MANOR HOUSE FARM, HELPERTHORPE, NORTH YORKSHIRE.

REPORT ON AN ARCHAEOLOGICAL GEOPHYSICAL SURVEY.

OSA REPORT No: OSA12EV02 (Geophysics).

January 2012.

OSA

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Report Summary.

PROJECT NO:	OSA12EV02 (Geophysics)
SITE NAME:	Manor House Farm, Helperthorpe
COUNTY:	North Yorkshire
NATIONAL GRID REFERENCE:	SE 94800 71222
HET REF NUMBER:	RF/GO/SHP900331
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1.0 Abstract

A geophysical survey was carried out by On-Site Archaeology Ltd *in advance of the submission of a planning application for a single mid-size wind turbine and associated cable trench. As the archaeological implications of the proposals could not be adequately assessed on the basis of currently available information, in accordance with the recommendations of Planning Policy Statement 5 a scheme of archaeological evaluation by geophysical survey was carried out.*

The evaluation has revealed responses mostly relating to current agriculture practice or to modern features. A small number of responses that may indicate the presence of infilled pit features, but in the absence of obvious archaeological response elsewhere in the survey area they should be considered as 'uncertain' and could also be of geological origin.

None of the data indicate an obvious presence of archaeological deposit and the survey is generally very 'quiet' in magnetic responses due to the low magnetism of the underlying hard geology.

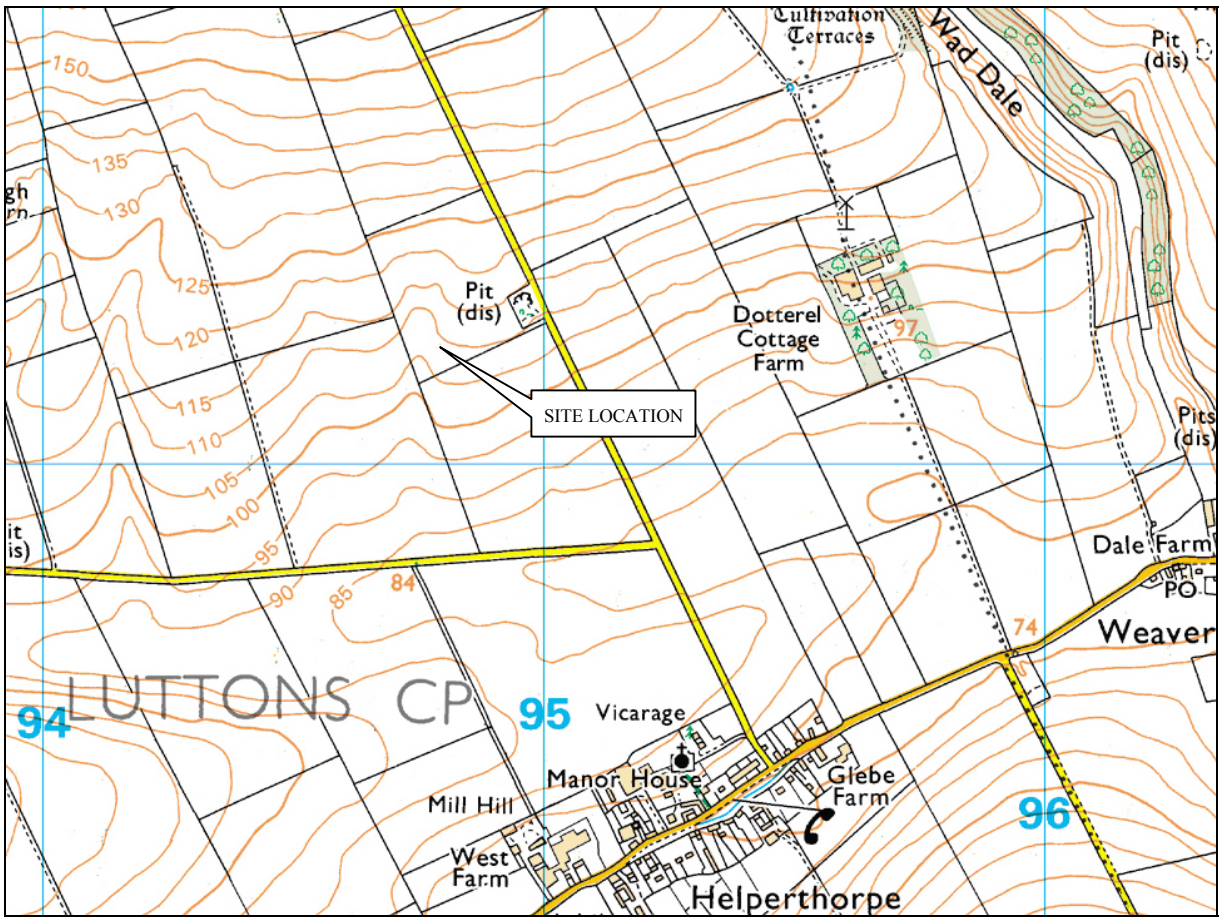

Figure 1: Site Location (NGR SE 94800 71222)

2.0 Site Location, Geology, Topography and Land Use.

The site considered by this report, centred at NGR SE 94800 71222, lies 1km north of the village of Helperthorpe on sloping ground in agricultural fields (Figure 1). The proposed development will be sited in agricultural land.

