Geophysical Survey Report

of

Land at Green Farm, Edge Green

Kenninghall, Norfolk

NGR: TM 0389 8499

For

Oxford Archaeology East

On Behalf Of

Crown Chicken Ltd.

Magnitude Surveys Ref: MSTM336

HER Event No: ENF144765

NCCES No: CNF48165

OASIS ID: magnitud1-327158

October 2018

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Report 2.1	Frederick Salmon BSc	Andrés Pérez Arana BA(Hons) PGCE MA	Edward Burton BA (Hons) PGCE	24 October 2018

Abstract

Magnitude Surveys was commissioned to assess the subsurface archaeological potential of a c. 8.89ha area of land at Green Farm, Edge Green, Kenninghall, Norfolk. A fluxgate magnetometer survey was successfully completed, and the results primarily reflect agricultural activity. This agricultural includes ploughing trends, field drains, and former field boundaries. Anomalies associated with modern activity have been identified as well. A few anomalies have been classified as 'Undetermined' where the origin of the response is ambiguous in the geophysical results and supplementary resources cannot indicate a more specific origin.

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1. Introduction

1.1. Magnitude Surveys Ltd (MS) was commissioned by Oxford Archaeology East (OAE) on behalf of Crown Chicken Ltd to undertake a geophysical survey on a c.8.89 ha area of land at Green Farm, Edge Green, Kenninghall, Norfolk (NGR- TM 0389 8499).

1.2. The geophysical survey comprised hand-pulled, cart-mounted and hand carried GNSS-positioned fluxgate magnetometer survey. The hand-pulled, cart-mounted system was used over the majority of the site, while the hand carried system was employed in the area of a young beet crop.

1.3. The survey was conducted in line with the current best practice guidelines produced by Historic England (David et al., 2008), the Chartered Institute for Archaeologists (CIfA, 2014), the European Archaeological Council (Schmidt et al., 2015) and Norfolk County Council (Robertson et al., 2018).

1.4. The survey was undertaken in response to a brief produced by Norfolk County Council (Hickling, 2018). The survey methodology was conducted in line with a Written Scheme of Investigation produced by OAE (Brudenell 2018), which conforms to Norfolk County Council's guidelines (Robertson et al., 2018).

1.5. The survey was completed was completed in two tranches due to cropping of the site. Area 1, in the north of site, was surveyed 11/07/2018 and Areas 3 and 5, through the centre and south, were surveyed from 09/08/2018 – 10/08/2018. The first tranche required the use of a hand-carried GNSS-positioned system, while the second tranche used a hand-pulled, GNSS positioned system.

2. Quality Assurance

2.1. Magnitude Surveys is a Registered Organisation of the Chartered Institute for Archaeologists (CIfA), the chartered UK body for archaeologists, and a corporate member of ISAP (International Society of Archaeological Prospection).

2.2. Director Graeme Attwood is a Member of CIfA, as well as the Secretary of GeoSIG, the CIfA Geophysics Special Interest Group. Director Finnegan Pope-Carter is a Fellow of the London Geological Society, the chartered UK body for geophysicists and geologists, as well as a member of GeoSIG, the CIfA Geophysics Special Interest Group. Director Chrys Harris has a PhD in archaeological geophysics from the University of Bradford and is the Vice-Chair of the International Society for Archaeological Prospection.

2.3. All MS managers have relevant degree qualifications to archaeology or geophysics. All MS field and office staff have relevant archaeology or geophysics degrees and/or field experience.

3. Objectives

3.1. The geophysical survey aimed to assess the subsurface archaeological potential of the survey area.

4. Geographic Background

4.1. The site is located c. 1km south of the village of Kenninghall, which lies 30km south-west from Norwich city centre (Figure 1). The site boundary spanned five different survey areas, forming a corridor which links Crown Chicken's facilities with North Lopham Road. The survey areas comprised arable land. Two sections of the corridor could not be surveyed due to the ground conditions (Figure 2).

4.2. Survey considerations:

Survey Area	Ground Conditions	Further Notes
1	Arable. Young beet crop, in ridges, at the time of survey. The field continued further in all directions.	Powerlines crossed the western side and the south-eastern corner of the survey area. The survey area is bounded by North Lopham Road to the northwest.
2	Landscaped areas, unsuitable for survey.	
3	Arable. Stubble. The field continued further in all directions. Land gently sloped down to the north and south from a ridge running east-west through the field.	The area was bounded by Heath Road to the south, and a hedge and ditch to the north-west, and a ditch to the north. A powerline ran north-south through the south-eastern corner. A gate was located at the south-eastern end.
4	Two small fields with overgrown vegetation. Unsuitable for survey.	
5	Arable. Stubble. Generally flat. The field continued further to the south and west.	The area was bounded by a hedge and a chain link to the north-east, and a wire fence to the east and south-east. A copse of trees was present to the south.

4.3. The underlying geology comprises undifferentiated chalk of the Lewes Nodular, Seaford, Newhaven, Culver and Portsdown Chalk Formations. Superficial deposit for most of the site is Diamicton of the Lowestoft Formation, except for the western end of Area 1 which is clay and silt of the Banham Member, and Areas 4 and 5 which is underlain by sand and gravel of the Croxton sand and gravel Member (British Geological Survey, 2018).

4.4. The soils consist freely draining slightly acid sandy soils for Areas 1 and 2, and slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils (Soilscapes, 2018).

5. Archaeological Background

5.1. The following archaeological background summarises a desk-based assessment (DBA) provided by the client, Oxford Archaeology (Bray 2018).

5.2. Prehistoric activity has been in the form of a pit containing worked flints c.200m north of site, Bronze Age and Iron Age features c.500m to the west, and findspots located c.1km to the south and to the east of site.

5.3. Romano-British activity in the wider landscape is limited to isolated findspots, including coins and other metallic finds identified at a number of locations to the north, south and east.

5.4. Early medieval activity is highlighted by an Early Saxon inhumation c.900m to the north of the site and a number of findspots. Medieval landscape management features include ridge & furrow to the north, a mill to the southwest and a possible park as indicated by place-name evidence. Findspots have also been located.

5.5. The earliest map evidence is derived from an Enclosure Map of 1794. This shows large irregular field pattern across the site, with the present road pattern notable. By the Tithe Map of 1840, the large irregular fields have largely been replaced by smaller rectilinear fields with the outlines of the fields for Areas 4 and 5 recognisable. Area 1 crosses two different fields, Area 3 crosses four field boundaries, and Area 6 is subdivided into nine separate fields. In the 1st ed. OS map of 1884 most of the fields across the site remain the same except for in Area 1, which now largely transect one field though the northern and eastern boundaries of the field bisect the corners of the surveyed area, and Area 6 which is subdivided into six different fields though one of the now field boundaries remains as a partial boundary. The field layout across the site remains the same in the 2nd ed. OS map. By the OS map of 1980 most of the field boundaries not present today had been removed from across the site.

6. Methodology

6.1. Data Collection

6.1.1. Geophysical prospection comprised the magnetic method as described in the following table.

6.1.2. Table of survey strategies:

Method	Instrument	Traverse Interval	Sample Interval
Magnetic	Bartington Instruments Grad-13 Digital Three-Axis Gradiometer	1m	200Hz reprojected to 0.125m

6.1.3. The magnetic data were collected using MS' bespoke hand-pulled cart and hand carried GNSS-positioned system.

6.1.3.1. MS' cart system was comprised of Bartington Instruments Grad 13 Digital Three-Axis Gradiometers. Positional referencing was through a multi-channel, multi-constellation GNSS Smart Antenna RTK GPS outputting in NMEA mode to ensure high positional accuracy of collected measurements. The RTK GPS is accurate to 0.008m + 1ppm in the horizontal and 0.015m + 1ppm in the vertical.

6.1.3.2. Magnetic and GPS data were stored on an SD card within MS' bespoke datalogger. The datalogger was continuously synced, via an in-field Wi-Fi unit, to servers within MS' offices. This allowed for data collection, processing and visualisation to be monitored in real-time as fieldwork was ongoing.

6.1.3.3. A navigation system was integrated with the RTK GPS, which was used to guide the surveyor. Data were collected by traversing the survey area along the longest possible lines, ensuring efficient collection and processing.

6.2. Data Processing

6.2.1. Magnetic data were processed in bespoke in-house software produced by MS. Processing steps conform to Historic England's standards for "raw or minimally processed data" (see sect 4.2 in David et al., 2008: 11).

Sensor Calibration – The sensors were calibrated using a bespoke in-house algorithm, which conforms to Olsen et al. (2003).

Zero Median Traverse – The median of each sensor traverse is calculated within a specified range and subtracted from the collected data. This removes striping effects caused by small variations in sensor electronics.

Projection to a Regular Grid – Data collected using RTK GPS positioning requires a uniform grid projection to visualise data. Data are rotated to best fit an orthogonal grid projection and are resampled onto the grid using an inverse distance-weighting algorithm.

Interpolation to Square Pixels – Data are interpolated using a bicubic algorithm to increase the pixel density between sensor traverses. This produces images with square pixels for ease of visualisation.

6.3.Data Visualisation and Interpretation

6.3.1. This report presents the gradient of the sensors' total field data as greyscale images, as well as the total field data from the lower sensors. The gradient of the sensors minimises external interferences and reduces the blown-out responses from ferrous and other high contrast material. However, the contrast of weak or ephemeral anomalies can be reduced through the process of calculating the gradient. Consequently, some features can be clearer in the respective gradient or total field datasets. Multiple greyscale images at different plotting ranges have been used for data interpretation. Greyscale images should be viewed alongside the XY trace plot (Figures 8, 11 and 14). XY trace plots visualise the magnitude and form of the geophysical response, aiding in anomaly interpretation.

6.3.2. Geophysical results have been interpreted using greyscale images and XY traces in a layered environment, overlaid against open street maps, satellite imagery, historic maps and soil and geology maps. Google Earth (2018) was consulted as well, to compare the results with recent land usages.

7. Results

7.1.Qualification

7.1.1. Geophysical results are not a map of the ground and are instead a direct measurement of subsurface properties. Detecting and mapping features requires that said features have properties that can be measured by the chosen technique(s) and that these properties have sufficient contrast with the background to be identifiable. The interpretation of any identified anomalies is inherently subjective. While the scrutiny of the results is undertaken by qualified, experienced individuals and rigorously checked for quality and consistency, it is often not possible to classify all anomaly sources. Where possible an anomaly source will be identified along with the certainty of the interpretation. The only way to improve the interpretation of results is through a process of comparing excavated results with the geophysical reports. MS actively seek feedback on their reports as well as reports of further work in order to constantly improve our knowledge and service.

