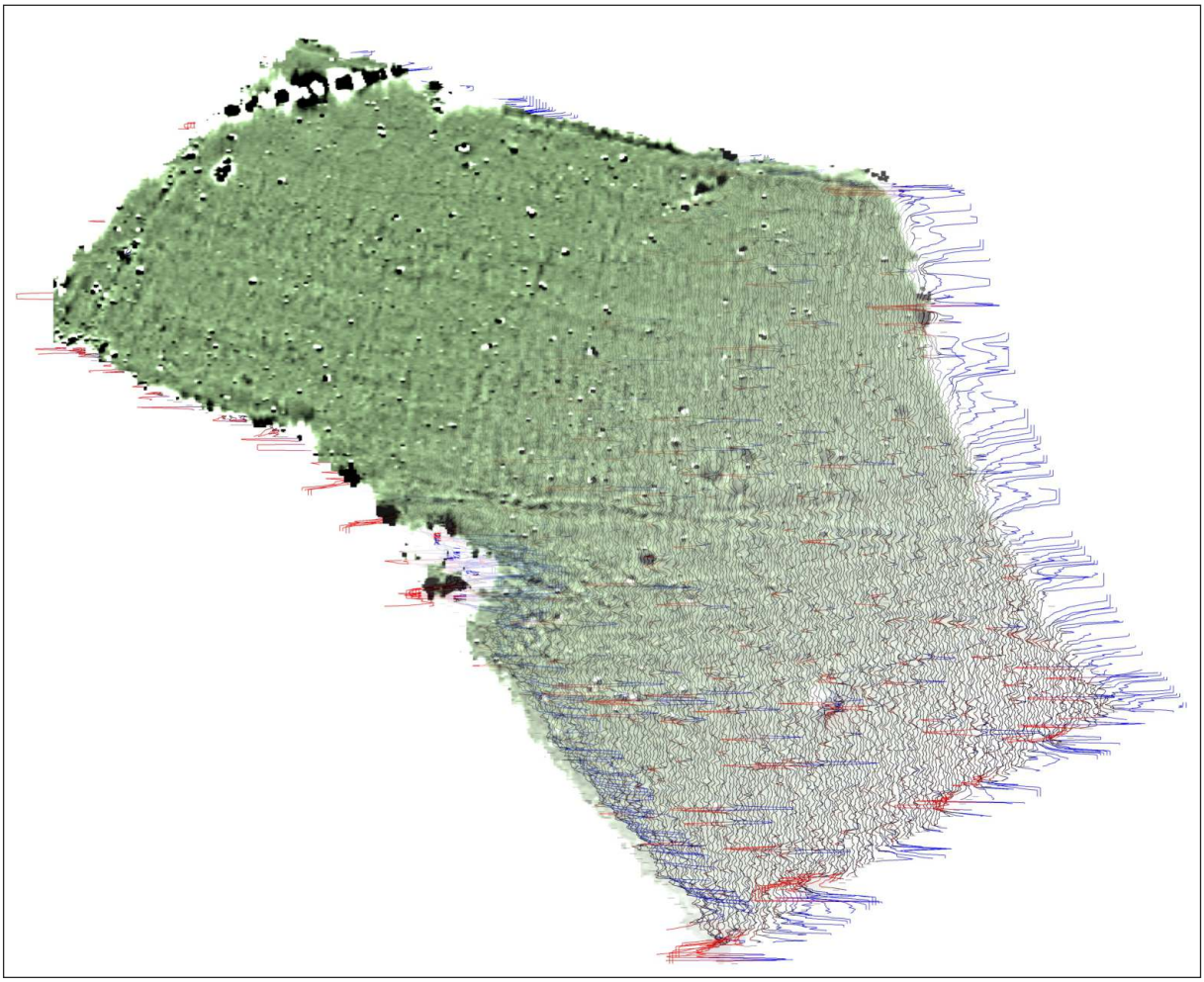
making sense of heritage

Tower Hill Solar Farm
Tytherington, South Gloucestershire

Detailed Gradiometer Survey Report



Ref: 104580.02
July 2014

geoservices

Tower Hill Solar Farm, Tytherington, South Gloucestershire

Detailed Gradiometer Survey Report

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June 2014

Report Ref.104580.02

Quality Assurance

Project Code	104580	**Accession Code**		**Client Ref.**	104580.02
Planning Application Ref.		**Ordnance Survey (OS) national grid reference (NGR)**	367051, 189157		

Version	Status*	Prepared by	Checked and Approved By	Approver's Signature	Date
v01	I	*JS/RDL*	*C Budd*		10/07/2014
File:	X:\PROJECTS\104580\Geophysics\Report				
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* I = Internal Draft; E = External Draft; F = Final

Tower Hill Solar Farm, Tytherington, South Gloucestershire

Detailed Gradiometer Survey Report

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Detailed Gradiometer Survey Report

Summary

A detailed gradiometer survey was conducted over land on Tower Hill Farm, near Tytherington, South Gloucestershire. The project was commissioned by AEE Renewables Plc. with the aim of establishing the presence, or otherwise, and nature of detectable archaeological features on the site ahead of a proposed development.

The site comprises of six pasture fields directly north and west off New Road and Cuttsheath Road, some 1.0 km to the north of the centre of Tytherington and 2.4 km south-east of Thornbury. The Site straddles a small valley towards the north of the Site, with the field boundary separating fields 3, 4 and 6 running along the centre of the valley which is orientated east-west. The height of the land descends from over 100m above the Ordnance datum (aOD) in the north to c. 85m aOD to the south at the base of the small valley. The fields to the south of the Site (fields 1,2,3 and 4) are relatively flat at a height of c.95m aOD. The gradiometer survey covered 24.1ha and has demonstrated the presence of anomalies of probable and possible archaeological interest within the survey area, along with regions of magnetic disturbance and ferrous response.

