GEOPHYSICAL SURVEY REPORT

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Tetsworth South, South Oxfordshire

Client
Stratera Energy

Survey Report
13338

Date
August 2018

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GEOPHYSICAL SURVEY REPORT

Project name:
Tetsworth South, South Oxfordshire

SUMO Job reference:
13338

Client:
Stratera Energy

Survey date:
20-24 August 2018

Report date:
30 August 2018

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TABLE OF CONTENTS

LIST OF FIGURES

1 SUMMARY OF RESULTS

A detailed magnetometer survey was conducted over approximately 23 ha of arable farmland near Tetsworth, Oxfordshire. No definite archaeological responses have been identified. Linear anomalies of uncertain origin have been mapped, along with a conjectural field boundary, land drains, evidence of modern ploughing and four underground services.

2 INTRODUCTION

2.1 Background synopsis

SUMO Geophysics Ltd were commissioned to undertake a geophysical survey of an area outlined for a solar farm development. This survey forms part of an archaeological investigation being undertaken by **Stratera Energy**.

2.2 Site details

NGR / Postcode	SP 667 027 / OX9 7BE
Location	The site comprises eleven fields and spans from north of the A40 near Lobb Cottage to the south past Lobb Farm towards Haseley Brook, over a distance of approximately 2.5km.
HER/SMR	Oxfordshire
District	South Oxfordshire
Parish	Great Haseley CP
Topography	Mostly level
Current Land Use	Arable farmland
Geology	Solid: Gault Formation - mudstone. Superficial: Alluvium (clay, silt, sand and gravel) is recorded along the route of the watercourse in the south. Head deposits (clay, silt, sand and gravel) are present across the southern extent (BGS 2018).
Soils	Denchworth Association (712b) - slowly permeable seasonally waterlogged clayey soils with similar fine loamy over clayey soils (SSEW 1983).
Archaeology	No details available.
Survey Methods	Magnetometer survey (fluxgate gradiometer)
Study Area	*c.* 23 ha - approximately 1.2 ha could not be surveyed due to game cover, a small area of plough and overgrown vegetation.

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 (EH 2008) (then English Heritage), the Chartered Institute for Archaeologists (CIfA 2014) and the European Archaeological Council (EAC 2016).

3.2 Survey methods

Detailed magnetic survey was chosen as an efficient and effective method of locating archaeological anomalies.

Technique	Instrument	Traverse Interval	Sample Interval
Magnetometer	Bartington Grad 601-2	1.0m	0.25m

More information regarding this technique is included in Appendices A and B.

3.3 Data Processing

The following basic processing steps have been carried out on the data used in this report:

De-stripe; de-stagger; interpolate

3.4 Presentation of results and interpretation

The presentation of the results includes a 'minimally processed data' and a 'processed data' greyscale plot. Magnetic anomalies are identified, interpreted and plotted onto the 'Interpretation' drawings.

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 other existing evidence, the anomalies will be given specific categories, such as: *Abbey Wall* or *Roman Road*. Where the interpretation is based largely on the geophysical data, levels of confidence are implied, 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 survey has been divided into eleven survey areas (Areas 1-11).

4.1 ***Probable / Possible Archaeology***

4.1.1 No magnetic responses have been recorded that could be interpreted as being of archaeological interest.

4.2 ***Uncertain***

4.2.1 A few weak linear anomalies are visible in the far south of the site, in Area 11, and are of uncertain origin. The responses are ditch-like in characteristics meaning an archaeological origin cannot be ruled out entirely, though such an interpretation is tentative. They are probably a result of agricultural activity.

4.3 ***Former Field Boundary***

4.3.1 A linear alignment of strongly magnetic dipole anomalies has been identified in Area 2 and may relate to a former field boundary that is not visible on available historic mapping.

4.4 ***Agricultural – Ploughing / Land Drains***

4.4.1 Evidence of ploughing is visible across northern parts of the site (Areas 1 and 3) in the form of magnetically weak, closely spaced, parallel linear anomalies.

4.4.2 Weak linear anomalies comprising positive and negative components have been mapped in Areas 5, 7, 8, 9 and 11 and are indicative of modern field drains.

4.5 ***Natural / Geological / Pedological / Topographic***

4.5.1 Several amorphous areas of increased magnetic response are visible across the site and are likely to be a result of localised natural variations in the underlying geology and alluvial deposits in the southern part of the site.

4.6 ***Ferrous / Magnetic Disturbance***

4.6.1 Four strongly magnetic linear anomalies are visible in Areas 1, 3, 4, 5 and 7 and are a result of underground services such as pipes or cables.

4.6.2 Areas of magnetic disturbance can be seen in several areas are likely to be of modern origin and relate to modern debris within the topsoil.

4.6.3 Ferrous responses close to boundaries are due to adjacent fences and gates. Smaller scale ferrous anomalies ("iron spikes") are present throughout the data and are characteristic of small pieces of ferrous debris (or brick / tile) in the topsoil; they are commonly assigned a modern origin. Only the most prominent of these are highlighted on the interpretation diagram.

5 DATA APPRAISAL & CONFIDENCE ASSESSMENT

5.1 Historic England guidelines (EH 2008) Table 4 states that the average magnetic response on mudstone is variable, while alluvial deposits have the potential to mask weaker, more ephemeral responses. The results from this survey indicate the presence of agricultural effects, linear anomalies of uncertain origin and land drains. It is therefore likely that the technique is likely to have detected any archaeological features, if present.

6 CONCLUSION

6.1 The survey at Tetsworth has not revealed any anomalies of definite archaeological origin. A small number of linear anomalies are of uncertain origin and may be archaeological or agricultural. A possible former field boundary has been mapped, along with ploughing effects, field drains, underground services and areas of disturbance from nearby ferrous objects.

