GEOPHYSICAL SURVEY REPORT

Project

ARCHAEOLOGICAL MAGNETIC GRADIOMETRY SURVEY

Location

Heolddu Solar Farm, Ferryside, Carmarthenshire

Client

Cotswold Archaeology

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Archaeological consultant:	T Young
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Reviewer:	S Hughes
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1.0	Draft	10/12/2024	C Bird	S Hughes	Updated
1.1	Draft	11/12/2024	C Bird/T Young	S Hughes	Archaeological interpretation included
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3.0	Final	09/04/2025	C Bird/T Young	S Hughes	Welsh executive summary added

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1 EXECUTIVE SUMMARY

1.1 This report describes a geophysical survey conducted near Ferryside, Carmarthenshire. The survey was conducted between 18th and 22nd of November 2024.

1.2 The proposed development site (PDS) is being considered for a solar farm, and a geophysical survey is required. A high-resolution magnetic gradiometry survey covering all accessible parts of the survey area is proposed to identify features that may be of archaeological significance.

1.3 The site measures ~87 ha in total and comprises 30 fields. It is a greenfield environment located ~2.5 km East of Ferryside, Carmarthenshire, centred on Ordnance Survey National Grid coordinates (239429,210539). The total surveyable area across the sites was ~ 78 ha.

1.4 Anomalous geophysical features of interest have been digitised and presented as summary archaeological interpretation plots.

1.5 The survey identified anomalies that can be categorised into four main groups:

1.5.1 Geological features:

- Shallow bedrock
- Periglacial 'patterned ground'

Both produce low-amplitude anomalies that could potentially obscure subtle archaeological features.

1.5.2 Modern/post-medieval features:

- Agricultural traces from deep ploughing
- Ceramic land drains
- Removed field boundaries (post-1840s)
- Two backfilled quarries
- Ferrous pipe

1.5.3 Earlier archaeological features:

- Multiple linear ditched boundaries
- Possible holloway track

1.5.4 Unknown age.

- Rectilinear arrangement of ditches (or possibly drains) of unknown purpose

1.5.5 The key findings are numerous linear boundaries and a trackway apparently predating the modern/post-medieval road/field systems.

2 CRYNODEB GWEITHREDOL

2.1 Mae'r adroddiad hwn yn disgrifio arolwg geoffisegol a gynhaliwyd ger Glan-y-fferi, Sir Gaerfyrddin. Cynhaliwyd yr arolwg rhwng y 18fed a 22ain o Dachwedd 2024.

2.2 Mae safle'r datblygiad arfaethedig (SDA) yn cael ei hystyried ar gyfer fferm solar, ac mae angen arolwg geoffisegol. Cynigir arolwg graddiometreg magnetig cydraniad-uchel sy'n cwmpasu pob rhan hygyrch o'r ardal arolwg i adnabod nodweddion a allai fod o arwyddocâd archaeolegol.

2.3 Mae'r safle'n mesur ~87 ha i gyd ac yn cynnwys 30 o gaeau. Mae'n amgylchedd maes glas wedi'i leoli ~2.5 km i'r Dwyrain o Glan-y-fferi, Sir Gaerfyrddin, wedi'i ganoli ar gyfesuriadau Grid Cenedlaethol yr Arolwg Ordnans (239429,210539). Cyfanswm yr ardal a gellir ei harolygu ar draws y safleoedd oedd ~ 78 ha.

2.4 Mae nodweddion geoffisegol anomalus o ddiddordeb wedi'u digideiddio a'u cyflwyno fel plotiau dehongliad archaeolegol cryno.

2.5 Nododd yr arolwg anomaleddau a gellir eu categoreiddio i bedwar prif grŵp:

2.5.1 Nodweddion daearegol:

- Creigwely bas
- 'Tir patrymog' ffinrewlifol

Mae'r ddau yn cynhyrchu anomaleddau osgled-isel a gall guddio nodweddion archaeolegol cynnil bosib.

2.5.2 Nodweddion modern/ôl-ganoloesol:

- Olion amaethyddol o aredi dwfn
- Draeniau tir seramig
- Ffiniau caeau wedi'u diddymu (ôl-1840au)
- Dau chwarel wedi'u llenwi'n ôl
- Pibell fferws

2.5.3 Nodweddion archaeolegol cynharach:

- Llawer o ffiniau ffosyddol llinellol
- Llwybr ‘holloway’ posib

2.5.4 Oedran anhysbys.

- Trefniant petryal o ffosydd (neu draeniau o bosib) o bwrpas anhysbys

2.6 Y canfyddiadau allweddol yw’r ffiniau llinellol niferus a thramwyfa sy'n ymddangos i cynddyddio systemau ffyrdd/caeau modern/ôl-ganoloesol.

3 INTRODUCTION

3.1 This report describes a geophysical survey conducted at land near Ferryside, Carmarthenshire. The survey was undertaken between the 18th and 22nd of November 2024.

3.2 The current proposed development site (PDS) is being considered for solar, and a geophysical survey is required. A high-resolution magnetic gradiometry survey covering all accessible parts of the survey area is proposed to identify features that may be of archaeological significance.

3.3 Site Description

3.3.1 The PDS is a greenfield environment east of Ferryside and is centred on Ordnance Survey National Grid (OSNG) coordinates (239429,210539). The site comprises three clusters of fields (30 fields in total):

- Western area: Centered on Maesmawr Farm, measuring approximately 55 ha
- Northern area: A small cluster of fields measuring approximately 7 ha
- Eastern area: Located in the Glan-Morlais-Uchaf area, measuring approximately 25 ha

3.3.2 The total survey area measures approximately ~87 ha. The land ranges in elevation from ~78 - 127 m AOD, forming part of a landscape of medium to large-sized irregular fields primarily used for improved pasture and livestock grazing. These fields are bounded by well-established hedgerows, frequently incorporating mature trees, which follow boundaries documented since at least the 1840 tithe survey.

