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Land off Harding Avenue
Upper Haugh
Rotherham
South Yorkshire

Geophysical Survey

August 2010

Report No. 2106

CLIENT

Taylor Wimpey Yorkshire

Land off Harding Avenue
Upper Haugh
Rotherham
South Yorkshire

Geophysical Survey

Summary

A geophysical (magnetometer) survey, covering approximately 8 hectares, was carried out at Upper Haugh, near Rotherham, in advance of a proposed housing development. A map regression was also undertaken. The survey and research have confirmed the location and extent of an open cast mine in the centre of the site in operation in the early 1950s; the land was re-instated and returned to agriculture in 1954. Anomalies caused by former field boundaries, drains, pipes and other 19th and 20th century activity have been identified. No anomalies of obvious archaeological potential have been identified. On the basis of the geophysical survey and research about one third of the site has no archaeological potential with the remainder considered as having a low archaeological potential.

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Report Information

Client:	Taylor Wimpey Yorkshire
Address:	Sandpiper House, Peel Avenue, Calder Park, Wakefield, WF2 7UA
Report Type:	Geophysical survey
Location:	Upper Haugh, Rotherham
County:	South Yorkshire
Grid Reference:	SE 425 978
Period(s) of activity represented:	Modern
Report Number:	2106
Project Number:	3569
Site Code:	UHR10
Planning Application No.:	RB2008/1404 (OUT)
Museum Accession No.:	-
Date of fieldwork:	August 2010
Date of report:	August 2010
Project Management:	Alistair Webb BA MIfA
Fieldwork:	Alex Harrison BSc Sam Harrison BSc MSc AIfA
Report:	Alistair Webb
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Authorisation for distribution: ---

ISOQAR ISO 9001:2008
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1 Introduction

Archaeological Services WYAS was commissioned by David Fisher, Senior Planning and Design Executive at Taylor Wimpey Yorkshire to undertake a geophysical (magnetometer) survey and map regression at Upper Haugh, near Rotherham (see Fig. 1) in advance of a proposed housing development at the site. The scheme of work was a condition of the outline planning permission granted in September 2009 (Ref. RB2008/1404(OUT)).

Site location, topography and land use

The site, centred at SE 425 978, is located on the northern edge of the village of Upper Haugh, approximately 4km north of Rotherham and 2km north-west of Rawmarsh. The main part of the site comprised a roughly rectangular parcel of land, approximately 10 hectares in area, bounded by Wentworth Road to the north, Harding Avenue to the east and residential properties to the south (see Fig. 2). Upper Haugh Cricket Ground bordered the site to the north-east. A second smaller area to the east of Harding Avenue, the site of a proposed balancing lagoon, was also surveyed at the request of the client.

The site was relatively flat at approximately 100m above Ordnance Datum and is currently used for agriculture having been harvested of a crop of oil seed rape immediately prior to survey. Coal had been mined from an open cast pit in the centre of the site prior to re-instatement in the mid 1950s (see Fig. 3).

Geology and soils

The geology comprises Middle Coal Measures carboniferous mudstone and sandstones overlain by slowly permeable, seasonally waterlogged, loamy soils of the Bardsey soil association.

2 Archaeological background

Research undertaken for the map regression has shown that the site was a single unenclosed parcel of land in 1780 (see Fig. 4). By the time of the first edition Ordnance Survey map in 1853 (see Fig. 5) the land encompassing the site had been divided into four separate fields of virtually identical shape and area. By the time of the second edition in 1892 (see Fig. 6) Low Stubbin Colliery, between the western edge of the site and Stubbin Lane, was in operation but by the 1930 edition the colliery had closed and the buildings demolished leaving the old shaft as the only physical reminder of the mining operation.

However, this was not the end of coal extraction on or near the site and in March 1954 open cast operations began in the centre of the current site. Coal Authority mapping (see Fig. 3) shows that an area of approximately 4 hectares was subject to open cast extraction between March and August 1954 with the site being handed back to agriculture in August 1955.

There are no known archaeological remains within the site itself but Roman Ridge Dyke runs just to the north of the site.

3 Aims, Methodology and Presentation

Following consultation with the South Yorkshire Archaeology Service it was determined that the first stage of the evaluation of the site would comprise a combined map regression and geophysical survey.

The general aim of the geophysical evaluation was to confirm the extent of the open cast coal extraction and to establish and clarify the nature of the archaeological resource within the remainder of the site not affected by the coal extraction. Given the map evidence for open casting on the site it was agreed with SYAS that the geophysical survey would be undertaken from the edges of the site towards the centre, where the mapping defines the former extraction zone, until the survey could confirm the extent of the former mining activity.

Specifically the survey sought to provide information about the nature and possible interpretation of any anomalies identified during the survey and thereby determine the presence or absence and likely extent of any buried archaeological remains. The survey covered approximately 8 hectares which included a separate area of approximately 1hectare to the east of Harding Avenue.

The information from the geophysical survey and map regression will enable further evaluation and/or mitigation measures, if required, to be designed in advance of the proposed development of the site.

The survey areas were set out using a Trimble 5500 total station theodolite and tied in to field boundaries, other permanent landscape features and to temporary reference points (survey marker stakes) which were established and left in place, for accurate geo-referencing, following completion of the fieldwork. The locations of the temporary reference points are shown on Figure 2.

Magnetometer survey

Bartington Grad601 instruments were used to take readings at 0.25m intervals on zig-zag 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.

Reporting

A general site location plan, incorporating the 1:50000 Ordnance Survey mapping is shown in Figure 1. Figure 2 is a more detailed site location showing the processed magnetometer data and the mapped extent of the open casting operation. The Coal Authority mapping, 1780 tithe map and early Ordnance Survey map editions, all showing the extent of the site, are presented in Figures 3 to 7 inclusive. The processed magnetometer greyscale data, the 'raw' XY trace plot data and interpretation figures are presented at a scale of 1:1000 in Figures 8 to 16 inclusive.

