



## Wylfa Newydd Project

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Geophysical Survey (Part 1/2)

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## WYLFA NEWYDD A5025 HIGHWAY IMPROVEMENTS, ANGLESEY

*Geophysical Survey*  
for *HORIZON NUCLEAR POWER LTD (HORIZON)*

*March 2016*

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HA Job no.:	WNPI/01
	<b>Area A</b> 229868,379031 / 229486,379247 to 229947,379662
NGR:	<b>Area B</b> 231731,381447 to 231661,383609
	<b>Area C</b> 231930,386082 to 231663,387276
	<b>Area D</b> 233724,389658 to 234185,390892
	<b>Area A Valley</b>
Parish:	<b>Area B</b> Valley / Bodedern / Llanfachraeth
	<b>Area C</b> Llanfaethlu
	<b>Area D</b> Cylch-y-Garn / Mechell
Council:	Isle of Anglesey

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# WYLFA NEWYDD A5025 HIGHWAY IMPROVEMENTS, ANGLESEY

## GEOPHYSICAL SURVEY

*Headland Archaeology (UK) Ltd undertook a geophysical (magnetometer) survey, covering approximately 55 hectares, at four locations along the Wylfa Newydd A5025 Highway Improvements scheme. These locations are termed off-line as they will require the construction of entirely new sections of carriageway. The work was undertaken at the request of Jacobs (UK) Ltd on behalf of Horizon Nuclear Power Ltd (Horizon) in order to assess the impact of the proposed scheme on any potential sub-surface archaeological remains. This report presents the results and interpretation of the magnetic survey data.*

*The survey has identified linear anomalies suggestive of former field systems at two locations to the north-east and south-east of the village of Llanfachraeth. The field systems are not depicted on any available historical maps and are therefore likely to be post-medieval or earlier in origin. Six localised clusters of anomalies, perhaps being due to burnt mounds, have also been located within this section of the scheme. East of the village of Llanfaethlu, and close to a Neolithic settlement site, several linear anomalies have been ascribed a possible archaeological origin, perhaps being caused by soil-filled ditches. Within the northernmost section of the scheme at Cefn Coch, anomalies have been identified which relate to the historical industrial landscape as depicted on early Ordnance Survey maps, including an in-filled mill pond, part of a mill-race, or mill infrastructure, and a section of former road. Within all of the survey areas anomalies have been identified which relate to former field boundaries whilst anomalies caused by near-surface geological variation are prevalent throughout.*

*There is no indication from any other source to suggest that the magnetic data provides anything other than an accurate representation of the sub-surface conditions and therefore, based solely on the results and interpretation of the data, the archaeological potential of the route is considered to be low with a locally moderate to high potential at Llanfachraeth and Llanfaethlu.*

### 1 INTRODUCTION

Headland Archaeology (UK) Ltd was commissioned by Jacobs (UK) Ltd on behalf of Horizon Nuclear Power Ltd (Horizon) to undertake a geophysical (magnetometer) survey along the proposed Wylfa Newydd A5025 Highway Improvements in Anglesey. The survey was undertaken in accordance with a Written Scheme of Investigation (Horizon 2015) submitted to and approved by Gwynedd Archaeological Planning Services (GAPS). Guidance contained within Planning Policy Wales (Edition 7, July 2014), Ch.6 Conserving the Historic Environment and within Welsh Office Circular 60/96 Planning and the Historic Environment: Archaeology was also followed. Current best practice (David et al. 2008) was adhered to throughout. The survey was carried out between August 24th and September 11th 2015. This report presents the results of the survey together with interpretations of the anomalies that have been identified.

#### 1.1 SITE LOCATION, TOPOGRAPHY AND LAND-USE

The section of carriageway associated with the proposed A5025 Improvements is approximately 18km long and

commences at the A5 trunk road at Valley, running northwards, broadly parallel to the west coast of Anglesey towards the settlement of Cemaes. The programme of geophysical survey is concerned with four sections of Off-line improvements, areas where new entirely new road will be constructed. On-line improvements are considered to be within the existing boundary. The four areas are at Valley Junction A5/A5025 between NGRs 229868, 379031 and 229486, 379247 to 229947, 379662 (Area A), at Llanfachraeth between NGR 231731, 381447 and 231661, 383609 (Area B), at Llanfaethlu between NGR 231930, 386082 and 231663, 387276 (Area C) and at Cefn Coch between NGR 233724, 389658 and 234185, 390892 (Area D) (see Illus 1).

Area A Valley Junction, is flat and low-lying, being at approximately 2m above Ordnance Datum (aOD). It comprises eleven fields (Field A1 to Field A11 inclusive) all but one of which were under pasture at the time of survey (see Illus 2). Areas of dense soft rush were common and restricted the survey areas in isolated locations (see Illus 3). Field A11 was under a crop of barley at the time of the survey and was unsuitable for survey (see Illus 4).

Area B Llanfachraeth, is undulating at between 9m and 14m aOD. It comprises 30 fields (Field B1 to Field B30 inclusive) of mainly pasture (see Illus 5, Illus 6 and Illus 7)

with the only exceptions being Field B<sub>7</sub> which was ploughed, Field B<sub>25</sub>/B<sub>28</sub> which was under the remnants of a harvested cereal crop and Field B<sub>29</sub> which was landscaped and contained a small plantation. Field B<sub>11</sub> and Field B<sub>12</sub> contained overgrown vegetation and were unsuitable for survey.

Area C Llanfaethlu, is sited on the eastern and south-eastern slopes of a low hill upon which the village of Llanfaethlu is located. It rises from approximately 55m aOD in the south and 70m aOD towards the village. Area C Llanfaethlu comprises 21 fields (Field C<sub>1</sub> to Field C<sub>21</sub> inclusive) of mainly permanent pasture (see Illus 8, Illus 9 and Illus 10). Field C<sub>4</sub> contained a mature oat crop at the time of the survey and was unsuitable for survey. Field C<sub>5</sub> was excluded from the survey at the request of the client. Field C<sub>6</sub> was a graveyard and therefore was unsuitable for survey. No survey was undertaken within Field 16 due to the minimal survey area.

Area D Cefn Coch, undulates between 30m aOD and 62m aOD and comprised of mainly permanent pasture (see Illus 11 and Illus 12) with the only exception being Field D<sub>7</sub> which was subdivided into horse paddocks and a small field of harvested hay. No access was granted to Field D<sub>3</sub> whereas no survey was undertaken within Field D<sub>5</sub>, Field D<sub>6</sub>, Field D<sub>11</sub> and Field D<sub>13</sub> due to the minimal survey areas. Field D<sub>17</sub> contained greenhouses, caravans and farm equipment and was unsuitable for survey whereas bales of silage and farm machinery prevented survey within Field D<sub>19</sub>. The survey areas were restricted locally by outcropping geology (see Illus 11) and overgrown vegetation (see Illus 13).

## 1.2 GEOLOGY AND SOILS

The underlying bedrock generally comprises Mona Complex schists of the New Harbour and Gwna groups. In addition, a band of Ordovician mudstone and sandstone (interbedded) is recorded within the south of Area D Cefn Coch (British Geological Survey 2015). Superficial deposits along the proposed route are dominated by glacial drift, primarily till. However, tidal flat deposits (clay and silt) are recorded throughout Area A Valley Junction, whilst river alluvium is recorded on the River Alaw within the south of Area B Llanfachraeth. The soils within the survey area are mainly classified in the Soilscape 17 association, characterised as slowly permeable, seasonally wet acid loams and clays (Landis 2015). However, at Llanfachraeth and Llanfaethlu soils are also recorded in the Soilscape 6 association, characterised as freely-draining loams.

## 2 ARCHAEOLOGICAL BACKGROUND

A Cultural Heritage Desk-Based Survey report which was produced for the scheme (Gwynedd Archaeological Trust 2014) identified 335 heritage assets either inside,

or within 300m of, the proposed route. The assets range from those of prehistoric date such as Capel Soar Scheduled Monument (see Illus 20), a standing stone south of Llanfaethlu, to medieval former mill sites, post-medieval field boundaries, houses, farms, mills, chapels and churches. Whilst the value of the assets have been assessed as ranging from negligible to high, the majority have been assessed to be of low to negligible value.

The report highlighted the potential throughout the scheme for unrecorded prehistoric features and sites to survive beneath the topsoil, in particular in locations close to water sources, such as burnt mound spreads. In addition, the potential of the study area for unknown archaeological remains dating to the prehistoric period is highlighted by the results of a recent archaeological excavation at Llanfaethlu during the winter of 2014/15, where two Neolithic rectangular structures and pit groups were uncovered (C.R. Archaeology 2015). The survey area at the north of Area C Llanfaethlu lies within 50m of the archaeological remains. In this area the potential for unknown archaeological remains has been assessed to be high (GAT 2014).

## 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 scheme on any potential sub-surface archaeological remains and for further evaluation or mitigation proposals, if appropriate, to be recommended.

The general archaeological objectives of the geophysical survey were:

- to provide information about the nature and interpretation of any magnetic anomalies identified; and
- to therefore model the presence/absence and extent of any buried archaeological features, either known or previously unknown; and
- to prepare a report summarising the results of the survey.

### 3.1 MAGNETOMETER SURVEY

Magnetic survey methods rely on the ability of a variety of instruments to measure very small magnetic fields associated with buried archaeological remains. A feature such as a ditch, pit or kiln can act like a small magnet, or series of magnets, that produce distortions (anomalies) in the Earth's magnetic field. In mapping these slight variations, detailed plans of sites can be obtained as buried features often produce reasonably characteristic anomaly shapes and strengths (Gaffney and Gater, 2003). Further information on soil

magnetism and the interpretation of magnetic anomalies is provided in Appendix 1.

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.

The site grid was laid out using a Trimble VRS differential Global Positioning System (Trimble GeoXR model).

### 3.2 REPORTING

A general site location plan is shown in Illus 1 at a scale of 1:50,000. Illus 2 to 13 inclusive are general, time-stamped, views of each of the archaeological survey areas. Illus 14 to Illus 23 inclusive are large scale (1:4000) survey location plans displaying the processed greyscale magnetometer data and accompanied by overall interpretations of the data at the same scale. Detailed data plots ('raw' and processed) and interpretative illustrations are presented at a scale of 1:1000 in Illus 24 to Illus 77 inclusive.

Technical information on the equipment used, data processing and magnetic survey methodology is given in Appendix 1. Appendix 2 details the survey location information and Appendix 3 describes the composition and location of the site archive.

The survey methodology, report and any recommendations comply with the Written Scheme of Investigation (Horizon 2015) and guidelines outlined by English Heritage (David et al. 2008) and by the Chartered Institute for Archaeologists (ClFA 2014). All illustrations reproduced from Ordnance Survey mapping are with the permission of the controller of Her Majesty's Stationery Office (© Crown copyright).

*The illustrations 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 illustrations are presented to most suitably display and interpret the data from this site based on the experience and knowledge of management and reporting staff.*

## 4 RESULTS AND DISCUSSION

The magnetic background across Area B Llanfachraeth, Area C Llanfaethlu and Area D Cefn Coch is extremely variable, almost certainly as a consequence of the nature and depth of the solid geology. In contrast, there is little magnetic background variation within Area A Valley Junction where the bedrock is overlain by tidal flat deposits. Against this variable background numerous anomalies have been identified and cross-

referenced to specific examples depicted on the interpretative figures.

### 4.1 FERROUS ANOMALIES

Ferrous anomalies, characterised as individual 'spikes', 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 most sites, often being present as a consequence of manuring or tipping/infilling.

Linear dipolar anomalies, A to J inclusive have been identified on a variety of alignments across Area A Valley Junction, Area B Llanfachraeth and Area C Llanfaethlu. The anomalies are caused by buried ferrous pipes. Within Field B16 (see Illus 42, Illus 43 and Illus 44), the east/west aligned linear dipolar anomaly, F, corresponds closely to the site of a post-medieval well which is recorded as Heritage Asset Number 84 (GAT 2014).

At the perimeters of most of the survey areas magnetic disturbance is caused by ferrous material within, or forming part of, the adjacent field boundaries. Other areas of magnetic disturbance, K to O inclusive, are due to above ground ferrous objects such as telegraph poles and cattle feeders and are of no archaeological relevance. A broad area of magnetic disturbance, P, (see Illus 36 to 41 inclusive) in the northern part of Field B10 cannot be explained by any above ground features. A second area of magnetic disturbance, Q, located in the west of Field B18 (see Illus 42 to 47 inclusive), also has no obvious cause. The high magnitude of the disturbance is likely to be caused by modern ferrous material in the topsoil.

Within the north of Area D Cefn Coch, Field D18 (see Illus 75, Illus 76 and Illus 77) is dominated by high magnitude magnetic disturbance, R, throughout. The magnetic disturbance corresponds to Heritage Asset Number 262 (GAT 2014), Mill Pond and Head Race (Site of), Pandy Cefn Coch, and is probably due to the ferrous material used to back-fill the post-medieval mill pond.

### 4.2 AGRICULTURAL ANOMALIES

Analysis of historical Ordnance Survey (OS) mapping indicates that the division and layout of land within the survey areas has remained largely unchanged since the publication of the first edition Ordnance Survey maps in 1889. Occasionally, field boundaries have been removed to form larger land parcels. All but one of these former boundaries manifest in the data as linear anomalies, S to Z inclusive, and are caused by soil-filled ditches. In addition to the former boundaries, several linear trend anomalies are interpreted as agricultural in

origin due to their linear form and/or orientation parallel with or at right angles to existing field boundaries. Within Field C12 a post-medieval low linear earthwork, identified as Heritage Asset Number 162 (GAT 2014), is recorded in the data as anomaly **Aa** (see Illus 62). The earthwork is not, however, recorded on any of the historic mapping. Other linear anomalies within the vicinity of the low earthwork, such as **Ab** and **Ac** (and **Ad** within Field C19) are also ascribed an agricultural origin, probably being due to former, unmapped field boundaries, surviving as soil-filled ditches.

Although the majority of the fields are currently permanent pasture, closely-spaced parallel linear trend anomalies have been identified within Field B8, Field B13, Field C17, Field C19, and Field D1 indicating that at least these five fields have been cultivated in the recent past; these anomalies are caused by ploughing. It is not considered likely that these ploughing anomalies would 'mask' the response from any underlying archaeological feature, if present.

Faint linear trend anomalies within Field B5, Field B8 and Field D16 are 'speckled' in appearance – a characteristic typical of modern field drains. The anomalies are caused by the slightly magnetic material used in the composition of the drain.

All other linear trend anomalies (shown in green), not specifically referenced above, are also interpreted as of likely agricultural origin and are not considered to be of any archaeological significance.

#### 4.3 GEOLOGICAL ANOMALIES

As noted above, the magnetic background is extremely variable across the study area with a relatively low level of background variation across Area A being due to the homogenous properties of the prevailing marine superficial deposits. In contrast, the varying magnetic background across Area B Llanfachraeth, Area C Llanfaethlu and Area D Cefn Coch is due to the varying nature and depth of the underlying bedrock and glacial superficial deposits. Numerous high magnitude anomalies are recorded throughout these areas, with clear localised areas of geological variation in Area B (**Ae**, **Af**, **Ag**, and **Ah**) corresponding to low hills or rises in the local topography. The anomalies are probably due to the solid geology outcropping closer to the surface than at other parts of the survey area, although the responses might also be consistent with small scale stone extraction. Conversely, within Area C Llanfaethlu, the clear area of background variation, **Ai**, within Field C12 is located on lower-lying topography.

