GEOPHYSICAL SURVEY REPORT

# STRATASCAN™

SUMO Survey Services
SUMO Group Member

Project name:

**Land off Station Road, Lower Stondon, Bedfordshire**

Client:

**CgMs Consulting**

Job ref:

**J9711**

**May 2016**

# GEOPHYSICAL SURVEY REPORT

| | |
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| Survey date:<br>**19th April 2016** | Report date:<br>**May 2016** |
| Field team:<br>**Stephen Weston** BA (Hons)<br>**Jack Larner**<br>**Samuel Wood** | Project Manager:<br>**Simon Haddrell** BEng(Hons) AMBCS PCIfA |
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| CAD illustrations by:<br>**Rebecca Davies** BSc (Hons) | Site Director:<br>**Peter Barker** CEng MICE MCIWEM MCIfA FCInstCES |
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| **V1** 04/05/2016 | 05/05/2016 |


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# 1 SUMMARY OF RESULTS

A detailed gradiometry survey was carried out over approximately 2.4 hectares of grassland, currently used as horse paddocks. No features of archaeological origin were identified, despite the prehistoric remains revealed on the adjacent site to the east. Evidence of ridge and furrow cultivation indicates the site has an agricultural past. Former fence-lines have been detected, along with areas of magnetic disturbance associated with nearby ferrous objects, and magnetic spikes which are likely to be modern rubbish.

# 2 INTRODUCTION

## 2.1 Background synopsis

Stratascan were commissioned to undertake a geophysical survey of an area outlined for residential development. This survey forms part of an archaeological investigation being undertaken by CgMs Consulting.

## 2.2 Site Details

| | |
|---|---|
| **NGR / Postcode** | TL 160 345 / SG16 6JH |
| **Location** | The site is located to the south of Station Road, Lower Stondon, Bedfordshire. |
| **HER/SMR** | Bedfordshire |
| **District** | Central Bedfordshire |
| **Parish** | Stondon |
| **Topography** | Flat |
| **Current Land Use** | Horse paddocks |
| **Weather Conditions** | Dry, clear |
| **Soils** | The overlying soils are known as Hanslope, which are typical calcareous pelosols. These consist of slowly permeable, calcareous, clayey soils (Soil Survey of England and Wales, Sheet 4 Eastern England). |
| **Geology** | The underlying geology across the majority of the site comprises Gault Formation – mudstone. The geology across the west of the site is recorded as chalk of West Melbury Marly Chalk formation, while in the east the underlying geology comprises Woburn Sands Formation – sandstone. Superficial deposits of Lowestoft Formation – Diamicton are present across the site (British Geological Survey website). |

| | |
|---|---|
| **Archaeology** | Extract from *Land off Station Road, Lower Stondon, Bedfordshire – Archaeological Desk-Based Assessment (draft)* (CgMs Consulting, 2016):<br><br>*"The land adjacent to the north-east of the site, known as 'Land to the rear of Station Road', was subject to pre-application archaeological works, including Desk-Based Assessment (CgMs 2012), geophysical survey (Stratascan 2013) and trial trenching and open area excavation (Albion Archaeology 2013).*<br><br>*The fieldwork revealed two large boundary ditches, dating from the early/middle Iron Age, which formed part of two enclosures (Albion Archaeology 2013).*<br><br>*The HER data contains one record of Prehistoric activity on the study site; small irregular enclosures identified as cropmarks on an aerial photograph (HER 16793).*<br><br>*The possible enclosures recorded on the study site potentially relate to the two early to middle Iron Age enclosures which were excavated by Albion Archaeology in 2013, approximately c.30m east of the site (HER 19455; Figure 4). During these works, a smaller Iron Age ditch, which cut the boundary ditch of Enclosure A, two smaller ditches and three postholes within Enclosure A and Iron Age linear features, post-dating Enclosure A were also excavated (Albion Archaeology 2013).*<br><br>*The suggested route of the Roman Road (HER 10480) between Ickleford to Bedford is located approximately 420m north-east of the site.*<br><br>*Data obtained from the HER contains no records of Medieval activity on the study site, although evidence of ploughed out ridge and furrow was identified during the excavations on the adjacent site (HER 19583; Albion Archaeology 2013).* |
| **Survey Methods** | Detailed magnetic survey (gradiometry) |
| **Study Area** | c. 2.4ha |

### 2.3 Aims and objectives

To locate and characterise any anomalies of possible archaeological interest within the study area.

# 3 METHODS, PROCESSING & PRESENTATION

### 3.1 Standards & Guidance

This report and all fieldwork have been conducted in accordance with the latest guidance documents issued by Historic England (2008) and the Chartered Institute for Archaeologists (2002 & 2014).

Stratascan Ltd are a Registered Organisation with the CIfA and are committed to upholding its policies and standards.

