Geophysical Survey Report

Land at Hill Lane, Markfield

Leicestershire

For

RPS

On Behalf Of

Glenalmond Developments

Magnitude Surveys Ref: MSSK841

HER Event Number: To be issued when submitted to HER

July 2021

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Abstract

Magnitude Surveys Ltd was commissioned to assess the subsurface archaeological potential of a c. 3.03ha area of land at Hill Lane, Markfield. A fluxgate gradiometer survey was successfully completed across the survey area, however c. 1.17ha could not be surveyed due to the presence of trees and overgrown vegetation. The geophysical survey has identified ridge and furrow cultivation along with potential headland ploughing. Previous LiDAR survey has recorded evidence of ridge and furrow cultivation within the vicinity. The potential remains of a former structure have also been identified. No anomalies suggestive of archaeological remains have been identified, however several undetermined anomalies have been detected for which an origin cannot be confidently ascribed. The highly magnetic background of the survey area, as a result of modern activity, may have obscured any weaker anomalies if present.

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1. Introduction

1.1. Magnitude Surveys Ltd (MS) was commissioned by RPS on behalf of Glenalmond Developments to undertake a geophysical survey over a c. 3.03ha area of land at Hill Lane, Markfield, Leicestershire (SK 4870 1053).

1.2. The geophysical survey comprised hand-carried 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, 2020) and the European Archaeological Council (Schmidt *et al.,* 2015).

1.4. It was conducted in line with a WSI produced by MS (Beck, 2020).

1.5. The survey commenced on 25th June 2021 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 for 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, is a Fellow of the Society of Antiquaries of London, 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, field and office staff have degree qualifications relevant to archaeology or geophysics 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.

4. Geographic Background

4.1. The survey area was located in the north-eastern corner of the town of Markfield, Leicestershire (Figure 1). Gradiometer survey was undertaken across two fields under fallow conditions. The survey area was bordered to the north, east and southeast by houses, the southwest by further fields, and to the west by Hill Lane (Figure 2). An estimated 1.17ha of land could not be surveyed due to the presence of trees and overgrown vegetation.

4.2. Survey considerations:

Survey Area	Ground Conditions	Further Notes
1	The survey area consisted of flat, fallow ground. Overgrown vegetation prevented survey along the borders of the survey area.	The survey area was bordered on all sides by hedges and trees. Trees and metal objects were located throughout the survey area. Disused farm buildings were located in the north-eastern corner. The survey area was surveyed in sub-divided into five sections due to obstructions.
2	The survey area consisted of flat, fallow ground. Overgrown vegetation prevented survey along the northern, eastern and southern borders.	The survey area was bordered by overgrown vegetation to the north, east and south, with Hill Lane to the west. Trees and metal objects were located throughout the survey area.

4.3. The underlying geology comprises Gunthorpe Member mudstone to the north with a strip of Cotgrave Sandstone Member to the south, with a further strip of Edwalton Member mudstone in the southern part of Area 2. The superficial deposits consist of Oadby Member to the east and Head deposits of clay, silt, sand and gravel to the west (British Geological Survey, 2021).

4.4. The soils consist of slowly permeable, seasonally wet, acidic, loamy, and clayey soils (Soilscapes, 2021).

5. Archaeological Background

5.1. The following is a summary of a search of the Leicestershire Historic Environment Record (HER) conducted on 18th December 2020 for records located within 1km of the survey area, provided by RPS.

5.2. The survey area is situated just to the east of the historic core of Markfield. The town of Markfield is listed in the Domesday Book suggesting a medieval or slightly earlier origin to the town.

5.3. The western half of the survey area under consideration in this report is located within an area previously subjected to a LiDAR survey. Analysis of the results predominantly found evidence of medieval ridge and furrow cultivation. Trial trenching in 2015 along a corridor of land c. 1km southwest of the survey area found no evidence of any archaeological activity although ridge and furrow earthworks were noted to be in the general area.

5.4. Historic farmsteads have been recorded within the surrounding environs of Markfield. Windmills have also been noted in the landscape.

