ARCHAEOLOGICAL SERVICES WYAS

Heysham South Windfarm
Heysham
Lancashire

Geophysical Survey

Report no. 2461

April 2013

Client: Banks Renewables Ltd

REGISTERED ORGANISATION IfA

Heysham South Windfarm
Heysham
Lancashire

Geophysical Survey

Summary

A geophysical (magnetometer) survey, covering approximately 5 hectares, was carried out at the proposed site of a three turbine windfarm to the south-east of Heysham. The survey covered areas of 1 hectare, centred on each turbine base, and a 20m wide corridor along the route of the access tracks and cable runs. Anomalies caused by sub-surface pipes, modern disturbance and recent agricultural activity have been identified. A number of possible archaeological anomalies have been identified in the area encompassing the proposed location of Turbine 3. However, all these anomalies are beyond the area that will be impacted by the proposed scheme layout. Therefore, on the basis of the geophysical survey the site is considered to have a low archaeological potential.

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Report Information

Client:	Banks Renewables Ltd
Address:	Inkerman House, St John's Wood, Meadowfield, Durham, DH7 8XL
Report Type:	Geophysical Survey
Location:	Heysham
County:	Lancashire
Grid Reference:	SD 432 599
Period(s) of activity:	Modern
Report Number:	2461
Project Number:	4035
Site Code:	HWL13
OASIS ID	archaeol11-148913
Planning Application No.:	Pre-determination (Outline)
Museum Accession No.:	n/a
Date of fieldwork:	March 2013
Date of report:	April 2013
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Fieldwork:	Chris Sykes BSc
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Photography:	David Harrison
Research:	n/a

Authorisation for distribution: --

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1 Introduction

Archaeological Services WYAS (ASWYAS) was commissioned by Steve Williams, Senior Project Manager at Banks Renewables, to carry out a geophysical (magnetometer) survey as part of pre-determination work to inform a planning application for the proposed Heysham South Windfarm, Lancashire (see Fig. 1). The survey covered the locations of the three turbines as well as along the route of access tracks and cable runs. The results of the survey will help assess the extent of the archaeological resource. The scheme of work was undertaken in accordance with guidance contained with the National Planning Policy Framework (2012) and to a Written Scheme of Investigation (WSI) produced by ASWYAS. The survey was carried out on March 18th and March 19th 2013.

Site location and topography

The proposed development area (PDA) is situated approximately 1.5km south-east of Heysham, centred at SD 432 599 (Figs 1 and 2). The village of Middleton is situated to the south-west of the site, with the hamlet of Heaton to its immediate east, and the village of Overton about 2km to its south. Much of the northern side of the site is bounded by the A683. The eastern and south-eastern sides of the site are defined by Downyfield Road, with industrial buildings and an oil depot located to the immediate west of the site.

The western side of the site consists of a level area of low lying fields, crossed by a network of drainage channels, with the former farmstead at Meadup House, where Turbine 1 and Turbine 2 are located, situated on a ridge of higher ground at about 10m above Ordnance Datum (aOD. To the east the ground level rises onto an area of low hills, reaching 23m to 25m aOD on Great Swart Hill and Windmill Hill, where Turbine 3 is to be erected.

The site is primarily in use as pasture for sheep and cattle, and divided into fields by hedgerows and wire fences, often overlying earthen banks. The site also contains numerous artificial ponds. Great Swart Barn and a smaller farm building, known as Butler’s Hall, are situated on the western side of Great Swart Hill, and Hillside Farm is located just outside the north-eastern edge of the site.

Geology and soils

The underlying geology of the proposed development site comprises Millstone Grit (British Geological Survey 2013). On the western side of the site this is primarily overlain by peaty, loamy and sandy soils, while to the east the soils consist of deep, well drained, reddish fine loamy soils with slowly permeable sub-soils (Soil Survey of England and Wales 1983).

2 Archaeological background

An archaeological desk-based assessment (DBA) of the site and surrounding area (Pollington 2010), undertaken for a previous scheme layout, concluded that there was potential for the survival of previously unrecorded prehistoric or Roman period sub-surface deposits within the PDA. The report also added that it was likely that much of the PDA has remained in agricultural use throughout its history and that therefore any evidence of medieval or later activity is likely to be associated with agricultural use. The DBA also indicated that additional archaeological work, specifically a geophysical survey in the first instance, would likely be required by Lancashire County Council to further inform on the archaeological implications of the proposed development.

3 Aims, Methodology and Presentation

The main aim of the geophysical survey was to provide sufficient information to enable an assessment to be made of the impact of the proposed development on any potential archaeological remains and for mitigation proposals, if appropriate, to be recommended.

To achieve this aim a magnetometer survey covering 1 hectare, centred on the proposed location of each turbine, was carried out. The survey of a larger area than will be impacted by the proposed development allows the micro-siting of the turbine without the need for further survey, should obvious archaeological features be identified at the preferred location. A corridor 30m in width was also surveyed along the proposed route of access tracks and cable runs.

The general objectives of the geophysical survey were:

- to provide information about the nature and possible interpretation of any magnetic anomalies identified;
- to therefore determine the presence/absence and extent of any buried archaeological features; and
- to prepare a report summarising the results of the survey.

Magnetometer survey

Bartington Grad601 magnetic gradiometers were used during the survey taking readings at 0.25m intervals on zig-zag traverses 1m apart within 30m by 30m grids so that 3600 readings were recorded in each grid. These readings were stored in the memory of the instrument and later downloaded to computer for processing and interpretation. Geoplot 3 (Geoscan Research) software was used to process and present the data. Further details are given in Appendix 1.

Reporting

A general site location plan, incorporating the Ordnance Survey map, is shown in Figure 1. Figure 2 is a large scale (1:5000) site location plan showing the greyscale magnetometer data and scheme layout whilst Figure 3 is an overall interpretation of the whole site, also at a scale of 1:5000. The processed and minimally processed data, together with interpretation graphics of the survey results are presented for each of the three turbine locations and access trackways in Figures 4 to 12 inclusive, at a scale of 1:1250.

Further technical information on the equipment used, data processing and survey methodologies are given in Appendix 1 and Appendix 2. Appendix 3 describes the composition and location of the site archive.

Archaeological Services WYAS is registered with the Online Access to the Index of archaeological investigations project (OASIS). The OASIS ID for this project is archaeol11 – 148913.

The geophysical survey methodology, report and any recommendations comply with guidelines outlined by English Heritage (David *et al.* 2008) and by the Institute for Archaeologists (IfA 2010). All figures reproduced from Ordnance Survey mapping are with the permission of the controller of Her Majesty's Stationery Office (© Crown copyright).

