Stutton Park Reservoir

Stutton, Suffolk

Client:
Mr Andrew Hawes

Date:
May 2018

STU 093
Geophysical Survey Report
SACIC Report No. 2018/047
Author: Timothy Schofield HND BSc MCIfA

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Author: Timothy Schofield

Illustrator: Timothy Schofield

Editor: Stuart Boulter

Report Date: May 2018

HER Information

Site Code:	**STU 093**
Site Name:	**Stutton Park Reservoir, Stutton, Suffolk**
Report Number	**2018/047**
Planning Application No:	**DC/18/01072**
Date of Fieldwork:	**17th – 20th April 2018**
Grid Reference:	**TM 1357 3345**
Oasis Reference:	**313758**
Curatorial Officer:	**Rachael Abraham**
Project Officer:	**Timothy Schofield**
Client/Funding Body:	**Andrew Hawes**

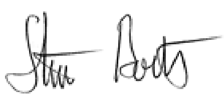
Digital report submitted to Archaeological Data Service:
http://ads.ahds.ac.uk/catalogue/library/greylit

Disclaimer

Any opinions expressed in this report about the need for further archaeological work are those of Suffolk Archaeology CIC. Ultimately the need for further work will be determined by the Local Planning Authority and its Archaeological Advisors when a planning application is registered. Suffolk Archaeology CIC cannot accept responsibility for inconvenience caused to the clients should the Planning Authority take a different view to that expressed in the report.

Prepared By: Timothy Schofield
Date: May 2018

Approved By: Stuart Boulter
Position: Senior Project Manager
Date: May 2018
Signed:



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Summary

In April 2018 Suffolk Archaeology Community Interest Company (SACIC) undertook a detailed fluxgate gradiometer survey on land for a proposed agricultural reservoir at Stutton Park, Stutton, Suffolk. A total area of 5.86ha was prospected for anomalies of an archaeological derivation within the footprint of the reservoir.

The detailed fluxgate gradiometer survey recorded a narrow range of anomalies, the majority of which were categorised as being geologically derived, relating to the River Stour, which is located just 550m to the south. A few anomalies of archaeological potential, include a single ditch type response and a series of seven pits. Overall, the non-intrusive survey results reveal a low potential for magnetic anomalies of an archaeological origin.

1. Introduction

The detailed magnetometer survey represents the first stage of archaeological investigations over the footprint of the proposed agricultural reservoir. This area covered some 6.5 hectares, within a single arable field at Stutton Park, Stutton, Suffolk (Fig. 1).

SACIC were commissioned to undertake the project by Mr Andrew Hawes in April 2018, prior to determination of the planning application, in accordance with paragraph 128, 129 and 141 of the National Planning Policy Framework, and requested by the Senior Archaeological Officer Rachael Abraham, of Suffolk County Council Archaeological Service/Conservation Team (SCCAS/CT) to inform the trial trenching evaluation brief.

Figure 1. Location map showing site boundary (red)

2. Geology and topography

The site lies within an arable setting, located *c*.1.9km to the southwest of the village of Stutton, in a single field at TM 1357 3345, bounded to the west by Queech Lane, to the north, south and east by boundary ditches and hedgerows (Fig.1). A dry valley is clearly extant within the field bisecting it from the southeast to the northwest corner. The lowest point can be found in the southeast corner of the field at 6m above ordnance datum (AOD) with the highest levels present in the northeast and southwest corners at 12m (AOD).

The bedrock geology is sedimentary in nature, consisting of Thames Group clay, silt and sand, formed 34 to 56 million years ago during the Palaeogene period. At the time of writing, no superficial deposits were recorded for this site (BGS 2018).

3. Archaeology and historical background

A geophysical survey was required by SCCAS in order to inform the archaeological evaluation trench brief for the proposed agricultural reservoir. A full search of the Suffolk Historic Environment Record has been commissioned and will be presented within the evaluation report, a short summary of the results is provided below.

The location of the proposed reservoir has a high archaeological potential, located overlooking the River Stour, on light sandy soils that were favoured by early human inhabitants. No previous systematic archaeological investigations have been undertaken on the proposed reservoir site. Mesolithic flint blades and a core (STU 021) were recorded 560m to the southeast. Late Iron Age to Roman pits, a saltern and artefacts including a triangular loomweight and Roman coins (STU 022) were recovered 580m to the southeast. A Roman trumpet brooch (STU Misc) was recovered by a metal detectorist 255m to the north. The post-medieval park and the Grade II* listed great house of Stutton Hall (STU 030) built in 1533, is located 490m to the northeast. A section of post-medieval flood defence (STU 066) is located 320m to the west. recorded 490m to the southeast is a post-medieval seawall (STU 073). A series of post-medieval and modern flood defences (BNT 054) are recorded 730m to the southwest. The proposed reservoir development is likely to cause a significant degree of ground disturbance, that could potentially damage any surviving heritage assets.

