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Land south of Navigation Lane
Caistor
North Lincolnshire

Geophysical Survey

November 2006

Report No. 1612

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Ben Bailey Homes.

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Land south of Navigation Lane

Caistor

North Lincolnshire

Geophysical Survey

Contents

Summary

A geophysical (magnetometer) survey carried out on land south of Navigation Lane, Caistor has not identified any anomalies thought to be archaeological in origin. A possible field boundary, ridge and furrow ploughing and a system of field drains have been located..

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1. Introduction and Archaeological Background

1.1 Archaeological Services WYAS was commissioned by Martin White of Ben Bailey Homes to carry out a geophysical (magnetic) survey on agricultural land south of Navigation Lane, Caistor, (see Fig. 1), in advance of a proposed housing development.

1.2 The site, centred at TA 1080 0095, is approximately 4 hectares in area and is located on the south-western outskirts of Caistor (an historic Roman town) in close proximity to the parish boundary with Nettleton (see Fig. 2). Tennyson Close forms the eastern site boundary, with open fields to the south and west. To the north is a track that is an extension of Navigation Lane and beyond that is a sewage works.

1.3 Topographically the site slopes gently to the west. The underlying geology of the site is Ancholme Clay of the Upper Jurassic Period overlain by soils classified in the Landbeach association. These soils, derived from glaciofluvial sand and gravels, are permeable calcareous loams that are affected by groundwater. At the time of the survey (November 9th and 10th 2006) the site was under arable crop seedlings. No problems were encountered during the survey.

1.4 Prior to the geophysical survey an archaeological desk-based assessment of the site and the immediate surrounding area was undertaken (Dodds 2004, revised Webb 2006). The assessment revealed that there were no known archaeological sites within the application area and that from at least the time of the Caistor Enclosure Act (late 18th century) the proposed development area has been agricultural land.

1.5 By contrast the wider study area showed the site to be located in an archaeologically rich landscape. Prehistoric activity is represented in the form of lithic (flint) scatters and the identification of possible settlements. In addition, to the east of the proposed development area, the discovery of a Bronze Age urn is believed to mark the location of a Bronze Age cemetery. Consequently the assessment concluded that there is a possibility that unknown prehistoric features or finds may be located within the proposed development area.

1.6 The majority of finds and excavation work within the study area has taken place in or around the scheduled monument area of the walled town of Roman Caistor (SAM 148). Discoveries within the town have included a range of Roman finds and have also highlighted Anglo-Saxon and later medieval activity. Little is still known about the particular activities that may have occurred within the Roman town, however, and no internal structures have been identified to provide further information. In contrast, extramural activities have been identified, such as pottery production sites both to the north and south of Navigation Lane from the 3rd to 4th centuries. It would also appear that the burial of the Roman dead was occurring beyond the town walls. A possible urnfield cemetery was discovered to the east of the proposed development area and four inhumation burials were also encountered to the north of Navigation Lane and may represent an additional cemetery.

1.7 Caistor remained of significant regional importance in the Anglo-Saxon period. Stray finds of a coin and pottery, in addition to the 9th century *titulus* that may represent an Anglo-Saxon precursor to the Church of St Peter and St Paul, indicate the continuation of the settlement at this time. The use of land outside the settlement for burial activities also continued until the early Anglian period. By the time of the Domesday Book, Caistor is recorded as having a church, priest and four mills, although unfortunately no medieval architecture with the exception of the Church of St Peter and St Paul survives.

2. Methodology and Presentation

2.1 Given the evidence for extramural industrial activity, in terms of pottery production and the prevalence of burial grounds, around Caistor during the Bronze Age, Roman and Anglian periods, it was recommended (in the desk-based assessment) that a geophysical survey within the proposed development site should form a preliminary stage of archaeological investigation.

2.2 It was suggested that a geophysical survey might assist in the identification of pre-18th century features that may have been masked by ridge and furrow, are invisible to techniques such as aerial photography and were not recorded on late-18th century and subsequent maps. The results of such a survey could then be used to inform on any further stages of archaeological mitigation that may be required. Thus the general aims of the survey were to obtain information that would contribute to an evaluation of the archaeological significance of the site.

