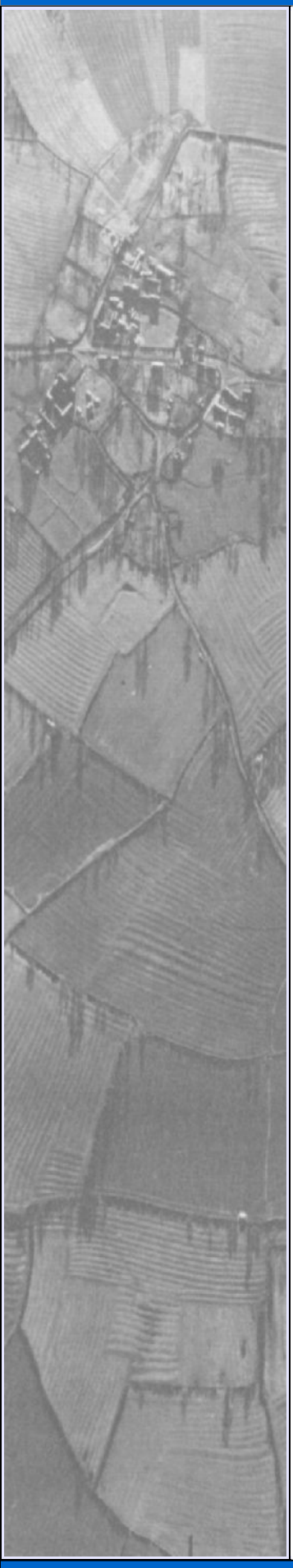

Land south of Filton Road
Winterbourne
South Gloucestershire

MAGNETOMETER SURVEY REPORT

for

Cotswold Archaeology

Kerry Donaldson & David Sabin

February 2018

Ref. no. J741

ARCHAEOLOGICAL SURVEYS LTD

Land south of Filton Road
Winterbourne
South Gloucestershire

Magnetometer Survey Report

for

Cotswold Archaeology

Fieldwork by David Sabin BSc (Hons) MCIfA
Report by Kerry Donaldson BSc (Hons)
Report checked by David Sabin
Primary archive location - Archaeological Surveys Ltd, Yatesbury, Wiltshire

Survey dates – 6th & 8th February 2018
Ordnance Survey Grid Reference – **ST 63155 78045**

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It is a Registered Organisation with the Chartered Institute for Archaeologists.

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SUMMARY

Detailed magnetometry was carried out by Archaeological Surveys Ltd, on behalf of Cotswold Archaeology Ltd, within two land parcels on land to the south of Filton Road and west of the M32 in Winterbourne, South Gloucestershire. The site is due to be developed into sports pitches by the University of the West of England and the survey was carried out as part of an archaeological investigation into the site prior to the development. The results indicate the presence of a number of positive linear, rectilinear, discrete and amorphous anomalies with archaeological potential in the northern part of the site (Area 2). Further positive linear and discrete anomalies have also been located and while they may relate to further cut features, they are weak and indistinct, preventing confident interpretation. A series of negative rectilinear anomalies have also been located within this part of the site; however, it is not possible to determine if they relate to further archaeological features, or if they relate to more recent land division, agricultural activity or land drainage. Within the southern part of the site (Area 1) there are a number of positive linear and discrete anomalies with uncertain origin, including two broad linear bands of positive and negative responses, one of which extends north westwards into Area 2. However, it is not possible to determine if they relate to former boundary features or lynchets, or if they are natural features. The majority of the anomalies within Area 1 relate to formerly mapped land boundaries, land drainage and agricultural activity.

1 INTRODUCTION

1.1 Survey background

1.1.1 Archaeological Surveys Ltd was commissioned by Cotswold Archaeology, on behalf of Verde Recreo Ltd, to undertake a magnetometer survey of an area of land to the south of Filton Road and adjacent to Hillside Gardens and the M32 within the parish of Winterbourne, South Gloucestershire. The University of the West of England (UWE) has been granted planning permission by South Gloucestershire Council (Application no: PT16/6218/F) for the development of two all weather sports pitches with floodlighting, a grass pitch, a training pitch, ponds, landscaping bund, parking and associated works.

1.1.2 The geophysical survey was carried out in accordance with a Method Statement produced by Archaeological Surveys and is part of an archaeological investigation of the site prior to commencement of groundworks.

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 Geophysical survey can provide useful information on the archaeological potential of a site; however, the outcome of any survey relies on a number of factors and as a consequence results can vary. The success in meeting the aims and objectives of a survey is, therefore, often impossible to predetermine.

1.3 Standards, guidance and recommendations for the use of this report

1.3.1 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.*

1.3.2 Archaeological Surveys Ltd provide a detailed geophysical survey report and it is recommended that where possible the contents should be considered in full. The Summary provides a brief overview of the results with more detail available in the Discussion and/or Conclusion. The *List of anomalies* within the Results provides a detailed assessment of the anomalies within separate categories which can be useful in inferring a level of confidence to the interpretation. Quality and factors influencing the interpretation of anomalies is also set out within the results.

1.3.3 It is recommended that the full report should always be considered when using data and interpretation plots; where this is not possible, in the field for example, the abstraction and interpretation plots should retain their colour coding and be used with a corresponding legend.

1.3.4 Where targeting of anomalies by excavation is to be carried out, care should be taken to place trenches over solid lines or features visible on the abstraction and interpretation plots. Archaeological Surveys abstraction and interpretation avoids the use of dashed or dotted lines; broken or fragmented anomalies may well correspond closely with subsurface truncation.

1.4 Site location, description and survey conditions

1.4.1 The site is located to the south of Filton Road and west of the M32 in Winterbourne, South Gloucestershire. It is centred on Ordnance Survey National Grid Reference (OS NGR) ST 63155 78045, see Figs 01 and 02.

1.4.2 The geophysical survey covers approximately 6ha within two separate land parcels. Area 1 lies in the southern part of the site, immediately west of the M32, and Area 2 lies to the south of Filton Road and east of Hillside Gardens. Area 1 is generally flat while Area 2 tends to rise gently towards the west.

