Note: Outline Planning Application (OPA) Site Boundary

The following report was produced prior to the finalisation of the application site boundary. The final application site boundary is shown on Figure 1.1 in ES Appendix 1.1. Therefore, references within the report to the site boundary do not reflect the site area and site boundary submitted with the OPA.

The reports were correct at the time of preparation, and all information within the Environmental Statement assessment reflects the latest relevant information.

Ground Penetrating Radar and Magnetometry Survey of the Roman Villa at Otterpool, near Hythe, Kent

For

Arcadis

On Behalf Of

Folkestone and Hythe District Council and Cozumel Estates

Magnitude Surveys Ref: MSTR375

October 2018

Unit 17, Commerce Court

Challenge Way

Bradford

BD4 8NW

01274 926020

info@magnitudesurveys.co.uk

Version	Purpose/Revision	Author	Interpretation/Figures	Approved By	Date Issued
Draft 1.0	Initial draft	Leanne Swinbank BA ACIfA Hugo Kesterton BSc	Amadeo Viccari Leanne Swinbank BA ACIfA	Finnegan Pope-carter BSc MSc FGS	24 October 2018
Draft 1.1	Client Comments	Dr Kayt Armstrong BA (hons) MSc PhD		Dr Kayt Armstrong BA (hons) MSc PhD	22 November 2018

Abstract

Magnitude Surveys was commissioned to assess the subsurface archaeological potential of a c. 4ha area of land at Otterpool, near Hythe, Kent. Of the c. 4ha survey area c. 3ha were to be surveyed by ground penetrating radar, 0.7ha of which was unavailable, and a further c. 1ha was to undergo a fluxgate magnetometer survey. Both survey types were successfully completed, and the radar survey identified a number of possible and probable archaeological responses. A number of these responses correlate with trenching data produced by Oxford Archaeology. Additional anomalies have been identified suggesting extensive archaeological activity on the site. Reduced depth GPR depth penetration, likely caused by conductive soils, has limited the effectiveness of the GPR survey, identifying only features within the top c. 60 cm. The magnetic survey, while responding adequately to the survey area's environment, did not identify any responses of possible archaeological origin. A number of anomalies with undetermined origins have been highlighted in the magnetic data.

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1. Introduction

1.1. Magnitude Surveys Ltd (MS) was commissioned by Arcadis on behalf of Folkestone and Hythe District Council and Cozumel Estates to undertake a ground penetrating radar survey on a c.3ha area of land, of which c.0.7ha was unsurveyable, and a magnetic geophysical survey on a c.1ha area of land at Otterpool, near Hythe, Kent (TR 1167 3664).

1.2. The work was undertaken prior to an outline planning application for a new garden settlement – Otterpool Park – accommodating up to 8,500 homes (use class C2 and C3) and use class D1, D2, A1, A2, A3, A4, B1a, B1b, B2, C1 development with related highways, green and blue infrastructure (access, appearance, landscaping, layout and scale matters to be reserved).

1.3. The geophysical survey comprised quad-towed, cart-mounted ground penetrating radar survey and hand-pulled, cart-mounted GNSS-positioned fluxgate magnetometer survey. MS' Ofcom Ground Probing Radar licence number is L1078291/1.

1.4. The survey was conducted in line with the current best practice guidelines produced by Historic England (David et al., 2008), the Chartered Institute for Archaeologists (CIfA, 2014) and the European Archaeological Council (Schmidt et al., 2015).

1.5. The survey commenced on 11/09/2018 and took 5 days to complete.

2. Quality Assurance

2.1. Magnitude Surveys is a Registered Organisation of the Chartered Institute for Archaeologists (CIfA), the chartered UK body for archaeologists, and a corporate member of ISAP (International Society of Archaeological Prospection).

2.2. Director Graeme Attwood is a Member of CIfA, as well as the Secretary of GeoSIG, the CIfA Geophysics Special Interest Group. Director Finnegan Pope-Carter is a Fellow of the London Geological Society, the chartered UK body for geophysicists and geologists, as well as a member of GeoSIG, the CIfA Geophysics Special Interest Group. Director Chrys Harris has a PhD in archaeological geophysics from the University of Bradford and is the Vice-Chair of the International Society for Archaeological Prospection.

2.3. All MS managers have relevant degree qualifications to archaeology or geophysics. All MS field and office staff have relevant archaeology or geophysics degrees and/or field experience.

3. Objectives

3.1. The geophysical survey aimed to assess the subsurface archaeological potential of the survey area.

4. Geographic Background

4.1. The site is located c.600m east of Otterpool Lane, Kent and c.1.0km north-northwest of the village of Lympne and c.4.8km northwest of Hythe (Figure 1). Survey was undertaken across two arable fields divided east-west by the A20 Ashford Road, with a third unsurveyable area directly west of the southern field, bounded by the A20 Ashford Road to the north and an unnamed private lane to the west. The fields continued beyond the survey area to the north and south, with the East Stour River to the north, and further agricultural fields to the south and east. To the west, there was housing adjacent to the northern survey area, with further fields in the southwest. Ground conditions were generally flat in the northern area of the site, with a gentle slope downwards towards the north in the southern area (Figure 2).

4.2. Survey considerations:

Survey Area	Ground Conditions	Further Notes
1	Flat arable field with short stubble coverage.	Bounded by hedgerows on the southern and western edges and a footpath with hedgerow on the eastern edge; the field continued to the north of the survey area.
2	Lightly ploughed arable field gently sloping upward in a southerly direction.	Bounded by a wire fence on the northern and southwestern edges, and overgrown ground with trees on the eastern edge; the field continued beyond the south-eastern and southwestern extents of the survey area.
3	Flat field overgrown with vegetation.	Unsurveyable due to overgrown vegetation.

4.3. The background underlying geology comprises interbedded sandstone and limestone of the Hythe Formation. An outcrop of sandstone, siltstone and mudstone of the Sandgate formation comprises the southern portion of the site. No superficial deposits are recorded (British Geological Survey, 2018).

4.4. The soils consist of loamy freely draining slightly acid but base-rich soils across much of the site, with the exception of the south-eastern part of area 2, which consist of loamy soils with naturally high groundwater (Soilscapes, 2018). Natural soil identified during the excavation by Oxford Archaeology (Davies, 2018) was variable across the site, although mostly comprised of clayey silt.

