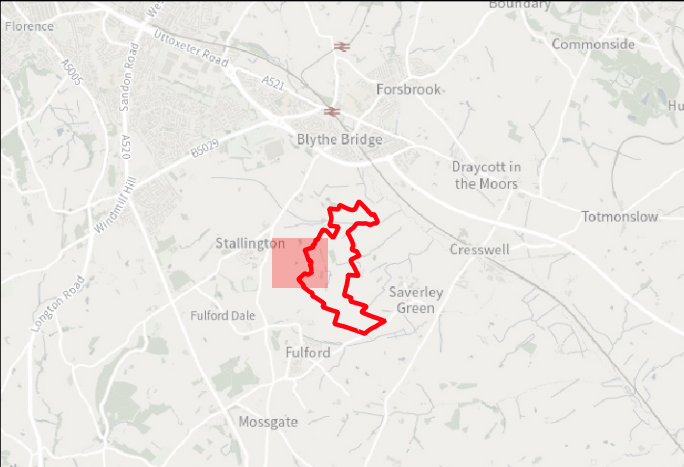





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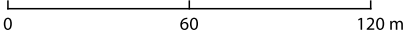


Key

-  Geophysical Survey Area
-  Survey Extent



+2nT
-1nT

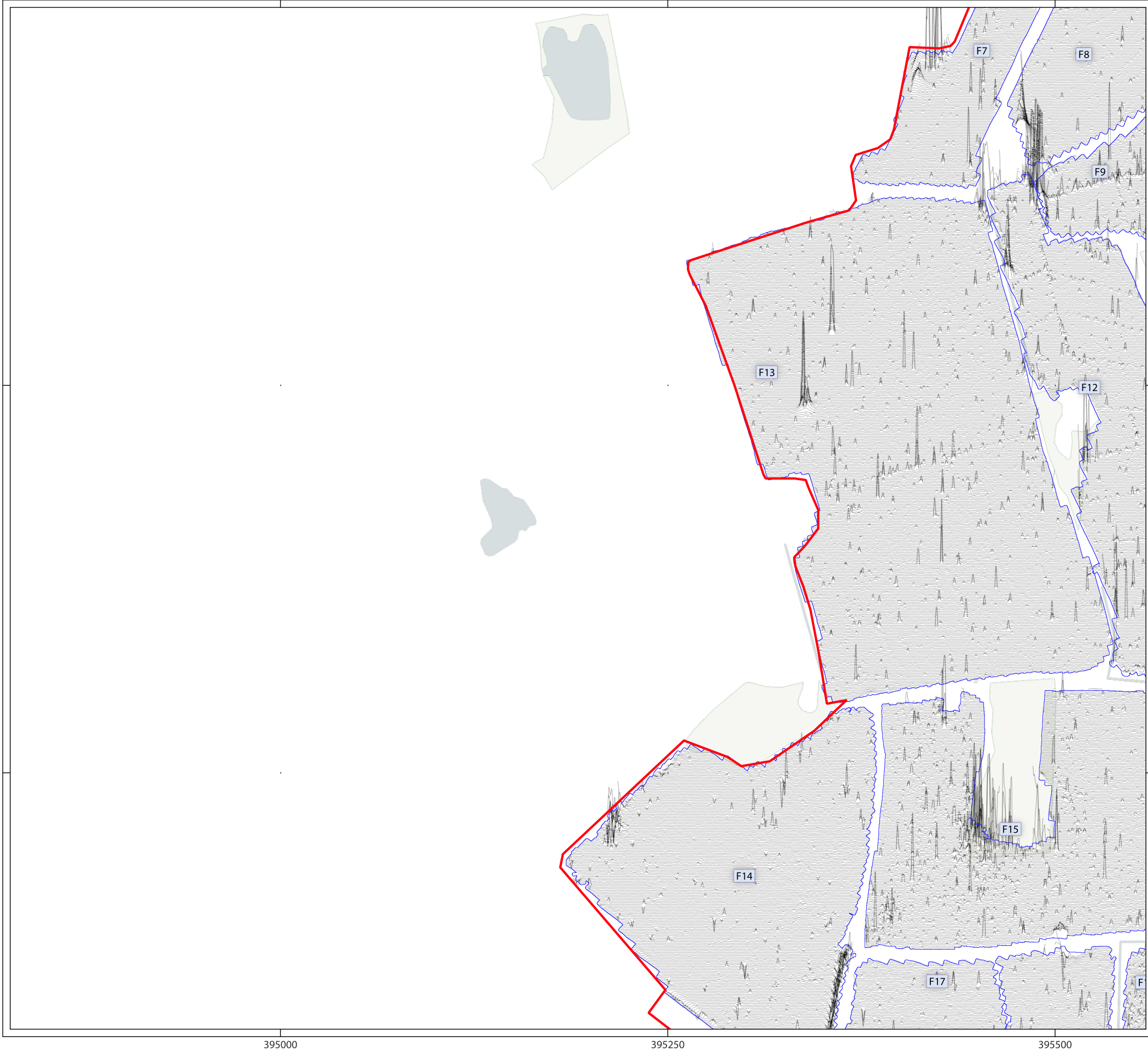


0 60 120 m

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Key

Geophysical Survey Area

Survey Extent

XY Trace (25nT/cm)

