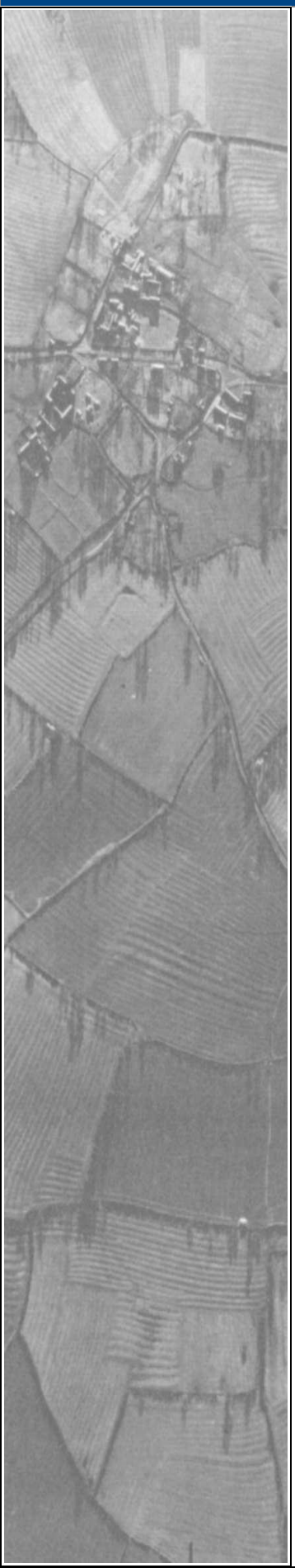

Land west of Buckingham Road
Deanshanger
Northamptonshire

MAGNETOMETER SURVEY REPORT

for

Pegasus Group

on behalf of

Davidsons Developments Ltd

Kerry Donaldson & David Sabin

February 2022

Ref. no. ENN110526/J905

ARCHAEOLOGICAL SURVEYS LTD

Land west of Buckingham Road
Deanshanger
Northamptonshire

MAGNETOMETER SURVEY REPORT

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Davidsons Developments Ltd

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

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Ordnance Survey Grid Reference – **SP 76475 39150**

Northamptonshire HER Event Unique Identifier: ENN110526
Archaeological Surveys Ltd report no: J905

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SUMMARY

Detailed magnetometry was carried out by Archaeological Surveys Ltd over approximately 9ha to the south of Deanshanger in Northamptonshire ahead of a proposed residential development. The results indicate the presence of a trapezoidal-shaped enclosure, containing a ring ditch and other cut features, joined to a sub-circular enclosure and other linear ditches. A number of pits have also been located in the vicinity. The full extent of the archaeology has been partially obscured by magnetic disturbance from a water pipe and magnetic debris derived from the demolition of an agricultural building. Elsewhere, anomalies are generally weak and poorly defined and although they could relate to further ditch-like and pit-like features, they lack a coherent morphology. Linear anomalies associated with former ridge and furrow cultivation have also been located.

1 INTRODUCTION

1.1 Survey background

1.1.1 Archaeological Surveys Ltd was commissioned by Pegasus Group on behalf of Davidsons Developments Ltd, to undertake a magnetometer survey of an area of land to the west of Buckingham Road, Deanshanger, Northamptonshire. The site has been outlined for a proposed residential development 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 (2022) and issued to Liz Mordue, Archaeological Advisor for West Northamptonshire, 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 Archaeological Surveys Ltd is a Registered Organisation with the Chartered

Institute for Archaeologists and both company directors are Members of the Chartered Institute for Archaeologists (MCIfA) and have therefore been assessed for their technical competence and ethical suitability and abide by the CIfA Codes of Conduct. 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) (updated 2020) *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 to the west of Buckingham Road on the southern edge of Deanshanger in West Northamptonshire. The central OS Grid Reference is SP 76475 39150 see Figs 01 and 02.

1.4.2 The geophysical survey covers approximately 9ha within a single arable field that contained open soil with no ground cover. It is bounded to the north by Deanshanger Primary School and residential dwellings within The Beeches, the eastern and southern edges are bounded by the disused Buckingham Arm of the Grand Union Canal and there is agricultural land to the west. The southern part of the site tends to slope down gently towards the south east, the central part slopes down slightly to the east and the northern part slopes down towards the north; the central part of the site is, therefore, somewhat elevated above the rest of the area.

1.4.3 The ground conditions across the site were generally considered to be poor for the collection of magnetometry data due to wet, sticky soil; however, geophysical anomalies have been identified within the results. Weather conditions during the survey were mainly fine.

Plate 1: Survey area looking south

1.5 Site history and archaeological potential

1.5.1 A Heritage Statement has been prepared by Pegasus Group (2021) which outlines that a geophysical survey and trial trench evaluation were undertaken within the northern part of the site in 2010 (ENN10561-2). Although no archaeological features were located by the geophysical survey a drain containing Romano-British pottery was identified during the evaluation along with evidence for medieval ridge and furrow. Aerial photograph survey indicates that the centre of the site is crossed by the Romano-British road from Olney to Water Stratford, known as *Viatores Route 171*. The Buckingham Arm of the Grand Union Canal forms the western and southern boundary of the site and Ordnance Survey mapping shows the field subdivided into three with an agricultural building in the northern central part of the site mapped until recently.

1.6 Geology and soils

1.6.1 The underlying solid geology across the site is interbedded siltstone and mudstone from the Lias group with overlying deposits of diamicton from the Oadby Member (BGS, 2017).

1.6.2 The overlying soil across the majority of the survey area is from the Hanslope

association and is a typical calcareous pelosol. It consists of a slowly permeable, calcareous, clayey soil over chalky till. In the northern part of the site the overlying soil is from the Aberford association which is a typical brown calcareous earth consisting of a shallow, locally brashy, well drained, calcareous, fine, loamy soil (Soil Survey of England and Wales,1983).

1.6.3 Magnetometry survey carried out across similar superficial drift geology and soils has produced variable results as the underlying glacial deposits can result in suppressed magnetic susceptibility. However, where there has been long term occupation and/or industrial activity then the soils may become sufficiently magnetically enhanced for some magnetic contrast between cut features and the material into which they are cut.

