



**magnitude
surveys**

**Geophysical Survey Report
of
Land off Hoyland, Barnsley**

**For
Oxford Archaeology**

**On Behalf Of
Newlands Property Developments LLP**

Magnitude Surveys Ref: MSSK665

HER Event Number: To be assigned after submission to HER

May 2020



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Abstract

Magnitude Surveys was commissioned to assess the subsurface archaeological potential of a c. 1.28ha area of land off Hoyland, Barnsley, an additional 1.12ha were outlined to be surveyed in compliance with EAC guidelines. A fluxgate gradiometer survey was successfully completed across the majority of the survey area. The geophysical survey has primarily detected ferrous-type anomalies likely related to the former industrial usage of the site. No anomalies strongly indicative of archaeological origin have been detected. Anomalies related to historical agricultural use have been detected and interpreted as possible ridge and furrow cultivation, a possible former field boundary and possible drainage features. The visibility of modern activities within the results is diminished because of the strong effect of intense historic industrial utilisation for ironstone mining and related infrastructure. However, a broad band of magnetic disturbance has been detected adjacent to Black Lane. Natural variations have been recorded in the centre of the survey area, which has been least effected by industrial activity. Anomalies of undetermined origin have been recorded where the magnetic signal is ambiguous, and the limited context of the survey area does not allow for confident classification.

Contents

Abstract.....	2
List of Figures	4
1. Introduction	5
2. Quality Assurance	5
3. Objectives.....	5
4. Geographic Background.....	6
5. Archaeological Background.....	6
6. Methodology.....	7
6.1. Data Collection.....	7
6.2. Data Processing.....	7
6.3. Data Visualisation and Interpretation.....	8
7. Results.....	9
7.1. Qualification.....	9
7.2. Discussion.....	9
7.3. Interpretation.....	10
7.3.1. General Statements	10
7.3.2. Magnetic Results - Specific Anomalies.....	10
8. Conclusions	11
9. Archiving	12
10. Copyright.....	12
11. References	12
12. Project Metadata	13
13. Document History	13

List of Figures

Figure 1:	Site Location	1:25,000 @ A4
Figure 2:	Location of Survey Areas	1:8,000 @ A3
Figure 3:	Magnetic Gradient (Overview)	1:3,000 @ A3
Figure 4:	Magnetic Interpretation Over Historic Maps (Overview)	1:3,000 @ A3
Figure 5:	Magnetic Gradient (North)	1:1,000 @ A3
Figure 6:	Magnetic Interpretation (North)	1:1,000 @ A3
Figure 7:	XY Trace Plot (North)	1:1,000 @ A3
Figure 8:	Magnetic Gradient (South)	1:1,500 @ A3
Figure 9:	Magnetic Interpretation (South)	1:1,500 @ A3
Figure 10:	XY Trace Plot (South)	1:1,500 @ A3

1. Introduction

- 1.1. Magnitude Surveys Ltd (MS) was commissioned by Oxford Archaeology on behalf of Newlands Property Developments LLP to undertake a geophysical survey on a c.1.28ha area of land off Hoyland, Barnsley (SK 35907 98820), and an additional c.1.12ha of survey required to meet EAC guidelines for the minimum width of survey corridors to be 30m.
- 1.2. The geophysical survey comprised hand-carried GNSS-positioned fluxgate gradiometer survey.
- 1.3. The survey was conducted in line with the current best practice guidelines produced by Historic England (David et al., 2008), the Chartered Institute for Archaeologists (CIfA, 2014) and the European Archaeological Council (Schmidt et al., 2015).
- 1.4. It was conducted in line with a WSI produced by MS (2020).
- 1.5. The survey commenced on 7 May 2020 and was completed on the same day.

2. Quality Assurance

- 2.1. Magnitude Surveys is a Registered Organisation of the Chartered Institute for Archaeologists (CIfA), the chartered UK body for archaeologists, and a corporate member of ISAP (International Society of Archaeological Prospection).
- 2.2. The directors of MS are involved in the cutting edge of research and the development of guidance/policy. Specifically, Dr. Chrys Harris has a PhD in archaeological geophysics from the University of Bradford, is a Member of CIfA and is the Vice-Chair of the International Society for Archaeological Prospection (ISAP); Finnegan Pope-Carter has an MSc in archaeological geophysics and is a Fellow of the London Geological Society, as well as a member of GeoSIG (CIfA Geophysics Special Interest Group); Dr. Kayt Armstrong has a PhD in archaeological geophysics from Bournemouth University, is a Member of CIfA, the Editor of ISAP News, and is the UK Management Committee representative for the COST Action SAGA; Dr. Paul Johnson has a PhD in archaeology from the University of Southampton, has been a member of the ISAP Management Committee since 2015, and is currently the nominated representative for the EAA Archaeological Prospection Community to the board of the European Archaeological Association.
- 2.3. All MS managers have relevant degree qualifications to archaeology or geophysics. All MS field and office staff have relevant archaeology or geophysics degrees and/or field experience.

3. Objectives

- 3.1. The objective of this geophysical survey is to assess the subsurface archaeological potential of the survey area.

4. Geographic Background

4.1. The survey area was located c.1.82km southwest of Hoyland (Figure 1). Survey was undertaken across four fields, one of which was under pasture and the rest under arable usage. The survey area was bounded by Black Lane to the southwest, woodland to the west, Bell Ground House in the northeast and further fields to the north, east and south (Figure 2). Some of the survey area could not be surveyed: c.0.5ha due to access restrictions, c.0.1ha due to overgrown vegetation.

4.2. Survey considerations:

Survey Area	Ground Conditions	Further Notes
1	Flat, arable field which was ploughed and rolled.	The area was bounded to the north by hedgerows and a wire fence, and to the east and south by hedgerows. To the west the field continued beyond the survey area.
2	Flat, field in use as a meadow.	The area was bounded to the south and north by hedgerows and wire fence. To the west and east the field continued beyond the survey area.
3	Arable field which was ploughed and rolled. The topography sloped down from north to south.	The area was bounded to the south and north by hedgerows and wire fence. To the west and east the field continued beyond the survey area.
4	Flat, arable field which was ploughed and rolled. An area of waist high overgrown thistles prevented a small section of survey.	The area was bounded to the west and north by hedgerows. To the east the field continued beyond the survey area. To the south the area was bounded by a stream and wire fencing. Overhead cables ran across the southern part of the area in a west to east alignment.

