

Geophysical Survey Report

TILE KILN FARM, STEVENAGE

for

CgMs CONSULTING LTD

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J2404

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Stratascan Job No: **J2404**

Techniques: **Detailed magnetic survey (gradiometry)**

National Grid Ref: **TL 259 278**



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1 SUMMARY OF RESULTS

The geophysical survey undertaken near Tile Kiln Farm, Stevenage has located a number of anomalies of possible archaeological origin. Positive area and linear anomalies indicate the presence of cut features such as ditches. Negative anomalies may be related to former earthworks or banks and discrete positive anomalies have been interpreted as pits of a possible archaeological origin.

2 INTRODUCTION

2.1 Background synopsis

Stratascan were commissioned by CgMs Consulting Ltd to undertake a geophysical survey of an area outlined for development.

2.2 Site location

The site is located near Tile Kiln Farm, Stevenage at OS ref. TL 259 278.

2.3 Description of site

The survey area consists of approximately 18ha of agricultural land used as both pasture and arable.

2.4 Geology and soils

The underlying geology is Chalk (British Geological Survey South Sheet, Fourth Edition Solid, 2001).

The overlying soils are known as Hornbeam 2 which are typical stagnogleyic paleo-argillic brown earths. These consist of deep fine loamy over clayey soils with slowly permeable subsoils and slight seasonal waterlogging (Soil Survey of England and Wales, Sheet 6 South East 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 nine days from 29th October 2007. Weather conditions during the survey were varied.

3.2 Grid locations

The location of the survey grids is based on the Ordnance Survey National Grid, see Figure 2. The referencing and alignment of grids was achieved using a Leica DGPS System 500.

A DGPS (differential 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. Calculations to correct for these errors are performed at an accurately located base station. The base station then transmits the corrections which are received by DGPS consoles giving sub metre accuracy averaging around 0.5m error.

3.3 Survey equipment

The magnetic survey was carried out using dual FM256 Fluxgate Gradiometers, manufactured by Geoscan Research and a dual sensor Grad601-2 Magnetic Gradiometer manufactured by Bartington Instruments Ltd. The FM256 gradiometers are suspended on a CF6 frame. One gradiometer acts as a master trigger that controls the second slave gradiometer. The instruments each consist of two fluxgates mounted 0.5m vertically apart, and 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 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.

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 and FM256 have 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 2) and trace plots (Figures 3 and 4), together with a greyscale plot of the processed data (Figure 5). Magnetic anomalies have been identified and plotted onto the 'Abstraction and Interpretation of Anomalies' drawing for the site (Figure 6).

4 RESULTS

4.1 Area 1

A number of positive area anomalies have been identified within Area 1. These anomalies indicate the presence of cut features such as ditches and may be of an archaeological origin. There is a particular concentration of these anomalies to the east of the path and a smaller concentration to the west of the path. Two parallel positive linear anomalies of a possible archaeological origin are also evident in the eastern limits of this survey area. A positive linear anomaly identified in the western limits of the survey area has been interpreted as being related to a former field boundary.

Discrete positive anomalies are evident across this survey area with the majority being located east of the path. These anomalies have been interpreted as pits of a possible archaeological origin.

An area of magnetic disturbance representing some form of ground disturbance has been observed in the eastern extents of this survey area.

Bipolar anomalies, indicating buried ferrous objects are evident across Area 1.

4.2 Area 2

Positive area and linear anomalies have been identified within Area 2. These are concentrated in the eastern and western limits of the survey area with a few anomalies spread between. These anomalies indicate cut features, such as ditches, of a possible archaeological origin.

Many of these positive anomalies have associated negative anomalies which may suggest the presence of bank and ditch arrangements. A positive linear anomaly identified in the southern limits of this survey area has been interpreted as a former field boundary.

4.3 Area 3

As with Areas 1 and 2, Area 3 has identified a large number of positive area anomalies representing cut features of a possible archaeological origin such as pits and ditches. Discrete positive anomalies indicating pits of a possible archaeological origin are also evident in this area.

