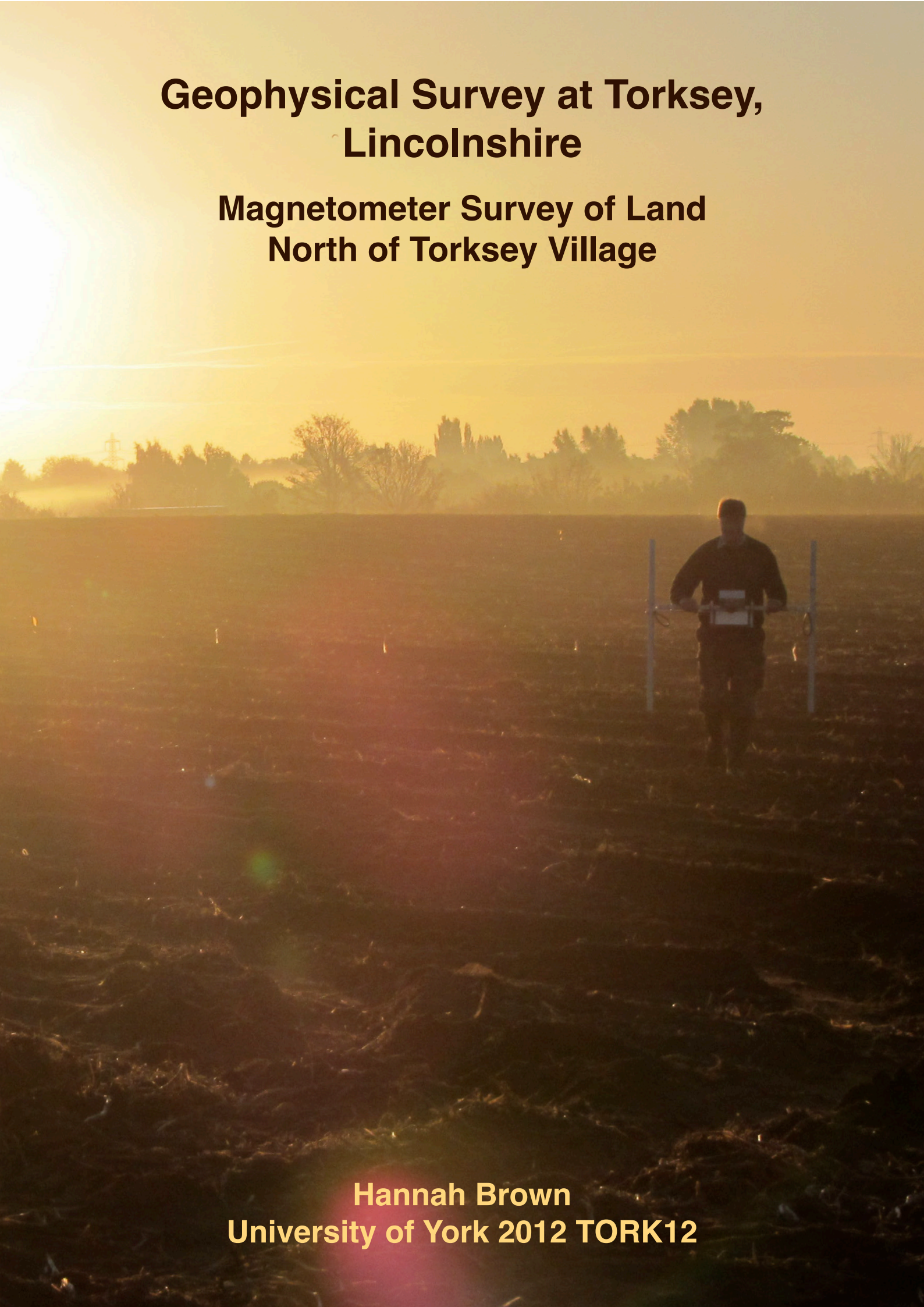
Geophysical Survey at Torksey, Lincolnshire

Magnetometer Survey of Land North of Torksey Village



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Contents

Acknowledgements

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The geophysical survey was carried out by Hannah Brown, ably assisted by Andrew Marriott.

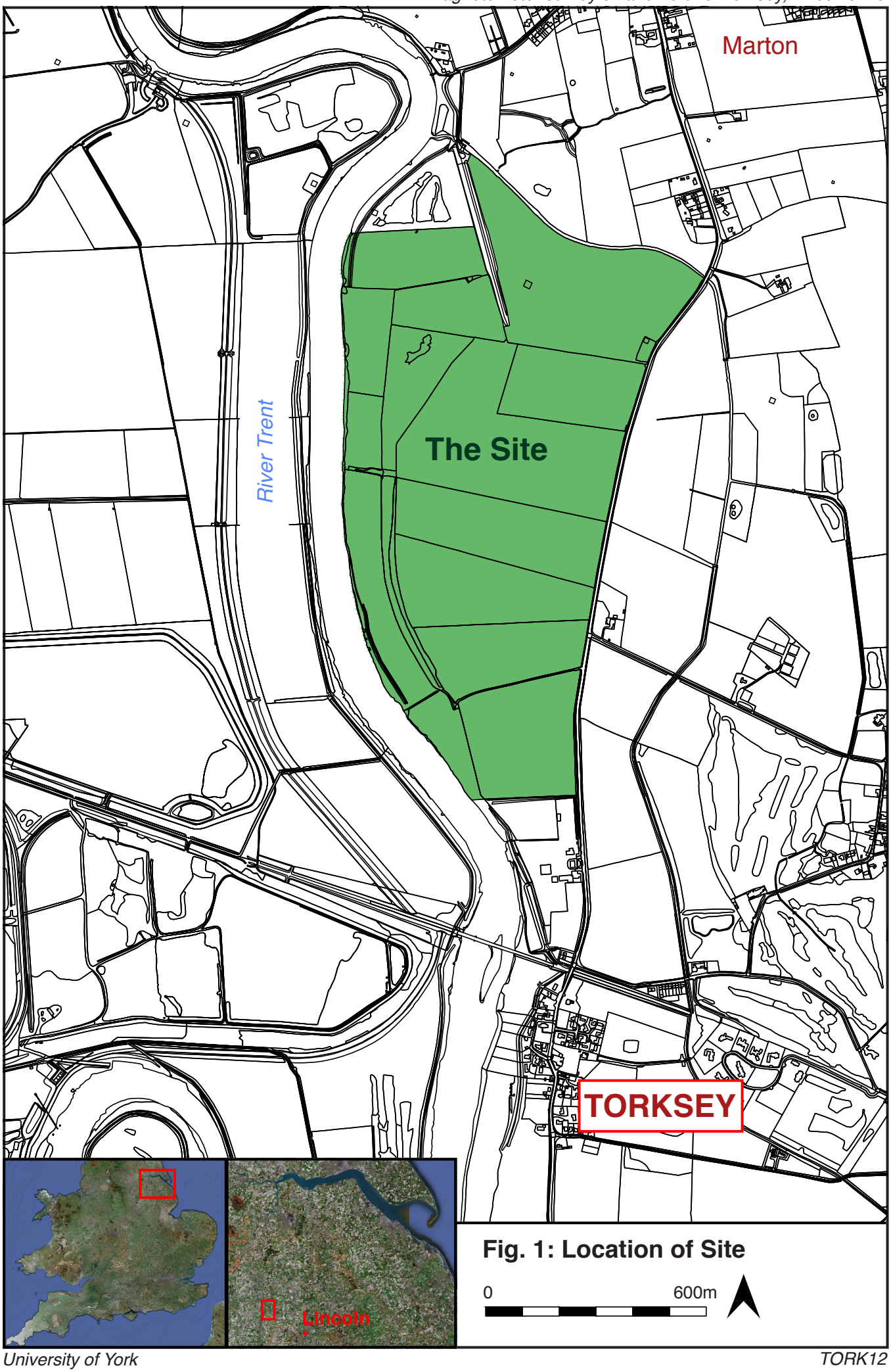

Fig. 1: Location of Site

1. INTRODUCTION

1.1. Project Background

1.1.1 Geophysical survey was undertaken as part of the Torksey Project (www.york.ac.uk/archaeology/research/current-projects/torksey), and funded by the British Academy and the Society of Antiquaries of London. Torksey is known from the *Anglo-Saxon Chronicle* (*ASC*) as the site of a Viking Army winter camp, and there is now an increasing corpus of metal detected evidence from the locality to support a Scandinavian presence in this period. The project aims to understand the character and significance of Torksey by investigating its spatial and temporal development. Geophysical survey - alongside other fieldwork techniques - forms part of the reconnaissance phase of a larger investigation into Early Medieval Torksey to be conducted over the coming years.

1.1.2 The only documentary references to Early Medieval Torksey come from the *ASC*, which records that, following raiding activity in Northumbria, the Viking 'Great Army' "took winter quarters at Torksey" in 872/3 (Swanton 2000). While the documentary evidence is not specific as to the location of the camp, the popularity of metal detecting as a hobby on the intensively ploughed arable land of Lincolnshire has resulted in the emergence of land to the north of the modern village as a likely focus of Viking activity. It is known that the Site has suffered considerably from 'night hawking', yet even without these unrecorded finds, it has become apparent in recent years that the Torksey assemblage is extraordinary in its concentration and composition of finds; the types of finds strongly indicate a Scandinavian presence during the 870s, and their quantity and distribution over some 26ha may suggest associated 'hangers on' in addition to the army itself (Blackburn 2002; 2011).

1.1.3 Previous research has tended to focus on the medieval urban settlement at Torksey (see Barley 1964 & 1981), which is known to have had 213 burgesses before 1066 and was ranked in Domesday as the third most important borough in Lincolnshire, after Lincoln and Stamford (Morgan & Thorn 1986: 337a). An established and regionally important pottery industry is known to have existed in the pre-Conquest period, and at least 15 kilns have been identified throughout the village. A mint was also operating at Torksey by this time and three coins minted by Thorketel are known (see PAS database).

1.1.4 In the Post-Conquest period, documentary evidence records that Torksey was granted a market and toll rights, exploiting the advantage of its location, and thrived as a trading/commercial centre: in 1237 the Sheriff of Lincoln noted that "of old time, they say, Torksey was the key

of Lindsey as Dover is the key of England" (Cole 1905: 473). It appears that the medieval framework of Torksey underlies the modern village, and can be partially traced on the ground through surviving documents detailing, for example, land transfers and water disputes (see Cole 1905: 471ff). Decline came in the later medieval period, with the changing emphasis of wool trade routes in Lincolnshire, reflected in the eventual silting up of the Foss Dyke. In recent years, Torksey's role has been primarily one of dormitory settlement and retirement community.

1.2 Survey Objectives

1.2.1 The primary aim of this survey was one of prospection: to establish the presence, distribution, morphology and character of any detectable archaeological remains within the survey area.

1.2.2 In particular, it aimed to identify any anomalies consistent with Anglo-Saxon or Viking activity, which might warrant further investigation, in order to inform the direction of future research. Geophysical survey was also intended to add to our knowledge of the landscape of Torksey through time, and facilitate understanding of the spatio-temporal development of the village and its surroundings as a context in which to place the Viking Great Army.

1.2.3 This report presents the survey data and provides an archaeological interpretation of them.

1.2.4 Field-walking, recorded metal detecting, geomorphological survey and test-pitting are also being carried out as part of the Project, and the geophysical survey is thus intended to produce a dataset that can be analysed in combination with this complementary information.

1.3 The Site

1.3.1 The Site is approximately centred on NGR SK 83587 80478 and lies on the eastern bank of the River Trent, to the north of the village of Torksey, Lincolnshire (fig. 1). The accessible Study Area comprises land between the Trent and the A156 and is bounded to the south by the compound of a portacabin business, and to the north by an artificial levee and a drainage channel that mark change of ownership of the land as it runs into the village of Marton; *c*. 86ha were available for fieldwork.

1.3.2 The Site comprises a ridge of higher ground that runs approximately north-south; the most prominent geomorphological feature is a

pronounced bluff, where the land falls steeply away to the flood plain on the west (figs. 2a-d). The highest point on the Site, *c.*16m aOD, is located on this scarp, roughly halfway between its northern and southern extents, and the high ground provides commanding views across the valley (fig. 3). The land slopes steadily down to the north, south and east, to *c.*4m aOD (figs. 4 & 5).

1.3.3 The name Torksey is derived from the Old English *Tureces iege* [Turoc's island] (Watt 2005: 301), implying that the higher ground between the Trent and the A156, now occupied by the modern village and the Site, was previously delimited on the eastern side by marshy ground. Peat core analyses of deposits to the east of the Site have detected evidence of paleochannels and suggest that peat began to form during prehistory, with late neolithic (Stein 2012) and late bronze/early iron age (PCA 1997) dates; there are also a number of post-medieval cartographic references to marshy ground in this area (see Estate Maps in Lincoln Archives). Studies of the Trent elsewhere in its middle and lower reaches suggest it is likely that the current course may be relatively recent (Elliott *et al.* 2004), although no systematic investigation has yet been carried out at Torksey.

1.3.4 Torksey is situated on Mercian mudstones, which are overlain by Holme Pierrepont sand and gravels, alluvial silts, humic clay and extensive deposits of aeolian sand (BGS 2012). These sediments are generally considered suitable for successful magnetometer survey, and effective surveys of this type have previously been carried out in Torksey and neighbouring parishes (as demonstrated by assorted records in Lincolnshire HER).

1.3.5 Little archaeological intervention has previously been conducted within the Survey Area itself. A porcelain factory, with a number of cottages located adjacent to it, is known to have been established *c.*1802 close to the river in Field F; survey and excavation was conducted prior to demolition in the 1970s (Chapman 1980). An evaluation trench, excavated by Wessex Archaeology in Field B in order to assess potential prehistoric cropmarks prior to construction of a gas pipeline, revealed a small number of sherds of Roman to Post-Medieval pottery in a colluvial deposit; intended magnetometer survey was not carried out due to the advanced stage of a cereal crop (WA 1996, 1997). To the immediate south of the Site, geophysical survey and archaeological evaluation were undertaken in advance of northward-expansion by the portacabin business; while the geophysical data was inconclusive, the trenches detected no archaeology (PCGeophysics 2007; Hamilton 2008). Magnetometer survey, magnetic susceptibility survey and excavation revealed late Saxon metal work and a pottery kiln, located to the north of

the railway line and immediately south of the previous intervention (Rowe 2011).

1.4 The Survey Areas

1.4.1 Gradiometer survey was conducted over 26.9ha within the Study Area (fig. 6). This took the form of two perpendicular, 60m wide transects which traverse the site north-south and east-west. Additional survey grids were added as practical. For purposes of clarity, the dataset has been split into Survey Areas A-H according to current field boundaries, despite the possibility that this may introduce artificial divisions when considering the data.

1.4.2 The primary land use in this region is agricultural and the majority of the Site is divided, by hedgerows, into medium sized fields that are part of a crop rotation regime. The flood plain is used as pasture for sheep and cattle.

1.4.3 **Area A** (fig. 7): 2.3ha. There is a sharp transition between the northern part of this survey area (extending approximately 180m south from the northern tip), and the southern section. The northern portion of the field is flat, with silty/clayey soil, a less dense crop and some remaining cereal stubble, while the area to the south of this slopes up towards the field boundary at the southern end, has considerably sandier soil and was under a crop of oilseed rape *c.*0.15-0.3m tall at the time of survey. A pylon is located at SK 8366 8097. The current axis of ploughing runs E-W.

1.4.4 **Area B** (fig. 8): 1.2ha. This area contained short stubble with a low growth of mixed wild plants approx. 0.3m tall and an uneven ground surface, having remained uncultivated since the previous harvest. The area is cut by a NNE-SSW hedgerow, and ploughing was aligned with this. The northwest corner of the survey area covered an area of made-ground and metalled track. A sub-surface gas main runs E-W across the southern end of this area.

1.4.5 **Area C** (fig. 9): 6.5ha. In the past this large L-shaped field was subdivided and is still cultivated as two separate areas, albeit without a fence line; it is divided across the centre by an extension of the existing NNE-SSW field boundary that forms the inner corner of the L-shape. At the time of survey, the eastern section contained small and sparse, self-seeded cereal plants, awaiting preparation for a new crop; the residual ploughing ridges ran NNW-SSE. The western section was also lying fallow at the time of survey, but was under the self-seeded remnants of

the previous cereal crop that had reached a height of *c.*0.4m and varying density across the area; a turf-covered path and *c.*20m wide strip of set-aside land (with taller crop remains) ran along the western field boundary. While the ground slopes down both to the east and west from the central ridge, the gradient is considerably steeper on the western side. The soil was sandy and very loose, with marked ploughing ridges. Particularly difficult ground conditions were experienced in the eastern section, which had fewer plant roots to stabilize the soil.

1.4.6 **Area D** (fig. 10): 5.7ha. This field slopes gently down to the east; the western side slopes more steeply down towards the flood plain, although the hedgerow marking the western edge is still several metres above the level of the river (this height is greater at the southern end, whereas the gradient of the northwestern corner is shallower). The field had no vegetation at the time of survey. Ground conditions were poor, with very dry sandy soil and deep ploughing ridges, which ran parallel to the northern and southern boundary hedges; the surface of the western-most *c.*60m was much more uneven, due to an area of clayey soil, which also demonstrated pronounced ploughing furrows and had baked into lumps due to an extended period of warm weather.

