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STRATASCAN

Geophysical Survey Report

Wykeham, Spalding

for

Archaeological Project Services

March 2007

J2307

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receipt acknowledged to APS
10/4/07
J. D. Nall

Conservation
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Highways & Planning
Directorate

SUMMARY OF RESULTS

Document Title: Geophysical Survey Report
Wykeham, Spalding

Client: Archaeological Project Services

Stratascan Job No: J2307

Techniques: Detailed magnetic survey (gradiometry)

National Grid Ref: TF 278 252

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1 SUMMARY OF RESULTS

The gradiometer survey undertaken over approximately 0.42ha of agricultural land near Wykeham, Spalding has identified a number of anomalies relating to the geology of the site.

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 undertaken by Archaeological Project Services

2.2 Site location

The site is located near Wykeham, Spalding at OS ref. TF 278 252.

2.3 Description of site

The survey area consists of approximately 0.42ha of flat agricultural land currently used for arable.

2.4 Geology and soils

The underlying geology is Oxford Clay and Kellaway Beds (British Geological Survey South Sheet, Fourth Edition Solid, 2001). The overlying soils are known as Wallsea 2 soils which are a type of pelo alluvial gley soil. These consist of deep stoneless clayey soils, calcareous in places. Some deep calcareous silty soils. Flat land often with low ridges giving a complex soil pattern (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 possible archaeological significance in order that they may be assessed prior to development.

2.7 Survey methods

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.

3 **METHODOLOGY**

3.1 Date of fieldwork

The fieldwork was carried out over one day on the 21st February 2007. Weather conditions during the survey were overcast.

3.2 Grid locations

The location of the survey grids has been plotted in Figure 2 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.

3.3 Survey equipment

The magnetic survey was carried out using a dual sensor Grad601-2 Magnetic Gradiometer manufactured by Bartington Instruments Ltd. The Grad601-2 consists of two high stability fluxgate gradiometers suspended on a single frame. Each sensor has a 1m separation between the sensing elements increasing the sensitivity to small changes in the Earth's magnetic field.

3.4 Sampling interval, depth of scan, resolution and data capture

3.4.1 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.

3.4.2 Depth of scan and resolution

The Grad601-2 has a typical depth of penetration of 0.5m to 1.0m. This would be increased if strongly magnetic objects have been buried in the site. The collection of data at 0.25m centres provides an appropriate methodology balancing cost and time with resolution. The data is collected at a reading resolution of 0.1nT.

3.4.3 Data capture

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

3.5 Processing, presentation of results and interpretation

3.5.1 Processing

Processing is performed using specialist software known as *Geoplot 3*. 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. 'Despiking' is also performed to remove the anomalies resulting from small iron objects often found on agricultural land. 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. *Despike* (useful for display and allows further processing functions to be carried out more effectively by removing extreme data values)

Geoplot parameters:

X radius = 1, y radius = 1, threshold = 3 std. dev.
Spike replacement = mean

2. *Zero mean grid* (sets the background mean of each grid to zero and is useful for removing grid edge discontinuities)

Geoplot parameters:

Threshold = 0.25 std. dev.

3. *Zero mean traverse* (sets the background mean of each traverse within a grid to zero and is useful for removing striping effects)

Geoplot parameters:

Least mean square fit = off

3.5.2 Presentation of results and interpretation

The presentation of the data for each site involves a print-out of the raw data both as greyscale (Figure 3) and trace plots (Figure 4 and 5), together with a greyscale plot of the processed data (Figure 6). Magnetic anomalies have been identified and plotted onto the 'Abstraction and Interpretation of Anomalies' drawing for the site (Figure 7).

4 RESULTS

The geophysical survey undertaken over 0.42ha of agricultural land near Wykeham, Spalding has located a number of positive and negative anomalies that seem to be of a geological origin.

A number of bipolar anomalies of varying amplitudes are evident across the survey area. These anomalies are likely to have been caused by buried ferrous objects.

5 CONCLUSION

No anomalies of apparent archaeological origin have been identified within the gradiometer data collected during the survey area. The anomalies that have been identified seem to be of a geological origin and relate to the complex soil patterns as mentioned above (2.4 Geology and Soils).

APPENDIX A – 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 *thermoremnant* 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.

Thermoremnance 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. Thermoremnant archaeological features can include hearths and kilns and material such as brick and tile may be magnetised through the same process.

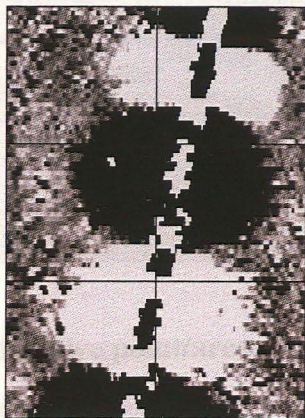
Silting and deliberate infilling of ditches and pits with magnetically enhanced soil creates a relative contrast against the much lower levels of magnetism within the subsoil into which the feature is cut. Systematic mapping of magnetic anomalies will produce linear and discrete areas of enhancement 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 either 0.5 or 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.

