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Knaresborough Castle
Knaresborough
North Yorkshire

Geophysical Survey

February 2011

Report No. 2177

CLIENT
Knaresborough Town Council

Knaresborough Castle
Knaresborough
North Yorkshire

Geophysical Survey

Summary

A geophysical survey (magnetometer and earth resistance) was carried out in the grounds of Knaresborough Castle at the proposed site of a bandstand/performance pavilion. No anomalies of definite archaeological potential have been identified although interpretation was difficult due to the small area available for survey. Magnetic anomalies due to landscaping and services have been identified. High resistance anomalies to the north of the survey area may be of archaeological potential, perhaps representing compacted surfaces or rubble spreads or potentially structural features. However, interpretation of these anomalies is tentative due to the amount of landscaping which is assumed to have taken place in the castle grounds, particularly from the Victorian period onwards.

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Report Information

Client:	Knaresborough Town Council
Address:	Knaresborough House, High Street, Knaresborough, North Yorkshire, HG5 0HW
Report Type:	Geophysical Survey
Location:	Knaresborough
County:	North Yorkshire
Grid Reference:	SE 3494 5691
Period(s) of activity represented:	post-medieval?/modern
Report Number:	2177
Project Number:	3670
Site Code:	KCP10
Planning Application No.:	-
Museum Accession No.:	-
Date of fieldwork:	January 2011
Date of report:	February 2011
Project Management:	Sam Harrison BSc MSc AIfA
Fieldwork:	David Harrison BA MSc Alex Harrison BSc
Report:	David Harrison
Illustrations:	David Harrison
Photography:	David Harrison
Research:	n/a

Authorisation for distribution: --

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1 Introduction

Archaeological Services WYAS (ASWYAS) was commissioned by Nicola Smith, Clerk to Knaresborough Town Council, to undertake a geophysical (earth resistance and magnetometer) survey at Knaresborough Castle on the proposed site of a bandstand/performance pavilion. The proposals include the erection of a bandstand or performance space, the foundations of which may disturb subsurface archaeological deposits associated with the occupation, use and disuse of the castle. The castle and its grounds are protected as a Scheduled Ancient Monument (National Monument No. 34841) and so a Section 42 Prospection Licence was sought from, and granted by, English Heritage prior to the survey (see Appendix 5).

Site location, topography and land-use

The castle is situated in the centre of Knaresborough with the survey area within the castle grounds to the east of the museum in an area generally known as the Putting Green. The survey area is centred at SE 3494 5690 and comprises a level grassed area bounded by gravel paths and mature trees (See Plate 1 and Plate 2). The survey covered an area of approximately 0.15 hectares (60m by 25m).

Geology and soils

The underlying solid geology comprises dolostone of the Cadeby Formation (BGS 1977) with subordinate mudstone, dolomitic siltstone and sandstone. No superficial deposits are recorded here and the soils in this area are classified as unsurveyed (SSEW 1983).

2 Archaeological background

Knaresborough Castle is thought to have been built in the first half of the 12th century between AD 1100-1160 with a reconstruction in 1212. However, there are few remains from this period with the extant buildings, consisting of a keep, gateway and curtain walls, dating from the 14th century.

By the time of the Civil War the castle was decaying and in July 1644 it was besieged by the Parliamentarians. The Royalist defenders surrendered in December 1644 and in 1648, under instruction from Parliament, the castle was demolished.

In the 18th century the castle became a popular site for tourists visiting Harrogate and by the end of the 19th century the grounds had been landscaped to form pleasure gardens to celebrate Queen Victoria's jubilee.

3 Aims, Methodology and Presentation

The general aim of the geophysical survey was to establish and clarify the potential for archaeological features within the proposed development area. 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 any anomalies identified during the survey and thereby determine the likely extent, presence or absence of any buried archaeological remains.

These aims were to be achieved by undertaking both magnetometer and earth resistance surveys within the scheduled area.

The survey area was set-out with a Trimble 5800 VRS differential GPS to the national grid. No temporary reference objects were left in-situ due to the status of the site as a scheduled monument. However, the survey grid was tied into the national grid and tie-in information is available upon request.

Earth resistance survey

A Geoscan RM15 resistance meter was used during the earth resistance survey, with the instrument logging each reading automatically at 1m intervals on traverses 1m apart. The mobile probe spacing was 0.5m with the remote probes 15m apart and at least 15m away from the grid under survey. This mobile probe spacing gives an approximate depth penetration of up to 1m for most archaeological features.

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.

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 resistance data on the Ordnance Survey map base at a scale of 1:500. The processed magnetometer greyscale data, the ‘raw’ XY trace plot data and magnetometer interpretation graphics are presented at a scale of 1:500 in Figures 3, 4 and 5. The processed and ‘raw’ (unprocessed) earth resistance data from the survey, together with an interpretation of the identified resistance anomalies, are presented at a scale of 1:500 in Figures 6, 7 and 8.

Further technical information on the equipment used, data processing and survey methodologies are given in Appendix 1, Appendix 2 and Appendix 3. Appendix 4 describes the composition and location of the site archive. The Section 42 Licence is included in Appendix 5.

