magnitude surveys

# Geophysical Survey Report

# Camp Road, Heyford Park

# Oxfordshire

**For**

**RPS**

**On Behalf Of**

**Richborough Estates**

**& Lone Star Land**

**Magnitude Surveys Ref: MSSP1040**

**HER Event Number: To be issued when final report processed**

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**November 2021**

**Unit 17, Commerce Court**

**Challenge Way**

**Bradford**

**BD4 8NW**

**01274 926020**

**info@magnitudesurveys.co.uk**

**Report By:**

Leigh A. Garst BFA MSc

**Report Approved By:**

Finnegan Pope-Carter BSc (Hons) MSc FGS

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# Abstract

Magnitude Surveys was commissioned to assess the subsurface archaeological potential of a c. 10ha area of land at Camp Road, Heyford Park, Oxfordshire. A fluxgate gradiometer survey was successfully completed across the survey area. Possible archaeological activity has been recorded in the form of disjointed linear ditch-like features, including a possible rectilinear enclosure and further possible land divisions. Anomalies related to agricultural use have been detected and interpreted as a former unmapped field boundary, ridge and furrow, and more recent agricultural practices. An enhanced magnetic background was detected in some places due to variations in the underlying geology and soils have been identified which may have hidden more ephemeral magnetic anomalies if present. Possible localised mineral extraction was identified in four locations in the east of the survey area, interpretation supported by the presence of known quarries in the vicinity. Further impact of modern activity on the results is limited to magnetic disturbances produced by field edges, and by a routeway crossing one area.

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# 1. Introduction

1.1. Magnitude Surveys Ltd (MS) was commissioned by RPS on behalf of Richborough Estates and Lone Star Land to undertake a geophysical survey over a c. 10ha area of land at Camp Road, Heyford Park, Oxfordshire (SP 52149 25882).

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 (Cantarano, 2021) and approved by Richard Oram, Lead Archaeologist at Oxfordshire County Council.

1.5. The survey commenced on 23/08/2021 and took 3 days 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 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 directly east of Upper Heyford (Figure 1). The survey area is bordered by an unnamed lane to the north, Chilgrove Drive to the east, Camp Road to the south and by fields and a stream to the west (Figure 2).

4.2. Survey considerations:

| Survey Area | Ground Conditions | Further Notes |
|---|---|---|
| 1 | The survey area consisted of gently undulating grassland. | The field was bordered to the south, east and west by hedges with wire fencing to the north. |
| 2 | The survey area consisted of gently undulating grassland. | The field was surrounded by hedges and trees backed by a trackway to the west. |
| 3 | The survey area consisted of gently undulating grassland. | The field was surrounded by hedges and trees. A trackway travelled through the eastern extent of the survey area from north to south. |
| 4 | The survey area consisted of gently undulating grassland. | The field was bordered by hedges to the east, west and south with a wire fence to the north. |
| 5 | The survey area consisted of gently undulating grassland. | The field was bordered by hedges to the east, west and south with a wire fence to the north. |

4.3. The underlying geology comprises Limestone from the Wite Limestone Formation. No superficial deposits have been recorded within the survey area but a band of Alluvium made of clay, silt, sand and gravel has been recorded c.500 m to the east. (British Geological Survey, 2021).

4.4. The soils consist of freely draining lime-rich loamy soils (Soilscapes, 2021).

# 5. Archaeological Background

5.1. The following is a summary of a Built Heritage and Archaeology constraints and opportunities report produced and provided by RPS (Hamilton-Rutter and Thornton, 2020).

5.2. Prehistoric activity has been identified in the form of a 3-mile-long Iron Age boundary ditch and bank, known as Aves Ditch, recorded running along the eastern boundary of the survey area. Possible Iron Age enclosures have been recorded from cropmarks identified on aerial photographs, located c. 365m northeast, c. 570m east, c. 610m south and c. 990m south of the survey area respectively. An undated but possibly Prehistoric or later circular enclosure was recorded c. 575m northeast of the survey area. Further undated but possibly Prehistoric/Roman rectilinear and circular enclosures were identified c. 470m and c. 610m east and c. 770m southwest of the survey area.

