

2EE02 EEW - HS2 Phase 2a Early Environmental Works

Site 100 - Geophysics Survey Report Heritage Non-intrusive Survey Reports Group 012

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			Headland	BB		
C01	Matt Berry	Sam Harrison	Alistair Webb	Antje Budge	31/10/2022	1 st Issue
C02	Matt Berry	Sam Harrison	Alistair Webb	Antje Budge	13/2/2023	2 nd issue - addressing HS2 comments

Methodology	Project Plan Site Code
Gradiometer (Magnetometer) Survey	2a20DWALMG

Security classification: OFFICIAL

Handling Instructions - None

HS2 Ltd - Code 1 - Accepted

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1 Executive Summary

- 1.1.1 This document comprises a Final Report for a non-intrusive geophysical survey on the route of the proposed Phase 2a of High Speed Two (HS2) covering land proposed for development or likely to be impacted during the scheme as part of the Early Environmental Works (EEW) package. This report contains the results of a magnetometer survey undertaken on 9th February 2022 at Site 100 within Group 012.
- 1.1.2 The aim of the survey is to establish the presence/absence, extent and character of detectable archaeological remains within the proposed route of HS2 Phase 2a. The scope of the surveys is dependent upon securing access to the land and for the areas to be suitable for survey.
- 1.1.3 EEW Group 012 is located to the west of Walton, Staffordshire, with the M6 to the west of the site, and Eccleshall Road running through between the sites. Site 100 is located to the south of Eccleshall Road and along Common Lane, with the M6 to the southwest. The site encompasses c.6.8ha although the area required for magnetometer survey consists of two separate parcels amounting to approximately 1.4ha.
- 1.1.4 Survey was only undertaken at the southernmost parcel amounting to 0.92ha due to the presence of horses in the remaining parcel at the time of survey.
- 1.1.5 The survey has not identified any anomalies of definite or possible archaeological origin. The only identifiable features in the magnetometer data are occasional sporadic low magnitude and dipolar 'spike' anomalies of natural and modern origin respectively and a strip of magnetic disturbance along the southern boundary of the parcel caused by fencing.
- 1.1.6 The findings of the survey reflect the limited archaeological potential of the general area which is not recorded as within a RAZ and that was identified in the Historic Environment search conducted for the HS2 Environmental Statement and remote sensing survey data which did not identify any features within Site 100.

2 Introduction

2.1 Project Background

- 2.1.1 HS2 is a new railway network proposed by the Government to provide a new link between London, the West Midlands, the East Midlands, South Yorkshire, Leeds and Manchester. HS2 Phase 2a comprises approximately 36 miles of railway starting at Fradley at its southern end and connects with the West Coast Main Line (WCML), south of Crewe, to allow HS2 services to join the existing network and call at Crewe Station.
- 2.1.2 The overall framework within which archaeological work will be undertaken is set out in the draft Environmental Minimum Requirements (EMR) for HS2 Phase 2a. Accordingly, the nominated undertaker or any contractors will be required to implement certain control measures in relation to archaeology before construction work begins.
- 2.1.3 The works have been undertaken in accordance with Written Scheme of Investigation (WSI, HS2 2019) and conform with current best practice and guidance for geophysical surveys as outlined in the Chartered Institute for Archaeologists' (CIfA) Standard and Guidance for archaeological geophysical survey (CIfA 2014) and European Archaeologiae Consilium Guidelines for the use of Geophysics in Archaeology (EAC 2016).
- 2.1.4 The selection of areas required for geophysical survey included as part of this Early Environmental Works (EEW) package are set out in location specific Written Scheme of Investigations (WSIs) based on Groups containing individual sites. HS2 Ltd has provided each EEW site along the Phase 2a route with a unique identifier Site Code.
- 2.1.5 Within EEW Group 012 (HS2 2021) the Site Code for geophysical survey is:
- Site 100: 2a20DPIRMG

2.2 Scope of Document

- 2.2.1 This report presents a brief description of the methodology followed by the detailed survey results and the archaeological interpretation of the geophysical data.

