SUFFOLK ARCHAEOLOGY

• A HISTORY OF EXPERTISE •

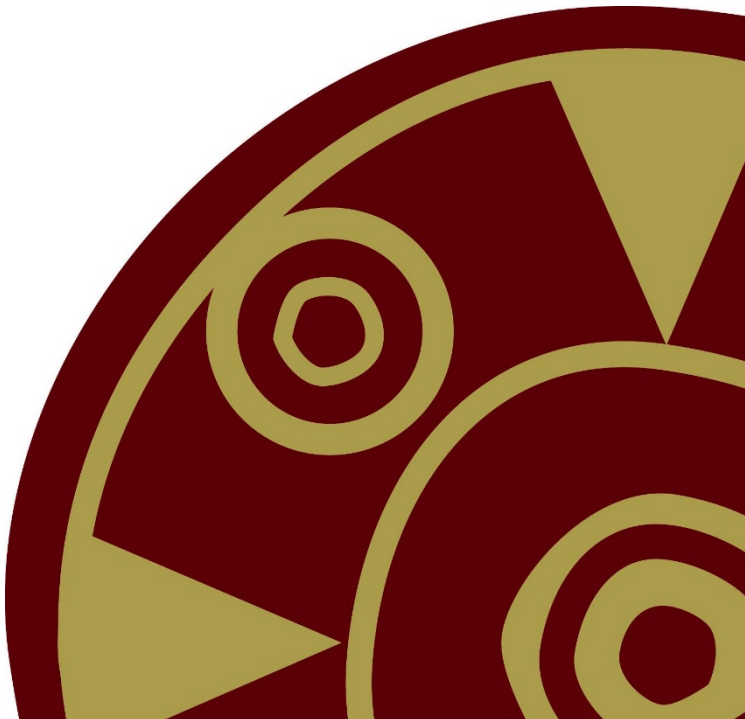
Lime Tree Farm, Tunstall Road

Blaxhall, Suffolk

Client:
Andrew Hawes

Date:
March 2019

BLX 039
Geophysical Survey Report
SACIC Report No. 2019/026
Author: Timothy Schofield HND BSc MCIfA



Lime Tree Farm, Tunstall Road, Blaxhall, Suffolk
BLX 039

Geophysical Survey Report

SACIC Report No. 2019/026

Author: Timothy Schofield

Illustrator: Timothy Schofield

Editor: Stuart Boulter

Report Date: March 2019

HER Information

Site Code:	**BLX 039**
Site Name:	**Lime Tree Farm, Tunstall Road Blaxhall, Suffolk**
Report Number	**2019/026**
Planning Application No:	**DC/19/0225/AGO**
Date of Fieldwork:	**18th – 19th March 2019**
Grid Reference:	**TM 3610 5640**
Oasis Reference:	**345084**
Curatorial Officer:	**Rachael Abraham**
Project Officer:	**Timothy Schofield**
Client/Funding Body:	**Andrew Hawes**

Digital report submitted to Archaeological Data Service:
http://ads.ahds.ac.uk/catalogue/library/greylit

Prepared By: Timothy Schofield
Date: March 2019

Approved By: Stuart Boulter
Position: Senior Project Officer
Date: March 2019
Signed:

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Summary

In March 2019 Suffolk Archaeology Community Interest Company (SACIC) undertook a detailed fluxgate gradiometer survey on land reserved for an agricultural reservoir, which lies to the east of Blaxhall Church Road, Blaxhall, Suffolk. A total area of 2.65ha was prospected for anomalies interpreted as having an archaeological derivation, within the cut line of the proposed reservoir.

The detailed fluxgate gradiometer survey recorded a narrow range of geophysical anomalies, indicative of relic field boundary ditches, archaeological pits, backfilled quarry pits and agricultural furrows; anomalies of unknown derivation were further prospected in the dataset. Overall, the results of the non-intrusive survey reveal a low to moderate potential for magnetic anomalies of an archaeological origin.

1. Introduction

The proposed reservoir and associated bunds will occupy a total area of *c.*7.5ha, however topsoil stripping and subsequent excavation will only be undertaken within the central reservoir area, with bunds built-up around the cut-line at the existing ground level. Suffolk Archaeology CIC (SACIC) were contracted to carry out the geophysical survey within the central cut line, a total of 2.65 hectares within a single arable field to the east of Blaxhall Church Road, Blaxhall, Suffolk (Fig. 1).

Andrew Hawes commissioned SACIC to undertake the project in March 2019, as a condition of planning application DC/19/0225/AGO.

Figure 1. Site location showing survey area (red)

2. Geology and topography

The survey area is set within an arable landscape, some 830m to the southwest of the settlement of Blaxhall, in the centre of a single arable field at TM 3610 5640. It is located between Church Road, that lies 240m to the west, School Road which is present 440m to the east and Station Road situated 540m to the north (see Fig.1).

The site is fairly level, sloping gently from 26m Above Ordnance Datum in the southwest to 21m in the northwest of the field.

Bedrock geology consists of Chillesford Church sand, formed 2 million years ago in the Quaternary Periods when the local environment was dominated by shallow seas, its upper boundary transitions into a Chillesford Clay Member consisting of clays and silts (BGS 2019). This is overlain by superficial deposits of Lowestoft Formation Diamicton, formed up to 2 million years ago in the Quaternary Period in glacigenic conditions, which is detrital in nature (BGS 2019).

The weather was sunny with occasional overcast periods; the crop had been harvested leaving a solid weathered clay topsoil that was compact underfoot.

3. Archaeology and historical background

The geophysical survey is required by SCCAS in order to inform the next phase of archaeological works, comprising a trenched evaluation, ahead of the construction of the proposed agricultural reservoir. Information held within the County Historic Environment Record (HER) reveals that the site is located within an area that has a high archaeological potential. Roman, Saxon and medieval find scatters (BLX 004, 005, TUN 019, 059) have been recorded around the periphery of the proposed reservoir. A detailed geophysical survey undertaken in 2015 (BLX 028), 630m to the east at Lime Tree Farm, prospected anomalies indicative of archaeological ditches and pits over similar soils. A full search of the Suffolk Historic Environment Record has been commissioned that will be included within the report of the trenched evaluation.

A study of the historic mapping held by SACIC has been made. The Ordnance Survey (OS) maps from 1883 reveal that the site was bisected through its centre by a field boundary running west to east, a quarry pit or pond is further recorded within the southern half of the field; neither are recorded on the 1975 OS map. These features can also be seen as cropmarks recorded on Google Earth images (2000-2011), along with further relic field boundaries and some large discrete cropmarks indicative of backfilled ponds or quarry pits.

4. Methodology

Instrument type

A Bartington DualGRAD 601-2 fluxgate gradiometer was employed to undertake the detailed geophysical survey; the weather, ground and geological soil conditions were found to be suitable for magnetometer survey.

Instrument calibration and settings

One hour was allocated to allow the instruments' sensors to reach optimum operating temperature before the survey commenced each day. Instrument sampling intervals were set to 0.25m along 1m traverses (four readings per metre).

Survey grid layout

The detailed survey was undertaken within 20m grids (Fig. 2, blue grid), orientated north to south and geolocated employing a Leica Viva GS08 Smart Rover RTK GLONASS GPS, which allowed an accuracy of +/- 0.03m. Data were converted to National Grid Transformation OSTN15.

Data capture

Detailed fluxgate gradiometer survey data points were recorded on an internal data logger that were downloaded and checked for quality at midday and in the evening, which allowed grids to be re-surveyed if necessary. A pro-forma survey sheet was completed to enable data composites to be created. Data were filed in unique project folders and backed-up onto an external storage device, before being stored on a remote server in the evening.

Data software, processing and presentation

The site had a low magnetic background signature, allowing good contrast between geophysical anomalies and the surrounding local magnetic field. Good quality raw survey data was collected and minimal data processing was required. Datasets were composited and processed using DW Consulting's Terrasurveyor v.3.0.35.10; raw grid files, composites and raster graphic plots will be stored and archived in this format. Data processing algorithms undertaken on the raw (Fig. 3) and processed datasets (Fig's 4 – 5) are presented in Appendix 1.

