NAA

GEOPHYSICAL SURVEY

SWEETBRIAR SOLAR FARM

ULCEBY
LINCOLNSHIRE

prepared for
Arcus Consultancy Services

NAA 21/55
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Northern
Archaeological
Associates

01833 690800
info@naaheritage.com
www.naaheritage.com
Marwood House
Harmire Enterprise Park
Barnard Castle
Co. Durham
DL12 8BN

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Manager	Alice James	
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Author Alice James
Illustrations Alice James and Dawn Knowles

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District North Lincolnshire

Grid Ref TA 11284 17238
Fieldwork 1st to 15th November 2021
Site Staff Craig Parkinson, Daniel Elcoat, Matthew Fay and Oskar Sveinbjarnarson

SWEETBRIAR FARM, ULCEBY, NORTH LINCOLNSHIRE
GEOPHYSICAL SURVEY REPORT

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FIGURE LIST

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.

SWEETBRIAR FARM, ULCEBY, NORTH LINCOLNSHIRE
GEOPHYSICAL SURVEY REPORT

Summary

Northern Archaeological Associates (NAA) was commissioned by Arcus Consultancy Services to undertake a geophysical (gradiometer) survey on land at Sweetbriar Farm, Ulceby, North Lincolnshire in advance of a solar farm development (NGR: TA 11284 17238).

The geophysical survey was carried out between the 1st and 15th November and covered six fields totalling c.43ha.

The results of the geophysical survey are largely of an agricultural, modern or geological origin. A linear anomaly was identified in the centre of the site that possibly denotes an infilled feature, although incomplete patterning means interpretation is very tentative and it is not possible to decipher its specific origin. Likewise, several weak and diffuse trends were identified across the survey area that lacked the necessary patterning and increases in magnetic value to be conclusively interpreted and so their origin is unknown.

The proposed development area lies within an area that is likely to have formed agricultural land to the north of the village of Ulceby since at least the medieval period. The results of the geophysical survey have identified numerous anomalies that relate to former field boundaries that were extant during the 19th and 20th centuries, land drains, and agricultural activity of an unknown origin. The most convincing evidence of ridge and furrow lies in the south of the site, but interpretation is tentative due to the weak increases in magnetic value that anomalies were composed of.

A linear bipolar anomaly runs through the centre of the site that relates to a buried pipeline. Several dipolar and bipolar anomalies were identified that are likely to be caused by material/objects with a high magnetic susceptibility in the topsoil and periphery of the site. In the south of the site, two bipolar anomalies were caused by pylons carrying overhead cables.

The survey area also contained vast areas of magnetic disturbance and broad anomalies that are likely to be of a geological origin and relate to pedological changes in the substrata.

1.0 INTRODUCTION

1.1 Northern Archaeological Associates (NAA) was commissioned by Arcus Consultancy Services to undertake a geophysical (gradiometer) survey on land at Sweetbriar Farm, Ulceby, North Lincolnshire in advance of a solar farm development (NGR: TA 11284 17238).

1.2 The geophysical survey was carried out between the 1st and 15th November and covered six fields totalling c.43ha.

1.3 This report details the setting (location, topography, geology) and archaeological background of the scheme and sets out the methodology used for the geophysical survey. The interpretation of the geophysical survey is achieved through the analysis of identified anomalies and is 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 six arable fields located c.3km to the north of Ulceby and 4km to the east of Wootton in North Lincolnshire (Fig. 1).

2.2 The site is largely surrounded by agricultural land. Carr Lane borders the site to the east. Three unnamed parallel tracks leading to farm buildings run perpendicular to Carr Lane on a north-northeast to south-southeast alignment, two of which run through the centre of the site and the third forms the southern boundary to the site.

Topography

2.3 The topography across the PDA is generally level with a gentle downward slope to the east. The highest point is recorded at 22m above Ordnance Datum (aOD) and the lowest point is 9m aOD.

