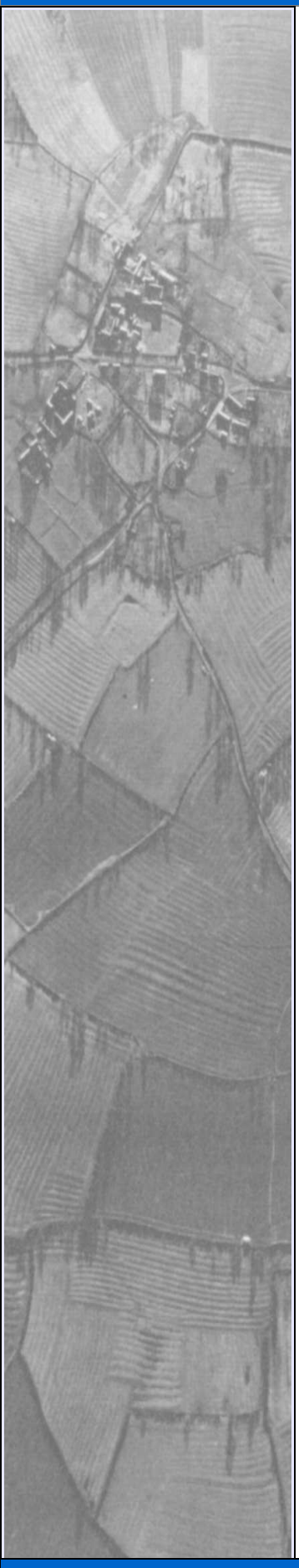

Area 12 (outstanding area)
Childrey Warren WTW Abstraction Closure
Oxfordshire

MAGNETOMETER SURVEY REPORT

for

SMB JV

Kerry Donaldson & David Sabin

May 2018

Ref. no. J752

ARCHAEOLOGICAL SURVEYS LTD

Area 12 (outstanding area)
Childrey Warren WTW Abstraction Closure
Oxfordshire

Magnetometer Survey Report

for

SMB JV

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 – 25th to 27th April 2018
Ordnance Survey Grid Reference – **SU 37150 85280**

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CONTENTS

LIST OF FIGURES

LIST OF PLATES

LIST OF TABLES

SUMMARY

A detailed magnetometer survey was carried out by Archaeological Surveys Ltd over a single area near Letcombe Bassett in Oxfordshire. The survey aimed to cover an outstanding survey area, not previously completed due to poor ground conditions, for a proposed new Thames Water pipeline between Lark Hill reservoir and Childrey Warren Water Treatment Works. The previous survey revealed a complex of enclosures and pits on land immediately to the south west and which appeared likely to continue into the current survey area. The results show a continuation of the archaeology, with a series of rectilinear enclosures as well as triangular and more irregularly shaped enclosures. A group of at least 10 ring ditches, associated with clusters of internal and external pits, have also been located beyond the pipeline easement. The majority of the archaeological features lie to the north of the proposed pipeline easement; however, the route does extend through some of the rectilinear enclosures, and also a currently proposed compound is situated over the site of a small, square enclosure on the western edge of the survey area.

1 INTRODUCTION

1.1 Survey background

1.1.1 Archaeological Surveys Ltd was commissioned by SMB JV, on behalf of Thames Water, to undertake a magnetometer survey of a single area of land near Letcombe Bassett, Oxfordshire. The area forms part of a corridor of survey for a new water pipe between Lark Hill reservoir and Childrey Warren Water Treatment Works (WTW), to the south of Wantage in Oxfordshire. The rest of the survey corridor was surveyed during November and December 2017 (Archaeological Surveys, 2018), but the current survey area (Area 12) was too roughly ploughed to survey at the time. It was, therefore, surveyed after cultivation and is reported on separately to the initial area.

1.1.2 A large area was surveyed as the pipeline route and compound sites had not been finalised at the time of survey. The wider area also allows for any archaeological features located within the narrow easement corridor to be placed in context with those in the wider vicinity.

1.1.3 The need for a new water pipeline between the Lark Hill reservoir and Childrey Warren WTW has been caused by low water flows within the Letcombe Brook at Wantage leading to an agreement between Thames Water and the Environment Agency to cease borehole water abstraction at Childrey Warren WTW. SMB JV is a joint venture between Skanska, Stantec (formerly MWH Global) and Balfour Beatty, selected by Thames Water to deliver their Asset Management Programme (AMP) 6 water infrastructure improvement programme between April 2015 and March 2020. SMB are part of the wider eight$_2$O delivery alliance for Thames Water.

1.1.4 The geophysical survey was carried out in accordance with a Written Scheme of Investigation (WSI) produced by Archaeological Surveys (2017) and approved by Hugh Coddington, County Archaeologist for Oxfordshire County Council.

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 construction of the new water pipeline. The methodology is considered an efficient and effective approach to archaeological prospection.

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

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

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

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

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

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

1.4 Site location, description and survey conditions

1.4.1 The site is located to the north west of Letcombe Bassett in Oxfordshire. It is centred on Ordnance Survey National Grid Reference (OS NGR) SU 37155 85235, see Figs 01 and 02.

1.4.2 The geophysical survey covers approximately 10.7ha within the southern half of a large arable field that had recently been cultivated. The area tends to slope down towards the south east, beyond the survey boundary the land falls steeply into a combe containing the Letcombe Brook. To the south of the area lies Holborn Farm with associated steel-framed barns surrounded by agricultural machinery and implements. Near to the eastern corner of the site a recently constructed narrow ditch crosses the survey area, and to the west of this there was a line of bales and an agricultural implement that impeded survey.

1.4.3 The ground conditions across the site were generally considered to be favourable for the collection of magnetometry data. Weather conditions during the survey were variable with periods of hail and high winds.

Plate 1: Survey area looking east

1.5 Site history and archaeological potential

1.5.1 To the west of the site the Oxfordshire Historic Environment Record (HER) lists a number of Bronze Age barrows (MOX10599 and MOX24207), a circular enclosure (MOX24289), a possible square enclosure (MOX24208) and a number of ditched boundary features (MOX24290 and MOX24288). Previous

geophysical survey to the south west located a rectilinear, curvilinear and triangular enclosures as well as numerous pits (Archaeological Surveys, 2018). They appeared likely to extend into the current survey area. There is anecdotal evidence that the survey area contains the crash site for a WWII German aircraft or possibly USAAF aircraft, but the actual aircraft details or location are not documented (Lang Hall Archaeology, 2018).

