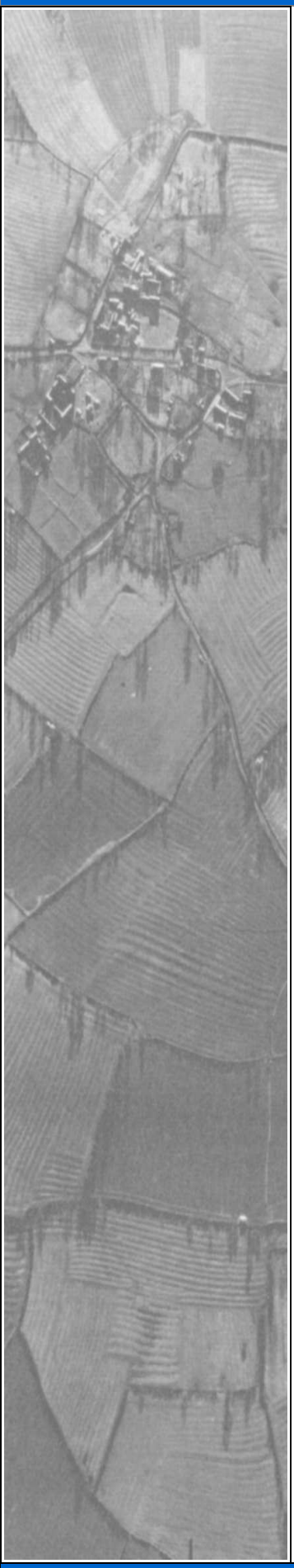

Land off Burwood Lane / Caddywell Lane
Great Torrington
Devon

MAGNETOMETER SURVEY REPORT

for

Beechcroft Land Ltd

Kerry Donaldson & David Sabin

January 2017

Ref. no. J702

OASIS ID: archaeol20-276842

ARCHAEOLOGICAL SURVEYS LTD

Land off Burwood Lane / Caddywell Lane
Great Torrington
Devon

Magnetometer Survey Report

for

Beechcroft Land Ltd

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

Survey dates – 16th to 18th January 2017
Ordnance Survey Grid Reference – **SS 50430 19015**

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SUMMARY

A geophysical survey, comprising detailed magnetometry, was carried out within three fields at Great Torrington, Devon, by Archaeological Surveys Ltd. The results indicate the presence of a large rectilinear enclosure in the easternmost field (Site C), with a large number of what appears to be natural features and a number of linear and discrete responses that could have an anthropogenic origin. Within the western and central fields (Sites A & B) anomalies relate to former land boundaries and also several sets of land drains within Site B that are generally contained within the confines of the former field boundaries. There are several positive linear and discrete responses, but they do not have a characteristic form or pattern preventing confident interpretation.

1 INTRODUCTION

1.1 Survey background

1.1.1 Archaeological Surveys Ltd was commissioned by Beechcroft Land Ltd to undertake a magnetometer survey of an area of land off Burwood Lane and Caddywell Lane, Great Torrington, Devon. The site has been outlined for a proposed residential development and 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). This considers the requirements of a Specification for Archaeological Geophysical Survey set out by Devon County Council Historic Environment Team (DCCHET, 2015). The WSI was approved by Stephen Reed, Senior Historic Environment Officer for Devon County Council, 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 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 on the south eastern edge of Great Torrington in north Devon. It is centred on Ordnance Survey National Grid Reference (OS NGR) SS 50430 19015, see Figs 01 and 02.

1.3.2 The geophysical survey covers approximately 8.5ha split within three separate fields, labelled Site A in the west, Site B in the centre and Site C in the east. Sites A and C contained a young cereal crop, while Site B was under pasture.

Plate 1: Site A looking west

Plate 2: Site B (foreground) and Site C (background) looking east

1.3.3 Site A is generally flat, although the northern part of the field slopes down towards the north. The soil was wet during the survey, although traversing was not impeded. Site B contains a shallow depression in the south western part of the field that deepens rapidly, beyond the south eastern boundary, to form a steep-sided combe. Two inspection chambers and a water trough are located

at the north eastern end of the field. Site C is located across land that slopes down towards the south west from an elevated flat area at near the northern corner of the field. The soil was drier and appeared more stony than that encountered in arable Area A.

1.3.4 The ground conditions across the site were generally considered to be favourable for the collection of magnetometry data. Weather conditions during the survey were mainly fine.

1.4 Site history and archaeological potential

1.4.1 The site has not been subject to archaeological fieldwork and so there is limited evidence for heritage assets within the site. There are flintwork finds in the wider vicinity including two Neolithic axes located 1.1km west of the site. Also within the wider vicinity there is evidence for medieval settlement, including Great Torrington mentioned in Domesday as *Torictun*, with a Norman castle established after the conquest and sited approximately 280m to the west of the site. Early mapping shows that the central (Site B) and western fields (Site A) were each sub-divided into three fields in the late 19th century, with the central field becoming one field by 1904 and the western field in the late 20th century. The easternmost field (Site C) lies within a block that has been identified by the Devon Historic Landscape Characterisation as enclosures of late medieval date. The central and western fields are characterised as modern fields created out of probable medieval enclosures. The western field lies within an area referred to as Caddywell Park in medieval records, but which may suggest a park or arable enclosure (Archaeological Landscape Investigation, 2015).

1.4.2 The Civil War Battle of Torrington took place in 1646 with the Parliamentarians approaching from the east and defeating the Royalist army. Although there are no direct records mentioning the site or fieldwalking finds, it is possible that skirmishes could have taken place within the survey area. However, this type of transient activity is unlikely to result in geophysical anomalies that can be attributed to the Civil War battle.

1.4.3 Although there are no known sites or findspots within the survey area, this could be due to the lack of fieldwork and it is always possible for the survey to locate geophysical anomalies that relate to previously unrecorded archaeological features, should they exist within the site. Evidence for previously recorded field boundaries is also likely as well as possible agricultural activity.

1.4.4 The surface conditions within Site A and Site C were suitable for the observation of cultural material during the course of the survey. No significant material was noted within Site C; however, a widespread scatter of medieval pottery sherds was observed within Site A. The material included a wide range of fabrics and sherds that appeared abraded and small suggesting the scatter may relate to manuring. In addition, Site A contains many small fragments of

modern plastic waste which is often associated with recent spreading of 'green compost' material. Sites subject to spreading of this organic material are often inadvertently contaminated with ferrous fragments, see 3.2.3 below. Close to the northern field boundary there was also evidence of some localised dumping or infill probably dating to the 19th/20th centuries.

1.5 Geology and soils

1.5.1 The underlying solid geology across the site is Carboniferous Sandstone from the Bude formation with overlying River Terrace deposits in the northern part of Site A and all of Site B. The very north eastern edge of the site is mudstone and siltstone from the Bude Formation (BGS, 2017).

1.5.2 The overlying soil across the majority of the survey area is from the Neath association and is a typical brown earth. It consists of a well drained, fine, loamy soil often over rock. The southern and south western parts of the site have soil from the Manod association which is a typical brown podzol that is well drained, fine, loamy or silty soil over rock (Soil Survey of England and Wales, 1983).

1.5.3 Magnetometry carried out over similar geology and soil has produced good results. The site is, therefore, considered suitable for magnetic survey.

