Geophysical Survey Report

Roots in Time

For

Worcestershire County Council

Magnitude Surveys Ref: MSSP724C

HER Event Number: WSM78305

OASIS Number: magnitud1-507967

S42 Number: SL00234287

July 2022

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Issue Date:

11 July 2022

Abstract

Magnitude surveys was commissioned to assess the subsurface protentional of a c. 4.5ha area of land at New Farm, Norton, Worcestershire. This survey expands upon a previous survey undertaken by Magnitude Surveys in 2020. The geophysical survey responded well to the environment of the survey area and detected anomalies indicative of archaeological activity, in the form of multiple prehistoric enclosures with internal subdivisions. Agricultural activity was also identified in the form of ridge and furrow ploughing. Industrial activity was identified in the northwest of the survey area, along the route of a mapped former railway line. Several undetermined anomalies were also identified. These vary in magnetic signal and shape, but none have any distinctive form or pattern which could be more confidently attributed to an archaeological origin. Nevertheless, an archaeological origin cannot be ruled out.

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1. Introduction

1.1. Magnitude Surveys Ltd (MS) was commissioned by Worcestershire County Council to undertake a geophysical survey over a c. 4.5ha area of land at New Farm Norton, Evesham, Worcestershire (SP051477).

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

1.4. It was conducted in line with a WSI produced by MS (Langston & Terry, 2022).

1.5. The survey commenced on 23/05/22 and took two 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 has served as 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 and a Member of CIfA, 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.

3.2. The survey will also look to identify the presence of any archaeological remains within the scheduled monument (WSM02761) in advance of work to create new public spaces and community orchards.

4. Geographic Background

4.1. The survey area was located c. 1.5km east of Norton (Figure 1). Gradiometer survey was undertaken across a pasture field. The survey area was bordered by a golf course to the east and by agricultural fields in all other directions (Figure 2).

4.2. Survey considerations:

Survey Area	Ground Conditions	Further Notes
1	The area consisted of flat grassland.	The area was bordered to the north by hedges, to the south by wire fencing and had no physical boundaries to the east or west.

4.3. The underlying geology comprises mudstone from the Blue Lias Formation and Charmouth Mudstone Formation. Superficial deposits consist of sand and gravel from the Wasperton Sand and Gravel Member (British Geological Survey, 2022).

4.4. The soils consist of freely draining slightly acid loamy soils (Soilscapes, 2022).

5. Archaeological Background

5.1. The following is a summary of a Historic Environment Record search produced and provided by Worcestershire County Council (Webley, 2020), which was carried out on a 500m radius of the boundary of the site.

5.2. The survey area lies within a prehistoric Scheduled Monument (WSM02761) which contains prehistoric enclosures. These have been identified as dating from the early Neolithic to late Iron Age and comprising possible barrows. Cropmarks interpreted as representing Prehistoric enclosures have been identified c. 100m east of the survey area.

5.3. Four Iron Age coins have been reported to the Portable Antiquities Scheme within close proximity to the survey area. Romano-British pottery has also been identified close to the survey area. A Romano-British enclosure was recorded c. 500m east of the survey area during salvage works undertaken within a wider area thought to be a Roman occupation site based on place-name evidence, and a Romano-British settlement is recorded c. 400m northeast of the survey area.

5.4. The medieval period is represented by records of ridge and furrow, a park pale c. 430m southeast of the survey area, and a possible moated site c. 1km southeast.

5.5. The post-medieval period is represented by records of ponds, marshes and osier beds in the vicinity of the river Avon, alongside the development of a cluster of farmsteads which came together to form the village at Norton. The known line of the disused Salford Priors to Evesham railway also passes along the eastern boundary of survey 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	0.5m	200Hz reprojected to 0.125m

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

6.1.4.1. 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.

6.1.4.2. 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 (2022) 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 satellite imagery and historical maps (Figure 7).

7.2.2. The fluxgate gradiometer survey responded well to the environment of the survey area. The geophysical survey has primarily detected archaeological and agricultural activity, as well as a former railway. Modern interference was limited to extant field boundaries.

