Geophysical Survey of land off Oxcroft Lane, Bolsover, Derbyshire

Interpretation of the Geophysical Survey Results

ARS Ltd Report 2015/69
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EXECUTIVE SUMMARY

This report presents the results of a geophysical survey undertaken on land off Oxcroft Lane, Bolsover, Derbyshire in advance of a planning application for a proposed housing development. An archaeological desk-based assessment (DBA) compiled in 2014 identified a number of HER entries in the vicinity of the subject area that relate to occupation during the Roman, medieval and post-medieval periods. The subject area also includes HER 11258 which appears to identify a square enclosure visible as cropmarks shown by aerial photographs (Sidebottom, 2014).

A geophysical survey was carried out between 30th April and 5th May 2015 using a Bartington 601 dual sensor fluxgate gradiometer. Approximately 6ha. was included in the survey. The results of the geophysical survey were generally very good and the raw data only required minimal processing to produce clear images and plots. The results have revealed definite evidence for potentially significant and previously unknown archaeological remains within the survey area which are possibly multi-phase.

In the east of the survey area an extensive collection of clearly defined inter-connected anomalies indicate the presence of the surviving remains of a field system and possible settlement enclosures of probable late Iron Age or Romano-British date. The field system of which the main axis is aligned approximately north-north-east/south-south-west includes probable field boundaries, paddocks and track-ways almost certainly associated with agriculture and animal husbandry and possible settlement. This particular group of anomalies does not correlate, in terms of alignment or location, with the crop marks referred to in the DBA (Sidebottom 2014, 20) and it is therefore likely that the anomalies represent a different phase of activity than those that has previously been interpreted from aerial photographs (HER 11258). Innumerable small discrete anomalies reminiscent of archaeological pits and other soil filled archaeological cut features have been interpreted as contemporary with this phase of activity. It should, however, also be considered that the pit features may not be contemporary and may even be natural in origin or represent more modern activity associated with the extraction of limestone (Sidebottom 2014).

Also in the east of the survey area a further group of anomalies are aligned more to the north-east/south-west and north-west/south-east and although they do not correspond exactly with the crop marks identified in the DBA (Sidebottom 2014, 21) it is likely that they represent some of the same features. All of the anomalies in this group are weak and poorly defined in the geophysical survey results but, where they can be identified, a number appear sufficiently regular to suggest anthropogenic activity. Others, however are more sinuous and are indicative of natural fissures in the limestone. It is possible that all the anomalies in this group are natural in origin but this is thought to be unlikely given the form and alignment of a number of the anomalies and taking into account the aerial photography transcription (HER 11258).

It is noteworthy that not all the features identified from aerial photography in the DBA (Sidebottom 2014) have been recorded in the geophysical survey results. Many more clearly defined but unrelated anomalies have, however, been recorded. As the aerial photographs that show the anomalies were taken in 1996, it is unlikely but possible, that some of the

features have been destroyed by the plough in the intervening years. More likely is that the features identified from aerial photography have produced a weaker geophysical signal for geological or pedological reasons and/or there has been a masking effect created by the stronger geophysical anomalies in the same part of the survey area.

In the western half of the survey area a more isolated anomaly indicates the presence of a further possible enclosure which although slightly remote from the main activity recorded in the east is potentially contemporary and may even be the main settlement enclosure associated with the fields to the east. Further anomalies recorded in the near vicinity may represent the heavily truncated remains of features that once connected the two areas. Linear anomalies recorded elsewhere in the survey area, particular towards the western extent may also be contemporary but are more remotely located.

Extensive evidence of agricultural activity was recorded in both the western and eastern halves of the survey area on three different alignments which respect the boundaries that were constructed at or since the time of enclosure of Bolsover. It is clear that below ground remains of this probable post-medieval ridge and furrow survive at the site but these remains possess a low historical value and are of local significance only. Evidence of more modern agricultural activity was recorded in the western survey block in the form of land drainage along the eastern boundary.

Two groups of anomalies in the central band of the survey area coinciding with the bottom of a dry valley and the low-point of the site may indicate the presence of accumulations of colluvium, although an archaeological origin cannot be entirely discounted.

1.0 INTRODUCTION

1.1 Background

1.1.1 Ackroyd and Abbott Ltd appointed Archaeological Research Services Ltd (ARS Ltd) to undertake a geophysical survey of land off Oxcroft Lane, Bolsover, Derbyshire. The survey was carried out in advance of a planning application for a proposed housing development.

1.1.2 The purpose of the survey was to determine the potential for sub-surface archaeological remains to survive at the site, to provide sufficient information to enable the Local Planning Authority to make an informed decision on the archaeological implications of the proposed development, together with any appropriate mitigation works.

1.1.3 The objective was to carry out a non-intrusive survey to identify whether any anomalies of possible archaeological origin could be identified within the survey area which may be affected by the proposed development and which, consequently, may require further evaluation and/or specific mitigation.

1.1.4 This report presents the results of the geophysical survey.

1.2 Location, Topography and Geology

1.2.1 The geophysical survey area is centred at NGR SK 47548, 71640. It is bounded to the west by properties on Shuttlewood Road; to the east by Oxcroft Lane; to the south-east by light industrial land and on all other sides by fields. The survey area comprises a single field which undulates between a high point of 171m AOD in the south-east to a low point of 160m AOD in the north-east corner of the western half of the survey area

1.2.2 The underlying solid geology of the survey area comprises Dolostone of the Cadeby Formation - Sedimentary Bedrock formed approximately 251 to 271 million years ago in the Permian Period and widely referred to as the "Magnesian Limestone". No superficial deposits have been recorded (British Geological Survey 2015). The site stands approximately 500 metres east of the interface with the Middle Coal Measures sandstone and Permian sedimentary rocks and approximately 100 metres from the edge of the Magnesian Limestone escarpment to the west. The soil type is described as a freely-draining, lime-rich, loamy soil (NSRI 2015).

2.0 Archaeological Background

2.1 The site has been the subject of a desk-based assessment by Phil Sidebottom Archaeological Consultancy in April 2014 and the following summary of the

archaeological background is extracted from the 'An Archaeological Desktop Assessment of land off Oxcroft Lane, Bolsover, Derbyshire' (Sidebottom 2014).

2.2 Finds of Mesolithic flints have been noted in the vicinity of the subject area. One findspot lies *c*.600m to the south (HER 11240) and another close to the centre of Bolsover town, just under 1km to the south (HER 11260). Flints found about 950m to the north-east of the subject area (HER 5249) may also belong to this period but this is uncertain. The flint scatter at HER 11260 may have also contained Neolithic material, but this is the sole evidence for Neolithic activity in the vicinity of the subject area.

