highways england

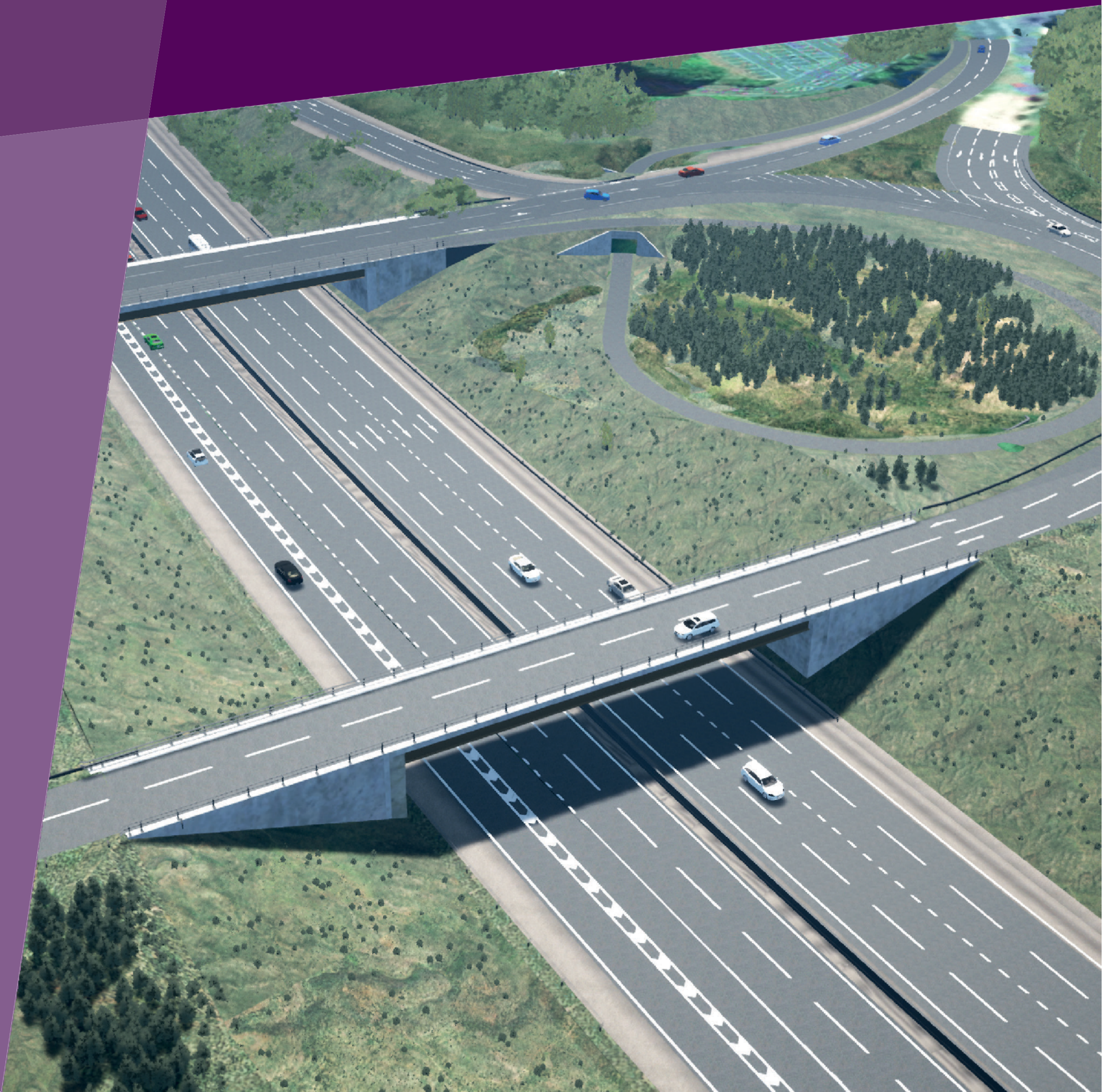
M3

junction 9 improvement scheme

Preliminary Environmental Information Report

Appendix 6.2 – Geophysical Survey Report

May 2021



Appendix 6.2 Geophyiscal Survey Summary Report

M3

Junction 9 Improvement Scheme

Geophysical Survey Summary Report

Registered office Bridge House, 1 Walnut Tree Close, Guildford, GU1 4LZ
Highways England Company Limited registered in England and Wales number 09346363