Data composites were exported as raster images into AutoCAD. An interpretation plan based on the combined results of the raw, processed and xy trace plots (Fig's. 3 – 5) has been produced (Fig. 6).

Survey grid restoration

Three virtual survey grid stations were placed on survey grid nodes along the baselines of the survey grid (Fig. 2), this will allow the geophysical anomalies to be retargeted during the subsequent trenched evaluation.

5. Results and discussion

A narrow range of anomalies were recorded in the dataset, consisting of positive linear anomalies, negative linear anomalies, discrete positive anomalies, areas of magnetic disturbance and isolated dipolar anomalies.

Negative linear anomalies (blue lines) are orientated north to south, in line with the current field boundary. These are located where wheel ruts and plough furrows, were prospected at greater depth from the base of the sensor, causing negative readings to be recorded in the dataset.

Isolated dipolar responses (yellow spots) are likely to be caused by magnetic, ferrous objects lost within the topsoil. It is possible that some may represent artefacts of an archaeological origin, or equally modern magnetic debris introduced into the ploughsoil during manuring events or agricultural processes.

Three areas of magnetic disturbance were recorded during the survey, two large discrete anomalies (light brown hatching), prospected within a metre of each other, are located where a pond or quarry pit is depicted on the 1883 to 1958 OS map. The third area of magnetic disturbance (yellow hatching) is of unknown origin, therefore it is worthy of further targeted archaeological investigation.

Nineteen discrete positive anomalies (orange hatching) were recorded across the dataset that are indicative of archaeological pits; there is no apparent clustering, so therefore a natural or modern derivation cannot be ruled out.

Five positive linear anomalies (red hatching), orientated north to south and perpendicular are indicative of relic field boundary ditches, one of which is recorded on OS mapping from 1883 until it was backfilled some time before the 1975 OS map was surveyed. These field subdivisions are orientated on a similar alignment to the current field boundary configuration, therefore they are thought to be broadly contemporary and of potential post-medieval origin.

Two positive linear anomalies (purple hatching) were prospected, their origin remains unknown. It would be prudent to further investigate these shorter linear anomalies in order to ascertain a derivation for their character and date.

6. Conclusion

The fluxgate gradiometer survey prospected a fairly narrow range of geophysical anomalies, which are thought to have a low to moderate archaeological potential. It would be prudent to target the full range of geophysical anomalies by trenched evaluation to assess the interpretations given within this report. Areas devoid of anomalies should further be investigated to check whether archaeological features remain undetected below the ploughsoil.

7. Archive deposition

The paper and digital archive will be kept at the SACIC office in Needham Market, before deposition in the Suffolk County Council Store in Bury St Edmunds.

8. Acknowledgements

The fieldwork was carried out by Rhiannon Gardiner and Tim Schofield, and directed by Tim Schofield. Project management was undertaken by Rhodri Gardner. The report illustrations were created by Tim Schofield and the report was edited by Stuart Boulter.

9. Bibliography

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Survey Station	Easting	Northing
STN 01	636018.110	256345.619
STN 02	636197.033	256325.959
STN 03	636214.508	256485.002

Figure 2. Survey grid location and georeferencing information

0 100m

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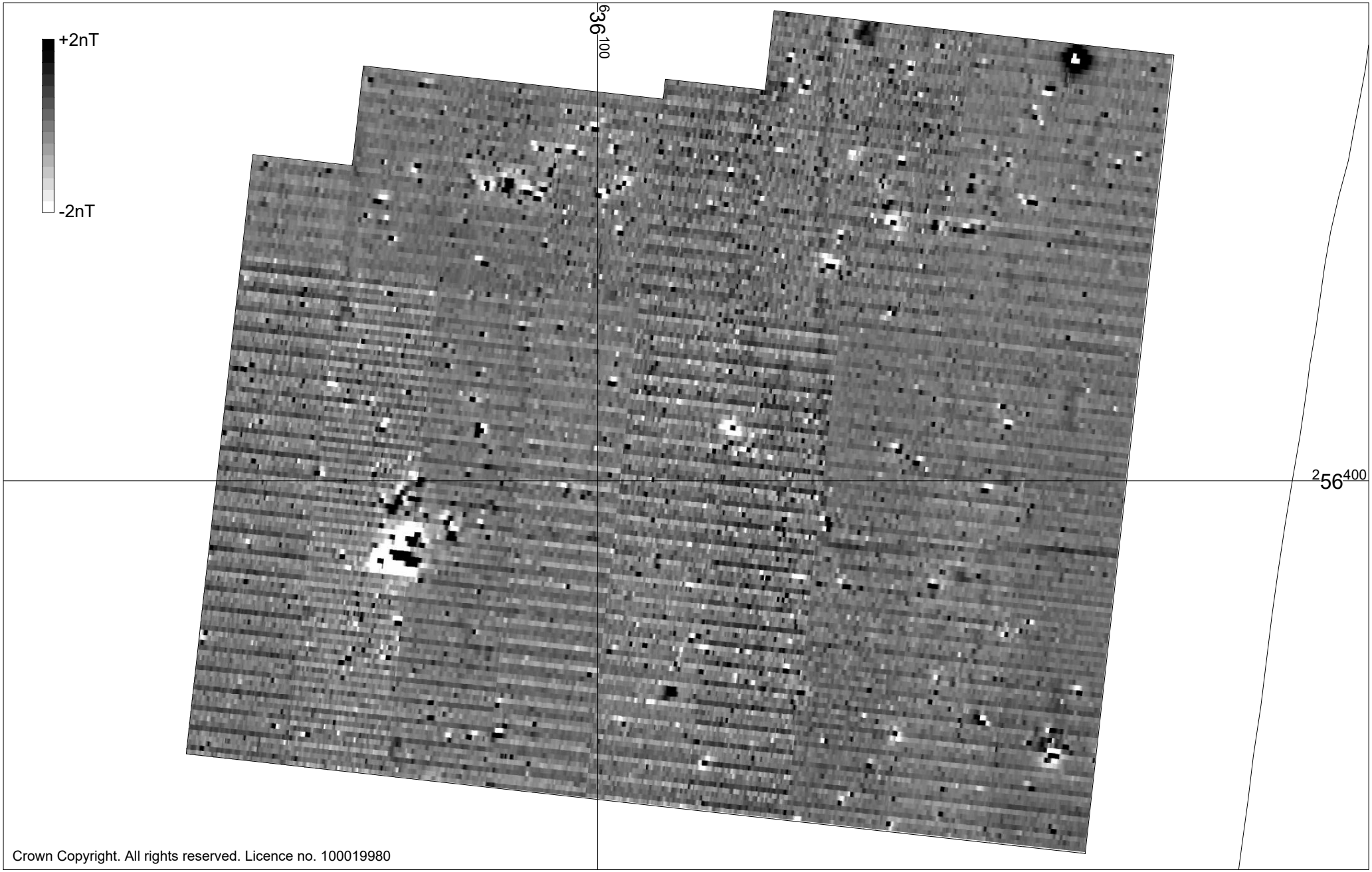

