magnitude surveys

Geophysical Survey Report

of

Tree planting area – Castle Hill, Bransholme

For

JBAB

On Behalf Of

The Environment Agency

Magnitude Surveys Ref: MSTA819A

December 2020

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Abstract

Magnitude Surveys was commissioned to assess the subsurface archaeological potential of a c. 6.5ha area of land at Bransholme, East Riding of Yorkshire. Due to waterlogging c.0.5ha was unsurveyable. A fluxgate gradiometer survey was successfully completed across the remaining survey area. The geophysical survey has primarily detected amorphous natural variations likely related to undulations in the underlying glacial till, alluvial deposits and high groundwater. Though no anomalies suggestive of significant archaeological activity have been identified, anomalies of undetermined origin have been detected, which likely relate to agricultural, or natural processes, although an archaeological origin cannot be ruled out. Anomalies of an agricultural origin have been detected in the form of modern ploughing trends and drainage features. The impact of modern activity on the results is generally limited to the perimeters of the survey area and a service across the north east corner of the survey area.

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1. Introduction

1.1. Magnitude Surveys Ltd (MS) was commissioned by JBAB on behalf of The Environment Agency to undertake a geophysical survey over a c. 6.5ha area of land near to Bransholme, Kingston upon Hull, East Riding of Yorkshire, TA 12473 35054.

1.2. The geophysical survey comprised quad-towed, cart-mounted GNSS-positioned fluxgate gradiometer survey. Magnetic survey is the standard primary geophysical method for archaeological applications in the UK due to its ability to detect a range of different features. The technique is particularly suited for detecting fired or magnetically enhanced features, such as ditches, pits, kilns, sunken featured buildings (SFBs) and industrial activity (David *et al*., 2008).

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. The survey commenced on 14/12/2020 and took one day to complete.

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 cutting edge 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 degree qualifications relevant 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 was to assess the subsurface archaeological potential of the survey area in advance of groundworks associated with the development of a tree planting area.

4. Geographic Background

4.1. The survey area was located c. 2.2km northeast of Bransholme (Figure 1). Gradiometer survey was undertaken across one grass field. The survey area was bounded by farmland of all sides (Figure 2). 0.5ha of the survey area was unsurveyable due to waterlogging.

4.2. Survey considerations:

Survey Area	Ground Conditions	Further Notes
1	Grass field sloping gently down from north to south.	Bounded by hedgerow to the north, east and south and a wire fence and hedgerow to the west. Sections of the survey area along the eastern boundary and areas in the middle of the survey area were unsurveyable due to waterlogging.

4.1. The underlying geology comprises chalk of the Flamborough Formation. Superficial deposits within the survey area comprise alluvium consisting of clay, silt, sand and gravel, with a band of Devensian till (diamicton) recorded along the western boundary (British Geological Survey, 2020).

4.2. The soils consist of loamy and clayey soils of coastal flats with naturally high groundwater (Soilscapes, 2020).

4.3. Previous test pits excavated within the survey area in 2019 identified a peat layer underneath the alluvium (Toop, 2019).

5. Archaeological Background

5.1. The following is a summary of an Archaeological Watching Brief and Geoarchaeological Recording produced by FAS Heritage (Toop, 2019), and an archaeological background within a Written Scheme of Investigation produced by JBA Bentley (Amy, 2020).

5.2. Previous geophysical surveys have been completed by MS in 2018 and 2020 immediately to the east, west and south west of the survey area. The 2018 survey identified soil changes related to fluvial landforms and some possible archaeological anomalies, although later test pits did not identify any anthropogenic features, and instead suggested these anomalies related to undulations in the underlying superficial geology. The 2020 survey identified natural variations in the soil, agricultural and drainage features and several anomalies with an undetermined origin which may be archaeological in origin (Langston, 2020).

5.3. A Bronze Age barrow is recorded c. 826m to the south west of the survey area. Geophysical surveys in 2017 identified rectilinear anomalies to the south of the survey area which were identified as potentially prehistoric in date. Previous excavation within the survey area and the wider area indicated a buried land surface with peat deposits up to 1.55m in depth. Scientific dating produced a calibrated late Neolithic to Early Bronze Age date for the buried surface, however no artefactual dating evidence was found and macrofossil preservation was poor.