M3 JUNCTION 9 IMPROVEMENT SCHEME

GEOPHYSICAL SURVEY SUMMARY REPORT

Highways England

First Issue

Project no: 70016638
Date: March 2018

The Victoria
150-182 The Quays,
Salford
M50 3SP

QUALITY MANAGEMENT

ISSUE/REVISION	FIRST ISSUE	REVISION 1	REVISION 2	REVISION 3
Remarks	P01			
Date	March 2018			
Prepared by	Charly Vallance Matthew Shepherd			
Signature				
Checked by	Alison Plummer			
Signature pp				
Authorised by	Joanne North			
Signature				
Project number	70016638			
Report number	HE551511-WSP-GEN-M3J9PCF3-RE-LH-00015			

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TABLE OF CONTENTS

1 INTRODUCTION

1.1 PURPOSE OF REPORT

1.1.1 WSP was commissioned by Highways England to undertake a geophysical survey of the proposed junction improvements at M3 Junction 9. This report summarises the survey and reporting (see Appendix 1) undertaken by Sumo Services Ltd in February 2018.

2 METHODOLOGY

2.1 SURVEY AND SURVEYING TECHNIQUES

2.1.1 The survey area was divided into four survey areas as shown in Figure 2.1. This included:

- Area 1 – Located between the M3 and the A34
- Area 2 – Located immediately north of the depot, north of the existing M3 Junction 9 roundabout
- Area 3 – Located to the south-east of the existing M3 Junction 9 roundabout
- Area 4 – Located to the east of the M3 and north east of the existing M3 Junction 9 roundabout.

2.1.2 Due to deep ploughing, the southern part of Area 3 could not be accessed for survey.

2.1.3 All fieldwork has been conducted in accordance with the latest guidance documents issued by Historic England[1] (then English Heritage), the Chartered Institute for Archaeologists[2] and the European Archaeological Council[3] .

2.1.4 Detailed magnetic surveying was chosen as it is an efficient and effective method of locating archaeological anomalies. Further information can be found in Appendix 1.

---

[1] English Heritage (2009), Geophysical Survey in Archaeological Field Evaluation
[2] Chartered Institute for Archaeologists (CIfA) (2014/6), Standard and Guidance for Archaeological Geophysical Survey. Amended 2016
[3] European Archaeoligical Council (EAC) (2016), Guidelines for the Use of Geophysics in Archaeology.