2.3 The Site

- 2.3.1 EEW Group 012 is located to the west of Walton, Staffordshire, with the M6 to the west of the site, and Eccleshall Road running through between the sites. Site 100 is located to the south of Eccleshall Road and along Common Lane, with the M6 to the southwest and is centred at NGR 389171 331919. The site encompasses c.6.8ha although the area required for magnetometer survey consists of two separate parcels under pasture south of Walton Heath Farm amounting to approximately 1.4ha.
- 2.3.2 Ordnance survey mapping and street view imagery suggests that the landscape around Site 100 is broadly flat, with a gradual slope from approximately 125m above Ordnance Datum (aOD) in the south towards 110m aOD in the northern access area to the site. The topography of the southernmost parcel surveyed is flat at 125m aOD.

- 2.3.3 The solid geology across both parcels within the Site is recorded as mudstone of the Mercia Mudstone Group though no overlying superficial deposits are recorded (BGS 2021).
- 2.3.4 The soils covering the Site area classified in Soilscape 8 Association described as slightly acid loamy and clayey soils with impeded drainage (Cranfield University 2020).
- 2.3.5 Average responses of magnetometer surveys over mudstone geologies are generally poor but results can be very variable depending on the nature and depth of the overlying deposits if present (English Heritage 2008; Table 4). It remains that magnetometry was the most appropriate geophysical technique for evaluating the Site taking account of the limitations noted in Section 4.3 below.

3 Archaeological Background

3.1 Summary of the archaeological resource

- 3.1.1 The following archaeological background summarises details from the Location Specific Written Scheme of Investigation (LSWSI, HS2 2021) together with information from publicly available online resources and other in-house resources.
- 3.1.2 The assessment and determination of the significance of archaeological assets is defined by Chapter 10 of the HS2 Ltd EIA Scope and Methodology Report (HS2 2017a).
- 3.1.3 The Recognised Archaeological Zones (RAZ) represent a high-level indication of likely concentrations of archaeological remains across the Phase 2a route. The location and spatial extent of RAZs has been determined using HS2 Environmental Statement (ES) Cultural Heritage information and subsequent survey data.
- 3.1.4 The HS2 Ltd Phase 2a GWSI: HERDS document indicates that the EEW Group area is not situated within a RAZ.
- 3.1.5 The Historic Environment search conducted for the HS2 Environmental Statement (ES; HS2 2017b) identified the northern end of the site lies within the same extensive area of low value medieval to post-medieval landscape comprised of field systems (STS013) as Site 94, though this is where the site follows the existent Common Lane. The site access pathways are also adjacent to the location of an existent 19th century farmstead (STS006) and the location of a former probably 19th century post-medieval farmstead (STS009), both of low value.
- 3.1.6 The Stone Tithe map from 1844 shows the site within a landscape of fields comparable to the layout that remains on modern OS mapping. Small areas of settlement are depicted at Walton Heath and Walton House Farm adjacent to the site. No further evidence of archaeological features is noted on available historic mapping.
- 3.1.7 Geophysical survey work is advised to have been undertaken within part of the largest works area for Site 100 (ES survey site number CA3-2089). The majority of features revealed were signs of agricultural activity, namely drains and plough marks, with occasional ferrous signals.
- 3.1.8 Remote sensing survey data did not identify any features within Site 1006. However, the assessment of aerial imagery shows that the northern access into the site lies within the same agricultural landscape as Site 94. The central area of the site lies partially within a further area of very residual and levelled ridge and furrow from the medieval to post-medieval period.

4 Methodology

4.1 Magnetometry

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 and Gater 2003). Further information on soil magnetism and the interpretation of magnetic anomalies is provided in Annex 1 and Annex 2 respectively.