### 3.2 Survey methods

Given that cropmarks of irregular shaped enclosures are recorded in the site on the HER, and that Iron Age enclosures have been identified immediately to the east, detailed magnetic survey was used as an efficient and effective method of locating archaeological anomalies.

More information regarding this technique is included in Appendix A.

### 3.3 Processing

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

1. *Destripe*
2. *Destagger*

### 3.4 Presentation of results and interpretation

The presentation of the data for each site involves a plot of the minimally processed data as a greyscale plot and a colour plot showing extreme magnetic values. Magnetic anomalies have been identified and plotted onto the 'Interpretation of Anomalies' drawing.

When interpreting the results several factors are taken into consideration, including the nature of archaeological features being investigated and the local conditions at the site (geology, pedology, topography etc.). Anomalies are categorised by their potential origin. Where responses can be related to very specific known features documented in other sources, this is done (for example: Abbey Wall, Roman Road). For the generic categories levels of confidence are indicated, for example: probable, or possible archaeology. The former is used for a confident interpretation, based on anomaly definition and/or other corroborative data such as cropmarks. Poor anomaly definition, a lack of clear patterns to the responses and an absence of other supporting data reduces confidence, hence the classification "possible".

# 4 RESULTS

The detailed magnetic gradiometer survey conducted at Lower Stondon has not identified any anomalies that have been characterised as being either of a *probable* or *possible* archaeological origin. The following numbered anomalies refers to numerical labels on the interpretation plots.

## *4.1 Probable Archaeology*

No probable archaeology has been identified within the survey area.

## *4.2 Possible Archaeology*

No possible archaeology has been identified within the survey area.

### 4.3 *Medieval/Post-Medieval Agriculture*

Evidence of ridge and furrow cultivation **[1]** has been identified in the north of the site, in the form of widely spaced, slightly curved, parallel linear anomalies.

### 4.4 *Other Anomalies*

A weak linear anomaly **[2]** in the south of the site and a series of magnetic spikes **[3]** are related to former fence-lines, both of which are visible on available aerial photographs, and the 2006 OS map. A similar linear feature **[4]** and magnetic spikes **[5]** in the north are likely to be related to a former fence-line but are not visible on available mapping or aerial photos. Areas of magnetic disturbance **[6]** are the result of nearby ferrous objects, such as fences. These effects can mask weaker archaeological anomalies. Smaller ferrous anomalies, or 'magnetic spikes' **[7]** indicate ferrous metal objects and are likely to be modern rubbish.

## 5 DATA APPRAISAL & CONFIDENCE ASSESSMENT

Underlying geologies of West Melbury Marly Chalk and Gault Formation mudstone can provide variable results for gradiometer survey, while Woburn Sands sandstone and superficial deposits of diamicton generally provide good results, as evidenced by the successful survey in the adjacent field (Stratascan, 2013). In this instance, the data across the site is fairly uniform in appearance, and there is no evidence of the known enclosure cropmarks (HER16793) within the survey area.

## 6 CONCLUSION

The survey at Lower Stondon has not identified any anomalies of archaeological origin, despite the potential for prehistoric remains and the known record of cropmark enclosures within the site. Evidence of ridge and furrow suggests that the site has been used for agricultural purposes since the medieval period. Former fence-lines, two of which are visible on available mapping and aerial photographs, have been identified, linking to its recent use as horse paddocks. The other features are also modern in origin and include areas of magnetic disturbance related to nearby ferrous objects, and magnetic spikes which are likely to be modern rubbish.

# 7 REFERENCES

Albion Archaeology, 2013. *Land to the rear of Station Road, Lower Stondon, Bedfordshire – Archaeological Trial Trench Evaluation and Open Area Excavation*

British Geological Survey, n.d., *website*: (http://www.bgs.ac.uk/opengeoscience/home.html?Accordion1=1#maps) Geology of Britain viewer. [Accessed 11/01/2015]

CgMs, 2012. *Heritage Assessment of Land at Lower Stondon (MD/14136)*

CgMs, 2016. *Land off Station Road, Lower Stondon, Bedfordshire – Archaeological Desk-Based Assessment*

Chartered Institute For Archaeologists. *Standard and Guidance for Archaeological Geophysical Survey. (*http://www.archaeologists.net/sites/default/files/CIfAS&GGeophysics_1.pdf)

English Heritage, 2008. *Geophysical Survey in Archaeological Field Evaluation.*

IfA 2002. The Use of Geophysical Techniques in Archaeological Evaluations, IFA Paper No 6, C. Gaffney, J. Gater and S. Ovenden. Institute for Archaeology, Reading

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

Stratascan, 2013. *Geophysical Survey Report – Lower Stondon, Bedfordshire (J3359)*

# Appendix A - Technical Information: Magnetometer Survey Method

**Grid Positioning**

For hand held gradiometers the location of the survey grids has been plotted together with the referencing information. Grids were set out using a Trimble R8 Real Time Kinematic (RTK) VRS Now GNSS GPS system.