7.2.Discussion

7.2.1. The geophysical results are presented in consideration with satellite imagery (Figure 4) and historic maps (Figure 5).

7.2.2. The fluxgate magnetometer survey has responded well to the site's environment. The results reveal mainly agricultural activity, including former field boundaries (Figure 6), ploughing trends and field drains. Multiple phases of ploughing have been identified; these have been indicatively marked as 'Agricultural (Trend)' and correlate well with regimes visible in recent satellite imagery (Google Earth, 2018).

7.2.3. Modern activity has also been identified and is primarily evidenced by strong dipolar responses limited to being along the edges of field and a minor magnetic interference from the overhead powerlines. These modern interferences do not significantly impact on the interpretation of the results; although the overwhelming halo produced by adjacent modern structures, particularly at the southern end of site, may overshadow and weaker underlying features.

7.2.4. A number of anomalies have been classified as 'Undetermined'; the specific origin of which is less clear. These may represent a combination of agricultural, modern or natural processes. While an archaeological origin cannot be entirely ruled out, the responses are not unique enough to warrant an archaeological classification. Numerous small, discrete enhanced anomalies have been detected across the site. It is conceivable some of these responses have an anthropogenic origin; however, an isolated pit of an archaeological origin would appear indistinguishable in the magnetic results from those of a natural origin.

7.3.Interpretation

7.3.1. General Statements

7.3.1.1. Geophysical anomalies will be discussed broadly as classification types across the survey area. Only anomalies that are distinctive or unusual will be discussed individually.

7.3.1.2. **Undetermined** – Anomalies are classified as Undetermined when the anomaly origin is ambiguous through the geophysical results and there is no supporting or correlative evidence to warrant a more certain classification. These anomalies are likely to be the result of geological, pedological or agricultural processes, although an archaeological origin cannot be entirely ruled out. Undetermined anomalies are generally not ferrous in nature.

7.3.1.3. **Ferrous (Discrete/Spread)** – Discrete ferrous-like, dipolar anomalies are likely to be the result of modern metallic disturbance on or near the ground surface. A ferrous spread refers to a concentrated deposition of these discrete, dipolar anomalies. Broad dipolar ferrous responses from modern metallic features, such as fences, gates, neighbouring buildings and services, may mask any weaker underlying archaeological anomalies should they be present.

7.3.2. Magnetic Results - Specific Anomalies (Area 1)

7.3.2.1. **Agricultural** – A former field boundary has been detected in the north of Area 1 [**1a**]. The response of 1a is characteristic of an enhanced, soil-filled feature. While there are ploughing trends that run parallel with 1a, the spacing and response of these linear anomalies is more typical of modern ploughing.

7.3.2.2. **Magnetic Disturbance and Undetermined** – Overhead powerlines across the southern end of Area 1 have introduced a minor magnetic disturbance [**1b**]. This produces a weak effect (Figure 8) and is minimised in the gradient. An area of enhanced material [**1c**] around the path of powerlines may be associated with its construction, as it occurs around the location of a pylon (Google Earth, 2018).

7.3.3. Magnetic Results – Specific Anomalies (Area 3)

7.3.3.1. **Modern** – A weak linear anomaly [**3a**] has been detected towards the south of the field on a NE-SW alignment. While 3a occurs in the vicinity of former field boundaries (Figure 6), its orientation does not match these previous features. Analysis with recent satellite imagery reveals this response occurs directly in-line with a cropmark feature extending through the field (Figure 4). Satellite imagery from 1999 (Google Earth, 2018) suggests this feature relates to the construction of an underground service.

7.3.3.2. **Undetermined** – Towards the north of Area 3, two very strong, discrete anomalies [**3b**] have been detected. The response of 3b is not typical of a ferrous origin; although the survey only appears to have clipped the edge of these features. A former pond or trough is recorded in the vicinity of 3b on historic maps (Figure 6), but the origin of 3b remains unclear.

7.3.4. Magnetic Results—Specific Anomalies (Area 5)

7.3.4.1. **Agricultural** – Several former field boundaries have been detected across Area 5 [**5a & 5b**] (Figure 6). The response of 5a is characteristic of an enhanced soil-filled feature, while 5b are more diffuse in nature and contain ferrous and other highly magnetic material (Figure 14). Such a response can be indicative of a boundary which has been deliberately filled and subsequently ploughed out. Field drains have been detected on a NW-SE alignment through the field. These are distinct in response from ploughing trends (Figure 4) on a similar alignment. The latter have been marked as 'Agricultural (Trend)' to distinguish from the drains.

7.3.4.2. **Undetermined** – A number of ambiguous discrete anomalies have been classified in Area 5. There is nothing uniquely distinct about these anomalies to suggest an archaeological origin; a natural or agricultural origin is considered more likely.

8. Conclusions

8.1. A fluxgate magnetometer survey has been successfully completed across most of the site. Only two small areas could not be surveyed due to modern landscaping and overgrown vegetation. The technique has responded generally well to the environment of the survey area. The results are relatively quiet, with primarily agricultural and modern activity identified. A few anomalies have been classified as 'Natural', but it is possible that most of the 'Undetermined' responses are of a natural origin as well.

8.2. Agricultural activity has been identified in the form of former field boundaries, modern ploughing trends, and field drains.

8.3. Modern activity is mainly represented by broad ferrous responses at the field edges, which represent adjacent metallic features and structures. Minor magnetic interference and soil disturbances can be attributed with the powerlines which run through the north of site and a subtle linear anomaly towards the centre of site may be associated with the construction of a buried service.

8.4. A number of anomalies have been classified as 'Undetermined' in origin. These are mainly characterised as enhanced discrete anomalies. While an anthropogenic origin is possible, the response of these anomalies would be indistinguishable from those of a natural origin.

9. Archiving

9.1. MS maintains an in-house digital archive, which is based on Schmidt and Ernenwein (2013). This stores the collected measurements, minimally processed data, georeferenced and un-georeferenced images, XY traces and a copy of the final report.

9.2. MS will upload a copy of this report to OASIS, following acceptance by Norfolk County Council. MS contributes reports to the ADS Grey Literature Library upon permission from the client, subject to the any dictated time embargoes.

10. Copyright

10.1. Copyright and the intellectual property pertaining to all reports, figures, and datasets produced by Magnitude Services Ltd. is retained by MS. The client is given full licence to use such material for their own purposes. Permission must be sought by any third party wishing to use or reproduce any IP owned by MS.

11. References

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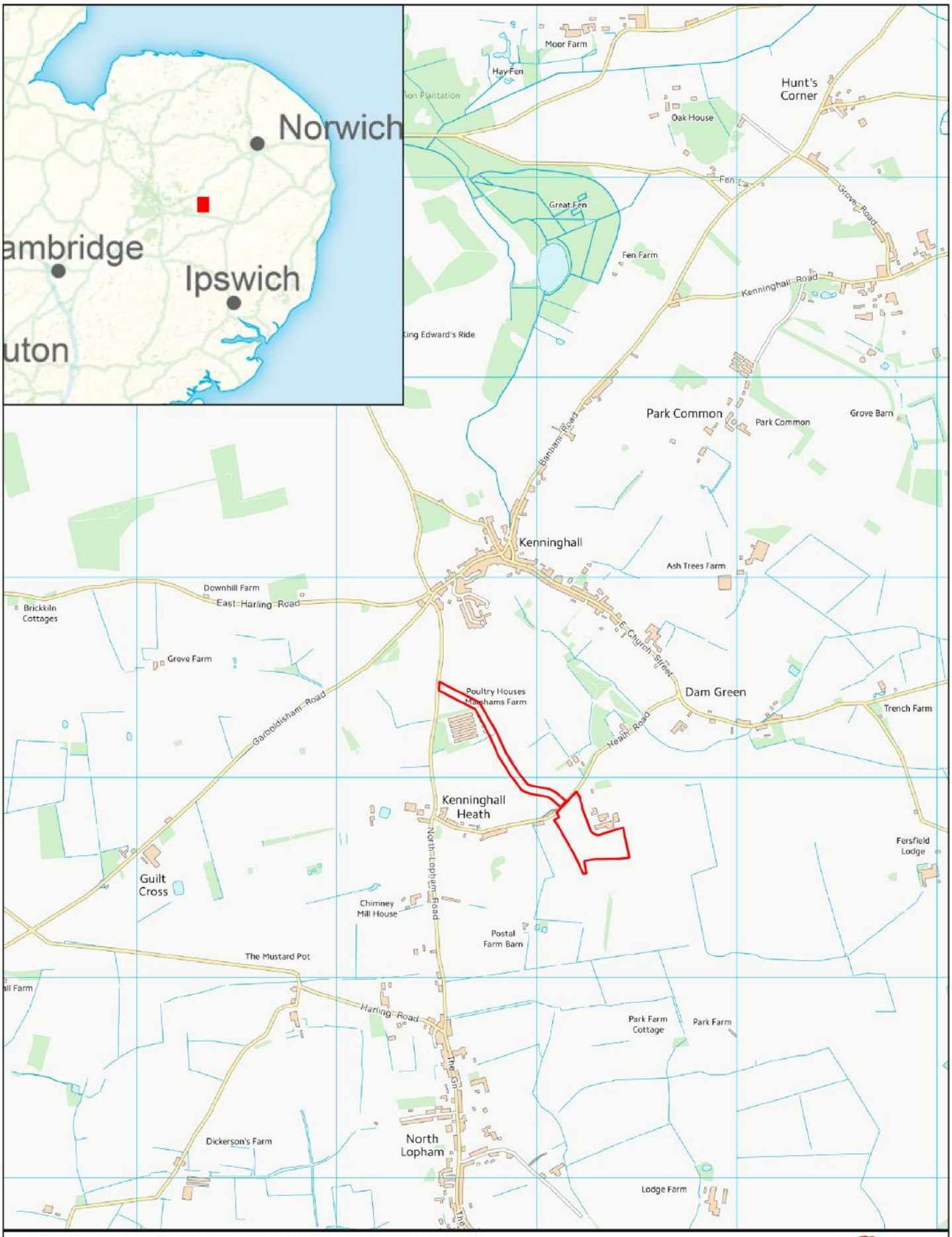


