

RRGO/01



LAND OFF RAWCLIFFE ROAD, GOOLE, EAST YORKSHIRE ELECTROMAGNETIC SURVEY

commissioned by WYG
on behalf of Central Land Holdings Ltd

DC/15/0305/STOUT/STRATPP-02930917

June 2017

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project info

HA JOB NO. RRG0/01
NGR SE 7260 2400
PARISH Goole
LOCAL AUTHORITY East Yorkshire
OASIS REF. headland5-288731

project team

PROJECT MANAGER Sam Harrison
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APPROVED BY Sam Harrison – Project Manager



 **HEADLAND
ARCHAEOLOGY**
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PROJECT SUMMARY

Headland Archaeology (UK) Ltd undertook a geophysical (electromagnetic) survey of land covering 31 hectares at Rawcliffe Road, near Goole, to assess the archaeological potential of the site and inform further archaeological strategies prior to the determination of a planning application. The survey was carried out using a multi-receiver coil which enables readings to be taken at three depths, utilising the in-phase (magnetic susceptibility) and quadrature (conductivity) components of the equipment. The conductivity data has been inverted to display apparent resistivity data.

The survey was carried out in order to map geomorphological features, such as palaeochannels and areas of higher ground, in the former wetland landscape which are now buried beneath alluvial and warped deposits. The identification of areas of higher ground may locate areas favoured for settlement in the prehistoric period. Broad and amorphous anomalies have been recorded in the quadrature and in-phase data, although there is little apparent correlation between the two datasets. The in-phase data shows that there is little change in the magnetic susceptibility of the soil with increasing depth, possibly indicating a uniform soil. The quadrature (apparent resistivity) data shows a number of high resistance areas which may locate areas when the soils are drier and which may have been favoured as areas for settlement amongst a marshy landscape. It should be noted that these interpretations are considered to be tentative. An area where post-medieval material has been spread across part of a field has also been identified in the data.

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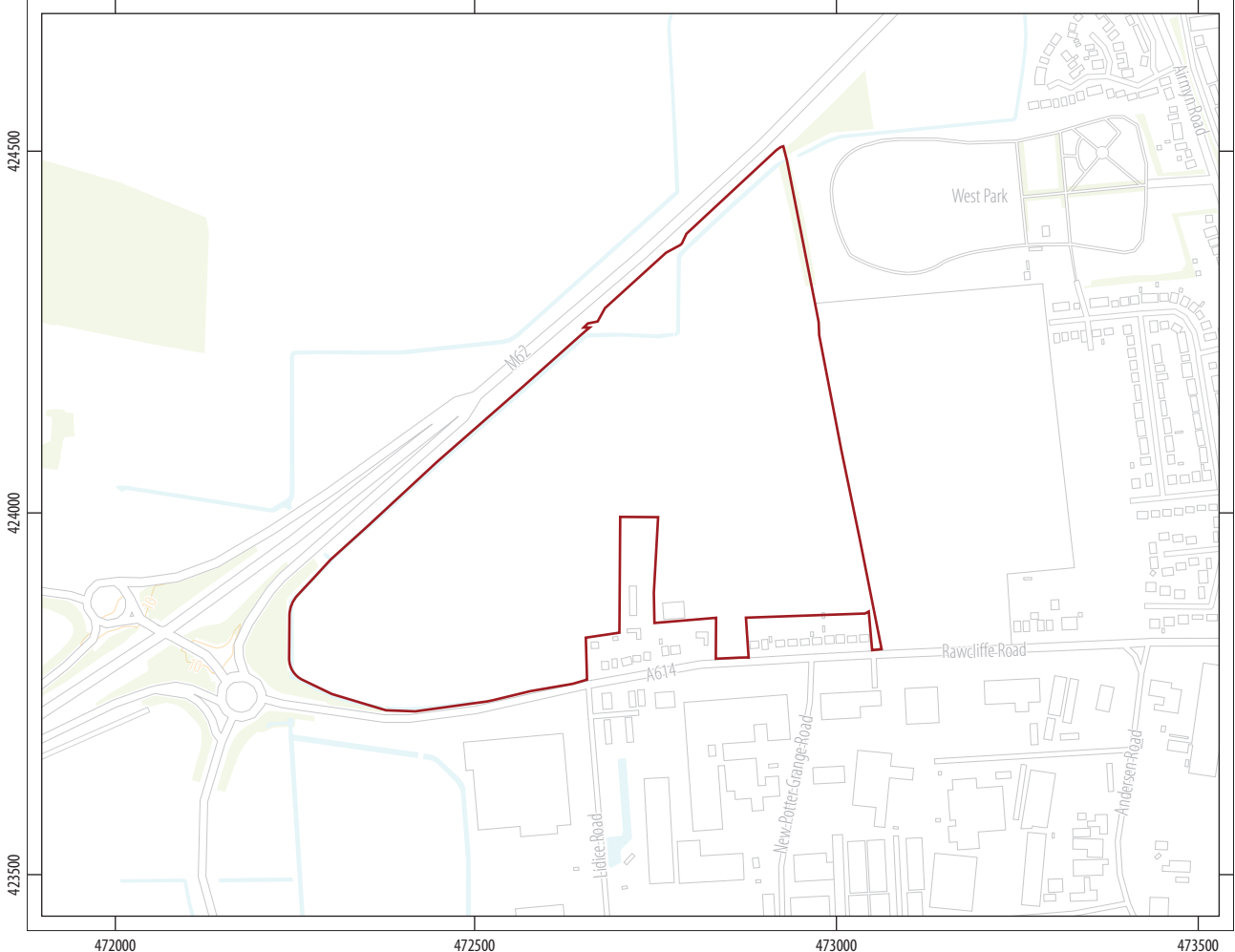
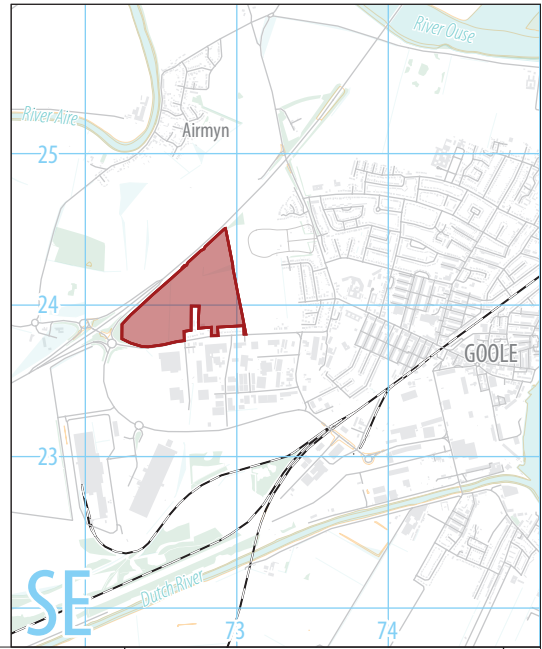
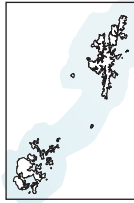
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RRGO/01
 land off Rawcliffe Road
 Goole
 East Yorkshire

