

## **GEOPHYSICAL SURVEY REPORT**

**Phase 3, Willow Heights, Thurnscoe, South Yorkshire**

Client

**MAP Archaeology Ltd**

Survey Report

**16831**

Date

**January 2020**



**Survey Report 16831: Phase 3, Willow Heights, Thurnscoe, South Yorkshire**

**Survey dates** 15-17 January 2020

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### 2. SURVEY TECHNIQUE

Detailed magnetic survey (magnetometry) was chosen as the most efficient and effective method of locating the type of archaeological anomalies which might be expected at this site.

Bartington Grad 601-2                      Traverse Interval 1.0m                      Sample Interval 0.25m

### 3 SUMMARY OF RESULTS

- 3.1 The survey has identified no anomalies of archaeological interest, though ridge and furrow ploughing has been recorded. Several anomalies of uncertain origin were identified, and these are likely modern and/or agricultural in origin. Four field boundaries have been identified, two of which correspond with boundaries recorded on historical mapping and two conjectural. An uncertain trend in the south-west of the dataset could potentially be a continuation of the conjectural field boundary separately identified in the results. A band magnetic disturbance corresponds with the location of a stream and other areas of magnetic disturbance and ferrous anomalies close to the edges of the survey are likely to be due to modern processes. The location of a service pipe has been marked.

### 4 INTRODUCTION

- 4.1 **SUMO Geophysics Ltd** were commissioned to undertake a geophysical survey of an area outlined for development. This survey forms part of an archaeological investigation being undertaken by **MAP Archaeology Ltd**.

#### 4.2 Site details

NGR / Postcode	SE 45828 06296 / S63 0AT
Location	The site is located 11km east of Barnsley and 12km west of Doncaster. The survey area is lies on the northern outskirts of Thurnscoe and is bounded to the south by Lingmore Leys, houses of Merrill Road to the west and by a railway line to the east.
HER	South Yorkshire Archaeological Services
District	Barnsley
Parish	Non civil parish
Topography	Undulating
Current Land Use	Agricultural
Geology (BGS 2020)	Bedrock: Pennine Upper Coal Measures Formation - mudstone, siltstone and sandstone Newstead Rock - sandstone Superficial: None recorded
Soils (CU 2020)	Soilscape 17: Slowly permeable seasonally wet acid loamy and clayey soils.
Archaeology (CS 2006)	The site is not located within a Conservation Area, nor are there any Scheduled Monuments or Listed Buildings within the site boundary. There is some potential for medieval archaeology within the site, as it is located near a probable medieval grange and the supposed site of a medieval chapel. Crop marks have been recorded in aerial photography; however, these lines seem to reflect modern field boundaries. Therefore, this site is believed to be of low archaeological potential.
Survey Methods	Magnetometer survey (fluxgate gradiometer)
Study Area	11 ha

#### 4.3 Aims and Objectives

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

## 5 RESULTS

*Specific anomalies have been given numerical labels [1] [2] which appear in the text below, as well as on the interpretation figure.*

### 5.1 **Probable / Possible Archaeology**

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

### 5.2 **Uncertain**

5.2.1 An uncertain trend [1] has been detected in the south-west corner of the site; given the close proximity of a conjectural field boundary [2] (see 5.3.2) to the east, it is possible it is a continuation of this boundary. The uncertain response is generally weaker than the conjectural field boundary, but this is possibly due to the heavy ploughing which has taken place west of the stream.

5.2.2 Several other uncertain trends and discrete anomalies have been identified, however these are likely to be modern and/or agricultural in origin.

### 5.3 **Field Boundaries (Corroborated / Conjectural)**

5.3.1 Two linear anomalies have been detected in the dataset and correspond with two former field boundaries that are visible on historic mapping and aerial imagery (see Figure 04).

5.3.2 Two discrete linear responses have been recorded which appear magnetically similar to the corroborated field boundaries (see 5.3.1), but do not appear on historical or contemporary mapping. Therefore, they have been classified as conjectural.

