STRATASCAN

Geophysical Survey Report

Proposed Community Centre
Barwell, Leicestershire

for

ULAS







May 2007

J2329

David Elks MSc. AIFA

REGISTERED ORGANISATION IFA

Geophysical Survey Summary Sheet

Job number: 2329
Location: Barwell, Leicestershire
Client: ULAS

Job name: Proposed Community Centre, Barwell
OS ref: SP 444 966

Site description:
The survey area is 1.5 ha of flat grass used as a recreation ground. The proposed development area lies outside the medieval village core of Barwell. However, evidence of medieval occupation has been found adjacent to the site. Other investigations have also identified prehistoric, Roman and post medieval deposits within the town. Minimal disturbance to the site suggests that the potential for observing archaeological features is considered high.

Geology/pedology:
The underlying geology is Triassic mudstone. The overlying soils are of the Beccles 3 soil association which are typical stagnogley soils. These consist of fine loamy over clayey soils with some calcareous clayey soils.

Current land use: Recreation ground

Technique: Detailed magnetic survey
Instrument: Bartington Grad601-2
Sample interval: 0.25m

Survey area: 1.5ha

Traverse interval: 1m

Summary of results:
The site appears to contain widespread areas of magnetic interference which are probably modern in date and reflect the land use as a local recreation ground. Two linear responses are observed in the northern corner of the site which may be associated with cut features, though these are difficult to interpret given the strength of the surrounding encroaching responses.

It is possible that the strong magnetic amplitudes encountered across the site may mask weaker responses from archaeological targets if such features are present.

Survey Date: April 2007

Report date: May 2007

Field Team Leader: Richard Fleming

Field Assistant: John Cook BSc.

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1 INTRODUCTION 3
1.1 Background synopsis 3
1.2 Site location 3
1.3 Description of site 3
1.4 Site history and archaeological potential 3
1.5 Survey objectives 3
1.6 Survey methods 3
2 METHODOLOGY 3
2.1 Standards and Guidance 3
2.2 Date of fieldwork 4
2.3 Grid locations 4
2.4 Survey equipment 4
2.5 Sampling interval, depth of scan, resolution and data capture 4
2.5.1 Sampling interval 4
2.5.2 Depth of scan and resolution 4
2.5.3 Data capture 4
2.6 Processing, presentation of results and interpretation 5
2.6.1 Processing 5
2.6.2 Presentation of results and interpretation 5
3 RESULTS 6
4 CONCLUSION 6
APPENDIX A – Basic principles of magnetic survey 7
APPENDIX B – Glossary of magnetic anomalies 8

LIST OF FIGURES

Figure 1	1:25 000	General location plan
Figure 2	1:1000	Site plan showing location of grids and referencing
Figure 3	1:1000	Plot of raw gradiometer data
Figure 4	1:1000	Trace plot of gradiometer data showing negative values
Figure 5	1:1000	Trace plot of gradiometer data showing positive values
Figure 6	1:1000	Plot of processed gradiometer data
Figure 7	1:1000	Abstraction and interpretation of gradiometer anomalies

1 INTRODUCTION

1.1 Background synopsis

Stratascan were commissioned by the University of Leicester Archaeological Services to undertake a geophysical survey of an area outlined for development in to a community centre.

1.2 Site location

The site is located at Barwell, Leicestershire at OS ref. SP 444 966.

1.3 Description of site

The survey area is 1.5 ha of flat grass used as a recreation ground. The underlying geology is Triassic mudstone (British Geological Survey South Sheet, Fourth Edition Solid, 2001). The overlying soils are of the Beccles 3 soil association which are typical stagnogley soils. These consist of fine loamy over clayey soils with some calcareous clayey soils (Soil Survey of England and Wales, Sheet 3 Midland and Western England).

1.4 Site history and archaeological potential (Bocock, 2006)

The proposed development area lies outside the medieval village core of Barwell. However, evidence of medieval occupation has been found adjacent to the site. Other investigations have also identified prehistoric, Roman and post medieval deposits within the town. Minimal disturbance to the site suggests that the potential for observing archaeological features is considered high.

1.5 Survey objectives

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

1.6 Survey methods

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

2 METHODOLOGY

2.1 Standards and Guidance

All site work and reporting has been carried out in accordance with English Heritage Research and Professional Services Guideline No.1: Geophysical Survey in Archaeological Field Evaluation, 1995.

Stratascan Limited is a Registered Archaeological Organisation and as such is committed to upholding the standards and policies set out by the Institute of Field Archaeologists.

2.2 Date of fieldwork

The fieldwork was carried out on a single day, 30th April 2007. Weather conditions during the survey were bright and warm. It should be pointed out that for magnetic surveys most weather conditions do not effect the capability of the instruments used nor the quality of the data recorded.

2.3 Grid locations

The location of the survey grids have 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.

2.4 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 giving a strong response to deep anomalies.

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

2.5.1 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.

2.5.2 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.

2.5.3 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 job, data is transferred to the office for processing and presentation.

