

TRRP20



# THE RIVER RODING PROJECT, STANFORD RIVERS AND NAVESTOCK, ESSEX

## GEOPHYSICAL SURVEY REPORT

commissioned by Jacobs U.K. Limited  
on behalf of The Environment Agency

August 2020



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#### PROJECT INFO:

HA Project Code **TRRP20** / NGR **TQ 52889 98296** / Parish **Stanford Rivers, Navestock** / Local Authority **Essex Council** / OASIS Ref. **headland5-400903**

#### PROJECT TEAM:

Project Manager **Sam Harrison** / Author **Matthew Berry** / Fieldwork **Ross Bishop and Matthew Berry** / Graphics **Beata Wiczorek-Oleksy, Ross Bishop**

Approved by **Sam Harrison**



Headland Archaeology Yorkshire & North  
Units 23–25 & 15 | Acorn Business Centre | Balme Road | Cleckheaton BD19 4EZ  
t 0113 387 6430  
e yorkshireandnorth@headlandarchaeology.com  
w www.headlandarchaeology.com



part of the **RSK** Group





## PROJECT SUMMARY

Headland Archaeology (UK) Ltd undertook a geophysical (magnetometer) survey of 7 hectares on land adjacent to Shonks Mill Road for the proposed location of the earth embankment of the Shonks Mill Flood Storage Area. The survey has successfully evaluated the Proposed Development Area (PDA) and has identified various anomalies of either, likely, or possible, archaeological potential. Spreads of magnetic anomalies and linear features close to the River Roding coincide with structures associated with Shonks Flour Mill and historic field boundaries respectively, recorded on the earliest OS maps. Also, of possible interest is a circular cluster of discrete anomalies adjacent to the former gravel pit on the western edge of the survey area which may mark the location of a Post-Medieval windmill.

The majority of the PDA however contains no anomalies of any archaeological potential and therefore, on the basis of the geophysical survey, the survey area is assessed as of low to moderate archaeological potential. The archaeological potential is deemed locally moderate to high in the vicinity of the areas of potential archaeological activity.

