ARCHAEOLOGICAL SERVICES
DURHAM UNIVERSITY

for
Brython Archaeology

A496 Llanbedr Access Improvements near Harlech Gwynedd

geophysical survey

report 4018
December 2015

Durham University

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1. Summary

The project

1.1 This report presents the results of a geophysical survey conducted in advance of proposed development of the A496 at Llanbedr, Gwynedd. The works comprised geomagnetic survey of 11 fields.

1.2 The works were commissioned by Brython Archaeology and conducted by Archaeological Services Durham University.

Results

1.3 The vast majority of anomalies detected in these surveys almost certainly reflect geological variation in the underlying natural subsoils and bedrock.

1.4 A ditch feature, of uncertain provenance, possibly a drainage channel, has been detected in Area 2.

1.5 Features recorded by historic OS editions have been identified in Areas 3, 6 and 7; including former field boundaries and a wooded area.

1.6 Possible remains of former ridge and furrow cultivation have been detected in Area 9.

1.7 Services have been detected in many of the survey areas, as well as a number of inspection chamber covers. Other features, including a probable drain, telegraph poles, fences, gates and a cattle feeder, have also been identified.

2. Project background

Location (Figure 1)

2.1 The proposed development area was located on land at Llanbedr, Gwynedd (centred at NGR: SH 5817 2683). Eleven surveys were conducted in 11 land parcels. To the east was the A496 and the town of Llanbedr. The Afon Arto bisected the survey area before turning north to run along the west edge of the northern surveys. The central survey areas occupied farmland between Plas y bryn Farm in the west, and Maes Arto in the east. Three small areas in the south were either side of the A496 road to the south of Llanbedr.

Development proposal

2.2 The proposal is for access improvements to Llanbedr from the A496 road.

Objective

2.3 The aim of the surveys was to assess the nature and extent of any sub-surface features of potential archaeological significance within the proposed development area, so that an informed decision may be made regarding the nature and scope of any further scheme of archaeological works that may be required in relation to the development.

2.4 The regional research framework *A Research Framework for the Archaeology of Wales* contains an agenda for archaeological research in the region, which is incorporated into regional planning policy implementation with respect to archaeology. In this instance, the scheme of works could address the following research priorities for North-west Wales: Later Bronze Age and Iron Age: *Settlement,* and *Economy and production*; Roman: *Campaigning and Military Occupation*, *Communications*, and *Rural Settlement*.

Methods statement

2.5 The surveys have been undertaken in accordance with instructions from the client, a written scheme of investigation prepared by Archaeological Services Durham University (ref DH15.479) and national standards and guidance (below, 5.1).

Dates

2.6 Fieldwork was undertaken between 30th November and 3rd December 2015. This report was prepared for December 2015.

Personnel

2.7 Fieldwork was conducted by Richie Villis (supervisor) and Mark Woolston-Houshold. Geophysical data processing and report preparation was by Richie Villis, with illustrations by David Graham. The project Manager was Duncan Hale. This report was edited by Peter Carne.

Archive

2.8 The site code is **GLA15**, for **G**wynedd **L**lanbedr **A**ccess improvements 20**15**. The survey archive will be retained at Archaeological Services Durham University and a copy supplied on CD to the client for deposition with the project archive in due course.

3. Historical and archaeological background

3.1 Llanbedr takes its name from the Church of Saint Peter at the north end of the village, to the north-east of the A496. It was once a chapel of ease to Llandanwg church, and may date to as early as the 13th century, but is probably predominantly of late 15th or early 16th century construction. The church was restored in 1883, and is now a Grade II* listed building.

3.2 A pair of standing stones, the Stones of Llanbedr, are located west of the church, only 150m east of Area 3. A number of other prehistoric monuments are also listed in the wider landscape, including a hillfort to the north-east, and probable hut-circles and field systems.

