Foel Fach Wind Farm Limited.

Foel Fach Wind Farm – Environmental Statement Volume III

Appendix 8.3: Geophysical Survey Report: Access Track and Compound, Foel Fach Wind Farm, Glan-Yr-Afon, North Wales

Project Reference: 664094

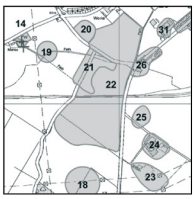
DECEMBER 2025

Energy for generations

Coriolis Energy

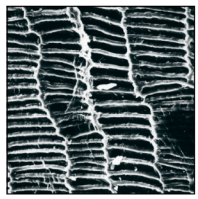
RSK

FWW24










ACCESS TRACK AND COMPOUND, FOEL FACH WIND FARM, GLAN-YR-AFON, NORTH WALES

GEOPHYSICAL SURVEY REPORT

on behalf of Foel Fach Wind Farm Limited

September 2025

HEADLAND ARCHAEOLOGY

REGISTERED ORGANISATION CIfA

ACCESS TRACK AND COMPOUND, FOEL FACH WIND FARM, GLAN-YR-AFON, NORTH WALES

GEOPHYSICAL SURVEY REPORT

on behalf of Foel Fach Wind Farm Limited

September 2025

This report adheres to the quality standard of ISO 9001:2015

PROJECT INFO:

HA Project Code **FWW24** / HA Report No **2025-118** / NGR **SH 91588 40889** /
Parish **Llandderfel** / Local Authority **Gwynedd Council** / Fieldwork Date **29/05/25 – 30/05/25**

PROJECT TEAM:

Project Manager **Sam Harrison** / Author **Eloise Turner** / Fieldwork **Emily Humphrey, Lara Brennan** /
Graphics **Beata Wieczorek-Oleksy, Eloise Turner, Joyce Heberden, Leia Carter, Toby O'Donoghue**

Approved by **Sam Harrison** .....

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HEADLAND ARCHAEOLOGY
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REGISTERED ORGANISATION CIfA

PROJECT SUMMARY

Headland Archaeology (UK) Ltd was commissioned by Foel Fach Wind Farm Limited (the Applicant), to undertake a geophysical (magnetometer) survey on Pen y Bwlch Gwyn, east of Glan-Yr-Afon, North Wales where a wind farm is proposed. The survey covered part of the route of the access track to the proposed wind farm as well as a proposed temporary compound area. This geophysical survey report will be submitted in support of any future planning application for the development. The results may also inform future archaeological strategy, if required.

The survey has primarily recorded anomalies of geological or natural origin, the likely result of changes in depth and composition of the mudstone, siltstone and igneous geologies, overlying superficial deposits, soils and the sloping nature of the Site.

Anomalies of agricultural origin have also been recorded reflecting the possible previous arable cultivation of the flatter parts of the Site. Former boundaries have been recorded by the survey as identified on historic maps and on LiDAR data. Possible land drains have also been recorded in the temporary compound area. A single discrete pit-like anomaly has been interpreted as of uncertain origin due to the shape and magnitude of the response: its location on the edge of the survey area, close to a boundary precludes a more confident interpretation. No anomalies of likely archaeological origin have been recorded by the survey.

The vague and ephemeral nature of the anomalies recorded indicates that there was possibly limited magnetic contrast for the detection of sub-surface archaeological features. However, the variety of anomalies identified suggests that any substantial archaeological activity would have been detected by the survey. The archaeological potential of the Site, based solely on the results of the geophysical survey, is therefore assessed as low.

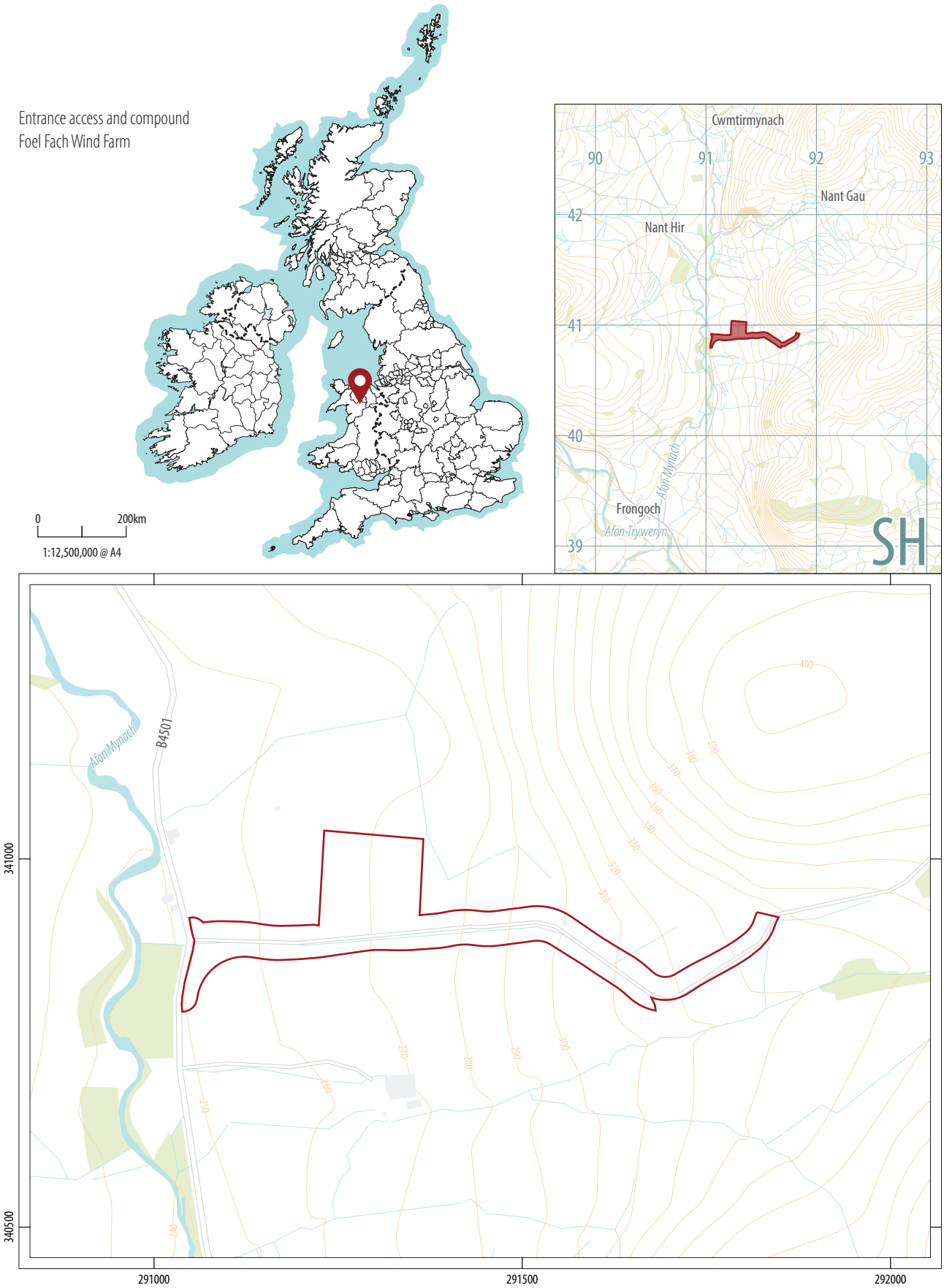
Cafodd Headland Archaeology (UK) Ltd ei gomisiynu gan Foel Fach Wind Farm Limited (y ymgeisydd), i ymgyryd arolwg geoffisegol (magnetomedr) ar Pen y Bwlch Gwyn, i yr dwyrain o Glan-Yr-Afon, Gogledd Cymru lle mae fferm gwynt yn gael ei gynnig. Roedd yr arolwg yn gwmpasu rhan o yr trac mynediad i yr fferm wynt ac yr compwnd sydd yn gael ei gynnig. Bydd adroddiad arolwg geoffisegol hwn yn gael ei gyflwyno i gefnogi ynrhyw cais cynllyunio ar gyfer y datblygiad yn y dyfodol. Gall y caluniadau hyn hefyd cyfarwyddo strategaeth archeolegol yn y dyfodol, os oes angen.

