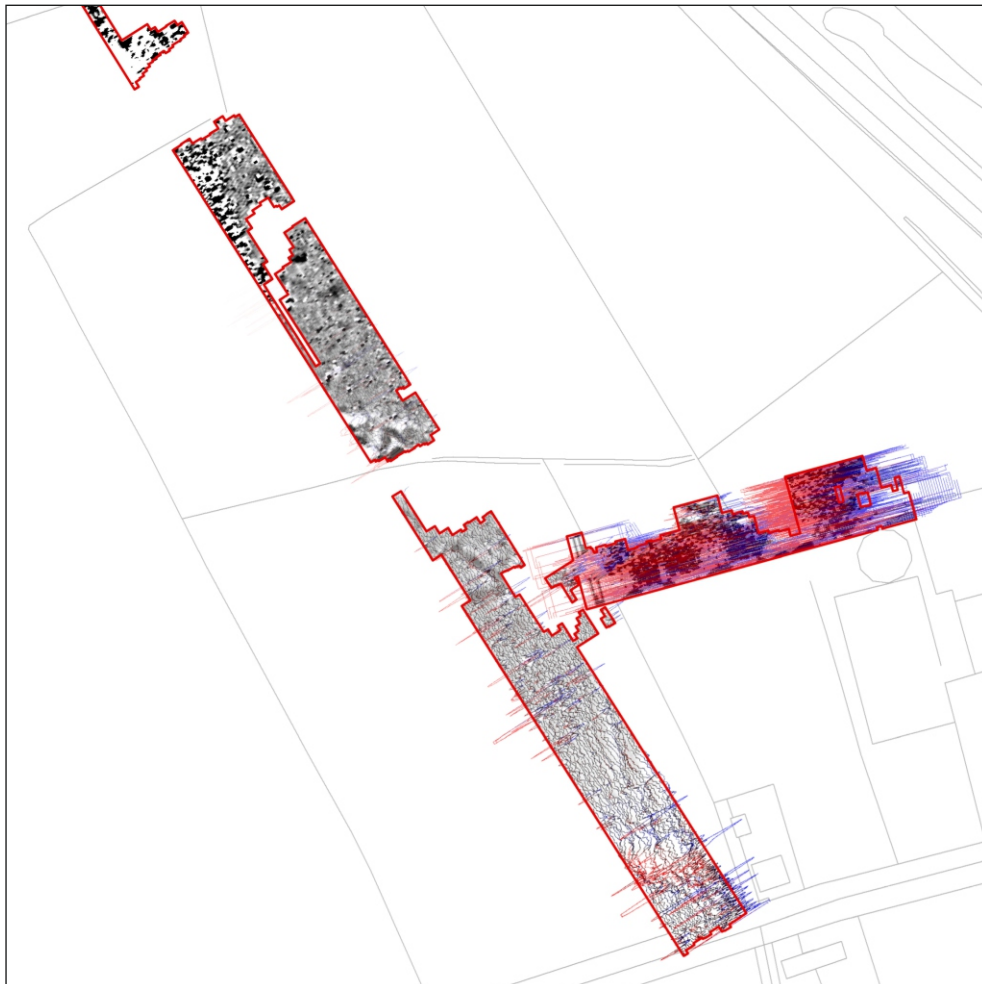




making sense of heritage

DVA Trunk Main Derbyshire

Detailed Gradiometer Survey Report



Ref: 101651.01
March 2014



DVA Trunk Main, Derbyshire

Detailed Gradiometer Survey Report

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DVA Trunk Main, Derbyshire

Detailed Gradiometer Survey Report

Contents

Summary	ii
Acknowledgements.....	iii
1 INTRODUCTION.....	1
1.1 Project background	1
1.2 The Scheme.....	1
2 ARCHAEOLOGICAL BACKGROUND	2
2.1 Introduction	2
2.2 Prehistoric and Romano-British.....	2
2.3 Anglo-Saxon and medieval.....	3
2.4 Post-medieval and modern.....	3
3 METHODOLOGY.....	3
3.1 Introduction	3
3.2 Method.....	4
4 GEOPHYSICAL SURVEY RESULTS AND INTERPRETATION.....	4
4.1 Introduction	4
4.2 Gradiometer survey results and interpretation.....	4
5 CONCLUSION.....	6
6 REFERENCES.....	7
APPENDIX 1: SURVEY EQUIPMENT AND DATA PROCESSING.....	8
APPENDIX 2: GEOPHYSICAL INTERPRETATION.....	10

Figures

Figure 1	Site location and survey extents
Figure 2	Greyscale (northern section)
Figure 3	Greyscale (central section)
Figure 4	Greyscale (southern section)
Figure 5	XY trace (northern section)
Figure 6	XY trace (central section)
Figure 7	XY trace (southern section)
Figure 8	Interpretation (northern section)
Figure 9	Interpretation (central section)
Figure 10	Interpretation (southern section)



DVA Trunk Main, Derbyshire

Detailed Gradiometer Survey Report

Summary

Wessex Archaeology was commissioned by Laing O'Rourke to undertake a geophysical survey of land near Church Wilne Reservoir, Derbyshire, running from National Grid Reference (NGR) 445419 332818 to 446012 331607 (hereafter 'the Scheme', **Figure 1**).

The Scheme is located in southeast Derbyshire close to its borders with Leicestershire and Nottinghamshire, approximately 1km southwest of Breaston and 3.9km west of Long Eaton. The Scheme runs through agricultural land spanning seven fields and is located close to the Church Wilne Reservoir.

A previous desk-based assessment (DBA; Wessex Archaeology 2013) indicated that there was potential for Romano-British and prehistoric remains along the Scheme. A geophysical survey was proposed prior to development in order to further identify any surviving archaeological remains.

The detailed gradiometer survey covered 2.9ha and has demonstrated the presence of a limited number of anomalies of possible archaeological interest, along with regions of probable modern intrusion, modern services and regions of geological responses.

The majority of the anomalies of possible archaeological interest are seen within the southern portions of the Site and comprise a number of large pit-like responses and several linear anomalies. Whilst none is conclusively archaeological in origin, such an interpretation cannot be ruled out entirely.

Also within the southernmost extents of the Site, broad responses consistent with near-surface geological changes can be seen.

The northernmost and easternmost extents of the survey are characterised by strong magnetic disturbance. In places, linear anomalies typical of modern services can be seen, although the central portion of the Site shows responses more consistent with the dumping of modern material, perhaps demolition debris.



DVA Trunk Main, Derbyshire

Detailed Gradiometer Survey Report

Acknowledgements

The detailed gradiometer survey was commissioned by Laing O'Rourke. The assistance of Denise Bacon is gratefully acknowledged in this regard.

The fieldwork was directed by Phil Roberts and assisted by David Loeb. Ben Urmston processed and interpreted the geophysical data and was aided by Chris Harrison in writing this report. Illustrations were prepared by Richard Milwain. The project was managed on behalf of Wessex Archaeology by Grace Corbett and Richard O'Neill.