A low concentration of archaeological features were identified across the site with several isolated pits, ditch sections and possible quarry pits accounting for the majority of the potential archaeological features. In addition to these archaeological features numerous agricultural features were detected including drains, ploughing scars and former field boundaries.

A modern service was identified in the survey area near to the western boundary of the Site; it appears to be a ferrous pipe. It is considered likely to be a water service for a trough.

Extensive magnetic disturbance associated with agricultural processes and numerous small-scale ferrous responses were seen throughout the dataset, particularly around the field boundaries.

The geophysical survey was undertaken on 16th to 24th June 2014.

Tower Hill Solar Farm, Tytherington, South Gloucestershire

Detailed Gradiometer Survey Report

Acknowledgements

The detailed gradiometer survey was commissioned by AEE Renewables Plc. and Wessex Archaeology is grateful to Roland Billington and Adam Banting in this regard.

The fieldwork was directed by Laura Andrews, Jen Smith and Alistair Salisbury. Jen Smith processed the geophysical data. Jen Smith and Ross Lefort interpreted the geophysical data in addition to writing this report. The geophysical work was quality controlled by Ross Lefort. Illustrations were prepared by Ross Lefort and Ken Lymer. The project was managed on behalf of Wessex Archaeology by Caroline Budd.

Tower Hill Solar Farm, Tytherington, South Gloucestershire

Detailed Gradiometer Survey Report

1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology was commissioned by AEE Renewables Plc to carry out a geophysical survey for land at Tower Hill Farm , Tytherington, South Gloucestershire (**Figure 1**), hereafter "the Site" (centred on NGR 367051, 189157). The survey forms part of an ongoing programme of archaeological works being undertaken ahead of proposed development at the Site.

1.1.2 The aim of the geophysical survey was to establish the presence/absence, extent and character of detectable archaeological remains within the survey area.

1.1.3 An archaeological Desk-Based Assessment (DBA) was carried out by Wessex Archaeology (2014) and will be referred to in relation to the interpretation of certain geophysical anomalies.

1.1.4 This report presents a brief description of the methodology followed, the detailed survey results and the archaeological interpretation of the geophysical data.

1.2 The Site

1.2.1 The survey area comprises of six pasture fields directly north and west off New Road and Cuttsheath Road, some 1.0 km to the north of the centre of Tytherington, 2.4 km south-east of Thornbury and 7.0 km north-west of Yate (**Figure 1**). Detailed gradiometer survey was undertaken over all accessible parts of the Site, a total of 24.1 ha.

1.2.2 The Site straddles a small valley towards the north of the Site, with the field boundary separating fields 3, 4 and 6 running along the centre of the valley which is orientated east-west. The height of the land descends from over 100m above the Ordnance datum (aOD) in the north to c. 85m aOD to the south at the base of the small valley. The fields at the south to the Site (fields 1,2,3 and 4) are relatively flat at a height of c.95m aOD. The survey extent is defined by the M5 to the north-west, New Road and Cuttsheath Road to the north-east, east and south, Tytherington Rocks F.C Playing Fields to the south-west and Woodlands road to the west.

1.3 Soils and Geology

1.3.1 The soils underlying the Site are likely to be brown rankers of the 313c (Crwbin) association (SSEW 1983). Soils derived from such geological parent material have been shown to produce magnetic contrasts acceptable for the detection of archaeological remains through magnetometer survey.

1.3.2 The underlying geology is depicted as a succession of roughly east-west bands with the Tintern Sandstone Formation in the north-eastern part of the Site succeeded by the Avon Group (Limestone), the Avon group (Mudstone and Limestone), the Black Rock Limestone Subgroup (Limestone) and the Black Rock subgroup (Dolostone) as you move southwards (British Geological Survey). At the southern corner of the Site a small spur of the Mercia Mudstone Group is shown extending into the Site area.

2 METHODOLOGY

2.1 Introduction

2.1.1 The detailed magnetometer survey was conducted using a Bartington Grad601-2 dual fluxgate gradiometer system. The survey was conducted in accordance with English Heritage guidelines (2008).

2.1.2 The geophysical survey was undertaken by Wessex Archaeology's in-house geophysics team on 16th to 24th June 2014. Field conditions at the time of the survey were mostly good.

2.2 Method

2.2.1 Individual survey grid nodes were established at 30m x 30m intervals using a Leica Viva RTK GNSS instrument, which is precise to approximately 0.02m and therefore exceeds English Heritage recommendations (2008).

2.2.2 The magnetometer survey was conducted using a Bartington Grad601-2 fluxgate gradiometer instrument, which has a vertical separation of 1m between sensors. Data were collected at 0.25m intervals along transects spaced 1m apart with an effective sensitivity of 0.03nT, in accordance with EH guidelines (2008). Data were collected in the zigzag method.

2.2.3 Data from the survey was subject to minimal data correction processes. These comprise a zero mean traverse function (±5nT thresholds) applied to correct for any variation between the two Bartington sensors used, and a de-step function to account for variations in traverse position due to varying ground cover and topography. These two steps were applied to all survey areas, with no interpolation applied.