Figure 3. Raw magnetometer greyscale plot

SUFFOLK ARCHAEOLOGY

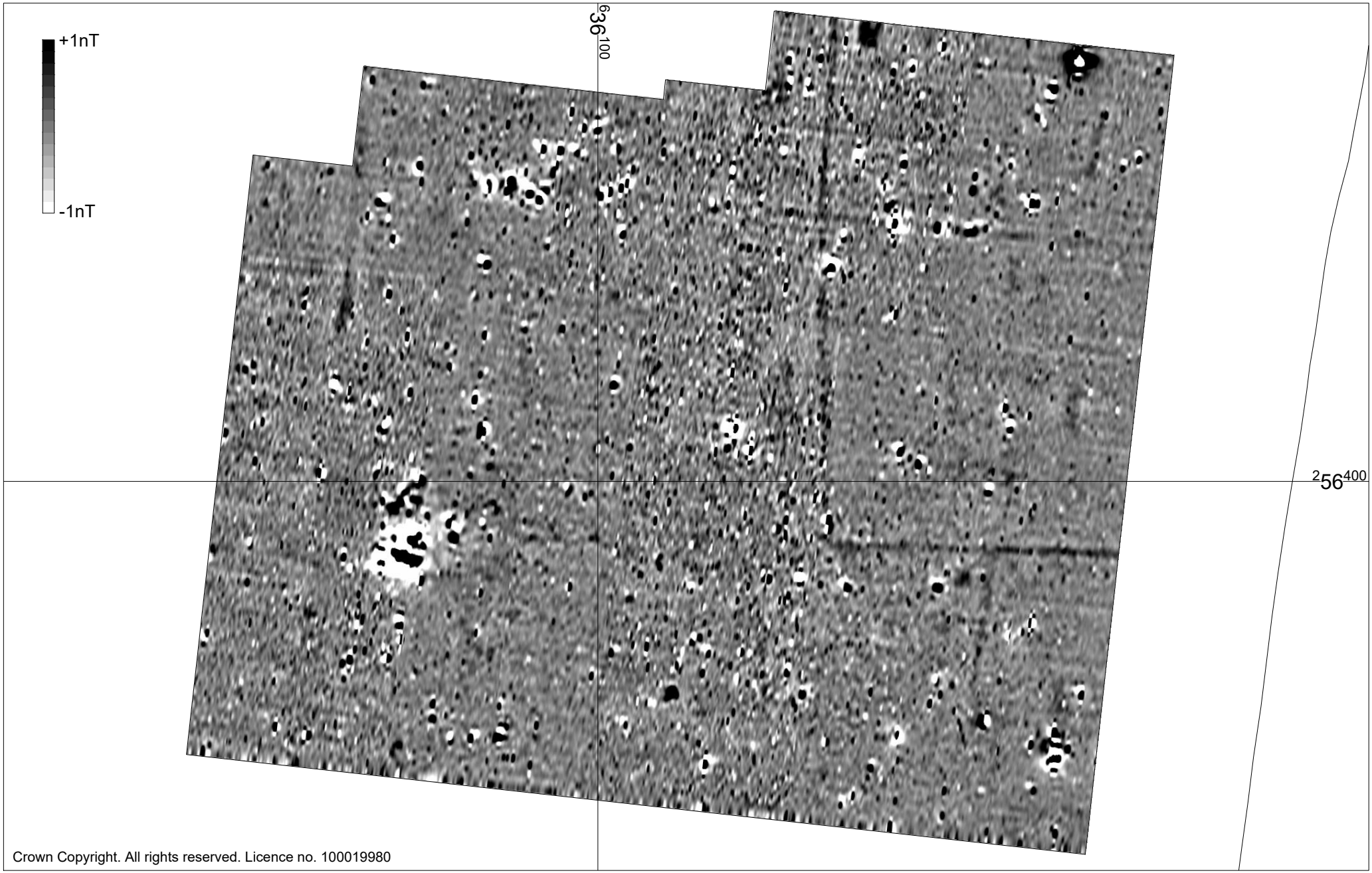

Figure 4. Processed magnetometer greyscale plot

Figure 5. Processed magnetometer xy trace plot

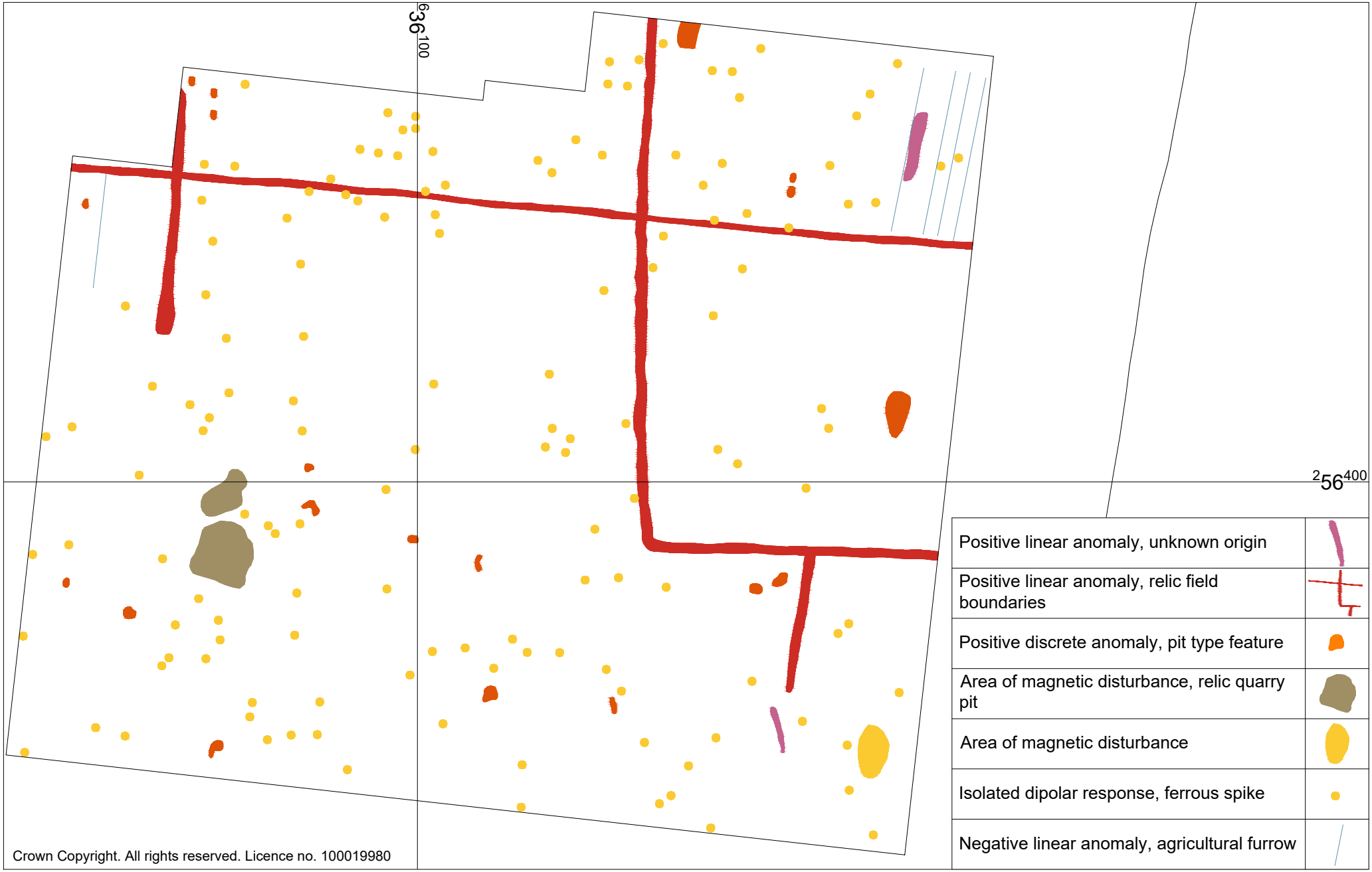

Figure 6. Interpretation plot of magnetometer anomalies

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Appendix 1. Metadata sheets

Grids

Source Grids: 67	
1	Col:0 Row:2 grids\46.xgd
2	Col:0 Row:3 grids\01.xgd
3	Col:0 Row:4 grids\02.xgd
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17	Col:2 Row:4 grids\12.xgd
18	Col:2 Row:5 grids\13.xgd
19	Col:2 Row:6 grids\14.xgd
20	Col:2 Row:7 grids\15.xgd
21	Col:3 Row:1 grids\51.xgd
22	Col:3 Row:2 grids\52.xgd
23	Col:3 Row:3 grids\16.xgd
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Raw Data

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Units	nT
Direction of 1st Traverse	90 deg
Collection Method	ZigZag
Sensors	2 @ 1m spacing.
Dummy Value	2047.5
Dimensions	
Survey Size (meters)	180m x 160m
X&Y Interval	0.25m
Stats	
Max	99.01
Min	-100.00
Std Dev	1.87
Mean	0.20
Median	0.18
Composite Area	2.88 ha
Surveyed Area	2.648 ha
Program	
Name	TerraSurveyor
Version	3.0.35.10

