ARCHAEOLOGICAL SERVICES WYAS

Lowe Hill Motte and Bailey Castle
Wakefield
West Yorkshire

Geophysical Survey

Report no. 3042

April 2015

Client: West Yorkshire Archaeology and Advisory Service

REGISTERED ORGANISATION CIfA

Lowe Hill Motte and Bailey Castle
Wakefield
West Yorkshire

Geophysical Survey and Earthwork Survey

Summary

A geophysical (magnetometer and earth resistance) and earthwork survey was carried out in Thornes Park, Wakefield as part of a community outreach project to better understand the relationship between the motte and bailey castle (known as Lowe Hill), a scheduled monument, and the surrounding landscape and therefore allow the monument to be better managed. Both the geophysical surveys have identified anomalies indicative of ridge and furrow cultivation in the two areas bordering the scheduled monument. Anomalies locating former 19th century boundaries, no longer extant, have also been identified. In addition the magnetometer survey has identified several discrete anomalies in the bailey area which could be indicative of archaeological features such as large pits. However, this interpretation should be viewed as tentative as the observed responses could equally easily be due to relatively recent activity. The topographic survey has mapped the earthworks and located back-filled trenches which were excavated in 1953, but has not identified any other features of archaeological significance.

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Report Information

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Address:	Registry of Deeds, Newstead Road, Wakefield
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Contents

Report information ii
Contents iii
List of Figures iv
List of Plates iv

1 Introduction 1
Site location, topography and land-use 1
Soils and geology 1
2 Archaeological Background 1
3 Aims, Methodology and Presentation 2
4 Results and Discussion 5
5 Conclusions 7

Figures
Plates

Appendices
Appendix 1: Magnetic survey: technical information
Appendix 2: Resistance survey: technical information
Appendix 3: Geophysical archive
Appendix 4: OASIS form

Bibliography

List of Figures

1 Site location (1:50000)
2 Location of geophysical surveys showing first edition Ordnance Survey mapping (1:2000)
3 Processed greyscale magnetometer data (1:1000)
4 XY trace plot of minimally processed magnetometer data (1:1000)
5 Interpretation of magnetometer data (1:1000)
6 Processed greyscale earth resistance data (1:1000)
7 Unprocessed greyscale earth resistance data (1:1000)
8 Interpretation of earth resistance data (1:1000)
9 Basic earthwork survey (1:1500)
10 Profile over ridge and furrow earthworks (1:250)

List of Plates

Plate 1 General view of Area 1, looking east
Plate 2 General view of Area 2, looking west
Plate 3 General view of Area 3, looking north-east
Plate 4 General view of Area 4, looking west
Plate 5 Extract from Hope-Taylor's Report on the Excavations at Lowe Hill, Wakefield, Yorkshire, 1953

1 Introduction

Archaeological Services WYAS (ASWYAS) was commissioned by Ian Sanderson, Principal Archaeologist at the West Yorkshire Archaeology Advisory Service (WYAAS), to undertake a geophysical survey, earthwork survey and community outreach on land within, and immediately adjacent to, the scheduled monument of Lowe Hill Motte and Bailey Castle in Thornes Park, Wakefield (Scheduled Monument No. 1010054). The work was undertaken following the submission of a Project Design (Harrison and Martin 2015) which proposed a scheme of work to investigate the monument whilst at the same time providing training opportunities and experience in archaeological techniques to members of the public, local schoolchildren and local archaeology society members. The work was undertaken in accordance with current best practice (CIfA 2014; David *et al.* 2008) and to a Project Design (see above) approved by WYAAS and English Heritage. The survey was carried out on February 9th 2015.

Site location, topography and land-use

The site is located in Thornes Park, approximately 1.2km to the south-west of Wakefield city centre, to the east of Thornes Park College, west of Denby Dale Road and south of Lawefield Lane and Park Avenue (see Fig. 1). The survey work was carried out around Lowe Hill motte and bailey castle, a scheduled monument centred at SE 3266 1969, a prominent mound largely overgrown with trees and vegetation. The surveys were undertaken where conditions were suitable and consequently the survey was split into four discrete blocks (see Fig. 2). The largest block, Area 1, is located to the north-west of the motte and comprised short grassland (see Plate 1) interspersed with occasional trees. Low earthworks indicative of ridge and furrow cultivation were evident throughout. Area 2 comprised the inner bailey (see Plate 2), to the immediate north-east of the motte, and was wholly within the scheduled area (see Fig. 2). Areas 3 and 4 are located immediately to the east and north-east of the scheduled area respectively (see Plate 3 and Plate 4).

Soils and geology

The underlying bedrock comprises Crigglestone Rock sandstone. No superficial deposits are recorded (British Geological Survey 2015). The soils in this area are unclassified but are likely to be in the Dale association being characterised as slowly permeable, seasonally waterlogged clays and loams (Soil Survey of England and Wales 1983).

2 Archaeological Background

The remains of the motte and bailey castle comprise a mound (motte), inner and outer bailey. A further earthwork was originally presumed to represent a third bailey, although this is now thought to have been a platform constructed to accommodate an octagonal bandstand in the

Victorian period. An archaeological investigation undertaken by the Wakefield Historical Society in 1953, led by Brian Hope-Taylor (see Plate 5), recovered a small amount of 12th century pottery from the fill of the ditch defining the motte. The trenching also revealed a hearth area within the inner bailey with more 12th century pottery, with an iron spur and a decorative iron and bronze stud also being recovered (Trench IV). These artefacts may be associated with the construction of the castle, rather than any subsequent occupation. It has been speculated, given the date of the finds, that this is an adulterine castle (one constructed without the permission of the king), built by the 3rd Earl Warrene during the civil war of 1138-49 between Stephen and Mathilda. The only known reference to a castle in Wakefield, as opposed to Sandal, is in a royal edict of 1324. Leland, writing in the 16th century, records that the castle was destroyed by a 'violence of wind', possibly in 1330. There is no evidence that it was ever rebuilt in stone, which supports an early date for its abandonment.

3 Aims and Methodology

Geophysical Survey

The aim of the geophysical survey as described in the Project Design (Harrison and Martin 2015) is to, as far as possible, identify the presence or absence, and extent and layout, of buried archaeological remains across the site, through the interpretation of anomalies identified following the processing of data gathered during the magnetometer and earth resistance surveys.

The survey grid was laid out using a Trimble VRS differential Global Positioning System (Trimble 5800 model) providing an accuracy greater than 0.01m. The locations of the survey grid and anomalies are available as a DXF file. 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.

Magnetometer Survey

Magnetic survey methods rely on the ability of a variety of instruments to measure very small magnetic fields associated with buried archaeological remains. Features such as a ditch, pit or kiln can act like a small magnet, or series of magnets, that produce distortions (anomalies) in the Earth’s magnetic field. In mapping these slight variations, detailed plans of sites can be obtained as buried features often produce reasonably characteristic anomaly shapes and strengths (Gaffney and Gater 2003). Further information on types of anomaly is provided as Appendix 1.

On this site Bartington Grad601 magnetic gradiometers were used. These instruments are calibrated to take readings at 0.25m intervals on zig-zag traverses 1m apart within a series of 30m by 30m grids resulting in 3600 readings per 30m grid square. The data is stored in the memory of the instrument before being downloaded to a lap-top computer every day for data processing and interpretation.

Resistance Survey

The resistance survey was undertaken using a Geoscan RM15 and MPX15 instrument set as a Twin Probe array to take readings at 1m intervals on traverses 1m apart, allowing 900 readings to be recorded in each grid square. The mobile probe spacing of 0.5m gives an approximate depth penetration of 1m for most archaeological features. These readings are stored in the memory of the instrument and were later downloaded for processing and interpretation. Geoplot 3 (Geoscan Research) software will be used to process and present the data.

Data Processing

The 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. 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'. The data in the greyscale images has been interpolated and selectively filtered, using Geoplot 3 (Geoscan Research) software 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.

Earthwork Survey

The aims and objectives of the programme of earthwork survey are to gather sufficient information to establish the nature, extent, condition, character and date (as far as the inherent limitations of the technique permit) of archaeological features within the Scheduled Area. Specifically to identify external features, such as ditches, and allow a better understanding of the relationship between the motte and bailey castle and determine their relative ages (where possible) and to accurately locate the ridge and furrow and any associated features (headlands, joints, balks etc.) so these features can be better managed/preserved.