3.3 Llanbedr would probably have grown around the slate quarrying industry, and the railway line opened in the mid-19th century. Llanbedr Airport (450m south-west of Area 6) opened in 1941 as RAF Llanbedr, an operational base for Towed Target and Target Drone services for the UK armed forces until 2004. It reopened as a general aviation airfield in 2014.

4. Landuse, topography and geology

4.1 At the time of survey the proposed development area comprised 11 pastoral fields, grazed by sheep and cows.

4.2 The area occupied varying terrain: Areas 1-3 occupied a very flat flood plain, with a mean elevation of around 3m OD, to the north and east of the Afon Arto. Areas 4-11 occupied rolling drumlins, with occasional steep inclines, Area 6 rising to 31m OD before dropping again to around 24m OD in Area 7, before rising again to the south, with Area 11 at a mean elevation of around 40m OD.

4.3 The underlying solid geology of the area comprises interbedded strata of siltstone and mudstone of the Llanbedr Formation, which is overlain by tidal flat deposits in the north (Areas 1-3), and Devensian diamicton till across the drumlins in the south (Areas 4-11) (BGS 2015).

5. Geophysical survey

Standards

5.1 The surveys and reporting were conducted in accordance with English Heritage guidelines, *Geophysical survey in archaeological field evaluation* (David, Linford & Linford 2008); the Chartered Institute for Archaeologists (CIfA) *Standard and Guidance for archaeological geophysical survey* (2014); the CIfA Technical Paper No.6, *The use of geophysical techniques in archaeological evaluations* (Gaffney, Gater & Ovenden 2002); and the Archaeology Data Service & Digital Antiquity *Geophysical Data in Archaeology: A Guide to Good Practice* (Schmidt 2013).

Technique selection

5.2 Geophysical survey enables the relatively rapid and non-invasive identification of sub-surface features of potential archaeological significance and can involve a suite of complementary techniques such as magnetometry, earth electrical resistance, ground-penetrating radar, electromagnetic survey and topsoil magnetic

susceptibility survey. Some techniques are more suitable than others in particular situations, depending on site-specific factors including the nature of likely targets; depth of likely targets; ground conditions; proximity of buildings, fences or services and the local geology and drift.

5.3 In this instance, it was considered possible that cut features such as ditches and pits might be present on the site, and that other types of feature such as trackways, wall foundations and fired structures (for example kilns and hearths) might also be present.

5.4 Given the anticipated shallowness of targets and the non-igneous geological environment of the study area a geomagnetic technique, fluxgate gradiometry, was considered appropriate for detecting the types of feature mentioned above. This technique involves the use of hand-held magnetometers to detect and record anomalies in the vertical component of the Earth's magnetic field caused by variations in soil magnetic susceptibility or permanent magnetisation; such anomalies can reflect archaeological features.

Field methods

5.5 A 30m grid was established across each survey area and related to the Ordnance Survey National Grid using a Leica GS15 global navigation satellite system (GNSS) with real-time kinematic (RTK) corrections typically providing 10mm accuracy.

5.6 Measurements of vertical geomagnetic field gradient were determined using Bartington Grad601-2 dual fluxgate gradiometers. A zig-zag traverse scheme was employed and data were logged in 30m grid units. The instrument sensitivity was nominally 0.03nT, the sample interval was 0.25m and the traverse interval was 1m, thus providing 3,600 sample measurements per 30m grid unit.

5.7 Data were downloaded on site into a laptop computer for initial processing and storage and subsequently transferred to a desktop computer for processing, interpretation and archiving.

Data processing

5.8 Geoplot v.3 software was used to process the geophysical data and to produce both continuous tone greyscale images and trace plots of the raw (minimally processed) data. The greyscale images and interpretations are presented in Figures 2-5; the trace plots are provided in Figure 6. In the greyscale images, positive magnetic anomalies are displayed as dark grey and negative magnetic anomalies as light grey. A palette bar relates the greyscale intensities to anomaly values in nanoTesla.