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. This results in an accuracy of around 0.01m.

| Technique | Instrument | Traverse Interval | Sample Interval |
|---|---|---|---|
| Magnetometer | Bartington Grad 601-2 | 1m | 0.25m |

**Instrumentation: Bartington *Grad*601-2**

Bartington instruments operate in a gradiometer configuration which comprises fluxgate sensors mounted vertically, set 1.0m apart. The fluxgate gradiometer suppresses any diurnal or regional effects. The instruments are carried, or cart mounted, with the bottom sensor approximately 0.1-0.3m from the ground surface. At each survey station, the difference in the magnetic field between the two fluxgates is measured in nanoTesla (nT). The sensitivity of the instrument can be adjusted; for most archaeological surveys the most sensitive range (0.1nT) is used. Generally, features up to 1m deep may be detected by this method, though strongly magnetic objects may be visible at greater depths. The Bartington instrument can collect two lines of data per traverse with gradiometer units mounted laterally with a separation of 1.0m.

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.

**Data Processing**

| | |
|---|---|
| Zero Mean Traverse | This process sets the background mean of each traverse within each grid to zero. The operation removes striping effects and edge discontinuities over the whole of the data set. |
| Step Correction (Destagger) | When gradiometer data are collected in 'zig-zag' fashion, stepping errors can sometimes arise. These occur because of a slight difference in the speed of walking on the forward and reverse traverses. The result is a staggered effect in the data, which is particularly noticeable on linear anomalies. This process corrects these errors. |

**Display**

| | |
|---|---|
| Greyscale/ Colourscale Plot | This format divides a given range of readings into a set number of classes. Each class is represented by a specific shade of grey, the intensity increasing with value. All values above the given range are allocated the same shade (maximum intensity); similarly all values below the given range are represented by the minimum intensity shade. Similar plots can be produced in colour, either using a wide range of colours or by selecting two or three colours to represent positive and negative values. The assigned range (plotting levels) can be adjusted to emphasise different anomalies in the data-set. |

**Interpretation Categories**

In certain circumstances (usually when there is corroborative evidence from desk based or excavation data) very specific interpretations can be assigned to magnetic anomalies (for example, *Roman Road, Wall,* etc.) and where appropriate, such interpretations will be applied. The list below outlines the generic categories commonly used in the interpretation of the results.

| | |
|---|---|
| *Archaeology/Probable Archaeology* | This term is used when the form, nature and pattern of the response are clearly or very probably archaeological and /or if corroborative evidence is available. These anomalies, whilst considered anthropogenic, could be of any age. |
| *Possible Archaeology* | These anomalies exhibit either weak signal strength and / or poor definition, or form incomplete archaeological patterns, thereby reducing the level of confidence in the interpretation. Although the archaeological interpretation is favoured, they may be the result of variable soil depth, plough damage or even aliasing as a result of data collection orientation. |
| *Industrial / Burnt-Fired* | Strong magnetic anomalies that, due to their shape and form or the context in which they are found, suggest the presence of kilns, ovens, corn dryers, metal- working areas or hearths. It should be noted that in many instances modern ferrous material can produce similar magnetic anomalies. |
| *Former Field Boundary (probable & possible)* | Anomalies that correspond to former boundaries indicated on historic mapping, or which are clearly a continuation of existing land divisions. Possible denotes less confidence where the anomaly may not be shown on historic mapping but nevertheless the anomaly displays all the characteristics of a field boundary. |
| *Ridge & Furrow* | Parallel linear anomalies whose broad spacing suggests ridge and furrow cultivation. In some cases the response may be the result of more recent agricultural activity. |
| *Agriculture (ploughing)* | Parallel linear anomalies or trends with a narrower spacing, sometimes aligned with existing boundaries, indicating more recent cultivation regimes. |
| *Land Drain* | Weakly magnetic linear anomalies, quite often appearing in series forming parallel and herringbone patterns. Smaller drains will often lead and empty into larger diameter pipes and which in turn usually lead to local streams and ponds. These are indicative of clay fired land drains. |
| *Natural* | These responses form clear patterns in geographical zones where natural variations are known to produce significant magnetic distortions. |
| *Magnetic Disturbance* | Broad zones of strong dipolar anomalies, commonly found in places where modern ferrous or fired materials (e.g. brick rubble) are present. They are presumed to be modern. |
| *Service* | Magnetically strong anomalies usually forming linear features indicative of ferrous pipes/cables. Sometimes other materials (e.g. pvc) cause weaker magnetic responses and can be identified from their uniform linearity crossing large expanses. |
| *Ferrous* | This type of response is associated with ferrous material and may result from small items in the topsoil, larger buried objects such as pipes, or above ground features such as fence lines or pylons. Ferrous responses are usually regarded as modern. Individual burnt stones, fired bricks or igneous rocks can produce responses similar to ferrous material. |
| *Uncertain Origin* | Anomalies which stand out from the background magnetic variation, yet whose form and lack of patterning gives little clue as to their origin. Often the characteristics and distribution of the responses straddle the categories of *Possible Archaeology* and *Possible Natural* or (in the case of linear responses) *Possible Archaeology* and *Possible Agriculture*; occasionally they are simply of an unusual form. |

