WYAS Archaeological Services

Paragon Phases 2b & 3

Wakefield

West Yorkshire

Geophysical Survey

Report no. 3708
Feb 2022

Client: Persimmon Homes West Yorkshire

Paragon Phases 2b & 3, Wakefield West Yorkshire

Geophysical Survey

Summary

A geophysical (magnetometer) survey was undertaken on approximately 8.5 hectares of land located to the north of Red Hall Lane, Wakefield, West Yorkshire. Anomalies of a possible archaeological origin have been detected in the form of a rectilinear enclosure along with the potential for a second. Former field boundaries have been detected along with possible ridge and furrow cultivation. Geological responses can be seen throughout and large areas of magnetic disturbance are thought to be associated with ground clearance and/or dumped ferrous material. Overall the archaeological potential of this Site is deemed to be high surrounding the enclosure and low elsewhere.

WYAS Archaeological Services

Report Information

Client:	Persimmon Homes West Yorkshire
Address:	3 Hepton Court, York Road, Leeds, LS9 6PW
Report Type:	Geophysical Survey
Location:	Wakefield
County:	West Yorkshire
Grid Reference:	SE 32218 22858
Period(s) of activity:	Romano-British / post medieval?/ modern
Report Number:	3708
Project Number:	XE50
Site Code:	PAN21
OASIS ID:	archaeol11-504290
Date of fieldwork:	January 2022
Date of report:	February 2022
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Document Issue Record

Ver	Author(s)	Reviewer	Approver	Date
1.0	EB	JR	JR	Feb 2022

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1 Introduction

Archaeological Services ASWYAS has been commissioned by Persimmon Homes West Yorkshire to undertake a geophysical survey at land at Paragon, Wakefield, West Yorkshire for Phases 2b and 3 of the development. This was undertaken in line with current best practice (CIfA 2014; Schmidt *et al.* 2015). The survey was carried out on the 6th and 7th January 2022 to provide additional information on the archaeological resource of the Site.

Site location, topography and land-use

The Site is located at SE 32218 22858 (approximate centre), comprising *c.* 8.5ha over two fields (Phase 2b and Phase 3) situated to the north west of Wakefield (see Fig. 1).

The Site is situated to the north of Red Hall Lane with the area consisting of recently cleared land (see Plates 1-4). It is bounded to the north by Snow Hill Beck and Broom Hall Avenue, to the west by Bradford Road and to the east by Red Hall. The site lies at 54m (above Ordnance Datum) aOD in the west, rising to approximately 64m aOD in the east. The northeast section of Phase 3 was unsuitable for survey as was overgrown and contained dumped materials (see Plate 2).

Soils and geology

The recorded bedrock geology comprises Pennine Middle Coal Measures Formation - mudstone, siltstone and sandstone, a sedimentary bedrock that formed approximately 310 to 318 million years ago in the Carboniferous Period. Superficial deposits have not been recorded (BGS 2022). Soils are described as slowly permeable, seasonally wet acid loamy and clayey (Soilscape 17) (CSAI 2022).

2 Archaeological Background

A desk-based assessment of the wider Snow Hill/Paragon site was carried out in 1999 (West Yorkshire Historic Environment Record PRN 7722). This identified a number of possible archaeological features including the presumed course of a Roman Road (No. 721) running to the south of the Site. The grade II listed Red Hall, lies to the east of the Site, which is documented from 1612 (National Historic List for England No. 1300079), along with associated ridge and furrow field systems and the possible remains of early coal mining were also highlighted.

The Paragon Business Village site located to the east of the Site underwent soil stripping without any archaeological mitigation and as a result it is not known if any archaeological remains were present.

Geophysical surveys of a site to the immediate south by ASWYAS (Sykes 2016) confirmed the presence of archaeological features. Overall the archaeological potential comprises the

back-filled ditches of late prehistoric and/or Roman period settlement enclosures, possible dwellings identified by circular geophysical anomalies, and field systems. No obvious indication of the conjectural course of the Roman Road was detected.

Archaeological investigations by ASWYAS (Moon *et al*. 2016) followed the above geophysical survey where an enclosure of Roman date was identified to the east of the area appended to a north-south aligned ditch. The majority of the features excavated were of medieval date including extensive ridge and furrow agriculture and a possible enclosure located in the southeast area of the Site. A subsequent phase of activity was characterised by later field boundaries and features associated with mining activity.

A geophysical survey was conducted in November 2021 for Phase 2a of the current development. Anomalies of a possible archaeological origin were detected which may be related to settlement features or part of a square-enclosure system. The majority of the responses were of a modern nature (Trace 2021). This was followed by trial trenching in December 2021 which encountered archaeological features including ditches, gullies and pits, the majority of which date from the post-medieval period (Buxton in progress).

3 Aims, Methodology and Presentation

The aims and objectives of the programme of geophysical survey were to gather sufficient information to establish the presence/absence, character and extent, of any archaeological remains within the specific area and to inform an assessment of the archaeological potential of the site. To achieve this aim, a magnetometer survey covering all amenable parts of the Site was undertaken (see Fig. 2).