Training Workshops and Community Outreach

The community outreach element of the project aims are to provide training opportunities and information about the site to interested members of the public, local school children and local society members and to engage and inform interested members of the public, local school children and local society members about the site, as a tool to help protect and preserve the site for the future.

Presentation

A general site location plan, incorporating the 1:50000 Ordnance Survey (OS) mapping, is shown in Figure 1. Figure 2 shows the survey areas together overlaid on the first edition Ordnance Survey mapping at a scale of 1:2000. The magnetometer data is presented and interpreted in Figures 3, 4 and 5 and the resistance data in Figures 6, 7 and 8, all at a scale of 1:1000. The earthwork survey is presented at a scale of 1:1500 as Figure 9.

Further information on magnetic survey and characterisation and interpretation of anomaly types are given in Appendix 1. Background on resistance surveys is given in Appendix 2. Appendix 3 describes the composition and location of the site archive and Appendix 4 reproduces the OASIS form.

The survey methodology, report and any recommendations comply with the Project Design (Harrison and Martin 2015) and guidelines outlined by English Heritage (David *et al.* 2008) and by the Chartered Institute for Archaeologists (CIfA 2014). All figures reproduced from Ordnance Survey mapping are with the permission of the controller of Her Majesty's Stationery Office (© Crown copyright).

Disclaimers

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.

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

4 Results and Discussion

Geophysical Survey - Overview

For reason of clarity the results are discussed by area rather than by technique. Unless stated otherwise any variation in resistance is assumed to be due to changes in soil compaction, degree of slope, geology, water retention or a combination of all these factors.

Area 1

This area was located to the immediate north-west of the motte. Here the magnetic data is dominated by the broad, parallel linear anomalies which are indicative of ridge and furrow cultivation; the ridges and furrows still survive as extant earthworks and have also been recorded by the earthwork survey. Across the majority of Area 1 the ploughing anomalies are aligned south-west/north-east but at the northern apex of the survey area they are aligned at right angles i.e north-west/south-east. The resistance survey has also identified some of these ploughing features but not with the same degree of clarity as afforded by the magnetic survey.

The magnetic survey has also identified another clearly defined linear anomaly, **A**, aligned east/west oblique to the ploughing trends. This anomaly is due to a sub-surface pipe which is also clearly identified as low resistance linear anomaly, **B**.

Former boundary features recorded on the first edition mapping also manifest as magnetic anomalies. Anomaly **C** is slightly oblique to the cultivation strips, just to the south of the pipe and the ploughing anomalies, and also aligns with an extant boundary immediately south of the survey area (see Fig. 5). Whether this boundary comprised a bank or a ditch (or both) is not clear. At right angles to, and intersecting with, **C** is a possible return, **D**, although this possible feature is not recorded on the historic mapping. Neither of these former features is clearly identified in the resistance data which, in this part of the survey area, is characterised as an area of very low resistance.

The location of a second linear feature is indicated by magnetic anomaly **E**, aligned north-west/south-east. The anomaly is due to a metalled track. The response from this feature (see Fig. 4) is higher in magnitude than that from the former boundary. This is due the magnetic properties of the material used in the surface of the track, such as fired brick and gravel. Only part of the route of the track was covered by the resistance survey but a broad low resistance anomaly, **F**, locates its line. The low resistance response is caused by the accumulation of water on and around the track surface.

Area 2

Area 2 was located in the inner bailey on the north-eastern side of the monument with the ground sloping gently down from the base of the motte to the north and north-east. The resistance data is characterised by a distinct area of high resistance readings, **N**,

approximately 25m in diameter, which is bound to the north, east and west by very low resistance. It is considered that the area of high resistance is most likely due to a compacted surface.

The magnetic data is more difficult to interpret with any certainty. The data is dominated by individual ferrous responses which, as individual 'spikes', are typically caused by ferrous (magnetic) material, either on the ground surface or in the plough-soil. Little importance is normally given to such anomalies, unless there is any supporting evidence for an archaeological interpretation, as modern ferrous debris or material is common on most sites, often being present as a consequence of manuring or tipping/infilling. Given the location of the survey some of these anomalies may be due to a ferrous archaeological artefact but equally any of these anomalies may be due to ferrous debris dropped at any time. In addition several small areas of enhanced magnetic response are also highlighted, **G – M**. These anomalies might also have an archaeological cause, possibly infilled pits, but they also may be due to relatively recent ground disturbance. Nevertheless, given the archaeological context these anomalies have been interpreted as being of possible archaeological origin.

Area 3

Area 3 is located immediately to the east of the scheduled area (see Fig. 2) on ground that slopes considerably down to the south-east (see Plate 3). The southern half of the area is characterised by linear magnetic anomalies caused by extant ridge and furrow earthworks. As in Area 1 better definition is provided by the magnetic survey. In the northern half of the area there is a distinct cluster of ferrous anomalies the cause or significance of which is impossible to gauge. Magnetic disturbance within the north of the area corresponds to a modern metalled footpath. Another footpath has been detected as an area of magnetic disturbance in the south. No definite anomalies, other than the broad linear trends indicative of the cultivation strips, have been identified by the resistance survey with the changes in resistance being attributed to differences in compaction, topography etc.

Area 4

This area was also outside of the scheduled area, immediately north-east of the bailey. Due to time constraints the resistance survey was not carried out in this part of the site. Although two former boundaries shown on the historic mapping intersect within this area (see Fig. 2) only very high magnitude readings indicative of severe ferrous contamination have been recorded here. Against this magnetic background it is impossible to identify any weaker anomalies of archaeological potential, if present.

Earthwork Survey (see Fig. 9)

The surface remains surrounding the monument comprise series of low linear features, spaced at regular intervals between 6m and 8m apart (see Fig. 10). The earthworks on the

northern and eastern sides of the monument are orientated north/south and east/west respectively so as to respect the steep slopes (see Plate 3). On the western side of the motte, the gradient is more gradual, with the ridge and furrow earthworks aligned north-east/south-west. These earthworks are constrained to the north by a low bank, a ploughing headland, beyond which a separate series of ridge and furrow earthworks are orientated north-west/south-east. It was not possible to determine the relationship between the ridge and furrow cultivation and the motte and bailey earthworks do to a combination of footpaths and modern landscaping.

Subtle areas of topographical variation were observed and recorded within the inner bailey. Some of these features are likely to be due to recent ground disturbance but two linear features have been identified which correspond to the location of trenches (Trench IV and Trench V) excavated by Wakefield Historical Society in 1953 (see Plate 5). No other earthworks of note were observed within the inner bailey.

5 Conclusions

The surveys have confirmed and mapped the extent of ridge and furrow earthworks, which have been recorded by both the magnetometer and resistance surveys in Area 1 and Area 3, immediately adjacent to the scheduled motte and bailey castle at Lowe Hill. Former field boundaries and a pipe have also been identified in Area 1. In the bailey area (Area 2) discrete anomalies which may be caused by pits have been located although a non-archaeological origin is equally plausible. The earthwork survey has accurately relocated two trenches which were excavated by Wakefield Historical Society in 1953. Overall the surveys have not identified any anomalies that are of definite archaeological origin although anomalies of potential have been recorded within the inner bailey.