Geology

2.4 The solid geology of the PDA consists of Burnham Chalk Formation with superficial deposits of Devensian Till (BGS 2021). The soils are mapped as Bishampton 1

Association (Soil Survey of England and Wales 1983), consisting primarily of deep occasionally waterlogged slowly permeable fine loamy soils (Jarvis *et al.* 1984, 110).

3.0 ARCHAEOLOGICAL AND HISTORICAL BACKGROUND

3.1 The following archaeological background is summarised from a heritage statement prepared for the Sweetbriar Solar Farm (Arcus, forthcoming).

3.2 There is no evidence for prehistoric or Roman activity in the vicinity of the PDA.

3.3 Several cropmarks have been recorded in a 1km study area of the site that relate to enclosures of an unknown date, the nearest of which are located c.500m to the west of the PDA.

3.4 During the medieval and post-medieval periods, it is likely the PDA belonged to agricultural land to the north of Ulceby. Ulceby is recorded in the Domesday Book of 1086 as being a settlement with 55 households. In the 12th century there are records suggesting Ulceby church was gifted to Thornton Abbey, which is located c.1.5km to the north-east of the site. Towards the end of the 12th century, Ulceby village became depopulated, after which time 'abandoned' fields were used by the abbey for grazing until the village was restored in the 13th century. The church of St Nicholas—located in the centre of Ulceby—is suggested to be 13th-century in origin and was plausibly built to serve a growing local population. The majority of the farmsteads and buildings associated with the railway located in the environs of the PDA—including Sweetbriar Farm and Zulu Farm to the west, and the New Hollland and Grimsby Branch Railway Cottage and Red House to the east—are post-medieval in origin and reflect the change in land management from being centred around a nucleated village to a series of dispersed farmsteads.

3.5 The Ulceby parish enclosure map of 1833 (not illustrated) shows the PDA being divided into four fields. By the 1886 and 1887 First Edition six-inch Ordnance Survey (OS) maps (not illustrated) the PDA was divided into 14 fields. With the exception of the removal of a field boundary in the east of the site at the beginning of the 20th century, no other changes to the composition of the PDA are recorded on 19th- and 20th-century maps.

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

aims 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 project were to:

- carry out 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 set out 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 was 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 carried out 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 and 8).

5.4 Interpretation of identified anomalies is generally achieved through analysis of anomaly patterning and increases in magnetic response and is often aided by examining supporting information. The interpreted data uses colour coding to highlight specific readings in the survey area (Figs 5, 7 and 9). Appendix C details the terminology and characterisation of anomalies used for interpreting data.

Surface conditions and other mitigating factors

5.5 Field boundaries comprised hedgerows and metal fencing; there were occasional areas of high vegetation along field edges and two pylons were located in Area 6.

5.6 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 The following section provides a detailed interpretation of the areas surveyed, then discusses anomalies identified generally across the PDA.

Area 1 (Figs 6 and 7)

6.2 Several weak and diffuse trends of an unknown origin were identified.

6.3 Two field boundaries depicted on 1886 and 1887 OS maps were identified in Area 1 (**1a** and **1b**). A linear anomaly (**1c**) was identified that runs perpendicular to **1a** that also plausibly relates to a field boundary but does not correspond with features recorded on historic maps.

6.4 Several alignments of regularly spaced linear anomalies were identified. Those running on a west-southwest to east-northeast alignment in the north of Area 1 have a broad spacing and a straight form typical of land drains. In the south of Area 1, two alignments of narrowly spaced linear anomalies were identified. Although interpretation is very tentative due to their weak increases in magnetic value, it is plausible that they denote modern ploughing.

6.5 Several bipolar anomalies and concentrations of dipolar anomalies were identified that are of a modern nature and are likely to denote ferrous material in the topsoil.

6.6 An area of magnetic disturbance comprising broad and non-uniform anomalies was identified in the north of Area 1 that is caused by geological or pedological changes in the substrata.

