Tritax Symmetry (Hinckley) Limited

HINCKLEY NATIONAL RAIL FREIGHT INTERCHANGE

The Hinckley National Rail Freight Interchange Development Consent Order

Project reference TR050007

Environmental Statement
Volume 2: Appendices

Appendix 13.4 - Geophysical Survey Report (Phase 2)

Document reference: 6.2.13.4

Revision: 01

October 2022

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 Regulation 5(2)(a)

The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 Regulation 14

This document forms a part of the Environmental Statement for the Hinckley National Rail Freight Interchange project.

Tritax Symmetry (Hinckley) Limited (TSH) has applied to the Secretary of State for Transport for a Development Consent Order (DCO) for the Hinckley National Rail Freight Interchange (HNRFI).

To help inform the determination of the DCO application, TSH has undertaken an environmental impact assessment (EIA) of its proposals. EIA is a process that aims to improve the environmental design of a development proposal, and to provide the decision maker with sufficient information about the environmental effects of the project to make a decision.

The findings of an EIA are described in a written report known as an Environmental Statement (ES). An ES provides environmental information about the scheme, including a description of the development, its predicted environmental effects and the measures proposed to ameliorate any adverse effects.

Further details about the proposed Hinckley National Rail Freight Interchange are available on the project website:

[redacted]

The DCO application and documents relating to the examination of the proposed development can be viewed on the Planning Inspectorate's National Infrastructure Planning website:

https://infrastructure.planninginspectorate.gov.uk/projects/east-midlands/hinckley-national-rail-freight-interchange/

Appendix 13.4: This document was prepared by Headland Archaeology in 2021 as part of the baseline gathering exercise for the HNRFI. Since this report was prepared amendments have been made to the defined Order Limits as a result of design development. Nonetheless, the contents of this report continue to form a robust evidence base and as such this appendix is used to support the assessment in Chapter 13 (document reference 6.1.13) of the ES.

HNFI21

Hinckley National Freight Interchange, Leicestershire

GEOPHYSICAL SURVEY REPORT

PLANNING REF. pre-application

Headland Archaeology Yorkshire & North
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for Cotswold Archaeology

07/06/2021

HEADLAND ARCHAEOLOGY

PROJECT INFORMATION:

PROJECT NAME	Hinckley National Freight Interchange
TYPE OF WORK	Geophysical Survey
PLANNING REF.	Pre-application
PARISH NUMBER	n/a
CONSULTANT/AGENT	The Environmental Dimension Partnership
CLIENT	Cotswold Archaeology
PROJECT CODE	HNFI21
HAS. NO (HEREFORD ONLY)	n/a
NGR	NGR SP 45197 95452
PARISH	Click or tap here to enter text.
LOCAL AUTHORITY	Leicestershire County Council
FIELDWORK DATES	17/05/2021 – 21/05/2021
OASIS REF.	n/a
ARCHIVE REPOSITORY	Headland Archaeology

PROJECT TEAM:

PROJECT MANAGER	Alistair Webb
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PROJECT SUMMARY

Headland Archaeology (UK) Ltd was commissioned by the Environmental Dimension Partnership on behalf of Cotswold Archaeology, to undertake a geophysical (magnetometer) survey at one of two locations near Hinckley, Leicestershire where improved road connections are required for the Hinckley National Rail Freight Interchange (HNRFI) development. The A47 Link Road Site covered 22 hectares either side of the proposed link road corridor and extends from the proposed new roundabout at the junction with the B4668 in the north-west to the railway line immediately south of Bridge Farm in the south-east. The survey was undertaken to assess the impact of the future development on the historic environment. The results of the survey will be submitted in support of a planning application for the future development of the land and may also inform future archaeological strategy.

The spreading of 'green waste' as soil improver over all the arable fields within the survey area (at least 75% of the site) has meant that it has not been possible to assess the archaeological potential of the survey area; the magnitude of the responses from the soil improver will almost certainly be 'masking' the much lower readings from any below ground archaeological features, if present. On the small areas of pasture where 'green waste' has not been spread only drains and modern disturbance have been recorded. No anomalies of possible or probable archaeological origin have been identified by the survey. The archaeological potential of the GSA therefore remains unknown.

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HINCKLEY NATIONAL FREIGHT INTERCHANGE, LEICESTERSHIRE

GEOPHYSICAL SURVEY REPORT

1. INTRODUCTION

Headland Archaeology (UK) Ltd was commissioned by the Environmental Dimension Partnership (EDP - the Consultant), on behalf of Cotswold Archaeology (the Client), to undertake a geophysical (magnetometer) survey at two locations near Hinckley, Leicestershire (Illus 1) where improved road connections are required for the Hinckley National Rail Freight Interchange (HNRFI) development. The two sites comprise the A47 Link Road Site and the Junction 21 Site although the latter site was subsequently de-scoped from the programme.

