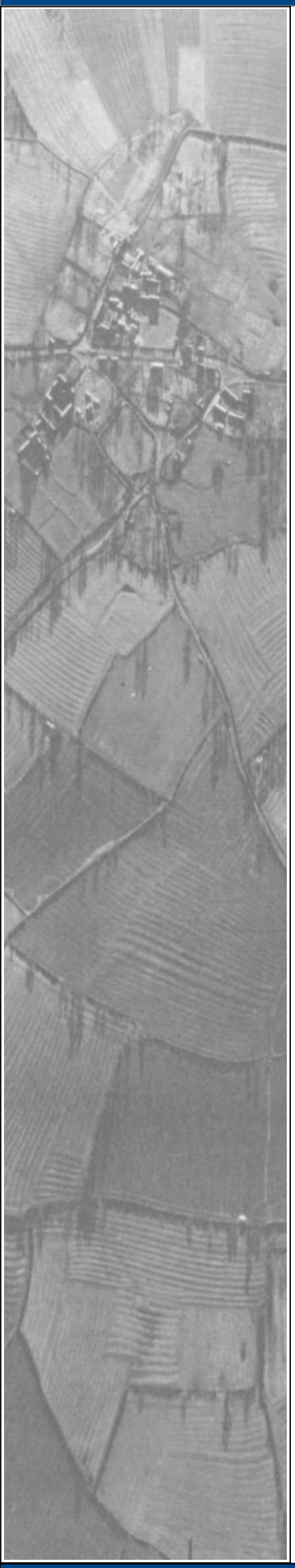

Dewar's Farm Quarry Extension
Ardley
Oxfordshire

MAGNETOMETER SURVEY REPORT

for

Landgage Heritage Ltd

Kerry Donaldson & David Sabin

April 2021

Ref. no. J856

ARCHAEOLOGICAL SURVEYS LTD

Dewar's Farm Quarry Extension
Ardley
Oxfordshire

MAGNETOMETER SURVEY REPORT

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Landgage Heritage Ltd

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 – 22nd March to 6th April 2021
Ordnance Survey Grid Reference – **SP 54700 25455**

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SUMMARY

A detailed magnetometry survey was undertaken by Archaeological Surveys Ltd ahead of an extension to Dewar's Farm Quarry near Ardley, Oxfordshire. The results indicate the presence of numerous naturally formed discrete pit-like anomalies within the underlying limestone geology in the northern part of the site. A small number of pit-like anomalies with a stronger response were also located within this part of the site and these are of uncertain origin. Within the southern part of the site widespread magnetic debris is associated with contaminated green waste and has partially obscured weaker anomalies. However, the survey has located a positive curvilinear anomaly that could relate to a ring ditch. Further positive discrete and possible fragmented curvilinear anomalies are located nearby and while they lack a coherent morphology, it is possible that these could also relate to former cut features.

1 INTRODUCTION

1.1 Survey background

1.1.1 Archaeological Surveys Ltd was commissioned by Landgage Heritage Ltd, on behalf of Smith & Sons (Bletchington) Ltd, to undertake a magnetometer survey of an area of land adjacent to Dewar's Farm Quarry near Ardley in Oxfordshire. The site has been outlined for a proposed extension to the limestone quarry and the survey forms part of an archaeological assessment.

1.1.2 The geophysical survey was carried out in accordance with a Written Scheme of Investigation (WSI) produced by Archaeological Surveys (2021) and issued to Richard Oram, Lead Archaeologist at Oxfordshire County Council, by the client prior to commencing the 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 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 follow the recommendations set out by: 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 line formats, and broken or fragmented lines used in interpretive plots may well correspond closely with truncation of archaeological features.

1.4 Site location, description and survey conditions

1.4.1 The site is located within arable land immediately to the east of Dewar's Farm Quarry, 1.5km south east of Ardley but within the parish of, and 750m west of, Bucknell in Oxfordshire. It is centred on Ordnance Survey National Grid Reference (OS NGR) SP 54700 25455, see Figs 01 and 02.