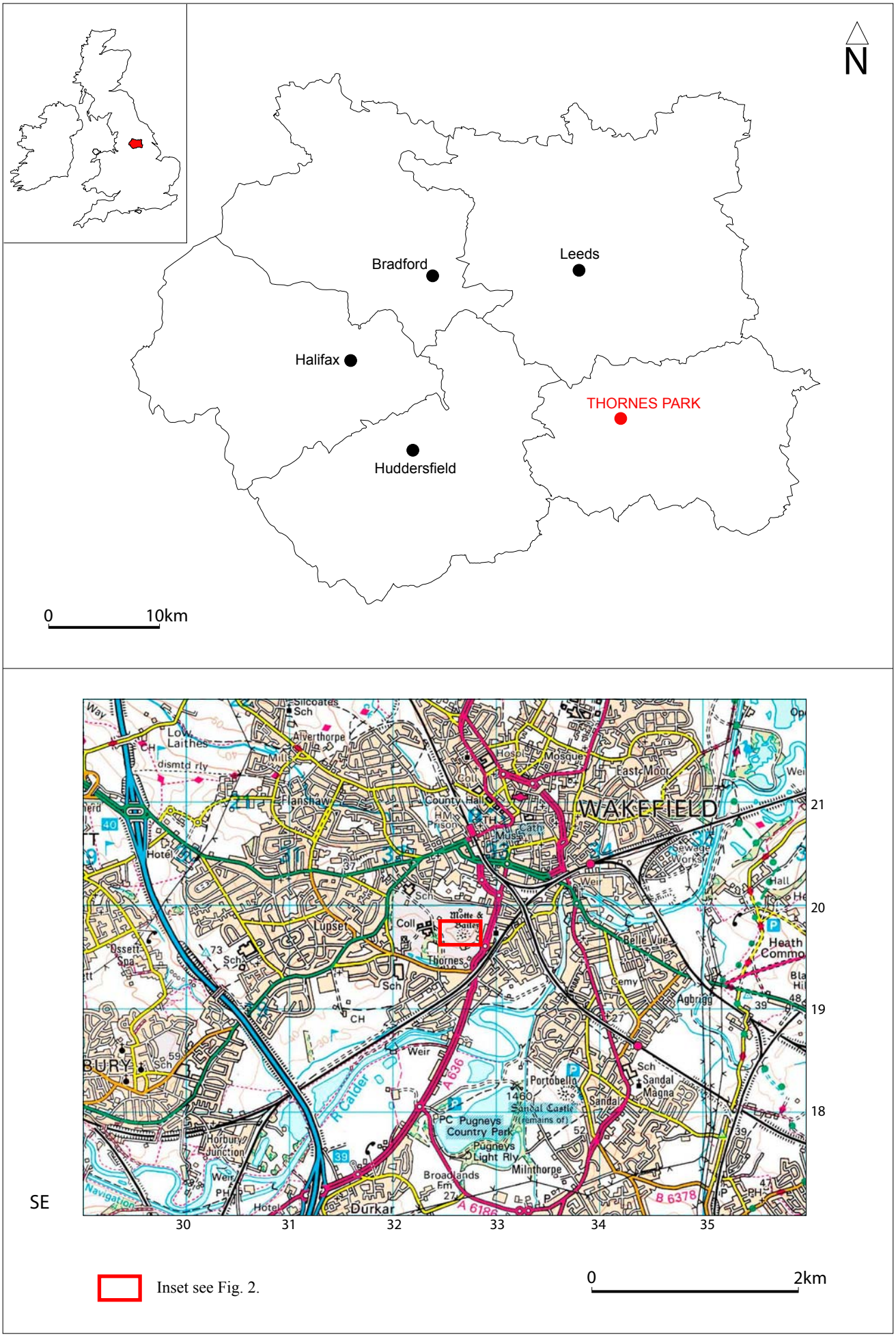

Fig. 1. Site location

	SCHEDULED MONUMENT AREA
	AREA OF MAGNETOMETER SURVEY
	AREA OF EARTH RESISTANCE SURVEY
1	LOCATION AND DIRECTION OF PLATES

N

420000

AREA 1

AREA 2

AREA 3

AREA 4

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432500

433000

0 50m

Fig. 2. Location of geophysical surveys showing first edition Ordnance survey mapping of 1854 (1:2000 @ A3)

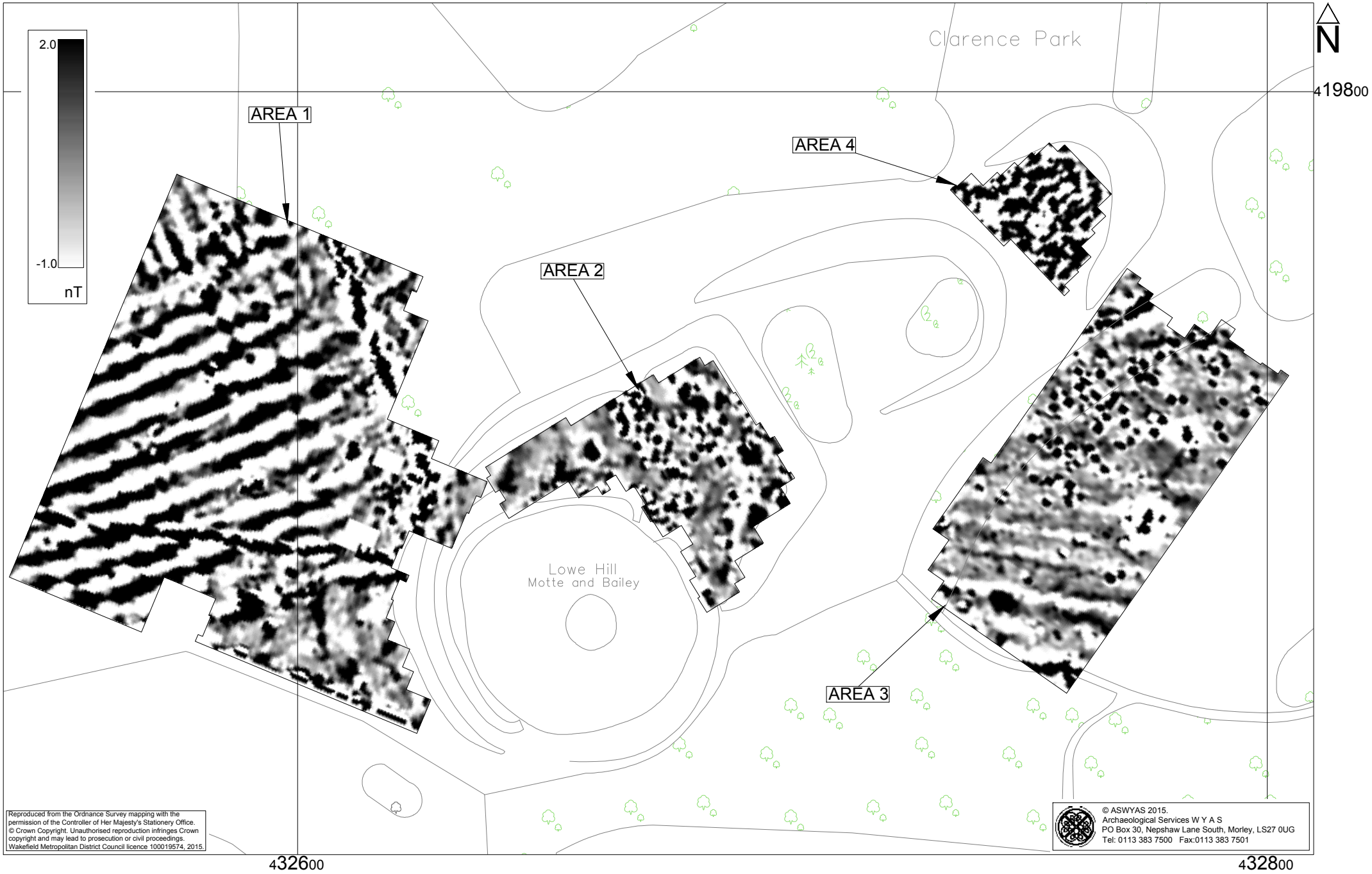

Fig. 3. Processed greyscale magnetometer data (1:1000 @ A4)

