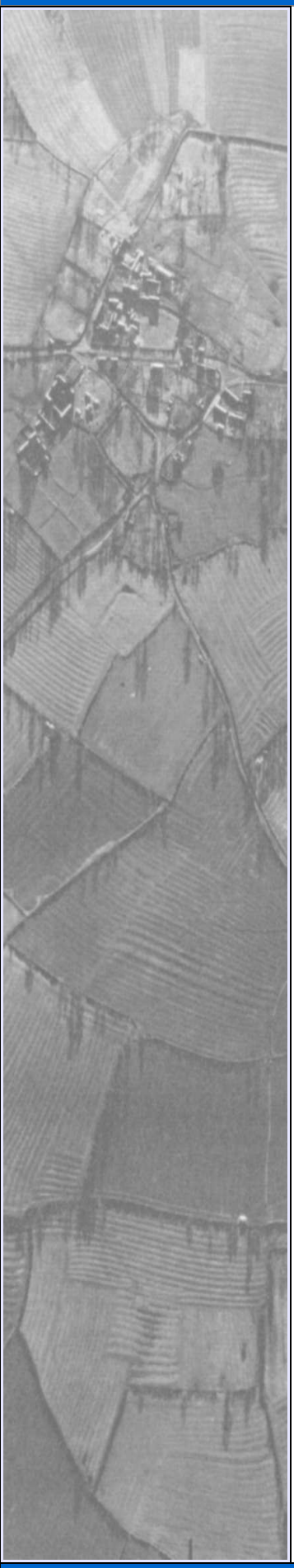

Moredon Multi Sports Hub
Swindon

MAGNETOMETER SURVEY REPORT

for

Swindon Borough Council

Kerry Donaldson & David Sabin

July 2017

Ref. no. J719

ARCHAEOLOGICAL SURVEYS LTD

Moredon Multi Sports Hub
Swindon

Magnetometer Survey Report

for

Swindon Borough Council

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Primary archive location - Archaeological Surveys Ltd, Yatesbury, Wiltshire

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Ordnance Survey Grid Reference – **SU 13100 86565**

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CONTENTS

LIST OF FIGURES

LIST OF PLATES

LIST OF TABLES

SUMMARY

A detailed magnetometer survey was carried out by Archaeological Surveys Ltd, at the request of Swindon Borough Council, within the site of Moredon Recreation Ground. The site has been outlined for the development of a multi sports hub which will include the upgrading of sports facilities and the introduction of a number of cycling disciplines. The results of the survey indicate the presence of a number of archaeological features including a series of enclosures near the far south western corner of the site, two linear ditches fragmented by ridge and furrow and a single ring ditch feature in the central western part of the site. There are a number of other weakly positive anomalies of uncertain origin, several of which lie within the vicinity of the archaeological features, others distributed more widely. Elsewhere, anomalies are associated with land drainage, sports pitches and other features of modern origin. A significant proportion of the site has been subject to past landscaping and ground make-up and it is possible that some anomalies below the original ground surface are too deep to locate. In addition, widespread magnetic debris in the north eastern part of the site may also prevent the location of features.

1 INTRODUCTION

1.1 Survey background

1.1.1 Archaeological Surveys Ltd was commissioned by Swindon Borough Council, to undertake a magnetometer survey of an area of land at Moredon Recreation Ground. The site has been outlined for a proposed development of a new multi sports hub which would include the updating of the existing football and cricket pitches and croquet lawns in the southern part of the site and to introduce a number of cycling disciplines within the former 3 par golf course in the northern part of the site. The survey forms part of an archaeological assessment of the site.

1.1.2 The geophysical survey was carried out in accordance with a Written Scheme of Investigation (WSI) produced by Archaeological Surveys (2017) and approved by Melanie Pomeroy-Kellinger, County Archaeologist for Wiltshire Council, prior to commencing fieldwork.

1.2 Survey objectives and techniques

1.2.1 The objective of the survey was to use magnetometry to locate geophysical anomalies that may be archaeological in origin so that they may be assessed prior to development of the site. The methodology is considered an efficient and effective approach to archaeological prospection.

1.2.2 The survey and report generally follow the recommendations set out by: English Heritage (2008) *Geophysical survey in archaeological field evaluation;* European Archaeological Council (2015) *Guidelines for the Use of Geophysics in Archaeology;* Institute for Archaeologists (2002) *The use of Geophysical Techniques in Archaeological Evaluations*. The work has been carried out to the Chartered Institute for Archaeologists (2014) *Standard and Guidance for*

Archaeological Geophysical Survey.

1.3 Site location, description and survey conditions

1.3.1 The site is located at Moredon Recreation Ground in West Swindon, to the south of Akers Way and north of Cheney Manor Industrial Estate. It is centred on Ordnance Survey National Grid Reference (OS NGR) SU 13100 86565, see Figs 01 and 02.

1.3.2 The geophysical survey covers approximately 11ha within a 16ha site which covers mainly sports pitches (Area 1), a croquet lawn (Area 3) and public open space (Areas 2 & 4). Several areas within the site were unsuitable for survey, including the site of the demolished Hreod Parkway School at the far western edge and a model car race track at the far eastern edge.

Plate 1: Area 1 looking west

Plate 2: Area 2 looking west

Plate 3: Area 3 looking north west

Plate 4: Area 4 looking east

1.3.3 Area 1 contains two cricket fields with two permanent pitches likely to be constructed from concrete and contain ferrous material that may produce magnetic disturbance. The northern part of the western half of Area 1 is notably lower than the eastern half, and the height difference is associated with a bank running approximately north - south. The height difference is greatest at the northern end of Area 1, approximately 1m, and diminishes in the central part of the area. There are a number of mature trees within the central part of the area, extending along part of the northern boundary, in the vicinity of the south eastern corner and forming the southern limit to the survey. The area tends to slope down towards the south and south west near the south western corner. A pavilion with steel security railings is located along the eastern side of the area and a tall steel mesh fence surrounds croquet lawns immediately to the north east.

1.3.4 Area 2 lies to the north of Area 1 and is separated from it by a metalled path. The northern limit of the area is a tributary of the River Ray known as the Hreod Burna or Hreod Brook. The western half of the area tends to slope down to the north towards the brook, while the eastern half appears to have been terraced to raise

and level the area resulting in a steep slope down to the brook along the northern side and a second steep slope down to the western half of the survey area. The height difference between the two halves of the survey area is a continuation of that noted in Area 1. It is estimated that the eastern half of Area 2 may have been raised by up to 2m in places. A zone within the eastern part of Area 2 was also previously fenced off and had been subject to former soil dumping associated with the construction of the nearby school. The fence has since been removed and only a small mound remains which was unsurveyable. Other notable features include part of a mature hedgerow in the north western part of the area and several mature trees that prevented survey in places. A large mound of soil towards the south eastern corner also impeded survey. Two bridges crossing the Hreod Brook were considered likely sources of magnetic disturbance due to their steel construction. Earthworks in the north eastern part of the area are former golf course features (see Fig 14).

