ARCHAEOLOGICAL SERVICES WYAS

Eskdale Park
Whitby
North Yorkshire

Geophysical Survey

March 2011

Report No. 2189

CLIENT

Barratt Homes Ltd

Eskdale Park
Whitby
North Yorkshire

Geophysical Survey

Summary

A geophysical (magnetometer) survey covering approximately 6 hectares was carried out at Eskdale Park, on the south-eastern outskirts of Whitby, prior to the proposed submission of a planning application for a new housing development. Anomalies due to the presence of an electricity pylon, water main and caused by ploughing, modern activity and geological variation have been identified. Despite the proximity of a known Iron Age/Romano-British settlement no anomalies of archaeological potential have been identified by the survey. On the basis of the magnetometer survey the site is assessed as having a low archaeological potential.

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Report Information

Client:	Barratt Homes Ltd
Address:	6, Alpha Court, Monks Cross Drive, York, YO32 9WN
Report Type:	Geophysical Survey
Location:	Eskdale Park, Whitby
County:	North Yorkshire
Grid Reference:	SE 9012 0945
Period(s) of activity represented:	Modern
Report Number:	2189
Project Number:	3710
Site Code:	LLW11
Planning Application No.:	n/a
Museum Accession No.:	n/a
Date of fieldwork:	March 2011
Date of report:	March 2011
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Fieldwork:	Alex Harrison BSc
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Photography:	Alex Harrison
Research:	n/a

Authorisation for distribution: --

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REGISTERED ORGANISATION IfA

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1 Introduction

Archaeological Services WYAS (ASWYAS) was commissioned by Sophie Langford at MAP Archaeological Consultancy Ltd on behalf of their client, Barratt Homes Ltd. (Yorkshire East Division), to undertake a geophysical (magnetometer) survey on land off Larpool Lane (Eskdale Park), Whitby (see Fig. 1) in advance of the determination of a planning application for a housing development. The work was undertaken in accordance with the requirements of Planning Policy Statement 5.

Site location, topography and land use

The site is located on the south-eastern outskirts of Whitby, centred at SE 9012 0945, east of Larpool Lane and Larpool Drive and north-east of Larpool Hall Hotel (see Fig. 2). The Proposed Development Area (PDA) covers approximately 6 hectares and includes a linear strip extending east from the main body of the site. A residential development borders the site to the north and east with agricultural farmland to the south. The site is currently under arable cultivation. Topographically the site slopes from 60m above Ordnance Datum (aOD) in the north-western corner to 70m aOD in the south-eastern corner.

Geology and soils

The solid geology of the area comprises sandstone, siltstone and mudstones of the Long Nab Member overlain by superficial deposits of glacial till. The soils are classified in the Salop association being characterised as slowly permeable, seasonally waterlogged, reddish fine and coarse loams.

2 Archaeological background

A desk-based assessment, undertaken as part of a previous phase of work by MAP Archaeological Consultancy Ltd (Burn and Hunter 2010), concluded that whilst there were no known archaeological sites within the site boundary that a programme of archaeological assessment, including geophysical survey, was needed to mitigate for any archaeological remains that may be present on the site.

The archaeological potential of the site primarily relates to the presence of an Iron Age and Romano-British settlement which was identified approximately 200m to the south of the PDA (see Fig. 2). Features indicative of settlement activity including enclosures and a hearth were found during excavation works for a Yorkshire Water pipeline undertaken by Northern Archaeological Associates in 1999. In the wider landscape isolated spot finds also attest to Roman activity in the vicinity of the PDA.

3 Aims, Methodology and Presentation

The general aim of the geophysical survey was to establish and clarify the potential for archaeological features within the PDA. This information would then enable further, informed, decisions to be taken prior to the finalisation of the development proposals and in support of any planning application.

Specifically the survey sought to provide information about the nature and possible interpretations of magnetic anomalies identified during the survey and thereby determine the likely extent, presence or absence of any buried archaeological remains.