2.3 In recent years, aerial photography has identified several rectangular enclosures as cropmarks, especially on the Magnesian Limestone ridge, which may be evidence for late Iron Age occupation. Possible enclosures have been noted *c*.450m to the north-east of the subject area. They are described as a partially visible enclosure, a rectilinear feature and a possible small curvilinear double-ditched enclosure nearby. All of the features are intermittently visible and some could be geological in origin (NMR 1153099). Within the subject area is another potential enclosure recorded by HER entry 11258. Here the feature is described as a single-ditched enclosure, about 30m^2 with possible internal features and a possible opening at the north-east corner. It is visible on aerial photographs taken in 1996.

2.4 In the vicinity of the subject area, a sherd of Roman pottery was discovered about 1km north-west together with a Roman coin retrieved nearby (HER 11211 and 11218). Part of a Romano-British settlement was discovered in 1992 close to Bolsover town centre (HER 11259). It was dated to no later than the 3rd century AD. The settlement comprised an enclosure with stake-holes found in the base of its ditch. Inside the enclosure was evidence for industrial activity contained in hearth pits, gullies and pits containing metallic residues, including slag and hammer-scale. It is entirely possible that the cropmarks of enclosures described above, are representative of Romano-British settlement rather than late Iron Age.

2.5 The Domesday survey of 1086 records Bolsover ('Belesovre') as land under the control of William Peverel. It had land for two ploughs (previously four), meadow and woodland pasture. This Domesday inventory for Bolsover indicates a settlement of reasonable size, but not excessively so. The study of place-names in Derbyshire by Cameron, records 'Bolsover Moor' in 1568 and 'Holme Close', near Oxcroft (to the north of the subject area), is first mentioned in 1611. 'Limekiln Field' (Lyme Kilne furlong) is first mentioned in 1625, and in 1780 is recorded as one of three open fields in Bolsover. When the land was enclosed, 40 acres remained unenclosed to enable the quarrying of limestone. Additional stone quarrying is noted in the Bolsover area, with some of the stone being burned for the production of lime. A limekiln is recorded in 1810 on the Oxcroft Estate (immediately south of the PDA) and the land was still being worked for limestone in the 1830s.

2.6 The most distinctive feature of small-scale farming in the recent history of Bolsover was the creation of an estate of small holdings intended to give unemployed men

and their families a chance to make a living from the land The Oxcroft Settlement of 40 acres in total was split into 5 acre holdings. It was created in 1936 and the only project of its kind in Derbyshire, and one of only two in England initiated by a county council. The Oxcroft Estate was located *c*.700m south of the subject area and a corn mill is recorded in Limekiln Field, about 200m south-west of the subject area, in 1793.

3.0 METHODOLOGY

3.1 Magnetometry is a non-intrusive scientific prospecting technique that is the preferred geophysical technique used to determine the presence or absence of buried archaeological features when site and geological conditions are favourable. It is an efficient and effective method for locating anomalies corresponding with archaeological features. The instrument chosen for this survey was a Bartington Grad 601 dual sensor fluxgate gradiometer which can detect weak changes in the Earth's magnetic field caused by buried features.

3.2 All fieldwork and reporting was undertaken following Historic England and Chartered Institute for Archaeologists (CIfA) standards and guidance (Gaffney *et al*. 2008; CIfA 2013; CIfA 2014).

3.3 The 30m by 30m survey grids were located to cover the entire site (Figure 2). In total 76 survey grids (including partial grids) were set out on site using a hand-held GPS unit. Each grid was then surveyed at 1m traverse intervals with the sampling at 0.250m (4 readings per metre) intervals. The survey was carried out in 'zig-zag' mode with each alternate traverse walked in opposite directions. The range of the instrument was set at 100nT (0.01nT resolution). The direction of the first traverse in each grid was north-east.

3.4 The survey was carried out by ARS Ltd over three days between the 30th and 5th May 2015. Throughout the survey the weather was warm and dry. The ground conditions in the survey area were predominantly firm underfoot and in that respect ideal for geophysical survey. At the time of the survey all fields were under cereal crop. The survey area was free of obstructions but slightly restricted around the edges by the presence of ferrous materials in the boundary fences.

3.5 Prior to commencing the survey each day the gradiometer was balanced and calibrated to the local conditions and this was repeated regularly throughout each day. At the end of each day, the data was downloaded into a computer, checked and archived on the ARS Ltd server. The data was downloaded using Bartington Instruments' *Grad 601 Communication Application.*

4.0 GEOPHYSICAL SURVEY RESULTS

4.1 Introduction

4.1.1 The data was processed using Geoplot software. The data was "clipped" (clipping parameters selected on the mean and standard deviation data values), random iron spikes were removed by setting the "despike" function to 2.5 and the striping that can often appear in gradiometer data was removed by utilising the "zero mean traverse" function. Some minor staggering in the data, a consequence of the sloping ground conditions, was removed by using the "de-stagger" function and finally the data was interpolated.

4.1.2 Occasionally processing the data to compensate for directional sensitivity or to remove iron spikes caused by miscellaneous ferrous objects can also inadvertently disguise anomalies that may be of archaeological origin, particularly long linear features in the direction of the traverses. The data have, therefore, been analysed in a number of different formats and at each stage of processing.

4.1.3 The data analysis is presented graphically in Figures 3 to 6. A greyscale shade plot of the processed gradiometer data is presented in Figure 3 and trace plots of the eastern and western halves of the survey area in Figures 4 and 5. An interpretative plan is presented in Figure 6.

4.1.4 Not all anomalies have been included in the results and discussion. The data was characterised by discrete widely dispersed anomalies that are common on most sites and almost certainly relate to bedrock fragments in the topsoil, natural variations in the soils and geology, agricultural disturbance and miscellaneous ferrous litter on the surface of the field.

4.2 Anomalies (refer to Figure 6)

4.2.1 The results in the eastern half of the survey area are dominated by a large group of clearly defined anomalies that represent the probable surviving remains of an extensive field system with a number of contemporary paddocks or possible settlement enclosures and two double-ditched track ways or major boundaries (anomaly group 1). Also within this area inumerable small discrete anomalies are suggestive of archaeological pits or truncated ditches but a proportion may represent natural soil-filled depressions in the underlying limestone or other geological features, possibly connected to the extraction of limestone (Sidebottom 2014, 21).