1.4.2 The geophysical survey covers approximately 33ha within two large fields. Area 1 is a very large arable field immediately west of the M40 Motorway, although a 20m wide strip adjacent to the motorway had been planted with saplings prior to the survey. In the central part of the field a large tree had been cut down and prevented survey within a small zone. The area contained a short arable crop at the time of survey. Area 2 lies at the south eastern end of Area 1 and is a small section of rough grassland. Area 3 is a triangular arable field forming the southern part of the site and this also contained a short arable crop, although some zones were devoid of crop and there are areas of quite dense surface stone. Within the southern part of the field there is a steel inspection chamber cover.

1.4.3 The land within the site generally slopes down gently towards the south and within Area 1 land also slopes down into a shallow valley running along the western boundary. The valley continues along the western and south western sides of Area 3.

1.4.4 The ground conditions across the site were generally considered to be favourable for the collection of magnetometry data. However, large amounts of surface stone was encountered within Area 3 and this created uneven surface conditions and was often difficult to traverse. Weather conditions during the survey were mainly fine but often cold with snow and sleet showers.

1.5 Site history and archaeological potential

1.5.1 The site does not contain any archaeological sites or findspots; however, it has not been subject to previous archaeological investigation. Prior to mineral extraction within land to the south, a programme of archaeological investigation recorded widespread features including Neolithic pits, Iron Age settlement and pit alignment and a Saxon inhumation cemetery. Possible linear cropmarks and a potential ring ditch were recorded from aerial photographs just to the south east of the site; however, no archaeological features were noted ahead of construction of the adjacent M40 motorway. A square enclosure has also been recorded from aerial photographs approximately 325m to the east of the site. Trow Pool is located at the southern end of the site and although associated with a waterworks, is recorded on early mapping and could relate to a medieval fishpond. Earlier Ordnance Survey mapping also shows the site was previously sub-divided into a number of smaller fields with the Ashendon to Aynho railway line bounding the northern end of the site which was constructed in the early 20th century, and the M40 Motorway bounding the eastern edge of the survey area which was constructed in the 1990s.

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. However, parts of Area 3 were devoid of crop which revealed a significant amount of modern contamination visible as a plethora of plastic and occasionally metal items. The modern material is indicative of the use of contaminated green waste used as a soil improver.

1.6 Geology and soils

1.6.1 The underlying solid geology across the western and southern parts of the site is from the White Limestone Formation, with a small band of interbedded mudstone and limestone from the Bladon Member towards the north eastern corner of the site, and limestone from the Forest Marble Formation across the eastern part of the site (BGS, 2017).

1.6.2 The overlying soil across the survey area is from the Aberford association and is a typical brown calcareous earth. It consists of a shallow, locally brashy, well

drained, calcareous, fine, loamy soil over limestone (Soil Survey of England and Wales, 1983).

1.6.3 Magnetometry carried out over similar geology and soil has produced good results although they can be associated with naturally formed pit-like features which can be difficult to distinguish from those with an anthropogenic origin.. The site is, therefore, considered suitable 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 (also known as thermoremanence) are factors associated with the formation of localised fields.

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). Additional details are set out in 2.2 below and within Appendix A.

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 20Hz. 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 measurement range of ±8000nT, although the recorded range is ±3000nT, and resolution is around 0.1nT. They are linked to a Leica GS10 RTK GNSS 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 manifests 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 the 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 ±3000nT 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.

2.3.4 Additional data processing has been carried out for Area 1 in the form of high pass filtering. This effectively removes low frequency variation along a traverse that has been caused by large magnetic bodies, cultivation or rapid temperature change. Data treated to additional processing have 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 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. In addition, traceplots cannot be meaningfully plotted against base mapping and in areas of complexity traces may be lost or highly confused. Traceplots may be used to demonstrate characteristic magnetic profiles across discrete features where it is considered beneficial.

2.3.7 The raster images are combined with base mapping using ProgeCAD Professional 2020, creating DWG (2018) 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 GNSS, resection method, etc.

2.3.8 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.

2.3.9 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.

2.3.10 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 three survey areas covering approximately 33ha.

3.1.2 Magnetic anomalies located can be generally classified as positive and negative anomalies of an uncertain origin, anomalies associated with land management, linear anomalies of an agricultural origin, anomalies with a natural 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 for Areas 1 and 2 and 3.5 for Area 3 below.

