1EW03 - Enabling Works Central

AWHe Fieldwork Report for Topographic Survey at Grim's Ditch Scheduled Monument (AC210/14)

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1 Executive Summary

1.1.1 This report details the survey methodology and results for a topographic survey, conducted between November and December 2020 at Grim's Ditch Scheduled Monument, Buckinghamshire (centred on NGR SP 89129 03572); Figure 1). The Site Code for the topographic investigation is 1C19GDMTO.

1.1.2 The Site is 2km north of Great Missenden and located between Woodlands Park on the A413 Aylesbury Road to the west and Hunt's Green Farm on Kings Lane to the east. The Site comprises a single parcel (C10021) covering a total area of 1.83ha.

1.1.3 The work was targeted on land required for the main rail alignment, which in this section will be in a cutting, as well as associated engineering works as outlined in the Project Plan (1EW03-FUS-EV-REP-CS03_CL05-009409). A 180m length of the 350m long earthwork monument is within the HS2 construction boundary and therefore may be impacted by the scheme.

1.1.4 The topographic survey was implemented to address the Project Plan (Doc. ref. (1EW03-FUS-EV-REP-CS03_CL05-009409) and followed the methodology laid out in the Location Specific Written Scheme of Investigation (Document Ref: 1EW03-FUS-IFA-EV-REP-CS03_CL05-000001).

1.1.5 There are numerous lengths of ancient linear earthworks bearing the name Grim's Ditch, in areas as diverse as Dorset, Essex and Leeds, but with most occurrences in the chalk grassland or 'downland' of the Chilterns and the downs of Oxfordshire and Wiltshire. The name is applied to numerous earthworks of unknown provenance were often attributed in the early medieval period. The Site is one of several extant sections within Buckinghamshire bearing the name 'Grim's Ditch', stretching north-eastwards across the county, from Bradenham to Berkhamsted. The date of Grim's Ditch is unknown and a key objective of this work, through the HS2 scheme, is to provide further understanding of the date and use of this monument along with its impact on the landscape.

1.1.6 The segment of the Grim's Ditch Scheduled Monument (List Entry 1021198), that lies within the site, is 145m long and is aligned northeast-southwest and has a visible upstanding bank on the west side of a linear ditch. The coverage demonstrated a continuation to the south of both the negative and positive elements but to the north, beyond the Monument, the area is entirely flat.

1.1.7 The results were able to rapidly capture detailed data which can be viewed as either orthomosaic photographic representations or as 3-dimensional models. This preserved the status of the Monument at one given point in time, provides a baseline of information to gauge future changes against.

2 Project Background and Scheme Design

2.1.1 High Speed Two (HS2) is a new railway network proposed by Government to provide a link between London, the West Midlands, the East Midlands, South Yorkshire, Leeds and Manchester. Phase One of HS2 will involve the construction of a new railway approximately 230km (143 miles) in length between London and the West Midlands. Powers for the construction, operation and maintenance of Phase One are conferred by the High-Speed Rail (London - West Midlands) Act 2017.

2.1.2 The overall framework within which archaeological work will be undertaken is set out in the Environmental Minimum Requirements (EMR), the Heritage Memorandum, the Code of Construction Practice (CoCP) for HS2 Phase One and the GWSI: HERDS. Accordingly, the nominated undertaker or the Archaeological Contractor are required to implement appropriate and reasonable measures to identify, avoid or where practicable reduce impacts to the significance of heritage assets prior to the start of construction.

2.1.3 The Site is required for the rail alignment formation, which in this section will be in a cutting, as well as for associated engineering works that include environmental bunds and tree-planting alongside the cutting, together with land needed for temporary soil storage areas.

3 Site Location

3.1.1 The Site (centred on SP 89129 03572) is 2km to the north of Great Missenden and is located between the entrance to Woodlands Park and the A413 Aylesbury Road to the west and Hunt's Green Farm to the east (Figure 1). The modern boundary between the civil parishes of Great Missenden and The Lee transects the monument, the evaluation trenches being on The Lee side of this boundary (Figure 1).

3.1.2 Grim's Ditch Scheduled Monument consists of a partly infilled ditch, up to 8m wide and 0.9m deep, with an eroded bank of similar width and up to 0.6m high. The monument extends north-eastward for 150m from the buildings of Cottage Farm, then turns through a 20-degree angle to continue on a more northerly direction for a further 200m. The western part is on sloping ground, rising from 175m aOD within woodland and parkland at the southern edge of Woodlands Park. The bend corresponds to the crest of the slope, with the eastern section on the flatter land of the Chiltern ridge, at 200m aOD, where it is surrounded by a landscape of arable fields.

4 Site Geology and Topography

4.1 Geology

4.1.1 The underlying bedrock comprises chalk of the Lewes Nodular Chalk and Seaford Chalk Formations, formed approximately 84 to 94 million years ago in the Cretaceous Period

in a local environment previously dominated by shallow seas. These are overlain by deposits of clay, silt, sands and gravels of the Clay-with-Flints formation laid down up to 23 million years ago, (BGS online 2020).

4.1.2 Soils are described as well-drained flinty fine silty soils, over chalk or chalk rubble on the valley sides varying to well drained fine silty or loam, and variably flinty over chalk (Cranfield Online 2020).

4.2 Topography

4.2.1 The Site occupies high ground between 190 and 200m above Ordnance Datum (aOD), on the eastern shoulder of the Misbourne Valley and covers a 1.83ha area. The ground slopes gently downwards from north to south, and while the area of the Monument itself undulates as a result of its construction, the surrounding arable fields are flat.

5 Previous Works

5.1.1 A Project Plan detailing the scope, aims and methodologies required to address specific GWSI: HERDS research objectives identified as being applicable to this Site was prepared for the works; *Project Plan for Trial Trench Evaluation at Grim's Ditch Scheduled Monument (AC210/14)* (1EW03-FUS-EV-REP-CS03_CL05-009409).

5.1.2 A Location Specific Written Scheme of Investigation detailing the methodology, deliverables, programme, health, safety and environmental requirements, resources and interfaces necessary to deliver the archaeological evaluation was prepared for the Site; *Location Specific Written Scheme of Investigation for Archaeological Trial Trenching at Grim's Ditch Scheduled Monument (AC210/14*) (1EW03-FUS-IFA-EV-REP-CS03_CL05-000001).

5.1.3 An Environmental Statement (CH-001-010 ES 3.5.2.10.4) was prepared in 2013, part of this was to provide an evidence base against which the assessment of assets that may be affected by the construction of the Proposed Scheme could be made. It contained information about known and potential heritage assets from a variety of sources and presented a chronological description and discussion of the development of the study area, placing assets within their historical and archaeological context. Other than the Scheduled Monument of Grim's Ditch (List Entry 1021198), no designated heritage assets were recorded within the Site. A further earthwork bank and parish boundary are recorded within the Site. Nearby heritage assets are also recorded in concentrations to the east of the Site in the vicinity of Hunts Green Farm and to the west in the vicinity of Cottage Farm, mostly consisting of findspots spanning multiple periods.

5.1.4 The Environmental Statement included the results of a remote sensing survey of the Site and its environs. The remote sensing survey included the interpretation of aerial photographs, hyperspectral imagery and LiDAR imagery. LiDAR survey (Doc Ref: HISETMC252 Aerial Photograph Interpretation Polygon CFA10), supplemented by

aerial photography interpretation (HISETMC252 Aerial Photograph Interpretation Polygon CFA10) identified various features.

5.1.5 This survey indicated possible areas of disturbance within the limits of the surviving ditch, towards the north-eastern end of the monument. The LiDAR data confirmed the presence of the Grim's Ditch earthwork along with a possible continuation within the Site, as well as areas of ridge and furrow immediately adjacent on the western side of the monument, approximately 75m to the south and 350m to the east. Other features identified included field boundaries (to the north) and possible quarries on the eastern side of the monument.

5.1.6 As part of the HS2 works, a geophysical survey was also undertaken across the Site (Doc Ref: C252-ETM-EV-REP-020-000263_P02) but due to tree coverage the area of the Monument was not accessible at the time. The geophysical survey results identified various linear and discrete features across the wider area of Hunts Green Farm, some of which were deemed to likely be of archaeological origin.

6 Aims and Specific Objectives

6.1 General Aims

6.1.1 The full aims and objectives for the archaeological investigations can be found in Section 3 of the Project Plan. Section 5 of the Project Plan provides a methodology and deliverables for the topographical survey.

6.1.2 The topographic survey was a non-intrusive survey. The principal aim of which was to record and characterise the three-dimensional forms of the Scheduled Monument prior to any intrusive works.

6.2 Specific Objectives

6.2.1 The topographic survey was required to:

- record an array of locational data points of a sufficient density to allow the construction of a 3-dimensional representation of the Scheduled Monument and sufficient of the surrounding level ground, to provide a point-cloud representation of the monument with an accuracy of ±0.20mm at 1:100 scale (in accordance with HE 2015 Metric Survey Specifications for Cultural Heritage).
- record interpretive survey data of the monument distinguishing top-of-slope, any breaks-of-slope, areas of disturbance and any other significant features.
- produce an interpretive description of the topography including representative maps and figures.

6.2.2 The overarching Grim's Ditch investigations sought to answer the following specific HERDS objectives:

- KC13: What was the date of the establishment of Grim's Ditch? What impact did it have on the landscape following its construction?
- KC15: Can we identify regional patterns in the form and location of Late Bronze Age and Iron Age settlements across the route, and are there associated differences in landscape organisation and enclosure?
- KC16: Investigate the degree of continuity that existed between Late Bronze Age and Iron Age communities in terms of population, mobility and subsistence strategies.

6.2.3 It is recognized that the undertaking of the topographic survey, as a standalone item, can only have a limited contribution to these objectives.

6.2.4 In addition, the LSWSI identified a number of Community Engagement objectives:

- CE1: Marking and communicating the changes to landscapes and environments
- CE2: Identifying and sharing our stories
- CE3: Meeting the challenge of inspiring the next generation
- CE4: Accessible information and knowledge sharing
- CE5: Contribute to the process and facilitation of audience project creation

6.3 Scope

6.3.1 A topographical survey as outlined in the LSWSI (1EW03-FUS_IFA-EV-REP-CS03_CL05-000001) was carried out after the vegetation was cleared from the Monument prior to any intrusive works.

7 Methodology

7.1 Introduction

7.1.1 The topographical survey comprised a photogrammetric survey to be undertaken by Unmanned Aerial Vehicle (UAV) and an array of locational data points to allow the construction of a 3-dimensional representation of the Scheduled Monument.

7.1.2 The resulting interpretive description of the topography including representative maps and figures was presented at the Stage 4 HOLD POINT meeting, (16/12/2020: Doc Ref 1EW03-FUS_IFA-EV-REP-CS03_CL05-009436) in accordance with 5.6.2 of the Project Plan.

7.1.3 The topographical survey was conducted in accordance with technical standards as well as Historic England guidelines (Historic England 2015).

7.1.4 Final deliverables will be supplied in an Esri format and adhere to standards set out in the HS2 Ltd Cultural Heritage GIS Standard (HS2-HS2-GI-SPE-000-000004).

7.2 Topographic Survey

7.2.1 A topographic Survey is the controlled measurement of natural and artificial landscape features (Historic England 2015, 6.1.1).

7.2.2 The purpose was to record the Site prior to any excavation works and to place any archaeological features on a location plan. The location, size and objectives of the works are set out in the Project Plan (1EW03-FUS-EV-REP-CS03_CL05-009409) in agreement with the GWSI:HERDS (HS2-HS2-EV-STR-000-000015).

7.2.3 All spatial setting out and recording was in accordance with The Ordnance Survey National Grid and Ordnance Survey Newlyn Datum (ODN) as defined by the OS Active Global National Satellite System (GNSS) network and use of a Virtual reference system.

7.2.4 An array of points was taken at regular intervals to produce a dense spread across the area to provide an objective topographic record referred to as a digital terrain model (DTM), (Plate 1). In addition, the breaks of slopes of all features were recorded and provided a more subjective topographic record. The data gathering was in accordance with the suggested array distancing as defined by Historic England (2015, 6.2.2):

7.2.5 Permanent Ground Markers (PGM) were established for the duration of the project, as per technical standards and detailed in the separate Survey Report (1EW03-FUS-EV-REP-CS03_CL05-000043). The locations were established using the Trimble Access software on Trimble Tablet, TSC3 or TSC7 controllers and R10 or R8s GNSS antennae, calibrated on 16th March and 6th April 2020. The survey used reference stations provided by Ordnance Survey. The OS Net base stations used for the survey were Oxford (E449130.188623, N214164.351931, 72.159934m AOD), Princes Risborough (E481016.735053, N202913.238152, 145.659487m AOD) and Amersham (E499706.540008, N198584.695216, 87.682022m AOD).

7.2.6 At least 3 PGM's were reoccupied during each survey to check the accuracy of the equipment. The survey equipment was purchased or hired from Korec who certified the accuracy of the equipment and performed regular maintenance.

7.2.7 All staff using the equipment were appropriately trained and the survey was undertaken in accordance with the sub-contractor's standards for surveying.

7.2.8 All archaeological recording was located to a horizontal accuracy of +/-500mm in relation to the detail illustrated in the contract drawing(s). The points at modern ground surface level were surveyed with Real Time Kinematic (RTK) Global Navigation Satellite System (GNSS) equipment or other suitable automated equipment referenced from the PGM's.

7.2.9 Surface heights and levels at the base of trenches were recorded using RTK GNSS and related to PGMs. Ordnance Survey Benchmarks (OSBM) were not used. Levelling accuracy was within 10 mm/k: where 'k' is the total distance levelled in kilometres.

7.3 Photogrammetric Surveying

7.3.1 A photogrammetric survey was undertaken by Unmanned Aircraft System (UAS), which involves the use of an Unmanned Aerial Vehicle (UAV) with a ground control system. The work was carried out in December 2020 and conducted by Adam Stanford RPQ-s, MCIfA, FSA. – CAA PfCO 991, using a DJI Inspire 2 – X4s, with a gimbal mounted camera. This was flown at 66m above ground level to obtain a spatial resolution of 1.64cm per image pixel. The full details are to be found in Appendix 3.

