Substrata
Archaeological Geophysical Surveyors

An archaeological gradiometer survey

Land at Ashwick Court Broadhempston, Devon

Ordnance Survey E/N: 280674,66365 (point)

Report: 140303

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3 March 2014

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Accompanying CD-ROM

1 Survey description and summary

Type of survey: twin-sensor fluxgate gradiometer
Date of survey: 16 January 2014
Area surveyed: 2 ha
Lead surveyor: Ross Dean BSc MSc MA MIfA

Client
AC Archaeology Ltd, 4 Halthaies Workshops, Bradninch, Nr Exeter, Devon EX5 4QL

Location

Site:	Land Ashwick Court
Civil Parish:	Broadhempston
District:	Teignbridge
County:	Devon
Nearest Postcode:	TQ9 6DB
NGR:	SX 806 663 (point)
Ordnance Survey E/N:	280674,66365 (point)
OASIS number:	substrata1-173090
Archive:	At the time of writing, the archive of this survey will be held by Substrata.

Summary
This report was commissioned by AC Archaeology Ltd on behalf of Cavanna Homes. It was prepared by Substrata as supporting information for a forthcoming planning application relating to a proposed residential development at the above site. The location of the site is shown in figure 4.

An Historic Environment Assessment of the site and surrounding area was prepared by AC Archaeology during May 2013 (Meaton, 2013).

The magnetic contrast across the survey areas was sufficient to be able to differentiate between anomalies representing possible archaeological features and background magnetic responses.

Nine magnetic anomaly groups were identified as pertaining to archaeological deposits or structures. Of these, one coincides with former field boundaries mapped on historical maps between 1841 and 1964. Severn groups are likely to reflect former field boundaries and a ditched track not recorded on maps from 1841 onwards. The remaining group may reflect former ridge-and-furrow cultivation across the survey area.

2 Survey aims and objectives

Survey aims
1. Define and characterise and detectable archaeological remains on the site.
2. Inform any future archaeological investigation of the area.

Survey Objectives
1. Complete a gradiometer survey across agreed parts of the survey area.
2. Identify any magnetic anomalies that may be related to archaeological deposits, structures or artefacts.
3. Within the limits of the techniques and dataset, archaeologically characterise any such anomalies or patterns of anomalies.
4. Accurately record the location of the identified anomalies.
5. Produce a report based on the survey that is sufficiently detailed to inform any subsequent development on the site about the location and possible archaeological character of the recorded anomalies.

3 Standards

The standards used to complete this survey are defined by the Institute for Archaeologists (2011). The codes of approved practice that were followed are those of the Institute for Archaeologists (2008 and 2009) and Archaeology Data Service/Digital Antiquity Guides (undated). The document text was written using the house style of the Institute for Archaeologists (Institute for Archaeologists, undated).

4 Site description

Landscape
The survey area was situated within one field bordered by fields to the north, and residential settlement to the south, west and east. The slopes gently to the southwest from approximately 60m to 45m O.D.

Land use at the time of the survey
Grass pasture.

Geology
The site is located on a solid geology of limestone of the Devonian Nordon Formation (British Geological Survey, undated).

The superficial geology is not recorded in the source used (British Geological Survey, undated).

5 Archaeological background

AC Archaeology Ltd have produced an Historic Environment Assessment of the site and surrounding area (Meaton, 2013). The reader is referred to this document for a comprehensive analysis of the historical and archaeological background of the site. What follows is a short summary of the information presented in the Assessment relevant to the understanding of the gradiometer survey.

The proposed development site lies within an area containing no certain sites of either prehistoric or Romano-British date, although there is evidence for Anglo-Saxon settlement as well as medieval and post-medieval agriculture and settlement. Closer to Broadhempston, there is the site of an Anglo-Saxon 'burh' whilst the village itself is a 'planned' or 'extended' medieval town. In the general area, archaeological sites are sparse, and restricted to three sub circular crop marks interpreted as possible Bronze Age round barrows and a small number of sites pertaining to post-medieval industry, settlement and agriculture.

