Substrata
Archaeological Geophysical Surveyors

An archaeological gradiometer survey

Land at Trevornick Farm
St Columb Major, Cornwall

Ordnance Survey E/N: 192545,065288 (point)

Report: 141002

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30 September 2014

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1 Survey description and summary

Type of survey: twin-sensor fluxgate gradiometer
Date of survey: September 2014
Area surveyed: 1.1ha
Lead surveyor: Ross Dean BSc MSc MA MIfA

Client
Mrs J. M. and Mr M. Cowling with project management by SLR Consulting Ltd, 69 Polsloe Road, Exeter, Devon EX1 2NF

Location

Site:	Land at Trevornick Farm
Civil Parish:	St Columb Major
Unitary Authority:	Cornwall
Nearest Postcode:	TR9 6DT
NGR:	SW 925 652 (point)
Ordnance Survey E/N:	192545,065288 (point)
OASIS number:	substrat1-191388
Archive:	At the time of writing, the archive of this survey will be held by Substrata.

Summary
This report was commissioned by Mrs J. M. and Mr M. Cowling under the project management of SLR Consulting Ltd to undertake an archaeological magnetometer survey as part of a programme of archaeological work supporting a planning application for the erection of a 50kW wind turbine with a maximum tip height of 35m and ancillary infrastructure at Trevornick Farm, St. Columb, Cornwall, TR9 6DT (the Site). The Survey Area consists of an approximately 1ha area around the turbine base as shown in Figure 1.

This report is required in accordance with Renewable Energy Planning Guidance Note 3 (Cornwall County Council, 2014), Table 1 'Summary of the type and level of information required to support any planning application for a wind turbine' which states, "Those sites in 'Anciently Enclosed Land' with HER sites within 500m will also require [in addition to an Historical Environment Assessment] a geophysical survey." A magnetometer survey, specifically a gradiometer survey, was selected as a standard, cost-effective and regularly used archaeological geophysical survey method to meet the requirements set out in Renewable Energy Planning Guidance Note 3.

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

Twenty groups of anomalies were identified as relating to possible archaeological deposits or structures. Of these, six groups may represent archaeological pits or large postholes with no pattern of distribution but could equally relate to natural deposits and only further archaeological investigations can resolve their origins. The remaining anomaly groups have linear anomaly patterns typical of field boundaries, enclosures and related structures of more than one phase of past land management. None of the anomaly groups relate to features recorded on historical mapping.

2 Survey aims and objectives

Aims
1. To cost-efficiently provide a prospection survey to record evidence for the extent and significance of subsurface features.
2. Produce a report containing the geophysical data and the data in interpreted form.
3. Provide the survey data, an assessment of the archaeological character of the recorded anomaly patterns, and accurate positional information so as to inform any further

archaeological assessment of the site.

Objectives

1. Complete a gradiometer survey across the survey area at a traverse interval of 1m and a sample interval of 0.25m.
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 GIS project with a fully populated database of identified anomalies pertaining to potential archaeological deposits and activities.
6. Produce a report based on the survey and GIS project 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 Site covers an area of approximately 0.14 hectares and is centred at National Grid Reference 192545,065288. The Survey area of approximately 1ha is centred on the Site. The Site lies approximately 1.52km northeast of St Columb Major, 0.43km east of the A39 and 0.32km east-northeast of Trevornick Farm. Located on a ridge, the immediate area is generally flat at approximately 118m O.D. A crushed aggregate track runs through the field to access barns and sheds to the east of the field.

Land use at the time of the survey

Arable, agricultural land.

Geology

The Site is located on a mapped geological boundary within the Devonian Meadfoot Group with Metalimestone and Pelite to the south and Slate, Siltstone and Sandstone to the north. The Meadfoot Group in general comprises dark shales and siltstones with sporadic grey-brown sandstones and beds of decalcified shell debris. The upper part exhibits red coloration in places. The superficial geology is not recorded in the source used (British Geological Survey, undated).

5 Archaeological background

A comprehensive description of the heritage assets within 1km of the bounds of the site can be found in the Desk-based Appraisal for this programme of work (SLR Consulting Ltd, 2014).

The following is a short interpretation of information obtained from the Desk-based Appraisal relevant to the immediate Survey Area.

