M54 to M6 Link Road

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Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

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Infrastructure Planning

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

M54 to M6 Link Road

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6.3 Environmental Statement Appendices

Appendix 6.3 Archaeological Geophysical Survey Report

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M54 to M6 / M6 Toll Link Road Scheme
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Archaeological geophysical survey

Project No. ARC/2586/965

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M54 to M6 / M6 Toll Link Road Scheme Staffordshire

Archaeological geophysical survey

Project No. ARC/2586/965

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1. SUMMARY

Phase Site Investigations Ltd was commissioned to carry out a magnetic gradient survey for the proposed M54 to M6 to M6 Toll Link Road Scheme in Staffordshire. The aim of the survey was to help establish the presence / absence, extent, character, relationships and date (as far as circumstances and the inherent limitations of the technique permits) of archaeological features within the survey area.

The survey was undertaken using a Phase Site Investigations Ltd multi-sensor array cart system (MACS). The MACS comprised 8 Foerster 4.032 Ferex CON 650 gradiometers with a control unit and data logger. The MACS data was collected on profiles spaced 0.5 m apart with readings taken at between 0.1 and 0.15 m intervals.

The majority of the anomalies identified by this survey relate to modern material / objects, agricultural activity and geological / pedological variations. There are numerous linear / curvi-linear anomalies and some discrete responses of uncertain origin but these do not form any clear patterns or relationship that would indicate an archaeological origin. It is considered that the majority of these responses will be associated with agricultural activity, drainage features or natural features / variations, although for some of the anomalies an archaeological origin cannot be completely ruled out.

The general magnetic background across large parts of the site is disturbed from the presence of significant amounts of surface / near-surface material. This material could be related to 'green waste' but the current and former land use of a number of the fields for car boot sales has undoubtedly added to the amount of ferrous material present, which has created significant magnetic 'noise'. It is possible that if any archaeological sub-surface features were present, which only produced relatively weak magnetic responses, then these may not be identified in the areas of disturbed magnetic background. The absence of responses indicative of archaeological features / activity cannot therefore be taken to indicate that no such features are present.

Other parts of the site contain very strong magnetic disturbance that is suggestive of the presence of made ground. These responses are so strong that they would mask responses from underlying features, if any such features were present (except for some modern ferrous objects such as large pipes). The depth extents of made ground and whether this has been cut into, or built up the previous ground level cannot be determined from the survey.

2. INTRODUCTION

2.1 Overview

Phase Site Investigations Ltd was commissioned by AECOM to carry out an archaeological geophysical survey for the proposed M54 to M6/M6 Toll Link Road Scheme in Staffordshire, utilising magnetic gradiometers.

The aim of the survey was to help establish the presence / absence, extent, character, relationships and date (as far as circumstances and the inherent limitations of the technique permits) of archaeological features within the survey area.

The location of the site is shown in drawing ARC_2586_965_01.

2.2 Site description

The survey covered the route and some adjoining areas of the proposed M54 to M6 / M6 Toll Link Road in Staffordshire. The route runs to the east of the villages of Featherstone (centred at NGR SJ 938 052) and Shareshill (centred at NGR SJ 945 065), to the north of Wolverhampton with the middle of the survey areas being located at approximately NGR SJ 951 059.

The survey area encompassed 19 fields / parts of fields, which were a mixture of arable and pasture fields. Several areas of dense vegetation / woodland, ponds, roads and other obstructions were present within the site.

For the purposes of this report each survey area has been given a number as shown in drawing ARC_2586_965_02. This numbering system is based upon the area numbers that were defined by the client. Descriptions for each area that were surveyed are provided in Section 4.

The geology of the majority of the survey areas consists of sandstone and conglomerate of the Chester Formation. The geology of the south of Area 5 and north of Area 8 consists of mudstone and sandstone of the Clent Formation and Enville Formation. The majority of the survey areas are overlain by diamicton deposits of Devensian Till, though there are areas where the superficial deposits are not recorded (British Geological Survey, 2019).

The soils of the north and south of the site are described as slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils. The soils in the centre of the site (Areas 5, 7, 8 and the northern edge of Area 6) are described as slightly acid loamy and clayey soils with impeded drainage. The soils of the south of Area 9 are described as freely draining slightly acid loamy soils (Soilscapes, 2019).

2.3 Archaeological background

An archaeology and historical background in a geophysics written scheme of investigation written by AECOM (2019) indicates that the site is located in an area that contains prehistoric and Roman features / activity.

Immediately to the east of Area 4 and Area 5 is Hilton Park, which is known as the location of the deserted settlement of Hilton or Haltone. It is stated that,

'the settlement was first recorded in the very late 10th century and is recorded in the Domesday book. The date of desertion is not known, and no above-ground evidence survives within the current park.'

Hilton Park is also the location of a moated site, which has been built over by an 18th century house.

The archaeology and historical background also indicates that,

'recorded sites of post-medieval date (1500 to 1900) located in the area predominantly relate to the agricultural use of the landscape, as well as evidence for increasing industrial activity in the 18th and 19th centuries.' and

'There is potential for previously unrecorded archaeological remains to be found along the route. While remains of any period cannot be discounted, remains associated with the later prehistoric periods and the medieval and post-medieval landscape is considered to be most likely to be discovered.'

2.4 Scope of work

The survey areas were specified by the client based on the proposed route of the M54 to M6 / M6 Toll Link Road, Staffordshire.

Area 4, Area 10 and Area 18 could not be surveyed due to the presence of livestock at the time of the survey. The eastern part of Area 6 contained vehicles and material related to a car boot sale and so could not be surveyed. Parts of other areas were not suitable / accessible for survey due to the presence of dense vegetation and modern material / features An area of approximately 56.8 ha was covered by the magnetic survey, the extents of which are shown in drawing ARC_2586_965_02.

No other problems were encountered during the survey which was carried out on days between 25 March and 10 April 2019.

3. SURVEY METHODOLOGY

3.1 Magnetic survey

The survey was undertaken using a Phase Site Investigations Ltd multi-sensor array cart system (MACS).

The MACS comprised 8 Foerster 4.032 Ferex CON 650 gradiometers with a control unit and data logger. The Foerster gradiometers do not require balancing as each sensor is automatically 'zeroed' using the control unit software.

The MACS utilises an RTK GNSS system which means that survey grids do not have to be established. Instead an area is surveyed over a series of continuous profiles and the position of each data point is recorded using an RTK GNSS system. The sensors have a separation of 0.5 m which means that data was collected on profiles spaced at 0.5 m apart. Readings were taken at between 0.1 m and 0.15 m intervals.

Data is collected on zig-zag profiles along the full length or width of a field, although fields can be sub-divided if they are particularly large. Marker canes are set-out along field boundaries at set intervals and these are used to align the profiles. The survey profiles are usually offset from field boundaries, buildings and other metallic features by several metres to reduce the detrimental effect that these surface magnetic features have on the data. The location of the MACS data is converted direct to Ordnance Survey co-ordinates using the UK OSTN 02 projection. As the survey is referenced direct to Ordnance Survey National Grid co-ordinates temporary survey stations are not established.

3.2 Data processing and presentation

The MACS data was stored direct to a laptop using in-house software which automatically corrects for instrument drift and calculates a mean value for each profile. A positional value is assigned to each data point based on the sensor number and recorded GNSS co-ordinates. The data is gridded using in-house software and parameters are set based on the sensor spacing and mean values. No additional processing is required. The gridded data is then displayed in Surfer 9 (Golden Software) and image files of the data are created.

The data was exported as raster images (PNG files). Greyscale plots are presented at a clip of -2 nT to 3 nT and -5 nT to 5 nT (scale 1:1500) for each area with an accompanying interpretation. Greyscale plots have been 'smoothed' using a visual interpolation but the data itself has not been interpolated. The two different ranges that the data has been displayed at show that the magnetic disturbance, although present across the majority of the site, is less noticeable in the wider range (-5 nT to 5 nT). This indicates that much of the magnetic disturbance is probably caused by relatively small surface / near surface material, although there are some areas that appear to have more significant made ground.

The data has been displayed relative to a digital Ordnance Survey base plan provided by the client as drawing *'Mapping.dwg'*. The base plan was in the Ordnance Survey National Grid co-ordinate system and as the survey grids / data were referenced directly to National Grid co-ordinates the data could be simply superimposed onto the base plan in the correct position.

X-Y trace plots were examined for all of the data and overlain onto the greyscale plot to assist in the interpretation, primarily to help identify dipolar and bipolar responses that will probably be associated with surface / near-surface iron objects. However, X-Y trace plots have not been presented here as they do not show any additional anomalies that are not

visible in the greyscale data. A digital drawing showing the X-Y trace plot overlain on the greyscale plot is provided in the digital archive.

All isolated responses have been assessed using a combination of greyscale and X-Y trace plots. There are a large number of 'iron spike', isolated dipolar anomalies present in the data. There is no evidence to suggest that they are associated with archaeological features and so these have not been shown in the interpretation.

Anomalies associated with agricultural regimes are present in the data but each individual anomaly has not been shown on the interpretation. Instead the general orientation of the regime is indicated.

The data was examined over several different ranges during the interpretation to ensure that the maximum information possible was obtained from the data.

The anomalies have been categorised based on the type of response that they exhibit and an interpretation as to the cause(s) or possible cause(s) of each anomaly type is also provided.

A general discussion of the anomalies is provided for the entire site and then the results are discussed on an area by area. A discussion of the general categories of anomaly which have been identified by the survey is provided in Appendix 1.5.

The geophysical interpretation drawing must be used in conjunction with the relevant results section and appendices of this report.

4. RESULTS

4.1 General

The data quality across the majority of the survey area is very good allowing the data to be viewed at a narrow range of readings to better identify weak anomalies. There are significant areas that have a more disturbed magnetic background or areas of strong magnetic disturbance but this is due to the presence of magnetic material in the topsoil or sub-surface, rather than low data quality.

Large parts of the site have a significant **'disturbed' magnetic background** or areas of **strong magnetic disturbance**. These two types of responses have been differentiated from each other as they relate to different sub-surface conditions. Both types of response relate to strong bipolar and dipolar responses and are usually associated with concentrations of relatively modern magnetic material. However, by viewing the data at different ranges it can be seen that the general background disturbance is less visible at wider ranges (-5 nT to 5 nT). This suggests that the disturbed background is caused by a significant amount of surface / near-surface modern material whereas the areas of strong magnetic disturbance do not visibly change with the wider range, indicating that these are related to a greater concentration / depth of modern material, such as made ground or tipped material.

It is possible that some of the general disturbance magnetic background is related to 'green waste' which contains significant amounts of ferrous material, although other recent land-use (such as car boot sales which have taken place in different parts of the site) have also contributed to the significant amount of surface / near-surface material that is present across the site. It is worth noting that the strong and extensive responses related to the modern activity could have masked responses from other underlying features, if any such features were present. It is not possible to reliably identify responses that may be related to discrete infilled features in the areas of disturbed background and magnetic disturbance and so no isolated responses have been shown in those areas.

4.2 Area 1

Basic topography: Relatively level.

Field description: Pasture. Bounded by fencing on all sides. Relatively firm underfoot in most places, uneven ground near the eastern boundary.

Interpretation drawing(s): ARC_2586_965_05.

Summary of anomalies: This area is dominated by strong magnetic disturbance that is probably associated with made ground.

Further discussion / additional information:

The area is dominated by strong magnetic disturbance. The strength of the responses are such that they suggest made ground rather than a spread of relatively shallow modern material.

4.3 Area 2

Basic topography: General slope downwards to the north-west. Undulating in the centre and east of the southern parts of the field.

Field description: Arable field with immature crop on the southern half and stubble on the northern half (which were separated by a partial treeline). Bounded by a trackway in the north and east, a fishing pond in the south-east and by hedges and trees in the south and west. Relatively firm underfoot.

Interpretation drawing(s): ARC_2586_965_05 & ARC_2586_965_08.

Summary of anomalies: Numerous isolated dipolar and small bipolar responses, that form a significant disturbed magnetic background and which are all thought to be associated with modern material. Individual responses have not been shown on the interpretation.

A linear bipolar anomaly with broad, strong associated response associated with sub-surface utility apparatus (probable pipe).

Areas of magnetic disturbance that are probably associated with made ground.

Very strong responses associated with strongly magnetic modern features / material. The feature / material causing the response may be located beyond the survey area.

Relatively weak, broadly parallel, diffuse linear responses are present. These may be caused by agricultural features / activity and could be related to the remnants of ridge and furrow.

Trends of uncertain origin.

Further discussion / additional information:

The whole area is dominated by responses from modern material. Two areas of strong magnetic disturbance are suggestive of made ground rather than a spread of relatively shallow modern material. Where across the rest of the area there is a general disturbed magnetic background related to a surface / near-surface spread of material.

There are a number of linear / curvi-linear trends visible within the general disturbed magnetic background. It is not known if these are a product of responses within the disturbance, that coincidently appear to form a linear / curvi-linear pattern, or if they may be related to features / variations which underlie the spread of modern material. As such the exact cause of these responses cannot be determined.

4.4 Area 3

Basic topography: Relatively level with a gradual slope upwards to the south-east.

Field description: Pasture. Bounded by a metal fence in the north, trees and bushes in the east, a trackway in the south and a hedge in the west. Firm underfoot.

Interpretation drawing(s): ARC_2586_965_08.

Summary of anomalies: Numerous isolated dipolar and small bipolar responses, which are all thought to be associated with modern material. Individual responses have not been shown on the interpretation.

Very strong responses associated with strongly magnetic modern features / material. The feature / material causing the response may be located beyond the survey area.

Relatively weak positive linear responses are present that are probably associated with a relatively modern ploughing regime.

Linear responses indicative of field drains.

A series of linear responses possibly associated with a regime of field drains, although they could be related to other agricultural activity

Trends of uncertain origin.

A number of isolated positive responses, the majority of which are probably geological / pedological in origin or related to relatively modern deeper buried ferrous / fired material.

Further discussion / additional information:

There are a number of weak or diffuse trends in this area. These are too weak to allow a definite interpretation or even ascertain if they are caused by sub-surface features. The responses could be caused by natural accumulations of material that is slightly more magnetic than the surrounding soil, be associated with agricultural or drainage activity or even be random collection of responses that appear to form linear / curvi-linear patterns. There is no evidence to indicate that they are related to archaeological features / activity, although as their cause is not certain this cannot be completely ruled out.

4.5 Area 4

Not surveyed as livestock present.

4.6 Area 5

Basic topography: Gradual slope down to the south-west and north-west.

Field description: Pasture. Bounded by trees and bushes in the south-west and north-west, by a hedge in the north-west. There was no fixed boundary in the south-east. Firm underfoot.

Interpretation drawing(s): ARC_2586_965_11.

Summary of anomalies: Numerous isolated dipolar and small bipolar responses, that are all thought to be associated with modern material. These have not been shown on the interpretation.

Relatively weak positive linear responses are present probably associated with a relatively modern ploughing regime.

Trends of uncertain origin.

Numerous isolated positive responses, the majority of which are probably geological / pedological in origin or related to relatively modern deeper buried ferrous / fired material. Only larger / stronger responses of this type have been shown.

Positive linear / curvi-linear responses of uncertain origin.

Further discussion / additional information:

Positive linear responses, trends and isolated positive responses (**Anomalies A**) are present in the south-west of the area. It is not certain of these are related to two closely aligned features or one feature that has produced a broad response. Adjacent to Anomalies A there is a strong positive linear anomaly that has two angled returns (**Anomaly B**). The cause of Anomalies A and B is not certain and it is not known if they are related. The linearity of the responses suggests that they may be caused by relatively modern features, such as drainage features, but this cannot be confirmed form the available information

There are a number of other weak or diffuse trends in this area. These are too weak to allow a definite interpretation or even ascertain if they are caused by sub-surface features. The responses could be caused by natural accumulations of material that is slightly more magnetic than the surrounding soil, be associated with agricultural or drainage activity or even be random collection of responses that appear to form linear / curvi-linear patterns. There is no evidence to indicate that they are related to archaeological features / activity, although as their cause is not certain this cannot be completely ruled out.

4.7 Area 6

Basic topography: Relatively level.

Field description: Pasture / grass - used for car boot sales. Bounded by hedges and trees on most sides and by a ditch in the south-east corner. Firm underfoot. Metal rods and other ferrous objects were present across the site, related to the use of the field for car boot sales.

Interpretation drawing(s): ARC_2586_965_11 & ARC_2586_965_14.

Summary of anomalies: Numerous isolated dipolar and small bipolar responses, which are all thought to be associated with modern material. These form a significant disturbed magnetic background in parts of the area. Individual responses have not been shown on the interpretation.

Areas of magnetic disturbance associated with relatively modern features / material.

Linear responses suggestive of field drains.

Trends of uncertain origin.

Further discussion / additional information:

The eastern part of the field could not be surveyed due to obstructions related to a car boot sale.

The whole area is dominated by responses from modern material. Responses related to field drains can be seen and two trends of uncertain origin are present.

4.8 Area 7

Basic topography: Gradual slope down from the centre to the south-west and a steep slope down from the centre to the north-east.

Field description: Arable field with immature crop. Bounded by a trackway and bushes in the north and east, a hedge and fencing in the south

and north-west with no physical boundary in the west. Relatively firm underfoot.

Interpretation drawing(s): ARC_2586_965_17 & ARC_2586_965_20.

Summary of anomalies: Numerous isolated dipolar and small bipolar responses, that form a significant disturbed magnetic background and which are all thought to be associated with modern material. Individual responses have not been shown on the interpretation.

Very strong responses associated with strongly magnetic modern features / material. The feature / material causing the response may be located beyond the survey area.

A negative linear response possibly associated with agricultural activity although it may be an artificial response related to data collection.

Linear responses suggestive of field drains.

Relatively weak positive linear responses are present probably associated with a relatively modern ploughing regime.

Relatively weak, broadly parallel, diffuse linear responses are present. These may be caused by agricultural features / activity and could be related to the remnants of ridge and furrow.

Trends of uncertain origin.

Further discussion / additional information:

Across the majority of the area there is a general disturbed magnetic background related to a surface / near-surface spread of material.

There are a number of linear / curvi-linear trends visible within the general disturbed magnetic background. It is not known if these are a product of responses within the disturbance, that coincidently appear to form a linear / curvi-linear pattern, or if they may be related to features / variations which underlie the spread of modern material. As such the exact cause of these responses cannot be determined.

A negative linear response is present (**Anomaly C**). This is on the alignment of the current agricultural regime and could be related to that, although it is also on the alignment that the data was collected and it could be an artificial response caused by a sensor jolt or movement. Several trends are present on the same alignment (**Anomalies C1**) and may be related to Anomaly C. None of these response are thought to be archaeological significant and their presence has not affected the overall data quality or interpretation.

Several parallel responses are present in the west of the area that are related to a drainage regime. Two additional linear anomalies are present that are suggestive of drainage features (**Anomalies D1 and D2**). Anomaly D2 could be caused by an infilled feature and whilst a drainage feature seems the most likely cause for the anomaly this cannot be confirmed with certainty. In the south of the area there are several short but strong bipolar responses (**Anomaly E**). Again, although the cause of these cannot be confirmed with certainty the responses are suggestive of a modern feature and it is likely that they are related to drainage activity.

Numerous weak or diffuse trends are present in this area. These are too weak to allow a definite interpretation or even ascertain if they are caused by sub-surface features. The responses could be caused by natural accumulations of material that is slightly more magnetic than the surrounding soil, be associated with agricultural or drainage activity or even be random collection of responses that appear to form linear / curvi-linear patterns. There is no evidence to indicate that they are related to archaeological features / activity, although as their cause is not certain this cannot be completely ruled out.

4.9 Area 8

Basic topography: Relatively steep slope down to the north-east.

Field description: Pasture. Bounded by dense vegetation and trees in the north, a trackway to the west with no fixed boundary to the east and south. Firm underfoot.

Interpretation drawing(s): ARC_2586_965_17.

Summary of anomalies: Numerous isolated dipolar and small bipolar responses, that form a significant disturbed magnetic background and which are all thought to be associated with modern material. Individual responses have not been shown on the interpretation.

Relatively weak positive linear responses are present that are probably associated with a relatively modern ploughing regime.

Trends of uncertain origin.

Three relatively large, strong isolated positive responses that stand out from the general disturbed magnetic background. The cause of these responses is not certain.

Further discussion / additional information:

Across the majority of the area there is a general disturbed magnetic background related to a surface / near-surface spread of material.

There are a number of linear / curvi-linear trends visible within the general disturbed magnetic background. It is not known if these are a product of responses within the disturbance, that coincidently appear to form a linear / curvi-linear pattern, or if they may be related to features / variations which underlie the spread of modern material. As such the exact cause of these responses cannot be determined.

Two relatively large, strong isolated positive responses (**Anomalies F**) and a more linear isolated positive anomaly (**Anomaly G**) are present in the east of the area. It is likely that these anomalies are related to each other and their shape suggests that they are anthropogenic in origin. It is not possible to determine the exact cause or date of the features producing these responses as some archaeological features / activity can cause similar anomalies but relatively modern features / material could also produce this type of anomaly. So whilst it is likely that they relate to anthropogenic activity the exact function and date of the underlying features / material is not known.

4.10 Area 9

Basic topography: Variable and undulating. General sloping down from the centre to the south and north and a slope down to the south-west.

Field description: Arable field with immature crop. Bounded by fencing, dense vegetation and trees in the north-west, north-east and south-west with no fixed boundary in the east. Soft underfoot.

Interpretation drawing(s): ARC_2586_965_20 and ARC_2586_965_23.

Summary of anomalies: Numerous isolated dipolar and small bipolar responses, that form a significant disturbed magnetic background and which are all thought to be associated with modern material. Individual responses have not been shown on the interpretation.

Relatively weak positive linear responses are present that are probably associated with a relatively modern ploughing regime.

Trends of uncertain origin.

Further discussion / additional information:

There are a number of linear / curvi-linear trends visible within the general disturbed magnetic background. It is not known if these are a product of responses within the disturbance, that coincidently appear to form a linear / curvi-linear pattern, or if they may be related to features / variations which underlie the spread of modern material. As such the exact cause of these responses cannot be determined.