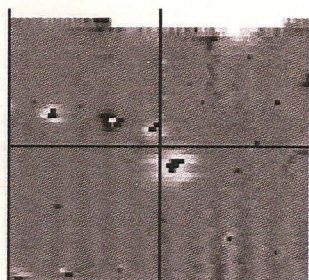
APPENDIX B – Glossary of magnetic anomalies

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

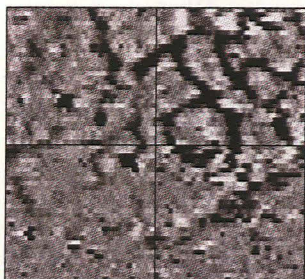


This consists of a single positive anomaly with an associated negative response. There should be no separation between the two polarities of response. These responses will be created by a single feature. The interpretation of the anomaly will depend on the magnitude of the magnetic measurements. A very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

Positive anomaly with associated negative response

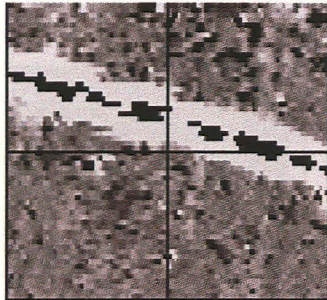
See bipolar and dipolar.

Positive linear



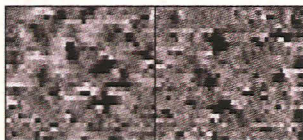
A linear response which is entirely positive in polarity. These are usually related to infilled cut features where the fill material is magnetically enhanced compared to the surrounding matrix. They can be caused by ditches of an archaeological origin, but also former field boundaries, ploughing activity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

Positive linear anomaly with associated negative response



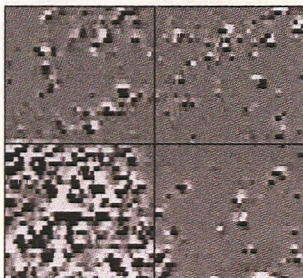
A positive linear anomaly which has a negative anomaly located adjacently. This will be caused by a single feature. In the example shown this is likely to be a single length of wire/cable probably relating to a modern service. Magnetically weaker responses may relate to earthwork style features and field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

Positive point/area



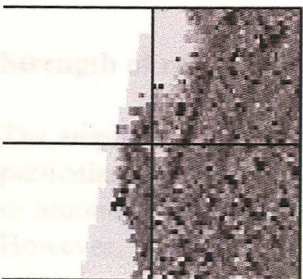
These are generally spatially small responses, perhaps covering just 3 or 4 reading nodes. They are entirely positive in polarity. Similar to positive linear anomalies they are generally caused by infilled cut features. These include pits of an archaeological origin, possible tree bowls or other naturally 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 ($\pm 3nT$) 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 ($\pm 250nT$) is more indicative of a spread of ferrous debris. Moderately strong anomalies may be the result of a spread of thermoremanent remnant material such as bricks or ash.

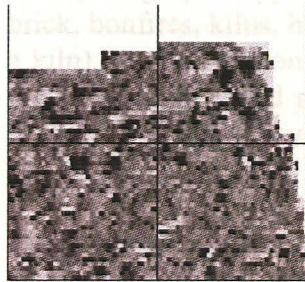
Magnetic disturbance



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.

Thermomagnetic response

Negative linear

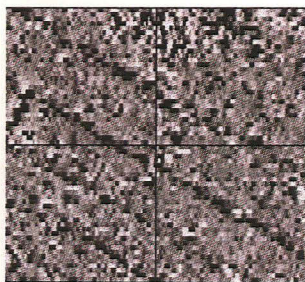


A linear response which is entirely negative in polarity. These are generally caused by earthen banks where material with a lower magnetic magnitude relative the background top soil is built up. See also ploughing activity.

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).

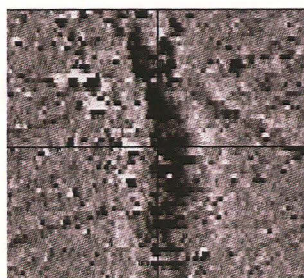
Strength of response

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. Trace plots are used to show the amplitude of response.

Thermoremnant 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 insitu (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