0 200km
 1:10,000,000 @ A4

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0 200m
 1:10,000 @ A4

proposed development boundary



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LAND OFF RAWCLIFFE ROAD, GOOLE, EAST YORKSHIRE

GEOPHYSICAL SURVEY

1 INTRODUCTION

Headland Archaeology (UK) Ltd was commissioned by WYG (the Consultant), on behalf of Central Land Holdings Ltd (the Client), to undertake a geophysical (electromagnetic) survey of land off Rawcliffe Road, Goole. The survey was carried out to assist in identifying areas of archaeological potential in advance of the determination of a planning application for a proposed residential development and associated infrastructure.

This work was undertaken in part fulfilment of a condition of the planning consent (Ref: DC/15/0305/STOUT/STRATPP-02930917).

All work was undertaken in line with current best practice (Chartered Institute for Archaeologists 2014, English Heritage 2008).

1.1 SITE LOCATION, LAND-USE AND TOPOGRAPHY

The proposed development area (PDA) comprises a triangular parcel of land, consisting of six fields (F1–F6). The site is bound by Rawcliffe Road, and residential properties along it, to the south with the M62 forming the north-west boundary. Agricultural land extends to the east (see Illus 1). The PDA is centred at NGR 472556 423975 and is located on low lying ground between 1.1m and 1.4m above Ordnance Datum (AOD). Fields F1–F4 were under mid-growth arable crop with two fields unsuitable for survey; F5 was overgrown and F6 not accessible.

The survey was carried out on May 23rd to May 25th 2017 in order to provide additional information on the archaeological potential of the site. The survey was carried out during very hot sunny conditions.

1.2 GEOLOGY AND SOILS

The underlying bedrock geology comprises sandstone of the Sherwood Sandstone Group which is overlain by alluvial superficial

deposits (NERC 2017). The soils are characterised as loams and clays of coastal flats with naturally high ground water with marginal ditches for drainage, being classified in the Soilscape 21 association (Cranfield University 2017a).

The detection of archaeological features beneath deep alluvial and warped deposits (see below) using remote sensing methods is difficult. The depth of alluvium, the magnetic susceptibility of the feature or archaeological deposit and the geomorphology will all have a bearing on the identification of potentially archaeological anomalies.

In addition to the naturally occurring alluvial deposits the surrounding landscape has been identified as containing 'warped' superficial deposits which are created when tide-water has been allowed to flood embanked land and deposit sediment over a period of time, before being released via sluices at a later ebb tide. In this way low marshy areas were gradually built up and transformed into better quality farmland. The process was possible only because of the large quantities of sediment carried by the rivers and the unusual tidal regime of short flow and long ebb (Cranfield University 2017b). This would suggest that the site is located in an area that was particularly marshy in the past.

2 ARCHAEOLOGICAL BACKGROUND

There are no known archaeological records within the PDA in the Humberside Sites and Monuments Record (SMR). Although there is no evidence of archaeological activity recorded within the site it is considered that this may be the result of a lack of archaeological investigation rather than a lack of features (WYG 2017). The primary purpose of the geophysical survey is to provide further information on the archaeological potential of the proposed development site



ILLUS 2 General view of the survey with the CMD Explorer in Field 1, looking west

Analysis of historic mapping indicates that the PDA has changed little since the first edition Ordnance Survey mapping of 1853, with the exception of the construction of the M62 motorway which bisected a number of fields, some of which have since had their boundaries removed. A square feature on the 1891 Ordnance Survey mapping is located towards the southern boundary of the PDA. This feature does not appear before or after this date on the available historic mapping (Old-maps 2017).

3 AIMS, METHODOLOGY AND PRESENTATION

The aims and objectives of the geophysical survey were to gather sufficient information to establish the presence/absence of any areas of potential archaeological activity within the PDA, and to inform further strategies, if required, although it is widely accepted that the detection of archaeological features at depths greater than 1m on alluvial landscapes is problematic (English Heritage 2008).

Initially a magnetometer survey was proposed by the Consultant (WYG 2017) although it was acknowledged that this may not be the most appropriate method under the prevailing site conditions. Therefore, following discussion with Headland Archaeology, it was

agreed that an alternative approach (ground conductivity) might have an increased chance of identifying archaeological activity by locating areas of higher ground which may have been suitable for settlement.

The instrument used for the survey (see below) has various environmental applications and is used to map landfills, buried metal objects, and shallow groundwater contamination, as well as geotechnical applications such as measuring soil thickness. The technique is also used in archaeological applications to identify geomorphological changes underneath alluvium, such as broad palaeochannels, which in turn may indicate where drier areas of land may have been in the past. It should be noted that individual archaeological features are not likely to be identified by this technique.

The specific archaeological objectives of the geophysical survey were:

- › to provide information about the nature and possible interpretation of any electromagnetic anomalies identified;
- › to therefore model the presence/absence and extent of any areas favourable for archaeological activity; and
- › to prepare a report summarising the results of the survey.

3.1 ELECTROMAGNETIC SURVEY

Electromagnetic (EM) survey methods measure the response of the ground to the transmission of electromagnetic waves. A transmitter coil induces an alternating magnetic field which creates electrical currents that are scaled to the conductivity of the ground at that point. These currents produce a secondary magnetic field that are measured by a receiver coil on the instrument. Two signals can be recorded; the in-phase component (proportional to the magnetic susceptibility), and the quadrature component (the response to electrical conductivity, which is the reciprocal of resistivity). Theoretically the EM instrument can collect datasets comparable to both the earth resistance and the magnetic response from a site (Gaffney and Gater 2003, David et al. 2008). For this report the conductivity readings have been inverted so as to display the data as apparent resistivity.

The survey was undertaken using a GF Instruments CMD Explorer with the CMD Control Unit attached to a GPS receiver. Terrasurveyor V3.0.32.4 (DWConsulting) software has been used to process and present the data.