2.2.4 Further details of the geophysical and survey equipment, methods and processing are described in **Appendix 1**.

3 GEOPHYSICAL SURVEY RESULTS AND INTERPRETATION

3.1 Introduction

3.1.1 The gradiometer survey has been successful in identifying several anomalies of probable and possible archaeological interest within the Site, along with areas of magnetic disturbance and ferrous responses. Results are presented as a series of greyscale and XY plots, and archaeological interpretations, at a scale of 1:1250 (**Figures 2** and **3**). The data is displayed at -2nT (white) to +3nT (black) for the greyscale image and ±25nT at 50nT per cm for the XY trace plots.

3.1.2 The interpretation of the datasets highlights the presence of potential archaeological anomalies, ferrous/burnt or fired objects, and magnetic trends (**Figure 4**). Full definitions of the interpretation terms used in this report are provided in **Appendix 2**.

3.1.3 Numerous ferrous anomalies are visible throughout the detailed survey dataset. These are presumed to be modern in provenance and are not referred to, unless considered relevant to the archaeological interpretation.

3.2 Gradiometer Survey Results and Interpretation

3.2.1 There are few archaeological anomalies of interest in field 1 with the majority of anomalies relating to recent agricultural activity. There are two positive pit-like anomalies around **4000** that measure 2.5m and 4m in length and both have magnetic values over +3nT. These features are considered to represent pits and are classed as probable archaeology.

3.2.2 There is an L-shaped arrangement of ditches around **4001**; it is not clear whether they represent some form of field drain or represent the fragmentary remains of an earlier field system. No correlation can be found between these ditches and features observed in the historic maps consulted in the DBA. These ditches have been interpreted as possible archaeology to reflect the uncertainty as to their date form and function.

3.2.3 There is a slightly higher concentration of potential archaeological features in field 2 with clear ditches observed at **4002** to **4004** that are classed as probable archaeology. These ditches have magnetic values around +2.5nT and some may constitute former field boundaries; none can be correlated with any map features. There are some weaker ditches (around +1.5nT such as at **4005** but the function of these is less clear; as a result they have been interpreted as possible archaeology. There are some small positive anomalies such as the sub-oval anomaly at **4006** that may possibly represent a pit.

3.2.4 A former field boundary is visible at **4007** that correlates with a field boundary marked on the 1839 Tytherington tithe map. A broad diffuse band of positive responses runs along the northern end of this boundary at **4008** although this band is considered to be geological.

3.2.5 Field 3 contains a ditch at **4009** that appears to divide part of this field. It starts and finishes within the field and looks to be agricultural although no correlation can be found with any observed map feature. There is a large sub-oval anomaly further north at **4010**; this features is defined by a mix of positive and negative responses and measures around 27m in length. This feature looks similar to the kind of response expected from a quarry pit or a geological hollow. As it is not possible to determine which is the case this feature has been classed as possible archaeology.

3.2.6 A former field boundary is visible at **4011** that correlates with a boundary marked on the 1839 tithe map. The broad diffuse band of geological responses observed in field 2 continues right across field 4 to this field at **4012**. This band corresponds closely to the position of a geological horizon recorded on BGS mapping between black rock limestone to the south and Avon group limestone and mudstone to the north. The reason why this horizon should produce a magnetic anomaly is unclear.

3.2.7 The most noticeable anomalies in field 4 are three regular sub-rectangular negative anomalies at **4013** to **4015**; all three have magnetic values around -1.5nT and run in a line parallel to the nearby field boundary. The form and function of these features are unclear but have been classed as probable archaeology due to their regularity.

3.2.8 There are two pit-like anomalies at **4016** and another 15m south of **4024**; these anomalies all measure 3m to 4m in length with magnetic values over +3nT. These three pits are all classed as probable archaeology.

3.2.9 There is another pair of large anomalies at **4017** and **4018** that are similar in form to **4010**. These anomalies are all located on the north side of the probable geological horizon observed in fields 2 and 3 and could represent targeted quarrying activity or are hollows that naturally occur at such horizons. As it is not clear which explanation is correct they have been interpreted as possible archaeology.

3.2.10 There are three weak (less than +1nT) ditch-like anomalies running through this field at a similar alignment at **4019** to **4021**. It is not clear whether they represent ditches forming part of a former field system or are remnants or ridge and furrow. All three have been classed as possible archaeology.

3.2.11 A modern service is visible at **4022** with a former field boundary close by at **4023** that correlates with a boundary marked on the tithe map. A ditch runs across the middle of the field at **4024** that does not appear to continue into the adjacent fields. This feature is considered to be agricultural although it cannot be linked with any map feature.

3.2.12 There are few archaeological features observed in field 5 with the majority of observed anomalies related to recent agricultural activity. There are a couple of pit-like anomalies at **4025** and a short possible ditch section at **4026**; these features are located close to strong ferrous responses and may be partially obscured. Both groups of features have been classed as possible archaeology.

3.2.13 There are numerous strong positive trends running across the area such as at **4027**; it is not clear whether these represent geological features or are remnants of some earlier agricultural activity. A former field boundary that correlates with a boundary marked on the tithe map is located at **4028**.

3.2.14 Field 6 has a low concentration of archaeological features, similar to field 5, with the only two anomalies of interest being two ditch-like features at **4029** and **4030**. These possible ditches have weak magnetic values around +1.5nT and could possibly relate to geological activity given the close proximity of geological features. Both have been classed as possible archaeology to reflect the uncertainty in their interpretation.

3.2.15 A band of diffuse positive responses is present at **4031**; this band is similar to the band marking a geological horizon further south and this band also appears to closely correspond to a change in the underlying geology. North of this line the geology is recorded as Tintern sandstone formation and south of this line the geology is recorded as Avon group limestone.

