fully representative they do allow general comparisons across a site and give a broad indication of susceptibility changes. This is usually enough to assess the susceptibility of a site and evaluate whether enhancement has occurred.

**Methodology: Gradiometer Survey**

There are two main methods of using the fluxgate gradiometer for commercial evaluations. The first of these is referred to as ***magnetic scanning*** and requires the operator to visually identify anomalous responses on the instrument display panel whilst covering the site in widely spaced traverses, typically 10m apart. The instrument logger is not used and there is therefore no data collection. Once anomalous responses are identified they are marked in the field with bamboo canes and approximately located on a base plan. This method is usually employed as a means of selecting areas for detailed survey when only a percentage sample of the whole site is to be subject to detailed survey.

The disadvantages of magnetic scanning are that features that produce weak anomalies (less than 2nT) are unlikely to stand out from the magnetic background and so will be difficult to detect. The coarse sampling interval means that discrete features or linear features that are parallel or broadly oblique to the direction of traverse may not be detected. If linear features are suspected in a site then the traverse direction should be perpendicular (or as close as is possible within the physical constraints of the site) to the orientation of the suspected features. The possible drawbacks mentioned above mean that a 'negative' scanning result should be validated by sample detailed magnetic survey (see below).

The second method is referred to as ***detailed survey*** and employs the use of a sample trigger to automatically take readings at predetermined points, typically at 0.25m intervals, on zig-zag traverses 1m apart. These readings are stored in the memory of the instrument and are later dumped to computer for processing and interpretation. Detailed survey allows the visualisation of weaker anomalies that may not have been detected by magnetic scanning.

During this survey a Bartington Grad601 magnetic gradiometer was used taking readings on the 0.1nT range, at 0.25m intervals on zig-zag traverses 1m apart within 30m by 30m square grids. The instrument was checked for electronic and mechanical drift at a common point and calibrated as necessary. The drift from zero was not logged.

**Data Processing and Presentation**

The detailed gradiometer data has been presented in this report in XY trace and greyscale formats. In the former format the data shown is 'raw' with no processing other than grid biasing having been done. The data in the greyscale images has been interpolated and selectively filtered to remove the effects of drift in instrument calibration and other artificial data constructs and to maximise the clarity and interpretability of the archaeological anomalies.

An XY plot presents the data logged on each traverse as a single line with each successive traverse incremented on the Y-axis to produce a ‘stacked’ plot. A hidden line algorithm has been employed to block out lines behind major ‘spikes’ and the data has been clipped. The main advantage of this display option is that the full range of data can be viewed, dependent on the clip, so that the ‘shape’ of individual anomalies can be discerned and potentially archaeological anomalies differentiated from ‘iron spikes’. Geoplot 3 software was used to create the XY trace plots.

Geoplot 3 software was used to interpolate the data so that 3600 readings were obtained for each 30m by 30m grid. The same program was used to produce the greyscale images. All greyscale plots are displayed using a linear incremental scale.

## Appendix 2: Survey location information

| Station | Easting | Northing |
|---|---|---|
| A | | |
| B | | |

***Archaeological Services WYAS cannot accept responsibility for errors of fact or opinion resulting from data supplied by a third party or for the removal of any of the survey reference points.***

## Appendix 3: Geophysical archive

The geophysical archive comprises:-

- an archive disk containing compressed (WinZip 8) files of the raw data, report text (Microsoft Word 2000), and graphics files (Adobe Illustrator CS2 and AutoCAD 2007) files.
- a full copy of the report

At present the archive is held by Archaeological Services WYAS although it is anticipated that it may eventually be lodged with the Archaeology Data Service (ADS). Brief details may also be forwarded for inclusion on the English Heritage Geophysical Survey Database after the contents of the report are deemed to be in the public domain (i.e. available for consultation in the relevant Sites and Monument Record Office).