5.4. Two hoards of Romano-British coins were recorded in the surrounding area, as well as 3rd century pottery and a lead spindle whorl.

5.5. The scheduled monument of Castle Hill, the site of a medieval castle, is located c. 670m to the south of the survey area. It is thought to date to 1200AD and is represented by a single motte with surrounding ditch.

5.6. Modern activity has been identified in the form of the Hull to Hornsea railway which runs c. 740m to the south of the survey area and was constructed in 1864, as well as various nearby drains and farmsteads.

6. Methodology

6.1. Magnetometer surveys are generally the most cost effective and suitable geophysical technique for the detection of archaeology in England. Therefore, a magnetometer survey should be the preferred geophysical technique unless its use is precluded by any specific survey objectives or the site environment. For this site, no factors precluded the recommendation of a standard magnetometer survey. Geophysical survey therefore comprised the magnetic method as described in the following section.

6.2. Data Collection

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

6.2.2. 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

6.2.3. The magnetic data were collected using MS' bespoke quad-towed cart system.

6.2.3.1. MS' cart 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.

6.2.3.2. 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.

6.2.3.3. 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.

6.3. Data Processing

6.3.1. 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 Section 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.

6.4. Data Visualisation and Interpretation

6.4.1. This report presents the gradient of the sensors' total field data as greyscale images, as well as the total field data from the lower sensors. 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. Consequently, some features can be clearer in the respective gradient or total field datasets. Multiple greyscale images of the gradient and total field at different plotting ranges have been used for data interpretation. Greyscale images should be viewed alongside the XY trace plot (Figure 7). XY trace plots visualise the magnitude and form of the geophysical response, aiding anomaly interpretation.

6.4.2. Geophysical results have been interpreted using greyscale images and XY traces in a layered environment, overlaid against open street maps, satellite imagery, historical maps, LiDAR data, and soil and geology maps. Google Earth (2020) was also consulted, to compare the results with recent land use.

6.4.3. 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.

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 from further work, in order to constantly improve our knowledge and service.

7.2. Discussion

7.2.1. The geophysical results are presented in combination with satellite imagery and historical maps (Figure 6).

7.2.2. A fluxgate gradiometer survey was successfully undertaken across the survey area. The survey has primarily identified anomalies related to natural processes, cultivation and drainage of the land. Although no anomalies suggestive of archaeological features were identified, a number of anomalies of less-certain identification are present in the dataset, thought likely to be of agricultural origins. Modern interference was identified in the form of magnetic disturbance along the edges of the survey area and across the northeast of the survey area caused by an underground service.

7.2.3. Natural variations within the underlying geology have been identified across the survey area as sinuous bands of positive anomalies and an enhanced slightly mottled background. These are considered to be reflective of variations in the underlying alluvium deposits caused by naturally high groundwater and undulating glacial till as identified in trial trenching conducted in a field to the east of the survey area (Reeves, 2020).

7.2.4. Parallel linear trends have been detected across the survey area in a north to south direction (Figure 4) which are characteristic of modern ploughing and are visible in satellite imagery (Figure 6).

7.2.5. Equally spaced, weak linear anomalies have been detected across the survey area on an east to west orientation which have have been identified as drains (Figure 5). In the wider area several drains are visible on mapping (Figures 1 and 2), running along the northern border of the survey area. Given the high groundwater, the underlying deposits of coastal soils and surrounding drains, drainage is a key activity in this area.

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. **Ferrous (Spike)** – Discrete dipolar anomalies are likely to be the result of isolated pieces of modern ferrous debris on or near the ground surface.

7.3.1.3. **Magnetic Disturbance** – The strong anomalies produced by extant metallic structures, typically including fencing, pylons, vehicles and service pipes, have been classified as 'Magnetic Disturbance'. These magnetic 'haloes' will obscure weaker anomalies relating to nearby features, should they be present, often over a greater footprint than the structure causing them.

7.3.1.4. **Undetermined** – Anomalies are classified as Undetermined when the origin of the geophysical anomaly is ambiguous and there is no supporting contextual evidence to justify 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 distinct from those caused by ferrous sources.