7 REFERENCES

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CIfA 2014 *Standard and Guidance for Archaeological Geophysical Survey.* Amended 2016. CIfA Guidance note. Chartered Institute for Archaeologists, Reading http://www.archaeologists.net/sites/default/files/CIfAS%26GGeophysics_2.pdf

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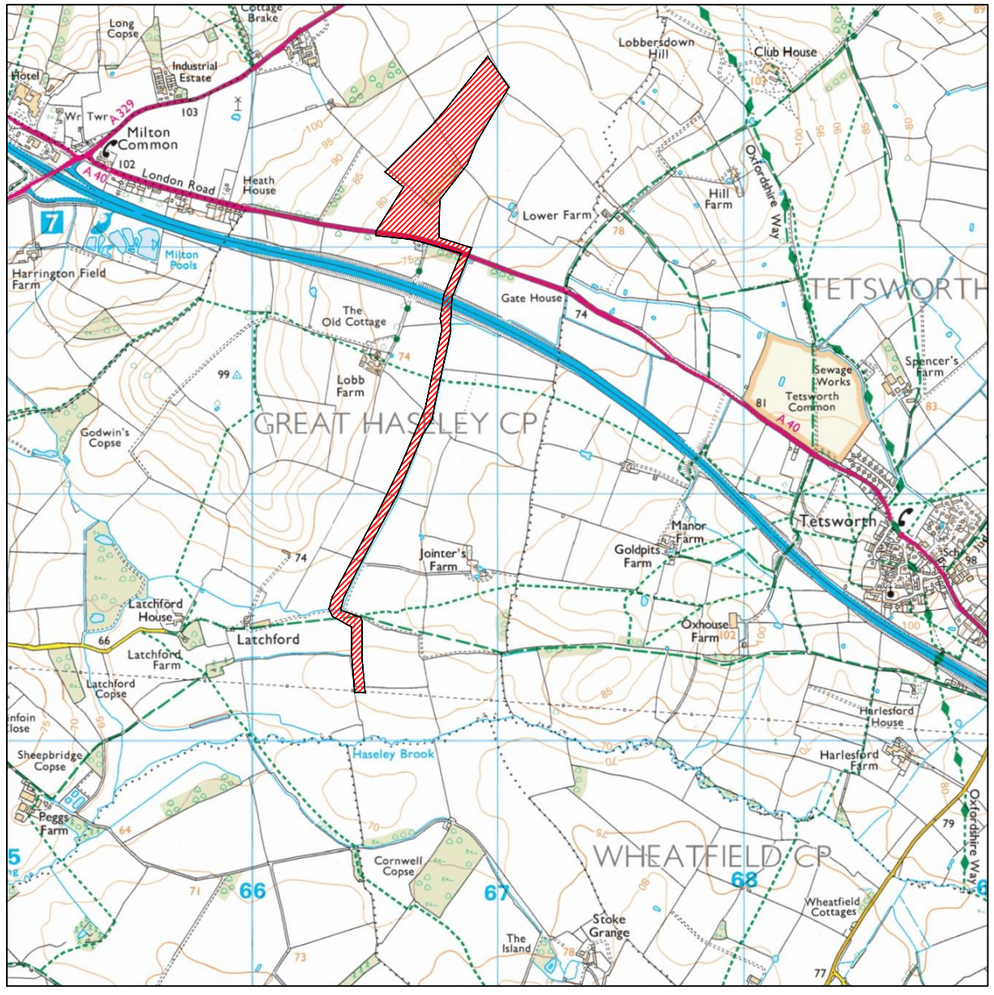

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Site Location

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Title:
Site Location Diagram

Client:
Stratera Energy

Project:
13338 - Tetsworth, South Oxfordshire

Scale:
0 metres 1000
1:25000 @ A3

Fig No:
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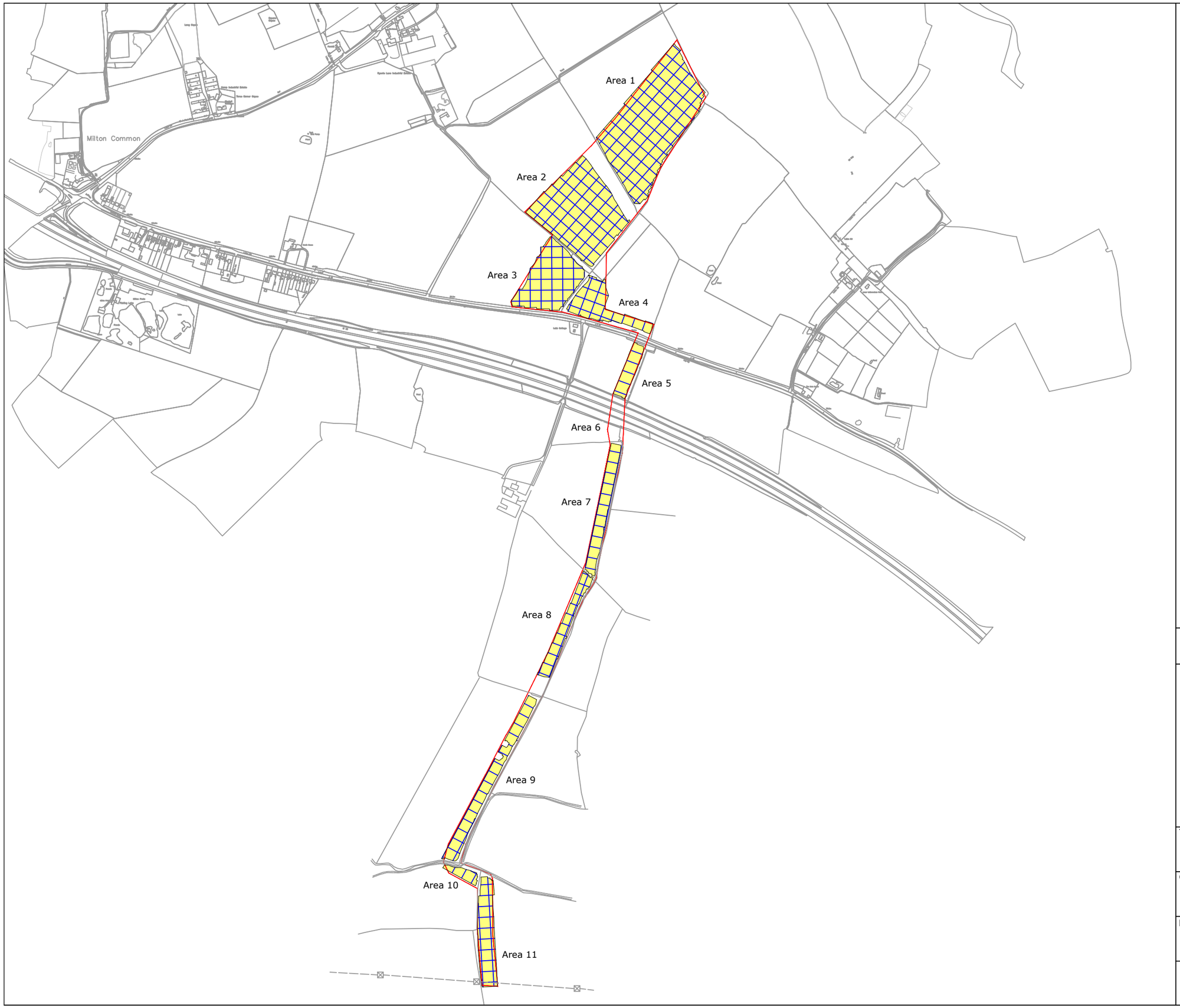