7.3.2 The 3-D models produced were uploaded to Projectwise on 24/02/2021.

7.3.3 Photogrammetry Images were processed in photogrammetry software to produce a 3D point-cloud with a horizontal density of 232 points per square metre. Data were exported as a raster digital elevation model (DEM) with a 6.56cm/pix spatial resolution and an orthophoto with a 0.82cm spatial resolution.

7.3.4 The photogrammetric model was referenced by eight ground control points that were distributed around the survey area. The points are visible in the aerial photographs (Appendix 3) and were also surveyed using high accuracy GPS to facilitate georeferencing to OS coordinates. The ground control points provide an error of 16mm.

Table 1 List of photogrammetry survey target co-ordinates

Survey Point	Easting	Northing	Height
GB_Amersham = control station	499706.6	198584.7	87.674
point 1	489122.6	203578.9	193.69
point 2	489135.5	203620.6	195.891
point 3	489158.1	203658.2	197.648
point 4	489178.9	203634.2	197.372
point 5	489166.2	203594.7	195.947
point 6	489147.5	203550.2	193.609
point 7	489128.1	203512.2	191.462
point 8	489111.2	203547.3	191.611

7.4 Data Processing and Visualization

7.4.1 ***Directional light shading***: simulated illumination of the terrain surface from a chosen light source direction was applied. This gives the viewer an intuitive sense of the 3D topography for a DEM but can fail to reveal some features that are aligned with the light source.

7.4.2 ***Ambient Light Shading***: simulated illumination of the terrain surface from a continuous encompassing light source was applied. Illumination of a given point was determined by surrounding terrain and other objects which occlude incoming light. It gives the viewer an intuitive sense of the 3D topography but can fail to reveal subtle features near much larger objects.

7.4.3 ***Terrain Flattening***: entails constructing a mathematical model that approximates broad-scale variation in the topography. This model surface was then subtracted from the original DEM to produce a new dataset that reflects only smaller scale features.

7.4.4 ***Relief Visualisation Toolbox (RVT) Processing***: involved the automated manipulation of DEM including further flattening, smoothing and light simulation to highlight subtle features in the landscape.

7.4.5 In addition, LiDAR was obtained from DEFRA to illustrate the wider landscape and contextualise the study area.

7.5 Topographic Plans and Profiles (Figures 3-6)

7.5.1 The results of the DTM and DEM can be presented as either a two-dimensional (2-D) or a three-dimensional (3-D) dataset reading as a plan, effectively the 3D version is a 'squashed' view. Views can be altered dependant on the viewpoint, for example either a vertical view or an oblique one can be achieved and displayed.

7.5.2 A 'site location plan', indicating site north was prepared at 1:2000. Individual 'area plans' were prepared at 1:1000, 1:600 and 1:500, and show the location of features and remains within the investigation area.

7.5.3 A record was made 'in plan' of all features as revealed in the investigation. These plans were normally based on digital survey data (digital planning methods were agreed in advance with the HS2 Ltd).

7.5.4 Profiles were obtained by extrapolating the forms from the objectively recorded points. Profiles were produced at scales of 1:1000, 1:500 and 1:200 at 1:1 ratio, and in order to understand any smaller fluctuations in the profile the profiles were also viewed and produced with a x 10 exaggeration on the Y axis (vertical enhancement).

8 Results

8.1 General

8.1.1 The Scheduled Monument (SM) is described as "*Grim's Ditch survives as a substantial earthwork along most of its length. The earthen bank measures up to 8m wide and stands up to 0.6m high. To the east of the bank lies a parallel ditch, up to 8m wide and up to 0.5m in depth.*" (SM list entry 1021198). The results of the topographic surveys have refined this information with increased accuracy over a wider area.

8.1.2 The segment of the Grim's Ditch Scheduled Monument, that lies within the site, is 145m long and is aligned northeast-southwest and has a visible upstanding bank on the

west side of a linear hollow / ditch (Figures 3-8, Plate 2). The UAS coverage extended beyond that of the area defined as the Site (as seen in Appendix 3) and demonstrated a continuation to the south of both the negative and positive elements but to the north beyond the SM the site is entirely flat.

8.1.3 The survey demonstrates that the maximum dimension of the earthwork ditch is 13.64m wide at the top with its lowest point at 191.03mOD; and that the bank is a maximum 10.92m wide at the base with a maximum height of 198.12mOD. This gives a differential from the top of the extant bank to the base of the ditch, as seen at ground level, of 7.09m. The width of the bank and ditch were not uniform and varied along the length.

8.1.4 An examination of the main northeast-southwest, longitudinal axis of the Monument (profile A-B) shows that the monument is at a higher elevation at the northeast end and gradually drops to the southwest. Over a distance of 140m the ground falls from 198m OD to 190m OD.

8.1.5 The extrapolated five cross-sectional profiles (Figures 5 and 6) show that the profile is deeper and sharper towards the north where evidence of disturbance features is seen, (Profiles L-J and N-M). Where undisturbed, as the more southerly profiles show, the bank has a gently convex profile, tapering into the gentle U-shaped concave ditch profile. The breaks of slope throughout the monument are gradual.

8.1.6 The interpreted hachure plan (Figure 2) derived from the subjective mapping of the breaks of slope was in accordance with the objective points and 3D modelling. It identified the negative linear ditch feature within the Monument area and to the west the positive remains of the bank, with a slight berm of unknown origin on the eastern side, much less well defined with less perceptible breaks of slope.

8.1.7 The bank is likely to have been formed by upcast material derived from the excavation of the ditch. The bank material may then have been denuded by natural erosion processes, with sediments being redeposited back within the ditch. This aspect is not evident from the ground surface and the earthwork appears in a stable condition with no evidence of soil creep or ongoing bank erosion. There was a noticeable soft ground cover of leaf litter along the ditch area where material had accumulated from the previous tree canopy, which slightly obscured the firmer ground surface beneath.

8.2 Disturbance / Pit Features

8.2.1 There are four large concave areas of disturbance visible towards the northeast end of the monument, all with relatively gradual breaks of slope (Figure 2, Plates 3-6). Two are much larger sized (1 and 3) and are located on the bank, while the smaller ones (2 and 4) lie mostly within the ditch area. The disturbances are generally round in plan and vary from 6.5m to 11.5m in diameter and are between 3.13m and 1.25m deep. The larger ones had steeper sides It is unclear what process had led to their formation but probable events include quarrying / extraction or tree uprooting, with the larger deeper disturbances being more likely to be the result of quarrying.

Table 1: disturbance features seen

Disturbance / Pit	Diameter (m)	Highest point (m AOD)	Lowest point (m AOD)
1	11.5	197.665	194.532
2	7.5	196.304	194.85
3	10	195.699	193.133
4	6.5	195.191	193.933

8.2.2 The trees that had become established on the monument had also grown within the disturbance areas, (Plate 3) suggesting that the disturbances took place prior to the tree growth, although the date is unknown. The distribution and density of these, detected as remaining above ground stumps, were visibly highlighted in the results of the UAV photogrammetry survey (Figures 7 and 8).

8.2.3 There are also two locations below ground disturbance from recent badger setts which have penetrated both the bank and ditch areas. The extent of the setts is unclear from the surface.

8.2.4 The results were able to rapidly capture detailed data which can be viewed as either orthomosaic photographic representations (Figure 8) or as 3-dimensional models. This preserved the status of the Monument at one given point in time. No anomalies were found between the various sources of surveyed data and the established record for the site, but greater accuracy was gained.

8.2.5 The topographic survey confirmed the presence and dimensions of a 145m long linear depression consistent with a ditch and an adjacent upstanding linear bank on the western side. Both elements are part of the Scheduled Monument referred to as Grim's Ditch (SM list entry 1021198).

8.2.6 The various aspects of the monument, which can be seen through the topographic survey indicate that, although it is fossilised within the landscape, it has not remained a static unchanged feature.

8.2.7 The survey also provided the basis for Stakeholder discussions on the proposed location of Trench 01 for the trial trench evaluation investigation (Doc Ref 1EW03-FUS_IFA-EV-REP-CS03_CL05-009436) corresponding to the area of the monument that will be impacted by the construction of the main line. The survey results show that for Trench 01 one section would include part of a small depression in the surface of the monument and the opposing side would record an uninterrupted section through the monument.

9 Potential

9.1.1 It is recognized that the undertaking of the topographic survey, as a standalone item, can only have a limited contribution to the specific HERDS objectives (KC13, KC15 and

KC16) relating to the dating of the Monument or identifying regional patterns in terms of landscape, population and resources during the relevant eras.

9.1.2 The work does have the potential to contribute to KC13 in terms of being able to demonstrate the impact Grim's Ditch has had on the landscape following its construction.

9.1.3 The survey results allow for interrogation of the data by stakeholders and interested parties and provides a baseline of information to gauge future changes against.

9.1.4 It also has the potential to aid in the presentation of the Monument to the public which contributes to the identified Community Engagement objectives:

9.1.5 CE1: Marking and communicating the changes to landscapes and environments – the data can help to create virtual reality reconstructions showing the construction and evolving history of the monument

9.1.6 CE2: Identifying and sharing our stories – the topographic results help to place Grim's Ditch into the landscape and can be used as a basis for producing models of the monument and landscape over time.

9.1.7 CE3: Meeting the challenge of inspiring the next generation – the topographic survey can provide a resource during school visits and provide a less static tool to help them see archaeology in action and it can be used on social media to stimulate interest and engagement.

9.1.8 CE4: Accessible information and knowledge sharing – the data and results can be part of presentations to local history and archaeology societies, and at open events for the public and local residents.

9.1.9 CE5: Contribute to the process and facilitation of audience project creation – the data, images and models can be shared with other interested groups in the community such as 'Mystery of Grim's Ditch' project, local history societies and art groups, to expand its reach beyond the archaeological use.

10 Archive deposition

10.1.1 Following completion of the archaeological evaluation, the subcontractor will provide the contractor with the required data, metadata and digital material as specified in the Historic Environment Digital Data Management and Archiving Procedure (C262-ARP-EV-SPE-000-000003) and the Historic Environment Digital Data Management and Archiving Strategy (HS2 Ltd, 2015a).

10.1.2 The security and stability of the digital archive will be ensured from fieldwork through to deposition.

10.1.3 The survey data will be edited to ensure that the archive deposited into the public domain is fit for purpose both as a record of the archaeology removed by excavation and to enhance understanding about the site from which it came.

10.1.4 The report will be uploaded to the OASIS database as required by HS2.

10.1.5 File-level metadata requirements for spreadsheets and databases are specified in the ADS *Guidelines for Depositors* (2014) Spreadsheets, Databases and Statistics Guidelines. These guidelines include a metadata template that can be downloaded in XLS, ODS and CSV formats.

11 Bibliography

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HS2, Generic Written Scheme of Investigation: Historic Environment Research and Delivery Strategy	HS2-HS2-EV-STR-000-000015
HS2 Cultural Heritage GIS Specification	HS2-HS2-GI-SPE-000-000004
HS2 Historic Environment Digital Data Management and Archiving Strategy	HS2-HS2-EV-STR-000-000019
HS2 Historic Environment Physical Archiving Strategy	HS2-HS2-EV-STR-000-000018
HS2, Location Specific Written Scheme of Investigation for Archaeological Trial Trench Evaluation at Grim's Ditch Scheduled Monument AC210/14	1EW03-FUS-IFA-EV-REP-CS03_CL05-000001

Title	Reference
HS2, Phase One Environmental Statement and Geophysical Survey Report	ES 3.5.2.10.4 C252-ETM-EV-REP-020-000263_P02
HS2, Project Plan for Trial Trench Evaluation Grim's Ditch Scheduled Monument AC210/14	1EW03-FUS-EV-REP-CS03_CL05-009409
HS2, AWH Summary of Stakeholder Hold Point Meeting for Grim's Ditch Scheduled Monument AC210/14	1EW03-FUS_IFA-EV-REP-CS03_CL05-009436
HS2, AWHe Survey Report for Topographical Survey of Grim's Ditch Scheduled Monument AC210/14	1EW03-FUS_IFA-EV-REP-CS03_CL05-000043
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HS2, Technical Standard: Route wide soil resource plan	HS2-HS2-EV-STD-000-000008
HS2, Technical Standard: Historic environment physical archive procedure	HS2-HS2-EV-STD-000-000039
HS2, Technical Standard: Historic environment digital data management and archiving procedure	HS2-HS2-EV-STD-000-00003
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12 Glossary of terms

12.1.1 The following terms have been used in this report:

- **Archaeological contractor** – INFRA, the organisation undertaking the specific historic environment works for the *Contractor*.
- **Contractor –** Fusion; the organisation undertaking the Enabling Works for Area Central on behalf of the Employer.
- **Employer –** HS2 Ltd, the organisation responsible for delivery of HS2 Phase One Scheme and all terms and conditions, policies, procedures, and payments
- **Evaluation -** A form of archaeological investigation involving the excavation of trenches to help determine the character and date of any discovered archaeology
- **Generic Written Scheme of Investigation: Historic Environment Research and Delivery Strategy (GWSI: HERDS)** – the framework for delivering all historic environment investigations undertaken as part of the HS2 Phase 1 programme.
- **Location** – a specific HS2 worksite or group of worksites that are being addressed as a combined historic environment investigation programme of assessment, evaluation and investigation.
- **Location Specific Written Scheme of Investigation (LSWSI)** - specification document assembling one or more Project Plans within an area of land defined primarily for construction programme purposes. The LS-WSIs will be agreed with the Project Manager and would provide a costed and programmed approach to delivering outcomes.
- **Project Plan** – specification document for each specific package of activity (e.g. a survey, desk-based assessment, excavation, recoding project). The plans would respond to the Specific Objectives set out in the GWSI: HERDS and be delivered within an agreed budget.
- **Works** – the specific historic environment assessment, evaluation or investigation works at each location.