5.9 The following basic processing functions have been applied to the geomagnetic data:

clip	clips data to specified maximum or minimum values; to eliminate large noise spikes; also generally makes statistical calculations more realistic
zero mean traverse	sets the background mean of each traverse within a grid to zero; for removing striping effects in the traverse direction and removing grid edge discontinuities

de-stagger	corrects for displacement of geomagnetic anomalies caused by alternate zig-zag traverses
interpolate	increases the number of data points in a survey to match sample and traverse intervals; in this instance the data have been interpolated to 0.25m x 0.25m intervals

Interpretation: anomaly types

5.10 A colour-coded geophysical interpretation plan is provided. Three types of geomagnetic anomaly have been distinguished in the data:

positive magnetic	regions of anomalously high or positive magnetic field gradient, which may be associated with high magnetic susceptibility soil-filled structures such as pits and ditches
negative magnetic	regions of anomalously low or negative magnetic field gradient, which may correspond to features of low magnetic susceptibility such as wall footings and other concentrations of sedimentary rock or voids
dipolar magnetic	paired positive-negative magnetic anomalies, which typically reflect ferrous or fired materials (including fences and service pipes) and/or fired structures such as kilns or hearths

Interpretation: features

General comments

5.11 A colour-coded archaeological interpretation plan is provided.

5.12 Except where stated otherwise in the text below, positive magnetic anomalies are taken to reflect relatively high magnetic susceptibility materials, typically sediments in cut archaeological features (such as ditches or pits) whose magnetic susceptibility has been enhanced by decomposed organic matter or by burning.

5.13 In this instance many of the geomagnetic anomalies detected across the survey areas are likely to be natural variations in the underlying geology rather than anthropogenic. There is a distinct difference in the background 'noise' between areas 1-3 and 4-11. Areas 1-3 are characterised by very smooth data, with little background variation. Series of amorphous and curvilinear weak geomagnetic anomalies have been detected; these are typical of geological features encountered on Tidal Flat Deposits (Archaeological Services 2010). Areas 4-11 are contrastingly different, with high concentrations of dipolar magnetic anomalies detected and a very 'noisy' magnetic background. Typically these types of anomalies are detected in igneous geological backgrounds. It is possible that the glacial action forming the till drumlins has deposited igneous rock components in the clay. Igneous intrusions are recorded across much of north-west Wales, including an unnamed Ordovician Igneous Intrusion of microgabbro which is recorded *c*. 600m east of Area 6 (BGS 2015). In the interests of clarity the majority of these anomalies have not been included on the interpretation drawings.

5.14 Small, discrete dipolar magnetic anomalies have been detected in all of the survey areas. These almost certainly reflect items of near-surface ferrous and/or fired

debris, such as horseshoes and brick fragments, and in most cases have little or no archaeological significance. A sample of these is shown on the geophysical interpretation plan, however, they have been omitted from the archaeological interpretation plan and the following discussion.

Area 1

5.15 Amorphous, weak dipolar magnetic anomalies have been detected across much of this area. These almost certainly reflect natural variation in the underlying superficial deposits.

5.16 A very strong dipolar magnetic anomaly has been detected in the north-west corner of the area. This corresponds to the metal field boundary to the north.

5.17 Two very small regions of 'dummy' data correspond to telegraph poles.

Area 2

5.18 As in Area 1 a series of magnetic anomalies have been detected here which almost certainly reflect natural variation.

5.19 A very narrow positive magnetic anomaly has been detected in the north-east corner of this area. This almost certainly reflects an anthropogenic soil-filled ditch, possible a drainage channel, although its exact provenance remains uncertain.

5.20 A chain of strong dipolar magnetic anomalies has been detected in the south of this area. This almost certainly reflects a service. A dipolar magnetic anomaly and small 'dummy' data to the west of this corresponds to an inspection chamber cover.

Area 3

5.21 A broadly north/south aligned band of weak and diffuse dipolar magnetic anomalies has been detected in the centre of this area. These almost certainly reflect natural variation, possibly the effects of former streams or watercourses. Historic OS editions show a number of trees in this area.

