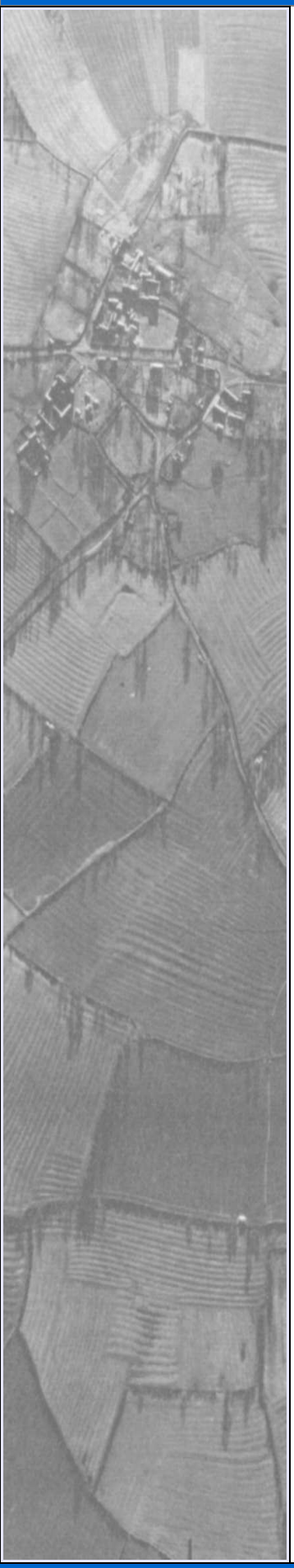

Land off Marshall Road
Devizes
Wiltshire

EARTH RESISTANCE & MAGNETOMETER SURVEY REPORT

for

Cotswold Archaeology

Kerry Donaldson & David Sabin

May 2017

Ref. no. J713

ARCHAEOLOGICAL SURVEYS LTD

Land off Marshall Road
Devizes
Wiltshire

Earth Resistance & Magnetometer Survey Report

for

Cotswold Archaeology

Fieldwork by David Sabin & Kerry Donaldson
Report by Kerry Donaldson BSc (Hons) and David Sabin BSc (Hons) MIFA

Survey dates – 5th, 6th, 28th April & 2nd May 2017
Ordnance Survey Grid Reference – **SU 01322 60175**

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SUMMARY

A geophysical survey was carried out by Archaeological Surveys Ltd on land off Marshall Road, Devizes. The underlying Upper Greensand geology and overlying soils can be poor for magnetometry so earth resistance survey (resistivity) was considered as the primary technique supplemented by magnetometry to support the interpretation and to compare and contrast results. The earth resistance survey indicated high resistance curvilinear anomalies in the north eastern part of the site and a broad high resistance rectilinear response further south that may in part have been truncated by ridge and furrow. The former ridge and furrow cultivation can be seen as a series of parallel linear responses in the resistivity. The magnetometry results revealed another series of parallel linear responses of agricultural origin on a slightly different orientation and probably of more recent date. There are also a number of positive linear and discrete responses with some possibly truncated by agricultural activity. Modern activity on the site was also encountered with anomalies relating to informal footpaths, visible within both datasets, and zones of magnetic debris around the field margins, which may have obscured weaker anomalies.

1 INTRODUCTION

1.1 Survey background

1.1.1 Archaeological Surveys Ltd was commissioned by Cotswold Archaeology to undertake a resistivity survey of an area of land off Marshall Road, Devizes, Wiltshire. An additional magnetometer survey was also undertaken across the site. The site has been outlined for the proposed development of a new urgent care centre and residential area adjacent to the newly constructed NHS Treatment Centre (Planning application no. 16/12285/OUT). The survey forms part of an archaeological assessment of the site.

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

1.1.3 Due to the underlying Upper Greensand geology earth resistance survey (resistivity) was considered potentially to be the most effective technique. Previous magnetometry surveys on similar geology in the vicinity of the site, and within the Vale of Pewsey, have been associated with poor results (see 1.5.3). However, magnetometry was also conducted over the site in order to test the efficacy of the technique and compare and contrast the results with the resistivity.

1.1.4 A trial was conducted using both the Geoscan RM85 earth resistance meter in

twin probe array configuration and with the MSP25 Mobile Sensor Platform in order to ascertain which configuration was most suitable. The twin probe array produced the best response and the survey was completed using that configuration.

1.2 Survey objectives and techniques

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

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

1.3 Site location, description and survey conditions

1.3.1 The site is located to the north of Marshall Road, on the southern edge of Devizes in Wiltshire. It is centred on Ordnance Survey National Grid Reference (OS NGR) SU 01322 60175, see Figs 01 and 02.

1.3.2 The geophysical survey covers approximately 2ha within a single field that contained a rough grass cover. The newly constructed NHS Treatment Centre is located immediately to the east of the survey area and is separated from the site by new hedgerows. The north eastern boundary is defined by the former GWR Berks and Hants Extension railway line with residential dwellings to the north and north west. The southern edge of the site is separated from Marshall Way by dilapidated fencing.

1.3.3 During the initial trial survey it was clear that the site was frequently used by dog walkers, runners, cyclists, etc. and several unofficial tracks had been created across the area. Due to health and safety considerations related to the use of trailing cables and ropes necessary for the resistivity survey, the site was subsequently closed off to the public by Heras fencing arranged by Cotswold Archaeology. This allowed for an unimpeded resistivity survey to be carried out without risk to the public, surveyors and equipment.

1.3.4 The ground conditions across the site were generally considered to be favourable for the collection of magnetometry and resistivity data. However, weather conditions during the survey were fine and dry and with prolonged spells of generally dry weather for weeks prior to the survey, combined with the sandy nature of the soil, ground contact problems were encountered when carrying out resistivity survey.

Plate 1: Survey area looking west

1.4 Site history and archaeological potential

1.4.1 An archaeological desk-based assessment has been carried out for the site (WYG, 2016). It outlines that the current survey area lies immediate west of an Iron Age and Romano-British settlement at Wayside Farm (MWI8685/8725). Later Iron Age and early Romano-British activity was confined to the northern part of the Wayside Farm site and included a cluster of storage pits and an east-west trackway with flanking ditches. Later Romano-British deposits from the 4th and 5th centuries comprised an extensive midden, a large pit and at least three inhumation burials. There was also evidence for structural remains associated with burnt material, possibly indicating ovens (Valentin & Robinson, 2002). Further Romano-British remains have been located 570m to the north (MWI74679 & 74680).

1.4.2 Immediately to the west of the survey area is the location of the former Wiltshire County Asylum, and Ordnance Survey mapping from the 1920s indicates the location of an associated Isolation Hospital the curtilage of which appears to extend into the northern part of the site. The dismantled GWR Berks and Hants Extension line (1862-1966) forms the north eastern boundary to the site.

1.4.3 The location of the Iron Age and Romano-British site immediately to the east indicates that there may be potential for the site to contain associated archaeological features.

1.4.4 Small patches of soil were observed during the course of the survey. The

presence of small fragments of ash and brick and generally a grey colour to the soil would tend to suggest frequent spreading of waste material for 'soil conditioning'. The material is likely to have originated from the nearby town or the County Lunatic Asylum a short distance to the west of the site, the latter containing an engine house for the generation of electricity from the late 19th century. The material is likely to exist in the topsoil only and is not considered archaeologically significant, although may well be associated with some magnetic anomalies and general background 'noise'.

1.5 Geology and soils

1.5.1 The underlying geology is Upper Greensand (BGS, 2017).

1.5.2 The overlying soil across the site is from the Ardington association and is a typical argillic brown earth. It consists of a deep, well drained, fine and coarse, loamy, glauconitic soil (Soil Survey of England and Wales, 1983).

1.5.3 Magnetic surveys carried out on the Upper Greensand in the Marden area have shown poor results with magnetometry and increased detail with resistivity (Martin, 2008; Field et al, 2009; Linford et al, 2013; Hardwick & Payne, 2013). The poor magnetic response is associated with the glauconitic soil which has a low magnetic susceptibility and often produces very poor contrast between the fill of cut features and the material into which they are cut. Resistivity has, therefore, been considered to be the most appropriate technique for archaeological prospection for this site.