2.6 Processing, presentation of results and interpretation

2.6.1 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:

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

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 = on

2.6.2 Presentation of results and interpretation

The presentation of the data for each site involves:

- A print-out of the raw data as grey scale (Figure 3), this viewing of the data allows comparison with the processed data showing the effect of processing steps.
- Trace plots (Figure 4 & 5), show the relative magnitude of data measurements which is important for interpretation.
- A print out of the processed data as grey scale (Figure 6), shows a 'clean' image of the data after artefacts of the data collection process have been removed.
- Magnetic anomalies have been identified and plotted onto the 'Abstraction and Interpretation of Anomalies' drawing for the site (Figure 7), showing the interpretation of the data. Often very weak anomalies revealing fine detail can be extracted by an experienced professional that may otherwise be overlooked.

3 RESULTS

The data are dominated by large areas of magnetic disturbance and debris across much of the site. This is the likely result of modern fencing and ferrous material respectively. It is possible that the strong magnetic amplitudes generated by these features may mask weaker responses from archaeological targets if such features are present. In the north corner of the site two weak positive linear responses are observed which may relate to cut features of archaeological origin. Being seen in isolation amongst far stronger responses they are difficult to interpret more accurately.

4 CONCLUSION

The site appears to contain widespread areas of modern magnetic interference which probably reflects the land use as a local recreation ground. Two linear responses may be associated with cut features although this is not certain given the strength of the surrounding encroaching anomalies.

5 REFERENCES

Bocock, S. 2006. *An Archaeological Desk Based Assessment for the Proposed New Community Centre, Barwell, Leicestershire,* Draft Report 2006-093, ULAS

British Geological Survey, 2001. *Geological Survey Ten Mile Map, South Sheet, Fourth Edition (Solid).* British Geological Society.

Soil Survey of England and Wales, 1983. *Soils of England and Wales, Sheet 3 Midland and Western England.*

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. Measuring the magnetic susceptibility of a soil can therefore give a measure of past human activity.

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.

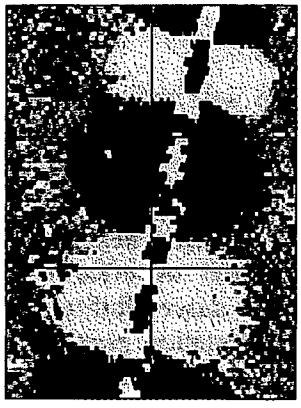
Silting and deliberate infilling of ditches and pits with magnetically enhanced soil creates a relative contrast against the much lower levels of magnetism within the subsoil into which the feature is cut. Systematic mapping of magnetic anomalies will produce linear and discrete areas of enhancement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

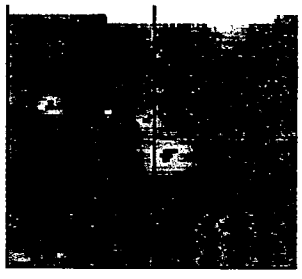
APPENDIX B – Glossary of magnetic anomalies

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

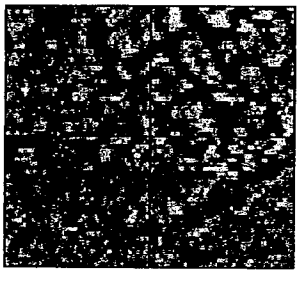


This consists of a single positive anomaly with an associated negative response. There should be no separation between the two polarities of response. These responses will be created by a single feature. The interpretation of the anomaly will depend on the magnitude of the magnetic measurements. A very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

Positive anomaly with associated negative response

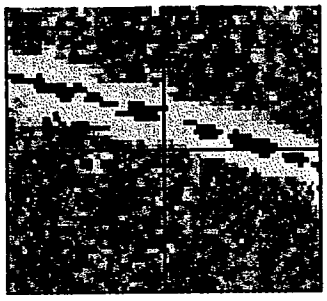
See bipolar and dipolar.

Positive linear



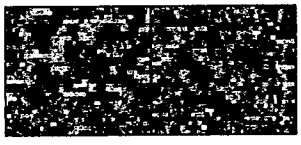
A linear response which is entirely positive in polarity. These are usually related to infilled cut features where the fill material is magnetically enhanced compared to the surrounding matrix. They can be caused by ditches of an archaeological origin, but also former field boundaries, ploughing activity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

Positive linear anomaly with associated negative response



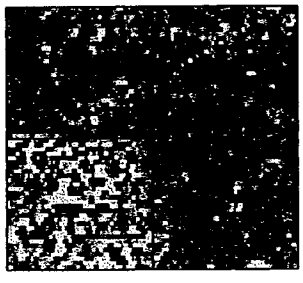
A positive linear anomaly which has a negative anomaly located adjacently. This will be caused by a single feature. In the example shown this is likely to be a single length of wire/cable probably relating to a modern service. Magnetically weaker responses may relate to earthwork style features and field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

Positive point/area



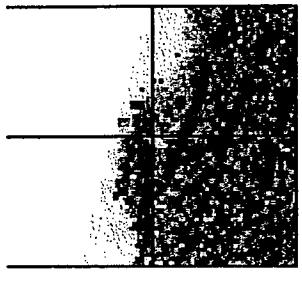
These are generally spatially small responses, perhaps covering just 3 or 4 reading nodes. They are entirely positive in polarity. Similar to positive linear anomalies they are generally caused by infilled cut features. These include pits of an archaeological origin, possible tree bowls or other naturally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

Magnetic debris



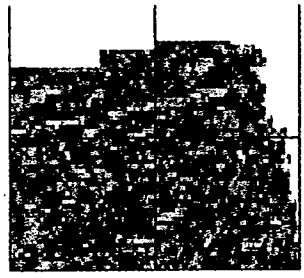
Magnetic debris consists of numerous dipolar responses spread over an area. If the amplitude of response is low (+/-3nT) then the origin is likely to represent general ground disturbance with no clear cause, it may be related to something as simple as an area of dug or mixed earth. A stronger anomaly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

Negative linear

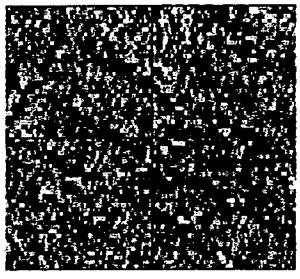


A linear response which is entirely negative in polarity. These are generally caused by earthen banks where material with a lower magnetic magnitude relative the background top soil is built up. See also ploughing activity.

