WYAS Archaeological Services

Lancaster Science Park

Lancaster University

Lancashire

Geophysical Survey

Report no. DRAFT
May 2016

Client: WYG

REGISTERED ORGANISATION CIfA

West Yorkshire Joint Services

Lancaster Science Park, Lancaster University, Lancastershire

Geophysical Survey

Summary

A geophysical (magnetometer) survey, covering approximately 11 hectares, was carried out on land located to the east of the A6, north of the University of Lancaster and south of Scotforth. The survey was undertaken prior to the proposed development of the site. Modern services and areas of disturbance have been detected along the western boundary and the northern aspect of the survey area. Ridge and furrow ploughing and associated former field boundaries have been identified across the site. A distinctive area of magnetic responses have been recorded and are considered to be geological in origin. Based on the geophysical survey evidence the archaeological potential of the survey area is considered to be low.

WYAS Archaeological Services

Report Information

Client:	WYG
Address:	Arndale Court, Headingley, Leeds, West Yorkshire, LS6 2UJ
Report Type:	Geophysical Survey
Location:	Lancaster University, Lancaster
County:	Lancashire
Grid Reference:	SD 4815 5810
Period(s) of activity:	Post-Medieval, Modern
Report Number:	2864
Project Number:	6371
Site Code:	LAN16
OASIS ID:	archaeol11-250695
Planning Application No.:	N/A
Museum Accession No.:	N/A
Date of fieldwork:	April 2016
Date of report:	May 2016
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Fieldwork:	Rebecca Goulding, BSc, MSc
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Photography:	Marina Rose
Research:	N/A

Authorisation for distribution: ----------

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1 Introduction

Archaeological Services WYAS (ASWYAS) was commissioned by WYG (the Client), to undertake a geophysical (magnetometer) survey at land between Lancaster University and Scotforth, to inform a proposed planning application for the Innovation Campus. The work was undertaken in accordance with a Project Design (Richardson 2016). Guidance contained within the National Planning Policy Framework (DCLG 2012) was also followed, in line with current best practice (CIfA 2014; David *et al*. 2008). The survey was carried out between 18th April and 20th April 2016, to provide additional information on the archaeological resource of the site.

Site location, topography and land-use

The Proposed Development Area (PDA) is located south of the village of Scotforth, northeast of the sports ground of Lancaster University, and to the east of the A6, centred at SD 4815 5810 (see Fig. 1). The PDA is bounded by agricultural land to the south and east and Bailrigg Lane to the north.

The PDA comprises of a single field, intercut by Ou Beck and wire fencing and was generally level, rising in the southeast. Earthwork features indicative of ridge and furrow, aligned west-east, are prevalent across the site. The PDA is located around 50m above Ordnance Datum (aOD).

Soils and geology

The underlying geology of the site is siltstone, mudstone and sandstone of the Roeburndale Member, with superficial deposits of Devensian till across the majority of the area, with a thin band of Lacustrine deposits of clay and silt noted on the eastern limits (BGS 2016). The overlying soils belong to the Eardiston 2 association (541d) described as well-drained coarse loamy soils over sandstone (SSEW1983).

2 Archaeological Background

A desk-based assessment (DBA) has previously been completed for the site (WYG 2009) and the assessment was reviewed and updated to reflect subsequent change in planning policy in 2012 (Lancaster City Council 2012). This information, reiterated in a Written Scheme of Investigation (WSI) by WYG (2015), is used here.

The DBA identified an absence of early prehistoric archaeological evidence within the area, detailing that the wider landscape is unlikely to have been inhabited during the Palaeolithic period, due to the extent of the glacial coverage in the region. The wider landscape has recorded evidence of Mesolithic and Neolithic occupation and activity, but not within the PDA. However, evidence for these periods is typically recognised from areas with concentrations of archaeological investigation, suggesting that rather than being absent from the immediate area, occupational evidence may simply not be that visible.

There is more extensive evidence for Bronze Age and Iron Age occupation in the surrounding landscape, including a possible Bronze Age log boat recovered during the construction of the Blea Tarn Reservoir in around 1897 to the east of the site. In addition, a potential Iron Age or Romano-British farmstead has been identified to the north of the site by cropmark evidence. This is further supported with evidence of an Iron Age field system to the immediate west of the site. Evidence of Roman activity in the area can be drawn from a Roman road which ran from the fort at Lancaster to Preston, approximately 400m to the west of the site, with milestones and statue fragments within a larger landscape.