4.2 Aims and Objectives

4.2.1 The aims of the survey comprise the following:

- To determine, as far as is reasonably possible, the nature of the detectable archaeological resource within a specified area using appropriate methods and practices; and
- To inform either the scope and nature of any further archaeological work that may be required; or the formation of a mitigation strategy (to offset the impact of the development on the archaeological resource); or a management strategy.

4.2.2 In order to achieve the above aims, the objectives of the geophysical survey are:

- To conduct a geophysical survey covering as much of the specified area as possible, allowing for on-site obstructions;
- To clarify the presence/absence of anomalies of archaeological potential; and
- Where possible, to determine the general nature of any anomalies of archaeological potential.

4.3 Assumptions and limitations

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. Magnetometry has the potential to rapidly confirm the presence/absence of a wide range of potential archaeological remains within the site and was thus chosen as the most appropriate technique in this instance.

4.4 Fieldwork Methodology

- 4.4.1 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 (Figure 1). 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, in accordance with EAC guidelines (EAC 2016).
- 4.4.2 Unenclosed areas were surveyed using the co-ordinates of the pre-determined Site boundary visible as an outline on the MLGrad601 software during data collection.
- 4.4.3 MLGrad601 (Geomar Software Inc.) software was used to collect the data.

4.5 Data processing

- 4.5.1 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.
- 4.5.2 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.
- 4.5.3 The data has also been clipped to remove extreme values and to improve data contrast.
- 4.5.4 MultiGrad601 (Geomar Software Inc.) software was used to export the survey data files.
- 4.5.5 Terrasurveyor V3.0.37.0 (DWConsulting) software was used to process and export graphical plots the data.

5 Geophysical Survey Results and Interpretation

5.1 Gradiometer survey results and interpretation

- 5.1.1 The magnetometer survey was carried out on the 9th February 2022 and covered an area of 0.9ha. A second parcel contained horses at the time of survey and was not surveyed.
- 5.1.2 Fully processed (greyscale) data, minimally processed data (XY trace plot) and interpretative plans are presented at a scale of 1:1,000 in Figures 2 – 4 inclusive.
- 5.1.3 The magnetic background is homogenous across the Site likely a result of the underlying mudstone geology.
- 5.1.4 The only anomalies present in the data consist of occasional sporadic low magnitude and dipolar 'spike' anomalies of likely natural and modern origin respectively. A strip of magnetic disturbance along the southern boundary of the parcel was caused by fencing at the field boundary.

6 Discussion

- 6.1 The survey has not identified any anomalies of definite or possible archaeological origin. The only identifiable features in the magnetometer data are occasional sporadic low magnitude and dipolar 'spike' anomalies of natural and modern origin respectively and a strip of magnetic disturbance along the southern boundary of the parcel caused by fencing.
- 6.2 The findings of the survey reflect the limited archaeological potential of the general area which is not recorded as within a RAZ and that was identified in the Historic Environment search conducted for the HS2 Environmental Statement (HS2 2017b) and remote sensing survey data which did not identify any features within Site 94 (HS2 2017c).

References

Bibliography

British Geological Survey (BGS) 2022 Geology of Britain 3D <http://www.bgs.ac.uk/> accessed 18th July 2022

Chartered Institute for Archaeologists (CIfA) 2014 Standard and guidance for archaeological geophysical survey (Reading)
https://www.archaeologists.net/sites/default/files/CifAS%26GGeophysics_3.pdf accessed 18th July 2022

Cranfield University 2020 Cranfield Soil and Agrifood Institute Soilscales
<http://www.landis.org.uk/soilscales/> accessed 18th July 2022

English Heritage 2008 Geophysical Survey in Archaeological Field Evaluation

Europae Archaeologia Consilium (EAC) 2016 EAC Guidelines for the Use of Geophysics in Archaeology: Question to Ask and Points to Consider (Namur, Belgium) <https://www.europae-archaeologiae-consilium.org/eac-guidlines> accessed 18th July 2022