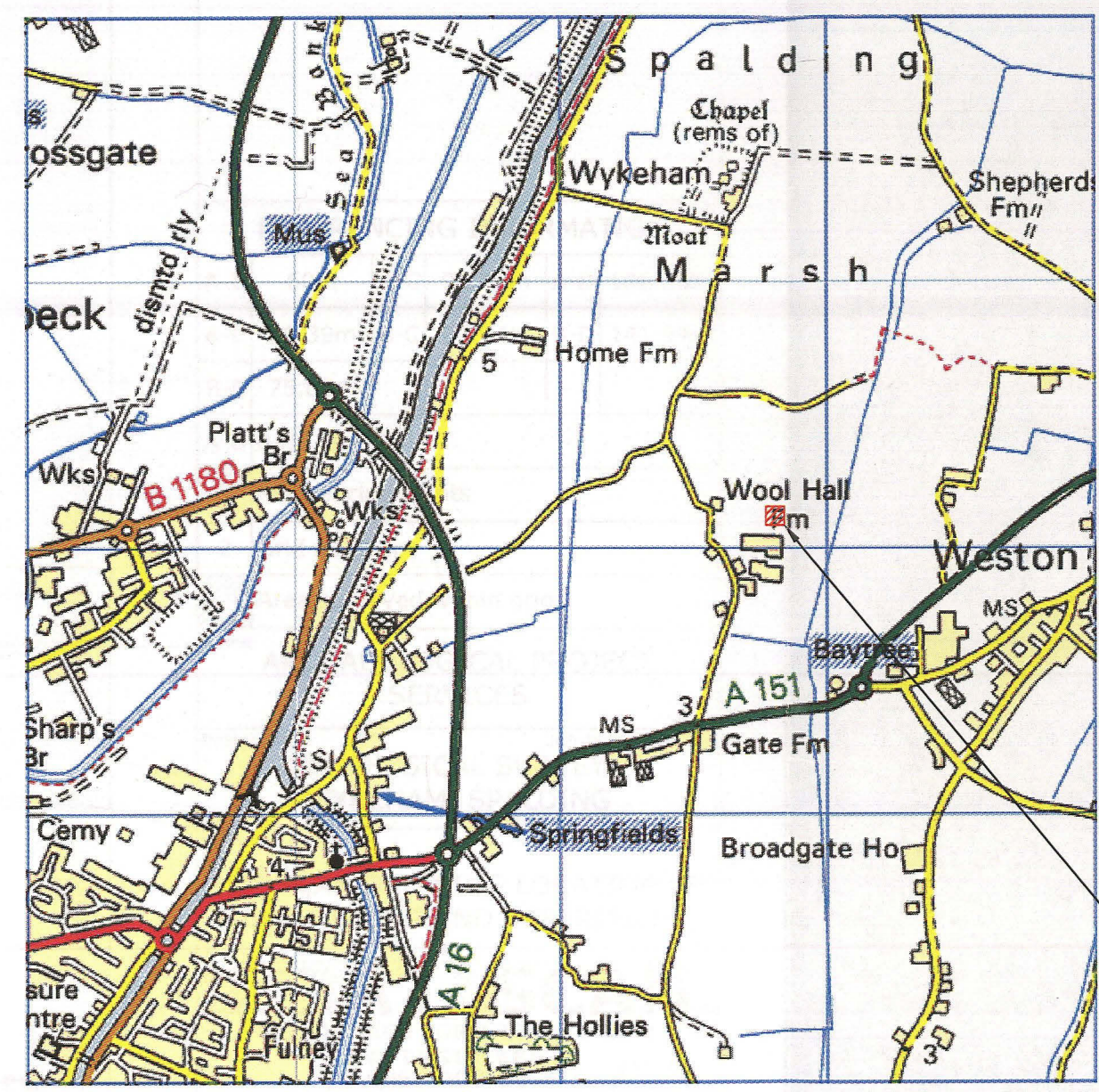


Weakly magnetic wide scale variations within the data can sometimes be seen within sites. These usually have no specific structure but can often appear curvy and sinuous in form. They are likely to be the result of natural features, such as soil creep, dried up (or seasonal) streams. They can also be 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.

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 OS 100km square = TF



27
26
25
24
23



Survey Area

25 26 27 28 29

Amendments		
Issue No.	Date	Description

Site centred on NGR **TF 278 252**

Client **ARCHAEOLOGICAL PROJECT SERVICES**

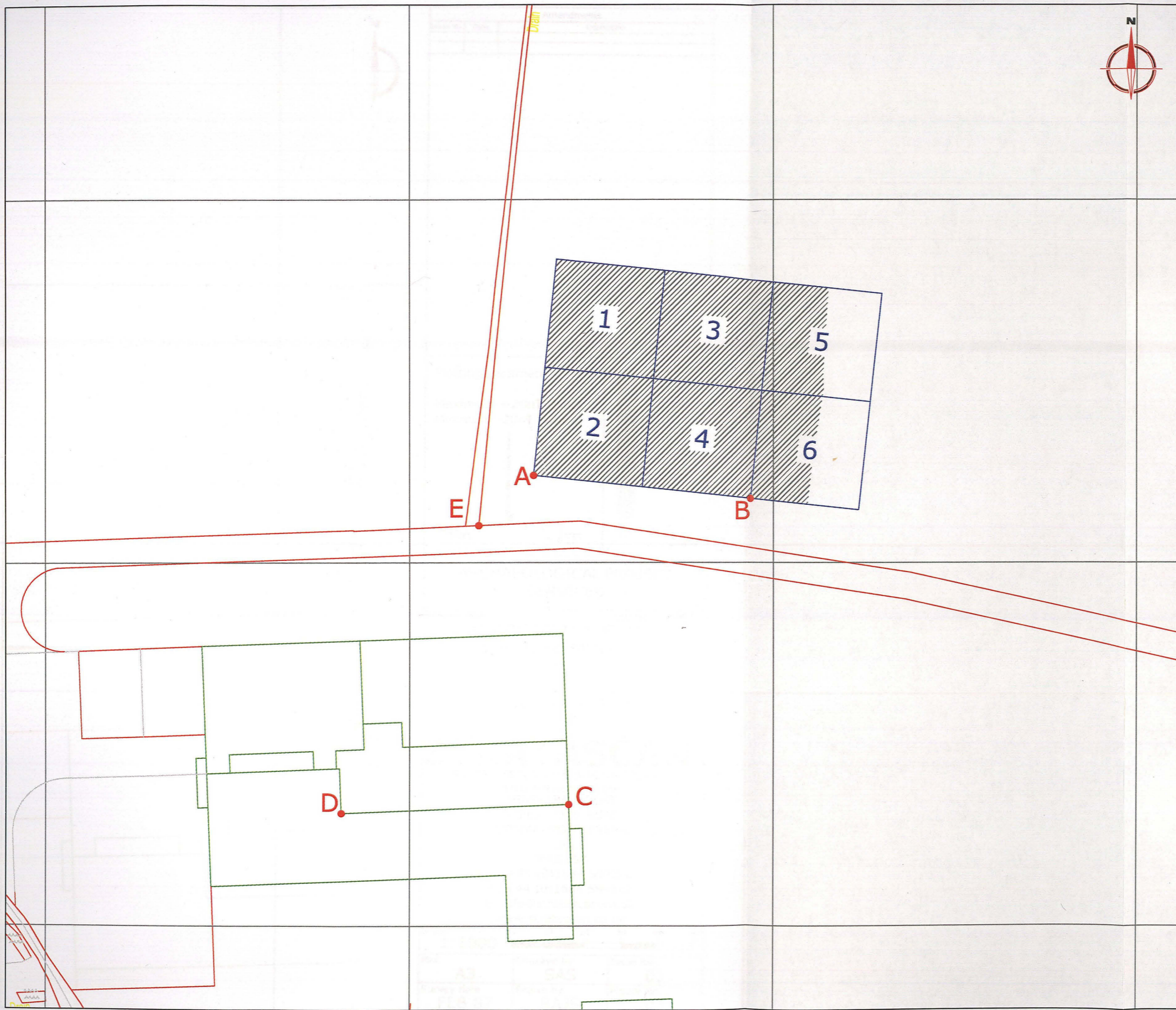
Project Title **GEOPHYSICAL SURVEY - WYKEHAM, SPALDING** Job No. 2307