1.4.7 **Area E** (fig. 11a & b): 2.9ha While the natural top soil is sandy, the field had been injected with abattoir waste approx. 8 months prior to survey taking place. The eastern part of the field, which slopes down to the road, is well drained and the soil was dry. Ground conditions in the western portion of the field, particularly throughout a shallow hollow created by two slight ridges of sand running N-S, were poor with an uneven ground surface and boggy conditions that made walking at constant speed difficult. Field E also contained pronounced plough ridges, and the remains of ridges, running parallel with the northern boundary hedge. Although no longer standing, a 19th century building was located close to the road in the northeastern corner of this field; the Survey Area was located to avoid disturbance from this.

1.4.8 **Area F** (fig. 12): *c.*1ha. The field is largely flat and at the time of survey was under a mixture of the remains of a failed winter barley crop and nettles *c.*0.5m tall. The Survey Area was located to avoid potential disturbance from the remains of Pottery Farm/Brampton Porcelain Factory which was located at the western end of this field.

1.4.9 **Area G** (fig. 13): 5.2ha. This survey area, forms the southern extent of the north-south transect, bordering the northern edge of the built-up area of the modern village. A potato crop had been harvested immediately prior to survey commencing, leading to poor ground conditions. The closely spaced plough ridges/furrows and vehicle tracks running

approximately east-west were very prominent and, in combination with the dry silty sand, hampered data collection somewhat. The area contained various topographic undulations, including a noticeable depression in the northwestern corner (which may have been emphasized by vehicular access).

1.4.10 **Area H** (fig. 14): 0.7ha. Area H marked the continuation of the E-W transect line onto the floodplain, running from Survey Area C to the riverbank. Used as grazing for cattle, this area comprised short-cropped mature pasture with patches of thistles and nettles. The area is bisected north-south by a drainage ditch with a small bridge, from which a modern path runs south-west towards an area used for feeding animals (outside survey area). The survey area is relatively flat, but contains localized ground disruption.

2 METHODOLOGY

2.1 Magnetic gradiometer survey was conducted over 26.9ha, using a fluxgate gradiometer instrument. The survey was conducted in accordance with English Heritage guidelines (2008).

2.2 Magnetometer survey was employed due to the anticipated nature of potential archaeology: this technique has been shown to be very successful over sites of this type due to its ability to detect cut features which are often characteristic of early medieval settlement (Aspinall *et al*. 2008). Magnetometer survey has the added benefit of rapid and efficient data collection, particularly when using a twin-sensor instrument.

2.3 Fieldwork took place in several phases between October 2011 and November 2012, as fields became available for survey. Periods on site were mostly dry, but also included spells of heavy rain; high winds caused problems with data collection at times.

2.4 A number of obstacles were encountered which made survey difficult: a large proportion of the Site (particularly Areas C, D, E and G) had been ploughed and left with numerous, very pronounced, ridges and furrows; across most of the Site, the topsoil was deep, dry sand, with some areas of wet clay; in Field E the injection of the topsoil with liquid abattoir waste several months before the survey was conducted resulted in very soft and uneven ground conditions; some fields contained crops. All of these factors made it difficult to walk in a straight line and at constant speed (a requirement of magnetometer survey with this instrument), and are reflected to varying degrees in the data.

2.5 The Survey Areas were divided into 30 x 30m survey grids, and corner points set out using a Leica 900 GPS system, with locational accuracy of 0.02m.

2.6 The magnetometer survey was conducted using a Bartington Grad601-2 fluxgate gradiometer. This instrument has a vertical separation of 1m between sensors and is sensitive to 0.03nT over a range of ±100nT.

2.7 A sampling interval of 0.25m was employed, along north-south traverses spaced 1m apart. Data were collected in a zig-zag manner.

2.8 In addition, 5 survey grids in Area D were repeated with an increased sample density (0.5 x 0.125m) in order to assess whether any greater detail could be obtained. All other parameters were the same. See Appendix 2.

2.9 The data were subjected to minimal correction processes using Geoplot 3.0 and additional software written by Ben Urmston. Zero mean traverse and deslope functions were used to correct any variation between sensors and to balance background levels between survey grids. A de-step function was applied to reduce variations in sample position caused by adverse ground conditions and topography.

2.10 The digital archive data will be lodged with the Archaeological Data Service.

3 RESULTS AND INTERPRETATION

3.1 Fig. 15 contains a summary greyscale of data collected over all Survey Areas. Data from the individual survey areas are then presented as greyscale and XY plots, and an archaeological interpretation provided (Figs. 16-31; Appendix 1). The data are displayed at -2nT (white) to +3nT (black) for the greyscale images and ±25nT at 25nT per cm for the XY trace plots (data clipped at ±100nT). Geophysical anomalies/reference markers have been assigned a numerical marker with the prefix 'G' to distinguish them from any other numbering systems used by the Project.

3.2 Area A

3.2.1 Towards the northern end of the survey area a number of anomalies have been detected which are interpreted as being likely to be of archaeological origin. At **G01** a positive linear anomaly, approximately 2.5m wide and accompanied by an associated negative response, runs roughly N-S through the survey area and turns to continue NW-SE. This anomaly is typical of responses generated by cut linear features and probably represents a boundary or enclosure ditch that has been backfilled with material that generates a stronger magnetic signal than the surrounding background. Immediately to the south of this, an anomaly of similar form runs approximately WNW-ESE across the survey area, although this anomaly is very uniform in shape and is likely to be caused by a more recent feature, perhaps relating to drainage or a modern field boundary.

3.2.2 Numerous sub-circular and sub-rectangular positive magnetic anomalies are located throughout the northernmost 150m of the survey area, which consists of lower, alluvial ground. Ranging in size from 0.5m to *c.*10m in diameter, they are consistent with responses from cut features, probably representing pits or sunken-featured structures. It is considered very likely that some of these anomalies represent plough damaged or inconsistently backfilled linear ditches; in particular, anomalies between **G02** and **G03** correspond to a linear discrepancy visible from the air (Google Earth 2013). Similarly, anomalies running ESE from **G04** appear to form an extended alignment, as, possibly, do those running SE to **G03**.

3.2.3 The dataset indicates that this area is also traversed at approximately 20m intervals by 9 parallel land drains that run SW-NE; the southernmost drain forks near the eastern edge of the survey area. Faint positive anomalies suggest that further drains run NW-SE at similar

intervals.

3.2.4 Around **G05**, which marks the break of slope, the pedological transition and topographic change apparent in the field are reflected in the data, for example, in the degree of soil noise and agricultural differentiation. To the south, a small number of anomalies have been identified which may be archaeological in origin, but, given their small size, isolation and lack of distinct shape, it is considered that they are most likely to have natural or agricultural origins.

3.2.5 There is clear evidence of former ridge and furrow across the southern half of the survey area, particularly around **G06** where numerous sets of parallel plough trends are visible in the data on several alignments.

3.2.6 The central part of this survey area is dominated by the strong magnetic response from the pylon (**G07**). Such responses are considerably stronger than those typically generated by archaeological features and will therefore mask any evidence of underlying weaker responses. The numerous discrete ferrous responses are presumed to be of modern provenance; their distribution is noticeably biased towards the southern portion of the field and is probably explained in part by artificial landscaping to the west and southwest, as well as increased agricultural activity on the better-drained ground.

3.2.7 A number of weakly magnetic linear and curvilinear trends are apparent in the data, some of which may be of archaeological interest, although they cannot be identified as such with confidence. Some of these trends are believed to be the result of further ploughing activity or drainage, while others may be of natural origin or represent chance alignments within the data.

3.3 Area B

3.3.1 There are no anomalies in this survey area that can categorically be identified as being of archaeological origin, although several small positive magnetic anomalies occur in the centre and northeast that may be anthropogenic.

3.3.2 A gas main crosses the southern end of the survey area (**G08**); the strong responses it generates mask any weaker magnetic signals in the vicinity.

3.3.3 Ferrous responses along the northern boundary of this survey area can be attributed to the metalled track, area of hardcore and field boundaries

located here.

3.3.4 This dataset also demonstrates numerous ploughing trends in addition to a number of curvilinear trends that may be indicative of archaeological features, although it is likely that they are natural or reflect agricultural regimes.

3.4 Area C

3.4.1 In the centre of Area C, a spread of strong positive anomalies indicate a complex of ditched enclosures extending over an area approx. 140 x 140m. These anomalies are approx. 1-1.5m wide, linear and curvilinear, with many demonstrating an associated negative response. Their morphology is characteristic of that of Romano-British settlement. Given the various layouts and alignments visible in the data, it appears that they represent several phases of activity. The anomalies are more complex on the eastern side of the area; in addition to the linear anomalies, a number of strong sub-circular responses approx. 5m across may reflect discrete cut features such as fire or rubbish pits, or sunken structures. Running almost N-S along the eastern edge of this area (**G09**), two linear anomalies are aligned roughly parallel approx. 5m apart; it is not clear whether they represent a delineated track-way or reflect different phases of settlement. The magnitude of the anomalies is strongest in this eastern area, decreasing significantly to the west; this may reflect occupation, with pits and ditches closest to the focus of settlement accumulating larger quantities of material of higher magnetic susceptibility (i.e. burnt material, ceramics, domestic waste etc.). A linear anomaly approx. 1.5m wide, with a negative value, runs south from the northern edge of the survey area to **G10**; this may reflect the remains of an earth bank or stonewall, or perhaps a modern field boundary.

3.4.2 Some of these enclosure anomalies have been truncated to the southwest by a significant area of extreme responses west of **G10**; while there was no apparent source on the surface, it is assumed that the data values are caused by modern ferrous debris, given that that a small structure is marked at this location on early 20th century OS maps.

3.4.3 Traces of a number of positive anomalies are visible that are cut by the north-south edge of the data to the north of **G09**, and which continue south of this point; these are aligned such that they may reflect features extending east in a similar manner to those visible to the west of **G09**, although the data does not definitively support this as any extended linear anomalies appear to have been truncated by ploughing.

3.4.4 To the southwest of **G11** a series of weakly magnetic linear anomalies, consistent with those generated by cut features, radiate out from a central point, through two concentric sub-circular anomalies of the same nature. Several discrete positively magnetic anomalies of probable anthropogenic origin are located within the central circle. The linear anomaly running NNE-SSW through the centre of this formation is orientated parallel to the negative linear at **G10**, while that running WNW-ESE through the centre is aligned directly with one of the strongest linear anomalies also at **G10**. See discussion below.

3.4.5 At **G12**, three quarters of an annular anomaly is visible in the data, measuring 13m in diameter and <1m wide. It is consistent with responses collected over ploughed-out barrows, roundhouses or similar. A discrete strong dipolar response is present in the interior of the anomaly; this is likely to be caused by modern ferrous, although it is possible it is associated with the archaeological feature.

3.4.6 Further linear and amorphous positive magnetic anomalies are located towards the southern and eastern extents of the survey area at **G13** and **G14**. Additional trends in the data in these areas imply traces of other features that may have succumbed to extensive ploughing. It is possible that such anomalies are indicative of further archaeological features associated with activity in the centre of Area C, but which are less magnetically visible due to geological conditions (see below).

3.4.7 A number of positive anomalies are also located around **G15** that appear to be anthropogenic, however, their lack of definition makes them difficult to interpret archaeologically.

3.4.8 A faint but persistent trend of disturbance is visible in the data, running east from **G16**; while not detectable beneath stronger and more structured anomalies, such as those at **G09** and **G11**, it reappears around **G12** and continues to **G14**. This may represent a former trackway or boundary, although it does not appear to relate to any of the modern boundaries in the immediate vicinity.

3.4.9 It would seem that disturbance around the southwestern corner of the survey area (**G17**) is connected with a plastic drainage pipe (detected as a narrow linear negative anomaly), a metal gate and the use of this area as access for farm vehicles into the adjacent field.

3.4.10 A number of trends are visible across the dataset, which may be of archaeological interest although they cannot be identified as such and may be of agricultural or natural origin.

3.4.11 It is clear from the data that the area has been extensively ploughed on various alignments. The ridges and furrows of ploughing at the time of survey are very apparent in the eastern half of the area as a series of dominant WNW-ESE responses. The increased soil noise this produces impedes the detection of fainter archaeological responses.

3.5 Area D

3.5.1 Survey in this area did not detect any anomalies that can be categorized definitively as being of archaeological origin; however, numerous sub-circular weakly positive anomalies approx. 1-2m in diameter were identified distributed across the field with increased frequency towards the eastern side of the survey area. These are consistent with anomalies produced by pits or similar cut features and possibly represent archaeological features.

3.5.2 In the north-eastern corner of this field a weakly positive anomaly which may be archaeological is visible running E-W. This is the most substantial of a number of weak linear trends in the data that can be discerned in this area, including several which appear to continue the alignment of the possible Romano-British enclosures in Area C. Some of these may reflect the remains of comparatively recent field boundaries, albeit not recorded by the OS maps.

3.5.3 Similarly, 2 separate spreads of increased magnetic response have been detected. These areas, ranging up to *c.*40m across and amorphous in form, demonstrate slight magnetic enhancement relative to background levels but have been highlighted as being anomalous data values. It is possible that they are anthropogenic in origin, perhaps reflecting accumulations of ploughed out archaeological/burnt material, or that they are the result of geological variation or agricultural influences.

3.5.4 The predominant direction of ploughing trends in the data (*i.e.* parallel with the northern and southern field boundaries) reflects extant ploughing furrows, while at least two earlier ploughing events are visible.

3.5.5 Along the western edge of the survey area, which corresponds with the edge of the bluff, several strong responses were detected which are known to be caused by modern ferrous objects such as barbed wire.

3.5.6 5 of the 30 x 30m survey grids in this area were surveyed at increased sample density in an attempt to illuminate the nature of the amorphous positive anomalies (see Appendix 2). It was noted that while the

increased resolution resulted in greater definition, it did not provide sufficient detail to alter the archaeological interpretation of anomalies; this backed-up our decision that, at this point in the project, the greater coverage allowed by the standard sampling resolution method (*i.e.* 15 traverses per survey grid) was of greater benefit than the possible increase in reading density (30 traverses per grid).

3.6 Area E

3.6.1 No definitive evidence of archaeology was detected in this field; the data is very similar to that collected over the previous survey area. A number of sub-circular positive anomalies of possible archaeological origin have been identified; they are distributed across the field, but most frequently located in the centre and east of the Survey Area.

3.6.2 A number of larger (*c.*5m diameter) sub-circular positive magnetic anomalies have been identified close to the western edge of the Survey Area *i.e.* along the highest point of the bluff. These may have been generated by modern ferrous sources (such as a grain hopper for feeding pheasants), although the character of the responses and slightly amorphous plot shape could also make some of them consistent with responses generated by archaeological features.

3.6.3 Three irregularly shaped areas of slightly increased magnetic response were also detected in this field, with possible archaeological, geological or agricultural origins.

3.6.4 Ploughing trends are not visible to the same extent in this field as the ground surface was uneven and disturbed at the time of survey due to previous fertilizer injection, although coherent directional trends remain identifiable.

3.7 Area F

3.7.1 There are no anomalies that can be identified definitively as archaeological in this survey area, although a small number of reasonably well-defined sub-circular positive anomalies, the largest of which is 3.5m in length, are distributed across the dataset; it is possible that they represent archaeological features such as pits.

3.7.2 The dataset shows numerous ploughing trends, predominantly orientated NE-SW and NW-SE, in addition to a number of linear and curvilinear trends of uncertain origin. It is likely that some of these also

derive from ploughing activity, while others may be of natural or possibly other anthropogenic origin.

3.7.3 Discrete ferrous anomalies of weak to medium strength are present throughout the dataset; the increased frequency of such responses within the southern c.60m of the survey area probably stems from landscaping activity, possibly associated with the removal of former buildings in this field, as pieces of ceramic building materials (which would produce such anomalies) were visible in the soil in places.

3.8 Area G

3.8.1 Area G contains a series of anomalies that are interpreted as being archaeological in origin, in addition to further anomalies that are considered likely to be archaeological, and numerous small anomalies that may also reflect archaeology. This field has, however, been heavily ploughed and the extant ridges and furrows are very apparent in the data as parallel narrow bands of alternately positive and negative responses running roughly E-W across the field; this reflects the increased magnetic value of the volume of soil in the ridges relative to the decreased magnetic levels measured over the air in adjacent furrows. For clarity, extant ploughing has not been labelled on this interpretation.

3.8.2 Around **G18**, a series of weakly positive linear anomalies roughly 1.5m wide form a complex of rectilinear enclosures covering an area measuring approximately 60 x 30m. 2-3 linear anomalies are aligned NW-SE, running roughly parallel and *c.*8m apart. These are connected by similar anomalies running perpendicular. In the south-eastern portion of this area, the anomalies aligned NE-SW occur every c.4m, although this regular pattern breaks down towards the northwest. The anomalies are similar in nature to those detected in Area C at **G11**. Around the periphery of the most clearly defined anomalies, many appear to have originally extended further on the same alignment, however, this continuation is now only apparent as trends in the data.

3.8.3 Surrounding these archaeological anomalies, a band of discrete positive magnetic anomalies categorised as probable archaeology are located, spreading from the centre of the eastern survey edge to the north-western corner.

3.8.4 Among these anomalies, approximately 8 (surrounding the archaeology at **G18** and at **G19**) are conspicuously larger than the others. While they vary in strength, these anomalies are sub-circular or sub-rectangular and

around 3m in diameter. There is no clear pattern to their distribution beyond being widely spaced, although, by chance or intention they appear to respect the complex of small linear enclosures. It is not possible to tell from the magnetometer data alone whether these anomalies are related to or contemporary with those identified as archaeological.

