NAA

GEOPHYSICAL SURVEY

WHINFIELD SOLAR FARM
COUNTY DURHAM

prepared for
Arcus Consultancy Services Ltd

NAA 21/10
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WHINFIELD SOLAR FARM, CO. DURHAM
GEOPHYSICAL SURVEY REPORT

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Disclaimer

The results of geophysical survey may not reveal all potential archaeology and do not provide a comprehensive map of the sub-surface, but only responses relative to the environment. Geological, agricultural and modern responses may mask archaeological features. Short-lived features may not give strong responses. Only clear features have been interpreted and discussed in this report.

WHINFIELD SOLAR FARM, CO. DURHAM
GEOPHYSICAL SURVEY REPORT

Summary

Northern Archaeological Associates (NAA) was commissioned by Arcus Consultancy Services to undertake a geophysical (gradiometer) survey of land surrounding Whinfield House Farm, Co. Durham, in advance of a solar farm development (NGR: NZ 30322 22452).

The geophysical survey was carried out between 1st and 9th February 2021 and covered six fields totalling c.27ha.

Several linear and rectilinear anomalies and trends were identified that are likely to be caused by infilled features. Generally, interpretation of these anomalies was tentative due to inconsistent increases in magnetic value and/or poor patterning. Anomalies with the greatest potential of having an archaeological origin are located in the west and south of the site and plausibly are caused by a former enclosure system. Otherwise, it was unknown if linear anomalies and trends are caused by buried archaeological deposits, agricultural activity or are geological in nature.

Evidence of agricultural activity occurred in all fields targeted by the geophysical survey and comprised ridge and furrow, modern ploughing and land drains. Former field boundaries, trackways and a stream depicted on the 1858 Ordnance Survey map are also evident in the survey results.

Several anomalies were caused by modern activity. In the west of the survey area there are several isolated bipolar anomalies caused by metal pylons that are supporting overhead electrical cables running north–south across the site. Linear bipolar anomalies were identified that relate to buried utilities, and dipolar and bipolar anomalies were present within the site that are caused by material/objects with a high magnetic susceptibility in the topsoil and periphery of the site.

Broad areas of magnetic disturbance were also identified that are caused by natural pedological and geological changes in the substrata.

1.0 INTRODUCTION

1.1 Northern Archaeological Associates (NAA) was commissioned by Arcus Consultancy Services Ltd to undertake a geophysical (gradiometer) survey of c.39.5ha of land surrounding Whinfield House Farm, Co. Durham, in advance of a solar farm development (NZ 30322 22452).

1.2 This report details the setting (location, topography, geology) and archaeological background of the scheme and sets out the methodology used for the geophysical survey. Interpretation of the geophysical survey was achieved through the analysis of identified anomalies and was aided by a rapid examination of supporting information. The results of the geophysical survey are discussed below, and the interpretations are supported by appropriate illustrations. Where feasible, a detailed synopsis of anomalies is provided and, if possible, the features that the anomalies are likely to relate to are suggested.

2.0 LOCATION, TOPOGRAPHY AND GEOLOGY

Location and land use

2.1 The proposed development area (PDA) comprises eight fields surrounding Whinfield House Farm (totalling c.39.5ha) within rural land east of Aycliffe Village in Co. Durham (Fig. 1). Of the eight fields, six fields were considered suitable for geophysical survey (totalling c.27ha).

2.2 The PDA is bordered by agricultural fields on all sides. Ricknall Lane runs to the east and north of the PDA, and the A1(M) is located to the west. The site is bisected by Lime Lane. Six of the fields within the survey area are directly to the north of Lime Lane and comprise arable farmland. The remaining two fields are located to the south of Lime Lane and contain pasture.

Topography

2.3 The topography of the PDA is generally level with a slight rise in the centre along Lime Lane. The north-west of the site forms the lowest point and is at 85m above Ordnance Datum (aOD), while the highest point is in the east at 101m aOD.

Geology and soils

2.4 The geology is composed of Sherwood Sandstone Group. Superficial deposits in the east of the site comprise Clay, Sand and Gravels of the Vale of York Formation. Alluvium and river terrace deposits of sand and gravel are present in the centre of the site, and Devensian Till is in the west of the site (BGS 2021).

2.5 The soils in the east of the site are mapped as being of the Crewe Association, consisting of stagnogley soils in reddish, stoneless till or lacustrine clay (Soil Survey of England and Wales 1983; Jarvis *et al*. 1984, 145). The soils in the west of the site comprise Duneswick Association, which is dominated by stagnogley soils in greyish brown drift derived from carboniferous rocks, Jurassic and Triassic sandstone and occasional limestone (Soil Survey of England and Wales 1983; Jarvis *et al*. 1984, 165).

3.0 ARCHAEOLOGICAL AND HISTORICAL BACKGROUND

3.1 A desk-based assessment for the project is currently being written. The following section therefore provides a short summary of information available at the time this report was prepared.

3.2 There are no listed buildings or scheduled monuments within the direct environs of the PDA. A Scheduled deserted medieval village is located c.1km north of the PDA at Preston-le-Skerne and the Grade II Listed post-medieval Preston Lodge Farmhouse and outbuilding are located c.0.8km to the east of the PDA. Fourteen non-designated heritage assets associated with medieval and post-medieval agricultural activity have been recorded as cropmarks on aerial photographs.

3.3 Historic maps show that the PDA has consisted of rural fields centred on Whinfield Farm since at least the mid-19th century. The First Edition 1858 Ordnance Survey (OS) map records a former trackway running east–west across Area H (see Fig. 2 for Areas). Area B is shown to contain woodland and a trackway until the mid-20th century. Nineteenth-century maps record the presence and growth of Preston Brick and Tile Works and associated clay pit, which were located directly to the north of the PDA until they fell out of use at the turn of the 20th century. On the 1923 OS map, the Preston Brick and Tile Works is labelled as disused.

4.0 AIMS AND OBJECTIVES

4.1 The aim of the geophysical survey was to map and record potential buried features located within the PDA. Through analysis of the results of the geophysical survey, NAA aimed to provide a detailed interpretation of the archaeological potential of the site that will inform subsequent archaeological mitigation strategies.

4.2 The objectives of the survey were to:

- undertake a geophysical survey across areas deemed suitable for data collection within the PDA;
- attempt to identify, record and where possible characterise any subsurface remains within the survey boundary;
- assess the archaeological potential of identified anomalies; and
- identify possible concentrations of past activity in order to inform the requirement for any further archaeological investigation at the site.

5.0 METHODOLOGY

5.1 All survey work was completed to appropriate standards contained in current guidelines (CIfA 2014; Schmidt *et al*. 2015). The gradiometer survey used Bartington Grad601-2 dual magnetic gradiometer systems with data loggers. Readings were recorded at a resolution of 0.01nT, and data was collected with a traverse interval of 1m and a sample interval of 0.25m. The survey data was collected with reference to a site survey grid comprised of individual 30m x 30m squares. The grid was established using Real Time Kinematic (RTK) differential GPS equipment and marked out using non-metallic survey markers. All grid nodes were set out with a positional accuracy of at least 0.1m and could be relocated on the ground by a third party. The base lines used to create the survey grids are shown on Figure 2 and further details are available in Appendix A.

5.2 The processing was undertaken using Geoplot 3.0 software and consisted of standard processing procedures. Details of processing steps applied to collected data are provided in Appendix B.

5.3 On the greyscale plots, positive readings are shown as increasingly darker areas and negative readings are shown as increasingly lighter areas (Figs 3, 4, 6, 8, 10, 12 and 14).

5.4 Identified anomalies are generally interpreted by analysis of patterning and increases in magnetic response, which is often aided by examining supporting information. The interpreted data uses colour coding to highlight specific readings in the survey area (Fig 5, 7, 9, 11, 13 and 15). Appendix C details the terminology and characterisation of anomalies used for interpreting data.

Surface conditions and other mitigating factors

5.5 During fieldwork there were several episodes of bad weather including heavy rainfall and snow. Consequently, ground conditions were variable, and areas were deemed not suitable for survey where heavy waterlogging occurred – such as the east of Area F and part of Area B. Areas C and D both contained ploughed soil with large clods and so could not be surveyed. In total, c.12.5ha of the PDA was deemed unsuitable for data collection.

5.6 Field boundaries comprised hedgerows and metal fencing; there were occasional areas of high vegetation along field edges. Several bird scarers were located in Area H and there were metal pylons in Areas A, B, F, G and H.

5.7 Several artificial negative anomalies running on an east–west orientation correspond with the edges of grids in Areas F and G.

5.8 Attempts were made to avoid areas affected by above-ground features that were likely to have a high magnetic susceptibility, such as metal fencing, to minimise the potential for their magnetic responses to impinge on the survey results and mask potential buried features.

6.0 RESULTS

6.1 This section provides a detailed interpretation of the areas surveyed, and discusses anomalies identified generally across the site.

General anomalies across the whole site (Figs 4 and 5)

6.2 There are several weak and diffuse linear trends. Generally, these fail to produce the necessary patterning or increases in magnetic response in order to be interpreted fully, and as a consequence their origin is unknown.

6.3 There are numerous alignments of regularly spaced linear anomalies considered most likely to relate to agricultural activity. Those with a broad spacing and an 'S' curve are considered to be indicative of earlier agricultural features, such as ridge and furrow, while those with a narrow spacing and straight form are likely to denote modern ploughing. Linear anomalies with a very broad spacing and straight form are likely to denote land drains. It should be noted that land drains were often built into ridge and furrow, so their location might identify the former features. Isolated linear anomalies with weak increases in magnetic strength are likely to be agricultural in origin, but their exact cause is unknown.

