Great North Road Solar and Biodiversity Park

Environmental Statement

Volume 4 – Technical Appendices

Technical Appendix A11.4: Phase 1 Geophysics Results - Part 4 of 4

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Revision number 2

January 2026

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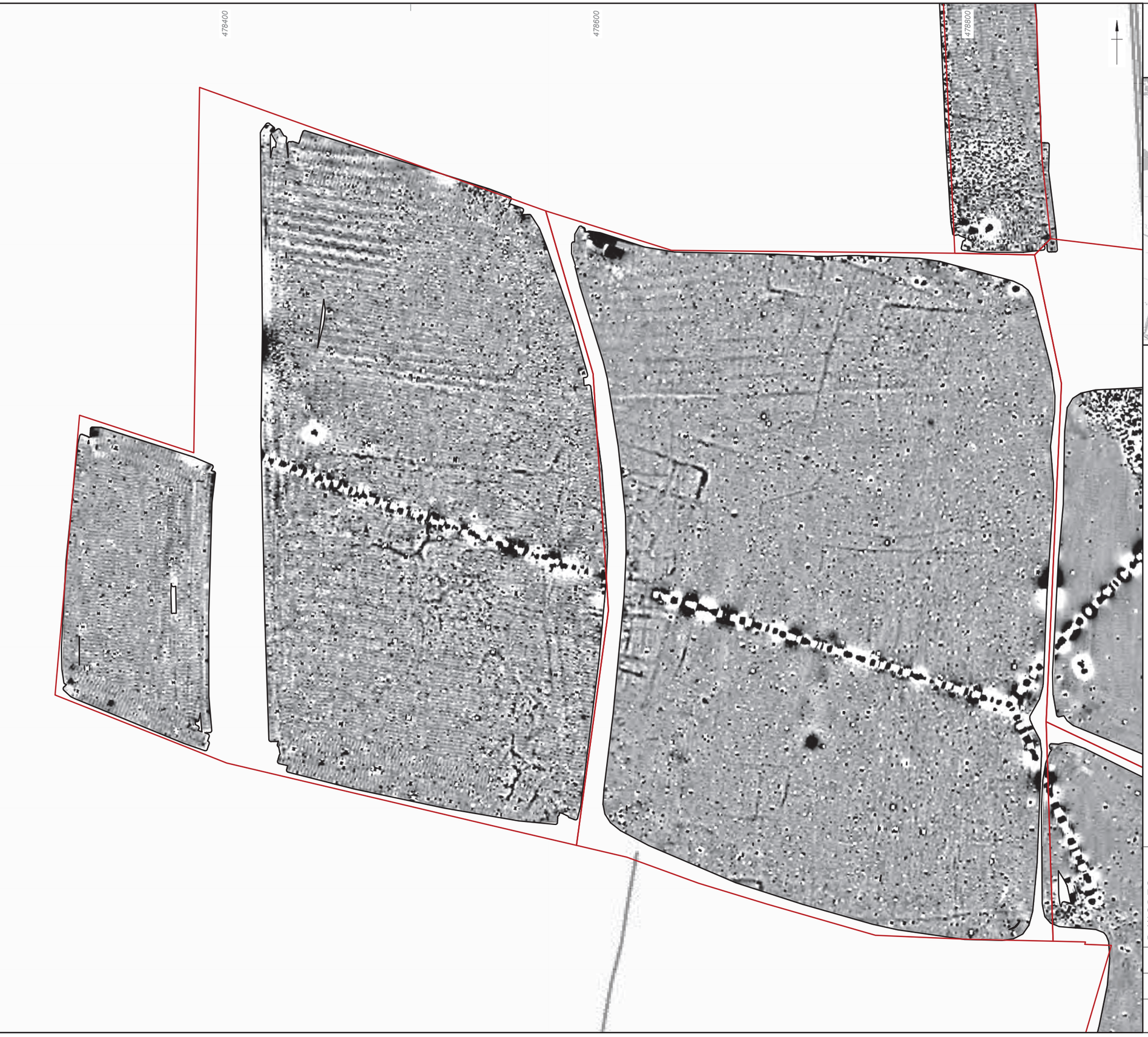
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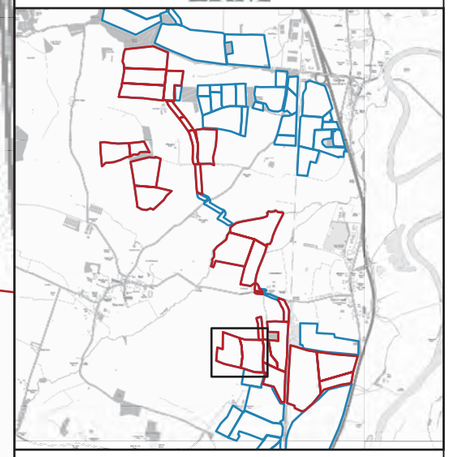
361200

361000

360800



ERM



Site boundary

Detailed survey extent

-2 nT 3 nT

0 50 m

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Figure 28: Detailed gradiometer survey results: greyscale plot (102 - 104)

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361200

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JKN-0053

JKN-0034

JKN-0036

JKN-0005

JKN-0004

JKN-0001

JKN-0035

JKN-0047

JKN-0002

JKN-0003

a

b

c

d

e

ERM

Site boundary
Detailed survey extent
Archaeology
Possible archaeology
Former field boundary
Historic landscape feature
Geology
Geomorphology
Historic cultivation
Modern service
Increased response
Ferrous
Agricultural feature
Drain
Trend

0 50 m

Coordinate system: OSGB 1936 British National Grid
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Figure 29: Detailed gradiometer survey results: interpretation (102 - 104)

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478800

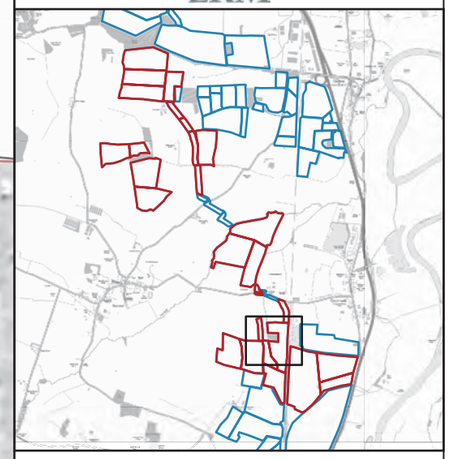
479000

479200

361400

361200

361000



Site boundary

Detailed survey extent

-2 nT

3 nT

0

50 m

Coordinate system: OSGB 1936 British National Grid
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Figure 30: Detailed gradiometer survey results: greyscale plot (103 - 106)

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478800

479000

479200

361400

361200

361000

JKN-0053

JKN-0005

JKN-0054

JKN-0004

JKN-0009

JKN-0047

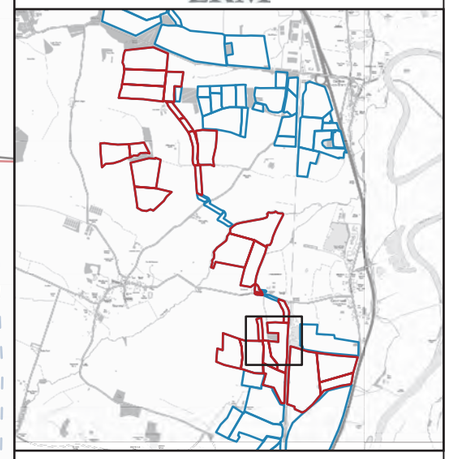
JKN-0025

a

b

a

ERM



Site boundary
Detailed survey extent
Archaeology
Possible archaeology
Former field boundary
Historic landscape feature
Geology
Geomorphology
Historic cultivation
Modern service
Increased response
Ferrous
Agricultural feature
Drain
Trend

0 50 m

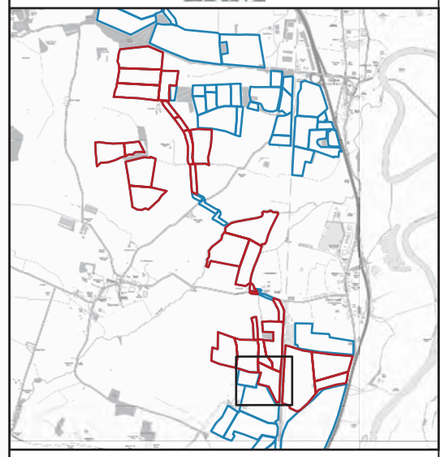
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Figure 31: Detailed gradiometer survey results: interpretation (103 - 106)

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478600
478800
479000
479200
360800
360600



Site boundary

Detailed survey extent

-2 nT 3 nT

0 50 m

Coordinate system: OSGB 1936 British National Grid
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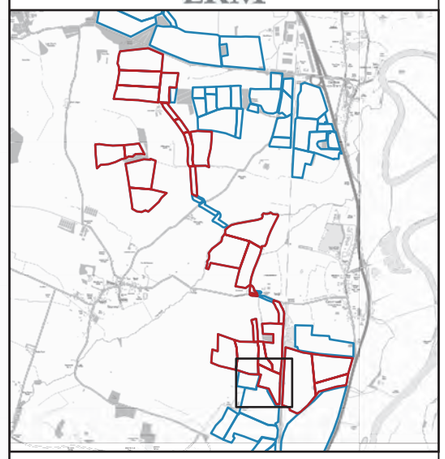
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Figure 32: Detailed gradiometer survey results: greyscale plot (105 - 107)

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478600
478800
479000
479200
360800
360600

JKN-0047
JKN-0025
JKN-0026
JKN-0010
JKN-0003
JKN-0030
a
b
c
c
LC



Site boundary
Detailed survey extent
Archaeology
Possible archaeology
Former field boundary
Historic landscape feature
Geology
Geomorphology
Historic cultivation
Modern service
Increased response
Ferrous
Agricultural feature
Drain
Trend

0 50 m

Coordinate system: OSGB 1936 British National Grid
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Figure 33: Detailed gradiometer survey results: interpretation (105 - 107)

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479400

479600

479800

361000

360800

360600



Site boundary

Detailed survey extent

-2 nT

3 nT

0

50 m

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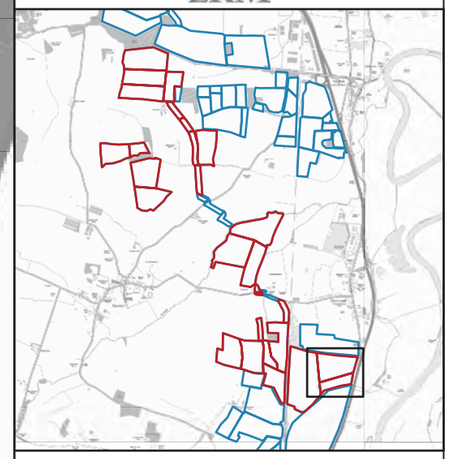
Figure 34: Detailed gradiometer survey results: greyscale plot (113 - 114)

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479400
479600
479800
361000
360800
360600

JKN-0055
JKN-0037
JKN-0007
JKN-0048
JKN-0008
JKN-0038
JKN-0006
DKN-0020

a
b
c
d
e
f
g
h



- Site boundary
- Detailed survey extent
- Archaeology
- Possible archaeology
- Former field boundary
- Historic landscape feature
- Geology
- Geomorphology
- Historic cultivation
- Modern service
- Increased response
- Ferrous
- Agricultural feature
- Drain
- Trend

0 50 m

Coordinate system: OSGB 1936 British National Grid
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Figure 35: Detailed gradiometer survey results: interpretation (113 - 114)

8 APPENDICES

8.1 Appendix 1: Gradiometer Survey Equipment and Data Processing (Sensys)

The magnetic data for this project were acquired using a non-magnetic cart fitted with eight SenSys FGM650/3 magnetic gradiometers. The instrument has four sensor assemblies fixed horizontally 1 m apart allowing four traverses to be recorded simultaneously. Each sensor contains two fluxgate magnetometers arranged vertically with a 0.6 m separation and measures the difference between the vertical components of the total magnetic field within each sensor array. This arrangement of magnetometers suppresses any diurnal or low frequency effects.

The gradiometers have an effective resolution of ±8 µT over ±1000 nT range. All of the data are then relayed to a CS35 tablet, running the MONMX program, which is used to record the survey data from the array of FMG650/3 probes at a rate of 20 Hz. The program also receives measurements from a GPS system, which is fixed to the cart at a measured distance from the sensors, providing real time locational data for each data point.

The cart-based system relies upon accurate GPS location data which is collected using a Leica Captivate system with a rover and base station. This receives corrections from a network of reference stations operated by the Ordnance Survey and Leica Geosystems, allowing positions to be determined with a precision of 0.02m in real-time and therefore exceed the level of accuracy recommended by European Archaeologiae Consilium recommendations (Schmidt et al. 2015) for geophysical surveys.

Data may be collected with a higher sample density where complex archaeological anomalies are encountered, to aid the detection and characterisation of small and ephemeral features. Data may be collected at up to 0.01 m intervals along traverses spaced up to 0.25m apart.

Post-processing

The magnetic data collected during the survey is downloaded from the system for processing and analysis using both commercial and in-house software. This software allows for both the data and the images to be processed to enhance the results for analysis; however, it should be noted that minimal data processing is conducted so as not to distort the anomalies.

Typical data and image processing steps may include:

GPS DeStripe – Determines the median of each transect and then subtracts that value from each data point in the transect within the defined window. May be used to remove the striping effect seen within a survey caused by directional effects, drift, etc.

Discard Overlaps - Intended to eliminate a track(s) that have been collected too close to one another. Without this, the results of the interpolation process can be distorted as it tries to accommodate very close points with potentially differing values.

GPS Base Interpolation – Sets the X & Y interval of the interpolated data and the track radius (the area around each datapoint that is included in the interpolated result).

Typical displays of the data used during processing and analysis:

Greyscale – Presents the data in plan view using a greyscale to indicate the relative strength of the signal at each measurement point. These plots can be produced in colour to highlight certain features but generally greyscale plots are used during the analysis of the data.

XY Plot – Presents the data as a trace or graph line for each traverse. Each traverse is displaced down the image to produce a stacked profile effect. This type of image is useful as it shows the full range of individual anomalies. XY plots can be made available upon request.

8.2 Appendix 2: Geophysical Interpretation

The following categories have been used for interpretation of the data throughout the report.

Archaeology

Used when the form, nature, and pattern of the anomaly are indicative of archaeological material. Further sources of information such as aerial photographs may also have been incorporated in providing the final interpretation.

Possible Archaeology

Used for anomalies that conform to the Archaeology category but have a lower level of confidence due to lack of form, pattern, or nature.

Historic Landscape Feature

Used for anomalies that correspond with features other than historic field boundaries on available mapping. This can include, but is not limited to, park and garden features, areas of woodland, ponds, and extraction pits.

Historic Cultivation

Used to denote historic cultivation regimes that differ from existing modern cultivation. They may differ due to size, orientation, or distribution in the landscape. If possible, LiDAR, aerial, and HER data should be consulted to corroborate results.

Former Field Boundary

Used anomalies that correspond to the position of boundaries marked on available mapping, visible on aerial photographs, or form clear extensions of existing boundaries.

Modern Agricultural feature

Used to identify any anomalies that are representative of modern ploughing or agricultural activity.

Geology

Used to denote natural variations is soils, superficial geology, or bedrock.

Geomorphology

Used to identify anomalies associated with more coherent geomorphological features. This may include, but is not limited to, paleochannels, solution hollows, and former high ground.

Increased Magnetic Response

Used for areas dominated by indistinct anomalies with increased magnetic values. While these may have some archaeological potential they may also relate to natural or modern features.

Modern Service

Used for anomalies indicative of services or service trenches. These are usually magnetically strong linear anomalies but can also be seen as weak anomalies in the case of plastic services where only disturbance associated with the trench is visible.

Drain

Used for anomalies thought to relate to drainage features either due to their nature or corresponding with features on available mapping.

Ferrous

Used for anomalies caused by ferrous material. These anomalies are likely to be of modern origin.

Unknown Feature

Used for anomalies that, due to their nature, pattern, or form, cannot be confidently interpreted. These may have some archaeological potential.

Trend

Used for low amplitude or indistinct linear anomalies that cannot be confidently interpreted. These may have some archaeological potential.

DETAILED GRADIOMETER SURVEY REPORT

LAND TO THE WEST OF A1, NORTH OF STAYTHORPE, NOTTINGHAMSHIRE (STANIFORTH LAND)

CULTURAL HERITAGE REPORT NUMBER: 268310

DATE: JULY 2023

Prepared By:

Environmental Resources Management

Exchequer court
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London
EC3A 8AA

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w www.erm.com

Registered in England & Wales No. 1014622

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1 EXECUTIVE SUMMARY

The document comprises a report on detailed gradiometer surveys on the site north of Staythorpe over multiple deployments between 16 November, 12 – 14 December 2022 and 13 – 17 February 2023. The project was commissioned by ERM with the aim of establishing the presence, or otherwise, and nature of detectable archaeological features to assess the archaeological potential of land parcels and their suitability for development.

The site at 'Staniforth Land' comprises several arable and pasture fields immediately south of the Hamlet Little Carlton Norwell. This comprises a mixture of agricultural land located between Kelham and South Muskham, covering an area of 79.5 ha.

The gradiometer survey has been successful in detecting anomalies of possible archaeological origin across the survey area. These anomalies are expected to be ditches of archaeological origin relating to multiple examples of multi-phase settlement activity.

A large and intense area of linear and curvilinear ditches have been identified in the south of the site. Most of these ditches are straight in form and broadly orientated north – south indicative of a Romano-British origin. The inclusion of curvilinear and penannular ring-ditches and round houses, however, illustrate a possible Iron-Age influence in the area. Whilst a definitive origin of these anomalies is not clear from the geophysical data alone. The combination of these findings are characteristic of multi-phase settlement activity.

These findings are like the recorded scheduled monument, located 2.5 km north-east of the survey area, listed as an Iron-Age settlement (NHLE 1003494), but later determined to be consistent with multi-phased occupation. Further settlement activity has been identified in the eastern portion of the survey area. However, the location of activity highlighted in the south-east corresponds with the known site of a Civil War Battery (MNT5640) containing circular and semi-circular works and ditches. This site is also 200 m north of a scheduled monument (NHLE 1017620) in the form of a Civil War Sconce near Muskham Bridge. Therefore, although these anomalies could be related to Iron-Age to Romano-British settlement activity, it is more likely that they are associated with the Civil War infrastructure from 1642 – 1646 AD.

Several weekly positive isolated linear anomalies have also been identified as possibly relating to archaeological ditches. Given their weak magnetic properties, however, and similar orientation to surrounding cultivation in the field it is equally possible these anomalies reflect enhanced agricultural trends. Although a possible archaeological origin cannot be ruled out entirely.

Evidence of historic cultivation has also been recorded in the form of a former field boundary and multiple areas of ridge and furrow. Modern drainage and ploughing are also present across the survey area. The remaining anomalies are expected to be modern in origin, relating to modern services and an area of increased magnetic disturbance associated with the demolition of an old brickyard.

2 INTRODUCTION

2.1 Project Background

ERM commissioned a geophysical survey on land to the north of A167 and the west of A1, Nottinghamshire. The survey area covers approximately 2100 ha and comprise a detailed gradiometer survey intended to assess the archaeological potential of land parcels and their suitability for development.

2.2 Scope of document

This report presents a brief description of the overall site details, archaeological background and methodology. This is followed by detailed survey results and the archaeological interpretation of the geophysical data for each land parcel.

3 SITE LOCATION, GEOLOGY AND TOPOGRAPHY

The following gives an overview of the site, with further details presented for the individual land parcels.

The site consists of multiple land parcels extending along two arms, north-east and north-west of Staythorpe, in the county of Nottinghamshire, west of the River Trent and extending from 4 km north-west of Newark-on-Trent. The north-east route of the survey is 16 km long, extending from Staythorpe and running towards the villages of North Muskam, Carlton-on-Trent, Ossington and Moorhouse. The north-west route is shorter, extending for 9 km from Staythorpe towards Kersall, before bifurcating and heading towards Eakring and Kneesall.

The bedrock geology across the site is principally Mercia Mudstone but the area around Eakring at the western end of the site is recorded as Siltstone of the Tarporley formation[1]. Superficial deposits comprising Holme Pierrepont sand and gravel, and undifferentiated Alluvium are recorded on the western edge of the River Trent floodplain. Alluvial deposits are also recorded adjacent to Moorhouse Beck, at the northern end of the eastern route, and between Caunton and Kersall in the west. In addition, Diamicton Till and Glaciofluvial Deposits are also recorded at the northern end of the north-west cable route around Buckshaw farm.

Soils derived from the above geological parent material have been shown to produce magnetic contrasts acceptable for the detection of archaeological remains through magnetometer survey. However, in areas where thick deposits of superficial material (e.g. Alluvium) are recorded, archaeological remains may be too deeply buried to be identified through this geophysical technique.

The general topography varies of across the site, but the slope is generally gradual in most areas. The lowest-lying region is the area associated with the floodplain of the River Trent at the eastern extent of the survey area, which ranges between 10 and 16 m above Ordnance Datum (aOD)[2]. The minor tributaries extending west from this also occupy moderately low-lying areas (30 – 45 m aOD), between Kersall and Caunton and alongside Moorhouse Beck. Adjacent to these, are several highpoints (>75 m aOD) at Eakring, Kneesall and Laxton.

[1] Geology of Britain viewer. http://mapapps.bgs.ac.uk/geologyofbritain/home.html (Accessed on 01/04/2022)

[2] United Kingdom Topographic Map. https://en-gb.topographic-map.com/maps/iu/United-Kingdom/ (Accessed 12/09/2022

4 ARCHAEOLOGICAL BACKGROUND

4.1 Introduction

No desk-based assessment of the survey area has yet been undertaken. However, HER data for the survey site and a 1.5 km study area around the survey site has been obtained. The following gives an overview of the site, with further details presented for the individual land parcels.

4.2 Previous Investigations

There are few records of previous intrusive investigations within the site. With the exception of ENT486, which encountered post-medieval remains, none of the other intrusive surveys found evidence of archaeology (ENT486, ENT1034, ENT3871, ENT3756 and ENT3888).

A detailed survey aerial photograph analysis exercise was undertaken along the route of the A1 and main settlements within the region (ENT738 and ENT1125). A wealth of potential archaeological features were identified that reside within the site boundary or lie adjacent to it [3]. These are discussed in section 4.3.

Many archaeological surveys have been completed within the study area with concentrations found within the historic settlements of North Muskham, South Muskham, Little Carlton, Averham, and Cromwell. Some of the investigations have uncovered archaeological remains, which are discussed in section 4.3 below.

4.3 Historical and archaeological background

4.3.1 Prehistoric

The Nottingham Historic Environment Record (NHER) holds limited evidence of Palaeolithic activity, mainly confined to Staythorpe to the south of the site, comprising the recovery of worked antler and bison bones (MNT5596 and MNT11139). The only other Palaeolithic dated material is a handaxe found 1.5 km north-west of the site (MNT4164).

With the exception of the possible site of a Neolithic henge, all of the NHER records for the Neolithic comprise of lithic (flint) finds, with a particular concentration on land directly west of the site just north of North Muskham. The quantity of material recovered would imply a permanent presence within the landscape rather than reflecting seasonal migration of peoples. This fits with the current historical narrative, which indicates that the River Trent Valley was a focus of activity during the period[4]. However, it is possible that fine-grained minerogenic deposits of Holocene alluvium that are likely located within the floodplain of the River Trent, may have deeply buried further evidence of this.

Alluvium is recorded in the eastern part of the site, on the floodplain of the River Trent. Previous studies within the Trent valley on alluvial deposits confirmed the presence of deeply buried organic material, offering the potential for the preservation of paleoenvironmental evidence[5]. Trenching around Staythorpe Power Station identified three paleochannels that, based on recovered organic evidence, provided four dates of between 6640 ± 60 BP. Together with pollen and insect data, this show that during the latter half of the Mesolithic period, the area was a mixture of alder, willow and aspen carr, with limited grassland and a background of oak, elm, and lime on the adjacent gravel terraces. The

[3] Historic England, Aerial Archaeology Mapping Explorer, https://historicengland.org.uk/research/results/aerial-archaeology-mapping-explorer/ (Accessed 12/09/2022)

[4] Cooper, N (ed) 2006. The Archaeology of the East Midlands. Available at: https://researchframeworks.org/emherf/

[5] The Archaeology of the East Midlands. Available at: https://researchframeworks.org/emherf/ (Accessed on 12/09/2022)

later Mesolithic deposits also yielded a human femur and animal bones from a range of species including roe deer and aurochs.

For the Bronze Age, there is a more defined permanent presence evidenced by the construction of several barrow cemeteries (MNT3597, MNT14748, MNT17094, MNT17127, and MNT8542; NHLE 1003492) and the identification of enclosures, hut circles/ring ditches and other features associated with land management during the aerial photography mapping exercises. These features are found on both sides of the river.

The site of Pit Alignments scheduled monument (NHLE 1003493) lies 100 m to the east of the site. The listing of the scheduled monument is based on the old county number (OCN) scheduling record and provides no further information on the pit alignment itself. The recent arial photography mapping exercise has, however, identified further pits around the scheduled monument (MNT17099). Although the pits have not been intrusively investigated, such features are typically of late prehistoric origin, although their use remains poorly understood[6].