An initial examination of historic mapping held by SACIC has been made, revealing that it has been a single field since the 1882 Ordnance Survey map was published. The removal of a section of the southern boundary to enlarge the field to the current configuration, took place between the 1967 and 1978 OS publications.

4. Methodology

Instrument type

A Bartington DualGRAD 601-2 fluxgate gradiometer was employed to undertake the detailed geophysical survey; the weather was very sunny every day, which caused a degree of sensor drift from zero as magnetic storms were encountered, producing diurnal drift. The crop was also growing on a daily basis and by the final day the bases of the sensors were starting to drag.

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 west-southwest to east-northeast and geolocated employing a Leica Viva GS14 Smart Rover RTK GLONASS/GPS, allowing 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, allowing grids to be re-surveyed if necessary. A pro-forma survey sheet was completed to allow data composites to be created. Data were filed in unique project folders and backed-up onto an external storage device and then a remote server in the evening.

Data software, processing and presentation

The site had a moderate magnetic background signature when overcast, which became more changeable when the sun was out. Striping caused by solar flares and magnetic storms that were not shielded from cloud cover caused a degree of sensor drift that regular re-zeroing could not reduce. Where large positive and negative geological anomalies were prospected, increased grid average magnetic backgrounds where recorded, this meant that the de-striping algorithm (zero median traverse) caused too much distortion to the data, and therefore this algorithm could not be used on these grids. Datasets were composited and processed using DW Consulting's Terrasurveyor v.3.0.33.6; raw grid files, composites and raster graphic plots will be stored and archived in this format. Minimal processing algorithms were undertaken on the raw (Fig. 3) and processed datasets (Figs. 4 – 5); data schedules 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 (Figs. 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 that will allow the geophysical anomalies to be retargeted during the subsequent phase of evaluation trenching (Fig. 2).

5. Results and discussion

Isolated dipolar responses (grey spots) were recorded throughout the dataset, these magnetic responses are likely to be caused by ferrous objects prospected within the ploughsoil. It is probable that these artefacts were introduced during manuring events and are of a modern origin, they could also represent archaeological artefacts.

Four linear magnetic disturbance anomalies (blue hatching) are likely to delineate the presence of ceramic land drains, cut into the superficial geology on a northeast to southwest and perpendicular alignments. One shorter linear trend is further recorded running on a different alignment of east to west.

Narrow negative linear trends (cyan hatching) record the presence of extant tractor wheel ruts running parallel with the current field boundary configuration.

Broad, diffuse positive anomalies (green hatching) are indicative of geological deposits with a strong magnetic signature. The largest of which is likely to have been deposited by a former course of the River Stour, currently located just 550m to the south.

Broad diffuse negative anomalies (purple hatching) have been prospected across the survey area, the majority of which were recorded near the positive geological deposits. It is likely that these low magnetically susceptible anomalies are of geological origin, potentially deposited during similar overbank floods or subglacial events.

Seven positive discrete anomalies (orange hatching) record the position of anomalies that are more indicative of archaeological rubbish pits, however their general lack of tight clustering may reveal that they have a more geological/natural origin.

A single positive linear anomaly (red hatching) running from the southern boundary of the survey area is potentially indicative of an archaeological or agricultural ditch. It is straighter and narrower than those of a more geological origin located directly to its north. However a more natural derivation cannot be ruled out.

6. Conclusion

The archaeological potential of the site was expected to be high, however the gradiometer survey recorded only a narrow range of geophysical anomalies. Those with a broad, irregular form are likely to be geological channels that have been infilled by alluvial and fluvial processes associated with the River Stour and also by the retreating ice sheets in the last glaciation.

Only a few anomalies were recorded that could have an archaeological derivation, including those indicative of pits and a single ditch-type linear response. A subsequent phase of trial trench evaluation will further investigate the anomalies prospected and determine whether low contrast magnetic anomalies of an archaeological origin 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 Stores in Bury St Edmunds.

8. Acknowledgements

The fieldwork was carried out by Timothy Schofield, Rui Oliveira, Filipe Santos, Cameron Bate and Catherine Douglas, and directed by Catherine Douglas. Project management was undertaken by Rhodri Gardner. The report and illustrations were created by Tim Schofield, and the report was edited by Stuart Boulter.

