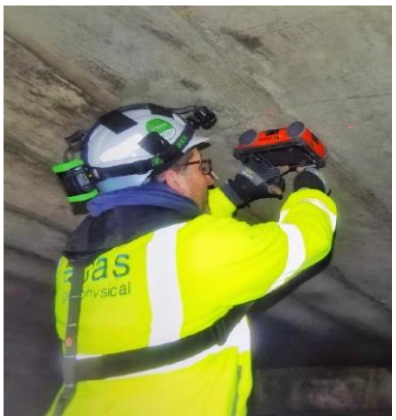

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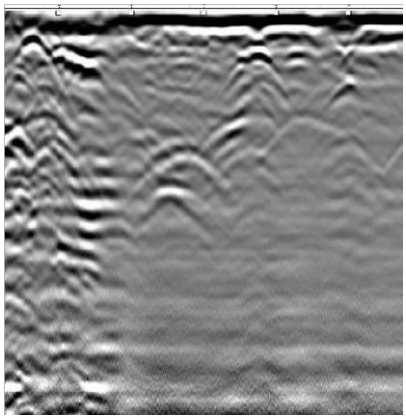

# Low Farm
# Geophysical Investigation


Revision 2.

This report documents a geophysical investigation of a 23.61 ha of land using a fluxgate gradiometer array.

The principal aim of the investigation was to assess the subsurface archaeological potential of the survey area.

Client: South West Archaeology Ltd

Project Number: AG1581

Date of issue: January 2022

# Contents

## 1. Distribution Sheet

**Low Farm**

**Geophysical Investigation**

**South West Archaeology Ltd**

| DISTRIBUTION | | | |
|---|---|---|---|
| Date: | Issued to | Name | Issue No: |
| January 2022 | South West Archaeology Ltd | Bryn Morris | 1 |
| January 2022 | South West Archaeology Ltd | Bryn Morris | 2 |
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## 2. Approval Sheet and Foreword

**Low Farm**
**Geophysical Investigation**
**South West Archaeology Ltd**

| | | |
|---|---|---|
| Report Status/Issue No: **Final/2** | | Date of Issue January 2022 |
| Issued to: South West Archaeology Ltd | | Project No: AG1581 |
| | Name: | Signature: |
| Author: | Stephen Twist MSc |  |
| Issued from AG Location: | Unit 12,<br>Swansea Valley Business Park,<br>Ystalyfera,<br>SA9 2EB | (t) 01639 874 104<br>(e) info@atlasgeo.co.uk<br>(w) atlasgeo.co.uk |

**FOREWORD**

1. This report has been prepared by Atlas Geophysical Limited with all reasonable skill, care, and diligence within the terms of the contract with the Client and the limitations of the resources devoted to it by agreement with the Client. It contains OS data © Crown copyright and database right (2021)
2. This report is confidential to South West Archaeology Ltd. Atlas Geophysical Limited accepts no responsibility whatsoever to third parties to whom this report or any part is made known. Any such party relies upon the report at their own risk.
3. This report shall not be used for engineering or contractual purposes unless signed above by the author and the approver unless the report status is 'Final'.

## 3. Executive Summary

3.1. A geophysical investigation using a fluxgate gradiometer was successfully completed across approximately 23.61 ha of fields in the vicinity of Low Farm, Grange Moor, Wakefield, Yorkshire.

3.2. The principal aim of the investigation was to assess the subsurface archaeological potential of the survey area.

3.3. Responses have been identified that suggest the presence of probable and possible archaeological features exist within in parcel 2, fields D and E.

3.4. It is the responsibility of the user of this information to follow Health & Safety guidelines (HSG47).

# 4. Introduction

4.1. A geophysical investigation using a fluxgate gradiometer was successfully completed across approximately 23.61 ha of field the vicinity of Low Farm, Grange Moor, Wakefield, Yorkshire.

4.2. The investigation area was split into nine parcels of land with each parcel containing one or more fields. The geophysical survey was only conducted in selected fields, see Table 1.

**Table 1 Field references and areas**

| Parcel | Field | Geophysical Survey | Area (ha) |
|---|---|---|---|
| 1 | A | No | n/a |
| 1 | B | No | n/a |
| 2 | C | No | n/a |
| 2 | D | Yes | 1.91 |
| 2 | E | Yes | 8.48 |
| 3 | F | No | n/a |
| 3 | G | No | n/a |
| 3 | H | Yes | 3.72 |
| 4 | I | Yes | 3.58 |
| 4 | J | Yes | 3.68 |
| 4 | K | No | n/a |
| 5 | L | No | n/a |
| 6 | M | No | n/a |
| 7 | N | Yes | 1.87 |
| 8 | O | No | n/a |
| 9 | P | Yes | 0.37 |

4.3. Data acquisition took place across several mobilisation between the 14th – 17th June and 20th - 24th November 2021.

4.4. The survey was undertaken at approximately 53:38:37.132N 1:37:54.715W (OSGB SE2443516411).

4.5. The principal aim of the investigation was to assess the subsurface archaeological potential of the survey area.

4.6. The proposed site is located to the north and south sides of the A642 Wakefield Road, north of the settlements of Flockton and Flockton Green. The proposed site comprises nine areas bounded on the northern side by woodland. The fields occupy sloping ground and vary between 125 m Above Ordnance Datum (AOD) and 190 m AOD across the proposal area.

4.7. Data were spatially referenced with RTK-GNSS with an accuracy of ±15 mm.

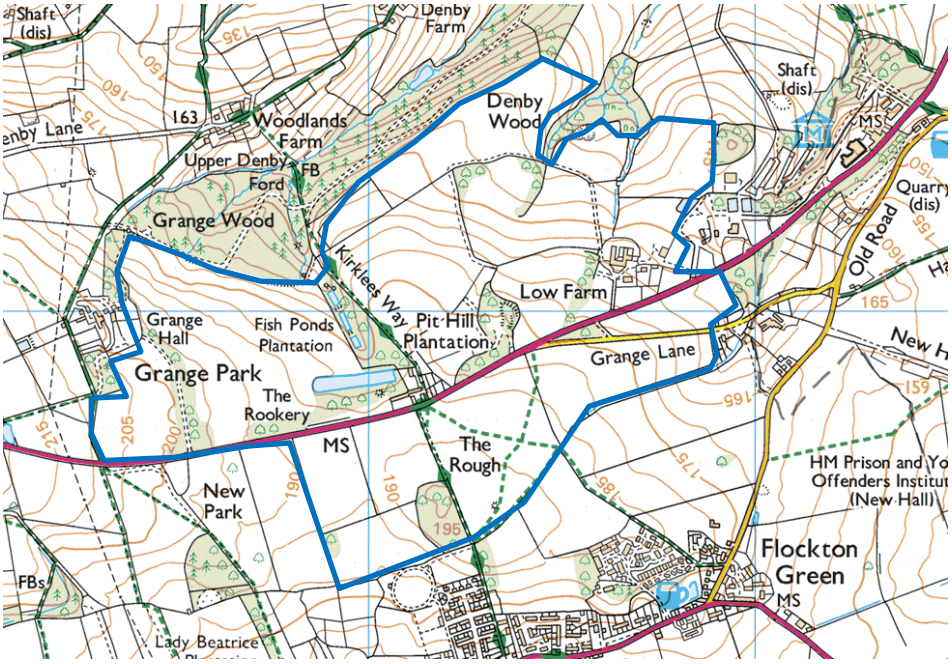


**Figure 1 Approximate Site Location**

## 5. Background Geology

5.1. Underlying the survey area the solid geology comprises mudstones, siltstones and sandstones of the Pennine Lower Coal Measures Formation and the Pennine Middle Coal Measures Formation; these meet the sandstones of the Birstall Rock Formation on the northern and south-western limits of the proposed development. This sedimentary rock formed approximately 318 to 319 million years ago in the Carboniferous Period.

5.2. No superficial deposits are recorded for the area [British Geological Survey, 2021].

5.3. The soils of the proposed area comprise the well-drained coarse loamy soils over sandstone of the Rivington 1 association and the slowly permeable seasonally waterlogged clayey, fine loamy over clayey and fine silty soils on soft rock of the Dale Association (SSEW 1983).