The CMD Explorer is a multi-receiver coil, with coils at 1.48m, 2.82m and 4.49m from the transmitter. When used in vertical dipole mode (as here) this equates to effective depth penetrations of 2.3m, 4.2m and 6.7m respectively. In-phase (magnetic susceptibility) and quadrature phase (conductivity) readings can be made from all three dipoles simultaneously. Data was collected at 5m traverse intervals with the sample interval set at 10Hz.

3.2 REPORTING

A general site location plan is shown in Illus 1 at a scale of 1:10,000. Illus 2 is a site condition photograph. Illus 3 to Illus 5 are 1:4,000 greyscale plots of the minimally processed apparent resistivity data. The combined interpretation of this data is shown in Illus 6 at the same scale. The minimally processed, in-phase, data are shown in Illus 7 and Illus 8 with accompanying combined interpretation in Illus 9, also at 1:4,000 scale.

Appendix 1 details the survey location information and Appendix 2 describes the composition and location of the site archive. Data processing details are presented in Appendix 3. A copy of the OASIS entry (Online Access to the Index of Archaeological Investigations) is reproduced in Appendix 4.

The survey methodology, report and any recommendations comply with the *Written Scheme of Investigation* (Headland Archaeology 2017) and guidelines outlined by Historic England (English Heritage 2008) and by the Chartered Institute for Archaeologists (CIfA 2014). All illustrations from Ordnance Survey mapping are reproduced with the permission of the controller of Her Majesty's Stationery Office (© Crown copyright).

The illustrations in this report have been produced following analysis of the data in 'raw' and processed formats and over a range of different display levels. All illustrations are presented to most suitably display and interpret the data from this site based on the experience and knowledge of management and reporting staff.

4 RESULTS AND DISCUSSION

The EM survey has identified a number of anomalies in each dataset (quadrature and in-phase). The cause of these anomalies is uncertain and an interpretation based on the potential archaeological value of these has been assigned. The quadrature (conductivity) survey has been subject to inversion so that the displayed data is apparent resistivity. Here the high readings are shown as black with the low resistance readings white. The in-phase data (magnetic susceptibility) is also shown where the high values are depicted black. No inversion has been undertaken on the in-phase data.

The in-phase survey is affected by anomalies closer to the surface than the quadrature survey, which inhibits the depth penetration of the in-phase technique. The height at which the instrument was held was due to the growth of the crop, which consequentially means there is no data for the shallow in-phase survey. The quadrature component penetrates deeper so the data collected at the shallow depth has not been affected by the height of the instrument above the ground.

During the survey there were changes in temperature which have affected the coils and this has been reflected in the data. This is particularly noticeable in the eastern part of Field 1 where the fluctuation in the readings obtained means that the data is not interpretable. It is not considered that this poor quality data has affected the overall interpretability of the data in this field.

Both datasets have recorded very high readings on the perimeter of the fields. This is caused by the sensitivity of the instruments to the conductive materials present in the field boundary (fences, pipes, ferrous detritus).

4.1 APPARENT RESISTIVITY (SEE ILLUS 3–6)

This survey has recorded a variable resistive background across the PDA although there is very little variation with depth.

Three areas of particularly low resistance have been identified to the south-west of Field 1 and the west of Field 4. These anomalous areas are potentially indicative of more water retentive areas but there are no anomalies indicative of palaeochannels.

Numerous irregular high resistance anomalies are also identified across the PDA but no coherent pattern can be discerned. It is difficult to offer a confident interpretation, although it can be surmised that the composition of the soils at these locations is less permeable than the surrounding soils and therefore might potentially locate gravel islands. If present such islands might have been the focus of any settlement activity.

A low resistance anomaly, LR1, within Field 2, measuring 45m by 50m, corresponds with the location of a rectangular feature on the historic mapping (see above). The cause of this anomaly is unknown although it does correlate with a large spread of post-medieval pottery which was noted during the survey.

4.2 IN-PHASE (SEE ILLUS 7–9)

The in-phase (magnetic susceptibility) survey has also recorded a varied background, with readings at both depths being affected by

material in the topsoil. The anomalies recorded at 5.7m depth are not as strong in magnitude and therefore it can be surmised that the anomalies are caused by shallow features or objects, rather than deeper buried deposits. Although there are recorded areas of magnetic enhancement (see Illus 9) there is no coherent or obvious pattern to suggest an archaeological origin and there is nothing in the data set to suggest an anthropogenic origin.

Anomaly HM1, corresponds with anomaly LR1 in the quadrature data and the feature on the historic mapping. The high magnetic reading here is caused by the spread of fired material seen on the surface during the survey.

5 CONCLUSION

Both the quadrature and in-phase data have identified variations in response caused by buried deposits in the alluvial landscape. However, neither data set has clearly identified any anomalies suggestive of palaeochannels. A number of areas of high resistance have been identified and it is possible that these responses may locate deposits of denser material, possible gravel 'islands', which if present may have been suitable for settlement. However, this interpretation is considered to be highly speculative.

The quadrature (apparent resistivity) survey has recorded low and high resistance anomalies in close proximity to the current field boundaries and these are thought to be the electromagnetic response to ferrous material in and along the boundaries.