MSTM336 - Land at Green Farm, Edge Green, Kenninghall, Norfolk
Figure 1 - Site Location
1:25,000 @ A4

Site Boundary

N

0 0.5 1 km

magnitude surveys

604000

605000

285000

285000

Area 1

Area 2

Area 3

Area 4

Area 5

Poultry Houses

Dam Gree

Kenninghall Heath

North Lopha

Church Street

Heath Road

MSTM336 - Land at Green Farm, Edge Green, Kenninghall, Norfolk
Figure 2 - Location of Survey Areas
1:5,000 @ A3

Survey Extent
Unsurveyable

N

0 100 200 300 m

magnitude surveys

604000

605000

Area 1

Poultry Houses

rshams Farm

Area 3

Dam Gree

urch Street

Heath Road

285000

285000

Kenninghall Heath

North Lopha

Area 5

MSTM336 - Land at Green Farm, Edge Green, Kenninghall, Norfolk
Figure 3 - Overview Magnetic Total Field (Lower Sensor)
1:5,000 @ A3

48,998 nT 49,003

N

0 100 200 300 m

magnitude surveys

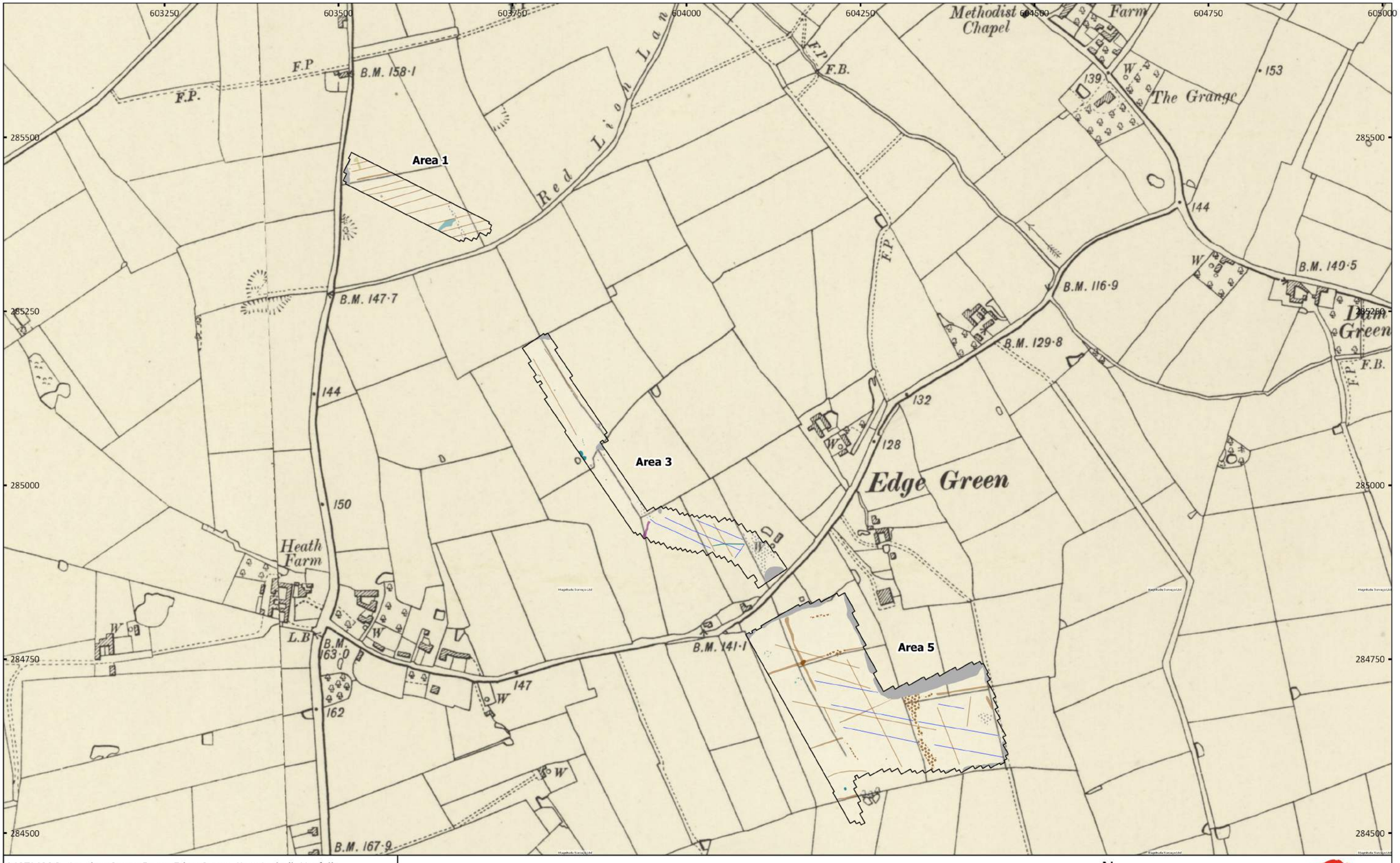
MSTM336 - Land at Green Farm, Edge Green, Kenninghall, Norfolk
Figure 4 - Overview Magnetic Interpretation Over Satellite Imagery
1:5,000 @ A3

- Agricultural (Strong)
- Agricultural (Weak)
- Agricultural (Spread)
- Agricultural (Trend)
- Drainage Feature
- Undetermined (Strong)
- Undetermined (Weak)
- Undetermined (Trend)
- Ferrous (Dipolar)
- Ferrous (Spread)
- Natural (Weak)
- Modern

N

0 100 200 300 m

magnitude surveys



MSTM336 - Land at Green Farm, Edge Green, Kenninghall, Norfolk
Figure 5 - Overview Magnetic Interpretation Over Historic Maps
1:5,000 @ A3

Contains historic maps: Ordnance Survey, 6" 2nd edition c. 1882-1913 © National Library of Scotland

- Agricultural (Strong)
- Agricultural (Weak)
- Agricultural (Spread)
- Agricultural (Trend)
- Drainage Feature
- Undetermined (Strong)
- Undetermined (Weak)
- Undetermined (Trend)
- Ferrous (Dipolar)
- Ferrous (Spread)
- Natural (Weak)
- Modern

N

0 100 200 300 m

magnitude surveys

603500 603600 603700 603800

285500 285500

285400 285400

285300 285300

Poultry

sham

MSTM336 - Land at Green Farm, Edge Green, Kenninghall, Norfolk
Figure 6 - Area 1 Magnetic Gradient
1:1,000 @ A3

-1 nT 2

N

0 25 50 75 m

magnitude surveys

603500 603600 603700 603800

285500 285500

285400 285400

285300 285300

1a

1b

1c

Poultry

shan

MSTM336 - Land at Green Farm, Edge Green, Kenninghall, Norfolk
Figure 7 - Area 1 Magnetic Interpretation
1:1,000 @ A3

Agricultural (Weak)
Agricultural (Trend)
Undetermined (Strong)
Undetermined (Weak)
Ferrous (Dipolar)
Magnetic Disturbance
Natural (Weak)

N

0 25 50 75 m

magnitude surveys

603500
603600
603700
603800
285500
285400
285300
Poultry
shan
MSTM336 - Land at Green Farm, Edge Green, Kenninghall, Norfolk
Figure 8 - Area 1 XY Trace Plot
20nT/cm @ 1:1,000 A3

N
0
25
50
75 m
magnitude surveys

603700 603800 603900 604000 604100 604200

285200 285100 285000 284900

inghall

MSTM336 - Land at Green Farm, Edge Green, Kenninghall, Norfolk
Figure 9 - Area 3 Magnetic Gradient
1:1,500 @ A3

-1 nT 2

N

0 25 50 75 m

magnitude surveys

603700 603800 603900 604000 604100 604200

285200 285100 285000 284900

3b

3a

inghall

MSTM336 - Land at Green Farm, Edge Green, Kenninghall, Norfolk
Figure 10 - Area 3 Magnetic Interpretation
1:1,500 @ A3

Undetermined (Strong)
Undetermined (Trend)
Agricultural (Trend)
Drainage Feature
Ferrous (Dipolar)
Ferrous (Spread)
Natural (Weak)
Modern

N

0 25 50 75 m

magnitude surveys

603700 603800 603900 604000 604100 604200

285200 285100 285000 284900

inghall

MSTM336 - Land at Green Farm, Edge Green, Kenninghall, Norfolk
Figure 11 - Area 3 XY Trace Plot
30nT/cm @ 1:1,500 A3

Contains mapping provided by client.

N

0 25 50 75 m

magnitude surveys

604100
604200
604300
604400
604500
604600
284800
284700
284600
284500

MSTM336 - Land at Green Farm, Edge Green, Kenninghall, Norfolk
Figure 12 - Area 5 Magnetic Gradient
1:1,500 @ A3

-1 nT 2

N

0 25 50 75 m

magnitude surveys

604100
604200
604300
604400
604500
604600
284800
284700
284600
284500
5a
5b

MSTM336 - Land at Green Farm, Edge Green, Kenninghall, Norfolk
Figure 13 - Area 5 Magnetic Interpretation
1:1,500 @ A3

- Agricultural (Strong)
- Agricultural (Weak)
- Agricultural (Spread)
- Agricultural (Trend)
- Drainage Feature
- Ferrous (Dipolar)
- Ferrous (Spread)
- Undetermined (Strong)
- Undetermined (Weak)

N

0 25 50 75 m

magnitude surveys

604100
604200
604300
604400
604500
604600
284800
284700
284600
284500

MSTM336 - Land at Green Farm, Edge Green, Kenninghall, Norfolk
Figure 14 - Area 5 XY Trace Plot
30nT/cm @ 1:1,500 A3

N

0 25 50 75 m

magnitude surveys

Norfolk County Council

BRIEF FOR PRE-APPLICATION EVAULATION BY GEOPHYSICAL (MAGNETOMETER) SURVEY
at the
Crown Chicken site, Kenninghall
NORFOLK

PLANNING AUTHORITY:	Breckland District Council
PLANNING REFERENCE:	N/A
HES REFERENCE	CNF48165
NHER EVENT NUMBER:	To be arranged
GRID REFERENCE:	TM 0409 8490
MAP EXTRACT ATTACHED:	Y/N
DEVELOPMENT PROPOSAL:	Expansion of the plant and new access road
CURRENT LAND USE:	Agricultural
ISSUED BY:	Steve Hickling Environment Service Culture and Heritage Norfolk County Council Union House, Gressenhall, Dereham Norfolk NR20 4DR Direct telephone line: 01362 869285 Email: steve.hickling@norfolk.gov.uk
DATE:	12th June 2018
NOTES:	The results of this survey will feed into the trench plan for a trial trench evaluation of the development site.

