Appendix 9.3 Geophysical Survey Report

GEOPHYSICAL SURVEY REPORT

STRATASCAN™

SUMO Survey Services
SUMO Group Member

Project Name:

South Bradwell, Great Yarmouth

Client:

Archaeological Solutions Ltd

January 2013

Job ref:

J3243

Report Author:

Richard Smalley BA (Hons) AIFA

GEOPHYSICAL SURVEY REPORT

Project Name:
South Bradwell, Great Yarmouth
Client:
Archaeological Solutions Ltd

Job ref:
J3243

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Techniques:
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Survey Date:
January 2013

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1 SUMMARY OF RESULTS

The geophysical survey undertaken over an area of land near Great Yarmouth has identified a number of features indicating the presence of prehistoric activity within the survey area. Rectilinear enclosures in the north western region of the site suggest the presence of Iron Age or prehistoric settlement or farmstead activity and two circular features may be related to prehistoric monuments.

A large number of other anomalies have been identified, but due to their amorphous character, a *probable* archaeological origin could not be attributed to them. These anomalies have been interpreted as being of a *possible* archaeological origin.

2 INTRODUCTION

2.1 Background synopsis

Stratascan were commissioned to undertake a geophysical survey of an area outlined for development. This survey forms part of an archaeological investigation being undertaken by Archaeological Solutions Ltd.

2.2 Site location

The site is located near Great Yarmouth, Norfolk at OS ref. TG 507 030.

2.3 Description of site

The survey area comprises approximately 75ha of agricultural land south west of Great Yarmouth. Approximately 15ha of the site could not be surveyed due to obstructions such as building sites and areas of deep plough.

2.4 Geology and soils

The underlying geology is sand and gravel (British Geological Survey website). The drift geology is recorded as sand (British Geological Survey website).

The overlying soils are known as Wick 3 which are typical brown earths. These consist of deep, well drained coarse soils (Soil Survey of England and Wales, Sheet 4 Eastern England).

2.5 Site history and archaeological potential

No specific details were available to Stratascan.

*2.6 **Survey objectives***

The objective of the survey was to locate any features of a possible archaeological origin in order that they may be assessed prior to development.

*2.7 **Survey methods***

This report and all fieldwork has been conducted in accordance with both the English Heritage guidelines outlined in the document: *Geophysical Survey in Archaeological Field Evaluation, 2008* and with the Institute For Archaeologists document *Standard and Guidance for Archaeological Geophysical Survey.*

Detailed magnetic survey (gradiometry) was used as an efficient and effective method of locating archaeological anomalies. More information regarding this technique is included in the Methodology section below and in Appendix A.

*2.8 **Processing, presentation and interpretation of results***

2.8.1 Processing

Processing is performed using specialist software. This can emphasise various aspects contained within the data but which are often not easily seen in the raw data. Basic processing of the magnetic data involves 'flattening' the background levels with respect to adjacent traverses and adjacent grids. Once the basic processing has flattened the background it is then possible to carry out further processing which may include low pass filtering to reduce 'noise' in the data and hence emphasise the archaeological or man-made anomalies.

The following schedule shows the basic processing carried out on all processed gradiometer data used in this report:

1. *Destripe* (Removes striping effects caused by zero-point discrepancies between different sensors and walking directions)
2. *Destagger* (Removes zigzag effects caused by inconsistent walking speeds on sloping, uneven or overgrown terrain)
3. *Deslope* (Used to correct for drift where the use of a destripe is inappropriate)

2.8.2 Presentation of results and interpretation

The presentation of the data for each site involves a print-out of the raw data both as a greyscale plot and a colour plot showing extreme magnetic values, together with a greyscale plot of the processed data. Magnetic anomalies have been identified and plotted onto the 'Abstraction and Interpretation of Anomalies' drawing for the site.

3 RESULTS

The detailed magnetic gradiometer survey conducted over land at South Bradwell, near Great Yarmouth has identified a number of anomalies that have been characterised as being either of a *probable* or *possible* archaeological origin.

The difference between *probable* and *possible* archaeological origin is a confidence rating. Features identified within the dataset that form recognisable archaeological patterns or seem to be related to a deliberate historical act have been interpreted as being of a probable archaeological origin.

Features of possible archaeological origin tend to be more amorphous anomalies which may have similar magnetic attributes in terms of strength or polarity but are difficult to classify as being archaeological or natural.