DVA Trunk Main, Derbyshire

Detailed Gradiometer Survey Report

1 INTRODUCTION

1.1 Project background

- 1.1.1 Wessex Archaeology was commissioned by Laing O'Rourke (hereafter 'the Client') to undertake a geophysical survey of land near Church Wilne Reservoir, Derbyshire, running from National Grid Reference (NGR) 445419 332818 to 446012 331607 (hereafter 'the Scheme', **Figure 1**).
- 1.1.2 A previous desk-based assessment (DBA; Wessex Archaeology 2013) indicated that there was potential for Romano-British and prehistoric remains along the Scheme. A geophysical survey was proposed prior to development in order to further identify any surviving archaeological remains. This report presents a brief description of the methodology followed, the detailed survey results and the archaeological interpretation of the geophysical data.
- 1.1.3 The aim of the geophysical survey was to establish the presence/absence, extent and character of detectable archaeological remains within the survey area.

1.2 The Scheme

- 1.2.1 The Scheme is located in southeast Derbyshire close to its borders with Leicestershire and Nottinghamshire approximately 1km southwest of Breaston and 3.9km west of Long Eaton (**Figure 1**).
- 1.2.2 The Scheme begins at the Severn Trent Treatment Works near Sawley, initially heading northwest before turning west-southwest, crossing Sawley Road before meeting with the northwest-southeast aligned section. This section begins approximately 180m north of Wilne Cross and runs to the southeast crossing Sawley Road close to Sawley Grange Cottage, the section continues to the southeast before crossing Wilne Lane and terminating approximately 230m southwest of Ivy House Farm.
- 1.2.3 The Scheme runs through agricultural land spanning seven fields and is located close to the Church Wilne Reservoir.
- 1.2.4 The Site is located within relatively flat land beginning at an elevation of 35m above Ordnance Datum (aOD) finishing at 32m aOD reaching a peak of 38m aOD south of Church Wilne.
- 1.2.5 The northwest end of the Scheme is underlain by mudstone from the Gunthorpe Member, moving southeast over sandstone from the Cotgrave Sandstone Member finally ending back on mudstone from the Edwalton Member. The superficial geology consists of patches of diamicton and sands and gravel associated with the river terrace (British Geological Survey: Sheet 151 - Loughborough). The soils underlying the Site are marked as being unsurveyed but are likely to comprise the typical brown alluvial soils of the 561a



(Wharfe) association (SSEW 1983). Such soils are considered to produce magnetic contrasts suitable for the detection of archaeological features through gradiometer survey.

2 ARCHAEOLOGICAL BACKGROUND

2.1 Introduction

2.1.1 The following section is summarised from the previous desk-based assessment (Wessex Archaeology 2013).

2.2 Prehistoric and Romano-British

2.2.1 The first evidence of human activity within the surrounding landscape dates to the Bronze Age. In 1985 a large spearhead, bronze shield fragment, a human skull and a quantity of animal bone were recovered from the conveyor belt at Elvaston Quarry. The findspot for the discovery is approximate but the DHER puts the location approximately 250m southwest of the Scheme where it crosses Sawley Road. The spearhead has been identified as Class IIIa, thought to date from 1300-1000BC. The human skull found was in good condition, whilst the animal bones were predominantly ox and deer with butchery marks present on some of the ox bones. It is thought the artefacts were deposited together; however the stratigraphy was destroyed during the extraction process so confirmation was impossible. The recovery of these types of artefacts along with a human skull provides evidence of a possible connection between human burial and high status metalwork deposition in riverine environments.

2.2.2 Other evidence of Bronze Age activity has been identified through cropmarks and earthworks transcribed from various aerial photographs: a circular ditched feature and linear with irregular enclosure at one end, located approximately 70m south of the end point of the Scheme, south of Wilne Lane; and a rectangular enclosure and small ring ditch located approximately 167m northeast of the Scheme at Ivy House Farm.

2.2.3 Further material, consisting of a Middle Bronze Age dagger found during the construction of the Church Wilne Reservoir and two Middle Bronze Age cremation burials and seven cremation related deposits identified during a watching brief, has been discovered within the wider landscape of the Scheme.

2.2.4 The surrounding landscape has significant evidence of activity during the Romano-British period exemplified by the route of a Roman road running south-east from Derby as far as Sawley, which crosses the Scheme northeast of "Netherlands". Most of the road is under the Church Wilne Reservoir; however, elsewhere it has been recorded through excavations in 1910 along sections of the road near Derby, as having been 12ft wide with metalling of heavy course sandstone covered with a 3 inch layer of smooth gravel.

2.2.5 In addition to the road, enclosures ascribed to a Romano-British farmstead were uncovered during excavations in advance of a new filter plant adjacent to the Scheme where it crosses Sawley Road.

2.2.6 Within the broader landscape, approximately 1.5km to the east of the Scheme and within the Sawley Conservation Area, is an area designated as a Scheduled Monument (NHLE Number 1007033) described as earthworks and cropmarks visible on aerial photographs consisting of a small rectangular earthwork, possibly a Roman fortlet, with a few fragments of Roman pottery having been recovered during an excavation.



- 2.2.7 Although no evidence relating to Iron Age activity is recorded within the Site or the Study Area the Scheme passes through one feature recorded as undated, with a further four undated features within the surrounding area. All of which consist of earthworks and cropmarks visible on aerial photographs and are located surrounding the Scheme as it crosses Wilne Lane. Due to their proximity to known Romano-British activity and the route of a Roman road, it is likely these features represent Iron Age/Romano-British settlement/farming activities and are described in more detail below.
- 2.2.8 The apparent corner of a double ditched enclosure which has been partially destroyed by gravel extraction is located at the southern end of the Scheme.

2.3 Anglo-Saxon and medieval

- 2.3.1 No finds or features of Anglo-Saxon or medieval date are located along the Scheme or the immediate surrounding area, although reference to Draycott, Breaston and Sawley in the Domesday Book indicates these settlements have their origins in this period.
- 2.3.2 The DHER records the site of a possible Deserted Medieval Village (DMV), approximately 930m west of the Scheme, centred on the medieval Church of St Chad. Archaeological investigations in 1974 and 1975, prompted by threats from gravel quarrying, recorded earthworks associated with the DMV and conducted small scale excavations which revealed the ground-plan of a rectangular timber-framed or mud constructed house that had been heavily disturbed by ploughing.

2.4 Post-medieval and modern

- 2.4.1 There is one post-medieval feature, Sawley Grange Farm, located close to the Scheme, lying approximately 65m to the east. The farmstead is unlikely to date to before c.1700 but was in existence before the reign of Queen Victoria.
- 2.4.2 The earliest cartographic evidence for the Study Area comes from “An Exact Map of Risley and Breaston” (1722) and covers the northern section of the Scheme before it crosses Sawley Road. It shows that most of the Scheme in this area ran through unenclosed land known as “Breaston Pasture” with the very northern end of the Scheme crossing two fields. By the time the Breaston Tithe Map has been drawn in 1841 the pasture has become enclosed with the Scheme now crossing three field boundaries including one visible on the 1722 map at the north end. The majority of the pipeline is covered by the Sawley Enclosure Plan 1788 and the Sawley Tithe Map 1849 which show most of the land to be enclosed.