4.2.2 Also within the eastern half of the survey area the results suggest a further phase of possible occupation on a different alignment to anomaly group 1 (anomaly group 2). In this case the results are less clear and also suggest a combination of

anthropogenic activity due to the regularity of a number of the anomalies (2a – 2i) and probable natural fissures in the limestone which are more sinuous in form.

4.2.3 The distribution of anomalies in the western half of the survey area suggest that this part of the site is host to far fewer surviving archaeological features than the east. However, towards the south, the results have revealed a significant anomaly (anomaly 3) that indicates three sides of a probable ditched enclosure greater than 30m in length by 20m wide with what appears to be an entrance causeway in the south-west corner. The alignment of anomaly 3 is similar to that of anomaly group 1 and the features may be contemporary but this cannot be stated with any certainty. Within anomaly group 3 there is evidence of internal features. To the south and south-east of anomaly group 3 a small group of linear and discrete anomalies (4) and an isolated linear anomaly (5) are likely to be associated as they share a similar alignment. To the north of anomaly group 3, two perpendicular anomalies again share a similar alignment although they are much less well defined in the data.

4.2.4 In the north-eastern corner of the western block of the survey area a cluster of discrete anomalies (anomaly group 6) are suggestive of a group of archaeological pits. However this is the lowest point in the survey area and the anomalies may therefore indicate the presence of accumulations of colluvium or silt-filled natural depressions at the bottom of the hill. Similarly, linear anomaly 7 and a number of discrete anomalies (group 8) are indicative of colluvium; an interpretation supported by the location close to the base of a dry valley.

4.2.5 Three groups of parallel anomalies were recorded in distinct parts of the survey area: in the western block anomalies aligned approximately east-west and respecting the alignment of the northern boundary (anomaly group 10); in the northern two thirds of the eastern block, anomalies aligned approximately west-north-west/east-south-east and respecting the alignment of the northern boundary in this block (anomaly group 11) and in the southern third of the western block, anomalies aligned approximately north-north-east/south-south-west and respecting the field boundaries in that part of the survey area (anomaly group 12). In all cases the boundaries dictating the alignment of these anomalies can be seen to have remained unchanged since at least the time of enclosure of Bolsover from cartographic evidence presented in the DBA (Sidebottom 2014, 15). The three anomaly groups have therefore been interpreted as the surviving remains of medieval or post-medieval ridge and furrow cultivation.

4.2.6 Evidence of more recent agricultural activity was recorded along the eastern boundary of the western block. A group of parallel linear anomalies (anomaly group 13) aligned approximately south-west/north-east represent field drainage which presumably has been laid down the slope towards the low part of the field. Towards the south-west corner of the western block a small group of strong dipolar anomalies (group 14) are suggestive of modern activity possibly associated with a utility service or electric fence. A linear anomaly passing through anomaly group 14 would appear to be associated but the exact origin is unclear and it is possible that

the position of the anomaly is coincidental and it may in fact be contemporary with anomalies 3, 4 and 5.

5.0 DISCUSSION AND CONCLUSIONS

5.1 The results of the geophysical survey were generally very good and the raw data only required minimal processing to produce clear images and plots. The results have revealed definite evidence for potentially significant and previously unknown archaeological remains within the survey area which are possibly multi-phase.

5.2 In the east of the survey area an extensive group of clearly defined inter-connected anomalies indicate the presence of the surviving remains of a field system of probable late-Iron Age or Romano-British date and possible settlement or paddock enclosures. The field system of which the main axis is aligned approximately north-north-east/south-south-west includes probable field boundaries, paddocks or settlement enclosures, and track ways almost certainly associated with agriculture and animal husbandry. This particular group of anomalies does not correlate, in terms of alignment or location, with the crop marks referred to in the DBA (Sidebottom 2014, 20) and it is therefore likely that the anomalies represent a different phase of activity than the one that has previously been interpreted from aerial photographs (HER 11258). Innumerable small discrete anomalies reminiscent of archaeological pits and other soil filled archaeological cut features have been interpreted as contemporary with this phase of activity. It should, however, also be considered that the features may not be contemporary and may even be natural in origin or represent more modern activity associated with the extraction of limestone (Sidebottom 2014).

5.3 Also in the east of the survey area a further group of anomalies are aligned more to the north-east/south-west and north-west/south-east and although they do not correspond exactly with the crop marks identified in the DBA (Sidebottom 2014, 21) it is likely that they represent some of the same features. All of the anomalies in this group are weak and poorly defined in the geophysical survey results but, where they can be identified, a number appear sufficiently regular to suggest anthropogenic activity. Others, however are more sinuous and are indicative of natural fissures in the limestone. It is possible that all the anomalies in this group are natural in origin but this is thought to be unlikely given the form and alignment of a number of the anomalies and taking into account the aerial photography transcription (HER 11258).

5.4 It is noteworthy that not all the features identified from aerial photography in the DBA (Sidebottom 2014) have been recorded in the geophysical survey results. Many more clearly defined but unrelated anomalies have, however, been recorded. As the aerial photographs that show the anomalies were taken in 1996, it is unlikely but possible, that some of the features have been destroyed by the plough in the intervening years. More likely is that the features identified from aerial photography have produced a weaker geophysical signal for geological or pedological reasons and/or there has been a masking effect created by the stronger geophysical anomalies in the same part of the survey area.

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5.6 Extensive evidence of agricultural activity was recorded in both the western and eastern halves of the survey area on three different alignments which respect the boundaries that were constructed at or since the time of enclosure of Bolsover. It is clear that below ground remains of this probable post-medieval ridge and furrow survive at the site but these remains possess a low historical value and are of local significance only. Evidence of more modern agricultural activity was recorded in the western survey block in the form land drainage along the eastern boundary

5.6 Two groups of anomalies in the central band of the survey area coinciding with the bottom of a dry valley and the low-point of the site may indicate the presence of accumulations of colluvium, although an archaeological origin cannot be entirely discounted.

5.8 The results of this geophysical survey should be considered in conjunction with the DBA (Sidebottom 2014).

6.0 PUBLICITY, CONFIDENTIALITY AND COPYRIGHT

6.1 Any publicity will be handled by the client.

6.2 Archaeological Research Services Ltd will retain the copyright of all documentary and photographic material under the Copyright, Designs and Patent Act (1988).

7.0 STATEMENT OF INDEMNITY

7.1 All statements and opinions contained within this report arising from the works undertaken are offered in good faith and compiled according to professional standards. No responsibility can be accepted by the author/s of the report for any errors of fact or opinion resulting from data supplied by any third party, or for loss or other consequence arising from decisions or actions made upon the basis of facts or opinions expressed in any such report(s), howsoever such facts and opinions may have been derived.