The exploitation of the River Trent Valley becomes clearer with the transition into the Iron Age. Several settlements, including a scheduled monument (NHLE 1003494), have been found close to South and North Muskham (MNT17097, MNT14313, MNT17091, MNT11991, and MNT14315), while an isolated small riverside settlement was found near Cromwell (MNT25849). The Cromwell barrow cemetery also remained in use during the Iron Age (MNT15145). In addition to the above, the aerial mapping exercises have also recorded a plethora of field enclosures, boundaries, pit alignments, hut circles/ring ditches, and linear features that may be of late prehistoric origin. Overall, there is a wealth of evidence that shows that this part of the River Trent Valley was heavily settled and exploited during the Iron Age.

4.3.2 Romano-British

Based on the current evidence, the Romano-British period is marked by a general abandonment of the earlier settlement pattern and establishment of new settlements within the landscape. The land around South Muskham, North Muskham, and Little Carlton continued to be the focus for habitation with seven settlements discovered (MNT17089, MNT17090, MNT8243, MNT8265, MNT17098, MNT8290, and MNT14318). However, similar levels of activity appear around Cromwell with a possible Romano-British villa located 430 m to the east of the site and an extra-mural settlement, designated a scheduled monument (NHLE list entry 1003490), discovered 60 m west of the site.

Four of the settlements discussed above fall within the site (MNT8243, MNT8265, and MNT17089), including the Scheduled settlement discussed above (NHLE 1003490). However, the aerial mapping exercises also identified a large number of regular enclosures which could be of Romano-British origin within the site's boundaries.

4.3.3 Anglo-Saxon

The Domesday Book of 1086 can be used to identify settlements that existed prior to the Norman Conquest. South Muskham, North Muskham, Little Carlton, Cromwell, Kneesall (referred to as 'Cauton'), Kelham, and Averham, all of which sit with the 1.5 km study area, are documented as being in existence in 1066 and would have had their origins in at least the Late Anglo-Saxon period.

Most of the NHER records relate to finds recovered during fieldwalking exercises completed on the fields that surround known Anglo-Saxon centres, such as North Muskham and South Muskham (MNT11098, MNT11050, MNT11732, MNT11047, MNT8286, MNT2881, MNT11042, and MNT3098) and Kneesall (MNT12174, MNT8556, MNT17128, and

[6] Cooper, N (ed) 2006. The Archaeology of the East Midlands. Available at: https://researchframeworks.org/emherf/

MNT12172). The recovery of the material helps define the main areas of activity during the period showing that landscape use may have been confined to the immediate hinterland of known settlements.

4.3.4 Medieval

The medieval period is characterised by an intensification in settlement activity and landscape use within the River Trent valley. The NHER has mapped many former medieval villages/hamlets located in the study area, most represented as shrunken or deserted villages, alongside known sites of medieval manors and deer parks (some of the manor sites are designated as Scheduled Monuments). One of these, the medieval deserted village of Little Carlton, which is a scheduled monument, falls partially within the site (MNT14312; NHLE 1019870).

Similar to the proceeding periods, most of the archaeological evidence for medieval activity takes the form of finds recovered during fieldwalking exercises. While the material could reflect further areas of settlement, it was common practice to add pottery to fields as part of the arable farming regime. This data at least shows a wider utilisation of the study area for agricultural uses, and it is possible that some of the features identified during the aerial mapping exercises are of medieval origin.

4.3.5 Post-medieval and Modern

The post-medieval period was a time of continuity and development for the River Trent valley. Until the passing of Enclosures Acts, much of the landscape was not too dissimilar to what had been created during the medieval period. The medieval interspersed settlement pattern remained with the local peoples still relying on agriculture for employment. However, the period was also marked by the rise of the landed gentry and development of large estates. Within the study area are four parks of varying size associated with an existing or former large country house, and include Ossington Hall (MNT26679), Kelham Hall (MNT26671), Averham Park (MNT26653), Winkburn Park (MNT26694), and Beesthorpe Hall (MNT26658).

The site of a English civil war Scone is located 200 m south of Field 276, listed as a scheduled monument in 1946 (NHLE 1017620). The monument lies 90m west of Muskham Bridge and includes the remains of earthworks defining a polygonal enclosure covering an area of approximately 50m by 45m with ramparts between 6m and 3m in width.

Post-medieval mapping shows that the site was located within post-enclosure field systems by the end of the 19th century. Few changes have occurred to the field system since. In the study area, the main changes illustrated comprise the construction of the Great Northern Railway line, development of industrial sites and expansion of the villages/settlements.

The majority of the NHER records of post-medieval and modern date relate to former or existing structures found throughout the study area. They comprise of farmsteads, residential buildings, structures associated with the railway, estate structures, and former industrial sites.

4.3.6 Undated

As discussed above, aerial mapping exercises have identified a large number of cropmarks/features within the study area, many of which fall within the site's boundaries. The NHER entries for each designated set of cropmarks provided little detail about them, other than their general shape and form (i.e., regular enclosures, hut circles, linear etc). Apart from the hut circles/ring ditches, which are associated with prehistoric settlement

practices, the rest of the cropmarks/features could be of any date prior to the establishment of the post-enclosure field systems.

5 METHODOLOGY

5.1 Introduction

The geophysical survey was undertaken over multiple deployments between 16 November, 12 – 14 December 2022 and 13 – 17 February 2023. Of the total 79.5 ha site, an overall coverage of 75.2 ha was achieved. The remaining area in Field 278 was under crop, at the time which the works were being undertaken.

The methods and standards employed throughout the geophysical survey conform to that set out in the Written Scheme of Investigation[7] (WSI), as well as to current best practice, and guidance outlined by the Chartered Institute for Archaeologists'[8] and European Archaeologiae Consilium[9].

5.2 Aims and objectives

The aims of the survey comprise the following:

- To determine, as far as is reasonably possible, the nature of the detectable archaeological resource within a specified area using appropriate methods and practices; and
- To inform either the scope and nature of any further archaeological work that may be required; or the formation of a mitigation strategy (to offset the impact of the development on the archaeological resource); or a management strategy.

In order to achieve the above aims, the objectives of the geophysical survey are:

- To conduct a geophysical survey covering as much of the specified area as possible, allowing for on-site obstructions;
- To clarify the presence/absence of anomalies of archaeological potential; and
- Where possible, to determine the general nature of any anomalies of archaeological potential.

5.3 Fieldwork Methodology

The cart-based gradiometer system used a Leica Captivate RTK GNSS instrument, which receives corrections from a network of reference stations operated by the Ordnance Survey (OS) and Leica Geosystems. Such instruments allow positions to be determined with a precision of 0.02 m in real-time and therefore exceeds European Archaeologiae Consilium recommendations (Schmidt et al. 2015).

The detailed gradiometer survey was undertaken using four SenSys FGM650/3 gradiometers spaced at 1 m intervals and mounted on a non-magnetic cart. Data were collected with an effective sensitivity of 0.03 nT at a rate of 10 Hz, producing intervals of 0.15 m along transects spaced 4 m apart.

5.4 Data processing

Data from the survey were subjected to minimal correction processes. These comprise a 'Destripe' function (±5 nT thresholds), applied to correct for any variation between the

[7] ERM, 2022 Written Scheme of Investigation: Geophysical Survey Land to the West of A1, North of Staythorpe, Nottinghamshire. Report ref. 22036

[8] Chartered Institute for Archaeologists [CIfA] 2014a Standards and guidance for archaeological geophysical survey. Reading, CIfA

[9] Schmidt, A, Linford, P, Linford, N, David, A, Gaffney, C, Sarris, A and Fassbinder, J. 2015 Guidelines for the use of geophysics in archaeology: questions to ask and points to consider. EAC Guidelines 2, Belgium: European Archaeological Council.

sensors, and an interpolation used to grid the data and discard overlaps where transects have been collected too close together.

Further details of the geophysical and survey equipment, methods and processing are described in Appendix 1.

6 DATA PRESENTATION

The processed data are exported as georeferenced TIFF files. The interpretation layers are digitised as ESRI shapefiles. The images and interpretation shapefiles are then used to produce the final figures in a GIS.

The gradiometer data are displayed at -2nT (white) to +3nT (black) for the greyscale image.

7 STANIFORTH LAND FIELD 261-263, 275-279, 298 AND C2

7.1 Site details

A detailed gradiometer survey was carried out over Fields 261 – 263, 275 – 279, 298, and C2 located south of Little Carlton (centred on NGR 477214, 356884) (Figure 4 – 21).

This survey comprises several arable fields. The survey area is bounded by the A606 and arable fields to the north and the Great North Road to the east. To the south the survey area is bounded by agricultural buildings, fields, and both Ollerton Road and Kelham Lane; and to the west by agricultural buildings and the junction of the A616 and Ollerton Road.

The survey area is on a steep incline, at 14 m aOD in the east of Field 276 and increasing to 32 m aOD in the west of Field 263.

The underlying geology across the survey area is recorded as Mudstone of the Mercia Mudstone Group, with a thin band of dolomitic Siltstone Mercia Mudstone Group crossing the west of Field 263. There are no recorded superficial deposits in Fields 263 and the west of 262, however alluvium (clay, silt, sand, and gravel) is recorded across the remainder of the survey area[10].

The soils underlying this survey area are likely to comprise a mixture of stagnogleyic argillic brown earths of Whimple 3 (572f) association in the west, peloalluvial gley soils of the Compton (813e) association in the south and east, and gleyic brown earths of the Arrow association in the centre of the area[11]. Soils in such geological settings have been demonstrated to produce magnetic contrasts suitable for the detection of anomalies through gradiometer survey.

7.2 Archaeological background

7.2.1 Listed Buildings

The only listed buildings in the immediate vicinity of the survey area are the Grade II Listed 18th century Manor Farm Cottages (NHLE 1301913) that are located 260 m to the north of Field 261.

7.2.2 Prehistoric

Within Field 261, 13 worked flints of Mesolithic – Neolithic date were discovered during fieldwalking. Neolithic – early Bronze Age flints (MNT10987) were also discovered during fieldwalking 360 m to the south of Field 261.

7.2.3 Iron Age – Roman

Within Field 261 is a settlement (MNT14313) comprising enclosures, pits, hut circle, pit alignment, and a double ring ditch identified via aerial photography. Sherds of Roman pottery were also discovered (MNT14313). Various other records pertaining to Iron Age – Roman settlement and agricultural activity are located immediately to the east and south-east of Field 261 (MNT14314, 17091 & 14315) likely linked to the other settlement activity within Field 261. Findspots of Roman pottery have been located in several fields in the wider area.

The location of an Iron Age scheduled monument is located 850 m north-east of Field C2 (NHLE 1003494), at the very southern extent of North Muskham Village. Little information has been recorded about this monument.

[10] Geology of Britain viewer. http://mapapps.bgs.ac.uk/geologyofbritain/home.html (Accessed on 01/04/2022)
[11] Soil Survey of England and Wales, 1983

Several instances of cropmark data has been recorded across the immediate area associated with Iron Age – Romano British settlement activity. Closest examples of this are located immediately north-west of Field 275 (MNT17098) and east of Field 276 (MNT8290) and south of Field 278 (MNT14315).

7.2.4 Medieval

Two medieval scheduled monuments are located 240 m to the north of Field 261, in the areas of Little Carlton medieval village and part of the meadow field system (NHLE 1019870), containing an earthwork and buried remains. The village was first mentioned in the Domesday survey of 1086 and the remains contain a rectangular enclosures or crofts, a hollow way, ponds, and water management banks and ditches.

Medieval pottery (MNT11028) was discovered within Field 261 during fieldwalking, and further findspots are located in fields surrounding the survey area.

7.2.5 Post-medieval

The site of an old brickyard (MNT14403) is located in Field 263 and 470 m to the south-west of Field 262 is the site of the disused Kelham brickworks and clay pit (MNT14449). A well (MNT14450) is marked on OS 1919 mapping 165 m to the north-east of Field 263.

The site of a 1640 – 1652 Civil War Sconce is located 150 m south of Field 276, west of Muskham Bridge (NHLE 1017620). The earthworks consisted of banks and ditches and varied in complexity including the remains of earthworks defining a polygonal enclosure covering an area of 50m by 45m with ramparts between 6m and 3m in width. They can be recognised today as surviving earthworks or as crop or soil marks on aerial photographs. Contemporary documentary sources indicate that the monument was a defensive work or sconce initially constructed by the Royalist forces defending Newark but which was subsequently stormed and briefly held by the Parliamentarians during the second siege of Newark in March 1645.

7.2.6 Undated

Fire cracked stones (MNT11102) were discovered within Field 261 during fieldwalking. In and of themselves they are undatable. Immediately to the south of Field 261, now under agricultural buildings, are several undated sub-rectangular enclosures (MNT8250) identified via aerial photography. Further undated features have been identified via aerial photography such as linear ditched features and a ring ditch (MNT8246) 270 m to the north of Field 262; linear features and a trackway (MNT8275) 290 m to the north-east of Field 261; linear features (MNT2957) 440 m to the north-east of Field 261; and a boundary, ditch, and enclosure (MNT9644) 165 m to the south of Field 262.

A series of undated complex cropmarks are present in Field 275 (MNT8273). They have been recorded via aerial photography of the area.

7.3 Detailed gradiometer survey results

The detailed gradiometer survey was carried out over multiple deployments between 16 November, 12 – 14 December 2022 and 13 – 17 February 2023 and covered 75.2 ha of the 79.5 ha survey area. The survey has identified archaeological anomalies characteristic of settlement activity.

Results are presented as a series of greyscale plots and archaeological interpretations, at a scale of 1:2000 (Figures 4 –21). The interpretation of the datasets highlights the presence of potential archaeological anomalies, ferrous, burnt or fired objects, and magnetic trends (Figure 3).

7.3.1 Interpretation: Archaeology and Possible Archaeology

A complex series of linear and curvilinear anomalies have been identified across three areas in Field 261 at STF-0001 – STF-0003 (Figure 9). The anomalies recorded in these three areas all have positive magnetic properties of various strengths, broadly orientated north-east to south-west.

The anomalies located centrally in Field 261 at STF-0001 are contained within an area 75 m wide 120 m long. The series of anomalies is made up of three sections, separated by two linear anomalies 3 m wide by 70 m long, orientated north-east to south-west to the north and south. Anomalies a and b are located in the central section, whilst sections c and d form the southern and northern portions respectively.

Section a consists of multiple concentric penannular anomalies between 1 – 2 m wide with an 8 – 20 m diameter. Whilst section b refers to a singular curvilinear anomaly comprising a penannular anomaly to the north and linear to the south. The penannular is 2 m wide with a 10 m diameter and break to the north. The linear continuation extends 9 m south before being diverted south – east for 15 m. The concentric circles at a appear to form three ditches with an entrance in their eastern side. However, the exact purpose of the anomaly is unclear. The anomalies at b are expected to be ditches, possibly pertaining to roundhouses or ring-ditches.

Anomaly c to the south is 1 m wide and appears to be a continuation of the southern dividing linear further south. From its north-westernmost point the anomaly extends south-west 20 m, it is then diverted south-east for 17 m before finally continuing 5 m east where it separates into two to the north-west and south-east respectively forming a 'C' shape. This anomaly is likely to be a ditch, which could once have been attached to the dividing north-west to south-east linears, possibly pertaining to a series of interconnected enclosures.

In the north of STF-0001 at d, an assortment of linear anomalies have been highlighted. The anomalies are between 2 – 3 m wide, orientated broadly north – south or east – west, with one anomaly orientated north-east to south-west. The anomalies at d are likely the remains of archaeological ditches of unknown origin.

Immediately west of STF-0001 are the anomalies at STF-0002 (Figure 9). Similarly, to the anomalies directly east, the series of anomalies at STF-0002 can be subdivided into three sections at a – c from north to south, covering an area 60 m wide by 110 m long. The anomalies at a in the northern third are all between 2 – 3 m wide on a broadly coaxial orientation either north-east to south-west or north-west to south-east. These linear anomalies appear to combine to form a large square-shaped anomaly 50 m wide by 40 m long containing additional internal linear anomalies. It is expected that these are ditches, likely interconnected to form a large square enclosure with internal sub-divisions.

In the central section of STF-0002, at b, rectilinear and penannular anomalies have been identified with the strongest positive magnetic properties compared to the rest of the anomalies in Field 261. The western rectilinear anomaly forms part of a 13 m square, whilst the three penannular anomalies to the east have a diameter of 6 m. It is likely that the rectilinear anomaly to the west is a small square enclosure with interconnected penannular anomalies that are the correct form and size to represent the remains of drip gullies associated with round houses, possibly originating from the Iron Age. However, the apparent interconnected alignment of the penannular anomalies is unusual and could suggest another, unknown, purpose.

The southern third of STF-0002, at c, comprises positive linear and rectilinear anomalies between 1 – 2 m wide orientated either north – south or east – west. These anomalies are expected to be ditches, possibly forming the remains of two adjacent, fragmented square enclosures 20 m wide by 20 m long, containing internal features or pits.

The third area of anomalies present in Field 261 are located 60 m east of STF-0001 at STF-0003 (Figure 9). The collection consists of large rectilinear, small penannular and small globular positive anomalies over an area 50 m wide by 130 m long, orientated north-east to south-west. Similarly to STF-0001 and STF-0002 the anomalies at STF-0003 are 1 – 3 m wide and can generally be confined to three sections at a – c. With a pair of parallel linear anomalies underlining the series to the south – east at d.

The central area of STF-0003, at a, is contained within four linear anomalies, combining to form one rectangular shaped anomaly 50 m wide by 20 m long. This likely forms an enclosure. In the south-eastern corner of this enclosure is a sub-rectangular anomaly, 1 m wide with an 8 m diameter and break to the north – east. Small discrete anomalies have also been identified internally. It is expected that area a is made up of ditches that combine to form a rectangular enclosure, containing pits and possible drip gullies associated with round houses.

Immediately south of a is the adjoining area at b. The eastern and western linear anomalies appear to continue south from a for 40 m into b, combining with a north-west to south-east linear anomaly to form a rectangular anomaly 40 m wide by 50 m long. Within this space, a number of discrete positive anomalies have been identified, partially masked by an area of magnetic disturbance. The anomalies a b are expected to be ditches that combine to form the remains of an enclosure with internal pit features. The area of internal disturbance is likely associated with naturally occurring geological variation.

The northern area within the collection, at c, consists of sub-rounded linear and rectilinear anomalies between 1 – 2 m wide orientated either north – south or east – west. The anomalies appear to be contained within an area 60 m wide by 40 m long. A collection of the western anomalies are interconnected to form adjacent rectangular anomalies sharing a similar orientation with the overall series. The two rectangular anomalies are 20 m wide by 15 m long and 14 m wide by 16 m long respectively. These two smaller anomalies to the west combined with the linear anomaly to the north and adjacent enclosure to the south, could also combine to form a larger, overarching anomaly 60 m wide by 40 m long. The anomalies at c are expected to be ditches that combine to form a large, broadly square square-shaped enclosure, with two internal enclosures making up its western extent.

In the south of STF-0003, two positive parallel linear anomalies have been identified at d. These anomalies are between 1 – 2 m wide and 80 m long orientated north-west to south-east. The anomalies at d are likely ditches that combine to form a possible trackway.

The series of anomalies highlighted at STF-0001 – STF-0003 are a combination of square and rectangular enclosures with small ring ditches or round houses of archaeological origin. Evidence of straight-edged enclosures orientated broadly north – south is indicative of Romano-British origin. Particularly when they are adjoining, forming a segmented areas reminiscent of a possible ladder settlement. Whilst, the identified ring ditches and roundhouses, however, are more characteristic of the Iron Age. As a result, these findings from Field 261 likely illustrate the remains of multi-phase settlement activity, possibly relating to a wider field system.

These findings are similar to the recorded scheduled monument, located 2.5 km north-east of the survey area, listed as an Iron Age settlement (NHLE 1003494), but later determined to be consistent with multi-phased occupation. The findings within Field 261 have been previously recorded as a complex settlement (MNT14313) via cropmarks visible in aerial photography.

The wealth of archaeological impact in this survey continues east from Field 261 into Field 277 as a densely packed area of rectilinear and curvilinear anomalies identified at STF-0004 – STF-0007 (Figure 11). The anomalies are between 2 – 3 m wide orientated north-east to south-west, like the findings in Field 261. The four groupings of anomalies are located in the western portion of Field 277 over an area 360 m wide by 360 m long.

The anomalies in STF-0004 make up the central portion of the area, with STF-0005 and STF-0006 forming the north-western and north-eastern portions respectively. The southern area comprises anomalies at STF-0007. The anomalies present in this area appear to have been heavily impacted by dominant ridge and furrow.

The central area at STF-0004 is made up of positive rectilinear and penannular anomalies. The exterior rectilinear anomalies are orientated either north-east to south-west or north-west to south-east and appear to combine to form a rectangular area 100 m wide by 80 m long. With one internal linear 2 m wide by 18 m long orientated north – west to south – east. The three penannular anomalies at a – c are located internally within the rectangular anomaly with internal globular anomalies and diameters between 8 – 10 m. It is expected that the larger anomaly forms a ditched enclosure with the internal penannular anomalies being small ring-ditches associated with round houses and pits.

A linear extends from the north-western corner of STF-0004 to STF-0005. This group of anomalies is made up of three parts at a – c over an area 60 m wide by 60 m long. Parts a and b are rectilinear anomalies connected by the north-western linear extending from STF-0004, whilst c is isolated immediately to the west. The anomalies at a – c are all between 1 – 3 m wide and aligned on a coaxial north-east to south-west or north-west to south-east orientation. It is likely that these rectilinear anomalies at STF-0005 are ditches that possibly once combined to form a series of small enclosures, now partially fragmented as a result of subsequent years of agricultural practice.

An additional linear extends from the north-eastern corner of STF-0004 to STF-0006 in the north-eastern corner of the overall series, mirroring STF-0005. Unlike the anomalies to the west, however, the grouping at STF-0006 contains curvilinear and penannular anomalies at a and b in addition to linear anomalies at c and d. The curvilinear anomalies at a combine to form a rounded rectangular shape 30 m wide by 40 m long orientated north-east to south-west. The penannular anomaly at b is located immediately north of a with a 15 m diameter and break to the east and west. Linear anomaly c is 2 m wide by 60 m long orientated north-east to south-west to the south of a. The final area of interest is the long linear anomaly at d to the east. Anomaly d is 2 m wide by 290 m long orientated NNE to SSW.

It is expected that the anomalies identified at STF-0006 are ditches of archaeological origin. Given the size and form of anomalies a and b, anomaly a is likely a sub-rounded enclosure, with b forming an associated ring-ditch or round house likely Iron Age in origin. The linear anomalies at c and d are likely defensive boundary ditches, with d possibly representing the outer extent of the whole area. Anomaly d combines the northern areas of STF-004 – STF-006 to the larger southern complex at STF-0007.

The anomalies at STF-0007 comprise the southern portion of the series in Field 227 over an area 330 m wide by 150 m long. They can be separated into three different areas at a – c. Area a forms the complex, dense series of positive rectilinear anomalies to the west. The anomalies are between 2 – 3 m wide and aligned on a coaxial north-east to south-west or north-west to south-east orientation. The anomalies at b to the east are much more sparsely populated than at a but share the same dimensions and orientations. There is also a sub-rounded curvilinear anomaly present, with a 16 m diameter towards the south-east. The central area listed as c is made up of two parallel linear anomalies orientated north-west to south-east, connecting area a to area b. The anomalies recorded at STF-0007 are expected to be ditches relating to a series of interconnected enclosures with internal sub-divisions relating to a larger field system. The curvilinear anomaly at b is likely a circular enclosure.

The collection of anomalies identified in the western portion of Field 277 are the remains of extensive settlement activity. Given the broadly north – south nature of the square and rectangular enclosures, these findings likely have a Romano-British influence. Whilst the round houses and ring ditches would be more associated with the Iron Age. A definitive

origin of these anomalies is not clear from the geophysical data alone. What can be identified is that these findings are characteristic of multi-phased settlement activity similar to the scheduled monument (NHLE 1003494), 2.5 km to the north-east. Some of the anomalies identified in this area have previously been recorded as cropmarks via ariel photography (MNT8330 and MNT2967).

An assortment of positive linear and curvilinear and penannular anomalies have been recorded in the south-eastern potion of Field 276 at STF-0008 – STF-0010 (Figure 15). The anomalies at STF-0008 consist of several curvilinear anomalies between 2 – 4 m wide, contained within an area 55 m wide by 80 m long between two linear anomalies, orientated east – west and NNE – SSW respectively. Most anomalies have a diameter between 10 – 15 m with a break to the east. The anomalies at STF-0009 immediately south of STF-0008 comprise two parallel linear anomalies with a rectilinear over an area 60 m wide by 20 m long. The final group of anomalies at STF-0010 directly west of STF-0008 are made up of linear and penannular anomalies. The linear anomalies are between 2 – 3 m wide orientated either north – south or east – west. Whilst the two penannular anomalies are 3 m and 1 m wide with a 13 m and 5 m dimeter respectively. The northern anomaly has a break to the north, whilst the southern has a break to the south.

The anomalies identified at STF-0008 are likely ring-ditches or round houses of possible Iron-Age to Romano-British in origin. Whilst the anomalies recorded at STF-0009 and STF-0010 are expected to be two areas of interconnected enclosures with internal ring-ditches, possibly Romano-British in origin due to their orientation. These results are likely to be connected given their proximity, forming the remains of possible settlement activity in the area. The location of STF-0008 and STF-0009, however, match with the known site of a Civil War Battery (MNT5640) containing circular and semi-circular works and ditches. This site is 200 m north of a scheduled monument (NHLE 1017620) in the form of a Civil War Sconce near Muskham Bridge. Therefore, although these anomalies could be related to Iron Age to Romano-British settlement activity, it is more likely that they are associated with the Civil War infrastructure from 1642 – 1646 AD.