4.11 Area 10

Not surveyed due to livestock / access issues.

4.12 Area 11

Basic topography: Gradual slope down to the south.

Field description: Pasture. Bounded by fencing and dense vegetation. An animal shelter / shed was present in the south-east of the field. Firm underfoot.

Interpretation drawing(s): ARC_2586_965_23.

Summary of anomalies: Numerous isolated dipolar and small bipolar responses, that are all thought to be associated with modern material. These have not been shown on the interpretation.

Very strong responses associated with strongly magnetic modern features / material. The feature / material causing the response may be located beyond the survey area.

A series of linear responses probably related to agricultural activity. They could be associated with the remnants of ridge and furrow but could also be related to drainage features / activity.

A linear anomaly is present which is indicative of a field drain.

Trends of uncertain origin.

Numerous isolated positive responses, the majority of which are probably geological / pedological in origin or related to relatively modern deeper buried ferrous / fired material.

Further discussion / additional information:

There are a number of very weak or diffuse trends in this field. Generally these are too weak to allow a definite interpretation or even ascertain if they are caused by sub-surface features. The responses could be caused by natural accumulations of material that is slightly magnetic than the surrounding soil, be associated with agricultural features or even be random collections of responses that appear to be linear but it is possible that some trends could be related to the remnants of sub-surface features.

Two curvi-linear trends (**Anomalies H**) stand out slightly. It is possible that these are a product of different intersecting agricultural regimes giving the appearance of a curving response or they may be related to natural features / variations. However, it is possible that they are caused by sub-surface features which only produce weak, intermittent responses. As their exact cause is not certain an archaeological origin cannot be completely ruled out.

There is no pattern to the distribution of the isolated positive responses that would suggest that they are related to archaeological features or activity and it is likely that they are all caused by geological / pedological variations or are related to relatively modern deeper buried ferrous / fired material.

4.13 Area 12

Basic topography: Gradual slope down to the south.

Field description: Pasture. Bounded by fencing in the south-west and by fencing and bushes on all other sides. Firm underfoot.

Interpretation drawing(s): ARC_2586_965_23.

Summary of anomalies: Several isolated dipolar and small bipolar responses, that are all thought to be associated with modern material. These have not been shown on the interpretation.

Very strong responses associated with strongly magnetic modern features / material. The feature / material causing the response may be located beyond the survey area.

A series of linear responses probably related to agricultural activity. They could be associated with the remnants of ridge and furrow but could also be related to drainage features / activity.

Trends of uncertain origin.

A number of isolated positive responses, the majority of which are probably geological / pedological in origin or related to relatively modern deeper buried ferrous / fired material.

Further discussion / additional information:

There are a number of very weak or diffuse trends in this field. Generally these are too weak to allow a definite interpretation or even ascertain if they are caused by sub-surface features. The responses could be caused by natural accumulations of material that is slightly magnetic than the surrounding soil, be associated with agricultural features or even be random collections of responses that appear to be linear but it is possible that some trends could be related to the remnants of sub-surface features.

There is no pattern to the distribution of the isolated positive responses that would suggest that they are related to archaeological features or activity and it is likely that they are all caused by geological / pedological variations or are related to relatively modern deeper buried ferrous / fired material.

4.14 Area 13

Basic topography: Slope downwards from the middle of the field to the south-east.

Field description: Pasture. Bounded by fencing, trees and dense vegetation on all sides. Firm underfoot.

Interpretation drawing(s): ARC_2586_965_23 and ARC_2586_965_26.

Summary of anomalies: This area is dominated by strong magnetic disturbance that is probably associated with made ground.

Further discussion / additional information:

The area is dominated by strong magnetic disturbance. The strength of the responses are such that they suggest made ground rather than a spread of relatively shallow modern material.

4.15 Area14

Basic topography: Gradual slope downwards to the south-west.

Field description: Pasture. Bounded by fencing, dense vegetation and trees on all sides. Firm underfoot.

Interpretation drawing(s): ARC_2586_965_29.

Summary of anomalies: Numerous isolated dipolar and small bipolar responses, that are all thought to be associated with modern material. These have not been shown on the interpretation.

An area of magnetic disturbance associated with relatively modern features / material.

Trends of uncertain origin.

A number of isolated positive responses, the majority of which are probably geological / pedological in origin or related to relatively modern deeper buried ferrous / fired material.

Further discussion / additional information:

The middle and southern part of the area is dominated by strong magnetic disturbance. The strength of the responses are such that they suggest made ground rather than a spread of relatively shallow modern material.

4.16 Area 15

Basic topography: Gradual slope down to the south-west.

Field description: Pasture. Bounded by fencing and trees on all sides. A metal skip / container was present in the north-west. Firm underfoot. This field was formerly used for car boot sales.

Interpretation drawing(s): ARC_2586_965_29.

Summary of anomalies: Numerous isolated dipolar and small bipolar responses, that are all thought to be associated with modern material. These have not been shown on the interpretation.

Areas of stronger magnetic disturbance associated with relatively modern features / material.

Trends of uncertain origin.

Further discussion / additional information:

The whole area is dominated by responses from modern material. Across the majority of the area there is a general disturbed magnetic background related to a surface / near-surface spread of material.

There are a number of linear / curvi-linear trends visible within the general disturbed magnetic background. It is not known if these are a product of responses within the disturbance, that coincidently appear to form a linear / curvi-linear pattern, or if they may be related to features / variations which underlie the spread of modern material. As such the exact cause of these responses cannot be determined.

4.17 Area 16

Basic topography: Relatively level in the east of the area with a slope down to the north-west in the west of the survey area.

Field description: Pasture. Bounded by fencing and trees. Temporary fencing divided the area in two. Firm underfoot. This field was formerly used for car boot sales.

Interpretation drawing(s): ARC_2586_965_29 and ARC_2586_965_32.

Summary of anomalies: Numerous isolated dipolar and small bipolar responses, that form a significant disturbed magnetic background and which are all thought to be associated with modern material. Individual responses have not been shown on the interpretation.

Very strong responses associated with strongly magnetic modern features / material. The feature / material causing the response may be located beyond the survey area.

Trends of uncertain origin.

Further discussion / additional information:

Across the majority of the area there is a general disturbed magnetic background related to a surface / near-surface spread of material.

There are a number of linear / curvi-linear trends visible within the general disturbed magnetic background. It is not known if these are a product of responses within the disturbance, that coincidently appear to form a linear / curvi-linear pattern, or if they may be related to features / variations which underlie the spread of modern material. As such the exact cause of these responses cannot be determined.

An alignment of trends (**Anomaly I**) stand out as being slightly stronger / more coherent and so may be related to a sub-surface feature, although the function and date of the possible underlying feature is not known.

4.18 Area 17

Basic topography: Gradual slope down to the south-west.

Field description: Pasture. Bounded by fencing and trees on all sides. Two portable toilets were present in the south of the field. The west of the field was covered in dense vegetation. Firm underfoot.

Interpretation drawing(s): ARC_2586_965_29 and ARC_2586_965_32.

Summary of anomalies: Numerous isolated dipolar and small bipolar responses, which are all thought to be associated with modern material. These form a significant disturbed magnetic background in parts of the area. Individual responses have not been shown on the interpretation.

Areas of magnetic disturbance associated with relatively modern features / material.

Linear responses suggestive of field drains.

Trends of uncertain origin.

Further discussion / additional information:

Across the majority of the area there is a general disturbed magnetic background related to a surface / near-surface spread of material.

There are a number of linear / curvi-linear trends visible within the general disturbed magnetic background. It is not known if these are a product of responses within the disturbance, that coincidently appear to form a linear / curvi-linear pattern, or if they may be related to features / variations which underlie the spread of modern material. As such the exact cause of these responses cannot be determined. Responses related to field drains are also present in this area.

4.19 Area 18

Not surveyed due to livestock / access issues.

4.20 Area 19

Basic topography: Gradual slope downwards to the south-west.

Field description: Pasture. Bounded by trees, dense vegetation and fencing in the north, east and south with no fixed boundary to the west.

Interpretation drawing(s): ARC_2586_965_32.

Summary of anomalies: Numerous isolated dipolar and small bipolar responses, which are all thought to be associated with modern material. These form a significant disturbed magnetic background in parts of the area. Individual responses have not been shown on the interpretation.

Very strong responses associated with strongly magnetic modern features / material. The feature / material causing the response may be located beyond the survey area.

Trends of uncertain origin.

Further discussion / additional information:

Across the majority of the area there is a general disturbed magnetic background related to a surface / near-surface spread of material.

There are a number of linear / curvi-linear trends visible within the general disturbed magnetic background. It is not known if these are a product of responses within the disturbance, that coincidently appear to form a linear / curvi-linear pattern, or if they may be related to features / variations which underlie the spread of modern material. As such the exact cause of these responses cannot be determined.

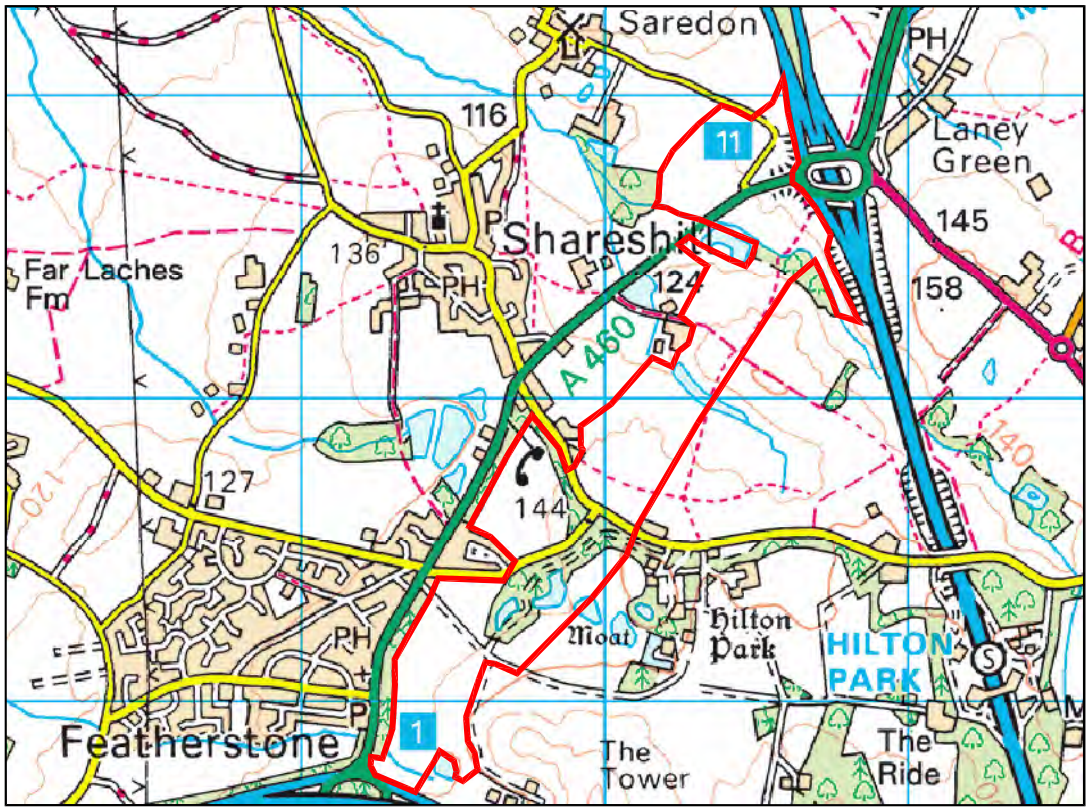
5. DISCUSSION AND CONCLUSIONS

The majority of the anomalies identified by this survey relate to modern material / objects, agricultural activity and geological / pedological variations. There are numerous linear / curvi-linear anomalies and some discrete responses of uncertain origin but these do not form any clear patterns or relationship that would indicate an archaeological origin. It is considered that the majority of these responses will be associated with agricultural activity, drainage features or natural features / variations, although for some of the anomalies an archaeological origin cannot be completely ruled out.

The general magnetic background across large parts of the site is disturbed from the presence of significant amounts of surface / near-surface material. This material could be related to 'green waste' but the current and former land use of a number of the fields for car boot sales has undoubtedly added to the amount of ferrous material present, which has created significant magnetic 'noise'. It is possible that if any archaeological sub-surface features were present, which only produced relatively weak magnetic responses, then these may not be identified in the areas of disturbed magnetic background. The absence of responses indicative of archaeological features / activity cannot therefore be taken to indicate that no such features are present.

Other parts of the site contain very strong magnetic disturbance that is suggestive of the presence of made ground. These responses are so strong that they would mask responses from underlying features, if any such features were present (except for some modern ferrous objects such as large pipes). The depth extents of made ground and whether this has been cut into, or built up the previous ground level cannot be determined from the survey.

It should be noted that a geophysical survey does not directly locate sub-surface features - it identifies variations or anomalies in the background response caused by features. The interpretation of geophysical anomalies is often subjective and it is rarely possible to identify the cause of all such anomalies. Not all features will produce a measurable anomaly and the effectiveness of a geophysical survey is also dependant on the site-specific conditions. The main factors that may limit whether a feature can be detected are the composition of a feature, its depth and size and the surrounding material. It is not possible to guarantee that a geophysical survey will identify all sub-surface features. Confirmation on the identification of anomalies and the presence or absence of sub-surface features can only be achieved by intrusive investigation.



APPROXIMATE SITE LOCATION

SCALE

0m 500m 1000m

NOTE

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Scale [A4 Sheet]	Drawing	Status
AS SHOWN	ARC_2586_965_01	FINAL

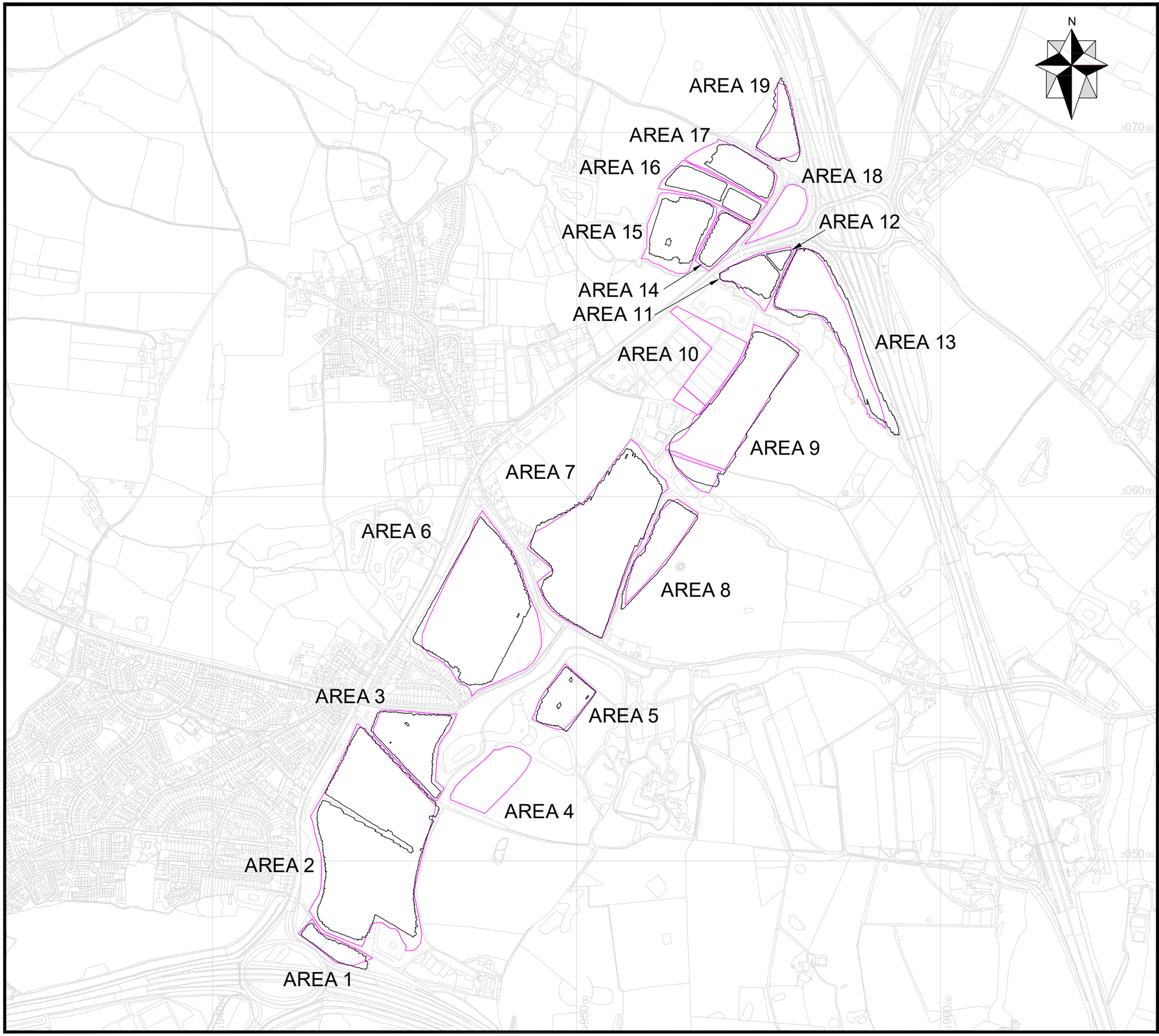
Client: AECOM LEEDS

Site: M54 to M6 / M6 TOLL LINK ROAD STAFFORDSHIRE

Title: SITE LOCATION MAP

Job No: ARC_2586_965

		Drawn	JW
Chk.	MW	Date	05/04/2019



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KEY

SURVEY AREA

EXTENTS OF MAGNETIC GRADIENT SURVEY

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Scale [A3 Sheet]	Drawing	Status
1:10000	ARC_2586_965_02	FINAL

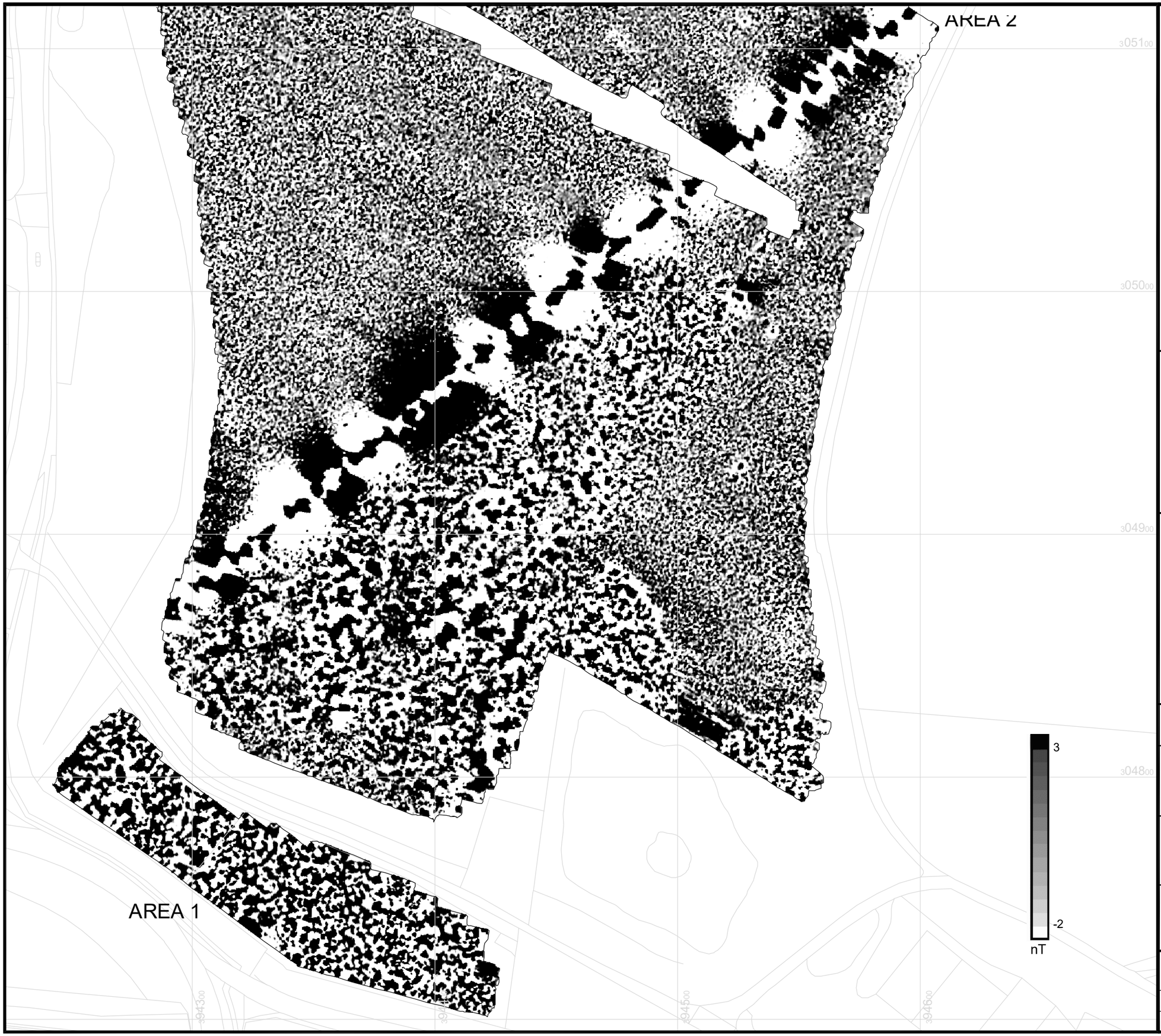
Client
AECOM
LEEDS

Site
M54 TO M6 / M6 TOLL LINK ROAD SCHEME
STAFFORDSHIRE

Title
LOCATION OF SITE SHOWING
MAGNETIC GRADIENT SURVEY AREAS

Job No
ARC_2586_965

Surveyed	JW, AB, CA	Drawn	JW
Chk.	NF	Date	10/04/2019



NOTES

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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_03	FINAL