## 6. Background Archaeology

6.1. This section is a summary of information supplied by client in the form of a Heritage Impact Assessment produced by South West Archaeology Ltd [Balmond and Morris, 2021].

6.2. The proposed development area lies within the former Denby Grange Estate. Denby Grange was a grange of Byland Abbey and it is recorded that iron working was carried out until the 14th century. Following the dissolution of the monasteries, the land was purchased by Arthur Kaye in the 16th century. It is thought that a new mansion may have been built in the 19th century by Sir John Lister Kaye and the ornamental park and fishponds were established. Throughout much of the 19th and 20th centuries the area comprised a combination of parkland, woodland and plantation and agricultural fields Much of the surrounding area was exploited for coal or stone with numerous pits, open works, and quarries evident on historic mapping

6.3. Little archaeological work has been carried out in this area although an excavation in 2008 uncovered the remains of miners' cottages to the north of the proposed development.

# 7. Fluxgate Gradiometer Survey Methodology

7.1. For this geophysical investigation, the fluxgate gradiometer manufactured by Sensys (Germany) was used. Magnetometry is considered the most cost effective and suitable technique for the detection of previous anthropogenic activity in the UK.

7.2. A fluxgate gradiometer is a specific type of magnetometer that consists of one or more cores of magnetic alloy, around which are wound wire coils. Through the coils an alternating current is passed. The variations in the electrical properties of the circuits and the magnetisation of the cores are converted into voltages proportional to the external magnetic field along the vertical core axis.

7.3. The measurements acquired by the sensors are digitised and fed into a ruggedised field computer and saved for post processing and interpretation.

7.4. The sensors are mounted on a wheeled frame approximately 1 m apart. The frame can be hand pushed, see Figure 2 Sensys MXPDA, or towed behind an all-terrain vehicle (ATV), see Figure 3 Sensys MXV3.

7.5. The Sensys systems do not require a linear grid to be marked out before the survey. They acquire spatial information directly from an RTK-GNSS receiver mounted on the frame, with a positional accuracy of ±15 mm. This also provides navigational information for the operator to ensure optimal data coverage is achieved.

7.6. This method of data acquisition complies with requirements set out by current EAC Guidelines for the use of Geophysics in Archaeology (2016).

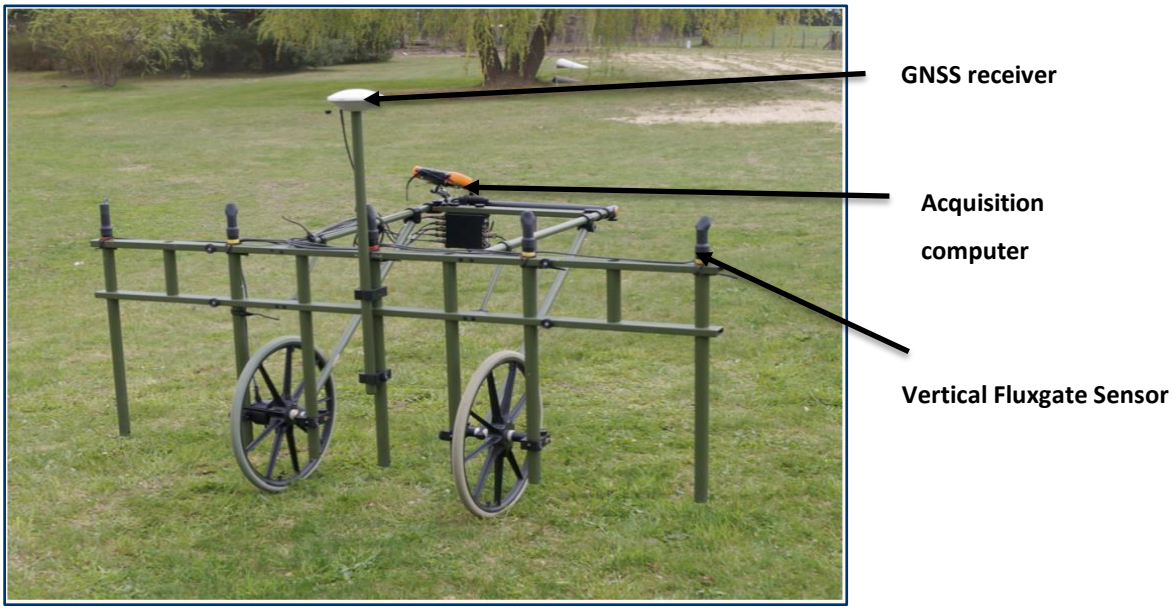


**Figure 2 Sensys MXPDA**

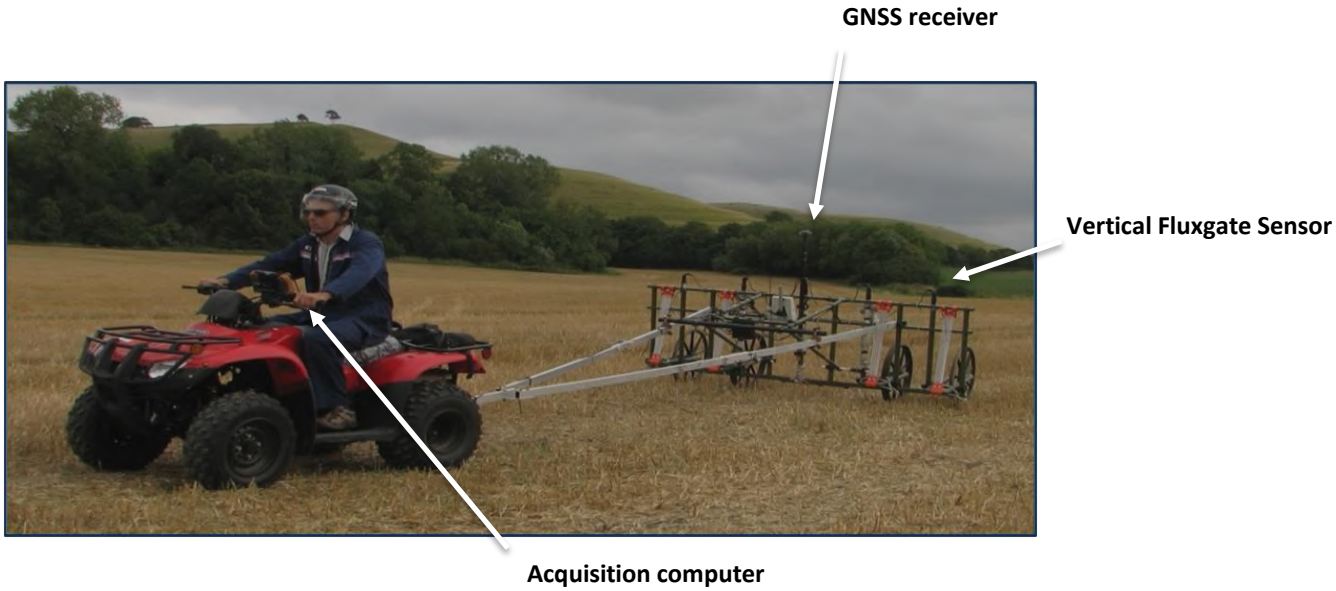


**Figure 3 Sensys MXV3**

## 8. Data Analysis

8.1. A small amount of post-acquisition processing is required to extract and visualise useful information from the acquired data.

8.2. Post-processing requires the deconvolution of the multi-element data and the georeferencing of each of the channels in relation to the direction of travel. Once this is achieved successfully, the data are gridded and presented in a graphic format, referred to as greyscales.

8.3. The georeferenced greyscales are exported into visualisation software for interpretation using a combination of maps and satellite imagery.

8.4. It should be noted that geophysical techniques are a measurement of material properties and detecting and mapping the desired targets requires a measurable contrast between the target and the surrounding ground material.

8.5. Interpretation of geophysical data should be carried out by qualified and experienced personnel but remains inherently subjective.

## 9. Results

9.1. Results from the investigation are summarised in the attached scaled drawings, appended to the rear of this report. Each drawing contains greyscale imagery and associated interpretation.

9.2. Even though much of the investigation area has been subjected to mineral exploration, using the open cast method, the acquired data are of good quality. It is possible to highlight anomalies and potential features within fields that have been remediated.