The geophysical survey was undertaken to assess the impact of the future development on the historic environment. The results of the survey will be submitted in support of a planning application for the future development of the land and may also inform future archaeological strategy at the sites, if required.

The survey was undertaken in accordance with the Archaeological Written Scheme of Investigation (WSI) (Headland 2021), submitted to Leicestershire County Council prior to the commencement of the survey, with guidance within the National Planning Policy Framework (MHCLG 2019) and in line with current best practice (Chartered Institute for Archaeologists 2014, Europae Archaeologia Consilium 2016).

The survey was carried out between May 17th and May 21st 2021.

1.1. SITE LOCATION, TOPOGRAPHY AND LAND USE

The A47 Link Road Site Development Control Order (DCO) redline boundary covers the area required to accommodate the A47 Link Road, which is proposed to extend west from the HNRFI main site. The geophysical survey area (GSA) did not include all the land within the DCO boundary but extended across part or all of nine fields (F1 to F9 inclusive) covering approximately 22 hectares either side of the proposed link road corridor which extends from the proposed new roundabout at the junction with the B4668 in the north-west to the railway line immediately south of Bridge Farm in the south-east, a distance of approximately 1km (Illus 6). The survey area is centred at SP 45197 95452 and comprises a mixture of grazed pasture to the north and maturing winter wheat crops to the south (Illus 2 to Illus 5 inclusive).

Topographically most of the GSA is relatively flat at approximately 92m Above Ordnance Datum (AOD) rising to 98m AOD immediately south of Bridge Farm.

1.2. GEOLOGY AND SOILS

The underlying bedrock geology comprises Mercia Mudstone Group – Mudstone. This is overlain by a narrow band of Alluvium – Clay, Silt, Sand and Gravel in the centre of the survey corridor and by Bosworth Clay Member – Clay and Silt, to the south-east around Bridge Farm. There are no recorded superficial deposits at the northern end of the survey corridor (NERC 2021).

The soils are classified in the Soilscape 18 Association which are described as slowly permeable, seasonally wet slightly acid but base-rich loamy and clayey soils to the southern end of the survey corridor and in the Soilscape 8 Association at the northern end of the corridor. These latter soils are described as slightly acid loamy and clayey soils with impeded drainage (Cranfield University 2021).

2. ARCHAEOLOGICAL BACKGROUND

Within the A47 link road DCO boundary, the HER records are limited to that of a desk-based assessment (ELE8716) undertaken in 2013 on the alignment of a sewerage pipeline through this land, and the record of the post-medieval turnpike road (MLE20657) on the alignment of the modern B4668.

A possible prehistoric enclosure (MLE2800) has been identified at Hinckley Football Stadium, to the north-west of the B4668. However, subsequent geophysical survey (ELE887) did not reveal any evidence of plausible archaeological features.

The London and North Western Railway (MLE16084) is located immediately south-east of the A47 Link Road DCO boundary, beyond which is the HNRFI main site, where recent geophysical survey (ELE10614) and trial trenching (forthcoming) has recorded the presence of low-density archaeological activity relating to discrete late prehistoric/Roman rural settlements (including a ring ditch (MLE23779) close to Hobbs Hayes Farm), as well as extensive medieval to post-medieval and modern agricultural activity.

To the east, the findspot of a single medieval penny (MLE10250) is recorded from the field to the east of Bridge Farm, while to the west, 20th century activity, in the form of World War I practice trenches (MLE21439), World War II defensive elements (MLE21438) and a rifle range (MLE21437), are recorded at Burbage Common.

3. THE SURVEY

3.1 AIMS & OBJECTIVES

The aim of the geophysical survey was to provide information on the extent, condition, character and date (as far as circumstances permit) of any archaeological features and deposits within the GSA and therefore to provide information to support the outline planning application and help determine the need any further archaeological works, if required.

The objectives were:

- to provide information about the nature and possible interpretation of any magnetic anomalies identified;
- to therefore determine the likely presence/absence and extent of any buried archaeological features; and
- to produce a comprehensive site archive and report.

3.2 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.

Magnetometry is the most widely used geophysical survey technique in archaeology as it can quickly evaluate large areas and, under favourable conditions, identify a wide range of archaeological features including infilled cut features such as large pits, gullies and ditches, hearths and areas of burning and kilns and brick structures. It is therefore good at locating settlements of all periods, prehistoric field systems and enclosures and areas of industrial or modern activity, amongst others. It is less successful in identifying smaller features such as post-holes and small pits (except when using a non-standard sampling interval), unenclosed (prehistoric) settlement sites and graves/burial grounds. However, magnetometry is by far the single most useful technique and was assessed as the best non-intrusive evaluation tool for this site.

3.3 METHODOLOGY

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 V3.0.37.0 (DWConsulting) software was used to process and present the data.