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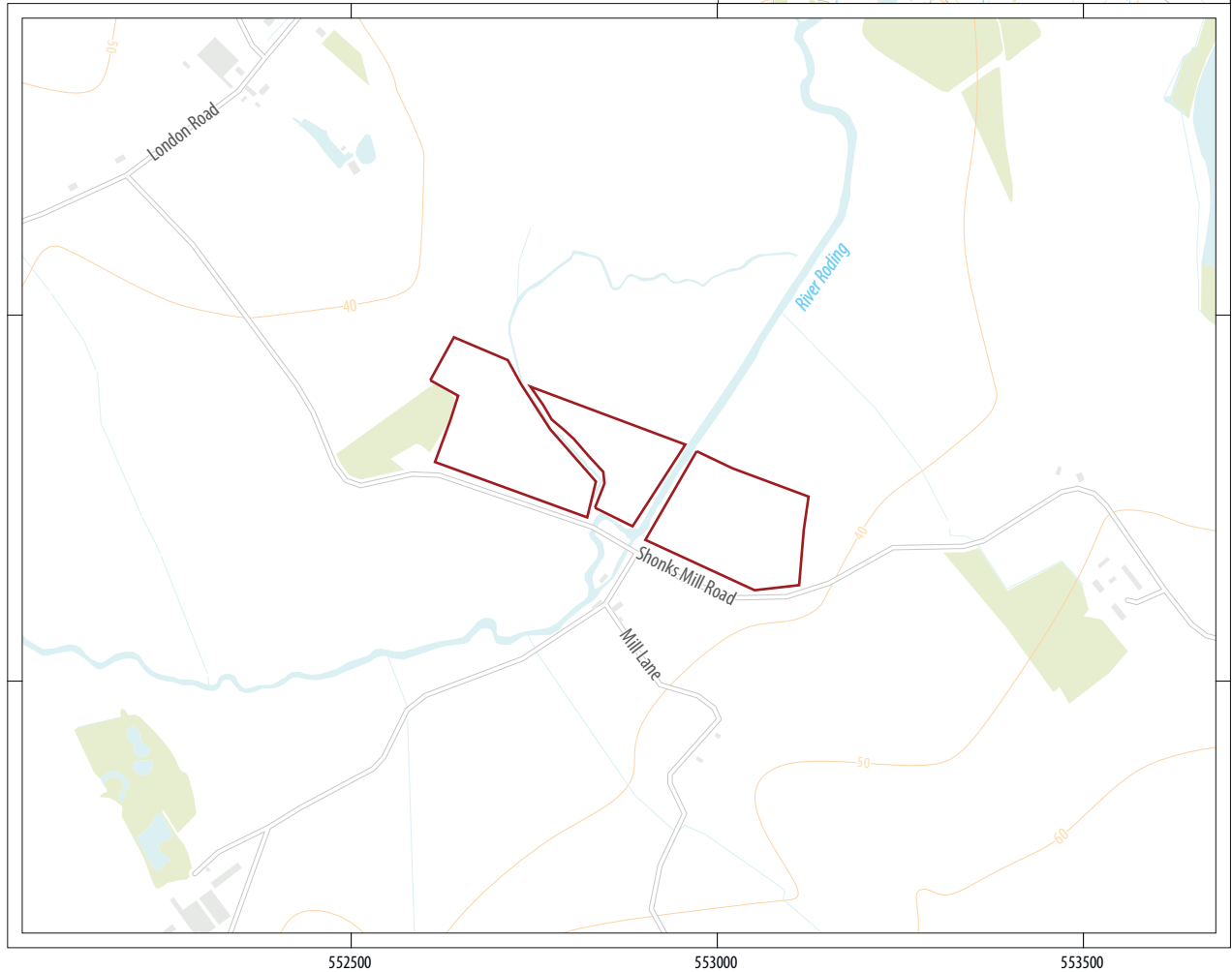
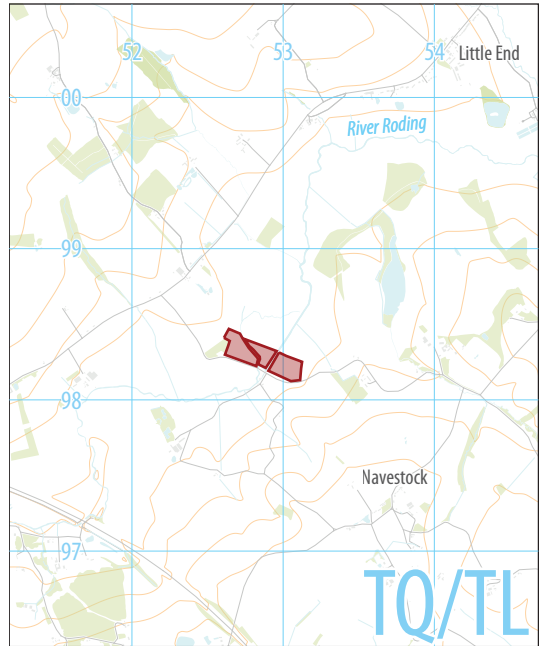
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The River Roding Project  
Flood Storage Area  
Essex



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



0 200m  
1:10,000 @ A4

 geophysical survey area



**HEADLAND  
ARCHAEOLOGY**  
Headland Archaeology Yorkshire & North  
Units 23–25 & 15 | Acorn Business Centre | Balme Road | Cleckheaton  
BD19 4EZ  
t 0113 387 6430  
e yorkshireandnorth@headlandarchaeology.com  
w www.headlandarchaeology.com



# THE RIVER RODING PROJECT, STANFORD RIVERS AND NAVESTOCK, ESSEX

## GEOPHYSICAL SURVEY REPORT

### 1 INTRODUCTION

Headland Archaeology (UK) Ltd was commissioned by Jacobs UK Ltd (The Consultant), on behalf of The Environment Agency (The Principal Contractor) to undertake a geophysical (magnetometer) survey on land for the proposed location of the earth embankment of the Shonks Mill Flood Storage Area. The results of the survey will inform future archaeological strategy at the site.

The survey was undertaken in order to assess the impact of the proposed site on the historic environment. It was undertaken in accordance with an Archaeological Written Scheme of Investigation (WSI) (Headland Archaeology 2020), 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 results will be disseminated through the preparation and deposition of an ordered archive submitted to the Archaeology Data Service (ADS) and a suitable final repository.

The survey was carried out between 13th and 14th July 2020 once the maturing crop had been removed from the survey area.

#### 1.1 SITE LOCATION, TOPOGRAPHY AND LAND-USE

The Proposed Development Area (PDA) comprises three irregularly shaped partial fields (F1 – F3) located either side, to the east and west of the River Roding centred on TQ 52889 98296 (Illus 1). The area covers 7 hectares and is bound to the south by Shonks Mill Road and partially by a small copse and former gravel pit to the west. The northern and eastern limits were pre-determined by the areas

cleared prior to survey. The site location is recorded to lie at a height of 32m above ordnance datum (AOD).