2.3 More specifically the survey aimed to:-

- determine the presence or absence of buried archaeological remains;
- provide information about the nature and possible interpretation of any anomalies identified by the survey.

2.4 In order to achieve these objectives it was proposed that detailed (recorded) magnetometer survey would be undertaken across the whole of the site, an area of approximately 4 hectares.

2.5 Detailed survey employs the use of a sample trigger to automatically take readings at predetermined points, typically at 0.25m intervals, on traverses 1m apart. These readings are stored in the memory of the instrument and are later downloaded to computer for processing and interpretation. Further details are given in Appendix 1. Detailed survey allows the visualisation of weaker anomalies that may not have been readily identifiable by magnetic scanning.

2.6 A Bartington Grad601 magnetic gradiometer was used during the survey with readings being taken at 0.25m intervals on zig-zag traverses 1m apart within 20m by 20m grids. The readings were stored in the memory of the instrument and later downloaded to computer for processing and interpretation using Geoplot 3 software.

2.7 The survey methodology, report and any recommendations comply with guidelines outlined by English Heritage (David 1995) and by the IFA (Gaffney, Gater and Ovenden 2002) and were agreed with the North Lincolnshire HER, who provide archaeological advise to the local planning authority. All figures reproduced from Ordnance Survey mapping are done so with the permission of the controller of Her Majesty's Stationery Office. © Crown copyright.

2.8 A general site location plan, incorporating the 1:50000 Ordnance Survey mapping, is shown in Figure 1. Figure 2 shows the processed magnetometer data superimposed onto a digital map base showing cropmark detail at a scale of 1:5000. The processed (greyscale) and unprocessed (XY trace plot) data, together with an accompanying interpretation diagram, are presented in Figures 3, 4 and 5 at a scale of 1:1000.

2.9 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 site archive.

3. Results

3.1 Throughout the field numerous isolated dipolar anomalies ('iron spikes' - see Appendix 1) have been identified. These anomalies are indicative of iron (ferrous) objects or other magnetic material in the topsoil/subsoil and, although archaeological artefacts may cause them, they are more often caused by modern cultural debris that has been introduced into the topsoil often as a consequence of manuring or public access. The larger areas of ferrous disturbance around the periphery of the field are caused by the proximity of wire strand fencing.

3.2 Perhaps the most obvious anomaly is the strong dipolar anomaly aligned broadly from north-east to south-west with a slight dog-leg at the southern end of the survey area. This anomaly is due to a ferrous pipe possibly taking water either to or from the sewage works north of Navigation Lane.

3.3 In the northern half of the survey area a series of other linear trend anomalies, possibly intersecting with this pipe, have been identified. It is thought that these anomalies are due to a system of field drains.

3.3.1 At the southern end of the site a series of weak, parallel, slightly curvi-linear anomalies broadly aligned east to west can be seen bounded to the north by another L-shaped anomaly. It is thought that these former anomalies are due to ridge and furrow ploughing and that the L-shaped anomaly is a relict field boundary. Even though modern ploughing has long since removed the characteristic earthworks the magnetic contrast between the infilled furrows and former ridges results in the striped magnetic effect.

4. Discussion and Conclusions

4.1 Although the site is situated within a landscape of considerable archaeological potential no anomalies have been identified during this survey that are thought to be due to underlying archaeological features. This 'negative' result reflects the conclusions of the desk-based assessment.

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.

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.