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 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. 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.

2.3.6 The raster images are combined with base mapping using ProgeCAD Professional 2021, 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.

2.3.7 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 the 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.

3 RESULTS

3.1 General assessment of survey results

3.1.1 The detailed magnetic survey was carried out over approximately 9ha within a single survey area.

3.1.2 Magnetic anomalies located can be generally classified as positive and negative linear and discrete positive responses of archaeological potential, positive and negative anomalies of an uncertain origin, 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. Magnetic disturbance caused by a steel pipeline running through the central part of the site has obscured anomalies of archaeological potential within a very small area.

3.2.2 The underlying superficial geology can be associated with soils of very low magnetic susceptibility and poor magnetic contrast. In order to assess the magnetic characteristics of the soils, mass specific magnetic susceptibility was measured on a single sample of the underlying Oadby Member superficial geology and a single sample of the topsoil from the Hanslope association. The samples were collected away from archaeological anomalies from small amounts of spoil left after augering associated with soil analysis not carried out by Archaeological Surveys. The samples were subdivided allowing several measurements of magnetic susceptibility using a Bartington MS2 with MS2B sensor. The Oadby Member produced an average value (X_{lf}) of 6.4 $10^{-8}m^3kg^{-1}$; the topsoil an average value of 15.6 $10^{-8}m^3kg^{-1}$. The results may not be representative of the whole site but are within the range expected for a clayey soil and considered capable of supporting useful magnetic contrast, particularly where human settlement has occurred. Anomalies may display a characteristic settlement effect where anomalies fade with distance away from core areas of activity.

3.2.3 Evidence of widespread former ridge and furrow cultivation within the site, as well as modern cultivation, may infer truncation of features with archaeological

potential.

3.3 Data interpretation

3.3.1 The list of sub-headings below attempts to define a number of separate categories that reflect the range and type of features located during the survey. A 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 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 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 centred on OS NGR 476475 239150, see Figs 03 – 08.

Anomalies of archaeological potential

(1) – Situated in the central, northern part of the survey area is a trapezoidal-shaped enclosure. It contains a ring ditch (2) with a number of positive discrete, linear and rectilinear anomalies inside as well as a number of discrete negative

responses. Other archaeological features (3) and (4) appear to be associated. The enclosure with internal ring ditch and features could suggest a small occupation site, but an association with ritual activity is also possible.

(2) – A positive curvilinear anomaly relates to a ring ditch with a south west facing entrance and a number of associated linear, rectilinear and discrete anomalies, both internal and external. Its morphology is consistent with the response to a prehistoric round house, which would suggest a habitation site, although an association with a ritual monument is possible.

(3) – A sub-circular enclosure is situated to the south west of enclosure (1) and appears to be conjoined, although it has been truncated by a steel water pipe at this point and the link is obscured by magnetic disturbance. This enclosure appears to contain associated cut features, possibly another ring ditch, but it is poorly defined.

(4) – Linear anomalies appear to extend towards the north western and south eastern corners of the trapezoidal enclosure (1). The response tends to become weaker further away from the enclosure and they appear to relate to associated linear boundary ditches.

(5) – A number of positive linear and curvilinear responses are situated to the north of enclosure (1). Although they are not well defined, they could relate to cut features with archaeological potential.

(6) – Positive linear anomalies appear to form associated rectilinear features. It is possible that they have been truncated by the ridge and furrow and later agricultural activity.

(7) – A group of positive responses relating to pits or post holes. The majority of these are small (c0.5m) and with a weak to moderate response (1-3nT); however, one is larger (1.3m x 2.2m) and has a response of over 35nT which indicates an association with burning or burnt material.

(8) – A number of discrete positive responses are situated outside of the confines of enclosure (1). They may relate to pits with archaeological potential.

Anomalies with an uncertain origin

(9) – Located in the central, southern part of the site are two groups of positive and negative responses. The origin of these anomalies is not clear, they could relate to ground disturbance or groups of pits and disturbed sub-soil or stone, but they lack a coherent morphology.

(10) – A small number of weakly positive and a negative linear anomalies have been located within the site. They are not well defined, and while some could relate to agricultural activity or land drainage, others could relate to cut features.

(11) – The eastern and southern parts of the site contain a number of discrete, positive responses. Some are situated in clusters and linear groups; however, they

are not clearly associated with other features. Such responses could relate to naturally formed features, several do have a magnitude of over 10nT which could indicate an association with burnt material and an archaeological origin is possible.

(12) – A weakly positive anomaly is situated on the southern edge of a low mound or bank that crosses the site from east to west. The origin of the response is uncertain. The proposed line of the Roman road *Viatores Route 171* has been previously recorded on the HER and which is purported to cross the central part of the site. It is possible that the weakly positive response is located in the position of the proposed Roman road, but anomalies associated to flanking ditches are not clearly defined in the results.

Anomalies with an agricultural origin

(13) – The site contains a series of linear anomalies relating to former ridge and furrow cultivation on different orientations.

Anomalies associated with magnetic debris

(14) – A zone of magnetic debris associated with a former agricultural building that was mapped from the 19th century and visible on Google Earth until 2009.

(15) – Two patches of magnetic debris are located in the central, western part of the site. They relate to spreads of ferrous and magnetically thermoremnant material and appear in the location of a formerly mapped field boundary that crossed the site.

(16) – The entire site contains numerous discrete, strong dipolar anomalies. These relate to ferrous items and fragments of brick/tile within the topsoil and are very widely distributed. Numerous small fragments of brick were noted across the site with increased frequency in the southern and eastern parts. It is possible this relates to waste material used as a soil conditioner, and larger fragments have the potential to produce dipolar anomalies and increase the general background level of magnetic ‘noise’.

Anomalies with a modern origin

(17) – A strong, multiple dipolar, linear anomaly extends through much of the survey area and has a small adjoining section in the north. It relates to a water pipe and it appears to have truncated the junction between enclosures (1) & (3) with magnetic disturbance obscuring the weaker anomalies.