6.4 Several bipolar responses were identified. Isolated bipolar anomalies are considered to be modern and caused by material with a high magnetic susceptibility, such as ferrous objects. Linear bipolar anomalies are likely to denote buried utilities. The strength and size of the anomaly associated with the buried utility reflect the highly magnetic responses of the ferrous material of the buried pipe rather than actual feature dimensions.

6.5 Dipolar anomalies often relate to ferrous or modern objects buried in the topsoil. Consequently, these anomalies are generally considered to be of a modern nature and so have not been depicted on interpretation plots.

6.6 Concentrations of dipolar anomalies have been identified that are likely to be caused by modern magnetic debris in the topsoil or near the surface; concentrations of bipolar anomalies—predominantly located along the edges of the survey area—relate to above-ground features external to the survey area, such as metal fencing, gates and electricity poles. There is evidence on 19th-century OS maps of a brick and tile works and clay pits to the north of the PDA, and so it is possible that concentrations of dipolar/bipolar anomalies may in part relate to activity associated with the works.

6.7 There are several broad responses that are considered likely to be caused by geological or pedological changes in the substrata.

Area A (Figs 6 and 7)

6.8 A linear anomaly runs diagonally north-west to south-east through the centre of Area A (**A1**). The increases in magnetic value suggest that **A1** relates to an infilled feature, but its location and patterning make interpretation difficult. Although very tentative, it is plausible that is it caused by a former trackway.

6.9 Regularly spaced linear anomalies were identified on an east–west orientation: those with a broad spacing in the east of Area A are likely to denote ridge and furrow, whilst those with a narrow spacing in the west of Area A are plausibly caused by modern ploughing. Anomalies to the east of the ridge and furrow running north–south are likely to form a headland. Several regularly spaced linear anomalies were identified on a north–south orientation. Although they are likely to be of agricultural in nature, detailed interpretation is tentative due to their weak increases in magnetic value, and it is not known if they relate to modern agricultural practices—such as land drains—or an historic period of land cultivation. There is a clear edge between anomalies running on an east–west orientation caused by ridge and furrow and those on a north–south orientation or of an unknown origin (**A2**). Although tentative, it is possible that this change in orientation of agricultural activity denotes a former field boundary.

6.10 Two bipolar anomalies were identified that correspond with locations of metal pylons that support electrical cables and run north–south across the PDA through Areas A, F, G and H (**A3**).

Area B (Figs 6 and 7)

6.11 Several broadly spaced linear anomalies correspond with ridge-and-furrow earthworks that run north–south in Area B. A second orientation of regularly spaced linear anomalies composed of weak increases in magnetic value runs east–west and is likely to denote an earlier period of ridge-and-furrow cultivation.

6.12 A former trackway recorded on the 1858 OS map appears as a linear concentration of bipolar anomalies (**B1**).

6.13 A bipolar linear anomaly caused by a buried utility runs north–south in the west of Area B (**B2**).

6.14 Several isolated bipolar anomalies were identified running on an east–west alignment through the north of Area B (**B3**). It is likely that these denote ferrous material. Although speculative, their alignment may be indicative of a buried utility with metal connectors.

6.15 A large bipolar anomaly occurs in the east of Area B, where historic maps depict a woodland during the 19th and first half of the 20th century (**B4**). Although it is likely that B4 relates to a ferrous object, it is unknown if it is caused by activity associated with the deforestation of the former woodland or pylons and other utilities running through this area.

6.16 The broad areas of magnetic disturbance identified in Area B is likely to be caused by geological or pedological changes in the substrata (**B5**).

Area D (Figs 8 and 9)

6.17 A former field boundary recorded on the 1858 OS map appears as a linear anomaly composed of very weak increases in magnetic value (**D1**).

6.18 Several regularly spaced anomalies associated with agricultural activity were identified. In the south of Area D, regularly spaced anomalies were identified on a north–south and east–west orientation, which possibly denote cultivation activity of an unknown date. Those running on north-west to south-east and north-east to south-west orientations in the north of Area D are composed of weak increases in magnetic value and have a very broad spacing. Interpretation is tentative, but it is plausible that these anomalies denote land drains. The linear anomalies running along the northern edge of the field are likely to relate to modern cultivation techniques and are caused by a headland or tractor tramlines.

6.19 A bipolar anomaly runs on a north-west to south-east orientation through the west of the field that denotes a buried utility (**D2**).

6.20 A concentration of dipolar anomalies was identified in the east of Area D that is likely to be caused by ferrous material in the topsoil (**D3**).

Area F (Figs 10 and 11)

6.21 A field boundary illustrated on the 1857 OS map runs north–south through the centre of Area F (**F1**).

6.22 A rectilinear anomaly was identified in the north of Area F (**F2**) that is likely to denote an infilled feature. Given the poor patterning and inconsistent increases in magnetic value it is not known if **F2** is of an agricultural, archaeological or geological origin.

6.23 A series of linear anomalies occurs in the south of Area F that is also likely to relate to infilled features (**F3**). Although tentative, it is plausible that they denote buried archaeological features and relate to an enclosure system.

6.24 Regularly spaced anomalies plausibly associated with land drains appear clearly on a north-northwest to south-southeast orientation in the west of Area F. Although speculative, it is plausible that these land drains were built into former ridge and furrow.

6.25 There are several orientations of narrowly spaced linear anomalies in the east of Area F composed of weak increases in magnetic value that are likely to relate to modern ploughing. Several anomalies composed of very weak increases in magnetic values were identified on a south-west to north-east orientation in the north of Area F that are possibly caused by land drains.

6.26 A bipolar anomaly was identified in the centre of Area F that corresponds with a metal pylon that carries electrical cables running through Areas A, F, G and H.

Area G (Figs 12 and 13)

6.27 Several linear anomalies were identified in the south of Area G (**G1**) that are likely to relate to infilled features. Although it cannot be completely dismissed that **G1** relates to buried archaeological features, inconsistent increases in magnetic value and incomplete patterning make interpretation difficult. Consequently, it is equally plausible that **G1** is in part agricultural or geological in nature. If **G1** is of an archaeological origin, it is likely to denote an enclosure system, but it is not possible to suggest whether they belong to the same period of activity as **F3**.

6.28 Regularly spaced linear anomalies running north–south are likely to be caused by ridge and furrow.

6.29 Two isolated bipolar anomalies (**B2** and **B3**), are caused by pylons located in the field that support electricity cables that traverse across Areas A, F, G and H.

Area H (Figs 14 and 15)

6.30 A weak and diffuse trend corresponds with the location of a feature (possible stream?) shown on the 1857 OS map (**H1**). Other trends were identified in the north of Area H but lacked the necessary increases in magnetic value and patterning for detailed interpretation. Consequently, their origin is not known.

6.31 Three possible orientations of ridge and furrow were identified within Area H, as well as several regularly spaced linear anomalies that possibly denote land drains.

6.32 The linear bipolar anomaly in the east of the area relates to a buried utility (**H3**) and the amorphous bipolar anomaly in the west of the area relates to a pylon (**H4;** Area G **G2**).

6.33 Several broad anomalies were identified that are plausibly caused by geological or pedological changes in the substrata (**H5**).

7.0 CONCLUSIONS

7.1 NAA was commissioned to undertake a geophysical (gradiometer) survey on land at Whinfield Farm, County Durham, to support a planning application for a proposed solar development.

7.2 Several linear and rectilinear anomalies were identified in the south and west of the PDA that are likely to relate to infilled features that plausibly denote a former enclosure system. Interpretation of these anomalies was tentative due to incomplete patterning and inconsistent increases in magnetic values. Consequently, these anomalies may also be, in part, caused by agricultural activity or geological or pedological changes in the substrata. Likewise, several trends were identified across the PDA, but were composed of weak increases in magnetic response or poor patterning and their origin is unknown.

7.3 Overwise, the results of the geophysical survey related to agricultural and modern activity. Several phases of ridge and furrow were identified across the survey area, as well as evidence of modern ploughing and land drains. Former field boundaries, trackways and a possible stream recorded on the 1858 OS map appeared within the survey results, as well as a possible trackway that is not depicted on historic maps.

7.4 Several linear bipolar anomlies were identified, which are caused by buried utilities and a series of large isolated bipolar and anomalies ran north–south across Areas A, F G and H and were caused by metal pylons supporting electricity cables. Concentrations of dipolar anomalies and linear areas of broad anomalies were also identified, and considered to be either modern or geological in nature.

8.0 STORAGE AND CURATION

8.1 The records of the geophysical survey are currently held by NAA. All material will be appropriately packaged for long-term storage in accordance with national guidelines (CIfA 2014; Schmidt *et al*. 2015). An OASIS form will be completed on the results of the works within three months of the completion of the project under the reference number northern1-415998. This will include submission of a PDF version of the final report to the Archaeology Data Service via the OASIS form.

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Online sources

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Historic England National Heritage List for England https://historicengland.org.uk/advice/hpg/heritage-assets/nhle/

Old Maps www.old-maps.co.uk

Google Earth http://earth.google.co.uk

Magic (DEFRA) http://magic.defra.gov.uk/MagicMap.aspx

NPPF Planning Practice Guidance https://www.gov.uk/government/collections/planning-practice-guidance

British Geological Survey GeoIndex https://www.bgs.ac.uk/

Domesday Book www.opendomesday.org

APPENDIX A:
TECHNICAL INFORMATION

GRADIOMETER SURVEY

Magnetic surveys measure distortions in the earth's magnetic field caused by small magnetic fields associated with buried features (Gaffney and Gater 2003, 36) that have either remanent or induced magnetic properties (Aspinal *et al*. 2008, 21–26). Human activity and inhabitation often alters the magnetic properties of materials (*ibid*., 21) resulting in the ability for numerous archaeological features to be detected through magnetic surveys. Intensive burning or heating can result in materials attaining a thermoremanent magnetisation; examples of which include kilns, ovens, heaths and brick structures (Gaffney and Gater 2003, 37; Aspinal *et al*. 2008, 27). When topsoil rich with iron oxides, fills a man-made depression in the subsoil, it creates an infilled feature, such as a pit or ditch, with a higher magnetic susceptibility compared to the surrounding soil (Gaffney and Gater 2003, 22–26; Aspinal *et al*. 2008, 37–41). Magnetic surveys can also detect features with a lower magnetically susceptibility than the surrounding soil, an example of which is a stone wall.

