

SPIT18



PRINCE WILLIAM OF GLOUCESTER BARRACKS, GRANTHAM, LINCOLNSHIRE

GEOPHYSICAL SURVEY

commissioned by Fisher German LLP

March 2020

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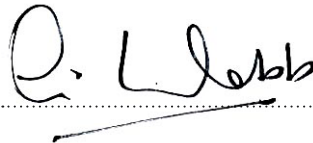
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PROJECT SUMMARY

Headland Archaeology (UK) Ltd undertook a geophysical (magnetometer) survey of a 183 hectare site at Prince William of Gloucester Barracks, Grantham, to provide information on the archaeological potential of the site in advance of a possible planning application for a residential and mixed-use development. This report presents the results of the survey undertaken to date, an area of approximately 54 hectares, in those areas not planted with trees. The survey has identified anomalies which locate a ditch feature which flanks the northern side of Salters Way, a Roman road which passes north-east/south-west through the site. These anomalies confirm data held by the Lincolnshire Historic Environment Record and LiDAR data and are assessed as of high archaeological potential. Numerous anomalies have been identified which are caused by 20th century military activity associated with the former RAF Spitalgate including two probable former runways and other infrastructure including buried service pipes and cables. These features may be of historical interest. Five localised areas containing anomalies of uncertain origin have also been identified. Whilst any of these may be of archaeological interest, a confident interpretation cannot be given and each is considered equally likely to have a modern or geological origin. These anomalies are currently assessed as of low archaeological potential although the whole data set from this phase of the survey will be re-evaluated and the interpretations re-assessed once the trees from the site have been cleared and the remainder of the site surveyed.

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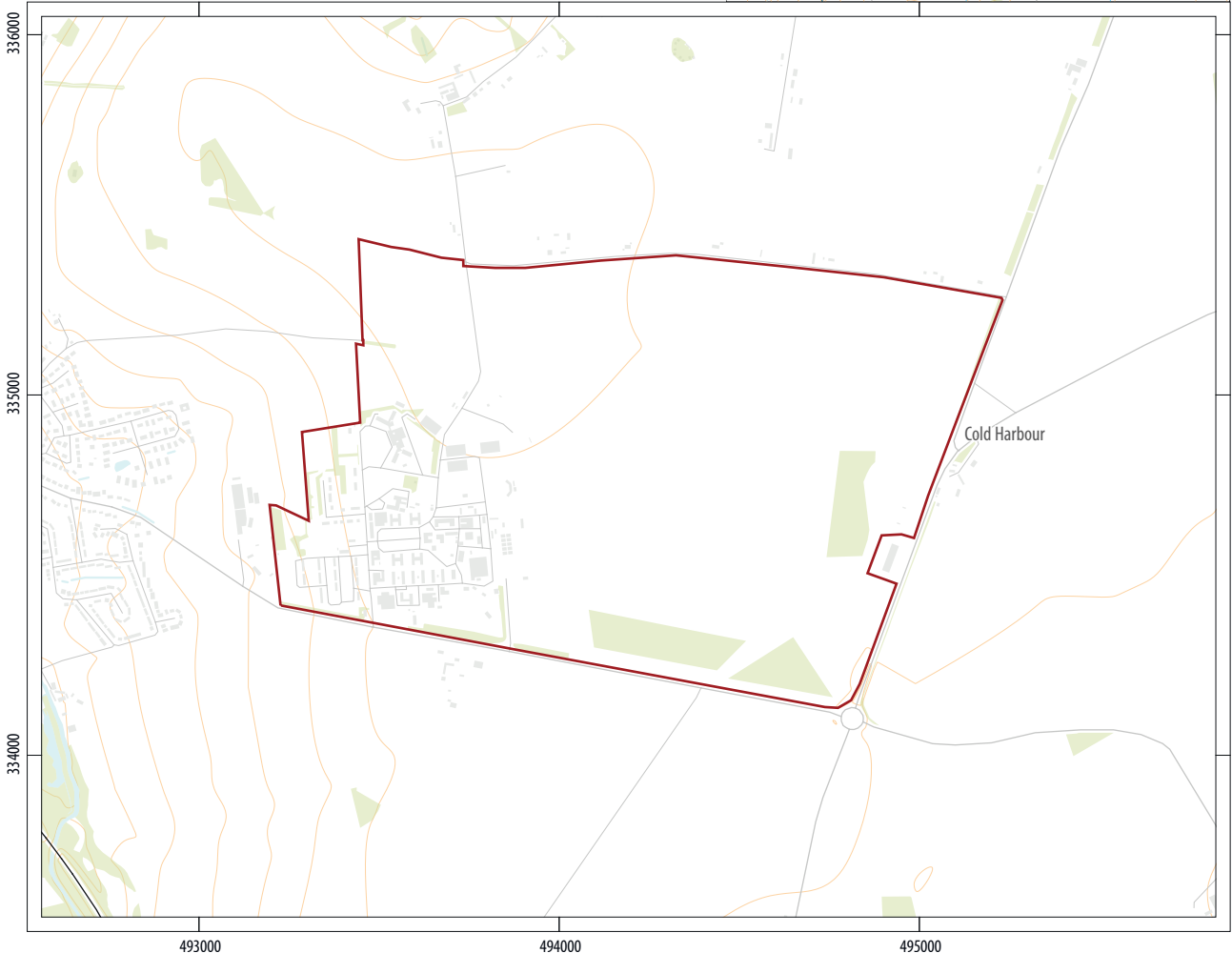
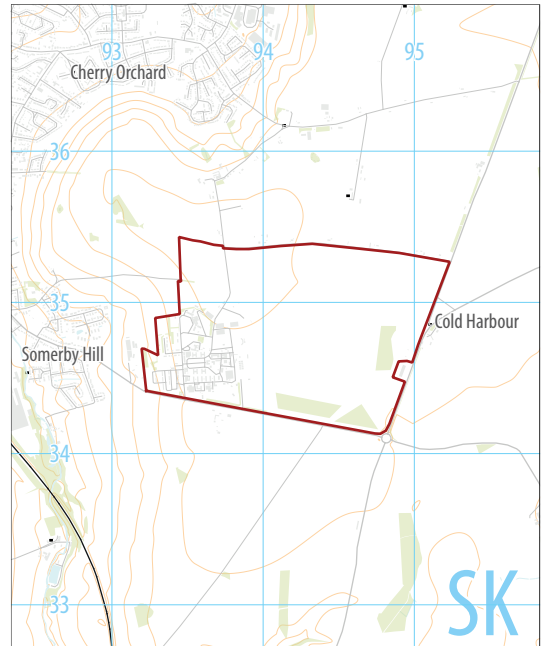
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Prince William of Gloucester Barracks
Grantham
Lincolnshire



0 200km
1:12,500,000 @ A4



0 400m
1:20,000 @ A4

MOD freehold boundary



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PRINCE WILLIAM OF GLOUCESTER BARRACKS, GRANTHAM, LINCOLNSHIRE

GEOPHYSICAL SURVEY

1 INTRODUCTION

Headland Archaeology (UK) Ltd was commissioned by Fisher German LLP (the Client), to undertake a geophysical (magnetometer) survey at Prince William of Gloucester Barracks, Grantham, where a residential and mixed-use development is proposed. The survey was undertaken in order to inform planning proposals by assessing the heritage potential of the geophysical survey area and, therefore the impact of any proposed development on the historic environment. This report presents the results of the survey undertaken to date and will be supplemented with a separate report once the site has been fully cleared of trees which currently cover most of the site.

The work was undertaken in accordance with Written Scheme of Investigation (Harrison 2018) which was submitted to the Client, with guidance within the National Planning Policy Framework (DCLG 2012) and in line with current best practice (Chartered Institute for Archaeologists 2014, English Heritage 2008).

The survey was carried out in two phases, on the 13th and 14th February 2018 and, following the drilling of arable land in the north, between the 21st and 29th May 2018.

1.1 SITE LOCATION, TOPOGRAPHY AND LAND-USE

Prince William of Gloucester Barracks lies on the south-eastern periphery of Grantham, Lincolnshire, centred on SK 9340 3430 (see Illus 1). The Ministry of Defence (MOD) Freehold boundary ('the site') comprises a sub-rectangular parcel of land, which is bound to the south and east by the A52, to the east by the B6403, to the north by Turnor Road and by arable fields to the west. The barracks are located in the south of the site with military infrastructure and training facilities located throughout. At the time of the survey,

the majority of the site was planted with young trees (see Illus 3) and was unsuitable for survey. Survey was therefore restricted to nine areas (F1–F9) around the perimeter of the site and five limited areas (F10.1–F10.5) within the interior of the site where ground cover allowed. F2–F4 were under arable production and had been recently drilled (Illus 2). F1 and F6–F9 (Illus 5) were recreational in use and under short mown grass with the remaining areas containing longer, tussocky grass.

The site is located on a limestone plateau immediately east of the Witham Valley and is largely flat although slopes slightly towards the south-east, being at 135m Above Ordnance Datum (AOD) in the north-west corner of the site and 121m AOD in the south-east.

1.2 GEOLOGY AND SOILS

The bedrock geology comprises of Upper Lincolnshire Limestone Member (limestone) with Lower Lincolnshire Limestone Member (lime-mudstone) recorded in the north-west corner of the site. No superficial deposits are recorded (NERC 2018).

The soils are classified in the Soilscape 3 association, characterised as freely draining lime-rich soils (Cranfield University 2018).

2 ARCHAEOLOGICAL BACKGROUND

The A52/B6043, which bounds the site to the east, follows the route of Ermine Street Roman road. A second Roman road, Salters Way, is recorded crossing the south of the site north-east/south-west between a river crossing on the River Witham and the junction with Ermine Street at Cold Harbour (Lincolnshire Historic Environment



ILLUS 2 F3, looking east **ILLUS 3** Area unsuitable for survey, looking south-east

Record SK93 SW23). To the south-west of the site Salters Way appears on aerial photographs as over 670m of discontinuous lengths of road-side ditches and, within the site itself, it appears on 2m resolution Digital Terrain Model (DTM) LiDAR data, as a north-east/south-west linear earthwork (see Illus 7; Environment Agency Geomatics Survey Data 2018).

The site was in use as an RAF station from 1915 until 1975 when the site became a British Army base.

3 AIMS, METHODOLOGY AND PRESENTATION

The general aim of the geophysical survey was to provide sufficient information to establish the presence/absence, character and extent of any archaeological remains within the site. This will therefore enable an assessment to be made of the impact of the proposed development on any sub-surface archaeological remains, if present.

The specific archaeological objectives of the geophysical survey were:

- › to provide information about the nature and possible interpretation of any magnetic anomalies identified;
- › to therefore model the presence/absence and extent of any buried archaeological features; and
- › to prepare a report summarising the results of the survey.