Area 2 (Figs 6 and 7)

6.7 Several weak and diffuse trends of an unknown origin were identified.

6.8 A field boundary shown on the 1887 Ordnance Survey (OS) map was identified in Field 2 (**2a**).

6.9 Broadly spaced linear anomalies that are likely to denote land drains were identified running in a north-northwest to south-southeast orientation.

6.10 The bipolar anomaly (**2b**) in the west of Area 2 denotes a buried pipeline that runs in a north-northwest to south-southeast orientation through the centre of the PDA in Areas 2, 4, 5 and 6. An amorphous bipolar anomaly (**2c**) was identified that is likely to denote a ferrous object either in the topsoil or external to the survey area.

6.11 Several concentrations of bipolar and dipolar anomalies were identified that are of a modern nature and are likely to denote ferrous material in the topsoil or objects with a high magnetic susceptibility in the periphery of the survey area such as metal fencing.

6.12 Two broad areas of magnetic disturbance were identified in Area 2 that are likely to be caused by geological or pedological changes in the substrata.

Area 3 (Figs 6 and 7)

6.13 Anomalies in Area 3 were largely considered to be of an agricultural or geological origin. Two orientations of regularly spaced linear anomalies were identified that are composed of weak increases in magnetic value. Because of this, it is not possible to determine the type of agricultural activity they relate to.

6.14 Several broad irregularly anomalies are present in Area 3 that are considered likely to be of a geological origin and relate to pedological or geological changes in the substrata.

Area 4 (Figs 6 and 7)

6.15 A linear anomaly (**4a**) was identified in Area 4 that possibly relates to an infilled feature of an unknown date. Interpretation is tentative due to incomplete and fragmented patterning, and so it is not known if **4a** denotes agricultural or archaeological activity. Several trends were also identified on a similar north-northwest to south-southeast orientation in Area 4 but were composed of very weak increases in magnetic value.

Consequently, it is not possible to ascertain their origin and deduce if they are agricultural, archaeological or geological in nature.

6.16 Two field boundaries (**4b**) were identified that are illustrated on the 1857 OS map.

6.17 Broadly spaced linear anomalies that are likely to denote land drains appear on a north-northwest to south-southeast orientation. Narrowly spaced linear anomalies that occur on a south-southwest to north-northeast orientation are composed of weak increases in magnetic value and so are of an unknown origin.

6.18 The bipolar anomaly (**4c**) in the west of Area 4 is the continuation of a buried pipeline identified in Area 2, which runs through the centre of the PDA in Areas 2, 4, 5 and 6.

6.19 Several concentrations of bipolar and dipolar anomalies were identified that are of a modern nature and are likely to denote ferrous material in the topsoil or objects with a high magnetic susceptibility in the periphery of the survey area such as metal fencing.

6.20 Several broad areas of magnetic disturbance were identified in Area 4 that are likely to be caused by geological or pedological changes in the substrata.

Area 5 (Figs 6, 7, 8 and 9)

6.21 Several weak and diffuse trends were identified of an unknown origin. Although tentative it is possible that **5a** is the continuation of anomalies identified in Area 4 as potentially denoting an infilled feature of an unknown date (**4a**).

6.22 Two field boundaries depicted on the 1887 Ordnance Survey (OS) map were identified in Area 5 (**5b** – **5d**). A further linear anomaly (**5e**) was identified running between **5c** and **5d** that also plausibly relates to a field boundary but does not correspond with features recorded on historic maps.

6.23 The bipolar anomaly (**5f**) in the west of Area 5 is the continuation of a buried pipeline identified in Areas 2 and 4.

6.24 The three broadly spaced bipolar anomalies in the west of Area 5 are likely to relate to agricultural activity and denote land drains. Broadly spaced anomalies with weak increases in magnetic value were identified in the east of Area 5 that are also considered likely to be caused by buried land drains. The difference in magnetic value of identified anomalies plausibly relates to differences in the materials that comprise the drains,

whereby bipolar anomalies are caused by a material with a high level of magnetic susceptibility.