The ground cover is short winter wheat the land lies at approximately 112m above Ordnance Datum (Figure 2).

The underlying geology is chalk of the Welton chalk formation and Burnham chalk formation (British Geological Survey http: //maps.bgs.ac.uk/) with no recorded superficial/drift deposits. The response of chalk geology to magnetometer survey is classified as good, especially over cretaceous chalk (English Heritage 2008, 15).

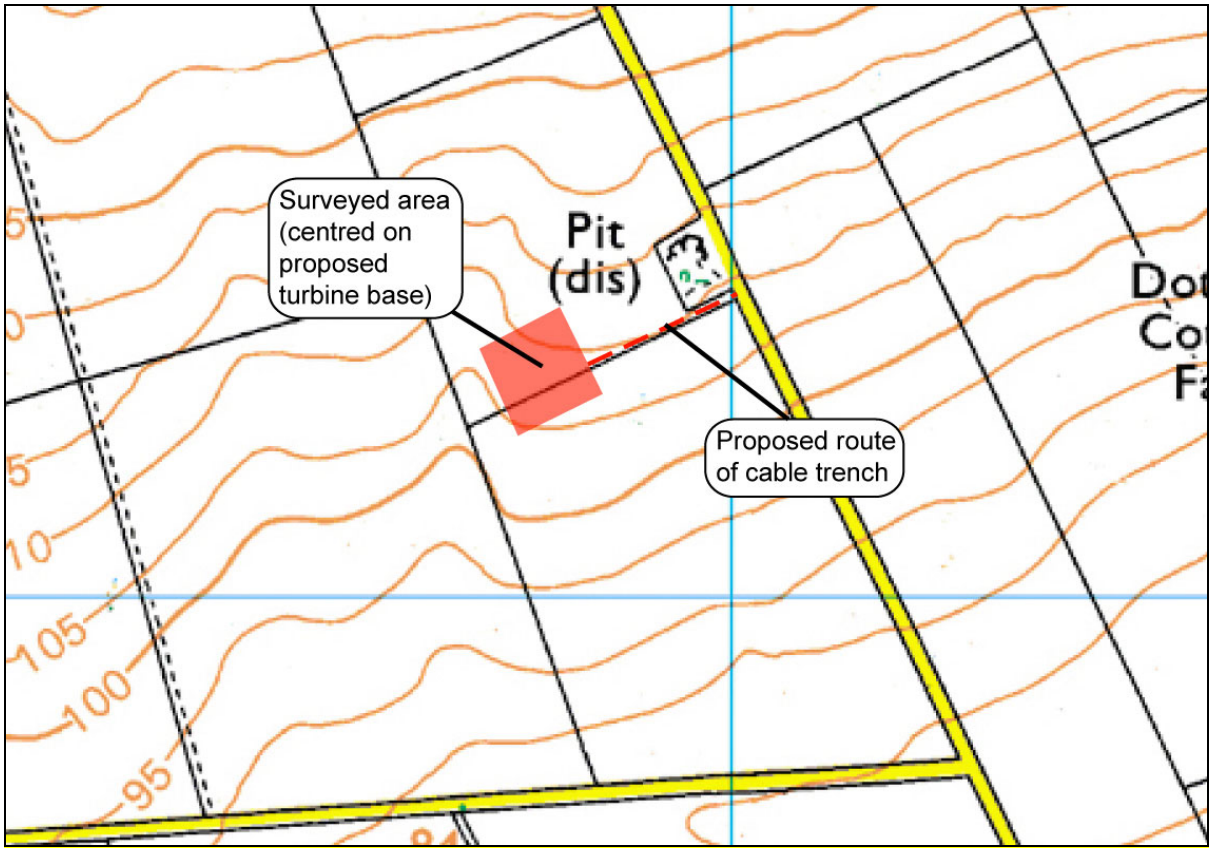

Figure 2: Location of survey

3.0 Archaeological Background.

The proposed development area lies within an area of high potential archaeological sensitivity and importance.

The National Monuments Record has an entry for the cropmarks of five ring ditches and 40-50 Iron Age square barrows arranged roughly in east-west rows, 5-15m, many with central pits, adjacent to a pit alignment. This is centred on grid reference SE 944 713, which lies in the field next door to the proposed wind turbine location.

Aerial photographic mapping shows the location of the square barrow cemetery less than 500m to the northeast of the location of the proposed wind turbine. A possible Bronze Age round barrow and linear ditch is also shown 500m to the north east of the proposed turbine location. Approximately 1km to the southwest lie further square barrows and to the southeast lie the cropmarks of a probable ladder settlement of Iron Age/Romano-British date (Stoertz 1997).

4.0 Methodology.

4.1 General

The surveys and reporting were conducted in accordance with the current professional guidelines "Geophysical Survey in Archaeological Field Evaluation" (English Heritage 2008) and "Draft Standard and Guidance for Archaeological Geophysical Survey" (Institute for Archaeologists 2010).

Geophysical surveying enables the relatively rapid and non-invasive identification of potential archaeological features within landscapes and can involve a variety of complementary techniques such as magnetometry, electrical resistivity, ground-penetrating radar and electromagnetic survey. Some techniques are more suitable than others in particular situations, depending on a variety of 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.