4 DISCUSSION

4.1.1 Anomalies with archaeological potential can be seen in the central, northern part of the site. The features include a trapezoidal enclosure (1) with dimensions of 32m long by between 20m and 32m wide, and it occupies a slightly more elevated east facing crest within the field. It appears that it may have an entrance towards the south western corner. The response to the fill of the enclosure ditch is variable from less than 1nT at the north western corner to up to 12nT adjacent to the south west entrance. The magnitude of the response probably indicates that burnt material has become incorporated into a ditch fill which may suggest a domestic site, but a ritual association is also possible. Inside this enclosure is a ring ditch (2) with an outer diameter of 13.6m and a 3.2m wide south east facing entrance. It has a small rectilinear feature attached to the north eastern edge and a number of associated internal and external features. Such a ring ditch could be consistent with a late prehistoric round house.

4.1.2 A number of cut features appear to extend towards or be attached to enclosure (1). These include a sub-circular enclosure (3) which appears to be attached to the south western corner of (1), although it has been truncated by a water pipe at this point and the resulting magnetic disturbance has obscured the junction. Linear anomalies appear to extend westwards from the north western corner and south eastwards from the south eastern corner (4) and they are generally weaker the further away from the enclosure they extend. Linear and curvilinear responses (5) appear to extend northwards from the north western corner of (3) and a number of discrete responses (8) relate to pits and/or are associated with burning and appear also to have archaeological potential.

4.1.3 Away from the main zone of archaeological features the geophysical responses (9-12) are either weak, isolated or lack a coherent morphology preventing confident interpretation. Some linears could be associated with agricultural activity or land drainage, but some could relate to cut features with archaeological potential. Discrete responses could also relate to pit-like features with archaeological potential; however, naturally formed pits, such as tree-throws could result in discrete responses.

4.1.4 A low bank can be seen crossing the central part of the site, and a recently removed field boundary could be partly associated with this, although it appears on a slightly different orientation. This formerly mapped boundary does not appear to have a corresponding geophysical response. The HER indicates that the route of the Roman road *Viatores Route 171* is purported to extend across this part of the site from the north east to south west, which could partially be associated with the low bank, but again is at a slightly different orientation. However, is possible that the weakly positive anomaly (12) is located along the line of the purported road and although it is poorly defined an archaeological origin cannot be ruled out.

5 CONCLUSION

5.1.1 The geophysical survey located a number of anomalies with archaeological potential, mainly in the northern, central part of the site. The anomalies include a trapezoidal enclosure which contains a ring ditch and other cut features with a small sub-circular enclosure joining the south western corner and several linear anomalies appearing to extend away from the enclosure.

5.1.2 In the southern part of the site there are a number of weak anomalies that are generally poorly defined and lack a coherent morphology, but an archaeological origin is possible. The site also contains evidence of former ridge and furrow cultivation indicative of a long period of agricultural use.

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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.

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

Filename: J905-mag-proc.xcp
Description: Imported as Composite from:
J905-mag.asc
Instrument Type: Sensys DLMGPS
Units:
UTM Zone: 30U
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 476322.47, 239387.45 m
Southeast corner: 476602.07, 238885.70 m
Collection Method: Randomised
Sensors: 5

Dummy Value: 32702
Dimensions
Survey Size (meters): 280 m x 502 m
X&Y Interval: 0.15 m
Source GPS Points: Active: 2718227, Recorded: 2718227
Stats
Max: 3.32
Min: -3.30
Std Dev: 1.09
Mean: 0.03

Median: 0.02
Composite Area: 14.029 ha
Surveyed Area: 8.5667 ha
PROGRAM
Name: TerraSurveyorPre
Version: 3.0.36.24
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 PDF copy will be supplied to the Northamptonshire Historic Environment Record with greyscale images and abstraction layers made available on request. The report will also be uploaded to the Online AccesS to the Index of archaeological investigationS (OASIS). In addition, digital data created during the survey will be archived with the Archaeology Data Service (ADS) in accordance with their procedures (Schmidt, 2013).

Archive contents:

File type	Naming scheme	Description
Data	ENN110526/J905-mag-**[area number/name]**.asc ENN110526/J905-mag-**[area number/name]**.xcp ENN110526/J905-mag-**[area number/name]**-proc.xcp	Raw data as ASCII CSV TerraSurveyor raw data TerraSurveyor minimally processed data
Graphics	ENN110526/J905-mag-**[area number/name]**-proc.tif	Image in TIF format
Drawing	ENN110526/J905-**[version number]**.dwg	CAD file in 2018 dwg format
Report	ENN110526/J905 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 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	Polyline or polygon (solid)
AS-ABST MAG POS CURVILINEAR RING DITCH		Magenta 255,0,255	Polyline or polygon (solid)
AS-ABST MAG POS ENCLOSURE DITCH		127,0,255	Line, polyline or polygon (solid)
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 NEG DISCRETE UNCERTAIN	Blue 0,0,255	Solid donut, point or polygon (solid)
AS-ABST MAG POS UNCERTAIN	255,127,0	Polygon (cross hatched ANSI37)
Anomalies with an agricultural origin		
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

Table 3: CAD layering

Appendix F – copyright and intellectual property

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Summary for archaeol20-504831

OASIS ID (UID)	archaeol20-504831
Project Name	Land west of Buckingham Road, Deanshanger, Northamptonshire Magnetometer Survey
Activity type	Geophysical Survey, Magnetometry Survey, MAGNETOMETRY SURVEY
Project Identifier(s)	J905, ENN110526
Planning Id	
Reason For Investigation	Planning: Pre application
Organisation Responsible for work	Archaeological Surveys Ltd
Project Dates	07-Feb-2022 - 09-Feb-2022
Location	Land west of Buckingham Road, Deanshanger, Northamptonshire NGR : SP 76475 39150 LL : 52.0454790451221, -0.886322479963468 12 Fig : 476475,239150
Administrative Areas	Country : England County : Northamptonshire District : South Northamptonshire Parish : Deanshanger
Project Methodology	Geophysical survey using detailed magnetometry over 9ha field
Project Results	Detailed magnetometry located previously unidentified archaeological features including enclosures and a ring ditch and associated pits and linear ditches. The purported line of a Roman road is recorded within the site, but it is not clear if there are any associated geophysical anomalies.
Keywords	Trapezoidal Enclosure - UNCERTAIN - FISH Thesaurus of Monument Types Ring Ditch - UNCERTAIN - FISH Thesaurus of Monument Types Ditch - UNCERTAIN - FISH Thesaurus of Monument Types Pit - UNCERTAIN - FISH Thesaurus of Monument Types Ridge And Furrow - POST MEDIEVAL - FISH Thesaurus of Monument Types D Shaped Enclosure - UNCERTAIN - FISH Thesaurus of Monument Types
HER	Northamptonshire SMR - unRev - STANDARD
HER Identifiers	HER Event No - ENN110526
Archives	Digital Archive - to be deposited with Archaeology Data Service Archive