1.5.2 The surface conditions within the site were suitable for the observation of cultural material during the course of the survey. Numerous sherds of Romano-British pottery were noted along the far western side of the survey area. The material included a large piece of greyware rim and decorated Samian. In addition, a piece of quernstone was noted in the vicinity of the pottery which appears to be of a white millstone grit type material that is not local and is frequently found associated with Roman settlement sites.

1.6 Geology and soils

1.6.1 The underlying geology is from the West Melbury Marly Chalk Formation (BGS, 2017).

1.6.2 The overlying soil across the survey area is from the Wantage 1 association and is a grey rendzina. It consists of a well drained, calcareous silty soil in places shallow over argillaceous rock (Soil Survey of England and Wales, 1983).

1.6.3 Magnetometry survey carried out across similar soils has produced good results although the magnetic contrast of the fill of cut features can be weak. The underlying geology and soils are, therefore, considered acceptable for magnetic survey.

2 METHODOLOGY

2.1 Technical synopsis

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

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

2.1.3 Magnetic thermoremnance can occur when ferrous minerals have been heated to

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

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

2.2 Equipment configuration, data collection and survey detail

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

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

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

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

2.3 Data processing and presentation

2.3.1 Magnetic data collected by the MAGNETO®MXPDA cart-based system are initially prepared using SENSYS MAGNETO®DLMGPS software. The software effectively allocates a geographic position for each data point and can compensate for fixed offsets present within the FGM650 sensors. The offsets are positive or negative values present on all fluxgate gradiometer sensors. Some systems use manual or electronic balancing to effectively zero the sensors; however, this is a short term measure that is prone to drift through temperature changes and vibration and can easily be incorrectly set due to localised magnetic fields. The FGM650 sensors are very accurately aligned to the vertical magnetic gradient and are highly stable showing negligible drift on long traverses. The offset values are removed using TerraSurveyor software.

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

2.3.3 The minimally processed data are collected between limits of ±10000nT and clipped for display at ±2nT. Data are interpolated to a resolution of effectively 0.5m between tracks and 0.15m along each survey track.

2.3.4 Appendix C contains metadata concerning the survey and data attributes and is derived directly from TerraSurveyor. Reference should be made to Appendix B for further information on processing.

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

2.3.6 The raster images are combined with base mapping using ProgeCAD Professional 2016, creating DWG (2010) file formats. All images are externally referenced to the CAD drawing in order to maintain good graphical quality.

The CAD plots are effectively georeferenced facilitating relocation of features using GPS, resection method, etc.

2.3.7 An abstraction and interpretation is drawn and plotted for all geophysical anomalies located by the survey. Anomalies are abstracted using colour coded points, lines and polygons. All plots are scaled to landscape A3 for paper printing. Appendix E sets out CAD layer names with colour and graphic content for each interpretation category, see 3.3.

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

2.3.9 The abstraction and interpretation procedure has been supported by analysis of a digital terrain model plot derived from the Environment Agency's LiDAR data. Shaded relief plots are created using Surfer 10.

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

3 RESULTS

3.1 General assessment of survey results

3.1.1 The detailed magnetic survey was carried out over a total of 10.7ha within the southern part of a large arable field.

3.1.2 Magnetic anomalies located can be generally classified as positive and negative anomalies of archaeological potential, positive linear anomalies of an uncertain origin, anomalies associated with land management, linear anomalies of an agricultural origin, areas of magnetic debris and disturbance, strong discrete dipolar anomalies relating to ferrous objects and strong multiple dipolar linear anomalies relating to buried services or pipelines.

3.1.3 Anomalies have been numbered and are described in 3.4 below with subsequent discussion in Section 4.

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

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

3.2.2 Localised magnetic disturbance, caused by barns, agricultural implements, machinery and pipeline, is apparent mainly along the southern edge of the survey area. It is unlikely that the disturbance has obscured significant

anomalies.

3.2.3 Several very small zones could not be surveyed; these are related to an electricity pole at the northern edge of the site and a newly cut ditch and line of bales with an agricultural implement towards the eastern end of the area. It is unlikely that significant anomalies have been missed, although the small zone at the northern edge of the survey area is located in the vicinity of pits and ring ditches.

3.2.4 The soil and underlying chalk geology are frequently associated with low levels of magnetic susceptibility and poor contrast between the fill of cut features and the surrounding natural. A recently constructed ditch indicated a relatively thin evenly coloured grey soil overlying crumbly chalk, with some thickening of the soil towards the lower southern edge of the field due to accumulated colluvial deposits. The boundary between the chalk and soil appears distinct, although it is likely that there is significant truncation and erosion of archaeological features as a result of modern cultivation.

3.3 Data interpretation

3.3.1 The list of sub-headings below attempts to define a number of separate categories that reflect the range and type of features located during the survey. A basic explanation of the characteristics of the magnetic anomalies is set out for each category in order to justify interpretation, see Table 1.