Bibliography

David, A., 1995. *Geophysical Survey in Archaeological Field Evaluation: Research and Professional Services Guidelines* No. 1. English Heritage

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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

Acknowledgements

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Figures

Appendices

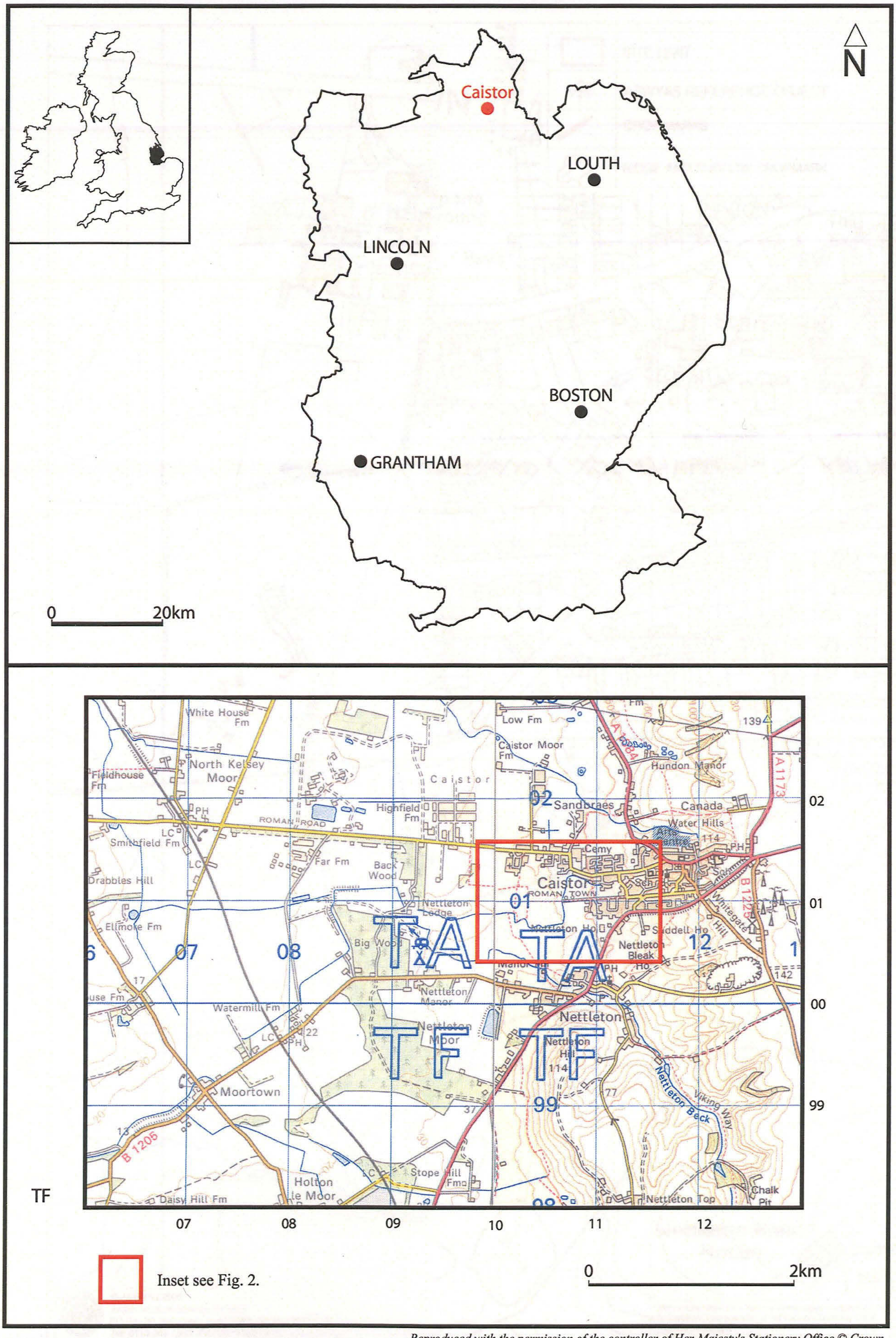

Fig. 1. Site location

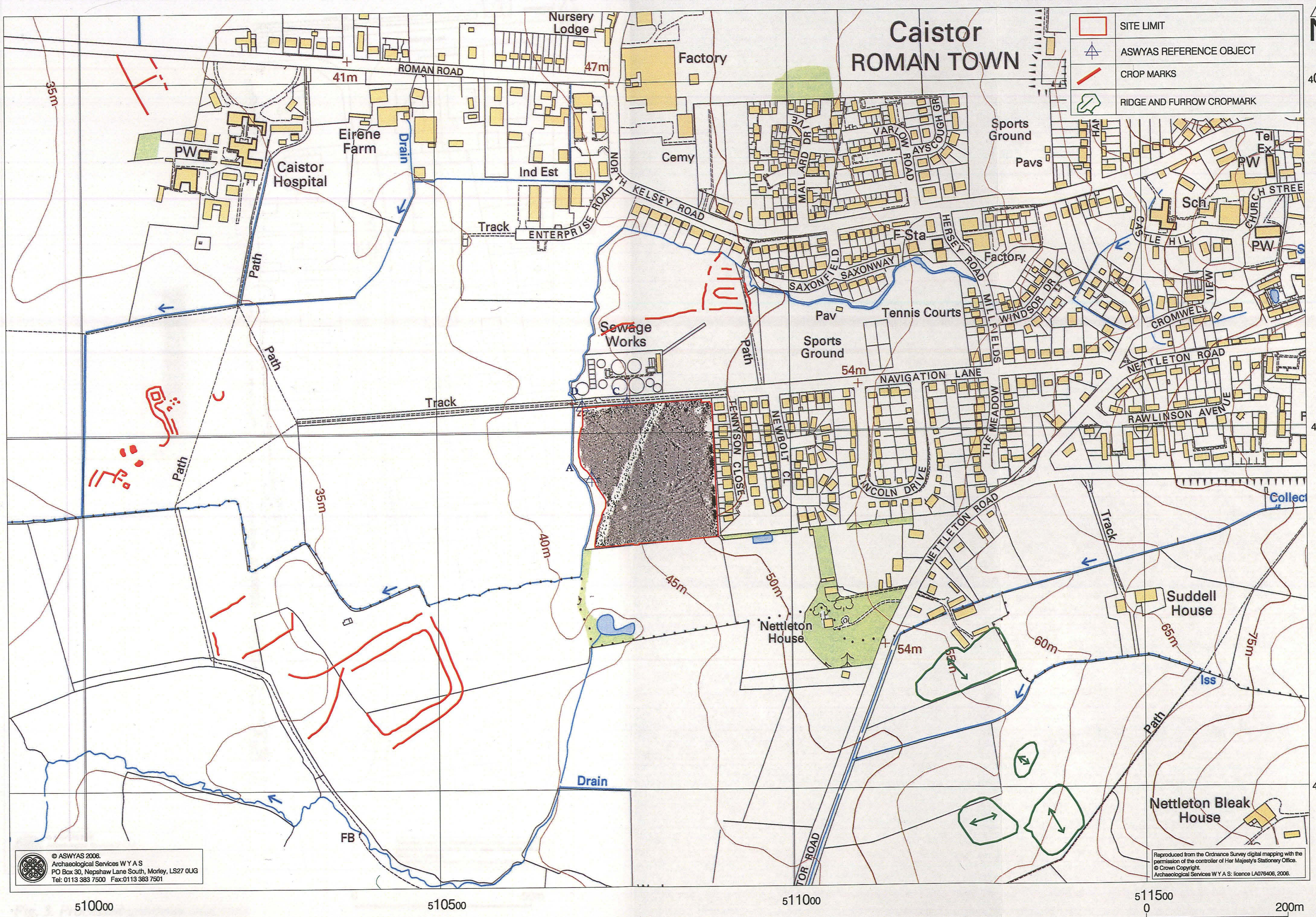

Fig. 2. Site location showing magnetometer data and cropmark detail (1:5000)