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 and Discussion

Magnetometer Data (Figures 3, 4 and 5)

The magnetometer data is dominated by magnetic disturbance from at least two pipes, probably relating to drains or water supply as suggested by the presence of manhole covers and grids. The strength of response from the pipes is such that the much weaker response from any underlying archaeological feature, if present, may be masked. No anomalies of archaeological potential have been identified in the magnetic data.

Earth Resistance Data (Figures 6, 7 and 8)

The resistance survey confirms the presence of one of the pipes located by magnetometry as evidenced by a linear low resistance trend which correspond with the linear dipolar anomaly identified in the magnetometer survey. This anomaly is likely to be caused by the moisture retentive, relatively loosely packed, material laid around and above the pipe; this material will offer a lesser resistance to the electric current than the more densely packed material outside the limits of the pipe trench.

The background resistance throughout the survey area is very variable suggesting some degree of ground disturbance throughout probably as a result of landscaping. However, two distinct areas of high resistance in the northern half of the survey area may be of archaeological interest, perhaps locating compacted surfaces, rubble spreads or even *in situ* structural remains. However, an archaeological interpretation is highly tentative and differential compaction of the upper soil horizons as a result of landscaping or any other recent intrusive activity could equally explain these anomalies or indeed any of the other observed variation in the resistance data set. Areas of relatively low resistance can also be seen to the south-east and north-west corners of the survey area. There is no obvious cause for these anomalies and they are therefore interpreted as being due to the relatively more moisture retentive soils in this part of the survey area.

5 Conclusions

Interpreting the data with any degree of confidence from such a small site is always difficult, particularly one on which there is assumed to have been a considerable amount of ground disturbance. The strong response from two pipes has compromised the results of the magnetometer survey – the magnetic response from these pipes is such that any response of lesser magnitude will have been masked in the vicinity of the pipes. No other magnetic anomalies have been identified.

The route of one of these pipes was subsequently confirmed by the resistance survey. In general there is considerable variation in the resistance across the survey area and this is primarily attributed to the degree of ground disturbance/landscaping that has almost certainly gone on in this part of the castle grounds. Against this background two areas of high resistance which may have some archaeological potential do stand out. However, these anomalies may also be due to recent ground disturbance.

No anomalies of definite archaeological potential have been identified. However, this should not be taken to indicate that any proposed development will not encounter archaeological features or deposits.

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.