4.3. The underlying geology across Areas 1, 2, 3 and the southern half of Area 4 comprised Pennine Middle Coal Measures Formation mudstone, siltstone and sandstone. The underlying geology in the north of Area 4 comprised Pennine Coal Measures sandstone. No superficial deposits are recorded across the survey area (British Geological Survey, 2020).

4.4. The soils consist slowly permeable seasonally wet acid loamy and clayey soils (Soilscapes, 2020).

5. Archaeological Background

5.1. The following is a summary of a desk-based assessment produced and provided by Oxford Archaeology (2020).

5.2. Little prehistoric activity is recorded within the vicinity of the survey area; Iron Age/ Romano-British field systems are recorded to the east of Barnsley, in Goldthorpe and Billingley areas. A curvilinear ditched enclosure dating to the Iron Age/Romano-British period has been recorded 1.4km to the southeast of the survey area (SYAS 05575). Roman roads in South Yorkshire run to the east of Barnsley close to the study area, and Roman coins were excavated at St Peter's Church 1.8km to the north of the survey area.

- 5.3. From the fifteenth century the survey area formed part of Tankersley deer park, and an engraving dating from 1709 shows that the survey area still fell within the park's boundaries, covered in trees and some grazing land. Enclosure of the land progressed into the mid-eighteenth century and mining became prominent in the region.
- 5.4. First edition map of 1855 shows Tankersley Park Railway ran through the northern half of the survey area, and numerous bell pits were located immediately north, east and west. A later map from 1893 shows a woodland plantation over the area of the former pits, and the removal of the railway. Lidgett colliery which was established in 1879 is marked immediately east of the survey area. Open cast mining continued in the vicinity of the survey area through to the early 1950s.

6. Methodology

6.1. Data Collection

6.1.1. Geophysical prospection comprised the magnetic method as described in the following table.

6.1.2. Table of survey strategies:

Method	Instrument	Traverse Interval	Sample Interval
Magnetic	Bartington Instruments Grad-13 Digital Three-Axis Gradiometer	1m	200Hz reprojected to 0.125m

6.1.3. The magnetic data were collected using MS' bespoke hand-carried GNSS-positioned system.

6.1.3.1. MS' hand-carried system was comprised of Bartington Instruments Grad 13 Digital Three-Axis Gradiometers. Positional referencing was through a multi-channel, multi-constellation GNSS Smart Antenna RTK GPS outputting in NMEA mode to ensure high positional accuracy of collected measurements. The RTK GPS is accurate to 0.008m + 1ppm in the horizontal and 0.015m + 1ppm in the vertical.

6.1.3.2. Magnetic and GPS data were stored on an SD card within MS' bespoke datalogger. The datalogger was continuously synced, via an in-field Wi-Fi unit, to servers within MS' offices. This allowed for data collection, processing and visualisation to be monitored in real-time as fieldwork was ongoing.

6.1.3.3. A navigation system was integrated with the RTK GPS, which was used to guide the surveyor. Data were collected by traversing the survey area along the longest possible lines, ensuring efficient collection and processing.

6.2. Data Processing

6.2.1. Magnetic data were processed in bespoke in-house software produced by MS. Processing steps conform to Historic England's standards for "raw or minimally processed data" (see sect 4.2 in David et al., 2008: 11).

Sensor Calibration – The sensors were calibrated using a bespoke in-house algorithm, which conforms to Olsen et al. (2003).

Zero Median Traverse – The median of each sensor traverse is calculated within a specified range and subtracted from the collected data. This removes striping effects caused by small variations in sensor electronics.

Projection to a Regular Grid – Data collected using RTK GPS positioning requires a uniform grid projection to visualise data. Data are rotated to best fit an orthogonal grid projection and are resampled onto the grid using an inverse distance-weighting algorithm.

Interpolation to Square Pixels – Data are interpolated using a bicubic algorithm to increase the pixel density between sensor traverses. This produces images with square pixels for ease of visualisation.

6.3.Data Visualisation and Interpretation

- 6.3.1. This report presents the gradient of the sensors' total-field data as greyscale images. The gradient of the sensors minimises external interferences and reduces the blown-out responses from ferrous and other high contrast material. However, the contrast of weak or ephemeral anomalies can be reduced through the process of calculating the gradient. Multiple greyscale images at different plotting ranges have been used for data interpretation. Greyscale images should be viewed alongside the XY trace plot (Figures 7 and 10). XY trace plots visualise the magnitude and form of the geophysical response, aiding in anomaly interpretation.
- 6.3.2. Geophysical results have been interpreted using greyscale images and XY traces in a layered environment, overlaid against open street maps, satellite imagery, historic maps, LiDAR data, and soil and geology maps. Google Earth (2020) was consulted as well, to compare the results with recent land usages.
- 6.3.3. Geodetic position of results - All vector and raster data have been projected into OSGB36 (ESPG27700) and can be provided upon request in ESRI Shapefile (.SHP) and Geotiff (.TIF) respectively. Figures are provided with raster and vector data projected against OS Open Data.

7. Results

7.1. Qualification

7.1.1. Geophysical results are not a map of the ground and are instead a direct measurement of subsurface properties. Detecting and mapping features requires that said features have properties that can be measured by the chosen technique(s) and that these properties have sufficient contrast with the background to be identifiable. The interpretation of any identified anomalies is inherently subjective. While the scrutiny of the results is undertaken by qualified, experienced individuals and rigorously checked for quality and consistency, it is often not possible to classify all anomaly sources. Where possible an anomaly source will be identified along with the certainty of the interpretation. The only way to improve the interpretation of results is through a process of comparing excavated results with the geophysical reports. MS actively seek feedback on their reports as well as reports of further work in order to constantly improve our knowledge and service.

7.2. Discussion

7.2.1. The geophysical results are presented in consideration with historic maps (Figure 4).

7.2.2. The fluxgate gradiometer survey has been impacted by the industrial heritage of the survey area across much of the site. The geophysical survey has detected strong magnetic variations in areas closest to the recorded open-air shaft mining in the north, and close to an old ironstone pit in the south (Figure 4). It is likely that the infrastructure related to the mining has produced some of the magnetic enhancement as the Tankersley Park Railway connected with the tramways of Lidgett Colliery within Area 2 (see section 5.4). In addition, a former building is recorded next to the old ironstone pit in the south of Area 3 (Figure 4). Modern activity is limited to magnetic disturbance along the southwest boundary of Area 4 adjacent to Black Lane. Natural variations have been detected at the centre of the survey area, this has produced a mottling effect likely related to local ironstone deposits.

