SUFFOLK ARCHAEOLOGY
• A HISTORY OF EXPERTISE •

Mildenhall Community Hub

Mildenhall, Suffolk

Client:
Suffolk County Council

Date:
October 2016

MNL 778
Geophysical Survey Report
SACIC Report No. 2016/080
Author: Timothy Schofield HND BSc MCIfA

Mildenhall Community Hub, Mildenhall, Suffolk
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Author: Timothy Schofield

Illustrator: Timothy Schofield

Editor: Stuart Boulter

Report Date: October 2016

HER Information

Site Code:	**MNL 778**
Site Name:	**Mildenhall Community Hub, Mildenhall, Suffolk**
Report Number	**2016/080**
Planning Application No:	**TBC**
Date of Fieldwork:	**September 2016**
Grid Reference:	**TL 7036 7472**
Oasis Reference:	**272908**
Curatorial Officer:	**Rachael Abraham**
Project Officer:	**Timothy Schofield**
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Disclaimer

Any opinions expressed in this report about the need for further archaeological work are those of Suffolk Archaeology CIC. Ultimately the need for further work will be determined by the Local Planning Authority and its Archaeological Advisors when a planning application is registered. Suffolk Archaeology CIC cannot accept responsibility for inconvenience caused to the clients should the Planning Authority take a different view to that expressed in the report.

Prepared By: Timothy Schofield
Date: October 2016

Approved By: Stuart Boulter
Position: Senior Project Officer
Date: October 2016
Signed:

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Summary

From the 27th September to the 12th October 2016 Suffolk Archaeology Community Interest Company undertook a detailed fluxgate gradiometer survey at the Mildenhall Community hub site immediately adjacent to West Row Road in Mildenhall, Suffolk. Four fields suitable for survey, comprising two arable fields and two school playing fields, were prospected for anomalies of archaeological origin.

The detailed fluxgate gradiometer survey recorded anomalies of potential archaeological origin in all four fields, with the highest potential for archaeological remains located in the southern half of Field 1 and across the majority of Field 2.

Further archaeological investigations should be undertaken within all four fields, targeting anomalies recorded by the fluxgate gradiometer and also blank areas of the geophysical dataset to determine whether archaeological features remain undetected below the ploughsoil.

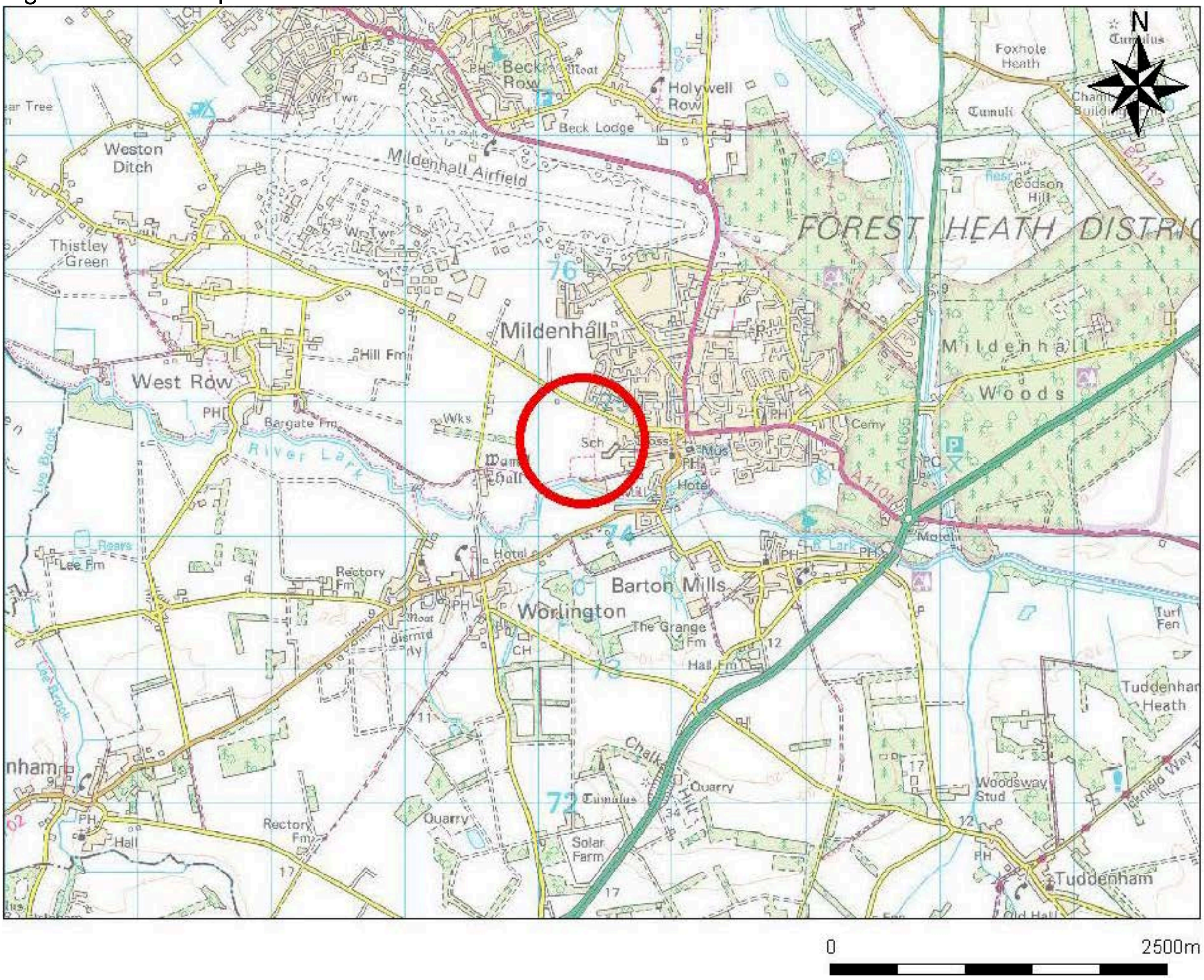
1. Introduction

In September and October 2016 detailed fluxgate gradiometer survey covering *c*. 22.5 hectares on four fields adjacent to West Row Road, Mildenhall, Suffolk (Fig.1) was undertaken by Suffolk Archaeology Community Interest Company (SACIC).

The detailed fluxgate gradiometer survey was requested by Suffolk County Council Archaeology Service/Conservation Team (SCCAS/CT). The scope of the project was originally detailed in a Brief (dated 11/08/2016) produced by the archaeological adviser to the LPA, Rachael Abraham (of SCCAS/CT) and then addressed by a SACIC Written Scheme of Investigation (Schofield, 2016, Appendix 4).

Suffolk Archaeology CIC were commissioned to undertake the work by Suffolk County Council.

Figure 1. Location plan



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2. Geology and topography

The site is located on the western edge of Mildenhall (TL 7036 7472) in four separate fields comprising an area of *c*. 22.5 hectares, bounded to the north by West Row Road, to the east by a housing estate, to the south by farmland and the River Lark and to the west by agricultural fields. The survey area slopes from 11m AOD in the northeastern corner down to 6m AOD in the northwestern corner.

The two western fields are believed to have been under agricultural use for the last few centuries for both grazing, allotments and crop production, they are currently under arable cultivation. Two playing fields belonging to Mildenhall College Academy Sixth Form were surveyed on the eastern half of the site.

The bedrock geology is described as Zig Zag Chalk Formation, formed approximately 94 to 100 million years ago during the Cretaceous Period in warm chalk seas. No superficial deposit records were available at the time of writing (BGS, 2016).

3. Archaeology and historical background

The site lies within an area of archaeological interest defined by information held within the Suffolk Historic Environment Record and also described within a brief issued by SCCAS/CT (Abraham, 2016), a geophysical survey followed by a subsequent targeted trial trench evaluation (separate WSI) was requested, prior to submission of the planning application.

Fieldwalking and metal detector surveys in the surrounding area have recovered artefactual material spanning from the prehistoric through to the medieval periods (MNL 141, 167, 220, 310, 421 and 428). The site overlooks the River Lark on a south facing slope which is topographically favourable for early settlement. On the opposing river bank lies a significant Iron Age settlement (BTM 040) and Neolithic and Bronze Age settlement activity (MNL 710) with human burials further recorded during the excavations. The archaeological potential for this development site is therefore considered high.

4. Methodology

Instrument type

A Bartington DualGRAD 601-2 fluxgate gradiometer was employed to undertake the detailed geophysical survey, the weather, ground and geological soil conditions were found to be suitable for survey.

Instrument calibration and settings

The magnetic susceptibility of the soil was found to be relatively noisy across the fields with a high degree of magnetic disturbance present, a suitable area (to correct diurnal drift) was located in the centre of each field. One hour was allocated to allow the instruments sensors to reach optimum operating temperature before the survey commenced. The weather was sunny and overcast with periods of short precipitation. Instrument sampling intervals were set to 0.25m along 1m traverses (four readings per metre).

Survey grid layout

The detailed survey was undertaken within 20m grids (Fig. 2, blue grid), orientated *c.* east to west and geolocated employing a Leica Viva GS08+ Smart Rover RTK GLONASS/GPS, allowing an accuracy of +/- 0.01m. Data were converted to National Grid Transformation OSTN02.

Data capture

Detailed fluxgate gradiometer survey data points were recorded on an internal data logger that were downloaded and checked for quality at midday and in the evening, allowing grids to be re-surveyed if necessary. A pro-forma survey sheet was completed to allow data composites to be created. Data were filed in unique project folders and backed-up onto an external storage device and then a remote server in the evening.

Data software, processing and presentation

Despite the relatively high degree of background magnetic noise good quality raw survey data was collected, allowing minimal data processing to be required. Datasets were composited and processed using DW Consulting's Terrasurveyor v.3.0.29.3, the raw grid files, composite and raster graphic plots will be stored and archived in this format. Minimal processing algorithms were undertaken on the raw (Fig's. 3a, 4a, 5a, 6a and 7a) and processed datasets (Fig's. 3b, 4b, 5b, 6b and 7b); schedules are presented in Appendix 1.

Data composites were exported as raster images into AutoCAD, an interpretation plan based on the combined results of the raw, processed and xy trace plots (Fig's. 3c, 4c, 5c, 6c and 7c) has been produced (Fig's. 3d, 4d, 5d, 6d and 7d). A combined processed magnetometer greyscale and interpretation plot has further been produced (Fig's. 8 and 9) to enable the entire survey to be viewed.

Survey grid restoration

Eight virtual survey grid stations were placed on survey grid nodes along the baselines of the four fields (Fig. 2), this will allow the position of the grid and the geophysical anomalies to be accurately relocated.

5. Results and discussion

The fluxgate gradiometer survey was successful in locating anomalies of potential archaeological derivation. Areas of magnetic disturbance (grey hatching) caused by ferrous objects from agricultural practices and field boundary furniture and isolated dipolar responses (grey spots) were prospected in all of the fields, 'iron spike' responses are likely to be caused by buried ferrous debris present within the topsoil horizon.

Field 1, North (Fig's 3a – 3d)

Field 1 was the largest of the four (14.38 hectares) and was located in the northwestern corner of the survey area. It had a relatively high magnetic background signature due to agricultural practices undertaken within it. The ploughsoil has been manured over the last few decades with ceramic building material and pottery observed throughout the ploughsoil in this field. The field had been previously cropped with potatoes whose furrows can be clearly seen in the dataset running *c.* north-south. This field was also formerly split up into large allotment plots that are labelled from the 1904 Ordnance Survey map and appear on the 1945 RAF air photographs. One building structure is also depicted on the 1904 Ordnance Survey map to the west of the trackway.

Two large areas of magnetic disturbance (grey hatching) are located within the field, one of which is oval and the second linear. The oval area is located in the entrance of the field and is likely to relate to magnetic rubble material laid down to provide traction to farm vehicles accessing the plot, or may indicate remnants of the stockpiling of manure to improve the field's ploughsoil. A linear area of magnetic disturbance that bisects the field is aligned north to south; it is clearly visible as a cambered earthwork and is further depicted on the First Edition 1882 Ordnance Survey map terminating in the southern half of Field 1. This trackway is recorded on top of one parallel running linear anomaly (red hatching).

Two strong dipolar linear responses (dark blue lines) were recorded in the northern half of Field 1, indicative of ferrous service pipes, the first is orientated northeast to southwest and the second (associated with extant manhole covers and recorded as stronger dipole readings) is aligned north-northeast to south-southwest. The magnetic signature of the two anomalies are quite distinct, the first is a narrower and stronger dipolar response suggesting that the anomaly is buried nearer to the ground surface and may be less substantial in width. The second has a broader wavelength and is of a lower magnitude which indicates that it is likely to have been buried deeper and/or may be a wider gauge service pipe.

Four broad weakly positive linear and curvilinear responses (dark green hatching) have also been recorded. These are characteristically indicative of geological anomalies; a likely cause in this case is the glacial infill of magnetic material within natural hollows of the lower magnetically susceptible chalk bedrock.

Nine isolated positive anomalies (orange hatching) have been recorded in the northern half of Field 1, that are commonly indicative of archaeological pits containing magnetic backfills. The largest response located approximately in the centre of the dataset is worthy of particular note.

Six positive linear and curvilinear anomalies (red hatching) have been prospected in the northern half of Field 1. The largest response is orientated west-southwest to east-northeast and is visible as an extant depression indicative of a relic ditch boundary on a similar alignment to the current field configuration. To the north lies a second parallel running positive linear anomaly that is narrower in character and forms an enclosure with a perpendicular running positive linear anomaly recorded parallel to the linear area of magnetic disturbance (trackway, grey hatching). A smaller weak positive curvilinear trend is located in the north-eastern corner of Field 1, this response becomes lost within the dipolar linear service run (dark blue line). A shorter narrow linear anomaly was prospected in the centre of the plot, to the east of which a relatively strong broad curving positive anomaly indicative of a ring-ditch type anomaly was further recorded. None of the positive linear anomalies are depicted on cartographic sources.

Field 1, South (Fig's 4a – 4d)

The linear area of magnetic disturbance (grey hatching) continues before terminating 100m before the southern boundary; it is depicted as a trackway on the 1882 to 1983 Ordnance Survey maps.

Three dipolar linear trends (dark blue lines) were prospected in the southern half of Field 1, two of which are described above. The third dipolar linear trend is orientated west-northwest to east-southeast; it is similar in character to the narrow strong dipolar service pipe orientated northeast to southwest in the north of Field 1.

Eight positive discrete anomalies (orange hatching) indicative of archaeological pits are recorded in the southern half of the field, located in close proximity and possibly associated with the positive linear anomalies (red hatching).

A series of (twenty-one) intermittent weak positive linear anomalies (red hatching) were recorded predominantly in the southwestern corner of Field 1, prospected either on a northeast to southwest or perpendicular alignment. These anomalies are intermittent in character which may indicate that agricultural activity, in particular recent deep potato furrow cropping, has caused some truncation to these potential archaeological features. It is possible that only the magnetic backfill within the ditches has been recorded, with the remaining ditch fill containing non-magnetic material that offers no contrast with the magnetic background readings.

Field 2 (Fig's 5a – 5d)

Field 2 is located to the south of Field 1 and covers an area of 5.63 hectares, its magnetic background was relatively high and of a similar magnitude to that prospected in the northern field.

A linear area of magnetic disturbance that bisects the field on a north-south alignment is recorded as a trackway on the First Edition 1882 Ordnance Survey map, it was observed in the field as a slight positive earthwork and is similar in character to the trackway recorded in Field 1.

A plethora of positive discrete anomalies (orange hatching) have been recorded by the fluxgate gradiometer in Field 2. Many of which are clustered in and around the positive perpendicular linear anomalies (red hatching) interpreted as potential settlement ditches. Their proximity to these settlement ditches increases the likelihood that they are of an archaeological origin.

Two negative linear anomalies (cyan hatching) were recorded in the dataset, the first of which is located on the western extent of the dataset orientated north to south and is of probable agricultural origin. It is possible that this anomaly could be the remains of a bank associated with a field boundary ditch that may be present to the west of the dataset. Alternatively, it could be the remains of a ditch that has been backfilled in reverse stratigraphic sequence with the non-magnetic chalk at the top of the ditch. The second negative linear anomaly is associated with a positive linear anomaly recorded on the same alignment (northeast to southwest) and appears to 'cut' through earlier positive linear anomalies. It is very straight and appears to run towards the school, therefore a modern derivation cannot be ruled out.

The parallel and perpendicular positive linear anomalies (red hatching) recorded in Field 2 are more extensive than those present in Field 1. These ditch-type anomalies have been arranged forming enclosures to the north of the River Lark. Associated discrete positive anomalies, likely to be related archaeological pits, have been recorded within and around the enclosure ditches.

Field 3 (Fig's 6a – 6d)

Field 3 is the smallest of the four fields and is located to the north of the sixth form college buildings, it has a total area of 1.55 hectares. The magnetic background of the soil here was relatively quiet, despite the field being used as a cricket and sports pitch. This field was employed for arable farming prior to the construction of the school in 1939.

Six areas of magnetic disturbance (grey hatching) were recorded, four oval areas of magnetic disturbance represent accumulations of magnetic material recorded within the field. The narrow rectangular anomaly towards the centre of the field delimits the all-weather cricket pitch that is orientated north to south. One dipolar linear anomaly interpreted as a ferrous service run terminates near to the all-weather cricket pitch before following a southerly course beyond the extent of the survey area.

Eight positive linear anomalies (green lines) were recorded, orientated north to south. Slight depressions noted by the surveyors in Field 3 may correlate with the locations of these trends. It is most likely that these linears are former agricultural strip fields or furrows.

Two positive linear anomalies (red hatching) were recorded in Field 3. They are orientated northeast to southwest and perpendicular, with one forming a corner. It is possible that these are archaeological ditches, however an agricultural or more modern origin cannot be ruled out.