0

60

120 m

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Key

Geophysical Survey Area

Survey Extent

Ferrous Objects

Agriculture

Field Boundary

Field Drain

Natural

Ridge and Furrow

Magnetic Disturbance

Natural

Abbreviations

Former Boundary

060120 m

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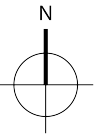
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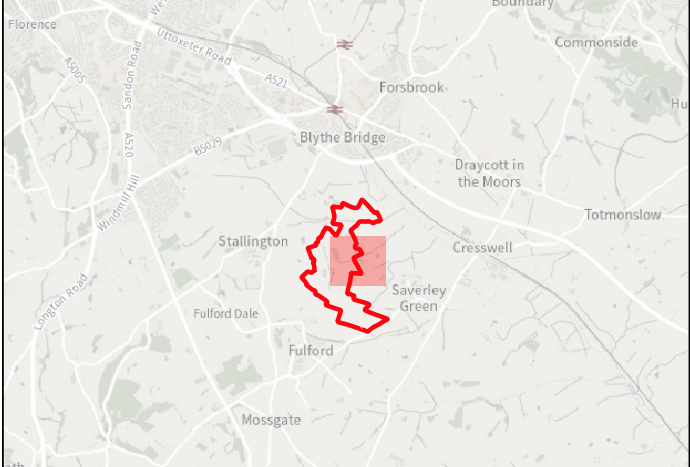