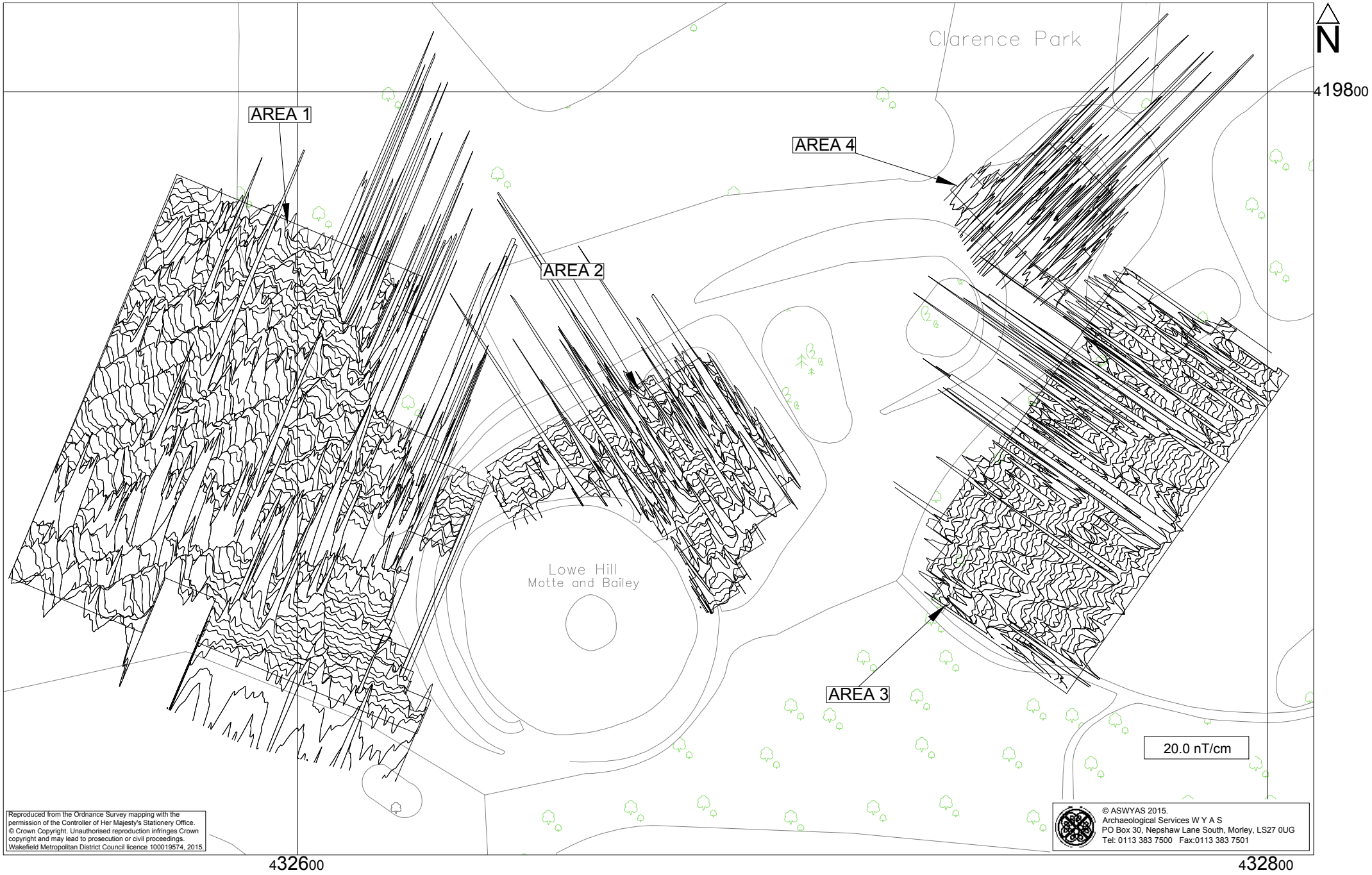

Fig. 4. XY trace plot of minimally processed magnetometer data (1:1000 @ A4)

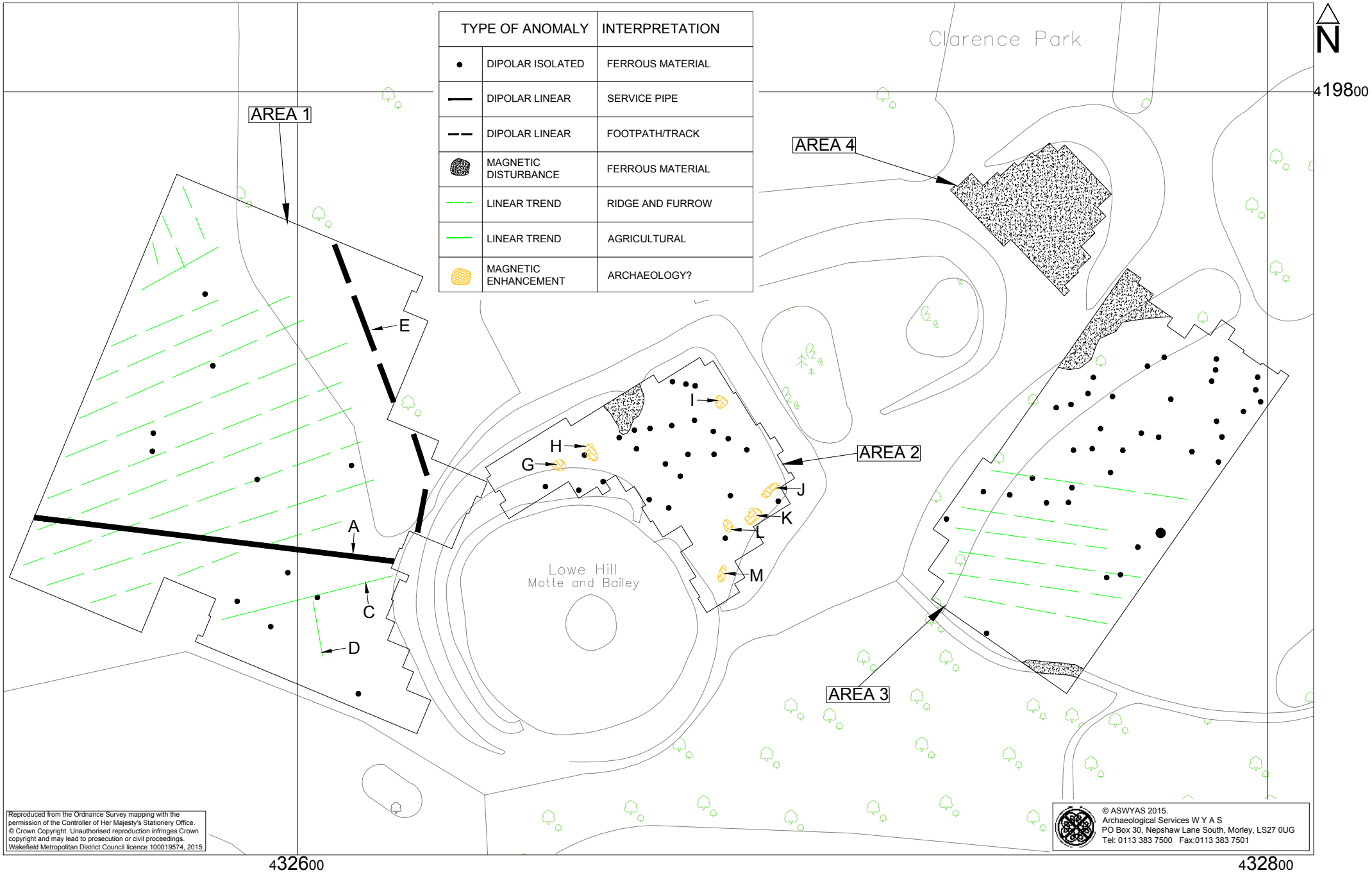

Fig. 5. Interpretation of magnetometer data (1:1000 @ A4)