1.3.5 Area 3 lies to the north east of Area 1 and is separated from it by tall steel mesh fencing considered to be a source of high magnitude magnetic disturbance. The area contains recently constructed croquet lawns with several steel containers providing storage etc. along the northern side. At the time of survey two low nets containing steel wire separated the area into three parts.

1.3.6 Area 4 lies to the east of Area 2 and contains numerous earthworks associated with landscaping and a former golf course. Generally the area slopes down towards the Hreod Brook that runs along the northern boundary. There are numerous mature trees within and surrounding the survey area. Sources of magnetic disturbance consisting of steel containers were noted along the southern boundary.

1.3.7 The ground conditions across the site were generally considered to be favourable for the collection of magnetometry data. Sources of magnetic disturbance have been outlined above but also include numerous inspection chambers, services and sports features such as goalpost sockets. Weather conditions during the survey were mainly very hot and sunny with extremely high temperatures preventing survey during mid to late afternoons due to health and safety concerns. The high temperatures did not exceed the operating range of the equipment and no detrimental effects on the data have been noted.

1.4 Site history and archaeological potential

1.4.1 The Wiltshire Historic Environment Record indicates that Romano-British pottery was found during the digging of a pipe trench in the southern part of the site in 1974, with further pottery sherds, pilae tile fragments and a brooch found within the bank of the River Ray to the south of the site (MWI15993). Medieval pottery was also found within the pipe trench (MWI16054). Three Iron Age post holes were found during evaluation 100m to the west of the site in 2003 by Oxford Archaeology (MWI15989). A flint flake of possible Neolithic date was also found 250m north west (MWI15980). The site of North Leaze (MWI67679), a demolished 19th century farmstead, lies 150m north west and an associated outfarm (MWI67729) 180m north.

1.4.2 The location of Romano-British and medieval pottery within the site and a number of Iron Age postholes to the west indicates that there is potential for the site to contain archaeological features. The use of the site as a sports ground in the south and golf course in the north in recent times indicates that there has been some modern ground disturbance. However, there is still potential for the survey to locate geophysical anomalies relating to previously unrecorded archaeology.

1.5 Geology and soils

1.5.1 The underlying solid geology across the southern part of the site is limestone from the Stanford Formation. In the north the geology is sandstone, siltstone and mudstone from the Hazlebury Bryan Formation with overlying alluvial deposits adjacent to the Hreod Brook, a tributary of the River Ray, along the northern edge of the site (BGS, 2017).

1.5.2 The overlying soil across the survey area is unmapped due to the urban location but is likely to be from the Sherborne association, which is a brown rendzina and consists of a shallow, well drained, brashy, calcareous, clayey soil (Soil Survey of England and Wales, 1983). Modern terracing and ground make up have taken place within the sports pitches and dumping of soil is also evident within the northern part of the site. The inclusion of highly magnetic material within the dumped soil and made ground is highly likely.

1.5.3 Magnetometry survey carried out across similar soils has produced good results. The underlying geology and soils are therefore considered acceptable for magnetic survey.

2 METHODOLOGY

2.1 Technical synopsis

2.1.1 Magnetometry survey records localised magnetic fields that can be associated with features formed by human activity. Magnetic susceptibility and magnetic thermoremnance are factors associated with the formation of localised fields. Additional details are set out below and within Appendix A.

2.1.2 Iron minerals within the soil may become altered by burning and the break down of biological material; effectively the magnetic susceptibility of the soil is increased, and the iron minerals become magnetic in the presence of the Earth's magnetic field. Accumulations of magnetically enhanced soils within features, such as pits and ditches, may produce magnetic anomalies that can be mapped by magnetic prospection.

2.1.3 Magnetic thermoremnance can occur when ferrous minerals have been heated to high temperatures such as in a kiln, hearth, oven etc. On cooling, a permanent magnetisation may be acquired due to the presence of the Earth's magnetic field. Certain natural processes associated with the formation of some igneous and metamorphic rock may also result in magnetic thermoremnance.

2.1.4 The localised variations in magnetism are measured as sub-units of the Tesla, which is a SI unit of magnetic flux density. These sub-units are nano Teslas (nT), which are equivalent to 10^{-9} Tesla (T).

2.2 Equipment configuration, data collection and survey detail

2.2.1 The detailed magnetic survey was carried out using a SENSYS MAGNETO®MXPDA 5 channel cart-based system. The instrument has 5 fluxgate gradiometers (FGM650) spaced 0.5m apart with readings recorded at 20 Hz. The cart is pushed at walking speed and not towed. Each sensor is not zeroed in the field as the vertical axis alignment is precisely fixed leaving sensor offsets that are removed during data processing. The fixing of the vertical alignment ensures the sensors are not unduly influenced by localised magnetic fields and that the vertical component of a magnetic anomaly is measured. The gradiometers have a range of recording data between ±0.1nT and ±10,000nT. They are linked to a Leica GS10 RTK GPS with data recorded by SENSYS MAGNETO®MXPDA software on a rugged PDA computer system.

2.2.2 Due to the fixed offsets within the fluxgate sensors, as a result of the manufacturing and tensioning process, the survey data do not provide a visually useful dataset until a zero median traverse algorithm is applied. It is recognised that this has the potential to affect some anomalies detrimentally by removing linear features orientated parallel to survey transects. However, this has not been noted as a particular problem with the system due to the high resolution data collection, generally long length of traverses and variability within the magnetic characteristics of a linear anomaly.

2.2.3 Data are collected along a series of parallel survey transects to achieve 100% coverage of the surveyable land. The length of each transect is variable and relates to the size of the survey area and other factors including ground conditions. A visual display allows accurate placing of transects and helps maintain the correct separation between adjacent traverses. Data are not collected within fixed grids and data points are considered to be random even though the data are collected in a systematic manner covering all accessible areas (Aspinall, Gaffney and Schmidt, 2009).

2.2.4 Fluxgate sensors are highly sensitive to temperature change and this is manifest as drift during the course of a survey. This can be particularly noticeable during the morning as temperatures rise and the equipment warms or cools. Sensor drift within the course of a traverse will appear as a line trending from negative to positive after processing with a zero median traverse algorithm. To remove the potential for temperature drift data were collected after a 20 minute stabilisation period and traverses were limited to a time of generally <100s.