7.2.3. Agricultural activity has been detected in the form of linear striations which overlay the mottling effect of the natural variations in the centre of the survey area. Although interpretation of these anomalies has been complicated by the strongly enhanced background variations, the broad and slightly curved nature of these anomalies is indicative of ridge and furrow cultivation. Close to these agricultural anomalies, but straighter and more widely spaced some possible drainage features have been identified. Further south a short curvilinear anomaly has been detected corresponding with the location of a former field boundary (Figure 4).

7.2.4. Linear anomalies which do not share the alignment of the probable ridge and furrow cultivation or the drainage features have been classified as “Undetermined” (Figure 9). The limited context of the survey area prevents the full extent of these anomalies from being identified, it is therefore unclear whether these are related to historic industrial, agricultural or even possibly archaeological activity.

7.3. Interpretation

7.3.1. General Statements

- 7.3.1.1. Geophysical anomalies will be discussed broadly as classification types across the survey area. Only anomalies that are distinctive or unusual will be discussed individually.
- 7.3.1.2. **Magnetic Disturbance** – The strong anomalies produced by extant metallic structures along the edges of the field have been classified as ‘Magnetic Disturbance’. These magnetic ‘haloes’ will obscure the response of any weaker underlying features, should they be present, often over a greater footprint than the structure they are being caused by.
- 7.3.1.3. **Ferrous (Spike)** – Discrete ferrous-like, dipolar anomalies are likely to be the result of isolated modern metallic debris on or near the ground surface.
- 7.3.1.4. **Ferrous/Debris (Spread)** – A ferrous/debris spread refers to a concentrated deposition of discrete, dipolar ferrous anomalies and other highly magnetic material.
- 7.3.1.5. **Undetermined** – Anomalies are classified as Undetermined when the anomaly origin is ambiguous through the geophysical results and there is no supporting or correlative evidence to warrant a more certain classification. These anomalies are likely to be the result of geological, pedological or agricultural processes, although an archaeological origin cannot be entirely ruled out. Undetermined anomalies are generally not ferrous in nature.

7.3.2. Magnetic Results - Specific Anomalies

- 7.3.2.1. **Industrial (Zone)/Former Building** – Multiple broad ferrous anomalies have been identified covering the majority of Areas 1 and 2 (Figure 6). This type of magnetic disturbance often correlates with areas of made ground; if these areas were subjected to the same open-air shaft mining practices as the land adjacent to them in the east, material may have been added later to make the ground suitable for cultivation. In addition, within Area 2 the former Tankersley Park Railway is recorded to have run through this area on the first edition OS map, it is therefore possible that some of the magnetic disturbance may be related to the removal of railway. Further south, in Area 3 (Figure 9) a similar area of strongly enhanced ferrous debris had been detected adjacent to a “Old Ironstone Pit” noted on 2nd edition OS map (Figure 4), this map also notes a building within the survey area. Strongly positive anomalies have been highlighted within the “Industrial (Zone)” of Area 3, these appear to directly correspond with the location of the former building and possibly indicate the presence of demolition rubble left in situ.
- 7.3.2.2. **Agricultural/Drainage** – A series of parallel linear anomalies have been detected in the north of Area 3 following a northeast to southwest alignment (Figure 9). The slight curvature of these anomalies and their relatively wide spacing of c.3m-5m is indicative of ridge and furrow cultivation. The underlying

geological variations within this area have caused the interpretation of these anomalies to be somewhat difficult. In addition, further linear anomalies in the same area follow a slightly different alignment and have a straighter linear form, these are considered more likely to be drainage features. In the south of the survey area in Area 4 (Figure 9), a short curvilinear linear anomaly has been detected on a northeast to southwest alignment. This anomaly appears to correspond with a former field boundary denoted on 2nd edition OS maps (Figure 4). Unfortunately, a small patch of overgrown vegetation prevented a small section of survey adjacent to this possible former field boundary anomaly, therefore, the interpretation is somewhat tentative.

8. Conclusions

- 8.1. A fluxgate gradiometer survey has successfully been undertaken across the majority of the survey area. No anomalies suggestive of significant archaeological features were identified. The geophysical survey has detected a range of different types of anomalies of industrial, agricultural, natural and undetermined origin. The underlying geology of the Pennine Coal Measures Formation has contributed to the more enhanced background variations noted in the centre of the survey area. Modern activity has been recorded to the south of the survey area in the form of magnetic disturbance along the boundary with Black Lane.
- 8.2. Much of the dataset has been impacted by historic industrial activity related to the extensive mining which occurred within the vicinity of the survey area. The survey area is situated close to former open-air shafts in the north and was once overlain by an associated railway. The centre of the survey area is adjacent to an old ironstone pit, and a former building stood within the survey area itself. This has produced strong magnetic variations, which may relate to demolition rubble, or extraction and backfill material.
- 8.3. Agricultural activity has been detected in the form of possible ridge and furrow cultivation, as well as possible drainage features.
- 8.4. Anomalies have been classified as “Undetermined” where the magnetic signal is ambiguous, or the limited context of the survey area prevents confident classification. Linear anomalies which do not follow the alignment of agricultural activity have been classified as undetermined.

9. Archiving

- 9.1. MS maintains an in-house digital archive, which is based on Schmidt and Ernenwein (2013). This stores the collected measurements, minimally processed data, georeferenced and un-georeferenced images, XY traces and a copy of the final report.
- 9.2. MS contributes reports to the ADS Grey Literature Library upon permission from the client, subject to the any dictated time embargoes.

10. Copyright

- 10.1. Copyright and the intellectual property pertaining to all reports, figures, and datasets produced by Magnitude Services Ltd. is retained by MS. The client is given full licence to use such material for their own purposes. Permission must be sought by any third party wishing to use or reproduce any IP owned by MS.