Field 4 (Fig's 7a – 7d)

Field 4 is located to the south of the sixth form college buildings, and covers an area of 2.54 hectares, of all the fields surveyed this had the highest magnetic background signature. The field had formerly been set aside to agriculture, followed by the creation of allotment gardens, prior to the construction of the school. It is currently used as a sports field with hardcourts, football posts and athletics paraphernalia situated within its bounds.

Two areas of 'dummy' readings, rectangular in shape have been recorded where extant ferrous goal posts were located within the playing field, that could not be removed prior to the survey.

Three areas of magnetic disturbance (grey hatching) were recorded in the dataset; the northwestern area records the presence of a 9ft high tennis hard court fence. Magnetic debris is likely to have caused the response on the southern boundary and a high jump runway has caused the large area of disturbance in the southwestern corner.

One rectangular area of magnetic enhancement (magenta hatching) has been prospected in the northeastern corner of the playing field. There was no obvious markings or topographic furniture present in this area, however it is likely to relate to modern activity. It may be associated with a line of four isolated dipolar anomalies (grey spots) prospected to its east.

One positive linear (orientated northeast to southwest) and a curvilinear trend (red hatching) are potentially archaeological ditch-type anomalies, however a geological or agricultural origin cannot be ruled out.

6. Conclusion

Anomalies of potential archaeological origin were recorded in all four fields surveyed, with the highest potential for archaeological remains likely to be located in the southern half of Field 1 and across the majority of Field 2. Further archaeological investigations should be undertaken within all four fields, targeting anomalies recorded by the fluxgate gradiometer and also blank areas of the geophysical dataset to determine whether archaeological features remain undetected below the ploughsoil.

7. Archive deposition

The paper, and digital archive will be kept at the SACIC office in Needham Market, before deposition in the Suffolk County Council Stores in Bury St Edmunds.

8. Acknowledgements

The fieldwork was carried out by Tim Schofield and Ed Palka and directed by Tim Schofield.

Project management was undertaken by Rhodri Gardner.

The report illustrations were created by Tim Schofield and the report was edited by Stuart Boulter.

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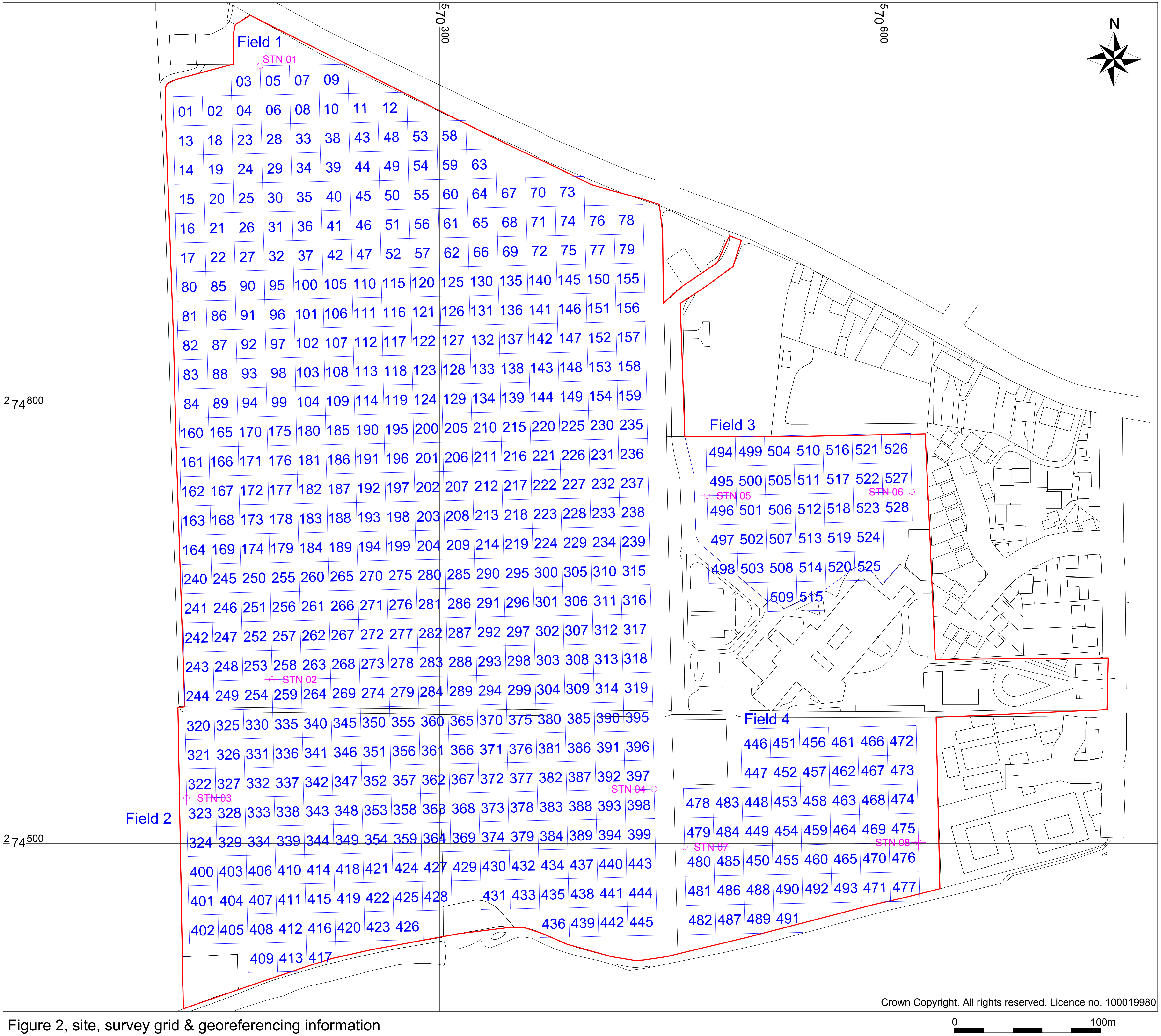

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STN 02	570185.424	274612.192
STN 03	570126.976	274531.052
STN 04	570446.917	274537.215
STN 05	570483.057	274737.948
STN 06	570623.031	274740.645
STN 07	570467.683	274497.607
STN 08	570627.654	274500.689