1.4.3 The ground cover at the time of survey was grass which was rough in places. Area 1 contains evidence for a removed field boundary orientated east – west in the central part of the field. At its western end there is a small pond or depression that was unsurveyable. Area 2 contained several infilled geotechnical trenches with associated rutted ground. An agricultural vehicle was parked in the north eastern corner where there was also evidence for dumped brick and stone. At the south eastern corner of the area there is a pond and area of concrete slab used to store haylage.

Plate 1: Area 1 looking south

Plate 2: Area 2 looking west

1.4.4 The ground conditions across the site were generally considered to be favourable for the collection of magnetometry data. A buffer zone around the agricultural vehicle in Area 2 was necessary in order to avoid high magnitude magnetic disturbance. In addition, infilled geotechnical pits produced erratic movement of the magnetometer within very small zones but this was not considered to be detrimental to the outcome of the survey. Weather conditions during the survey were mainly fine.

1.5 Site history and archaeological potential

1.5.1 The southern part of the survey area (Area 1) lies 300m north east of two parallel, possibly medieval banks (Monument No. 201311) which were mapped from aerial photographs and LiDAR imagery during the Severn Vale National Mapping Programme (NMP). The southern end also lies approximately 200m north east of the former Stoke Deer Park, emparked by the Berkeley family during the 14th century. Situated 600m to the west of the northern part of the survey area (Area 2) is the site of a Second World War military camp (Monument No. 1595527). Early Ordnance Survey mapping shows that the southern part of the site (Area 1) was previously subdivided into four separate land parcels, with a trackway extending across the northern part of Area 1. Area 2 was part of a larger field with a pond in the south eastern corner and a footpath along the eastern edge, continuing south westwards across the north western corner of Area 1.

1.5.2 The surface conditions within the site were generally not suitable for the observation of cultural material during the course of the survey. Some small soil exposures relating to infilled geotechnical pits were observed and several small pieces of ferrous tap slag were noted within the western half of Area 2.

1.6 Geology and soils

1.6.1 The underlying geology across the majority of Area 1, in the southern part of the site, is Triassic sandstone from the Redcliffe Sandstone Member with mudstone and halite stone from the Mercia Mudstone Group in the far north western corner of Area 1 and within Area 2. The majority of Area 1 is over overlain by head deposits except for a narrow band along the eastern side (BGS, 2018).

1.6.2 The overlying soil across the site is from the Worcester association and is a typical argillic pelosol. It consists of a slowly permeable, non-calcareous and calcareous reddish clayey soil over mudstone (Soil Survey of England and Wales, 1983).

1.6.3 The underlying geology and soils can be associated with low magnetic contrast and low levels of magnetic susceptibility. However, cut features of archaeological potential may be located where human activity has altered the magnetic characteristics of the soil sufficiently. 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 ±5nT. Data are interpolated to a resolution of effectively 0.5m between tracks and 0.15m along each survey track.

2.3.4 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.

2.3.5 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 are considered by the manufacturer to be data that are 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 the very high density of data collection.

2.3.6 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.

2.3.7 An abstraction and interpretation is 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. Appendix E sets out CAD layer names with colour and graphic content for each interpretation category, see 3.3.

2.3.8 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.

2.3.9 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 two survey areas covering approximately 6ha.

3.1.2 Magnetic anomalies located can be generally classified as positive responses of archaeological potential, positive and negative anomalies of an uncertain origin, anomalies associated with land management, linear anomalies of an agricultural origin, 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. Some localised zones of magnetic debris and disturbance have the potential to obscure weak anomalies although the likelihood is considered to be low.

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, see Table 1.

Interpretation category	Description and origin of anomalies
Anomalies with archaeological potential	Anomalies have the characteristics (mainly morphological) of a range of archaeological features such as pits, ring ditches, enclosures, etc. The category is used where there is a high level of confidence which may be due to additional supporting information where morphology is unclear or uncharacteristic.
Anomalies with an uncertain origin	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.

	Morphology may be unclear or uncharacteristic and there may be a lack of additional supporting information. 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 relating to land management	Anomalies are mainly linear and may be indicative of the magnetically enhanced fill of cut features (i.e. ditches). The anomalies may be long and/or form rectilinear elements and they may relate to topographic features or be visible on early mapping. Associated agricultural anomalies (e.g. headlands, plough marks and former ridge and furrow) may support the interpretation. 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 ceramic land drains.
Anomalies with an agricultural origin	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. This category does not include agricultural features of early date or considered to be of archaeological potential (e.g. animal stockades, enclosures, farmsteads, etc).
Anomalies associated with magnetic debris	Magnetic debris often appears as areas containing many small dipolar anomalies that may range from weak to very strong in magnitude. They often occur where there has been dumping or ground make-up and are 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, hearths and nail spreads from former wooden structures or rooves 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	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 these 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 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 363135 178000, see Figs 05 & 06.

Anomalies with an uncertain origin

(1) - A broad, positive linear anomaly extends south westwards from the northern edge of the survey area. Although this type of response could relate to a cut, ditch-like feature, it appears that two possible land drains extend towards it from the east and an association is possible.

(2) - Two very weakly positive curvilinear anomalies are located to the west of anomaly (1). It is not possible to determine if they relate to cut features, or if they have been caused by modern ground disturbance, such as ruts caused by vehicles.

(3 & 4) - In the northern part of Area 1 is a broad positive anomaly with associated

negative anomalies (3), a similar response is located 175m to the south west (4). Anomaly (3) also appears to extend north westwards into Area 2 as anomaly (23). It is possible that they relate to former broad boundary features or lynchets: however, a natural origin should also be considered.

(5) - Located in the southern part of the survey area are a small number of positive linear anomalies. Their origin is uncertain.

Anomalies associated with land management

(6 -9) - The survey area contains a number of positive linear anomalies or broad linear zones of magnetic debris that relate to former field boundaries that were removed during the later 20th century.

(10) - Positive linear responses appear to relate to land drains.

Anomalies with an agricultural origin

(11) - Moderately strongly positive linear anomalies appear to relate to agricultural activity or possible land drainage.

(12) - Negative linear anomalies associated with agricultural activity.

Anomalies associated with magnetic debris

(13) - There are a number of zones of magnetic debris, many of them are associated with former field boundaries or tracks.

(14) - The entire site contains widespread and numerous strong, discrete, dipolar responses which indicate ferrous and magnetically thermoremnant material such as brick and tile has been spread throughout the site.

