GEOPHYSICAL SURVEY REPORT

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Chalks Farm, Sawbridgeworth, Hertfordshire

Client
CgMs Heritage (part of RPS)

Survey Report
13494

Date
October 2018

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GEOPHYSICAL SURVEY REPORT

Project name:
Chalks Farm, Sawbridgeworth, Hertfordshire

SUMO Job reference:
13494

Client:
CgMs Heritage (part of RPS)

Survey date:
12-14 September 2018

Report date:
5 October 2018

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TABLE OF CONTENTS

LIST OF FIGURES

1 SUMMARY OF RESULTS

A detailed magnetometer survey was conducted over approximately 13.8 ha of arable farmland at Chalks Farm, Sawbridgeworth. An area of probable Romano-British occupational activity has been detected, and includes rectilinear enclosures, trackways, a possible ring-ditch and other discrete features. Several former field boundaries have been identified while the remaining responses are modern and are a result of nearby ferrous objects, such as electricity pylons, cables and fences.

2 INTRODUCTION

2.1 Background synopsis

SUMO Geophysics Ltd 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 Heritage (part of RPS)**.

2.2 Site details

NGR / Postcode	TL 472 153 / CM21 0BP
Location	The site is located to the west of the town of Sawbridgeworth, Hertfordshire. West Road bounds the site to the north, with residential properties of Coney Gree and Nursery Fields to the east.
HER/SMR	Hertfordshire
District	East Hertfordshire
Parish	Sawbridgeworth CP
Topography	Gradual slope from north-west to south-east
Current Land Use	Arable
Geology	Solid: London Clay Formation - clay, silt and sand. Superficial: Lowestoft Formation - diamicton (BGS 2018).
Soils	Hanslope Association (411d) - slowly permeable calcareous clayey soils (SSEW 1983).
Archaeology	Few prehistoric or Roman finds have been recorded within a 1km radius of the study site and the overall archaeological potential for remains is low. The site lay well outside of the late medieval and post medieval town of Sawbridgeworth and has likely formed part of the agricultural land surrounding the town (CgMs 2018).
Survey Methods	Magnetometer survey (fluxgate gradiometer)
Study Area	13.8 ha

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 two survey areas (Areas 1-2) and specific anomalies have been given numerical labels [1] [2] *which appear in the text below, as well as on the Interpretation Figure(s).*

4.1 *Probable / Possible Archaeology*

4.1.1 A series of responses indicative of a settlement complex have been detected in the north-west of the site. These include a rectilinear feature [1] comprising a double-ditched enclosure, internal features and having an entrance on its eastern side along with several other rectilinear and linear anomalies.

4.1.2 To the north of [1], a further rectilinear anomaly [2] has been identified, within which a poorly defined sub-circular anomaly [3] can be seen. The latter is indicative of a ring-ditch, roundhouse or other small circular ditched enclosure. The form of the anomalies suggests that they are Romano-British in date and comprise multiple phases of activity.

4.1.3 Two curvilinear ditch-type anomalies [4] can be seen extending eastwards from the area of settlement and are likely to be a result of a trackway or droveway.

4.1.4 Two parallel linear anomalies [5] at the western edge of the area could be related to a further trackway associated with the area of occupation, though their alignment with contemporary field boundaries suggests that they could equally be a result of modern agricultural activity.

4.2 *Uncertain*

4.2.1 Parallel linear anomalies [6] to the north of the trackway [4] could be archaeological, however it is more likely that they are a result of agricultural activity, or even land drains.

4.2.2 Two weak linear trends [7] in the south of the area have been categorised as having an uncertain origin. They could be related to either the Romano-British activity or the historic field system [8-14].

4.2.3 Small discrete positive anomalies are visible in the west and east of the site and again have an uncertain origin. It is possible that these have an archaeological provenance, though this interpretation is tentative at best. They are more likely to have natural or modern origins.