The general objectives of the geophysical survey were:

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

Magnetometer survey

The site grid was laid out using a Trimble VRS differential Global Positioning System (Trimble R6 model). The survey was undertaken using Bartington Grad601 magnetic gradiometers. These were employed taking readings at 0.25m intervals on zig-zag traverses 1.0m apart within 30m by 30m grids, so that 3600 readings were recorded in each grid. These readings were stored in the memory of the instrument and later downloaded to computer for

processing and interpretation. Bespoke in-house software was used to process and present the data. Further details are given in Appendix 1.

Reporting

A general site location plan, incorporating the 1:50000 Ordnance Survey (OS) mapping, is shown in Figure 1. Figure 2 displays an overall view showing the current and previous survey at a scale of 1:2000. Figure 3 shows the processed magnetometer data at a scale of 1:1500 and Figure 4, the interpretation at the same scale. Processed and minimally processed data, together with interpretation of the survey results are presented in Figures 5 to 10 inclusive at a scale of 1:1250.

Technical information on the equipment used, data processing and survey methodologies are given in Appendix 1. Technical information on locating the survey area is provided in Appendix 2. Appendix 3 describes the composition and location of the archive. A copy of the completed OASIS form is included in Appendix 4.

The survey methodology, report and any recommendations comply with guidelines outlined by the European Archaeological Council (Schmidt *et al*. 2015) and by the Chartered Institute for Archaeologists (CIfA 2014). All figures reproduced from Ordnance Survey mapping are with the permission of the controller of Her Majesty's Stationery Office (© Crown copyright).

The figures in this report have been produced following analysis of the data in processed formats and over a range of different display levels. All figures are presented to most suitably display and interpret the data from this site based on the experience and knowledge of Archaeological Services staff.

4 Results and Discussion (see Figures 3 to 10)

Ferrous anomalies and magnetic disturbance

Ferrous anomalies, as individual 'spikes', or as large discrete areas 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 or material is common on rural sites, often being present as a consequence of manuring or tipping/infilling. There is no obvious pattern or clustering to their distribution in this survey to suggest anything other than a random background scatter of ferrous debris in the plough-soil.

Large areas of magnetic disturbance can be seen across the most of Phase 2b and in the southern, northern and western sections of Phase 3. This is likely due to ground disturbance

and dumped ferrous materials from the adjacent housing. It is also possible that the responses could represent past mining activity given the geological bedrock consisting of Pennine Middle Coal Measures.

Smaller areas of magnetic disturbance within the dataset could also be attributed to the geology or dumped materials.

Geological anomalies

The survey has detected a number of anomalies that have been interpreted as geological in origin. It is thought that the responses have been detected because of the variation in the composition and depth of the deposits of superficial material in which they derive. A number of these responses are likely to correspond with former ground disturbance and tree removal.

As mentioned in the previous category, some of the disturbance responses may also be attributed to the geological bedrock.

Agricultural anomalies

Former field boundaries have been detected in both areas which correlate to Ordnance Survey (OS) mapping dated 1905. These have been highlighted on the interpretation figures as **FFB1 - FFB4**. Boundary **FFB1** has been removed by the mapping dating 1937 whilst the three remaining boundaries are still visible on the OS map published 1956 (NLS 2022).

Parallel linear trends in the south of Phase 2b are thought to relate to medieval/post-medieval ridge and furrow cultivation associated with Red Hall.

Linear trends in the north of Phase 3 are likely to be associated with modern agricultural influences, although an earlier date cannot be ruled out.

Uncertain anomalies

Anomalies (**U1**) within the centre of a possible square enclosure (see below) have been interpreted as having an uncertain origin. It is possible that they may have an archaeological origin and be associated with the enclosure, but given the amount of geological responses in the vicinity, a natural cause cannot be ruled out.

Anomalies (**U2**) in the northern section of Phase 2b appear to form 3 sides of a rectilinear enclosure, measuring approximately 40m by at least 25m. Given the position of the responses, within and close to the magnetic disturbance, however, an uncertain origin has been assigned.

Possible archaeological anomalies

A large rectilinear enclosure (**P1**) has been recorded in the southern half of Phase 3. The enclosure measures approximately 37m by 40m and has a potential entrance along its eastern

side. There is also the potential of a second entrance along the northern limits. Due to amount of magnetic disturbance in the area and the lack of corroborative evidence, a possible archaeological interpretation has been given, but given the archaeological features found in previous works to the south of this Site, it is likely that this enclosure adds to the Prehistoric/Roman activity within the area.

5 Conclusions

The geophysical survey has detected magnetic anomalies associated with possible archaeological origins in the form of a large enclosure. There is also the possibility of a second enclosure, although this has been hampered by modern interference.

Former field boundaries has been recorded which relate to historic mapping. Possible ridge and furrow cultivation in the south of the Site may be related to Red Hall.

Magnetic disturbance, located across the site, likely relates to the ground clearance and dumping of ferrous materials. Geological responses have also been recorded throughout, in which some may be associated with former mining.

Based on the interpretation of the magnetic survey the archaeological potential of the Site is deemed to be high surrounding the enclosure (**P1**) and low elsewhere.