3.3.3 Plate 1 shows the site location; Plate 2 shows the extent of the PDS in detail.

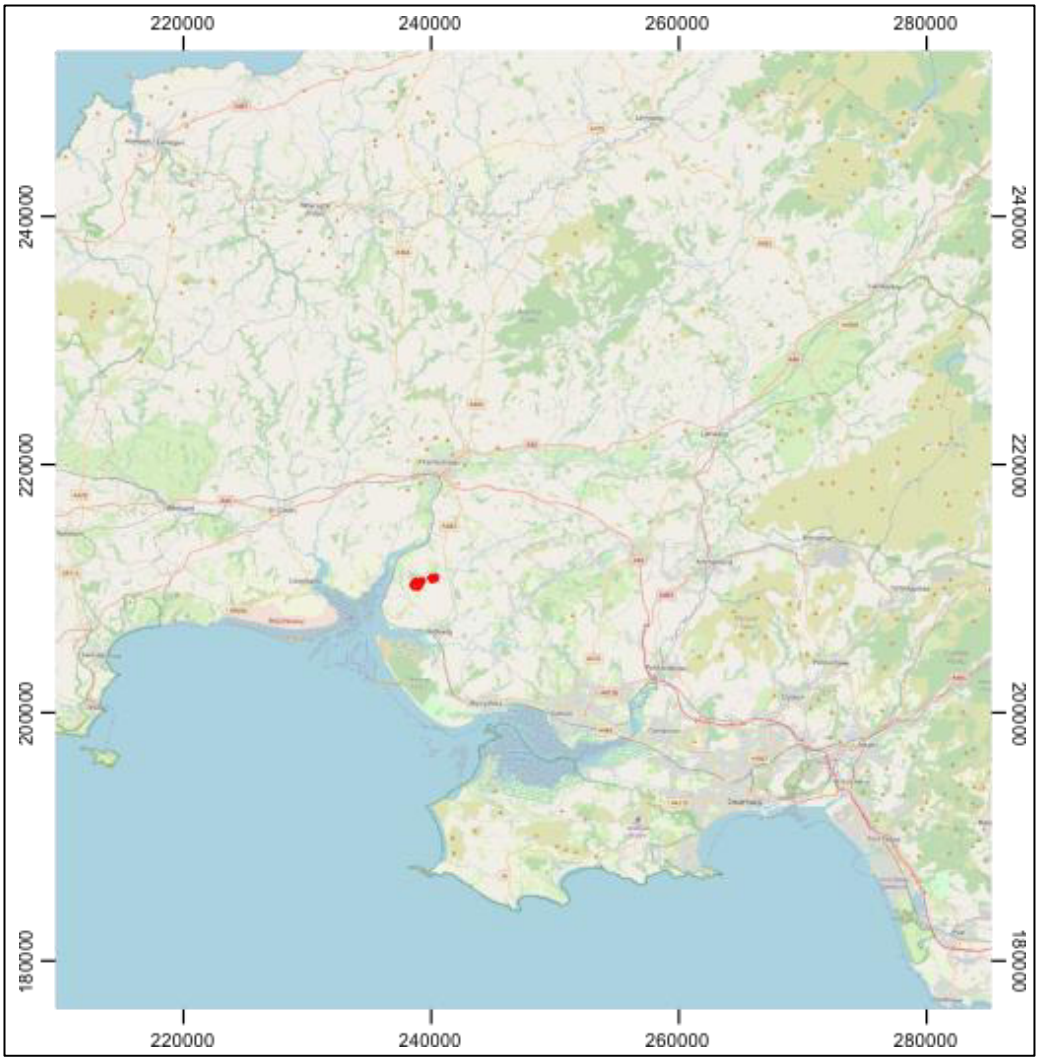

Plate 1: *Site Location.*

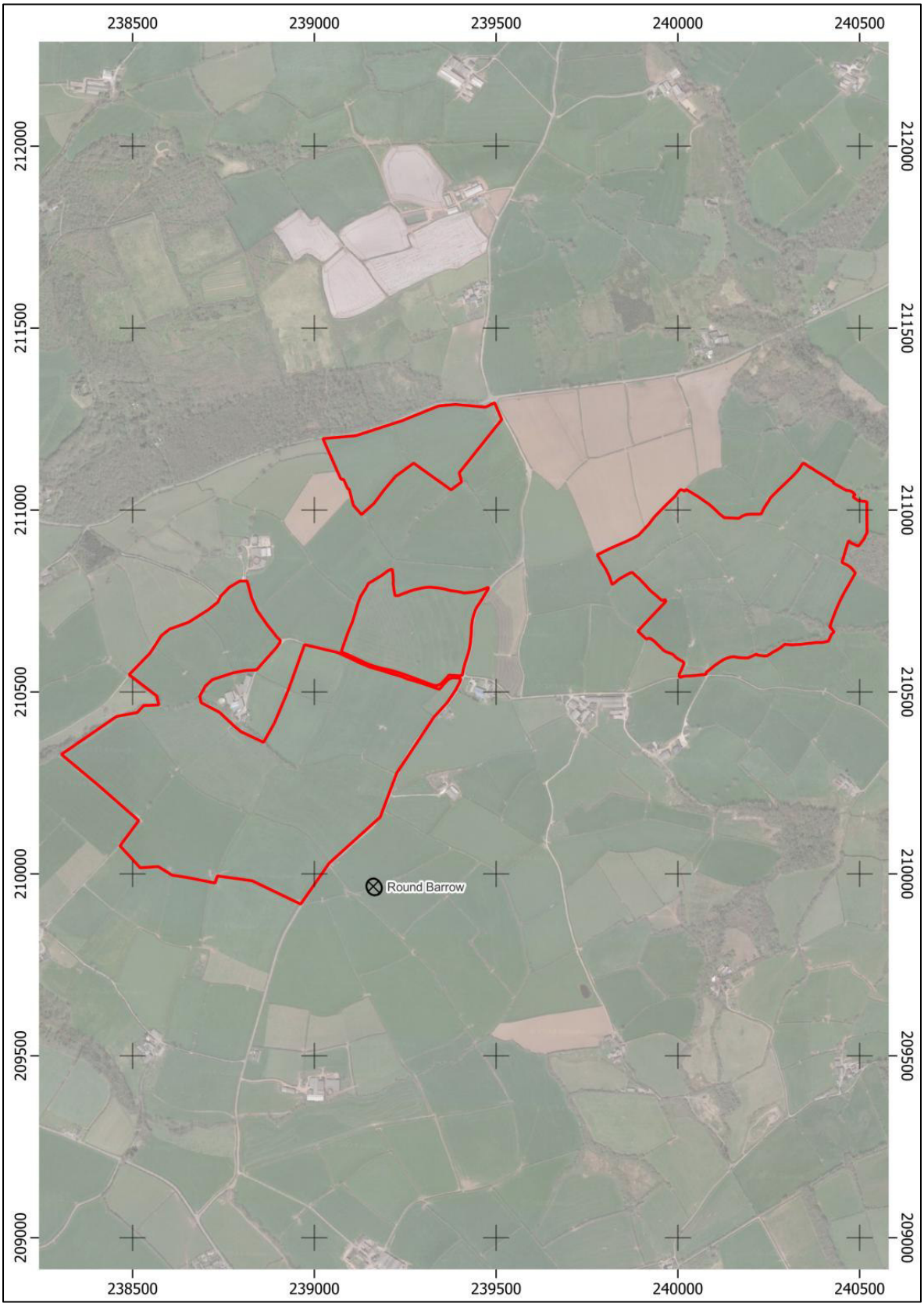

Plate 2: *Detail of the survey area.*

3.4 Geological Setting

3.4.1 Plate 3 shows the bedrock and Quaternary geology of the local area overlain on a DTM produced from the regional LiDAR data.

3.4.2 Bedrock Geology

3.4.2.1 The site's bedrock geology comprises rocks of the Milford Haven Group, dating to the Devonian-Silurian period (approximately 419-393 million years ago). This Group consists predominantly of argillaceous rocks - mudstones and siltstones - with interbedded sequences of subordinate sandstone and conglomerate.

3.4.3 Quaternary Geology

3.4.3.1 The British Geological Survey mapping indicates no significant recorded superficial deposits at the site. However, Till is recorded infilling the shallow valley in the extreme south of the eastern survey area.

3.4.4 Soils

3.4.4.1 The soils at the site are classified within the LandIS system as "freely draining slightly acid loamy soils" (Soilscape 6).

3.4.5 Implications for Magnetic Gradiometry Survey

3.4.5.1 The bedrock geology of the Milford Haven Group, comprising predominantly argillaceous rocks with subordinate sandstone and conglomerates, should, unless very shallow, provide a relatively magnetically 'quiet' background against which archaeological features should be readily detectable.

3.4.5.2 The lack of superficial deposits is advantageous, as there are few glacial or alluvial deposits to mask or interfere with archaeological responses. The freely draining, slightly acid, loamy soils (Soilscape 6) would typically develop strong magnetic enhancement through pedogenic processes, particularly in areas of sustained agricultural activity, creating good magnetic contrast for any cut features.

3.4.5.3 Features such as ditches, pits, and postholes should be readily detectable. However, some factors should be considered:

- Possible geological variations in the sandstone and conglomerate beds might create background magnetic 'noise'
- Enhanced magnetic responses from long-term agricultural activity could potentially mask subtle archaeological features.