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 Data from Area 1 were subject to additional high pass filtering to suppress low magnitude linear anomalies relating either to rapid temperature change caused by snow showers and/or ruts related to agricultural activity. Both filtered and unfiltered data are analysed and compared in order to ensure no significant anomalies have been altered or removed.

3.2.3 The survey has located numerous pit-like and amorphous anomalies caused by natural variations in the soil – solid geology interface. However, it may be impossible to separate these from similar anomalies relating to anthropogenic features should they exist within the site.

3.2.4 Contaminated green waste used as a soil conditioner in Area 3 contains a very large number of small fragments of ferrous material that is visible in the data as a rash of magnetic debris formed by small dipolar anomalies. Observations on open areas of soil during the course of the survey indicated the presence of a very large number of fragmented modern objects, probably general household waste, along with fragmented plastic objects characteristic of contaminated green waste. The ferrous component within the contamination is sufficiently dense and high enough in magnitude to obscure

weak anomalies should they exist within the area. The data does contain anomalies probably related to former cut features, so it is possible to abstract some features if they have sufficient magnitude. However, the widespread pit-like and amorphous anomalies related to the underlying geology, and clearly visible in Area 1, do appear to be obscured by the debris as they would be expected to continue south into Area 3. The results would tend to indicate, therefore, that anomalies of low magnitude may not be visible within the data from Area 3 particularly if they do not have a linear morphology.

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 general 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 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.
Anomalies with a natural origin	Naturally formed magnetic anomalies are caused by localised variability in the magnetic susceptibility of soils, subsoils and other drift or solid geologies. Anomalies may be amorphous, linear or curvilinear and may appear 'fluvial' or discrete; the latter are almost impossible to distinguish from pit-like anomalies with an anthropogenic origin. Fluvial, glacial and periglacial processes may be responsible for their formation within drift material and subsoil. Igneous and metamorphic activity can lead to anomalies within more solid geology.

Table 1: List and description of interpretation categories

3.4 List of anomalies - Areas 1 & 2

Area centred on OS NGR 454740 225595, see Figs 03 – 08.

Anomalies with an uncertain origin

(1) – A fragmented linear anomaly, comprising sections of both positive and negative responses, extends northwards from the edge of the survey area for at least 385m. This type of anomaly suggests an association with a linear boundary feature; however, none has been mapped in this location. It also appears to bound the large zone of numerous pit-like responses (7) but it is not clear if it is of anthropogenic or of natural origin. It does not appear to extend southwards into Area 3.

(2) – A number of discrete positive responses are located outside of the main zones of naturally formed pits (7). While it is possible that they are of natural origin, they are generally much stronger at 8-20nT than the predominantly natural pits, at 1-4nT, and an anthropogenic origin is possible.

(3) – Appearing to lie within the zones of numerous natural pit-like responses are a number of amorphous, linear and discrete anomalies. It is highly likely that they are directly associated with the natural pits; however, there are rectilinear elements and also some similarities with former small scale quarrying, so an anthropogenic origin should also be considered.

Anomalies associated with land management

(4) – Positive linear anomalies, some associated with strong dipolar responses and magnetic debris, relate to formerly mapped field boundaries removed in the late 20th century.

(5) – Situated in the south eastern corner of the site (Area 2) are a number of weakly multiple dipolar linear anomalies. Some are parallel with the former ridge and furrow (6) but others extend across them at right angles. The response is indicative of ceramic land drains.

Anomalies with an agricultural origin

(6) – A series of parallel linear anomalies can be seen along the eastern edge of Areas 1 and 2. They appear to be associated with former ridge and furrow and although they would likely to have extended westwards, they can only be seen at the eastern edge.

Anomalies with a natural origin

(7) – Area 1 contains widespread zones containing numerous discrete positive

responses. Some are joined to form linear anomalies, but the widespread distribution, numerous amount and general lack of a clear morphology indicates that these relate to an increased depth of topsoil within naturally formed pits within the underlying geology.

Anomalies associated with magnetic debris

(8) – Strong, discrete, dipolar anomalies are a response to ferrous and other magnetically thermoremnant objects within the topsoil.

Anomalies with a modern origin

(9) – A strong, multiple dipolar, linear anomaly crosses Area 2 and relates to a buried service/pipe. It does not appear to extend south westwards into Area 3.