4. RESULTS AND DISCUSSION

4.1. DATA PRESENTATION & TECHNICAL DETAIL

A general site location plan is shown in Illus 1 at a scale of 1:50,000. Illus 2 to Illus 5 inclusive show typical conditions on site. Illus 6 shows the GPS swaths at 1:5,000 and photograph locations. Illus 7 and Illus 8, also at 1:5,000, present the greyscale data for the whole GSA and an overall interpretation. Fully processed data (greyscale), minimally processed data (XY trace plot) format and interpretation plots are presented by Sector at a scale of 1:2,000 in Illus 9 to Illus 14 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 (Headland 2021), guidelines outlined by Europae Archaeologia Consilium (EAC 2016) and by the Chartered Institute for Archaeologists (CIfA 2014).

All illustrations from Ordnance Survey (OS) 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' (minimally processed) and processed formats and over a range of different display levels. All illustrations are presented to display and interpret the data to best effect. The interpretations are based on the experience and knowledge of management and reporting staff.

4.2. SITE CONDITIONS

Magnetometer survey is generally recommended over any sedimentary bedrock with the response reported as 'average' on mudstone (English Heritage 2008). Consequently, it was considered likely that magnetometry was an appropriate methodology given the prevailing geology, taking account of the limitations noted in Section 3.2 above.

However, although ground conditions were good throughout the GSA and data quality was consequently also good with only minimal post-processing required, it is immediately apparent that the data recorded in all the arable fields has been adversely affected by the application of 'green waste' as a soil improver. The result is that the data presents as a dense, homogenous mass of highly enhanced readings against which only the very highest magnitude readings stand out as anomalous. The green waste often includes ferrous debris amongst the organic material which can also be highly magnetic in its own right due to the breakdown of the organic material during the decomposition process, although this effect decreases over time. The overall result is that the elevated readings due to the green waste have severely reduced the possibility of identifying archaeological anomalies by effectively 'masking' the likely much lower readings from any archaeological features, if present.

4.3. FERROUS AND MODERN ANOMALIES

As discussed above the only anomalies identified in the areas contaminated by green waste are a very high magnitude land drain and a ferrous pipe, both in F4.

In the areas of pasture individual ferrous anomalies, characterised as individual 'spikes', are recorded. These anomalies 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 introduced into the topsoil during manuring or tipping/infilling. There is no obvious clustering to the ferrous anomalies within any of the fields or across the GSA more

generally to 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.

Larger areas or bands of magnetic disturbance are recorded around the entrance into F2 and adjacent to the outbuildings at Bridge Farm in F7 and F8. These areas of disturbance are due to tipping or infilling around the gateway and to the proximity of the farm buildings respectively.

Linear bands of disturbance are also recorded around most of the field edges. This disturbance is typically caused by the accumulation of ferrous debris at field edges or to magnetic material such as barbed wire or wire mesh in the boundary itself.

4.4. AGRICULTURAL ANOMALIES

In the non-arable parts of the GSA parallel linear trends in the data are recorded in F1, F2, F3 and F9 (Illus 11 and Illus 14). These anomalies are due to field drains.

4.5. POSSIBLE ARCHAEOLOGICAL ANOMALIES

No anomalies of possible or probable archaeological origin have been identified by the survey.

5. CONCLUSION

The spreading of green waste over at least 75% of the site has meant that it has not been possible to assess the archaeological potential of the GSA based on the results of the survey; the magnitude of the responses from the soil improver will almost certainly be 'masking' the much lower readings from below ground archaeological features, if present. On the areas of pasture drains and modern disturbance have been recorded. No anomalies of possible or probable archaeological origin have been identified by the survey. The archaeological potential of the GSA therefore remains unknown.

6. REFERENCES

Chartered Institute for Archaeologists (CIfA) 2014 Standard and guidance for archaeological geophysical survey (Reading) [redacted]

Natural Environment Research Council (NERC) 2018 British Geological Survey [redacted] accessed 7th June 2021

Europae Archaeologia Consillium (EAC) 2016 EAC Guidelines for the Use of Geophysics in Archaeology: Question to Ask and Points to Consider (Namur, Belgium) [redacted] accessed 7th June 2021

Gaffney C & Gater J 2003 Revealing the Buried Past: Geophysics for Archaeologists Stroud

Headland Archaeology Ltd 2021 Hinckley National Freight Interchange: Written Scheme of Investigation for Geophysical Survey Unpublished Client Doc Ref. HNFI21

Ministry of Housing, Communities and Local Government (MHCLG) 2019 National Planning Policy Framework [redacted] June 2021