3 METHODOLOGY

3.1 Introduction

- 3.1.1 The detailed gradiometer survey was conducted using a Bartington Grad601-2 dual fluxgate gradiometer system. The survey was conducted in accordance with English Heritage guidelines (2008).
- 3.1.2 The geophysical survey was undertaken by Wessex Archaeology’s in-house geophysics team between 27th and 30th January 2014. Field conditions at the time of the survey were poor, with the survey area having been heavily rained upon immediately prior to survey.



3.2 Method

- 3.2.1 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).
- 3.2.2 The gradiometer 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.
- 3.2.3 Data from the survey was subject to minimal data correction processes. These comprise a zero mean traverse function ($\pm 5\text{nT}$ 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.
- 3.2.4 Further details of the geophysical and survey equipment, methods and processing are described in **Appendix 1**.

4 GEOPHYSICAL SURVEY RESULTS AND INTERPRETATION

4.1 Introduction

- 4.1.1 The gradiometer survey has been successful in identifying an area of possible archaeological interest, along with regions of magnetic disturbance and linear trends. A modern service is also visible. Results are presented as a series of greyscale and XY plots, and archaeological interpretations, at a scale of 1:2000 (**Figures 2 to 10**). The data are displayed at -2nT (white) to $+3\text{nT}$ (black) for the greyscale image and $\pm 25\text{nT}$ at 50nT per cm for the XY trace plots.
- 4.1.2 The interpretation of the datasets highlights the presence of potential archaeological anomalies, ferrous/burnt or fired objects, and magnetic trends (**Figures 8 to 10**). Full definitions of the interpretation terms used in this report are provided in **Appendix 2**.
- 4.1.3 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.

4.2 Gradiometer survey results and interpretation

- 4.2.1 At the northern extent of the survey two weak linear trends are visible, interceded by a stronger curvilinear trend **4000** that is possibly related to similar responses further south along the survey area. These trends are in close proximity to an area of severe magnetic disturbance along the western edge of the survey area (**Figures 2, 5 and 8**).
- 4.2.2 An area of extensive ferrous-like anomalies can be seen towards the centre of **Figure 2 (4001)**, with no definitive structure. Whilst the origin of this region is unclear, it is possible that it represents a near-surface deposit being ploughed to the surface; although it is unlikely to be of archaeological significance given the lack of anomalies of interest nearby.



- 4.2.3 A modern service **4002** extends across the northern portion of the site (**Figures 2, 5 and 8**), oriented WSW-ENE, with extensive magnetic disturbance that would have masked any weaker anomalies.
- 4.2.4 A linear anomaly **4003** towards the south of **Figure 2** is consistent with a modern service, however, it does not have the same clear appearance and therefore its origin is unclear. The strength of the surrounding magnetic disturbance would have masked any weaker anomalies.
- 4.2.5 The central region of the survey area (**Figures 3, 6 and 9**) is mostly populated by a region of strong ferrous anomalies. However, various extensive linear and curvilinear trends **4004** are visible within this region, although with no obvious structure. It is possible that these responses are the result of modern dumped material, such as demolition debris.
- 4.2.6 The most northern region of **Figure 4** has an area of increased magnetic response **4005** towards the western extent. Whilst the origin of this region is unclear, it is possible that it represents a near-surface deposit being ploughed to the surface, although it is unlikely to be of archaeological significance given the lack of anomalies of interest nearby.
- 4.2.7 Two sizeable pit-like anomalies **4006** are thought to be of possible archaeological interest, visible towards the northern extents of **Figure 10**. It is conceivable that these responses may be the result of agricultural or geological activity, however, an archaeological origin cannot be excluded entirely.
- 4.2.8 A cluster of trends **4007** is visible towards the centre of **Figure 10**, with strong broadly-varying responses. These are likely to be natural or geological in origin, and therefore less likely to be of archaeological interest.
- 4.2.9 Intersecting linear anomalies **4008** thought to be of possible archaeological interest are located towards the centre of **Figure 10**. They have the appearance of ditch-like anomalies consistent with possible field boundaries. It is conceivable that these responses may be the result of agricultural or geological activity, however, an archaeological origin cannot be excluded entirely.
- 4.2.10 Extensive magnetic disturbance can be seen within the eastern section of the site at **4009** and **4010**. Given the magnitude of the responses it is likely that these are associated with a modern service, although no characteristic anomaly is apparent for **4009**; however, there does appear to be responses characteristic to that of a modern service along the southern extents of this region of the survey area. The strength of the surrounding magnetic disturbance would have masked any weaker anomalies within this region.
- 4.2.11 A linear anomaly **4011** thought to be of possible archaeological interest can be seen towards the southern extents of the survey area. It is surrounded by a region of superficial geological responses, but is strong enough to not be considered of the same origin.
- 4.2.12 An area of magnetic disturbance **4012** thought to be superficial geology extends across the southernmost region of the survey area. It is possible that the strength of these responses could have masked the presence of any weaker anomalies within this region.



5 CONCLUSION

- 5.1.1 The detailed gradiometer survey has been successful in detecting anomalies of possible archaeological interest within the Scheme, in addition to regions of increased magnetic response, several trends and a modern service.
- 5.1.2 The nature of anomalies **4006**, **4008** and **4011** is unclear, although it is possible that these represent a former field system, although their overall alignment correlates only weakly.
- 5.1.3 The strong magnetic disturbance seen in the northwestern extents of the survey is consistent with the presence of a modern service, although no characteristic anomalies can be seen within the survey area. Similarly the magnetic disturbance at the centre of the Scheme is likely to be modern in provenance.
- 5.1.4 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. Similarly, it is difficult to estimate the depth of burial of the services through gradiometer survey.
- 5.1.5 The extent of magnetic disturbance associated with the services and the frequency of small-scale ferrous anomalies have reduced the area in which it is possible to detect archaeological features.
- 5.1.6 It should be noted that small, weakly magnetised features may produce responses that are below the detection threshold of gradiometers. It may therefore be the case that more archaeological features may be encountered than have been identified through geophysical survey.



6 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 3, Midland and Western England*. Ordnance Survey, Southampton.

Wessex Archaeology, 2013. *DVA Trunk Main, Derbyshire, Archaeological Desk-Based Assessment*. Unpublished client report.



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 gradiometers 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 gradiometers suppresses any diurnal or low frequency effects.

The gradiometers have an effective resolution of 0.03nT over a ± 100 nT 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 gradiometer;
- 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.