2 METHODOLOGY

2.1 Technical synopsis

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

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

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

2.1.4 The localised variations in magnetism are measured as sub-units of the Tesla, which is a SI unit of magnetic flux density. These sub-units are nano Teslas (nT),

which are equivalent to 10^{-9} Tesla (T).

2.2 Equipment configuration, data collection and survey detail

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

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

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

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

2.3 Data processing and presentation

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

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

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

2.3.3 The minimally processed data are collected between limits of ±10000nT and clipped for display at ±10nT for Sites A & C and ±5nT for Site B. 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 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.

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

2.3.7 An abstraction and interpretation is 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.

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

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

3 RESULTS

3.1 General assessment of survey results

3.1.1 The detailed magnetic survey was carried out over a total of three survey areas covering approximately 8.5ha.

3.1.2 Magnetic anomalies located can be generally classified as positive rectilinear responses of archaeological potential, positive and negative anomalies of an uncertain origin, anomalies associated with land management, linear anomalies of an agricultural origin, areas of magnetic debris and disturbance, strong discrete dipolar anomalies relating to ferrous objects and anomalies with a possible natural origin.

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

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

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

3.2.2 The soils and underlying geology appear to support strong magnetic contrast producing clear anomalies associated with former cut features. However, as a consequence, the cultivated land is associated with linear anomalies of agricultural origin that have the potential to confuse or obscure other features. In addition, Site C also has evidence of widespread linear and rectilinear anomalies that are related to formations within the shallow solid geology; these can easily be confused with anomalies of anthropogenic origin and it can be impossible to confidently separate the two. The abstraction and interpretation of anomalies within this area necessarily contains a degree of caution and uncertainty.

3.2.3 Moderately high levels of magnetic debris were encountered with Site A. Observations of small plastic fragments within the soil may be indicative of the recent use of green composted material that may in part be responsible for the magnetic debris. It is known from many other sites across the UK that the

composted material is contaminated with ferrous fragments as well as plastics, although the latter tend to give a useful visual indicator that this type of compost has been used. The magnetic debris may also relate to the close proximity of the field to the core of the town and, as a consequence, it has been a convenient area for waste material from the medieval period. In recent years a re-enactment of the Battle of Torrington was held within the field which could also account for some magnetic debris.

3.3 Data interpretation

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

Report sub-heading CAD layer names and plot colour	**Description and origin of anomalies**
Anomalies with archaeological potential AS-ABST MAG POS ENCLOSURE DITCH	Anomalies have the characteristics (mainly morphological) of a an archaeological feature indicating a former enclosure ditch.
Anomalies with an uncertain origin AS-ABST MAG POS LINEAR UNCERTAIN AS-ABST MAG NEG LINEAR UNCERTAIN AS-ABST MAG POS DISCRETE UNCERTAIN AS-ABST MAG POS UNCERTAIN	The category applies to a range of anomalies where there is not enough evidence to confidently suggest an origin. Anomalies in this category may well be related to archaeologically significant features, but equally relatively modern features, geological/pedological features and agricultural features should be considered. Positive anomalies are indicative of magnetically enhanced soils that may form the fill of 'cut' features or may be produced by accumulation within layers or 'earthwork' features; soils subject to burning may also produce positive anomalies. Negative anomalies are produced by material of comparatively low magnetic susceptibility such as stone and subsoil.
Anomalies relating to land management AS-ABST MAG BOUNDARY AS-ABST MAG LAND DRAIN	Anomalies are mainly linear and may be indicative of the magnetically enhanced fill of cut features (i.e. ditches). The anomalies may be long and/or form rectilinear elements and they may relate to topographic features or be visible on early mapping. Associated agricultural anomalies (e.g. headlands, plough marks and former ridge and furrow) may support the interpretation. Land drains can appear in a classic herringbone pattern of interconnected multiple dipolar linear anomalies, or as parallel linear anomalies. The multiple dipolar response indicates a ceramic land drain.
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 	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.
Anomalies with a possible natural origin AS-ABST MAG NATURAL FEATURES	Naturally formed magnetic anomalies are are caused by localised variability in the magnetic susceptibility of soils, subsoils and other drift or solid geologies. Anomalies may be amorphous, linear or curvilinear and may appear 'fluvial' or discrete; the latter are almost impossible to distinguished from pit-like anomalies with an anthropogenic origin. Fluvial, glacial and periglacial processes may be responsible for their formation within drift material and subsoil. Igneous and metamorphic activity can lead to anomalies within more solid geology.

Table 1: List and description of interpretation categories

3.4 List of anomalies - Site A

Area centred on OS NGR 250175 118960, see Figs 05 & 06.

Anomalies with an uncertain origin

(1) - The survey area contains a number of discrete positive responses. These appear to relate to pit-like features; however, they are widespread and do not appear to be associated with other features. While they may be caused by anthropogenic activity, a natural origin is possible.

(2) - A small number of positive linear and curvilinear anomalies. They lack a coherent morphology preventing confident interpretation. Although a natural origin is possible, anthropogenic features should also be considered.

(3) - Several linear bands of positive and negative linear anomalies extend across the survey area with an approximately east-west orientation. Natural variations within the underlying geology are a possible cause, although former agricultural activity or land division is also possible.

Anomalies associated with land management

(4, 5 & 6) - Positive linear anomalies relating to field boundaries (4 & 5) which were mapped between at least 1843 and 1953, but removed by 1969. Anomaly (6) is unmapped, and indicates a field boundary removed prior to 1843.

Anomalies associated with magnetic debris

(7) - Within the centre of the survey area, centred on field boundary (4) and lying between (5 & 6) is a narrow zone of magnetic debris. Although this may be modern in origin, the position centred on the former field boundaries may indicate that it is associated. This type of response often indicates dumped ferrous and magnetically thermoremnant material, such as brick or tile.

(8) - The entire survey area contains widespread strong, discrete, dipolar anomalies, too numerous to abstract in full. This is likely to be as a result of spreading of magnetically contaminated material during the process of manuring. A re-enactment of the Battle of Torrington has also been held within the field, which may also have contributed to the magnetic contamination.

Anomalies with a modern origin

(9) - A very strongly magnetic response is located close to the north eastern corner of the survey area. Its origin is uncertain but dumped material is possible.

3.5 List of anomalies - Site B

Area centred on OS NGR 250400 119005, see Figs 07 & 08.

Anomalies with an uncertain origin

(10) - A number of positive responses appear to extend towards anomaly (14). This relates to a ditch and former boundary within the field, and it is possible that they are associated although ditch-like cut features is also possible.

(11) - Positive linear anomalies parallel with former boundary (13). They may be associated or relate to agricultural activity.

(12) - The survey area contains a number of positive linear and negative linear anomalies with no coherent form or pattern. While it is possible that they relate to cut features, an association with agriculture or land drainage is possible.

Anomalies associated with land management

(13 & 14) - Formerly mapped as field boundaries until the early 20th century. Anomaly (14) follows the line of a natural hollow and continues southwards as a steep combe.

(15) - The survey area contains a number of different sets of land drainage systems. Several are confined by the former field boundaries (13 & 14), possibly indicating that they date to at least the 19th century. The response may indicate that they are constructed from stone.

3.6 List of anomalies - Site C

Area centred on OS NGR 250690 119080, see Figs 09 & 10.

Anomalies of archaeological potential

(16) - A positive rectilinear anomaly appears to relate to a large rectilinear enclosure ditch. It also appears to have deliberate gaps or entrances on the northern side and close to the north eastern corner, with another smaller possible gap facing towards the north west. It is not clear if it contains any associated features due to the presence of numerous natural soil filled cracks within the entire field (19).