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Key

-  Geophysical Survey Area
-  Survey Extent

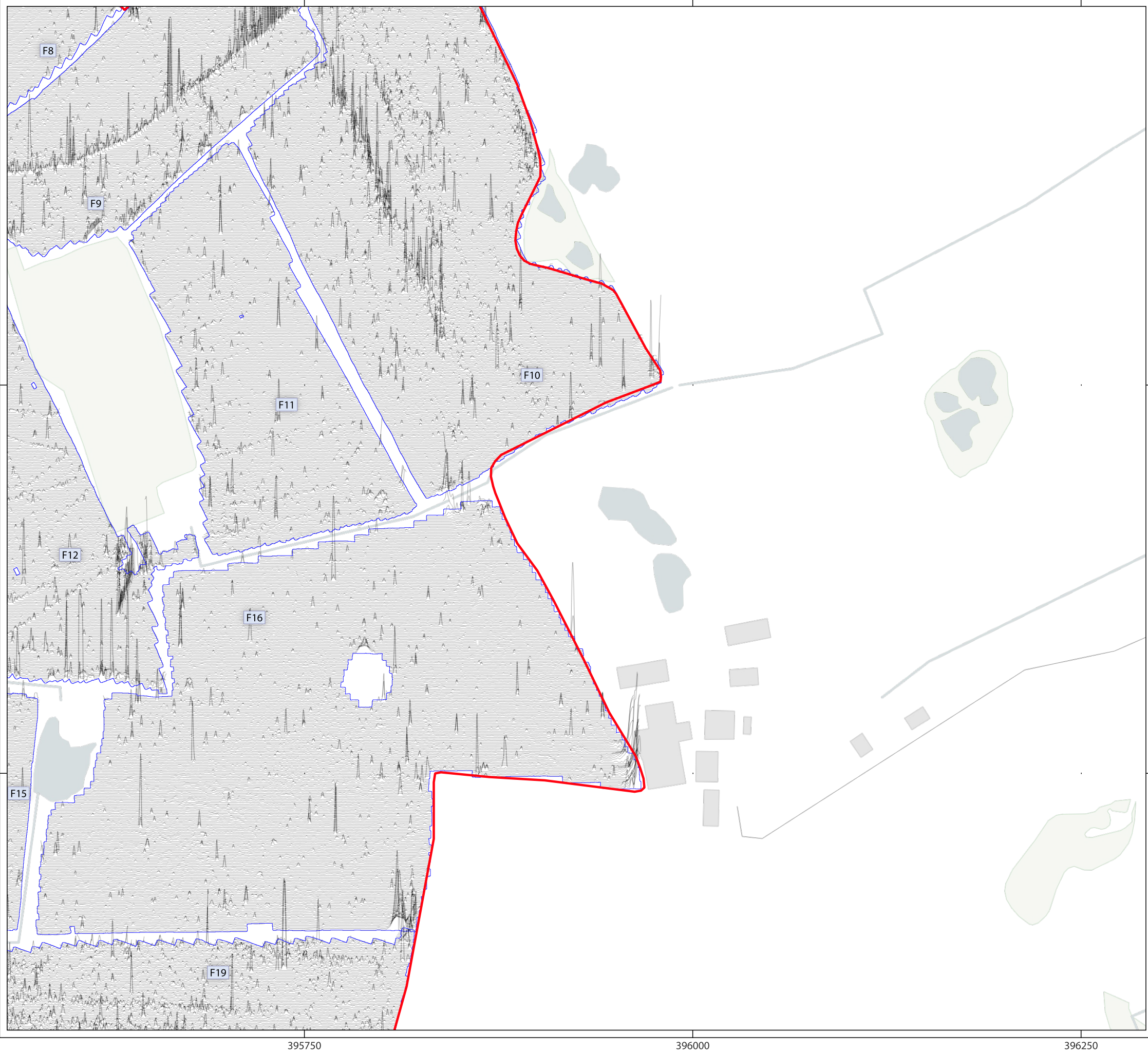


0 60 120 m

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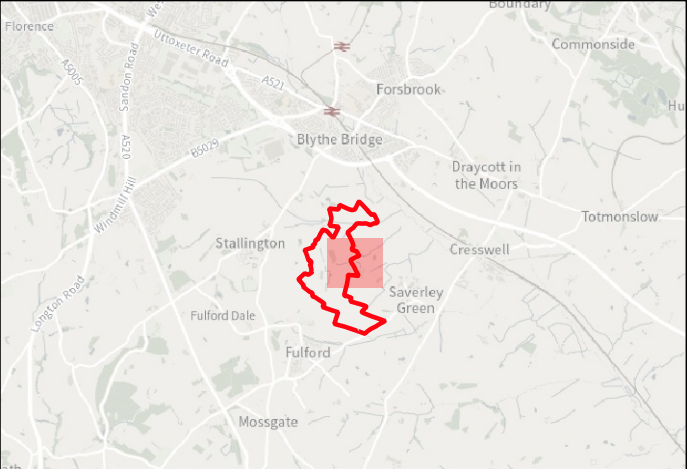









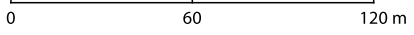
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Key

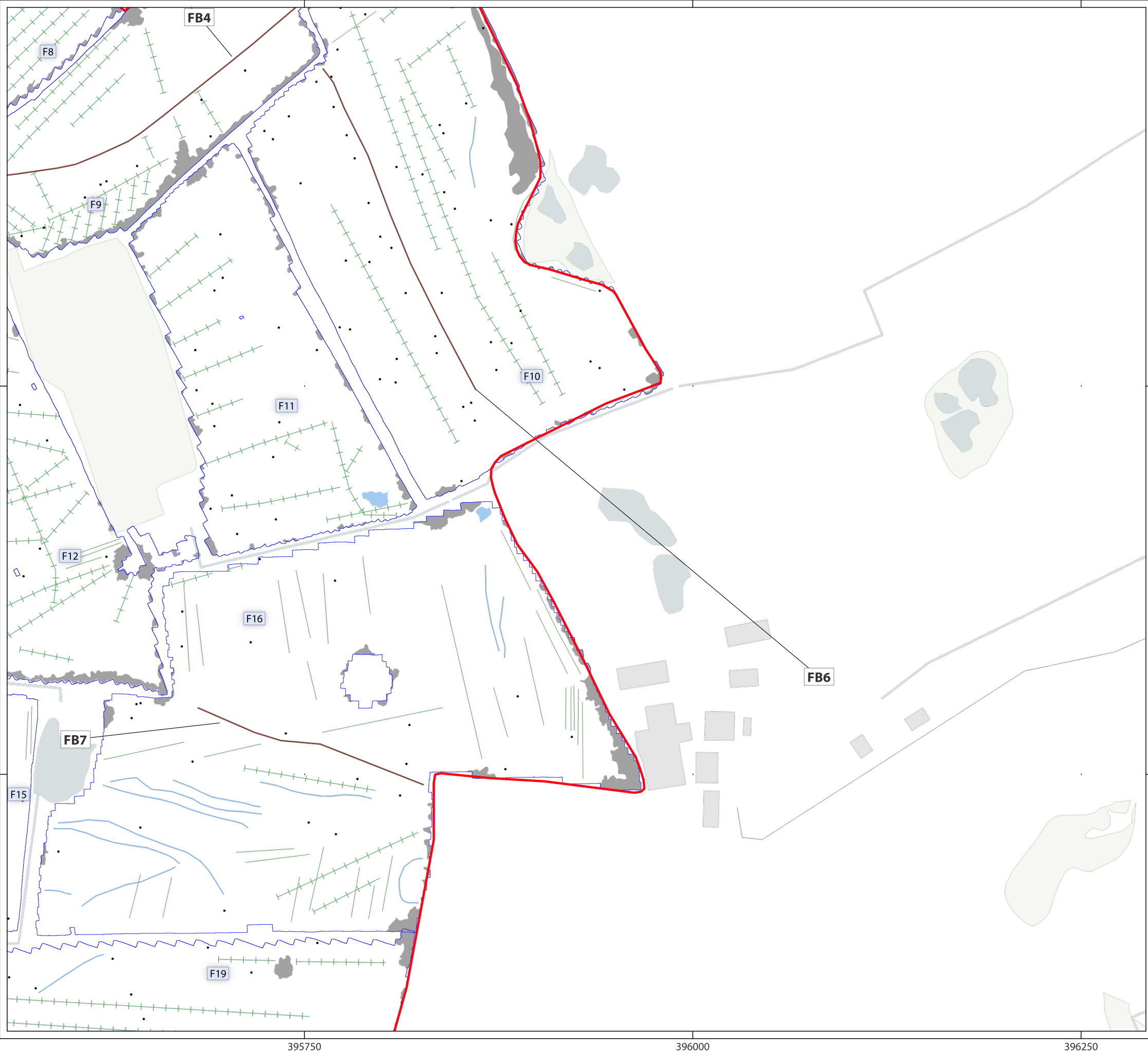
-  Geophysical Survey Area
-  Survey Extent
-  XY Trace (25nT/cm)