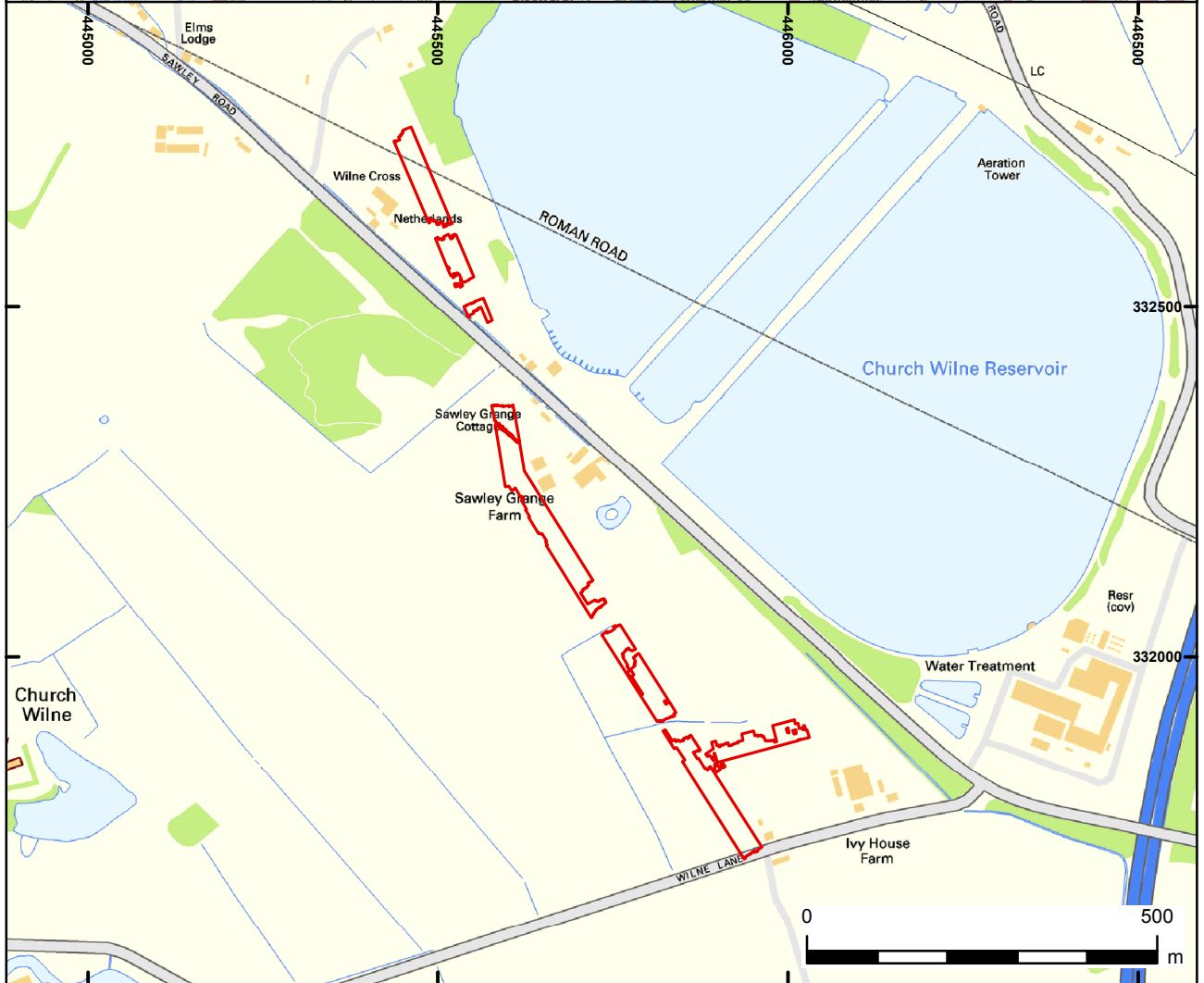
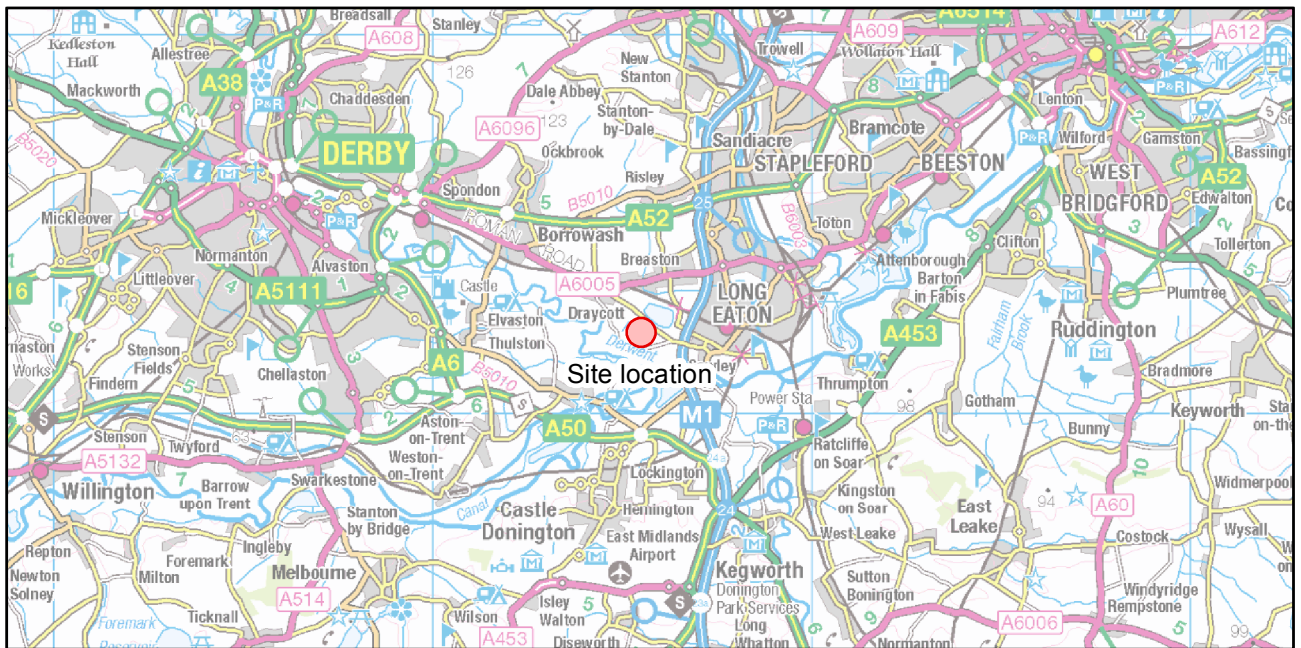
The archaeological category is used for features when the form, nature and pattern of the anomaly are indicative of archaeological material. Further sources of information such as aerial photographs may also have been incorporated in providing the final interpretation. This category is further sub-divided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