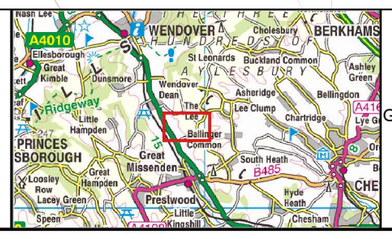
Appendix 1 – Figures

489 000 E

204 000 N

Legend

C10021 Site extent



High Speed Two
Grim's Ditch Scheduled Monument C10021
Figure 1. Site location

Published

HS2

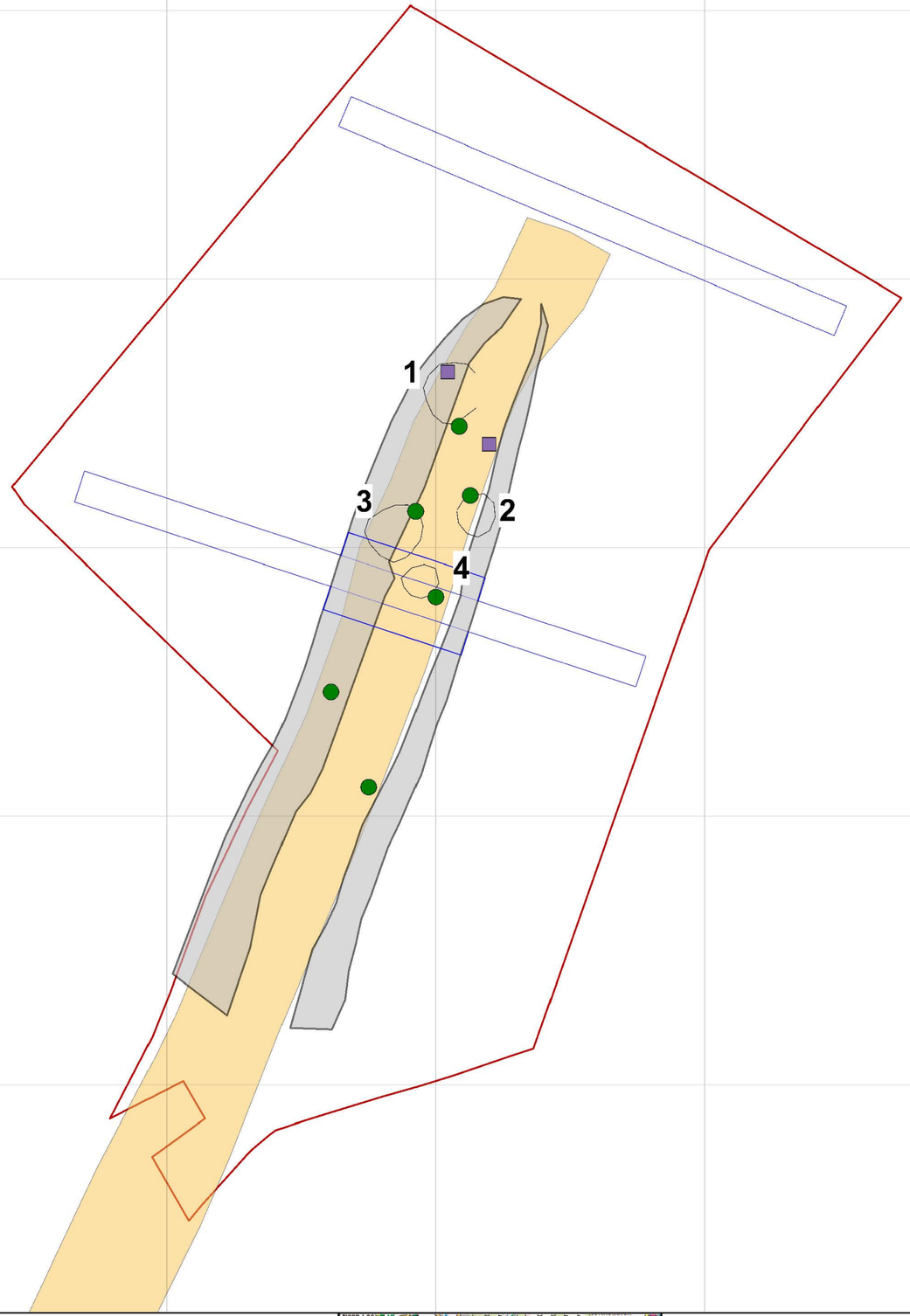
Scale at A3: 1: 5 000

0 50 100 150 200
Metres

Revision: C01
Doc Number: 1EW03-FUS_IFA-GI-MAP-CS03_CL05-000048 **Date:** 22/02/22

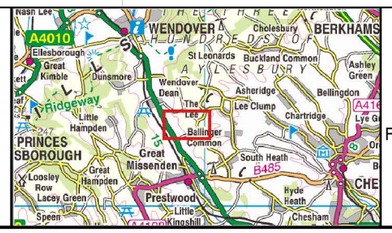
489 000 E

203 600 N



Legend

- Monument site extent
- Grims Ditch scheduled ancient monument
- Bank
- Initial trench design
- Location of pit
- Badger set
- Tree trunks