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Survey Areas - showing 30m grid

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GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Location of Survey Areas

Client:
Stratera Energy

Project:
13338 - Tetsworth, South Oxfordshire

Scale:
0 metres 500
1:10 000 @ A3

Fig No:
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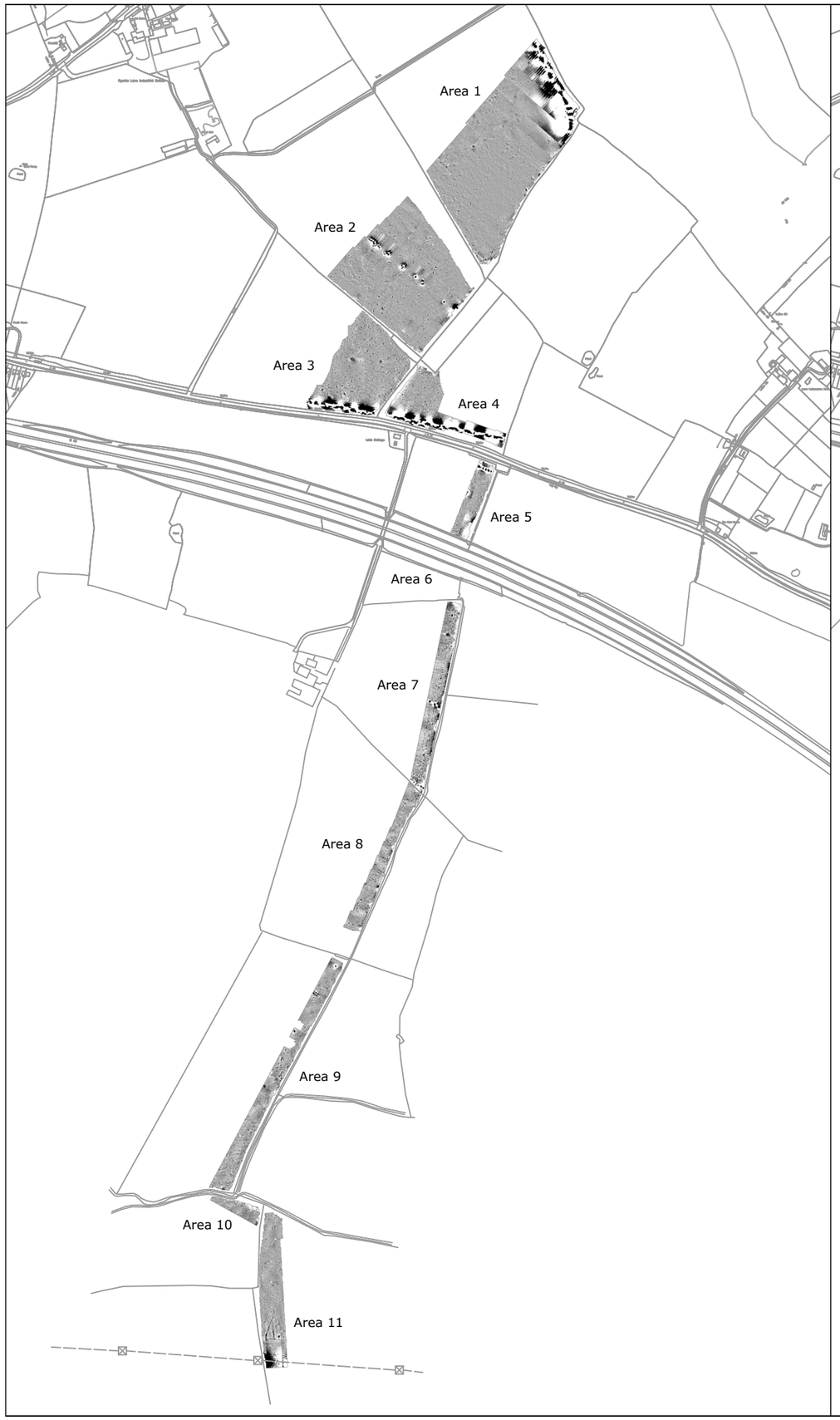