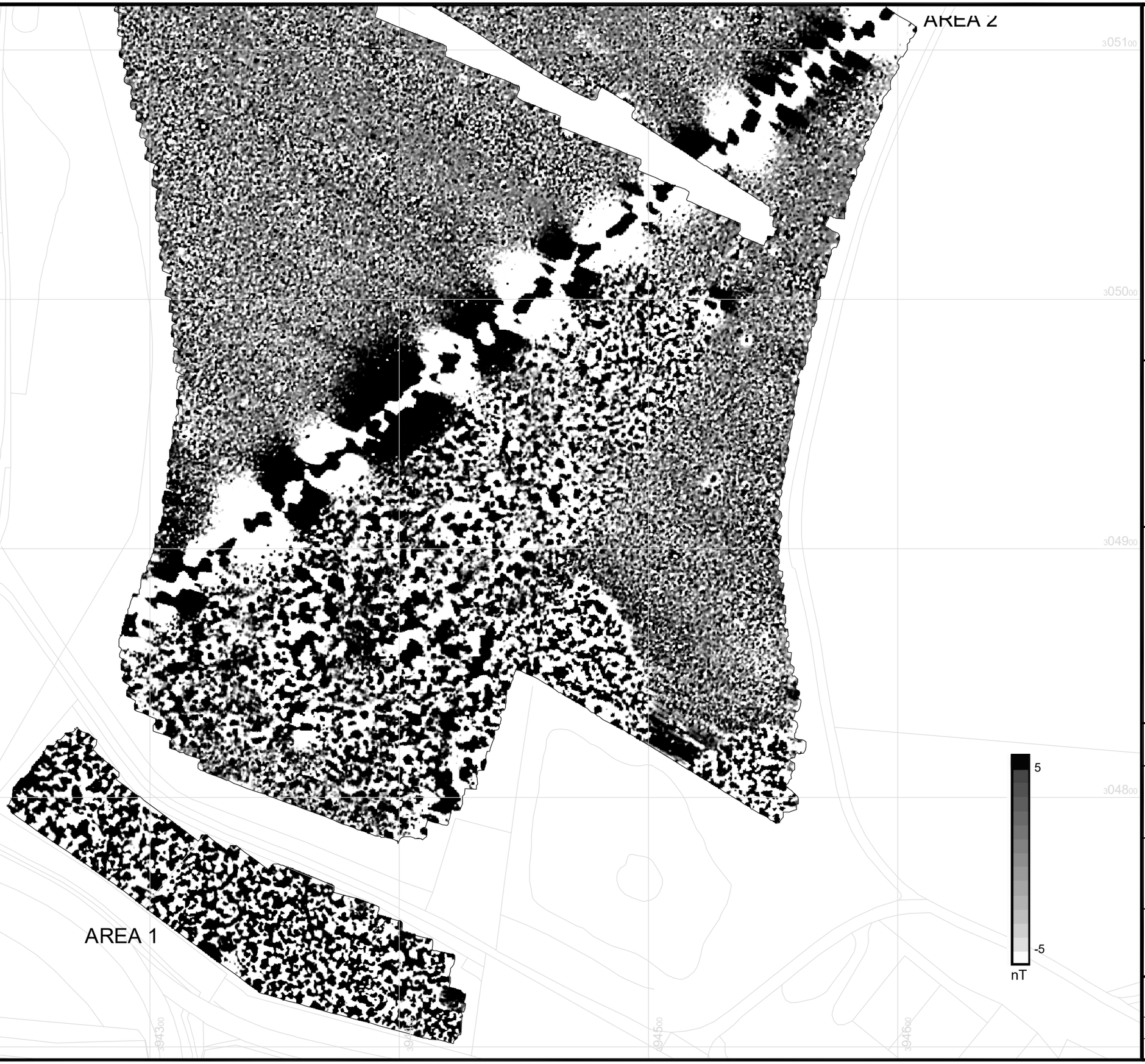
Client
AECOM
LEEDS

Site
M54 TO M6 / M6 TOLL LINK ROAD SCHEME
STAFFORDSHIRE

Title GREYSCALE PLOTS OF MAGNETIC GRADIENT DATA: AREA 1 & PART OF AREA 2

Job No
ARC_2586_965

Surveyed	JW, AB, CA	Drawn	JW
Chk.	NF	Date	10/04/2019



NOTES

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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_04	FINAL

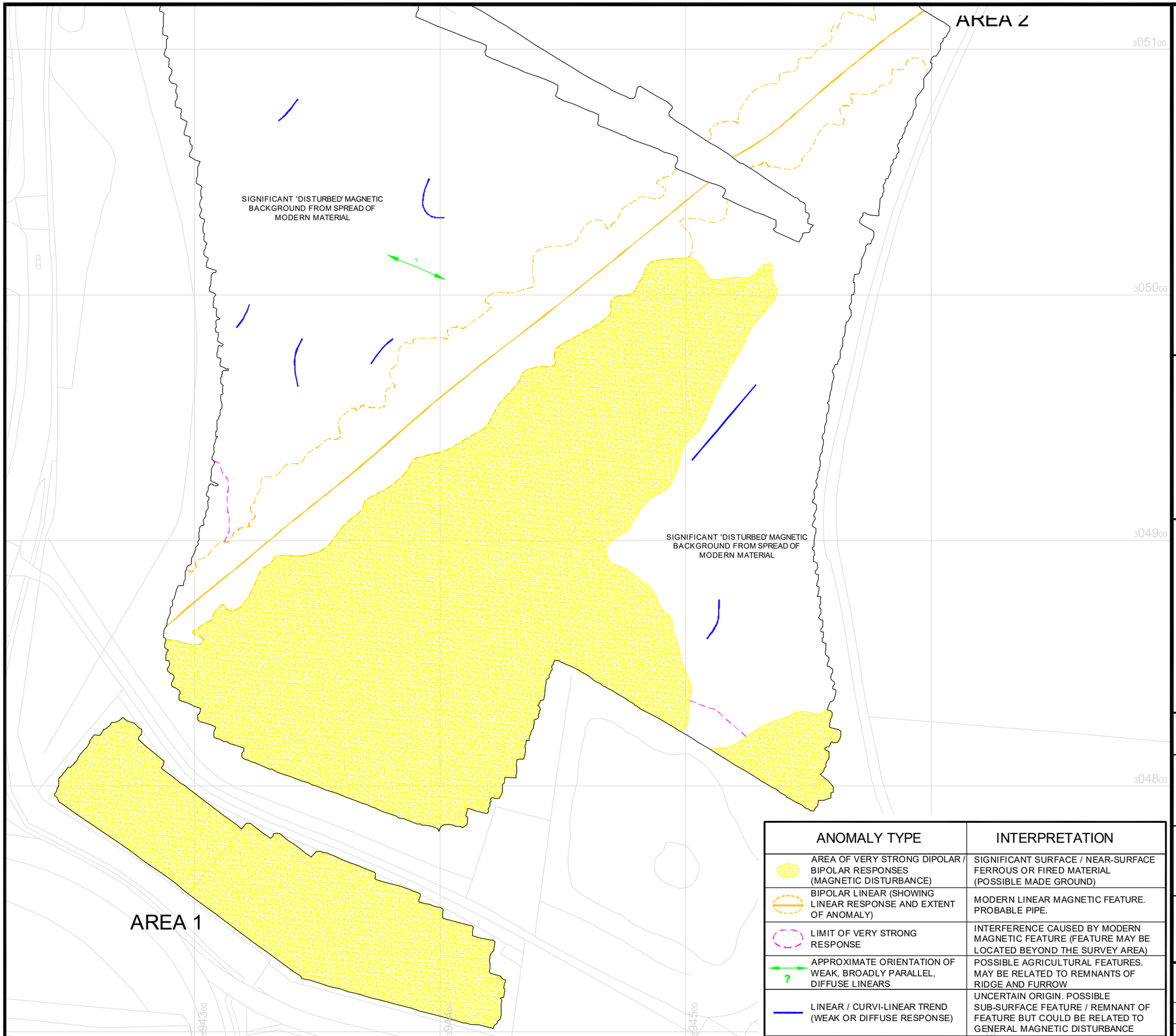
Client
AECOM
LEEDS

Site
M54 TO M6 / M6 TOLL LINK ROAD SCHEME
STAFFORDSHIRE

Title GREYSCALE PLOTS OF MAGNETIC GRADIENT DATA (WIDER RANGE): AREA 1 & PART OF AREA 2

Job No
ARC_2586_965

Surveyed	JW, AB, CA	Drawn	JW
Chk.	NF	Date	10/04/2019



ANOMALY TYPE	INTERPRETATION
AREA OF VERY STRONG DIPOLAR / BIPOLAR RESPONSES (MAGNETIC DISTURBANCE)	SIGNIFICANT SURFACE / NEAR-SURFACE FERROUS OR FIRED MATERIAL (POSSIBLE MADE GROUND)
BIPOLAR LINEAR (SHOWING LINEAR RESPONSE AND EXTENT OF ANOMALY)	MODERN LINEAR MAGNETIC FEATURE. PROBABLE PIPE.
LIMIT OF VERY STRONG RESPONSE	INTERFERENCE CAUSED BY MODERN MAGNETIC FEATURE (FEATURE MAY BE LOCATED BEYOND THE SURVEY AREA)
APPROXIMATE ORIENTATION OF WEAK, BROADLY PARALLEL, DIFFUSE LINEARS	POSSIBLE AGRICULTURAL FEATURES. MAY BE RELATED TO REMNANTS OF RIDGE AND FURROW
LINEAR / CURVI-LINEAR TREND (WEAK OR DIFFUSE RESPONSE)	UNCERTAIN ORIGIN. POSSIBLE SUB-SURFACE FEATURE / REMNANT OF FEATURE BUT COULD BE RELATED TO GENERAL MAGNETIC DISTURBANCE

NOTES

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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_05	FINAL

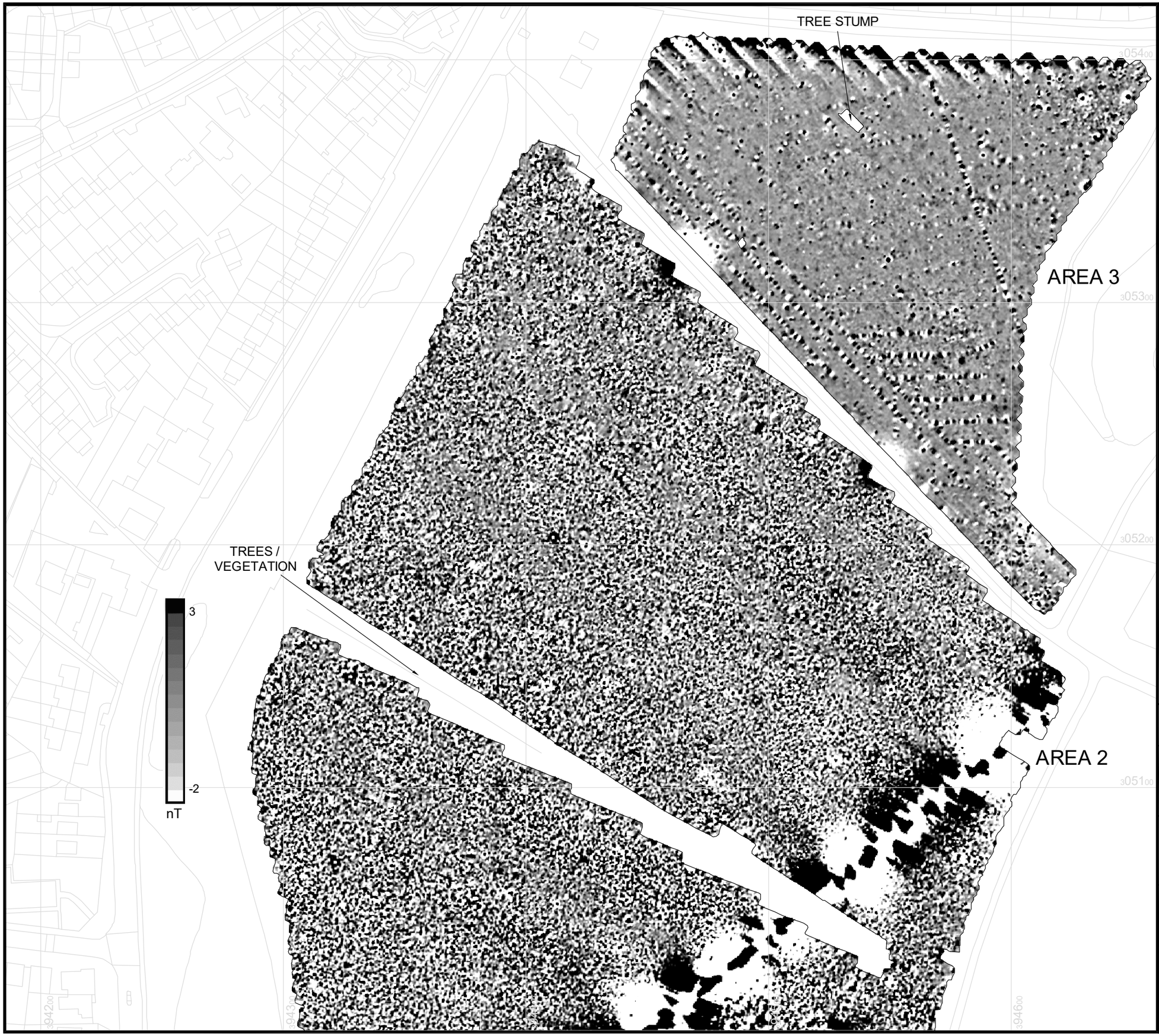
Client: AECOM LEEDS

Site: M54 TO M6 / M6 TOLL LINK ROAD SCHEME STAFFORDSHIRE

Title: INTERPRETATION OF MAGNETIC GRADIENT DATA: AREA 1 & PART OF AREA 2

Job No: ARC_2586_965

Surveyed	JW, AB, CA	Drawn	MW, JW
Chk.	NF	Date	10/04/2019



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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_06	FINAL

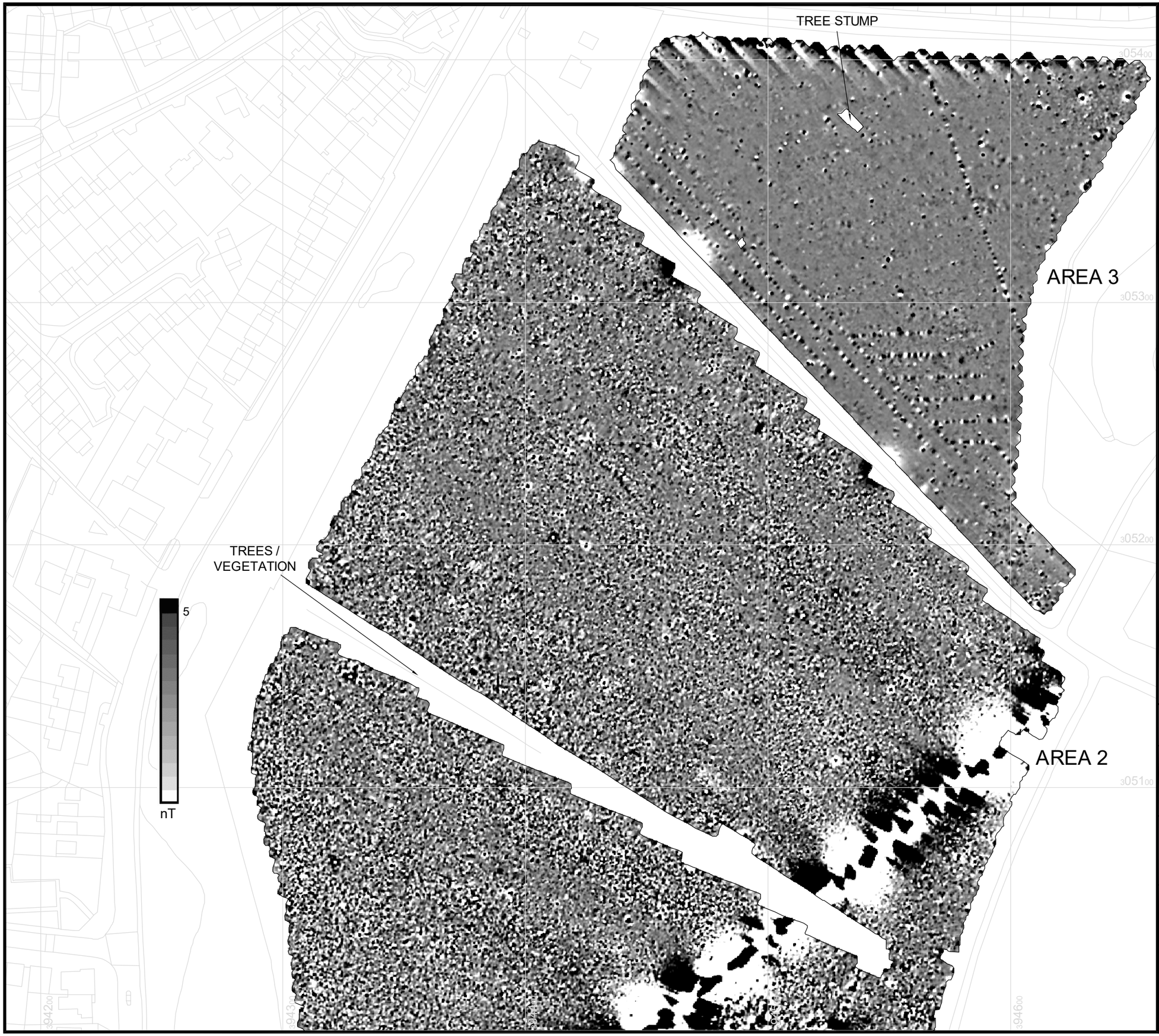
Client
AECOM
LEEDS

Site
M54 TO M6 / M6 TOLL LINK ROAD SCHEME
STAFFORDSHIRE

Title GREYSCALE PLOTS OF MAGNETIC GRADIENT DATA: AREA 3 & PART OF AREA 2

Job No
ARC_2586_965

Surveyed	JW, AB, CA	Drawn	JW
Chk.	NF	Date	10/04/2019



NOTES

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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_07	FINAL

Client
AECOM
LEEDS

Site
M54 TO M6 / M6 TOLL LINK ROAD SCHEME
STAFFORDSHIRE

Title GREYSCALE PLOTS OF MAGNETIC GRADIENT DATA (WIDER RANGE): AREA 3 & PART OF AREA 2

Job No
ARC_2586_965

Surveyed	JW, AB, CA	Drawn	JW
Chk.	NF	Date	10/04/2019

ANOMALY TYPE	INTERPRETATION
AREA OF VERY STRONG DIPOLAR / BIPOLAR RESPONSES (MAGNETIC DISTURBANCE)	SIGNIFICANT SURFACE / NEAR-SURFACE FERROUS OR FIRED MATERIAL (POSSIBLE MADE GROUND)
BIPOLAR LINEAR (SHOWING LINEAR RESPONSE AND EXTENT OF ANOMALY)	MODERN LINEAR MAGNETIC FEATURE. PROBABLE PIPE.
LIMIT OF VERY STRONG RESPONSE	INTERFERENCE CAUSED BY MODERN MAGNETIC FEATURE (FEATURE MAY BE LOCATED BEYOND THE SURVEY AREA)
APPROXIMATE ORIENTATION OF WEAK, BROADLY PARALLEL POSITIVE LINEARS	AGRICULTURAL FEATURES. PROBABLE MODERN PLOUGHING REGIME
APPROXIMATE ORIENTATION OF WEAK, BROADLY PARALLEL, DIFFUSE LINEARS	POSSIBLE AGRICULTURAL FEATURES. MAY BE RELATED TO REMNANTS OF RIDGE AND FURROW
BIPOLAR LINEAR	AGRICULTURAL FEATURE. FIELD DRAIN
APPROXIMATE ORIENTATION OF BROADLY PARALLEL POSITIVE LINEARS	AGRICULTURAL FEATURES. POSSIBLE DRAINAGE REGIME BUT COULD BE RELATED TO OTHER AGRICULTURAL ACTIVITY
LINEAR / CURVI-LINEAR TREND (WEAK OR DIFFUSE RESPONSE)	UNCERTAIN ORIGIN. POSSIBLE SUB-SURFACE FEATURE / REMNANT OF FEATURE BUT COULD BE RELATED TO GENERAL MAGNETIC DISTURBANCE
ISOLATED POSITIVE RESPONSE	PROBABLE GEOLOGICAL / PEDOLOGICAL VARIATION OR BURIED FERROUS / FIRED MATERIAL BUT COULD ALSO BE DEEPER INFILLED ISOLATED FEATURE

TREE STUMP

SIGNIFICANT 'DISTURBED' MAGNETIC BACKGROUND FROM SPREAD OF MODERN MATERIAL

AREA 3

SIGNIFICANT 'DISTURBED' MAGNETIC BACKGROUND FROM SPREAD OF MODERN MATERIAL

SIGNIFICANT 'DISTURBED' MAGNETIC BACKGROUND FROM SPREAD OF MODERN MATERIAL

TREES / VEGETATION

SIGNIFICANT 'DISTURBED' MAGNETIC BACKGROUND FROM SPREAD OF MODERN MATERIAL

SIGNIFICANT 'DISTURBED' MAGNETIC BACKGROUND FROM SPREAD OF MODERN MATERIAL

AREA 2

SIGNIFICANT 'DISTURBED' MAGNETIC BACKGROUND FROM SPREAD OF MODERN MATERIAL

FD

FD?

?