Anomalies with an uncertain origin

(17) - A number of discrete pit-like responses are located both within and externally to the enclosure (16). Some have a very strong response of over 100nT, indicating an association with burning. It is not possible to determine if these relate to archaeological features, natural features or modern features.

(18) - A number of positive linear anomalies have a more linear form than the majority of anomalies (19) which appear to be of natural origin. It is not possible to determine if these relate to further natural features, or if they have an anthropogenic origin.

Anomalies with a possible natural origin

(19) - The survey area contains numerous and widespread positive linear anomalies. While they often have a curvilinear or rectilinear form, they appear to relate to an increased depth of topsoil within joints and cracks within the underlying geology. Several pit-like responses are also evident, and they have a similar response to the linear anomalies and so may also relate to natural features.

4 DISCUSSION

4.1.1 Site A contains a number of former field boundaries some of which are mapped on the 1843 Great Torrington tithe map. It shows the site split into three fields, which relate to the northern part of anomaly (4) and anomaly (5). The survey, however, shows anomaly (4) extending south westwards, and also an additional field boundary (6) which has not been mapped, but which is parallel with anomaly (5). Other broad linear anomalies cross this survey area, and while they may relate to natural bands within the underlying geology, an association with agricultural activity or possible former land divisions is possible.

4.1.2 Site B also contains evidence for boundary features mapped in the 19th century and also several sets of land drainage systems generally contained within these former boundaries indicating that they may at least date from the 19th century. Other linear anomalies can be seen within the survey area, but they lack a clear and coherent morphology preventing confident interpretation.

4.1.3 Within Site C the magnetometry has revealed a large rectilinear enclosure

feature (16) with apparent gaps or entrances. The response varies along its length, 10-15nT along the western edge, 15-30nT along the northern section and over 30nT in the north east and east, with the strongest responses close to the gaps or entrances. This may be a result of an increased depth of topsoil within a substantial ditch, but the strength may also indicate that it contains burnt material. There are a small number of strongly magnetic discrete responses (17) both within and outside of the enclosure, and while these may have an association with burning, their age or origin cannot be determined. There are a large number of what appear to be natural features across the entire field but other archaeological features within the enclosure are not readily apparent in the data. There are a number of positive linear anomalies within the survey area which may also relate to natural features; however, their morphology may indicate that they relate to cut, ditch-like features.

4.1.4 An Ordnance Survey drawing by John Hewitt in 1804 depicts a field boundary in the western part of the Site C, possibly on a similar orientation to the south western edge of the enclosure ditch, although the position of the field boundary is not clear against modern mapping. While it is possible that the former field boundary is associated with the enclosure, the morphology and layout of the enclosure indicates that it is likely to pre-date the current and previously mapped field boundaries.

5 CONCLUSION

5.1.1 The results of the detailed magnetometer survey have revealed a previously unrecorded rectilinear enclosure in the easternmost part of the site (Site C). No other obviously archaeological features can be seen within the confines of the enclosure or external to it, but a number of strongly magnetic discrete responses and several linear anomalies are located within the field. While the majority of the responses appear to relate to naturally formed soil filled features within the underlying geology, several of the discrete and linear responses could have an anthropogenic origin and have been highlighted as uncertain in origin.

5.1.2 Within the western and central survey areas (Sites A & B), the majority of the anomalies relate to land management in the form of field boundaries and also several sets of land drainage systems contained within the former field boundaries within Site B. These survey areas also contain a small number of positive linear and discrete anomalies which lack a coherent morphology preventing confident interpretation.

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Appendix A – basic principles of magnetic survey

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

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

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

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

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

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

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

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

Appendix B – data processing notes

Clipping

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

Zero (destripe) Median/Mean Traverse

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

High Pass Filtering

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

Low Pass Filtering

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

Appendix C – survey and data information

Site A

Filename: J702-mag-SiteA.xcp
Description: Imported as Composite from: J702-mag-Area3.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 30U
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 250044.964739464, 119079.181584514 m
Southeast corner: 250310.164739464, 118843.681584514 m
Collection Method: Randomised
Sensors: 5
Dummy Value: 32702

Source GPS Points: 1023900

Dimensions
Composite Size (readings): 1768 x 1570
Survey Size (meters): 265 m x 236 m
Grid Size: 265 m x 236 m
X Interval: 0.15 m
Y Interval: 0.15 m

Stats
Max: 11.05
Min: -11.00
Std Dev: 4.30
Mean: 0.10
Median: 0.04
Composite Area: 6.2455 ha
Surveyed Area: 3.6597 ha

PROGRAM
Name: TerraSurveyor
Version: 3.0.23.0

Processes: 1
1 Base Layer

GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (to OSGB36).
3 DeStripe Median Traverse:
4 Clip from -10.00 to 10.00 nT

Site B

Filename: J702-mag-SiteB.xcp
Description: Imported as Composite from: J702-mag-Area2.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 30U
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 250277.533437375, 119108.034763723 m
Southeast corner: 250520.083437375, 118902.234763723 m
Collection Method: Randomised
Sensors: 5
Dummy Value: 32702

Source GPS Points: 631900

Dimensions
Composite Size (readings): 1617 x 1372
Survey Size (meters): 243 m x 206 m
Grid Size: 243 m x 206 m
X Interval: 0.15 m
Y Interval: 0.15 m

Stats
Max: 5.53
Min: -5.50
Std Dev: 1.75
Mean: 0.05
Median: -0.01
Composite Area: 4.9917 ha
Surveyed Area: 2.4854 ha

Processes: 1
1 Base Layer

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

Site C

Filename: J702-mag-SiteC.xcp
Description: Imported as Composite from: J702-mag-Area1.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 30U
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 250558.194020191, 119173.344103844 m
Southeast corner: 250802.394020191, 119013.144103844 m
Collection Method: Randomised
Sensors: 5
Dummy Value: 32702

Source GPS Points: 595600

Dimensions
Composite Size (readings): 1628 x 1068
Survey Size (meters): 244 m x 160 m
Grid Size: 244 m x 160 m
X Interval: 0.15 m
Y Interval: 0.15 m

Stats
Max: 11.05
Min: -11.00
Std Dev: 4.25
Mean: 0.10
Median: -0.01
Composite Area: 3.9121 ha
Surveyed Area: 2.1936 ha

Processes: 1
1 Base Layer

GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (to OSGB36).
3 DeStripe Median Traverse:
4 Clip from -10.00 to 10.00 nT

Appendix D – digital archive

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

In order to comply with the Specification for Archaeological Geophysical Survey set out by the Devon Historic Environment Team the geophysical data will be archived with the Archaeology Data Service (ADS) in their acceptable formats and carried out with regard to the ADS guides (Schmidt, 2013). A PDF copy will also be uploaded to the Online AccesS to the Index of archaeological investigationS (OASIS) and it is understood that the Devon Historic Environment Team will download the report on the understanding that it will in future be made available to researchers via a web-based version of the Historic Environment Record.