3.2.16 A broad band of ferrous responses runs up the northwest edge of the field at **4032**; this material may constitute a modern trackway with metal and ceramic laid down to create a firm surface.

3.2.17 A former field boundary is present at **4033** and correlates with the position of a boundary marked on the 1839 tithe map.

3.3 Gradiometer Survey Results and Interpretation: Modern Services

3.3.1 A modern service is observed in field 4 at **4022** and appears to run into the southern part of field 5 and terminate at a cattle feeder. This service is considered to represent a metallic or ceramic pipe that serves the farm, most likely to fill the water trough.

3.3.2 It is not clear from the geophysical data whether any of the services identified are in active use. It should also be noted that gradiometer survey may not detect all services present

on Site. This report and accompanying illustrations should not be used as the sole source for service locations and appropriate equipment (e.g. CAT and Genny) should be used to confirm the location of buried services before any trenches are opened on Site.

4 CONCLUSION

4.1.1 The detailed gradiometer survey has been successful in detecting a few anomalies of probable and possible archaeological interest within the Site, in addition to regions of increased magnetic response and a modern service.

4.1.2 Most of the anomalies detected relate to recent agricultural activity and the concentration of archaeological features is considered low. The most notable anomalies are the ditch sections at **4002** to **4004**, the probable pits at **4000** and **4016**, the unusual negative anomalies at **4013** to **4015** and the possible quarry pits at **4010**, **4017** and **4018**.

4.1.3 Several former field boundaries were identified and correlated to map features identified in the DBA. It is possible that other ditches detected may constitute field boundaries but as none can be linked to the historical mapping available they must remain classified either as agricultural or archaeological.

4.1.4 The occurrence of bands of positive responses at geological horizons is difficult to explain but may be a product of the ability of the gradiometer to detect areas of change but to filter out broad areas of homogenous readings.

4.1.5 The relative dimensions of the modern services identified by the gradiometer survey are indicative of the strength of their magnetic response, which is dependent upon the materials used in their construction and the backfill of the service trenches. The physical dimensions of the services indicated may therefore differ from their magnetic extents in plan; it is assumed that the centreline of services is coincident with the centreline of their anomalies, however. Similarly, it is difficult to estimate the depth of burial of the services through gradiometer survey

4.1.6 It should be noted that small, weakly magnetised features may produce responses that are below the detection threshold of magnetometers. It may therefore be the case that more archaeological features may be encountered than have been identified through geophysical survey.

5 REFERENCES

English Heritage, 2008. *Geophysical Survey in Archaeological Field Evaluation*. Research and Professional Service Guideline No 1, 2nd edition.

Soil Survey of England and Wales, 1983. *Sheet 5, Soils of South West England*. Ordnance Survey, Southampton.

Wessex Archaeology, 2014. *Tower Hill Solar Farm, Tytherington, South Gloucestershire: Archaeological Desk-Based Assessment.* Unpublished client report. Report reference: 104580.01.

APPENDIX 1: SURVEY EQUIPMENT AND DATA PROCESSING

Survey Methods and Equipment

The magnetic data for this project was acquired using a Bartington 601-2 dual magnetic gradiometer system. This instrument has two sensor assemblies fixed horizontally 1m apart allowing two traverses to be recorded simultaneously. Each sensor contains two fluxgate magnetometers arranged vertically with a 1m separation, and measures the difference between the vertical components of the total magnetic field within each sensor array. This arrangement of magnetometers suppresses any diurnal or low frequency effects.

The gradiometers have an effective resolution of 0.03nT over a ±100nT range, and measurements from each sensor are logged at intervals of 0.25m. All of the data are stored on an integrated data logger for subsequent post-processing and analysis.

Wessex Archaeology undertakes two types of magnetic surveys: scanning and detail. Both types depend upon the establishment of an accurate 20m or 30m site grid, which is achieved using a Leica Viva RTK GNSS instrument and then extended using tapes. The Leica Viva system receives corrections from a network of reference stations operated by the Ordnance Survey and Leica Geosystems, allowing positions to be determined with a precision of 0.02m in real-time and therefore exceed the level of accuracy recommended by English Heritage (2008) for geophysical surveys.

Scanning surveys consist of recording data at 0.25m intervals along transects spaced 10m apart, acquiring a minimum of 80 data points per transect. Due to the relatively coarse transect interval, scanning surveys should only be expected to detect extended regions of archaeological anomalies, when there is a greater likelihood of distinguishing such responses from the background magnetic field.

The detailed surveys consist of 20m x 20m or 30m x 30m grids, and data are collected at 0.25m intervals along traverses spaced 1m apart. These strategies give 1600 or 3600 measurements per 20m or 30m grid respectively, and are the recommended methodologies for archaeological surveys of this type (EH, 2008).

Data may be collected with a higher sample density where complex archaeological anomalies are encountered, to aid the detection and characterisation of small and ephemeral features. Data may be collected at up to 0.125m intervals along traverses spaced up to 0.25m apart, resulting in a maximum of 28800 readings per 30m grid, exceeding that recommended by English Heritage (2008) for characterisation surveys.

Post-Processing

The magnetic data collected during the detail survey are downloaded from the Bartington system for processing and analysis using both commercial and in-house software. This software allows for both the data and the images to be processed in order to enhance the results for analysis; however, it should be noted that minimal data processing is conducted so as not to distort the anomalies.

As the scanning data are not as closely distributed as with detailed survey, they are georeferenced using the GPS information and interpolated to highlight similar anomalies in adjacent transects. Directional trends may be removed before interpolation to produce more easily understood images.