Areas of lesser background magnetic variation are noted close to watercourses such as south of the River Alaw within Field B10 and within the east of Field D8 (**Aj**). This lower level of variation is probably due to

alluvial superficial deposits along the route of the watercourses.

Broad, high magnitude geological anomalies within Area B Llanfachraeth are particularly worthy of note. The broad curvilinear anomaly, **Ak**, within the south of Field B13 (see Illus 39, Illus 40 and Illus 41) corresponds to a prominent scarp in this part of the field (see Illus 6) and marks the edge of the floodplain of the adjacent River Alaw. The anomaly is probably due to the magnetic properties of the near-surface bedrock. To the north and traversing Field B21 and Field B16 to Field B19 inclusive (see Illus 42 to 47 inclusive) an extremely high magnitude band of linear anomalies, **Al**, some 100m in width, dominates the datasets. The band is not recorded by the British Geological Survey but is likely to be caused by an igneous dyke or intrusion, several of which are recorded in the surrounding landscape (British Geological Survey 2015).

Numerous lower magnitude discrete anomalies recorded throughout the survey area are also likely to be due to variation in the composition of the soils.

#### 4.4 POSSIBLE QUARRYING ANOMALIES

Broad high magnitude rectangular anomalies, **Am** and **An**, have been identified within Field B27 (see Illus 51, Illus 52 and Illus 53). The anomalies may be caused by near-surface geological variation although their rectangular form suggest cut features. It is likely therefore that the anomalies are due to back-filled quarry pits.

#### 4.5 POSSIBLE ARCHAEOLOGICAL ANOMALIES

*Unless otherwise stated, anomalies of possible archaeological origin are thought to be caused by infilled cut features such as ditches, often forming part of a system of land division and settlement, and by discrete features such as pits.*

##### Area B Llanfachraeth

Six clusters of high magnitude anomalies within Area B Llanfachraeth, **Ao** to **At** inclusive (see Illus 36 to 41 inclusive and Illus 48 to 45 inclusive), are interpreted as being of possible archaeological potential perhaps being due to spreads of enhanced material. Anomalies **Aq** to **At** in particular are located in low lying areas adjacent or close to water sources and may be due to burnt mounds. However, no clear archaeological pattern is visible in the data and, given the varying and unpredictable nature of the underlying geology, a geological origin cannot be dismissed.

Within the east of Field B13 (see Illus 39, Illus 40 and Illus 41), linear anomalies **Au** and **Av** appear to form part of a rectangular enclosure. The enclosure appears on the same north/south alignment as Bedo-Fawr farmhouse (Heritage Asset Number 60, GAT 2014)

which lies to the immediate north of the proposed route. The farmhouse is assessed as post-medieval in origin and as being of low archaeological value. It is possible that the anomalies are caused by an earlier or unrecorded field enclosure.

### Area C Llanfaethlu

Fragmented and linear anomalies, **Aw**, have been identified on a north/south alignment within Field C8 (see Illus 57, Illus 58 and Illus 59). The anomalies correspond closely to the location of a forking trackway (Heritage Asset Number 152, GAT 2014) which is depicted on the 1724-7 Bodorgan Estate Map. The anomalies are likely to be caused by soil-filled ditches flanking the former trackway.

At the northern end of this section of the road, and either side of the A5025 in Field C19 and Field C21, are three possibly interconnecting linear anomalies, **Ax**, **Ay** and **Az** (see Illus 63, Illus 64 and Illus 65). No correlation with boundary features on the historic mapping has been found. On the basis that a non-archaeological origin cannot be confidently ascribed the possibility that the anomalies may be of archaeological potential cannot be dismissed. These anomalies are therefore interpreted as being of possible archaeological origin, perhaps ditches forming an enclosure or small field. However, the anomalies correspond broadly to the projected extension of linear natural features which were excavated in Field C20 (C.R. Archaeology 2014) and it is possible that these anomalies are caused by soil-filled natural features.

In the 30m x 30m grid surveyed in Field C20, nearest the Neolithic settlement (Heritage Asset Number 177, GAT 2014), several pit-type responses **Bd** and three linear anomalies, **Ba**, **Bb** and **Bc**, are located (see Illus 63, Illus 64 and Illus 65). Anomaly **Ba** may form the western continuation of the feature identified in Field C19 as **Ay** and has also therefore been interpreted as of possible archaeological origin. Parallel anomalies **Bb** and **Bc** also cannot be confidently interpreted but as they run parallel with the field edge are considered more likely to have an agricultural origin but again an archaeological origin cannot be dismissed, especially given the proximity of the prehistoric activity.

Two negative linear anomalies cross the survey area at the northern end of Field C21, **Be** and **Bf**. Anomaly **Be** clearly correlates with a trackway (Heritage Asset Number 180, GAT 2014) that is depicted on the 1889 first edition mapping and which accessed the adjacent 19th century quarry (Heritage Asset Number 181, GAT 2014). Anomaly **Bf** does not correlate with any features on historic mapping and is of uncertain origin. It has therefore been tentatively ascribed a possible archaeological origin.

### Area D Cefn Coch

Parallel linear anomalies, **Bg**, have been identified on a north-south alignment within the east of Field D8 (see

Illus 69, Illus 70 and Illus 71). The anomalies correspond with the former route of a road which is shown on the first edition OS map (1889). The identified road appears to be re-routed to its position of the current A5025 by the 1953 OS edition. The anomalies are caused by soil-filled ditches flanking either side of the road.

Within the north of Field D8 a high magnitude linear anomaly, **Bh**, is identified on an east-west alignment running parallel with the adjacent stream. The anomaly lies to the immediate south of a mill (Heritage Asset Number 251, GAT 2014 – Melin Bodronyn) which is thought to be medieval or post-medieval in origin. The anomaly may be caused by a wall or earthen structure perhaps for the management of the flow of the adjacent stream. Such features are depicted within the mill site to the immediate north (see Illus 69, Illus 70 and Illus 71). Immediately south of **Bh**, a broad area of high magnitude magnetic disturbance, **Bi**, may be caused by a spread of buried demolition material.

## 4.6 ARCHAEOLOGICAL ANOMALIES

Linear and rectilinear anomalies indicative of former field systems have been identified within two distinct areas to the north-east and south-east of the village of Llanfachraeth (Area B Llanfachraeth). The anomalies are oblique to the existing pattern of land division and whilst they may be post-medieval in origin an earlier origin cannot be discounted. For the purposes of this report these features are assumed to be of archaeological potential and have been ascribed a probable archaeological origin.

The first former field system is located to the south-east of Llanfachraeth on elevated ground within Field B9 and Field B10 (see Illus 36 to Illus 41 inclusive). The former fields are defined by parallel north-west/south-east aligned fragmented linear anomalies (soil-filled ditches), **Bj** to **Bn** inclusive, and intersected at right-angles by north-east/south-west anomalies **Bo** and **Bp**. Anomaly **Bq** is the only exception to this pattern and comprises parallel linear anomalies on a north/south orientation at right angles to the existing field boundaries. It is possible therefore that **Bq** is caused by a separate (unmapped) phase of land division but is ascribed a probable archaeological potential given the local context.

The second former field system is located to the north-east of Llanfachraeth, also on elevated ground and spans Field B19 and Field B20 (see Illus 45, Illus 46 and Illus 47). The fields appear on a north/south orientation defined by **Br** to **Bt** which are aligned east/west and **Bu**, **Bv** and **Bz** which are aligned north/south. Parallel linear anomalies, **Bw** and **By**, are similar in appearance, probably being caused by a double-ditched boundary feature and may form part of the same discontinuous curving feature. It is possible that some of these linear anomalies may be due to features depicted on the Pen

yr Orsedd Estate Map of 1780 although no direct correlation can be discerned.

## 5 CONCLUSION

Unenclosed settlement and discrete features, such as isolated pits, are particularly difficult to identify with remote sensing surveys without other supporting information. However, soil-filled features have been identified across most parts of the scheme and it is considered probable that had there been major settlement activity within the survey areas that this would also have manifested in the data.

No anomalies of archaeological potential have been identified at Area A Valley Junction within the south of the scheme with the low level of background variation being consistent with tidal flat superficial deposits and wetland environments.

To the north-east and the south-east of Area B Llanfachraeth, two distinct areas of linear and rectilinear anomalies are interpreted as probably being due to unmapped post-medieval field systems.

Anomalies of possible archaeological potential have been identified throughout the survey areas including six possible burnt mounds to the east of Area B Llanfachraeth, and part of a post-medieval or earlier farm, also at Area B Llanfachraeth.

At Area C Llanfaethlu, whilst no anomalies of obvious archaeological potential have been identified in the vicinity of the Neolithic settlement site, linear anomalies and pit-type anomalies may be archaeological in origin. Post-medieval trackways manifest as linear anomalies in the data towards the south of this section and in the north.

The magnetic data within the northernmost section, Area D Cefn Coch, is dominated by near-surface geological variation. Nevertheless, anomalies have been identified which relate to the post-medieval industrial landscape in the form of an infilled mill pond and part of a separate medieval or post medieval mill complex. Evidence of more recent agricultural activity and modern features are also identified in the data set together with a plethora of responses interpreted as being due to geology.

There is no indication from any other source to suggest that the magnetic data provides anything other than an accurate representation of the sub-surface conditions and therefore, based solely on the results and interpretation of the data, the archaeological potential of the survey areas is considered to be low with a locally moderate to high potential at Area B Llanfachraeth and Area C Llanfaethlu.

## 6 REFERENCES

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## 7 APPENDIX 1

## 7.1 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 haemite. 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. This effect can lead to the detection of features such as hearths, kilns or areas of burning.

## 7.2 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.

## 8 APPENDIX 2

### 8.1 SURVEY LOCATION INFORMATION

The site grid was laid out using a Trimble VRS differential Global Positioning System (Trimble GeoXR model). The accuracy of this equipment is better than 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 coordinates are measured off hard copies of the mapping rather than using the digital coordinates.

*Headland Archaeology cannot accept responsibility for errors of fact or opinion resulting from data supplied by a third party.*

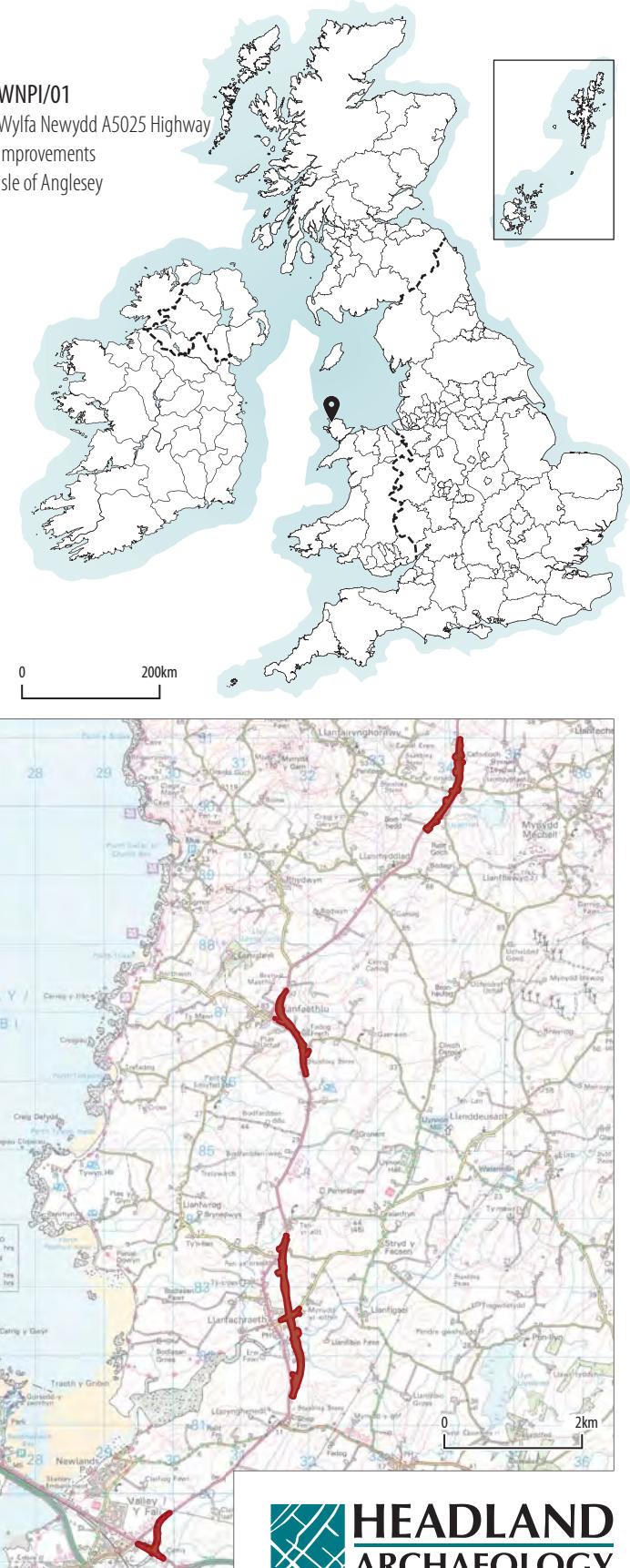
## 9 APPENDIX 3

### 9.1 GEOPHYSICAL SURVEY ARCHIVE

The geophysical archive comprises:-

- an archive disk containing the raw data in XYZ format, a raster image of each greyscale plot with associate world file, and a PDF of the report

The digital archive will be submitted to The National Monuments Record of Wales (NMRW) in accordance with the RCAHMS Guidelines for Archiving of Archaeological Projects (V13, 2013). The project will also be archived in-house in accordance with recent good practice guidelines ([http://guides.archaeologydataservice.ac.uk/g2gp/Geophysics\\_3](http://guides.archaeologydataservice.ac.uk/g2gp/Geophysics_3)). The data will be stored in an indexed archive and migrated to new formats when necessary.