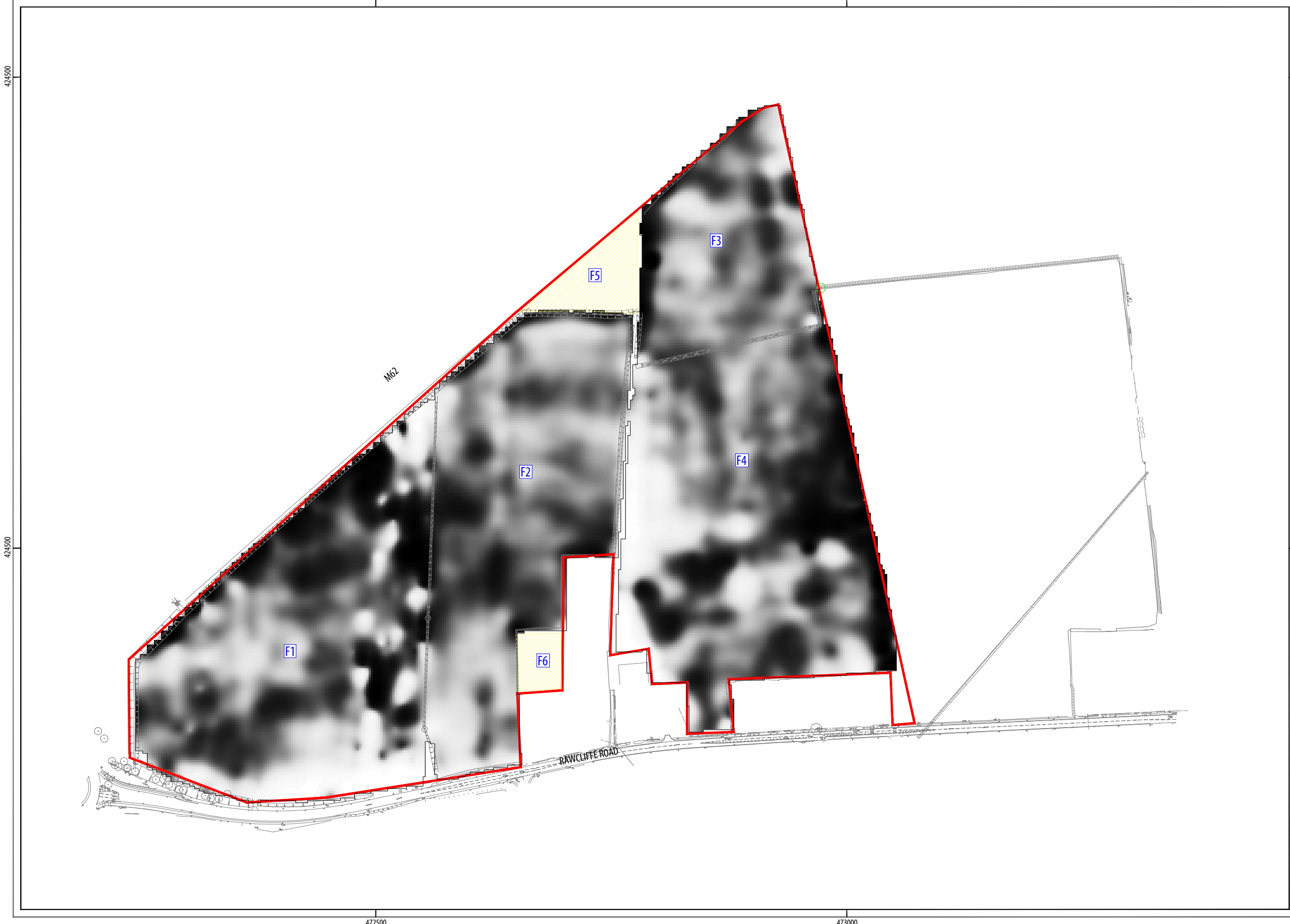
The in-phase (magnetic susceptibility) survey has mainly identified anomalies within the topsoil and there is little correlation with the quadrature survey.

A rectangular anomaly has been identified in both datasets which corresponds to a feature shown on historic mapping. A cluster of post-medieval pottery was noted at this location during the survey suggesting a spread of material.

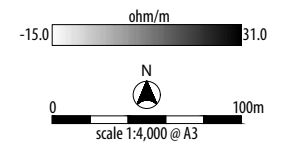
The electromagnetic survey has identified areas within the PDA that have the potential to have been drier pieces of land in the past before subsequent episodes of flooding and warping. However, no clear pattern emerges and it is difficult to draw too many conclusions from the survey.

6 REFERENCES

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- WYG 2017 *Land off Rawcliffe Road, Goole: Written Scheme of Investigation for Geophysical Survey*



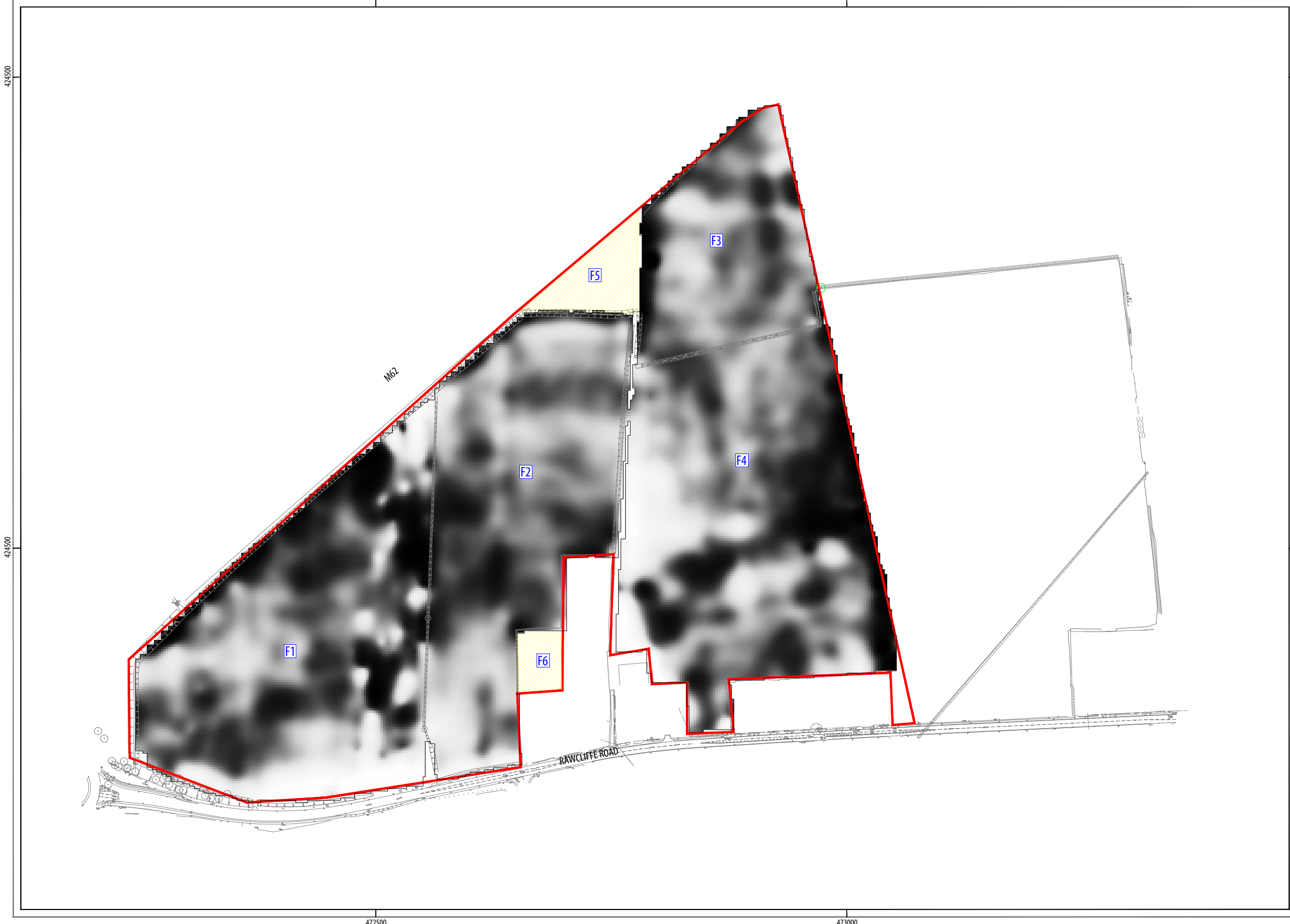
proposed development
area unsuitable for survey