Subject **LOCATION PLAN OF SURVEY AREA**

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Scale **1:25 000**
 0m 500 1000m

Plot A3	Checked by SAS	Issue No. 01
Survey date FEB 07	Drawn by RAJS	Figure No. 01



Amendments		
Issue No.	Date	Description
-	-	-
-	-	-

REFERENCING INFORMATION					
A-B	60m	A-C	91.06m	A-D	106.89m
A-E	20.39m	B-C	97.94m	B-D	141.94m
B-E	75.03m				
A-B	Base line				
C, D, E	Referencing points				
2	Grid number				
	Area surveyed within grid				

Client
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Project Title
GEOPHYSICAL SURVEY - WYKEHAM, SPALDING

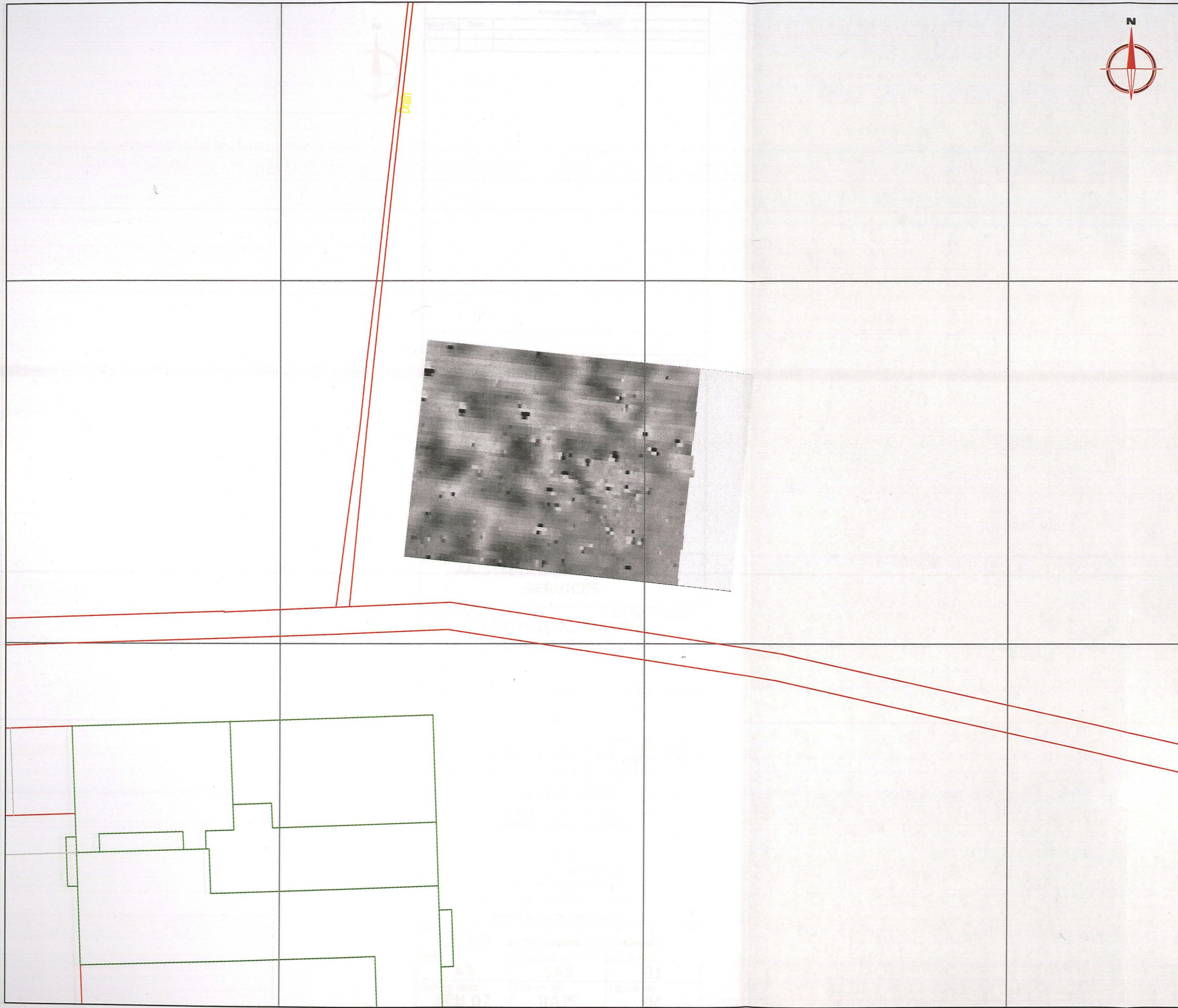
Job No. 2307

Subject
SITE PLAN SHOWING LOCATION OF SURVEY GRIDS AND REFERENCING

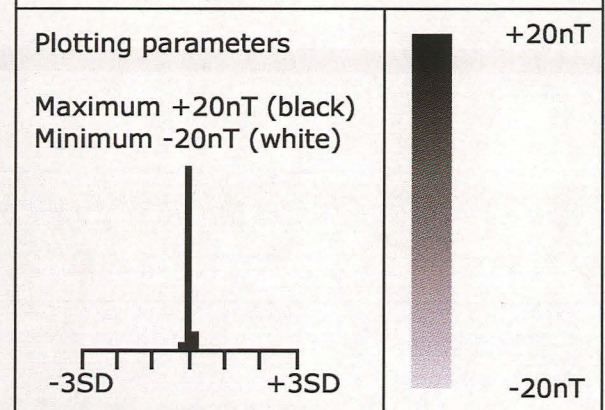
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Scale	1:1000	
Plot	A3	Issue No. 01
Survey date	FEB 07	Figure No. 02
	Checked by SAS	
	Drawn by RAJS	



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Issue No.	Date	Description
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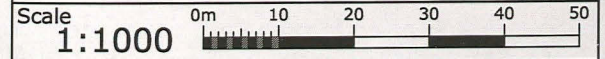


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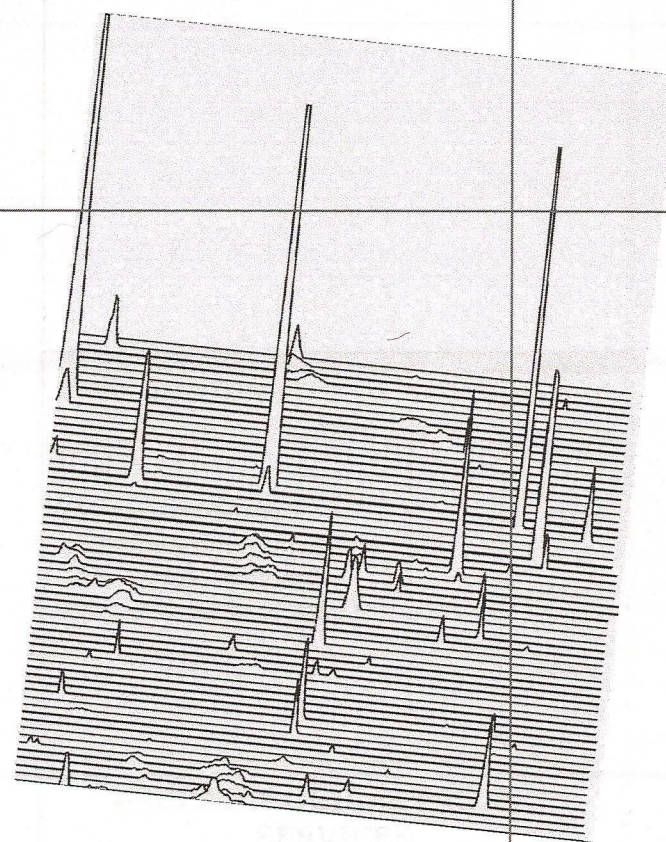
Project Title Job No. 2307
GEOPHYSICAL SURVEY - WYKEHAM, SPALDING

Subject
PLOT OF RAW GRADIOMETER DATA

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Plot A3	Checked by SAS	Issue No. 01
Survey date FEB 07	Drawn by RAJS	Figure No. 03



Amendments		
Issue No.	Date	Description
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-	-	-

Plotting parameters +40nT (Positive values displace above the trace line. Hidden values have not been plotted)	200nT
	160nT
	120nT
	80nT
	40nT
	0nT

