

Land North of A47 Normandy Way and West of A447 Ashby Road

Hinckley, Leicestershire

Documentary Research Report

May 2024

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Richborough**

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Land North of A47 Normandy Way and West of A447 Ashby Road, Hinckley, Leicestershire

Documentary Research Report

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1 INTRODUCTION

- 1.1.1 Oxford Archaeology (OA) has been commissioned by RPS on behalf of Richborough to prepare a Documentary Research report on extensive ridge and furrow remains west of Ashby Road, Hinckley, Leicestershire, henceforth known as 'the site'. The site is centred on SP 427 959, and its location is shown on Figure 1. A written scheme of investigation (WSI) has been prepared for the aerial survey supplemented by this documentary report, and a later trial trenching evaluation at this site (OA 2024).
- 1.1.2 This report has been prepared in accordance with the Chartered Institute for Archaeologists (CIfA) Standards and Guidance for Historic Environment Desk-based Assessments (2020) and Planning Practice Guidance - Historic Environment, published by the Ministry of Housing, Communities and Local Government (2021).

2 DOCUMENTARY RESEARCH – RIDGE AND FURROW

2.1 Historic Background

- 2.1.1 The site is located at the southern extent of the Stoke Golding Rolling Farmland landscape, between the settlements of Barwell and Wykin, c 3km south of Stapleton and c 1.5km north of the historic core of Hinckley, on a westward falling slope that varies between c 124m above Ordnance Datum (aOD) and c 107m aOD (LUC 2017, 49-52).
- 2.1.2 The early medieval origins of these settlements are not well recorded but there are indications of early medieval activity noted in the 1km Historic Environment Record (HER) search detailed in the desk-based assessment (DBA) (RPS 2024). These including one enclosure c 800m to the north of the site at Crabtree Road, Barwell (MLE26653) and a poorly located findspot of a possible sword pommel (MLE24947).
- 2.1.3 Understanding of the site and its landscape improves after the 1086 Domesday survey. Hinckley is mentioned as hinehelie, a settlement in the hundred of Guthlaxton under the lordship of Earl Aubrey of Coucy and comprised sixty-nine households (Domesday Online 2024b). Barwell (Barewelle) and Stapleton (Stapleton) are also recorded in the survey within the same hundred, comprising an estimated 22 households and 13 households respectively. Barwell was under the lordship of St Mary's Abbey, Coventry, and Stapleton was divided between the lordship of the Benedictine houses of St Mary's Abbey, Coventry, St Guthlac's Abbey, Crowland, and Hugh of Gradmesnil (Domesday 2024a; 2024c). These manors passed through several lordships across the medieval period as detailed in Volume 4, Part 2 of the Victoria County History of Leicestershire (Nichols 1811) but few other changes are recorded. By 1564, there were 48 families in Barwell, and 15 in Stapleton (Nichols 1811, 475).
- 2.1.4 The HER search too, included more medieval evidence including a possible moated site near Hinckley Road, Barwell (MLE2804/MLE2818) with an adjacent fishpond (MLE2805/MLE2819), and enclosure (MLE27123). Another indication of medieval activity adjacent to the site are the 'Old Gallows' (MLE2873) noted on a 1785 map (Figure 2), and which are located to the east of the site under a modern housing development. The DBA notes that in addition to the site of a gallows, human remains were recovered in the same

area (MLE2872, RPS 2024). Finally, there is the site of a medieval post-mill or windmill at Middlefield Lane, Hinckley (MLE27223), which may be the Hinckley mill, which first appears in the records in 1326 (Nichols 1811, 670). This mill was excavated during trial trenching on the fields immediately west of the site, to the south of Middlefield Farm and appears to have been constructed between AD 1200 and 1450, and to have burnt down in the 16th century (Groundworks Archaeology 2022, 12-13). Ploughed out remains of medieval ridge and furrow were also encountered across the site in both the evaluation trenches and identified in the earlier geophysical survey (MOLA 2022).

2.2 Ridge and Furrow

- 2.2.1 The DBA noted the presence of extant medieval ridge and furrow on the site, in the fields north and west of Westfield Farm. The presence of the ridge and furrow was confirmed by the LiDAR survey, aerial photography, walkover survey, and geophysical survey (MOLA 2023, RPS 2024; SUMO 2024). No evidence of other medieval features or settlement were identified during that assessment (RPS 2024). This concurs with the medieval character of Leicestershire which Parker (1948, 9) characterises as 'open-field country (champaign), very largely arable ... and in the main devoid of woodland' in 1485.
- 2.2.2 The ridge and furrow on site run from the northeast to the southwest down the slight westward slope described above. This slope would have contributed to the drainage of the fields. The central of the three fields which contained the longest (c 600m) surviving earthworks, probably represent a near complete furlong's length of c 700m (Historic England 2018). The surviving selions (strips) were separated by c 6-9m and are in the usual aratral curve (a reverse 's-shape') characteristic of medieval ploughing with a team of oxen (*ibid*; Eyre 1955; Upex 2004).
- 2.2.3 The ridge and furrow earthworks within the site are described in the DBA as somewhat eroded but with upstanding remains that were noticeable at ground level in both the long central field and the field to the west (RPS 2024). The LiDAR data suggests that there is also evidence of ridge and furrow in the fields immediately north and south of the long central field but that these features would not be as evident at ground level (SUMO 2024).
- 2.2.4 Ridge and furrow cultivation would have dominated the landscape of Leicestershire in the medieval period, but much has been flattened or ploughed out with more modern ploughing techniques (Hartley 2004). The LiDAR data shows that the nearest surviving examples were located c 450m to the northwest and c 1km to the east; in each case in discrete, isolated fields (Figures 3 and 4). These surviving patches of ridge and furrow are likely to have survived because of a shift from arable to animal husbandry, and, in the case of the area within the site, the reorganisation of the local landscape due to the construction of the 19th century Westfield Farm.
- 2.2.5 The other features noted during the above surveys were largely post-medieval and probably related to the enclosure of fields and reorganisation of the landscape during this period. In Leicestershire the reorganisation of the agricultural landscape through enclosure started in small parcels from the 14th century but in the area around the site, the enclosure process appears to have started later in the 16th century: 2 virgates of land at Hinckley were enclosed between 1511 and 1520; 50 acres of land at Stapleton were enclosed between 1581 and 1591, with a further 22 enclosed between 1601 and 1607; and by 1596, 100 acres of the common land from the village of Barwell was

enclosed (Parker 1948, 238, 241, 244). An Act of Parliament received royal assent in 1760 which approved the enclosure of Hinckley's remaining open fields (33 Geo 2. c. 42).

2.3 Discussion

- 2.3.1 The landscape of the site demonstrates that this area of Leicestershire, and specifically the fields in question, had a continuous history of agriculture from at least the medieval period into the 19th century with each successive phase of use influenced by the original medieval organisation of the landscape.
- 2.3.2 Ridge and furrow earthworks in the East Midlands have been assessed for their heritage significance by David Hall on behalf of English Heritage (Hall 2001). The objectives of the *Turning the Plough* report were 'to select priority townships of nationally important examples suitable for preservation' (Hall 2001; Anderton and Went 2002). A 2012 update of the *Turning the Plough* assessment recorded only a 4.24% reduction of ridge and furrow recorded in the 2001 assessment (Catchpole and Priest 2012), and an assessment carried out by Worcestershire County Council (2018) determined that the best method to preserve ridge and furrow earthworks in that county was to restrict the land use to sheep grazing with careful management. The site discussed here was within the study area of the original report but was not identified as a priority township area for preservation of the ridge and furrow. Nevertheless, the ridge and furrow does represent the survival of aspects of an otherwise erased medieval landscape of this area north of Hinckley.

3 BIBLIOGRAPHY

Anderton, M, and Went, D, 2002 Turning the plough: Loss of a landscape legacy, *Conservation Bulletin* **42**: 52-55

Catchpole, T, and Priest, R, 2012, Turning the Plough Update Assessment 2012, English Heritage Report 60/2012, Gloucestershire County Council / English Heritage

Eyre, S R, 1955 The Curving Plough-strip and its Historical Implications, *Agricultural History Review* **3**(2): 80-94

Groundworks Archaeology, 2022 Archaeological Evaluation Report: Land East of Stoke Road and North of Normandy Way, Hinckley, Leicestershire, unpubl report

Hall, D, 2001 *Turning the Plough. Midland open fields: landscape character and proposals for management*, English Heritage / Northamptonshire County Council