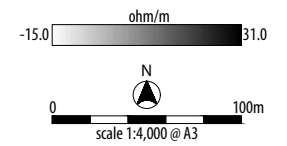
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area unsuitable for survey

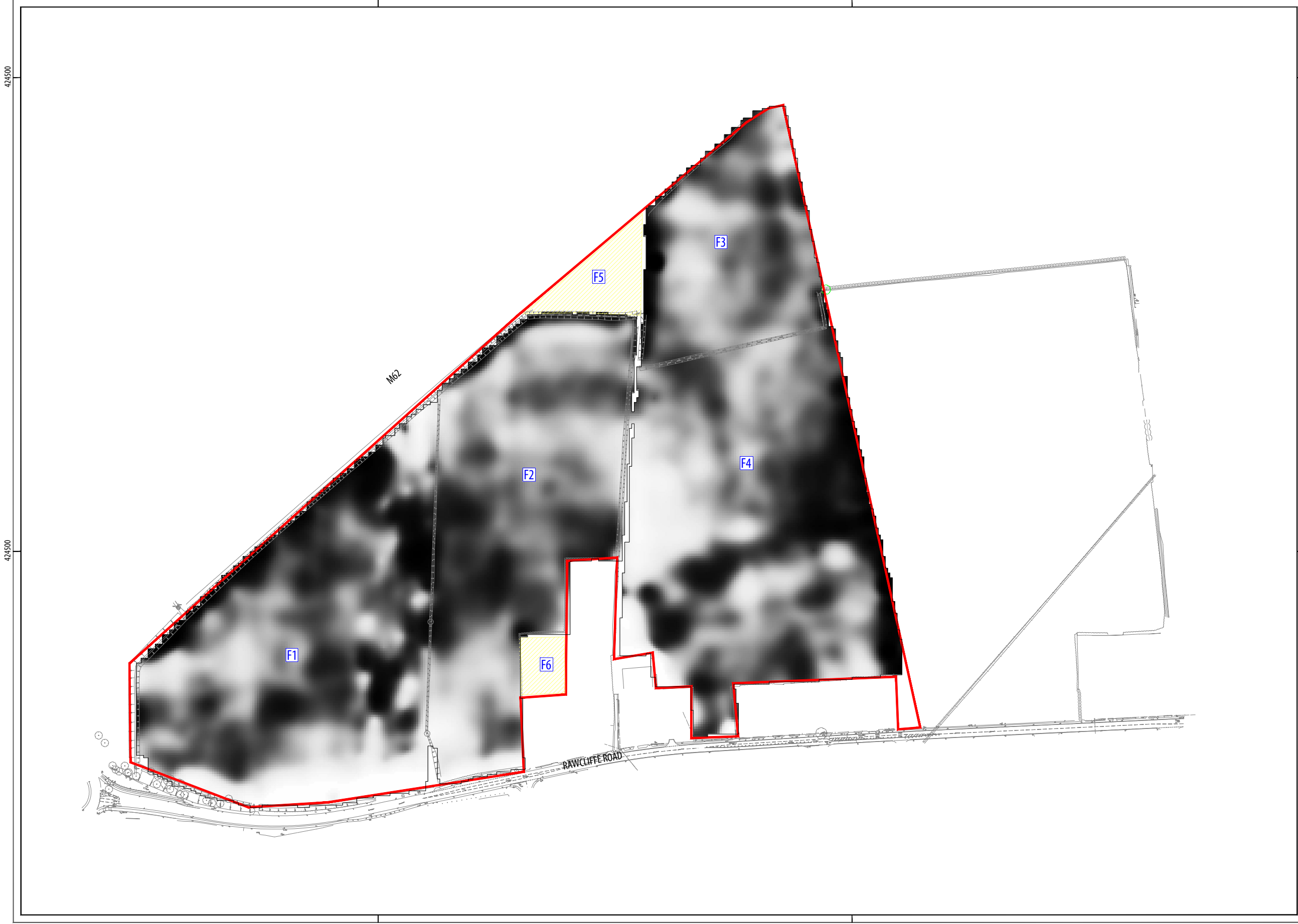


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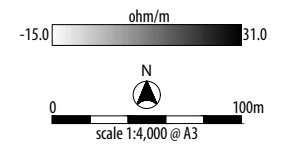


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ILLUS 4 Processed apparent resistivity data; Effective depth of 3.2m