2 METHODOLOGY

2.1 Technical synopsis

2.1.1 The electrical resistance or resistivity of the soil depends upon the moisture content and distribution within the soil. Buried features such as walls can affect the moisture distribution and are usually more moisture resistant than other features such as the infill of a ditch. A stone wall will generally give a high resistance response and the moisture retentive content of a ditch can give a low resistance response. Localised variations in resistance are measured in ohms (Ω) which is the SI unit for electrical impedance or resistance.

2.1.2 The Twin Probe configuration used in this survey is favoured for archaeological prospection and can give a response to features up to 1m in depth with a mobile probe separation of 0.5m.

2.1.3 Magnetometry survey records localised magnetic fields that can be associated with features formed by human activity. Magnetic susceptibility and magnetic thermoremnance are factors associated with the formation of localised fields.

Additional details are set out below and within Appendix A.

2.1.4 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.

2.1.5 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.

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

2.2 Equipment configuration, data collection and survey detail

2.2.1 The earth resistance survey was carried out using Geoscan Research Ltd RM85 resistance meter using a mobile parallel twin probe array with a 0.5m electrode separation. Data were recorded at 1m intervals along traverses separated by 1m within 40m grids with a zig-zag progression. The instrument was set to filter stray earth currents which can cause errors within the resistance measurements.

2.2.2 The earth resistance survey grids were set out to the Ordnance Survey OSGB36 datum using a Leica GS10 RTK GPS. The GPS is used in conjunction with Leica's SmartNet service, where positional corrections are sent via a mobile telephone link. Positional accuracy of around 10 – 20mm is possible using the system. The instrument is regularly checked against the ETRS89 reference framework using Ordnance Survey ground marker C1ST7784 (Horton).

2.2.3 The detailed magnetic survey was carried out using a SENSYS MAGNETO®MXPDA 5 channel cart-based system. The instrument has 5 fluxgate gradiometers spaced 0.5m apart with readings recorded at 20 Hz. The gradiometers have a range of recording data between 0.1nT and 10,000nT. It is linked to a Leica GS10 RTK GPS with data recorded by SENSYS MAGNETO®MXPDA software on a rugged PDA computer system.

2.2.4 Data are collected along a series of parallel survey transects wherever possible. 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.

2.3 Data processing and presentation

2.3.1 Data logged by the resistance meter are downloaded and processed within both Geoplot and TerraSurveyor software. Raw data are analysed and displayed within the report as well as processed data. The following processing has been carried out on data in this survey:

- raw earth resistance data have been shown with absolute readings of between -54.45Ω and 204.7Ω with visual clipping of 3SD,
- processed data have been data have been “despiked” in order to remove spurious high contact responses in Geoplot, 1 data point in x and y radius, threshold 3SD, mean spike replacement
- processed data have been clipped between 13Ω and 34Ω to enhance any possible archaeological anomalies.

2.3.2 Graphic raster images in Tagged Image Format (.TIF) are initially prepared in TerraSurveyor for the display of the resistivity data. Regardless of survey orientation, data captured along each traverse are displayed and processed by TerraSurveyor from left to right. Prior to displaying against base mapping, raster graphics require a rotation of 145° anticloc kwise to restore north to the top of the image upon insertion into AutoCAD.

2.3.3 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.

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

2.3.5 The minimally processed magnetometer data are collected between limits of ±10000nT and clipped for display at ±5nT. Data are interpolated to a resolution of effectively 0.5m between tracks and 0.15m along each survey track.

2.3.6 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.

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

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

2.3.9 An abstraction and interpretation is also drawn and plotted for all geophysical anomalies located by the survey. Anomalies are abstracted using colour coded points, lines and polygons. All plots are scaled to landscape A3 for paper printing.

2.3.10 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. Where further interpretation is possible, or where a number of possible origins should be considered, more subjective discussion is set out in Section 4.

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

3 RESULTS

3.1 General assessment of survey results - resistivity

3.1.1 The earth resistance survey was carried out over approximately 2ha.

3.1.2 Resistance anomalies located can be generally classified as high and low resistance anomalies of uncertain origin, anomalies associated with

agricultural activity and anomalies associated with modern land use. Anomalies located within each survey area have been numbered and will be outlined in 3.4 below with subsequent discussion in Section 4.

3.2 Statement of data quality and other factors influencing the results - resistivity

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

3.2.2 Numerous resistive 'spikes' were encountered across the site but mainly along the line of tracks or where ground cover was thin. The very high erroneous readings occur due to poor contact between the mobile probes and the ground surface. Although not unusual, contact problems have been caused by the very dry conditions prior to and during the survey, The surface of the sandy soil is prone to rapid drying particularly where there is little or no ground cover. Processing effectively removes the high responses and comparison is made between processed and unprocessed data to ensure that there are no detrimental effects on other anomalies.

3.2.3 Generally the data demonstrate useful resistive contrast and numerous high and low resistance anomalies are present.

3.3 Data interpretation - resistivity

3.3.1 The listing of sub-headings below attempts to define a number of separate categories that reflect the range and type of features located during the earth resistance survey. A basic explanation of the characteristics of the anomalies is set out for each category in order to justify interpretation, a basic key is indicated to allow cross reference to the abstraction and interpretation plot. Sub-headings are then used to group anomalies with similar characteristics within the survey area.

Report sub-heading CAD layer names and plot colour	**Description and origin of anomalies**
Anomalies with an uncertain origin AS-ABST RES HIGH LINEAR UNCERTAIN AS-ABST RES LOW LINEAR UNCERTAIN AS-ABST RES HIGH AREA UNCERTAIN	The category applies to a range of anomalies where there is not enough evidence to confidently suggest an origin. Anomalies in this category may well be related to archaeologically significant features, but equally relatively modern features, geological/pedological features and agricultural features should be considered. High resistance anomalies are indicative of comparatively low moisture and may indicate stone, compacted soil, changes in drainage, etc. Low resistance anomalies are indicative of comparatively high moisture and may relate to the fill of cut features, organic material within the soil, damp areas etc..
Anomalies with an agricultural origin AS-ABST RES RIDGE & FURROW	The anomalies are often linear and form a series of parallel responses or are parallel to extant land boundaries. Where the response is broad, former ridge and furrow is likely; narrow response is often related to modern ploughing. Anomalies associated with land drainage often form distinctive patterns.

Anomalies with a modern origin AS-ABST LOW RES PATH -----	Anomalies relating to existing paths and tracks can be high or low resistance anomalies and relate to visible or mapped paths.

Table 1: List and description of resistivity interpretation categories

3.4 List of anomalies – resistivity

Area centred on OS NGR SU 01322 60175, see Figs 03 - 05.

Anomalies of uncertain origin

(1) - High resistance curvilinear anomalies are located in the north eastern part of the site. They are located close to Iron Age and Romano-British settlement features discovered further to the north east beyond the site boundary. Although a modern origin is possible, an archaeological origin should be considered.

(2) - A low resistance rectilinear anomaly located close to the eastern corner of the site. While it has a similar response to footpaths (8), it does have a rectilinear form and appears to contain a high resistance response. It appears to be orientated at a similar angle to a recently constructed boundary hedge surrounding the new NHS Treatment Centre.

(3) - A rectilinear high resistance response has its north-south axis parallel with ridge and furrow, but the east-west axis appears to have been truncated by the ridge and furrow. It is possible that it relates to a former boundary feature and an archaeological origin should be considered.

(4) - The survey area contains a number of low resistance linear anomalies. Some are oriented north east to south west, slightly different from the ridge and furrow (7). They have a similar response to the footpaths (8), but do not relate to obvious features on the ground.

(5) - A small number of high resistance linear anomalies can be seen within the site. They do not have a coherent morphology or pattern preventing confident interpretation.

(6) - Zones of high resistance response can be seen throughout the survey area. Several are close to the eastern edge of the site but this is bounded by the dismantled railway and a modern origin is possible.

