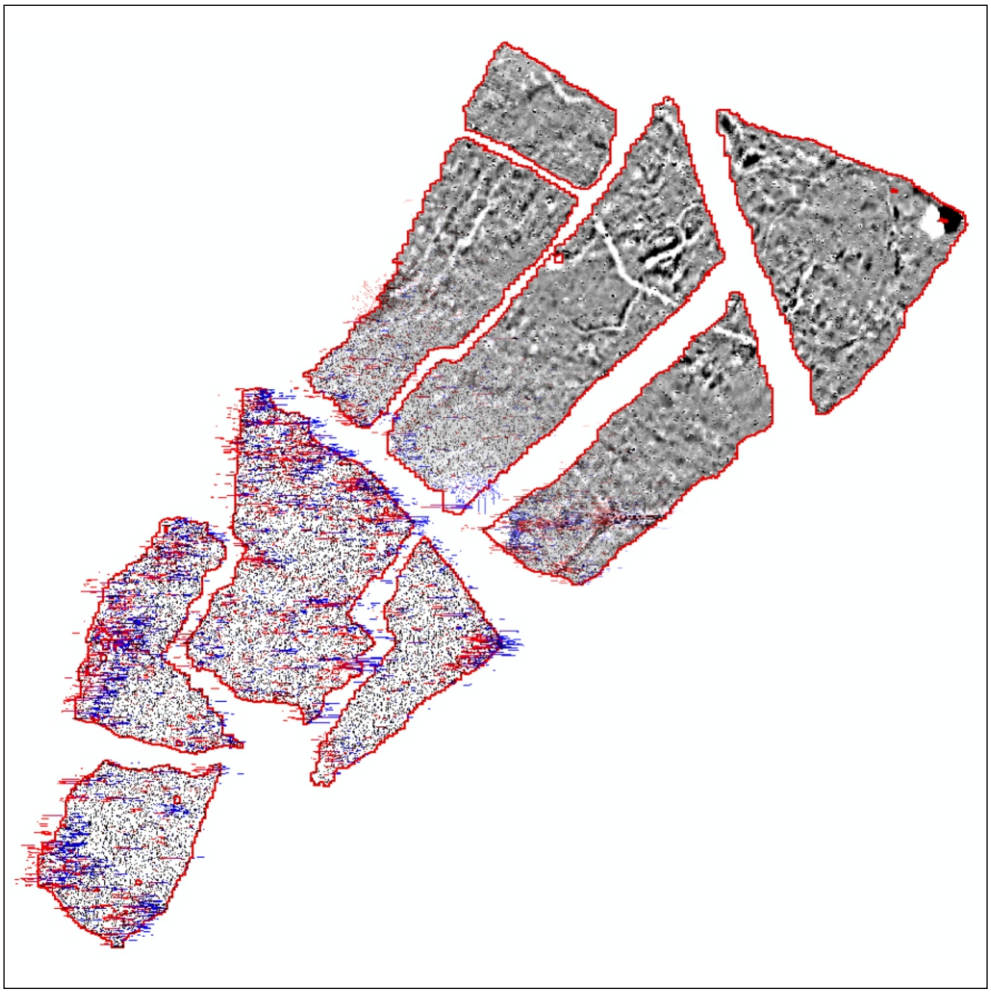
making sense of heritage

Land at Lawrence Weston Road Avonmouth, Bristol

Detailed Gradiometer Survey Report



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geoservices

Land at Lawrence Weston Road
Avonmouth, Bristol

Detailed Gradiometer Survey Report

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* I = Internal Draft; E = External Draft; F = Final

Land at Lawrence Weston Road Avonmouth, Bristol

Detailed Gradiometer Survey Report

Contents

Figures

Land at Lawrence Weston Road Avonmouth, Bristol

Detailed Gradiometer Survey Report

Summary

A detailed gradiometer survey was conducted over land at Lawrence Weston Road, Avonmouth, Bristol. The project was commissioned by Alandem Consulting, on behalf of Bristol City Council, with the aim of establishing the presence, or otherwise, and nature of detectable archaeological features on the site ahead of the proposed development of the Site.

The site comprises nine pasture fields at the northwest edge of Bristol, some 8km from the city centre and 2.6km ENE of Avonmouth, centred on NGR 354125, 1792225. The site occupies an area of flat land within the Henbury Levels. The gradiometer survey covered an area measuring 16.6ha and covered all accessable parts of the Site. The survey has demonstrated the presence of a few anomalies of possible archaeological interest within the survey area along with agricultural features and a wide spread of geological deposits.

Some pit-like anomalies have been detected in the data although their close association with geological features strongly suggest they are natural in origin.

The geophysical data has largely revealed agricultural features with former field boundaries, several field drains and ploughing trends detected across the site.

The survey was undertaken between 11th and 15th August 2014.

Land at Lawrence Weston Road Avonmouth, Bristol

Detailed Gradiometer Survey Report

Acknowledgements

The detailed gradiometer survey was commissioned by Alandem Consulting, on behalf of Bristol City Council. The assistance of Richard Harris of Alandem Consulting is gratefully acknowledged in this regard.

The fieldwork was undertaken by Laura Andrews, Rachel Chester and Patrick Dresch. Jen Smith processed and 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 Karen Nichols. The project was managed on behalf of Wessex Archaeology by Sue Farr.