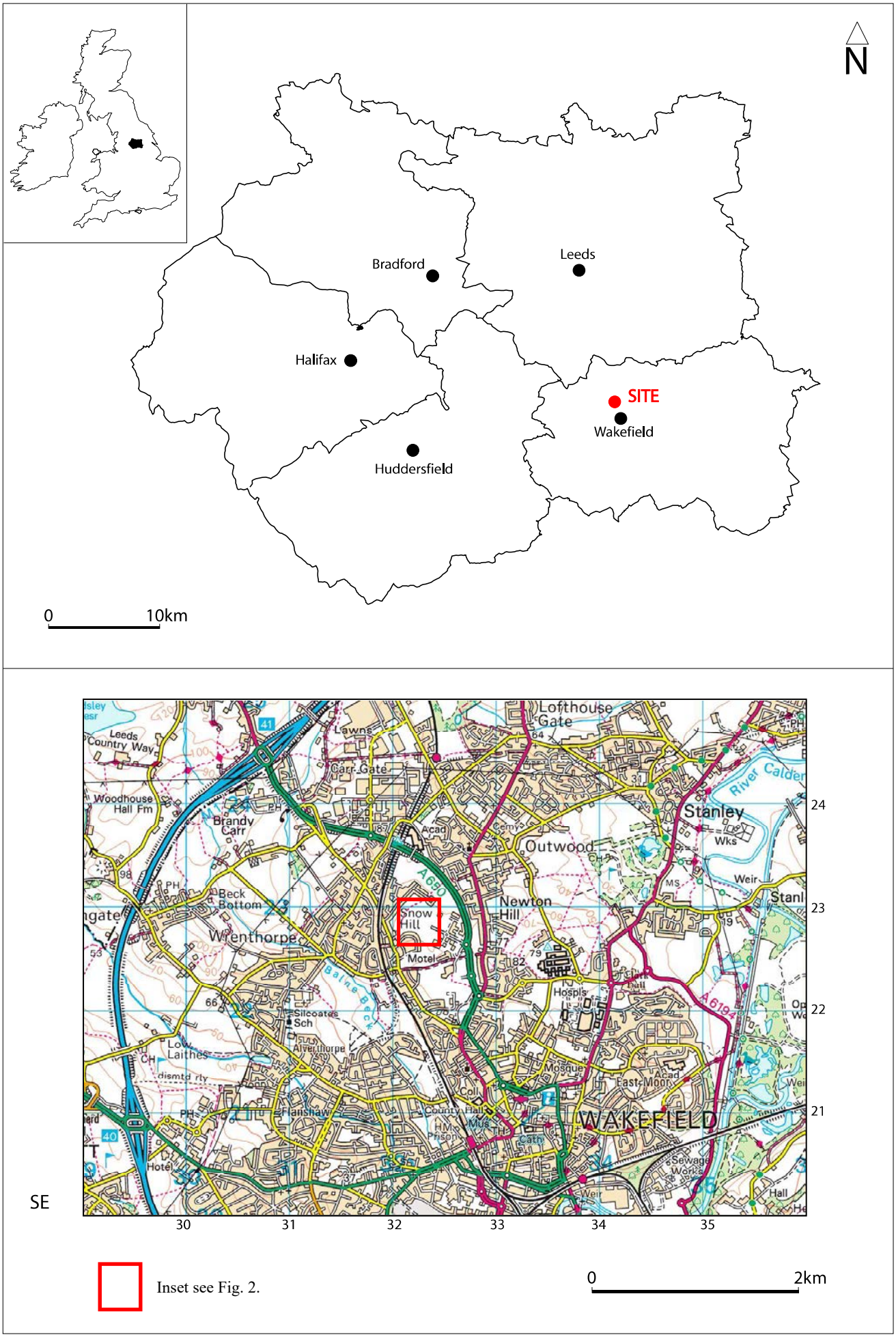
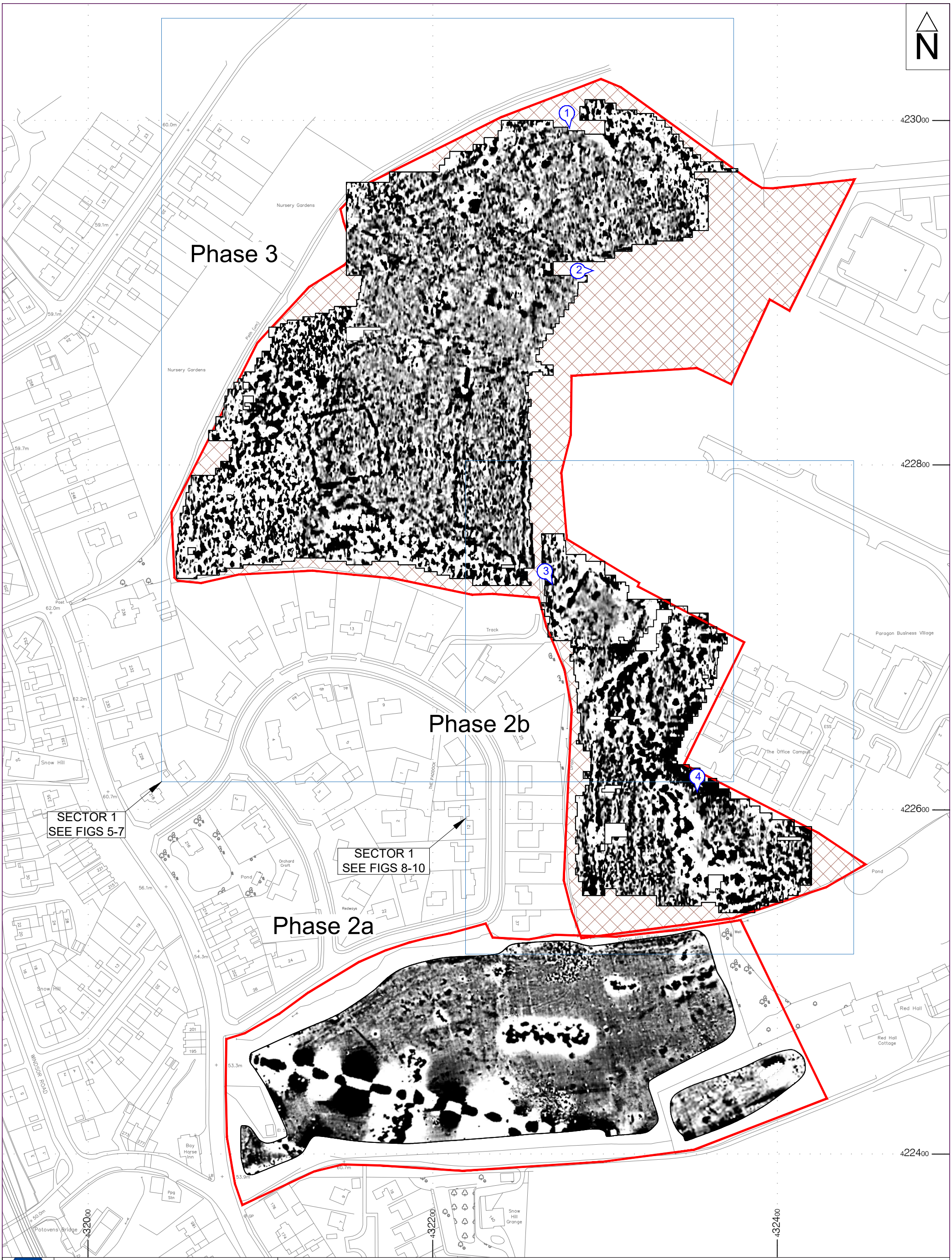