7.2.3. Archaeological activity has been identified in the form of a group of multiple enclosures with interior segments and a possible trackway (Figure 5). These enclosures appear to extend out past the eastern boundary into an area of a previously surveyed land, which detected further anomalies of archaeological origins. These enclosures, which are part of the Scheduled Monument, are thought to have prehistoric origins but have undetermined usage (Section 5.2). This evidence expands on previous investigations undertaken in the immediate surroundings of the survey area which illustrated the presence of prehistoric enclosures of domestic or industrial use or prehistoric funerary mounds which extend into the current survey area (Burton & Carli, 2020). Further archaeological activity has been identified in the form of a singular rectilinear alignment of anomalies, that may present a further enclosure (Figure 5).

7.2.4. Agricultural activity has been identified across the survey area with ridge and furrow ploughing running approximately north to south (Section 5.4).

7.2.5. Industrial activity has been identified in the form of a former railway oriented along the eastern boundary, this had also been identified within the previous survey (Figure 8) (Section 5.5.).

7.2.6. Several anomalies have been categorised as ‘Undetermined’. These vary in magnetic signal, and shape, but none have any distinctive form or pattern which could be more confidently attributed to an archaeological origin. Nevertheless, an archaeological origin cannot be ruled out.

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. **Probable Archaeology (Strong & Weak)** – Within the northeast and east of the survey area, multiple anomalies have been identified (Figure 5). These anomalies appear to form large, intersecting rectilinear enclosures, with further interior subcircular and rectilinear segments, along with associated linear anomalies surrounding these (Figure 5). Some of these anomalies extend east beyond the boundary of the survey area and align with archaeological anomalies identified within a previous survey carried out by Magnitude Surveys (Burton & Carli, 2020) (Figure 8). The anomalies in the previous survey have been identified as prehistoric enclosures of domestic or industrial use, or prehistoric funerary mounds (Section 5.2) (Burton & Carli, 2020). The surrounding enclosures identified within the current survey are thus most likely prehistoric in date and of similar use. To the southeast of the survey area, two weak parallel linear anomalies have been identified extending south of these enclosures which are possibly indicative of a trackway defined by ditches (Figure 5).

7.3.2.2. **Possible Archaeology (weak)** – Within the northwest of the survey area, a rectilinear alignment of weak linear and curvilinear anomalies has been identified (Figure 5). These anomalies present different signals and alignment to the nearby identified probable archaeology but have both defined edges and are morphologically indicative of archaeology. Due to this they have been classified as possible archaeology.

7.3.2.3. **Industrial/Modern (Spread) –** A spread of weak discrete anomalies have been identified running parallel to the western boundary (Figure 5). These align with the dismantled line of the Salford Priors to Evesham railway visible in historic mapping (Figure 7) (Section 5.5).

7.3.2.4. **Ridge and Furrow (Trend) –** An alignment of regularly spaced linear anomalies has been identified across the survey area, running approximately north to south (Figure 5). They are indicative of ridge and furrow ploughing due to their morphology and general 5-8m spacing.

8. Conclusions

8.1. A fluxgate gradiometer survey was successfully completed across the survey area. This survey expands upon a previous survey carried out by Magnitude Surveys in 2020. The geophysical survey has detected a range of anomalies related to archaeological activity, as well as anomalies of agricultural, industrial and undetermined origins. Modern interference is limited to the edges of the field.

8.2. Archaeological activity has been identified in the form of multiple intersecting enclosures with internal subdivisions and features. A further possible enclosure has been identified in the northwest of the survey area, and while it presents a different orientation and signal to the archaeology in the northeast, due to the surrounding areas containing archaeology, it is likely that these anomalies have an archaeological origin as well. A double ditch trackway has also been identified in the southeast of the survey area.

8.3. Agricultural activity has been identified in the form of ridge and furrow ploughing. Industrial activity has also been identified in the form of a former railway.

8.4. Several anomalies have been categorised as 'Undetermined'. These vary in magnetic signal and shape, but none have any distinctive form or pattern which could be more confidently attributed to an archaeological origin. Nevertheless, an archaeological origin cannot be ruled out.