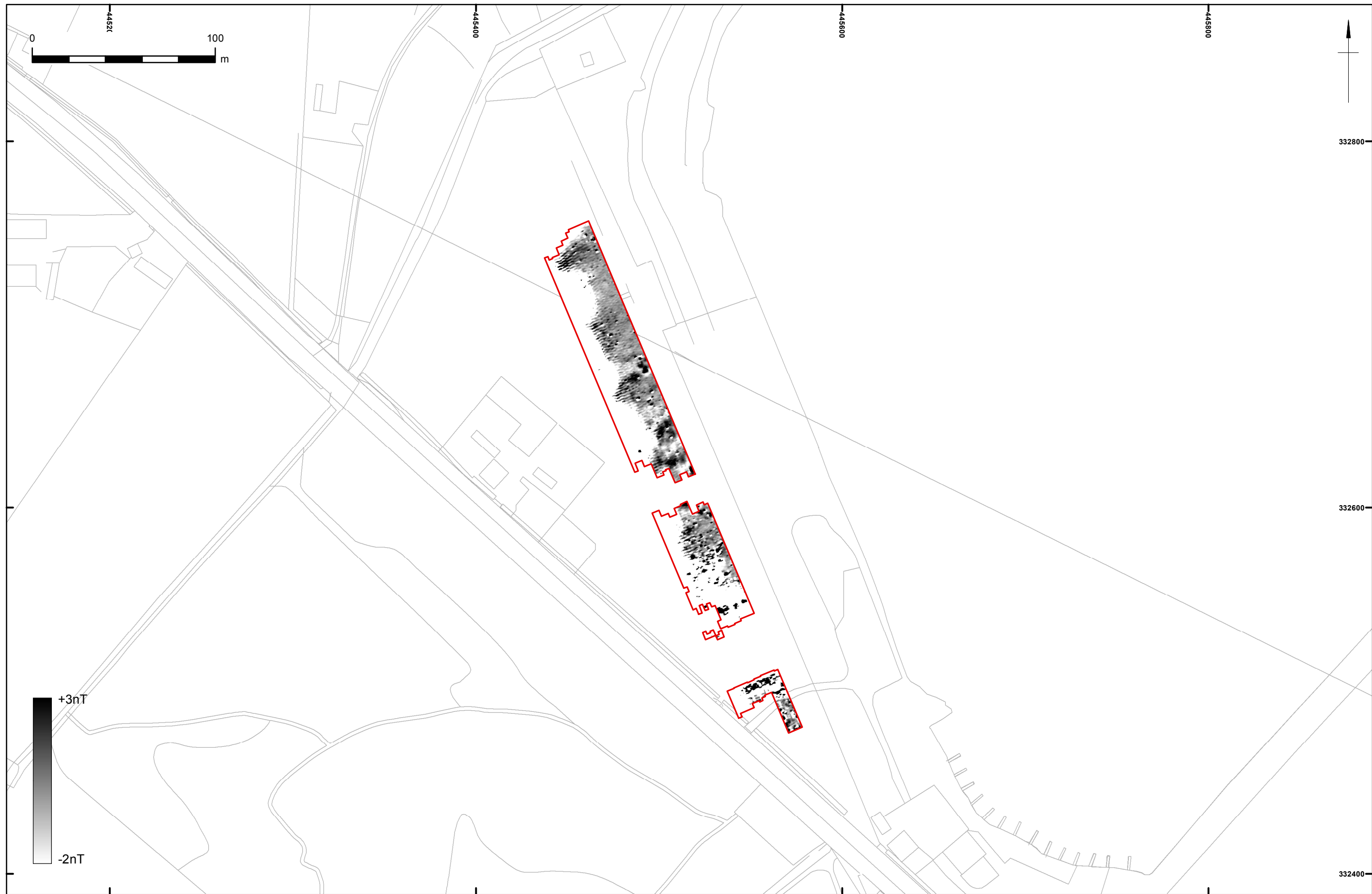
Finally, services such as water pipes are marked where they have been identified.



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Site location and survey extents

Figure 1



Survey Extents

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Greyscale (northern section)

Figure 2



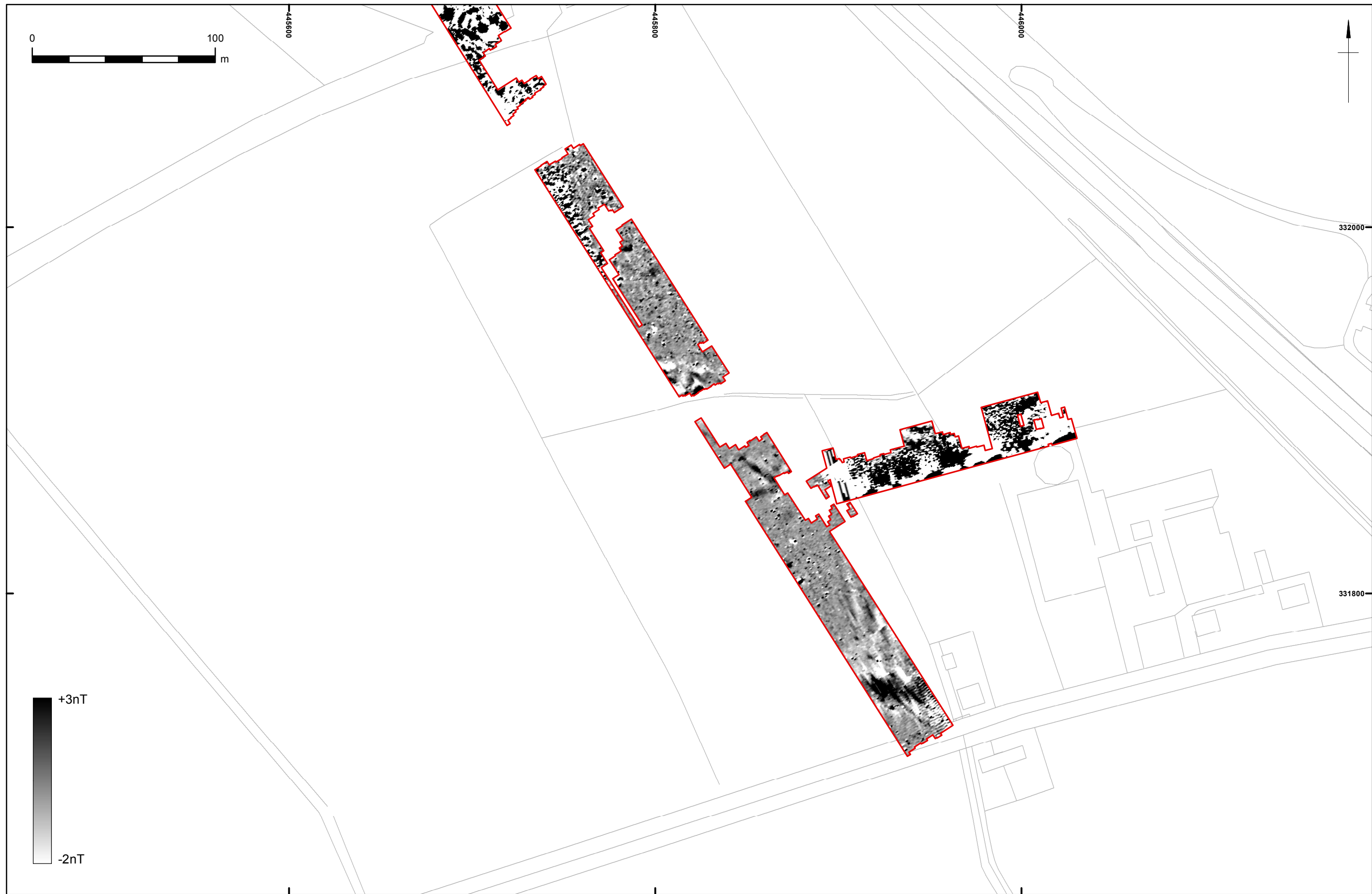
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Greyscale (central section)