Typical data and image processing steps may include:

- Destripe – Applying a zero mean traverse in order to remove differences caused by directional effects inherent in the magnetometer;
- Destagger – Shifting each traverse longitudinally by a number of readings. This corrects for operator errors and is used to enhance linear features;
- Despike – Filtering isolated data points that exceed the mean by a specified amount to reduce the appearance of dominant anomalous readings (generally only used for earth resistance data)

Typical displays of the data used during processing and analysis:

- XY Plot – Presents the data as a trace or graph line for each traverse. Each traverse is displaced down the image to produce a stacked profile effect. This type of image is useful as it shows the full range of individual anomalies.
- Greyscale – Presents the data in plan view using a greyscale to indicate the relative strength of the signal at each measurement point. These plots can be produced in colour to highlight certain features but generally greyscale plots are used during analysis of the data.

APPENDIX 2: GEOPHYSICAL INTERPRETATION

The interpretation methodology used by Wessex Archaeology separates the anomalies into two main categories: archaeological and unidentified responses.

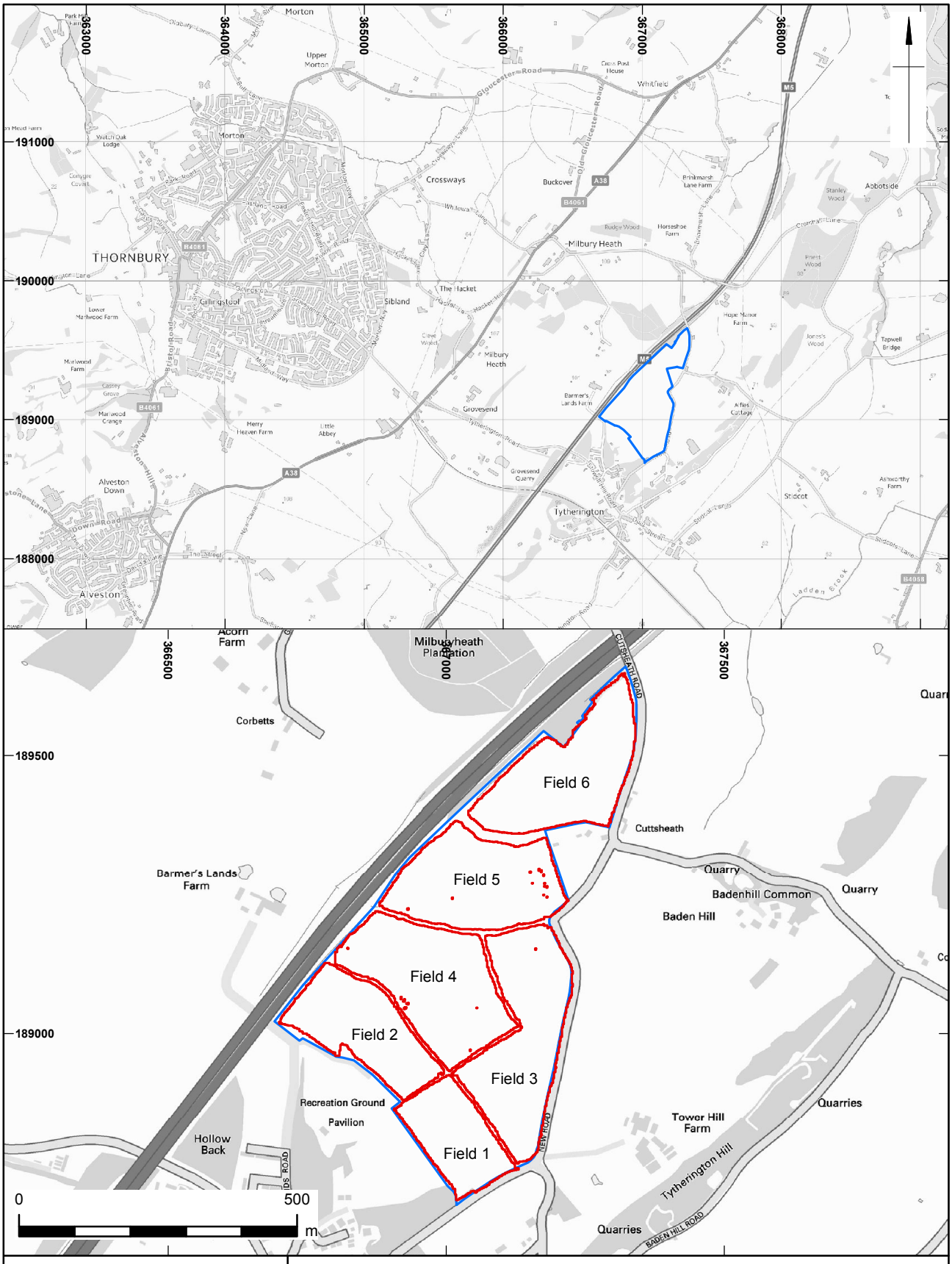
The archaeological category is used for features when the form, nature and pattern of the anomaly are indicative of archaeological material. Further sources of information such as aerial photographs may also have been incorporated in providing the final interpretation. This category is further sub-divided into three groups, implying a decreasing level of confidence:

- Archaeology – used when there is a clear geophysical response and anthropogenic pattern.
- Probable archaeology – used for features which give a clear response but which form incomplete patterns.
- Possible archaeology – used for features which give a response but which form no discernible pattern or trend.

