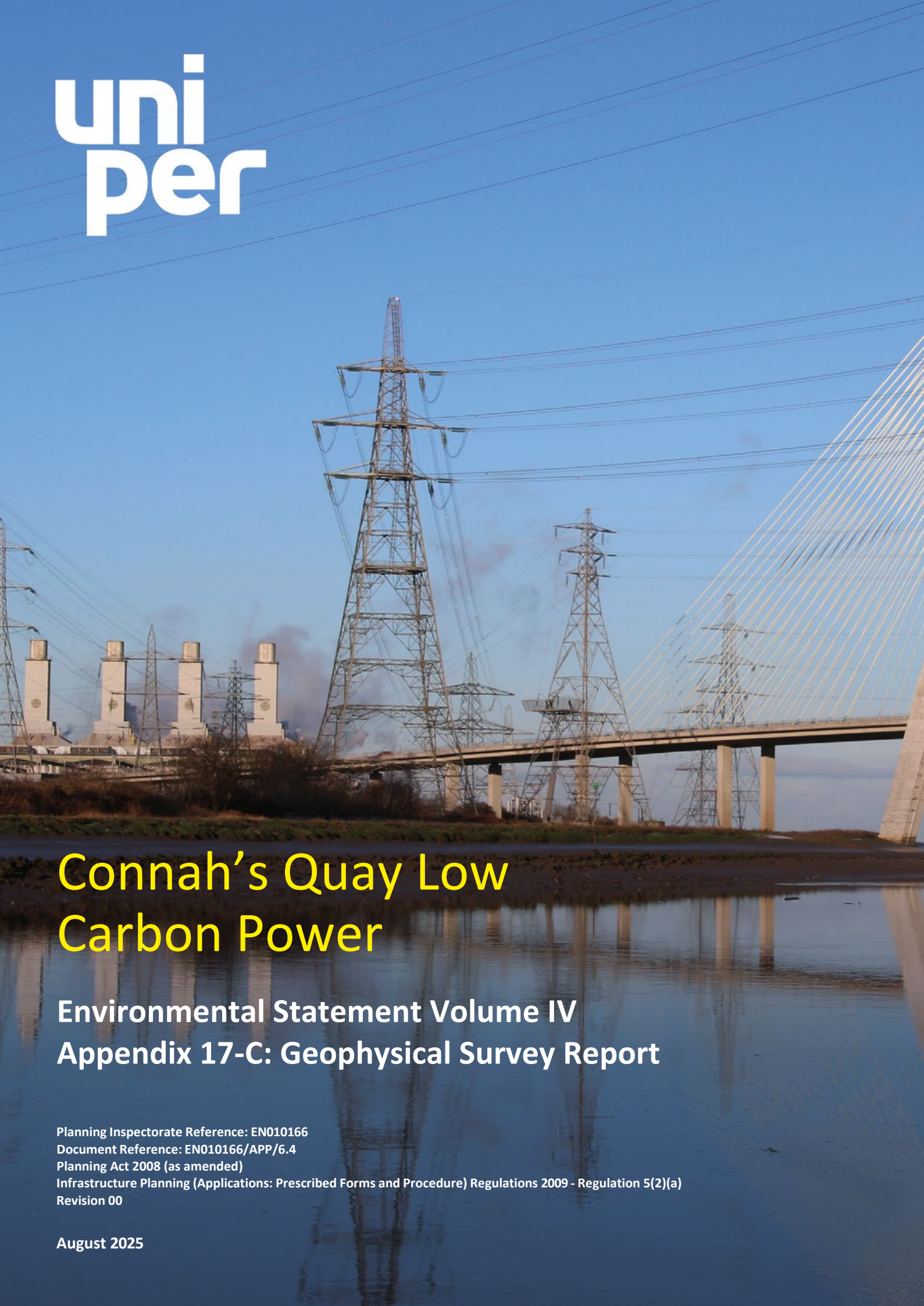

Connah's Quay Low Carbon Power

Environmental Statement Volume IV
Appendix 17-C: Geophysical Survey Report

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Geophysical Survey Report

Connahs Quay

Y Fflint, Flintshire

For

AECOM

Magnitude Surveys Ref: MSSJ1873

HER Event Number: TBA

October 2024

Contents

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1. Introduction

1.1. Magnitude Surveys Ltd (MS) was commissioned by AECOM to undertake a geophysical survey over a c. 7.4ha area of land at Connahs Quay, Y Fflint, Flintshire (SJ 25242 70924).