**ILLUS 2** General view of Area A Valley Junction, looking north

**ILLUS 3** View of area unsuitable for survey within Field A7, looking south-east

**ILLUS 4** View of area unsuitable for survey within Field A11, looking north-east



**ILLUS 5** General view of Area B Llanfachraeth (south) looking south-west

**ILLUS 6** View of River Alaw (Area B Llanfachraeth), looking south-west

**ILLUS 7** General view of Area B Llanfachraeth (north), looking north



**ILLUS 8** General view of Area C Llanfaethlu, looking north-west

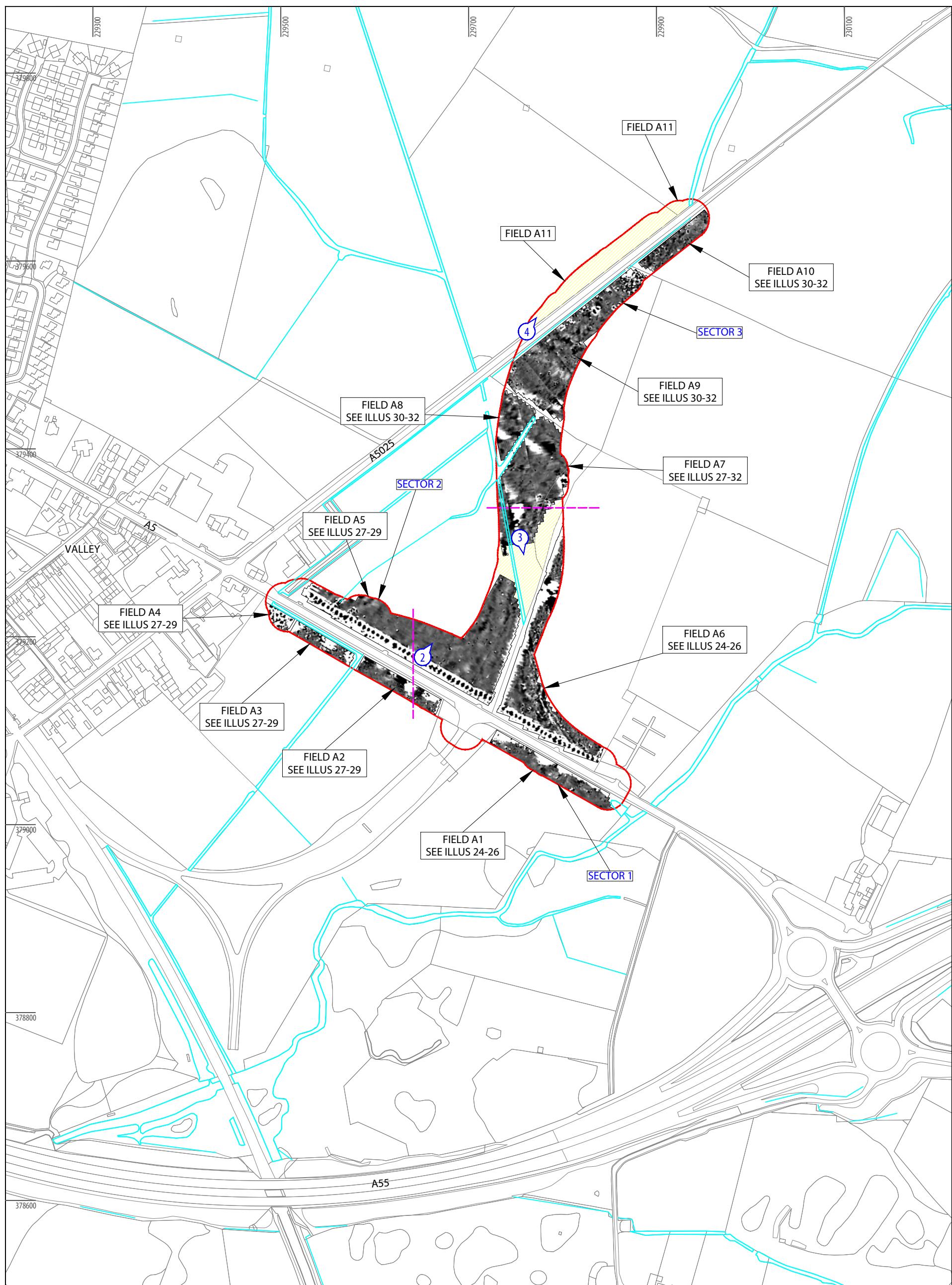
**ILLUS 9** General view of Area C Llanfaethlu, looking south-east

**ILLUS 10** General view of Area C Llanfaethlu (north) looking south-west



**ILLUS 11** View of Area D Cefn Coch (south) showing outcropping geology, looking south-west

**ILLUS 12** General view of Area D Cefn Coch (north), looking south    **ILLUS 13** General view of Field D18, looking north



 Geophysical survey area

-  Sector boundary
-  Area unsuitable for survey
-  Location and Direction of Illus 2-13
-  Surface water

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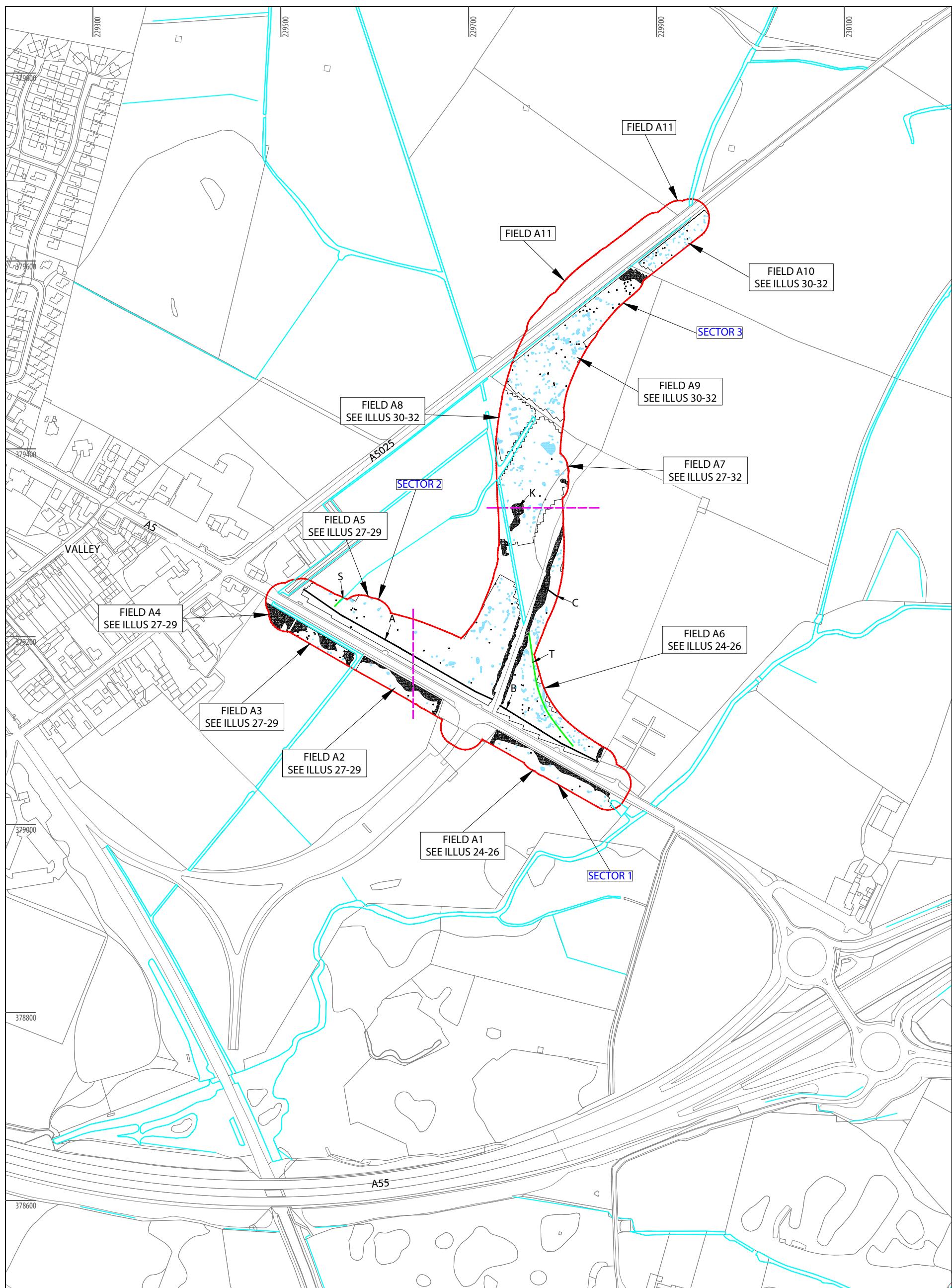
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PROJECT Wylfa Newydd A5025  
Highway Improvements  
(WNPI/01)