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Tel: 01249 814 231

Archaeological Surveys
Specialist Geophysical Surveyors

Geophysical Survey
Land west of Buckingham Road
Deanshanger
Northamptonshire

Map of survey area

Survey location

Survey location

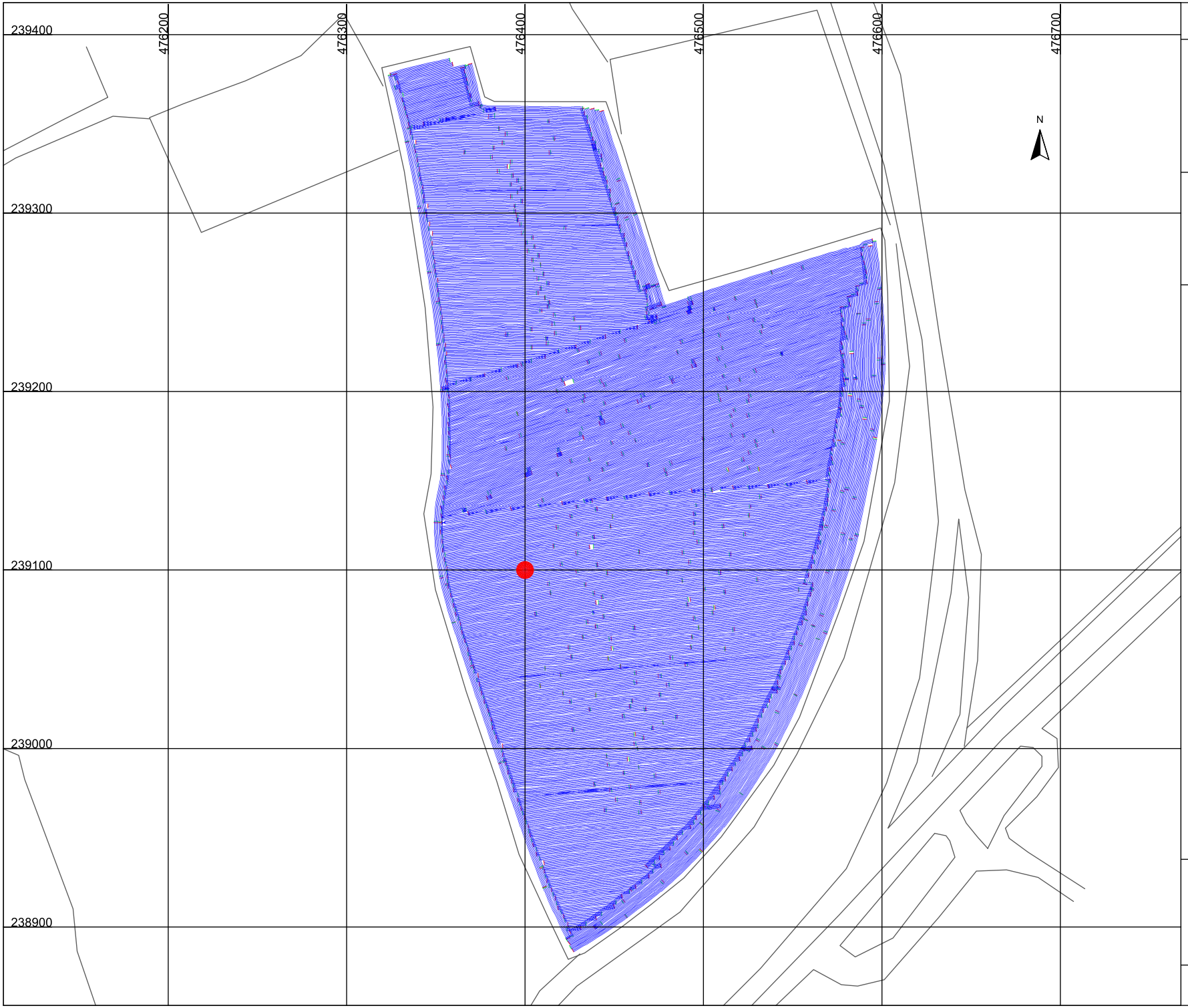
Site centred on OS NGR
SP 76475 39150

SCALE 1:25 000

0m 500m 1000m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 01



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Geophysical Survey
Land west of Buckingham Road
Deanshanger
Northamptonshire