A complex series of linear and curvilinear anomalies have been recorded in the western half of Field 275 at STF-0011 (Figure 17). The anomalies have positive magnetic properties, covering an area 185 m wide by 120 m long. The individual linear anomalies are between 2 – 4 m wide and are broadly orientated either north – south or east – west. The linear anomalies appear to be interconnected, yet a small number of penannular anomalies have been identified within the series, with diameters between 8 – 12 m. The anomalies identified at STF-0011 are expected to relate to a complex assortment of ditches, likely associated with Iron Age to Romano-British occupation given their form and orientation. The area is made up of interconnected enclosures and ring-ditches associated with round houses, characteristic of settlement activity.

A group of positive linear and curvilinear anomalies have been identified in the north-western corner of Field 262 at STF-0012 (Figure 7). The group can be separated into three parts at a – c. The central anomalies at part a are made up of two mirrored curvilinear ‘C’ shaped anomalies and one central linear anomaly between 2 – 4 m wide orientated north – south. The gently curving southern anomaly at b underlines the group 3 m wide and 40 m long, orientated north-west to south-east. Immediately north-east of a are two parallel linear anomalies at c. These are 2 – 3 m wide by 15 m long, orientated north-west by south-east. The disturbance caused by modern drainage in the field has made the interpretation of these anomalies difficult. As a result, these anomalies are expected to be archaeological ditches, however, their origin cannot be determined from the geophysical data alone. further investigation would be required for more specific identification.

Several weakly positive linear anomalies have been identified across Field 298 at STF-0013 – STF-0016 (Figure 5). These anomalies are between 2 – 4 m wide orientated either NNE – SSW or WNW – ESE. Anomalies STF-0013 at a and b are located centrally

forming a 'T-shape' with a forming the 95 m long horizontal base orientated WNW – ESE and b forming the vertical 45 m linear orientated NNE – SSE. Parallel anomalies STF-0014 and STF-0015 to the north and south of STF-0013, traverse WNW – ESE across the width of Field 298, 270 m and 240 m long respectively. The final recorded anomaly at STF-0016 is in the south-eastern corner of Field 298. From its southern-most point, it extends 40 m NNE before being diverted 25 m WNW. It is possible that this collection of anomalies is representative of ditches and partial remains of two enclosures to the west and east. Given the weak magnetic properties of the anomalies, however, it is also possible that they reflect enhanced agricultural trends, such as ploughing or land drains.

Two positive linear anomalies have been identified in Fields 275 and 277 at STF-0017 and STF-0018 (Figure 13 and 17). Anomaly STF-0017 is 2 m wide by 150 m long and orientated NNE – SSW. Whilst STF-0018 is 4 m wide by 30 m long. Whilst it is possible that these anomalies represent the remains of ditches, both are orientated parallel to recorded cultivation in their respective field and are expected to be associated as a result.

An assortment of weakly positive anomalies has been identified in proximity to the settlement activity in Field 277 at STF-0019 to the north and STF-0020 to the west (Figure 11). The anomalies at STF-0019 consist of connected linears that form a 'T-shape' 105 m wide by 40 m long. An additional linear extends north 20 m from the north-eastern corner of the 'T'. Anomaly STF-0020 is 25 m west – east on its southern extent, it then turns north for an additional 25 m on its eastern extent and finally returns north-west for 20 m along its northern extent. It forms a sub-square shape, oriented north-east to south-west with a break to the west.

Given their proximity to the settlement activity in Field 277, it is possible that anomalies STF-0019 and STF-0020 are ditches related to the settlement. Anomaly STF-0019 could relate to defensive boundary ditches to the north. Whilst STF-0020 could highlight the partial remains of a small enclosure to the west. Given their weak magnetic properties, however, and similar orientation to surrounding cultivation in the field it is equally possible these anomalies reflect enhanced agricultural trends. Although a possible archaeological origin cannot be ruled out entirely.

7.3.2 Interpretation: Historical Agriculture

A weakly positive linear anomaly has been identified in the southern portion of Field 278 that correlates with a known former field boundary at STF-0021 (Figure 9). The boundary is 2 m wide by 150 m long and was first recorded on 1888 OS mapping and last recorded on the 1961 mapping. As of satellite mapping of the area dating from 2002, the boundary is no longer visible (Google Earth 2023).

Several areas of weak, positive, parallel, linear anomalies have been identified at STF-0022 – STF-0027 (Figures 9 – 17). The average distance between lines is 6 m, orientated either east – west (STF-0022 and STf-0023) or north – south (STF-0024 – STF-0027). These anomalies have been interpreted as areas of ridge and furrow.

7.3.3 Interpretation: Modern Agriculture

Limited evidence of modern agriculture has been recorded within this survey. Some enhanced linear trends have been identified along the field boundaries, likely associated with modern ploughing generating headland areas.

7.3.4 Interpretation: Natural

Limited evidence of geological or geomorphological variation has been identified within the survey.

7.3.5 Interpretation: Modern

Three strong linear dipolar anomalies have been identified at in Fields 263, 298 and C2 at STF-0028 – STF-0030 respectively (Figures 5, 7, and 17). All three are orientated NNE – SSW between 130 – 200 m long. The strong dipolar magnetic characteristics of this anomaly are indicative of modern services.

Several thin linear anomalies have been identified across the survey area. These anomalies are exclusively highlighted due to their either negative or dipolar magnetic properties, or their equal spacing indicative of modern drainage. Strong examples of this are present in Fields 262 and 278.

The survey has also detected multiple isolated clusters of low magnitude and dipolar anomalies that have been interpreted as ferrous in origin. These likely relate to natural variation in the soils and background geology and are of little archaeological impact. Further examples of ferrous responses have been identified around the periphery of certain fields. This is likely due to metal fencing within the boundaries and interference from the adjacent roads and tracks.

An area of increased magnetic response has been identified in the north-eastern corner of Field 263 at STF-0031 (Figure 7). The location of this disturbance broadly corresponds with the known site of an old brickyard (MNT14403) demolished in 1965.

7.3.6 Interpretation: Unknown

A series of linear trends have been recorded across the parcel. They have been recorded as such due to their uncertain origin. Whilst the majority are expected to be modern in origin and associated with agricultural activity, a possible archaeological origin cannot be ruled out entirely. Especially those recorded in the south of the parcel in proximity to the recorded settlement activity.

7.4 Preliminary Conclusions

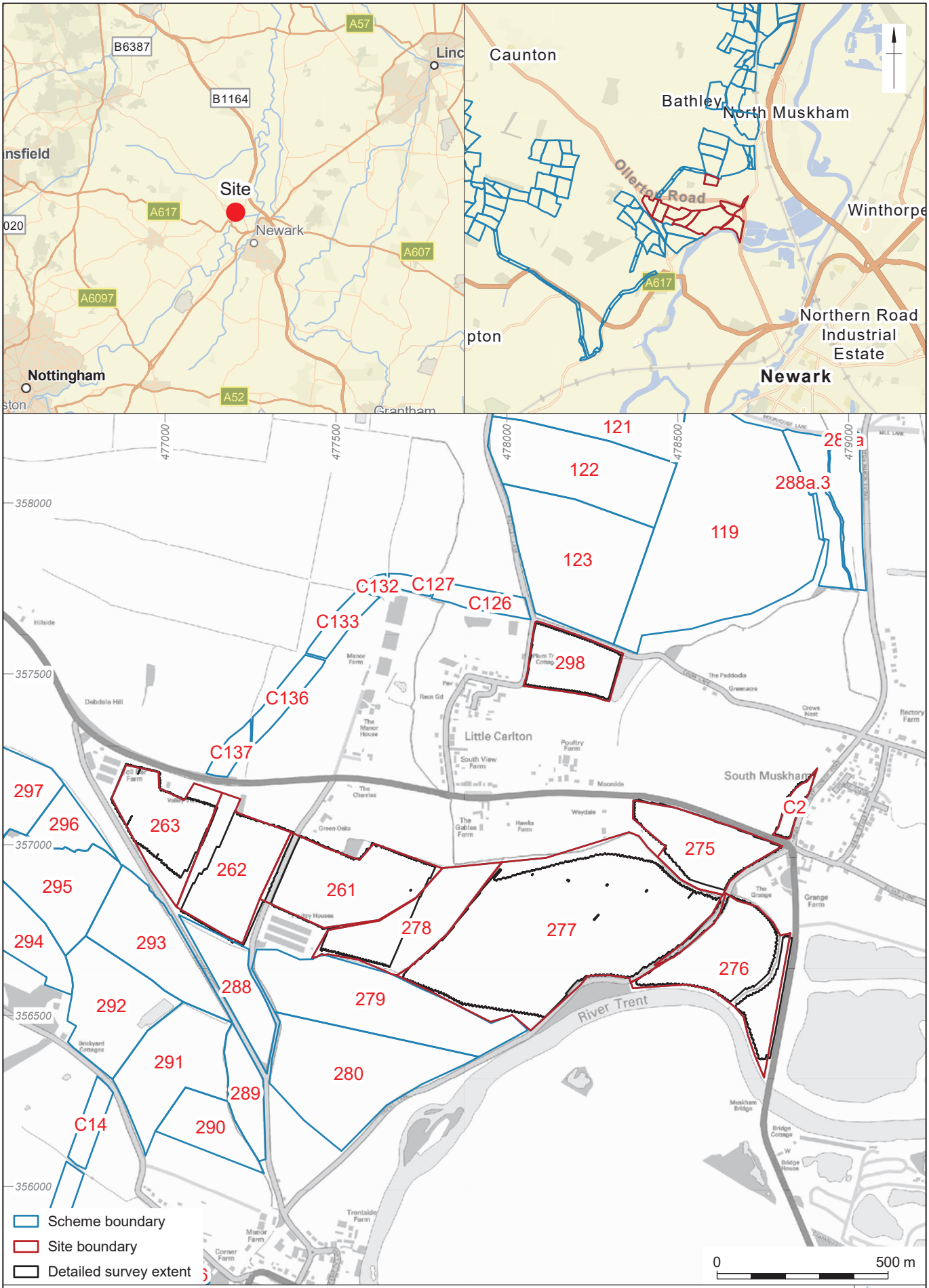
The gradiometer survey has been successful in detecting anomalies of possible archaeological origin across the survey area. These anomalies are expected to be ditches of archaeological origin relating to multiple examples of multi-phase settlement activity.

A large and intense area of linear and curvilinear ditches have been identified in the south of the parcel. Most of these ditches are straight in form and broadly orientated north – south indicative of a Romano-British origin. The inclusion of curvilinear and penannular ring-ditches and round houses, however, illustrate a possible Iron Age influence in the area. Of particular note are three concentric penannular ditches at the centre of the area, all with openings to the east. While the exact purpose of this is not clear, it may relate to funerary activity. Similarly, three interconnected penannular anomalies have been identified in the area although their purpose is unclear. Whilst a definitive origin of these anomalies is not clear from the geophysical data alone, the combination of these findings are characteristic of multi-phase settlement activity.

These findings are like the recorded scheduled monument, located 2.5 km north-east of the survey area, listed as an Iron Age settlement (NHLE 1003494), but later determined to be consistent with multi-phased occupation. Further settlement activity has been identified in the eastern portion of the survey area. However, the location of activity highlighted in the south-east corresponds with the known site of a Civil War Battery (MNT5640) containing circular and semi-circular works and ditches. This site is also 200 m north of a scheduled monument (NHLE 1017620) in the form of a Civil War Sconce near Muskham Bridge. Therefore, although these anomalies could be related to Iron Age to Romano-British settlement activity, it is more likely that they are associated with the Civil War infrastructure from 1642 – 1646 AD.

Several weekly positive isolated linear anomalies have also been identified as possibly relating to archaeological ditches. Given their weak magnetic properties, however, and similar orientation to surrounding cultivation in the field it is equally possible these anomalies reflect enhanced agricultural trends. Although a possible archaeological origin cannot be ruled out entirely.

Evidence of historic cultivation has also been recorded in the form of a former field boundary and multiple areas of ridge and furrow. Modern drainage and ploughing are also present across the survey area. The remaining anomalies are expected to be modern in origin, relating to modern services and an area of increased magnetic disturbance associated with the demolition of an old brickyard.



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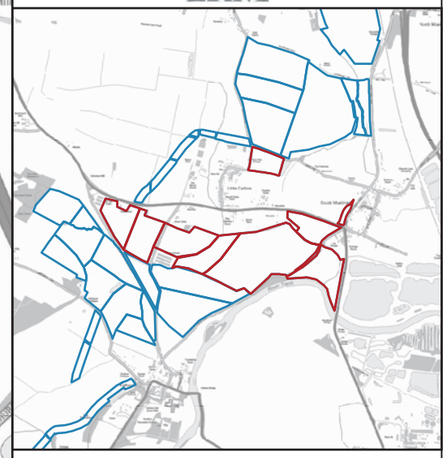
Date: 05/07/2023	Created by: ADT	Revision: 0	Scale: 1:15,000 at A4

Figure 1: Site location and survey extents

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ERM



Site boundary

Detailed survey extent

-2 nT 3 nT

0 500 m

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Figure 2: Detailed gradiometer survey results: overall greyscale plots (-2nT to 3nT)

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Figure 3: Detailed gradiometer survey results: overall interpretation

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357800

478000

478200

478400

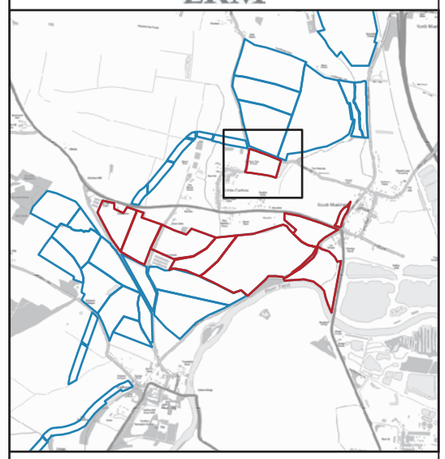
357600

298

357400

Little Carlton

Poultry Farm



Site boundary

Detailed survey extent

-2 nT 3 nT

0 50 m

Coordinate system: OSGB 1936 British National Grid
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Scale: 1:2000	Revision: 0

Figure 4: Detailed gradiometer survey results: greyscale plot (298)

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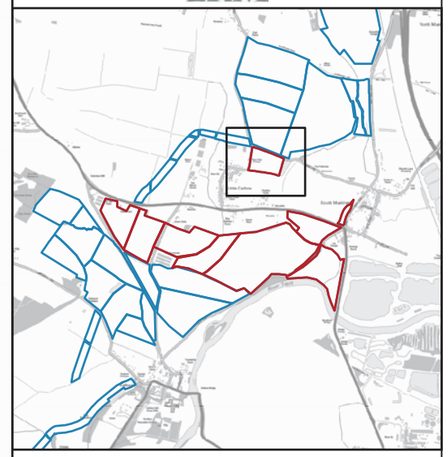
357800
478000
478200
478400
357600
357400

STF-0029
STF-0014
STF-0013
a
b
STF-0015
STF-0016

lum Tree
Cottage

Little Carlton
Poultry
Farm

ERM



Site boundary
Detailed survey extent
Archaeology
Possible archaeology
Former field boundary
Historic landscape feature
Geology
Geomorphology
Historic cultivation
Modern service
Increased response
Ferrous
Agricultural feature
Drain
Trend

0 50 m

Coordinate system: OSGB 1936 British National Grid
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Figure 5: Detailed gradiometer survey results: interpretation (298)

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476800

477000

477200

357200

357000

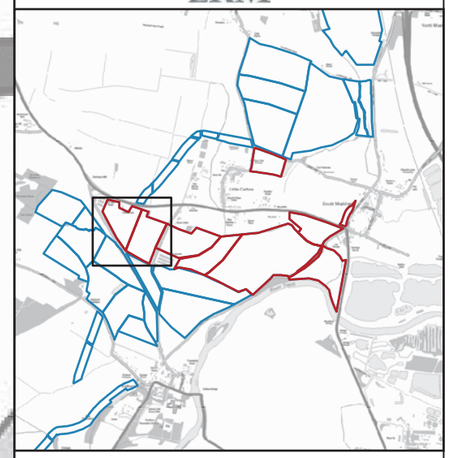
356800

263

262

261

ERM



Site boundary

Detailed survey extent

-2 nT

3 nT

0

50 m

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Figure 6: Detailed gradiometer survey results: greyscale plot (262 - 263)

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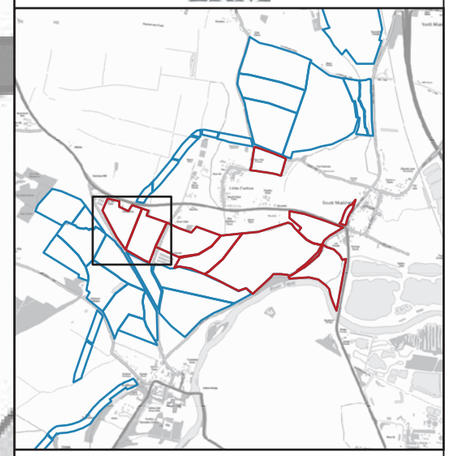
476800
477000
477200
357200
357000
356800

Toll Bar Farm

Valley View

STF-0028
STF-0031
STF-0012
STF-0002
a
b
c
c

ERM



Site boundary
Detailed survey extent
Archaeology
Possible archaeology
Former field boundary
Historic landscape feature
Geology
Geomorphology
Historic cultivation
Modern service
Increased response
Ferrous
Agricultural feature
Drain
Trend

0 50 m

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Figure 7: Detailed gradiometer survey results: interpretation (262 - 263)

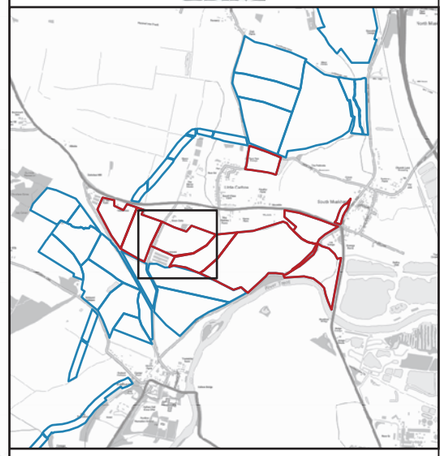
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477200
477400
477600
357000
356800
356600

Green Oaks

262
261
278
277

ERM



Site boundary
Detailed survey extent

-2 nT
3 nT

0
50 m

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Figure 8: Detailed gradiometer survey results: greyscale plot (261 and 278)

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477200
477400
477600
357000
356800
356600

Green Oaks

STF-0012
STF-0002
STF-0001
STF-0003
STF-0022
STF-0021

a
b
c
d

ERM

Site boundary
Detailed survey extent
Archaeology
Possible archaeology
Former field boundary
Historic landscape feature
Geology
Geomorphology
Historic cultivation
Modern service
Increased response
Ferrous
Agricultural feature
Drain
Trend

0 50 m

Coordinate system: OSGB 1936 British National Grid
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Figure 9: Detailed gradiometer survey results: interpretation (261 and 278)

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357000

477800

478000

478200

261

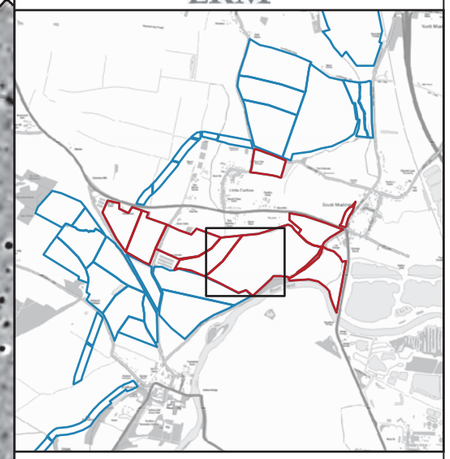
278

277

356800

356600

River T



Site boundary

Detailed survey extent

-2 nT

3 nT

0

50 m

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Figure 10: Detailed gradiometer survey results: greyscale plot (277)

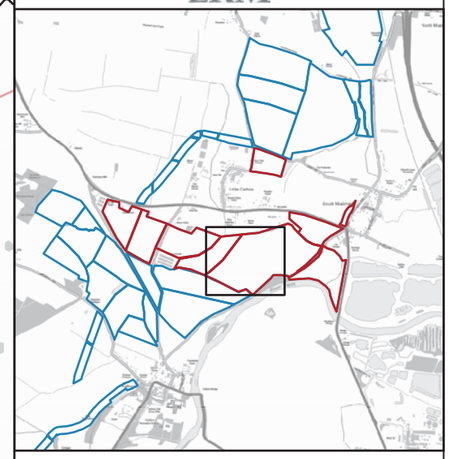
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357000
477800
478000
478200
356800
356600

STF-0005
STF-0019
STF-0023
STF-0006
STF-0020
STF-0004
STF-0007

a
b
c
d

River T



Site boundary
Detailed survey extent
Archaeology
Possible archaeology
Former field boundary
Historic landscape feature
Geology
Geomorphology
Historic cultivation
Modern service
Increased response
Ferrous
Agricultural feature
Drain
Trend

0 50 m

Coordinate system: OSGB 1936 British National Grid
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Figure 11: Detailed gradiometer survey results: interpretation (277)

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478200
478400
478600
357000
356800
356600

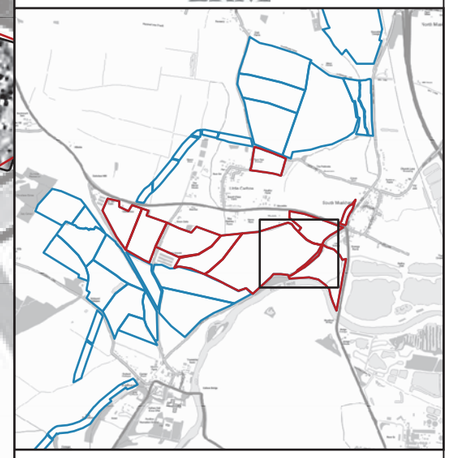
275
277
276

The Grange

GRAHAM LANE

River Trent

ERM



Site boundary
Detailed survey extent

-2 nT
3 nT

0
50 m

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Figure 12: Detailed gradiometer survey results: greyscale plot (277)

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478200
478400
478600
357000
356800
356600

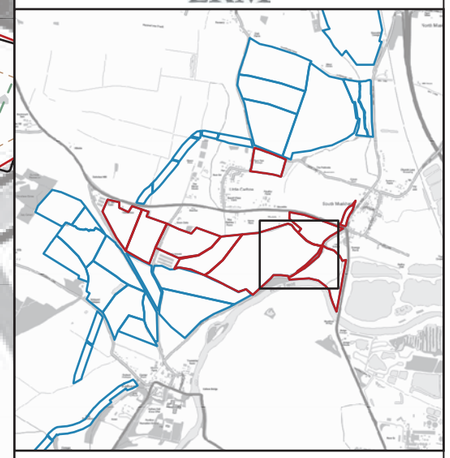
STF-0011
STF-0024
STF-0017
STF-0018
STF-0027
STF-0026
STF-0010

The Grange

KELHAM LANE

River Trent

b
d



Site boundary
Detailed survey extent
Archaeology
Possible archaeology
Former field boundary
Historic landscape feature
Geology
Geomorphology
Historic cultivation
Modern service
Increased response
Ferrous
Agricultural feature
Drain
Trend

0 50 m

Coordinate system: OSGB 1936 British National Grid

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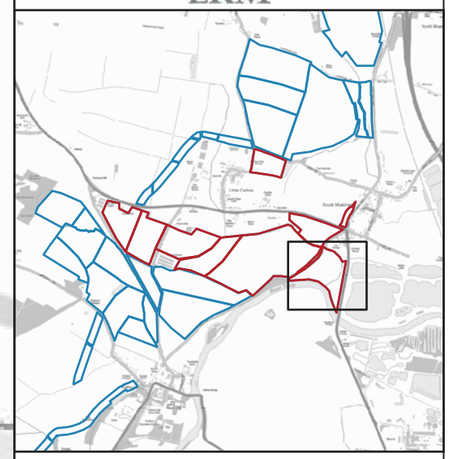
Figure 13: Detailed gradiometer survey results: interpretation (277)

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478400
478600
478800
356800
356600
356400

277
276

The Grange
Grange Farm
ent



Site boundary
Detailed survey extent

-2 nT
3 nT

0
50 m

Coordinate system: OSGB 1936 British National Grid
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Figure 14: Detailed gradiometer survey results: greyscale plot (276)

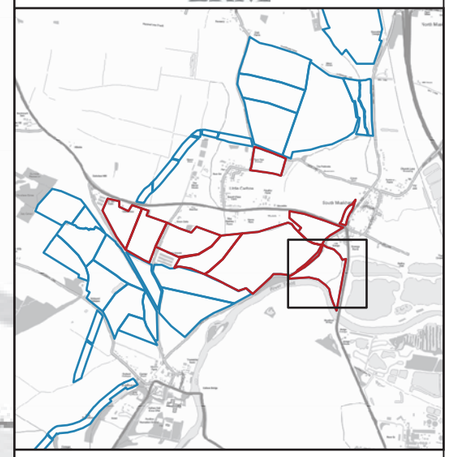
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478400
478600
478800
356800
356600
356400

The Grange
Grange Farm
KELHAM LANE
ent

STF-0018
STF-0027
STF-0026
STF-0010
STF-0008
STF-0025
STF-0009

ERM



- Site boundary
- Detailed survey extent
- Archaeology
- Possible archaeology
- Former field boundary
- Historic landscape feature
- Geology
- Geomorphology
- Historic cultivation
- Modern service
- Increased response
- Ferrous
- Agricultural feature
- Drain
- Trend