The reader is advised that this summary should not be used outside the context of this report and is referred to the Cornwall County Council Historic Environment Service for informed provision of the Historical Environment Record (HER).

Historic Landscape
The Site is located in the HLC Type 'Farmland: Medieval' (HCO4) within the Broad Type of 'Anciently Enclosed Land'.

Heritage assets within the Survey Area
There are no recorded heritage assets within the Survey Area.

Previous archaeological work within or adjacent to the Survey Area
No previous archaeological work has been undertaken at the Site.

Historical Environment Summary
Prehistoric activity is evident within the 1km Study Area defined in the Desk-Based Assessment (SLR, 2014), particularly to the west and east of the Site. The finds based evidence reflects periods from the early Mesolithic to the late Bronze Age and the aerial photographic evidence provides evidence from the Bronze Age through to the Romano-British period. A curvilinear, univallate enclosure visible as an earthwork on aerial photographs (HER entry MCO8821) at Trevornick may be a possible small, enclosed settlement or round of Iron Age or Romano-British date 0.14km southwest of the Site.

The evidence for the Early Medieval period is strongly represented within the 1km Study Area in the form of settlement, agricultural and industrial activity. The Site lies at Trevornick which is now subdivided into 'Great Trevornick' and 'Little Trevornick'. Little Trevornick is recorded on the First Edition Ordnance Survey map of 1880-1881 (scale 1:2,500) and is the present-day Trevornick Farm. The probable Domesday site of Great Trevornick lies 0.15km east of the Site.

The Medieval period is represented by settlement, industrial, agricultural and religious related activity. Medieval finds have been recorded by the Portable Antiquities Scheme 0.85km southwest of the Site.

The Post-Medieval evidence within the 1km Study Area is mainly based on agriculture and industry and there are no modern Cornwall County Council Historic Environments Record monuments listed. The lack of modern development with the Study Area is notable.

There are no features shown within the bounds of the Site on the Ordnance Survey historic mapping. Great Trevornick lies to the east of the Site.

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 and includes the location of the anomaly groups identified as relating to potential 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.

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

A plot of the processed data is provided in Figure 2 and 3 (Appendix 1).

Site: An archaeological gradiometer survey
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anomaly group	associated anomalies	anomaly characterisation certainty & class	anomaly form	additional archaeological characterisation	comments
1		possible, positive	linear		
2		possible, positive	linear		
3		possible, positive	linear		
4	5	possible, positive	linear		may be associated with group 5 and so represent part of a potential enclosure
5	4	possible, positive	disrupted linear		may be associated with group 4 and so represent part of a potential enclosure
6		possible, positive	oval	pit or large posthole	a discreet, pronounced anomaly that may represent a pit, posthole or a natural feature
7		possible, positive	linear		
8		possible, positive	linear		
9		possible, positive	oval	pit or large posthole	a discreet, pronounced anomaly that may represent a pit, posthole or a natural feature
10		possible, positive	oval	pit or large posthole	a discreet, pronounced anomaly that may represent a pit, posthole or a natural feature
11	16	possible, pos/neg/pos	disrupted rectilinear	Cornish bank field boundary	anomaly groups are typical of those representing a Cornish bank (a field boundary comprising a stone-revetted earthen bank with flanking ditches)
12		possible, positive	oval	pit or large posthole	a discreet, pronounced anomaly that may represent a pit, posthole or a natural feature
13		possible, positive	oval	pit or large posthole	a discreet, pronounced anomaly that may represent a pit, posthole or a natural feature
14		possible, positive	oval	pit or large posthole	a discreet, pronounced anomaly that may represent a pit, posthole or a natural feature
15		possible, positive	linear		
16	11	possible, positive	linear		anomaly group may represent the same feature as group 11
17		possible, positive	disrupted linear(s)		anomaly groups may represent parallel ditches such as those found in Cornish banks or a series of linears possibly representing a former routeway (a holloway sequence)
18		possible, positive	linear		
19	20	possible, positive	linear		anomaly group may represent the same feature as group 20
20	19	possible, positive	linear		anomaly group may represent the same feature as group 19

Table 1: data analysis

192500 m

192600 m

N

65300 m

65300 m

survey area

turbine base location &
approximate cable route

Potential archaeology

certainty, anomaly type

possible positive

possible negative

0

40 m

192500 m

192600 m

British Grid
centre X: 192544.52 m, centre Y: 65276.39 m

Scale: 1:500 @ 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. 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, 2 and 3.