Cofnododd yr arolwg anomaleddau o darddiad daearegol neu naturiol yn bennaf, sydd yn debygol of fod yn galyniad o newidadau i ddyfnder a chyfnasoddiad y daearegau carreg laid ac igneaidd, dydoddion arwynebol, tros briddoedd, a natur llethrog y safle. Cofnododd hefyd nomeleddau o darddiad amaethyddol posib sydd yn adlweyrchu amaethiad âr blaenorol posib dros rhannau y safle sydd yn fwy gwastad. Nododd yr arolwg terfynau blaenorol sydd yn weladwy ar mapiau hanesyddol ac ar data LiDAR. Canfodd hefyd draeniau tir posib yn ardal y compwnd. Cafodd un anomledd arwahanol a tebyg i pwll ei ddehongli fel un ansicr oherwydd siâp a maint yr ymateb yn ogystal ac ei leoliad yn agos i ymyl yr ardal arolwg a terfyn sydd yn atal dehongliad mwy sicr. Ni chofnododd yr arolwg anomaleddau sydd yn debygol i fod o darddiad archeolegol.

Mae natur amwys ac effemeraidd yr anomaleddau a chofnododd yn dynodi cyferbyniad magnetig cyfyngedig posibl ar gyfer datgelu nodweddion archeolegol isarwyeb. Yn seiliedig ar canlyniadau yr arolwg geoffisegol yn unig asesir bod y potesial archeologel felly yn isel.

CONTENTS

LIST OF ILLUSTRATIONS



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ILLUS 1 Site location

ACCESS TRACK AND COMPOUND, FOEL FACH WIND FARM, GLAN-YR-AFON, NORTH WALES

GEOPHYSICAL SURVEY REPORT

1 INTRODUCTION

Headland Archaeology (UK) Ltd was commissioned by Foel Fach Wind Farm Limited (the Applicant), to undertake a geophysical (magnetometer) survey on Pen y Bwlch Gwyn, east of Glan-Yr-Afon, North Wales in advance of a proposed wind farm development. The survey covered part of the route of the track that will afford access to the proposed wind farm as well as a proposed temporary entrance compound (Illus 1). This geophysical survey report will be submitted in support of any future planning application for the development. The results may also inform future archaeological strategy, if required.

The scheme of work was undertaken in accordance with the requirements of the Planning Policy Wales 2024 (Edition 12, Ch.6 The Historic Environment) and with the Written Scheme of Investigation for Geophysical Survey (WSI) (Headland Archaeology 2025).

The WSI was produced to the standards laid down in the European Archaeological Council's guideline publication, EAC Guidelines for the Use of Geophysics in Archaeology (Europae Archaeologia Consilium 2016) and the Chartered Institute for Archaeologists' (CIfA) Standard and Guidance for Archaeological Geophysical Survey (CIfA 2020). The survey was carried out in line with the same best practice guidelines.

The survey was carried out on May 29 and May 30, 2025.

1.1 SITE LOCATION, TOPOGRAPHY AND LAND-USE

The geophysical survey area (GSA - Site) covered the route of the track that will allow access to the proposed Foel Fach Wind Farm as well as a proposed temporary compound area. The GSA is centred at NGR SH 91588 40889, east of Glan-Yr-Afon, north-east of Frongoch, south-east of Cwmtirmynach and west of Foel Fach and covers approximately 5.3 hectares (ha) within the wider scheme application boundary which covers approximately 92.4ha. All the GSA was under permanent pasture (Illus 2 to Illus 5 inclusive) at the time of survey.

The Site slopes down from the eastern end of the GSA at 341m Above Ordnance Datum (AOD) to the western end at 256m AOD.

1.2 GEOLOGY AND SOILS

The solid bedrock geology across the western half of the Site is siltstone of the Nant Ffrancon Subgroup, a sedimentary bedrock formed between 477.7 and 449 million years ago during the Ordovician period.

To the east of the Site the solid bedrock geology consists of bands of siltstone of the Glyn Gower Siltstones Member, tuff, felsic of the Frondderw Tuff Member, and mudstone of the Ceiswyn Formation (from west to east).

The Glyn Gower Siltstones Member and Ceiswyn Formation sedimentary bedrock geologies formed between 455.25 and 454 million years ago, and 457.5 and 452.75 million years ago respectively during the Ordovician period. The Frondderw Tuff Member igneous bedrock formed 455.25 and 454 million years ago during the Ordovician period.

The superficial deposits overlying the survey area are recorded as Till, Devensian – Diamicton, a sedimentary superficial deposit formed between 116 and 11.8 thousand years ago during the Quaternary period (NERC 2025).

ILLUS 2 F1, looking north-west

The soils covering the east of the GSA are classified in Soilscape 17 being described as slowly permeable seasonally wet acidic loams and clays. The soils in the west of the GSA are classified in Soilscape 13 being described as freely draining, acidic, loams over rock (Cranfield University 2025).

2 ARCHAEOLOGICAL BACKGROUND

The following archaeological background has been abstracted from an Archaeological Desk-Based and Stage 1 Setting Assessment Statement (ADBA - Headland Archaeology 2025a).

The ADBA established that there are no designated or non-designated historic assets within the GSA but that there are 44 non-designated historic assets, 43 of which are recorded on the Heneb/Trust for Welsh Archaeology (WAT) HER, in the wider search area assessed for the ADBA. The non-designated assets are predominantly of post-medieval date or of an unknown origin (see below).

The assets are mostly agricultural in character and include farms, outbuildings or outfarms, sheepfolds and shelters, and enclosures. Features including a pond, a sluice, peat cuttings, mines and quarries and gravel pits are indicative of small-scale industrial and extraction activity. Small features such as boundary markers, trackways, and a dam are also recorded as assets.

Two non-designated historic assets date to the prehistoric period. These comprise a grass covered cairn on the summit of Garnedd Fawr, and a hut circle: the latter has been suggested to possibly be a medieval or post-medieval livestock shelter. The remaining two non-designated historic assets are from the medieval period and are associated with the former township of Llaethgwm, and a possible former hermitage.

The DBA concluded that 'a review of HER data ….. demonstrates that the remains of Bronze Age activity and medieval to post-medieval are possibly preserved within the Site' and that 'the potential for hitherto unknown archaeological remains of low to medium importance to be preserved within the Site is assessed as medium'.

A previous geophysical survey (Headland Archaeology 2025b) was undertaken to the east of the GSA, over the proposed access track where it passes through the recorded township. The survey primarily recorded anomalies of geological or natural origin. A single L-shaped anomaly has been interpreted as of uncertain origin. It's right-angled linear form and elevated magnetic strength suggest an anthropogenic origin is most likely, perhaps associated with the possible land drains recorded immediately to the west.

