ARCHAEOLOGICAL SERVICES WYAS

Land south of Thornton Road, Pickering North Yorkshire

Geophysical Survey

July 2010

Report No. 2098

CLIENT

MAP Archaeological Consultancy Ltd

Land south of Thornton Road, Pickering, North Yorkshire

Geophysical Survey

Summary

A geophysical (magnetometer) survey, covering approximately 2 hectares, was carried out on land to the south of Thornton Road, Pickering. Although much of the site was unsuitable for survey anomalies caused by field drains and ridge and furrow ploughing have been identified. Some of the ridge and furrow was still visible as slight linear earthworks. A line of 'iron spike' anomalies locates a former field boundary which is shown on the first edition Ordnance Survey mapping of 1854. No anomalies of obvious archaeological potential have been identified and therefore on the basis of the geophysical survey the site is considered to have a relatively low archaeological potential.

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Report Information

Client:	MAP Archaeological Consultancy Ltd
Address:	Showfield Lane, Malton, YO17 6BT
Report Type:	Geophysical survey
Location:	Pickering
County:	North Yorkshire
Grid Reference:	SE 807 832
Period(s) of activity represented:	Post-medieval
Report Number:	2098
Project Number:	3609
Site Code:	PIC10
Planning Application No.:	pre-determination
Museum Accession No.:	-
Date of fieldwork:	July 2010
Date of report:	July 2010
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Photography:	Ian Wilkins/Alex Harrison
Research:	n/a
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Contents

Report Information ii
Contents iii
List of Figures iv

1 Introduction 1
Site location, topography and land use 1
Geology and soils 1
2 Archaeological background 1
3 Aims, Methodology and Presentation 1
4 Results and Discussion 3
5 Conclusions 4

Figures

Plates

Appendices
Appendix 1: Magnetic survey: technical information
Appendix 2: Survey location information
Appendix 3: Geophysical archive

Bibliography

List of Figures

1 Site location (1:50000)
2 Site location showing greyscale magnetometer data (1:2500)
3 Processed greyscale magnetometer data (1:1000)
4 XY trace plot of unprocessed magnetometer data (1:1000)
5 Interpretation of magnetometer data (1:1000)

List of Plates

Plate 1. Field 1, showing ridge and furrow earthworks to left of frame, looking south.
Plate 2. Unsurveyed area between Field 1 and Field 2, looking north.
Plate 3. Farm buildings at the northern end of Field 2, looking south-east.
Plate 4. Field 2 showing surveyed area with the unsurveyed sheep/goat paddock to the north, looking north.
Plate 5. Field 2, showing unsurveyed area of rough ground containing livestock, looking south.
Plate 6. Field 3, showing unsurveyed pig field, looking north.
Plate 7. Field 3, looking south.
Plate 8. Field 4, looking south.

1 Introduction

Archaeological Services WYAS was commissioned by Sophie Langford of MAP Archaeological Consultancy Ltd on behalf of their clients David Wilson Homes to undertake a geophysical (magnetometer) survey on land south of Thornton Road in Pickering, North Yorkshire (see Fig. 1) in advance of a proposed housing development. The commissioned survey is in line with the requirements of PPS5.

Site location, topography and land use

The site, centred at SE 807 832, is located on the south-east side of Pickering (see Fig. 1), to the south of the A170 (Thornton Road), between Thornton Road Industrial Estate and Outgang Road. The survey area covered approximately 3.5 hectares and comprised a number of strip fields (see Fig. 2) under permanent pasture. Some of the strips had been sub-divided into smaller paddocks using wire fencing and contained livestock making some of them unsuitable for survey (see Plates). Overgrown vegetation and agricultural equipment further reduced the area suitable for survey. Approximately half of the site was not surveyed due to the factors detailed above.

The fields were generally level at 30-35m above Ordnance Datum.

Geology and soils

The geology comprises Upper Jurrasic Ampthill and Kimmeridge Clay Formations. The soils are classified as un-surveyed/urban but are presumably mainly clay soils.

2 Archaeological background

No information has been provided but the location of the survey is in an area of strip fields possibly indicating a medieval or post-medieval origin. Slight ridge and furrow earthworks are present across parts of the site.

The first edition Ordnance Survey mapping of 1854 depicts a similar field layout as today.