6.25 There are several large areas of magnetic disturbance in Area 5 that are likely to relate to pedological or geological changes in the substrata.

Area 6 (Figs 8 and 9)

6.26 Several weak and diffuse trends of an unknown origin were identified. Although those with a good patterning could be considered to have a higher potential for relating to infilled features (i.e. **6a**), it should be noted that the weak increase in magnetic value of anomalies makes interpretation very tentative, and that identified trends are equally likely to denote agricultural activity or geological variations in the subsoil.

6.27 Two field boundaries were identified that are shown on the 1887 OS map (**6b**).

6.28 Several alignments of regularly spaced linear anomalies were identified that are caused by agricultural activity. Those running north-northwest to south-southeast have a broad spacing and a straight form and so are considered likely to be caused by land drains. Weakly enhanced regularly spaced linear anomalies on a west-southwest to east-northeast orientation are of an unknown agricultural origin. Although very tentative, several regularly spaced anomalies are extant on a west-southwest to east-northeast orientation in the south of Area 6 with a broad spacing and a slight curve that may be indicative of ridge and furrow.

6.29 The bipolar anomaly (**6c**) in the west of Area 6 is the continuation of a buried pipeline running through the centre of the PDA and identified in Areas 2, 4 and 5.

6.30 Two bipolar anomalies relate to pylons carrying overhead cables (**6d** and **6e**).

6.31 Several bipolar anomalies and concentrations of dipolar anomalies were identified that are of a modern nature and are likely to denote ferrous material in the topsoil.

General anomalies across the PDA (Figs 4 and 5)

6.32 There are several weak and diffuse linear trends across the survey area. Generally, these fail to produce the necessary patterning or increases in magnetic response in order to be interpreted fully, and consequently their origin is unknown.

6.33 Several linear anomalies have been identified that are likely to denote field boundaries. A tentative interpretation applies to anomalies with weak increases in magnetic value or that

6.34 Anomalies with clear increases in magnetic value that correspond with the location of field boundaries on historic maps are considered likely to denote infilled material associated with the removal of field boundaries. A tentative interpretation applies to linear anomalies that either do not correspond with the location of field boundaries on historic maps or are composed of weak increases in magnetic value.

6.35 There are numerous alignments of regularly spaced linear anomalies, which are 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 be caused by land drains. Isolated linear anomalies with weak increases in magnetic strength are considered to be agricultural in origin, but their exact cause is unknown.

6.36 Several bipolar responses have been identified. Isolated bipolar anomalies are generally of a modern nature and caused by material with a high magnetic susceptibility, such as ferrous objects. Linear bipolar anomalies are likely to denote buried utilities. It should be noted that 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.

6.37 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 have not been depicted on interpretation plots.

6.38 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—predominately 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.

6.39 There are several broad responses that are considered likely to be caused by geological or pedological changes in the substrata. Many of these correspond with topographic changes and cropmarks identified on Google Earth.

7.0 CONCLUSIONS

7.1 NAA undertook a geophysical survey over six fields—totalling 43ha—located to the north of the village of Ulceby in North Lincolnshire.

7.2 The results of the survey largely relate to agricultural activity, modern features and geological or pedological changes in the substrata. It is possible that identified linear anomalies and trends may in part relate to infilled features, but their weak increases in magnetic value and fragmented patterning has resulted in a tentative interpretation. It is equally plausible that identified anomalies and trends are instead agricultural or geological in nature. The most convincing anomaly is in the centre of the PDA and comprises an isolated linear anomaly with incomplete patterning and so is of an unknown origin.

7.3 Numerous field boundaries were identified that were present on the 1886 and 1887 OS maps. Evidence of land drains appears commonly across the PDA, as well as weakly enhanced linear anomalies that are of an unknown agricultural origin. The most convincing evidence of ridge and furrow is located in the south of the PDA, but a very tentative interpretation applies due to the weak increases in magnetic value

7.4 The results have also identified isolated bipolar anomalies, linear bipolar anomalies (indicative of buried utilities), and areas of modern disturbance, as well as several areas of magnetic disturbance that are likely to be of a geological origin.