Fig. 1. Site location



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Project ID: XE50_PGN21

Survey location showing processed magnetometer data

Fig.2

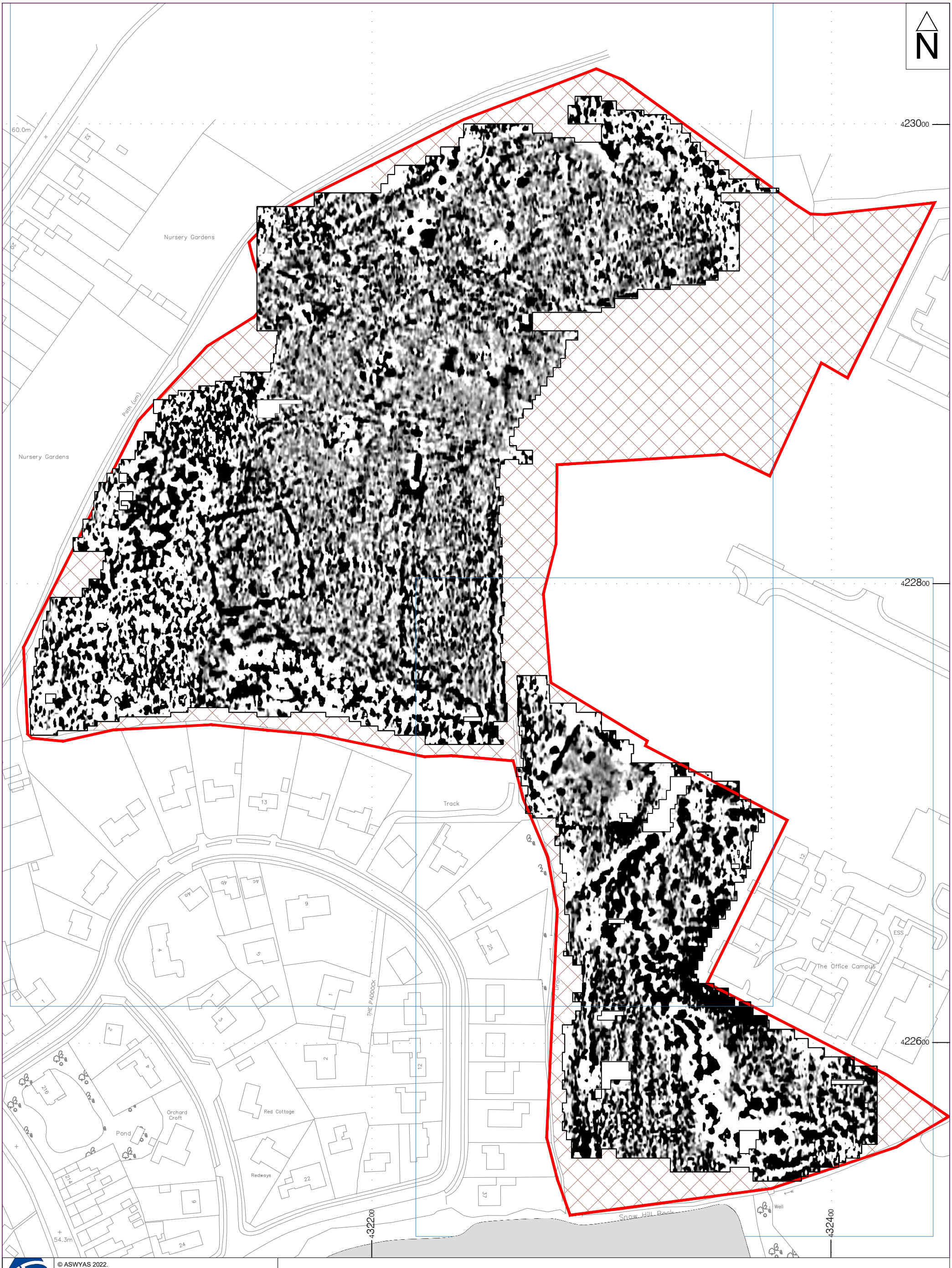
Title

- SURVEY AREA
- SECTOR BOUNDARY
- UNSUITABLE FOR SURVEY
- PHOTO LOCATIONS

nT -1.0 2.0

0 100m

1:2000 @ A3



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Overall processed greyscale magnetometer data

Fig.3

Title

SURVEY AREA

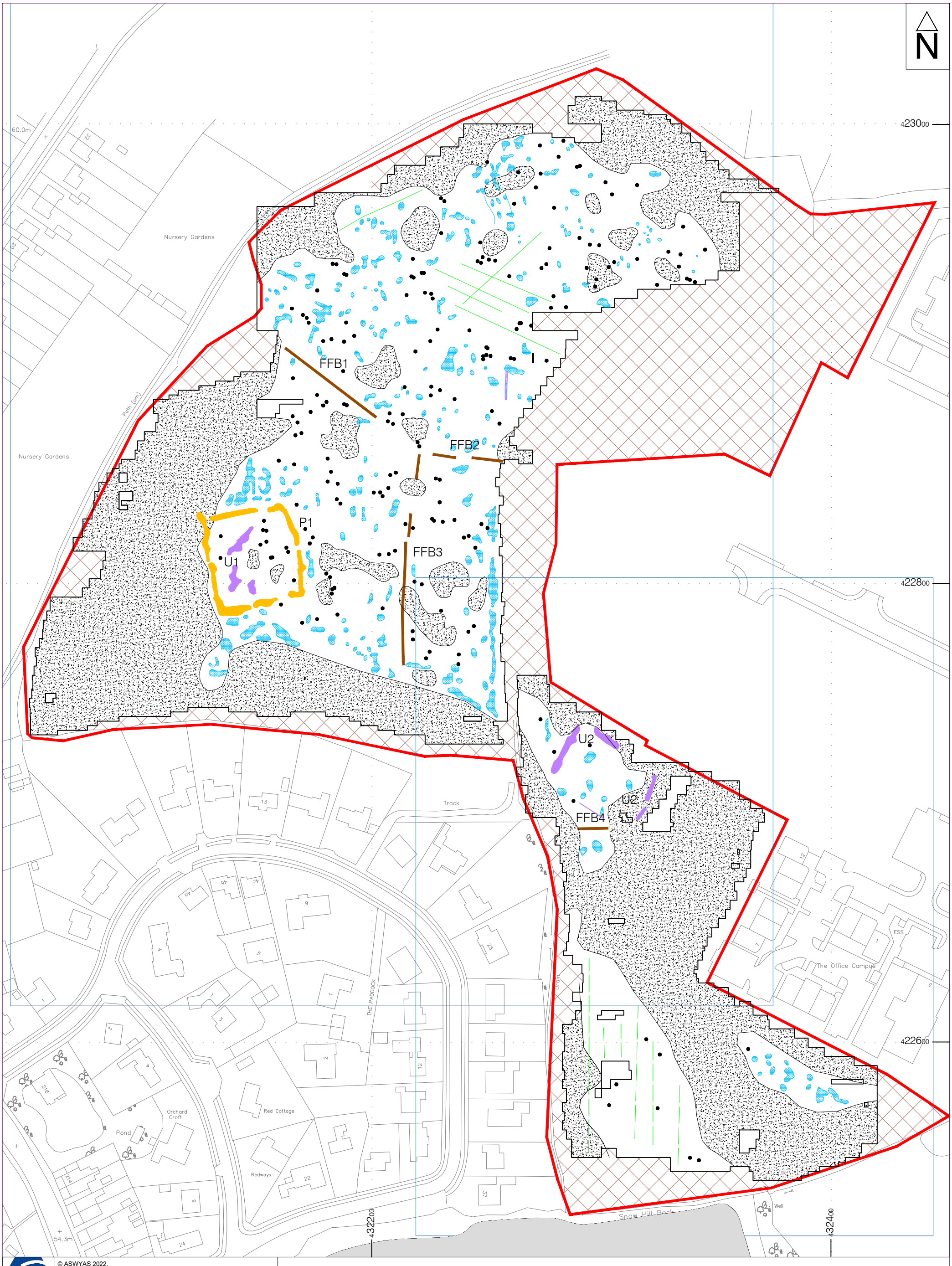
SECTOR BOUNDARY

UNSUITABLE FOR SURVEY

nT -1.0 2.0

0 50m

1:1500 @ A3



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Overall interpretation of magnetometer data