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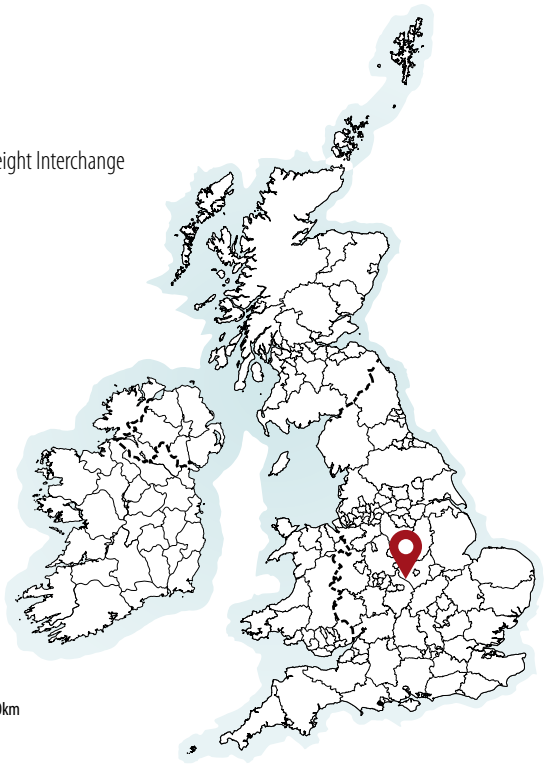