9.3. The clarity of the responses is difficult to explain and would be considered unusual given the amount of ground disturbance associated with open cast works and the subsequent remediation. Therefore, the responses are probably related to the open cast works and subsequent agricultural activity.

9.4. Responses have been identified that suggest the presence of probable and possible archaeological features within in parcel 2, fields D and E.

9.5. Distinctive anomalies characteristic of mineral extraction have been identified by the interpretation in all parcels, with the exception of parcel 9.

9.6. Variations that correspond to previous agricultural activity have been identified in all parcels. These may relate to former field boundaries, variations in ploughing orientations or land drainage features. In particular, the parallel responses in parcel 9 possibly relate to ridge and furrow.

9.7. A linear trend has been identified in parcel 9 that probably corresponds to the presence of a buried utility pipe or cable.

## 9.8. Interpretation

9.8.1. The interpretation of the acquired data has been carried out in reference to online imagery and historical maps.

9.8.2. Only the most distinct or notable anomalies are discussed individually.

9.8.3. Anomaly [2_Da] has been identified in the north-eastern corner of parcel 2, field D. This strong positive response has a rectilinear geometry that may be suggestive of a former building.

9.8.4. Anomalies [2_Ea] have been identified as a series of curvilinear, strong positive magnetic responses in parcel 2, field E. It is possible that this group of anomalies represent part of a larger system of boundary ditches, subsequently intersected by the more recent field boundary.

9.8.5. Anomalies [2_Eb] are subcircular positive magnetic responses within the boundary created by [2_Ea]. They are therefore presented as possible archaeology.

9.8.6. Anomalies [2_Ec] have been identified as a series of curvilinear, positive magnetic that surround [2_Ea]. Although this response is weaker, similarly to [2_Ea] it is possible that they represent a larger system of boundary ditches, subsequently intersected by the more recent field boundary.

9.8.7. Anomalies [2_Ed] are a much more linear, curvilinear positive magnetic response, that appear to lead to/from [2_Ea]. These responses are weaker in parts than [2_Ea] so have been presented as possible archaeology.

9.8.8. Anomaly [2_Ee] is a relatively weak curvilinear positive magnetic responses within boundary created by [2_Ea]. It has therefore presented as possible archaeology.

9.8.9. Anomalies [3a] have been identified as a group of elongated anomalies in the south-western and south-eastern corners of parcel 3, field H. It is possible that this anomaly represents mineral extraction, possibly associated with coal working known to have occurred in this area.

9.8.10. Anomaly [3b] is a relatively weak positive linear anomaly that has good co-location with data showing the southern boundary of Surface Mining (past and current) in this field.

9.8.11. Anomalies [4a] have been identified as a group of sub rectangular anomalies across most of parcel 4, field I. It is possible that they represent mineral extraction, associated with coal working known to have occurred in this area.

## 10. Conclusions

10.1. A geophysical investigation using a fluxgate gradiometer was successfully completed across approximately 23.61 ha.

10.2. Responses have been identified that suggest the presence of probable and possible archaeological features exist within in parcel 2, fields D and E.

## 11. Archiving

11.1. Atlas Geophysical maintains an in-house, offline, secure digital archive.

11.2. This archive stores the project documentation, geophysical data from the raw and minimally processed data stages, project notes, georeferenced images, XY traces and a copy of the final report.

11.3. When appropriately guided by the client a data deposit may be made with an Archiving Body.

## 12. Copyright

12.1. Atlas Geophysical retains all copyright and intellectual property for all data, reports, and figures. The client is given full licence to use such material but any third party requiring use of any material requires prior express permission of Atlas Geophysical.

## 13. References

Balmond, F. Morris, B. 2021., Results of a Heritage Impact Assessment, South West Archaeology.

British Geological Survey, 2021. Geology of Britain. [Grange Moor, Yorkshire] [http://mapapps.bgs.ac.uk/geologyofbritain/home.html/]. [Accessed 04/01/2022].

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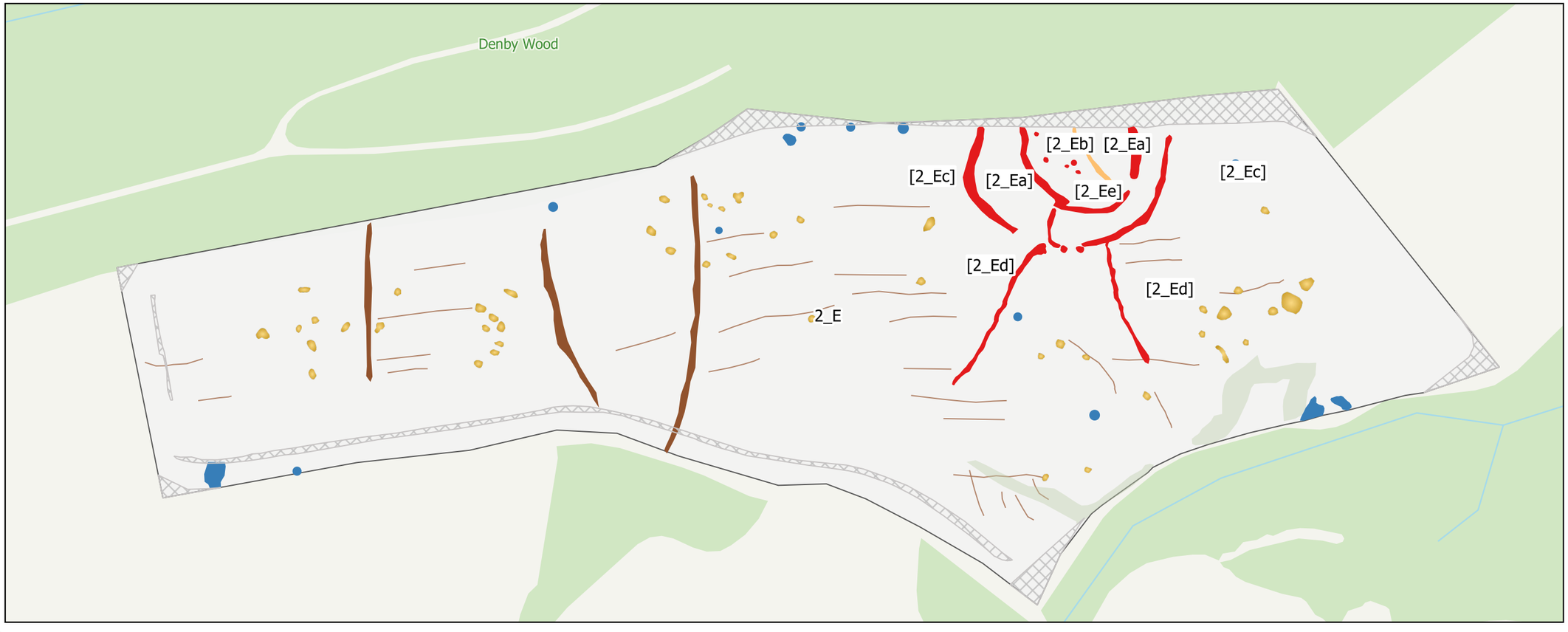
Schmidt, A., Linford, P., Linford, N., David, A., Gaffney, C., Sarris, A. and Fassbinder, J., 2015. Guidelines for the use of geophysics in archaeology: questions to ask and points to consider. EAC Guidelines 2. European Archaeological Council: Belgium.

Soilscapes, 2021. [Grange Moor, Yorkshire]. Cranfield University, National Soil Resources Institute [http://landis.org.uk]. [Accessed 04/01/2022].

The Coal Authority, 2020. Interactive Viewer [Grange Moor, Yorkshire] [https://mapapps2.bgs.ac.uk/coalauthority/home.html]. [Accessed 04/01/2022].

## 14. Figures


## General Notes & Key

For this geophysical investigation, the fluxgate gradiometer array manufactured by Sensys (Germany) was used.
The sensors were mounted on a wheeled frame approximately 0.25 - 1.0 m apart with positional data provided by an RTK GNSS.

A small amount of post-acquisition processing is required to extract and visualise useful information from the acquired data. Once this is achieved successfully, the data are gridded and presented in this greyscales format.

Geophysical techniques are a measurement of material properties. Detecting and mapping the desired targets requires a measurable contrast between the target and the surrounding ground material. Interpretation of geophysical data should be carried out by qualified and experienced personnel but remains inherently subjective.