proposed development
area unsuitable for survey

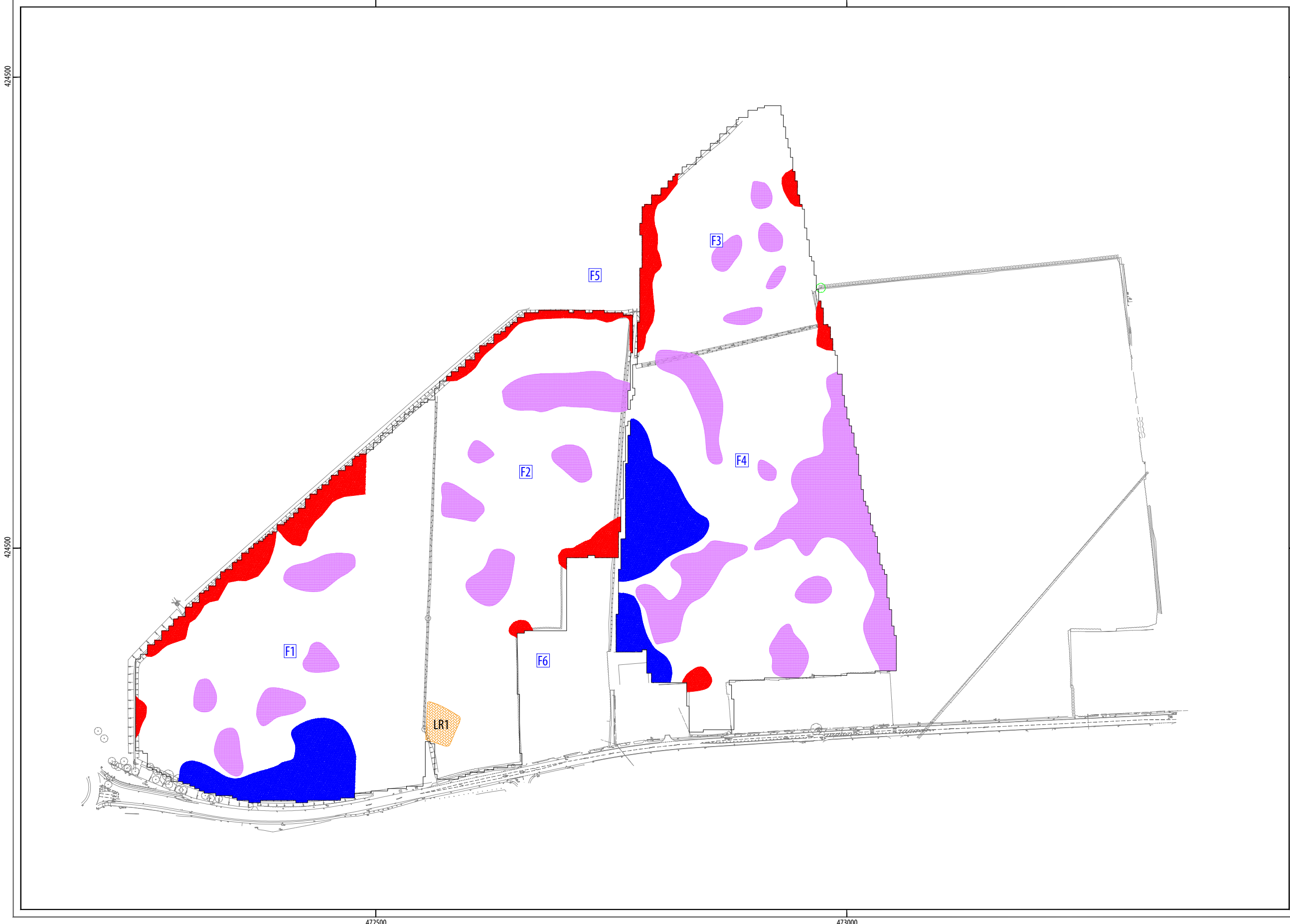


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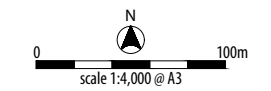


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ILLUS 5 Processed apparent resistivity data; Effective depth of 5.7m



TYPE OF ANOMALY	INTERPRETATION
low resistance	moisture retentive area
low resistance	historic mapping feature
high resistance	debris in field boundary
high resistance	drier area?
void data	

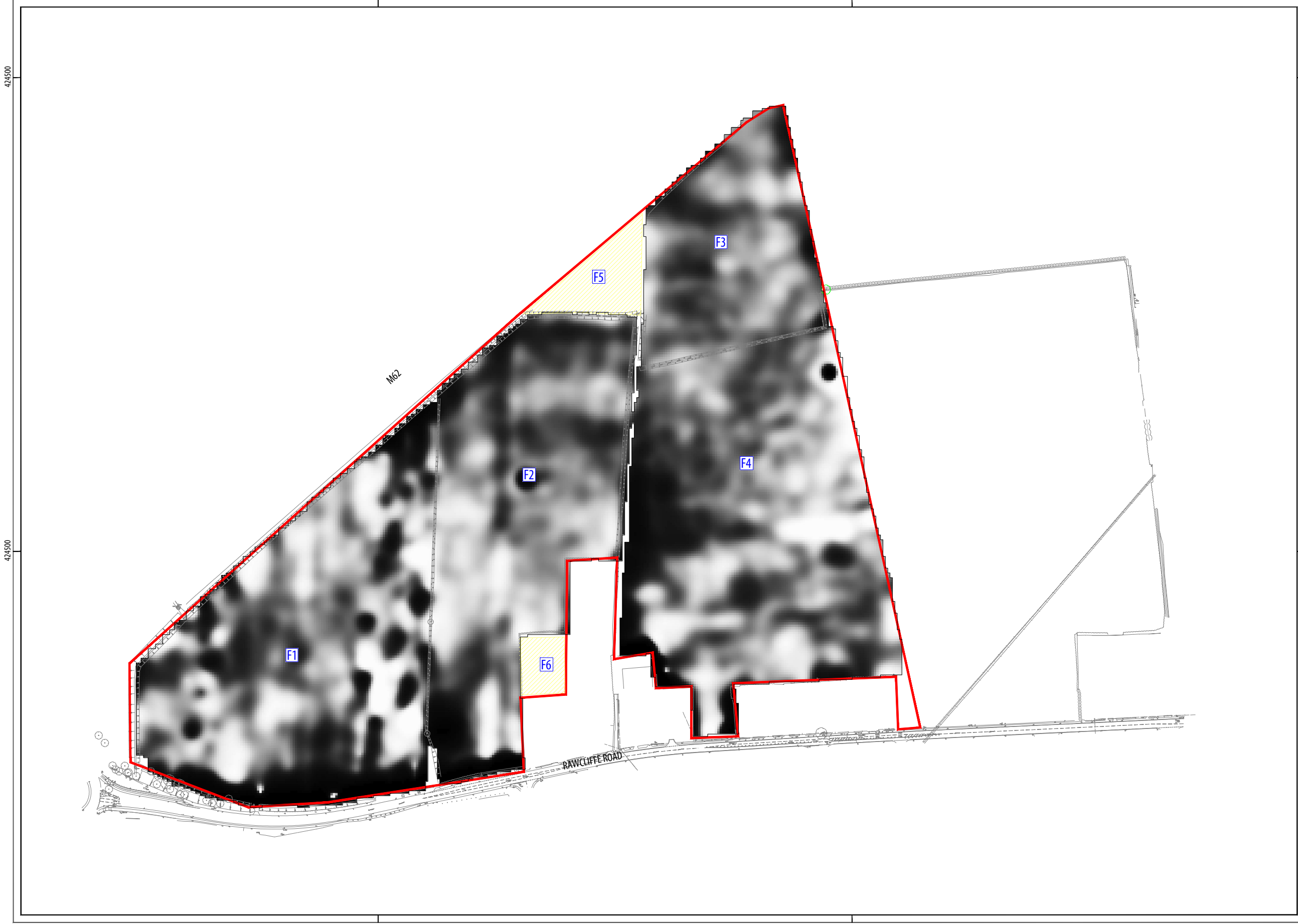


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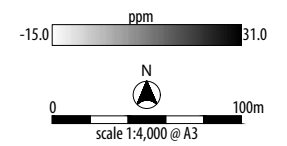


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ILLUS 6 Interpretation of combined apparent resistivity data