8.0 ACKNOWLEDGEMENTS

8.1 Archaeological Research Services Ltd would like to thank those involved in the project for their help and assistance. In particular we would like to thank Bob

Askham of Ackroyd and Abbott Ltd for commissioning the survey and arranging access and Steve Baker Development Control Archaeologist at Derbyshire County Council for his help and advice and for approving the Written Scheme of Investigation.

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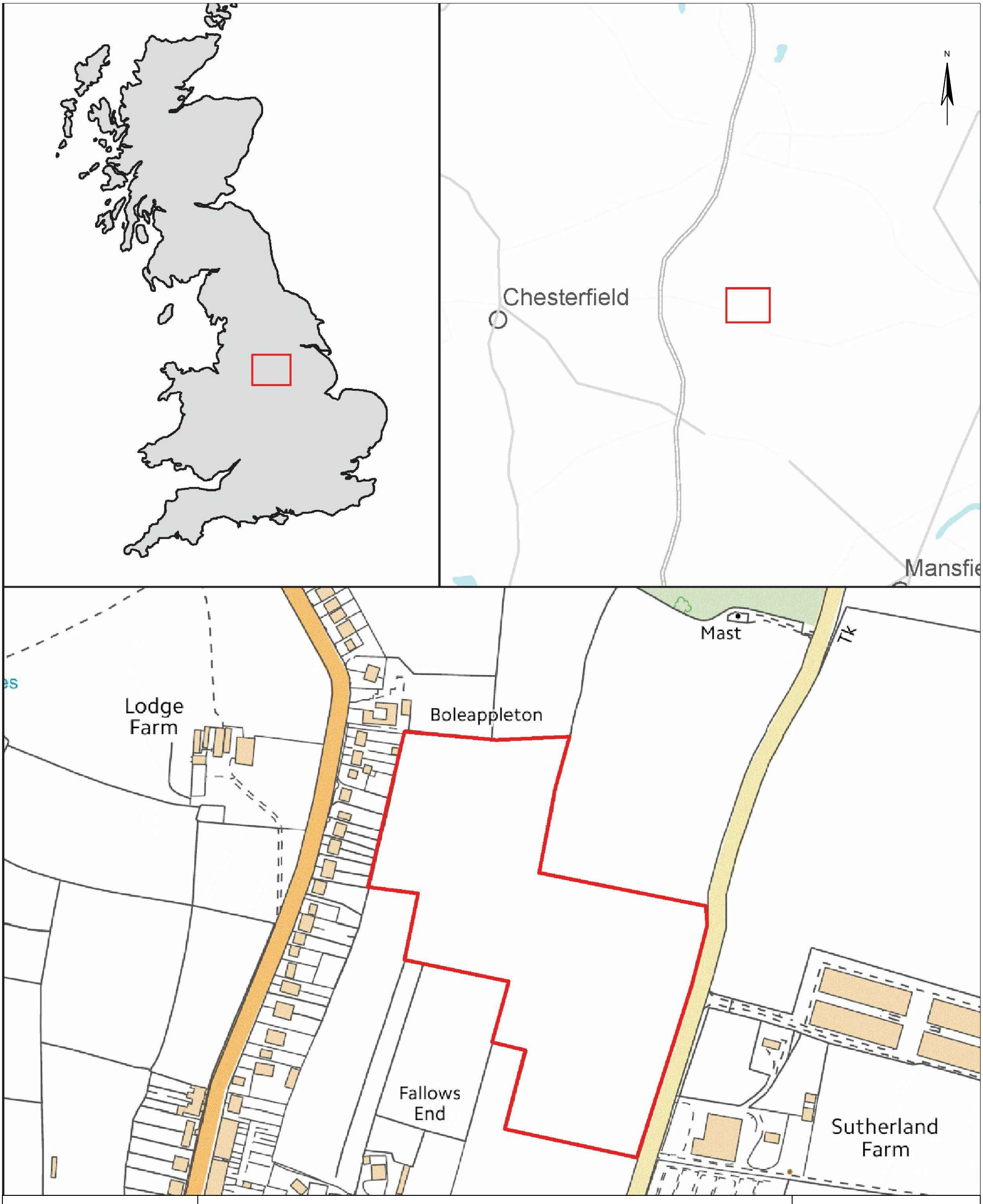
Appendix 1: Figures



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Site Code: Bolsover
Drawing Ref: Figure 1
Date: May 2015
Drawn: RD
Scale: As shown

Figure 1
Site Location

Key:

Geophysical Survey Area

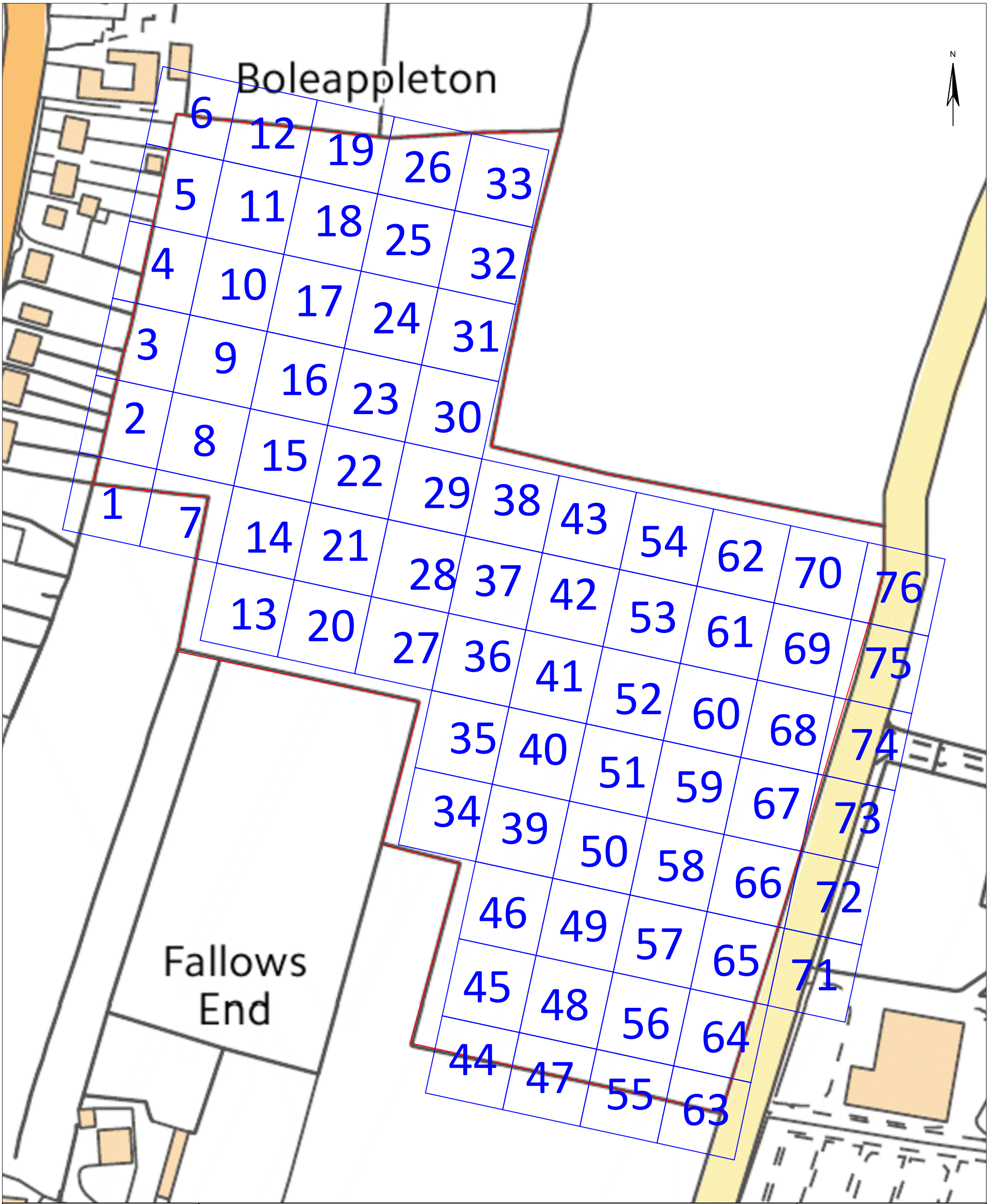

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Figure 2
Location of Survey Grids

Key:

Geophysical Survey Area

1 30m x 30m Survey Grids

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Site Code: Bolsover
Drawing Ref: Figure 3
Date: May 2015
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Scale: As shown

Figure 3
Greyscale Shade Plot of Processed Gradiometer Data

Key:

Geophysical Survey Area

3.00
2.50
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
-2.50
-3.00
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Site Code: Bolsover
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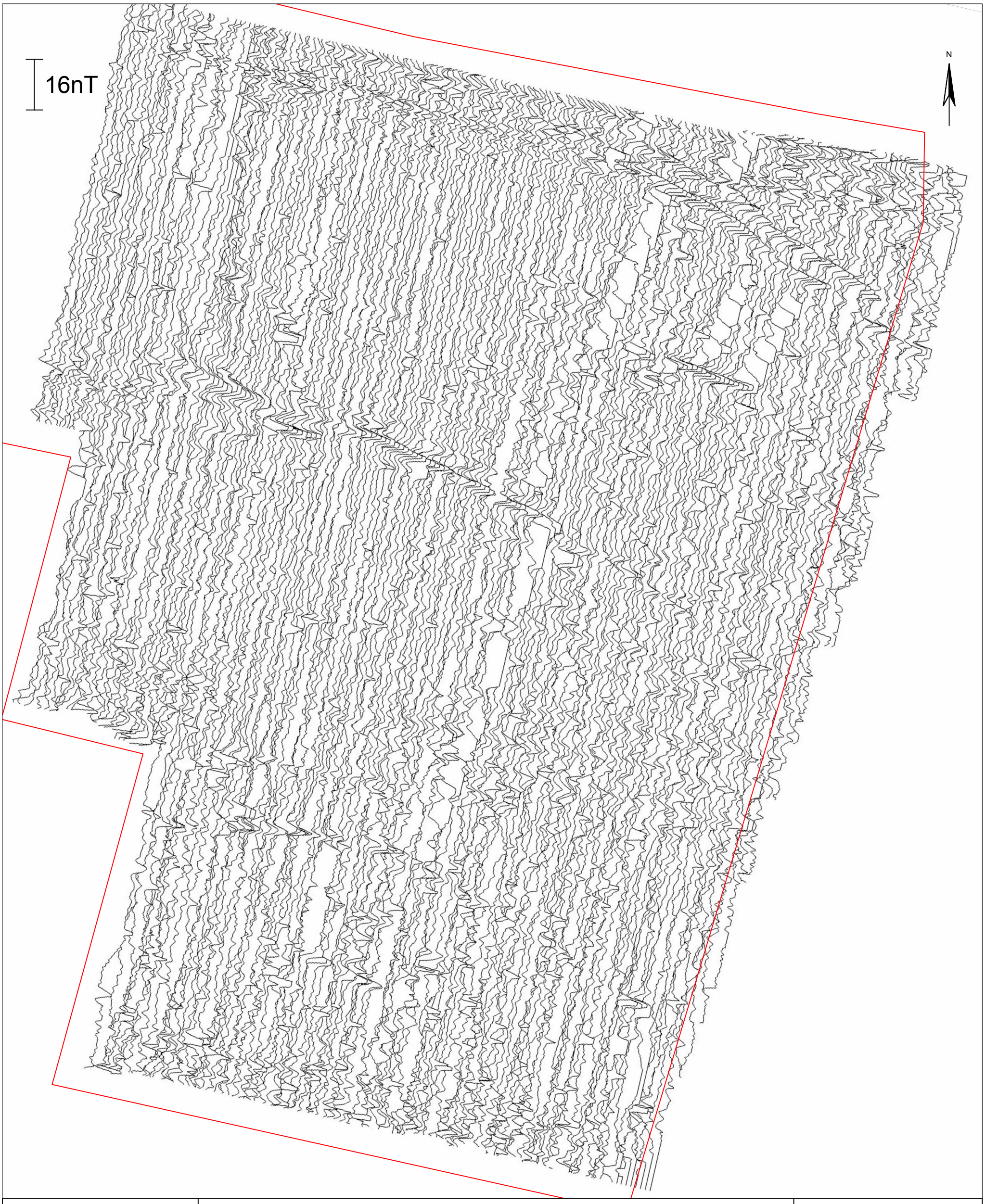
Figure 4
Trace Plot (west)

Key:

Geophysical Survey Area



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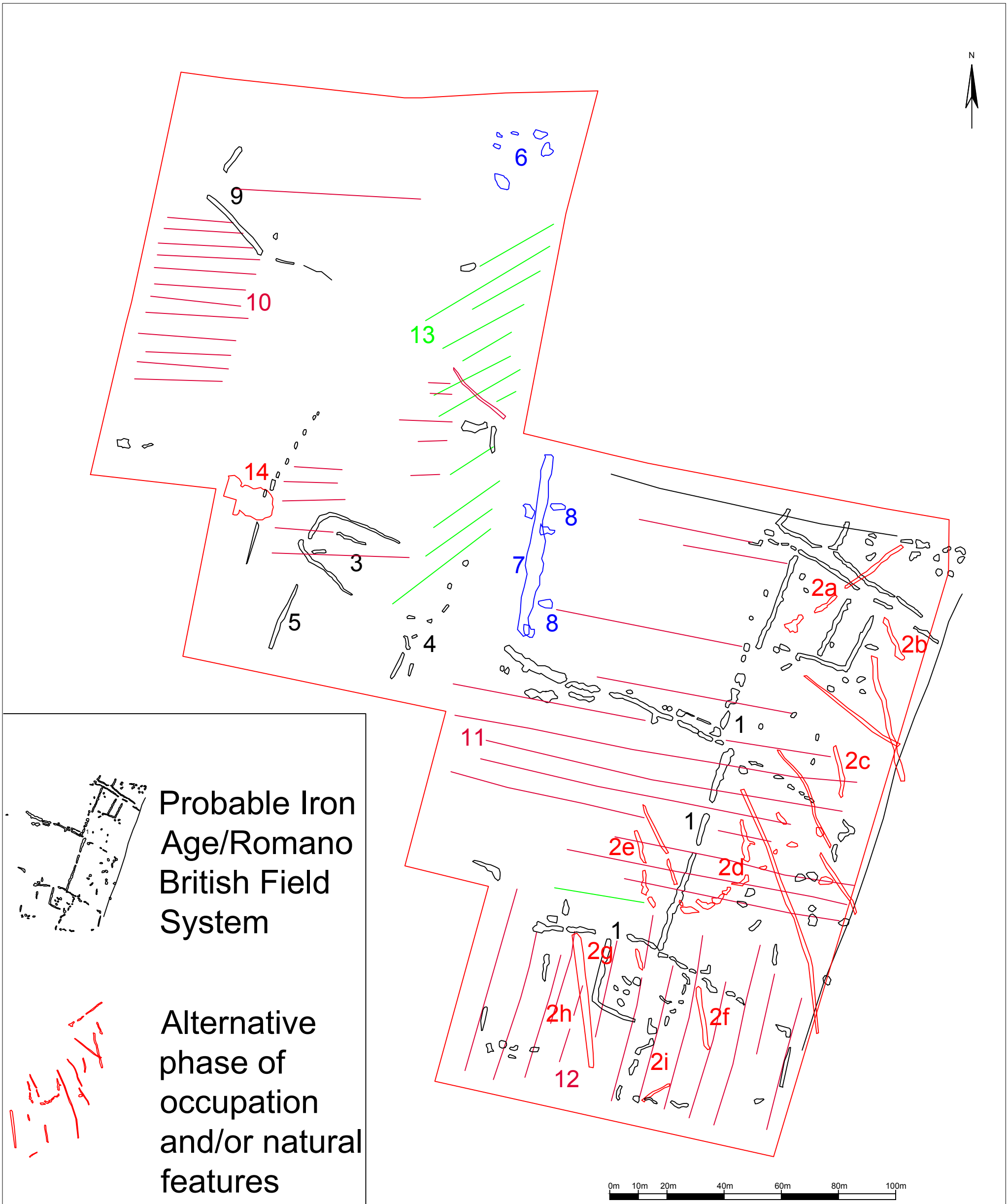
Site Code: Bolsover
Drawing Ref: Figure 4
Date: May 2015
Drawn: RD
Scale: As shown

Figure 5
Trace Plot (east)

Key:

Geophysical Survey Area



Probable Iron Age/Romano British Field System

Alternative phase of occupation and/or natural features

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Site Code: Bolsover
Drawing Ref: Figure 6
Date: May 2015
Drawn: RD
Scale: As shown

Figure 6
Interpretative Plan

Key:
- Geophysical Survey Area
- Archaeology
- Archaeology/geology
- Field boundary
- Natural/archaeology
- Ridge and furrow
- Field Drainage
- Modern

Appendix 2: Written Scheme of Investigation

Archaeological Research Services Ltd

Land West of Oxcroft Lane, Bolsover, Derbyshire

Written Scheme of Investigation for a Geophysical Survey

April 2015

1 Introduction

1.1 Project Background

1.1.1 This document comprises a Written Scheme of Investigation (WSI) for a geophysical survey of land west of Oxcroft Lane, Bolsover, Derbyshire. It outlines the proposed method of investigation to be used by Archaeological Research Services Ltd (ARS Ltd) for surveying the *c.*5.6 ha site.

1.1.2 DLP Planning Ltd has submitted a planning application (REF: 15/00076/OUT) on behalf of Ackroyd and Abbot to develop the land west of Oxcroft Lane, Bolsover. In consultation with the Derbyshire Development Control officer, the site should be assessed for potential archaeological remains by geophysical (magnetometry) survey.

1.2 Location and Land-Use

1.2.1 The site comprises a single field to the west of Oxcroft Lane and east of the B6419, almost 1km north of Bolsover town centre and is centred at NGR SK 47536 71665 (Figure 1: see below).

1.2.2 The subject area lies at typically 160-170m AOD on Permain Magnesian Limestone of the Cadeby Formation and stands approximately 500m east of its interface with Middle Coal Measures sandstone and Permain sedimentary rocks and approximately 100m from the edge of the Magnesian Limestone escarpment, to the west. (BGS 2015). The soil type is described as a freely-draining, lime-rich, loamy soil (NSRI 2014).

2 Archaeological Background

2.1 The site has been the subject of a desk-based assessment by Phil Sidebottom Archaeological Consultancy in April 2014 and the following summary of the archaeological background is extracted from the 'An Archaeological Desktop Assessment of land off Oxcroft Lane, Bolsover, Derbyshire' (Sidebottom 2014).