- Probable Aracheaology
- Possible Archaeology
- Natural
- Agricultural (Strong)
- Ferrous Point
- Extraction
- Unable to Survey
- Agricultural (Weak)

-5 nT 5 nT

0 20 40 60 m

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AG1581 Low Farm, Flockton Green Yorkshire

**Client:**
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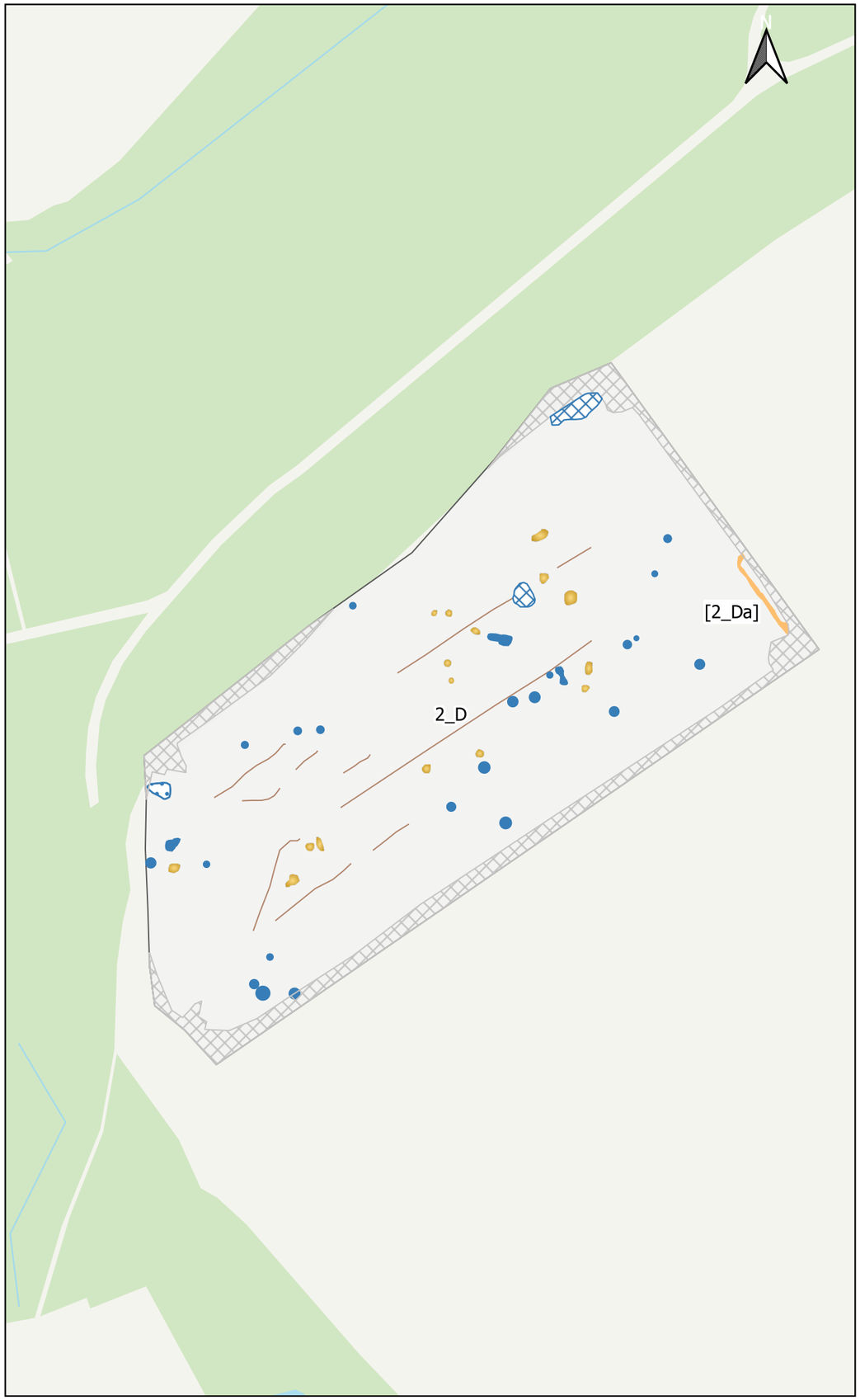


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- Possible Archaeology
- Ferrous Point
- Ferrous Spread
- Magnetic Interference
- Extraction
- Unable to Survey
- Agricultural (Weak)

-5 nT 5 nT

0 10 20 30 m

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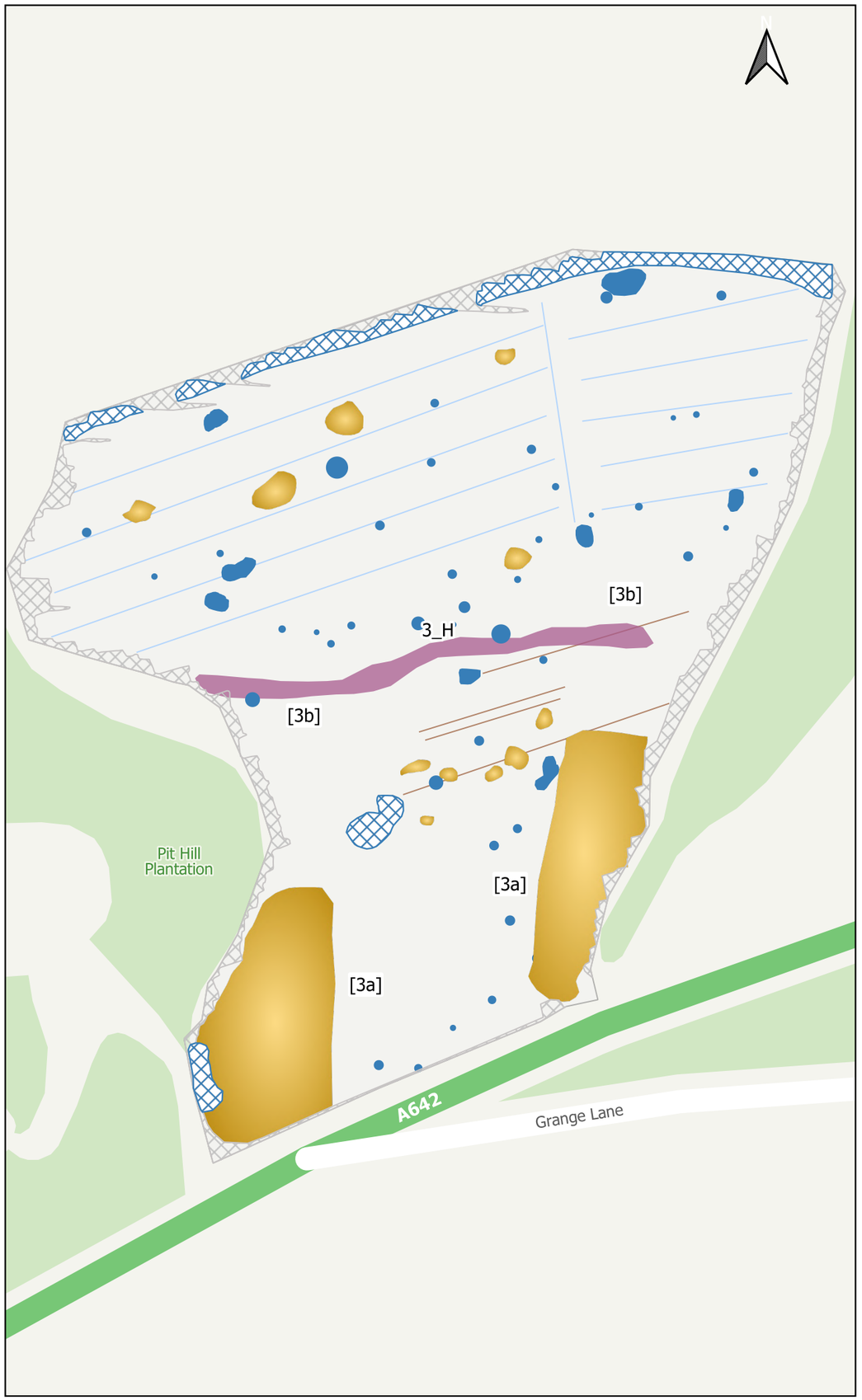