5.3. Evidence of Roman activity has been recorded in the form of a possible Roman settlement, located c. 570m north of the survey area.

5.4. Conjectural evidence of Saxon inhumation burials has been recorded. Although the location of these burials is unclear, a possible location has been identified c. 620m north of the survey area, with an alternate location c. 100m south.

5.5. The survey area is located adjacent to the southeast of the RAF Upper Heyford Conservation Area. This airfield comprises buildings, structures and infrastructure relating to a Cold War fast jet operation.

# 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 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 6). 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. A fluxgate gradiometer survey was carried out over c. 10ha of land at Camp Road, Heyford Park, Oxfordshire. The geophysical results are presented in combination with satellite imagery and historical maps (Figure 7).

7.2.2. The fluxgate gradiometer survey has responded well to the environment of the survey area. The geophysical survey has detected possible archaeological and agricultural features as well as possible extraction and natural variations in the geology and soils. Magnetic disturbance can be seen emanating from fences along the edges of the field boundaries and within close proximity of a road crossing the northwest part of the survey area. Variations in the underlying geology and soils have been identified as an enhanced magnetic background mostly visible in the east of the survey area (Figure 5 & 6). This may potentially mask low magnitude anomalies.

7.2.3. Possible archaeological activity has been detected as a series of disjointed linear ditch-like features in the north of the survey area (Figure 5). These anomalies' morphology is characteristic of anthropogenic activity and they do not match former field boundaries recorded on available historical maps, and as such have been interpreted to be of possible archaeological origin. They may represent a former organisation of landscape divisions, including a possible larger enclosure. However, a more confident classification cannot be made from these magnetic data alone and another origin such as more recent agricultural activity cannot be ruled out for the larger enclosure and a natural origin or agricultural origin for the more ephemeral anomalies.

7.2.4. Historical agricultural activity has been detected in the north of the survey area as a possible former field boundary and the remnants of ridge and furrow contained within. Neither of these features were extant at the time of survey but they appear to suggest a former field division (Figure 7). Linear trends corresponding to modern cultivation practices, including probable drains have also been identified.

7.2.5. Several localities within the survey area have been identified as possible extraction sites. Available historic mapping records two former quarries in the vicinity of the survey area (Figure 7), one of which is immediately to the south of one of the possible extraction anomaly. These may demonstrate older, unmapped utilisation of the limestone bedrock, that has naturally been backfilled.

7.2.6. Several weak linear and curvilinear anomalies have been identified across the survey area, which are either too isolated or small to classify more confidently than as Undetermined (Figures 4 and 5). One amorphous anomaly detected in the centre of the survey area may be related to extraction activity, however a natural origin is as likely (Figure 3 and 5). A band detected in the north of the survey present an ambiguous magnetic signal. Although its general shape indicates a natural origin, a series of weak discrete magnetic anomalies running within the band suggest an anthropogenic origin. It is also located next to the anomalies identified as possible archaeology. Due to the lack of further supporting, contextual information a confident interpretation is not possible.

## 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. **Archaeological Possible** – In the north of Area 4 a series of strong [**4a**] and weak [**4b**] positive and disjointed, linear anomalies have been detected (Figure 5). These anomalies are indicative of ditches, infilled with magnetically enhanced material. [**4a**] appear to form a rectangular enclosure which does not match former field boundaries recorded on available historical maps. The anomalies' morphology and orientation are suggestive of anthropogenic potential and, due to their proximity to possible Iron Age and later Prehistoric/Romano-British enclosures recorded in the wider surroundings (see section 5), a possible archaeological origin has been assigned. The anomalies forming [**4b**] have a weaker magnetic signal and are more difficult to distinguish against the background, however their pattern and location near [**4a**] suggest a possible anthropogenic origin, although a natural origin cannot be ruled out. It is difficult to establish a clear link between [**4a**] and [**4b**], however, these anomalies may represent a former organisation of landscape divisions.