Referencing information

Referencing grid to OSGB36 datum at 100m intervals

476400 239100

Survey tracks

Survey track start

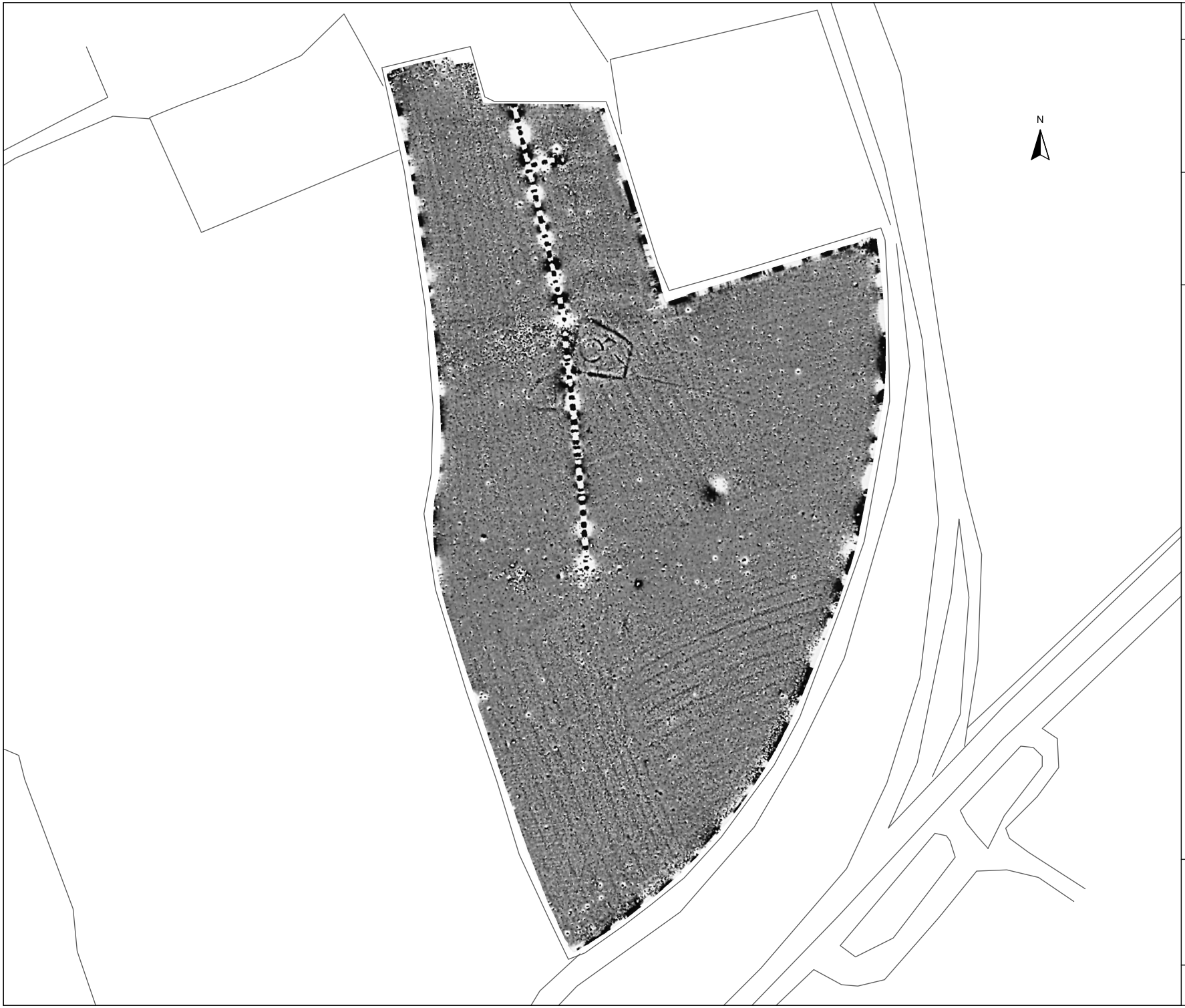
Survey track stop

SCALE 1:2000

0m 20 40 60 80 100m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 02



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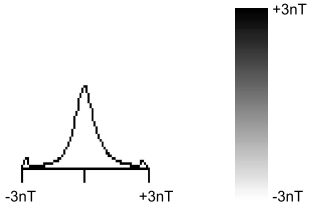
Northamptonshire