Where appropriate some anomalies will be further classified according to their form (positive or negative) and relative strength and coherence (trend: weak and poorly defined).

# Appendix B - Technical Information: Magnetic Theory

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. 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.

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.

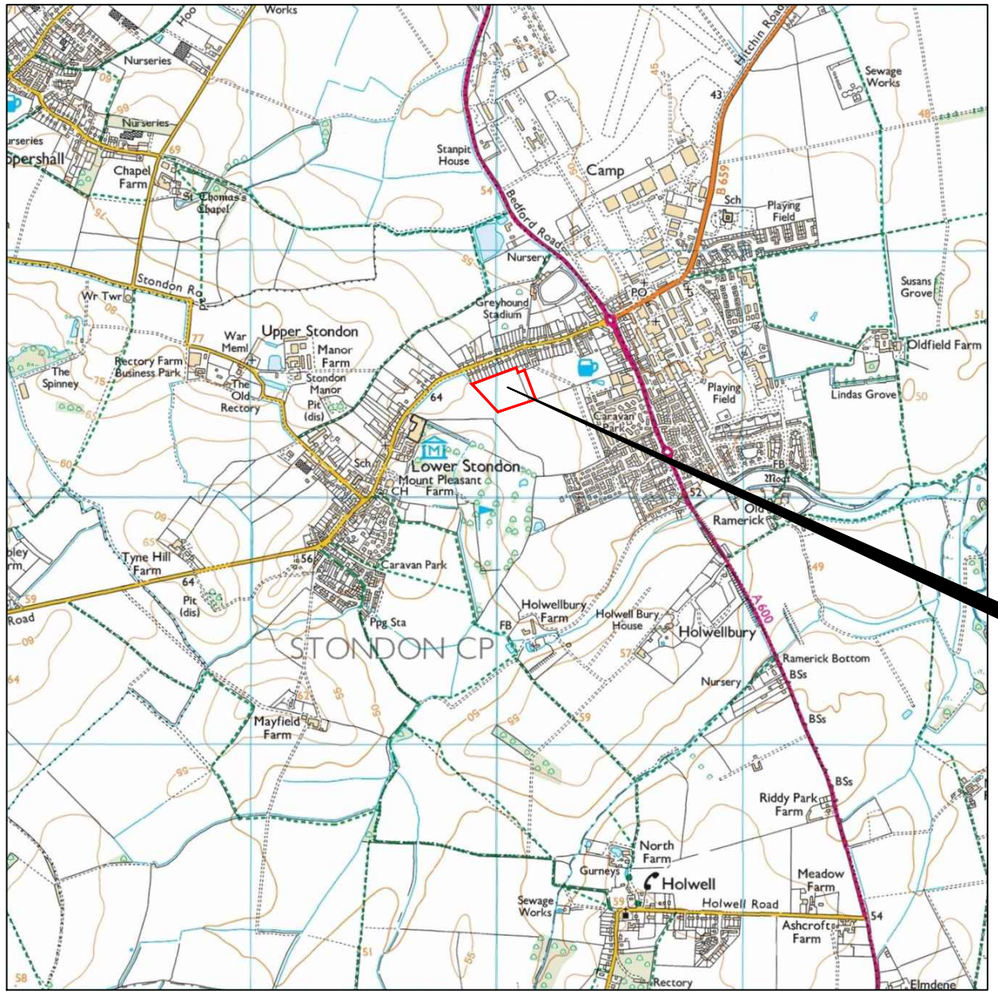
Silting and deliberate infilling of ditches and pits with magnetically enhanced soil creates a relative contrast against the much lower levels of magnetism within the subsoil into which the feature is cut. Systematic mapping of magnetic anomalies will produce linear and discrete areas of enhancement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

OS 100km square = TL

36
35
34
33
32




14 15 16 17 18

N

## Amendments

| Issue No. | Date | Description |
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| - | - | - |