The figures in this report have been produced following analysis of the data in 'raw' and processed formats and over a range of different display levels. All figures are presented to most suitably display and interpret the data from this site based on the experience and knowledge of Archaeological Services staff.

4 Results (see Figs 4 – 12 inclusive)

The anomalies identified on this site can be divided into several categories according to their cause.

Ferrous Anomalies – modern activity

Ferrous anomalies, either as individual 'spikes' or more extensive areas of magnetic disturbance, are typically caused by ferrous (magnetic) material, either on the ground surface or in the plough-soil. Little importance is normally given to such anomalies, unless there is any supporting evidence for an archaeological interpretation, as modern ferrous debris or material is common on rural sites, often being present as a consequence of manuring or tipping/infilling. Throughout the majority of the site iron spike anomalies are common and there is no obvious pattern or clustering to their distribution to suggest anything other than a random background scatter of ferrous debris in the plough-soil.

Larger linear and non-linear areas of magnetic disturbance are noted at several locations. All are due to modern activity and are of no archaeological interest. In the north-eastern corner of the area encompassing the proposed location of Turbine 1 (T1), a massive area of disturbance is due to building rubble from the demolition of Meadup House. To the south of this the disturbance is due to the proximity of a large shed. In the T2 survey area another area of magnetic disturbance on the southern edge of the block is due to the magnetic material used to backfill a small pond, one of several ponds in the area (see Fig. 2).

To the north of Meadup House a strongly magnetic linear anomaly along the centre of Access Track 1 (AT1) is caused by the track leading to Meadup House. Similar responses, also due to existing trackways, are noted at two locations along AT2, between T1 and T2. Other linear dipolar anomalies locate sub-surface pipes.

Linear trend anomalies - agricultural anomalies

Parallel linear trend anomalies, aligned south-west/north-east have been identified across the whole of the T3 survey area. These anomalies are caused by the former agricultural technique of ridge and furrow ploughing with the characteristic striped appearance to the data due to the magnetic contrast between the former soil filled furrows and ridges. Other linear trend anomalies, also interpreted as due to ploughing, are identified around T2 and also at the northern end of AT3.

Geological Anomalies

Along AT3 broad anomalies, characterised as areas of magnetic enhancement, have been identified. These anomalies are interpreted as geological in origin being due to variations in the composition and depth of the upper soil horizons.

Possible Archaeological Anomalies

To the north of T3 a small cluster of discrete anomalies stand out against the relatively uniform magnetic background in this part of the site. For this reason and because these anomalies do not obviously fall into any other of the categories an archaeological cause cannot be dismissed. Of particular interest is the faint anomaly, **A**, in the north-east corner of the survey area which appears to be square in shape with a slight enhanced response in the centre.

5 Discussion and Conclusions

The geophysical survey has not identified any anomalies of definite archaeological potential with most of the anomalies being due to recent agricultural activity or by modern activity. A square shaped anomaly has been identified in the north of T3 which might be caused by an archaeological feature, possibly a square barrow. However, the anomaly is extremely weak and all the anomalies in T3 could be due to variations in the composition of the soils. In any case all of these anomalies are located to the north of the proposed location of the turbine (T3) and are unlikely to be impacted by the scheme in its current layout. Therefore, the archaeological potential of the areas likely to be impacted by the scheme are considered to be low.

The results and subsequent interpretation of data from geophysical surveys should not be treated as an absolute representation of the underlying archaeological and non-archaeological remains. Confirmation of the presence or absence of archaeological remains can only be achieved by direct investigation of sub-surface deposits.