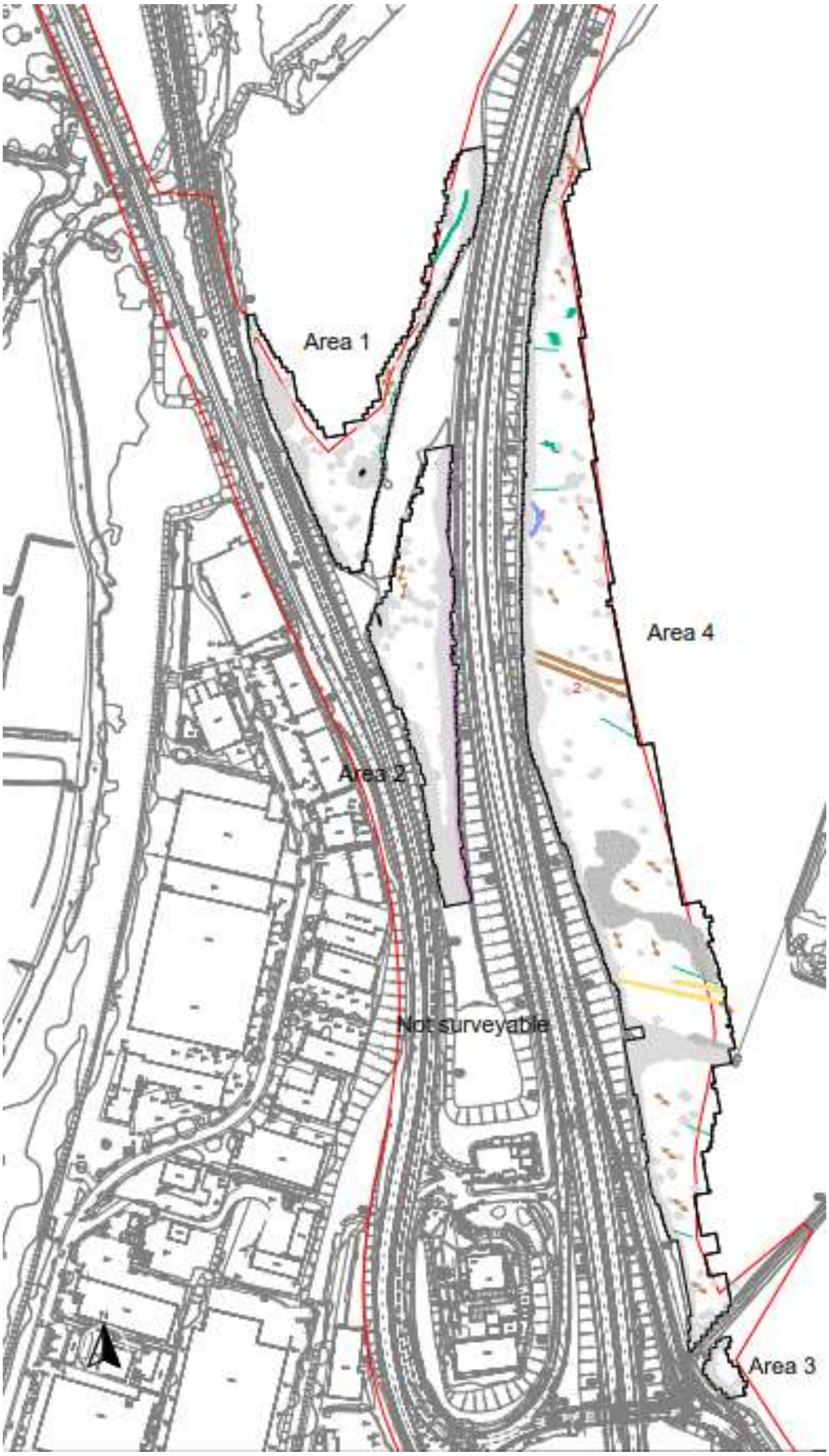

Figure 2.1 - Survey Areas

2.1.5 All anomalies discovered fall within one of the following interpretation categories:

- Possible Archaeology
  - These anomalies exhibit either weak signal strength, 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 signal distortion as a result of data collection orientation.
- 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.
- Former Field Boundary (probable and 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.
- Agriculture (ploughing)
  - Parallel linear anomalies or trends with a narrower spacing, sometimes aligned with existing boundaries, indicating more recent cultivation regimes.
- 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.

3 SUMMARY OF RESULTS

POSSIBLE ARCHAEOLOGY

3.1.1 A short ditch-like anomaly in Area 4 forms an arc and may represent part of a prehistoric ring ditch truncated by the motorway.

UNCERTAIN

3.1.2 Several discrete anomalies and trends across the survey areas have been classified as Uncertain Origin. They lack the defined morphology of anomalies that would normally be interpreted as having an archaeological provenance; they are isolated and form no discernible pattern. These anomalies probably reflect variations in pedology or underlying geology, or may be due to agricultural causes. Some ostensibly pit-like responses may be due to deeply buried ferrous objects.

FORMER FIELD BOUNDARIES

3.1.3 Two former field boundaries depicted on First Edition OS mapping have been identified in Area 4. The first former field boundary traverses the area, while a short length of a second example is visible in the extreme north in the approximate position of the mapped boundary.

3.1.4 Positive linear anomalies could be due to former boundaries, but none are shown in this location on available historic mapping. They have therefore been categorised as Former Field Boundary – Conjectural.

AGRICULTURAL – PLOUGHING

3.1.5 Magnetically weak, often barely visible, closely spaced narrow anomalies in all areas suggest relatively recent ploughing (not archaeologicall).

FERROUS AND MAGNETIC DISTURBANCE

3.1.6 Areas 1, 2 and 3 are magnetically “noisy”. This is unsurprising given their locations and is due to the construction of the surrounding motorways and new roads.

3.1.7 An area of magnetic disturbance in Area 4 is probably of relatively recent origin.

3.1.8 A pipe was detected crossing the south of Area 4.

3.1.9 Ferrous responses close to boundaries are due to adjacent fences and gates. Smaller scale ferrous anomalies ("iron spikes") are present throughout the data and their form is best illustrated in the XY trace plots. These responses are characteristic of small pieces of ferrous debris (or brick / tile) in the topsoil and are commonly assigned a modern origin. Only the most prominent of these are highlighted on the interpretation diagram.

4 RECOMMENDATIONS

4.1.1 The survey report should be submitted to the Planning Archaeologist at Winchester City Council so they can make recommendations for any intrusive investigations that may need to be carried out as part of the environmental assessment works.