Site centred on NGR: TL 160 345

Client: CgMs CONSULTING

Project Title: GEOPHYSICAL SURVEY - LOWER STONDON, BEDFORDSHIRE

Job No. 9711

Subject: LOCATION PLAN OF SURVEY AREA

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Scale: 1:25000 (0m 500 1000m)

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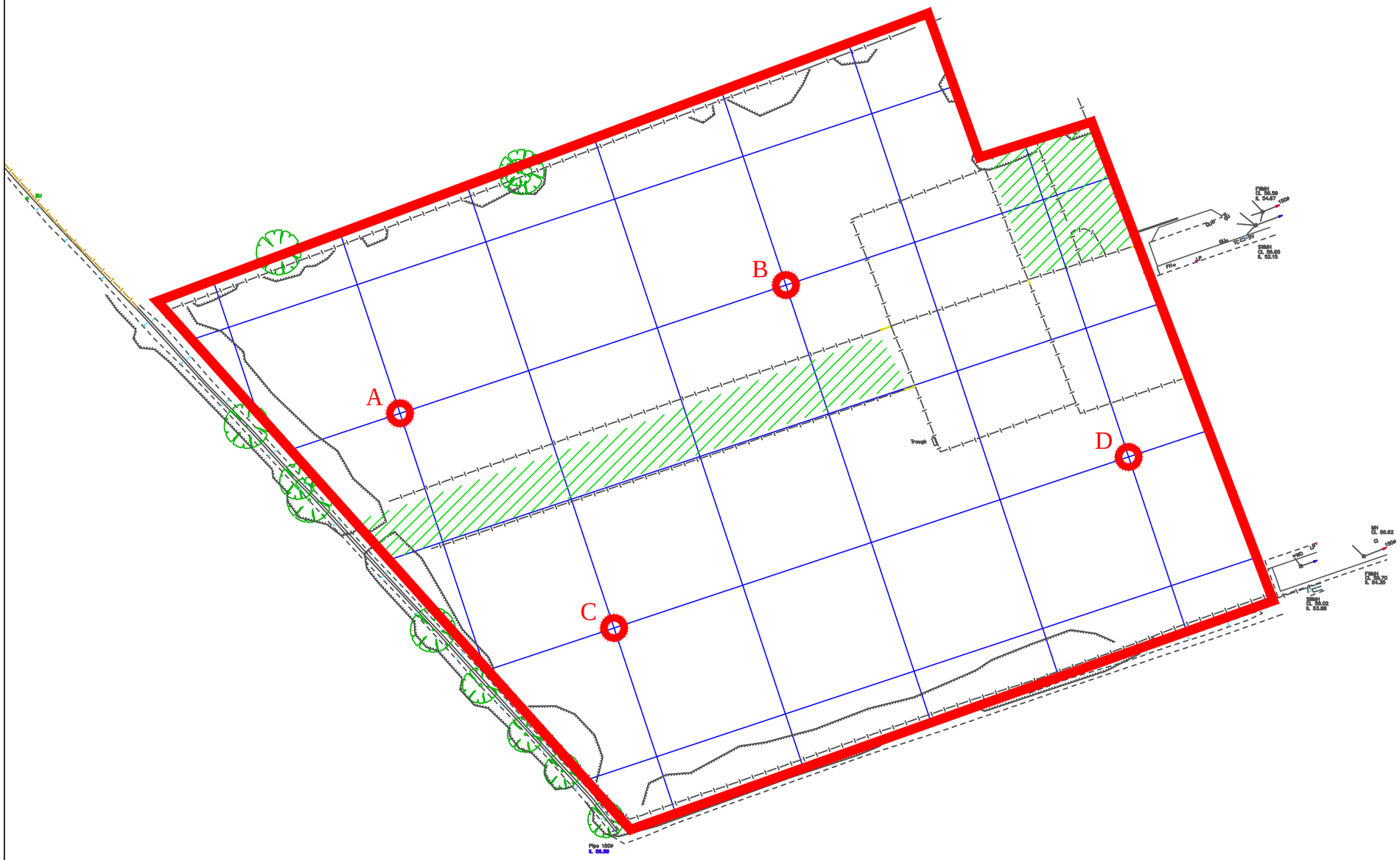


## Amendments

| Issue No. | Date | Description |
|---|---|---|
| - | - | - |
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Unsurveyable - horses/inaccessible

## OS GRID REFERENCES

| | |
|---|---|
| A | 515963.60, 235437.98 |
| B | 516049.02, 235466.35 |
| C | 516010.98, 235390.50 |
| D | 516124.87, 235428.32 |