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 summarised in Table 1.

General points
Referring to Figures 2 and 3, there are clear sets of parallel, linear anomaly groups across the survey area. Those trending approximately east to west are most likely to reflect relatively recent ploughing. Those trending approximately north-north-west to south-south-east are most likely to represent ploughing disturbance of the subsoils and may represent former ridge-and-furrow cultivation.

Anomalies thought to relate to natural features were not mapped.

Recent man-made objects such as manholes, water management equipment or drains have not been mapped and in the main did not comprise significant magnetic responses across the dataset. The exception is a linear group of negative magnetic anomalies with some traces of flanking linear positive anomalies that together represent an extant crushed aggregate track running through the field at the southern end of the survey area (Figures 2 and 3).

Strong magnetic responses mapped close to the track are likely to relate to relatively recent magnetic materials and objects within the track except where indicated otherwise in Figure 1.

Data relating to historical maps and other records
No anomalies in the dataset could be attributed to historically mapped features.

Data with no previous provenance
The majority of magnetic anomaly groups identified as relating to potential archaeology have linear anomaly patterns typical of former field boundaries, enclosures and related structures of more than one phase of past land management. Of these, groups **4 and 5** appear to form a relatively large enclosure or field boundary but only further archaeological work will demonstrate whether this is indeed the case.

Anomaly group **11** has a pattern typical of Cornish bank field boundary footings. These comprise a stone-revetted earthen bank flanked on each side by ditches. No field boundary coinciding with these anomalies has been recorded on historical or recent Ordnance Survey maps. The anomaly group does appear to coincide with an extant field boundary and track on its southern return (Figure 1).

Group **17** may represent the disrupted remains of a second Cornish bank or possibly a series of holloways from a former routeway.

Groups **6, 9, 10, 12, 13 and 14** stand out in the dataset as distinct, well defined anomalies which can represent pits or large postholes but could equally relate to natural deposits.

6.3 Conclusions

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

Twenty groups of anomalies were identified as relating to possible archaeological deposits or structures. Of these, six groups may represent archaeological pits or large postholes with no pattern of distribution but could equally relate to natural deposits and only further archaeological investigations can resolve their origins. The remaining anomaly groups have linear anomaly patterns typical of field boundaries, enclosures and related structures of more than one phase of past land management. None of the anomaly groups relate to features recorded on historical mapping.

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 Andrew Turk and Helen Smart of SLR Consulting Ltd for arranging the commissioning and providing the SLR-based project management of the survey.

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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.

192500 m

192600 m

N

65300 m

65300 m

Gradiometer processed data shade

nT

4

-4

0

40 m

192500 m

192600 m

British Grid
centre X: 192544.52 m, centre Y: 65276.39 m

Scale: 1:500 @ A3. Spatial Units: Meter. Do not scale off this drawing

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Figure 2: shade plot of processed data