All three fields had been cleared of crop prior to the survey (Illus 2–4).

#### 1.2 GEOLOGY AND SOILS

The PDA is underlain by London Clay Formation sedimentary bedrock from the Palaeogene Period, consisting of clay, silt and sand.

Superficial deposits vary across the PDA from alluvium in the low lying areas to the west of the River Roding, river terrace deposits close to the river and Quaternary period clay, silt, sand and gravel Head deposits to the east of the river (NERC 2020).

The central and western fields of the PDA are classified in the Soilscape 20 Association characterised as loams and clay floodplain soils with naturally high groundwater. The eastern part of the PDA, on slightly higher ground is covered by Soilscape 18 Association and is characterised by slowly permeable slightly acid but base-rich loams and clays (Cranfield University 2020).

### 2 ARCHAEOLOGICAL BACKGROUND

The archaeological background summarised for this report is drawn from the Heritage Appraisal Report (Mott Macdonald 2019) and Geophysical Survey Scoping documents (Jacobs 2020). The Appraisal Report details the heritage assets for a much larger scheme within a 500m survey area, however only those areas immediately relevant to the present PDA are discussed herein.



**ILLUS 2** F1, looking north-west    **ILLUS 3** F2, looking north

There are no designated heritage assets recorded within the PDA. There are however a number of non-designated heritage assets within the PDA identified by the Essex Historic Environment Record (HER).

These non-designated heritage assets relate to Post-Medieval activity predominantly focused around Shonks Flour Mill. The name Shonks Mill is recorded in 1566 in connection with the bridge adjacent to the flour mill. It is recorded on a map of 1835 (based on an earlier map dated 1785) that shows the parish boundary as the original route of the River Roding before its rechannelling in connection with the mill.

This extant water channel is an artificial water course which would have been used at a mill head race (leat) as part of the mills water management system. This mill leat is not recorded in the HER and is not a designated heritage asset but does hold low heritage significance.

From map regressions detailed in the Heritage Appraisal Report (Mott Macdonald 2019) it is evident that the L-shaped Shonks Mill had fallen into disuse by the late 19th century and is completely demolished by 1920. Ancillary structures possibly farm buildings of unknown date located immediately to the north-east are demolished before the turn of the 20th century.

Likely Post Medieval cropmarks of former field boundaries associated with the site of Shonks Mill (MEX 1049637) are recorded as a non-designated heritage asset.

The only other non-designated heritage asset not associated with Shonks Mill within the PDA refers to a Post Medieval windmill (MEX 2425). No longer extant the location of this windmill is recorded on the western edge of the PDA and is identifiable on maps of 1724 and 1799.



ILLUS 4 F3, looking north-west

Immediately adjacent this location, north of the small copse which bounds the site, the 1873 first edition OS Map depicts a gravel pit. Subsequent maps do not label the pit but do for a time record its depression and is henceforth shown as part of an enlarged copse or marshy area. A footpath is also shown on successive historic maps heading north-west from Shonks Mill Road which brings it close to the course of the River Roding.

Evidence of activity from other periods close to the PDA is scarce. The early prehistoric period is not well represented in the surrounding landscape. A small number of Bronze Age records highlight some activity however the dating of cropmark features remains uncertain based on local topographic analysis. The nearest non-designated heritage assets to the PDA include cropmarks of unknown date, possibly Bronze Age but also possibly Post Medieval field boundaries (MEX 1036513) recorded approximately 500m to the north.

There is only one record dating to the Roman period approximately 300m to the west of the PDA, which relates to Roman building material found during excavation works for a pipeline (MEX 1035092).

Further cropmarks of former post-medieval field boundaries which are visible on the 1st edition OS Map and an extraction pit are located approximately 550m to the north-east (MEX 1050049).

Two separate clusters of post-medieval grade II listed buildings are located 500m to the east and north-west of the PDA. The types of structures present include farmhouses, barns, a lawn and granary and reflect the rural character of the landscape and nature of built heritage within it.