During the 19th and early 20th centuries the survey area comprised three fields of planted orchards and a fourth agricultural field.

The historic landscape characterisation of the survey field is 'modern enclosures adapting post-medieval fields' which are characterised as modern enclosures that have been created by adapting earlier fields of probable post-medieval date (Devon County Council, undated). The broader landscape is largely designated as either 'historic settlement' or 'medieval enclosures based on strip fields'. In general the site is considered to form part of a fossilised medieval landscape.

Heritage assets
There are no designated heritage assets within the survey area. Six non-designated heritage assets were identified by AC Archaeology:

- Four former field boundaries mapped on the Broadhempston tithe map and on historical Ordnance Survey maps.

Evidence for these boundaries was recorded in the survey dataset (anomaly group 1 in figure 1)

- Two linear topographic anomalies identified during a walkover survey undertaken by AC Archaeology.
  Evidence for these anomalies was recorded in the survey dataset (anomaly groups 2 to 5 in figure 1).

Archaeological works adjacent to the survey area

There are no records for work within or immediately adjacent to the survey area.

6 Results, discussion and conclusions

This survey was designed to record magnetic anomalies. The anomalies themselves cannot be regarded as actual archaeological features and the dimensions of the anomalies shown do not represent the dimensions of any associated archaeological features. The analysis presented below attempts to identify and characterise anomalies and anomaly groups that may pertain to archaeological deposits and structures.

The reader is referred to section 7.

6.1 Results

Figure 1 (this section) shows the interpretation of the survey across all survey areas including the anomaly groups identified as pertaining to archaeological deposits along with their numbers. Table 1 is an extract from a detailed analysis of the survey data provided in the attribute tables of the GIS project on the accompanying CD-ROM.

Only those anomaly groups considered likely or possibly pertain to archaeological deposits or features are recorded in figure 1 and table 1.

Figure 1 and table 1 comprise the analysis of the survey data.

Plots of the processed data are provided in figures 2 and 3 (appendix 1).