7.3.2.2. **Ridge and Furrow (Trend)** – A grouping of parallel linear anomalies have been detected in Area 4 (Figure 5). Spacing between the anomalies is typically between 6-8m and is reflective of ridge and furrow ploughing. Although these share an alignment with the anomalies of possible archaeological origin (Figure 5), they appear to intersect the possible archaeology which suggest that the features are not contemporary with each other.

7.3.2.3. **Agricultural (Weak)** – A weak positive linear anomaly was identified at a north to south alignment, typical of a cut feature with enhanced fill (Figure 4). This anomaly appears to mark the western extent of the aforementioned ridge and furrow regime, suggesting that there was an earlier field division in this area which does not appear on available mapping. Although it is located in close proximity to possible archaeology, its apparent location at the end of the possible ridge and furrow trend suggest an historical agricultural origin.

7.3.2.4. **Agricultural (Trend)** – Across the survey area a series of parallel linear anomalies have been detected which exhibit a much weaker magnetic signal, most notable in the Total Field (Figure 3). The orientation is well matched with modern cultivation visible in recent satellite imagery and are interpreted as agricultural trends caused by modern ploughing (Figure 4 & 6).

7.3.2.5. **Drains** – Two linear anomalies have been detected exhibiting differences in their magnetic signature in comparison to other agricultural trends, including ridge and furrow: they have a wider separation, are straighter in form and weakly dipolar which is suggestive of anomalies produced by drainage features (Figure 3 & 4).

7.3.2.6. **Possible Extraction** – Throughout Area 1, several localities have been detected characterised by a change in background consistency (Figures 3-5). This mottled effect with distinctive strong enhancement at the edges is characteristic of area of extraction. It is likely these are a result of the extraction of the limestone

bedrock that has been backfilled through natural processes. One of these localities in the south of Area 1 [**1a**] presents a stronger magnetic signal which may suggest an anthropogenically enhanced backfill. The possible extraction interpretation is strengthened by the presence of known quarries in the vicinity, including one immediately to the south of [**1a**].

7.3.2.7. **Natural (Strong, Weak and Zone)** – The underlying geology across the survey area consists of limestone and free flowing lime-rich loamy soils. Magnetically enhanced zones are visible in Areas 1 and 4 (Figure 3-5). These zones could be caused by impeded drainage over the undulating landscape as water flows through and naturally depositing the topsoil, however, the defined zones could also be an indicator of a change in agricultural land use. In the centre of the survey areas a band of strong positive magnetic signal is visible in a meandering path transecting Area 2 (Figure 5). The path of this anomaly follows an extant waterway to the west but could also be caused by natural drainage.

7.3.2.8. **Undetermined** – A number of anomalies have been detected throughout the survey area which have no evidence to corroborate either a natural or anthropological origin (Figures 3-4). Whilst many of these do not present a clear layout, their defined edges suggest they are of anthropogenic potential. Additionally, in the centre of Area 4 a series of possible discrete anomalies surrounded by a weak negative magnetic enhancement [**4c**] has been identified bisecting the area. [**4c**] does not appear to correspond with any mapped features on available historic maps or satellite imagery (Figure 7). Although a natural origin later disturbed by agricultural activity is likely, the weak magnetic signal, its location near possible archaeology and the lack of further supporting contextual evidence does not allow a confident interpretation.

# 8. Conclusions

8.1. A fluxgate gradiometer survey has successfully been undertaken across the survey area. The geophysical survey has detected a range of anomalies of archaeological, agricultural, natural and undetermined origins. Variations in the natural soils and geology are visible throughout the survey area. These are visible as zones of enhanced material and a band following the same directions than an extant waterway. It is possible these have masked more ephemeral magnetic anomalies. Modern activity in the form of magnetic disturbance is generally limited to the boundaries of the survey area and along a routeway and service.

8.2. A series of possible archaeological anomalies have been detected in the form of disjointed linear ditch-like features, including a possible enclosure and further possible land divisions. However the lack of further context to the anomalies and the weak signal associated with some of the anomalies prevent a more confident categorisation.