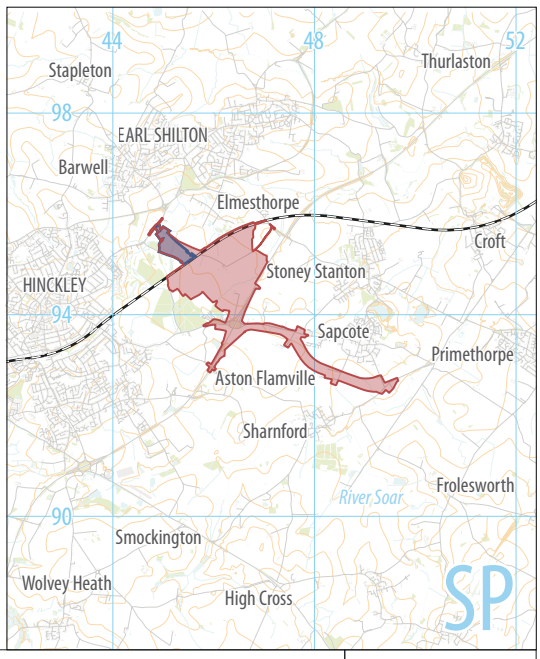

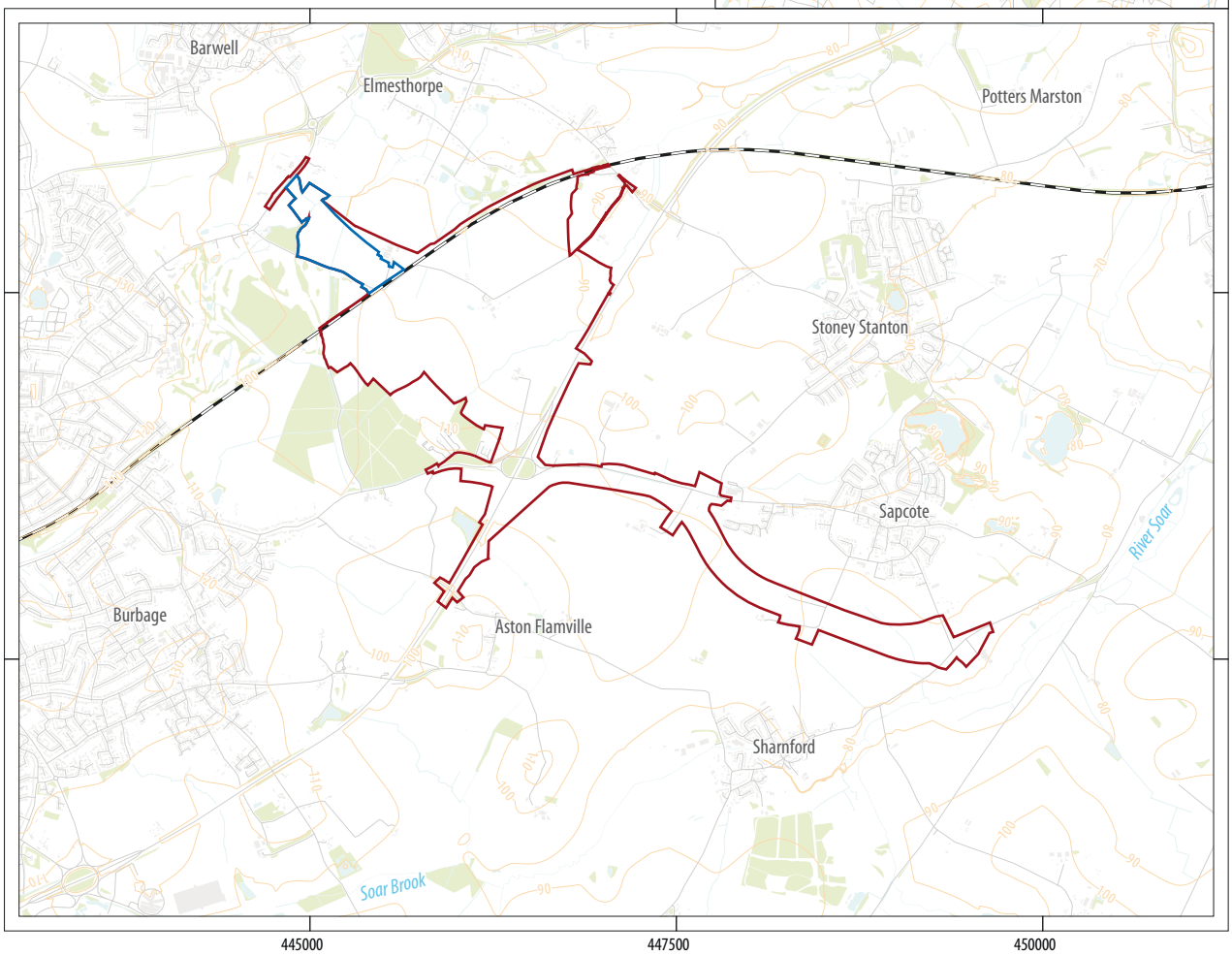

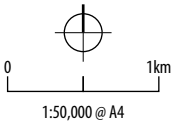

DCO limit
geophysical survey area

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[redacted]