### 5.4 **Agricultural – Ploughing**

5.4.1 Broad parallel linear responses in the data are indicative of past ridge and furrow; this is especially prominent in the western half of the site.

### 5.5 **Service Pipes**

5.5.1 A dipolar ferrous response has been detected traversing the survey area roughly east to west. Such a response is indicative of a service pipe.

### 5.6 **Ferrous / Magnetic Disturbance**

5.6.1 The large magnetic response orientated from the north and curving to the south west of the site is due to the small stream flowing through the area.

5.6.2 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.

## 6 DATA APPRAISAL & CONFIDENCE ASSESSMENT

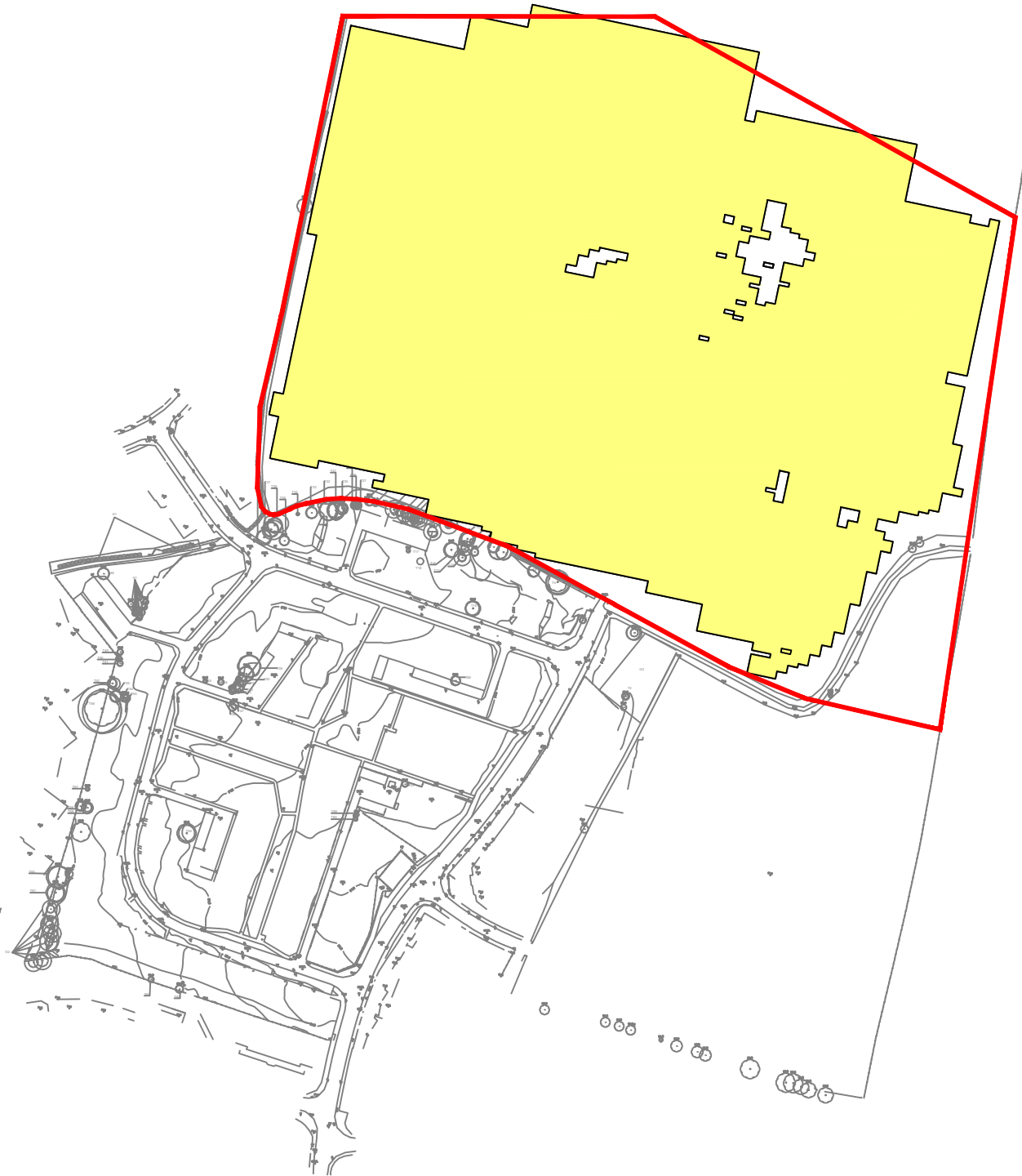
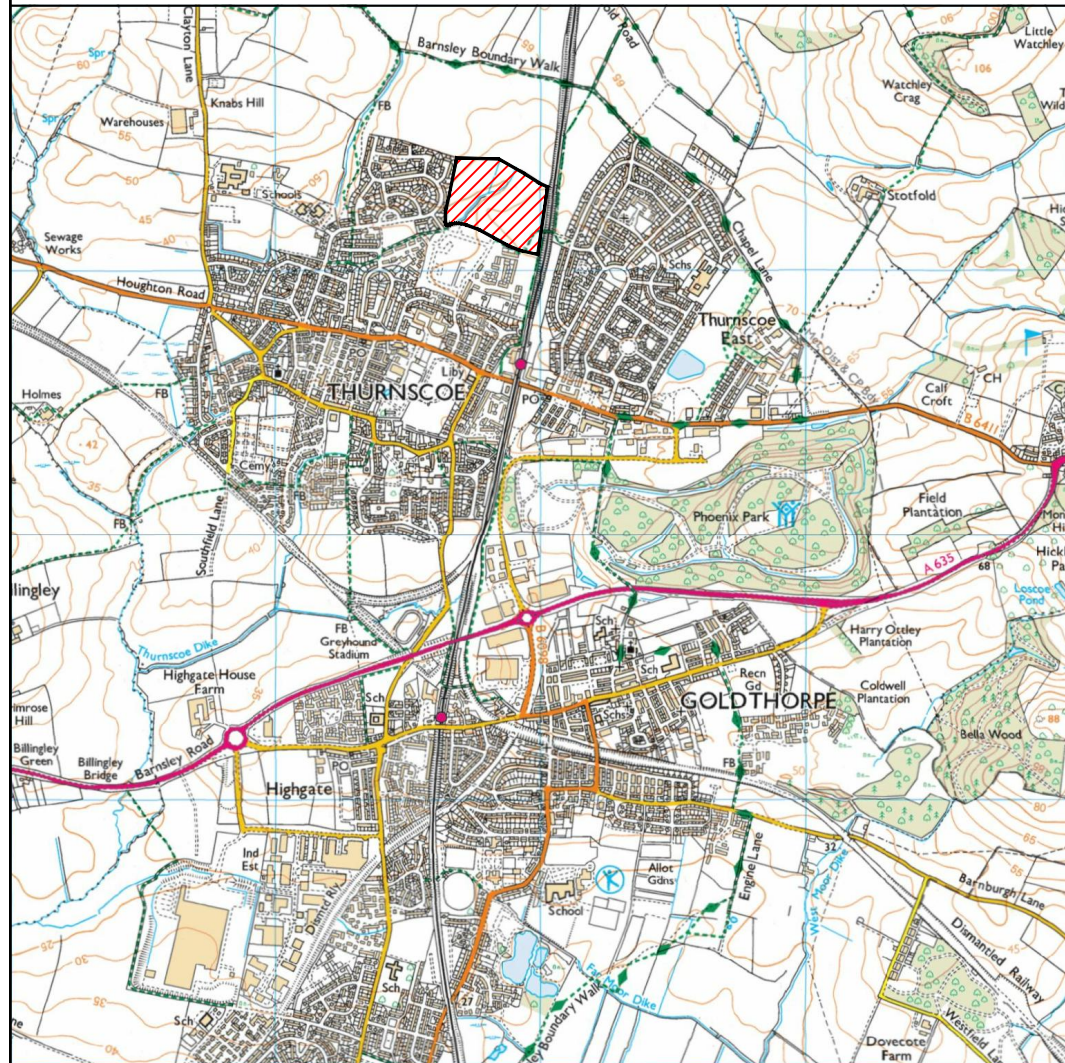
- 6.1 Historic England guidelines (EH 2008) Table 4 states that the typical magnetic response on the local soils / geology can range from poor to average. The results from this survey indicate the presence of ridge and furrow and former field boundaries; consequently, there is no *a priori* reason why archaeological features would not have been detected, if present.