ILLUS 3 F4, unsuitable for survey looking north

3 AIMS, METHODOLOGY & PRESENTATION

3.1 AIMS AND OBJECTIVES

The principal objectives of the geophysical survey were to gather information to establish the presence/absence, character, and extent of any archaeological remains within the GSA, and thereby support any forthcoming planning application and inform any further investigation strategies.

The aims of the survey were:

- to provide information about the nature and possible interpretation of any magnetic anomalies identified,
- to therefore determine the likely presence/absence and extent of any buried archaeological features, or other geophysical anomalies, and provide an interpretation, and
- to produce a comprehensive site archive and report.

3.2 METHODOLOGY

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 & Gater 2003). Further information on soil magnetism and the interpretation of magnetic anomalies is provided in Appendix 1.

Magnetometry is the most widely used geophysical survey technique in archaeology as it can quickly evaluate large areas and, under favourable conditions, identify a wide range of archaeological features including infilled cut features such as large pits, gullies and ditches, hearths, and areas of burning, and kilns and brick structures. It is therefore good at locating settlements of all periods, prehistoric field systems and enclosures, and areas of industrial or modern activity, amongst others. It is less successful in identifying smaller features such as post-holes and small pits (except when using a non-standard sampling interval), unenclosed (prehistoric) settlement sites and graves or burial grounds. However, magnetometry is by far the single most useful technique and was assessed as the best non-intrusive evaluation methodology for this Site.

The survey was undertaken using a five-sensor hand-carried array deploying Sensys FGM650/10 sensors mounted at 1m intervals (1m traverse interval) onto a rigid frame. The system was programmed to take readings at a frequency of 100Hz (allowing for a 1-2cm sample interval) on roaming traverses (swaths) 4m apart. These readings were stored on an external weatherproof laptop and later downloaded for processing and interpretation. The system was linked to a Geode Real Time Kinetic (RTK) differential Global

ILLUS 4 F4, unsuitable for survey looking east

Positioning System (dGPS) outputting in NMEA mode to ensure a high positional accuracy for each data point. MonMX (Sensys GmbH) software was used to collect and export the data.

Anomaly GeoSurvey v1.12.3 (Lichenstone Geoscience) and QGIS v.3.34.6 software was used to process and present the data respectively.

3.3 DATA PRESENTATION AND TECHNICAL DETAIL

A general site location plan is shown in Illus 1 at a scale of 1:7,500. Illus 2 to Illus 5 inclusive are site condition photographs. Illus 6 shows the location and direction of the site condition photographs at a scale of 1:5,000. Illus 7 and Illus 8 present overviews of the processed greyscale data and interpretation of the data, also at 1:5,000. Illus 9 to Illus 14 inclusive show the fully processed (greyscale) data, minimally processed (XY trace plot) data and interpretative plans, by Sector, at a scale of 1:2,500.

Technical information on the equipment used, data processing and magnetic survey methodology is given in Annex 1. Annex 2 details the survey location information and Annex 3 describes the composition and location of the site archive. Data processing details are presented in Annex 4. A copy of the OASIS entry (Online Access to the Index of Archaeological Investigations) is reproduced in Annex 5.

The survey methodology, report and any recommendations comply with the Written Scheme of Investigation (Headland Archaeology 2025), and guidelines outlined by Europae Archaeologia Consilium (EAC 2016) and by the Chartered Institute for Archaeologists (ClfA 2020).

The illustrations in this report have been produced following analysis of the data in 'raw' (minimally processed) and processed formats and over a range of different display levels. All illustrations are presented to display and interpret the data to best effect. The interpretations are based on the experience and knowledge of Headland Archaeology management and reporting staff.

4 RESULTS & DISCUSSION

4.1 SITE CONDITIONS

Magnetometer survey is generally recommended over any sedimentary geology, but results can be variable over mudstone bedrock geologies and overlying till superficial deposits. Thermoremanent effects can preclude survey over some igneous rock types (basalts) but other types of igneous rock may not have such an adverse effect (English Heritage 2008; Table 4).

The magnetic background is quite variable throughout the GSA reflecting the different types of bedrock geology, the heterogenous nature of the overlying superficial deposits and the degree of slope and therefore depth of the topsoil.

Against this magnetic background, anomalies of agricultural, modern, and geological origin have been recorded. No anomalies of archaeological potential have been recorded.

The vague and ephemeral nature of some of the anomalies recorded indicates that there was possibly limited magnetic contrast for the detection of sub-surface archaeological features within the GSA. The variety of anomalies identified and the limited effects of the igneous intrusion, however, suggests that any substantial archaeological activity would have been detected by the survey, if present, notwithstanding the limitations of magnetometer survey to identify the types, sizes and period of archaeological features as described in Section 3.2. It is therefore considered that the results of the survey provide a reasonable indication of the archaeological potential of the Site.

Surface conditions were generally good (Illus 2) and consequently data quality was also good with only minimal post-processing required. Small areas were unsuitable for survey due to debris (Illus 3 and Illus 5): cattle in the northern section of F4 also precluded survey here.

The anomalies recorded by the survey are discussed below according to their interpreted origin.

ILLUS 5 F5, unsuitable for survey looking south

4.2 ANOMALIES OF FERROUS AND MODERN ORIGIN

Ferrous anomalies, characterised as individual 'spikes', are typically caused by ferrous (magnetic) material, either on the ground surface or in the topsoil. Little importance is normally given to such anomalies, unless there is any supporting evidence for an archaeological interpretation, as modern ferrous debris is common on most sites, often being introduced into the topsoil during manuring or tipping/infilling. There is no obvious clustering of the 'spike' responses, so these anomalies are likely to be indicative of a random distribution of modern ferrous debris in the topsoil.

Bands or small areas of magnetic disturbance recorded along the boundaries of the GSA are likely to be due to the accumulation of ferrous debris around field margins, or due to ferrous material in the boundary itself.

A band of magnetic disturbance across F4 is caused by the extant boundary (Illus 14).

A linear dipolar anomaly (Illus 11 – SP1) records the location of a buried service pipe which extends from east to west from F1 to the west of F4 parallel to the route of the current track.

A small area of magnetically enhanced anomalies is recorded at either end of SP1 (Illus 11 and Illus 14) and may be associated with the buried service. It is also possible that these areas of magnetic enhancement may record infilling and/or ferrous material or debris within the topsoil suggested by the location of the responses alongside the current field boundaries and trackway.

An area of magnetic enhancement (Illus 11 – FW1) correlates to the location of a well, recorded on historic Ordnance Survey (OS) mapping. It is possible that this response records the infilling of the well at this location, however, it is similar in response to other areas of magnetic disturbance along the field boundary and may just record clusters of ferrous debris.

4.3 ANOMALIES OF AGRICULTURAL ORIGIN

Several faint linear trends have been recorded. In F2 and F3 three parallel curvilinear trend anomalies (Illus 11) likely record agricultural activity such as ploughing suggested by their parallel association. Another possibility is that these trends are natural in origin, caused by the superficial deposits and/or sloping topography.

In F1 (Illus 11) four parallel 'negative' anomalies aligned east to west are more likely to be caused by land drains rather than by ploughing.

A more prominent, higher magnitude linear anomaly aligned east to west parallel and close to the northern limits of F1 (Illus 11) is likely

to be indicative of a field drain. Other short discontinuous trends, on different alignments to the south of the drain in F1 described above, are also interpreted as likely drains.

Three former boundaries have been identified by the survey. FB1 (Illus 11) correlates to a former boundary recorded on historic OS maps. FB2 (Illus 11) and FB3 (Illus 14) are not recorded on historic OS maps but have been interpreted as former boundaries based on the strength and linearity of their response both in the magnetic data and on LiDAR images.