1.2. The geophysical survey comprise hand-carried, GNSS-positioned fluxgate gradiometer survey. Magnetic survey is the standard primary geophysical method for archaeological applications in the UK due to its ability to detect a range of different features. The technique is particularly suited for detecting fired or magnetically enhanced features, such as ditches, pits, kilns, sunken featured buildings (SFBs) and industrial activity (David *et al*., 2008).

1.3. The survey was conducted in line with the current best practice guidelines produced by Historic England (David *et al*., 2008), the Chartered Institute for Archaeologists (CIfA, 2020) and the European Archaeological Council (Schmidt *et al.,* 2015).

1.4. It was conducted in line with a WSI produced by MS (Nichols, 2024).

1.5. The survey was carried out on 3/10/24.

2. Quality Assurance

2.1. Magnitude Surveys is a Registered Organisation of the Chartered Institute for Archaeologists (CIfA), the chartered UK body for archaeologists, and a corporate member of ISAP (International Society for Archaeological Prospection).

2.2. The directors of MS are involved in cutting edge research and the development of guidance/policy. Specifically, [redacted]

2.3. All MS managers, field and office staff have degree qualifications relevant to archaeology or geophysics and/or field experience.

3. Objectives

3.1. The objective of this geophysical survey was to assess the subsurface archaeological potential of the survey area.

4. Geographic Background

4.1. The survey area was located c. 1.0km south-east of St. Marys Catholic Primary School in Y Fflint (Figure 1). Gradiometer survey was undertaken across two arable fields and pasture. The survey area was located c. 700m south-east of the playing field in Y Fflint, immediately the east of Allt-Goch Lane. The survey area was bordered by further agricultural land to the north, east and south (Figure 2). A small area in the east of Area 2 could not be surveyed due to overgrown vegetation present.

4.2. Survey considerations:

Survey Area	Ground Conditions	Further Notes
1	The area consisted of flat pasture.	The survey area was bordered by trees to the south-east, and hedgerow on all sides. Telegraph poles with overhead cables ran west to east through the centre of the survey area.
2	The area consisted of flat pasture.	The survey area was bordered by hedgerow on all sides. Metal gates were present in northern and northeastern corner of the survey area. A small, c. 0.1ha area in the east of this field was unable to be surveyed due to overgrown vegetation.

4.3. The underlying geology comprises mudstone, siltstone and sandstone of the Pennine Lower Coal Measures Formation. Superficial deposits comprise Devensian till throughout (British Geological Survey, 2025).

4.4. The soils consist of slowly permeable, seasonally wet, slightly acid but base-rich loamy and clayey soils (Soilscapes, 2025).

5. Archaeological Background

5.1. The following is a summary of a Desk Based Assessment produced and provided by AECOM (AECOM, 2024).

5.2. No evidence of archaeological activity is known within the survey area.

5.3. Although no Palaeolithic or Mesolithic findspots have been recorded, archaeological remains pertaining to these periods are known to have been found within c. 1km of the survey area.

5.4. A Neolithic round barrow is present at Moel y Gaer (FL307100) approximately c. 4.3km south-west of the survey area, in addition to a further round barrow at Pen y Parc (FL300847). Whilst prehistoric activity has been identified within the wider landscape, only isolated small finds have been recorded within c. 1km of the survey area. These include a Bronze Age tanged flint arrowhead (HER 103007) and a bronze celt (HER100134), c. 770m to the south-east of the survey area.

5.5. The Roman Road connecting Chester to St Asaph (HER104576 – HER104579) has been identified about 875m north of the survey area, following the modern route of Chester Road. An extensive Roman settlement has been recorded c. 800-900m west of the survey area, at the southern

extent of Oakenholt. Archaeological investigations undertaken in 1856 identified a small Roman cemetery, with five adult inhumations buried north of Chester Road, alongside several lead smelting furnaces (HER 57650). Excavations in 1924 and 1958 identified a further six Roman furnaces and several shallow pits and two brick walls, indicating this area was used extensively for industrial smelting (HER128792, HER 128795 HER128763 and HER 128796). Further excavation has uncovered a 'villa'-type complex c. 900m west of the survey area, in addition to a Roman industrial settlement at Pentre Ffwrndan c. 1km north.