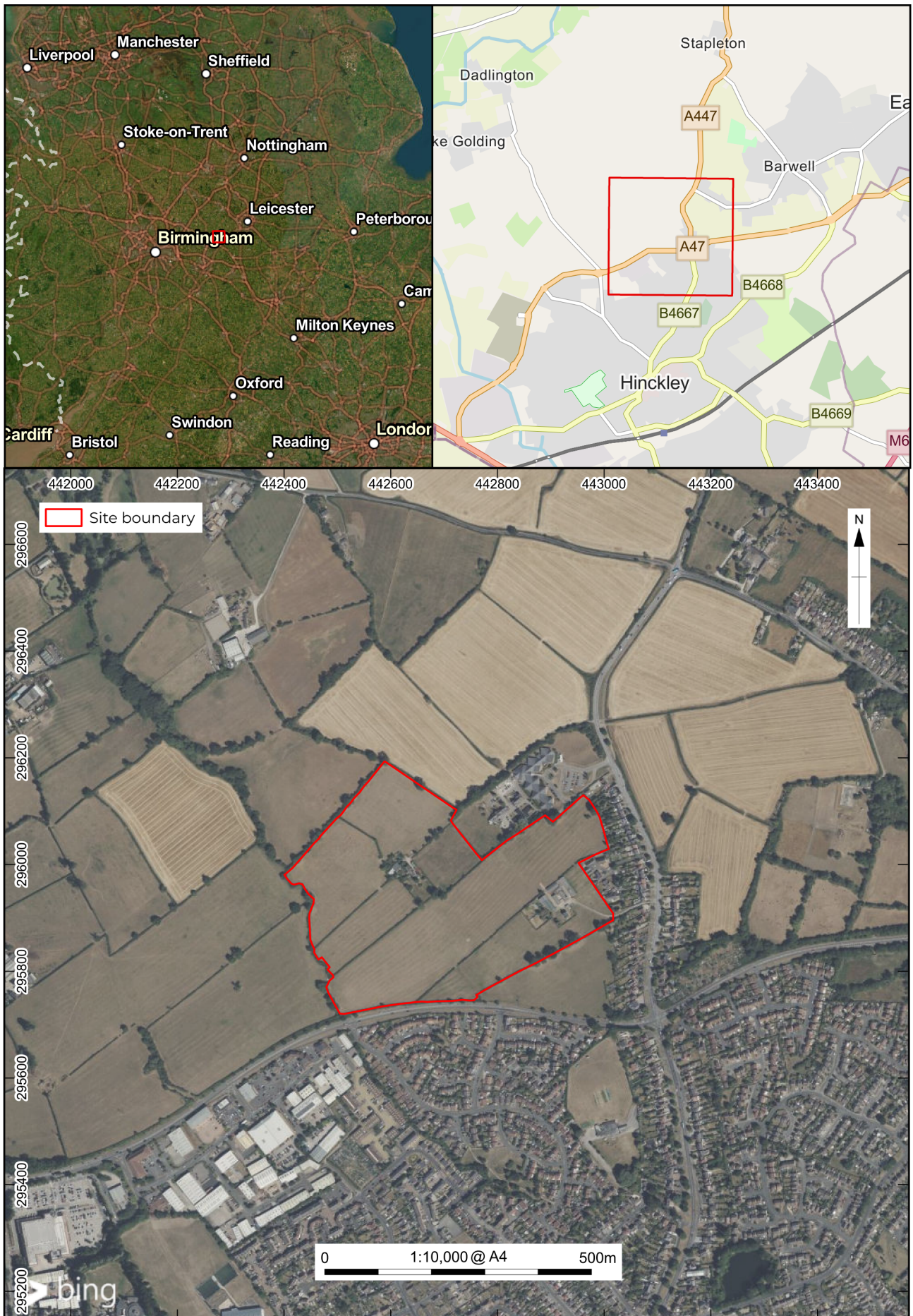
Hartley, R F, 2004 Mapping the Medieval Landscape, in Bowman, P, and Liddle, P, *Leicestershire Landscapes*, Leicestershire Museums Archaeological Fieldwork Group Monograph **1**, Leicester, leicsfieldworkers.org/wp-content/uploads/2021/03/14-hartley.pdf, accessed 23/05/2024

Historic England, 2018 *Field Systems: Introductions to Heritage Assets*, Swindon

LUC, 2017 Hinckley and Bosworth Borough Landscape Character Assessment, report prepared for Hinckley and Bosworth Borough Council

- Ministry of Housing, Communities and Local Government, 2019. *Planning Practice Guidance – Historic Environment*
- MOLA, 2022 Archaeological geophysical survey on land north of Normandy Way, Hinckley, Leicestershire, unpubl Museum of London Archaeology report reference 22/014
- MOLA, 2023 Archaeological geophysical survey on land north of Normandy Way, Hinckley, Leicestershire Phase 2, unpubl Museum of London Archaeology report reference 23/088
- Nichols, J, 1811 *The History and Antiquities of the County of Leicester: Volume IV, Part II Containing Sparkenhoe Hundred*, London
- OA, 2024 Land North of A47 Normandy Way and West of A447 Ashby Road, Hinckley, Leicestershire: Written Scheme of Investigation, unpubl Oxford Archaeology document
- Open Domesday, 2023a Barwell, opendomesday.org/place/SP4496/barwell/, accessed 23/05/2024
- Open Domesday, 2023b Hinckley, opendomesday.org/place/SP4293/hinckley/, accessed 23/05/2024
- Open Domesday, 2023c Stapleton, opendomesday.org/place/SP4398/stapleton/, accessed 23/05/2024
- Parker, L A, 1948 Enclosure in Leicestershire, 1485-1607, PhD Thesis, University of Leicester, hdl.handle.net/2381/35582, accessed 23/05/2024
- Parliament of Great Britain, 1760 An Act for enclosing and dividing the Open and Common Fields of Hinckley, in the County of Leicester, 33 Geo. 2. c. 42
- RPS, 2024 ARCHAEOLOGICAL DESK-BASED ASSESSMENT: Land North of A47 Normandy Way and West of A447 Ashby Road, Hinckley, unpubl RPS report
- SUMO, 2024 Normandy Way, Hinckley, Leicestershire: RGB and Multispectral UAS Landscape Survey, unpubl SUMO Geophysics Ltd. report
- CIfA, 2020. *Standard and Guidance for historic environment desk-based assessment*, Chartered Institute for Archaeologists
- Upex, S, 2004 A classification of ridge and furrow by an analysis of cross-profiles, *Landscape History*, **26**(1): 59-75
- Worcestershire County Council, 2018 A Resource Assessment of Ridge and Furrow: Challenges for Conservation in Landscapes of Change Final Report, Worcestershire County Council report 7618MAIN

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World Imagery: Earthstar Geographics
OpenStreetMap: Map data © OpenStreetMap contributors, Microsoft, Facebook, Inc.