LIMITATIONS

Poor results can be due to several factors including short-lived archaeological occupation/use or sites with minimal cut or built features. Results can also be limited in areas with soils naturally deficient in iron compounds or in areas with soils overlying naturally magnetic geology, which will produce strong responses masking archaeological features.

Overlying layers, such as demolition rubble or layers of made ground, can hide any earlier archaeological features. The presence of above ground structures and underground services containing ferrous material can distort or mask nearby features.

Particularly uneven or steep ground can increase the processing required, or distort results beyond the capabilities of processing. It is also possible in areas containing dramatic topographical changes that natural weathering, such as hillwash, often in combination with intensive modern ploughing, will reduced the topsoil on slopes and towards the peaks of hills and possibly destroy or truncate potential archaeological features. Conversely, features at the bottom of slopes may be covered by a greater layer of topsoil and so if buried features are present they appear faint within the results, if at all.

Over processing of data can also obscure or remove features, especially if they are on the same orientation as the direction of data collection. Consequently, where possible, attempts are made to ensure data is not collected on the same orientation as known potential features and that data quality is sufficient to minimise the required data processing.

INSTRUMENTATION

The data was collected using handheld Bartington Grad 601-2 fluxgate gradiometers. The Bartington 601-2 is a single axis, vertical component fluxgate gradiometer comprising a data logger battery cassette and two sensors. The sensors are Grad-01-1000L cylindrical gradiometer sensors mounted on a rigid carrying frame; each sensor contains two fluxgate magnetometers with 1m vertical separation.

The difference in the magnetic field between the two fluxgates in each sensor is measured in nanoTesla (nT). NAA gradiometer data is recorded with a range of ±100nT, which equates to a resolution of 0.01nT. It should be noted that the actual resolution is limited to 0.03nT as a consequence of internal instrumental noise (Bartington Instruments Ltd n.d., 23).

The gradiometer records two lines of data on each traverse, the grids are walked in a zig-zag pattern amounting to 15 traverses. The gradiometers are calibrated at the start of every day and recalibrated whenever necessary.

SURVEY DETAILS

Table A1: survey summary.

	Survey
Grid size Traverse interval Reading interval Direction of 1st traverse	30m x 30m 1m 0.25m N
Number of Grids	421
Area covered	27ha

Table A2: baseline co-ordinates (baseline is shown on Fig. 2).

Grid point (gp) A	Grid point (gp) B
NGR: 430260.1225 430260.1225	NGR: 430320.1225 522965.4235

Table A3: site information and conditions.

Item	Detail
Geology Superficial deposits	Sherwood Sandstone Group E – Clay, Sand and Graves of the Vale of York C – Alluvium and river terrace deposits of sand and gravel W – Devensian Till
Soils	Crewe Association
Topography	85m to 101m aOD
Land use	Mixed used: pasture/arable
Weather/conditions prior to and during survey	Overcast, heavy rain, heavy snowstorms

APPENDIX B:

DATA PROCESSING INFORMATION

Gradiometer survey data is downloaded using the Bartington Grad 601 software and the processing was undertaken using Geoplot 3.0 software.

Table B1: commonly applied techniques.

Process	Effect
Zero mean traverse	Removes stripping which can occur as a consequence of using multi sensor arrays or a zig-zag data collection method by setting the mean reading for each traverse to zero.
Destagger	Removes stagger in the data introduced through inconsistence data collection pace and often exacerbated through the zig-zag methodology.
Clip	Clips data above or below a set value to potentially enhance potential weaker anomalies.
Despike	Removes random spikes or high readings to reduce the appearance of dominant readings, often created by modern ferrous objects that can distort the results.
Low pass filter	Removes low frequency waves or broad anomalies such as those caused by strong or large gradual variations in the soil's magnetic susceptibility often caused by geological or natural changes in the substrata.
Interpolation	Used to smooth or reduce the blocky appearance of data by improving the spatial density and balance the quantity of data points in the X and Y directions.

Table B2: processing steps.

Minimal processing	Increased processing
• Zero mean traverse +5/-5 • Destagger	• Low Pass Filter • Interpolate Y, Expand – Linear

APPENDIX C:

DATA VISUALISATION INFORMATION

FIGURES

The data from the surveys was used to produce a series of images to represent the results. The terminology is detailed below:

- Greyscale/Colourscale Plot: this visualised the results as a shaded drawing with highest readings showing as black, running through to lowest shade showing as white.

- XY-trace Plot: this creates a line drawing showing the peaks and troughs of the readings as vertical offset from a centreline.

- Interpreted Plot: through detailed analysis, anomalies have been interpreted and possible features identified. Interpretation drawings are used to show potential features and, in particular, to reinforce and clarify the written interpretation of the data. Anomalies have been characterised using the terminology detailed in the following section, and have been assigned colour coding outlined in keys found on the relevant figures associated with this report.

MAGNETIC ANOMALIES AND TERMINOLOGY

Table C1: lexicon of terminology.

Terminology	Detail
Anomaly	Any outstanding high or low readings forming a particular shape or covering a specific area with the survey results.
Feature	A man-made or naturally created object or material that has been detected through investigation works and has sufficient characteristics or supporting evidence for positive identification.
Magnetic susceptibility	The ability of a buried feature to be magnetically induced when a magnetic field is applied.
Magnetic response	The strength of the changes in magnetic values caused by a buried feature with either a greater or lesser ability to be magnetised compared with the soil around it. Anomalies are considered to either have strong/weak or positive/negative responses. The strength of magnetic response (along with patterning) can be essential in determining the nature of an anomaly, but it should be noted that the size or strength of the magnetic response does not correlate with the size of the buried feature.
Patterning of an anomaly	The shape or form of an individual anomaly.

Different anomalies can represent different features created by human, agricultural or modern activity, or natural pedological or geological changes in the substrata.

Anomalies interpreted with a ‘greater’ categorisation are considered more likely to be of the interpreted characterisation; whereas a more tentative interpretation is applied to those with a 'lesser' categorisation as a consequence of weaker increases in magnetic response or the anomalies incomplete patterning or irregular form.

The strength and size of anomalies can vary depending on the magnetic properties of the feature, the magnetic susceptibility of the soil, the depth to which the feature is buried, and the state of preservation.

Table C2: characterisation of anomalies.

Characterisation	Detail
Archaeology?	
Linear anomaly (infilled feature)	Linear anomalies with a positive or negative magnetic responses, and composed of a patterning or shape that is suggestive of a buried archaeological feature. These are often indicative of structural remains or infilled features such as ditches. The strength of anomaly signal can be suggestive of the properties of the feature. Negative linear anomalies represent upstanding or infilled features that are less magnetically susceptible than background readings, for example structures or ditches composed of a non-igneous stone material. Bipolar linear anomalies considered to be of an archaeological nature are indicative of material with a high magnetic susceptibility, such as a brick wall.
Trends	Weak and diffuse anomalies with an uncertain origin are denoted by trends. It is possible that these belong to archaeological features, but given their weak signatures or incomplete patterning it is equally plausible that they relate to agricultural features or natural soil formations.
Agriculture	
Field boundary	Isolated linear anomalies that are likely to be indicative of former land divisions. A more conclusive interpretation is given to linear anomalies that correspond with the location of field boundaries recorded on historic maps, Aerial photos or LiDAR coverage of the site.
Ridge and furrow	Broadly spaced linear anomalies that are likely to be indicative of earlier forms of agriculture, such as ridge and furrow. These often correspond with the location of earthworks visible on the ground or identified on aerial photos or LiDAR survey coverage.
Agriculture (plough)	Regularly spaced linear anomalies, often with a narrower spacing, that conform with ploughing regime at the time of survey, or a recent regime recorded on aerial photos of the site.
Agriculture (land drain)	The response and distribution of land drains varies depending on the composition of the land drain and associated ditch or channel. Consequently, land drains can be composed of weak/strong positive/negative magnetic responses and are identified as a product of either their variance in magnetic values or positioning compared with regularly spaced linear anomalies considered to relate to modern ploughing. Land drains can be located within former agricultural regimes, such as ridge and furrow.
Agriculture?	Weak, irregularly spaced or isolated linear anomalies that possibly relate to agricultural activity. Given the tentative interpretation, the agricultural process they are caused by is also likely to unknown.
Modern	

Characterisation	Detail
Bipolar response (modern)	Positive anomalies with associated negative 'halo' (bipolar) denote features with a strong magnetic response are likely to be of a modern origin. Isolated bipolar responses of a modern nature are likely to relate to buried ferrous material or objects, such as metallic agricultural debris. If a trend is noted in the alignment or spacing of isolated bipolar responses, it is possible that they are indicative of ferrous fittings or connectors used on buried non-magnetic buried utilities. Linear bipolar anomalies are likely to be indicative of modern services.
Dipolar response	Dipolar anomalies relate to individual spikes within the data and tend to be caused by ferrous objects. These responses have only been shown when located near to archaeological features. When the site is located in a mining landscape it is possible that identified dipolar anomalies relate to mining activity and are indicative of further pits or mine shafts.
Area of increased magnetic response	Areas of increased magnetic response denote areas of disturbance containing a high concentration of dipolar and/or bipolar responses. These are generally considered to be caused by modern debris in the top soil, although it is possible that the disturbance is in part also caused by isolated archaeological material or geological or pedological changes in the substrata. Areas of magnetic disturbance, often along the edges of survey areas are caused by standing metal structures such as fencing and buildings.
Natural	
Area of disturbance (geology)	Areas of variable magnetic responses can demonstrate natural features or changes in geology or soil type these often correspond with topographical variations.