4.4 ANOMALIES OF GEOLOGICAL ORIGIN

The magnetic background is variable throughout the GSA, comprised of varying concentrations of discrete anomalies reflecting changes between bedrock geologies and in the superficial deposits. Larger, more amorphous anomalies recorded in F5 (Illus 14) likely record the band of igneous bedrock.

Vague sinuous anomalies in F1 (Illus 11) likely record variations in the overlying superficial deposits. The low magnitude, curvilinear anomalies in F4 and F6 (Illus 14) likely record changes in topography such as gullies visible on the satellite imagery.

4.5 ANOMALIES OF POSSIBLE OR PROBABLE ARCHAEOLOGICAL ORIGIN

No anomalies of possible or probable archaeological origin have been recorded by the survey.

4.6 ANOMALIES OF UNCERTAIN ORIGIN

A single discrete anomaly has been interpreted as of uncertain origin on the basis that it cannot be confidently interpreted in any other category (Illus 14 – U1). The shape and magnitude of the response is like that from a pit-like feature. However, the uncertain interpretation of the anomaly is appropriate given its location on the edge of the survey area adjacent to a field boundary.

5 CONCLUSION

The survey has primarily recorded anomalies of geological or natural origin, the likely result of changes in depth and composition of the mudstone, siltstone and igneous geologies, overlying superficial deposits, soils and the sloping nature of the Site.

Anomalies of agricultural origin have also been recorded reflecting the possible previous arable cultivation of the flatter parts of the Site. Former boundaries have been recorded by the survey as identified on historic maps and on LiDAR data. Possible land drains have also been recorded in the temporary compound area. A single discrete pit-like anomaly has been interpreted as of uncertain origin due to the shape and magnitude of the response: its location on the edge of the survey area, close to a boundary precludes a more confident interpretation. No anomalies of likely archaeological origin have been recorded by the survey.

The vague and ephemeral nature of the anomalies recorded indicates that there was possibly limited magnetic contrast for the detection of sub-surface archaeological features. However, the variety of anomalies identified suggests that any substantial archaeological activity would have been detected by the survey. The archaeological potential of the Site, based solely on the results of the geophysical survey, is therefore assessed as low.

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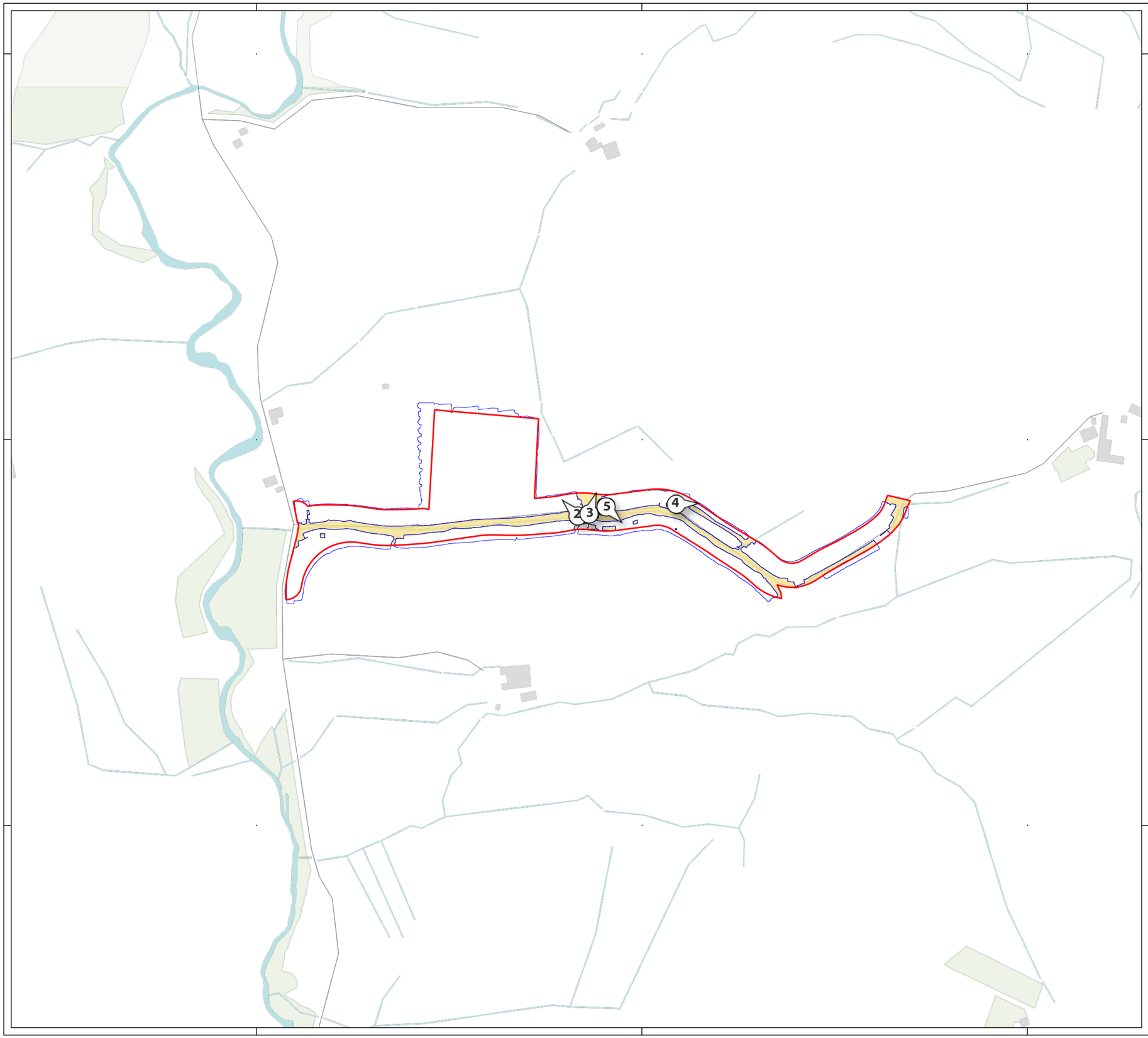

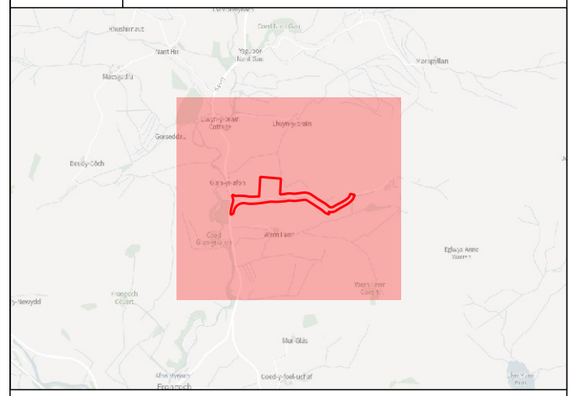

Key

- Geophysical Survey Area
- Survey Extent
- Location and Direction for Illus 2 to 5
- Unsuitable Survey Area