Land at Lawrence Weston Road Avonmouth, Bristol

Detailed Gradiometer Survey Report

1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology was commissioned by Alandem Consulting, on behalf of Bristol City Council, to carry out a geophysical survey over 18.5ha of land at Lawrence Weston Road, Avonmouth, Bristol (**Figure 1**), hereafter "the Site" (centred on NGR 354125, 179225). The survey forms part of an ongoing programme of archaeological works being undertaken in advance 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 This report presents a brief description of the methodology followed, the detailed survey results and the archaeological interpretation of the geophysical data.

1.2 Site Location and Topography

1.2.1 The Site is located at the north west limit of Bristol, some 8km northwest of the city centre and 2.6km to the ENE of Avonmouth (**Figure 1**). The survey area comprises of nine parcels of land all currently under pasture and the survey extents are defined by fields boundaries in all directions with the M49 and M5 partially defining this area.

1.2.2 The Site lies in an area of flat land known as the Henbury Levels and is at an elevation of approximately 6m above Ordnance Datum (aOD). The fields are all partially defined by drainage ditches that flow into drainage rhines (also rhynes or reens) with Salt Rhine passing through the northern half of the survey area. The River Avon flows past the site to the south and southwest before flowing into the Severn Estuary.

1.3 Soils and Geology

1.3.1 The bedrock geology under the Site is recorded as Mudstone and Halite stone from the Mercia Mudstone Group that dates to the Triassic period. Superficial deposits are of Tidal Flat deposits composed of silt and clay which formed in the Quaternary period (BGS).

1.3.2 The soils underlying the Site are likely to be pelo-calcareous alluvial gley soils of the 814c (Newchurch 2) 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.

1.4 Archaeological Background

1.4.1 An archaeological Desk-Based Assessment (DBA) was recently carried out by Wessex Archaeology (2014). This assessment revealed no recorded heritage assets within the Site but a number within a 5km buffer area (Wessex Archaeology 2014). The results of this DBA will be discussed in relation to the geophysical survey results where relevant.

2 METHODOLOGY

2.1 Introduction

2.1.1 The detailed magnetometer survey was conducted using a Bartington Grad 601-2 dual fluxgate gradiometer system. The survey was conducted in accordance with English Heritage guidelines (English Heritage 2008).

2.1.2 The geophysical survey was undertaken by Wessex Archaeology geophysics team between 11th and 15th August 2014. Field conditions at the time of the survey were largely good with the exception of a few small inaccessible areas. A total of 16.6ha was covered of the proposed 18.5ha area with only a small area lost to field boundaries and small surface obstructions.

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 (ZMT) 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. The deslope function was used to process out some grid edge discontinuities resulting from the application of the ZMT function. These three 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 a few anomalies of possible archaeological interest across the Site, the majority of detected features appear to relate to agricultural activity. Results are presented as a series of greyscale and XY plots, with corresponding archaeological interpretations, at a scale of 1:2000 (**Figures 2** to **7**). The data are displayed at -2nT (white) to +3nT (black) for the greyscale image and ±25nT at 25nT 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** and **7**). 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 All nine fields within the survey area are dominated by geological responses particularly towards the northern half of the Site. These geological spreads are characterised by broad weakly positive and negative diffuse edged anomalies.

3.2.2 **Field 1** (**Figures 2** to **4**) contains few anomalies of potential archaeological interest with the majority of features relating to agricultural use of this area. A linear ferrous response is present at **4000** that corresponds to a line of a former field boundary marked on modern mapping that may have taken the form of a fence. What looks to be a series of three parallel metallic field drains are present at **4001** with some ceramic field drains visible further north around **4002**. The remaining anomalies in this field are geological with a probable palaeochannel visible at **4003**.

3.2.3 **Field 2** (**Figures 2** to **4**) contains a few strong positive anomalies such as the one at **4004**; this anomaly has positive magnetic values over +3nT and clearly defined edges. This anomaly could potentially represent a pit but its close association with an area of geological responses indicates it is possibly geological; for this reason this anomaly has been classed as possible archaeology. Two ferrous field boundaries have been observed further south at **4005** and **4006**.

3.2.4 **Field 3** (**Figures 2** to **4**) has another pit-like anomaly at **4007** that is similar to **4004**; this has been classed as possible archaeology as it is situated in an area of geological features. The other notable feature is a ditch that corresponds to a former field boundary at **4008** that is marked on modern mapping as a drainage ditch.

3.2.5 **Field 4** (**Figures 2** to **4**) contains few archaeological anomalies with the majority of detected features relating to agricultural features such as some ceramic field drains visible around **4009**.

3.2.6 **Field 5** (**Figures 5** to **7**) has a group of pit-like anomalies around **4010**; these are associated with geological anomalies and are therefore classed as possible archaeology only. The remaining anomalies are agricultural with a possible fence at **4011** and a negative ditch at **4012** that runs into **Field 6**.

3.2.7 **Field 6** (**Figures 5** to **7**) contains some more pit-like features of possible archaeological interest such as at **4013** along with the continuation of the negative ditch from **Field 5** into this field at **4014**. This feature has magnetic values below -2nT and is considered to represent a drainage ditch as it runs in straight sections from existing field junctions into Salt Rhine. This anomaly is negative and this is perhaps due to the fill being magnetically sterile compared to the background geology.