Anomalies with a modern origin

(15) - A probable water pipe extends from the northern edge of the survey area, southwards. There appears to be two spurs leading westwards from it in the centre of the survey area.

3.5 List of anomalies - Area 2

Area centred on OS NGR 363160 178220, see Figs 07 & 08.

Anomalies of archaeological potential

(16) – A positive rectilinear anomaly forming an L-shaped feature with a response of up to 8nT. To the north is a similar but shorter feature. It is possible that they relate

to enclosures; however, the western and southern extents are not clearly represented in the results.

(17) - Amorphous zones of positive responses can be seen to the east and north of anomalies (16). While the responses are not clearly defined, it is possible that they relate to archaeological features. A small number of discrete positive responses lie in the vicinity and may also be of archaeological potential.

(18) - At the western edge of the survey area are a small number of positive linear anomalies. While their morphology is not well defined, the magnetic response is up to 12nT indicating the presence of magnetically enhanced material.

(19) - In the central part of the survey area are two discrete positive responses. One has a value of over 20nT, the other 6nT. They appear to be situated along a negative linear anomaly (20) and an association is possible. The strength of the response indicates magnetically enhanced or possibly burnt material and an archaeological origin should be considered.

Anomalies with an uncertain origin

(20) - The survey area contains a number of negative linear and rectilinear anomalies. While such responses could relate to relatively modern cultivation or land drainage, the trend is generally parallel with anomalies (16) and an association is possible. A negative response indicates material with less magnetic enhancement than the surrounding soil, such as subsoil.

(21) - A number of weakly positive linear responses can be seen to the west of anomaly (16) along with a number of pit-like features. It is possible that they are associated with (16), but they are very weak (<1nT) and indistinct.

(22) - A number of positive linear and possible curvilinear anomalies can be seen within the survey area; however, they have a weak response and lack of coherent morphology preventing confident interpretation.

(23) – A broad negative anomaly with adjacent positive response appears to be a continuation of anomaly (3) seen to the south east in Area 1. It is not clear if it is natural or anthropogenic in origin.

(24) - A number of discrete positive responses have been located within the survey area. However, it is not clear if they relate to pit-like features with an archaeological, natural or more modern anthropogenic origin.

Anomalies with a modern origin

(25) - Negative linear anomalies relate to vehicle ruts created during recent geotechnical ground investigations carried out prior to to the geophysical survey.

4 DISCUSSION

4.1.1 The geophysical survey within Area 1 in the southern part of the site located a number of anomalies, the majority of which are associated with formerly mapped land boundaries, agricultural activity and land drainage. There are, however, a number of positive linear and discrete anomalies within the survey area, but they are either weak or short and lack a coherent morphology preventing confident interpretation. There is a north west to south east oriented band of positive and adjacent negative responses (3) in the northern part of Area 1 that appears to continue north westwards into Area 2 (23); however, it is not possible to determine if it relates to a natural feature within the underlying geology or if it relates to a broad linear feature, such as a lynchet or boundary.

4.1.2 Area 2 lies in the northern part of the site and contains several positive responses that appear to relate to archaeological features. These include two rectilinear anomalies (16) that could relate to enclosures, but the southern and western extents are not visible within the results. Adjacent to them are amorphous zones of positive responses (17), which although not clearly defined, could relate to material associated with archaeological features. A number of discrete, pit-like features lie within close proximity and also have archaeological potential. In the central part of the survey area are further short, positive linear anomalies (18) and two pit-like responses (19), which do appear to correspond with a negative linear anomaly. This negative anomaly is associated with a series of rectilinear features (20), which although could relate to relatively modern agricultural activity or land drainage/division, do appear to be parallel with the positive rectilinear anomalies in the north eastern corner (16) and an association should, therefore, be considered. Elsewhere there are a number of short positive linear and discrete positive responses which could relate to ditch-like (21 & 22) and pit-like features (24), but they are generally very weak and indistinct (<1nT). The majority of the linear and discrete features with archaeological potential have stronger responses (3-20nT) and are clearer and more well defined in the results.

5 CONCLUSION

5.1.1 Detailed magnetometry was carried out within two survey areas covering approximately 6ha. Area 1 lies in the southern part of the site and contained a small number of positive linear and discrete responses; however, they lack a coherent morphology and cannot be confidently interpreted. A broad positive and negative response extends north westwards into Area 1, but it is not clear if it relates to a natural or anthropogenic feature. The majority of the responses in Area 1 relate to formerly mapped field boundaries, agricultural activity and land drainage.

5.1.2 In the northern part of the site, Area 2 contains a number of positive linear, rectilinear, discrete and amorphous responses that appear to relate to cut features with archaeological potential. A series of negative linear and rectilinear anomalies could relate to relatively modern land division or land drainage, but they are parallel with the archaeological features and an association is possible. Other positive linear and discrete anomalies could also relate to cut features; however, they are generally weak and indistinct.

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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 magnetic field. The difference between the two sensors will relate to the strength of 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: J741-mag-Area1-proc.xcp
Description: Imported as Composite from: J741-mag-Area1.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 30U
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 363032.18, 178158.25 m
Southeast corner: 363282.38, 177787.30 m
Collection Method: Randomised
Sensors: 5
Dummy Value: 32702
Source GPS Points: 966300
Dimensions
Composite Size (readings): 1668 x 2473
Survey Size (meters): 250 m x 371 m
Grid Size: 250 m x 371 m
X Interval: 0.15 m
Y Interval: 0.15 m
Stats
Max: 5.53
Min: -5.50
Std Dev: 2.49
Mean: 0.02
Median: 0.04
Composite Area: 9.2812 ha
Surveyed Area: 3.321 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 -5.00 to 5.00 nT

Area 2 minimally processed data

Filename: J741-mag-Area2-proc.xcp
Description: Imported as Composite from: J741-mag-Area2.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 30U
Survey corner coordinates (X/Y):OSGB
Northwest corner: 363070.37, 178322.90 m
Southeast corner: 363261.92, 178120.10 m
Source GPS Points: 770000
Dimensions
Composite Size (readings): 1277 x 1352
Survey Size (meters): 192 m x 203 m
Grid Size: 192 m x 203 m
X Interval: 0.15 m
Y Interval: 0.15 m
Stats
Max: 5.53
Min: -5.50
Std Dev: 1.67
Mean: 0.00
Median: 0.01
Composite Area: 3.8846 ha
Surveyed Area: 2.5011 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 -5.00 to 5.00 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 PDF copy will be supplied to the South Gloucestershire Historic Environment Record (HER). Greyscale images as TIFs with TFWs and CAD abstraction layers as a DWG made can be made available to the HER on request. The report will also be uploaded to the Online AccesS to the Index of archaeological investigationS (OASIS).