3.5 List of anomalies – Area 3

Area centred on OS NGR 454605 225175, see Figs 03, 04, 09 – 11.

Anomalies with an uncertain origin

(10) – A fragmented, positive curvilinear anomaly is located towards the southern end of Area 3. Although the anomaly is weak, obscured by magnetic debris and does not appear to have any response on the south western side, it is consistent with that of a ring ditch with a 12m diameter, indicative of a late prehistoric round house and an archaeological origin should be considered. The anomaly has been categorized as uncertain due to the lack of clarity caused by magnetic debris.

(11) – A number of positive discrete and possible curvilinear anomalies are located 20-50m north east of anomaly (10). Although poorly defined and lacking a coherent morphology, they have a similar magnitude (2-7nT) to anomaly (10) and they could relate to cut features with archaeological potential. These anomalies have been categorized as uncertain due to the lack of clarity caused by lack of coherent morphology and magnetic debris.

(12) – A number of strongly positive responses are located along the southern and south western edge of the survey area. Modern and former mapping shows the parish boundary between Bucknell and Middleton Stoney just within Area 3 very close to these anomalies and an association is possible.

(13) – A small number of possible curvilinear anomalies are located in the north eastern part of the survey area. They are poorly defined, but have a similar response to anomalies (10) & (11) and it is possible that they relate to cut features.

Anomalies associated with land management

(14) – A positive linear anomaly crosses the north western part of Area 3 and extends to join anomaly (4) in Area 1 to the north. It is mapped as a field boundary from 1884 but removed by the 1980s.

Anomalies associated with magnetic debris

(15) – The entire survey area contains widespread magnetic debris. This is a response to fragments of ferrous material within contaminated green waste which has been used as a soil conditioner. The magnetic contamination is strong and very dense, obscuring weaker anomalies.

Anomalies with a modern origin

(16) – Two strong, multiple dipolar, linear anomalies extend east to west across the southern part of the survey area and relate to buried pipes/services.

4 CONCLUSION

4.1.1 The geophysical survey located a small number of positive responses at the southern end of the site which includes a curvilinear anomaly that could relate to a ring ditch. To the north east of this are further partial curvilinear and discrete responses that could relate to other cut features; however, the southern part of the site contains widespread magnetic debris which has partially obscured the weaker features.

4.1.2 In the northern part of the site there are widespread zones containing numerous discrete positive anomalies which are a response to soil-filled naturally formed pit-like features within the underlying limestone geology. A small number of linear, discrete and amorphous positive responses have also been located, but it is possible that these are also natural features. A north to south oriented linear anomaly appears to bound one zone of natural pits, and its origin is uncertain. There is also evidence for recently removed field boundaries, ridge and furrow and land drainage.

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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. Different ranges are applied to data in order to determine the most suitable for anomaly abstraction and display.

Despike

Removal of data points that exceed the mean/median/threshold by selecting a window size of data points and replace by mean/median/threshold. Magnetic spikes can be caused iron objects on the surface or within the topsoil. Despike can improve the appearance of data and remove extreme readings that may affect further processing.

High Pass Filter

Removes low frequency anomalies within the data that are not considered to be archaeologically significant and may be natural in origin. A window passes over the data, the mean of all the data within the window is subtracted from the centre value. The size of the window is adjusted as is the weighting which may be uniform or Gaussian. The process is used to improve the visibility of anomalies of interest.

Low Pass Filter

Removes high frequency anomalies or 'noise' within datasets and provides a smoother output. A window passes over the data, the mean of all the data within the window is used to replace the centre value. The size of the window is adjusted as is the weighting. The process is used to improve the visibility of anomalies of interest.

Zero Median/Mean Traverse

The median (or mean) of data from 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 offset values of the gradiometer sensors. The process can remove archaeological features that run along a traverse but with the high resolution datasets created by the Sensys FGM650 sensors and the method of data collection this has not been a notable problem. In fact, the removal of offsets using software avoids carrying out a balancing procedure on site, which inevitably can never be done in magnetically clean conditions and results in improperly aligned fluxgate sensors and/or electronic adjustment values.