0 100 200 m

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Checked by:	ET
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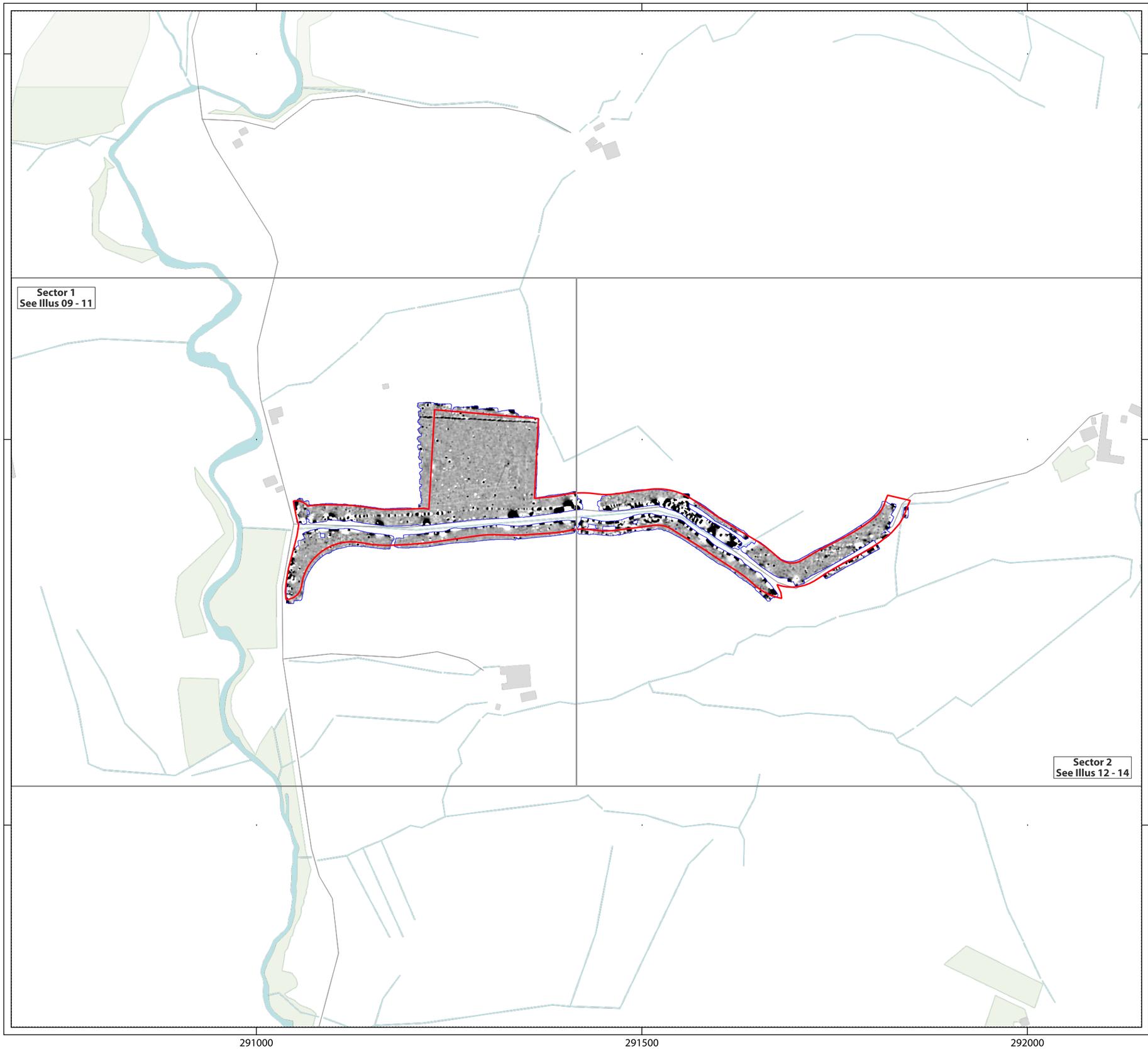
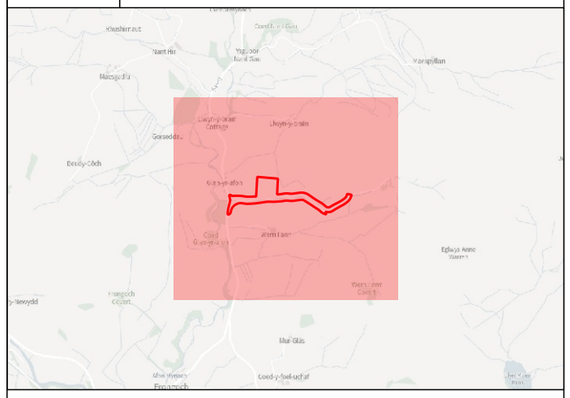
Illus 06 - Survey location showing photograph locations and areas unsuitable for survey





Key

- Geophysical Survey Area
- Survey Extent
- Area for Illus 9 to 14

+2nT

-1nT

0 100 200 m

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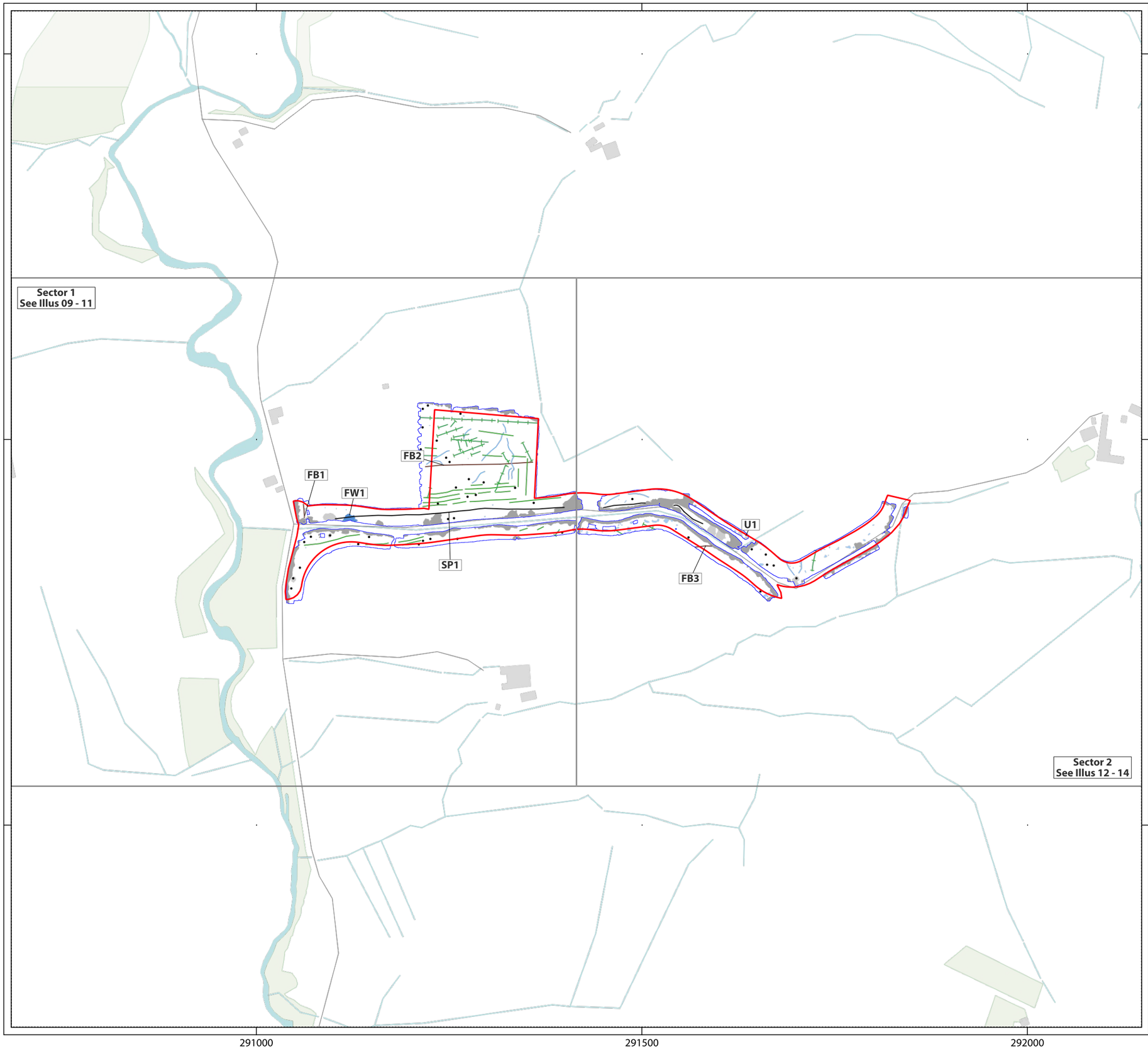
Illus 07 - Overall greyscale plot of processed magnetometer data