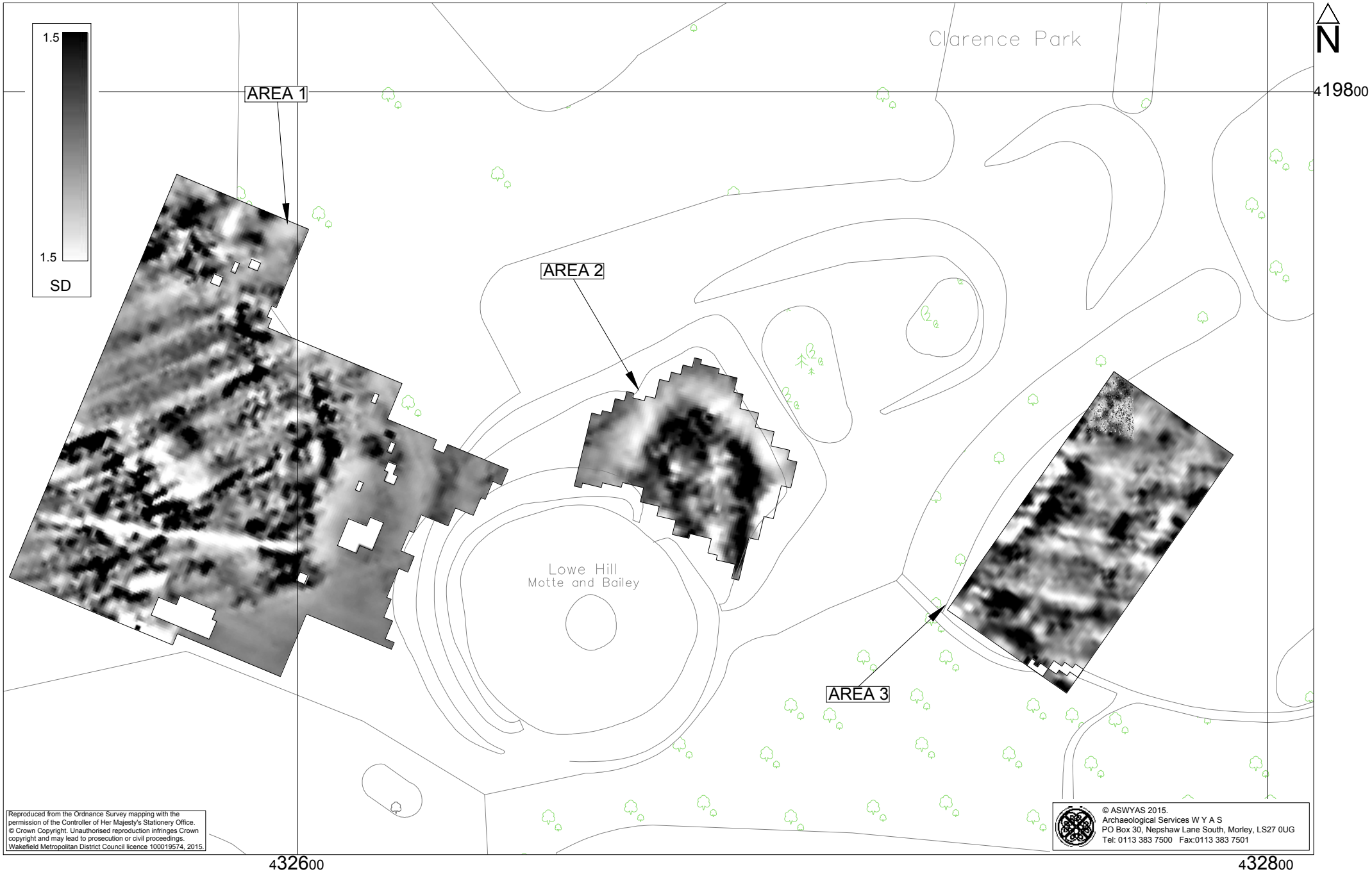

Fig. 6. Processed greyscale earth resistance data (1:1000 @ A4)

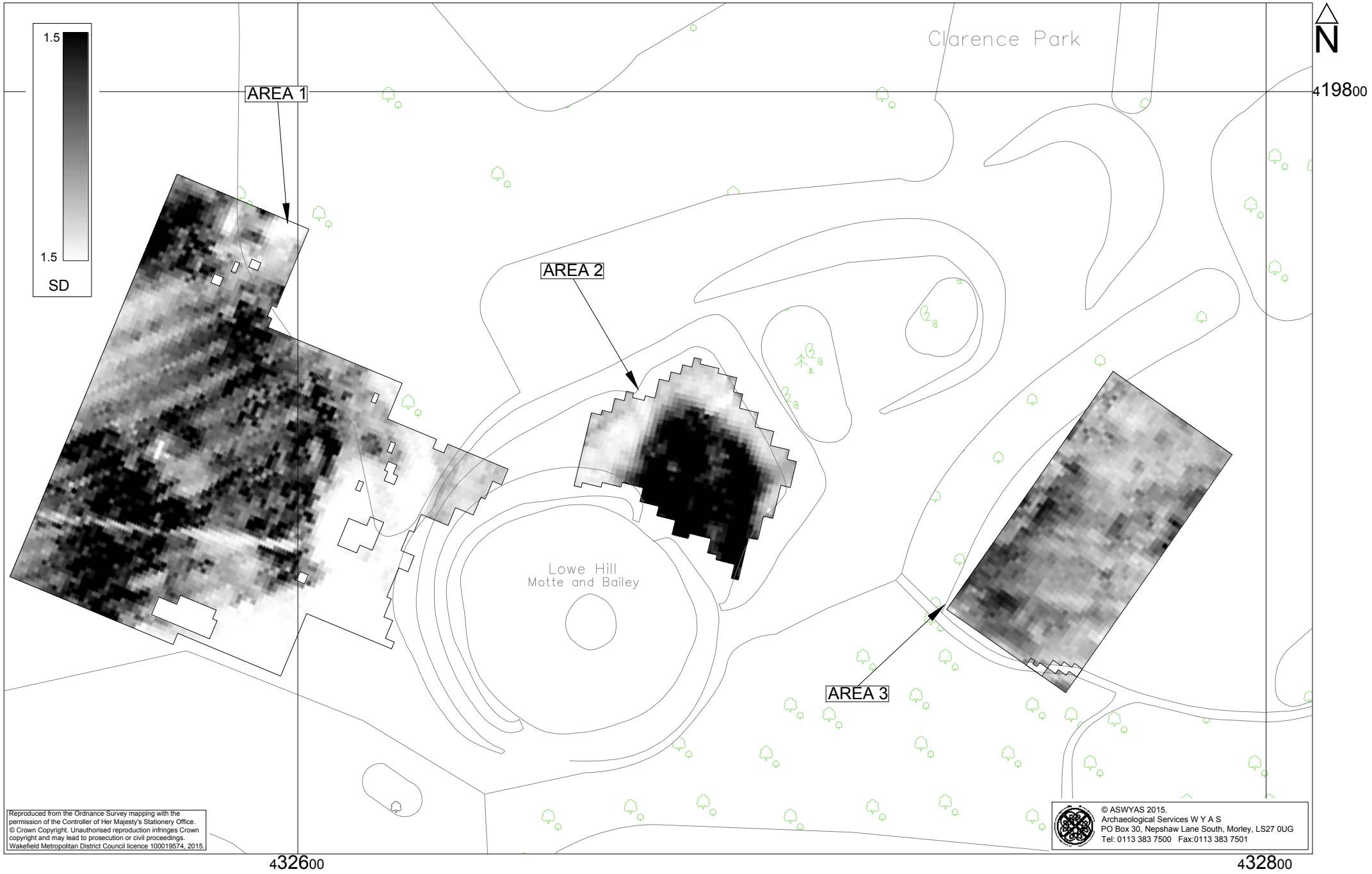

Fig. 7. Unprocessed greyscale earth resistance data (1:1000 @ A4)

