Archaeological Services
University of Durham

Stobhill Wind Farm, Bolam, County Durham

geophysical surveys

for
WYG Environment

on behalf of
RWE Npower Renewables

Report 2286
November 2009

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Arndale Court, Otley Road, Headingley, Leeds LS6 2UJ

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Contents

1. Summary

The project

1.1 This report presents the results of geophysical surveys conducted in advance of a proposed development north-west of the village of Bolam in County Durham. The works comprised geomagnetic and earth electrical resistance surveys at proposed wind turbine and access track locations.

1.2 The works were commissioned by WYG Environmental on behalf of RWE Npower Renewables and conducted by Archaeological Services Durham University.

Results

1.3 The surveys have detected several areas of former ridge and furrow cultivation, which are presumed to be medieval or later, at least one former field boundary and several probable soil-filled features of possible archaeological origin.

1.4 The location of a small rectilinear earthwork has been recorded.

1.5 Land drains have been identified in some areas.

2. Project background

Location (Figures 1 & 2)

2.1 The study area was located at Stobhill, north-west of Bolam, in County Durham (NGR centre: NZ 1850 2325). Thirty-one geomagnetic surveys covering 12.16ha have been undertaken at proposed wind turbine locations and along proposed access track routes. Earth electrical resistance surveys totalling 1.4ha were also undertaken over an area of igneous geology, where the geomagnetic technique was less likely to detect anomalies of potential archaeological origin.

Development proposal

2.2 The proposed development is for a wind farm comprising six turbines and associated access tracks.

Objective

2.3 The principal aim of the surveys was to assess the nature and extent of any sub-surface features of potential archaeological significance within the proposed development area, so that an informed decision may be made regarding the nature and scope of any further scheme of archaeological works that may be required in advance of development.

Methods statement

2.4 The surveys have been undertaken in accordance with a Written Scheme of Investigation (WSI) provided by WYG Environmental and approved by Durham County Council Archaeology Section (DCCAS). The WSI is provided as an Appendix to this report. A variation to the WSI, also approved by DCCAS and included in the Appendix, allowed for earth resistance survey to be undertaken over areas of igneous geology where a geomagnetic technique would be less effective at detecting potential archaeological features.

Dates

2.5 Fieldwork was undertaken in two phases between the 13th and 27th October 2009. This report was prepared between 23rd October and 6th November 2009.

Personnel

2.6 Fieldwork was conducted by Matt Claydon, Ed Davies, Duncan Hale, Andy Platell, Natalie Swann (Supervisor) and Richie Villis (Supervisor). This report was prepared by Duncan Hale, the Project Manager, with illustrations by Ed Davies, David Graham and Janine Watson.

Archive/OASIS

2.7 The site code is **BSW09**, for **B**olam **S**tobhill **W**indfarm 20**09**. The survey archive will be supplied on CD to the Bowes Museum in due course. Archaeological Services Durham University is registered with the **O**nline **A**cces**S** to the **I**ndex of archaeological investigation**S** project (OASIS). The OASIS ID number for this project is **archaeol3-66940**.

3. Archaeological and historical background

3.1 A desk-based assessment of the archaeological potential of the study area has been conducted by WYG Environment. The following summary of the known and potential archaeological resource is based on that report (Holland 2009, 14-15):

3.2 Within the proposed development site there are several recorded archaeological features. There are several areas of visible ridge and furrow remains within the south-east area of the development site. There are several former field boundaries within the development site identified from historic mapping. Operation of the former quarry in the central part of the site will have been removed any earlier archaeological remains there. A small square earthwork near the southern end of the site is of unknown date or function.

3.3 There is a potential to discover previously unrecorded archaeological remains within the development site and access road alignment. The lack of modern development within the study area means that the potential to discover and record new archaeological sites has so far been limited to aerial and desk-based techniques. This lack of development may be partially responsible for a bias towards low numbers of recorded sites of pre-medieval date. There is considered to be a very low potential to record sites of early prehistoric date (up to the Neolithic period) within the development area due to the almost complete lack of evidence from the surrounding region. There is moderate potential to record sites of later prehistoric date (Bronze Age and Iron Age) within the development site. The numerous undated cropmarks (Sites 12, 15, 17-20, 22), Bronze Age axehead (Site 43) and the Iron Age forts in the wider region at Shackleton Beacon and to the north-west at The Tofts indicate that there was a later prehistoric presence in the area which may have left archaeological remains as yet undiscovered.

3.4 There is considered to be a moderate potential to discover previously unrecorded archaeological remains of Roman date within the development area. This potential is considered to be greatest within the area of the access road as this is closer to the apex of two Roman roads. The south-facing slopes of the southern area of the development site may also have been considered a favourable location for settlement.

3.5 There is considered to be a relatively low potential to discover sites of early medieval and later date within the development site. The focus of settlement and associated industry in this period is considered likely to have been concentrated on the village centres which have endured to the modern period or are recorded as deserted villages. It is probable that during this period the development site would have been utilised for agriculture as indicated by the ridge and furrow remains and fieldscape. There is the potential for further buried remains of ridge and furrow or former field boundaries to be discovered

4. Landuse, topography and geology

4.1 At the time of survey the proposed development area comprised pasture with exception of three fields in the south and west of the site, which contained survey Areas 3, 4, 9 and 28. Some areas were particularly marshy, such as between Areas 13 and 14 and around the proposed location for Turbine 2; ground conditions there prevented any data collection.

4.2 The proposed development area ranges in height from approximately 190m OD in its central and southern parts to approximately 140m OD in the north.

4.3 The majority of the underlying solid geology of the area comprises Westphalian strata of the Pennine Lower Coal Measures Formation, which are overlain by Devensian till. However, an igneous dyke, part of the Armathwaite-Cleveland Dyke, crosses the central part of the study area. Some of this has been quarried away and the site used for landfill, however, based on British Geological Survey mapping, part of the dyke was considered likely to be present in the area of Turbine 4.

5. Geophysical survey

Standards

5.1 The surveys and reporting were conducted in accordance with English Heritage guidelines, *Geophysical survey in archaeological field evaluation 2nd edition* (David, Linford & Linford 2008); the Institute for Archaeologists Technical Paper No.6, *The use of geophysical techniques in archaeological evaluations* (Gaffney, Gater & Ovenden 2002); and the Archaeology Data Service *Geophysical Data in Archaeology: A Guide to Good Practice* (Schmidt 2002).

Technique selection

5.2 Geophysical survey enables the relatively rapid and non-invasive identification of sub-surface features of potential archaeological significance and can involve a suite of complementary techniques such as magnetometry, earth electrical resistance, ground-penetrating radar, electromagnetic survey and topsoil magnetic susceptibility survey. Some techniques are more suitable than others in particular situations, depending on site-specific factors including the nature of likely targets; depth of likely targets; ground conditions; proximity of buildings, fences or services and the local geology and drift.

5.3 In this instance, based on desk-based assessment, it was considered likely that cut features such as ditches and pits might be present on the site, and that other types of feature such as trackways, wall foundations and fired structures (for example kilns and hearths) might also be present.

5.4 A geomagnetic technique (fluxgate gradiometry) was considered to be the most appropriate technique for the majority of the development site, however, given the likelihood of the strongly magnetised igneous dyke underlying the central part of the development site, it was anticipated that such a survey would be unlikely to provide useful information in that area. Earth electrical

resistance survey was therefore undertaken in the area of the dyke, since it is not affected by igneous geology.

5.5 Fluxgate gradiometry involves the use of hand-held magnetometers to detect and record anomalies in the vertical component of the Earth's magnetic field caused by variations in soil magnetic susceptibility or permanent magnetisation; such anomalies can reflect archaeological features. For earth resistance survey, when a small electrical current is injected through the earth it encounters resistance which can be measured. Since resistance is linked to moisture content and porosity, stone and brick features will give relatively high resistance values while soil-filled features, which retain more moisture, will provide relatively low resistance values.

Field methods

5.6 A 20m grid was established across the survey area and tied-in to known, mapped Ordnance Survey points using a Trimble Pathfinder Pro XRS global positioning system (GPS) with real-time correction.