Further technical information on the equipment used, data processing and survey methodologies are given in Appendix 1 and Appendix 2. Appendix 3 describes the composition and location of the site archive.

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

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.

4 Results and Discussion

Summary

Numerous anomalies have been recorded across all parts of the site although none of any obvious archaeological potential have been identified.

Detail

Two linear dipolar anomalies, **A** and **B**, are identified aligned north-north-west/south-south-east parallel with the site boundaries at the northern and southern edges of the survey area respectively. These anomalies are caused by ferrous service pipes. An arcing, intermittent, series of dipolar anomalies (iron spikes), **C**, to the south of the survey area respects the mapped edge of the extraction zone and it is thought that these anomalies are probably also caused by pipes or drains installed during the reinstatement process.

A regular series of parallel linear anomalies aligned north-west/south-east in the northern half of the site are due to a system of field drains. Similar anomalies extending across the former open casting area and to the south of the site are also interpreted as being due to field drains.

A massive ferrous anomaly, **D**, is due to the proximity of an electricity pylon. Sixty metres to the north-east a second large ferrous anomaly, **E**, is identified although there is no surface feature to account for this response.

Former field boundaries depicted on the first four editions of the Ordnance Survey mapping can be identified, either as specific linear anomalies, or inferred through a change in orientation or cessation/termination of other anomalies. To the west of the site intersecting linear anomalies, **F** and **G**, clearly locate former field boundaries shown on all Ordnance Survey mapping up to and including the 1930 edition, east of Low Stubbin Colliery. An area of variable magnetic readings to the north of the intersection of these two boundaries correlates with the position of a powder magazine, presumably a structure used for the safe storage of explosives for use in the adjacent mine, shown on the 1892 edition mapping (see Fig. 6). Anomaly **F** peters out just to the north of the intersection (see Fig. 10) but the continuation of the boundary can be inferred by an edge along which the field drain anomalies terminate. The edge along which the field drains terminate in the east marks the alignment of another former boundary. Although no specific anomaly to locate this feature is identified there is a large magnetically disturbed zone either side of this former boundary at the northern edge of the site. This disturbance is attributed to modern activity.

Another former boundary, **H**, is identified as a linear anomaly, immediately south of the electricity pylon (**D**), traversing across the site on a west/east alignment. Its continuation and survival (as manifest by Anomaly **I)**, where it intersects with the boundaries forming the south-western corner of Upper Haugh Cricket Ground, suggests that the extraction may not have gone quite as far to the north as the Coal Authority mapping suggests. It would therefore seem plausible that the boundaries identified as **Anomalies F** and **H/I** acted as natural boundaries to the northern and western extents of the former mining operation.

Linear anomaly, **J**, locates another former boundary in the field to the east of Harding Avenue in the balancing lagoon area. To the east of **J** linear trends in the data are caused by ploughing.

Numerous other linear trend anomalies have also been noted, both in the main part of the site and in the area of the balancing lagoon. No definite interpretation can be offered for any of these anomalies but, in the absence of any evidence to suggest that they could be caused by underlying archaeological features, it is considered likely that they will be due to modern activity, possibly associated with drainage.

Throughout the site numerous anomalies comprising discrete areas of magnetic enhancement of varying extent, some exhibiting a degree of linearity, have been identified. There is no coherent pattern to their distribution and they are therefore interpreted as being due either to variation in the composition of the soils or to modern disturbance of the topsoil/subsoil horizons. These anomalies are not considered to be archaeologically significant.

Several slightly larger areas of magnetic variation have also been noted. These anomalies differ from the small areas of enhancement described above by virtue of being more extensive, often containing a more ferrous component. These anomalies are also not thought to have any archaeological potential probably due to modern material being mixed into the topsoil horizons.

5 Conclusions

Despite surveying over and across the mapped edge of the former open cast area there is no discernible change in the magnetic background to differentiate between the undisturbed ground and the ground infilled and re-instated after the mining was completed. However, the identification of anomalies **F** and **H**, which are caused by infilled former field boundaries, and the correlation with the mapped extent of the mining serve to confirm that these field boundaries served as physical boundaries to the extraction zone in this part of the site thus confirming the accuracy of the mining map in this part of the site. To the south of the site the location and alignment of arcing anomaly, **C**, again very closely correlates with the mapped southern edge of the open casting. It is suggested that this anomaly is also caused by a pipe or drain probably laid along the edge of the infilling at the time of the re-instatement and re-soiling thereby again demonstrating the accuracy of the mining map regarding the southern extent of the mining.

The only part of the site where there may be some doubt as to the accuracy of the mining map is adjacent to the south-west corner of the cricket ground. Here Anomaly **I**, which correlates with the continuation of the former boundary identified as Anomaly **H** to the west of the site, is several metres south of the mapped northern extent of the mining suggesting that the mining may not have extended as far north as shown but again respected pre-existing field boundaries.

In the areas demonstrably outside the area impacted by the open cast mining numerous anomalies have been identified. With the exception of those caused by field drains, services and above ground structures most cannot be confidently interpreted. Many of the smaller discrete anomalies are probably due to localised variation in the composition of the upper soil horizons or to ground disturbance in the recent past. The linear trends are less easy to interpret with a variety of possible causes presenting including drains, agricultural or other modern activity, perhaps associated with the open cast extraction. The lack of any coherent pattern to any of the anomalies is considered likely to preclude an archaeological interpretation. However, an archaeological cause for any of the anomalies of uncertain origin cannot be completely dismissed. Nevertheless, on the basis of the geophysical survey, the site is considered to have a low archaeological potential.

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.