In this instance, based on existing knowledge of sites in the vicinity, it was considered likely that cut features, such as ditches and pits, may be present on the site, and that other types of feature such as trackways, and possibly fired (such as kilns and hearths) might also be present (see Stoertz 1997, Ancient Landscapes of the Yorkshire Wolds).

Magnetic survey is generally well suited to the detection of such features (including ditches, pits, etc - in a range of conditions, and provides the most rapid means of assessment of the extent of archaeological deposits over large areas. It is particularly well suited to the detection of archaeological features on calcareous geology, which presents a very consistent geomagnetic character.

The most commonly used magnetic technique in archaeological survey in Britain employs the use of hand-held magnetometers (Fluxgate Gradiometer) which detect and record minor variations in the vertical component of the local magnetic field at a given sample interval over the extent to of the survey area. These variations are often caused by changes in soil's magnetic susceptibility or permanent thermo-remnant magnetisation that in many cases can reflect archaeological activity and the form and extent of discrete features.

It should be noted that this technique, whilst capable of identifying possible archaeological anomalies, is also responsive to changes in the magnetic gradient caused by geological composition or by ferrous material in the soil and above the surface. This means that service points, conduits, metal fences/ buildings, and modern ferrous objects in the topsoil all yield elevated magnetic responses, and where these features exist in the survey area, more subtle fluctuations resulting from archaeological features can sometimes be masked.

It is also important to note that like many geophysical methods, magnetic survey detects many types of archaeological feature, but does not provide information on dating or their relative phasing.

4.2 Fieldwork methodology

The data collection for the survey was carried out in several gridded areas comprised of 30m squares across the site in order to cover the proposed development area. In total, 9 grid squares comprising 8,100m^2 were surveyed. The survey grids were tied-in to known, mapped Ordnance Survey points using a Leica GPS900. The GPS900 is an RTK GPS unit providing survey quality location information accurate to around 10mm.

Data collection was carried out using Bartington Grad 601-2 fluxgate gradiometer with automatic data logging facilities. Samples were recorded using an interval of 0.25 x 1 m in accordance with current archaeological guidelines (English Heritage 2008), yielding 3600 measurements per 30m square. The instrument sensitivity was set to 0.03nT within a +/- 100nT range ensuring the accurate recording of small variation in the local magnetic gradient.

4.3 Processing and data treatment

Following initial field survey, data is prepared and processed using a series of software tools to eliminate any data defects resulting from local conditions or collection problems. Once defects have been identified, images are prepared using a greyscale representation of the relative strength of magnetic response in the survey areas. The greyscale plots provide a graphic‘ 2D image’ of subsurface magnetic conditions and form the basis of the interpretation diagram in Figure 7. (Additional ‘X/Y trace’ plots are also included where applicable, and in this case data has been presented in X/Y for comparison of processed results.)

For processing, Geoscan *Geoplot 3.0* software was used for initial data processing and Golden Software’s *Surfer* used for the production of both raw and processed data plots.

The following processing and image enhancement functions have been applied to the Helperthorpe dataset (see Appendix 1 for details):

Despike – Used to locate and reduce the effects of random ferrous responses in the survey area largely resulting from iron objects near to the surface. NB Some features cannot be eliminated using despike and thus responses from some ferrous content are often present even after use of this processing procedure.

Although metallic pollution in the topsoil was not a significant problem in this survey, some despiking was necessary. The parameters used for the despike process to remove random responses from metal in the topsoil were: radius of X4x Y1 readings for local averaging with a threshold of 3.0. A ‘mean spike replacement method’ was applied using the despike filter in Geoplot 3.0 software.

Zero Mean Traverse – For removing striping effects in the data caused by the orientation of the instrument sensors; also removes traverse striping caused by abnormally strong responses caused by ferrous pollution. NB the use of Zero Mean Traverse can mask or remove natural linear anomalies that run parallel to the traverse direction, and thus it is only applied after reviewing the clipped date for any such responses. For settings see Appendix 2 below.

Interpolation – Increases the number of data points in a survey on one or both axes. In this instance survey data was collected using a 0.25 x 1m sampling interval, and for final graphic preparation clipped and processed data was interpolated on the Y-axis resulting in a smoothed greyscale plot. Geoplot's *sin x/x* interpolation method was used for this process.

5.0 Results.

The raw data is presented here using greyscale plots in its raw format with minimal processing to give an impression of the full range data statistics (Figures 3, 4 and 5). Darker greys and blacks represent elevated magnetic readings, and lighter values lower readings, while middle grey indicates the 'survey average' response of the underlying geological conditions.

Magnetic values are measured here in Nanotesla (*nT)* and the Bartington is configured at a sensitivity of 0.3 *nT* and records data within a range of -100nT/ +100nT. Within this range most archaeological and geological features occupy relatively low magnitude with respect to the survey zero (typically between -20 and +20 nT).

Responses of very high magnitude in the top and bottom end of this usually result from isolated random or major ferrous objects, but very few of these are present in the Helperthorpe data. Where they are present they represent small iron objects present in the topsoil such as parts of farm machinery, rubbish/ building debris or field boundary.