7.3.2. Magnetic Results - Specific Anomalies

7.3.2.1. **Agricultural (Trend) –** An agricultural regime has been identified (Figure 5) detected as narrowly spaced weakly positive linear anomalies running north to south. These follow the previous modern ploughing regime, identified on satellite imagery (Figure 6).

7.3.2.2. **Drainage Feature –** Numerous linear trends on an east to west orientation have been detected throughout the survey area. These exhibit a weak positive magnetic signal, some of which are masked by the more enhanced geology in the area. Given the important role of drainage in the surrounding area, and the slightly stronger signal of the anomalies compared to the ploughing trends, they anomalies have been interpreted as drainage features.

7.3.2.3. **Natural –** Natural variations in the survey area have been detected as bands of strong positive anomalies, weak amorphous positive anomalies and zones of enhanced magnetic background (Figure 4). The sinuous shape and arrangement of these anomalies are characteristic of alluvial deposits (see Section 4.1). This interpretation is further supported by test pitting which has been conducted in the immediate surroundings (Reeves, 2020.; Toop, 2019). The 2020 report identified that a previous geophysical survey conducted in 2018 had detected natural variations rather than archaeological anomalies. The natural anomalies detected in this survey are considered to be caused by the recorded irregular and undulating surface of the underlying glacial till, and the alluvium which overlies this. The alluvium was recorded as being progressively drier as it neared the surface and Holderness Drain (Reeves, 2020), although the area has a high groundwater level. While a natural origin is considered likely for all these anomalies, it should be noted that due to known archaeological activity and features within close proximity to the survey area (see section 5), an archaeological origin cannot be fully discounted; discrete archaeological features such as pits can be very difficult to distinguish from natural anomalies in these circumstances.

7.3.2.4. **Undetermined** – Several linear anomalies have been identified which have been categorised as undetermined. These anomalies have been categorised as undetermined because they are better defined and more regular in form than the more amorphous natural anomalies which dominate the survey area, resulting in an increased possibility of them being anthropogenic in origin. Due to the known archaeological activity in the vicinity of the survey area (see Section 5) an archaeological origin cannot be fully discounted, although an agricultural origin is considered more likely. This conclusion is further supported by the previous investigations in the vicinity of the survey area which did not identify any anthropogenic features (Reeves, 2020.; Toop, 2019).

Service – A strong dipolar linear anomaly in the north east of the survey area has been identified and interpreted as a service. The strength of the anomaly and its halo could obscure weaker anomalies in its immediate surroundings.

8. Conclusions

8.1. A fluxgate gradiometer survey has successfully been undertaken across the survey area, with 0.5ha unsurveyable due to waterlogging. The geophysical survey has detected a range of different anomaly types of natural, agricultural and modern origins. The impact of modern interference is limited to the survey edges including a service running across the north east of the survey area.

8.2. No anomalies suggestive of an archaeological origin have been identified within the survey area. Some anomalies have been identified as ‘undetermined’ may have anthropogenic origins, though agricultural origins appear more likely in light of previous investigations in the vicinity of the survey area.

8.3. Strong natural variations have been detected across the survey area related to the undulating glacial till, deposits of alluvium and high groundwater. This interpretation has been supported by the previous programmes of test pitting conducted in the survey area and immediate surroundings.

8.4. Agricultural and drainage activity has been detected across the survey area in the form of modern ploughing trends and drainage features.

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 any dictated time embargoes.

10. Copyright

10.1. Copyright and 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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12. Project Metadata

MS Job Code	MSTA918A
Project Name	Tree Planting Area – Castle Hill, Bransholme
Client	JBAB
Grid Reference	TA 12473 35054.
Survey Techniques	Magnetometry
Survey Size (ha)	6.5ha
Survey Dates	2020-12-14
Project Lead	Christian Adams BA MSc
Project Officer	Christian Adams BA MSc
HER Event No	N/A
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	SP	CA	18 December 2020
0.2	Draft for Director Approval	SP	KA	21 December 2020