Site: An archaeological gradiometer survey
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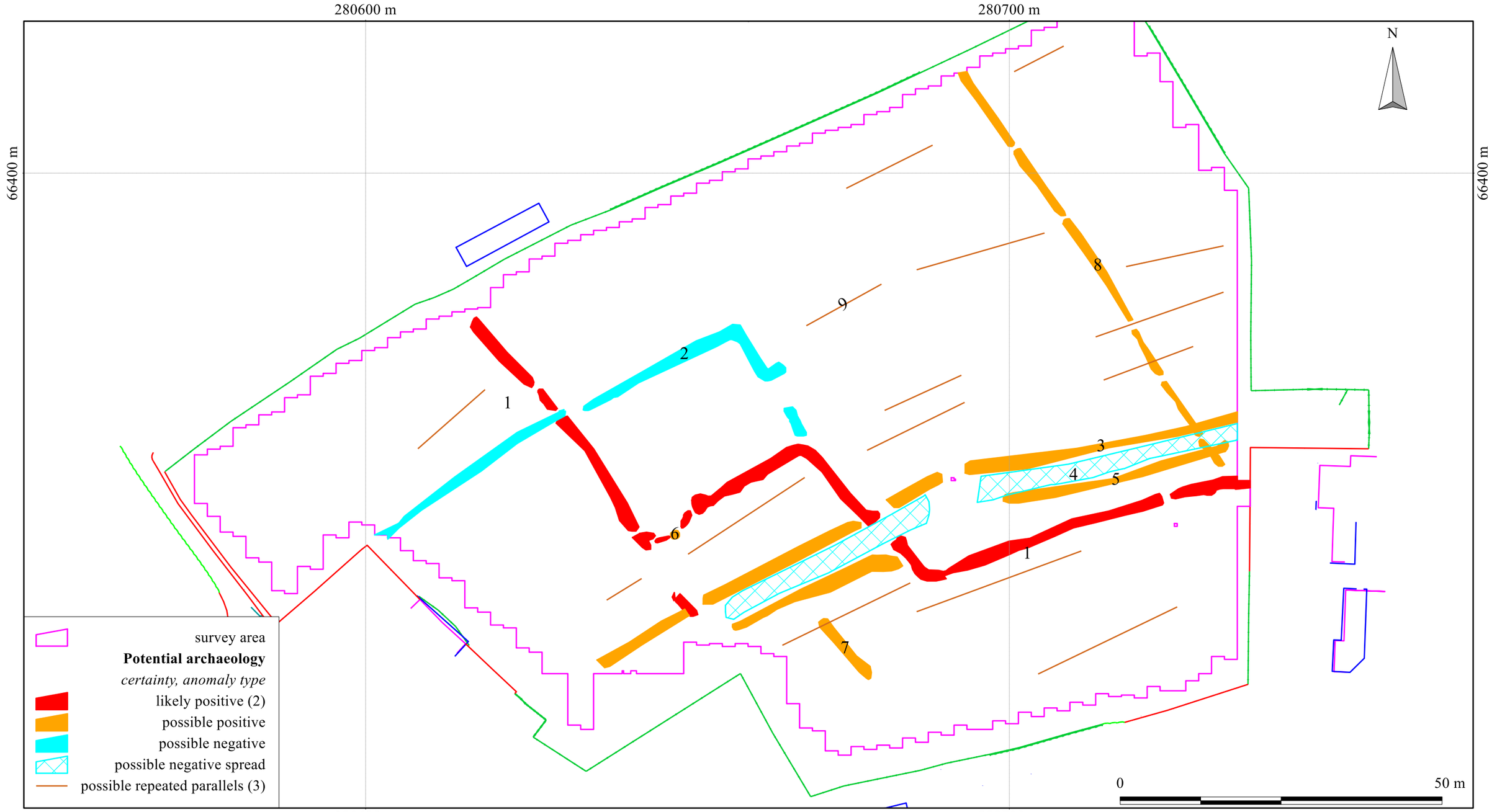
anomaly group	associated anomolies	anomaly characterisation certainty & class	anomaly form	additional archaeological characterisation	comments	supporting evidence
1	6	likely positive	disrupted multilinear	field boundary	anomaly groups coincide with a field boundary mapped on the 1841 tithe map and on OS maps between 1891 and 1964	1841 Broadhempston tithe map & Ordnance Survey maps between 1891 and 1964
2		possible negative	disrupted multilinear			
3	4 5	possible positive	disrupted linear	track edge ditch	anomaly groups may represent the ditched edge of a former track	
4	3 5	possible negative spread	disrupted broad linear	stony surface	anomaly groups may represent a stony surface of a former track or be 'shadow anomalies' of groups 3 and 5	
5	3 4	possible positive	disrupted linear	track edge ditch	anomaly groups may represent the ditched edge of a former track	
6	1	possible positive	oval	pit or large post hole	anomaly group likely to be part of anomaly group 1 but may be a posthole or pit	
7		possible positive	linear			
8		possible positive	disrupted linear			
9		possible parallel linears		cultivation traces	possibly ridge-and-furrow	

Table 1: data analysis



British Grid
centre X: 280659.48 m, centre Y: 66362.47 m

Scale: 1:600 @ A3. Spatial Units: Meter. Do not scale off this drawing

Notes:

1. All interpretations are provisional and represent potential archaeological deposits.
2. Anomalies designated "likely archaeology" have supporting evidence e.g. historical maps and or visible earthworks.
3. Representative; not all instances are mapped.
4. Anomalies likely to represent geological or other natural deposits are not mapped unless relevant to potential archaeological events or deposits.

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Figure 1: survey interpretation

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6.2 Discussion

Refer to figures 1 (this section), 2 and 3 (appendix 1).

Not all anomalies or anomaly groups identified in the survey dataset are necessarily discussed below. All identified anomaly groups are recorded in the GIS project on the accompanying CD-ROM. Those anomaly groups possibly representing archaeological deposits are included in data analysis table 1.