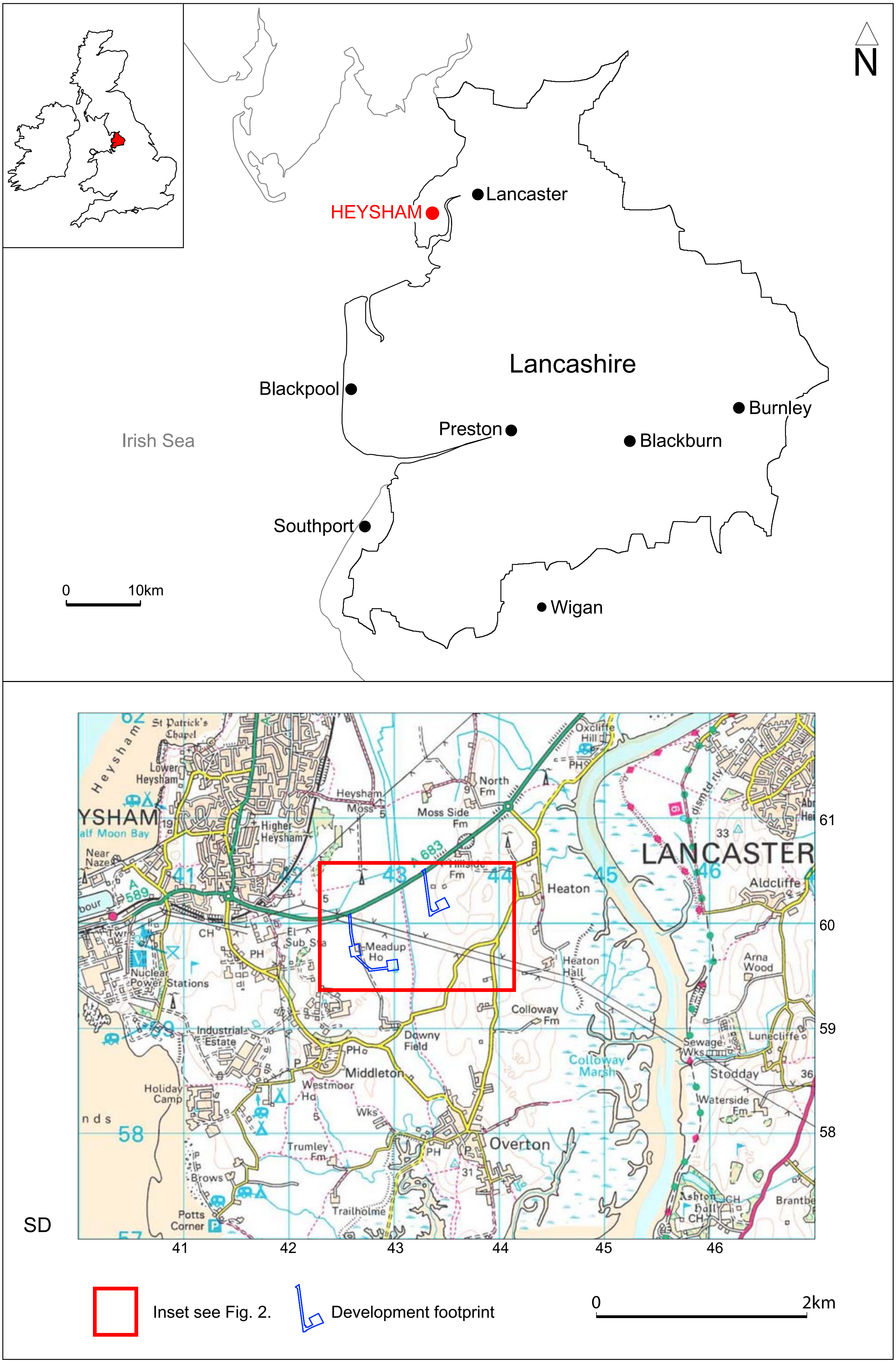

Fig. 1. Site location

Fig. 2. Site location showing greyscale magnetometer data (1:5000 @ A3)

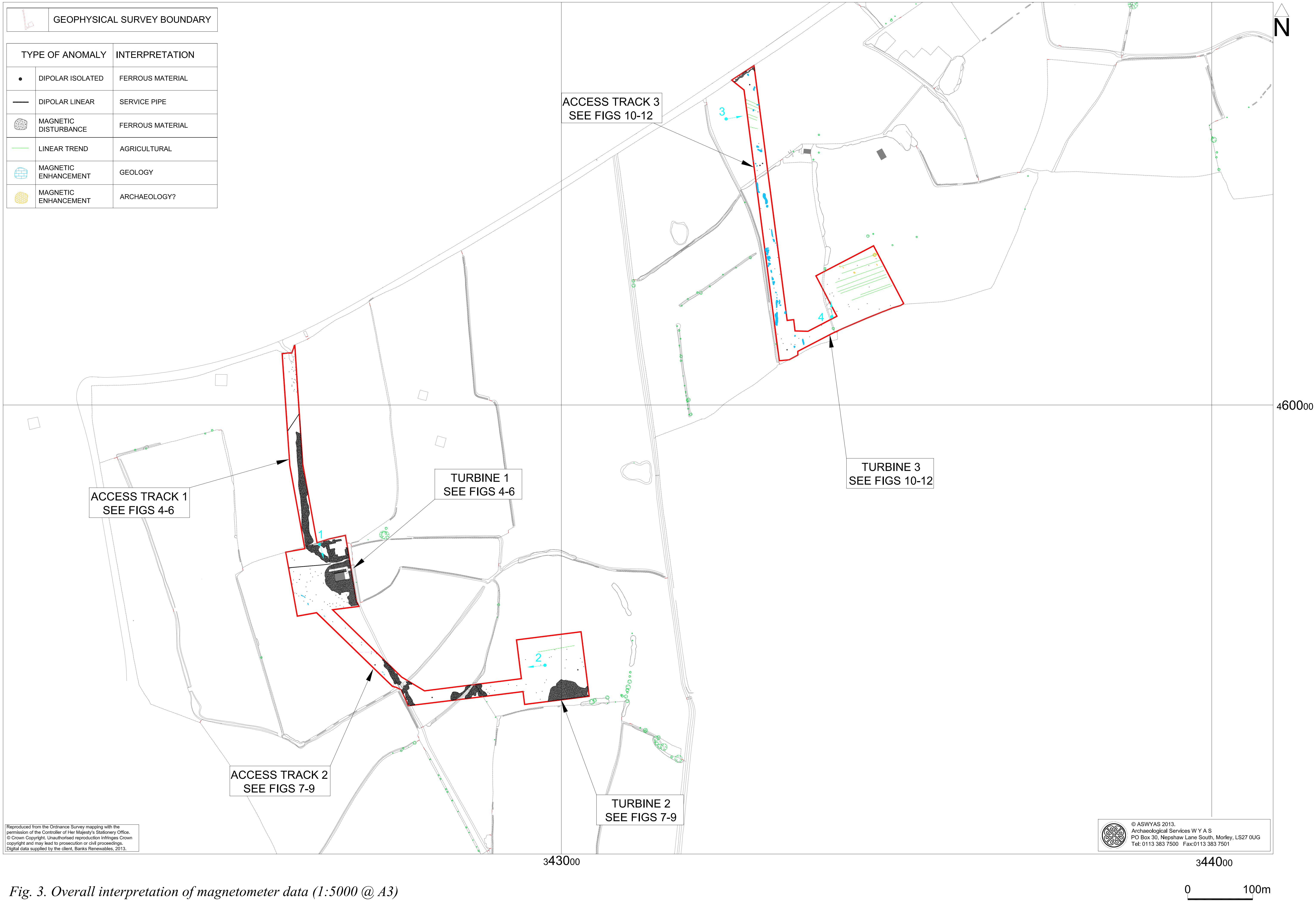

Fig. 3. Overall interpretation of magnetometer data (1:5000 @ A3)