Fig.4

Interpretation

- FERROUS
- MAGNETIC DISTURBANCE
- RIDGE & FURROW
- AGRICULTURAL
- FORMER FIELD BOUNDARY
- GEOLOGY
- UNCERTAIN
- ARCHAEOLOGY?

0 50m

1:1500 @ A3

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Processed greyscale magnetometer data; Sector 1

Fig.5

nT -1.0 2.0

0 50m

1:1250 @ A3

N

4230^{00}

4228^{00}

4322^{00}

60.0m

Nursery Gardens

Path (um)

Nursery Gardens

Track

Drain

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XY trace plot of minimally processed data; Sector 1

Fig.6

20.0 nT/cm

0 50m

1:1250 @ A3

N

4230^{00}

4228^{00}

4322^{00}

60.0m

Nursery Gardens

Path (um)

Track

Drain

FFB1

FFB2

FFB3

FFB4

P1

U1

U2

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Interpretation of magnetometer data; Sector 1

Fig.7

Interpretation

- FERROUS
- MAGNETIC DISTURBANCE
- RIDGE & FURROW
- AGRICULTURAL
- FORMER FIELD BOUNDARY
- GEOLOGY
- UNCERTAIN
- ARCHAEOLOGY?

0 50m

1:1250 @ A3

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Processed greyscale magnetometer data; Sector 2