Whinfield Solar Farm, County Durham: Area A, looking north-west *Plate 1*

Whinfield Solar Farm, County Durham: Area B, looking east *Plate 2*

Whinfield Solar Farm, County Durham: Area D, looking north-west *Plate 3*

Whinfield Solar Farm, County Durham: Area E, looking south *Plate 4*

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Whinfield Solar Farm, County Durham: Area F, looking east

Plate 5

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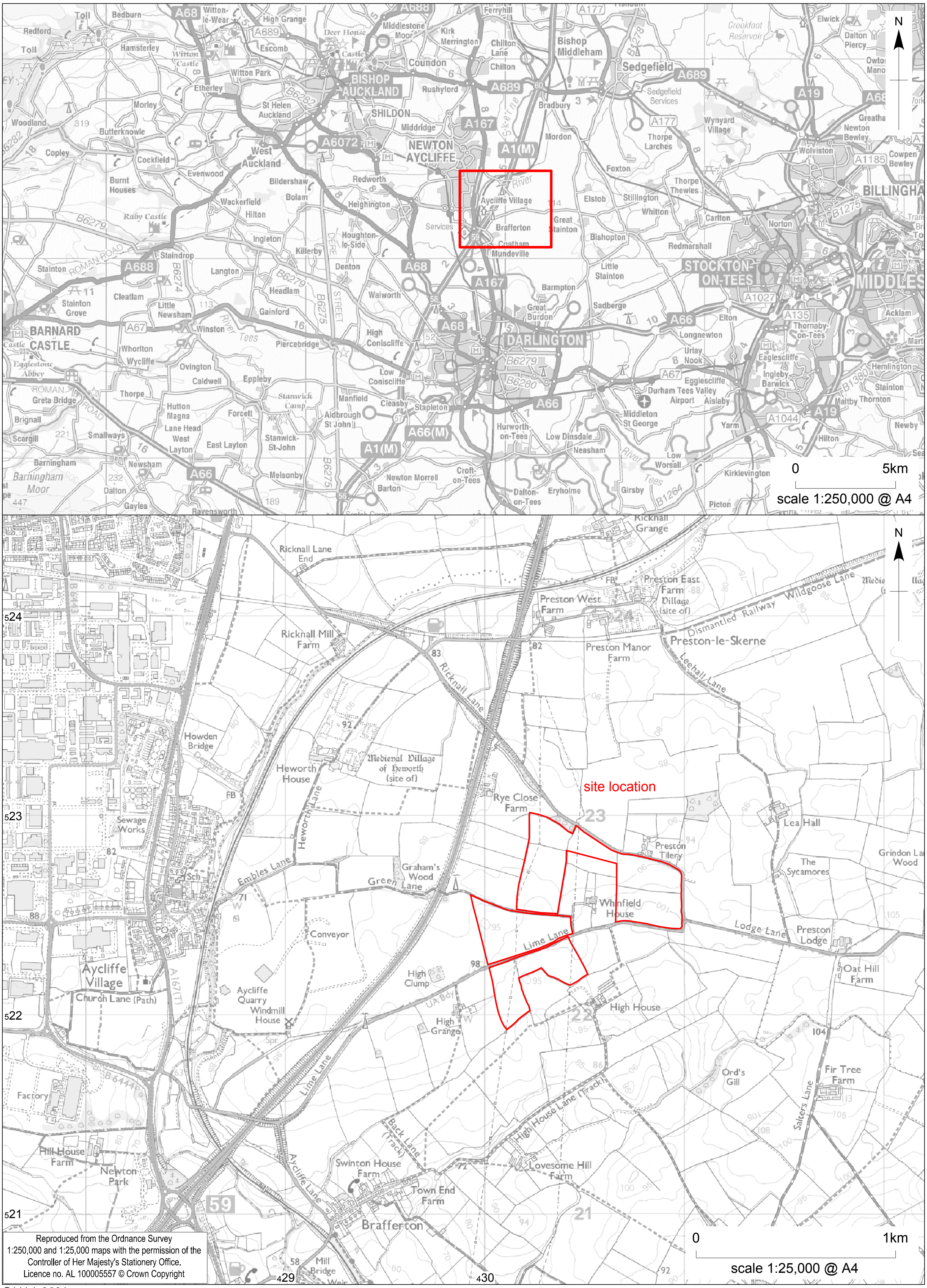
Whinfield Solar Farm, County Durham: Area G, looking south-west

Plate 6

Whinfield Solar Farm, County Durham: Area H, looking south-east

Plate 7



Whinfield, County Durham: site location *Figure 1*

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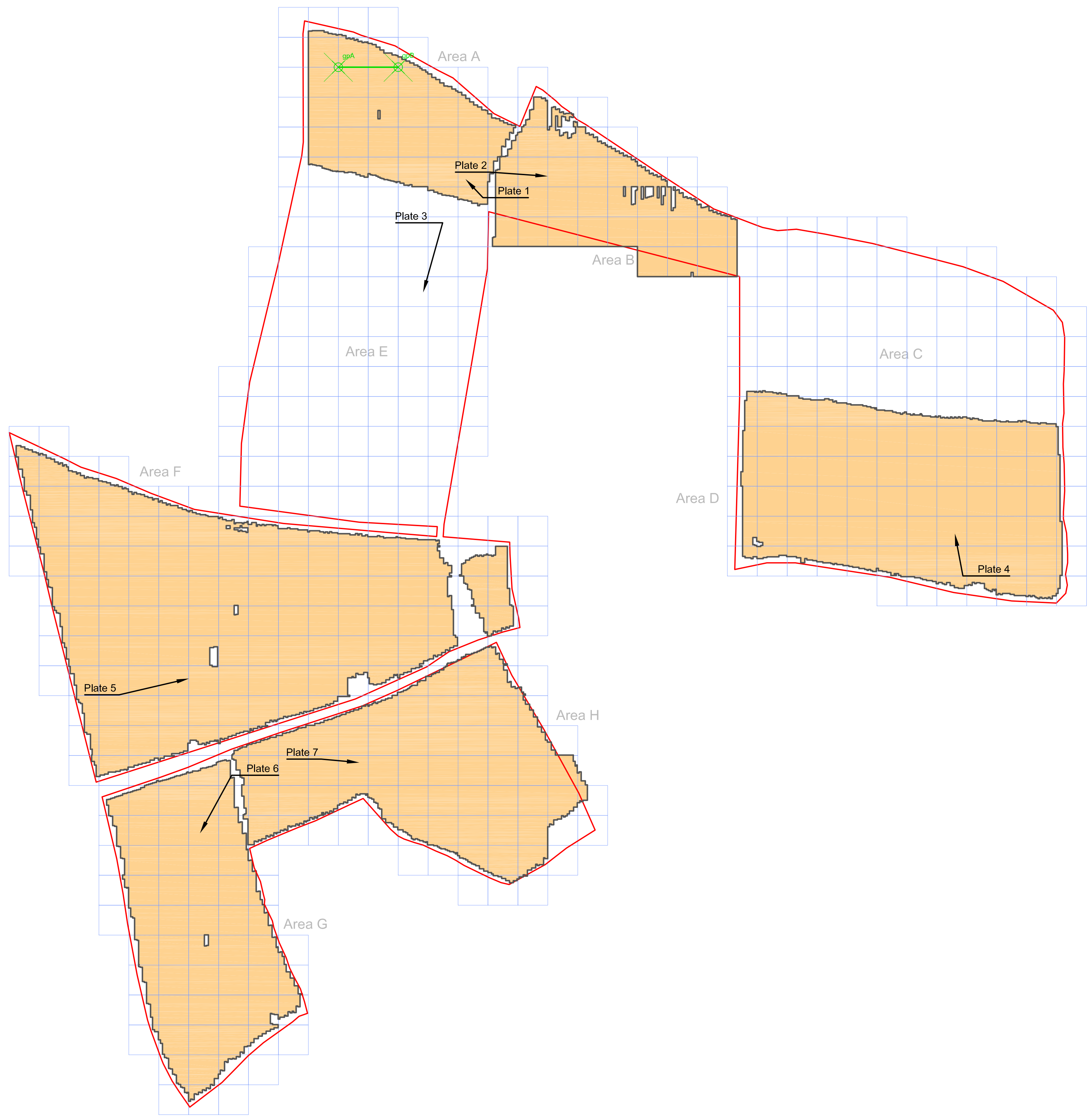


KEY
- geophysical survey baseline
- geophysical survey grid
- geophysical survey area
- proposed development area