3054 00
3053 00
3052 00
3051 00
3942 00
3943 00
3944 00
3946 00

NOTES

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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_08	FINAL

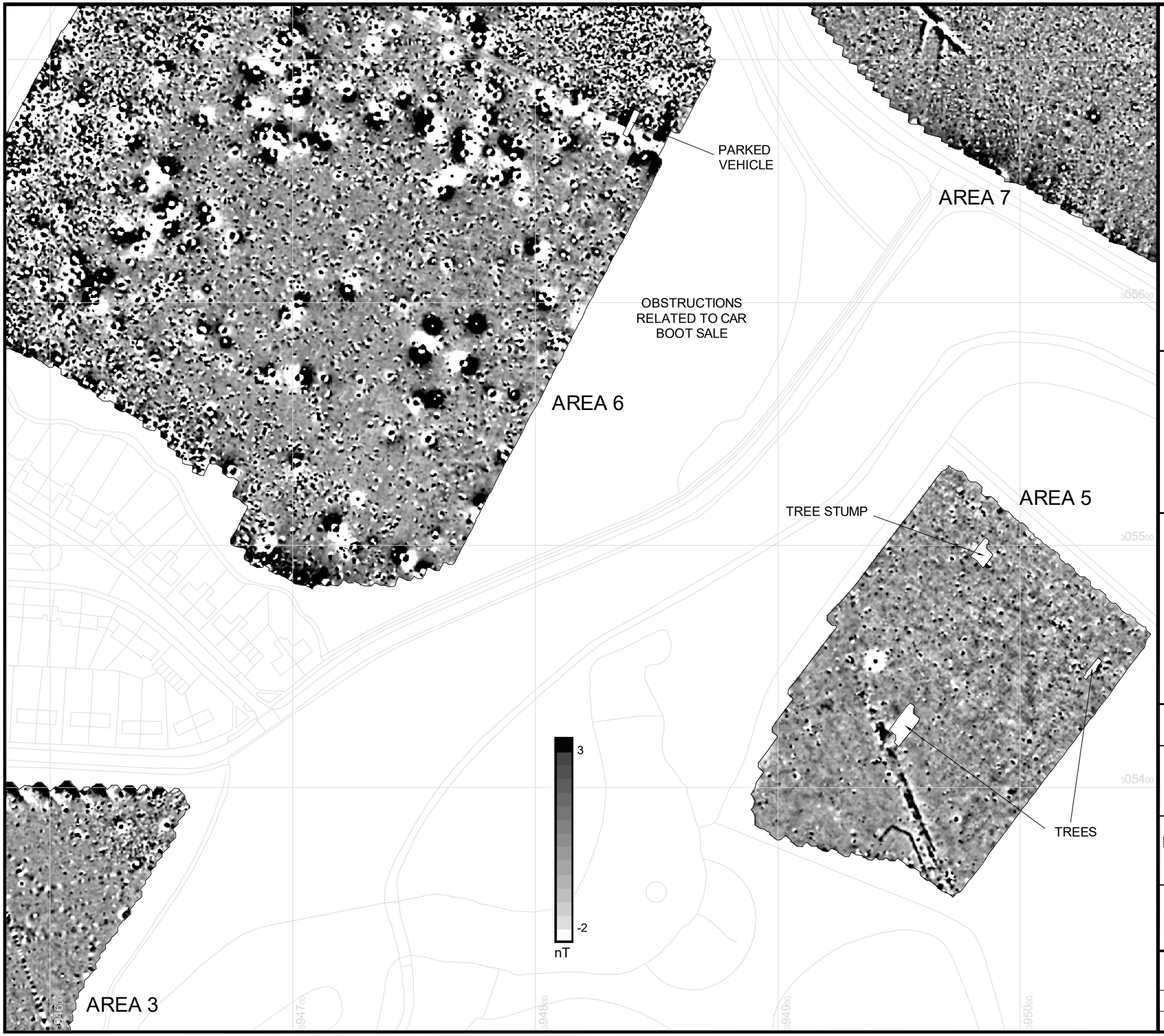
Client: AECOM LEEDS

Site: M54 TO M6 / M6 TOLL LINK ROAD SCHEME STAFFORDSHIRE

Title: INTERPRETATION OF MAGNETIC GRADIENT DATA: AREA 3 & PART OF AREA 2

Job No: ARC_2586_965

Surveyed	JW, AB, CA	Drawn	MW, JW
Chk.	NF	Date	10/04/2019



NOTES

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3. PHASE SITE INVESTIGATIONS CANNOT ACCEPT RESPONSIBILITY FOR THE RELIABILITY OR ACCURACY OF ANY INFORMATION PROVIDED BY A THIRD PARTY.
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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_09	FINAL

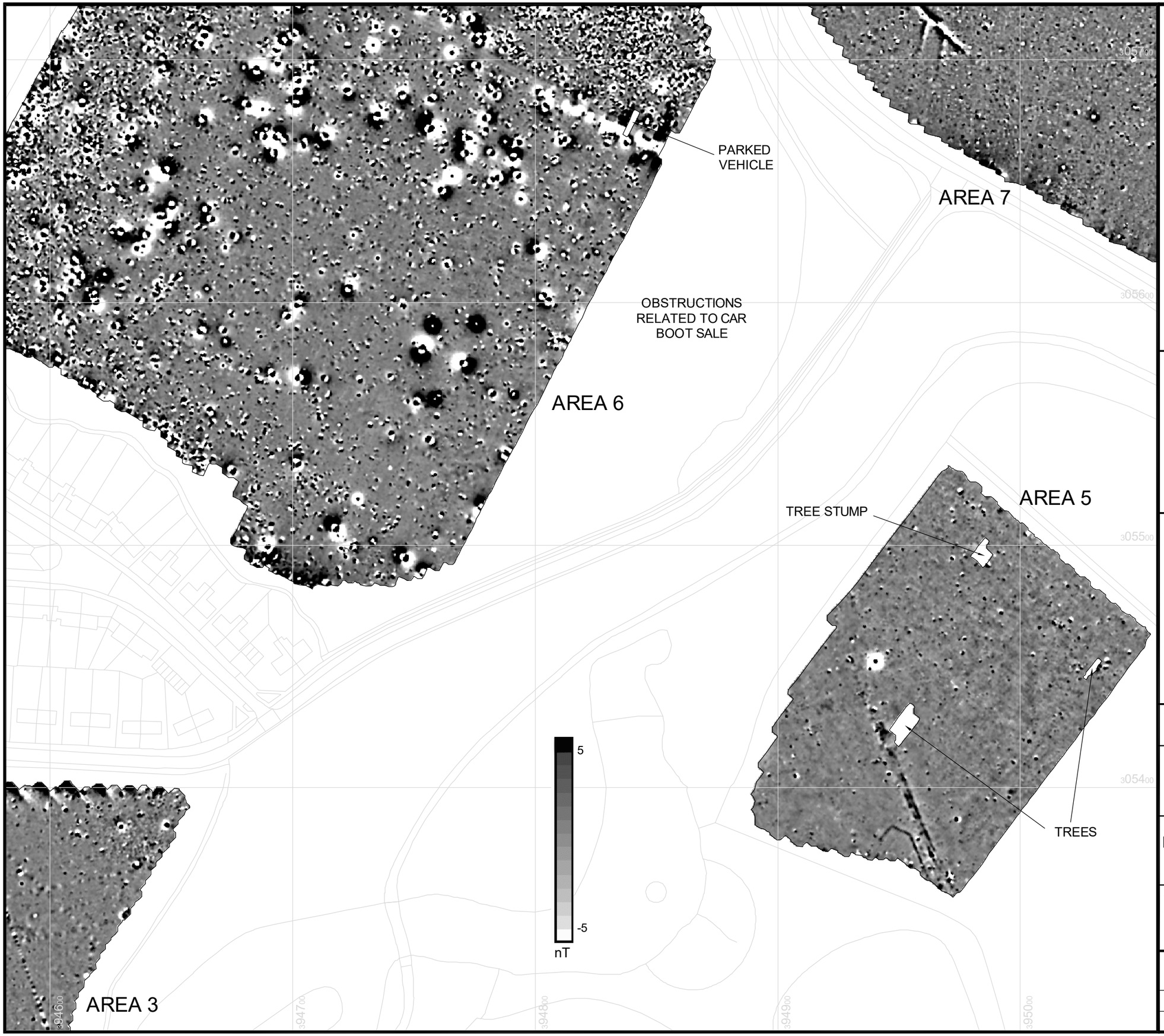
Client
AECOM
LEEDS

Site
M54 TO M6 / M6 TOLL LINK ROAD SCHEME
STAFFORDSHIRE

Title GREYSCALE PLOTS OF MAGNETIC GRADIENT DATA: AREA 5 & PARTS OF AREAS 3, 6 & 7

Job No
ARC_2586_965

Surveyed	JW, AB, CA	Drawn	JW
Chk.	NF	Date	10/04/2019



NOTES

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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_10	FINAL

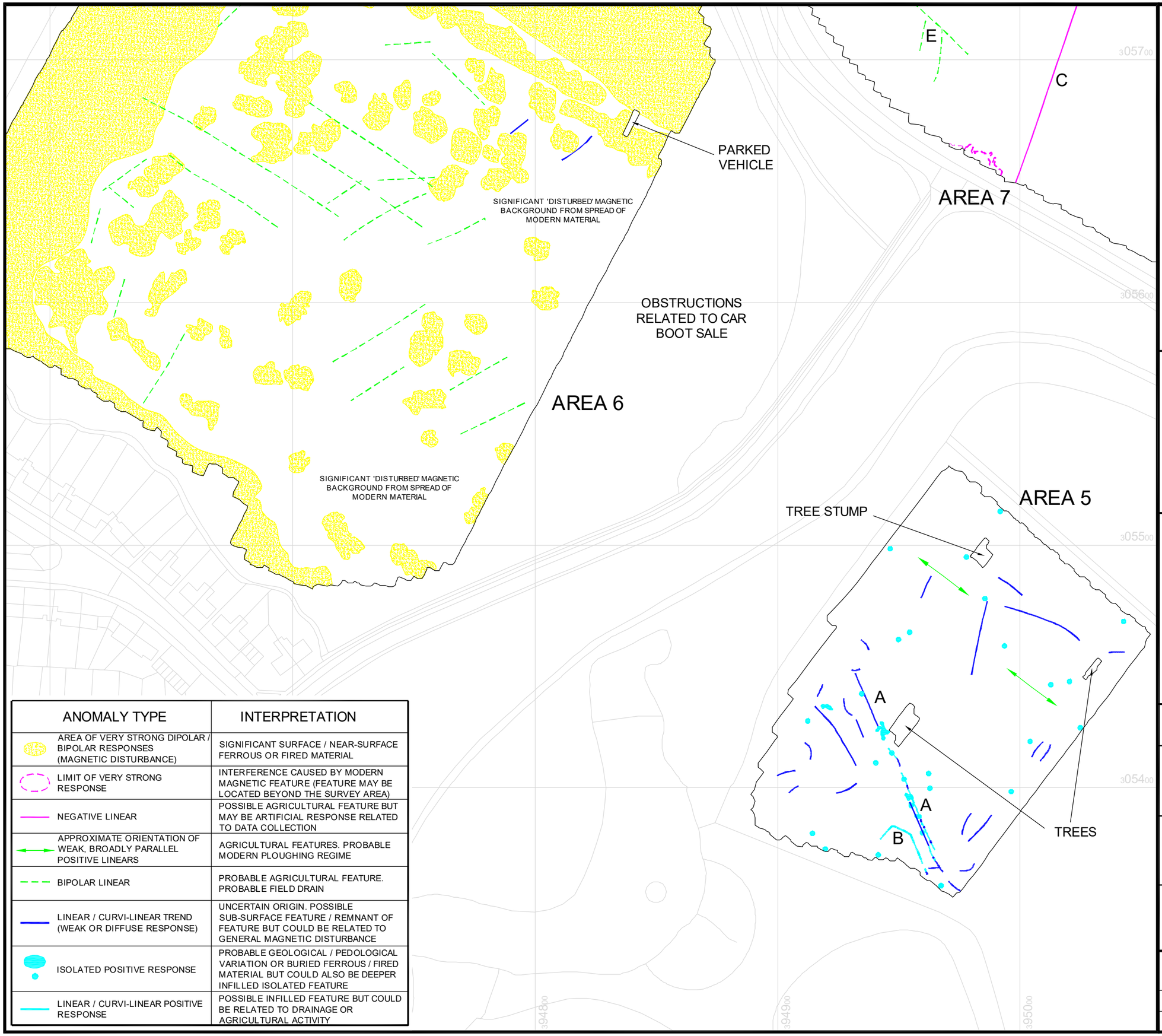
Client
AECOM
LEEDS

Site
M54 TO M6 / M6 TOLL LINK ROAD SCHEME
STAFFORDSHIRE

Title GREYSCALE PLOTS OF MAGNETIC GRADIENT DATA (WIDER RANGE): AREA 5 & PARTS OF AREAS 3, 6 & 7

Job No
ARC_2586_965

Surveyed	JW, AB, CA	Drawn	JW
Chk.	NF	Date	10/04/2019



ANOMALY TYPE	INTERPRETATION
AREA OF VERY STRONG DIPOLAR / BIPOLAR RESPONSES (MAGNETIC DISTURBANCE)	SIGNIFICANT SURFACE / NEAR-SURFACE FERROUS OR FIRED MATERIAL
LIMIT OF VERY STRONG RESPONSE	INTERFERENCE CAUSED BY MODERN MAGNETIC FEATURE (FEATURE MAY BE LOCATED BEYOND THE SURVEY AREA)
NEGATIVE LINEAR	POSSIBLE AGRICULTURAL FEATURE BUT MAY BE ARTIFICIAL RESPONSE RELATED TO DATA COLLECTION
APPROXIMATE ORIENTATION OF WEAK, BROADLY PARALLEL POSITIVE LINEARS	AGRICULTURAL FEATURES. PROBABLE MODERN PLOUGHING REGIME
BIPOLAR LINEAR	PROBABLE AGRICULTURAL FEATURE. PROBABLE FIELD DRAIN
LINEAR / CURVI-LINEAR TREND (WEAK OR DIFFUSE RESPONSE)	UNCERTAIN ORIGIN. POSSIBLE SUB-SURFACE FEATURE / REMNANT OF FEATURE BUT COULD BE RELATED TO GENERAL MAGNETIC DISTURBANCE
ISOLATED POSITIVE RESPONSE	PROBABLE GEOLOGICAL / PEDOLOGICAL VARIATION OR BURIED FERROUS / FIRED MATERIAL BUT COULD ALSO BE DEEPER INFILLED ISOLATED FEATURE
LINEAR / CURVI-LINEAR POSITIVE RESPONSE	POSSIBLE INFILLED FEATURE BUT COULD BE RELATED TO DRAINAGE OR AGRICULTURAL ACTIVITY

NOTES

1. THIS DRAWING MUST BE USED IN CONJUNCTION WITH THE ACCOMPANYING REPORT (ARC_2586_965_RPT.PDF) WHICH PROVIDES DETAILS OF THE TECHNIQUES EMPLOYED, THEIR INHERENT LIMITATIONS AND ANY SITE SPECIFIC ISSUES.
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W: www.PhaseSI.com

Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_11	FINAL

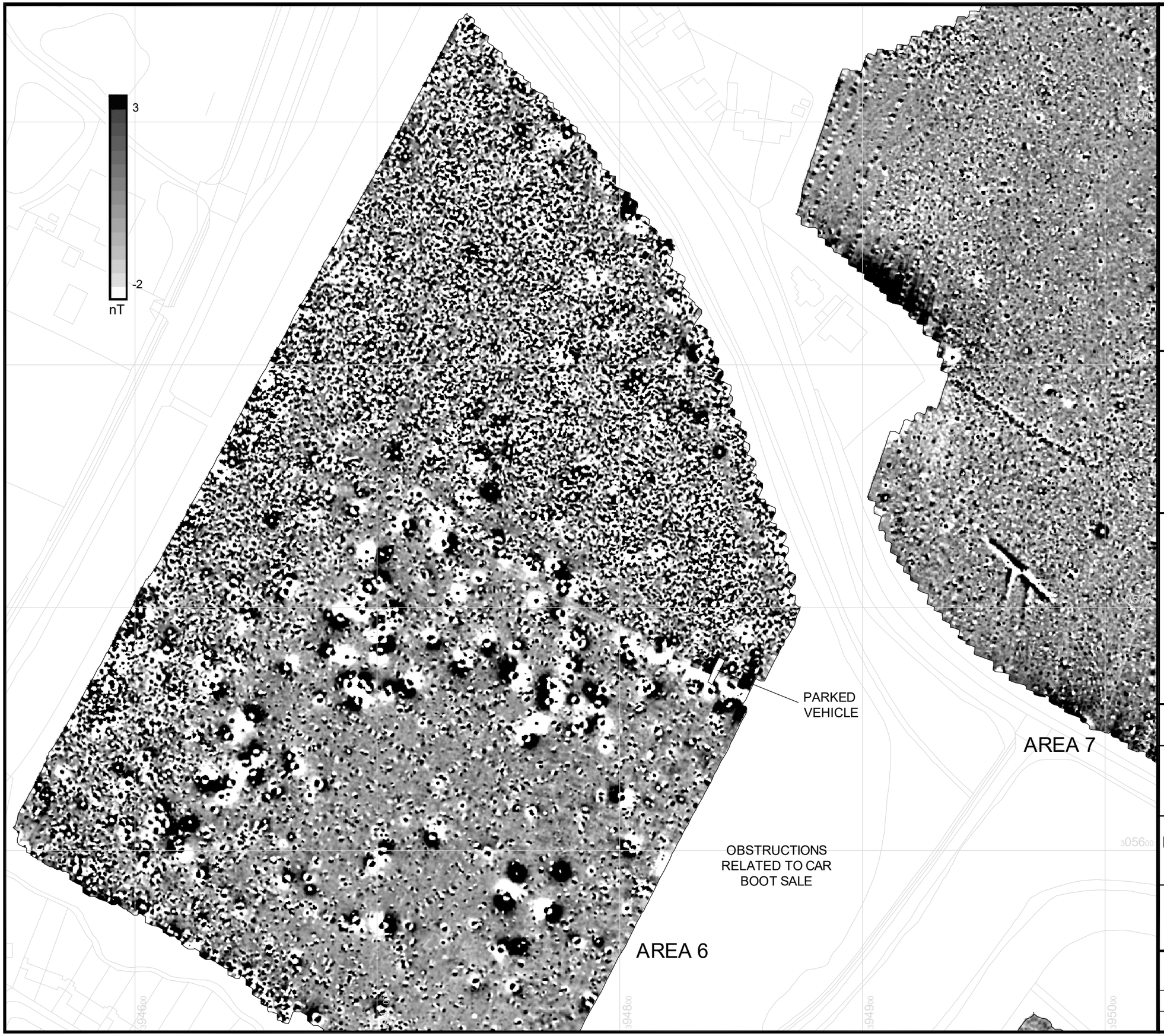
Client
AECOM
LEEDS

Site
M54 TO M6 / M6 TOLL LINK ROAD SCHEME
STAFFORDSHIRE

Title
INTERPRETATION OF MAGNETIC GRADIENT DATA: AREA 5 & PARTS OF AREAS 6 & 7

Job No
ARC_2586_965

Surveyed	JW, AB, CA	Drawn	MW, JW
Chk.	NF	Date	10/04/2019



NOTES

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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_12	FINAL

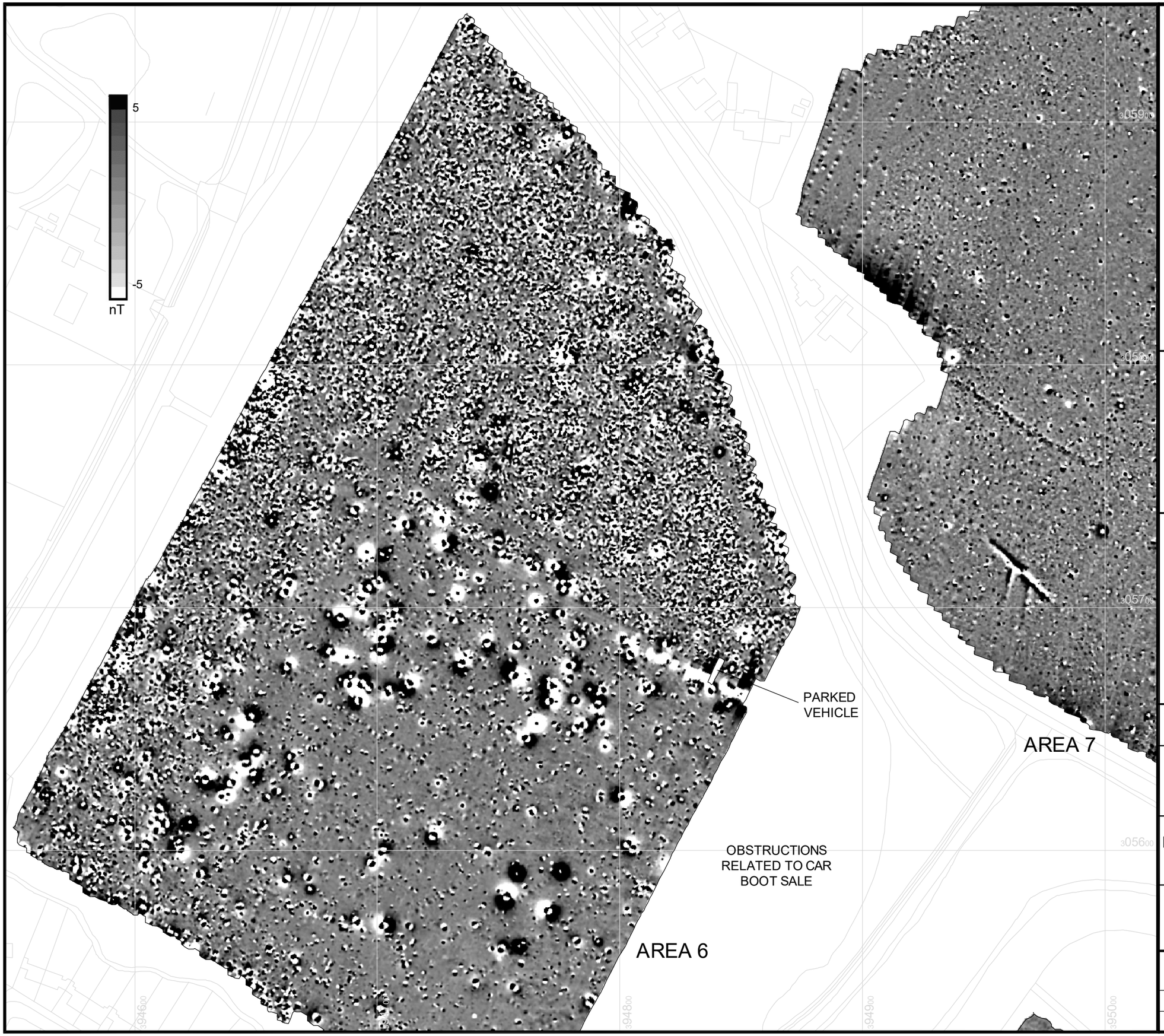
Client
AECOM
LEEDS

Site
M54 TO M6 / M6 TOLL LINK ROAD SCHEME
STAFFORDSHIRE

Title GREYSCALE PLOTS OF MAGNETIC GRADIENT DATA: PARTS OF AREAS 6 & 7

Job No
ARC_2586_965

Surveyed	JW, AB, CA	Drawn	JW
Chk.	NF	Date	10/04/2019



NOTES

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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_13	FINAL