5. Archaeological Background

5.1. The following archaeological background provides a summary of an archaeological evaluation report by Oxford Archaeology of the survey area (Davies, 2018), an HER search of the online resource Heritage Gateway (2018) and a map regression, for the site and a 1km radius around it.

5.2. Prior to our geophysical prospection, a programme of trial trenching was carried out by Oxford Archaeology across Areas 2 and 3 and land immediately south of area 2, targeting potential archaeological remains identified by an earlier magnetometry survey. This geophysical survey revealed multiple rectilinear anomalies along a linear boundary towards the north-western edge of Areas 2 and 3, which it was suggested could represent a Roman villa; the trial trenching confirmed this interpretation, revealing extensive archaeological material of Roman origin. This included the foundations of limestone walls and associated floor layers, a hypocaust system, a malting oven, a potential bathhouse, a boundary ditch and wall, a road, and linear ditches and pits. The excavation also recovered Roman pottery, wall plaster, fired clay, coins, metalworking, glass, and animal remains. The Roman site was dated to between the 1st and 4th centuries AD, with the majority of the archaeological material being belonging to the middle Roman period. Just south of the survey area, trial trenching revealed the remains of a barrow, along with Beaker pottery and a Mesolithic flint assemblage predating the barrow.

5.3. Prehistoric activity is evident in the wider area surrounding the site. There is a findspot of Upper Palaeolithic and Mesolithic worked flints c.680m east-northeast of the survey area; Roman pottery finds and a possible Anglo-Saxon palace are also recorded at this location. Another Mesolithic flint findspot is recorded c.380m northeast of the site, in addition to a multiperiod findspot c.680m southwest of the survey area, which included Mesolithic artefacts as well as late Bronze Age/early Iron Age, late Iron Age, and post-Roman archaeological material. There is a Neolithic flint axe findspot c.340m southwest of the site, and Neolithic or Bronze Age flints were discovered c.860m north-northeast of the survey area. 2 Bronze Age bowl barrows are recorded within a 1km radius of the site, c.440m north-northwest and c.970m northwest of it. Further Bronze Age activity is indicated by an occupation site and associated field system c.730m south-southwest of the survey area, and Bronze Age ditches and a pit identified c.800m north-northeast of the site. Prehistoric activity also includes a late Iron Age rural landscape consisting of enclosures, a droveway, and 2 structures, c.830m north-northeast of the survey area.

5.4. Medieval activity is also prevalent in the landscape surrounding the survey area. A 6th century brooch was found c.690m west-southwest of the site, and there is an 11th century stirrup strap mount findspot c.790m southwest of the survey area. There is the scheduled monument of Westenhanger Castle c.740m northeast of the site, which has 14th century origins and further medieval and post-medieval modifications. A 13th century church (now completely destroyed) is recorded c.700m northeast of the site, and a deserted medieval village is recorded c.760m northeast. Multiple medieval features and a pottery scatter are recorded c.870m north-northeast of the site, including a field system, ditched enclosure, post and stake holes, and a corn drying oven.

5.5. There are several post-medieval farmsteads in the area surrounding the site, though none of them are within the survey area.

5.6. Undated archaeology within 1km radius of the survey area includes a ring ditch c.740m to the southwest, and another one c.920m to the northwest.

5.7. A map regression shows little change to boundaries within the survey area since 1873. A division between area 2 and area 3 is shown on maps from 1877 and earlier, which appears to correspond with the current field configuration of the survey area, despite not being visible on maps from 1898 and onward.

6. Methodology

6.1. Data Collection

6.1.1. Geophysical prospection comprised Ground Penetrating Radar (GPR) and the magnetic method as described in the following table.

6.1.2. Table of survey strategies:

Method	Instrument	Traverse Interval	Sample Interval
Ground Penetrating Radar	MALA MiniMIRA	0.5m	0.05m
Magnetic	Bartington Instruments Grad-13 Digital Three-Axis Gradiometer	1m	200Hz reprojected to 0.125m

6.1.3. GPR data were collected along lines, using the system's odometer wheel to position sampling points. The lines were set out within a grid established using a Hemisphere S321 GNSS Smart Antenna RTK GPS which is accurate to 0.008 m + 1 ppm in the horizontal and 0.015 m + 1 ppm in the vertical.

6.1.4. The magnetic data were collected using MS' bespoke hand-pulled cart system.

6.1.4.1. MS' cart system was comprised of Bartington Instruments Grad 13 Digital Three-Axis Gradiometers. Positional referencing was through a multi-channel, multi-constellation GNSS Smart Antenna RTK GPS outputting in NMEA mode to ensure high positional accuracy of collected measurements. The RTK GPS is accurate to 0.008m + 1ppm in the horizontal and 0.015m + 1ppm in the vertical.

6.1.4.2. Magnetic and GPS data were stored on an SD card within MS' bespoke datalogger. The datalogger was continuously synced, via an in-field Wi-Fi unit, to servers within MS' offices. This allowed for data collection, processing and visualisation to be monitored in real-time as fieldwork was ongoing.

6.1.4.3. A navigation system was integrated with the RTK GPS, which was used to guide the surveyor. Data were collected by traversing the survey area along the longest possible lines, ensuring efficient collection and processing.

6.2. Data Processing

6.2.1. GPR data were processed in the standard commercial software package ReflexW 3D. GPR Processing steps were limited to:

DC Shift – The waveform response for each traverse was centred to correct for striping effects caused by small variations in sensor electronics and orientation.

Bandpass Filter – Frequencies outside the normal range of the measuring antennae were filtered out to remove errors from external sources.

Gain Adjust – A gain curve was manually calculated to account for signal attenuation with depth. The gain adjust allows features at depth with a weaker signal to be resolved at the same plotting scale as near surface features.

Hyperbola fitting – Manual fitting of hyperbola curves was conducted to calculate the velocity of the wave. This allows the calculation of response depth from response time.

6.2.2. Magnetic data were processed in bespoke in-house software produced by MS. Processing steps conform to Historic England's standards for "raw or minimally processed data" (see sect 4.2 in David et al., 2008: 11).