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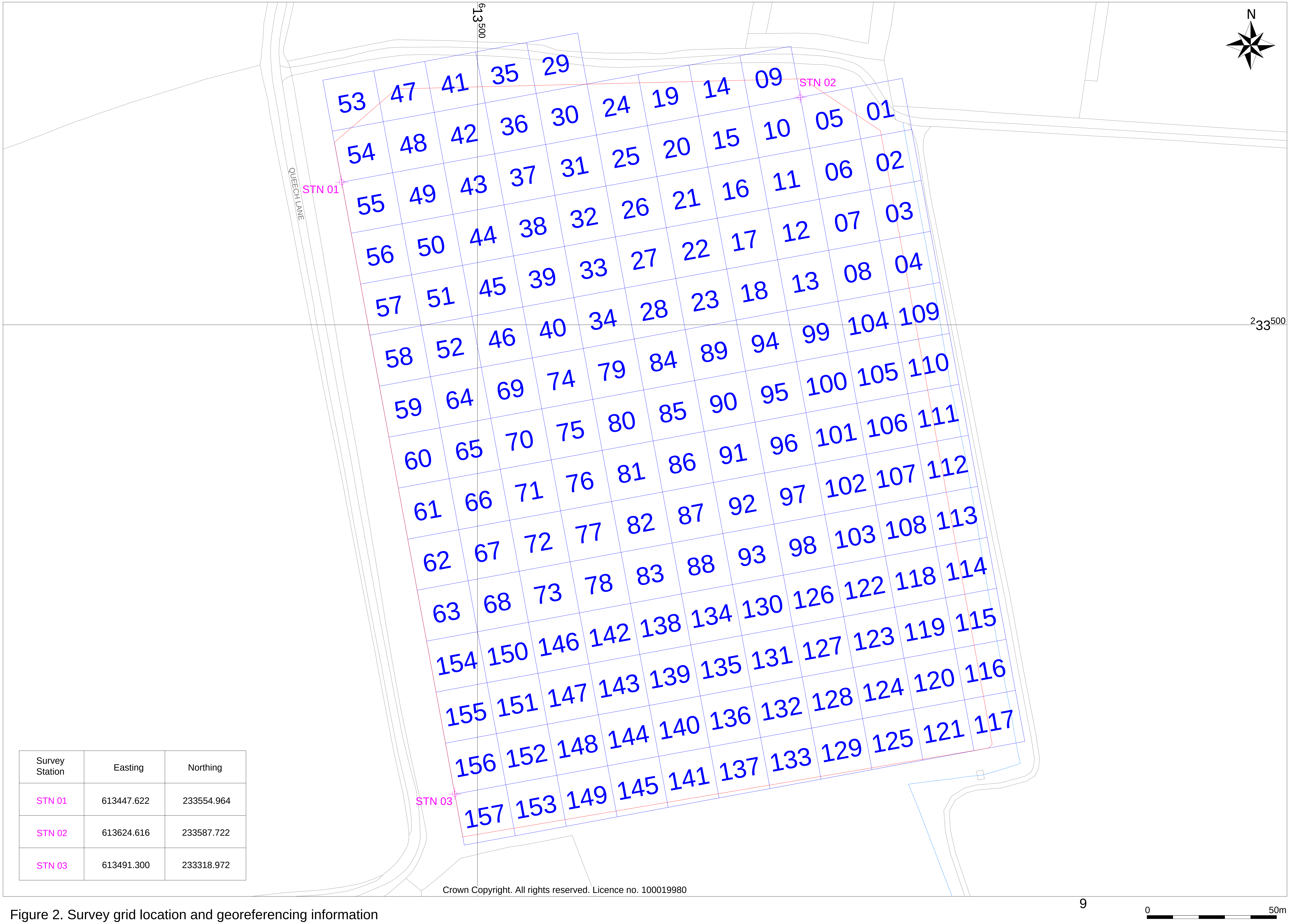

Survey Station	Easting	Northing
STN 01	613447.622	233554.964
STN 02	613624.616	233587.722
STN 03	613491.300	233318.972