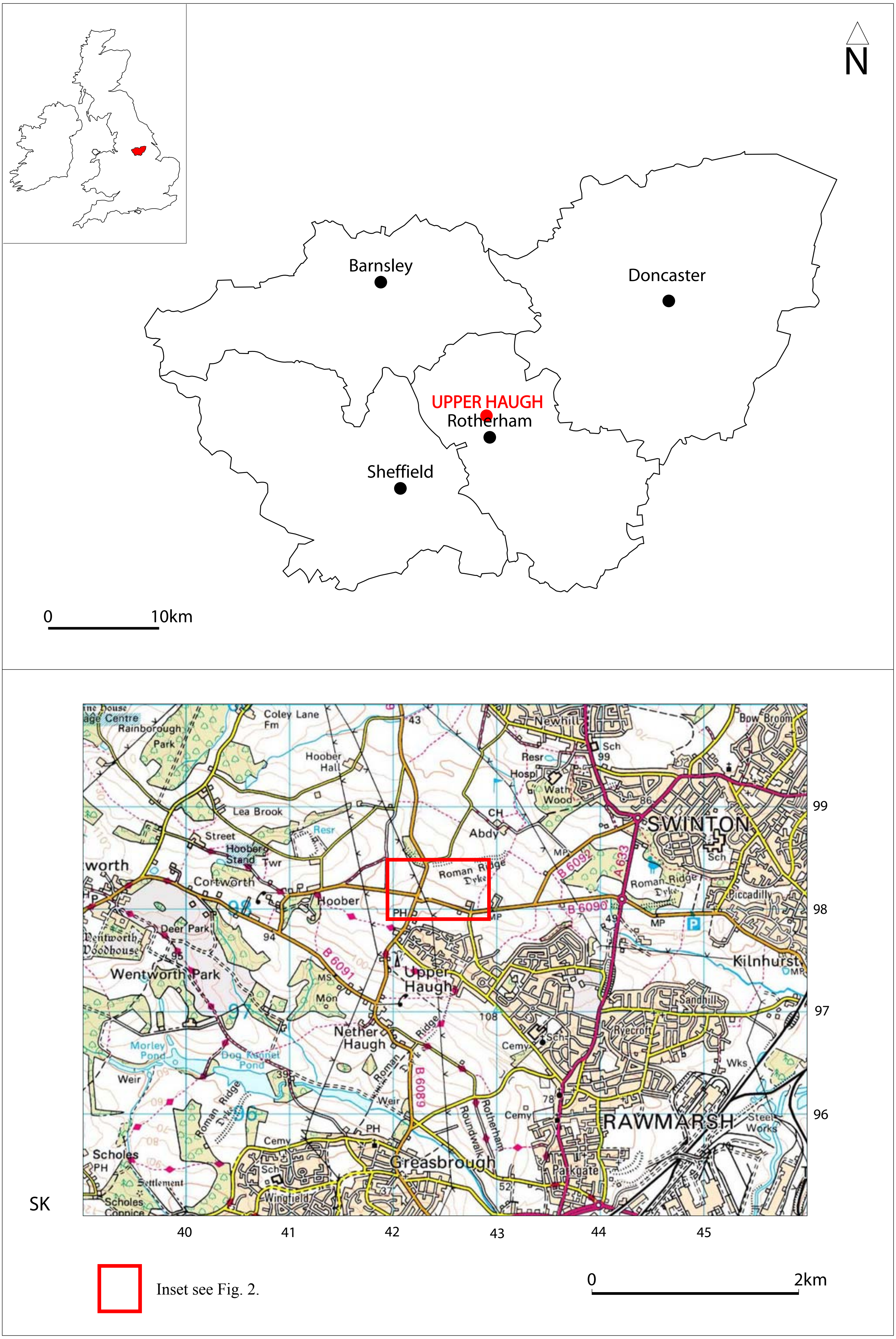

Fig. 1. Site location

Fig. 2. Site location showing magnetometer data and extent of open cast mining (1:2500 @ A3)

Fig. 3. Coal Authority plan showing extent of open cast mining (1:2500 @ A3)