Archive contents:

Geophysical data - path: J702_Great_Torrington_geophysics				
Path and Filename	**Software**	**Description**	**Date**	**Creator**
J702_Great_Torrington_mag_raw .zip Zipped file contains J702_mag_SiteA.csv, J702_mag_SiteB.csv J702_mag_SiteC.csv	Sensys DLMGPS	ASCII CSV (tab) file representing survey areas in eastings, northings (UTM Z30N), magnetic measurement, traverse file and sensor number. Zipped file contains J702_mag_SiteA.csv, J702_mag_SiteB.csv & J702_mag_SiteC.csv	19/01/17	K.T.Donaldson
J702_Great_Torrington_mag _proc.zip	TerraSurveyor 3.0.23.0	Composite data file derived from ASCII CSV for minimally processed composite (zmt and clipping to ±5nT for Site B and ±10nT for Sites A & C). Zipped file contains J702_mag_SiteA_proc.csv, J702_mag_SiteB_proc.csv & J702_mag_SiteC_proc.csv	26/01/17	K.T.Donaldson
J702_Great_Torrington_geophysics_metadata.ods	OpenOffice.4.1.1 Calc	ADS spreadsheet for geophysics metadata	24/01/17	K.T.Donaldson
Graphic data - path: J702_Great_Torrington_GIS				
J702_mag _proc_images.zip Zipped file contains J702_mag_SiteA_proc.tif J702_mag_SiteB_proc.tif J702_mag_SiteC_proc.tif J702_mag_SiteA_proc.tfw J702_mag_SiteB_proc.tfw J702_mag_SiteC_proc.tfw	TerraSurveyor 3.0.23.0	Zipped TIF file showing a minimally processed greyscale plot clipped to ±5nT for Site B and ±10nT for Sites A & C World file for georeferencing TIF to OSGB36.	26/01/17	K.T.Donaldson
J702_gis_metadata	OpenOffice.4.1.1 Calc	ADS spreadsheet for graphic TIF metadata	26/01/17	K.T.Donaldson
CAD data - path: J702_Great_Torrington_CAD				
J702_Great_Torrington_CAD.dwg	ProgeCAD 2016	CAD file for creating plots of greyscales, abstraction, interpretation and mapping. Grid coordinates as OSGB. AutoCAD 2010 format.	27/01/17	K.T.Donaldson
J702_CAD_metadata	OpenOffice.4.1.1 Calc	ADS spreadsheet for CAD metadata	27/01/17	K.T.Donaldson

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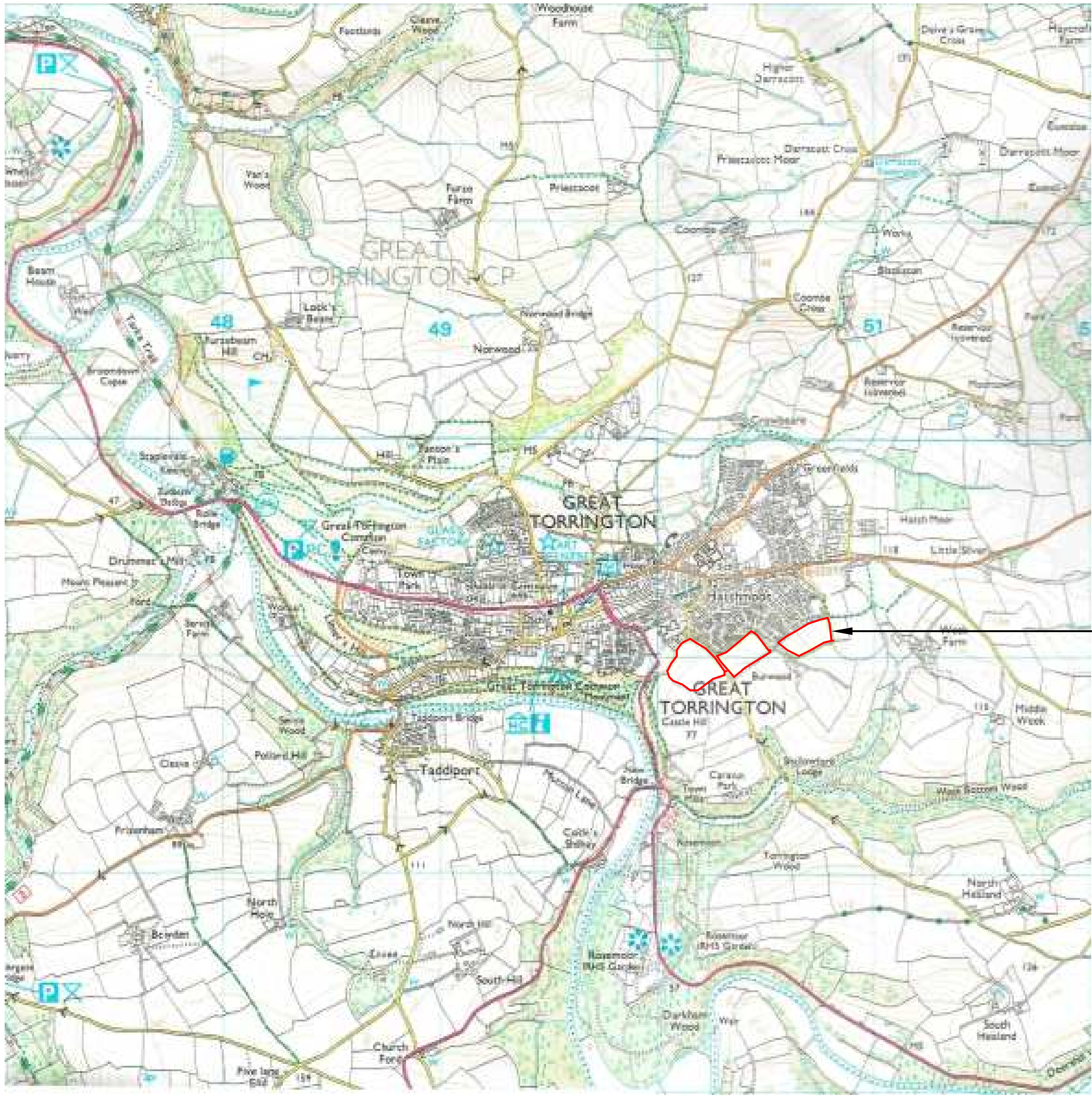

N

Archaeological Surveys Ltd

Geophysical Survey
Land off Burwood Lane / Caddywell Lane
Great Torrington
Devon

Map of survey area

Reproduced from OS Explorer map nos. 126 & 127 1:25 000 by permission of Ordnance Survey on behalf of The Controller of Her Majesty's Stationery Office.