Figure 2. Survey grid location and georeferencing information

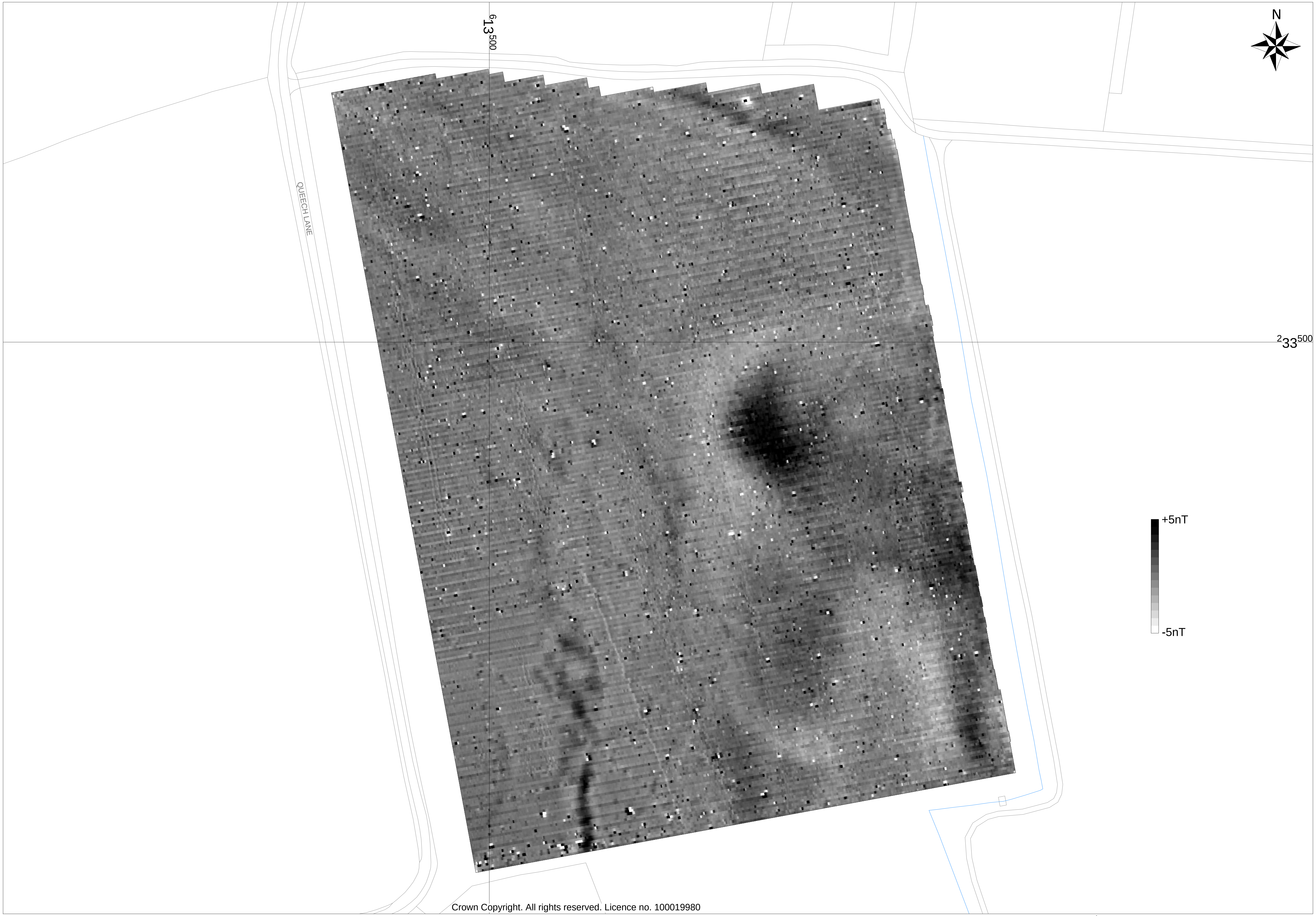

Figure 3. Raw magnetometer greyscale plot

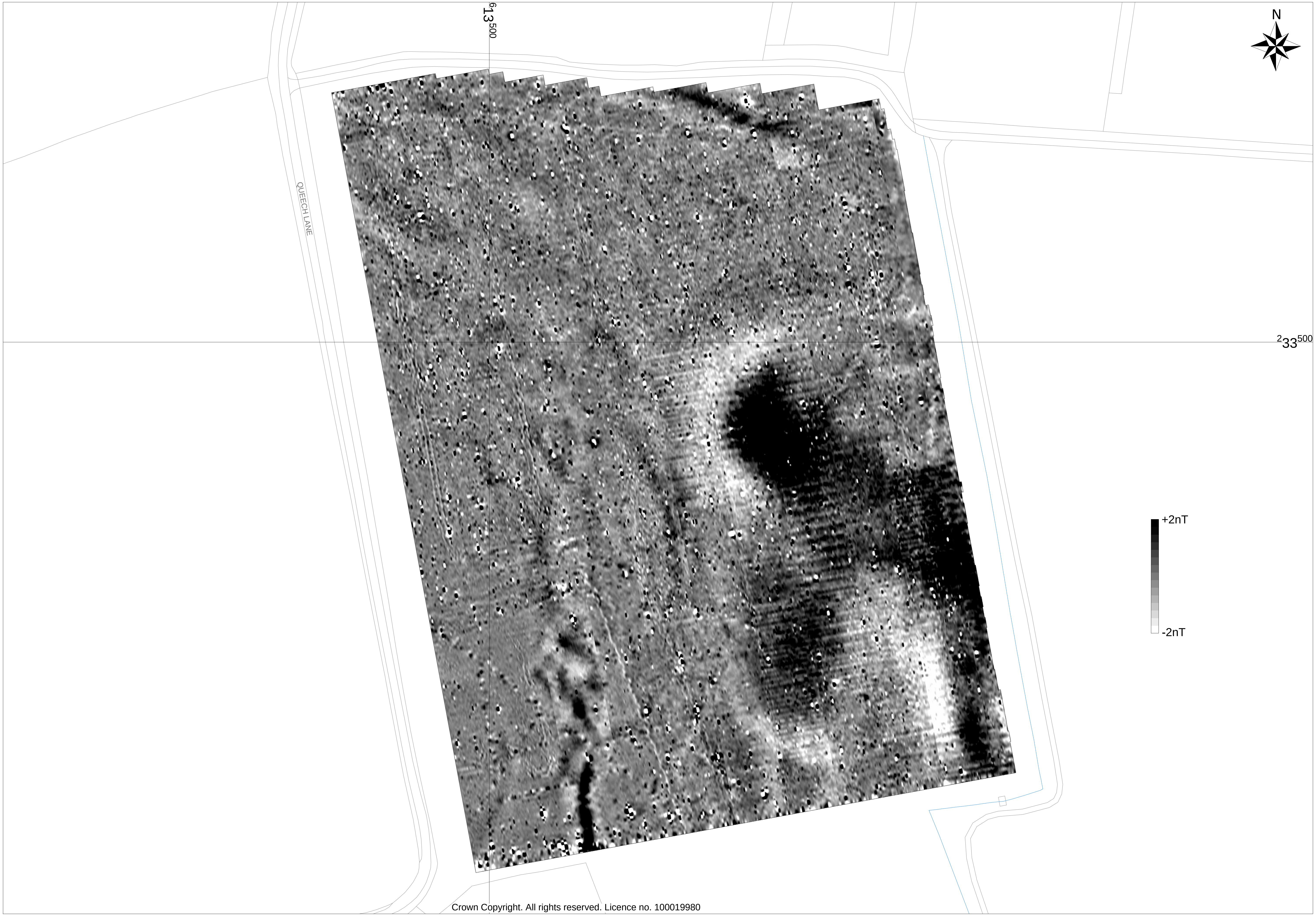

Figure 4. Processed magnetometer greyscale plot

Figure 5. Processed magnetometer xy trace plot

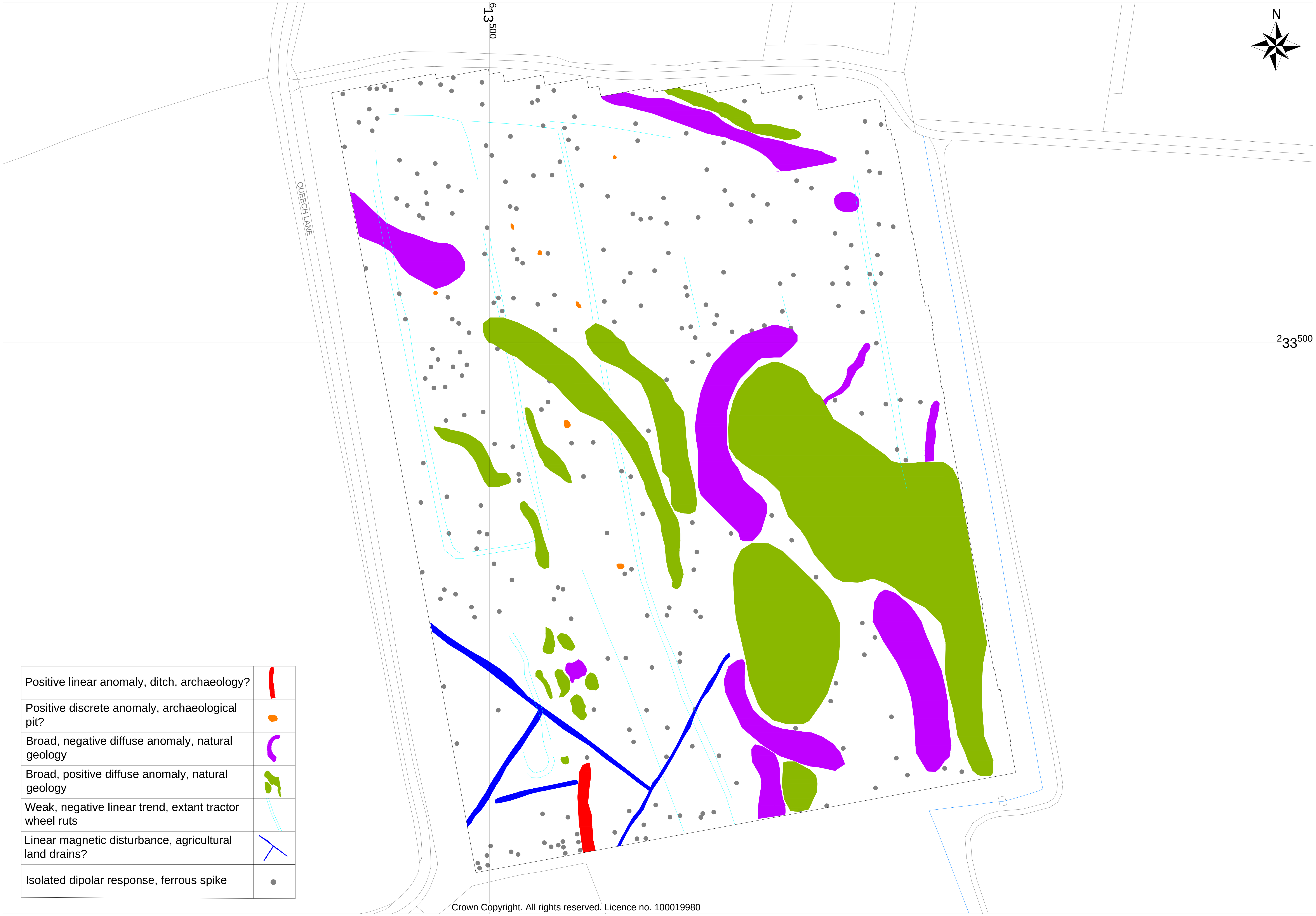

Figure 6. Interpretation plot of magnetometer data anomalies

Appendix 1. Metadata sheets

Survey Grids

Source Grids: 157
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Raw Data

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Dummy Value	2047.5
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Survey Size (meters)	220 m x 300 m
Grid Size	20 m x 20 m
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Y Interval	1 m
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Max	99.26
Min	-100.00
Std Dev	1.86
Mean	0.35
Median	0.26
Composite Area	6.6 ha
Surveyed Area	5.8557 ha
Program	
Name	TerraSurveyor
Version	3.0.33.6