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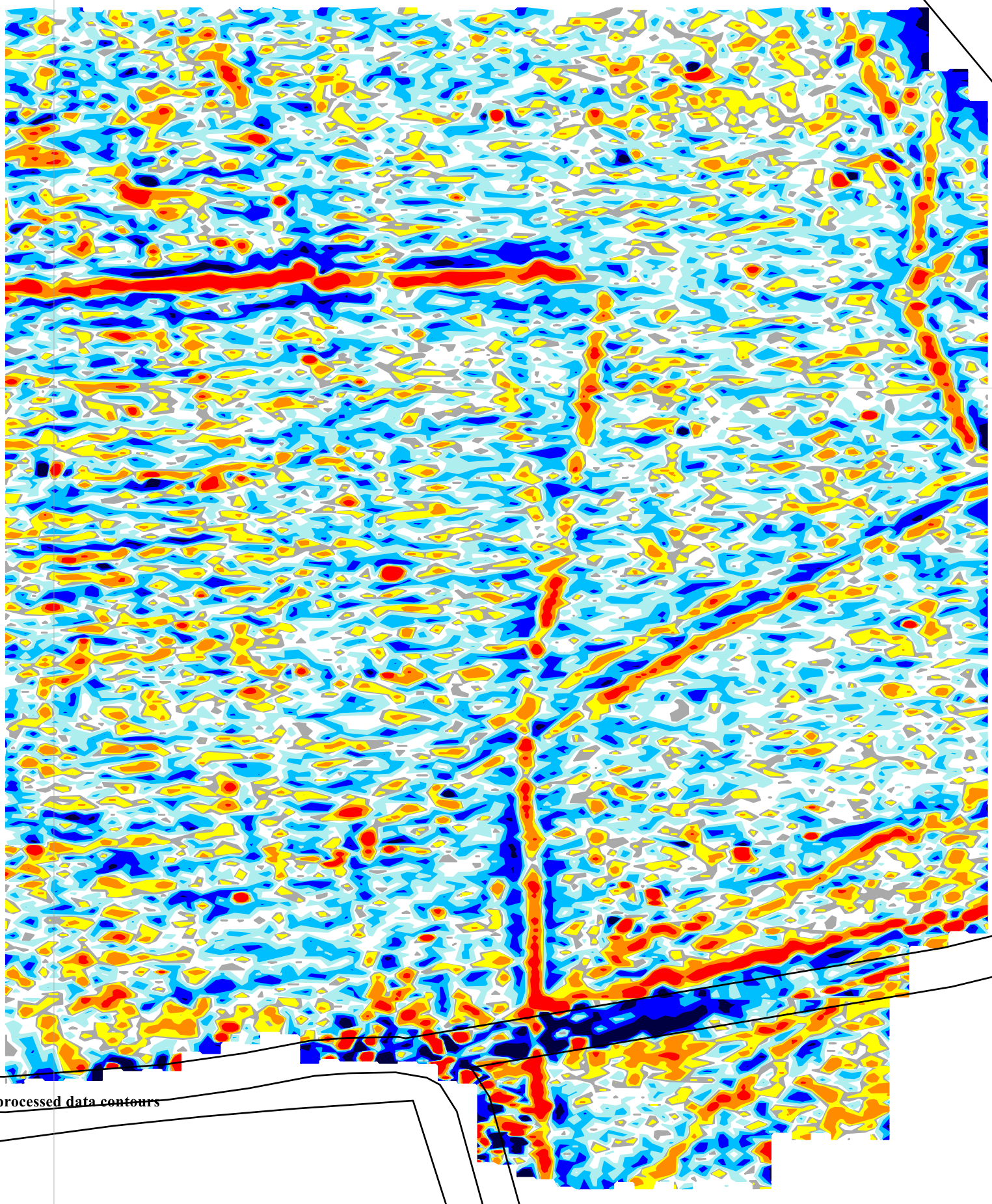
192500 m

192600 m

N

65300 m

65300 m



Gradiometer processed data contours

nT

- > 8.00
- 4.00 - 8.00
- 2.00 - 4.00
- 1.00 - 2.00
- -1.00 - 1.00
- -2.00 - -1.00
- -4.00 - -2.00
- -8.00 - -4.00
- < -8.00

0

40 m

192500 m

192600 m

British Grid
centre X: 192544.52 m, centre Y: 65276.39 m

Scale: 1:500 @ A3. Spatial Units: Meter. Do not scale off this drawing

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Figure 2: shade plot of processed data