CLIENT Jacobs UK Ltd for  
Horizon Nuclear Power

Based on Ordnance Survey mapping supplied  
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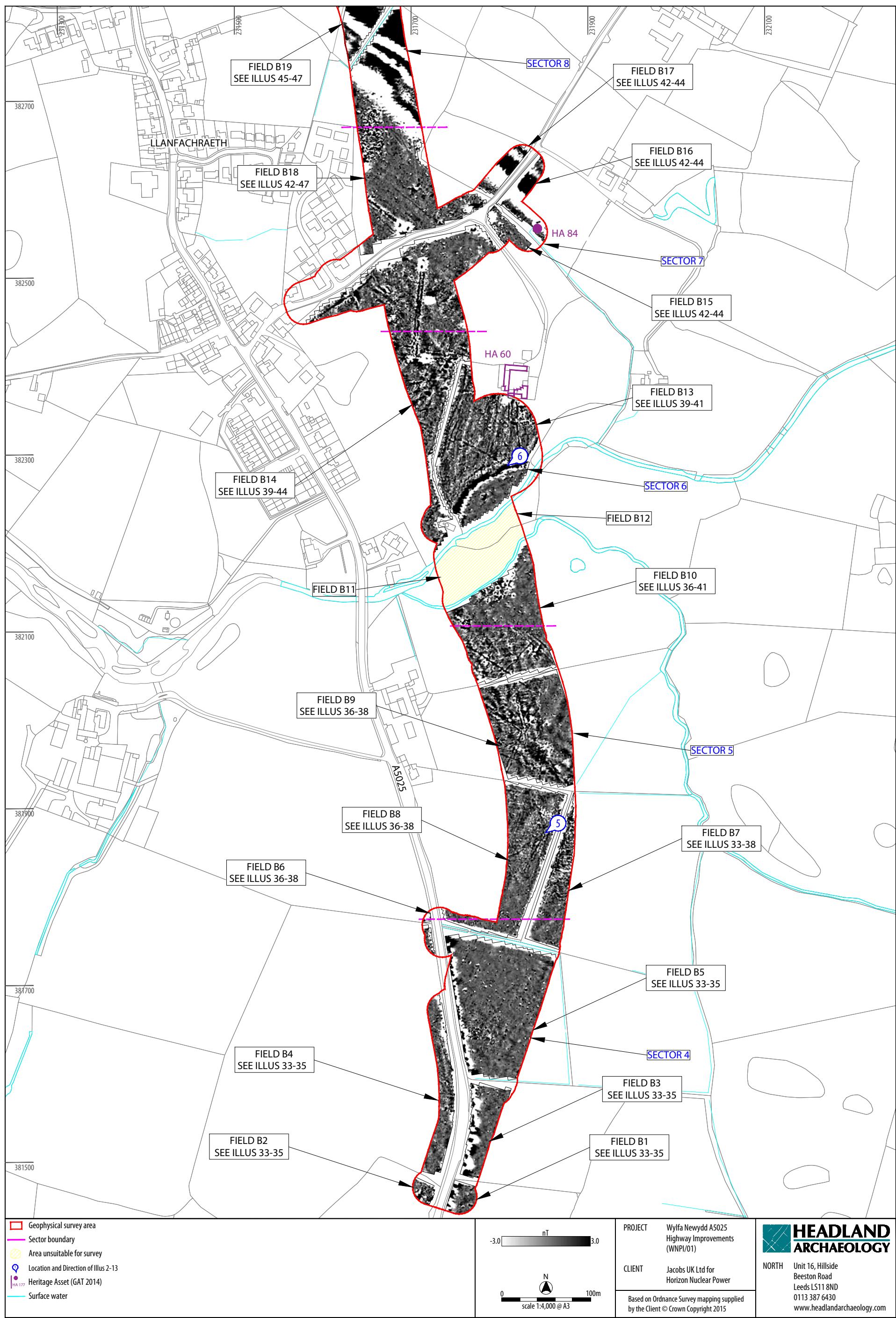
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Geophysical survey area	TYPE OF ANOMALY	INTERPRETATION	PROJECT	CLIENT	HEADLAND ARCHAEOLOGY
■ Geophysical survey area	● Dipolar Isolated	Ferrous Material	Wylfa Newydd A5025 Highway Improvements (WNPI/01)	Jacobs UK Ltd for Horizon Nuclear Power	NORTH Unit 16, Hillside Beeston Road Leeds LS11 8ND 0113 387 6430 www.headlandarchaeology.com
— Sector boundary	● Magnetic Disturbance	Ferrous Material			
📍 Location and Direction of Illus 2-13	— Dipolar Linear	Service Pipe			
~~~~ Surface water	— Linear Trend	Agricultural			
	— Linear	Former field boundary			
	■ Magnetic Enhancement	Geology			
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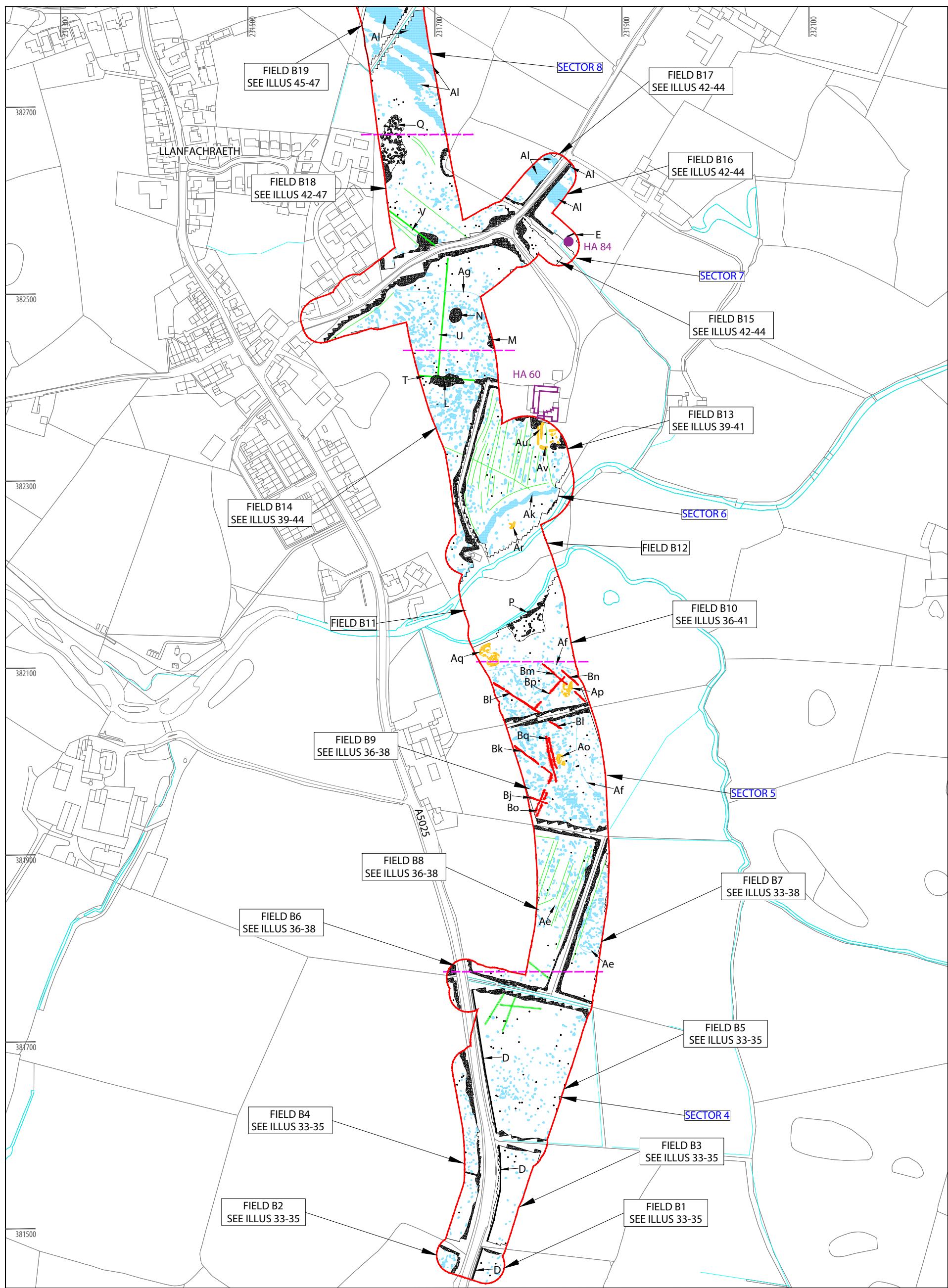
ILLUS 15

Overall interpretation of magnetometer data; Area A Valley Junction



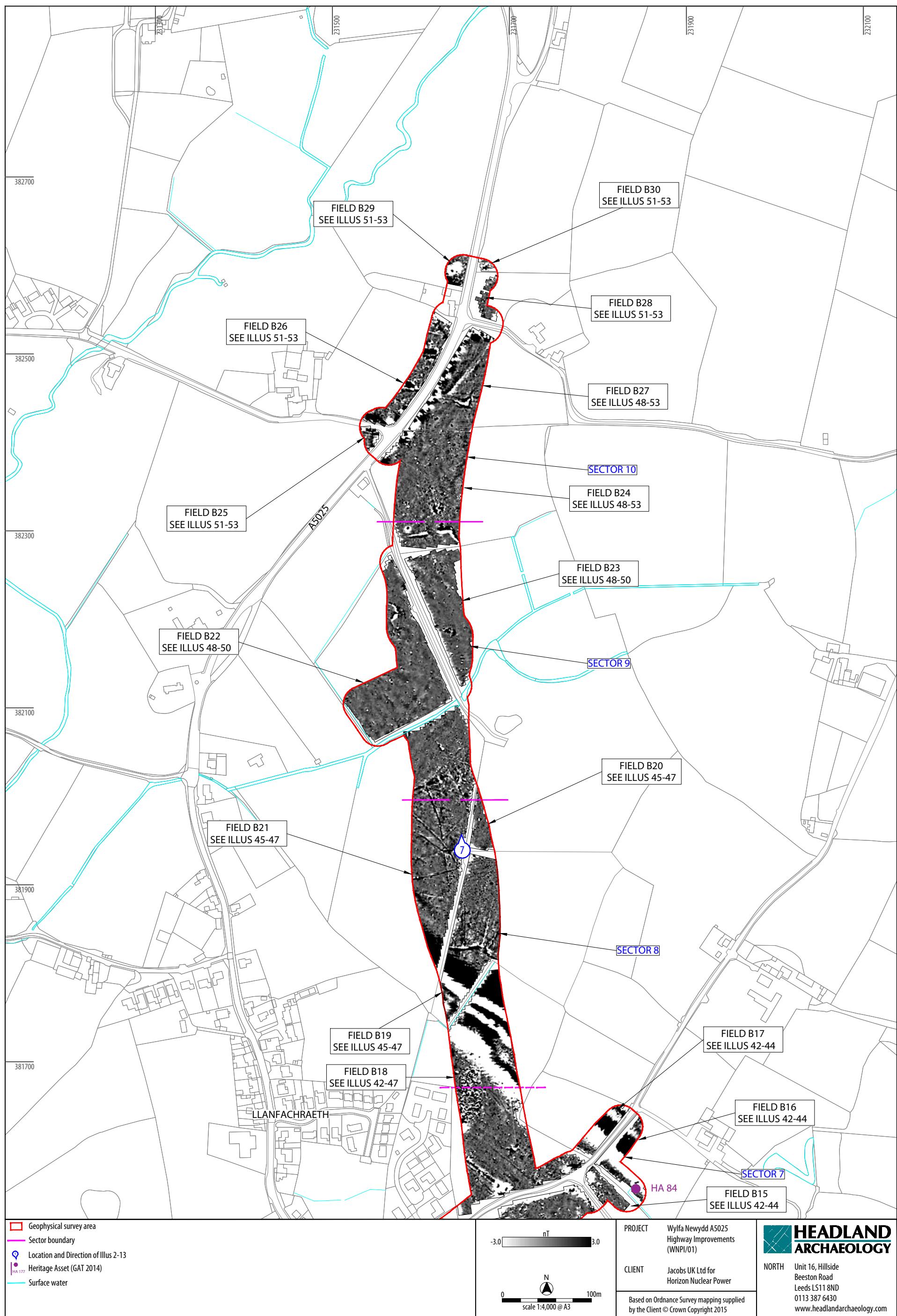
ILLUS 16

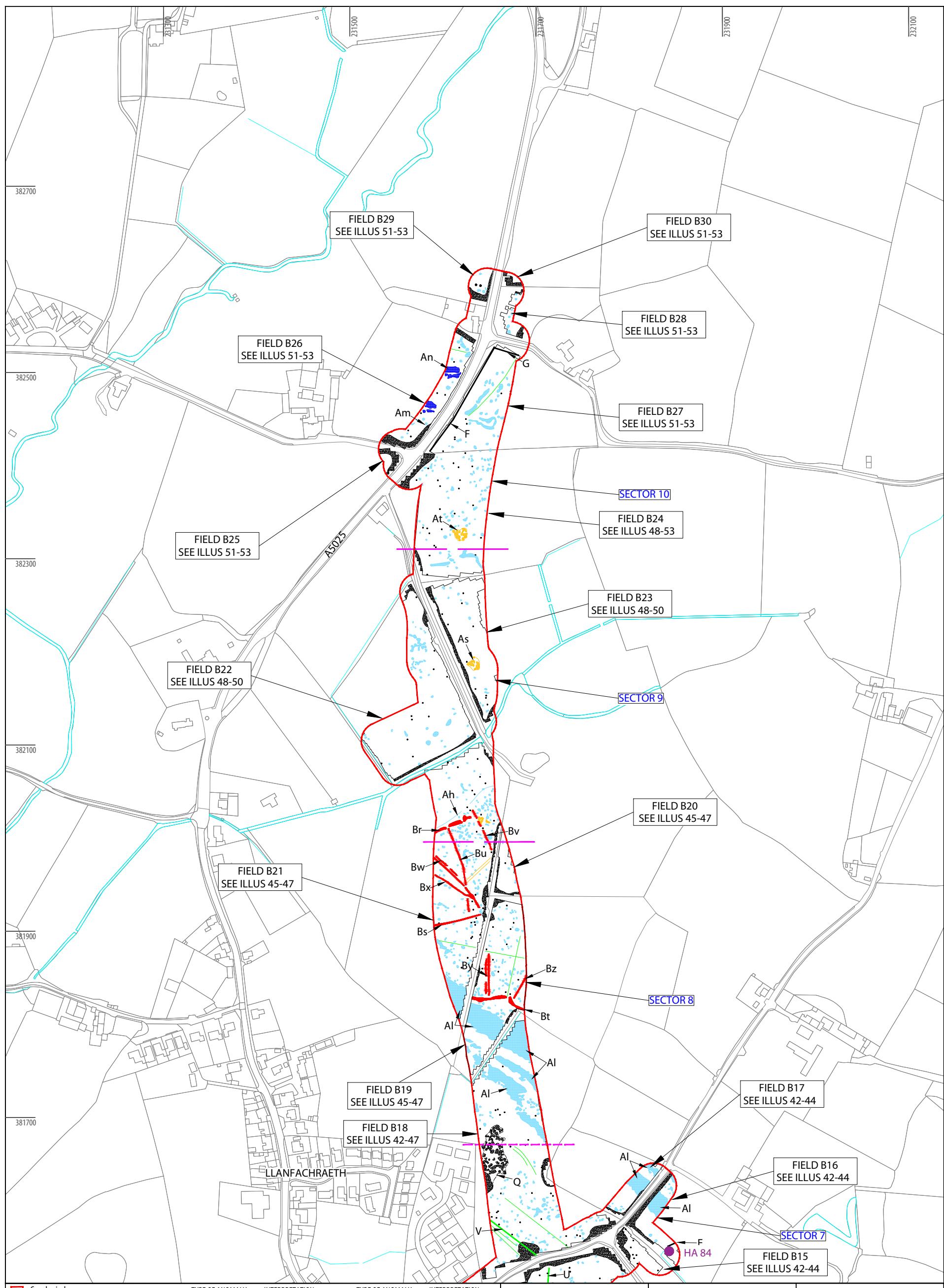
Survey location showing greyscale magnetometer data; Area B Llanfachraeth (south)



ILLUS 17

## Overall interpretation of magnetometer data; Area B Llanfachraeth (south)

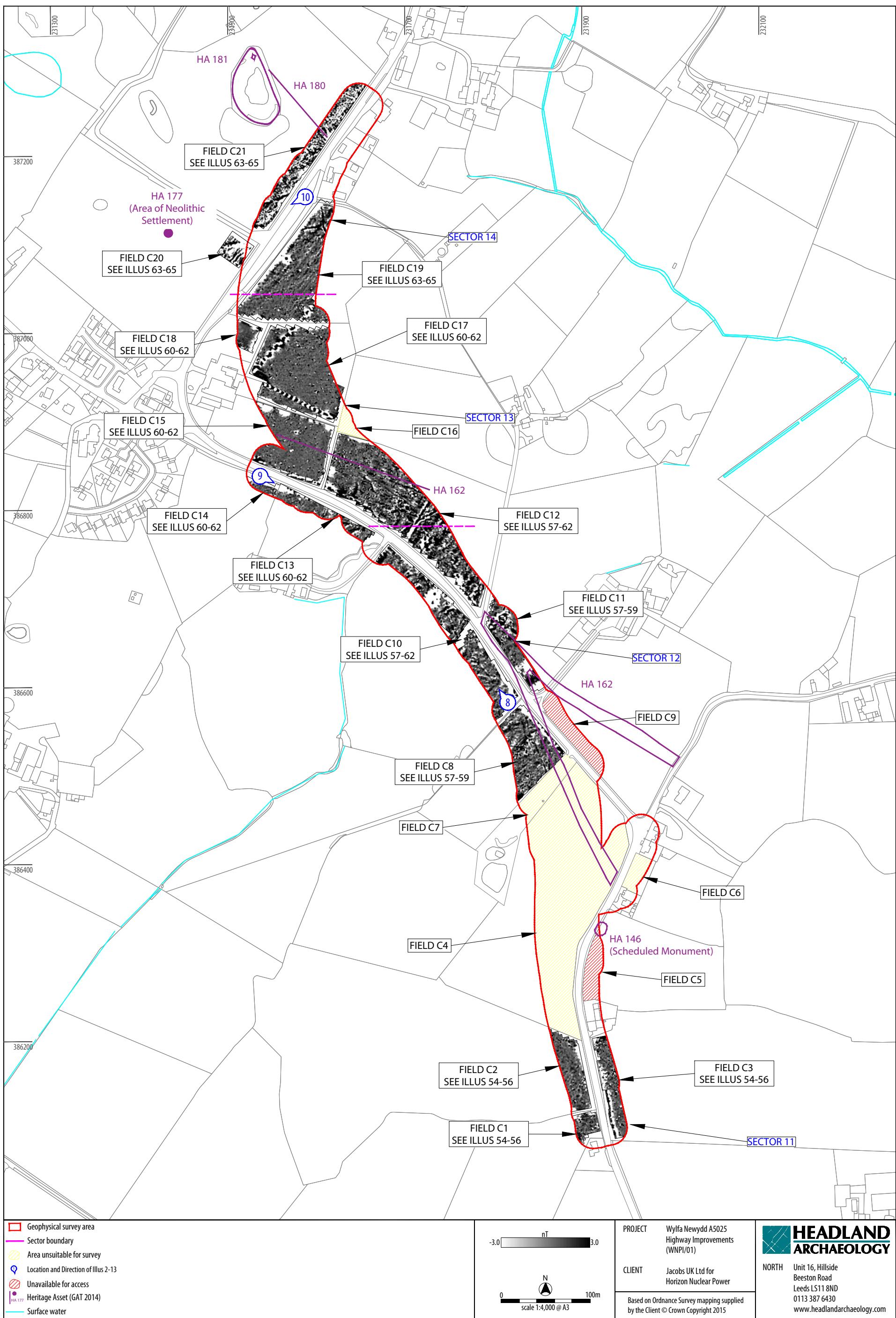




Geophysical survey area	TYPE OF ANOMALY	INTERPRETATION	TYPE OF ANOMALY	INTERPRETATION	PROJECT	Wylfa Newydd A5025 Highway Improvements (WNPI/1)	HEADLAND ARCHAEOLOGY