Sensor Calibration – The sensors were calibrated using a bespoke in-house algorithm, which conforms to Olsen et al. (2003).

Zero Median Traverse – The median of each sensor traverse is calculated within a specified range and subtracted from the collected data. This removes striping effects caused by small variations in sensor electronics.

Projection to a Regular Grid – Data collected using RTK GPS positioning requires a uniform grid projection to visualise data. Data are rotated to best fit an orthogonal grid projection and are resampled onto the grid using an inverse distance-weighting algorithm.

Interpolation to Square Pixels – Data are interpolated using a bicubic algorithm to increase the pixel density between sensor traverses. This produces images with square pixels for ease of visualisation.

6.3.Data Visualisation and Interpretation

6.3.1. The individual GPR radargrams have been stacked to form a three-dimensional cube of measurements. Greyscales have been created by horizontally slicing the cube to produce plan-view time-slices. These "timeslices" were initially considered in an animated GIF form to analyse the three-dimensional extent of anomalies. For print purposes, two gross soil volumes are considered: shallow, and deep. The mean of the timeslices within each gross soil volume was taken and used as a representative time slice for the interpretation figures. Timeslices were interpreted in a layered environment, overlaid against open street mapping, satellite imagery, historic mapping, LiDAR data, and soil and geology mapping. The timeslices were also interpreted in consideration with the radargrams, which visualise the form of the geophysical response, aiding in anomaly interpretation.

6.3.2. GPR depth penetration is related to the GPR frequency and the conductivity of the ground. Highly conductive ground causes high signal attenuation, diminishing the depth of penetration of the energy emitted by the antenna. Soil conductivity is a complex science and it is rarely possible to have sufficient data about the chemical and physical properties of the soil prior to survey (Conyers 2012). Minor changes in land use and/or moisture content can cause complex interactions between soil constituents, greatly increasing the soil conductivity over relatively short distances.

6.3.3. GPR datasets are typically time-depth corrected using a velocity obtained from discrete hyperbola. These hyperbolae are normally the result of services, drainage or other similar narrow linear features. No suitable hyperbolae have been identified in this dataset precluding the calculation of a site-specific velocity. As a result, depths are described in nano seconds (ns) rather than metres. An approximate correction of 0.14ns per metre can be used to give an indication of depth. This corresponds with typical velocities on similar sites and allows for a close depth correlation between radargram and excavation on matching features.

6.3.4. This report presents the gradient of the magnetic sensors' total field data as greyscale images, as well as the total field data from the upper and/or lower sensors. The gradient of the sensors minimises external interferences and reduces the blown-out responses from ferrous and other high contrast material. However, the contrast of weak or ephemeral anomalies can be reduced through the process of calculating the gradient. Consequently, some features can be clearer in the respective gradient or total field datasets. Multiple greyscale images at different plotting ranges have been used for data interpretation. Greyscale images should be viewed alongside the XY trace plot (Figure 15). XY trace plots visualise the magnitude and form of the geophysical response, aiding in anomaly interpretation.

6.3.5. Geophysical results have been interpreted using greyscale images and XY traces in a layered environment, overlaid against open street maps, satellite imagery, historic maps, LiDAR data, and soil and geology maps. Google Earth (2018) was consulted as well, to compare the results with recent land usages.

7. Results

7.1. Qualification

7.1.1. Geophysical results are not a map of the ground and are instead a direct measurement of subsurface properties. Detecting and mapping features requires that said features have properties that can be measured by the chosen technique(s) and that these properties have sufficient contrast with the background to be identifiable. The interpretation of any identified anomalies is inherently subjective. While the scrutiny of the results is undertaken by qualified, experienced individuals and rigorously checked for quality and consistency, it is often not possible to classify all anomaly sources. Where possible an anomaly source will be identified along with the certainty of the interpretation. The only way to improve the interpretation of results is through a process of comparing excavated results with the geophysical reports. MS actively seek feedback on their reports as well as reports of further work in order to constantly improve our knowledge and service.

7.1.2. The GPR survey has suffered from poor signal penetration beyond the layers of topsoil. The British Geological Survey (2018) mapping identified the base geological material to be primarily sandstone, limestone and siltstone while Soilscapes (2018) shows the soils as loamy freely draining slightly acid but base-rich soils. However, the excavations on site by Oxford Archaeology (Davies 2018) found that natural in most areas comprised clayey silt. These clays, unknown to us at the time of survey, are almost certainly responsible for the lack of GPR depth penetration.

7.2. Discussion

7.2.1. The geophysical results are presented in consideration with satellite imagery (Figures 10 and 14) and LiDAR imagery (Figures 6, 9 and 13).

7.2.2. Wet conditions during the survey affected the ground conditions, this may have further limited the signal penetration for the GPR survey. Some data collection artefacts have been noted at the perimeters of the GPR survey area, and processing affects are also visible in the merged timeslices (Figure 3). Two depths have been selected for detailed interpretation from the indicative merged timeslices, which show the most detailed results, referred to as shallow and deep. Given the limited depth penetration of the GPR survey these depths correspond to approximately < 30cm & > 40cm respectively.

7.2.3. The GPR survey has been successful at identifying a number of features previously excavated during trial trenching by Oxford Archaeology. These include two wall features, three ditch features and a pit, all of which have been dated to the Roman period or are undated. The GPR survey has complemented this previous trial trenching detecting additional anomalies of probable and possible archaeological origin which were not identified by the previous geophysical survey on the site (Sumo, 2018). Other types of anomalies identified through the GPR survey include agricultural trends relating to modern ploughing, and others possibly more historic in origin. Anomalies of undetermined origin have also been identified, where an archaeological origin is not considered likely but also cannot be ruled out.

7.2.4. The fluxgate magnetometer survey has responded adequately to the survey area's environment with the magnetic data principally reflecting a quiet magnetic background commonly encountered on sites with limestone or sandstone geology. However, the site has been impacted by modern activity, particularly on the perimeters of the survey areas. Broad, strong ferrous anomalies associable with metallic structures are located along the eastern, southern and western boundaries of the survey area. Other anomalies appear to reflect the location of services, while smaller discrete ferrous anomalies reflect metallic disturbances at or near the ground surface.