● Survey location

Site centred on OS NGR SS 50430 19015

SCALE 1:25 000

0m 500m 1000m

FIG 01

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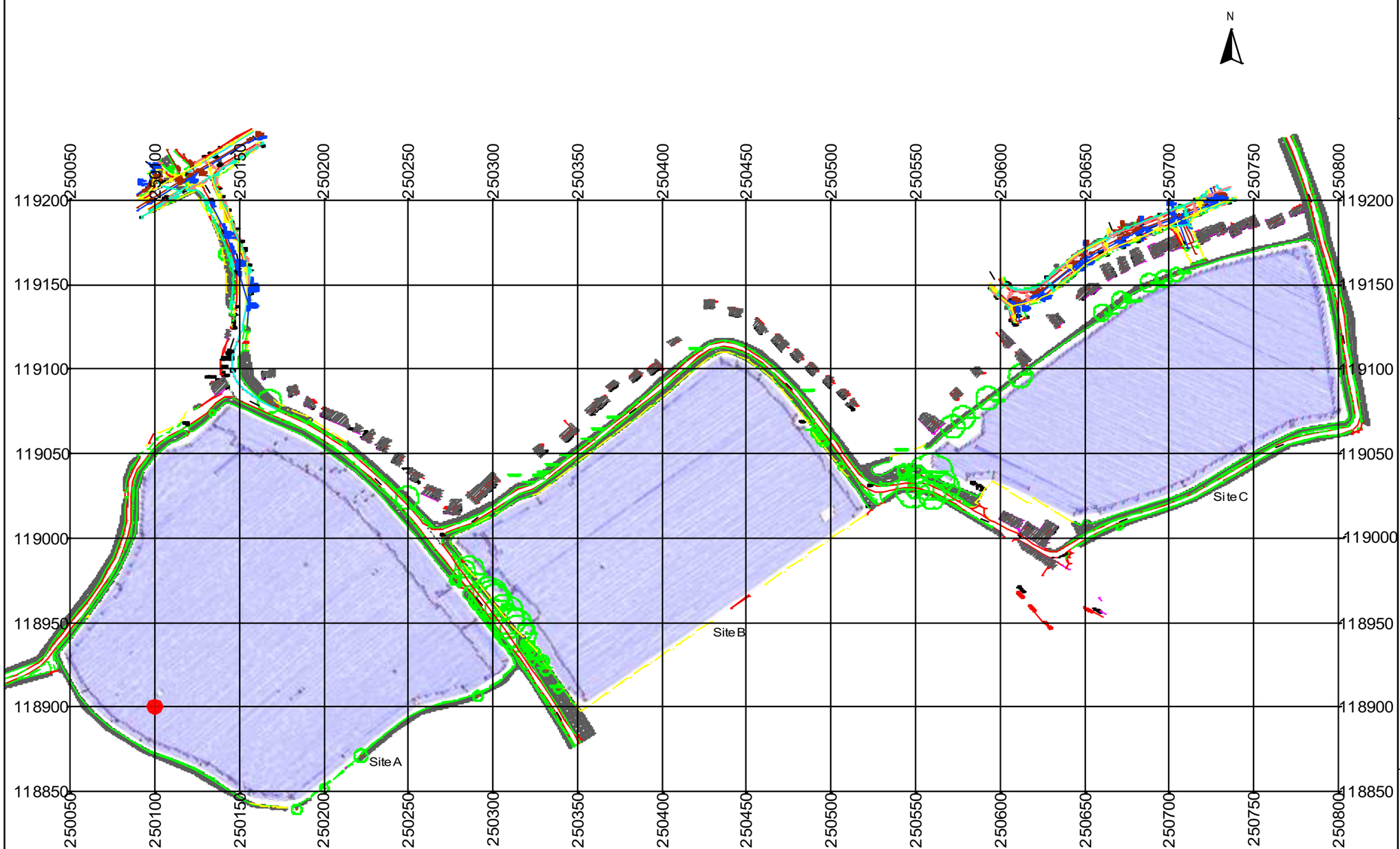
Geophysical Survey
Land off Burwood Lane / Caddywell Lane
Great Torrington
Devon