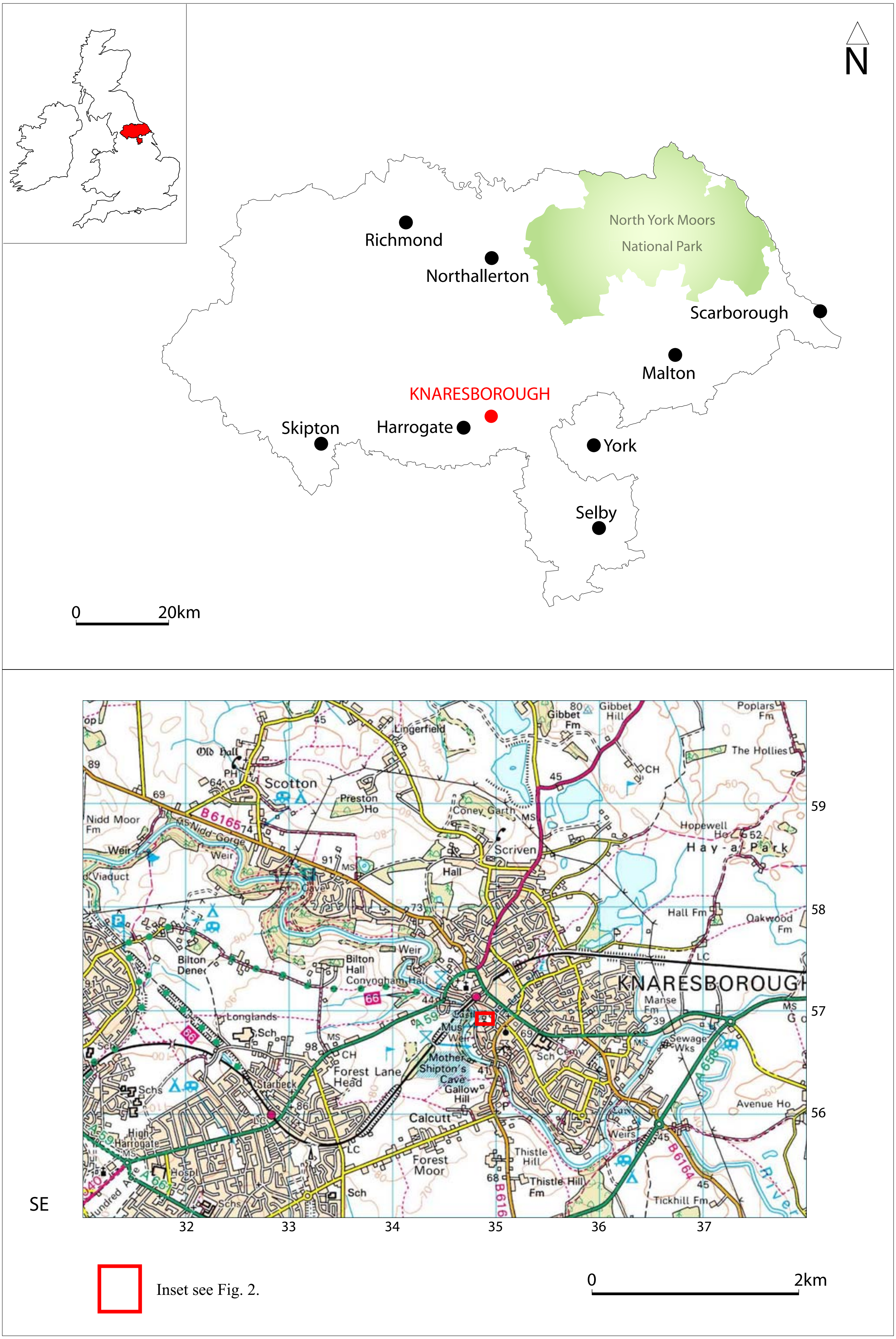

Fig. 1. Site location

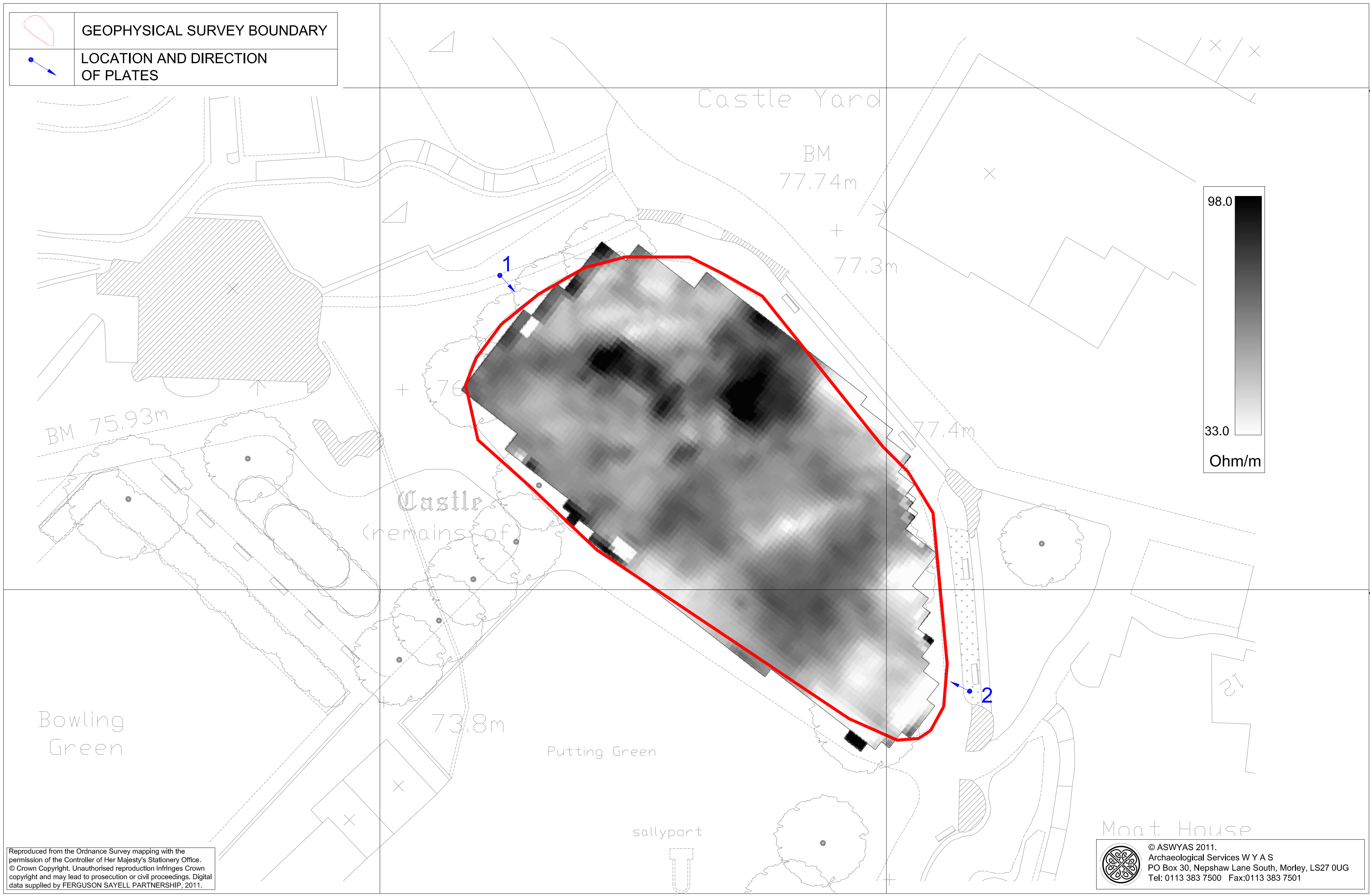

Fig. 2. Site location showing processed greyscale earth resistance data (1:500 @ A4)