The unidentified category is used for features when the form, nature and pattern of the anomaly are not sufficient to warrant a classification as an archaeological feature. This category is further sub-divided into:

- Increased magnetic response – used for areas dominated by indistinct anomalies which may have some archaeological potential.
- Trend – used for low amplitude or indistinct linear anomalies.
- Ferrous – used for responses caused by ferrous material. These anomalies are likely to be of modern origin.

Finally, services such as water pipes are marked where they have been identified.



Detailed Survey Extents

Site Boundary

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Site location map and detailed survey extents

Figure 1

366750

367000

367250

189000

188750

Detailed Survey Extents

+3nT

-2nT

0

100

m

Date:	09/07/2014
Revision Number:	0
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Greyscale plot, south

Figure 2

366750

367000

367250

189000

188750

Detailed Survey Extents

+25nT

-25nT

0

100

m

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Revision Number:	0
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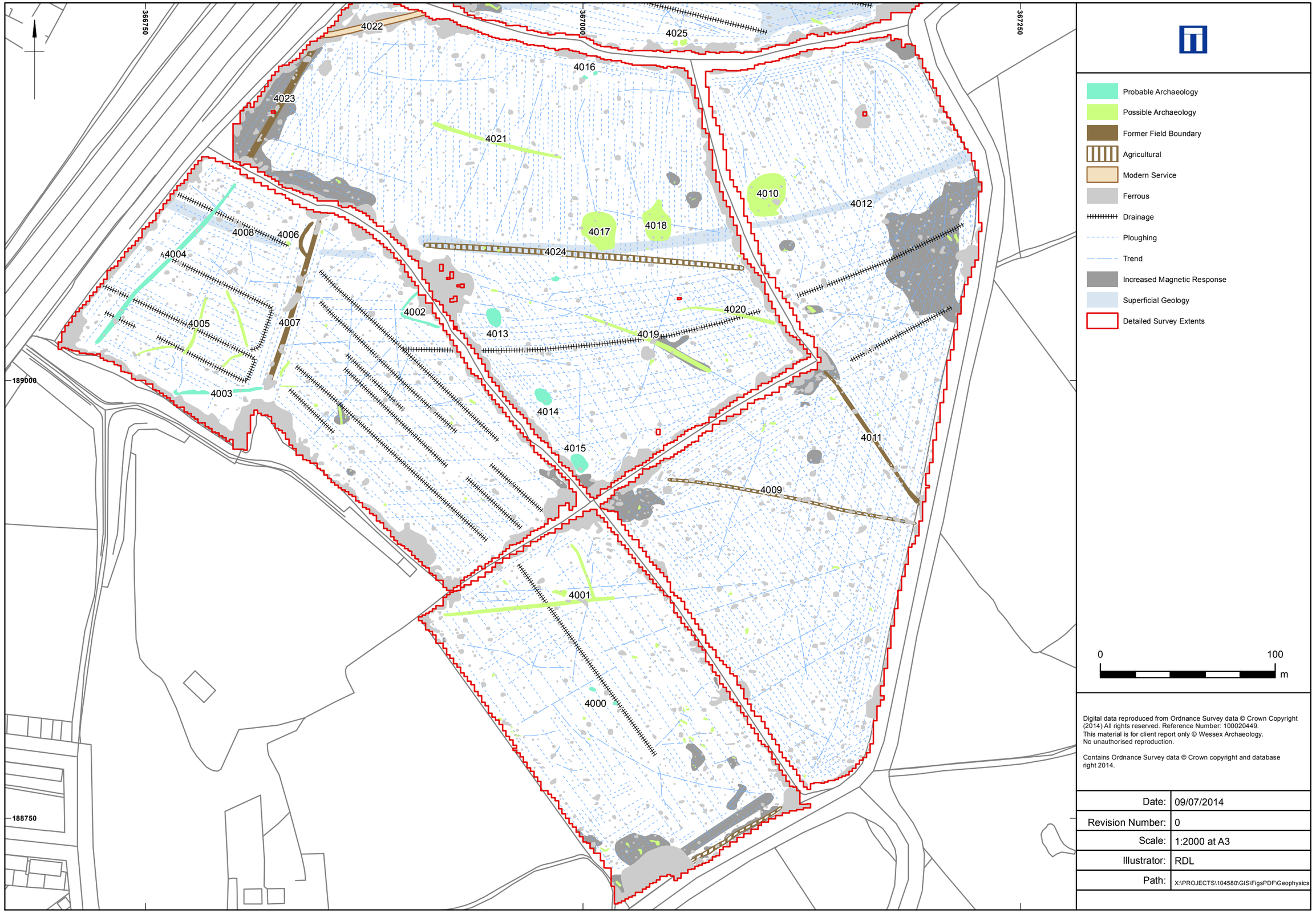
XY trace plot, south