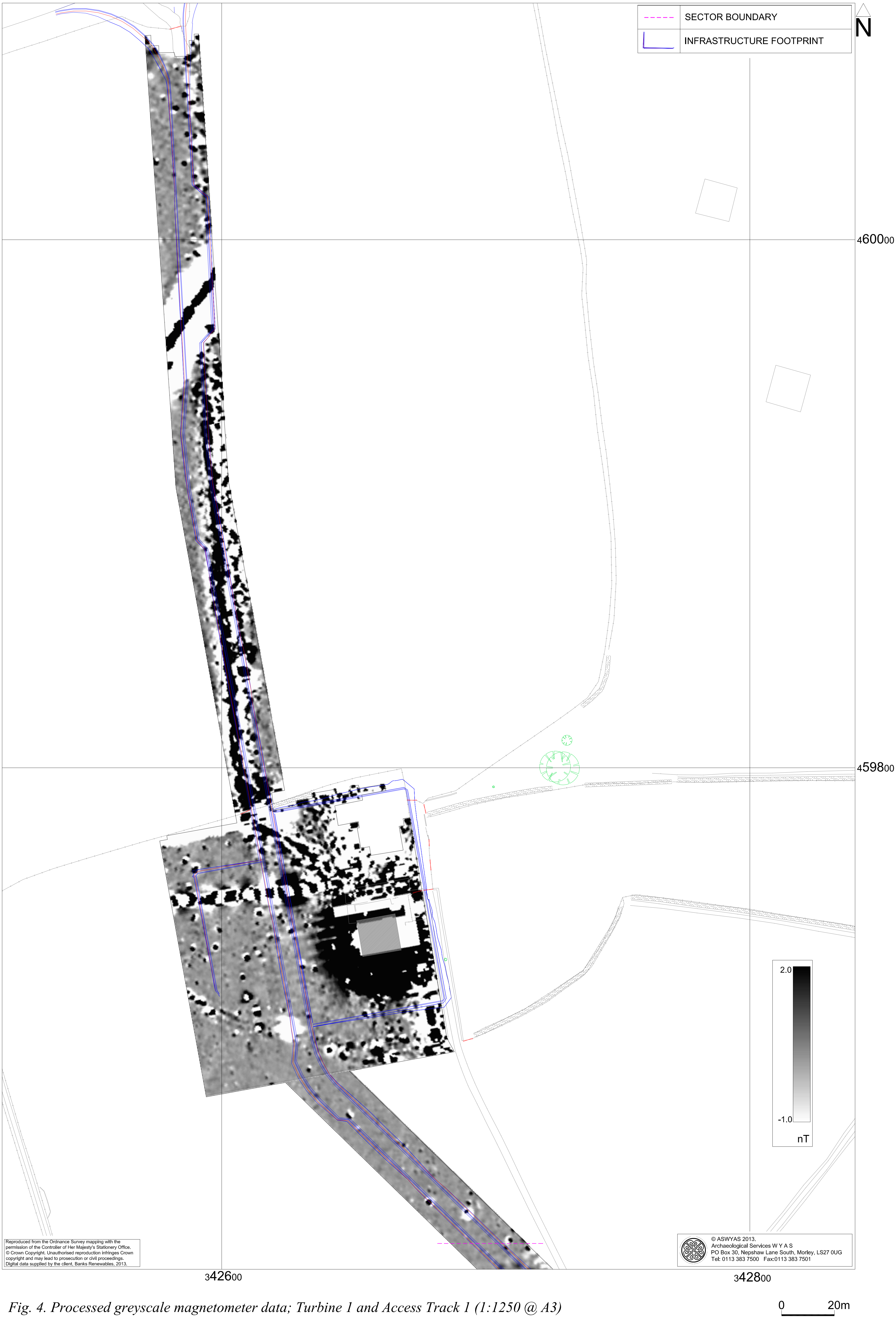

Fig. 4. Processed greyscale magnetometer data; Turbine 1 and Access Track 1 (1:1250 @ A3)

Fig. 5. XY trace plot of minimally processed magnetometer data; Turbine 1 and Access Track 1 (1:1250 @ A3)

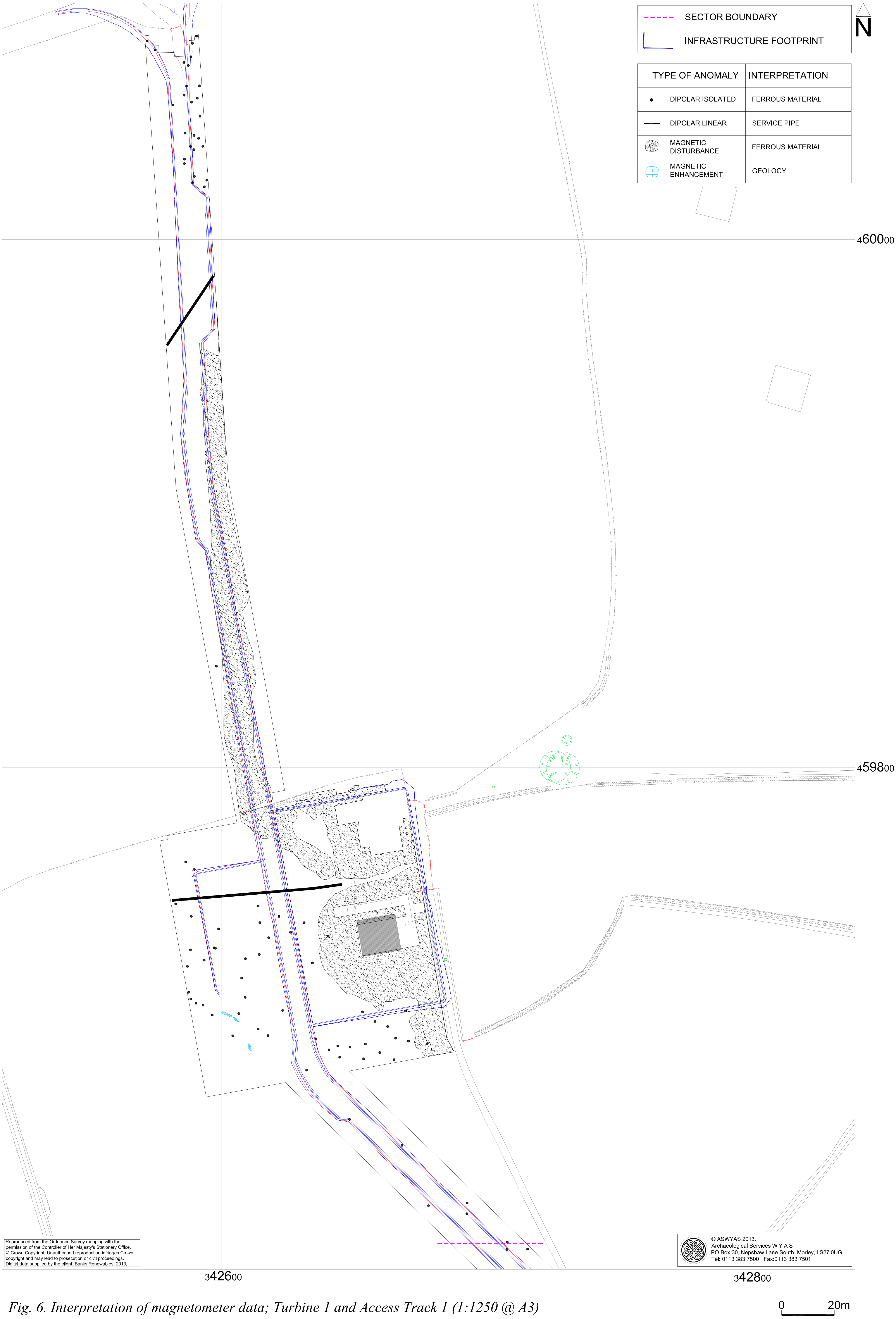

Fig. 6. Interpretation of magnetometer data; Turbine 1 and Access Track 1 (1:1250 @ A3)