High Speed Two

Figure 2. Overview of Grim's Ditch C10021

Published

HS2

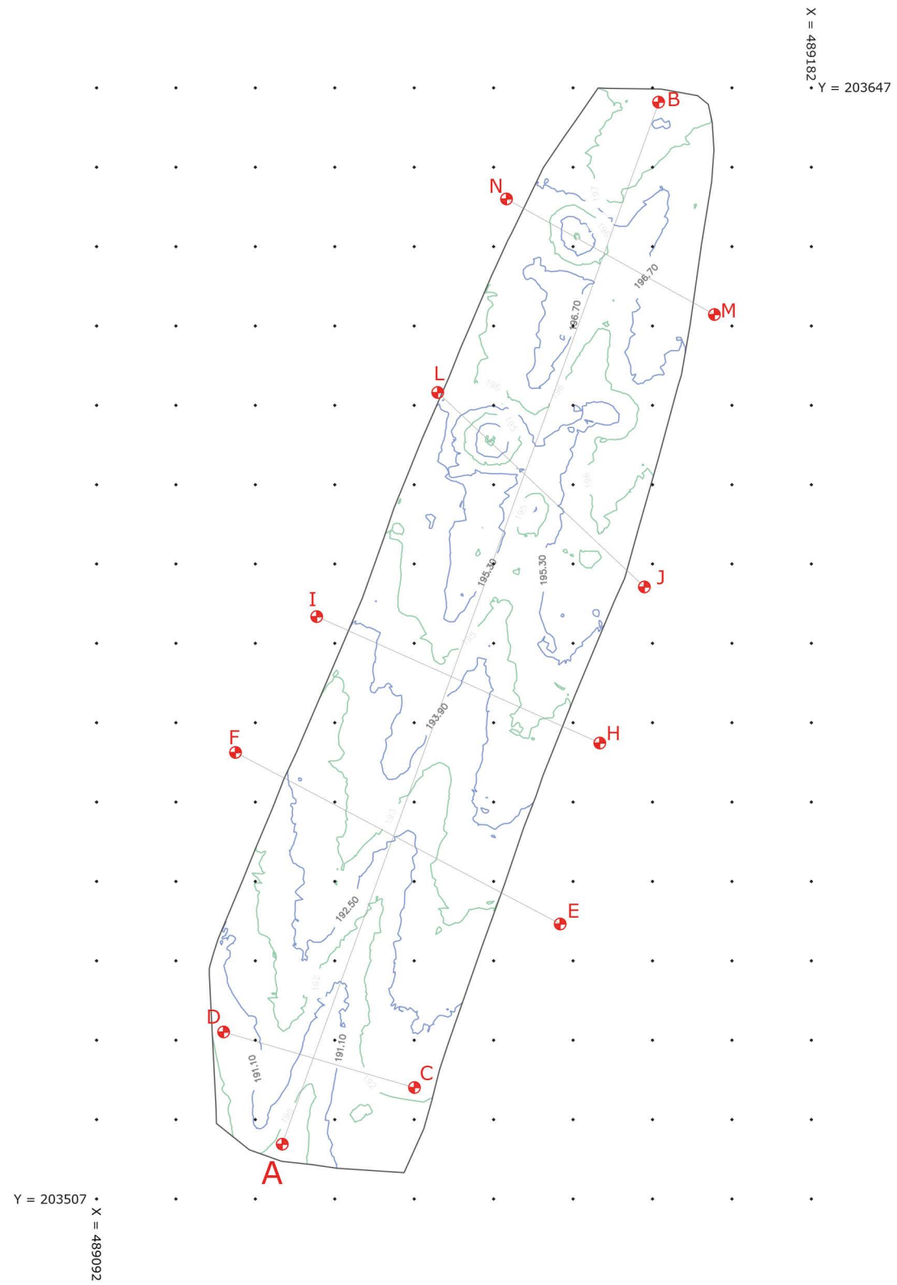
Scale at A3: 1: 1000

0 10 20 30 40

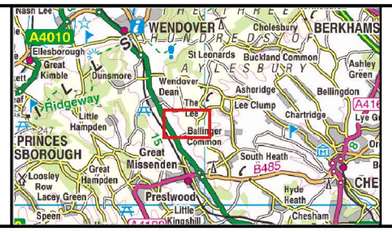
Metres

Revision: C01

Doc Number: 1EW03-FUS_IFA-GI-MAP-CS03_CL05-000048 **Date:** 22/02/22



Legend



High Speed Two

Figure 3. Topographical survey results, Grim's Ditch C10021

Published

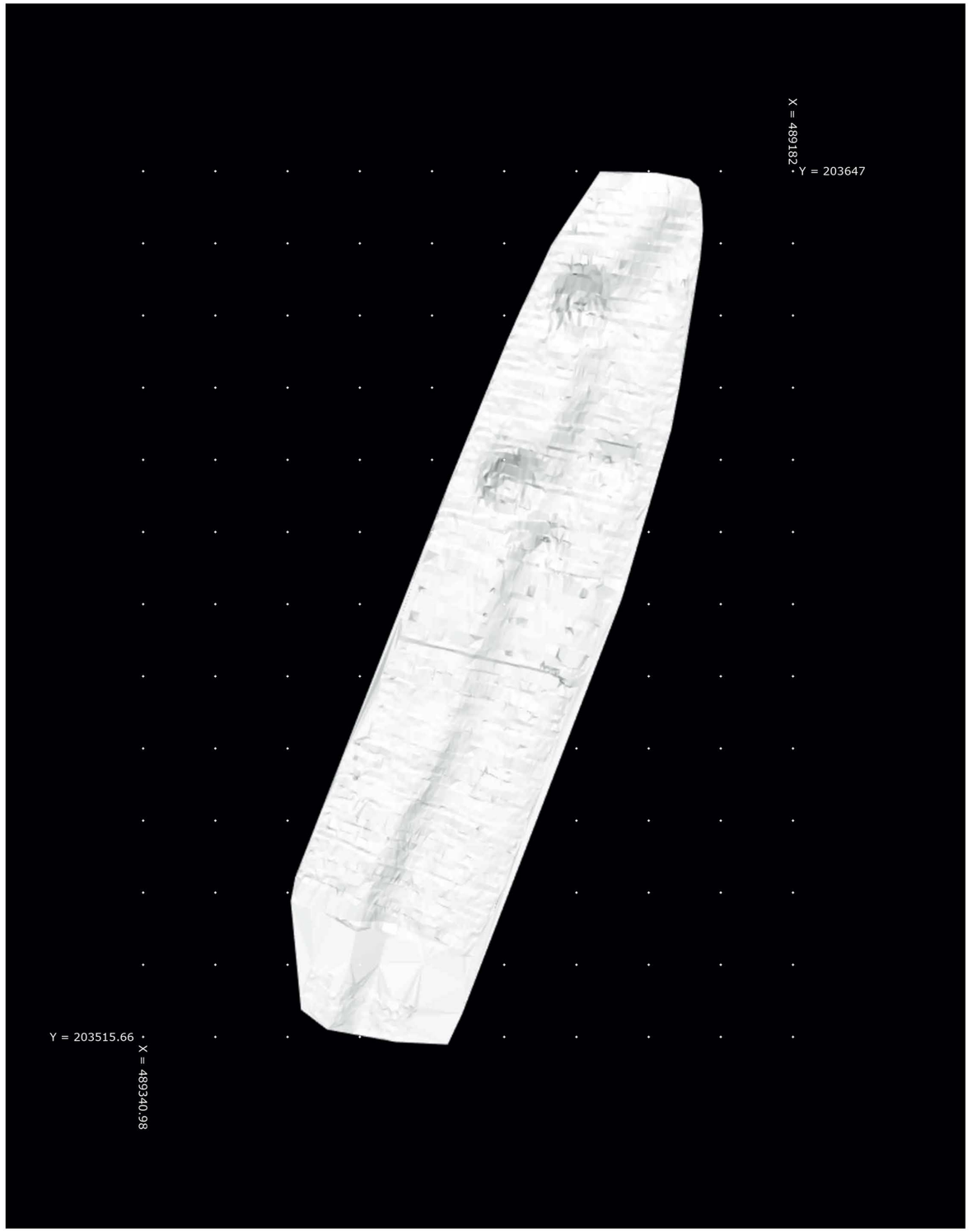
HS2

Scale at A3: 1: 500

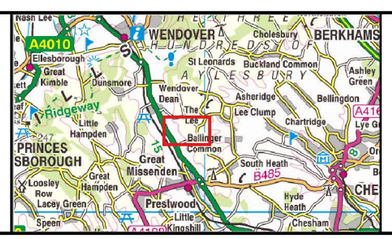
0 5 10 15 20
Metres

Revision: C01

Doc Number: 1EW03-FUS_IFA-GI-MAP-CS03_CL05-000048 **Date:** 22/02/22



Legend



High Speed Two

Figure 4. 3D Surface
Grim's Ditch C10021

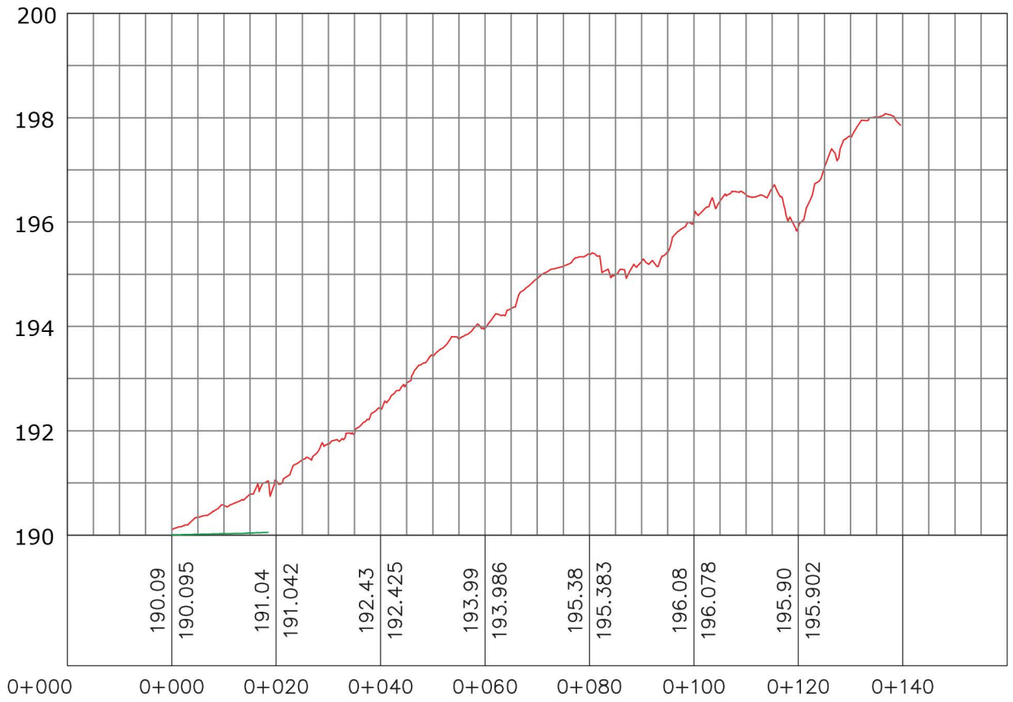
Published

HS2

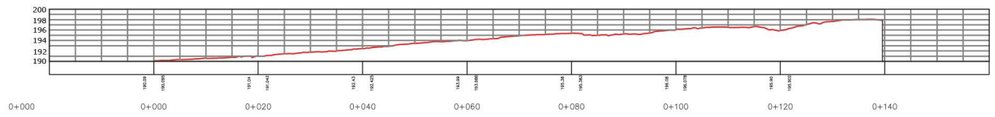
Scale at A3: 1: 500

0 5 10 15 20
Metres

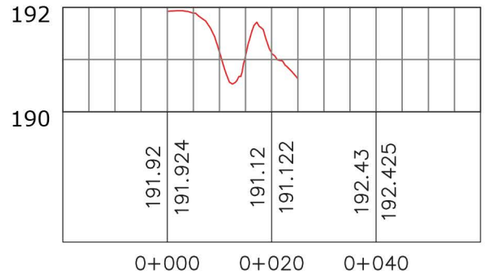
Revision: C01
Doc Number: 1EW03-FUS_IFA-GI-MAP-CS03_CL05-000048 **Date:** 22/02/22



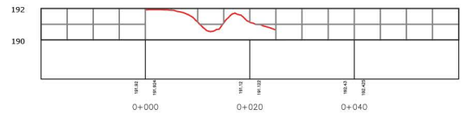
Profile A-B, Scale factor 10x on the y-axis



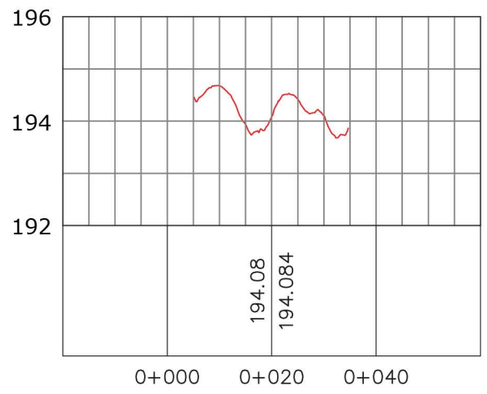
Profile A-B



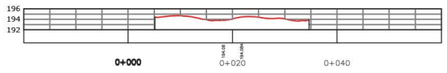
Profile C-D, Scale factor 10x on the y-axis



Profile C-D, Scale factor 2x on the y-axis

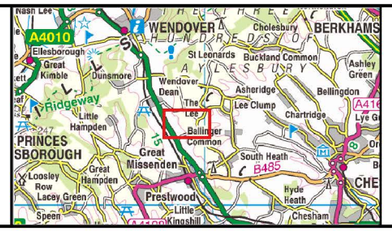


Profile H-I, Scale factor 10x on the y-axis



Profile H-I

Legend



High Speed Two

Figure 5. Profiles A-B, C-D, H-I, Grim's Ditch C10021

Published

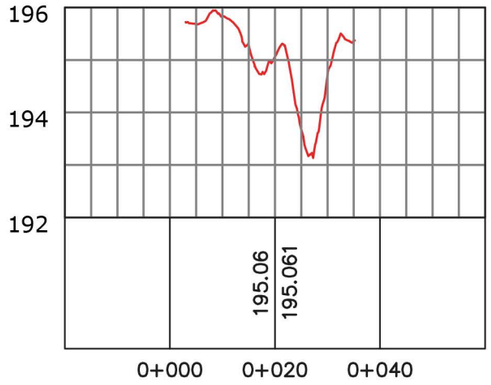
HS2

Scale at A3: 1: 1000

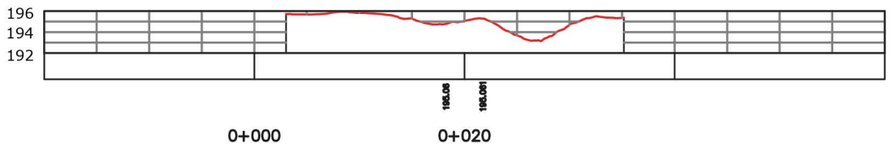
0 10 20 30 40
Metres

Revision: C01

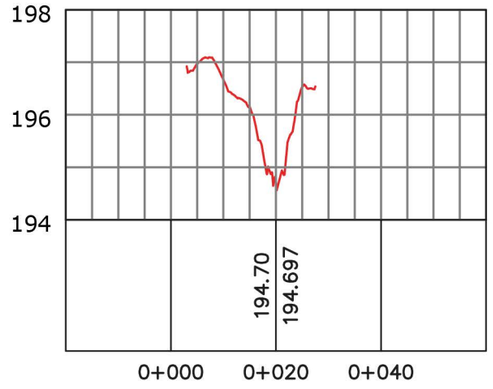
Doc Number: 1EW03-FUS_IFA-GI-MAP-CS03_CL05-000048 **Date:** 22/02/22



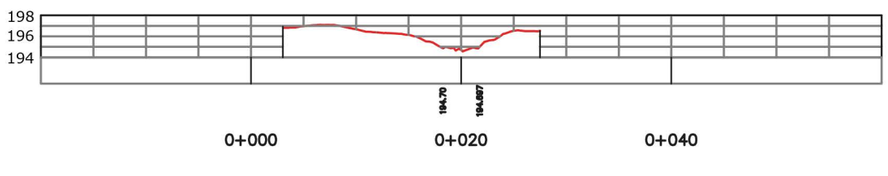
Profile J-L, Scale factor 10x on the y-axis



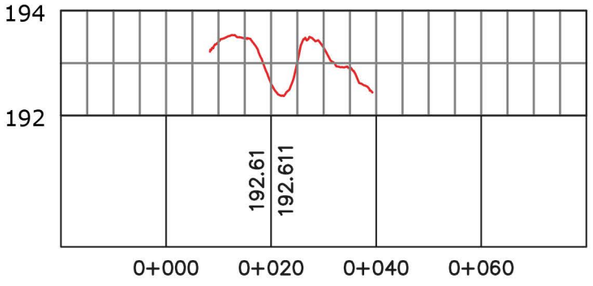
Profile J-L



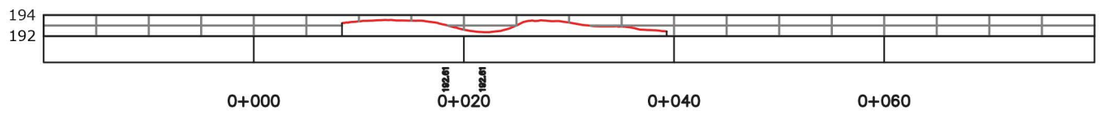
Profile M-N, Scale factor 10X y-axis



Profile M-N

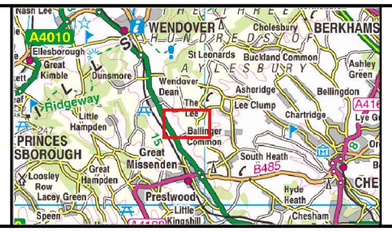


Profile E-F, Scale factor 10X y-axis



Profile E-F

Legend



High Speed Two

Figure 6. Profiles E-F, J-L, M-N
Grim's Ditch C10021

Published

HS2

Scale at A3: 1: 500

0 5 10 15 20
Metres

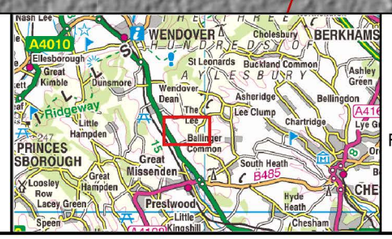
Revision: C01
Doc Number: 1EW03-FUS_IFA-GI-MAP-CS03_CL05-000048 **Date:** 22/02/22

489 100 E

203 600 N

Legend

- Monument site extent
- Initial trench design



High Speed Two

Figure 7. HIgh Definition UAV topographic

Published

HS2

Scale at A3: 1: 600

0 6 12 18 24
Metres

Revision: C01

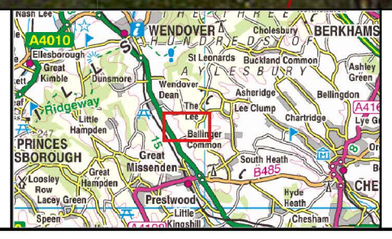
Doc Number: 1EW03-FUS_IFA-GI-MAP-CS03_CL05-000048 **Date:** 22/02/22

489 100 E

203 600 N

Legend

- Monument site extent
- Initial trench design



High Speed Two

Figure 8. HIgh Definition UAV colour

Published

HS2

Scale at A3: 1: 600

0 6 12 18 24
Metres

Revision: C01

Doc Number: 1EW03-FUS_IFA-GI-MAP-CS03_CL05-000048 **Date:** 22/02/22

Appendix 2 – Plates

Plate 1 - Working shot of topographic survey, looking south

Plate 2 - Bank and ditch earthwork, looking southeast

Plate 3 - Disturbance feature 1, looking west

Plate 4 - Disturbance feature 2, looking northeast

Plate 5 - Disturbance feature 3, looking west

Plate 6 - Disturbance feature 4, looking north

Appendix 3 Aerial Photogrammetry Survey

AERIAL PHOTOGRAMMETRY SURVEY REPORT

Grim's Ditch

Client

Red River Archaeology (Infra) / Fusion / HS2

Survey Report

AC-22-AER-06

Date

09/02/2022

Survey Report AC-22-AER-06: Grim's Ditch

Survey dates	02/12/2020
Field co-ordinator	Adam Stanford MCIfA FSA
Report Date	09/02/2022
Report Author	Simon Batsman
Project Manager	Adam Stanford MCIfA FSA
Report approved	Adam Stanford MCIfA FSA

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TABLE OF CONTENTS

LIST OF FIGURES

1 SUMMARY OF RESULTS

An aerial photogrammetry survey of an ~260m stretch of Grim's Ditch near Kingsash in Buckinghamshire was conducted to record the ancient earthwork and associated features. LiDAR obtained from DEFRA has also been used to show the wider landscape and to compare the results with the photogrammetry.

2 INTRODUCTION

2.1 Background Synopsis

SUMO / Aerial-Cam Ltd was commissioned by Red River Archaeology (Infra) on behalf of Fusion/HS2 to conduct a photogrammetry survey of Grim's Ditch.