5.22 A broadly north-east/south-west aligned chain of dipolar magnetic anomalies has been detected in this area. This almost certainly reflects a service. A second, broadly north/south aligned, line of dipolar magnetic anomalies, linked by a very weak linear anomaly, also probably reflects a service. In this instance it is probably a plastic pipe with metal collaring. Inspection chamber covers were noted along this line.

5.23 A large and strong dipolar magnetic anomaly has been detected in the south of this area, along with a small 'dummy' data reading. This corresponds to a telegraph pole. A second telegraph pole stood north of this. Other regions of 'dummy' data in this area correspond to piles of dead wood and fencing material.

Areas 4 & 5

5.24 These areas occupy steep north-facing slopes, and are characterised by a high concentration of dipolar magnetic anomalies. This almost certainly reflects geological variation, probably caused by igneous rocks and pebbles in the glacial clay.

Area 6

5.25 As with Areas 4 & 5 this area is located on rolling glacial hills. The natural background is very magnetically noisy, which probably reflects igneous material in the glacial clay. Broad positive magnetic anomalies have been detected in the north-east and south-east of the area; these correspond to steep slopes and scoops in the hillside.

5.26 A short linear dipolar magnetic anomaly has been detected in the centre of the area. This is typical of anomalies which reflect igneous intrusions in the underlying bedrock (Archaeological Services 2013).

5.27 A chain of dipolar magnetic anomalies has been detected between the two copses of trees. This corresponds to a small earthwork feature on the ground with occasional metal post bases. A second similar anomaly has been detected to the east of the copse in the centre of the area. These anomalies correspond to former field boundaries as shown on historic OS editions. A similar anomaly has been detected to the north of the copse of trees in the south of the area. This corresponds to the former boundary surrounding the trees. Further OS features, including former field boundaries and a Summer House, are recorded on historic editions in the west of the area. These have not been detected.

5.28 A chain of very strong dipolar magnetic anomalies has been detected in the west of the area. This almost certainly reflects a service. A number of steel and concrete inspection chambers for a high voltage electric cable were noted at the north end of this anomaly, just north of the survey area. A further inspection chamber was noted in the south of the area.

5.29 A chain of weaker dipolar magnetic anomalies detected in the north of the area may also reflect a service.

5.30 A curvilinear negative magnetic anomaly has been detected at the north of the area, parallel to the northern boundary. This is likely to reflect a drain.

5.31 Strong dipolar magnetic anomalies have been detected along the edges of the area. These reflect the metal field boundaries and other highly magnetically susceptible features, such as gates and buildings. A discrete, strong dipolar magnetic anomaly detected in the west of the area corresponds to a cattle feeder.

Area 7

5.32 This area is very similar in character to Area 6, to the north. The same magnetically noisy background has been detected. Again this is likely to reflect an igneous component to the underlying geology.

5.33 A chain of dipolar magnetic anomalies has been detected to the south of the copse in the north of the area. This reflects the former boundary, as was identified in Area 6 to the north.

5.34 Several chains of strong dipolar magnetic anomalies have been detected in this area. These almost certainly reflect services, including a continuation of the electric cable detected in Area 6 to the north. A linear negative magnetic anomaly, with occasional corresponding dipolar magnetic anomalies, has been detected in the east of the

area. This also likely to reflect a service, continuing into Area 8 to the south. An inspection chamber was noted at the north end of this.

5.35 Dipolar magnetic anomalies detected at the edges of the area reflect a metal boundary, with gates in the north-west, north-east and south.

Area 8

5.36 The magnetically noisy background noted in Areas 4-7 to the north has also been detected in this area.

5.37 A linear negative magnetic anomaly has been detected in the west of this area. This almost certainly reflects a continuation of a service detected in Area 7, to the north. A dipolar magnetic anomaly detected at the north of this corresponds to an inspection chamber.