Archive contents:

File type	Naming scheme	Description
Data	J741-mag-**[area number/name]**.asc J741-mag-**[area number/name]**.xcp J741-mag-**[area number/name]**-proc.xcp	Raw data as ASCII CSV TerraSurveyor raw data TerraSurveyor minimally processed data
Graphics	J741-mag-**[area number/name]**-proc.tif	Image in TIF format
Drawing	J741-**[version 2]**.dwg	CAD file in 2010 dwg format
Report	J741 report.odt	Report text in Open Office odt format

Table 2: Archive metadata

Appendix E – CAD layers for abstraction and interpretation plots

The table below sets out Archaeological Surveys Ltd CAD layer names with associated colours and graphical content. Where CAD files are available layers may be extracted for further CAD/GIS use. Note: hatched polygon boundaries are contained within layers with the RGB colour code 254, 255, 255 (near white) in order to prevent their visibility.

Report sub-heading and associated CAD layer names	Colour with RGB index	Layer content
Anomalies with archaeological potential		
AS-ABST MAG POS DISCRETE ARCHAEOLOGY	Red 255,0,0	Solid donut, point or polygon (solid)
AS-ABST MAG POS LINEAR ARCHAEOLOGY	Red 255,0,0	Line, polyline or polygon (solid)
AS-ABST MAG POS ARCHAEOLOGY	Red 255,0,0	Polygon (cross hatched ANSI37)
Anomalies with an uncertain origin		
AS-ABST MAG POS LINEAR UNCERTAIN	255,127,0	Line, polyline or polygon (solid)
AS-ABST MAG NEG LINEAR UNCERTAIN	Blue 0,0,255	Line, polyline or polygon (solid)
AS-ABST MAG POS DISCRETE UNCERTAIN	255,127,0	Solid donut, point or polygon (solid)
AS-ABST MAG POS UNCERTAIN	255,127,0	Polygon (cross hatched ANSI37)
AS-ABST MAG NEG UNCERTAIN	Blue 0,0,255	Polygon (cross hatched ANSI37)
Anomalies relating to land management		
AS-ABST MAG BOUNDARY	127,0,0	Line, polyline or polygon (solid or cross hatched ANSI37)
AS-ABST MAG LAND DRAIN	Cyan 0,255,255	Line or polyline
Anomalies with an agricultural origin		
AS-ABST MAG AGRICULTURAL	Green 0,255,0	Line or polyline
Anomalies associated with magnetic debris		
AS-ABST MAG DEBRIS	132, 132, 132	Polygon (cross hatched ANSI37)
AS-ABST MAG STRONG DIPOLAR	132, 132, 132	Solid donut, point or polygon (solid)
Anomalies with a modern origin		
AS-ABST MAG DISTURBANCE	132, 132, 132	Polygon (hatched ANSI31)
AS-ABST MAG SERVICE	132, 132, 132	Line or polyline

Table 3: CAD layering

Appendix F – copyright and intellectual property

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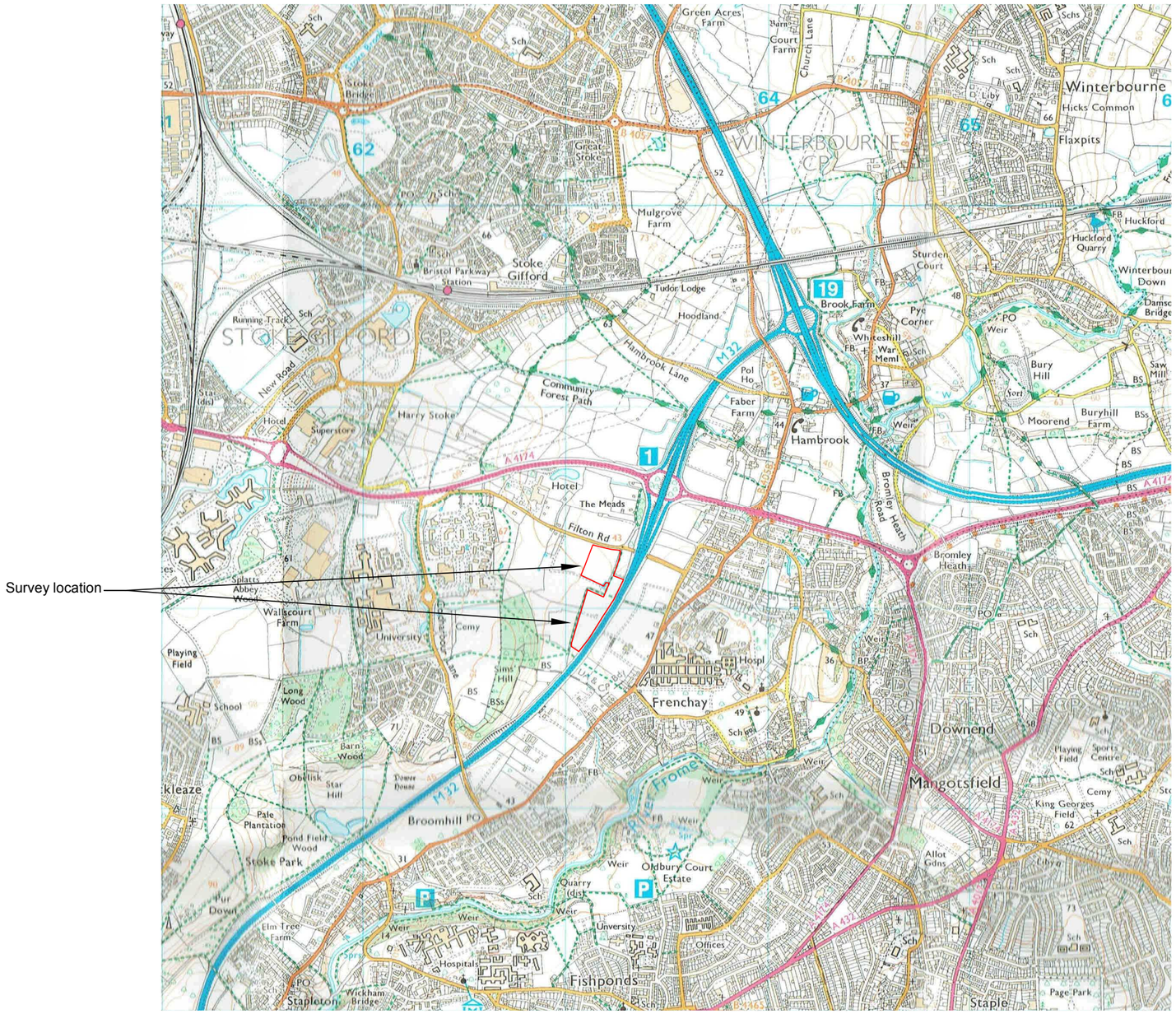
Archaeological Surveys Ltd