2.3 Data processing and presentation

2.3.1 Magnetic data collected by the MAGNETO®MXPDA cart-based system are initially prepared using SENSYS MAGNETO®DLMGPS software. The software effectively allocates a geographic position for each data point and can compensate for fixed offsets present within the FGM650 sensors. The offsets are positive or negative values present on all fluxgate gradiometer sensors. Some

systems use manual or electronic balancing to effectively zero the sensors; however, this is a short term measure that is prone to drift through temperature changes and vibration and can easily be incorrectly set due to localised magnetic fields. The FGM650 sensors are very accurately aligned to the vertical magnetic gradient and are highly stable showing negligible drift on long traverses. The offset values are removed using TerraSurveyor software.

2.3.2 Survey tracks are analysed and georeferenced raw data (UTM Z30N) are then exported in ASCII format for further analysis and display within TerraSurveyor. The removal of offset values (compensation) of the sensors is also carried out in TerraSurveyor using a zero median traverse function. Data are then considered to be minimally processed. Note: without the zero median traverse function it is not possible to create a meaningful data plot as all sensors have a different offset value. Although a zero median traverse algorithm can remove anomalies aligned with the survey tracks, in practice this rarely occurs due to the use of long traverses, high resolution measurement and variability within the magnetic susceptibility of long linear features.

2.3.3 The minimally processed data are collected between limits of ±10000nT and clipped for display at ±3nT. Data are interpolated to a resolution of effectively 0.5m between tracks and 0.15m along each survey track. A plot of the data, clipped at ±50nT is also included to show the location of highly magnetic anomalies associated with ground make up and modern ferrous objects (Fig 03).

2.3.4 Additional data processing has been carried out for Areas 2 and 3 in the form of high pass filtering. This effectively removes low frequency variation along a traverse that has been caused by large magnetic bodies. Data treated to additional processing has been compared to unprocessed data to ensure that no significant anomalies have been removed.

2.3.5 Appendix C contains metadata concerning the survey and data attributes and is derived directly from TerraSurveyor. Reference should be made to Appendix B for further information on processing.

2.3.6 A TIF file is produced by TerraSurveyor software along with an associated world file (.TFW) that allows automatic georeferencing (OSGB36 datum) when using GIS or CAD software. The main form of data display used in the report is the minimally processed greyscale plot. With regard to the Sensys MXPDA, minimally processed data is considered by the manufacturer to be data that is compensated by SENSYS MAGNETO DLMGPS software, see 2.3.1 and 2.3.2. Note: traceplots are not considered to be appropriate as they do not provide an accurate or useful assessment of the magnetic anomalies due to very high density of data collection.

2.3.7 The raster images are combined with base mapping using ProgeCAD Professional 2016, creating DWG (2010) file formats. All images are externally referenced to the CAD drawing in order to maintain good graphical quality. The CAD plots are effectively georeferenced facilitating relocation of features using GPS, resection method, etc.

2.3.8 An abstraction and interpretation is also drawn and plotted for all geophysical anomalies located by the survey. Anomalies are abstracted using colour coded

points, lines and polygons. All plots are scaled to landscape A3 for paper printing.

2.3.9 A brief summary of each anomaly, with an appropriate reference number, is set out in list form within the results (Section 3) to allow a rapid and objective assessment of features within each survey area. Where further interpretation is possible, or where a number of possible origins should be considered, more subjective discussion is set out in Section 4.

2.3.10 The abstraction and interpretation procedure has been supported by analysis of a digital terrain model derived from the Environment Agency's LiDAR data recorded at 1m resolution. Shaded relief plots are created using Surfer 10 (Fig 14).

2.3.11 A digital archive is produced with this report, see Appendix D below. The main archive is held at the offices of Archaeological Surveys Ltd.

3 RESULTS

3.1 General assessment of survey results

3.1.1 The detailed magnetic survey was carried out over a total of four survey areas covering approximately 11ha.

3.1.2 Magnetic anomalies located can be generally classified as positive responses of archaeological potential, positive anomalies of an uncertain origin, linear anomalies of an agricultural origin, anomalies associated with land management, areas of magnetic debris and disturbance, strong discrete dipolar anomalies relating to ferrous objects and strong multiple dipolar linear anomalies relating to buried services or pipelines.

3.1.3 Anomalies located within each survey area have been numbered and are described in 3.4 below with subsequent discussion in Section 4.

3.2 Statement of data quality and factors influencing the interpretation of anomalies

3.2.1 Data are considered representative of the magnetic anomalies present within the site. There are no significant defects within the dataset.

3.2.2 Evidence of ground make-up consisting of terracing was noted in the north eastern part of Area 1 and eastern part of Area 2. Area 3 is also likely to lie on top of made ground. In support of these observations, several broad dipolar anomalies, indicative of deeply buried ferrous objects, are present within data from the eastern half of Area 2. Where ground levels have been made up any anomalies below the original ground surface will be weakened, and tend to broaden, due to the increased distance between the sensors and the magnetic source. Additionally, made ground often contains magnetic debris in the form of small ferrous objects and these can increase background 'noise' and effectively obscure weak anomalies of archaeological potential. The results of the survey may, therefore, not be representative of the archaeological potential of areas

subject to ground make-up.

3.2.3 Former golf course features were noted within Area 4 and part of Area 2. It is unclear as to the amount of former ground disturbance and landscaping associated with these features, but it should be considered that they may have the potential to obscure anomalies.

3.2.4 Dense zones of magnetic debris, particularly notable in Area 4, and smaller zones of magnetic disturbance, associated with modern ferrous objects, both have the potential to obscure anomalies of archaeological potential.

3.3 Data interpretation

3.3.1 The list of sub-headings below attempts to define a number of separate categories that reflect the range and type of features located during the survey. A basic explanation of the characteristics of the magnetic anomalies is set out for each category in order to justify interpretation, a basic key is indicated to allow cross referencing to the abstraction and interpretation plot. CAD layer names are included to aid reference to associated digital files (.dwg/.dxf). Sub-headings are then used to group anomalies with similar characteristics for each survey area.