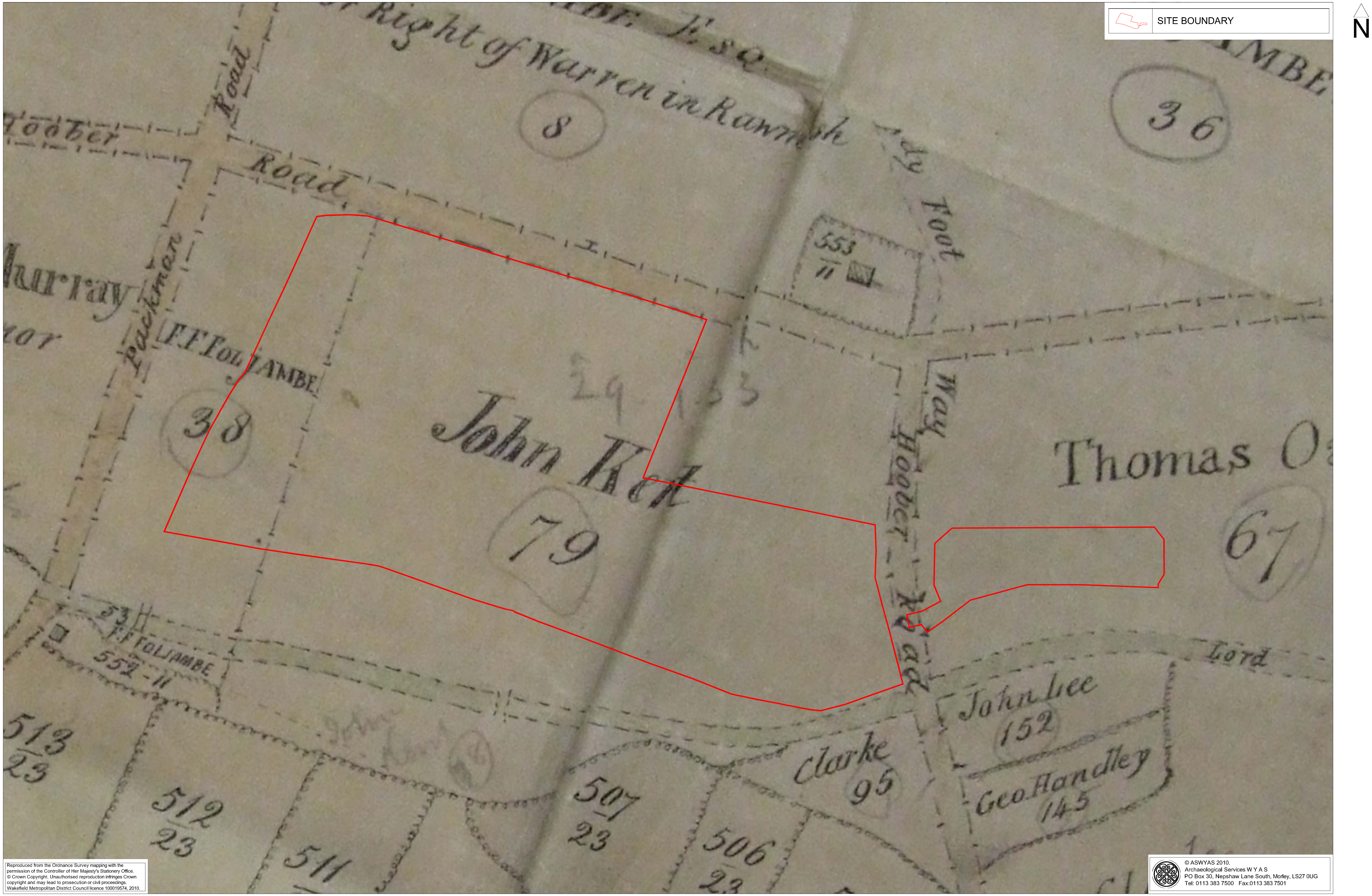

Fig. 4. Tithe map of 1780 showing approximate extent of site

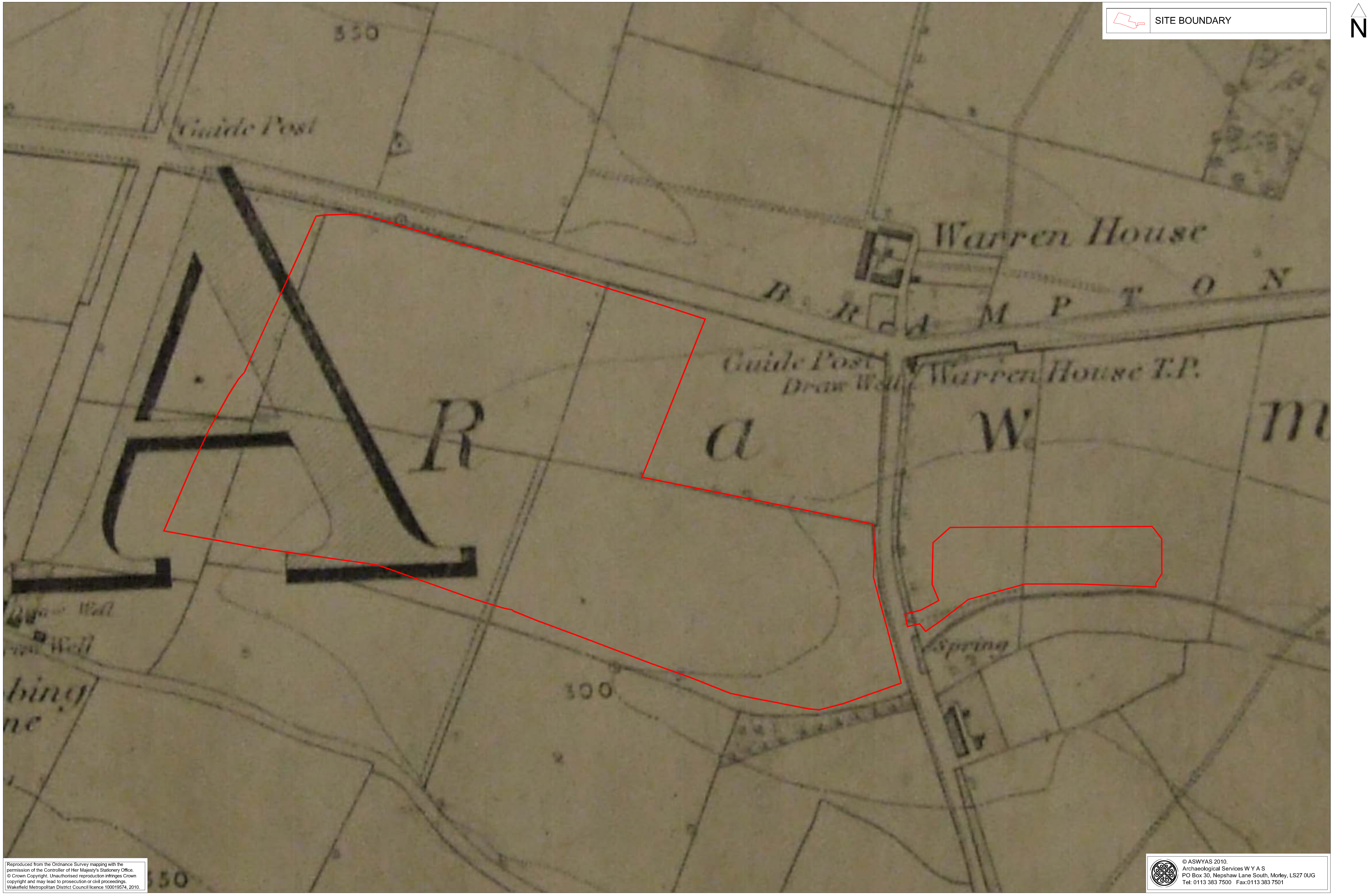

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Fig. 5. First edition Ordnance Survey 6" map of 1853 showing approximate extent of site