APPENDICES

GEOPHYSICAL SURVEY REPORT

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

M3 J9 Improvement Scheme

Client
WSP
For
Highways England

Survey Report
12354

Date
February 2018

Incorporating

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and

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GEOPHYSICAL SURVEY REPORT

Project name:
M3 J9 Improvement Scheme

SUMO Job reference:
12354

Client:
WSP
For:
Highways England

Survey date:
12 – 15 February 2018

Report date:
28 February 2018

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Project Manager:
Jon Tanner BSc MSc PCIfA

Report approved by:
Dr John Gater BSc DSc(Hon) MCIfA FSA

TABLE OF CONTENTS

LIST OF FIGURES

DIGITAL CONTENT (Archive Data CD/DVD)

- Minimally Processed Greyscale Images and XY Trace Plots in DWG format
- Digital Copies of Report Text and Figures (both PDF and native formats)

1 SUMMARY OF RESULTS

1.1 The geophysical survey at Junction 9 of the M3 motorway identified a possible partial ring ditch, truncated by the road embankment. Former field boundaries, both corroborated and conjectural, were recorded and a pipe was located. Relatively recent plough marks are also visible in the dataset.

2 INTRODUCTION

2.1 Background synopsis

2.1.1 **SUMO Geophysics** were commissioned to undertake a geophysical survey of an area outlined for motorway improvements. This survey forms part of an archaeological investigation being undertaken by **WSP** on behalf of **Highways England**.

2.2 Site details

NGR / Postcode	SU 496 304 / SO23 7UD
Location	The site is located on the north-east edge of Winchester, either side of the M3 motorway immediately north of Junction 9.
HER/SMR	Winchester HER
District / County	Winchester City Council / Hampshire CC
Parish	Itchen Valley CP
Topography	Flat
Current Land Use	Arable and pasture. The area south of Area 3 was ploughed and unsurveyable.
Weather	Fair
Geology	Solid: Seaford Chalk Formation - chalk. Superficial: none recorded (BGS 2018).
Soils	Areas 1 and 2: none recorded. Areas 3 and 4: Andover 1 (343h) association shallow well-drained calcareous silty soils over chalk on slopes and crests. Deep calcareous and non-calcareous fine silty soils in valley bottoms (SSEW 1983).
Archaeology	Extensive Prehistoric and Romano-British settlement has been identifed in the surrounding landscape. A number of cropmarks are recorded within the survey area (WSP 2017).
Survey Methods	Magnetometer survey (fluxgate gradiometer)
Study Area	14.2ha

2.3 Aims and Objectives

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

3 METHODS, PROCESSING & PRESENTATION

3.1 Standards & Guidance

3.1.1 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

3.2.1 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 Appendix A.

3.3 Data Processing

3.3.1 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

3.4.1 The presentation of the results for each site involves a grey-scale plot of processed data. Magnetic anomalies are identified, interpreted and plotted onto the 'Interpretation' drawings. The minimally processed data are provided as a greyscale image in the Archive Data Folder with an XY trace plot in CAD format. A free viewer is available: https://viewer.autodesk.com

3.4.2 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 four survey areas (Areas 1 - 4) and specific anomalies have been given numerical labels [1] [2] *which appear in the text below, as well as on the Interpretation Figure.*

4.1 *Possible Archaeology*

4.1.1 A short ditch-like anomaly [1] in Area 4 forms an arc and may represent part of a ring ditch truncated by the motorway.

4.2 *Uncertain*

4.2.1 Several discrete anomalies and trends across the survey areas have been classified as *Uncertain Origin.* They lack the defined morphology of anomalies that would normally be interpreted as having an archaeological provenance; they are isolated and form no discernible pattern. These anomalies probably reflect variations in pedology or underlying geology, or may be due to agricultural causes. Some ostensibly pit-like responses may be due to deeply buried ferrous objects.

4.3 *Former Field Boundaries*

4.3.1 Two former field boundaries depicted on First Edition OS mapping have been identified in Area 4. The first traverses the area at [2] whilst a short length of a second example [3] is visible in the extreme north in the approximate position of the mapped boundary.

4.3.2 Positive linear anomalies [4] could be due to former boundaries, but none are shown in this location on available historic mapping. They have therefore been categorised as *Former Field Boundary – Conjectural.*

4.4 *Agricultural – Ploughing*

4.4.1 Magnetically weak, often barely visible, closely spaced narrow anomalies in all areas suggest relatively recent ploughing.

4.5 *Ferrous / Magnetic Disturbance*

4.5.1 Areas 1, 2 and 3 are magnetically “noisy”. This is unsurprising given their locations and is due to the construction of the surrounding motorways and new roads.