The following list of numbered anomalies refers to numerical labels on the interpretation plots.

3.1 Probable Archaeology

1-27 A number of positive linear, circular and area anomalies have been identified within the survey data. These features have been interpreted as cut features, such as ditches, of a probable archaeological origin.

Anomalies **3-19** form a series of rectilinear enclosures and are located in the north western region of the site. These anomalies, being heavily truncated in places by ploughing activity, are difficult to interpret fully but may be related to Iron Age or Romano-British settlement or farmstead activity.

Anomalies **1**, **2** and **21-26** are long linear ditches which may be related to prehistoric field boundaries.

Anomaly **27** is a circular ditched feature located in the southern region of the survey area. This feature is approximately 26m in diameter and contains two internal pit-like anomalies (**27a** and **27b**). This anomaly is characteristic of a ring ditch associated with a prehistoric round barrow.

28 Anomaly 28 is a circular banked feature located in the western region of the site. This anomaly measures approximately 17m in diameter and may be related to a prehistoric monument. The weak positive halo around this feature may indicate the presence of an outer ditch.

29-32 A number of long linear anomalies can be identified across the survey area. These anomalies are characteristic of post-medieval field boundaries and have been interpreted as such. Some of these anomalies correlate well with former field boundaries as shown in historic mapping of the area (www.old-maps.co.uk).

3.2 ***Possible Archaeology***

33-73 A large number of isolated discrete positive anomalies can be noted throughout the survey area. These anomalies may be related to cut features, such as pits, of an archaeological origin. However, the amorphous character of these anomalies means that a natural origin cannot be ruled out at this stage. This type of anomaly also occurs in large swathes (**71**-**73**) which may provide further weight to a geological or pedological interpretation.

74 This negative linear anomaly may be related to a ploughed out earthwork, such as a bank.

3.3 ***Other Anomalies***

75 A number of magnetic 'spikes' (strong focussed values with associated antipolar response) indicate the presence of ferrous metal objects. These are likely to be related to modern debris.

76 Large swathes of magnetic variation are evident in the western half of the site. This variation is likely to be related to changes in pedology or geology.

77 Areas of magnetic disturbance are the result of substantial nearby ferrous metal objects such as fences and underground services. These effects can mask weaker archaeological anomalies, but on this site have not affected a significant proportion of the area.

4 CONCLUSION

The detailed magnetic gradiometer survey undertaken over land at South Bradwell near Great Yarmouth has identified a number of anomalies of a probable archaeological origin. Evidence for Iron Age or Romano-British settlement activity, prehistoric and post-medieval field boundaries and prehistoric monuments has been identified within the survey data.

The majority of features of a probable archaeological origin are located in the western half of the survey area between Browston Lane and Clay Lane. The circular ring ditch feature is located in the southern region of the site, east of Hobland Lane.

A large number of other positive anomalies are present throughout the data set. These anomalies may be related to pits of an archaeological origin. However, they may equally have been caused by localised changes in geology and pedology, or by the presence of tree boles.

5 REFERENCES

British Geological Survey South Sheet, 1977. *Geological Survey Ten Mile Map, South Sheet First Edition (Quaternary).* Institute of Geological Sciences.

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Soil Survey of England and Wales, 1983. *Soils of England and Wales, Sheet 4 Eastern England*.

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APPENDIX A – METHODOLOGY & SURVEY EQUIPMENT

Grid locations

The location of the survey grids has been plotted together with the referencing information. Grids were set out using a Leica 705auto Total Station and referenced to suitable topographic features around the perimeter of the site or a Leica Smart Rover RTK GPS.

An RTK GPS (Real-time Kinematic Global Positioning System) can locate a point on the ground to a far greater accuracy than a standard GPS unit. A standard GPS suffers from errors created by satellite orbit errors, clock errors and atmospheric interference, resulting in an accuracy of 5m-10m. An RTK system uses a single base station receiver and a number of mobile units. The base station re-broadcasts the phase of the carrier it measured, and the mobile units compare their own phase measurements with those they received from the base station. A SmartNet RTK GPS uses Ordnance Survey's network of over 100 fixed base stations to give an accuracy of around 0.01m.

Survey equipment and gradiometer configuration

Although the changes in the magnetic field resulting from differing features in the soil are usually weak, changes as small as 0.2 nanoTeslas (nT) in an overall field strength of 48,000nT, can be accurately detected using an appropriate instrument.