3.8.5 A cluster of positive anomalies around **G20** are also interpreted as likely to be of archaeological origin, given the curvilinear pattern of their distribution. Weak data trends reinforce this alignment between the strongest responses, although it is not clear whether this indicates the remains of a single curvilinear cut feature, or the 'smearing' of magnetically enhanced material from discrete features by previous ploughing events.

3.8.6 Numerous small positive anomalies are distributed across the survey area. These are consistent with archaeologically generated responses, but cannot be identified as such with confidence and may have natural or agricultural origins. They are generally sub-circular and vary in size up to *c.*2m in diameter. They are found with greatest frequency to the north and east of **G19**, spreading across to the southwest of the field. If the anomalies are archaeological in origin, it is not clear from the geophysical data whether this distribution reflects original variation in activity/settlement or is a function of survival, particularly given the probability that **G21** marks the line of a former boundary (see below).

3.8.7 Positive responses at **G21** and **G22** probably represent the remains of a linear ditch feature; the anomalies detected at the eastern and western edges of the survey area, where they are *c.*3m wide, are joined by a trend in the data running between them. Anomalies of this type are often associated with the demarcation of land boundaries and this anomaly corresponds with the location of the parish boundary on modern OS maps. Furthermore, documentary evidence from 1237 detailing the parish boundary of Torksey indicates that this is also the position of the medieval parish boundary (Cole 1905). It is probable that this boundary has at some point been marked by a double ditch, given the presence of a similar linear anomaly 15m to the south of **G22** and aligned parallel, although any extension of this feature to the west cannot be identified clearly in the dataset.

3.8.8 A further anomaly of a similar nature is identifiable at **G23**, and lies on a similar ENE-WSW alignment to those at **G21-2**, although this anomaly is only visible for 40m before its path becomes lost in the ploughing trends. This may represent a former field boundary as it echoes the alignment of a number of the surrounding extant boundaries.

3.8.9 A number of linear ploughing trends are visible, predominantly aligned NW-SE and NE-SW.

3.8.10 A small number of other curvilinear trends are present in the data, which may be archaeological interest or of natural origin.

3.8.11 An area of increased magnetic response is apparent in the northwest corner of the survey area, coinciding with access into the field.

3.9 Area H

3.9.1 Much of the western section of this survey area is dominated by anomalies, such as those at **G24**, that are weakly positive or negative, amorphous and varying in size; it is believed that the magnetometer is detecting the influence of superficial geology. This interpretation is supported by the conspicuous change in the nature of the responses and absence of geological anomalies in the data to the east of the drainage ditch (gap in the data), which also coincides with the break of slope as the land rises off the flood plain.

3.9.2 Several small positive anomalies, up to 1.5m in diameter, which would be consistent with the response over small cut archaeological features such as pits, have been identified in this dataset. They are predominantly located in the north-eastern quadrant (**G25**), although one anomaly 2.5m in diameter is located roughly in the centre of the survey area. They cannot, however, be identified definitely as archaeological, and may be natural in origin.

3.9.3 Ferrous responses and magnetic disturbance along the northern and southern perimeters of the survey area, and adjacent to the drainage ditch (data gap), are the result of modern disturbance, made-ground and drainage management. A number of curvilinear trends identified in the southwest quadrant of the dataset are also likely to be associated with modern disturbance. A bridge is located near **G26** and a modern path runs from there to the southwest corner, accounting for the data trends that run in this direction.

3.9.4 Parallel trends aligned NW-SE and NE-SW in the data indicate that, although currently used as pasture, this area has been ploughed in the past.

4 DISCUSSION

4.1 Magnetometer survey has been successful in detecting a number of anomalies that can be interpreted, with varying degrees of certainty, as being archaeological in origin, although no anomalies were detected that can be interpreted as definitive evidence of a Viking winter camp or related Early Medieval settlement.

4.2 Few Viking winter camps have been identified in the UK that could provide parallels for Torksey, and fewer have been subjected to geophysical survey. Although geophysical techniques (magnetometry and earth resistance) were used to trace the substantial D-shaped ditch interpreted as the defences of the Viking winter camp (occupied a year after Torksey), technological development at this time was such that the results were of limited resolution and scope, and revealed little beyond the line of the ditch (Biddle & Kjølbe-Biddle 1992 and Aspinall 1984). More recent survey at the Viking site of Woodstown, Co. Waterford (Bonsall & Gimson 2003), provides a good example of magnetometer investigation with similar parameters to that conducted by the Torksey Project, over a river-side site which shows many parallels with Torksey in terms of finds and evidenced activities. The survey undertaken at Woodstown demonstrates the type and distribution of anomalies that could reasonably be expected to be found at Torksey, including evidence for an enclosing ditch, numerous pits and possible areas of burning, and some probable structures (Bonsall & Gimson 2003). At Torksey, anomalies interpreted as pits, possible burnt deposits or structures are primarily located across the southwest of the Survey Area, in Areas D, E and G, as might be suggested by the combined evidence of metal detected finds and topography. It is interesting to note that reports of a high concentration of Scandinavian finds in Field G (and, previously, the field immediately south of the Site) (P. & D. Stanley 2011 pers. comm.) coincide with 13th century documentary evidence that the meadow adjoining the river at this point, known as the Denesheyng, formerly belonged to Odo the Dane (Cole 1905: 476). It is, however, worth bearing in mind that a 19th century description of Billingsley's porcelain factory, located in the south-western corner of Field F, makes mention of clay and sand extraction in "adjacent fields", although no more detail is provided (O'Neill 1897: 153). Similarly, such anomalies may be consistent with natural negative features such as old tree throws, or variation in the ferrous content of sediments.

4.3 Given the quantity of Scandinavian metal-detected finds from known positions at Torksey, it is perhaps surprising that more evidence of related occupation has not been detected in the geophysical data.

Where anomalies have been interpreted as pits, possible burnt deposits or possible structures, they show a scattered distribution of considerably lower density than comparable features at Woodstown. It is believed that the Site has a much higher potential for Early Medieval archaeology than is immediately apparent from this magnetometer dataset: it is considered likely that the presence of a deep layer of aeolian sand across large portions of the Site has rendered the magnetometer ineffective in distinguishing the magnetic fields of archaeological features as distinct from the background readings. The recorded magnetic flux density associated with a sub-surface feature that acts as a magnetic dipole, such as a pit, is dependent on both the magnetization of the feature (*i.e.* the intensity and orientation) and its depth; the strength of the flux density is inversely proportional to the cube of the distance from the dipole (Aspinall *et al*. 2008: 58-78). Consequently, the presence of a thick sand deposit significantly increases the distance between the gradiometer sensors and the intended target field, essentially putting the archaeology 'out of reach' of the magnetometer. Moreover, the technique of gradiometer survey depends upon the detection of relative, rather than absolute, magnetic field values; thus if features are backfilled relatively rapidly with blown sand - as is likely to have happened to features left open or abandoned in this area - the resulting magnetic contrast with the natural background will be minimal. The Bartington gradiometer has a sensor separation of 1m, which is theoretically more discerning than alternative instruments on the market with shorter separations, but the instrument appears to have struggled to detect what in any case is likely to be comparatively ephemeral archaeology.

4.4 This hypothesis is supported by results of soil coring survey conducted as part of the Torksey Project, which involved the analysis of cores from across the Site and provides an indication of the distribution of the sand deposits (Stein 2012). This data suggests that, on the whole, areas that are overlain by a greater depth of sand demonstrate less coherent anthropogenic magnetometer data. The north-central portion of Area C and the southern part of the Site (Area G), for example, which demonstrate geophysical evidence of archaeological activity, are overlain by shallower sand deposits, with the more deeply covered central, western and northeastern areas (Areas B, D, E and F) displaying fewer anomalies. The effect is particularly apparent when comparing well-defined anomalies from alluvial areas such as Area A. It is therefore likely that while the settlement evidence noted around **G09**/**G10** appears to 'fade out' to the east, south and west, this distribution is a function of the reduced clarity and magnitude of the magnetic anomalies; the archaeology may well continue in some or all of these areas. It has been noted that the linear enclosure anomalies detected to the south of the field boundary separating Areas B and C are not visible in to the north, in

Area B; it was observed during fieldwork that the ground surface of Area B is >1m higher than that outside the boundary hedges, suggesting that the visibility of archaeology is related to overburden depth. While the quality of the magnetometer data is sufficient to conclude that the gradiometer survey has produced an accurate measurement of the magnetic anomalies across the surface of the Survey Area, it is important to remember that the instrument is producing measurements of the vertical component of the magnetic field at a given point - which can then be interpreted as being characteristic of archaeological features - rather than measuring 'archaeology' *per se*.

4.5 The survey found no evidence of a defensive ditch, such as that detected with excavation and geophysical techniques at Repton and interpreted as the distinctive D-shaped enclosure of the Viking defences (Biddle & Kjølbe-Biddle 1992; Aspinall 1984), unless such a ditch at Torksey was fossilized in a later parish or field boundary. This inevitably raises the issues of negative evidence. While it is entirely possible that the geological conditions described above have masked a magnetic anomaly that would otherwise be detected over the ditch, bearing in mind the Trent and low-lying, wet surroundings that were central to the 'island' nature of the Site (Stein 2012), it may not be the case that defences of this type existed.

4.6 The most striking archaeological anomalies were found in Area C, where the data shows a complex of rectilinear enclosures located towards the northern end of the ridge of high ground that forms the 'island' of the Site (**G09**). Although somewhat confused by the possible continuation of the later NNE-SSW field boundary through the area (as recorded on 19th century maps) and ferrous responses from modern debris, the alignment of these anomalies is suggestive of multiphase use. The morphology and character of the magnetic anomalies are characteristic of those found over Romano-British settlements, incorporating rectilinear ditched enclosures, possible droveways and discrete pits, and they are interpreted as a farmstead or similar. It is noted that this location provides an appreciable 360° view of the surroundings, including potential contemporary settlement at Marton and a stretch of the Trent.

4.7 The complex is likely to continue to the north, running undetected beneath the boundary with Field B and masked by the high ferrous responses of the gas pipeline. While no continuation of these anomalies was detected within Field B, this is likely to reflect the poor-visibility of the magnetic signatures of the features (see above). It may be worth noting that previous archaeological evaluation in this field (WA 1997) was based on an HER record of prehistoric crop marks (although this record was not found when the HER was examined for this project).

4.8 The interpretation of these anomalies is reinforced by observations made during fieldwalking that their location corresponds to concentrations of Roman pottery that are absent from the rest of the field (J. Young 2011 pers. comm.); similarly, initial analysis of the distribution of material found by metal detectorists would suggest an increased frequency of Roman finds in this area (A. Woods 2011 pers. comm.).

4.9 These features would have been located within a landscape of Roman activity, although it has generally been assumed that any Roman occupation focussed on the southern extent of the village, where the Foss Dyke is likely to have been a Roman construction (EH Mon. No.: 1034549). Roman kilns were located to the south of the canal (EH Mon. No.: 324688), nineteenth-century OS maps record finds of Roman coins and pavements to the south of the village, and Torksey Castle incorporates Roman tiles (Cole 1905: 507), although no Roman archaeology has been definitively established on the northern bank of the Foss. However, increasing numbers of Roman coins and metal work are now being retrieved, and reported, from the Study Area by metal detectorists (P. Stanley 2011 pers. comm.). To the north of the Site, the Roman road Till Bridge Lane crosses the Trent with associated settlement at Littleborough (EH Mon. No.: 1003669), and a small fort was located at Marton (EH Mon. No.: 1004935) that would have been visible from the northern end of the Torksey Site.

4.10 Of the group of anomalies detected at the northern end of Area A, some are convincingly anthropogenic in origin, and are interpreted as being generated by at least one continuous curvilinear enclosure ditch; alignments of the anomalies that are similar but smaller, suggest the original presence of at least two similar ditches. It is considered most likely that the smaller, irregular anomalies are also of anthropogenic origin. Given that they are appear to reflect ubiquitous cut-feature types and an insufficient area was surveyed to identify any characteristic layout forms, they cannot be identified as typical of any specific archaeological culture or period; the form of the ditches, however, possibly suggests that they could plausibly be interpreted as late-Prehistoric or Romano-British. It is not possible from the magnetometer data to determine their chronological relationship to other features on Site, though they appear to be cut by the land-drains. Detection of this archaeology on the low ground of the flood plain may suggest it relates to activities carried out either distanced from the domestic sphere (industrial processes?), deliberately making use of the flood plain (stock management, clay extraction?), or associated with the river itself (trade- or fishing-related activity on the foreshore?); alternatively, it may suggest that this land has not always been as prone to flooding as it is now. The

faint trends to the south of this area, marking the break of slope and change in soils, may be related to a previous physical boundary, as this line also marks the Brampton-Marton parish boundary.

4.11 On the basis of the morphology and magnitude of the complex of anomalies at **G11** in Area C, it is tentatively suggested that they reflect an artificial rabbit warren of the type that were reasonably common features in the later Medieval and Post-Medieval landscape *(cf.* Williamson 2006). The same origin is proposed for the complex of rectilinear enclosures **G18** in Area G. Allowing for documented regional variation, these features comprised a rectangular or circular 'pillow' mound with a surrounding ditch; the mound was usually built over a rectilinear grid or radial pattern of slots, some of which were capped with stones, and although the rabbits often elaborated upon the original burrow pattern, constructed burrows made the extraction (using ferrets, dogs etc.) of rabbits easier; examples of multiple mounds located adjacent to each other are known (see Williamson 2006). The possible warren in Area G is visible on both sides of the double ditch running SW-NE across the field; although it appears that the boundary feature cuts the ?warren, it is not possible to ascertain definite chronology from the magnetometer data alone.

4.12 As a whole, the dataset clearly demonstrates the difficulties encountered with extensive ploughing on the Site, and both current and previous plough furrows are visible across all of the fields. While it was not practical to wait for all the fields to be rolled or cultivated before survey, Areas G and C in particular illustrate the artefacts generated by the uneven surface (exacerbated by the soft sandy soil). Even if archaeology has not been directly damaged by ploughing, this excess ‘noise’ can prevent the identification of weak archaeological responses, as well as distracting the eye from patterns of anomalies. Where archaeological features of increased magnetic susceptibility are damaged by ploughing, it is common for the magnetically enhanced material to be dragged along the plough route, simultaneously increasing the magnetic value of the ridges and decreasing that of the remains of the feature.

5 CONCLUSIONS

5.1 Magnetometer survey has been successful in detecting a number of anomalies that can be interpreted, with varying degrees of certainty, as being archaeological in origin, which are widely distributed across the Survey Area in terms of both space and time. Among the anthropogenic anomalies, some, such as those in Areas C and A, are particularly well defined, suggesting good preservation of complex archaeology on a site- (rather than feature-) scale.

5.2 The survey has not identified any magnetic anomalies that can be categorized specifically as Early Medieval or Viking, although many of those identified as archaeological (e.g. in Area G) may prove to be of this date on closer investigation. It may also be the case that, with few clear examples of Viking winter camps on which to build an interpretation at Torksey, identification is limited.

5.3 The dataset raises issues over the visibility of archaeological features, given the geology of the Site. It is suspected that the deposits of wind blown sand noted during coring survey (Stein 2012) are obscuring detection of archaeology that, even under ideal conditions, can be expected to demonstrate comparatively weak magnetic contrasts with the surrounding soil. Such deposits may, however, have positive implications, ensuring survival of archaeology intact beneath the reach of the plough.

5.4 The survey has successfully added to our knowledge of the landscape at Torksey, and gives an indication of it's evolution through time, from the scattered prehistoric worked flints that were picked up during fieldwork to the nineteenth-century field boundaries and structures that are no longer extant (e.g. in Area C). Archaeology such as the Romano-British enclosures in Area C and the possible rabbit warrens in Areas C and G were previously unknown, and the geophysical data gives an indication that this area of higher ground has proved important both before and after Viking utilization.

5.5 The magnetometer survey has also served to provide a spatial and temporal context for some of the metal-detected finds and pottery obtained both from local detectorists and through fieldwalking. Preliminary comparisons suggest further analysis incorporating both geophysical plots and find distribution data within a GIS would be rewarding.

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Fig. 2a: Showing the bluff on the western edge of the site. View from the flood plain, looking south towards the village and church.

Fig. 2b: Showing the bluff on the western edge of the site. Looking north-east across the Trent towards the northern end of the scarp.

Fig. 2c: Showing the bluff on the western edge of the site. Looking down to the flood plain from the top of the bank.

Fig. 2d: Aerial view of the Site, showing the scarp edge (in shadow) following the curve of the river. © Google Earth 2013.

Fig. 3: View northwest from the scarp edge.

Fig. 4: Looking southwest across the higher ground that forms the Site, showing the dune-like topography.

Fig. 5: View east from the Site, showing the land sloping down to the A156, with low-lying ground between the road and the ridge in the distance

Fig. 7: Survey Area A: looking N from the southern boundary; the change in crop marks the break of slope and change in soils.