5.7 Measurements of vertical geomagnetic field gradient were determined using Bartington Grad601-2 dual fluxgate gradiometers. A zig-zag traverse scheme was employed and data were logged in 20m grid units. The instrument sensitivity was set to 0.1nT, the sample interval to 0.25m and the traverse interval to 1m, thus providing 1600 sample measurements per 20m grid unit.

5.8 Measurements of earth electrical resistance were determined using a Geoscan RM15D resistance meter with a mobile twin-probe separation of 0.5m. A zig-zag traverse scheme was employed and data were logged in 20m grid units. The instrument sensitivity was set to 0.1ohm, the sample interval to 1m and the traverse interval to 1m, thus providing 400 sample measurements per 20m grid unit.

5.9 Data were downloaded on site into a laptop computer for initial processing and storage and subsequently transferred to a desktop computer for processing, interpretation and archiving.

Data processing

5.10 Geoplot v.3 software was used to process the geophysical data and to produce both continuous tone greyscale images and trace plots of the raw (unfiltered) data. The greyscale images and interpretations are presented in Figures 3-11; the trace plots are provided in Figures 12-13. For presentation purposes in this report the site has been divided into three zones: southern, central and northern. In the greyscale images, positive magnetic/high resistance anomalies are displayed as dark grey and negative magnetic/low resistance anomalies as light grey. Palette bars relates the greyscale intensities to anomaly values in nanoTesla/ohm as appropriate.

5.11 The following basic processing functions have been applied to the geomagnetic data:

clip	clips, or limits data to specified maximum or minimum values; to eliminate large noise spikes; also generally makes statistical calculations more realistic.
zero mean traverse	sets the background mean of each traverse within a grid to zero; for removing striping effects in the traverse direction and removing grid edge discontinuities.
despike	locates and suppresses iron spikes in gradiometer data and spikes in data due to poor contact resistance.
interpolate	increases the number of data points in a survey to match sample and traverse intervals. In this instance the data have been interpolated to 0.25 x 0.25m intervals.

5.12 The following basic functions have been applied to the resistance data:

despike	locates and suppresses poor contact resistance spikes in resistance data.
add	adds or subtracts a positive or negative constant value to defined blocks of data; used to reduce discontinuity at grid edges.
interpolate	increases the number of data points in a survey to match sample and traverse intervals. In this instance the data have been interpolated to 0.25m x 0.25m intervals.

Interpretation: anomaly types

5.13 Colour-coded geophysical interpretation plans are provided. Three types of geomagnetic anomaly have been distinguished in the data:

positive magnetic	regions of anomalously high or positive magnetic field gradient, which may be associated with high magnetic susceptibility soil-filled structures such as pits and ditches.
negative magnetic	regions of anomalously low or negative magnetic field gradient, which may correspond to features of low magnetic susceptibility such as wall footings and other concentrations of sedimentary rock or voids.
dipolar magnetic	paired positive-negative magnetic anomalies, which typically reflect ferrous or fired materials (including fences and service pipes) and/or fired structures such as kilns or hearths.

5.14 Two types of resistance anomaly have been distinguished in the data:

high resistance	regions of anomalously high resistance, which may reflect foundations, tracks, paths and other concentrations of stone or brick rubble.

low resistance regions of anomalously low resistance, which may be associated with soil-filled features such as pits and ditches.

Interpretation: features

General comments

5.15 Colour-coded archaeological interpretation plans are provided, which include the proposed development layout for the tracks and turbines. The depicted footprint of each turbine on the archaeological interpretation plans is greater than the diameter of the turbine foundation. The locations of ancillary structures are yet to be determined and the final layout may differ from that shown. In the following text, the surveys are described and interpreted from south to north.

5.16 Except where stated otherwise in the text below, positive magnetic anomalies are taken to reflect relatively high magnetic susceptibility materials, typically sediments in cut archaeological features (such as furrows, ditches or pits) whose magnetic susceptibility has been enhanced by decomposed organic matter or by burning.

5.17 Small, discrete dipolar magnetic anomalies have been detected in all of the survey areas. These almost certainly reflect items of near-surface ferrous and/or fired debris, such as horseshoes and brick fragments, and in most cases have little or no archaeological significance. A sample of these is shown on the geophysical interpretation plans, however, they have been omitted from the archaeological interpretation plans and the following discussion.

Areas 1 and 31

5.18 These surveys are both within the southernmost field of the proposed development site and include the proposed location of Turbine 6.

5.19 Parallel, weak, alternate positive and negative magnetic anomalies have been recorded across this area, which reflect the upstanding ridge and furrow cultivation remains there. In this instance the negative magnetic anomalies correspond to the furrows. Within the survey areas, a number of slight terraces are also evident on the ground, aligned east-west.

5.20 There is a relatively high concentration of magnetic objects across the southern part of Area 1, possibly a result of former manuring practices.

Areas 2, 24 and 25

5.21 These surveys cover access track routes and part of the area around Turbine 5.

5.22 Parallel, weak, alternate positive and negative magnetic anomalies have been recorded across the northern part of this field, reflecting the upstanding ridge and furrow cultivation remains there. Two strong positive magnetic anomalies were detected to the immediate south of the ridge and furrow. The northern anomaly may reflect a headland, while the southern one corresponds to a former field boundary shown on the first edition Ordnance Survey.

5.23 A water trough is located between the two survey transects in the southern part of the field. Pipes are known to be associated with the trough and some have been detected geomagnetically in both surveys.

5.24 There is a small, slight earthwork feature of potential archaeological origin partly within Area 24. The location of the earthwork was recorded with a GPS instrument during the geophysical survey and is shown on Figure 5. Very weak positive magnetic anomalies were detected at the approximate locations of the northern and southern sides of the earthwork where they enter the survey area.

5.25 A relatively strong positive magnetic anomaly to the south of this feature probably reflects a soil-filled ditch.

5.26 Some vey weak negative magnetic anomalies aligned east-west in Area 25 may reflect land drains.

Areas 3, 4 and 28

5.27 These surveys cover access track routes and the remainder of the area around Turbine 5.

5.28 The magnetic anomalies in these areas are typically either very weak and diffuse, or intense and localised. They are likely to reflect subtle geomorphological or geological variation and near-surface ferrous debris, respectively, rather than features of potential archaeological significance.

Areas 5, 6, 26 and 27

5.29 These surveys were all undertaken in the southern two thirds of one field, over possible track routes to the south of the proposed location of Turbine 4.

5.30 Areas 5 and 6 overlap in the east of the field. Both surveys there have detected broad and diffuse, though relatively strong, bands of positive and negative magnetisation, which are almost certainly associated with the igneous dyke shown to the north and east on geological maps. Similar but stronger anomalies were detected just to the north in Area 26, closer to the expected location of the dyke. The dyke, or at least the magnetic anomalies associated with it, is more extensive than previously mapped.

5.31 In these areas, however, it has still been possible to identify weaker anomalies of possible archaeological origin. Narrow positive magnetic anomalies aligned broadly east-west in all these areas could reflect soil-filled ditches.

Areas 7 and 8

5.32 Some relatively strong and well-defined anomalies here, mostly in Area 7, could reflect soil-filled ditches. Some of these ditches appear to be contemporary and could form boundaries and associated small enclosures.

5.33 Very weak and broad areas of positive magnetisation could reflect geomorphological or geological variation.

Areas 9 and 10

5.34 These surveys cover the area around the proposed location for Turbine 3.

5.35 A very broad area of magnetic anomalies aligned roughly north-west/south-east has been detected in Area 9. The extents of this area appear to be defined by linear positive magnetic anomalies; within these, the anomalies are typically small and intense. The southernmost positive anomaly broadly corresponds to the course of a stream shown on the first edition Ordnance Survey, and which is still present in the field to the east. The northernmost positive anomaly is similar in nature and probably also reflects a former stream course. This group of anomalies almost certainly reflects an area of ground disturbed by former stream courses (and possibly a more recent culvert) containing ferrous and/or fired materials as well as possibly igneous material from the dyke on higher ground above.