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Key

Geophysical Survey Area

Survey Extent

•

Ferrous Objects

Agriculture

Field Boundary

Field Drain

Natural

Magnetic Disturbance

Natural

Abbreviations

FB

Former Boundary

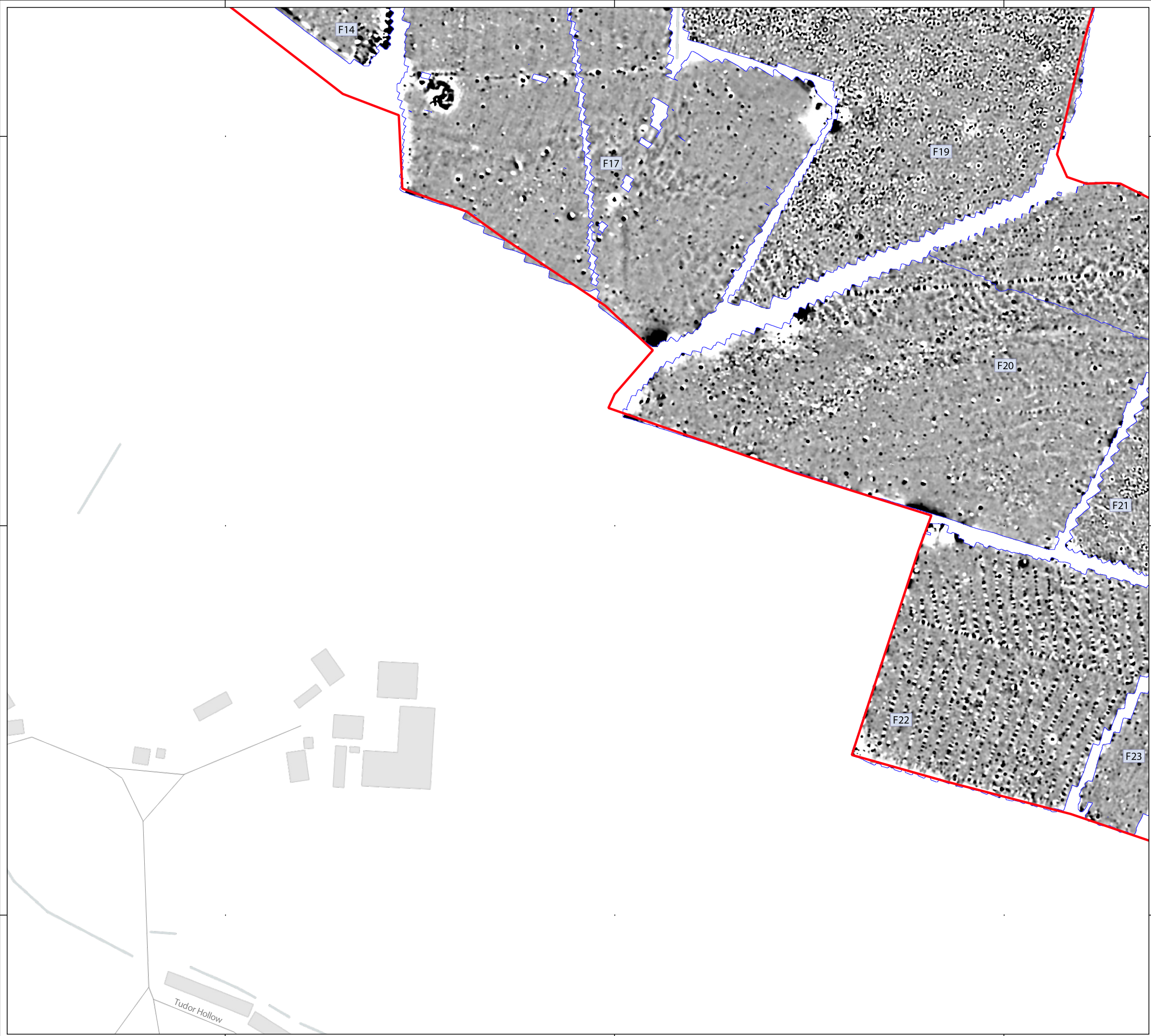
060120

m

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Key

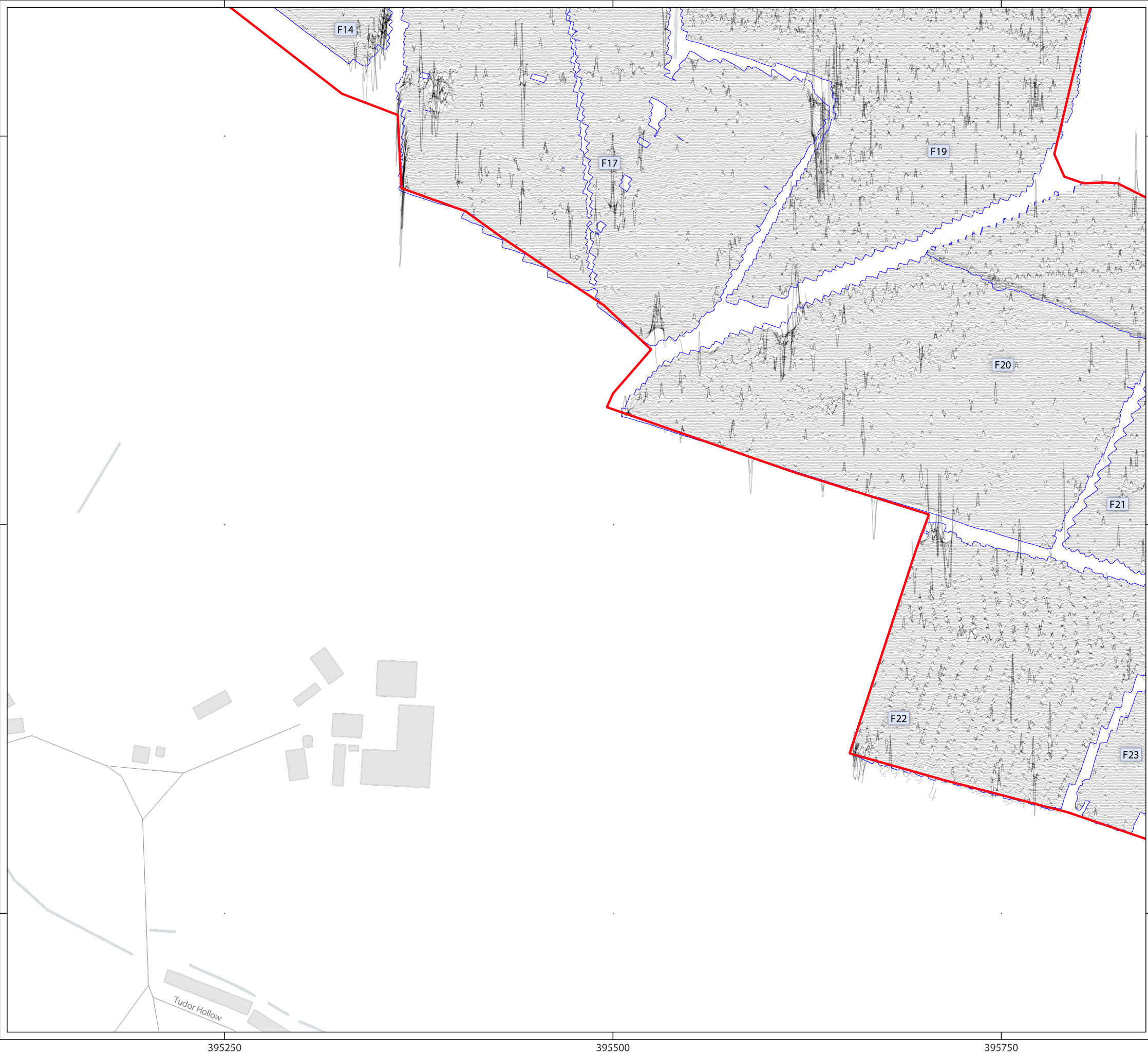