Anomalies with an agricultural origin

(7) - A series of parallel linear anomalies appear to relate to ridge and furrow. They have a slightly different orientation to linear anomalies (14) seen in the magnetometer results.

Anomalies with a modern origin

(8) - A number of low resistance linear anomalies can be seen within the survey area. These relate to informal footpaths.

3.5 General assessment of survey results - magnetometry

3.5.1 The detailed magnetic survey was carried out over approximately 2ha.

3.5.2 Magnetic anomalies located can be generally classified as positive and negative linear anomalies of an uncertain origin, linear anomalies of an agricultural origin, anomalies relating to footpaths, areas of magnetic debris and disturbance, strong discrete dipolar anomalies relating to ferrous objects. Anomalies located within the survey area have been numbered and are described in 3.8 below with subsequent discussion in Section 4.

3.6 Statement of data quality - magnetometry

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

3.6.2 Zones of high magnitude magnetic debris and disturbance occur mainly towards the perimeter of the site and have the potential to obscure or confuse weak anomalies. All parts of the site appear to contain magnetic debris that forms a moderate amount of background 'noise'.

3.6.3 The magnetic data do reveal a number of positive and negative linear anomalies but given the observations of ash and brick mentioned above (1.4.4), it is possible that the majority are shallow and associated with the distribution of relatively modern magnetically thermoremnant material.

3.7 Data interpretation - magnetometry

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

Report sub-heading **CAD layer names and plot colour**	**Description and origin of anomalies**
Anomalies with an uncertain origin AS-ABST MAG POS LINEAR UNCERTAIN	The category applies to a range of anomalies where there is not enough evidence to confidently suggest an origin. Anomalies in this category may well be related to archaeologically significant

AS-ABST MAG NEG LINEAR UNCERTAIN AS-ABST MAG POS DISCRETE UNCERTAIN 	features, but equally relatively modern features, geological/pedological features and agricultural features should be considered. Positive anomalies are indicative of magnetically enhanced soils that may form the fill of 'cut' features or may be produced by accumulation within layers or 'earthwork' features; soils subject to burning may also produce positive anomalies. Negative anomalies are produced by material of comparatively low magnetic susceptibility such as stone and subsoil.
Anomalies with an agricultural origin AS-ABST MAG AGRICULTURAL 	The anomalies are often linear and form a series of parallel responses or are parallel to extant land boundaries. Where the response is broad, former ridge and furrow is likely; narrow response is often related to modern ploughing.
Anomalies associated with magnetic debris AS-ABST MAG DEBRIS AS-ABST MAG STRONG DIPOLAR 	Magnetic debris often appears as areas containing many small dipolar anomalies that may range from weak to very strong in magnitude. It often occurs where there has been dumping or ground make-up and is related to magnetically thermoremnant materials such as brick or tile or other small fragments of ferrous material. This type of response is occasionally associated with kilns, furnace structures, or hearths and may therefore be archaeologically significant. It is also possible that the response may be caused by natural material such as certain gravels and fragments of igneous or metamorphic rock. Strong discrete dipolar anomalies are responses to ferrous objects within the topsoil.
Anomalies with a modern origin AS-ABST MAG DISTURBANCE AS-ABST MAG PATH 	The magnetic response is often strong and dipolar indicative of ferrous material and may be associated with extant above surface features such as wire fencing, cables, pylons etc.. Often a significant area around such features has a strong magnetic flux which may create magnetic disturbance; such disturbance can effectively obscure low magnitude anomalies if they are present. Fluxgate sensors may respond erratically and with hysteresis adjacent to strong magnetic sources. Negative or positive linear anomalies associated with visible or mapped paths and tracks.

Table 2: List and description of interpretation categories

3.8 List of anomalies – magnetometry

Area centred on OS NGR SU 01322 60175, see Figs 06 & 07.

Anomalies with an uncertain origin

(9) - A negative and parallel positive curvilinear anomaly is located in the eastern part of the site. It is located adjacent to high resistance curvilinear anomalies (1).

(10) - Just to the north of anomaly (9) is a positive anomaly, with another fragmented positive linear to the west. The responses may indicate cut features, and the fragmentation appears to be caused by later agricultural activity.

(11) - A positive linear anomaly in the eastern part of the site appears to correspond to part of the low resistance rectilinear response (11). While an association with a footpath is possible, a cut, ditch-like feature should also be considered.

(12) - Located in the north western part of the survey area are a number of short positive linear and discrete responses. This zone contains widespread magnetic debris and appears to have been located within the curtilage of the Isolation Hospital and the anomalies may be associated with this.

(13) - A positive linear anomaly appears to have been truncated by agricultural activity. It is possible that it relates to a cut feature.

Anomalies with an agricultural origin

(14) - A series of parallel positive and negative linear anomalies can be seen throughout the survey area. They are at a slightly different orientation to resistance anomalies (7) which appear to relate to ridge and furrow. These linear responses could indicate a different series of ridge and furrow, or cultivation of strip fields, or be associated with land drainage.

Anomalies associated with magnetic debris

(15) - Zones of magnetic debris are located at the edges of the site, with a linear zone extending through the centre of the low resistance rectilinear anomaly (2) at the eastern edge of the site. The response indicates ferrous and other magnetically thermoremnant waste material. Zones in the north western corner of the survey area have not been abstracted in order not to obscure other anomalies.

Anomalies with a modern origin

(16) - Linear anomalies within the site relate to informal footpaths and correspond to low resistance anomalies (8).

4 DISCUSSION

4.1.1 Resistivity and magnetometry were conducted in order to gain a complimentary data set. The Upper Greensand geology and overlying soils in the Devizes and Pewsey Vale can be poor to variable for magnetic prospection, with more favourable results often produced by resistivity. The results demonstrate some correlation between anomalies but also a number of different anomalies were located by the two techniques.

4.1.2 In the area closest to the Iron Age and Romano-British settlement site, located immediately to the east of the dismantled railway, a number of high resistance curvilinear anomalies (1) have been located. They lie close to a positive and parallel negative curvilinear anomaly (9) seen in the magnetometry data; however, it is not possible to confidently determine their origin. A low resistance rectilinear response is located to the south, but it is parallel with a new hedgerow and a zone of magnetic debris extends through it.

4.1.3 The magnetometer results demonstrate the presence of a number of positive linear and discrete anomalies in the northern part of the site (12); however, magnetic debris along the margins of the field has partially obscured the weaker anomalies. It is possible that anomalies within this part of the site relate to the former Isolation Hospital that was located immediately north but the curtilage of which extended through the northern part of the survey area.

4.1.4 The resistivity survey has located a broad high resistance rectilinear anomaly (3) which appears partly to be associated with former ridge and furrow but also may have been truncated by it. It is possible that the response is to a former land boundary, but this is uncertain. The high resistance response could indicate a former bank.

5 CONCLUSION

5.1.1 The geophysical survey comprised resistivity and magnetometry within the site. The results of the resistivity demonstrate the presence of a number of high resistance curvilinear responses towards the north eastern edge of the site and a broad high resistance response that may be partly truncated by ridge and furrow. Other anomalies include a series of ridge and furrow and a low resistance rectilinear anomaly that is parallel with a modern hedgerow just to the south. Modern informal footpaths can also be seen in the data.

5.1.2 The magnetometry results have revealed a number of positive linear anomalies, some of which appear to have been truncated by agricultural activity, which may relate to cut, ditch-like features. A weak curvilinear anomaly was also located in the vicinity of the high resistance curvilinear anomalies noted above.

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Appendix A – basic principles of magnetic survey

Iron minerals are always present to some degree within the topsoil and enhancement associated with human activity is related to increases in the level of magnetic susceptibility and thermoremnant material.

Magnetic susceptibility is an induced magnetism within a material when it is in the presence of a magnetic field. This can be thought of as effectively permanent due to the presence of the Earth's magnetic field.

Thermoremnant magnetism occurs when ferrous material is heated beyond a specific temperature known as the Curie Point. Demagnetisation occurs at this temperature with re-magnetisation by the Earth's magnetic field upon cooling.