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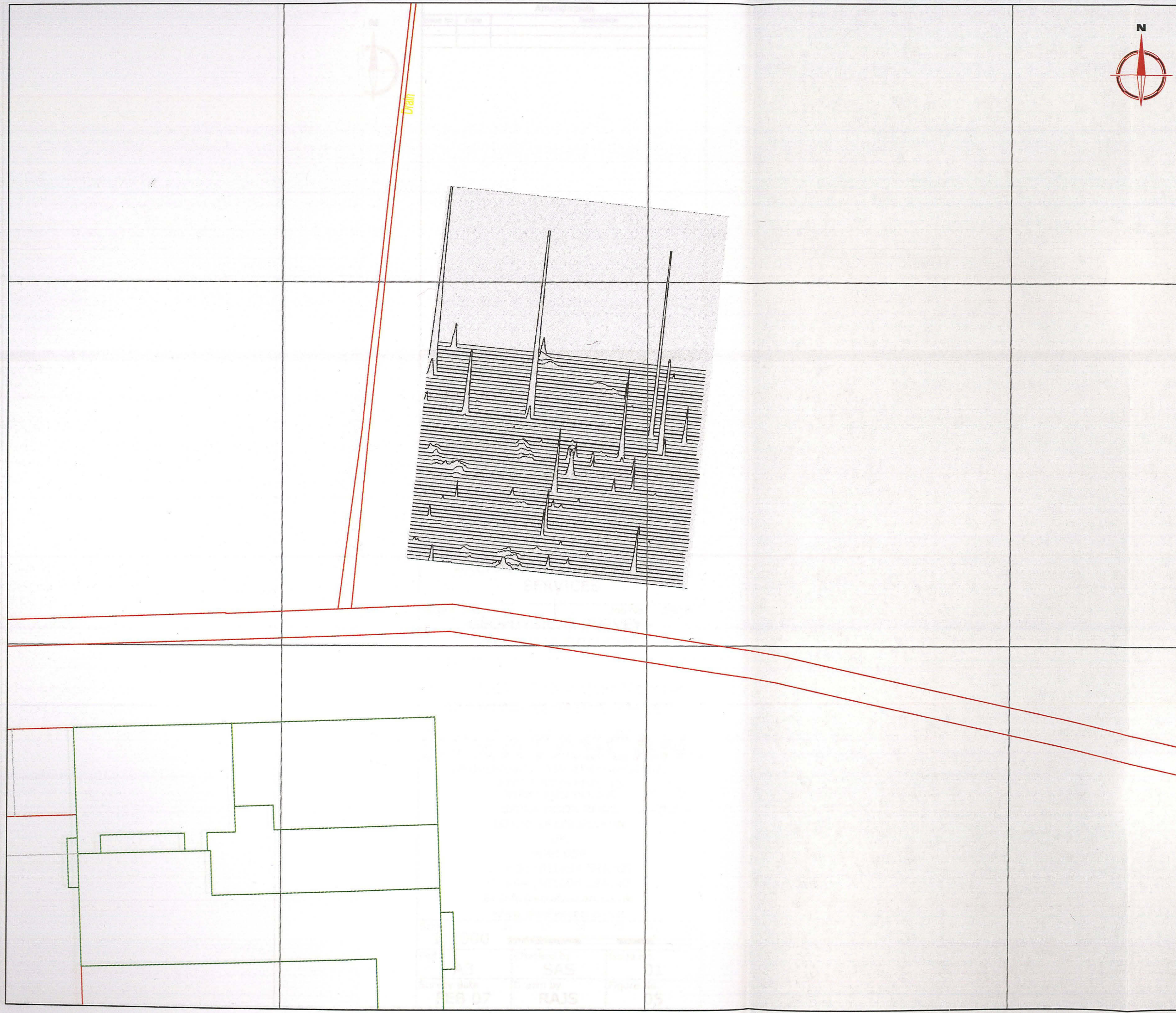
Project Title Job No. 2307
GEOPHYSICAL SURVEY - WYKEHAM, SPALDING