IN TRAN communication for all

If you need this document in large print, audio, Braille, alternative format or in a different language please contact hep@norfolk.gov.uk and we will do our best to help.

Introduction

Planning permission will soon be sought for an expansion of the Crown Chicken site, Kenninghall including a new access road. An evaluation by geophysical survey is required prior to the determination of any future planning application (National Planning Policy Framework 2012, paragraph128).

This brief outlines the requirements of an evaluation by trial trenching which includes:

1) Full adherence to the *Standards for Development-led Archaeological Projects in Norfolk* (Robertson *et al* 2018, to be introduced on 1 May 2018) and all relevant national legislation, standards and guidance.

2) The production of an approved Written Scheme of Investigation for the evaluation by geophysical survey.

3) The production of a final grey literature archive report including specialist post-fieldwork analyses.

4) Provision for publication, where results warrant it.

5) Provision for archive deposition with a recognised archive depository.

This brief is valid for a period of one year from the date of issue. After that time, it may need to be revised to take account of new discoveries, changes in policy or the introduction of new working practices or techniques.

Policy Background

Relevant planning policies can be found in:

Breckland Council's *Breckland District Local Plan Adopted Version* (September 1999), policies ENV 15-18.

and

National Planning Policy Framework. The Department of Communities and Local Government (2012).

Archaeological Background

Little is known of the archaeological remains of this area due to a lack of fieldwork and the unsuitability of the geology for producing cropmarks. The few archaeological interventions which have taken place in the area have produced some evidence of prehistoric activity.

Requirement for work

Field survey by geophysical prospection is required to determine the extent and significance of subsurface features. Magnetometer surveys will be conducted using

cart mounted sensors unless ground conditions prevent the use of such a system. Data should be collected at sub-metre traverse intervals, with a minimum of four samples per metre and located using appropriate instrument metric survey techniques.

Unless the sensor array used renders it unnecessary and agreed in advance, each day on site, the survey team must survey one traverse twice, to demonstrate the repeatability of the results. The grid should not be surveyed twice in quick succession, but should be repeated at a later point in the day. The results of both surveys of the traverses must be presented as an appendix to the site report as raw data.

The 'Standards for development-Led Archaeological Projects in Norfolk' 2018 and relevant CiFA and Historic England standards and guidance must be followed.

Advice for developers

You should forward a copy of this brief to one or more archaeological contractors, and discuss with them the timing and costs. Your contractor/s should be asked to submit a draft Written Scheme of Investigation to Norfolk County Council Environment Service (NCCES) for approval. Once this document has been approved by NCCES you can include it in a formal planning application to the local planning authority for your proposed development.

NCCES does not see contractors' costings, nor do we give advice on the costs of archaeological projects. This is between you and the archaeological contractor/s. You may wish to obtain a number of quotations or to employ the services of an archaeological consultant.

From 1 October 2018 archaeological fieldwork in Norfolk must be undertaken by Chartered Institute for Archaeologists Registered Organisations or, in the case of sole traders, individuals that are professional accredited and hold MCIfA status.

Details of archaeological contractors can be found in the Registered Organisation section of the Chartered Institute for Archaeologists website (http://www.archaeologists.net/regulation/organisations). Professionally accredited archaeologists are listed in the Chartered Institute for Archaeologists *Yearbook and Directory* 2017 (available at https://www.archaeologists.net/publications/yearbook).

Land at Green Farm, Kenninghall, Norfolk

Written Scheme of Investigation

Client: Crown Chicken Ltd

Prepared by	Matt Brudenell
Date prepared	July 2018
Version	1

Planning application no.	Pre-application
Site code	XNFGFK18
Project number	22147
Project type	Geophysical Survey
NGR	TM 0409 8490
NHER Event no.	ENF144765
NCCES consultation no.	CNF48165

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magnitude surveys

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1 GENERAL BACKGROUND

1.1.1 This Written Scheme of Investigation (WSI) conforms to the principles identified in Historic England's guidance document 'Management of Research Projects in the Historic Environment', specifically the MoRPHE Project Manager's Guide (2015).

1.1.2 All work will be conducted to professional standards, and will be executed in line with appropriate section of Gurney, D. 2003. 'Standard for Field Archaeology in the East of England', as adopted by the Association of Local Government Archaeological Officers for the East of England Region and published as 'East Anglian Archaeology Occasional Paper 14'.

1.1.3 The survey and reporting will be carried out in accordance with Historic England's guidance document 'Geophysical Survey in Archaeological Field Evaluation' (2008), the Chartered Institute for Archaeologists guidance document 'Standard and guidance for archaeological geophysical survey' (2014), and the Norfolk County Council Environment Service document 'Standards for development-Led Archaeological Projects in Norfolk' (2018)

1.2 Circumstances of the project

1.2.1 Oxford Archaeology East (OA East) have been commissioned by Crown Chicken Ltd (the Client) to conduct a geophysical survey on land proposed for the expansion of an existing mill and hatchery site with new access road.

1.2.2 This WSI has been prepared on behalf of the Client in response to an Archaeological brief for evaluation issued by Steve Hickling of the Norfolk County Council Environment Service (NCCES; 'Brief for a pre-application evaluation by geophysical (magnetometer) survey at the Crown Chicken site, Kenninghall') dated 28/06/2018.

1.2.3 The survey is required by the NCCES prior to the determination of any future planning application at the site to provide information on the significance of any below ground heritage assets potentially affected by the scheme.

1.2.4 The results of this survey will feed into the design of a trench plan for a trial trench evaluation. This will be subject to a separate WSI based on a separate brief issued by the NCCES.

1.3 Archaeological strategy

1.3.1 A geophysical survey (magnetometry) is required across the survey development area. This is will be conducted by Magnitude Surveys who have been sub-contracted to OA East. Magnitude Survey's Method Statement is attached to the WSI as Appendix 1.

1.4 Changes to this method statement

1.4.1 If changes need to be made to the methods outlined below – either before or during works on site – the NCCES will be informed and asked to consider changes before they are made. Changes will be agreed in before work on site commences, or else at the earliest available opportunity.

2 THE GEOLOGY, TOPOGRAPHY AND OTHER FEATURES OF THE SITE

2.1.1 The site is situated to the south of Kenninghall, 16 km east of Thetford within the administrative boundary of Breckland District. The site measures c. 10 ha and comprises the current Crown Chicken Ltd hatchery and part of a large field to the southwest. It also includes a thin parcel of land crossing a number of fields to the north of Heath Road where the proposed access road will be located. The site and surrounding landscape is largely rural in character and comprises large irregular fields under arable cultivation.

2.1.2 The site and the surrounding landscape is predominately flat and is at a height of 45 mOD. The underlying bedrock geology is recorded as Lewes Nodular Chalk, Seaford Chalk, Newhaven Chalk, Culver Chalk and Portsdown Chalk (undifferentiated) Formations. Lowestoft Formation, a Diamicton deposit resulting from deglaciation is recorded overlying the bedrock geology across the majority of the site and was formed up to two million years ago. A small outcrop of Croxton Sand and Gravel is recorded overlying the chalk bedrock along the northern boundary of the site (BGS, 2018).

3 ARCHAEOLOGICAL BACKGROUND

3.1 Introduction

3.1.1 The following section provides a brief period summary of known heritage assets within a c. 1km radius of the site. This information is drawn from the Norfolk Historic Environment Record (NHER).

3.2 Prehistoric

3.2.1 The majority of prehistoric finds from the surrounding area relate to unstratified metal detector finds, or artefacts found in the course of metal detecting. The latter include Neolithic worked flints (NHER 35414; 39262) and an Early Bronze Age axe fragment (NHER 39262). Other Bronze Age metalwork finds comprise two possible Bronze Age Hoards (NHER 10797; 32005), together with a variety of single stay finds including a Bronze Age awl (NHER 19545), spear (NHER 61107), axes (NHER 32862; 30454) and a Bronze Age socketed sickle or knife (NHER 35407).

3.2.2 Later Iron Age metalwork has also been recovered, with finds including Iron Age terrets (NHER 32862; 38946), a brooch (NHER 61107) and coins (NHER 35167; 39262).

3.2.3 Despite the number of prehistoric finds within the study area there has been a limited number of features identified (although this is likely to be at least partially attributable to the limited number of archaeological investigations). To the north of the site a possible pit or natural feature (NHER 42712) containing two late Neolithic or Early Bronze Age worked flints was recorded during a watching brief. A further four flints of similar date were recovered from the topsoil. To the west of the site archaeological investigation revealed multiple phases of prehistoric activity (NHER 61874). The earliest features were Bronze Age in date and included a shallow pit and ditches. There was also a pair of ditches that contained a single sherd of Iron Age pottery.

3.3 Roman

3.3.1 Roman activity in the surrounding landscape is attested by unstratified finds recovered during metal, many of them being coins (e.g. NHER 58700; 19146; 58675). Other Romano-British finds include brooches (19146; 30454; 32755; 35407), Roman seal box lid (NHER 19545), finger ring (NHER 38946), cosmetic spoon (NHER 35167), a pinhead (OA 91), bracelet (NHER 58700), lock pin (NHER 58675) and a nail cleaner a button and loop fastener (NHER 61107). These finds are all domestic in character and likely suggest the presence of a settlement nearby.

3.3.2 No Romano-British features have been found within the site or the study area and there is a paucity of features of this date within the wider landscape

3.4 Saxon

3.4.1 An early Anglo-Saxon inhumation cemetery (NHER 1048) was found 650 m north of the site on the northern side of Garboldisham Road. Skeletons were buried with iron shield bosses, spearheads, swords, amber and glass beads, bronze buckles, brooches and wrist. A trial trench evaluation to the south of the cemetery recorded an early Saxon brooch (NHER 43127) in the topsoil but no further evidence of a cemetery was found.