Interpretation category	Description and origin of anomalies
Anomalies with archaeological potential	Anomalies have the characteristics (mainly morphological) of a range of archaeological features such as pits, ring ditches, enclosures, etc. The category is used where there is a high level of confidence which may be due to additional supporting information where morphology is unclear or uncharacteristic.
Anomalies with an uncertain origin	The category applies to a range of anomalies where there is not enough evidence to confidently suggest an origin. Anomalies in this category may well be related to archaeologically significant features, but equally relatively modern features, geological/pedological features and agricultural features should be considered. Morphology may be unclear or uncharacteristic and there may be a lack of additional supporting information. Positive anomalies are indicative of magnetically enhanced soils that may form the fill of 'cut' features or may be produced by accumulation within layers or 'earthwork' features; soils subject to burning may also produce positive anomalies. Negative anomalies are produced by material of comparatively low magnetic susceptibility such as stone and subsoil.
Anomalies relating to land management	Anomalies are mainly linear and may be indicative of the magnetically enhanced fill of cut features (i.e. ditches). The anomalies may be long and/or form rectilinear elements and they may relate to topographic features or be visible on early mapping. Associated agricultural anomalies (e.g. headlands, plough marks and former ridge and furrow) may support the interpretation. Land drains can appear in a classic herringbone pattern of interconnected multiple dipolar linear anomalies, or as parallel linear anomalies. The multiple dipolar response indicates ceramic land drains.
Anomalies with an agricultural origin	The anomalies are often linear and form a series of parallel responses or

	are parallel to extant land boundaries. Where the response is broad, former ridge and furrow is likely; narrow response is often related to modern ploughing. This category does not include agricultural features of early date or considered to be of archaeological potential (e.g. animal stockades, enclosures, farmsteads, etc).
Anomalies associated with magnetic debris	Magnetic debris often appears as areas containing many small dipolar anomalies that may range from weak to very strong in magnitude. They often occur where there has been dumping or ground make-up and are related to magnetically thermoremnant materials such as brick or tile or other small fragments of ferrous material. This type of response is occasionally associated with kilns, furnace structures, hearths and nail spreads from former wooden structures or rooves and may, therefore, be archaeologically significant. It is also possible that the response may be caused by natural material such as certain gravels and fragments of igneous or metamorphic rock. Strong discrete dipolar anomalies are responses to ferrous objects within the topsoil.
Anomalies with a modern origin	The magnetic response is often strong and dipolar indicative of ferrous material and may be associated with extant above surface features such as wire fencing, cables, pylons etc.. Often a significant area around these features has a strong magnetic flux which may create magnetic disturbance; such disturbance can effectively obscure low magnitude anomalies if they are present. Fluxgate sensors may respond erratically adjacent to strong magnetic sources. Buried services may produce characteristic multiple dipolar anomalies dependant upon their construction.

Table 1: List and description of interpretation categories

3.4 List of anomalies

Area centred on OS NGR 437150 185280, see Figs 03 – 12.

Anomalies of archaeological potential

(1) - A small, square enclosure is situated close to the south western edge of the survey area. It is approximately 18m across, and it appears to have truncated a much smaller 6.5m wide enclosure to the west. This lies within an area outlined for a currently proposed site compound within the pipeline easement. Romano-British pottery sherds were observed in the vicinity.

(2) - A series of rectilinear enclosures with a north west to south east and north east to south west orientation. They are indicative of a Romano-British field system and there is some evidence for phases of development with smaller internal divisions; they are also generally parallel with elements forming anomaly (1).

(3) – An irregularly shaped enclosure ditch may have been truncated by enclosure ditches (2). If the long axis is projected southwards, it appears to be on the same orientation as a broad positive response identified during the previous geophysical survey to the south west.

(4) - A small triangular enclosure contains a number of pits. It appears to have been partly truncated by another enclosure ditch and there is some complexity to the archaeological features within this area.

(5) - A larger triangular enclosure with a stronger response and some complexity along the northern side and a possible entrance facing west. A similar, but larger triangular enclosure is located within Area 13, 150m to the south west.

(6 & 7) - A broad, sinuous, weakly positive linear anomaly (6) appears to bound anomalies (8) to (11). A similar sinuous linear anomaly appears to bound the western edge of the enclosures seen 330m south west in Area 13. A much narrower linear anomaly (7) appears to join anomaly (6) from the east

(8) – A very weakly positive, narrow, curvilinear anomaly with some evidence for an internal negative curvilinear response may relate to a ring ditch that appears to be surrounded by other smaller ring ditches (9). Other positive responses are located within its confines, but it is not possible to determine if they are associated. It appears to form a ring ditch with a diameter of approximately 20m. The south western edge may have been truncated by a smaller ring ditch feature.

(9) - There is evidence for at least 10 ring ditches with diameters of between 12m and 15m. The majority contain or are surrounded by numerous pits (10) and there appears to be evidence for more than one phase of construction. Their size and morphology would indicate that they relate to prehistoric round houses.

(10) - Numerous pits are located within the area of the ring ditches (9). Many are clustered and some could form rings suggesting the remains of further, eroded ring ditches.

(11) – Positive linear anomalies appear to form ditches flanking a possible trackway extending towards anomaly (8).

(12) - A discrete, positive response is situated in the corner of a number of enclosures. It is stronger than the majority of anomalies (10nT) which may indicate burnt material is incorporated into a pit.

Anomalies with an uncertain origin

(13) - A number of discrete positive responses are located close to the far western corner of the survey area. One large response is particularly strong at 30nT and these may well relate to pits or areas of burning with an archaeological origin. The cautious interpretation is due to the proximity of the anomalies to the edge of the survey area where dumping of magnetic material can be concentrated and so an association with modern material is also possible.

(14) - There are a small number of weakly positive linear and discrete responses within the confines of the enclosures (2). It is possible that they relate to further ditch-like and pit-like features.

(15) - A small group of discrete positive responses lie close to a small patch of magnetic debris in the centre of the survey area along the line of the proposed pipeline. It is not possible to determine if they relate to pit-like features with an

archaeological origin; however, they may be associated with a broad, low, former boundary bank that can be seen in the LiDAR imagery (Fig 13), but cannot be seen as a magnetic anomaly in the data.

(16) - Situated to the east of anomaly (6) are a number of very weakly positive possible curvilinear anomalies. Due to the weak and indistinct response it is not possible to determine if they relate to further ring ditch features.

(17) - The eastern half of the survey area contains a number of very weakly positive linear and possibly curvilinear responses. The anomalies are very weak and indistinct and it is not possible to determine if they relate to cut, ditch-like features. Some could relate to agricultural activity.

(18) - Situated towards the eastern end of the survey area is a broad, weakly positive anomaly. It is not possible to determine the origin of the magnetic enhancement.

(19) - At the far eastern end of the survey area is an amorphous positive response. It is situated at the southern end of a broad linear boundary feature and appears to be associated.

Anomalies associated with land management

(20) - Two weakly positive linear anomalies flank a negative response; they relate to a recently removed field boundary.