5.5. Two quarries are located in proximity to the survey area. Old Cliff Hill Quarry is c. 1km to the west of the survey area. It was established in the 1870s, continuing in operation until 1989. Quarrying then resumed in 2006. Markfield Quarry 'Hill Hole' is located c. 250m south of the survey area. The quarry was in use from the 1860s untill 1914.

5.6. A Cold War underground monitoring post is located c. 294m north of the survey area. In 1999 it is listed as having all surface features intact.

5.7. The surrounding areas have been noted on the Historic Landscape Characterisation as being used as enclosed farming land.

5.8. A map regression has shown that buildings were once located within the survey area. While one building remains at the eastern edge of Area 1, a building just to the south of this is only noted as being present in the 1982 OS map of the area.

6. Methodology

6.1. Data Collection

6.1.1. 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.

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

6.1.3. 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

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

6.1.4.1. 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.

6.1.4.2. 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.

6.1.4.3. 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 the EAC and Historic England guidelines for 'minimally enhanced data' (see Section 3.8 in Schmidt *et al.*, 2015: 33 and Section IV.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 a greyscale image, 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.

6.3.2. 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 (2021) was also consulted, to compare the results with recent land use.

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 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 historical maps and satellite imagery (Figure 6).

7.2.2. The geophysical survey was completed across the survey area. An estimated area of 1.17ha could not be surveyed due to the presence of trees and overgrown vegetation. The fluxgate gradiometer survey has been impacted by modern activity; with modern debris being noted on site at the time of survey (see section 4.2). This has contributed to a strong magnetic background. The strength of the magnetic background, particularly in Area 2, may have obscured weak anomalies if present.

7.2.3. Anomalies relating to the historical agricultural use of the survey area have been detected. These comprise mainly of ridge and furrow cultivation. The presence of ridge and furrow is also supported by earlier LiDAR analysis (see section 5.3). This places the survey area within the wider historic landscape of Markfield, indicating its past agricultural usage. An anomaly located in the south-eastern part of Area 1 has also been found to align with a building noted on the 1982 OS Plan. It can be inferred that the magnetic disturbance identified in that area can be attributed to the demolition debris or remains of the former building.

7.2.4. Several undetermined curvilinear anomalies have been recorded. It is difficult to ascribe a confident interpretation due to the anomalies' weak magnetic enhancement and the strength of the magnetic background, however an archaeological origin cannot be discounted.

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. **Ferrous/Debris (Spread)** – A ferrous/debris spread refers to a concentration of multiple discrete, dipolar anomalies usually resulting from highly magnetic material such as rubble containing ceramic building materials and ferrous rubbish.

7.3.1.4. **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.

7.3.1.5. **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. **Ridge and Furrow –** A series of parallel curvilinear anomalies running in an east-west orientation have been identified within the south-western part of Area 1 (Figures 3 & 4). The anomalies have a weakly diffuse magnetic signal and are spaced between c. 5m and c. 7m apart on average, which is typical of ridge and furrow cultivation. The presence of ride and furrow cultivation is also supported by earlier LiDAR analysis (see section 5.3).

7.3.2.2. **Agricultural (Trend) –** In the centre of Area 1 a linear anomaly with a weakly positive magnetic signal has been identified (Figure 4). The anomaly is likely produced by agricultural activity such as headland ploughing as it runs parallel to the western boundary of the field.

7.3.2.3. **Magnetic Disturbance and Ferrous Debris (Spread) –** Located in the south-eastern part Area 1 is a spread of highly magnetic material [**1a**] (Figures 4 & 5). This concentration of dipolar anomalies aligns with a building recorded on the 1982 OS Plan of the survey area. It is likely that the anomaly relates to the demolition debris or remains of this building.

7.3.2.4. **Undetermined (Weak) –** Within Area 1 are four linear and curvilinear anomalies (Figure 4 & 5). It is not possible to give a confident interpretation for these anomalies due to their weak magnetic enhancement and the strength of the magnetic background. Nevertheless, an archaeological interpretation cannot be discounted.