MSTA819 - Castle Hill
Figure 1 - Site Location
1:25,000 @ A4

N

0 0.5 1 km

Site Boundary

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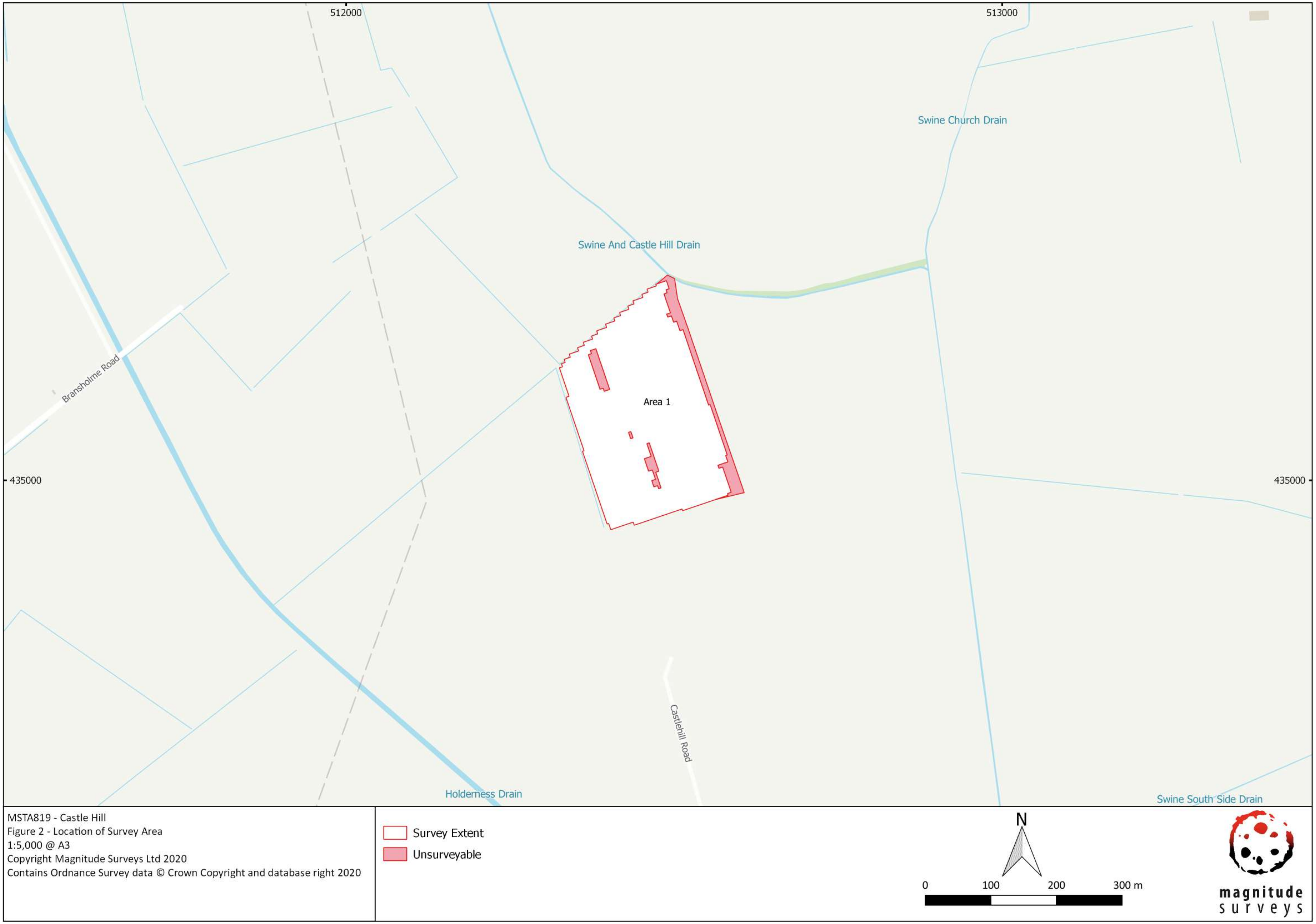
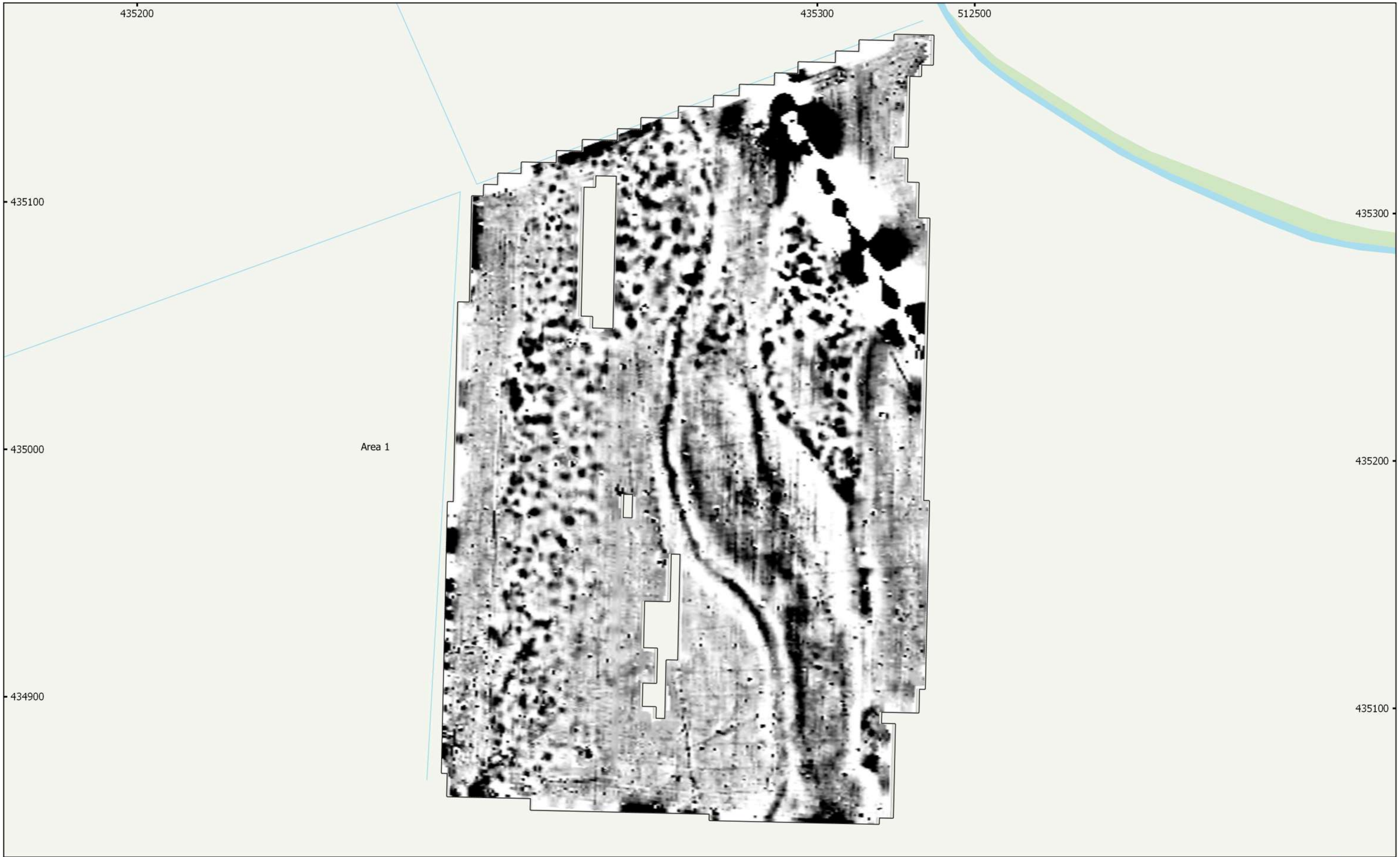