The mapping of the anomaly in a systematic manner will allow an estimate of the type of material present beneath the surface. Strong magnetic anomalies will be generated by buried iron-based objects or by kilns or hearths. More subtle anomalies such as pits and ditches can be seen if they contain more humic material which is normally rich in magnetic iron oxides when compared with the subsoil.

To illustrate this point, the cutting and subsequent silting or backfilling of a ditch may result in a larger volume of weakly magnetic material being accumulated in the trench compared to the undisturbed subsoil. A weak magnetic anomaly should therefore appear in plan along the line of the ditch.

The magnetic survey was carried out using a dual sensor Grad601-2 Magnetic Gradiometer manufactured by Bartington Instruments Ltd. The instrument consists of two fluxgates very accurately aligned to nullify the effects of the Earth's magnetic field. Readings relate to the difference in localised magnetic anomalies compared with the general magnetic background. The Grad601-2 consists of two high stability fluxgate gradiometers suspended on a single frame. Each gradiometer has a 1m separation between the sensing elements so enhancing the response to weak anomalies.

Sampling interval

Readings were taken at 0.25m centres along traverses 1m apart. This equates to 3600 sampling points in a full 30m x 30m grid.

Depth of scan and resolution

The Grad 601-2 has a typical depth of penetration of 0.5m to 1.0m, though strongly magnetic objects may be visible at greater depths. The collection of data at 0.25m centres provides an optimum methodology for the task balancing cost and time with resolution.

Data capture

The readings are logged consecutively into the data logger which in turn is daily down- loaded into a portable computer whilst on site. At the end of each site survey, data is transferred to the office for processing and presentation.

APPENDIX B – BASIC PRINCIPLES OF MAGNETIC SURVEY

Detailed magnetic survey can be used to effectively define areas of past human activity by mapping spatial variation and contrast in the magnetic properties of soil, subsoil and bedrock.

Weakly magnetic iron minerals are always present within the soil and areas of enhancement relate to increases in *magnetic susceptibility* and permanently magnetised *thermoremanent* material.

Magnetic susceptibility relates to the induced magnetism of a material when in the presence of a magnetic field. This magnetism can be considered as effectively permanent as it exists within the Earth's magnetic field. Magnetic susceptibility can become enhanced due to burning and complex biological or fermentation processes.

Thermoremanence is a permanent magnetism acquired by iron minerals that, after heating to a specific temperature known as the Curie Point, are effectively demagnetised followed by re-magnetisation by the Earth's magnetic field on cooling. Thermoremanent archaeological features can include hearths and kilns and material such as brick and tile may be magnetised through the same process.

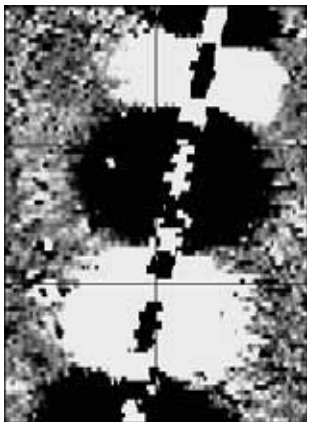
Silting and deliberate infilling of ditches and pits with magnetically enhanced soil creates a relative contrast against the much lower levels of magnetism within the subsoil into which the feature is cut. Systematic mapping of magnetic anomalies will produce linear and discrete areas of enhancement allowing assessment and characterisation of subsurface features. Material such as subsoil and non-magnetic bedrock used to create former earthworks and walls may be mapped as areas of lower enhancement compared to surrounding soils.

Magnetic survey is carried out using a fluxgate gradiometer which is a passive instrument consisting of two sensors mounted vertically 1m apart. The instrument is carried about 30cm above the ground surface and the top sensor measures the Earth's magnetic field whilst the lower sensor measures the same field but is also more affected by any localised buried field. The difference between the two sensors will relate to the strength of a magnetic field created by a buried feature, if no field is present the difference will be close to zero as the magnetic field measured by both sensors will be the same.

Factors affecting the magnetic survey may include soil type, local geology, previous human activity, disturbance from modern services etc.