11. References

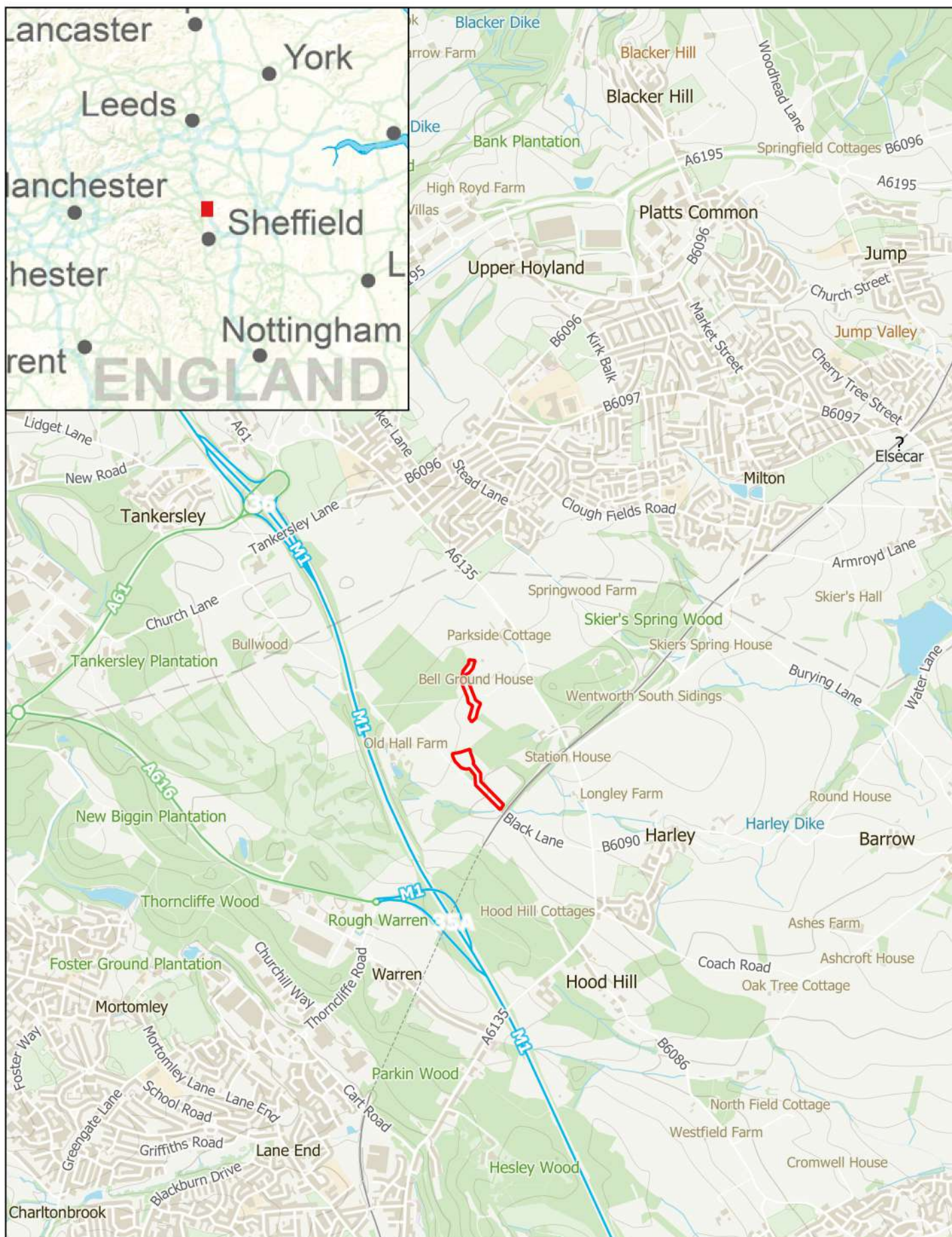
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- Soilscapes, 2020. [Barnsley, South Yorkshire]. Cranfield University, National Soil Resources Institute [<http://landis.org.uk>]. [Accessed 13/05/2020].

12. Project Metadata

MS Job Code	MSSK665
Project Name	Land off Hoyland, Barnsley
Client	Oxford Archaeology
Grid Reference	SK 35907 98820
Survey Techniques	Magnetometry
Survey Size (ha)	2.4ha
Survey Dates	07/05/2020
Project Lead	Finnegan Pope-Carter BSc (Hons) MSc FGS
Project Officer	Leanne Swinbank BA ACIfA
HER Event No	To be assigned after submission to the HER
OASIS No	N/A
S42 Licence No	N/A
Report Version	0.2

13. Document History

Version	Comments	Author	Checked By	Date
0.1	Initial draft for Project Lead to Review	LS	FS	15 May 2020
0.2	In corporation of line manager comments	LS	PJ	18 May 2020