3.2.8 **Fields 7** and **8** (**Figures 5** to **7**) contains few anomalies of interest besides a few positive anomalies such as those around **4015** and **4016** and agricultural features including a ceramic field drain.

3.2.9 **Field 9** (**Figures 5** to **7**) contains a few short ditch sections at **4017** to **4019**; all three have magnetic values over +3nT and look more regular in shape than other anomalies encountered so far and are regarded as of possible archaeological interest. Aside from a few pit-like anomalies of possible interest such as those around **4020** the remaining anomalies are considered to be of modern, geological or uncertain origin.

3.2.10 There are some clearly defined and strongly positive anomalies within the geological spreads discussed above; these all have magnetic values over +3nT and look similar to the sort of anomalies expected from pits. These strong anomalies have been classed as possible archaeology as their close association with geological spreads suggests they may prove to be natural.

3.2.11 There are numerous weak trends running through the data. These are considered to be of uncertain origin and could represent anything from geological to archaeological features but this cannot be established with any certainty from the geophysical data alone.

3.3 Gradiometer Survey Results and Interpretation: Modern Services

3.3.1 No clear modern services were observed in the geophysical data; a few modern fencelines that appeared to resemble services were detected but cartographic evidence suggests they are more likely to be agricultural. It should 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 possible archaeological interest, in addition to former field boundaries and superficial geological responses.

4.1.2 The majority of the detected anomalies appear to be superficial geological responses that are visible throughout the entire dataset and seems to correspond to the tidal flat deposits recorded by the British Geological Survey (BGS). These geological deposits are fairly weak across most of the Site but it is unclear whether they, or even the stronger responses, mask deeply buried weak archaeological features.

4.1.3 The majority of the detected anthropogenic features appear to relate to agricultural activity with former field boundaries, ceramic field drains, ploughing scars and other unidentified agricultural features identified in the data.

4.1.4 Many of positive anomalies identified as possible archaeology may turn out to be geological. Their form suggests they could be pits but their close association with geological spreads and palaeochannels suggest a geological explanation for them is more likely.

4.1.5 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

5.1 Bibliography

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

Institute for Archaeologists, 2011. *Standards and Guidance for Archaeological Geophysical Survey* Unpublished Guidance

Wessex Archaeology, 2014. *Lawrence Weston Road, Avonmouth, Bristol: Archaeological Desk-Based Assessment.* Unpublished client report. Report reference 103590.01.

5.2 Cartographic Sources

British Geological Survey
http://www.bgs.ac.uk/discoveringgeology/geologyofbritain/viewer.html [accessed September 2014]

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

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 four main categories: archaeological, modern, agricultural and uncertain origin/geological.

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 modern category is used for anomalies that are presumed to be relatively modern in date:

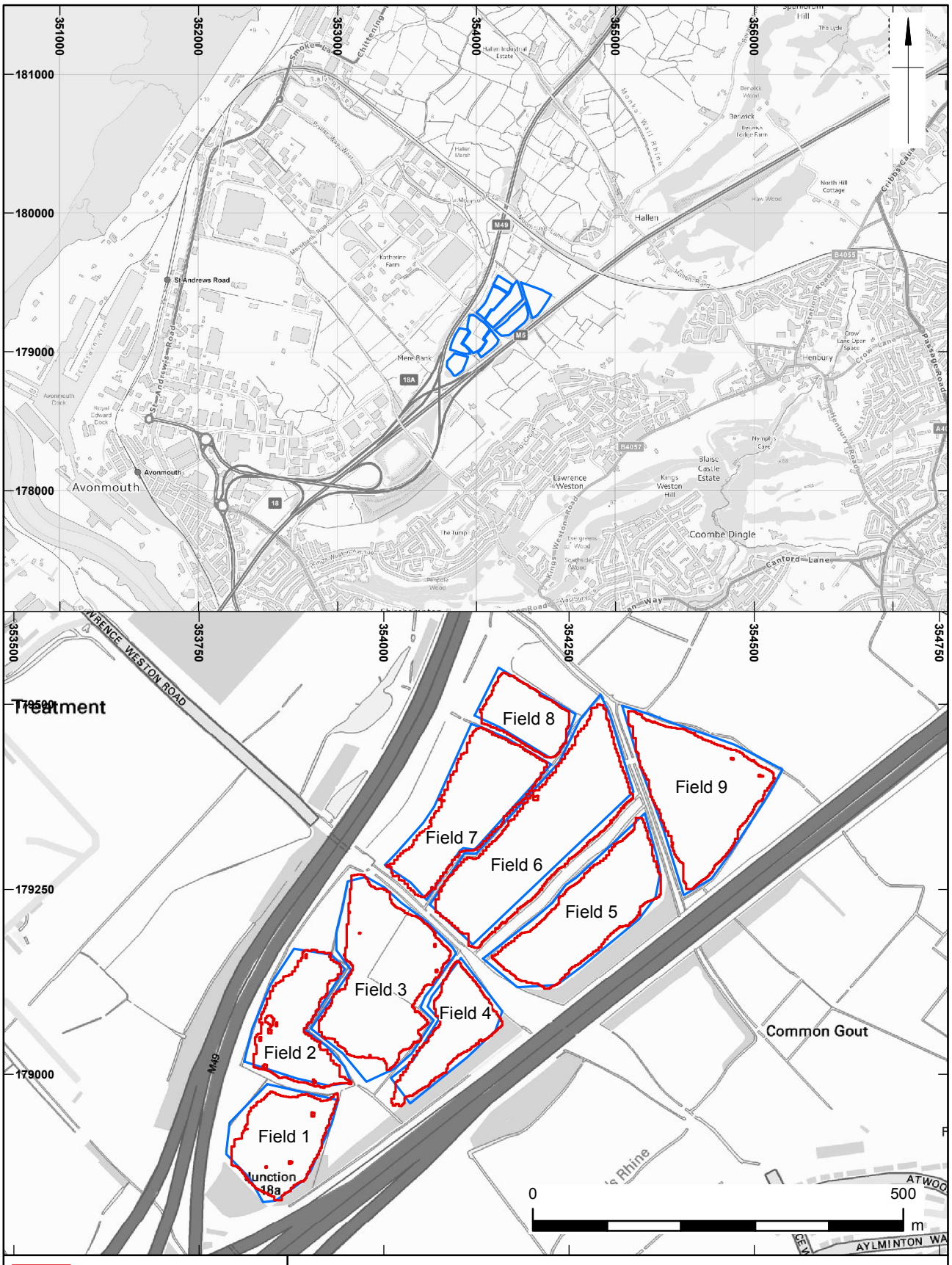
- Ferrous – used for responses caused by ferrous material. These anomalies are likely to be of modern origin.
- Modern service – used for responses considered relating to cables and pipes; most are composed of ferrous/ceramic material although services made from non-magnetic material can sometimes be observed.