Figure 2, site, survey grid & georeferencing information

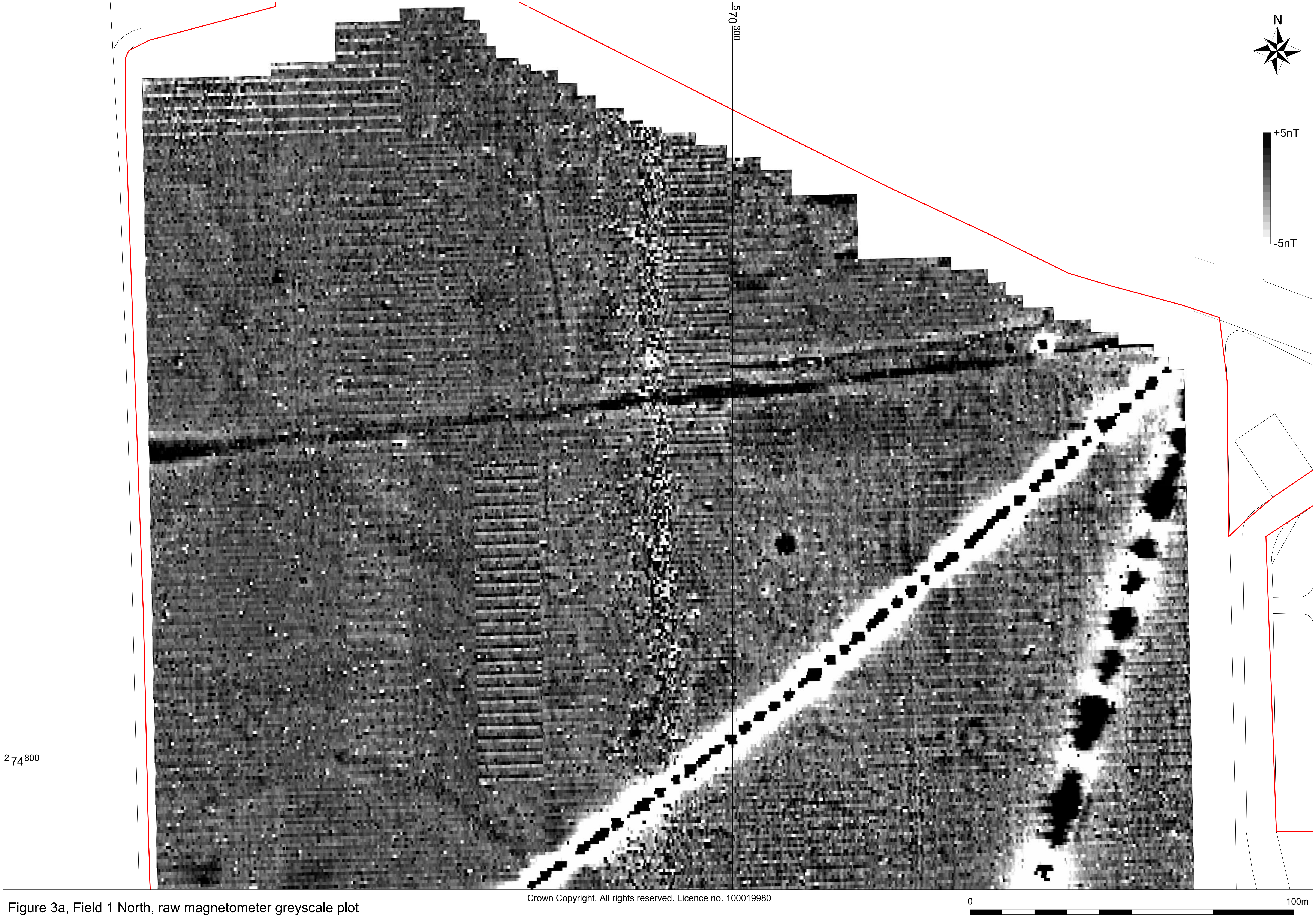

Figure 3a, Field 1 North, raw magnetometer greyscale plot

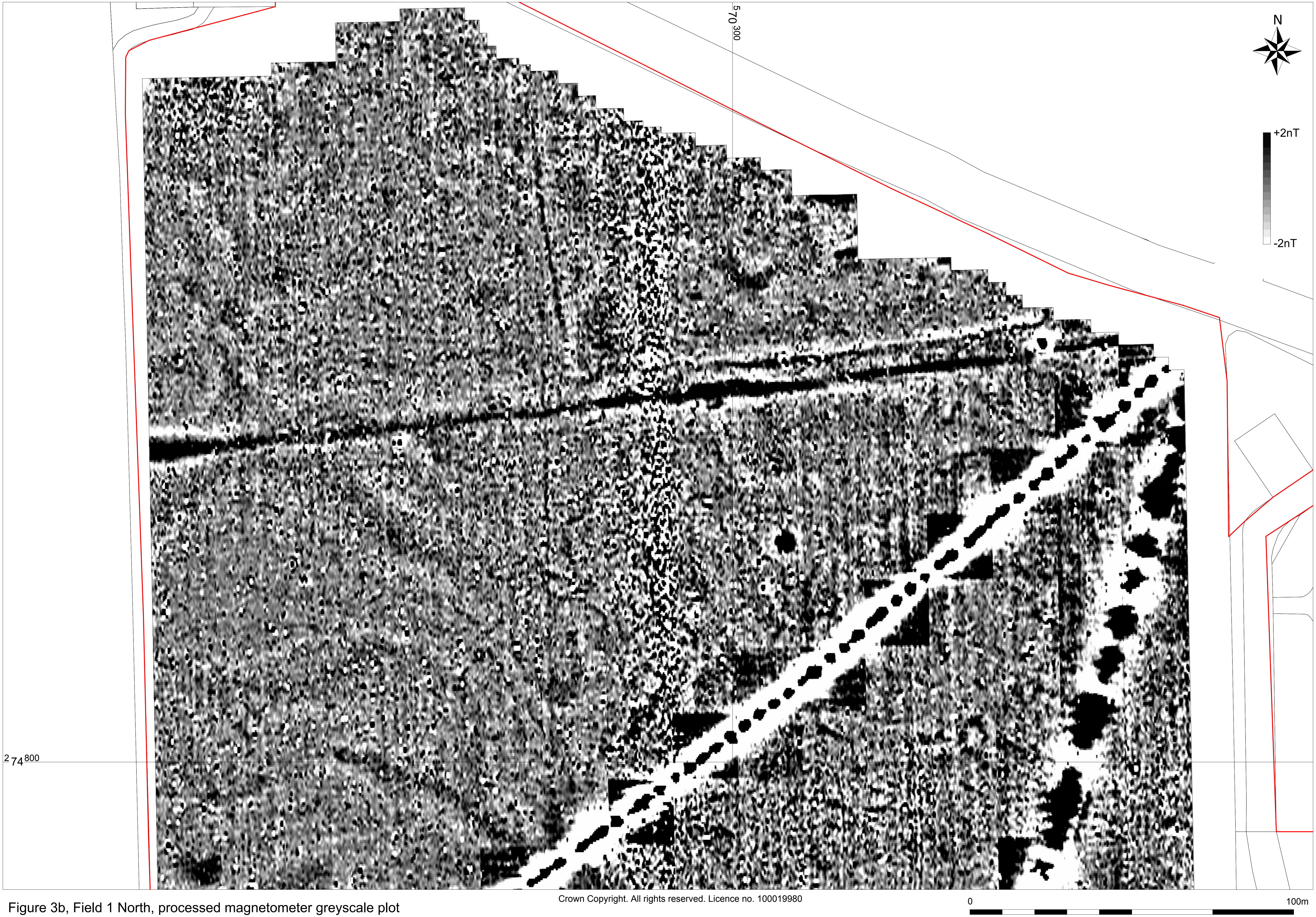

Figure 3b, Field 1 North, processed magnetometer greyscale plot

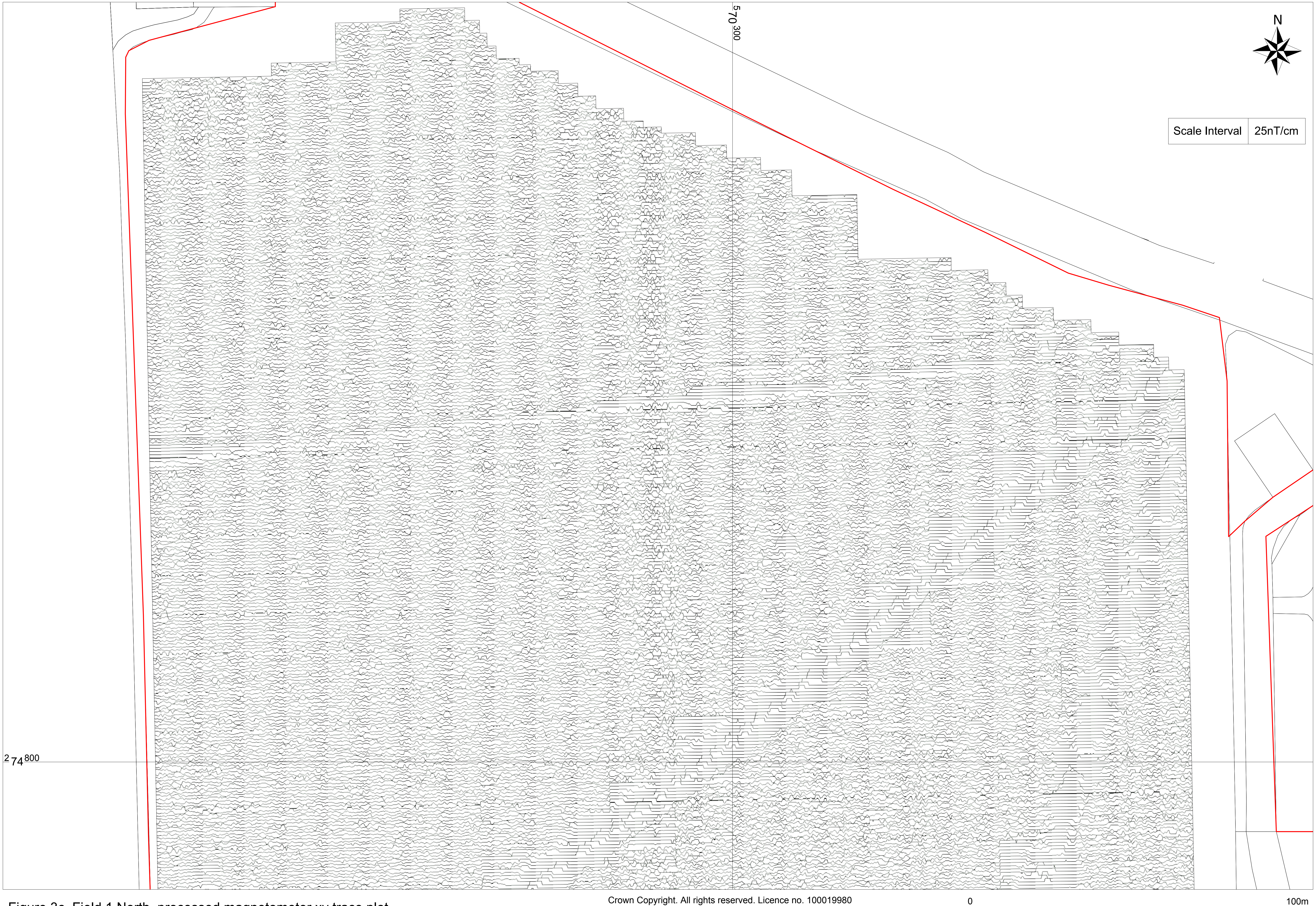

Figure 3c, Field 1 North, processed magnetometer xy trace plot

Figure 3d, Field 1 North, interpretation plot of magnetometer anomalies

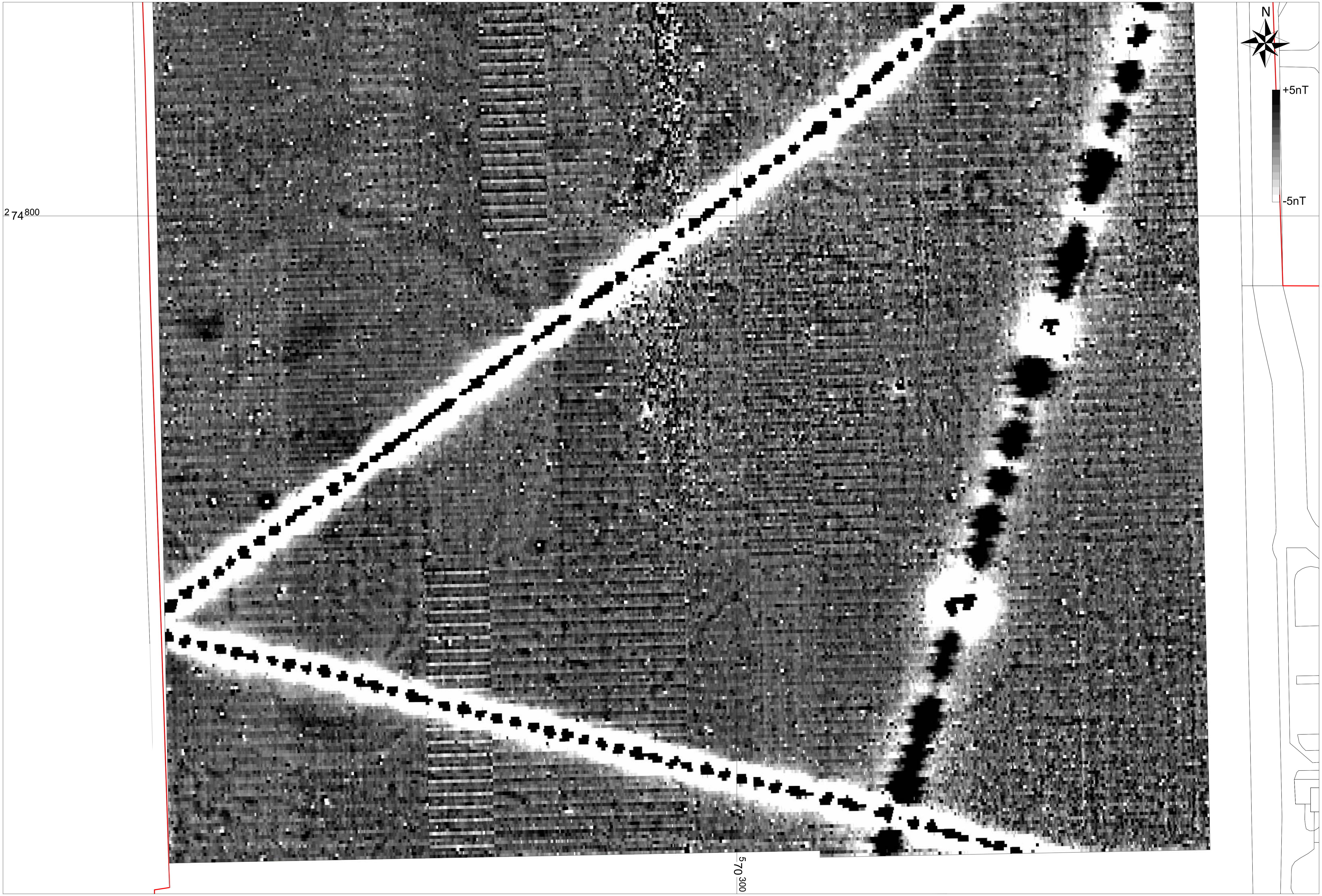

Figure 4a, Field 1 South, raw magnetometer greyscale plot

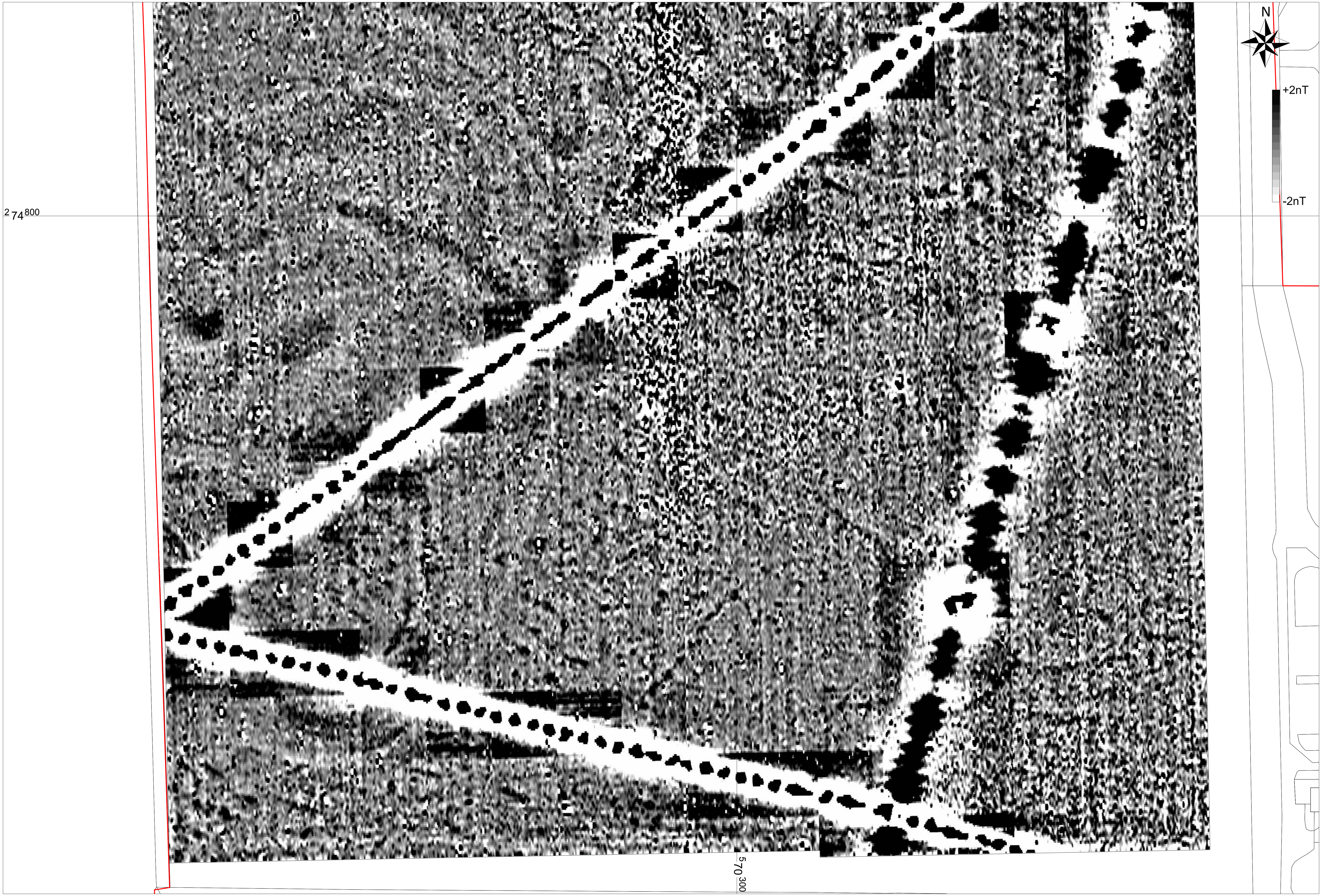

Figure 4b, Field 1 South, processed magnetometer greyscale plot

Figure 4c, Field 1 South, processed magnetometer xy trace plot

0 100m

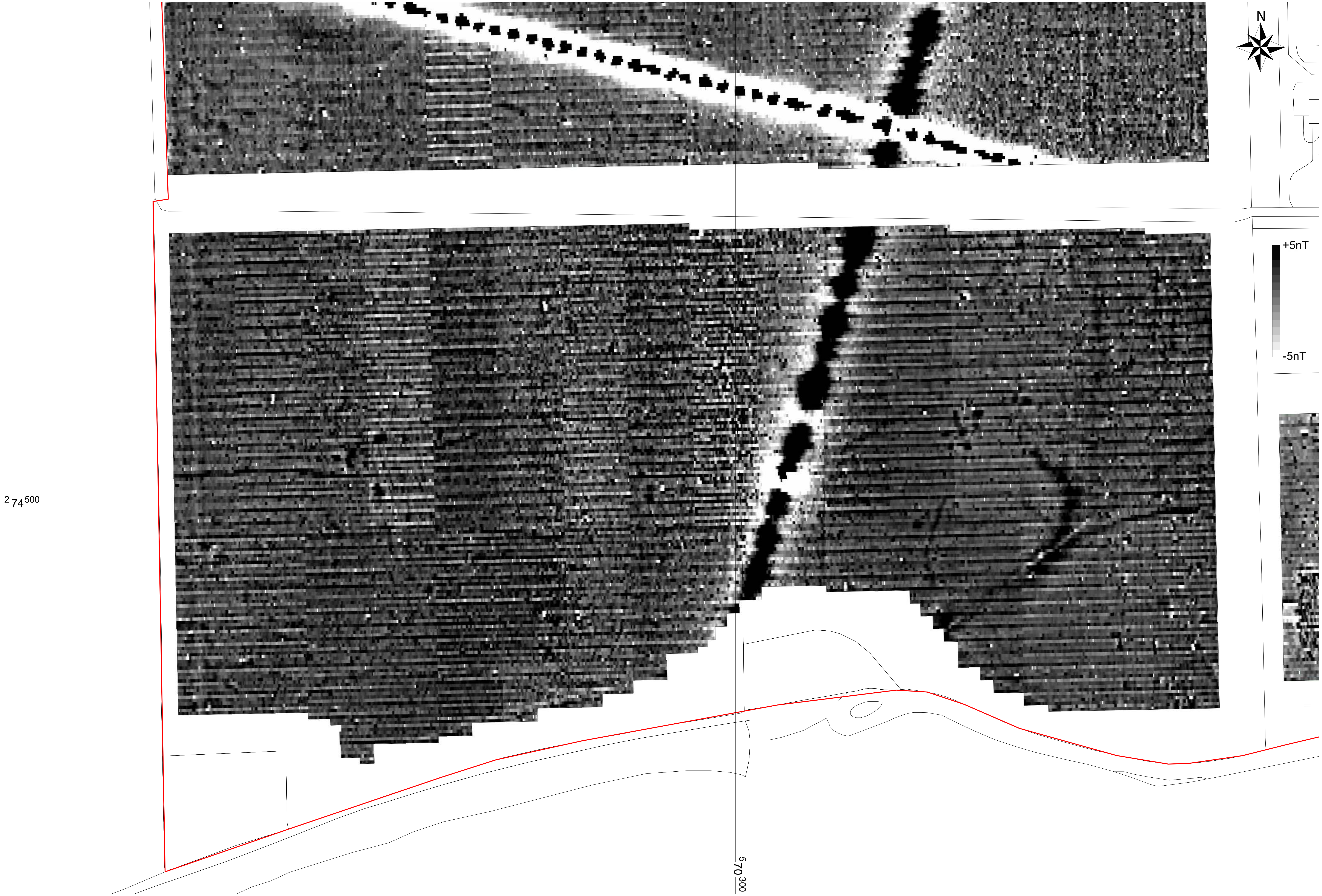

Figure 5a, Field 2, raw magnetometer greyscale plot

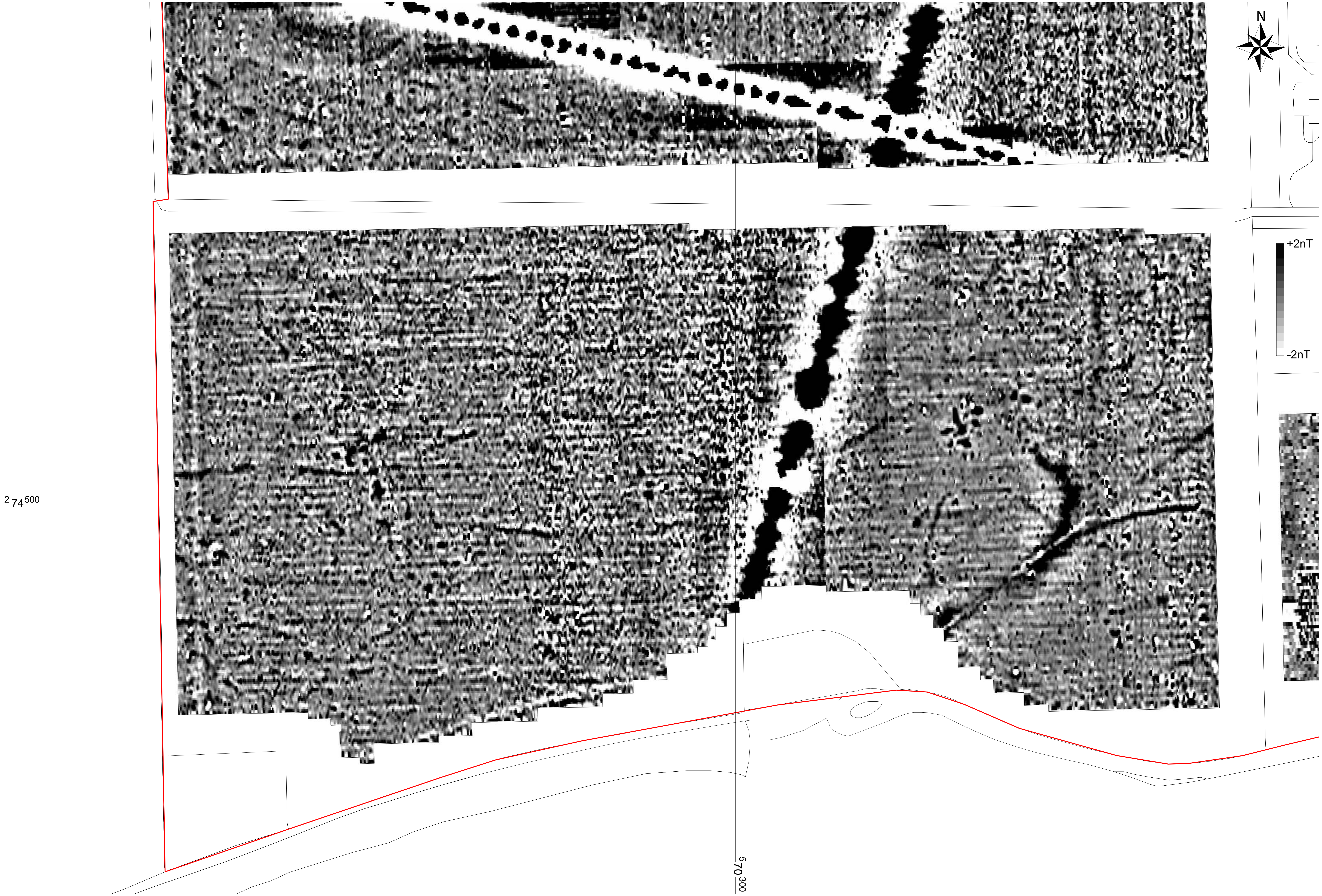

Figure 5b, Field 2, processed magnetometer greyscale plot

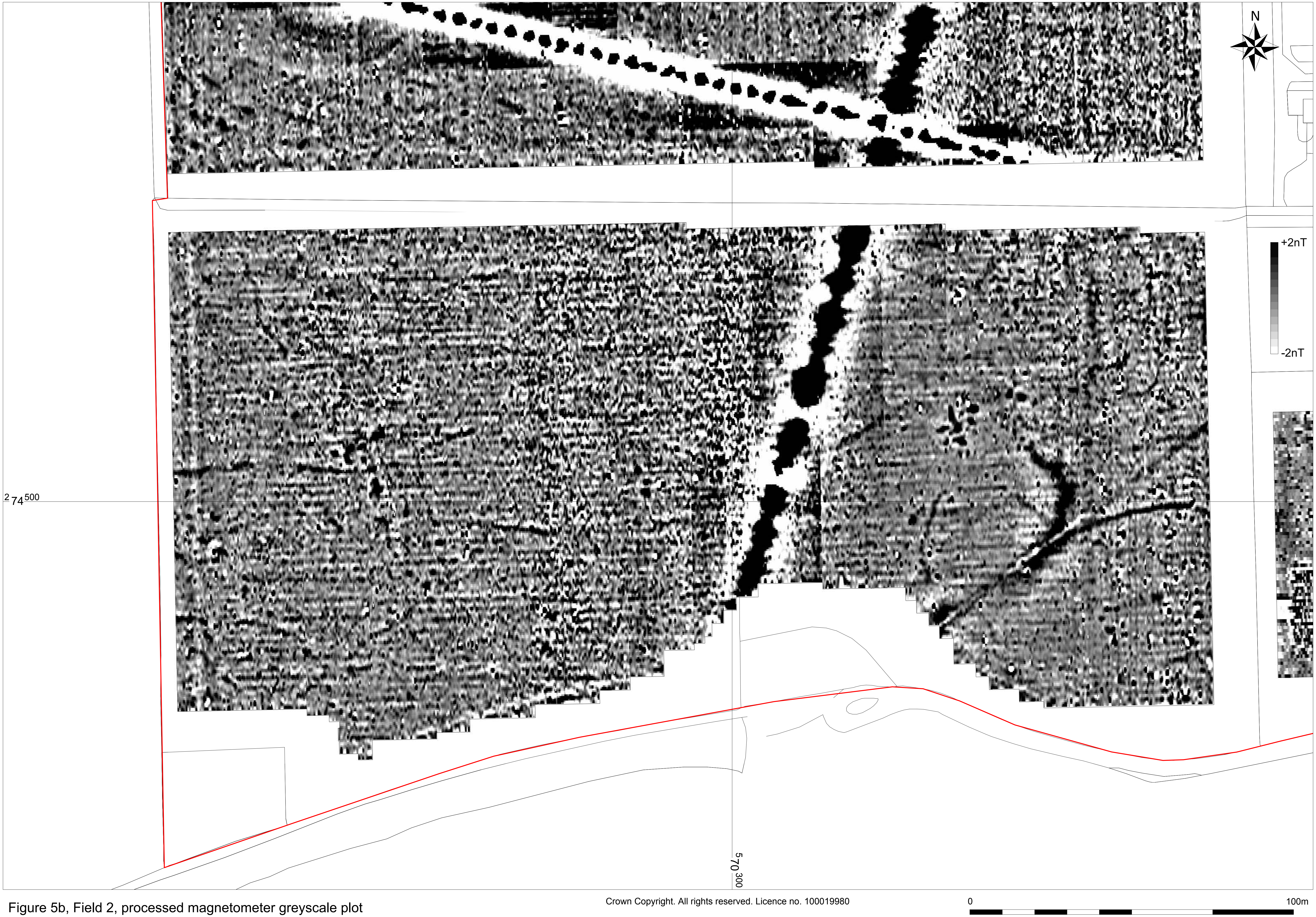

Figure 5b, Field 2, processed magnetometer greyscale plot

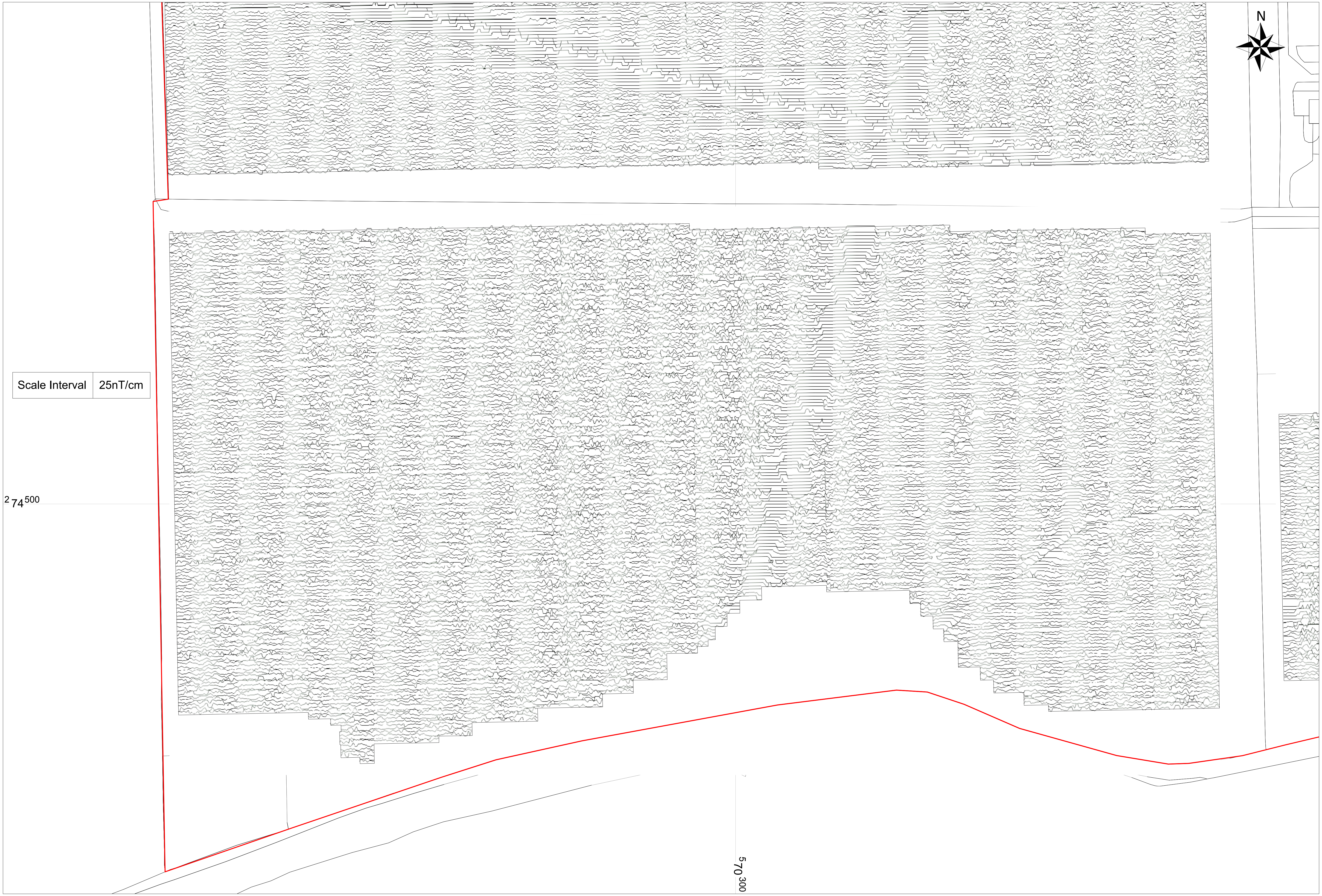

Figure 5c, Field 2, processed magnetometer xy trace plot