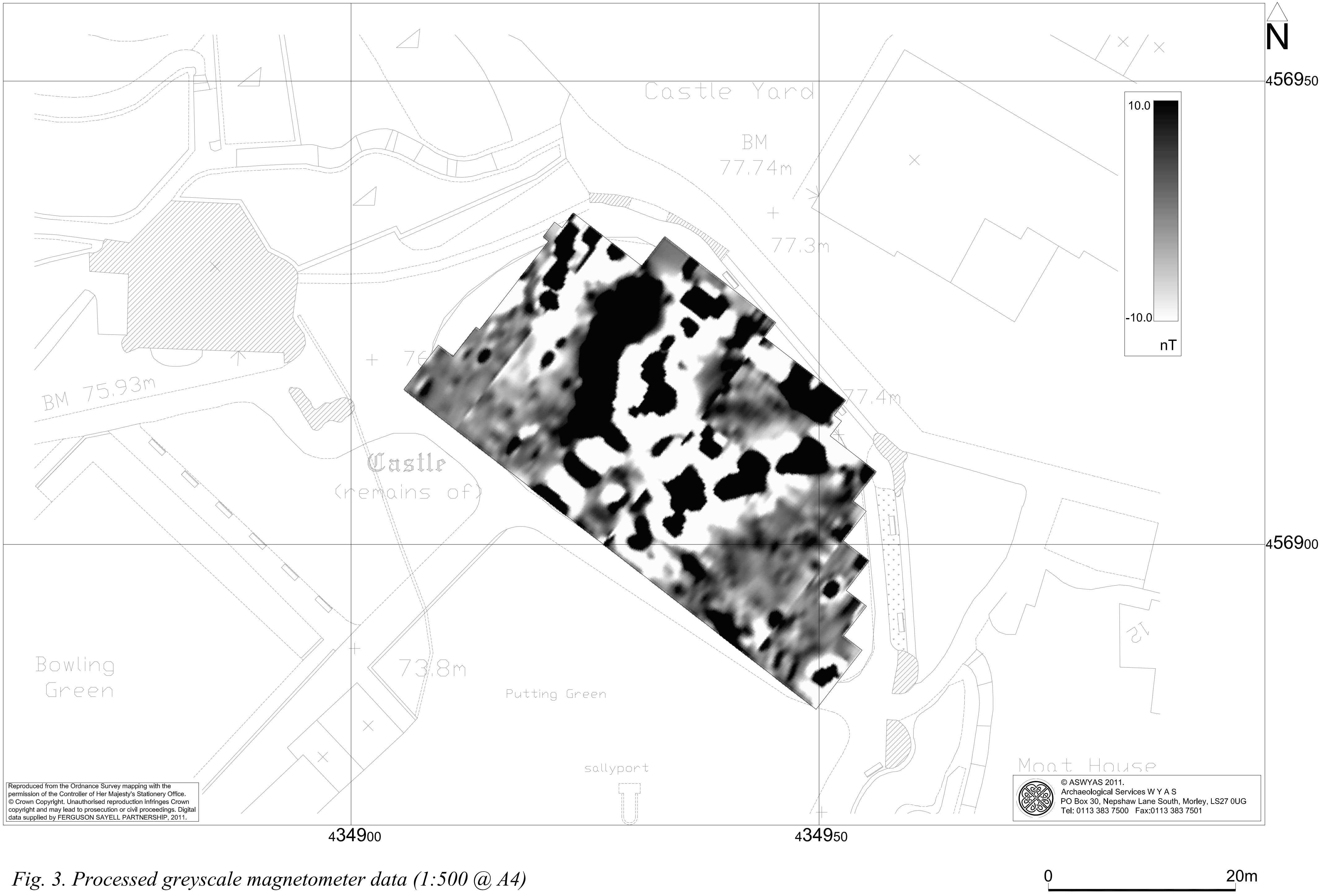

Fig. 3. Processed greyscale magnetometer data (1:500 @ A4)