■ Geophysical survey area	● Dipolar Isolated	Ferrous Material	● Magnetic Enhancement	Geology	CLIENT	Jacobs UK Ltd for Horizon Nuclear Power	
■ Sector boundary	● Magnetic Disturbance	Ferrous Material	● Magnetic Enhancement	Geological variation			
■ Heritage Asset (GAT 2014)	— Dipolar Linear	Service	● Magnetic Enhancement	Quarrying?			
■ Surface water	— Linear Trend	Agricultural	● Magnetic Enhancement	Archaeology?			
	— Linear	Former field boundary	— Linear	Archaeology?			
	— Linear	Field Drain	● Magnetic Enhancement	Archaeology			
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					NORTH	Unit 16, Hillside Beeston Road Leeds LS11 8ND 0113 387 6430	www.headlandarchaeology.com

ILLUS 19

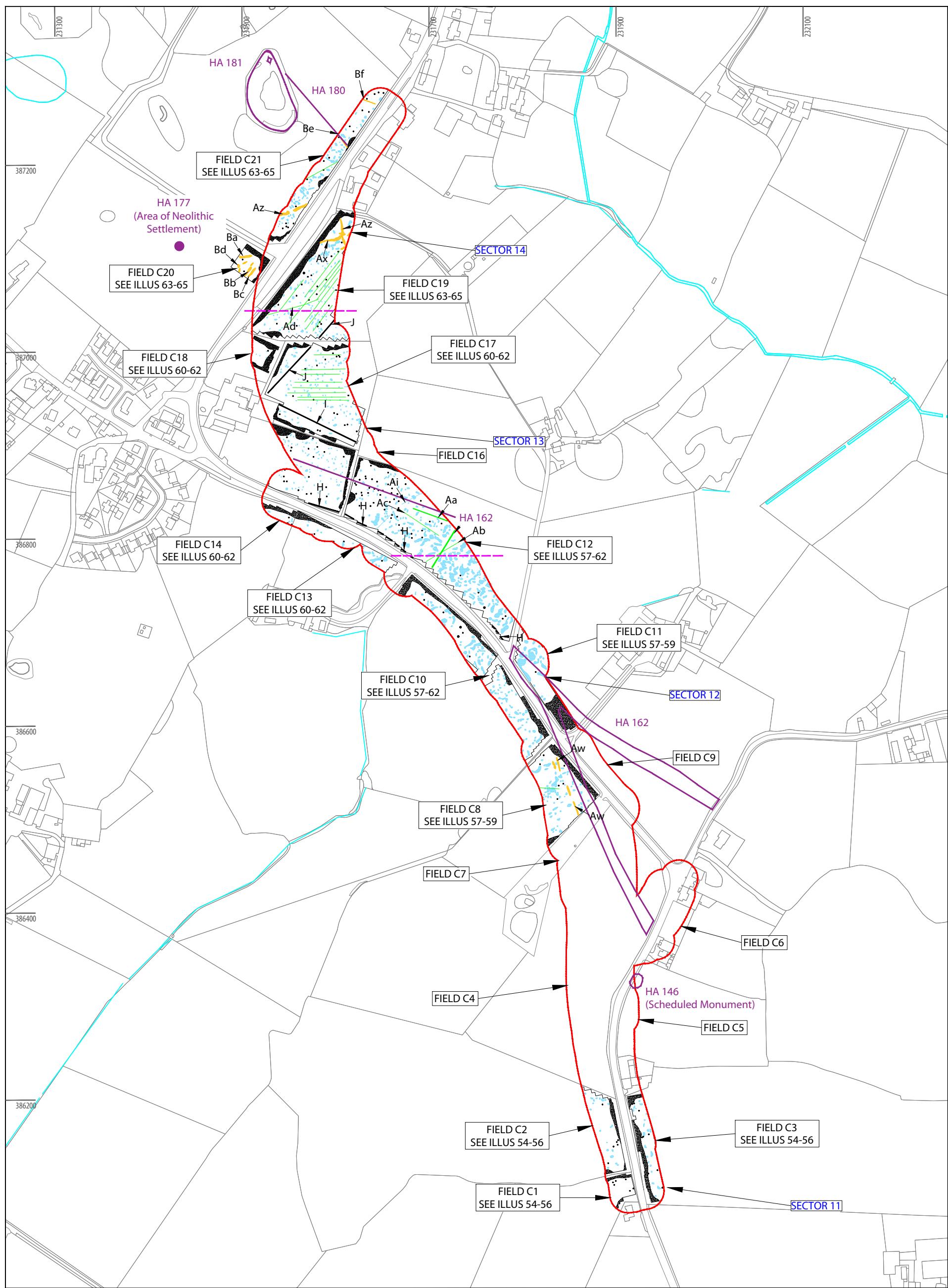
Interpretation of magnetometer data; Area B Llanfachraeth (north)



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## ILLUS 20

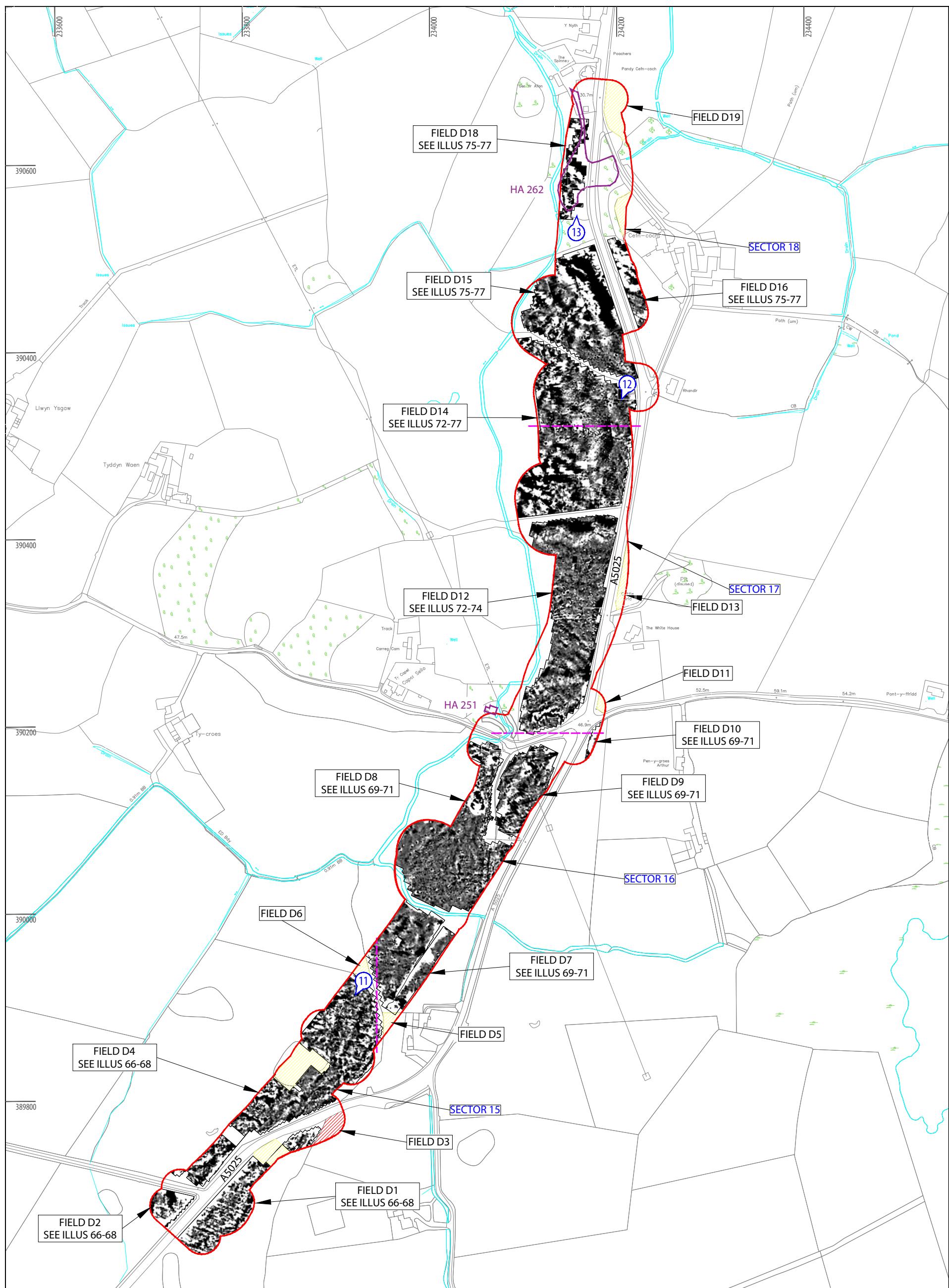
Survey location showing greyscale magnetometer data; Area C Llanfaethlu



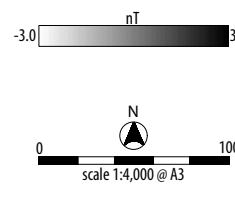
<b>Geophysical survey area</b> <b>Sector boundary</b> <b>HA 177</b> <b>Surface water</b>	<b>TYPE OF ANOMALY</b> ● Dipolar Isolated ● Magnetic Disturbance — Dipolar Linear — Linear Trend — Linear — Magnetic Enhancement	<b>INTERPRETATION</b> Ferrous Material Ferrous Material Service Pipe Agricultural Former field boundary Geology	<b>TYPE OF ANOMALY</b> <span style="color: yellow;">◆</span> Magnetic Enhancement <span style="color: yellow;">—</span> Linear	<b>INTERPRETATION</b> Archaeology? Archaeology?	