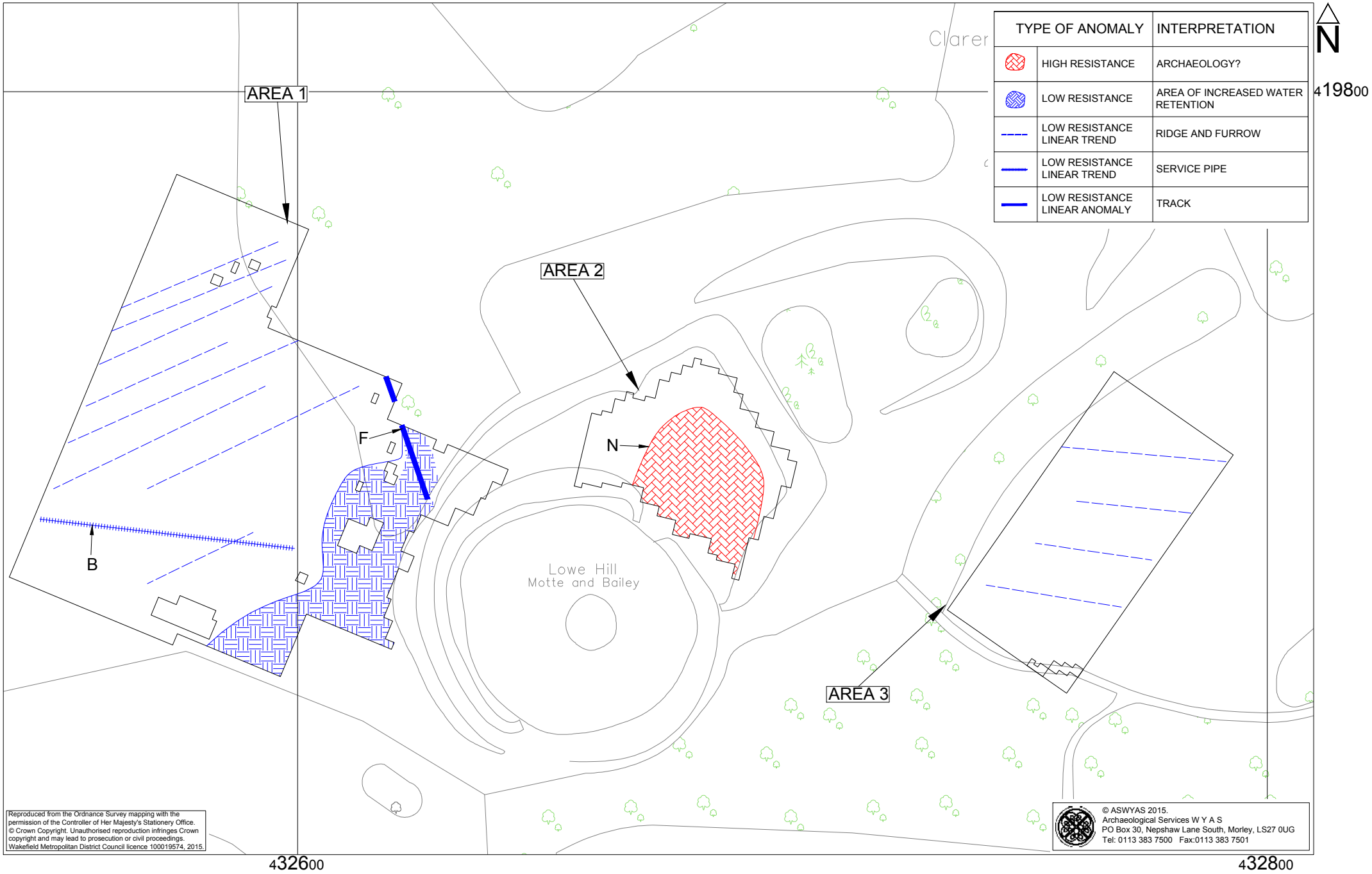

Fig. 8. Interpretation of earth resistance data (1:1000 @ A4)

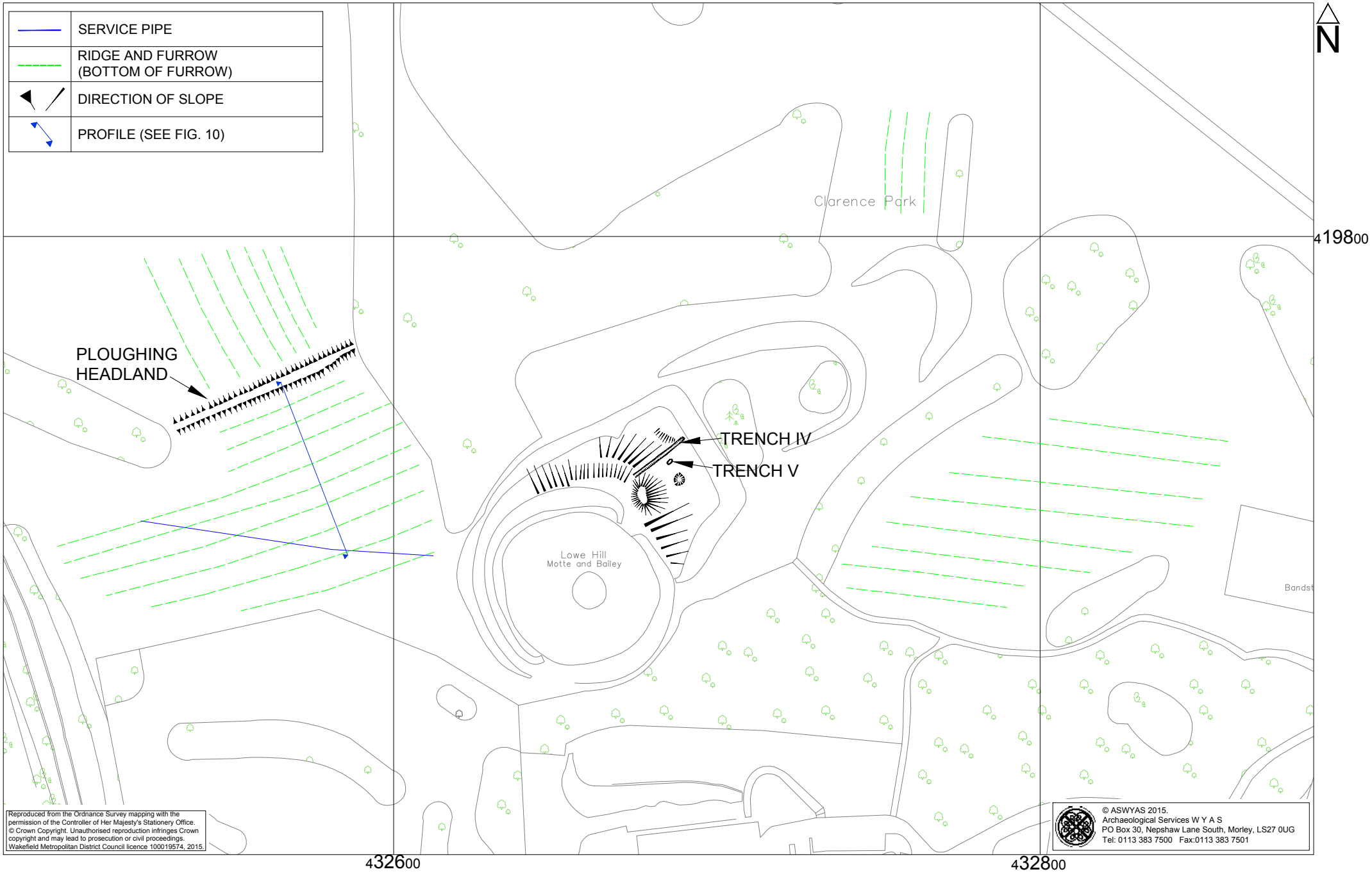

Fig. 9. Basic earthwork survey (1:1500 @ A4)