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

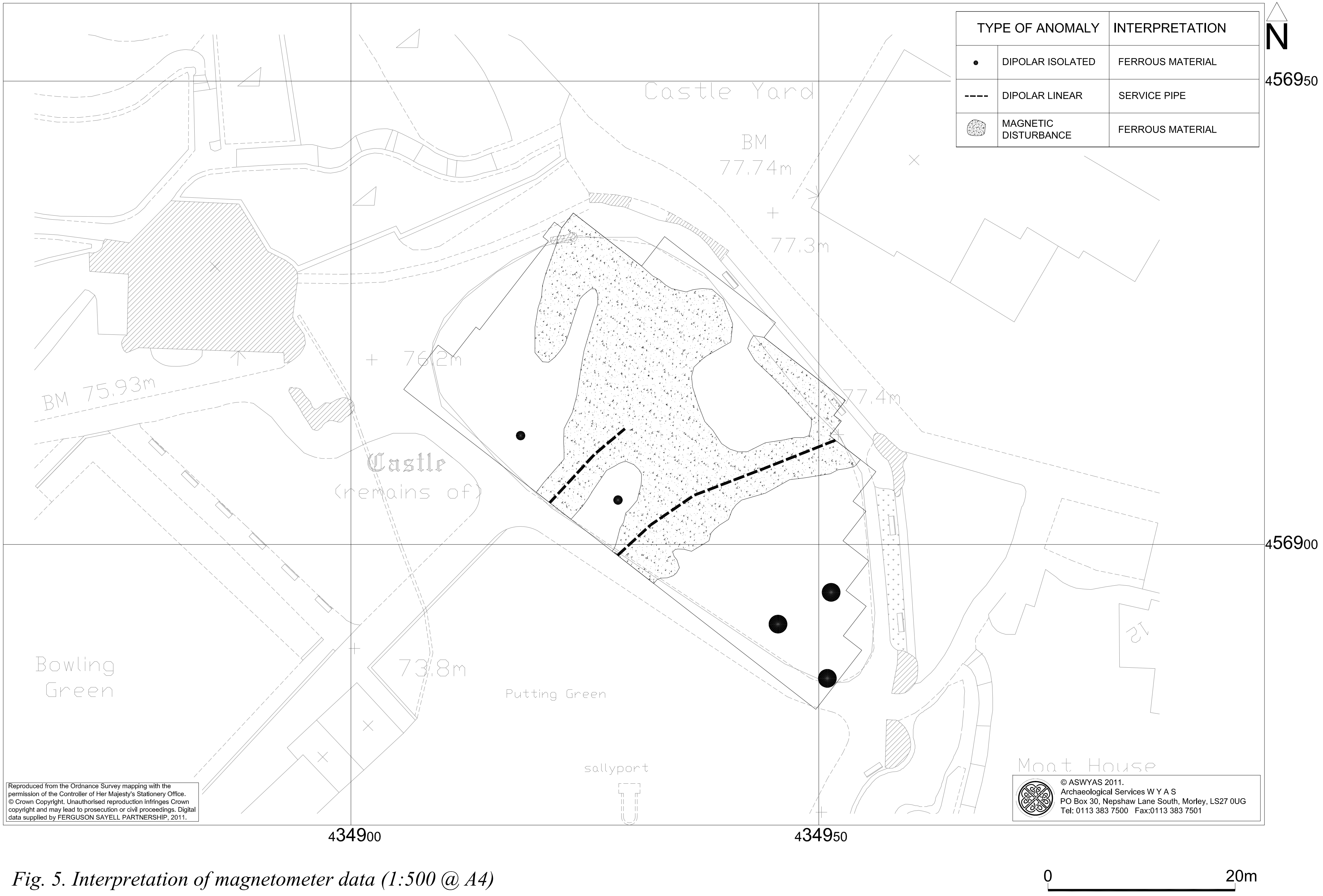

Fig. 5. Interpretation of magnetometer data (1:500 @ A4)