Fig. 6. Second edition Ordnance Survey map of 1892 showing approximate extent of site

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Fig. 7. Third edition Ordnance Survey map of 1903 showing approximate extent of site

Fig. 8. Processed greyscale magnetometer data; Sector 1 (1:1000 @ A3)

Fig. 9. XY trace plot of unprocessed magnetometer data; Sector 1 (1:1000 @ A3)

0 50m

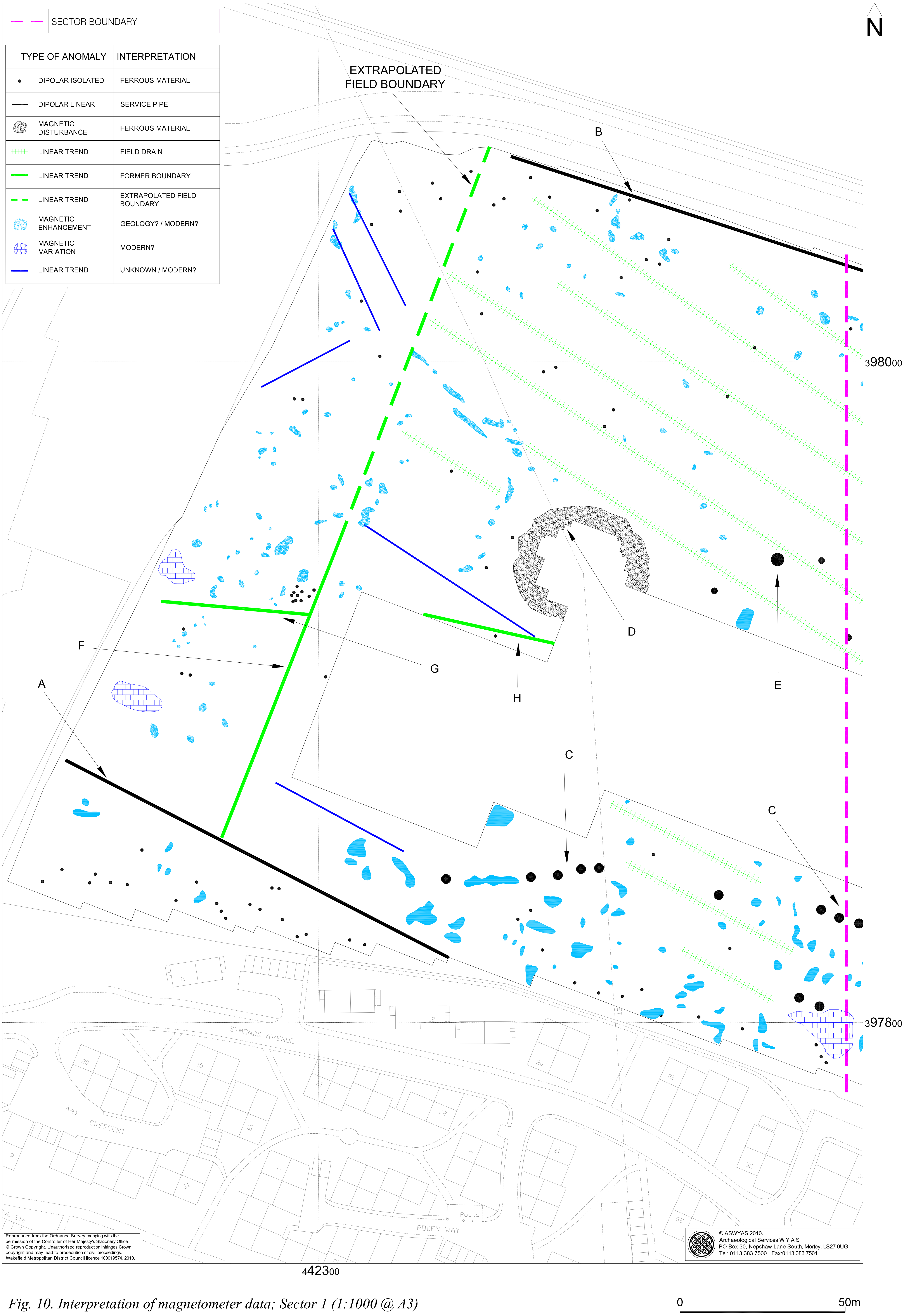

Fig. 10. Interpretation of magnetometer data; Sector 1 (1:1000 @ A3)