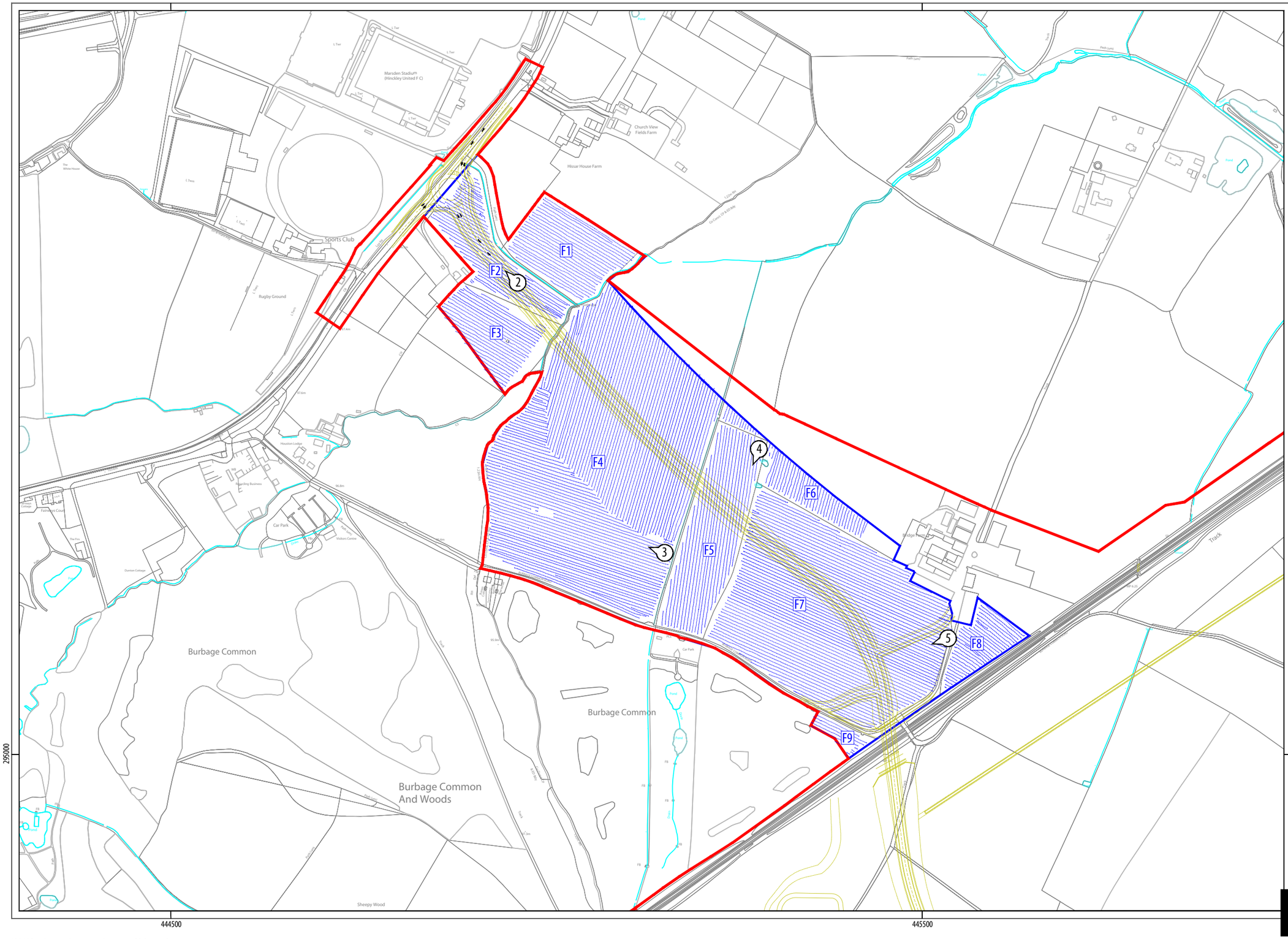
ILLUS 1 Site location

Illus 2. F2, looking north-west

Illus 3. F4, looking west

Illus 4. F5, looking south-west

Illus 5. F7, looking south-west



0 100m
1:5,000 @ A3

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ILLUS 6 Survey location showing GPS swaths

proposed link road

nT
-1.0 2.0

0 100m
1:5,000 @ A3

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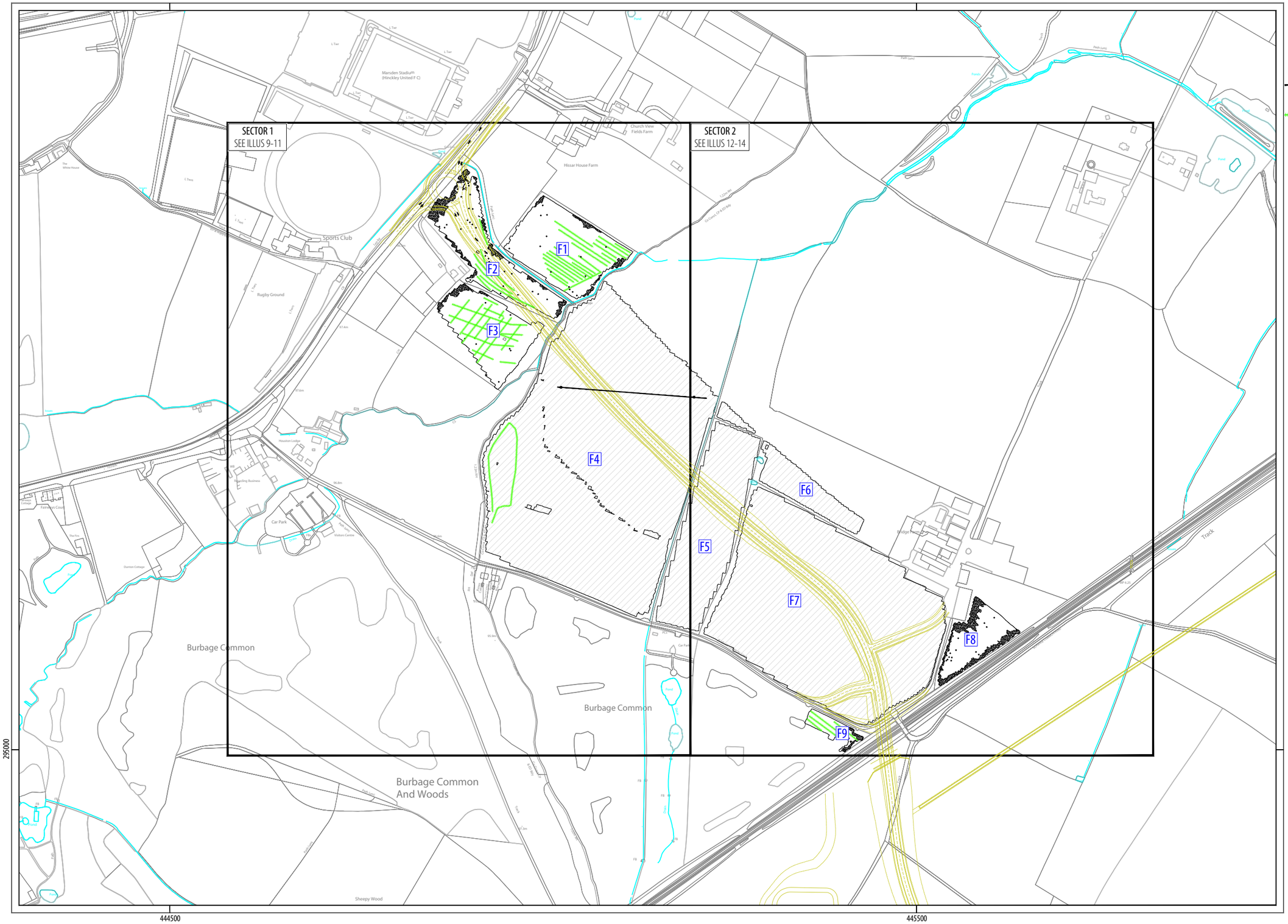
ILLUS 7 Processed greyscale magnetometer data



proposed link road

TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
dipolar linear	service pipe
magnetic disturbance	green waste
linear trend	field drain