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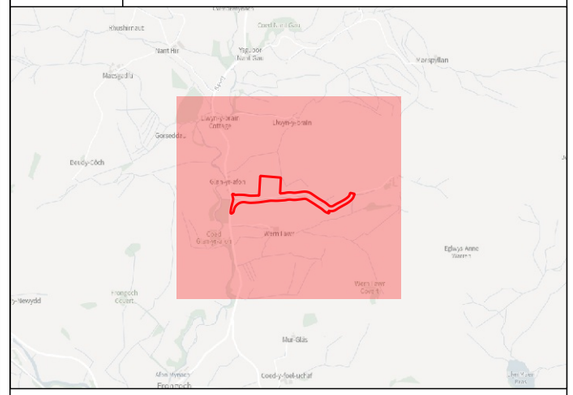

Key

- Geophysical Survey Area
- Survey Extent
- Area for Illus 9 to 14
- Ferrous Objects
- Agriculture
- Field Boundary
- Field Drain
- Natural
- Service
- Magnetic Disturbance (Above Ground)
- Magnetic Disturbance (Below Ground)
- Natural
- Uncertain
- Former Well

	Abbreviation
FB	Former Field Boundary
FW	Former Well
SP	Service Pipe
U	Uncertain

0 100 200 m

Site:	FFWW24
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Illus 08 - Overall interpretation of magnetometer data

N

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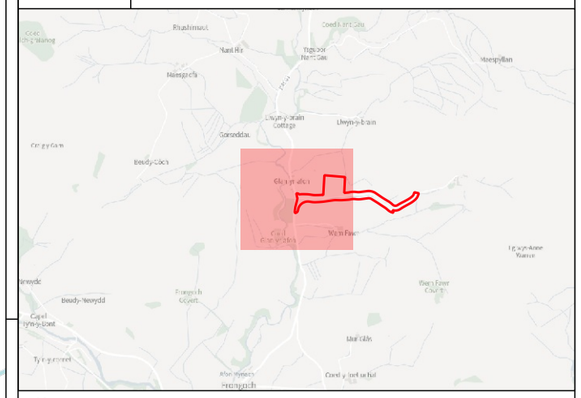

Key

Survey Extent

+2nT

-1nT

0 50 100 m

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Checked by:	ET
Version:	v1.2
Date:	29/07/2025
Scale:	1:2,500 @ A3

Illus - 09 Processed greyscale magnetometer data; Sector 1

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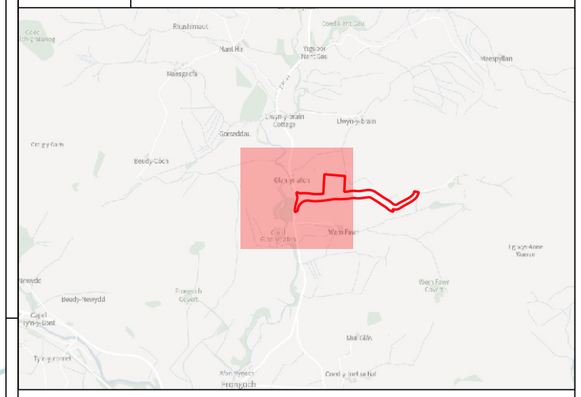

Key

Survey Extent

XY Trace (25nT/cm)

0 50 100 m

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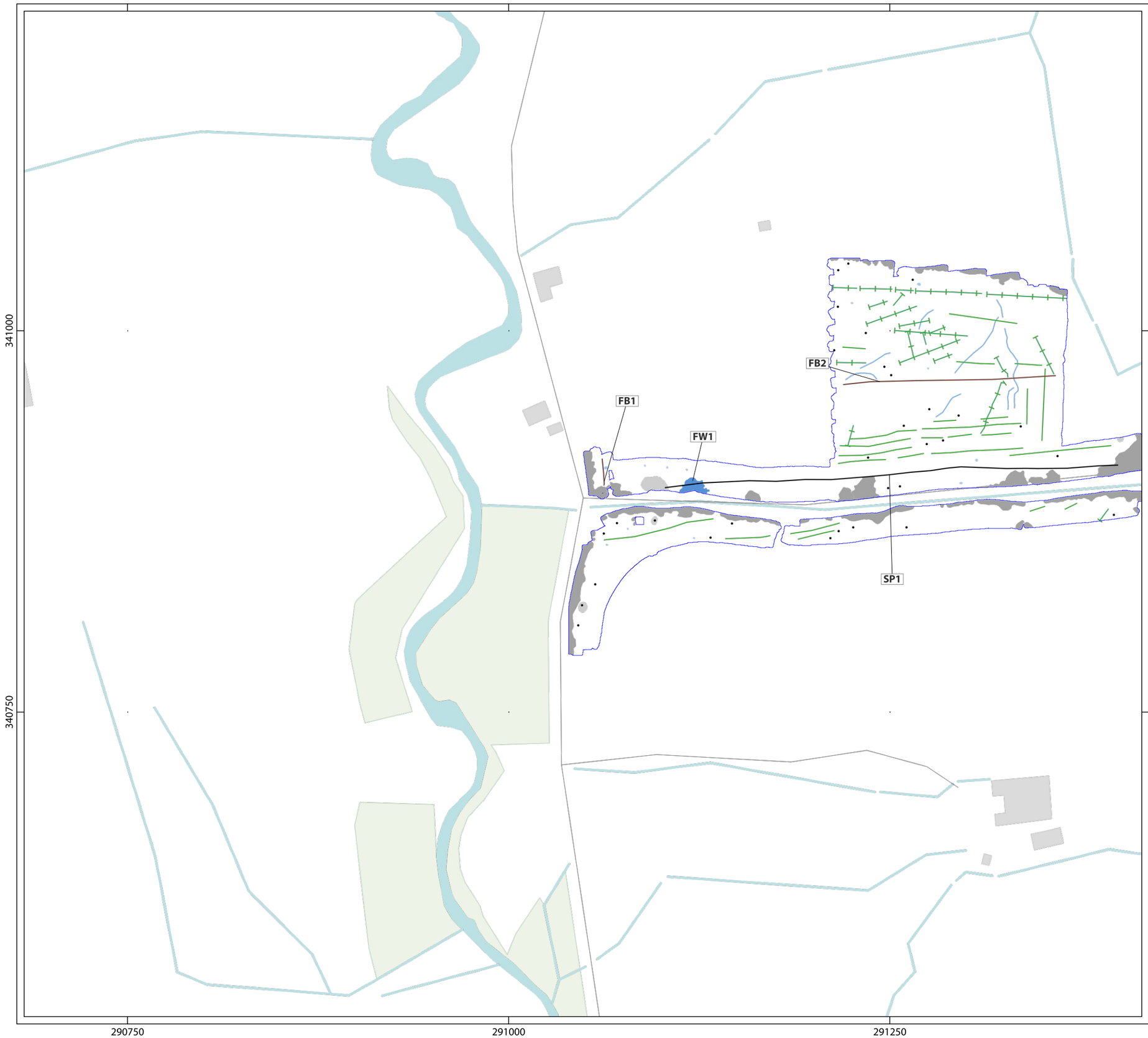
Checked by:	ET
Version:	v1.2
Date:	29/07/2025
Scale:	1:2,500 @ A3