3.4.2 A variety of Saxon find have been recovered by metal detectorists predominately to the north of the site. Finds include brooches (NHER 19146; 30454; 32862; 61107), a gold thyrmsa and a box or stirrup mount (NHER 19545), a Saxon penny (NHER 29890), a cosmetic instrument (NHER 39262), a hooked tag (NHER 58700) and a stirrup terminal (NHER 58675) all of which indicate activity in the area during the early medieval period.

3.4.3 By the end of the Saxon period Keninchala (Kenninghall) was a relatively large settlement. It is first recorded in the Domesday Survey in 1086 and was owned directly by King William. It is recorded as having 36 households and a possible population of 180. It had three mills, 35 acres of meadow and woodland for 324 pigs (Palmer and Powell-Smith, 2018). Kenninghall derives from an Old English personal name and likely means 'nook of land of the family or followers of a man called Cēna' (Mills, 2011) however it has also been suggested that it derives from Cyning, the Old English for King and that Kenninghall was the seat of the East Anglian Kings (Blomefield, 1805).

3.5 Medieval

3.5.1 As with earlier periods, the majority of records form the medieval period relate finds found by metal detectorists. In addition to medieval coins, other finds include a knife or dagger (NHER 10799), a horse harness stud (NHER 38946), a medieval seal (NHER 34594) and various dress accessories: pendants (NHER 19146; 19545; 31411; 34270); a purse bar and belt stiffener (NHER 30454); strap ends (NHER 30454, 35416; 61107); buckles (NHER 30531; 30955; 35414; 58700; 34594; 35416), an annular brooch (NHER 32755), and a belt mount (NHER 35407).

3.5.2 To the north of the site ridge and furrow earthworks (NHER 57397) comprising three banks approximately 10 m wide are visible on aerial photographs. There is reported to have been a post mill (NHER 10879) from as early as the thirteenth century at Chimney Mill House to the southwest of the site although no evidence of a mill has been found earlier than 1773. Places names such as Park Farm, Park Barn and Park Lane suggest the presence of a medieval park (NHER 10878) at the southern end of the study area and possibly associated with Kenninghall Palace. Kenninghall Palace is located 2.5 km east of the site and was built between 1505 and 1524 by the Duke of Norfolk to replace East Hall. East Hall is a scheduled monument (NHLE: 1004010) described as a timber castle but more likely a palace or fortified manor house.

3.5.3 It is thought that the study area may have formed common edge settlement and farming during the medieval period. To maintain soil fertility an open-field system and course rotation of crops and un-cropped fallow periods had been in use since the prehistoric period. During the medieval period, this was increasingly regulated and managed by estates (Natural England, 2015).

3.6 Post-medieval

3.6.1 More than 70 percent of the Breks area was enclosed after 1750 with a peak at the beginning of the nineteenth century. Forced enclosure of former common arable land and wider heath areas allowed for an improved crop rotation and stock management. The exact date of original Inclosure within the immediate area is unknown but it appears that the majority had been enclosed on a piecemeal basis by the time of the publication of the Kenninghall Inclosure map in 1794. This map shows that the present day road pattern was already in existence with large irregular fields bound by trees or hedgerows. On the southern side of Heath Road, the site forms the northern part of lands owned by Isaac Mendham and Robert Brewester. The site covers part of their lands that were enclosed under the formal agreement. On the northern side of Heath Road, the site passes through land owned by Isaac Mendham, The Earl of Albermarle, and William Murton. During this period, the study area was characterised by a number of small farmsteads such as Sunart Edge Green Farm (NHER 13949), Edge Green Farm (NHER 29846), Grange Farm (NHER 48935), Dam Green Farm (NHER 48932), Wash Farm (NHER 48933) and Postal Farm (NHER 48938). Two buildings are depicted close to Heath Road within the land held by Robert Brewester. The function of the buildings is unclear.

3.6.2 In the early nineteenth century, and by the publication of the Kenninghall Tithe map in 1842, the surrounding study area had been transformed by formal Inclosure. This resulted in the subdivision of the larger irregular fields to create smaller regular enclosures bound by hedgerows and trees which were either under arable cultivation or used for pasture. Within the site one of the buildings depicted on the Inclosure map of 1794 was still present. The other had been demolished and two smaller structures constructed. These building are all within Plot 285 which is described as cottages and gardens.

3.6.3 The first edition Ordnance Survey map in 1884 shows few changes within the wider study area. Within the site the earlier buildings directly south of Heath Road were still present and a U-shaped farmstead had been constructed towards the eastern boundary and set back from the southern side of Heath Road.

3.7 Modern

3.7.1 The immediate soundings of the site changed little during the first half of the twentieth century. Significant boundary loss occurred during the second half of the twentieth century to create larger fields. Within the site, the buildings shown on the Tithe map and first edition Ordnance Survey map had been removed by 1905. The U-Shaped farmstead appears to have been

extended and by the 1970s the current hatchery is depicted and was known as Green Farm.

4 AIMS AND OBJECTIVES

4.1 Aims of the geophysical survey

4.1.1 The aim of the geophysical survey will be to be help determine the presence or absence of archaeological remains within the development area, and, as far as possible, determine their nature, extent and quality to enable an assessment of their relative importance in a local, regional and nation context.

4.2 Research frameworks

4.2.1 This survey takes place within, and will contribute to the goals of Regional Research Frameworks relevant to this area:

- Research and Archaeology Revisited: A Revised Framework for the East of England (Medlycott 2011, East Anglian Archaeology Occasional Papers 24)
- Research and Archaeology: A Framework for the Eastern counties: 1. Resource Assessment (Glazebrook 1997, East Anglian Archaeology Occasional Papers 3);
- Research and Archaeology: A Framework for the Eastern counties: 2. Research Agenda and Strategy (Brown & Glazebrook 2000, East Anglian Archaeology Occasional Papers 8)

5 METHODS OF SURVEY, VISUALISTAION AND INTERPRETATION

5.1 Geophysical Survey

5.1.1 An area measuring c. 9.56ha is available for geophysical survey within the proposed development site. This will comprise a hand-pulled/quad-towed, cart mounted, fluxgate gradiometer survey. The results from this survey will better inform whether archaeological remains are present at the site and allow for trenches to target any potential remains.

5.1.2 The survey will be conducted by Magnitude Surveys Ltd, under the direction of Graeme Attwood (see Appendix 1 for full details). It will be carried out in accordance with current best practice guidelines produced by Historic England (David et al., 2008), the Chartered Institute of Field Archaeologists (CIfA, 2014) and the European Archaeological Council (Schmidt et al., 2015)

5.1.3 Magnetic data will be collected using MS' bespoke, hand-pulled/quad-towed cart system. MS' cart system will be comprised of Bartington Instruments Grad 13 Digital Three-Axis Gradiometers. Positional referencing will be through a Hemisphere S321 GNSS Smart Antenna RTK GPS outputting in NMEA mode to ensure high positional accuracy of collected measurements. The Hemisphere S321 GNSS Smart Antenna is accurate to 0.008 m + 1 ppm in the horizontal and 0.015 m + 1 ppm in the vertical.

5.1.4 Magnetic and GPS data will be stored on an SD card within MS' bespoke datalogger. The datalogger is continuously synced, via an in-field Wi-Fi unit, to servers within MS' offices. This allows data collection, processing and visualisation to be monitored in realtime as fieldwork is ongoing.

5.2 Visualisation and interpretation

5.2.1 Multiple greyscales images will be used for data interpretation; these will be at different plotting ranges and show different components of the vector magnetic field. Greyscale images will be interpreted alongside the XY trace plots. XY trace plots visualise the magnitude and form of the geophysical response, aiding in anomaly interpretation.

5.2.2 Geophysical results will be interpreted using greyscale images and XY traces in a layered environment, overlaid against open street mapping, satellite imagery, historic mapping and LiDAR data. Google Earth will be consulted as well, to compare the results with recent land usages

5.3 Pre-commencement

5.3.1 Before work on site commences, service plans will be checked to ensure that access and groundworks can be conducted safely.

5.3.2 In order to minimise damage to the site and disruption to site users, Oxford Archaeology will agree the following with the client/landowner before work on site commences:

- the location of entrance ways
- sites for welfare units

6 REPORTING

6.1 Survey report

6.1.1 A detailed report of the survey will be produced after all data collection is completed. The report will detail the results and interpretation of the geophysical survey, both in a general context and discusses specific anomalies of archaeological interest. Greyscale images and corresponding interpretations will be displayed at appropriate scales. Interpretations will also be displayed over satellite imagery, historic mapping and LiDAR—if freely available—to provide further context to the interpretations. All figures will include a detailed scale bar, north arrow and key.

6.1.2 Further detail of the report structure is given in Appendix 1

6.2 Draft and final reports

6.2.1 A draft copy of the report will be supplied to the NCCES for comment.

6.2.2 Following approval of the report, one unbound hard copy of the report and one pdf/A format copy on CD will be presented to the NCCES for deposition with the Norfolk HER. A copy will also be sent to Historic England's Regional Scientific Advisor.

6.2.3 A summary report will be prepared for the *Norfolk Archaeology*.

6.3 OASIS

6.3.1 A digital copy of the approved report will be uploaded to the OASIS database.

6.3.2 A copy of the OASIS Data Collection Form will be included in the report.

7 ARCHIVING

Archive standards

7.1.1 The site archive will conform to the requirements Appendix 1 of the Historic England's (2015) *Management of Research Projects in the Historic Environment* (MoRPHE), and the requirements of the Norfolk Museums and Archaeology Service.

7.1.2 The preparation of the archive will follow the guidelines contained in *Guidelines for the Preparation of Excavation Archives for Long Term Storage* (United Kingdom Institute for Conservation, 1990), *Standards in the Museum care of Archaeological Collections* (Museums and Galleries Commission 1992), and *Archaeological Archives: A guide to best practice in creation, compilation, transfer and curation (*Brown 2007*).*

7.1.3 It is Oxford Archaeology Ltd's policy, in line with accepted practice, to keep site archives (paper and artefactual) together wherever possible.

7.1.4 A digital security copy of all documentary parts of the archive will also be made and retained by Oxford Archaeology.

8 TIMETABLE AND STAFFING

8.1.1 The geophysical survey is expected to take 2-3 working days to complete with two surveyors. It is scheduled to begin the week commencing August 13th 2018 (subject to crop harvesting).