Referencing information



Referencing grid to OSGB36 datum at 50m intervals

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

250100 118900

Survey tracks

Survey track start

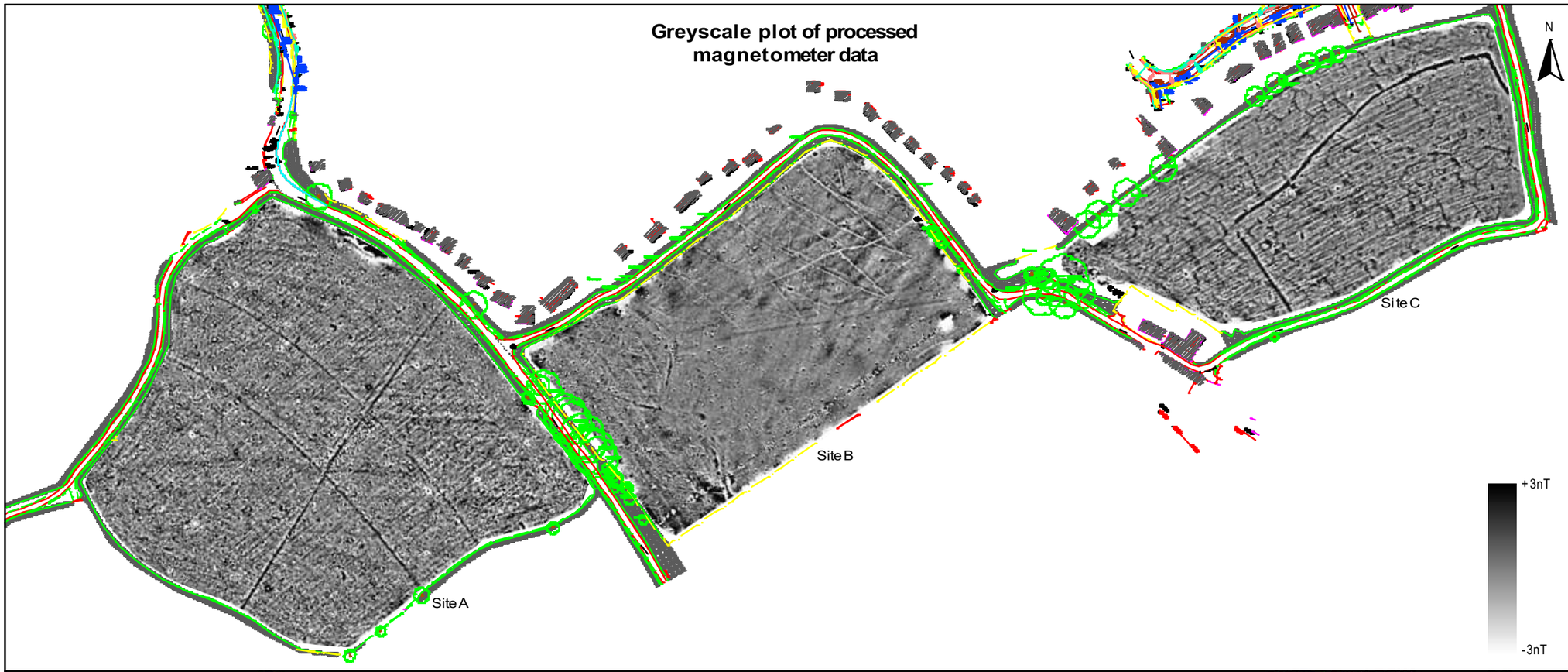
Survey track stop

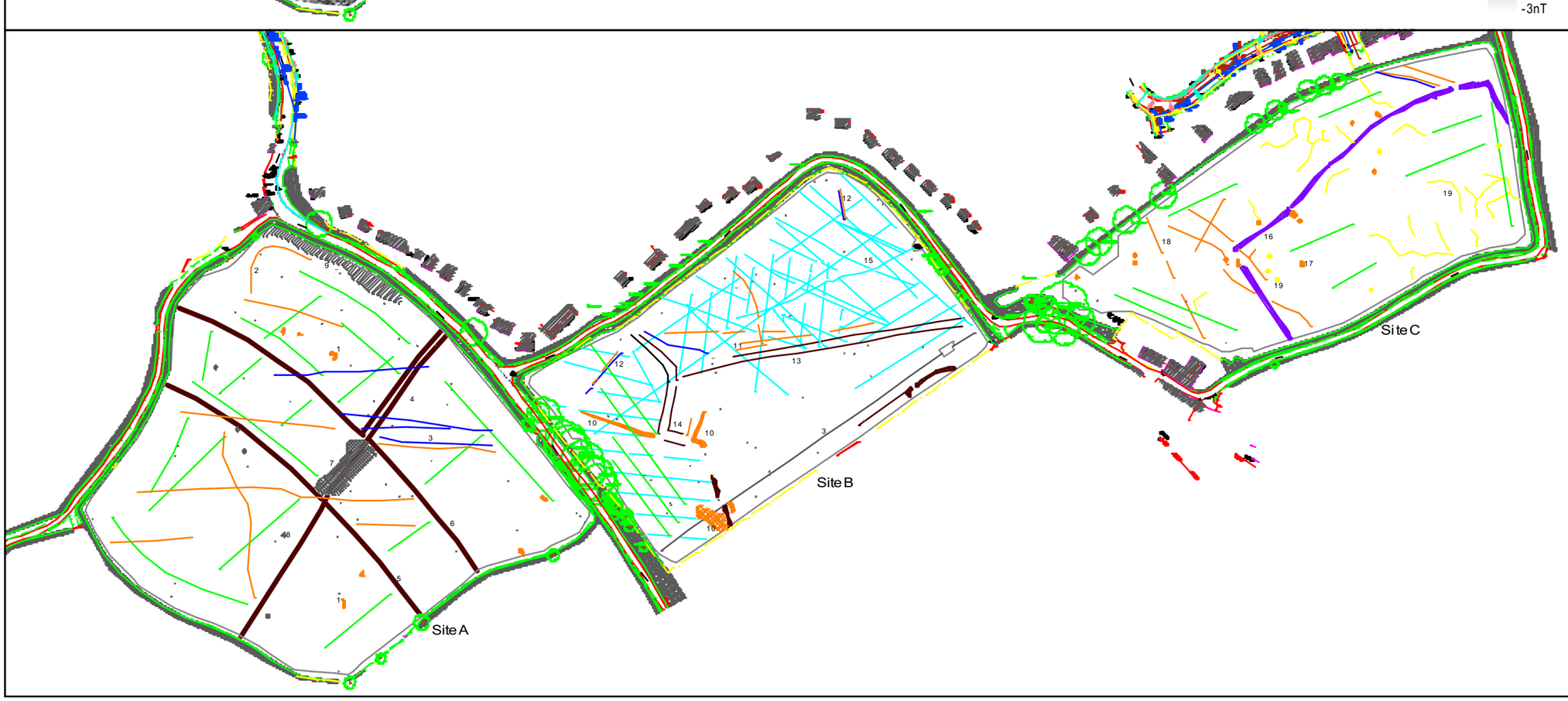
SCALE 1:2500

0m 50 100m

FIG 02

Greyscale plot of processed magnetometer data





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Geophysical Survey
Land off Burwood Lane / Caddywell Lane
Great Torrington
Devon

Abstraction and interpretaion of magnetic anomalies

- Positive rectilinear anomaly - enclosure ditch
- Positive linear anomaly - possible ditch-like feature
- Linear anomaly - of agricultural origin
- Negative linear anomaly - land drain
- Positive linear anomaly - former field boundary
- Negative linear anomaly - material of low magnetic susceptibility
- Positive linear anomaly - of possible natural origin
- Discrete positive response - possible pit-like feature
- Discrete positive response - of possible natural origin
- Positive anomaly - magnetically enhanced material
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Magnetic disturbance from ferrous material
- Strong dipolar anomaly - ferrous object

SCALE 1:2500

0m 50 100m

FIG 03

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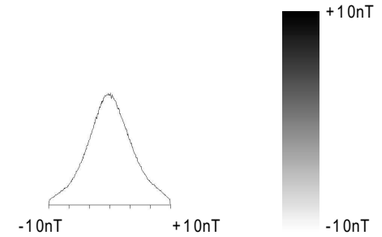
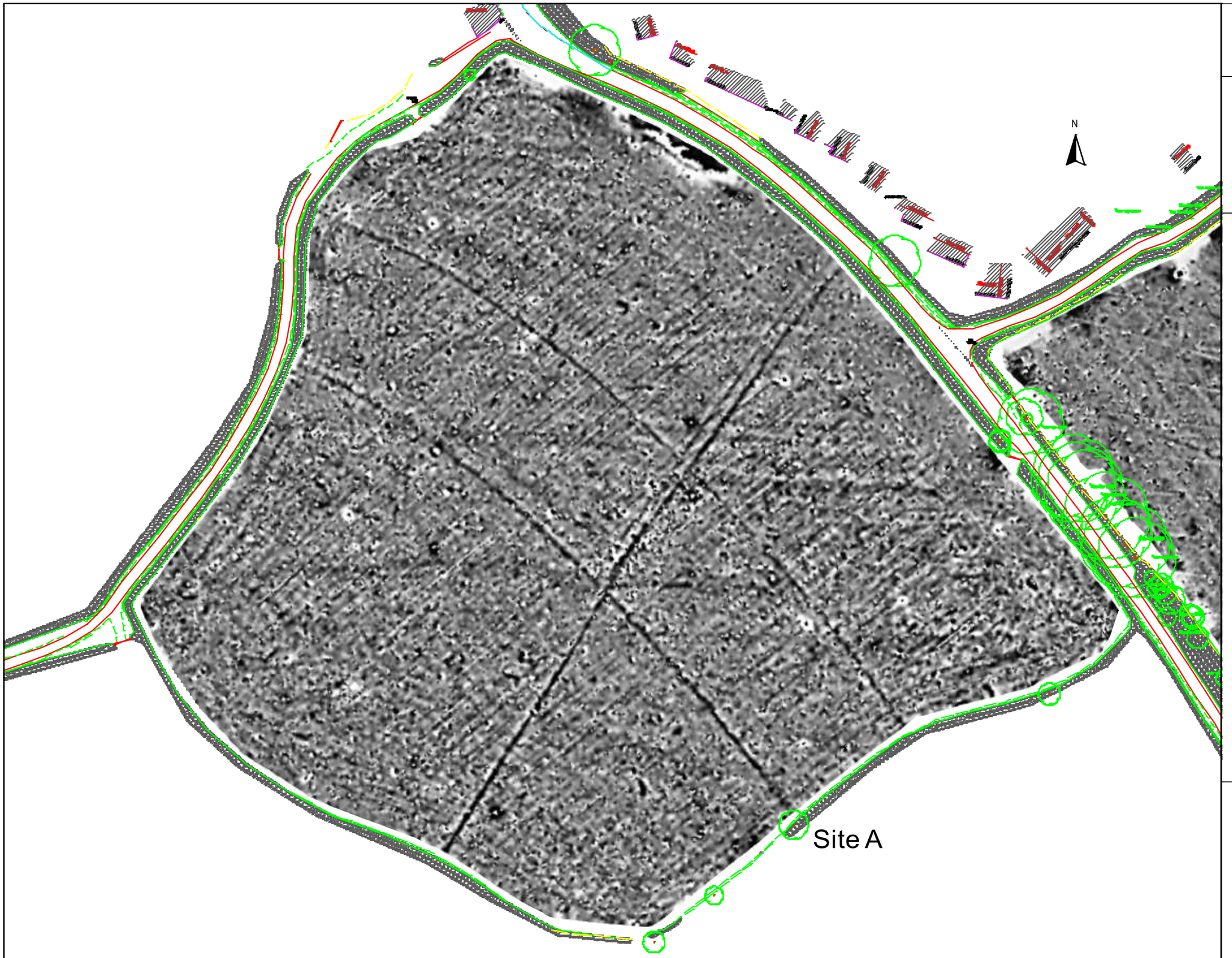
Great Torrington
Devon