### 3 AIMS, METHODOLOGY AND PRESENTATION

The general aim of the geophysical survey was to provide enough information to establish the presence/absence, character and extent of any archaeological remains within the PDA. 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 gather enough information to inform the extent, condition, character and date (as far as circumstances permit) of any archaeological features and deposits within the PDA;
- › to obtain information that will contribute to an evaluation of the significance of the scheme upon cultural heritage assets; 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 V3.0.35.1 (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 1:10,000. Illus. 2-4 are site photographs highlighting survey conditions across the site. Illus. 5 is a 1:2,000 survey location plan showing the direction of survey as GPS swaths and site photographs. Large-scale, fully processed (greyscale) data, minimally processed data (XY trace plot) and an interpretative plot at a scale of 1:2,000 are presented in Illus. 6-8 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 Archaeology 2020), 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' 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.

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## 4 RESULTS AND DISCUSSION

Ground conditions were very good throughout the PDA contributing to a high standard of data collection. The survey has detected a low level of background magnetic variation which is characterised by sporadic, discrete low magnitude anomalies. This is likely due to the depth and composition of the topsoil and the superficial deposits from which they derive. Against this background several distinct and clusters of anomalies have been identified.

### 4.1 FERROUS AND MODERN 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 result of agricultural manuring or tipping/infilling.

The survey has identified multiple isolated areas of strong magnetic anomalies where an archaeological interpretation is most likely. These are discussed in more detail in section 4.4 below.

One area where an archaeological interpretation is not immediately apparent however is in the south-west corner of the PDA (F1), where a group of high magnitude responses could possibly represent the infilling of a gravel pit (IP) known from late 19th century maps to have existed close to this location.

In addition to these areas there are a number of isolated 'spike' responses likely caused by the random distribution of ferrous debris in the upper soil horizons. Magnetic disturbance around the field edges is due to ferrous material within, or adjacent to, the boundaries and is of no archaeological interest.

### 4.2 AGRICULTURAL ANOMALIES

Two prominent linear anomalies aligned northwest - southeast in the east of the PDA within F3, are likely land drains based on their magnetic response. These linear anomalies terminate at their northern extent at a curvilinear anomaly which runs from the site of Shonks Mill heading roughly north-east past the site of the ancillary mill buildings and likely represents another field drain or unmapped field boundary (PB1). A further field drain is visible to the north of these anomalies.

A clear field boundary (FB1), identifiable on historic maps in the north-west corner of the PDA in F1 has been detected. This part rectangular boundary adjoins the River Roding and encloses an area of high magnitude responses which extends beyond the limits of the survey.

A series of low magnitude parallel linear trend anomalies are discernible in F2 located between the natural course and canalised section of the River Roding. These anomalies aligned parallel to the canalised section of the river roughly northeast-southwest and located in the flood plain are likely patterns of modern land drains.

### 4.3 GEOLOGICAL ANOMALIES

The survey has identified a number of broad low magnitude irregular, sub-linear and curvilinear responses in the central and western parts of the PDA. These responses typical of underlying geological variations such as palaeochannels and other fluvial events neatly coincide with the location of the flood plain of the River Roding and known superficial alluvial deposits.

## 4.4 POSSIBLE ARCHAEOLOGICAL ANOMALIES

A group of low amplitude anomalies arranged in loose circular pattern (PW) are present on the western edge of the survey, within F1. These discrete anomalies could represent the remains of a Post-Medieval windmill (MEX 2425) listed in the HER in this location.

In F3, on the site of ancillary buildings likely associated with Shonks Mill shown on historic maps, the survey has detected a spread of high magnitude magnetic anomalies with no discernible shape or form (DB1).

Further areas of high magnitude responses are recorded on the periphery of the survey on the site of Shonks Mill and in the area between the River Roding and canalised section. These responses could indicate the below ground presence of further features associated with the mill.