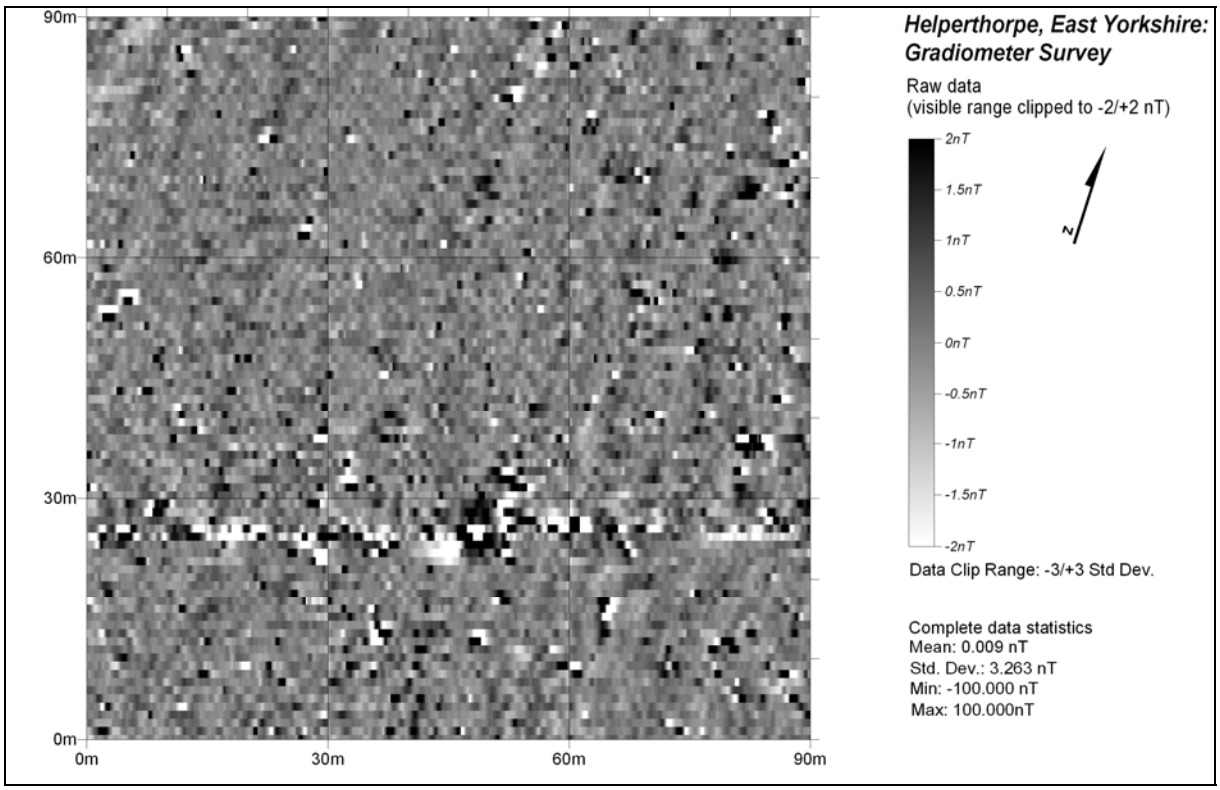

Figure 3: Greyscale plot of raw results (visible greyscale range -2/ +2 nT)

Processed Data

Processing of results was undertaken to eliminate data anomalies. As outlined above these include*, Despike, ZMT, and Interpolate*. The results are displayed in Figures 4 and 5.

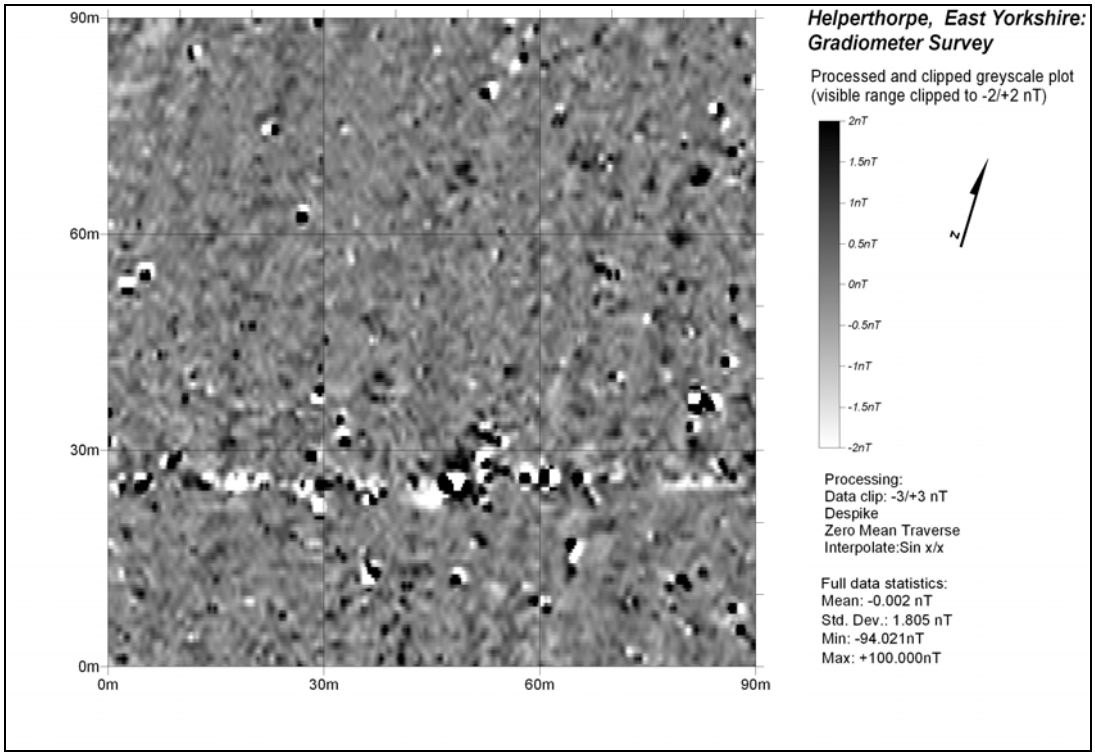

Figure 4: Greyscale plot of processed results (visible greyscale range -2/ +2 nT)

