Substrata
Archaeological Geophysical Surveyors

An archaeological gradiometer survey

Land at North Wayton Farm, Landulph, Cornwall
National grid coordinates: 241580, 63149

Report: 120907
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6 October 2012

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Colin Wakeham

Accompanying CD-ROM

Report ..... Adobe PDF format
Copies of report figures ..... Adobe PDF format
Data Files and grid plan
Survey areas and grids ..... Adobe PDF format
Data files ..... grid files generated using DW Consulting ArcheoSurveyor2
Minimal processing data plots and metadata ..... Adobe PDF format
GIS project, shape files and classification schema
GIS project and shape files ..... ESRI standard
GIS classification schema ..... Adobe PDF format

1 Survey description and summary

Type of survey: twin-sensor fluxgate gradiometer
Date of survey: 18 to 20 September 2012
Area surveyed: 16ha.
Lead surveyor: Ross Dean BSc MSc MA MIfA

Client
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Location

Site:	Land at North Wayton Farm
Parish:	Landulph
County:	Cornwall
NGR:	SX 41580 63149
NG coordinates:	241580, 63149
OASIS number:	substrat1-135118

Summary
This report was commissioned by AC Archaeology Ltd and prepared by Substrata in support of a forthcoming planning application for a solar farm and associated infrastructure at the above site by Kronos Solar GmbH. AC Archaeology have prepared a Historic Environment Assessment of a wider study area, of which this survey area is a part, in support of the forthcoming planning application (Kerr-Peterson and Passmore, 2012).

The magnetic contrast across the survey areas was sufficient to be able to differentiate between anomalies representing possible archaeological features and background magnetic responses. A total of thirty-seven magnetic anomaly groups were identified as pertaining to potential archaeology. Three of these anomaly groups probably represent archaeological deposits forming one or more phases of concentric, sub-rectangular enclosures with maximum internal dimensions of approximately 85m by 95m. A group anomalies in close proximity to these enclosures were identified as representing possible pits or large postholes. Elsewhere in the survey area, a possible subcircular archaeological deposit of approximately 12.5m internal diameter was highlighted but this may prove to be a coincidental pattern. A group of five curvilinear anomaly patterns may represent archaeological deposits that formed one or more phases of a ditch and bank structure. It seems that the extant field boundary crossing these groups has followed their trend. Five anomaly groups can be related to field boundaries recorded on historical maps. The majority of the other highlighted anomaly groups form linear and curvilinear patterns that may represent remnants of more than one phase of former field boundaries and/or other enclosures.

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.

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).

2 Site description

Landscape
Refer to figure 1.
The survey area comprises six fields (plots 1 to 6) in an irregular block 900m northwest of Landulph.

Land use at the time of the survey
Grass pasture.

Geology
The site is located on a solid geology of the Upper Devonian Tavy Formation (British Geological Survey, undated 1) which comprise pale green and grey-green slaty silty mudstones with minor thin fine-grained sandstone beds and lenses (British Geological Survey, undated 2).

Soils
The soils are of the Denbigh 1 association (Soil Survey of England and Wales, 1983) which are characterised as fine, loamy, typical brown earths on solid or shattered rock within a depth of 0.8m (Findley et al, 1983: 145).

Historic Landscape Characterisation
Medieval Farmland: 'The agricultural heartland with farming settlements documented before the 17th century AD and whose field patterns are morphologically distinct from the generally straight sided fields of late enclosure. Either medieval or prehistoric origin' (Cornwall Historic Landscape Characterisation mapping project, after Peterson and Passmore (2012)).

Known archaeological sites in the survey area
Refer to figure 1.
There is one Historical Environment Record within the survey area (at the northern boundary of plot 2) and one some 15m to the east of plot 1.

> MCO47882, SX 41359 63301; extant structure; a deserted Post-medieval settlement northwest of North Wayton. The anomaly patterns in this area were dominated by those representing recently dumped rubble and other material.
>
> MCO21729, SX 41688 63247; cropmarks on oblique aerial photographs; an Iron Age or Romano-British sub-rectangular enclosure.

A summary of the archaeological and historical background to this site can be found in Kerr-Peterson and Passmore (2012).

Previous fieldwork within the survey area
The Cornish National Mapping Project covered the survey area. No other formal programmes of archaeological work are recorded that directly relate to the survey area (Kerr-Peterson and Passmore, 2012).

3. 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 4.

3.1 Results

Figures 1 (this section) and 2 (appendix 1) show the interpretation of the survey and 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.

Figures 1 and 2 along with table 1 comprise the analysis and interpretation of the survey data.