- Geophysical Survey Area
- Survey Extent

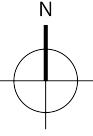
0 60 120 m


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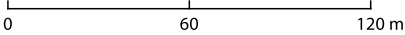
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Key

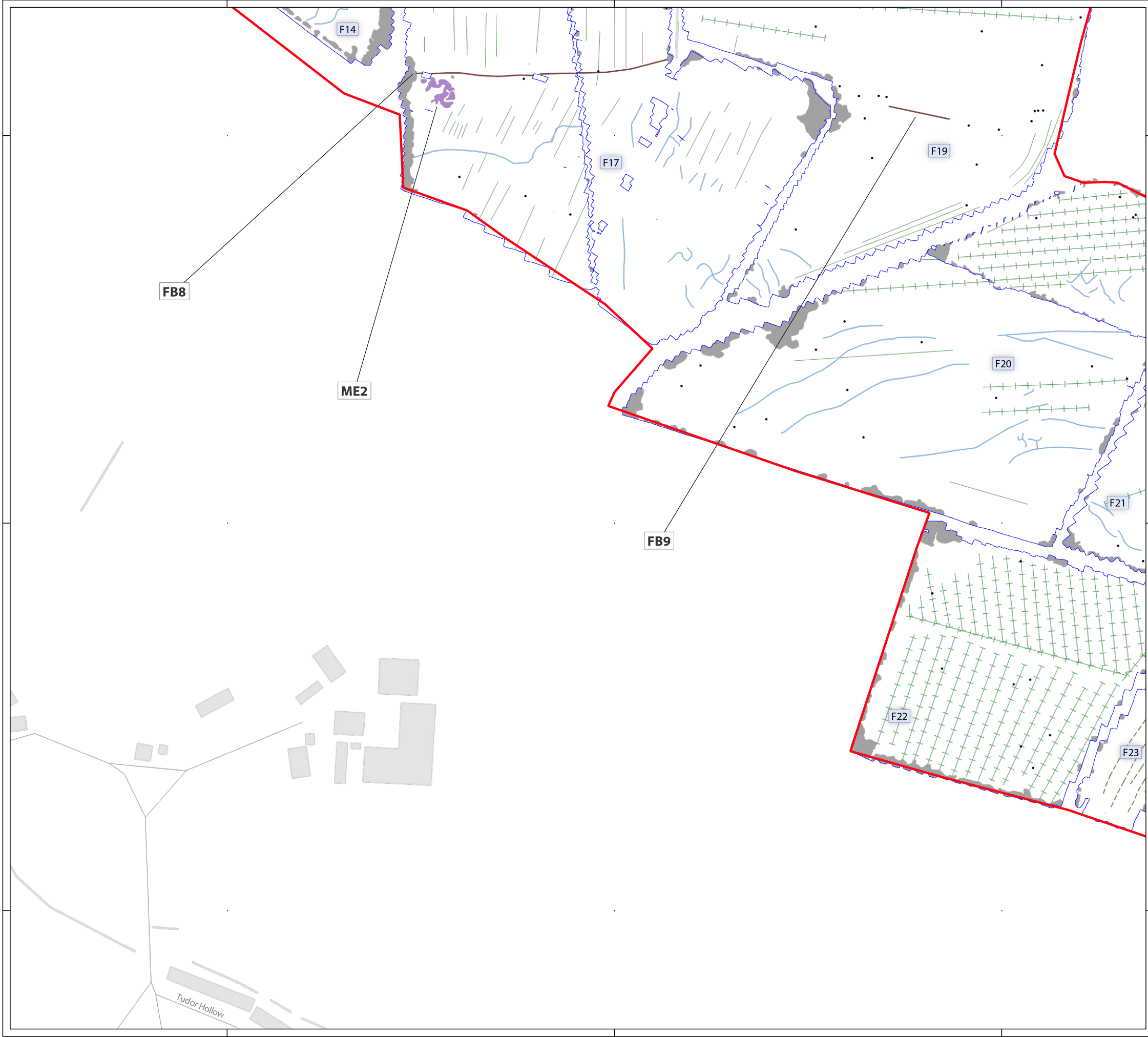
-  Geophysical Survey Area
-  Survey Extent
-  XY Trace (25nT/cm)