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GEOPHYSICAL SURVEY - LOWER STONDON, BEDFORDSHIRE

Subject

LOCATION OF SURVEY GRIDS AND REFERENCING

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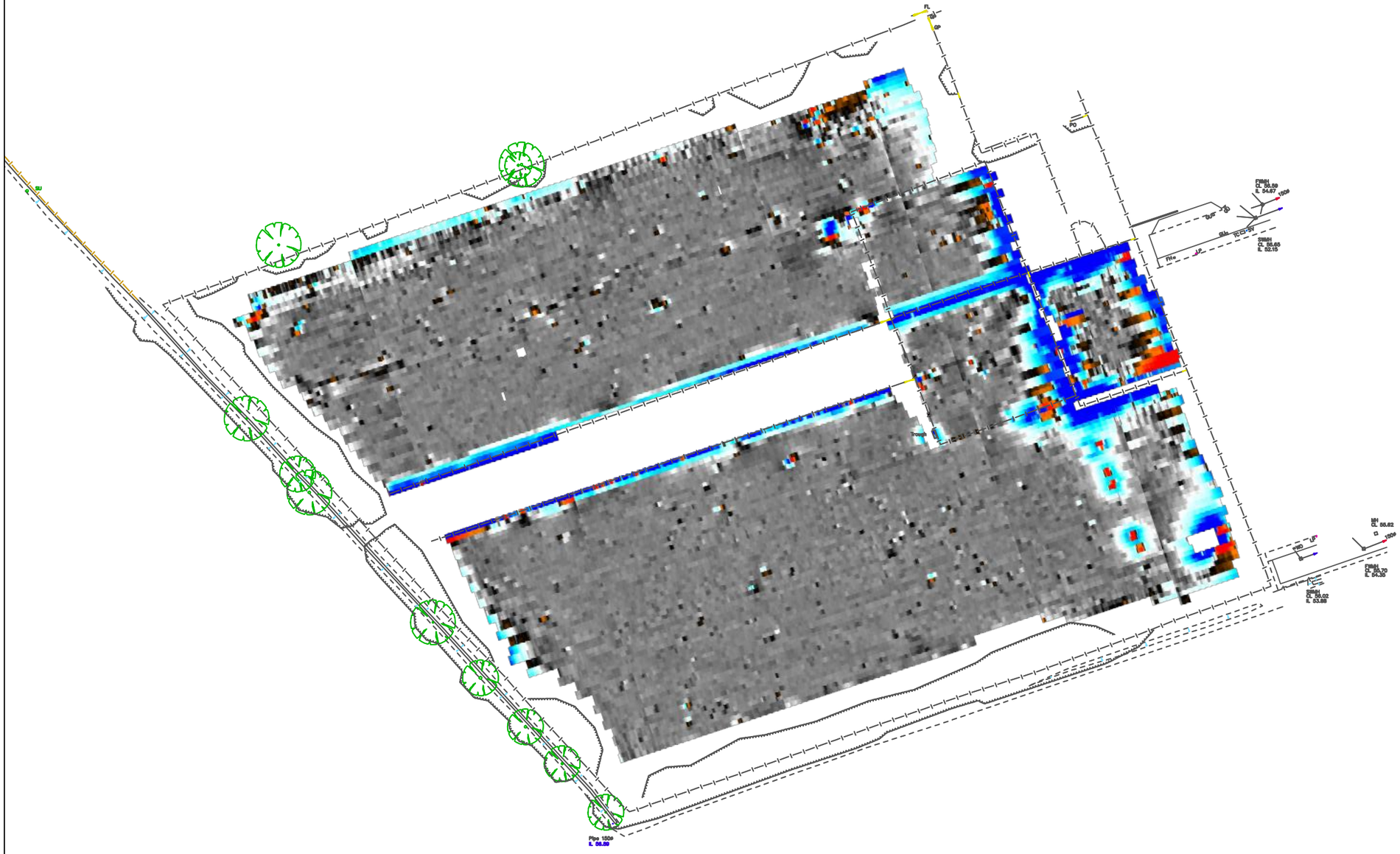


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Plotting parameters

Maximum +100nT (red)
Minimum -100nT (blue)

+100nT
+25nT
+3nT
-3nT
-25nT
-100nT

Client

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Project Title — Job No. 9711