Figure 1: Site location

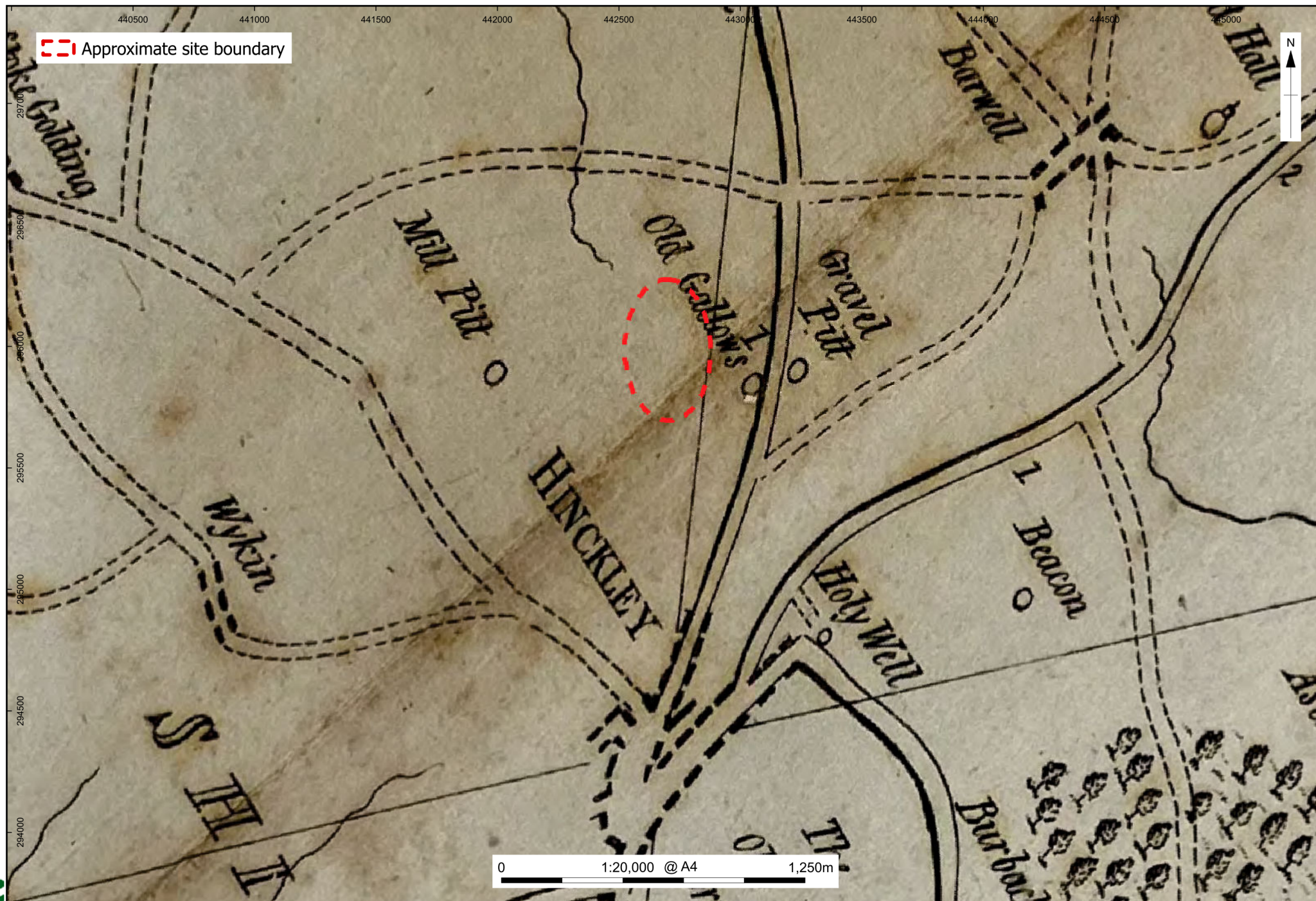


Figure 2: 1785 Map of the county five miles round Hinckley

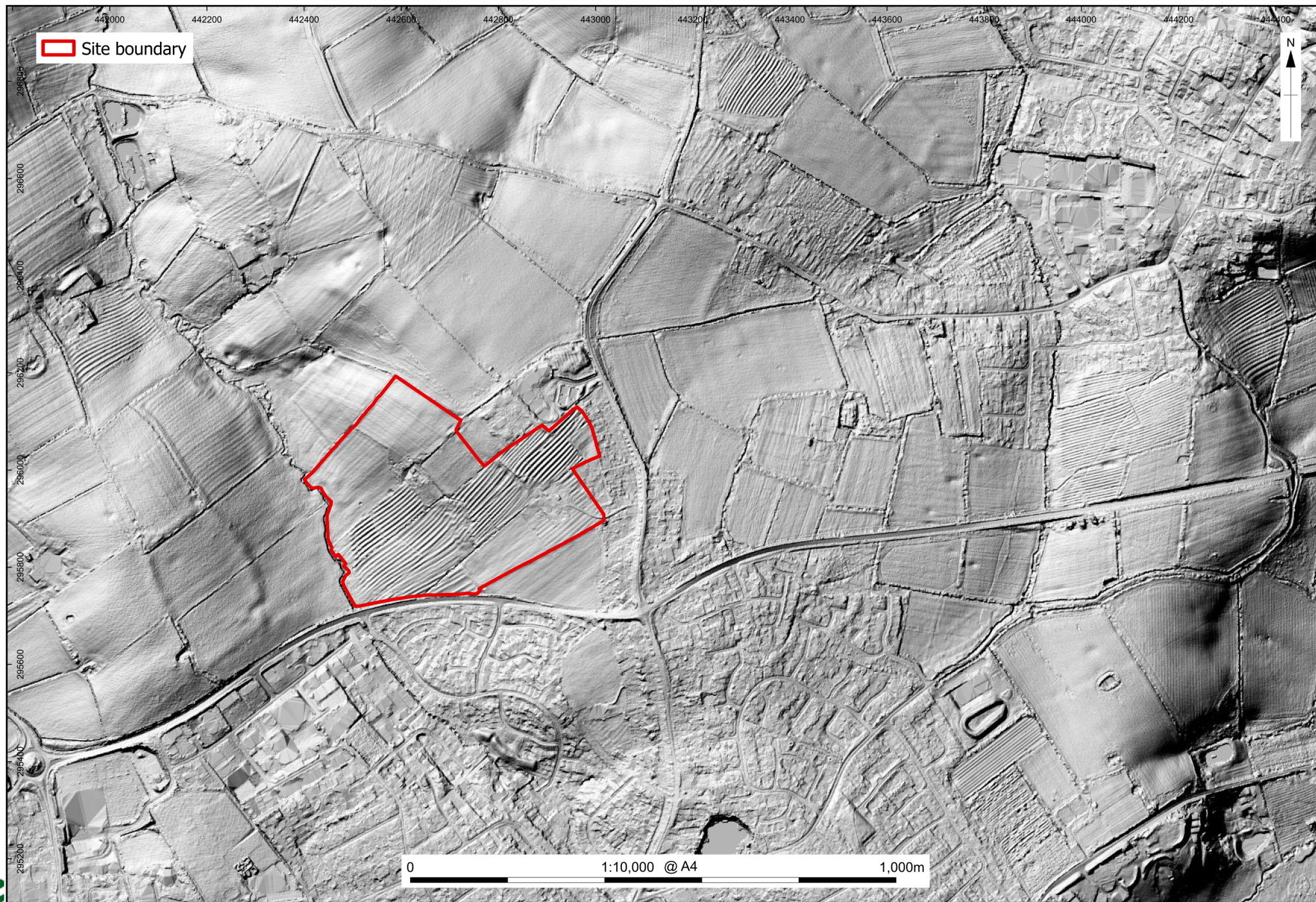
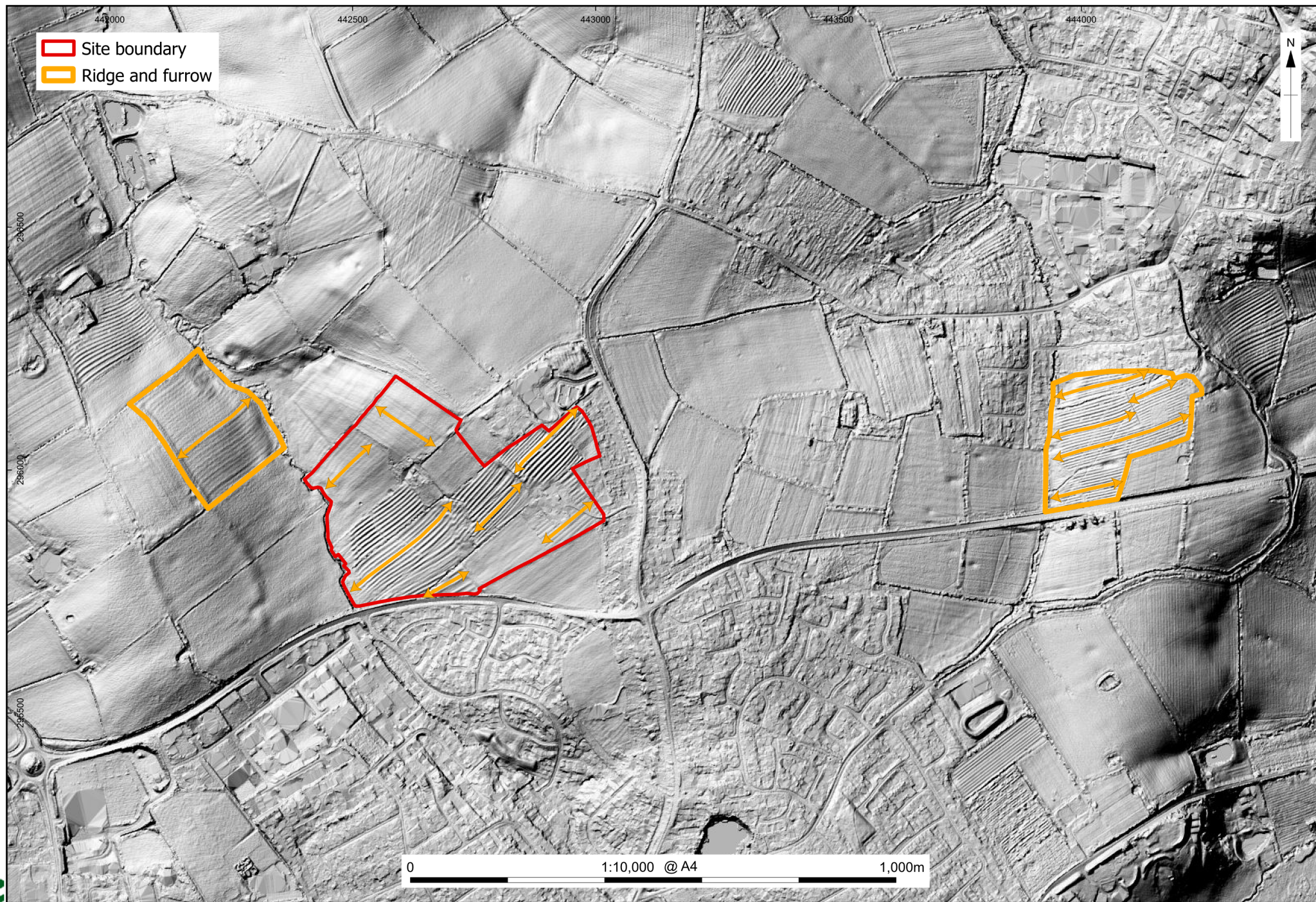


Figure 3: LiDAR 1m multi-view hillshade DTM



APPENDIX A GAZETTEER OF RELEVANT HERITAGE ASSETS WITHIN THE STUDY AREA

HER Ref	Name	Period	Grid Reference
MLE2804	Possible medieval moated site, Hinckley Road, Barwell	Medieval	SP 435 961
MLE2805	Pond, north-west of Barwell Fields Farm, Hinckley	Medieval	SP 434 957
MLE2818	Medieval moated site, rear of 74 Hinckley Road, Barwell	Medieval	SP 436 963
MLE2819	Fishpond adjacent to moated site, Barwell	Medieval	SP 436 964
MLE2872	Burials near Hangmans Lane, Hinckley	Medieval	SP 431 952
MLE2873	Site of gallows, Hangmans Lane, Hinckley	Medieval	SP 431 952
MLE24947	Possible Anglo-Saxon sword pommel cap, north of Community Hospital, Hinckley	Early medieval	SP 43 96
MLE26653	Possible Anglo-Saxon / medieval enclosure, Crabtree Road, Barwell	Early medieval to Medieval	SP 4377 9622
MLE27223	Site of medieval windmill, Middlefield Lane, Hinckley	Medieval	SP 4213 9559

APPENDIX B DRONE SURVEY REPORT

Normandy Way, Hinckley, Leicestershire

RGB and Multispectral UAS Landscape Survey

Prepared for:	Oxford Archaeology
Authored by:	Dr Scott Williams MCIfA
Edited by:	Simon Batsman PCIfA
Report Reference:	AC-24-SGS-14
Report Date:	16 th May 2024
Version:	1.0
Survey Date:	10 th May 2024
Field Coordinator:	Adam Stanford MCIfA FSA
Site Surveyor:	Adam Stanford MCIfA FSA
Project Manager:	Adam Stanford MCIfA FSA

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ACKNOWLEDGEMENTS

SUMO GeoSurveys would like to thank Oxford Archaeology for commissioning the work documented here.

EXECUTIVE SUMMARY

SUMO GeoSurveys conducted UAS RGB and Multispectral landscape surveys at land to the north of Normandy Way, Hinckley, Leicestershire. The RGB survey was commissioned by Oxford Archaeology to investigate the archaeological potential of the survey area, which comprises c. 17 ha of land. SUMO GeoSurveys carried out a multispectral survey at their own discretion to demonstrate the technique and complement the earthwork survey. The data were processed in Agisoft Metashape and QGIS.

The RGB and Multispectral UAS surveys conducted at land to the north of Normandy Way, Hinckley, Leicestershire, have successfully produced a detailed visual record of the landscape within the survey area. The central area of the survey is dominated by ridge and furrow ploughing, which occupies a belt of land from the higher ground towards the northeast and down towards the southwest.

Two anomalous features were observed within the multispectral data when processed as vegetation indices. An anomaly that appears to depict an L-shaped linear feature—which appears to respect the general alignment of the field—was observed in the northernmost field of the survey area. A second anomaly, that appears to depict a U-shaped linear feature, was observed towards the southwest of the survey area. The possible ephemeral feature is aligned along a northeast to southwest orientation. It is uncertain what these anomalous features may represent.