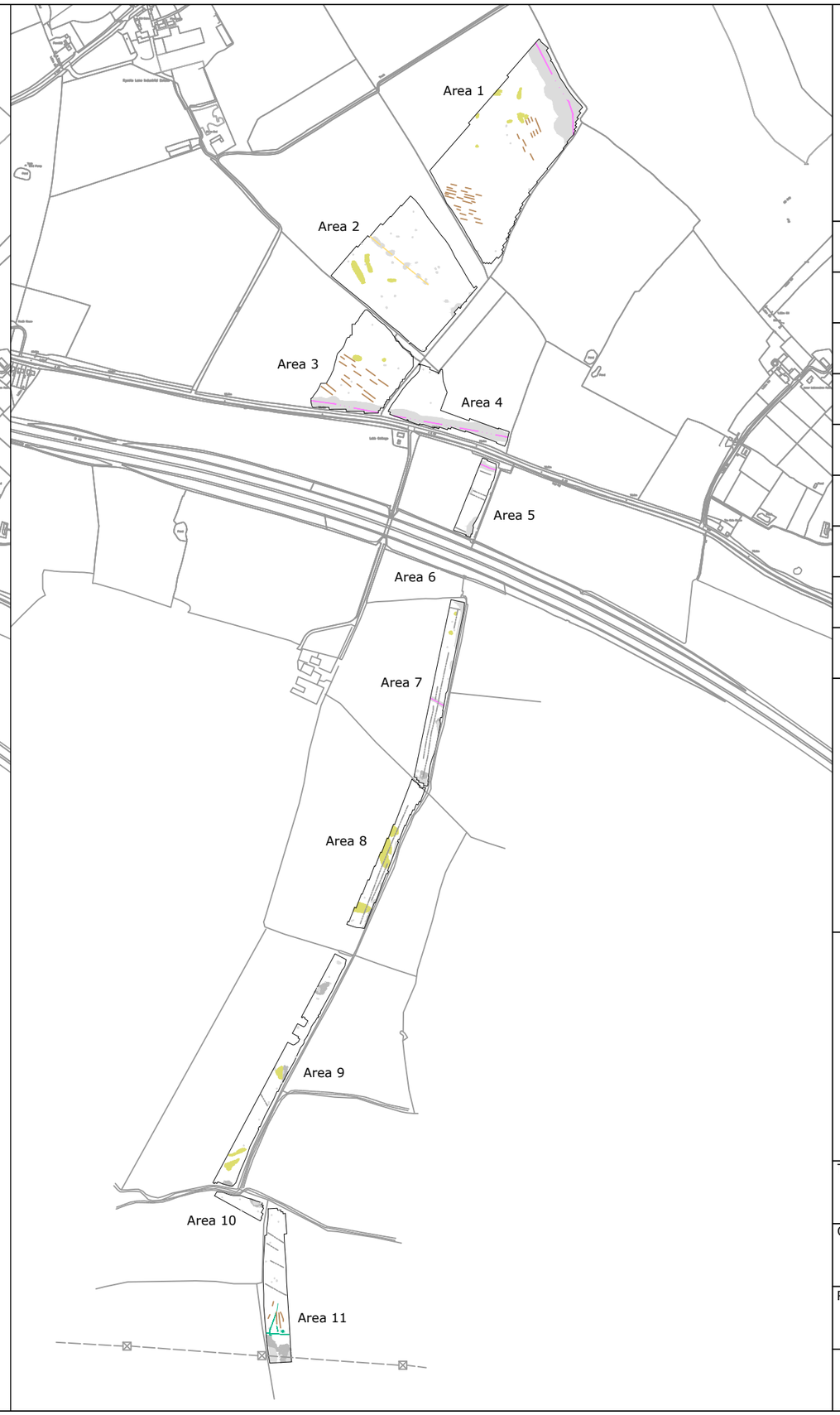

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KEY

	Uncertain Origin (discrete anomaly / trend)
	Former field boundary (conjectural)
	Agriculture (plough)
	Land drain
	Natural (e.g. geological / pedological)
	Magnetic disturbance
	Service
	Ferrous

+2nT

-1nT

sumo Survey

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Magnetometer Survey - Greyscale Plots & Interpretation - Overview

Client:
Stratera Energy

Project:
13338 - Tetsworth, South Oxfordshire

Scale:
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1:10 000 @ A3

Fig No:
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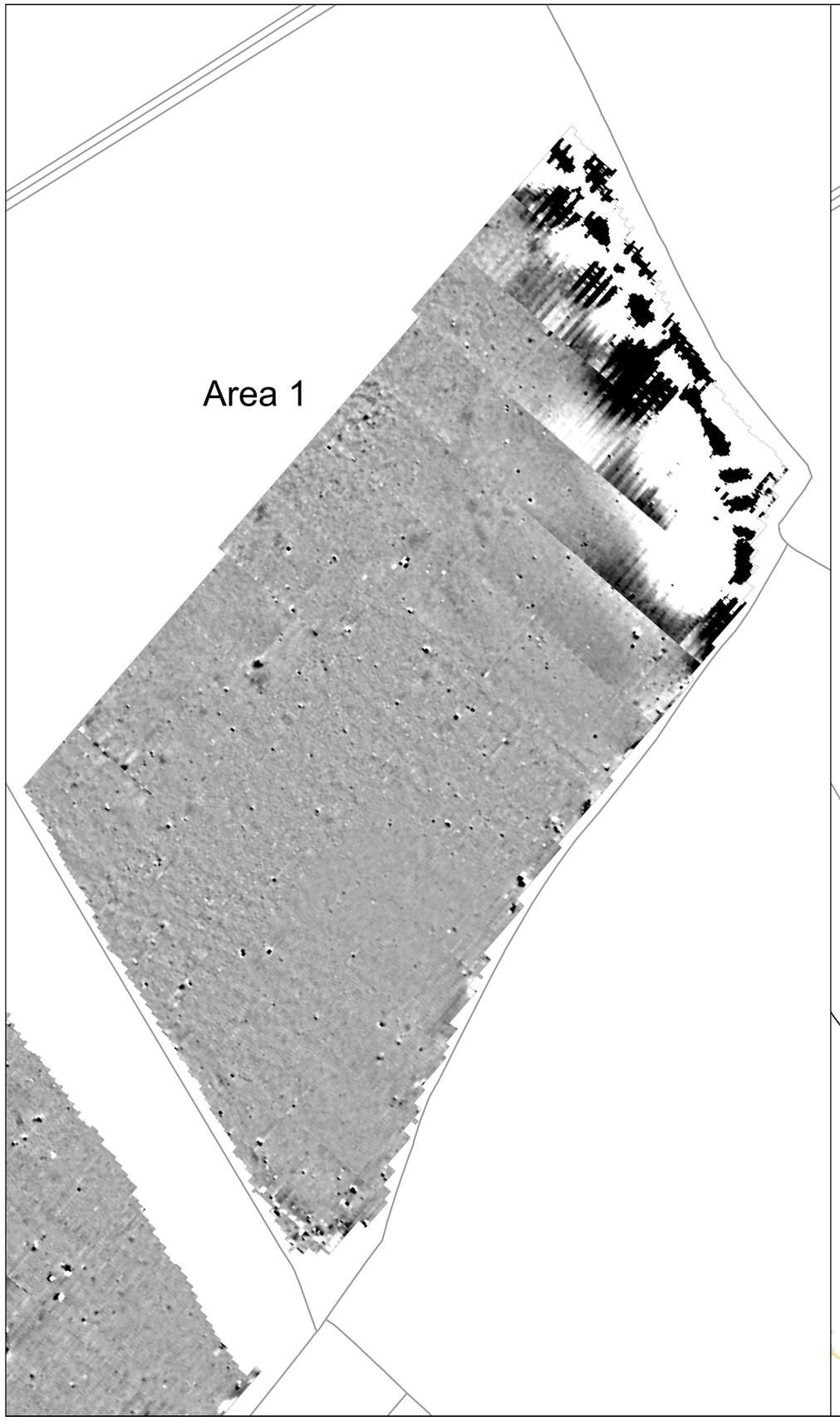