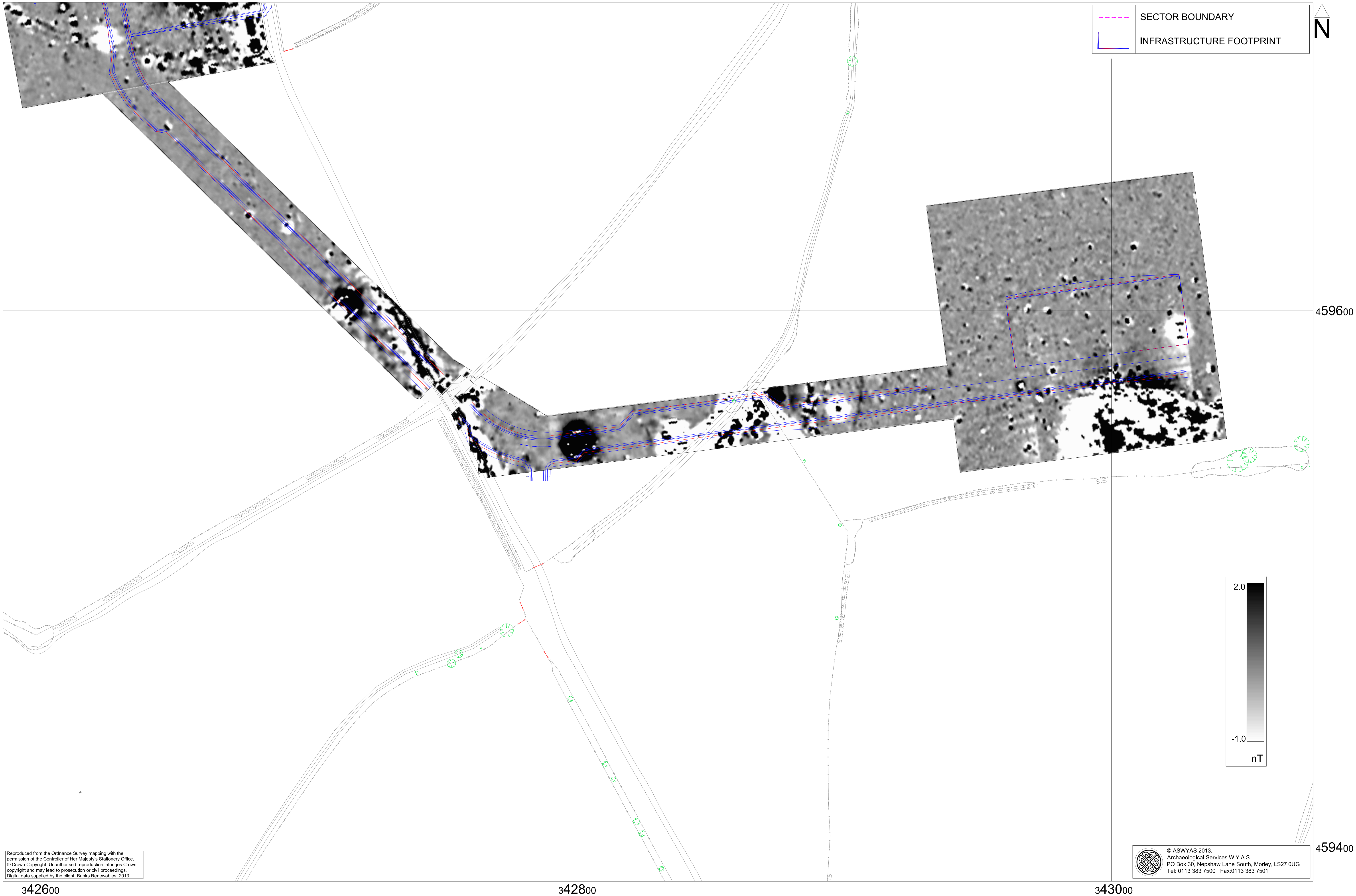

Fig. 7. Processed greyscale magnetometer data; Turbine 2 and Access Track 2 (1:1000 @ A3)