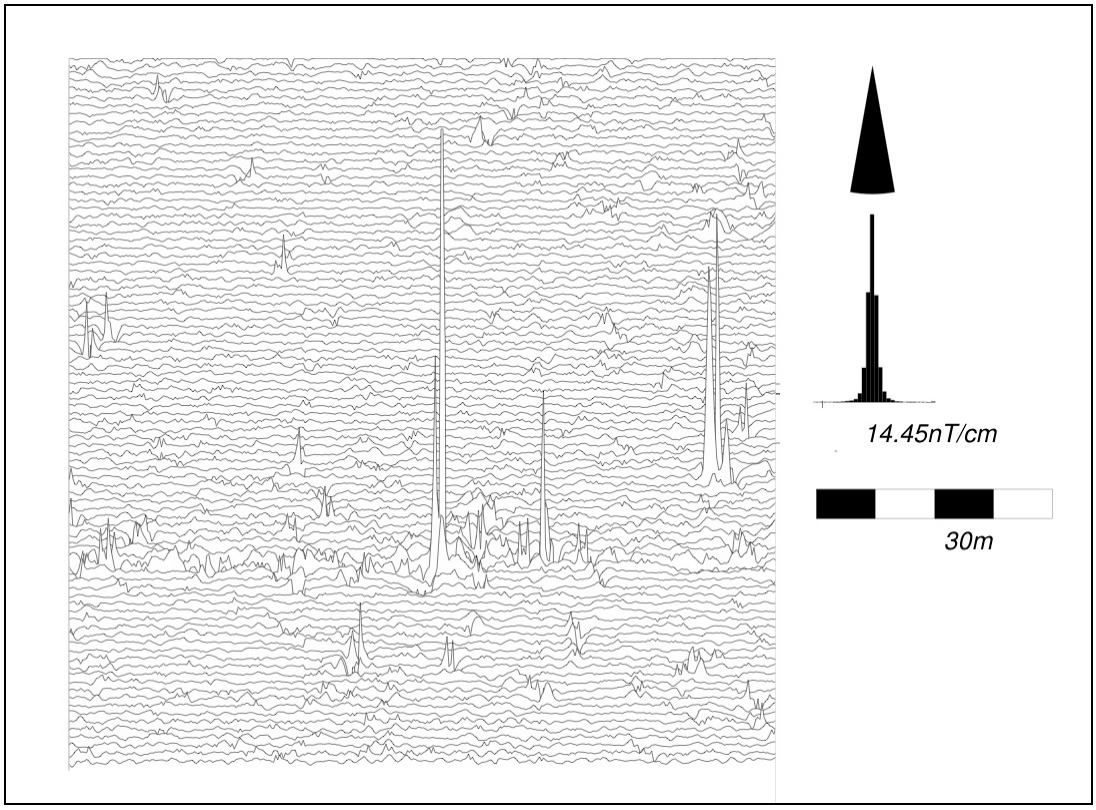

Figure 5: X/Y trace plot of processed results (visible greyscale range -3/ +3 nT)

6.0 Interpretation.

Figures 6 and 7 illustrate interpretation of anomalies within the survey area. For discussion see below.