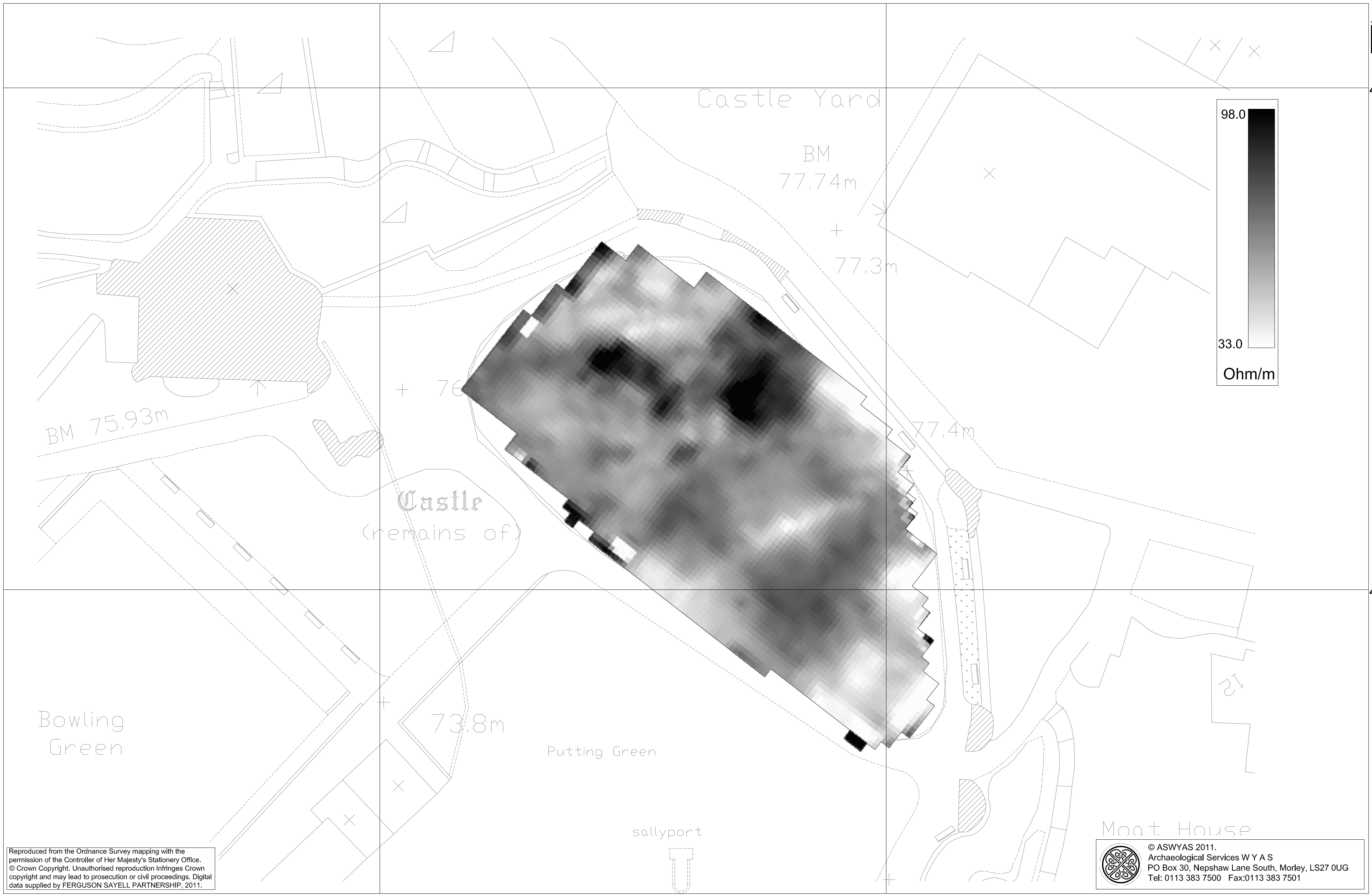

Fig. 6. Processed greyscale earth resistance data (1:500 @ A4)

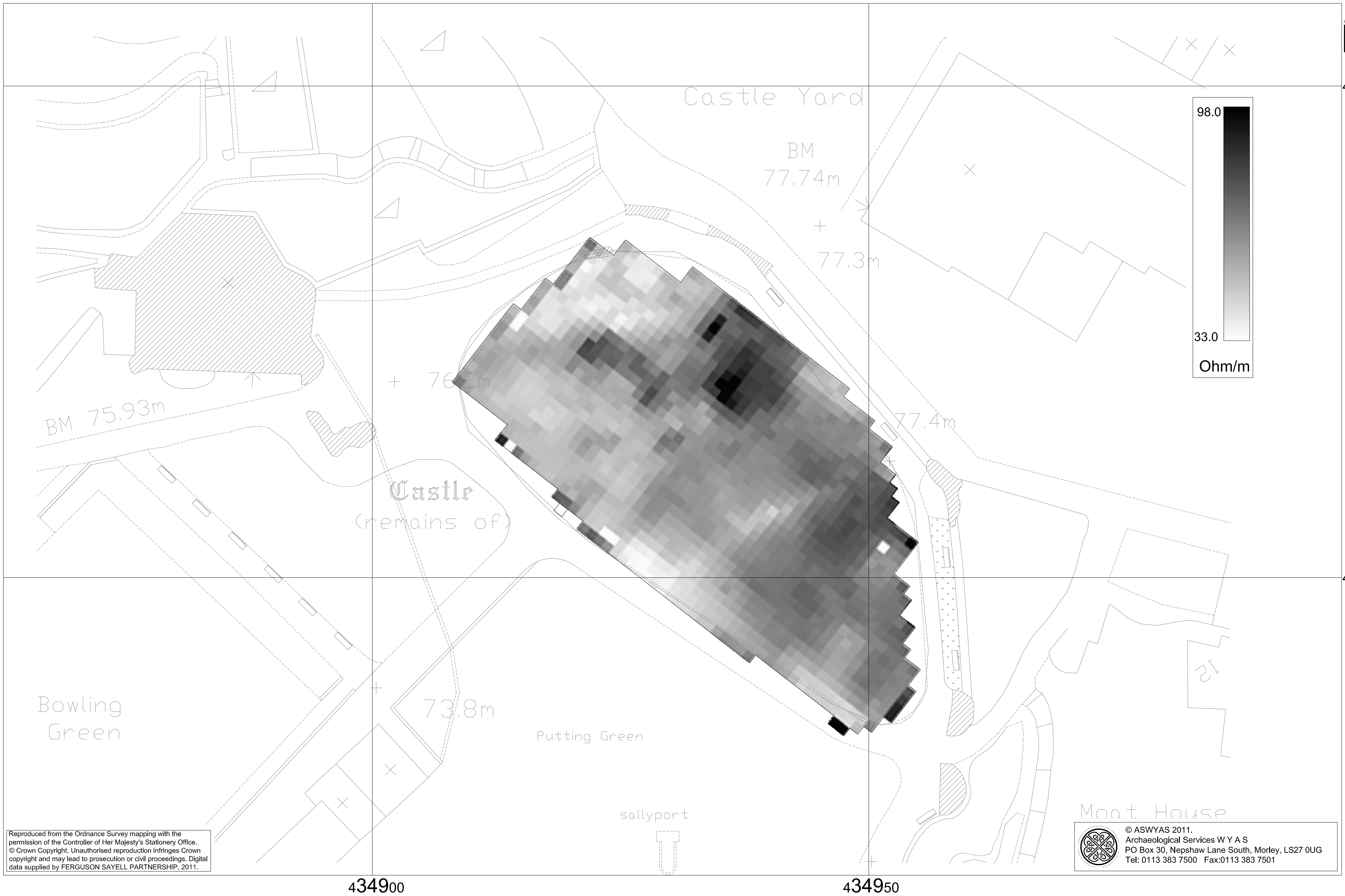

Fig. 7. Unprocessed greyscale earth resistance data (1:500 @ A4)