General points
Data collection along the field edges was restricted as shown in figures 2 and 3 due to the presence of magnetic materials in and adjacent to the field boundaries.

Data relating to historical maps and other records
Anomaly group **1** coincides with field boundaries mapped on the 1841 Broadhemptonstead tithe map and on Ordnance Survey maps between 1891 and 1964.

Data with no previous provenance
Group **2** has a pattern typically associated with former field boundaries or similar enclosures. An associated earthwork was recorded by AC Archaeology during a walkover survey (Meaton, 2013).

Groups **3 to 5** also have associated earthworks recorded during the AC Archaeology walkover survey (ibid). The anomaly patterns are indicative of a former ditched track, possibly with a stony track surface.

Groups **7 and 8** may reflect field or enclosure boundaries.

There are two trends in the survey data running approximately north-north-west to south-south-east and west-south-west to east-north-east (figure 3), They are both likely to represent disturbance of near-surface deposits during cultivation and the latter may represent ridge-and-furrow ploughing (group **9**).

6.3 Conclusions

The magnetic contrast across the survey areas was sufficient to be able to differentiate between anomalies representing possible archaeological features and background magnetic responses.

Nine magnetic anomaly groups were identified as pertaining to archaeological deposits or structures. Of these, one coincides with former field boundaries mapped on historical maps between 1841 and 1964. Severn groups are likely to reflect former field boundaries and a ditched track not recorded on maps from 1841 onwards. The remaining group may reflect former ridge-and-furrow cultivation across the survey area.

7 Disclaimer and copyright

The description and discussion of the results presented in this report are the authors, based on his interpretation of the survey data. Every effort has been made to provide accurate descriptions and interpretations of the geophysical data set. The nature of archaeological geophysical surveying is such that interpretations based on geophysical data, while informative, can only be provisional. Geophysical surveys are a cost-effective early step in the multi-phase process that is archaeology. The evaluation programme of which this survey is part may also be informed by other archaeological assessment work and analysis. It must be presumed that more archaeological features will be evaluated than those specified in this report.

8 Acknowledgements

Substrata would like to thank John Valentin of AC Archaeology Ltd for commissioning us to complete this survey.

9 Bibliography

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Appendix 1 Supporting plots

General Guidance

The anomalies represented in the survey plots provided in this appendix are magnetic anomalies. The apparent size of such anomalies and anomaly patterns are unlikely to correspond exactly with the dimensions of any associated archaeological features.

A rough rule for interpreting magnetic anomalies is that the width of an anomaly at half its maximum reading is equal to the width of the buried feature, or its depth if this is greater (Clark, 2000: 83). Caution must be applied when using this rule as it depends on the anomalies being clearly identifiable and distinct from adjacent anomalies. In northern latitudes the position of the maximum of a magnetic anomaly will be displaced slightly to the south of any associated physical feature.

280600 m

280700 m

66400 m

66400 m

N

1

Processed gradiometer data

nT

5

-5

0

50 m

280600 m

280700 m

British Grid
centre X: 280659.48 m, centre Y: 66362.47 m

Scale: 1:600 @ A3. Spatial Units: Meter. Do not scale off this drawing

Notes:

1. All interpretations are provisional and represent potential archaeological deposits.
2. Anomalies designated "likely archaeology" have supporting evidence e.g. historical maps and or visible earthworks.
3. Representative; not all instances are mapped.
4. Anomalies likely to represent geological or other natural deposits are not mapped unless relevant to potential archaeological events or deposits.