Appendix C – survey and data information

Area 1

Filename: J856-mag-Area1-proc.xcp
Description: Imported as Composite from: J856-mag-Area1.asc
Instrument Type: Sensys DLMGPS
Units:
UTM Zone: 30U
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 454482.55, 226035.52m
Southeast corner: 454915.15, 225276.22 m
Collection Method: Randomised
Sensors: 5
Dummy Value: 32702
Dimensions
Survey Size (meters): 433 m x 759 m
X&Y Interval: 0.15 m
Source GPS Points: Active: 5813449, Recorded: 5813449
Stats
Max: 3.32
Min: -3.30
Std Dev: 0.72
Mean: 0.23
Median: 0.19
Composite Area: 32.847 ha
Surveyed Area: 20.851 ha
PROGRAM
Name: TerraSurveyorPre
Version: 3.0.36.19
GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to UTM).
3 DeStripe Median Traverse:
4 Clip from -3.00 to 3.00

Filename: J856-mag-Area1-proc-hpf.xcp
Stats
Max: 3.32
Min: -3.30
Std Dev: 0.72
Mean: 0.23
Median: 0.19
Composite Area: 32.847 ha
Surveyed Area: 20.851 ha
GPS based Proce6
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to UTM).
3 DeStripe Median Traverse:
4 High pass Uniform (median) filter: Window dia: 250
5 Clip from -5.00 to 5.00
6 Clip from -3.00 to 3.00

Area 2
Filename: J856-mag-Area2-proc.xcp
Northwest corner: 454729.56, 225281.54m
Southeast corner: 454905.06, 225156.74 m
Dimensions
Survey Size (meters): 176 m x 125 m
X&Y Interval: 0.15 m
Source GPS Points: Active: 360100, Recorded: 360100
Stats
Max: 3.32
Min: -3.30
Std Dev: 0.95
Mean: 0.01
Median: 0.00
Composite Area: 2.1902 ha
Surveyed Area: 1.1784 ha
GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to UTM).
3 DeStripe Median Traverse:
4 Clip from -3.00 to 3.00

Area 3

Filename: J856-mag-Area3-proc.xcp
Northwest corner: 454461.93, 225406.16 m
Southeast corner: 454859.88, 224900.51 m
Dimensions
Survey Size (meters): 398 m x 506 m
X&Y Interval: 0.15 m
Source GPS Points: Active: 3269384, Recorded: 3269384
Stats
Max: 3.32
Min: -3.30
Std Dev: 1.83
Mean: 0.02
Median: 0.03
Composite Area: 20.122 ha
Surveyed Area: 11.191 ha
GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to UTM).
3 DeStripe Median Traverse:
4 Clip from -3.00 to 3.00

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 draft copy will be supplied to the Oxfordshire county archaeological officer for comment and the agreed final copy supplied in PDF format to the Oxfordshire Historic Environment Record. 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	J856-mag-**[area number/name]**.asc J856-mag-**[area number/name]**.xcp J856-mag-**[area number/name]**-proc.xcp	Raw data as ASCII CSV TerraSurveyor raw data TerraSurveyor minimally processed data
Graphics	J856-mag-**[area number/name]**-proc.tif	Image in TIF format
Drawing	J856-**[version number]**.dwg	CAD file in 2018 dwg format
Report	J856 report.odt	Report text in LibreOffice 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 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)
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
AS-ABST MAG RIDGE AND FURROW	0,127,63	Line, polyline or polygon (cross hatched ANSI37)
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
Anomalies with a natural origin		
AS-ABST MAG NATURAL FEATURES	Yellow 255,255,0	Polygon (DOTS)