Greyscale plot of minimally processed magnetometer data - Site A





SCALE 1:1000

0m 10 20 30 40 50m

FIG 04

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Geophysical Survey
Land off Burwood Lane / Caddywell Lane
Great Torrington
Devon

Abstraction and interpretation of magnetic anomalies - Site A

- Positive linear anomaly - possible ditch-like feature
- Linear anomaly - of agricultural origin
- Positive linear anomaly - former field boundary
- Negative linear anomaly - material of low magnetic susceptibility
- Discrete positive response - possible pit-like feature
- 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

FIG 05

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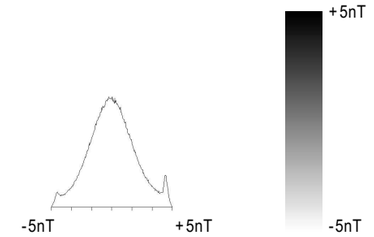
Devon

Greyscale plot of minimally processed magnetometer data - Site B



SCALE 1:1000

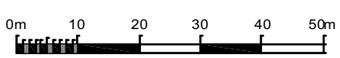


FIG 06

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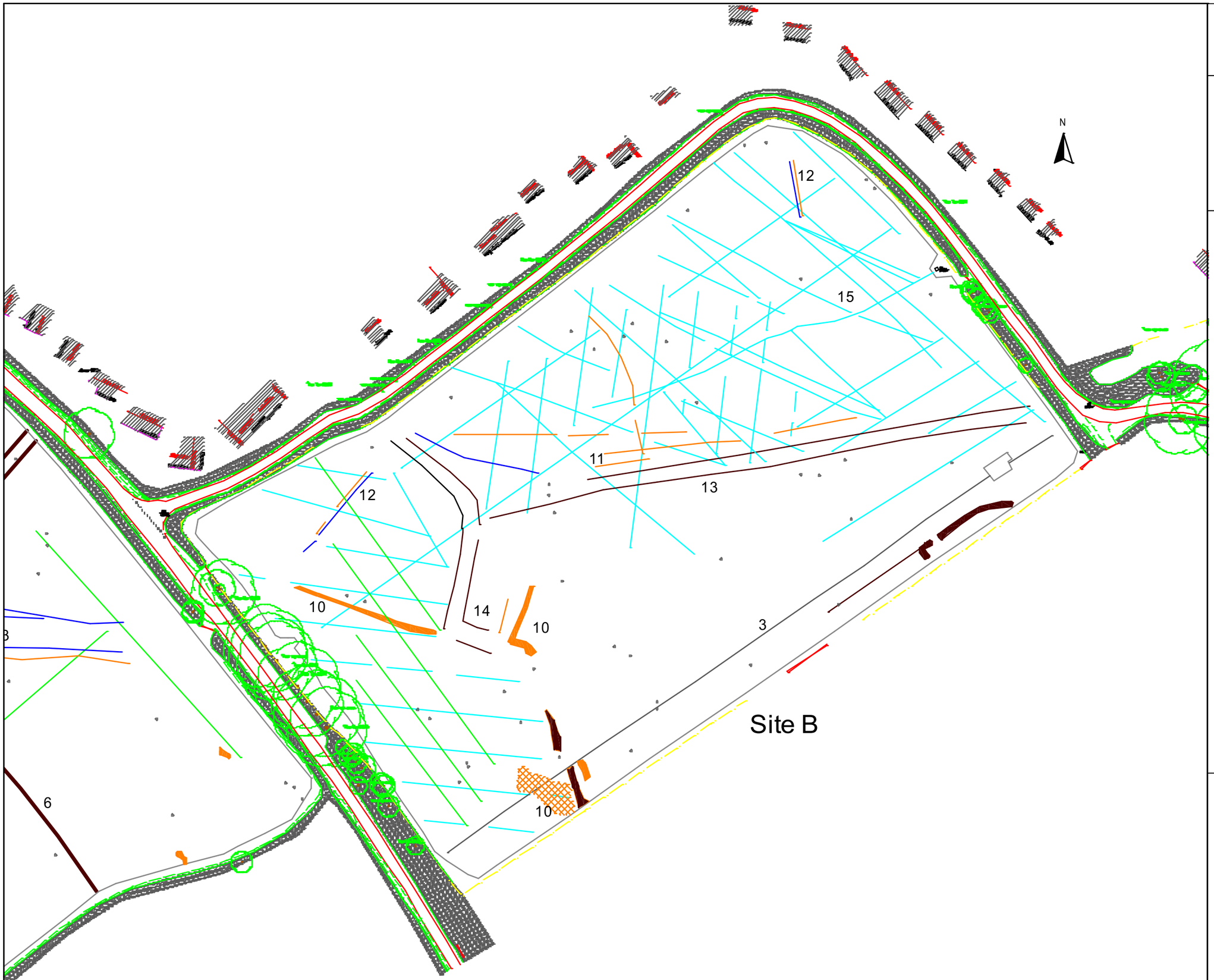
Abstraction and interpretation of magnetic anomalies - Site B



- Positive linear anomaly - possible ditch-like feature
- Positive linear anomaly - land drain
- Positive linear anomaly - former field boundary
- Negative linear anomaly - material of low magnetic susceptibility
- Positive anomaly - magnetically enhanced material
- Strong dipolar anomaly - ferrous object