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

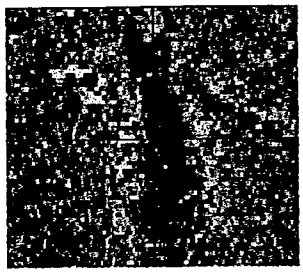
The amplitude of a magnetic response is an important factor in assigning an interpretation to a particular anomaly. For example a positive anomaly covering a $10m^2$ area may have values up to around 3000nT, in which case it is likely to be caused by modern magnetic interference. However, the same size 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).

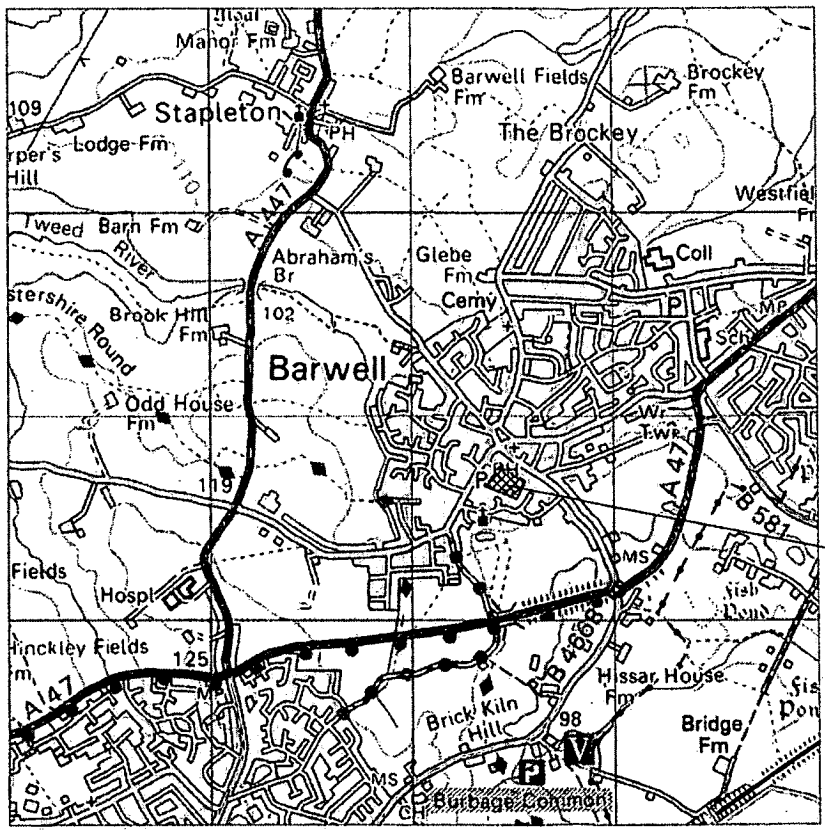
Weak background variations

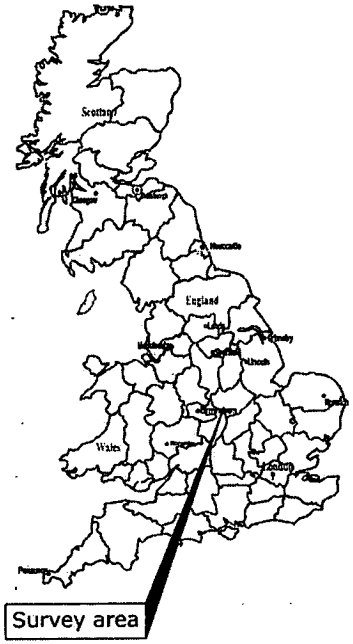


Weakly magnetic wide scale variations within the data can sometimes be seen within sites. These usually have no specific structure but can often appear curvy and sinuous in form. They are likely to be the result of natural features, such as soil creep, dried up (or seasonal) streams. They can also be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