The processed gradiometer data is presented in figure 3, appendix 1.

Survey data analysis

Site: An Archaeological Gradiometer Survey
Land at North Wayton Farm, Landulph, Cornwall
National grid coordinates: 241580, 63149
Report: 120907

anomaly group	associated anomaly group(s)	characterisation certainty	anomaly form	additional archaeological characterisation	comments	supporting evidence
1		likely	curvilinear	field boundary	anomaly group represents a field wall shown on the 1840 tithe map	1840 Landulph tithe map
2		possible	linear	field boundary; Cornish bank	anomaly group indicative of a Cornish bank	
3		possible	disrupted linear		anomaly group may represent as stony linear surface - possibly a former routeway	
4		possible	linear			
5		possible	linear			
6		likely	linear	field boundary	anomaly group represents a field wall shown on the 1840 tithe map	1840 Landulph tithe map
7		possible	curvilinear			
8		possible	linear	field boundary; Cornish bank		
9		possible	disrupted curvilinear			
10		possible	curvilinear			
11		possible	curvilinear			
12		possible	curvilinear			
13		possible	disrupted curvilinear			
14		likely	disrupted curvilinear	field boundary; Cornish bank	anomaly group represents a field wall shown on the 1840 tithe map	1840 Landulph tithe map
15		possible	disrupted curvilinear			
16		possible	broad linear		anomalies suggest linear features but influenced by modern field boundaries and ground disturbance	
17		possible	disrupted linear			
18		likely	multilinear	field boundary; Cornish bank	anomaly group represents a field wall shown on the 1840 tithe map	1840 Landulph tithe map
19	20 21	possible	disrupted rectilinear			
20	19 21	possible	disrupted rectilinear			
21	19 20	possible	disrupted rectilinear			
22		possible	oval	pits	anomalies well defined AND in vicinity of a likely prehistoric structure	
23		possible	linear			
24		possible	oval	stone	anomaly well defined and unusual in dataset	
25		possible	disrupted linear	field boundary; Cornish bank (?)		
26		likely	rectilinear	field boundary; Cornish bank (?)	anomaly group represents a field wall shown on the 1840 tithe map	1840 Landulph tithe map
27		possible	linear			
28		possible	curvilinear			
29		possible	curvilinear			
30		possible	subcircular		tenuous	
31		possible	disrupted linear			
32		possible	linear			
33		likely	linear		extant bank	earthwork
34		possible	linear			
35		possible	linear			
36		possible	linear			
37		possible	linear			

Table 1: data analysis

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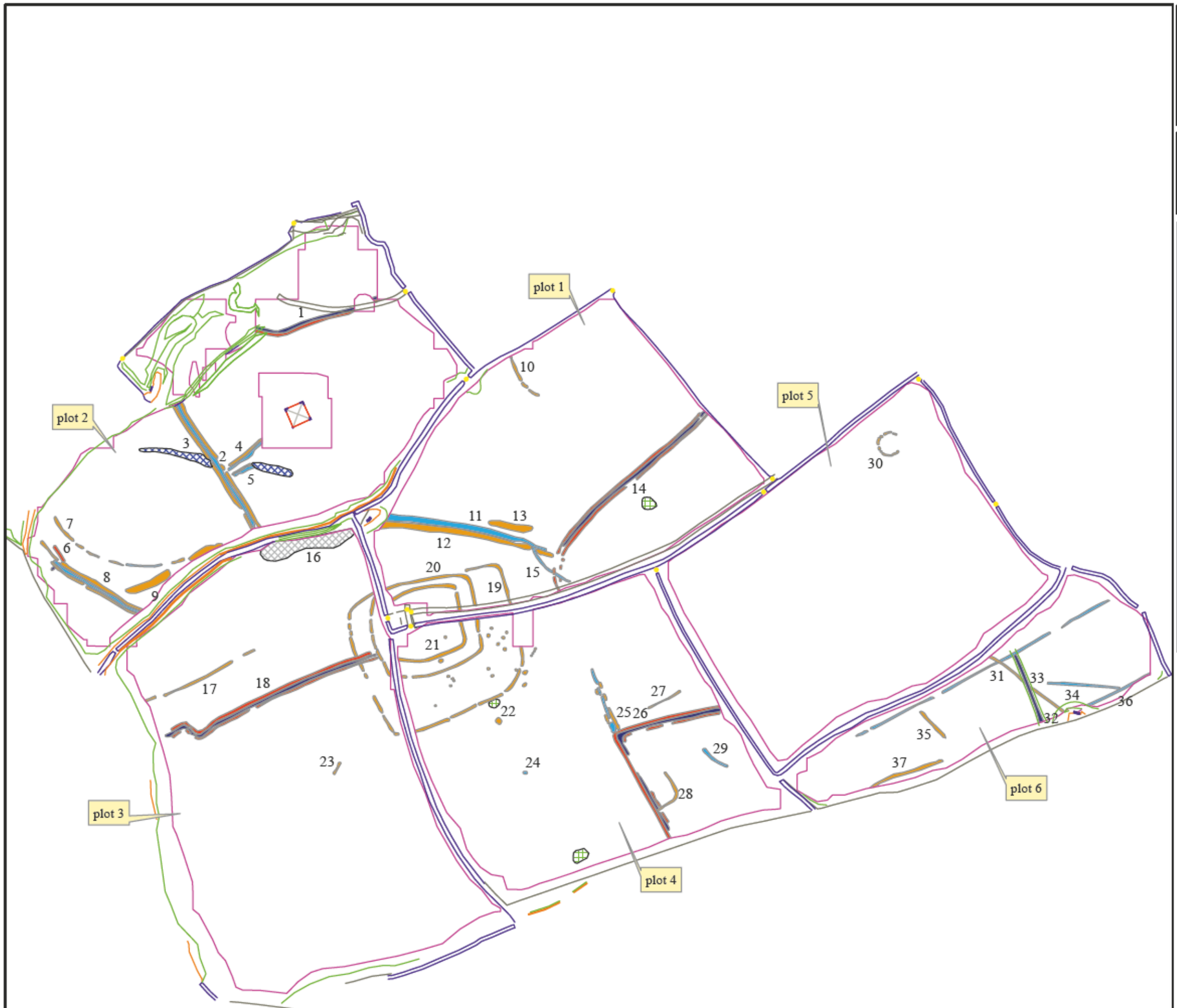