0 50 m

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Figure 15: Detailed gradiometer survey results: interpretation (276)

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478400
478600
478800
357200
357000
356800

South Muskham
Moorside
The Grange
Gran Farm
GREAT N
A616
B6325
275
277
276
C2

ERM

Site boundary
Detailed survey extent

-2 nT
3 nT
0
50 m

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Figure 16: Detailed gradiometer survey results: greyscale plot (275)

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478400 478600 478800

357200

357000

356800

Moorside

South Muskham

STF-0011

STF-0024

STF-0017

STF-0018

STF-0027

A616

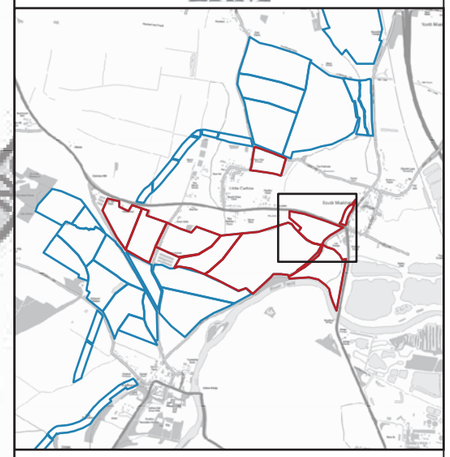
B6325

GREAT N

The Grange

Gran Farr

ERM



- Site boundary
- Detailed survey extent
- Archaeology
- Possible archaeology
- Former field boundary
- Historic landscape feature
- Geology
- Geomorphology
- Historic cultivation
- Modern service
- Increased response
- Ferrous
- Agricultural feature
- Drain
- Trend

0 50 m

Coordinate system: OSGB 1936 British National Grid
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Scale: 1:2000 | Revision: 0

Figure 17: Detailed gradiometer survey results: interpretation (275)

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478600

478800

479000

357200

357000

Crows Nest

South Muskham

GREAT NORTH ROAD

FORGE CLOSE

MAIN STREET

SLAKE

A616

B6325

C2

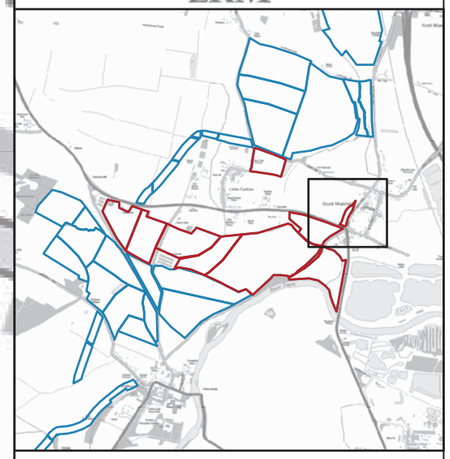
275

277

276

The Grange

Grange



Site boundary

Detailed survey extent

-2 nT

3 nT

0

50 m

Coordinate system: OSGB 1936 British National Grid
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Figure 18: Detailed gradiometer survey results: greyscale plot (C2)

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478600

478800

479000

357200

357000

Crows Nest

South Muskham

STF-0030

STF-0024

STF-0017

GREAT NORTH ROAD

FORGE CLOSE

MAIN STREET

A616

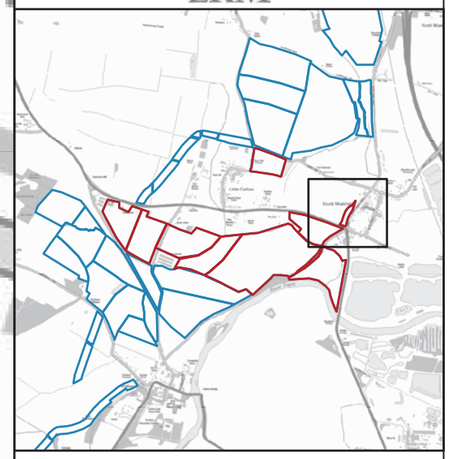
B6325

SLAKE

The Grange

Grange

ERM



- Site boundary
- Detailed survey extent
- Archaeology
- Possible archaeology
- Former field boundary
- Historic landscape feature
- Geology
- Geomorphology
- Historic cultivation
- Modern service
- Increased response
- Ferrous
- Agricultural feature
- Drain
- Trend

0 50 m

Coordinate system: OSGB 1936 British National Grid
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Date: 05/07/2023	Created by: ADT
Scale: 1:2000	Revision: 0

Figure 19: Detailed gradiometer survey results: interpretation (C2)

8 APPENDICES

8.1 Appendix 1: Gradiometer Survey Equipment and Data Processing (Sensys)

The magnetic data for this project were acquired using a non-magnetic cart fitted with eight SenSys FGM650/3 magnetic gradiometers. The instrument has four sensor assemblies fixed horizontally 1 m apart allowing four traverses to be recorded simultaneously. Each sensor contains two fluxgate magnetometers arranged vertically with a 0.6 m separation and measures the difference between the vertical components of the total magnetic field within each sensor array. This arrangement of magnetometers suppresses any diurnal or low frequency effects.

The gradiometers have an effective resolution of ±8 µT over ±1000 nT range. All of the data are then relayed to a CS35 tablet, running the MONMX program, which is used to record the survey data from the array of FMG650/3 probes at a rate of 20 Hz. The program also receives measurements from a GPS system, which is fixed to the cart at a measured distance from the sensors, providing real time locational data for each data point.

The cart-based system relies upon accurate GPS location data which is collected using a Leica Captivate system with a rover and base station. This receives corrections from a network of reference stations operated by the Ordnance Survey and Leica Geosystems, allowing positions to be determined with a precision of 0.02m in real-time and therefore exceed the level of accuracy recommended by European Archaeologiae Consilium recommendations (Schmidt et al. 2015) for geophysical surveys.

Data may be collected with a higher sample density where complex archaeological anomalies are encountered, to aid the detection and characterisation of small and ephemeral features. Data may be collected at up to 0.01 m intervals along traverses spaced up to 0.25m apart.

Post-processing

The magnetic data collected during the survey is downloaded from the system for processing and analysis using both commercial and in-house software. This software allows for both the data and the images to be processed to enhance the results for analysis; however, it should be noted that minimal data processing is conducted so as not to distort the anomalies.

Typical data and image processing steps may include:

GPS DeStripe – Determines the median of each transect and then subtracts that value from each data point in the transect within the defined window. May be used to remove the striping effect seen within a survey caused by directional effects, drift, etc.

Discard Overlaps - Intended to eliminate a track(s) that have been collected too close to one another. Without this, the results of the interpolation process can be distorted as it tries to accommodate very close points with potentially differing values.

GPS Base Interpolation – Sets the X & Y interval of the interpolated data and the track radius (the area around each datapoint that is included in the interpolated result).

Typical displays of the data used during processing and analysis:

Greyscale – Presents the data in plan view using a greyscale to indicate the relative strength of the signal at each measurement point. These plots can be produced in colour to highlight certain features but generally greyscale plots are used during the analysis of the data.

XY Plot – Presents the data as a trace or graph line for each traverse. Each traverse is displaced down the image to produce a stacked profile effect. This type of image is useful as it shows the full range of individual anomalies. XY plots can be made available upon request.

8.2 Appendix 2: Geophysical Interpretation

The following categories have been used for interpretation of the data throughout the report.

Archaeology

Used when the form, nature, and pattern of the anomaly are indicative of archaeological material. Further sources of information such as aerial photographs may also have been incorporated in providing the final interpretation.

Possible Archaeology

Used for anomalies that conform to the Archaeology category but have a lower level of confidence due to lack of form, pattern, or nature.

Historic Landscape Feature

Used for anomalies that correspond with features other than historic field boundaries on available mapping. This can include, but is not limited to, park and garden features, areas of woodland, ponds, and extraction pits.

Historic Cultivation

Used to denote historic cultivation regimes that differ from existing modern cultivation. They may differ due to size, orientation, or distribution in the landscape. If possible, LiDAR, aerial, and HER data should be consulted to corroborate results.

Former Field Boundary

Used anomalies that correspond to the position of boundaries marked on available mapping, visible on aerial photographs, or form clear extensions of existing boundaries.

Modern Agricultural feature

Used to identify any anomalies that are representative of modern ploughing or agricultural activity.

Geology

Used to denote natural variations is soils, superficial geology, or bedrock.

Geomorphology

Used to identify anomalies associated with more coherent geomorphological features. This may include, but is not limited to, paleochannels, solution hollows, and former high ground.

Increased Magnetic Response

Used for areas dominated by indistinct anomalies with increased magnetic values. While these may have some archaeological potential they may also relate to natural or modern features.

Modern Service

Used for anomalies indicative of services or service trenches. These are usually magnetically strong linear anomalies but can also be seen as weak anomalies in the case of plastic services where only disturbance associated with the trench is visible.

Drain

Used for anomalies thought to relate to drainage features either due to their nature or corresponding with features on available mapping.

Ferrous

Used for anomalies caused by ferrous material. These anomalies are likely to be of modern origin.

Unknown Feature

Used for anomalies that, due to their nature, pattern, or form, cannot be confidently interpreted. These may have some archaeological potential.

Trend

Used for low amplitude or indistinct linear anomalies that cannot be confidently interpreted. These may have some archaeological potential.

DETAILED GRADIOMETER SURVEY REPORT

LAND TO THE WEST OF A1, NORTH OF STAYTHORPE, NOTTINGHAMSHIRE (HEWSON LAND)

CULTURAL HERITAGE REPORT NUMBER: 268310

DATE: JULY 2023

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1 EXECUTIVE SUMMARY

The document comprises a report on detailed gradiometer surveys on the site north of Staythorpe between 13 February – 3 March and 3 – 11 April 2023. The project was commissioned by ERM with the aim of establishing the presence, or otherwise, and nature of detectable archaeological features to assess the archaeological potential of land parcels and their suitability for development.

The site at 'Hewson Land' comprises several arable and pasture fields over a large area to the north and east of Ossington Hamlet. This comprises a mixture of agricultural land located north-west of Newton on Trent, covering an area of 146.3 ha.

The gradiometer survey has been successful in detecting anomalies of archaeological origin in the northern portion of the site. Two separate areas of settlement activity have been identified in the form of a trackway and associated enclosures.

The anomalies identified in the very north of the site are likely ditches representing a trackway and adjacent enclosures of an unknown origin. It is possible that the activity is medieval in age, linked to similar trackway and enclosure cropmarks identified 1 km east, near the village of Weston. A similar series of larger enclosures with internal divisions has been identified 1.2 km to the south-east associated with a recorded former field boundary. Although an origin for this settlement in unclear, it is likely to be medieval in date related to the recorded former field boundary attached to the west.

Several isolated linear and curvilinear ditches have also been identified across the site, expected to be associated with archaeological activity. Given their isolation or little corroborative evidence, however, it is also possible that they are of geological or agricultural origin.

Several strongly positive linear anomalies have been identified across the site that correlate with known former field boundaries. In addition to a historic landscape feature that has been recorded in the south of the site, associated with a former building or structure recorded on 1888 OS Mapping. An area of ridge and furrow has also been identified, possibly medieval in origin similar to visible cropmarks in the area.

Limited evidence of geological variation has been recorded in this survey, although a complex network of paleochannels has been identified centrally on site.

The remaining anomalies recorded on site are of a modern origin such as modern services and land drains.

2 INTRODUCTION

2.1 Project Background

ERM commissioned a geophysical survey on land to the north of A167 and the west of A1, Nottinghamshire. The survey area covers approximately 2100 ha and comprise a detailed gradiometer survey intended to assess the archaeological potential of land parcels and their suitability for development.

2.2 Scope of document

This report presents a brief description of the overall site details, archaeological background and methodology. This is followed by detailed survey results and the archaeological interpretation of the geophysical data for each land parcel.

3 SITE LOCATION, GEOLOGY AND TOPOGRAPHY

The following gives an overview of the site, with further details presented for the individual land parcels.

The site consists of multiple land parcels extending along two arms, north-east and north-west of Staythorpe, in the county of Nottinghamshire, west of the River Trent and extending from 4 km north-west of Newark-on-Trent. The north-east route of the survey is 16 km long, extending from Staythorpe and running towards the villages of North Muskam, Carlton-on-Trent, Ossington and Moorhouse. The north-west route is shorter, extending for 9 km from Staythorpe towards Kersall, before bifurcating and heading towards Eakring and Kneesall.

The bedrock geology across the site is principally Mercia Mudstone but the area around Eakring at the western end of the site is recorded as Siltstone of the Tarporley formation[1]. Superficial deposits comprising Holme Pierrepont sand and gravel, and undifferentiated Alluvium are recorded on the western edge of the River Trent floodplain. Alluvial deposits are also recorded adjacent to Moorhouse Beck, at the northern end of the eastern route, and between Caunton and Kersall in the west. In addition, Diamicton Till and Glaciofluvial Deposits are also recorded at the northern end of the north-west cable route around Buckshaw farm.

Soils derived from the above geological parent material have been shown to produce magnetic contrasts acceptable for the detection of archaeological remains through magnetometer survey. However, in areas where thick deposits of superficial material (e.g. Alluvium) are recorded, archaeological remains may be too deeply buried to be identified through this geophysical technique.

The general topography varies of across the site, but the slope is generally gradual in most areas. The lowest-lying region is the area associated with the floodplain of the River Trent at the eastern extent of the survey area, which ranges between 10 and 16 m above Ordnance Datum (aOD)[2]. The minor tributaries extending west from this also occupy moderately low-lying areas (30 – 45 m aOD), between Kersall and Caunton and alongside Moorhouse Beck. Adjacent to these, are several highpoints (>75 m aOD) at Eakring, Kneesall and Laxton.

[1] Geology of Britain viewer. http://mapapps.bgs.ac.uk/geologyofbritain/home.html (Accessed on 01/04/2022)

[2] United Kingdom Topographic Map. https://en-gb.topographic-map.com/maps/iu/United-Kingdom/ (Accessed 12/09/2022

4 ARCHAEOLOGICAL BACKGROUND

4.1 Introduction

No desk-based assessment of the survey area has yet been undertaken. However, HER data for the survey site and a 1.5 km study area around the survey site has been obtained. The following gives an overview of the site, with further details presented for the individual land parcels.

4.2 Previous Investigations

There are few records of previous intrusive investigations within the site. With the exception of **ENT486**, which encountered post-medieval remains, none of the other intrusive surveys found evidence of archaeology (**ENT486**, **ENT1034**, **ENT3871**, **ENT3756** and **ENT3888**).

A detailed survey aerial photograph analysis exercise was undertaken along the route of the A1 and main settlements within the region (**ENT738** and **ENT1125**). A wealth of potential archaeological features were identified that reside within the site boundary or lie adjacent to it [3]. These are discussed in **section 4.3**.

Many archaeological surveys have been completed within the study area with concentrations found within the historic settlements of North Muskham, South Muskham, Little Carlton, Averham, and Cromwell. Some of the investigations have uncovered archaeological remains, which are discussed in **section 4.3** below.

4.3 Historical and archaeological background

4.3.1 Prehistoric

The Nottingham Historic Environment Record (NHER) holds limited evidence of Palaeolithic activity, mainly confined to Staythorpe to the south of the site, comprising the recovery of worked antler and bison bones (**MNT5596** and **MNT11139**). The only other Palaeolithic dated material is a handaxe found 1.5 km north-west of the site (**MNT4164**).

With the exception of the possible site of a Neolithic henge, all of the NHER records for the Neolithic comprise of lithic (flint) finds, with a particular concentration on land directly west of the site just north of North Muskham. The quantity of material recovered would imply a permanent presence within the landscape rather than reflecting seasonal migration of peoples. This fits with the current historical narrative, which indicates that the River Trent Valley was a focus of activity during the period[4]. However, it is possible that fine-grained minerogenic deposits of Holocene alluvium that are likely located within the floodplain of the River Trent, may have deeply buried further evidence of this.

Alluvium is recorded in the eastern part of the site, on the floodplain of the River Trent. Previous studies within the Trent valley on alluvial deposits confirmed the presence of deeply buried organic material, offering the potential for the preservation of paleoenvironmental evidence[5]. Trenching around Staythorpe Power Station identified three paleochannels that, based on recovered organic evidence, provided four dates of between 6640 ± 60 BP. Together with pollen and insect data, this show that during the latter half of the Mesolithic period, the area was a mixture of alder, willow and aspen carr, with limited grassland and a background of oak, elm, and lime on the adjacent gravel terraces. The

[3] Historic England, Aerial Archaeology Mapping Explorer, https://historicengland.org.uk/research/results/aerial-archaeology-mapping-explorer/ (Accessed 12/09/2022)
[4] Cooper, N (ed) 2006. The Archaeology of the East Midlands. Available at: https://researchframeworks.org/emherf/
[5] The Archaeology of the East Midlands. Available at: https://researchframeworks.org/emherf/ (Accessed on 12/09/2022)

later Mesolithic deposits also yielded a human femur and animal bones from a range of species including roe deer and aurochs.

For the Bronze Age, there is a more defined permanent presence evidenced by the construction of several barrow cemeteries (**MNT3597**, **MNT14748**, **MNT17094**, **MNT17127**, and **MNT8542;** NHLE list entry 1003492) and the identification of enclosures, hut circles/ring ditches and other features associated with land management during the aerial photography mapping exercises. These features are found on both sides of the river.

100 m to the east of the site lies the Site of Pit Alignments scheduled monument (NHLE list entry 1003493). The listing of the scheduled monument is based on the old county number (OCN) scheduling record and provides no further information on the pit alignment itself. The recent arial photography mapping exercise has, however, identified further pits around the scheduled monument (**MNT17099**). Although the pits have not been intrusively investigated, such features are typically of late prehistoric origin, although their use remains poorly understood[6].

The exploitation of the River Trent Valley becomes clearer with the transition into the Iron Age. Several settlements, including a scheduled monument (NHLE list entry 1003494), have been found close to South and North Muskham (**MNT17097**, **MNT14313**, **MNT17091**, **MNT11991**, and **MNT14315**), while an isolated small riverside settlement was found near Cromwell (**MNT25849**). The Cromwell barrow cemetery also remained in use during the Iron Age (**MNT15145**). In addition to the above, the aerial mapping exercises have also recorded a plethora of field enclosures, boundaries, pit alignments, hut circles/ring ditches, and linear features that may be of late prehistoric origin. Overall, there is a wealth of evidence that shows that this part of the River Trent Valley was heavily settled and exploited during the Iron Age.

4.3.2 Romano-British

Based on the current evidence, the Romano-British period is marked by a general abandonment of the earlier settlement pattern and establishment of new settlements within the landscape. The land around South Muskham, North Muskham, and Little Carlton continued to be the focus for habitation with seven settlements discovered (**MNT17089**, **MNT17090**, **MNT8243**, **MNT8265**, **MNT17098**, **MNT8290**, and **MNT14318**). However, similar levels of activity appear around Cromwell with a possible Romano-British villa located 430 m to the east of the site and an extra-mural settlement, designated a scheduled monument (NHLE list entry 1003490), discovered 60 m west of the site.

Four of the settlements discussed above fall within the site (**MNT8243**, **MNT8265**, and **MNT17089**), including the Scheduled settlement discussed above (NHLE list entry 1003490). However, the aerial mapping exercises also identified a large number of regular enclosures which could be of Romano-British origin within the site's boundaries.

4.3.3 Anglo-Saxon

The Domesday Book of 1086 can be used to identify settlements that existed prior to the Norman Conquest. South Muskham, North Muskham, Little Carlton, Cromwell, Kneesall (referred to as 'Cauton'), Kelham, and Averham, all of which sit with the 1.5 km study area, are documented as being in existence in 1066 and would have had their origins in at least the Late Anglo-Saxon period.

Most of the NHER records relate to finds recovered during fieldwalking exercises completed on the fields that surround known Anglo-Saxon centres, such as North Muskham and South Muskham (**MNT11098**, **MNT11050**, **MNT11732**, **MNT11047**, **MNT8286**, **MNT2881**,

[6] Cooper, N (ed) 2006. The Archaeology of the East Midlands. Available at: https://researchframeworks.org/emherf/

MNT11042, and **MNT3098**) and Kneesall (**MNT12174**, **MNT8556**, **MNT17128**, and **MNT12172**). The recovery of the material helps define the main areas of activity during the period showing that landscape use may have been confined to the immediate hinterland of known settlements.

4.3.4 Medieval

The medieval period is characterised by an intensification in settlement activity and landscape use within the River Trent valley. The NHER has mapped many former medieval villages/hamlets located in the study area, most represented as shrunken or deserted villages, alongside known sites of medieval manors and deer parks (some of the manor sites are designated as Scheduled Monuments). One of these, the medieval deserted village of Little Carlton, which is a scheduled monument, falls partially within the site (**MNT14312**; NHLE list entry 1019870).

Similar to the proceeding periods, most of the archaeological evidence for medieval activity takes the form of finds recovered during fieldwalking exercises. While the material could reflect further areas of settlement, it was common practice to add pottery to fields as part of the arable farming regime. This data at least shows a wider utilisation of the study area for agricultural uses, and it is possible that some of the features identified during the aerial mapping exercises are of medieval origin.

4.3.5 Post-medieval and Modern

The post-medieval period was a time of continuity and development for the River Trent valley. Until the passing of Enclosures Acts, much of the landscape was not too dissimilar to what had been created during the medieval period. The medieval interspersed settlement pattern remained with the local peoples still relying on agriculture for employment. However, the period was also marked by the rise of the landed gentry and development of large estates. Within the study area are four parks of varying size associated with an existing or former large country house, and include Ossington Hall (**MNT26679**), Kelham Hall (**MNT26671**), Averham Park (**MNT26653**), Winkburn Park (**MNT26694**), and Beesthorpe Hall (**MNT26658**).

Of the parks discussed above, Averham Park falls within the site (**MNT26653**). The park is first shown on Chapman's map of 1774 and was described in 1835 as "park which was heretofore an ornament to the neighbourhood, and a splendid appendage to the mansion ... on it remains the keeper's house and a few of the park fence". Little is known of the original layout of the parkland as Chapman's map is of limited detail and later Ordnance Survey (OS) mapping shows the land as fields. Lost parkland features may fall within the site.

According to the NHER, two brick yards fell within the site. The first brick yard is located south-west of Little Carlton and was created during the post-medieval period (**MNT14403**). After it fell out use, woodland was planted over the brick yard, which is first shown on the 1st edition OS map. The second brick yard is of modern date and located northeast of Upton (**MNT14432**). The brickworks fell out of use by 1915.

Post-medieval mapping shows that the site was located within post-enclosure field systems by the end of the 19th century. Few changes have occurred to the field system since. In the study area, the main changes illustrated comprise the construction of the Great Northern Railway line, development of industrial sites and expansion of the villages/settlements.

The majority of the NHER records of post-medieval and modern date relate to former or existing structures found throughout the study area. They comprise of farmsteads, residential buildings, structures associated with the railway, estate structures, and former industrial sites.

4.3.6 Undated

As discussed above, aerial mapping exercises have identified a large number of cropmarks/features within the study area, many of which fall within the site's boundaries. The NHER entries for each designated set of cropmarks provided little detail about them, other than their general shape and form (i.e., regular enclosures, hut circles, linear etc). Apart from the hut circles/ring ditches, which are associated with prehistoric settlement practices, the rest of the cropmarks/features could be of any date prior to the establishment of the post-enclosure field systems.

5 METHODOLOGY

5.1 Introduction

The geophysical survey was undertaken between 13 February – 3 March and 3 – 11 April 2023. Of the total 146.3 ha site, an overall coverage of 37.2 ha was achieved. Fields 5, 17 and 46 were all heavily ploughed and were deemed unsuitable for survey at the time which the works were being undertaken. Field 45 was partially surveyed in areas not containing crop.

The methods and standards employed throughout the geophysical survey conform to that set out in the Written Scheme of Investigation[7] (WSI), as well as to current best practice, and guidance outlined by the Chartered Institute for Archaeologists'[8] and European Archaeologiae Consilium[9].

5.2 Aims and objectives

The aims of the survey comprise the following:

- To determine, as far as is reasonably possible, the nature of the detectable archaeological resource within a specified area using appropriate methods and practices; and
- To inform either the scope and nature of any further archaeological work that may be required; or the formation of a mitigation strategy (to offset the impact of the development on the archaeological resource); or a management strategy.

In order to achieve the above aims, the objectives of the geophysical survey are:

- To conduct a geophysical survey covering as much of the specified area as possible, allowing for on-site obstructions;
- To clarify the presence/absence of anomalies of archaeological potential; and
- Where possible, to determine the general nature of any anomalies of archaeological potential.

5.3 Fieldwork Methodology

The cart-based gradiometer system used a Leica Captivate RTK GNSS instrument, which receives corrections from a network of reference stations operated by the Ordnance Survey (OS) and Leica Geosystems. Such instruments allow positions to be determined with a precision of 0.02 m in real-time and therefore exceeds European Archaeologiae Consilium recommendations (Schmidt et al. 2015).

[7] ERM, 2022 Written Scheme of Investigation: Geophysical Survey Land to the West of A1, North of Staythorpe, Nottinghamshire. Report ref. 22036

[8] Chartered Institute for Archaeologists [CIfA] 2014a Standards and guidance for archaeological geophysical survey. Reading, CIfA

[9] Schmidt, A, Linford, P, Linford, N, David, A, Gaffney, C, Sarris, A and Fassbinder, J. 2015 Guidelines for the use of geophysics in archaeology: questions to ask and points to consider. EAC Guidelines 2, Belgium: European Archaeological Council.