Raw Data Schedule

Processes:
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Processed Data

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Instrument Type	Grad 601 (Gradiometer)
Units	nT
Direction of 1st Traverse	90 deg
Collection Method	ZigZag
Sensors	2 @ 1.00 m spacing.
Dummy Value	2047.5
Dimensions	
Composite Size (readings)	880 x 300
Survey Size (meters)	220 m x 300 m
Grid Size	20 m x 20 m
X Interval	0.25 m
Y Interval	1 m
Stats	
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Min	-100.92
Std Dev	1.82
Mean	0.18
Median	0.05
Composite Area	6.6 ha
Surveyed Area	5.8557 ha
Program	
Name	TerraSurveyor
Version	3.0.33.6

Processed Data Schedule

Processes:
1 DeStripe Median Sensors
2 Display Clip -2 +2
3 Graduated Shade

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 ID: suffolka1-313758

Project details	
Project name	Stutton Park Reservoir, Stutton, Suffolk, Geophysical Survey
Short description of the project	In April 2018 Suffolk Archaeology Community Interest Company (SACIC) undertook a detailed fluxgate gradiometer survey on land for a proposed agricultural reservoir at Stutton Park, Stutton, Suffolk. A total area of 5.86ha was prospected for anomalies of an archaeological derivation within the footprint of the reservoir. The detailed fluxgate gradiometer survey recorded a narrow range of anomalies, the majority of which were categorised as being of a geological derivation related to the River Stour, which is located just 550m to the south. A few anomalies of archaeological potential, include a single ditch type response and a series of seven pits. Overall, the non-intrusive survey results reveal a low potential for magnetic anomalies of an archaeological origin.
Project dates	Start: 17-04-2018 End: 20-04-2018
Previous/future work	No / Yes
Any associated project reference codes	2018/047 - Contracting Unit No.
Any associated project reference codes	STU 093 - 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 ANNOMALY Uncertain
Monument type	PIT TYPE ANOMALIES Uncertain
Monument type	FORMER RIVER STOUR COURSE ANOMALIES Uncertain
Significant Finds	NONE None
Methods & techniques	"Geophysical Survey"
Development type	Agricultural Reservoir
Prompt	National Planning Policy Framework - NPPF
Position in the planning process	Pre-application
Solid geology (other)	Thames Group Clay, Silt and Sand
Drift geology	Unknown
Techniques	Magnetometry
Project location	
Country	England
Site location	SUFFOLK BABERGH STUTTON Stutton Park Reservoir, Stutton, Suffolk

Study area	6.5 Hectares
Site coordinates	TM 1357 3345 51.957907061187 1.108733763054 51 57 28 N 001 06 31 E Point
Height OD / Depth	Min: 6m Max: 12m

Project creators

Name of Organisation	Suffolk Archaeology CIC
Project brief originator	Local Planning Authority (with/without advice from County/District Archaeologist)
Project design originator	Tim Schofield
Project director/manager	Rhodri Gardner
Project supervisor	Catherine Douglas
Type of sponsor/funding body	Client
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","GIS","Geophysics","Images raster / digital photography","Spreadsheets","Survey","Text"
Paper Archive recipient	Suffolk HER
Paper Contents	"Survey"
Paper Media available	"Report","Survey ","Unpublished Text"

Project bibliography 1

Publication type	Grey literature (unpublished document/manuscript)
Title	Stutton Park Reservoir, Stutton, Suffolk, Geophysical Survey
Author(s)/Editor(s)	Schofield, T. P.
Other bibliographic details	2018/047
Date	2018
Issuer or publisher	Suffolk Archaeology CIC
Place of issue or publication	Needham Market

Description	A4 report with A3 fold-out figures
URL	www.suffolkarchaeology.co.uk
Entered by	Tim Schofield (tim.schofield@suffolkarchaeology.co.uk)
Entered on	1 May 2018

Appendix 4. Written scheme of investigation

Stutton Park Reservoir
Stutton, Suffolk

Client:
Mr Andrew Hawes

Date:
April 2018

STU 093
Written Scheme of Investigation and Risk Assessment – Geophysical Survey
Author: Tim Schofield HND BSc MCIfA