N

Legend

- gradiometer survey area

gradiometer potential archaeology

- likely archaeology, positive anomaly (supporting evidence)
- likely archaeology, negative anomaly (supporting evidence)
- possible archaeology, positive anomaly
- possible archaeology, negative anomaly
- possible archaeology, mixed anomalies
- possible archaeology, negative spread

gradiometer potential natural

- possible natural, spring

Notes:

1. All interpretations are provisional and represent potential archaeological deposits.
2. Representative of trends; only anomalies relevant to potential archaeology are recorded.
3. Anomalies likely to represent very recent ground disturbance are not highlighted.
4. Filled circles used to define anomalies are symbols and do not indicate possible circular archaeological features unless specifically indicated in the text.

0 25 50 100 Meters

Figure 1: survey interpretation

3.2 Discussion

Refer to figures 1 and 2

Not all anomalies or anomaly groups identified in the survey dataset are 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.

Anomaly groups **1** (plot 2), **6** (plot 2), **14** (plot 1), **18** (plot 3) and **26** (plot 4) represent former field boundaries mapped on the 1840 Landulph tithe map. Of these, all but group 1 have patterns typical of former Devon bank footings (Devon banks comprise a central bank and flanking ditches on each side). Group **25** is an extension of group 26 removed sometime before 1840.

Anomaly group **3** (plot 2)has a pattern consistent with a linear stony spread. It may represent a former routeway or footings of a wall or bank.

The curvilinear anomaly groups **9** (plot 2), **11**, **12**, **13** (plot 1) and possibly **16** (plot 3) may represent archaeological deposits, possibly former ditches and banks, that may have resulted from one or more phases of activity. It seems that the extant field boundary crossing these groups has followed their trend. These anomalies have a broader form not encountered elsewhere in the data set and are unlikely to be of the same phase of activity as the former historical field walls discussed above.

Of all the anomalies identified as pertaining to archaeological deposits or structures, groups **19**, **20** and **21** stand out (plots 1, 3 and 4). While it cannot be certain from the geophysical data alone, it is likely that this series of concentric rectilinear anomaly groups represent a single archaeological structure or more than one phase of construction of an archaeological structure with maximum internal dimensions of approximately 85m by 95m. Figure 2 (appendix 1) shows that these anomaly groups are situated on a small east-west trending spur.

Group **22** (plot 4) are a set of oval anomaly patterns that are presented as possible archaeology because of their proximity to groups 19 to 21 and relative density compared to elsewhere in the data set. They may represent former pits or large postholes.

Group **24** (plot 4) stands out in the data set and may represent a buried stone or stony deposit.