1. INTRODUCTION

1.1 PROJECT BACKGROUND

SUMO GeoSurveys conducted UAS RGB and Multispectral landscape surveys at land to the north of Normandy Way, Hinckley, Leicestershire. The RGB survey was commissioned by Oxford Archaeology to investigate the archaeological potential of the survey area, which comprises c. 17 ha of land (Figure 1). SUMO GeoSurveys carried out a multispectral survey at their own discretion to demonstrate the technique and complement the earthwork survey. The data were processed in Agisoft Metashape and QGIS.

1.2 SITE DETAILS

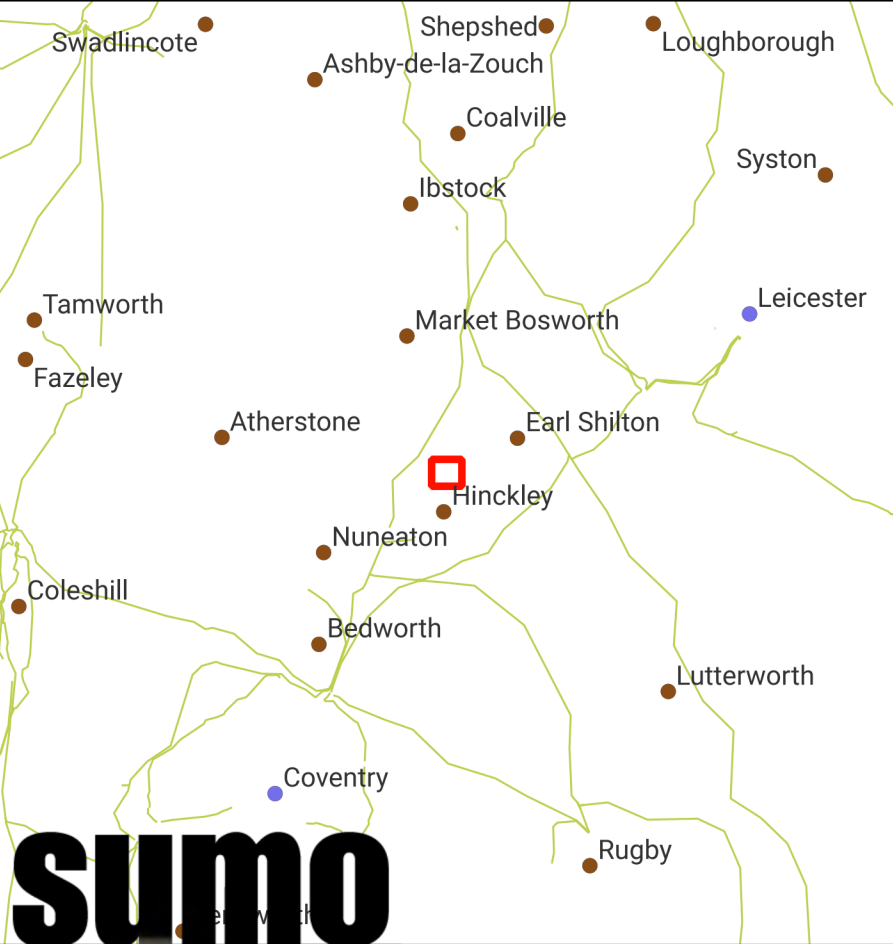
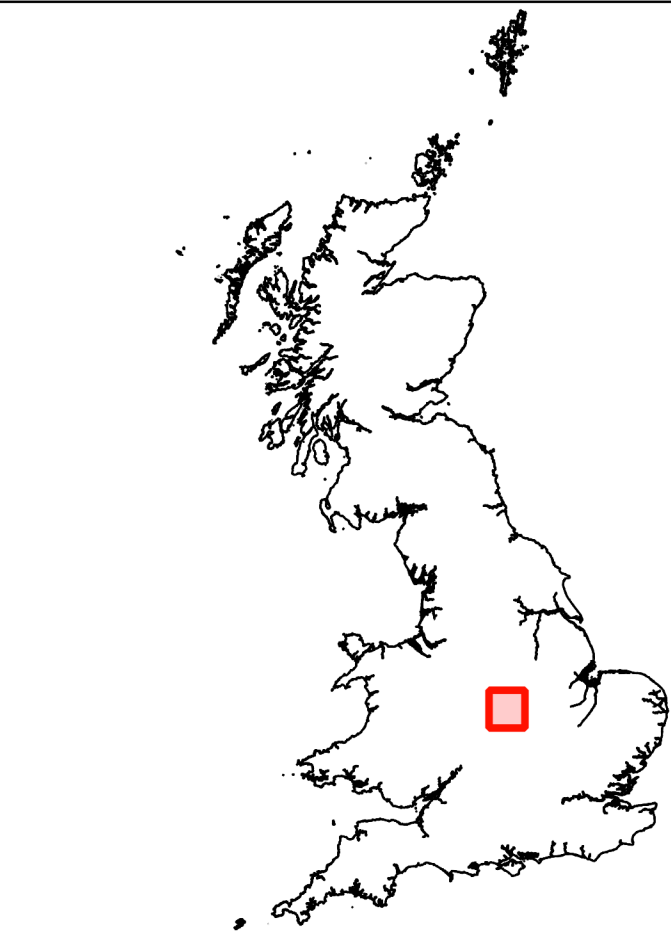
NGR / Postcode	SP 42600 95900 / LE10 1XJ
Location	The site is located to the north of Normandy Way, at the northern periphery of Hinckley, Leicestershire
HER	Leicestershire Historic Environment Record
District	Hinckley and Bosworth
County	Leicestershire
Geology	Bedrock: Mudstone of the Mercia Mudstone Group Superficial: Sand and gravel of the Dunsmore Gravel deposit (across the northeast of the area); Diamicton of the Oadby Member (towards the northeast); Sand and gravel of the Wolston Sand and Gravel deposit (across the central area); Clay and silt of the Bosworth Clay Member (across the southwest of the area) (BGS 2024)
Archaeology	Ridge and furrow
Survey Methods	UAS RGB and Multispectral photogrammetry
Study Area	c. 17 ha
Topography	The site slopes gently down towards the southwest from an elevation of c. 127 m above Ordnance Datum (aOD) to an elevation of c. 111 m aOD
Current Land Use	Predominantly pasture

1.3 AIMS AND OBJECTIVES

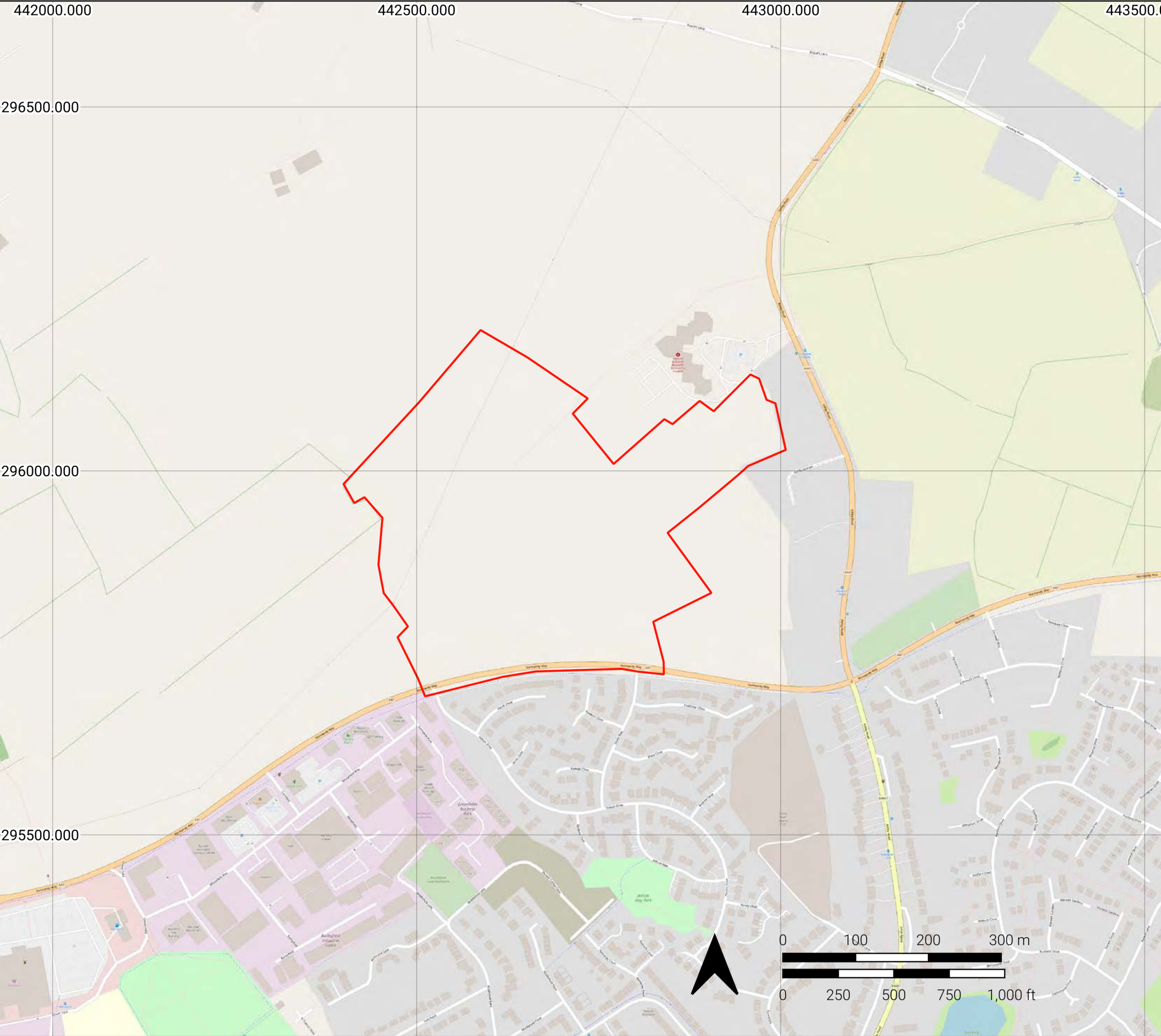
To conduct a detailed UAS (drone) geospatial landscape survey using RGB photogrammetry of the survey area.