Amendments

Issue No.	Date	Description

Site centred on NGR: SP 444 966

Client: ULAS

Project Title: GEOPHYSICAL SURVEY - PROPOSED COMMUNITY CENTRE, BARWELL

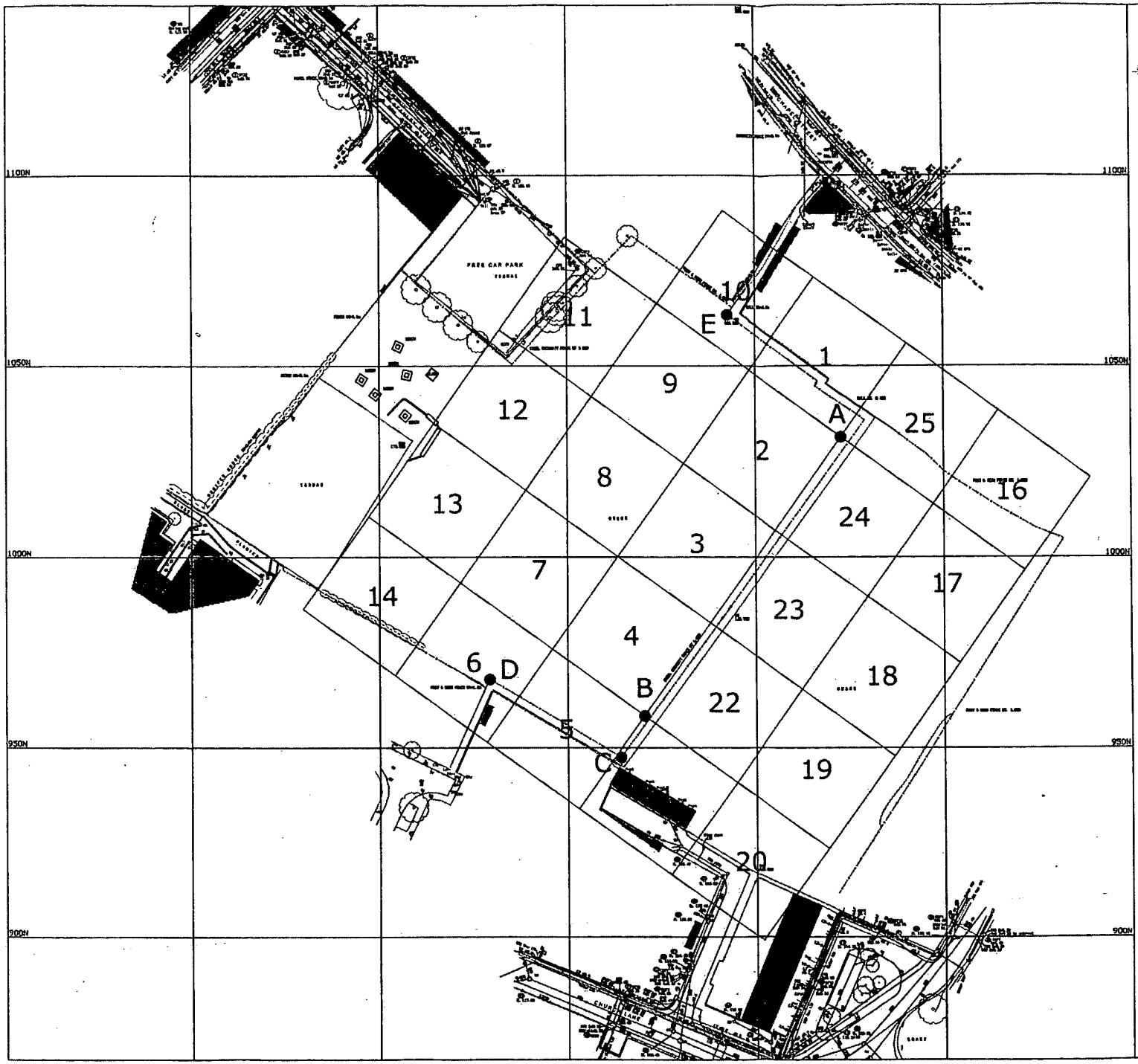
Job No. 2329

Subject: LOCATION PLAN OF SURVEY AREA

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Scale: 1:25 000 (0m 500 1000m)

Plot	Checked by	Issue No.
A3	SAS	01
Survey date	Drawn by	Figure No.
APR 07	DGE	01



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

REFERENCING INFORMATION

A-B	90m	A-C	102.45m	A-D	113.08m
A-E	43.99m	B-C	12.50m	B-D	42.16m
B-E	107.42m				

A-B	Base line
C,D,E	Referencing points
2	Grid number

Client

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Project Title — Job No. 2329