Raw Data Schedule

Display Clip -2 +2

Processed Data

Filename	Blaxhall1Pro -1+1.xcp
Description	
Instrument Type	Grad 601-2 (Gradiometer)
Units	nT
Direction of 1st Traverse	90 deg
Collection Method	ZigZag
Sensors	2 @ 1m spacing.
Dummy Value	2047.5
Dimensions	
Survey Size (meters)	180m x 160m
X&Y Interval	0.25m
Stats	
Max	99.00
Min	-100.68
Std Dev	1.85
Mean	0.03
Median	0.00
Composite Area	2.88 ha
Surveyed Area	2.648 ha
Program	
Name	TerraSurveyor
Version	3.0.35.10

Processed Data Schedule

Destripe Median Sensors

Display Clip -1 +1

Appendix 2. Technical data

Detailed magnetometer survey

Detailed magnetometer survey is the most commonly employed archaeological geophysical prospection method in Britain; sensitive sensors can cost-effectively cover large areas of ground, rapidly recording anomalies that are indicative of cultural settlement activity. These anomalies can then be further investigated by field archaeologists to quantify a form and function. The magnetometer is a passive instrument that detects both permanent thermoremanent and temporary magnetic responses.

Thermoremanent Magnetism

When a material containing iron oxides, for example clay, is heated above the Curie point, weakly magnetic compounds transform in to highly magnetic oxides that can be detected by the sensors of a magnetometer (Clark, 1996). For instance, the iron oxide haematite has a Curie temperature of 675 Celsius and magnetite 565 Celsius. Once these temperatures are reached, the oxides become demagnetised, on cooling their magnetic properties become permanently re-magnetised and align in the direction of the Earth's magnetic field (Gaffney and Gater, 2003). Over time the direction of the Earth's magnetic field changes allowing these directional differences to be detected by the magnetometer.

Strongly heated features such as hearths, kilns or furnaces frequently reach the Curie temperature and become permanently magnetised. These permanent magnetic responses are some of the strongest cultural features that can be recorded.

Temporary Magnetism

Magnetic susceptibility is the ease with which a magnetic field can pass through a material, therefore the higher the material's magnetic susceptibility, the stronger the induced magnetic field will be. Temporary magnetisation occurs within material that is magnetically susceptible, this material acquires its own local magnetic field that combines with the Earth's magnetic field causing an anomaly to stand out from the background noise (Clark, 1996). These anomalies are subtler in nature, being derived from material that has been magnetically enhanced by cultural activity which has become concentrated into features over time. Anomalies that have temporary

magnetisation include backfilled pits, ditches, field systems, occupation areas, land drains, remnant and existing field boundaries (David *et al*, 2014).

The key to a successful survey is having good contrast between the magnetic susceptibility of an archaeological feature with the surrounding superficial deposits. If there is no discernible difference between the two mediums it may be unlikely that the magnetometer will successfully prospect the feature. Archaeological features can also be masked by high magnetically susceptible topsoil, or deep overlying subsoil and colluvial deposits.

Ferrous anomalies

Ferrous objects are a common source of permanent magnetism, usually isolated with a strong dipolar signature. Some of these responses may have an archaeological derivation, however they are probably more indicative of modern iron objects introduced through manuring or lost within the topsoil.

Bartington DualGRAD 601-2 Fluxgate Gradiometers

Fluxgate gradiometers are the most commonly employed class of instrument in the UK. Two 1m sensitive sensors are affixed to a frame mounted 1m apart in a vertical plane and harnessed to the trunk of a geophysical surveyor or attached to a cart. Each sensor contains two fluxgate magnetometers with a 1m vertical separation. The sensor above records the Earth's magnetic field (magnetic background) while the sensor below records the local magnetic field. The two sensors need aligning before recording can begin and a zero station is located in an area with low magnetic variation for this purpose. After the sensors have been aligned, the survey can begin. When differences in the magnetic field strength occur between the two vertical magnetometers within each sensor, a positive or negative reading is recorded that is relative to the magnetic background of the zero station. Positive anomalies include pits, ditches and agricultural furrows. Negative anomalies commonly prospected include earthwork embankments, land drains and geological features.

Sensors are normally mounted to a height of 0.30m above the surface, and can detect to a depth of between one and two metres below the ground. The first survey traverse is commonly undertaken in an east to west direction.

Magnetic Anomalies

Isolated dipolar responses

Isolated dipolar responses are commonly recorded throughout a dataset and are usually indicative of modern ferrous material deposited within the topsoil horizon. In some instances, the anomalies may be of an archaeological derivation. They are isolated, strong and dipolar in character.

Areas of magnetic disturbance

These anomalies are usually caused by building demolition rubble, ferrous boundaries, slag waste dumps, modern buried rubbish, pylons and services. Strong and dipolar in character, they are commonly recorded over a wide area.

Linear trends

Linear trends can be either positive or negative magnetic responses depending on the nature of the material present within the feature. If the anomaly is broad and weak, it is more likely to be of geological origin. Stronger positive linear trends are more likely to be of archaeological derivation, caused by settlement activity washing rich humic, charcoal and fired deposits into a feature. Negative linear trends are more commonly associated with bank deposits or land drains, with the less magnetically susceptible superficial deposits deposited at the top of the feature. Curvilinear trends are usually of archaeological origin, commonly interpreted as ring ditches or drip-gullies.

Discrete anomalies

Discrete anomalies can either be positive or negative in nature recorded within a localised area. Those that are positive are more likely to be of an archaeological origin, with negative discrete anomalies more commonly interpreted as natural geological variations.

Thermoremanent responses

These responses are caused by the heating of material containing iron to above the Curie temperature, they are strong and discrete in nature. In Britain high positive readings are recorded to the south of the anomaly with high negative readings recorded to the north.

Appendix 3. OASIS form

OASIS DATA COLLECTION FORM: England

Printable version

OASIS ID: suffolka1-345084

Project details

Project name	Lime Tree Farm, Tunstall Road, Blaxhall, Geophysical Survey
Short description of the project	In March 2019 Suffolk Archaeology Community Interest Company (SACIC) undertook a detailed fluxgate gradiometer survey on land reserved for an agricultural reservoir, which lies to the east of Blaxhall Church Road, Blaxhall, Suffolk. A total area of 2.65ha was prospected for anomalies of an archaeological derivation, within the cut line of the proposed reservoir. The detailed fluxgate gradiometer survey recorded a narrow range of geophysical anomalies, indicative of relic field boundary ditches, archaeological pits, backfilled quarry pits and agricultural furrows, anomalies of unknown derivation were further prospected in the dataset. Overall, the results of the non-intrusive survey reveal a low to moderate potential for magnetic anomalies of an archaeological origin.
Project dates	Start: 18-03-2019 End: 19-03-2019
Previous/future work	No / Yes
Any associated project reference codes	BLX 039 - Sitecode
Type of project	Field evaluation
Site status	None
Current Land use	Cultivated Land 3 - Operations to a depth more than 0.25m
Monument type	DITCH TYPE ANOMALY Uncertain
Monument type	PIT TYPE ANOMALY Uncertain
Monument type	ISOLATED DIPOLAR ANOMALIES Uncertain
Monument type	MAGNETIC DISTURBANCE Uncertain
Monument type	AGRICULTURAL FURROWS Modern
Significant Finds	NONE None
Methods & techniques	"Geophysical Survey"
Development type	Agricultural Reservoir
Prompt	National Planning Policy Framework - NPPF
Position in the planning process	After outline determination (eg. As a reserved matter)
Solid geology (other)	Chillesford Church Sand
Drift geology (other)	Lowestoft Formation Diamicton
Techniques	Magnetometry

Project location

Country	England
Site location	SUFFOLK SUFFOLK COASTAL BLAXHALL Lime Tree Farm, Tunstall Road, Blaxhall, Suffolk
Study area	2.65 Hectares
Site coordinates	TM 3610 5640 52.154726297856 1.451931457532 52 09 17 N 001 27 06 E Point
Height OD / Depth	Min: 21m Max: 26m