The objectives of the UAS geospatial survey were:

- Undertake a UAS geospatial survey using RGB photogrammetry for analysis
- Suggest a proposal for archaeological investigation, if required
- Document the survey result
- Ensure all work was carried out in accordance with the *Code of Conduct* of the Chartered Institute for Archaeologists (CIfA) (2022) and in line with current Historic England guidance for photogrammetry and landscape surveys (HE 2017a; 2017b)



Project	Normandy Way, Hinckley
Client	Oxford Archaeology
Date	15/05/24
Job No.	SUMO-17522-1



Location map

2. METHODOLOGY

2.1 SURVEY METHODOLOGY – TOPOGRAPHIC

2.1.1 PHOTOGRAPHY

An Unmanned Aircraft System (UAS) with a gimbal-mounted camera was flown at an average elevation of 128 m (419 ft) above ground level.

2.1.2 PHOTOGRAMMETRY

Images were processed in Agisoft Metashape photogrammetric software to produce a 3D pointcloud with a Point Density of 84.1 points/m². Data were exported as a raster Digital Elevation Model (DEM) with an average 10.9 cm/pix spatial resolution and an orthophoto with an average 2.73 cm/pix.

2.1.3 REFERENCING

The photogrammetric models were referenced by six ground control points (GCPs) that were distributed across the area. The six points are visible in the aerial photographs and were also surveyed using high accuracy GPS to facilitate georeferencing to OS coordinates, which provided an average error of 1.99 cm across the area (Table 1).

Point	Easting	Northing	Elevation
1	442704.802	296107.118	122.308
2	442546.648	296049.760	115.857
3	442491.481	295775.048	108.975
4	442772.652	295753.013	115.812
5	442875.834	295954.564	122.914
6	442903.581	296056.788	124.635

Table 1 Coordinate data for the GCPs

2.2 SURVEY METHODOLOGY – MULTISPECTRAL

2.2.1 PHOTOGRAPHY

An Unmanned Aircraft System (UAS) with a gimbal-mounted camera was flown at an average elevation of 104 m (341 ft) above ground level.

2.2.2 PHOTOGRAMMETRY

Images were processed in Agisoft Metashape photogrammetric software to produce an orthophoto with an average 4.76 cm/pix resolution.

2.2.3 REFERENCING

See Section 2.1.3 above.

2.3 DATA PROCESSING AND VISUALISATION

2.3.1 DIRECTIONAL LIGHT SHADING (HILLSHADE)

Simulated illumination of the terrain surface from a chosen light source direction. This gives the viewer an intuitive sense of the 3D topography but can fail to reveal some features that are aligned with the light source. This has been achieved using the hillshade capabilities within QGIS.

2.3.2 AMBIENT LIGHT SHADING (OCCLUSION)

Simulated illumination of the terrain surface from a continuous encompassing light source. Illumination of a given point is determined by surrounding terrain and other objects which occlude incoming light and simulates diffuse, and scattered light that is reflected by various surfaces. It gives the viewer an intuitive sense of the 3D topography but can fail to reveal subtle features near much larger objects. This has been achieved using both Relief Visualisation Toolbox (RVT) and Terrain Shading within QGIS.

2.3.3 VISUALISATION FOR ARCHAEOLOGICAL TOPOGRAPHY (VAT)

This method requires the combination of four information layers (terrain hillshade, slope, openness (positive), and sky-view factor) into a single raster output. The blending of the input layers enables enhanced visibility of features of varied scale and orientation on terrain from very flat to very steep (Verbovšek *et al* 2019). This has been achieved using Relief Visualisation Toolbox (RVT) within QGIS.

2.3.4 MULTI-SCALE TOPOGRAPHIC POSITION (MSTP)

The Multi-scale Topographic Position approach is based on calculating an integral image from a Digital Elevation Model and applying multi-scale statistical analysis of the deviation from mean elevation. The results are combined into a single output that is composed of macro-, meso-, and micro-scale results (Guyot *et al* 2018). This has been achieved using Relief Visualisation Toolbox (RVT) within QGIS.

2.3.5 TERRAIN FLATTENING

Terrain flattening entails constructing a mathematical model that approximates broad-scale variation in the topography. This model surface is then subtracted from the original DEM to produce a new dataset that reflects only smaller scale features. This has been achieved using Anomaly.

2.4 MULTISPECTRAL ANALYSIS – VEGETATION INDICES

Vegetation indexes aim to approximate surface vegetation vigour through the reflectance characteristics of chlorophyll in leaves. Vegetation vigour can act as a proxy for subsurface variations in soil depth and moisture content.

2.4.1 NDVI

Normalized Difference Vegetation Index (NDVI) quantifies the presence of living green vegetation using reflected light in the visible and near-infrared bands. An NDVI was calculated from calibrated 840nm Near Infrared (NIR) and 650nm Red (R) reflectance measurements using the formula:

$$\text{NDVI} = (\text{NIR} - \text{R}) / (\text{NIR} + \text{R})$$

2.4.2 GNDVI

Green Normalized Difference Vegetation Index (GNDVI) has wider dynamic range than NDVI and is generally at least five times more sensitive to chlorophyll-a concentration. GNDVI is used to sense the concentration of chlorophyll and can be used to assess plant stress. GNDVI was calculated from calibrated 840nm Near Infrared (NIR) and 560nm Green (G) reflectance measurements using the formula:

$$\text{NDVI} = (\text{NIR} - \text{G}) / (\text{NIR} + \text{G})$$

2.4.3 RENDVI

Red Edge Normalized Difference Vegetation Index (RENDVI) uses reflectance measurements in the Red Edge (RE) to establish changes in vegetation health.

$$\text{RENDVI} = (\text{NIR} - \text{RE}) / (\text{NIR} + \text{RE})$$

2.4.4 RDVI

Renormalized Difference Vegetation Index (RDVI) uses the difference between near-infrared and red wavelengths, along with the NDVI, to highlight healthy vegetation. It is insensitive to the effects of soil and sun viewing geometry.

$$\text{RDVI} = (\text{NIR} - \text{R}) / \text{SQRT}(\text{NIR} + \text{R})$$

2.4.5 NDRER

Normalized Difference Red Edge/Red (NDRER) uses Red Edge information instead of the Near Infrared reflectance to establish changes in vegetation health.

$$\text{NDRER} = (\text{RE} - \text{R}) / (\text{RE} + \text{R})$$

2.4.6 MSR

Modified Simple Ratio (MSR) uses a combination of Simple Ratio (the ratio of green leaf scattering in the Near Infrared band and chlorophyll absorption in the Red band using the formula NIR / R) and Normalized Difference Vegetation Index to improve sensitivity to vegetation characteristics.

$$\text{MSR} = (\text{NIR} / \text{R}) - 1 / \text{SQRT}(\text{NIR} / \text{R}) + 1$$

2.4.7 OSAVI

Optimised Soil Adjusted Vegetation Index (OSAVI) is based on the Soil Adjusted Vegetation Index (SAVI) (formula = $1.5 * (\text{NIR} - \text{RED}) / (\text{NIR} + \text{R} + 0.5)$). It uses a standard value of 0.16 for the canopy background adjustment factor. This value provides greater soil variation than SAVI for low vegetation cover, while demonstrating increased sensitivity to vegetation cover greater than 50%. This index is best used in areas with relatively sparse vegetation where soil is visible through the canopy.

$$\text{OSAVI} = (\text{NIR} - \text{R}) / (\text{NIR} + \text{R} + 0.16)$$

2.4.8 GRVI

Green Ratio Vegetation Index (GRVI) is a modification to Simple Ratio that is sensitive to the rate of photosynthesis.

$$\text{GRVI} = \text{NIR} / \text{G}$$

2.4.9 RGRI

Red Green Ratio Index (RGRI) provides an indication of leaf production and stress using the single Red and single Green bands.

$$\text{RGRI} = \text{R} / \text{G}$$

3. RESULTS

3.1 INTRODUCTION

The results from the UAS RGB and Multispectral surveys are presented below as a series of figures followed by a discussion.

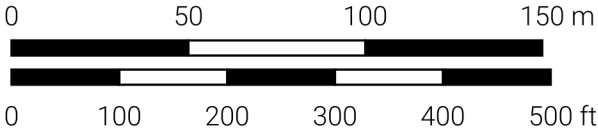
 Survey Area



Project	Normandy Way, Hinckley	Drawn	SW
Client	Oxford Archaeology	Version	1.0
Date	15/05/24	Surveyed	AS
Job No.	SUMO-17522-1	Figure	2

Orthomosaic generated from UAS photogrammetry

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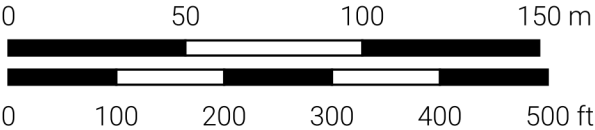
 Survey Area