2.2 Finds of Mesolithic flints have been noted in the vicinity of the subject area. One findspot lies *c.*600m to the south (HER 11240) and another close to the centre of Bolsover town, just under 1km to the south (HER 11260). Flints found about 950m to the north-east of the

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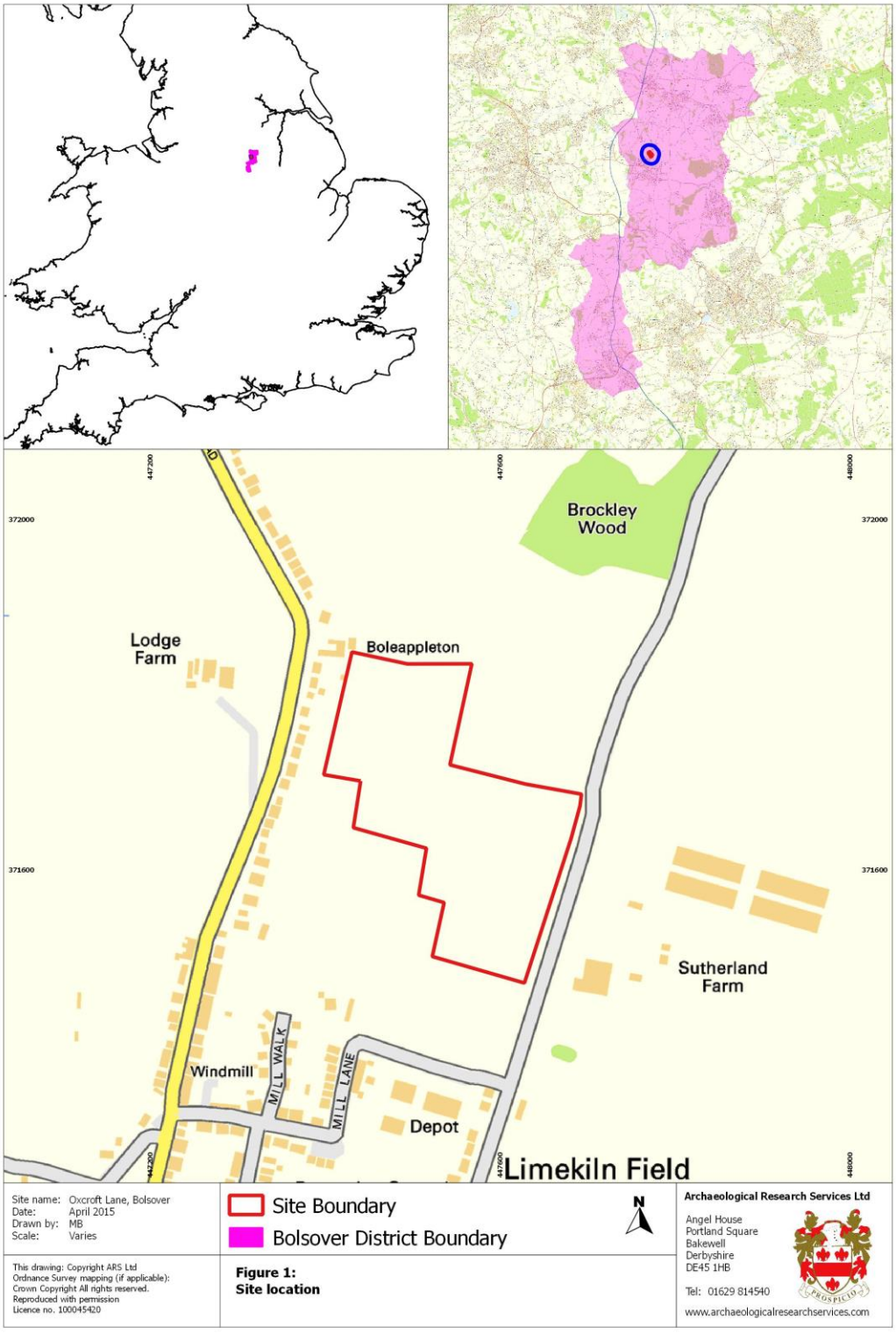

2.3 In recent years, aerial photography has identified several rectangular enclosures as cropmarks, especially on the Magnesian Limestone ridge, which may be evidence for late-Iron Age occupation. Possible enclosures have been noted *c.* 450m to the north-east of the subject area. They are described as a partially visible enclosure, a rectilinear feature and a possible small curvilinear double-ditched enclosure nearby. All of the features are intermittently visible and some could be geological in origin (NMR 1153099). Within the subject area is another potential enclosure recorded by HER entry 11258. Here the feature is described as a single-ditched enclosure, about 30m^2 with possible internal features and a possible opening at the north-east corner. It is visible on aerial photographs taken in 1996.

2.4 In the vicinity of the subject area, a sherd of Roman pottery was discovered about 1km north-west together with a Roman coin retrieved nearby (HER 11211 and 11218). Part of a Romano-British settlement was discovered in 1992 close to Bolsover town centre (HER 11259). It was dated to no later than the 3rdc. CE. The settlement comprised an enclosure with stake-holes found in the base of its ditch. Inside the enclosure was evidence of industrial activity contained in health pits, gullies and cuts containing metallic residues, including slag and hammer-scale. It is entirely possible that the cropmarks of enclosures described above, are representative of Romano-British settlement rather than late-Iron Age.

2.5 The *Domesday* survey of 1086 records Bolsover ('Belesovre') as land under the control of William Peverel. It had land for two ploughs (previously four), meadow and woodland pasture. This *Domesday* inventory for Bolsover indicates a settlement of reasonable size, but not excessively so. The study of place-names in Derbyshire by Cameron, records 'Bolsover Moor' in 1568 and 'Holme Close', near Oxcroft)to the north of the subject area) is first mentioned in 1611. 'Limekiln Field' (Lyme Kilne furlong) in first mentioned in 1625, and in 1780 is recorded as one of three open fields in Bolsover. When the land was enclosed, 40 acres remained unenclosed to enable the quarry of limestone. Additional stone quarrying is noted in the Bolsover area, with some of the stone being burned for the production of lime. A limekiln is recorded in 1810 on the Oxcroft Estate (immediately south of the PDA) and the land was still being worked for limestone in the 1830s.

2.6 The most distinctive feature of small-scale farming in the recent history of Bolsover was the creation of an estate of small holdings intended to give unemployed men and their families a chance to make a living from the lane. The Oxcroft Settlement of 40 acres in total was split into 5 acre holdings. It was created in 1936 and the only project of its kind in Derbyshire, and one of only two in England initiated by a county council. The Oxcroft Estate was located *c.* 700m south of the subject area and a corn mill is recorded in Limekiln Field, about 200m south-west of the subject area, in 1793.

3 Objectives

3.1 The objective of the gradiometer survey is to identify anomalies of possible archaeological origin within the survey area (see Figure 1) in order to identify and record the possible presence/absence, location, nature and extent of prehistoric and later historic archaeological deposits that may exist on the proposed development site.