Report sub-heading CAD layer names and plot colour	**Description and origin of anomalies**
Anomalies with archaeological potential AS-ABST MAG POS LINEAR ARCHAEOLOGY AS-ABST MAG POS DISCRETE ARCHAEOLOGY AS-ABST MAG POS RING DITCH AS-ABST MAG POS ENCLOSURE DITCH	Anomalies have the characteristics (mainly morphological) of a range of archaeological features such as pits, ring ditches, enclosures, etc.
Anomalies with an uncertain origin AS-ABST MAG POS LINEAR UNCERTAIN AS-ABST MAG POS DISCRETE UNCERTAIN AS-ABST MAG POS UNCERTAIN	The category applies to a range of anomalies where there is not enough evidence to confidently suggest an origin. Anomalies in this category may well be related to archaeologically significant features, but equally relatively modern features, geological/pedological features and agricultural features should be considered. Positive anomalies are indicative of magnetically enhanced soils that may form the fill of 'cut' features or may be produced by accumulation within layers or 'earthwork' features; soils subject to burning may also produce positive anomalies. Negative anomalies are produced by material of comparatively low magnetic susceptibility such as stone and subsoil.
Anomalies with an agricultural origin AS-ABST MAG RIDGE AND FURROW	The anomalies are often linear and form a series of parallel responses or are parallel to extant land boundaries. Where the response is broad, former ridge and furrow is likely; narrow response is often related to modern ploughing.
Anomalies relating to land management AS-ABST MAG LAND DRAIN	Land drains can appear in a classic herringbone pattern of interconnected multiple dipolar linear anomalies, or as parallel linear anomalies. The multiple dipolar response indicates a ceramic land drain, a negative response can indicate plastic, stone or gravel.
Anomalies associated with magnetic debris AS-ABST MAG DEBRIS AS-ABST MAG STRONG DIPOLAR	Magnetic debris often appears as areas containing many small dipolar anomalies that may range from weak to very strong in magnitude. It often occurs where there has been dumping or ground make-up and is related to magnetically thermoremnant materials such as brick or tile or other small fragments of ferrous

	material. This type of response is occasionally associated with kilns, furnace structures, or hearths and may therefore be archaeologically significant. It is also possible that the response may be caused by natural material such as certain gravels and fragments of igneous or metamorphic rock. Strong discrete dipolar anomalies are responses to ferrous objects within the topsoil.
Anomalies with a modern origin AS-ABST MAG DISTURBANCE AS-ABST MAG SERVICE AS-ABST MAG SPORTS PITCH	The magnetic response is often strong and dipolar indicative of ferrous material and may be associated with extant above surface features such as wire fencing, cables, pylons etc.. Often a significant area around such features has a strong magnetic flux which may create magnetic disturbance; such disturbance can effectively obscure low magnitude anomalies if they are present. Fluxgate sensors may respond erratically and with hysteresis adjacent to strong magnetic sources. Buried services may produce characteristic multiple dipolar anomalies dependant upon their construction.

Table 1: List and description of interpretation categories

3.4 List of anomalies - Area 1

Area centred on OS NGR 413030 186510, see Figs 06 – 09.

Anomalies of archaeological potential

(1) - In the northern part of the survey area is a positive curvilinear anomaly which appears to form a ring ditch with a 10m diameter. Internally there are a number of possible pits or postholes and the centre appears to have been truncated by a furrow. The response would suggest the presence of a prehistoric round house.

(2) - Two fragmented positive linear anomalies are also located in the northern part of the survey area. The southernmost linear appears to extend towards anomaly (1), which may indicate that they are contemporary. They have been truncated by furrows.

(3) - Located in the south western corner of Area 1 are a number of positive linear, rectilinear, curvilinear and discrete responses which form a series of former enclosures, linear ditches and pits.

Anomalies with an uncertain origin

(4) - Extending towards anomalies (3) are a number of weakly positive linear anomalies. They tend to have a north east to south west orientation which could indicate an association with former agricultural activity. However, they do appear to have been truncated by land drains (8) and an association with cut features is possible.

(5) - A number of positive linear, discrete and amorphous anomalies are located in the vicinity of anomalies (1) and (2). While it is possible they relate to cut features such as ditches and pits, some may relate to underlying deposits disturbed by the later ridge and furrow. However, they are weak and lack a coherent morphology for their origin to be confidently interpreted.

(6) - A number of positive linear anomalies are oriented west north west to east south east. It is not possible to determine if they relate to cut features, agricultural activity, ridge and furrow or more modern land use.

(7) - A number of positive linear and discrete anomalies have been located in the eastern part of the survey area. They lack a coherent morphology preventing interpretation as cut features.

Anomalies associated with land management

(8, 9 & 10) - A number of land drains are evident within the survey area. In the west, they are negative linear anomalies, in the east, positive linear anomalies and in the south east they are strongly magnetic and laid out in a herringbone formation. They relate to drainage of the sports pitches.

Anomalies with an agricultural origin

(11) - A series of parallel linear anomalies are located in the north western part of the survey area. They relate to a series of broad positive responses which indicate the ridges with alternate negative responses relating to the furrows. The furrows have truncated the earlier linear ditches (2), while they are preserved beneath the ridges.

Anomalies associated with magnetic debris

(12) - A rectangular zone of magnetic debris, associated with a series of land drains in the southern part of the site, relates to material used in the ground make-up of a former sports pitch.

(13) - Small patches of magnetic debris are evident within the survey area, some associated with football goal posts.

(14) - Strong, discrete, dipolar anomalies relate to ferrous and other magnetically thermoremnant objects within the survey area.

Anomalies with a modern origin

(15) - Rectangular anomalies associated with cricket pitches.

(16) - Buried services are located at the north eastern edge of the survey area.

3.5 List of anomalies - Area 2

Area centred on OS NGR 413075 186660, see Figs 10 & 11.

Anomalies with an uncertain origin

(17) - The survey area contains a number of weakly positive responses. These appear to be associated with ridges of the ridge and furrow.

(18) - A small number of very weakly positive linear anomalies have been located. It is not possible to determine if they relate to cut features.

Anomalies with an agricultural origin

(19) - The survey contains indistinct ridge and furrow.

Anomalies associated with land management

(20) - A negative linear anomaly appears to relate to a land drain or service. It is associated with magnetic debris at the northern end.

Anomalies associated with magnetic debris

(21) - The survey area contains zones of magnetic debris and strong dipolar anomalies which relate to a previously fenced off spoil heap, associated with the construction of the Hreod Parkway School, much of which has been removed in recent times.

(22) - Several dipolar anomalies are characteristically broader and weaker than others and this is indicative of ferrous objects that are unusually deep. This would support observations of terracing and ground make-up within this part of the site.

3.6 List of anomalies - Area 3

Area centred on OS NGR 413147 186553, see Figs 08 - 11.

Area 3 is the croquet enclosure and contains magnetic disturbance from fencing within and surrounding the enclosure as well as magnetic debris at the north eastern end.

3.7 List of anomalies - Area 4

Area centred on OS NGR 413313 186597, see Figs 12 & 13.

Area 4 contains widespread very strongly magnetic debris mainly within the eastern half of the survey area. Evidence for land drainage and a modern service (gas) can also be seen in the western part of the survey area.