GEOPHYSICAL SURVEY - PROPOSED COMMUNITY CENTRE, BARWELL

Subject

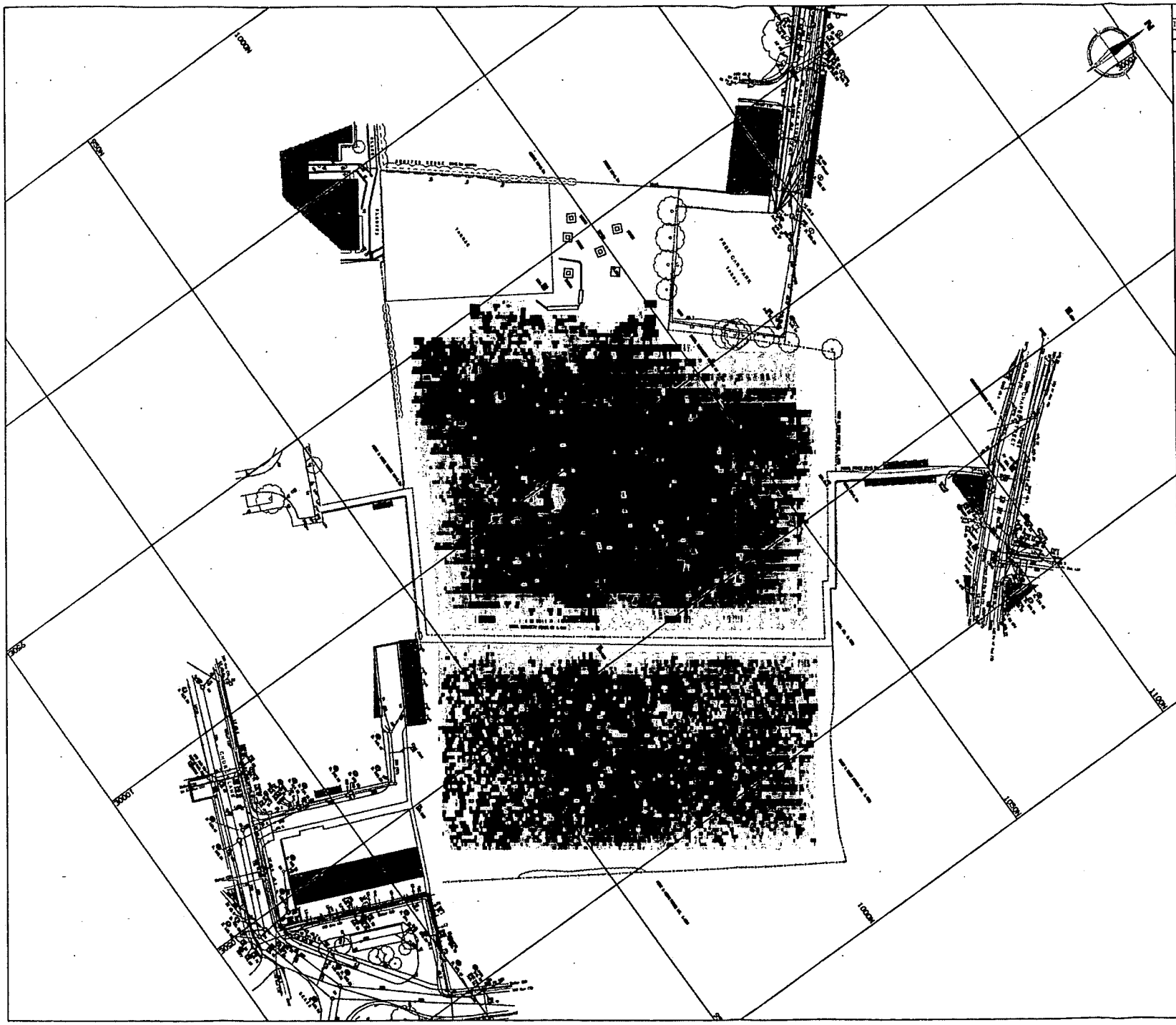
SITE PLAN SHOWING LOCATION OF SURVEY GRIDS AND REFERENCING

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Scale 1:1000 — 0m 10 20 30 40 50

Plot	Checked by	Issue No.
A3	SAS	01
Survey date	Drawn by	Figure No.
APR 07	DGE	02



Amendments		
Issue No.	Date	Description
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-	-	-

Plotting parameters

Maximum +5nT (black)
Minimum -5nT (white)

-3SD +3SD

+2nT

-2nT

Client

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Project Title Job No. 2329

GEOPHYSICAL SURVEY - PROPOSED COMMUNITY CENTRE, BARWELL

Subject

PLOT OF RAW GRADIOMETER DATA

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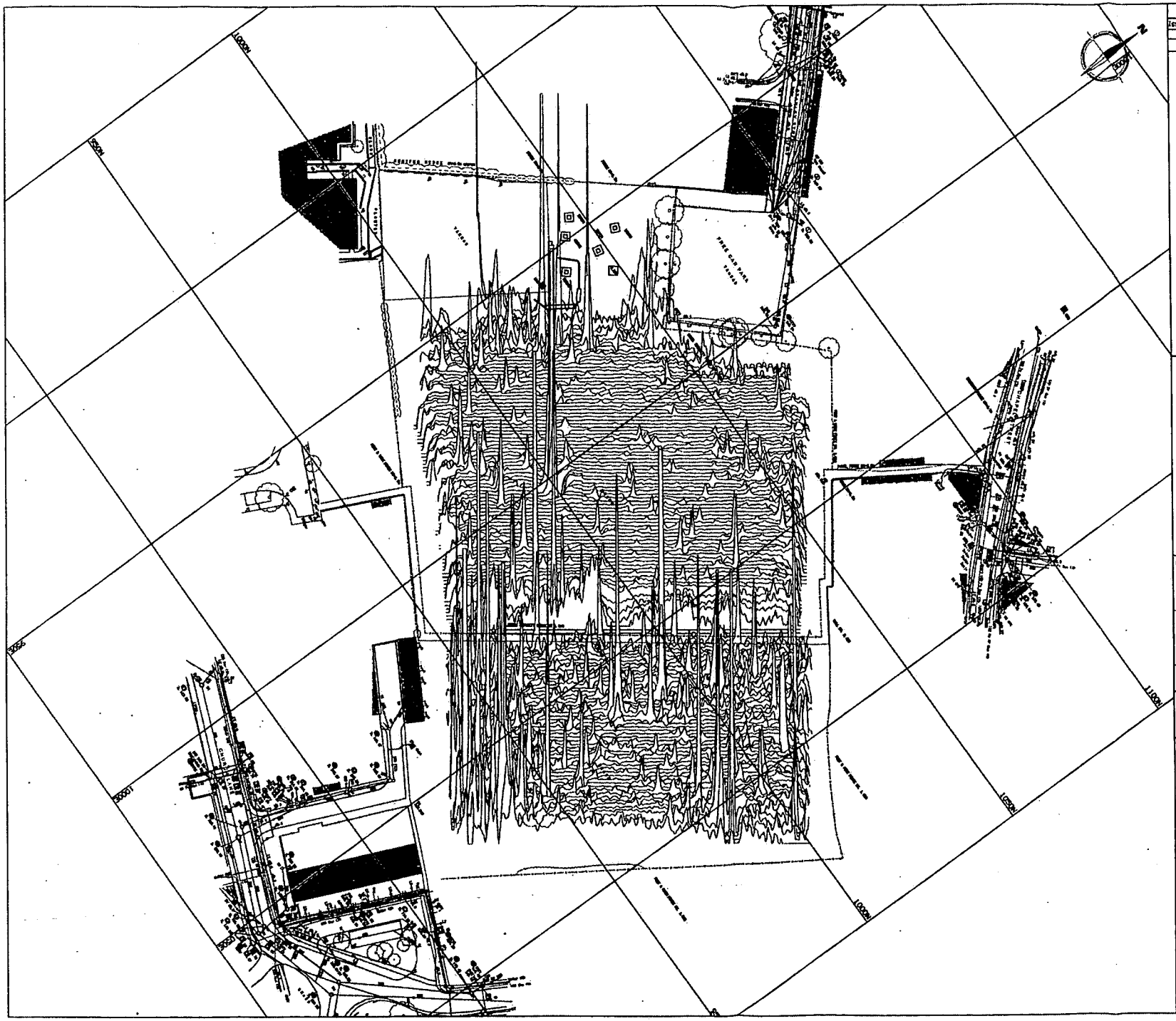
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Survey date	Drawn by	Figure No.
APR 07	DGE	03