4.4 Area 4

The data collected from Area 4 is dominated by the presence of magnetic disturbance related to made ground. There is also magnetic disturbance related to a pipe or cable in this area. This magnetic disturbance may mask subtle features of an archaeological origin.

4.5 Area 5

Area 5 is dominated by the presence of magnetic debris. The widespread nature of this debris may suggest that it is of a geological or pedological origin.

5 **CONCLUSION**

The geophysical survey undertaken over approximately 18ha of agricultural land near Tile Kiln Farm, Stevenage has identified a number of anomalies of possible archaeological origin.

Positive area anomalies are evident in all of the survey areas with the exception of Areas 4 and 5. Particular concentrations of these anomalies can be noted in the northern limits of Area 1 and the south western limits of Area 2 suggesting possible centres of activity. The large number of these cut features may suggest that some form of industrial or intrusive ground activity has taken place at some point in the past.

Discrete positive anomalies are evident in Areas 1 and 3. These anomalies have been interpreted as pits of a possible archaeological origin.

Magnetic variation has been identified in many of the survey areas. This may be due to geological or pedological variation within the survey area.

6 REFERENCES

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 6 Southeast 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.

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.

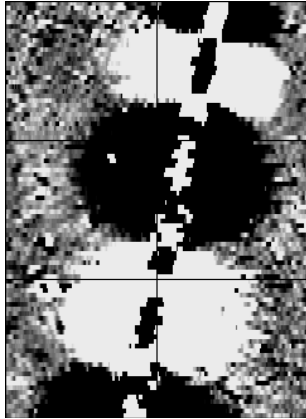
Silting and deliberate infilling of ditches and pits with magnetically enhanced soil creates a relative contrast against the much lower levels of magnetism within the subsoil into which the feature is cut. Systematic mapping of magnetic anomalies will produce linear and discrete areas of enhancement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

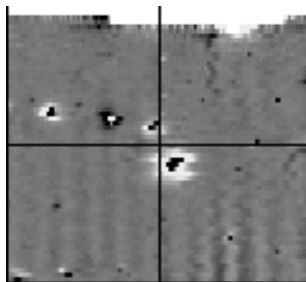
APPENDIX B – Glossary of magnetic anomalies

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

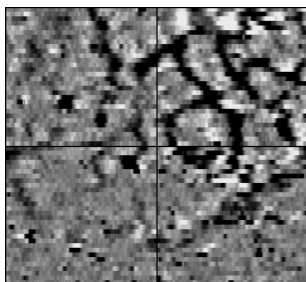


This consists of a single positive anomaly with an associated negative response. There should be no separation between the two polarities of response. These responses will be created by a single feature. The interpretation of the anomaly will depend on the magnitude of the magnetic measurements. A very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

Positive anomaly with associated negative response

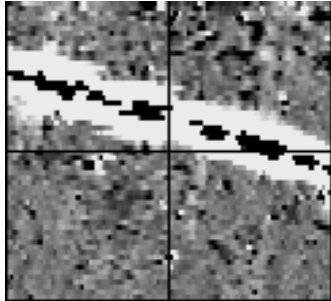
See bipolar and dipolar.

Positive linear



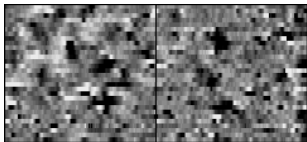
A linear response which is entirely positive in polarity. These are usually related to infilled cut features where the fill material is magnetically enhanced compared to the surrounding matrix. They can be caused by ditches of an archaeological origin, but also former field boundaries, ploughing activity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

Positive linear anomaly with associated negative response



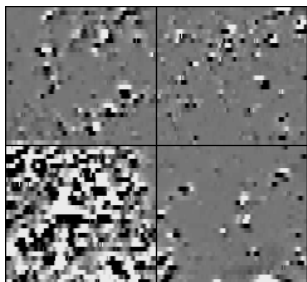
A positive linear anomaly which has a negative anomaly located adjacently. This will be caused by a single feature. In the example shown this is likely to be a single length of wire/cable probably relating to a modern service. Magnetically weaker responses may relate to earthwork style features and field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