2.2 Site Details

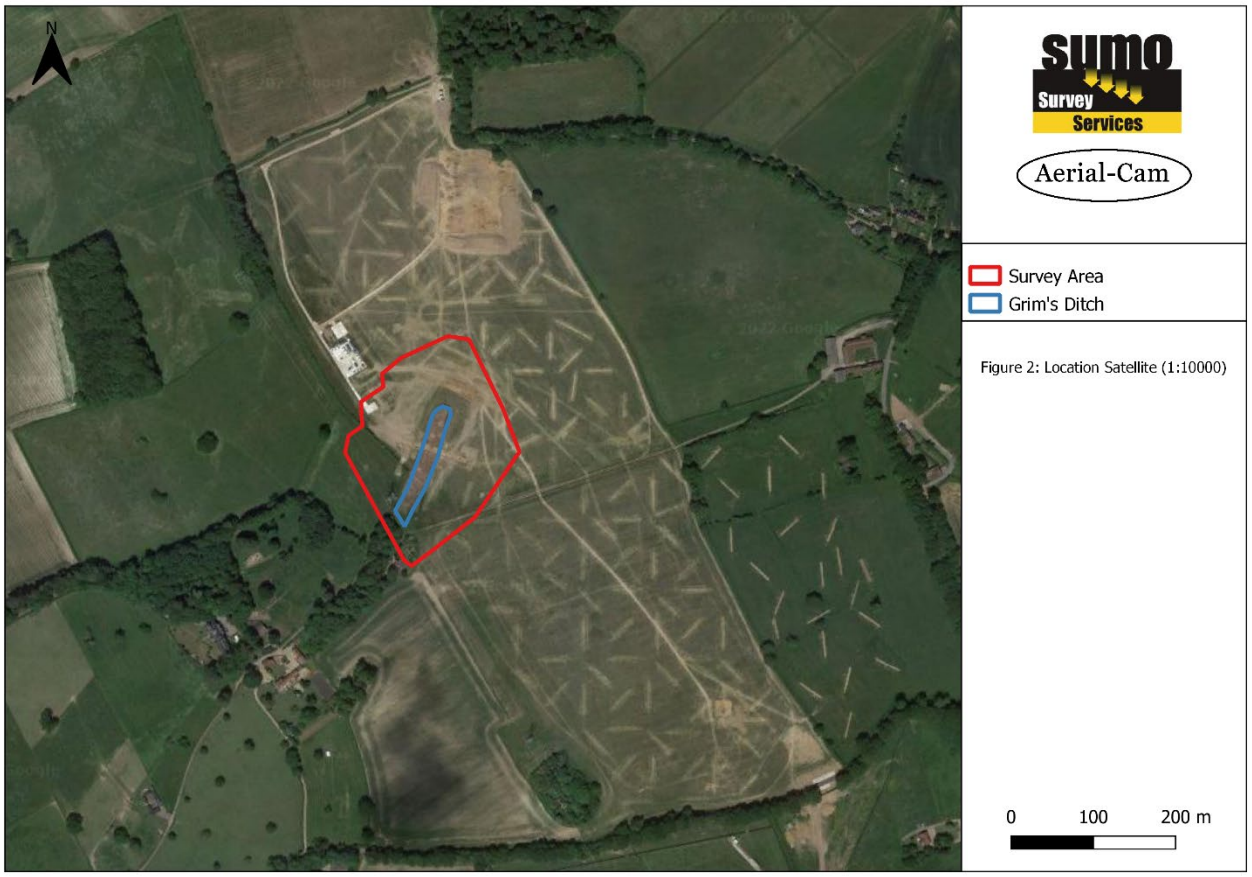
NGR	SP891036
Location	King's Lane, The Lee, Kingsash, Buckinghamshire.
HER	Buckinghamshire HER
District	Chiltern
Parish	The Lee
Topography	The site slopes down moderately from a height of 198.4m (656ft) in the east to 190m (620ft) in the west.
Current Land Use	Agriculture. Acquired by HS2
Geology	Bedrock: Lewes Nodular Chalk Formation and Seaford Chalk Formation Superficial: Clay-with-flint Formation - Clay, Silt, Sand And Gravel (BGS 2022)
Archaeology	Grim's Ditch, or Grim's Dyke, is a boundary ditch stretching across 18km of the Chilterns. It is the focal part of archaeological investigations taking place in this location due to the HS2 preconstruction phase. An evaluation and excavation in the field has also occurred subsequent to the excavation of Grim's Ditch.
Survey Methods	Aerial photogrammetry
Study Area	3.89

2.3 Aims and Objectives

To identify and characterise earthworks and other features of archaeological significance relating to Grim's Ditch.

2.4 Site Location

Figure 1: Site Location (1:25000), produced from Open Street Map (2022)



3 METHODS

3.1 Survey Methodology - Topographic

3.1.1 PHOTOGRAPHY

A UAS with a gimbal mounted camera was flown at 66m above ground level to obtain a spatial resolution of 1.64cm per image pixel.

3.1.2 PHOTOGRAMMETRY

Images were processed in photogrammetry software to produce a 3D pointcloud with a horizontal density of 232 points per square metre. Data were exported as a raster digital elevation model with a 6.56cm/pix spatial resolution and an orthophoto with a 0.82cm spatial resolution.

3.1.3 REFERENCING

The photogrammetric model was referenced by 8 ground control points that were distributed around the survey area. The seven points are visible in the aerial photographs and were also surveyed using high accuracy GPS to facilitate georeferencing to OS coordinates. The ground control points provide an error of 1.6cm.

3.2 Data Processing and Visualization

3.2.1 DIRECTIONAL LIGHT SHADING

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.

3.2.2 AMBIENT LIGHT SHADING

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. It gives the viewer an intuitive sense of the 3D topography but can fail to reveal subtle features near much larger objects.

3.2.3 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.

digital elevation model

3.2.4 RELIEF VISUALIZATION TOOLBOX (RVT) PROCESSING

Automated manipulation of DEM including further flattening, smoothing and light simulation to highlight subtle features in the landscape.

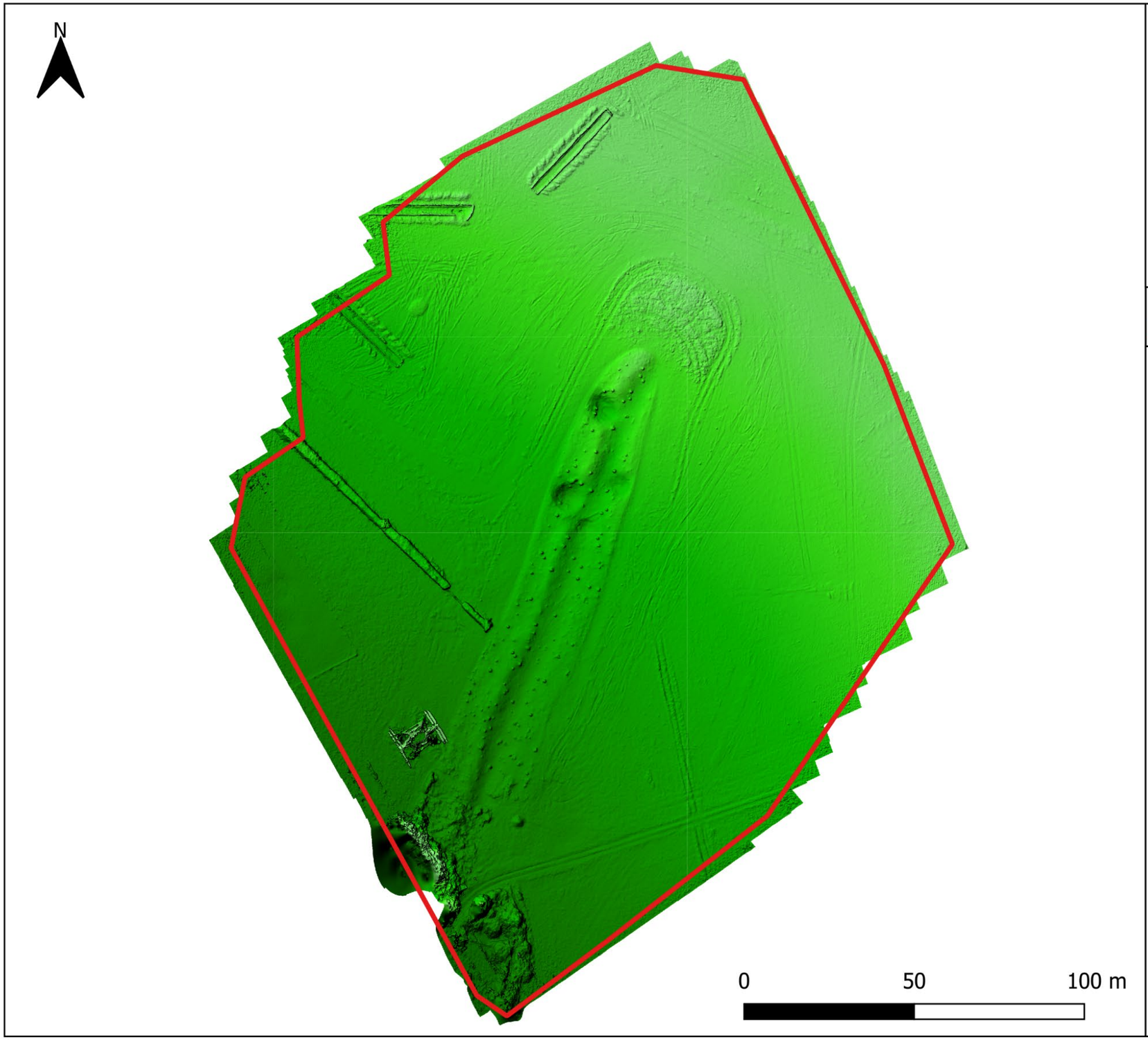
3.2.5 LiDAR

LiDAR was obtained from DEFRA to illustrate the wider landscape and contextualise the study area.

4 RESULTS

Survey Area

Figure 3: Orthophoto (1:1500)



sumo Survey Services

Aerial-Cam

Survey Area

Figure 4: DEM (1:1500)

Simulated illumination from north-west

Elevation (metres)

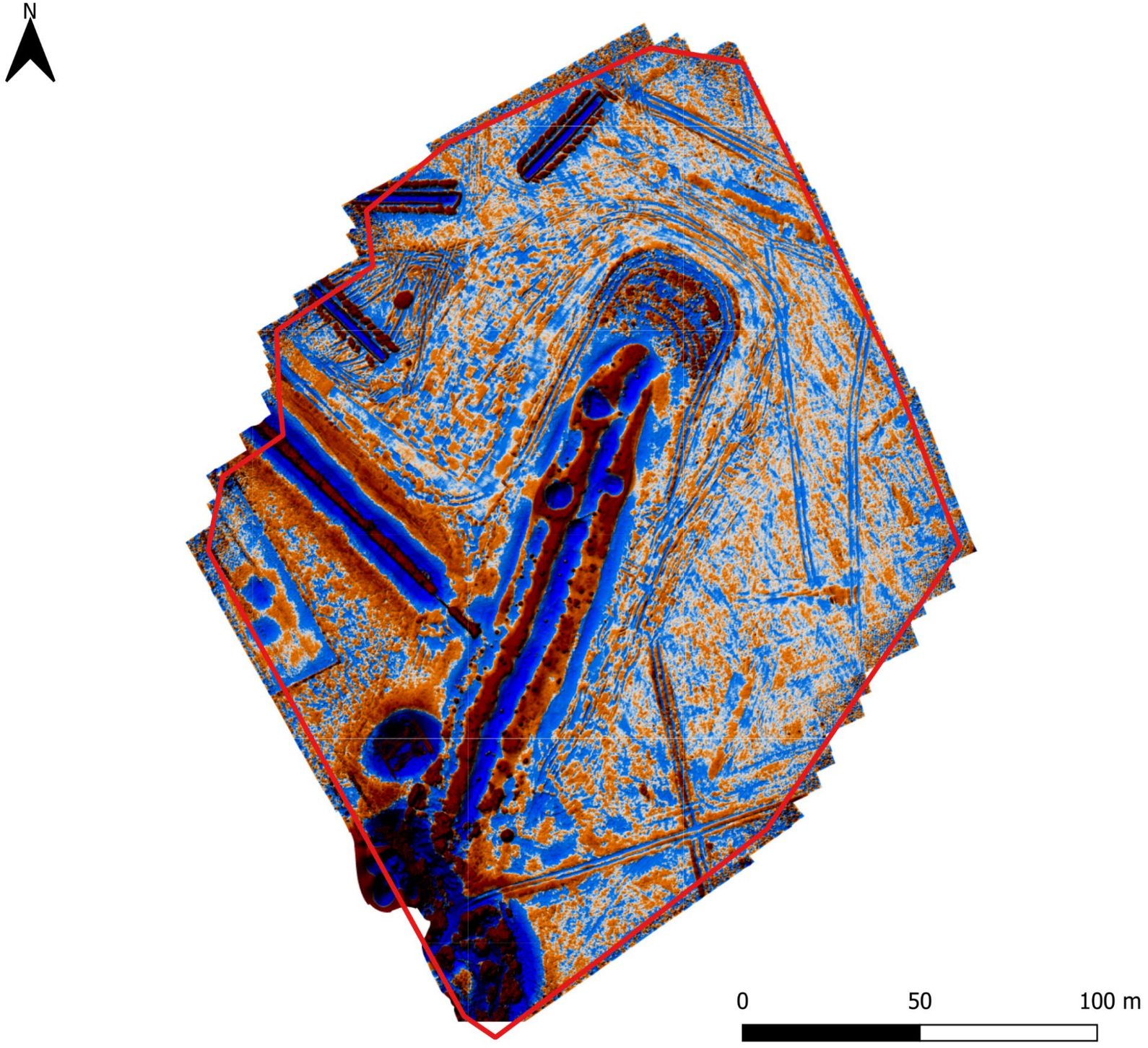
+198.4

+197.4

+195.7

+191.4

+181.0



sumo Survey Services

Aerial-Cam

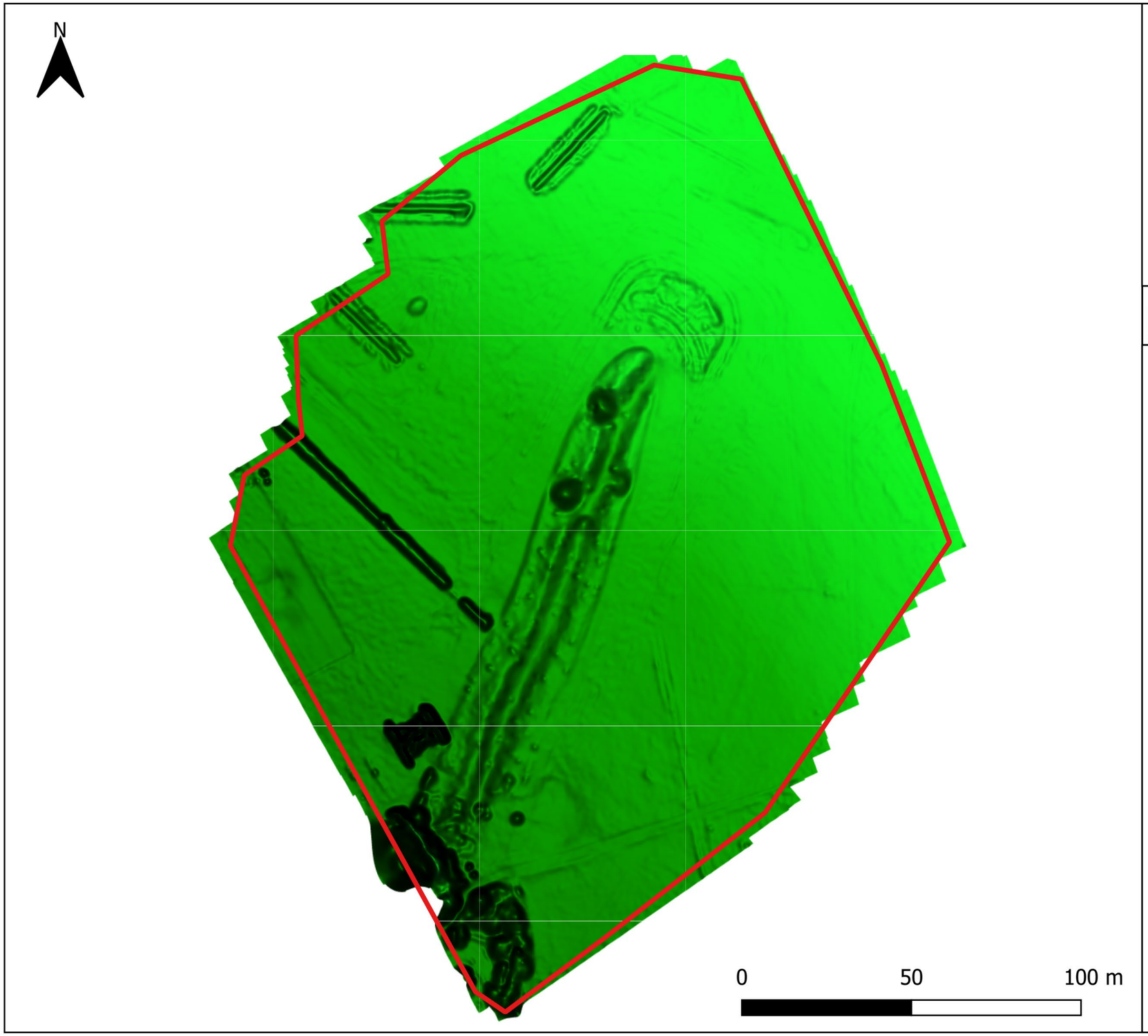
Survey Area

Figure 5: Flattened topography
(1:1500)