5.36 No anomalies of potential archaeological significance have been identified in these areas.

Areas 11, 12, 29 and 30

5.37 These surveys cover the area around the proposed location for Turbine 4 and proposed access tracks.

5.38 Two discontinuous linear magnetic anomalies in the west of Area 12 could possibly reflect land drains or truncated ditch features. Two weak curvilinear positive magnetic anomalies in the north of Area 12, and a possibly associated linear anomaly, could reflect soil-filled ditch remains. Additional positive magnetic anomalies within the igneous part of Area 12 could also reflect soil-filled features, but might equally be associated with the underlying geology; in particular, the origin of a strong, clear linear anomaly aligned north-east/south-west is not known. Since the geomagnetic survey of Area 12 detected increasingly intense, broad anomalies towards the east, associated with the igneous dyke, earth resistance surveys were undertaken over the eastern part of Area 12 and all of Area 11.

5.39 Centrally placed within Area 11 is a possible rectilinear high resistance feature measuring *c*.40m by 35m. Despite its location on a south-west-facing hillslope this might possibly reflect the remains of a stone-built shieling or other enclosure. Whilst there are anomalous areas of high resistance within the possible enclosure they do not form recognizable patterns and could have either anthropogenic or geological origins.

5.40 The resistance survey of Area 11 detected a number of areas of anomalously high resistance and other areas of relatively high resistance. These probably reflect topographic variation in the underlying rockhead, with shallower rockhead producing higher resistance. A band of high resistance was also detected along the existing field boundary between Areas 11 and 12, possibly reflecting stone rubble. High resistance anomalies were also recorded in the area around the gateway linking the two fields, presumably reflecting hardcore rubble there.

5.41 The resistance data from the relatively level part of Area 12, in the east, are particularly smooth, with the exception of the anomalies mentioned above. Downslope to the west, however, the data are more variable but generally show very high resistance values, almost certainly due to underlying rock.

Areas 13 and 14

5.42 Parallel positive and negative magnetic lineations in the southern part of Area 13, aligned broadly north-south, almost certainly reflect traces of former ridge and furrow cultivation.

5.43 The land between Areas 13 and 14 was particularly marshy. A series of well-defined, parallel positive magnetic anomalies aligned north-west/south-east across Area 14 almost certainly reflect land drains. A linear positive magnetic anomaly also traversing this area could reflect a soil-filled feature, though may be associated with the land drains.

5.44 The marshy ground conditions to the east, around proposed Turbine 2, prevented any data collection there.

Areas 15 and 32

5.45 These surveys cover the area around the proposed location for Turbine 1 and associated access tracks.

5.46 Two possible soil-filled features were detected in the west of Area 15 and a possible third was detected in Area 32. Although the anomalies are weak and diffuse they could reflect ploughed out ditch remains. These possible features are in an area of probable former ridge and furrow cultivation.

Areas 16-22

5.47 These areas all contain relatively high concentrations of small, intense, near-surface anomalies, which are unlikely to reflect an archaeological resource.

5.48 No other features of potential archaeological significance have been identified.

Area 23

5.49 Series of alternate, parallel positive and negative magnetic anomalies across this area reflect former ridge and furrow cultivation, some remains of which are upstanding. A number of quite large dipolar magnetic anomalies probably reflect near-surface ferrous debris.

6. Conclusions

6.1 Geomagnetic and earth electrical resistance surveys have been undertaken at Stobhill, near Bolam in County Durham, prior to the proposed development of a windfarm.

6.2 The surveys have detected several areas of former ridge and furrow cultivation, which are presumed to be medieval or later, at least one former field boundary and several probable soil-filled features of possible archaeological origin.

6.3 The location of a small rectilinear earthwork has been recorded.

6.4 Land drains have been identified in some areas.

Confidence statement

6.5 The deployment of two geophysical techniques has been an effective approach in this instance. The geomagnetic survey has been effective at detecting a range of anomalies, which could reflect features of potential archaeological and more recent origin, across the majority of the site, in all but the area of the igneous dyke where an earth resistance technique was deployed. There was sufficient magnetic susceptibility or resistance contrast to enable the detection of potential archaeological features using these techniques, however, there is the potential for features with insufficient contrast to remain undetected. We are not aware of any factors which might have significantly restricted the reliability or interpretation of these data.

7. Sources

David, A, Linford, N, & Linford, P, 2008 *Geophysical Survey in Archaeological Field Evaluation, 2nd edition*. English Heritage

Gaffney, C, Gater, J, & Ovenden, S, 2002 *The use of geophysical techniques in archaeological evaluations*. Technical Paper **6**, Institute of Field Archaeologists

Schmidt, A, 2002 *Geophysical Data in Archaeology: A Guide to Good Practice*. Archaeology Data Service, Arts and Humanities Data Service

Holland, K 2009 *Stobhill Wind Farm, Bolam, County Durham: Cultural Heritage Desk-Based Assessment*. Unpublished report, WYG Environment

Appendix: Project specification

WYG Environment
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RWE npower renewables

Stobhill Windfarm

Written Scheme of Investigation for Geophysical Survey

October 2009

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Appendix Contents

WSI Geophysical Survey, Stobhill Windfarm

1.0 Introduction

A geophysical survey is required prior to the submission of a planning application for a windfarm development at Stobhill, Bolam. This survey is required to inform the assessment of potential cultural heritage impacts and the design of an appropriate mitigation strategy.

This Written Scheme of Investigation has been prepared by Kirsten Holland, Senior Archaeologist at WYG Environment on behalf of RWE npower renewables. The WSI has been prepared in accordance with the requirements of Lee White, Assistant Archaeology Officer, Durham County Council.

This WSI covers the above site only and relates only to the above requirement pertaining to the site in question. It does not address the archaeological requirements for subsequent development of further areas or phases.

2.0 Site Location and Development Proposals

The site is located at to the north-west of the village of Bolam, County Durham (NGR: centered NZ 1850 2325; E 418500, N 523250). A site location plan is included in Appendix B. The site varies between 140m and 190m AOD and generally rises to a central ridge.

A proposed development layout is shown on the figure indicating areas for survey (Figure A042201/4104/597/09, Appendix C). It is currently proposed that six wind turbines are located within the development site. An access track will be required to service these turbines accessing the site from the A68 near Bildershaw Grange Farm.

3.0 Geology and Environment

The site is underlain by Coal Measures. The site and the majority of the study area are overlain by boulder clays. An exception to this is an area of tholeitic dolerite to the north-west of Bolam and between the northern and southern sections of the proposed windfarm (BGS, 1969). This area has been partially quarried and was the location of the waste disposal site. The quarried area is outside of the area for geophysical survey.

The site is currently in use as agricultural land, primarily under pasture, although some of the fields are under arable cultivation (as shown on Figure A042201/4104/597/09, Appendix C). The surrounding area is primarily used as agricultural land.

4.0 Archaeological Background

The development site has been the subject of a desk-based assessment. The full desk-based assessment will be made available to the successful contractor to enable potential anomalies to be placed within context.

Within the study area the only recorded sites of prehistoric date are a possible round barrow and a Bronze Age flat axe findspot. There are a large number of identified cropmarks of unclassified date within the study area. A number of these cropmarks may be of prehistoric origin which would be in keeping with the archaeology of the wider region.

This area does not appear to have been heavily settled in the Roman period. There were substantial forts at Binchester to the north, Bowes to the south-west and Piercebridge to the south of the study area respectively. These forts were connected by roads which pass through the study area. There are no further recorded sites within the study area of Roman date, however additional sites have been identified to the south of the study area indicating that further sites may remain unrecorded.

There are no recorded sites of early medieval date within the study area, however a number of settlements of medieval date are likely to have had their origins in the early medieval period. The villages of Bolam, Hilton, Morton Tinmouth and Hilton Tofts have medieval origins and many display evidence of shrinkage or desertion between the medieval period and the present day. Features typical of this period such as enclosures, settlement remains and ridge and furrow are recorded as well as a potential hospital at Bolam.

There are visible remains of ridge and furrow across several fields within the development site. These remains are generally located within the south-east of the development site in the hinterland of the village of Bolam. Within the study area a square earthwork was also noted during the walkover survey close to a spring and water trough within the south of the development site. This is anticipated to lie to the east of the access road alignment.

The majority of the built heritage of the study area dates to the post-medieval period. The archaeological remains of the area are dominated by the industrial activity of the region, particularly focussed around the coal mining industry. Some areas of the site and the immediate area to the east have been subject to

limestone extraction. The historic landscape structure of the area has also been heavily influenced by the medieval and post-medieval agricultural economy of the area.