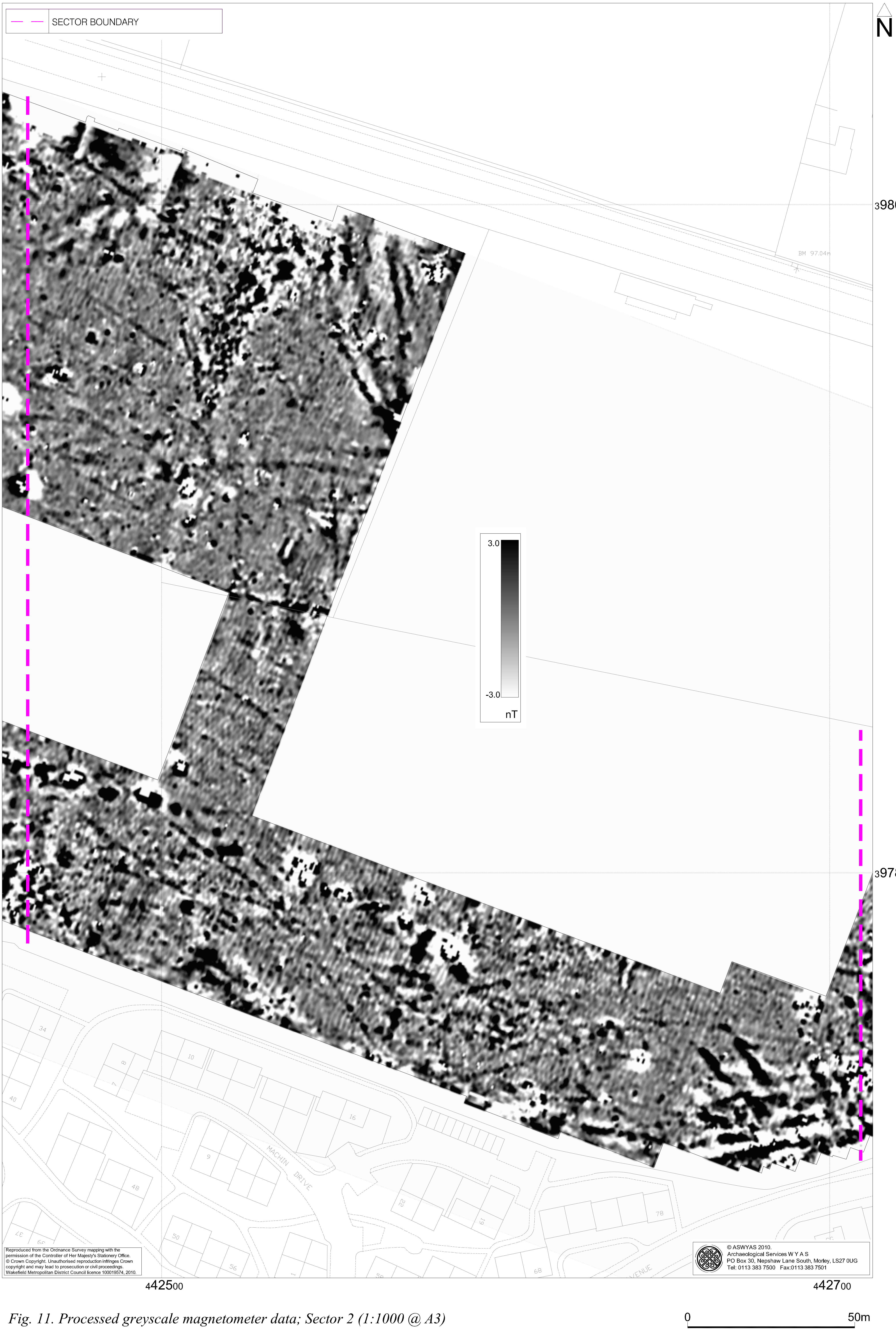

Fig. 11. Processed greyscale magnetometer data; Sector 2 (1:1000 @ A3)

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Fig. 12. XY trace plot of unprocessed magnetometer data; Sector 2 (1:1000 @ A3)