3.4.6 Topography

3.4.6.1 The survey area demonstrates varied topographic characteristics across its three distinct zones (western, northern, and eastern), all forming part of the broader eastern slopes of the Tywi Valley.

3.4.6.2 The western area exhibits a gently undulating landscape characterised by a broad, shallow valley system running northwest-southeast through its central portion. Several subtle ridgelines and spurs extend east-west across the fields, with more pronounced slopes along the northern boundary forming natural terraces. The local relief is modest, with gentle transitions between higher and lower ground.

3.4.6.3 In contrast, the northern area is steeper. The eastern portion sits at the highest elevation, with the ground sloping steadily westward. A clear topographic break marks the woodland boundary along the northern edge, while subtle linear features running across the slope suggest historic landscape modification.

3.4.6.4 The eastern area presents the most complex topography of the three zones. It is characterised by a prominent east-west valley system cutting through its southern portion, creating a series of well-defined spurs and ridges. The terrain shows more dramatic elevation changes, particularly around the valley margins, with steeper slopes along the southern boundary. The northern section features gentler, undulating terrain with more subtle variations in gradient.

3.4.6.5 Field boundaries generally respect the natural topography throughout all three areas, particularly evident around the more pronounced landscape features. Subtle evidence of historic landscape modification through agricultural practices is visible across the survey area, manifesting as linear features and slight terracing on slopes.

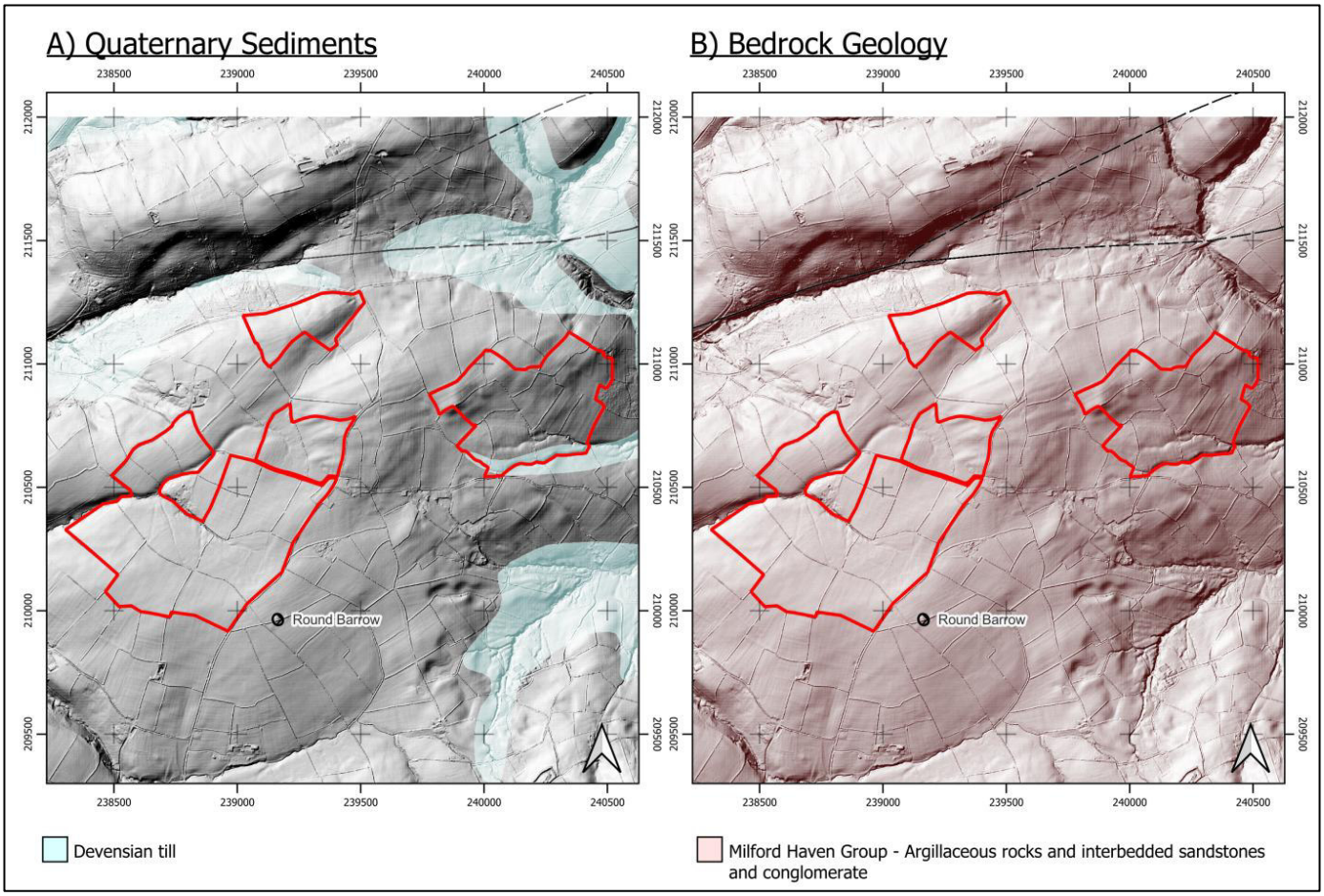

Plate 3: *Superficial geology (left) and solid geology (right) of the site and surrounding area.*

3.5 Administrative and archaeological setting

3.5.1 This assessment provides a general overview of the site's archaeological context to support the geophysical survey results. It is not intended as a detailed desk-based assessment (DBA) of the site's archaeological potential.

3.5.2 The site occupies a favourable topographic position on the eastern slopes of the Tywi Valley, centred at OSNG coordinates (239429, 210539). The immediate landscape demonstrates significant archaeological evidence spanning multiple periods.

3.5.3 The prehistoric period is well-represented through Bronze Age monuments. The scheduled Pen-yr-Heol round barrow (SAM CM190), located approximately 130 m southeast of the western survey area's southeastern corner, is the most significant archaeological monument in the immediate area. This barrow forms part of a broader pattern of Bronze Age monuments recorded in the area. The concentration of funerary and ceremonial monuments indicates settled agricultural communities nearby.

3.5.4 The Roman period has no recorded evidence within 2 km of the site. It lies well beyond the immediate hinterland of Moridunum (Carmarthen, approximately 10 km North), suggesting limited Roman activity in this area.

3.5.5 Early medieval activity is poorly attested in the immediate area, though the site falls within the early medieval kingdom of Seisyllwg, later Deheubarth. Medieval finds and features are limited, primarily relating to agricultural activities. While no settlement evidence is recorded, documented ecclesiastical landholdings in the vicinity suggest organised agrarian exploitation.

3.5.6 The post-medieval and modern landscape is characterised by remarkable stability. Cartographic regression from the 1840 tithe map through successive OS editions demonstrates consistent field boundaries and agricultural use, suggesting minimal ground disturbance during this period. The western survey area lies within the Tywi Valley Registered Landscape of Historic Interest, with the eastern survey area just outside its boundary.

3.6 Survey objectives

3.6.1 The primary objective of the geophysical survey is to locate and describe any detectable archaeological features present. The survey will provide context and insight as a standalone document and facilitate any subsequent fieldwork phase by indicating the detected features' location, character, extent, and potential significance.

3.6.2 The geophysical survey results will inform any subsequent archaeological assessment and, ultimately, the design layout. Therefore, it is being conducted before the other archaeological evaluations.