## 7 CONCLUSION

- 7.1 No responses of archaeological interest were recorded over the course of this survey. While some uncertain responses were detected, these are likely modern and agricultural in nature. Two corroborated former field boundaries have been identified along with two conjectural boundaries. An uncertain trend may be a continuation of one of these postulated boundaries. Ridge and furrow ploughing has been detected in the dataset, especially in the area west of the stream. The band of disturbance from north to south west follows the line of a stream flowing through the site. A service pipe has been located, along with a related strong ferrous feedback. The magnetic and ferrous responses identified around the site edges are due to modern field boundaries and pathways.


## 8 REFERENCES

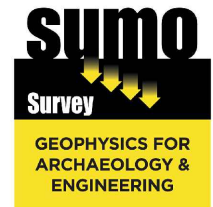
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 Site Location

 Magnetometer Survey



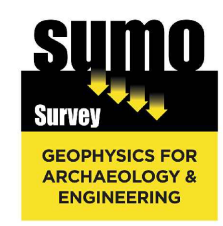
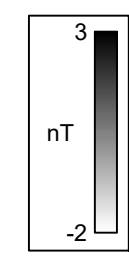
Title: Site Location

Client: MAP Archaeology Ltd

Project: 16831 Phase 3, Willow Heights, Thurnscoe, South Yorkshire

not to scale







Fig No: 01

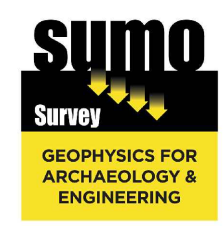



Title:	Magnetometer Survey Greyscale Plot	
Client:	MAP Archaeology Ltd	
Project:	16831 Phase 3, Willow Heights, Thurnscoe, South Yorkshire	
Scale:	 0 metres 75 1:1500 @ A3	Fig No: 02