7.2.5. Several anomalies have been identified as being of 'Undetermined' origins scattered across the centre, south and west of the survey area. These responses do not possess a form or magnetic signals which are typically associated with archaeological features; however, the proximity of known, excavated, archaeological features directly south of these responses mean an archaeological origin cannot be entirely ruled out.

7.3.Interpretation

7.3.1. General Statements

7.3.1.1. Geophysical anomalies will be discussed broadly as classification types across the survey area. Only anomalies that are distinctive or unusual will be discussed individually.

7.3.1.2. **Undetermined** – Anomalies are classified as Undetermined when the anomaly origin is ambiguous through the geophysical results and there is no supporting or correlative evidence to warrant a more certain classification. These anomalies are likely to be the result of geological, pedological or agricultural processes, although an archaeological origin cannot be entirely ruled out.

7.3.1.3. **Ferrous (Discrete/Spread)** – In the magnetic results discrete ferrous-like, dipolar anomalies are likely to be the result of modern metallic disturbance on or near the ground surface. A ferrous spread refers to a concentrated deposition of these discrete, dipolar anomalies. Broad dipolar ferrous responses from modern metallic features, such as fences, gates, neighbouring buildings and services, may mask any weaker underlying archaeological anomalies should they be present.

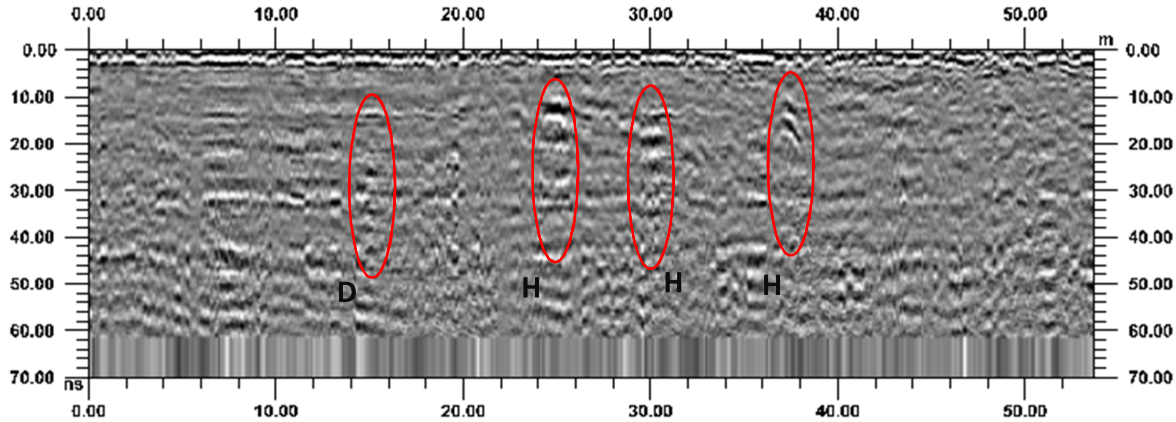
7.3.2. GPR Results – Specific Anomalies

7.3.2.1. **Archaeology Probable/ Possible** – Anomalies which align with archaeological features excavated by Oxford Archaeology (Davies, 2018) have been given an "Archaeology (Probable)" classification. These include anomalies [**A**, **B**, **C**], some responses have been given a "Possible" classification where they are part of larger responses not excavated by Oxford Archaeology [**D**, **E, F**]. Some responses have been identified which do not align with excavations carried out by Oxford Archaeology (Davies, 2018), but do correspond with responses identified in a magnetometer survey carried out by SUMO (2018) these are also detailed below.

7.3.2.2. **Archaeology Probable –** On the northwest boundary of the site anomaly [**A**], consists of two c.5m long responses with a weak signal strength, visible only in the shallow timeslices. The northern extent of trench 246 transects these responses, and the southern response aligns perfectly with context 24614, this was described as an undated wall feature in the trenching report. The northern response identified through the GPR survey would be part of context 24617 which is described as evidence of terracing. There is no corresponding magnetic response in the SUMO (2018) geophysical report.

7.3.2.3. **Archaeology Probable –** Further north of [**A**] two linear responses have been highlighted at [**B**]. The southern of these responses has a strong signal strength whilst the response to the north is much weaker. These represent two features which were excavated in trench 257 and 258; the anomaly that crosses trench 258 (See Appendix 1) corresponds with contexts 25808 and 25811. These are described as wall features dated to early/ middle Roman period in the trenching report. The GPR anomaly suggest that the wall feature extends c. 5m and has a right-angled extension to the south with a length of c.8m. The southern tip of the probable wall feature extends into trench 243, and corresponds with context 24208, another wall feature, as well as context 24333 described as a hypocaust arch. The weak anomaly to the north of [**B**] crosses the centre of trench 257 corresponds with context 25726, in the excavation report this is described as an unexcavated ditch with Roman pottery found on the surface. The GPR results indicate that this ditch feature extends to c.18m in length. Both of the responses indicated at [**B**] are visible only in the shallow timeslices and do not align perfectly with responses identified in the previous magnetic survey.

7.3.2.4. **Archaeology Probable –** In the centre of the northern half of the site anomaly [**C**] crosses the southern half of trench 244 and roughly corresponds with contexts 24411 and 24410. These were described as a wall feature and a linear ditch of Middle/ Late Roman period respectively. The GPR results suggest that these responses are part of a much larger complex of responses forming a rectilinear enclosure, c.10mX10m. These responses are visible in the shallow and deep timeslices but are more defined at the deeper depth. [**C**] adjoins a second feature with the same size and shape of a small enclosure. The similarity of both signals suggests the same origin however, no trenching has been undertaken on the second enclosure, see 7.3.2.9. The SUMO magnetic survey identified an anomaly in the same region, however, it did not identify the full details of the anomaly being part of a small enclosure.