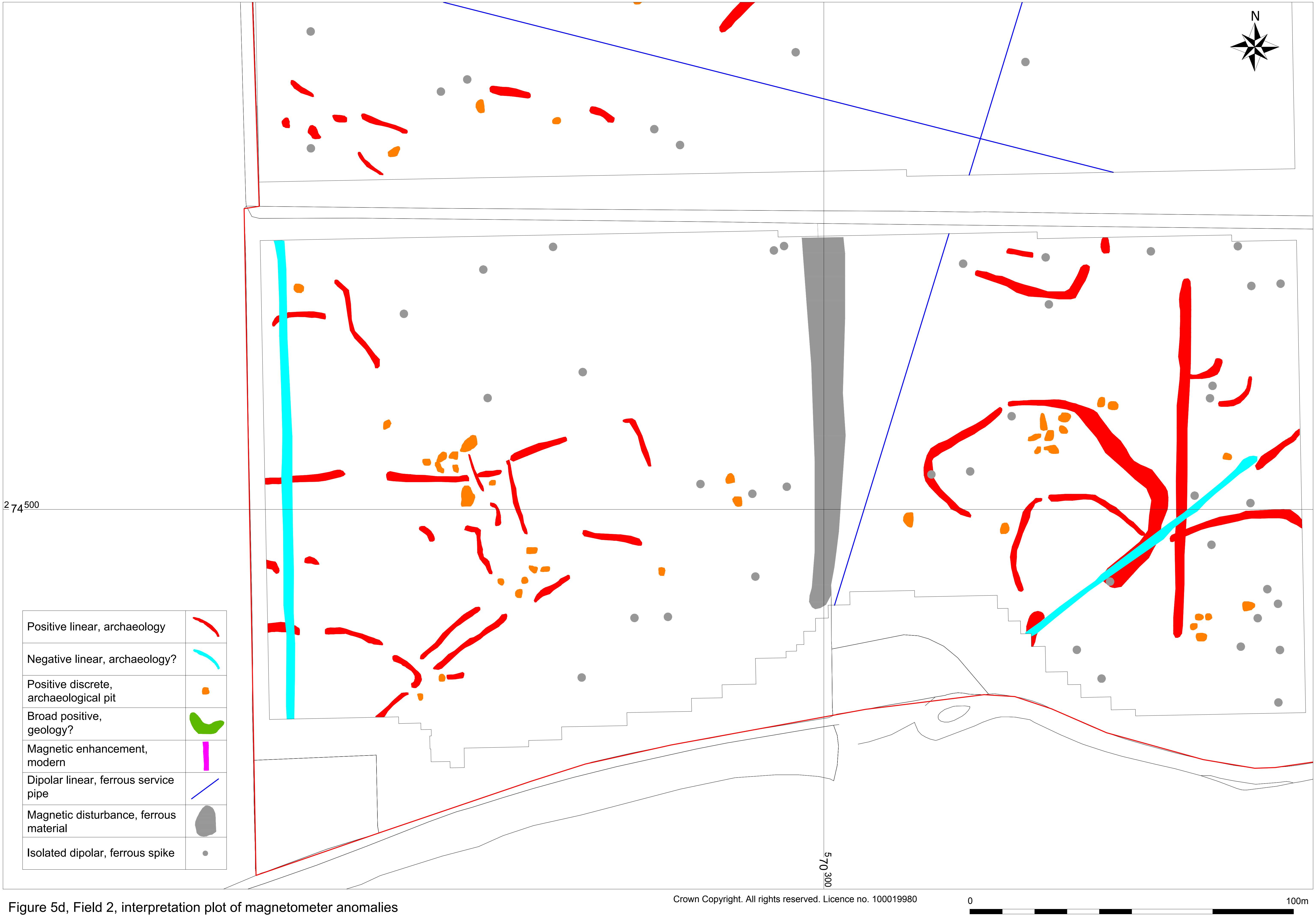

Figure 5d, Field 2, interpretation plot of magnetometer anomalies

Figure 6a, Field 3, raw magnetometer greyscale plot

Figure 6b, Field 3, processed magnetometer greyscale plot

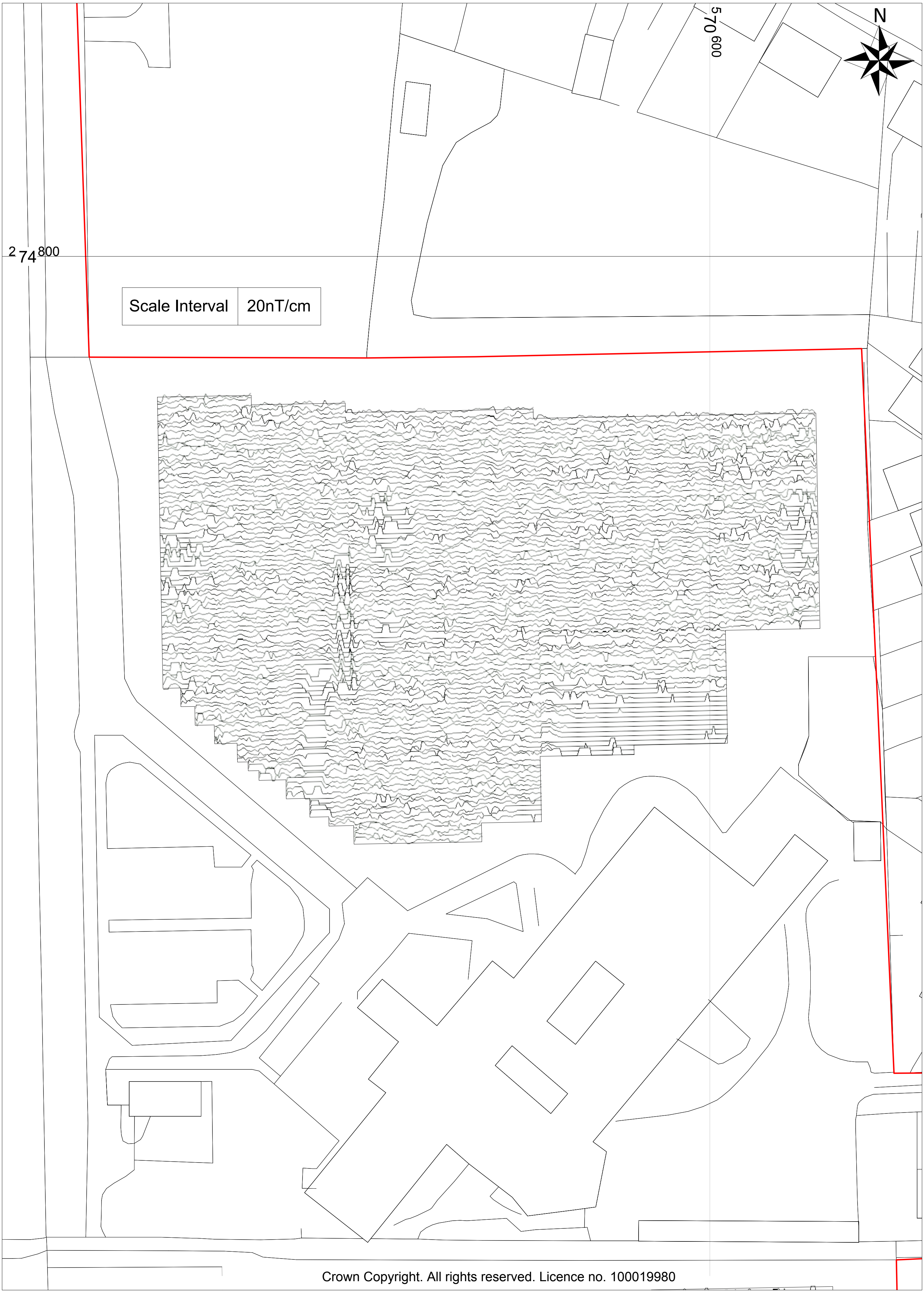

Figure 6c, Field 3, processed magnetometer xy trace plot

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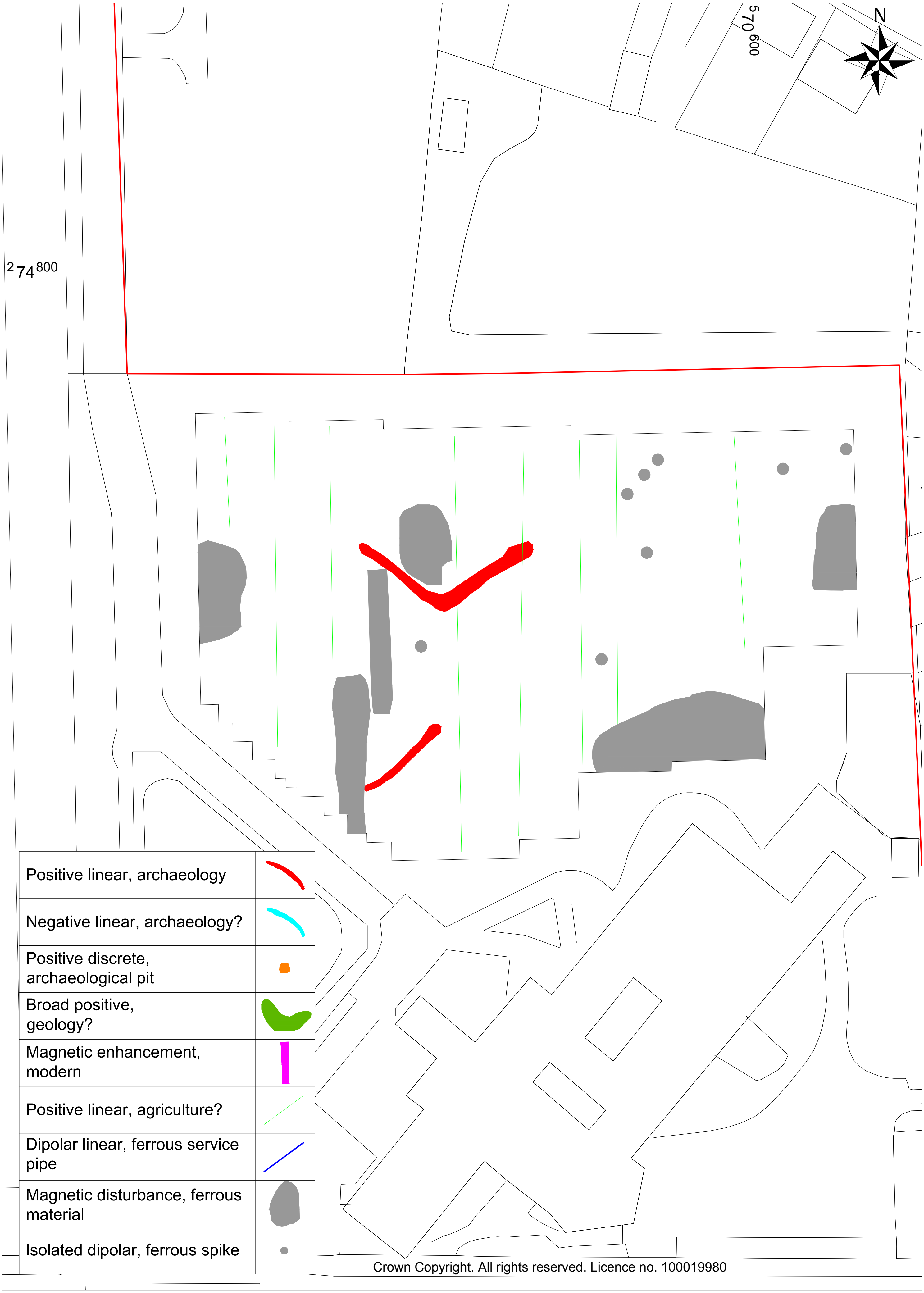

Figure 6d, Field 3, interpretation plot of magnetometer anomalies

Figure 7a, Field 4, raw magnetometer greyscale plot

Figure 7b, Field 4, processed magnetometer greyscale plot

0 50m

Figure 7c, Field 4, processed magnetometer xy trace plot

Figure 7d, Field 4, interpretation plot of magnetometer anomalies

Figure 8, Combined processed magnetometer greyscale plot

Figure 9, Combined interpretation plot of magnetometer anomalies

Appendix 1. Metadata sheets

Field 1, Grids

Source Grids: 319
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92 Col:4 Row:5 grids\36.xgd
93 Col:4 Row:6 grids\37.xgd
94 Col:4 Row:7 grids\100.xgd
95 Col:4 Row:8 grids\101.xgd
96 Col:4 Row:9 grids\102.xgd