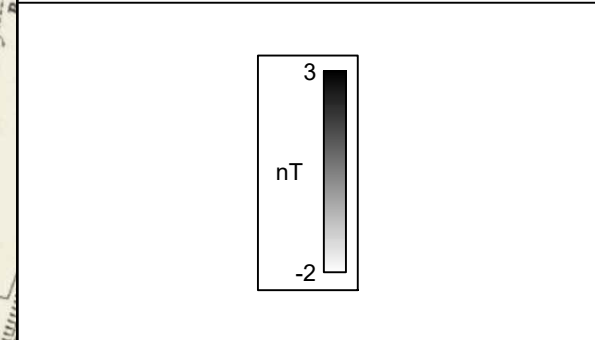
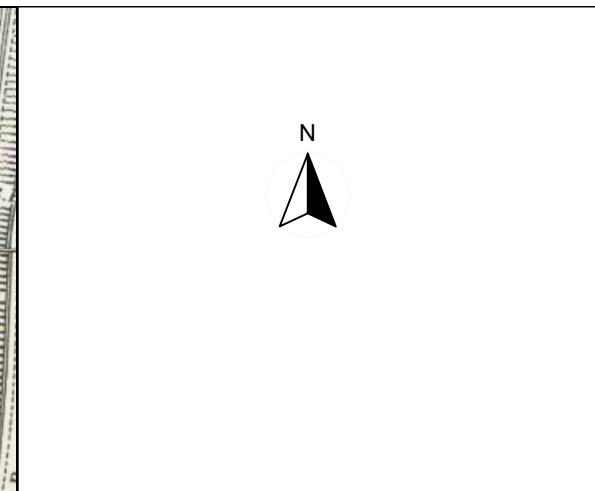