In plot 5, anomaly group **30** may represent a circular archaeological deposit with an internal diameter of approximately 12.5m but the group is not continuous and may form a coincidental pattern.

The remaining anomaly groups identified as pertaining to archaeological deposits or structures form linear and curvilinear patterns which typically represent former enclosure and field boundaries. Some of these are not on the orientation of the current field system. It is likely that they represent more than one phase of past land management

3.3 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. A total of thirty-seven magnetic anomaly groups were identified as pertaining to potential archaeology.

Three of these anomaly groups probably represent archaeological deposits forming one or more phases of concentric, sub-rectangular enclosures with maximum internal dimensions of approximately 85m by 95m. A group anomalies in close proximity to these enclosures were identified as representing possible pits or large postholes.

A possible subcircular archaeological deposit of approximately 12.5m internal diameter was highlighted but this may prove to be a coincidental pattern.

A group of five curvilinear anomaly patterns may represent archaeological deposits that formed one or more phases of a ditch and bank structure. It seems that the extant field boundary crossing these groups has followed their trend.

Five anomaly groups can be related to field boundaries and tracks recorded on historical maps. The majority of the other highlighted anomaly groups form linear and curvilinear patterns that may represent remnants of more than one phase of former field boundaries and/or other enclosures.

4 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.

5 Acknowledgements

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

6 References

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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.

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gradiometer potential natural

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Notes:
1. All interpretations are provisional and represent potential archaeological deposits.
2. Representative of trends; only anomalies relevant to potential archaeology are recorded.
3. Anomalies likely to represent very recent ground disturbance are not highlighted.
4. Filled circles used to define anomalies are symbols and do not indicate possible circular archaeological features unless specifically indicated in the text.

0 12.5 25 50 Meters

Figure 2: survey interpretation, likely archaeological site with 0.5m contour lines (metres A.O.D.)

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N

Legend

gradiometer processed data (nT)

High : 318.52

Low : -230.15

Data scale: +/- 1SD
Maximum and minimum values
also shown

0 25 50 100 Meters

Figure 3: shade plot of processed data

Appendix 2 Methodology

Table 2: methodology	
Documents Project design: Dean (2012)	
Methodology 1. The work was undertaken in accordance with the project design. 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.	
Equipment *Instrument:* Bartington Instruments grad601-2 *Firmware:* version 6.1	**Data Capture** *Sample Interval:* 0.125-metres *Traverse Interval:* 1 metre *Traverse Method:* zigzag *Traverse Orientation:* GN
Data Processing, Analysis and Presentation Software DW Consulting ArcheoSurveyor2 ArcGIS 9.3 Microsoft Corp. Office Publisher 2003.	

Appendix 3 Data processing

Table 3: gradiometer survey - processed data metadata
Software: DW Consulting ArcheoSurveyor v 2.5.19.3
Stats Max: 158.11 Min: -147.11 Std Dev: 11.97 Mean: 0.54 Median: 0.00 Surveyed Area: 16.026 ha Processes: 4 1 Base Layer 2 Clip at 2.00 SD 3 DeStripe Median Traverse: Grids: All 4 De Stagger: Grids: All Mode: Both By: -8 intervals Note: interpolation match x & y doubled is completed during export from ArcheoSurveyor to georeferenced ERSI format

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. The gradiometers (a type of magnetometer) and resistance meters employed are sensitive to depths of between 0 and 1.5m below ground level, with maximum sensitivity at depths of 1m or less.

2 Magnetometer surveying

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 magnetised 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. 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.

A gradiometer is a type of magnetometer and is sensitive to relatively small changes in the earth's magnetic field. Substrata uses two types of gradiometer both specifically designed for field use by archaeologists. Our primary surveying instruments are Bartington *Grad*601-2 (dual sensor) fluxgate gradiometers with automatic data loggers. We also use a Geoscan FM36 fluxgate gradiometer with the option of either manual or automatic sampling triggers. The Bartington gradiometers provide proven technology in archaeological magnetic surveying and offer fast, accurate set-up and survey rates. The Geoscan FM36 provides an effective, if older, solution when surveys are required within woodland and other areas of limited accessibility.

3 Earth resistance surveying

This method measures changes in the electrical resistance of the ground being surveyed. In practice, differences in the electrical resistance of materials facilitates the detection and interpretation of masonry and brick foundations, paving and floors, drains and other cavities, large pits, building platforms, robber trenches, timber structures, 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 multi-probe resistance meters and purpose-built automatic data-loggers. The MPX15 multi-probe facility can be used to speed up standard surveys and it is also useful when simultaneous multiple-depth analysis is required.