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. This will include submission of a PDF version of the final report to the Archaeology Data Service via the OASIS form.

REFERENCES

Arcus (forthcoming) *Sweetbriar Solar Farm – Heritage statement.* Arcus unpublished Report.

Aspinal, A., Gaffney., C. and Schmidt, A. (2008) *Magnetometry for Archaeologists*. Plymouth: Altamira Press.

Bartington Instruments (n.d.) *Grad601 Single Axis Magnetic Field Gradiometer system.* Oxford: Bartington Instruments.

British Geological Survey (2021) *Geology of Britain viewer*. [Online] Available at: https://www.bgs.ac.uk/discoveringGeology/geologyOfBritain/viewer.html (accessed on 02/10/2021).

Chartered Institute for Archaeologists (CIfA) (2014) *Standard and guidance for archaeological geophysical survey*. Reading: Chartered Institute for Archaeologists.

Gaffney, C. and Gater, J. (2003) *Revealing the Buried Past*. Stroud: Tempus Publishing.

Jarvis, R. A., Bendelow, V. C., Bradley, R. I., Carroll, D. M., Furness, R. R., Kilgour, I. N. L. and King, S. J. (1984) *Soils and their use in Northern England*. Soil Survey Bulletin No. 10. Harpenden: Rothamsted Experimental Station.

Schmidt, A., Linford, P., Linford, N., David, A., Gaffney, C., Sarris, A. and Fassbinder, J. (2015) *EAC Guidelines for the Use of Geophysics in Archaeology.* EAC Guidelines 2. Belgium: Europae Archaeologiae Consilium.

Soil Survey of England and Wales (1983) *Soils of England and Wales 1:250 000 Map Sheet 1: Northern England*. Southampton: Ordnance Survey.

Online sources

National Library of Scotland http://maps.nls.uk/

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 (Aspinal *et al*. 2008, 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 there 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 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	30m x 30m
Traverse interval	1m
Reading interval	0.25m
Direction of 1st traverse	N
Number of Grids	614
Area covered	43ha

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

Grid point (gp) A	Grid point (gp) B
NGR: 510695.6766 417474.6378	NGR: 510785.6766 417474.6378

Table A3: Site information and conditions

Item	Detail
Geology	Burnham Chalk Formation
Superficial deposits	Devensian Till
Soils	Bishampton 1 Association
Topography	9m aOD to 22m aOD
Land use	Arable
Weather/conditions prior to and during survey	Overcast

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 were 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