Client: AECOM LEEDS

Site: M54 TO M6 / M6 TOLL LINK ROAD SCHEME STAFFORDSHIRE

Title: GREYSCALE PLOTS OF MAGNETIC GRADIENT DATA (WIDER RANGE): PARTS OF AREAS 6 & 7

Job No: ARC_2586_965

Surveyed	JW, AB, CA	Drawn	JW
Chk.	NF	Date	10/04/2019

ANOMALY TYPE	INTERPRETATION
AREA OF VERY STRONG DIPOLAR / BIPOLAR RESPONSES (MAGNETIC DISTURBANCE)	SIGNIFICANT SURFACE / NEAR-SURFACE FERROUS OR FIRED MATERIAL
LIMIT OF VERY STRONG RESPONSE	INTERFERENCE CAUSED BY MODERN MAGNETIC FEATURE (FEATURE MAY BE LOCATED BEYOND THE SURVEY AREA)
NEGATIVE LINEAR	POSSIBLE AGRICULTURAL FEATURE BUT MAY BE ARTIFICIAL RESPONSE RELATED TO DATA COLLECTION
BIPOLAR LINEAR	PROBABLE AGRICULTURAL FEATURE. PROBABLE FIELD DRAIN
LINEAR / CURVI-LINEAR TREND (WEAK OR DIFFUSE RESPONSE)	UNCERTAIN ORIGIN. POSSIBLE SUB-SURFACE FEATURE / REMNANT OF FEATURE BUT COULD BE RELATED TO GENERAL MAGNETIC DISTURBANCE

D2

SIGNIFICANT 'DISTURBED' MAGNETIC BACKGROUND FROM SPREAD OF MODERN MATERIAL

E

PARKED VEHICLE

SIGNIFICANT 'DISTURBED' MAGNETIC BACKGROUND FROM SPREAD OF MODERN MATERIAL

AREA 7

OBSTRUCTIONS RELATED TO CAR BOOT SALE

AREA 6

SIGNIFICANT 'DISTURBED' MAGNETIC

3058 00

3057 00

3056 00

3946 00

3948 00

3949 00

3950 00

NOTES

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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_14	FINAL

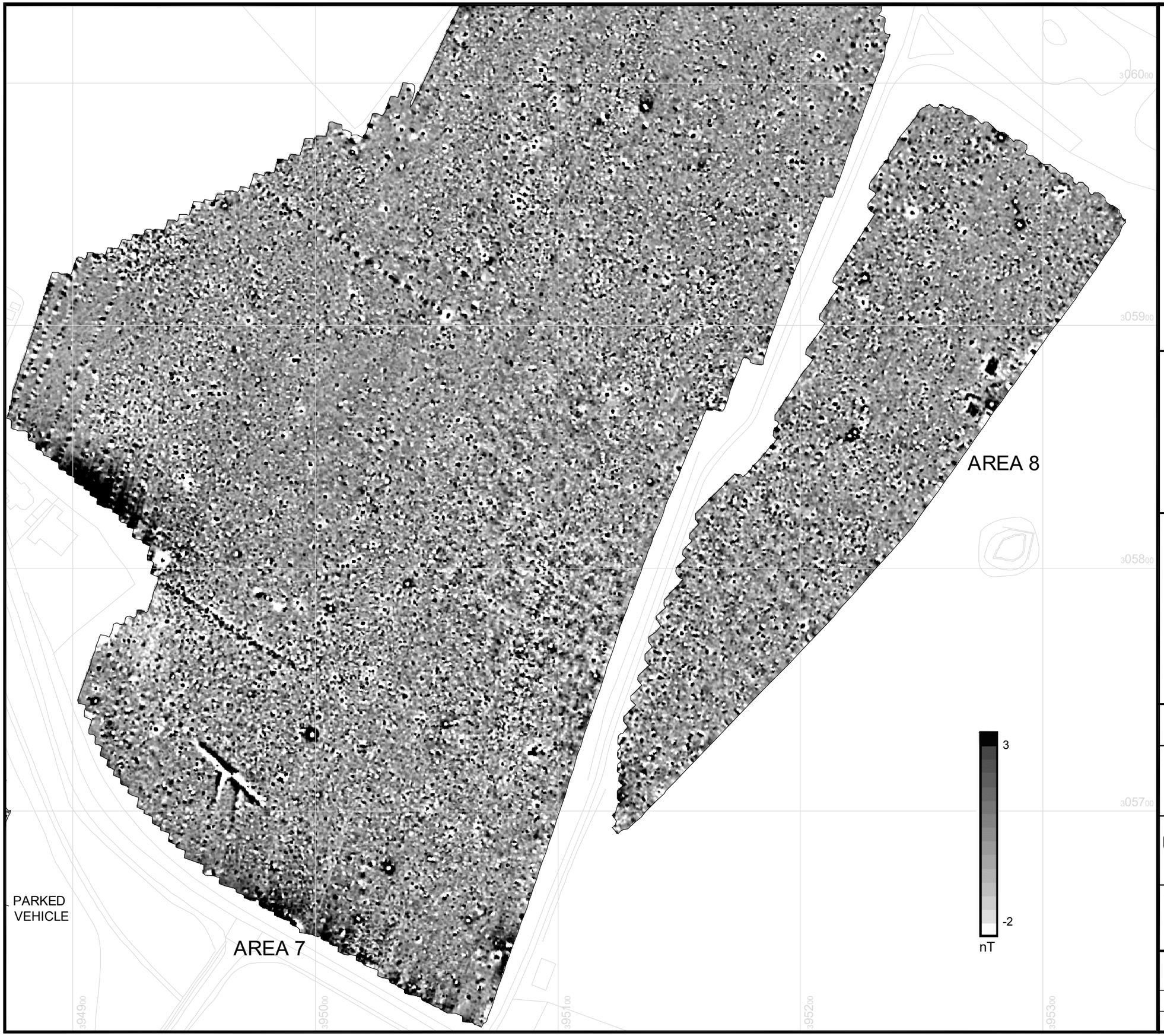
Client
AECOM
LEEDS

Site
M54 TO M6 / M6 TOLL LINK ROAD SCHEME
STAFFORDSHIRE

Title
INTERPRETATION OF MAGNETIC GRADIENT DATA: PARTS OF AREAS 6 & 7

Job No
ARC_2586_965

Surveyed	JW, AB, CA	Drawn	MW, JW
Chk.	NF	Date	10/04/2019



NOTES

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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_15	FINAL

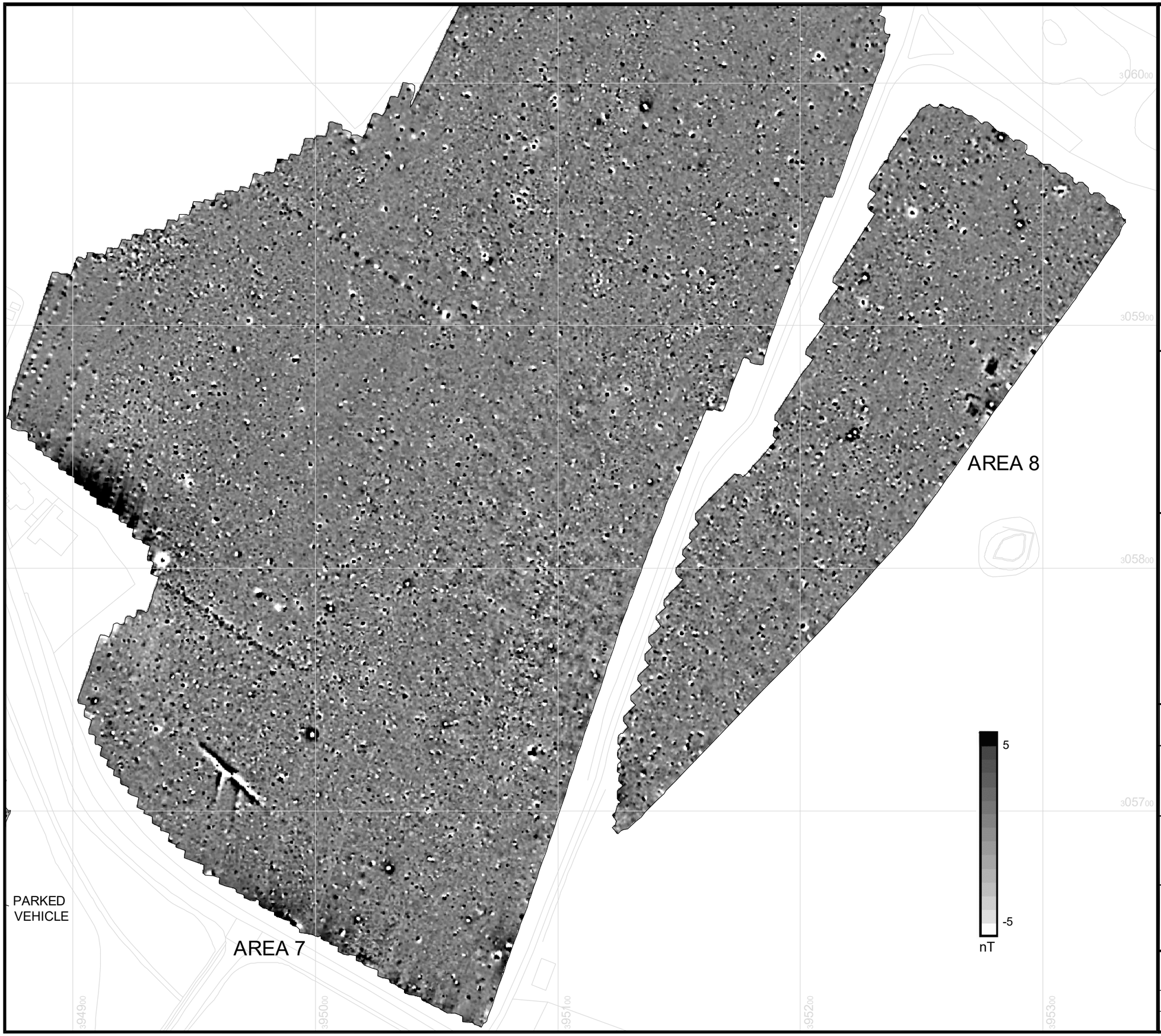
Client
AECOM
LEEDS

Site
M54 TO M6 / M6 TOLL LINK ROAD SCHEME
STAFFORDSHIRE

Title GREYSCALE PLOTS OF MAGNETIC GRADIENT DATA: AREA 8 & PART OF AREA 7

Job No
ARC_2586_965

Surveyed	JW, AB, CA	Drawn	JW
Chk.	NF	Date	10/04/2019



NOTES

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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_16	FINAL

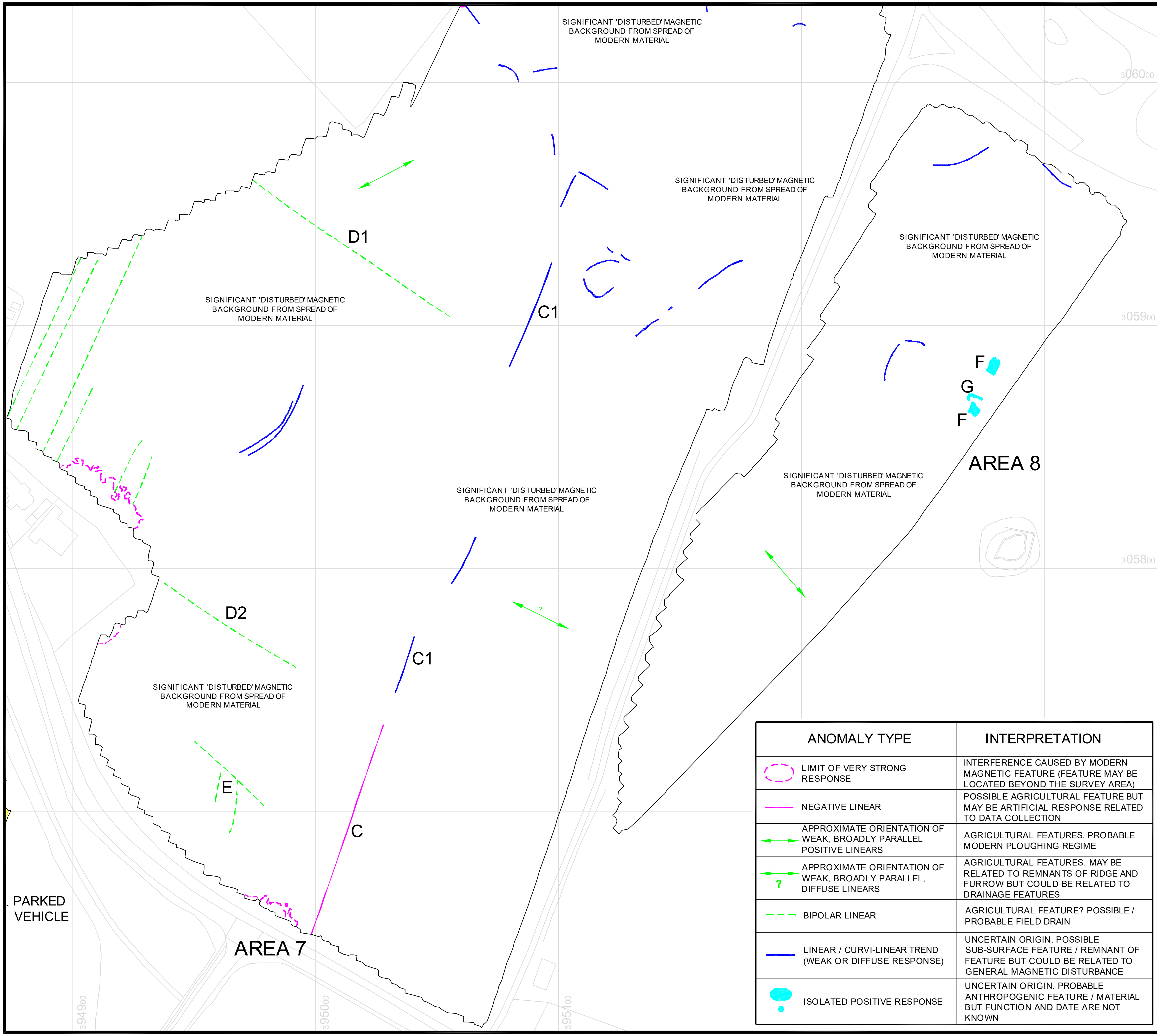
Client
AECOM
LEEDS

Site
M54 TO M6 / M6 TOLL LINK ROAD SCHEME
STAFFORDSHIRE

Title GREYSCALE PLOTS OF MAGNETIC GRADIENT DATA (WIDER RANGE): AREA 8 & PART OF AREA 7

Job No
ARC_2586_965

Surveyed	JW, AB, CA	Drawn	JW
Chk.	NF	Date	10/04/2019



ANOMALY TYPE	INTERPRETATION
LIMIT OF VERY STRONG RESPONSE	INTERFERENCE CAUSED BY MODERN MAGNETIC FEATURE (FEATURE MAY BE LOCATED BEYOND THE SURVEY AREA)
NEGATIVE LINEAR	POSSIBLE AGRICULTURAL FEATURE BUT MAY BE ARTIFICIAL RESPONSE RELATED TO DATA COLLECTION
APPROXIMATE ORIENTATION OF WEAK, BROADLY PARALLEL POSITIVE LINEARS	AGRICULTURAL FEATURES. PROBABLE MODERN PLOUGHING REGIME
? APPROXIMATE ORIENTATION OF WEAK, BROADLY PARALLEL, DIFFUSE LINEARS	AGRICULTURAL FEATURES. MAY BE RELATED TO REMNANTS OF RIDGE AND FURROW BUT COULD BE RELATED TO DRAINAGE FEATURES
BIPOLAR LINEAR	AGRICULTURAL FEATURE? POSSIBLE / PROBABLE FIELD DRAIN
LINEAR / CURVI-LINEAR TREND (WEAK OR DIFFUSE RESPONSE)	UNCERTAIN ORIGIN. POSSIBLE SUB-SURFACE FEATURE / REMNANT OF FEATURE BUT COULD BE RELATED TO GENERAL MAGNETIC DISTURBANCE
ISOLATED POSITIVE RESPONSE	UNCERTAIN ORIGIN. PROBABLE ANTHROPOGENIC FEATURE / MATERIAL BUT FUNCTION AND DATE ARE NOT KNOWN

NOTES

1. THIS DRAWING MUST BE USED IN CONJUNCTION WITH THE ACCOMPANYING REPORT (ARC_2586_965_RPT.PDF) WHICH PROVIDES DETAILS OF THE TECHNIQUES EMPLOYED, THEIR INHERENT LIMITATIONS AND ANY SITE SPECIFIC ISSUES.
2. THIS DRAWING IS BASED UPON AN EXTRACT FROM DRAWING 'Mapping.dwg' PROVIDED BY THE CLIENT. THE ORDNANCE SURVEY CO-ORDINATES OBTAINED FOR THIS SURVEY WERE MEASURED USING THE UKOSTN02 PROJECTION. THIS PROJECTION SHOULD BE TAKEN INTO ACCOUNT IF THE SURVEY GRID IS RELOCATED.
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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_17	FINAL

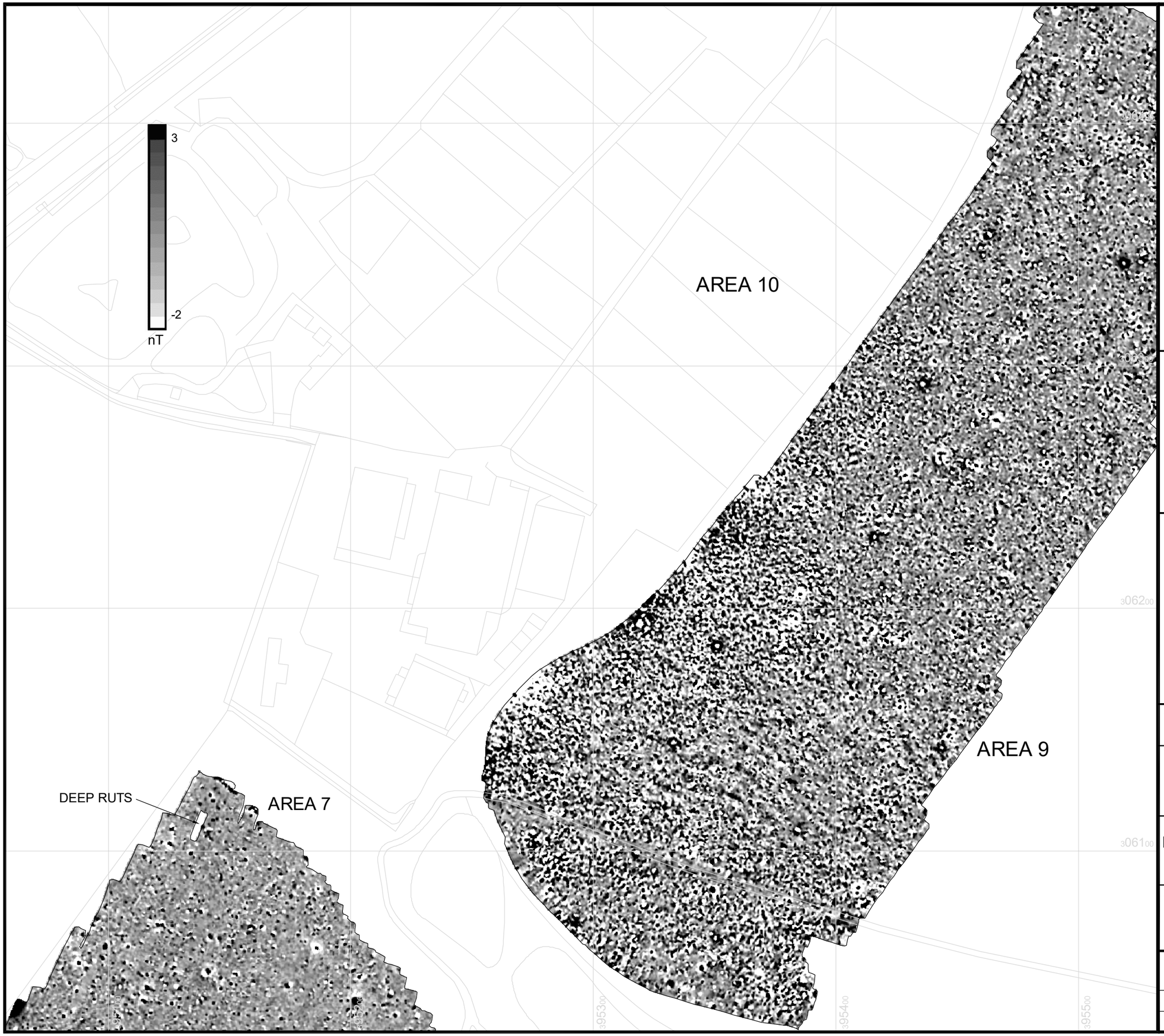
Client
AECOM
LEEDS

Site
M54 TO M6 / M6 TOLL LINK ROAD SCHEME
STAFFORDSHIRE

Title
INTERPRETATION OF MAGNETIC GRADIENT DATA: AREA 8 & PART OF AREA 7

Job No
ARC_2586_965

Surveyed	JW, AB, CA	Drawn	MW, JW
Chk.	NF	Date	10/04/2019



NOTES

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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_18	FINAL