8.1.2 Preliminary results will be available within 5 working day. These will be discussed with the NCCES. The full report will be submitted within four weeks of fieldwork completion.

9 OTHER MATTERS

9.1 Monitoring

9.1.1 The NCCES will be informed appropriately of start dates.

9.1.2 During fieldwork, representatives of the client, OA East, and the NCCES may meet on site to monitor the survey, if required.

9.2 Insurance

9.2.1 OA East is covered by Public and Employer's Liability Insurance. The underwriting company is Lloyds Underwriters, policy number CC004337. Details of the policy can be supplied on request to the Oxford Archaeology East office.

9.3 Chartered Institute for Archaeologists

9.3.1 Oxford Archaeology is a Registered Organisation with the Chartered Institute for Archaeologists (CIfA), and is bound by CIfA By-Laws, Standards, and Policy.

9.4 Services, Public Rights of Way, Tree Preservation Orders etc.

9.4.1 The client will inform the project manager of any live or disused cables, gas pipes, water pipes or other services that may be affected by the proposed excavations before the commencement of fieldwork. Hidden cables/services should be clearly identified and marked where necessary. If there are overhead cables on the site or in the approachways, a survey must be completed by the relevant authority before plant is taken onto site.

9.4.2 The client will likewise inform the project manager of any public rights of way or permissive paths on or near the land which might affect or be affected by the work.

9.4.3 The client will inform the Project Manager if the site is a Scheduled Ancient Monument, Site of Special Scientific Interest (SSSI), or any other type of designated site. The client will also inform the project manager of any trees subject to Tree Preservation Orders, protected hedgerows, protected wildlife, nesting birds, or areas of ecological significance within the site or on its boundaries.

9.5 Site Security

9.5.1 Unless previously agreed with the Project Manager in writing, this specification and any associated statement of costs is based on the assumption that the site will be sufficiently secure for archaeological work to commence. All security requirements, including fencing, padlocks for gates etc. are the responsibility of the client.

9.6 Access

9.6.1 The client will secure access to the site for archaeological personnel and plant, and obtain the necessary permissions from owners and tenants to place a mobile office and portable toilet on or near to the site. Any costs incurred to secure access, or incurred as a result of withholding of access will not be Oxford Archaeology's responsibility. The costs of any delays as a result of withheld access will be passed on to the client in addition to the project costs already specified.

9.7 Site Preparation

9.7.1 The client is responsible for clearing the site and preparing it so as to allow archaeological work to take place without further preparatory works, and any cost statement accompanying or associated with this specification is offered on this basis. Unless previously agreed in writing, the costs of any preparatory work required, including tree felling and removal, scrub or undergrowth clearance, removal of concrete or hard standing, demolition of buildings or sheds, or removal of excessive overburden, refuse or dumped material, will be charged to the client, in addition to any costs for archaeological evaluation already agreed.

9.8 Site offices and welfare

9.8.1 All site facilities – including welfare facilities, tool stores, mess huts, and site offices – will be positioned to minimise disruption to other site users, and to minimise impact on the environment (including buried archaeology).

9.9 Health and Safety, Risk Assessments

9.9.1 A risk assessment and method statement (RAMS) covering all activities to be carried out during the lifetime of the project will be prepared before work commences, and sent to the County Archaeologist.

9.9.2 The risk assessment will conform to the requirements of health and safety legislation and regulations, and will draw on OA East's activity-specific risk assessment literature.

9.9.3 All aspects of the project, both in the field and in the office will be conducted according to OA East's Health and Safety Policy, Oxford Archaeology Ltd's Health and Safety Policy, and Health and Safety in Field Archaeology (J.L. Allen and A. St John-Holt, 1997). A copy of OA East's Health and Safety Policy can be supplied on request.

10 APPENDIX 1: SURVEY METHOD STATEMENT

Method Statement

For a Geophysical Survey

of

Land at Green Farm, Edge Green, Kenninghall, Norfolk

For

Oxford Archaeology

Magnitude Surveys Ref: MSTM336

July 2108

Unit 17, Commerce Court

Challenge Way

Bradford

BD4 8NW

01274 926020

info@magnitudesurveys.co.uk

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Figure 1 – Site Location 1:25,000 @ A4

Figure 2 – Survey Area 1:10,000 @ A3

Appendix 1—Standard Magnetic Fieldwork Risk Assessment

Appendix 2—Site Specific Risk Assessment

1. Introduction

1.1. This document details a Method Statement for a geophysical survey by Magnitude Surveys Ltd (MS) for Oxford Archaeology. The survey comprises a c.9.56 ha area of land at Green Farm, Edge Green, Kenninghall, Norfolk (TM 04034 84863).

1.2. The geophysical survey will comprise hand-pulled/quad-towed, cart-mounted or hand-carried GNSS-positioned fluxgate gradiometer survey. Magnetic survey is the standard primary geophysical method for archaeological applications in the UK for its ability to detect a range of different features. The technique is particularly suited for detecting fired or magnetically enhanced features, such as ditches, pits, kilns, sunken earth houses, and industrial activity (David *et al*., 2008).

1.3. The survey will be conducted in line with the current best practice guidelines produced by Historic England (David et al., 2008), the Chartered Institute for Archaeologists (2014) and the European Archaeological Council (Schmidt et al., 2015).

2. Objective

2.1. The objective of this geophysical survey is to assess the subsurface archaeological potential of the survey area.

3. Quality Assurance

3.1. Magnitude Surveys is a Registered Organisation of the Chartered Institute for Archaeologists (CIfA), the chartered UK body for archaeologists, and a corporate member of ISAP (International Society of Archaeological Prospection).

3.2. Director Graeme Attwood is a Member of CIfA, as well as the Secretary of GeoSIG, the CIfA Geophysics Special Interest Group. Director Finnegan Pope-Carter is a Fellow of the London Geological Society, the chartered UK body for geophysicists and geologists, as well as a member of GeoSIG, the CIfA Geophysics Special Interest Group. Director Chrys Harris has a PhD in archaeological geophysics from the University of Bradford and is the Vice-Chair of the International Society for Archaeological Prospection.

3.3. All MS managers have relevant degree qualifications to archaeology or geophysics. All MS field and office staff have relevant archaeology or geophysics degrees and/or field experience.

3.4. MS has developed a bespoke geophysical system whereby data are live-streamed from the field back to the office while fieldwork is ongoing. This allows for data to be regularly monitored not only in the field, but by managers in a controlled office environment. Coverage gaps or small errors within the data can be quickly identified and rectified, improving quality control of field survey. The live data streaming allows MS to provide processed data to the client at regular intervals, allowing all parties to be informed of the field survey's progress. Should it become apparent that the survey is being compromised by local conditions, such as the spreading of green waste, this will be reported back to the client and a mitigation strategy can be devised if necessary.

4. Risk Assessment

4.1. MS' standard magnetic fieldwork risk assessment and site-specific risk assessment have been appended to the end of this document. Before geophysical survey will commence, a brief walkover will be undertaken to identify any additional hazards of an unusual or site-specific nature. If any additional hazards are identified, the site-specific risk assessment will be updated to include these hazards and all surveyors will be informed of the risk. If appropriate mitigation factors cannot be put in place, then the field or part thereof will not be surveyed.

4.2. Field staff will attend a site induction if required. Necessary PPE will be supplied and worn. Wet and cold/hot weather protection is also supplied.

4.3. All surveyors have been issued company mobile phones. Survey teams are expected to make regular contact with the office to keep all parties updated with survey progress. Any change in conditions that may affect the health and safety of the survey team must be reported immediately.

4.4. The survey van contains suitable welfare facilities. Antiseptic hand gel is provided, as is bottled drinking water. A first aid kit is stored in the cab of the van, with a second kit near personnel within the survey area.

4.5. The nearest NHS urgent care centre is at West Suffolk Hospital, Hardwick Lane, Bury St Edmunds, IP33 2QZ. Should toilets be unavailable on site the nearest public accessible toilet is located at Roydon Service Station, High Rd, Roydon, Diss, IP22 5RD.

5. Methodology

5.1. Data Collection

5.1.1. Geophysical survey will comprise the magnetic method as described in the following table.

5.1.2. Table of survey strategies:

Method	Instrument	Traverse Interval	Sample Interval
Magnetic	Bartington Instruments Grad-13 Digital Three-Axis Gradiometer	1 m	200 Hz reprojected to 0.125 m

5.1.3. Magnitude Surveys employs a modular cart system, which can easily be configured to be towed by quad, pulled by hand, or carried depending on what is most suitable for the site configuration and conditions. Consisting of a cart frame, and backpack system survey can be undertaken should conditions preclude survey with the wheels. The hand carried system retains all of the advantages of a cart system because it is still GNSS positioned and the sensors are maintained at a consistent height.

5.1.4. Magnetic data will be collected using MS' bespoke, [hand-pulled/quad-towed cart system OR hand-carried GNSS-positioned system]. MS' [cart OR hand-carried] system will be comprised of Bartington Instruments Grad 13 Digital Three-Axis Gradiometers. Positional referencing will be through a Hemisphere S321 GNSS Smart Antenna RTK GPS

outputting in NMEA mode to ensure high positional accuracy of collected measurements. The Hemisphere BRX6 GNSS Smart Antenna is accurate to 0.008 m + 1 ppm in the horizontal and 0.015 m + 1 ppm in the vertical.

5.1.5. Magnetic and GPS data will be stored on an SD card within MS' bespoke datalogger. The datalogger is continuously synced, via an in-field Wi-Fi unit, to servers within MS' offices. This allows data collection, processing and visualisation to be monitored in real-time as fieldwork is ongoing (see 3.6).

5.1.6. A navigation system Will be integrated with the RTK GPS will be used to guide the surveyor. Data will be collected by traversing the survey area along the longest possible lines, ensuring efficient collection and processing.

5.2.Data Processing

5.2.1. Magnetic data will be processed in bespoke in-house software produced by MS. Processing steps conform to Historic England's standards for "raw or minimally processed data" (see sect 4.2 in David et al., 2008: 11).

Sensor Calibration – The sensors will be calibrated using a bespoke in-house algorithm, which conforms to Olsen et al. (2003).

Zero Median Traverse – The median of each sensor traverse will be calculated within a specified range and subtracted from the collected data. This removes striping effects caused by small variations in sensor electronics.