Project creators

Name of Organisation	Suffolk Archaeology CIC
Project brief originator	Local Planning Authority (with/without advice from County/District Archaeologist)
Project design originator	Rachael Abraham
Project director/manager	Rhodri Gardner
Project supervisor	Timothy Schofield
Type of sponsor/funding body	Landowner
Name of sponsor/funding body	Andrew Hawes

Project archives

Physical Archive Exists?	No
Digital Archive recipient	Suffolk HER
Digital Contents	"Survey"
Digital Media available	"Database","Geophysics","Images raster / digital photography","Images vector","Survey","Text"
Paper Archive recipient	Suffolk HER
Paper Contents	"Survey"
Paper Media available	"Survey ","Unpublished Text"

Project bibliography 1

Publication type	Grey literature (unpublished document/manuscript)
Title	Proposed Reservoir, Lime Tree Farm, Tunstall Road, Blaxhall, Suffolk, BLX 039; Geophysical Survey
Author(s)/Editor(s)	Schofield, T. P.
Other bibliographic details	2019/026
Date	2019
Issuer or publisher	Suffolk Archaeology CIC

Place of issue or publication	Needham Market
Description	A4 bound report with figures
URL	www.suffolkarchaeology.co.uk

Entered by	Timothy Schofield (tim.schofield@suffolkarchaeology.co.uk)
Entered on	21 March 2019

OASIS:

Appendix 4. Written scheme of investigation

SUFFOLK ARCHAEOLOGY

• A HISTORY OF EXPERTISE •

Lime Tree Farm, Tunstall Road

Blaxhall, Suffolk

Client:
Andrew Hawes

Date:
March 2019

BLX 039
Written Scheme of Investigation and Risk Assessment – Geophysical Survey
Author: Tim Schofield HND BSc MCIfA

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Project details

Planning Application No:	DC/19/0225/AGO
Curatorial Officer:	Rachael Abraham (SCCAS)
Grid Reference:	TM 3610 5640
Area:	*c*. 7.50ha
HER Event No/Site Code:	BLX 039
OASIS Reference:	345084
Project Start date:	18th-19th March 2019
Project Fieldwork Duration:	*c*. 2 days
Client/Funding Body:	Andrew Hawes
SACIC Project Manager:	Rhodri Gardner
SACIC Project Officer:	Tim Schofield
SACIC Job Code:	BLX LIM 001

1. Introduction

- A program of geophysical survey is required on the site of a proposed agricultural reservoir, at Lime Tree Farm, Tunstall, Blaxhall, Suffolk (Fig. 1), prior to determination of the planning application, in accordance with paragraph 199 of the National Planning Policy Framework.
- The work is required by the archaeological adviser to the Local Planning Authority (LPA) Rachael Abraham, of Suffolk County Council Archaeological Service (SCCAS).
- The proposed reservoir, including bunds, occupies an area of *c.*7.5ha, however Suffolk Archaeology Community Interest Company (SACIC) has been informed that the development will only involve topsoil stripping and subsequent excavation within the central reservoir, with the surrounding bunds being built up from the existing ground level.
- Suffolk Archaeology have been contracted to carry out a 2.28ha survey of this central area that will be subjected to significant ground disturbance by the development. This Written Scheme of Investigation (WSI) details how the survey will meet the requirements as laid out in the SCCAS geophysical survey guidelines (SCCAS 2017), and has been submitted to SCCAS for approval on behalf of the LPA. It provides the basis for measurable standards and will be adhered to in full, unless otherwise agreed with SCCAS.
- It should be noted that the geophysical survey is only the first stage in the program of archaeological works, this WSI covers the geophysical survey only. Further stages of required archaeological work have been specified by SCCAS and a new WSI will be written for the trenched evaluation stage.

Figure 1. Site location showing survey area (red)

2. The Site

- The site lies within an arable landscape, located 830m to the southwest of the settlement of Blaxhall, in the centre of a single arable field at TM 3610 5640. Church Road is located 240m to the west, School Road is present 440m to the east and Station Road lies 540m to the north (see Fig.1).
- The site slopes from 26m Above Ordnance Datum in the southwest to 21m in the northwest.
- The bedrock geology consists of Chillesford Church sand, formed 2 million years ago in the Quaternary Periods when the local environment was dominated by shallow seas (BGS 2019). This is overlain by superficial deposits of Lowestoft Formation Diamicton, formed up to 2 million years ago in the Quaternary Period in glacigenic conditions, detrital in nature (BGS 2019).

3. Archaeological and Historical Background

- The geophysical survey is required by SCCAS in order to inform the next phase of archaeological works, comprising trenched evaluation ahead of the construction of the proposed agricultural reservoir.
- The proposed reservoir site is situated within a single agricultural field, when consulting information held within the County Historic Environment Record (HER) the site has good archaeological potential. Roman, Saxon and medieval find scatters (BLX 004, 005, TUN 019, 059) have been recorded around the periphery of the proposed reservoir. A detailed geophysical survey undertaken in 2015 (BLX 028), 630m to the east at Limetree Farm, prospected anomalies indicative of archaeological ditches and pits over similar soils. A full search of the Suffolk Historic Environment Record has been commissioned that will be used within the final geophysical survey report.
- An initial examination of historic mapping held by SACIC has been made. The Ordnance Survey (OS) maps from 1883 reveal that the site was bisected through its centre by a relic field boundary running west to east and a quarry pit or pond is depicted within the southern half of the field, both features are no longer recorded on the 1975 OS map. These features can also be seen on cropmarks recorded on Google Earth images (2000-2011), along with further relic field boundary cropmarks and some large discrete cropmarks indicative of backfilled ponds or quarry pits.

4. Project Objectives

- A systematic fluxgate gradiometer survey is to be undertaken across all areas of the proposed reservoir site where groundworks will be carried out.