8.3. Agricultural activity is visible throughout the survey including a possible former unmapped field boundary, distinct ridge and furrow ploughing regimens and modern agricultural practices.

8.4. Four small localised areas of possible extraction have been detected in the east of the survey area. This is a common practice in areas with limestone bedrock and historic quarries have been identified nearby.

8.5. Several anomalies have been categorised as 'Undetermined'. These vary in magnetic signal and shape, though lack wider contextual evidence from which to inform a confident interpretation. Nevertheless, an archaeological origin cannot be discounted.

# 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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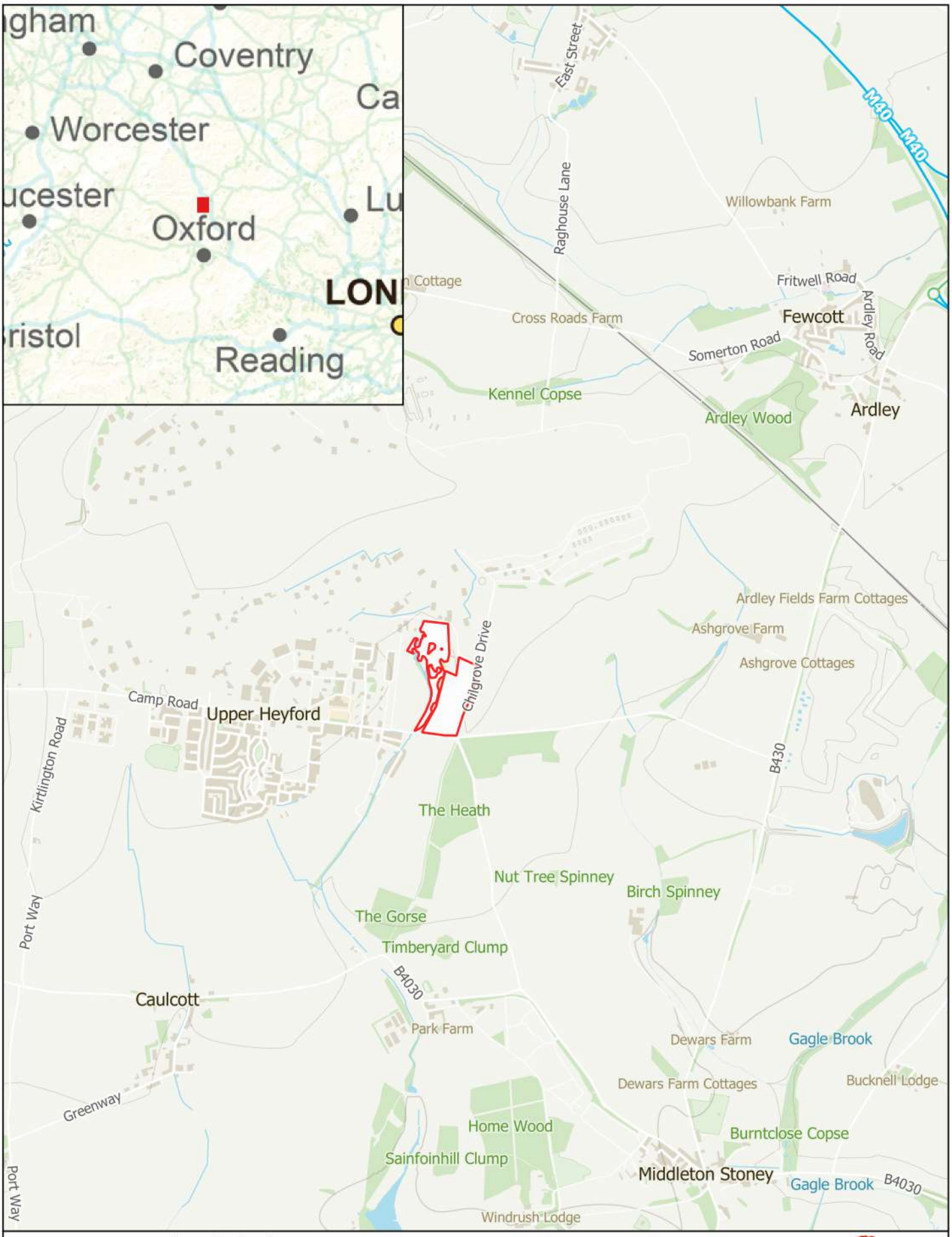
# 12. Project Metadata