0 20m

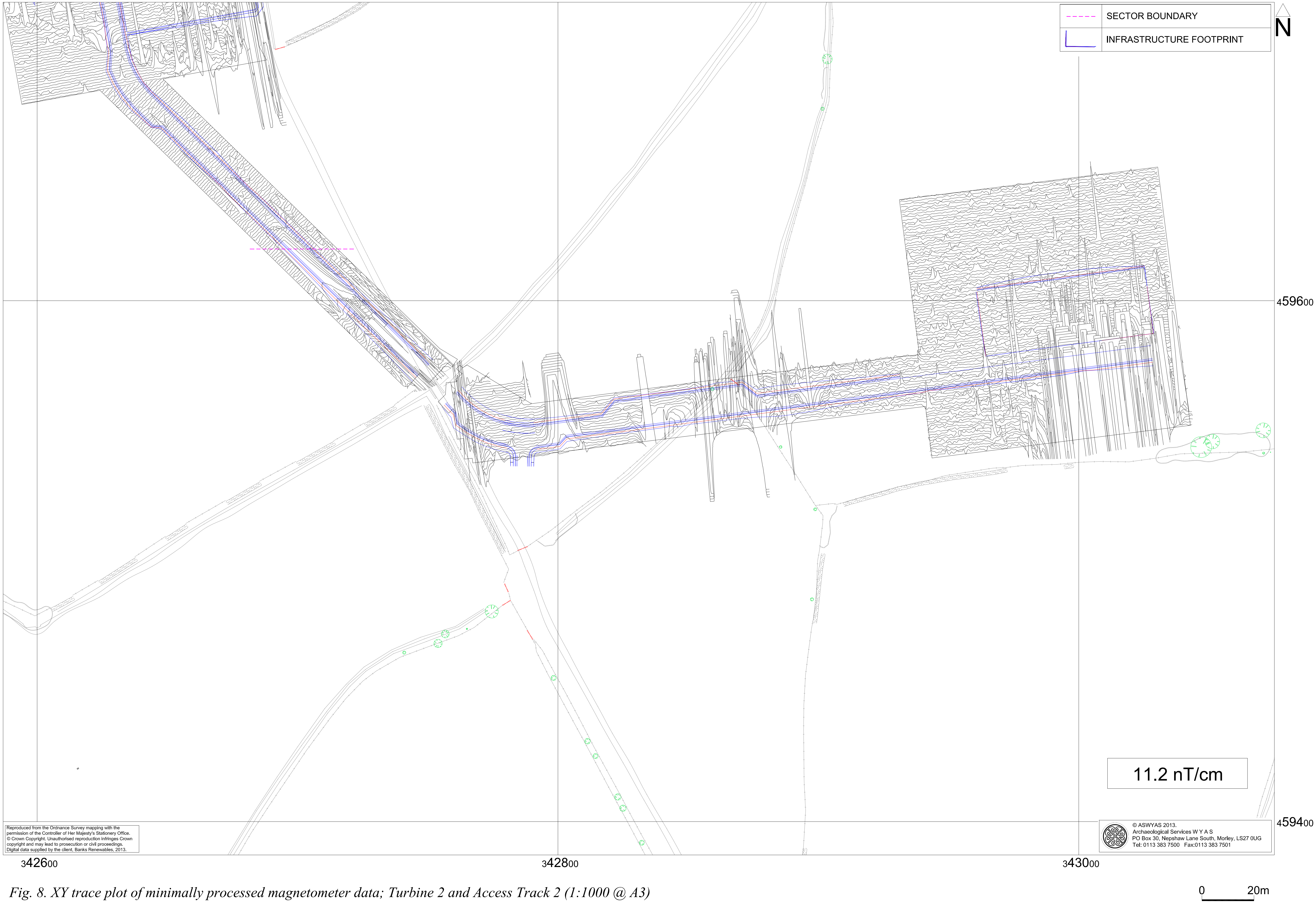

Fig. 8. XY trace plot of minimally processed magnetometer data; Turbine 2 and Access Track 2 (1:1000 @ A3)

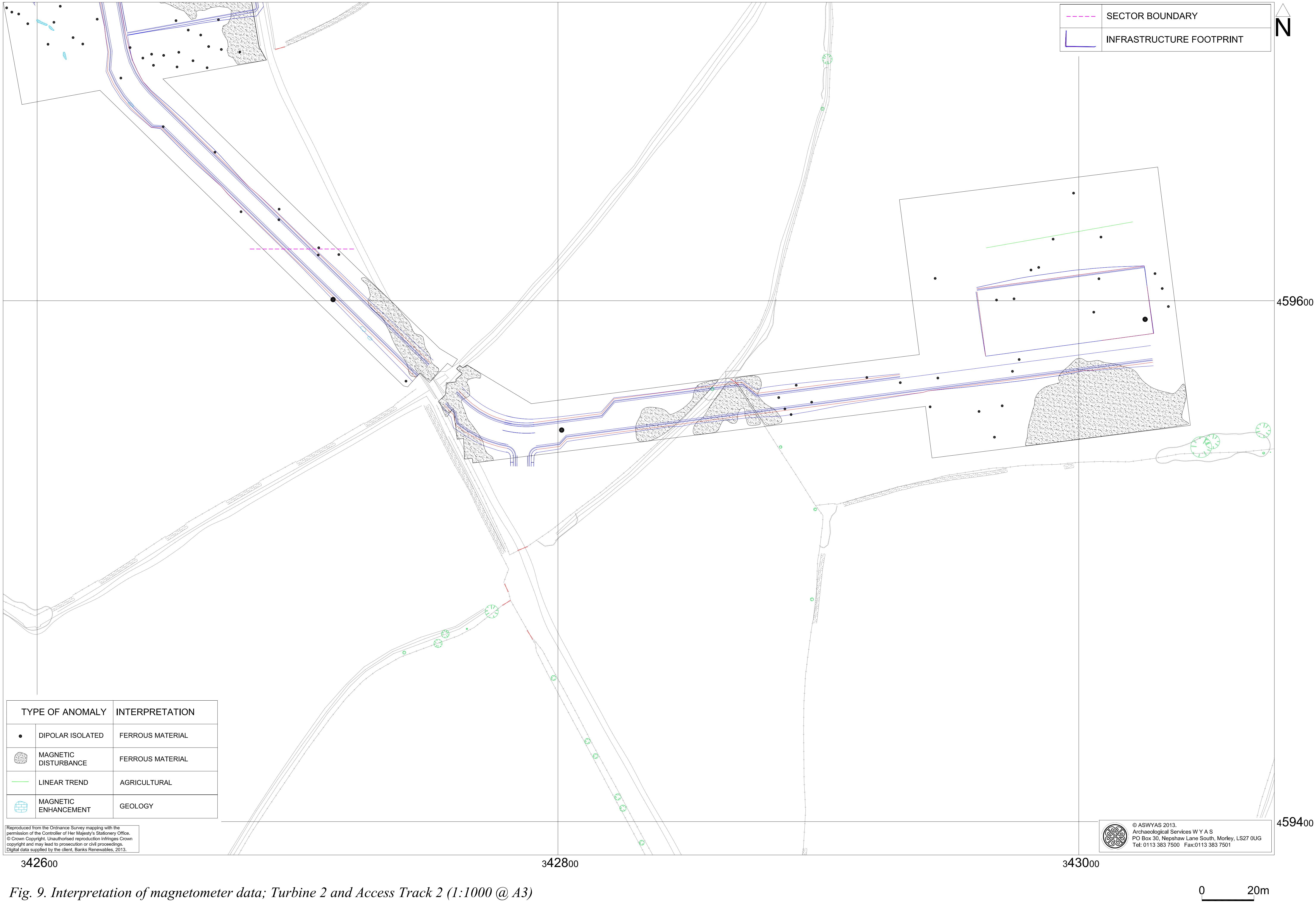

Fig. 9. Interpretation of magnetometer data; Turbine 2 and Access Track 2 (1:1000 @ A3)