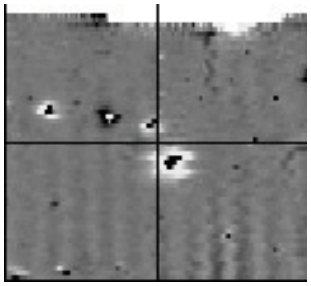
APPENDIX C – GLOSSARY OF MAGNETIC ANOMALIES

Bipolar



A bipolar anomaly is one that is composed of both a positive response and a negative response. It can be made up of any number of positive responses and negative responses. For example a pipeline consisting of alternating positive and negative anomalies is said to be bipolar. See also dipolar which has only one area of each polarity. The interpretation of the anomaly will depend on the magnitude of the magnetic field strength. A weak response may be caused by a clay field drain while a strong response will probably be caused by a metallic service.

Dipolar

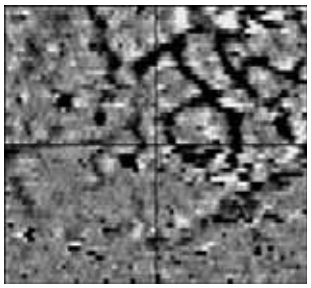


This consists of a single positive anomaly with an associated negative response. There should be no separation between the two polarities of response. These responses will be created by a single feature. The interpretation of the anomaly will depend on the magnitude of the magnetic measurements. A very strong anomaly is likely to be caused by a ferrous object.

Positive anomaly with associated negative response

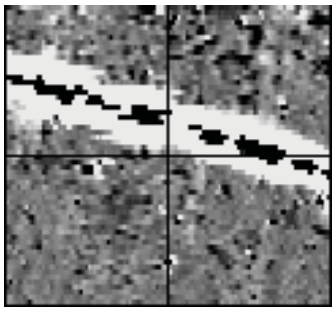
See bipolar and dipolar.

Positive linear



A linear response which is entirely positive in polarity. These are usually related to in-filled cut features where the fill material is magnetically enhanced compared to the surrounding matrix. They can be caused by ditches of an archaeological origin, but also former field boundaries, ploughing activity and some may even have a natural origin.

Positive linear anomaly with associated negative response

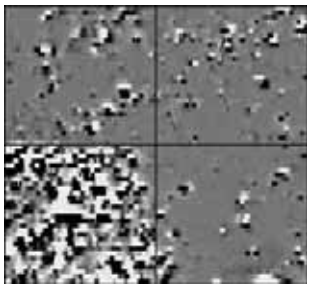


A positive linear anomaly which has a negative anomaly located adjacently. This will be caused by a single feature. In the example shown this is likely to be a single length of wire/cable probably relating to a modern service. Magnetically weaker responses may relate to earthwork style features and field boundaries.

Positive point/area

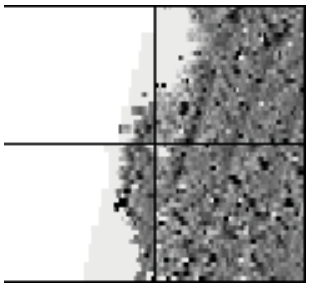
These are generally spatially small responses, perhaps covering just 3 or 4 reading nodes. They are entirely positive in polarity. Similar to positive linear anomalies they are generally caused by in-filled cut features. These include pits of an archaeological origin, possible tree bowls or other naturally occurring depressions in the ground.

Magnetic debris



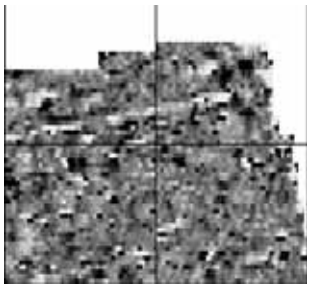
Magnetic debris consists of numerous dipolar responses spread over an area. If the amplitude of response is low (+/-3nT) then the origin is likely to represent general ground disturbance with no clear cause, it may be related to something as simple as an area of dug or mixed earth. A stronger anomaly (+/-250nT) is more indicative of a spread of ferrous debris. Moderately strong anomalies may be the result of a spread of thermoremanent material such as bricks or ash.

Magnetic disturbance



Magnetic disturbance is high amplitude and can be composed of either a bipolar anomaly, or a single polarity response. It is essentially associated with magnetic interference from modern ferrous structures such as fencing, vehicles or buildings, and as a result is commonly found around the perimeter of a site near to boundary fences.