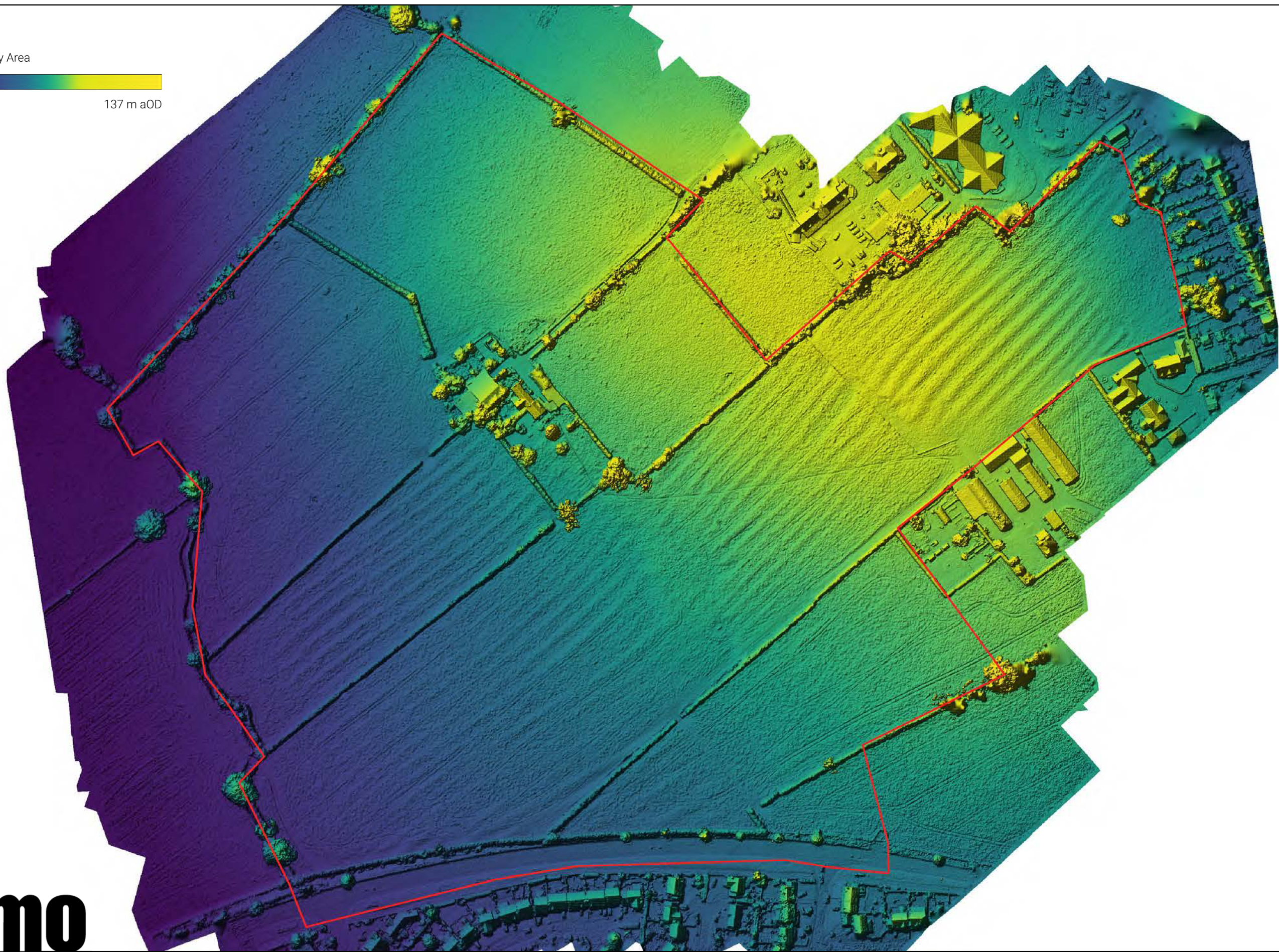
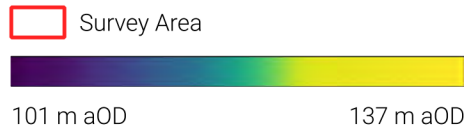


Project	Normandy Way, Hinckley	Drawn	SW
Client	Oxford Archaeology	Version	1.0
Date	15/05/24	Surveyed	AS
Job No.	SUMO-17522-1	Figure	3

Digital Elevation Model with hillshade overlaid onto satellite imagery. Map Data: Google

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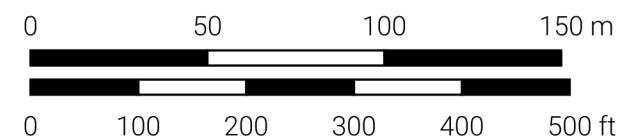




Project	Normandy Way, Hinckley	Drawn	SW
Client	Oxford Archaeology	Version	1.0
Date	15/05/24	Surveyed	AS
Job No.	SUMO-17522-1	Figure	4

DEM with elevation colour-scale expressed in metres above Ordnance Datum (aOD)

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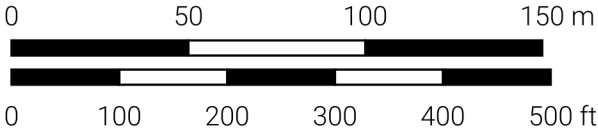
 Survey Area



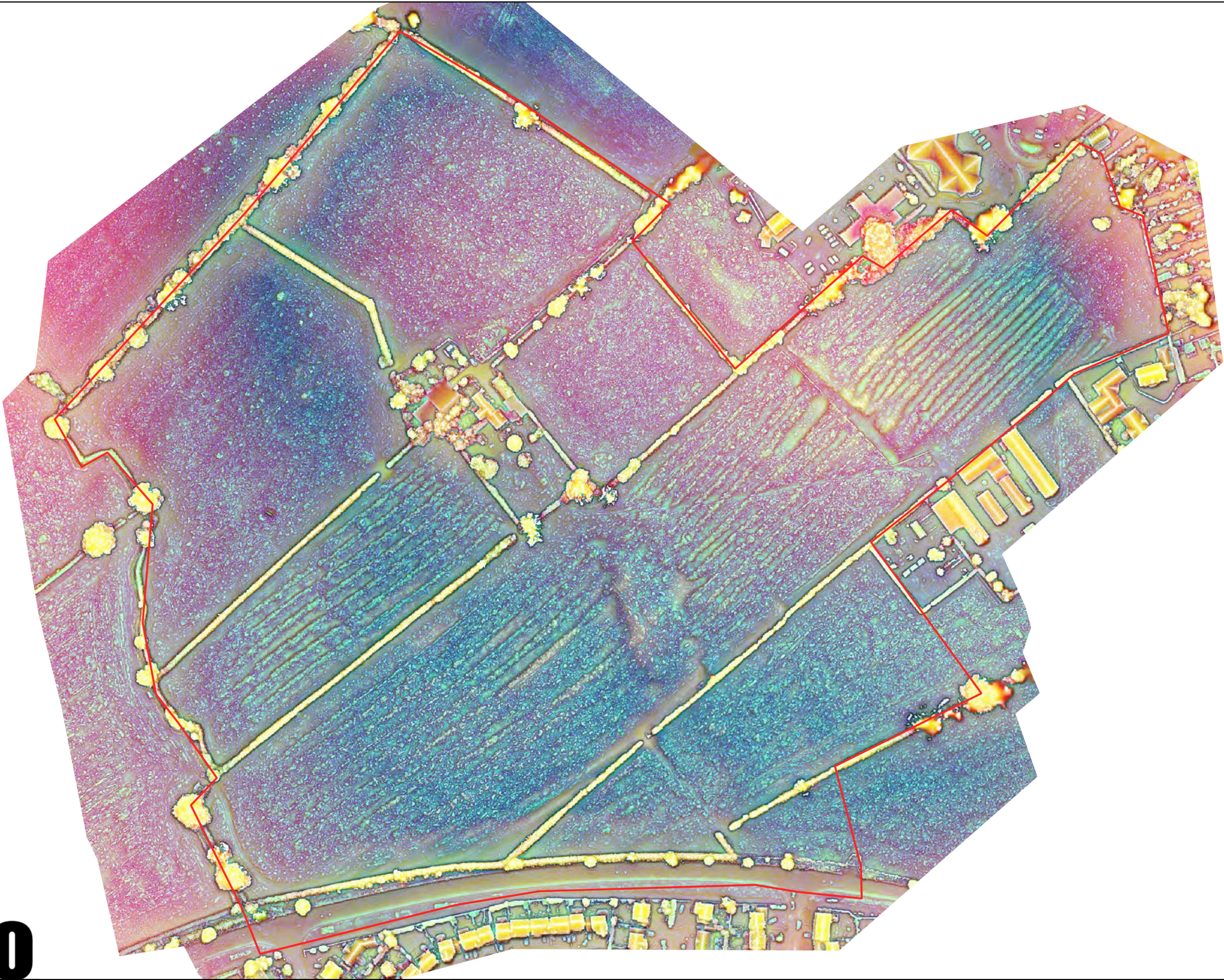
Project	Normandy Way, Hinckley	Drawn	SW
Client	Oxford Archaeology	Version	1.0
Date	15/05/24	Surveyed	AS
Job No.	SUMO-17522-1	Figure	5

Digital Elevation Model with hillshade. Azimuth 315 degrees / Altitude 45 degrees / Z factor 2

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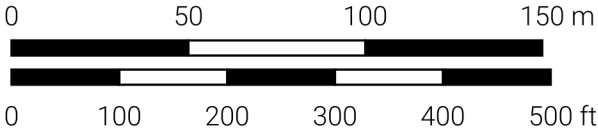
 Survey Area