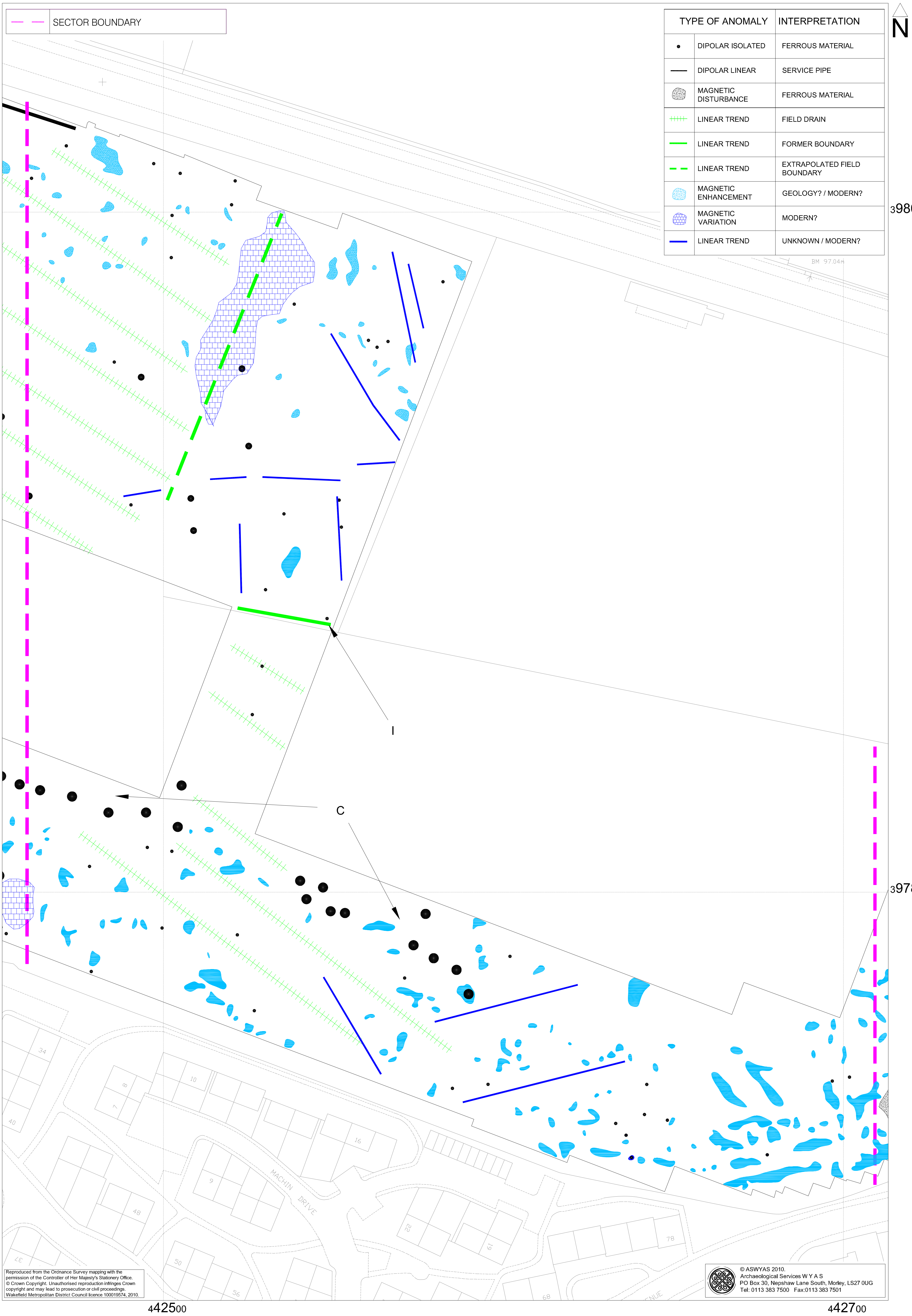

Fig. 13. Interpretation of magnetometer data; Sector 2 (1:1000 @ A3)

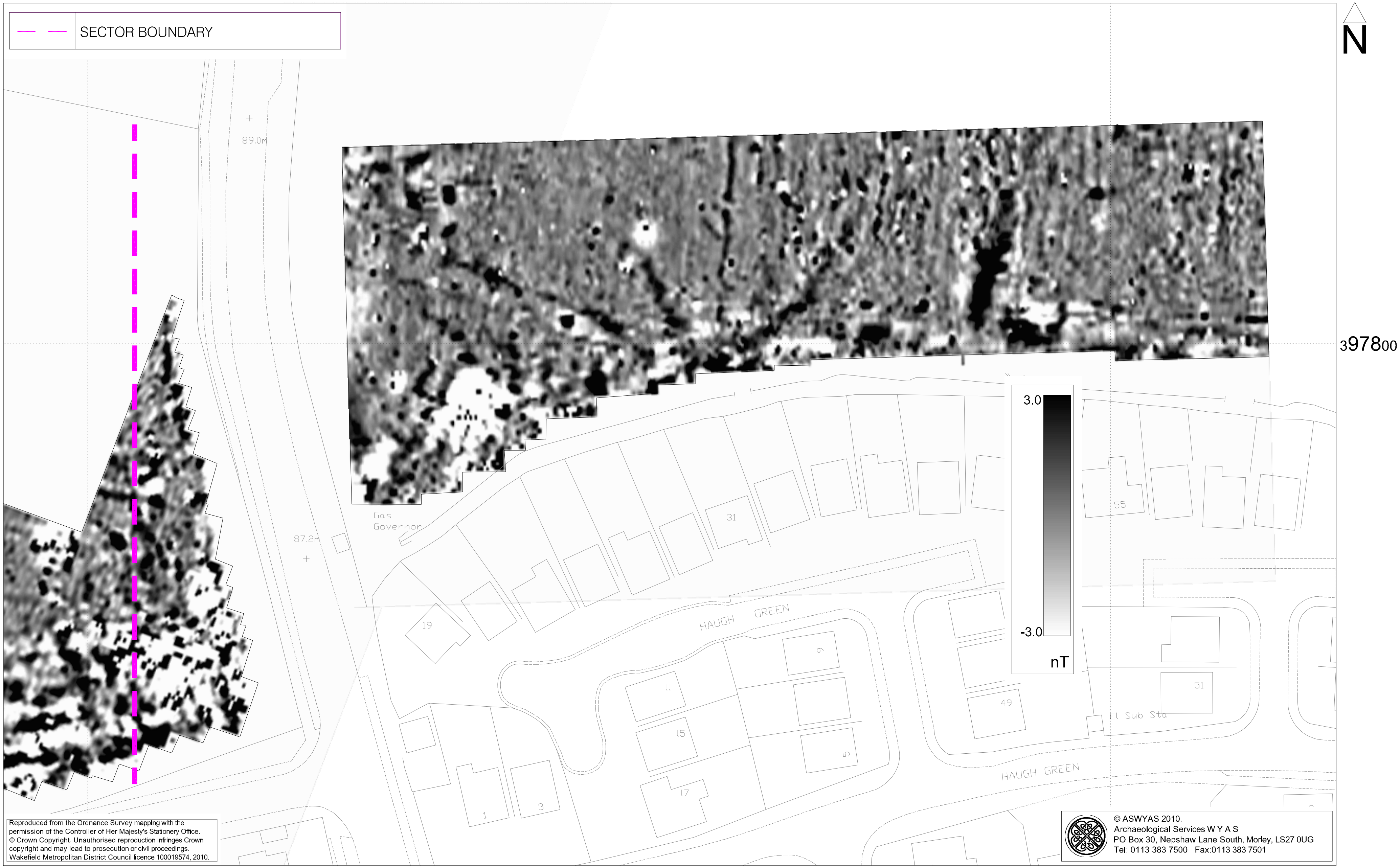

Fig. 14. Processed greyscale magnetometer data; Sector 3 (1:1000 @ A4)

0 50m

Fig. 15. XY trace plot of unprocessed magnetometer data; Sector 3 (1:1000 @ A4)