Enhancement of magnetic susceptibility can occur in areas subject to burning and complex fermentation processes on biological material; these are frequently associated with human settlement. Thermoremnant features include ovens, hearths, and kilns. In addition thermoremnant material such as tile and brick may also be associated with human activity and settlement.

Silting and deliberate infilling of ditches and pits with magnetically enhanced soil can create an area of enhancement compared with surrounding soils and subsoils into which the feature is cut. Mapping enhanced areas will produce linear and discrete anomalies allowing an assessment and characterisation of hidden subsurface features.

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

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

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

Appendix B – basic principles of earth resistance survey (resistivity)

Earth resistance survey, commonly known as resistivity, relies on the variability of conduction of current through soil and the subsurface matrix. The variability relates to the distribution of moisture within different materials so that porous features, such as foundations, produce a relatively high resistance response and more moisture retentive soil, such as found within the fill of a former ditch, produces a low resistance measurement. The technique is, therefore, influenced by climatic factors although the success of a survey can be difficult to predict based on these alone. Soil type, ground use, vegetative cover and the nature of buried features and subsoil are all factors that will influence the outcome of a survey.

The technique involves inputting a small electrical current into the ground and measuring subtle variations to the current at regular intervals across an area. The current input and measurement requires a series of probes to be inserted into the ground and the configuration of these can influence the resolution of resistive anomalies and the depth of response. Research has demonstrated that the twin electrode configuration is one of the most useful for archaeological prospection. It requires a mobile frame with two electrodes separated usually by 0.5m and a pair of remote probes linked to the logging instrument using a long cable.

Cart-based systems are also regularly used in archaeological prospection, and generally these require four spiked wheels to inject current into the ground and take measurements. The four wheels act as a square array which can be electronically switched to change the orientation of measurement and current input. Two or three readings are rapidly logged at each recording station and these are referred to as alpha, beta and gamma. The gamma is often not recorded as this represents the difference between the alpha and beta configurations and can be derived during data processing. The alpha and beta datasets often demonstrate subtle differences that relate to the orientation of subsurface features and both are analysed as part of the abstraction and interpretation process. Advantages of cart systems are speed and resolution and they do not require a trailing cable; however, ground conditions are more critical and problems can be encountered with ground cover and in areas that are excessively damp or dry.

When using the twin probe configuration a useful reading interval for archaeological prospection across an area is 1m. Data are logged at 1m centres along traverses separated by 1m. Where areas contain known archaeological features 0.5m x 0.5m or 1m x 0.5 readings are considered more informative. Data collected by cart-based systems is typically at 0.25m centres along traverses separated by 1m.

Appendix C – 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.

Edge Match

Calculates the mean of the 2 lines (rows or columns) of data either side of the edge to match. It then subtracts the difference between the means from all datapoints in the selected area.

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.

Zero Median/Mean Traverse

The median (or mean) of each traverse is calculated ignoring data outside a threshold value, the median (or mean) is then subtracted from the traverse. The process is used to equalise slight differences between the set-up and stability of gradiometer sensors and can remove striping. The process can remove archaeological features that run along a traverse so data analysis is also carried out prior its application.

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

Appendix D – survey and data information

Magnetometer data

Filename: J713-mag.xcp
Description: Imported as Composite from: J713-mag.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 30U
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 401201.2688816, 160307.132039154 m
Southeast corner: 401422.6688816, 160102.382039154 m
Collection Method: Randomised
Sensors: 5
Dummy Value: 32702

Source GPS Points: 596100

Dimensions
Composite Size (readings): 1476 x 1365
Survey Size (meters): 221 m x 205 m
Grid Size: 221 m x 205 m
X Interval: 0.15 m
Y Interval: 0.15 m

Stats
Max: 5.53
Min: -5.50
Std Dev: 2.27
Mean: -0.05
Median: 0.01
Composite Area: 4.5332 ha

Surveyed Area: 2.0434 ha

PROGRAM
Name: TerraSurveyor
Version: 3.0.23.0

Processes: 1
1 Base Layer

GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 DeStripe Median Traverse:
4 Clip from -5.00 to 5.00 nT

Raw resistivity data

Filename: J713-res.xcp
Description: Imported as Composite from GeoPlot : J713-res
Instrument Type: Resist. (RM85P)
Units: ohm
Collection Method: Zig-zag
Sensors: 4
Dummy Value: 2047.5
Dimensions
Composite Size (readings): 200 x 240
Survey Size (meters): 200 m x 240 m
Grid Size: 40 m x 40 m
X Interval: 1 m
Y Interval: 1 m

Stats
Max: 34.00
Min: 13.00
Std Dev: 4.03
Mean: 22.91
Median: 22.75
Composite Area: 4.8 ha
Surveyed Area: 1.9816 ha
Processes: 2
1 Base Layer
2 Clip from 13.00 to 34.00 ohm

Processed resistivity data

Filename: J713-res-proc.xcp
Description: Imported as Composite from GeoPlot : J713-res-proc
Stats
Max: 34.00
Min: 13.00
Std Dev: 3.81
Mean: 22.74
Median: 22.70
Composite Area: 4.8 ha
Surveyed Area: 1.9816 ha

Processes: 4
1 Base Layer
2 Clip from 10.00 to 39.00 ohm
3 Clip from 13.00 to 34.00 ohm
4 Despike Threshold 3SD Window size 1x1

Appendix E – digital archive

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

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

Geophysical data - path: J713 Devizes\Data				
Path and Filename	**Software**	**Description**	**Date**	**Creator**
Res\comps\J713-res.xcp	TerraSurveyor 3.0.23.0	Composite data file	02/05/17	D.J.Sabin
Res\comps\J713-res-proc.xcp	TerraSurveyor 3.0.23.0	Processed composite data file	02/05/17	D.J.Sabin
Mag\devizesnhs\MX\.dgb, .disp,.prm	Sensys MXPDA	Proprietary data formats representing magnetometer survey traverses logged to a PDA.	06/04/17	D.J.Sabin
devizesnhs1\MX\J713-mag.asc	Sensys DLMGPS	ASCII CSV (tab) file representing survey area in eastings, northings (UTM Z30N), magnetic measurement, traverse file and sensor number.	06/04/17	D.J.Sabin
Mag\comps\J713-mag.xcp	TerraSurveyor 3.0.23.0	Composite data file derived from ASCII CSV.	06/04/17	D.J.Sabin
Mag\comps\J713mag-proc.xcp	TerraSurveyor 3.0.23.0	Processed composite data file (zmt and clipping to ±5nT).	06/04/17	D.J.Sabin
Graphic data - path: J713 Devizes Data				
Res\graphics\ J713-res-raw.tif	TerraSurveyor 3.0.23.0	TIF file showing a raw greyscale plot clipped to 3SD	04/05/17	D.J.Sabin
Res\graphics\ J713-res-proc.tif	TerraSurveyor 3.0.23.0	TIF file showing a processed greyscale plot, high pass filtered and clipped to 3SD	04/05/17	D.J.Sabin
Mag\graphics\J713mag-proc.tif	TerraSurveyor 3.0.23.0	TIF file showing a minimally processed greyscale plot clipped to ±5nT.	06/04/17	D.J.Sabin
Mag\graphics\J713mag-proc.tfw	TerraSurveyor 3.0.23.0	World file for georeferencing TIF to OSGB36.	06/04/17	D.J.Sabin
CAD data - path: J713 Devizes\CAD				
J713 version 2.dwg	ProgeCAD 2014	CAD file for creating plots of greyscales, abstraction, interpretation and mapping. Grid coordinates as OSGB. AutoCAD 2010 format.	06/04/17	K.T.Donaldson
Text data - path: J713 Devizes\Documentation				
J713 report.odt	OpenOffice.org 3.0.1 Writer	Report text as an Open Office document.	04/05/17	K.T.Donaldson