The settlement of Scotforth had early medieval origins, being recorded in the Domesday Book as Scozford and translates as “the ford used by the Scots”. Post Norman Conquest, the manor of Scotforth passed into the hands of Count Roger of Poitou, later becoming land granted to the Lancaster family. Ashton Hall, to the west of the PDA had a deer park and land which extended towards the site, and whilst it was not part of this landscape, there may be associated landscape management features within the site.

Analysis of place names within close proximity to the site suggest post-medieval industry and activity in the area. Wind Mill Hill to the north of the site, along with Killen Close, which may indicate evidence of a kiln. Evidence of agricultural activity in this area can be found within the PDA in the form of ridge and furrow, which probably dates from around this period.

3 Aims and Methodology

The main aim of the geophysical survey was to provide sufficient information to enable an assessment to be made of the impact of the development on potential sub-surface archaeological remains and for further evaluation or mitigation proposals, if appropriate, to be recommended. To achieve this aim, a magnetometer survey covering all amenable parts of the PDA was undertaken (see Fig. 2).

The general objectives of the geophysical survey were:

- to provide information about the nature and possible interpretation of any magnetic anomalies identified;
- to therefore determine the presence/absence and extent of any buried archaeological features; and
- to prepare a report summarising the results of the survey.

Magnetometer survey

The site grid was laid out using a Trimble VRS differential Global Positioning System (Trimble 5800 model). The survey was undertaken using a Bartington Grad601 magnetic gradiometers. These were employed taking readings at 0.25m intervals on zig-zag traverses 1.0m 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 (OS) mapping, is shown in Figure 1. Figure 2 displays a processed greyscale image of the overall survey area at a scale of 1:2500. Figure 3 gives an overall interpretation at the same scale. The processed and minimally processed data, together with an interpretation of the survey results are presented in Figures 4 to 9 inclusive at a scale of 1:1000.

Technical information on the equipment used, data processing and survey methodologies are given in Appendix 1 and Appendix 2. Appendix 3 describes the composition and location of the archive.

The survey methodology, report and any recommendations comply with 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).

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 (see Figures 4 to 9)

Ferrous anomalies

Ferrous anomalies, as individual 'spikes', or as large discrete areas 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 rural sites, often being present as a consequence of manuring or tipping/infilling. There is no obvious pattern or clustering to their distribution to suggest anything other than a random background scatter of ferrous debris in the plough-soil.

Distinctive magnetic linear responses are indicative of services pipes which run along the western boundary of the PDA, aligned with the course of the A6. A solitary service is aligned west-east across the north of the area surveyed.

A distinct area of magnetic disturbance has been recorded within a crux of two banks, to the west of the site. The origin of the anomaly is unknown, but it is unlikely to be archaeological in origin.

Geological anomalies

The magnetic background is fairly similar throughout the survey area resulting in a mostly grey tone with a slight 'speckling' appearance to the data. This is due to the nature of the subsoil and the land's use for agriculture. A large inverted "V" of magnetic responses have been recorded at a point where the Ou Beck alters its course. It is likely that these responses are associated with material deposition.

Agricultural anomalies

As an aspect of cultivation, ploughing disturbs the subsoil is disturbed, causing variations in the magnetic susceptibility of the soil as it is backfilled or repacked with material different to that of the surrounding area. Curvilinear trend anomalies indicative of medieval or post-medieval ridge and furrow cultivation and other more recent agricultural activities are present throughout the survey area. While these practices correspond to anthropogenic activity, they are not of high archaeological interest or potential.

Evidence of post-medieval ridge and furrow has been identified, as have former field boundaries, all of which have been previously identified. Prominent former field boundaries are recorded on the Scotforth tithe map and have been identified, however not every boundary has been detected.

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.

5 Conclusions

The survey has not detected any anomalies that can be considered to be definitively archaeological in origin. The large areas of magnetic disturbance that have been identified are attributed to the below ground service pipes and residual interference from modern agricultural practice. Responses consistent with the underlying geology have been identified. Former agricultural activity in the form of ridge and furrow and former field boundaries have been detected. Consequently the archaeological potential of this site is deemed to be low.