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Figure 2: shade plot of processed data

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280600 m

280700 m

66400 m

66400 m

N

Processed gradiometer data contours

Areas : Height

< -4.00

-4.00 - -2.00

-2.00 - -1.00

-1.00 - -0.50

-0.50 - 0.50

0.50 - 1.00

1.00 - 2.00

2.00 - 4.00

> 4.00

0

50 m

280600 m

280700 m

British Grid
centre X: 280659.48 m, centre Y: 66362.47 m

Scale: 1:600 @ A3. Spatial Units: Meter. Do not scale off this drawing

Notes:

1. All interpretations are provisional and represent potential archaeological deposits.
2. Anomalies designated "likely archaeology" have supporting evidence e.g. historical maps and or visible earthworks.
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Figure 3: contour plot of processed data

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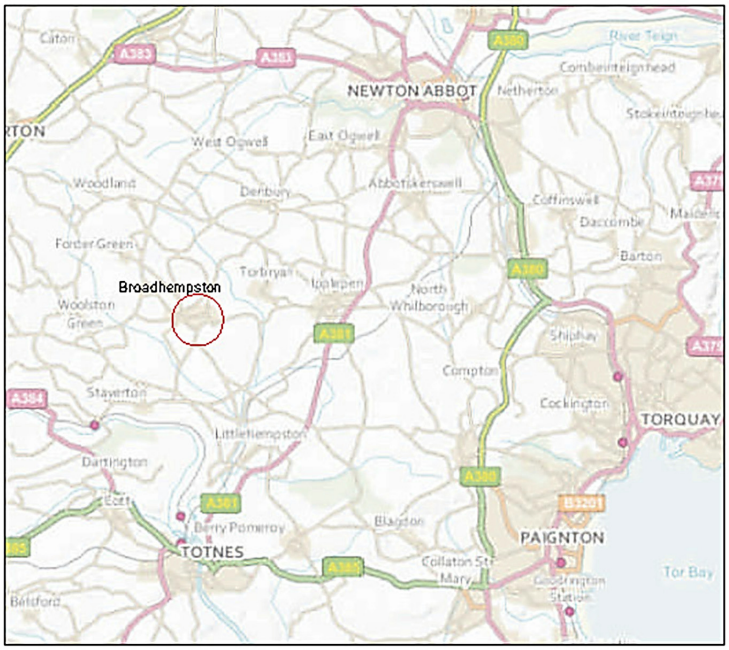
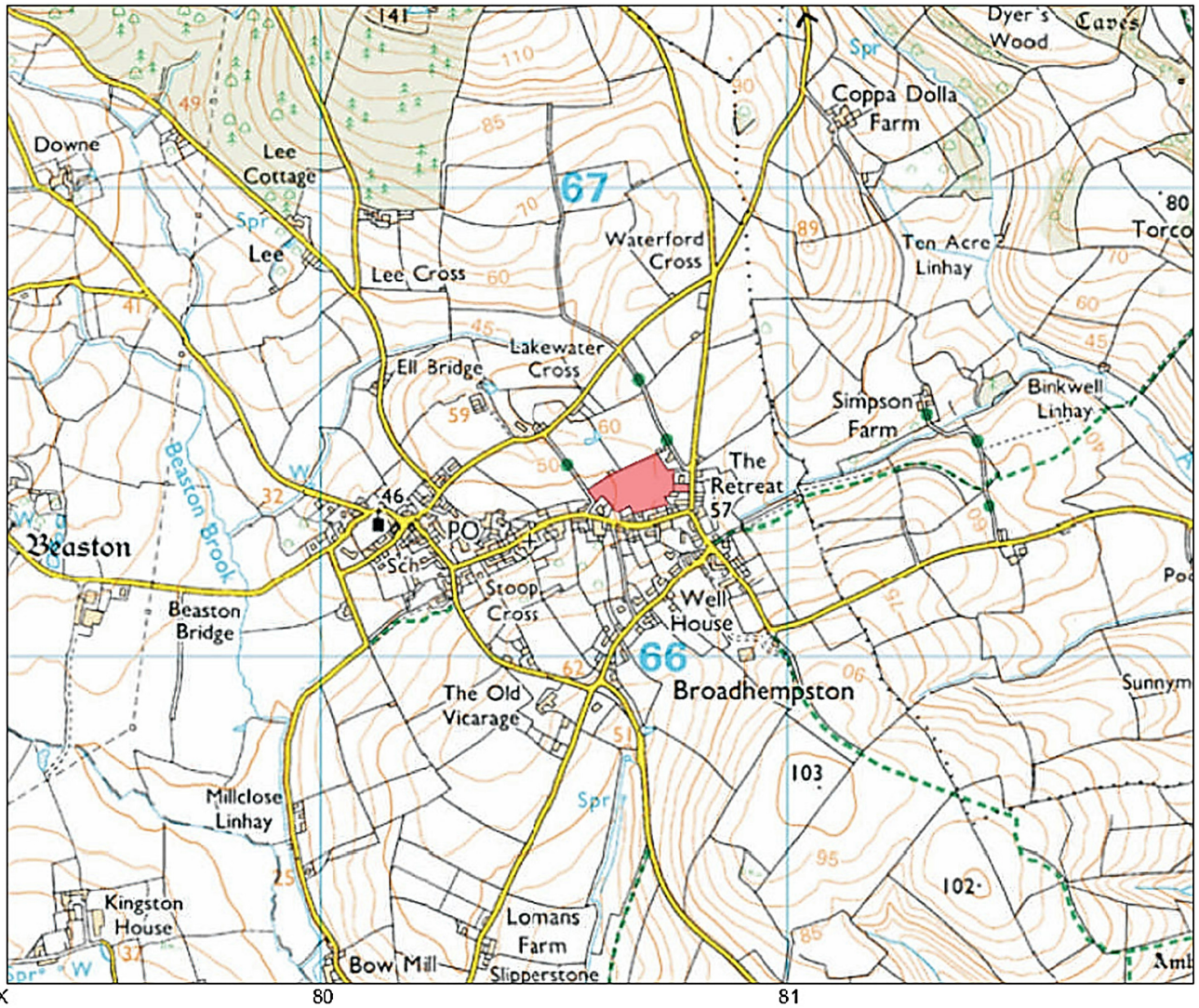