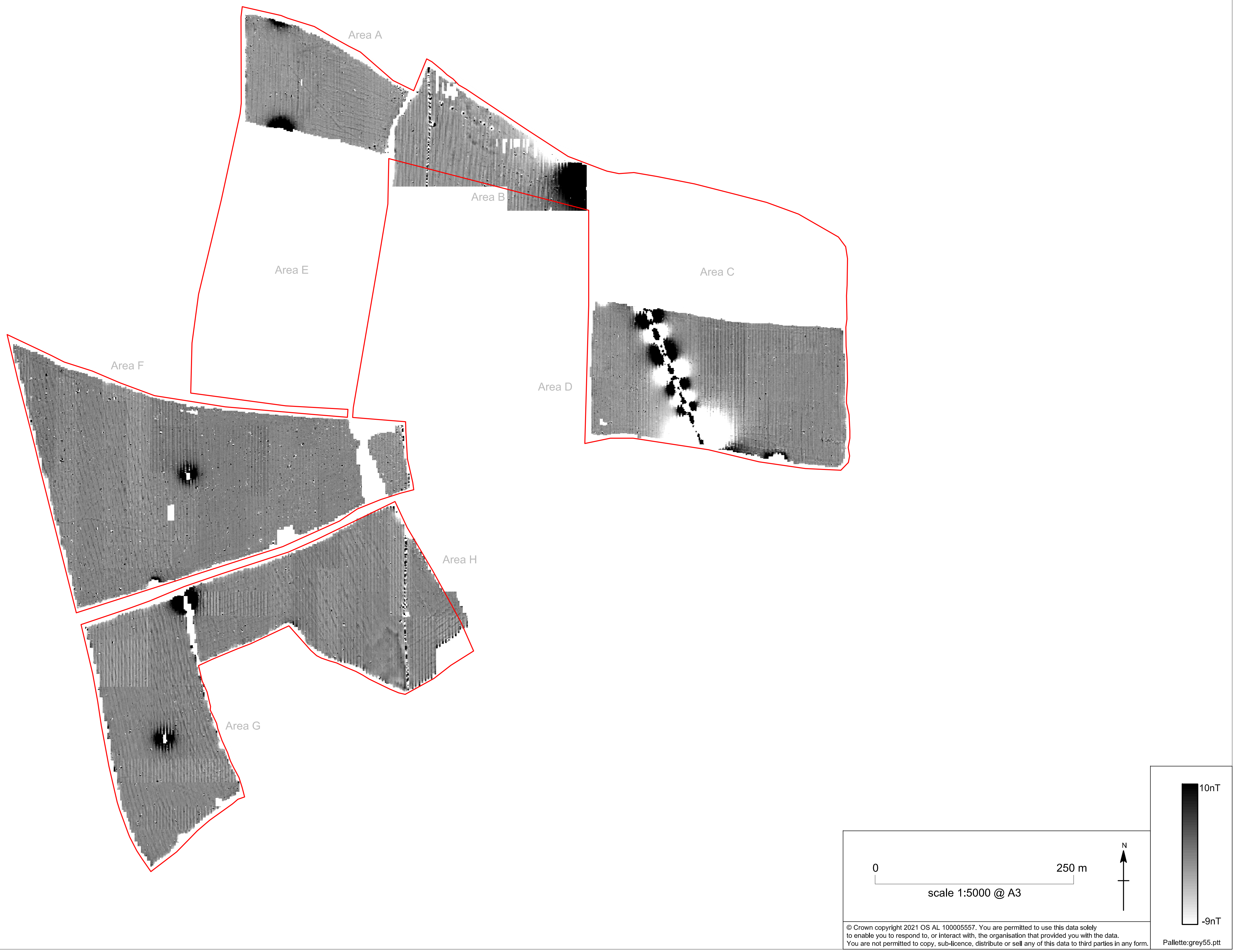
N

0 200 m

scale 1:5000 @ A3

Whinfield Solar Farm, County Durham: location of geophysical survey areas

Figure 2



Whinfield Solar Farm, County Durham: unprocessed greyscale plots of gradiometer survey results

Figure 3

Whinfield Solar Farm, County Durham: processed greyscale plots of gradiometer survey results

Figure 4

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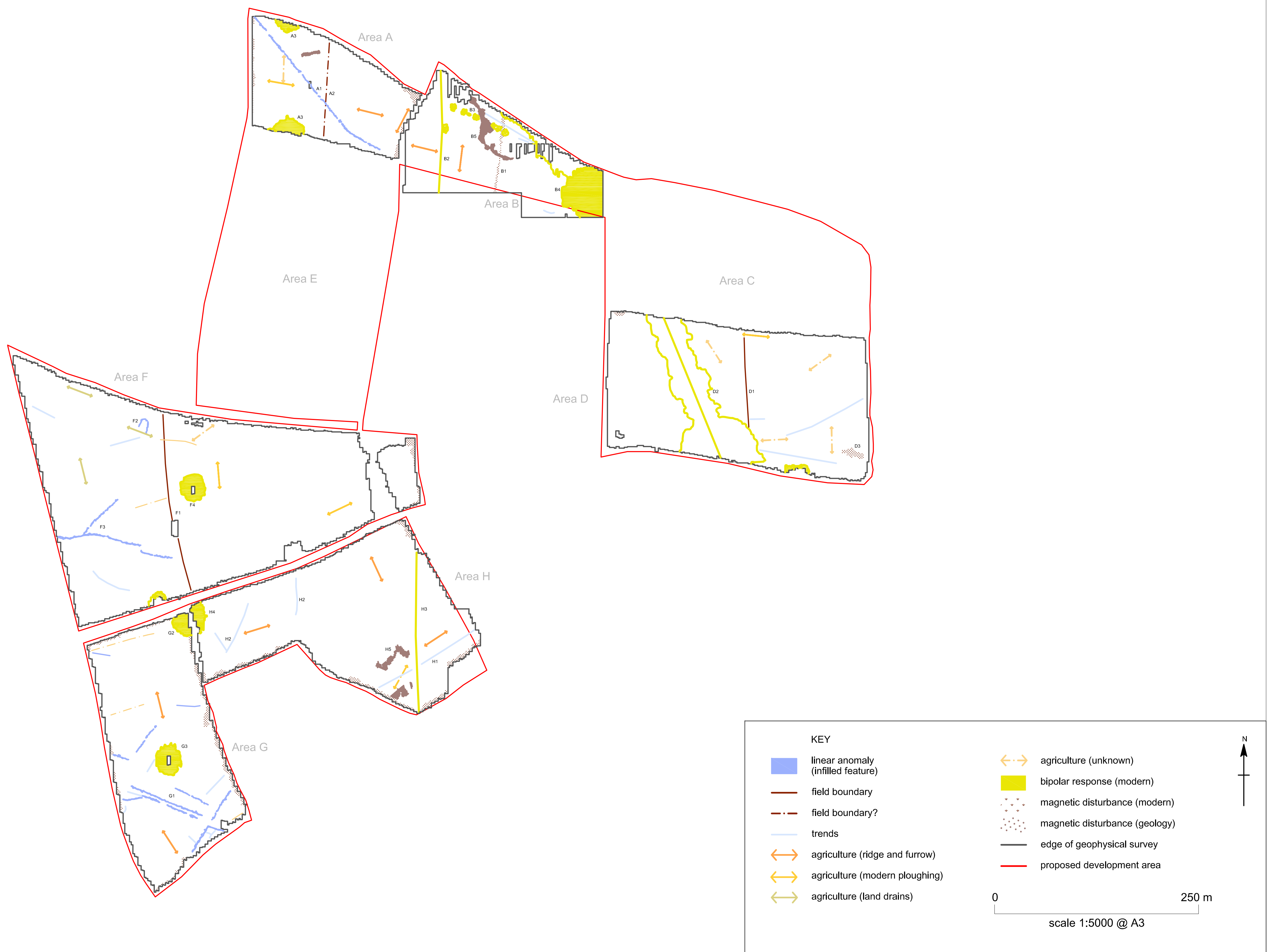
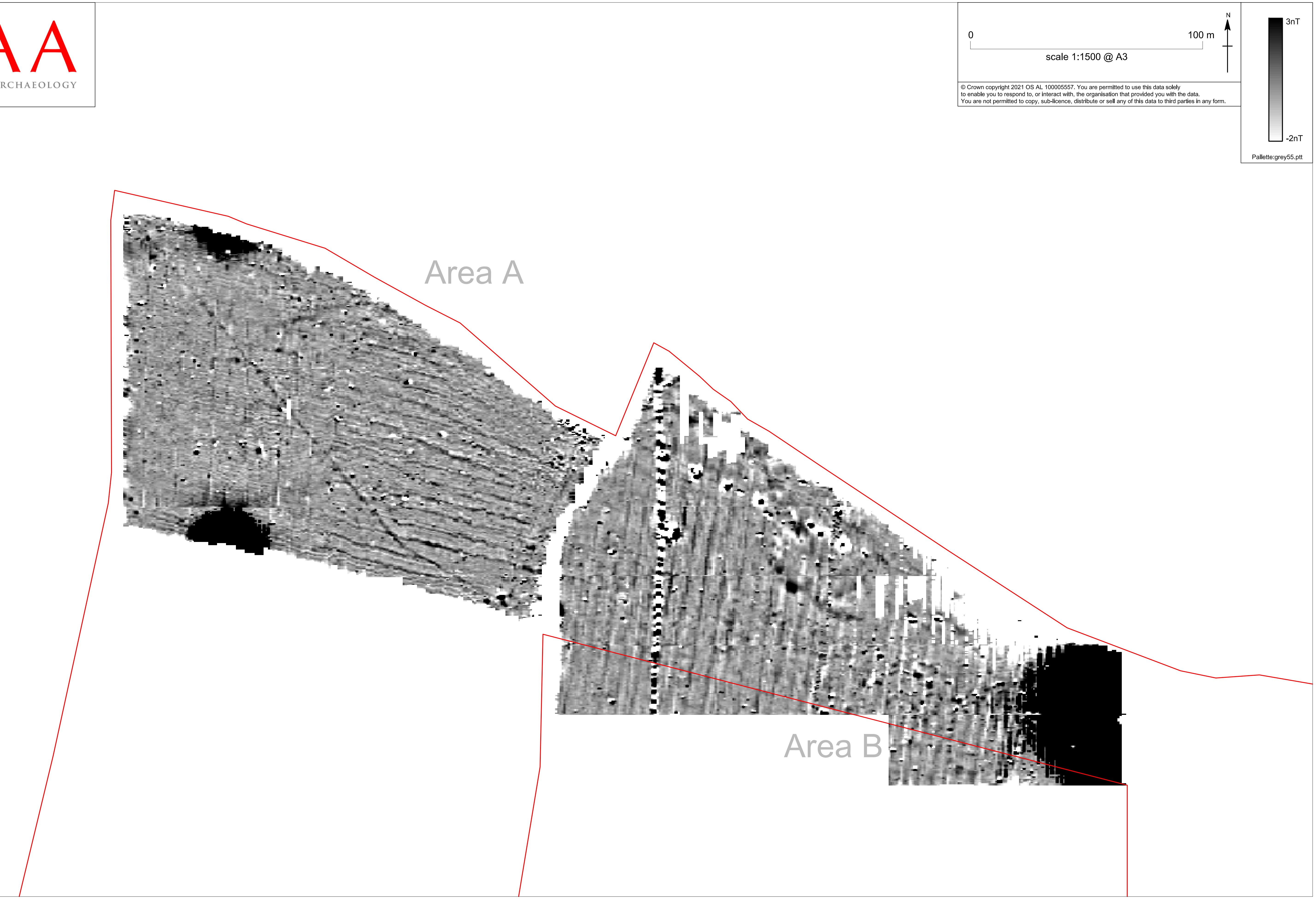
HERITAGE & ARCHAEOLOGY