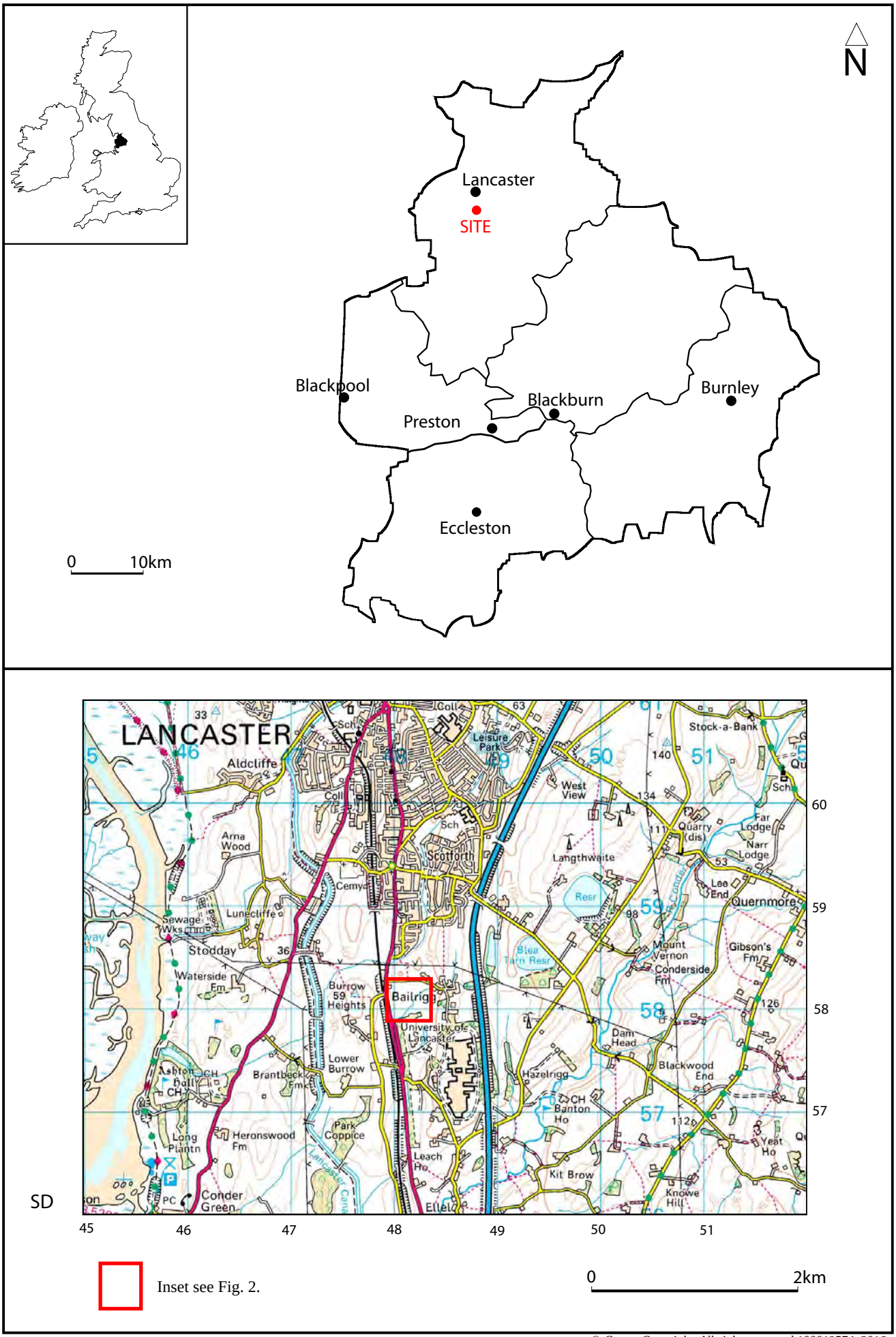

Fig. 1. Site location

— —	SECTOR BOUNDARY
1	LOCATION AND DIRECTION OF PLATES

N

SECTOR 1
SEE FIGS 4-6

SECTOR 2
SEE FIGS 7-9

2.0
-1.0
nT

458400
458200
458000
457800

347800
348000
348200
348400
348600

0 100m

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

SECTOR BOUNDARY

TYPE OF ANOMALY		INTERPRETATION
•	DIPOLAR ISOLATED	FERROUS MATERIAL
——	DIPOLAR LINEAR	SERVICE PIPE
	MAGNETIC ENHANCEMENT	MAGNETIC DISTURBANCE
	LINEAR TREND	RIDGE AND FURROW
	LINEAR TREND	FORMER FIELD BOUNDARY
	MAGNETIC ENHANCEMENT	GEOLOGY