8. Conclusions

8.1. A fluxgate gradiometer survey has successfully been undertaken across the survey area. The geophysical survey has detected anomalies of agricultural and undetermined origins. No anomalies strongly suggestive of archaeological activity have been identified. The modern use of the survey area has resulted in a greatly enhanced magnetic background, which may have obscured weaker anomalies if present.

8.2. Agricultural activity has been detected within the survey area. These comprise of ridge and furrow cultivation, also recorded by earlier LiDAR analysis, and possible headland ploughing.

8.3. Magnetic disturbance as a result of demolition debris or the remains of a former structure have also been detected.

8.4. Anomalies of an undetermined classification have been detected within the survey area. It is not possible to determine if these anomalies are the result of archaeological, agricultural, natural or modern processes and as such a confident interpretation cannot be made.

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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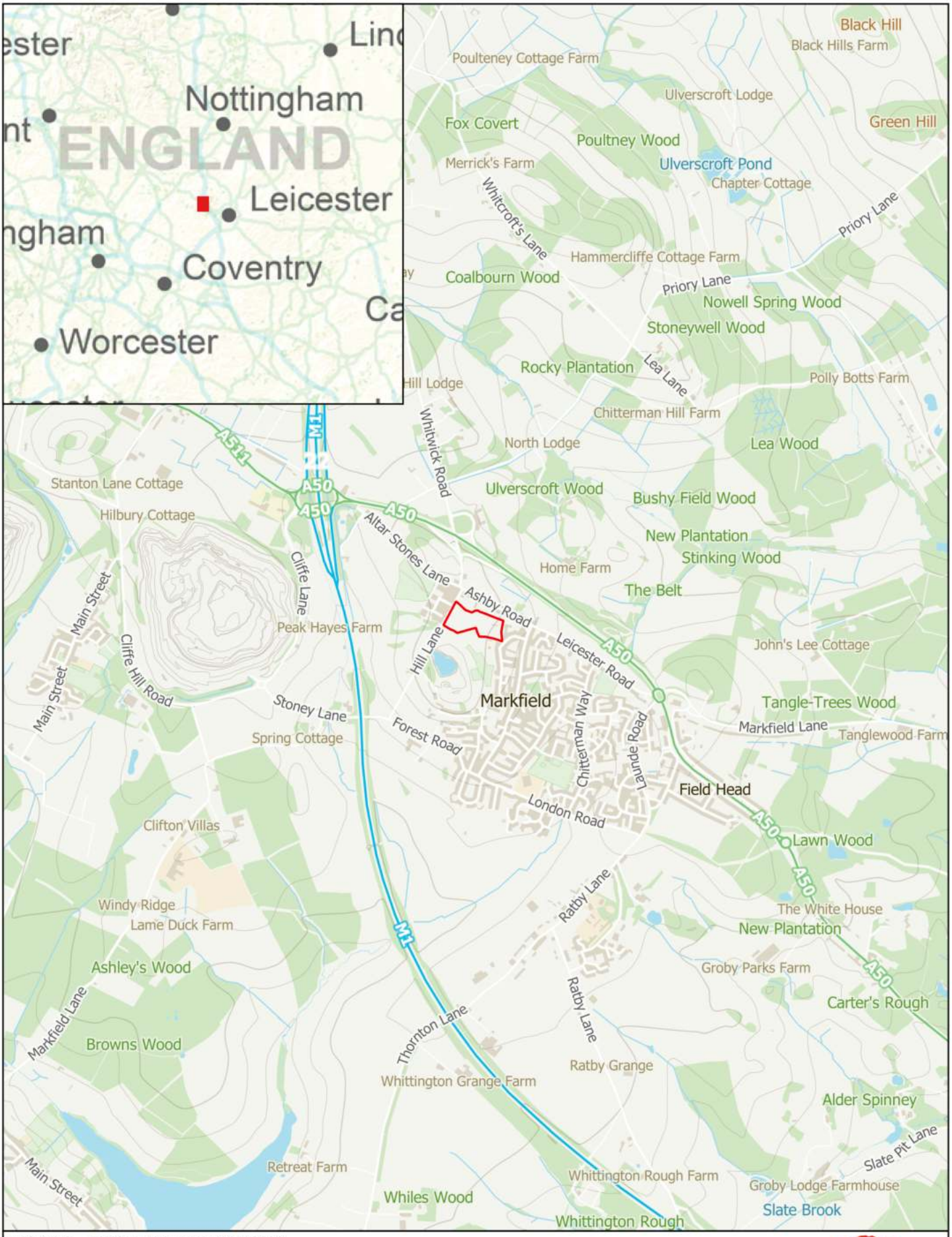
12. Project Metadata