4.5.2 An area of magnetic disturbance in Area 4 is probably of relatively recent origin.

4.5.3 A pipe was detected crossing the south of Area 4

4.5.4 Ferrous responses close to boundaries are due to adjacent fences and gates. Smaller scale ferrous anomalies ("iron spikes") are present throughout the data and their form is best illustrated in the XY trace plots. These responses are characteristic of small pieces of ferrous debris (or brick / tile) in the topsoil and 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 chalk is good. As a possible partial ring dich and former field boundaries have been identified it can be deemed that the technique has worked successfully.

6 CONCLUSION

6.1 A possible truncated ring ditch has been identified. Former field boundaries and a pipe have also been detected. Anomalies of uncertain origin are likely to be due to natural or agricultural soil effects.

7 REFERENCES

BGS 2018 British Geological Survey, Geology of Britain viewer [accessed 27/02/2018] *website*: (http://www.bgs.ac.uk/opengeoscience/home.html?Accordion1=1#maps)

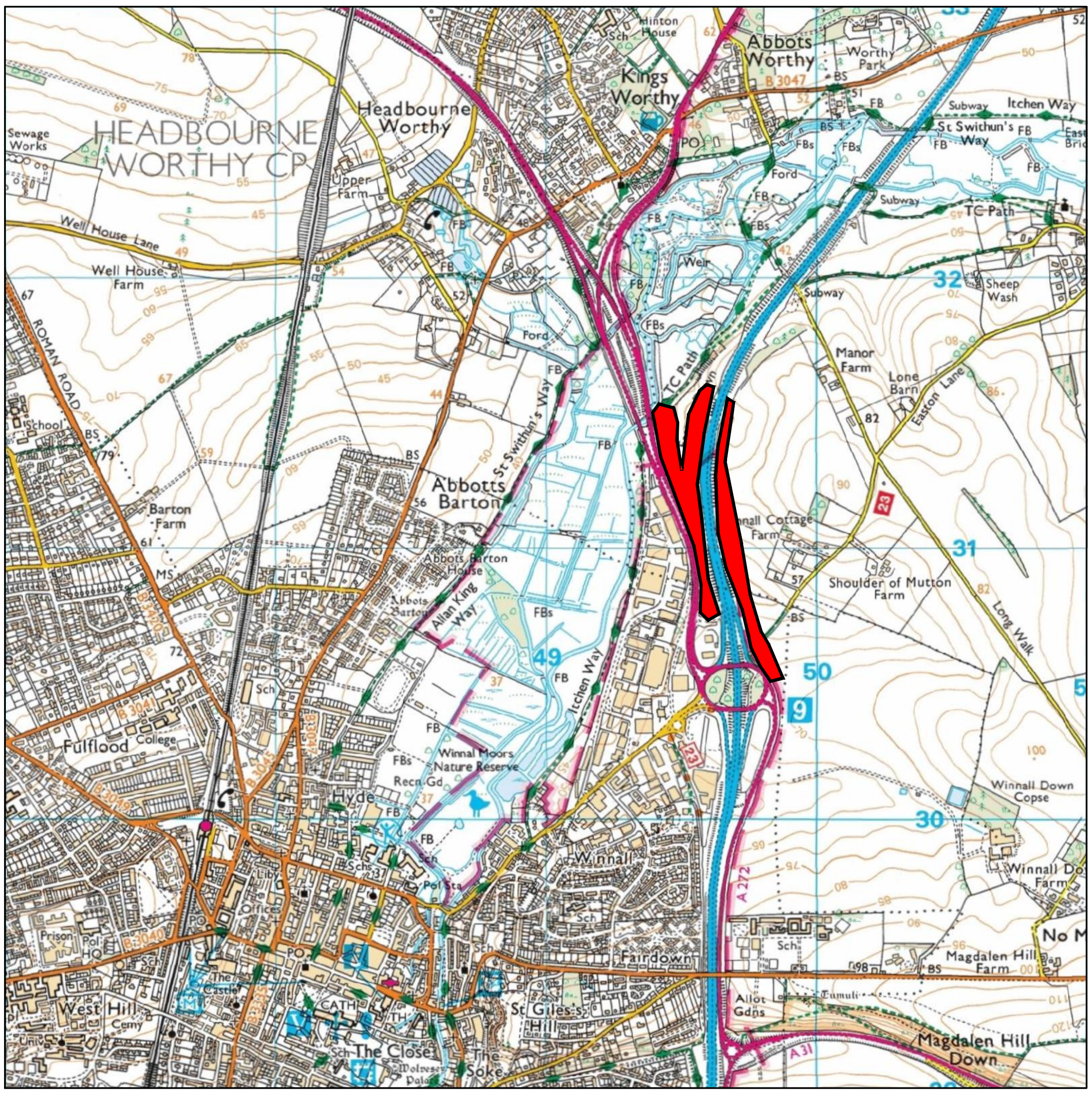
CIfA 2014 *Standard and Guidance for Archaeological Geophysical Survey.* Amended 2016. CIfA Guidance note. Chartered Institute for Archaeologists, Reading http://www.archaeologists.net/sites/default/files/CIfAS%26GGeophysics_2.pdf

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 6 South East England*. Soil Survey of England and Wales, Harpenden.