5.6. The site is situated in an area that was largely used for agricultural purposes during the medieval period, with evidence of ridge and furrow (HER86953) located underneath the current location of the A548 roundabout, c. 840m north of the survey area.

5.7. A section of the Buckley branch of the London and North-East Railway line (HER141492) is located centrally within Connahs Quay: several railway boundary posts are still extant in Pentre (HER89577, HER89558), approximately c. 360m west of the survey area, just south of the existing railway line. St Marks school (HER17149), built in 1837, is located c. 320m to the south-east alongside The Old Quay House Inn (HER87982) located c. 470m to the east of the survey area. Evidence of coal mining was identified approximately c. 640m south-east of the survey area (HER87957). Three Methodist Churches (HER1001753) were built in 1876, located approximately c. 700m south-east of the survey area, with St. Johns Church (HER124897) located c. 800m to the east.

6. Methodology

6.1. Data Collection

6.1.1. Magnetometer surveys are generally the most cost effective and suitable geophysical technique for the detection of archaeology in England. Therefore, a magnetometer survey should be the preferred geophysical technique unless its use is precluded by any specific survey objectives or the site environment. For this site, no factors precluded the recommendation of a standard magnetometer survey. Geophysical survey therefore comprised the magnetic method as described in the following section.

6.1.2. Geophysical prospection comprised the magnetic method as described in the following table.

6.1.3. Table of survey strategies:

Method	Instrument	Traverse Interval	Sample Interval
Magnetic	Bartington Instruments Grad-13 Digital Three-Axis Gradiometer	1m	200Hz reprojected to 0.125m

6.1.4. The magnetic data were collected using MS' bespoke hand-carried GNSS-positioned system.

6.1.4.1. MS' hand-carried system was comprised of Bartington Instruments Grad 13 Digital Three-Axis Gradiometers. Positional referencing was through a multi-channel, multi-constellation GNSS Smart Antenna RTK GPS outputting in NMEA mode to

ensure high positional accuracy of collected measurements. The RTK GPS is accurate to 0.008m + 1ppm in the horizontal and 0.015m + 1ppm in the vertical.

6.1.4.2. Magnetic and GPS data were stored on an SD card within MS' bespoke datalogger. The datalogger was continuously synced, via an in-field Wi-Fi unit, to servers within MS' offices. This allowed for data collection, processing and visualisation to be monitored in real-time as fieldwork was ongoing.

6.1.4.3. A navigation system was integrated with the RTK GPS, which was used to guide the surveyor. Data were collected by traversing the survey area along the longest possible lines, ensuring efficient collection and processing.

6.2. Data Processing

6.2.1. Magnetic data were processed in bespoke in-house software produced by MS. Processing steps conform to the EAC and Historic England guidelines for 'minimally enhanced data' (see Section 3.8 in Schmidt *et al.*, 2015: 33 and Section IV.2 in David *et al.,* 2008: 11).

Sensor Calibration – The sensors were calibrated using a bespoke in-house algorithm, which conforms to Olsen *et al*. (2003).

Zero Median Traverse – The median of each sensor traverse is calculated within a specified range and subtracted from the collected data. This removes striping effects caused by small variations in sensor electronics.

Projection to a Regular Grid – Data collected using RTK GPS positioning requires a uniform grid projection to visualise data. Data are rotated to best fit an orthogonal grid projection and are resampled onto the grid using an inverse distance-weighting algorithm.

Interpolation to Square Pixels – Data are interpolated using a bicubic algorithm to increase the pixel density between sensor traverses. This produces images with square pixels for ease of visualisation.

6.3. Data Visualisation and Interpretation

6.3.1. This report presents the gradient of the sensors' total field data as greyscale images, as well as the total field data from the lower sensors. The gradient of the sensors minimises external interferences and reduces the blown-out responses from ferrous and other high contrast material. However, the contrast of weak or ephemeral anomalies can be reduced through the process of calculating the gradient. Consequently, some features can be clearer in the respective gradient or total field datasets. Multiple greyscale images of the gradient and total field at different plotting ranges have been used for data interpretation. Greyscale images should be viewed alongside the XY trace plot (Figure 7). XY trace plots visualise the magnitude and form of the geophysical response, aiding anomaly interpretation.