MS Job Code	MSSK841
Project Name	Land at Hill Lane, Markfield
Client	RPS Newark
Grid Reference	SK 4870 1053
Survey Techniques	Magnetometry
Survey Size (ha)	3.03ha (Magnetometry)
Survey Dates	25/06/2021
Project Lead	Lauren Beck BA
Project Officer	Lauren Beck BA
HER Event No	TBC
OASIS No	N/A
S42 Licence No	N/A
Report Version	0.3

13. Document History

Version	Comments	Author	Checked By	Date
0.1	Initial draft for Project Lead to Review	MC	LB	01 July 2021
0.2	Draft for Director Approval	MC	PSJ	02 July 2021
0.3	Draft for Client review	MC	PSJ	02 July 2021



MSSK841 - Land at Hill Lane, Markfield
Figure 1 - Site Location
1:25,000 @ A4
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Site Boundary

N

0 0.5 1 km

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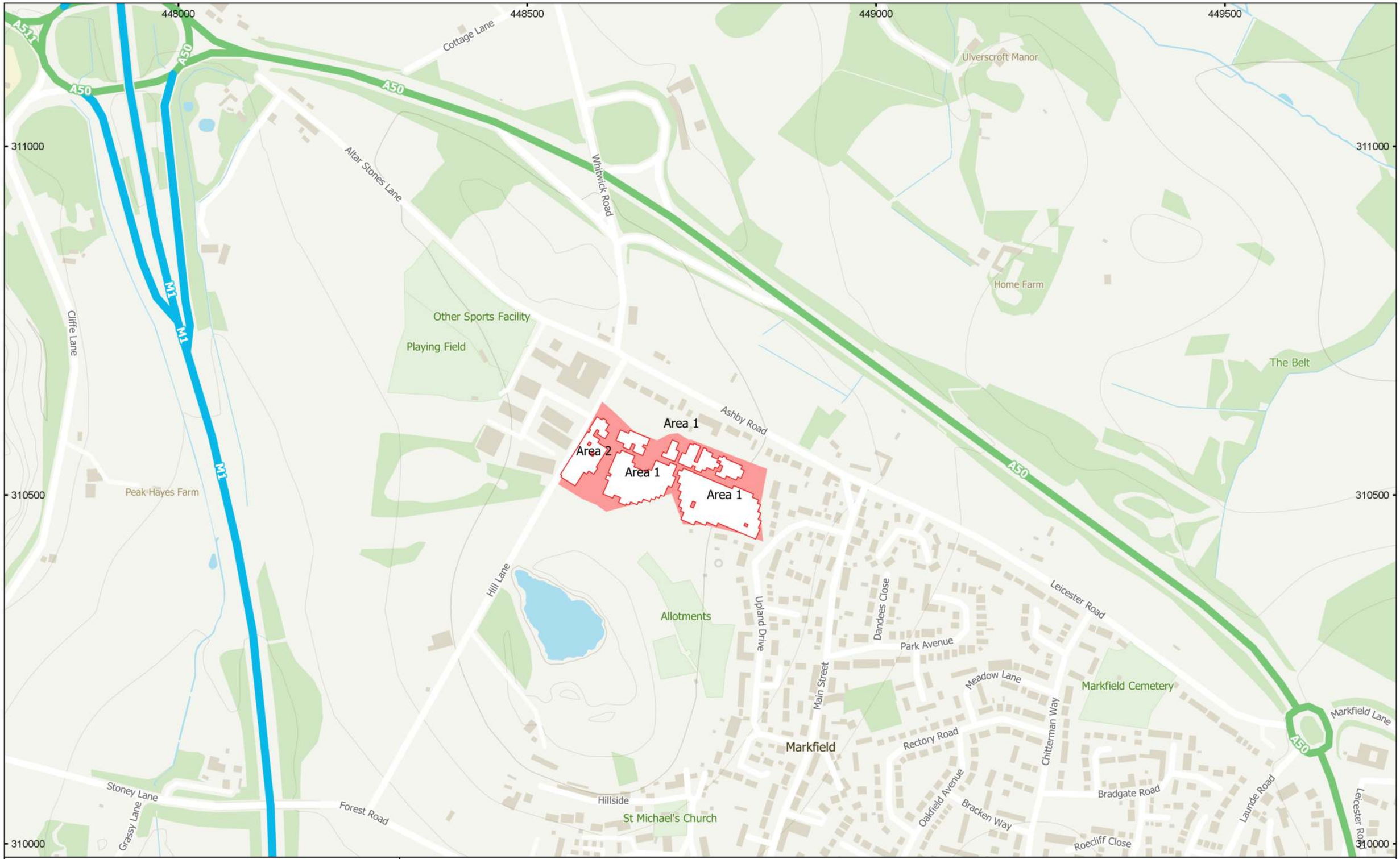