## 5 CONCLUSION

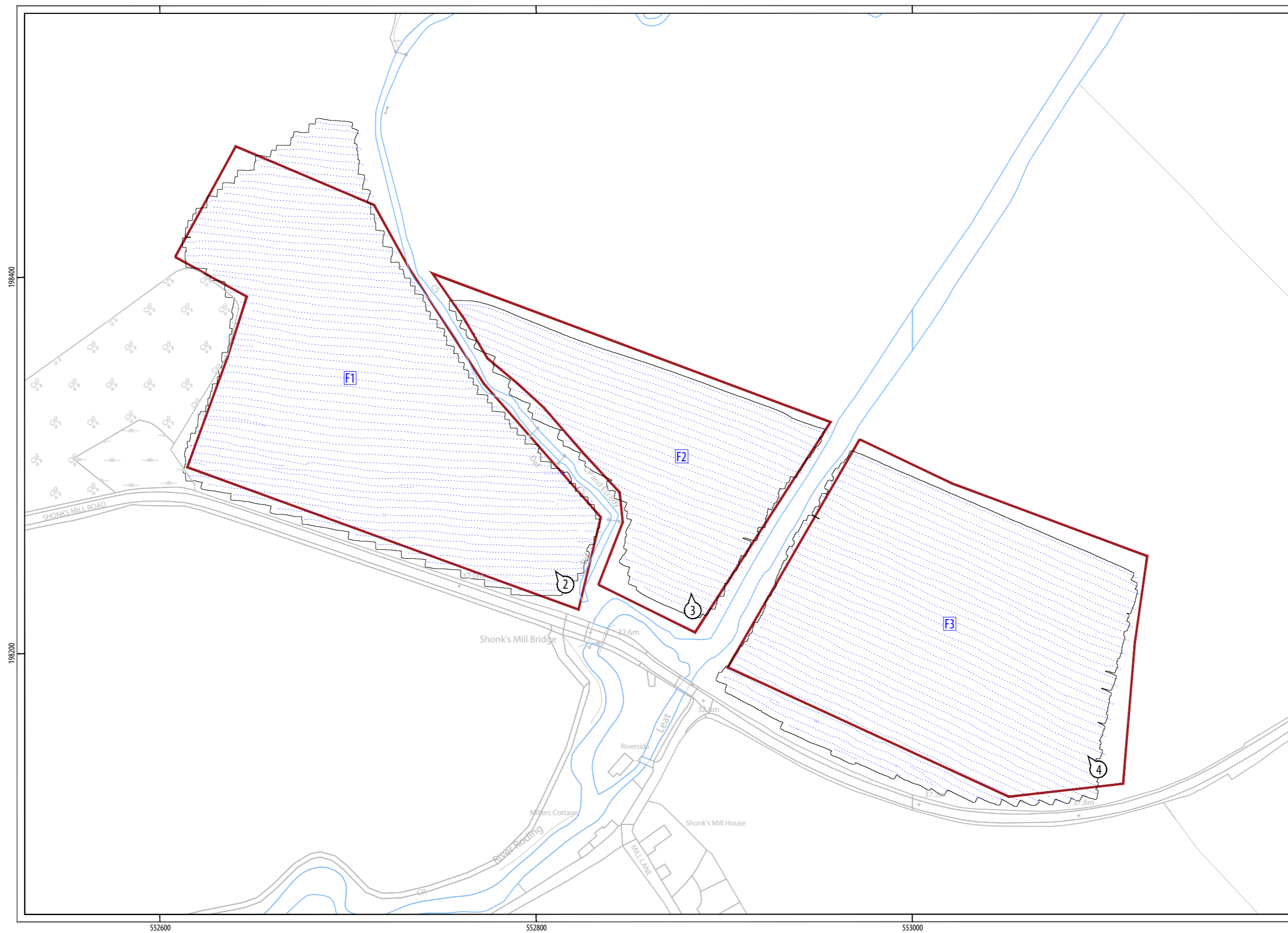
The survey has successfully evaluated the Proposed Development Area and has identified various anomalies of either, likely, or possible, archaeological potential. Spreads of magnetic anomalies and linear features close to the River Roding neatly coincide with structures associated with Shonks Flour Mill and historic field boundaries respectively, recorded on the earliest OS maps. Also of interest is a circular cluster of discreet anomalies adjacent to the former gravel pit on the western edge of the survey area, which could represent the remains of a Post-Medieval windmill.

Overall, based on the geophysical survey the archaeological potential of the site is assessed as low with a localised moderate to high potential in the vicinity of Shonks Mill and north of the former gravel quarry pit, with the potential for below ground preservation of structures associated with the flour mill and windmill.

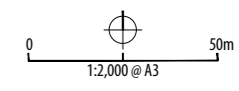
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- geophysical survey area
- GPS swaths
- location and direction of ILLUS 2-4



**PROJECT** TRRP20  
The River Roding Project  
Shonks Mill Road  
Essex

**CLIENT** Jacobs

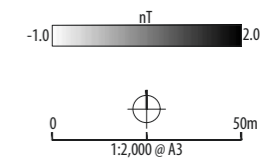


Headland Archaeology Yorkshire & North  
Unit 16 | Hillside, Beeston Road | Leeds LS11 8ND  
t 0113 387 6430  
e yorkshireandnorth@headlandarchaeology.com  
www.headlandarchaeology.com

ILLUS 5 Survey location showing GPS swaths (1:2,000)