4 DISCUSSION

4.1.1 The south western part of the site (Area 1) contains a number of anomalies of archaeological potential. These include as series of enclosure features at the extreme south eastern corner. There is evidence for phases of construction with features cutting one another. The strength of the anomalies (6-13nT) indicates that there may be burnt material contained within the fill of the ditches. An irregularly shaped anomaly at the southern edge appears also to be associated. It has a response of up to 50nT, which may indicate burning or an association with possible industrial activity. Just to the north of the enclosures are positive linear anomalies that appear to have been re-cut. They may bound the enclosures. A number of weakly positive linear anomalies are located in the vicinity, and while they may relate to associated cut features, this is not certain.

4.1.2 Located 175m north east of the enclosures is a single ring ditch feature which may relate to a round house. It has a diameter of 10m and appears to contain a number of pits or postholes. However, the location of a bank immediately to the east and spreads of magnetic debris in the vicinity may indicate that the internal responses are associated with more modern material within the topsoil. A number of discrete positive anomalies can be seen to the west of the ring ditch and these could relate to further pit-like features with archaeological potential.

4.1.3 Two fragmented positive linear anomalies can also be seen close to the ring ditch. The anomalies have been truncated by ridge and furrow, indicating that they relate to parallel linear ditches that pre-date this type of agricultural practice. The anomalies are 10m apart, with the southernmost ending at the ring ditch and the northernmost ending at an extant bank just to the east (see Fig 14). This bank is likely to be associated with ground make-up and terracing during construction of the sports pitches, and although there is a short positive linear anomaly on the same orientation located 60m to the east adjacent to the croquet enclosures, it is not possible to determine if this is a continuation of the linear ditch.

4.1.4 Elsewhere within Area 1 there are a number of positive linear, discrete and amorphous anomalies. While these may relate to cut features such as ditches and pits, an association with former agricultural activity, land drainage or land disturbance relating to the sports pitches is also possible.

4.1.5 The remaining parts of the site contain predominantly widespread magnetic debris which is associated with a former spoil heap from the adjacent school construction, which has subsequently been removed, and also infilling of the former golf course features. It should be considered that where ground surfaces have been raised and terraced archaeological features may not produce sufficiently strong magnetic anomalies for their location. Also within zones of magnetic debris and disturbance, anomalies of archaeological potential can be obscured.

5 CONCLUSION

5.1.1 Detailed magnetometry has located a number of anomalies with archaeological potential within the south western part of the site (Area 1). The anomalies include a series of enclosures in the far south western corner and two parallel linear ditches and a single ring ditch further north. Other positive anomalies are evident within the site, but they are weak, indistinct and lack a coherent morphology for them to be confidently interpreted as cut features.

5.1.2 Site observations of terracing and ground make-up are supported by magnetic anomalies indicative of ferrous objects buried unusually deep. The areas affected appear to be the north eastern quarter of Area 1 and eastern half of Area 2. Area 4 in the eastern part of the site also appears to have been landscaped but the degree of change to the surface is unclear as there are former golf course features and it may be localised. However, widespread magnetic debris within Area 4 may indicate magnetically contaminated soil brought into the site.

5.1.3 Other anomalies are associated with the use of the site for sporting activities, including goal posts, cricket pitches and land drains. Evidence of former ridge and furrow cultivation in the western part of the site tends to imply lesser impact from landscaping and ground make-up compared to eastern and north eastern parts.

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Appendix A – basic principles of magnetic survey

Iron minerals are always present to some degree within the topsoil and enhancement associated with human activity is related to increases in the level of magnetic susceptibility and thermoremnant material. Magnetic susceptibility is an induced magnetism within a material when it is in the presence of a magnetic field. This can be thought of as effectively permanent due to the presence of the Earth's magnetic field. Thermoremnant magnetism occurs when ferrous material is heated beyond a specific temperature known as the Curie Point. Demagnetisation occurs at this temperature with re-magnetisation by the Earth's magnetic field upon cooling.

Enhancement of magnetic susceptibility can occur in areas subject to burning and complex fermentation processes on biological material; these are frequently associated with human settlement. Thermoremnant features include ovens, hearths, and kilns. In addition thermoremnant material such as tile and brick may also be associated with human activity and settlement.Silting and deliberate infilling of ditches and pits with magnetically enhanced soil can create an area of enhancement compared with surrounding soils and subsoils into which the feature is cut. Mapping enhanced areas will produce linear and discrete anomalies allowing an assessment and characterisation of hidden subsurface features.

It should be noted that areas of negative enhancement can be produced from material having lower magnetic properties compared to the topsoil. This is common for many sedimentary bedrocks and subsoils which were often used in the construction of banks and walls etc. Mapping these 'negative' anomalies may also reveal archaeological features.

Magnetic survey or magnetometry can be carried out using a fluxgate gradiometer and may be referred to as gradiometry. The SENSYS gradiometer is a passive instrument consisting of two fluxgate sensors mounted vertically 65cm apart. The instrument is carried about 10-20cm above the ground surface and the upper sensor measures the Earth's magnetic field as does the lower sensor but this is influenced to a greater degree by any localised buried field. The difference between the two sensors will relate to the strength the magnetic field created by the buried feature.

There are a number of factors that may affect the magnetic survey and these include soil type, local geology and previous human activity. Situations arise where magnetic disturbance associated with modern services, metal fencing, dumped waste material etc., obscures low magnitude fields associated with archaeological features.

Appendix B – data processing notes

Clipping

Minimum and maximum values are set and replace data outside of the range with those values. Extreme values are removed improving colour or greyscale contrast associated with data values that may be archaeologically significant. It has been found that clipping data to ranges between ±5nT and ±3nT often improves the appearance of features associated with archaeology. Different ranges are applied to data in order to determine the most suitable for anomaly abstraction and display.

Zero (destripe) Median/Mean Traverse

The median (or mean) of each traverse is calculated ignoring data outside a threshold value, the median (or mean) is then subtracted from the traverse. The process is used to equalise differences between the baseline value of gradiometer sensors.

High Pass Filtering

A mathematical process used to remove low frequency anomalies relating to survey tracks, modern agricultural features and other large magnetic bodies within or adjacent to survey areas.

Low Pass Filtering

A mathematical process used to remove high frequency anomalies relating to uneven ground, vibration, etc.