MSSK665 - Land off Hoyland, Barnsley

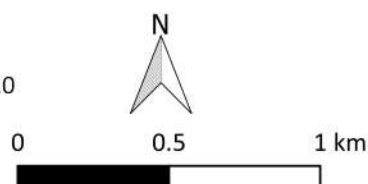
Figure 1 - Site Location

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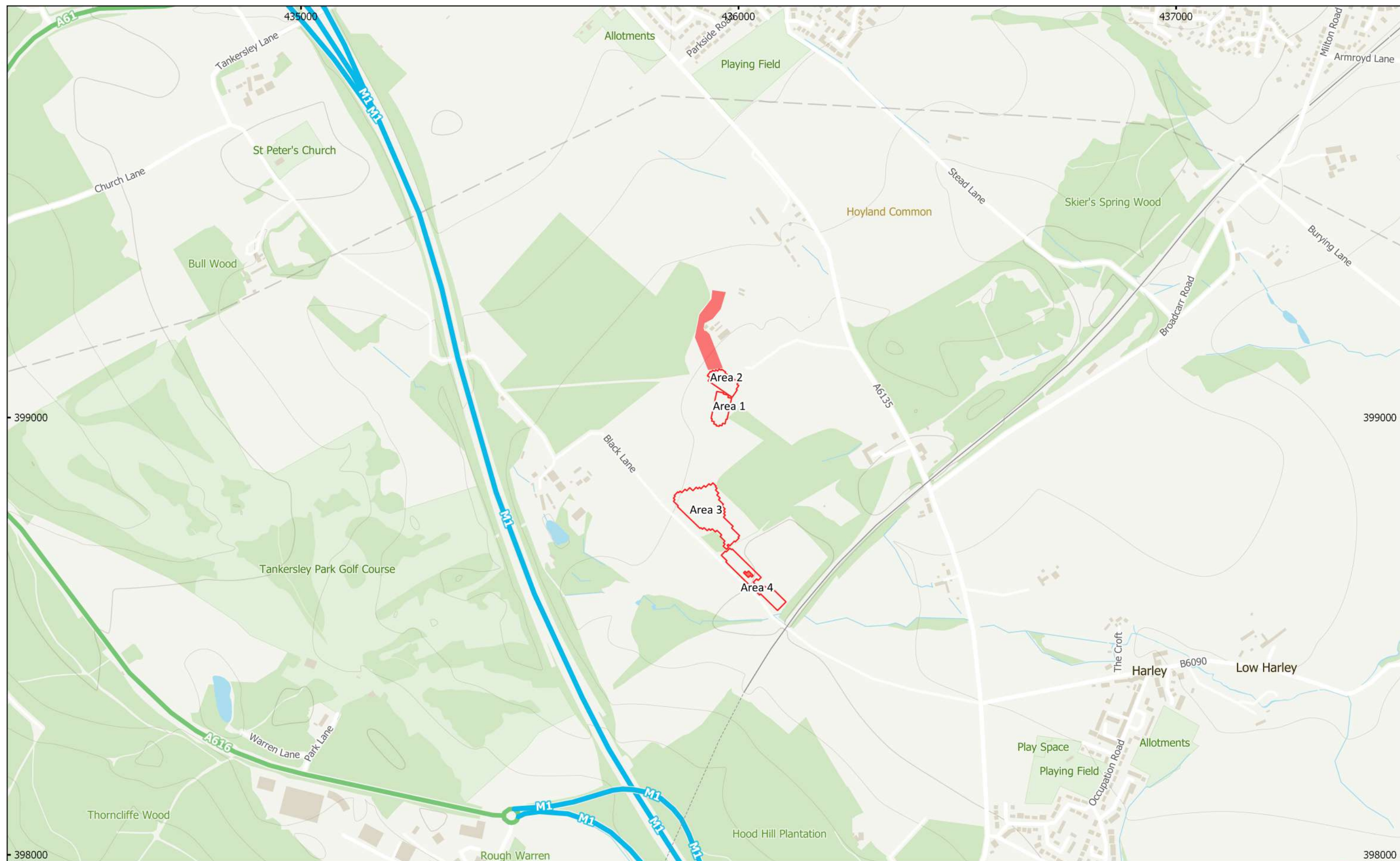
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 Site Boundary

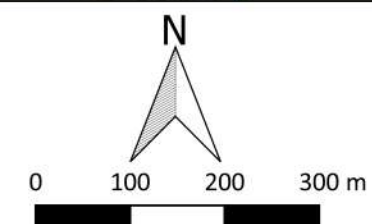


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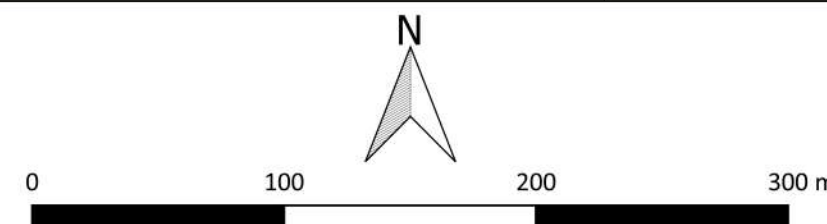
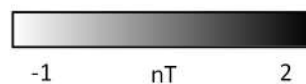
MSSK665 - Land off Hoyland, Barnsley
 Figure 2 - Location of Survey Areas
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- Survey Extent
- Unsurveyable