Figure 3



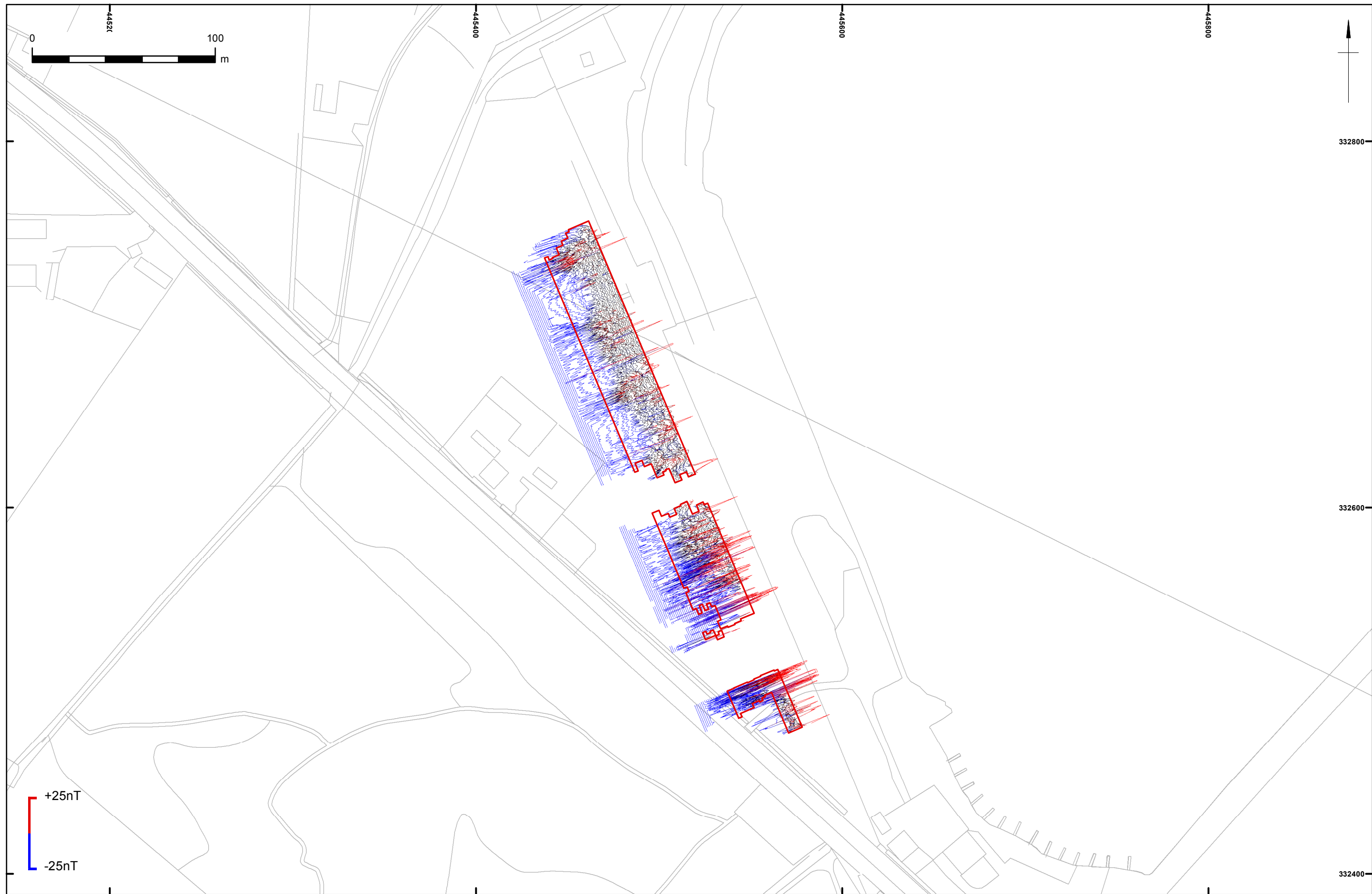
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Greyscale (southern section)

Figure 4



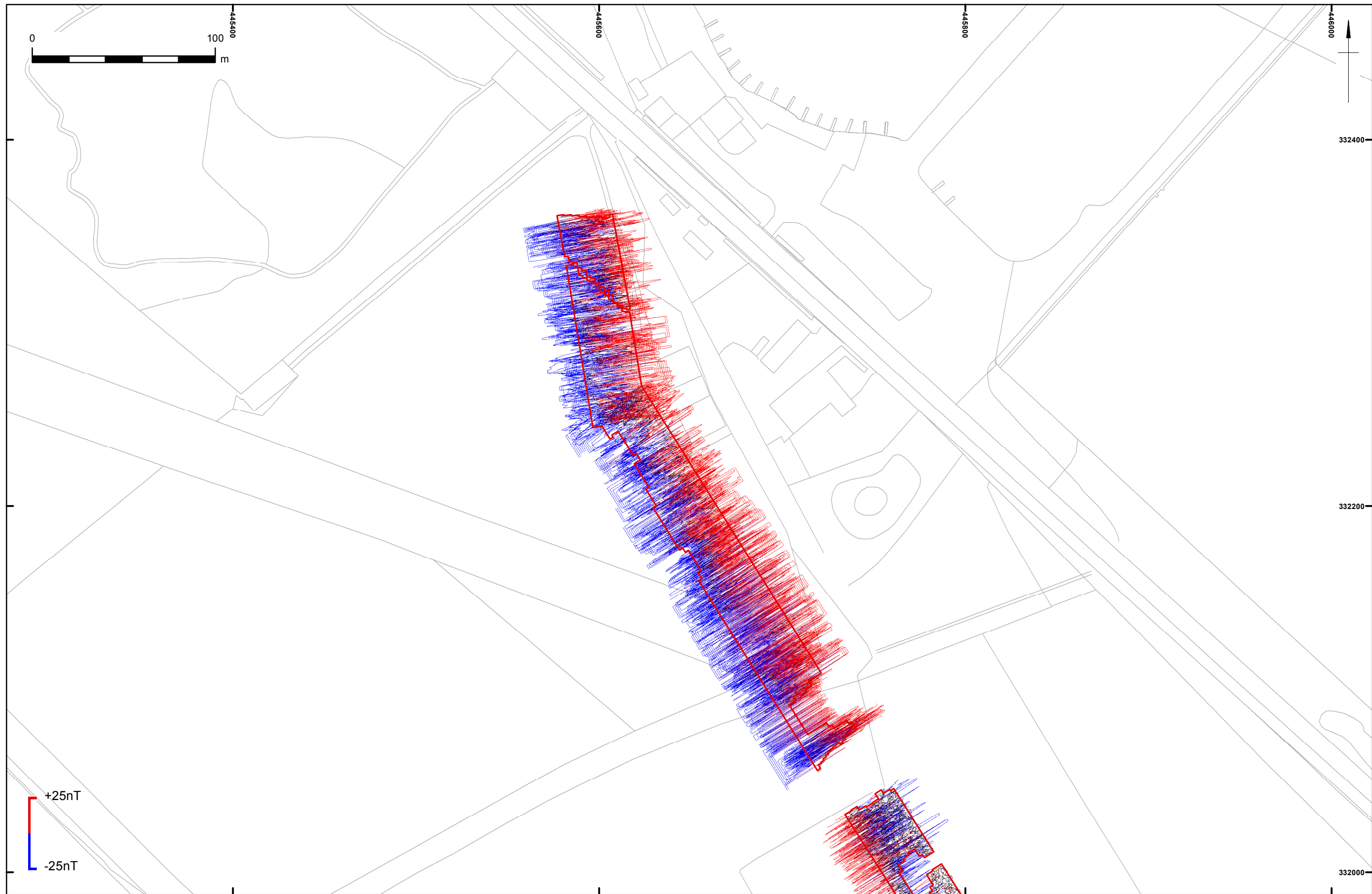
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XY trace (northern section)