Appendix C – survey and data information

Area 1 minimally processed data

Filename: J719-mag-Area1-proc.xcp
Description: Imported as Composite from: J719-mag-Area1.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 30U
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 412837.500098069, 186643.743448073 m
Southeast corner: 413214.000098069, 186390.693448073 m
Collection Method: Randomised
Sensors: 5
Dummy Value: 32702
Source GPS Points: 1501900
Dimensions
Composite Size (readings): 2510 x 1687
Survey Size (meters): 377 m x 253 m
Grid Size: 377 m x 253 m
X Interval: 0.15 m
Y Interval: 0.15 m
Stats
Max: 3.32
Min: -3.30
Std Dev: 1.25
Mean: -0.04
Median: 0.01
Composite Area: 9.5273 ha
Surveyed Area: 5.9025 ha
PROGRAM
Name: TerraSurveyor
Version: 3.0.23.0
Processes: 1
1 Base Layer
GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 DeStripe Median Traverse:
4 Clip from -3.00 to 3.00 nTArea 2 minimally processed data

Area 2 minimally processed data

Filename: J719-mag-Area2-proc.xcp
Description: Imported as Composite from: J719-mag-Area2.asc
Northwest corner: 412916.056639694, 186767.111285424 m
Southeast corner: 413209.456639694, 186575.861285424 m
Source GPS Points: 630300
Dimensions
Composite Size (readings): 1956 x 1275
Survey Size (meters): 293 m x 191 m
Grid Size: 293 m x 191 m
X Interval: 0.15 m
Y Interval: 0.15 m
Stats
Max: 3.32
Min: -3.30
Std Dev: 1.39
Mean: -0.04
Median: 0.02
Composite Area: 5.6113 ha
Surveyed Area: 2.2764 ha
Processes: 1
1 Base Layer
GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 DeStripe Median Traverse:
4 Clip from -3.00 to 3.00 nT

Area 2 filtered data

Filename: J719-mag-Area2.xcp
Description: Imported as Composite from: J719-mag-Area2.asc
Stats
Max: 3.32
Min: -3.30
Std Dev: 1.21
Mean: -0.01
Median: 0.00
Composite Area: 5.6113 ha
Surveyed Area: 2.2764 ha
Processes: 1
1 Base Layer
GPS based Proce5
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 DeStripe Median Traverse:
4 High pass Uniform (median) filter: Window dia: 100
5 Clip from -3.00 to 3.00 nT

Area 3 minimally processed data

Filename: J719-mag-Area3-proc.xcp
Description: Imported as Composite from: J719-mag-Area3.asc
Source GPS Points: 66700
Dimensions
Composite Size (readings): 626 x 280
Survey Size (meters): 93.9 m x 42 m
Grid Size: 93.9 m x 42 m
X Interval: 0.15 m
Y Interval: 0.15 m
Stats
Max: 3.32
Min: -3.30
Std Dev: 1.81
Mean: 0.07
Median: 0.01
Composite Area: 0.39438 ha
Surveyed Area: 0.27045 ha
Processes: 1
1 Base Layer
GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 DeStripe Median Traverse:
4 Clip from -3.00 to 3.00 nT

Area 3 filtered data

Filename: J719-mag-Area3.xcp
Description: Imported as Composite from: J719-mag-Area3.asc
Northwest corner: 413100.218552014, 186578.042138975 m
Southeast corner: 413194.118552014, 186536.042138975 m
Source GPS Points: 66700
Dimensions
Composite Size (readings): 626 x 280
Survey Size (meters): 93.9 m x 42 m
Grid Size: 93.9 m x 42 m
X Interval: 0.15 m
Y Interval: 0.15 m
Stats
Max: 3.32
Min: -3.30
Std Dev: 1.25
Mean: 0.04
Median: 0.00
Composite Area: 0.39438 ha
Surveyed Area: 0.27045 ha
Processes: 1
1 Base Layer
GPS based Proce6
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 DeStripe Median Traverse:
4 High pass Uniform (median) filter: Window dia: 100
5 Lo pass Uniform (median) filter: Window dia: 13
6 Clip from -3.00 to 3.00 nT

Area 4 minimally processed data

Filename: J719-mag-Area4.xcp
Description: Imported as Composite from: J719-mag-Area4.asc
Northwest corner: 413222.000077047, 186653.107889351 m
Southeast corner: 413401.250077047, 186545.557889351 m
Source GPS Points: 301300
Dimensions
Composite Size (readings): 1195 x 717
Survey Size (meters): 179 m x 108 m
Grid Size: 179 m x 108 m
X Interval: 0.15 m
Y Interval: 0.15 m
Stats
Max: 3.32
Min: -3.30
Std Dev: 2.35
Mean: 0.01
Median: 0.02
Composite Area: 1.9278 ha
Surveyed Area: 1.291 ha
Processes: 1
1 Base Layer
GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 DeStripe Median Traverse:
4 Clip from -3.00 to 3.00 nT

Appendix D – digital archive

Archaeological Surveys Ltd hold the primary digital archive at their offices in Wiltshire. Data are backed-up onto an on-site data storage drive and at the earliest opportunity data are copied to CD ROM for storage on-site and off-site.

A printed copy of the report and a PDF copy will be supplied to the Wiltshire Historic Environment Record. The report will also be uploaded to the Online AccesS to the Index of archaeological investigationS (OASIS).

Archive contents:

Geophysical data Area path: J719 Moredon Multi Sports Hub\Data				
Path and Filename	**Software**	**Description**	**Date**	**Creator**
mor1\MX\.prm,.dgb,.disp mor2\MX\.prm,.dgb,.disp mor3\MX\.prm,.dgb,.disp mor4\MX\.prm,.dgb,.disp	Sensys MXPDA	Proprietary data formats representing magnetometer survey traverses logged to a PDA.	21/06/17 22/06/17 22/06/17 23/06/17	D.J.Sabin
mor1\MX\J719-mag-Area1.asc mor2\MX\J719-mag-Area2.asc mor3\MX\J719-mag-Area3.asc mor4\MX\J719-mag-Area4.asc	Sensys DLMGPS	ASCII CSV (tab) file representing survey area in eastings, northings (UTM Z30N), magnetic measurement, traverse file and sensor number.	22/06/17 23/06/17 23/06/17 23/06/17	K.T.Donaldson
Area1\comps\J719-mag-Area1.xcp Area2\comps\J719-mag-Area2.xcp Area3\comps\J719-mag-Area3.xcp Area4\comps\J719-mag-Area4.xcp	TerraSurveyor 3.0.23.0	Composite data file derived from ASCII CSV.	22/06/17 23/06/17 23/06/17 23/06/17	K.T.Donaldson
Area1\comps\J719-mag-Area1-proc.xcp Area2\comps\J719-mag-Area2-proc.xcp Area3\comps\J719-mag-Area3-proc.xcp Area4\comps\J719-mag-Area4-proc.xcp	TerraSurveyor 3.0.23.0	Processed composite data file (zmt and clipping to ±3nT).	22/06/17 23/06/17 23/06/17 23/06/17	K.T.Donaldson
Graphic data - path: J719 Moredon Multi Sports Hub\Data				
Area1\graphics\J719-mag-Area1-proc.tif Area2\graphics\J719-mag-Area2-proc.tif Area3\graphics\J719-mag-Area3-proc.tif Area4\graphics\J719-mag-Area4-proc.tif	TerraSurveyor 3.0.23.0	TIF file showing a minimally processed greyscale plot clipped to ±3nT.	23/06/17	K.T.Donaldson
Area1\graphics\J719-mag-Area1-proc.tfw Area2\graphics\J719-mag-Area2-proc.tfw Area3\graphics\J719-mag-Area3-proc.tfw Area4\graphics\J719-mag-Area4-proc.tfw	TerraSurveyor 3.0.23.0	World file for georeferencing TIF to OSGB36.	23/06/17	K.T.Donaldson
CAD data - path: J719 Moredon Multi Sports Hub\\CAD				
J719 version 1.dwg	ProgeCAD 2016	CAD file for creating plots of greyscales, abstraction, interpretation and mapping. Grid coordinates as OSGB. AutoCAD 2010 format.	22/06/17	K.T.Donaldson
Text data - path: J719 Moredon Multi Sports Hub\\Report				
J719 report.odt	OpenOffice.org 3.0.1 Writer	Report text as an Open Office document.	27/06/17	K.T.Donaldson