## Bibliography


David, A., N. Linford, P. Linford and L. Martin, 2008. *Geophysical Survey in Archaeological Field Evaluation: Research and Professional Services Guidelines (2nd edition)* English Heritage

Gaffney, C., Gater, J. and Ovenden, S. 2002. *The Use of Geophysical Techniques in Archaeological Evaluations*. IFA Technical Paper No. 6

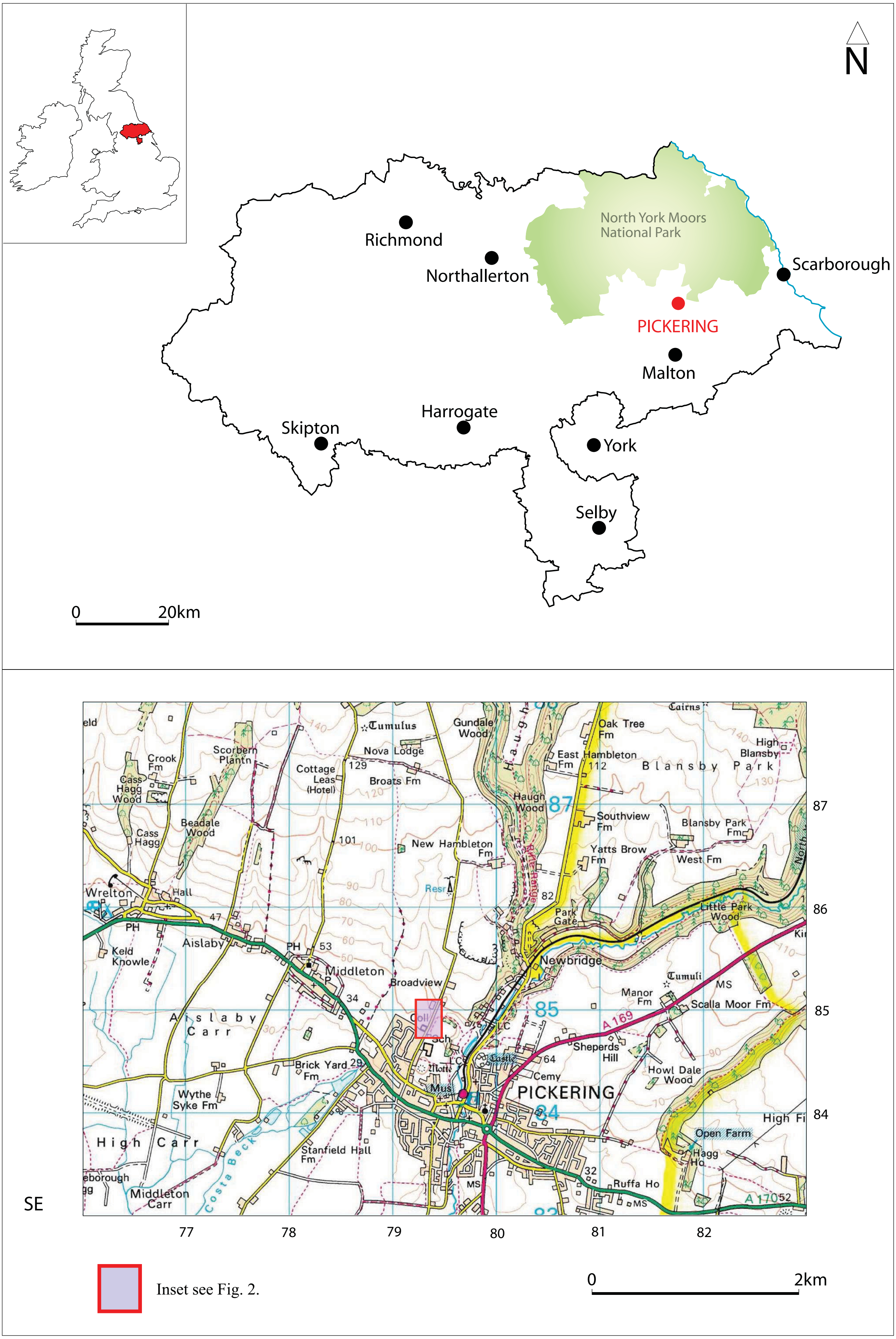


*Fig. 1. Site location*