5.38 Dipolar magnetic anomalies along the north edge of the area correspond to the metal boundary. A small region of 'dummy' data in the east corresponds to a telegraph pole.

Area 9-11

5.39 As in Areas 4-8 to the north, these areas are characterised by dipolar magnetic anomalies typical of igneous geological features.

5.40 A series of parallel positive magnetic anomalies have been detected in Area 9. This may reflect a former ploughing regime, such as ridge and furrow cultivation.

5.41 Chains of strong dipolar magnetic anomalies have been detected along the north and east edges of this Area 9 and the east edge of Area 10. These almost certainly reflect services.

5.42 A concentration of dipolar magnetic anomalies at the south end of Area 9 corresponds to a public bridleway.

6. Conclusions

6.1 Geomagnetic survey has been undertaken prior to proposed improvements to the A496 at Llanbedr, Gwynedd.

6.2 The vast majority of anomalies detected in these surveys almost certainly reflect geological variation in the underlying natural subsoils and bedrock.

6.3 A ditch feature, of uncertain provenance, possibly a drainage channel, has been detected in Area 2.

6.4 Features recorded by historic OS editions have been identified in Areas 3, 6 and 7; including former field boundaries and a wooded area.

6.5 Possible remains of former ridge and furrow cultivation have been detected in Area 9.

6.6. Services have been detected in many of the survey areas, as well as a number of inspection chamber covers. Other features, including a probable drain, telegraph poles, fences, gates and a cattle feeder, have also been identified.

7. Sources

Archaeological Services 2010 *Withy End Farm, East Huntspill, Somerset: geophysical survey*. Unpublished report **2559**, Archaeological Services Durham University

Archaeological Services 2013 *J7 A55, Gaerwen, Anglesey: geophysical survey*. Unpublished report **3194**, Archaeological Services Durham University

BGS 2015 online *Geology of Britain viewer* available from: http://mapapps.bgs.ac.uk/geologyofbritain/home.html accessed 16th February 2015

CIfA 2014 *Standard and Guidance for archaeological geophysical survey*. Chartered Institute for Archaeologists

David, A, Linford, N, & Linford, P, 2008 *Geophysical Survey in Archaeological Field Evaluation*. English Heritage

Gaffney, C, Gater, J, & Ovenden, S, 2002 *The use of geophysical techniques in archaeological evaluations*. CIfA Technical Paper **6**, Chartered Institute for Archaeologists

Schmidt, A, 2013 *Geophysical Data in Archaeology: A Guide to Good Practice*. Archaeology Data Service & Digital Antiquity, Oxbow

Regional research framework:

A Research Framework for the Archaeology of Wales available from: http://www.archaeoleg.org.uk/intro.html accessed 16th December 2015

proposed development area

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0 500m
scale 1:12 500 for A3 plot

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Figure 1: Site location

survey area

proposed works

proposed works

-10 nT 12

276

274

272

270

268

266

264

262

576 578 580 582 584 586 588

Area 1

Area 2

Area 3

Area 4

Area 5

Area 6

Area 7

Area 8

Area 9

Area 10

Area 11

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0 250m
scale 1:5000 for A3 plot