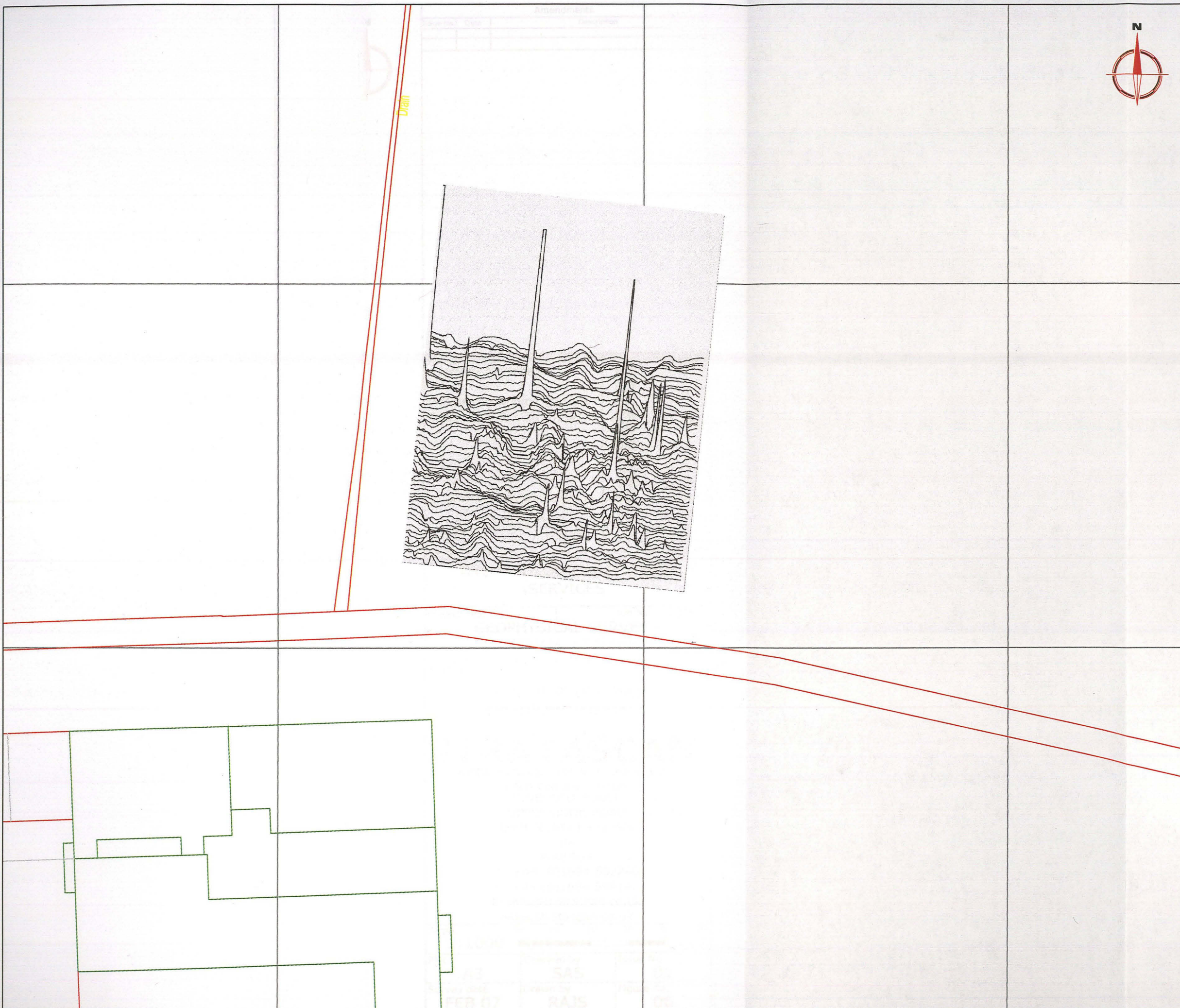
Subject
TRACE PLOT OF GRADIOMETER DATA SHOWING POSITIVE VALUES

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Scale
1:1000

Plot A3	Checked by SAS	Issue No. 01
Survey date FEB 07	Drawn by RAJS	Figure No. 04





Amendments		
Issue No.	Date	Description
-	-	-
-	-	-

Plotting parameters	-200nT
-40nT	-160nT
(Negative values displace above the trace line. Hidden values have not been plotted)	-120nT