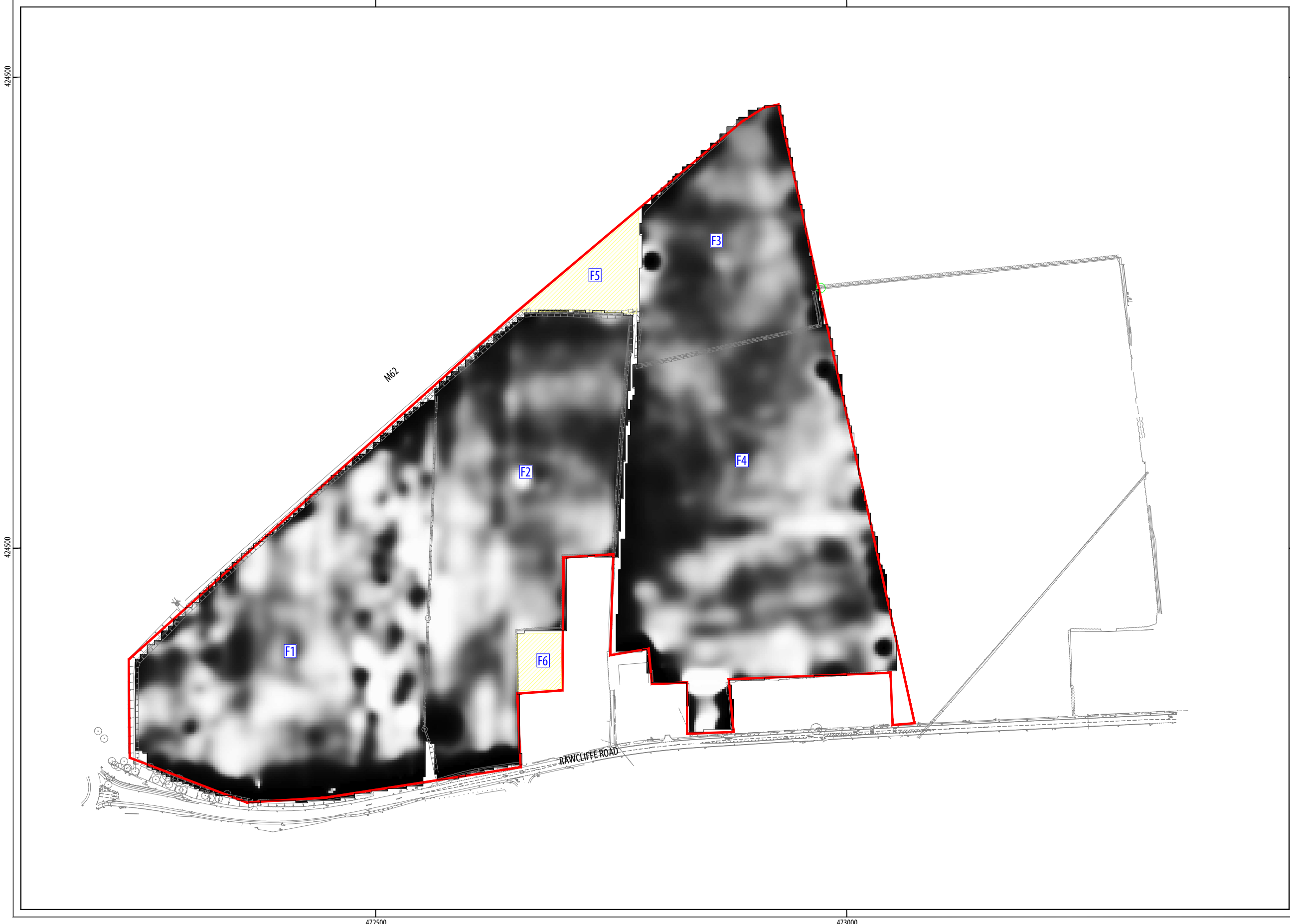
proposed development
area unsuitable for survey



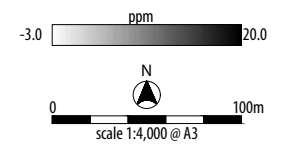
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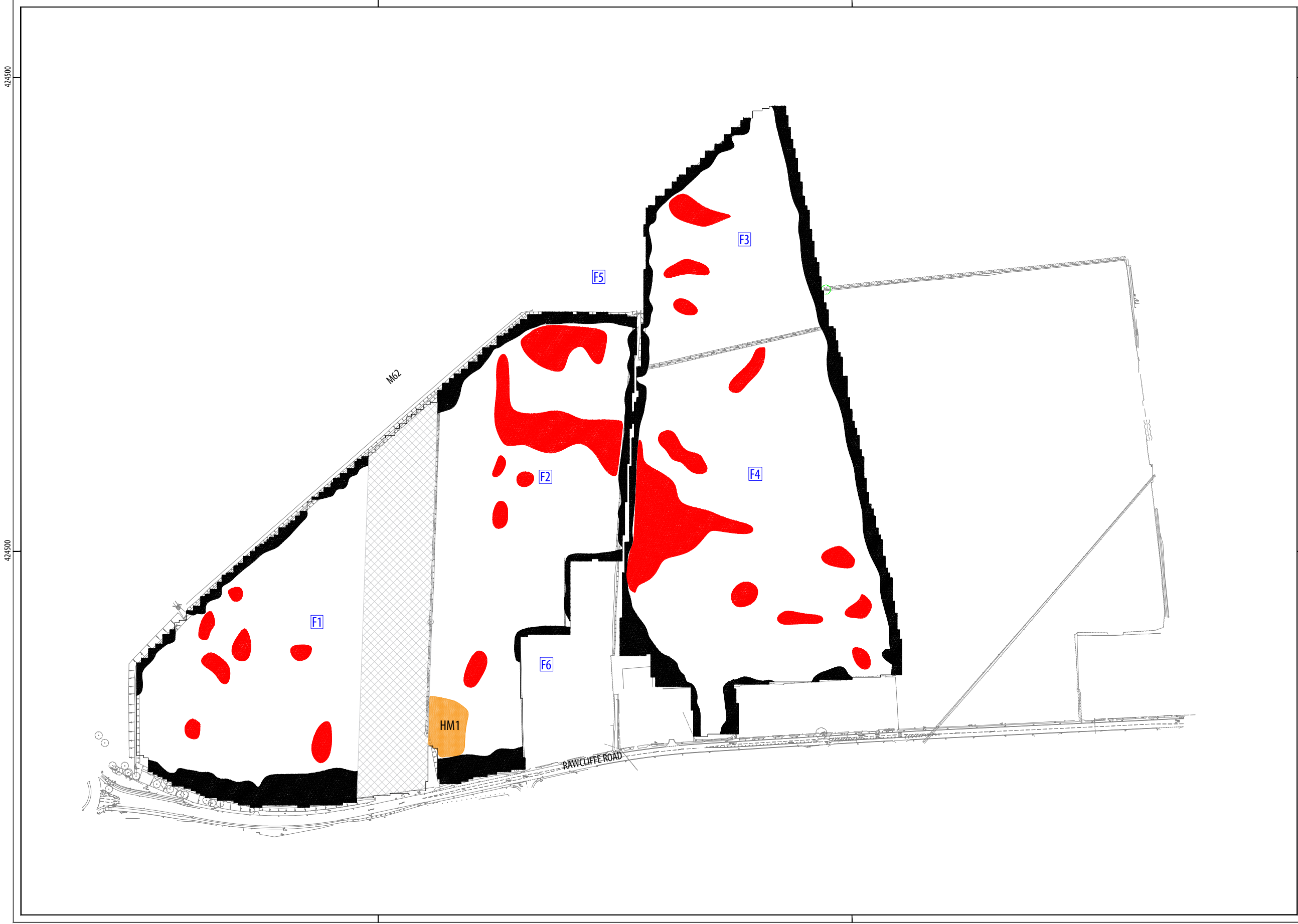
proposed development
area unsuitable for survey