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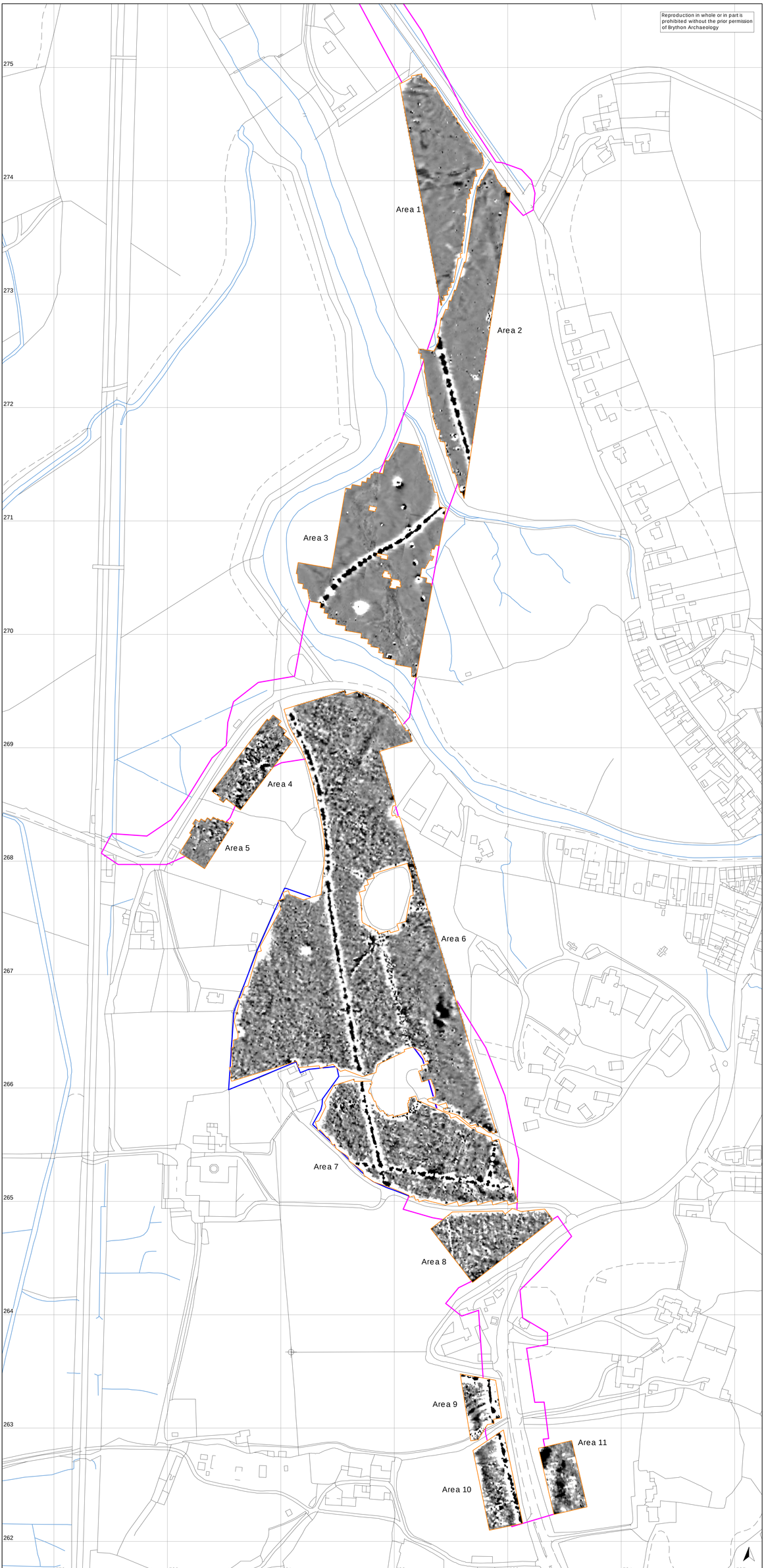
Figure 2: Geophysical survey overview