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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GEOPHYSICAL SURVEY - PROPOSED COMMUNITY CENTRE, BARWELL

Subject

TRACE PLOT OF GRADIOMETER DATA SHOWING POSITIVE VALUES

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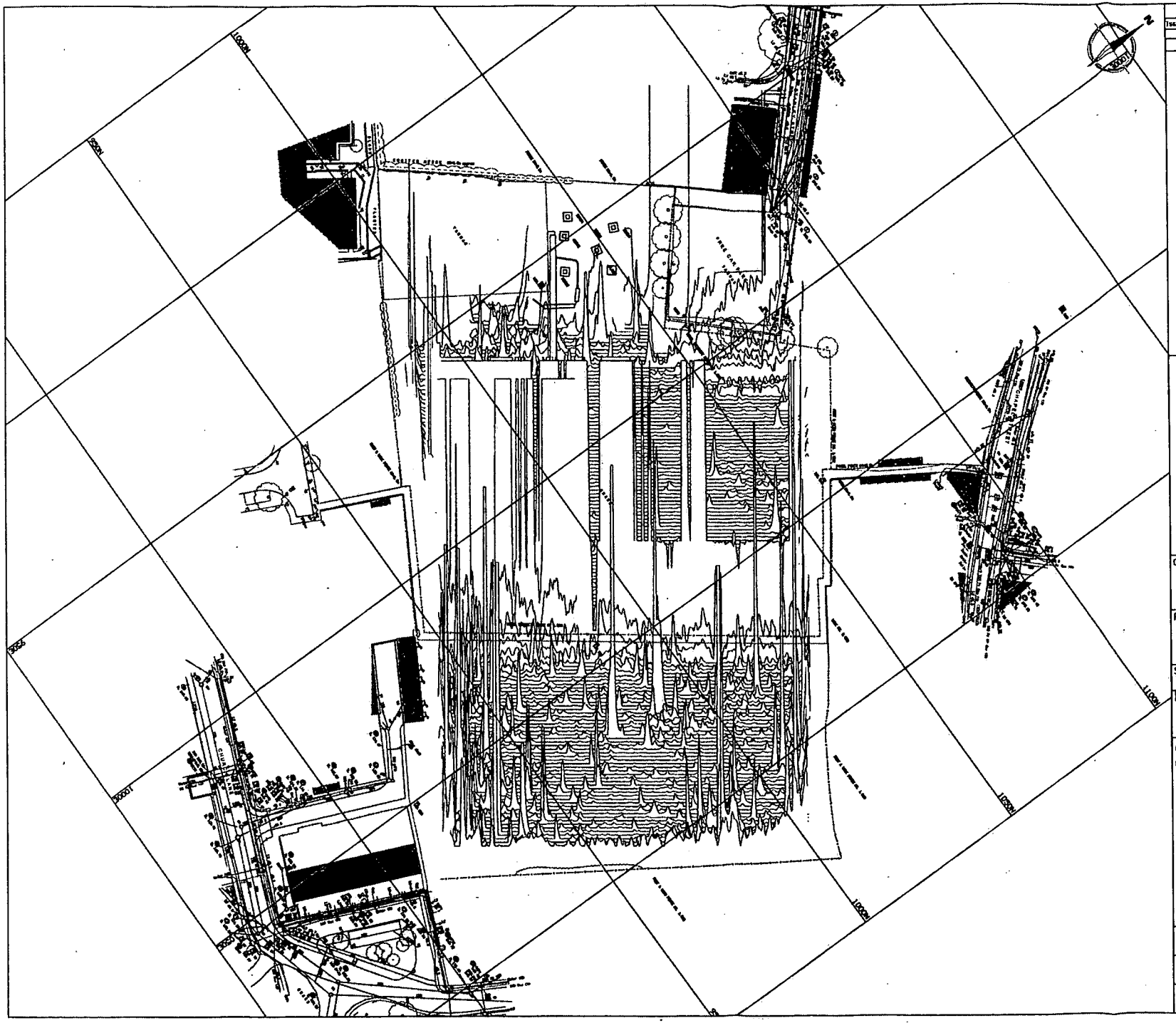
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Scale 1:1000 — 0m 10 20 30 40 50