Appendix F – copyright and intellectual property

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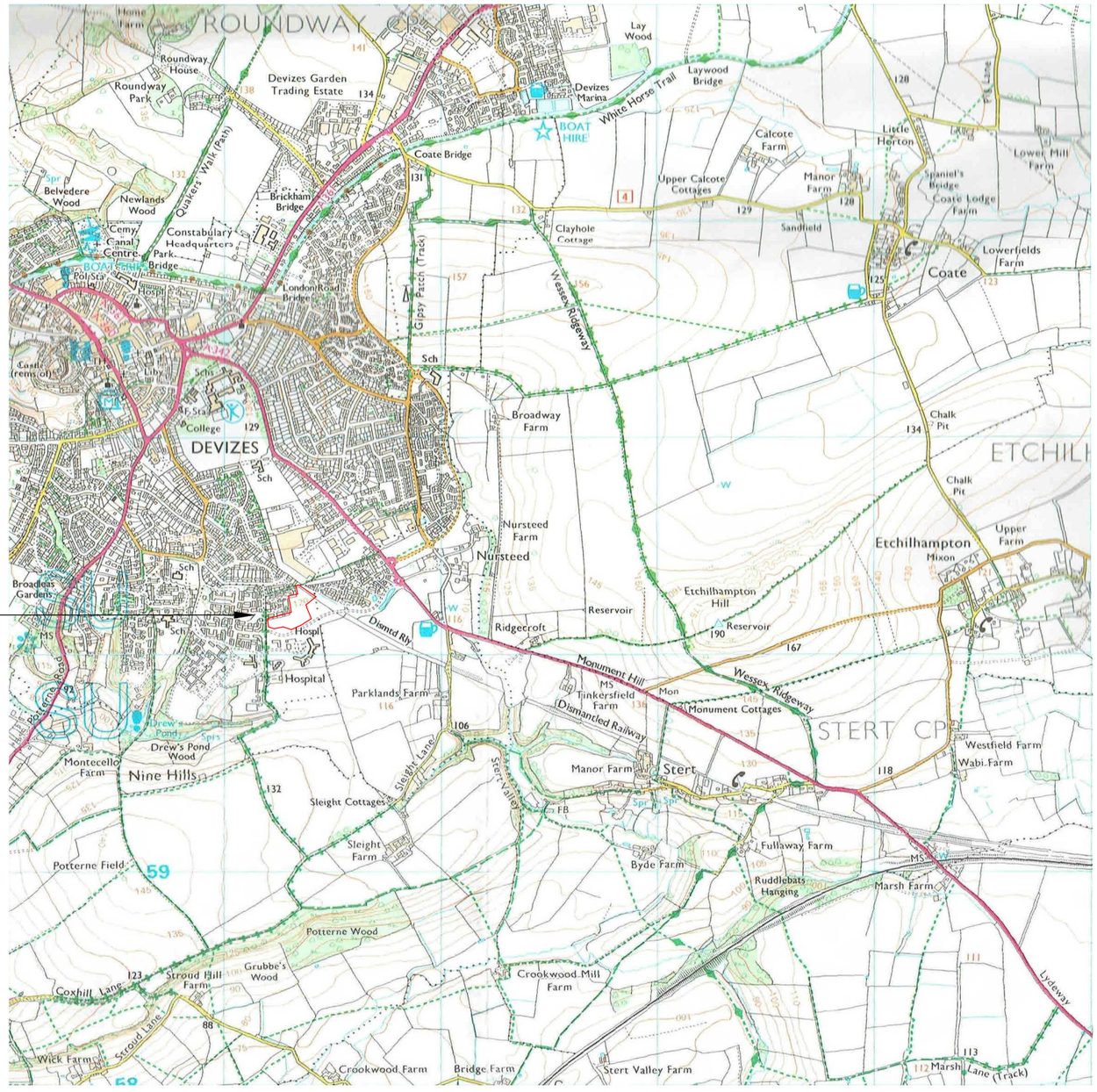
Survey location



N

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Geophysical Survey
Land off Marshall Road
Devizes
Wiltshire