Projection to a Regular Grid – Data collected using RTK GPS positioning requires a uniform grid projection to visualise data. Data will be rotated to best fit an orthogonal grid projection and are resampled onto the grid using an inverse distance-weighting algorithm.

Interpolation to Square Pixels – Data will be interpolated using a bicubic algorithm to increase the pixel density between sensor traverses. This produces images with square pixels for ease of visualisation.

5.3.Data Visualisation and Interpretation

5.3.1. The report will present the gradient of the sensors' total field data as greyscale images, as well as the total field data from the upper and/or lower sensors. The gradient of the sensors minimises external interferences and reduces the blown-out responses from ferrous and other high contrast material. However, the contrast of weak or ephemeral anomalies can be reduced through the process of calculating the gradient. Consequently, some features can be clearer in the respective gradient or total field datasets. Multiple greyscale images at different plotting ranges will be used for data interpretation.

5.3.2. Geophysical results will be interpreted using greyscale images and XY traces in a layered environment, overlaid against open street maps, satellite imagery, historic maps, LiDAR data, and soil and geology maps. Google Earth (2018) will be consulted as well, to compare the results with recent land usages.

6. Reporting

6.1. A detailed report of the survey will be produced after data collection is completed. The Planning Archaeologist will be provided with a draft report for approval, and the approved report will be submitted to the HER. The final report will include as standard:

- Abstract
- Introduction – Details site location and client details.
- Quality Assurance – Details the expertise of Magnitude Surveys and Magnitude Surveys employees undertaking the work.
- Objectives—Details survey objectives.
- Geographic Background – Details the soils and geology of the survey area, as well as providing a general summary of site conditions at time of survey.
- Archaeological Background – Details a brief summary of the archaeological and historical background of the site and its immediate environs. While this will not be an exhaustive assessment of the known sites, it will draw on elements relevant to the results obtained during survey.
- Methodology—Details survey strategy employed, instruments used, data collection strategy, data processing and visualisation methods.
- Survey Considerations – Details specific points of note for each survey area, including topography, upstanding obstructions or neighbouring objects.
- Results—Details the results and interpretation of the geophysical survey, both in a general context and discusses specific anomalies of archaeological interest. Geophysical reports will be discussed in consideration with satellite imagery, historic mapping and LiDAR data—if freely available—as supporting interpretative evidence.
- Conclusions
- Archiving
- Copyright
- References
- Figures—The site location and individual survey areas will be presented. Greyscale images and corresponding interpretations will be displayed at appropriate scales. Interpretations will also be displayed over satellite imagery, historic mapping and LiDAR—as applicable—to provide further context to the interpretations. All figures will include a detailed scale bar, north arrow and key.

7. Archiving

7.1. MS maintains an in-house digital archive, which is based on Schmidt and Ernenwein (2013). This archive stores the collected measurements, minimally processed data, georeferenced and un-georeferenced images, XY traces and a copy of the final report. A copy of this archive will be included in a disk with the final printed report.

7.2. MS contributes reports to the ADS Grey Literature Library upon permission from the client, subject to the any dictated time embargoes.

7.3. An OASIS form will be filled in on completion of the survey, providing permission from the client.

8. Copyright

8.1. Copyright and the intellectual property pertaining to all reports, figures, and datasets produced by Magnitude Services Ltd. is retained by MS. The client is given full licence to use such material for their own purposes. Permission must be sought by any third party wishing to use or reproduce any IP owned by MS.

9. References

Chartered Institute for Archaeologists, 2014. Standards and guidance for archaeological geophysical survey. CIfA.

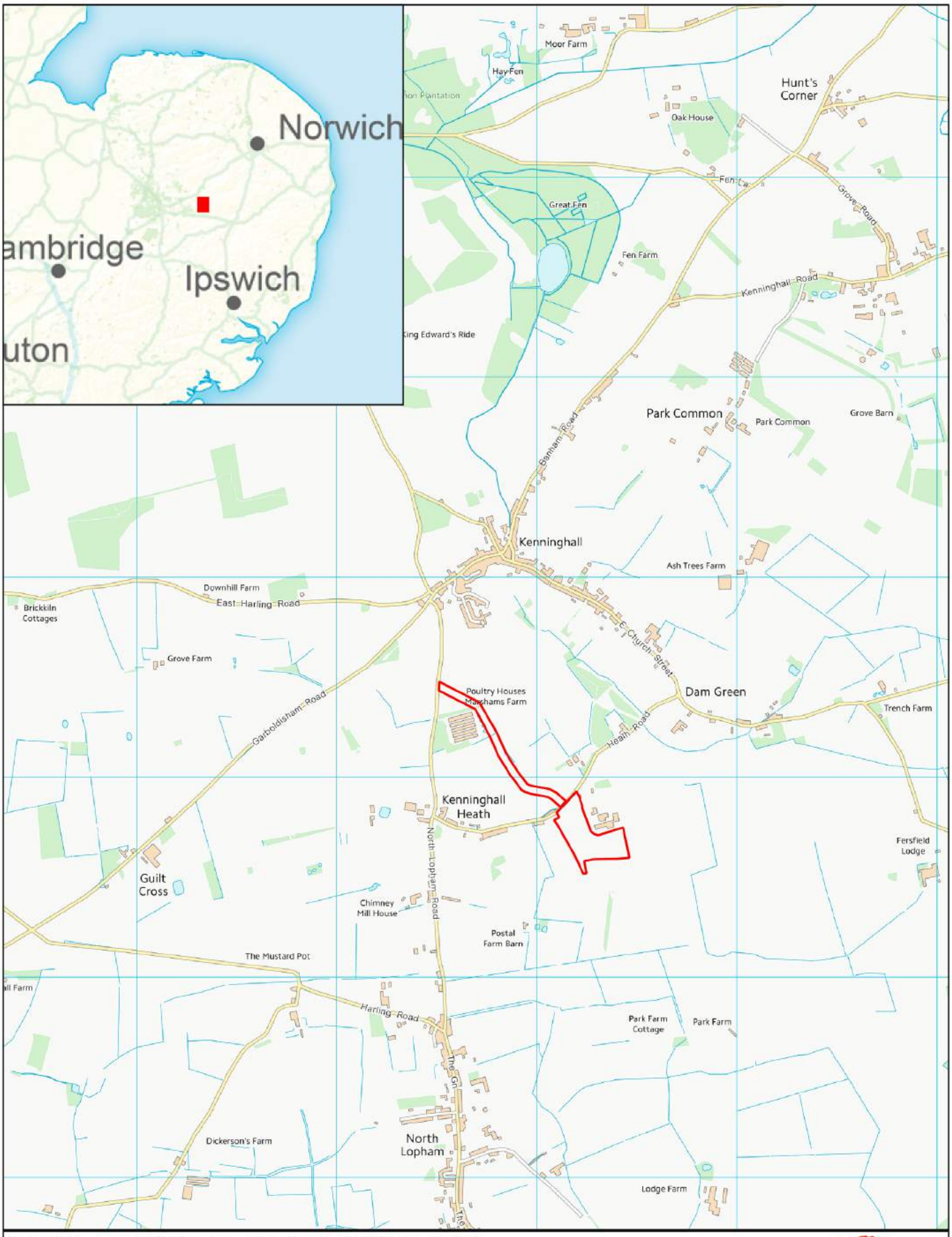
David, A., Linford, N., Linford, P. and Martin, L., 2008. Geophysical survey in archaeological field evaluation: research and professional services guidelines (2nd edition). Historic England.

Google Earth, 2018. Google Earth Pro V 7.1.7.2606.

Olsen, N., Toffner-Clausen, L., Sabaka, T.J., Brauer, P., Merayo, J.M.G., Jorgensen, J.L., Leger, J.M., Nielsen, O.V., Primdahl, F., and Risbo, T., 2003. Calibration of the Orsted vector magnetometer. *Earth Planets Space* 55: 11-18.

Schmidt, A. and Ernenwein, E., 2013. Guide to Good Practice: Geophysical Data in Archaeology. 2nd ed., Oxbow Books, Oxford.

Schmidt, A., Linford, P., Linford, N., David, A., Gaffney, C., Sarris, A. and Fassbinder, J., 2015. Guidelines for the use of geophysics in archaeology: questions to ask and points to consider. EAC Guidelines 2.



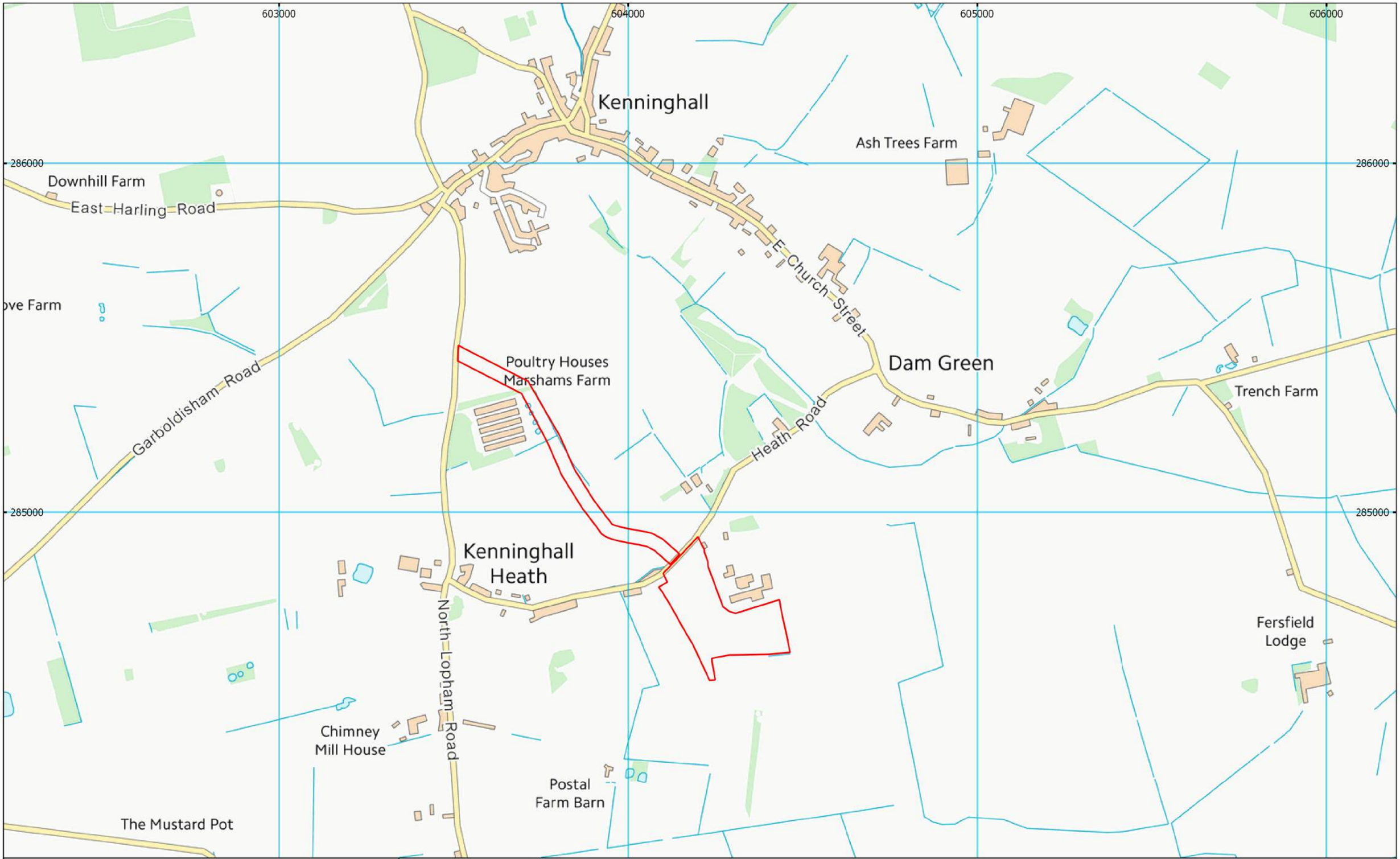
MSTM336 - Land at Green Farm, Edge Green, Kenninghall, Norfolk
Figure 1 - Site Location
1:25,000 @ A4