	-80nT
	-40nT
	0nT

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GEOPHYSICAL SURVEY - WYKEHAM, SPALDING

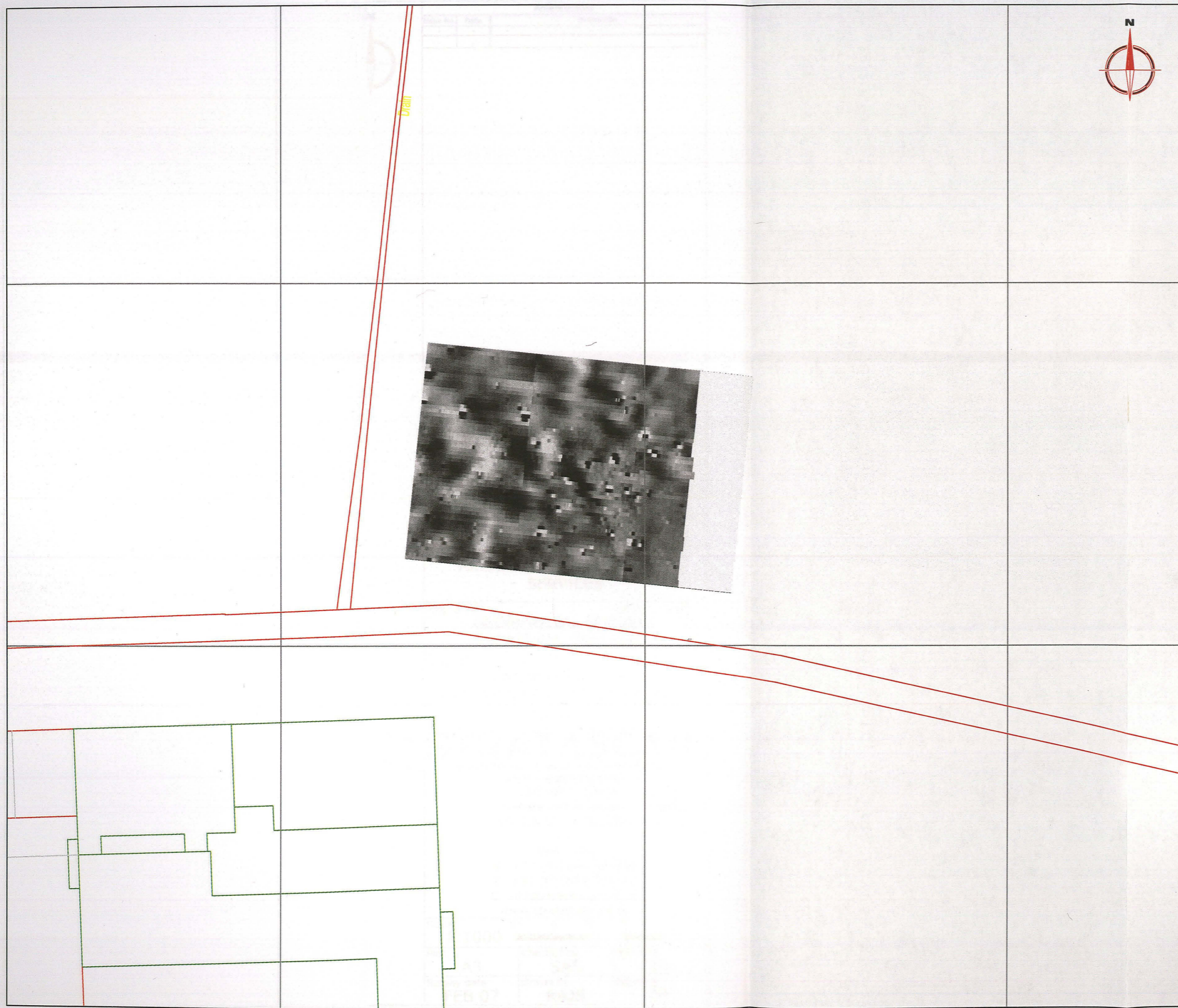
Subject
TRACE PLOT OF GRADIOMETER DATA SHOWING NEGATIVE VALUES

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Scale 1:1000
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Plot A3	Checked by SAS	Issue No. 01
Survey date FEB 07	Drawn by RAJS	Figure No. 05