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Key

- Geophysical Survey Area
- Survey Extent
- Ferrous Objects
- Agriculture
- Field Boundary
- Field Drain
- Natural
- Ridge and Furrow
- Magnetic Disturbance
- Uncertain

Abbreviations

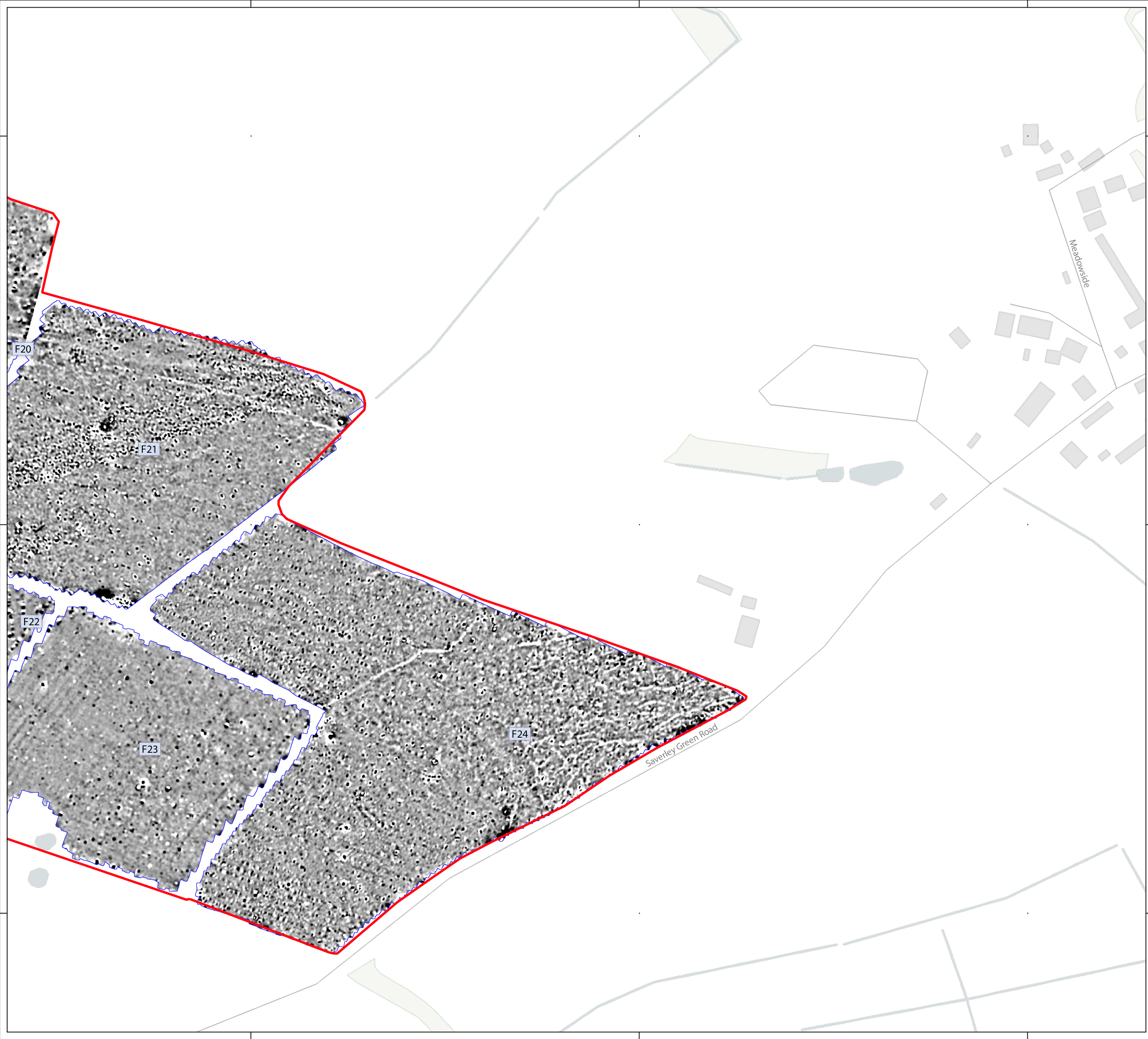
FB	Former Boundary
ME	Magnetic Enhancement