Figure 3



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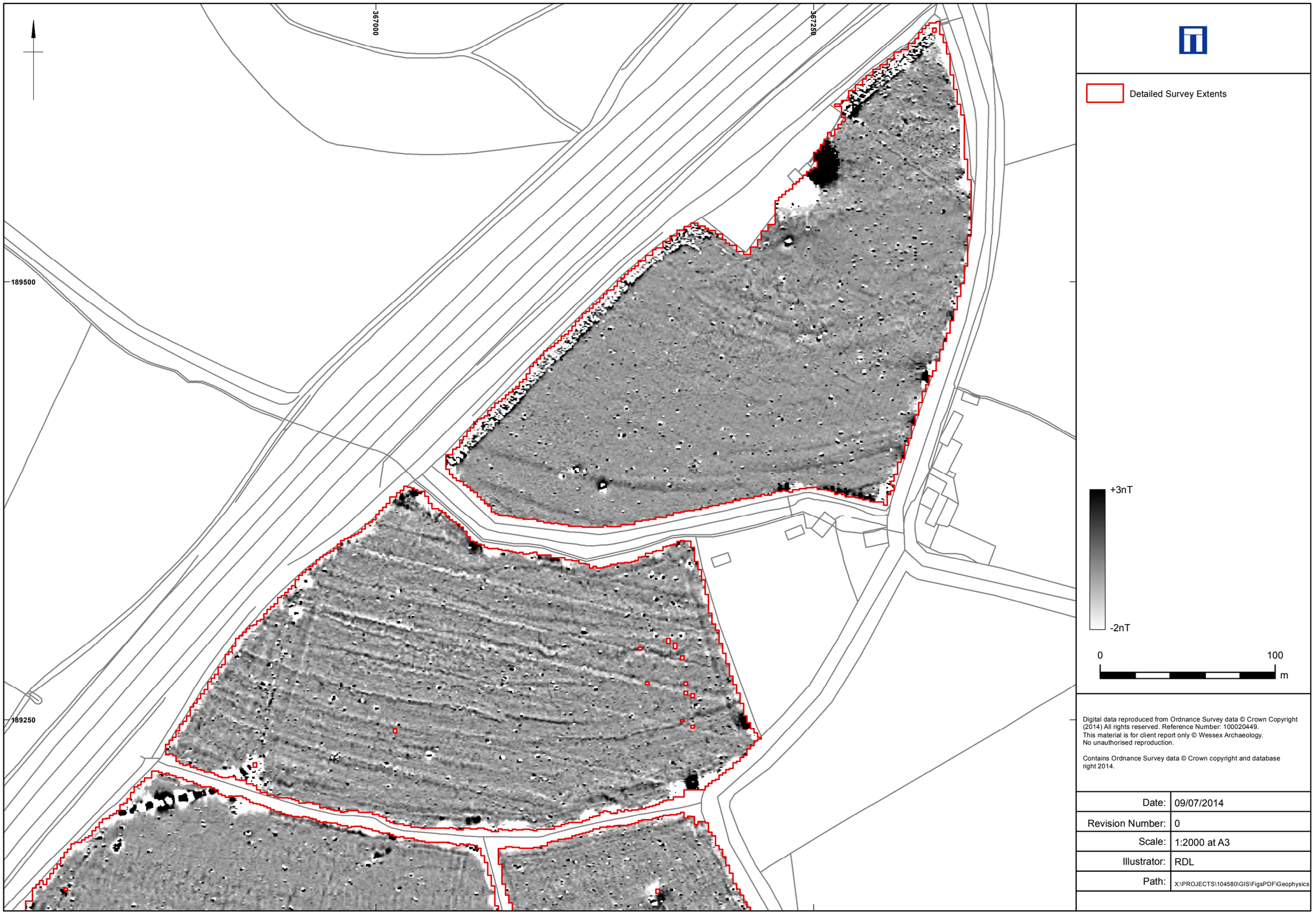
Interpretation, south

Figure 4



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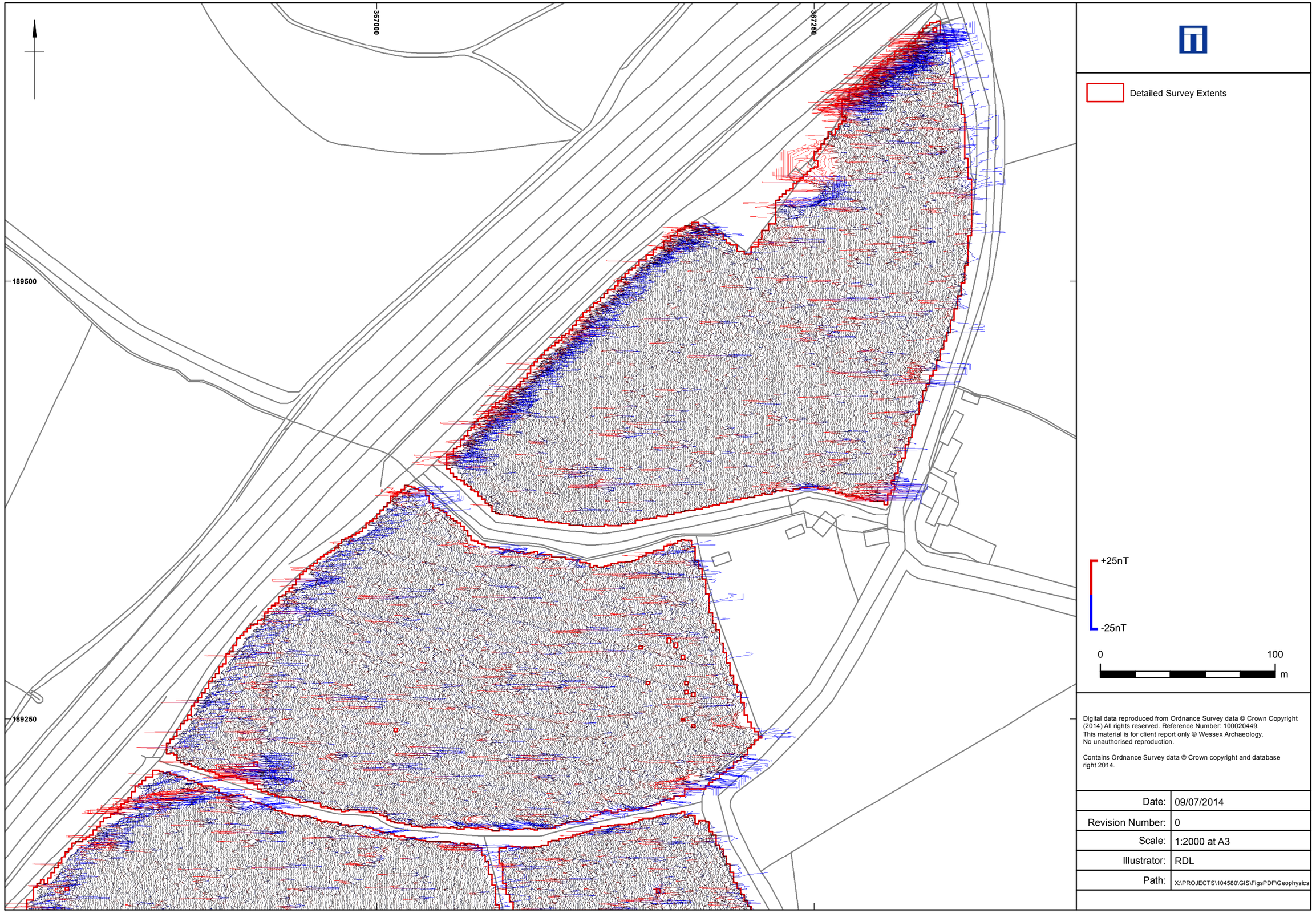
Greyscale plot, north