3.7 Quality control

3.7.1 TerraDat (UK) Ltd follows industry best practices in archaeology and geophysics. All work complies with British Standard 5930:2015 for site investigations, the Chartered Institute for Archaeologists' Standards and Guidance for Archaeological Geophysical Survey (2014), and Europae Archaeologiae Consilium Guidelines for Geophysics in Archaeology (2016). Data collection adheres to both manufacturer specifications and TerraDat's standard operating procedures

3.7.2 On completion of the survey, the data were downloaded from the survey instrument onto a computer and backed up appropriately. The acquired data set was initially checked for errors that may be caused by instrument noise, low batteries, positional discrepancies, etc., and any field notes were either written up or incorporated in the initial data processing stage. The data set was then processed using standard processing routines. Once processed, the resulting plots are subject to peer review to ensure the integrity of the interpretation. Our quality control standards are BS EN ISO 9001:2015 certified.

4 SURVEY DESCRIPTION

4.1 The survey was conducted using magnetic gradiometry. The results are presented as interpreted data plans indicating identified anomalous features' location and physical characteristics and a text description.

4.2

4.3 Topographic survey/grid layout

4.3.1 The *SENSYS MAGNETO MXV3* data acquisition is controlled by proprietary software *MONMX,* which provides a real-time graphical display of ground coverage based on the RTK GPS positioning system mounted on the trailer. Survey traverses are acquired to provide as little overlap between traverses as possible while minimising any gaps between the traverses. Survey traverses are driven as straight as is reasonably practicable until the entire field is covered, after which 'headland' files are acquired at the field edges to ensure maximum coverage.

4.4 Magnetic survey

4.4.1 Magnetic surveys are designed to exploit the subtle deviation in the Earth's magnetic field caused by variable magnetic properties in the subsurface of objects/materials. These properties include ferromagnetism, remanent magnetism, and magnetic susceptibility. In an archaeological setting, these tend to be buried ferrous objects, burnt materials, or the disturbance or accumulation of naturally occurring ferrous minerals within the soil. The recorded data value is the magnetic gradient (the difference in the magnetic field strength recorded by two vertically separated fluxgate magnetometers).

4.4.2 A plan image showing the variation in the magnetic gradient of the site survey area is produced. Based on the recorded magnetic variation, it is possible to identify buried archaeological features such as walls, hearths, kilns, ditches, and pits.

4.4.3 Magnetic survey - field activity

4.4.3.1 The magnetic gradiometry data were acquired using a multi-sensor array (8 fluxgate gradiometer probes installed at 0.5 m sensor separation) mounted on a specialist modular (*Sensys Magneto MXV3*; Plate 3). Network-corrected RTK GPS provides real-time GPS positioning. The trailer is towed across the survey area behind an ATV (Plate 4) at speeds of <15 km/h. This system allows for the acquisition of 0.5 m horizontal resolution gradiometry data within a 3.5 m wide swathe. The data were acquired at a rate of 200Hz, nominally providing data at 0.025 m intervals along each traverse. This approach enhances resolution (double that of a conventional hand-held instrument in both x and y directions) and acquisition rate; However, a trade-off can be a poorer signal-to-noise ratio.

Plate 4: *John Deer Gator and Sensys Magneto MXV3 (Library photo).*

4.4.4 Magnetic survey - data processing

4.4.4.1 The gradiometry data were acquired using *SENSYS* proprietary software *MONMX*, which produces a data file for each acquired survey line. These files are compiled in *DLMGPS*, which associates each gradiometry data point with a GPS coordinate, calculated based on the location of each sensor within the array, thus creating a single swathe of gradiometry data up to 3.5 m wide. The software applies a constant median filter to normalise the data within each swathe; the data are then exported as raw ASCII files.

4.4.4.2 The ASCII files output from *DLMGPS* were further processed using TerraDat proprietary software *MultiMag* (Plate 5) to remove any poor-quality data (sensor drop-outs/data spikes, etc/overlapping data.) and apply 50 Hz and rolling median filters. The 50 Hz filter removes artefacts principally associated with electrical power lines, while the median filter equalises the background data across the swathes within a dataset, removing any apparent striping between them. Plate 6 shows an example of raw data

alongside filtered data. Table 1 details the processing steps that are applied to the ASCII data.