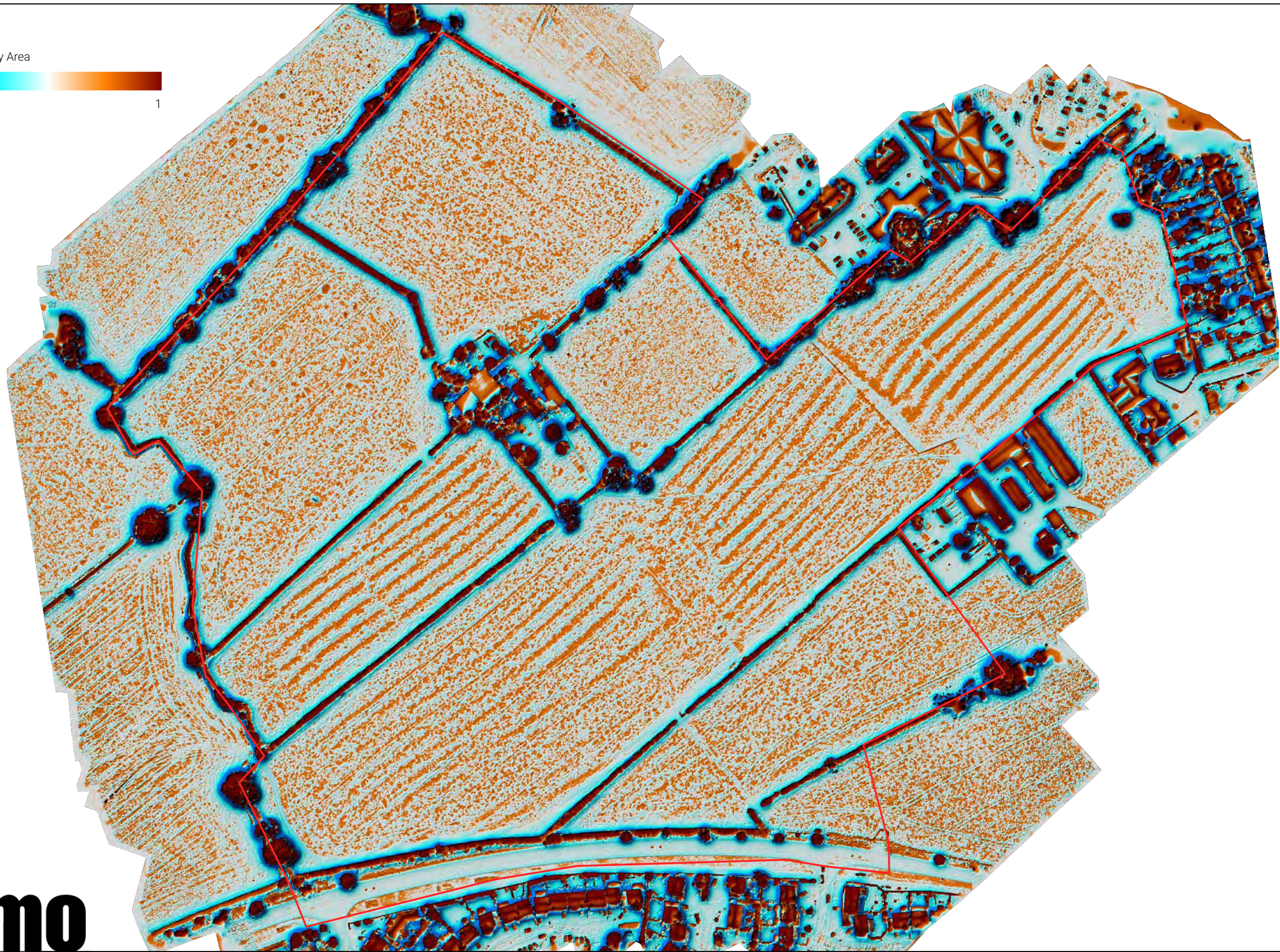
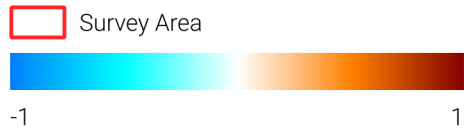


Project	Normandy Way, Hinckley	Drawn	SW
Client	Oxford Archaeology	Version	1.0
Date	15/05/24	Surveyed	AS
Job No.	SUMO-17522-1	Figure	10

RVT enhanced Multi-scale Topographic Position analysis

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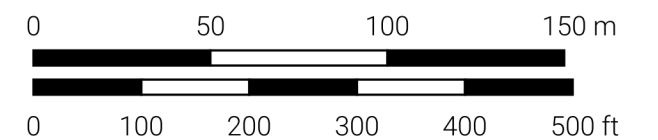




Project	Normandy Way, Hinckley	Drawn	SW
Client	Oxford Archaeology	Version	1.0
Date	15/05/24	Surveyed	AS
Job No.	SUMO-17522-1	Figure	11

Terrain flattened Digital Elevation Model

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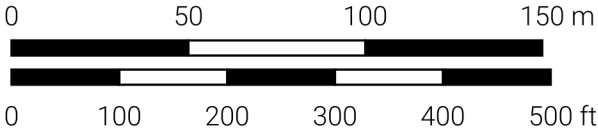
 Survey Area

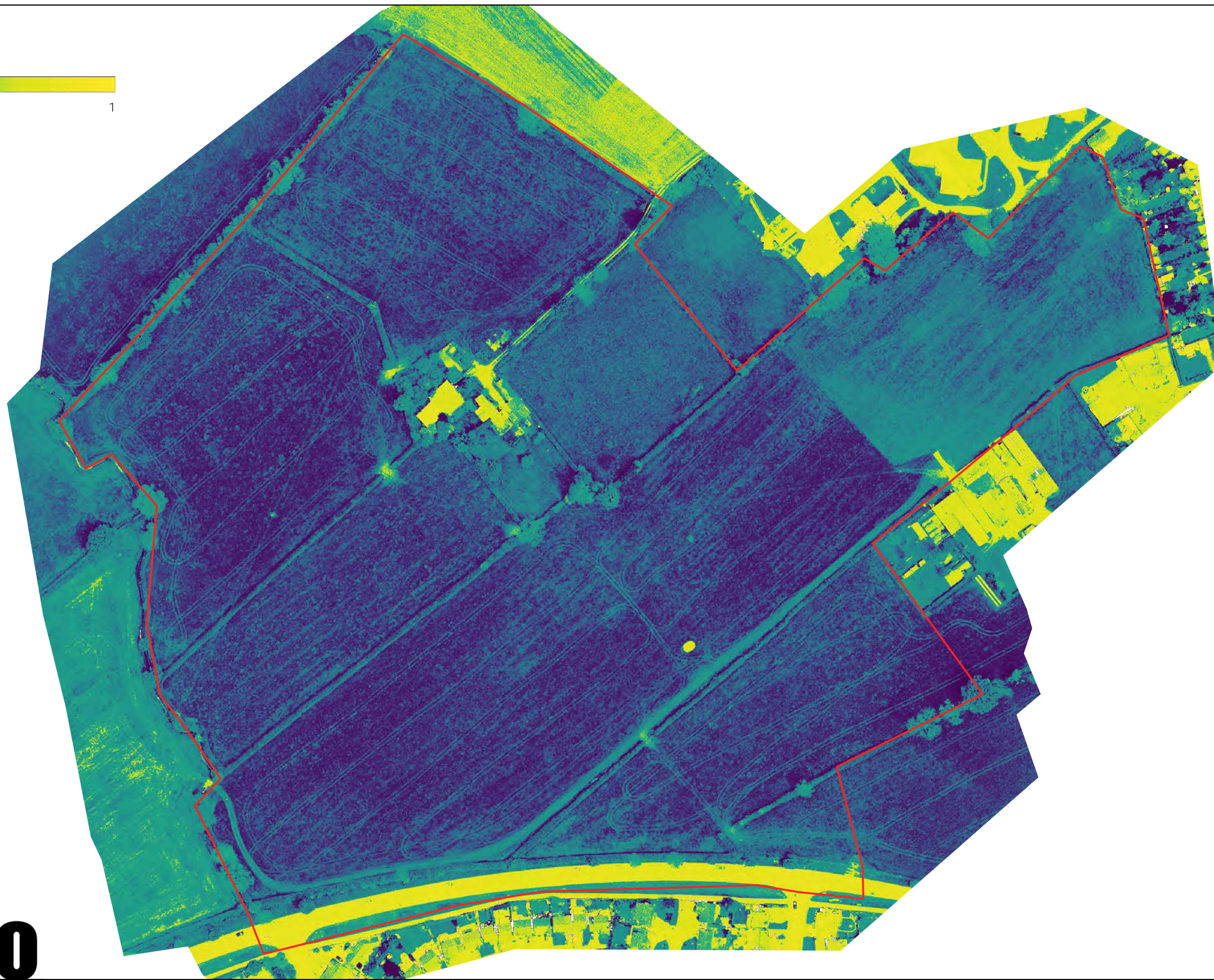
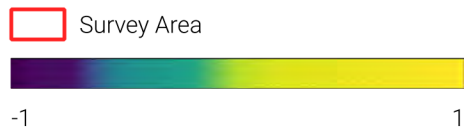


Project	Normandy Way, Hinckley	Drawn	SW
Client	Oxford Archaeology	Version	1.0
Date	15/05/24	Surveyed	AS
Job No.	SUMO-17522-1	Figure	12

Multispectral Band 1 - Green: 560 nm $\pm$ 16 nm

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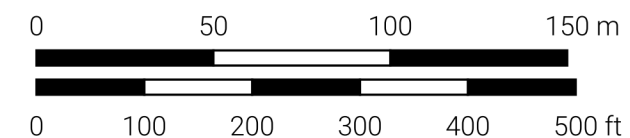