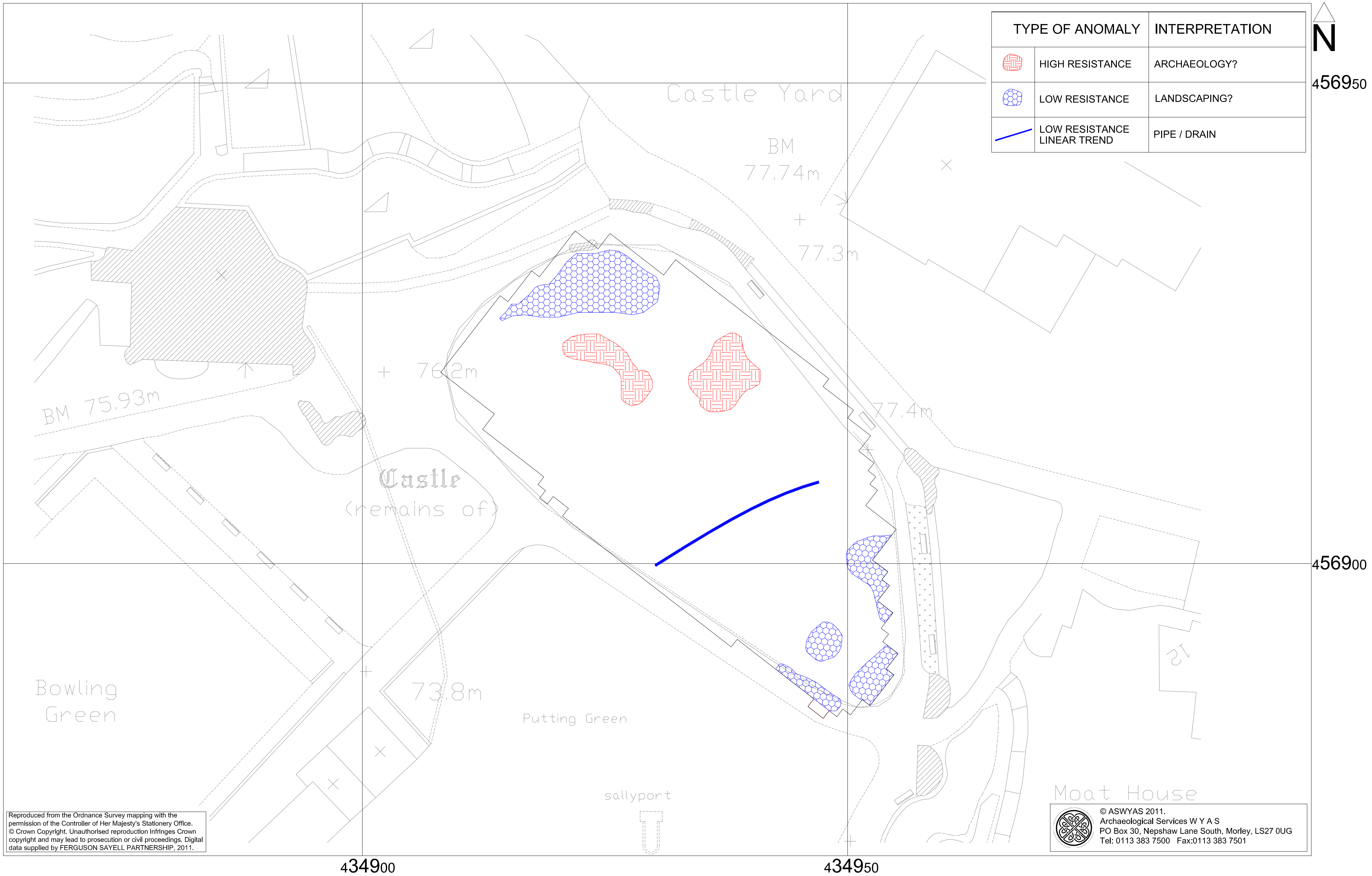

Fig. 8. Interpretation of earth resistance data (1:500 @ A4)

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

Plate 2. General view of the 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: Earth Resistance Survey - technical information

Soil Resistance

The electrical resistance of the upper soil horizons is predominantly dependant on the amount and distribution of water within the soil matrix. Buried archaeological features, such as walls or infilled ditches, by their differing capacity to retain moisture, will impact on the distribution of sub-surface moisture and hence affect electrical resistance. In this way there may be a measurable contrast between the resistance of archaeological features and that of the surrounding deposits. This contrast is needed in order for sub-surface features to be detected by a resistance survey.

The most striking contrast will usually occur between a solid structure, such as a wall, and water-retentive subsoil. This shows as a resistive high. A weak contrast can often be measured between the infill of a ditch feature and the subsoil. If the infill material is soil it is likely to be less compact and hence more water retentive than the subsoil and so the feature will show as a resistive low. If the infill is stone the feature may retain less water than the subsoil and so will show as a resistive high.