Table 3: CAD layering

Appendix F – copyright and intellectual property

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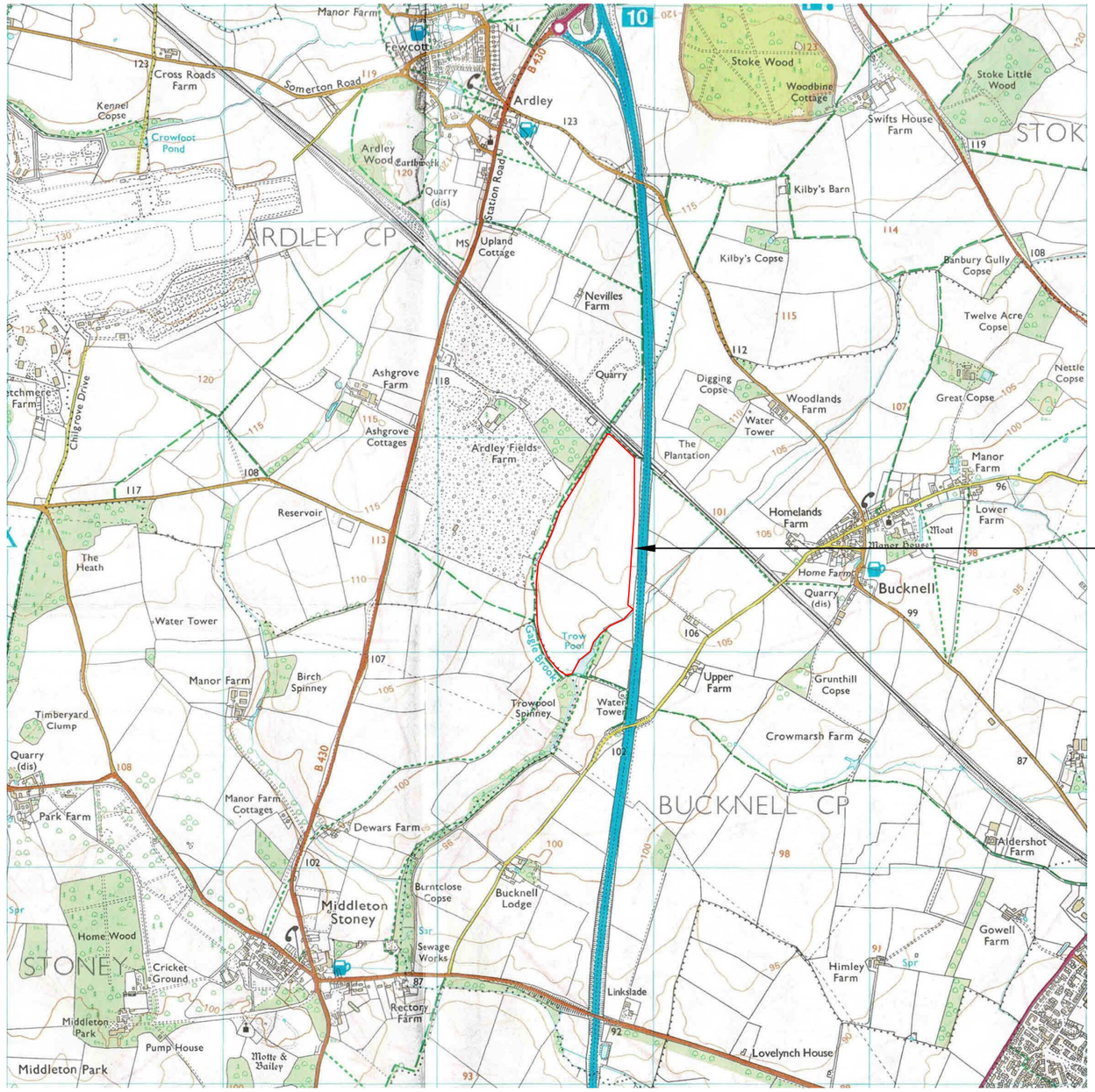
Tel: 01249 814 231

Archaeological Surveys
Specialist Geophysical Surveyors

Geophysical Survey
Dewar's Farm Quarry Extension
Ardley
Oxfordshire

Map of survey area



Survey location

Site centred on OS NGR
SP 54700 25455

SCALE 1:25 000

0m 500m 1000m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 01

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Referencing information

Referencing grid to OSGB36 datum at 100m intervals

454700 225500

Survey tracks

Survey track start

Survey track stop

SCALE 1:5000

0m 100 200m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 02

Figs 05 & 06 - north

Figs 07 & 08 - centre

Figs 09, 10 & 11 - south

Area 1

Area 2

Area 3

New tree planting

RAILWAY

M40 Motorway

Ardley Energy Recovery Facility

Dewars Farm Quarry

Balancing Pond

Tree Pool

Pond

Water Tower

N

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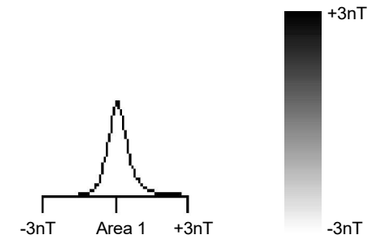
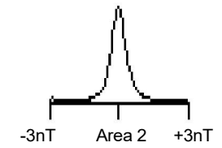
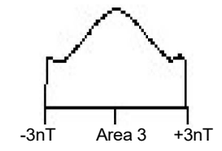
Oxfordshire