Positive point/area



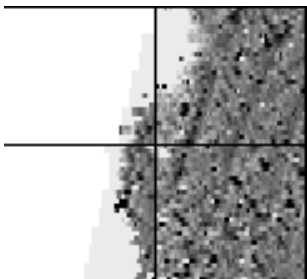
These are generally spatially small responses, perhaps covering just 3 or 4 reading nodes. They are entirely positive in polarity. Similar to positive linear anomalies they are generally caused by infilled cut features. These include pits of an archaeological origin, possible tree bowls or other naturally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

Magnetic debris



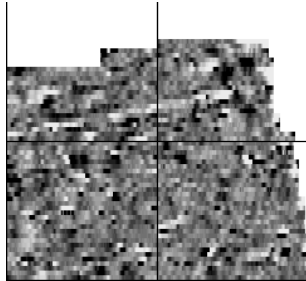
Magnetic debris consists of numerous dipolar responses spread over an area. If the amplitude of response is low ($\pm 3\text{nT}$) then the origin is likely to represent general ground disturbance with no clear cause, it may be related to something as simple as an area of dug or mixed earth. A stronger anomaly ($\pm 250\text{nT}$) 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

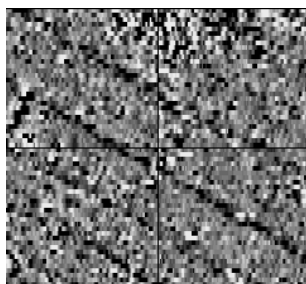


A linear response which is entirely negative in polarity. These are generally caused by earthen banks where material with a lower magnetic magnitude relative the background top soil is built up. See also ploughing activity.

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).

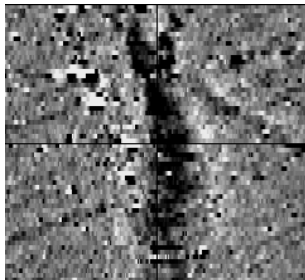
Strength of response

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 10m² 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.