The survey area was set-out using a Trimble 5600 Total Station Theodolite and tied into permanent landscape features and superimposed onto digital Ordnance Survey mapping supplied by the client. Temporary reference objects (wooden survey marker stakes) were established and left in place following completion of the fieldwork for accurate geo-referencing. The locations of the temporary reference objects are shown on Figure 2 and their Ordnance Survey co-ordinates tabulated in Appendix 2.

Magnetometer survey

Bartington Grad601 instruments were used to take readings at 0.25m intervals on zigzag 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 survey allows the visualisation of weaker anomalies that may not have been readily identifiable by magnetometer (magnetic) scanning.

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 magnetometer data on the Ordnance Survey map base at a scale of 1:4000. The processed greyscale data, the 'raw' XY trace plot data and interpretation figures are presented at a scale of 1:1000 in Figures 3 to 8 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 with 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

Ferrous, dipolar anomalies

Numerous ferrous anomalies, iron 'spikes', have been identified in the data set. These anomalies are typically caused by ferrous (magnetic) material, either on the ground surface or in the topsoil. Little importance is normally given to such anomalies unless there is any supporting evidence for an archaeological interpretation, as modern ferrous objects or material are common on rural sites, often being present as a consequence of manuring, deliberate tipping/infilling or modern landscaping.

A large area of magnetic disturbance in the south-western corner of Sector 1 is due to the presence of an electricity pylon (see Figs. 4 and 5; Plate 1).

The linear dipolar anomaly crossing the site on a north/south alignment is caused by a water pipe which was installed in 1999 (see Section 2); the route of this pipe is also clearly visible on Google Earth images of the site. A second pipe, which probably feeds in to the main, can also be seen in the north-west corner of the site parallel with the western boundary of the PDA.

Geological/modern anomalies

Numerous discrete anomalies have been identified throughout the survey area. The majority of these anomalies are interpreted as geological in origin, most likely resulting from localised variations of sands and/or gravels in the composition of the topsoil and superficial deposits. However, some, notably those around the electricity pylon and along the eastern boundary of the site adjacent to the new housing development, are likely to be due to recent ground disturbance.

Agricultural anomalies

Linear striations aligned north-north-west/south-south-east are due to recent ploughing.

5 Discussion and Conclusions

No anomalies of archaeological potential have been identified by the survey with the majority of the anomalies due to variation in the superficial deposits. Modern ploughing trends are clearly visible in the data but there is no evidence of the former field boundaries shown on the first edition Ordnance Survey mapping. On the basis of the geophysical survey the archaeological potential of the site is considered to be low despite the proximity of Iron Age/Romano-British activity. However, it should be noted that this activity is at least 200m south of the current PDA.

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.