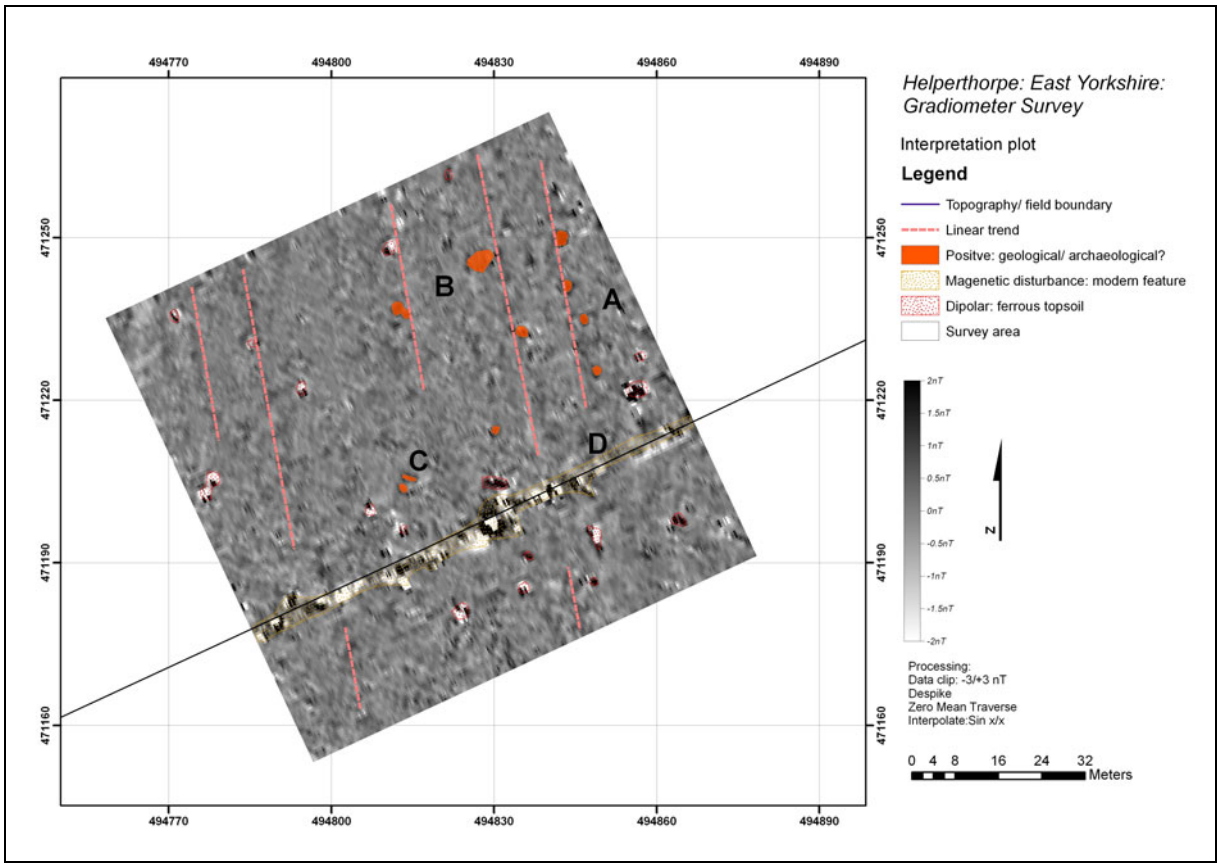

Figure 6: Greyscale plot with colour-coded interpretation: greyscale range clipped to –2/+2 nT

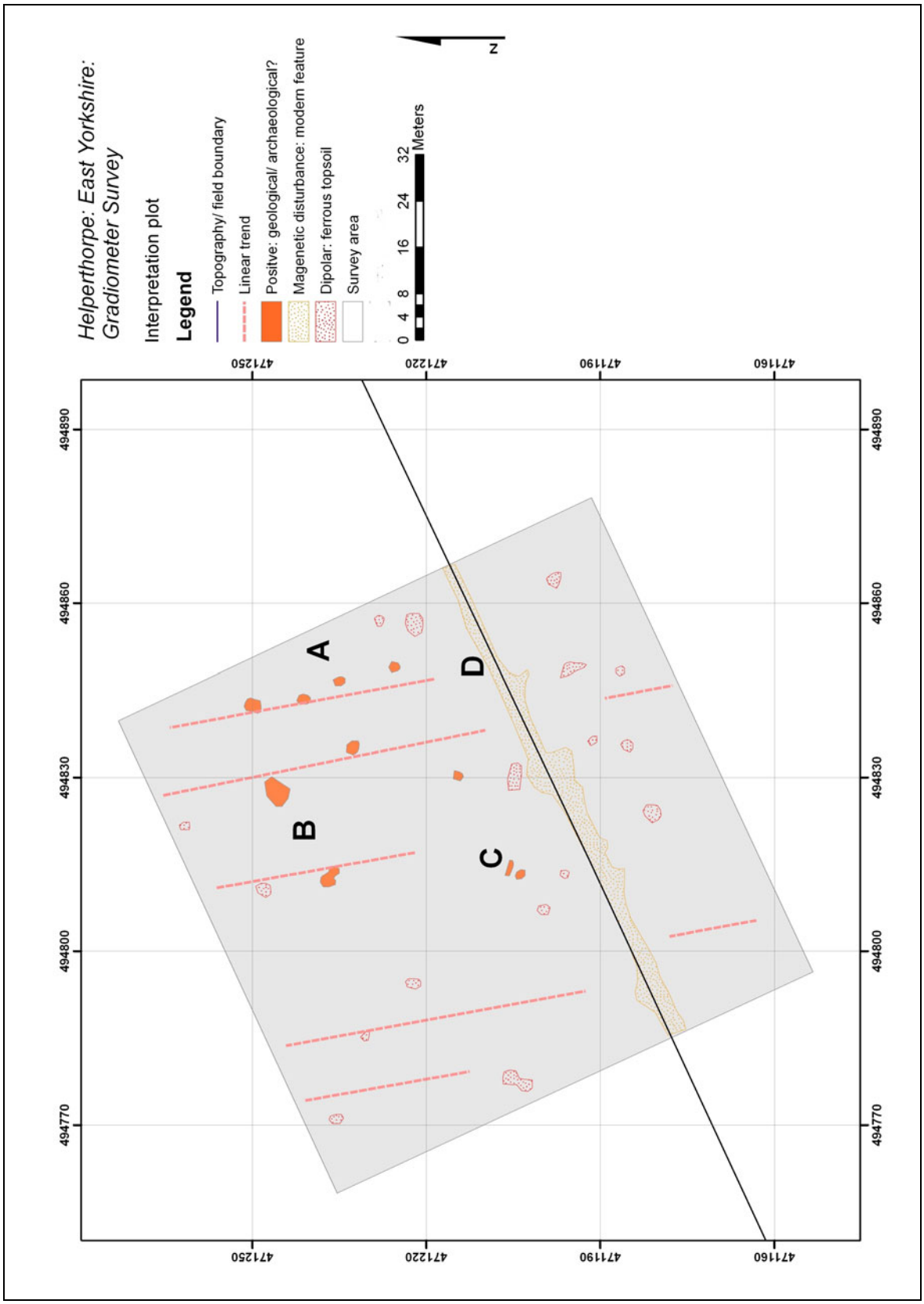

Figure 7: Interpretation with significant anomalies labelled.