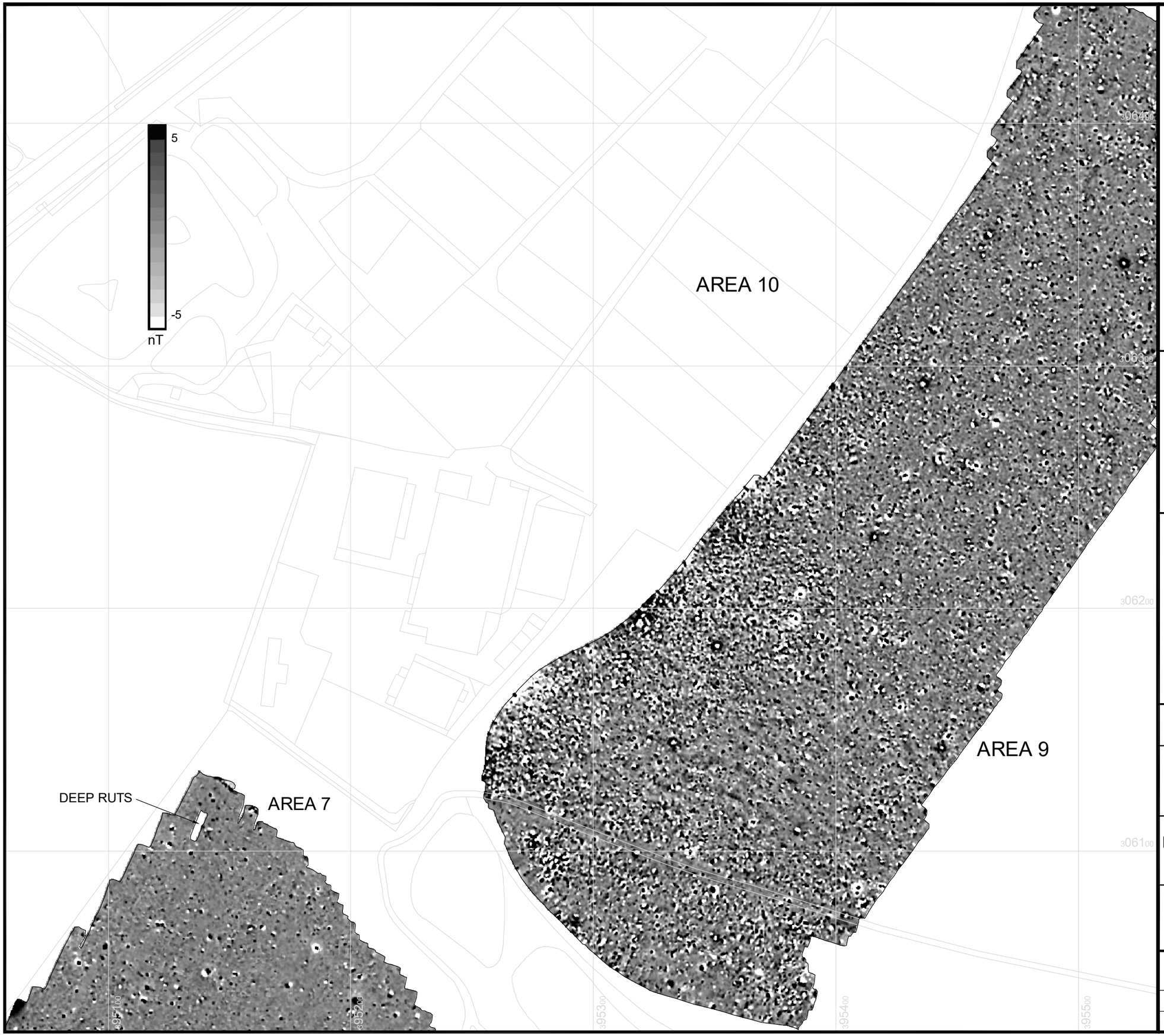
Client
AECOM
LEEDS

Site
M54 TO M6 / M6 TOLL LINK ROAD SCHEME
STAFFORDSHIRE

Title GREYSCALE PLOTS OF MAGNETIC GRADIENT DATA: PARTS OF AREAS 7 & 9

Job No
ARC_2586_965

Surveyed	JW, AB, CA	Drawn	JW
Chk.	NF	Date	10/04/2019



NOTES

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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_19	FINAL

Client
AECOM
LEEDS

Site
M54 TO M6 / M6 TOLL LINK ROAD SCHEME
STAFFORDSHIRE

Title
GREYSCALE PLOTS OF MAGNETIC GRADIENT DATA (WIDER RANGE): PARTS OF AREAS 7 & 9

Job No
ARC_2586_965

Surveyed	JW, AB, CA	Drawn	JW
Chk.	NF	Date	10/04/2019

ANOMALY TYPE	INTERPRETATION
LIMIT OF VERY STRONG RESPONSE	INTERFERENCE CAUSED BY MODERN MAGNETIC FEATURE (FEATURE MAY BE LOCATED BEYOND THE SURVEY AREA)
APPROXIMATE ORIENTATION OF WEAK, BROADLY PARALLEL POSITIVE LINEARS	AGRICULTURAL FEATURES. PROBABLE MODERN PLOUGHING REGIME
LINEAR / CURVI-LINEAR TREND (WEAK OR DIFFUSE RESPONSE)	UNCERTAIN ORIGIN. POSSIBLE SUB-SURFACE FEATURE / REMNANT OF FEATURE BUT COULD BE RELATED TO GENERAL MAGNETIC DISTURBANCE

AREA 10

AREA 9

AREA 7

DEEP RUTS

SIGNIFICANT 'DISTURBED' MAGNETIC BACKGROUND FROM SPREAD OF MODERN MATERIAL

SIGNIFICANT 'DISTURBED' MAGNETIC BACKGROUND FROM SPREAD OF MODERN MATERIAL

SIGNIFICANT 'DISTURBED' MAGNETIC BACKGROUND FROM SPREAD OF MODERN MATERIAL

SIGNIFICANT 'DISTURBED' MAGNETIC

3064 00

3063 00

3062 00

3061 00

3951 00

3952 00

3953 00

3954 00

3955 00

NOTES

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2. THIS DRAWING IS BASED UPON AN EXTRACT FROM DRAWING 'Mapping.dwg' PROVIDED BY THE CLIENT. THE ORDNANCE SURVEY CO-ORDINATES OBTAINED FOR THIS SURVEY WERE MEASURED USING THE UKOSTN02 PROJECTION. THIS PROJECTION SHOULD BE TAKEN INTO ACCOUNT IF THE SURVEY GRID IS RELOCATED.
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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_20	FINAL

Client
AECOM
LEEDS

Site
M54 TO M6 / M6 TOLL LINK ROAD SCHEME
STAFFORDSHIRE

Title
INTERPRETATION OF MAGNETIC GRADIENT DATA: PARTS OF AREAS 7 & 9

Job No
ARC_2586_965

Surveyed	JW, AB, CA	Drawn	MW, JW
Chk.	NF	Date	10/04/2019

AREA 15

AREA 14

AREA 12

AREA 11

AREA 13

ANIMAL SHELTER / SHED

AREA 9

AREA 10

3
-2
nT

NOTES

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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_21	FINAL

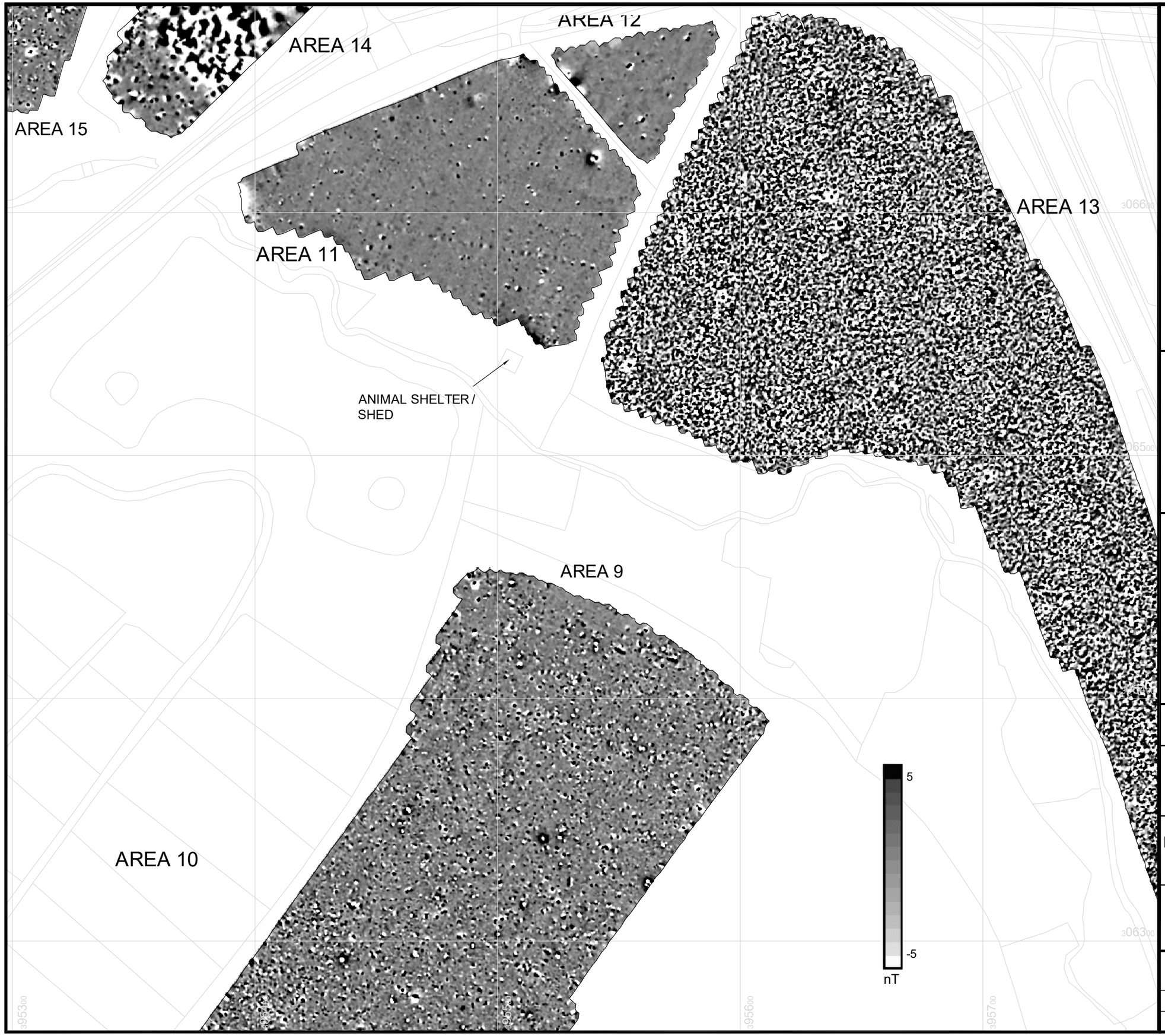
Client: AECOM LEEDS

Site: M54 TO M6 / M6 TOLL LINK ROAD SCHEME STAFFORDSHIRE

Title: GREYSCALE PLOTS OF MAGNETIC GRADIENT DATA: AREAS 11, 12 & PARTS OF AREAS 9, 13, 14 & 15

Job No: ARC_2586_965

Surveyed	JW, AB, CA	Drawn	JW
Chk.	NF	Date	10/04/2019



NOTES

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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_22	FINAL

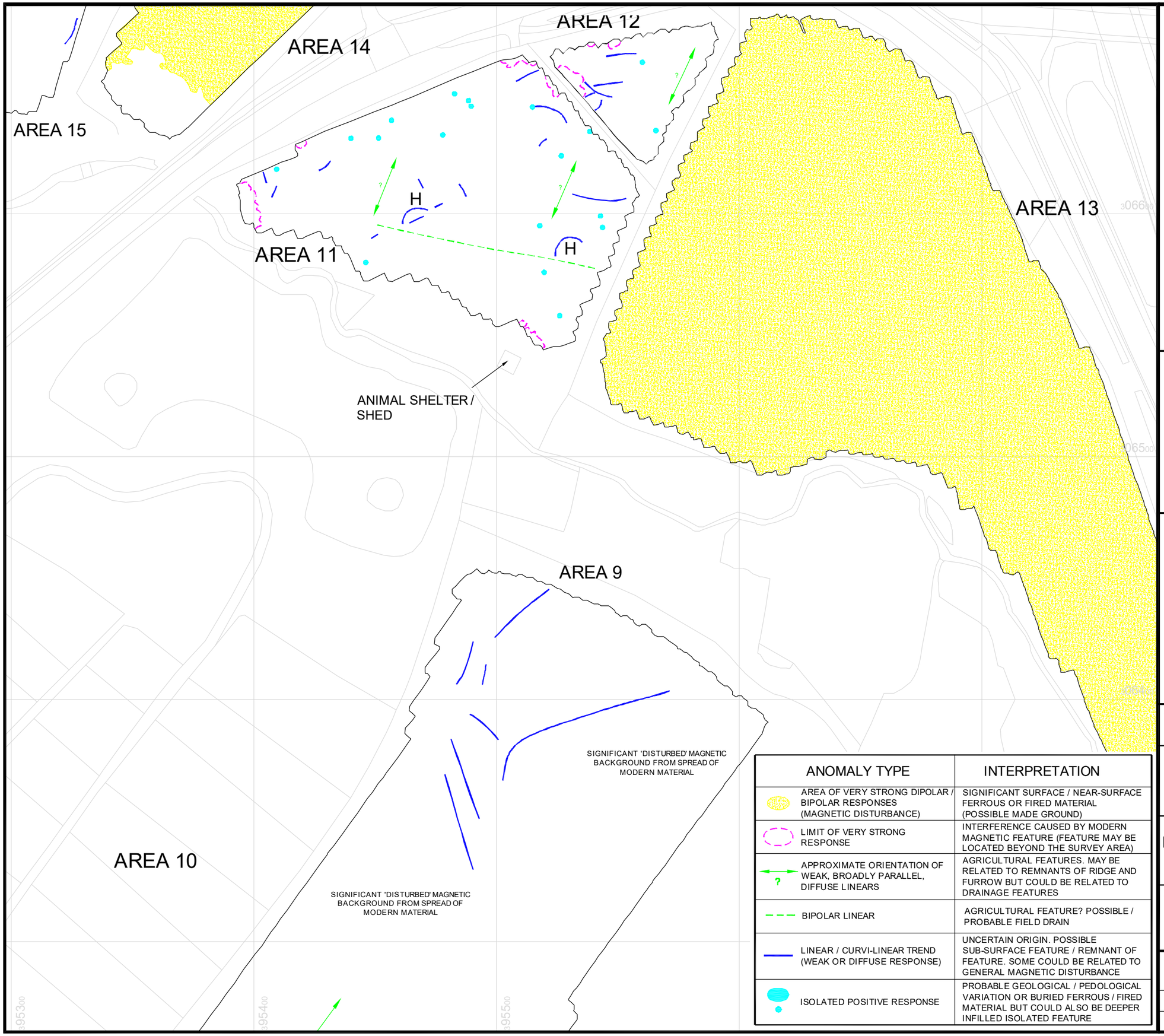
Client: AECOM LEEDS

Site: M54 TO M6 / M6 TOLL LINK ROAD SCHEME STAFFORDSHIRE

Title: GREYSCALE PLOTS OF MAGNETIC GRADIENT DATA (WIDER RANGE): AREAS 11, 12 & PARTS OF AREAS 9, 13, 14 & 15

Job No: ARC_2586_965

Surveyed	JW, AB, CA	Drawn	JW
Chk.	NF	Date	10/04/2019



NOTES

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ANOMALY TYPE	INTERPRETATION
AREA OF VERY STRONG DIPOLAR / BIPOLAR RESPONSES (MAGNETIC DISTURBANCE)	SIGNIFICANT SURFACE / NEAR-SURFACE FERROUS OR FIRED MATERIAL (POSSIBLE MADE GROUND)
LIMIT OF VERY STRONG RESPONSE	INTERFERENCE CAUSED BY MODERN MAGNETIC FEATURE (FEATURE MAY BE LOCATED BEYOND THE SURVEY AREA)
APPROXIMATE ORIENTATION OF WEAK, BROADLY PARALLEL, DIFFUSE LINEARS	AGRICULTURAL FEATURES. MAY BE RELATED TO REMNANTS OF RIDGE AND FURROW BUT COULD BE RELATED TO DRAINAGE FEATURES
BIPOLAR LINEAR	AGRICULTURAL FEATURE? POSSIBLE / PROBABLE FIELD DRAIN
LINEAR / CURVI-LINEAR TREND (WEAK OR DIFFUSE RESPONSE)	UNCERTAIN ORIGIN. POSSIBLE SUB-SURFACE FEATURE / REMNANT OF FEATURE. SOME COULD BE RELATED TO GENERAL MAGNETIC DISTURBANCE
ISOLATED POSITIVE RESPONSE	PROBABLE GEOLOGICAL / PEDOLOGICAL VARIATION OR BURIED FERROUS / FIRED MATERIAL BUT COULD ALSO BE DEEPER INFILLED ISOLATED FEATURE

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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_23	FINAL

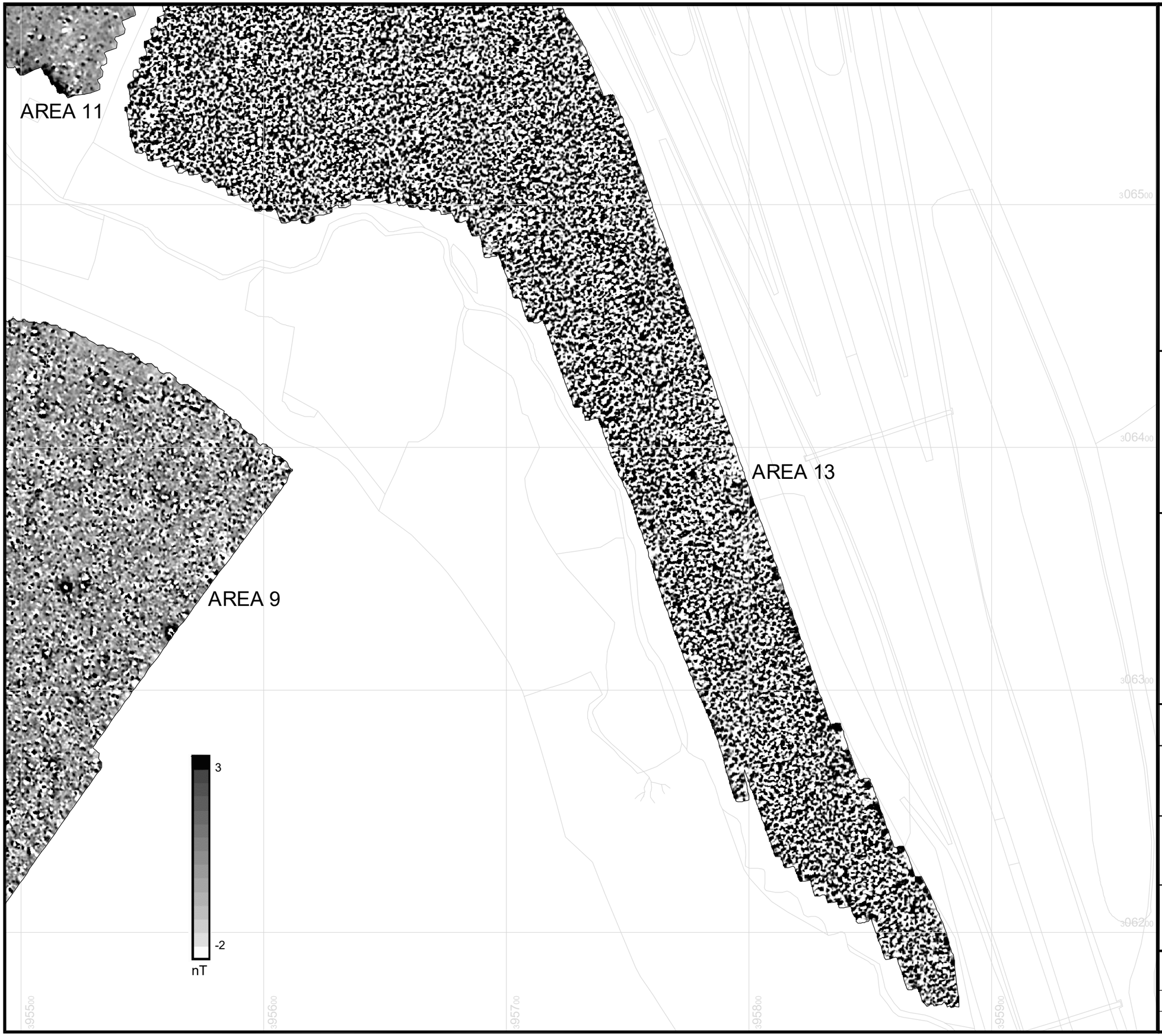
Client
AECOM
LEEDS

Site
M54 TO M6 / M6 TOLL LINK ROAD SCHEME
STAFFORDSHIRE

Title
INTERPRETATION OF MAGNETIC GRADIENT DATA: AREAS 11, 12 & PARTS OF AREAS 9, 10, 13, 14 & 15

Job No
ARC_2586_965

Surveyed	JW, AB, CA	Drawn	MW, JW
Chk.	NF	Date	10/04/2019



NOTES

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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_24	FINAL