3.1 MAGNETOMETER SURVEY

Magnetic survey methods rely on the ability of a variety of instruments to measure very small magnetic fields associated with buried archaeological remains. A feature such as a ditch, pit or kiln can act like a small magnet, or series of magnets, that produce distortions (anomalies) in the earth's magnetic field. In mapping these slight variations, detailed plans of sites can be obtained as buried features often produce reasonably characteristic anomaly shapes and strengths (Gaffney & Gater 2003). Further information on soil magnetism and the interpretation of magnetic anomalies is provided in Appendix 1.

The survey was undertaken using four Bartington Grad601 sensors mounted at 1m intervals (1m traverse interval) onto a rigid carrying frame. The system was programmed to take readings at a frequency of 10Hz (allowing for a 10–15cm sample interval) on roaming traverses (swaths) 4m apart. These readings were stored on an external weatherproof laptop and later downloaded for processing and interpretation. The system was linked to a Trimble R8s Real Time Kinetic (RTK) differential Global Positioning System (dGPS) outputting in NMEA mode to ensure a high positional accuracy for each data point.

MLGrad601 and MultiGrad601 (Geomar Software Inc) software was used to collect and export the data. Terrasurveyor V3.0.32.4 (DWConsulting) software was used to process and present the data.

3.2 REPORTING

A general site location plan is shown in Illus 1 at a scale of 1:20,000. Illus 2–5 are site condition photographs. Illus 6 is a 1:7,500 survey location plan showing the direction of survey as GPS swaths. Illus 7 shows the 2m resolution DTM LiDAR data, also at 1:7,500. The processed greyscale data and an overall interpretation plot are presented, also at 1:7,500, in Illus 8 and Illus 9. Large-scale, fully processed (greyscale) data, minimally processed data (XY traceplot) and accompanying interpretative plots are presented at a scale of 1:2,500 in Illus 10 – Illus 24 inclusive.

Technical information on the equipment used, data processing and magnetic survey methodology is given in Appendix 1. Appendix 2 details the survey location information and Appendix 3 describes the composition and location of the site archive. Data processing details are presented in Appendix 4. A copy of the OASIS entry (Online Access to the Index of Archaeological Investigations) is reproduced in Appendix 5.

The survey methodology, report and any recommendations comply with the Written Scheme of Investigation (Harrison 2018), 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).



ILLUS 4 F5, looking south ILLUS 5 F6 looking north

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 ground conditions varied from very even, mown grass around the barracks, to drilled plough-soil in the north and long tussocky grass elsewhere. Whilst the tussocky conditions impeded progress there has been no visible effect on data quality which is of a high standard throughout.

The survey has detected a variable magnetic background throughout the datasets. This is mainly due to ground disturbance and ferrous contamination of the topsoil in those areas close to military infrastructure, and to magnetic interference from adjacent fences and structures. Low magnitude magnetic variation within F3, manifesting in the data as a broad concentration of discrete anomalies and linear and curvilinear anomalies, is thought to be geological in origin, probably being due to soil-filled cracks and hollows in the Upper Lincolnshire Limestone bedrock. Against these backgrounds, numerous linear and discrete anomalies have been identified and these are discussed below and cross-referenced to specific examples on the interpretive figures, where appropriate.

4.1 FERROUS ANOMALIES

Ferrous anomalies, characterised as individual 'spikes', are typically caused by ferrous (magnetic) material, either on the ground surface or in the plough-soil. Little importance is normally given to such anomalies, unless there is any supporting evidence for an archaeological interpretation, as modern ferrous debris is common on most sites, often being present as a consequence of manuring or tipping/infilling. There is no obvious clustering to these ferrous anomalies which might indicate an archaeological origin. Far more probable is that the 'spike' responses are likely caused by the random distribution of ferrous debris in the upper soil horizons.

Magnetic disturbance is common throughout the datasets and is caused by ferrous material within the topsoil or on the ground surface. Disturbance around the perimeter of the survey areas and along the field edges is due to ferrous material within, or adjacent to the boundaries is of no archaeological interest. However, it should be noted that magnetic disturbance may mask any low magnitude anomalies of archaeological potential, if present, within the affected area.

4.2 FORMER AIRFIELD INFRASTRUCTURE AND MODERN ANOMALIES

Numerous high magnitude dipolar linear anomalies and low magnitude linear anomalies are visible criss-crossing F1 and F6–F9, immediately east of the barracks (see Illus 10–12 and Illus 19–21). These anomalies locate buried service pipes and cables. Broader, amorphous areas of magnetic disturbance may be due to buried structures, airfield infrastructure and demolition material.

Several high magnitude ferrous anomalies are identified along the northern edge of F3 including short dipolar linear anomalies, large ferrous spikes and sub-rectangular anomalies. The broad area of magnetic disturbance (PB1; see Illus 13–15) in the centre (north) of F3 is due to an extant pillbox and it is likely that the other ferrous anomalies along Turnor Road are also due to former military/airfield infrastructure, perhaps searchlight batteries. A second pillbox (PB2; see Illus 16–18) is located in the east of F4.

Parallel linear alignments of ferrous spike anomalies (RW1; see Illus 13–15 and RW2; see Illus 22–24), approximately 42m apart, probably locate former runways. RW1 is aligned north-east/south-west across F10.2, whereas RW2 is identified on a north-west/south-east alignment across F10.5 and extending into F5. The anomalies are thought to be due to buried ferrous objects flanking the former runways, perhaps relating to services or fixtures for a temporary runway surface.

Clear parallel linear trends in F5 (see Illus 4 and 22–24) and F10.1 (see Illus 13–15) correspond to vehicle ruts and unsurfaced tracks which were observed during the fieldwork and are of no archaeological interest.

4.3 AGRICULTURAL ANOMALIES

Analysis of historical OS mapping indicates that several field boundaries were removed during construction of the RAF station in the early twentieth century. Thirteen of these former field boundaries (FB1–FB13) have been partially identified by the survey as linear anomalies. The anomalies are caused by the magnetic contrast between the soil-fill of a ditch and the surrounding soil.

Closely-spaced linear trend anomalies are identified within most of the datasets, mostly aligned parallel with the former pattern of land division. These anomalies are due to ploughing, and ploughing headlands, pre-dating the RAF station and airfield. More broadly-spaced parallel linear anomalies within F10.2 and F10.4 are typical of field drains (see Illus 13–15).

4.4 GEOLOGICAL ANOMALIES

Discrete areas of magnetic enhancement are identified most notably along the northern fringes of the site in F3 and F2 comprising apparently random clusters of linear, curvilinear and discrete anomalies and broader trends in the data. These anomalies are interpreted as geological in origin being due to soil filled fissures, cracks and solution hollows in the sedimentary bedrock and are not considered to be of any archaeological interest.

4.5 ANOMALIES OF UNCERTAIN ORIGIN

Unless otherwise specified the anomalies of uncertain origin (AUO) are thought to be caused by soil-filled features or by spreads of magnetically enhanced material within the upper soil horizons. These anomalies may be due to archaeological features such as pits and/or ditches, but no definite patterns are discernible in the data and a modern or geological origin is also plausible. A more confident interpretation of these anomalies (particularly those in F2 and F7) may be informed by additional geophysical survey of the remainder of the site following the removal of the trees which currently cover the site.

A cluster of broad, high magnitude and amorphous anomalies are clearly visible in the south-west corner of F2 (AUO1; see Illus 10–12). The anomalies may be due to modern activity but are less magnetic than those which are interpreted as modern or military in origin. The anomalies are thought to be due to soil-filled features, perhaps infilled quarry pits. Further survey in the west of this field will aid a more confident interpretation.

In the north of F3, a discontinuous high magnitude linear anomaly (AUO2; see Illus 13–15) aligned north-west/south-east may be of archaeological interest. The anomaly is located in an area of notable background variation including numerous linear and curvilinear anomalies which have been interpreted as geological. This anomaly may also be geological in origin, perhaps a soil filled fissure in the bedrock. However, AUO2 is higher in magnitude than the other geological anomalies and may be due to a soil-filled ditch. No other similar anomalies are identified in the vicinity and therefore AUO2 is also ascribed an uncertain origin.

An isolated low magnitude sub-circular anomaly, 11m in diameter, is identified in the east of F5 (AUO3; see Illus 22–24). The anomaly may be due to a small enclosure. However, given its shape and location at

the perimeter of the former airfield, a military origin is thought more likely, perhaps locating a former structure, such as a pillbox. Its origin nevertheless remains uncertain.

Finally, two broad clusters of high magnitude, non-ferrous, anomalies, in F6 and F7, are identified against an otherwise variable magnetic background with frequent ferrous contaminants (AUO4 and AUO5; see Illus 19–21). Given the location of these two clusters within an area currently in use as sports pitches it is considered most likely that the anomalies are due to recent ground disturbance or landscaping. Again an archaeological origin cannot be dismissed and so AUO4 and AUO5 are also interpreted as of uncertain origin.

4.6 ARCHAEOLOGICAL ANOMALIES

Linear anomalies (D1 and D2; see Illus 6) are clearly identified on a north-east/south-west alignment within two narrow datasets, F10.4 and F10.5. The anomalies are 440m apart but are thought to be due to the same soil-filled ditch defining the north-western side of Salters Way Roman Road. The road itself has not been detected by the survey although this does not necessarily suggest an absence of archaeology. Roman roads were typically constructed from layers of clay, sand and gravel with little magnetic contrast between the road surface and the surrounding soils. Further survey within the central part of the site is likely to reveal the continuation of these anomalies.

5 CONCLUSION

The survey has evaluated the available geophysical survey areas and has identified anomalies which locate a soil-filled ditch flanking the northern side of the Salters Way Roman road which passes north-east/south-west through the site. These anomalies confirm the Lincolnshire Historic Environment Record and LiDAR data and are assessed as of high archaeological potential.

Numerous anomalies have been identified which are caused by 20th century military activity associated with the former RAF Spitalgate including two probable former runways and other infrastructure including buried service pipes and cables. Some of these features may be of historical interest.

Five localised areas containing anomalies of uncertain origin have been identified. These include a possible ditch and four clusters of broad, non-ferrous anomalies which cannot confidently be attributed to modern activity, nor to any geological or agricultural origin. However, until further survey has been carried out they are interpreted as of low archaeological potential.