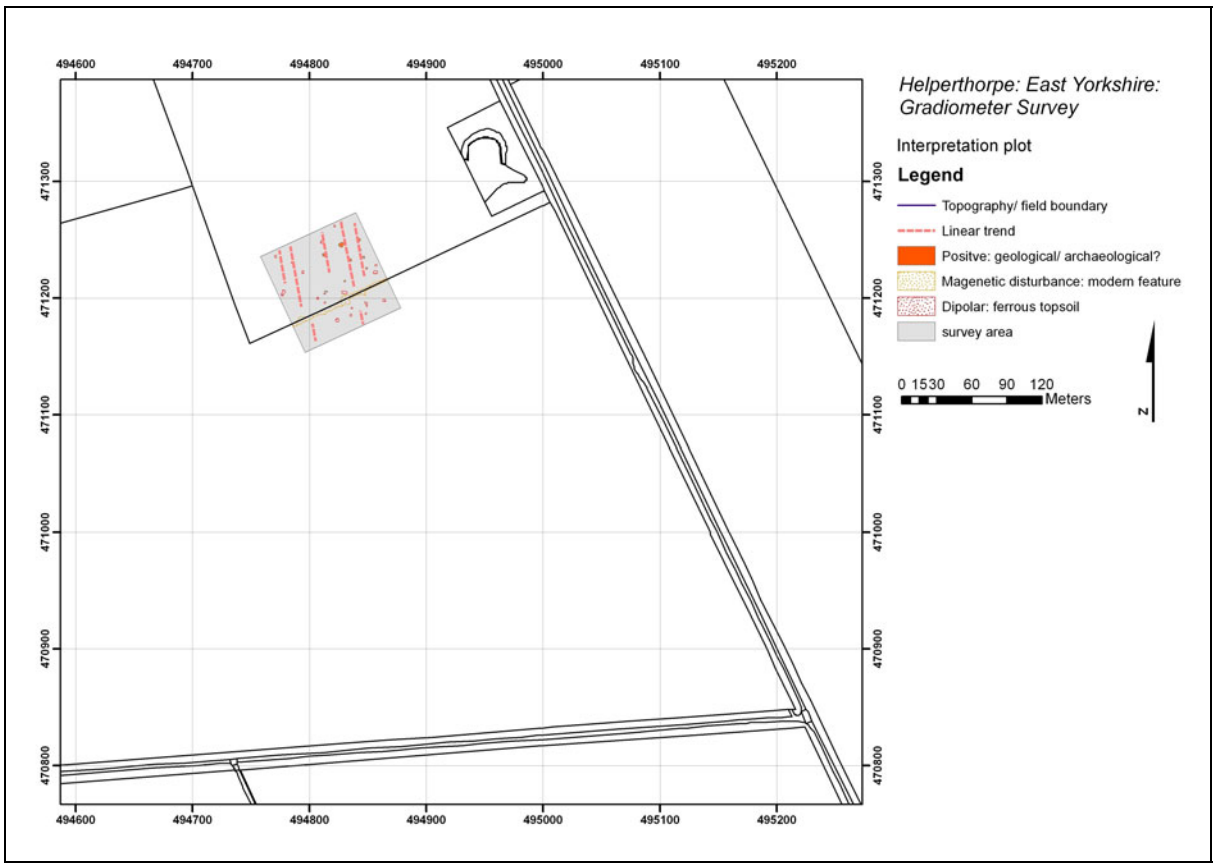

Figure 8: Survey area with interpretation.

The categories of response present in the survey are relatively limited due to the generally 'quiet' magnetic character of the chalk geology and the agricultural setting. Archaeological and geological features typically show up moderately very well in such conditions especially for features cut into the underlying geology, which often are identifiable as areas of elevated magnetic response with respect to the background soil magnetism. Variations in magnetic enhancement can be detected and plotted with spatial accuracy dependant on the level of 'masking' by modern agricultural practice.

In the Helperthorpe data there is little variation in local background soil magnetism. Variations that have been detected can be attributed predominantly to isolated ferrous 'spikes' resulting from metallic objects in the plough-soil, and to current and historical agricultural practices. There are also a very limited number of responses suggestive of either local geological anomalies or possible archaeological features.

Figures 6 and 7 contain and interpretation of anomaly types with various categories of anomaly outlined in the associated legend.

To clarify issues of terminology, in magnetic survey, responses are described by their *nT* value in relation to the survey '*zero'* or *mean.* Therefore, *positive* refers to elevated or enhanced magnetic values, *negative* refers to lower values, and *dipolar* refers to responses that consist of an elevated peak and a negative trough. Depending on their origin and cause, each of these can exist as linear features, localised features, or area features.