6.3.2. Geophysical results have been interpreted using greyscale images and XY traces in a layered environment, overlaid against open street maps, satellite imagery, historical maps, LiDAR data, and soil and geology maps. Google Earth (2025) was also consulted, to compare the results with recent land use.

6.3.3. Geodetic position of results – All vector and raster data have been projected into OSGB36 (ESPG27700) and can be provided upon request in ESRI Shapefile (.SHP) and Geotiff (.TIF) respectively. Figures are provided with raster and vector data projected against OS Open Data.

7. Results

7.1. Qualification

7.1.1. Geophysical results are not a map of the ground and are instead a direct measurement of subsurface properties. Detecting and mapping features requires that said features have properties that can be measured by the chosen technique(s) and that these properties have sufficient contrast with the background to be identifiable. The interpretation of any identified anomalies is inherently subjective. While the scrutiny of the results is undertaken by qualified, experienced individuals and rigorously checked for quality and consistency, it is often not possible to classify all anomaly sources. Where possible, an anomaly source will be identified along with the certainty of the interpretation. The only way to improve the interpretation of results is through a process of comparing excavated results with the geophysical reports. MS actively seek feedback on their reports, as well as reports from further work, in order to constantly improve our knowledge and service.

7.2. Discussion

7.2.1. The geophysical results are presented in combination with satellite imagery and historical maps (Figure 4).

7.2.2. A fluxgate gradiometer survey was carried out over c. 6.2ha of land at Connahs Quay, Y Fflint, Flintshire. Areas of scattered, mixed ferrous debris possibly related to greenwaste or to a similar material, have been identified within Area 1 and have complicated the identification of anomalies in that area (Figures 3 & 4). Further interference from modern sources is related to magnetic disturbance from metal fencing and from a buried service.

7.2.3. Former, mapped field boundaries were identified in both Areas 1 & 2 and are visible on historical mapping (1890s OS maps) (Figure 4). Further evidence of agricultural activity is present in the form of sets of parallel linear anomalies identified in Area 2 (Figures 5 & 6). These may correspond to drains or ploughing regimes.

7.2.4. At least three concentrations of discrete anomalies were identified across Areas 1 and 2 and correspond with former, mapped ponds (Figure 4).

7.2.5. Linear anomalies of undetermined origin were detected in the north of Area 1 and east of Area 2 (Figures 5-7). These do not correspond with any known features but are considered likely to relate to agricultural and/or modern features.

7.3. Interpretation

7.3.1. General Statements

7.3.1.1. Geophysical anomalies will be discussed broadly as classification types across the survey area. Only anomalies that are distinctive or unusual will be discussed individually.

7.3.1.2. **Data Artefact** – Data artefacts usually occur in conjunction with anomalies with strong magnetic signals due to the way in which the sensors respond to very strong point sources. They are usually visible as minor 'streaking' following the line of data collection. While these artefacts can be reduced in post-processing through data filtering, this would risk removing 'real' anomalies. These artefacts are therefore indicated as necessary in order to preserve the data as 'minimally processed'.

7.3.1.3. **Ferrous (Spike)** – Discrete dipolar anomalies are likely to be the result of isolated pieces of modern ferrous debris on or near the ground surface.

7.3.1.4. **Ferrous/Debris (Spread)** – A ferrous/debris spread refers to a concentration of multiple discrete, dipolar anomalies usually resulting from highly magnetic material such as rubble containing ceramic building materials and ferrous rubbish.

7.3.1.5. **Magnetic Disturbance** – The strong anomalies produced by extant metallic structures, typically including fencing, pylons, vehicles and service pipes, have been classified as 'Magnetic Disturbance'. These magnetic 'haloes' will obscure weaker anomalies relating to nearby features, should they be present, often over a greater footprint than the structure causing them.

7.3.1.6. **Undetermined** – Anomalies are classified as Undetermined when the origin of the geophysical anomaly is ambiguous and there is no supporting contextual evidence to justify a more certain classification. These anomalies are likely to be the result of geological, pedological or agricultural processes, although an archaeological origin cannot be entirely ruled out. Undetermined anomalies are generally distinct from those caused by ferrous sources.