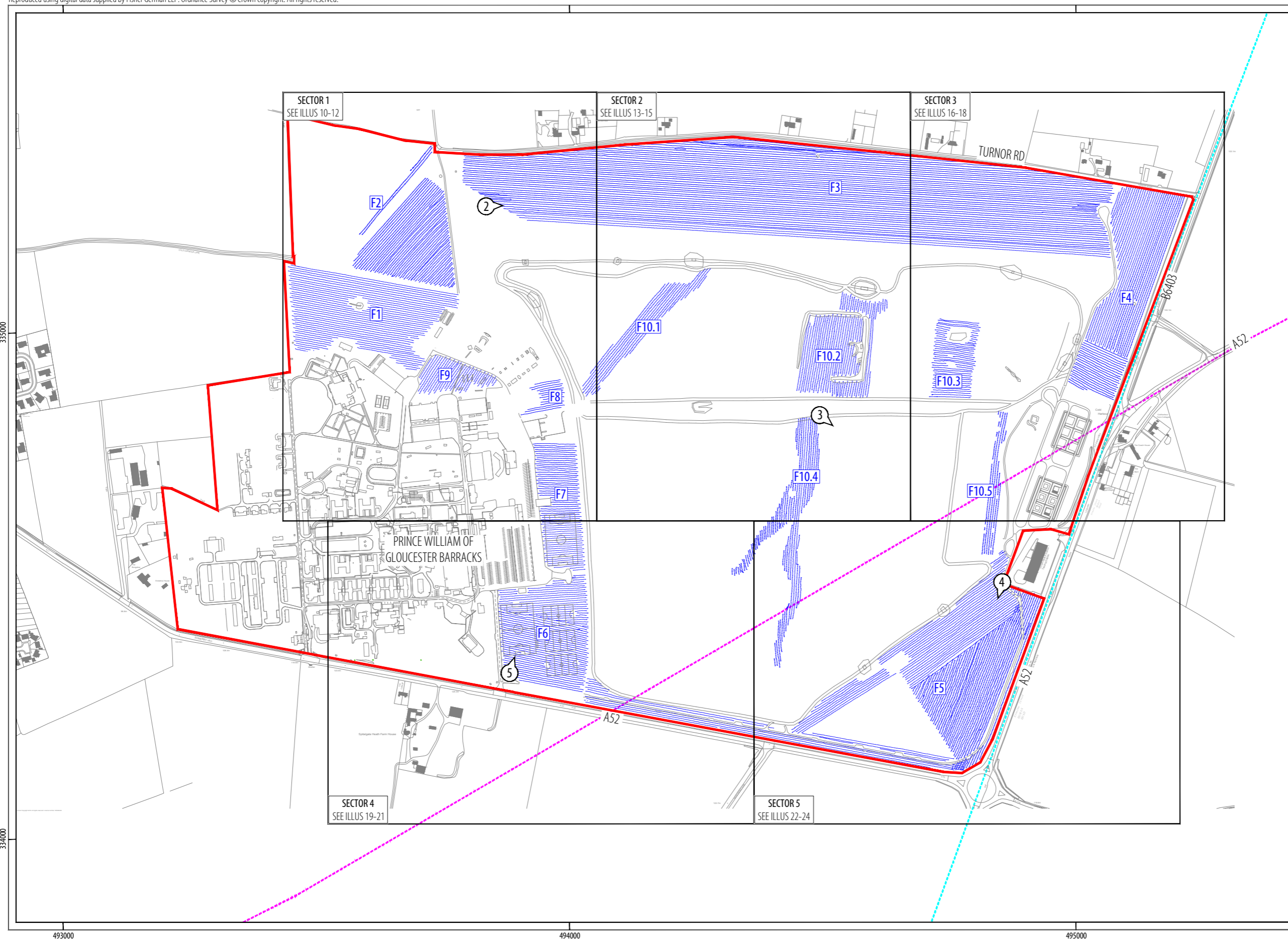
No anomalies of obvious archaeological potential have been identified over most of the area surveyed and therefore, with the exception of along the line of the Roman road the majority of the site surveyed to date is currently assessed as of low archaeological potential.

However, it is difficult to confidently interpret anomalies within small and narrow survey 'windows', especially against a variable magnetic background. For this reason, all the data will be fully re-evaluated and, if necessary, reinterpreted once the trees have been removed and the survey completed.

6 REFERENCES

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- MOD Freehold Boundary
- ▨ GPS swaths
- - - Salters Way Roman road
- - - Ermine Street Roman road
- ⊙ location and direction of ILLUS 2-5



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 Lincolnshire

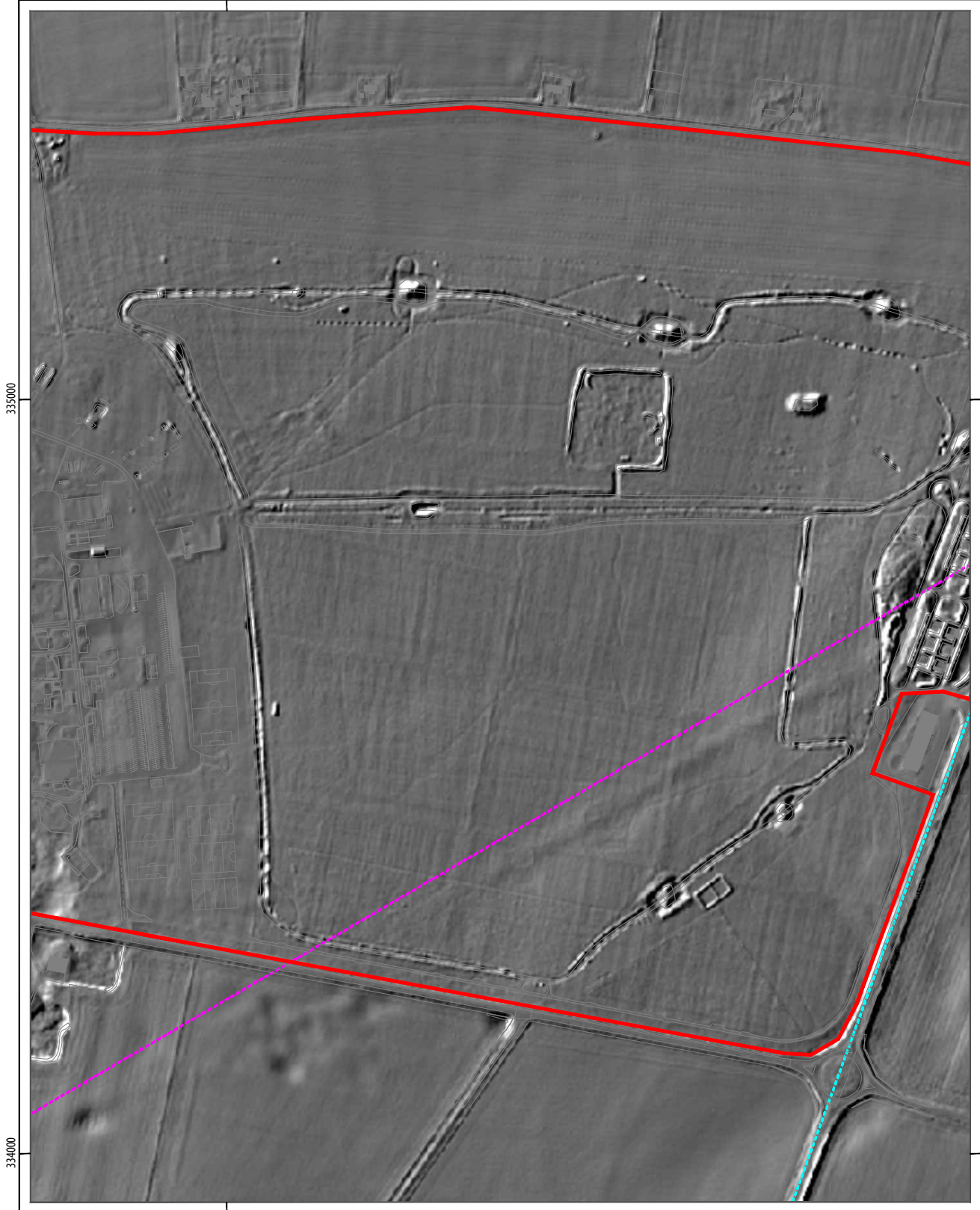
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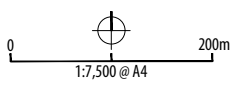
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ILLUS 6 Survey location showing GPS swaths (1:7,500)

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- ▭ MOD Freehold boundary
- - - Salters Way Roman road
- - - Ermine Street Roman road



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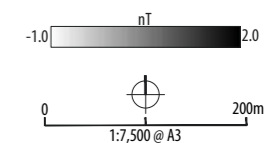
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ILLUS 7 Survey location showing 2m resolution DTM LiDAR data (1:7,500)

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- MOD Freehold boundary
- - - Salters Way Roman road
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ILLUS 8 Processed greyscale magnetometer data (1:7,500)

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TYPE OF ANOMALY	INTERPRETATION
● dipolar isolated	ferrous material
● magnetic disturbance	ferrous material
⊗ magnetic disturbance	airfield infrastructure
● dipolar isolated	airfield infrastructure
— dipolar linear	service pipe/service cable
— linear	airfield infrastructure
— linear	former runway
— linear	modern ground disturbance
— linear trend	agricultural
— linear trend	field drain
— linear	former field boundary
— linear trend	geological variation
⊕ magnetic enhancement	geology
⊗ magnetic enhancement	uncertain
● magnetic enhancement	archaeology

ABBREVIATIONS

AU0	anomalies of uncertain origin
D	ditch
FB	former boundary
P	pit
PB	pillbox
RW	runway



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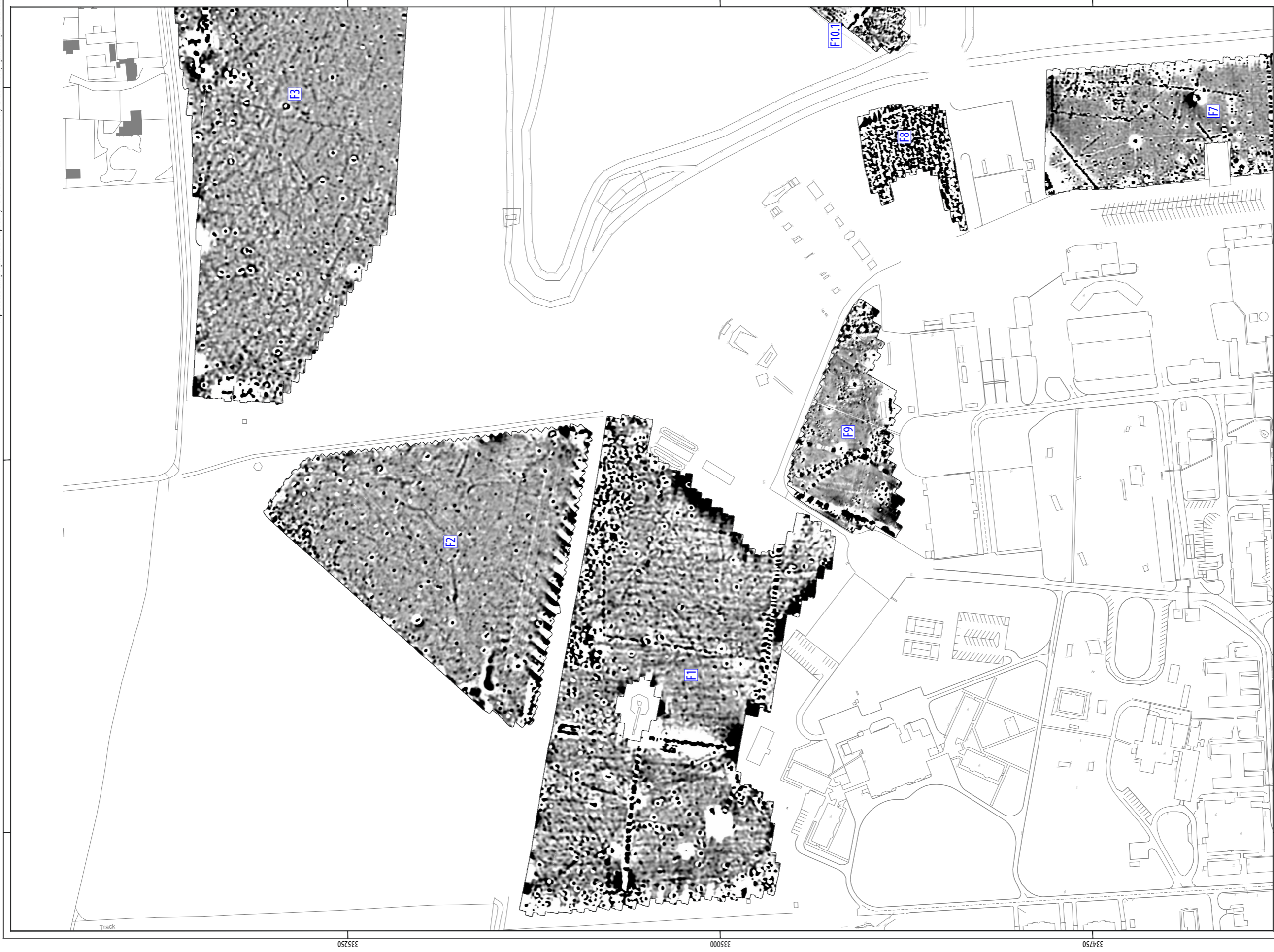
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ILLUS 9 Interpretation of magnetometer data (1:7,500)