97 Col:4 Row:10 grids\103.xgd
98 Col:4 Row:11 grids\104.xgd
99 Col:4 Row:12 grids\180.xgd
100 Col:4 Row:13 grids\181.xgd
101 Col:4 Row:14 grids\182.xgd
102 Col:4 Row:15 grids\183.xgd
103 Col:4 Row:16 grids\184.xgd
104 Col:4 Row:17 grids\260.xgd
105 Col:4 Row:18 grids\261.xgd
106 Col:4 Row:19 grids\262.xgd
107 Col:4 Row:20 grids\263.xgd
108 Col:4 Row:21 grids\264.xgd
109 Col:5 Row:0 grids\09.xgd
110 Col:5 Row:1 grids\10.xgd
111 Col:5 Row:2 grids\38.xgd
112 Col:5 Row:3 grids\39.xgd
113 Col:5 Row:4 grids\40.xgd
114 Col:5 Row:5 grids\41.xgd
115 Col:5 Row:6 grids\42.xgd
116 Col:5 Row:7 grids\105.xgd
117 Col:5 Row:8 grids\106.xgd
118 Col:5 Row:9 grids\107.xgd
119 Col:5 Row:10 grids\108.xgd
120 Col:5 Row:11 grids\109.xgd
121 Col:5 Row:12 grids\185.xgd
122 Col:5 Row:13 grids\186.xgd
123 Col:5 Row:14 grids\187.xgd
124 Col:5 Row:15 grids\188.xgd
125 Col:5 Row:16 grids\189.xgd
126 Col:5 Row:17 grids\265.xgd
127 Col:5 Row:18 grids\266.xgd
128 Col:5 Row:19 grids\267.xgd
129 Col:5 Row:20 grids\268.xgd
130 Col:5 Row:21 grids\269.xgd
131 Col:6 Row:1 grids\11.xgd
132 Col:6 Row:2 grids\43.xgd
133 Col:6 Row:3 grids\44.xgd
134 Col:6 Row:4 grids\45.xgd
135 Col:6 Row:5 grids\46.xgd
136 Col:6 Row:6 grids\47.xgd
137 Col:6 Row:7 grids\110.xgd
138 Col:6 Row:8 grids\111.xgd
139 Col:6 Row:9 grids\112.xgd
140 Col:6 Row:10 grids\113.xgd
141 Col:6 Row:11 grids\114.xgd
142 Col:6 Row:12 grids\190.xgd
143 Col:6 Row:13 grids\191.xgd
144 Col:6 Row:14 grids\192.xgd
145 Col:6 Row:15 grids\193.xgd
146 Col:6 Row:16 grids\194.xgd

147 Col:6 Row:17 grids\270.xgd
148 Col:6 Row:18 grids\271.xgd
149 Col:6 Row:19 grids\272.xgd
150 Col:6 Row:20 grids\273.xgd
151 Col:6 Row:21 grids\274.xgd
152 Col:7 Row:1 grids\12.xgd
153 Col:7 Row:2 grids\48.xgd
154 Col:7 Row:3 grids\49.xgd
155 Col:7 Row:4 grids\50.xgd
156 Col:7 Row:5 grids\51.xgd
157 Col:7 Row:6 grids\52.xgd
158 Col:7 Row:7 grids\115.xgd
159 Col:7 Row:8 grids\116.xgd
160 Col:7 Row:9 grids\117.xgd
161 Col:7 Row:10 grids\118.xgd
162 Col:7 Row:11 grids\119.xgd
163 Col:7 Row:12 grids\195.xgd
164 Col:7 Row:13 grids\196.xgd
165 Col:7 Row:14 grids\197.xgd
166 Col:7 Row:15 grids\198.xgd
167 Col:7 Row:16 grids\199.xgd
168 Col:7 Row:17 grids\275.xgd
169 Col:7 Row:18 grids\276.xgd
170 Col:7 Row:19 grids\277.xgd
171 Col:7 Row:20 grids\278.xgd
172 Col:7 Row:21 grids\279.xgd
173 Col:8 Row:2 grids\53.xgd
174 Col:8 Row:3 grids\54.xgd
175 Col:8 Row:4 grids\55.xgd
176 Col:8 Row:5 grids\56.xgd
177 Col:8 Row:6 grids\57.xgd
178 Col:8 Row:7 grids\120.xgd
179 Col:8 Row:8 grids\121.xgd
180 Col:8 Row:9 grids\122.xgd
181 Col:8 Row:10 grids\123.xgd
182 Col:8 Row:11 grids\124.xgd
183 Col:8 Row:12 grids\200.xgd
184 Col:8 Row:13 grids\201.xgd
185 Col:8 Row:14 grids\202.xgd
186 Col:8 Row:15 grids\203.xgd
187 Col:8 Row:16 grids\204.xgd
188 Col:8 Row:17 grids\280.xgd
189 Col:8 Row:18 grids\281.xgd
190 Col:8 Row:19 grids\282.xgd
191 Col:8 Row:20 grids\283.xgd
192 Col:8 Row:21 grids\284.xgd
193 Col:9 Row:2 grids\58.xgd
194 Col:9 Row:3 grids\59.xgd
195 Col:9 Row:4 grids\60.xgd
196 Col:9 Row:5 grids\61.xgd

197 Col:9 Row:6 grids\62.xgd
198 Col:9 Row:7 grids\125.xgd
199 Col:9 Row:8 grids\126.xgd
200 Col:9 Row:9 grids\127.xgd
201 Col:9 Row:10 grids\128.xgd
202 Col:9 Row:11 grids\129.xgd
203 Col:9 Row:12 grids\205.xgd
204 Col:9 Row:13 grids\206.xgd
205 Col:9 Row:14 grids\207.xgd
206 Col:9 Row:15 grids\208.xgd
207 Col:9 Row:16 grids\209.xgd
208 Col:9 Row:17 grids\285.xgd
209 Col:9 Row:18 grids\286.xgd
210 Col:9 Row:19 grids\287.xgd
211 Col:9 Row:20 grids\288.xgd
212 Col:9 Row:21 grids\289.xgd
213 Col:10 Row:3 grids\63.xgd
214 Col:10 Row:4 grids\64.xgd
215 Col:10 Row:5 grids\65.xgd
216 Col:10 Row:6 grids\66.xgd
217 Col:10 Row:7 grids\130.xgd
218 Col:10 Row:8 grids\131.xgd
219 Col:10 Row:9 grids\132.xgd
220 Col:10 Row:10 grids\133.xgd
221 Col:10 Row:11 grids\134.xgd
222 Col:10 Row:12 grids\210.xgd
223 Col:10 Row:13 grids\211.xgd
224 Col:10 Row:14 grids\212.xgd
225 Col:10 Row:15 grids\213.xgd
226 Col:10 Row:16 grids\214.xgd
227 Col:10 Row:17 grids\290.xgd
228 Col:10 Row:18 grids\291.xgd
229 Col:10 Row:19 grids\292.xgd
230 Col:10 Row:20 grids\293.xgd
231 Col:10 Row:21 grids\294.xgd
232 Col:11 Row:4 grids\67.xgd
233 Col:11 Row:5 grids\68.xgd
234 Col:11 Row:6 grids\69.xgd
235 Col:11 Row:7 grids\135.xgd
236 Col:11 Row:8 grids\136.xgd
237 Col:11 Row:9 grids\137.xgd
238 Col:11 Row:10 grids\138.xgd
239 Col:11 Row:11 grids\139.xgd
240 Col:11 Row:12 grids\215.xgd
241 Col:11 Row:13 grids\216.xgd
242 Col:11 Row:14 grids\217.xgd
243 Col:11 Row:15 grids\218.xgd
244 Col:11 Row:16 grids\219.xgd
245 Col:11 Row:17 grids\295.xgd
246 Col:11 Row:18 grids\296.xgd

247 Col:11 Row:19 grids\297.xgd
248 Col:11 Row:20 grids\298.xgd
249 Col:11 Row:21 grids\299.xgd
250 Col:12 Row:4 grids\70.xgd
251 Col:12 Row:5 grids\71.xgd
252 Col:12 Row:6 grids\72.xgd
253 Col:12 Row:7 grids\140.xgd
254 Col:12 Row:8 grids\141.xgd
255 Col:12 Row:9 grids\142.xgd
256 Col:12 Row:10 grids\143.xgd
257 Col:12 Row:11 grids\144.xgd
258 Col:12 Row:12 grids\220.xgd
259 Col:12 Row:13 grids\221.xgd
260 Col:12 Row:14 grids\222.xgd
261 Col:12 Row:15 grids\223.xgd
262 Col:12 Row:16 grids\224.xgd
263 Col:12 Row:17 grids\300.xgd
264 Col:12 Row:18 grids\301.xgd
265 Col:12 Row:19 grids\302.xgd
266 Col:12 Row:20 grids\303.xgd
267 Col:12 Row:21 grids\304.xgd
268 Col:13 Row:4 grids\73.xgd
269 Col:13 Row:5 grids\74.xgd
270 Col:13 Row:6 grids\75.xgd
271 Col:13 Row:7 grids\145.xgd
272 Col:13 Row:8 grids\146.xgd
273 Col:13 Row:9 grids\147.xgd
274 Col:13 Row:10 grids\148.xgd
275 Col:13 Row:11 grids\149.xgd
276 Col:13 Row:12 grids\225.xgd
277 Col:13 Row:13 grids\226.xgd
278 Col:13 Row:14 grids\227.xgd
279 Col:13 Row:15 grids\228.xgd
280 Col:13 Row:16 grids\229.xgd
281 Col:13 Row:17 grids\305.xgd
282 Col:13 Row:18 grids\306.xgd
283 Col:13 Row:19 grids\307.xgd
284 Col:13 Row:20 grids\308.xgd
285 Col:13 Row:21 grids\309.xgd
286 Col:14 Row:5 grids\76.xgd
287 Col:14 Row:6 grids\77.xgd
288 Col:14 Row:7 grids\150.xgd
289 Col:14 Row:8 grids\151.xgd
290 Col:14 Row:9 grids\152.xgd
291 Col:14 Row:10 grids\153.xgd
292 Col:14 Row:11 grids\154.xgd
293 Col:14 Row:12 grids\230.xgd
294 Col:14 Row:13 grids\231.xgd
295 Col:14 Row:14 grids\232.xgd
296 Col:14 Row:15 grids\233.xgd

297 Col:14 Row:16 grids\234.xgd
298 Col:14 Row:17 grids\310.xgd
299 Col:14 Row:18 grids\311.xgd
300 Col:14 Row:19 grids\312.xgd
301 Col:14 Row:20 grids\313.xgd
302 Col:14 Row:21 grids\314.xgd
303 Col:15 Row:5 grids\78.xgd
304 Col:15 Row:6 grids\79.xgd
305 Col:15 Row:7 grids\155.xgd
306 Col:15 Row:8 grids\156.xgd
307 Col:15 Row:9 grids\157.xgd
308 Col:15 Row:10 grids\158.xgd
309 Col:15 Row:11 grids\159.xgd
310 Col:15 Row:12 grids\235.xgd
311 Col:15 Row:13 grids\236.xgd
312 Col:15 Row:14 grids\237.xgd
313 Col:15 Row:15 grids\238.xgd
314 Col:15 Row:16 grids\239.xgd
315 Col:15 Row:17 grids\315.xgd
316 Col:15 Row:18 grids\316.xgd
317 Col:15 Row:19 grids\317.xgd
318 Col:15 Row:20 grids\318.xgd
319 Col:15 Row:21 grids\319.xgd

Field 1, Raw Data

Filename	Mild F1 R.xcp
Description	
Instrument Type	Grad 601-2 (Gradiometer)
Units	nT
Direction of 1st Traverse	90 deg
Collection Method	ZigZag
Sensors	2 @ 1.00 m spacing.
Dummy Value	2047.5
Dimensions	
Composite Size (readings)	1280 x 440
Survey Size (meters)	320 m x 440 m
Grid Size	20 m x 20 m
X Interval	0.25 m
Y Interval	1 m
Stats	
Max	5.00
Min	-5.00
Std Dev	2.48
Mean	1.05
Median	1.38
Composite Area	14.08 ha
Surveyed Area	12.279 ha
Program	
Name	TerraSurveyor
Version	3.0.29.3

Field 1, Raw data presentation

Data clipped to -5.00 to 5.00 nT.

No processing.

Field 1, Processed

Filename	Mild F1 P.xcp
Description	
Instrument Type	Grad 601-2 (Gradiometer)
Units	nT
Direction of 1st Traverse	90 deg
Collection Method	ZigZag
Sensors	2 @ 1.00 m spacing.
Dummy Value	2047.5
Dimensions	
Composite Size (readings)	2560 x 880
Survey Size (meters)	320 m x 440 m
Grid Size	20 m x 20 m
X Interval	0.25 m
Y Interval	1 m
Stats	
Max	2.00
Min	-2.00
Std Dev	1.32
Mean	0.03
Median	0.02
Composite Area	14.08 ha
Surveyed Area	12.279 ha
Program	
Name	TerraSurveyor
Version	3.0.29.3

Field 1, Processed data presentation

Destripe median sensors all.

Interpolate X & Y Doubled.

Clip from -2.00 to 2.00 nT.

Field 2, Grids

Source Grids: 126
1 Col:0 Row:0 grids\320.xgd
2 Col:0 Row:1 grids\321.xgd
3 Col:0 Row:2 grids\322.xgd
4 Col:0 Row:3 grids\323.xgd
5 Col:0 Row:4 grids\324.xgd
6 Col:0 Row:5 grids\400.xgd
7 Col:0 Row:6 grids\401.xgd
8 Col:0 Row:7 grids\402.xgd
9 Col:1 Row:0 grids\325.xgd
10 Col:1 Row:1 grids\326.xgd
11 Col:1 Row:2 grids\327.xgd
12 Col:1 Row:3 grids\328.xgd
13 Col:1 Row:4 grids\329.xgd
14 Col:1 Row:5 grids\403.xgd
15 Col:1 Row:6 grids\404.xgd
16 Col:1 Row:7 grids\405.xgd
17 Col:2 Row:0 grids\330.xgd
18 Col:2 Row:1 grids\331.xgd
19 Col:2 Row:2 grids\332.xgd
20 Col:2 Row:3 grids\333.xgd
21 Col:2 Row:4 grids\334.xgd
22 Col:2 Row:5 grids\406.xgd
23 Col:2 Row:6 grids\407.xgd
24 Col:2 Row:7 grids\408.xgd
25 Col:2 Row:8 grids\409.xgd
26 Col:3 Row:0 grids\335.xgd
27 Col:3 Row:1 grids\336.xgd
28 Col:3 Row:2 grids\337.xgd
29 Col:3 Row:3 grids\338.xgd
30 Col:3 Row:4 grids\339.xgd
31 Col:3 Row:5 grids\410.xgd
32 Col:3 Row:6 grids\411.xgd
33 Col:3 Row:7 grids\412.xgd
34 Col:3 Row:8 grids\413.xgd
35 Col:4 Row:0 grids\340.xgd
36 Col:4 Row:1 grids\341.xgd
37 Col:4 Row:2 grids\342.xgd
38 Col:4 Row:3 grids\343.xgd
39 Col:4 Row:4 grids\344.xgd
40 Col:4 Row:5 grids\414.xgd
41 Col:4 Row:6 grids\415.xgd
42 Col:4 Row:7 grids\416.xgd
43 Col:4 Row:8 grids\417.xgd
44 Col:5 Row:0 grids\345.xgd
45 Col:5 Row:1 grids\346.xgd
46 Col:5 Row:2 grids\347.xgd
47 Col:5 Row:3 grids\348.xgd
48 Col:5 Row:4 grids\349.xgd

49 Col:5 Row:5 grids\418.xgd
50 Col:5 Row:6 grids\419.xgd
51 Col:5 Row:7 grids\420.xgd
52 Col:6 Row:0 grids\350.xgd
53 Col:6 Row:1 grids\351.xgd
54 Col:6 Row:2 grids\352.xgd
55 Col:6 Row:3 grids\353.xgd
56 Col:6 Row:4 grids\354.xgd
57 Col:6 Row:5 grids\421.xgd
58 Col:6 Row:6 grids\422.xgd
59 Col:6 Row:7 grids\423.xgd
60 Col:7 Row:0 grids\355.xgd
61 Col:7 Row:1 grids\356.xgd
62 Col:7 Row:2 grids\357.xgd
63 Col:7 Row:3 grids\358.xgd
64 Col:7 Row:4 grids\359.xgd
65 Col:7 Row:5 grids\424.xgd
66 Col:7 Row:6 grids\425.xgd
67 Col:7 Row:7 grids\426.xgd
68 Col:8 Row:0 grids\360.xgd
69 Col:8 Row:1 grids\361.xgd
70 Col:8 Row:2 grids\362.xgd
71 Col:8 Row:3 grids\363.xgd
72 Col:8 Row:4 grids\364.xgd
73 Col:8 Row:5 grids\427.xgd
74 Col:8 Row:6 grids\428.xgd
75 Col:9 Row:0 grids\365.xgd
76 Col:9 Row:1 grids\366.xgd
77 Col:9 Row:2 grids\367.xgd
78 Col:9 Row:3 grids\368.xgd
79 Col:9 Row:4 grids\369.xgd
80 Col:9 Row:5 grids\429.xgd
81 Col:10 Row:0 grids\370.xgd
82 Col:10 Row:1 grids\371.xgd
83 Col:10 Row:2 grids\372.xgd
84 Col:10 Row:3 grids\373.xgd
85 Col:10 Row:4 grids\374.xgd
86 Col:10 Row:5 grids\430.xgd
87 Col:10 Row:6 grids\431.xgd
88 Col:11 Row:0 grids\375.xgd
89 Col:11 Row:1 grids\376.xgd
90 Col:11 Row:2 grids\377.xgd
91 Col:11 Row:3 grids\378.xgd
92 Col:11 Row:4 grids\379.xgd
93 Col:11 Row:5 grids\432.xgd
94 Col:11 Row:6 grids\433.xgd
95 Col:12 Row:0 grids\380.xgd
96 Col:12 Row:1 grids\381.xgd
97 Col:12 Row:2 grids\382.xgd
98 Col:12 Row:3 grids\383.xgd

99 Col:12 Row:4 grids\384.xgd
100 Col:12 Row:5 grids\434.xgd
101 Col:12 Row:6 grids\435.xgd
102 Col:12 Row:7 grids\436.xgd
103 Col:13 Row:0 grids\385.xgd
104 Col:13 Row:1 grids\386.xgd
105 Col:13 Row:2 grids\387.xgd
106 Col:13 Row:3 grids\388.xgd
107 Col:13 Row:4 grids\389.xgd
108 Col:13 Row:5 grids\437.xgd
109 Col:13 Row:6 grids\438.xgd
110 Col:13 Row:7 grids\439.xgd
111 Col:14 Row:0 grids\390.xgd
112 Col:14 Row:1 grids\391.xgd
113 Col:14 Row:2 grids\392.xgd
114 Col:14 Row:3 grids\393.xgd
115 Col:14 Row:4 grids\394.xgd
116 Col:14 Row:5 grids\440.xgd
117 Col:14 Row:6 grids\441.xgd
118 Col:14 Row:7 grids\442.xgd
119 Col:15 Row:0 grids\395.xgd
120 Col:15 Row:1 grids\396.xgd
121 Col:15 Row:2 grids\397.xgd
122 Col:15 Row:3 grids\398.xgd
123 Col:15 Row:4 grids\399.xgd
124 Col:15 Row:5 grids\443.xgd
125 Col:15 Row:6 grids\444.xgd
126 Col:15 Row:7 grids\445.xgd

Field 2, Raw

Filename	Mild F2 R.xcp
Description	
Instrument Type	Bartington (Gradiometer)
Units	nT
Direction of 1st Traverse	90 deg
Collection Method	ZigZag
Sensors	2 @ 1.00 m spacing.
Dummy Value	2047.5
Dimensions	
Composite Size (readings)	1280 x 180
Survey Size (meters)	320 m x 180 m
Grid Size	20 m x 20 m
X Interval	0.25 m
Y Interval	1 m
Stats	
Max	5.00
Min	-5.00
Std Dev	2.06
Mean	2.21
Median	2.37

Composite Area	5.76 ha
Surveyed Area	4.4718 ha
Program	
Name	TerraSurveyor
Version	3.0.29.3

Field 2, Raw data presentation

Data clipped to -5.00 to 5.00 nT.