0 100m
1:5,000 @ A3

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ILLUS 8 Interpretation of magnetometer data

nT
-1.0 2.0

0 50m
1:2,500 @ A3

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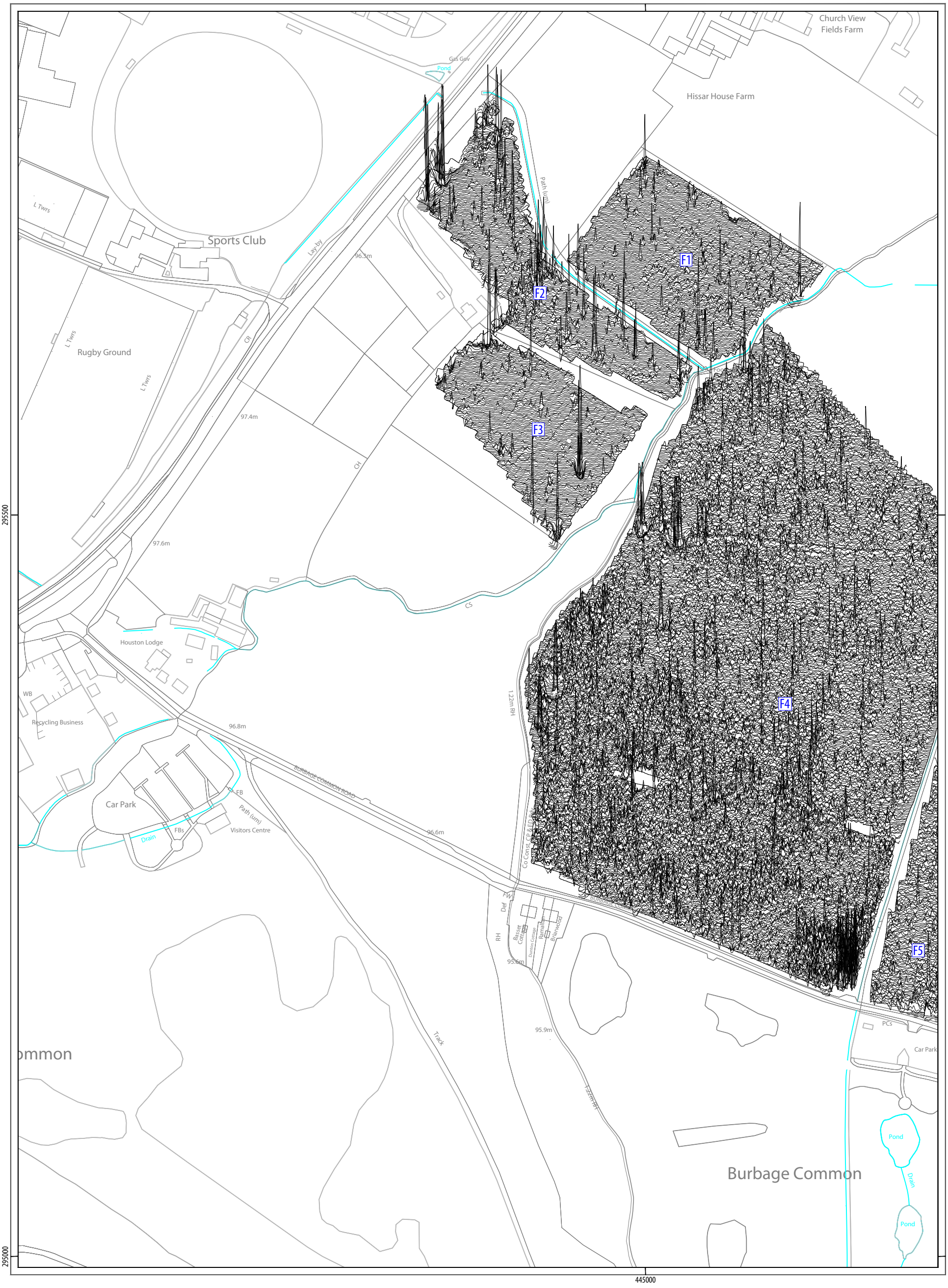
ILLUS 9 Processed greyscale magnetometer data; Sector 1