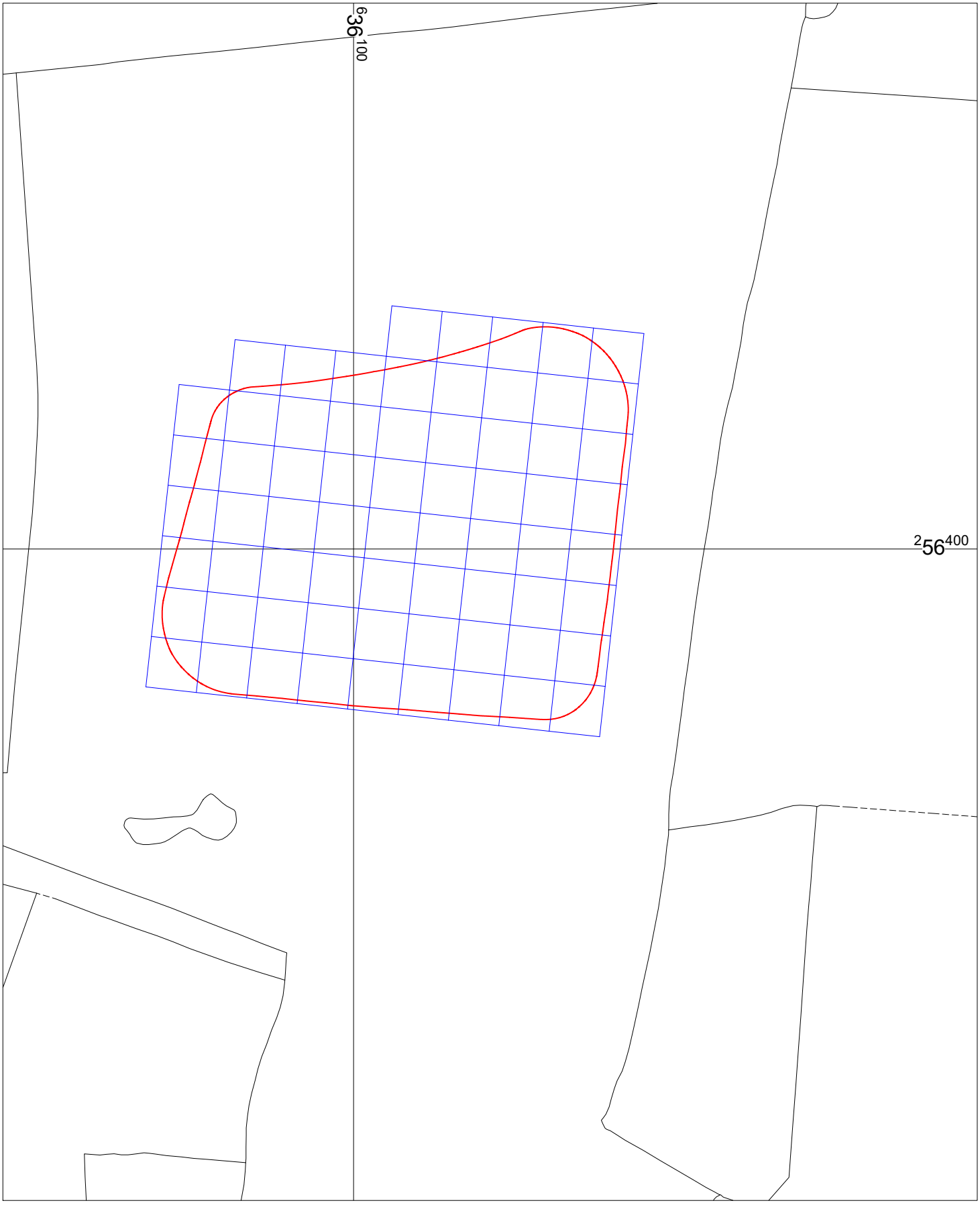

Figure 2. Proposed survey grid location

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5. Geophysical Survey Method Statement

5.1. Management

- The project will be managed by SACIC Project Officer Tim Schofield in accordance with the principles of *Management of Research Projects in the Historic Environment* (MoRPHE, Historic England 2015).
- SCCAS will be given five days' notice of the commencement of the fieldwork and arrangements made for a SCCAS site visit if required.
- Full details of project staff are given in section 6 below.

5.2. Project preparation

- A Parish Code has been obtained from the SCCAS HER Officer and will be included on all future project documentation. An HER search has further been requested.
- An OASIS online record has been initiated and key fields have been completed in the details section, location, and creator forms.
- A Risk Assessment for the project has also been completed (see Appendix 5).

5.3. Fieldwork

- Fieldwork standards will be guided by 'Standards for Field Archaeology in the East of England', EAA Occasional Papers 14, and the Chartered Institute for Archaeology's (CIfA) paper 'Standard and Guidance for archaeological geophysical survey', December 2014.
- Fieldwork will be carried out by members of SACIC led by Project Officer Tim Schofield. The fieldwork team will be drawn from a pool of suitable staff at SACIC.
- The project requires a geophysical survey of 2.28 hectares over the proposed development area (Fig. 2), centred on the cut plan provided by the client. Minor modifications to the survey area may need to be made onsite to respect any areas of disturbance/contamination or other obstacles.

Instrument type and set-up

- The site will be surveyed using a Bartington Dual-Grad 601-2 which has high sensor sensitivity combined with rapid ground coverage. Good contrast between the magnetic susceptibility of a feature's fill (charcoal rich or humic deposits providing the best soil medium) and the local magnetic background signature of the superficial deposits will be important in achieving successful survey results.
- Best practice dictates that sensors will be secured on the same side of the instrument until the completion of the survey, and sensor heights equalised to achieve a consistent elevation across the area. The instrument will be switched on and left for at least 20 minutes before the survey of the first grid to allow the sensors to reach a suitable operating temperature.
- A zero station with low magnetic susceptibility shall be prospected within the field to allow the correction of diurnal sensor drift. This unique station will be employed throughout the survey providing a common calibration location.

Sampling interval and grid size

- The 20m survey grid will be set-out using a Leica Viva Glonass Smart Rover GS08+ to the Ordnance Survey OSGB36, converted to the National Grid Transformation OSTN15 datum that has an accuracy of +/- 0.03m. Regular testing of the instruments accuracy will be undertaken employing stations with known ETRS89 coordinates. All raw data recorded by the GPS will be uploaded to the project folder, suitably labelled and kept as part of the project archive.
- A 1m traverse interval and 0.25m sample interval will be utilised.

Data capture and archiving

- A pro-forma survey sheet will be completed each day; unique grid numbers will be allocated to enable a data composite to be created. Instrument readings will be recorded on the internal data logger and downloaded to a laptop at midday and also in the evening, this will allow the data to be checked for quality on site and for grids to be re-surveyed if required.

- Data will be filed in project specific folders separated into daily datasets. The daily datasets will be combined into a single composite on completion of the fieldwork.
- Data will be stored in project specific folders that will be downloaded onto a laptop and then backed-up onto an external server in the evening of each day.
- Metadata sheets will be completed and inserted into the report as an appendix.
- All data derived on-site will be entered into a SACIC digital database compatible with the Suffolk HER.

Data processing and presentation

- Raw survey data will be collected to a high standard, enabling only minimal processing of the datasets to be required. Typically, these algorithms may comprise de-stripe and zero median sensor. The data will also be clipped at a suitable level to enable the anomalies to be presented with best clarity.
- Raw and processed greyscale plots and xy trace plots of the datasets shall be exported from Terrasurveyor into AutoCAD.
- An interpretation plan based on the combined interpretations of the raw, processed and xy trace plots will be produced using AutoCAD. All figures shall be georeferenced within the National Grid and printed at an appropriate scale.

Software

- The software used to process the data will be DW Consulting's Terrasurveyor v3.0.35.10. Images will be exported from Terrasurveyor into a geo-referenced grid within an AutoCAD drawing. Interpretation plans of the anomalies will then be digitised using AutoCAD.

5.4. Report

- The report will be commensurate with the results of the fieldwork and will be consistent with the principles of Management of Research Projects in the Historic Environment (MoRPHE, Historic England, 2015), Geophysical survey in Field

Evaluation (Historic England, 2008) and the Standard and Guidance for Archaeological Geophysical Survey (Chartered Institute for Archaeologists, 2014), containing the following: a summary, description of the project background, site location, survey methodology, detailed description of the nature, location and extent of anomalies, discussion of the anomalies, impact assessment, site potential and possible further work. Scaled raw, processed, xy data plans and an interpretation plan will also be included.

- The report will include a summary in the established format for inclusion in the annual *'Archaeology in Suffolk'* section of the Proceedings of the Suffolk Institute of Archaeology and History.
- A copy of this Written Scheme of Investigation will be included as an appendix in the report.
- Metadata sheet tables will form one of the appendices within the report.
- A technical data sheet will be included as an appendix.
- The report will include a copy of the completed project OASIS form as an appendix.
- An unbound draft copy of the report will be submitted to SCCAS for approval within 6 months of completion of fieldwork.

5.5. Project archive

- On approval of the report a printed and bound copy will be lodged with the Suffolk HER. A digital .pdf file will also be supplied, together with a digital and fully georeferenced vector plan showing the application area and survey location, compatible with MapInfo software.
- The online OASIS form for the project will be completed and a .pdf version of the report uploaded to the OASIS website for online publication by the Archaeological Data Service. A paper copy of the form will be included in the project archive.
- A second bound copy of the report will be included with the project archive.
- A digital .pdf copy of the approved report will be supplied to the client, together with our final invoice for outstanding fees. Printed and bound copies will be supplied to the client on request.

- The project archive, consisting of all paper and digital records, will be deposited in the SCCAS Archaeological Store at Bury St Edmunds within 6 months of completion of fieldwork. The project archive will be consistent with MoRPHE (Historic England, 2015) and ICON guidelines. The project archive will also meet the requirements of SCCAS (SCCAS 2017).
- The project costing includes a sum to meet SCCAS archive charges. A form transferring ownership of the archive to SCCAS will be completed and included in the project archive.
- If the client, on completion of the project, does not agree to deposit the archive with, and transfer it to SCCAS, they will be expected to either nominate another suitable depository approved by SCCAS.