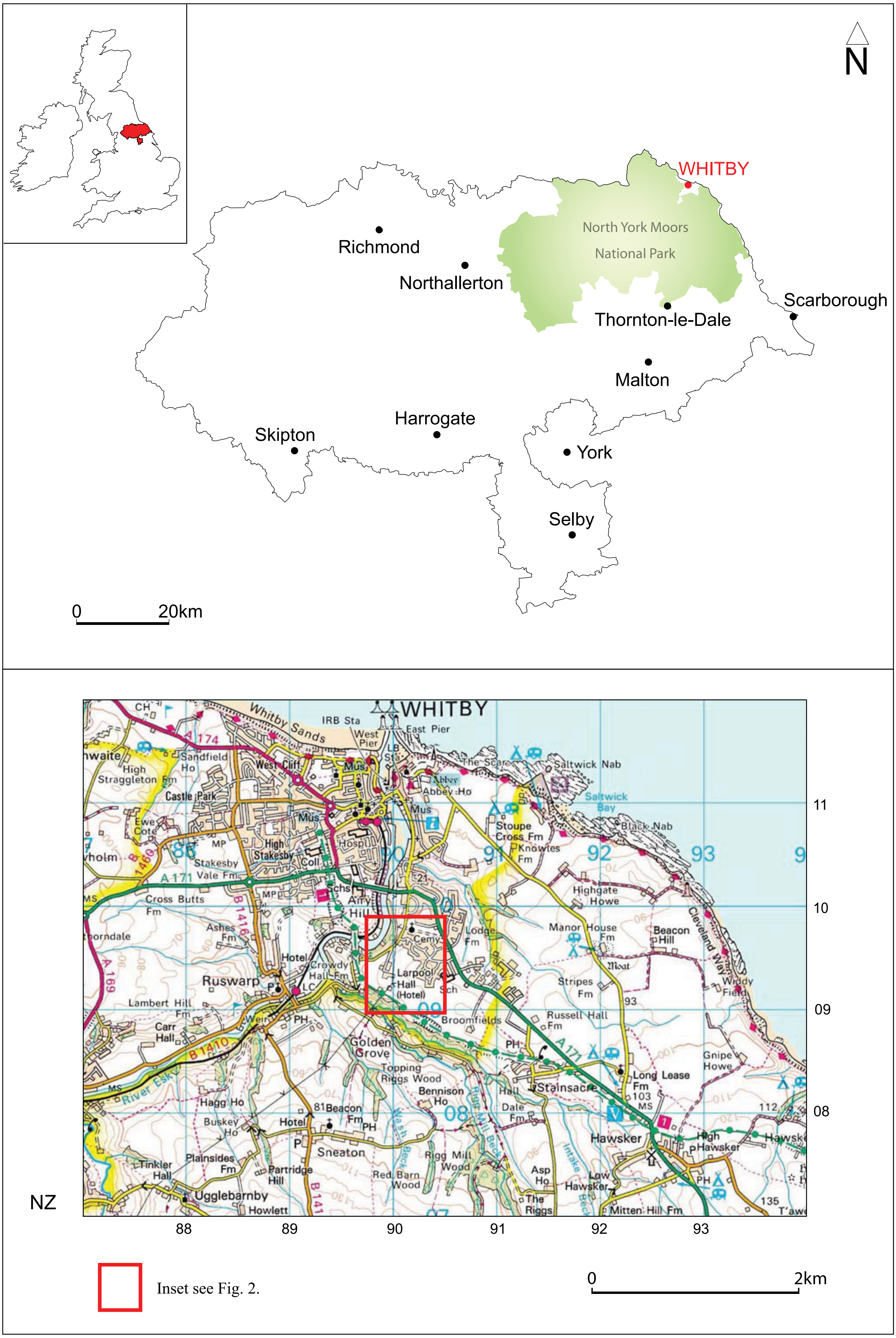

Fig. 1. Site location

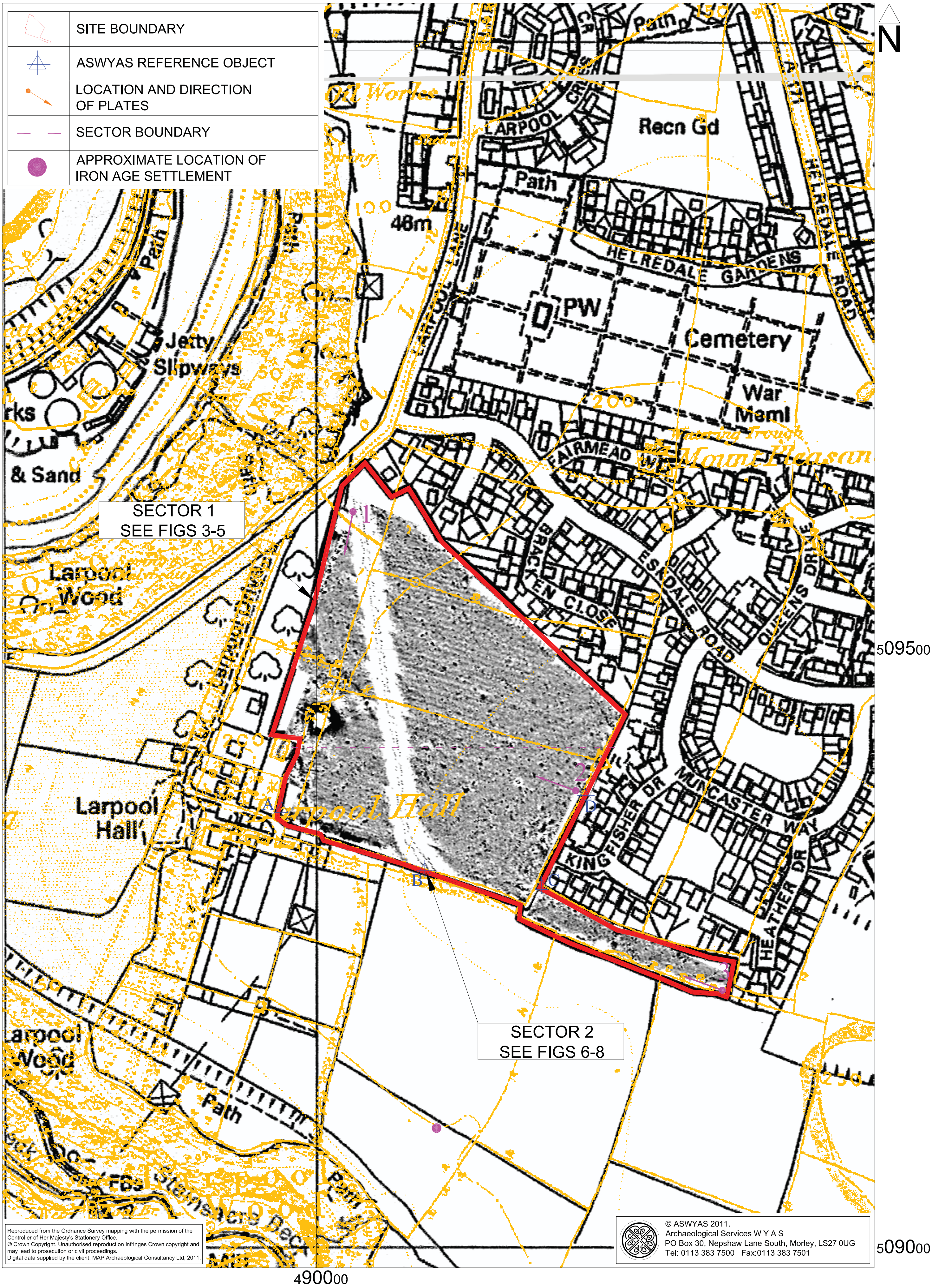

Fig. 2. Site location showing greyscale magnetometer data and first edition Ordnance Survey mapping of 1853 (1:4000 @ A4)

Fig. 3. Processed greyscale magnetometer data; Sector 1 (1:1000 @ A3)

Fig. 4. XY trace plot of unprocessed magnetometer data; Sector 1 (1:1000 @ A3)