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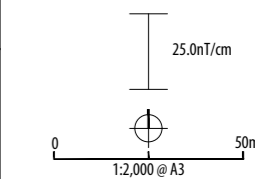
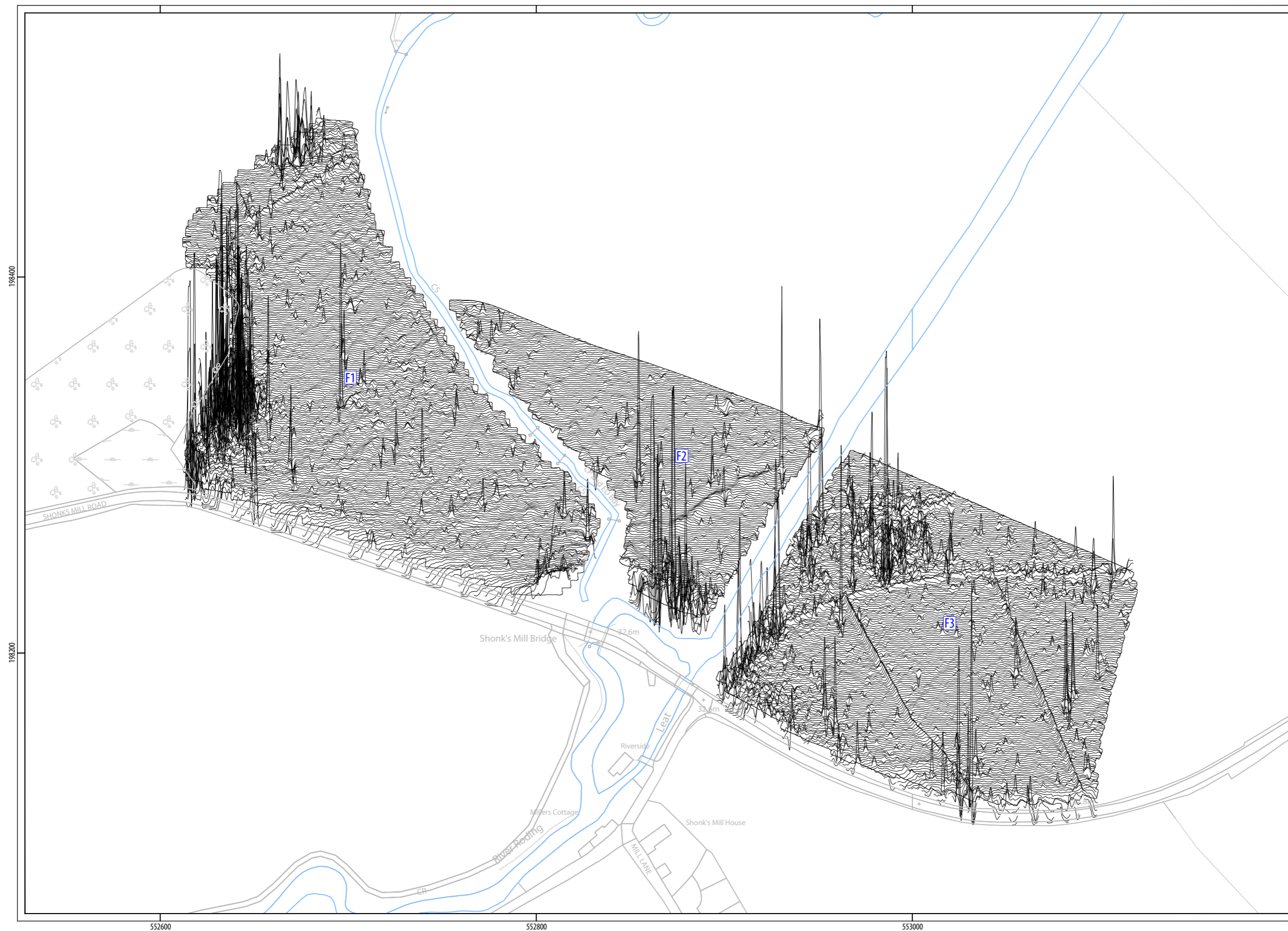
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Headland Archaeology Yorkshire & North  
Unit 16 | Hillside, Beeston Road | Leeds LS11 8ND  
t 0113 387 6430  
e yorkshireandnorth@headlandarchaeology.com  
www.headlandarchaeology.com

ILLUS 6 Processed greyscale magnetometer data (1:2,000)