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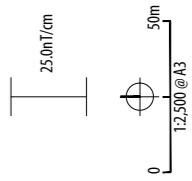
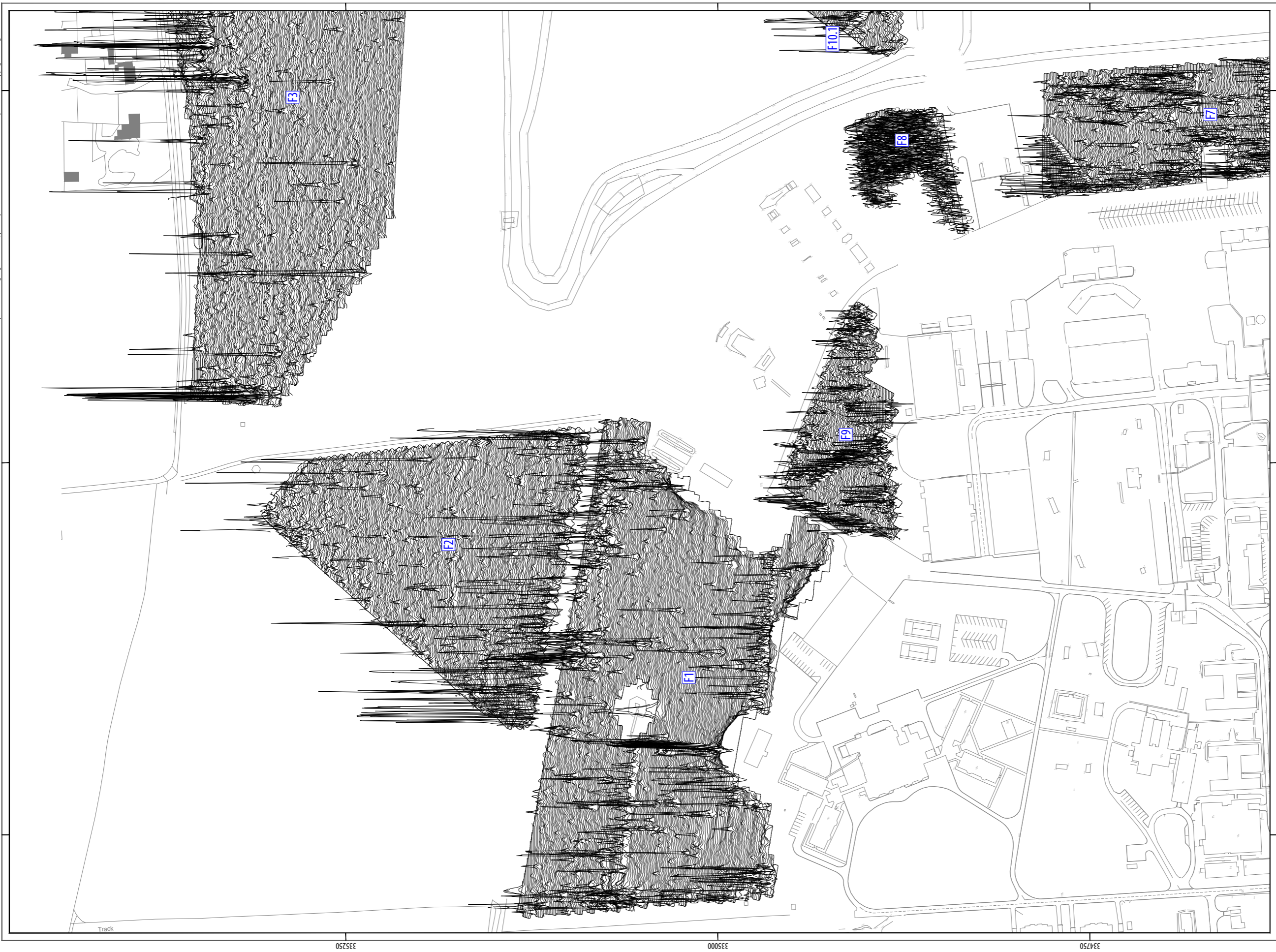
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ILLUS 10 Processed greyscale magnetometer data: Sector 1 (1:2,500)