SCALE 1:1000

0m 10 20 30 40 50m

FIG 07

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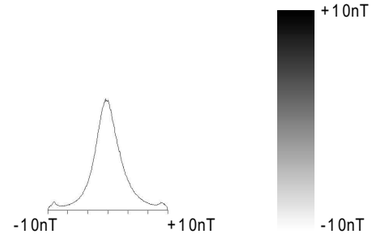
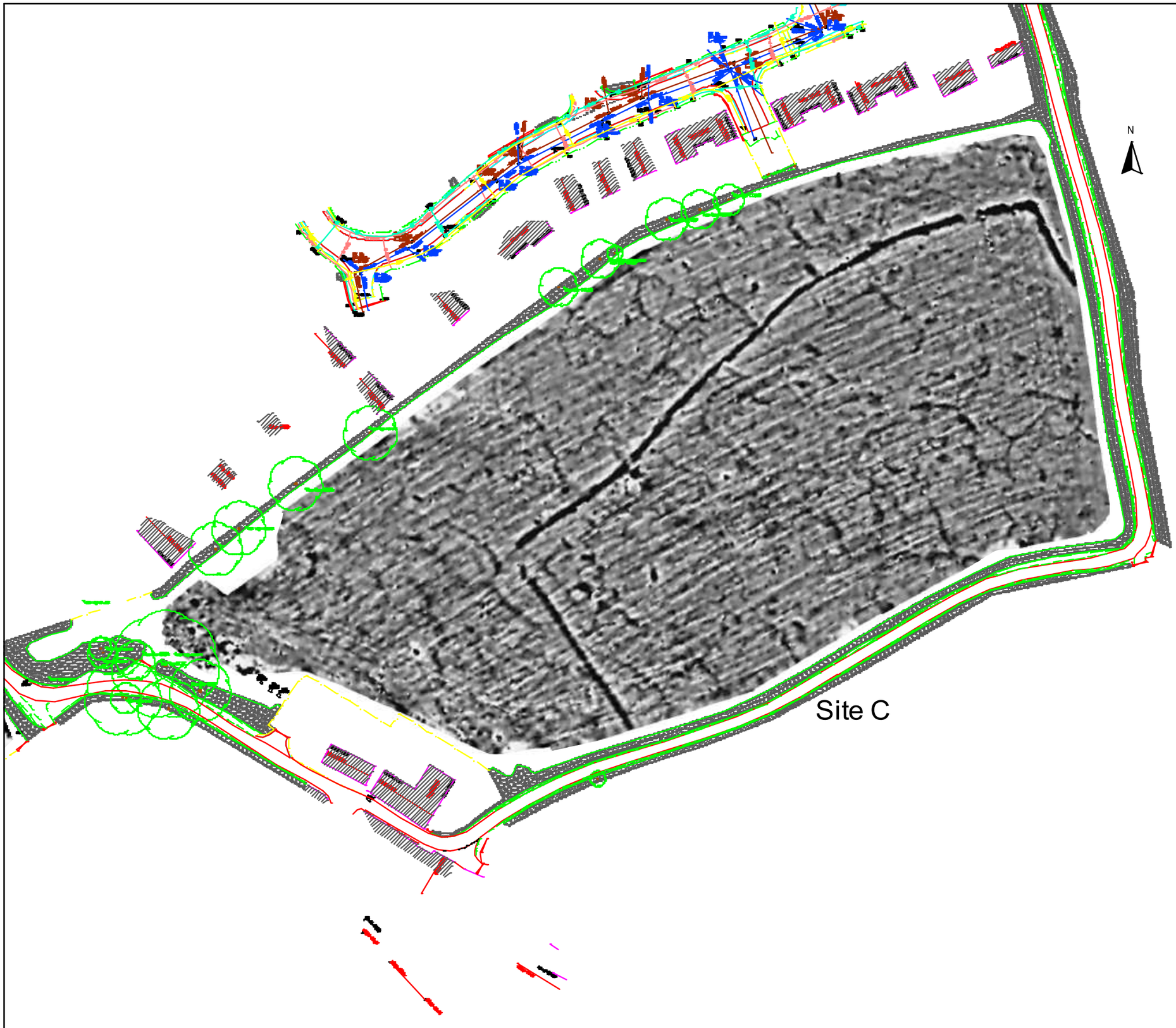
Great Torrington
Devon

Greyscale plot of minimally processed magnetometer data - Site C





SCALE 1:1000

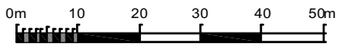


FIG 08

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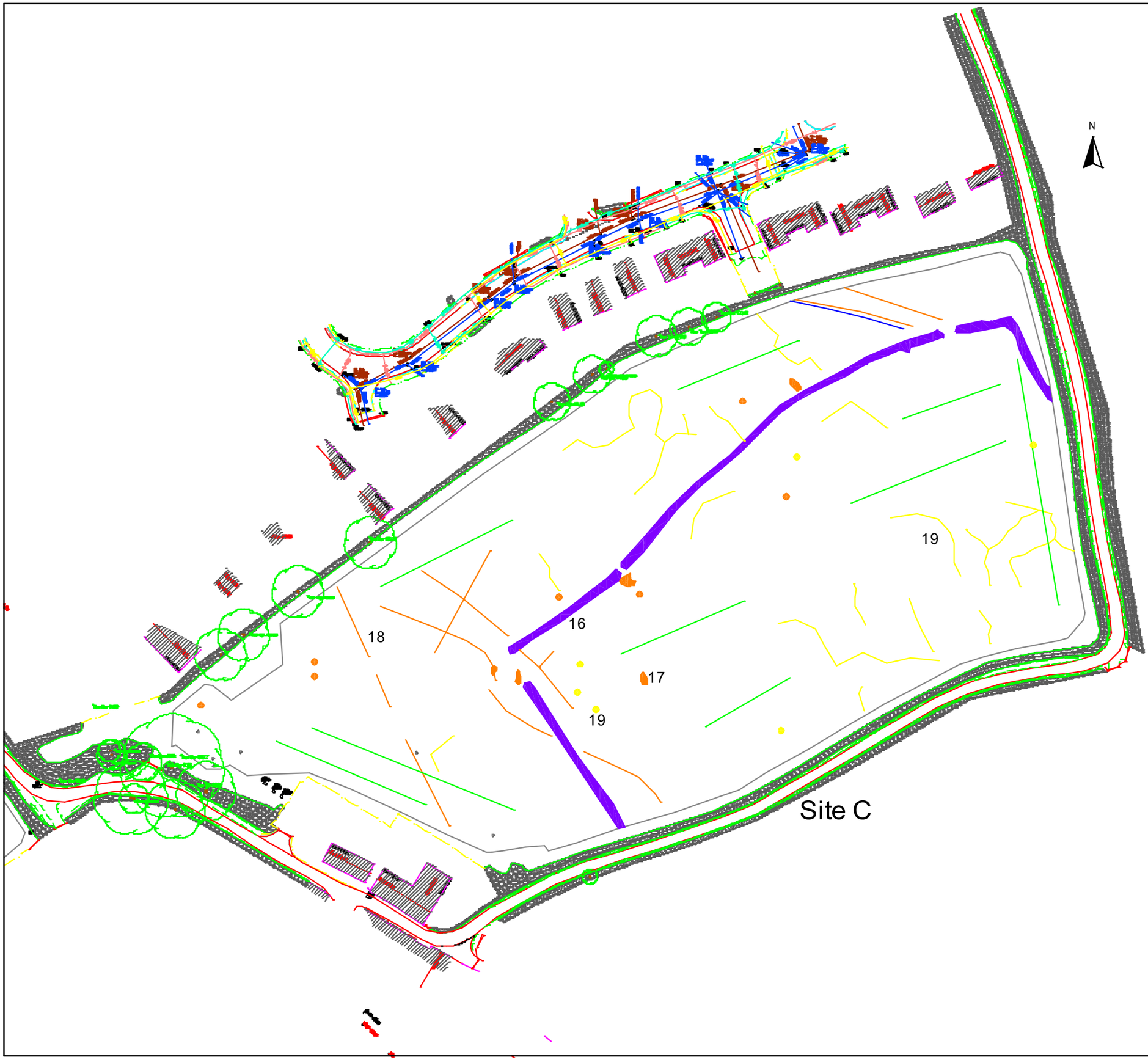
Geophysical Survey
Land off Burwood Lane / Caddywell Lane
Great Torrington
Devon

Abstraction and interpretation of magnetic anomalies - Site C



- Positive curvilinear/rectilinear anomaly - enclosure ditch
- Positive linear anomaly - possible ditch-like feature
- Negative linear anomaly - material of low magnetic susceptibility
- Linear anomaly - of agricultural origin
- Positive linear anomaly - of possible natural origin
- Discrete positive response - possible pit-like feature
- Discrete positive response - of possible natural origin

SCALE 1:1000

0m 10 20 30 40 50m

FIG 09