WSP 2017 *M3 Junction 9 Improvement Scheme: Cultural Heritage Desk-Based Assessment.* Unpublished report. WSP Salford.



N

Site Location

Reproduced from Ordnance Survey's 1:25 000 map of 1998 with the permission of the controller of Her Majesty's Stationery Office.

SUMO Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

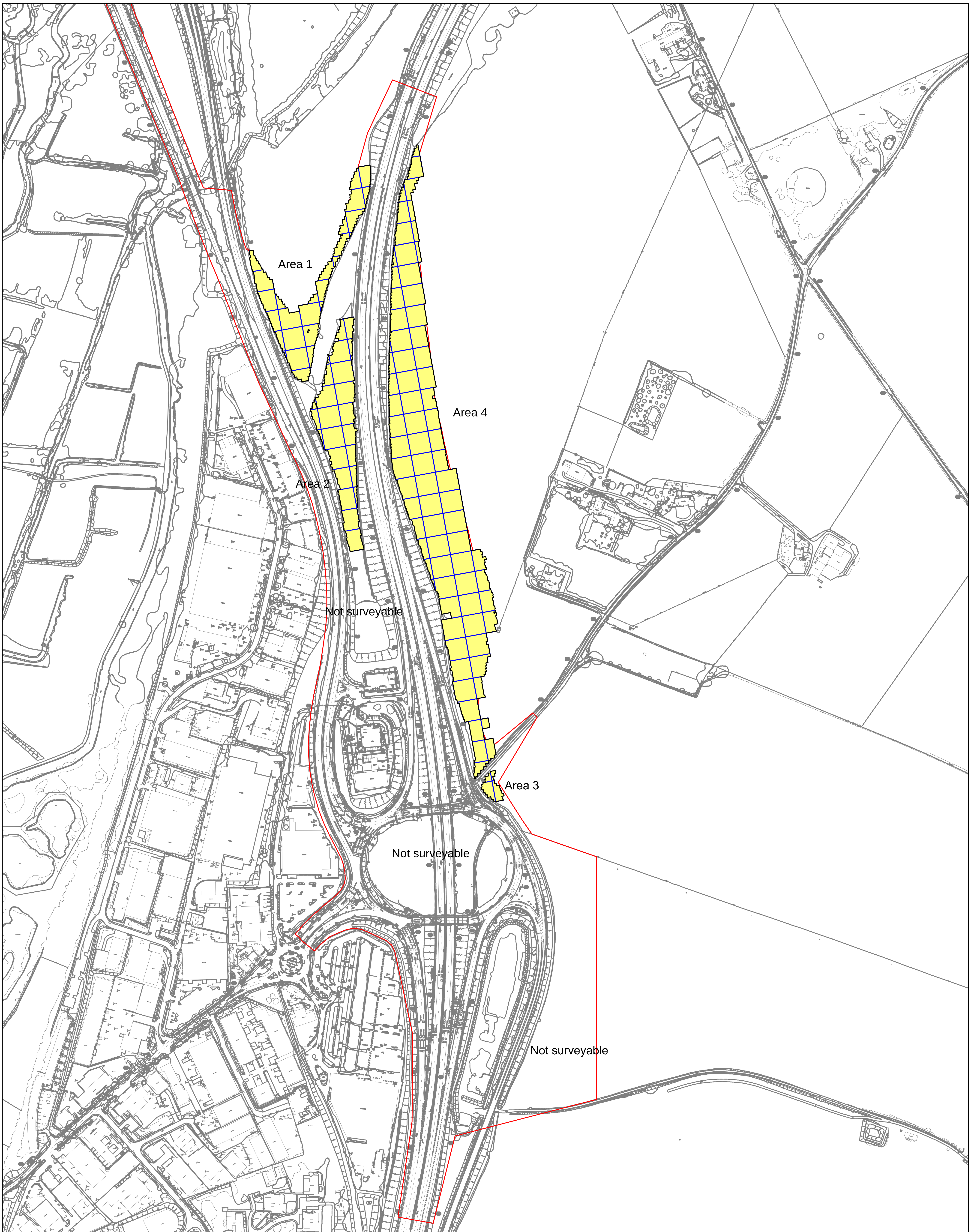
Title: Site Location Diagram

Client: WSP

Project: 12354 M3 J9 Improvement Scheme

Scale: 0 metres 1250
1:25000 @ A3

Fig No: 01



Magnetometer Survey Area showing 30m grids

N