5.0 Archaeological Potential

There is a potential to discover previously unrecorded archaeological remains within the development site and access road alignment. The lack of modern development within the study area means that the potential to discover and record new archaeological sites has been limited to the advances made in largely desk-based assessment techniques and studies. This lack of development may be partially responsible for a bias towards low numbers of recorded sites of pre-medieval date.

There is considered a very low potential to record sites of early prehistoric date (up to the Neolithic period) within the development area due to the almost complete paucity of evidence from the surrounding region. There is moderate potential to record sites of later prehistoric date (Bronze Age and Iron Age) within the development site. The numerous undated and the Iron Age forts in the wider region at Shackleton Beacon and to the north-west at The Tofts indicate that there was a later prehistoric presence in the area which may have left archaeological remains as yet undiscovered.

There is considered to be a moderate potential to discover previously unrecorded archaeological remains of Roman date within the development area. This potential is considered to be greatest within the area of the access road as this is closer to the apex of the two Roman rods. The south facing slopes of the southern area of the development site may also have been considered a favourable location for settlement.

There is considered to be a relatively low potential to discover sites of early medieval and later date within the development site. The focus of settlement and associated industry in this period is considered likely to have been concentrated on the village centres which have endured to the modern period or are recorded as deserted villages. It is probable that during this period the development site would have been utilised for agriculture as indicated by the ridge and furrow remains and fieldscape. There is the potential that further buried remains of ridge and furrow or former field boundaries are discovered.

6.0 Aim of the Evaluation

The overall aim of the geophysical survey programme is to gather sufficient information to establish the extent, condition, character and date (as far as circumstances permit) of any archaeological features and deposits within the site area.

A further objective is to obtain information that will contribute to an evaluation of the significance of impact of the scheme upon cultural heritage, and which will enable further evaluation and/or mitigation measures to be designed.

7.0 Geophysical Survey Requirements

Magnetometer survey is required over the area of the proposed development as indicated on Figure A042201/4104/597/09 Appendix C. The maximum area for survey has been calculated as 11.76ha; however, this figure is indicative only.

Generally this survey will cover an area of 1ha around proposed turbine bases and a 20m width along proposed access tracks. The survey should be undertaken within all of these areas except where ground conditions, vegetation or water cover makes it impracticable. This may be an issue around the proposed location of Turbine 2.

In addition a buffer zone around field boundaries and buildings has been included to reduce interference from fences, footpaths and debris often associated with field boundaries. Partial grids below 10m have also been discarded.

The contractor will be required to ensure at the tender stage that all staff appointed to work on the project are qualified and experienced in all elements of the work they will perform. Information on the composition (to include curriculum vitae) of the proposed team shall be provided. Only named individuals will undertake the magnetometer survey. These individuals will have undertaken similar projects in the last 18 months and will provide evidence of this experience; including archaeological sites they have detected using this method.

All survey work shall be planned, managed and carried out in accordance with the guidelines and standards set out by English Heritage in "Geophysical Survey in Archaeological Field Evaluation" (2008). The works will also be carried out using the standards laid out by The Institute of Field Archaeologists in "The use of Geophysical Techniques in Archaeological Evaluations" (2002) and "Standard and Guidance for Archaeological Field Evaluations" (1994, rev 2001).

7.1 Methodology

The detailed survey shall be undertaken using a hand held fluxgate instrument with a 1m sensor separation, or other instrument as deemed appropriate. The operator shall assess the level of background noise.

The geophysical survey should be undertaken utilising traverses of 1m with readings taken at intervals of 0.25m within a 20mx20m survey grid. The area to be surveyed is shown on Figure A042201/4104/597/09, Appendix C.

The survey grid should be independently re-locatable on the ground by a third party, by measuring to a permanent feature. The grid tie-in information should be made available in, or with, the final report so that the location plan can be related to the OS National Grid. Upon completion of the survey any markers will be removed from site.

During fieldwork a record should be made of surface and weather conditions that may have a bearing on the subsequent interpretation of field data.

7.2 Data Processing

Data from the gridded survey shall be processed using appropriate software to maximise the clarity of the of the archaeological data, including as appropriate the removal of striping or other survey artefacts, random spikes, drift in the machine calibration and the minimising of background noise or other natural or modern features which tend to obscure archaeological anomalies. The software and methodology to be used by the contractor shall be indicated in advance.

7.3 Reporting

A full report on the detailed gridded survey shall be produced within four weeks of the completion of the fieldwork. The report shall be prepared in accordance to the requirements listed above and using English Heritages guidelines. As a minimum the report shall contain the following information:

- A title page, with the name of the project, the name of the contractor and author(s) of the report, the title of the report and date of the report.
- A non-technical summary of the findings

- A description of and a background to the nature of the works
- A brief description of the site location and any previously known archaeology in the survey area.
- The layout, total area and purpose of the survey area, with six figure grid references for at least two points which shall be clearly marked on all supporting illustrations;
- A description of techniques, instrumentation and methodology employed
- A description of the nature and the layout of the anomalies recorded at the site, with any constraints and limitations of interpretation outlined.
- A written archaeological interpretation of the survey results (as separate from the descriptive account) that sets out the reason for the reached interpretations and includes a confidence statement;
- General and detailed location plans at appropriate scales, with survey areas accurately positioned on Ordnance Survey base maps using points recorded by instrument survey;
- Grey-scale plots of the raw, unprocessed data at 1:250 or 1:1000 scale, with additional trace plots for magnetic surveys;
- Plots of all processed data illustrated as grey scale and x-y plots at an appropriate scale (1:500, 1:1000 or 1:1250) agreed in advance, with keys and north point accurately positioned, orientated and on the base map using points recorded at the time of the survey;
- Detailed plots at 1:500 or larger scale of any major anomalies or groups of anomalies, accurately positioned, orientated and on the base map where these are required for interpretative purposes;

The report should also identify any areas, which were unresponsive to any applied survey technique, together with an interpretation of the reasons for any such variations in responsiveness and any recommendations for alternative techniques.

The contractor shall submit one copy of the draft report initially for review by WYG, who may also consult the curator during this review period. The contractor shall rectify any defects and make any amendments

as identified by the consultant and shall subsequently submit the final report within in one week of the consultants comments.

Six final hard copy reports will be required. Digital copies of the report on CD-ROM shall also be provided in pdf format. The digital copy shall also include one full set of interpretative drawings in AutoCAD format, based on the Ordnance Survey tiles which shall be supplied to the successful tenderer by WYG. These drawings shall be tied to the National Grid, with each type of geophysical anomaly saved on a different layer. An interpretative key will also be provided.

Copies of the final report should be produced and submitted to:

- WYG (four hard copies and two CD-ROM copies),
- Durham Historic Environment Record (hard copy and CD-ROM copy)
- English Heritage Geophysical Survey Database (pdf)
- OASIS (pdf)

An OASIS summary form should be completed and a copy included with the report.

8.0 Archive

Provision will be made for the deposition of the archive, subject to the permission of the relevant landowner(s) (and if no further archaeological work is to be initiated).

The site archive will contain all the data collected during the survey. It will be quantified, ordered, indexed and internally consistent. Adequate resources will be provided during fieldwork to ensure that all records are checked and internally consistent. The integrity of the primary field record will be preserved. Security copies will be maintained where appropriate. Archive consolidation will be undertaken immediately following the conclusion of fieldwork.

The archive will be assembled in accordance with the specification set out in English Heritage's "Management of Archaeological Projects 2" (English Heritage, 1991; Appendix 3). In addition to the primary site records the archive shall contain the full survey report.

The archiving of any digital data arising from the project should be undertaken in a manner consistent with professional standards and guidance (Schmidt A ed 2002 Geophysical Data in Archaeology: A Guide to Good Practice. (AHDS http://ads.ahds.ac.uk/project/goodguides/excavation/).

The archive should be deposited with the Bowes Museum. The archaeological contractor should liaise with the museum curator to establish their detailed requirements and discus the transfer of the archive. It should be noted that the archive will charge for deposition in line with the published charging policy and appropriate arrangements for payment of the archive fees must be made.

The archaeological contractor should also liaise with the HER Officer, Durham County Council, to make arrangements for appropriate digital information arising from the project to be submitted to Durham County Council for HER enhancement purposes.