Fig.8

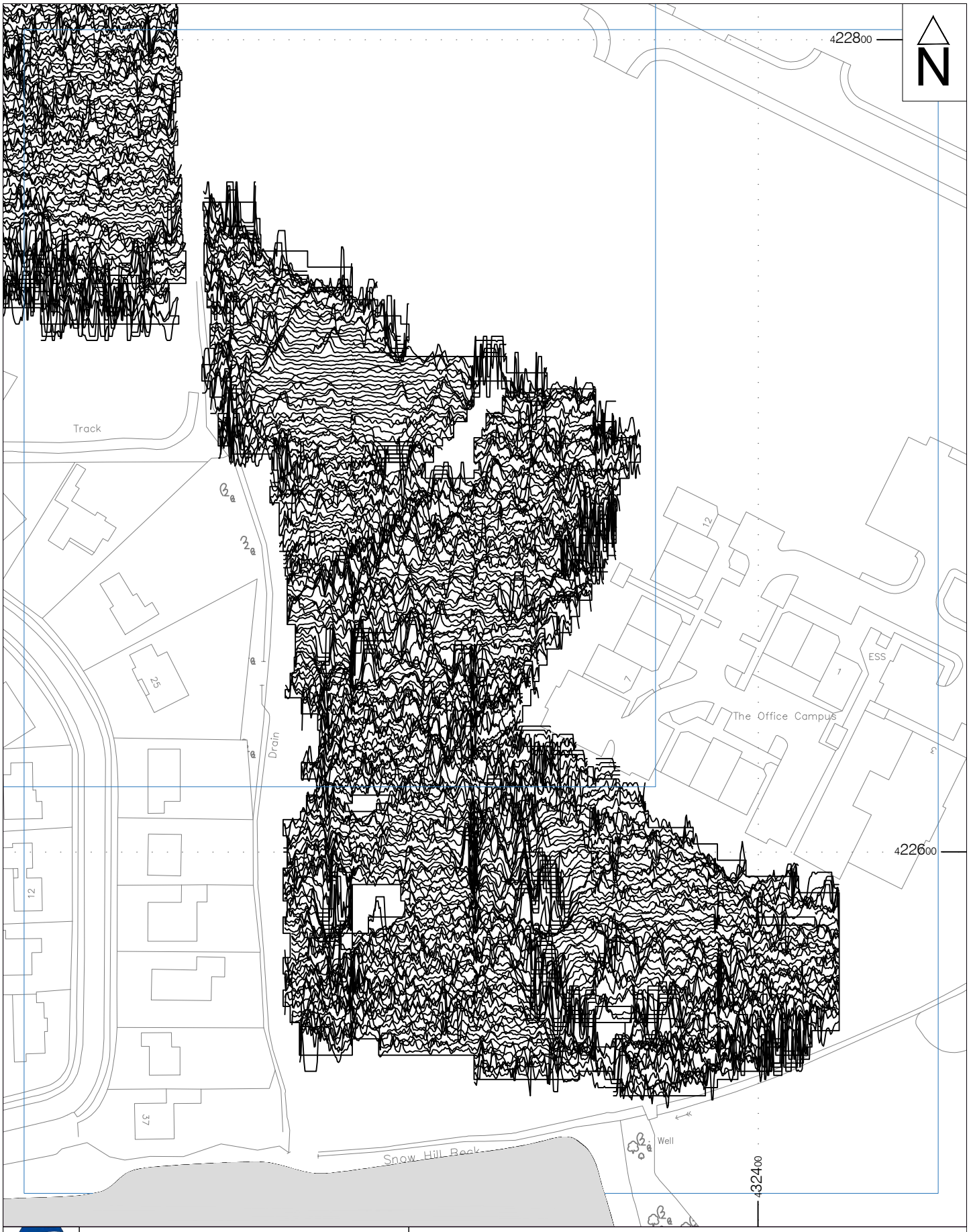
Title

PHASE 2A

-1.0 2.0
nT

0 50m

1:1250 @ A4



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Project ID: XE50_PGN21

XY trace plot of minimally processed data; Sector 2

Fig.9

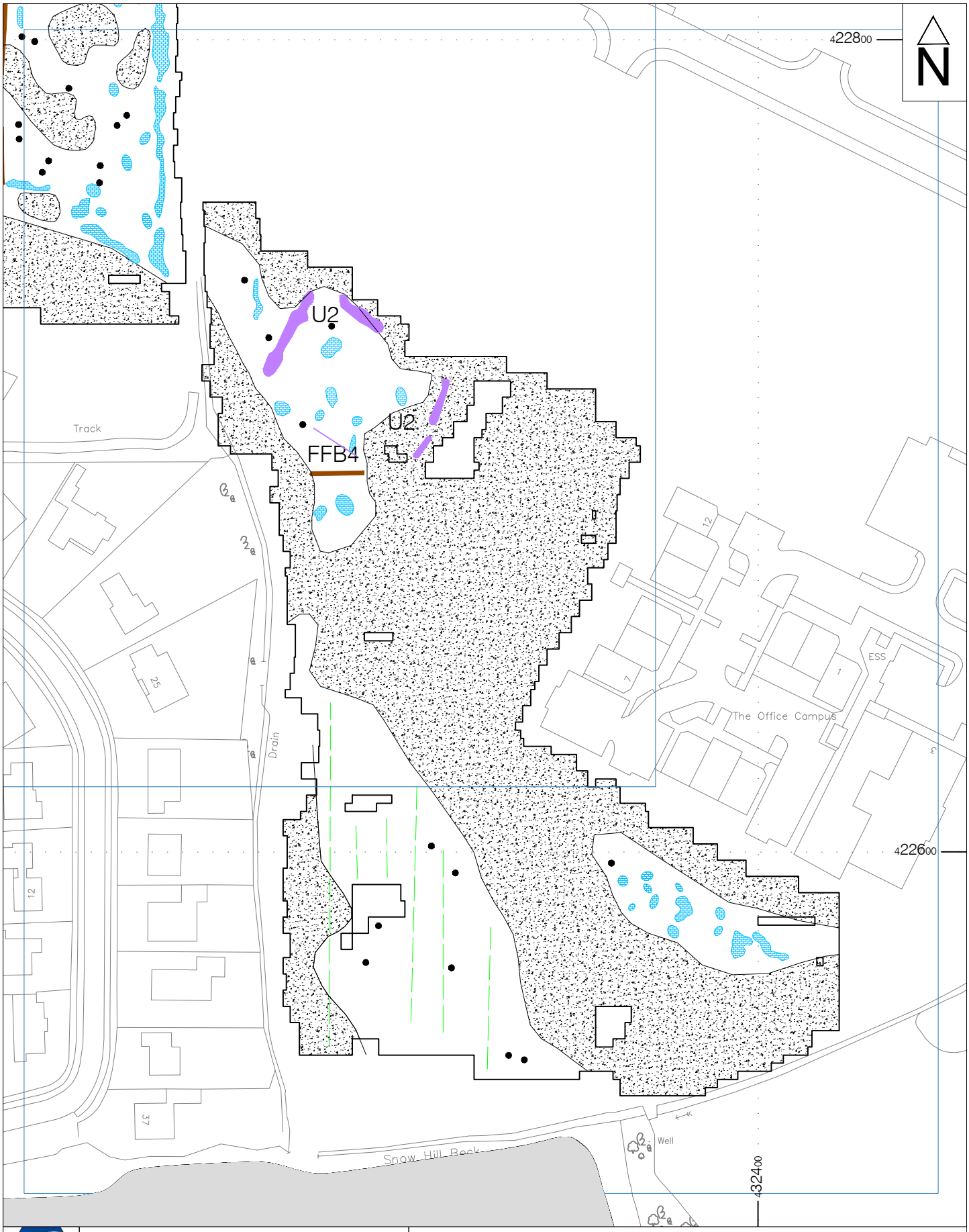
Title

PHASE 2A

20.0 nT/cm

0 50m

1:1250 @ A4



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Project ID: XE50_PGN21

Interpretation of magnetometer data; Sector 2

Fig.10

Interpretation

FERROUS	FORMER FIELD BOUNDARY
MAGNETIC DISTURBANCE	GEOLOGY
RIDGE & FURROW	UNCERTAIN

0 50m

1:1250 @ A4

Plate 1. General view of Phase 3, looking south

Plate 2. General view of Phase 3, looking east

Plate 3. General view of Phase 2b, looking southeast

Plate 4. General view of Phase 2b, looking south

Appendix 1: Magnetic survey - technical information

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 haemetite. 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. Areas of human occupation or settlement can then be identified by measuring the magnetic susceptibility of the topsoil because 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 and the fermentation and bacterial effects associated with rubbish decomposition. The area of enhancement is usually quite large, mainly due to the tendency of discard areas to extend beyond the limit of the occupation site itself, and spreading by the plough.