Simulated illumination from north-west

Elevation (Metres)

+0.18
+0.019
+0.0
-0.02
-0.29



sumo Survey Services

Aerial-Cam

Survey Area

Figure 6: Smoothed topography (1:1500)

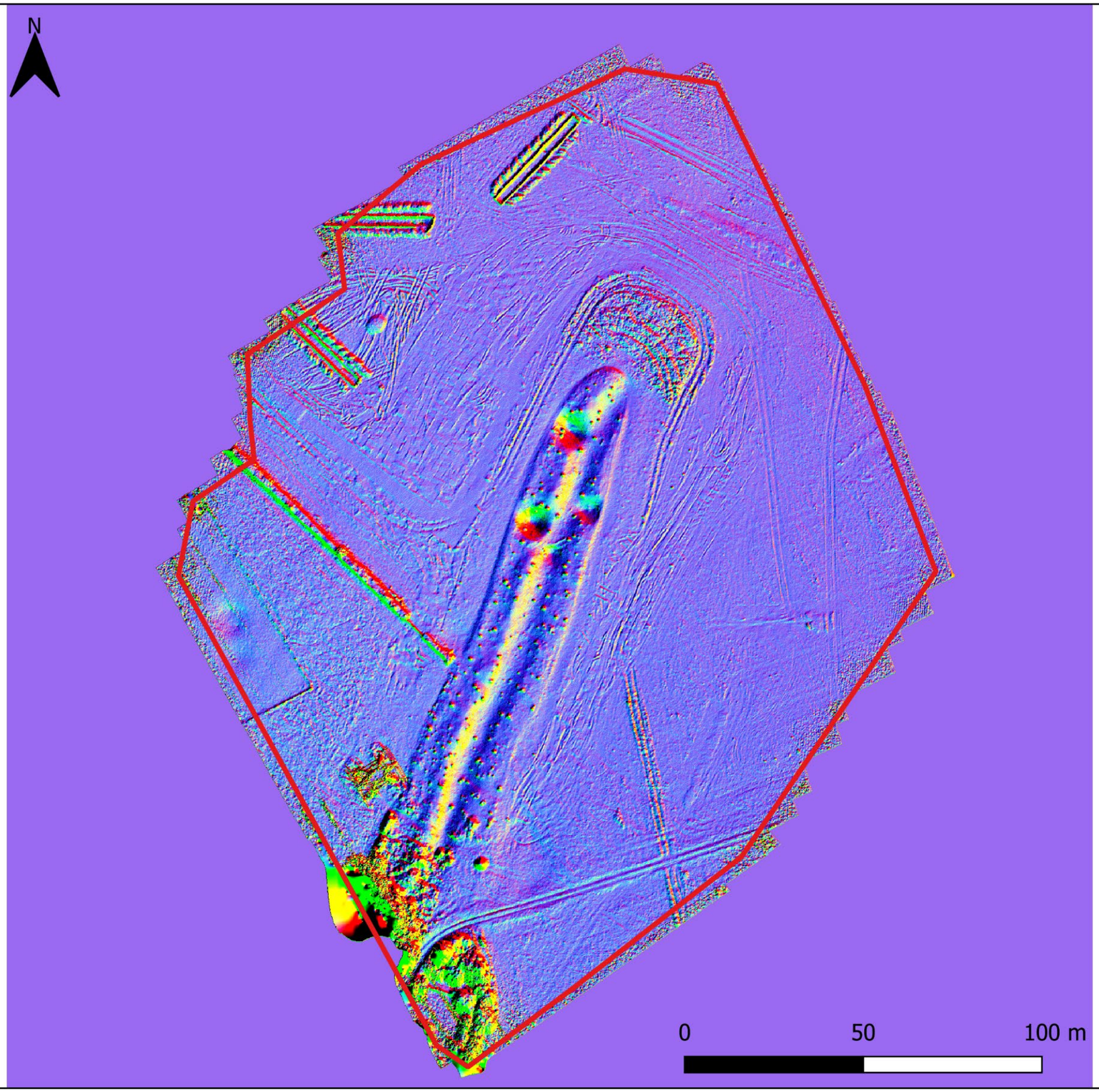
Simulated illumination from above

Elevation (metres)

+198.4

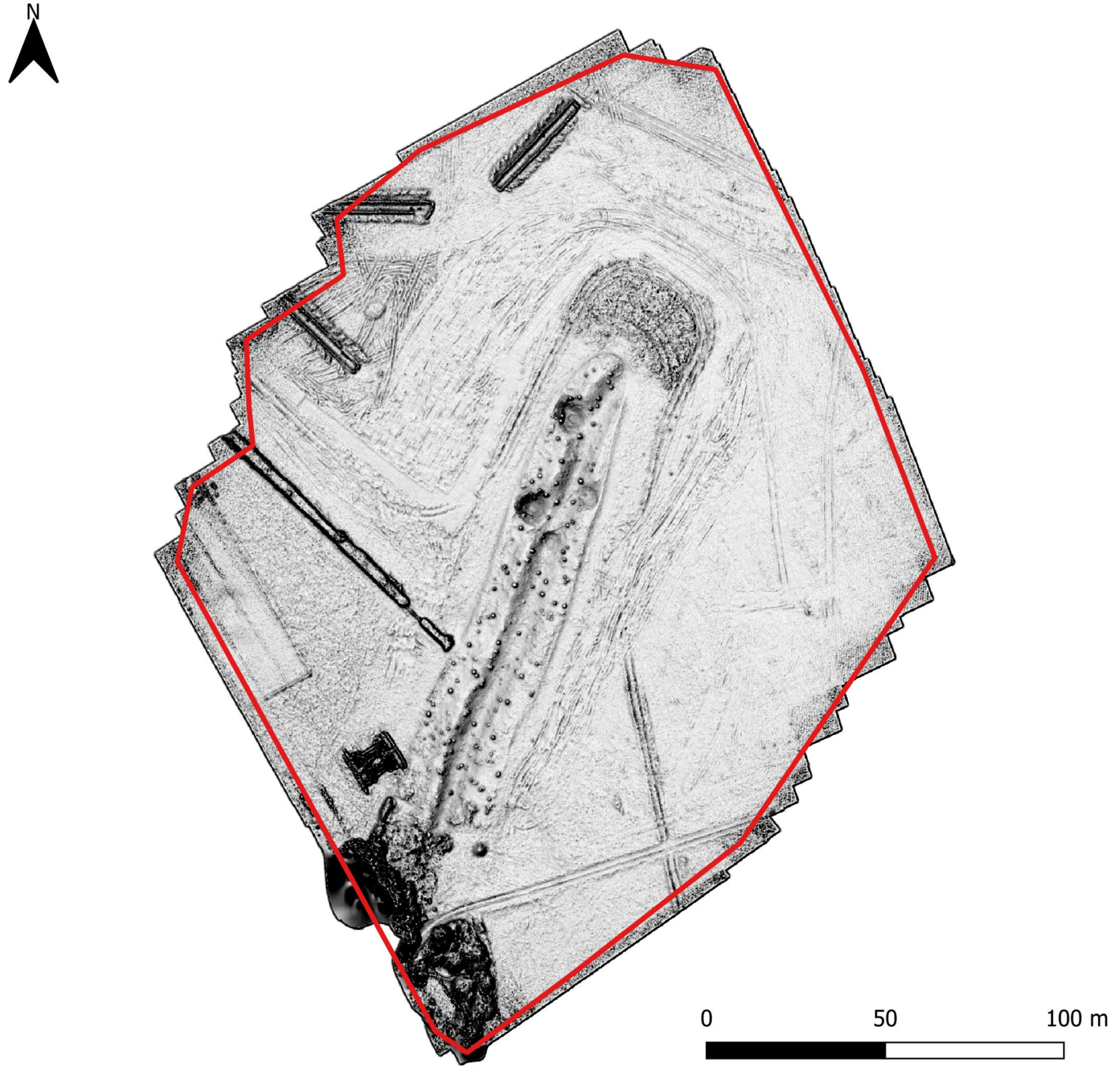
+195.7

+190.0



Survey Area

Figure 7: RVT enhanced luminance (1:1500)



sumo Survey Services

Aerial-Cam

Survey Area

Figure 8: RVT smoothed and flattened topography, greyscale (1:1500)

sumo Survey Services

Aerial-Cam

- Survey Area
- Bank
- Buffer
- Field Boundary
- Pit
- Tree Stump
- Evaluation Trench
- Ditch
- Farm Track
- Pylon
- Vegetation

Figure 9: Interpretations (1:1500)