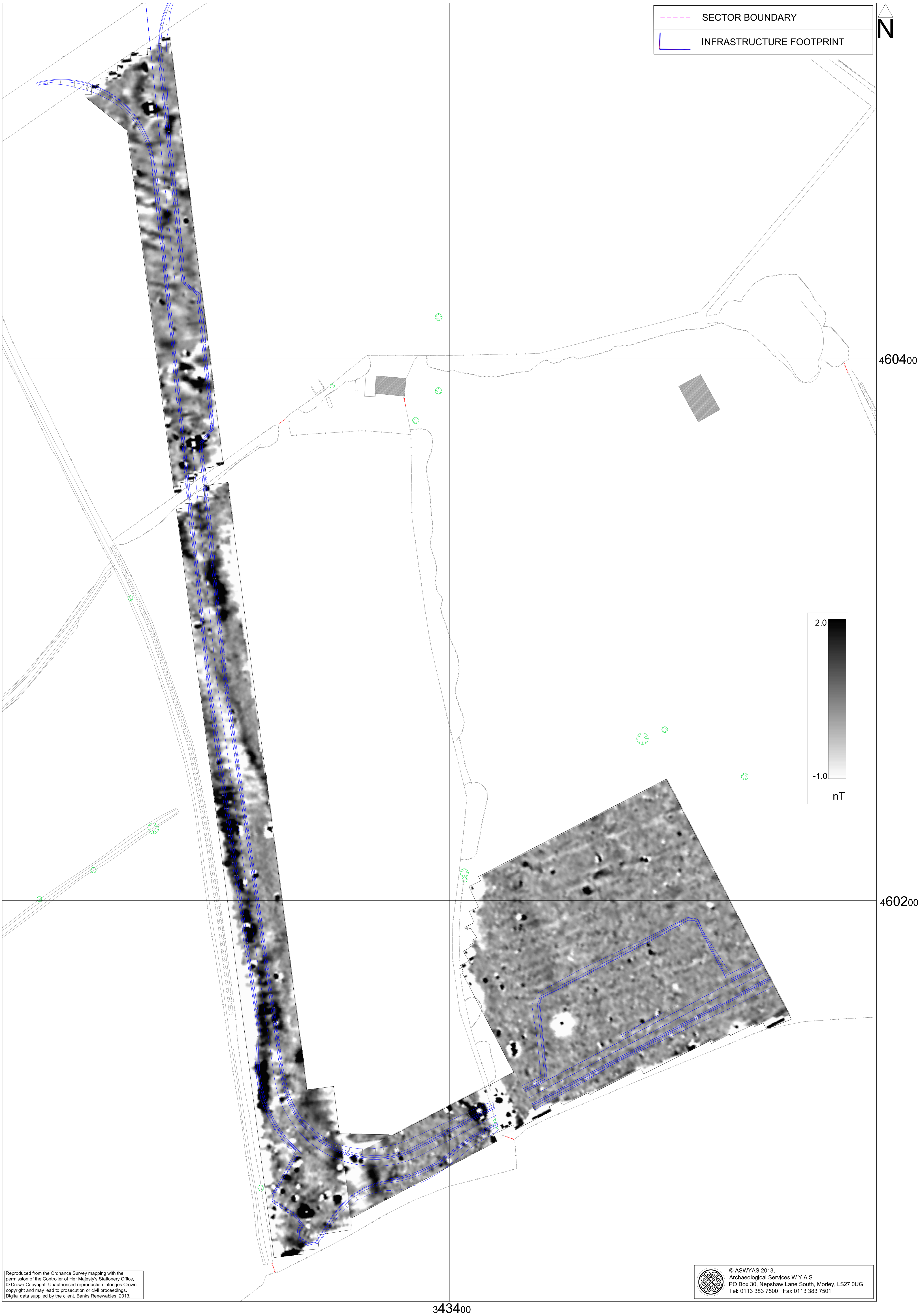

Fig. 10. Processed greyscale magnetometer data; Turbine 3 and Access Track 3 (1:1000 @ A3)

0 20m

Fig. 11. XY trace plot of minimally processed magnetometer data; Turbine 3 and Access Track 3 (1:1000 @ A3)

Fig. 12. Interpretation of magnetometer data; Turbine 3 and Access Track 3 (1:1000 @ A3)

Plate 1. General view of Turbine 1, looking south

Plate 2. General view of Turbine 2 and Access Track 2, looking west

Plate 3. General view of Access Track 3, looking east

Plate 4. General view of Turbine 3, looking north

Appendix 1: Magnetic survey - technical information

Magnetic Susceptibility and Soil Magnetism

Iron makes up about 6% of the Earth's crust and is mostly present in soils and rocks as minerals such as maghaemite and haemetite. These minerals have a weak, measurable magnetic property termed magnetic susceptibility. Human activities can redistribute these minerals and change (enhance) others into more magnetic forms so that by measuring the magnetic susceptibility of the topsoil, areas where human occupation or settlement has occurred can be identified by virtue of the attendant increase (enhancement) in magnetic susceptibility. If the enhanced material subsequently comes to fill features, such as ditches or pits, localised isolated and linear magnetic anomalies can result whose presence can be detected by a magnetometer (fluxgate gradiometer).

In general, it is the contrast between the magnetic susceptibility of deposits filling cut features, such as ditches or pits, and the magnetic susceptibility of topsoils, subsoils and rocks into which these features have been cut, which causes the most recognisable responses. This is primarily because there is a tendency for magnetic ferrous compounds to become concentrated in the topsoil, thereby making it more magnetic than the subsoil or the bedrock. Linear features cut into the subsoil or geology, such as ditches, that have been silted up or have been backfilled with topsoil will therefore usually produce a positive magnetic response relative to the background soil levels. Discrete feature, such as pits, can also be detected. The magnetic susceptibility of a soil can also be enhanced by the application of heat and the fermentation and bacterial effects associated with rubbish decomposition. The area of enhancement is usually quite large, mainly due to the tendency of discard areas to extend beyond the limit of the occupation site itself, and spreading by the plough. An advantage of magnetic susceptibility over magnetometry is that a certain amount of occupational activity will cause the same proportional change in susceptibility, however weakly magnetic is the soil, and so does not depend on the magnetic contrast between the topsoil and deeper layers. Susceptibility survey is therefore able to detect areas of occupation even in the absence of cut features. On the other hand susceptibility survey is more vulnerable to the masking effects of layers of colluvium and alluvium as the technique, using the Bartington system, can generally only measure variation in the first 0.15m of ploughsoil.

Types of Magnetic Anomaly

In the majority of instances anomalies are termed 'positive'. This means that they have a positive magnetic value relative to the magnetic background on any given site. However some features can manifest themselves as 'negative' anomalies that, conversely, means that the response is negative relative to the mean magnetic background.

Where it is not possible to give a probable cause of an observed anomaly a '?' is appended.

It should be noted that anomalies interpreted as modern in origin might be caused by features that are present in the topsoil or upper layers of the subsoil. Removal of soil to an archaeological or natural layer can therefore remove the feature causing the anomaly.

The types of response mentioned above can be divided into five main categories that are used in the graphical interpretation of the magnetic data:

Isolated dipolar anomalies (iron spikes)

These responses are typically caused by ferrous material either on the surface or in the topsoil. They cause a rapid variation in the magnetic response giving a characteristic 'spiky' trace. Although ferrous archaeological artefacts could produce this type of response, unless there is supporting evidence for an archaeological interpretation, little emphasis is normally given to such anomalies, as modern ferrous objects are common on rural sites, often being present as a consequence of manuring.