MSTA819 - Castle Hill
Figure 2 - Location of Survey Area
1:5,000 @ A3

magnitude surveys

MSTA819 - Castle Hill
Figure 3 - Magnetic Total Field (Lower Sensor)
1:1,500 @ A3

magnitude surveys



MSTA819 - Castle Hill
Figure 4 - Magnetic Gradient
1:1,500 @ A3

-1 nT 2

N

0 50 100 150 m

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MSTA819 - Castle Hill
Figure 5 - Magnetic Interpretation
1:1,500 @ A3

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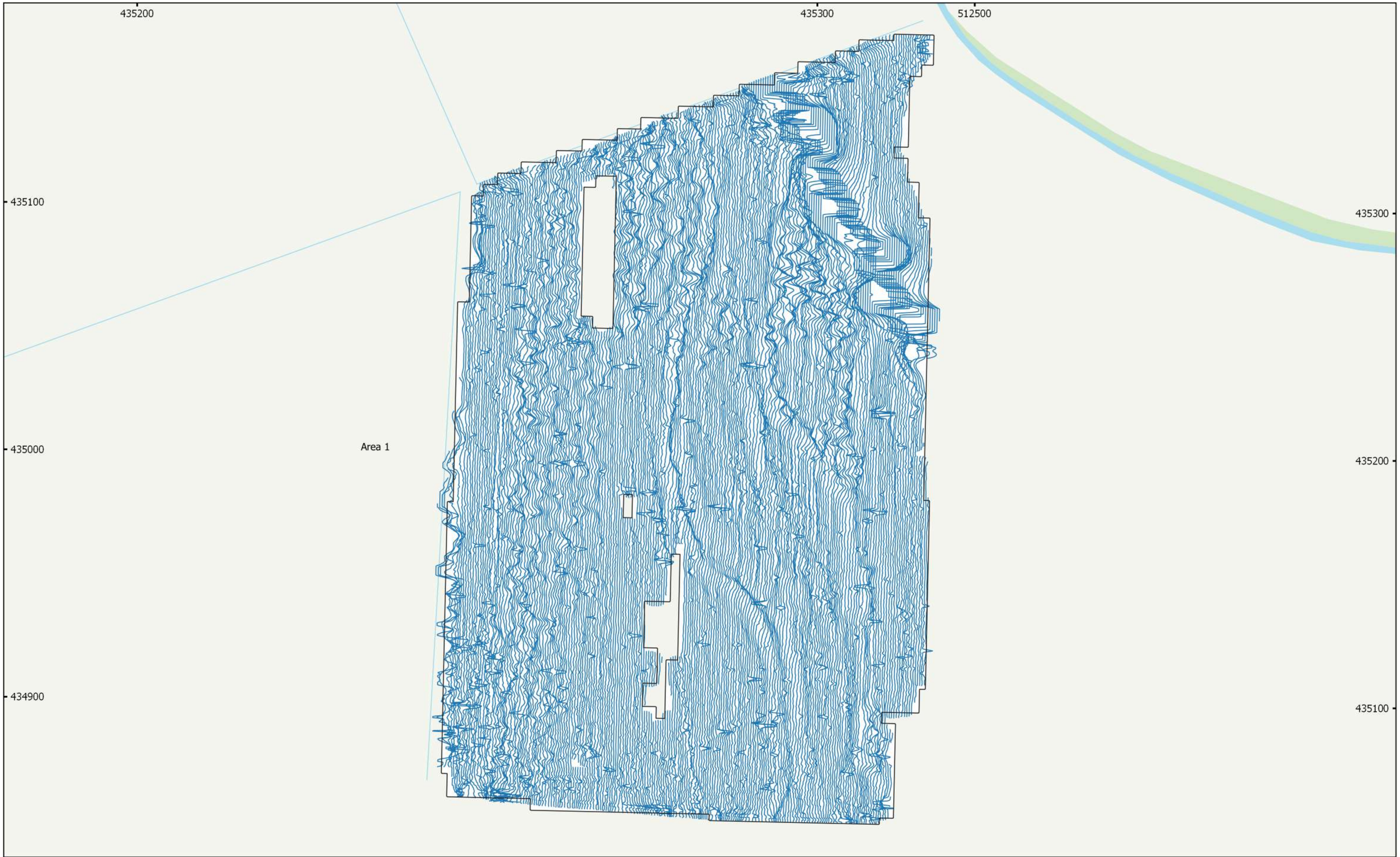
MSTA819 - Castle Hill
Figure 6 - Magnetic Interpretation Over Historical Maps and Satellite Imagery
1:2,000 @ A3

Natural (Strong)
Natural (Weak)
Natural (Zone)
Magnetic Disturbance
Undetermined (Weak)
Agricultural (Trend)
Service
Drainage Feature
Ferrous (Spike)

N

0 50 100 150 m

magnitude surveys



MSTA819 - Castle Hill
Figure 7 - XY Trace Plot
30nT/cm at 1:1,500 @ A3

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