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

HS2 Ltd, 2017a High Speed Rail (West Midlands-Crewe). Environmental Statement. Volume 5: Technical appendices. Environment Impact Assessment Scope and Methodology Report (CT-001-001). Available at: <https://www.gov.uk/government/publications/scope-and-methodology-report-for-hs2-phase-2a>

HS2 Ltd, 2017b High Speed Rail (West Midlands-Crewe). Environmental Statement. Volume 5: Technical appendices. CA3: Stone to Swynnerton. Gazetteer of heritage assets. (CH-002-003). Available at: <https://www.gov.uk/government/collections/hs2-phase-2a-environmental-statement#volume-5:-environmental-reports-and-maps-by-community-area>

HS2 Ltd, 2017c High Speed Two Phase 2a (West Midlands-Crewe). Background Information and Data. CA3: Stone and Swynnerton. Cultural heritage survey reports. (BID-CH-004-003). Available at: <https://www.gov.uk/government/collections/hs2-phase-2a-environmental-statement#volume-5:-environmental-reports-and-maps-by-community-area>

HS2 2019 HS2 Phase 2a Written Scheme of Investigation for EI-711 Surveys Package 1: Magnetometry (HS2-HS2-EV-MST-A000001)

HS2, 2021, Phase 2a LS-WSI: EEW Group 012, EEW Site 94 & 100 (HS2 Document no: 2EE0-BAF-EV-PRO-A000-000007, Revision: 05)

Annex 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.

Annex 2: Geophysical Interpretation

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.

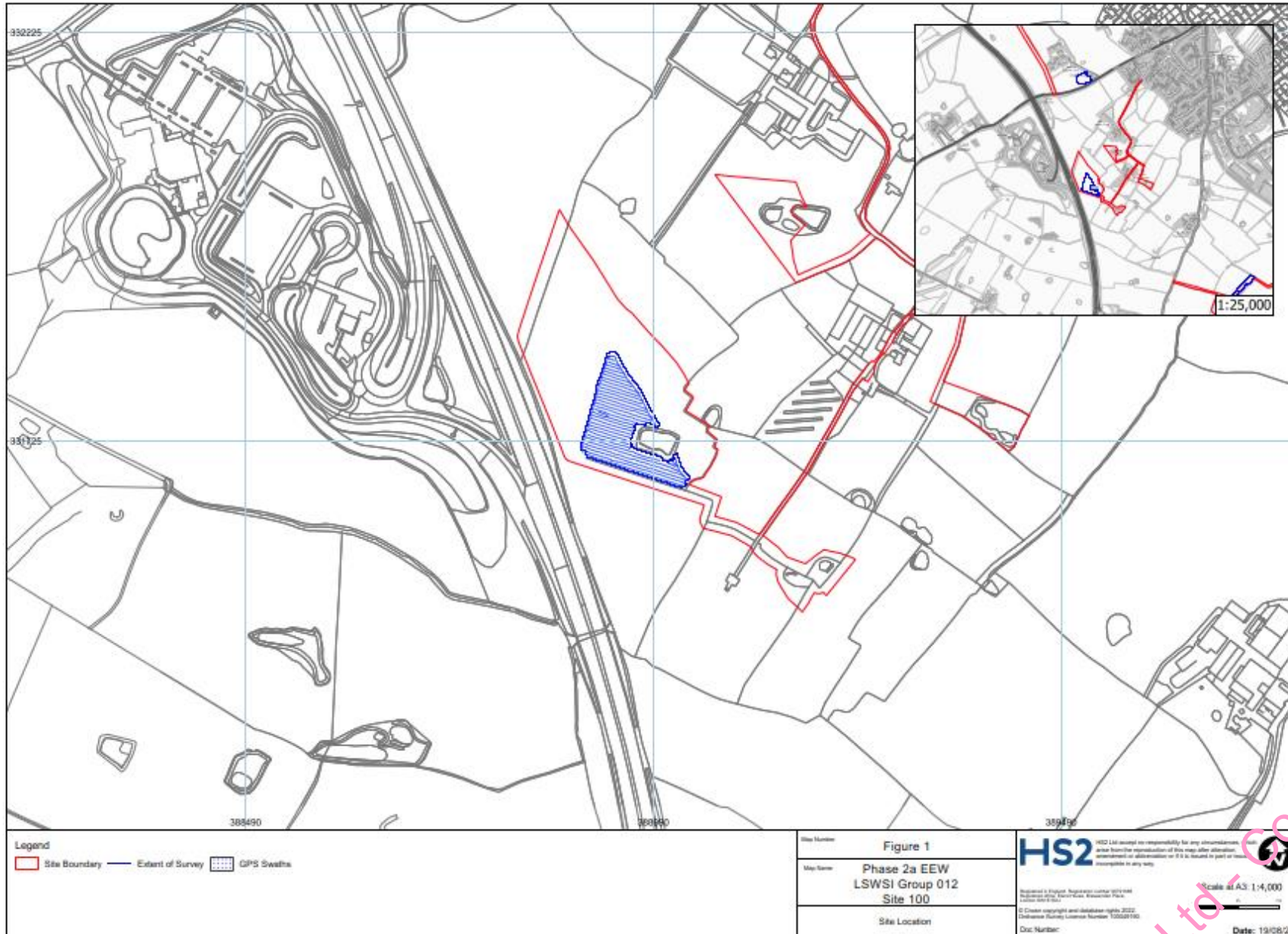
Areas of magnetic enhancement/positive isolated anomalies