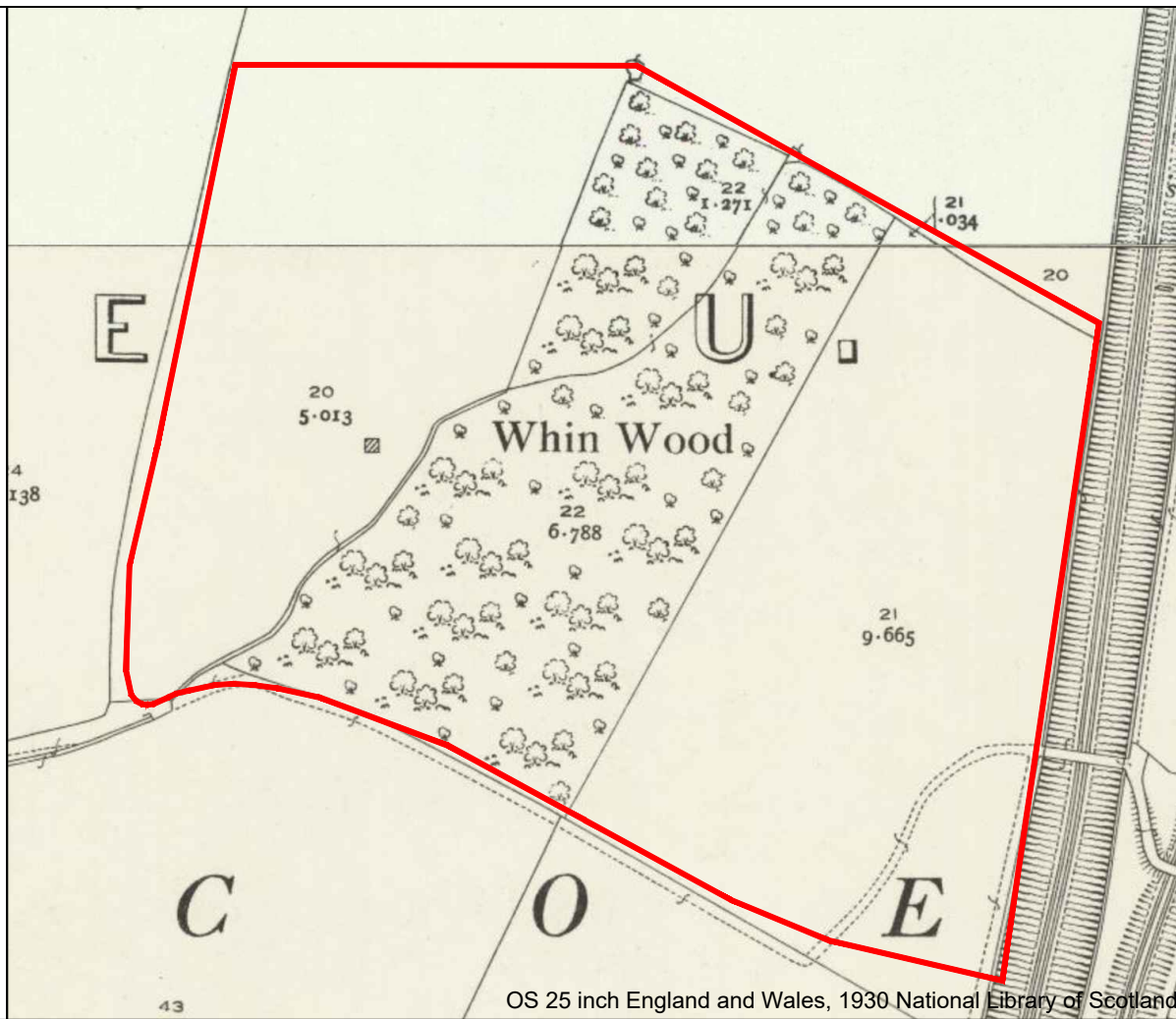
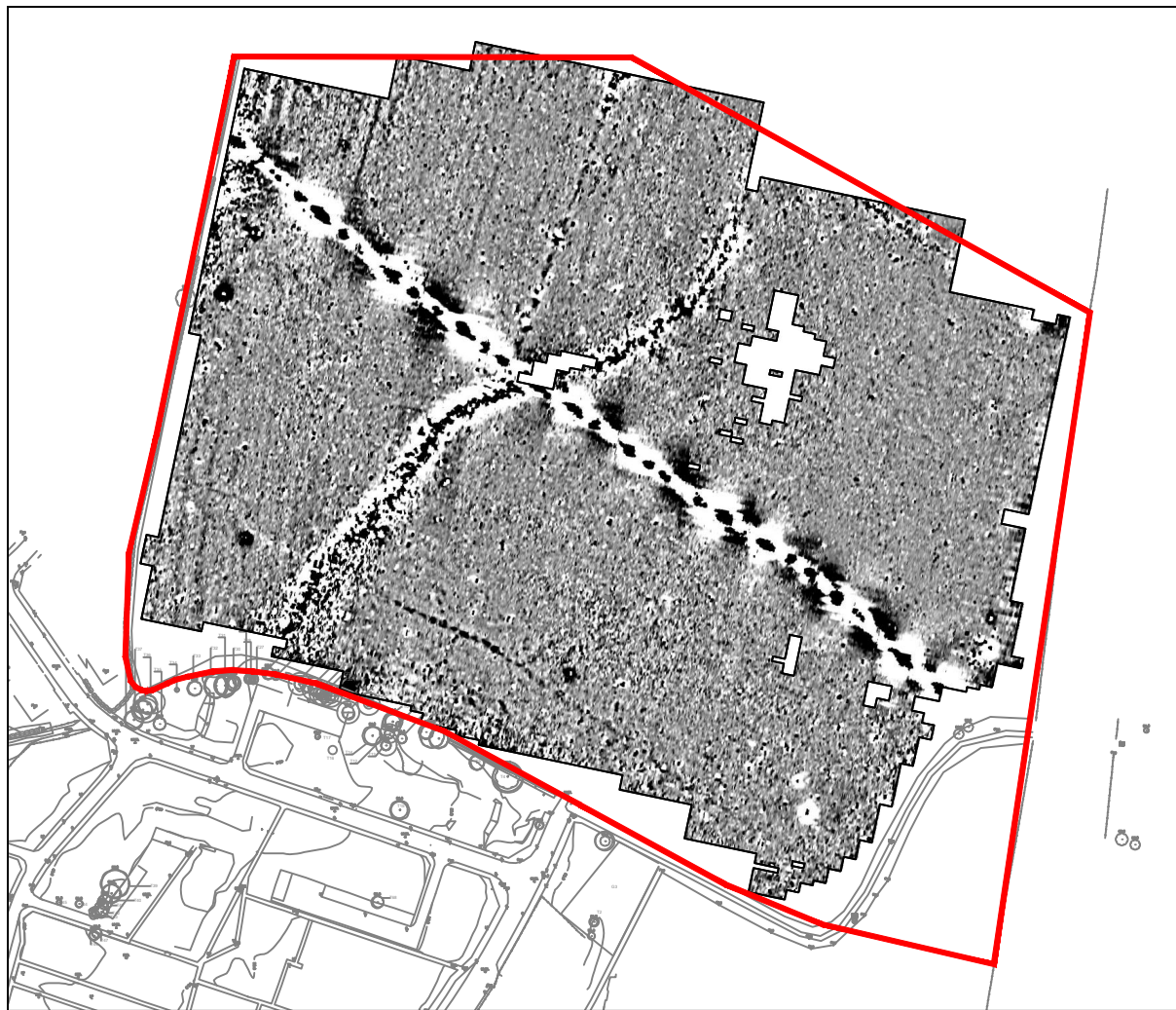