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- Modern
- Ferrous Point
- Magnetic Interference
- Extraction
- Unable to Survey
- Agricultural (Weak)
- Possible land drain

-5 nT 5 nT

0 10 20 30 m

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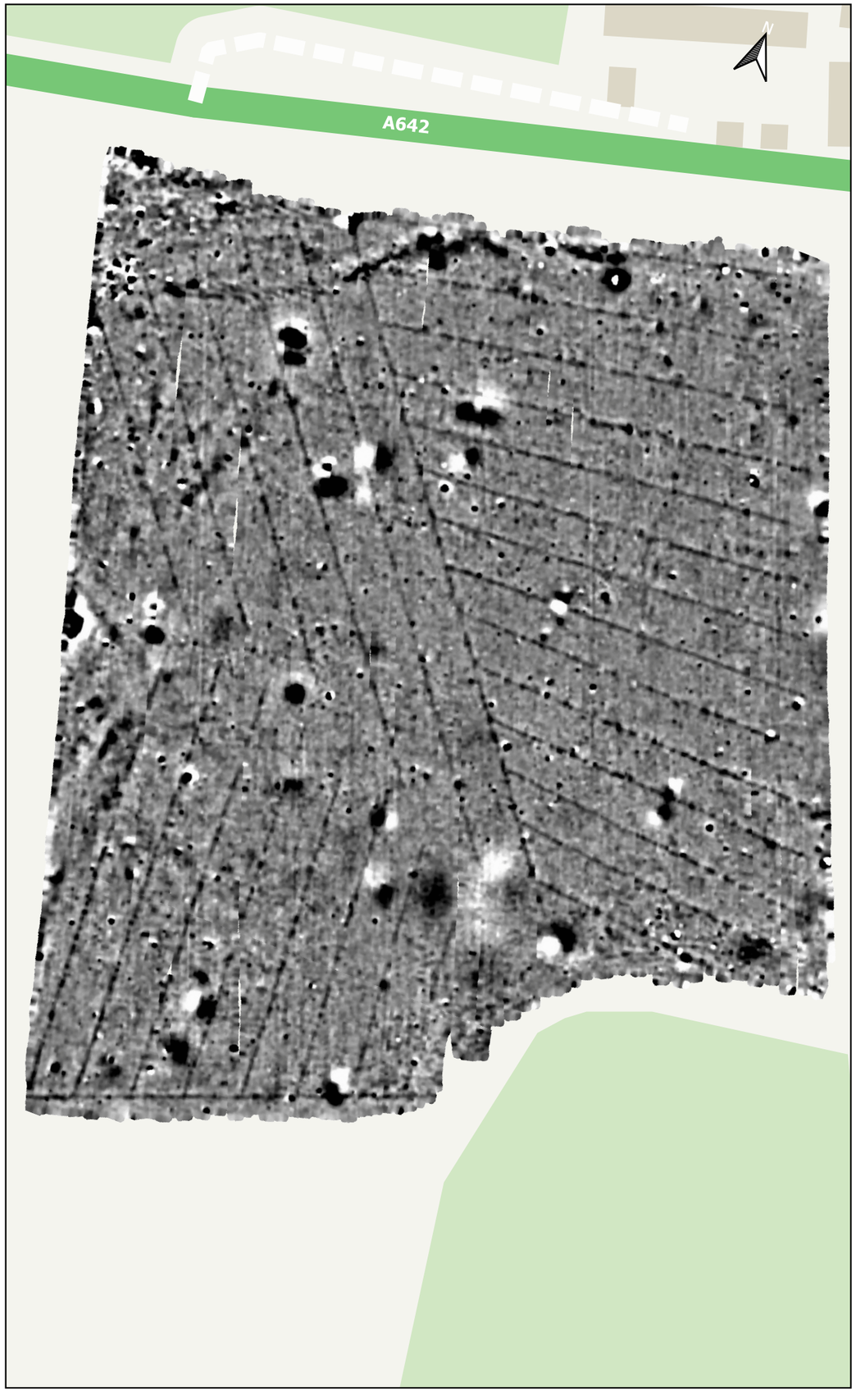


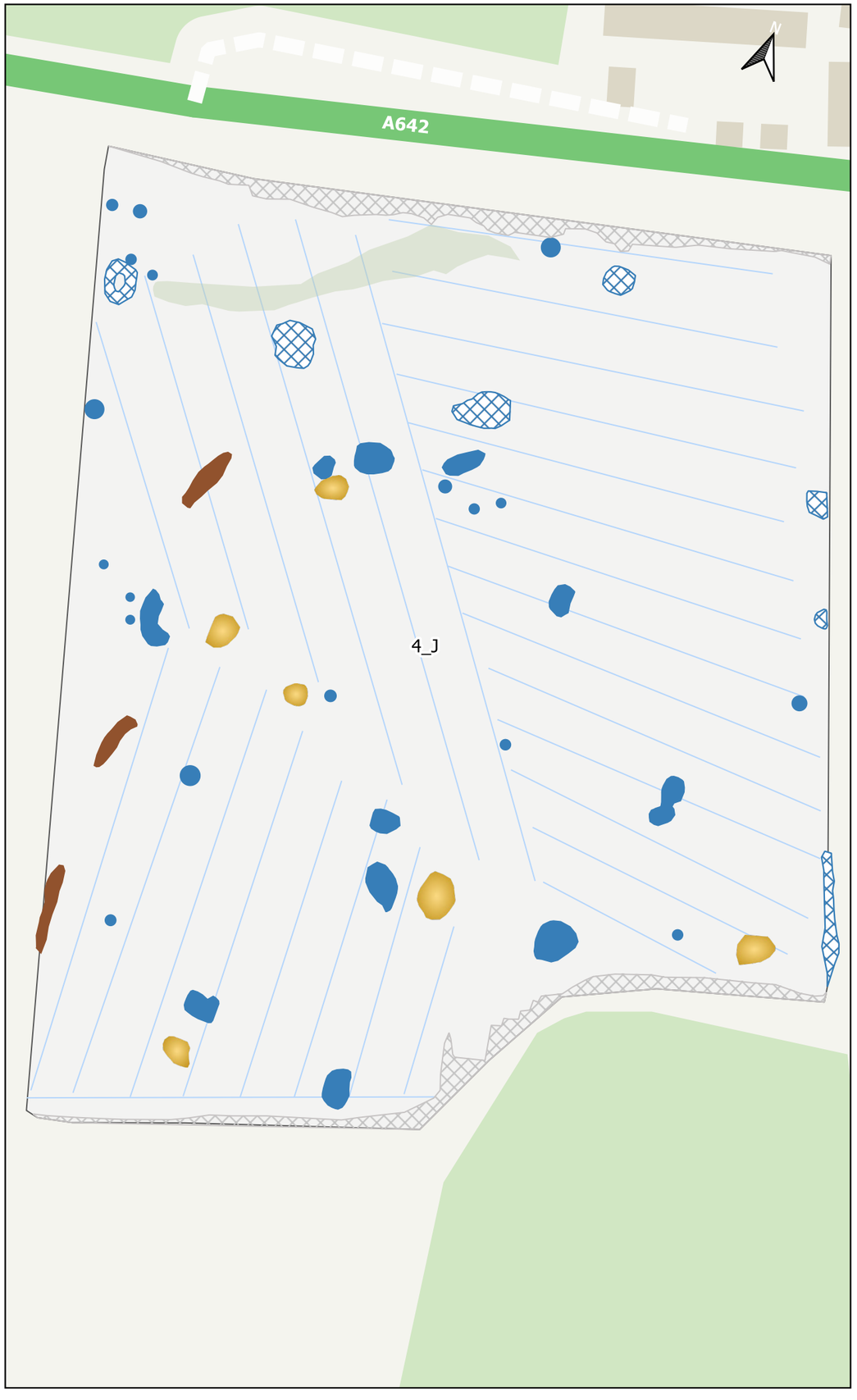


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- Natural
- Agricultural (Strong)
- Ferrous Point
- Magnetic Interference
- Extraction
- Unable to Survey
- Possible land drain