No processing.

Field 2, Processed

Filename	Mild F2 P.xcp
Description	
Instrument Type	Bartington (Gradiometer)
Units	nT
Direction of 1st Traverse	90 deg
Collection Method	ZigZag
Sensors	2 @ 1.00 m spacing.
Dummy Value	2047.5
Dimensions	
Composite Size (readings)	2560 x 360
Survey Size (meters)	320 m x 180 m
Grid Size	20 m x 20 m
X Interval	0.25 m
Y Interval	1 m
Stats	
Max	2.00
Min	-2.00
Std Dev	1.19
Mean	0.06
Median	0.02
Composite Area	5.76 ha
Surveyed Area	4.4718 ha
Program	
Name	TerraSurveyor
Version	3.0.29.3

Field 2, Processed data presentation

Destripe median sensors all.

Interpolate X & Y Doubled.

Clip from -2.00 to 2.00 nT.

Field 3, Grids

Source Grids: 35
1 Col:0 Row:0 grids\494.xgd
2 Col:0 Row:1 grids\495.xgd
3 Col:0 Row:2 grids\496.xgd
4 Col:0 Row:3 grids\497.xgd
5 Col:0 Row:4 grids\498.xgd
6 Col:1 Row:0 grids\499.xgd
7 Col:1 Row:1 grids\500.xgd
8 Col:1 Row:2 grids\501.xgd
9 Col:1 Row:3 grids\502.xgd
10 Col:1 Row:4 grids\503.xgd
11 Col:2 Row:0 grids\504.xgd
12 Col:2 Row:1 grids\505.xgd
13 Col:2 Row:2 grids\506.xgd
14 Col:2 Row:3 grids\507.xgd
15 Col:2 Row:4 grids\508.xgd
16 Col:2 Row:5 grids\509.xgd
17 Col:3 Row:0 grids\510.xgd
18 Col:3 Row:1 grids\511.xgd
19 Col:3 Row:2 grids\512.xgd
20 Col:3 Row:3 grids\513.xgd
21 Col:3 Row:4 grids\514.xgd
22 Col:3 Row:5 grids\515.xgd
23 Col:4 Row:0 grids\516.xgd
24 Col:4 Row:1 grids\517.xgd
25 Col:4 Row:2 grids\518.xgd
26 Col:4 Row:3 grids\519.xgd
27 Col:4 Row:4 grids\520.xgd
28 Col:5 Row:0 grids\521.xgd
29 Col:5 Row:1 grids\522.xgd
30 Col:5 Row:2 grids\523.xgd
31 Col:5 Row:3 grids\524.xgd
32 Col:5 Row:4 grids\525.xgd
33 Col:6 Row:0 grids\526.xgd
34 Col:6 Row:1 grids\527.xgd
35 Col:6 Row:2 grids\528.xgd

Field 3, Raw

Filename	Mild F3 R.xcp
Description	
Instrument Type	Bartington (Gradiometer)
Units	nT
Direction of 1st Traverse	90 deg
Collection Method	ZigZag
Sensors	2 @ 1.00 m spacing.
Dummy Value	2047.5
Dimensions	
Composite Size (readings)	560 x 120
Survey Size (meters)	140 m x 120 m

Grid Size	20 m x 20 m
X Interval	0.25 m
Y Interval	1 m
Stats	
Max	5.00
Min	-5.00
Std Dev	2.56
Mean	1.20
Median	1.60
Composite Area	1.68 ha
Surveyed Area	1.0491 ha
Program	
Name	TerraSurveyor
Version	3.0.29.3

Field 3, Raw data presentation

Data clipped to -5.00 to 5.00 nT.

No processing.

Field 3, Processed

Filename	Mild F3 P.xcp
Description	
Instrument Type	Bartington (Gradiometer)
Units	nT
Direction of 1st Traverse	90 deg
Collection Method	ZigZag
Sensors	2 @ 1.00 m spacing.
Dummy Value	2047.5
Dimensions	
Composite Size (readings)	560 x 120
Survey Size (meters)	140 m x 120 m
Grid Size	20 m x 20 m
X Interval	0.25 m
Y Interval	1 m
Stats	
Max	3.00
Min	-3.00
Std Dev	1.66
Mean	-0.14
Median	-0.07
Composite Area	1.68 ha
Surveyed Area	1.0491 ha
Program	
Name	TerraSurveyor
Version	3.0.29.3

Field 3, Processed data presentation

Destripe median sensors all.

Clip from -3.00 to 3.00 nT.

Field 4, Grids

Source Grids: 48
1 Col:0 Row:2 grids\478.xgd
2 Col:0 Row:3 grids\479.xgd
3 Col:0 Row:4 grids\480.xgd
4 Col:0 Row:5 grids\481.xgd
5 Col:0 Row:6 grids\482.xgd
6 Col:1 Row:2 grids\483.xgd
7 Col:1 Row:3 grids\484.xgd
8 Col:1 Row:4 grids\485.xgd
9 Col:1 Row:5 grids\486.xgd
10 Col:1 Row:6 grids\487.xgd
11 Col:2 Row:0 grids\446.xgd
12 Col:2 Row:1 grids\447.xgd
13 Col:2 Row:2 grids\448.xgd
14 Col:2 Row:3 grids\449.xgd
15 Col:2 Row:4 grids\450.xgd
16 Col:2 Row:5 grids\488.xgd
17 Col:2 Row:6 grids\489.xgd
18 Col:3 Row:0 grids\451.xgd
19 Col:3 Row:1 grids\452.xgd
20 Col:3 Row:2 grids\453.xgd
21 Col:3 Row:3 grids\454.xgd
22 Col:3 Row:4 grids\455.xgd
23 Col:3 Row:5 grids\490.xgd
24 Col:3 Row:6 grids\491.xgd
25 Col:4 Row:0 grids\456.xgd
26 Col:4 Row:1 grids\457.xgd
27 Col:4 Row:2 grids\458.xgd
28 Col:4 Row:3 grids\459.xgd
29 Col:4 Row:4 grids\460.xgd
30 Col:4 Row:5 grids\492.xgd
31 Col:5 Row:0 grids\461.xgd
32 Col:5 Row:1 grids\462.xgd
33 Col:5 Row:2 grids\463.xgd
34 Col:5 Row:3 grids\464.xgd
35 Col:5 Row:4 grids\465.xgd
36 Col:5 Row:5 grids\493.xgd
37 Col:6 Row:0 grids\466.xgd
38 Col:6 Row:1 grids\467.xgd
39 Col:6 Row:2 grids\468.xgd
40 Col:6 Row:3 grids\469.xgd
41 Col:6 Row:4 grids\470.xgd
42 Col:6 Row:5 grids\471.xgd
43 Col:7 Row:0 grids\472.xgd
44 Col:7 Row:1 grids\473.xgd
45 Col:7 Row:2 grids\474.xgd
46 Col:7 Row:3 grids\475.xgd
47 Col:7 Row:4 grids\476.xgd
48 Col:7 Row:5 grids\477.xgd

Field 4, Raw

Filename	Mild F4 R.xcp
Description	
Instrument Type	Bartington (Gradiometer)
Units	nT
Direction of 1st Traverse	90 deg
Collection Method	ZigZag
Sensors	2 @ 1.00 m spacing.
Dummy Value	2047.5
Dimensions	
Composite Size (readings)	640 x 140
Survey Size (meters)	160 m x 140 m
Grid Size	20 m x 20 m
X Interval	0.25 m
Y Interval	1 m
Stats	
Max	10.00
Min	-10.00
Std Dev	3.97
Mean	0.82
Median	0.89
Composite Area	2.24 ha
Surveyed Area	1.6561 ha
Program	
Name	TerraSurveyor
Version	3.0.29.3

Field 4, Raw data presentation

Data clipped to -10.00 to 10.00 nT.

No processing.

Field 4, Processed

Filename	Mild F4 P.xcp
Description	
Instrument Type	Bartington (Gradiometer)
Units	nT
Direction of 1st Traverse	90 deg
Collection Method	ZigZag
Sensors	2 @ 1.00 m spacing.
Dummy Value	2047.5
Dimensions	
Composite Size (readings)	640 x 140
Survey Size (meters)	160 m x 140 m
Grid Size	20 m x 20 m
X Interval	0.25 m
Y Interval	1 m
Stats	
Max	5.00
Min	-5.00

Std Dev	2.68
Mean	0.07
Median	0.00
Composite Area	2.24 ha
Surveyed Area	1.6561 ha
Program	
Name	TerraSurveyor
Version	3.0.29.3

Field 4, Processed data presentation

Destripe median sensors all.

Clip from -5.00 to 5.00 nT.

Appendix 2. Technical data

Detailed magnetometer survey

Detailed magnetometer survey is the most commonly employed archaeological geophysical prospection method in Britain, sensitive sensors can cost-effectively cover large areas of ground, rapidly recording anomalies that are indicative of cultural settlement activity. These anomalies can then be further investigated by field archaeologists to quantify a form and function. The magnetometer is a passive instrument that detects both permanent thermoremanent and temporary magnetic responses.

Thermoremanent Magnetism

When a material containing iron oxides, for example clay, is heated above the Curie point, weakly magnetic compounds transform in to highly magnetic oxides that can be detected by the sensors of a magnetometer (Clark, 1996). For instance the iron oxide haematite has a Curie temperature of 675 Celsius and magnetite 565 Celsius. Once these temperatures are reached, the oxides become demagnetised, on cooling their magnetic properties become permanently re-magnetised and align in the direction of the Earth's magnetic field (Gaffney and Gater, 2002). Over time the direction of the Earth's magnetic field changes allowing these directional differences to be detected by the magnetometer.

Strongly heated features such as hearths, kilns or furnaces frequently reach the Curie temperature and become permanently magnetised. These permanent magnetic responses are some of the strongest cultural features that can be recorded.

Temporary Magnetism

Magnetic susceptibility is the ease with which a magnetic field can pass through a material, therefore the higher the materials magnetic susceptibility, the stronger the induced magnetic field will be. Temporary magnetisation occurs within material that is magnetically susceptible, this material acquires its own local magnetic field that combine with the Earth's magnetic field causing an anomaly to stand out from the background noise (Clark, 1996). These anomalies are subtler in nature, being derived from material that has been magnetically enhanced by cultural activity and become concentrated into features over time. Anomalies that have temporary magnetisation include backfilled pits, ditches, field systems, occupation areas, land drains, remnant and existing field boundaries (David, 2011).

The key to a successful survey is having good contrast between the magnetic susceptibility of an archaeological feature with the surrounding superficial deposits. If there is no discernible difference between the two mediums it may be unlikely that the magnetometer will successfully prospect the feature. Archaeological features can also be masked by high magnetically susceptible topsoil, or deep overlying subsoil and colluvial deposits.

Ferrous anomalies

Ferrous objects are a common source of permanent magnetism, usually isolated with a strong dipolar signature. Some of these responses may have an archaeological derivation, however they are probably more indicative of modern iron objects introduced through manuring or lost within the topsoil.

Bartington DualGRAD 601-2 Fluxgate Gradiometers

Fluxgate gradiometers are the most commonly employed class of instrument in the UK. Two 1m sensitive sensors are affixed to a frame mounted 1m apart in a vertical plane and harnessed to the trunk of a geophysical surveyor or attached two a pulled cart. Each sensor contains two fluxgate magnetometers with 1m vertical separation. The sensor above records the Earth’s magnetic field (magnetic background) while the sensor below records the local magnetic field. The two sensors need aligning before recording can begin, a zero station is located in an area with low magnetic variation for this purpose. After the sensors have been aligned, the survey can begin. When differences in the magnetic field strength occur between the two vertical magnetometers within each sensor, a positive or negative reading is recorded that is relative to the magnetic background of the zero station. Positive anomalies include pits, ditches and agricultural furrows. Negative anomalies commonly prospected include earthwork embankments, land drains and geological features.

Sensors are normally mounted to a height of 0.30m above the surface, and can detect to a depth of between one and two metres below the ground. The first survey traverse is commonly undertaken in an east to west direction.

Magnetic Anomalies

Isolated dipolar responses

Isolated dipolar responses are commonly recorded throughout a dataset and are usually indicative of modern ferrous material deposited within the topsoil horizon. In some instances, the anomalies may be of an archaeological derivation. They are isolated, strong and dipolar in character.

Areas of magnetic disturbance

These anomalies are usually caused by building demolition rubble, ferrous boundaries, slag waste dumps, modern buried rubbish, pylons and services. Strong and dipolar in character, they are commonly recorded over a wide area.

Linear trends

Linear trends can be either positive or negative magnetic responses depending on the nature of the material present within the feature. If the anomaly is broad and weak, it is more likely to be of geological origin. Stronger positive linear trends are more likely to be of archaeological derivation, caused by settlement activity washing rich humic, charcoal and fired deposits into a feature. Negative linear trends are more commonly associated with bank deposits or land drains, with the less magnetically susceptible superficial deposits deposited at the top of the feature. Curvilinear trends are usually of archaeological origin, commonly interpreted as ring ditches or drip-gullies.

Discrete anomalies

Discrete anomalies can either be positive or negative in nature recorded within a localised area. Those that are positive are more likely to be of an archaeological origin, with negative discrete anomalies more commonly interpreted as natural geological variations.

Thermoremanent responses

These responses are caused by the heating of material containing iron to above the Curie temperature, they are strong and discrete in nature, in Britain high positive readings are recorded to the south of the feature, and high negative readings are recorded to the north.