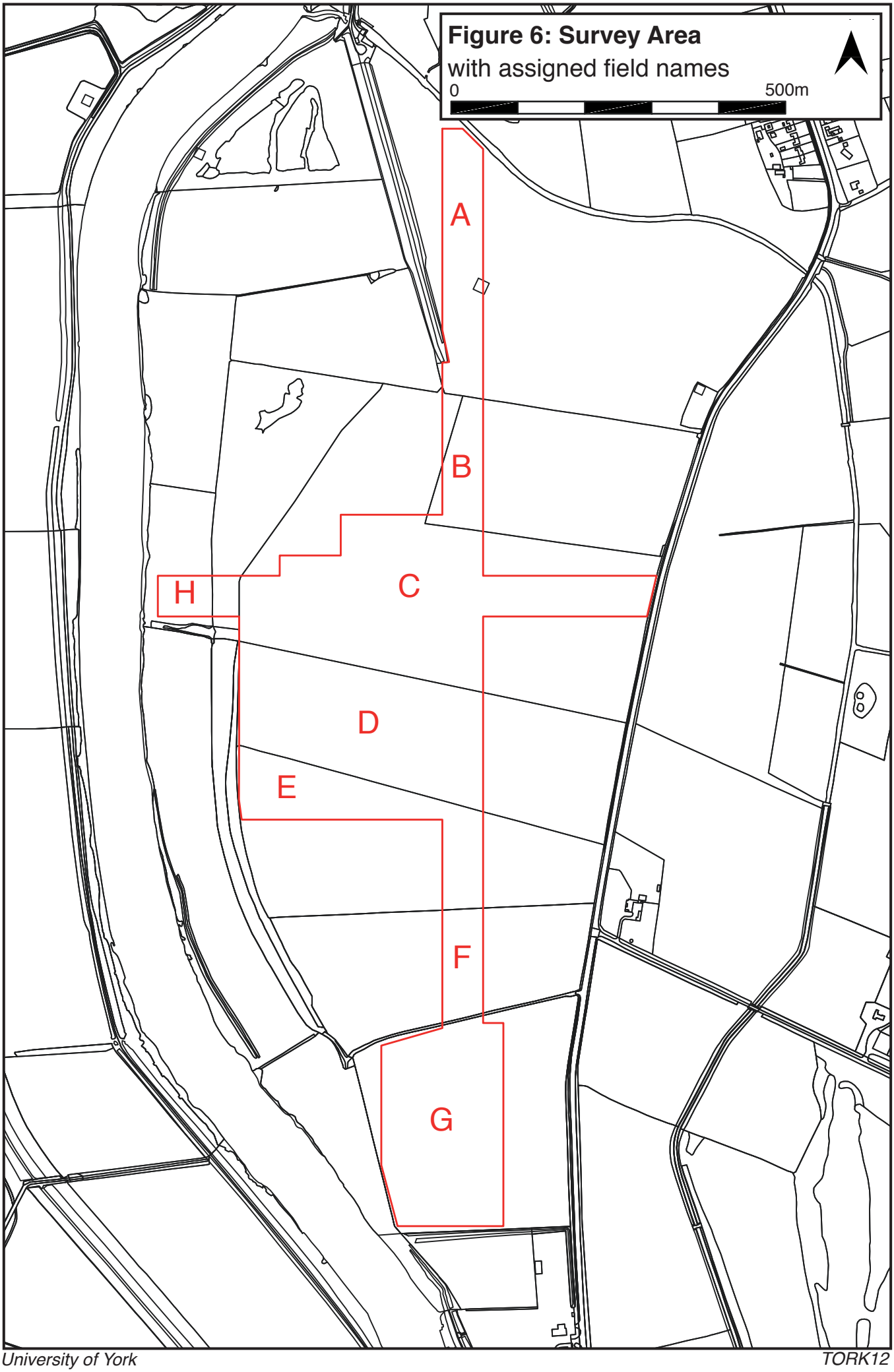


Figure 6: Survey Area
with assigned field names
0
500m
A
B
C
D
E
F
G
H

Fig. 8: Survey Area B: looking south across the corner of Area B, with Area C in the distance.

Fig. 9: Survey Area C: looking north across Area C from its southern boundary; the division of the field at the time of survey is visible with the western section standing fallow and the east being prepared for a cereal crop. The pylon on the horizon is in Area A and the white stake faintly visible directly in front of it marks the gas pipe running beneath the corner of Area B.

Fig. 10: Survey Area D: view east across Area D; previously under sugar beet, pronounced ploughing ridges remained. The visible footprints give an indication of the ground conditions on the dry, sandy soil.

Fig. 11a: Survey Area E at the time of survey; looking southwest; while the topsoil is dry and sandy, the darker patches in the distance are the result of intensive injection with liquid abattoir waste.

Fig. 11b: Survey Area E: prior to survey, under a carrot crop, this view looking west shows the hollows in the centre of the field more clearly.

Fig. 12: Survey Area F: looking south from the northern field boundary.

Fig. 13: Survey Area G: looking northeast from the southwestern corner, with metal detectorists providing human scale; the topographic variation and poor walking conditions are visible.

Fig. 14: Survey Area H: looking northeast from the southwestern corner of the survey area towards the hedgerow, which marks the edge of Area C and the scarp line; the line of thistles parallel to the hedge marks a drainage ditch, with a bridge close to the centre of the image, and disturbed ground visible in the foreground.

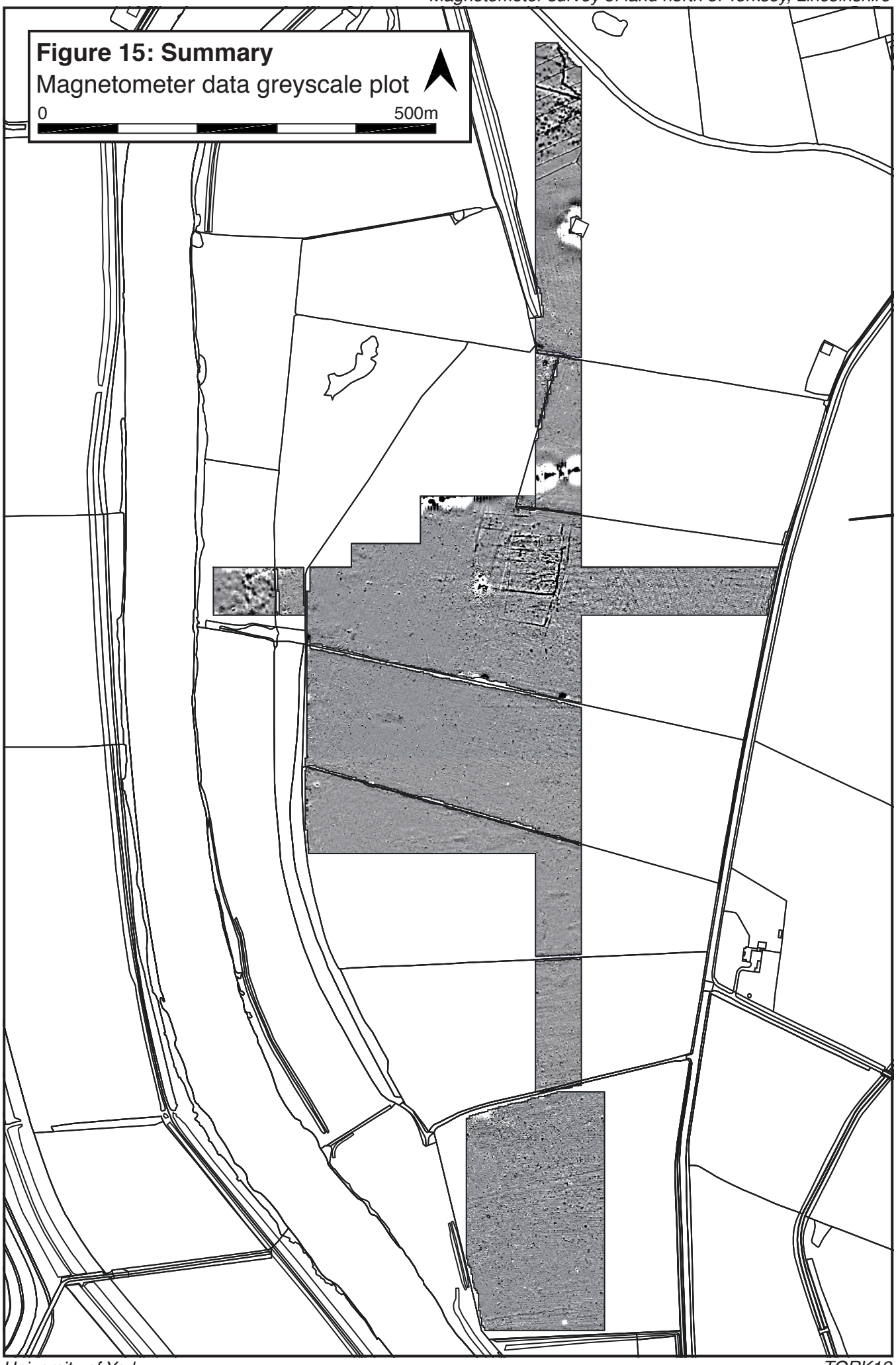


Figure 15: Summary
Magnetometer data greyscale plot
0
500m

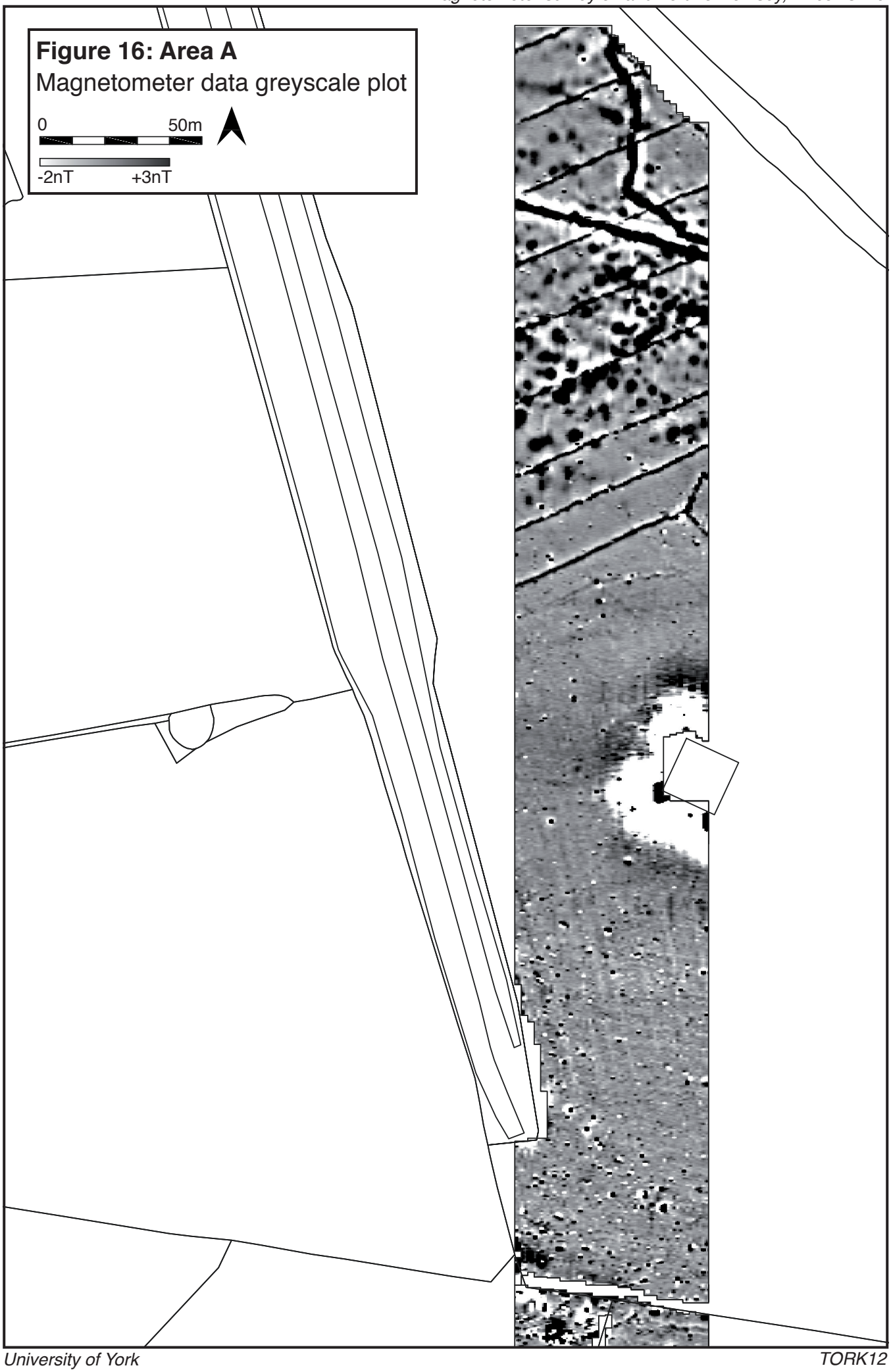


Figure 16: Area A
Magnetometer data greyscale plot
0
50m
-2nT
+3nT

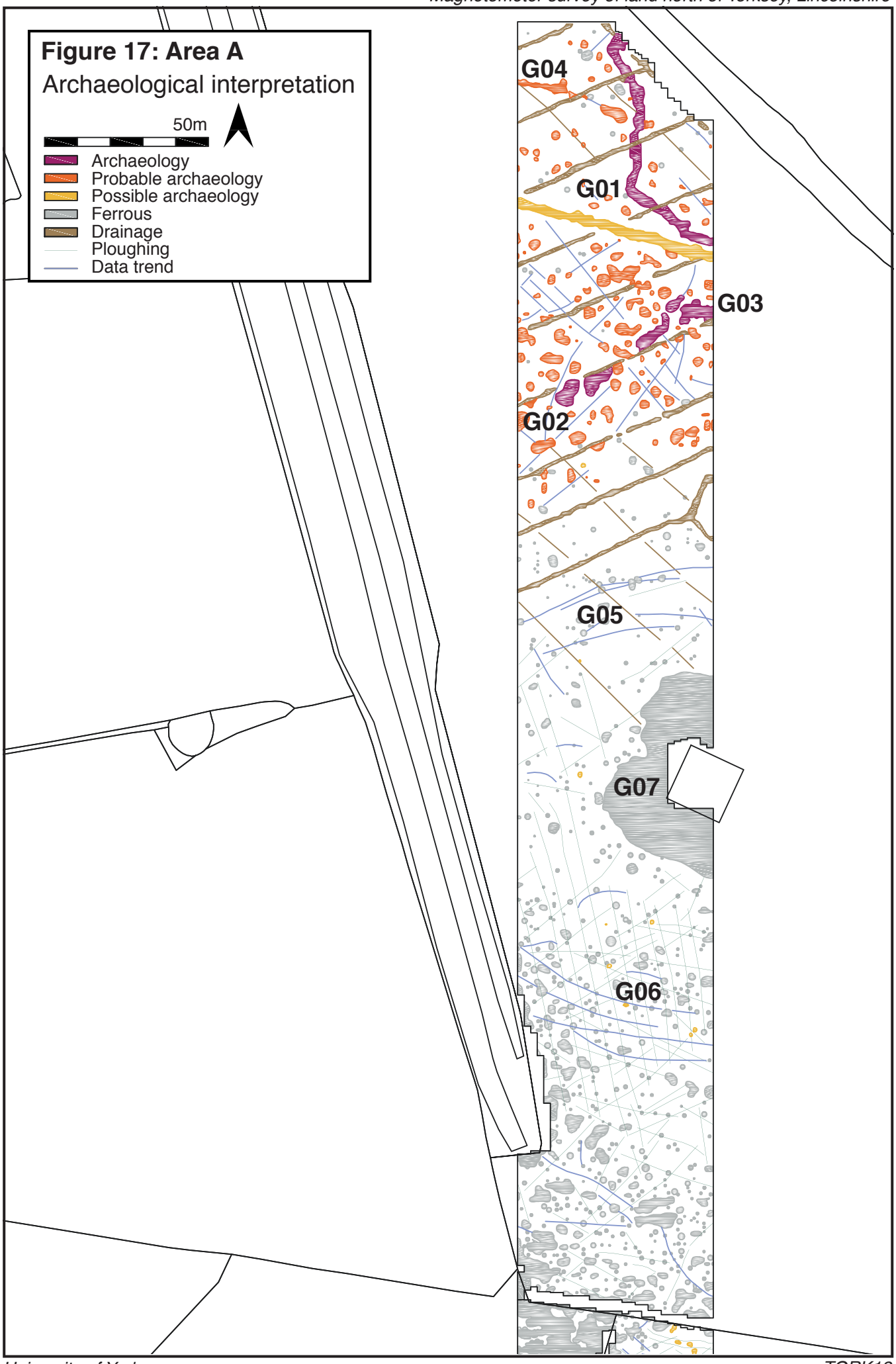


Figure 17: Area A
Archaeological interpretation
50m
Archaeology
Probable archaeology
Possible archaeology
Ferrous
Drainage
Ploughing
Data trend
G04
G01
G03
G02
G05
G07
G06