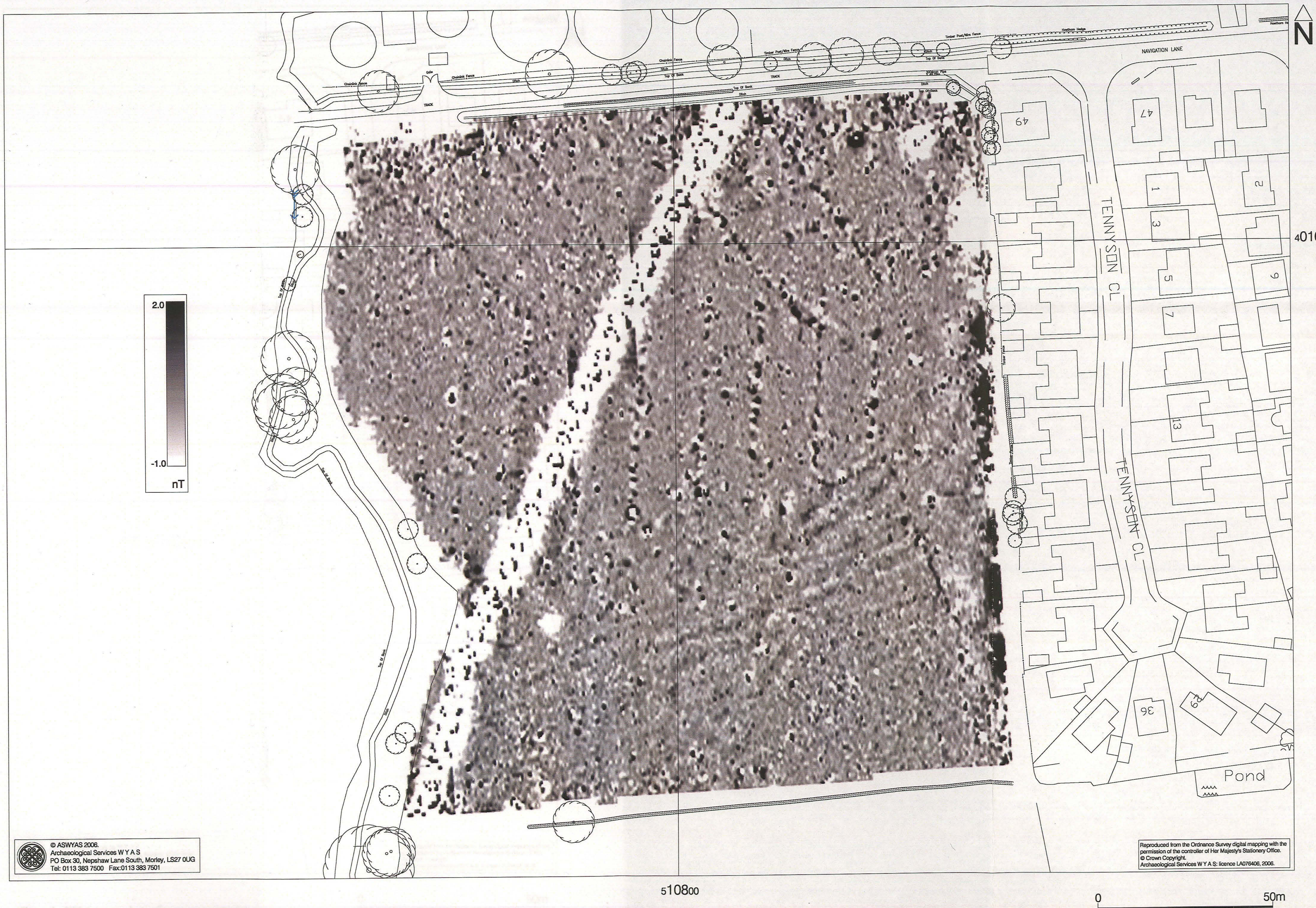

Fig. 3. Processed greyscale magnetometer data (1:1000)