Illus - 10 XY trace plot of minimally processed magnetometer data; Sector 1



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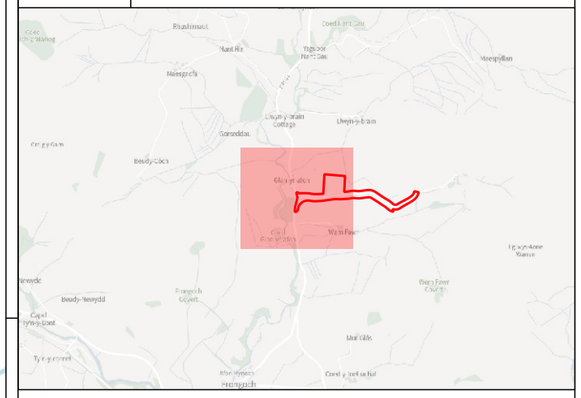

Key

- Survey Extent
- Ferrous Objects
- Agriculture
- Field Boundary
- Field Drain
- Natural
- Service
- Magnetic Disturbance (Above Ground)
- Magnetic Disturbance (Below Ground)
- Natural
- Former Well

	Abbreviation
FB	Former Field Boundary
FW	Former Well
SP	Service Pipe

0 50 100 m

Site:	FFWW24
Created by:	JH
Checked by:	ET
Version:	v1.2
Date:	29/07/2025
Scale:	1:2,500 @ A3

Illus - 11 Interpretation of magnetometer data; Sector 1

341000

340750

291500

291750

292000

N

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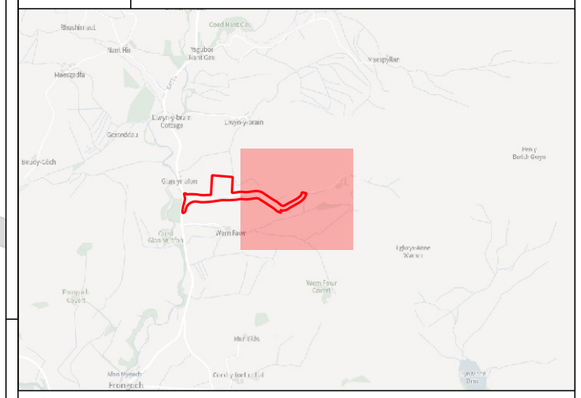


Key

Survey Extent

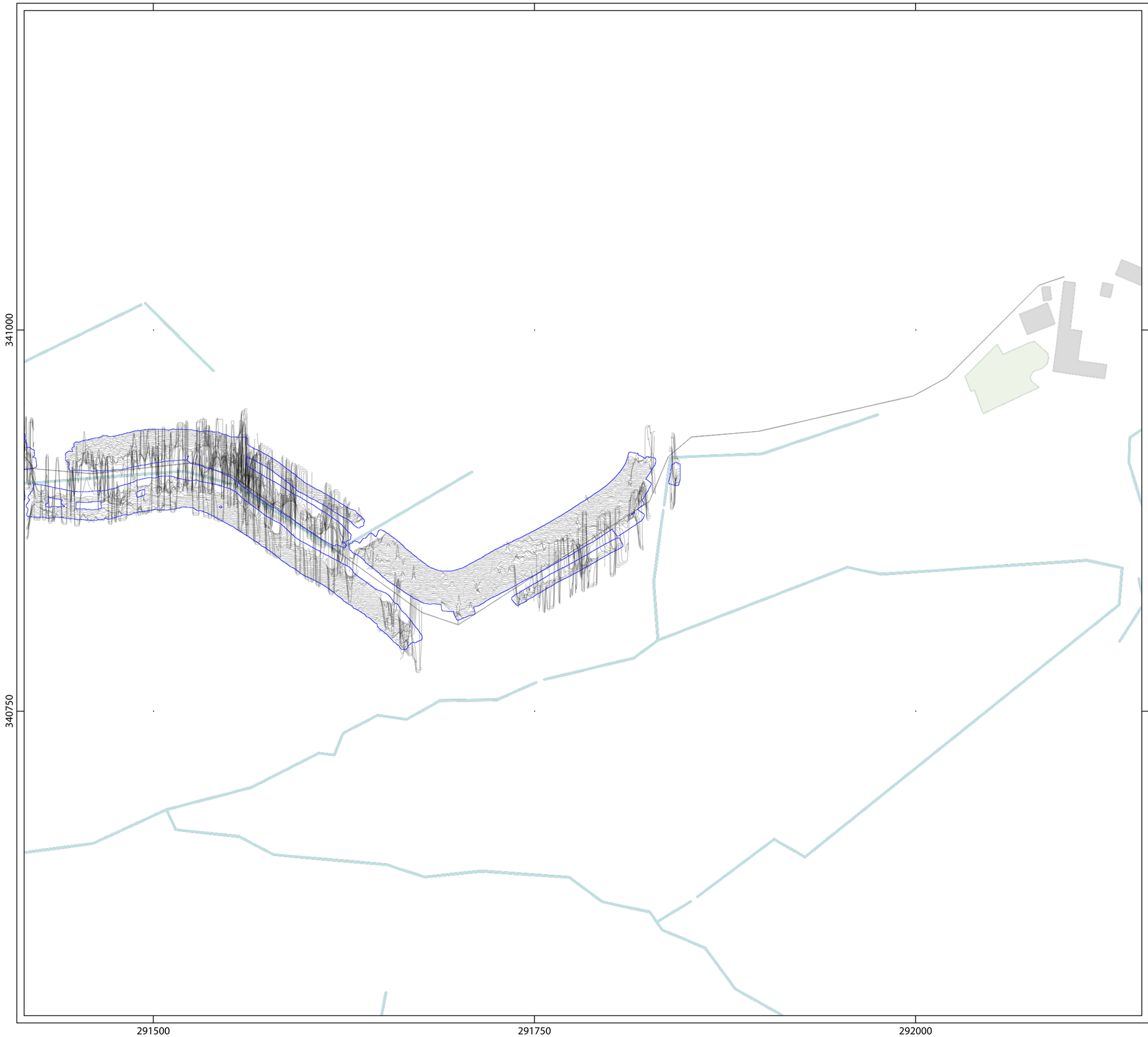
+2nT

-1nT

0 50 100 m

Site:	FFWW24
Created by:	JH
Checked by:	ET
Version:	v1.2
Date:	29/07/2025
Scale:	1:2,500 @ A3

Illus - 12 Processed greyscale magnetometer data; Sector 2



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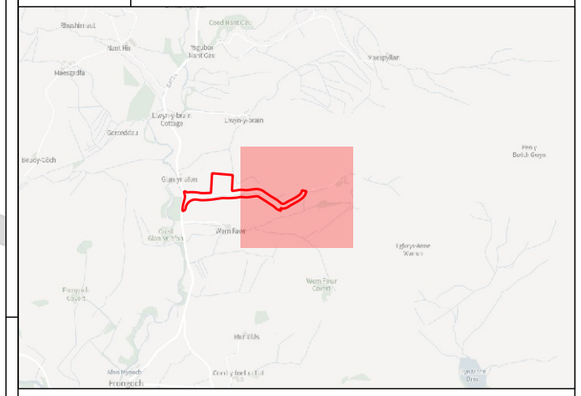