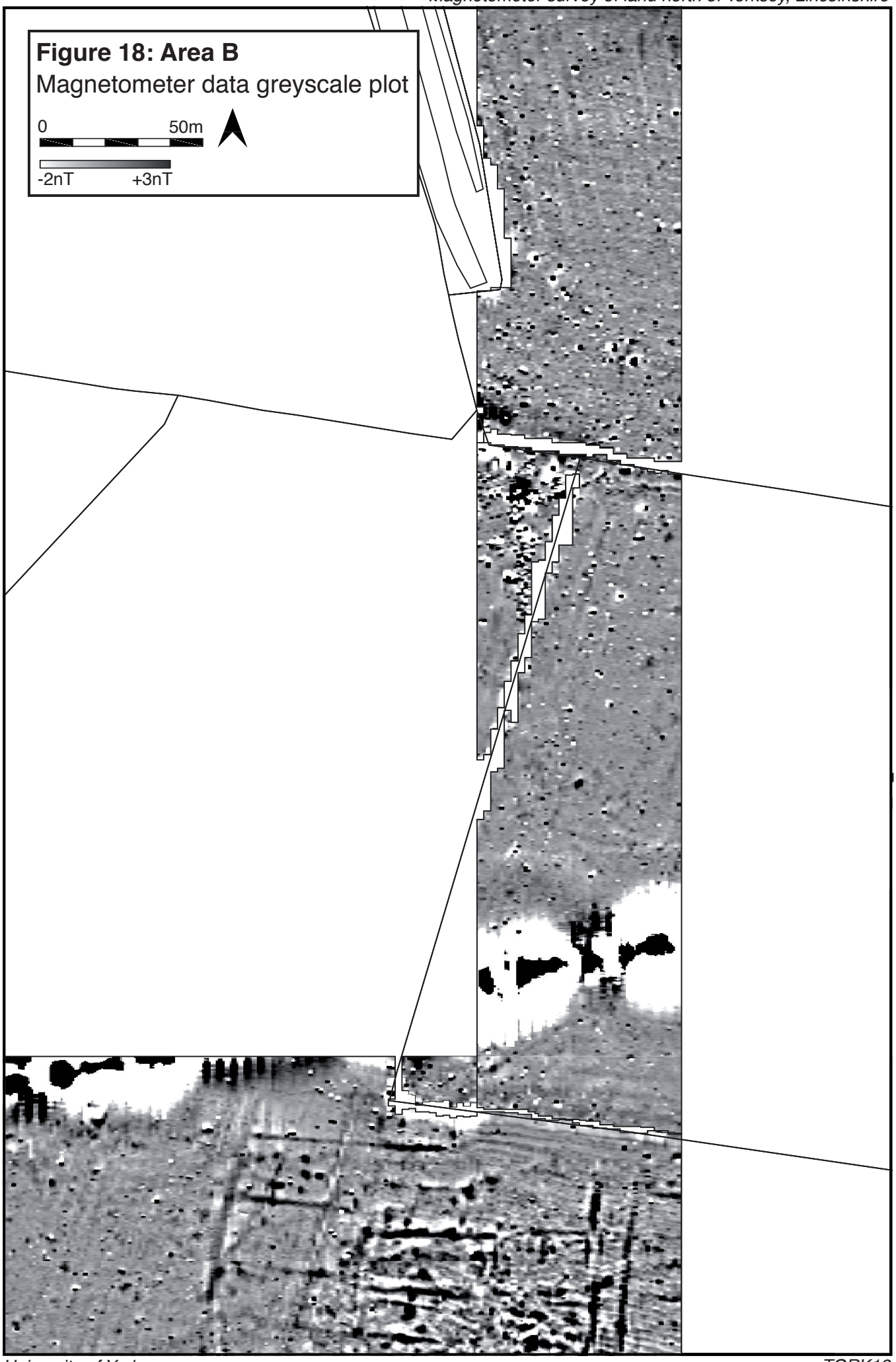


Figure 18: Area B
Magnetometer data greyscale plot
0
50m
-2nT
+3nT


Figure 19: Area B
Archaeological interpretation
50m
Possible archaeology
Service
Ferrous
Ploughing
Data trend
G08

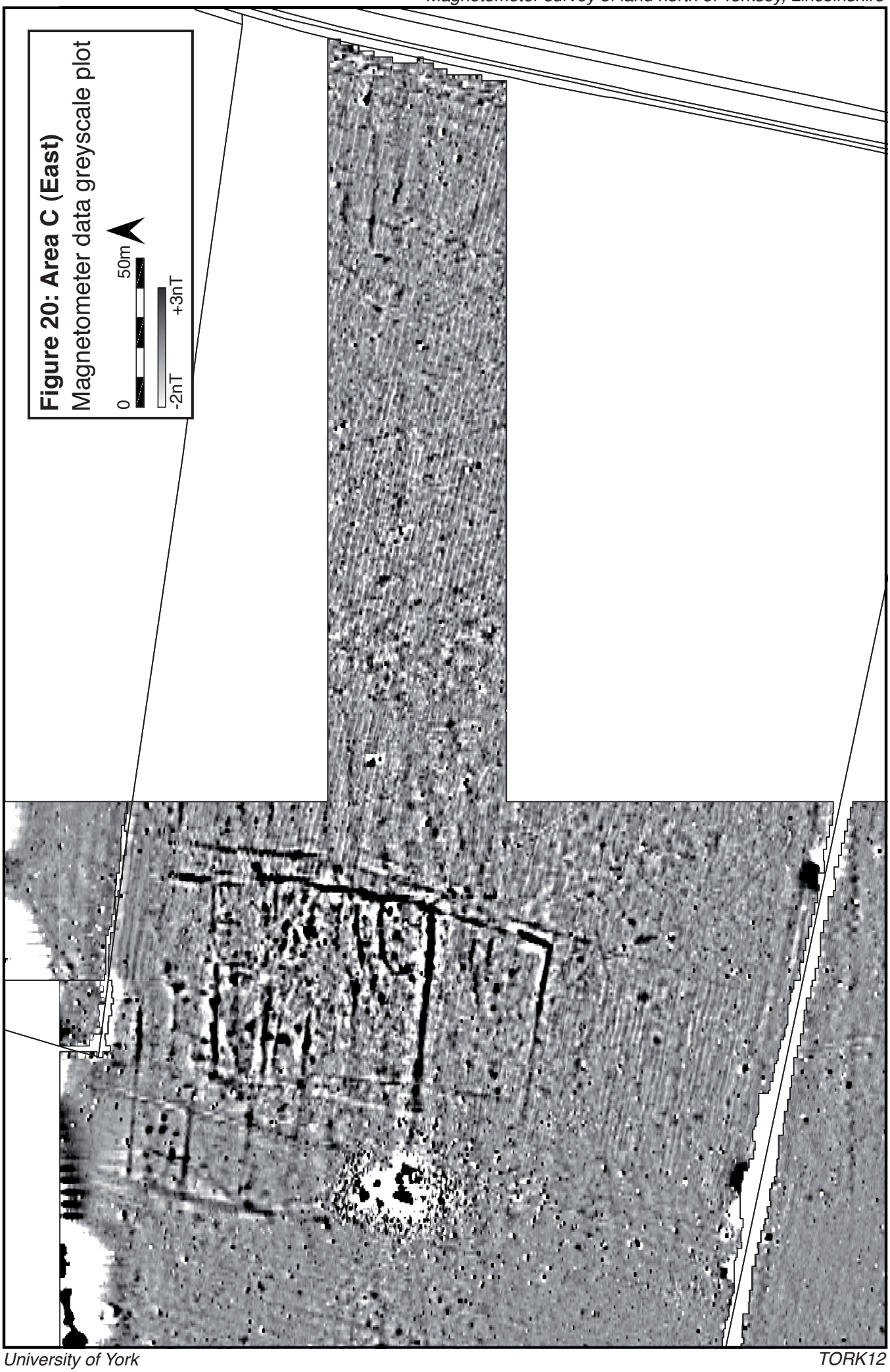
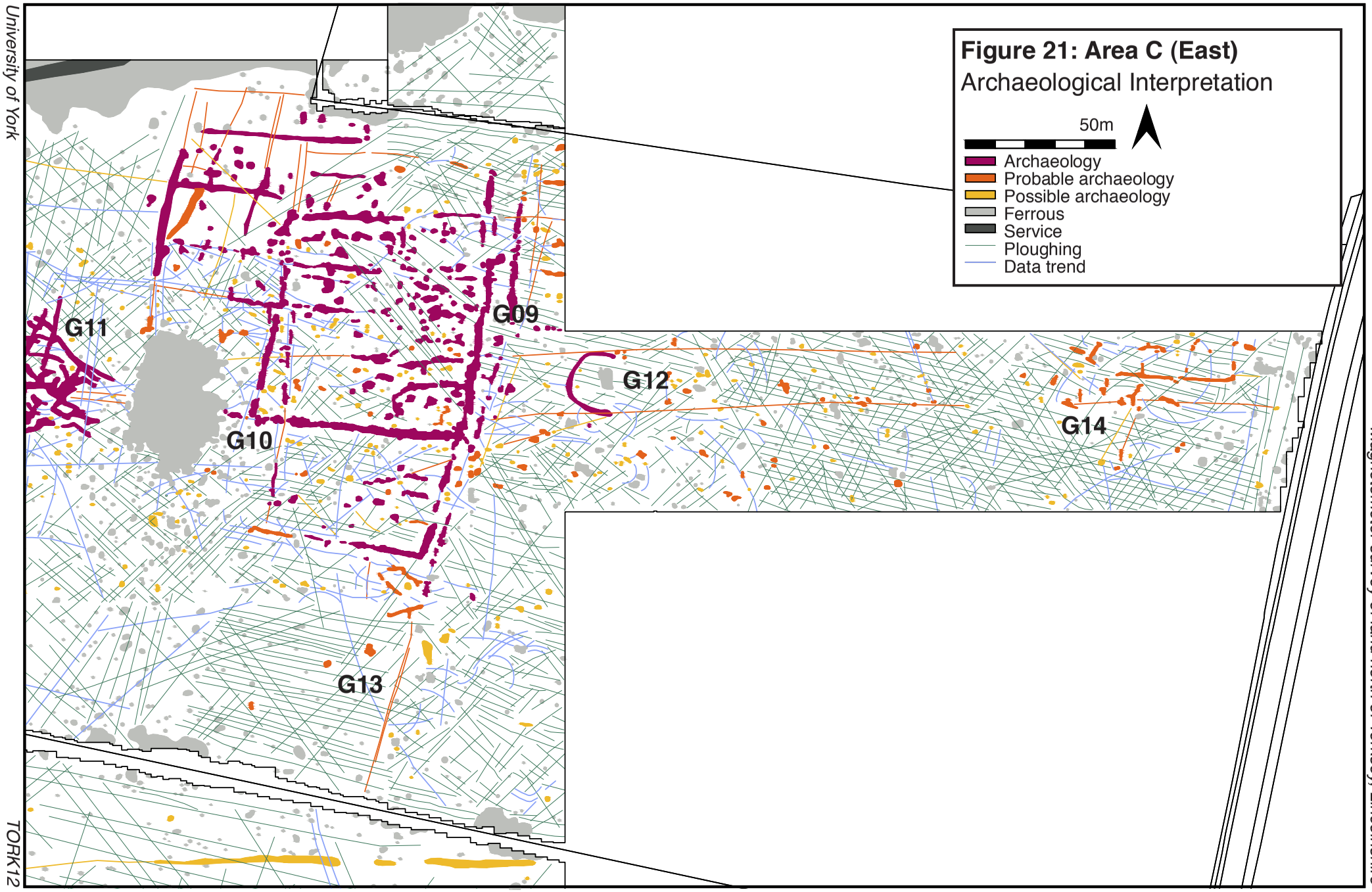


Figure 20: Area C (East)
Magnetometer data greyscale plot
0
50m
-2nT
+3nT



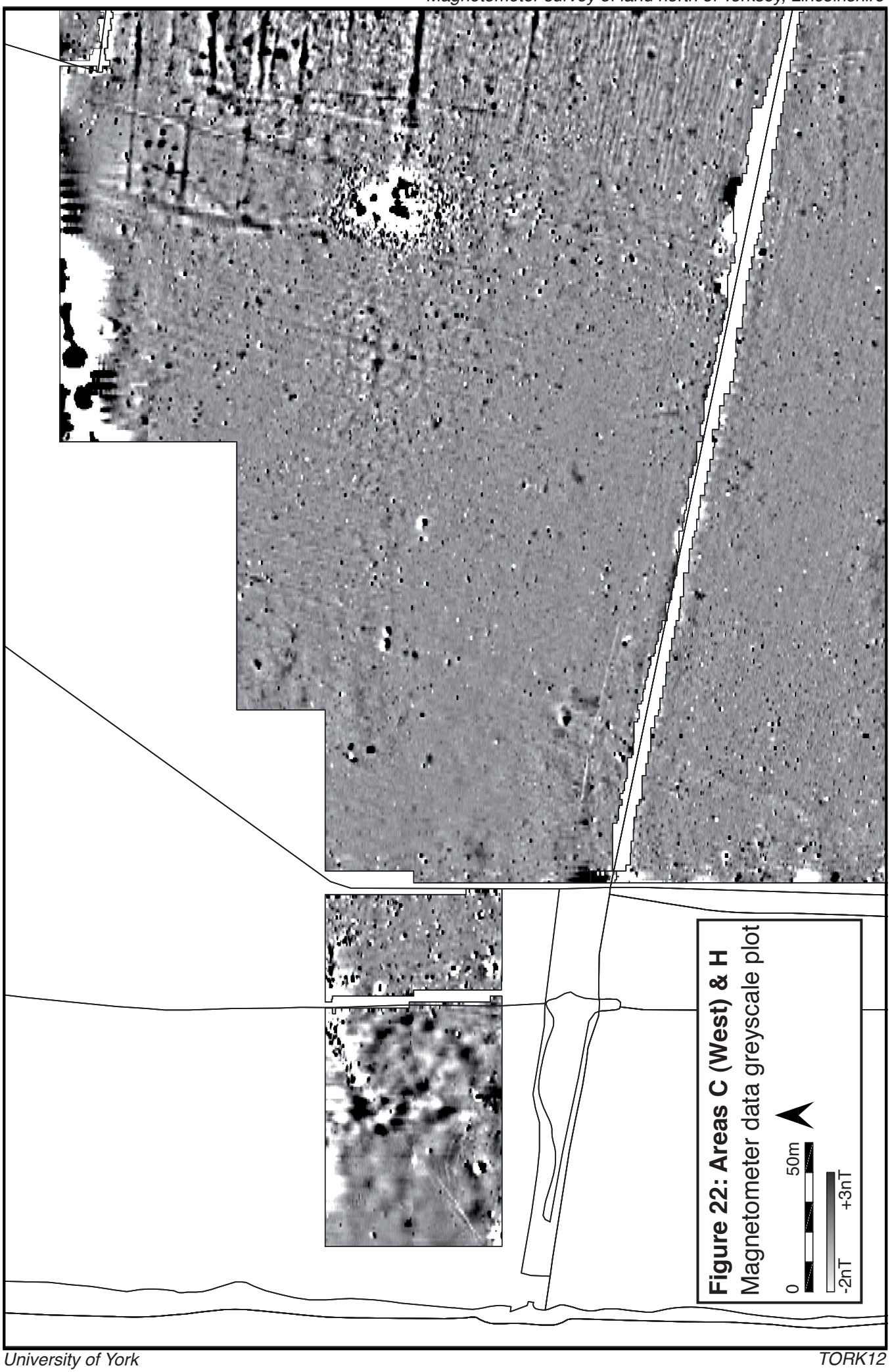
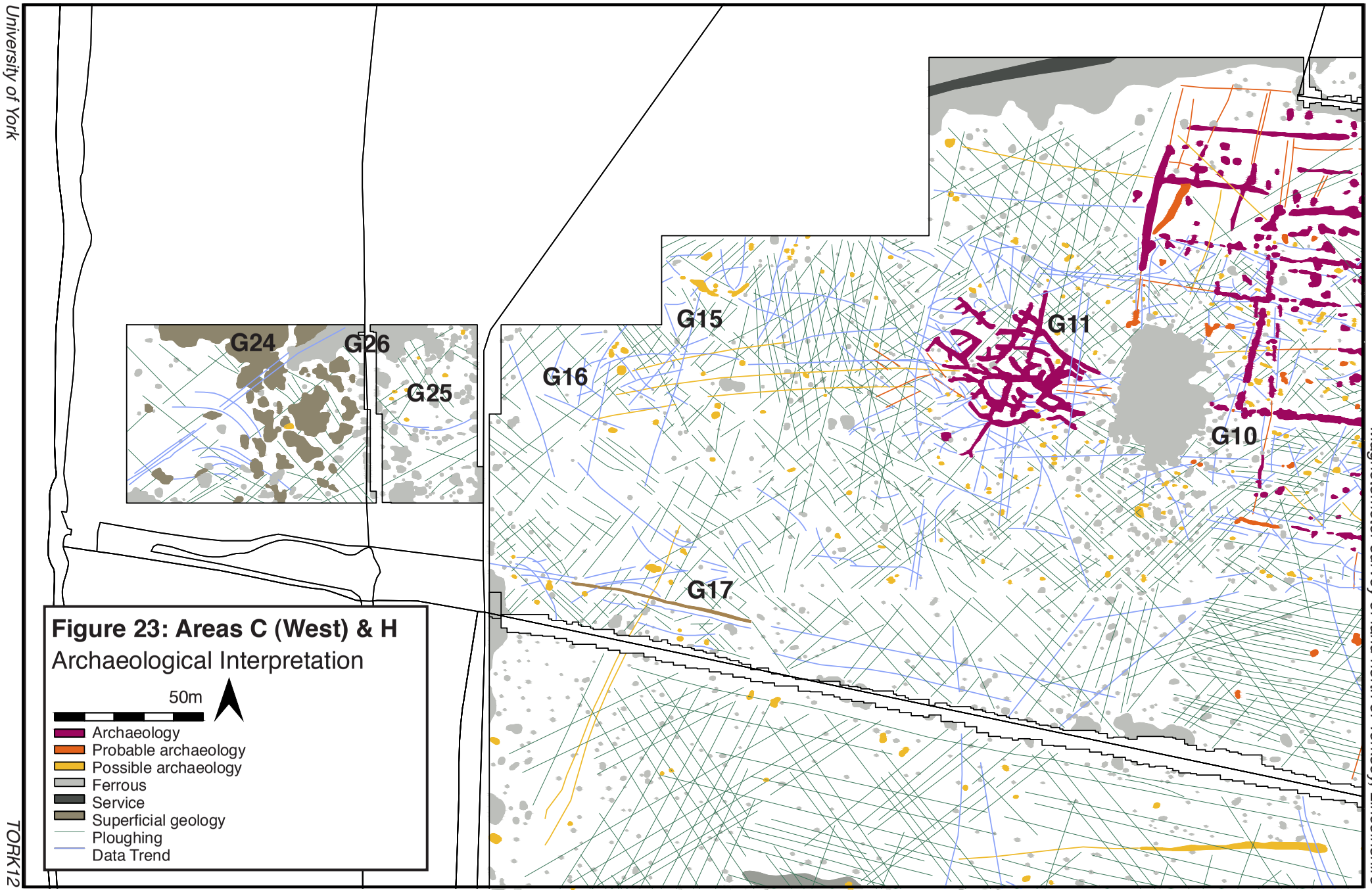