Radargram 1: reflections indicated D and H (x3) are discussed in sections 7.3.2.5 and .9 respectively below

7.3.2.5. **Archaeology Possible –** In the northeast of the site, anomaly [**D**] represents a linear anomaly with right-angled features identified in the GPR results. The eastern extent of [**D**] crosses western edge of trench 245. The trench may not have extended far enough west to uncover [**D**], but a shallow pit cut, with a fill of early Roman pottery, tile and animal bone was excavated only a few metres away. Anomaly [**D**] in the timeslices appears to be part of a small, weak rectilinear group of boundaries (c.7mX9m). In Radargram 1 [**D**] is shown to have quite a weak response when compared to other nearby boundary anomalies, see 7.3.2.9, however, the signal type is indicative of a possible wall feature. A spread of possibly associated material has been highlighted to the south, this is only visible in the shallow GPR timeslices. The shallow spread of material noted may be related to context 24500 in trench 245, which has been described as topsoil containing finds of Roman brick. In the deeper timeslices, the shape of the enclosure is lost, and an amorphous spread is detected. There is no corresponding magnetic response in the SUMO geophysical results.

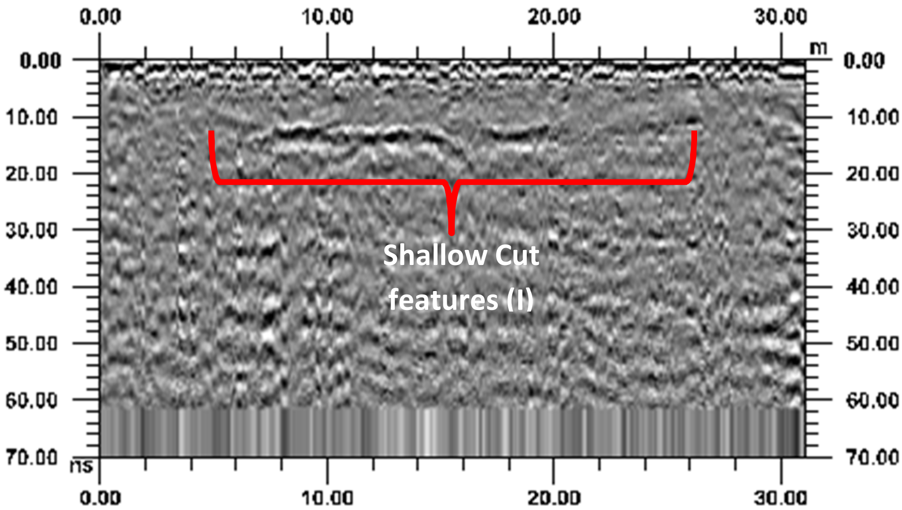
7.3.2.6. **Archaeology Possible –** To the west of the site, Anomaly [**E**] is part of a weak response which crosses the south of trench 247 and roughly corresponds with context 24718. In the trenching report this context is described as a linear ditch which was not excavated. GPR results show this to be part of a larger feature, possibly a system of ditches, two linear responses join at [**E**] and extend westwards at an acute angle c.19m and 18m respectively. No similar anomalies were identified in this location in the SUMO magnetic survey.

7.3.2.7. **Archaeology Possible –** In the southern half of the site, two parallel linear responses have been identified orientated on a northeast to southwest alignment, c.13m apart [**F**], these have been given a possible archaeological classification. The northern response at [**F**] has been highlighted which corresponds with a response on the SUMO geophysical survey. The eastern extent of this linear responses transects trench 250, and corresponds with context 25021, which is an undated feature only noted on the trench plans. The southern response at [**F**] also aligns with a linear anomaly identified in the magnetic survey, and transects trench 250, again this is marked as an undated feature on the trench plans but is not given an individual context number.

7.3.2.8. **Archaeology Probable –** In the east of the northern half of the site, a northwest to southeast aligned linear response, [**G**], is positioned in a location not previously excavated by Oxford Archaeology. This responses measures c.13m in length and has a right-angled extension in the south that extends c.9m east. The magnetic survey carried out by SUMO identified an anomaly in the same location and alignment as [**G**], but the magnetic anomaly was much longer, a total of c.112m in length, and did not include the extension to the east. This difference in detection between the two methods indicates different fill compositions in different parts of this cut feature.

7.3.2.9. **Archaeology Probable –** Only c.2.5m northwest of [**G**], a sub-rectangular boundary response c.10mX10m, [**H**], has been detected, this is adjoined to anomaly group [**C**] which is the same size and on the same alignment. No trenching has been carried out over [**H**], and the previous magnetic survey has not detected this anomaly. However, the magnetic survey did detect a linear response running through the centre of the bounded area which would be a continuation of the linear response [**G**]. This boundary anomaly is strongly visible in the deep timeslices, and weakly apparent in the shallower timeslices. Radargram 1 shows northeast and southwest extents of [**H**] quite clearly positioned c.10m apart, it also shows a weaker response central to the extents of [**H**] which is not clear in either of the timeslices. The signal of each of these responses within the radargram appear as though they could be wall features. This central response on Radargram 1 could relate to the magnetic response identified by SUMO which passes through the centre of [**H**].

7.3.2.10. **Archaeology Probable –** Near the centre of the site, anomalies at [**I**] are characterised by strong, linear and curvilinear responses. These anomalies have a high amplitude in the shallow and deep timeslices. Radargram 2 crosses this group of responses and shows a broad but shallow cut feature. This group does not correspond with any of the anomalies in the magnetic data collected by SUMO, and it has not undergone excavation by Oxford Archaeology.



Radargram 2, showing data that suggests a shallow cut feature at I (see section 7.3.2.10)

7.3.2.11. **Archaeology Possible –** A weak, linear response, [**J**], running northwest to southeast, in the southeast of the site corresponds with a linear anomaly highlighted in the magnetic survey. In the magnetic survey carried out by SUMO [**J**] and [**G**] are sections of the same long linear response; the GPR survey has not found a connection between the two responses. [**J**] has only a weak signal in both the shallow and deep timeslices and has not been previously excavated.

7.3.3. Magnetic Results - Specific Anomalies

7.3.3.1. **Undetermined** - Scattered to the west and south of the magnetic survey area are several anomalies of 'undetermined' origins. These vary in form from irregular shapes, through to small rounded discrete anomalies. The exact interpretation of these responses is difficult. Although not typically archaeological in form, their proximity of known archaeological features directly to the south makes it impossible to completely discount an archaeological origin for them.