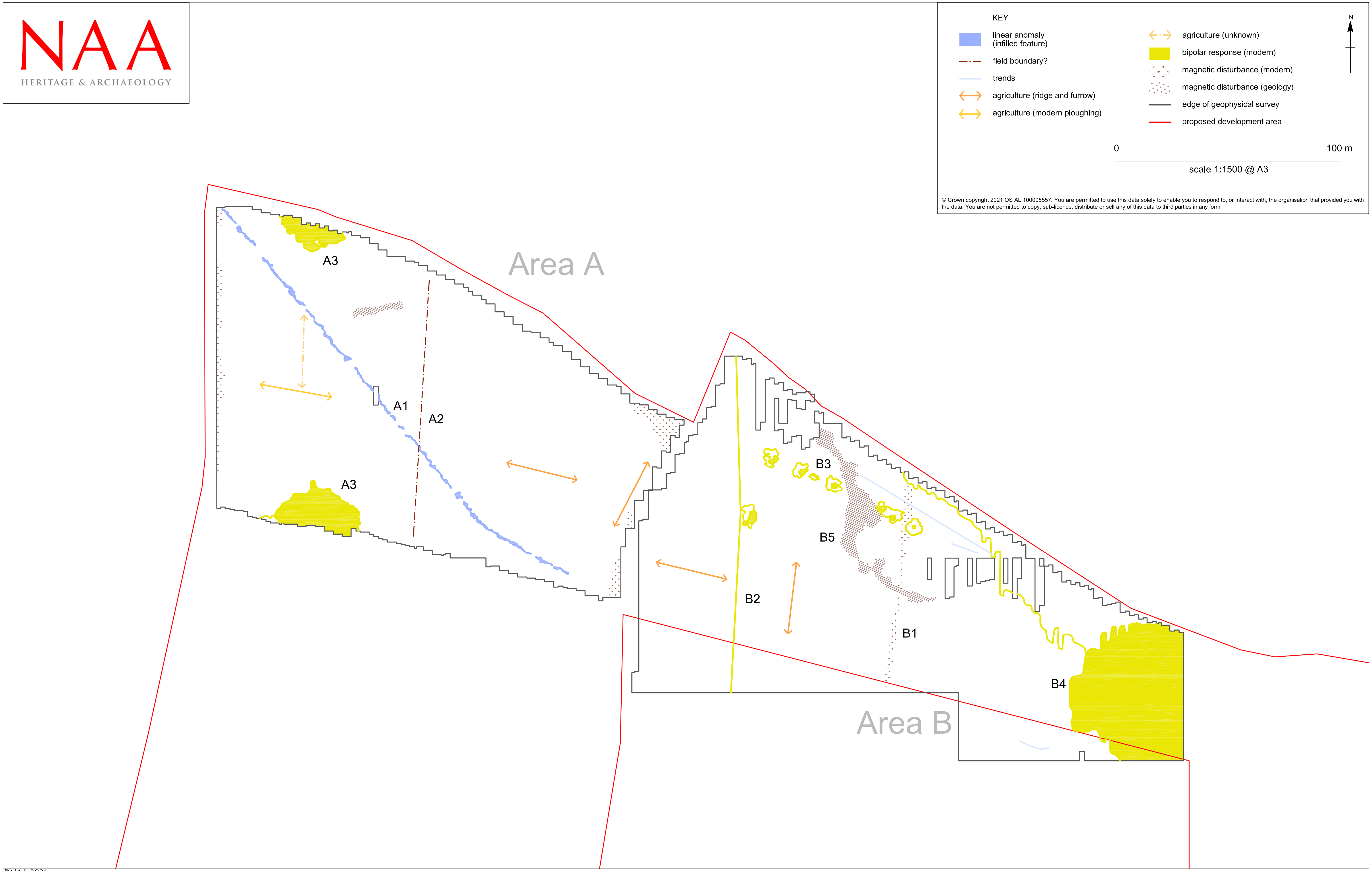
Whinfield Solar Farm, County Durham: interpretation of gradiometer survey results

Figure 5



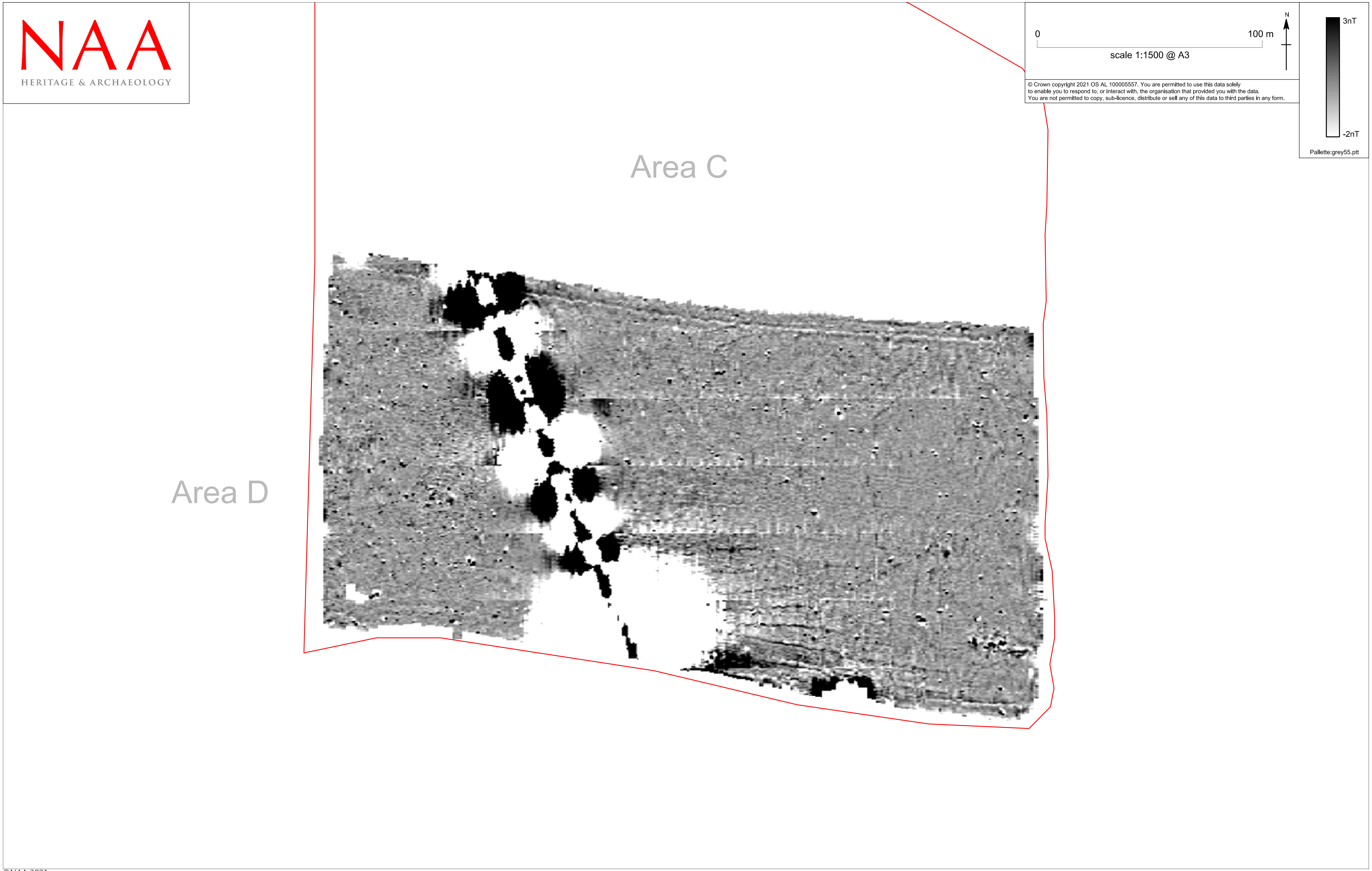
Whinfield Solar Farm, County Durham: processed greyscale plots of gradiometer survey results - Areas A and B