Figure 22: Areas C (West) & H
Magnetometer data greyscale plot


University of York
TORK12
Magnetometer survey of land north of Torksey, Lincolnshire
G24
G26
G25
G15
G16
G11
G10
G17
Figure 23: Areas C (West) & H
Archaeological Interpretation
50m
Archaeology
Probable archaeology
Possible archaeology
Ferrous
Service
Superficial geology
Ploughing
Data Trend

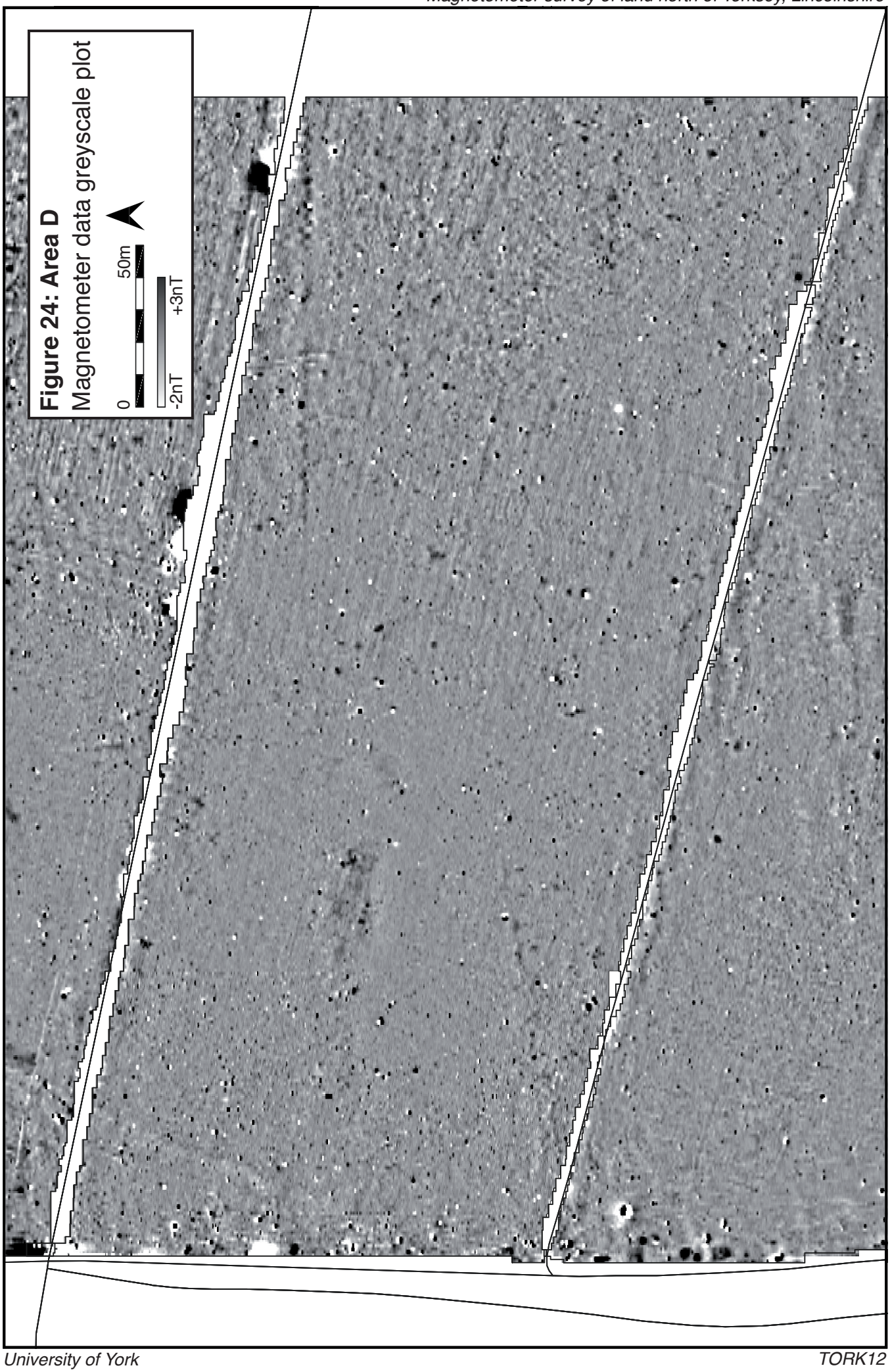


Figure 24: Area D
Magnetometer data greyscale plot
0
50m
-2nT
+3nT

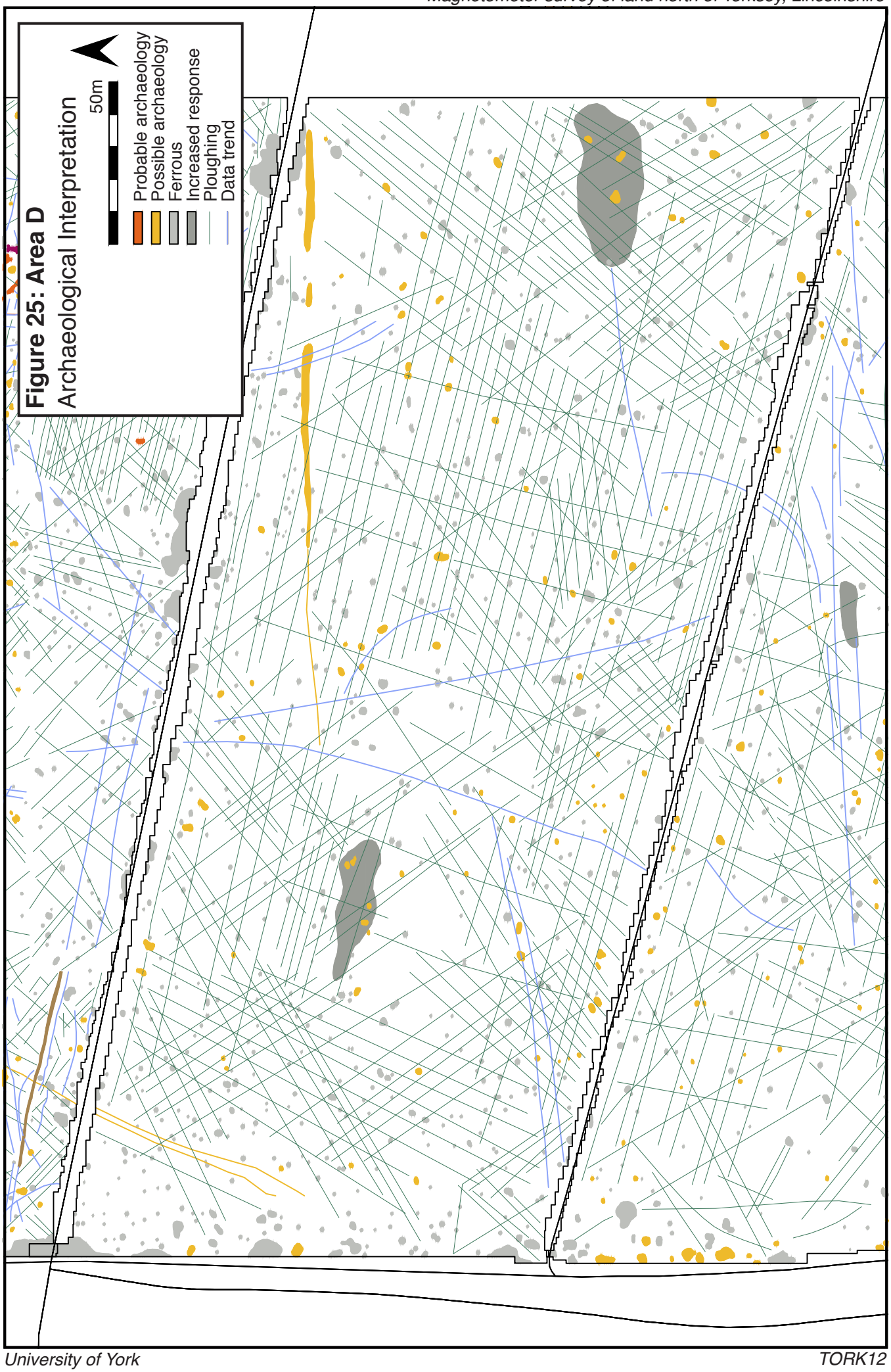


Figure 25: Area D
Archaeological Interpretation
50m
Probable archaeology
Possible archaeology
Ferrous
Increased response
Ploughing
Data trend

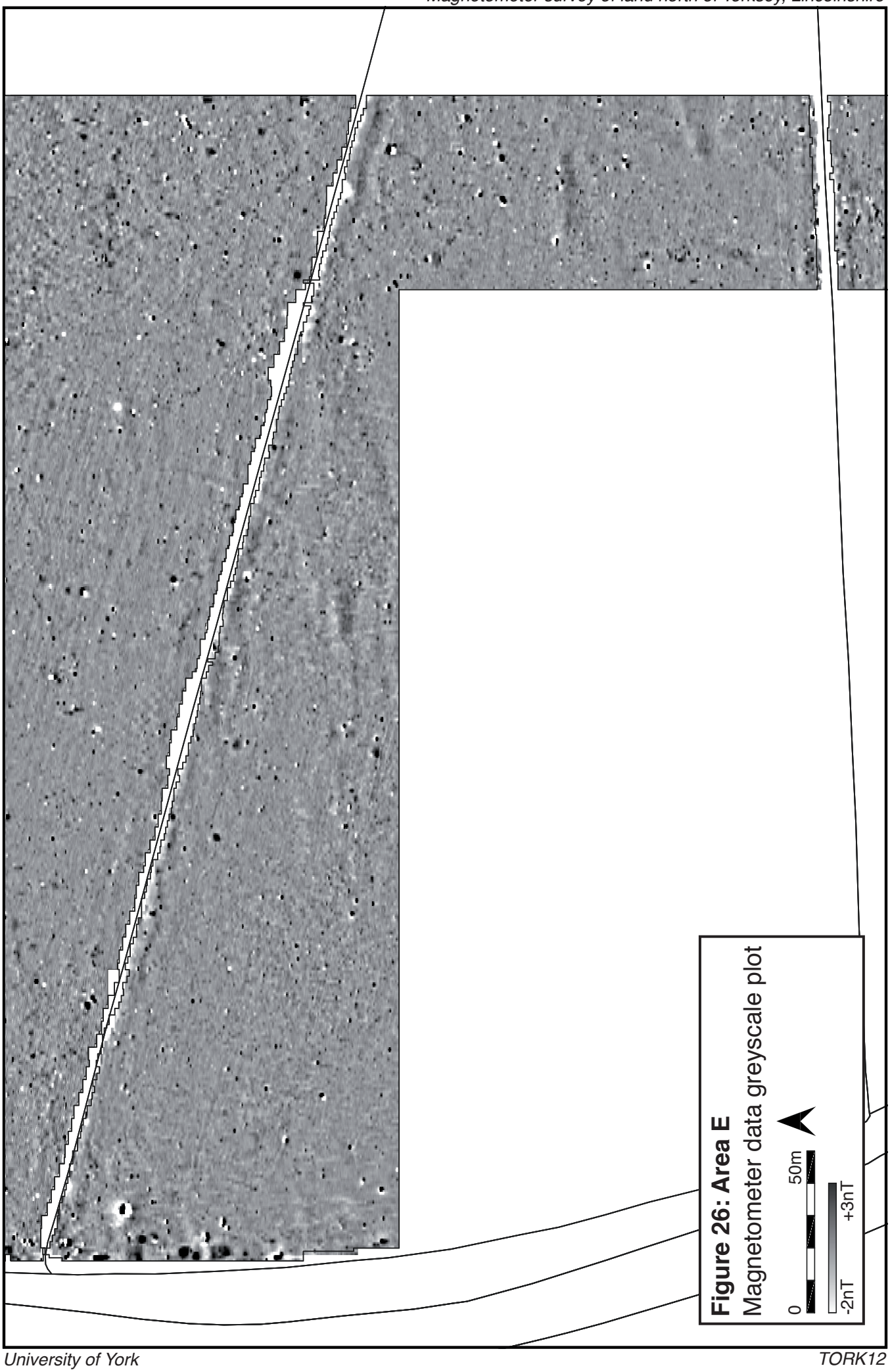


Figure 26: Area E
Magnetometer data greyscale plot

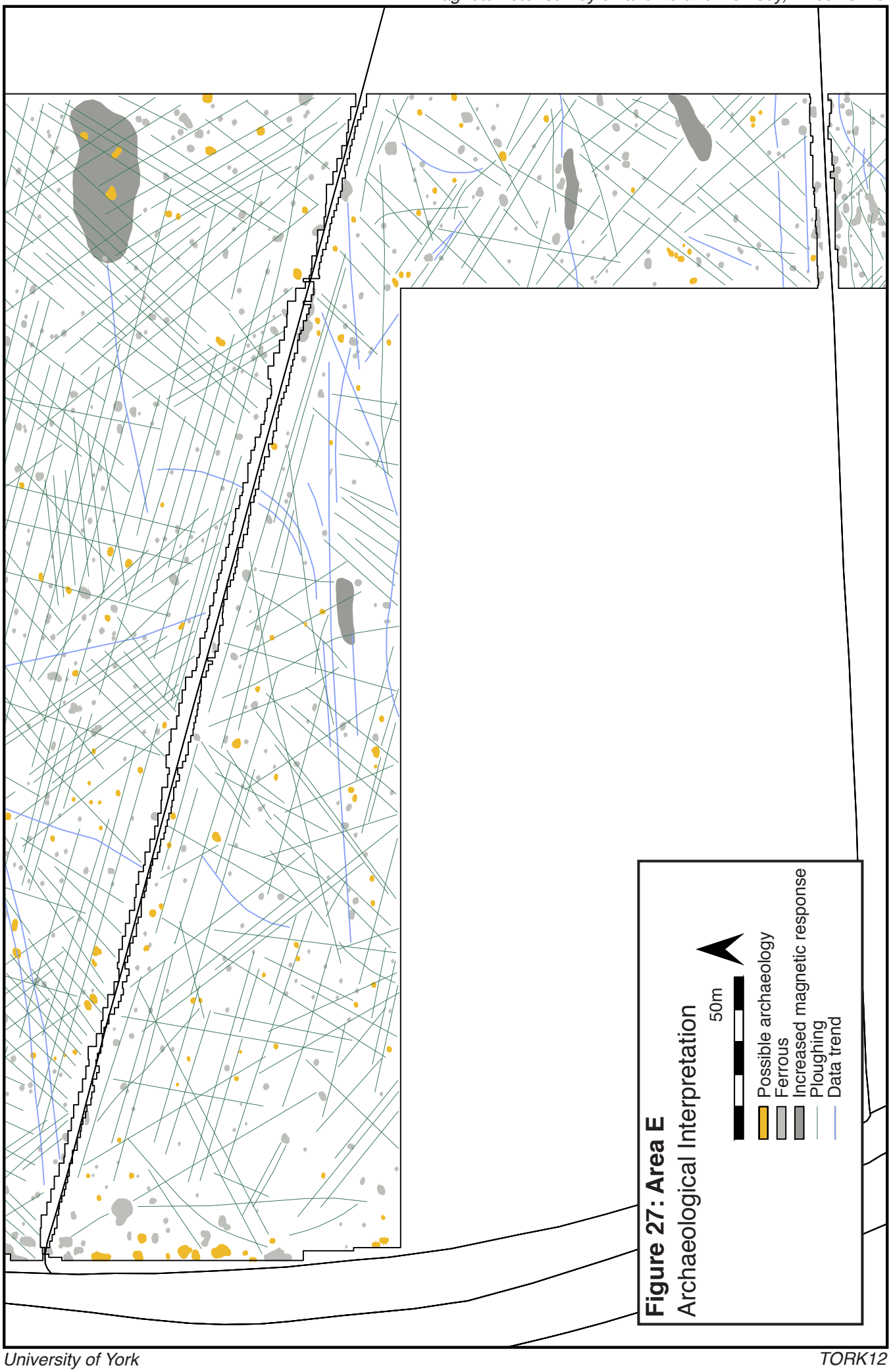
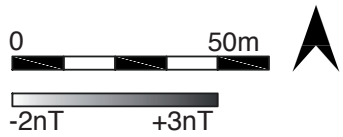


Figure 27: Area E
Archaeological Interpretation
50m
Possible archaeology
Ferrous
Increased magnetic response
Ploughing
Data trend