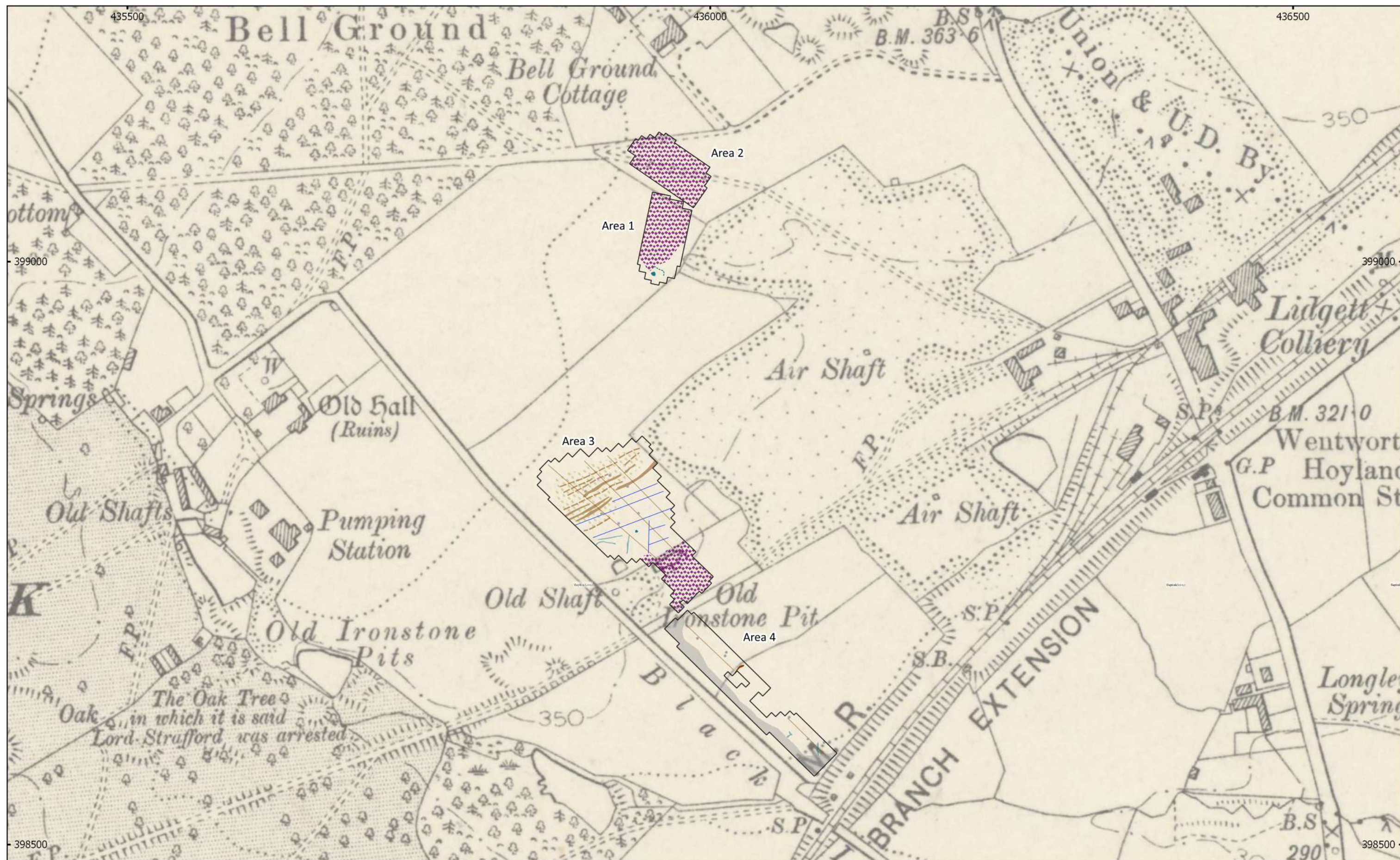




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Figure 3 - Magnetic Gradient (Overview)
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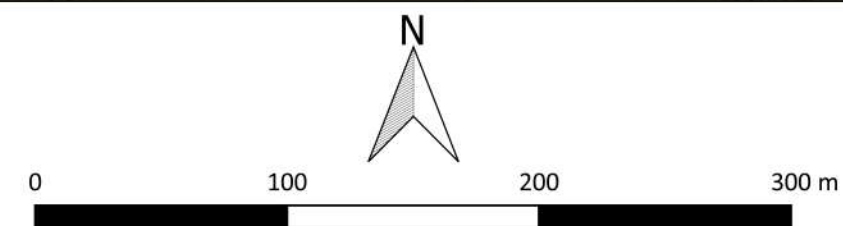


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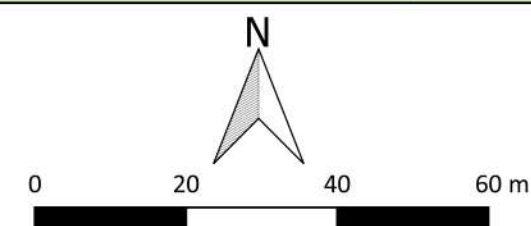
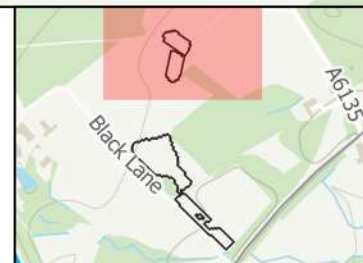
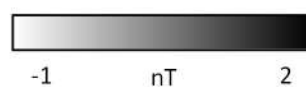
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 Figure 4 - Magnetic Interpretation Over Historic Maps (Overview)
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 Contains historic maps: Ordnance Survey, 6" 2nd edition c. 1882-1913 ©
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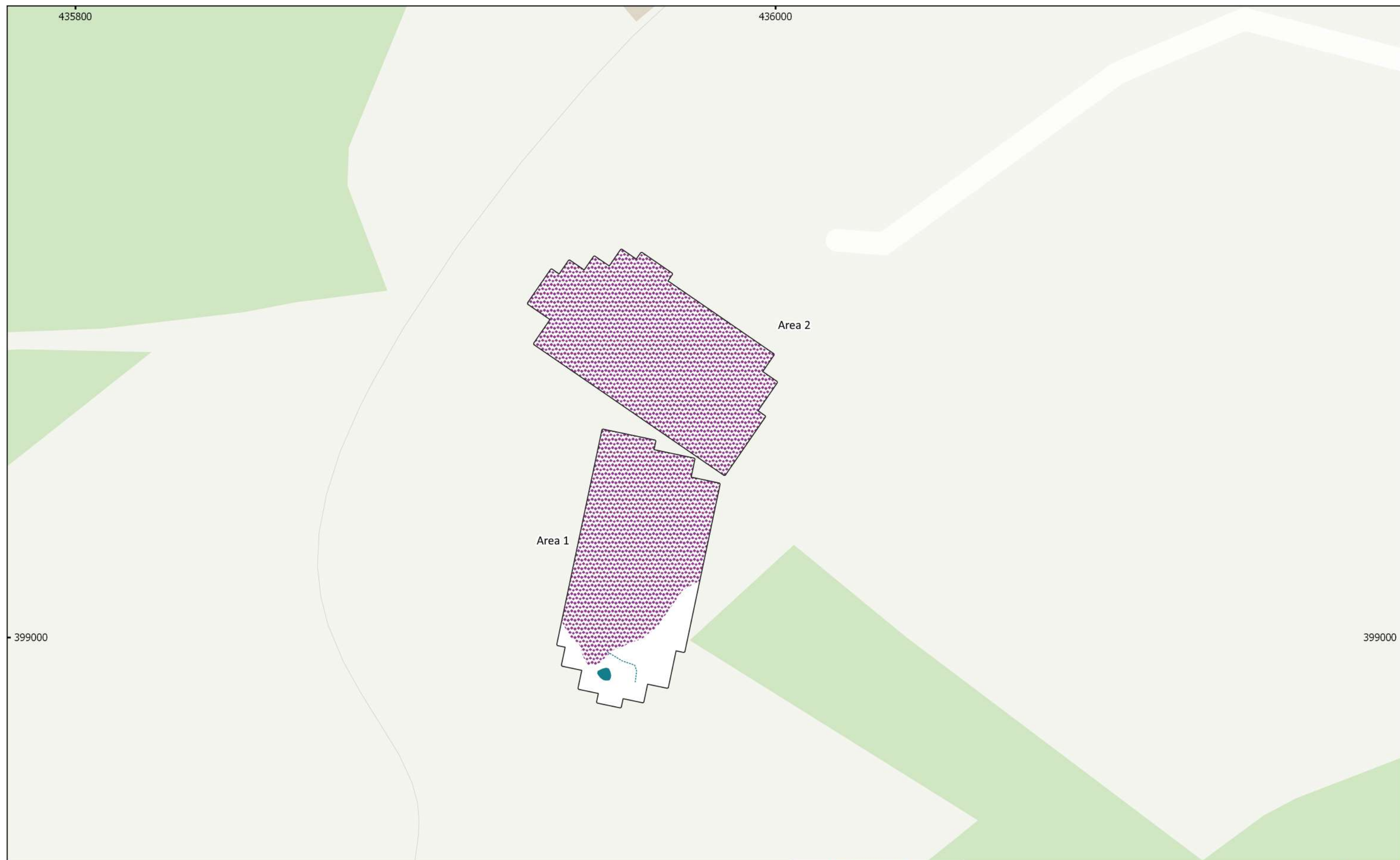
- | | |
|-----------------------|--------------------------|
| Agricultural (Strong) | Former Building |
| Agricultural (Weak) | Agricultural (Trend) |
| Magnetic Disturbance | Undetermined (Trend) |
| Natural (Spread) | Ridge and Furrow (Trend) |
| Undetermined (Strong) | Drainage Feature |
| Undetermined (Weak) | Ferrous (Spike) |
| Industrial (Zone) | |