Greyscale plot of minimally processed magnetometer data

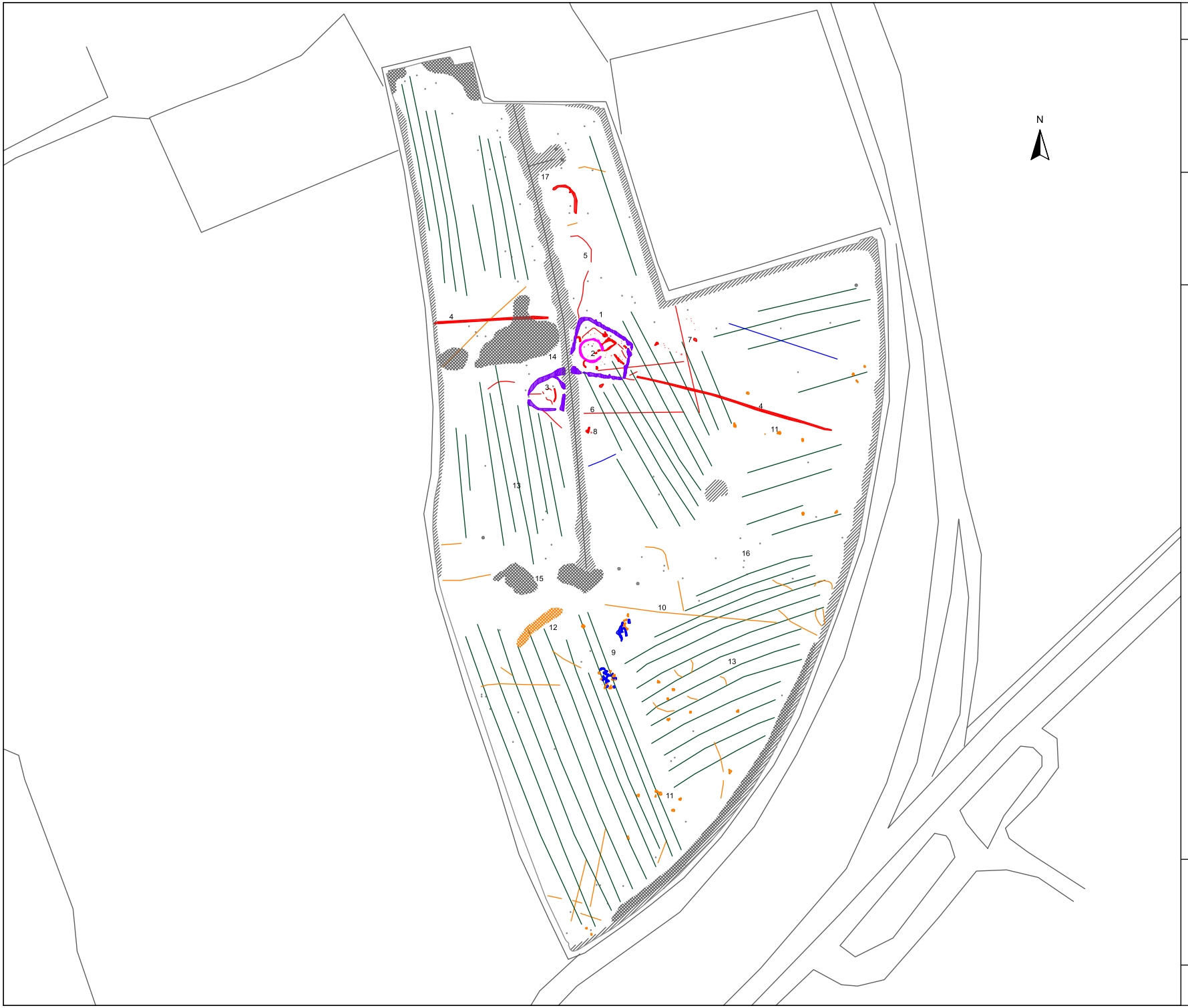


SCALE 1:2000

0m 20 40 60 80 100m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 03



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Abstraction and interpretation of magnetic anomalies

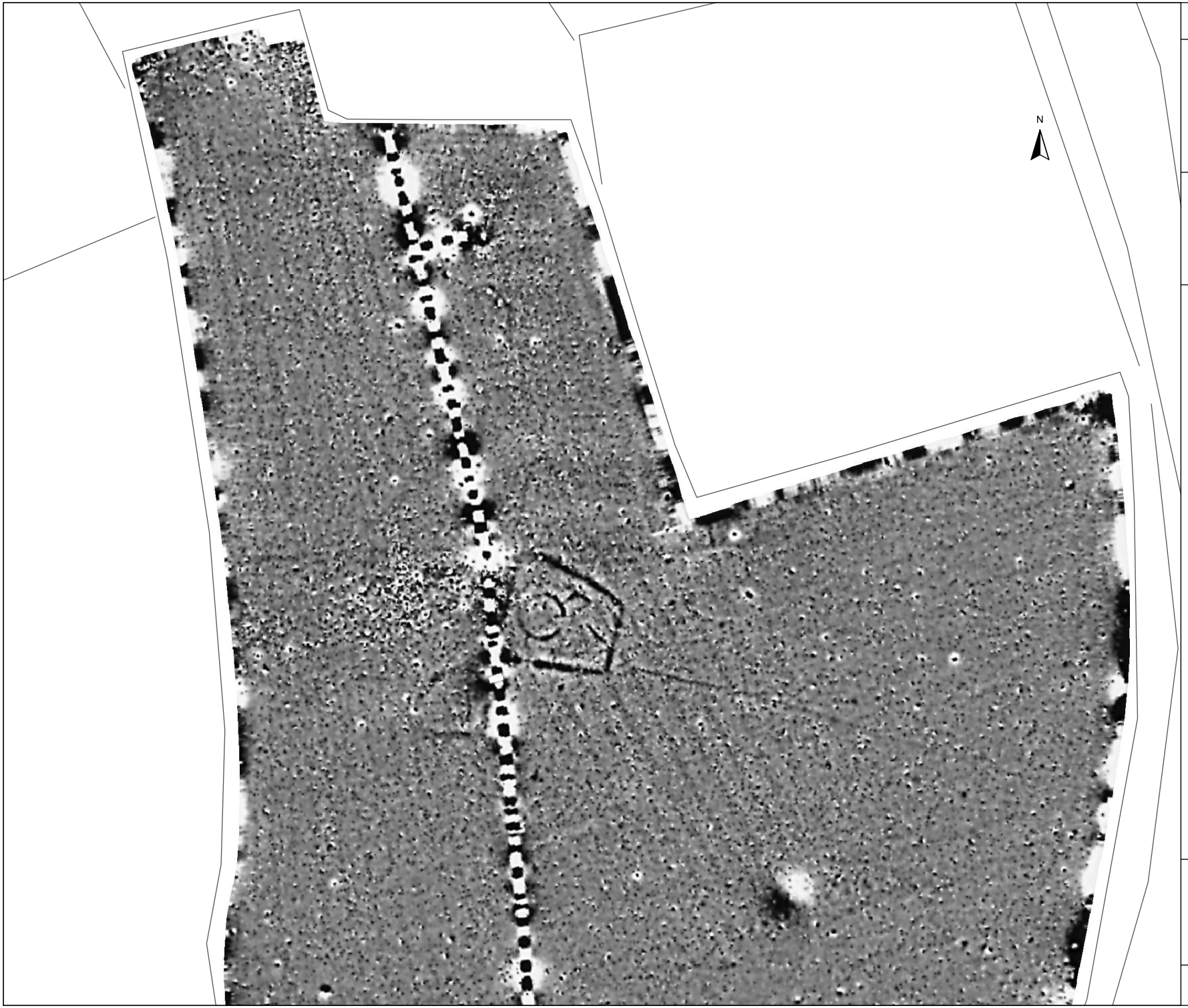
- Positive linear anomaly - cut feature of archaeological potential
- Positive curvilinear/rectilinear anomaly - enclosure ditch
- Positive curvilinear anomaly - ring ditch
- Positive linear anomaly - possible ditch-like feature
- Negative linear anomaly - material of low magnetic susceptibility
- Linear anomaly - ridge and furrow
- Discrete positive response - cut feature of archaeological potential
- Discrete positive response - possible pit-like feature
- Discrete negative response - low magnetic susceptibility (eg stone/subsoil)
- Positive anomaly - magnetically enhanced material
- 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