0 50m

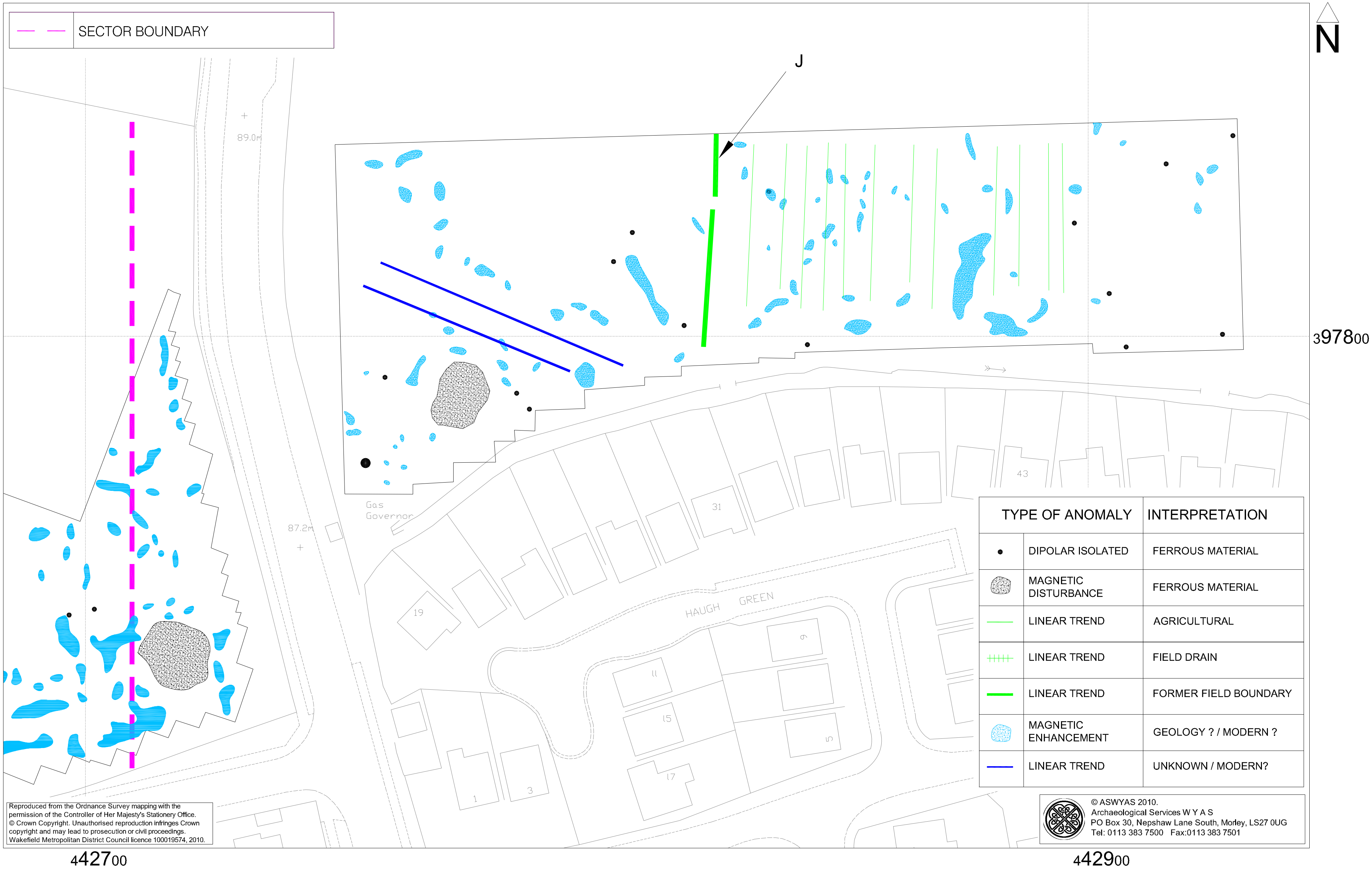

Fig. 16. Interpretation of magnetometer data; Sector 3 (1:1000 @ A4)

0 50m

Plate 1. Western part of main survey area; looking west.

Plate 2. Area of balancing lagoon (Sector 3); looking east.

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. The magnetic susceptibility of a soil can also be enhanced by the application of heat and the fermentation and bacterial effects associated with rubbish decomposition. The area of enhancement is usually quite large, mainly due to the tendency of discard areas to extend beyond the limit of the occupation site itself, and spreading by the plough. An advantage of magnetic susceptibility over magnetometry is that a certain amount of occupational activity will cause the same proportional change in susceptibility, however weakly magnetic is the soil, and so does not depend on the magnetic contrast between the topsoil and deeper layers. Susceptibility survey is therefore able to detect areas of occupation even in the absence of cut features. On the other hand susceptibility survey is more vulnerable to the masking effects of layers of colluvium and alluvium as the technique, using the Bartington system, can generally only measure variation in the first 0.15m of ploughsoil.

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.

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. These anomalies are often caused by agricultural activity, either ploughing or land drains being 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. For field surveys a Bartington MS2 meter with MS2D field loop is used due to its speed and simplicity. 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 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. 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

The site grid was laid out using a Trimble VRS differential Global Positioning System (Trimble 5800 model). The accuracy of this equipment is better then 0.01m. The locations of the temporary reference points left on site are shown on Figure 2 and the Ordnance Survey grid co-ordinates tabulated below. The internal accuracy of these markers is better than 0.01m. The survey grids were then super-imposed onto a base map provided by the client to produce the displayed block locations. However, it should be noted that Ordnance Survey positional accuracy for digital map data has an error of 0.5m for urban and floodplain areas, 1.0m for rural areas and 2.5m for mountain and moorland areas. This potential error must be considered if co-ordinates are measured off hard copies of the mapping rather than using the digital co-ordinates.

Temporary reference objects were left on site (see Fig. 2). The Ordnance Survey reference points are listed below.

Station	**Easting**	**Northing**
A	442538.4233	398010.8649
B	442551.1541	397876.4012
C	442449.7507	397783.5922
D	442744.3192	397834.8694
E	442838.1539	397795.8544

Archaeological Services WYAS cannot accept responsibility for errors of fact or opinion resulting from data supplied by a third party. Archaeological Services WYAS cannot accept responsibility for errors of fact or opinion resulting from data supplied by a third party.

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 Historic Environment Record).

Bibliography

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