Geophysical Survey
Land south of Filton Road
Winterbourne
South Gloucestershire

Map of survey area



Reproduced from OS Explorer map no.155 1:25 000 by permission of Ordnance Survey on behalf of The Controller of Her Majesty's Stationery Office.
© Crown copyright. All rights reserved.
Licence number 100043739.

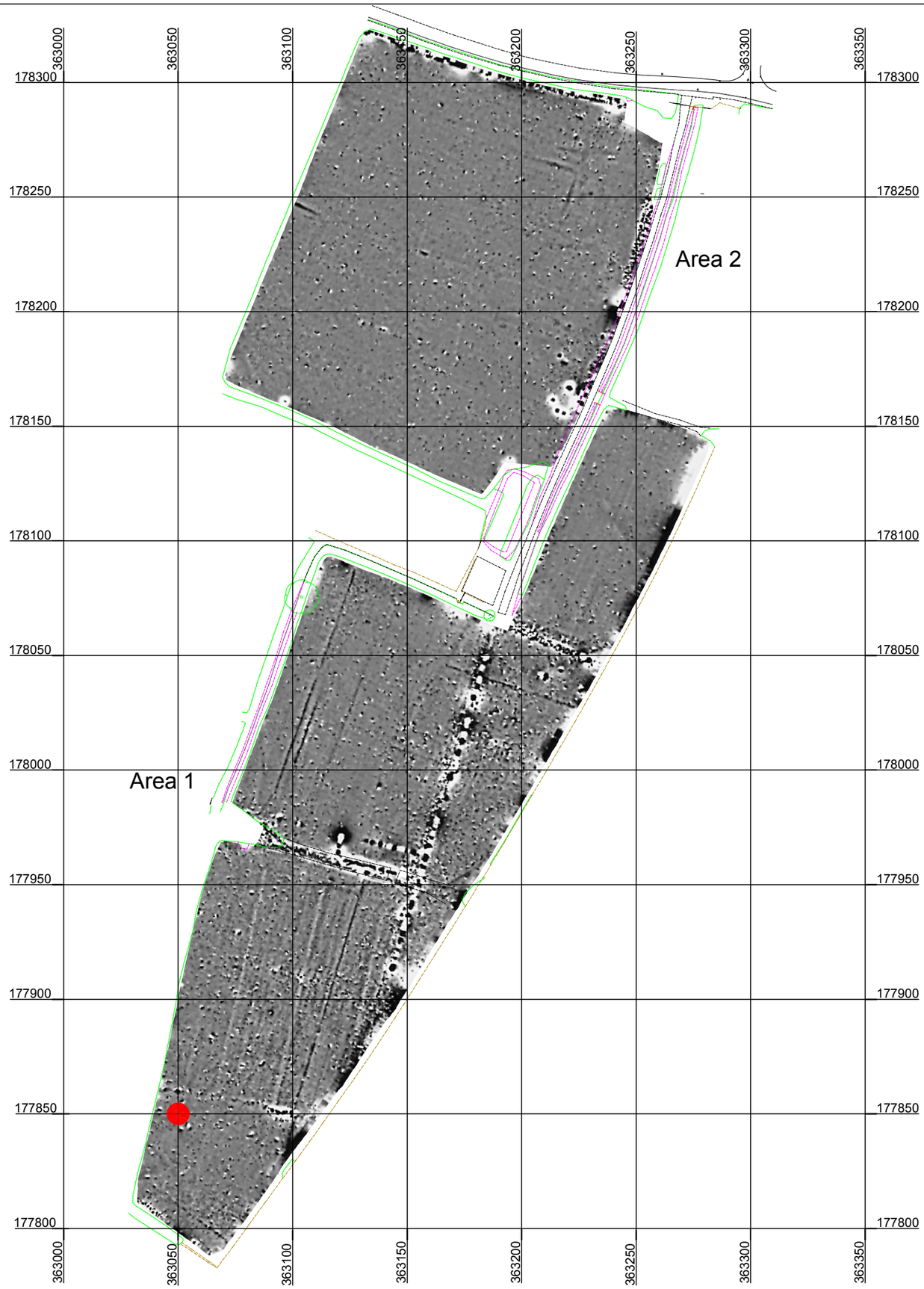
Site centred on OS NGR
ST 63155 78045

SCALE 1:25 000

0m 500m 1000m

SCALE TRUE AT A3

FIG 01



Archaeological Surveys Ltd

Geophysical Survey
Land south of Filton Road
Winterbourne
South Gloucestershire

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

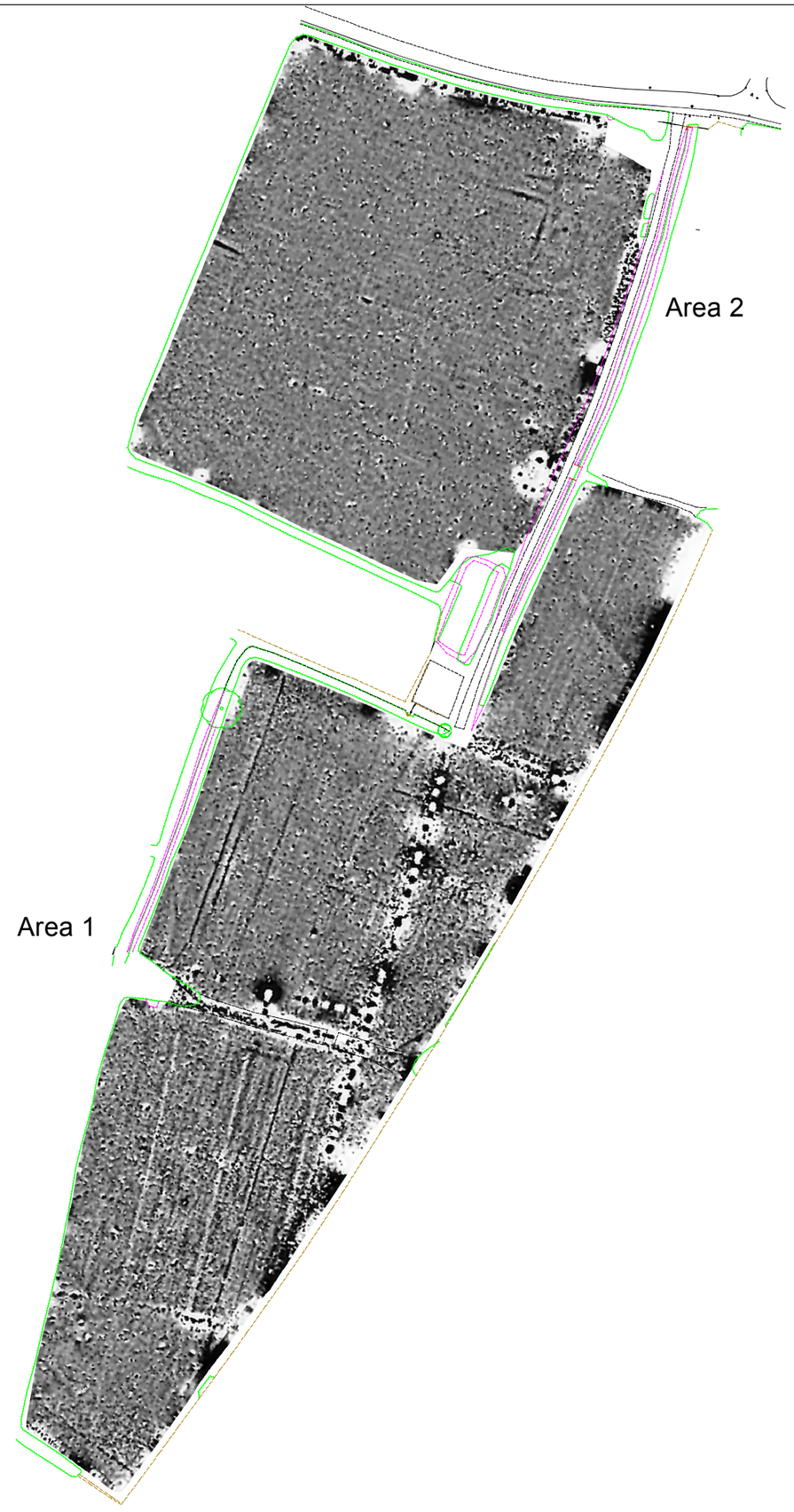
● 363050 177850

SCALE 1:2000

0m 20 40 60 80 100m

SCALE TRUE AT A3

FIG 02

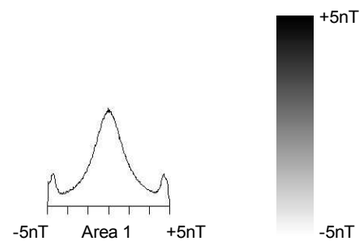


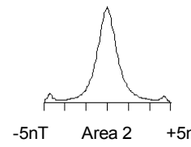
N

Archaeological Surveys Ltd

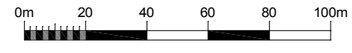
Geophysical Survey
Land south of Filton Road
Winterbourne
South Gloucestershire