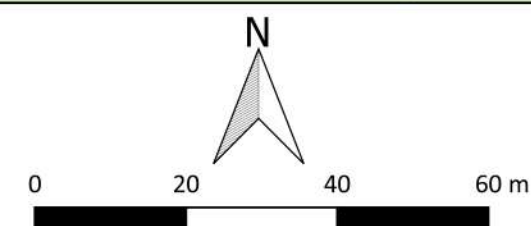
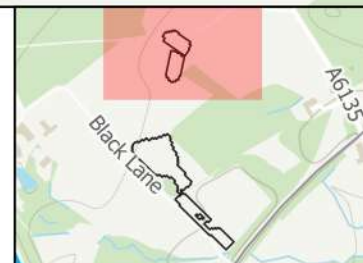
MSSK665 - Land off Hoyland, Barnsley
Figure 5 - Magnetic Gradient (North)
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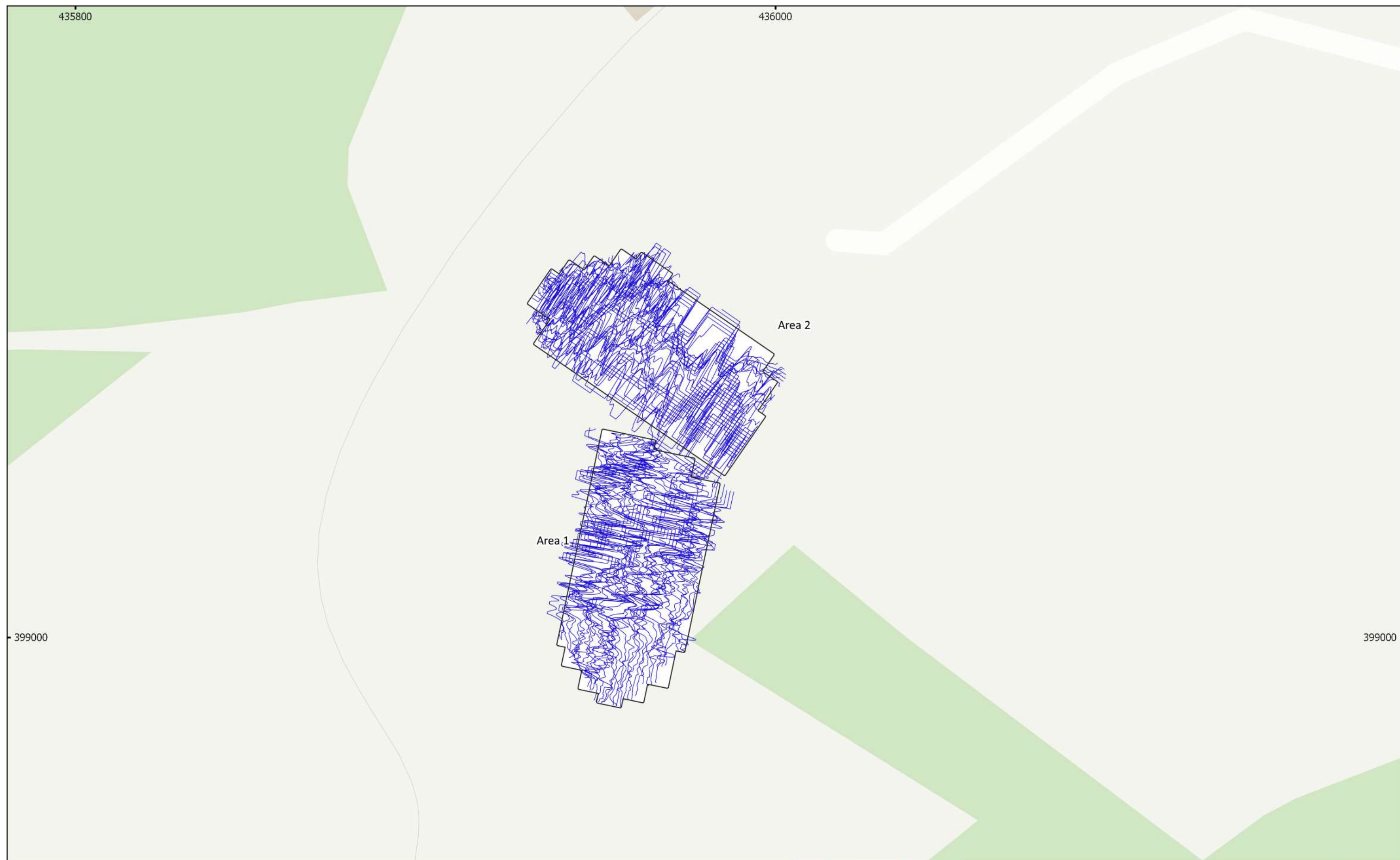




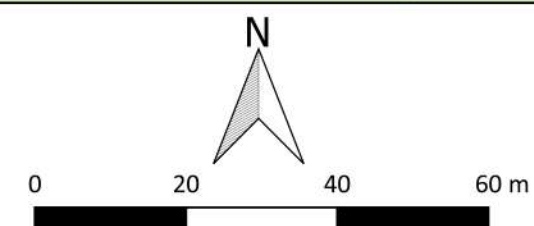
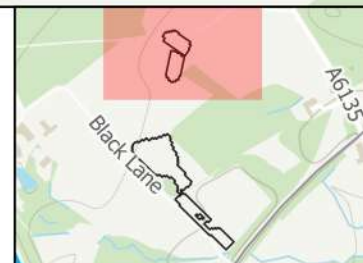
MSSK665 - Land off Hoyland, Barnsley
 Figure 6 - Magnetic Interpretation (North)
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Undetermined (Strong)
 Undetermined (Trend)
 Industrial (Zone)