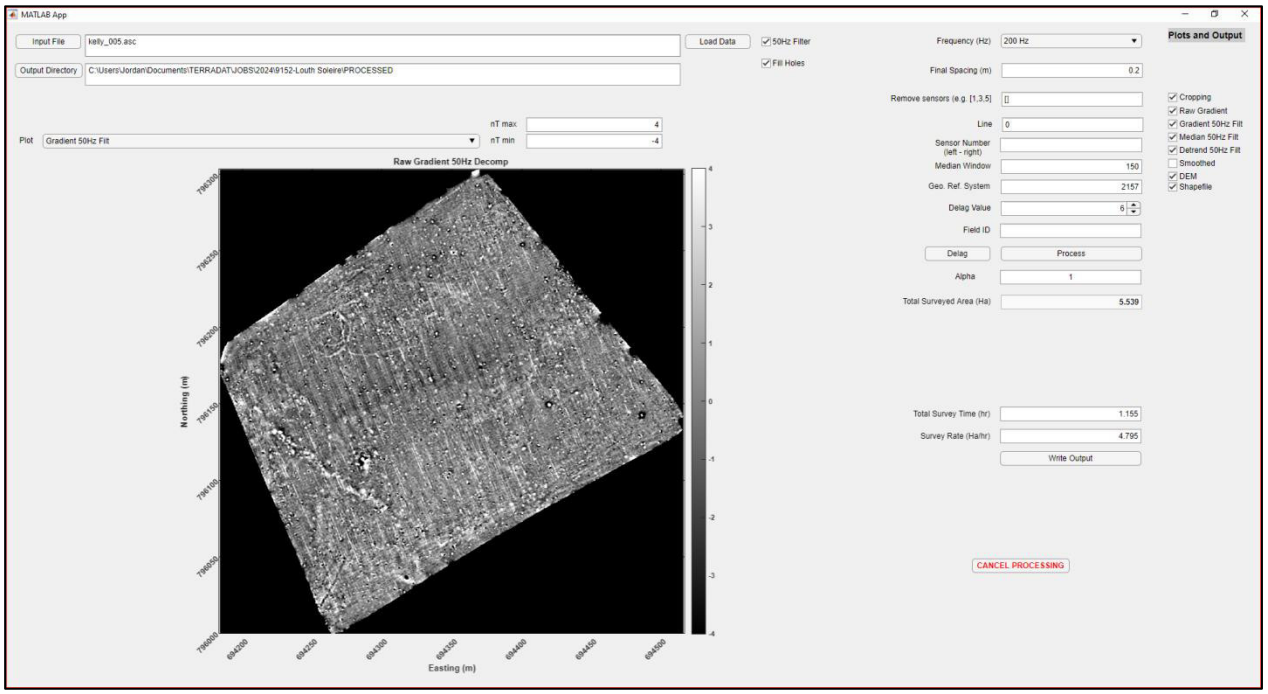

Plate 5: *TerraDat proprietary software MultiMag*

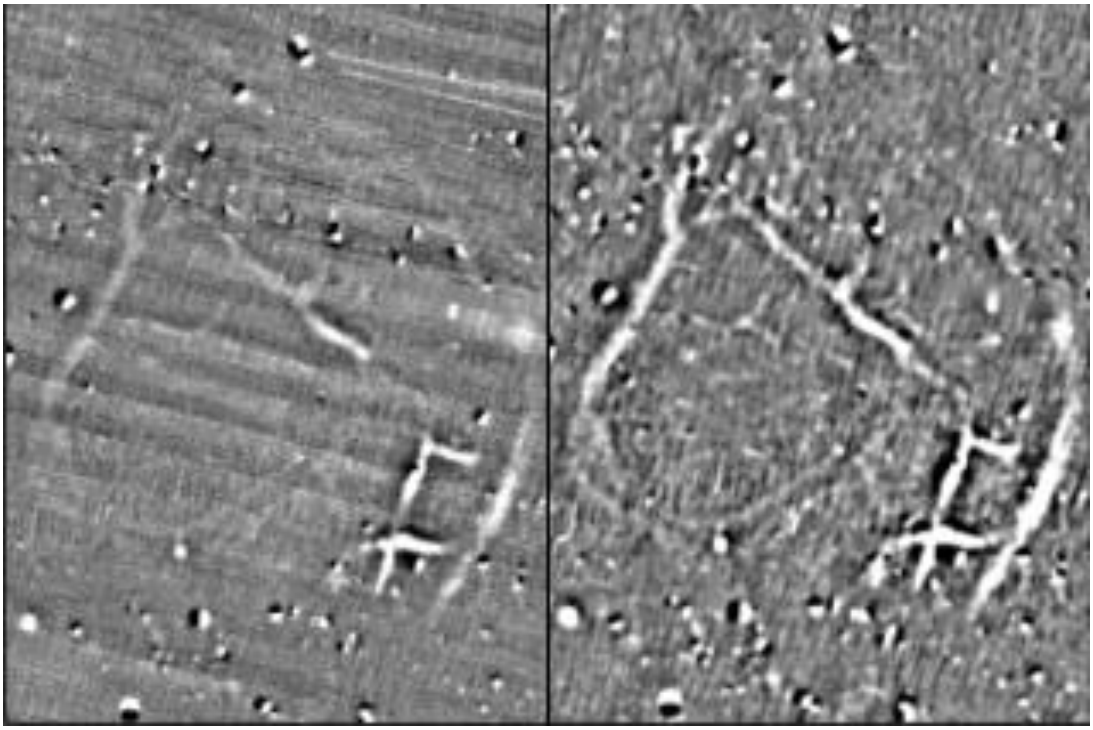

Plate 6: *Raw data (left) and filtered data (right)*

Processing Step	Description

Raw data input	Raw data (.asc) file is imported, and X,Y,Z,gradient,Time_stamp,sensor columns are retained. All other columns are removed.
Truncate Time_Stamp	Alphanumeric Time_stamp variable is truncated to the last digits (e.g. L1_20221007-095821_GZ.prm becomes 95821) to create unique IDs for each line.
Create line_number	Variable 'line_number' (i.e. 1 to #lines) is created by identifying all unique 'Time_stamp' values.
Rolling median	The median filter is calculated per line, per sensor, on values within -/+20nT and removed from the gradient to create a new 'GM' column. The rolling median filter has a window length of 400 data points centred on the input value. Therefore, the first and last 200 data points do not have sufficient information to calculate the median. In these cases, the first value calculated is applied back to the start of the line, and the last value calculated is filled forward to the end of the line. In practical terms, the median window length is equivalent to 10m of data acquisition.
Filter 50Hz Noise	50Hz noise from electrical utilities is removed through wavelet analysis, signal decomposition, and a 50Hz Bandstop filter. Both methods yield similar results. Multiple combinations of Median and 50Hz filters are created (i.e. G50, G50M, G50BS and G50BSM) for comparison.
Calculate Mean Spacing	Mean along-track spacing is calculated.
Thin data	Data are thinned to specified output resolution using the calculated mean spacing
Crop overlapping data	Calculate bounding polygons around each line of data. Remove data located within reverse-ordered overlapping polygons.
Display Data	Plot thinned data and cropped areas, plot 50Hz filtered data, plot median filtered data.
Write output file	Write output file containing thinned data with X,Y,Z, gradient,Time_stamp,sensor,Gm,G50,G50M,linenum,G50BS,G50BSM.
Write output GPS	Write output X,Y,Z gps file using centre (actual GPS) data.

***Table 1**: Processing steps applied to the raw magnetic gradiometry data.*

4.4.4.3 The magnetic gradiometry data is output as raw and filtered 'XYZ' files in .CSV format. The height data from the GPS is also output as an approximately 3 m x 0.125 m

resolution DTM of the Site. These files are gridded in Oasis Montaj, using minimum curvature gridding and a grid cell size of 0.125 m. Once the data is gridded and an appropriate colour scale applied, the data is exported as high-resolution GeoTiff images (900 DPI) before being imported into the open-source GIS software qGIS. Features of interest are then digitised to produce summary archaeological interpretation plans. These are integrated with the DTM to allow consideration of any identified archaeological features within the site's topography. Final figures are created in CorelDraw.

5 RESULTS AND DISCUSSION

5.1 The final processed data quality is good. There is an issue with the persistence of subtle 'tank-tracking' (narrow longitudinal oscillations in background values between +/-1 nT) due to the slight bobbing motion of the cart and a few holes/gaps in the data where adjacent traverses have not overlapped correctly or due to obstructions/poor site conditions, specifically the presence of significantly wet or soft ground. These inaccessible areas represent a minor percentage of the overall survey area.

5.2 The data are presented as a series of grey-scaled plots exhibiting variations in the intensity of the magnetic gradient across the survey area. Both raw and processed magnetic data are used for the archaeological interpretation; therefore, both data types are presented in the figures. The figures are presented at a scale of (1:5000) for the western and northern fields and a smaller scale of (1:3000) for the eastern fields.

5.3 Anomalous geophysical features of interest have been digitised and presented as summary interpretation plots; Plate 7 presents a key to be used in conjunction with these plots. A table with descriptions of interpretive features is provided in the appendix.

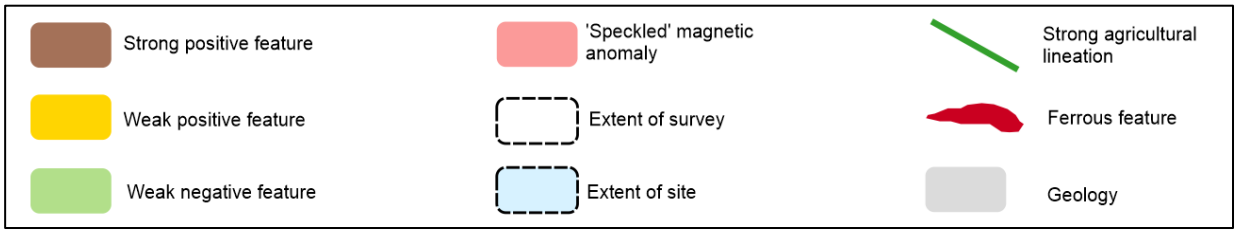

***Plate 7**: Key to be used in conjunction with the interpretive plots*

5.4 Magnetic gradiometry

5.4.1 Magnetic gradiometry (measurement of the vertical gradient of the Earth's magnetic field, using two sensors, one positioned above the other typically at 1.0 m separation) developed from magnetometry (measurement of the Earth's magnetic field strength, using a single sensor) to free magnetic surveys from the constraint of requiring base-station measurements to compensate for diurnal variation in field strength.

5.4.2 The identified magnetic anomalies (i.e. areas with a magnetic gradient that deviates from that of the typical site background) may be due to the influence of one of three main magnetic properties: ferromagnetism (that exhibited by a magnetic object of ferrous metal), remanent magnetism (a permanent sympathetic magnetic field acquired during the cooling of a hot object, commonly seen in both fixed archaeological features such as hearths, as well as portable materials, (such as ceramic building material [CBM]) and most importantly of all, magnetic susceptibility ([MS], a measure of the temporary

sympathetic magnetic field generated by a body in an ambient field). Typically, weathering elevates the magnetic susceptibility, so soils have a higher MS than their parent rock. Anthropogenic processes (particularly heating) may also enhance MS. Thus, the fills of archaeological cut features typically show a higher magnetic susceptibility than the substrate into which they are cut (and thus appear as positive anomalies). There are exceptions to this sense of susceptibility contrast – for instance, where a cut feature is filled by stone with low magnetic susceptibility. For structures built of stone, there is typically a stronger contrast between the lower MS stonework and higher MS occupation deposits (meaning that stone walls, drains, etc., usually show negative magnetic anomalies).