<b>PROJECT</b> Wylfa Newydd A5025 Highway Improvements (WNPI/01)	<b>CLIENT</b> Jacobs UK Ltd for Horizon Nuclear Power  Based on Ordnance Survey mapping supplied by the Client © Crown Copyright 2015	<b>HEADLAND</b> <b>ARCHAEOLOGY</b> NORTH Unit 16, Hillside Beeston Road Leeds LS11 8ND 0113 387 6430 www.headlandarchaeology.com
					0 scale 1:4,000 @ A3 100m		

ILLUS 21

Overall interpretation of magnetometer data; Area C Llanfaethlu



**ILLUS 22**  
Survey location showing greyscale magnetometer data; Area D Cefn Coch

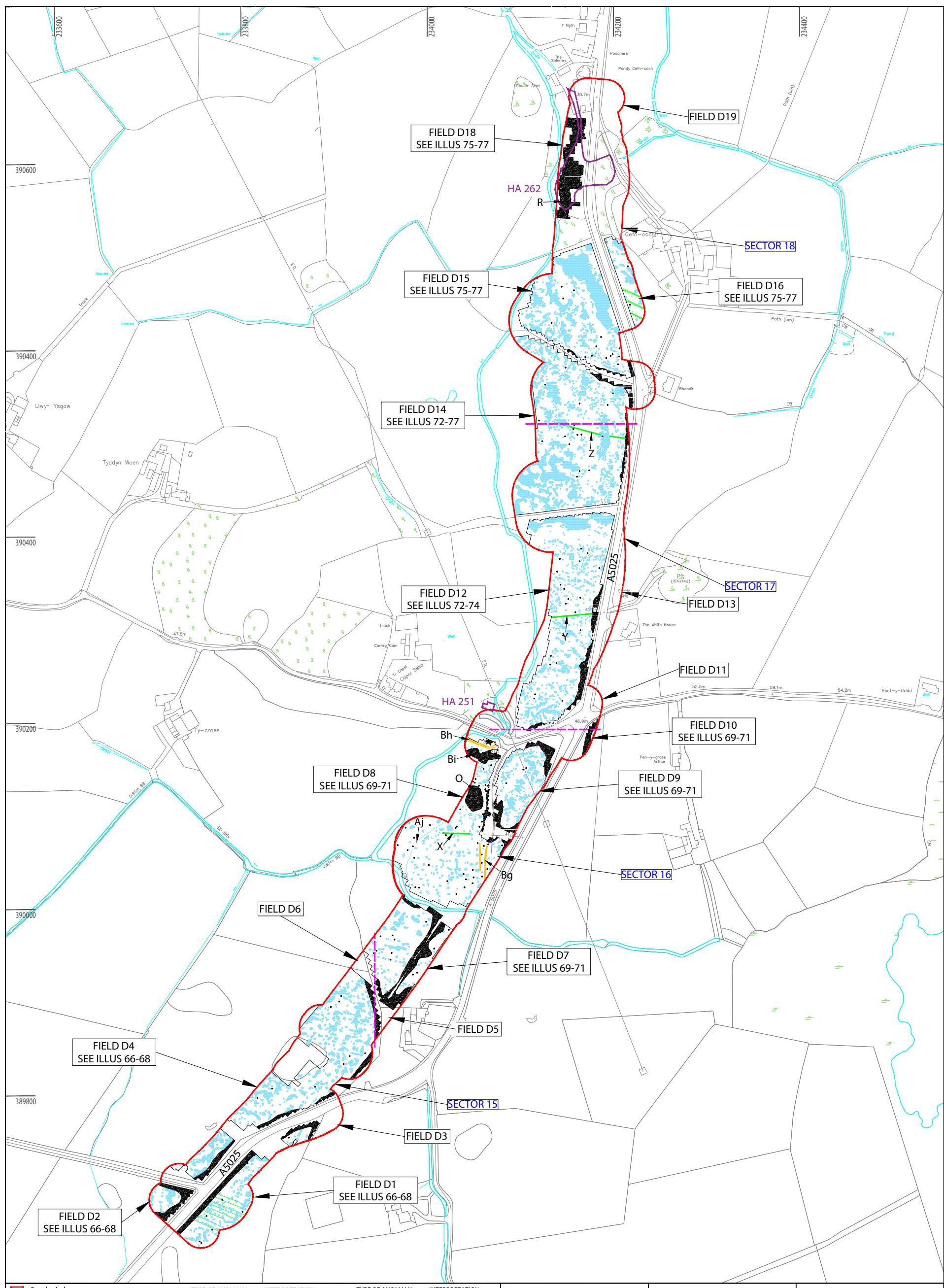


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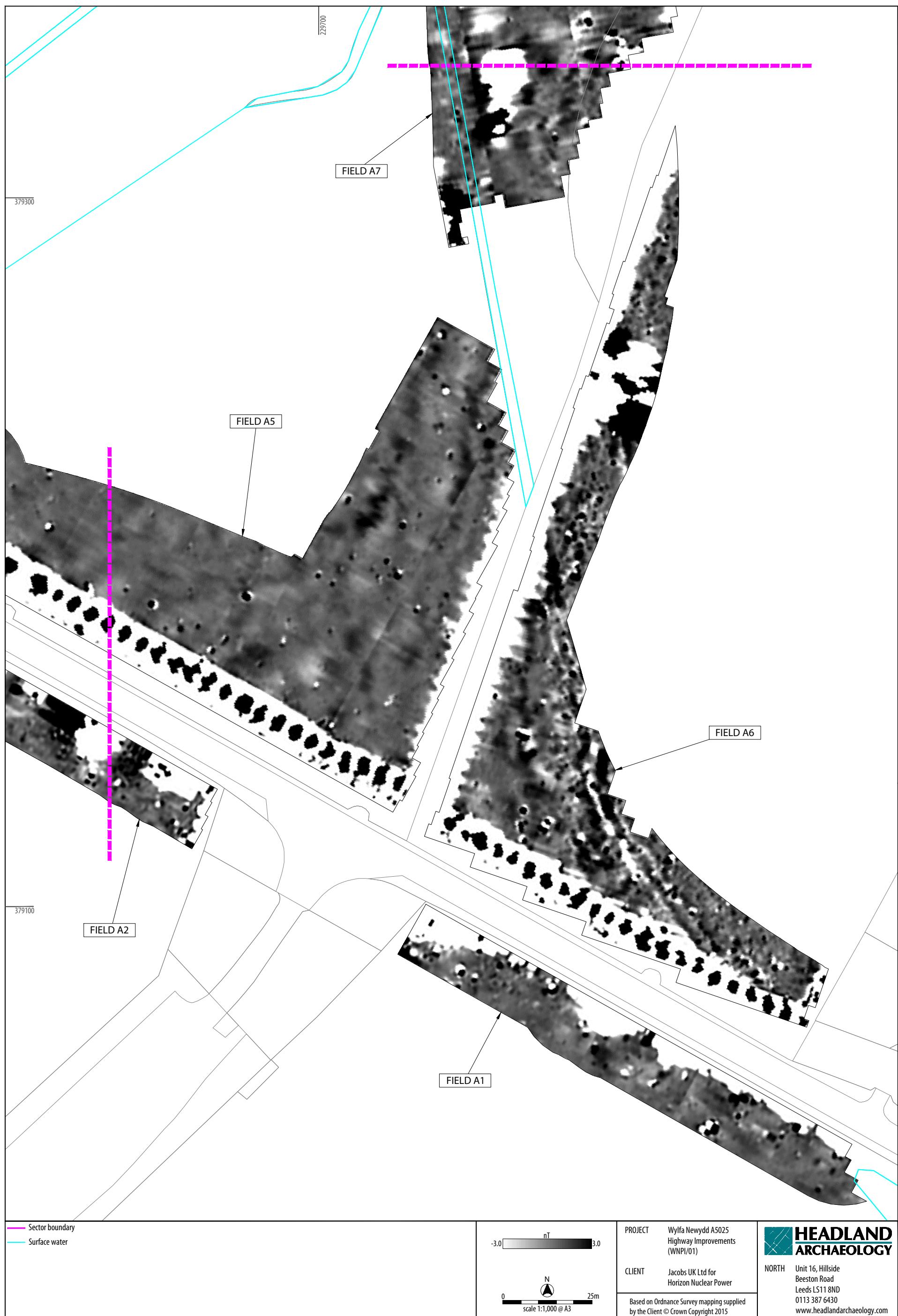
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 Geophysical survey area	 Dipolar Isolated	Ferrous Material	 Magnetic Enhancement	Geology		PROJECT	Wylfa Newydd A5025 Highway Improvements (WNPI/01)							
 Sector boundary	 Magnetic Disturbance	Ferrous Material	 Magnetic Enhancement	Archaeology?		CLIENT	Jacobs UK Ltd for Horizon Nuclear Power							
 Heritage Asset (GAT 2014)	 Linear Trend	Agricultural				Based on Ordnance Survey mapping supplied by the Client © Crown Copyright 2015								
 Surface water	 Linear	Former field boundary				0 scale 1:4,000 @ A3 100m								
	 Linear Trend	Field Drains												
	 Geological Variation	Geological Variation												