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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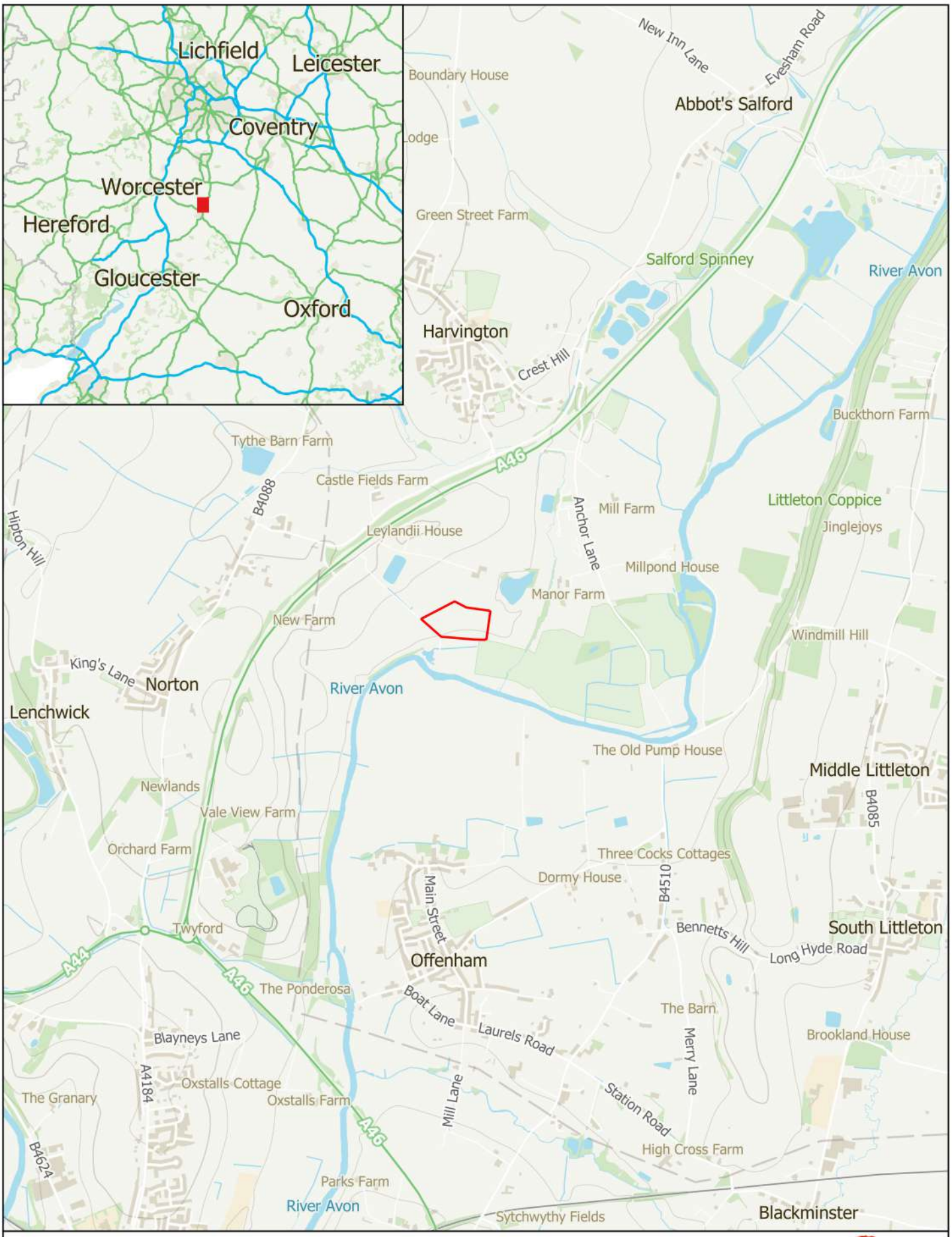
12. Project Metadata

MS Job Code	MSSP724C
Project Name	Roots in Time
Client	Worcestershire County Council
Grid Reference	SP051477
Survey Techniques	Magnetometry
Survey Size (ha)	4.5ha (Magnetometry)
Survey Dates	2022-05-23 to 2022-05-24
Project Lead	Alison Langston BA PCIfA
Project Officer	Isabella Carli BA MA PCIfA
HER Event No	WSM78305
OASIS No	magnitud1-507967
S42 Licence No	SL00234287
Report Version	1.0