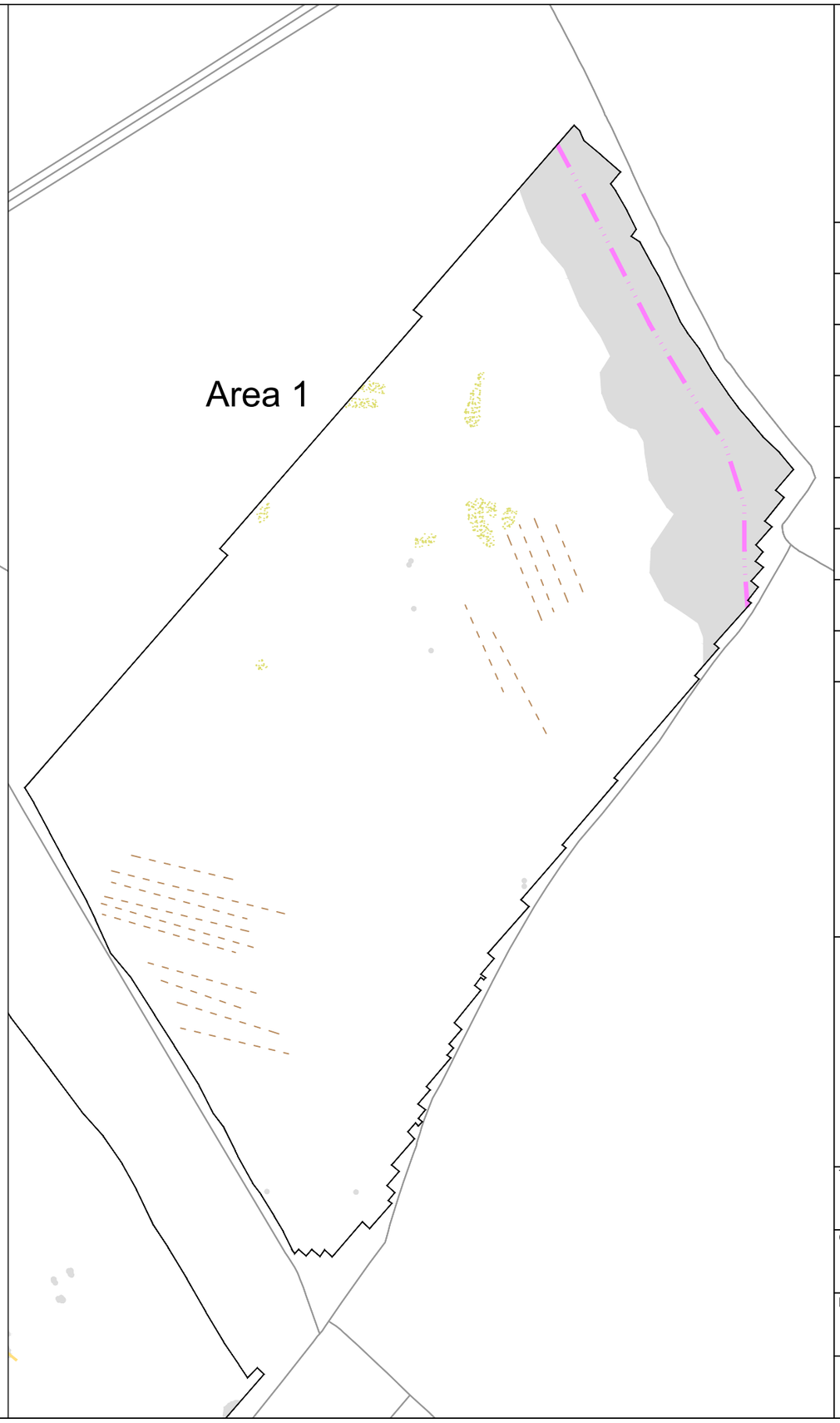

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KEY

	Uncertain Origin (discrete anomaly / trend)
	Former field boundary (conjectural)
	Agriculture (plough)
	Land drain
	Natural (e.g. geological / pedological)
	Magnetic disturbance
	Service
	Ferrous

+2nT

-1nT

sumo Survey

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Magnetometer Survey - Greyscale Plots & Interpretation - Area 1

Client:
Stratera Energy

Project:
13338 - Tetsworth, South Oxfordshire

Scale:
0 metres 100
1:2000 @ A3

Fig No:
04

N

+2nT

-1nT

sumo Survey

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Magnetometer Survey - Greyscale Plots - Areas 2, 3 & 4

Client:
Stratera Energy

Project:
13338 - Tetsworth, South Oxfordshire

Scale:
0 metres 100
1:2000 @ A3

Fig No:
05

N

KEY

	Uncertain Origin (discrete anomaly / trend)
	Former field boundary (conjectural)
	Agriculture (plough)
	Land drain
	Natural (e.g. geological / pedological)
	Magnetic disturbance
	Service
	Ferrous

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Magnetometer Survey - Interpretation - Areas 2, 3 & 4