SECTOR 1
SEE FIGS 4-6

SECTOR 2
SEE FIGS 7-9

N

458400

458200

458000

457800

347800 348000 348200 348400 348600

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0 100m

Fig. 3. Overall interpretation of magnetometer data (1:2500 @ A3)

SECTOR BOUNDARY

N

BAILRIGG LANE

FARMLAND

CYCLE PATH

HOUSING

TARMAC

GRASS

PAVIING

SETTS

4582000

3480000

3482000

2.0

-1.0

nT

0

50m

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Fig. 4. Processed greyscale magnetometer data; Sector 1 (1:1000 @ A3)

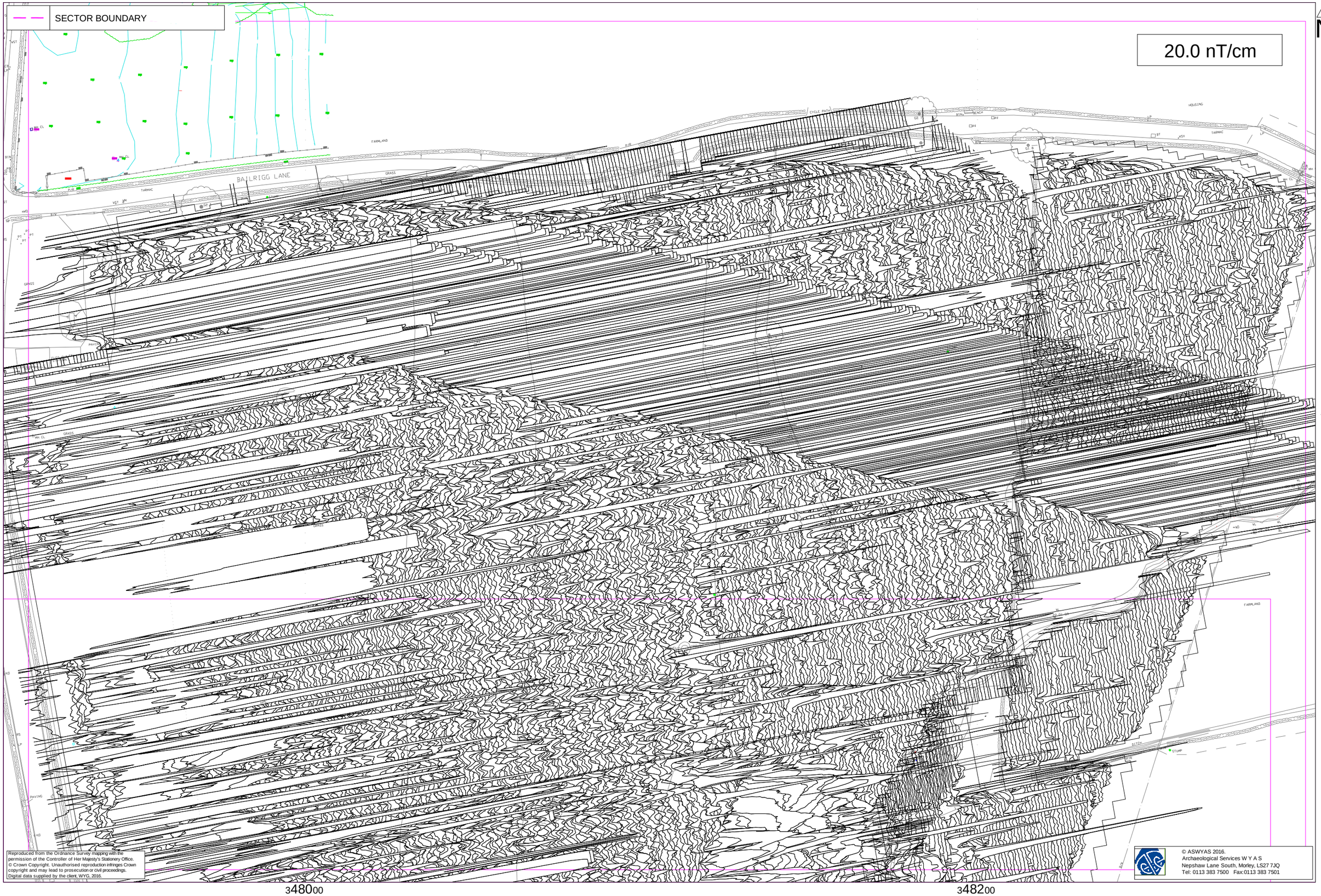

Fig. 5. XY trace plot of minimally processed magnetometer data; Sector 1 (1:1000 @ A3)

SECTOR BOUNDARY	

TYPE OF ANOMALY		INTERPRETATION
•	DIPOLAR ISOLATED	FERROUS MATERIAL
——	DIPOLAR LINEAR	SERVICE PIPE
	MAGNETIC ENHANCEMENT	MAGNETIC DISTURBANCE
- - -	LINEAR TREND	RIDGE AND FURROW
- - -	LINEAR TREND	FORMER FIELD BOUNDARY
	MAGNETIC ENHANCEMENT	GEOLOGY

N

458200

BAILRIGG LANE

CYCLE PATH

FARMLAND

TARMAC

GRASS

GRAVEL

PAVING

SETTS

STUMP

FENCE

HEDGE

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348000

348200

0 50m

Fig. 6. Interpretation of magnetometer data; Sector 1 (1:1000 @ A3)

SECTOR BOUNDARY

N

SCOTFORTH ROAD (A6)

DD01A

DD01

EXISTING BUILDING

DENSE WOODLAND

2.0

-1.0

nT

4580 00

3480 00

3482 00

0 50m

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Fig. 7. Processed greyscale magnetometer data; Sector 2 (1:1000 @ A3)

SECTOR BOUNDARY

N

458000

348000

348200

20.0 nT/cm

0 50m

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Fig. 8. XY trace plot of minimally processed magnetometer data; Sector 2 (1:1000 @ A3)

SECTOR BOUNDARY	

TYPE OF ANOMALY		INTERPRETATION
•	DIPOLAR ISOLATED	FERROUS MATERIAL
——	DIPOLAR LINEAR	SERVICE PIPE
	MAGNETIC ENHANCEMENT	MAGNETIC DISTURBANCE
- - -	LINEAR TREND	RIDGE AND FURROW
——	LINEAR TREND	FORMER FIELD BOUNDARY
	MAGNETIC ENHANCEMENT	GEOLOGY

N

SCOTFORTH ROAD (A6)

FARMLAND

GRASS

DENSE WOODLAND

GRASS PLAYING FIELD

EXISTING BUILDING

DD01

DD01A

4580 00

3480 00

3482 00

0 50m

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Fig. 9. Interpretation of magnetometer data; Sector 2 (1:1000 @ A3)

Plate 1. General view of field looking southeast.

Plate 2. General view of field looking south.

Plate 3. General view of field and Ou Beck, looking west.

Plate 4. General view of field, looking 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. 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.

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 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: Gradiometer Survey

The main method of using the fluxgate gradiometer for commercial evaluations is referred to as ***detailed survey*** and requires the surveyor to walk at an even pace carrying the instrument within a grid system. A sample trigger automatically takes 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 dumped to computer for processing and interpretation.

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 0.5m 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.

The gradiometer data has been presented in this report in processed greyscale format. 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.

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

Appendix 2: Survey location information

An initial survey station was established using a Trimble VRS differential Global Positioning System (Trimble R6 model). The data was geo-referenced using the geo-referenced survey station with a Trimble RTK differential Global Positioning System (Trimble R6 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.

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

Appendix 3: Geophysical archive

The geophysical archive comprises:-

- an archive disk containing compressed (WinZip 8) files of the raw data, report text (Microsoft Word 2000), and graphics files (Adobe Illustrator CS2 and AutoCAD 2008) files; 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 Lancashire Environment Record).

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