| | |
|---|---|
| MS Job Code | MSSP1040 |
| Project Name | Camp Road, Heyford Park, Oxfordshire |
| Client | RPS |
| Grid Reference | SP 52149 25882 |
| Survey Techniques | Magnetometry |
| Survey Size (ha) | 10.08ha (Magnetometry) |
| Survey Dates | 2021-08-23 to 2021-08-25 |
| Project Lead | Julia Cantarano Ingénieur PCIfA |
| Project Officer | Julia Cantarano Ingénieur PCIfA |
| HER Event No | TBC |
| OASIS No | TBC |
| Report Version | 1.0 |

# 13. Document History

| Version | Comments | Author | Checked By | Date |
|---|---|---|---|---|
| 0.1 | Initial draft for Project Lead to Review | LAG | JC | 21 October 2021 |
| 0.2 | Revised draft to Project Lead for Review. Draft for Director Approval | RK, JC | FPC | 27 October 2021 |
| 0.3 | Comments from Client | JC | FPC | 17 November 2021 |
| 1.0 | Updating Clients' name - Issued as Final | JC | FPC | 22 December 2021 |




MSSP1040 - Camp Road, Heyford Park
Figure 1 - Site Location
1:25,000 @ A4
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Site Boundary

N

0 0.5 1 km

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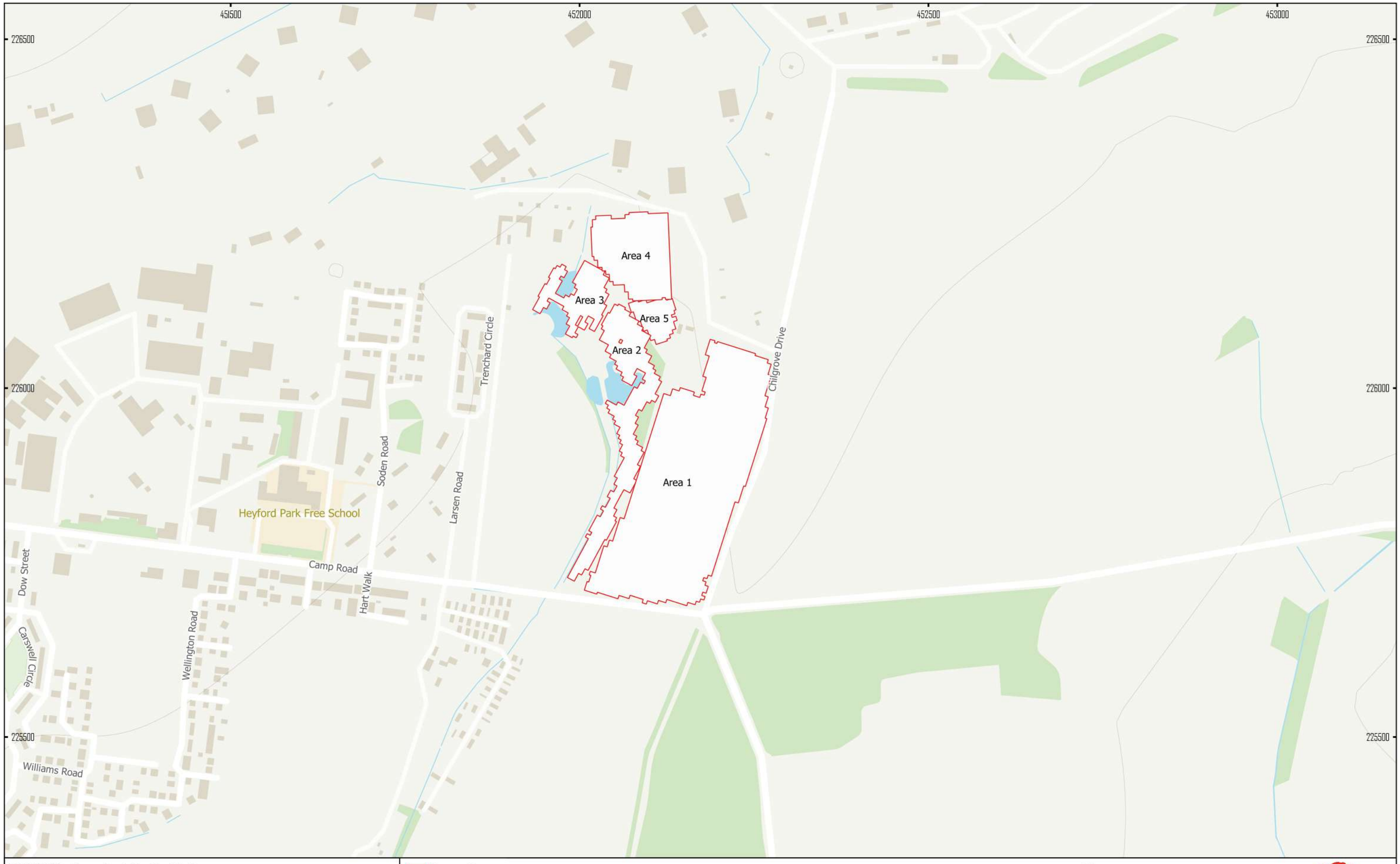