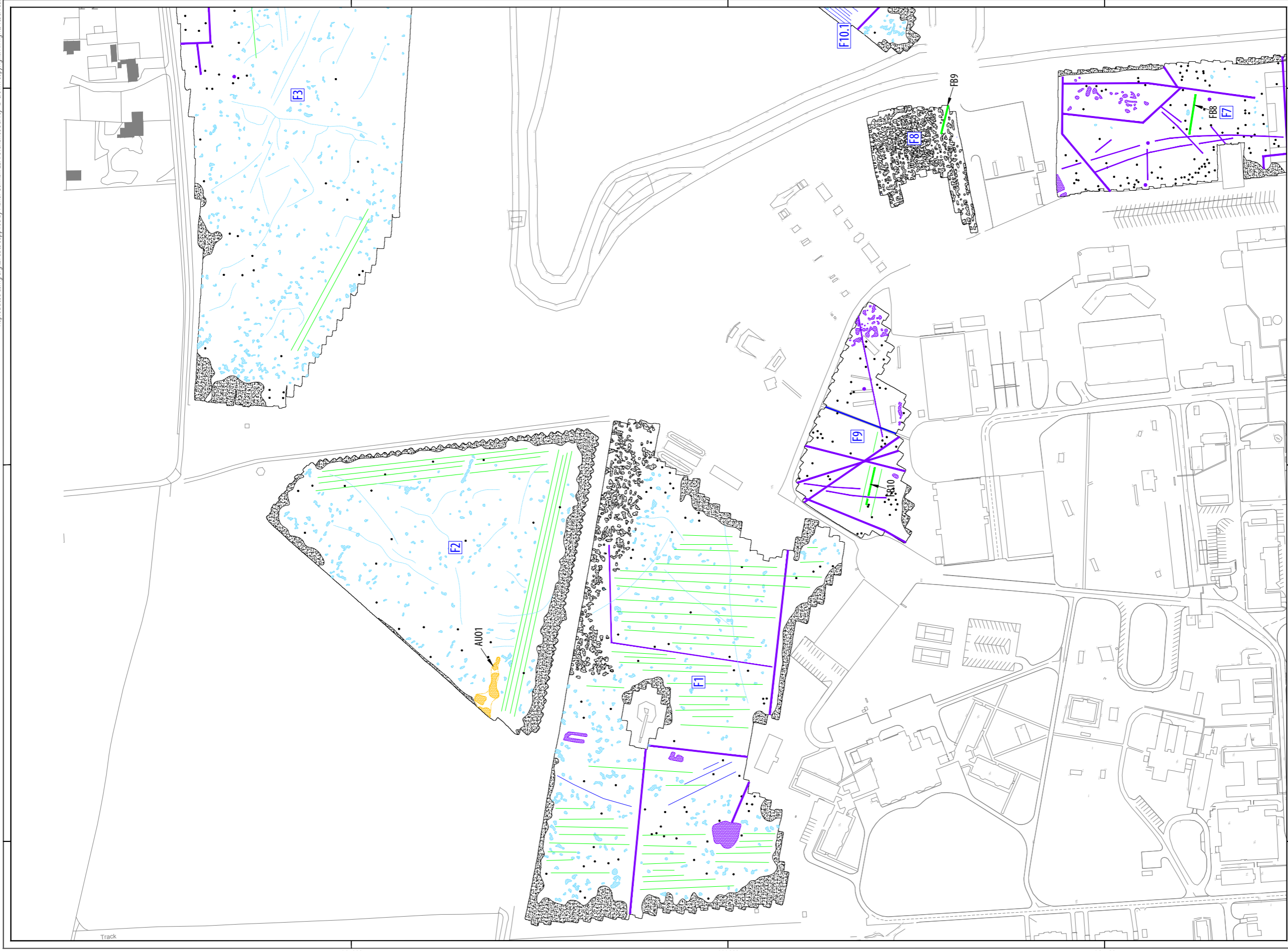


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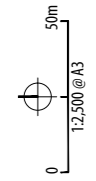
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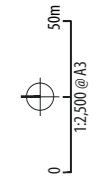
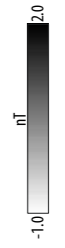
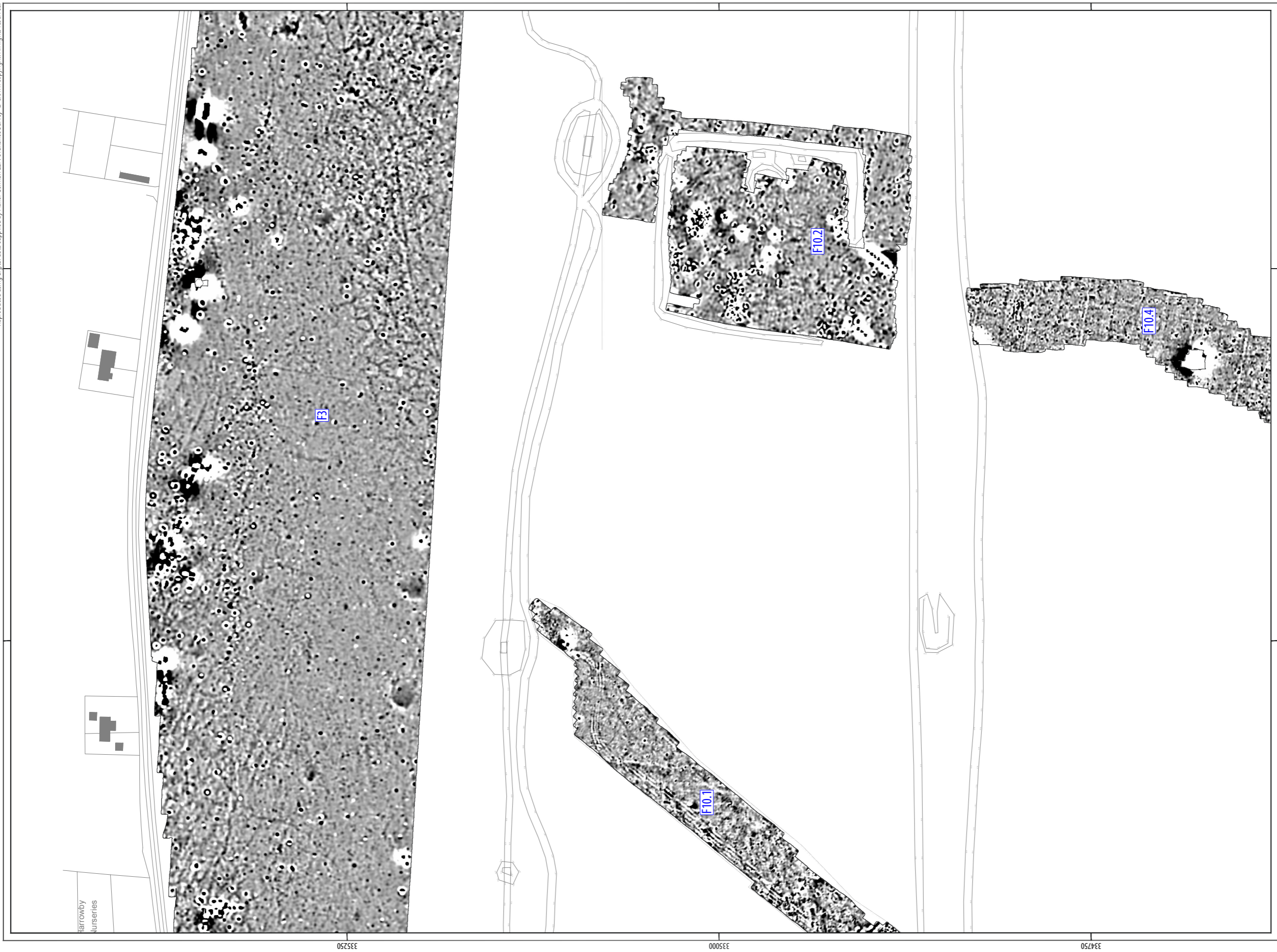
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<p>TYPE OF ANOMALY</p> <ul style="list-style-type: none"> ● dipolar isolated ● magnetic disturbance ● magnetic disturbance ● dipolar isolated ● dipolar linear — linear 	<p>INTERPRETATION</p> <ul style="list-style-type: none"> ferrous material ferrous material airfield infrastructure airfield infrastructure service pipe/service cable modern ground disturbance 	<p>TYPE OF ANOMALY</p> <ul style="list-style-type: none"> — linear trend — linear — linear trend — magnetic enhancement — magnetic enhancement 	<p>INTERPRETATION</p> <ul style="list-style-type: none"> agricultural former field boundary geology geology uncertain 	<p>ABBREVIATIONS</p> <ul style="list-style-type: none"> AU0 anomalies of uncertain origin FB former boundary 	<p>PROJECT</p> <p>SPIT18 Prince William of Gloucester Barracks Grantham Lincolnshire</p>	<p>CLIENT</p> <p>Fisher German LLP</p>	<p>HEADLAND ARCHAEOLOGY</p> <p>NORTH Unit 16, Hillside, Beeston Road Leeds LS11 8ND 0113 387 6430 www.headlandarchaeology.com</p>
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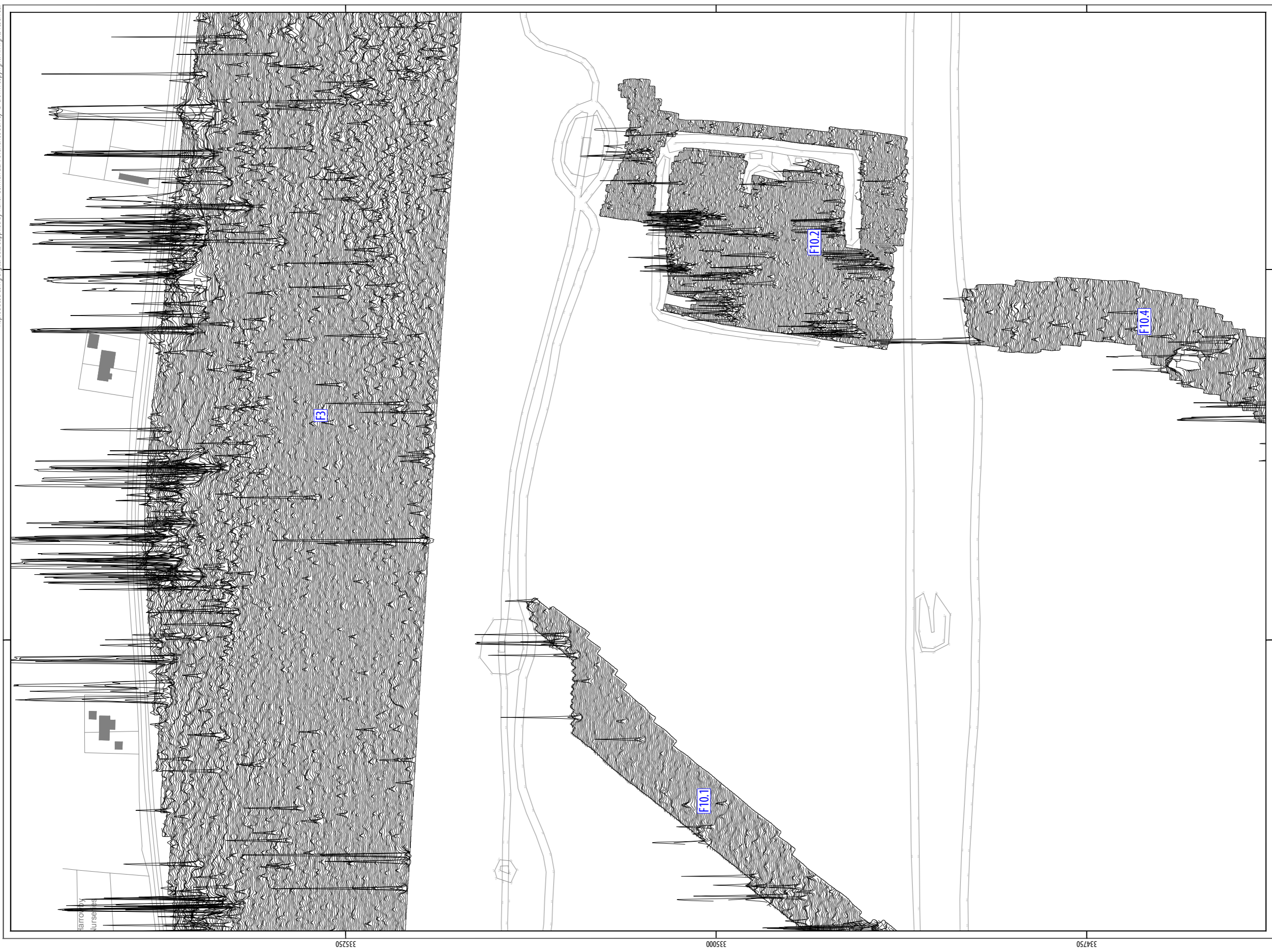
ILLUS 12 Interpretation of magnetometer data; Sector 1 (1:2,500)



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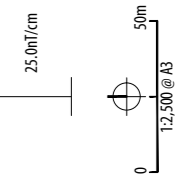
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ILLUS 14 XY trace plot of minimally processed magnetometer data; Sector 2 (1-2,500)



<ul style="list-style-type: none"> ● dipolar isolated ● magnetic disturbance ● magnetic disturbance ● dipolar isolated ● dipolar linear ● linear 	<ul style="list-style-type: none"> — ferrous material — ferrous material — airfield infrastructure — airfield infrastructure — service pipe/service cable — former runway 	<ul style="list-style-type: none"> — linear — linear trend — linear trend — linear — linear trend — magnetic enhancement 	<ul style="list-style-type: none"> — modern ground disturbance — agricultural — field drain — former field boundary — geological variation — geology 	<ul style="list-style-type: none"> FB former boundary PB pillbox RW runway
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INTERPRETATION

TYPE OF ANOMALY

ABBREVIATIONS

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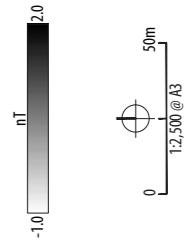
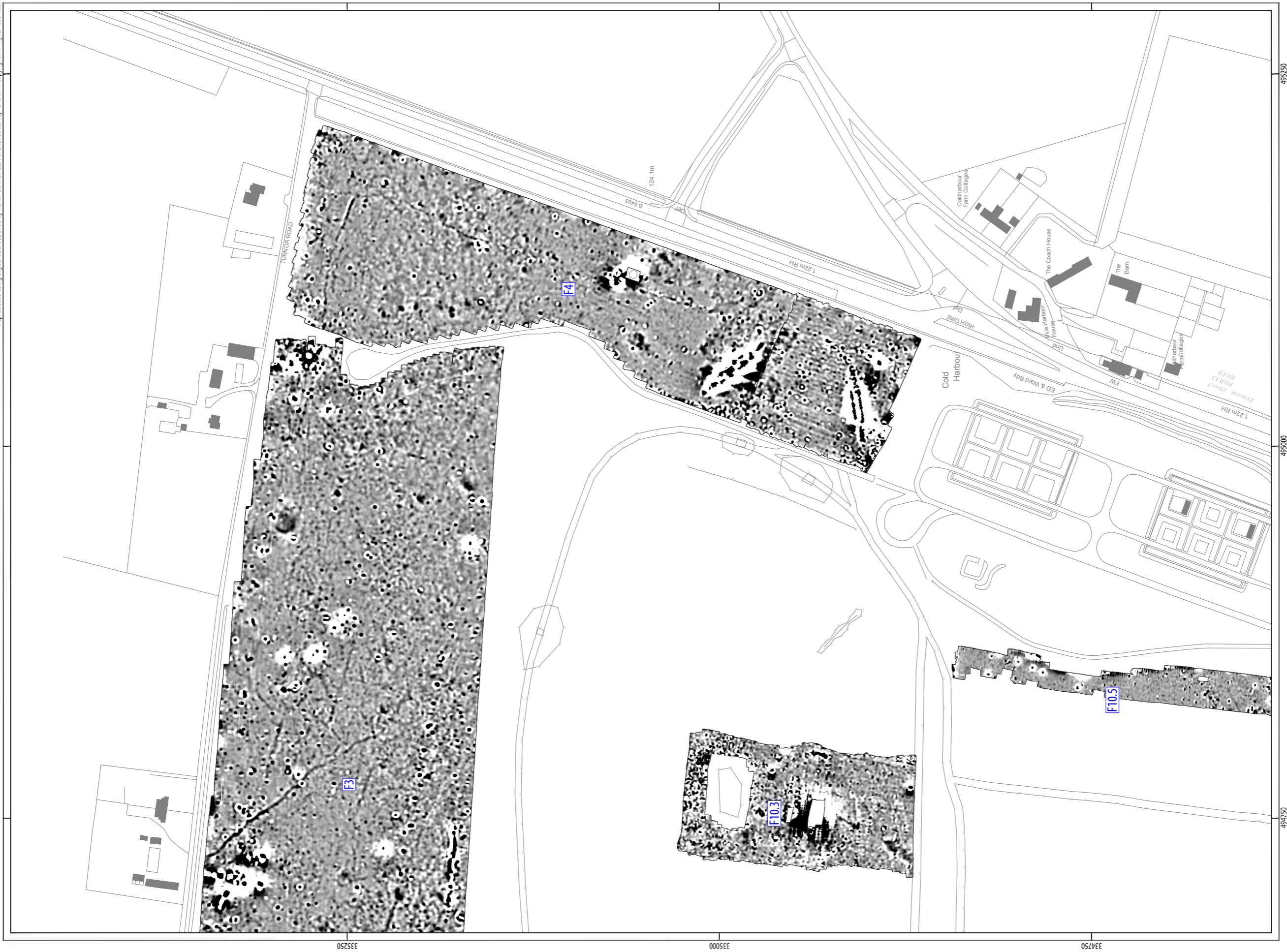
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ILLUS 15 Interpretation of magnetometer data; Sector 2 (1:2,500)