3 Aims, Methodology and Presentation

The general aim of the geophysical evaluation was to establish and clarify the nature of the archaeological resource within the site. Specifically the survey sought to provide information about the nature and possible interpretation of any magnetic anomalies identified during the survey and thereby determine the presence or absence and likely extent of any buried archaeological remains. These aims were to be achieved by undertaking detailed (recorded) magnetometer survey within the site boundaries as designated by the client.

The information from the geophysical survey will enable further evaluation and/or mitigation measures 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 the corners of a building and other permanent landscape features. Temporary reference points (survey marker stakes) were established and left in place following completion of the fieldwork for accurate geo-referencing. The locations of the temporary reference points are shown on Figure 2. The survey data is superimposed on to a digital raster Ordnance Survey map base supplied by the client. This was geo-referenced as accurately as possible within the constraints of the raster map.

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. The processed greyscale data, the 'raw' XY trace plot data and interpretation figures are presented at a scale of 1:1000 in Figures 3, 4 and 5.

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

Magnetometer Survey

The survey areas have been identified by individual field numbers. Fields where survey was not possible are not numbered.

Ferrous, dipolar anomalies/areas of magnetic disturbance - modern

Ferrous anomalies either as individual ‘iron spikes’ or more extensive areas of magnetic disturbance 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 infilling or fly tipping. Iron spike anomalies are present in all the surveyed areas and as there is no obvious pattern or clustering they are assumed to be caused by random ferrous debris in the topsoil.

In Field 1 (see Fig. 2 and Fig. 5) the magnetic disturbance along the boundaries of the field can be attributed to the enclosing metal and wire strand fences. The wide band (20m) of magnetic disturbance along the southern edge of the field is due to the proximity of buildings in the adjacent coach depot. In Field 2 and Field 3 the wire fencing around the boundary and subdividing the field strips accounts for most of the magnetic disturbance. Again in Field 3 and Field 4 the extensive magnetic disturbance along the southern edge of the survey areas is thought to be caused by the proximity of the industrial buildings to the south of the site boundary. In Field 4 the magnetic disturbance on the western edge is due to the proximity of a derelict building.

A series of strong ‘iron spike’ anomalies aligned north/south through the centre of Field 4 correlate with a former field boundary shown on the first edition Ordnance Survey mapping of 1854. These anomalies are thought to be possibly caused by a drain laid along the former boundary (see below).

Linear anomalies and trends - agricultural

Broad ridge and furrow earthworks were extant aligned north/south in fields 1, 2 and 4 (see Plate 1). The earthworks were less prominent in Field 2 and the tall grass in Field 3 (see Plate 7) obscured the ground surface. The magnetic data clearly shows linear anomalies due to the ploughing features in Field 1 and Field 4 but the anomalies are much less prominent in Field 2 and Field 3. The geophysical data does not show the full extent of the ridge and furrow evident at the site.

Several short linear trends have been identified in Field 4. These anomalies are tentatively interpreted as being due to field drains which may feed into the main drain which, it is suggested, may be aligned along the former field boundary (see above).

5 Conclusions

Much of the site was unsuitable for magnetic survey either due to the presence of livestock, agricultural paraphernalia or because of the overgrown nature of the site. The sub-division of the already small strip fields by fences, often of barbed wire or mesh, further reduced the area suitable for survey. Consequently only just over half the site was surveyed. The proximity of buildings, particularly to the southern boundary, resulted in extensive areas of magnetic disturbance. In these areas it will not have been possible to identify responses from archaeological features, if present.

Nevertheless most parts of the site have been sampled by the survey and no anomalies of obvious archaeological origin, with the exception of the ridge and furrow earthworks, have been identified. Overall, the archaeological potential of this site, based solely on the results and interpretation of the geophysical (magnetometer) survey data, is considered to be low.

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.