5.6. Bibliography

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Witten, A. J., 2006, *Handbook of Geophysics and Archaeology.* Equinox Publishing Ltd. London.

Websites

British Geological Survey 2017

http://mapapps.bgs.ac.uk/geologyofbritain/home.html

6. Project Staffing

6.1. Management

SACIC Project Manager	Dr Rhodri Gardner
SACIC Project Manager	John Craven

6.2. Fieldwork

The fieldwork team will be derived from the following pool of SACIC staff.

Name	Job Title	First Aid	Other skills/qualifications
Tim Schofield	Project Officer	Yes	Geophysical Surveyor
Rhiannon Gardiner	Project Officer	Yes	Geophysical Surveyor
Filipe Santos	Project Assistant	No	Geophysical Surveyor
Cameron Bate	Project Assistant	No	Geophysical Surveyor
Katy Mossman	Project Assistant	No	Geophysical Surveyor

6.3. Report production

The production of the site report, graphics and submission of the project archive will be carried out by Tim Schofield.

Appendix 1. Health and Safety

1. Introduction

The project will be carried out following the SACIC Health and Safety Management System at all times. The SACIC Health and Safety Policy Statement reads as follows:

Suffolk Archaeology Community Interest Company is committed to ensuring the health, safety and welfare of its employees, and it will, so far as is reasonably practicable, establish procedures and systems necessary to implement this commitment and to comply with its statutory obligations on health and safety. Our Personnel are informed of their responsibilities to ensure they take all reasonable precautions, to ensure the safety, health and welfare of those that are likely to be affected by the acts and emissions of our organisations undertakings.

Suffolk Archaeology Community Interest Company understands our duty to identify the significant hazards that may be created by our undertakings and to risk assess these accordingly to ensure that suitable and effective controls are implemented to minimise risk to a suitable level as far as is reasonably practicable.

We also acknowledge our duty, so far as is reasonably practicable:

- *To provide a safe working environment for our workforce, fulfil our statutory commitments and actively manage and supervise health and safety at work;*
- *To identify the risks associated with our business activities and ensure suitable and sufficient control measures are in place.*
- *Ensure regular consultation with our employees on matters which affect their health and Safety.*
- *To ensure that all plant and equipment used by our employees is fit for purpose and adequately maintained.*
- *To provide suitable storage and ensure safe handling of Hazardous substances.*
- *To ensure that all workers are competent to undertake their daily work activities by providing all relevant information and training, consideration will also be given to any employees who do not have English as a first language.*
- *To prevent accidents and cases of work related ill health by ensuring a robust reporting and investigation system is in place.*
- *To liaise and communicate effectively regarding health and safety matters when working on other persons premises.*
- *To ensure that there is an effective system of induction, training, communication and supervision to other persons visiting or working on our premises.*
- *To have access to competent advice, this will be provided by Agility UK (Training and Consultancy) Ltd. Who will assists us in the continuous improvement in our health and safety performance and management through regular review and revision of this policy; and to provide suitable resources required to make this policy and our Health and Safety arrangements effective.*

2. Specific project issues

Introduction

All SACIC staff will be aware that they have a responsibility to:

- Take care of their own health and safety and that of others who may be affected by what they do, or fail to do, at work.
- Follow safe systems of work and other precautions identified in the project risk assessments.
- Report any changes to personal circumstances that may affect their ability to work safely.
- Report potential hazards, incidents and near misses to the Project Officer/supervisor.

A pre-site inspection has been made of the site and applicable SACIC Risk Assessments for the project are included below.

All SACIC staff are experienced in working on a variety of archaeological sites and permanent staff all hold a CSCS (Construction Skills Certification Scheme) card. All staff have been shown the SACIC Health and Safety Manual, copies of which are held at the SACIC office in Needham Market. All staff will read the site WSI and Risk Assessments and receive a site safety induction from the Project Officer prior to starting work. All staff will be issued with appropriate PPE.

From time to time it may be necessary for site visits by other SACIC staff, external specialists, SCCAS staff or other members of the public. All such staff and visitors will be issued with the appropriate PPE and will undergo the required inductions.

Site staff, official visitors and volunteers are all covered by SACIC insurance policies. SACIC also has professional negligence insurance. Copies of these policies are available on request.

Welfare facilities

Due to the limited nature of the project, it is proposed that SACIC staff will work from their vehicle and travel to public facilities if required. A vehicle will be on site at all times.

First Aid

A member of staff with the First Aiders at Work qualification will be on site at all times. A First Aid kit and a fully charged mobile will also be in vehicle/on site at all times.

Site access and security

Access to the site is off the unnamed road to the east of the field, a couple of entranceways could be used. The site is private arable land, bounded by hedgerows, but is open to general access.

Contaminated ground

Details of any ground contamination have not been provided by the client. If any such is identified then groundworks will cease until adequate safety and environmental precautions are in place.

Advice will be sought from HSE and relevant authorities if required concerning any of these issues.

Hazardous Substances

No hazardous substances are specifically required in order to undertake the archaeological works.

Underground services

Details of known services have not been provided by the client.

Overhead Powerlines

An overhead powerline crosses the site.

Personal Protective Equipment (PPE)

The following PPE is issued to all site staff as a matter of course. Additional PPE will be provided if deemed necessary.

- Hard Hat (to EN397).
- High Visibility Clothing (EN471 Class 2 or greater).
- Safety Footwear (EN345/EN ISO 20346 or greater – to include additional penetration-resistant midsole).

- Gloves (to EN388).
- Eye Protection (safety glasses to at least EN 166 1F).

SACIC Environment Policy

Suffolk Archaeology is committed to the sustainable management of the local and global environment to support local communities and growth in our local economy. We will strive to reduce our carbon emissions, to protect and enhance the natural and historic environment and to tackle the issues of a changing climate. In delivering our services, we are committed to meeting all relevant regulatory, legislative and other requirements, and to the continual improvement of our environmental performance.

We will endeavour to:

- Prevent environmental pollution and minimise waste;
- Reduce our carbon emissions;
- Continually improve our energy efficiency and reduce our use of resources;
- Reduce the impact of vehicle travel by our employees;
- Implement sustainable procurement practices where possible;
- Enhance biodiversity, conserve distinctive landscapes and protect the historic environment.

All existing and new SACIC subcontractors are issued annually with an Environmental Guidance Note For Contractors.

On site the SACIC Project Officer will monitor environmental issues and will alert staff to possible environmental concerns. In the event of spillage or contamination, e.g. from plant or fuel stores, EMS reporting and procedures will be carried out in consultation with the SACIC EMS Officer.

The client and/or landowner has not informed SACIC of any environmental constraints upon the development area but none are expected as the site is wholly within arable agricultural use

All rubbish will be bagged and removed either to areas designated by the client or returned to SACIC for disposal.

3. Project Contacts

SACIC

SACIC Manager	Dr Rhodri Gardner	01449 900120
SACIC Project Manager	John Craven	01449 900121
SACIC Finds Dept	Richenda Goffin	01449 900129
SACIC H&S	John Craven	01449 900121
SACIC EMS	Jezz Meredith	01449 900124

Emergency services

Local Police		101
Local GP	6 Acer Road, Rendlesham, Woodbridge, Suffolk, IP12 2GA	01728 747101
Location of nearest A&E	Ipswich Hospital, Heath Rd, Ipswich IP4 5PD	01473 712233
Environment Agency	Customer Services Line (8am to 6pm)	03708 506 506
	24 hour Emergency Hotline	0800 807060
Essex and Suffolk Water	24 hour Emergency Hotline	0845 782 0999
National Gas Emergency Service	Gas emergency hotline	0800 111 999
UK Power Networks	East England electricity emergency hotline	0800 783 8838
Anglian Water	24 hour Emergency Hotline	08457 145 145

Client contacts

Client	Andrew Hawes	07879 420150
Client Agent		
Site landowner	Will Brice	07791 320031

Archaeological contacts

Curator	Rachael Abraham (SCCAS)	01284 741232
Consultant		
EH Regional Science Advisor	Dr Zoe Outram	01223 582707

4. Geophysical Technical Information

Detailed magnetometer survey

Detailed magnetometer survey is the most commonly employed archaeological geophysical prospection method in Britain, sensitive sensors can cost-effectively cover large areas of ground, rapidly recording anomalies that are indicative of cultural settlement activity. These anomalies can then be further investigated by field archaeologists to quantify a form and function. The magnetometer is a passive instrument that detects both permanent thermoremanent and temporary magnetic responses.