### KEY

	Uncertain (Discrete / Trend)
	Former Field Boundary (Corroborated / Conjectural)
	Ridge and Furrow
	Service Pipe
	Magnetic Disturbance
	Ferrous

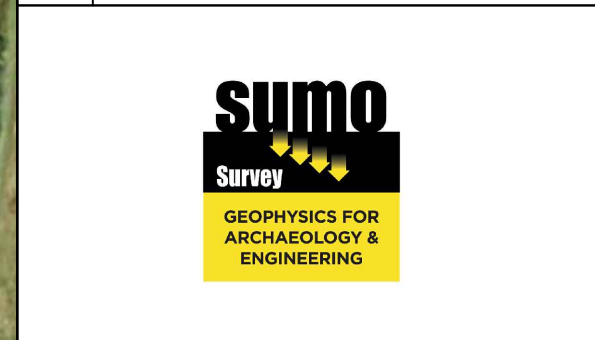


Title:	Magnetometer Survey Interpretation	
Client:	MAP Archaeology Ltd	
Project:	16831 Phase 3, Willow Heights, Thurnscoe, South Yorkshire	
Scale:	 0 metres 75 1:1500 @ A3	Fig No: 03



**KEY**

	Uncertain (Discrete / Trend)
	Former Field Boundary (Corroborated / Conjectural)
	Ridge and Furrow
	Service Pipe
	Magnetic Disturbance
	Ferrous



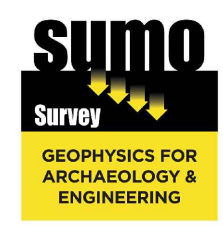
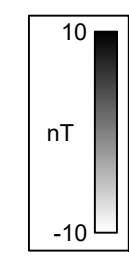
Title: Magnetometer Survey Greyscale Plot / Interpretation / 1930 OS Mapping / Aerial Imagery

Client: MAP Archaeology Ltd

Project: 16831 Phase 3, Willow Heights, Thurnscoe, South Yorkshire

Scale: 0 metres 150  
1:3000 @ A3

Fig No: 04



Title: Magnetometer Survey [Minimally Processed] Greyscale Plot	
Client: MAP Archaeology Ltd	
Project: 16831 Phase 3, Willow Heights, Thurnscoe, South Yorkshire	
Scale: 0 metres 75 1:1500 @ A3	Fig No: 05

## 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).

## 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	This process sets the background mean of each traverse within each grid to zero.
Traverse	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.
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## **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.

## 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.

<i>Archaeology / Probable Archaeology</i>	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.
<i>Possible Archaeology</i>	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.
<i>Industrial / Burnt-Fired</i>	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.
<i>Former Field Boundary (probable &amp; possible)</i>	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.
<i>Ridge &amp; Furrow</i>	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.
<i>Agriculture (ploughing)</i>	Parallel linear anomalies or trends with a narrower spacing, sometimes aligned with existing boundaries, indicating more recent cultivation regimes.
<i>Land Drain</i>	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.
<i>Natural</i>	These responses form clear patterns in geographical zones where natural variations are known to produce significant magnetic distortions.
<i>Magnetic Disturbance</i>	Broad zones of strong dipolar anomalies, commonly found in places where modern ferrous or fired materials (e.g. brick rubble) are present.
<i>Service</i>	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.
<i>Ferrous</i>	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.
<i>Uncertain Origin</i>	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 <i>Possible Archaeology / Natural</i> or (in the case of linear responses) <i>Possible Archaeology / Agriculture</i> ; 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.

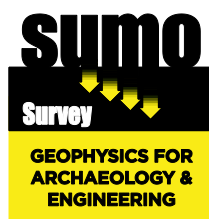
Magnetic susceptibility relates to the induced magnetism of a material when in the presence of a magnetic field. This magnetism can be considered as effectively permanent as it exists within the Earth's magnetic field. Magnetic susceptibility can become enhanced due to burning and complex biological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