The combination of factors including: subsurface/ surface conditions, by the depth of the anomaly and material composition all affect the form of magnetic responses. In the current dataset the following general categories were observed:

1. *Dipolar responses associated with ferrous material in topsoil*- A range of isolated dipolar responses across the survey area indicate the likely presence of ferrous objects near the surface in the topsoil. The dipolar form of the response is caused by the alignment of the local magnetic polarity of the feature.

2. The despike process eliminated many of the isolated responses of this type, but the interpretive plot shows where the stronger of such responses have been retained (typical range -25/+25 *nT* or lower).

3. *Area of magnetic disturbance* – A field boundary running on an E/W axis in the southern half of the survey has caused a mid range magnetic interference. The data had been clipped to counteract the masking effects of this, but the readings in the immediate proximity of these features should not be considered in interpretation of geology or archaeology

4. *Positive and negative linear: modern and historic ploughing* – In parts of the northern field there is evidence of recent agricultural activity. The associated magnetic response is one of gently alternating positive and negative readings arrange in alignment with the direction of ploughing. They are marked a 'Linear trend' on the interpretation plot.

5. *Magnetic enhancement: geological/ archaeological?* - Features of a slightly elevated response with respect to the background mean. These are few and of a non-distinct isolated form, and do not seem to indicate obvious archaeological deposits. They are caused either natural or archaeological features, but in this instance the former is likely. They are treated individually below where applicable.

Specific anomalies of note are labelled alphabetically in Figures 6 and 7. They are as follows:

A) A string of four isolated low magnitude responses to the east of the survey area. The responses are typical of a silted up depressions or cuts into the chalk geology. They are aligned with modern ploughing patterns and may be associated.

B) Two similar responses to the west of A, but slightly larger in extent. Magnetic values are in the range of +1 to +5nT and indicate a localised magnetic enhancement similar to A. As in the case of A, they probably indicate silted depressions or cuts into the chalk geology

C) As above in A and B, but isolated

D) An area of magnetic enhancement/ disturbance, cased by a field boundary.

7.0 Discussion and Conclusions.

The evaluation has revealed responses mostly relating to current agriculture practice or to modern features. A small number of responses that may indicate the presence of infilled pit features, but in the absence of obvious archaeological response elsewhere in the survey area they should be considered as 'uncertain' and could also be of geological origin.

None of the data indicate an obvious presence of archaeological deposit and the survey is generally very 'quiet' in magnetic responses due to the low magnetism of the underlying hard geology.

It is recommended that further investigation in the form of a strip and record exercise is carried out prior to the construction of the wind turbine base itself and that a watching brief is maintained during excavation of the cable trenching.

8.0 Appendix 1: Methodology.

Survey area	Helperthorpe, Malton, North Yorkshire	
Crop types	Winter Wheat	
Geology	Chalk, East Yorkshire Wolds	
Instrumentation	Bartington Grad 601-2 Leica GPS900	
Software	Geoplot 3.00, ArcGIS 9.3, AutoCAD 2004, ArcGIS 9.3 Surfer	
Survey	Resolution: Sample Interval: Traverse interval: Grid Size: Cell size: Traverse method Survey Date	0.03nT/m used in 100nT range 0.5m 1m 30x30m 1x0.25m Zig-Zag July 2011
Processing	Using Geoplot 3.0 software: Clip, Despike, Zero Mean Grid, Zero Mean Traverse, Interpolation	
Coordinate system	GB Ordnance Survey	
Staff	Ben Gourley	

9.0 Appendix 2: Processing Methodology.

All processing and image preparation was done using Geoplot 3.00 software

Data Statistics: min/ max/mean and std. dev:

Mean: 0.009 nT

Std. Dev.: 3.263 nT

Min: -100.00

Max: 100.00

Processing procedures:

Despike: Search radius X=4 Y=1, Threshold: 3, Replacement method: Mean

Zero mean traverse: using Threshold Standard Deviation= 0.25

Zero mean traverse: using Geoplot Presets Grid=All, LMS=On. Pos.Threshold = +5, Neg.Threshold = -5.

Interpolate Using Geoplot Sin X/X on y-axis.

10.0 Appendix 3: Equipment used.

Bartington Grad 601- 2 dual fluxgate gradiometer. Data is stored in a non-volatile memory.

Full technical specification is available via http://www.bartington.com/templates/asset-relay.cfm?frmAssetFileID=102

Geoscan Geoplot 3.0 software http://www.geoscan-research.co.uk/page9.html

Leica GPS900 RTK dual frequency GPS. The GPS900 is a dual-frequency, geodetic, real-time RTK receiver with a potential accuracy of Kinematic (phase) Horizontal: 10mm + 1ppm and moving mode after initialisation Vertical: 20mm + 1ppm.

Full technical data and specification for the GPS900 may be obtained from http://www.leica-geosystems.com/en/downloads-downloads-search_74590.htm?search=true&product=GPS900

11.0 Appendix 4: Bibliography.

British Geological Survey *OpenGeoscience*
http://maps.bgs.ac.uk/geologyviewer_google/googleviewer.html

English Heritage 2008 *Geophysical Survey in Archaeological Field Evaluation.* English Heritage 2008.

Institute for Archaeologists 2010 *Draft Standard and Guidance for Archaeological Geophysical Survey.* Institute for Archaeologists 2010.

Stoertz, C 1997 *Ancient Landscapes of the Yorkshire Wolds*. RCHME.