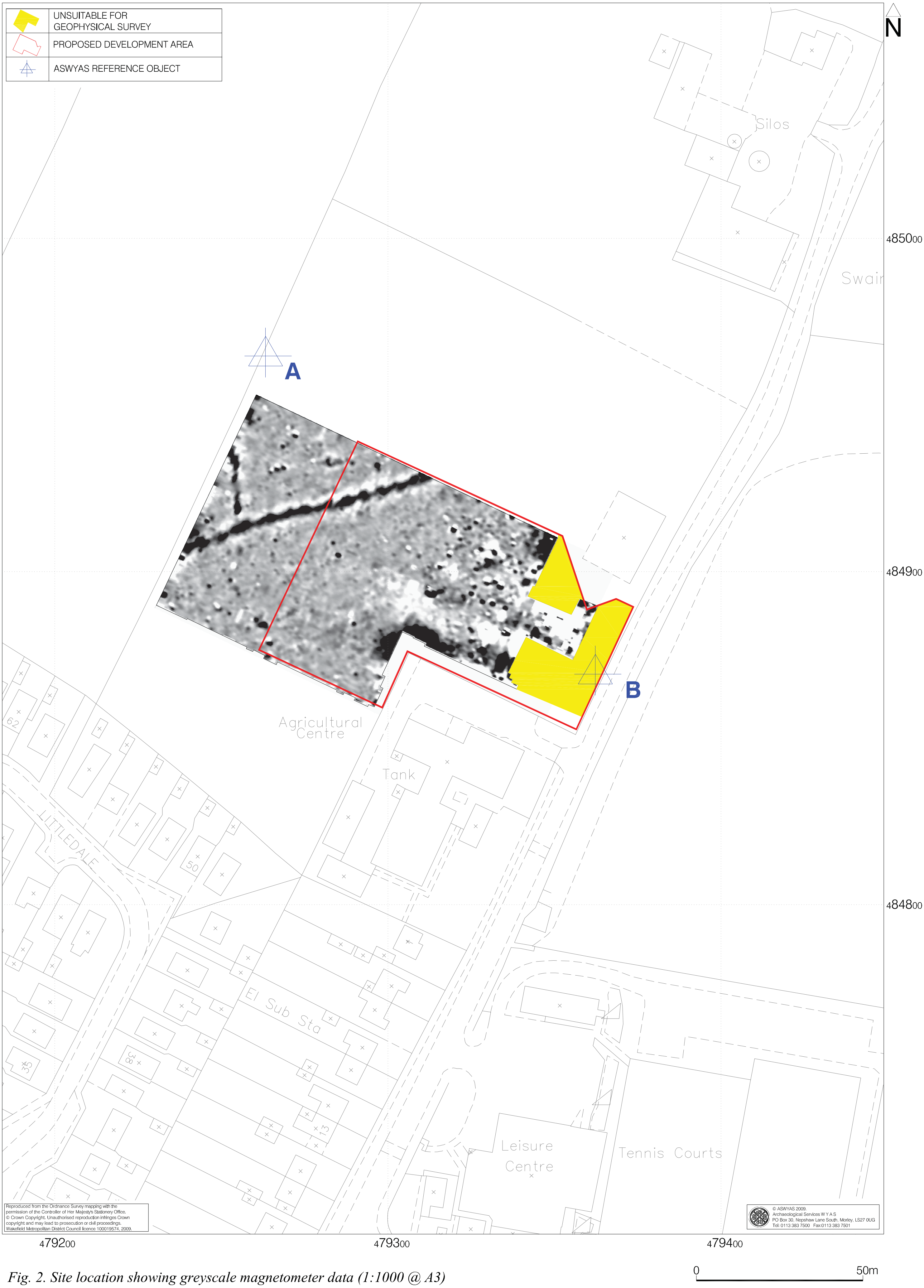


*Fig. 2. Site location showing greyscale magnetometer data (1:1000 @ A3)*

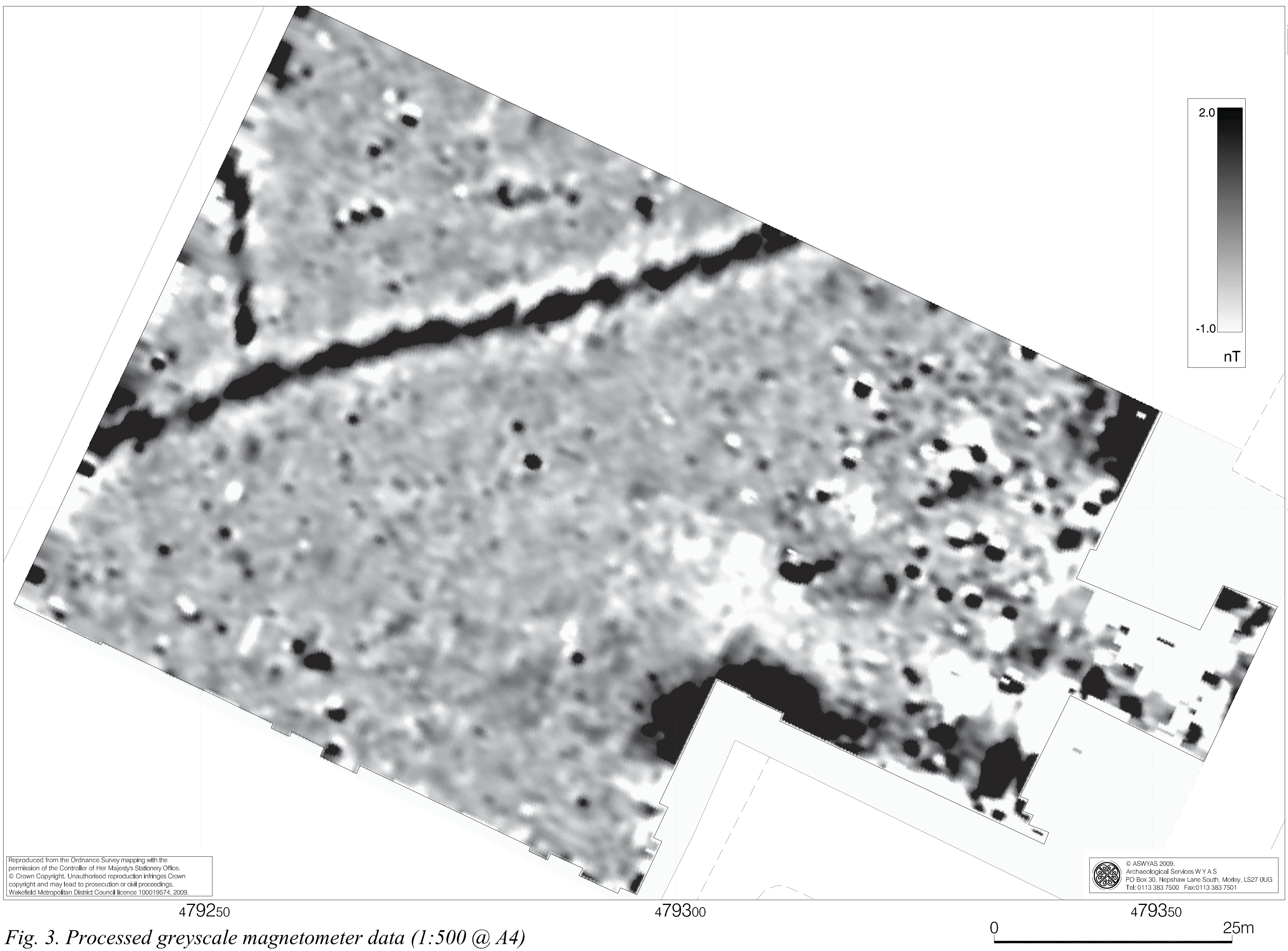


*Fig. 3. Processed greyscale