Appendix 3. OASIS form

OASIS DATA COLLECTION FORM: England

Printable version

OASIS ID: suffolka1-272908

Project details

Project name	Mildenhall Community Hub, Mildenhall, Suffolk, MNL 778
Short description of the project	From the 27th September to the 12th October 2016 Suffolk Archaeology Community Interest Company undertook a detailed fluxgate gradiometer survey at the Mildenhall Community hub site immediately adjacent to West Row Road in Mildenhall, Suffolk. Four fields suitable for survey, comprising two arable fields and two school playing fields, were prospected for anomalies of archaeological origin. The detailed fluxgate gradiometer survey recorded anomalies of potential archaeological origin in all four fields, with the highest potential for archaeological remains located in the southern half of Field 1 and across the majority of Field 2. Further archaeological investigations should be undertaken within all four fields, targeting anomalies recorded by the fluxgate gradiometer and also blank areas of the geophysical dataset to determine whether archaeological features remain undetected below the ploughsoil.
Project dates	Start: 27-09-2016 End: 12-10-2016
Previous/future work	Not known / Yes
Any associated project reference codes	MNL 778 - Sitecode
Type of project	Field evaluation
Site status	None
Current Land use	Cultivated Land 3 - Operations to a depth more than 0.25m
Monument type	NONE None
Significant Finds	NONE None
Methods & techniques	"Geophysical Survey"
Development type	Community Hub
Prompt	Direction from Local Planning Authority - PPS
Position in the planning process	Pre-application
Solid geology (other)	Zig-Zag Chalk Formation
Drift geology	Unknown
Techniques	Magnetometry

Project location

Country	England
Site location	SUFFOLK FOREST HEATH MILDENHALL Mildenhall Community Hub, Mildenhall, Suffolk

Study area	22.5 Hectares
Site coordinates	TL 7036 7472 52.343621150957 0.501191508862 52 20 37 N 000 30 04 E Point
Height OD / Depth	Min: 6m Max: 11m

Project creators

Name of Organisation	Suffolk Archaeology CIC
Project brief originator	Local Authority Archaeologist and/or Planning Authority/advisory body
Project design originator	Rachael Abraham
Project director/manager	Rhodri Gardner
Project supervisor	Timothy Schofield
Type of sponsor/funding body	County Council
Name of sponsor/funding body	Suffolk County Council

Project archives

Physical Archive Exists?	No
Digital Archive recipient	Suffolk HER
Digital Contents	"Survey"
Digital Media available	"Database","Geophysics","Images raster / digital photography","Images vector","Spreadsheets","Survey","Text"
Paper Archive recipient	Suffolk HER
Paper Contents	"Survey"
Paper Media available	"Report","Survey ","Unpublished Text"

Project bibliography 1

Publication type	Grey literature (unpublished document/manuscript)
Title	Mildenhall Community Hub, Mildenhall, Suffolk. Geophysical Survey Report.
Author(s)/Editor(s)	Schofield, T. P.
Other bibliographic details	2016/080
Date	2016
Issuer or publisher	Suffolk Archaeology CIC
Place of issue or publication	Needham Market
Description	A4 bound report with A3 fold-out figures
URL	www.suffolkarchaeology.co.uk

Entered by	Tim Schofield (tim.schofield@suffolkarchaeology.co.uk)
Entered on	10 January 2017

OASIS:

Appendix 4. Written scheme of investigation

Mildenhall Community Hub, Mildenhall, Suffolk

Written Scheme of Investigation
For
Geophysical Survey

Client:
Suffolk County Council

Date:
October 2016

MNL 778
Author: Timothy Schofield HND BSc MCIfA

Contents

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Appendices

Project details

Planning Application No:	TBC
Curatorial Officer:	Rachael Abraham
Grid Reference:	TL 704 747
Area:	*c.* 22.5ha
HER Event No/Site Code:	ESF24753/MNL778
Oasis Reference:	263962
Project Start date:	27th September 2016
Project Fieldwork Duration:	*c.*12 days
Client/Funding Body:	Suffolk County Council
SACIC Project Manager:	Rhodri Gardner
SACIC Project Officer:	Tim Schofield
SACIC Job Code:	MNL Hub 001

1. Introduction

1.1. A geophysical survey is required on land for a proposed community hub development to the south of West Row Road, Mildenhall, Suffolk (Fig. 1) in accordance with paragraph 128, 129 and 141 of the National Planning Policy Framework.

1.2. The Brief (dated 11/08/2016) produced by the archaeological adviser to the Local Planning Authority (LPA), Rachael Abraham of Suffolk County Council Archaeological Service/Conservation Team (SCCAS/CT) specifies the undertaking of a geophysical survey over the *c*.22.5 hectare site.

1.3. Suffolk Archaeology (SACIC) has been contracted to carry out the project. This document details how the requirements of the Brief and general SCCAS/CT guidelines (SCCAS 2011) will be met, and has been submitted to SCCAS/CT for approval on behalf of the LPA. It provides the basis for measurable standards and will be adhered to in full, unless otherwise agreed with SCCAS/CT.

2. The Site

2.1. The site is located on the western edge of Mildenhall in four separate fields comprising an area of *c*.22.5 hectares, bounded to the north by West Row Road, to the east by a housing estate, to the south by farmland and the River Lark and to the west by agricultural fields. The survey area overlooks the River Lark on a south facing slope at a height of between 11m AOD in the northeastern corner to 6m AOD in the northwestern corner.

2.2. The field is believed to have been under agricultural use for the last few centuries for both grazing, allotments and crop production and is currently being used for arable cultivation.

2.3. The bedrock geology is described as Zig Zag Chalk Formation, formed approximately 94 to 100 million years ago during the Cretaceous Period in warm chalk seas. No superficial deposit records were available at the time of writing (BGS, 2016).

3.1. 3. Archaeological and historical background

3.2. The site lies within an area of archaeological interest defined by information held within the Suffolk Historic Environment Record and in a brief issued by SCCAS/CT (Abraham, 2016), a geophysical survey followed by a subsequent targeted trial trench evaluation (separate WSI) was requested, prior to consideration of the planning application.

3.3. Fieldwalking and metal detector surveys in the surrounding area have recovered artefactual material spanning from the prehistoric through to medieval periods (MNL 141, 167, 220, 310, 421 and 428). The site overlooks the River Lark on a south facing slope which topographically is favourable for early settlement. On the opposing river bank lies a significant Iron Age settlement (BTM040) and Neolithic and Bronze Age settlement activity (MNL 710) with human burials further recorded during these excavations. The archaeological potential for this development site is therefore considered high.

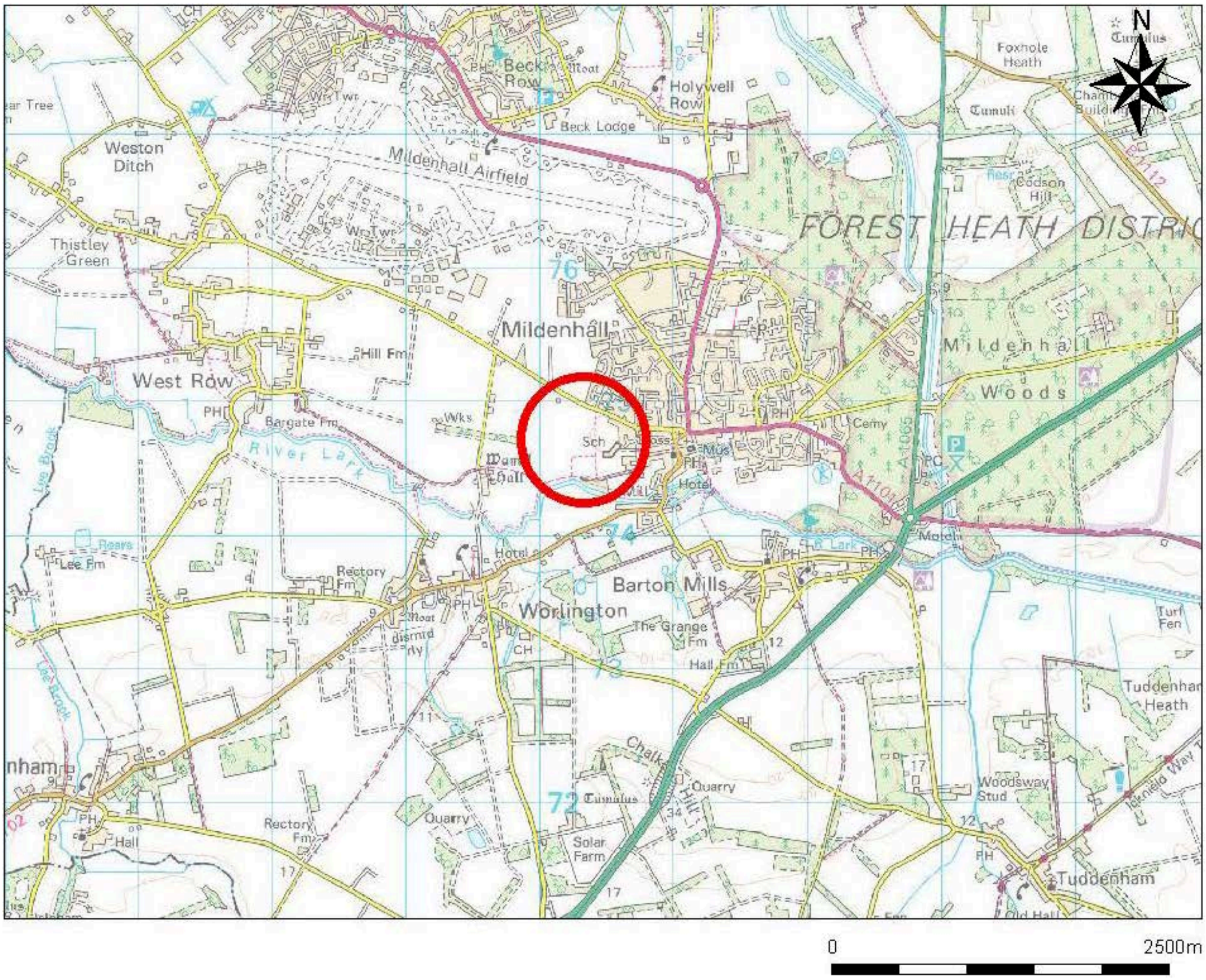

Figure 1. Location map

Contains Ordnance Survey data © Crown copyright and database right 2016

4. Project Objectives

4.1 A non-intrusive geophysical survey is required of the development, followed by targeted trial trench evaluation to enable the archaeological resource, both in quality and extent, to be accurately quantified.

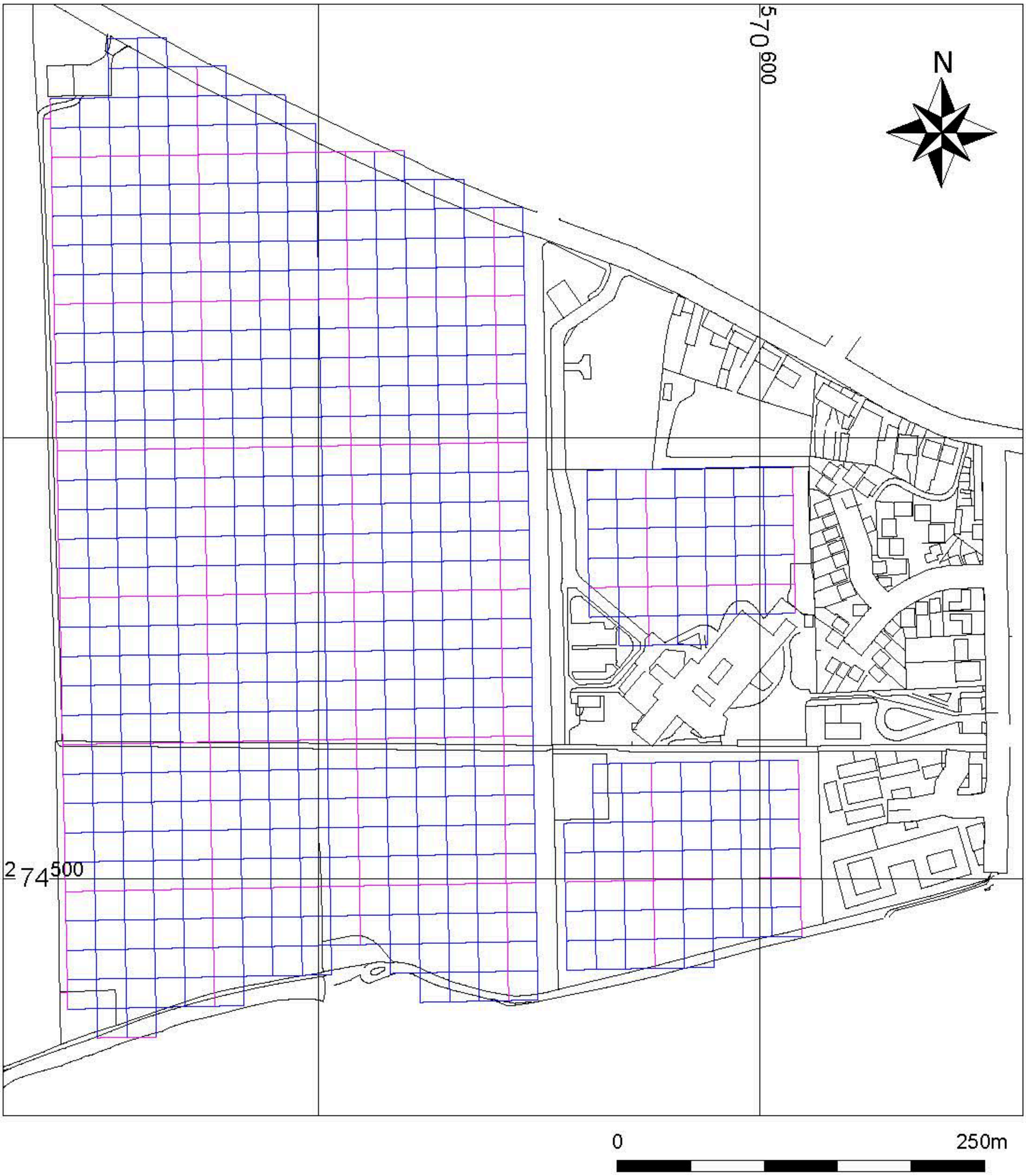

Figure 2. Survey grid location

5. Geophysical Survey method statement

5.1. Management

5.1.1. The project will be managed by SACIC Project Officer Tim Schofield in accordance with the principles of *Management of Research Projects in the Historic Environment* (MoRPHE, Historic England 2015).

5.1.2. SCCAS/CT will be given ten days' notice of the commencement of the fieldwork and arrangements made for SCCAS/CT site visit if required.

5.1.3. Full details of project staff are given in section 6 below.

5.2. Project preparation

5.2.1. An event number has been obtained from the SCCAS HER Officer and will be included on all future project documentation.

5.2.2. An OASIS online record has been initiated and key fields in details, location and creator forms have been completed.

5.2.3. A pre-site inspection and Risk Assessment for the project have been completed.

5.3. Fieldwork

5.3.1. Fieldwork standards will be guided by 'Standards for Field Archaeology in the East of England', EAA Occasional Papers 14, and the Chartered Institute for Archaeology's (CIfA) paper 'Standard and Guidance for archaeological geophysical survey', December 2014.

5.3.2. The fieldwork will be carried out by members of SACIC led by Project Officer Tim Schofield. The fieldwork team will be drawn from a pool of suitable staff at SACIC.

5.3.3. The project Brief requires the survey of *c*.22.5 hectares over the development area (Fig. 2). Minor modifications to the survey area may be made onsite to respect any areas of disturbance/contamination or other obstacles.

5.3.4. A 5 – 10m exclusion zone around the sites periphery will be kept to minimise the amount of magnetic disturbance associated with the field boundaries.

Instrument type and set-up

5.3.5 The site will be surveyed using a Bartington Dual-Grad 601-2 which has high sensor sensitivity combined with rapid ground coverage. Good contrast between the magnetic susceptibility of a feature's fill (charcoal rich or humic deposits providing the best soil medium) and the local magnetic background signature of the superficial deposits will be important in achieving successful survey results.

5.3.6 Best practice dictates that sensors will be secured on the same side of the instrument until the completion of the survey, and sensor heights equalised to achieve a consistent elevation across the area. The instrument will be switched on and left for at least 20 minutes before the survey of the first grid to allow the sensors to reach a suitable operating temperature.

5.3.7 A zero station with low magnetic susceptibility shall be prospected within each field on site to allow the correction of sensor diurnal drift. This unique station will be employed throughout the survey providing a common calibration location.

Sampling interval and grid size

5.3.8 The 20m survey grid will be set-out using a Leica Viva Glonass Smart Rover GS08+ to the Ordnance Survey OSGB36, converted to the National Grid Transformation OSTN02 datum that has an accuracy of +/- 0.01m. Regular testing of the instruments accuracy will be undertaken employing stations with known ETRS89 coordinates. All raw data recorded by the GPS will be uploaded to the project folder, suitably labelled and kept as part of the project archive.

5.3.9 A 1m traverse interval and 0.25m sample interval will be utilised.

Data capture and archiving

5.3.10 A pro-forma survey sheet will be completed each day; unique grid numbers will be allocated to enable a data composite to be created. Instrument readings will be recorded on the internal data logger and downloaded to a laptop at midday and also in the evening, this will allow the data to be checked for quality on site and for grids to be re-surveyed if required.

5.3.11 Data will be filed in project specific folders separated into daily datasets. The daily datasets will be combined into a single composite on completion of the fieldwork.

5.3.12 Data will be stored in project specific folders that will be downloaded onto a laptop and then backed-up onto an external server in the evening of each day.

5.3.13 Metadata sheets will be completed and inserted into the report as an appendix.

5.3.14 All on-site derived site data will be entered onto a digital (Microsoft Access) SACIC database compatible with the Suffolk HER.

Data processing and presentation

5.3.15 Raw survey data will be collected to a high standard to enable only minimal processing of the datasets to be required. Typically, these algorithms may comprise de-spike and zero mean sensor. The data will also be clipped at a suitable level to enable the anomalies to be presented with best clarity.

5.3.16 Raw and processed greyscale plots and xy trace plots of the datasets shall be exported from Terrasurveyor into AutoCAD.

5.3.17 An interpretation plan based on the combined interpretations of the raw, processed and xy trace plots will be produced using AutoCAD. All figures shall be georeferenced within the National Grid and printed at an appropriate scale.

Software

5.3.18 The software used to process the data will be DW Consulting's Terrasurveyor v3.0.29.3. Images will be exported from Terrasurveyor into a geo-referenced grid within an AutoCAD drawing. Interpretation plans of the anomalies will then be digitised using AutoCAD.

Outreach

5.3.19 A single day of project outreach has been allocated, where a geophysical survey presentation will be given to the school's history club.

5.4. Report

5.4.1. The report will be commensurate with the results of the fieldwork and will be consistent with the principles of Management of Research Projects in the Historic Environment (MoRPHE, Historic England, 2015), Geophysical survey in Field Evaluation (Historic England, 2008) and the Standard and Guidance for Archaeological Geophysical Survey (Chartered Institute for Archaeologists, 2014), containing the following:

5.4.2. The report will contain a summary, description of the project background, site location, survey methodology, detailed description of the nature, location and extent of anomalies, discussion of the anomalies, impact assessment, site potential and possible further work. Scaled raw, processed, xy data plans and an interpretation plan will also be included.

5.4.3. The report will include a summary in the established format for inclusion in the annual *'Archaeology in Suffolk'* section of the Proceedings of the Suffolk Institute of Archaeology and History.