9.0 Copyright

Copyright in the documentation prepared by the archaeological contractor and specialist sub-contractors should be the subject of additional licences in favour of the repository accepting the archive and Durham County Council Archaeology Service to use such documentation for their statutory educational and museum service functions, and to provide copies to third parties as an incidental to such functions.

Under the Environmental Information Regulations 2005 (EIR), information submitted to the HER becomes publicly accessible, except where disclosure might lead to environmental damage, and reports cannot be embargoed as 'confidential' or 'commercially sensitive'.

Requests for sensitive information are subject to a public interest test, and if this is met, then the information has to be disclosed. The archaeological contractor should inform the client of EIR requirements, and ensure that any information disclosure issues are resolved before completion of the work. Intellectual property rights are not affected by the EIR.

10.0 Programme

The contractor shall submit a detailed programme of works after appointment and before commencing works and shall also provide verbal progress reports on request from the consultant during the course of the fieldwork.

The survey will be required to start on a date to be determined and may be dependent upon agricultural and livestock issues, including the harvest of arable crops. The contractor shall inform the development control archaeologist, DCC, of the commencement of works as soon as possible prior to the start of works.

An interim report and initial plots will be completed and delivered to WYG within one week of the completion of the survey. A full draft report on the survey shall be completed and delivered to the consultant within three weeks of the completion of site works. A final issue of the report shall be delivered within one week of receiving comments on the draft.

11.0 Access and Monitoring

WYG shall be responsible for all negotiations and arrangements with the land owners agents relating to access to the site. The contractor shall liaise with the consultant over such arrangements before submitting their detailed programme of works. A contact list shall be supplied upon appointment and the contractor will be expected to make contact with the landowner or their agent 24 hours before entering the site. Suitable access to the site is to be determined and access shall be by this route, or these routes, only.

The project will be monitored as necessary and practicable by the Durham County Council Archaeology Service, in its role as "curator" of the county's archaeology. DCC will receive as much notice as possible of the intention to start fieldwork. This notification is to be supplied in writing, and copied to the relevant curator at DCC (Lee White). This notification is to be supplied in writing, and copied to WYG. External monitoring does not replace the need for proper self-regulation.

It should be noted that Durham County Council Archaeology Section charge for site and monitoring meetings and ongoing progress or development meetings in line with the published charging strategy.

12.0 Health and Safety

Health and safety must take priority over archaeological matters. All geophysicists must comply with all Health and Safety legislation. All geophysicists and organisations undertaking the fieldwork should ensure that they, or any proposed sub-contractors are appropriately qualified and adequately insured to undertake such projects.

The geophysicist appointed will need to provide a copy of their health and safety policy. In additional a site specific risk assessment should be undertaken.

13.0 Further Information

Further information or clarification of any aspects of this Written Scheme of Investigation may be obtained from:

Kirsten Holland
Senior Archaeologist
WYG Environment
Arndale Court
Headingley
Leeds
LS6 2UJ

Kirsten.Holland@wyg.com
0113 278 7111

14.0 References

English Heritage (2008) Geophysical Survey in Archaeological Field Evaluation

Institute of Field Archaeologists (1994 rev 2001) Standards and Guidance for Archaeological Field Evaluation

Institute of Field Archaeologists (2002) IFA Paper No. 6: The Use of Geophysical Techniques in Archaeological Evaluations.

Schmidt A (2002) Geophysical Data in Archaeology: Guide to Good Practice, Second Edition. AHDS http://ads.ahds.ac.uk/project/goodguides/geophys/.

WYG (2009) Stobhill Windfarm, Archaeological and Cultural Heritage Desk-Based Assessment.

WSI Geophysical Survey, Stobhill Windfarm

Appendices

RWE npower renewables

A042201 October 2009

WSI Geophysical Survey, Stobhill Windfarm

Appendix A – Report Conditions

WSI Geophysical Survey, Stobhill Windfarm

Written Scheme of Investigation for Geophysical Survey, Stobhill Windfarm

This report is produced solely for the benefit of RWE npower renewables and no liability is accepted for any reliance placed on it by any other party unless specifically agreed in writing otherwise.

This report is prepared for the proposed uses stated in the report and should not be used in a different context without reference to WYG. In time improved practices, fresh information or amended legislation may necessitate a re-assessment. Opinions and information provided in this report are on the basis of WYG using due skill and care in the preparation of the report.

This report refers, within the limitations stated, to the environment of the site in the context of the surrounding area at the time of the inspections. Environmental conditions can vary and no warranty is given as to the possibility of changes in the environment of the site and surrounding area at differing times.

This report is limited to those aspects reported on, within the scope and limits agreed with the client under our appointment. It is necessarily restricted and no liability is accepted for any other aspect. It is based on the information sources indicated in the report. Some of the opinions are based on unconfirmed data and information and are presented as the best obtained within the scope for this report.

Reliance has been placed on the documents and information supplied to WYG by others but no independent verification of these has been made and no warranty is given on them. No liability is accepted or warranty given in relation to the performance, reliability, standing etc of any products, services, organisations or companies referred to in this report.

Whilst skill and care have been used, no investigative method can eliminate the possibility of obtaining partially imprecise, incomplete or not fully representative information. Any monitoring or survey work undertaken as part of the commission will have been subject to limitations, including for example timescale, seasonal and weather related conditions.

Although care is taken to select monitoring and survey periods that are typical of the environmental conditions being measured, within the overall reporting programme constraints, measured conditions may not be fully representative of the actual conditions. Any predictive or modelling work, undertaken as part of the commission will be subject to limitations including the representativeness of data used by the model and the assumptions inherent within the approach used. Actual environmental conditions are typically more complex and variable than the investigative, predictive and modelling approaches indicate in practice, and the output of such approaches cannot be relied upon as a comprehensive or accurate indicator of future conditions.

The potential influence of our assessment and report on other aspects of any development or future planning requires evaluation by other involved parties.

The performance of environmental protection measures and of buildings and other structures in relation to acoustics, vibration, noise mitigation and other environmental issues is influenced to a large extent by the degree to which the relevant environmental considerations are incorporated into the final design and specifications and the quality of workmanship and compliance with the specifications on site during construction. WYG accept no liability for issues with performance arising from such factors