Greyscale plot of minimally processed magnetometer data







N

Area 1

Area 2

Area 3

RAILWAY

M40 Motorway

Ardley Energy Recovery Facility

Balancing Pond

Pond

Trow Pool

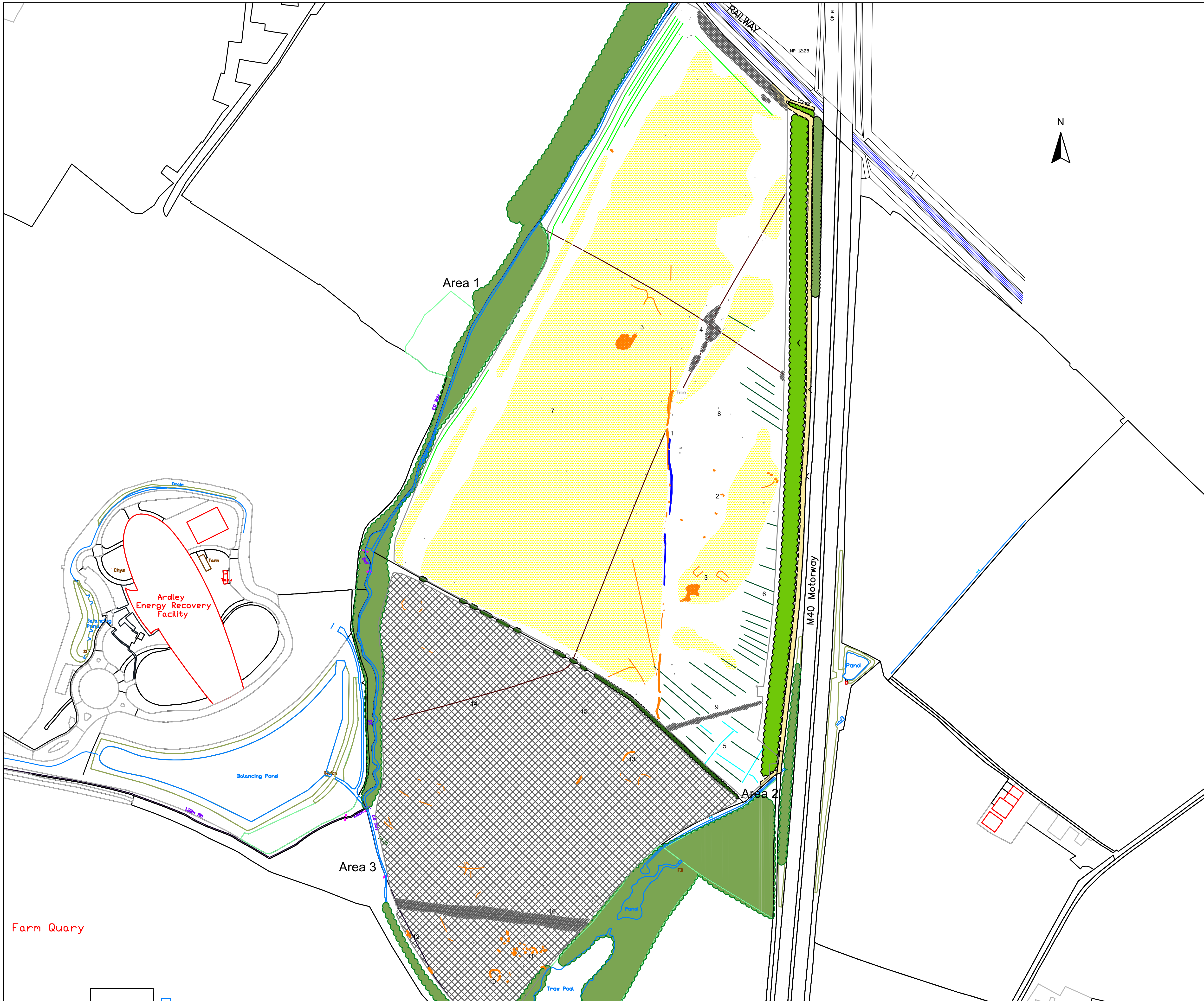
Farm Quary

SCALE 1:4000

0m 40 80 120 160 200m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 03



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Abstraction and interpretation of magnetic anomalies

- Positive linear anomaly - possible ditch-like feature
- Negative linear anomaly - material of low magnetic susceptibility
- Positive linear anomaly - former field boundary
- Linear anomaly - of agricultural origin
- Linear anomaly - ridge and furrow
- Positive linear anomaly - possible land drain
- Discrete positive response - possible pit-like feature
- Positive anomaly - of uncertain origin
- Zone of numerous discrete positive responses - of natural origin
- 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 1:4000

0m 40 80 120 160 200m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 04

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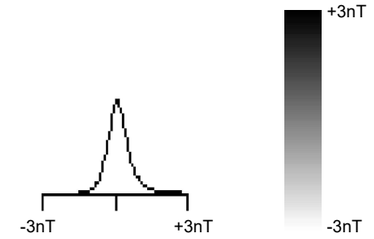
Greyscale plot of filtered magnetometer data - north



RAILWAY

MP 12.25

M 40

N

Track

Area 1

SCALE 1:1500

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 05

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Oxfordshire

Abstraction and interpretation of magnetic anomalies - north

RAILWAY

MP 12.25

M 40

N

Track

Area 1

3

4

- Positive linear anomaly - possible ditch-like feature
- Positive linear anomaly - former field boundary
- Linear anomaly - of agricultural origin
- Discrete positive response - possible pit-like feature
- Zone of numerous discrete positive responses - of natural origin
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Strong dipolar anomaly - ferrous object

SCALE 1:1500

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 06

Area 1

E.D. Bdy

Tree

N

M40 Motorway

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Greyscale plot of filtered magnetometer data - centre