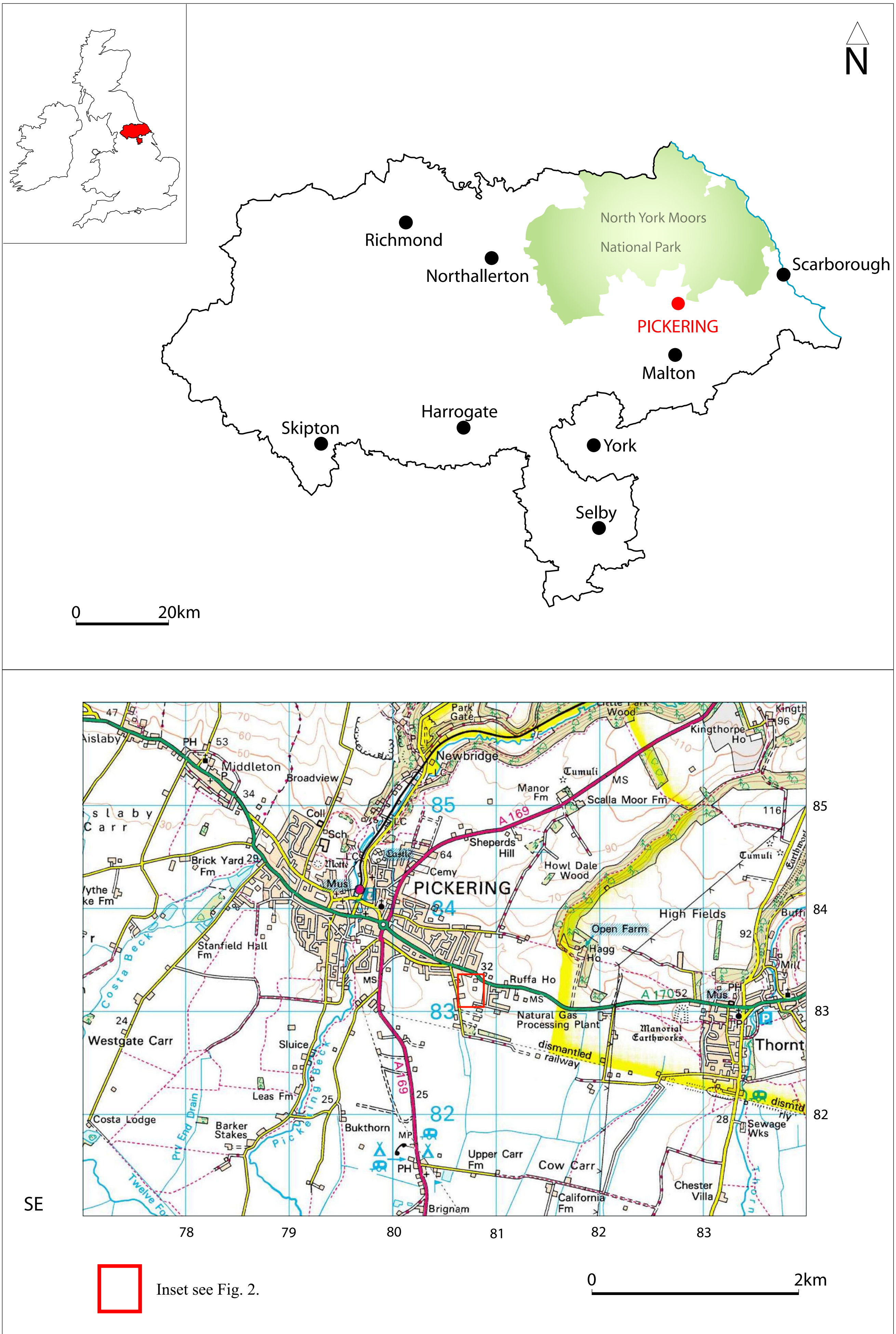

Fig. 1. Site location

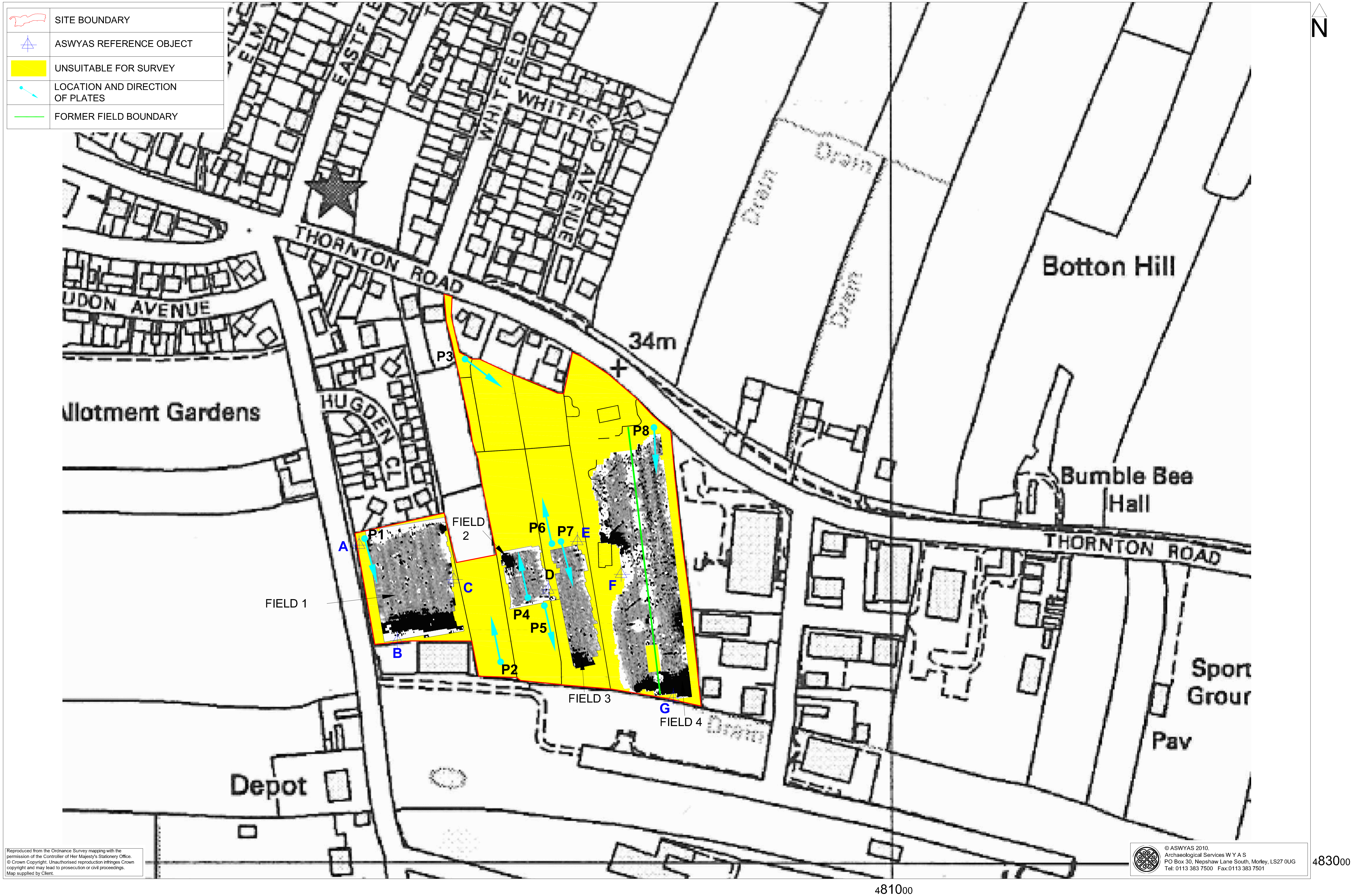

Fig. 2. Site location showing greyscale magnetometer data (1:2500 @ A3)

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

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

0 40m

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

Plate 1. Field 1, showing ridge and furrow earthworks to left of frame, looking south.

Plate 2. Unsurveyed area between Field 1 and Field 2, looking north.

Plate 3. Farm buildings at the northern end of Field 2, looking south-east.

Plate 4. Field 2 showing surveyed area and unsurveyed sheep/goat paddock to the north, looking north.


Plate 5. Field 2, showing unsurveyed area of rough ground containing livestock, looking south.


Plate 6. Field 3, showing unsurveyed pig field, looking north.


Plate 7. Field 3, looking south.


Plate 8. Field 4, looking south.

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 5500 total station theodolite and tied in to the corners of permanent landscape features and to temporary reference points (survey marker stakes) that were established and left in place following completion of the fieldwork for accurate geo-referencing. The locations of the temporary reference points 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 raster map image, that was roughly geo-referenced, provided by the client, as a 'best fit' to produce the displayed block locations. The coordinates of the reference markers are not exact due to the raster map base. This potential error must be considered if co-ordinates are measured off for relocation purposes.

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

Station	**Easting**	**Northing**
A	480601.6389	483238.0509
B	480630.1835	483166.6214
C	480672.3401	483212.3458
D	480074.8689	483204.6050
E	480764.5928	483240.7802
F	480797.2382	483216.2804
G	480836.2807	483124.0737

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

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