Anomalies with an agricultural origin

(21) - Parallel positive linear anomalies situated at the western end of the survey area relate to agricultural activity.

Anomalies associated with magnetic debris

(22) - An amorphous patch of magnetic debris is situated in the central southern part of the survey area. There is anecdotal evidence for a WWII crashed aircraft within the field, and while magnetic debris could relate to associated material, this type of response could also relate to dumped magnetically thermoremnant material or an area of burning which has been spread by agricultural activity.

(23) - To the east of anomaly (22) are linear zones of magnetic debris. These may relate to magnetically thermoremnant material spread by ploughing, but the origin of the responses is uncertain. Smaller patches are evident elsewhere.

(24) - Patches of magnetic debris lie in a line, but immediately south of a broad, low linear bank that can be seen in the LiDAR imagery. It is not possible to determine the origin or age of the material.

(25) - Situated to the north of the triangular enclosure (5) is a small patch of magnetic debris. The origin of the anomaly is uncertain, but it may be modern.

(26) - The entire survey area contains strong, discrete, dipolar responses, too numerous to abstract in entirety. They are likely to relate to small fragments of ferrous and other magnetically thermoremnant objects that have been incorporated into the topsoil.

Anomalies with a modern origin

(27) - Extending along the southern edge of the survey area is an existing water pipeline.

4 DISCUSSION

4.1.1 The detailed magnetometer survey located a number of enclosures towards the western end of the survey area. The majority are rectilinear (2), but there are also triangular enclosures (5) and some with a more irregular appearance (3). There are phases of construction and use, and it appears that the rectilinear enclosures cut the more irregular ones. Similar features can be seen within the previous survey Area 13 located to the south west (Archaeological Surveys, 2018). Part of the south eastern edge of the rectilinear enclosures lie within the pipeline easement and the junction of the enclosures and the pit (12) lie on, or are immediately adjacent to, the line of the proposed pipeline.

4.1.2 A small, square enclosure (1) is located on the south western edge of the survey area. It appears to have truncated an earlier, smaller enclosure on its western side. Romano-British pottery sherds were evident on the ground surface at the time of survey which may suggest domestic occupation, and the enclosure may be associated. This enclosure lies within a currently proposed site compound.

4.1.3 Located to the north east of the enclosures are a number of ring ditches (9). They are generally very weak and eroded, but there is some evidence for phases of use and development and they are generally associated with large and numerous pits (10), both located internally and externally. It is possible that some of the rings or clusters of pits may relate to further eroded ring ditches. The complex relates to a prehistoric settlement which appears to be bounded by a broad, sinuous boundary ditch (6); however, weakly positive curvilinear anomalies have been located to the east (16). These are so weak and indistinct that a confident interpretation is not possible. The ring ditches also appears to surround a zone that contains very few pits, but which has a very narrow, but larger ring ditch (8) as a focus. This ring ditch does not have the wide ditches associated with anomalies (9), but is narrow and very indistinct. An internal negative response could relate to a former bank, but it is not clear. A possible trackway (11) may lead towards it from the north west.

4.1.4 The archaeological features are concentrated within the western part of the survey area and cover at least 4ha, with a continuation to the north, beyond the surveyed area highly likely. The LiDAR imagery reveals a widespread pattern of field systems in the vicinity, with a number of broad linear banks extant within the survey area. These banks do not have a corresponding magnetic response.

4.1.5 While a number of very weakly positive linear, curvilinear, rectilinear and discrete anomalies have been located in the eastern part of the survey area, they are generally very indistinct and lack a coherent morphology. Weakly positive linear and discrete anomalies within the confines of the archaeology are either unclear (14), or close to the edge of the survey area (13) and could also relate to archaeological features.

4.1.6 There has been anecdotal evidence that the survey area contains the crash site for a WWII aircraft (Lang Hall Archaeology, 2018). Several patches of magnetic debris have been located, (22 & 23) it is not possible to determine if any relate to an aircraft crash site, or if they relate to dumped magnetically thermoremnant material. During the course of the survey, surface conditions were suitable for the observation of cultural material; however, no aluminium or steel objects or fragments were observed that could be considered to relate to aircraft debris.

5 CONCLUSION

5.1.1 The detailed magnetometer survey located a number of archaeological features within the western part of the survey area. These comprise a series of rectilinear enclosures, triangular enclosures and more irregularly shaped enclosures and other ditches indicating phases of development and use from the prehistoric into the Roman period. A small square enclosure is situated close to the south western edge of the survey area and Romano-British pottery was noted nearby on the surface at the time of survey. The square enclosure, as well as a number of rectilinear enclosure ditches and two pits, are located within the pipeline easement and currently proposed compound.

5.1.2 To the north east of the majority of the enclosures, and beyond the pipeline easement, are a group of at least 10 ring ditches which are associated with numerous internal and external pits and relate to a prehistoric settlement. They surround an area that appears to contain a larger but very weak ring ditch. The ring ditches and clusters of pits are bounded by a sinuous enclosure ditch to the east. Although several anomalies have been located in the eastern half of the survey area, they are generally poorly defined and their origin cannot be interpreted.

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Soil Survey of England and Wales, 1983. *Soils of England and Wales, Sheet 6 South East England.*

Appendix A – basic principles of magnetic survey

Iron minerals are always present to some degree within the topsoil and enhancement associated with human activity is related to increases in the level of magnetic susceptibility and thermoremnant material. Magnetic susceptibility is an induced magnetism within a material when it is in the presence of a magnetic field. This can be thought of as effectively permanent due to the presence of the Earth's magnetic field. Thermoremnant magnetism occurs when ferrous material is heated beyond a specific temperature known as the Curie Point. Demagnetisation occurs at this temperature with re-magnetisation by the Earth's magnetic field upon cooling.