Negative linear

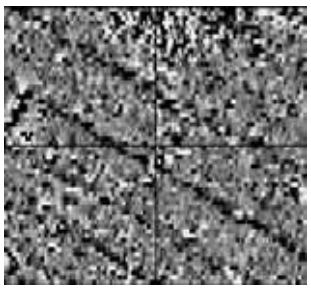


A linear response which is entirely negative in polarity. These are generally caused by earthen banks where material with a lower magnetic magnitude relative the background top soil is built up. See also ploughing activity.

Negative point/area

Opposite to positive point anomalies these responses may be caused by raised areas or earthen banks. These could be of an archaeological origin or may have a natural origin.

Ploughing activity



Ploughing activity can often be visualised by a series of parallel linear anomalies. These can be of either positive polarity or negative polarity depending on site specifics. It can be difficult to distinguish between ancient ploughing and more modern ploughing, clues such as the separation of each linear, straightness, strength of response and cross cutting relationships can be used to aid this, although none of these can be guaranteed to differentiate between different phases of activity.

Polarity

Term used to describe the measurement of the magnetic response. An anomaly can have a positive polarity (values above 0nT) and/or a negative polarity (values below 0nT).

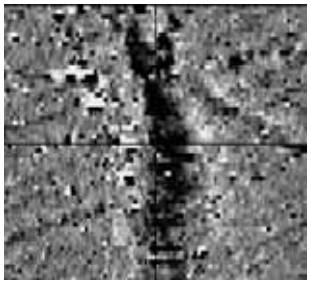
Strength of response

The amplitude of a magnetic response is an important factor in assigning an interpretation to a particular anomaly. For example a positive anomaly covering a $10m^2$ area may have values up to around 3000nT, in which case it is likely to be caused by modern magnetic interference. However, the same size and shaped anomaly but with values up to only 4nT may have a natural origin. Colour plots are used to show the amplitude of response.

Thermoremanent response

A feature which has been subject to heat may result in it acquiring a magnetic field. This can be anything up to approximately +/-100 nT in value. These features include clay fired drains, brick, bonfires, kilns, hearths and even pottery. If the heat application has occurred in situ (e.g. a kiln) then the response is likely to be bipolar compared to if the heated objects have been disturbed and moved relative to each other, in which case they are more likely to take an irregular form and may display a debris style response (e.g. ash).