magnetic survey

-10 nT 10

proposed works

proposed works

0 50m

scale 1:1250 for A0 plot

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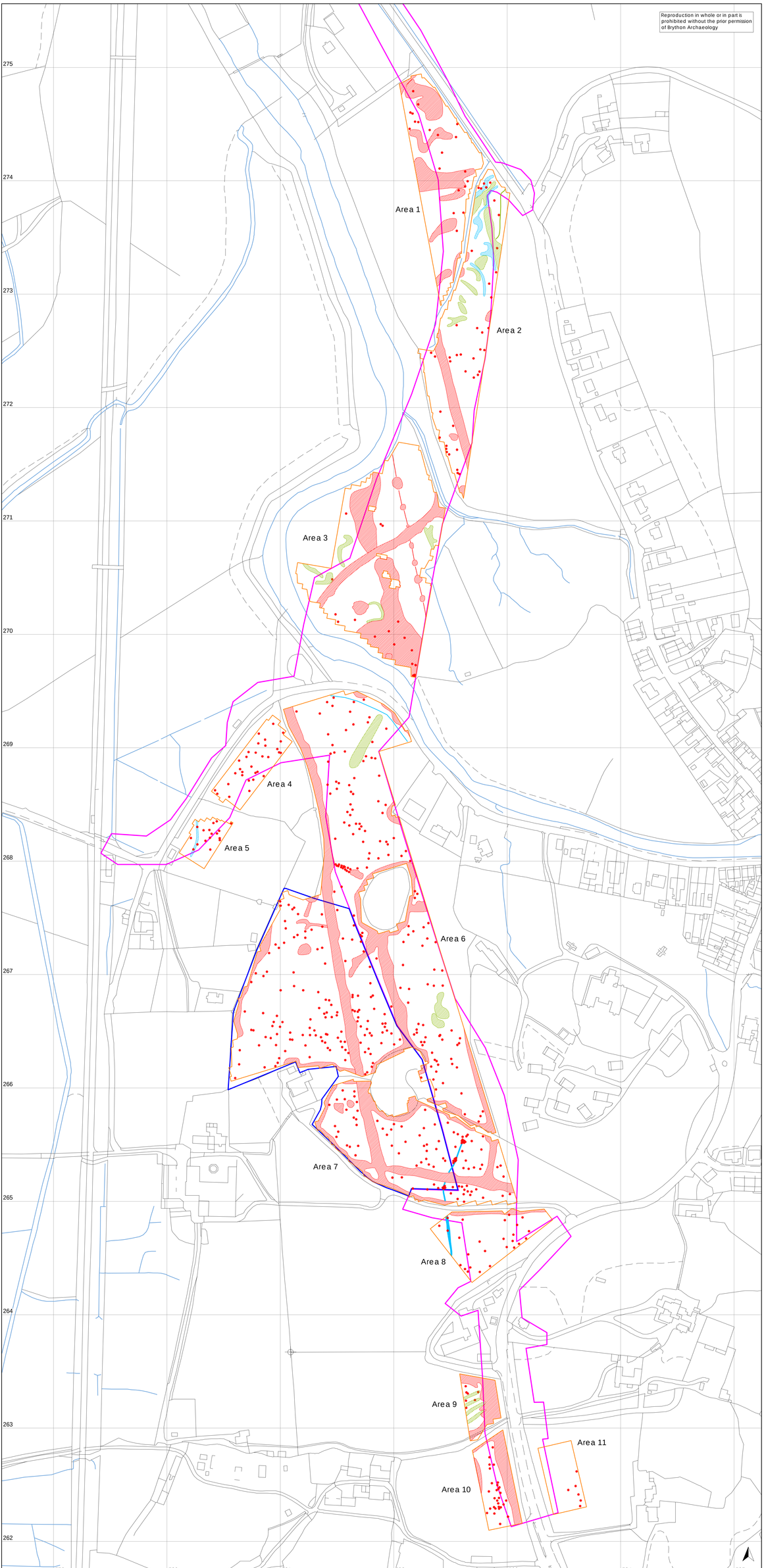
Figure 3: Geophysical survey



magnetic survey
proposed works
proposed works
dipolar magnetic anomaly
postive magnetic anomaly
negative magnetic anomaly