Figure 5



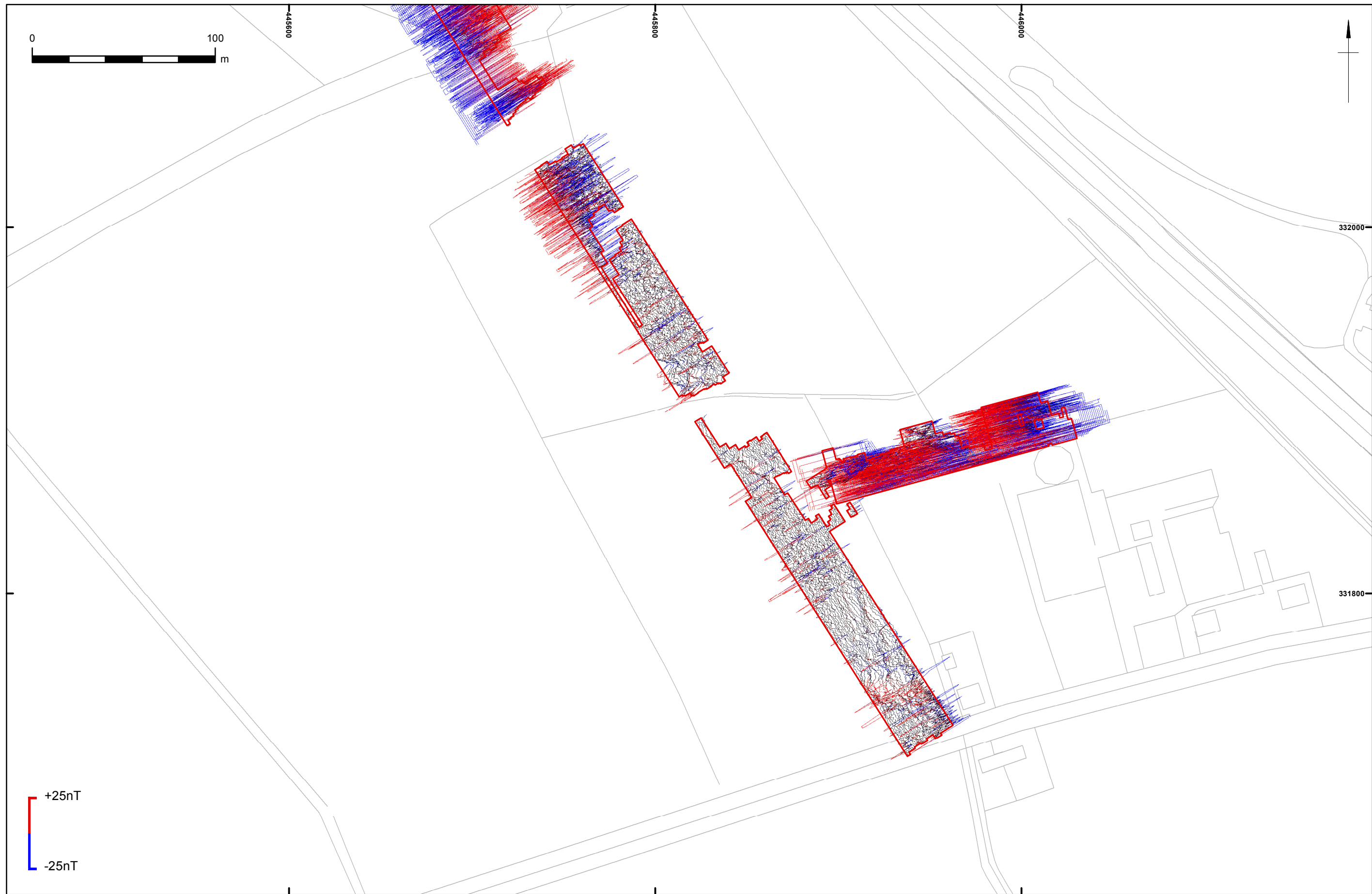
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XY trace (central section)