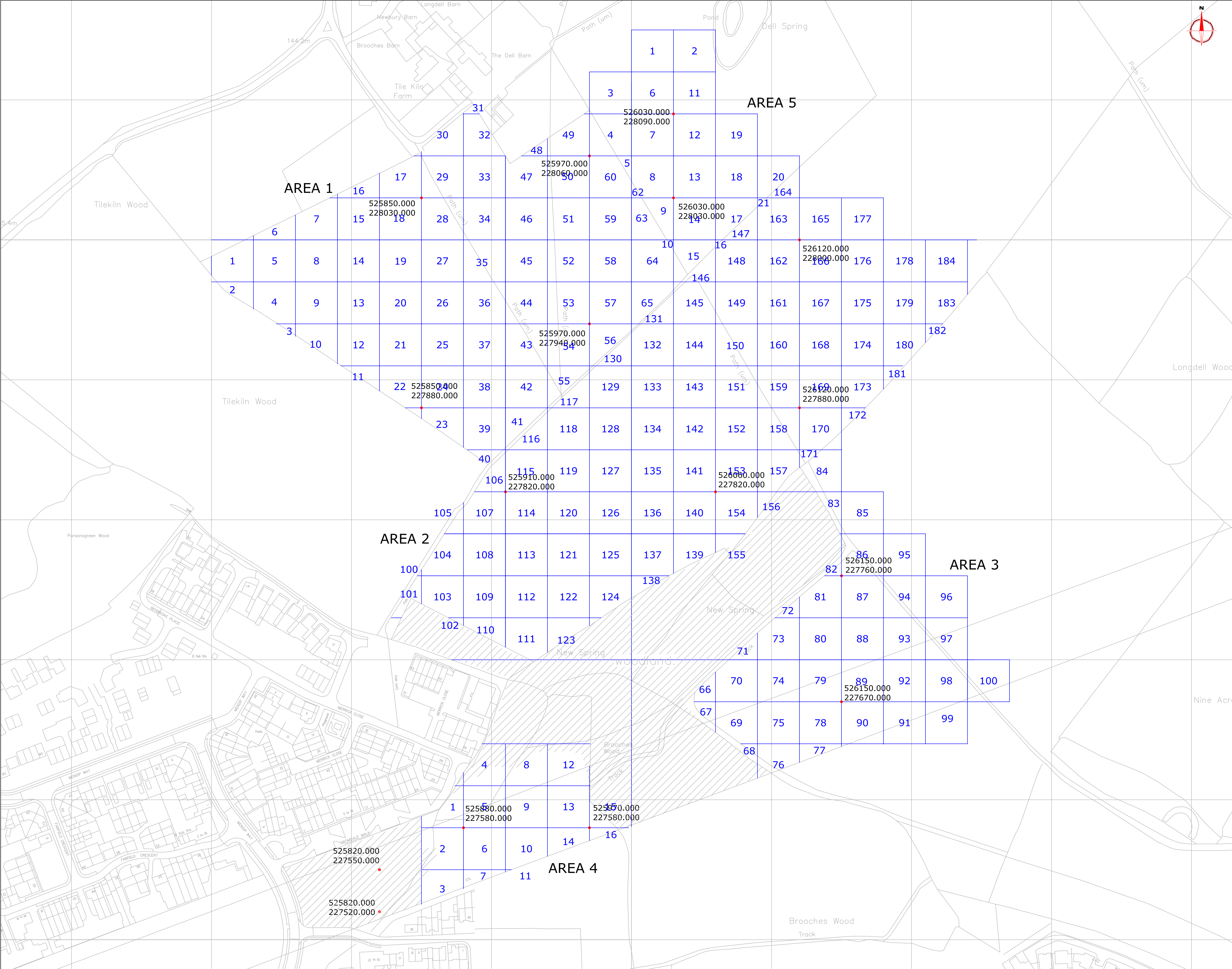
Thermoremnant response

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.



Amendments

Issue No.	Date	Description
-	-	-
-	-	-

Site centred on NGR TL 259 278

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526150.000 227670.000	OS grid reference		
33	Grid number		
☐	Survey grid		
Job No.	2404	Survey Date	NOV 2007
Client			
CgMs CONSULTING LTD			
Project Title			
GEOPHYSICAL SURVEY- TILE KILN FARM, STEVENAGE			
Subject			
SITE LOCATION AND SURVEY AREA			
STRATASCAN™ GEOPHYSICS FOR ARCHAEOLOGY AND ENGINEERING VINEYARD HOUSE UPPER HOOK ROAD UPTON UPON SEVERN UK WR8 0SA T: +44 (0)1684 592266 F: +44 (0)1684 594142 E: info@stratascan.co.uk www.stratascan.co.uk			
Scale	1:1250		
Plot	A1	Checked by	SAS
Date	NOV 07	Drawn by	RAJS
		Issue No.	01
		Figure No.	01