The agricultural category is used for the following:

- Former field boundaries – used for ditch sections that correspond to the position of boundaries marked on earlier mapping.
- Agricultural ditches – used for ditch sections that are aligned parallel to existing boundaries and former field boundaries that are not considered to be of archaeological significance.
- Ridge and furrow – used for broad and diffuse linear anomalies that are considered to indicate areas of former ridge and furrow.
- Ploughing – used for well-defined narrow linear responses, usually aligned parallel to existing field boundaries.
- Drainage – used to define the course of ceramic field drains that are visible in the data as a series of repeating bipolar (black and white) responses.

The uncertain origin/geological 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.
- Superficial geology – used for diffuse edged spreads considered to relate to shallow geological deposits. They can be distinguished as areas of positive, negative or broad bipolar (positive and negative) anomalies.



Detailed Survey Extents

Site Boundary

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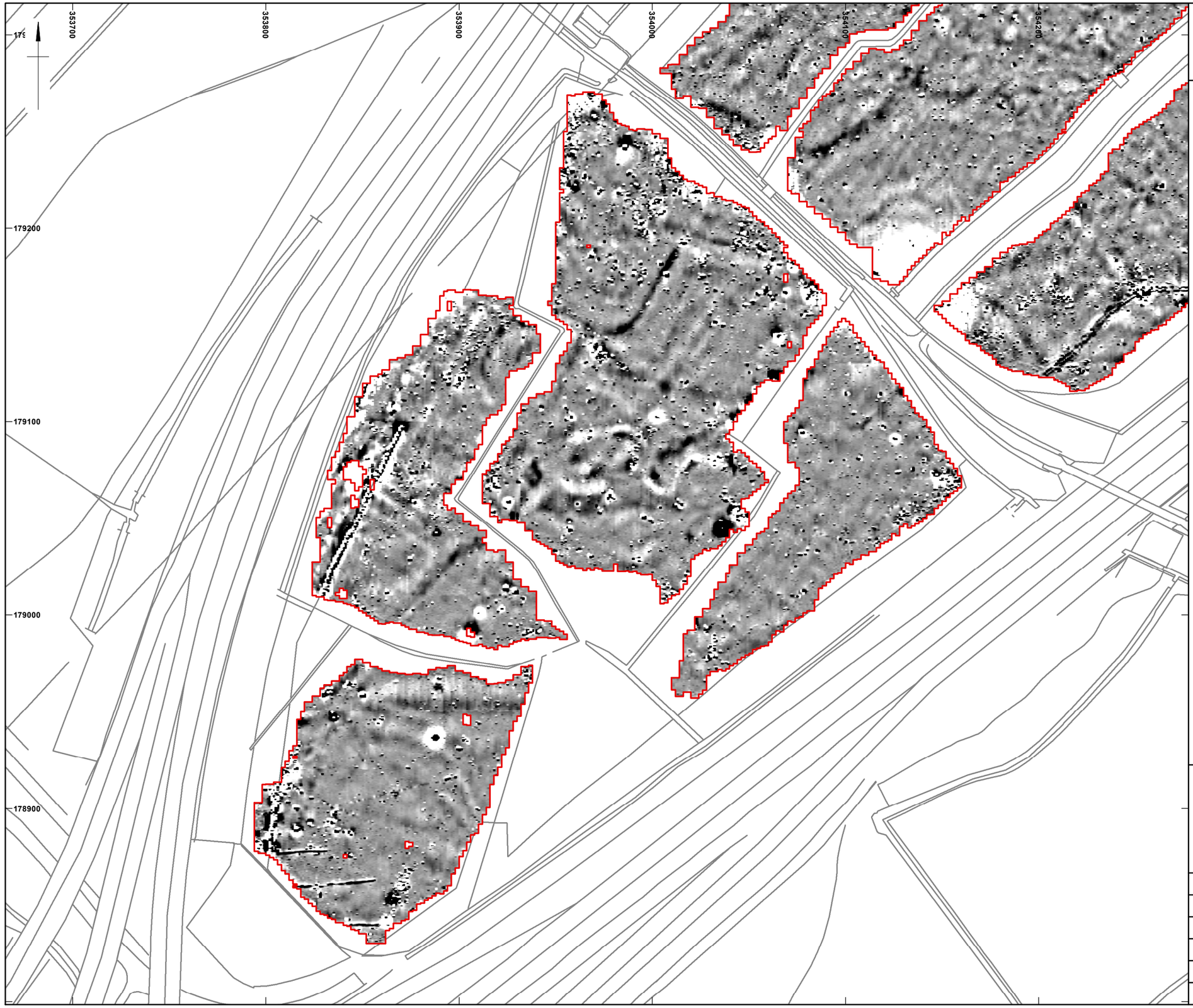
Site location and detailed survey extents