Client:
Stratera Energy

Project:
13338 - Tetsworth, South Oxfordshire

Scale:
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Fig No:
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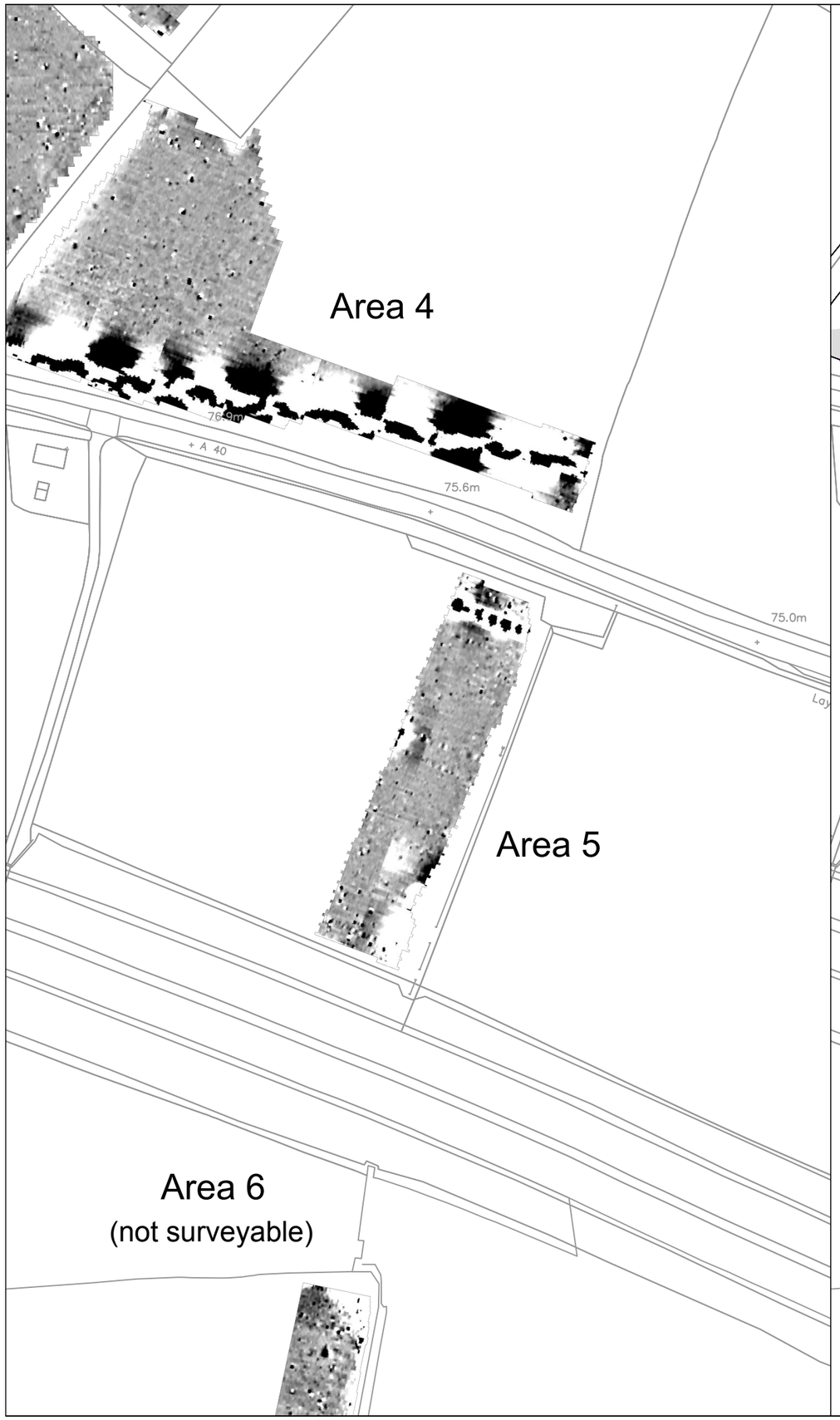

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KEY

	Uncertain Origin (discrete anomaly / trend)
	Former field boundary (conjectural)
	Agriculture (plough)
	Land drain
	Natural (e.g. geological / pedological)
	Magnetic disturbance
	Service
	Ferrous

+2nT

-1nT

sumo Survey

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title: Magnetometer Survey - Greyscale Plots & Interpretation - Area 5