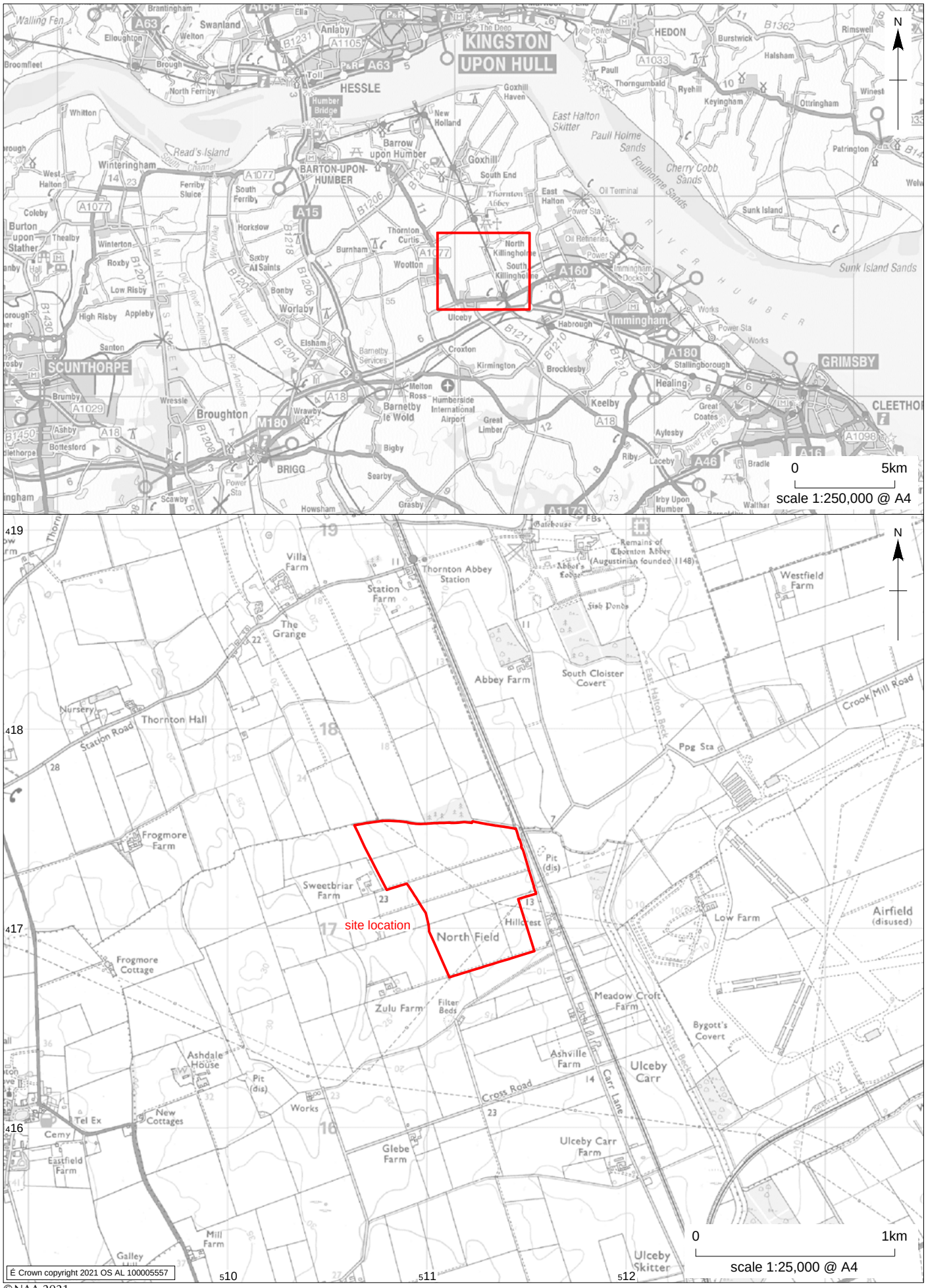
'lesser' categorisation as a consequence of weaker increases in magnetic response or the anomalies incomplete patterning or irregular form.

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	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 (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?	Regularly spaced linear anomalies that are likely to be of an agricultural nature. However, the lack of supporting information, weak responses, or non-uniform distribution means that it is unclear as to the nature or origin of the agricultural process they are caused by.
Modern	
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.

Characterisation	Detail
	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 anomaly	Dipolar anomalies relate to individual spike 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.
Magnetic disturbance (modern)	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 topsoil, 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	
Magnetic disturbance (geology)	Broad isolated responses that have an irregular patterning that may be indicative of geological or pedological changes in the substrata. It should be notes that ground water can naturally dissolve or erode porous or permeable bedrock, such as limestone, and create fissures and cracks. Depending on the magnetic susceptibility of the soil it is possible for these fissures to appear as a series of contiguous rectilinear anomalies, often having a similar appearance to archaeological enclosures.