Amendments		
Issue No.	Date	Description
-	-	-
-	-	-

Plotting parameters

Maximum +10nT (black)
Minimum -10nT (white)

-3SD +3SD

+10nT

-10nT

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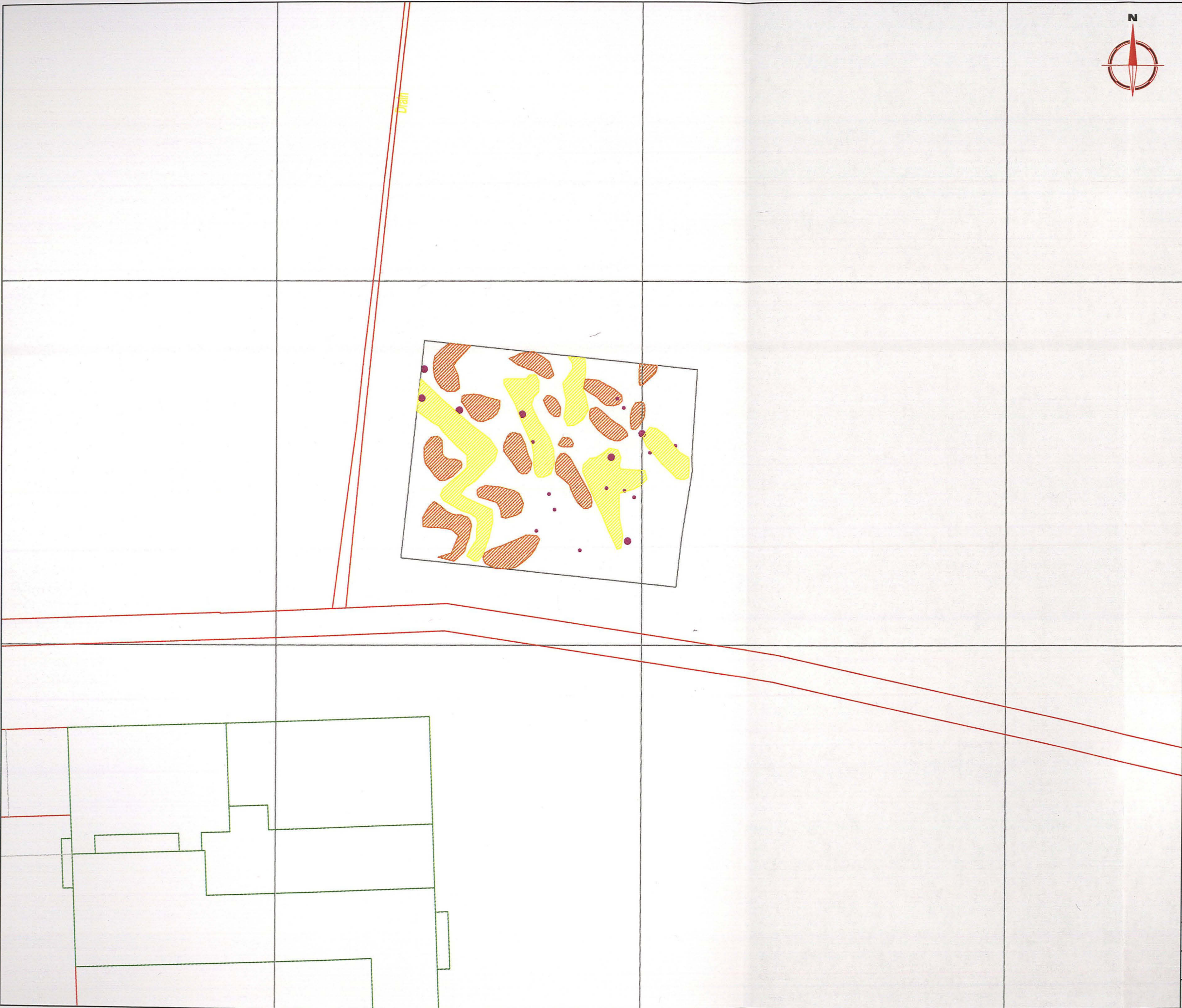
Project Title Job No. 2305
GEOPHYSICAL SURVEY - WYKEHAM, SPALDING

Subject
PLOT OF PROCESSED GRADIOMETER DATA




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Scale 1:1000 0m 10 20 30 40 50

Plot A3	Checked by SAS	Issue No. 01
Survey date FEB 07	Drawn by RAJS	Figure No. 06



Amendments		
Issue No.	Date	Description
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-	-	-

KEY	
	Positive anomaly with associated negative response - ferrous object
	Positive area anomaly- geological origin
	Negative area anomaly- geological origin

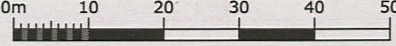
Client
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Project Title Job No. 2307
GEOPHYSICAL SURVEY - WYKEHAM, SPALDING

Subject
ABSTRACTION AND INTERPRETATION OF GRADIOMETER ANOMALIES

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Scale 1:1000 

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