5.4.4. A copy of this Written Scheme of Investigation will be included as an appendix in the report.

5.4.5. Metadata sheet tables will form one of the appendices within the report.

5.4.6. A technical data sheet will be included as an appendix.

5.4.7. The report will include a copy of the completed project OASIS form as an appendix.

5.4.8. An unbound draft copy of the report will be submitted to SCCAS/CT for approval within 6 months of completion of fieldwork.

5.5. Project archive

5.5.1. On approval of the report a printed and bound copy will be lodged with the Suffolk HER. A digital .pdf file will also be supplied, together with a digital and fully georeferenced vector plan showing the application area and survey location, compatible with MapInfo software.

5.5.2. The online OASIS form for the project will be completed and a .pdf version of the report uploaded to the OASIS website for online publication by the Archaeological Data Service. A paper copy of the form will be included in the project archive.

5.5.3. A second bound copy of the report will be included with the project archive.

5.5.4. A digital .pdf copy of the approved report will be supplied to the client, together with our final invoice for outstanding fees. Printed and bound copies will be supplied to the client on request.

5.5.5. The project archive, consisting of all paper and digital records, will be deposited in the SCCAS Archaeological Store at Bury St Edmunds within 6 months of completion of fieldwork. The project archive will be consistent with MoRPHE (Historic England, 2015) and ICON guidelines. The project archive will also meet the requirements of SCCAS (SCCAS 2010).

5.5.6. All physical site records and paperwork will be labelled and filed appropriately. Digital files will be stored in the relevant SCCAS archive parish folder on the SCC network site.

5.5.7. The project costing includes a sum to meet SCCAS archive charges. A form transferring ownership of the archive to SCCAS will be completed and included in the project archive.

5.5.8. If the client, on completion of the project, does not agree to deposit the archive with, and transfer to, SCCAS, they will be expected to either nominate another suitable depository approved by SCCAS.

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6. Project Staffing

6.1. Management

SACIC Manager	Dr Rhodri Gardner
SACIC Project Manager	Dr Rhodri Gardner
SACIC Finds Dept	Richenda Goffin

6.2. Fieldwork

The fieldwork team will be derived from the following pool of SACIC staff.

Name	Job Title	First Aid	Other skills/qualifications
Tim Schofield	Project Officer	Yes	Geophysical Surveyor
Robert Brooks	Project Officer	Yes	Surveyor
Simon Cass	Project Officer	Yes	Surveyor
Michael Green	Project Officer	Yes	Surveyor
Laszlo Lichenstein	Project Officer	Yes	
Simon Picard	Project Officer		Surveyor
Preston Boyle	Project Assistant	Yes	
Tim Carter	Project Assistant	Yes	Metal detectorist
Edmund Palka	Project Assistant	No	Geophysical Surveyor

6.3. Report production

The production of the site report, graphics and submission of the project archive will be carried out by Tim Schofield.

Appendix 1. Health and Safety

1. Introduction

The project will be carried out following the SACIC Health and Safety Management System at all times. The SACIC Health and Safety Policy Statement reads as follows:

Suffolk Archaeology Community Interest Company is committed to ensuring the health, safety and welfare of its employees, and it will, so far as is reasonably practicable, establish procedures and systems necessary to implement this commitment and to comply with its statutory obligations on health and safety. Our Personnel are informed of their responsibilities to ensure they take all reasonable precautions, to ensure the safety, health and welfare of those that are likely to be affected by the acts and emissions of our organisations undertakings.

Suffolk Archaeology Community Interest Company understands our duty to identify the significant hazards that may be created by our undertakings and to risk assess these accordingly to ensure that suitable and effective controls are implemented to minimise risk to a suitable level as far as is reasonably practicable.

We also acknowledge our duty, so far as is reasonably practicable:

- *To provide a safe working environment for our workforce, fulfil our statutory commitments and actively manage and supervise health and safety at work;*
- *To identify the risks associated with our business activities and ensure suitable and sufficient control measures are in place.*
- *Ensure regular consultation with our employees on matters which affect their health and Safety.*
- *To ensure that all plant and equipment used by our employees is fit for purpose and adequately maintained.*
- *To provide suitable storage and ensure safe handling of Hazardous substances.*
- *To ensure that all workers are competent to undertake their daily work activities by providing all relevant information and training, consideration will also be given to any employees who do not have English as a first language.*
- *To prevent accidents and cases of work related ill health by ensuring a robust reporting and investigation system is in place.*
- *To liaise and communicate effectively regarding health and safety matters when working on other persons premises.*
- *To ensure that there is an effective system of induction, training, communication and supervision to other persons visiting or working on our premises.*
- *To have access to competent advice, this will be provided by Agility UK (Training and Consultancy) Ltd. Who will assists us in the continuous improvement in our health and safety performance and management through regular review and revision of this policy; and to*

provide suitable resources required to make this policy and our Health and Safety arrangements effective.

2. Specific project issues

Introduction

All SACIC staff will be aware that they have a responsibility to:

- Take care of their own health and safety and that of others who may be affected by what they do, or fail to do, at work.
- Follow safe systems of work and other precautions identified in the project risk assessments.
- Report any changes to personal circumstances that may affect their ability to work safely.
- Report potential hazards, incidents and near misses to the Project Officer/supervisor.

A pre-site inspection has been made of the site and applicable SACIC Risk Assessments for the project are included below.

All SACIC staff are experienced in working on a variety of archaeological sites and permanent staff all hold a CSCS (Construction Skills Certification Scheme) card. All staff have been shown the SACIC Health and Safety Manual, copies of which are held at the SACIC office in Needham Market. All staff will read the site WSI and Risk Assessments and receive a site safety induction from the Project Officer prior to starting work. All staff will be issued with appropriate PPE.

From time to time it may be necessary for site visits by other SACIC staff, external specialists, SCCAS/CT staff or other members of the public. All such staff and visitors will be issued with the appropriate PPE and will undergo the required inductions.

Site staff, official visitors and volunteers are all covered by SACIC insurance policies. SACIC also has professional negligence insurance. Copies of these policies are available on request.

Welfare facilities

Due to the limited nature of the project, it is proposed that SACIC staff will work from their vehicle and use client welfare facilities if available. If not staff will be able to travel to public facilities. Additional facilities, toilet, site accommodation etc, will be provided if the project is extended. Fresh, clean water for drinking and hand washing is carried in SACIC vehicles. A vehicle will be on site at all times.

First Aid

A member of staff with the First Aiders at Work qualification will be on site at all times. A First Aid kit and a fully charged mobile will also be in vehicle/on site at all times.

Working within School Grounds

SACIC staff and sub-contractors will follow any requirements made by the school, such as sign in procedures.

All SACIC staff have passed an enhanced Criminal Records Bureau check. Other than for access to welfare facilities staff will be working solely within the site and will have limited interaction with the school and pupils. Staff will be informed that they are not to go elsewhere on the school grounds unless authorized.

Site access and security

Access to the site is off High Road and has been agreed with the client and/or landowner. The site is bounded by hedgerows and not open to public access.

Contaminated ground

Details of any ground contamination have/have not been provided by the client. If any such is identified then groundworks will cease until adequate safety and environmental precautions are in place.

Advice will be sought from HSE and relevant authorities if required concerning any of these issues.

Hazardous Substances

No hazardous substances are specifically required in order to undertake the archaeological works.

Underground services

Details of known services have not been provided by the client.

Overhead Powerlines

No overhead powerlines cross the site.

Personal Protective Equipment (PPE)

The following PPE is issued to all site staff as a matter of course. Additional PPE will be provided if deemed necessary.

- Hard Hat (to EN397).
- High Visibility Clothing (EN471 Class 2 or greater).
- Safety Footwear (EN345/EN ISO 20346 or greater – to include additional penetration-resistant midsole).
- Gloves (to EN388).
- Eye Protection (safety glasses to at least EN 166 1F).

SACIC Environment Policy

Suffolk Archaeology is committed to the sustainable management of the local and global environment to support local communities and growth in our local economy. We will strive to reduce our carbon emissions, to protect and enhance the natural and historic environment and to tackle the issues of a changing climate. In delivering our services, we are committed to meeting all relevant regulatory, legislative and other requirements, and to the continual improvement of our environmental performance.

We will endeavour to:

- Prevent environmental pollution and minimise waste.
- Reduce our carbon emissions.
- Continually improve our energy efficiency and reduce our use of resources.
- Reduce the impact of vehicle travel by our employees
- Implement sustainable procurement practices where possible.
- Enhance biodiversity, conserve distinctive landscapes and protect the historic environment.

All existing and new SACIC subcontractors are issued annually with an Environmental Guidance Note For Contractors.

On site the SACIC Project Officer will monitor environmental issues and will alert staff to possible environmental concerns. In the event of spillage or contamination, e.g. from plant or fuel stores, EMS reporting and procedures will be carried out in consultation with the SACIC EMS Officer.

The client and/or landowner has not informed SACIC of any environmental constraints upon the development area.

All rubbish will be bagged and removed either to areas designated by the client or returned to SACIC for disposal.

3. Project Contacts

SACIC

SACIC Manager	Dr Rhodri Gardner	01449 900120
SACIC Project Manager	Dr Rhodri Gardner	01449 900120
SACIC Finds Dept	Richenda Goffin	01449 900129
SACIC H&S	Stuart Boulter	01449 900122
SACIC EMS	Jezz Meredith	01449 900124

Emergency services

Local Police	School Road, Elmswell, IP30 9EE	101, 01359 240211
Location of nearest A&E	Hardwick Lane, Bury St Edmunds, IP33 2QZ	01284 701993
Environment Agency	Customer Services Line (8am to 6pm)	03708 506 506
	24 hour Emergency Hotline	0800 807060
Essex and Suffolk Water	24 hour Emergency Hotline	0845 782 0999
National Gas Emergency Service	Gas emergency hotline	0800 111 999
UK Power Networks	East England electricity emergency hotline	0800 783 8838
Anglian Water	24 hour Emergency Hotline	08457 145 145

Client contacts

Client	Suffolk County Council	
Client Agent		
Site landowner		

Archaeological contacts

Curator		
Consultant		
EH Regional Science Advisor	Dr Zoe Outram	01223 582707

Sub-contractors

Plant hire		
Misc. Equipment hire		
Toilet/facilities hire		

4. Geophysical Technical Information

Detailed magnetometer survey

Detailed magnetometer survey is the most commonly employed archaeological geophysical prospection method in Britain, sensitive sensors can cost-effectively cover large areas of ground, rapidly recording anomalies that are indicative of cultural settlement activity. These anomalies can then be further investigated by field archaeologists to quantify a form and function. The magnetometer is a passive instrument that detects both permanent thermoremanent and temporary magnetic responses.

Thermoremanent Magnetism

When a material containing iron oxides, for example clay, is heated above the Curie point, weakly magnetic compounds transform in to highly magnetic oxides that can be detected by the sensors of a magnetometer (Clark). For instance the iron oxide haematite has a Curie temperature of 675 Celsius and magnetite 565 Celsius. Once these temperatures are reached, the oxides become demagnetised, on cooling their magnetic properties become permanently re-magnetised and align in the direction of the Earth's magnetic field (Gaffney and Gater). Over time the direction of the Earth's magnetic field changes allowing these directional differences to be detected by the magnetometer.

Strongly heated features such as hearths, kilns or furnaces frequently reach the Curie temperature and become permanently magnetised. These permanent magnetic responses are some of the strongest cultural features that can be recorded.

Temporary Magnetism

Magnetic susceptibility is the ease with which a magnetic field can pass through a material, therefore the higher the materials magnetic susceptibility, the stronger the induced magnetic field will be. Temporary magnetisation occurs within material that is magnetically susceptible, this material acquires its own local magnetic field that combine with the Earth's magnetic field causing an anomaly to stand out from the background noise (Clark). These anomalies are more subtle in nature, being derived from material that has been magnetically enhanced by cultural activity and become concentrated into features over time. Anomalies that have temporary magnetisation include backfilled pits, ditches, field systems, occupation areas, land drains, remnant and existing field boundaries (David, 2011).

The key to a successful survey is having good contrast between the magnetic susceptibility of an archaeological feature with the surrounding superficial deposits. If there is no discernible difference between the two mediums it may be unlikely that the magnetometer will successfully prospect the feature. Archaeological features can also be masked by high magnetically susceptible topsoil, or deep overlying subsoil and colluvial deposits.

Ferrous anomalies

Ferrous objects are a common source of permanent magnetism, usually isolated with a strong dipolar signature. Some of these responses may have an archaeological derivation, however they are probably more indicative of modern iron objects introduced through manuring or lost within the topsoil.

Bartington DualGRAD 601-2 Fluxgate Gradiometers

Fluxgate gradiometers are the most commonly employed class of instrument in the UK. Two 1m sensitive sensors are affixed to a frame mounted 1m apart in a vertical plane and harnessed to the trunk of a geophysical surveyor or attached two a pulled cart. Each sensor contains two fluxgate magnetometers with 1m vertical separation. The sensor above records the Earth's magnetic field (magnetic background) while the sensor below records the local magnetic field. The two sensors need aligning before recording can begin, a zero station is located in an area with low magnetic variation for this purpose. After the sensors have been aligned, the survey can begin. When differences in the magnetic field strength occur between the two vertical magnetometers within each sensor, a positive or negative reading is recorded that is relative to the magnetic background of the zero station. Positive anomalies include pits, ditches and agricultural furrows. Negative anomalies commonly prospected include earthwork embankments, land drains and geological features.

Sensors are normally mounted to a height of 0.30m above the surface, and can detect to a depth of between one and two metres below the ground. The first survey traverse is commonly undertaken in an east to west direction.

Magnetic Anomalies

Isolated dipolar responses

Isolated dipolar responses are commonly recorded throughout a dataset and are usually indicative of modern ferrous material deposited within the topsoil horizon. In some instances the anomalies may be of an archaeological derivation. They are isolated, strong and dipolar in character.

Areas of magnetic disturbance

These anomalies are usually caused by building demolition rubble, ferrous boundaries, slag waste dumps, modern buried rubbish, pylons and services. Strong and dipolar in character, they are commonly recorded over a wide area.

Linear trends

Linear trends can be either positive or negative magnetic responses depending on the nature of the material present within the feature. If the anomaly is broad and weak, it is more likely to be of geological origin. Stronger positive linear trends are more likely to be of archaeological derivation, caused by settlement activity washing rich humic, charcoal and fired deposits into a feature. Negative linear trends are more commonly associated with bank deposits or land drains, with the less magnetically susceptible superficial deposits deposited at the top of the feature.

Curvilinear trends are usually of archaeological origin, commonly interpreted as ring ditches or drip-gullies.

Discrete anomalies

Discrete anomalies can either be positive or negative in nature recorded within a localised area. Those that are positive are more likely to be of an archaeological origin, with negative discrete anomalies more commonly interpreted as natural geological variations.

Thermoremanent responses

These responses are caused by the heating of material containing iron to above the Curie temperature, they are strong and discrete in nature, in Britain high positive readings are recorded to the south of the feature, and high negative readings are recorded to the north.

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• A HISTORY OF EXPERTISE •

Geophysical Survey Risk Assessments

A pre-site inspection and assessment has been made of the site and the following SACIC Risk Assessments apply to the project and are included below.

SACIC GSRA1	Manual handling and outdoor working
SACIC GSRA2	Use of hand tools and instrumentation

Geophysical Survey Risk Assessment 1 Manual handling and outdoor working

Activity	Location	Hazard	Risks	Persons affected	Initial risk	Control measures	Residual risk	Name	Date	Rescue procedures
Manual handling of survey instruments and working outdoors.	Various.	Extremes of heat, cold and wet weather. Trip hazards.	Hypothermia, heat stroke, sunburn. Minor injuries. Carrying heavy equipment for prolonged periods.	All field staff.	9	All staff provided with appropriate clothing for weather conditions. No staff to work alone in extreme conditions. Regular sweep for trip hazards.	2	T Schofield	26/09/16	First Aid if required. Call emergency services if necessary.

	Likelihood				
Severity	1	2	3	4	5
1	1	2	3	4	5
2	2	4	6	8	10
3	3	6	9	12	15
4	4	8	12	16	20
5	5	10	15	20	25

Initial Risk
Residual Risk

Likelihood	Severity	Risk (likelihood x severity)
1. Highly unlikely	1. Slight inconvenience	1-5 Low
2. May occur but very rarely	2. Minor injury requiring first aid	
3. Does occur but only rarely	3. Medical attention required	6-12 Medium
4. Occurs from time to time	4. Major injury leading to hospitalisation	
5. Likely to occur often	5. Fatality or serious injury leading to disablement	13-25 High

Geophysical Survey Risk Assessment 2 Use of hand tools and survey instruments

Activity	Location	Hazard	Risks	Persons affected	Initial risk	Control measures	Residual risk	Name	Date	Rescue procedures
Surveying, setting out and use of small hand tools and marker canes.	Various.	Splinters from poorly maintained equipment, trip hazards from unused equipment, trip hazards from uneven ground, some heavy lifting, tape winding.	Minor injuries.	All field staff.	8	Ensure all tools in serviceable condition. Careful policing of temporarily unused equipment (e.g. no discarded hand tools, hand tapes pegged down). Ensure all tools and instrumentation carried appropriately.	4	T Schofield	26/09/16	First Aid if required. Call emergency services if necessary.

	Likelihood				
Severity	1	2	3	4	5
1	1	2	3	4	5
2	2	4	6	8	10
3	3	6	9	12	15
4	4	8	12	16	20
5	5	10	15	20	25

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Suffolk Archaeology CIC
Unit 5 | Plot 11 | Maitland Road | Lion Barn Industrial Estate
Needham Market | Suffolk | IP6 8NZ

Rhodri.Gardner@suffolkarchaeology.co.uk
01449 900120

www.suffolkarchaeology.co.uk

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www.twitter.com/suffolkarchcic

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