Figure 28: Area F
Magnetometer data greyscale plot



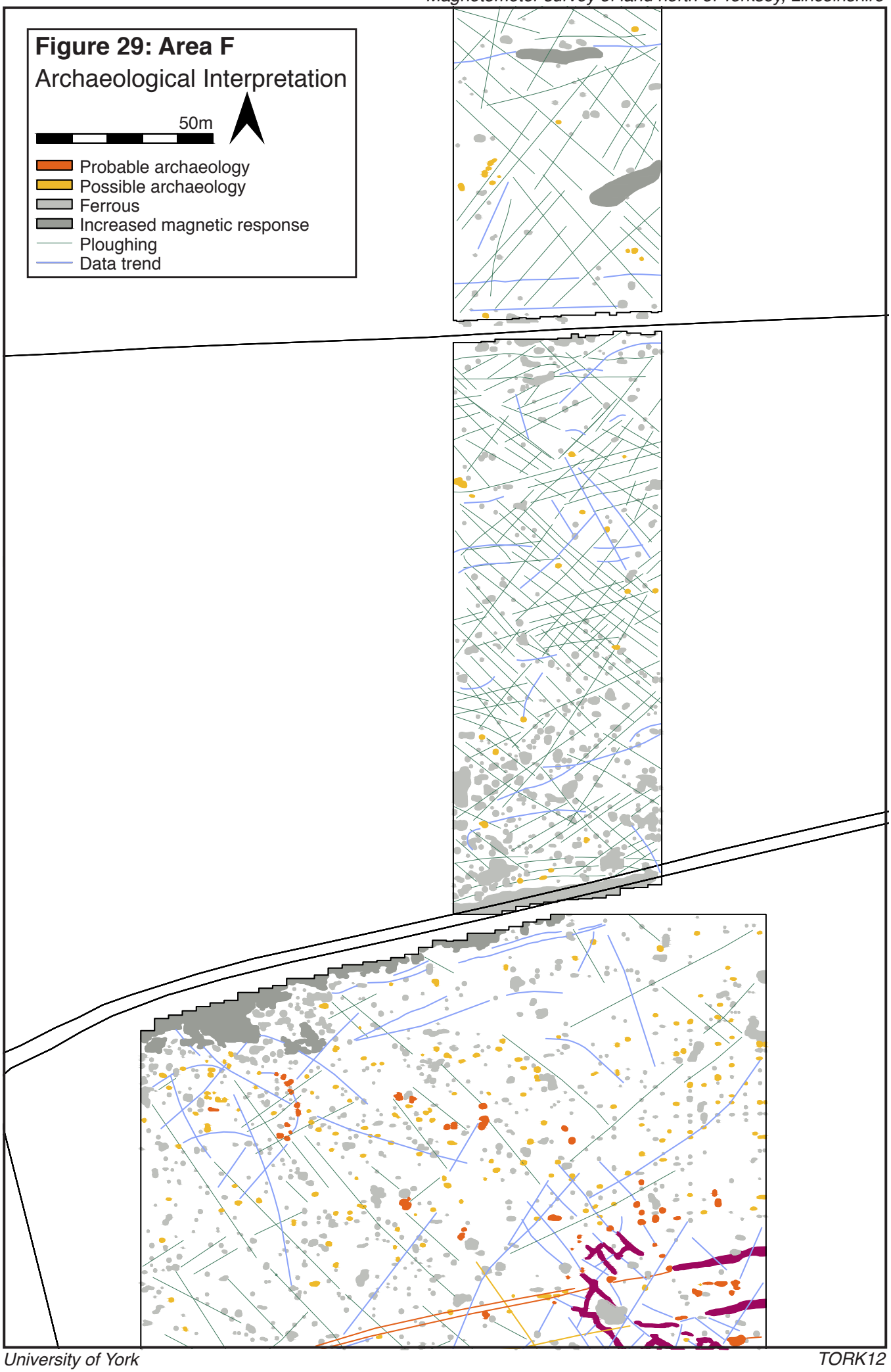
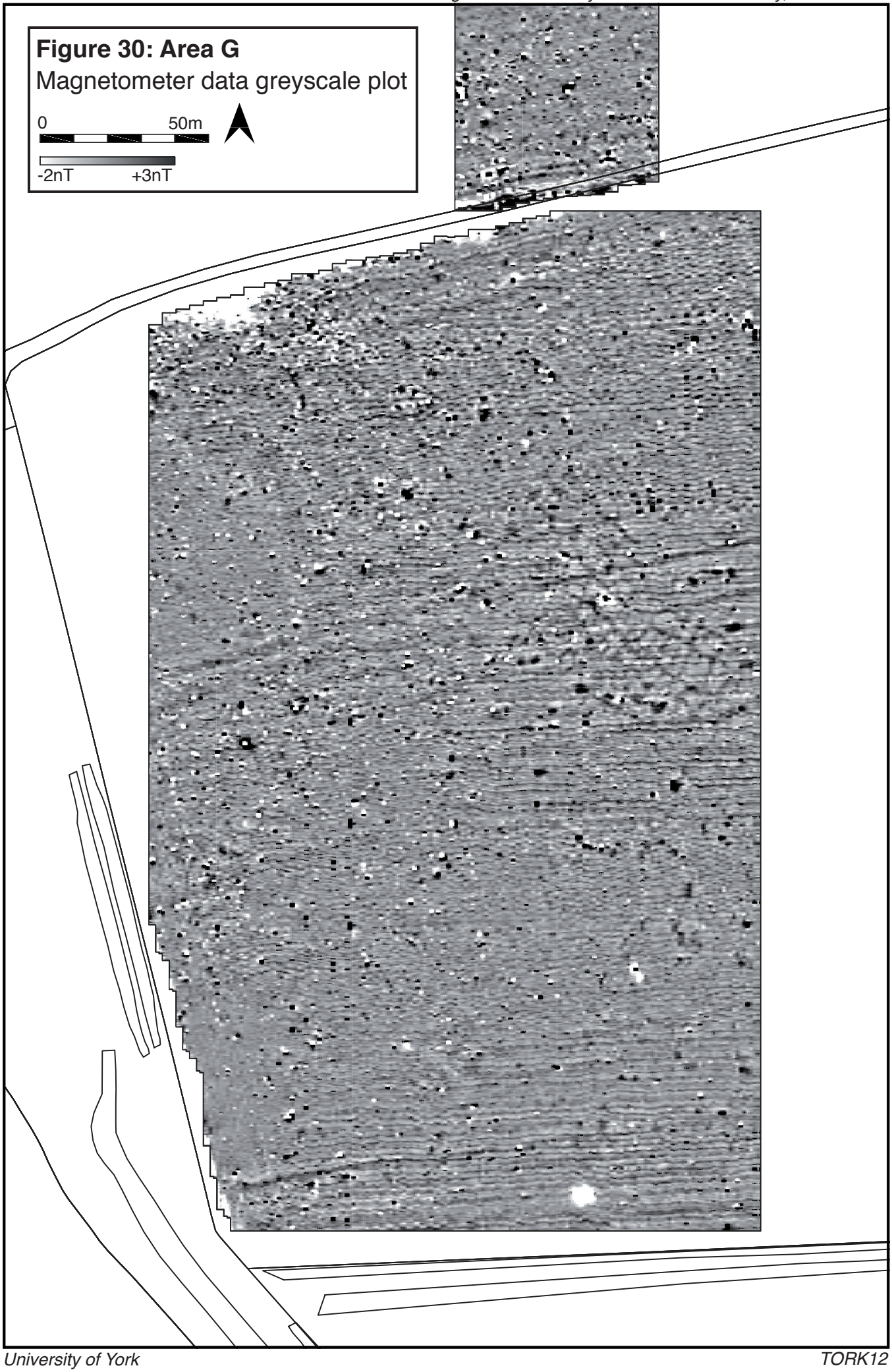


Figure 29: Area F
Archaeological Interpretation
50m
Probable archaeology
Possible archaeology
Ferrous
Increased magnetic response
Ploughing
Data trend

Figure 30: Area G
Magnetometer data greyscale plot



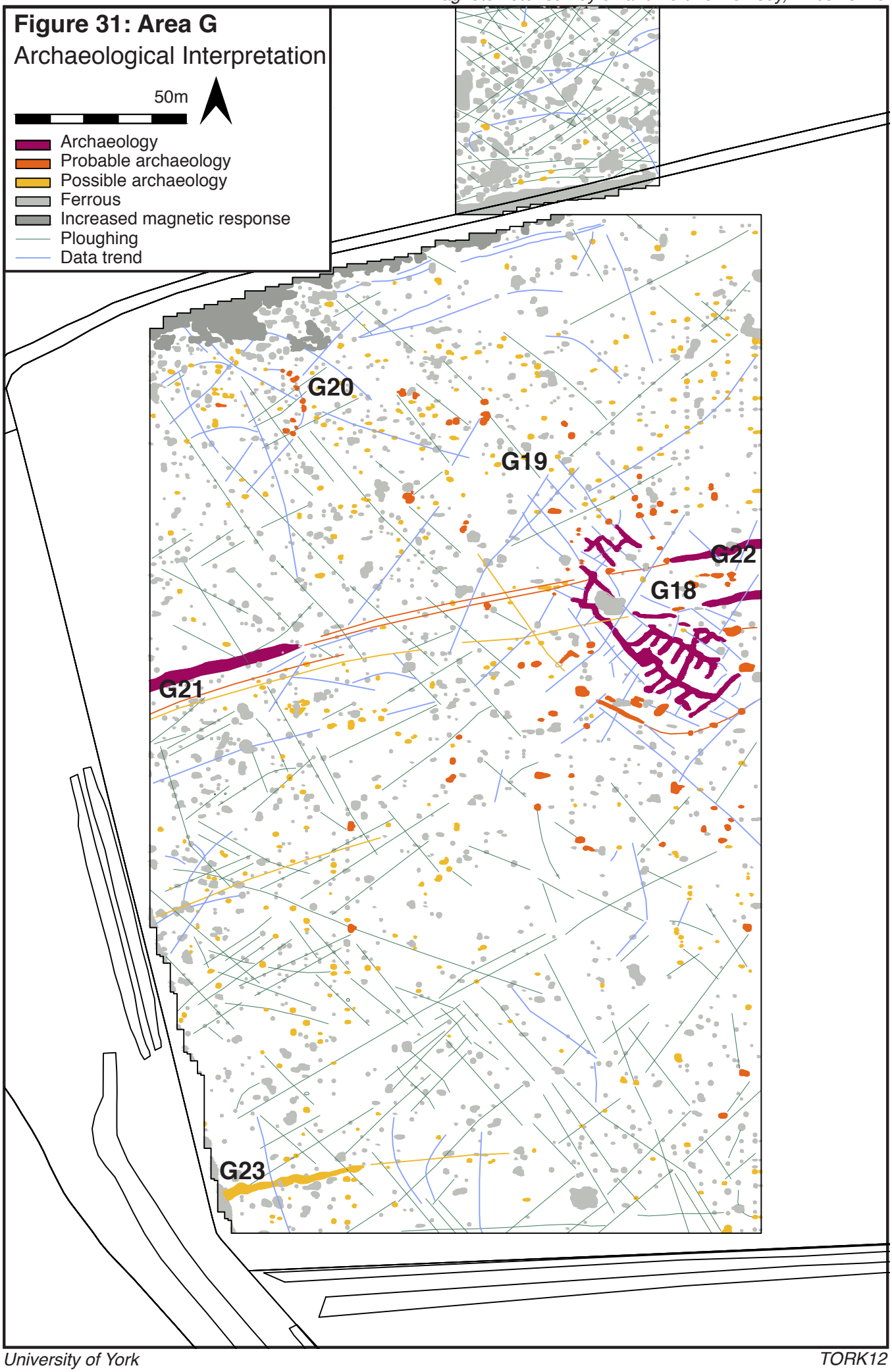
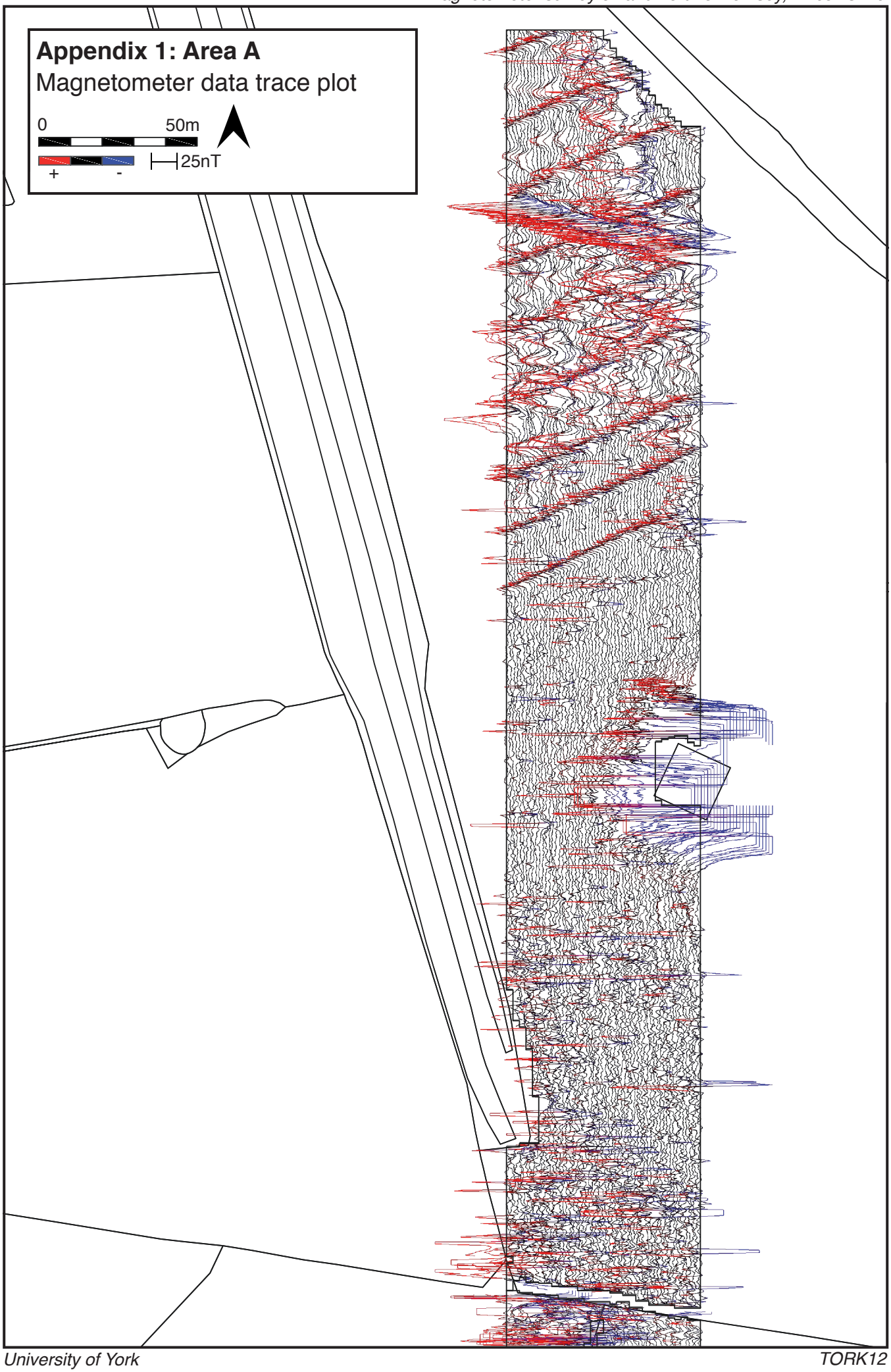
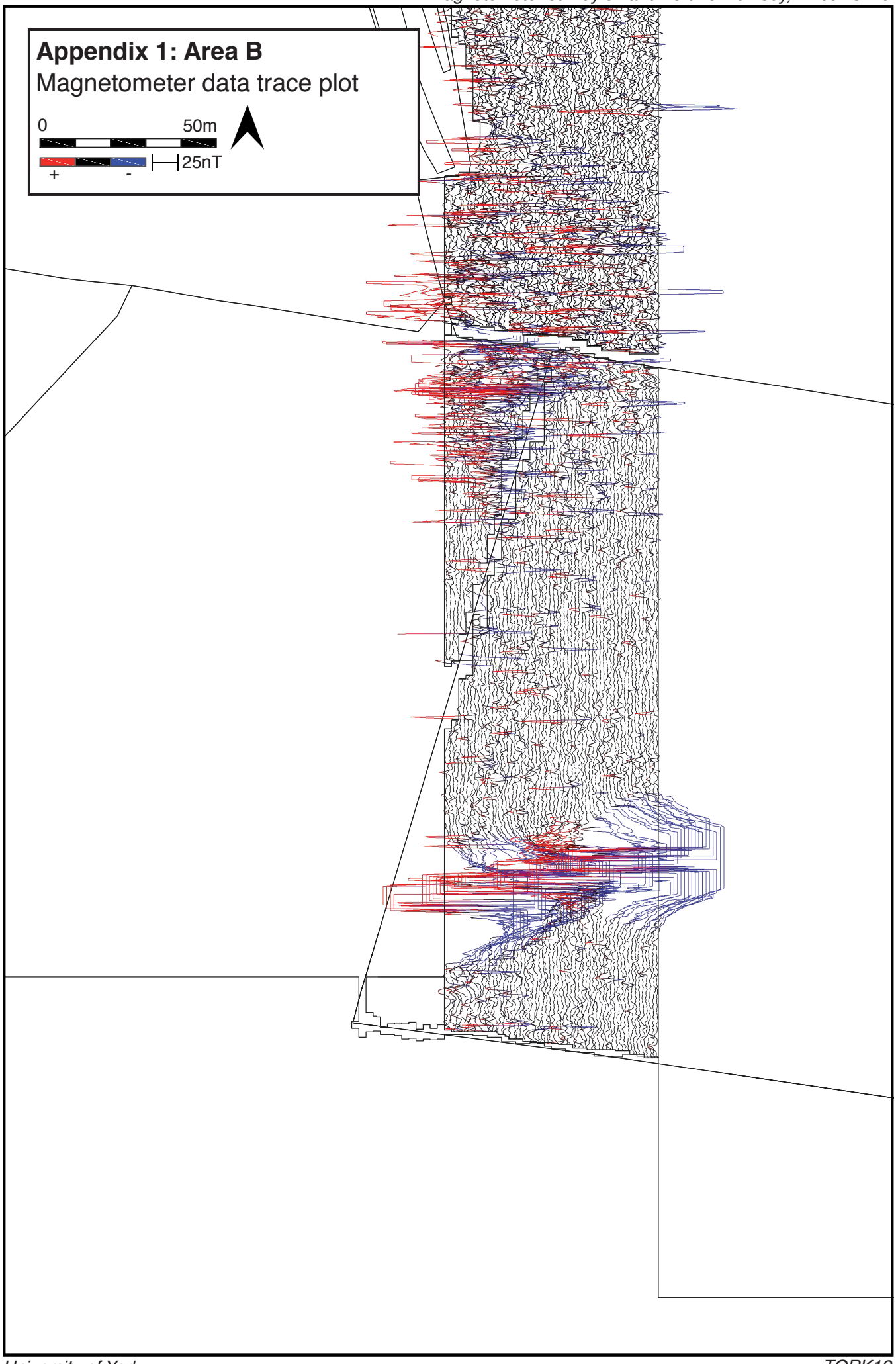
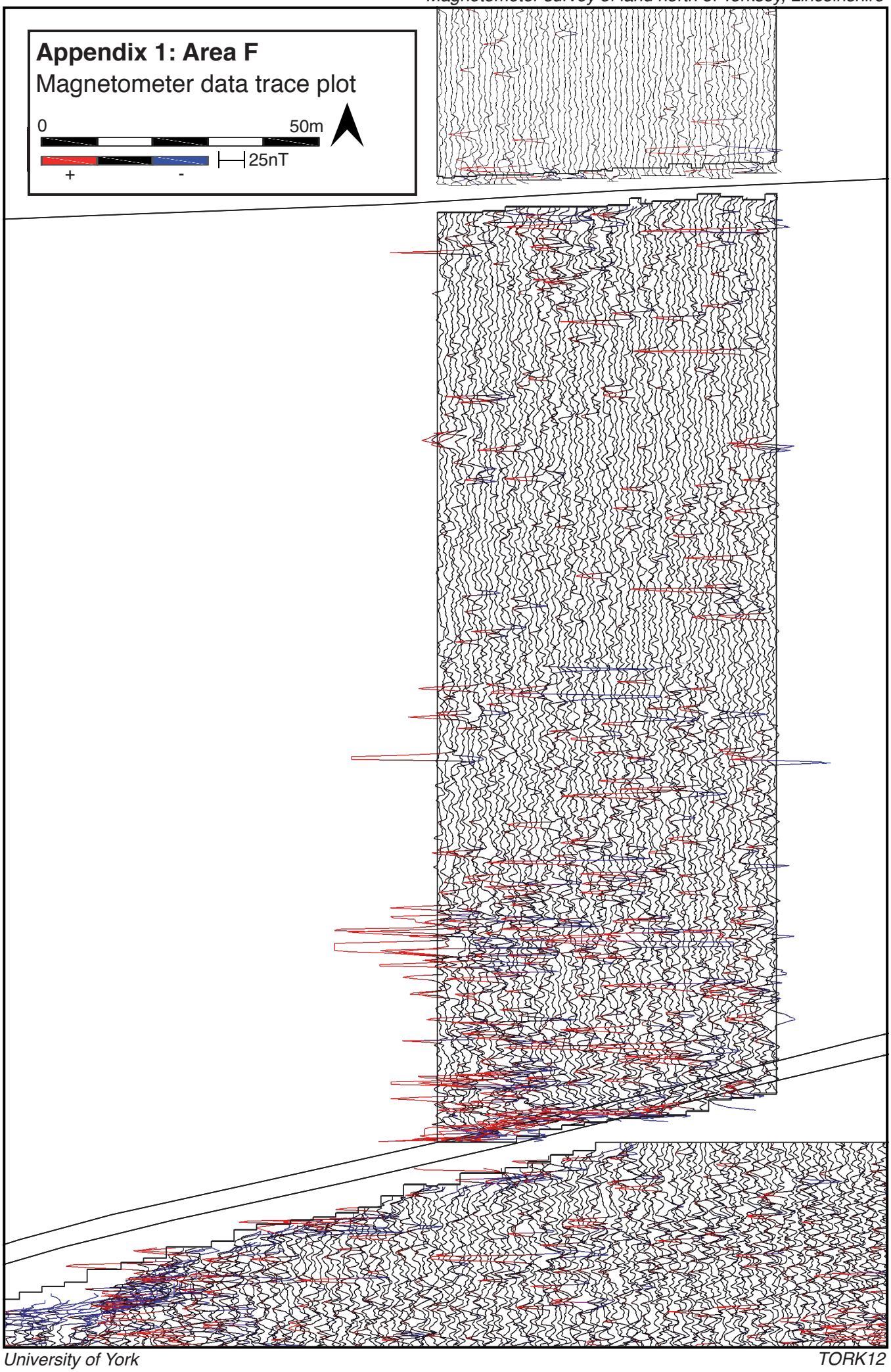