Appendix E – copyright and intellectual property

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Site boundary

Surveyable area

Archaeological Surveys Ltd

Geophysical Survey
Moredon Multi Sports Hub
Swindon

Map of survey area

Survey location

Site centred on OS NGR
SU 13100 86565

SCALE 1:25 000

0m 500m 1000m

SCALE TRUE AT A3

FIG 01

Archaeological Surveys Ltd

Geophysical Survey
Moredon Multi Sports Hub
Swindon

Referencing information

Referencing grid to OSGB36 datum at 50m intervals

Data collected at 20Hz and georeferenced to ETRS89 zone 30 with conversion to OSGB36 using OSTN02

412900 186450

SCALE 1:2000

0m 20 40 60 80 100m

FIG 02

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Moredon Multi Sports Hub
Swindon

Greyscale plot of minimally processed magnetometer data clipped at ±50nT

+ 50nT

- 50nT

Area 1

- 50nT + 50nT

Area 2

- 50nT + 50nT

Area 3

- 50nT + 50nT

Area 4

- 50nT + 50nT

SCALE 1:2000

0m 20 40 60 80 100m

FIG 03

Area 1

Area 2

Area 3

Area 4

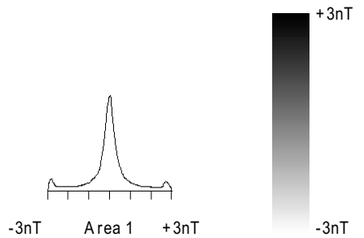
Cheney Manor Industrial Estate

Water

Archaeological Surveys Ltd

Geophysical Survey
Moredon Multi Sports Hub
Swindon

Greyscale plot of minimally processed magnetometer data clipped at ±3nT



SCALE 1:2000

0m 20 40 60 80 100m

FIG 04

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Moredon Multi Sports Hub
Swindon

Abstraction and interpretation of magnetic anomalies

- Positive linear anomaly - cut feature of archaeological potential
- Positive curvilinear anomaly - ring ditch
- Positive curvilinear/rectilinear anomaly - enclosure ditch
- Positive linear anomaly - possible ditch-like feature
- Linear anomaly - ridge and furrow
- Positive linear anomaly - possible land drain
- Discrete positive response - cut feature of archaeological potential
- Discrete positive response - possible pit-like feature
- Positive anomaly - magnetically enhanced material
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Magnetic disturbance from ferrous material
- Magnetic disturbance from cricket pitch
- Strong multiple dipolar linear anomaly - pipeline / cable / service
- Strong dipolar anomaly - ferrous object

SCALE 1:2000

0m 20 40 60 80 100m

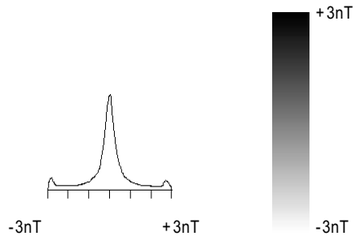
SCALE TRUE AT A3

FIG 05

Archaeological Surveys Ltd

Geophysical Survey
Moredon Multi Sports Hub
Swindon

Greyscale plot of minimally processed magnetometer data - Area 1 west



Area 1

Area 3

Drain

N

SCALE 1:1000

0m 10 20 30 40 50m

FIG 06

Archaeological Surveys Ltd

Geophysical Survey
Moredon Multi Sports Hub
Swindon

Abstraction and interpretation of magnetic anomalies - Area 1 west

- Positive linear anomaly - cut feature of archaeological potential
- Positive curvilinear anomaly - ring ditch
- Positive curvilinear/rectilinear anomaly - enclosure ditch
- Positive linear anomaly - possible ditch-like feature
- Linear anomaly - ridge and furrow
- Positive linear anomaly - possible land drain
- Discrete positive response - cut feature of archaeological potential
- Discrete positive response - possible pit-like feature
- Positive anomaly - magnetically enhanced material
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Magnetic disturbance from ferrous material
- Magnetic disturbance from cricket pitch
- Strong multiple dipolar linear anomaly - pipeline / cable / service
- Strong dipolar anomaly - ferrous object

SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

FIG 07

Area 1

Area 3

Drain

Pavilion

N

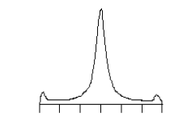
Archaeological Surveys Ltd

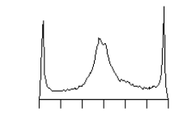
Geophysical Survey
Moredon Multi Sports Hub
Swindon

Greyscale plot of minimally processed magnetometer data - Area 1 east

+3nT

-3nT





SCALE 1:1000

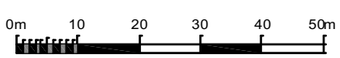


FIG 08

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Moredon Multi Sports Hub
Swindon

Abstraction and interpretation of magnetic anomalies - Area 1 east

- Positive linear anomaly - cut feature of archaeological potential
- Positive curvilinear anomaly - ring ditch
- Positive linear anomaly - possible ditch-like feature
- Linear anomaly - ridge and furrow
- Positive linear anomaly - possible land drain
- Discrete positive response - cut feature of archaeological potential
- Discrete positive response - possible pit-like feature
- Positive anomaly - magnetically enhanced material
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Magnetic disturbance from ferrous material
- Magnetic disturbance from cricket pitch
- Strong multiple dipolar linear anomaly - pipeline / cable / service
- Strong dipolar anomaly - ferrous object