GEOPHYSICAL SURVEY - LOWER STONDON, BEDFORDSHIRE

Subject

COLOUR PLOT OF GRADIOMETER DATA SHOWING EXTREME VALUES

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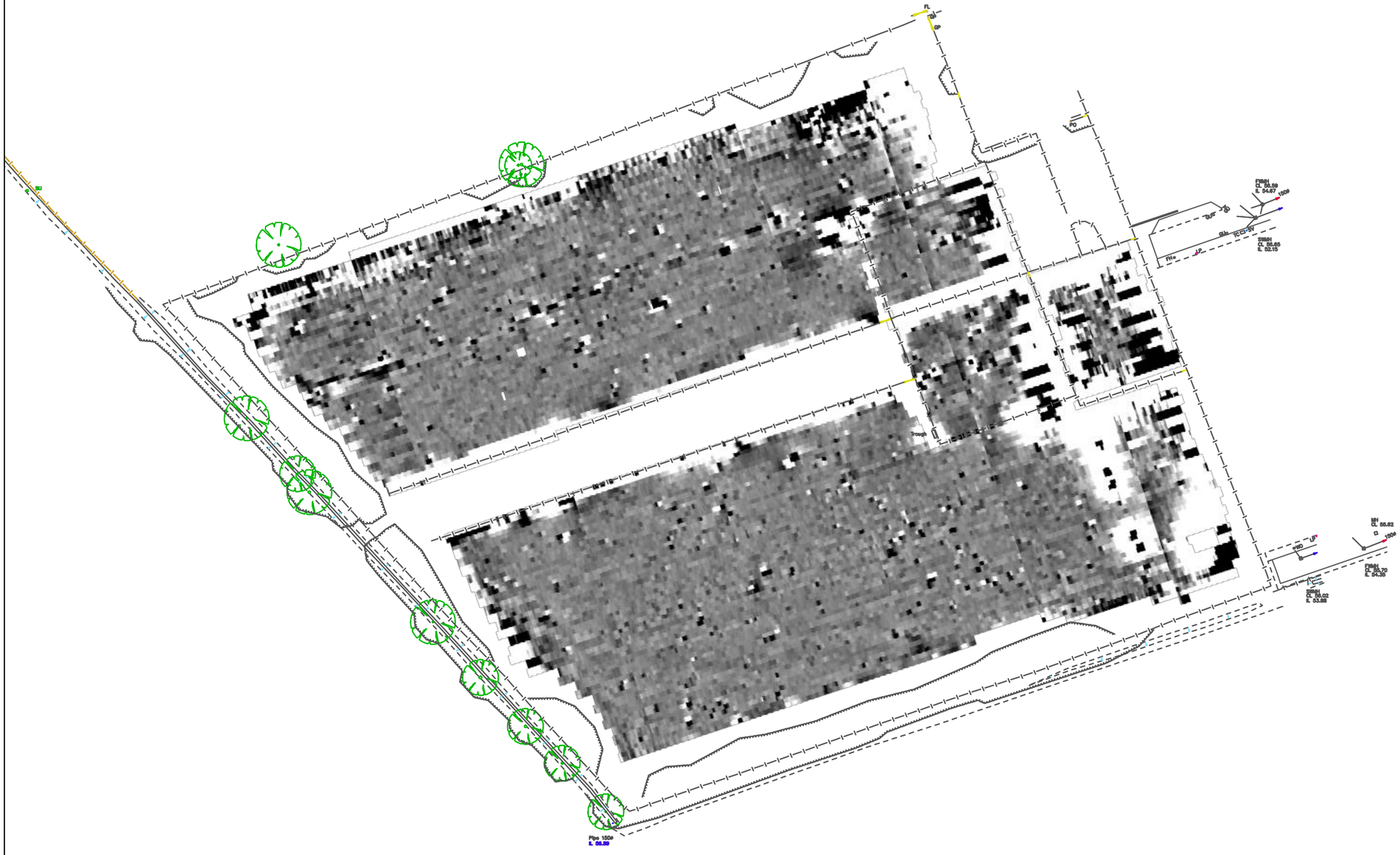


## Amendments

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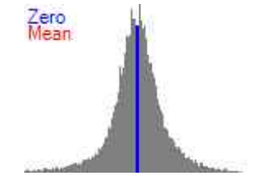


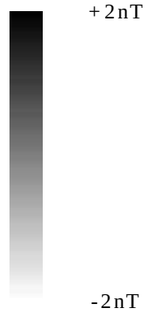


Client

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Project Title — Job No. 9711