The method of measuring variations in ground resistance involves passing a small electric current (1mA) into the ground via a pair of electrodes (current electrodes) and then measuring changes in current flow (the potential gradient) using a second pair of electrodes (potential electrodes). In this way, if a structural feature, such as a wall, lies buried in a soil of uniform resistance much of the current will flow around the feature following the path of least resistance. This reduces the current density in the vicinity of the feature, which in turn increases the potential gradient. It is this potential gradient that is measured to determine the resistance. In this case, the gradient would be increased around the wall giving a positive or high resistance anomaly.

In contrast a feature such as an infilled ditch may have a moisture retentive fill that is comparatively less resistive to current flow. This will increase the current density and decrease the potential gradient over the feature giving a negative or low resistance anomaly.

Survey Methodology

The most widely used archaeological technique for earth resistance surveys uses a twin probe configuration. One current and one potential electrode (the remote or static probes) are fixed firmly in the ground a set distance away from the area being surveyed. The other current and potential electrodes (the mobile probes) are mounted on a frame and are moved from one survey point to the next. Each time the mobile probes make contact with the ground an electrical circuit is formed between the current electrodes and the potential gradient between the mobile and remote probes is measured and stored in the memory of the instrument.

A Geoscan RM15 resistance meter was used during this survey, with the instrument logging each reading automatically at 1m intervals on traverses 1m apart. The mobile probe spacing was 0.5m with the remote probes 15m apart and at least 15m away from the grid under survey. This mobile probe spacing of 0.5m gives an approximate depth of penetration of 1m for most archaeological features. Consequently a soil cover in excess of 1m may mask, or significantly attenuate, a geophysical response.

Data Processing and Presentation

All of the illustrations incorporating a digital map base were produced in AutoCAD 2008 (© Autodesk).

The resistance data is presented in this report in greyscale format with a linear gradation of values and was obtained by exporting a bitmap from the processing software (Geoplot v3.0; Geoscan Research) into AutoCAD 2008. The data has been processed and has also been interpolated by a value of 0.5 in both the X and Y axes using a sine wave (x)/x function to give a smoother, better defined plot.

Appendix 3: 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 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.

Due to the status of the survey area as a scheduled monument, no temporary reference objects were left on site. Tie-in information is available upon request.

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

Appendix 4: 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 relevant Historic Environment Record Office).

Appendix 5: Section 42 Prospection Licence

ENGLISH HERITAGE
YORKSHIRE & THE HUMBER REGION

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West Yorkshire Archaeology Service
PO Box 30
Morley
LEEDS
LS27 0UG

Direct Dial: 01904 601897
Direct Fax: 01904 601999

Our ref: AA/AA20634/5

18 November 2010

Dear Mr Harrison

Ancient Monuments and Archaeological Areas Act 1979 (as amended) section 42 - licence to carry out a geophysical survey

KNARESBOROUGH CASTLE, CASTLE YARD, KNARESBOROUGH, KNARESBOROUGH, HARROGATE, NORTH YORKSHIRE, HG5 8AS
Case No:SL00000767
Monument no: 34841

I refer to your application dated 18 November 2010, to carry out a geophysical survey at the above site.

English Heritage is empowered to grant licences for such activity and I can confirm that we are prepared to do so as set out below.

By virtue of powers contained in section 42 of the 1979 Ancient Monuments and Archaeological Areas Act (as amended by the National Heritage Act 1983) English Heritage hereby grants permission for geophysical survey of KNARESBOROUGH CASTLE, for the areas shown on the map that accompanied your application (copy attached). This permission is subject to the following conditions.

1. The permission shall only be exercised by Alistair Webb, and Sam Harrison, David Harrison, and Alex Harrison and by no other person. It is not transferable to another individual.

2. The permission shall commence on 29 November 2010 and shall cease to have effect on 31 January 2011.

3. A full report summarising the results of the survey and their interpretation shall be sent to Neil Redfern and to Paul Linford of the English Heritage Geophysics Team at Fort Cumberland (Fort Cumberland Road, Eastney, Portsmouth, Hampshire, PO4 9LD), no later than 4 months after the completion of the

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survey.

You are also asked to complete and return the enclosed questionnaire about the survey to the Geophysics Team, Fort Cumberland (address as above), in order to assist with maintenance of our national database of geophysical surveys. Information from this questionnaire will be entered onto our database as a preliminary record which would be updated when you send to us a copy of the full report. If the work is to be done by a contractor could you please pass the form on to the surveyor.

Being part of our survey database, some details of your survey will be made publicly accessible on the Internet, although no images or data sets will be included. We will assume you have no objection to this unless you let us know to the contrary.

This letter does not carry any consent or approval required under any enactment, bye-law, order or regulation other than section 42 of the 1979 Act (as amended).

You are advised that the person nominated under this licence to carry out the activity should keep a copy of this licence in their possession in case they should be challenged whilst on site.

Yours sincerely

JLIrane

pp **Neil Redfern**
Team Leader North Yorkshire
E-mail: Neil.Redfern@english-heritage.org.uk

POSITIVE ABOUT DISABLED PEOPLE

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www.english-heritage.org.uk

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