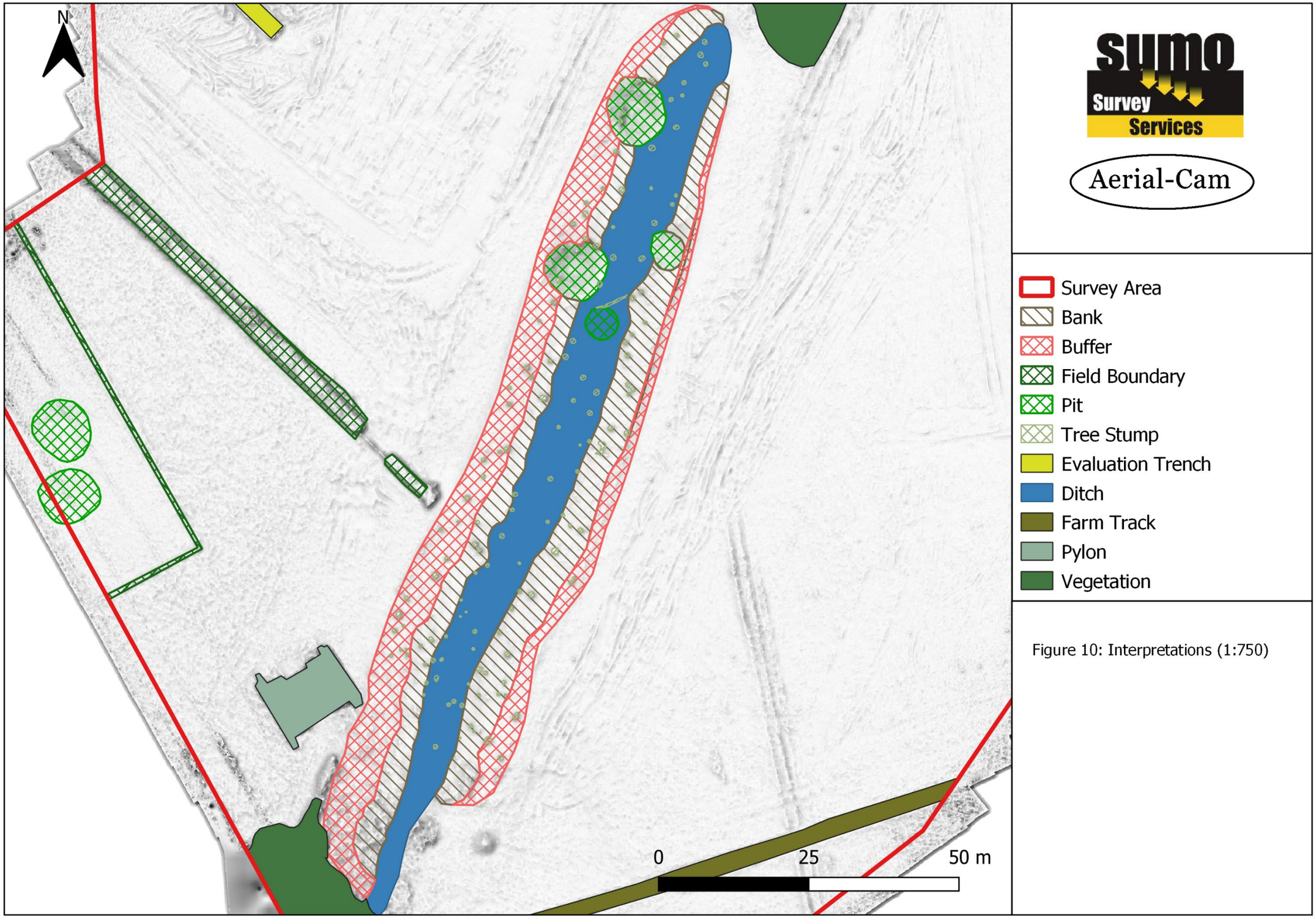
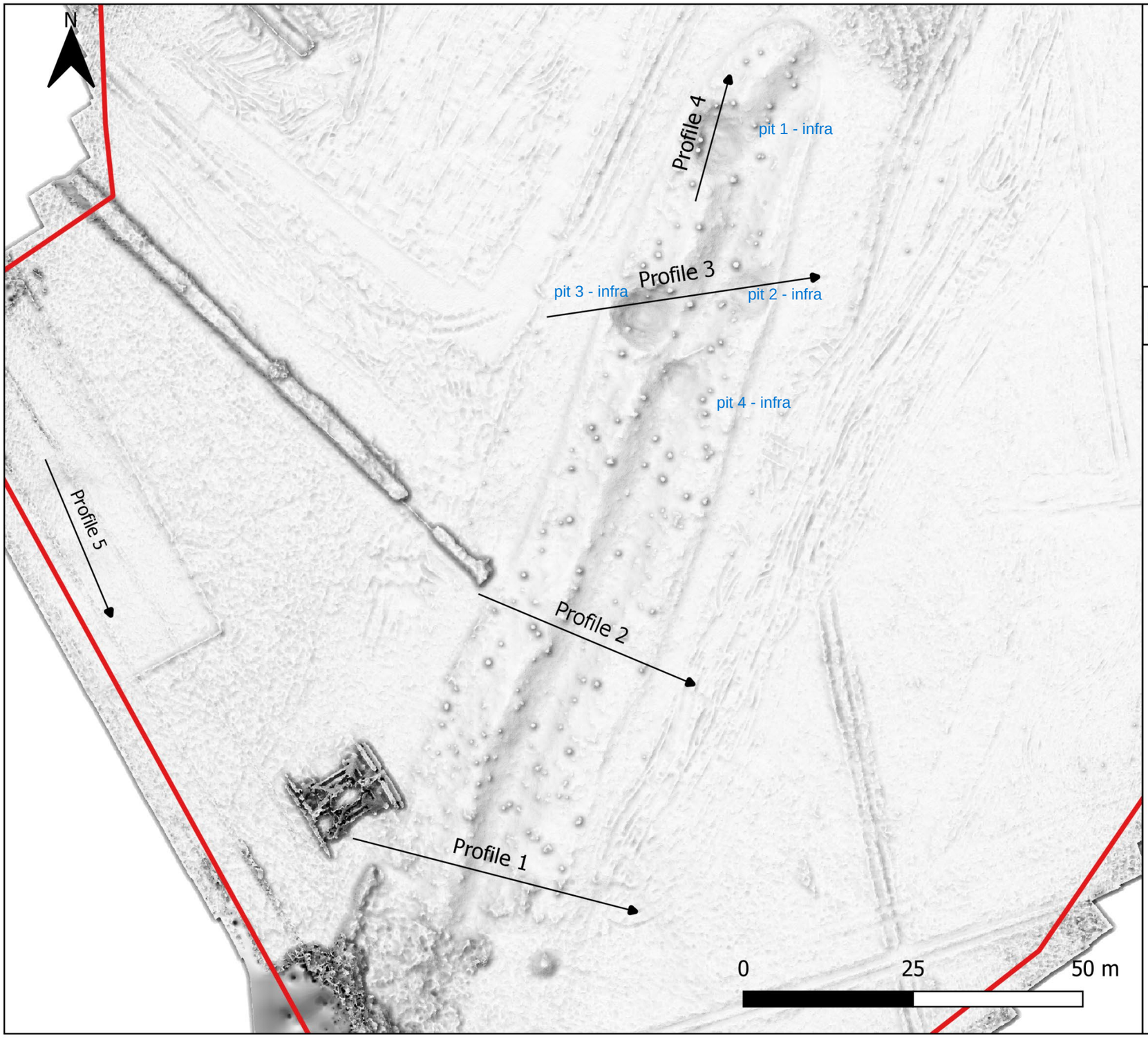
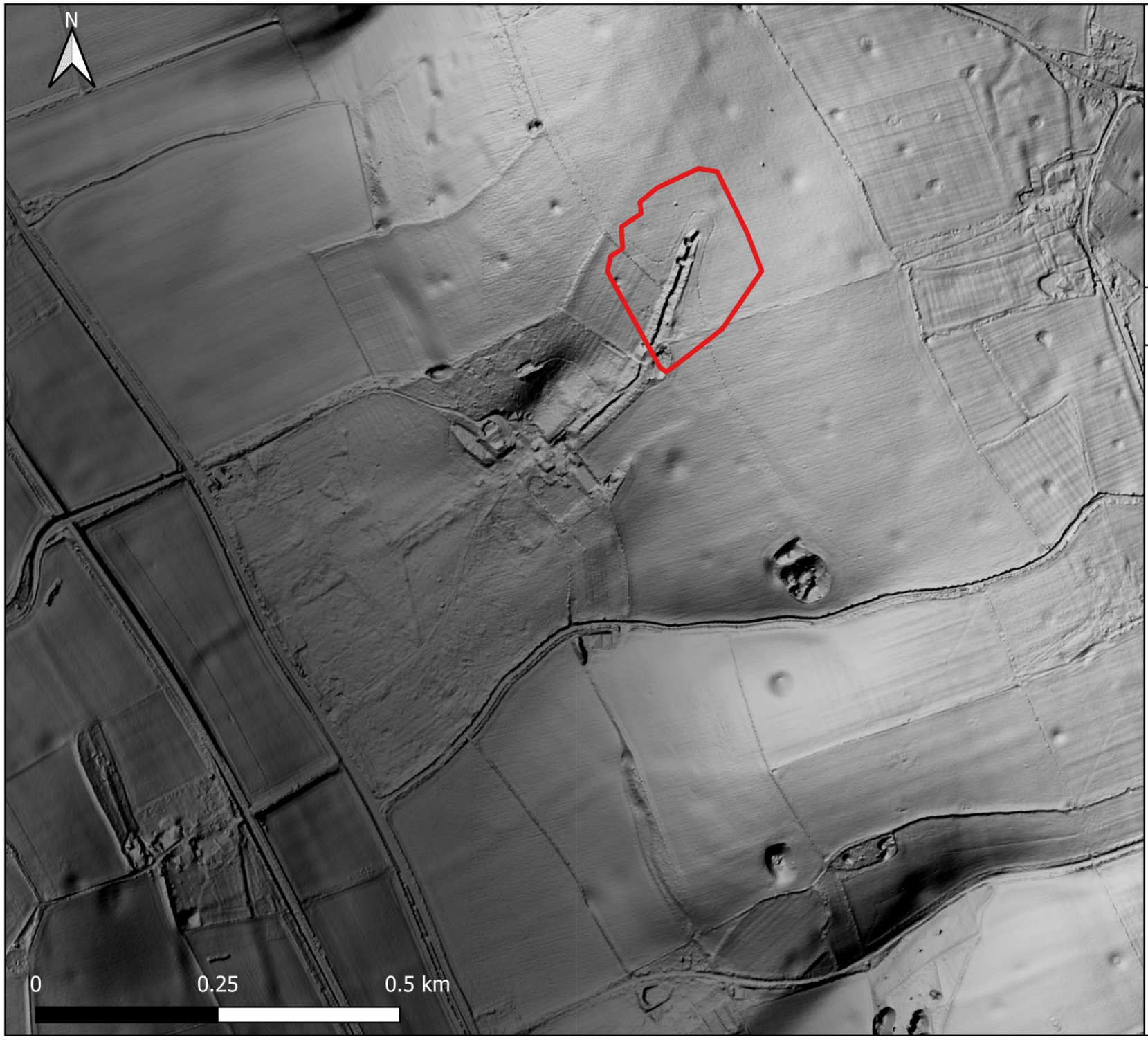


Figure 10: Interpretations (1:750)



Survey Area

Figure 11: Profile Line Locations
(1:750)

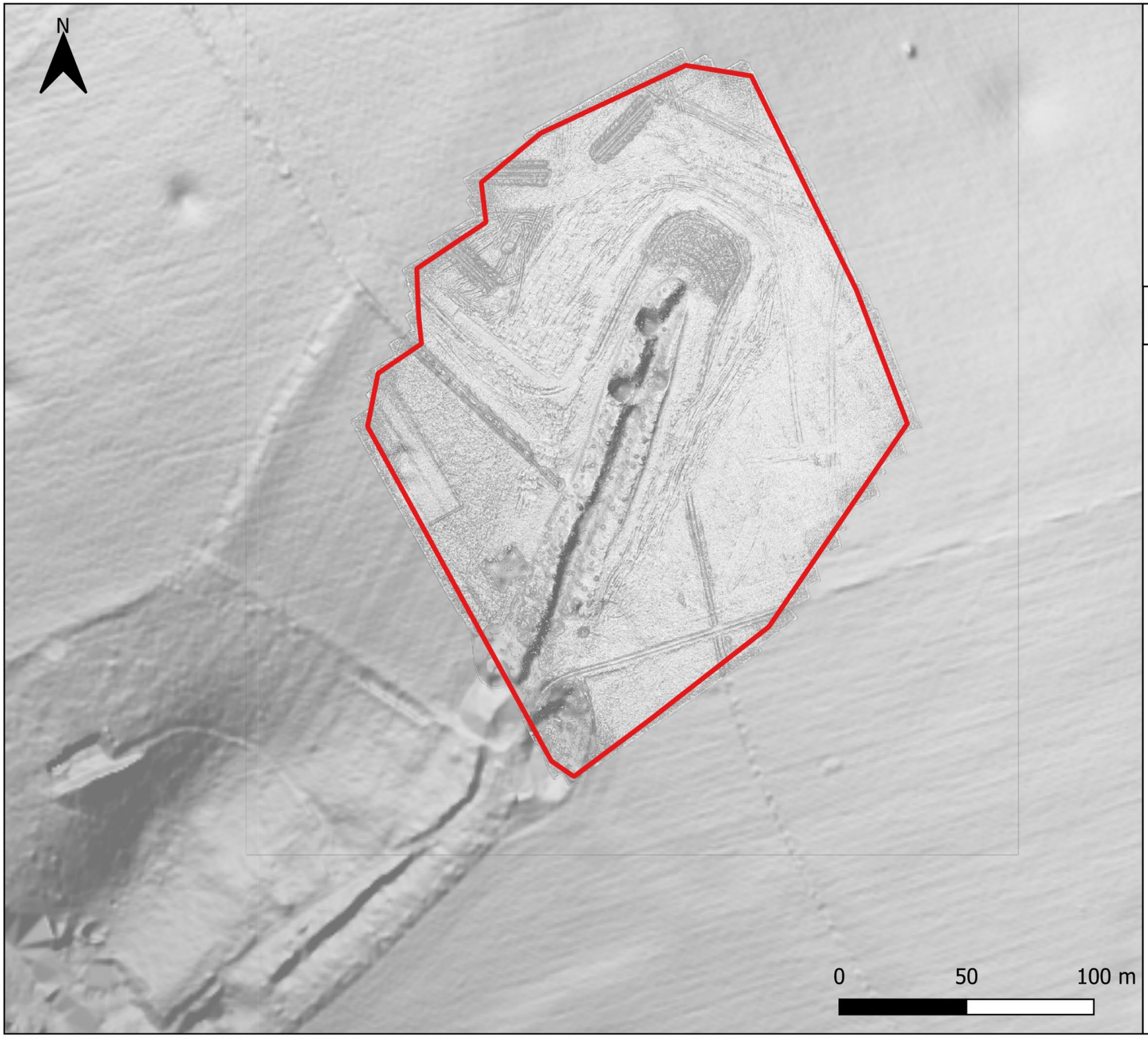


Survey Area

Figure 17: LiDAR wider landscape
DTM 1m (1:7000)

Elevation (metres)

+218.0
+198.0
+186.0
+162.0
+133.0



Survey Area

Figure 18: LiDAR (DTM 1m) overlain by DEM (6.56cm/pix) with smoothed and flattened topography (1:2000)

4.1 Monument

The monument consists of a ditch contained between a bank on either side, following an ENE-WSW alignment. In addition to the banks, there is a vegetation buffer between the monument and the ploughed field. In Profile 1 (Figure 12), **Bank 1** is ~5m wide and ~0.75m tall with steep edges on both sides. **Bank 2** is ~2.5m wide and also ~0.75m tall. Similarly it has steep edges on both sides. The ditch here is ~6m wide and 0.9m deep, with a U-shaped base and steep sides.
The buffer to the west is ~9m wide and 1m tall with a relatively flat peak. The east buffer is ~8m wide and 0.5m tall.

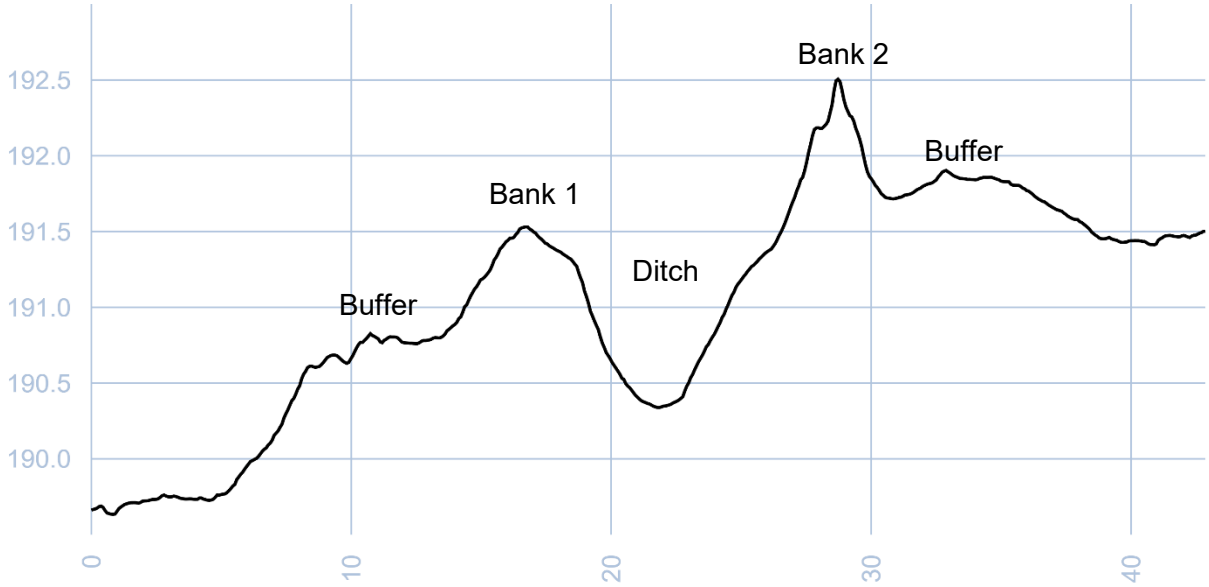


Figure 12: Profile 1 - WNW-ESE across Grim's Ditch

In Profile 2 (Figure 13), **Bank 1** is ~5m wide and ~0.3m tall though its boundary with the buffer is more diffuse here. **Bank 2** is ~6m wide and 0.6m tall, with a shallower dip on the inside before sharply dropping into the ditch. The ditch is ~10.5m wide and ~1.1m deep, with steep edges.