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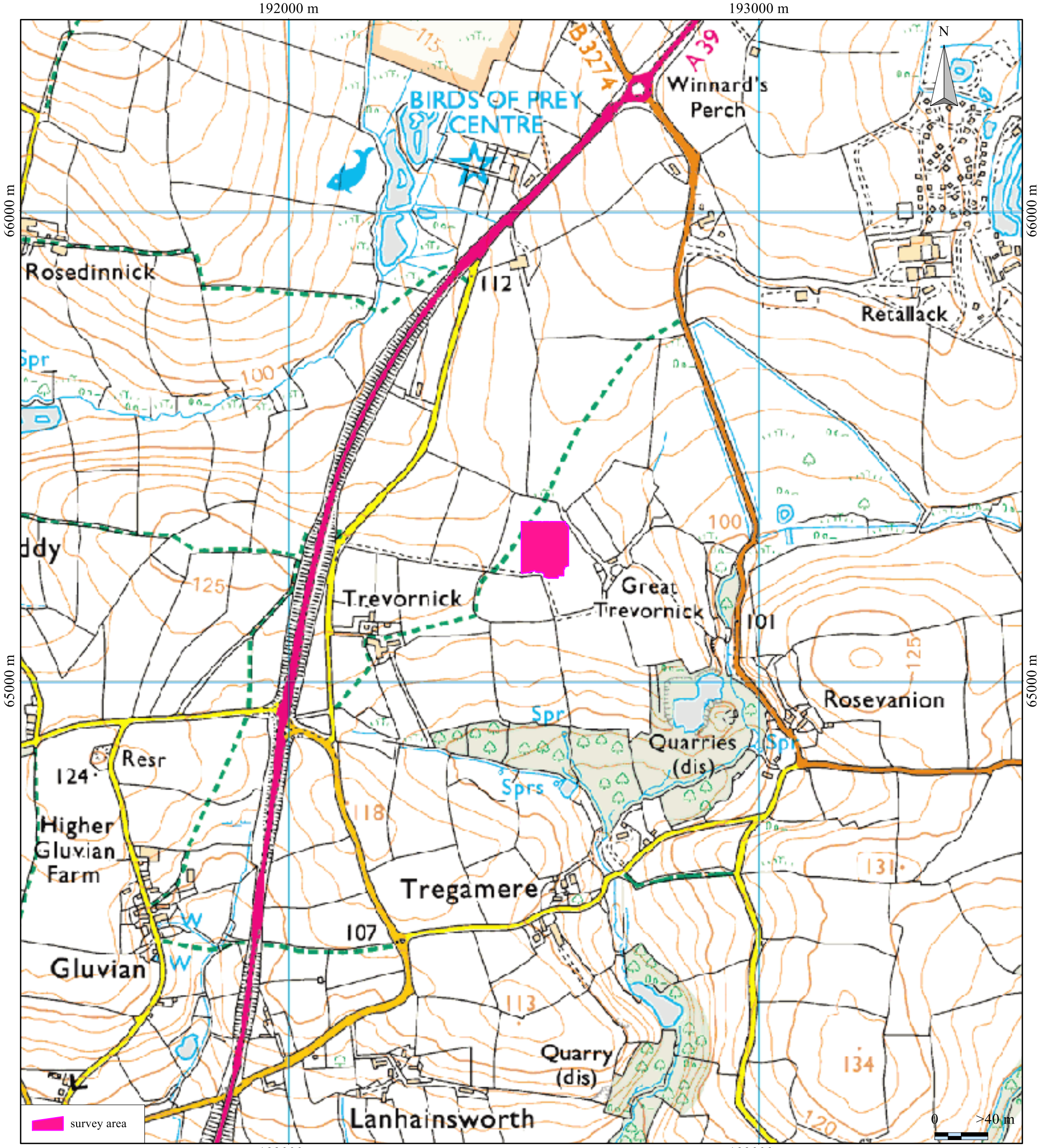

British Grid
centre X: 192495.23 m, centre Y: 65211.26 m

Scale: 1:8000 @ A3. Spatial Units: Meter. Do not scale off this drawing

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Figure 4: location map

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Appendix 2 Methodology Summary

Table 2: methodology summary	
Documents Survey method 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	**Data Capture** *Sample Interval:* 0.25-metres *Traverse Interval:* 1 metre *Traverse Method:* zigzag *Traverse Orientation:* GN0
Data Processing, Analysis and Presentation Software IntelliCAD Technology Consortium IntelliCAD 7.2 DW Consulting TerraSurveyor3 Manifold System 8 GIS Microsoft Corp. Office Excel 2013 Microsoft Corp. Office Publisher 2013 Adobe Systems Inc Adobe Acrobat 9 Pro Extended	

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

Stats
Max: 22.83
Min: -21.98
Std Dev: 3.63
Mean: -0.56
Median: -0.70
Surveyed Area: 1.1024 ha

PROGRAM
Name: TerraSurveyor
Version: 3.0.25.1

Processes: 5
1 Base Layer
2 Clip at 4.00 SD
3 De Stagger: Grids: All Mode: Both By: -1 intervals
4 De Stagger: Grids: t11.xgd Mode: Both By: -2 intervals
5 De Stagger: Grids: t12.xgd Mode: Both By: -2 intervals

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.