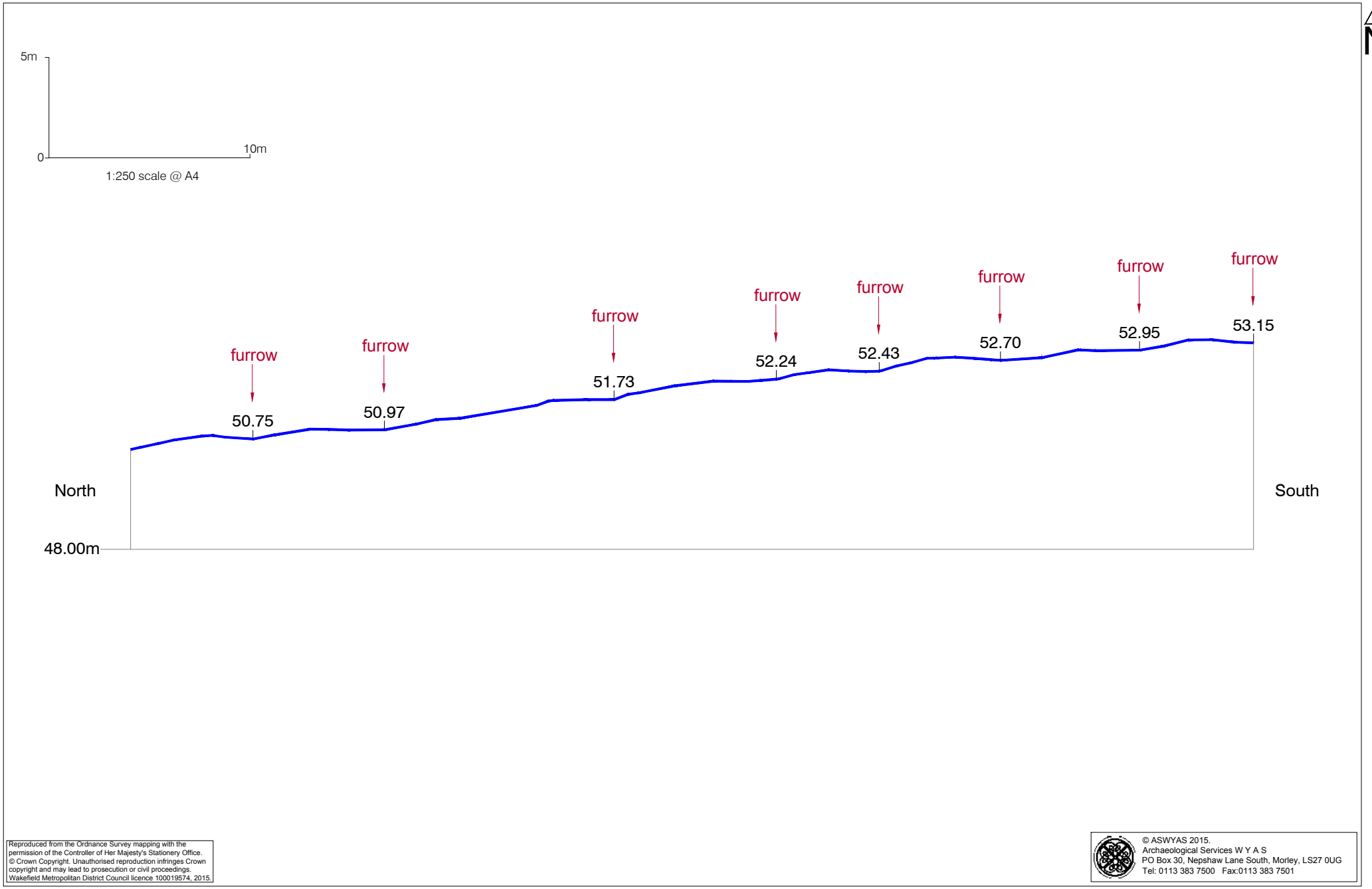

Fig. 10. Profile over ridge and furrow earthworks (1:250 @ A4)

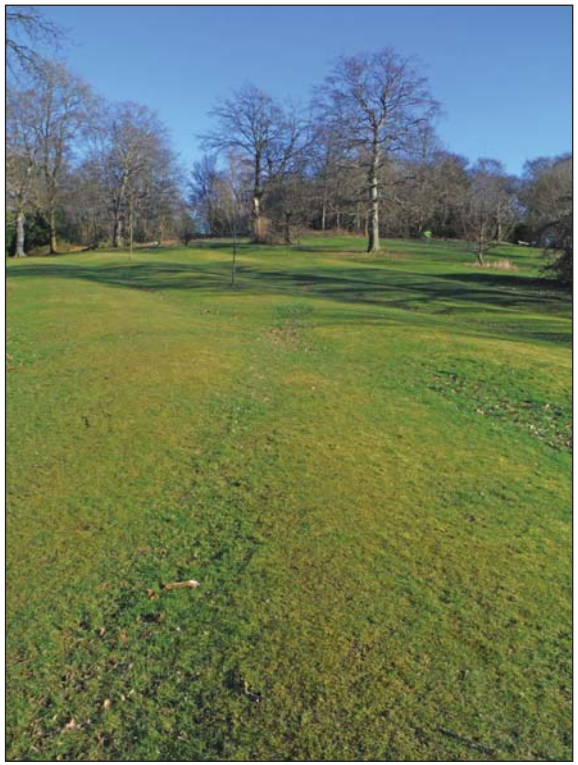

Plate 1. General view of Area 1, looking east

Plate 2. General view of Area 2, looking west

Plate 3. General view of Area 3, looking north-east

Plate 4. General view of Area 4, looking west

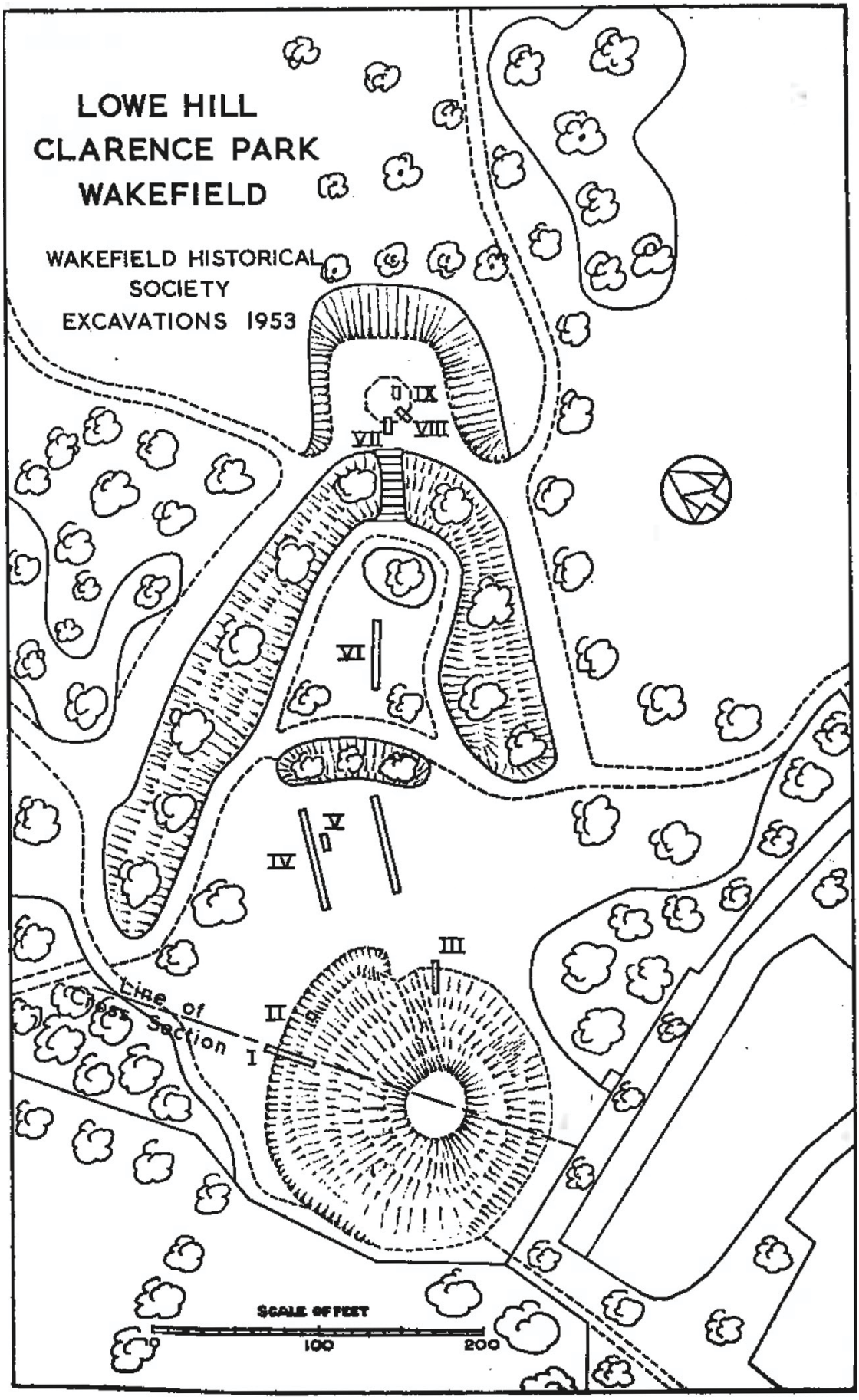

Plate 5. Extract from Hope-Taylor's Report on the Excavations at Lowe Hill, Wakefield, Yorkshire, 1953

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. Areas of human occupation or settlement can then be identified by measuring the magnetic susceptibility of the topsoil because 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.