Figure 6



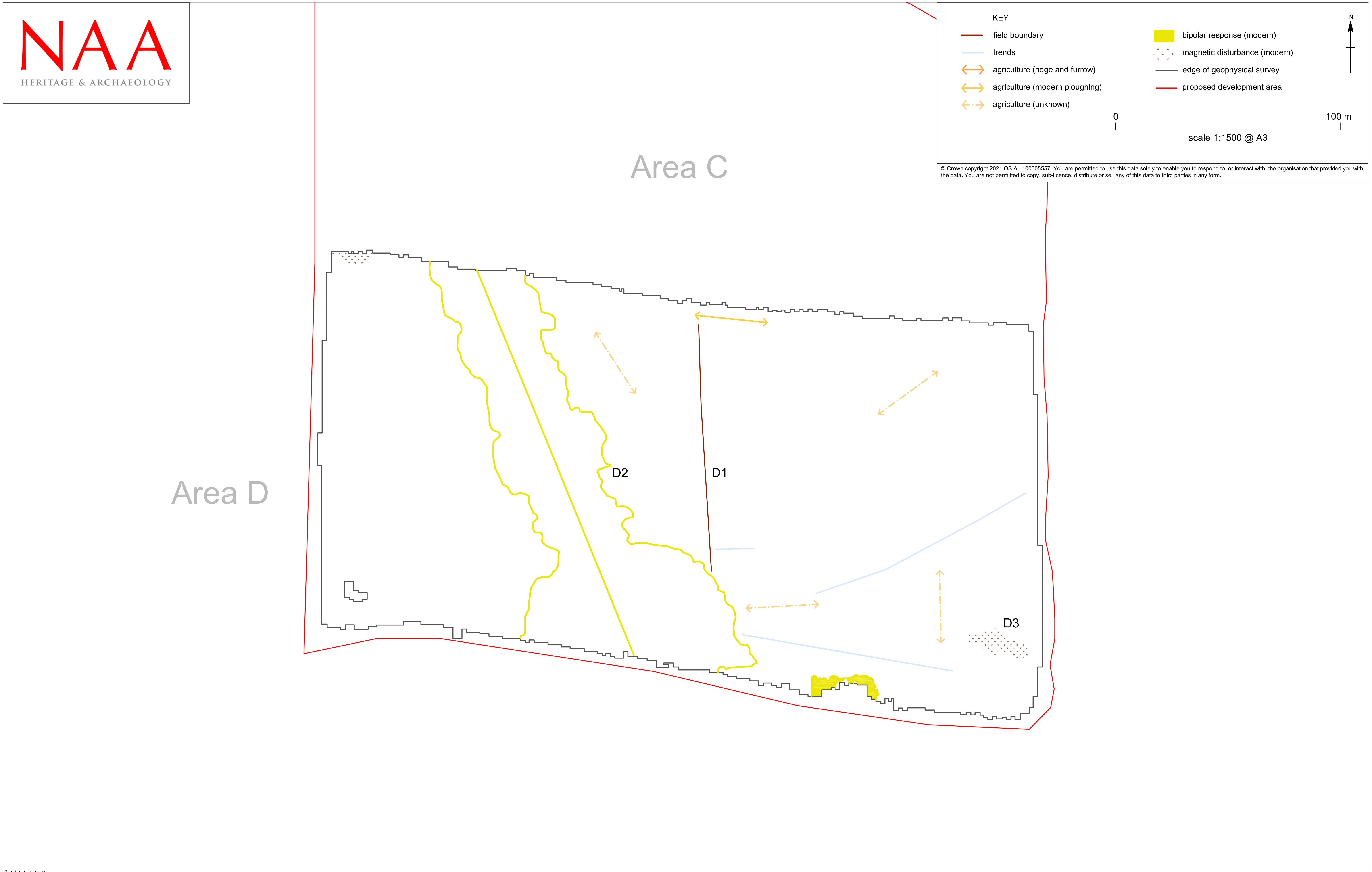
Whinfield Solar Farm, County Durham: interpretation of gradiometer survey results - Areas A and B

Figure 7



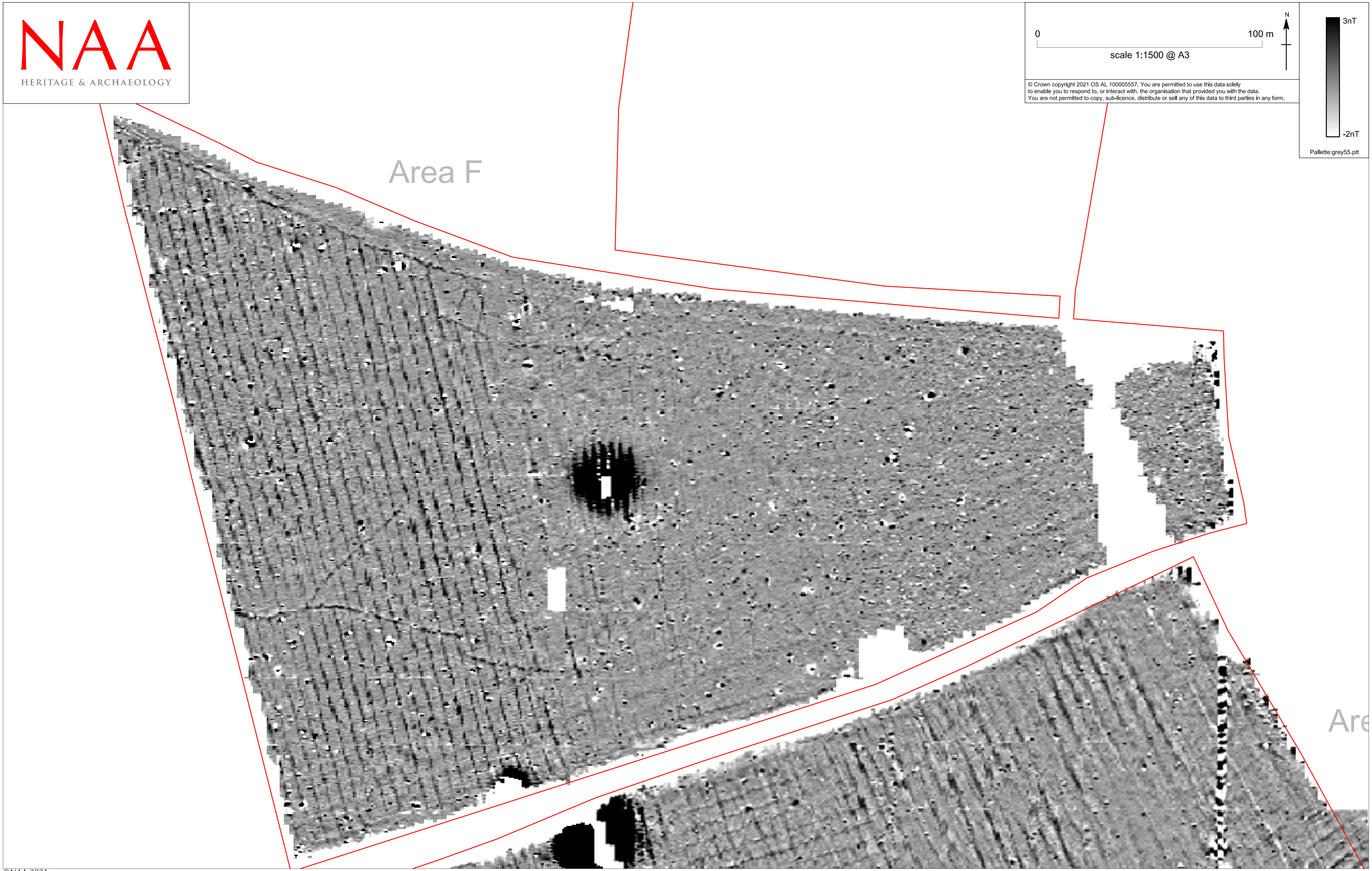
Whinfield Solar Farm, County Durham: processed greyscale plots of gradiometer survey results - Area D

Figure 8



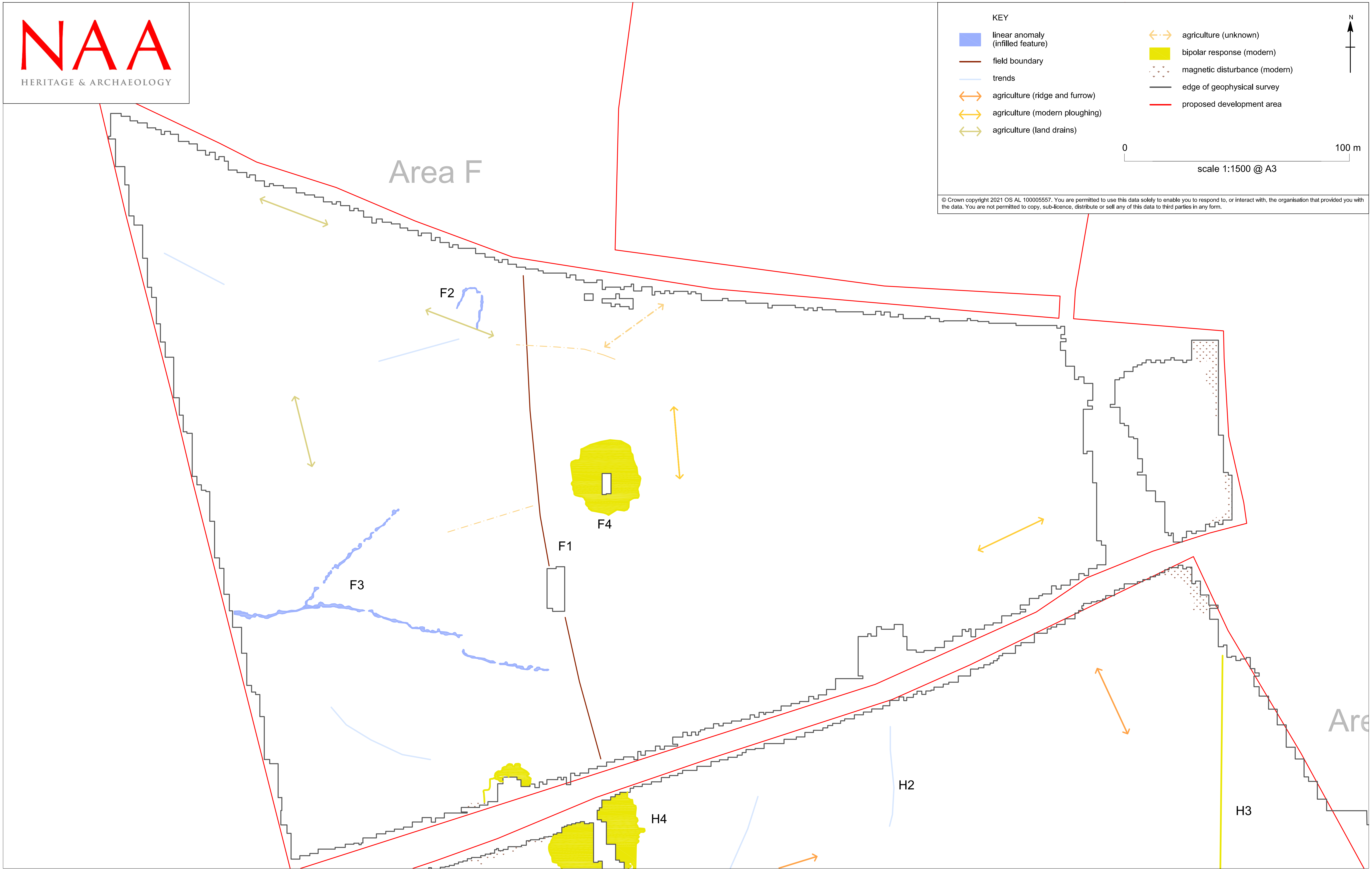
Whinfield Solar Farm, County Durham: interpretation of gradiometer survey results - Area D