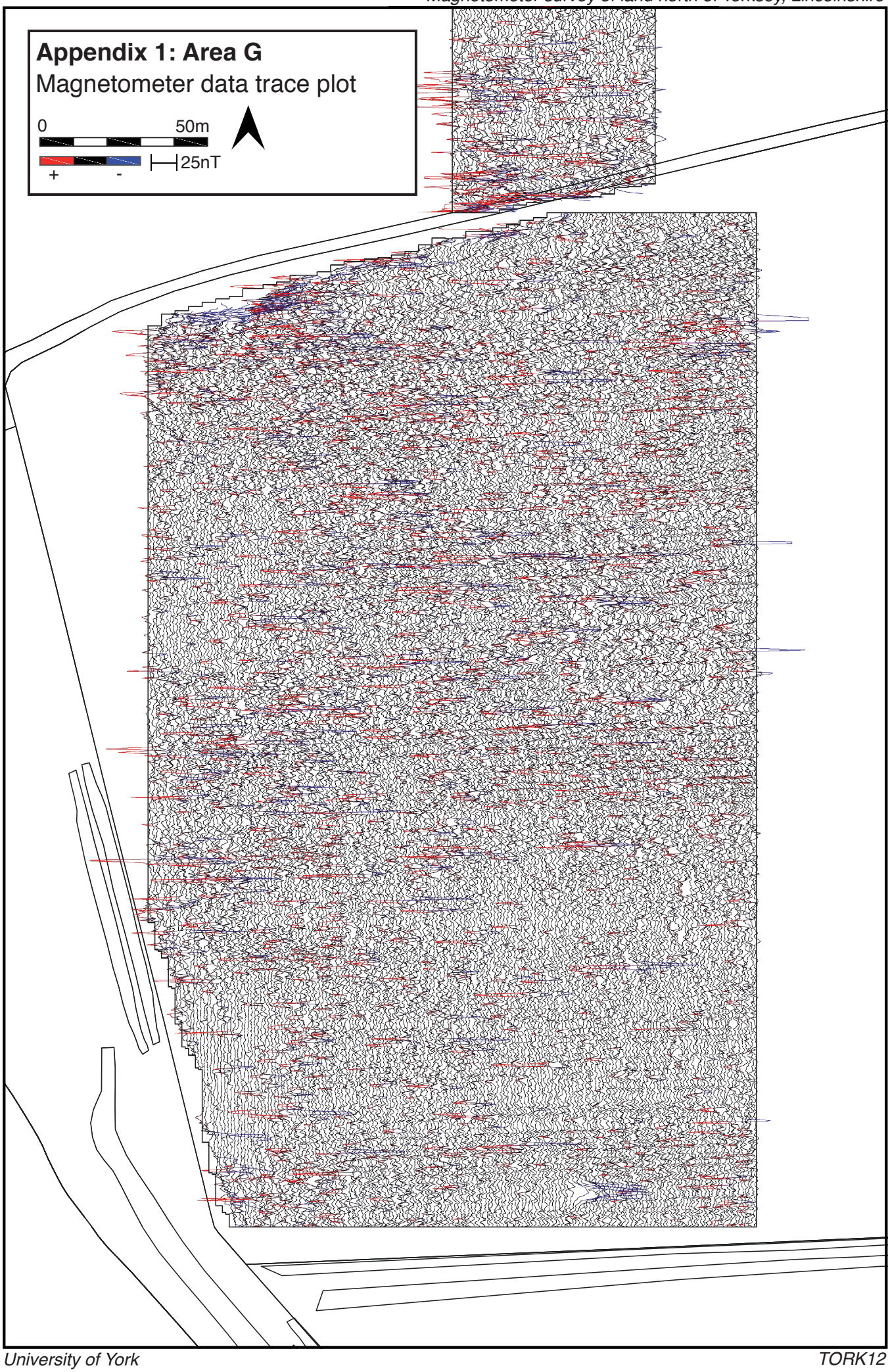
Figure 31: Area G
Archaeological Interpretation
50m
Archaeology
Probable archaeology
Possible archaeology
Ferrous
Increased magnetic response
Ploughing
Data trend
G20
G19
G22
G18
G21
G23

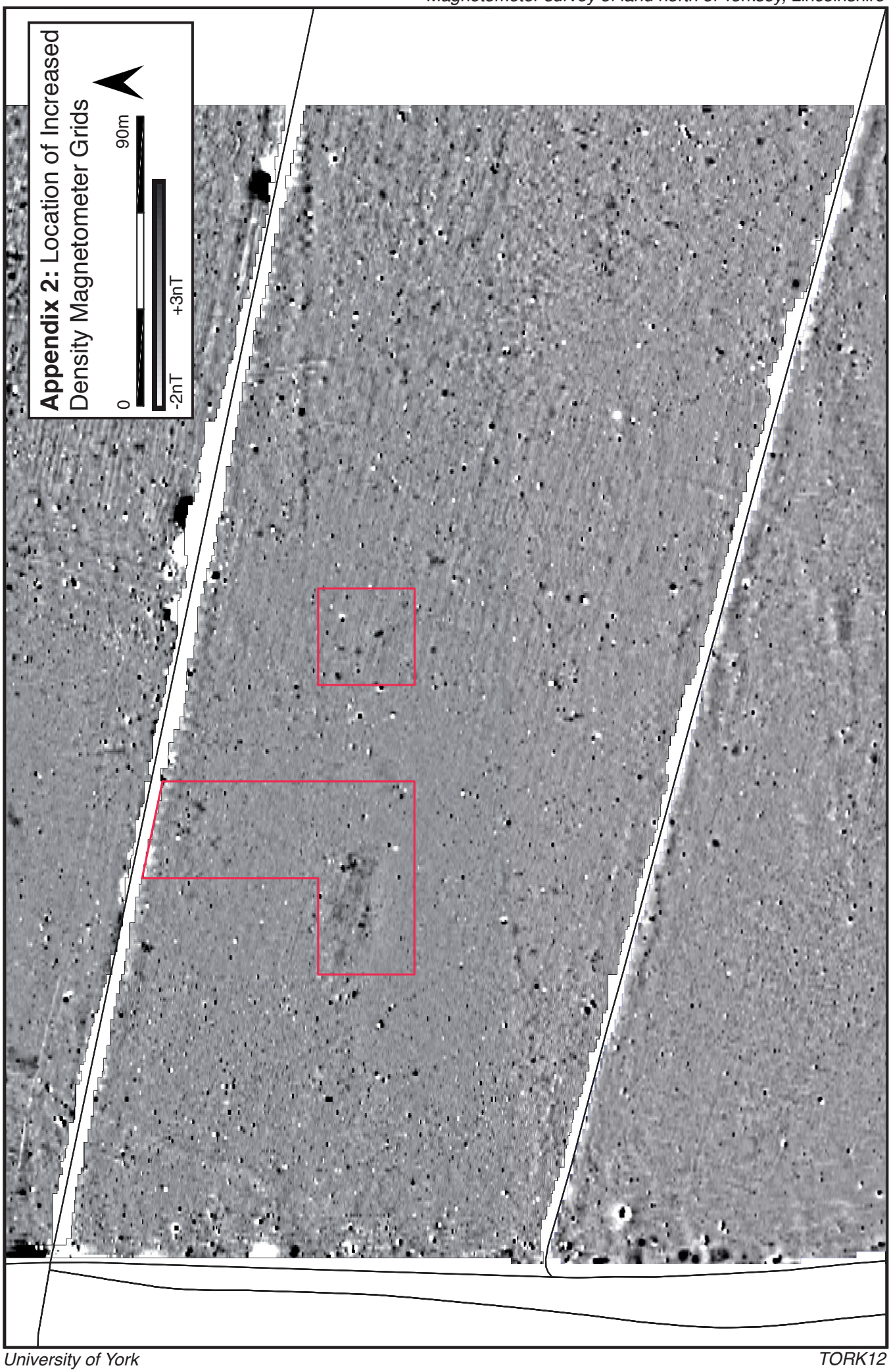

Appendix 1: Area A
Magnetometer data trace plot
0
50m
25nT
+
-

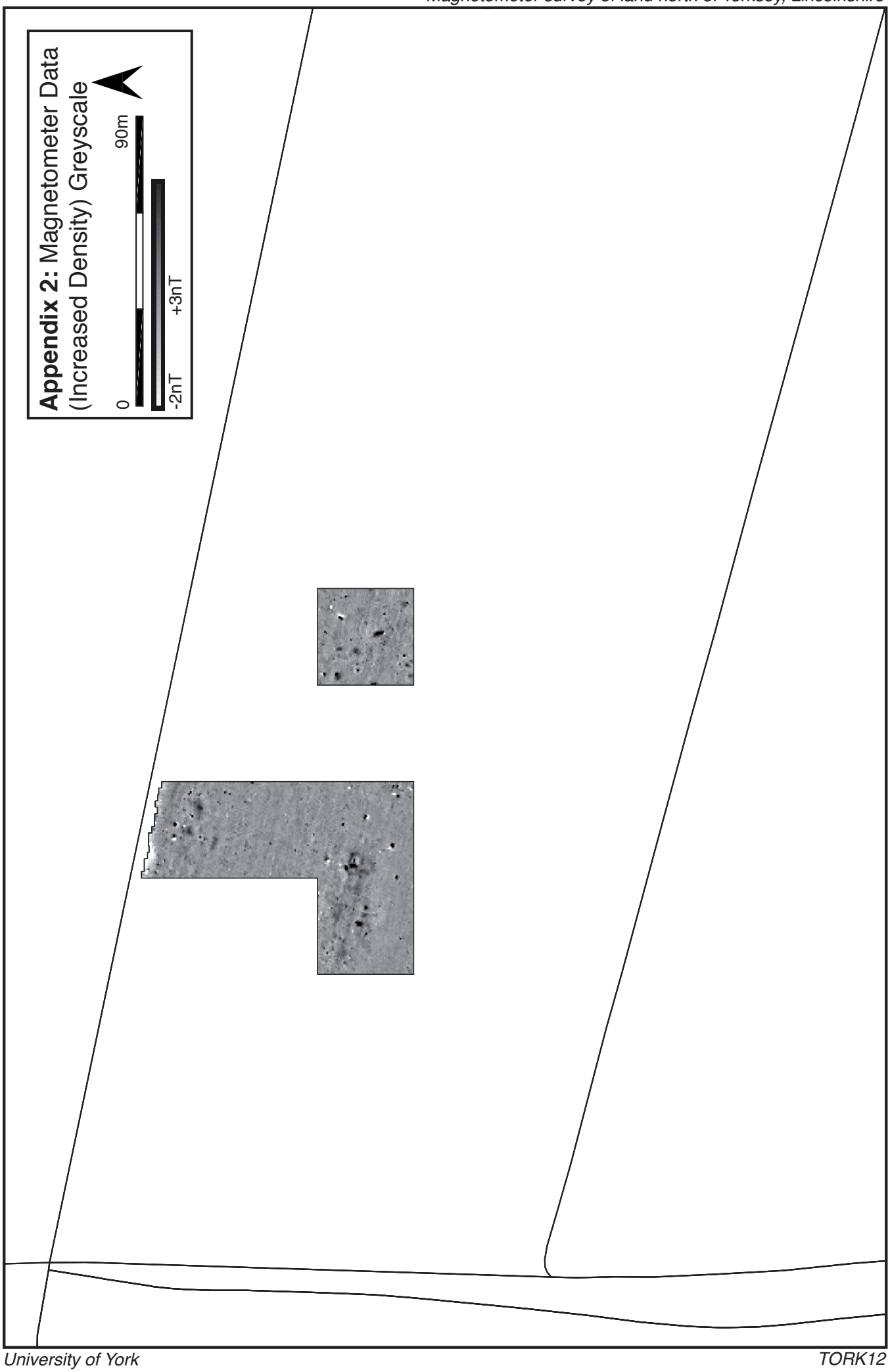

Appendix 1: Area B
Magnetometer data trace plot
0
50m
25nT
+
-


Appendix 1: Area E
Magnetometer data trace plot
0
50m
25nT
-
+


Appendix 1: Area F
Magnetometer data trace plot
0
50m
25nT
+
-


Appendix 1: Area G
Magnetometer data trace plot
0
50m
25nT
+
-


Appendix 2: Location of Increased Density Magnetometer Grids
0
90m
-2nT
+3nT


Appendix 2: Magnetometer Data
(Increased Density) Greyscale
0
90m
-2nT
+3nT