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Project details

Planning Application No:	TBC
Curatorial Officer:	Rachael Abraham (SCCAS/CT)
Grid Reference:	TM 1357 3345
Area:	*c*. 6.2ha
HER Event No/Site Code:	STU 093
OASIS Reference:	313758
Project Start date:	17th April 2018
Project Fieldwork Duration:	*c*. 3 days
Client/Funding Body:	Andrew Hawes
SACIC Project Manager:	Rhodri Gardner
SACIC Project Officer:	Tim Schofield
SACIC Job Code:	STU PAR 001

1. Introduction

- A program of geophysical survey is required on the site of a proposed agricultural reservoir, at Stutton Park, Stutton, Suffolk (Fig. 1), prior to determination of the planning application, in accordance with paragraph 128, 129 and 141 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/Conservation Team (SCCAS/CT).
- The proposed reservoir occupies an area of *c.*6.2ha. This Written Scheme of Investigation (WSI) details how the survey will meet the requirements as laid out in the SCCAS/CT geophysical survey guidelines (SCCAS/CT 2017) and has been submitted to SCCAS/CT 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/CT.
- It should be noted that the geophysical survey is only a first stage in a potential program of works. This WSI covers the geophysical survey only. Any further stages of archaeological work that are required in relation to the proposed development after the survey will be specified by SCCAS/CT, and will require new documentation (Brief and WSI) and estimate of costs. Such works could have considerable time and cost implications for the development and the client is advised to consult with SCCAS/CT as to their obligations following receipt of the geophysical survey report.

Figure 1. Location map showing site boundary (red)

2. The Site

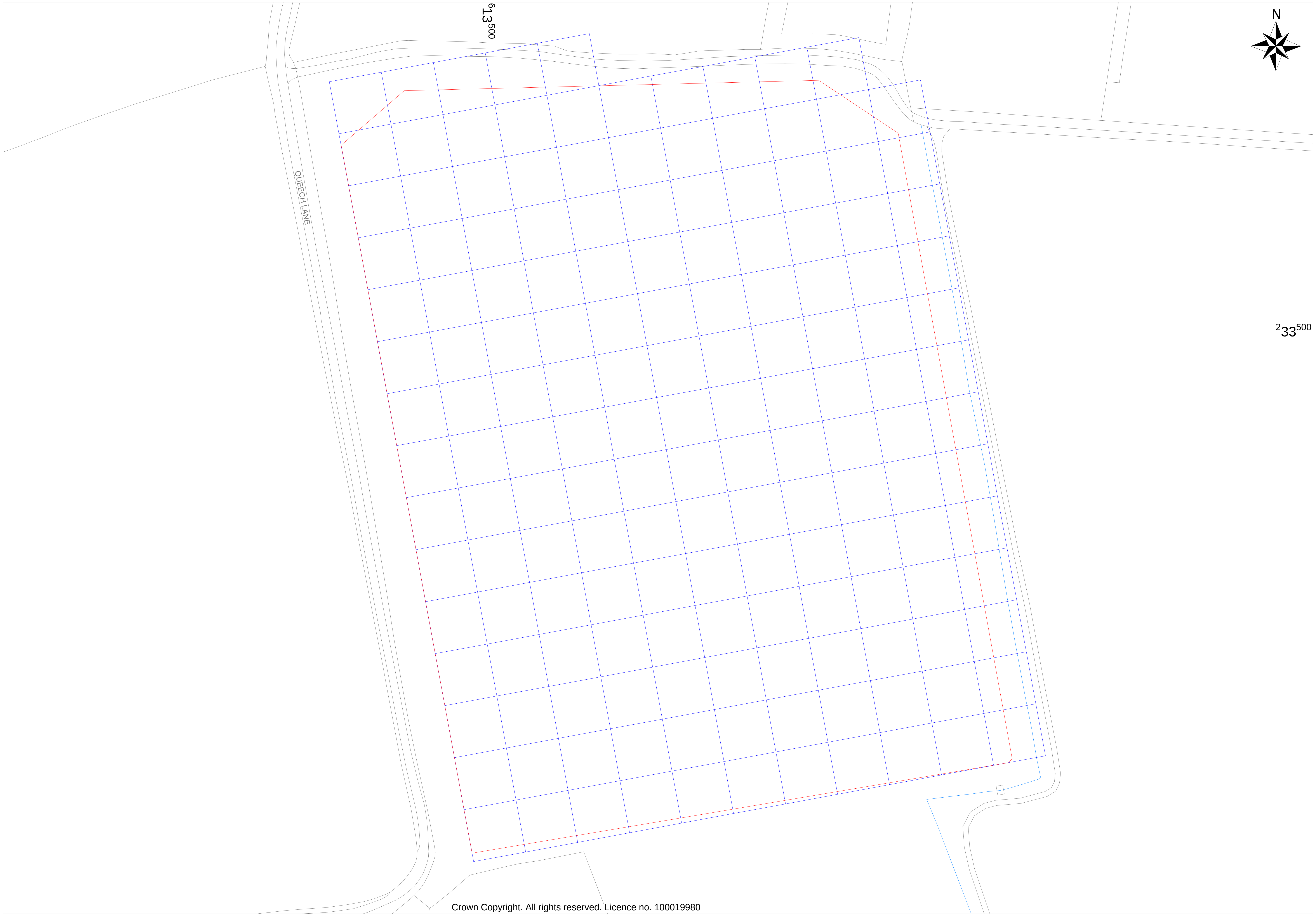
- The site lies within an arable landscape, located *c*.1.9km to the southwest of the settlement of Stutton, in a single field at TM 1357 3345, bounded to the west by Queech Lane, and ditches and hedgerows to the north, south and east (Fig.1).
- The site is located within a dry valley that bisects the field running from the southeast to the northwest corners, the lowest point is found in the southeast corner of the field at 6m above ordnance datum (AOD), with the highest present in the northeast and southwest corners at 12m (AOD).
- The bedrock geology is sedimentary in nature consisting of Thames Group clay, silt and sand, formed 34 to 56 million years ago during the Palaeogene period. No superficial deposits were recorded for this site during the preparation of this WSI (BGS 2018).