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

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

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

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

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

Appendix B – data processing notes

Clipping

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

Zero (destripe) Median/Mean Traverse

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

High Pass Filtering

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

Low Pass Filtering

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

Appendix C – survey and data information

Filename: J752-mag-proc.xcp
Description: Imported as Composite from: J752-mag.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 30U
Survey corner coordinates (X/Y):
Northwest corner: 436764.894, 185441.096 m
Southeast corner: 437501.244, 185128.046 m
Collection Method: Randomised
Sensors: 5
Dummy Value: 32702
Source GPS Points: 3253900
Dimensions
Composite Size (readings): 4909 x 2087
Survey Size (meters): 736 m x 313 m
Grid Size: 736 m x 313 m
X Interval: 0.15 m
Y Interval: 0.15 m

Stats
Max: 2.21
Min: -2.20
Std Dev: 0.78
Mean: 0.03
Median: 0.02
Composite Area: 23.051 ha
Surveyed Area: 10.751 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 -2.00 to 2.00 nT

Appendix D – digital archive

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

A draft digital copy of the summary report (in PDF format) shall be supplied to the office of the County Archaeological Officer for Oxfordshire; for verification and assessment by the CAO or their representative. When the report has been agreed a final digital copy will then be supplied to the Oxfordshire Historic Environment Record (HER) at archaeology@oxfordshire.gov.uk on the understanding that it will become a public document after an appropriate period of time (generally not exceeding six months). The report will also be uploaded to the Online AccesS to the Index of archaeological investigationS (OASIS).

Archive contents:

File type	Naming scheme	Description
Data	J752-mag-**[area number/name]**.asc J752-mag-**[area number/name]**.xcp J752-mag-**[area number/name]**-proc.xcp	Raw data as ASCII CSV TerraSurveyor raw data TerraSurveyor minimally processed data
Graphics	J752-mag-**[area number/name]**-proc.tif	Image in TIF format
Drawing	J752-**[version number]**.dwg	CAD file in 2010 dwg format
Report	J752 report.odt	Report text in Open Office odt format

Table 2: Archive metadata

Appendix E – CAD layers for abstraction and interpretation plots

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

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

Table 3: CAD layering

Appendix F – copyright and intellectual property

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Archaeological Surveys Ltd

Geophysical Survey
Area 12 (outstanding area)
Childrey Warren WTW
Abstraction Closure
Oxfordshire

Map of survey area

● Survey location

Site centred on OS NGR
SU 37150 85280

SCALE 1:25 000

0m 500m 1000m

SCALE TRUE AT A3

FIG 01

Archaeological Surveys Ltd

Geophysical Survey
Area 12 (outstanding area)
Childrey Warren WTW
Abstraction Closure
Oxfordshire

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

436800 185250

Easement/working width

Proposed pipeline

SCALE 1:2500

0m 50 100m

SCALE TRUE AT A3

FIG 02

Area 12

Area 13 previously surveyed

Letcombe Bassett

N

436750 436800 436850 436900 436950 437000 437050 437100 437150 437200 437250 437300 437350 437400 437450 437500

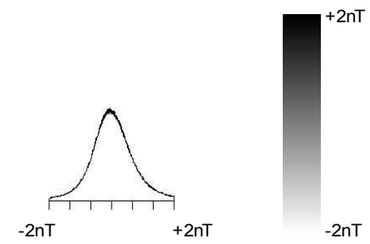
185450 185400 185350 185300 185250 185200 185150 185100

Thatched Cottage
Brook House
114.1m
Foot Bridge
Watercress Bed
106.4m
Watercress Beds
Spring
White's Farm
112.2m
Watercress Beds
Spring
Stone
144.1m BS
HOLBORN HILL
Track
Ivy Stables
Holborn House
Warren Down House
Winton
123.7m
Holborn Farmhouse
Orchard
Holborn Farm Barn
Dehamare
114.0m
Arabella's Cottage
Chapel Cottage
Shamlin
Warms View
KNOLL CLOSE
BECKORY LANE
Downs House
Tennis Court
Highbank
The Cottage
GP
Wellands
Spanswick Farm Cottages
121.2m
HOLBORN HILL
Spanswick Farm Cottages
Spanswick Farm
Yew Tree Inn
Downs View
Downs View Cottage
Filey Alley
Ridge View
Frog Hollow
GRIMPS HILL
Hall
Porlock
Court Farmhouse
Stables
The Grain Store
124.2m
Doverhay
The Old Manor House
127.5m
The Old Rectory
The Old Manor Stables
Rectory Cottage
Rectory Farm
FORSTERS LANE
Church End
St Michael's Church

Archaeological Surveys Ltd

Geophysical Survey
Area 12 (outstanding area)
Childrey Warren WTW
Abstraction Closure
Oxfordshire

Greyscale plot of minimally processed magnetometer data



SCALE 1:2500

0m 50 100m

SCALE TRUE AT A3

FIG 03

Archaeological Surveys Ltd

Geophysical Survey
Area 12 (outstanding area)
Childrey Warren WTW
Abstraction Closure
Oxfordshire

Abstraction and interpretation of magnetic anomalies

- Positive linear anomaly - cut feature of archaeological potential
- Positive curvilinear/rectilinear anomaly - enclosure ditch
- Positive curvilinear anomaly - ring ditch
- Negative linear anomaly - of archaeological potential
- Positive linear anomaly - possible ditch-like feature
- Positive linear anomaly - of agricultural origin
- Discrete positive response - cut feature of archaeological potential
- Discrete positive response - possible pit-like feature
- Positive anomaly - magnetically enhanced material of archaeological potential
- Broad negative anomaly with flanking positive responses - former boundary
- Positive anomaly - magnetically enhanced material
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Magnetic disturbance from ferrous material
- Strong multiple dipolar linear anomaly - pipeline
- Strong dipolar anomaly - ferrous object

SCALE 1:2500

0m 50 100m

SCALE TRUE AT A3

FIG 04

Archaeological Surveys Ltd

Geophysical Survey
Area 12 (outstanding area)
Childrey Warren WTW
Abstraction Closure
Oxfordshire