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A3	SAS	01
Survey date	Drawn by	Figure No.
APR07	DGE	04



Amendments		
Issue No.	Date	Description
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-	-	-

Plotting parameters

-40nT

(*Negative values displace above the trace line. Hidden values have not been plotted*)

-200nT
-160nT
-120nT
-80nT
-40nT
0nT

Client

ULAS

Project Title — Job No. 2329

GEOPHYSICAL SURVEY - PROPOSED COMMUNITY CENTRE, BARWELL

Subject

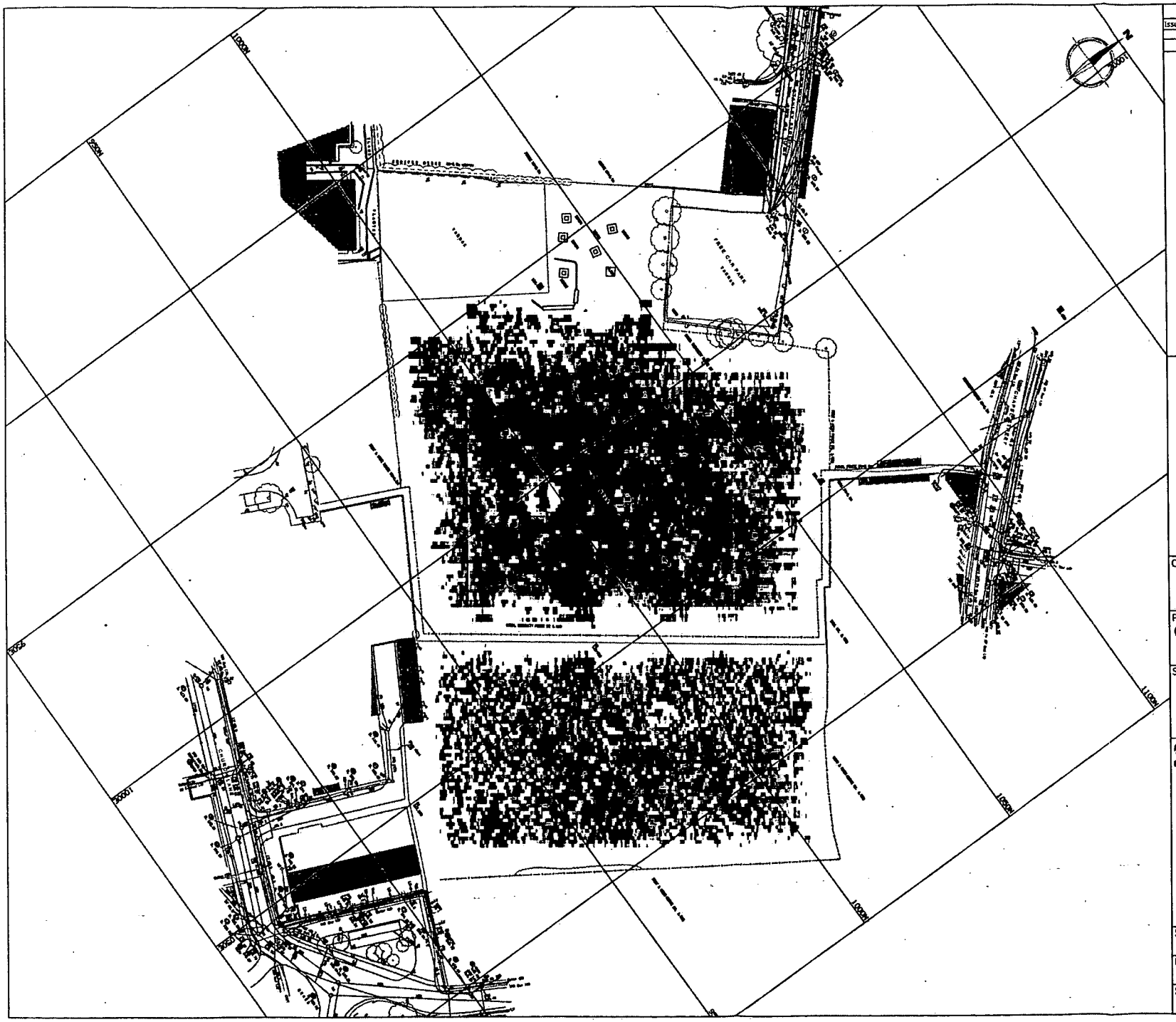
TRACE PLOT OF GRADIOMETER DATA SHOWING NEGATIVE VALUES

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REGISTERED ORGANISATION IFA

Scale 1:1000 — 0m 10 20 30 40 50

Plot	Checked by	Issue No.
A3	SAS	01
Survey date	Drawn by	Figure No.
APR 07	DGE	05