SCALE 1:1000

0m 10 20 30 40 50m

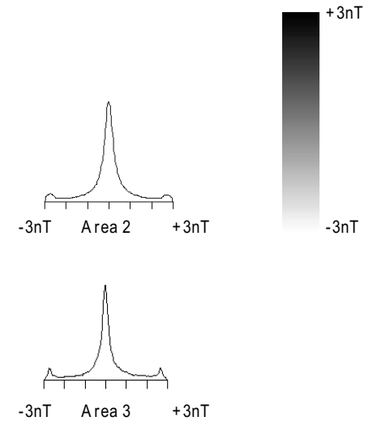
SCALE TRUE AT A3

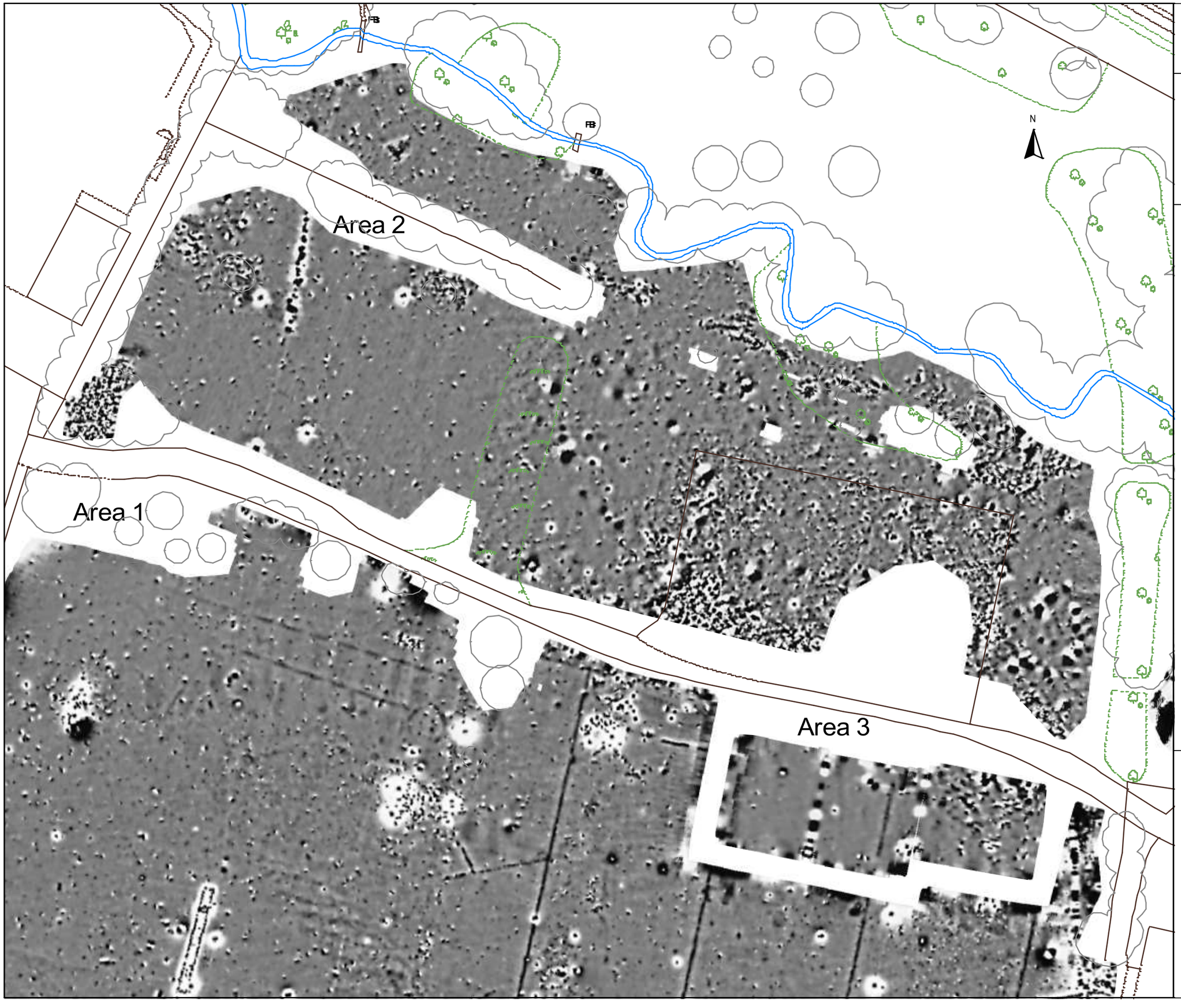
FIG 09

Archaeological Surveys Ltd

Geophysical Survey
Moredon Multi Sports Hub
Swindon

Greyscale plot of filtered magnetometer data - Areas 2 & 3





SCALE 1:1000

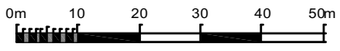


FIG 10

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Abstraction and interpretation of magnetic anomalies - Areas 2 & 3

- Positive linear anomaly - possible ditch-like feature
- Linear anomaly - ridge and furrow
- Positive linear anomaly - possible land drain
- Positive anomaly - magnetically enhanced material
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Magnetic disturbance from ferrous material
- Strong dipolar anomaly - ferrous object

SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

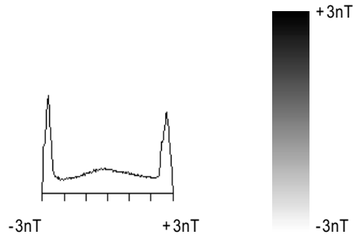
FIG 11

FB
FB
N
Area 2
Area 1
Area 3
1
2
4
5
7
9
11
15
16
17
18
19
20
21
22

Archaeological Surveys Ltd

Geophysical Survey
Moredon Multi Sports Hub
Swindon

Greyscale plot of minimally processed magnetometer data - Area 4



Area 4

Area 3

N

FB

Outfall

Culverts

Pavilion

96.3m

SCALE 1:1000

0m 10 20 30 40 50m

FIG 12

Archaeological Surveys Ltd

Geophysical Survey
Moredon Multi Sports Hub
Swindon

Abstraction and interpretation of magnetic anomalies - Area 4

- Negative linear anomaly - land drain
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Magnetic disturbance from ferrous material
- Strong multiple dipolar linear anomaly - pipeline / cable / service
- Strong dipolar anomaly - ferrous object

SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

FIG 13

N

FB

Outfall

Collects

Area 4

Area 3

21

16

7

Pavilion

96.3m

Archaeological Surveys Ltd

Geophysical Survey
Moredon Multi Sports Hub
Swindon

Shaded Relief Plot of
Digital Terrain Model

Derived from Environment Agency's LiDAR data 1m resolution

SCALE 1:2000

0m 20 40 60 80 100m

SCALE TRUE AT A3

FIG 14