Map of survey area

● Survey location

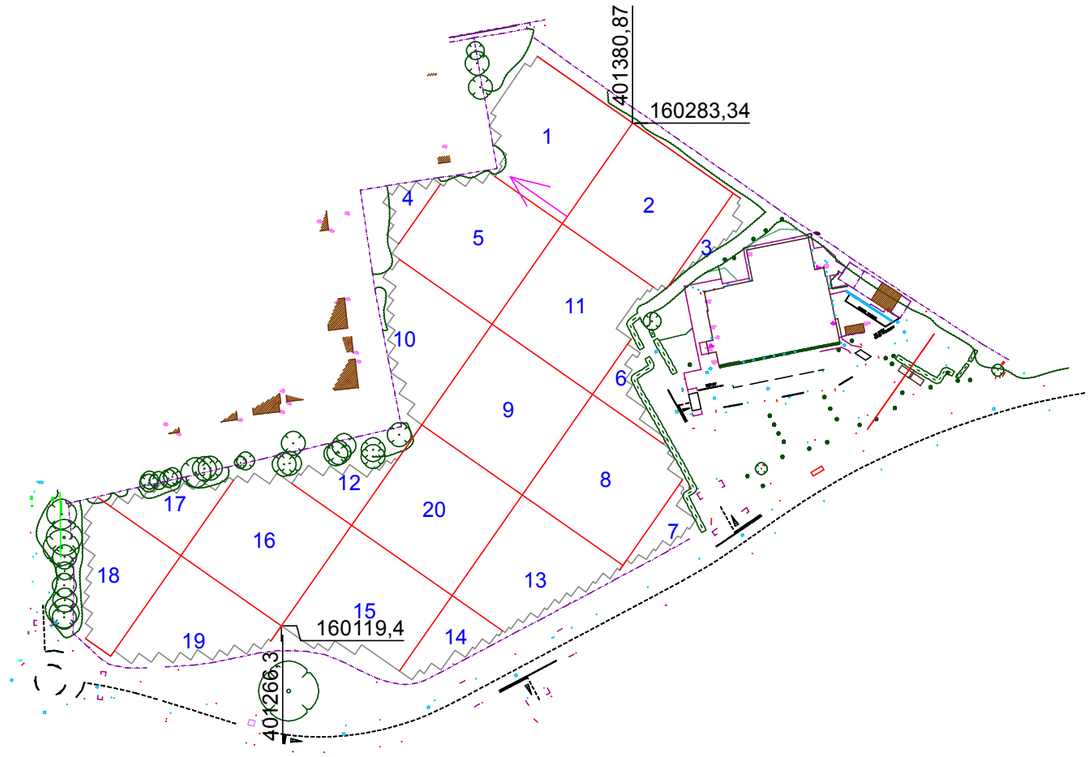
Site centred on OS NGR
SU 01322 60175

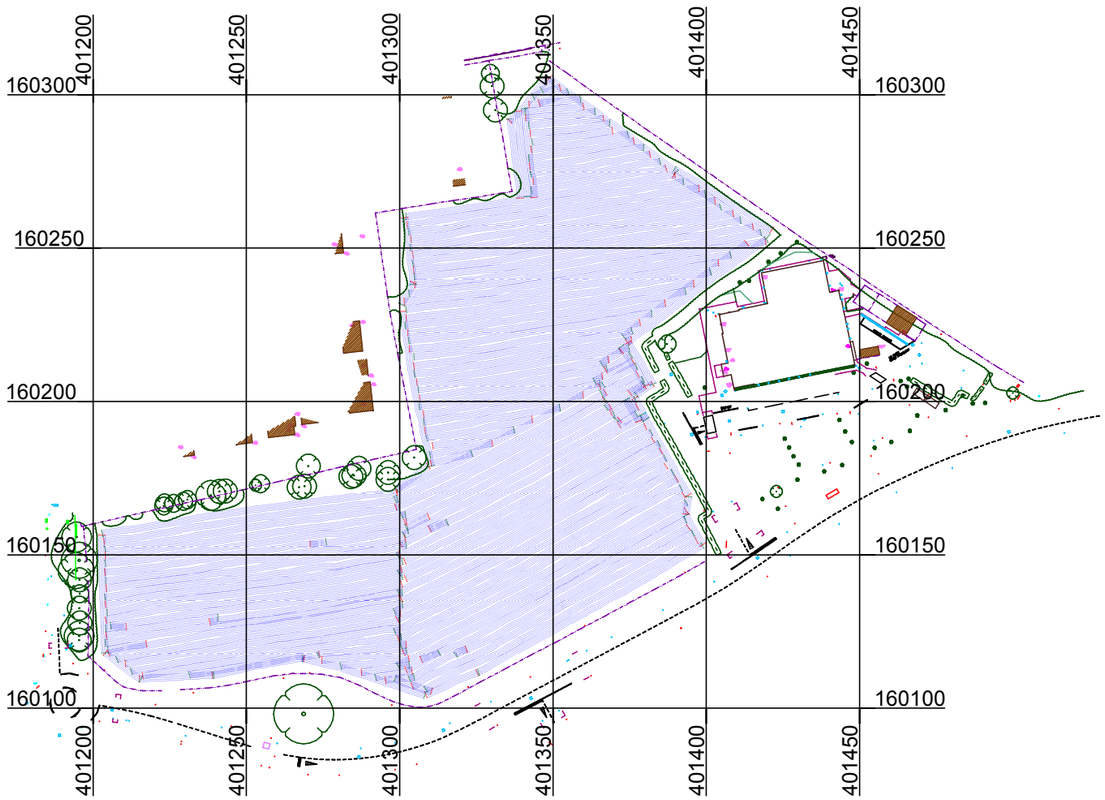
SCALE 1:25 000

0m 500m 1000m

SCALE TRUE AT A3

FIG 01





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Devizes
Wiltshire

Referencing information

Resistivity survey grid size = 40m

Survey start and traverse direction

1 Grid reference number and filename

Survey carried out at 1.0m centres along 1.0m traverses.

Grid coordinates based on Ordnance Survey OSGB36 datum. Grids set out using RTK GPS with Leica SmartNet correction data RTCMv2 format OSTN02 transformation

Magnetometry referencing grid to OSGB36 datum at 50m intervals

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

Survey tracks

Survey track start

Survey track stop

SCALE 1:2000

0m 20 40 60 80 100m

SCALE TRUE AT A3

FIG 02

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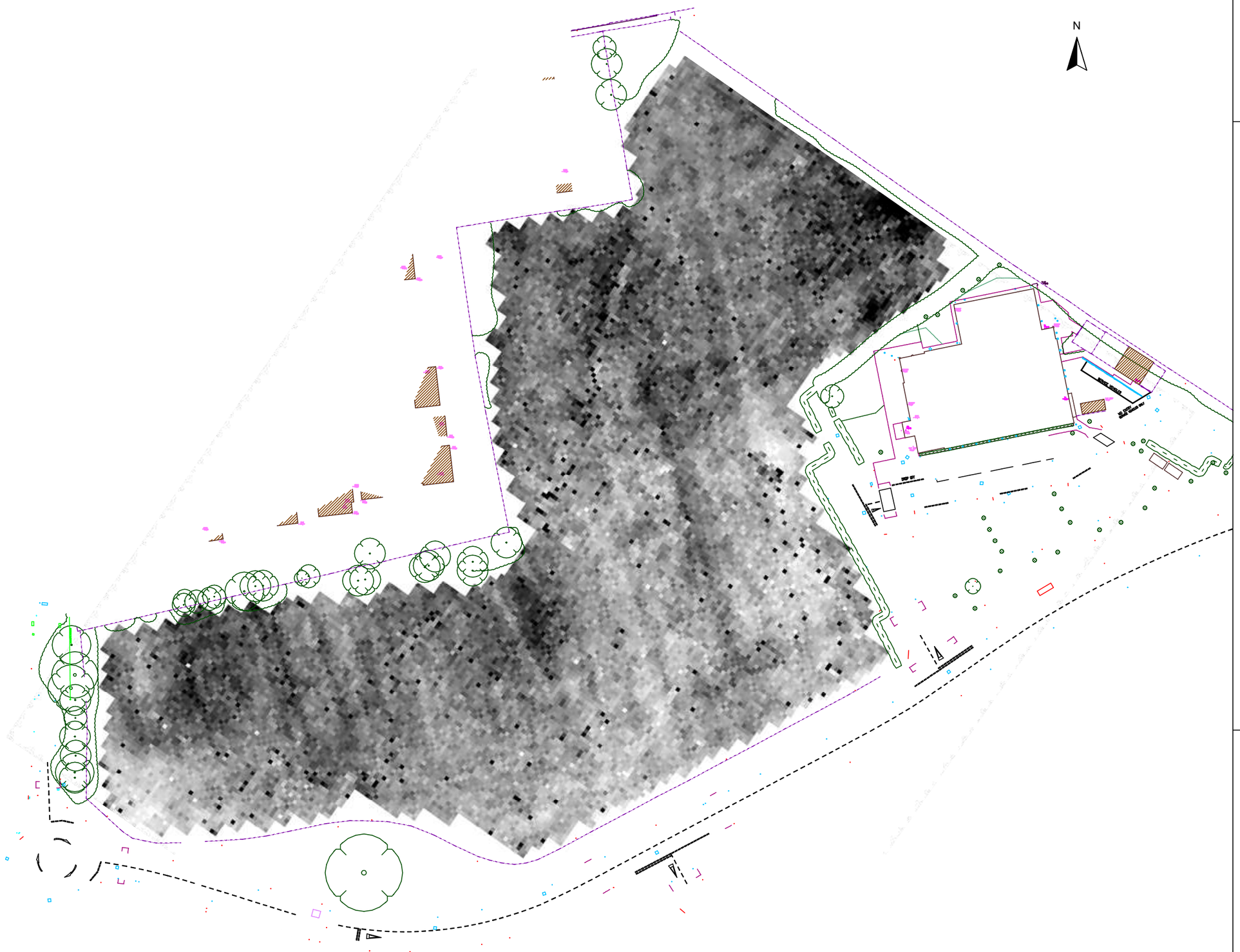
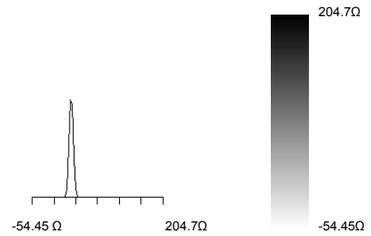
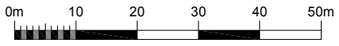