Figure 9



Whinfield Solar Farm, County Durham: processed greyscale plots of gradiometer survey results - Area F

Figure 10



Whinfield Solar Farm, County Durham: interpretation of gradiometer survey results - Area F

Figure 11

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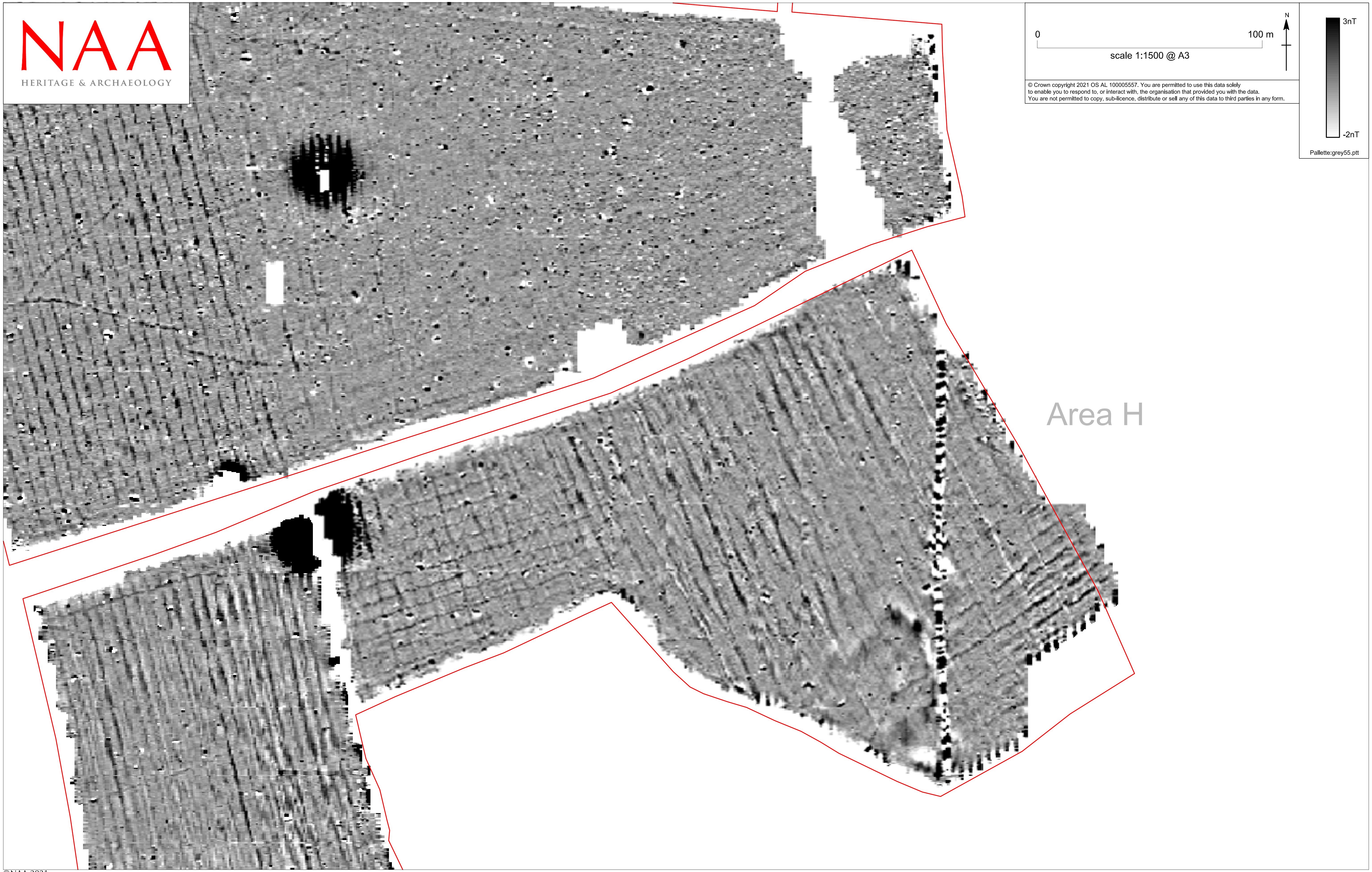
Whinfield Solar Farm, County Durham: processed greyscale plots of gradiometer survey results - Area G

Figure 12

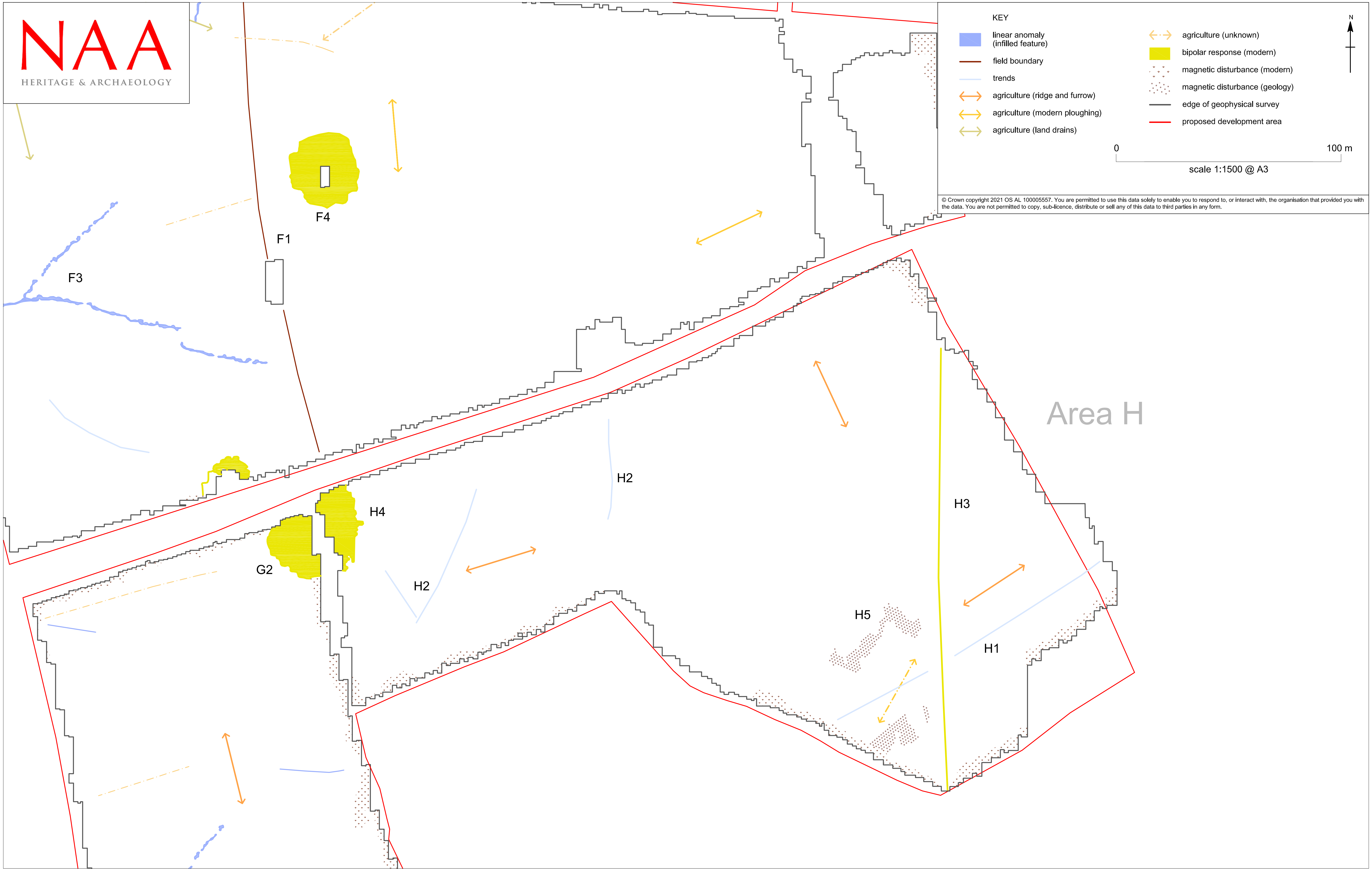
Whinfield Solar Farm, County Durham: interpretation of gradiometer survey results - Area G

Figure 13



Whinfield Solar Farm, County Durham: processed greyscale plots of gradiometer survey results - Area H

Figure 14



Whinfield Solar Farm, County Durham: interpretation of gradiometer survey results - Area H

Figure 15