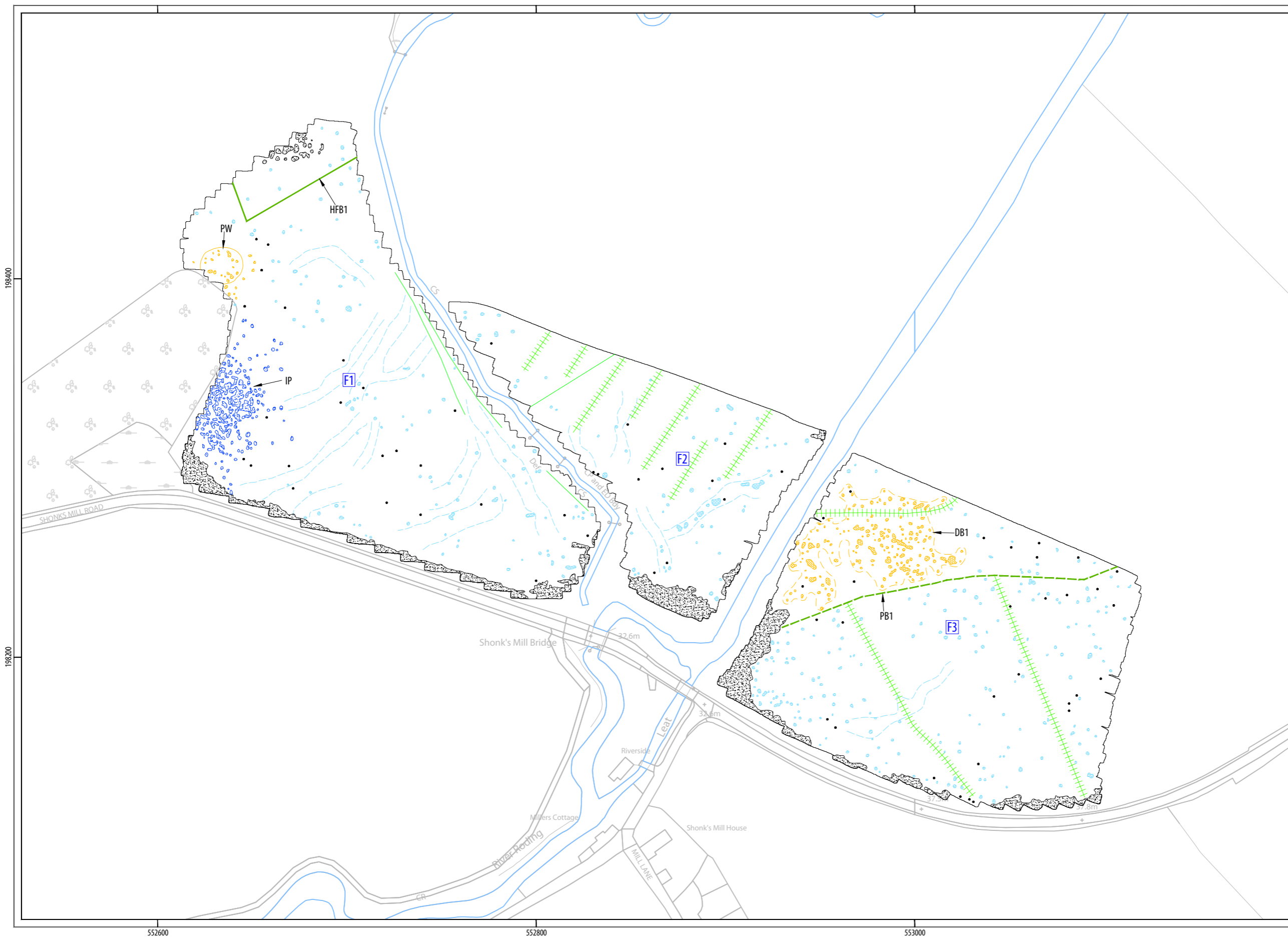
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Headland Archaeology Yorkshire & North  
Unit 16 | Hillside, Beeston Road | Leeds LS11 8ND  
t 0113 387 6430  
e yorkshireandnorth@headlandarchaeology.com  
w www.headlandarchaeology.com

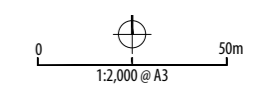




TYPE OF ANOMALY	INTERPRETATION
● dipolar isolated	ferrous material
● magnetic disturbance	ferrous material
● magnetic disturbance	infill material
— linear trend	agricultural
— linear trend	field drain
— linear	former field boundary
— linear	possible former boundary
— linear trend	geological variation
● magnetic enhancement	geology
● magnetic enhancement	archaeology?