7.3.2. Magnetic Results - Specific Anomalies

7.3.2.1. **Agricultural (Weak)** – Discontinuous, linear anomalies weak in magnetic signal were identified in Area 1 (Figures 5-7). These correspond to the location of mapped boundaries visible on historical mapping (Figure 4).

7.3.2.2. **Agricultural (Spread)** – Concentrations of linear and discrete anomalies were identified across Area 2 and Area 1 (Figures 5-7). Their locations also correspond with that of former mapped boundaries (Figure 4).

7.3.2.3. **Agricultural (Trend)** – Two sets of strongly enhanced parallel linear anomalies have been identified in Area 2 (Figures 5-7). The signal and shape of these anomalies are suggestive of an agricultural origin and they could represent drains or ploughing trends.

7.3.2.4. **Pond –** In the north and centre of Area 1, and the very north-western corner of Area 2, strongly enhanced amorphous anomalies have been detected (Figures 5-7). These anomalies overlap with pond features present in historical mapping of the area.

7.3.2.5. **Undetermined (Weak)** - Linear anomalies showing a weak magnetic signal were identified along the eastern boundary of Area 2 and in the north of Area 1 (Figures

5-7). These do not show any correspondence with mapped features or with features visible on recent and past satellite imagery. It is possible these represent features of agricultural and/or modern origin but their origins remain uncertain.

8. Conclusions

8.1. A fluxgate gradiometer survey has successfully been undertaken across the survey area. Areas of scattered, mixed ferrous debris possibly related to greenwaste or to a similar material, have been identified within Area 1 and have complicated the identification of anomalies in that area. Further interference from modern sources is related to magnetic disturbance from metal fencing and from a buried service. No anomalies indicative of archaeological features have been detected.

8.2. Agricultural activity was identified in the form of former mapped field boundaries in Areas 1 and 2, as well as two sets of drains or ploughing regimes. Former mapped ponds were also identified across both Areas 1 and 2.

8.3. Linear anomalies of undetermined origin were identified in Areas 1 and 2. While their origin is uncertain, these are considered likely to correspond to features of agricultural and/or modern origin.

9. Archiving

9.1. MS maintains an in-house digital archive, which is based on Schmidt and Ernenwein (2013). This stores the collected measurements, minimally processed data, georeferenced and un-georeferenced images, XY traces and a copy of the final report.

9.2. MS contributes reports to the ADS Grey Literature Library upon permission from the client, subject to any dictated time embargoes.

9.3. The Heneb: Clwyd Powys Archaeology HER will receive a high resolution PDF copy of the reports.

9.4. The full digital archive will be sent to the National Monuments Record, RCAHMW.

10. Copyright

10.1. Copyright and intellectual property pertaining to all reports, figures and datasets produced by Magnitude Services Ltd is retained by MS. The client is given full licence to use such material for their own purposes. Permission must be sought by any third party wishing to use or reproduce any IP owned by MS.