5.4.3 Ferrous materials will usually strongly influence the magnetic gradient but of a limited spatial extent. These anomalies typically show strong negative and positive components (so a small iron object appears as a black/white dot on the plots). Accumulations of iron objects may generate a speckled appearance – typical, for instance, of the sites of former wire fences. The remanent magnetic fields of CBM may also produce speckled textures – brick rubble will appear similar to a spread of ferrous debris but with lower magnitude 'spikes'.

6 GEOPHYSICAL INTERPRETATION

6.1 Anomalies associated with the geological setting

6.1.1 The bedrock lies close to the surface across much of the survey area, with the bedding of the geology imaged by the magnetic gradiometry in many places. As discussed in section 2.4, the bedrock is provided by rocks of the Milford Haven Group. Surveys in other areas of the outcrop of this lithology (e.g. near Pembroke Dock and Jordanstown) have also noted the detailed imaging of the bedrock structure.

6.1.2 In other parts of the area, the rockhead and superficial deposits have been modified by periglacial processes, resulting in the formation of 'patterned ground' of a somewhat variable nature. Again, very similar structures were recorded during a survey at Jordanstown.

6.1.3 Both these groups of geological features form very low amplitude positive linear magnetic anomalies. This pervasive and variable background means that small archaeological features could produce anomalies that might not be capable of certain discrimination.

6.2 Anomalies associated with modern and post-medieval agriculture

6.2.1 The dominant pastoral land use has resulted in relatively little fine-scale magnetic featuring. A few areas show a strong agricultural lineation, likely associated with deep ploughing as part of land improvement rather than arable cultivation. Since the land will have received little manuring, there is only a very light scatter of ferrous debris across most of the survey area.

6.2.2 A small proportion of the area shows evidence of ceramic land drains (in areas SE and SW of Maesmawr and along the eastern margin of the southern sector).

6.2.3 The post-medieval system of land division in the survey area commonly entailed smaller fields than those surviving. The geophysical data include evidence for boundaries removed since the 1st Edition OS (published in the 1880s) and other examples removed after the Tithe Map (c. 1840) and before the 1st Edition OS. Figure 9 highlights these removed boundaries; they are variously marked by slight positive or negative anomalies (where the boundary was a simple fence, wall or ditch), by paired positive anomalies approximately 3 m apart with a negative anomaly between (where small ditches flanked a hedge or wall) or, in one instance, by an array of point ferrous-type anomalies (where the boundary was formed by metal fencing).

6.2.4 As well as geophysical anomalies corresponding to the location of boundaries removed since the early cartography, some anomalies appear to form part of the same system but are not recorded on any cartography. Most of these are probably boundaries that

were removed before 1840, but it is also possible that some may have been created and destroyed between revisions of the cartography. Figure 10 shows the extent of these boundaries.

6.2.5 The age of the origin of the field system remains uncertain. It may be significant that the element 'Park' is found within the names of almost all the fields in the survey area in the Tithe Apportionment (c. 1840). In most areas of Wales, this element would suggest that the field was formed by enclosing part of a pre-existing park (in the sense of enclosed open land, often containing deer). Here, the name is so common as to suggest it is associated simply with the act of enclosure – and the ubiquity of the unusual name element may indicate that there was a restricted phase of enclosure.

6.2.6 Other features of the post-medieval landscape include two backfilled quarries, 20 m to 30 m across (centred upon [239455, 210764] and [239352, 210572]) (***1, 2***), an area of made-ground (to the N of Maesmawr) and a ferrous pipe (probably a steel water pipe) close to the S margin of the survey area (running from [238613, 210005] to [238726, 209988]) (***3***).

6.3 Anomalies associated with earlier archaeological features

6.3.1 Several linear positive magnetic anomalies, suggestive of ditches, are cross-cut by the post-medieval field system described above (their significance is discussed in section 5.4.).

6.3.2 A linear positive anomaly (***a***), approximately 2m wide and slightly curvilinear, runs sub-parallel to and West of the modern lane from [238914, 209941]. At [239193, 210201], it merges with an existing field boundary north of Mynydd-Uchaf to the East. This boundary, which marked the northern extent of the Mynydd-Uchaf property in 1840, continues East to meet a former minor lane (now removed) at [239604, 210342] - the same point where the Parish boundary intersects from the East. This feature likely predates the modern roads and later field systems that cross-cut it.

6.3.3 Similar to anomaly (***a***), anomaly (***b***) does not conform to modern roads or field systems. Running from [239213, 211085] to [239310, 211255], it is truncated to its North by the line of the existing road, though a field boundary continues on the same line to the N of the road (at least in the 1880s; the boundary between the road and stream is not depicted on the Tithe Map). This anomaly varies from 2.5 m to 4 m in width and is locally of high amplitude.

6.3.4 To the West of anomaly (***a***), there are three further extensive, sub-N-S oriented linear magnetic anomalies (***c***,***d*** and ***e***), all cross-cut by the later field system.

6.3.5 Anomaly (***c***) runs from the southern boundary of the survey area (at [238810, 209991]) to a point SE of Maesmawr ([238811, 210335]), where its orientation is very similar to a modern field boundary, possibly the line of its continuation, to the North. This variable anomaly typically comprises a central negative anomaly, 3 m - 4 m wide, flanked by irregular positive anomalies.

6.3.6 Anomaly (***d***) runs from the point where anomaly (***c***) reached the S margin of the survey area (at [238810, 209991]), passing NNW to a point just NW of Maesmawr ([238676, 210448]) and possibly extends even further to the N of the stream (an anomaly runs from [238680, 210529] to [238671, 210592] where it turns westwards towards [238583, 210609]). As this anomaly passes to the S of Maesmawr, it shows multiple narrower positive linear anomalies close to its line, particularly to its S. In this area, the main central component of the anomaly is positive and 3.5 m in width. Comparison with the LiDAR data shows that this anomaly runs in a slight hollow. The multiple parallel anomalies and the hollow both suggest that the anomaly either represents a ditched boundary with a trackway on its southern side or, much more likely, the main anomaly represents the holloway track.

6.3.7 Anomaly (***e***) runs almost parallel to anomaly (***c***) but approximately 230 m to its W. It runs from [238578, 210021] in the south and reaches the stream west of Maesmwr at the same point as anomaly (***d***) ([238676, 210448]). The two anomalies have a similar nature and width and merge in a neat 'Y'-like shape. Towards the southern half of their length, anomalies (***d***) and (***e***) become simple, narrow, low-amplitude positive anomalies. Approximately 140 m from the S tip of anomaly (***d***) (at [238591, 210155]), a similar perpendicular anomaly extends for some 90 m to the West to [238496, 210162], suggesting additional land division (fields?) in this western area.

6.3.8 Within the northern sector of the survey area, there are several potentially early features besides anomaly (***b***).

6.3.9 In the northern sector of the survey area, a broad, very low amplitude, positive, curvilinear magnetic anomaly running from [239298, 211115] in the West to [239450, 211188] (***f***) in the East may be a slight lynchet. However, no topographic expression is visible within the LiDAR data.

6.3.10 Two straight, narrow, linear positive magnetic anomalies lie west of anomaly (***b***). The first (***g***) runs from [239200, 211074] to [239089, 211085], but its relationship with anomaly (***b***) is not seen. The second (***h***) starts from anomaly (***b***) at [239213, 211095], running north-westwards to [239164, 211114].