Greyscale plot of raw resistance data



SCALE 1:1000



SCALE TRUE AT A3

FIG 03

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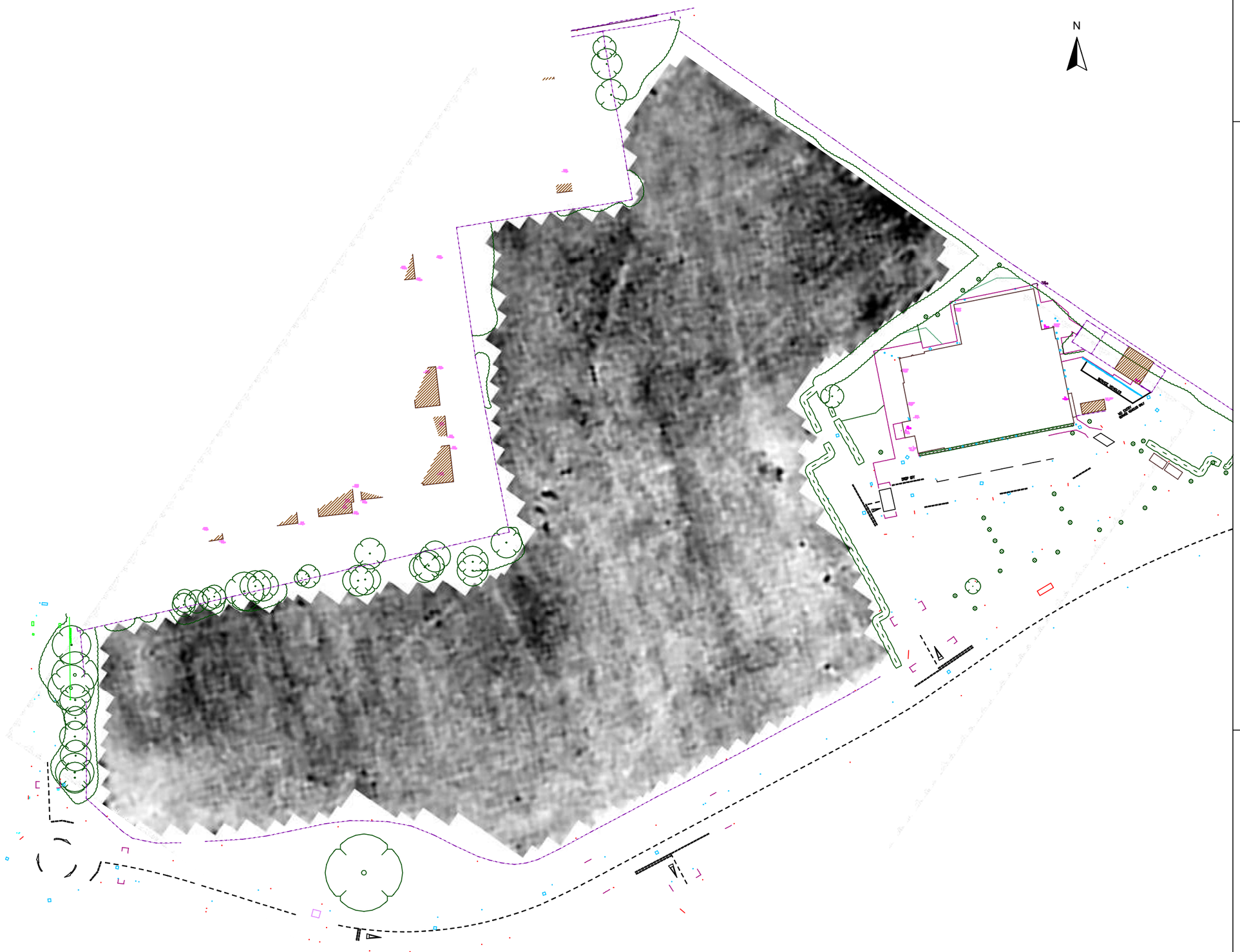
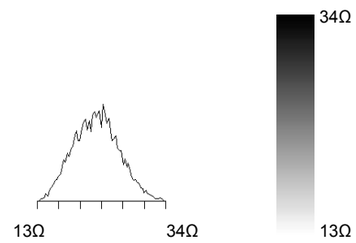


Greyscale plot of processed resistance data



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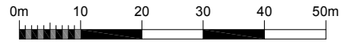

SCALE TRUE AT A3

FIG 04

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Abstraction and interpretation of resistance anomalies

- High resistance linear anomaly - of uncertain origin
- Low resistance linear anomaly - of uncertain origin
- High resistance linear anomaly - ridge & furrow
- Low resistance linear anomaly - footpaths
- Area of high resistance - of uncertain origin

SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

FIG 05

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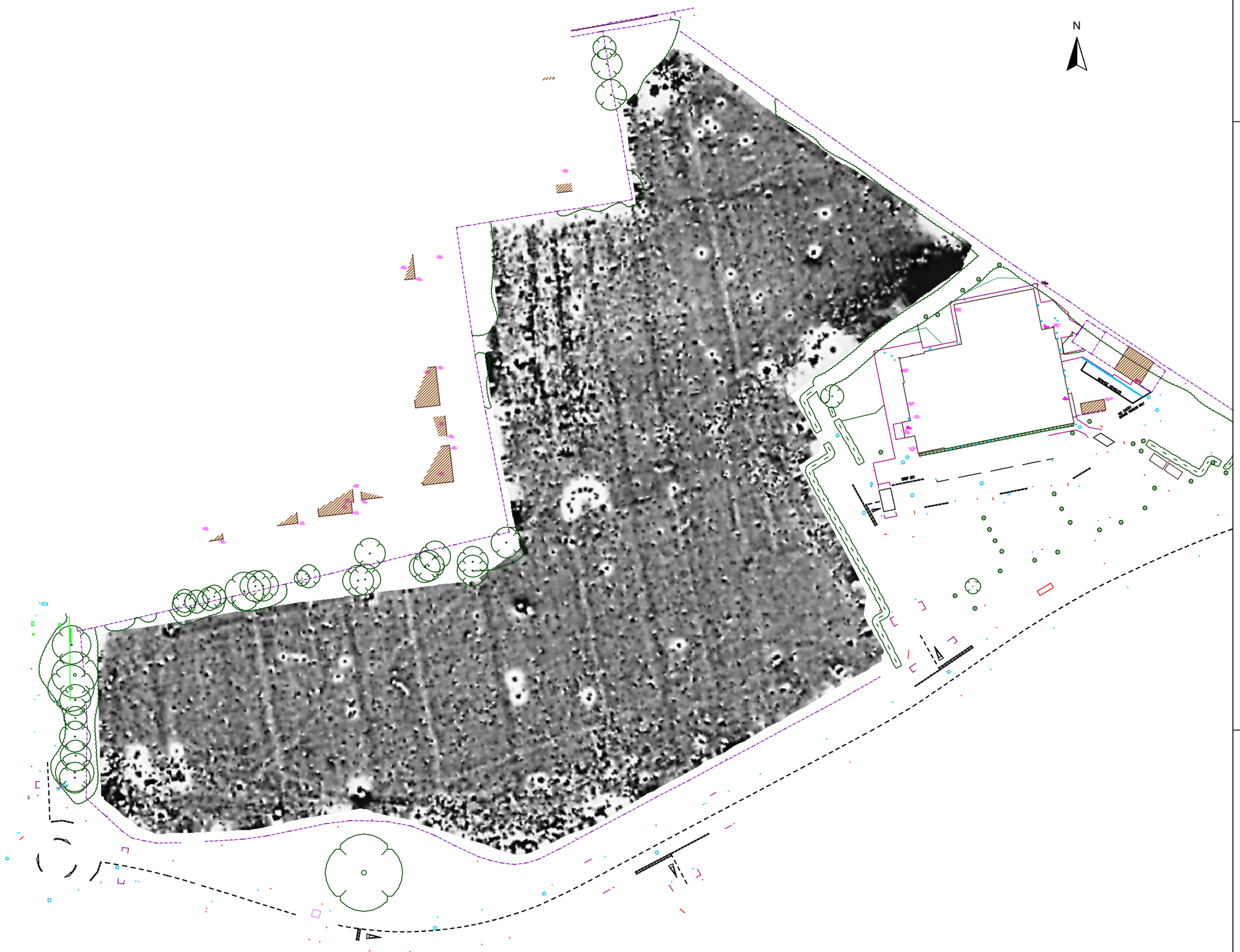
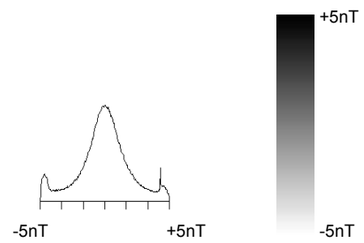
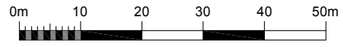