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 04



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Northamptonshire

Greyscale plot of minimally processed magnetometer data - north

-3nT +3nT

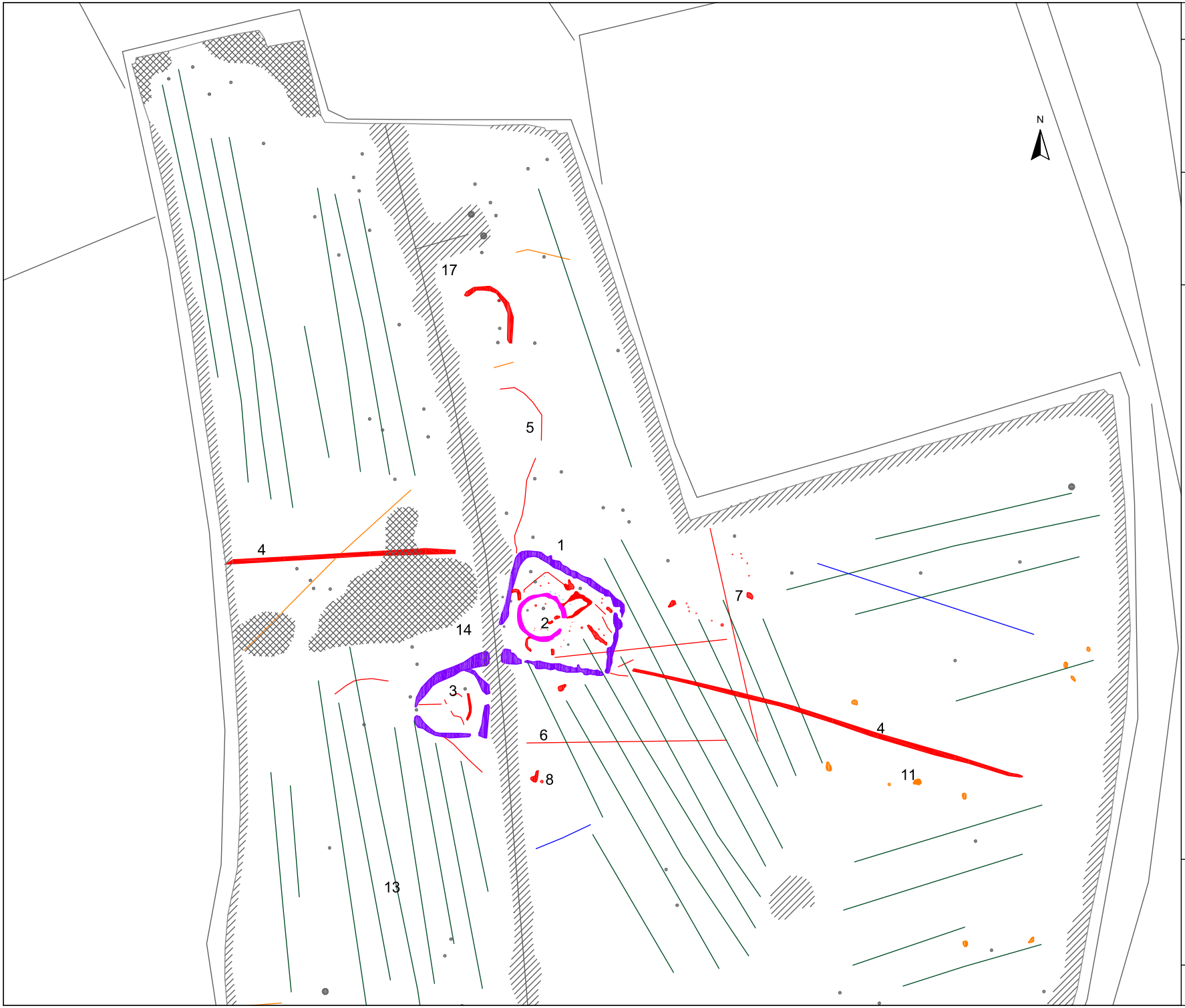
+3nT
-3nT

SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 05



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Abstraction and interpretation of magnetic anomalies - north

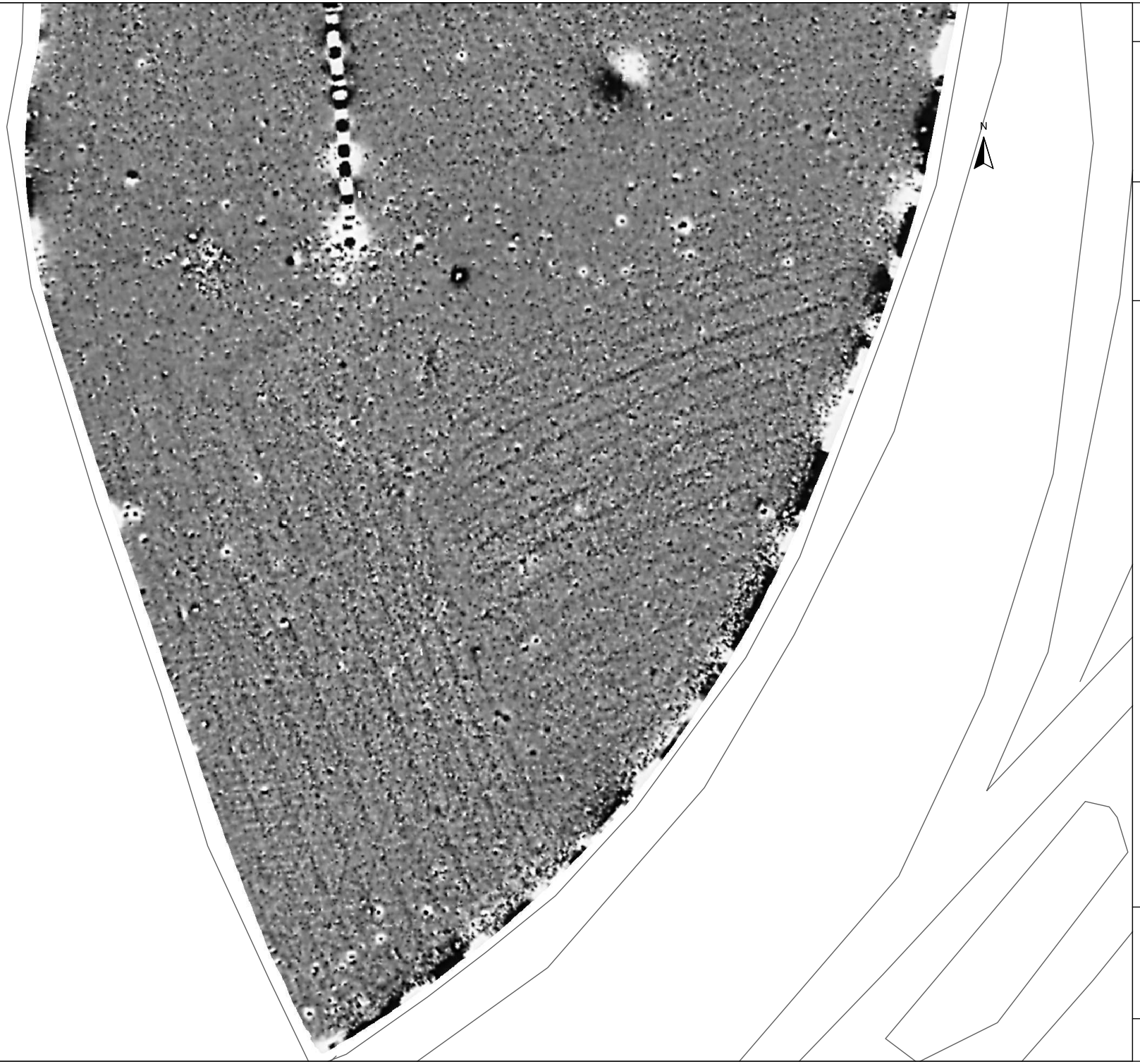
- Positive linear anomaly - cut feature of archaeological potential
- Positive curvilinear/rectilinear anomaly - enclosure ditch
- Positive curvilinear anomaly - ring ditch
- Positive linear anomaly - possible ditch-like feature
- Negative linear anomaly - material of low magnetic susceptibility
- Linear anomaly - ridge and furrow
- Discrete positive response - cut feature of archaeological potential
- 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 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 06