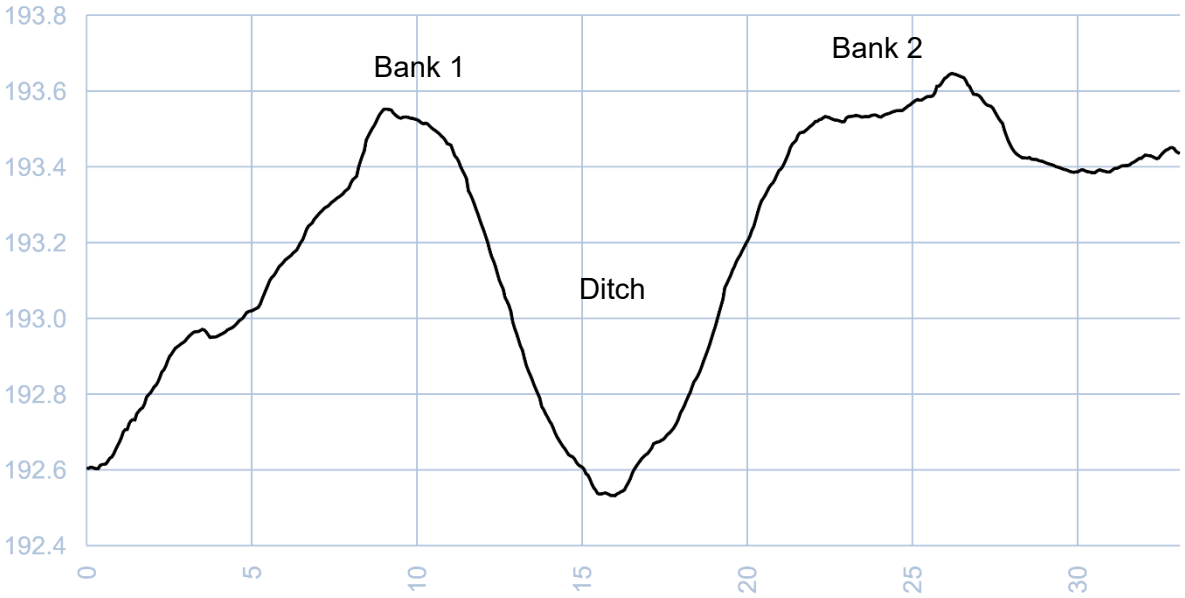


Figure 13: Profile 2 - WNW-ESE across Grim's Ditch

In Profile 3 (Figure 14), **Bank 1** has been completely truncated by **Pit 1. Pit 1** measures to ~2.1m deep, ~10m in diameter at the top and ~1.5m in diameter at the base. It has very steep sides and a U-shaped base. **Pit 2** is smaller with dimensions of ~1.4m in depth and a diameter of 6.5m. The outer slope is moderately steep whereas the inside slope is lost to the ditch. Here, the ditch is shallower reaching a depth of ~0.42m and width of ~7.8m. **Bank 2** is also shallower here, measuring a height of ~0.1m and diameter of ~1.5m.

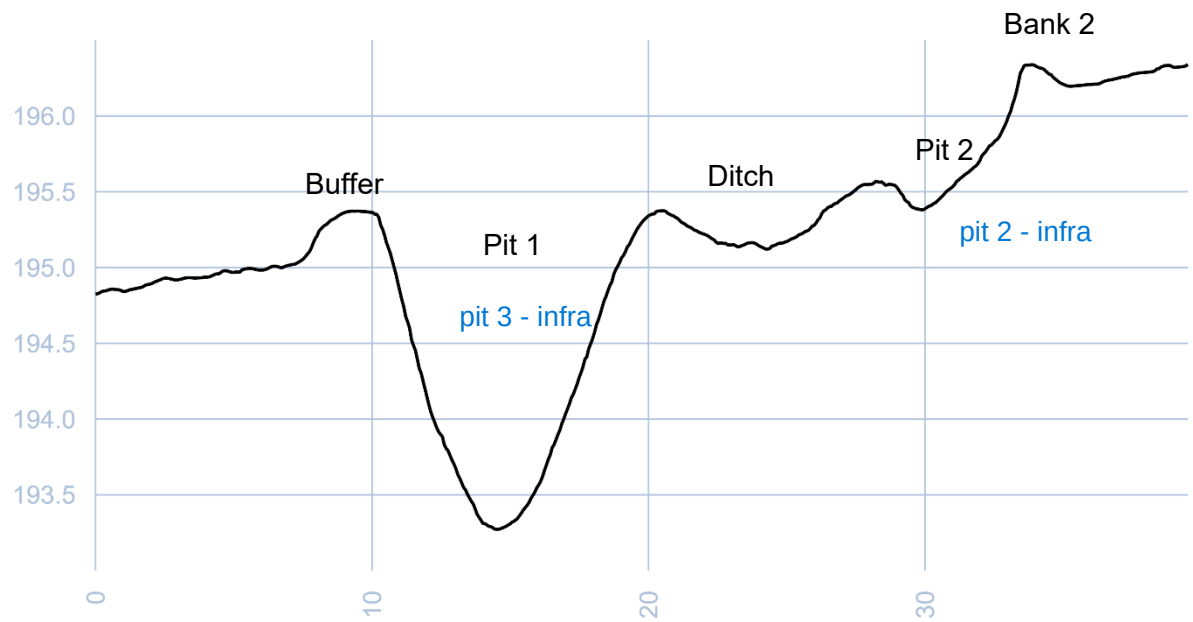


Figure 14: Profile 3 - WSW-ENE across Grim's Ditch and pits

Pit 3 has a diameter of ~11.5m and a depth of ~2.75m (Figure 15: Profile 4).

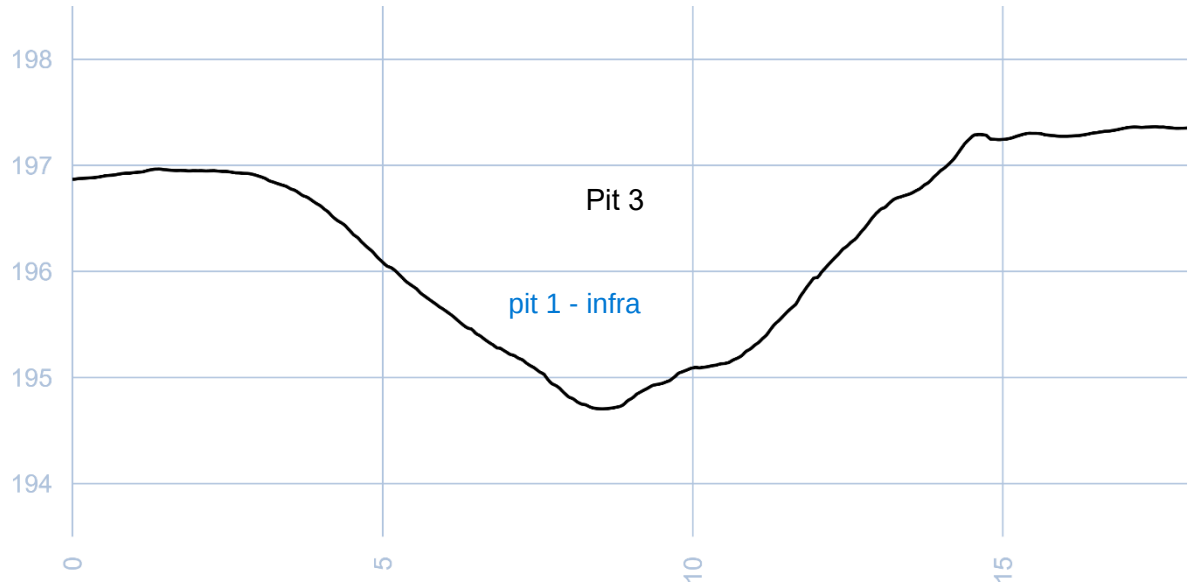


Figure 15: Profile 4 - NNE-SSW through pit

To the west of Grim's Ditch are two shallower, more diffuse pits. **Pit 4** has a depth of ~0.26m and a diameter of ~14m. **Pit 5** has a depth of 0.4m and diameter of 7.4m.

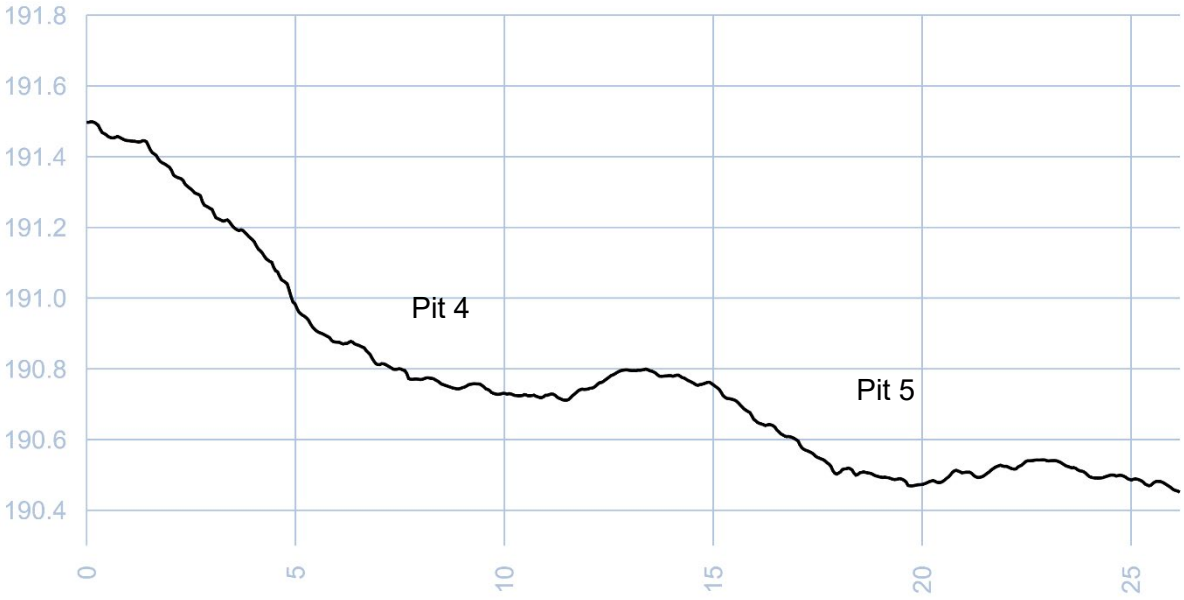


Figure 16: Profile 5 - NNW-SSE through shallow pits

Pits 1 to **3** likely relate to the machine excavation of Grim's Ditch and the removal of trees. It is unclear what **Pits 4** and **5** may relate to.

5 LIMITATIONS

Due to extensive ploughing and machine tracking over the area surrounding the monument, additional earthworks may have been lost or otherwise not detected by the survey. It is possible that other features of archaeological significance exist in this area, including the continuation of the ditch heading northwards.

6 CONCLUSION

The aerial survey has successfully mapped this portion of Grim's Ditch and identified the features that comprise the monument including the ditch and banks, as well as excavation pits/tree throws, ploughing buffer, and shallow pits in adjoining field.

7. REFERENCES

British Geological Survey – Geology of Britain Viewer
http://mapapps.bgs.ac.uk/geologyofbritain/home.html

DEFRA Survey Data Download
https://environment.data.gov.uk/DefraDataDownload/?Mode=survey

Historic England Photogrammetric Applications for Cultural Heritage
https://historicengland.org.uk/images-books/publications/photogrammetric-applications-for-cultural-heritage/heag066-photogrammetric-applications-cultural-heritage/

Appendix 4 OASIS form

Summary for hs2infra1-504770

OASIS ID (UID)	hs2infra1-504770
Project Name	Topographic Survey at Grim's Ditch Scheduled Monument
Activity type	Topographic Survey
Project Identifier(s)	C10021
Planning Id	
Reason For Investigation	Planning: Between application and determination
Organisation Responsible for work	HS2INFRA
Project Dates	10-Dec-2020 - 18-Dec-2020
Location	Fieldwork Report for Topographical Survey at Grim's Ditch Scheduled Monument NGR : SP 89219 03572 LL : 51.7237816052324, -0.709736786326687 12 Fig : 489219,203572
Administrative Areas	Country : England County : Buckinghamshire District : Chiltern Parish : The Lee
Project Methodology	The topographical survey comprised a photogrammetric survey to be undertaken by Unmanned Aerial Vehicle (UAV) and an array of locational data points to allow the construction of a 3-dimensional representation of the Scheduled Monument.
Project Results	The results were able to rapidly capture detailed data which can be viewed as either orthomosaic photographic representations or as 3-dimensional models. This preserved the status of the Monument at one given point in time, provides a baseline of information to gauge future changes against. The segment of the Grim’s Ditch Scheduled Monument, that lies within the site, is 145m long and is aligned northeast-southwest and has a visible upstanding bank on the west side of a linear ditch. The aerial coverage extended beyond that of the area defined as the Site and demonstrated a continuation to the south of both the negative and positive elements but to the north beyond the Scheduled Monument the site is entirely flat.
Keywords	Boundary Ditch - UNCERTAIN - FISH Thesaurus of Monument Types Bank (Earthwork) - UNCERTAIN - FISH Thesaurus of Monument Types
HER	Buckinghamshire HER - unRev - STANDARD
HER Identifiers	
Archives	