Types of Magnetic Anomaly

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

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

It should be noted that anomalies interpreted as modern in origin might be caused by features that are present in the topsoil or upper layers of the subsoil. Removal of soil to an archaeological or natural layer can therefore remove the feature causing the anomaly.

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

Isolated dipolar anomalies (iron spikes)

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

Areas of magnetic disturbance

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

Linear trend

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

Areas of magnetic enhancement/positive isolated anomalies

Areas of enhanced response are characterised by a general increase in the magnetic background over a localised area whilst discrete anomalies are manifest by an increased response 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.

Methodology: Gradiometer Survey

The main method of using the fluxgate gradiometer for commercial evaluations is referred to as ***detailed survey*** and requires the surveyor to walk at an even pace carrying the instrument within a grid system. A sample trigger automatically takes readings at predetermined points, typically at 0.25m intervals, on traverses 1m apart. These readings are stored in the memory of the instrument and are later dumped to computer for processing and interpretation.

During this survey a Bartington Grad601 magnetic gradiometer was used taking readings on the 0.1nT range, at 0.25m intervals on zig-zag traverses 0.5m apart within 30m by 30m square grids. The instrument was checked for electronic and mechanical drift at a common point and calibrated as necessary. The drift from zero was not logged.

The gradiometer data have been presented in this report in processed greyscale format. The data in the greyscale images have been interpolated and selectively filtered to remove the effects of drift in instrument calibration and other artificial data constructs and to maximise the clarity and interpretability of the archaeological anomalies.

Appendix 2: Survey location information

The data was geo-referenced with a Carlton VRS differential Global Positioning System (Carlton BRX 7). The accuracy of this equipment is better than 0.01m. The greyscale data as then super-imposed onto a base map 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 co-ordinates are measured off hard copies of the mapping rather than using the digital co-ordinates.

Archaeological Services WYAS cannot accept responsibility for errors of fact or opinion resulting from data supplied by a third party.

Appendix 3: Geophysical archive

The geophysical archive comprises:-

- an archive disk containing compressed (WinZip 8) files of the raw data, report text (Microsoft Word 2012), and graphics files (Adobe Illustrator CS6 and AutoCAD 2017) files; and
- a full copy of the report.

At present the archive is held by Archaeological Services WYAS although it is anticipated that it may eventually be lodged with the Archaeology Data Service (ADS). Brief details may also be forwarded for inclusion on the English Heritage Geophysical Survey Database after the contents of the report are deemed to be in the public domain (i.e. available for consultation in the West Yorkshire Historic Environment Record).

Appendix 4: Oasis form

Summary for archaeol11-504290

OASIS ID (UID)	archaeol11-504290
Project Name	Geophysical Survey at Paragon Phases 2b & 3
Activity type	Geophysical Survey, MAGNETOMETRY SURVEY
Project Identifier(s)	
Planning Id	
Reason For Investigation	Planning: Pre application
Organisation Responsible for work	Archaeological Services WYAS
Project Dates	06-Jan-2022 - 07-Jan-2022
Location	Paragon Phases 2b & 3 NGR : SE 32218 22858 LL : 53.7011684507105, -1.51347228445461 12 Fig : 432218,422858
Administrative Areas	Country : England County : West Yorkshire District : Wakefield Parish : Wakefield, unparished area
Project Methodology	The site grid was laid out using a Trimble VRS differential Global Positioning System (Trimble R6 model). The survey was undertaken using Bartington Grad601 magnetic gradiometers. These were employed taking readings at 0.25m intervals on zig-zag traverses 1.0m apart within 30m by 30m grids, so that 3600 readings were recorded in each grid. These readings were stored in the memory of the instrument and later downloaded to computer for processing and interpretation. Bespoke in-house software was used to process and present the data.
Project Results	A geophysical (magnetometer) survey was undertaken on approximately 8.5 hectares of land located to the north of Red Hall Lane, Wakefield, West Yorkshire. Anomalies of a possible archaeological origin have been detected in the form of a rectilinear enclosure along with the potential for a second. Former field boundaries have been detected along with possible ridge and furrow cultivation. Geological responses can be seen throughout and large areas of magnetic disturbance are thought to be associated with ground clearance and/or dumped ferrous material. Overall the archaeological potential of this Site is deemed to be high surrounding the enclosure and low elsewhere.
Keywords	Square Enclosure - UNCERTAIN - FISH Thesaurus of Monument Types
HER	West Yorkshire HER - unRev - STANDARD
HER Identifiers	
Archives	

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