Greyscale plot of minimally processed magnetometer data



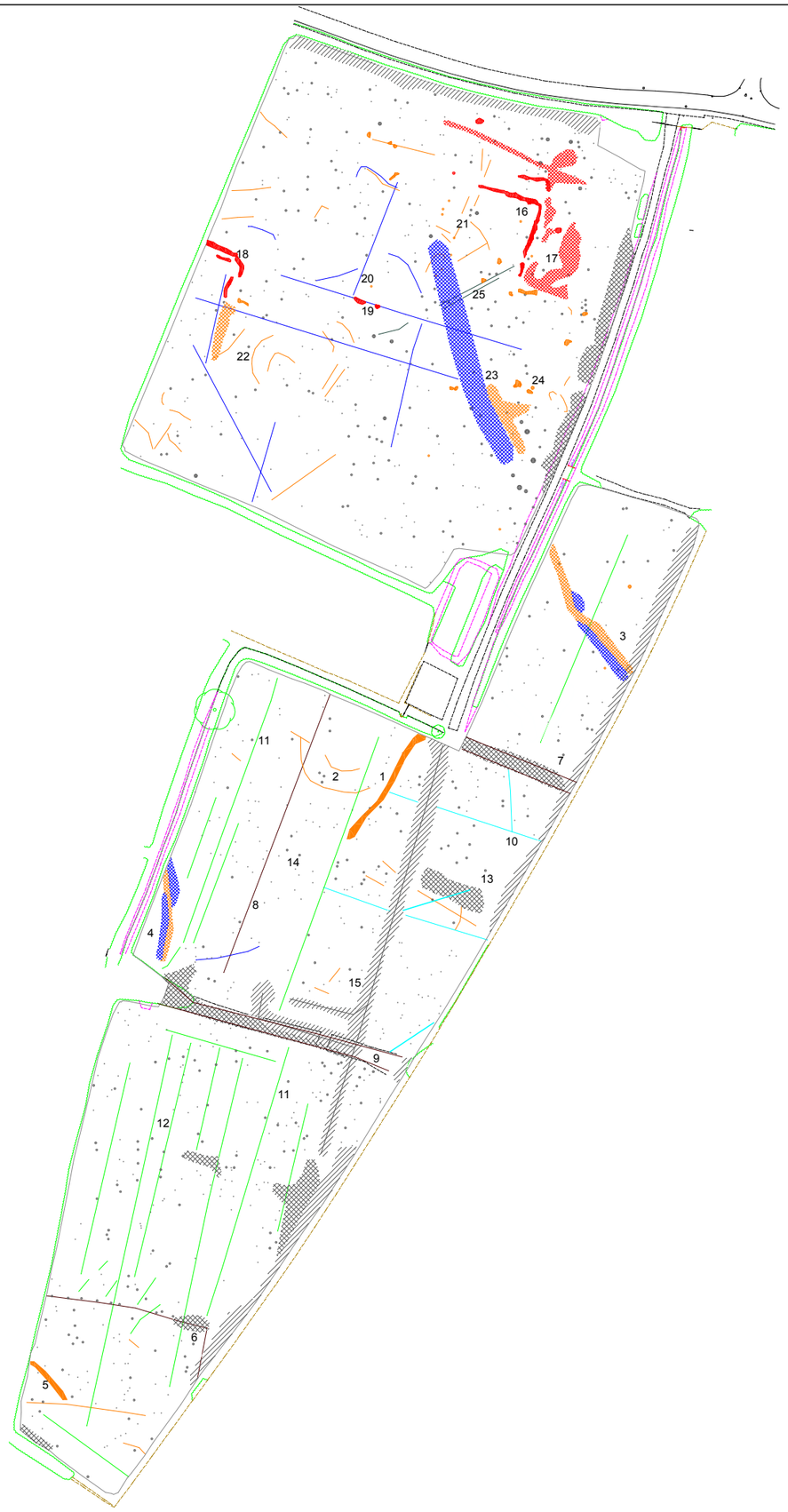


SCALE 1:2000



SCALE TRUE AT A3

FIG 03



Archaeological Surveys Ltd

Geophysical Survey
Land south of Filton Road
Winterbourne
South Gloucestershire

Abstraction and interpretation of magnetic anomalies

- Positive linear anomaly - cut feature of archaeological potential
- Positive linear anomaly - possible ditch-like feature
- Negative linear anomaly - material of low magnetic susceptibility
- Positive linear anomaly - former field boundary
- Positive linear anomaly - possible land drain
- Negative linear anomaly - vehicle rut
- Linear anomaly - of agricultural origin