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Northamptonshire

Greyscale plot of minimally processed magnetometer data - south

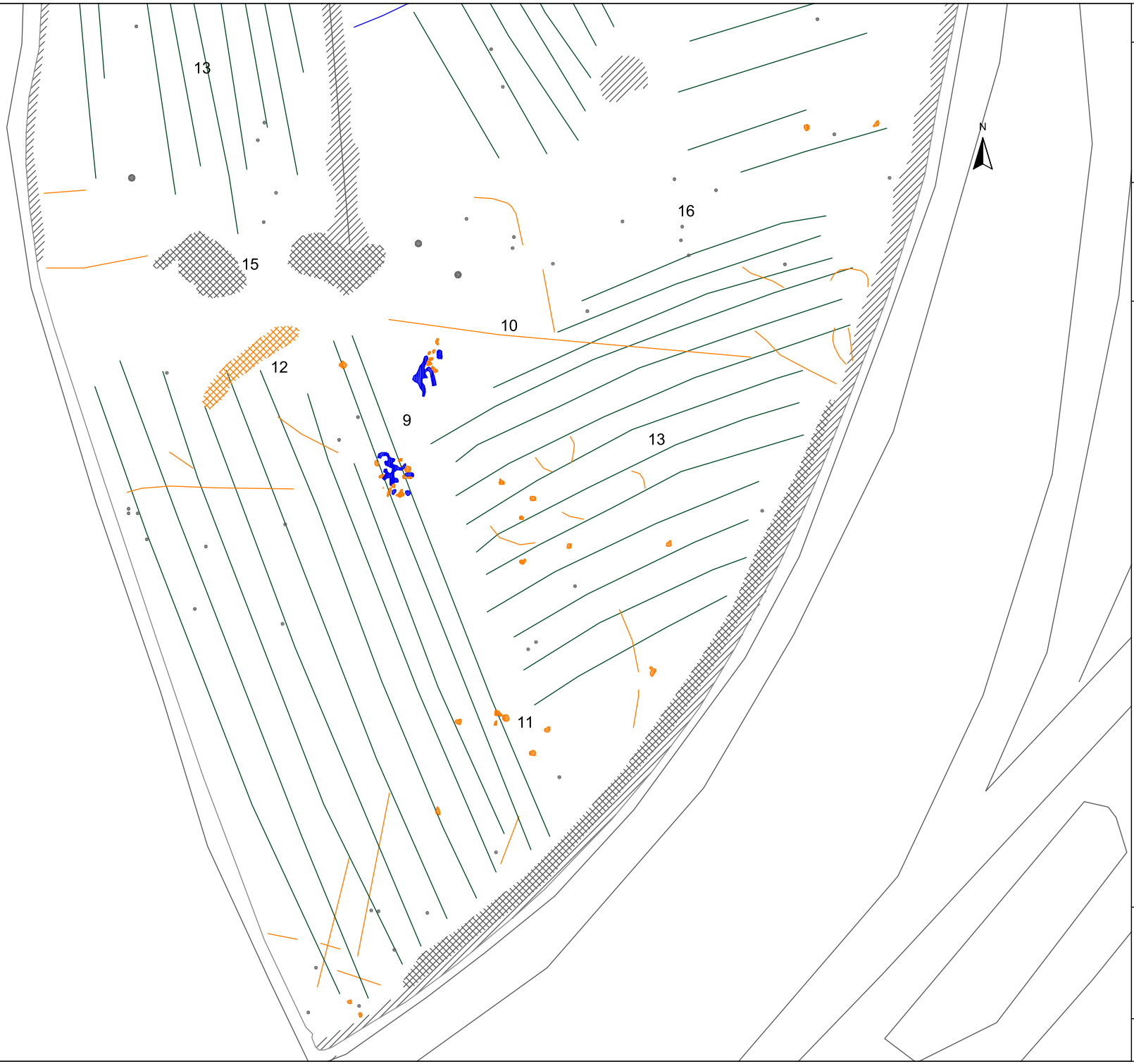
+3nT
-3nT
-3nT
+3nT

SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 07



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Northamptonshire

Abstraction and interpretation of magnetic anomalies - south

- Positive linear anomaly - possible ditch-like feature
- Negative linear anomaly - material of low magnetic susceptibility
- Linear anomaly - ridge and furrow
- Discrete positive response - possible pit-like feature
- Discrete negative response - low magnetic susceptibility (eg stone/subsoil)
- Positive anomaly - magnetically enhanced material
- 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

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 08