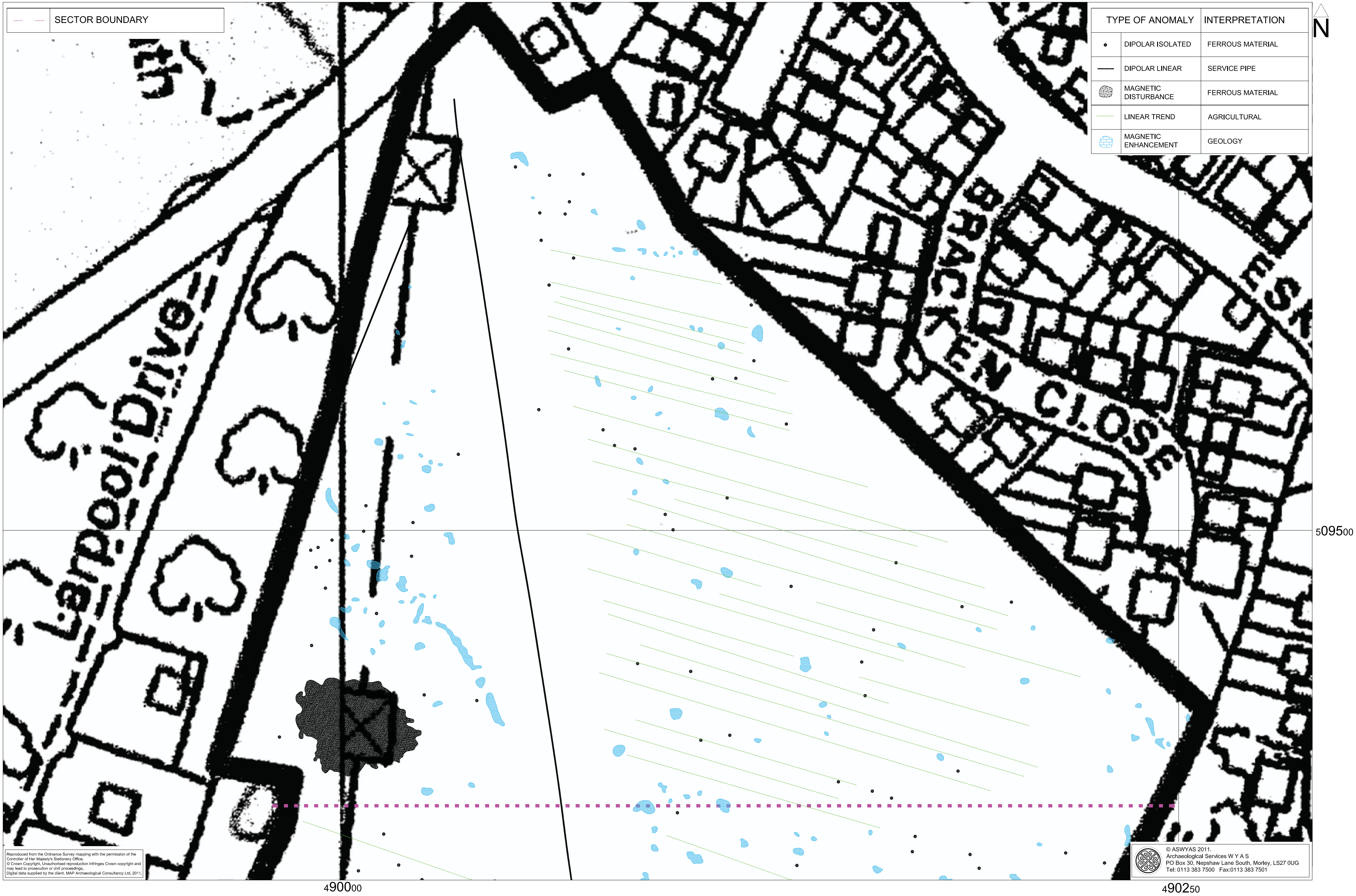

Fig. 5. Interpretation of magnetometer data; Sector 1 (1:1000 @ A3)

Fig. 6. Processed greyscale magnetometer data; Sector 2 (1:1000 @ A3)