Greyscale plot of minimally processed magnetometer data - east

+2nT

-2nT +2nT

-2nT

SCALE 1:1500

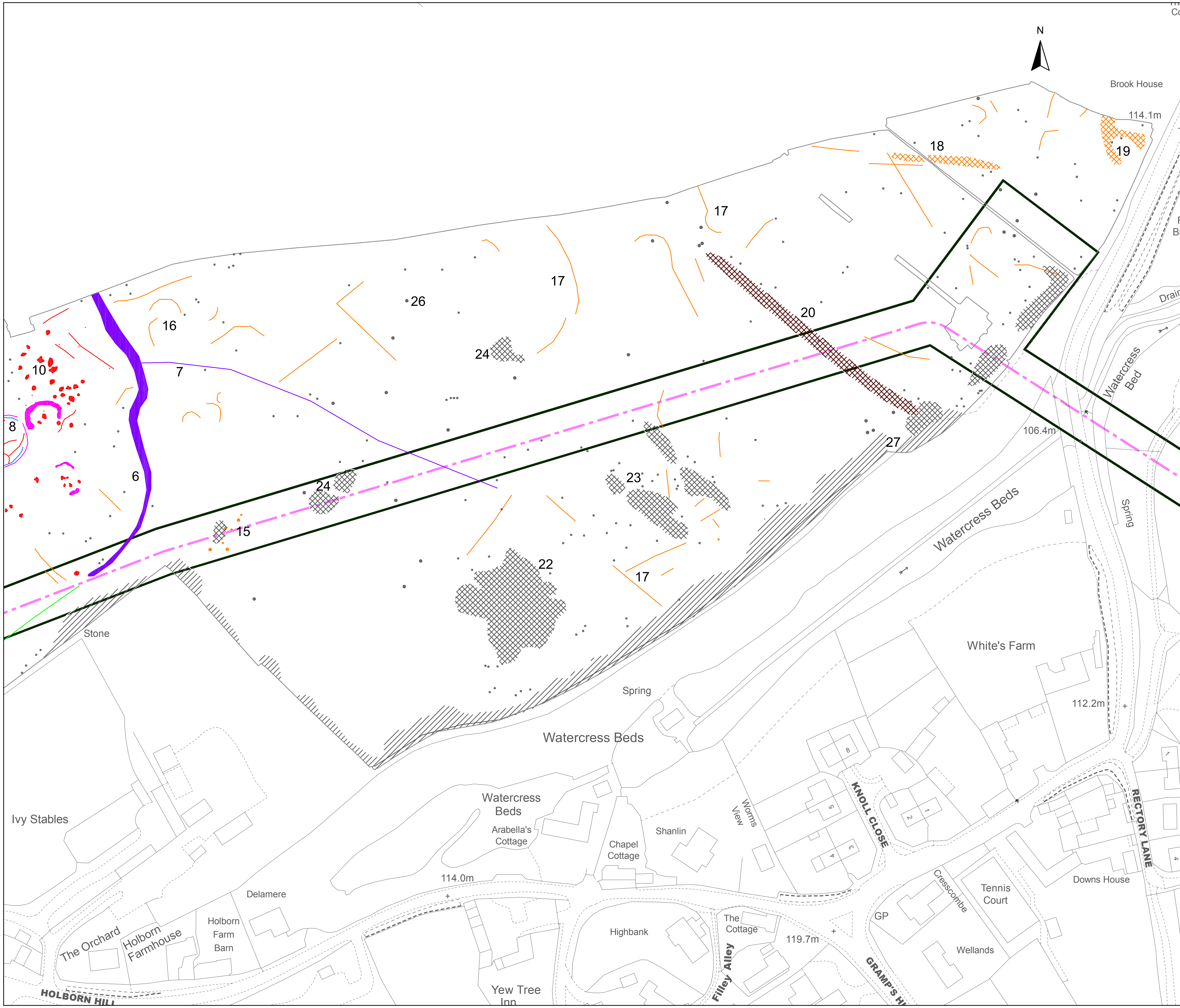
0m 10 20 30 40 50m

SCALE TRUE AT A3

FIG 05

N

Brook House
114.1m
Drain
Watercress Bed
106.4m
Watercress Beds
Spring
Stone
White's Farm
112.2m
Spring
Watercress Beds
Ivy Stables
Watercress Beds
Arabella's Cottage
Chapel Cottage
Shanlin
Worms View
KNOLL CLOSE
RECTORY LANE
Downs House
114.0m
Delamere
Holborn Farm Barn
Holborn Farmhouse
The Orchard
Highbank
The Cottage
119.7m
Filley Alley
Cressombe
Tennis Court
GP
Wellands
HOLBORN HILL
Yew Tree Inn



Archaeological Surveys Ltd

Geophysical Survey
Area 12 (outstanding area)
Childrey Warren WTW
Abstraction Closure
Oxfordshire

Abstraction and interpretation of magnetic anomalies - east

- Positive linear anomaly - cut feature of archaeological potential
- Positive curvilinear/rectilinear anomaly - enclosure ditch
- Positive curvilinear anomaly - ring ditch
- Positive linear anomaly - possible ditch-like feature
- Discrete positive response - cut feature of archaeological potential
- Discrete positive response - possible pit-like feature
- Broad negative anomaly with flanking positive responses - former boundary
- Positive anomaly - magnetically enhanced material
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Magnetic disturbance from ferrous material
- Strong multiple dipolar linear anomaly - pipeline
- Strong dipolar anomaly - ferrous object

SCALE 1:1500

0m 10 20 30 40 50m

SCALE TRUE AT A3

FIG 06

Archaeological Surveys Ltd

Geophysical Survey
Area 12 (outstanding area)
Childrey Warren WTW
Abstraction Closure
Oxfordshire