11. References

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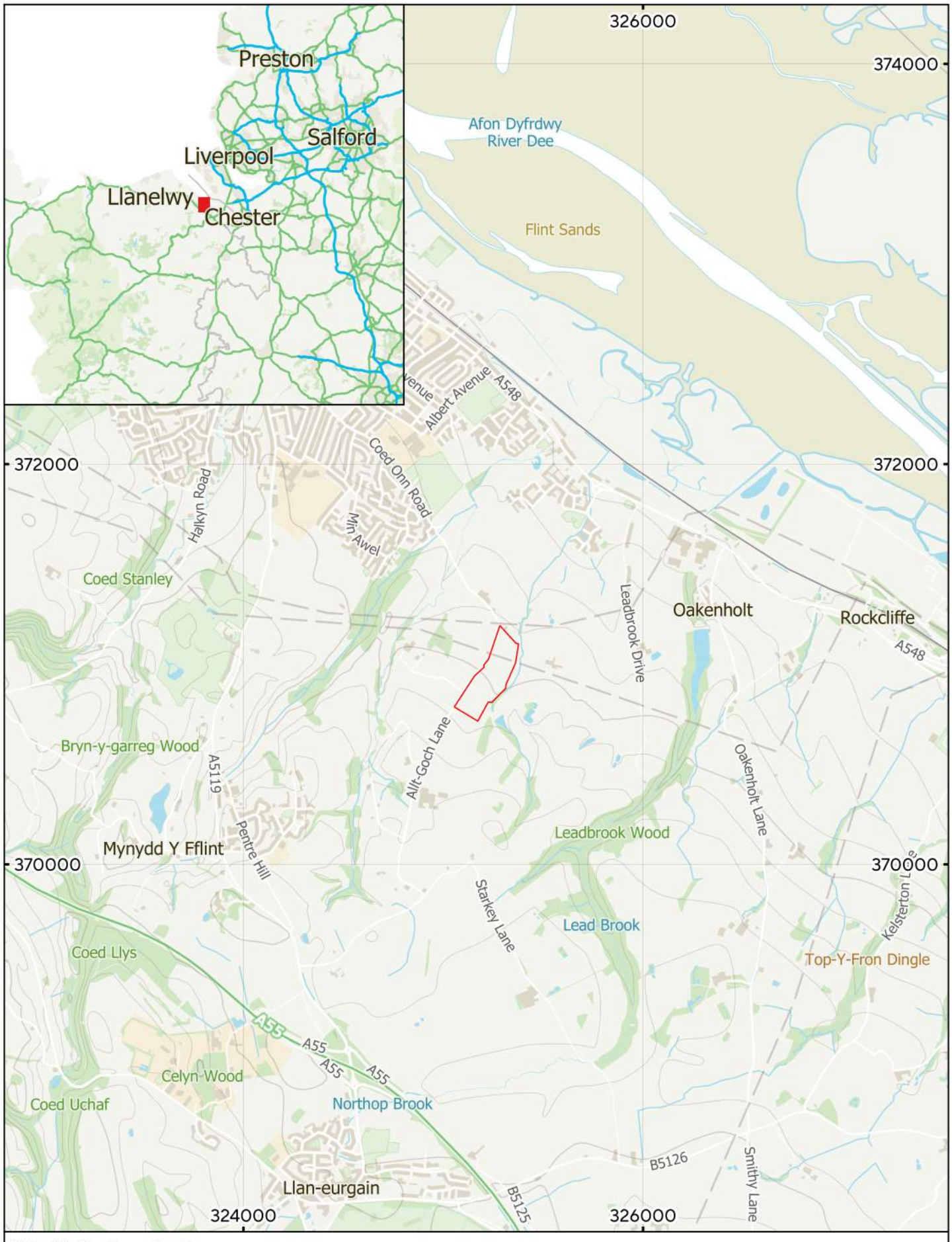
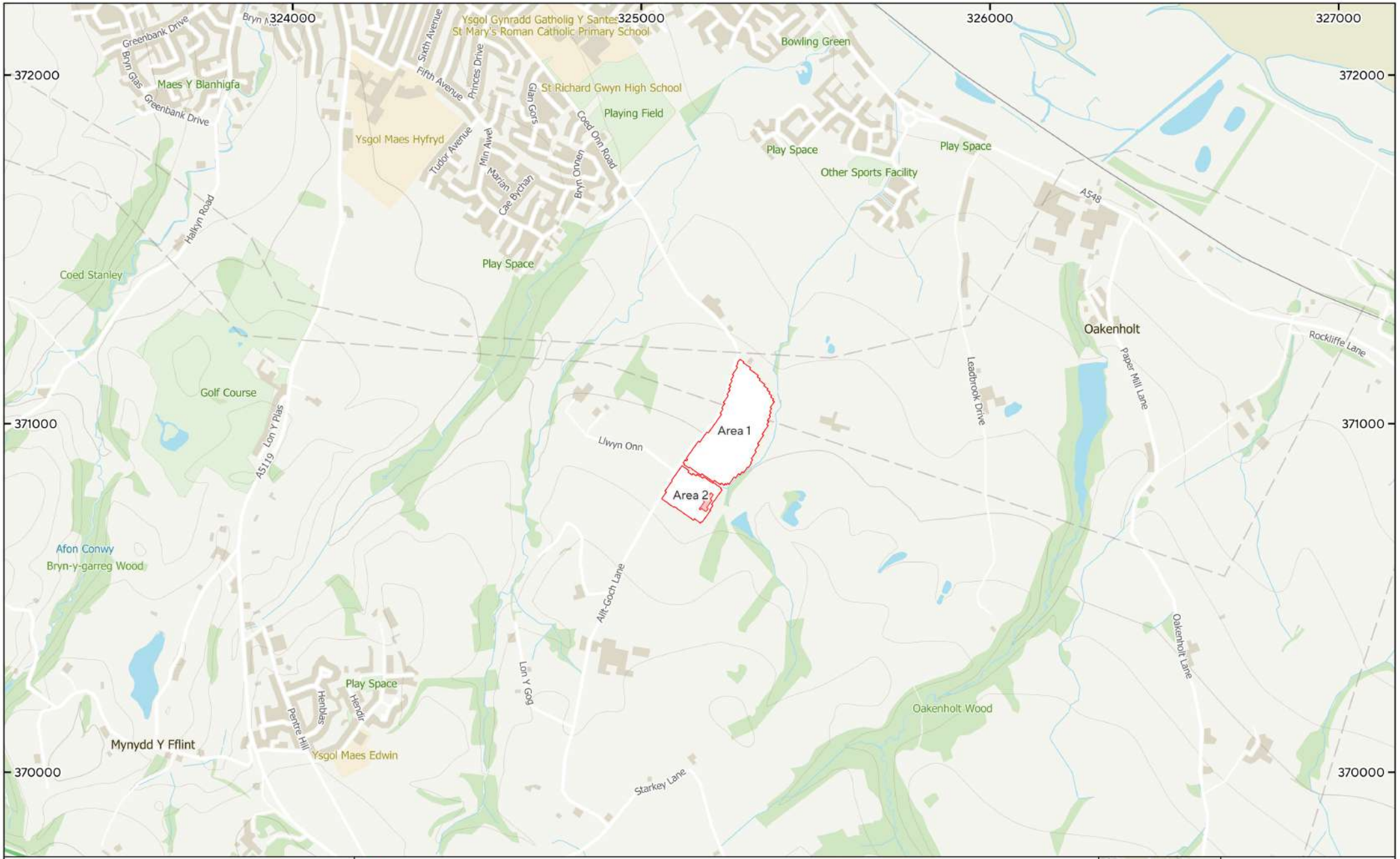