GEOPHYSICAL SURVEY - LOWER STONDON, BEDFORDSHIRE

Subject

PLOT OF MINIMALLY PROCESSED GRADIOMETER DATA

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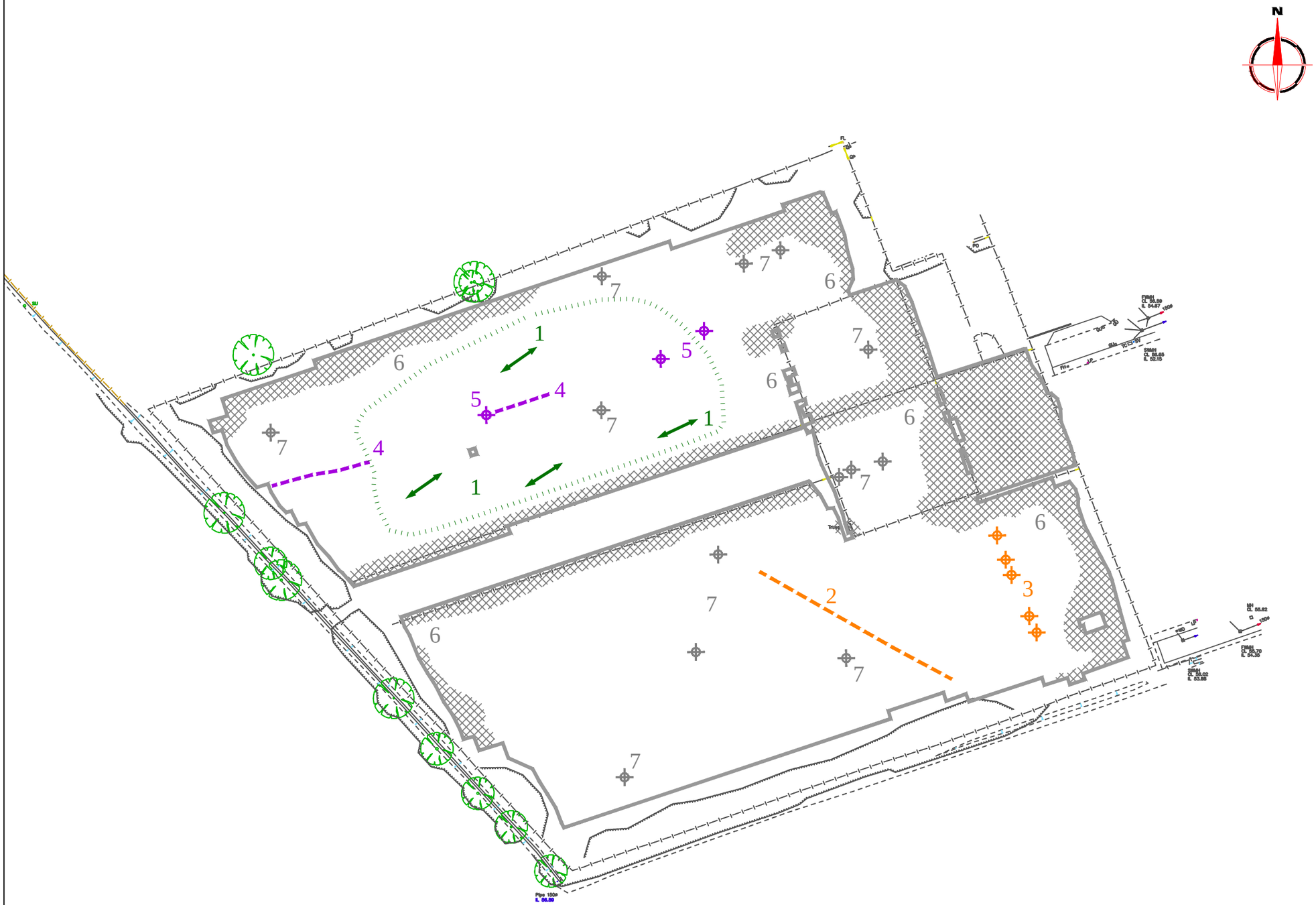


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### PROBABLE ARCHAEOLOGY

- Positive anomaly / weak positive anomaly - probable cut feature of archaeological origin
- Negative anomaly / weak negative anomaly - probable bank or earthwork of archaeological origin

### POSSIBLE ARCHAEOLOGY

- Positive anomaly / weak positive anomaly - possible cut feature of archaeological origin
- Negative anomaly / weak negative anomaly - possible bank or earthwork of archaeological origin

### MEDIEVAL/POST-MEDIEVAL AGRICULTURE

- Widely spaced curving parallel linear anomalies - probably related to ridge-and-furrow
- Closely spaced parallel linear anomalies - probably related to agricultural activity such as ploughing
- Linear anomaly - probably related to a former field boundary not present on available mapping
- Linear anomaly - related to a former field boundary present on available mapping

### OTHER ANOMALIES

- Linear anomaly - related to former fenceline visible on available aerial photographs
- Magnetic spike - related to former fenceline visible on available aerial photographs
- Linear anomaly - probably related to former fenceline, not visible on available mapping or aerial photographs
- Magnetic spike - probably related to former fenceline, not visible on available mapping or aerial photographs
- Magnetic disturbance associated with nearby metal object such as service or field boundary
- Scattered magnetic debris
- Magnetic spike - probable ferrous object

Client
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Project Title
GEOPHYSICAL SURVEY - LOWER STONDON, BEDFORDSHIRE

Job No. 9711

Subject
ABSTRACTION AND INTERPRETATION OF GRADIOMETER ANOMALIES

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Scale 1:1000

0m 10 20 30 40 50

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| MAR 16 | RD | 05 |

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