Key

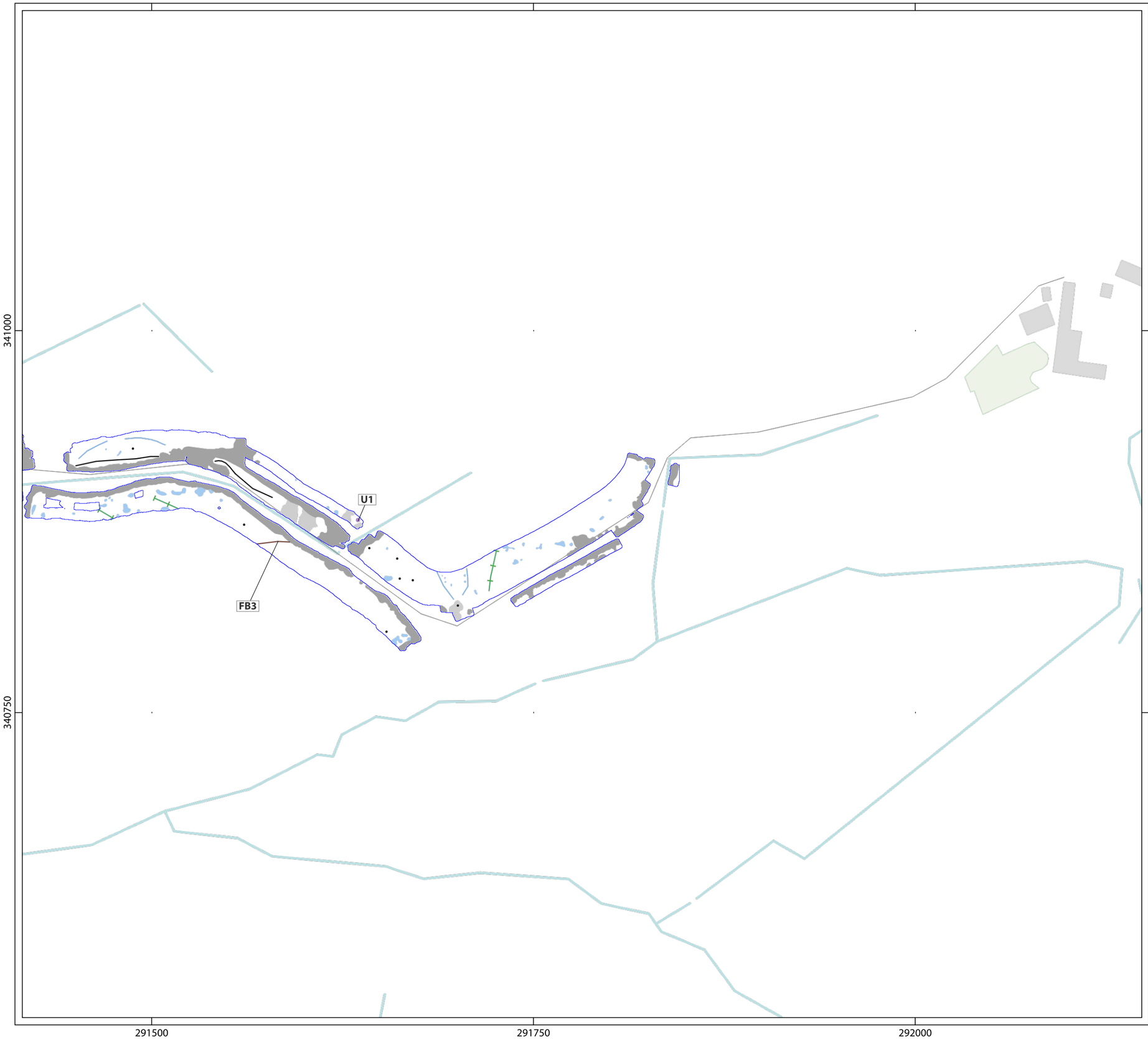
Survey Extent

XY Trace (25nT/cm)

0 50 100 m

Site:	FFWW24
Created by:	JH
Checked by:	ET
Version:	v1.2
Date:	29/07/2025
Scale:	1:2,500 @ A3

Illus - 13 XY trace plot of minimally processed magnetometer data; Sector 2



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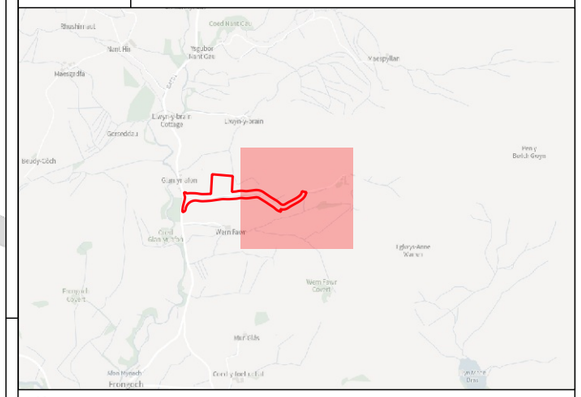

Key

- Survey Extent
- Ferrous Objects
- Field Boundary
- Field Drain
- Natural
- Service
- Magnetic Disturbance (Above Ground)
- Magnetic Disturbance (Below Ground)
- Natural
- Uncertain

	Abbreviation
FB	Former Field Boundary
U	Uncertain

0 50 100 m

Site:	FFWW24
Created by:	JH
Checked by:	ET
Version:	v1.2
Date:	29/07/2025
Scale:	1:2,500 @ A3

Illus - 14 Interpretation of magnetometer data; Sector 2

7 ANNEXES

ANNEX 1 MAGNETOMETER SURVEY

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 haematite. 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 the topsoil, subsoil, and rock, 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.

Types of magnetic anomaly

In most 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 introduced into the topsoil during manuring.

Areas of magnetic disturbanceM 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 and buried pipes can also cause the same disturbed response. A modern origin is usually assumed unless there is other supporting information.

Lightning-induced remnant magnetisation (LIRM) LIRM anomalies are thought to be caused in the near surface soil horizons by the flow of an electrical current associated with lightning strikes. These observed anomalies have a strong bipolar signal which decreases with distance from the spike point and often appear as linear or radial in shape.

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.

ANNEX 2 SURVEY LOCATION INFORMATION

The magnetometer data was collected and is geo-located based on survey grade Real Time Kinetic (RTK) differential Global Positioning System (dGPS) used on both hand-carried and towed systems. The accuracy of this dGPS equipment is better than 0.01m. The GPS systems output in NMEA mode in real time, with a visual guide of survey tracks and any survey area boundaries displayed on a tablet device in view of the survey operator to ensure full coverage. Any survey area boundaries are uploaded as a string of co-ordinates or shapefile to the tablet prior to the commencement of survey.

ANNEX 3 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 project will be archived in-house in accordance with recent good practice guidelines (http://guides.archaeologydataservice.ac.uk/g2gp/Geophysics_3). The data will be stored in an indexed archive and migrated to new formats when necessary.

ANNEX 4 DATA PROCESSING

The gradiometer data has been presented in this report in processed greyscale and minimally processed XY trace plot format.

Data collected using RTK GPS-based methods cannot be produced without minimal processing of the data. The minimally processed data has been interpolated to project the data onto a regular grid and de-striped to correct for slight variations in instrument calibration drift, heading errors and any other artificial data.

The XY data has been clipped to remove extreme values and to improve the interpretability of the data.

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