4.3 *Former Field Boundary*

4.3.1 Several linear anomalies [8-12] are visible in the data, all of which relate to former field boundaries visible on historic mapping of the site. The eastern-most anomlaies [8-10] are visible only on the 1838 Sawbridgeworth Tithe Map while the boundaries in the centre are visible from 1838 to 1921.

4.3.2 Two further linear anomalies [13-14] are thought to be the result of former field boundaries as they share the same alignment as the corroborated ones, however they are not visible on historic mapping; hence the conjectural interpretation.

4.4 *Agricultural – Ploughing*

4.4.1 Magnetically weak, closely spaced, parallel linear anomalies are visible across the entirety of Area 1 and are a result of agricultural activity, such as ploughing.

4.5 ***Ferrous / Magnetic Disturbance***

4.5.1 A bipolar linear anomaly can be seen running from the northern edge of Area 2 towards an electricity pylon and is likely to be related to an underground cable.

4.5.2 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 London Clay geologies is generally poor but can vary. The results from this survey indicate clear archaeological type responses. As a consequence, it can be determined that the technique has been effective.

6 CONCLUSION

6.1 The survey at Chalks Farm, Sawbridgeworth has revealed evidence of a probable Romano-British settlement, comprising a double-ditched rectilinear enclosure, additional rectangular enclosures and a potential ring-ditch, along with a curvilinear trackway extending to the east. Further linear trends identified could be archaeological or a result of agricultural activity. Several former field boundaries have been detected, along with an underground service and areas of modern magnetic disturbance.

7 REFERENCES

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CgMs 2018 *Archaeological Desk-Based Assessment - Land at Chalks Farm, Sawbridgeworth, Hertfordshire, CM21 0BW.* CgMs Heritage; unpublished report.

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EAC 2016 *EAC Guidelines for the Use of Geophysics in Archaeology,* European Archaeological Council, Guidelines 2.

EH 2008 *Geophysical Survey in Archaeological Field Evaluation.* English Heritage, Swindon https://content.historicengland.org.uk/images-books/publications/geophysical-survey-in-archaeological-field-evaluation/geophysics-guidelines.pdf/

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

N

Site Location

sumo Survey
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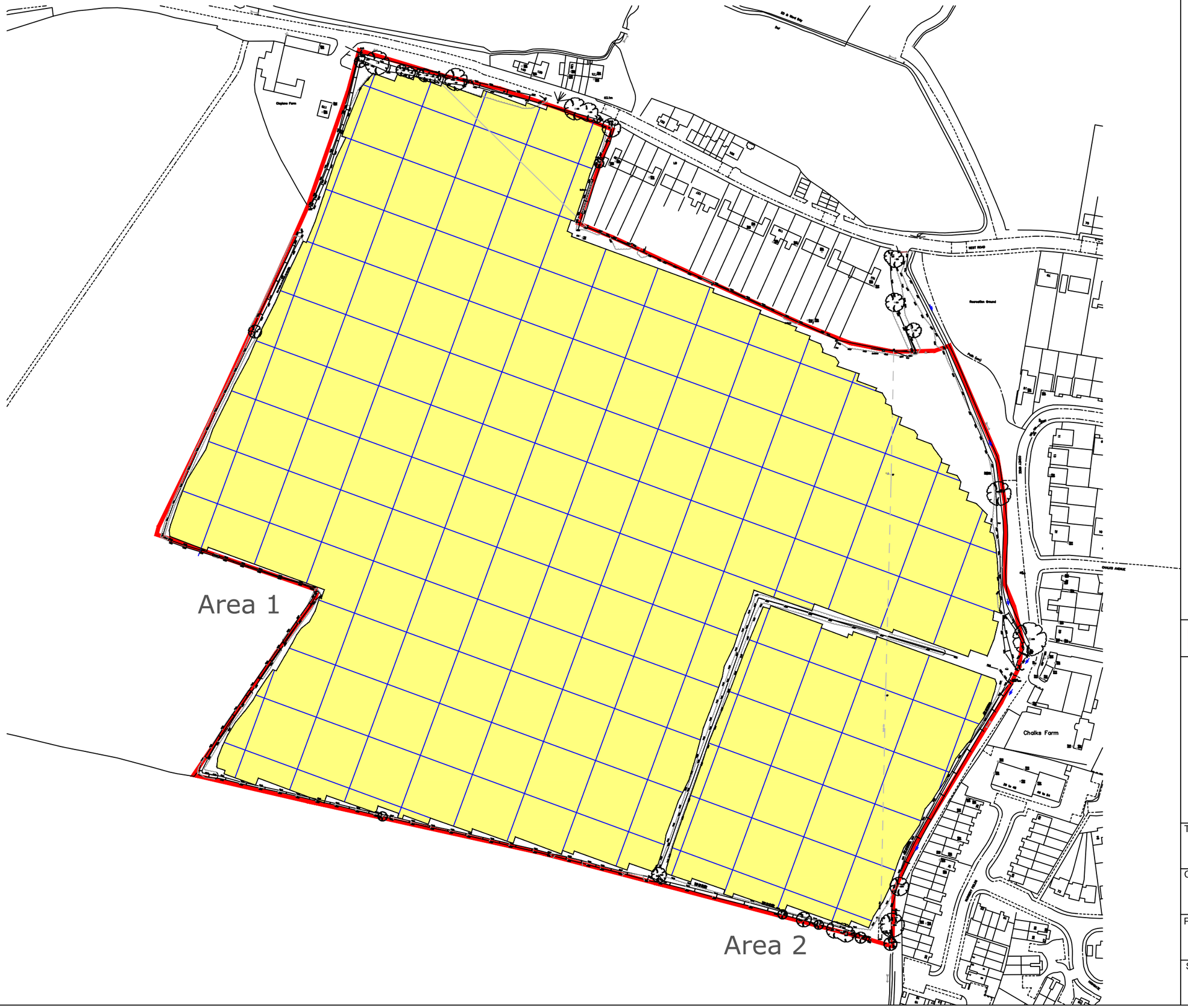
Title:
Site Location Diagram