Figure 6



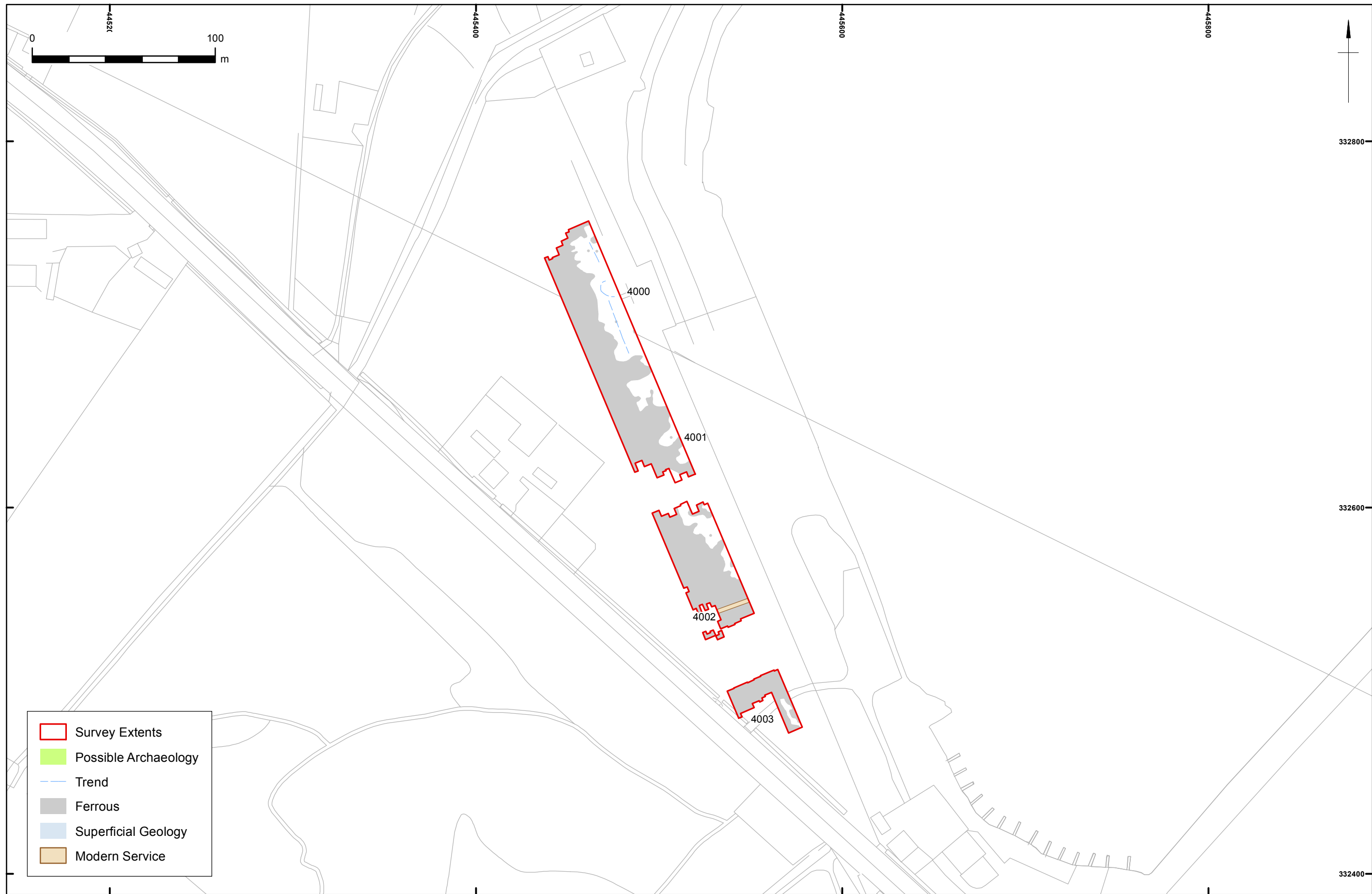
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XY trace (southern section)

Figure 7



- Survey Extents
- Possible Archaeology
- Trend
- Ferrous
- Superficial Geology
- Modern Service

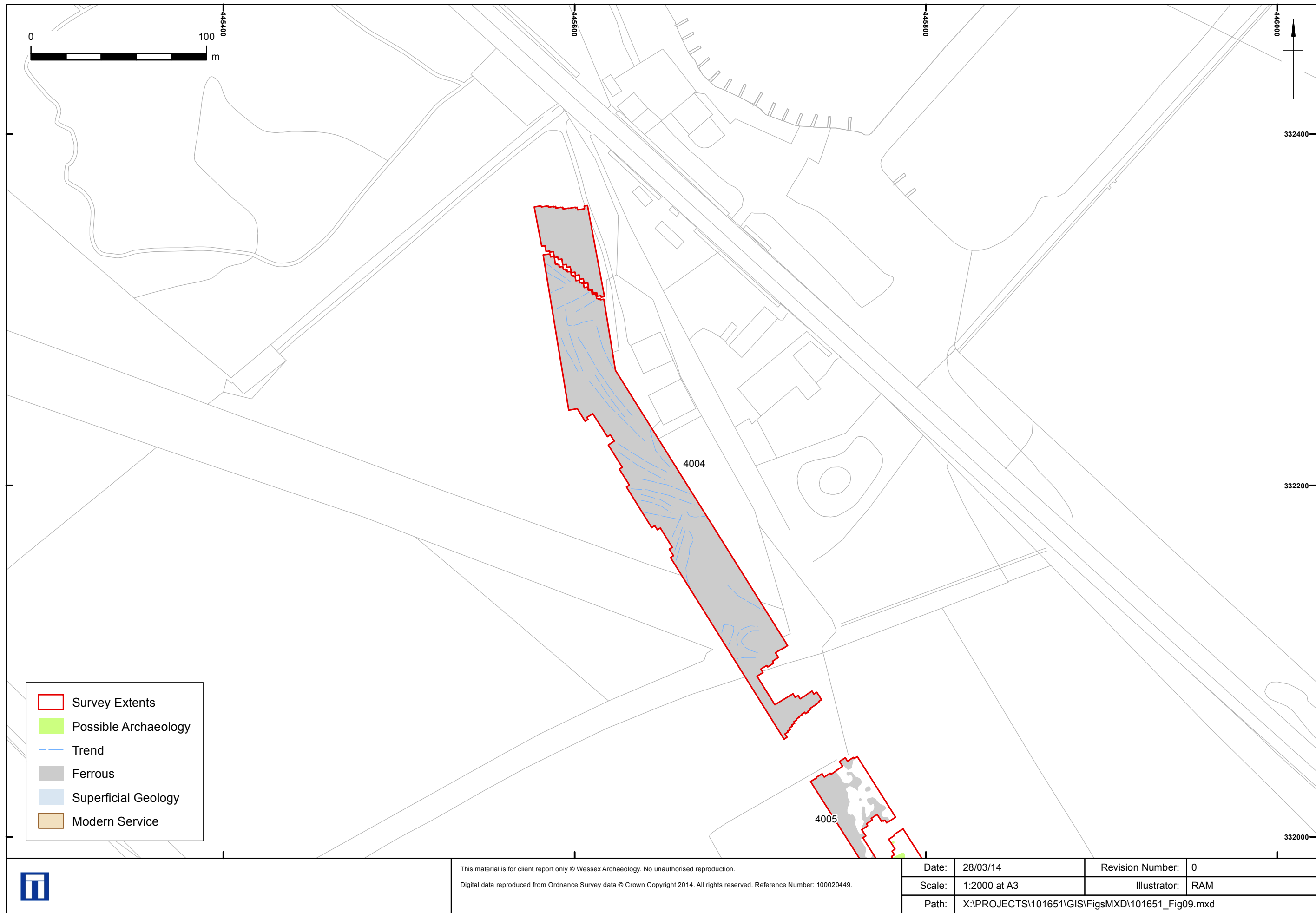


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Interpretation (northern section)

Figure 8



Interpretation (central section)

Figure 9



Interpretation (southern section)

Figure 10



salisbury rochester sheffield edinburgh



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