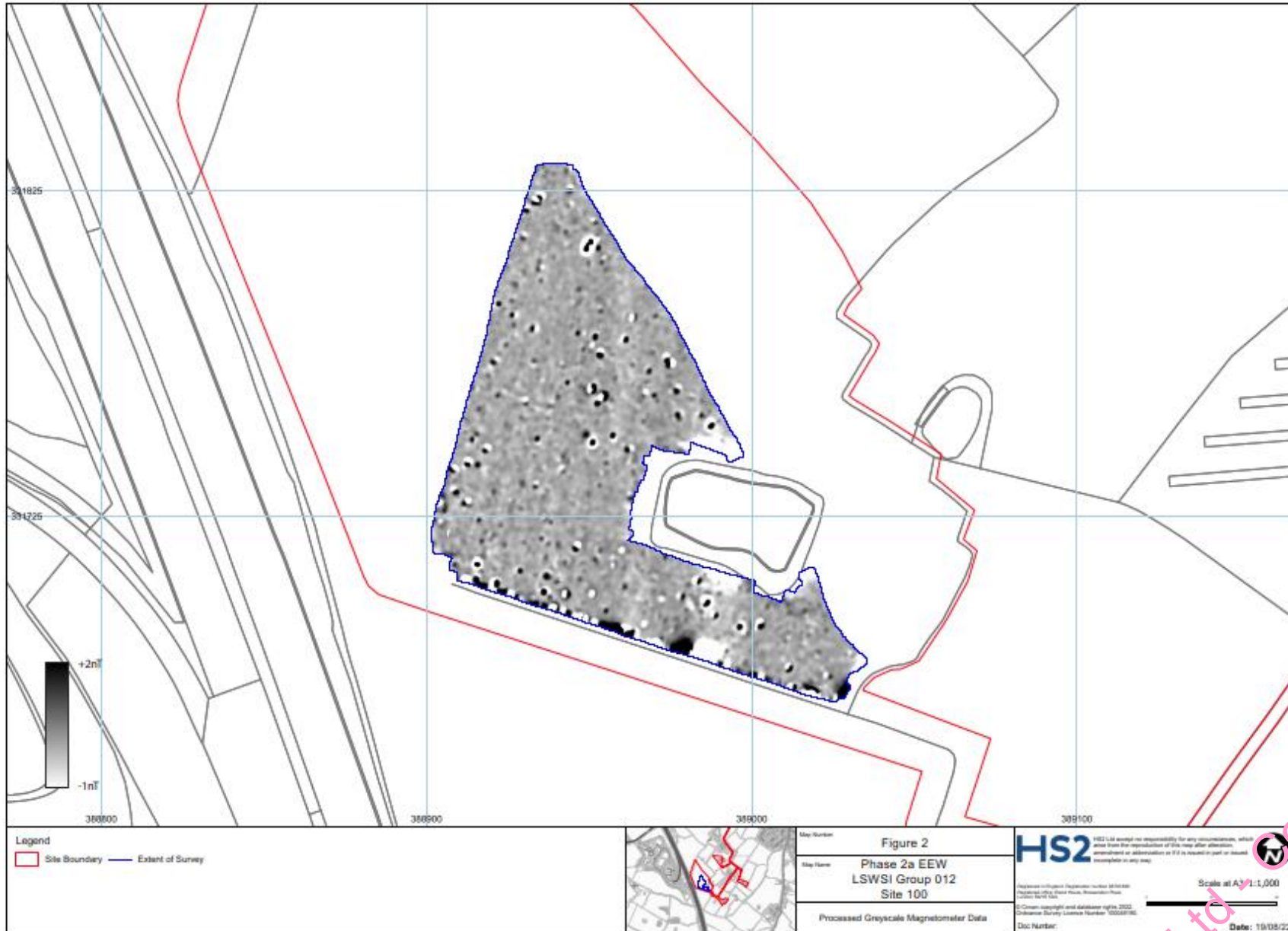
Areas of enhanced response are characterised by a general increase in the magnetic background over a localised area whilst discrete anomalies are manifest by an increased response (sometimes only visible on an XY trace plot) on two or three successive traces. In neither instance is there the intense 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.