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

Plotting parameters

Maximum +2nT (black)
Minimum -2nT (white)

-3SD +3SD

+2nT

-2nT

Client

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Project Title Job No. 2329

GEOPHYSICAL SURVEY - PROPOSED COMMUNITY CENTRE, BARWELL

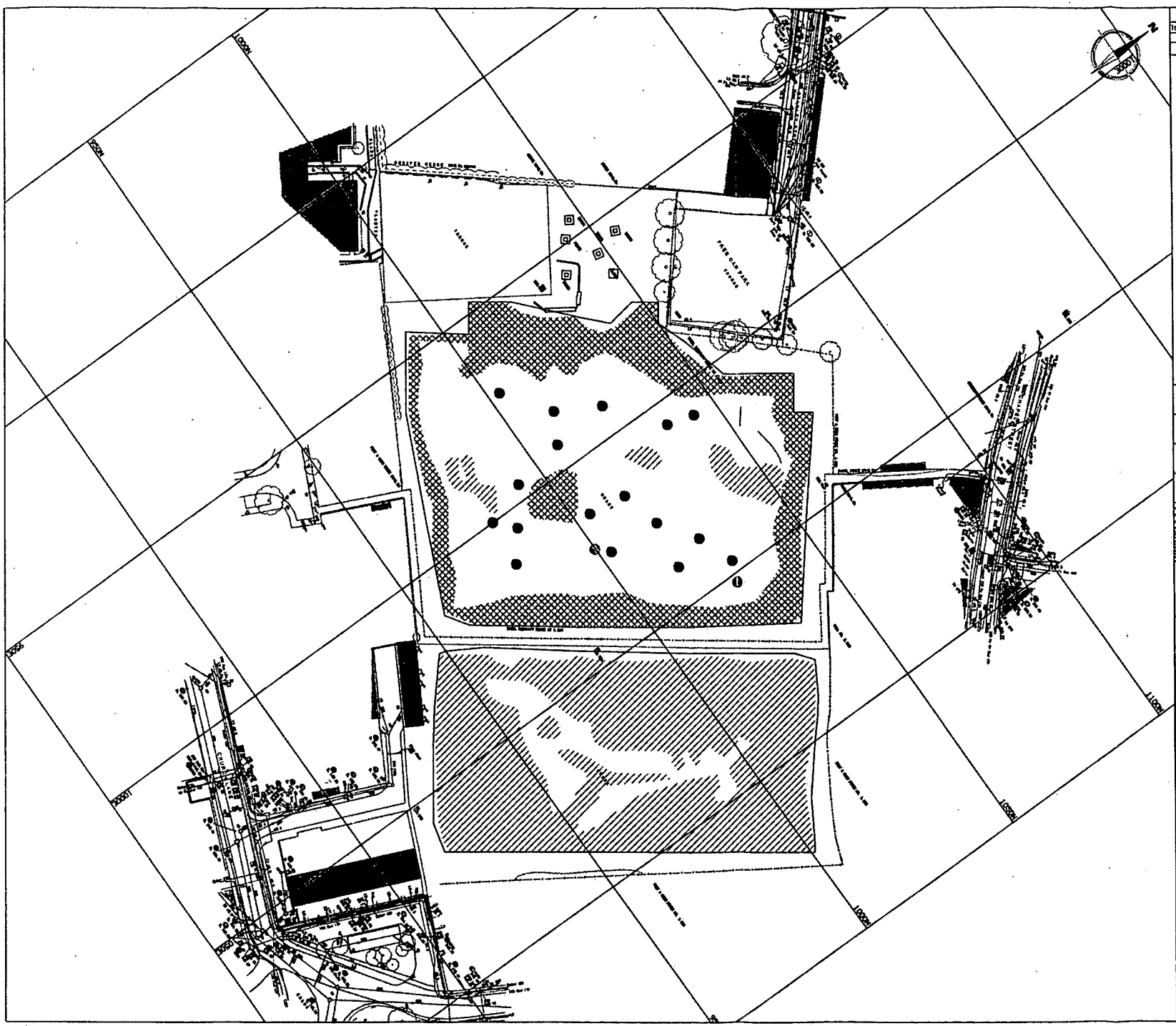
Subject

PLOT OF PROCESSED GRADIOMETER DATA

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Scale 1:1000 0m 10 20 30 40 50

Plot	Checked by	Issue No.
A3	SAS	01
Survey date	Drawn by	Figure No.
APR 07	DGE	06



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

KEY

	Positive linear anomaly - possible cut feature
	Strong discrete positive response with associated negative response - likely ferrous object
	Weak discrete positive response with associated negative response - unknown origin
	Magnetic debris - probably caused by scatter of ferrous objects
	Magnetic disturbance - probably caused by modern magnetic interference

Client

ULAS

Project Title — Job No. 2329

GEOPHYSICAL SURVEY - PROPOSED COMMUNITY CENTRE, BARWELL

Subject

ABSTRACTION AND INTERPRETATION OF GRADIOMETER ANOMALIES

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REGISTERED ORGANISATION IFA

Scale 1:1000 — 0m 10 20 30 40 50

Plot	Checked by	Issue No.
A3	SAS	01
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