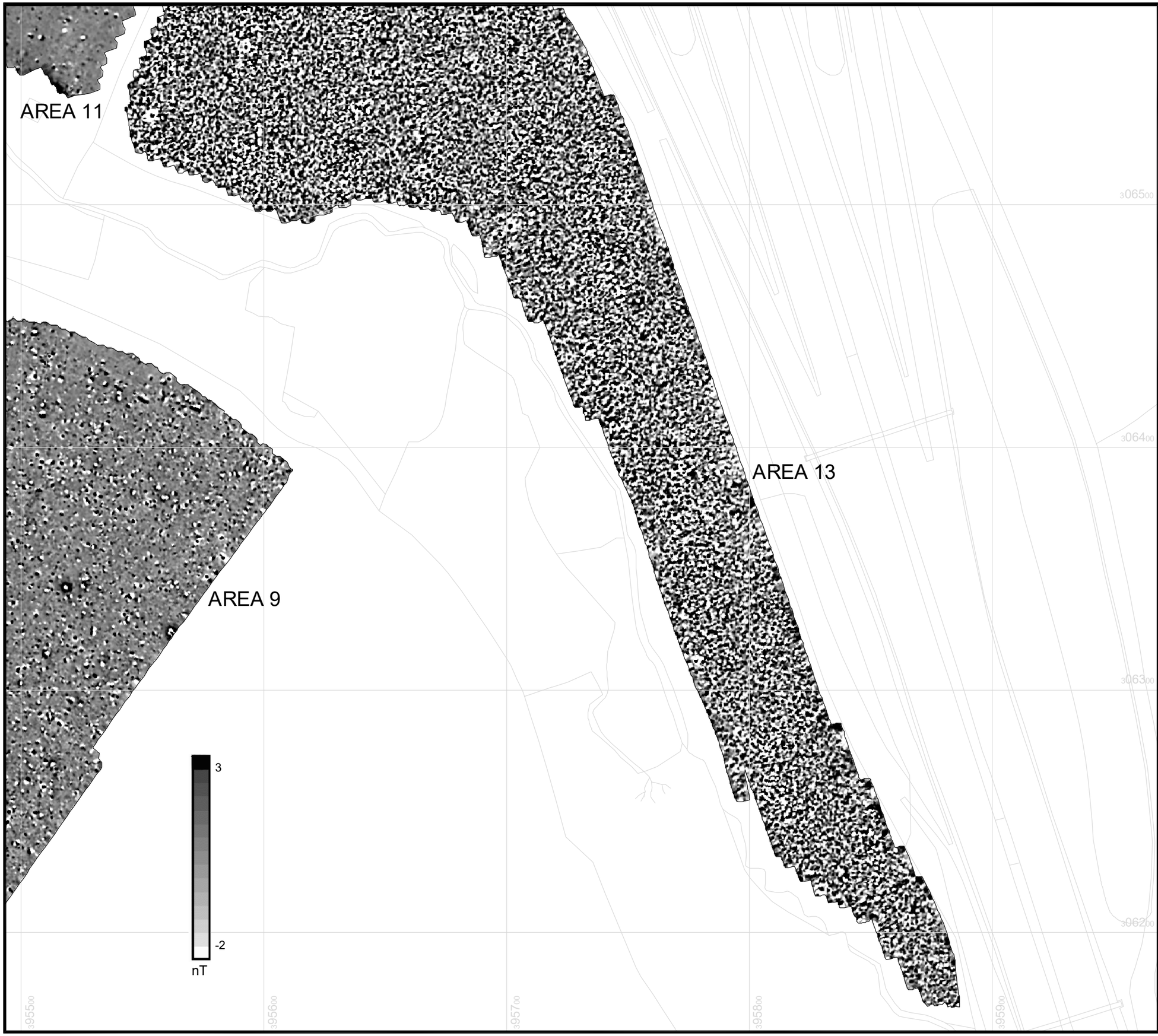
Client: AECOM LEEDS

Site: M54 TO M6 / M6 TOLL LINK ROAD SCHEME STAFFORDSHIRE

Title: GREYSCALE PLOTS OF MAGNETIC GRADIENT DATA: PARTS OF AREAS 9, 11 & 13

Job No: ARC_2586_965

Surveyed	JW, AB, CA	Drawn	JW
Chk.	NF	Date	10/04/2019



NOTES

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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_25	FINAL

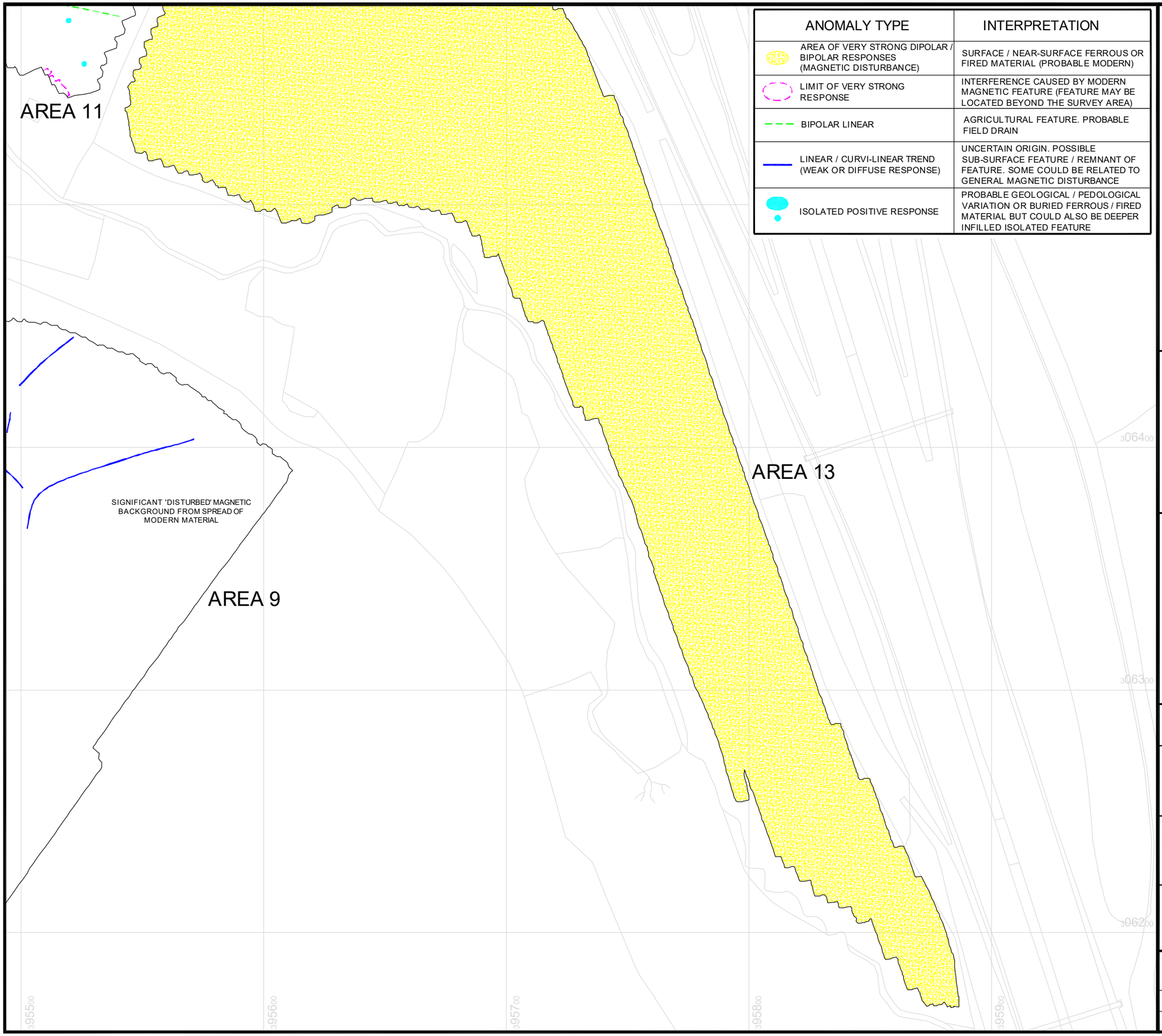
Client: AECOM LEEDS

Site: M54 TO M6 / M6 TOLL LINK ROAD SCHEME STAFFORDSHIRE

Title: GREYSCALE PLOTS OF MAGNETIC GRADIENT DATA (WIDER RANGE): PARTS OF AREAS 9, 11 & 13

Job No: ARC_2586_965

Surveyed	JW, AB, CA	Drawn	JW
Chk.	NF	Date	10/04/2019



ANOMALY TYPE	INTERPRETATION
AREA OF VERY STRONG DIPOLAR / BIPOLAR RESPONSES (MAGNETIC DISTURBANCE)	SURFACE / NEAR-SURFACE FERROUS OR FIRED MATERIAL (PROBABLE MODERN)
LIMIT OF VERY STRONG RESPONSE	INTERFERENCE CAUSED BY MODERN MAGNETIC FEATURE (FEATURE MAY BE LOCATED BEYOND THE SURVEY AREA)
BIPOLAR LINEAR	AGRICULTURAL FEATURE. PROBABLE FIELD DRAIN
LINEAR / CURVI-LINEAR TREND (WEAK OR DIFFUSE RESPONSE)	UNCERTAIN ORIGIN. POSSIBLE SUB-SURFACE FEATURE / REMNANT OF FEATURE. SOME COULD BE RELATED TO GENERAL MAGNETIC DISTURBANCE
ISOLATED POSITIVE RESPONSE	PROBABLE GEOLOGICAL / PEDOLOGICAL VARIATION OR BURIED FERROUS / FIRED MATERIAL BUT COULD ALSO BE DEEPER INFILLED ISOLATED FEATURE

NOTES

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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_26	FINAL

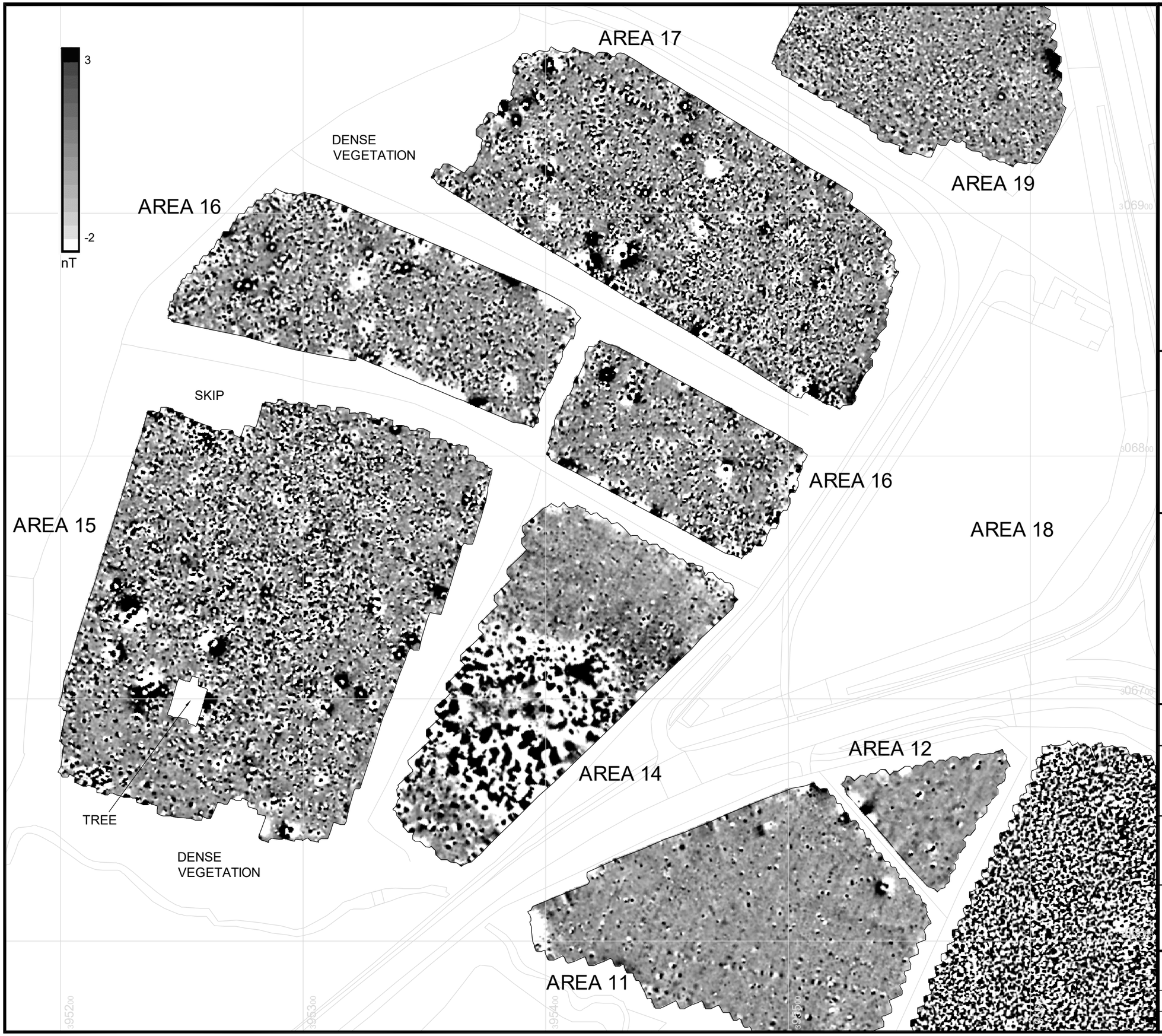
Client: AECOM LEEDS

Site: M54 TO M6 / M6 TOLL LINK ROAD SCHEME STAFFORDSHIRE

Title: INTERPRETATION OF MAGNETIC GRADIENT DATA: PARTS OF AREAS 9, 11 & 13

Job No: ARC_2586_965

Surveyed	JW, AB, CA	Drawn	MW, JW
Chk.	NF	Date	10/04/2019



NOTES

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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_27	FINAL

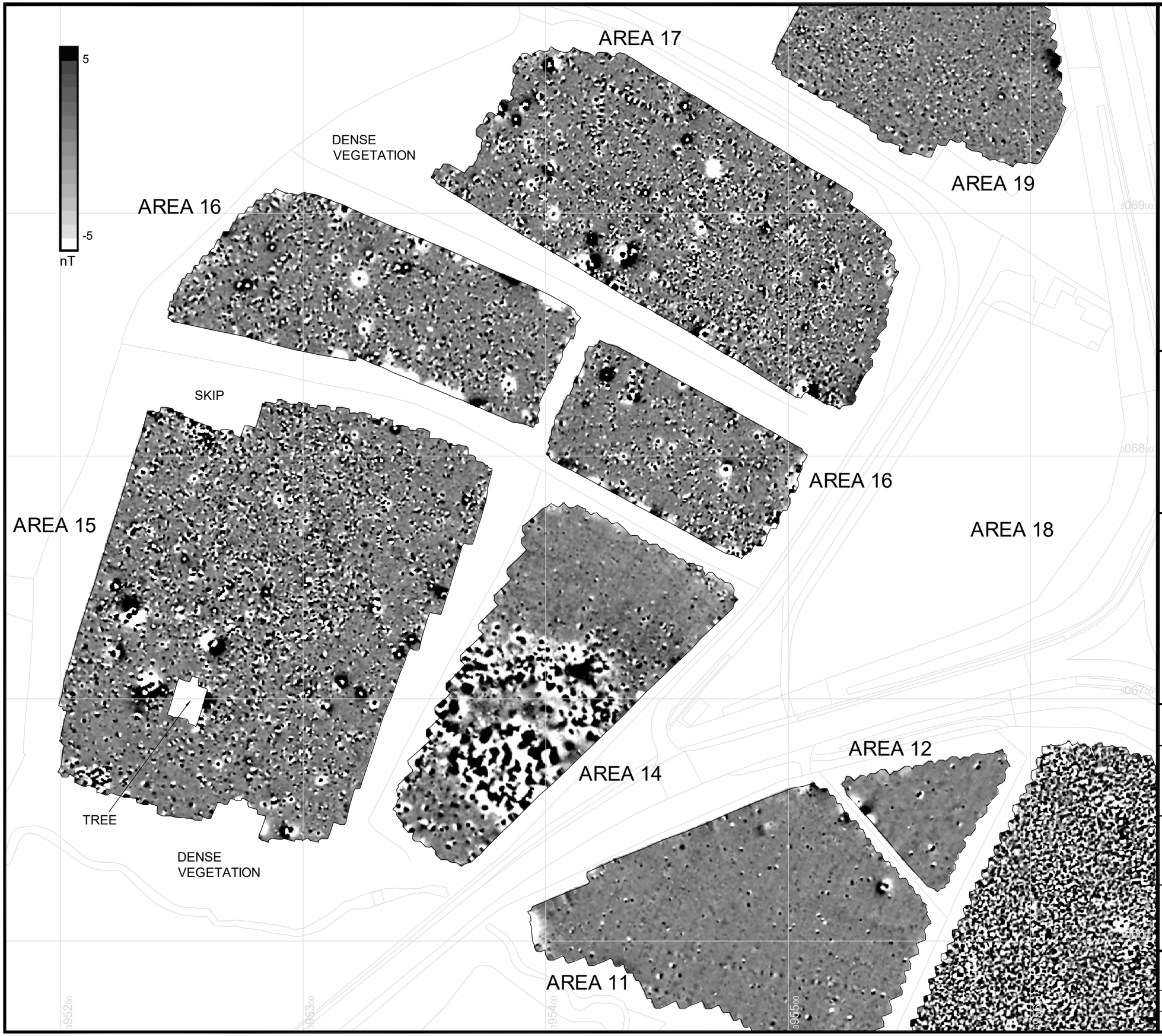
Client: AECOM LEEDS

Site: M54 TO M6 / M6 TOLL LINK ROAD SCHEME STAFFORDSHIRE

Title: GREYSCALE PLOTS OF MAGNETIC GRADIENT DATA: AREAS 12, 14, 15, 16 & 17 & PARTS OF AREAS 11, 13 & 19

Job No: ARC_2586_965

Surveyed	JW, AB, CA	Drawn	JW
Chk.	NF	Date	10/04/2019



NOTES

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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_28	FINAL

Client: AECOM LEEDS

Site: M54 TO M6 / M6 TOLL LINK ROAD SCHEME STAFFORDSHIRE

Title: GREYSCALE PLOTS OF MAGNETIC GRADIENT DATA (WIDER RANGE): AREAS 12, 14, 15, 16 & 17 & PARTS OF AREAS 11, 13 & 19

Job No: ARC_2586_965

Surveyed	JW, AB, CA	Drawn	JW
Chk.	NF	Date	10/04/2019

AREA 17

SIGNIFICANT 'DISTURBED' MAGNETIC BACKGROUND FROM SPREAD OF MODERN MATERIAL

DENSE VEGETATION

AREA 19

AREA 16

SIGNIFICANT 'DISTURBED' MAGNETIC BACKGROUND FROM SPREAD OF MODERN MATERIAL

SIGNIFICANT 'DISTURBED' MAGNETIC BACKGROUND FROM SPREAD OF MODERN MATERIAL

SKIP

SIGNIFICANT 'DISTURBED' MAGNETIC BACKGROUND FROM SPREAD OF MODERN MATERIAL

AREA 16

AREA 15

AREA 18

SIGNIFICANT 'DISTURBED' MAGNETIC BACKGROUND FROM SPREAD OF MODERN MATERIAL

AREA 14

AREA 12

TREE

DENSE VEGETATION

H

AREA 11

ANOMALY TYPE	INTERPRETATION
AREA OF VERY STRONG DIPOLAR / BIPOLAR RESPONSES (MAGNETIC DISTURBANCE)	SIGNIFICANT SURFACE / NEAR-SURFACE FERROUS OR FIRED MATERIAL (POSSIBLE MADE GROUND)
LIMIT OF VERY STRONG RESPONSE	INTERFERENCE CAUSED BY MODERN MAGNETIC FEATURE (FEATURE MAY BE LOCATED BEYOND THE SURVEY AREA)
APPROXIMATE ORIENTATION OF WEAK, BROADLY PARALLEL, DIFFUSE LINEARS	AGRICULTURAL FEATURES. MAY BE RELATED TO REMNANTS OF RIDGE AND FURROW BUT COULD BE RELATED TO DRAINAGE FEATURES
BIPOLAR LINEAR	AGRICULTURAL FEATURE. PROBABLE FIELD DRAIN
LINEAR / CURVI-LINEAR TREND (WEAK OR DIFFUSE RESPONSE)	UNCERTAIN ORIGIN. POSSIBLE SUB-SURFACE FEATURE / REMNANT OF FEATURE. SOME COULD BE RELATED TO GENERAL MAGNETIC DISTURBANCE
ISOLATED POSITIVE RESPONSE	PROBABLE GEOLOGICAL / PEDOLOGICAL VARIATION OR BURIED FERROUS / FIRED MATERIAL BUT COULD ALSO BE DEEPER INFILLED ISOLATED FEATURE

NOTES

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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_29	FINAL

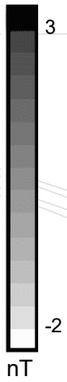
Client: AECOM LEEDS

Site: M54 TO M6 / M6 TOLL LINK ROAD SCHEME STAFFORDSHIRE

Title: INTERPRETATION OF MAGNETIC GRADIENT DATA: AREAS 14, 15, 16 & 17 & PARTS OF AREAS 11 & 19

Job No: ARC_2586_965

Surveyed	JW, AB, CA	Drawn	MW, JW
Chk.	NF	Date	10/04/2019



AREA 19

AREA 17

DENSE
VEGETATION

AREA 16

SKIP

AREA 15

AREA 14

AREA 16

AREA 18

3071 00

3070 00

3069 00

3068 00

3952 00

3954 00

3955 00

3956 00

NOTES

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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_30	FINAL