November 2008
WYG Environment Planning Transport Ltd

WSI Geophysical Survey, Stobhill Windfarm

Appendix B – Site Location Plan

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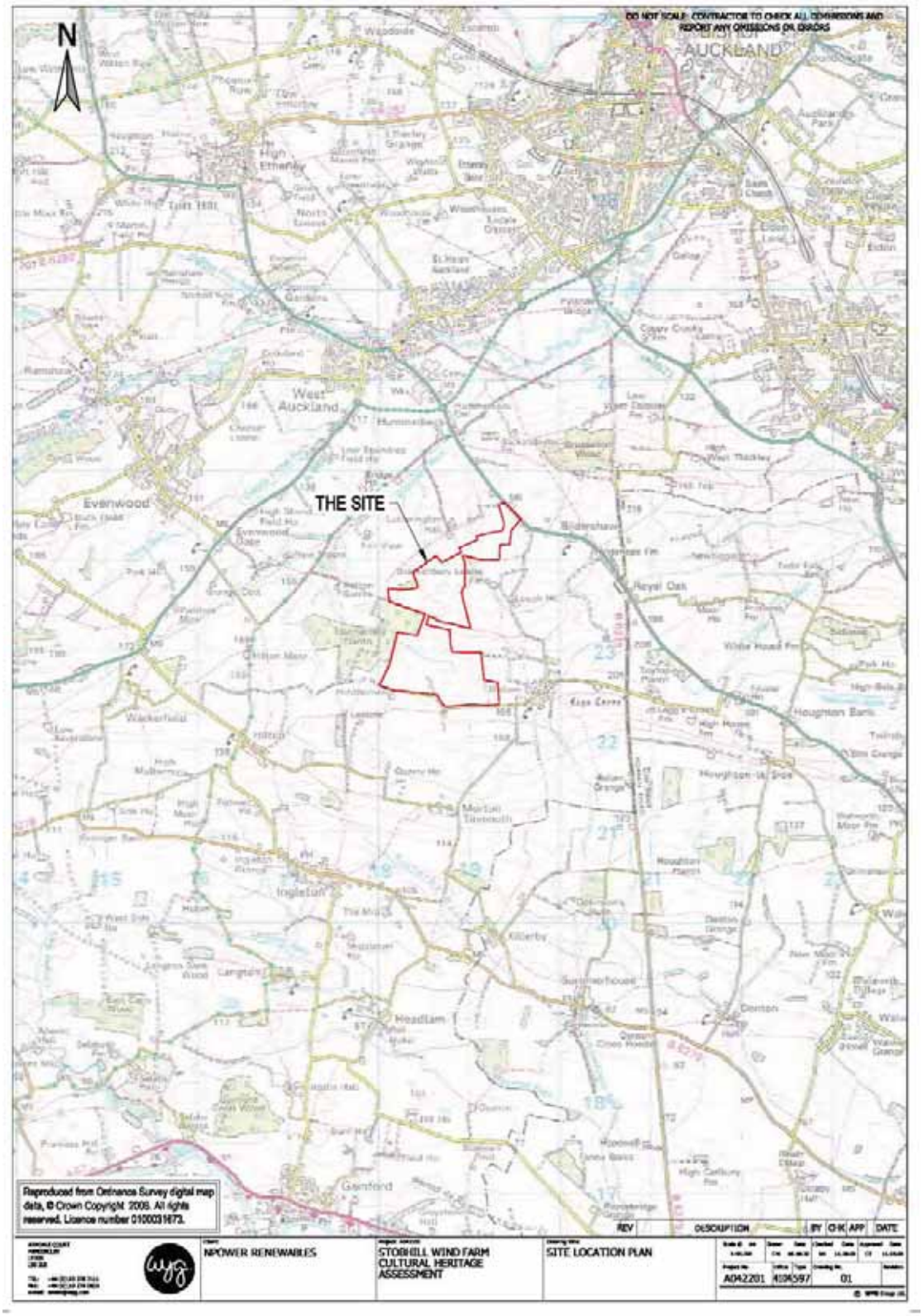
A042201 October 2009

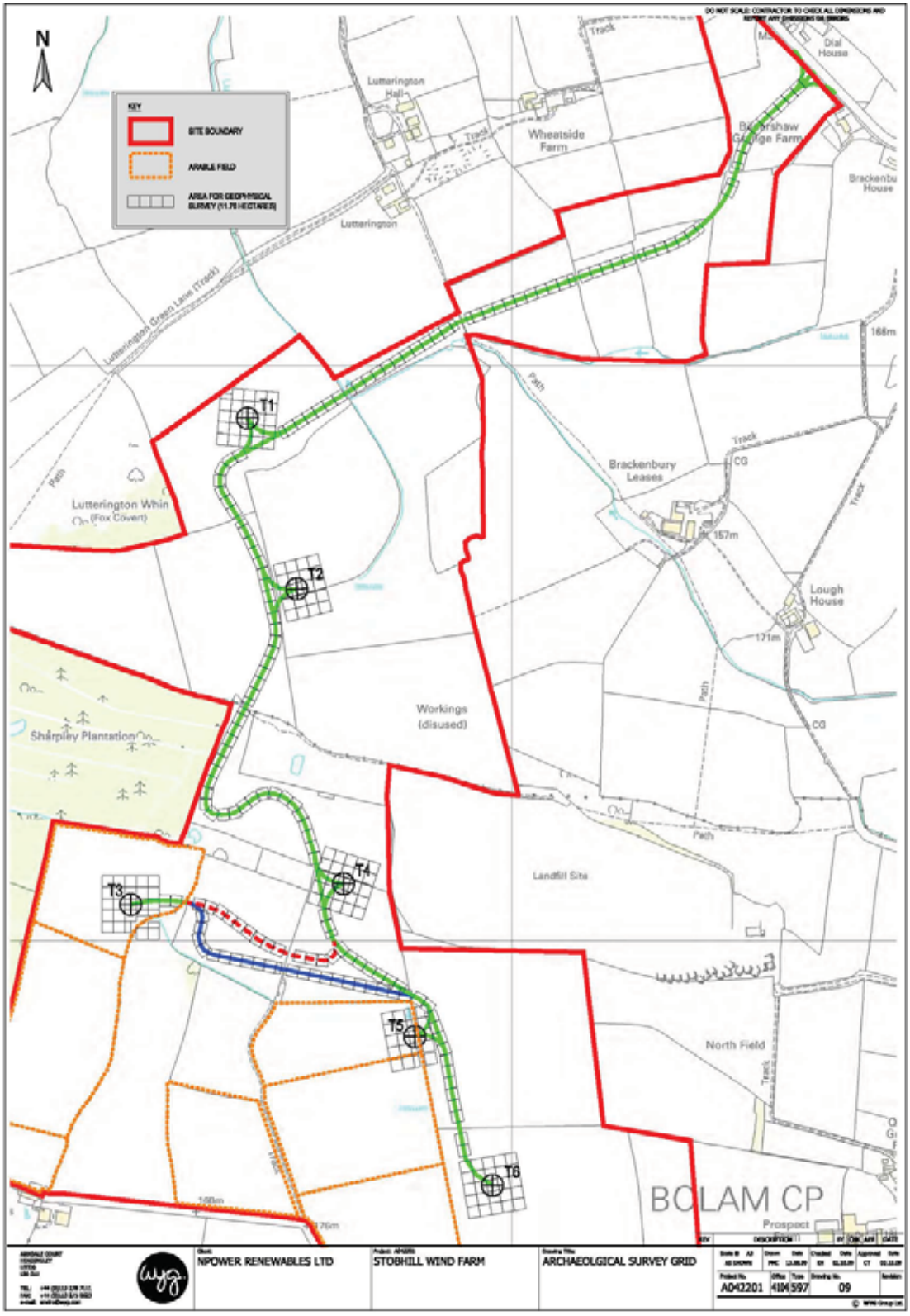

N
DO NOT SCALE - CONTRACTOR TO CHECK ALL DIMENSIONS AND REPORT ANY OMISSIONS OR ERRORS
AUCKLAND
West Auckland
Evenwood
THE SITE
Royal Oak
Houghton Banks
Reproduced from Ordnance Survey digital map data, © Crown Copyright 2009. All rights reserved. Licence number 0100031673.
REV
DESCRIPTION
BY
CHK
APP
DATE
NPOWER RENEWABLES
STOBHILL WIND FARM CULTURAL HERITAGE ASSESSMENT
SITE LOCATION PLAN
AD42201
01

WSI Geophysical Survey, Stobhill Windfarm

Appendix C – Area for Geophysical Survey

RWE npower renewables

A042201 October 2009


N
KEY
SITE BOUNDARY
ARABLE FIELD
AREA FOR GEOPHYSICAL SURVEY (11.78 HECTARES)
Lutterington Hall
Wheatside Farm
Dial House
Lutterington
Lutterington Green Lane (Track)
Lutterington Whin (Fox Covert)
Brackenbury Leases
Lough House
Workings (disused)
Sharpley Plantation
Landfill Site
North Field
T1
T2
T3
T4
T5
T6
168m
157m
171m
BOLAM CP
Prospect
NPOWER RENEWABLES LTD
STOBHILL WIND FARM
ARCHAEOLGICAL SURVEY GRID
AD42201
09

WYG Environment
part of the **WYG** group

Ref: KRH/A042201/Le-12

Date: 1st October 2009

Ms Lee White
Assistant Archaeology Officer
Libraries, Learning and Culture
Durham County Council Adult & Community Services
The Rivergreen Centre
Aykley Heads
Durham
DH1 5TS

Dear Lee

Stobhill Windfarm, Variation to Geophysical Survey Written Scheme of Investigation

Further to the provision of the draft Written Scheme of Investigation for Geophysical Survey at the proposed Stobhill windfarm please find with this letter a proposed variation to the WSI.

Our preferred sub-contractor for the survey identified that part of the survey area (Turbine 4) was underlain by an igneous geological intrusion which may mask archaeological remains surveyed by a magnetic techniques such as magnetometry. We are therefore proposing on their recommendation that a resistance survey technique is adopted in the area of the igneous geology to ensure that the potential for archaeological remains is appropriately assessed.

Please find following this letter a variation to the methodology proposed within the WSI. We would be grateful if you could confirm that you accept the original Written Scheme of Investigation in conjunction with this variation.