MSSP1040 - Camp Road, Heyford Park
Figure 2 - Location of Survey Area
1:5,000 @ A3
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Survey Extent

N

0 100 200 300 m

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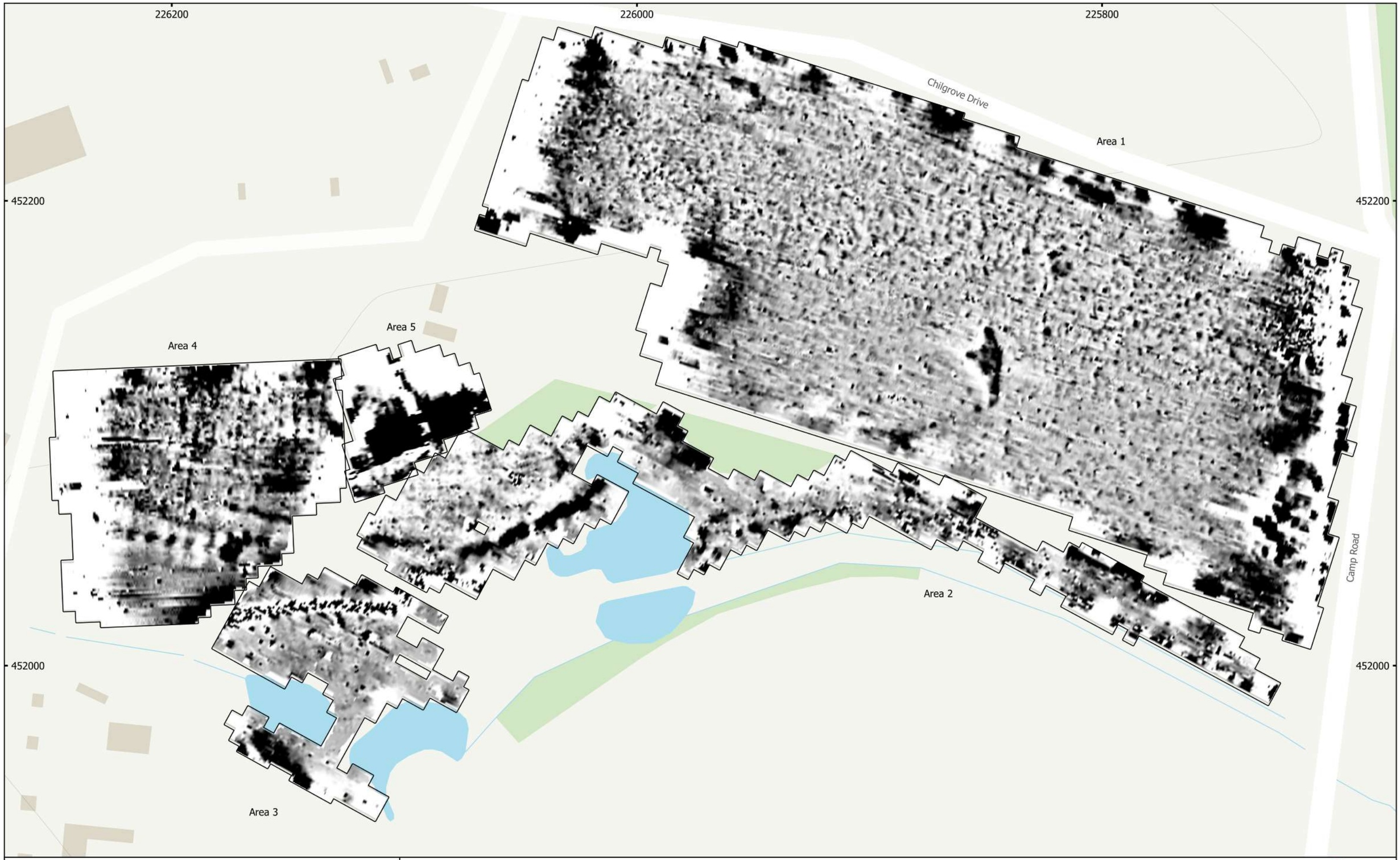