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

Plotting parameters

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

-3SD +3SD

+5nT
-5nT

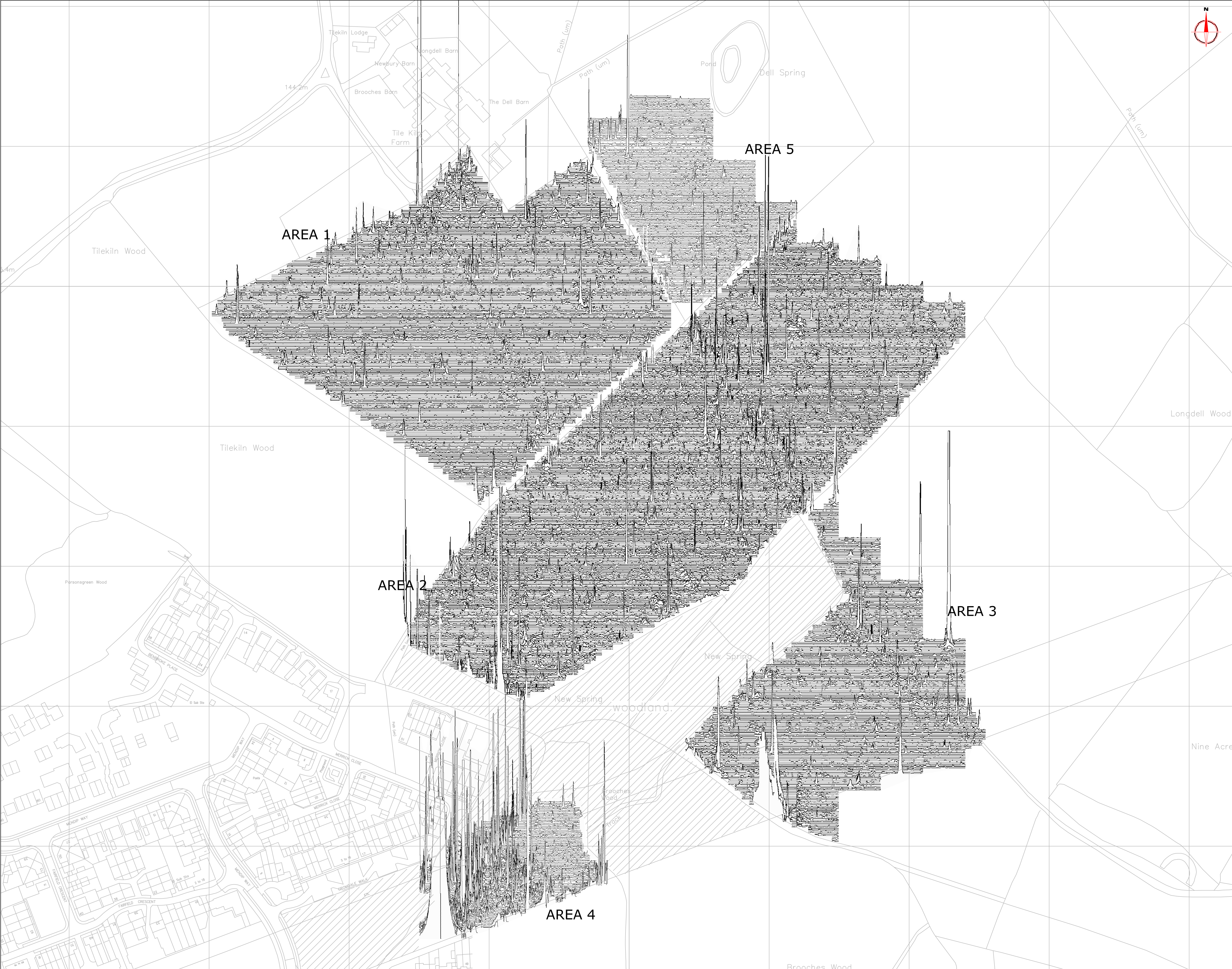
Job No.	2404	Survey Date	OCT 2007
Client			
CgMs CONSULTING LTD			
Project Title			
GEOPHYSICAL SURVEY- TILE KILN FARM, STEVENAGE			
Subject			
RAW GRADIOMETER DATA			

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0m 10 20 30 40 50 60 70 80m

Scale
1:1250

Plot	Checked by	Issue No.
A1	SAS	01
Date	Drawn by	Figure No.
NOV 07	RAJS	02



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

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

Job No. **2404** Survey Date **NOV 2007**

Client
CgMs CONSULTING LTD

Project Title
GEOPHYSICAL SURVEY- TILE KILN FARM, STEVENAGE

Subject
TRACE PLOT SHOWING POSITIVE VALUES

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Scale **1:1250**
0m 10 20 30 40 50 60 70 80m

Plot A1	Checked by SAS	Issue No. 01
Date NOV 07	Drawn by RAJS	Figure No. 03