4 Geophysical Survey

4.1 Coverage

4.1.1 It is intended to conduct a geophysical (magnetometer) survey over a *c.*4.5ha area of the site of the proposed development.

4.2 Selected technique

4.2.1 The geophysical survey technique selected for the site is magnetometry. Magnetometry using Fluxgate Gradiometer instruments is the preferred geophysical technique utilised for the detection of buried features such as iron-based features and objects, or those subjected to firing such as kilns, hearths and even the buried remains of brick walls. It is also used to locate more subtle features such as boundary or enclosure ditches, pits and post holes which have been gradually in-filled by more humic material. The breakdown of organic matter through microbiotic activity leads to the humic material becoming rich in magnetic iron oxides when compared with the subsoil allowing features to be detected. In addition to this, variations in the magnetic susceptibility between the topsoil, subsoil and bedrock have a localised effect on the Earth's magnetic field enabling the detection of features such as backfilled ditches or pits due to the fact that the topsoil has more magnetic properties than the subsoil or bedrock, resulting in a 'positive' magnetic anomaly. Conversely, earthwork or embankment features can also be identified as 'negative' magnetic anomalies due to the action of placing less magnetic subsoil on top of more magnetic top soil.

4.3 Methodology

4.3.1 A survey grid comprising 30m x 30m individual grids will be set up over the selected survey areas. The survey will use a temporary survey grid accurately positioned using a suitable DGPS system. The temporary grid will be co-registered to the Ordnance Survey National Grid using digital tiles provided by ARS Ltd or suitable digital map tiles provided by the client.

4.3.2 These grids will then be surveyed using a Bartington Grad 601-2 gradiometer. The Grad 601-2 has two gradiometer sensors and therefore collects two lines of data during each traverse. Data are collected in a zigzag fashion within the grid starting in the north-west corner, facing east. Readings are taken every 0.25m on traverses 1m apart. This equates to 3600 readings in a complete 30mx30m grid. Sensor balance will be checked and adjusted at regular intervals.

4.3.3 At the end of each day the data will be downloaded to a PC or laptop using Geoscan *Geoplot V3*.

4.3.4 All staff employed on the geophysical survey will be suitably qualified and experienced for their respective project roles and have practical experience of geophysical survey.

4.3.5 All staff will be made aware of the archaeological potential of the area and will be fully briefed on the work required by this WSI.

4.4 Data Processing, Interpretation and Report

4.4.1 Data processing will be undertaken by a geophysicist using Geoscan *Geoplot V3*. Anomalies will be digitised and geo-referenced. They will be colour coded using ARS Ltd's standard

scheme to provide the most likely interpretation. Anomalies will be numbered and catalogued as systematic groups or individual anomalies as appropriate. The final report will include a graphical and textual account of the techniques undertaken, the data obtained and an archaeological interpretation of that data and conclusions about any likely archaeology. The report will describe the work undertaken and the results obtained. It will (as a minimum) include the following.

- A Non-technical summary
- Introduction
- Geological and topographical setting
- Methodology
- Discussion of archaeological and historical background
- Discussion on the results of the survey
- Conclusions and recommendations
- Sources
- Copy of brief
- Figure showing location of the site
- Figure showing location of survey grids and referencing
- Figure showing processed data
- Figure showing trace plots of processed data
- Figure showing abstraction and interpretation of anomalies.

4.4.2 The presentation and interpretation of the results will be carried out in accordance with the *Code of Conduct* of the Chartered Institute for Archaeologists (CIfA 2014a) and will follow the English Heritage guidelines (2008) *Geophysical Survey in Archaeological Field Evaluation* and CIfA *Standard and Guidance for archaeological geophysical survey* (2014b). ARS Ltd is a corporate member of the International Society of Archaeological Prospection (ISAP).

5 Project management

5.1 ARS Ltd is a Registered Organisation with the Chartered Institute for Archaeologists (CIfA). Registered Organisations are continuously assessed to ensure that the highest standards of work are carried out, in line with the *Code of Conduct* of the CIfA (2014a). In addition to our key management staff, who have achieved the highest grade of corporate CIfA membership, many of our field staff also hold corporate grade membership.

5.2 All staff employed on the project will be suitably qualified and experienced for their respective project roles and have practical experience of geophysical surveying and reporting. All staff will be made aware of the archaeological importance of the area surrounding the site and will be fully briefed on the work required by this specification. Each member of staff will be fully conversant with the aims and methodologies and will be given a copy of this WSI to read. All members of staff employed by ARS Ltd are fully qualified and experienced archaeologists, this will ensure that appropriate decisions regarding excavation and sampling will be made in the field.

5.3 *Project Team*

Project management:	Chris Scott BA, MLitt, MIfA (ARS Ltd)
Geophysical surveyors:	Richard Durkin BEng (ARS Ltd)

6 Access

6.1 ARS Ltd will give the Derbyshire Development Control Officer at least two weeks (or less if so agreed) notice of the commencement of fieldwork.

6.2 ARS Ltd will liaise with the Derbyshire Development Control Officer at regular intervals throughout the course of the work to ensure that the project aims and objectives are met.

Steve Baker
Derbyshire County Council
Shand House
Dale Road South
Matlock
Derbyshire
DE4 3RY
Tel: 01629 539773

7 Report Deposition

7.1 An OASIS online record http://ads.ahds.ac.uk/project/oasis/ will be initiated and, as the project proceeds, information will be added to this record. Key fields will be completed on Details, Location and Creators forms. All parts of the OASIS online form will be completed for submission to the HER. This will include an uploaded .pdf version of the entire report (a paper copy will also be included within the archive).

7.2 Copies of the final report will be deposited with the Derbyshire Historic Environment Record in bound and PDF/A format.

7.3 The Derbyshire Development Control Officer will be notified of the final deposition of the report.

8 Changes to Methodology or Work Programme

8.1 Changes to the approved methodology or programme of works will only be made with the prior written approval of the Derbyshire Development Control Officer.

9 Health and Safety

9.1 A full health and safety risk assessment will be carried out prior to the survey commencing. All people working on the site will be briefed on the safety requirements whilst working on-site and given access to a copy of the risk assessment and all ARS Ltd staff working on the site will undergo a Health and Safety induction. ARS Ltd maintains a strict health and safety policy, as well as having Contractors Health and Safety Assessment Scheme (CHAS) Accreditation. The appointed Health and Safety Officer for the company is Chris Scott.

10 References

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