MSSP1040 - Camp Road, Heyford Park
Figure 5 - Magnetic Total Field (Lower Sensor)
1:1,500 @ A3
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48,997 nT 49,005

N

0 50 100 150 m

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226200
226000
225800
452200
452200
Chilgrove Drive
Area 1
Area 4
Area 5
Area 2
Camp Road
452000
452000
Area 3

MSSP1040 - Camp Road, Heyford Park
Figure 4 - Magnetic Gradient
1:1,500 @ A3
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-1 nT -2

N

0 50 100 150 m

magnitude surveys

226200
226000
225800
452200
452200
452000
452000
Chilgrove Drive
Camp Road
Area 1
Area 2
Area 3
Area 4
Area 5
4a
4b
4c
1a

MSSP1040 - Camp Road, Heyford Park
Figure 5 - Magnetic Interpretation
1:1,500 @ A3
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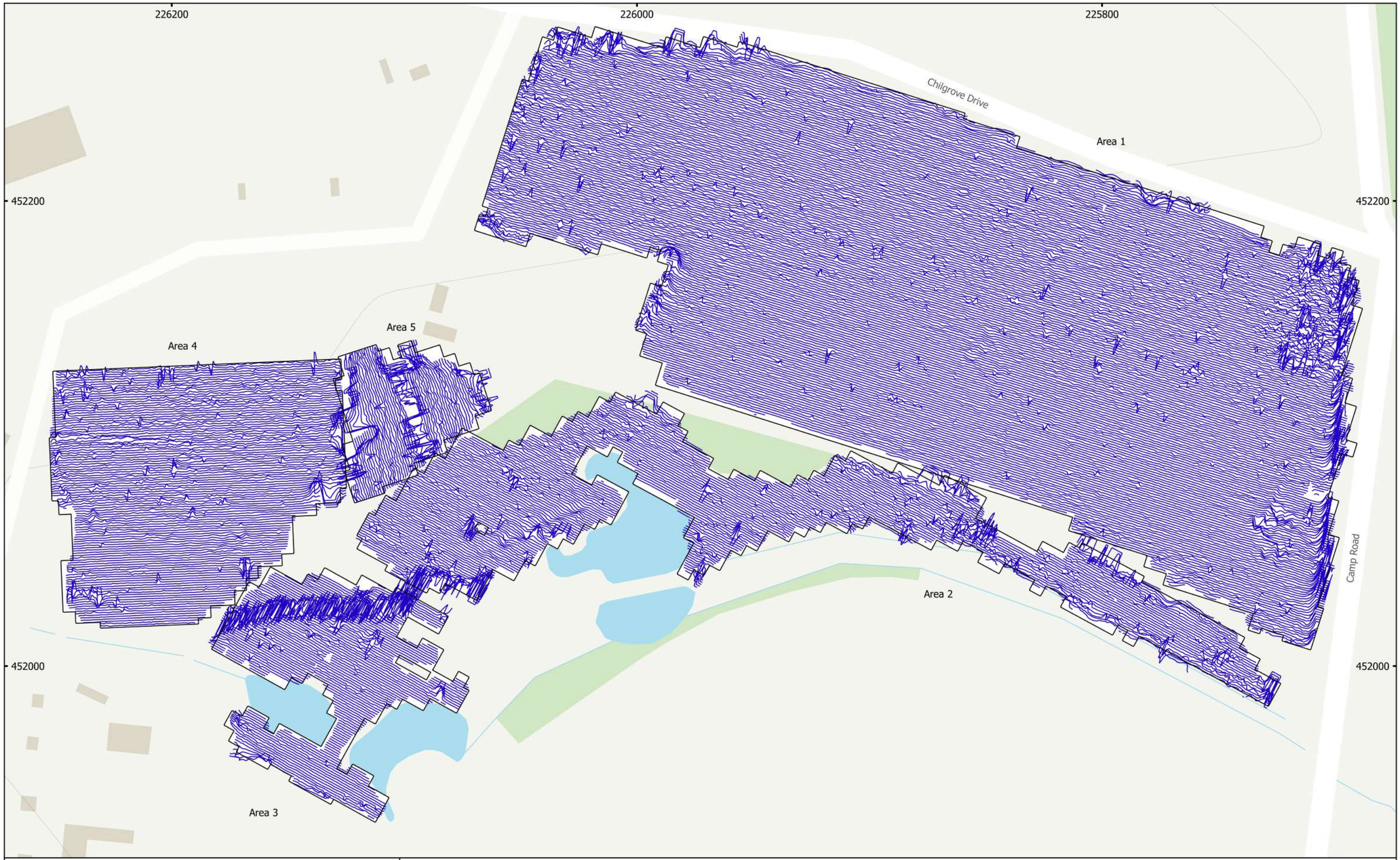
- Archaeology Possible (Strong)
- Archaeology Possible (Weak)
- Agricultural (Weak)
- Natural (Strong)
- Natural (Weak)
- Natural (Zone)
- Possible Extraction
- Possible Extraction (Zone)
- Magnetic Disturbance
- Ferrous/Debris (Spread)
- Undetermined (Strong)
- Undetermined (Weak)
- Agricultural (Trend)
- Ridge and Furrow (Trend)
- Ferrous (Spike)

N

0 50 100 150 m

magnitude surveys




MSSP1040 - Camp Road, Heyford Park
Figure 6- XY Trace Plot
30nT/cm at 1:1,500 @ A3
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N

0 50 100 150 m

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MSSP1040 - Camp Road, Heyford Park
Figure 7 - Magnetic Interpretation of Combined Historical Map and Satellite Imagery
1:3,500 @ A3
Copyright Magnitude Surveys Ltd 2021
Contains historic maps: Ordnance Survey 6" 2nd edition c. 1882-1913
Contains Satellite Imagery data © Bing 2021

- Archaeology Possible (Strong)
- Archaeology Possible (Weak)
- Agricultural (Weak)
- Natural (Strong)
- Natural (Weak)
- Natural (Zone)
- Possible Extraction
- Possible Extraction (Spread)
- Ferrous/Debris (Spread)
- Magnetic Disturbance
- Undetermined (Strong)
- Undetermined (Weak)
- Agricultural (Trend)
- Ridge and Furrow (Trend)
- Ferrous (Spike)

N

0 50 100 150 m

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