- Discrete positive response - cut feature of archaeological potential
- Discrete positive response - possible pit-like feature
- Positive anomaly - magnetically enhanced material of archaeological potential
- Positive anomaly - magnetically enhanced material
- Negative anomaly - material of low magnetic susceptibility
- 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

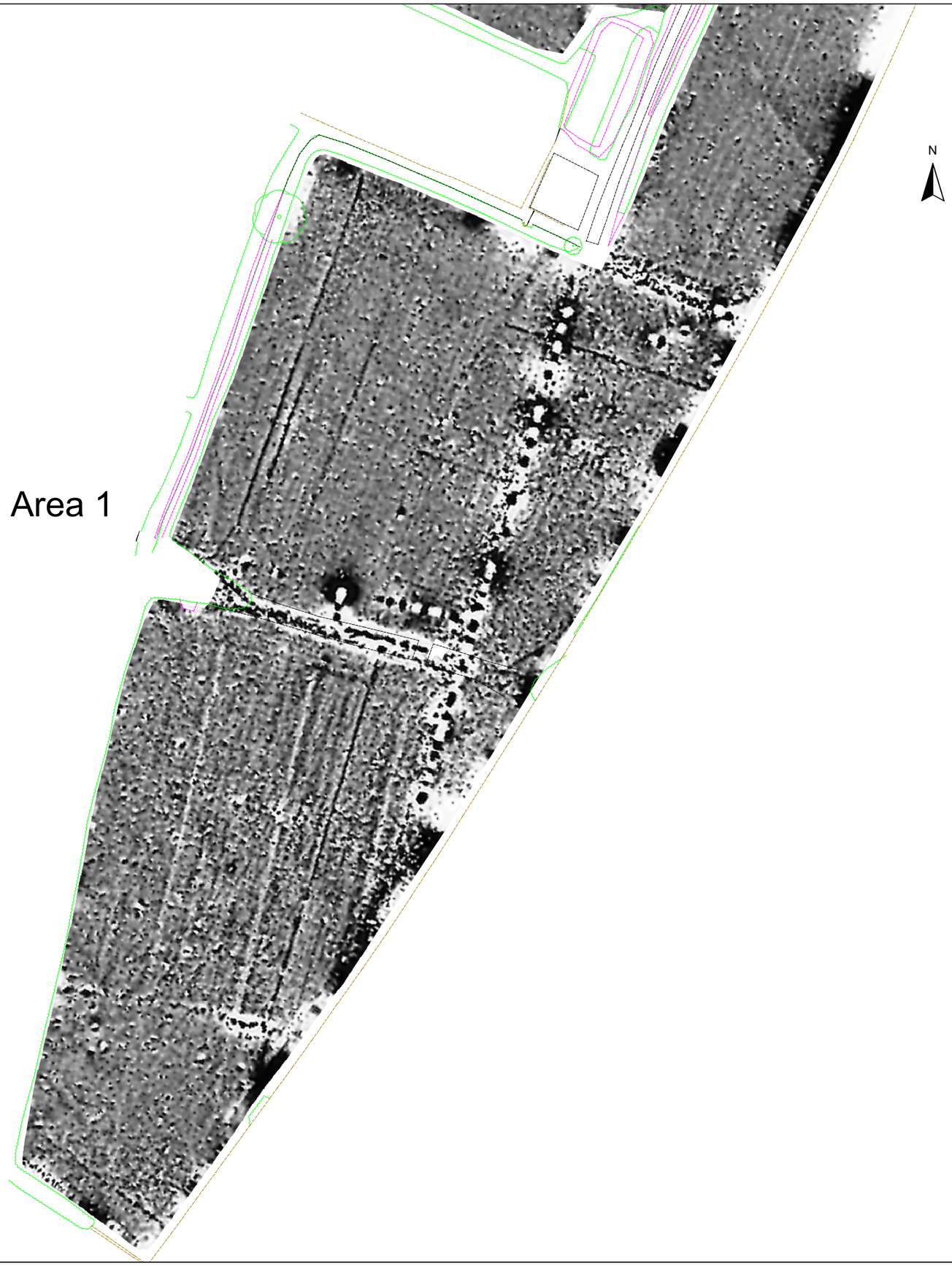
SCALE 1:2000

0m 20 40 60 80 100m

SCALE TRUE AT A3

FIG 04

Area 1



N

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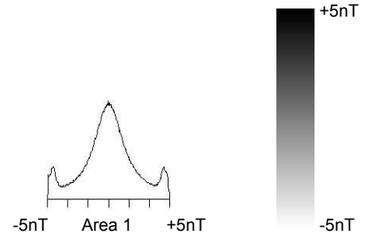
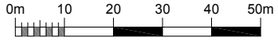
Geophysical Survey
Land south of Filton Road
Winterbourne
South Gloucestershire