3. Archaeological and Historical Background

- The geophysical survey is required by SCCAS/CT in order to inform the archaeological evaluation trench brief for the proposed agricultural reservoir.
- A full search of the Suffolk Historic Environment Record has been commissioned and will be used within the survey report. A summary of the results is presented below. The proposed reservoir location has a high archaeological potential, located overlooking the River Stour, on light sandy soils that were favoured by early human inhabitants. No systematic archaeological investigation has been undertaken on the proposed reservoir site. Mesolithic flint blades and a core (STU 021) were recorded 560m to the southeast. Late Iron Age to Roman pits, a saltern and artefacts including a triangular loomweight and Roman coins (STU 022) were recovered 580m to the southeast. A Roman trumpet brooch (STU Misc) was recovered by a metal detectorist 255m to the north. The post medieval park and the Grade II* listed great house of Stutton Hall (STU 030) built in 1533 is located 490m to the northeast. A section of post-medieval flood defence (STU 066) is located 320m to the west. recorded 490m to the southeast is a post-medieval seawall (STU 073). A series of post-medieval and modern flood defences (BNT 054) are recorded 730m to the southwest. The proposed reservoir development is likely to cause a significant degree of ground disturbance, that could potentially damage surviving heritage assets.
- An initial examination of historic mapping held by SACIC has been made, revealing that it has been a single field since the 1882 Ordnance Survey map was published. The removal of part of the southern boundary into the current field configuration took place between the 1967 and 1978 OS publications.

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.



0 50m

Figure 2. Proposed survey grid location

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/CT will be given five days' notice of the commencement of the fieldwork and arrangements made for a SCCAS/CT site visit if required.
- Full details of project staff are given in section 6 below.

5.2. Project preparation

- A Parish sitecode has been obtained from the SCCAS/CT HER Officer and will be included on all project documentation. An HER search has been requested.
- An OASIS online record has been initiated and key fields in details, location and creator forms have been completed.
- A Risk Assessment for the project has been completed.

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.
- The 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 the survey of *c*.6.2 hectares over the proposed reservoir development (Fig. 2). The survey area will cover the footprint of the quarry, minor modifications to the survey area may need to be made onsite to respect any areas of disturbance/contamination or other obstacles.
- The outline of the survey area ensures that a 5-10m exclusion zone can be

maintained from surrounding field boundaries in order to minimise the amount of associated magnetic disturbance.

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 GS14 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 on-site derived site data will be entered onto a digital (Microsoft Access) SACIC database compatible with the Suffolk HER.

Data processing and presentation

- Raw survey data will be collected to a high standard to enable only minimal processing of the datasets to be required. Typically, these algorithms comprise 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 v3.0.33.6. 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/CT 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/CT 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/CT (SCCAS/CT 2017).
- The project costing includes a sum to meet SCCAS/CT archive charges. A form transferring ownership of the archive to SCCAS/CT 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 to, SCCAS/CT, they will be expected to either nominate another suitable depository approved by SCCAS/CT.

5.6. Bibliography

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SCCAS, 2017, *Requirements for a Geophysical Survey*.

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

Websites

British Geological Survey 2018

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

6. Project Staffing

6.1. Management

SACIC 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
Catherine Douglas	Project Officer	Yes	Geophysical Surveyor
Cameron Bate	Project Assistant	No	Geophysical Surveyor
Rui Oliveira	Project Assistant	No	Geophysical Surveyor
Filipe Santos	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/CT 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 Queech Lane, in the northwestern corner of the field. 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

No overhead powerlines cross 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
SACIC Outreach Officer	Alex Fisher	01449 900125

Emergency services

Local Police		101
Local GP	Holbrook Surgery, The Street, Holbrook, IP9 2QS	01473 328263
Location of nearest A&E	Ipswich Hospital, Heath Road, Ipswich, IP4 5PD	01473 702033
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	
Client Agent		
Site landowner	TBC	

Archaeological contacts

Curator	Rachael Abraham (SCCAS/CT)	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 •

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	12/04/18	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	12/04/18	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
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