-10 nT — 10 nT

0 10 20 30 m

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| Project: AG1581 | Sheet: Field 4_J AG1581 |
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- Natural
- Agricultural (Strong)
- Agricultural (Weak)
- Ferrous Point
- Ferrous Spread
- Magnetic Interference
- Extraction
- Unable to Survey
- Agricultural (Strong)
- Agricultural (Weak)

-5 nT 5 nT

0 10 20 30 m

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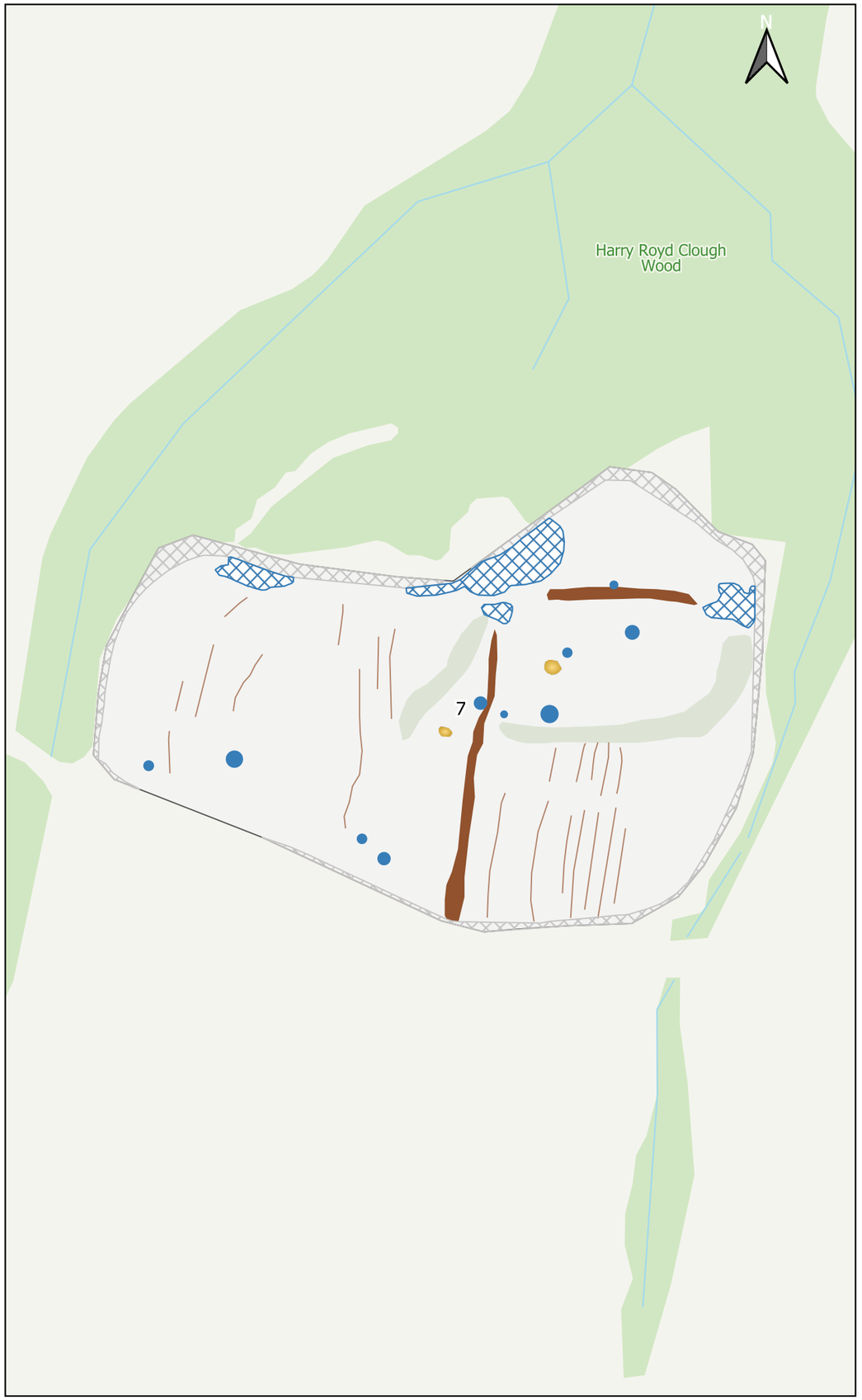


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- Natural
- Agricultural (Strong)
- Ferrous Point
- Magnetic Interference
- Extraction
- Unable to Survey
- Agricultural (Weak)

-5 nT — 5 nT

0 10 20 30 m

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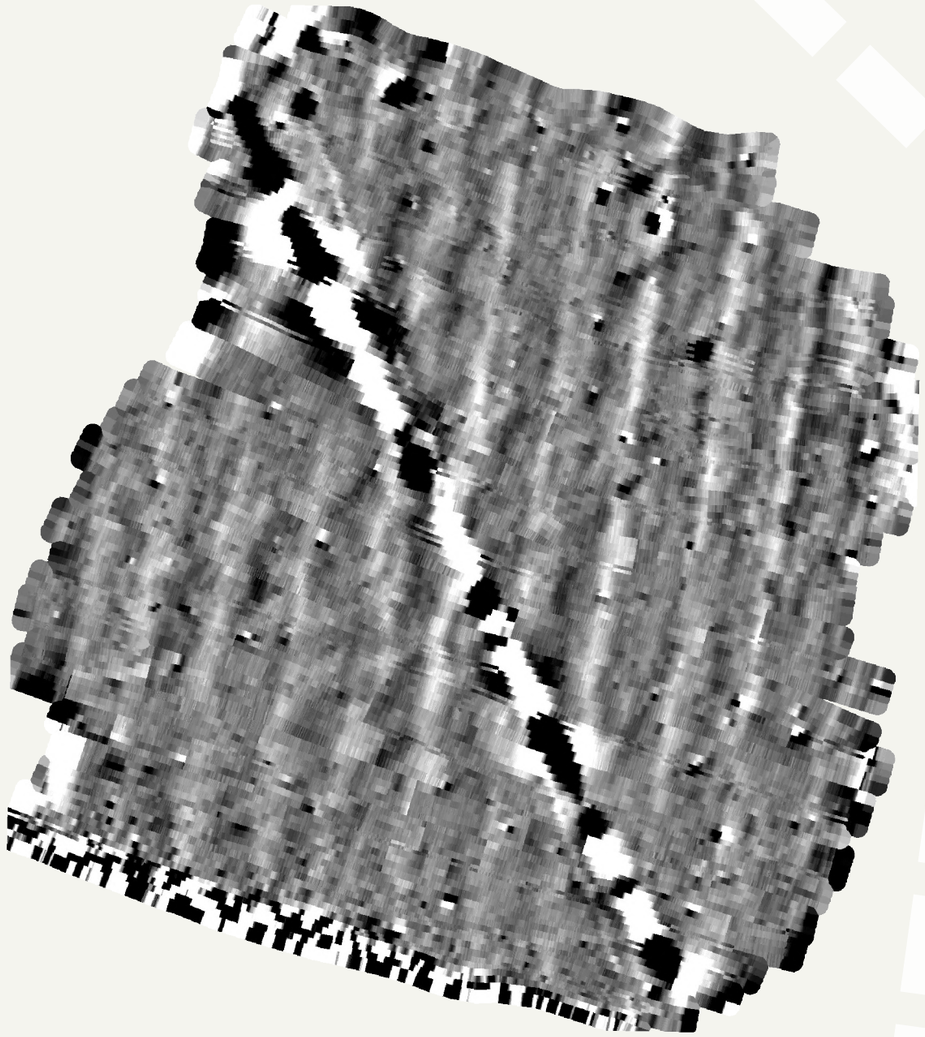