13. Document History

Version	Comments	Author	Checked By	Date
0.1	Initial draft for Project Lead to Review	IT	IC	01 June 2022
0.2	Corrections from Project Officer	IT	PSJ	08 June 2022
1.0	Report issued as Final, Addition of HER and OASIS numbers	N/A	AL	11 July 2022



MSSP724C - Roots in Time
Figure 1 - Site Location
1:25,000 @ A4

Site Boundary

N

0 0.5 1 km

magnitude surveys

405000
406000
248000
248000
A46
Area 1
Manor Farm
Golf Course
River Avon

MSSP724C - Roots in Time
Figure 2 - Location of Survey Area
1:3,000 @ A3

Survey Extent

N

0 90 180 270 m

magnitude surveys

405204

405404

405604

247800

247800

Area 1

247600

247600

MSSP724C - Roots in Time
Figure 3 - Magnetic Total Field (Lower Sensor)
1:1,500 @ A3

48,997 nT 49,005

N

0 40 80 120 m

magnitude surveys

405204

405404

405604

247800

247800

Area 1

247600

247600

MSSP724C - Roots in Time
Figure 4 - Magnetic Gradient
1:1,500 @ A3

-1 nT 2

N

0 40 80 120 m

magnitude surveys

405204

405404

405604

247800

247800

Area 1

247600

247600

MSSP724C - Roots in Time
Figure 5 - Magnetic Interpretation
1:1,500 @ A3

- Archaeology Probable (Strong)
- Archaeology Probable (Weak)
- Archaeology Possible (Strong)
- Archaeology Possible (Weak)
- Undetermined (Weak)
- Magnetic Disturbance
- Industrial/Modern (Spread)
- Ridge and Furrow (Trend)
- Ferrous (Spike)

N

0 40 80 120 m

magnitude surveys

405204

405404

405604

247800

247800

Area 1

247600

247600

MSSP724C - Roots in Time
Figure 6 - XY Trace Plot
30nT/cm at 1:1,500 @ A3

N

0 40 80 120 m

magnitude surveys

404800 405000 405200 405400 405600 405800 406000 406200

248000 247800 247600 247400 247200

Area 1

S.P

M.P

Well

Liable to Floods

RIVER AVON

C.R.

Weir

MSSP724C - Roots in Time
Figure 7 - Magnetic Interpretation Over Historical Maps and Satellite Imagery
1:4,000 @ A3

Contains historical mapping © CLS Data 2022: Ordnance Survey, 6" 2nd edition c. 1882-1913
Contains satellite imagery © Bing Satellite 2022

- Archaeology Probable (Strong)
- Archaeology Probable (Weak)
- Archaeology Possible (Strong)
- Archaeology Possible (Weak)
- Undetermined (Weak)
- Magnetic Disturbance
- Industrial/Modern (Spread)
- Ridge and Furrow (Trend)
- Ferrous (Spike)

N

0 100 200 300 m

magnitude surveys

404800 405000 405200 405400 405600 405800 406000 406200

248000 247800 247600 247400 247200

Farm

S.P

M I D L E

(B A R N T G R E E N,

M.P

M.P

Well

L i a b l e t o F l o o d s

R I V E R A V O N

C.R.

Liable to Floods

L i a b l e t o

Weir

MSSP724C - Roots in Time
Figure 8 - Magnetic Interpretation Over Historical Maps and Satellite Imagery With Previous Surveys Interpretation
1:4,000 @ A3

Contains historical mapping © CLS Data 2022: Ordnance Survey, 6" 2nd edition c. 1882-1913
Contains satellite imagery © Bing Satellite 2022

- Archaeology Probable (Strong)
- Archaeology Probable (Weak)
- Archaeology Possible (Strong)
- Archaeology Possible (Weak)
- Agricultural (Strong)
- Agricultural (Weak)
- Undetermined (Strong)
- Undetermined (Weak)
- Undetermined (Spread)
- Natural (Strong)
- Natural (Weak)
- Magnetic Disturbance
- Ferrous/Debris (Spread)
- Industrial/Modern (Spread)
- Industrial/Modern
- Agricultural (Trend)
- Service
- Ridge and Furrow (Trend)
- Drainage Feature
- Ferrous (Spike)
- Previous Survey

N

0 100 200 300 m

magnitude surveys