Sweetbriar Farm: site location *Figure 1*

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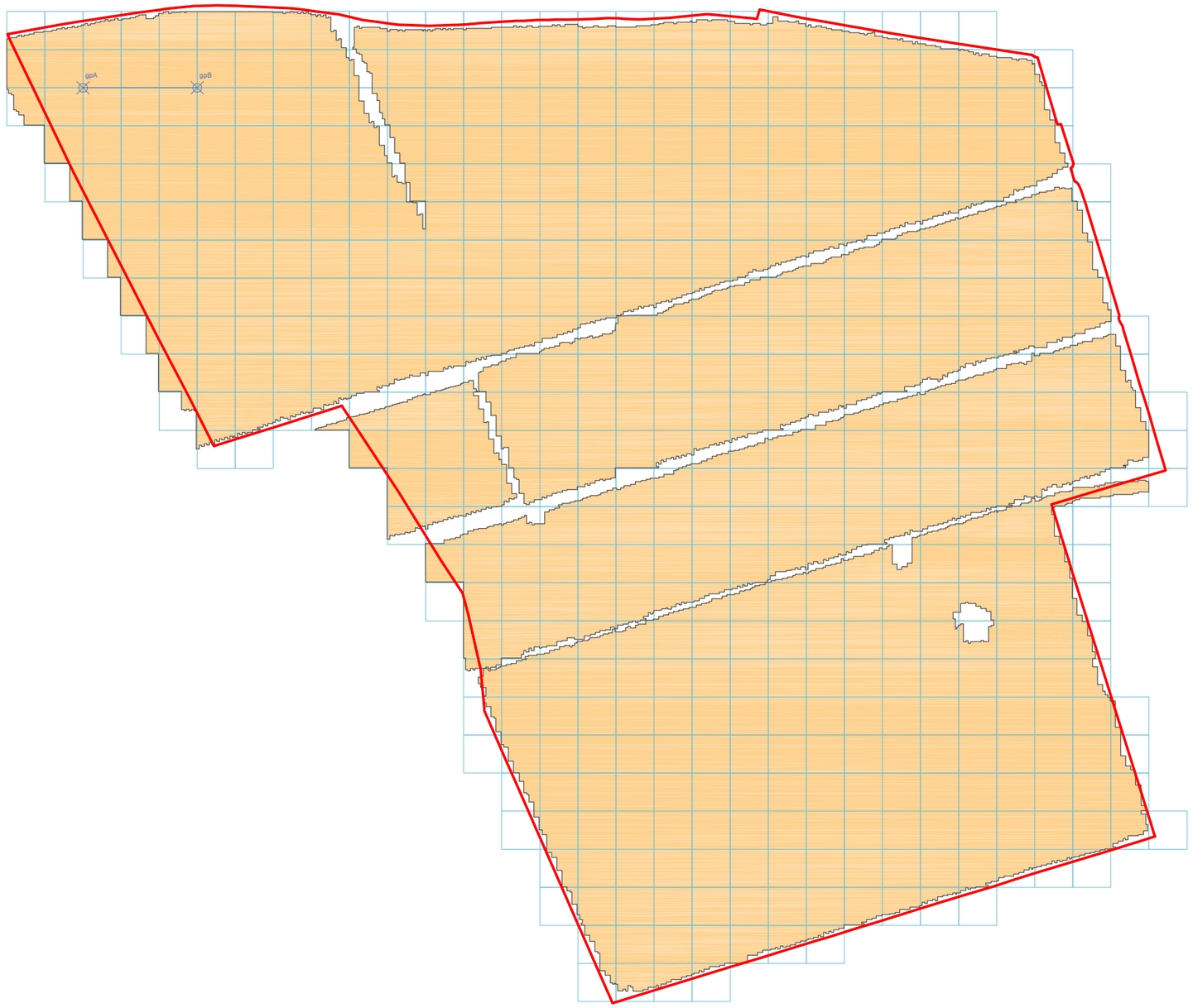

KEY
geophysical survey baseline
geophysical survey grid
geophysical survey area
proposed development area
N
0
200 m
scale 1:4000 @ A3

Sweetbriar Farm: geophysical survey areas

Figure 2