Areas of magnetic disturbance

These responses can have several causes often being associated with burnt material, such as slag waste or brick rubble or other strongly magnetised/fired material. Ferrous structures such as pylons, mesh or barbed wire fencing and buried pipes can also cause the same disturbed response. A modern origin is usually assumed unless there is other supporting information.

Linear trend

This is usually a weak or broad linear anomaly of unknown cause or date. These anomalies are often caused by agricultural activity, either ploughing or land drains being a common cause.

Areas of magnetic enhancement/positive isolated anomalies

Areas of enhanced response are characterised by a general increase in the magnetic background over a localised area whilst discrete anomalies are manifest by an increased response (sometimes only visible on an XY trace plot) on two or three successive traverses. In neither instance is there the intense dipolar response characteristic exhibited by an area of magnetic disturbance or of an 'iron spike' anomaly (see above). These anomalies can be caused by infilled discrete archaeological features such as pits or post-holes or by kilns. They can also be caused by pedological variations or by natural infilled features on certain geologies. Ferrous material in the subsoil can also give a similar response. It can often therefore be very difficult to establish an anthropogenic origin without intrusive investigation or other supporting information.

Linear and curvilinear anomalies

Such anomalies have a variety of origins. They may be caused by agricultural practice (recent ploughing trends, earlier ridge and furrow regimes or land drains), natural geomorphological features such as palaeochannels or by infilled archaeological ditches.

Methodology: Magnetic Susceptibility Survey

There are two methods of measuring the magnetic susceptibility of a soil sample. The first involves the measurement of a given volume of soil, which will include any air and moisture that lies within the sample, and is termed volume specific susceptibility. This method results in a bulk value that it not necessarily fully representative of the constituent components of the sample. For field surveys a Bartington MS2 meter with MS2D field loop is used due to its speed and simplicity. The second technique overcomes this potential problem by taking into account both the volume and mass of a sample and is termed mass specific susceptibility. However, mass specific readings cannot be taken in the field where the bulk properties of a soil are usually unknown and so volume specific readings must be taken. Whilst these values are not fully representative they do allow general comparisons across a site and give a broad indication of susceptibility changes. This is usually enough to assess the susceptibility of a site and evaluate whether enhancement has occurred.

Methodology: Gradiometer Survey

There are two main methods of using the fluxgate gradiometer for commercial evaluations. The first of these is referred to as ***magnetic scanning*** and requires the operator to visually identify anomalous responses on the instrument display panel whilst covering the site in widely spaced traverses, typically 10m apart. The instrument logger is not used and there is therefore no data collection. Once anomalous responses are identified they are marked in the field with bamboo canes and approximately located on a base plan. This method is usually employed as a means of selecting areas for detailed survey when only a percentage sample of the whole site is to be subject to detailed survey.

The disadvantages of magnetic scanning are that features that produce weak anomalies (less than 2nT) are unlikely to stand out from the magnetic background and so will be difficult to detect. The coarse sampling interval means that discrete features or linear features that are parallel or broadly oblique to the direction of traverse may not be detected. If linear features are suspected in a site then the traverse direction should be perpendicular (or as close as is possible within the physical constraints of the site) to the orientation of the suspected features. The possible drawbacks mentioned above mean that a ‘negative’ scanning result should be validated by sample detailed magnetic survey (see below).

The second method is referred to as ***detailed survey*** and employs the use of a sample trigger to automatically take readings at predetermined points, typically at 0.25m intervals, on zig-zag traverses 1m apart. These readings are stored in the memory of the instrument and are later dumped to computer for processing and interpretation. Detailed survey allows the visualisation of weaker anomalies that may not have been detected by magnetic scanning.

During this survey a Bartington Grad601 magnetic gradiometer was used taking readings on the 0.1nT range, at 0.25m intervals on zig-zag traverses 1m apart within 30m by 30m square grids. The instrument was checked for electronic and mechanical drift at a common point and calibrated as necessary. The drift from zero was not logged.

Data Processing and Presentation

The detailed gradiometer data has been presented in this report in XY trace and greyscale formats. In the former format the data shown is 'raw' with no processing other than grid biasing having been done. The data in the greyscale images has been interpolated and selectively filtered to remove the effects of drift in instrument calibration and other artificial data constructs and to maximise the clarity and interpretability of the archaeological anomalies.

An XY plot presents the data logged on each traverse as a single line with each successive traverse incremented on the Y-axis to produce a 'stacked' plot. A hidden line algorithm has been employed to block out lines behind major 'spikes' and the data has been clipped. The main advantage of this display option is that the full range of data can be viewed, dependent on the clip, so that the 'shape' of individual anomalies can be discerned and potentially archaeological anomalies differentiated from 'iron spikes'. Geoplot 3 software was used to create the XY trace plots.

Geoplot 3 software was used to interpolate the data so that 3600 readings were obtained for each 30m by 30m grid. The same program was used to produce the greyscale images. All greyscale plots are displayed using a linear incremental scale.

Appendix 2: Survey location information

The site grid was laid out using a Trimble VRS differential Global Positioning System (Trimble 5800 model). The accuracy of this equipment is better then 0.01m. The survey grids were then super-imposed onto a base map provided by the client to produce the displayed block locations. However, it should be noted that Ordnance Survey positional accuracy for digital map data has an error of 0.5m for urban and floodplain areas, 1.0m for rural areas and 2.5m for mountain and moorland areas. This potential error must be considered if co-ordinates are measured off hard copies of the mapping rather than using the digital co-ordinates.

Archaeological Services WYAS cannot accept responsibility for errors of fact or opinion resulting from data supplied by a third party

Appendix 3: Geophysical archive

The geophysical archive comprises:-

- an archive disk containing compressed (WinZip 8) files of the raw data, report text (Microsoft Word 2000), and graphics files (Adobe Illustrator CS2 and AutoCAD 2008) files; and
- a full copy of the report.

At present the archive is held by Archaeological Services WYAS although it is anticipated that it may eventually be lodged with the Archaeology Data Service (ADS). Brief details may also be forwarded for inclusion on the English Heritage Geophysical Survey Database after the contents of the report are deemed to be in the public domain (i.e. available for consultation in the Lancashire Historic Environment Record).

Bibliography

British Geological Survey, 2013. http://maps.bgs.ac.uk/geologyviewer/ (Viewed March 20th 2013)

David, A., N. Linford, P. Linford and L. Martin, 2008. *Geophysical Survey in Archaeological Field Evaluation: Research and Professional Services Guidelines (2nd edition)* English Heritage

Institute for Archaeologists, 2010. *Standard and Guidance for archaeological geophysical survey*. Institute for Archaeologists

Soil Survey of England and Wales, 1983, Soils of Northern England, Sheet 1.