Greyscale plot of minimally processed magnetometer data - east

+2nT
-2nT
-2nT
+2nT

SCALE 1:1500

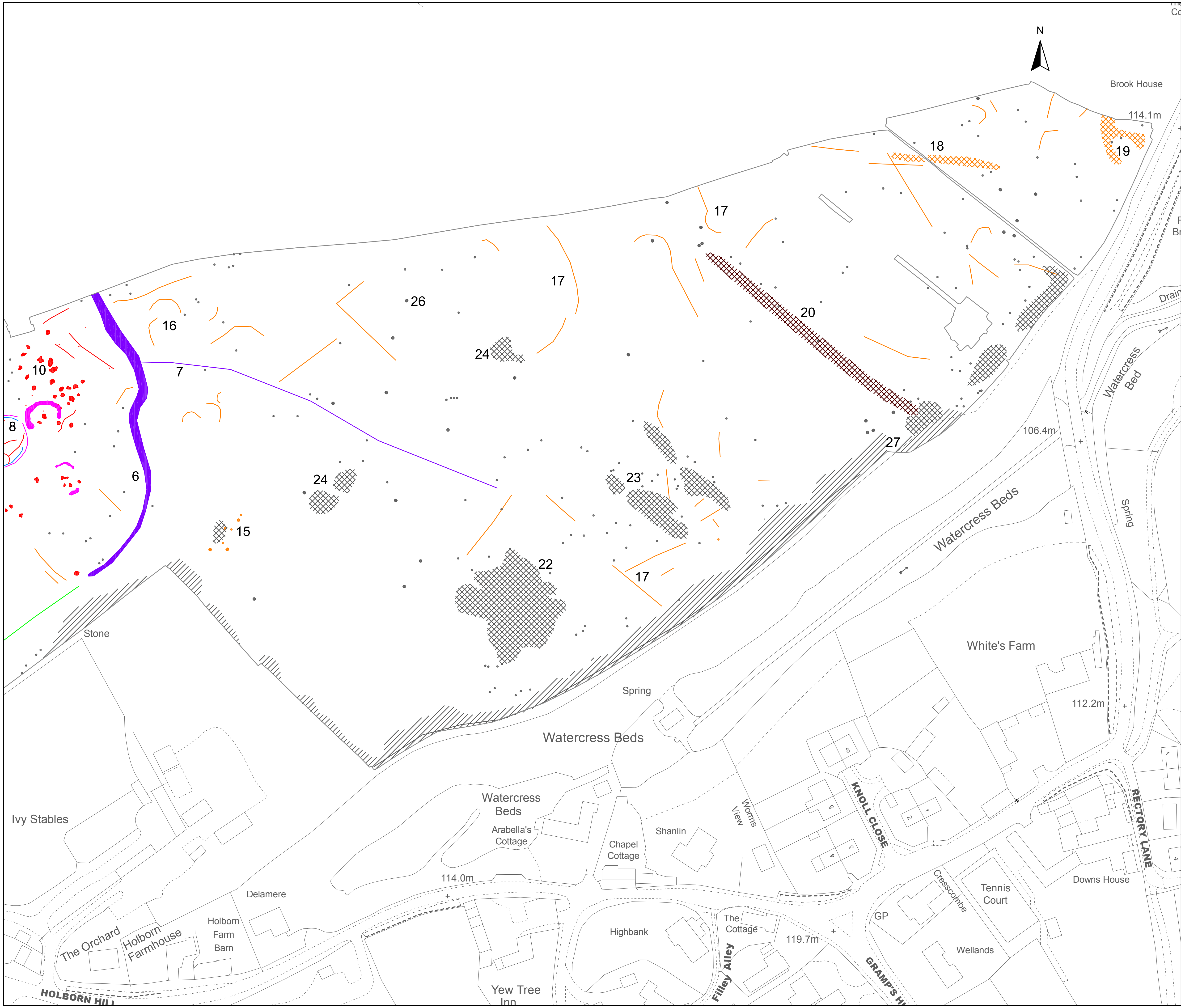
0m 10 20 30 40 50m

SCALE TRUE AT A3

FIG 07

N

Brook House
114.1m
Drain
Watercress Bed
106.4m
Spring
Watercress Beds
White's Farm
112.2m
Stone
Spring
Watercress Beds
Ivy Stables
Watercress Beds
Arabella's Cottage
Chapel Cottage
Shanlin
Worms View
KNOLL CLOSE
RECTORY LANE
Downs House
Delamere
114.0m
The Orchard
Holborn Farmhouse
Holborn Farm Barn
HOLBORN HILL
Highbank
The Cottage
119.7m
Riley Alley
Yew Tree Inn
GRAMP'S HILL
GP
Cresscombe
Tennis Court
Wellands



Archaeological Surveys Ltd

Geophysical Survey
Area 12 (outstanding area)
Childrey Warren WTW
Abstraction Closure
Oxfordshire

Abstraction and interpretation of magnetic anomalies - east

- Positive linear anomaly - cut feature of archaeological potential
- Positive curvilinear/rectilinear anomaly - enclosure ditch
- Positive curvilinear anomaly - ring ditch
- Positive linear anomaly - possible ditch-like feature
- Discrete positive response - cut feature of archaeological potential
- Discrete positive response - possible pit-like feature
- Broad negative anomaly with flanking positive responses - former boundary
- Positive anomaly - magnetically enhanced material
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Magnetic disturbance from ferrous material
- Strong multiple dipolar linear anomaly - pipeline
- Strong dipolar anomaly - ferrous object

SCALE 1:1500

0m 10 20 30 40 50m

SCALE TRUE AT A3

FIG 08

Archaeological Surveys Ltd

Geophysical Survey
Area 12 (outstanding area)
Childrey Warren WTW
Abstraction Closure
Oxfordshire

Greyscale plot of minimally processed magnetometer data - west

+2nT

-2nT +2nT

-2nT

SCALE 1:1500

0m 10 20 30 40 50m

SCALE TRUE AT A3

FIG 09

Archaeological Surveys Ltd

Geophysical Survey
Area 12 (outstanding area)
Childrey Warren WTW
Abstraction Closure
Oxfordshire

Abstraction and interpretation of magnetic anomalies - west

- Positive linear anomaly - cut feature of archaeological potential
- Positive curvilinear/rectilinear anomaly - enclosure ditch
- Positive curvilinear anomaly - ring ditch
- Negative linear anomaly - of archaeological potential
- Positive linear anomaly - possible ditch-like feature
- Positive linear anomaly - of agricultural origin
- Discrete positive response - cut feature of archaeological potential
- Discrete positive response - possible pit-like feature
- Positive anomaly - magnetically enhanced material of archaeological potential
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Magnetic disturbance from ferrous material
- Strong multiple dipolar linear anomaly - pipeline
- Strong dipolar anomaly - ferrous object