N								NORTH Unit 16, Hillside Beeston Road Leeds LS11 8ND 0113 387 6430 <a href="http://www.headlandarchaeology.com">www.headlandarchaeology.com</a>						

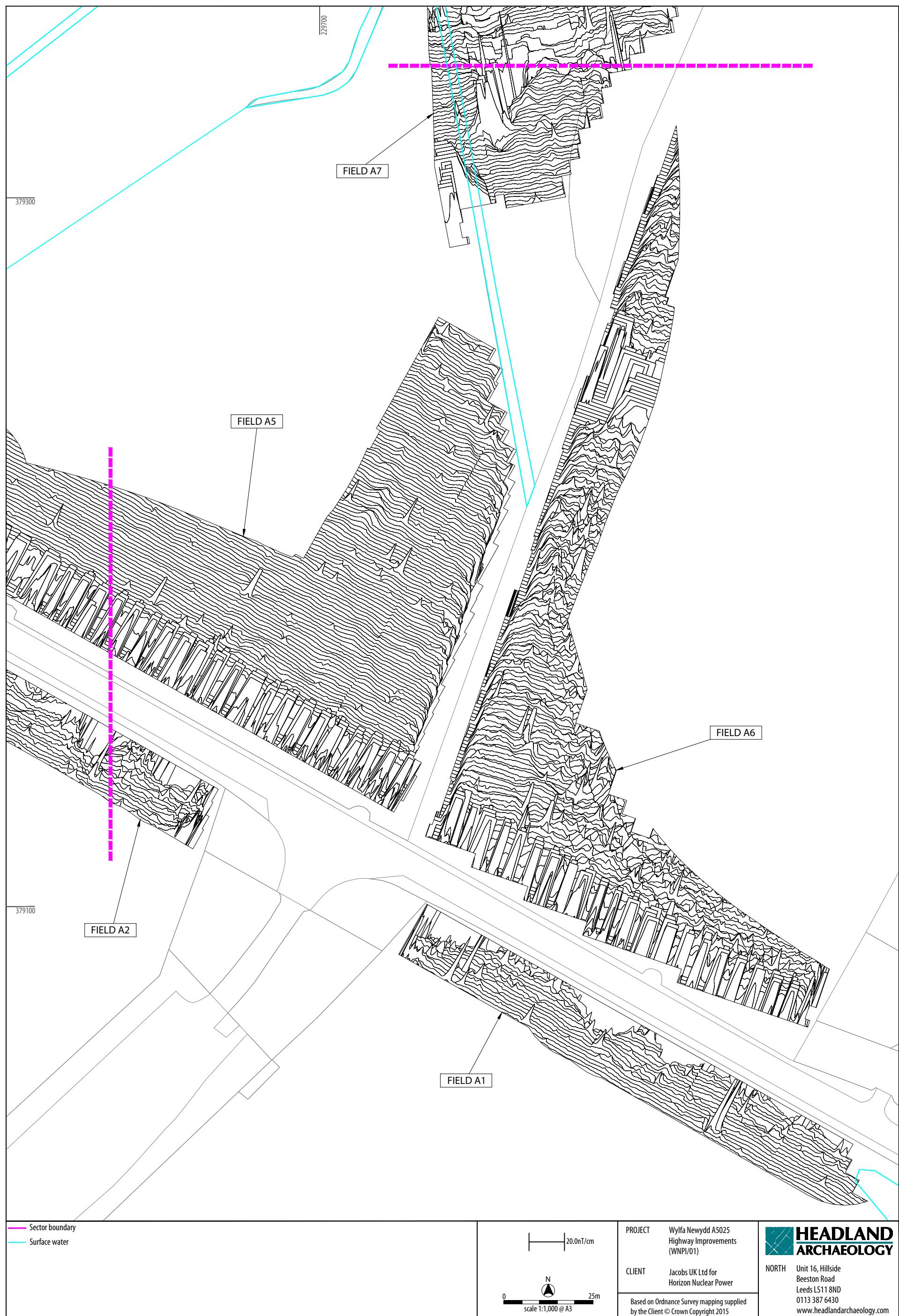
### ILLUS 23

## Interpretation of magnetometer data; Area D Cefn Coch



Illus 24

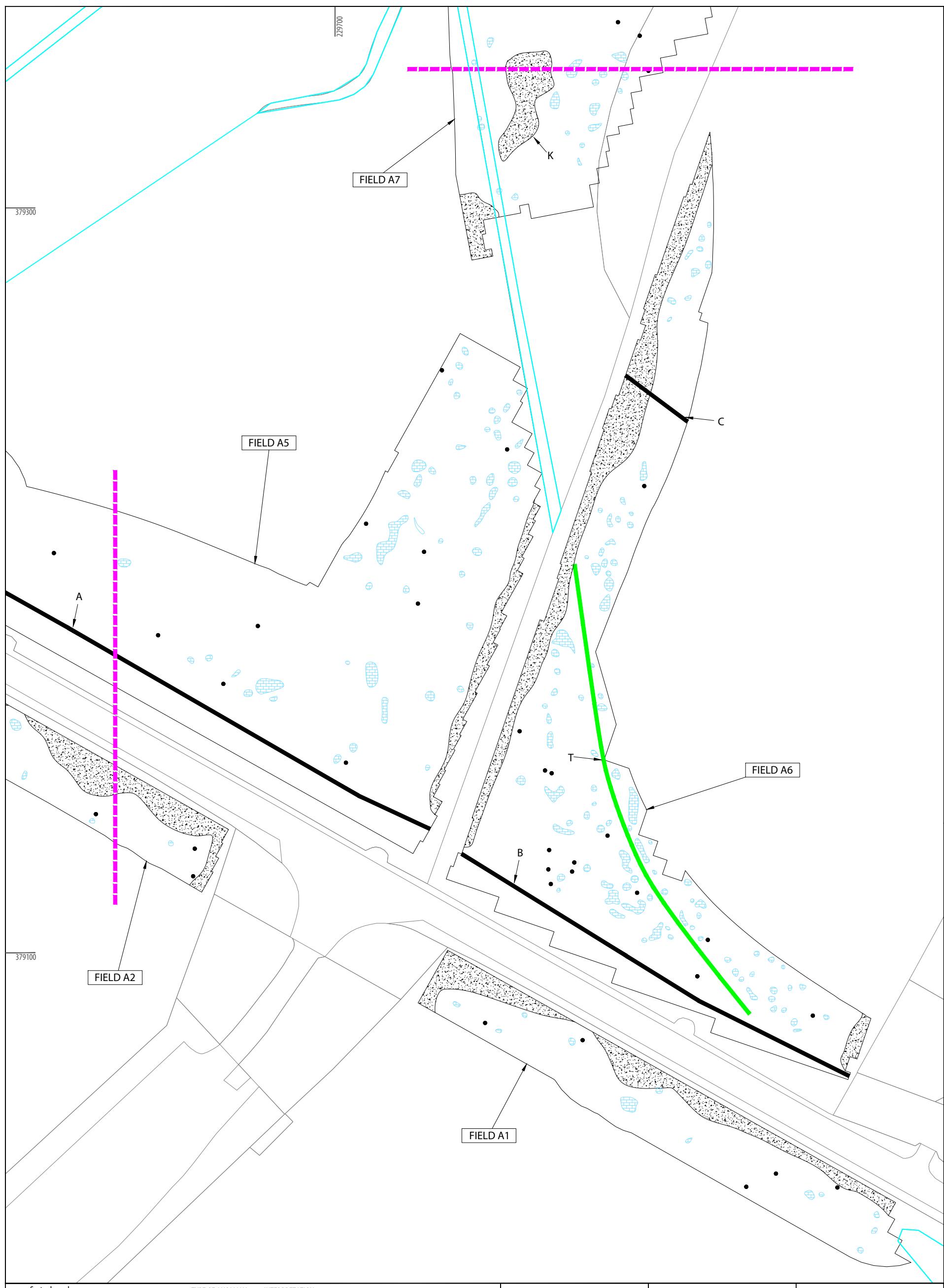
Processed greyscale magnetometer data; Sector 1



Illus 25

XY trace plot of minimally processed magnetometer data; Sector 1

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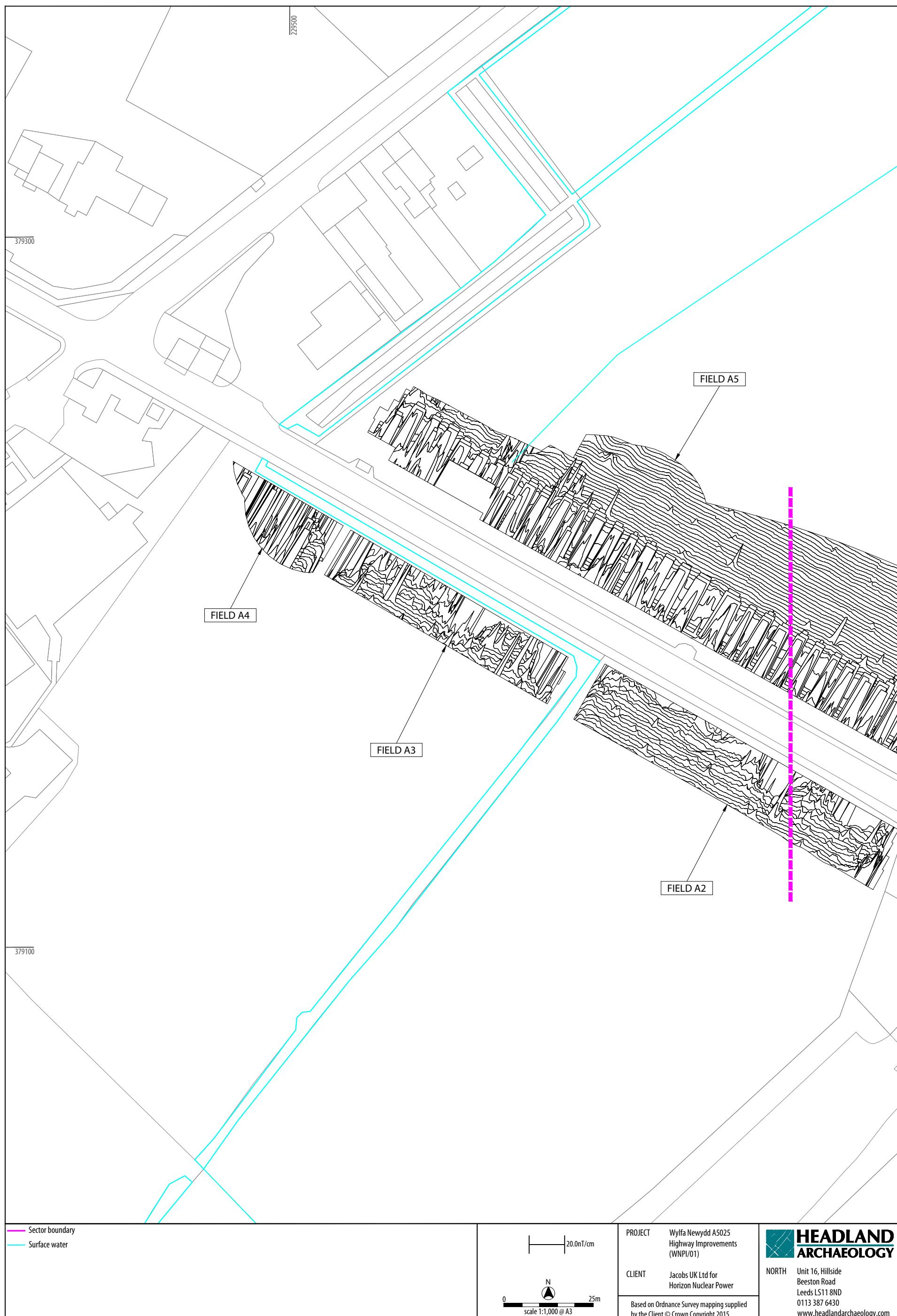
Sector boundary	TYPE OF ANOMALY	INTERPRETATION	PROJECT	Wylfa Newydd A5025
Surface water	● Dipolar Isolated	Ferrous Material	Highway Improvements (WNPI/1)	
	● Magnetic Disturbance	Ferrous Material	CLIENT	Jacobs UK Ltd for
	— Dipolar Linear	Service Pipe		Horizon Nuclear Power
	— Linear Trend	Agricultural		
	— Linear	Former field boundary		
	— Magnetic Enhancement	Geology		
				Based on Ordnance Survey mapping supplied by the Client © Crown Copyright 2015
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Illus 26  
Interpretation of magnetometer data; Sector 1



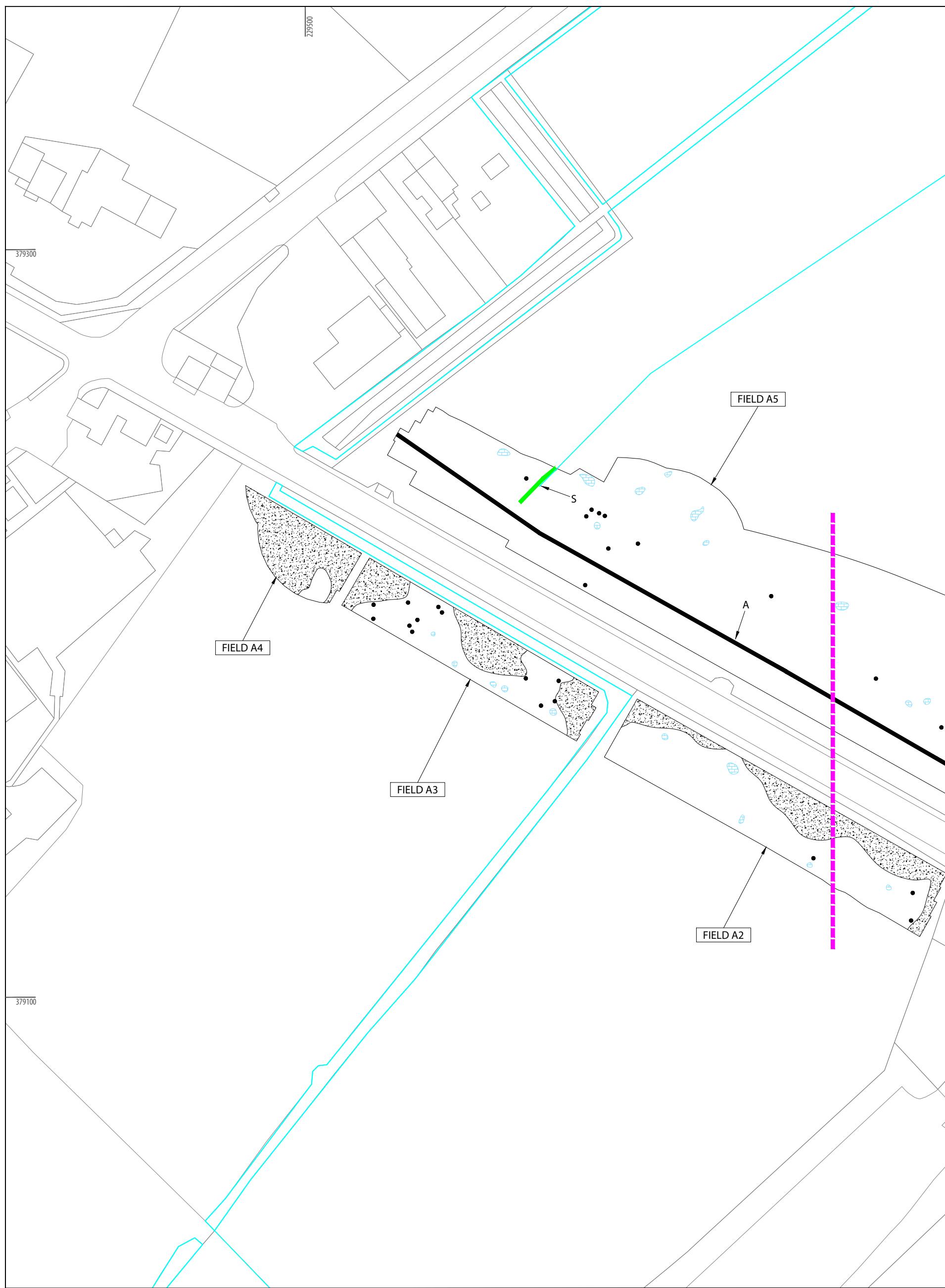
Illus 27

Processed greyscale magnetometer data; Sector 2



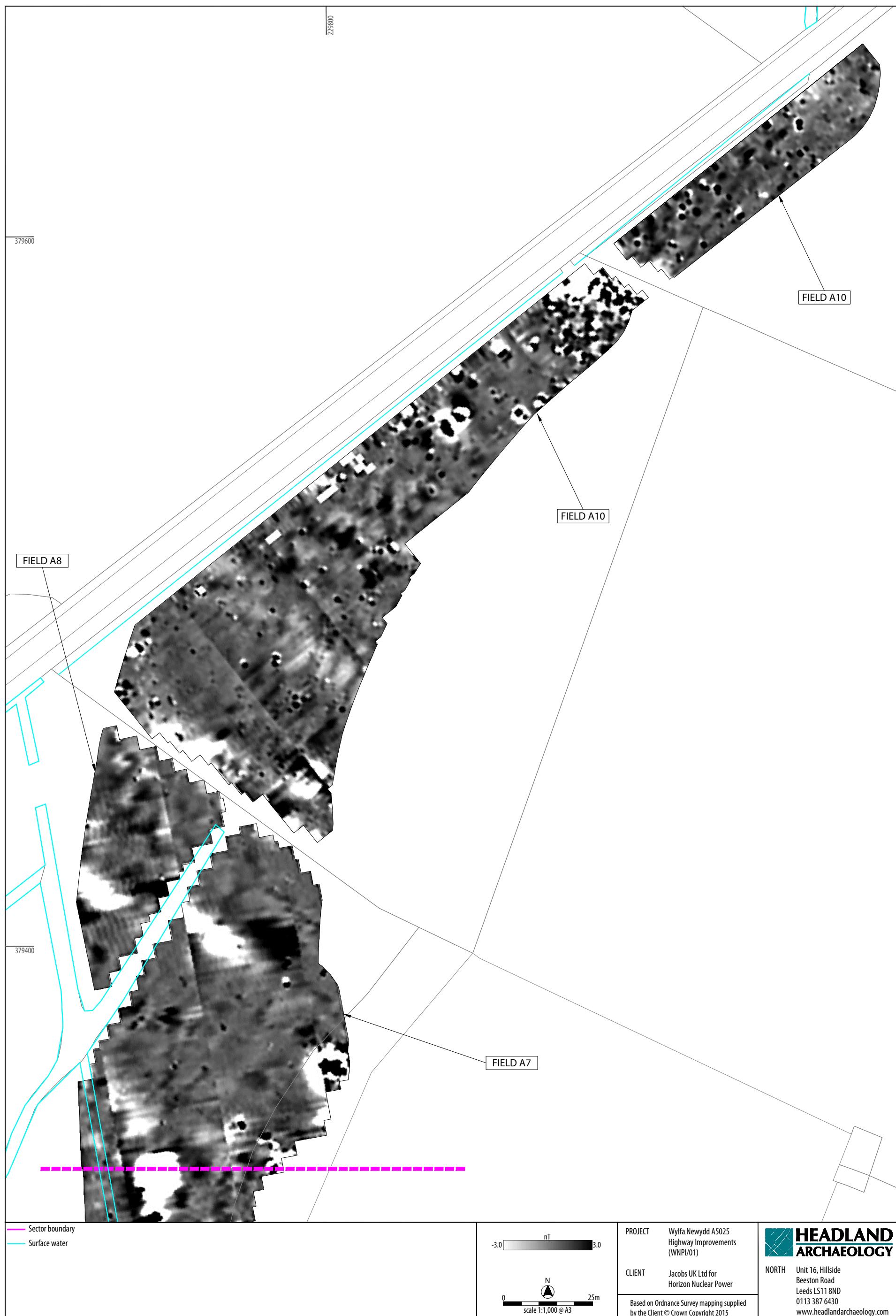
Illus 28

XY trace plot of minimally processed magnetometer data; Sector 2



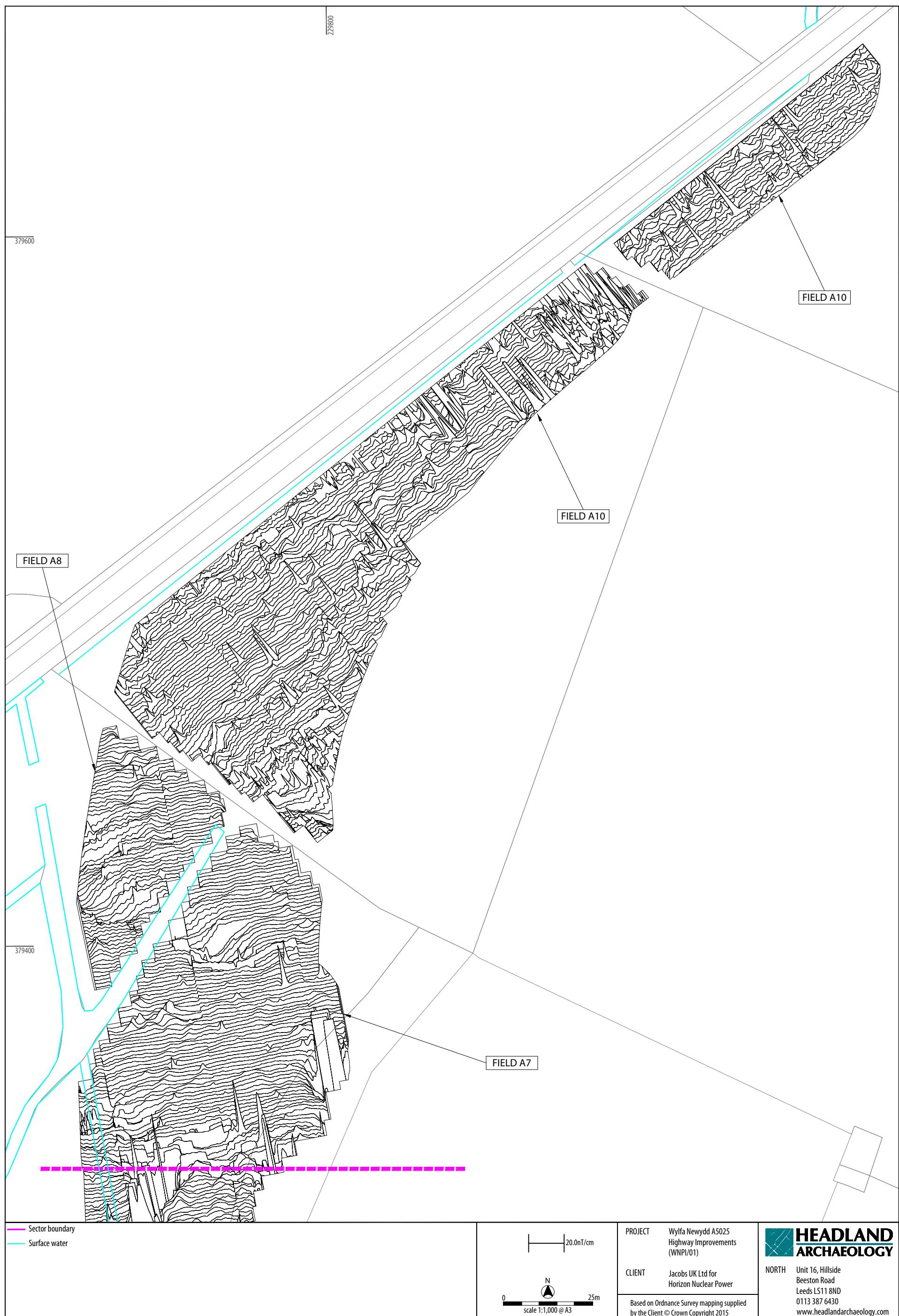
Illus 29

Interpretation of magnetometer data; Sector 2



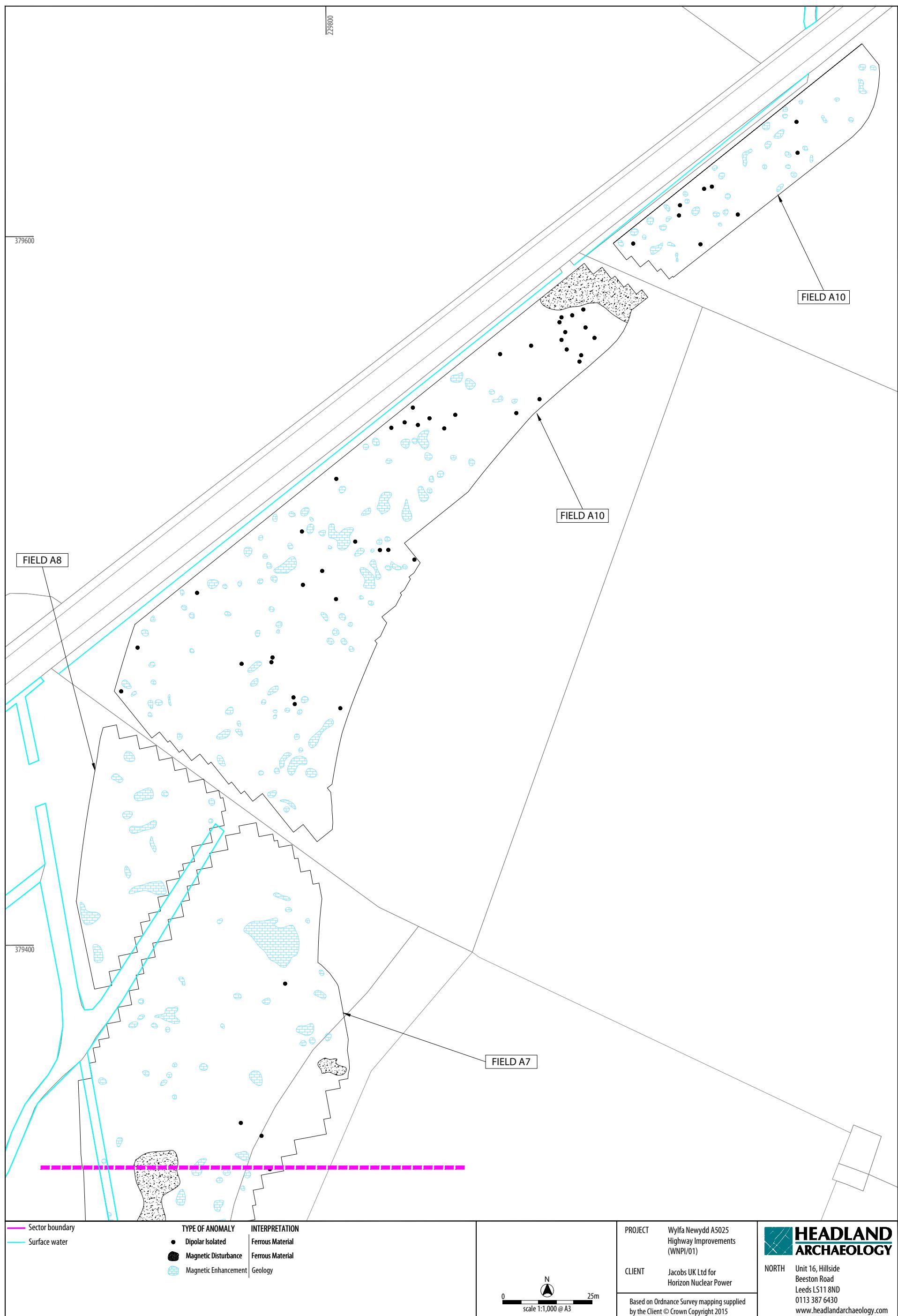
Illus 30

Processed greyscale magnetometer data; Sector 3



Illus 31