N



0 100m

Scale 1:15,000@A4

Application area

PROJECT

Ashwick Court, Broadhempston, Devon

TITLE

Fig.4 : Location of site

AC archaeology

Appendix 2 Methodology Summary

Table 2: methodology summary	
Documents Survey methodology statement: Dean (2014)	
Methodology 1. The work was undertaken in accordance with the survey methodology statement. The geophysical (gradiometer) survey was undertaken with reference to standard guidance provided by the Institute for Archaeologists (2011) and Archaeology Data Service/Digital Antiquity Guides (undated). 2. The survey grid location information and grid plan was recorded as part of the project in a suitable GIS system. 3. Data processing was undertaken using appropriate software, with all anomalies being digitised and geo-referenced. The final report included a graphical and textual account of the techniques undertaken, the data obtained and an archaeological interpretation of that data and conclusions about any likely archaeology.	
Grid *Method of Fixing:* DGPS set-out using pre-planned survey grids and Ordnance Survey coordinates. *Composition:* 30m by 30m grids *Recording:* Geo-referenced and recorded using digital map tiles. *DGPS used:* Spectra Precision PM5V2 GPS with external antenna and survey pole and DigiTerra Explorer 7 as the survey control program.	
Equipment *Instrument:* Bartington Instruments grad601-2 *Firmware:* version 6.1	**Data Capture** *Sample Interval:* 0.25-metres *Traverse Interval:* 1 metre *Traverse Method:* zigzag *Traverse Orientation:* GN
Data Processing, Analysis and Presentation Software DW Consulting TerraSurveyor3 Manifold System 8 Microsoft Corp. Office Publisher 2013.	

Appendix 3 Data processing

Table 3: gradiometer survey - processed data metadata
SITE Instrument Type: Bartington Grad 610 Units: nT Direction of 1st Traverse: 0 deg Collection Method: ZigZag Sensors: 2 @ 1.00 m spacing. Dummy Value: 32702 PROGRAM Name: TerraSurveyor Version: 3.0.22.1
Stats Max: 108.45 Min: -116.26 Std Dev: 7.22 Mean: 0.05 Median: 0.00 Surveyed Area: 2.0574 ha Processes: 4 1 Base Layer 2 Clip at 1.00 SD 3 De Stagger: Grids: All Mode: Both By: -4 intervals 4 DeStripe Median Sensors: All Note: exporting the processed data from TerraSurveyor into Manifold GIS for analysis imposes an 'x matches y' interpolation on the data which is reflected in the processed data figures.