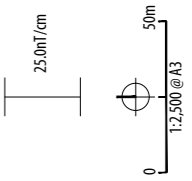


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ILLUS 16 Processed greyscale magnetometer data; Sector 3 (1-2,500)

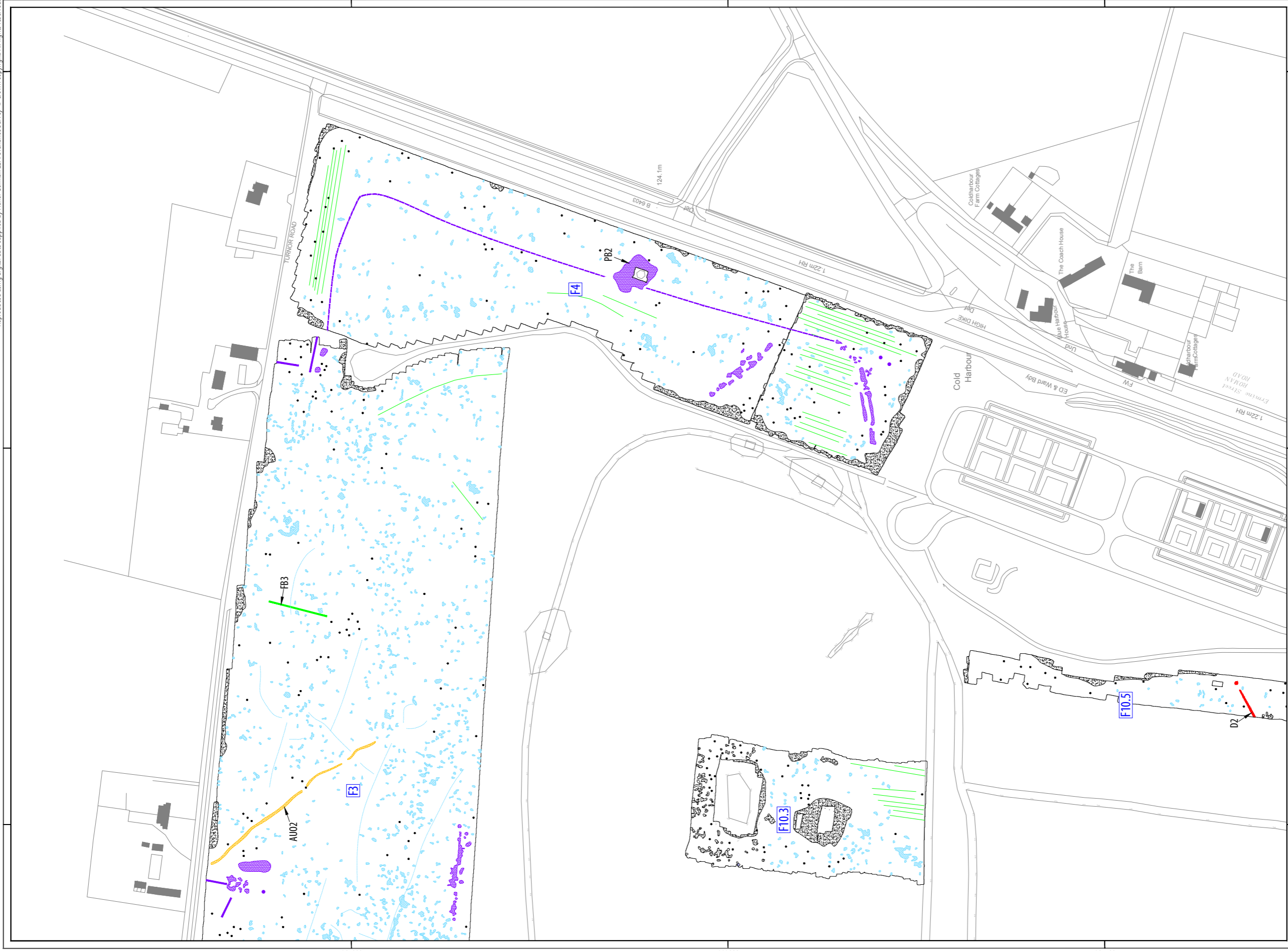


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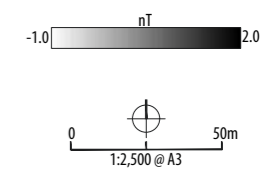
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TYPE OF ANOMALY	INTERPRETATION	TYPE OF ANOMALY	INTERPRETATION	ABBREVIATIONS	PROJECT	CLIENT
<ul style="list-style-type: none"> • dipolar isolated • magnetic disturbance • magnetic disturbance • dipolar isolated • dipolar linear • linear 	<ul style="list-style-type: none"> ferrous material ferrous material airfield infrastructure airfield infrastructure service pipe/service cable airfield infrastructure 	<ul style="list-style-type: none"> linear trend linear linear trend linear trend magnetic enhancement magnetic enhancement magnetic enhancement 	<ul style="list-style-type: none"> agricultural former field boundary geological variation geology archaeology? archaeology 	<ul style="list-style-type: none"> AU0 anomalies of uncertain origin FB former boundary PB pillbox 	<p>SPIT18 Prince William of Gloucester Barracks Grantham Lincolnshire Fisher German LLP</p>	<p>HEADLAND ARCHAEOLOGY NORTH Unit 16, Hillside, Beeston Road Leeds LS11 8ND 0113 387 6430 www.headlandarchaeology.com</p>

ILLUS 18 Interpretation of magnetometer data: Sector 3 (1-2,500)

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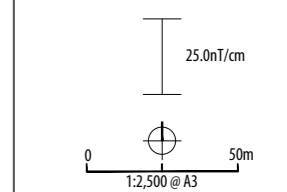
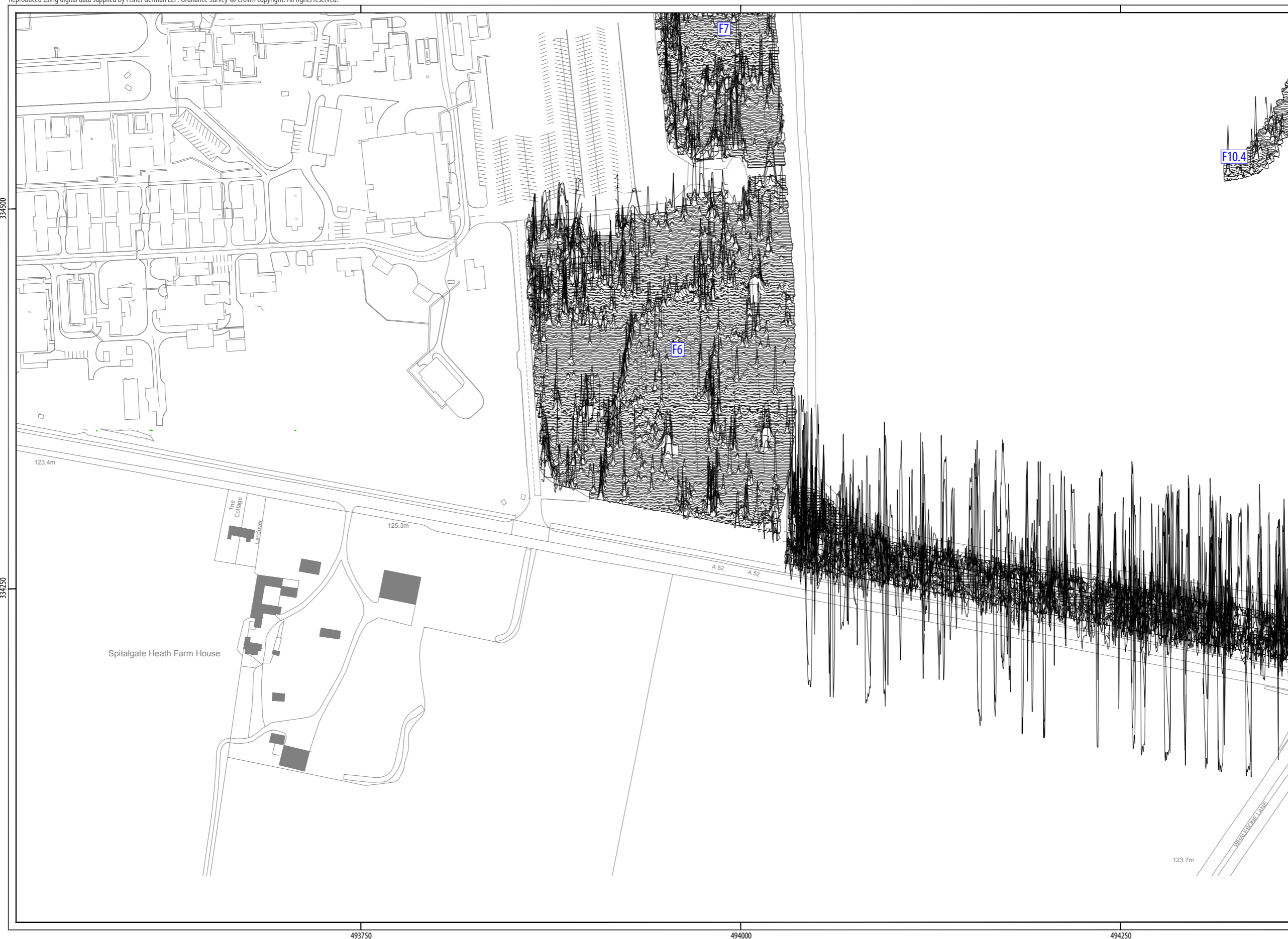
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ILLUS 19 Processed greyscale magnetometer data; Sector 4 (1:2,500)