Greyscale plot of processed magnetometer data



SCALE 1:1000



SCALE TRUE AT A3

FIG 06

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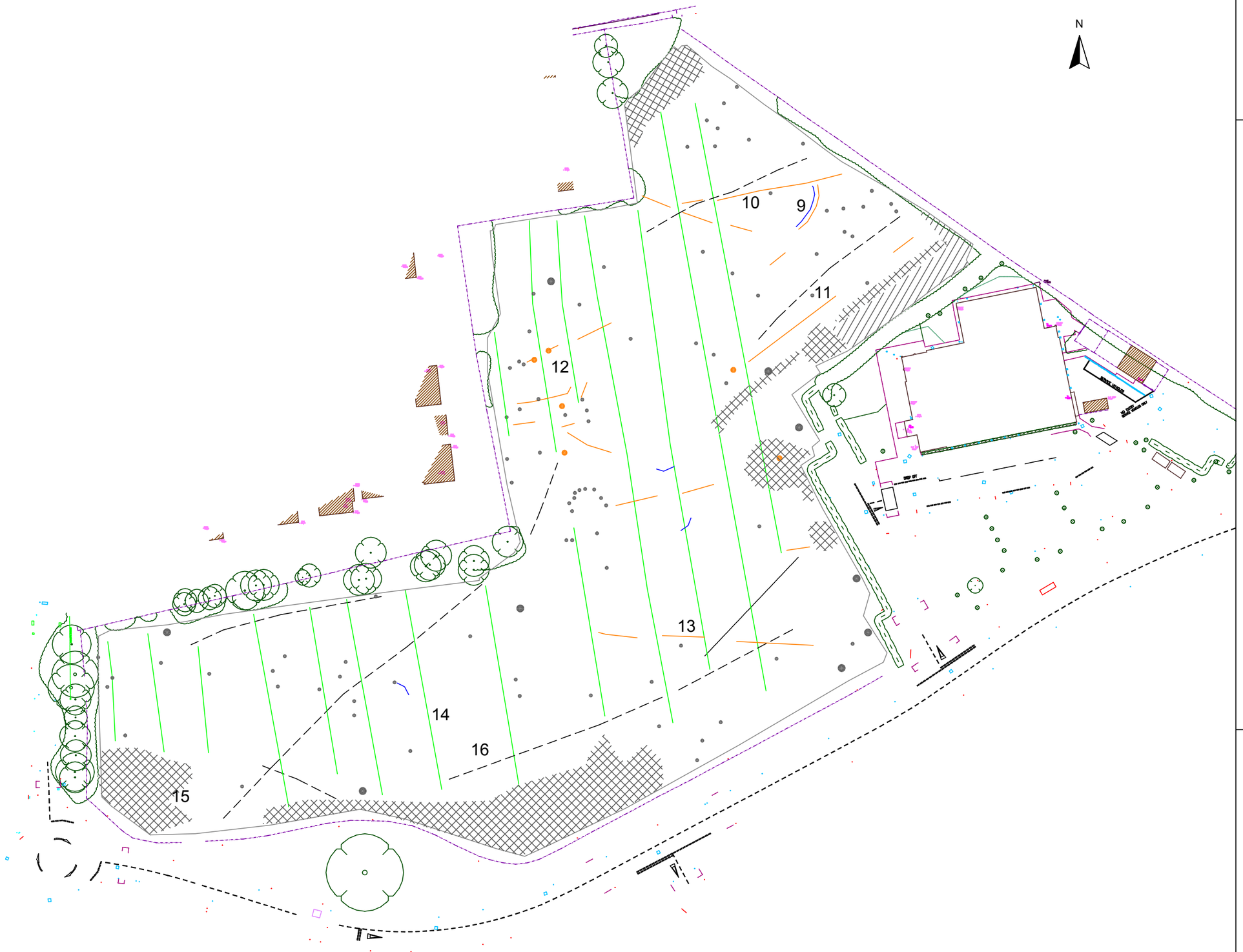
Abstraction and interpretation of magnetic anomalies



- Positive linear anomaly - possible ditch-like feature
- Negative linear anomaly - material of low magnetic susceptibility
- Negative linear anomaly - footpath
- Linear anomaly - of agricultural origin
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Magnetic disturbance from ferrous material
- Strong dipolar anomaly - ferrous object

SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

FIG 07

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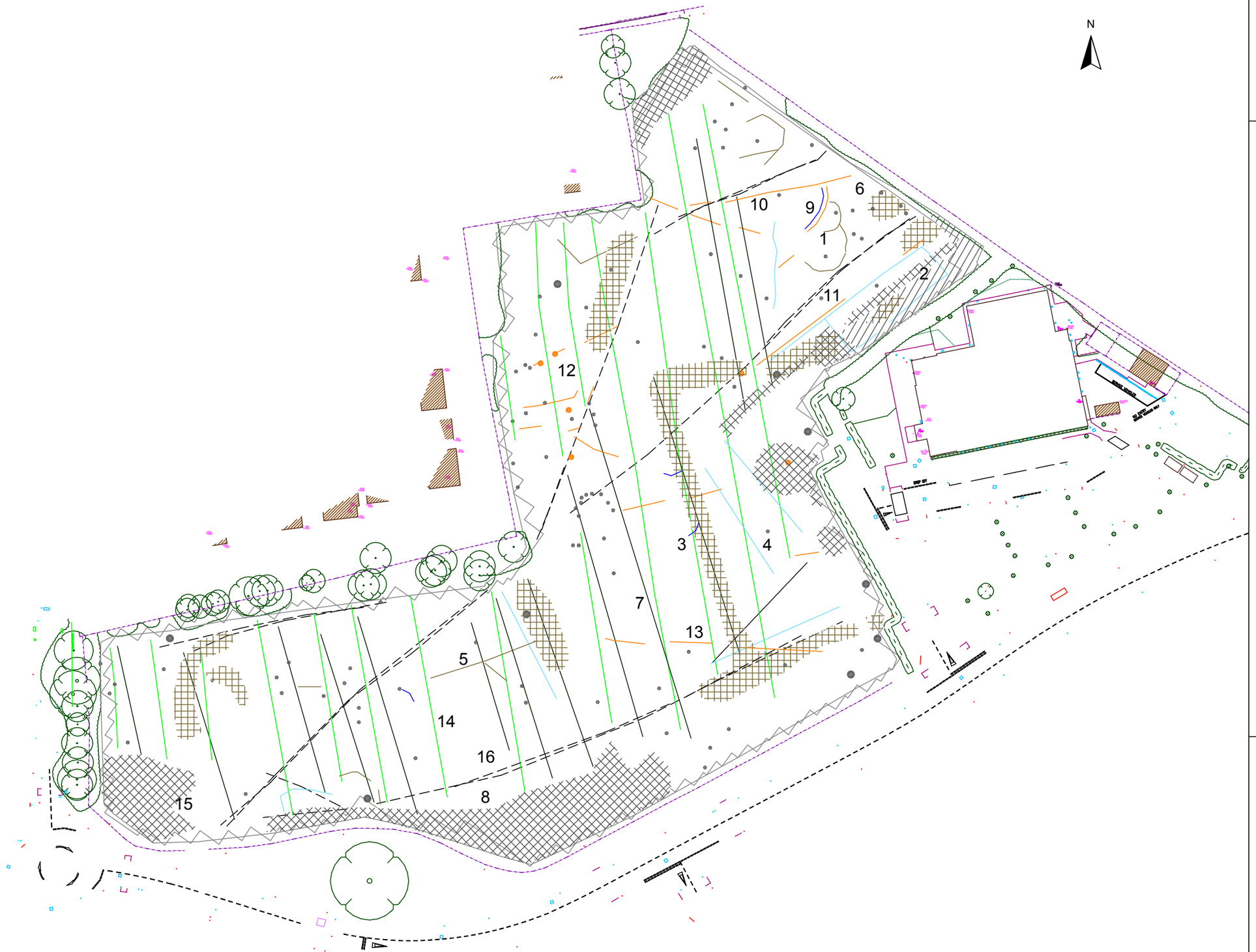

Abstraction and interpretation of resistance & magnetic anomalies

- High resistance linear anomaly - of uncertain origin
- Low resistance linear anomaly - of uncertain origin
- High resistance linear anomaly - ridge & furrow
- Low resistance linear anomaly - footpaths
- Area of high resistance - of uncertain origin
- Positive linear anomaly - possible ditch-like feature
- Negative linear anomaly - material of low magnetic susceptibility
- Negative linear anomaly - footpath
- Linear anomaly - of agricultural origin
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Magnetic disturbance from ferrous material
- Strong dipolar anomaly - ferrous object

SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

FIG 08