Greyscale plot of minimally processed magnetometer data - Area 1



SCALE 1:1250



SCALE TRUE AT A3

FIG 05

Area 1

Archaeological Surveys Ltd

Geophysical Survey
Land south of Filton Road
Winterbourne
South Gloucestershire

Abstraction and interpretation of magnetic anomalies - Area 1

- Positive linear anomaly - possible ditch-like feature
- Linear anomaly - of agricultural origin
- Positive linear anomaly - former field boundary
- Positive linear anomaly - possible land drain
- Discrete positive response - possible pit-like feature
- Positive anomaly - magnetically enhanced material
- Negative anomaly - material of low magnetic susceptibility
- 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 1:1250

0m 10 20 30 40 50m

SCALE TRUE AT A3

FIG 06

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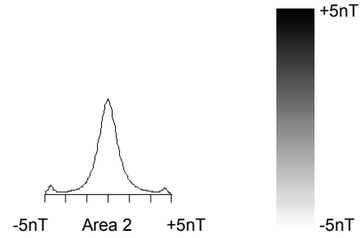
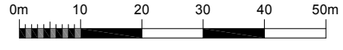
Geophysical Survey
Land south of Filton Road
Winterbourne
South Gloucestershire

Greyscale plot of minimally processed magnetometer data - Area 2



SCALE 1:1000



SCALE TRUE AT A3

FIG 07

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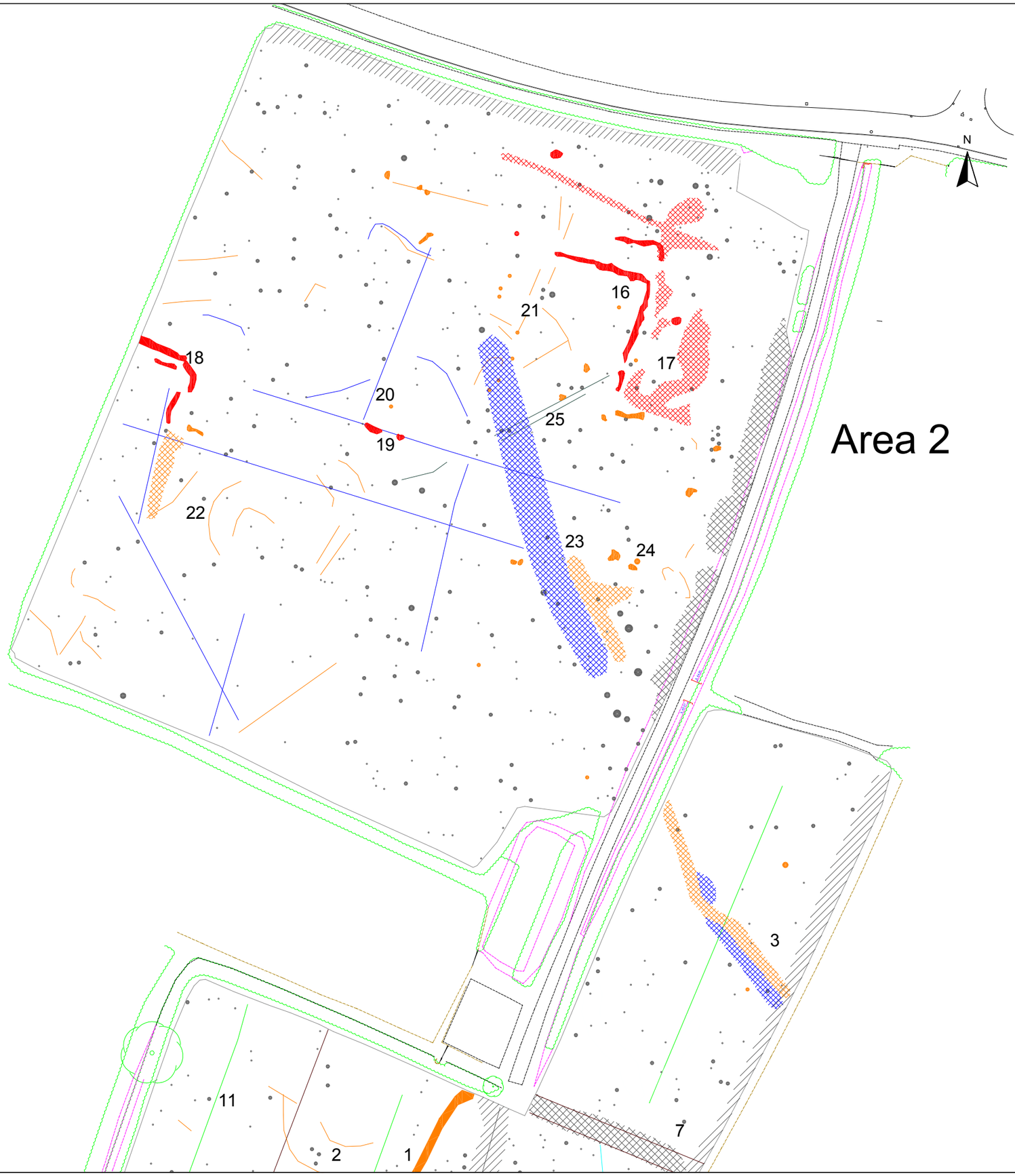
Geophysical Survey
Land south of Filton Road
Winterbourne
South Gloucestershire

Abstraction and interpretation of magnetic anomalies - Area 2



- Positive linear anomaly - cut feature of archaeological potential
- Positive linear anomaly - possible ditch-like feature
- Negative linear anomaly - material of low magnetic susceptibility
- Discrete positive response - cut feature of archaeological potential
- Discrete positive response - possible pit-like feature
- Positive anomaly - magnetically enhanced material of archaeological potential
- Positive anomaly - magnetically enhanced material
- Negative anomaly - material of low magnetic susceptibility
- 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 08