Client: Stratera Energy

Project: 13338 - Tetsworth, South Oxfordshire

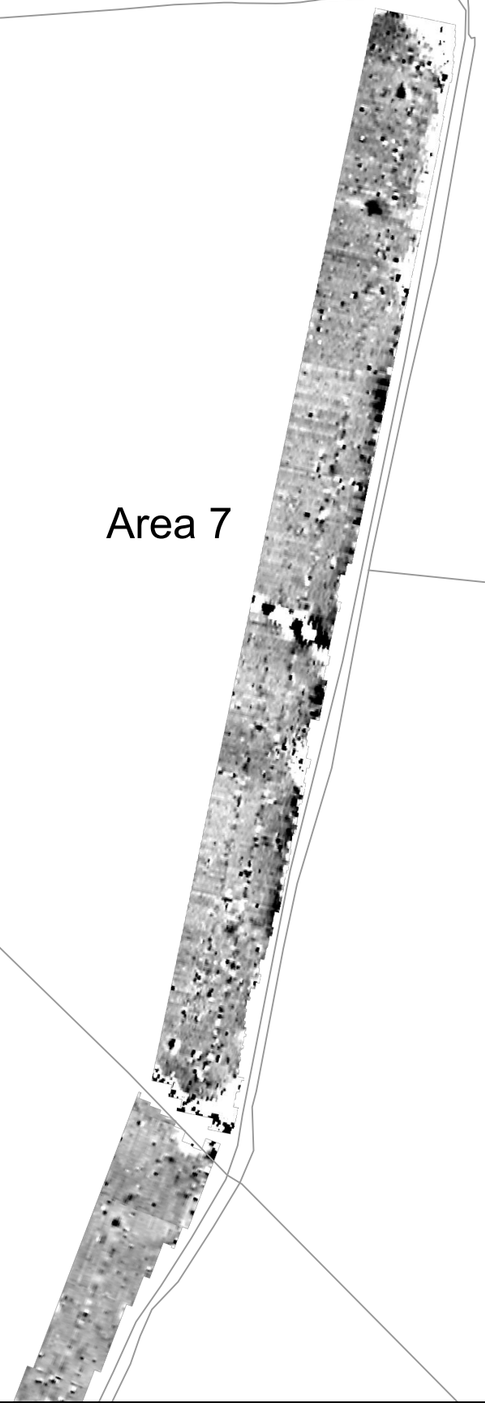
Scale: 0 metres 100

1:2000 @ A3

Fig No: 07

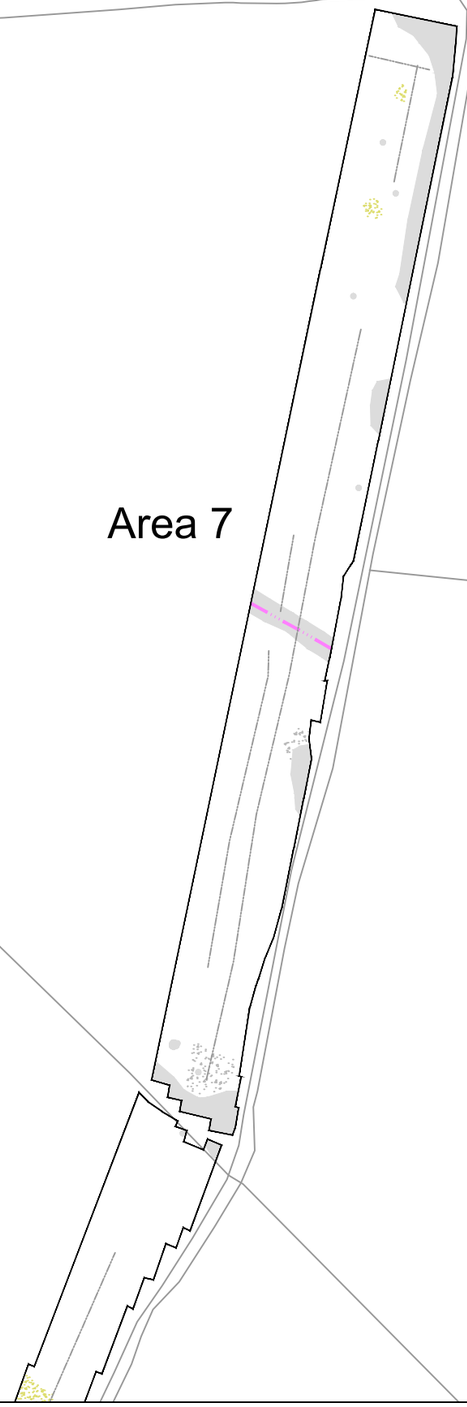
Area 6
(not surveyable)

Area 7



Area 6
(not surveyable)

Area 7



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KEY

	Uncertain Origin (discrete anomaly / trend)
	Former field boundary (conjectural)
	Agriculture (plough)
	Land drain
	Natural (e.g. geological / pedological)
	Magnetic disturbance
	Service
	Ferrous

+2nT

-1nT

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Magnetometer Survey - Greyscale Plots & Interpretation - Area 7

Client:
Stratera Energy

Project:
13338 - Tetsworth, South Oxfordshire

Scale:
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Fig No:
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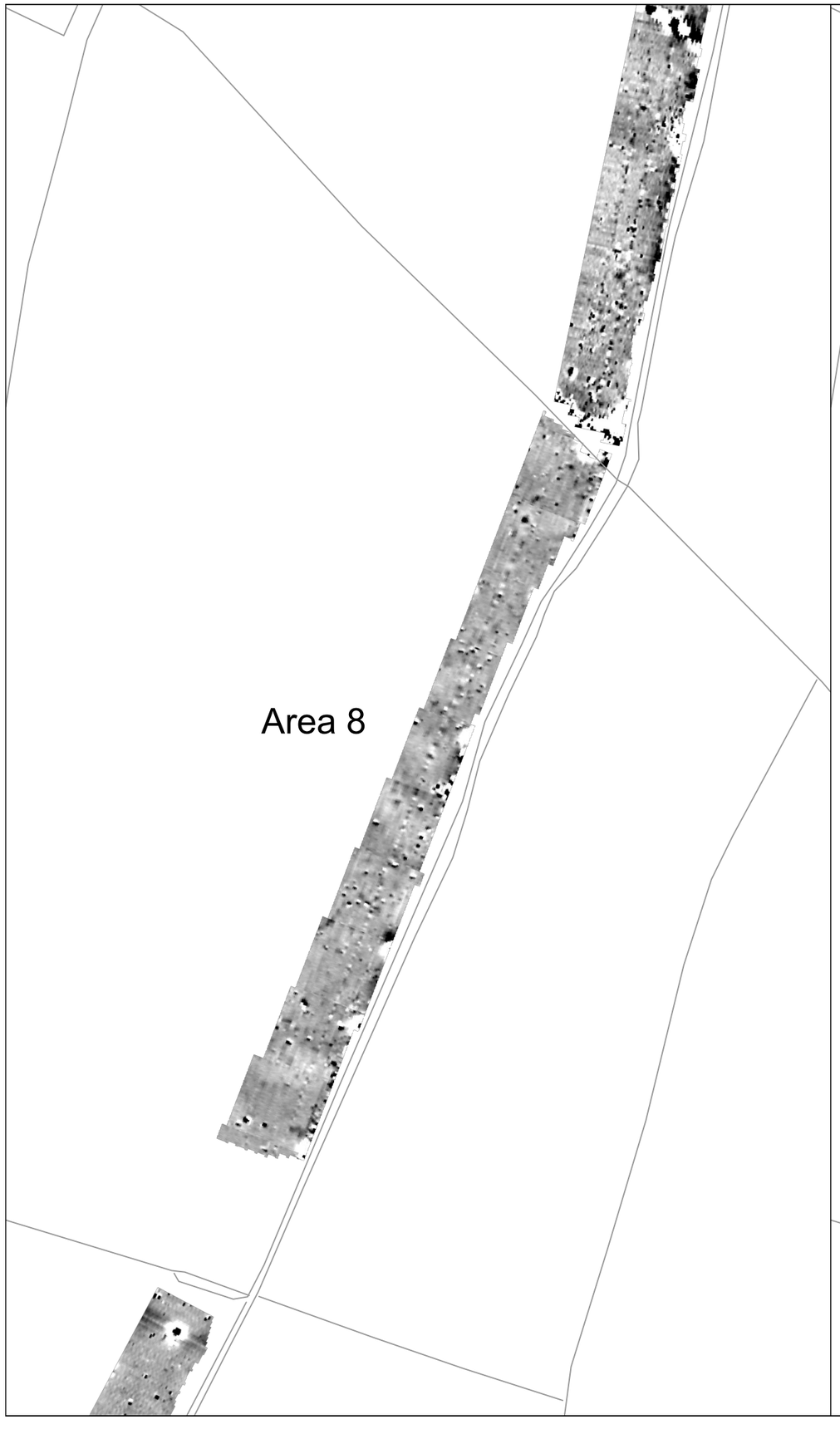

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KEY

	Uncertain Origin (discrete anomaly / trend)
	Former field boundary (conjectural)
	Agriculture (plough)
	Land drain
	Natural (e.g. geological / pedological)
	Magnetic disturbance
	Service
	Ferrous

+2nT

-1nT

sumo Survey

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Magnetometer Survey - Greyscale Plots & Interpretation - Area 8