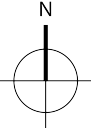
0 60 120 m


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Key

-  Geophysical Survey Area
-  Survey Extent

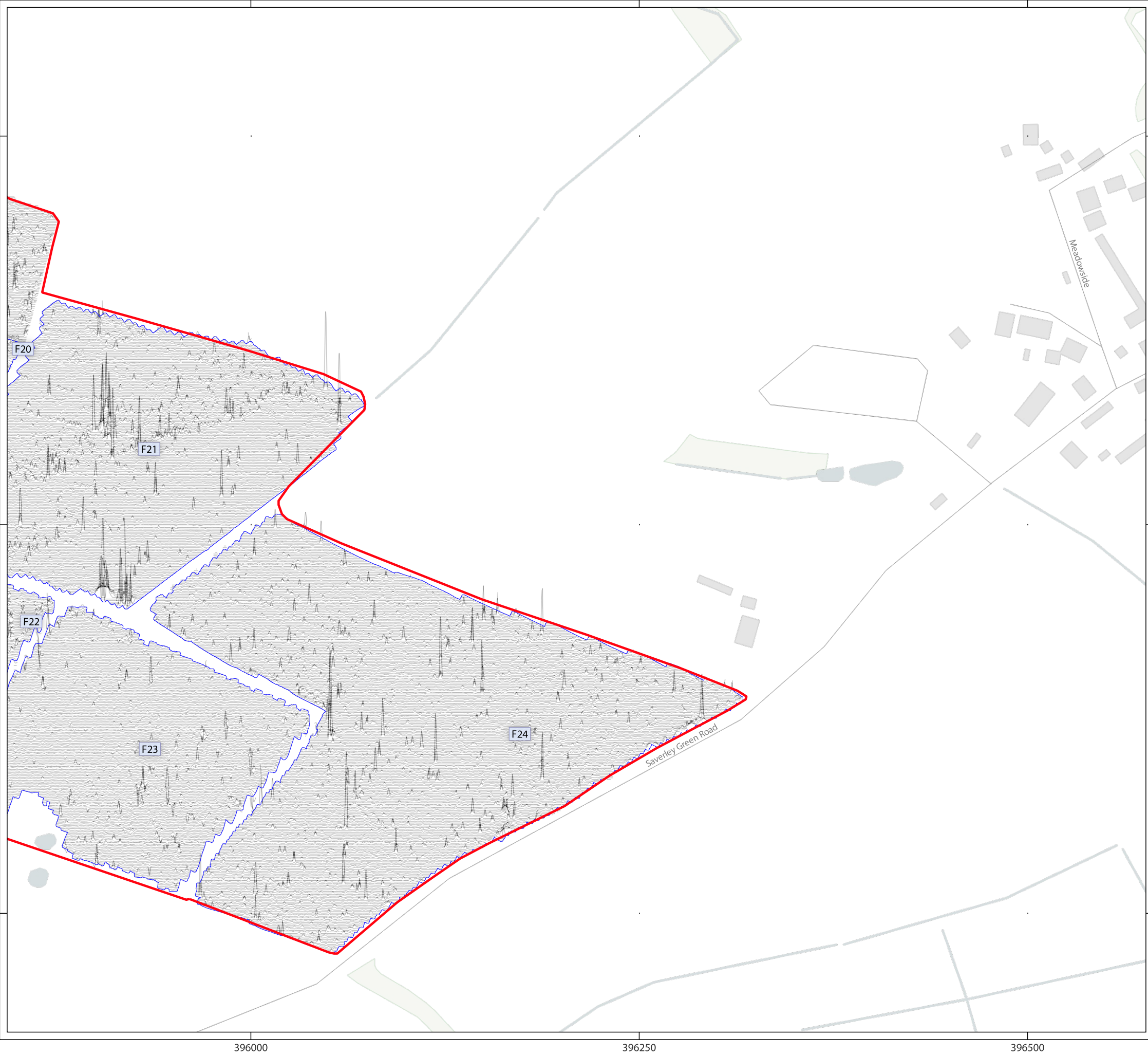


0 60 120 m

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Key

Geophysical Survey Area

Survey Extent

XY Trace (25nT/cm)