0 50m

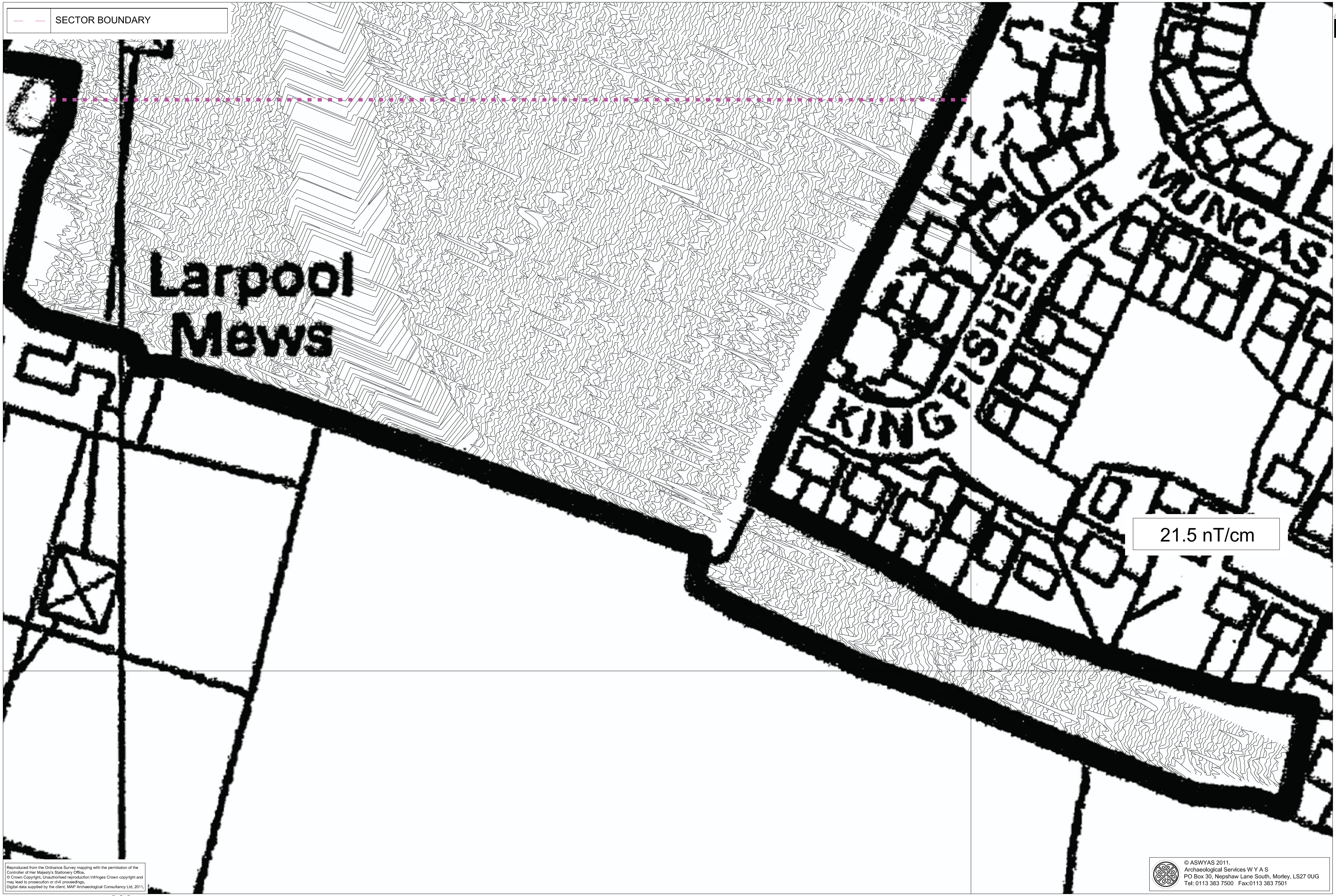

Fig. 7. XY trace plot of unprocessed magnetometer data; Sector 2 (1:1000 @ A3)

Fig. 8. Interpretation of magnetometer data; Sector 2 (1:1000 @ A3)

Plate 1. General view of survey area, looking south-south-east

Plate 2. General view of survey area, looking north-west

Plate 3. General view of survey area, looking north-west

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 topsoil's, subsoil's 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 plough-soil.

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 zigzag 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 zigzag 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 the survey grid relative to these markers is better than 0.05m. The survey grids were then superimposed onto a map base provided by the client as a 'best fit' to produce the displayed block locations. Overall there was a good correlation between the local survey and the digital map base and it is estimated that the average 'best fit' error is better than ±1.5m. However, it should be noted that Ordnance Survey co-ordinates for 1:2500 map data have an error of ±1.9m at 95% confidence. This potential error must be considered if co-ordinates are measured off for relocation purposes.

Station	**Easting**	**Northing**
A	489970.8475	509366.5188
B	490089.7048	509315.2847
C	490187.4094	509302.2204

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 2008) 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 North Yorkshire County Council Historic Environment Record Office).

Bibliography

Burn, Z. and Hunter, K. 2010. Eskdale Park, Whitby, North Yorkshire: Desk Based Assessment. Unpubl. Client Report MAP Archaeological Consultancy

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