Client:
CgMs Heritage (part of RPS)

Project:
13494 - Chalks Farm, Sawbridgeworth, Hertfordshire

Scale:
0 metres 1000
1:25000 @ A3

Fig No:
01



N

Survey Area - showing 30m grid

sumo Survey
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Title:
Location of Survey Areas

Client:
CgMs Heritage (part of RPS)

Project:
13494 - Chalks Farm, Sawbridgeworth, Hertfordshire

Scale:
0 metres 100
1:2000 @ A3

Fig No:
02

N

+2nT

-1nT

sumo Survey

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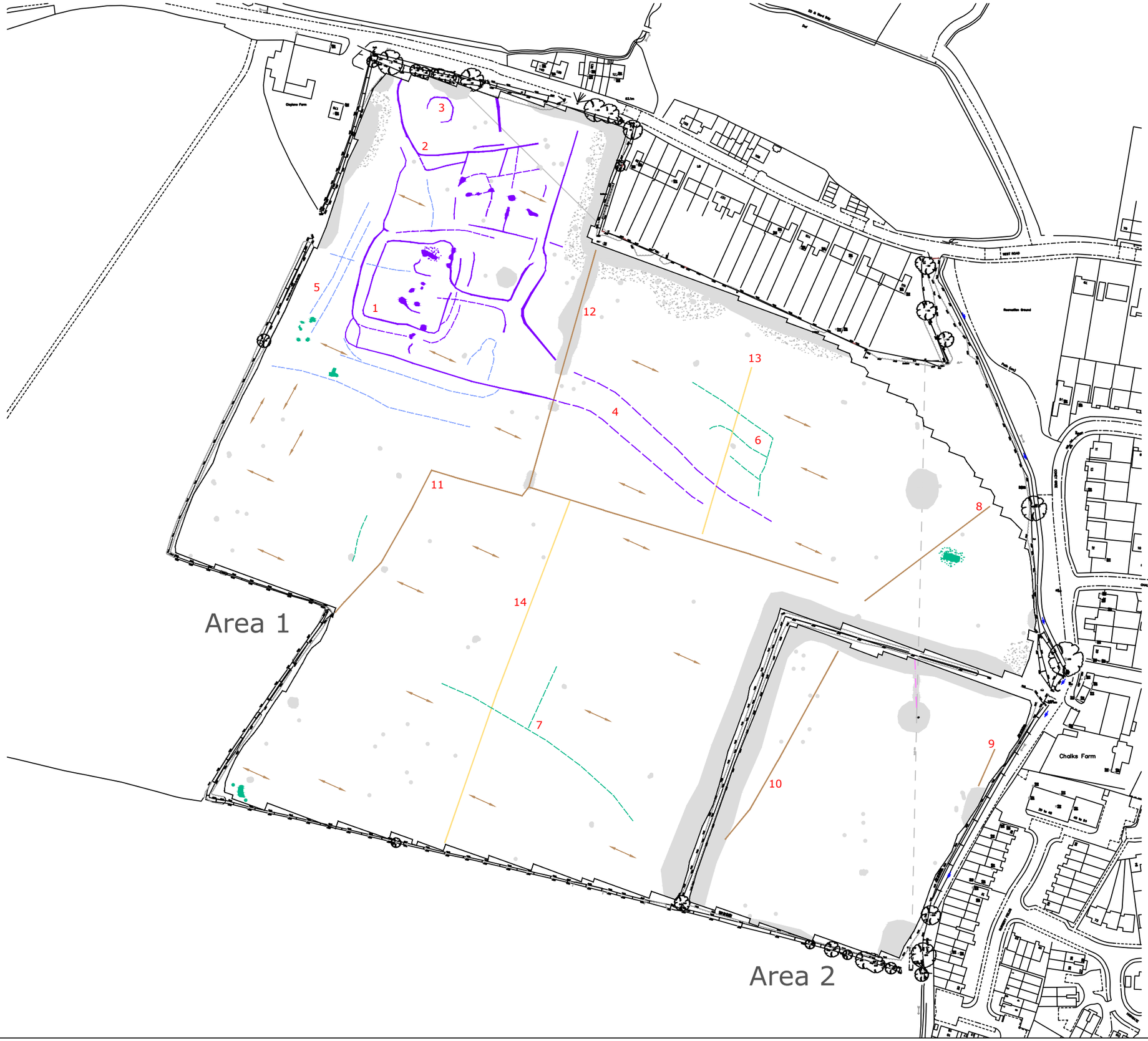
Title:
Magnetometer Survey - Greyscale Plots

Client:
CgMs Heritage (part of RPS)

Project:
13494 - Chalks Farm, Sawbridgeworth, Hertfordshire

Scale:
0 metres 100
1:2000 @ A3

Fig No:
03



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KEY

	Probable archaeology (discrete anomaly / trend / magnetic enhancement)
	Possible archaeology (discrete anomaly / trend)
	Uncertain Origin (discrete anomaly / trend / magnetic enhancement)
	Former field boundary (corroborated)
	Former field boundary (conjectural)
	Agriculture (plough)
	Magnetic disturbance
	Service
	Ferrous

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Magnetometer Survey - Interpretation

Client:
CgMs Heritage (part of RPS)

Project:
13494 - Chalks Farm, Sawbridgeworth, Hertfordshire

Scale:
0 metres 100
1:2000 @ A3

Fig No:
04

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Minimally Processed Data - Greyscale Plots

Client:
CgMs Heritage (part of RPS)

Project:
13494 - Chalks Farm, Sawbridgeworth, Hertfordshire

Scale:
0 metres 100
1:2000 @ A3

Fig No:
05

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.

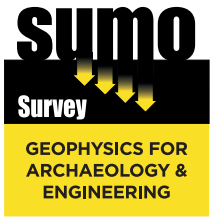
Magnetic susceptibility relates to the induced magnetism of a material when in the presence of a magnetic field. This magnetism can be considered as effectively permanent as it exists within the Earth's magnetic field. Magnetic susceptibility can become enhanced due to burning and complex biological 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.



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