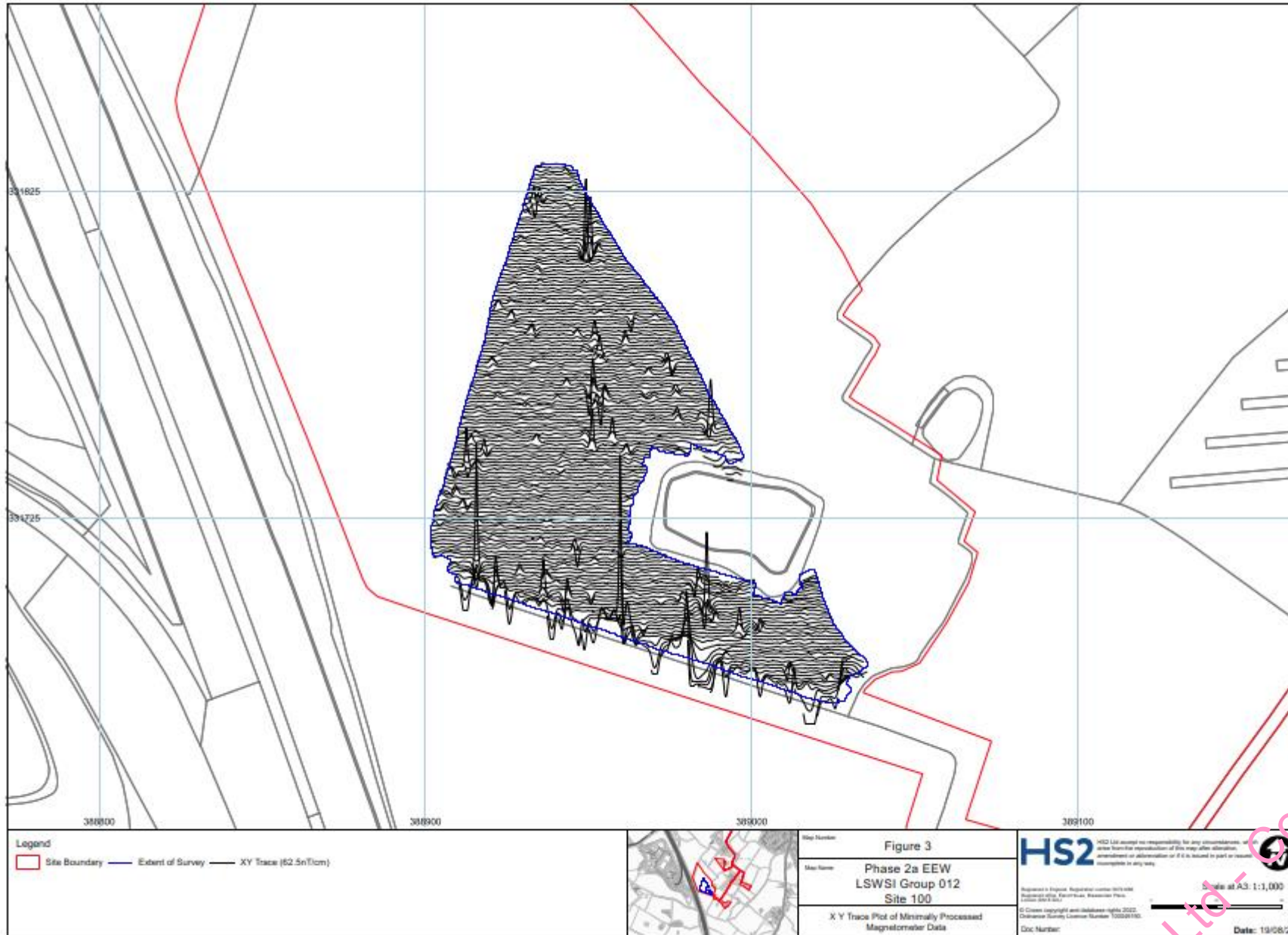
Linear and curvilinear anomalies

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.