8. Conclusions

8.1. A ground penetrating radar (GPR) survey has been undertaken across the site. The conditions for this survey were not ideal and a number of collection and processing artefacts are visible within the final processed data. Limited GPR depth penetration, almost certainly as a result of the highly conductive properties of the wet clayey soils on the site, has reduced the GPR surveys effectiveness, limiting detected features to comparatively shallow depths. Previous trial trenching and a magnetometer survey on the site have aided the interpretation of the GPR results. Despite the issues of signal penetration the GPR results have identified additional probable and possible archaeological features not identified in either the magnetic survey or the trial trenching and have clarified the possible relationships between features revealed in the trial trenches.

8.2. Archaeological anomalies on the site include two adjoining bounded areas, one of which has been partially excavated revealing a wall of Roman date. The similarity in response and signal types indicate that the adjoined anomalies are of the same origin. Further possible wall features have been identified to the north of these enclosures, suggesting a complex area of archaeological activity. A number of ditches have also been identified on the site, some confirmed by previous trial trenching and others identified only in the GPR data.

8.3. Other responses identified through the GPR survey include shallow agricultural responses which relate to modern ploughing regimes, and some anomalies of undetermined origin.

8.4. Fluxgate magnetometer survey has responded adequately to the survey area's environment with the data reflecting a quiet magnetic environment in the centre of the area. This method is unlikely to be of use in detecting wall of any period on the site that are constructed from the same material as the local geological parent. Broad, strong ferrous anomalies associated with contemporary metal structures are located on the perimeter, and inside the survey area producing magnetic halos. Several small, discrete ferrous anomalies indicative of surface and near surface metallic disturbances are distributed primarily to the east of the area. Several anomalies of undetermined origin were identified scattered to the west and south of the survey area.

8.5. If further characterisation of the archaeological remains on the site is required, we suggest that a trial of a lower frequency, single channel radar should be undertaken to see if this will provide greater signal penetration and a clearer picture of the survival of material below c. 0.6m. A trial of high density, multi-depth frequency domain electromagnetic survey (using both signal components) would usefully complement the existing datasets and might distinguish building remains and thermal structures more readily in this soil environment than GPR.

9. Archiving

9.1. MS maintains an in-house digital archive, which is based on Schmidt and Ernenwein (2013). This stores the collected measurements, minimally processed data, georeferenced and un-georeferenced images, XY traces and a copy of the final report.

9.2. MS contributes reports to the ADS Grey Literature Library upon permission from the client, subject to the any dictated time embargoes.