6.3.11 A positive linear anomaly (***i***) to the E of Anomaly (***b***) running from [239462, 211216] to [239389, 211196] is somewhat diffuse and is less certainly of archaeological origin – it may be geological.

6.3.12 In the eastern sector of the survey area, only a single anomaly might be an early archaeological feature (***j***). It is a low amplitude positive magnetic anomaly that runs irregularly between [240327, 210804] and [240367, 210845].

6.3.13 In the southwest of the study area, two positive linear magnetic anomalies do not clearly relate to the other 'early' features in the area but are cross-cut by boundaries apparently related to the modern field system.

6.3.14 The first is a narrow (0.5 m wide) positive anomaly, interpretable as a ditch or drain (***k***) that defines three sides of a rectangle (25 m x 42 m) open to the SE. The anomaly starts from [238402, 210250], runs NW to [238393, 210275], then NE to [238437, 210286] and finally SE to [238443, 210261].

6.3.15 To the S of this feature, and sharing the same NW-SE alignment, is a strong linear positive magnetic anomaly (***l***), 1.3 m in width, running W from [238519, 210246] to pass out of the survey area at [238427, 210223], also interpretable as a ditch or drain.

6.4 Discussion

6.4.1 The long, ditched boundaries and associated trackway(s) present the most significant archaeological features in the survey. The evidence for at least one being, or being accompanied by, a trackway quite distinct from modern routes, together with the cross-cutting nature of the modern roads, suggests that they may relate to early landscape development, predating the establishment of the modern roads and field systems.

6.4.2 Long, parallel ditched boundaries are commonly associated with prehistoric (particularly Bronze Age) systems of landscape division, but, in this case, the possible relationship with the location of the Parish boundary perhaps suggests that they are unlikely to be pre-medieval.

6.4.3 The prevalence of the 'Park' field name element across a wide area makes it unlikely that these fields were all enclosed from a medieval park, but they do suggest that there may have been a single phase of enclosure (or just possibly of the naming of enclosures) during which this element was employed – perhaps, in turn, suggesting a widespread unenclosed landscape before this period.

6.4.4 The rectilinear anomaly (***k***) is of uncertain age and purpose.

6.4.5 Figure 9 presents a composite of all anomalies thought to be associated with the current, post-medieval field system. Figure 10 highlights those geophyscial amonalies that are thought to predate the modern/post-medieval field system.

Disclaimer

This report represents an opinionated interpretation of the geophysical data. It is intended to guide follow-up invasive investigation. Features that do not produce measurable geophysical anomalies or are hidden by other features may remain undetected. Geophysical surveys complement invasive/destructive methods and provide a tool for investigating the subsurface; they do not produce data that can be taken to represent all of the ground conditions found within the surveyed area. Areas that have not been surveyed due to obstructed access or any other reason are excluded from the interpretation.

Appendices

7 Appendix A: Glossary

7.1 Survey Methodology

- **Archaeological Magnetic Gradiometry**: A geophysical survey technique measuring variations in the Earth's magnetic field to detect buried archaeological features
- **Fluxgate Gradiometer**: Device used to measure magnetic field gradients
- **Magnetic Gradient**: Change in magnetic field strength between two points
- **Data Acquisition**: Process of collecting geophysical measurements
- **Grid Layout**: Systematic arrangement of survey areas
- **Survey Traverse**: Path followed during data collection
- **nT (nanoTesla)**: Unit of magnetic field strength
- **Resolution**: Level of detail in survey data
- **RTK (Real-Time Kinematic)**: High-precision satellite navigation technique
- **Network-corrected RTK GPS**: High-precision GPS system with real-time corrections
- **Minimum Curvature Gridding**: Mathematical method for interpolating data points
- **Signal-to-noise Ratio**: Measure of desired signal strength compared to background noise
- **Tank-tracking**: Pattern of parallel linear anomalies caused by survey vehicle
- **Wavelet Analysis**: Mathematical method for processing survey data

7.2 Anomaly Types

- **Anomaly**: A deviation from the expected or background reading in geophysical data
- **Background Signal**: The typical or average geophysical reading for an area
- **Positive Anomaly**: Reading higher than background values
- **Negative Anomaly**: Reading lower than background values
- **Ferrous Anomaly**: Strong dipolar signal typically caused by iron objects
- **Linear Anomaly**: Elongated signal pattern, often indicating ditches, walls, or other linear features
- **Discrete Anomaly**: Isolated signal, commonly indicating pits, postholes, or individual objects

7.3 Magnetic Properties

- **Ferromagnetism**: Strong form of magnetism associated with iron and similar materials
- **Remanent Magnetism**: Permanent magnetisation remaining in materials after external field removal
- **Magnetic Susceptibility**: Measure of how magnetisable a material is

- **Thermoremanent Magnetism**: Magnetic properties acquired when materials cool below Curie temperature

7.4 Archaeological Features

- **Cut Feature**: An archaeological feature that has been dug into the ground, such as a ditch or pit
- **Lynchet**: A bank of earth that builds up on the downslope of a field plowed over a long period
- **Holloway**: A sunken lane or track, created by erosion from repeated use
- **Periglacial 'Patterned Ground'**: Distinct ground patterns formed in areas affected by repeated freezing and thawing

7.5 Geological Terms

- **Bedrock**: Solid rock beneath surface materials
- **Superficial Deposits**: Geological materials lying on bedrock
- **Alluvial Deposits**: Sediments deposited by flowing water
- **Till**: Unsorted glacial sediment
- **Lithology**: Physical characteristics of rocks
- **Argillaceous Rocks**: Clay-bearing rocks such as mudstone and siltstone
- **Quaternary**: The most recent geological period covering approximately the last 2.6 million years

7.6 Landscape Features

- **Field Boundary**: Physical division between different areas of land
- **Tithe Map**: Historic maps from around 1840 showing land ownership for taxation purposes
- **DTM (Digital Terrain Model)**: Digital representation of ground surface topography
- **LiDAR**: Light Detection and Ranging; remote sensing method using laser light
- **AOD**: Above Ordnance Datum (height above sea level)

7.7 Dating Terminology

- **Bronze Age**: Archaeological period (circa 2500-800 BCE in Britain)
- **Medieval**: Historical period (circa 1066-1500 CE in Britain)
- **Post-medieval**: Historical period after 1500 CE
- **Modern**: Generally referring to the 19th century onwards

7.8 Technical References

- **OSNG**: Ordnance Survey National Grid coordinates
- **BS EN ISO 9001:2015**: International standard for quality management systems
- **DBA**: Desk-Based Assessment

7.9 Data Processing Terms

- **Raw Data**: Unprocessed survey measurements
- **Data Processing**: Methods used to clean and enhance raw survey data
- **Filtering**: Techniques to remove unwanted signals or enhance specific aspects of data
- **GIS (Geographic Information System)**: Software for analysing spatial data
- **Interpretive Plot**: Visual representation of processed survey data