If you have any comments please do not hesitate to contact me on 0113 219 7111 or Kirsten.holland@wyg.com

Yours sincerely
for **WYG Environment Planning Transport Ltd**

Kirsten Holland
Senior Archaeologist

creative minds safe hands

Arndale Court, Headingley, Leeds LS6 2UJ
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WYG Environment Planning Transport Ltd Registered in England Number: 3050297
Registered office: Arndale Court, Otley Road, Headingley, Leeds, LS6 2UJ

WYG Environment

part of the WYG group

Variation to Written Scheme of Investigation for Geophysical Survey at the Proposed Stobhill Windfarm

Background

A Draft Written Scheme of Investigation for Geophysical Survey at the proposed Stobhill windfarm has been prepared by WYG (WYG 2009). The WSI proposed a fluxgate gradiometer survey over six turbine bases and a survey corridor along access tracks.

There is an igneous dyke, part of the Armathwaite-Cleveland Dyke, crossing the central part of the study area. Some of this has been quarried away and the site used for landfill, however, based on BGS mapping, the dyke is likely to be present in the area of Turbine 4. If present, geomagnetic survey is unlikely to provide useful information and an electrical resistance survey could be employed as a useful alternative.

Variation to methodology

Geophysical survey is proposed over six turbine bases and an associated access track. Survey of each turbine base will cover approximately 1ha and a 20m-wide survey corridor will cover the access track. The maximum total survey area is anticipated to be up to 11.76ha.

Except in the Area around Turbine 4, a geomagnetic technique (fluxgate gradiometry) will be used and data will be collected at 0.25m intervals along traverses 1m apart, as detailed in the Draft WSI.

An alternative approach for the survey around Turbine 4 and the proposed track to the immediate north-west would be to conduct geomagnetic scanning there and if the gradiometer values appear relatively constant and comparable to those in the surrounding surveys then further detailed geomagnetic survey would seem appropriate. If, however, the gradiometer values appear to vary considerably, with many unusually high and low values, then it is likely that the dyke is present and resistance survey should be conducted instead. Resistance data would be collected at 1m intervals along traverses 1m apart.

Based on BGS mapping, it is estimated that approximately 1.2ha of the proposed survey grid might overly the dyke.

All geophysical work, data processing and reporting will be carried out in accordance with English Heritage guidelines, Geophysical survey in archaeological field evaluation (David et al. 2008); the Institute for Archaeologists Paper No.6, The use of geophysical techniques in archaeological evaluations (Gaffney et al. 2002); and the Archaeology Data Service Geophysical Data in Archaeology: A Guide to Good Practice (Schmidt 2002).

Variation to timetable

If earth electrical resistance survey is undertaken over 1.2ha, this may add one or two days to the total fieldwork time. However, if sufficient resources are available at the time of survey, the fieldwork may still be completed within one week.

Archaeological Services University of Durham

Stobhill Wind Farm, Bolam, County Durham

geophysical surveys

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Figure 1

Site location

for

WYG Environment

on behalf of

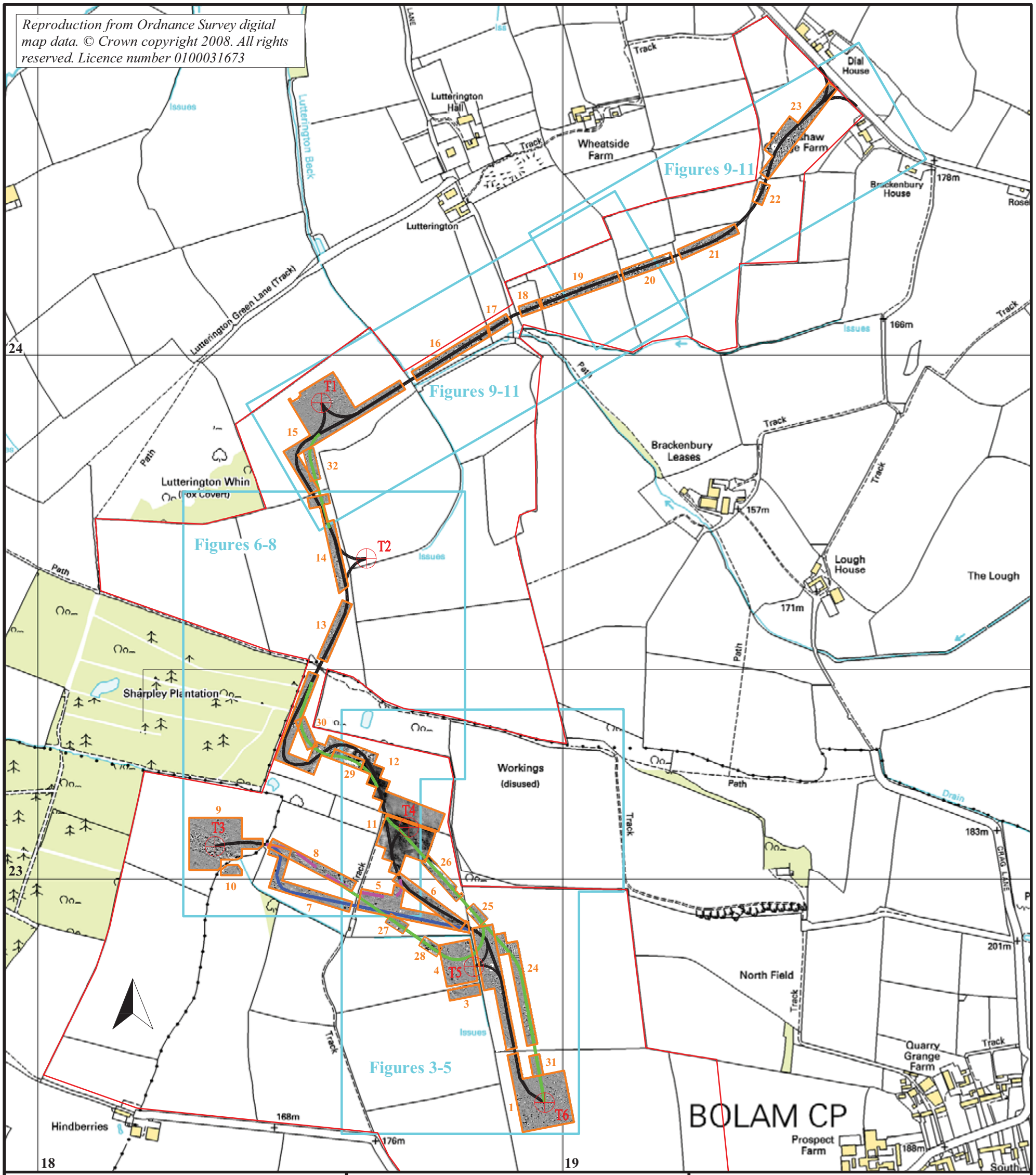
RWE Npower Renewables

0 1km

scale 1:25 000 - for A3 plot

site boundary

geophysical surveys



Archaeological Services
University of Durham

Stobhill Wind Farm,
Bolam, County Durham

geophysical surveys

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Figure 2

Overview of surveys and development options

for
WYG Environment

on behalf of
RWE Npower Renewables

0 300m

scale 1:7500 - for A3 plot

- site boundary
- outline of survey area
- proposed development access track
- proposed turbine

Resistance surveys

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Area 12
Area 11
Area 26
Area 6
Area 25
Area 5
Area 27
Area 28
Area 4
Area 3
Area 2
Area 24
Area 31
Area 1
Track
Issues

outline of survey area

Area 11, resistance survey

100.00
94.17
88.33
82.50
76.67
70.83
65.00
59.17
53.33
47.50
41.67
35.83
30.00 ohm

Area 12, resistance survey

150.00
141.67
133.33
125.00
116.67
108.33
100.00
91.67
83.33
75.00
66.67
58.33
50.00 ohm