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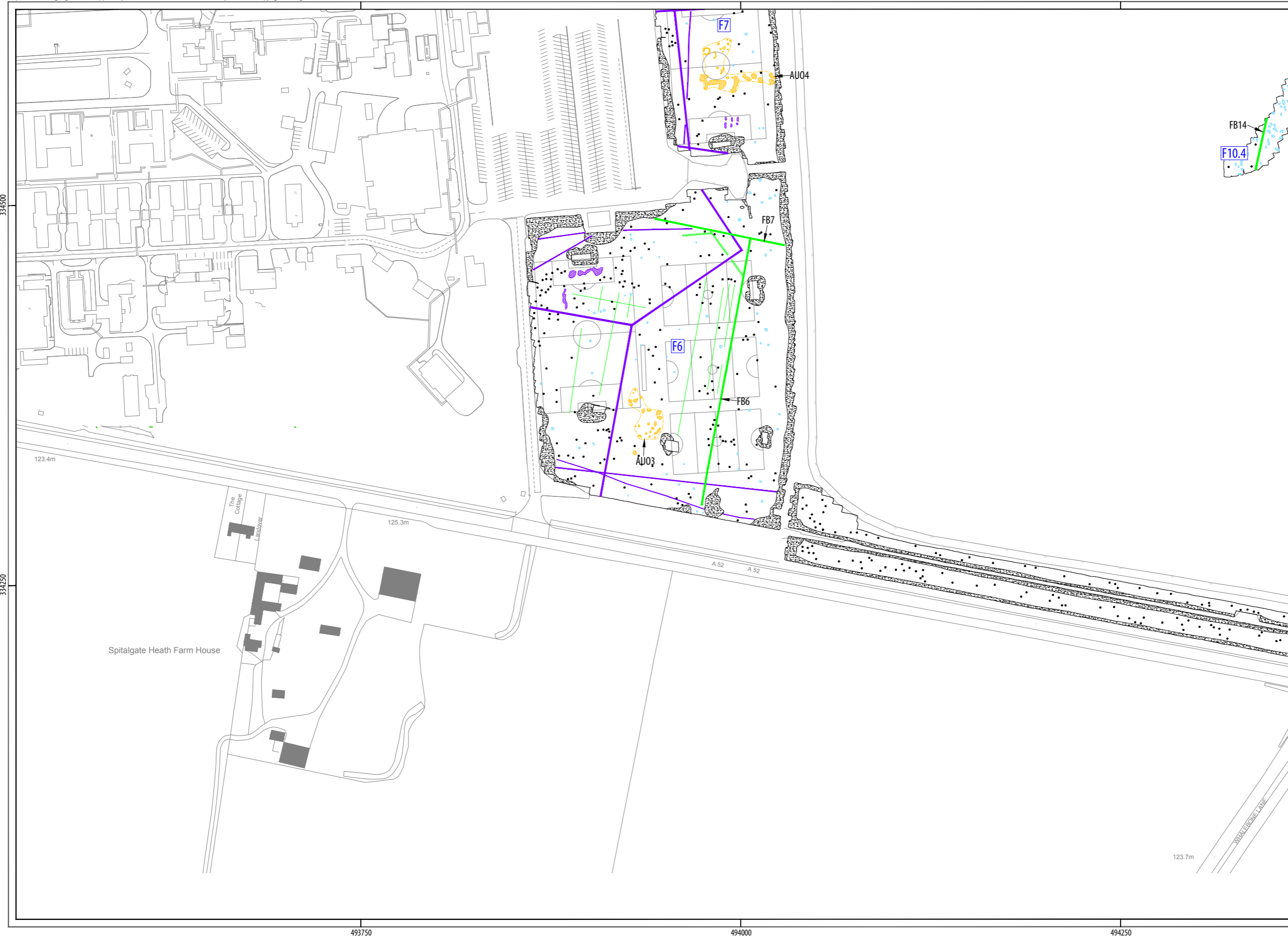


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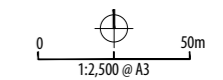
ILLUS 20 XY trace plot of minimally processed magnetometer data; Sector 4 (1:2,500)

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TYPE OF ANOMALY	INTERPRETATION
● dipolar isolated	ferrous material
● magnetic disturbance	ferrous material
⊗ magnetic disturbance	airfield infrastructure
— dipolar linear	service pipe/service cable
— linear trend	agricultural
— linear trend	field drain
— linear	former field boundary
● magnetic enhancement	geology
⊗ magnetic enhancement	uncertain

ABBREVIATIONS
 AUO anomalies of uncertain origin
 FB former boundary



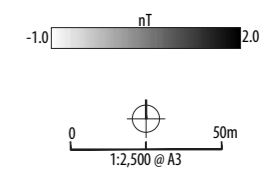
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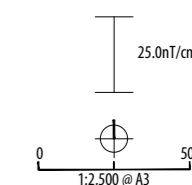
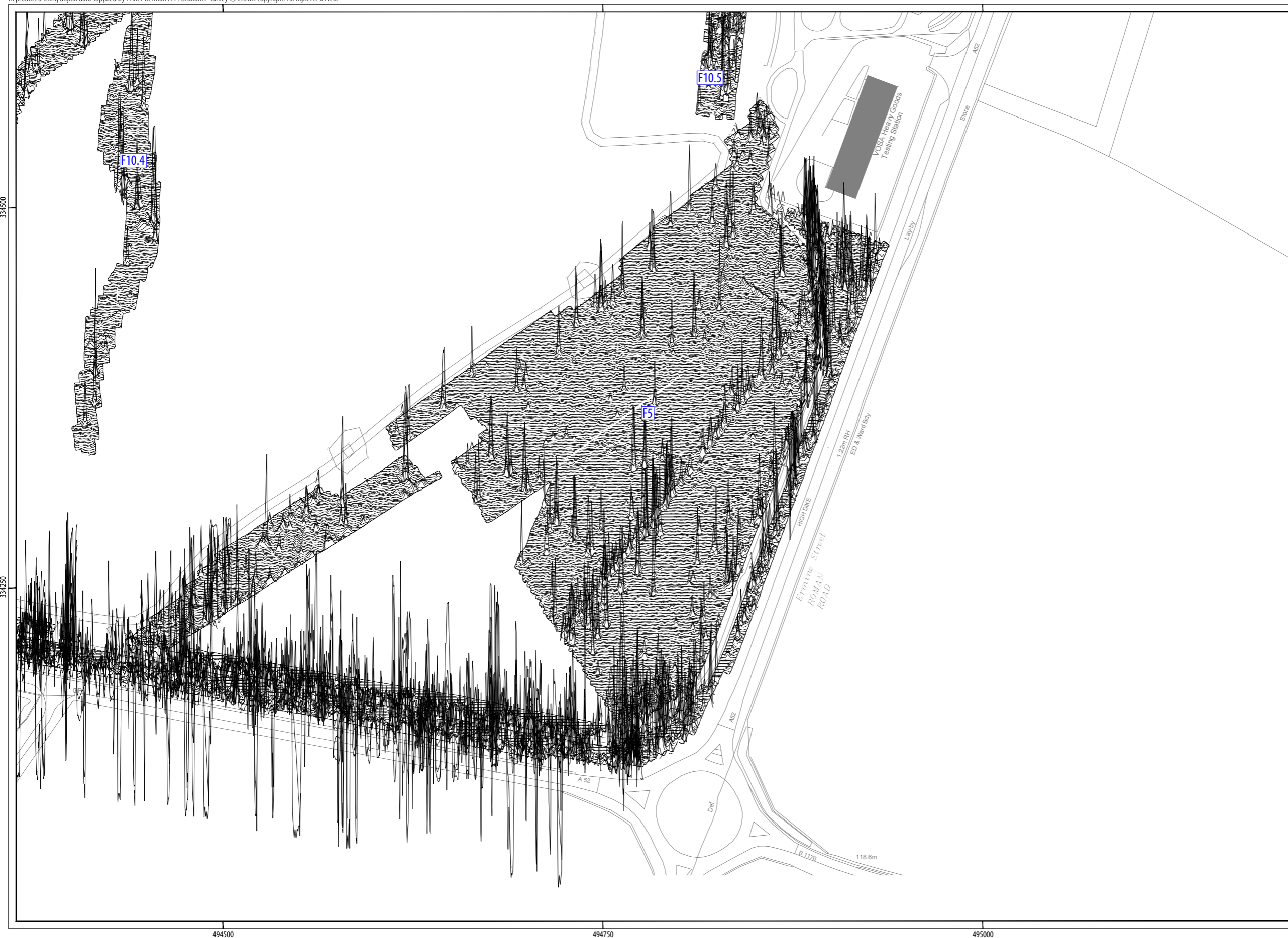
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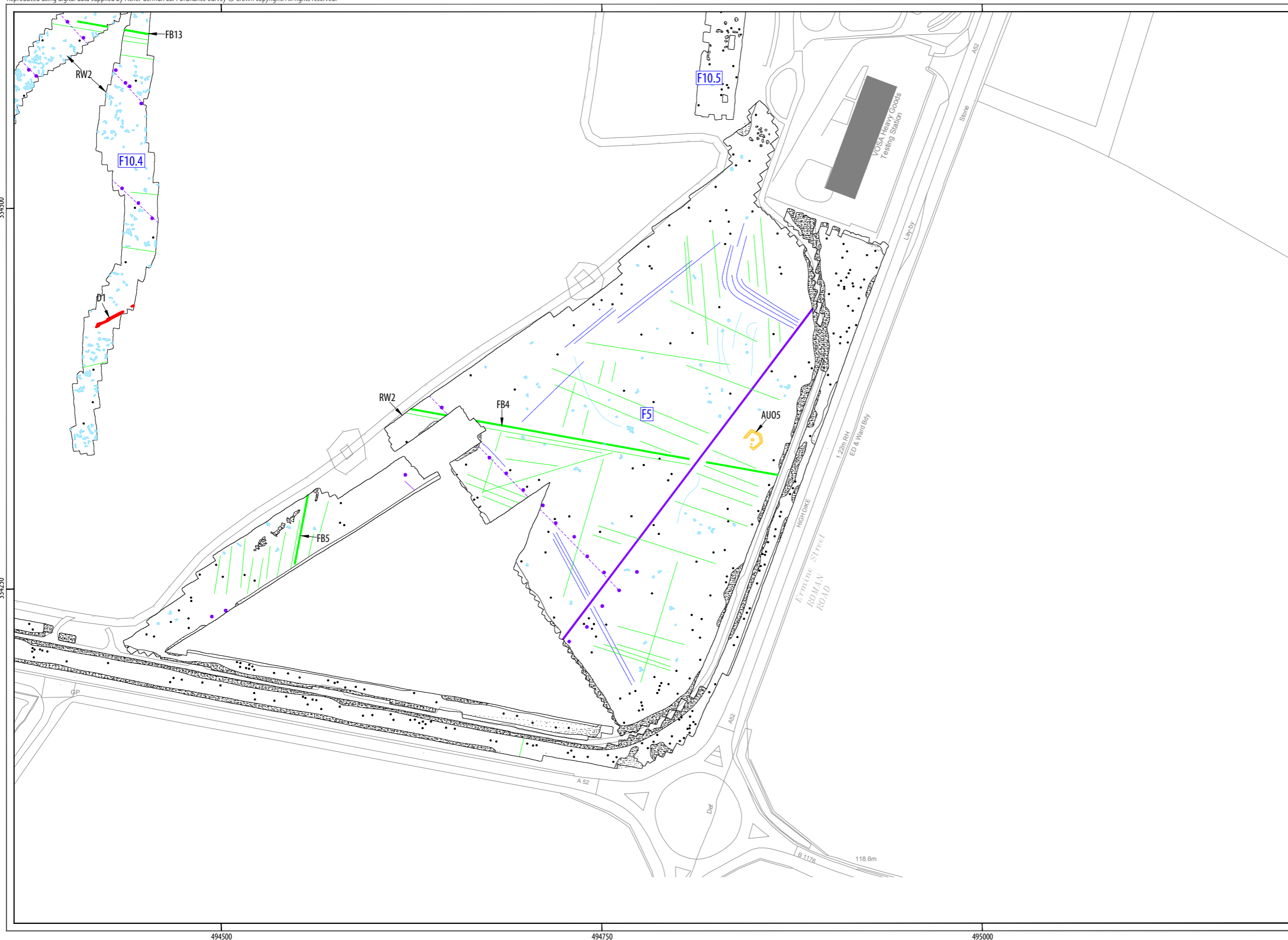
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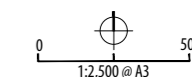
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TYPE OF ANOMALY	INTERPRETATION
● dipolar isolated	ferrous material
● magnetic disturbance	ferrous material
● dipolar isolated	airfield infrastructure
— dipolar linear	service pipe/service cable
— linear	former runway
— linear	modern ground disturbance
— linear trend	agricultural
— linear	former field boundary
— linear trend	geological variation
● magnetic enhancement	geology
● magnetic enhancement	uncertain
● magnetic enhancement	archaeology