MSSJ1873 - Connahs Quay
Figure 1 - Geophysical Survey Location
1:25,000 @ A4

Geophysical Survey Area

0 0.5 1 km



MSSJ1873 - Connahs Quay
Figure 2 - Location of Survey Areas
1:10,000 @ A3

Survey Extent
Unable to be Surveyed

Y Fflint

Magnitude Surveys

0 90 180 270 360 m

MSSJ1873 - Connahs Quay
Figure 4 - Magnetic Total Field (Lower Sensor)
1:3,000 @ A3

48,997 nT 49,005

Magnitude Surveys

0 25 50 75 100 m

MSSJ1873 - Connahs Quay
Figure 4 - Magnetic Interpretation Over Historical Mapping and Satellite Imagery
1:3,000 @ A3

- Agricultural (Spread)
- Agricultural (Weak)
- Magnetic Disturbance
- Ferrous/Debris (Spread)
- Undetermined (Weak)
- Pond
- Agricultural (Trend)
- Service
- Ferrous (Spike)

Magnitude Surveys

0 25 50 75 100 m

MSSJ1873 - Connahs Quay
Figure 5 - Magnetic Gradient
1:1,500 @ A3

-1 nT 2

Magnitude Surveys

0 20 40 60 m

MSSJ1873 - Connahs Quay
Figure 5 - Magnetic Interpretation
1:1,500 @ A3

Agricultural (Spread)
Agricultural (Weak)
Magnetic Disturbance
Ferrous/Debris (Spread)
Undetermined (Weak)
Pond
Agricultural (Trend)
Service
Ferrous (Spike)

Magnitude Surveys

0 20 40 60 m

MSSJ1873 - Connahs Quay
Figure 7 - XY Trace Plot
30nT/cm at 1:1,500 @ A3

Magnitude Surveys

0 20 40 60 m

MSSJ1873 - Connahs Quay
Figure 8 - GNSS Plot
1:1,500 @ A3

Magnitude Surveys

0 20 40 60 m