magnetometer data (1:500 @ A4)*




*Fig. 4. XY trace plot of unprocessed magnetometer data (1:500 @ A4)*

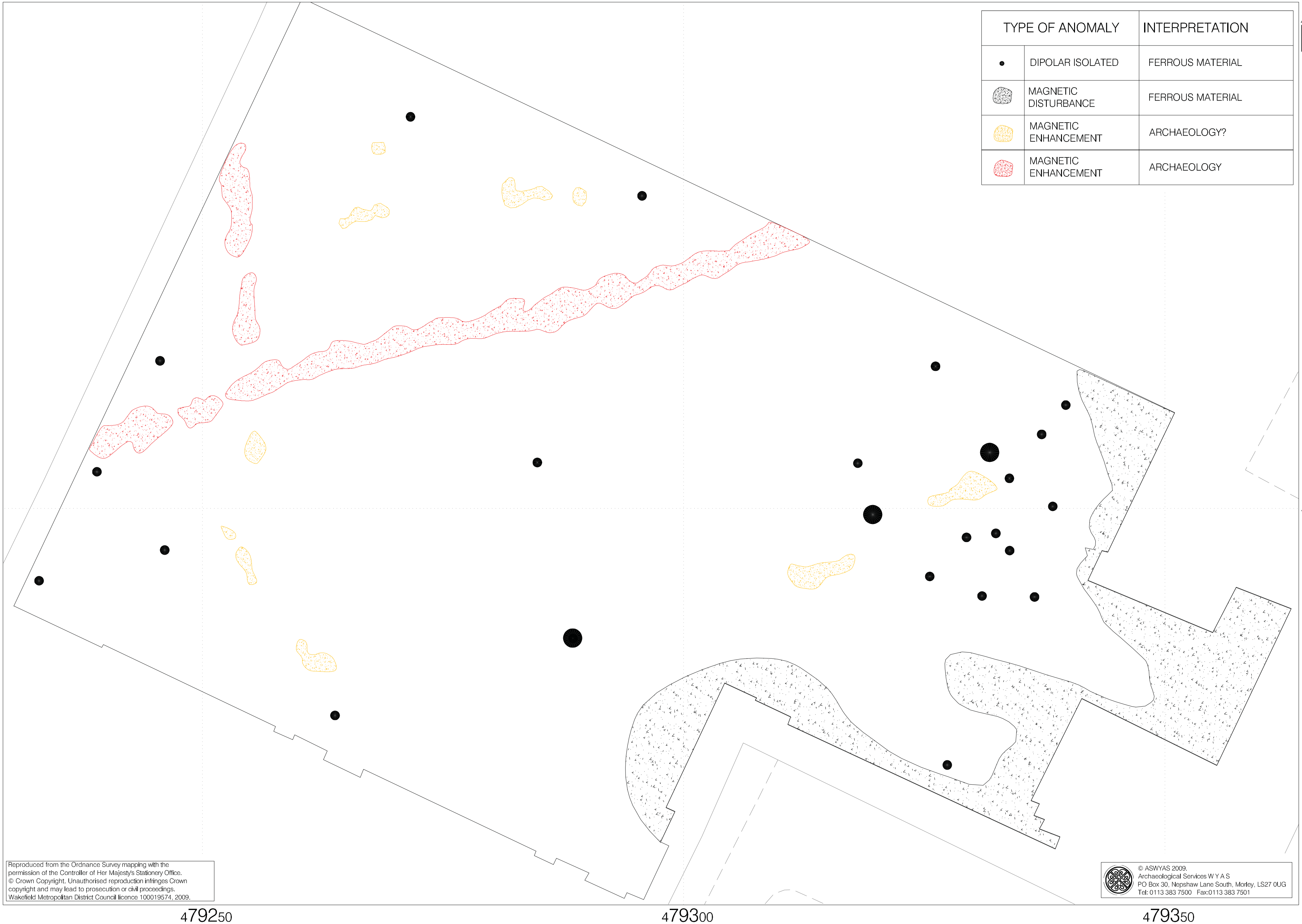


*Fig. 5. Interpretation of magnetometer data (1:500 @ A4)*