10. Copyright

11. References

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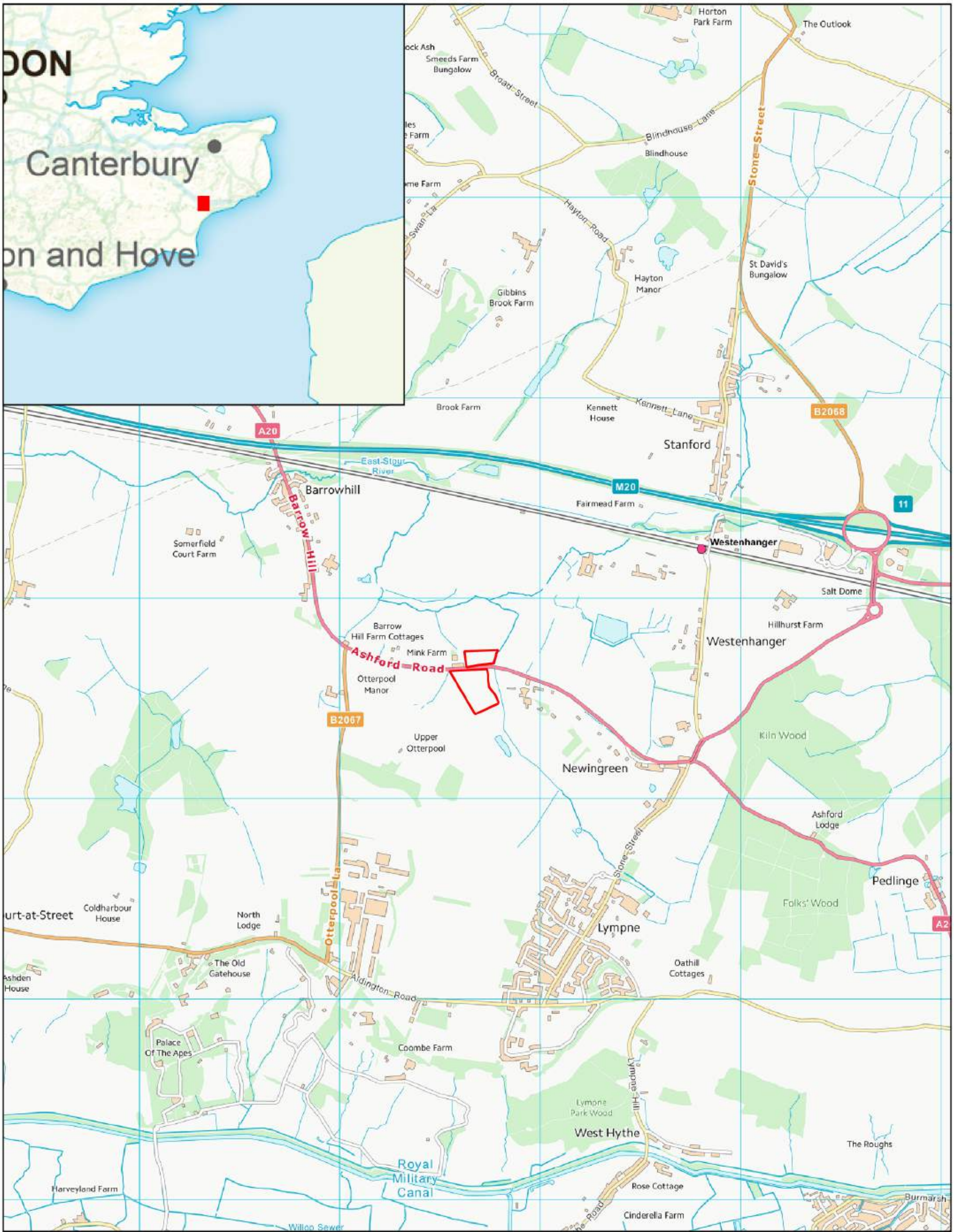
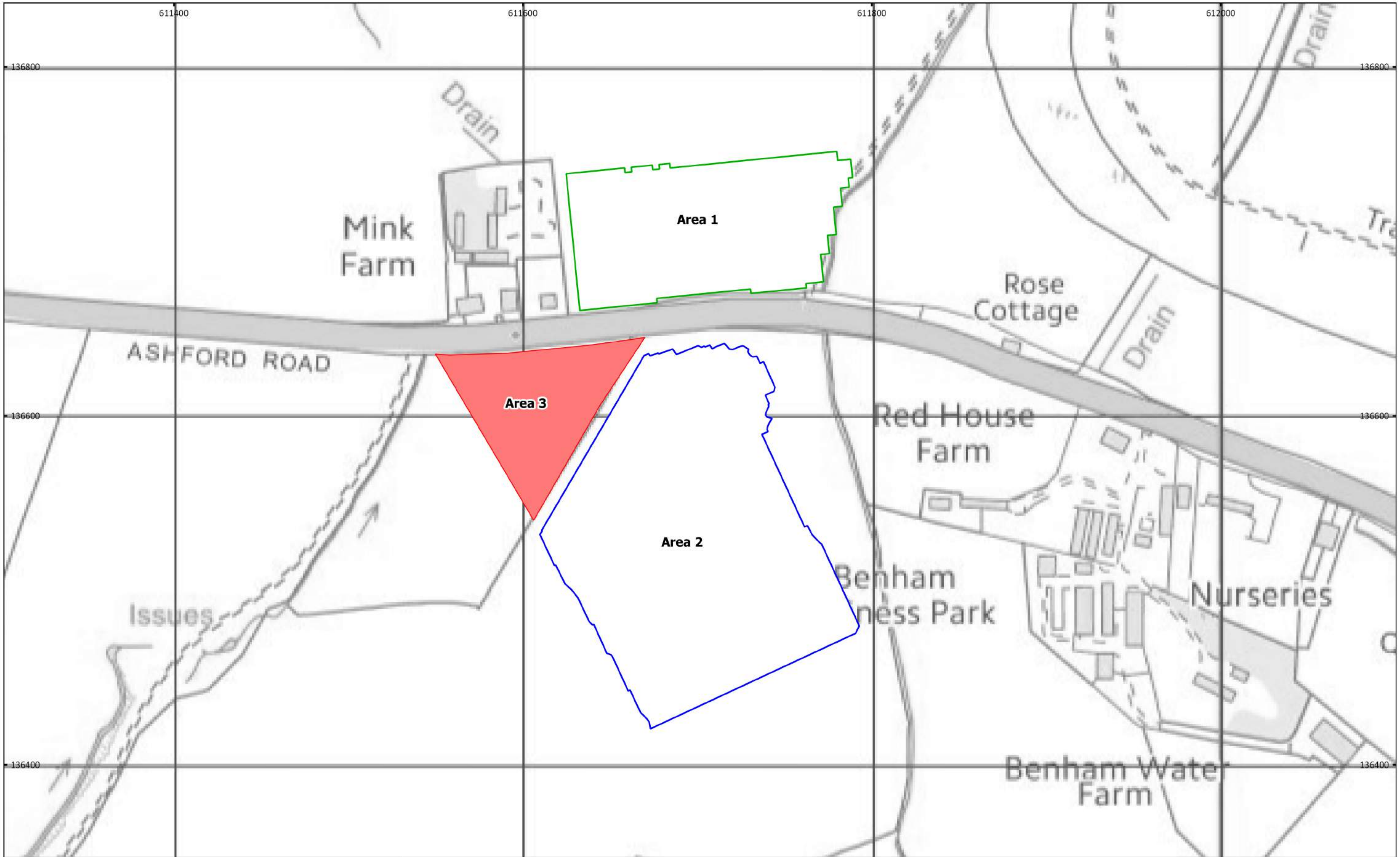


MSTR375 - Ground Penetrating Radar and Magnetometry Survey of the Roman Villa at Otterpool, near Hythe, Kent
Figure 1 - Site Location
1:25,000 @ A4