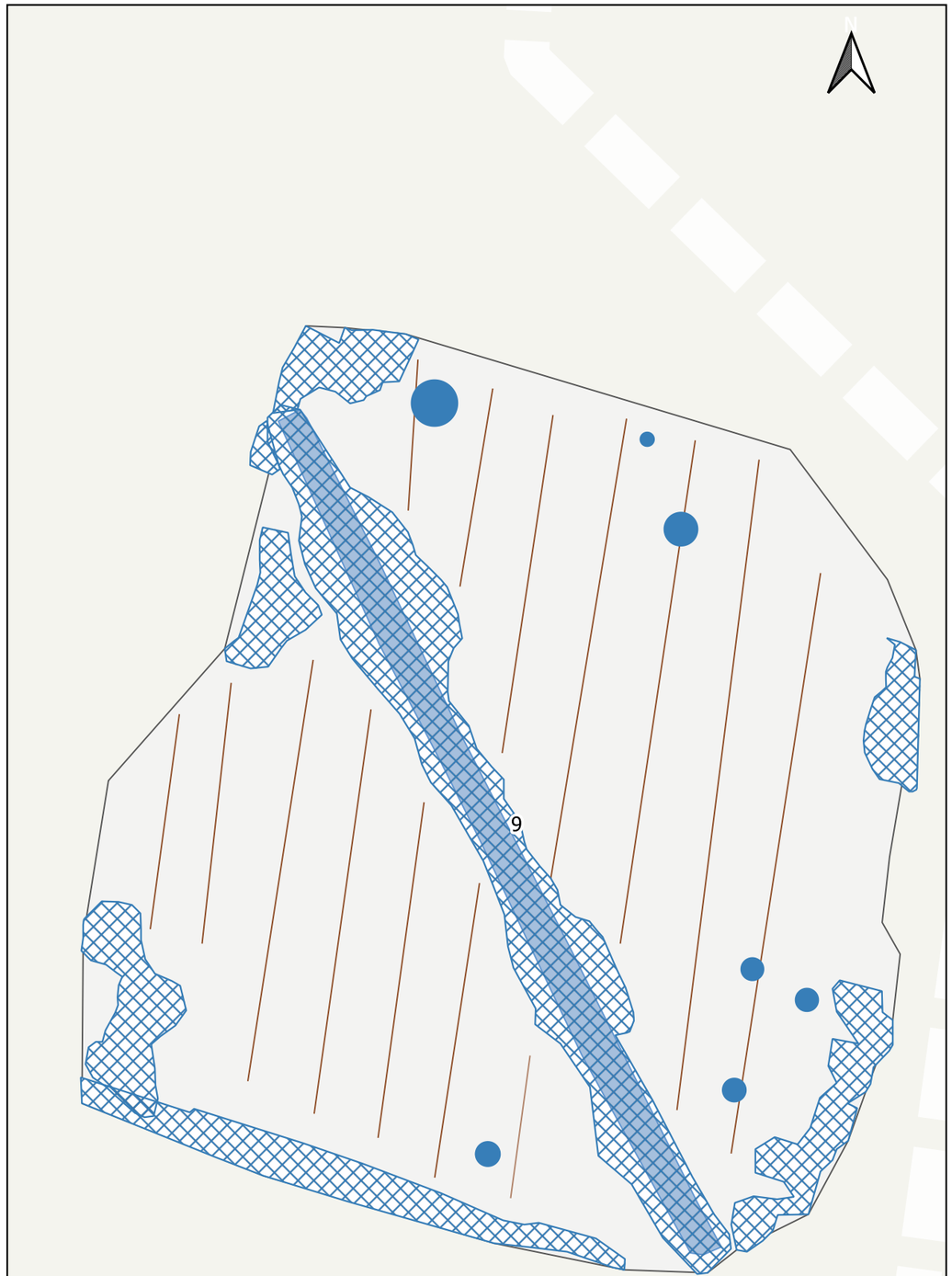


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- Ferrous Point
- Magnetic Interference
- Possible Buried Utility
- Agricultural (Strong)
- Agricultural (Weak)

-10 nT — 10 nT

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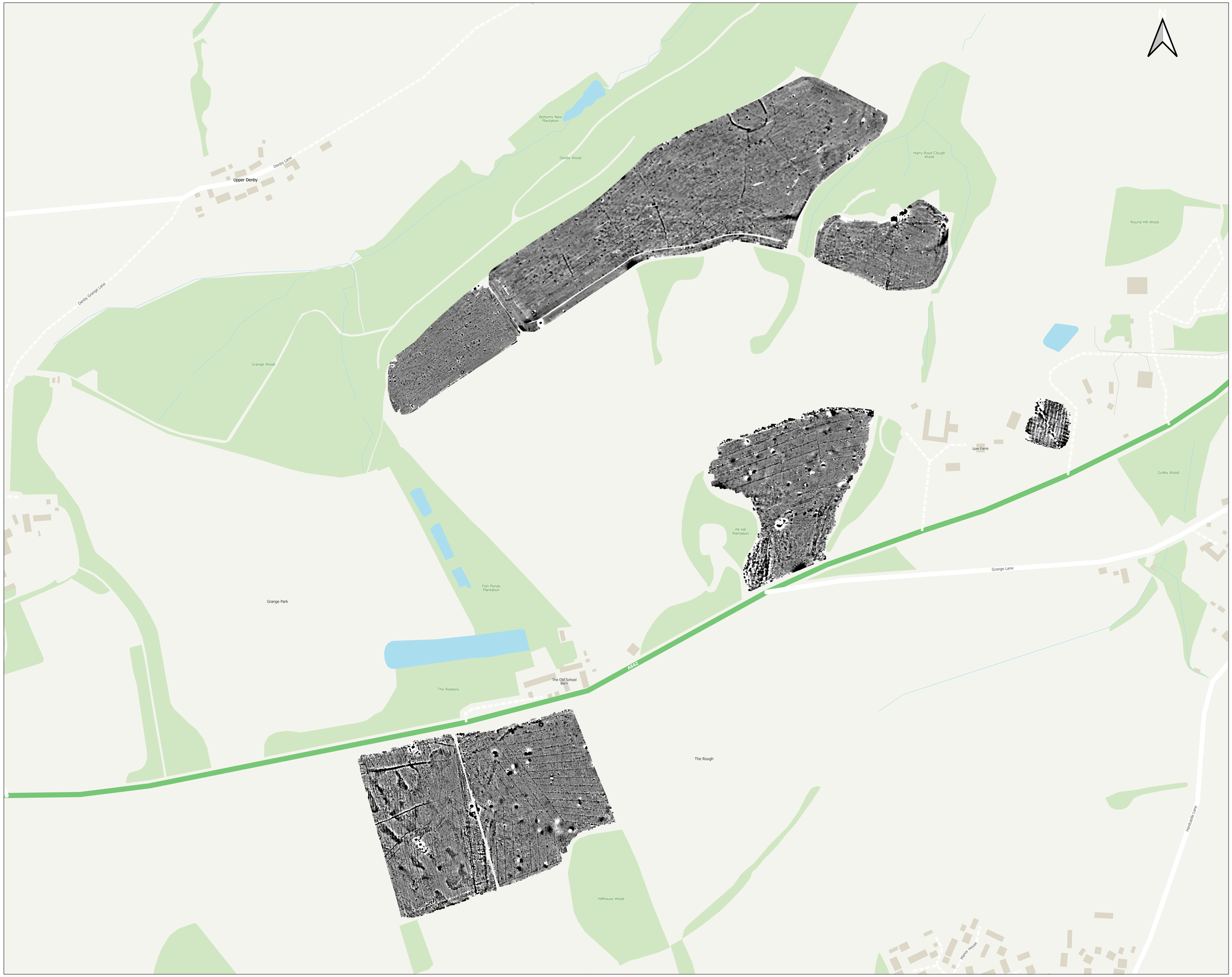


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Geophysical techniques are a measurement of material properties. Detecting and mapping the desired targets requires a measurable contrast between the target and the surrounding ground material. Interpretation of geophysical data should be carried out by qualified and experienced personnel but remains inherently subjective.