0 50m
scale 1:1250 for A0 plot

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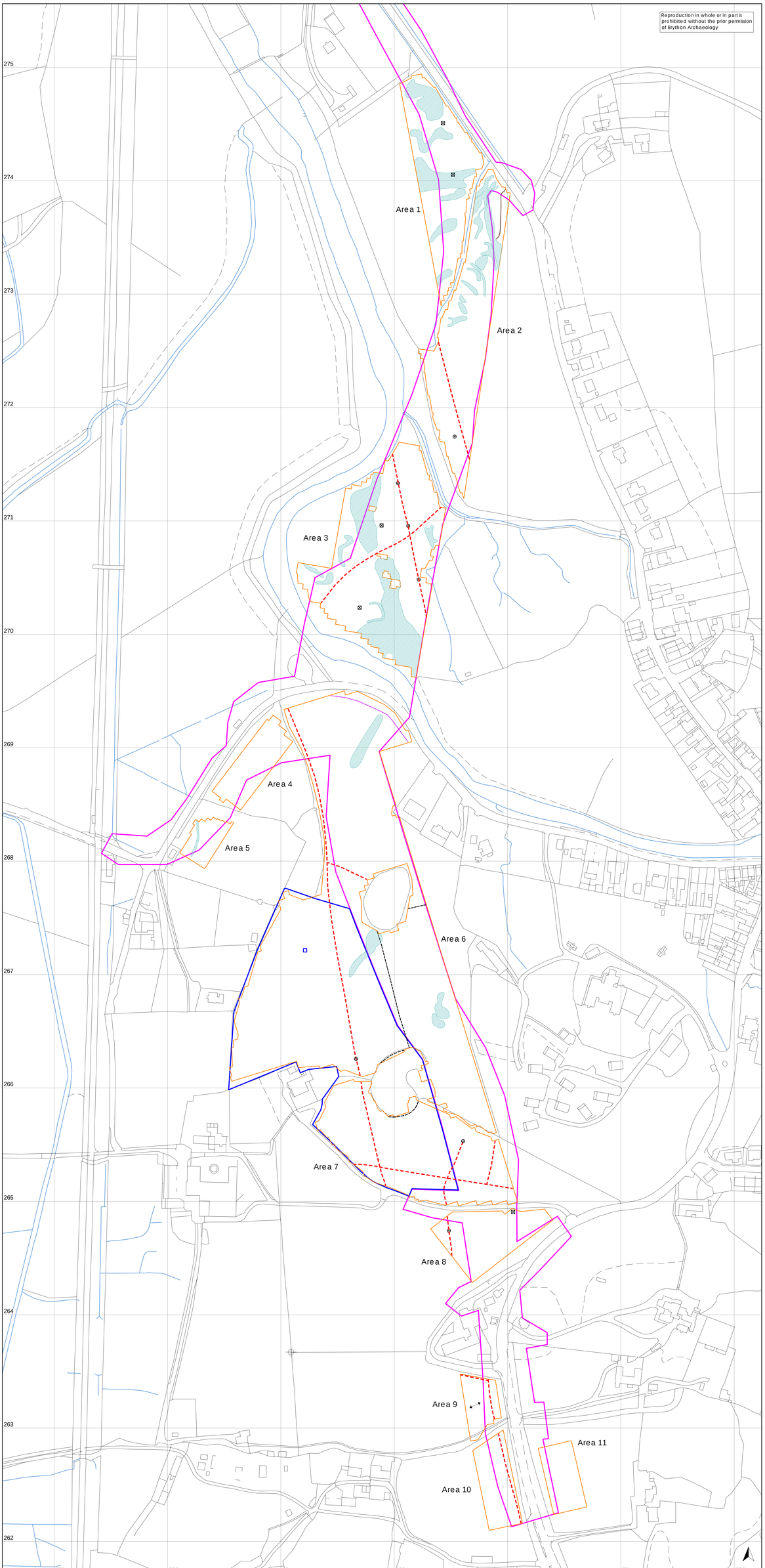
Figure 4: Geophysical interpretation



magnetic survey
proposed works
proposed works
soil-filled feature
geological features
service
ridge and furrow
land drain
former field boundary
telegraph pole
inspection cover
cattle feeder

0 50m
scale 1:1250 for A0 plot

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Figure 5: Archaeological interpretation

0 50m
scale 1:1250 for A0 plot

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Figure 6: Trace plots of geomagnetic data