Figure 1



Detailed Survey Extents

+3nT

-2nT

0 100 m

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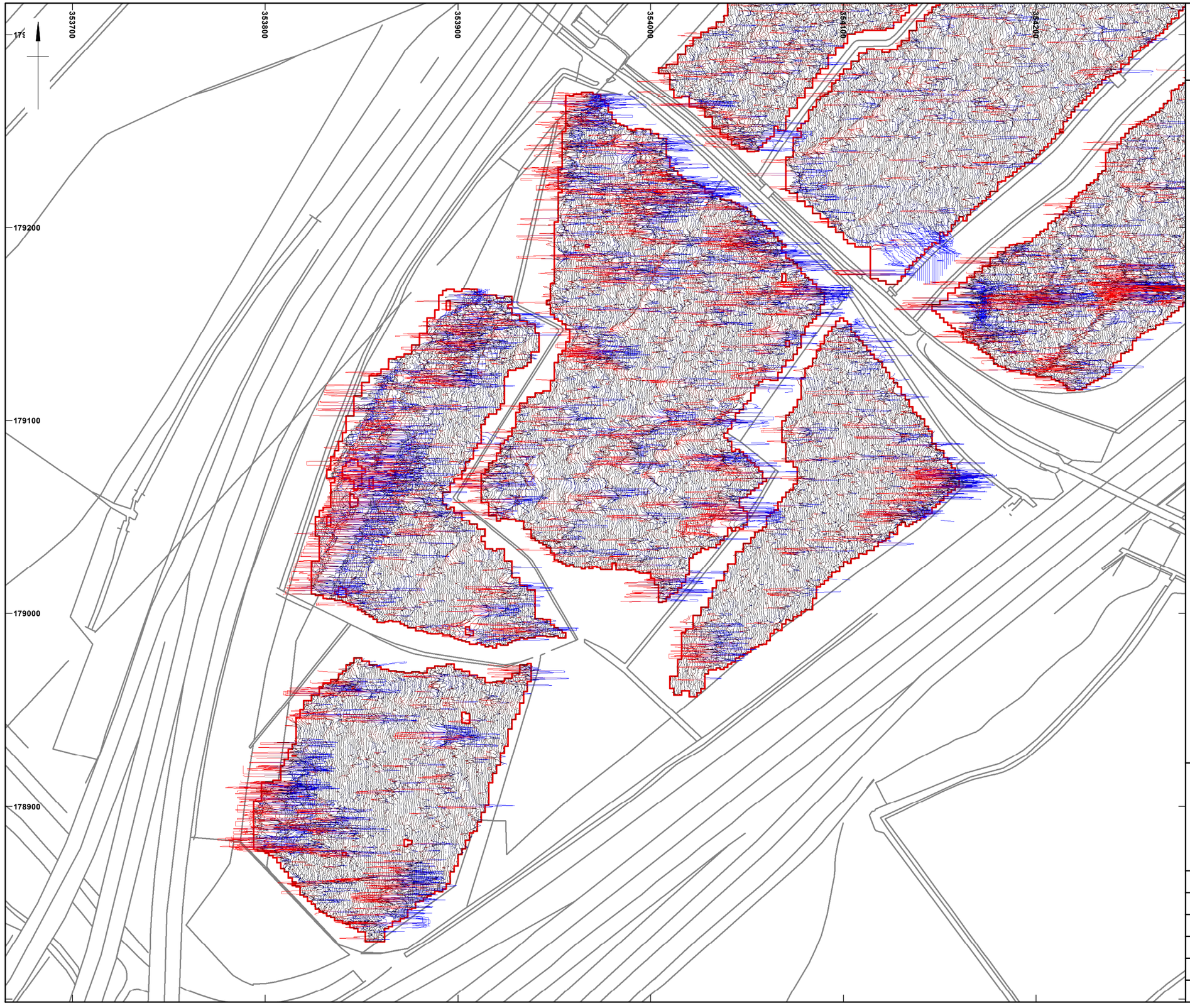
Greyscale plot: south