Thermoremanent Magnetism

When a material containing iron oxides, for example clay, is heated above the Curie point, weakly magnetic compounds transform in to highly magnetic oxides that can be detected by the sensors of a magnetometer (Clark). For instance the iron oxide haematite has a Curie temperature of 675 Celsius and magnetite 565 Celsius. Once these temperatures are reached, the oxides become demagnetised, on cooling their magnetic properties become permanently re-magnetised and align in the direction of the Earth's magnetic field (Gaffney and Gater). Over time the direction of the Earth's magnetic field changes allowing these directional differences to be detected by the magnetometer.

Strongly heated features such as hearths, kilns or furnaces frequently reach the Curie temperature and become permanently magnetised. These permanent magnetic responses are some of the strongest cultural features that can be recorded.

Temporary Magnetism

Magnetic susceptibility is the ease with which a magnetic field can pass through a material, therefore the higher the materials magnetic susceptibility, the stronger the induced magnetic field will be. Temporary magnetisation occurs within material that is magnetically susceptible, this material acquires its own local magnetic field that combine with the Earth's magnetic field causing an anomaly to stand out from the background noise (Clark). These anomalies are more subtle in nature, being derived from material that has been magnetically enhanced by cultural activity and become concentrated into features over time. Anomalies that have temporary magnetisation include backfilled pits, ditches, field systems, occupation areas, land drains, remnant and existing field

boundaries (David, 2011).

The key to a successful survey is having good contrast between the magnetic susceptibility of an archaeological feature with the surrounding superficial deposits. If there is no discernible difference between the two mediums it may be unlikely that the magnetometer will successfully prospect the feature. Archaeological features can also be masked by high magnetically susceptible topsoil, or deep overlying subsoil and colluvial deposits.

Ferrous anomalies

Ferrous objects are a common source of permanent magnetism, usually isolated with a strong dipolar signature. Some of these responses may have an archaeological derivation, however they are probably more indicative of modern iron objects introduced through manuring or lost within the topsoil.

Bartington DualGRAD 601-2 Fluxgate Gradiometers

Fluxgate gradiometers are the most commonly employed class of instrument in the UK. Two 1m sensitive sensors are affixed to a frame mounted 1m apart in a vertical plane and harnessed to the trunk of a geophysical surveyor or attached to a pulled cart. Each sensor contains two fluxgate magnetometers with 1m vertical separation. The sensor above records the Earth's magnetic field (magnetic background) while the sensor below records the local magnetic field. The two sensors need aligning before recording can begin, a zero station is located in an area with low magnetic variation for this purpose. After the sensors have been aligned, the survey can begin. When differences in the magnetic field strength occur between the two vertical magnetometers within each sensor, a positive or negative reading is recorded that is relative to the magnetic background of the zero station. Positive anomalies include pits, ditches and agricultural furrows. Negative anomalies commonly prospected include earthwork embankments, land drains and geological features.

Sensors are normally mounted to a height of 0.30m above the surface, and can detect to a depth of between one and two metres below the ground. The first survey traverse is commonly undertaken in an east to west direction.

Magnetic Anomalies

Isolated dipolar responses

Isolated dipolar responses are commonly recorded throughout a dataset and are usually indicative of modern ferrous material deposited within the topsoil horizon. In some instances the anomalies may be of an archaeological derivation. They are isolated, strong and dipolar in character.

Areas of magnetic disturbance

These anomalies are usually caused by building demolition rubble, ferrous boundaries, slag waste dumps, modern buried rubbish, pylons and services. Strong and dipolar in character, they are commonly recorded over a wide area.

Linear trends

Linear trends can be either positive or negative magnetic responses depending on the nature of the material present within the feature. If the anomaly is broad and weak, it is more likely to be of geological origin. Stronger positive linear trends are more likely to be of archaeological derivation, caused by settlement activity washing rich humic, charcoal and fired deposits into a feature. Negative linear trends are more commonly associated with bank deposits or land drains, with the less magnetically susceptible superficial deposits deposited at the top of the feature. Curvilinear trends are usually of archaeological origin, commonly interpreted as ring ditches or drip-gullies.

Discrete anomalies

Discrete anomalies can either be positive or negative in nature recorded within a localised area. Those that are positive are more likely to be of an archaeological origin, with negative discrete anomalies more commonly interpreted as natural geological variations.

Thermoremanent responses

These responses are caused by the heating of material containing iron to above the Curie temperature, they are strong and discrete in nature, in Britain high positive readings are recorded to the south of the feature, and high negative readings are recorded to the north.

SUFFOLK ARCHAEOLOGY

• A HISTORY OF EXPERTISE •

5. Geophysical Survey Risk Assessments

A pre-site inspection and assessment has been made of the site and the following SACIC Risk Assessments apply to the project and are included below.

SACIC GSRA1	Manual handling and outdoor working
SACIC GSRA2	Use of hand tools and instrumentation

Geophysical Survey Risk Assessment 1 Manual handling and outdoor working

Activity	Location	Hazard	Risks	Persons affected	Initial risk	Control measures	Residual risk	Name	Date	Rescue procedures
Manual handling of survey instruments and working outdoors.	Various.	Extremes of heat, cold and wet weather. Trip hazards.	Hypothermia, heat stroke, sunburn. Minor injuries. Carrying heavy equipment for prolonged periods.	All field staff.	9	All staff provided with appropriate clothing for weather conditions. No staff to work alone in extreme conditions. Regular sweep for trip hazards.	2	T Schofield	07/03/19	First Aid if required. Call emergency services if necessary.

	Likelihood				
Severity	1	2	3	4	5
1	1	2	3	4	5
2	2	4	6	8	10
3	3	6	9	12	15
4	4	8	12	16	20
5	5	10	15	20	25

Initial Risk
Residual Risk

Likelihood	Severity	Risk (likelihood x severity)
1. Highly unlikely	1. Slight inconvenience	1-5 Low
2. May occur but very rarely	2. Minor injury requiring first aid	
3. Does occur but only rarely	3. Medical attention required	6-12 Medium
4. Occurs from time to time	4. Major injury leading to hospitalisation	
5. Likely to occur often	5. Fatality or serious injury leading to disablement	13-25 High

Geophysical Survey Risk Assessment 2 Use of hand tools and survey instruments

Activity	Location	Hazard	Risks	Persons affected	Initial risk	Control measures	Residual risk	Name	Date	Rescue procedures
Surveying, setting out and use of small hand tools and marker canes.	Various.	Splinters from poorly maintained equipment, trip hazards from unused equipment, trip hazards from uneven ground, some heavy lifting, tape winding.	Minor injuries.	All field staff.	8	Ensure all tools in serviceable condition. Careful policing of temporarily unused equipment (e.g. no discarded hand tools, hand tapes pegged down). Ensure all tools and instrumentation carried appropriately.	4	T Schofield	07/03/19	First Aid if required. Call emergency services if necessary.

	Likelihood				
Severity	1	2	3	4	5
1	1	2	3	4	5
2	2	4	6	8	10
3	3	6	9	12	15
4	4	8	12	16	20
5	5	10	15	20	25

Initial Risk
Residual Risk

Likelihood	Severity	Risk (likelihood x severity)
1. Highly unlikely	1. Slight inconvenience	1-5 Low
2. May occur but very rarely	2. Minor injury requiring first aid	
3. Does occur but only rarely	3. Medical attention required	6-12 Medium
4. Occurs from time to time	4. Major injury leading to hospitalisation	
5. Likely to occur often	5. Fatality or serious injury leading to disablement	13-25 High

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