Magnetic surveys

6.00
5.17
4.33
3.50
2.67
1.83
1.00
0.17
-0.67
-1.50
-2.33
-3.17
-4.00 nT

0 50m

scale 1:1000 - for A1 plot

for
WYG Environment

on behalf of
RWE Npower Renewables

Archaeological Services
University of Durham

Stobhill Wind Farm,
Bolam, County Durham

geophysical surveys

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Figure 3

Southern area - geophysical surveys

Resistance surveys

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Area 12
Area 11
Area 26
Area 6
Area 25
Area 5
Area 27
Area 28
Area 4
Area 3
Area 2
Area 31
Area 1
Track
Issues

outline of survey area
positive magnetic anomalies
negative magnetic anomalies
dipolar magnetic anomalies
high electrical resistance

0 50m
scale 1:1000 - for A1 plot

for
WYG Environment

on behalf of
RWE Npower Renewables

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Bolam, County Durham

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Figure 4

Southern area - geophysical interpretation

Area 12

Workings (disused)

Area 11

Area 26

Area 6

Area 25

Area 5

Area 27

Area 28

Area 4

Area 3

Area 2

Area 31

Area 1

Track

earthwork

headland

old field boundary

outline of survey area

soil-filled features

service pipes

orientation of ridge and furrow

possible stone feature

geological feature

land drains

disturbed area

0 50m

scale 1:1000 - for A1 plot

for
WYG Environment

on behalf of
RWE Npower Renewables

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Bolam, County Durham**

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Figure 5

Southern area - archaeological interpretation

Fox Covert)

237

236

235

234

233

232

231

230

antation

Area 14

Area 13

Area 30

Area 12

Area 29

Area 9

Area 8

Area 11

Area 10

Area 7

Issues

track

outline of survey area

6.00
5.17
4.33
3.50
2.67
1.83
1.00
0.17
-0.67
-1.50
-2.33
-3.17
-4.00 nT

0 50m

scale 1:1000 - for A1 plot

for
WYG Environment

on behalf of
RWE Npower Renewables

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Figure 6

Central area - geophysical surveys

183 184 185 186 187

Fox Covert)

Area 14

Issues

Area 13

antation

Area 30

Area 12

Area 29

Area 9

Area 8

Area 11

Track

Area 10

Area 7

outline of survey area

positive magnetic anomalies

negative magnetic anomalies

dipolar magnetic anomalies

0 50m

scale 1:1000 - for A1 plot

for
WYG Environment

on behalf of
RWE Npower Renewables

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Bolam, County Durham

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Figure 7

Central area - geophysical interpretation

237
236
235
234
233
232
231
230
183
184
185
187

Fox Covert)

antation

Area 14

Area 13

Area 30

Area 12

Area 29

Area 9

Area 8

Area 11

Area 10

Area 7

T2

T3

T4

Issues

track

237
236
235
234
233
233
231
230
183
184
185
187

outline of survey area
soil-filled features
orientation of ridge and furrow
possible stone feature
geological feature
land drains
disturbed area

0 50m

scale 1:1000 - for A1 plot

for
WYG Environment

on behalf of
RWE Npower Renewables

Archaeological Services
University of Durham

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Bolam, County Durham

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Figure 8

Central area - archaeological interpretation

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outline of survey area

6.00
5.17
4.33
3.50
2.67
1.83
1.00
0.17
-0.67
-1.50
-2.33
-3.17
-4.00 nT

0 50m

scale 1:1000 - for A1 plot

for
WYG Environment

on behalf of
RWE Npower Renewables

Archaeological Services
University of Durham

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Bolam, County Durham

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Figure 9

Northern area - geophysical surveys

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Area 15
Area 16
Area 17
Area 18
Area 19
Area 20
Area 21
Area 22
Area 23
Area 32

Path

Dial House

Bildershaw Grange Farm

outline of survey area
positive magnetic anomalies
negative magnetic anomalies
dipolar magnetic anomalies

0 50m
scale 1:1000 - for A1 plot

for
WYG Environment

on behalf of
RWE Npower Renewables

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Figure 10

Northern area - geophysical interpretation

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T1

Area 15

Area 16

Area 17

Area 18

Area 19

Area 20

Area 32

Area 19

Area 20

Area 21

Area 22

Area 23

Bildershaw Grange Farm

Dial House

Path

outline of survey area

soil-filled features

orientation of ridge and furrow

disturbed area

0 50m

scale 1:1000 - for A1 plot

for
WYG Environment

on behalf of
RWE Npower Renewables

Archaeological Services
University of Durham

Stobhill Wind Farm,
Bolam, County Durham

geophysical surveys

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Figure 11

Northern area - archaeological interpretation

Figure 12: Trace plots of geomagnetic data

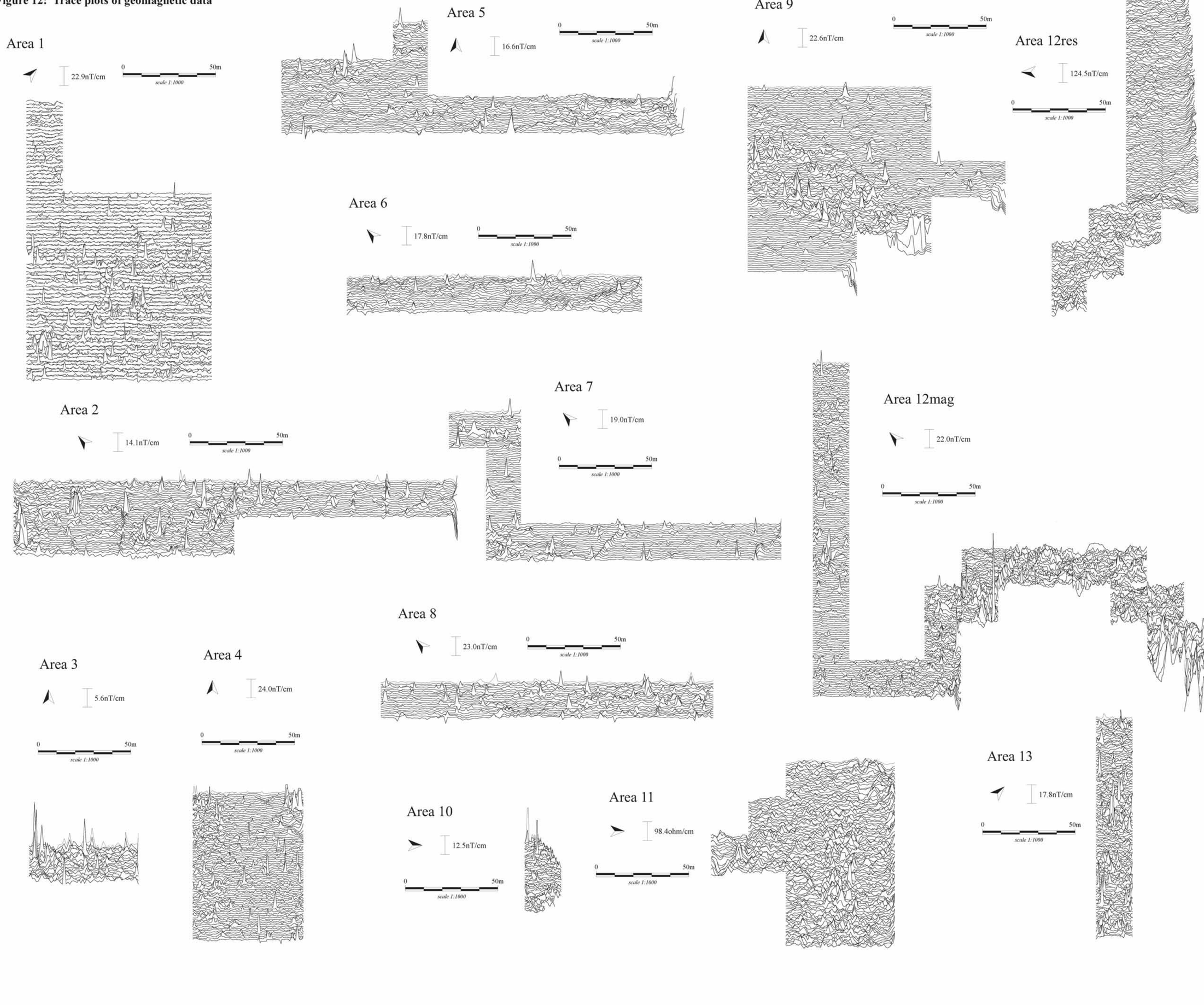

Figure 13: Trace plots of geomagnetic data