The detailed gradiometer survey was undertaken using four SenSys FGM650/3 gradiometers spaced at 1 m intervals and mounted on a non-magnetic cart. Data were collected with an effective sensitivity of 0.03 nT at a rate of 10 Hz, producing intervals of 0.15 m along transects spaced 4 m apart.

5.4 Data processing

Data from the survey were subjected to minimal correction processes. These comprise a 'Destripe' function (±5 nT thresholds), applied to correct for any variation between the sensors, and an interpolation used to grid the data and discard overlaps where transects have been collected too close together.

Further details of the geophysical and survey equipment, methods and processing are described in **Appendix 1**.

6 DATA PRESENTATION

The processed data are exported as georeferenced TIFF files. The interpretation layers are digitised as ESRI shapefiles. The images and interpretation shapefiles are then used to produce the final figures in a GIS.

The gradiometer data are displayed at -2nT (white) to +3nT (black) for the greyscale image.

7 HWESON LAND - FIELD 4 – 5, 9, 17, 45 – 46, 301 AND C80

7.1 Site details

A detailed gradiometer survey was carried out over land located between the A1 to the north-east and the village of Moorhouse to the south-west. For the purposes of the parcel's background this report has been split into Area 1 (Fields 4 and 5 centred on NGR 475535 367740), Area 2 (Fields 9, 17 and 301 centred on NGR 476970 366988), and Area 3 (Fields 045, 046 and C80 centred on NGR 478244 364505) (**Figure 4 – 17**).

7.1.1 Area 1

Area 1 comprises two adjacent arable Fields 4 to the north and 5 to the south. To the north of Field 4 and south of Field 5 the area is bounded by hedges leading to further fields and woodland, to the west both Fields 4 and 5 are bounded by Moorhouse Road, and to the east the fields abut Fields 6 and 8 from the Chase land.

The area is on an incline from 23 m aOD in the south-east to 45 m aOD in the north-west.

The underlying geology is recorded as Mudstone from the Mercia Mudstone Group across the area, with a thin strip of Dolomitic Siltstone of the same group running through Field 005[10].

The soils underlying this survey area are likely to comprise argillic pelosols of the Worcester (431) association[11]. Soils in such geological settings have been demonstrated to produce magnetic contrasts suitable for the detection of anomalies through gradiometer survey.

7.1.2 Area 2

Area 2 comprises three adjacent arable fields - 9 to the north-west, 301 to the north-east and 17 in the centre. The northern edges of Fields 9 and 17 are bounded by the A1. The western edge of Field 9 runs down to the Moorhouse Beck, and the southern edge is bounded by hedgerow. The eastern edge of Field 17 abuts Field 9 with tress and hedges in between, which continues along the southern edge. The western edge of the survey opens out into the remainder of the field. Field 301 abuts the southern edge of Field 17, and is hedged to north, west, and south, opening out to further arable beyond the survey extent.

The area undulates from a highest point of 32 m aOD where Fields 9 and 17 meet, declining down to 20 m aOD along the edge of the Moorhouse Beck in Field 009 to the north-west, and down to a trough of 25 m aOD to the south-east in the centre of Field 17, inclining back up to 32 m aOD where Fields 17 and 301 meet. Field 301 is flat at 32 m aOD.

The underlying geology is recorded as Mudstone from the Mercia Mudstone Group across the area, with a thin strip of Dolomitic Siltstone of the same group running through Field 17[12]. Along the north and western edges of Field 9 sediments of clay silt, sand, and gravel from superficial deposits of alluvium may be present.

The soils underlying this survey area are likely to comprise stagnogleyic argillic brown earths of the Whimple 3 (572f) association[13]. Soils in such geological settings have been demonstrated to produce magnetic contrasts suitable for the detection of anomalies through gradiometer survey.

[10] Geology of Britain viewer. http://mapapps.bgs.ac.uk/geologyofbritain/home.html (Accessed on 17/03/2023)
[11] Soil Survey of England and Wales, 1983, *Soils of Midland and Western England Sheet 3*, Southampton
[12] Geology of Britain viewer. http://mapapps.bgs.ac.uk/geologyofbritain/home.html (Accessed on 17/03/2023)
[13] Soil Survey of England and Wales, 1983, *Soils of Midland and Western England Sheet 3*, Southampton

7.1.3 Area 3

Area 3 comprises three adjacent arable fields - 45 to the west, 46 to the east, and C80 to the north. The northern edge of the area is bounded by hedges and trees in Field 45 and a private track in Field 46, a copse of trees to the west, Ossington Road along the southern edge and a small area of pasture on the eastern edge of Field 046. C80 covers the south-western corner of an arable field running parallel to a small copse of trees.

The area is on an incline from 16 m aOD at the eastern edge up to 44 m aOD to the west.

The underlying geology is recorded as Mudstone from the Mercia Mudstone Group across the area, with a thin strip of Dolomitic Siltstone of the same group running through Field 17[14].

The soils underlying this survey area are likely to comprise stagnogleyic argillic brown earths of the Whimple 3 (572f) association to the east and argillic pelosols of the Worcester (431) association to the west[15]. Soils in such geological settings have been demonstrated to produce magnetic contrasts suitable for the detection of anomalies through gradiometer survey.

7.2 Archaeological background

7.2.1 Listed Buildings

Area 1 and 2

To the north of Areas 1 and 2 there are two listed buildings; Scarthingmoor House situated on the old Great North Road (**NHLE 1045943**), Scarthingmoor Mill Farmhouse (**NHLE 1179802**) 850 m away listed at Grade II.

To the south-west in the village of Moorhouse three listed buildings lie 800 m away from the area consisting of a Grade II Church Farmhouse (**NHLE 1045632**) and Aggrie House (**NHLE 1302636**), a post-medieval redbrick house, and the 12th century Grade II* Moorhouse Chapel (**NHLE 1045631**).

To the east in the village of Weston four listed buildings lie 700 – 900 m away from the area consisting of the 13th century Grade I parish Church of All Saints (**NHLE 1179778**), and Grade II listings for a Dovecote and Adjoining Pigeoncote (**NHLE 1045942**), a sundial (**NHLE 1370001**) and a stable and pigeoncote at Sunnyside Farm House (**NHLE 1179789**).

Area 3

Area 3 in centred between three villages with medieval or post-medieval origins: Sutton on Trent to the north-east, Carlton on Trent to south-east, and Ossington to the west. Each of these villages contain a number of listed buildings, however only a small number lie within the study area for this survey, the Farmhouse (**NHLE 1045971**), Barn (**NHLE 1369977**) and Pigeoncote and Stable (**NHLE 1045972**) of Yew Tree Farm, Holly Cottage (**NHLE 1369978**), Boundary Wall, Gate Piers and Gates at Carlton Hall (**NHLE 1302340**) leading to Carlton Hall (**NHLE 1046012** Grade II*) all within Carlton on Trent at Grade II (bar Carlton Hall) 1 km east of Area 3.

7.2.2 Prehistoric

Area 1 and 2

A few findspots of worked flints and stone are scattered across the study area, including a large flint flake in the Moorhouse Beck 150 m south of Field 009 (**MNT322556**), a

[14] Geology of Britain viewer. http://mapapps.bgs.ac.uk/geologyofbritain/home.html (Accessed on 17/03/2023)
[15] Soil Survey of England and Wales, 1983, *Soils of Midland and Western England Sheet 3*, Southampton

sandstone axe-hammer of late Neolithic or Early Bronze Age date 1 km south (**HER L4171**), and a scatter of Neolithic flints at Scarthing Moor 1 km to the north-east of Field 004 (**HER L4221**).

Area 3

The only positively dated evidence of prehistoric activity around Area 3 are crop marks of a series of Bronze Age ring ditches and enclosures 1 km to the east (**MNT322689**). Cropmarks of other ditches and features have been identified 700 m east of the area but is so far undated (**HER L4197**), as well as a later prehistoric pit alignment, possibly Bronze or Iron Age in date in the same area (**MNT1456174**).

7.2.3 Iron Age – Roman

Area 1 and 2

Along with the flint blade mentioned above Roman pottery was also found in Moorhouse Beck in a similar location (**MNT322556**), and other pottery sherds of colour coat and grey ware have been found 700 m south of Field 5 (**HER L4169**) and 900 m south-east Field 301 (**MNT322529**). Of greater significance, one or possibly two sub-rectangular ditched enclosures with associated boundary ditches of Iron Age or Roman date have been identified via aerial photography just 400 m south-east of Field 301 (**MNT1461469**).

Area 3

Romano-British activity is also present around Area 3 consisting of Romano-British pottery sherds of colour coat and coarse grey ware 0.9 km to the south (**MNT322678**), a pit alignment of Iron Age or Romano-British date 0.7 km east of the eastern edge of the area (**MNT322708**) and crop marks of a possible square Romano-British farmstead 800 m south-east of south-east corner of Field 046 (**MNT322702**)

7.2.4 Medieval

Area 1 and 2

The medieval presence in the study area is quite noticeable, punctuating the landscape with earthworks, cropmarks, and trackways of continued use. The scheduled 'Moat, three fishponds, enclosures, hollow way and part of a road at Hall Yard' (**NHLE 1008247**) 600 m north-east of Area 2 was likely part of the village of Weston, a nucleated medieval village that straddled the Great North Road and is of 12th century origin (**MNT1380345**). Possible crop mark remains of medieval ridge and furrow agriculture to the south of the moated site indicate a wider use of the landscape at this time (**MNT1380326**). Two trackways run near the area of probably medieval date: Infield Lane runs through the field north of Field 17 and possibly run into it before it was truncated by the A1 (**MNT1380324**) and Wadnall Lane leading to Fields 9 and 17 (**MNT1380331**).

Area 3

Ploughed out ridge and furrow can also be seen as crop marks 600 m east of Area 3 (**MNT1456180**), and there is a hollow way parallel with Ossington Road 500 m east of the area (**HER L10225**).

7.2.5 Post-medieval

Area 1 and 2

Weston has a set of post-medieval stocks (**MNT1380329**), a milepost (**MNT1380328**), and some field boundaries that may be planted on previous medieval hedgerows (**MNT1380317**).

OS mapping from 1885 – 1900 shows Wadnall Lane continuing through Field 9 towards the Moorhouse Beck to a ford as well as an east-west running track across Field 17 splitting

at a north-south T-junction on the western edge[16]. Additionally the 1900s map shows Fields 4, 5, 9 and 17 split into many smaller fields, the boundaries of which may appear in the survey data.

Area 3

Carlton on Trent train station situated 400 m east of the area was in use from 1850 – 1955 on the London to York line (**MNT509021**).

Similarly with Areas 1 and 2, the fields in Area 3 were previously split into many smaller fields, as seen on the 1990s map, which may appear in the survey data.

7.3 Detailed gradiometer survey results

The detailed gradiometer survey was carried out between 13 February – 3 March and 3 – 11 April 2023 and covered 37.3 ha of the 146.3 ha survey area. The survey has identified archaeological anomalies in the form of a possible trackway and enclosures of varying size and orientation.

Results are presented as a series of greyscale plots and archaeological interpretations, at a scale of 1:2000 (**Figures 4** – **17**). The interpretation of the datasets highlights the presence of potential archaeological anomalies, ferrous, burnt or fired objects, and magnetic trends (**Figure 3**).

7.3.1 Interpretation: Archaeology and Possible Archaeology

In the northern portion of the parcel, a complex series of positive linear and curvilinear anomalies have been identified in Field 4 at **HWN-0001** (**Figure 7**). The anomalies are between 2 – 3 m wide, orientated NNE – SSW over an area 60 m wide by 90 long.

The series can be divided into four areas at **a** – **d**. Area **a** highlights a gently curvilinear anomaly 110 m long orientated NNE – SSW. This anomaly is the main spine of the series, from which all other anomalies appear to stem from. It also has the strongest magnetic properties. Area **b** consists of an additional anomaly, broadly parallel to **a**, 15 m west. It is 70 m long, with additional, smaller linears extending eastward towards **a**. Areas **c** and **d** represent two weakly positive adjacent rectilinear anomalies in the series, extending eastward from **a**. Anomaly **c** is southern of the two, 25 m wide and 20 m long. Whilst anomaly **d** is 25 m wide and 10 m long immediately north. Anomaly **d** is more rounded in form compared to **c**.

The anomalies at **HWN-0001** are likely ditches of archaeological origin, that combine to form a larger area of activity. Due to their parallel nature, anomalies **a** and **b** could represent the remains of a trackway, with **c** and **d** forming adjacent enclosures of an unknown origin. It is possible that the activity is medieval in age, linked to similar trackway and enclosure cropmarks identified 1 km east, near the village of Weston.

A collection of positive linear and curvilinear anomalies have been recorded in the northern portion of the parcel in Field 9 at **HWN-0002** (**Figure 9**). The grouping is orientated broadly NNW – SSE, covering an area 80 m wide and 120 m long. Whilst the individual anomalies at **HWN-0002** are between 1 – 3 m wide aligned on a coaxial NNW – SSE by ENE – WSW orientation. The collection is also adjacent and parallel to a former field boundary present on OS mapping. The former field boundary appears to form the western extent of the anomalies as it appears to truncate them.

The collection can be divided into three sections at **a** – **c**. Sections **a** and **b** form two large rectilinear areas, whilst **c** appears to form a narrow connecting corridor for **a** and **b**. Grouping **a** is the northern-most section, 40 m wide by 70 m long containing much stronger positive magnetic properties than **b** and is also far more complex. Within the rectilinear

[16] National Library of Scotland Historic Maps https://maps.nls.uk/ (Accessed on 17/03/2023)

exterior there are several internal linear anomalies parallel to one another, creating double ditched and triple ditched features.

Area **b** to the south-east has a much simpler layout consisting of a 45 m wide by 45 m long square-shaped anomaly. The anomaly is fragmented with a break along its western extent and the majority of its northern extent not visible in the data. The interconnecting corridor at **c** is 20 m long and 10 m wide, with additional linear anomalies extending to the east and west.

The overall series of anomalies are likely to be the remains of ditches as part of larger archaeological activity. The areas **a** and **b** are likely enclosures, with **c** forming an accessway between them with additional linears extending to the east and west. It is also possible that **c** represents an additional, heavily fragmented enclosure. The additional linears within **a** are likely internal divisions, possibly highlighting internal access routes across the settlement. Although an origin for this settlement in unclear, it is likely to be medieval in date related to the recorded former field boundary attached to the west.

Further positive linear anomalies have been identified 15 m south of **HWN-0002** at **HWN-0003** (**Figure 9**). They consist of two anomalies, the southern one is 2 m wide and 20 m long orientated north – south, and northern is 2 m wide and 16 m long, orientated north-east to south-west. These two anomalies are likely ditches that could be related to **HWN-0002**, creating a continuation of the activity further south. It is also possible that these anomalies are geological in origin or related to modern agricultural practises.

Three linear and curvilinear anomalies have been highlighted in the south of the parcel in Field 45 at **HWN-0004** (**Figure 15**). The anomalies are 1 – 2 m wide and comprise two mirrored 'C'-shaped anomalies at **a** and **b**, underlined by a linear anomaly at **c**. Anomaly **a** is 40 m along its southern extent, in its south-western point it turns north-west for an additional 65 m and finally returns east for 40 m. From its south-western-most point, anomaly **b** extents 10 m north-east, before turning north-west on a curved trajectory for 75 m. Anomaly **c** is 95 m long, orientated ENE – WSW and appears to be truncated by the former field boundary to the east. Anomalies **b** and **c** likely continue west, however the area was unsurveyable at the time, so no data has been recorded in this area.

It is possible that these anomalies represent ditches of archaeological origin, possibly combining to form wider activity. They may be associated with the former field boundary truncating **c** to the east. Given their weak magnetic properties and the small survey area they were identified in, however, little context can be gained from the survey data alone. It is also possible that these anomalies are related to modern agricultural practices such as enhanced trends or land drains. More evidence could be gained when the remaining parts of Field 45 are surveyed at a later date.

A collection of positive linear and rectilinear anomalies have been identified centrally in Field C80 at **HWN-0005** (**Figure 13**). The anomalies are 2 m wide, broadly orientated either north – south or east – west. They can be sub-divided into three individual anomalies at **a** – **c**. Anomaly **a** is the largest anomaly, it is 'r-shaped' in form, 30 m long north – south by 45 m long east – west. Immediately south-east of **a** is **b**, the central, linear anomaly 20 m long. The final anomaly in the collection is **c** to the south-east. This anomaly has a similar 'r-shaped' form to **a**, yet it is smaller and more concave in its curvature. Anomaly **c** is 10 m long north – south and 22 m long east – west. It is possible that these anomalies represent ditches of archaeological origin, yet it is equally possible that they are enhanced trends generated by modern agricultural practices.

In the north-east corner of Field 301 a positive rectilinear anomaly has been recorded at **HWN-0006** (**Figure 11**). This anomaly is a 2 m wide mirrored 'u-shape', orientated NNW – SSE. Its western limb is 20 m long from north to south with its curved arm extending 35 m east and north, 6 m from the western limbs southern-most point. It is possible that this anomaly could relate to archaeological ditches on an unknown origin, however it is

more likely that it relates to paleochannels or modern land drains, similar to others recorded in Field 301.

An isolated, positive linear anomaly has been identified in the southern portion of the parcel in Field 45 at **HWN-0007** (**Figure 13**). This anomaly is 2 m wide and 37 m long orientated north – south. Anomaly **HWN-0007** shares a similar orientation to a former field boundary (now a modern service) 60 m to the east. It is possible that this anomaly is also a former field boundary that either predates or was not recorded on OS mapping from 1888. It is also possible that this anomaly is representative of a paleochannel or modern land drain.

7.3.2 Interpretation: Historical Agriculture

Several strongly positive linear anomalies have been identified across the parcel that correlate with known former field boundaries at **HWN-0008 – HWN-0015** (**Figure 5 – 9, 13 and 15**). All are first recorded on 1888 OS mapping, although appear to have been removed or modified since. All are last recorded on the 1961 mapping, but no longer visible on satellite mapping dated 2002 (Google Earth 2023). A small ferrous anomaly has been highlighted in Field 45 at **HWN-0016** (**Figure 15**), that corresponds to the location of a possible building or structure recorded on 1888 OS mapping. It is expected that this anomaly illustrates some magnetic material or rubble associated with the historic landscape features removal.

A large area of weak, positive, parallel, linear anomalies has been identified in northern half of Field 9 at **HWN-0017** (**Figure 9**). The average distance between lines is 6 m, orientated north-west to south-east, with a slight curvature in form. These anomalies have been interpreted as areas of ridge and furrow. Given their spacing and curved form, it is possible that these anomalies are medieval in date. Like others recorded cropmarks in the in the area.

7.3.3 Interpretation: Modern Agriculture

Limited evidence of modern agriculture has been recorded within this survey. Some enhanced linear trends have been identified along the field boundaries, likely associated with modern ploughing generating headland areas.

7.3.4 Interpretation: Natural

No evidence of large-scale geological variation has been identified within the survey. Although a complex network of negative interconnected sinuous anomalies has been identified centrally across Field 301. The form and magnetic properties of these anomalies is characteristic of paleochannels. This interpretation is strengthened by the intense assortment of land drains recorded in Field 301, likely deposited to avoid flooding in the area.

7.3.5 Interpretation: Modern

Three strong linear and curvilinear dipolar anomalies has been identified in Fields 4, 45, and C80 at **HWN-0018 – HWN-0020** (**Figure 7** and **13**). Anomaly **HWN-0018** is 415 m long orientated east – west, **HWN-0019** is 60 m long orientated north – south and **HWN-0020** is 74 m long curving broadly north-east to south-west. The strong dipolar magnetic characteristics of these anomalies are indicative of modern services. Anomalies **HWN-0018** and **HWN-0019** both correspond with former field boundaries recorded on 1888 OS mapping. It is likely that these services replaced the boundaries.

Several thin linear anomalies have been identified in across the survey area. These anomalies are exclusively highlighted due to their either negative or dipolar magnetic properties, indicative of modern drainage.

The survey has also detected multiple isolated clusters of low magnitude and dipolar anomalies that have been interpreted as ferrous in origin. These likely relate to natural variation in the soils and background geology and are of little archaeological impact. Further examples of ferrous responses have been identified around the periphery of certain fields. This is likely due to metal fencing within the boundaries and interference from the adjacent roads and tracks.

7.3.6 Interpretation: Unknown

A series of linear trends have been recorded across the parcel. They have been recorded as such due to their uncertain origin. Whilst the majority are expected to be modern in origin associated with agricultural activity, a possible archaeological origin cannot be ruled out entirely. Especially those recorded in proximity to **HWN-0001** and **HWN-0002**.

7.4 Preliminary Conclusions

The gradiometer survey has been successful in detecting anomalies of archaeological origin in the northern portion of the parcel. Two separate areas of settlement activity have been identified in the form of a trackway and associated enclosures.

The anomalies identified in the very north of the parcel are likely ditches representing a trackway and adjacent enclosures of an unknown origin. It is possible that the activity is medieval in age, linked to similar trackway and enclosure cropmarks identified 1 km east, near the village of Weston. A similar series of larger enclosures with internal divisions has been identified 1.2 km to the south-east associated with a recorded former field boundary. Although an origin for this settlement in unclear, it is likely to be medieval in date related to the recorded former field boundary attached to the west.

Several isolated linear and curvilinear ditches have also been identified across the parcel, expected to be associated with archaeological activity. Given their isolation or little corroborative evidence, however, it is also possible that they are of geological or agricultural origin.

Several strongly positive linear anomalies have been identified across the parcel that correlate with known former field boundaries. In addition to a historic landscape feature that has been recorded in the south of the parcel, associated with a former building or structure recorded on 1888 OS mapping. An area of ridge and furrow has also been identified, possibly medieval in origin similar to visible cropmarks in the area.

Limited evidence of geological variation has been recorded in this survey, although a complex network of paleochannels has been identified centrally on parcel.

The remaining anomalies recorded on parcel are of a modern origin such as modern services and land drains.

8 APPENDICES

8.1 Appendix 1: Gradiometer Survey Equipment and Data Processing (Sensys)

The magnetic data for this project were acquired using a non-magnetic cart fitted with eight SenSys FGM650/3 magnetic gradiometers. The instrument has four sensor assemblies fixed horizontally 1 m apart allowing four traverses to be recorded simultaneously. Each sensor contains two fluxgate magnetometers arranged vertically with a 0.6 m separation and measures the difference between the vertical components of the total magnetic field within each sensor array. This arrangement of magnetometers suppresses any diurnal or low frequency effects.

The gradiometers have an effective resolution of ±8 µT over ±1000 nT range. All of the data are then relayed to a CS35 tablet, running the MONMX program, which is used to record the survey data from the array of FMG650/3 probes at a rate of 20 Hz. The program also receives measurements from a GPS system, which is fixed to the cart at a measured distance from the sensors, providing real time locational data for each data point.

The cart-based system relies upon accurate GPS location data which is collected using a Leica Captivate system with a rover and base station. This receives corrections from a network of reference stations operated by the Ordnance Survey and Leica Geosystems, allowing positions to be determined with a precision of 0.02m in real-time and therefore exceed the level of accuracy recommended by European Archaeologiae Consilium recommendations (Schmidt et al. 2015) for geophysical surveys.

Data may be collected with a higher sample density where complex archaeological anomalies are encountered, to aid the detection and characterisation of small and ephemeral features. Data may be collected at up to 0.01 m intervals along traverses spaced up to 0.25m apart.

Post-processing

The magnetic data collected during the survey is downloaded from the system for processing and analysis using both commercial and in-house software. This software allows for both the data and the images to be processed to enhance the results for analysis; however, it should be noted that minimal data processing is conducted so as not to distort the anomalies.

Typical data and image processing steps may include:

GPS DeStripe – Determines the median of each transect and then subtracts that value from each data point in the transect within the defined window. May be used to remove the striping effect seen within a survey caused by directional effects, drift, etc.

Discard Overlaps - Intended to eliminate a track(s) that have been collected too close to one another. Without this, the results of the interpolation process can be distorted as it tries to accommodate very close points with potentially differing values.

GPS Base Interpolation – Sets the X & Y interval of the interpolated data and the track radius (the area around each datapoint that is included in the interpolated result).

Typical displays of the data used during processing and analysis:

Greyscale – Presents the data in plan view using a greyscale to indicate the relative strength of the signal at each measurement point. These plots can be produced in colour to highlight certain features but generally greyscale plots are used during the analysis of the data.

XY Plot – Presents the data as a trace or graph line for each traverse. Each traverse is displaced down the image to produce a stacked profile effect. This type of image is useful as it shows the full range of individual anomalies. XY plots can be made available upon request.

8.2 Appendix 2: Geophysical Interpretation

The following categories have been used for interpretation of the data throughout the report.

Archaeology

Used when the form, nature, and pattern of the anomaly are indicative of archaeological material. Further sources of information such as aerial photographs may also have been incorporated in providing the final interpretation.

Possible Archaeology

Used for anomalies that conform to the Archaeology category but have a lower level of confidence due to lack of form, pattern, or nature.

Historic Landscape Feature

Used for anomalies that correspond with features other than historic field boundaries on available mapping. This can include, but is not limited to, park and garden features, areas of woodland, ponds, and extraction pits.

Historic Cultivation

Used to denote historic cultivation regimes that differ from existing modern cultivation. They may differ due to size, orientation, or distribution in the landscape. If possible, LiDAR, aerial, and HER data should be consulted to corroborate results.