Figure 2



Detailed Survey Extents

+25nT

-25nT

0 100 m

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Revision Number:	0
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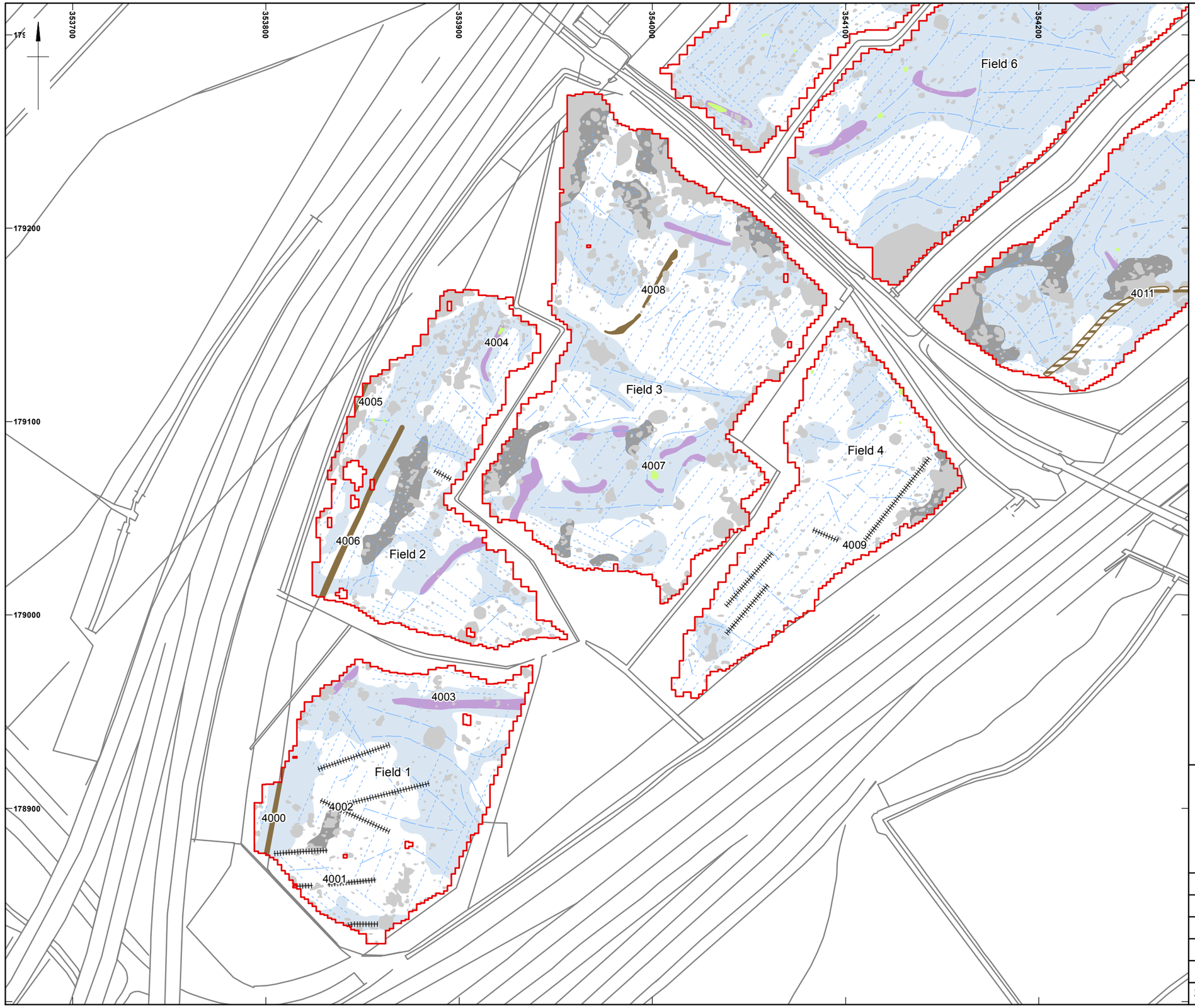
XY trace plot: south

Figure 3



Detailed Survey Extents
Possible Archaeology
Former Field Boundary
Agricultural
Drainage
Ferrous
Trend
Ploughing
Increased Magnetic Response
Palaeochannel
Superficial Geology