-5 nT 5 nT

0 50 100 150 m

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01639 874 104

info@atlasgeo.co.uk
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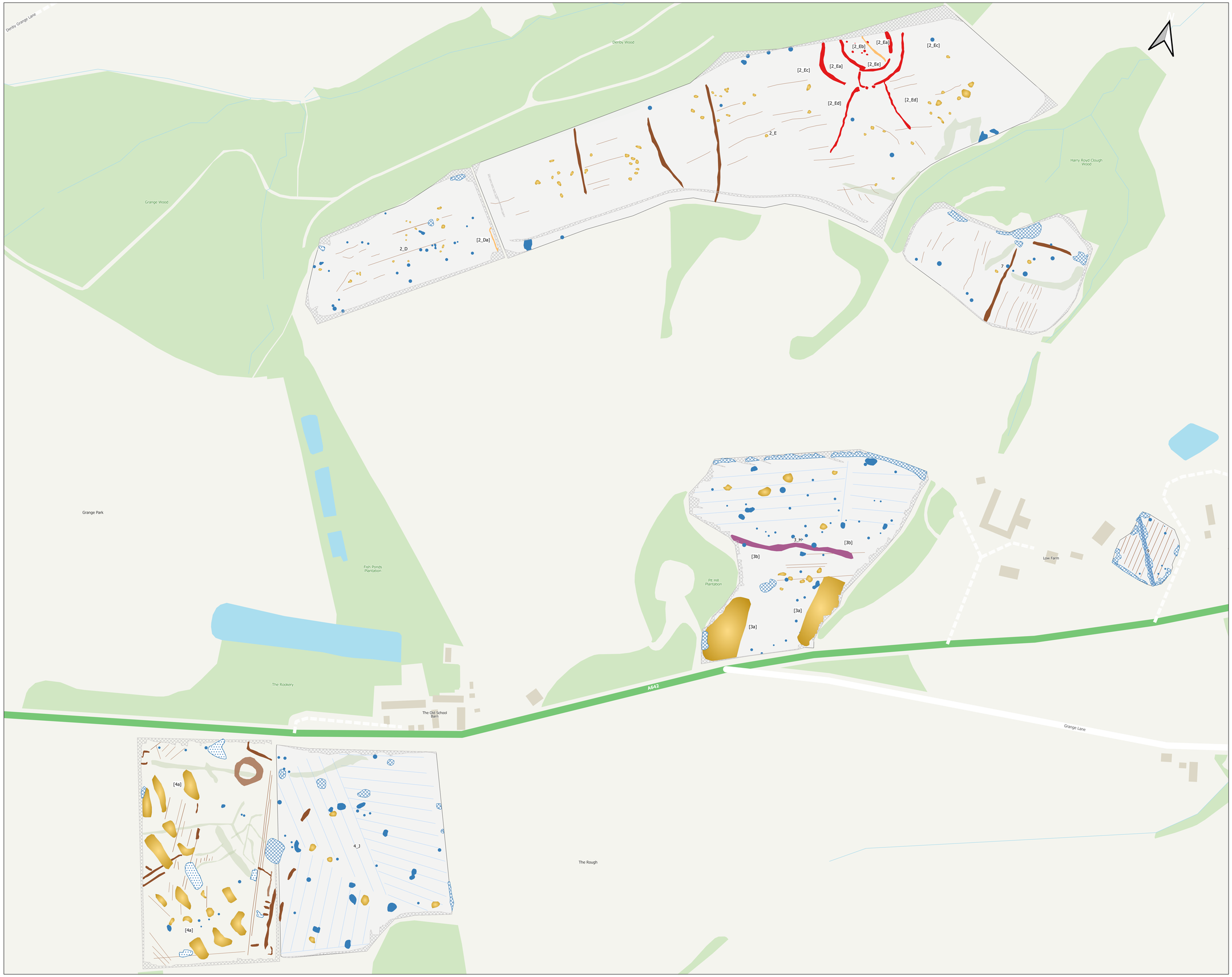
Project:

AG1581 Low Farm, Flockton Green, Yorkshire

Client:

South West Archaeology Ltd

| | |
|---|---|
| Project: AG1581 | Sheet: Overview - Gradiometer data AG1581 |
| Date: January 2022 | |
| Scale: 1 : 3000 @A0 | |




## General Notes & Key

For this geophysical investigation, the fluxgate gradiometer array manufactured by Sensys (Germany) was used.
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- Probable Aracheaology
- Possible Archaeology
- Natural
- Agricultural (Strong)
- Agricultural (Weak)
- Modern
- Ferrous Point
- Ferrous Spread
- Magnetic Interference
- Possible Buried Utility
- Extraction
- Unable to Survey
- Agricultural (Strong)
- Agricultural (Weak)
- Possible land drain

0 25 50 75 m

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Project:

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Client:

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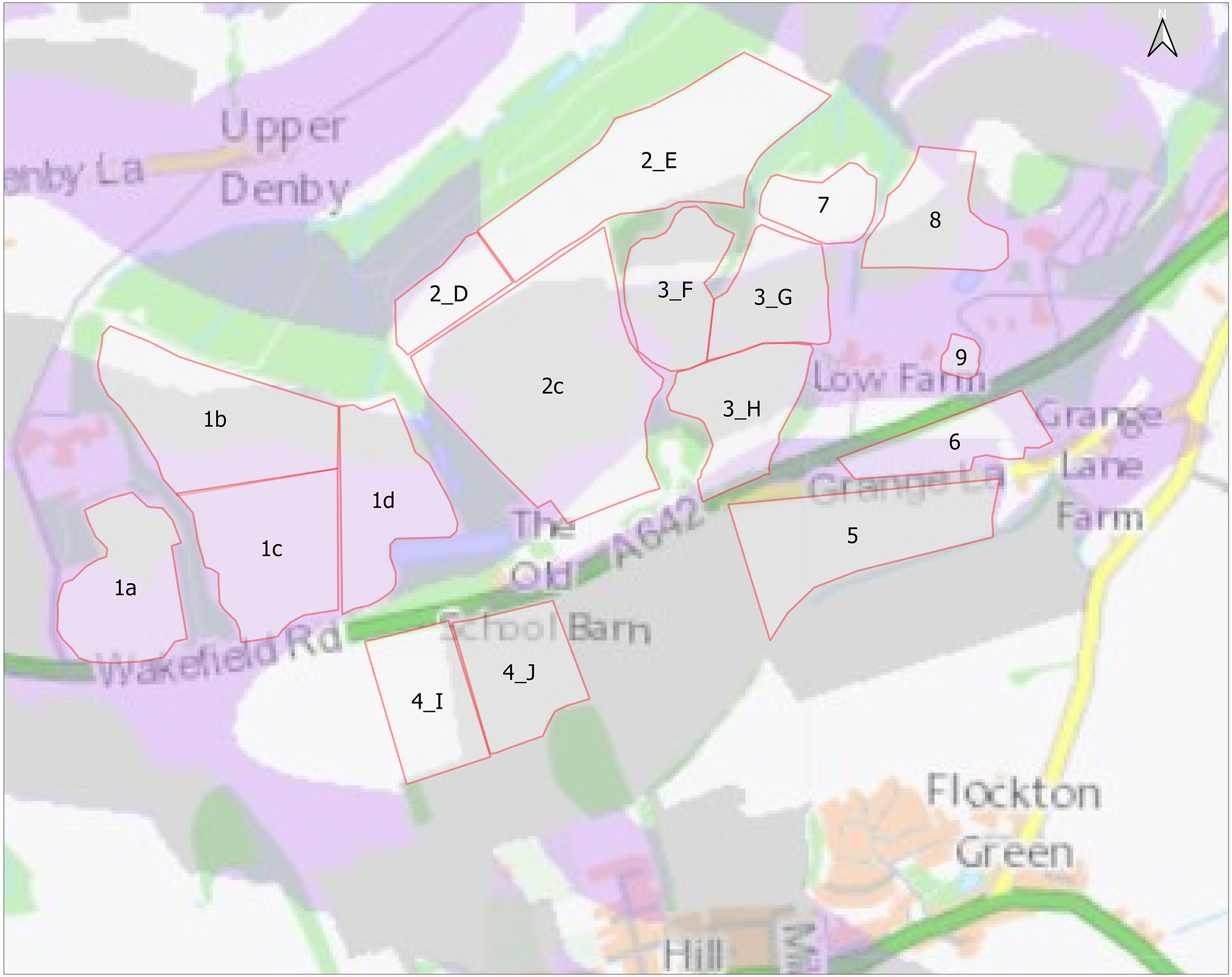
|---|---|
| Project: AG1581 | Sheet: Overview - Interpretation AG1581 |
| Date: January 2022 | |
| Scale: 1 : 2250 @A0 | |

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Field Boundary

Surface Mining (Past and Current)

Probable shallow coal mine workings

0 50 100 150 m

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Project:

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Client:

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| | |
|---|---|
| Project: AG1581 | Sheet: Overview - Coal mining activity AG1581 |
| Date: January 2022 | |
| Scale: 1 : 3500 @A0 | |