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

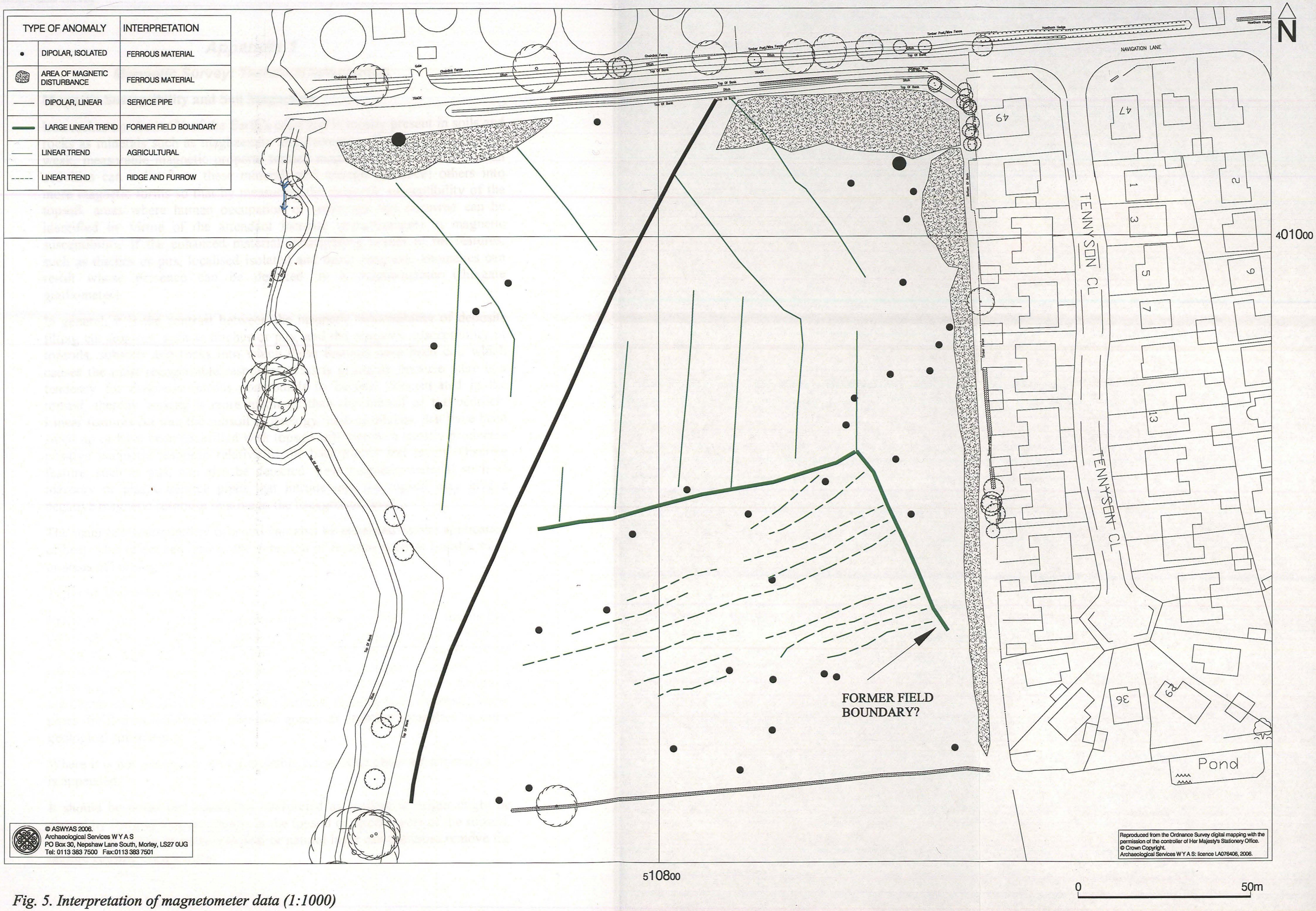

Fig. 5. Interpretation of magnetometer data (1:1000)

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 0.5m or 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 20m by 20m 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 1600 readings were obtained for each 20m by 20m 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

The site grid was laid out using a Geodimeter 600s total station theodolite and tied in to the corners of buildings and other 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 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	510717.5609	400933.0318
C	510768.4490	401038.5068
D	510704.7755	401033.9079

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 (Word 2000), and graphics files (Adobe Illustrator, CorelDraw6 and AutoCAD 2000) 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).

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Yours I believe.

Regards Alison

WITH COMPLIMENTS