Site Boundary

N

0 0.5 1 km

magnitude surveys



MSTM336 - Land at Green Farm, Edge Green, Kenninghall, Norfolk
Figure 2 - Location of Survey Areas
1:10,000@ A3

Survey Extent

N

0 250 500 750 m

magnitude surveys

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STANDARD MAGNETIC FIELDWORK RISK ASSESSMENT

Likelihood of Accident/Incident Occurring	Severity of Consequences
1. Highly improbable 2. Probable – annually 3. Infrequent – 2-3 times/year 4. Occasional – monthly 5. Frequent – weekly	1. Minor injury minor damage to plant/equipment/buildings 2. Injury (no time lost) damage repair costs are low 3. Injury (time lost) high damage repair costs 4. Major reportable injury very high damage repair costs 5. Fatality major damage and major costs

Details of tasks to be carried out	Potential Hazard	A Likelihood	B Severity Rating	Overall Risk Rating A x B	Control Measures	Action	Revised Risk Rating
Driving company vehicle	Losing control of vehicle, sudden breaking or swerving. Hitting another road user, pedestrian or stationary object.	2 2	5 5	10 Moderate 10 Moderate	Do not drive vehicle if feeling unwell or tired. Take regular breaks on long journeys. Take turns driving when working in groups. Try to avoid driving in adverse weather	If weather is severe pull over. Stay in a hotel if work has been delayed or weather conditions are extreme.	1x5=5 Low 1x5=5 Low
Parking company vehicle	Parking in an unsafe location, such as a blind corner or hidden dip or on the side of a major highway. Pausing while farm gates are opened in order to exit highway.	3 4	5 4	15 High 16 High	Where possible park off-road in car parks, farm yards, fields or lay-bys. If it is not possible to access a survey area in a safe manner, stop and make new arrangements, such as obtaining keys or codes to locked gates. Use vehicle lights, such as dipped headlights, and hazards. Avoid packing or unpacking the vehicles in the dark. When performing reversing procedures while entering or exiting fields, position a colleague in a safe place where they can be seen and heard in order to direct and	Wear high visibility clothing when working around vehicles. Use the floodlight when necessary and safe to do so. Return early during winter months to prevent working in dusk conditions Only stop on highway if safe to do so. Use hazard lights.	1x5=5 Low 1x4=4 Low

STANDARD MAGNETIC FIELDWORK RISK ASSESSMENT

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1. Highly improbable 2. Probable – annually 3. Infrequent – 2-3 times/year 4. Occasional – monthly 5. Frequent – weekly	1. Minor injury minor damage to plant/equipment/buildings 2. Injury (no time lost) damage repair costs are low 3. Injury (time lost) high damage repair costs 4. Major reportable injury very high damage repair costs 5. Fatality major damage and major costs

					communicate information on the road traffic.		
Loading and unloading the cart	Muscle strain, dropping equipment, slips trips and falls.	4	2	8 Moderate	Work in a pair, never lift the cart in or out on your own. Move the cart to the edge of the van and then lower to the ground. Never step out the van while lowering to the floor. Follow manual handling training.	Clear both the interior and surrounding van area before attempting to lift the cart in or out the van.	2x1=2 Low
Entering and commencing work in a new survey area	Coming into contact with unknown hazards in a new survey area.	4	2	8 Moderate	Where possible, arrange for livestock to be removed from survey areas before work is begun. Liaise with farmer with regard to livestock. Complete a walkover survey and dynamic risk assessment of the survey area to identify any hidden or unusual hazards, remove or reduce the hazard as best as possible and inform all other staff members of both the hazard and the measures that are being implemented to minimise the risk.	Provide a project questionnaire a to be completed by the client before commencement of fieldwork to reduce or eliminate hazards before commencing fieldwork.	2x1=2 Low
Balancing the magnetic sensors	To complete the sensors' calibration requires the cart to be lifted and turned upside down.	4	3	12 Moderate	When the cart must be lifted, ensure it is set up by two people. Before the cart is lifted, a set of steps and commands should be agreed, who will perform each step and when. If either party feels uncomfortable with the procedure, they should immediately let their partner now and safely put the cart down together.		3x2=6 Low

STANDARD MAGNETIC FIELDWORK RISK ASSESSMENT

Likelihood of Accident/Incident Occurring	Severity of Consequences
1. Highly improbable 2. Probable – annually 3. Infrequent – 2-3 times/year 4. Occasional – monthly 5. Frequent – weekly	1. Minor injury minor damage to plant/equipment/buildings 2. Injury (no time lost) damage repair costs are low 3. Injury (time lost) high damage repair costs 4. Major reportable injury very high damage repair costs 5. Fatality major damage and major costs

					The cart should not be lifted in high winds or when the ground is slippery underfoot.		
Surveying with the cart	Slips, trips and falls while walking with instrument. Strains to muscles while pulling cart.	4	3	12 Moderate	Care taken when working in field. Work not to be undertaken where there are poor field conditions, such as heavy plough or thick vegetation - where a clear view of the underfoot condition is not possible.	Safety survey boots to be worn while walking. Warm up/ down in cold conditions.	3x2=6 Low
Working in all weather conditions.	Hypothermia and heat stroke.	3	3	9 Moderate	Stop survey and take shelter in heavy rain and strong wind to avoid accidents and illness. Take regular breaks in hot weather.	Appropriate PPE to be worn, full waterproofs and safety boots are provided. Make use of the provided, water, sun tan lotion and aftersun. Wear a hat.	3x1=3 Low

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SITE SPECIFIC RISK ASSESSMENT

Project Name: Project No:

Client: Assessor:

Date of Survey: Signature:

Description:

Hazard	Who could be harmed?	Mitigation strategies?	Any further action required?	Who should take action? When?	Has the hazard been resolved?

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REGISTERED CIfA ORGANISATION

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OASIS DATA COLLECTION FORM: England

Printable version

OASIS ID: magnitud1-327158

Project details

Project name	Land at Green Farm, Edge Green, Kenninghall
Short description of the project	Magnitude Surveys was commissioned to assess the subsurface archaeological potential of a c. 8.89ha area of land at Green Farm, Edge Green, Kenninghall, Norfolk. A fluxgate magnetometer survey was successfully completed, and the results primarily reflect agricultural activity. This agricultural includes ploughing trends, field drains, and former field boundaries. Anomalies associated with modern activity have been identified as well. A few anomalies have been classified as 'Undetermined' where the origin of the response is ambiguous in the geophysical results and supplementary resources cannot indicate a more specific origin.
Project dates	Start: 11-07-2018 End: 10-08-2018
Previous/future work	Not known / Not known
Any associated project reference codes	ENF144765 - HER event no.
Any associated project reference codes	CNF48165 - Related HER No.
Type of project	Field evaluation
Current Land use	Cultivated Land 4 - Character Undetermined
Monument type	FIELD BOUNDARY Post Medieval
Monument type	DRAIN Modern
Significant Finds	NONE None
Methods & techniques	"'Geophysical Survey"'
Development type	Not recorded
Prompt	Unknown
Position in the planning process	Not known / Not recorded
Solid geology	CHALK (INCLUDING RED CHALK)
Drift geology (other)	Diamicton, clay, silt
Techniques	Magnetometry

Project location

Country	England
Site location	NORFOLK BRECKLAND KENNINGHALL Crown Chicken Site, Kenninghall

Study area	8.89 Hectares
Site coordinates	TM 0409 8490 52.423462222734 1.00193298743 52 25 24 N 001 00 06 E Point

Project creators

Name of Organisation	Magnitude Surveys Ltd
Project brief originator	Norfolk County Council
Project design originator	Magnitude Surveys Ltd
Project director/manager	Chrys Harris
Project supervisor	Leanne Swinbank

Project archives

Physical Archive Exists?	No
Digital Archive recipient	Magnitude Surveys
Digital Contents	"Survey"
Digital Media available	"GIS","Geophysics","Images raster / digital photography","Survey"
Paper Archive Exists?	No

Project bibliography 1

Publication type	Grey literature (unpublished document/manuscript)
Title	Geophysical Survey Report of Land at Green Farm, Edge Green, Kenninghall, Norfolk
Author(s)/Editor(s)	Salmon, F. Perez, A. Burton, E.
Other bibliographic details	Magnitude Surveys Ref: MSTM336
Other bibliographic details	Revision 2.1
Date	2018
Issuer or publisher	Magnitude Surveys
Place of issue or publication	Bradford
Description	Final Report, Digital PDF-A

Entered by	Edward Burton (e.burton@magnitudesurveys.co.uk)
Entered on	24 October 2018

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