0 100 m

Date:	08/09/2014
Revision Number:	0
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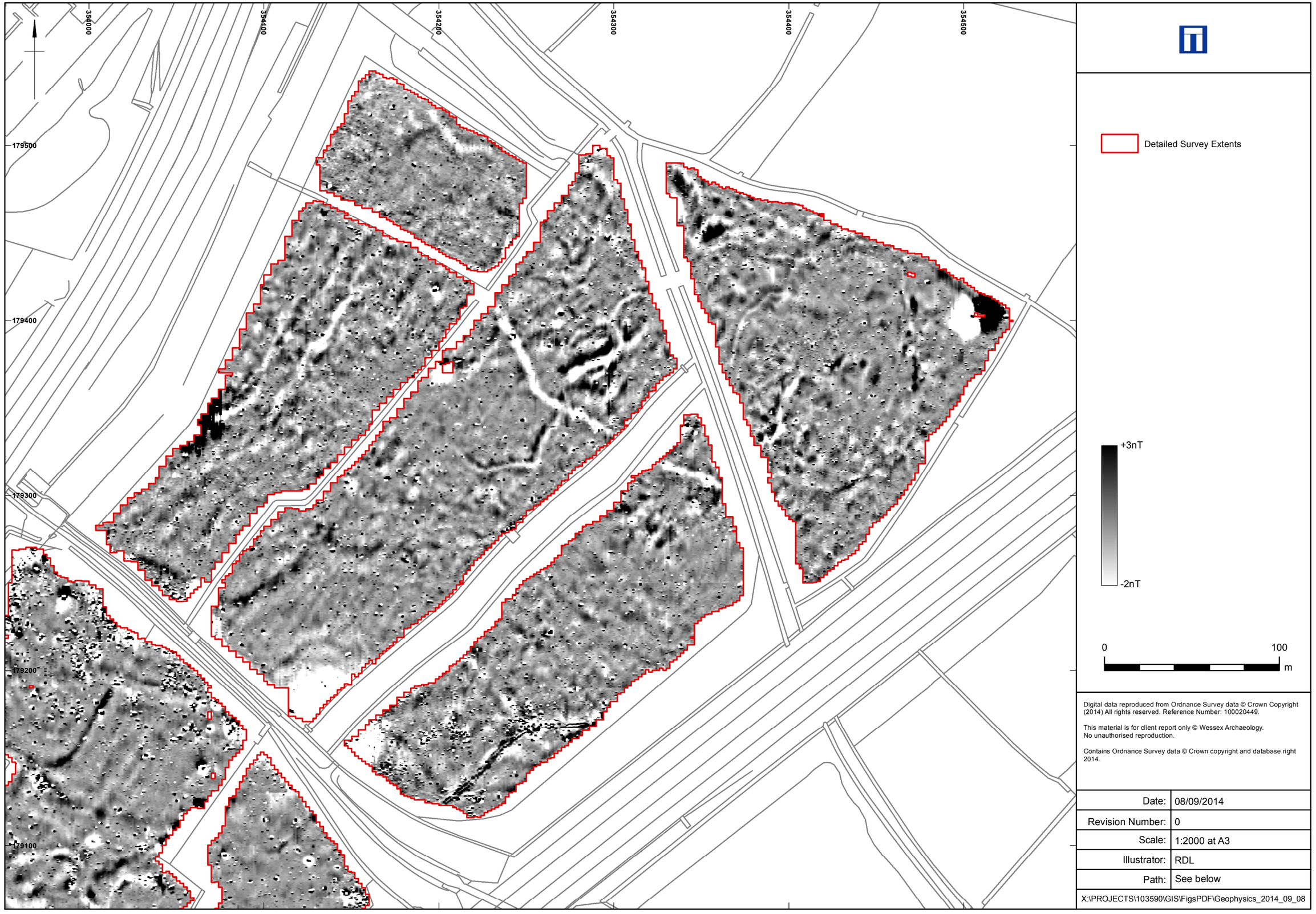
Interpretation: south

Figure 4



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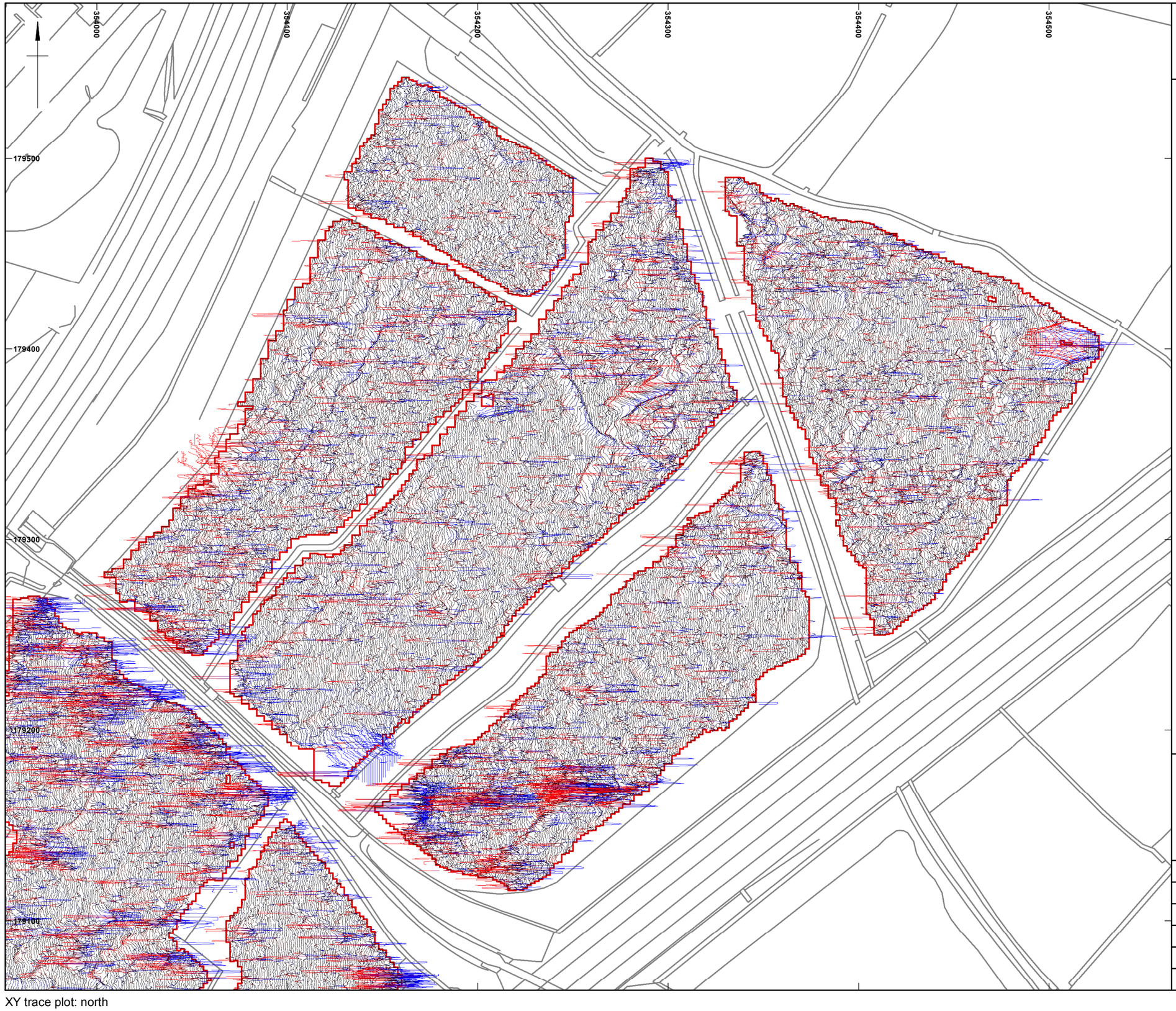
Greyscale plot: north