MSSK841 - Land at Hill Lane, Markfield
Figure 2 - Location of Survey Areas
1:5,000 @ A3
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Survey Extent
Unsurveyed Areas

N

0 100 200 300 m

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448600
448800
449000
310700
310600
310500
310400
A50
Hill Lane Close
Ashby Road
Hill Lane
Area 1
Area 2
Area 1
Area 1
Leicester Road
Main Street
Upland Drive
Main Street
The Paddock
Dandees Close

MSSK841 - Land at Hill Lane, Markfield
Figure 3 - Magnetic Total Field (Lower Sensor)
1:1,500 @ A3
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48,990 nT 49,020

N

0 50 100 150 m

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448600
448800
449000
310700
310600
310500
310400
A50
Hill Lane Close
Ashby Road
Hill Lane
Area 1
Area 2
Area 1
Area 1
Leicester Road
Main Street
Upland Drive
Main Street
The Paddock
Dandees Close

MSSK841 - Land at Hill Lane, Markfield
Figure 4 - Magnetic Gradient
1:1,500 @ A3
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-1 nT 2

N

0 50 100 150 m

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MSSK841 - Land at Hill Lane, Markfield
Figure 5 - Magnetic Interpretation
1:1,500 @ A3
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- Magnetic Disturbance
- Ferrous/Debris (Spread)
- Undetermined (Weak)
- Agricultural (Trend)
- Ridge and Furrow (Trend)
- Ferrous (Spike)

N

0 50 100 150 m

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MSSK841 - Land at Hill Lane, Markfield
Figure 6 - Magnetic Interpretation Over Historical Maps and Satellite Imagery
1:2,000 @ A3
Copyright Magnitude Surveys Ltd 2021
Contains historical maps: Ordnance Survey, 6" 2nd edition c. 1882-1913.
Contains satellite imagery © 2021 Bing Satellite

- Magnetic Disturbance
- Ferrous/Debris (Spread)
- Undetermined (Weak)
- Agricultural (Trend)
- Ridge and Furrow (Trend)

N

0 50 100 150 m

magnitude surveys

448600
448800
449000
310700
310600
310500
310400
A50
Hill Lane Close
Ashby Road
Hill Lane
Area 1
Area 1
Area 1
Area 2
Leicester Road
Main Street
Upland Drive
Main Street
The Paddock
Dandees Close

MSSK841 - Land at Hill Lane, Markfield
Figure 7 - XY Trace Plot
30nT/cm at 1:1,500 @ A3
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N

0 50 100 150 m

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