Appendix 4 Geophysical surveying techniques

1 Introduction

Substrata offers magnetometer and earth resistance surveying. We also provide other archaeology-specific geophysical surveys such as ground penetrating radar and resistivity. The particular method or combination of methods used depends on local soil conditions and the survey requirements. These methods are capable of delivering fast and accurate assessments of the archaeology of both large and small sites.

Further details can be found on our website at www.substrata.co.uk.

2 Magnetometer surveying

Standard magnetometer surveys are the workhorse of archaeological surveying when speed and cost-effectiveness are important. Identifiable archaeological features include areas of occupation, hearths, kilns, furnaces, ditches, pits, post-holes, ridge-and-furrow, timber structures, wall footings, roads, tracks and similar buried features.

Magnetometer surveying is used to detect and map small changes in the earth's magnetic field caused by concentrations of ferrous-based minerals within the soil and subsoil, and by materials buried beneath the surface. While most of these changes are too small to affect a compass needle, they can be detected and mapped by sensitive field equipment. During surveys the different magnetic properties of top-soils, sub-soils, rock formations and archaeological features are recorded as variations against a background value. Subsequently magnetic anomalies resulting from potential archaeology can be identified and interpreted.

Bartington grad601-2 gradiometers

A gradiometer is a type of magnetometer and is sensitive to relatively small changes in the earth's magnetic field. Our primary surveying instruments are Bartington Grad601-2 (dual sensor) fluxgate gradiometers with automatic data loggers. They are specifically designed for field use by archaeologists. The Bartington gradiometers provide proven technology in archaeological magnetic surveying and offer fast, accurate set-up and survey rates. They are sensitive to depths of between 0 and 1.5m below ground level, with optimum sensitivity at depths of 1m or less.

Multiple sensor arrays

A technique relatively new to commercial archaeological surveying but well understood in academic circles involves the use of multiple magnetometer sensors towed behind a quad bike or similar vehicle. With multiple sensors and the use of on-board GPS units, it is possible to achieve faster survey rates at competitive commercial rates when compared to the use of multiple instruments and the techniques discussed above provided the ground is suitable for the vehicle and array. Substrata is pleased to announce that we now offer this service on suitable larger sites

3 Earth resistance surveying

Earth resistance surveying is an excellent tool for detecting buried archaeology. Its relatively slow rate of survey compared to magnetometer surveys means that it usually employed in commercial surveys when a detailed understanding of buried building remains is required. This technique measures changes in the electrical resistance of the ground being surveyed. In practice, the recording of differences in the electrical resistance of near-surface deposits and structures allows the detection and interpretation of masonry and brick foundations, paving and floors, drains and other cavities, large pits, building platforms, robber trenches, ditches, graves and similar buried features.

Resistance to electrical current flow in the ground depends on the moisture content and structure of the soil and other materials buried beneath the surface. For example, the higher the moisture content of a soil, the less resistant it is to electrical current flow. A ditch completely buried beneath the present ground surface is likely to have an infill soil different to that surrounding the ditch in terms of compactness and composition. As a result, the soil filling the buried ditch will retain moisture in a different way to the surrounding soil which means it will

have an electrical resistance at variance with the surrounding environment. By passing a small current through the ground it is possible to detect, record, plot and interpret such changes in electrical resistance.

For earth resistance surveying Substrata uses the Geoscan Research RM15 series multi-probe resistance meters and purpose-built automatic data-loggers. The Geoscan MPX15 multiplexer is an integral part to the instrument configuration and facilitates multi-probe arrays which speed up survey area coverage rates and, if required, facilitate simultaneous multiple-depth data collection.