Figure 5



Detailed Survey Extents

+25nT

-25nT

0 100 m

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Revision Number:	0
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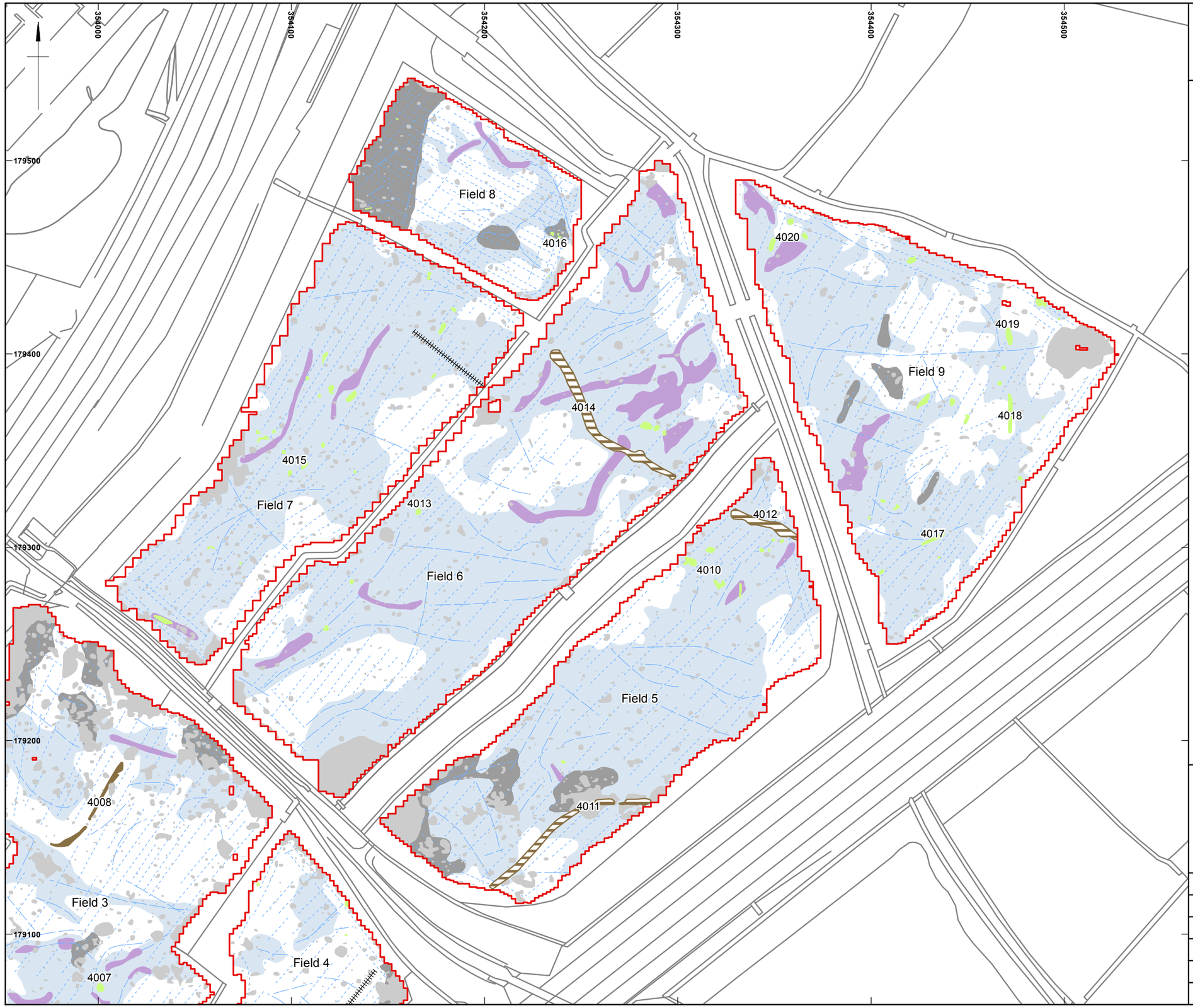
XY trace plot: north

Figure 6



Detailed Survey Extents
Possible Archaeology
Former Field Boundary
Agricultural
Drainage
Ferrous
Trend
Ploughing
Increased Magnetic Response
Palaeochannel
Superficial Geology

0 100 m

Date:	08/09/2014
Revision Number:	0
Scale:	1:2000 at A3
Illustrator:	RDL
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Interpretation: north

Figure 7

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