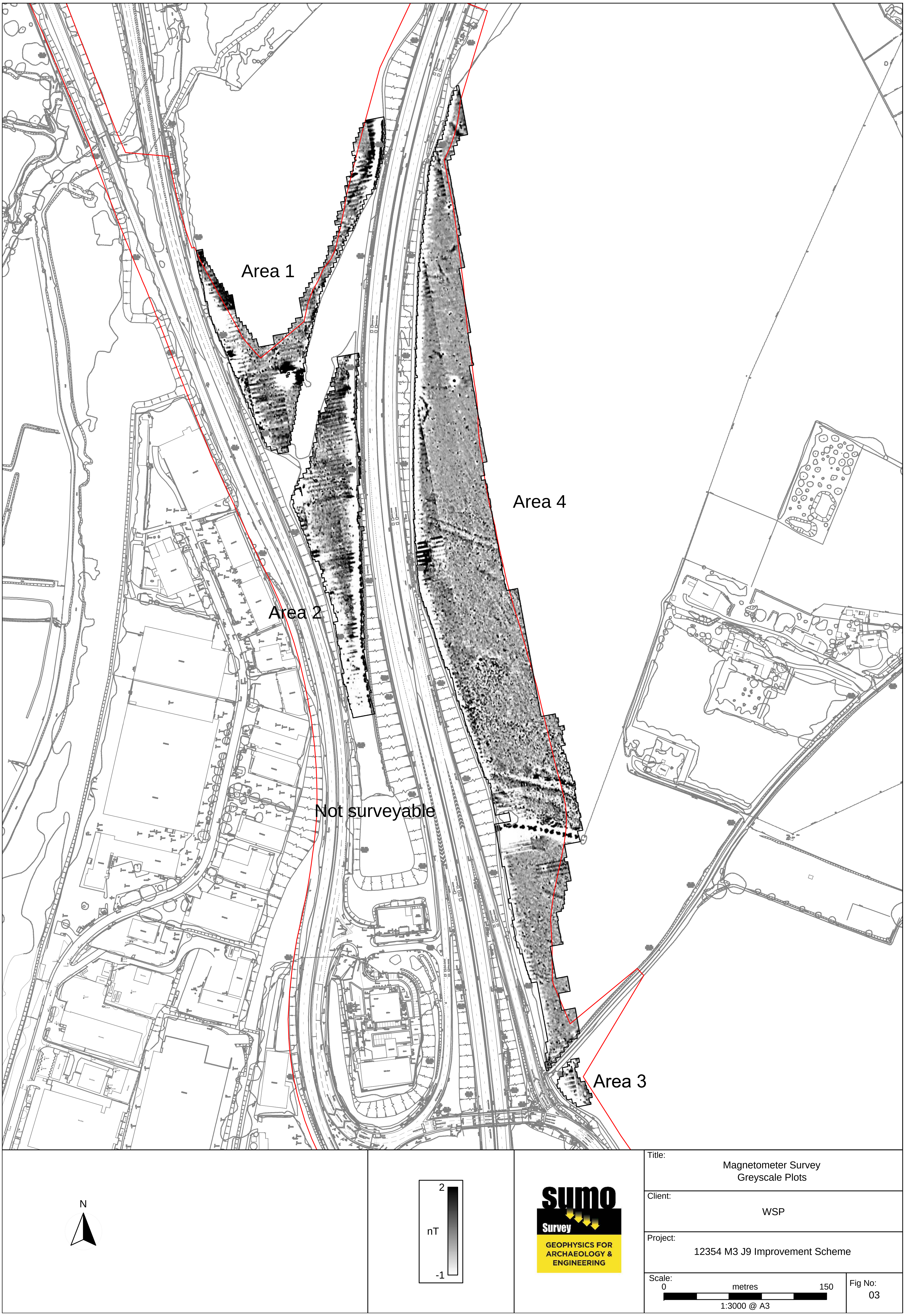
Title: Location of Survey Areas

Client: WSP

Project: 12354 M3 J9 Improvement Scheme

Scale: 0 metres 250 1:5000 @ A3

Fig No: 02



Title: Magnetometer Survey Greyscale Plots

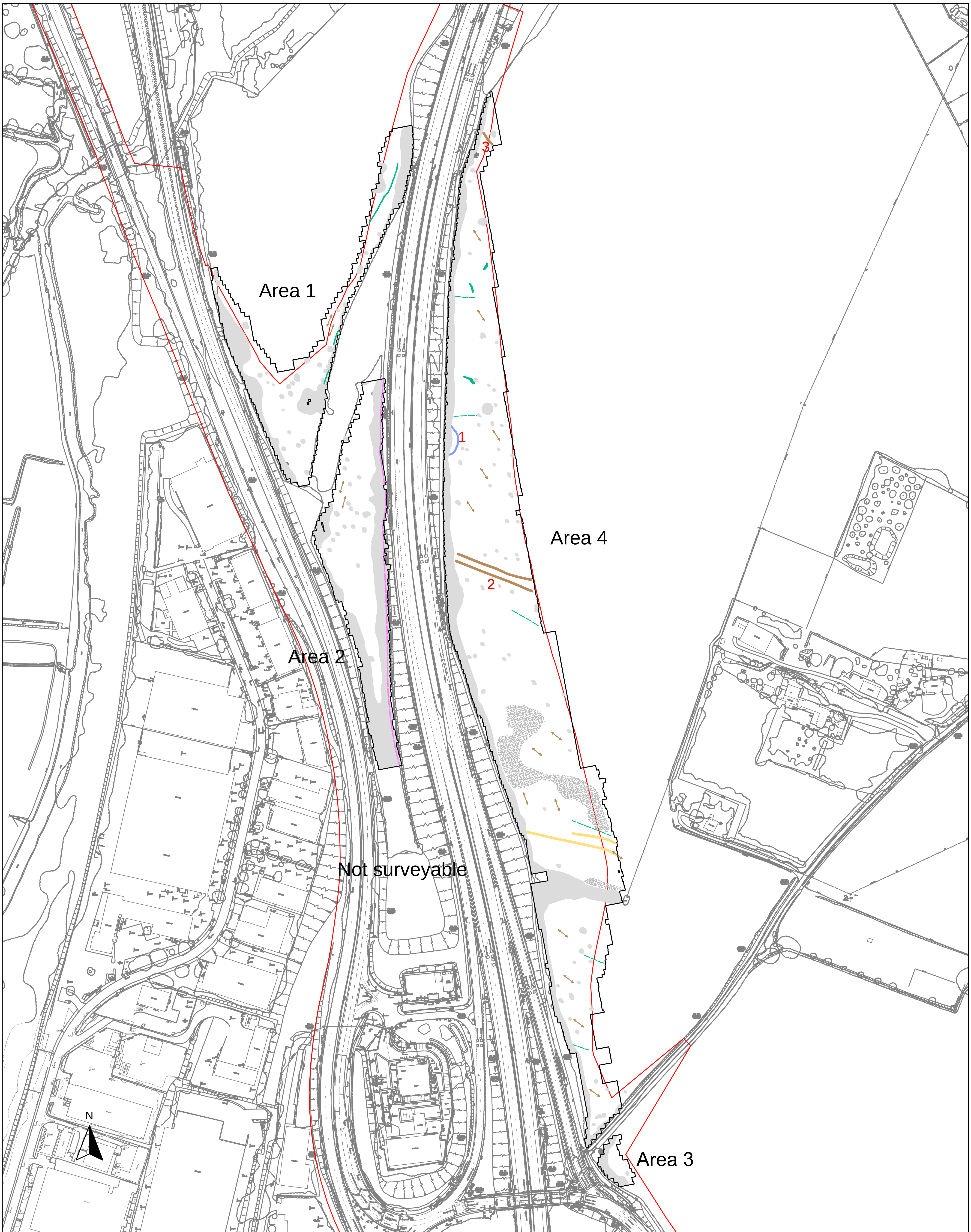
Client: WSP

Project: 12354 M3 J9 Improvement Scheme

Scale: 0 metres 150 1:3000 @ A3

Fig No: 03

SUMO Survey GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING



KEY

	Possible Archaeology		Ploughing
	Uncertain Origin (discrete / trend)		Pipe
	Former Field Boundary (corroborated)		Magnetic Disturbance
	Former Field Boundary (conjectural)		Ferrous

SUMO Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title: Magnetometer Survey Interpretation

Client: WSP

Project: 12354 M3 J9 Improvement Scheme

Scale: 0 metres 150
1:3000 @ A3

Fig No: 04

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.
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.

SUMO Survey

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

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

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