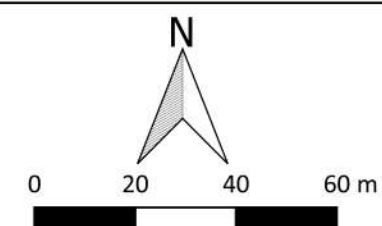
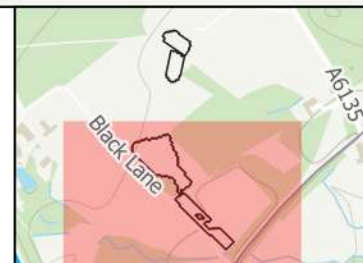
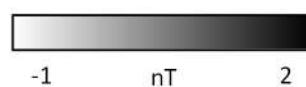


MSSK665 - Land off Hoyland, Barnsley
Figure 7 - XY Trace Plot (North)
30nT/cm at 1:1,000 @ A3
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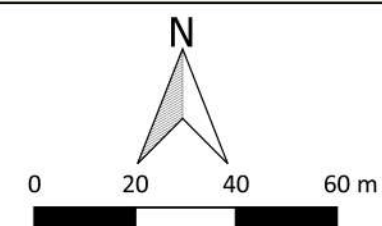
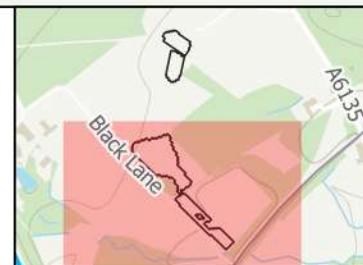
MSSK665 - Land off Hoyland, Barnsley
 Figure 8 - Magnetic Gradient (South)
 1:1,500 @ A3
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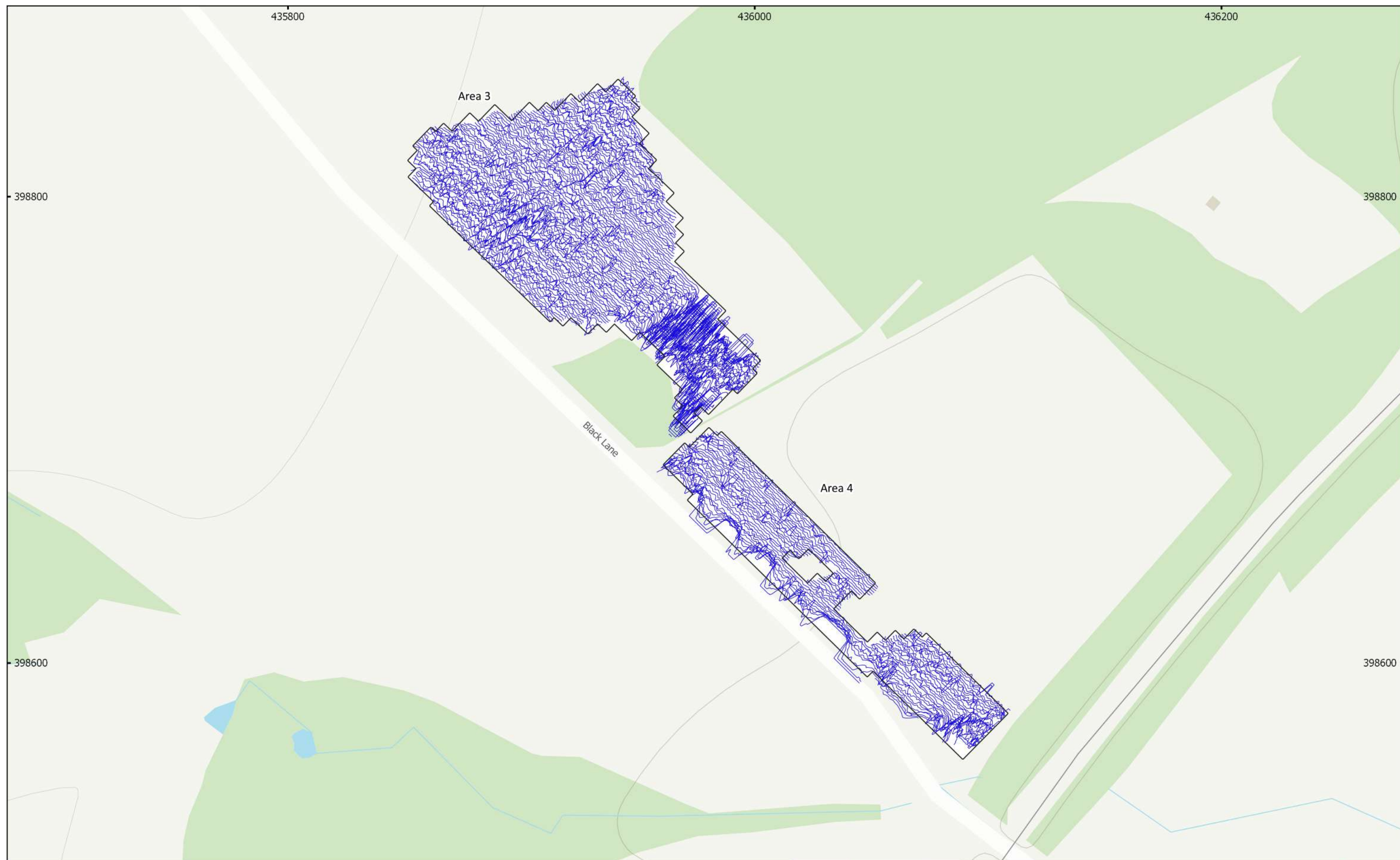




MSSK665 - Land off Hoyland, Barnsley
 Figure 9 - Magnetic Interpretation (South)
 1:1,500 @ A3
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- | | |
|-----------------------|--------------------------|
| Agricultural (Strong) | Industrial (Zone) |
| Agricultural (Weak) | Former Building |
| Magnetic Disturbance | Agricultural (Trend) |
| Natural (Spread) | Ridge and Furrow (Trend) |
| Undetermined (Strong) | Drainage Feature |
| Undetermined (Weak) | Ferrous (Spike) |





MSSK665 - Land off Hoyland, Barnsley
Figure 10 - XY Trace Plot (South)
30nT/cm at 1:1,500 @ A3
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