Former Field Boundary

Used anomalies that correspond to the position of boundaries marked on available mapping, visible on aerial photographs, or form clear extensions of existing boundaries.

Modern Agricultural feature

Used to identify any anomalies that are representative of modern ploughing or agricultural activity.

Geology

Used to denote natural variations is soils, superficial geology, or bedrock.

Geomorphology

Used to identify anomalies associated with more coherent geomorphological features. This may include, but is not limited to, paleochannels, solution hollows, and former high ground.

Increased Magnetic Response

Used for areas dominated by indistinct anomalies with increased magnetic values. While these may have some archaeological potential they may also relate to natural or modern features.

Modern Service

Used for anomalies indicative of services or service trenches. These are usually magnetically strong linear anomalies but can also be seen as weak anomalies in the case of plastic services where only disturbance associated with the trench is visible.

Drain

Used for anomalies thought to relate to drainage features either due to their nature or corresponding with features on available mapping.

Ferrous

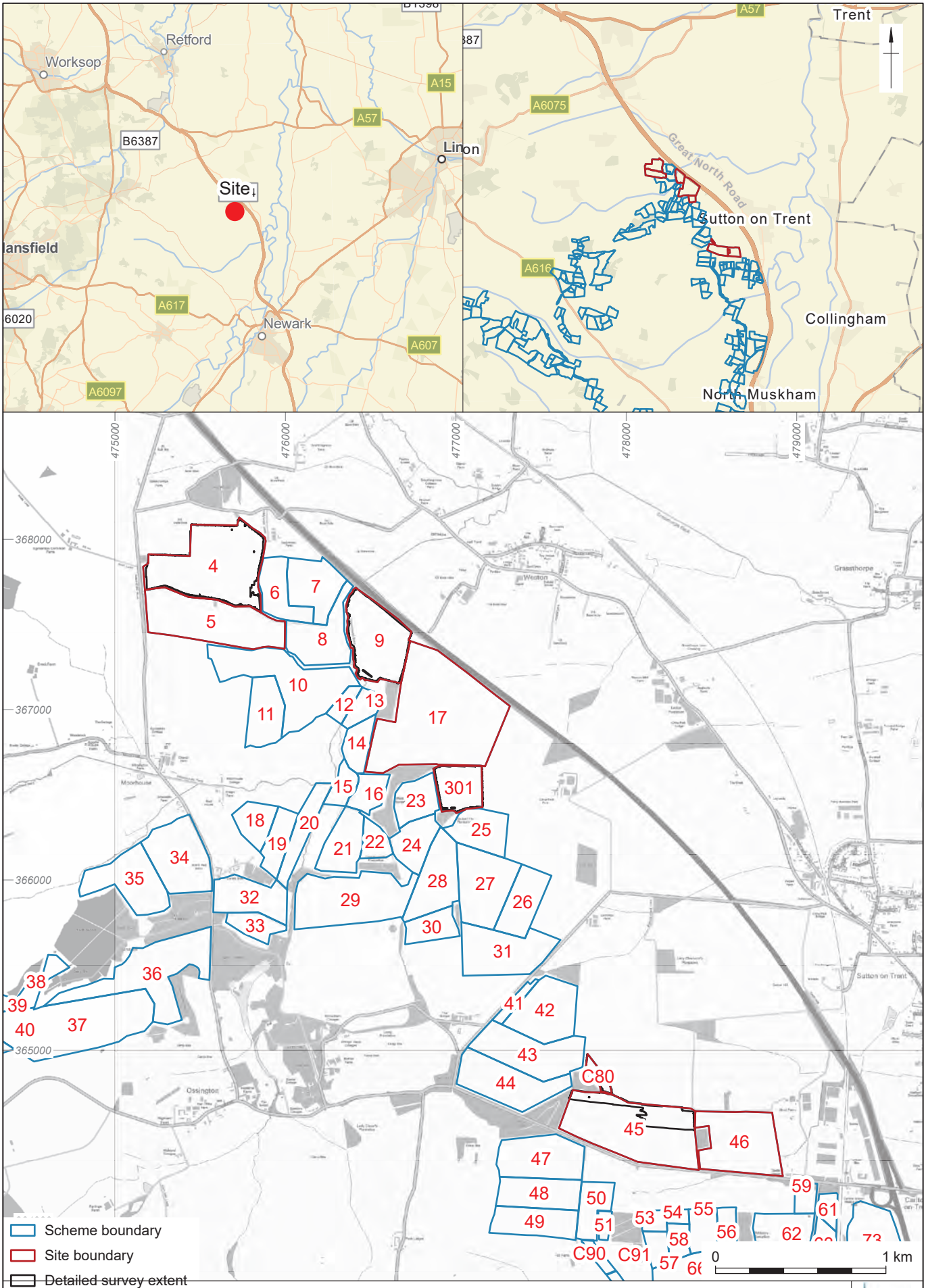
Used for anomalies caused by ferrous material. These anomalies are likely to be of modern origin.

Unknown Feature

Used for anomalies that, due to their nature, pattern, or form, cannot be confidently interpreted. These may have some archaeological potential.

Trend

Used for low amplitude or indistinct linear anomalies that cannot be confidently interpreted. These may have some archaeological potential.



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Figure 1: Site location and survey extents

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Figure 4
Figure 6
Figure 8
Figure 14
Figure 16
Figure 10
Figure 12

Normanton on Trent
Grassthorpe
Weston
Moorhouse
Ossington
Sutton on Trent
Carlton-on-Trent

ERM

Site boundary
Detailed survey extent

-2 nT
3 nT

0
1 km

Coordinate system: OSGB 1936 British National Grid
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Date: 04/07/2023	Created by: ADT
Scale: 1:20,000	Revision: 0

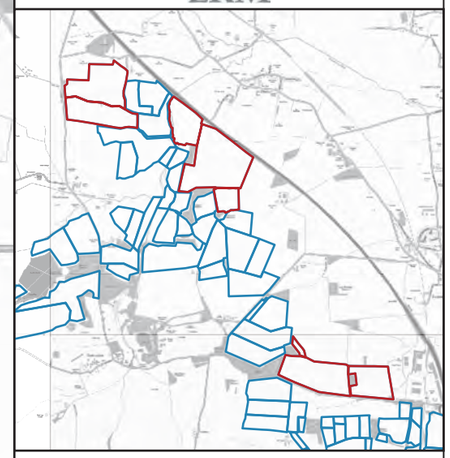
Figure 2: Detailed gradiometer survey results: overall greyscale plots (-2nT to 3nT)

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Normanton on Trent
Grasthorpe
Weston
Moorhouse
Ossington
Sutton on Trent
Carlton-on-Trent

Figure 5
Figure 7
Figure 9
Figure 15
Figure 17
Figure 11
Figure 13



Site boundary
Detailed survey extent
Archaeology
Possible archaeology
Former field boundary
Historic landscape feature
Geology
Geomorphology
Historic cultivation
Modern service
Increased response
Ferrous
Agricultural feature
Drain
Trend

0 1 km

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Figure 3: Detailed gradiometer survey results: overall interpretation

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367800

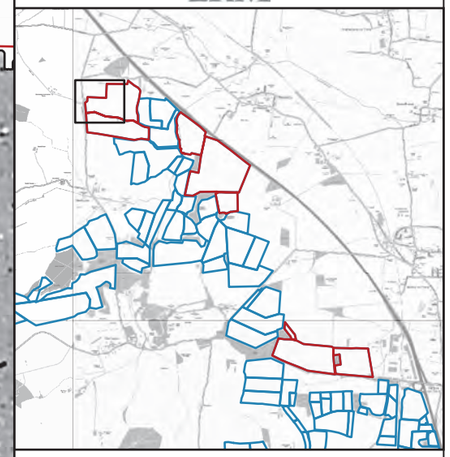
367600

Oil
Bore Hole

GG LANE

MOORHOUSE ROAD

ERM



Site boundary

Detailed survey extent

-2 nT

3 nT

0

50 m

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Figure 4: Detailed gradiometer survey results: greyscale plot (4)

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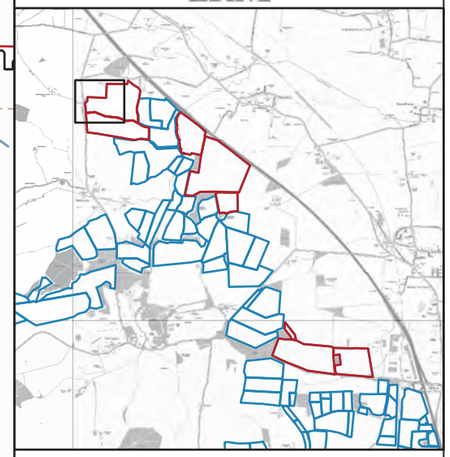
Oil
Bore Hole

475200
475400
475600
368000
367800
367600

GG LANE
MOORHOUSE ROAD

HWN-0001
a
b
c
d
HWN-0018
HWN-0008

ERM



- Site boundary
- Detailed survey extent
- Archaeology
- Possible archaeology
- Former field boundary
- Historic landscape feature
- Geology
- Geomorphology
- Historic cultivation
- Modern service
- Increased response
- Ferrous
- Agricultural feature
- Drain
- Trend

0 50 m

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Figure 5: Detailed gradiometer survey results: interpretation (4)

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475800

476000

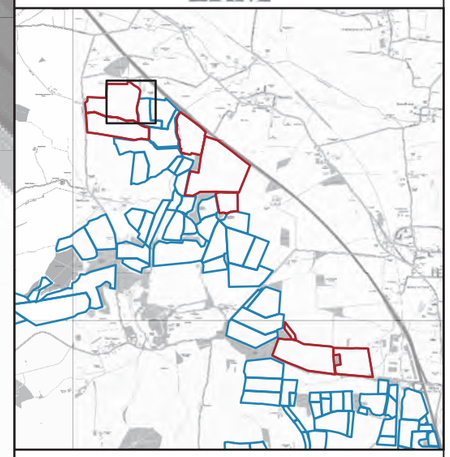
368000

367800

367600

Ladywood Lane

Ladywood Farm



Site boundary

Detailed survey extent

-2 nT

3 nT

0

50 m

Coordinate system: OSGB 1936 British National Grid
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Figure 6: Detailed gradiometer survey results: greyscale plot (4)

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475600

475800

476000

368000

367800

367600

HWN-0009

HWN-0001

HWN-0018

CHS-0002

a

b

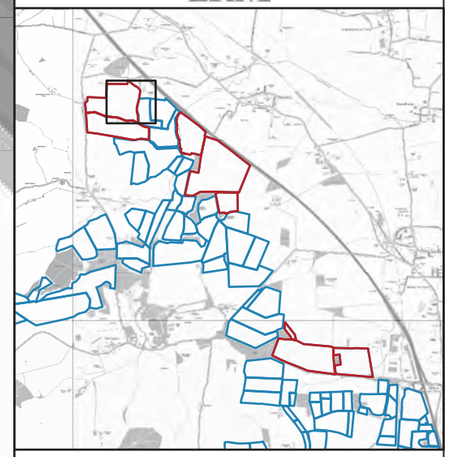
c

d

Lane

Ladywood Farm

ERM



Site boundary
Detailed survey extent
Archaeology
Possible archaeology
Former field boundary
Historic landscape feature
Geology
Geomorphology
Historic cultivation
Modern service
Increased response
Ferrous
Agricultural feature
Drain
Trend

0 50 m

Coordinate system: OSGB 1936 British National Grid
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Figure 7: Detailed gradiometer survey results: interpretation (4)

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476600

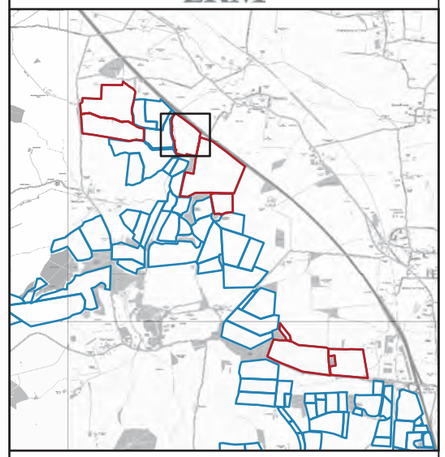
476800

476400

367600

367400

367200



Site boundary

Detailed survey extent

-2 nT 3 nT

0 50 m

Coordinate system: OSGB 1936 British National Grid
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Date: 04/07/2023	Created by: ADT	
Scale: 1:2000	Revision: 0	

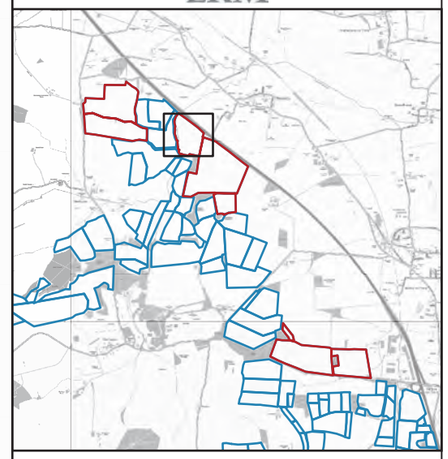
Figure 8: Detailed gradiometer survey results: greyscale plot (9)

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476400
476600
476800
367600
367400
367200

CHS-0014
CHS-0006
CHS-0011
CHS-0007
HWN-0010
HWN-0017
HWN-0011
HWN-0002
a
c
b
HWN-0012
HWN-0003
Moorhouse Beck

ERM



- Site boundary
- Detailed survey extent
- Archaeology
- Possible archaeology
- Former field boundary
- Historic landscape feature
- Geology
- Geomorphology
- Historic cultivation
- Modern service
- Increased response
- Ferrous
- Agricultural feature
- Drain
- Trend

0 50 m

Coordinate system: OSGB 1936 British National Grid
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Figure 9: Detailed gradiometer survey results: interpretation (9)

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366800

476800

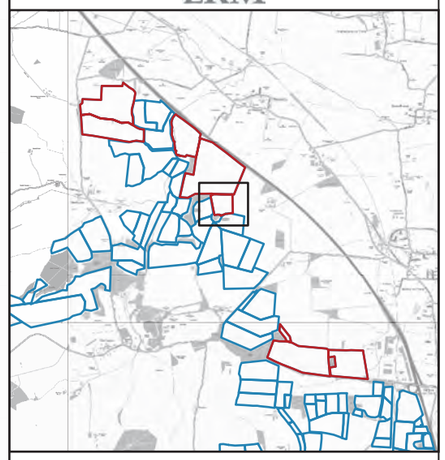
477000

477200

366600

366400

Cocked Hat Plantation



Site boundary

Detailed survey extent

-2 nT

3 nT

0

50 m

Coordinate system: OSGB 1936 British National Grid
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Scale: 1:2000	Revision: 0	

Figure 10: Detailed gradiometer survey results: greyscale plot (301)

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366800

476800

477000

477200

366600

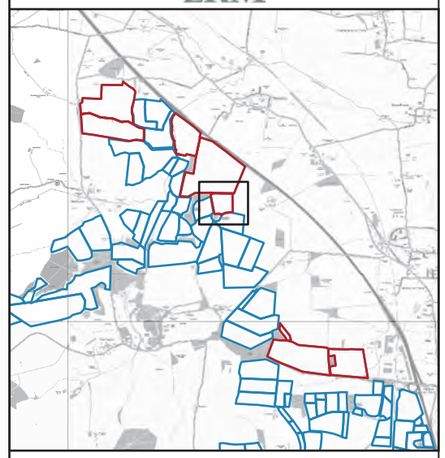
366400

HWN-0006

GER-0002

Cocked Hat Plantation

ERM



- Site boundary
- Detailed survey extent
- Archaeology
- Possible archaeology
- Former field boundary
- Historic landscape feature
- Geology
- Geomorphology
- Historic cultivation
- Modern service
- Increased response
- Ferrous
- Agricultural feature
- Drain
- Trend

0 50 m

Coordinate system: OSGB 1936 British National Grid
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Figure 11: Detailed gradiometer survey results: interpretation (301)

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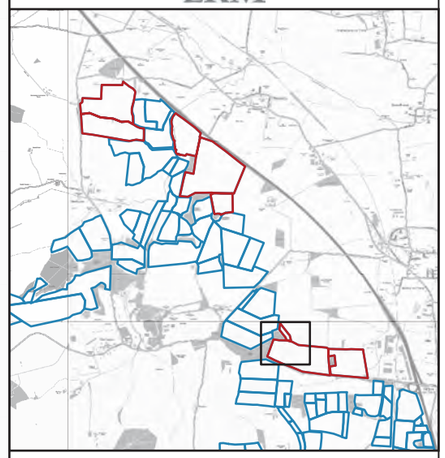
477600

477800

478000

364800

364600



Site boundary

Detailed survey extent

-2 nT

3 nT

0

50 m

Coordinate system: OSGB 1936 British National Grid
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Scale: 1:2000 | Revision: 0

Figure 12: Detailed gradiometer survey results: greyscale plot (C80 and 45)

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477600

477800

478000

364800

364600

HWN-0015

a

b

c

HWN-0020

HWN-0005

HWN-0007

HWN-0019

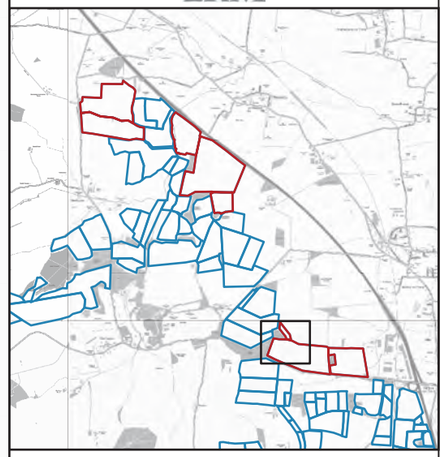
HWN-0013

HWN-0016

JKN-0013

JKN-0041

ERM



Site boundary

Detailed survey extent

Archaeology

Possible archaeology

Former field boundary

Historic landscape feature

Geology

Geomorphology

Historic cultivation

Modern service

Increased response

Ferrous

Agricultural feature

Drain

Trend

0 50 m

Coordinate system: OSGB 1936 British National Grid
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Scale: 1:2000 | Revision: 0

Figure 13: Detailed gradiometer survey results: interpretation (C80 and 45)

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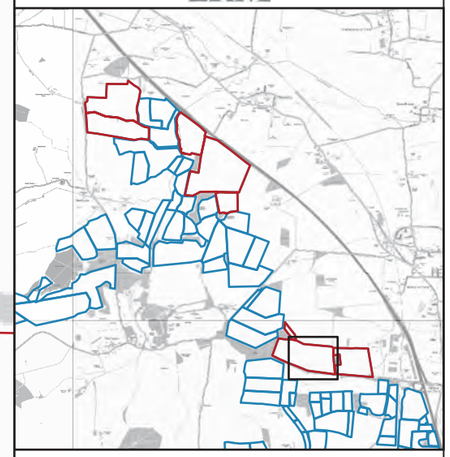
478000

478200

478400

364600

364400



Site boundary

Detailed survey extent

-2 nT

3 nT

0

50 m

Coordinate system: OSGB 1936 British National Grid
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Figure 14: Detailed gradiometer survey results: greyscale plot (45)

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478000

478200

478400

364600

364400

HWN-0004

a

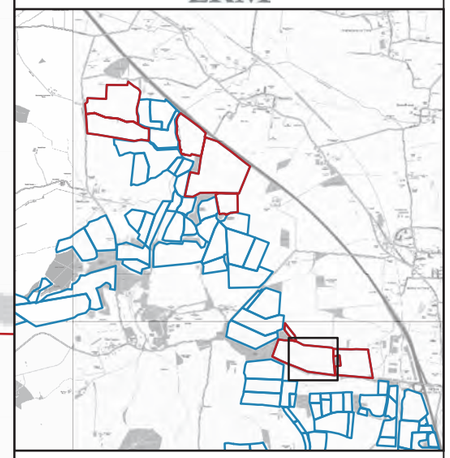
b

c

HWN-0013

HWN-0016

HWN-0014



Site boundary
Detailed survey extent
Archaeology
Possible archaeology
Former field boundary
Historic landscape feature
Geology
Geomorphology
Historic cultivation
Modern service
Increased response
Ferrous
Agricultural feature
Drain
Trend

0 50 m

Coordinate system: OSGB 1936 British National Grid
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Scale: 1:2000 | Revision: 0

Figure 15: Detailed gradiometer survey results: interpretation (45)

DETAILED GRADIOMETER SURVEY REPORT

LAND TO THE WEST OF A1, NORTH OF STAYTHORPE, NOTTINGHAMSHIRE (GRANGE FARM LAND)

CULTURAL HERITAGE REPORT NUMBER: 268310

DATE: JULY 2023

Prepared By:

Environmental Resources Management

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1 EXECUTIVE SUMMARY

The document comprises a report on detailed gradiometer surveys on the site north of Staythorpe between 31 October – 11 November 2022 and 20 – 22 February 2023. The project was commissioned by ERM with the aim of establishing the presence, or otherwise, and nature of detectable archaeological features to assess the archaeological potential of land parcels and their suitability for development.

The site at 'Grange Farm Land' comprises several arable and pasture fields immediately west of the village of North Muskham. This comprises a mixture of agricultural land located north-west of Newton on Trent, covering an area of 69.47 ha.

The gradiometer survey has been successful in detecting anomalies of archaeological origin across the site, particularly the possible multi-phase settlement activity located in the western portion of the site.

The linear and rectilinear ditches identified in the west of the site are likely representative of enclosures of a Romano-British origin. Whilst the penannular anomalies identified in the same area are the correct form and size to represent the remains of drip gullies associated with round houses possibly originating from the Iron Age. These findings therefore could be an example of multi-phase settlement activity from the Iron Age to the Romano-British period, like the Iron Age enclosures and pit alignments located 260 m to the north-west of site.

Further evidence for archaeological activity has been recorded in the south-eastern portion of the site, where two isolated enclosures of varying size and form have been identified. The larger, more northern, square-shaped enclosure appears more complex containing internal divisions and is surrounded by possible boundary ditches. Whilst the smaller, sub-rectangular enclosure further south does not contain any internal identifying features. The origin of both enclosures is unknown, further investigation will be necessary in establishing a date and context for this feature.

Several possible ditches have also been recorded across the site, expected to be representative of either; former boundaries not recorded on OS mapping, possible boundary ditches and the partial remains of a small enclosure. It is also possible that these anomalies are natural or agricultural in origin.

Evidence of the site's historical past has been recorded in the form of several former field boundaries, historic landscape features and areas of ridge and furrow. A modern service and evidence of modern fertilisation have also been recorded at in the site.

2 INTRODUCTION

2.1 Project Background

ERM commissioned a geophysical survey on land to the north of A167 and the west of A1, Nottinghamshire. The survey area covers approximately 2100 ha and comprise a detailed gradiometer survey intended to assess the archaeological potential of land parcels and their suitability for development.

2.2 Scope of document

This report presents a brief description of the overall site details, archaeological background and methodology. This is followed by detailed survey results and the archaeological interpretation of the geophysical data for each land parcel.

3 SITE LOCATION, GEOLOGY AND TOPOGRAPHY

The following gives an overview of the site, with further details presented for the individual land parcels.

The site consists of multiple land parcels extending along two arms, north-east and north-west of Staythorpe, in the county of Nottinghamshire, west of the River Trent and extending from 4 km north-west of Newark-on-Trent. The north-east route of the survey is 16 km long, extending from Staythorpe and running towards the villages of North Muskam, Carlton-on-Trent, Ossington and Moorhouse. The north-west route is shorter, extending for 9 km from Staythorpe towards Kersall, before bifurcating and heading towards Eakring and Kneesall.

The bedrock geology across the site is principally Mercia Mudstone but the area around Eakring at the western end of the site is recorded as Siltstone of the Tarporley formation[1]. Superficial deposits comprising Holme Pierrepont sand and gravel, and undifferentiated Alluvium are recorded on the western edge of the River Trent floodplain. Alluvial deposits are also recorded adjacent to Moorhouse Beck, at the northern end of the eastern route, and between Caunton and Kersall in the west. In addition, Diamicton Till and Glaciofluvial Deposits are also recorded at the northern end of the north-west cable route around Buckshaw farm.

Soils derived from the above geological parent material have been shown to produce magnetic contrasts acceptable for the detection of archaeological remains through magnetometer survey. However, in areas where thick deposits of superficial material (e.g. Alluvium) are recorded, archaeological remains June be too deeply buried to be identified through this geophysical technique.

The general topography varies of across the site, but the slope is generally gradual in most areas. The lowest-lying region is the area associated with the floodplain of the River Trent at the eastern extent of the survey area, which ranges between 10 and 16 m above Ordnance Datum (aOD)[2]. The minor tributaries extending west from this also occupy moderately low-lying areas (30 – 45 m aOD), between Kersall and Caunton and alongside Moorhouse Beck. Adjacent to these, are several highpoints (>75 m aOD) at Eakring, Kneesall and Laxton.

[1] Geology of Britain viewer. http://mapapps.bgs.ac.uk/geologyofbritain/home.html (Accessed on 01/04/2022)

[2] United Kingdom Topographic Map. https://en-gb.topographic-map.com/maps/iu/United-Kingdom/ (Accessed 12/09/2022

4 ARCHAEOLOGICAL BACKGROUND

4.1 Introduction

No desk-based assessment of the survey area has yet been undertaken. However, HER data for the survey site and a 1.5 km study area around the survey site has been obtained. The following gives an overview of the site, with further details presented for the individual land parcels.