ABBREVIATIONS

AUO	anomalies of uncertain origin
D	ditch
FB	former boundary
RW	runway



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7 APPENDICES

APPENDIX 1 MAGNETOMETER SURVEY

Magnetic susceptibility and soil magnetism

Iron makes up about 6% of the earth's crust and is mostly present in soils and rocks as minerals such as maghaemite and haematite. These minerals have a weak, measurable magnetic property termed magnetic susceptibility. Human activities can redistribute these minerals and change (enhance) others into more magnetic forms so that by measuring the magnetic susceptibility of the topsoil, areas where human occupation or settlement has occurred can be identified by virtue of the attendant increase (enhancement) in magnetic susceptibility. If the enhanced material subsequently comes to fill features, such as ditches or pits, localised isolated and linear magnetic anomalies can result whose presence can be detected by a magnetometer (fluxgate gradiometer).

In general, it is the contrast between the magnetic susceptibility of deposits filling cut features, such as ditches or pits, and the magnetic susceptibility of topsoils, subsoils and rocks into which these features have been cut, which causes the most recognisable responses. This is primarily because there is a tendency for magnetic ferrous compounds to become concentrated in the topsoil, thereby making it more magnetic than the subsoil or the bedrock. Linear features cut into the subsoil or geology, such as ditches, that have been silted up or have been backfilled with topsoil will therefore usually produce a positive magnetic response relative to the background soil levels. Discrete feature, such as pits, can also be detected.

The magnetic susceptibility of a soil can also be enhanced by the application of heat. This effect can lead to the detection of features such as hearths, kilns or areas of burning.

Types of magnetic anomaly

In the majority of instances anomalies are termed 'positive'. This means that they have a positive magnetic value relative to the magnetic background on any given site. However some features can manifest themselves as 'negative' anomalies that, conversely, means that the response is negative relative to the mean magnetic background.

Where it is not possible to give a probable cause of an observed anomaly a '?' is appended.

It should be noted that anomalies interpreted as modern in origin might be caused by features that are present in the topsoil or upper

layers of the subsoil. Removal of soil to an archaeological or natural layer can therefore remove the feature causing the anomaly.

The types of response mentioned above can be divided into five main categories that are used in the graphical interpretation of the magnetic data:

Isolated dipolar anomalies (iron spikes) These responses are typically caused by ferrous material either on the surface or in the topsoil. They cause a rapid variation in the magnetic response giving a characteristic 'spiky' trace. Although ferrous archaeological artefacts could produce this type of response, unless there is supporting evidence for an archaeological interpretation, little emphasis is normally given to such anomalies, as modern ferrous objects are common on rural sites, often being present as a consequence of manuring.

Areas of magnetic disturbance These responses can have several causes often being associated with burnt material, such as slag waste or brick rubble or other strongly magnetised/fired material. Ferrous structures such as pylons, mesh or barbed wire fencing and buried pipes can also cause the same disturbed response. A modern origin is usually assumed unless there is other supporting information.

Linear trend This is usually a weak or broad linear anomaly of unknown cause or date. These anomalies are often caused by agricultural activity, either ploughing or land drains being a common cause.

Areas of magnetic enhancement/positive isolated anomalies Areas of enhanced response are characterised by a general increase in the magnetic background over a localised area whilst discrete anomalies are manifest by an increased response (sometimes only visible on an XY trace plot) on two or three successive traverses. In neither instance is there the intense dipolar response characteristic exhibited by an area of magnetic disturbance or of an 'iron spike' anomaly (see above). These anomalies can be caused by infilled discrete archaeological features such as pits or post-holes or by kilns. They can also be caused by pedological variations or by natural infilled features on certain geologies. Ferrous material in the subsoil can also give a similar response. It can often therefore be very difficult to establish an anthropogenic origin without intrusive investigation or other supporting information.

Linear and curvilinear anomalies Such anomalies have a variety of origins. They may be caused by agricultural practice (recent ploughing trends, earlier ridge and furrow regimes or land drains), natural geomorphological features such as palaeochannels or by infilled archaeological ditches.

APPENDIX 2 SURVEY LOCATION INFORMATION

An initial survey base station was established using a Trimble VRS differential Global Positioning System (dGPS). The magnetometer data was georeferenced using a Trimble RTK differential Global Positioning System (Trimble R8s model).

Temporary sight markers were laid out using a Trimble VRS differential Global Positioning System (Trimble R8s 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. However, it should be noted that Ordnance Survey positional accuracy for digital map data has an error of 0.5m for urban and floodplain areas, 1.0m for rural areas and 2.5m for mountain and moorland areas. This potential error must be considered if coordinates are measured off hard copies of the mapping rather than using the digital coordinates.

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

APPENDIX 3 GEOPHYSICAL SURVEY ARCHIVE

The geophysical archive comprises an archive disk containing the raw data in XYZ format, a raster image of each greyscale plot with associated 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 4 DATA PROCESSING

The gradiometer data has been presented in this report in processed greyscale and minimally processed XY trace plot format.

Data collected using RTK 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.

A high pass filter has been applied to the greyscale plots to remove low frequency anomalies (relating to survey tracks and modern agricultural features) in order to maximise the clarity and interpretability of the archaeological anomalies.

The data has also been clipped to remove extreme values and to improve data contrast.

APPENDIX 5 OASIS DATA COLLECTION FORM: ENGLAND

OASIS ID: *headland5-389774***PROJECT DETAILS**

Project name	Prince William of Gloucester Barracks, Grantham
Short description of the project	Headland Archaeology (UK) Ltd undertook a geophysical (magnetometer) survey of a 183 hectare site at Prince William of Gloucester Barracks, Grantham, to provide information on the archaeological potential of the site in advance of a possible planning application for a residential and mixed-use development. This report presents the results of the survey undertaken to date, an area of approximately 54 hectares, in those areas not planted with trees. The survey has identified anomalies which locate a ditch feature which flanks the northern side of Salters Way, a Roman road which passes north-east/south-west through the site. These anomalies confirm data held by the Lincolnshire Historic Environment Record and LiDAR data and are assessed as of high archaeological potential. Numerous anomalies have been identified which are caused by 20th century military activity associated with the former RAF Spitalgate including two probable former runways and other infrastructure including buried service pipes and cables. These features may be of historical interest. Five localised areas containing anomalies of uncertain origin have also been identified. Whilst any of these may be of archaeological interest, a confident interpretation cannot be given and each is considered equally likely to have a modern or geological origin. These anomalies are currently assessed as of low archaeological potential although the whole data set from this phase of the survey will be re-evaluated and the interpretations re-assessed once the trees from the site have been cleared and the remainder of the site surveyed.
Project dates	Start: 21-05-2018 End: 29-05-2018
Previous/future work	Not known / Not known
Any associated project reference codes	SPIT – Sitecode
Type of project	Field evaluation
Site status	None
Current Land use	Cultivated Land 1 – Minimal cultivation
Monument type	None
Monument type	None
Significant Finds	None
Significant Finds	None
Methods & techniques	“Geophysical Survey”
Development type	Housing estate
Prompt	National Planning Policy Framework – NPPF
Position in the planning process	Not known / Not recorded
Solid geology (other)	Upper Lincolnshire Limestone Member (limestone) with Lower Lincolnshire Limestone Member (lime-mudstone)
Drift geology (other)	None
Techniques	Magnetometry

PROJECT LOCATION

Country	England
Site location	Lincolnshire, South Kesteven, Londonthorpe And Harrowby Without, Prince William of Gloucester Barracks, Gratham
Study area	54 Hectares
Site coordinates	SK 9340 3430 52.897693841647 -0.611371634397 52 53 51 N 000 36 40 W Point

PROJECT CREATORS

Name of Organisation	Headland Archaeology
Project brief originator	Consultant
Project design originator	Headland Archaeology
Project director/manager	Alistair Webb

Project supervisor Ross Bishop

Type of sponsor/funding body Developer

PROJECT ARCHIVES

Physical Archive Exists? No

Digital Archive recipient In house

Digital Contents "other"

Digital Media available "Geophysics", "Images raster / digital photography", "Images vector"

Paper Archive Exists? No

PROJECT BIBLIOGRAPHY 1

Publication type Grey literature (unpublished document/manuscript)

Title Prince William of Gloucester Barracks, Grantham, Lincolnshire: Geophysical Survey

Author(s)/Editor(s) David Harrison

Other bibliographic details SPIT

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