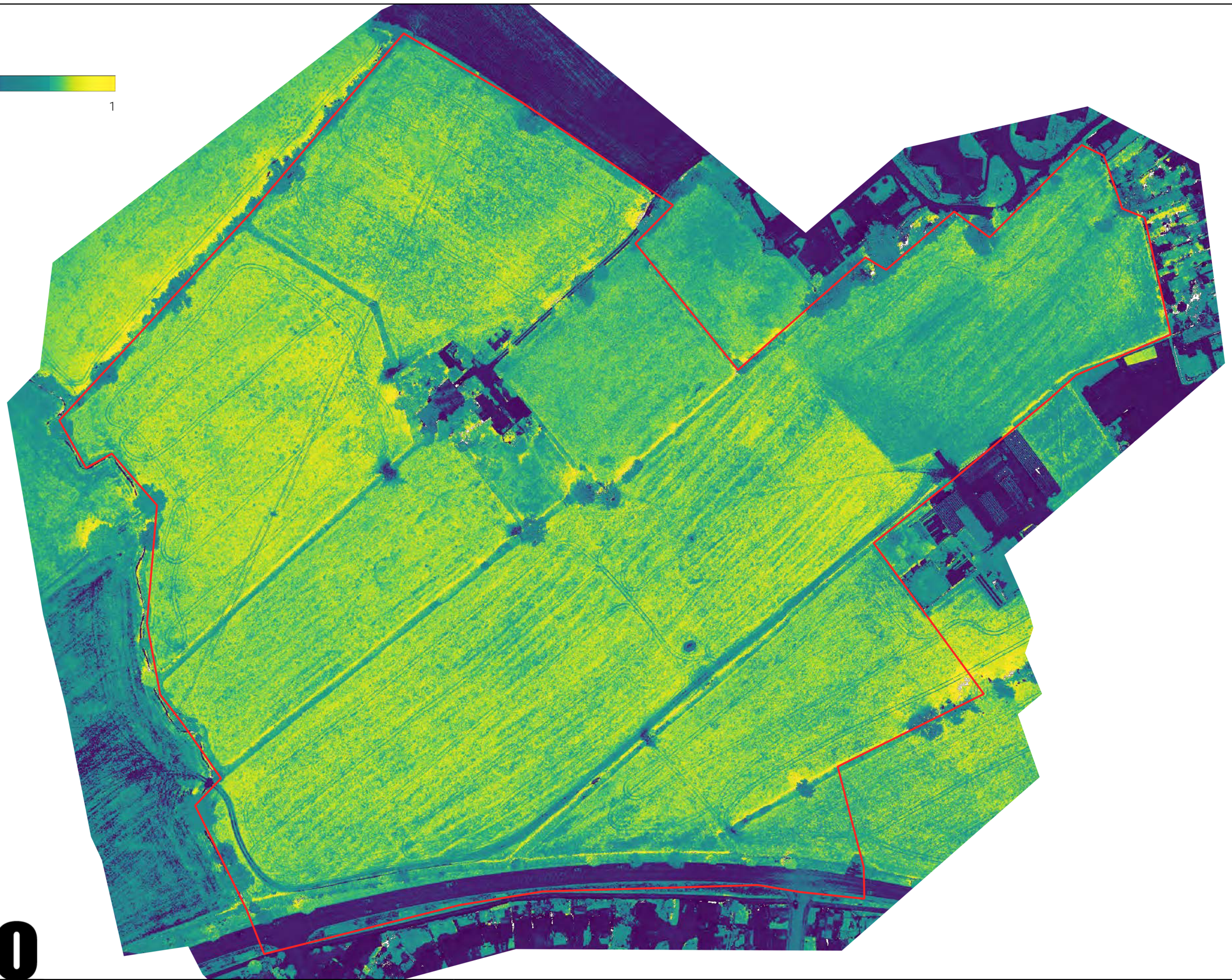
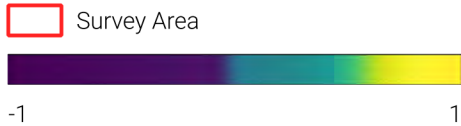


Project	Normandy Way, Hinckley	Drawn	SW
Client	Oxford Archaeology	Version	1.0
Date	15/05/24	Surveyed	AS
Job No.	SUMO-17522-1	Figure	17

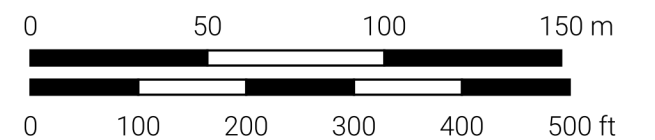
Vegetation Index: GNDVI

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Project	Normandy Way, Hinckley	Drawn	SW
Client	Oxford Archaeology	Version	1.0
Date	15/05/24	Surveyed	AS
Job No.	SUMO-17522-1	Figure	18



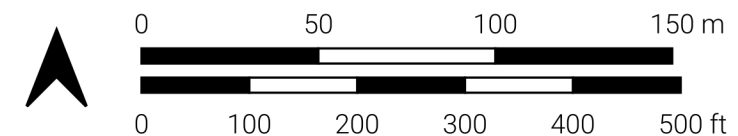
-  Survey Area
-  Ridge and furrow
-  Probable ridge and furrow
-  Multispectral Anomaly



Project	Normandy Way, Hinckley	Drawn	SW
Client	Oxford Archaeology	Version	1.0
Date	15/05/24	Surveyed	AS
Job No.	SUMO-17522-1	Figure	25

Interpretation of features

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4. DISCUSSION

4.1 INTRODUCTION

The UAS photogrammetry survey has enabled the construction of an orthomosaic image (Figure 2), Digital Elevation Model (DEM) (Figure 3), and 3D photogrammetric model of the landscape to the north of Normandy Way, Hinckley, Leicestershire.

4.2 GROUND CONDITIONS

The fields within the survey area were under grass and divided by hedgerows and mature trees. The ground conditions were conducive to UAS survey methods.

4.3 DIGITAL ELEVATION MODEL

A DEM was produced for the survey area from the RGB photogrammetry. Elevation in metres above Ordnance Datum is depicted using a colour-scale overlay (Figure 4). The DEM provides a good indication of the topographic characteristics through hillshade manipulation in a Geographical Information System (GIS) (Figure 5 to Figure 7). This technique is also useful for the identification of micro-topographical archaeological features expressed at surface level.

4.4 GIS ANALYSIS

Hillshade analysis of the DEM using different light azimuths has not illustrated any micro-topographical features that are not already clearly visible on the ground. More detailed analysis using RVT Anisotropic Sky-view did not produce any significant results beyond features already identified, and so this was cross-checked using Terrain Shading Ambient Occlusion analysis from which the results were similar (Figure 8). Visualisation Archaeological Topography combined (VATc) analysis was also applied (Figure 9) along with enhanced Multi-scale Topographic Position (eMSTP) analysis (Figure 10). The DEM was flattened using Anomaly software to further enhance the visibility of any micro-topographic surface features (Figure 11).

4.5 MULTISPECTRAL ANALYSIS

Multispectral survey (Figure 12–15) provides a unique dataset, detecting heat, reflected light, and moisture signatures on the surface. This can reveal features beneath the ground that leave little, or no, topographic trace. Therefore, multispectral photogrammetry has the potential to highlight archaeologically sensitive areas which are otherwise invisible to RGB photogrammetry. When used in conjunction with RGB photogrammetry it provides a powerful prospection tool.

4.6 VEGETATION INDICES

Vegetation Index (VIs) formulae combine surface reflectance using two or more wavelengths that are designed to highlight a particular property of vegetation, which may then indicate subsurface variation. These formulae are applied to multispectral images to produce a variety of indices (Figure 16–24).

4.7 ASSESSMENT

The interpretation results are depicted on Figure 25.

4.7.1 RIDGE AND FURROW

The fields across the centre of the survey area are predominantly characterised by extensive ridge and furrow ploughing [A]. The ridge and furrow systems occupy both the higher ground to the northeast, and the sloping ground towards the southwest. Where no ridge and furrow is present in the northern and northwesternmost fields, it is possible that it has been denuded by extensive modern mechanical ploughing. A small area of probable ridge and furrow [B]—within a sub-square field adjacent to the northeastern boundary of the survey area—only remains visible in the UAS multispectral data, having no expression at surface level.

4.7.2 MULTISPECTRAL ANOMALIES

Two anomalous features were observed within the multispectral data when processed as vegetation indices. An anomaly that appears to depict an L-shaped linear feature [C] was observed in the northernmost field. The possible ephemeral feature—which appears to respect the general alignment of the field—is aligned along a roughly northwest to southeast orientation for c. 118 m before turning towards the northeast for c. 41 m.

A second anomaly, that appears to depict a U-shaped linear feature [D], was observed towards the southwest of the survey area. The possible ephemeral feature is aligned along a northeast to southwest orientation and runs for a length of c. 70 m towards the southwest, before turning 90° towards the southeast for c. 25 m, then returning towards the northeast for c. 18 m.

It is uncertain what these anomalous features may represent.

5. CONCLUSIONS

5.1 LIMITATIONS

The weather conditions were very good during the survey, with a consistent intensity of sunlight. Low level power lines are present across the northwestern part of the survey area and are visible in the orthomosaic photograph. This did not impede the survey.

5.2 CONCLUSION

The RGB and Multispectral UAS surveys conducted at land to the north of Normandy Way, Hinckley, Leicestershire, have successfully produced a detailed visual record of the landscape within the survey area. The central area of the survey is dominated by ridge and furrow ploughing, which occupies a belt of land from the higher ground towards the northeast and down towards the southwest.

Two anomalous features were observed within the multispectral data when processed as vegetation indices. An anomaly that appears to depict an L-shaped linear feature—which appears to respect the general alignment of the field—was observed in the northernmost field of the survey area. A second anomaly, that appears to depict a U-shaped linear feature, was observed towards the southwest of the survey area. The possible ephemeral feature is aligned along a northeast to southwest orientation. It is uncertain what these anomalous features may represent.

5.3 RECOMMENDATIONS

It may be desirable to ground truth the anomalous features derived from the multispectral data through archaeological intervention, probably in the form of test pits or trial trenching.

6. SOURCES

6.1 BIBLIOGRAPHY

Chartered Institute for Archaeologists (CIfA). 2022. *Code of Conduct*. Reading, Chartered Institute for Archaeologists.

Guyot, A., Hubert-Moy, L., and Lorho, T. 2018. Detecting Neolithic Burial Mounds from LiDAR-Derived Elevation Data Using a Multi-Scale Approach and Machine Learning Techniques. *Remote Sensing*. [Online] 10 (2), 225. [online]. Available from: <http://dx.doi.org/10.3390/rs10020225>.

Historic England (HE). 2017a. *Historic England Photogrammetric Applications for Cultural Heritage, Guidance for Good Practice*. Swindon: Historic England.

Historic England (HE). 2017b. *Understanding the Archaeology of Landscapes - A Guide to Good Recording Practice (Second Edition)*. Swindon: Historic England.

Verbovšek, T., Popit, T., and Kokalj, Z. 2019. VAT Method for Visualization of Mass Movement Features: An Alternative to Hillshaded DEM. *Remote Sensing*. [Online] 11 (24), 2946. [online]. Available from: <http://dx.doi.org/10.3390/rs11242946>.

6.2 WEBSITES

BGS. 2023. *British Geological Survey - Geology of Britain Viewer*. Available from: <https://geologyviewer.bgs.ac.uk> (Accessed 15/05/2024)

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