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: 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; and
- 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 West Yorkshire Historic Environment Record).

Appendix 4: Section 42

ENGLISH HERITAGE

YORKSHIRE OFFICE

Mr David Harrison
Archaeological Services WYAS
PO Box 30
Nepshaw Lane South
Morley
West Yorkshire
LS27 0UG

Direct Dial: 01904 601897
Direct Fax: 01904 601999

Our ref: AA/026020/5

28 October 2013

Dear Mr Harrison

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

LOWE HILL MOTTE & BAILEY CASTLE, WAKEFIELD
Case No:SL00066291
Monument no: 1010054

I refer to your application dated 24 October 2013, 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 LOWE HILL MOTTE & BAILEY 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 David Harrison and by no other person. It is not transferable to another individual.

2. The permission shall commence on 29 October 2013 and shall cease to have effect on 31 March 2015.

3. A full report summarising the results of the geophysical survey and their interpretation shall be sent in hard copy to Lisa Bond at the address below and electronic (pdf) format to hannah.saxton@english-heritage.org.uk, copied to Paul.Linford@english-heritage.org.uk no later than 3 months after the completion of the survey.

4. The enclosed questionnaire shall be completed and appended to the survey

report. For convenience an electronic version of this questionnaire can be downloaded from http://www.english-heritage.org.uk/professional/advice/advice-by-topic/heritage-science/archaeological-science/geophysics/.

5. A copy of the report shall also be sent (in their preferred format) to the local Historic Environment Record (HER). The local HER's contact details can be found at http://www.heritagegateway.org.uk/gateway/chr/default.aspx.

6. A record signposting your investigation shall be made with the Archaeology Data Service using their online OASIS Data Collection form no later than 3 months after completion of the survey. Please see http://oasis.ac.uk/ for details or contact oasis@english-heritage.org.uk for information and training.

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

Hannah Saxton
Assistant Inspector of Ancient Monuments
E-mail: hannah.saxton@english-heritage.org.uk
cc

ENGLISH HERITAGE

YORKSHIRE OFFICE

Enclosure:

English Heritage Geophysical Survey Database Questionnaire

Survey Details

Name of Site: LOWE HILL MOTTE & BAILEY CASTLE

County:

NGR Grid Reference (Centre of survey to nearest 100m):

Start Date: **End Date:**

Geology at site (Drift and Solid):

Known archaeological Sites/Monuments covered by the survey
(Scheduled Monument No. or National Archaeological Record No. if known)

Archaeological Sites/Monument types detected by survey
(Type and Period if known. "?" where any doubt).

Surveyor (Organisation, if applicable, otherwise individual responsible for the survey):

Name of Client, if any:

37 TANNER ROW YORK YO1 6WP

Telephone 01904 601901 Facsimile 01904 601999
www.english-heritage.org.uk

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Purpose of Survey:

Location of:

a) Primary archive, i.e. raw data, electronic archive etc:

b) Full Report:

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www.english-heritage.org.uk

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Technical Details

(Please fill out a separate sheet for each survey technique used)

Type of Survey (Use term from attached list or specify other):

Area Surveyed, if applicable (In hectares to one decimal place):

Traverse Separation, if regular: **Reading/Sample Interval:**

Type, Make and model of Instrumentation:

For Resistivity Survey:

Probe configuration:

Probe Spacing:

Land use at the time of the survey (Use term/terms from the attached list or specify other):

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Additional Remarks (Please mention any other technical aspects of the survey that have not been covered by the above questions such as sampling strategy, non standard technique, problems with equipment etc.):

List of terms for Survey Type

Magnetometer (includes gradiometer)

Resistivity

Resistivity Profile

Magnetic Susceptibility

Electro-Magnetic Survey

Ground Penetrating Radar

Other (please specify)

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List of terms for Land Use:

Arable
Grassland - Pasture
Grassland - Undifferentiated
Heathland
Moorland
Coastland - Inter-Tidal
Coastland - Above High Water
Allotment
Archaeological Excavation
Garden
Lawn
Orchard
Park
Playing Field
Built-Over
Churchyard
Waste Ground
Woodland
Other (please specify)

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Appendix 5: OASIS Form

OASIS DATA COLLECTION FORM: England

OASIS ID: archaeol11-301094

Project details

Project name	Lowe Hill Motte and Bailey Castle
Short description of the project	A geophysical (magnetometer and earth resistance) and earthwork survey was carried out in Thornes Park, Wakefield as part of a community outreach project to better understand the relationship between the motte and bailey castle (known as Lowe Hill), a scheduled monument, and the surrounding landscape and therefore allow the monument to be better managed. Both the geophysical surveys have identified anomalies indicative of ridge and furrow cultivation in the two areas bordering the scheduled monument. Anomalies locating former 19th century boundaries, no longer extant, have also been identified. In addition the magnetometer survey has identified several discrete anomalies in the bailey area which could be indicative of archaeological features such as large pits. However, this interpretation should be viewed as tentative as the observed responses could equally easily be due to relatively recent activity. The topographic survey has mapped the earthworks and located back-filled trenches which were excavated in 1953, but has not identified any other features of archaeological significance.
Project dates	Start: 09-02-2015 End: 09-02-2015
Previous/future work	Yes / Not known
Any associated project reference codes	4332 - Sitecode
Any associated project reference codes	1010054 - SM No.
Type of project	Research project
Site status	Scheduled Monument (SM)
Current Land use	Other 8 - Land dedicated to the display of a monument
Monument type	MOTTE AND BAILEY CASTLE Medieval
Significant Finds	RIDGE AND FURROW Medieval
Investigation type	"Geophysical Survey"
Prompt	Research
Solid geology (other)	Crigglestone Rock Sandstone
	clay and loams

Drift geology (other)	
Techniques	Magnetometry
Techniques	Resistivity - area

Project location

Country	England
Site location	WEST YORKSHIRE WAKEFIELD WAKEFIELD Lowe Hill Motte and Bailey Castle
Study area	1.5 Hectares
Site coordinates	SE 327 197 53.67251871837 -1.504967844291 53 40 21 N 001 30 17 W Point

Project creators

Name of Organisation	Archaeological Services WYAS
Project brief originator	West Yorkshire Archaeological Advisory Service
Project design originator	West Yorkshire Archaeology Advisory Service
Project director/manager	D. Harrison
Project supervisor	D. Harrison

Project archives

Physical Archive Exists?	No
Digital Archive recipient	West Yorkshire Archaeology Advisory Service
Digital Contents	"Survey"
Digital Media available	"Geophysics","Images raster / digital photography","Survey","Text"
Paper Archive Exists?	No

Project bibliography 1

Publication type	Grey literature (unpublished document/manuscript)
Title	Lowe Hill Motte and Bailey Castle, Wakefield
Author(s)/Editor (s)	Webb, A.
Date	2015
Issuer or publisher	ASWYAS
Place of issue or publication	Leeds
Description	A4 report with A3 figures

Bibliography

British Geological Survey, 2015. www.bgs.ac.uk/discoveringGeology/geology OfBritain/viewer.html. (Viewed March 31st 2015)

Chartered Institute for Archaeologists, 2014. *Standard and Guidance for archaeological geophysical survey.* CIfA

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

DCLG, 2012. *National Planning Policy Framework*. Department of Communities and Local Government

Gaffney, C. and Gater, J., 2003. *Revealing the Buried Past: Geophysics for Archaeologists* Tempus Publishing Ltd

Harrison, D and Martin, L, 2015. *Lowe Hill Motte and Bailey Castle, Wakefield, West Yorkshire: Geophysical Survey Project Design.* Unpublished ASWYAS document

Hope-Taylor, B., 1953. *Report on the excavations at Lowe Hill, Wakefield, Yorkshire* Wakefield Historical Society

Soil Survey of England and Wales, 1983. *Soil Survey of England and Wales: Soils of Northern England*, Sheet 3