0

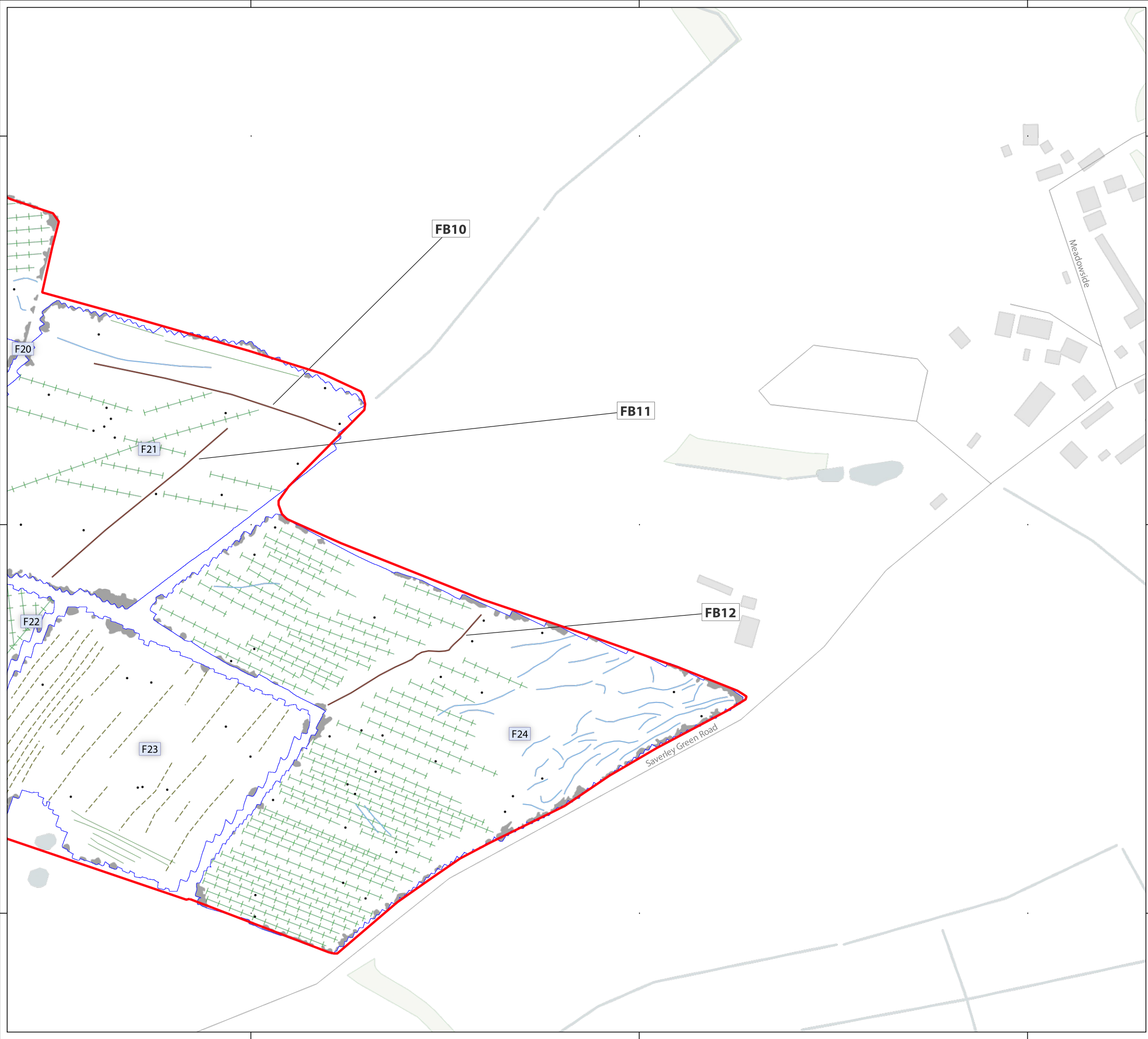
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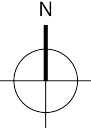
120 m


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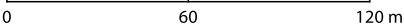


Key

-  Geophysical Survey Area
-  Survey Extent
-  Ferrous Objects
-  Agriculture
-  Field Boundary
-  Field Drain
-  Natural
-  Ridge and Furrow
-  Magnetic Disturbance

Abbreviations

-  Former Boundary



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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 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

In most 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 introduced into the topsoil 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 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 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) 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 FROM: ENGLAND

OASIS ID (UID): headland1-517225

Project Name:	Geophysical Survey at Fulford Solar Farm
Activity type:	Geophysical Survey, Magnetometry Survey
Project Identifier(s):	FLFD23
Planning Id:	[no data]
Reason for Investigation:	Planning requirement
Organisation Responsible for work:	Headland Archaeology (UK) Ltd
Project Dates:	16-May-2023 – 19-May-2023
HER:	Staffordshire Historic Environment Record
HER Identifiers:	[no data]
Project Methodology:	The survey was undertaken using four Bartington Grad601 sensors mounted at 1m intervals (1m traverse interval) onto a rigid 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 (Illus 6). These readings were stored on an external weatherproof laptop and later downloaded for processing and interpretation. The system was linked to a Trimble R10 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.
Project Results:	By far the most common anomalies identified within the dataset are due to geological, agricultural or modern causes. Anomalies locating eleven former field boundaries have been identified as well as field drains and service pipes. A single anomaly of uncertain origin has been recorded. No anomalies of archaeological potential have been recorded. Overall, it is determined that the survey results provide a reliable indication of the archaeological potential of the geophysical survey area (GSA). The archaeological potential is consequently assessed as very low.
Keywords:	[no data]
Archive:	[no data]
Reports in OASIS	Bishop R (2023) Geophysical Survey at Fulford Solar Farm. Cleckheaton: Headland Archaeology (UK) Ltd



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