4.2 Previous Investigations

There are few records of previous intrusive investigations within the site. With the exception of ENT486, which encountered post-medieval remains, none of the other intrusive surveys found evidence of archaeology (ENT486, ENT1034, ENT3871, ENT3756 and ENT3888).

A detailed survey aerial photograph analysis exercise was undertaken along the route of the A1 and main settlements within the region (ENT738 and ENT1125). A wealth of potential archaeological features were identified that reside within the site boundary or lie adjacent to it [3]. These are discussed in section 4.3.

Many archaeological surveys have been completed within the study area with concentrations found within the historic settlements of North Muskham, South Muskham, Little Carlton, Averham, and Cromwell. Some of the investigations have uncovered archaeological remains, which are discussed in section 4.3 below.

4.3 Historical and archaeological background

4.3.1 Prehistoric

The Nottingham Historic Environment Record (NHER) holds limited evidence of Palaeolithic activity, mainly confined to Staythorpe to the south of the site, comprising the recovery of worked antler and bison bones (MNT5596 and MNT11139). The only other Palaeolithic dated material is a hand axe found 1.5 km north-west of the site (MNT4164).

With the exception of the possible site of a Neolithic henge, all of the NHER records for the Neolithic comprise of lithic (flint) finds, with a particular concentration on land directly west of the site just north of North Muskham. The quantity of material recovered would imply a permanent presence within the landscape rather than reflecting seasonal migration of peoples. This fits with the current historical narrative, which indicates that the River Trent Valley was a focus of activity during the period[4]. However, it is possible that fine-grained minerogenic deposits of Holocene alluvium that are likely located within the floodplain of the River Trent, June have deeply buried further evidence of this.

Alluvium is recorded in the eastern part of the site, on the floodplain of the River Trent. Previous studies within the Trent valley on alluvial deposits confirmed the presence of deeply buried organic material, offering the potential for the preservation of paleoenvironmental evidence[5]. Trenching around Staythorpe Power Station identified three paleochannels that, based on recovered organic evidence, provided four dates of between 6640 ± 60 BP. Together with pollen and insect data, this show that during the latter half of the Mesolithic period, the area was a mixture of alder, willow and aspen carr, with limited grassland and a background of oak, elm, and lime on the adjacent gravel terraces. The

[3] Historic England, Aerial Archaeology Mapping Explorer, https://historicengland.org.uk/research/results/aerial-archaeology-mapping-explorer/ (Accessed 12/09/2022)
[4] Cooper, N (ed) 2006. The Archaeology of the East Midlands. Available at: https://researchframeworks.org/emherf/
[5] The Archaeology of the East Midlands. Available at: https://researchframeworks.org/emherf/ (Accessed on 12/09/2022)

later Mesolithic deposits also yielded a human femur and animal bones from a range of species including roe deer and aurochs.

For the Bronze Age, there is a more defined permanent presence evidenced by the construction of several barrow cemeteries (MNT3597, MNT14748, MNT17094, MNT17127, and MNT8542; NHLE list entry 1003492) and the identification of enclosures, hut circles/ring ditches and other features associated with land management during the aerial photography mapping exercises. These features are found on both sides of the river.

100 m to the east of the site lies the Site of Pit Alignments scheduled monument (NHLE list entry 1003493). The listing of the scheduled monument is based on the old county number (OCN) scheduling record and provides no further information on the pit alignment itself. The recent arial photography mapping exercise has, however, identified further pits around the scheduled monument (MNT17099). Although the pits have not been intrusively investigated, such features are typically of late prehistoric origin, although their use remains poorly understood[6].

The exploitation of the River Trent Valley becomes clearer with the transition into the Iron Age. Several settlements, including a scheduled monument (NHLE list entry 1003494), have been found close to South and North Muskham (MNT17097, MNT14313, MNT17091, MNT11991, and MNT14315), while an isolated small riverside settlement was found near Cromwell (MNT25849). The Cromwell barrow cemetery also remained in use during the Iron Age (MNT15145). In addition to the above, the aerial mapping exercises have also recorded a plethora of field enclosures, boundaries, pit alignments, hut circles/ring ditches, and linear features that June be of late prehistoric origin. Overall, there is a wealth of evidence that shows that this part of the River Trent Valley was heavily settled and exploited during the Iron Age.

4.3.2 Romano-British

Based on the current evidence, the Romano-British period is marked by a general abandonment of the earlier settlement pattern and establishment of new settlements within the landscape. The land around South Muskham, North Muskham, and Little Carlton continued to be the focus for habitation with seven settlements discovered (MNT17089, MNT17090, MNT8243, MNT8265, MNT17098, MNT8290, and MNT14318). However, similar levels of activity appear around Cromwell with a possible Romano-British villa located 430 m to the east of the site and an extra-mural settlement, designated a scheduled monument (NHLE list entry 1003490), discovered 60 m west of the site.

Four of the settlements discussed above fall within the site (MNT8243, MNT8265, and MNT17089), including the Scheduled settlement discussed above (NHLE list entry 1003490). However, the aerial mapping exercises also identified a large number of regular enclosures which could be of Romano-British origin within the site's boundaries.

4.3.3 Anglo-Saxon

The Domesday Book of 1086 can be used to identify settlements that existed prior to the Norman Conquest. South Muskham, North Muskham, Little Carlton, Cromwell, Kneesall (referred to as 'Cauton'), Kelham, and Averham, all of which sit with the 1.5 km study area, are documented as being in existence in 1066 and would have had their origins in at least the Late Anglo-Saxon period.

Most of the NHER records relate to finds recovered during fieldwalking exercises completed on the fields that surround known Anglo-Saxon centres, such as North Muskham and South Muskham (MNT11098, MNT11050, MNT11732, MNT11047, MNT8286, MNT2881,

[6] Cooper, N (ed) 2006. The Archaeology of the East Midlands. Available at: https://researchframeworks.org/emherf/

MNT11042, and MNT3098) and Kneesall (MNT12174, MNT8556, MNT17128, and MNT12172). The recovery of the material helps define the main areas of activity during the period showing that landscape use June have been confined to the immediate hinterland of known settlements.

4.3.4 Medieval

The medieval period is characterised by an intensification in settlement activity and landscape use within the River Trent valley. The NHER has mapped many former medieval villages/hamlets located in the study area, most represented as shrunken or deserted villages, alongside known sites of medieval manors and deer parks (some of the manor sites are designated as Scheduled Monuments). One of these, the medieval deserted village of Little Carlton, which is a scheduled monument, falls partially within the site (MNT14312; NHLE list entry 1019870).

Similar to the proceeding periods, most of the archaeological evidence for medieval activity takes the form of finds recovered during fieldwalking exercises. While the material could reflect further areas of settlement, it was common practice to add pottery to fields as part of the arable farming regime. This data at least shows a wider utilisation of the study area for agricultural uses, and it is possible that some of the features identified during the aerial mapping exercises are of medieval origin.

4.3.5 Post-medieval and Modern

The post-medieval period was a time of continuity and development for the River Trent valley. Until the passing of Enclosures Acts, much of the landscape was not too dissimilar to what had been created during the medieval period. The medieval interspersed settlement pattern remained with the local peoples still relying on agriculture for employment. However, the period was also marked by the rise of the landed gentry and development of large estates. Within the study area are four parks of varying size associated with an existing or former large country house, and include Ossington Hall (MNT26679), Kelham Hall (MNT26671), Averham Park (MNT26653), Winkburn Park (MNT26694), and Beesthorpe Hall (MNT26658).

Of the parks discussed above, Averham Park falls within the site (MNT26653). The park is first shown on Chapman's map of 1774 and was described in 1835 as “park which was heretofore an ornament to the neighbourhood, and a splendid appendage to the mansion … on it remains the keeper's house and a few of the park fence”. Little is known of the original layout of the parkland as Chapman’s map is of limited detail and later Ordnance Survey (OS) mapping shows the land as fields. Lost parkland features June fall within the site.

According to the NHER, two brick yards fell within the site. The first brick yard is located south-west of Little Carlton and was created during the post-medieval period (MNT14403). After it fell out use, woodland was planted over the brick yard, which is first shown on the 1st edition OS map. The second brick yard is of modern date and located northeast of Upton (MNT14432). The brickworks fell out of use by 1915.

Post-medieval mapping shows that the site was located within post-enclosure field systems by the end of the 19th century. Few changes have occurred to the field system since. In the study area, the main changes illustrated comprise the construction of the Great Northern Railway line, development of industrial sites and expansion of the villages/settlements.

The majority of the NHER records of post-medieval and modern date relate to former or existing structures found throughout the study area. They comprise of farmsteads, residential buildings, structures associated with the railway, estate structures, and former industrial sites.

4.3.6 Undated

As discussed above, aerial mapping exercises have identified a large number of cropmarks/features within the study area, many of which fall within the site's boundaries. The NHER entries for each designated set of cropmarks provided little detail about them, other than their general shape and form (i.e., regular enclosures, hut circles, linear etc). Apart from the hut circles/ring ditches, which are associated with prehistoric settlement practices, the rest of the cropmarks/features could be of any date prior to the establishment of the post-enclosure field systems.

5 METHODOLOGY

5.1 Introduction

The geophysical survey was undertaken between 31 October – 11 November 2022 and 20 – 22 February 2023.. Of the total 69.5 ha site, an overall coverage of 61.6 ha was achieved, with small patches of the site deemed unsuitable for survey at the time which the works were being undertaken.

The methods and standards employed throughout the geophysical survey conform to that set out in the Written Scheme of Investigation[7] (WSI), as well as to current best practice, and guidance outlined by the Chartered Institute for Archaeologists'[8] and European Archaeologiae Consilium[9].

5.2 Aims and objectives

The aims of the survey comprise the following:

- To determine, as far as is reasonably possible, the nature of the detectable archaeological resource within a specified area using appropriate methods and practices; and
- To inform either the scope and nature of any further archaeological work that June be required; or the formation of a mitigation strategy (to offset the impact of the development on the archaeological resource); or a management strategy.

In order to achieve the above aims, the objectives of the geophysical survey are:

- To conduct a geophysical survey covering as much of the specified area as possible, allowing for on-site obstructions;
- To clarify the presence/absence of anomalies of archaeological potential; and
- Where possible, to determine the general nature of any anomalies of archaeological potential.

5.3 Fieldwork Methodology

The cart-based gradiometer system used a Leica Captivate RTK GNSS instrument, which receives corrections from a network of reference stations operated by the Ordnance Survey (OS) and Leica Geosystems. Such instruments allow positions to be determined with a precision of 0.02 m in real-time and therefore exceeds European Archaeologiae Consilium recommendations (Schmidt et al. 2015).

The detailed gradiometer survey was undertaken using four SenSys FGM650/3 gradiometers spaced at 1 m intervals and mounted on a non-magnetic cart. Data were

[7] ERM, 2022 Written Scheme of Investigation: Geophysical Survey Land to the West of A1, North of Staythorpe, Nottinghamshire. Report ref. 22036

[8] Chartered Institute for Archaeologists [CIfA] 2014a Standards and guidance for archaeological geophysical survey. Reading, CIfA

[9] Schmidt, A, Linford, P, Linford, N, David, A, Gaffney, C, Sarris, A and Fassbinder, J. 2015 Guidelines for the use of geophysics in archaeology: questions to ask and points to consider. EAC Guidelines 2, Belgium: European Archaeological Council.

collected with an effective sensitivity of 0.03 nT at a rate of 10 Hz, producing intervals of 0.15 m along transects spaced 4 m apart.

5.4 Data processing

Data from the survey were subjected to minimal correction processes. These comprise a 'Destripe' function (±5 nT thresholds), applied to correct for any variation between the sensors, and an interpolation used to grid the data and discard overlaps where transects have been collected too close together.

Further details of the geophysical and survey equipment, methods and processing are described in Appendix 1.

6 DATA PRESENTATION

The processed data are exported as georeferenced TIFF files. The interpretation layers are digitised as ESRI shapefiles. The images and interpretation shapefiles are then used to produce the final figures in a GIS.

The gradiometer data are displayed at -2nT (white) to +3nT (black) for the greyscale image.

7 GRANGE FARM - FIELD 115 – 118 AND 281 – 283

7.1 Site details

A detailed gradiometer survey was carried out over Fields 115 – 118 and 281 – 283, North Muskham (centred on NGR 478674 359141) (Figure 4 – 13).

This survey comprises six arable fields. The survey area is bounded by Vicarage Lane to the north, a railway line to the east, agricultural buildings and Great North Road to the south-east, and agricultural fields to the south and west. Agricultural buildings and a residential building are located just outside the western boundary of Field 118. Bathley Lane separates Fields 117 and 118.

The survey area is relatively flat at between 11 – 12 m aOD.

The underlying geology across the survey area is recorded as Mudstone of the Mercia Mudstone Group with superficial deposits of sand and gravel of the Holme Pierrepont Sand and Gravel Member[10].

The soils underlying the majority of this survey area are likely to comprise gleyic brown earths of the Arrow (543) association with a small band of pelo-alluvial gley soils of the Compton (813e) association[11] along the western boundary. Soils in such geological settings have been demonstrated to produce magnetic contrasts suitable for the detection of anomalies through gradiometer survey.

7.2 Archaeological background

7.2.1 Listed Buildings

There are five post-medieval Grade II listed buildings within 500 m of the survey area, all located on the eastern and northern extents of the village of North Muskham. These comprise a hotel (formerly a vicarage) (NHLE 1369986) and associated coach house (NHLE 1045947), a house (formerly a vicarage) (NHLE 1045948) and associated outbuilding, and railings and gate (NHLE 1045949 & 1370006).

7.2.2 Prehistoric

The earliest archaeological activity in the area is evidenced by three Neolithic flint findspots within Fields 115 and 117 in the form of flint axes, blades, and scrapers (MNT5586-8). Additionally, in the north-east of Field 118 a Neolithic greenstone axe was discovered (MNT3043), and on another occasion, a Bronze Age barbed and tanged arrowhead (MNT5583).

Other Bronze Age flints have been discovered 440 m to the north of Field 116 (MNT2965) and 300 m to the east of Field 118, which June also be late Neolithic (MNT11015).

260 m to the north-west of survey area a number of enclosures and a pit alignment (MNT2948) were discovered which, though undated by material evidence, are likely of prehistoric origin. However, an Iron Age pottery sherd and a prehistoric flint blade (Mesolithic - Iron Age) were recorded as associated finds.

7.2.3 Iron Age – Roman

The only Roman activity in the parcel consists of a single pottery findspot 300 m to east of Field 118 (MNT11025).

[10] Geology of Britain viewer. http://mapapps.bgs.ac.uk/geologyofbritain/home.html (Accessed on 01/04/2022)
[11] Soil Survey of England and Wales, 1983

7.2.4 Medieval

In the same location as the above finds, 300 m to the east of Field 118, early medieval or roman pottery was identified (MNT11050), along with some medieval and post medieval pottery sherds (MNT11051).

7.2.5 Post-medieval

Most of the post-medieval presence in the parcel is represented through the listed buildings still upstanding (see above), however 375 m to the east of Field 118 was once the site of a post-medieval windmill (MNT14485).

7.2.6 Undated

The parcel contains several undated archaeological features identified via aerial photography and cropmarks. Within Fields 115 – 118 seven areas of interest have been recorded; linear features in Fields 115 and 116 (MNT2950) and an enclosure ditch in that same location (MNT9634); field boundaries, a boat shaped enclosure and a pit alignment spreading over the southern edge of Fields 115 and 116 and the northern edge of Field 117 (MNT8257); an undated settlement comprising enclosures and a possible hut circle in the south-east of Field 117 (MNT17093); as well as rectilinear enclosures to the south of a possibly later date (MNT8259); and enclosure ditches and linear features in Field 118 (MNT2955, 2956).

Outside of the survey area the density of undated archaeological features is quite high. Immediately to the north of Field 116 a cropmark complex (MNT2964) and a series of linear features (MNT2949) have been identified, along with partially destroyed linear features and a pit alignment 85 m east of the parcel (MNT8277), cut through by the A1, and a circular enclosure 90 m west of Field 117 (HER L2973).

Slightly further out of the survey area, 230 m to the west of Field 115 (MNT2953) an undated linear feature and pit alignment, possibly within a large rectangular enclosure, has been identified along with another linear feature and pit alignment just beyond that 350m west of the parcel (MNT2951).

300 m east of Field 118 an undated linear feature and ring ditch (MNT8278, 8280) and some fire-cracked pebbles (MNT11073), though they are not necessarily contemporaneous.

Towards the furthest extents of the study area a crop mark complex has been identified 400 m to the east of Field 118 (MNT8281), 500 m to the west of the parcel lies a series of enclosures (MNT8262), and 500 m to the north a double ring ditch was identified via aerial photography (MNT4158) and a group of post holes and a paleochannel was uncovered via trenching (MNT11971).

7.3 Detailed gradiometer survey results

The detailed gradiometer survey was carried out over 31 October – 11 November 2022 and 20 – 22 February 2023. covered 44.91 ha of the 46.77 ha survey area. The survey has identified possible multi-phase settlement activity in the form of possibly linked Romano-British enclosures and Iron-Age ring ditches.

Results are presented as a series of greyscale plots and archaeological interpretations, at a scale of 1:2000 (Figures 4 – 13). The interpretation of the datasets highlights the presence of potential archaeological anomalies, ferrous, burnt or fired objects, and magnetic trends (Figure 3).

7.3.1 Interpretation: Archaeology and Possible Archaeology

An assortment of curvilinear and rectilinear anomalies have been recorded in the western portion of the parcel in Field 283 at GRF-0001 and GRF-0002 (Figure 11). The anomalies are between 1 – 3 m wide, orientated broadly north – south over an area 70 m wide and 120 m long. Due to the presence of overhead powerlines, a 15 m wide, north – south corridor of Field 283 has not been surveyed. This was done to avoid interference with the magnetometry equipment. This unsurveyable corridor unfortunately cuts through the both GRF-0001 and GRF-0002.

The southern anomalies at GRF-0001 are enclosed within a 65 m wide by 75 m long rectilinear and can be subdivided into 3 areas at a – c. Area a is located in the north-western portion of the grouping, consisting of a penannular anomaly with a break to the north. It has an almost complete circumference of 53 m. Area b to the east is made up of a partial square-shaped rectilinear 30 m wide by 30 m long. The centre of this anomaly is located beneath the unsurveyable powerlines. Area c consists of linear anomalies to the south-west, indicating internal linear anomalies in addition to delineating the southern and western extents of GRF-0001.

The northern series of linear and curvilinear anomalies at GRF-0002 are confined to a smaller area 10 m north of GRF-0001, 60 m wide by 40 m long. The grouping consists of two areas at a and b. Anomalies in area a are 2 m wide, orientated either north – south or east – west. These combine to form the partial remains of square-shaped rectilinear anomalies. Area b comprises two small penannular anomalies, with 5 m respective diameters, attached to a 50 m long linear anomaly orientated east – west.

The series of anomalies identified at GRF-0001 and GRF-0002 are likely ditches that have combined to form larger structures. The linear and rectilinear ditches are likely representative of enclosures. Which, given their form and orientation could be indicative of a Romano-British origin. Whilst the penannular anomalies are the correct form and size to represent the remains of drip gullies associated with round houses, possibly originating from the Iron Age. These findings therefore could be an example of multi-phase settlement activity from the Iron Age to the Romano-British period, similar to the Iron Age enclosures and pit alignments located 260 m to the north-west of the area.

A complex assortment of interconnected, positive, rectilinear anomalies has been identified in the north-western corner of Field 118 at GRF-0003 (Figure 13). The anomalies are confined within an area 70 m wide by 90 m long. Most anomalies are between 1 – 2 m wide and aligned on a co-axial NNE-SSE and WNW-ESE orientation. A penannular anomaly has also been identified centrally with a 12 m diameter and break to the south. Although relatively fragmented in parts, these positive anomalies likely represent ditch features, possibly relating to a larger enclosure and ring-ditch of uncertain origin. Within the broader external limits of the enclosure, some of the internal ditches could relate to further divisions creating rooms or sub-sections. Although further investigation would be necessary in establishing a definitive date and context for this feature.

In the southern end of the scheme, a positive rectilinear anomaly has been recorded in the south of Field 118 at GRF-0004 (Figure 13). The anomaly is broadly orientated east – west, covering an area 55 m wide by 40 m long. Its sub-rectangular form is between 1 – 2 m wide and slightly indented to the south-east. This anomaly is likely a collection of ditches that combine to form an isolated enclosure of unknown origin.

Two weakly positive linear anomalies have been identified in Field 115 at GRF-0005 (Figure 7). The two anomalies are of similar size and orientated, between 2 – 3 m wide by 80 – 85 m long orientated WNW – ESE. It is suggested that these anomalies could be ditches associated with archaeological origin. Given their proximity and shared alignment to the recorded former field boundary immediately south, however, it is also possible that

these anomalies are representative of former boundaries not recorded on OS mapping. They could equally be related to geological variation or modern agricultural practices.

A similar interpretation can be applied to the strongly positive rectilinear anomalies in Field 117 at GRF-0006 (Figure 9). These anomalies appear to be a continuation of a former field boundary to the west, on the same WNW – ESE orientation but are not recorded on OS mapping. It is possible that the 2 – 3 m wide anomalies are ditches of archaeological origin but is more likely that they represent boundary ditches associated with the former field boundary to the west. Equally, they could be enhanced agricultural trends or associated with ridge and furrow to the immediate east.

An isolated rectilinear anomaly has been identified in Field 117 at GRF-0007 (Figure 9). The anomaly is 2 m wide consisting of positive magnetic properties. Anomaly GRF-0007 is 10 m north – south on its eastern extent, it then turns west for an additional 10 m, north for 14 m and finally returns east for 5 m along its northern extent. It forms a sub-square shape, oriented north-east to south-west with a slight break to the north-east. It is possible that this anomaly is a ditch that highlights the partial remains of a small enclosure. Given the anomaly's isolation from any supporting archaeological evidence, however, it is also possible that it is geological in origin or related to modern agricultural practices.

Immediately north-west of the settlement activity at GRF-0002, a pair of positive linear anomalies have been recorded at GRF-0008 (Figure 11). These anomalies are between 1 – 2 m wide and 30 – 35 m long, orientated broadly north – south. It is expected that these anomalies are defensive boundary ditches associated with the settlement activity to the south. Given their far weaker magnetic properties and similar orientation to the surrounding agricultural anomalies, they may simply reflect enhanced agricultural trends.

7.3.2 Interpretation: Historical Agriculture

Several former field boundaries have been identified across the parcel at GRF-0009 – GRF-0014 (Figures 7 and 13). These field boundaries are all first recorded on OS mapping from 1888 but have been modified or removed at different times since. Boundaries GRF-0009 – GRF-0012 were all still visible on OS mapping dated from 1965 but are no longer visible by the time that satellite imagery was taken of the area in 2004 (Google 2023). Whilst boundaries GRF-0013 – GRF-0014 are last recorded on OS mapping from 1914.

Two historic landscape features have also been recorded across the parcel at GRF-0015 – GRF-0017 (Figures 11 and 13). The first is an area containing the suspected demolished remains of a building or structure, present in the south of Field 118 on 1888 OS mapping at GRF-0015. The second is a former footpath or access track visible on satellite mapping in 2017 and 2020 (Goggle 2023) at GRF-0016 and GRF-0017. It is also possible that this anomaly is representative of a modern land drain.

In Fields 117 and 118, isolated areas of weak, positive, parallel linear anomalies aligned east–west have been recorded at GRF-0018 – GRF-0020 (Figures 9 and 13). These anomalies have a regular spacing and slightly stronger magnetic properties than surrounding agricultural trends and are thought to be indicative of ridge and furrow. Their generally straight nature suggest a post-medieval origin.

7.3.3 Interpretation: Modern Agriculture

Evidence of modern agriculture has been recorded across the parcel as enhanced linear trends. The majority of these trends are likely associated with modern ploughing.

7.3.4 Interpretation: Natural

There are multiple large bands of low-magnitude anomalies across the south of the parcel. Due to their lack of clear shape or pattern, these have been interpreted as natural

geological variations, thought to be caused by variations in the depth and composition of the soils and the superficial deposits from which they derive. The most dominant examples of this can be seen in Field 116 and 117 (Figure 7). Some more isolated and coherent geomorphological anomalies such as paleochannels, hollows, and former higher grounds have also been identified across the in Field 283 and 117.

7.3.5 Interpretation: Modern

Numerous small, isolated, dipolar anomalies have been recorded throughout the survey, typically caused by ferrous material, either on the ground surface or in the plough-soil. There is no obvious pattern or clustering to their distribution in this survey to suggest anything other than a random background scatter of ferrous debris in the plough-soil. Further examples of ferrous responses have been identified around the periphery of certain areas. This is likely due to metal fencing within the boundaries and interference from the adjacent roads and tracks. A land drain has also been identified due to its straight form and negative magnetic properties.

A strongly dipolar linear anomaly has been identified in the north of Field 118, protruding from Bathely lane to the south-west for 72 m at GRF-0021 (Figure 13). This is indicative of a modern service.

Several areas of increased magnetic response have been identified across the area. Evidence of agricultural activity associated with fertilisation has been identified in Field 281 and 283, GRF-0022 – GRF-0025 (Figures 5 and 11). Whilst in the south of Field 283 an isolated area of intense linear disturbance has been recorded at GRF-0026 (Figure 11), possibly associated with the extraction or deposition of heavily magnetic material. This disturbance limits the effectiveness of the survey and our ability to interpret what is and isn't there.