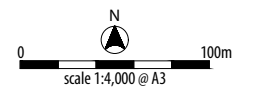
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TYPE OF ANOMALY	INTERPRETATION
● high magnetic susceptibility	ferrous material
● high magnetic susceptibility	historic mapping feature
● weak magnetic susceptibility	geology?
● void data	



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7 APPENDICES

APPENDIX 1 SURVEY LOCATION INFORMATION

The survey was georeferenced a Satellite-based augmentation systems (SBASA) GPS system, with an accuracy of $\pm 0.3\text{m}$. This was deemed suitable for the spatial resolution used in this survey.

Temporary sight markers were laid out using a Trimble VRS differential Global Positioning System (Trimble GeoXR model) to guide the operator and ensure full coverage. The accuracy of this dGPS equipment is better than 0.01m.

The survey data were then super-imposed onto a base map provided by the client to produce the displayed block locations.

Headland Archaeology cannot accept responsibility for errors of fact or opinion resulting from data supplied by a third party.

APPENDIX 2 GEOPHYSICAL SURVEY ARCHIVE

The geophysical archive comprises the raw data in XYZ format, a raster image of each greyscale plot with associate world file, and a PDF of the report.

The project will be archived in-house in accordance with recent good practice guidelines (http://guides.archaeologydataservice.ac.uk/g2gp/Geophysics_3). The data will be stored in an indexed archive and migrated to new formats when necessary.

APPENDIX 3 DATA PROCESSING

The electromagnetic data has been presented in this report in minimally processed greyscale format. The quadrature (conductivity) data has undergone inversion in CMD Data Transfer v1.5.1. Terrasurveyor V3.0.32.4 (DWConsulting) software has been used to process and present the data.

Data collected using GPS-based methods cannot be produced without minimal processing of the data. The minimally processed data has been interpolated to project the data onto a regular grid and de-striped to correct for slight variations in instrument calibration drift and any other artificial data.

APPENDIX 4 OASIS DATA COLLECTION FORM: ENGLAND

OASIS ID: headland5-288731

PROJECT DETAILS	
Project name	Land off Rawcliffe Road, Goole, East Yorkshire
Short description of the project	Headland Archaeology (UK) Ltd undertook a geophysical (electromagnetic) survey of land covering 31 hectares at Rawcliffe Road, near Goole, to assess the archaeological potential of the site and inform further archaeological strategies prior to the determination of a planning application. The survey was carried out using a multi-receiver coil which enables readings to be taken at three depths, utilising the in-phase (magnetic susceptibility) and quadrature (conductivity) components of the equipment. The conductivity data has been inverted to display apparent resistivity data. The survey was carried out in order to map geomorphological features, such as palaeochannels and areas of higher ground, in the former wetland landscape which are now buried beneath alluvial and warped deposits. The identification of areas of higher ground may locate areas favoured for settlement in the prehistoric period. Broad and amorphous anomalies have been recorded in the quadrature and in-phase data, although there is little apparent correlation between the two datasets. The in-phase data shows that there is little change in the magnetic susceptibility of the soil with increasing depth, possibly indicating a uniform soil. The quadrature (apparent resistivity) data shows a number of high resistance areas which may locate areas when the soils are drier and which may have been favoured as areas for settlement amongst a marshy landscape. It should be noted that these interpretations are considered to be tentative. An area where post-medieval material has been spread across part of a field has also been identified in the data.
Project dates	Start: 23-05-2017 End: 25-05-2017
Previous/future work	Not known / Not known
Any associated project reference codes	RRGO-01 - Contracting Unit No.
Type of project	Field evaluation
Site status	None
Current Land use	Cultivated Land 4 - Character Undetermined
Monument type	N/A None
Monument type	N/A None
Significant Finds	N/A None
Significant Finds	N/A None
Methods & techniques	Geophysical Survey'
Development type	Housing estate
Prompt	National Planning Policy Framework - NPPF
Position in the planning process	After full determination (eg. As a condition)
Solid geology (other)	Sherwood Sandstone Group
Drift geology	Raised beach and marine deposits
Techniques	Electromagnetic
PROJECT LOCATION	
Country	England
Site location	East riding of Yorkshire, Goole. Land off Rawcliffe Road, Goole, East Yorkshire
Study area	31 Hectares
Site coordinates	SE 7260 2400 53.707143993212 -0.90001945678 53 42 25 N 000 54 00 W Point

PROJECT CREATORS

Name of Organisation	Headland Archaeology UK Ltd
Project brief originator	Headland Archaeology UK Ltd
Project design originator	Headland Archaeology UK Ltd
Project director/manager	Harrison, S
Project supervisor	Evans, M
Type of sponsor/funding body	Developer

PROJECT ARCHIVES

Physical Archive Exists?	No
Digital Archive recipient	In house
Digital Contents	Survey
Digital Media available	Geophysics'
Paper Archive Exists?	No

PROJECT BIBLIOGRAPHY 1

Publication type	Grey literature (unpublished document/manuscript)
Title	Land off Rawcliffe Road, Goole, East Yorkshire; Electromagnetic Survey
Author(s)/Editor(s)	Harrison, S.
Date	2017
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