SCALE 1:1500

0m 10 20 30 40 50m

SCALE TRUE AT A3

FIG 10

Archaeological Surveys Ltd

Geophysical Survey
Area 12 (outstanding area)
Childrey Warren WTW
Abstraction Closure
Oxfordshire

Greyscale plot of minimally processed magnetometer data - west

+2nT
-2nT
+2nT
-2nT

N

144.1m
BS
122m RH
HOLBORN HILL
Track
Stone
Ivy Stables
Holborn House
Warren Down House
Winton
Winton
123.7m
121.2m
HOLBORN HILL
The Orchard
Holborn Farmhouse
Holborn Farm Barn
Delamere
114.0
Spanswick Farm Cottages
Spanswick Farm Cottages
Track
Track
Spanswick Farm

SCALE 1:1500

0m 10 20 30 40 50m

SCALE TRUE AT A3

FIG 11

Archaeological Surveys Ltd

Geophysical Survey
Area 12 (outstanding area)
Childrey Warren WTW
Abstraction Closure
Oxfordshire

Abstraction and interpretation of magnetic anomalies - west

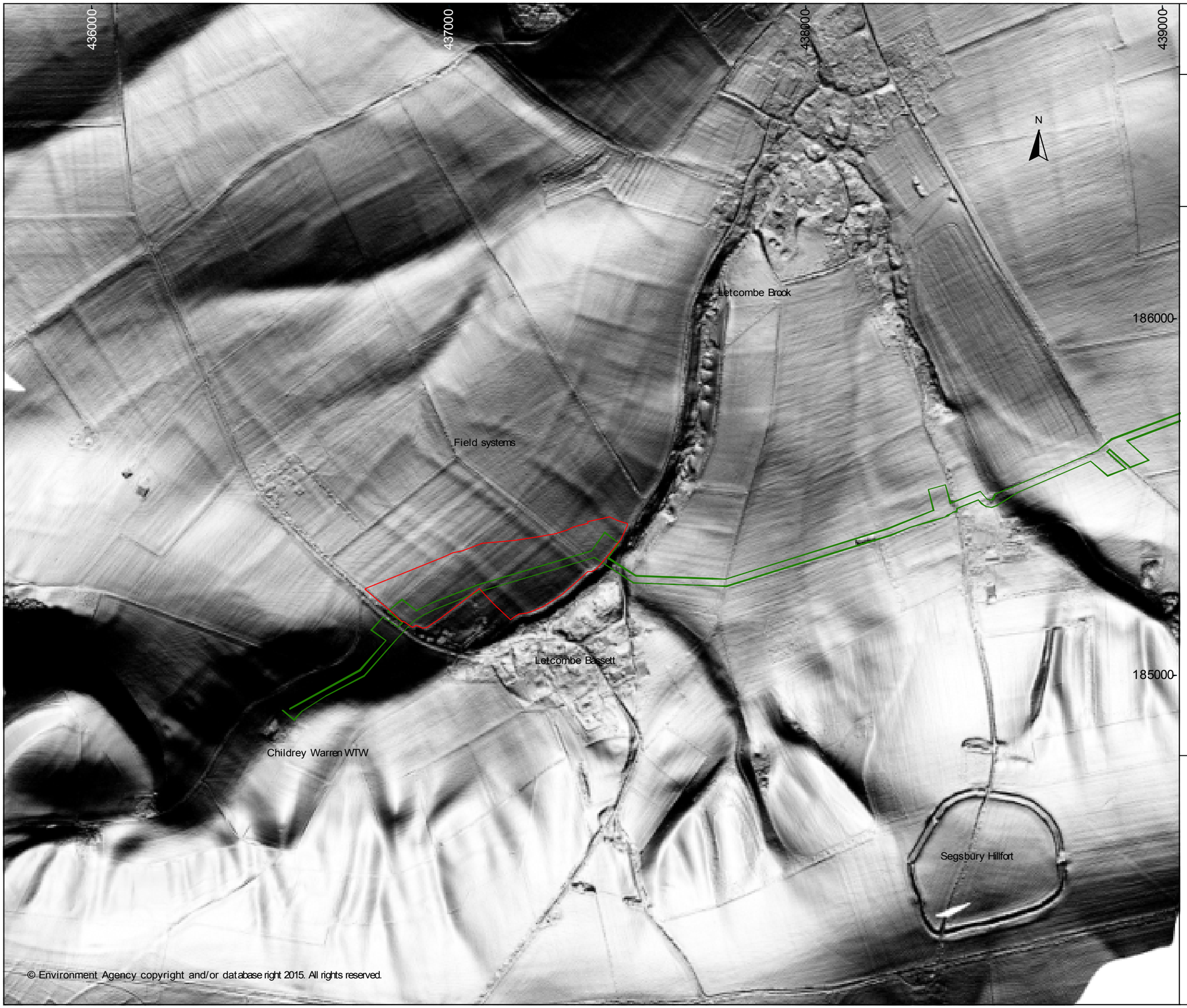
- Positive linear anomaly - cut feature of archaeological potential
- Positive curvilinear/rectilinear anomaly - enclosure ditch
- Positive curvilinear anomaly - ring ditch
- Negative linear anomaly - of archaeological potential
- Positive linear anomaly - possible ditch-like feature
- Positive linear anomaly - of agricultural origin
- Discrete positive response - cut feature of archaeological potential
- Discrete positive response - possible pit-like feature
- Positive anomaly - magnetically enhanced material of archaeological potential
- Broad negative anomaly with flanking positive responses - former boundary
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Magnetic disturbance from ferrous material
- Strong multiple dipolar linear anomaly - pipeline
- Strong dipolar anomaly - ferrous object

SCALE 1:1500

0m 10 20 30 40 50m

SCALE TRUE AT A3

FIG 12



Archaeological Surveys Ltd

Geophysical Survey
Area 12 (outstanding area)
Childrey Warren WTW
Abstraction Closure
Oxfordshire

Digital Terrain Model

Derived from Environment Agency's LiDAR data 1m resolution

SCALE 1:10 000

0m 10 20 30 40 50m

SCALE TRUE AT A3

FIG 13