Figure 5



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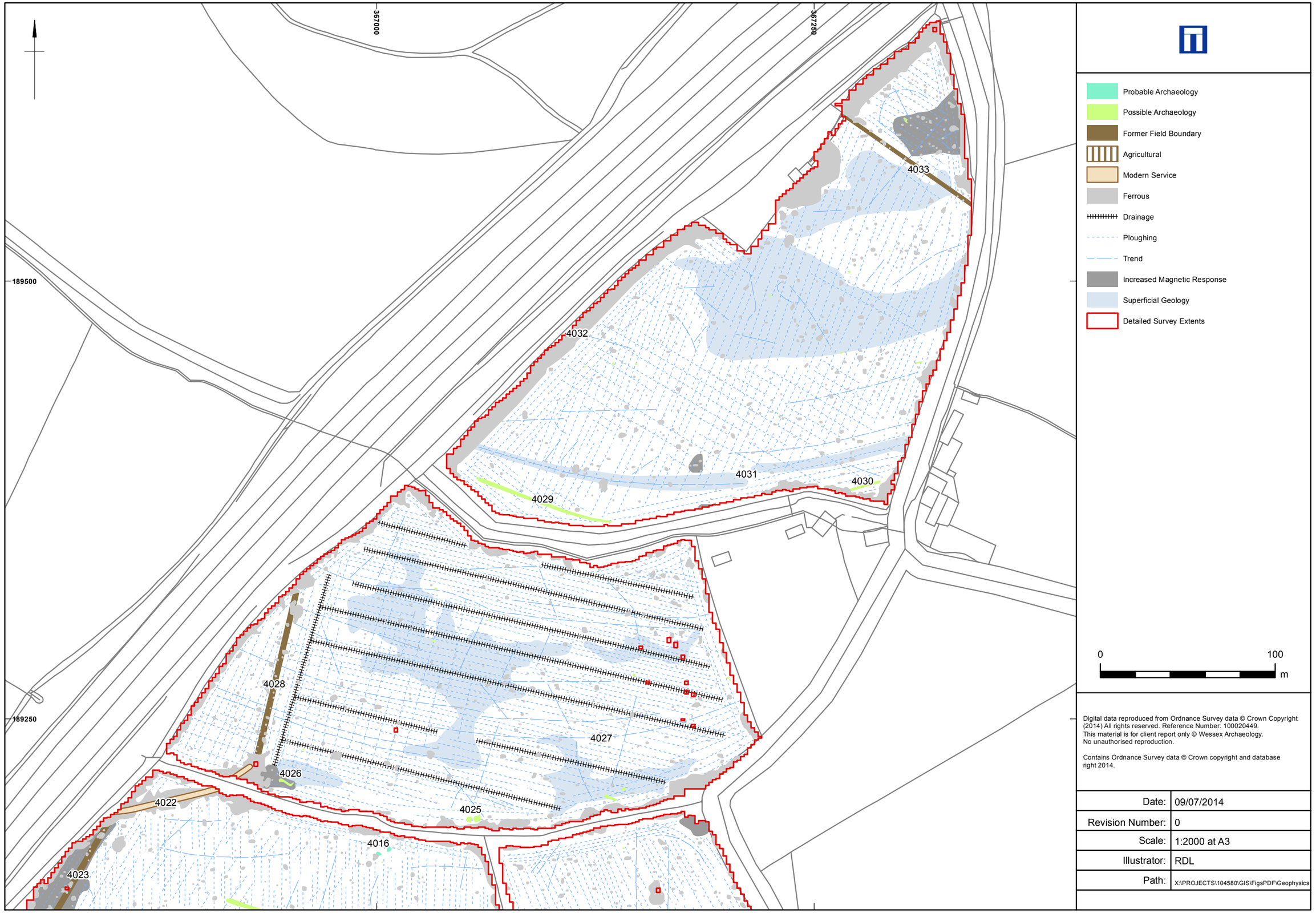
XY trace plot, north

Figure 6



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Revision Number:	0
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Interpretation, north

Figure 7

wessex archaeology

salisbury rochester sheffield edinburgh

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