25.0nT/cm

0 50m

1:2,500 @ A3

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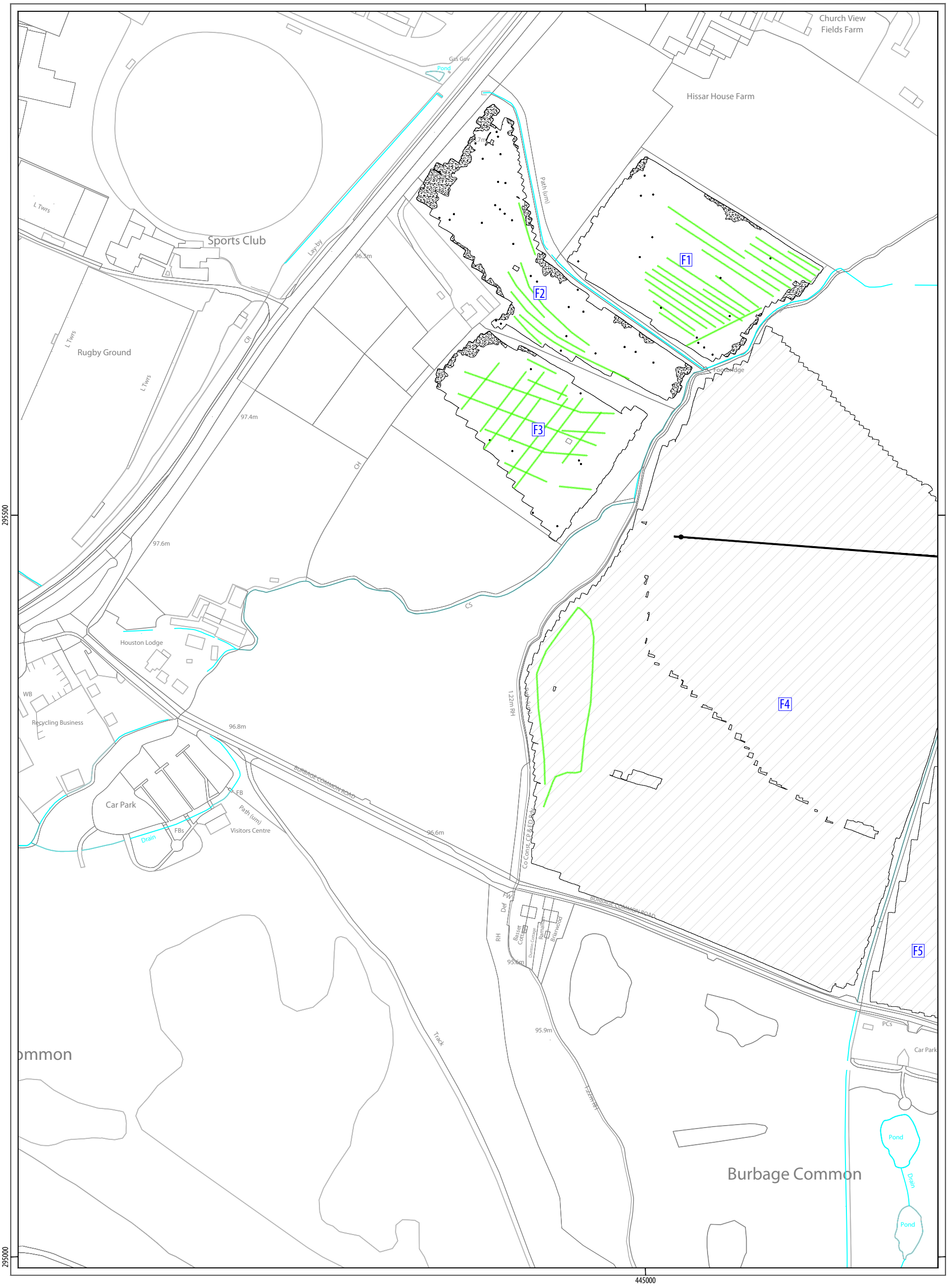
ILLUS 10 XY trace plot of minimally processed magnetometer data; Sector 1



TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
dipolar linear	service pipe
magnetic disturbance	green waste
linear trend	field drain

0 50m
1:2,500 @ A3

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ILLUS 11 Interpretation of magnetometer data; Sector 1

nT
-1.0 2.0

0 50m
1:2,500 @ A3

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[redacted]

ILLUS 12 Processed greyscale magnetometer data; Sector 2

25.0nT/cm

0 50m

1:2,500 @ A3

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[redacted]

ILLUS 13 XY trace plot of minimally processed magnetometer data; Sector 2

TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
dipolar linear	service pipe
magnetic disturbance	green waste
linear trend	field drain

0 50m
1:2,500 @ A3

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[redacted]

ILLUS 14 Interpretation of magnetometer data; Sector 2

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 the topsoil, subsoil and rock 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

Most 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 introduced into the soil during 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.

Lightning-induced remnant magnetisation (LIRM)

LIRM anomalies are thought to be caused in the near surface soil horizons by the flow of an electrical current associated with lightning strikes. These observed anomalies have a strong bipolar signal which decreases with distance from the spike point and often appear as linear or radial in shape.

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 traces. 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 internal Headland digital archive comprises an archive disk containing the raw data in XYZ format, a raster image of each greyscale plot with associated word file, and a PDF of the report. 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) to maximise the clarity and interpretability of the archaeological anomalies, if present.

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

APPENDIX 5 OASIS ARCHIVE