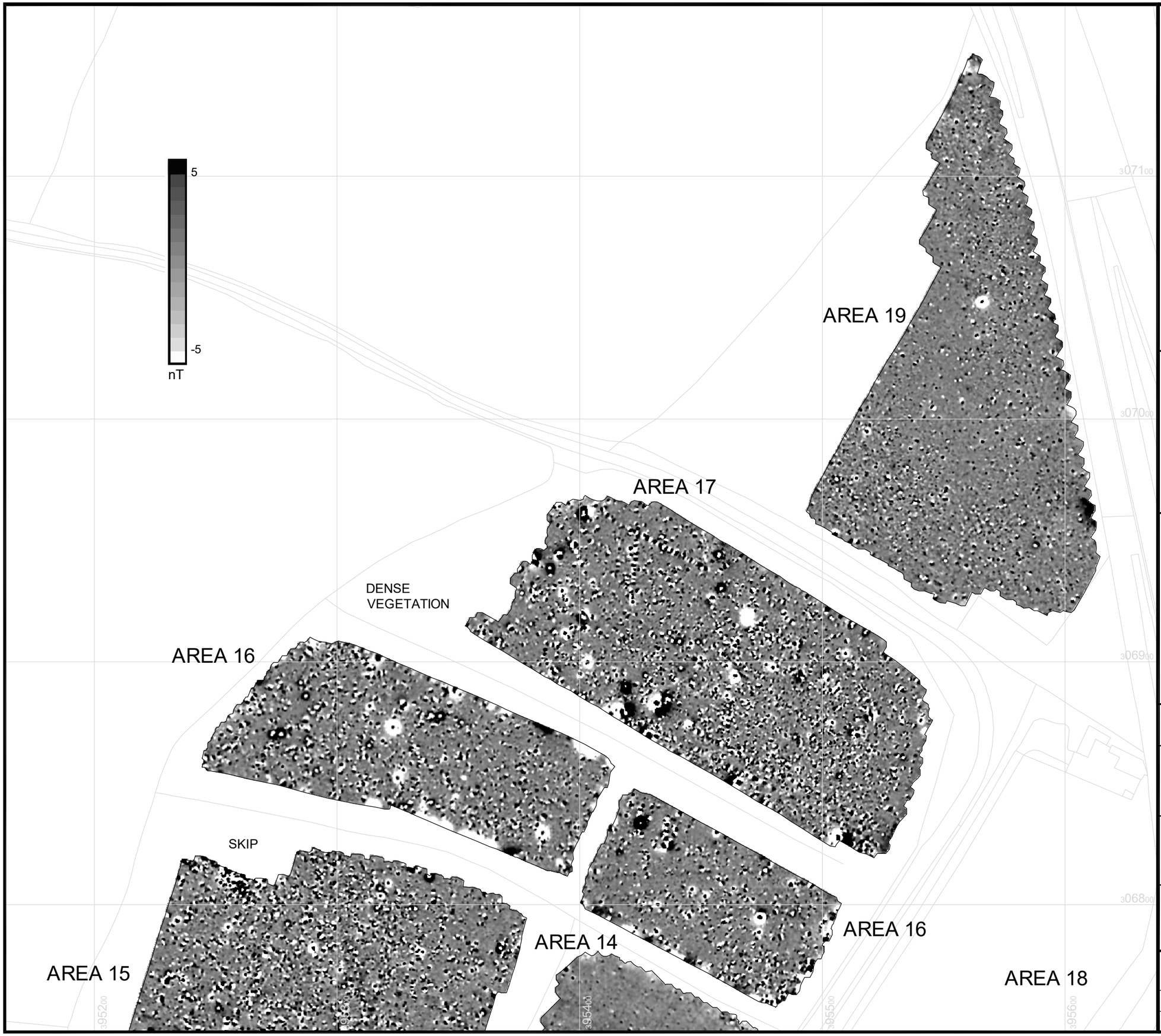
Client
AECOM
LEEDS

Site
M54 TO M6 / M6 TOLL LINK ROAD SCHEME
STAFFORDSHIRE

Title GREYSCALE PLOTS OF MAGNETIC GRADIENT DATA: AREAS 16, 17 & 19 & PARTS OF AREAS 14 &15

Job No
ARC_2586_965

Surveyed	JW, AB, CA	Drawn	JW
Chk.	NF	Date	10/04/2019



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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_31	FINAL

Client: AECOM LEEDS

Site: M54 TO M6 / M6 TOLL LINK ROAD SCHEME STAFFORDSHIRE

Title: GREYSCALE PLOTS OF MAGNETIC GRADIENT DATA (WIDER RANGE): AREAS 16, 17 & 19 & PARTS OF AREAS 14 & 15

Job No: ARC_2586_965

Surveyed	JW, AB, CA	Drawn	JW
Chk.	NF	Date	10/04/2019

ANOMALY TYPE	INTERPRETATION
AREA OF VERY STRONG DIPOLAR / BIPOLAR RESPONSES (MAGNETIC DISTURBANCE)	SIGNIFICANT SURFACE / NEAR-SURFACE FERROUS OR FIRED MATERIAL (POSSIBLE MADE GROUND)
LIMIT OF VERY STRONG RESPONSE	INTERFERENCE CAUSED BY MODERN MAGNETIC FEATURE (FEATURE MAY BE LOCATED BEYOND THE SURVEY AREA)
BIPOLAR LINEAR	AGRICULTURAL FEATURE. PROBABLE FIELD DRAIN
LINEAR / CURVI-LINEAR TREND (WEAK OR DIFFUSE RESPONSE)	UNCERTAIN ORIGIN. POSSIBLE SUB-SURFACE FEATURE / REMNANT OF FEATURE BUT COULD BE RELATED TO GENERAL MAGNETIC DISTURBANCE
ISOLATED POSITIVE RESPONSE	PROBABLE GEOLOGICAL / PEDOLOGICAL VARIATION OR BURIED FERROUS / FIRED MATERIAL BUT COULD ALSO BE DEEPER INFILLED ISOLATED FEATURE

AREA 19

AREA 17

AREA 16

AREA 15

AREA 14

AREA 18

SIGNIFICANT 'DISTURBED' MAGNETIC BACKGROUND FROM SPREAD OF MODERN MATERIAL

DENSE VEGETATION

SKIP

3071 00

3070 00

3069 00

3068 00

3952 00

3953 00

3954 00

3955 00

3956 00

NOTES

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Scale [A3 Sheet]	Drawing	Status
1:1500	ARC_2586_965_32	FINAL

Client: AECOM LEEDS

Site: M54 TO M6 / M6 TOLL LINK ROAD SCHEME STAFFORDSHIRE

Title: INTERPRETATION OF MAGNETIC GRADIENT DATA: AREAS 16, 17 & 19 & PARTS OF AREAS 14 & 15

Job No: ARC_2586_965

Surveyed	JW, AB, CA	Drawn	MW, JW
Chk.	NF	Date	10/04/2019

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APPENDIX 1

Magnetic survey: technical information

1.1 Theoretical background

1.1.1 Magnetic instruments measure the value of the Earth's magnetic field; the units of which are nanoTeslas (nT). The presence of surface and sub-surface features can cause variations or anomalies in this magnetic field. The strength of the anomaly is dependent on the magnetic properties of a feature and the material that surrounds it. The two magnetic properties that are of most interest are magnetic susceptibility and thermoremnant magnetism.

1.1.2 Magnetic susceptibility indicates the amount of ferrous (iron) minerals that are present. These can be redistributed or changed (enhanced) by human activity. If enhanced material subsequently fills in features such as pits or ditches then these can produce localised increases in magnetic responses (anomalies) which can be detected by a magnetic gradiometer even when the features are buried under additional soil cover.

1.1.3 In general, it is the contrast between the magnetic susceptibility of deposits filling cut features, such as ditches or pits, and the magnetic susceptibility of topsoils, subsoils and rocks into which these features have been cut which causes the most recognisable responses. This is primarily because there is a tendency for magnetic ferrous compounds to become concentrated in the topsoil, thereby making it more magnetic than the subsoil or the bedrock. Linear features cut into the subsoil or geology, such as ditches, that have been silted up or have been backfilled with topsoil will therefore usually produce a positive magnetic response relative to the background soil levels. Discrete feature, such as pits, can also be detected. Less magnetic material such as masonry or plastic service pipes which intrude into the topsoil may give a negative magnetic response relative to the background level. The strength of magnetic responses that a feature will produce will depend on the background magnetic susceptibility, how rapidly the feature has been infilled, the level and type of human activity in the area and the size and depth of a feature. Not all infilled features can be detected and natural variations can also produce localised positive and negative anomalies.

1.1.4 Thermoremnant magnetism indicates the amount of magnetism inherent in an object as a result of heating. Material that has been heated to a high temperature (fired), such as brick, can acquire strong magnetic properties and so although they may not appear to have a high iron content they can produce strong magnetic anomalies

1.1.5 The magnetic survey method is highly sensitive to interference from surface and near-surface magnetic 'contaminants'. Surface features such as metallic fencing, reinforced concrete, buildings or walls all have very strong magnetic signatures that can dominate readings collected adjacent to them. Identification of anomalies caused by sub-surface features is therefore more difficult, or even impossible, in the vicinity of surface magnetic features. The presence of made ground also has a detrimental effect on the magnetic data quality as this usually contains magnetic material in the form of metallic scrap and brick. Identification of features beneath made ground is still possible if the target feature is reasonably large and has a strong magnetic response but smaller features or magnetically weak features are unlikely to be identified.

1.1.6 The interpretation of magnetic anomalies is often subjective and it is rarely possible to identify the cause of all magnetic anomalies. Not all features will produce a measurable magnetic response and the effectiveness of a magnetic survey is also dependant on the site-specific conditions. The main factors that may limit whether a feature can be detected are the

composition of a feature, its depth and size and the surrounding material. It is not possible to guarantee that a magnetic survey will identify all sub-surface features.

1.1.7 Most high resolution, near surface magnetic surveys utilise a magnetic gradiometer. A gradiometer is a hand-held instrument that consists of two magnetic sensors, one positioned directly above the other, which allows measurement of the magnetic gradient component of the magnetic field. A gradiometer configuration eliminates the need for applying corrections due to natural variations in the overall field strength that occur during the course of a day but it only measures relative variations in the local magnetic field and so comparison of absolute values between sites is not possible.

1.1.8 Features that are commonly located using magnetic surveys include archaeological ditches and pits, buried structures or foundations, mineshafts, unexploded ordnance, metallic pipes and cables, buried piles and pile caps. The technique can also be used for geological mapping; particularly the location of igneous intrusions.

1.2 Instrumentation

1.2.1 A multi-sensor array cart system (MACS) utilising 8 Foerster 4.032 Ferex CON 650 gradiometers, spaced at 0.5 m intervals, with a control unit and data logger was used for the magnetic survey.

1.3 Survey methodology

1.3.1 The MACS utilises an RTK GNSS system which means that survey grids do not have to be established. Instead an area is surveyed over a series of continuous profiles and the position of each data point is recorded using an RTK GNSS system. The sensors have a separation of 0.5 m which means that data was collected on profiles spaced at 0.5 m apart. Readings were taken at between 0.1 m and 0.15 m intervals.

1.3.2 Data is collected on zig-zag profiles along the full length or width of a field, although fields can be sub-divided if they are particularly large. Marker canes are set-out along field boundaries at set intervals and these are used to align the profiles. The survey profiles are usually offset from field boundaries, buildings and other metallic features by several metres to reduce the detrimental effect that these surface magnetic features have on the data. The location of the MACS data is converted direct to Ordnance Survey co-ordinates using the UK OSTN 02 projection. As the data is related direct to Ordnance Survey National Grid co-ordinates temporary survey stations are not established.

1.3.3 The Foerster gradiometers have a resolution of 0.2 nT but the stability of the cart system significantly reduces noise caused by instrument tilt and movement when compared with a traditional hand-held gradiometer system and the increased data intervals provide a higher resolution data set. The sensors have a range of ± 10,000nT and readings are taken at 0.1 nT resolution.

1.4 Data processing and presentation

1.4.1 The MACS data is stored direct to a laptop using in-house software which automatically corrects for instrument drift and calculates a mean value for each profile. A positional value is assigned to each data point based on the sensor number and recorded GNSS co-ordinates. The data is gridded using in-house software and parameters are set based on the sensor spacing and mean values. No additional processing is required. The gridded data is then displayed in Surfer 9 (Golden Software) and image files of the data are created.

1.4.2 The data was exported as raster images (PNG files), and are presented in greyscale format at 1:1500.

1.4.3 The data has been displayed relative to a digital Ordnance Survey base plan provided by the client as drawing *' Mapping.dwg'*. The base plan was in the Ordnance Survey National Grid co-ordinate system and as the survey grids were set-out directly to National Grid co-ordinates the data could be simply superimposed onto the base plan in the correct position.

1.5 Interpretation

1.5.1 The anomalies have been categorised based on the type of response that they have and an interpretation as to the cause(s) or possible cause(s) of each anomaly type is also provided. The following anomaly types may be present within the data:

Dipolar, bipolar and strong responses

Dipolar and bipolar responses are those that have a sharp variation between strongly positive and negative components.

In the majority of cases these responses are usually caused by modern ferrous features / objects, although fired material (such as brick), some ferrous or industrial archaeological features and strongly magnetic gravel could also produce dipolar and bipolar responses.

Isolated dipolar responses are those that have a single positive and negative element. They are usually caused by isolated, ferrous or fired material on or near to the surface. The objects that cause dipolar responses are usually relatively small, such as spent shotgun cartridges, iron nails and horseshoes (hence they are often referred to as 'iron spikes') or pieces of modern brick or pot. Some types of archaeological artefacts can also produce this type of response but unless there is strong supporting evidence to the contrary they are assumed not to be of archaeological significance.

Bipolar anomalies have strong positive and negative components but are not technically magnetic dipoles. The majority of **isolated bipolar responses** are caused by ferrous or fired material on or near to the surface. These responses tend to be produced from larger objects, compared to dipolar anomalies, or a concentration of smaller objects. Some archaeological features/ activity, including areas of burning or industrial activity can also produce this type of response but unless there is strong supporting evidence to the contrary they are assumed not to be of archaeological significance.

Isolated dipolar and bipolar responses have not been shown on the interpretation as there is no evidence to suggest that they may be archaeological in origin.

Bipolar linear anomalies are usually produced by buried pipes / cables that are usually metallic, although in some instances ceramic pipes can also produce popular anomalies. In some instances the anomaly can extend for a sigfncaint distance beyond the feature that produces the anomaly. Bipolar anomalies are often very strong and can potentially mask responses from other sub-surface features in the vicinity of the pipe or cable.

Areas containing numerous **strong dipolar / bipolar responses** (**magnetic disturbance**) are usually caused by greater concentrations of ferrous or fired material and are often found adjacent to field boundaries where such material tends to accumulate. Above ground metallic or strongly magnetic features, such as fences, gates, pylons and buildings can also produce very strong bipolar responses. If an area of magnetic disturbance is located away from existing field boundaries then it could indicate a former field boundary, several large isolated objects in close proximity, an area where modern material has been

tipped or an infilled cut feature, such as a quarry pit. Areas of dipolar / bipolar response can occasionally be caused by features / material associated with archaeological industrial activity or natural deposits that have varying magnetic properties but they are usually caused by modern activity. Responses in areas of magnetic disturbance can sometimes be so strong that archaeological features located beneath them may not be detected.

Very strong responses, notably bipolar anomalies, from modern features can dominate the data for a significant distance beyond the feature. The extent of these areas is usually shown either as part of the bipolar anomaly or as a **limit of very strong response.** It should be noted that this effect extends beyond the feature and so the limit of the response does not correspond to the actual size or location of the feature within it. In many cases where these strong responses are present at the edge of survey area the feature causing the anomaly be actually be located beyond the survey area. It should be recognised that other sub-surface features located within these areas may not be detected.

Negative linear anomalies

Negative linear anomalies occur when a feature has lower magnetic readings than the surrounding material and can often be associated with ploughing regimes or plastic / concrete pipes or natural features.

They can also indicate the presence of a feature that cuts into magnetic soils or bedrock and which is infilled with less magnetic material and in certain geologies can be associated with archaeological features.

On this site it is believed that the any negative linear anomalies that may be present are related to agricultural activity.

Linear / curvi-linear anomalies (probable agricultural)

In many geological / pedological conditions agricultural features / regimes can produce magnetic anomalies due to the accumulation / alignment of magnetic topsoil. In most cases these are exhibited as a series of **broadly parallel positive linear** anomalies. The majority of these responses are associated with modern ploughing regimes but in some instances, where the responses are broader and more widely spaced, they can indicate the presence of the remnants of ridge and furrow.

Field drain systems can also produce linear anomalies, usually where the drains are made from fired ceramic or infilled with magnetic gravels.

Where a series of parallel anomalies are present then the approximate orientation of the anomalies are shown on the interpretation drawing to indicate the direction of the agricultural regime but for the sake of clarity individual anomalies have not been shown.

Individual anomalies may be shown if the response is not part of a regime.

Broad area of positive / negative responses

Broad areas of positive / negative responses can have a variety of causes. If the areas are generally quite large and irregular in shape then they are usually suggestive of natural features, such as lenses of sand and gravel deposits, palaeochannels or other natural features / variations where the natural material differs from the surrounding sub-surface. In some instances anomalies of this type can be associated with anthropogenic (usually modern) activity.

There are no anomalies of this type in this data set.

Linear / curvi-linear trends

An anomaly is categorised as a **trend** if it is not certain that the response is associated with an extant sub-surface feature. Trends are usually weak, irregular, diffuse or discontinuous and it is usually not certain what their cause is, if they represent significant sub-surface features or even if they are associated with definite features.

It is possible that some of the trends are associated with geological / pedological variations. Others may be produced by artificial constructs within the data, either caused by processing or in some instances by intersecting anomalies (usually different agricultural regimes) that give the appearance of curving or regular shapes. Many trends are a product of weak, naturally occurring responses that happen to form a regular pattern but which are not associated with a sub-surface feature.

In some instances former features that have been severely truncated can still produce broad, diffuse or weak responses even if the underlying feature has been removed. This is due to the presence of magnetic soils associated with the former feature still being present along its route. In other instances the magnetic properties of the soils filling a feature may vary and so the magnetic signature of the feature can change, even if the sub-surface feature itself remains uniform. If a response from a feature becomes significantly weak or diffuse then part of the anomaly may be shown as a trend as it is uncertain if the feature is still present or has been severely truncated or removed.

Isolated positive responses

Isolated positive responses can occur if the magnetism of a feature, area or material has been enhanced or if a feature is naturally more magnetic than the surrounding material. It is often difficult to determine which of these factors causes any given responses and so the origin of this type of anomaly can be difficult to determine. They can have a variety of causes including geological variations, infilled archaeological features, areas of burning (including hearths), industrial archaeological features, such as kilns, or deeper buried ferrous material and modern fired material.

The large number of isolated responses and lack of an obvious pattern to their distribution suggests that these anomalies are probably associated with geological / pedological variations or deeper buried ferrous or fired material. Only the larger or stronger areas of positive response have been shown on the interpretation. The majority, if not all of these responses, will be related to natural variations or relatively modern material but have been shown as their exact cause cannot be determined with certainty.

Positive linear / curvi-linear anomalies

Positive magnetic anomalies indicate an increase in magnetism and if the resulting anomaly is linear or curvi-linear then this can indicate the presence of a man-made feature. **Positive or enhanced linear / curvi-linear** anomalies can be associated with agricultural activity, drainage features but they can also be caused by ditches that are infilled with magnetically enhanced material and as such can indicate the presence of archaeological features. Some natural infilled features can also produce positive anomalies.

1.5.2 Several different ranges of data were used in the interpretation to ensure that the maximum information possible is obtained from the data.

1.5.3 X-Y trace plots were examined for all of the data and overlain onto the greyscale plot to assist in the interpretation, primarily to help identify dipolar / bipolar responses that will probably be associated with surface / near-surface iron objects. X-Y trace plots have not been used in

the report as they do not show any additional anomalies that are not visible in the greyscale data. A digital drawing showing the X-Y trace plot overlain on the greyscale plot has been provided in the digital archive.

1.5.4 All isolated responses have been assessed using a combination of greyscale and X-Y trace plots.

1.5.5 Anomalies associated with agricultural regimes are present in the data. The general orientation of these regimes has been shown on the interpretation but, for the sake of clarity, each individual anomaly has not been shown.

1.5.6 The greyscale plots and the accompanying interpretations of the anomalies identified in the magnetic data are presented as 2D AutoCAD drawings. The interpretation is made based on the type, size, strength and morphology of the anomalies, coupled with the available information on the site conditions. Each type of anomaly is displayed in separate, easily identifiable layers annotated as appropriate.

1.6 Limitations of magnetic surveys

1.6.1 The magnetic survey method requires the operator to walk over the site at a constant walking pace whilst holding the instrument. The presence of an uneven ground surface, dense, high or mature vegetation or surface obstructions may mean that some areas cannot be surveyed.

1.6.2 The depth at which features can be detected will vary depending on their composition, size, the surrounding material and the type of magnetometer used for the survey. In good conditions large, magnetic targets, such as buried drums or tanks can be located at depths of more than 4 m. Smaller targets, such as buried foundations or archaeological features can be located at depths of between 1 m and 2 m.

1.6.3 A magnetic survey is highly sensitive to interference from surface and near-surface magnetic 'contaminants'. Surface features such as metallic fencing, reinforced concrete, buildings or walls all have very strong magnetic signatures that can dominate readings collected adjacent to them. Identification of anomalies caused by sub-surface features is therefore more difficult or even not possible in the vicinity of surface and near-surface magnetic features.

1.6.4 The presence of made ground also has a detrimental effect on the magnetic data quality as this usually contains magnetic material in the form of metallic scrap and brick. Identification of features beneath made ground is still possible if the target feature is reasonably large and has a strong magnetic response but smaller features or magnetically weak features are unlikely to be identified.

1.6.5 It should be noted that anomalies that are interpreted as modern in origin may be caused by features that are present in the topsoil or upper layers of the subsoil. Removal of soil to an archaeological or natural layer can therefore remove the feature causing the anomaly.

1.6.6 A magnetic survey does not directly locate sub-surface features - it identifies variations or anomalies in the local magnetic field caused by features. It can be possible to interpret the cause of anomalies based on the size, shape and strength of response but it should be recognised that a magnetic survey produces a plan of magnetic variations and not a plan of all sub-surface features. Interpretation of the anomalies is often subjective and it is rarely possible to identify the cause of all magnetic anomalies. Geological or pedological (soil) variations or features can produce responses similar to those caused by man-made (anthropogenic) features.

1.6.7 Anomalies identified by a magnetic survey are located in plan. It is not usually possible to obtain reliable depth information on the features that cause the anomalies.

1.6.8 Not all features will produce a measurable magnetic response and the effectiveness of a magnetic survey is also dependant on the site-specific conditions. It is not possible to guarantee that a magnetic survey will identify all sub-surface features. A magnetic survey is often most-effective at identifying sub-surface features when used in conjunction with other complementary geophysical techniques.