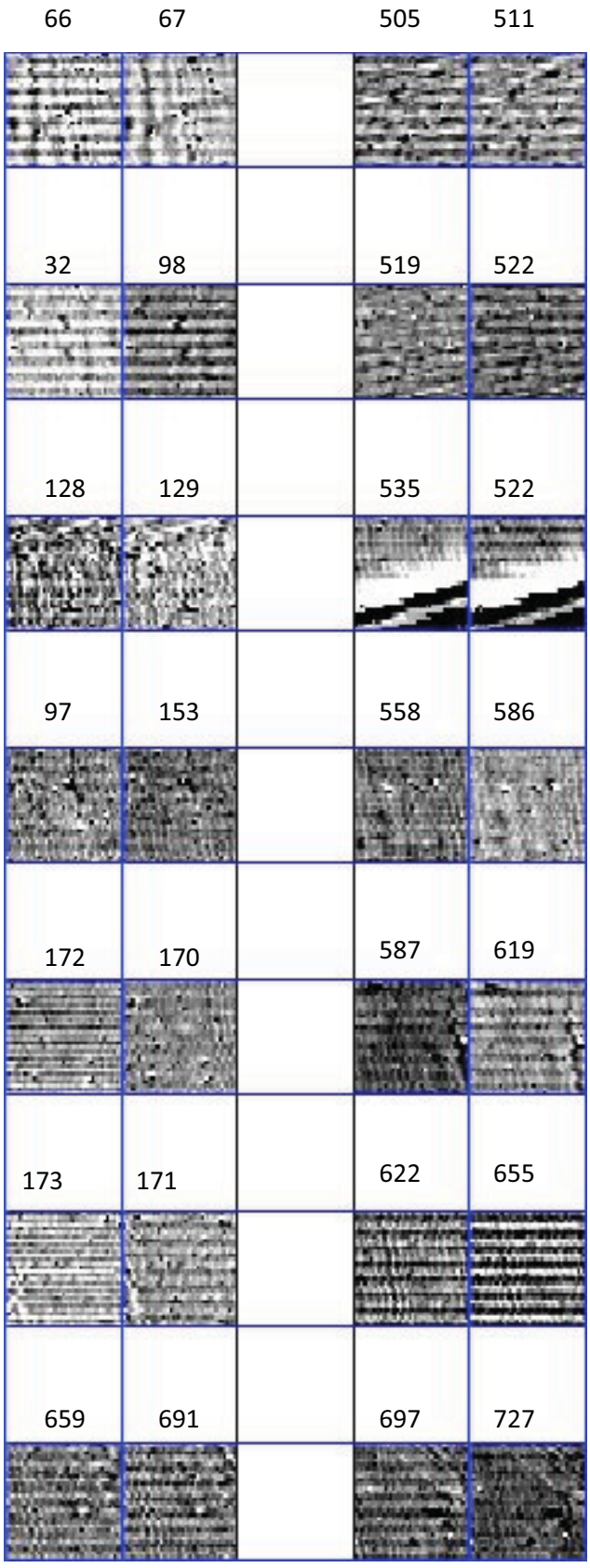
Weak background variations



Weakly magnetic wide scale variations within the data can sometimes be seen within sites. These usually have no specific structure but can often appear curvy and sinuous in form. They are likely to be the result of natural features, such as soil creep, dried up (or seasonal) streams. They can also be caused by changes in the underlying geology or soil type which may contain unpredictable distributions of magnetic minerals, and are usually apparent in several locations across a site.

APPENDIX D – RE-COLLECT

As requested by the Senior Historic Environment Officer.



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OASIS DATA COLLECTION FORM: England

Printable version

OASIS ID: archaeol7-336563

Project details

Project name	SOUTH BRADWELL, GREAT YARMOUTH, NORFOLK (GEO)
Short description of the project	The Geophysical Survey Undertaken at great Yarmouth has identified a number of features indicating the presence of preistoric activity. Recitilnear enclosures in the north western reigon of the site suggests the presence of iron age or prehistoric settlements or farmstead activity and two circular features may be related to prehistoric monuments. A large number of other anomiles have been identified, but due to their amorphous charecter, a probable archaeological origin could not be attributed to them.
Project dates	Start: 01-01-2013 End: 30-01-2013
Previous/future work	Not known / Not known
Any associated project reference codes	P4837 - Contracting Unit No.
Type of project	Recording project
Site status	Area of Archaeological Importance (AAI)
Current Land use	Other 15 - Other
Monument type	SETTLEMENTS Middle Iron Age
Monument type	SETTLEMENTS Post Medieval
Monument type	SETTLEMENTS Late Prehistoric
Significant Finds	NONE None
Investigation type	"Geophysical Survey"
Prompt	Planning condition
Solid geology (other)	Sand and Gravel
Drift geology (other)	sand
Techniques	Magnetometry

Project location

Country	England
Site location	NORFOLK GREAT YARMOUTH BRADWELL South Bradwell, Great Yarmouth, Norfolk (GEO)
Postcode	NR31 8TS
Study area	75 Hectares

Site coordinates	TG 5073 0302 52.566525051037 1.700193133709 52 33 59 N 001 42 00 E Point
Height OD / Depth	Min: 10m Max: 12m

Project creators

Name of Organisation	Archaeological Solutions Ltd
Project brief originator	NCC
Project design originator	Jon Murray
Project director/manager	Jon Murray
Project supervisor	Archaeological Solutions
Type of sponsor/funding body	Persimmons Homes (Anglia) Ltd
Type of sponsor/funding body	Persimmons Homes (Anglia) Ltd
Name of sponsor/funding body	Persimmons Homes (Anglia) Ltd

Project archives

Physical Archive Exists?	No
Digital Archive recipient	Unknown
Digital Contents	"none"
Digital Media available	"Database","Images raster / digital photography","Spreadsheets","Text"
Paper Archive recipient	Unknown
Paper Contents	"none"
Paper Media available	"Context sheet","Drawing","Map","Photograph","Plan","Report","Section","Survey "

Project bibliography 1

Publication type	Grey literature (unpublished document/manuscript)
Title	South Bradwell, Great Yarmouth, Norfolk. A Geophysical Survey
Author(s)/Editor(s)	Smalley, R
Other bibliographic details	J3243
Date	2013
Issuer or publisher	Archaeological Solutions Ltd
Place of issue or publication	Bury St Edmunds

Entered by	Hollie Wesson (admin@ascontract.co.uk)

Entered on 12 December 2018

OASIS:

Please e-mail Historic England for OASIS help and advice