Client:
Stratera Energy

Project:
13338 - Tetsworth, South Oxfordshire

Scale:
0 metres 100
1:2000 @ A3

Fig No:
09

N

KEY

	Uncertain Origin (discrete anomaly / trend)
	Former field boundary (conjectural)
	Agriculture (plough)
	Land drain
	Natural (e.g. geological / pedological)
	Magnetic disturbance
	Service
	Ferrous

+2nT

-1nT

sumo Survey

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Magnetometer Survey - Greyscale Plots & Interpretation - Areas 9 & 10

Client:
Stratera Energy

Project:
13338 - Tetsworth, South Oxfordshire

Scale:
0 metres 100
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Fig No:
10

N

KEY

	Uncertain Origin (discrete anomaly / trend)
	Former field boundary (conjectural)
	Agriculture (plough)
	Land drain
	Natural (e.g. geological / pedological)
	Magnetic disturbance
	Service
	Ferrous

+2nT

-1nT

sumo Survey

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Magnetometer Survey - Greyscale Plots & Interpretation - Areas 10 & 11

Client:
Stratera Energy

Project:
13338 - Tetsworth, South Oxfordshire

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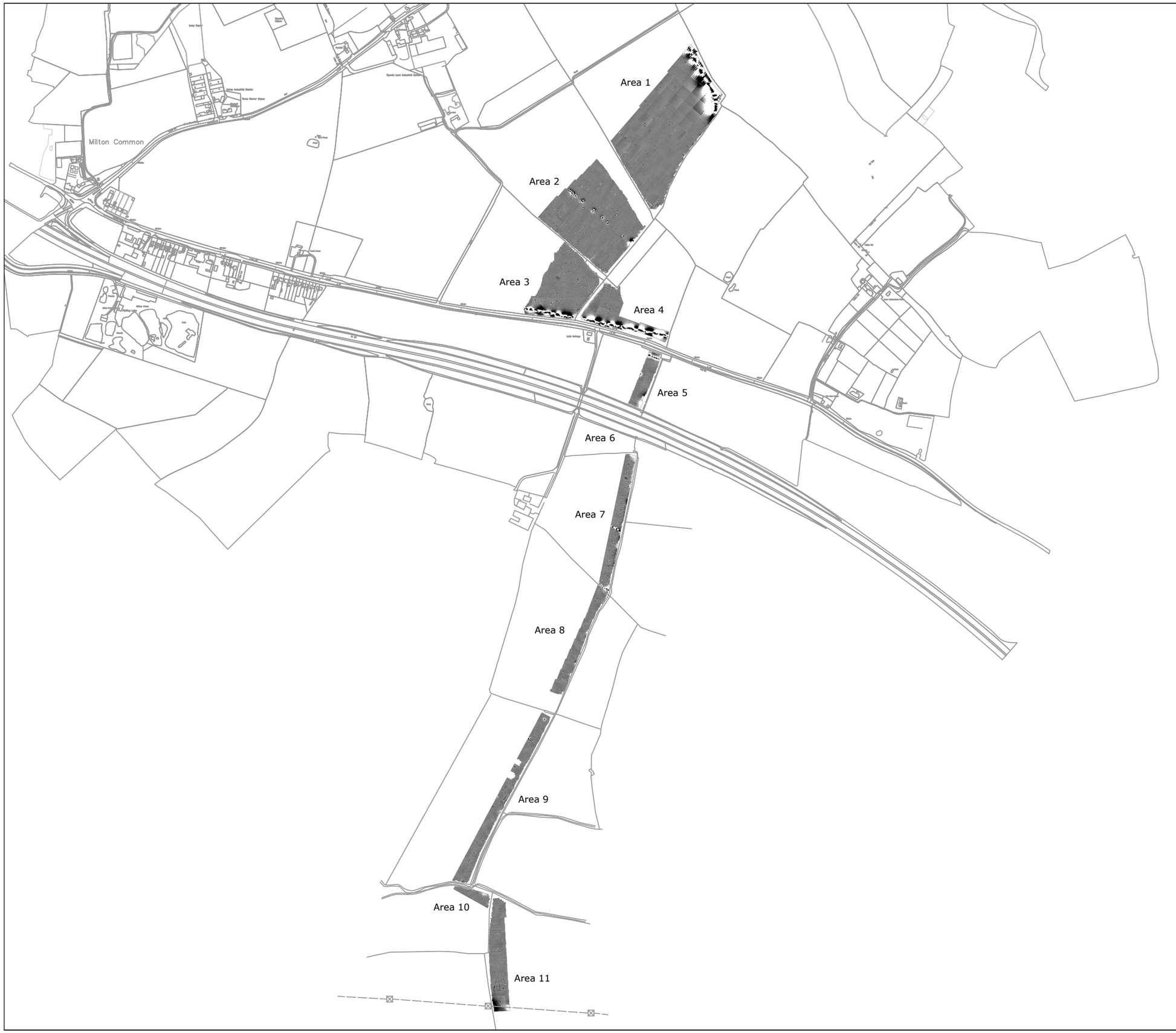

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+5nT

-5nT

sumo Survey

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:

Minimally Processed Data - Greyscale Plots

Client:

Stratera Energy

Project:

13338 - Tetsworth, South Oxfordshire

Scale:

0 metres 500

1:10 000 @ A3

Fig No:

12

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 (De-stagger)	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 responses 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 may lead and empty into larger diameter pipes, 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 are indicative of ferrous pipes/cables. Sometimes other materials (e.g. pvc) or the fill of the trench can cause weaker magnetic responses which can be identified from their uniform linearity.
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* / *Natural* or (in the case of linear responses) *Possible Archaeology* / *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 0.1 nanoTeslas (nT) in an overall field strength of 48,000 (nT), 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.

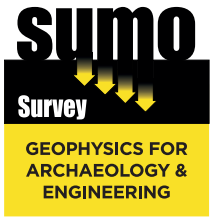
Magnetic susceptibility relates to the induced magnetism of a material when in the presence of a magnetic field. This magnetism can be considered as effectively permanent as it exists within the Earth's magnetic field. Magnetic susceptibility can become enhanced due to burning and complex biological 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; 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 feature. The difference between the two sensors will relate to the strength of a magnetic field created by this 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 and disturbance from modern services.



- Archaeological
- Geophysical
- Laser Scanning
- Measured Building
- Topographic
- Utility Mapping

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