8 Appendix B: Feature Description Table

Feature Type	Symbol Description	Archaeological Interpretation
MAGNETIC SIGNATURES		
Strong positive feature	Brown fill	Typically indicates thermoremanent features (hearths, kilns, furnaces), filled pits with organic/burnt material
Weak positive feature	Yellow fill	Often represents shallow cut features (ditches, pits, postholes), ploughed-out archaeological deposits
Weak negative feature	Light green fill	Usually indicates banks, walls, stone features, or soil displacement
'Speckled' magnetic Anomaly	Pink/salmon fill	Areas of magnetic disturbance from modern debris, burned material scatter
SURVEY BOUNDARIES		
Extent of survey	Black dashed line	Defines total area covered by geophysical survey
Extent of site	Light blue dashed line	Indicates site boundary
ARCHAEOLOGICAL FEATURES		
Archaeological site	Red outline	Area of archaeological interest based on survey evidence
Sites and monuments record	Red diamond	Known archaeological sites recorded in official databases
Possible archaeology	Black curved/shaded line	Potential archaeological features
HISTORICAL LANDSCAPE FEATURES		
Old field boundary	Brown dashed line	Former field boundaries from historical Ordnance Survey maps
Feature on historical AP	Dotted line	Features visible in aerial photographs
ACCESS INFORMATION		
Inaccessible area	Cross-hatched area	Areas where the survey was not possible
ADDITIONAL FEATURES		
Ferrous feature	Red fill	Modern metal objects, pipes, cables, historicial metalwork
LIRM	Light blue fill	Lightning-Induced Remanent Magnetisation
Geology	Grey fill/text	Natural variations in bedrock or superficial geology
Agricultural lineation	Green line	Regular plough marks
Probable field drain	Blue line	Subsurface agricultural drainage systems
Pylon	Pink circle	Modern electrical infrastructure

238500 239000 239500

211000 210500 210000

238500 239000 239500

N

Extent of site

Inaccessible area

Magnetic Gradient
nT
-3.9 -3.4 -2.8 -2.2 -1.7 -1.1 -0.5 0.1 0.6 1.1 1.6 2.1 2.6 3.1 3.6

Title:
AREA 1 - RAW MAGNETIC GRADIOMETRY - +/- 4 nT

Project:
HEOLDDU SOLAR FARM FERRYSIDE

TERRA DAT
down to earth geophysics
Tel: +44 (0) 2920 700127
Web: www.terradat.co.uk
Email: web@terradat.co.uk

Scale: 1:5000 at A3
Drawn by/Ref: JRM - 9205/1
Date: 11/12/2024

FIGURE 1

238500 239000 239500

211000 210500 210000

238500 239000 239500

N

Extent of site

Inaccessible area

Magnetic Gradient
nT
-3.9 -3.4 -2.8 -2.2 -1.7 -1.1 -0.5 0.1 0.6 1.1 1.6 2.1 2.6 3.1 3.6

Title:
AREA 1 - PROCESSED MAGNETIC GRADIOMETRY - +/- 4 nT

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Drawn by/Ref: JRM - 9205/2
Date: 11/12/2024

FIGURE 2

238500 239000 239500

211000 210500 210000

N

Strong positive feature
Weak positive feature
Weak negative feature
'Speckled' magnetic anomaly
Extent of survey
Extent of site
Strong agricultural lineation
Ferrous feature
Geology

Title:
AREA 1 - SUMMARY ARCHAEOLOGICAL INTERPRETATION

Project:
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Email: web@terradat.co.uk

Scale: 1:5000 at A3
Drawn by/Ref: JRM - 9205/3
Date: 11/12/2024

FIGURE 3

238500 239000 239500

211000 210500 210000

Elevation (AOD)

78 127

N

Strong positive feature

Weak positive feature

Weak negative feature

'Speckled' magnetic anomaly

Extent of survey

Extent of site

Strong agricultural lineation

Ferrous feature

Geology

Title:
AREA 1 - SUMMARY ARCHAEOLOGICAL INTERPRETATION WITH TOPOGRAPHY

Project:
HEOLDDU SOLAR FARM FERRYSIDE

TERRA DAT down to earth geophysics
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Email: web@terradat.co.uk

Scale: 1:5000 at A3
Drawn by/Ref: JRM - 9205/4
Date: 11/12/2024

FIGURE 4

240000

240500

211000

210500

240000

240500

N

Extent of site

Inaccessible area

Magnetic Gradient
nT

-3.9 -3.4 -2.8 -2.2 -1.7 -1.1 -0.5 0.1 0.6 1.1 1.6 2.1 2.6 3.1 3.6

Title:

AREA 2 - RAW MAGNETIC GRADIOMETRY - +/- 4 nT

Project:

HEOLDDU SOLAR FARM FERRYSIDE

TERRA DAT
down to earth geophysics
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Web: www.terradat.co.uk
Email: web@terradat.co.uk

Scale: 1:3000 at A3

Drawn by/Ref: JRM - 9205/5

Date: 11/12/2024

FIGURE 5

240000

240500

211000

210500

240000

240500

N

Extent of site

Inaccessible area

Magnetic Gradient
nT
-3.9 -3.4 -2.8 -2.2 -1.7 -1.1 -0.5 0.1 0.6 1.1 1.6 2.1 2.6 3.1 3.6

Title:
AREA 2 - PROCESSED MAGNETIC GRADIOMETRY - +/- 4 nT

Project:
HEOLDDU SOLAR FARM FERRYSIDE

TERRA DAT
down to earth geophysics
Tel: +44 (0) 2920 700127
Web: www.terradat.co.uk
Email: web@terradat.co.uk

Scale: 1:3000 at A3
Drawn by/Ref: JRM - 9205/6
Date: 11/12/2024

FIGURE 6

240000

240500

211000

211000

210500

210500

238500

240500

N

Strong positive feature

Weak positive feature

Weak negative feature

'Speckled' magnetic anomaly

Extent of survey

Extent of site

Strong agricultural lineation

Ferrous feature

Geology

Title:

AREA 2 - SUMMARY ARCHAEOLOGICAL INTERPRETATION

Project:

HEOLDDU SOLAR FARM FERRYSIDE

TERRA DAT
down to earth geophysics
Tel: +44 (0) 2920 700127
Web: www.terradat.co.uk
Email: web@terradat.co.uk

Scale: 1:3000 at A3

Drawn by/Ref: JRM - 9205/7

Date: 11/12/2024

FIGURE 7

240000

240500

211000

211000

210500

210500

238500

240000

240500

Elevation (m AOD)

78 — 127

N

- Strong positive feature
- Weak positive feature
- Weak negative feature
- 'Speckled' magnetic anomaly
- Extent of survey
- Extent of site
- Strong agricultural lineation
- Ferrous feature
- Geology

Title:
AREA 2 - SUMMARY ARCHAEOLOGICAL INTERPRETATION WITH TOPOGRAPHY

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Web: www.terradat.co.uk
Email: web@terradat.co.uk

Scale: 1:3000 at A3
Drawn by/Ref: JRM - 9205/8
Date: 11/12/2024

FIGURE 8

238500 239000 239500 240000 240500

211500 211000 210500 210000

N

Removed boundaries - Possibly pre-tithe

Removed boundaries - Since tithe

Removed boundaries - Since 1st ed OS map

Title:
ANOMALIES INDICATIVE OF REMOVED FIELD BOUNDARIES ASSOCIATED WITH THE SURVIVING FIELD SYSTEM

Project:
HEOLDDU SOLAR FARM FERRYSIDE

TERRA DAT
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Email: web@terradat.co.uk

Scale: 1:7000 at A3
Drawn by/Ref: JRM - 9205/9
Date: 11/12/2024

FIGURE 9

238500 239000 239500 240000 240500

211500 211000 210500 210000

N

Boundaries predating modern / post medieval field system

Title:
ANOMALIES INDICATIVE OF FEATURES APPARENTLY PRE-DATING THE MODERN/POST-MEDIEVAL FIELD SYSTEM

Project:
HEOLDDU SOLAR FARM FERRYSIDE

TERRA DAT
down to earth geophysics
Tel: +44 (0) 2920 700127
Web: www.terradat.co.uk
Email: web@terradat.co.uk

Scale: 1:7000 at A3
Drawn by/Ref: JRM - 9205/10
Date: 11/12/2024

FIGURE 10