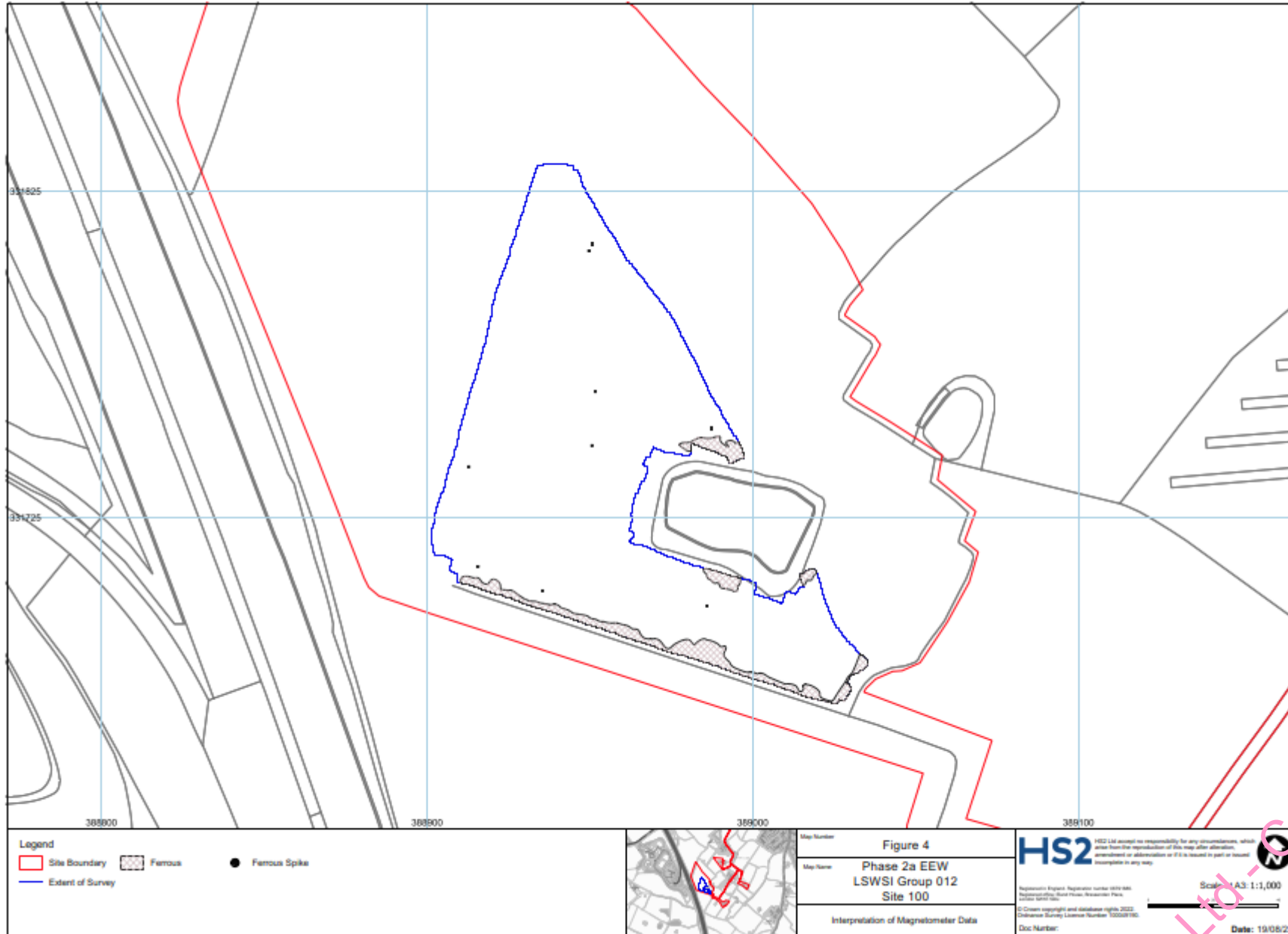




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Annex 3: OASIS Form

Project Details:

Project name	Geophysical Survey at Group 012 Site 100	
Type of project	Geophysical Survey, MAGNETOMETRY SURVEY	
Project description	<p>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, in accordance with EAC guidelines (EAC 2016).</p> <p>The survey has not identified any anomalies of definite or possible archaeological origin. The only identifiable features in the magnetometer data are occasional sporadic low magnitude and dipolar 'spike' anomalies of natural and modern origin respectively and a strip of magnetic disturbance along the southern boundary of the parcel caused by fencing. The findings of the survey reflect the limited archaeological potential of the general area which is not recorded as within a RAZ and that was identified in the Historic Environment search conducted for the HS2 Environmental Statement and remote sensing survey data which did not identify any features within Site 100.</p>	
Project dates	Start: 09-Feb-2022	End 09-Feb-2022:
Previous work	N/A	

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Future work		N/A			
Project Code:	Group 012 Site 100	HER event no.			

		NMR no.		OASIS form ID:	hs2headl1-509455
		SM no.			
Planning Application Ref.					
Site Status	None				
Land use	Arable and Pasture				
Monument type	N/A		Period	N/A	

Project Location:

Site Address	located to the south of Eccleshall Road and along Common Lane, with the M6 to the southwest			Postcode	
County	Staffordshire	District	Stafford	Parish	Stone Rural
Study Area	1.4ha	Height OD	Between 110 and 125m Above Ordnance Datum	NGR	SJ 88955 31743

Project Creators:

Name of Organisation	HS2 Headland Archaeology (UK) Ltd		
Project brief originator	HS2	Project design originator	HS2
Project Manager	Alistair Webb	Project Supervisor	Matt Berry
Sponsor or funding body	Balfour Beatty	Type of Sponsor	Client

Project Archive and Bibliography:

Physical archive	N/A	Digital Archive	Geophysical survey and report	Paper Archive	N/A
Report title	Phase 2a Heritage Non-intrusive Surveys Report: Group 012 Site 100 Geophysics survey report			Date	31/10/2022
Author	Headland Archaeology	Description	PDF/A	Report ref.	