7.3.6 Interpretation: Unknown

Isolated linear and curvilinear anomalies have been recorded across the parcel. These anomalies are of unknown origin, due to their faint magnetic properties. It is possible that some may be associated with archaeological features when identified in close proximity. The majority, however, are likely geological in origin or the result of modern agricultural practices.

7.4 Preliminary Conclusions

The gradiometer survey has been successful in detecting anomalies of archaeological origin across the parcel, particularly the possible multi-phase settlement activity located in the western portion of the parcel.

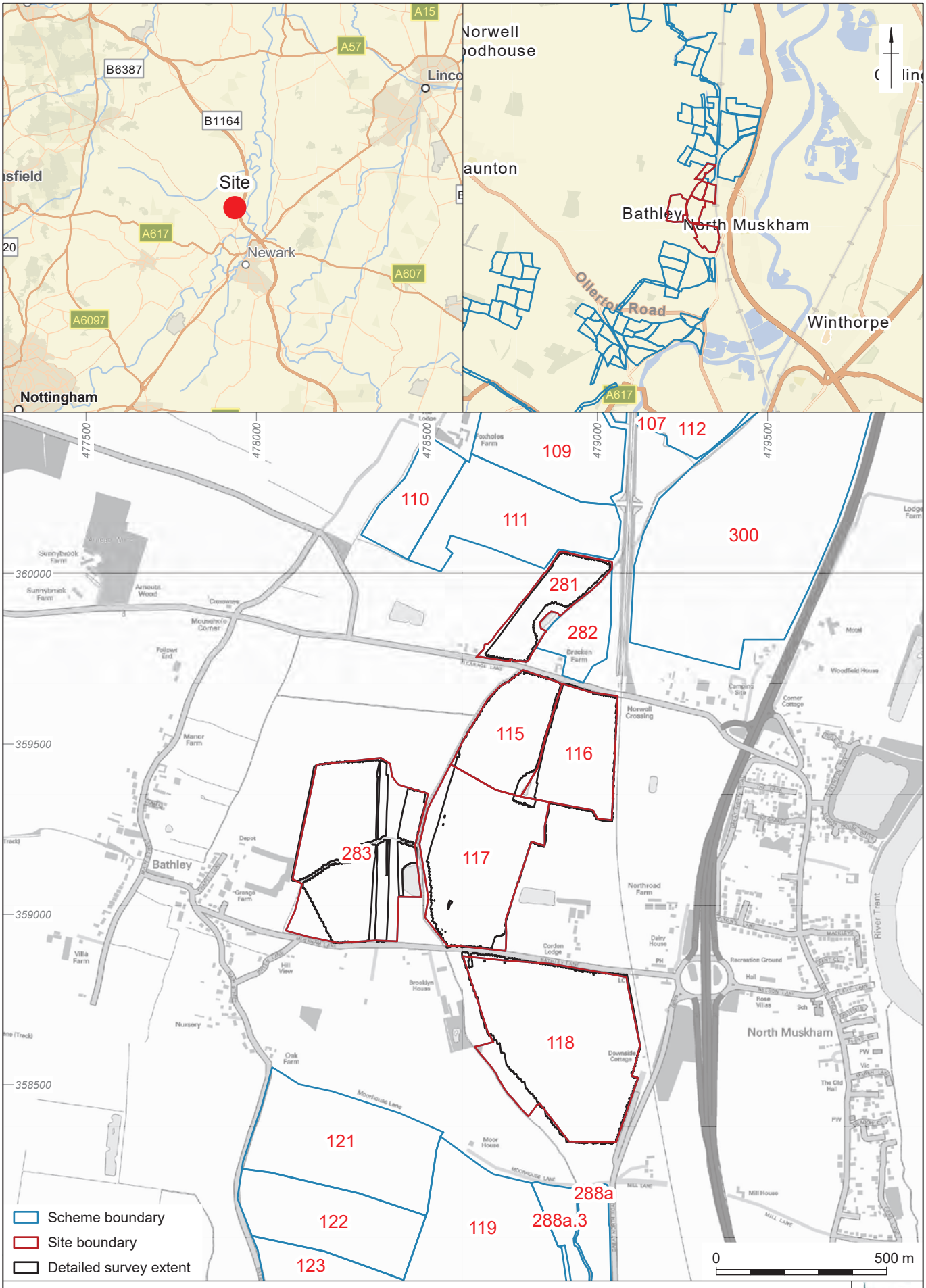
The linear and rectilinear ditches identified in the west of the parcel are representative of enclosures of a Romano-British origin. Whilst the penannular anomalies identified in the same area are the correct form and size to represent the remains of drip gullies associated with round houses possibly originating from the Iron Age. These findings therefore could be an example of multi-phase settlement activity from the Iron Age to the Romano-British period, like the Iron Age enclosures and pit alignments located 260 m to the north-west.

Further evidence for archaeological activity has been recorded in the south-eastern portion of the parcel, where two isolated enclosures of varying size and form have been identified. The larger, more northern, square-shaped enclosure appears more complex containing internal divisions and is surrounded by possible boundary ditches. Whilst the smaller, sub-rectangular enclosure further south does not contain any internal identifying features. The origin of both enclosures is unknown, further investigation will be necessary in establishing a date and context for this feature.

Several possible ditches have also been recorded across the parcel, expected to be representative of either; former boundaries not recorded on OS mapping, possible boundary ditches and the partial remains of a small enclosure. It is also possible that these anomalies are natural or agricultural in origin.

Evidence of the parcel's historical past has been recorded in the form of several former field boundaries, historic landscape features and areas of ridge and furrow. A modern service and evidence of modern fertilisation has also been recorded.

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Figure 1: Site location and survey extents

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Figure 4

Figure 6

Figure 8

Figure 10

Figure 12

Site boundary

Detailed survey extent

-2 nT 3 nT

0 250 m

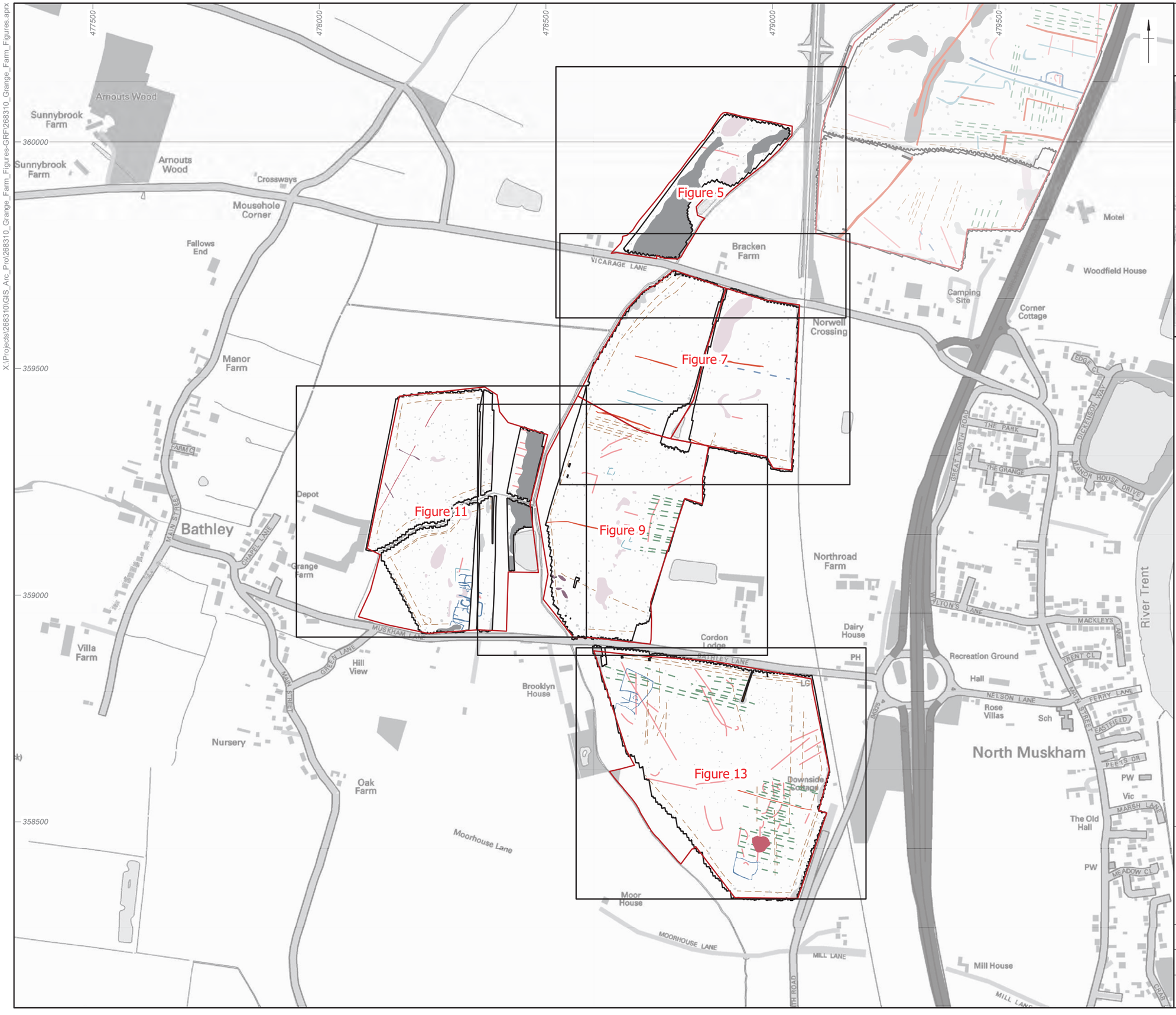
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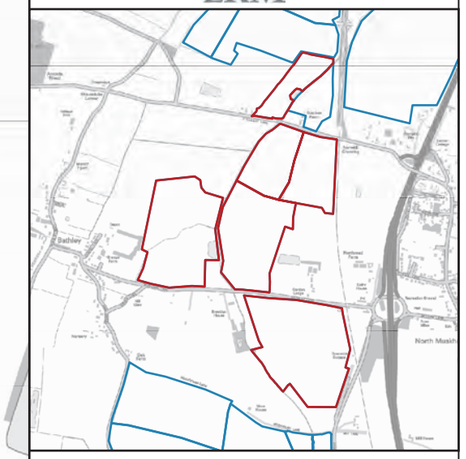
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Figure 2: Detailed gradiometer survey results: overall greyscale plots (-2nT to 3nT)

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ERM

- Site boundary
- Detailed survey extent
- Archaeology
- Possible archaeology
- Former field boundary
- Historic landscape feature
- Geology
- Geomorphology
- Historic cultivation
- Modern service
- Increased response
- Ferrous
- Agricultural feature
- Drain
- Trend

0 250 m

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Figure 3: Detailed gradiometer survey results: overall interpretation

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478800

479000

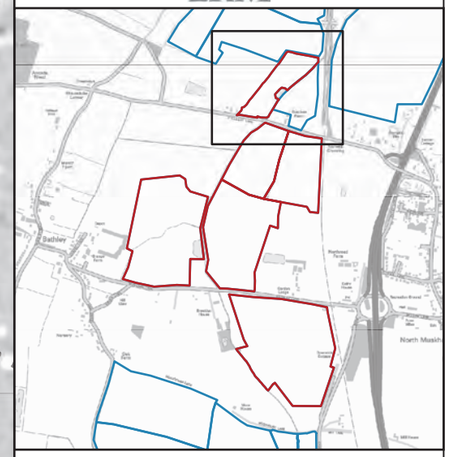
360000

359800

Bracken Farm

VICARAGE LANE

ERM



Site boundary

Detailed survey extent

-2 nT

3 nT

0

50 m

Coordinate system: OSGB 1936 British National Grid
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Figure 4: Detailed gradiometer survey results: greyscale plot (281)

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478800

479000

360000

359800

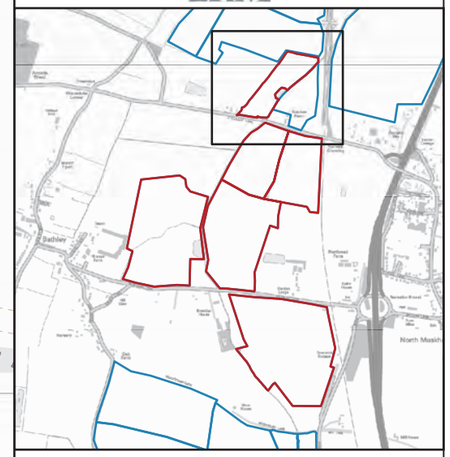
GRF-0023

GRF-0022

Bracken Farm

VICARAGE LANE

ERM



- Site boundary
- Detailed survey extent
- Archaeology
- Possible archaeology
- Former field boundary
- Historic landscape feature
- Geology
- Geomorphology
- Historic cultivation
- Modern service
- Increased response
- Ferrous
- Agricultural feature
- Drain
- Trend

0 50 m

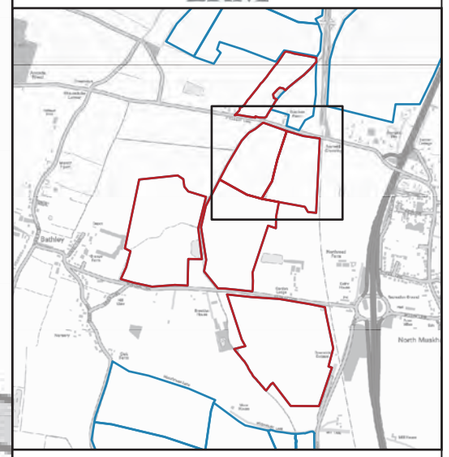
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Figure 5: Detailed gradiometer survey results: interpretation (281)

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Site boundary

Detailed survey extent

-2 nT 3 nT

0 50 m

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Figure 6: Detailed gradiometer survey results: greyscale plot (115 - 116)

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ERM

VICARAGE LANE

Bracken Farm

Norwell Crossing

478600

478800

479000

359600

359400

GRF-0013

GRF-0014

GRF-0005

GRF-0009

GRF-0010

GRF-0007

Site boundary
Detailed survey extent
Archaeology
Possible archaeology
Former field boundary
Historic landscape feature
Geology
Geomorphology
Historic cultivation
Modern service
Increased response
Ferrous
Agricultural feature
Drain
Trend

0 50 m

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Figure 7: Detailed gradiometer survey results: interpretation (115 - 116)

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359400
359200
359000
478400
478600
478800

Cordon Lodge

ERM

Site boundary
Detailed survey extent

-2 nT
3 nT

0
50 m

Coordinate system: OSGB 1936 British National Grid
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Date: 05/07/2023 | Created by: ADT
Scale: 1:2000 | Revision: 0

Figure 8: Detailed gradiometer survey results: greyscale plot (117)

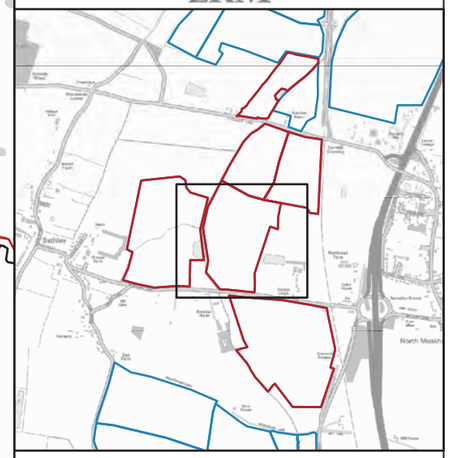
X:\Projects\268310\GIS_Arc_Pro\268310_Grange_Farm_Figures-GRF\268310_Grange_Farm_Figures.aprx

359400
478400
478600
478800
359200
359000

GRF-0009
GRF-0010
GRF-0007
GRF-0024
GRF-0025
GRF-0011
GRF-0018
GRF-0006

Cordon Lodge

ERM



Site boundary
Detailed survey extent
Archaeology
Possible archaeology
Former field boundary
Historic landscape feature
Geology
Geomorphology
Historic cultivation
Modern service
Increased response
Ferrous
Agricultural feature
Drain
Trend

0 50 m

Coordinate system: OSGB 1936 British National Grid
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Figure 9: Detailed gradiometer survey results: interpretation (117)

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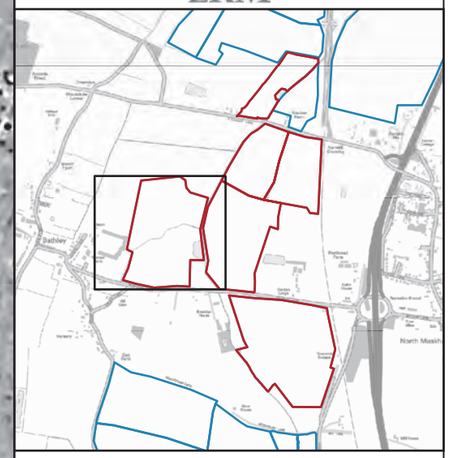
478000
478200
478400
359400
359200
359000

Depot

range
Farm

MUSKHAM LANE

ERM



Site boundary

Detailed survey extent

-2 nT 3 nT

0 50 m

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Figure 10: Detailed gradiometer survey results: greyscale plot (283)

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478000
478200
478400
359400
359200
359000

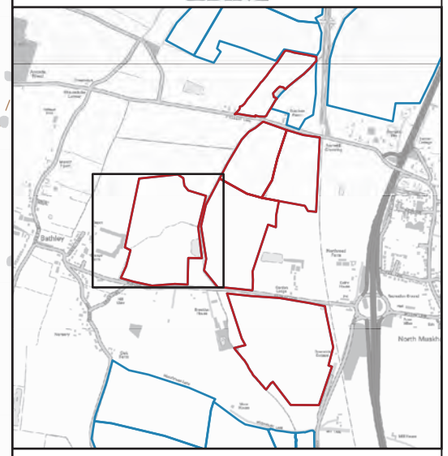
GRF-0017
GRF-0016
GRF-0024
GRF-0025
GRF-0011
GRF-0008
GRF-0002
GRF-0001
GRF-0026

a
b
a
b
c

Depot
range
Farm

MUSKHAM LANE

ERM



- Site boundary
- Detailed survey extent
- Archaeology
- Possible archaeology
- Former field boundary
- Historic landscape feature
- Geology
- Geomorphology
- Historic cultivation
- Modern service
- Increased response
- Ferrous
- Agricultural feature
- Drain
- Trend

0 50 m

Coordinate system: OSGB 1936 British National Grid
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Date: 05/07/2023 | Created by: ADT

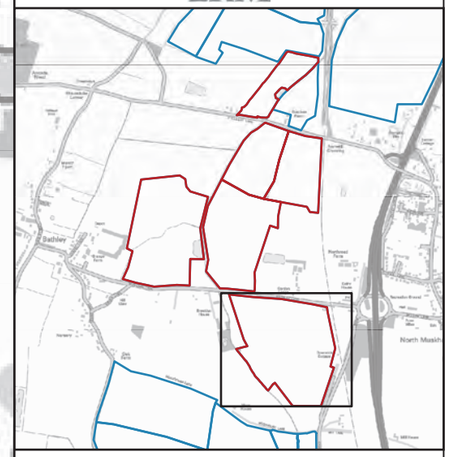
Scale: 1:2000 | Revision: 0

Figure 11: Detailed gradiometer survey results: interpretation (283)

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478600
478800
479000
358800
358600
358400
BATHLEY LANE
Moor

ERM



Site boundary
Detailed survey extent

-2 nT
3 nT

0
50 m

Coordinate system: OSGB 1936 British National Grid
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Figure 12: Detailed gradiometer survey results: greyscale plot (118)

X:\Projects\268310\GIS_Arc_Pro\268310_Grange_Farm_Figures-GRF\268310_Grange_Farm_Figures.aprx

478600
478800
479000
358800
358600
358400

BATHLEY LANE

PH

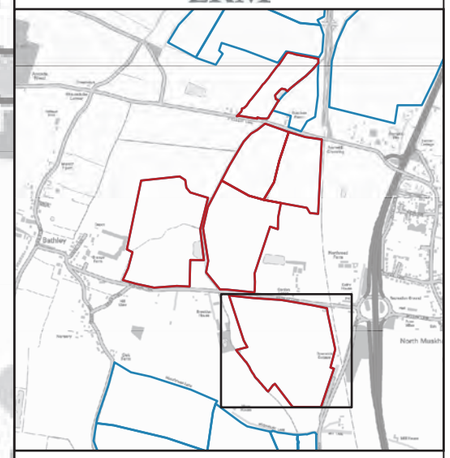
LC

GRF-0003
GRF-0019
GRF-0021
GRF-0012
GRF-0020
GRF-0015
GRF-0004

Downside Cottage

Moor

ERM



- Site boundary
- Detailed survey extent
- Archaeology
- Possible archaeology
- Former field boundary
- Historic landscape feature
- Geology
- Geomorphology
- Historic cultivation
- Modern service
- Increased response
- Ferrous
- Agricultural feature
- Drain
- Trend

0 50 m

Coordinate system: OSGB 1936 British National Grid
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Figure 9: Detailed gradiometer survey results: interpretation (118)

8 APPENDICES

8.1 Appendix 1: Gradiometer Survey Equipment and Data Processing (Sensys)

The magnetic data for this project were acquired using a non-magnetic cart fitted with eight SenSys FGM650/3 magnetic gradiometers. The instrument has four sensor assemblies fixed horizontally 1 m apart allowing four traverses to be recorded simultaneously. Each sensor contains two fluxgate magnetometers arranged vertically with a 0.6 m separation and measures the difference between the vertical components of the total magnetic field within each sensor array. This arrangement of magnetometers suppresses any diurnal or low frequency effects.

The gradiometers have an effective resolution of ±8 µT over ±1000 nT range. All of the data are then relayed to a CS35 tablet, running the MONMX program, which is used to record the survey data from the array of FMG650/3 probes at a rate of 20 Hz. The program also receives measurements from a GPS system, which is fixed to the cart at a measured distance from the sensors, providing real time locational data for each data point.

The cart-based system relies upon accurate GPS location data which is collected using a Leica Captivate system with a rover and base station. This receives corrections from a network of reference stations operated by the Ordnance Survey and Leica Geosystems, allowing positions to be determined with a precision of 0.02m in real-time and therefore exceed the level of accuracy recommended by European Archaeologiae Consilium recommendations (Schmidt et al. 2015) for geophysical surveys.

Data June be collected with a higher sample density where complex archaeological anomalies are encountered, to aid the detection and characterisation of small and ephemeral features. Data June be collected at up to 0.01 m intervals along traverses spaced up to 0.25m apart.

Post-processing

The magnetic data collected during the survey is downloaded from the system for processing and analysis using both commercial and in-house software. This software allows for both the data and the images to be processed to enhance the results for analysis; however, it should be noted that minimal data processing is conducted so as not to distort the anomalies.

Typical data and image processing steps June include:

GPS DeStripe – Determines the median of each transect and then subtracts that value from each data point in the transect within the defined window. June be used to remove the striping effect seen within a survey caused by directional effects, drift, etc.

Discard Overlaps - Intended to eliminate a track(s) that have been collected too close to one another. Without this, the results of the interpolation process can be distorted as it tries to accommodate very close points with potentially differing values.

GPS Base Interpolation – Sets the X & Y interval of the interpolated data and the track radius (the area around each datapoint that is included in the interpolated result).

Typical displays of the data used during processing and analysis:

Greyscale – Presents the data in plan view using a greyscale to indicate the relative strength of the signal at each measurement point. These plots can be produced in colour to highlight certain features but generally greyscale plots are used during the analysis of the data.

XY Plot – Presents the data as a trace or graph line for each traverse. Each traverse is displaced down the image to produce a stacked profile effect. This type of image is useful as it shows the full range of individual anomalies. XY plots can be made available upon request.

8.2 Appendix 2: Geophysical Interpretation

The following categories have been used for interpretation of the data throughout the report.

Archaeology

Used when the form, nature, and pattern of the anomaly are indicative of archaeological material. Further sources of information such as aerial photographs June also have been incorporated in providing the final interpretation.

Possible Archaeology

Used for anomalies that conform to the Archaeology category but have a lower level of confidence due to lack of form, pattern, or nature.

Historic Landscape Feature

Used for anomalies that correspond with features other than historic field boundaries on available mapping. This can include, but is not limited to, park and garden features, areas of woodland, ponds, and extraction pits.

Historic Cultivation

Used to denote historic cultivation regimes that differ from existing modern cultivation. They June differ due to size, orientation, or distribution in the landscape. If possible, LiDAR, aerial, and HER data should be consulted to corroborate results.

Former Field Boundary

Used anomalies that correspond to the position of boundaries marked on available mapping, visible on aerial photographs, or form clear extensions of existing boundaries.

Modern Agricultural feature

Used to identify any anomalies that are representative of modern ploughing or agricultural activity.

Geology

Used to denote natural variations is soils, superficial geology, or bedrock.

Geomorphology

Used to identify anomalies associated with more coherent geomorphological features. This June include, but is not limited to, paleochannels, solution hollows, and former high ground.

Increased Magnetic Response

Used for areas dominated by indistinct anomalies with increased magnetic values. While these June have some archaeological potential they June also relate to natural or modern features.

Modern Service

Used for anomalies indicative of services or service trenches. These are usually magnetically strong linear anomalies but can also be seen as weak anomalies in the case of plastic services where only disturbance associated with the trench is visible.

Drain

Used for anomalies thought to relate to drainage features either due to their nature or corresponding with features on available mapping.

Ferrous

Used for anomalies caused by ferrous material. These anomalies are likely to be of modern origin.

Unknown Feature

Used for anomalies that, due to their nature, pattern, or form, cannot be confidently interpreted. These June have some archaeological potential.

Trend

Used for low amplitude or indistinct linear anomalies that cannot be confidently interpreted. These June have some archaeological potential.