+3nT
-3nT
+3nT
-3nT

SCALE 1:1500

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 07

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Abstraction and interpretation of magnetic anomalies - centre

- Positive linear anomaly - possible ditch-like feature
- Negative linear anomaly - material of low magnetic susceptibility
- Positive linear anomaly - former field boundary
- Linear anomaly - of agricultural origin
- Linear anomaly - ridge and furrow
- Discrete positive response - possible pit-like feature
- Zone of numerous discrete positive responses - of natural origin
- 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 1:1500

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 08

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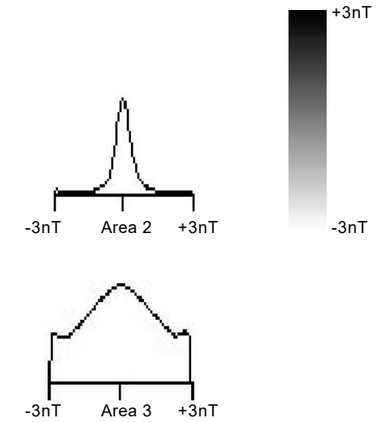
Greyscale plot of processed magnetometer data - south



SCALE 1:1500

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 09

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Abstraction and interpretation of magnetic anomalies - south

- Positive linear anomaly - possible ditch-like feature
- Positive linear anomaly - former field boundary
- Linear anomaly - ridge and furrow
- Positive linear anomaly - possible land drain
- Discrete positive response - possible pit-like feature
- 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 1:1500

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 10

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Abstraction and interpretation of magnetic anomalies without magnetic debris - south

- Positive linear anomaly - possible ditch-like feature
- Positive linear anomaly - former field boundary
- Linear anomaly - ridge and furrow
- Positive linear anomaly - possible land drain
- Discrete positive response - possible pit-like feature
- Magnetic disturbance from ferrous material
- Strong multiple dipolar linear anomaly - pipeline / cable / service
- Strong dipolar anomaly - ferrous object

SCALE 1:1500

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 11