XY trace plot of minimally processed magnetometer data; Sector 3



Illus 32  
Interpretation of magnetometer data; Sector 3

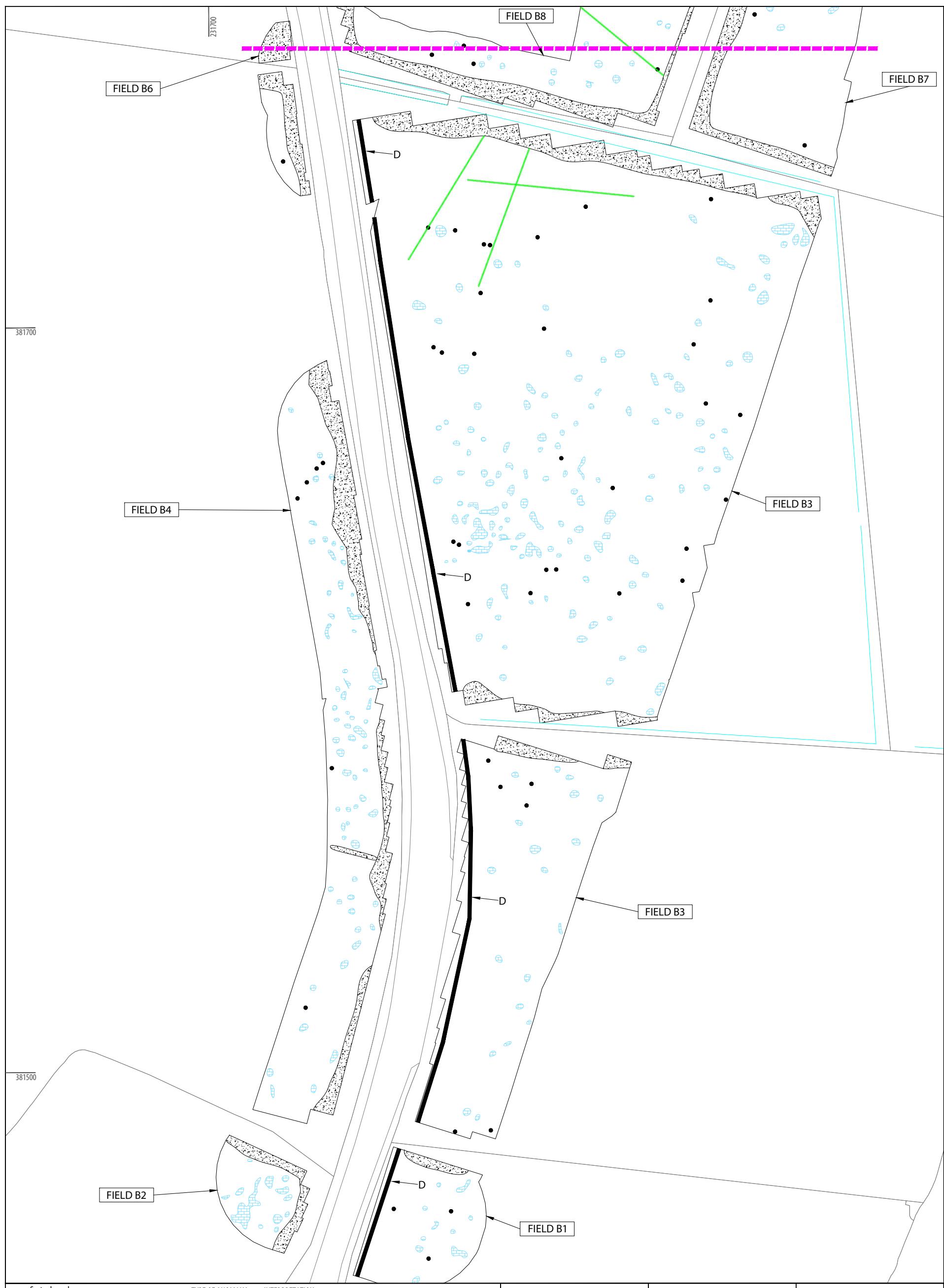


### Illus 33 Processed greyscale magnetometer data; Sector 4



Illus 34

XY trace plot of minimally processed magnetometer data; Sector 4



TYPE OF ANOMALY	INTERPRETATION	PROJECT	CLIENT	NORTH
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● Magnetic Disturbance	Ferrous Material	Highway Improvements (WNPI/1)	Horizon Nuclear Power	ARCHAEOLOGY
— Dipolar Linear	Service Pipe			Unit 16, Hillside
— Linear Trend	Field Drain			Beeston Road
● Magnetic Enhancement	Geology			Leeds LS11 8ND
		Based on Ordnance Survey mapping supplied		0113 387 6430
		by the Client © Crown Copyright 2015		<a href="http://www.headlandarchaeology.com">www.headlandarchaeology.com</a>

Illus 35  
Interpretation of magnetometer data; Sector 4



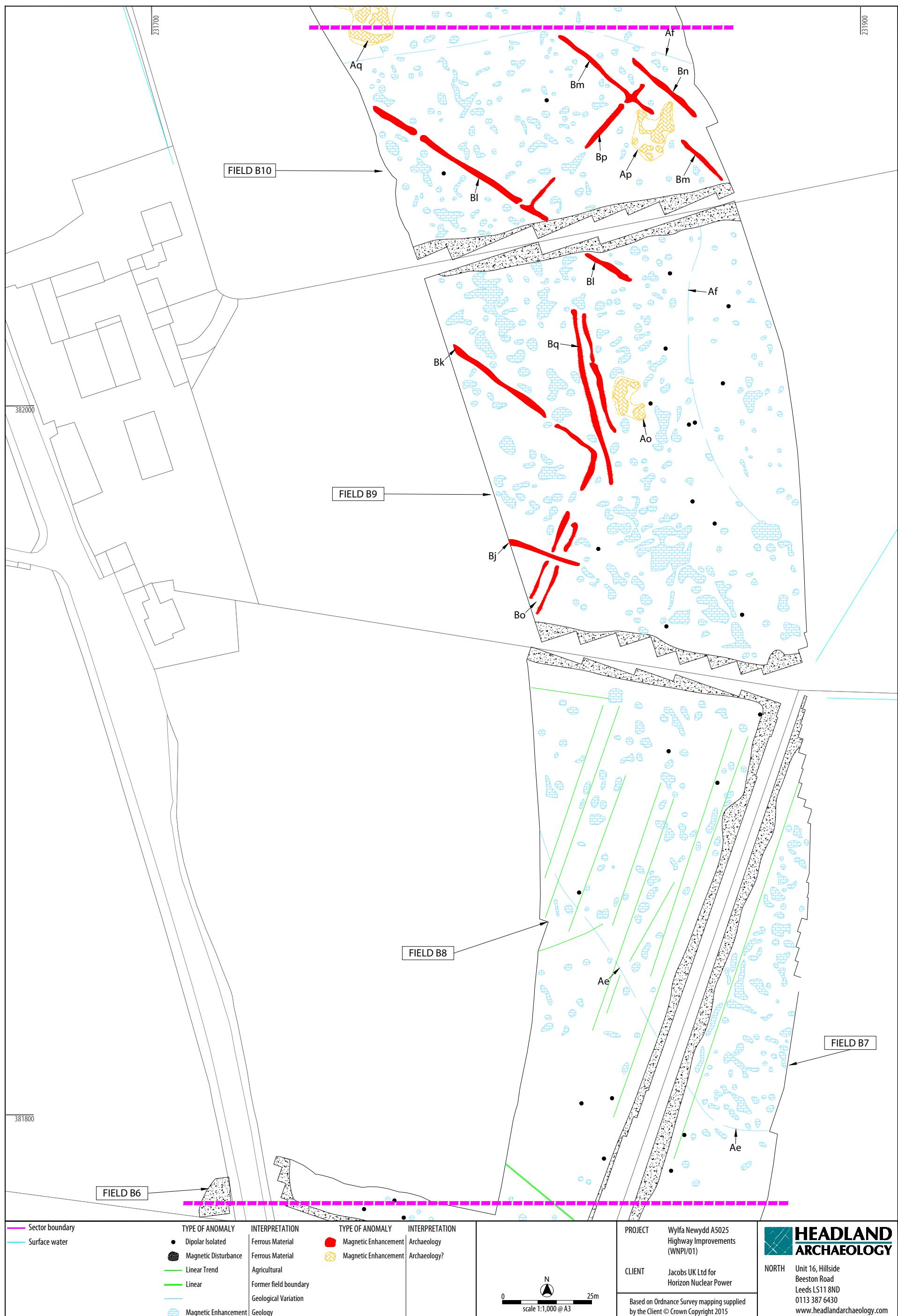
Illus 36

Processed greyscale magnetometer data; Sector 5



Illus 37

XY trace plot of minimally processed magnetometer data; Sector 5



Illus 38  
Interpretation of magnetometer data; Sector 5



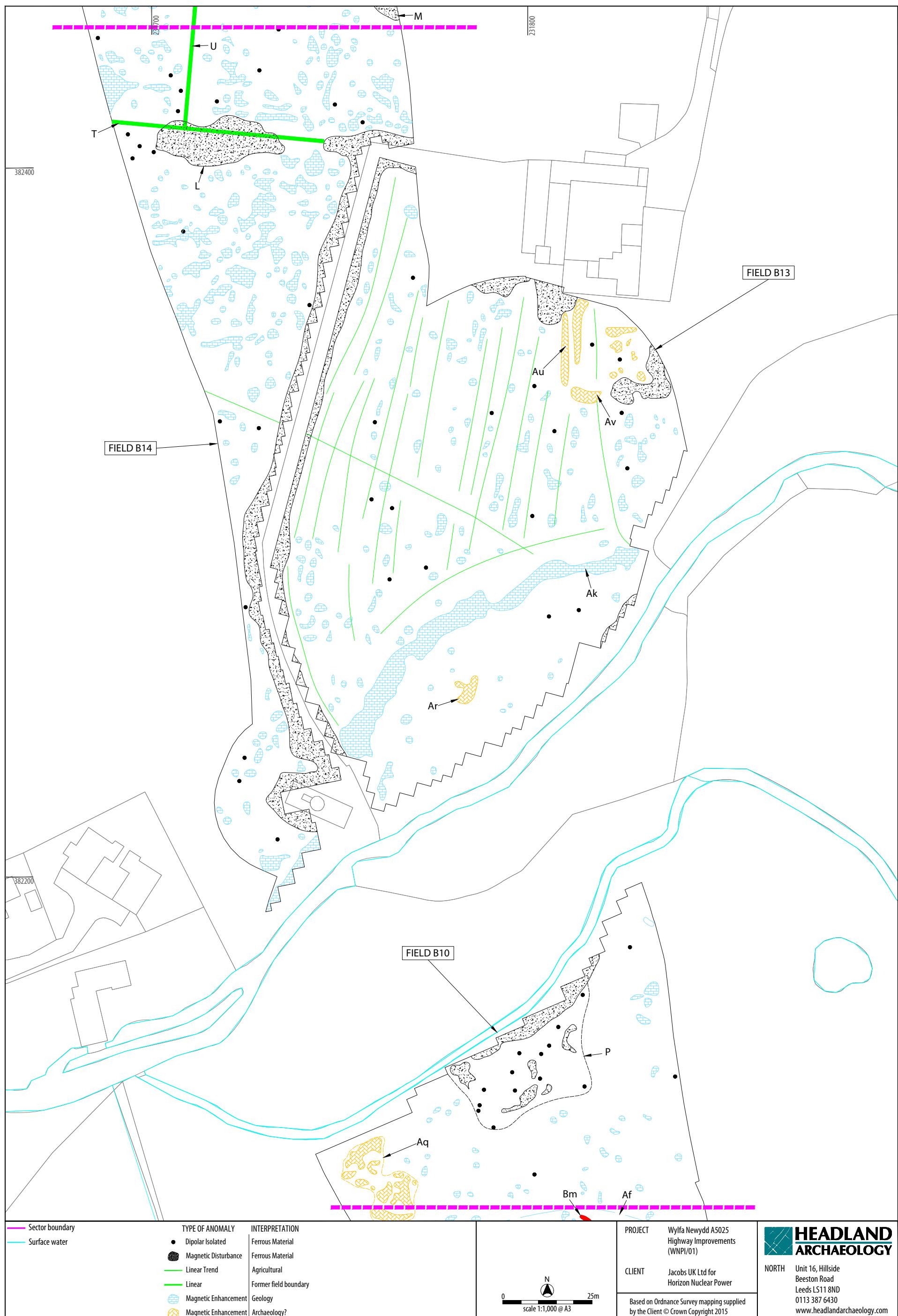
Illus 39

Processed greyscale magnetometer data; Sector 6

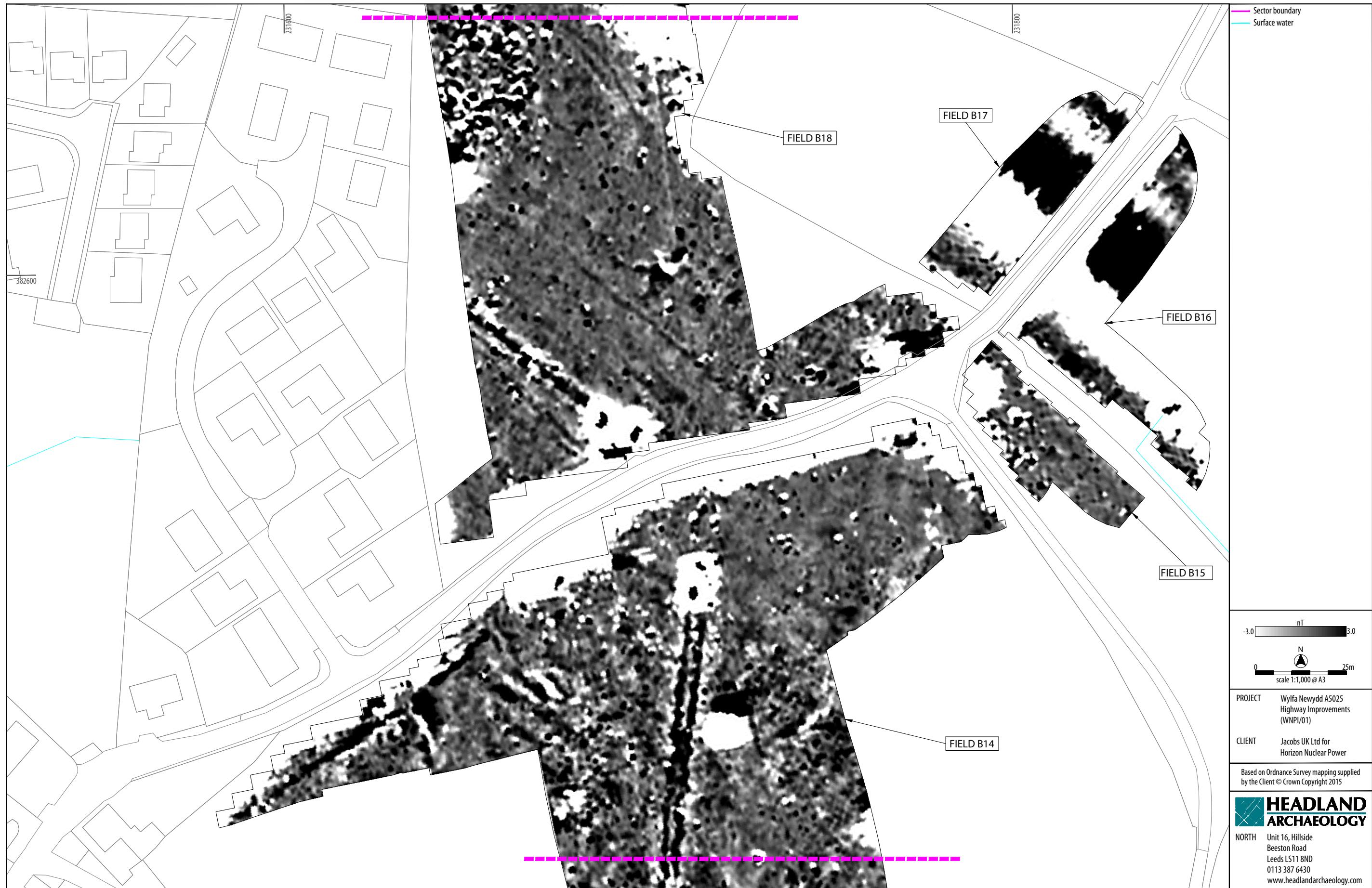


Illus 40

XY trace plot of minimally processed magnetometer data; Sector 7



Illus 41  
Interpretation of magnetometer data; Sector 7



Illus 42  
Processed greyscale magnetometer data; Sector 7