Abbreviations

DB	demolished building
IP	infilled pit
HFB	historic field boundary
PB	possible boundary
PW	possible windmill



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**CLIENT** Jacobs



Headland Archaeology Yorkshire & North  
Unit 16 | Hillside, Beeston Road | Leeds LS11 8ND  
t 0113 387 6430  
e yorkshireandnorth@headlandarchaeology.com  
w www.headlandarchaeology.com



## 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.

**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 associate world file, and a PDF of the report.

The project will be archived in-house in accordance with recent good practice guidelines ([http://guides.archaeologydataservice.ac.uk/g2gp/Geophysics\\_3](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: *headland5-400903***PROJECT DETAILS**

Project name	The River Roding Project, Stanford Rivers and Navestock
Short description of the project	Headland Archaeology (UK) Ltd undertook a geophysical (magnetometer) survey of 7 hectares on land adjacent to Shonks Mill Road for the proposed location of the earth embankment of the Shonks Mill Flood Storage Area. The survey has successfully evaluated the Proposed Development Area (PDA) and has identified various anomalies of either, likely, or possible, archaeological potential. Spreads of magnetic anomalies and linear features close to the River Roding coincide with structures associated with Shonks Flour Mill and historic field boundaries respectively, recorded on the earliest OS maps. Also, of possible interest is a circular cluster of discrete anomalies adjacent to the former gravel pit on the western edge of the survey area which may mark the location of a Post-Medieval windmill. The majority of the PDA however contains no anomalies of any archaeological potential and therefore, on the basis of the geophysical survey, the survey area is assessed as of low to moderate archaeological potential. The archaeological potential is deemed locally moderate to high in the vicinity of the areas of potential archaeological activity.
Project dates	Start: 13-07-2020 End: 14-07-2020
Previous/future work	Not known / Not known
Any associated project reference codes	TRRP20 - Sitecode
Type of project	Field evaluation
Site status	None
Current Land use	Cultivated Land 4 - Character Undetermined
Monument type	N/A None
Monument type	N/A None
Significant Finds	N/A None
Significant Finds	N/A None
Methods & techniques	"Geophysical Survey"
Development type	Flood Alleviation
Prompt	National Planning Policy Framework - NPPF
Position in the planning process	Pre-application
Solid geology (other)	London Clay Formation
Drift geology	ALLUVIUM
Drift geology	SAND AND GRAVEL OF UNCERTAIN AGE OR ORIGIN
Techniques	Magnetometry

**PROJECT LOCATION**

Country	England
Site location	ESSEX BRENTWOOD NAVESTOCK The River Roding Project
Site location	ESSEX EPPING FOREST STANFORD RIVERS The River Roding Project
Study area	7 Hectares
Site coordinates	TQ 52889 98296 51.662125265718 0.210799475471 51 39 43 N 000 12 38 E Point

**PROJECT CREATORS**

Name of Organisation	Headland Archaeology
Project brief originator	Consultant
Project design originator	Jacobs
Project director/manager	Harrison, S
Project supervisor	Bishop, R

Type of sponsor/funding body Environment Agency

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**PROJECT ARCHIVES**

Physical Archive Exists? No

Digital Archive recipient In house

Digital Contents "other"

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

Paper Archive Exists? No

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**PROJECT BIBLIOGRAPHY 1**

Publication type Grey literature (unpublished document/manuscript)

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part of the **RSK** Group

**Headland Archaeology** Scotland  
13 Jane Street  
Edinburgh EH6 5HE  
t 0131 467 7705  
e scotland@headlandarchaeology.com

**Headland Archaeology** Yorkshire & North  
Units 23–25 & 15 | Acom Business Centre | Balme Road  
Cleckheaton BD19 4EZ  
t 0113 387 6430  
e yorkshireandnorth@headlandarchaeology.com

**Headland Archaeology** South & East  
Building 68C | Wrest Park | Silsoe  
Bedfordshire MK45 4HS  
t 01525 861 578  
e southandeast@headlandarchaeology.com

**Headland Archaeology** Midlands & West  
Unit 1 | Clearview Court | Twyford Rd  
Hereford HR2 6JR  
t 01432 364 901  
e midlandsandwest@headlandarchaeology.com

**Headland Archaeology** North West  
Fourways House | 57 Hilton Street  
Manchester M1 2EJ  
t 0161 236 2757  
e northwest@headlandarchaeology.com

[www.headlandarchaeology.com](http://www.headlandarchaeology.com)