Site Boundary

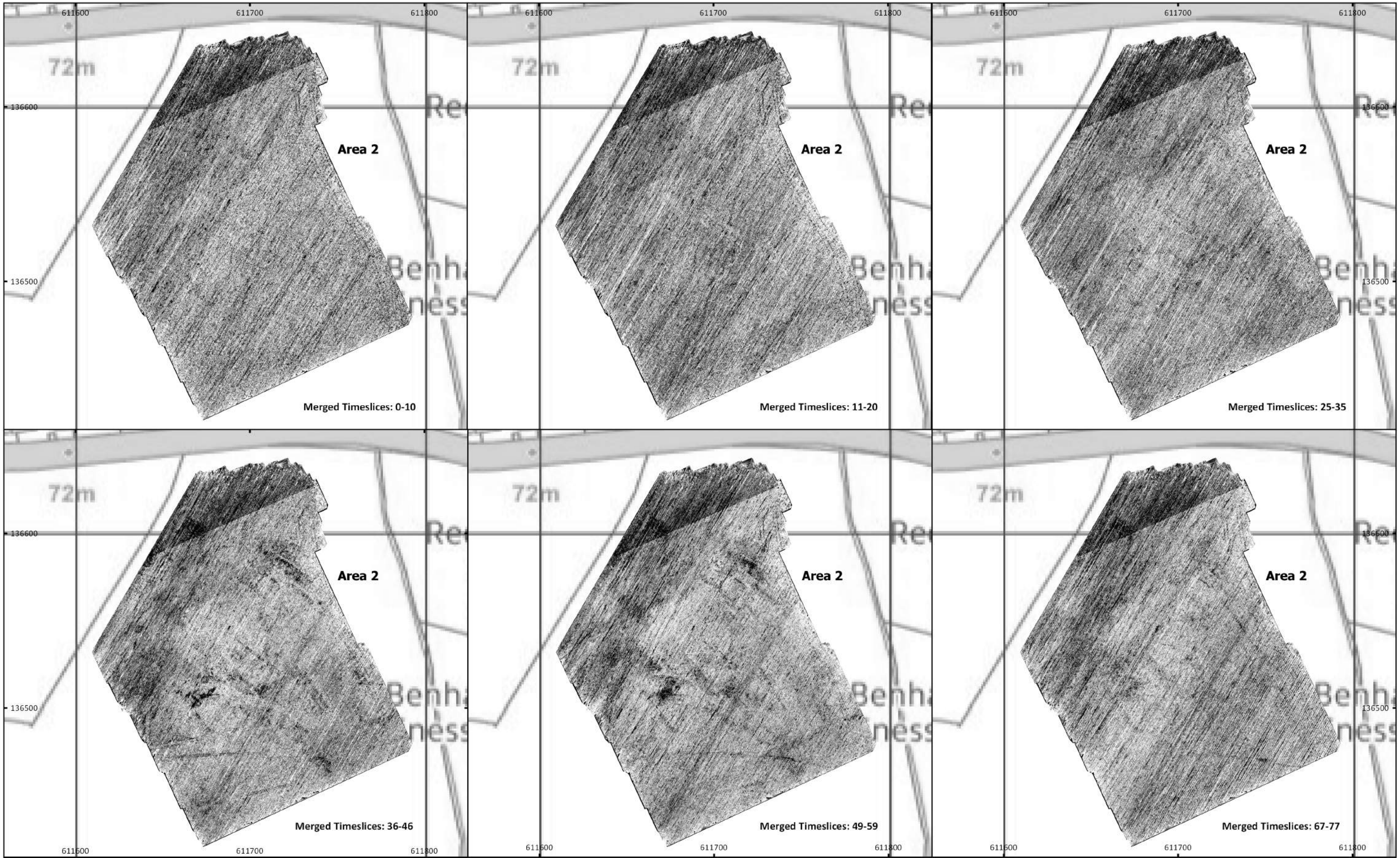
magnitude surveys



MSTR 375 - Otterpool Kent
Figure 2 - Location of Survey Areas
1:2,000 @ A3

Magnetic Survey Extent
GPR Survey Extent
GPR Unsurveyable

magnitude surveys

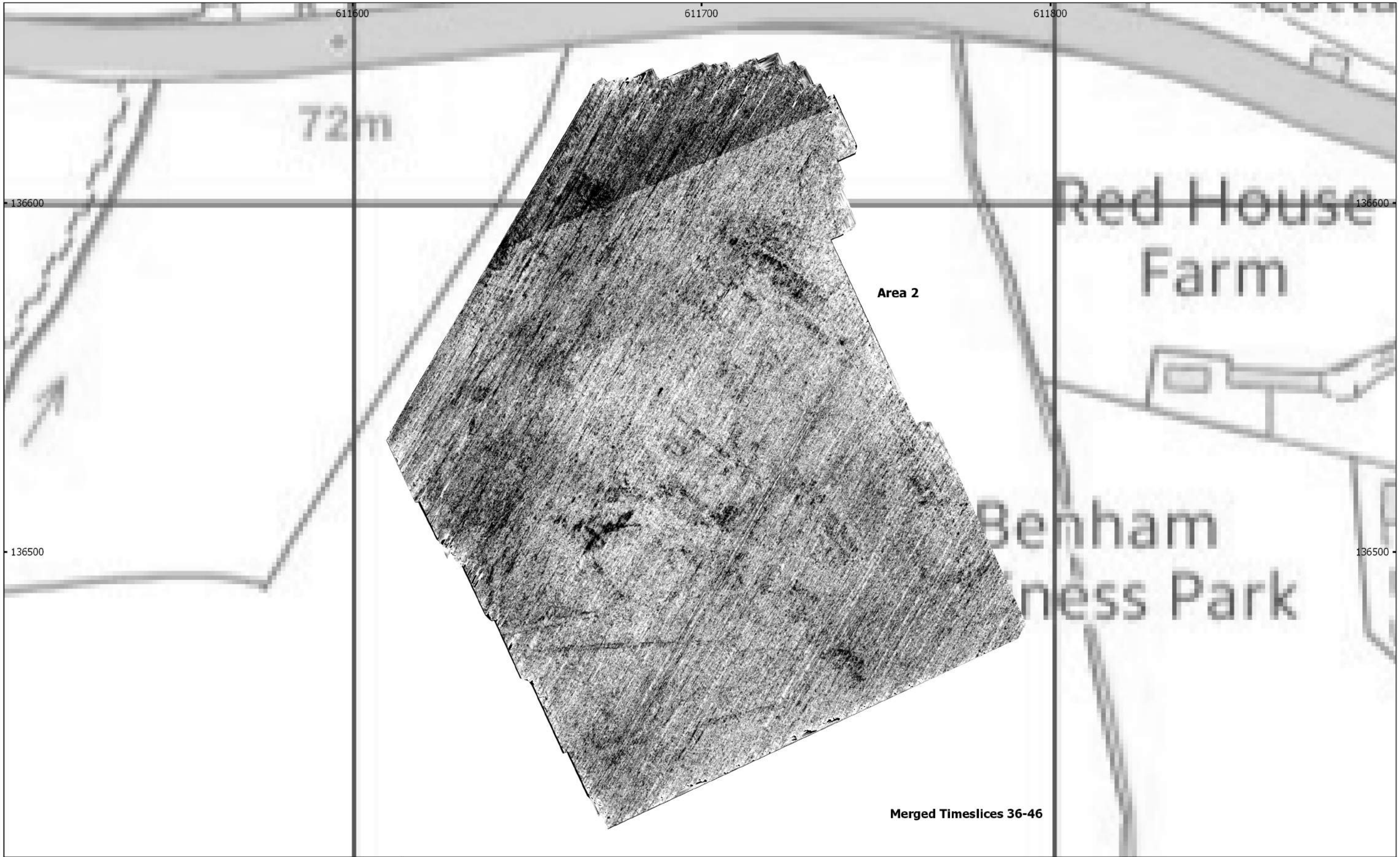


MSTR375 - Ground Penetrating Radar and Magnetometry Survey of the Roman Villa at Otterpool, near Hythe, Kent

Figure 3 - Indicative GPR Merged Timeslices (top-left, moving clockwise): Shallow-Deep

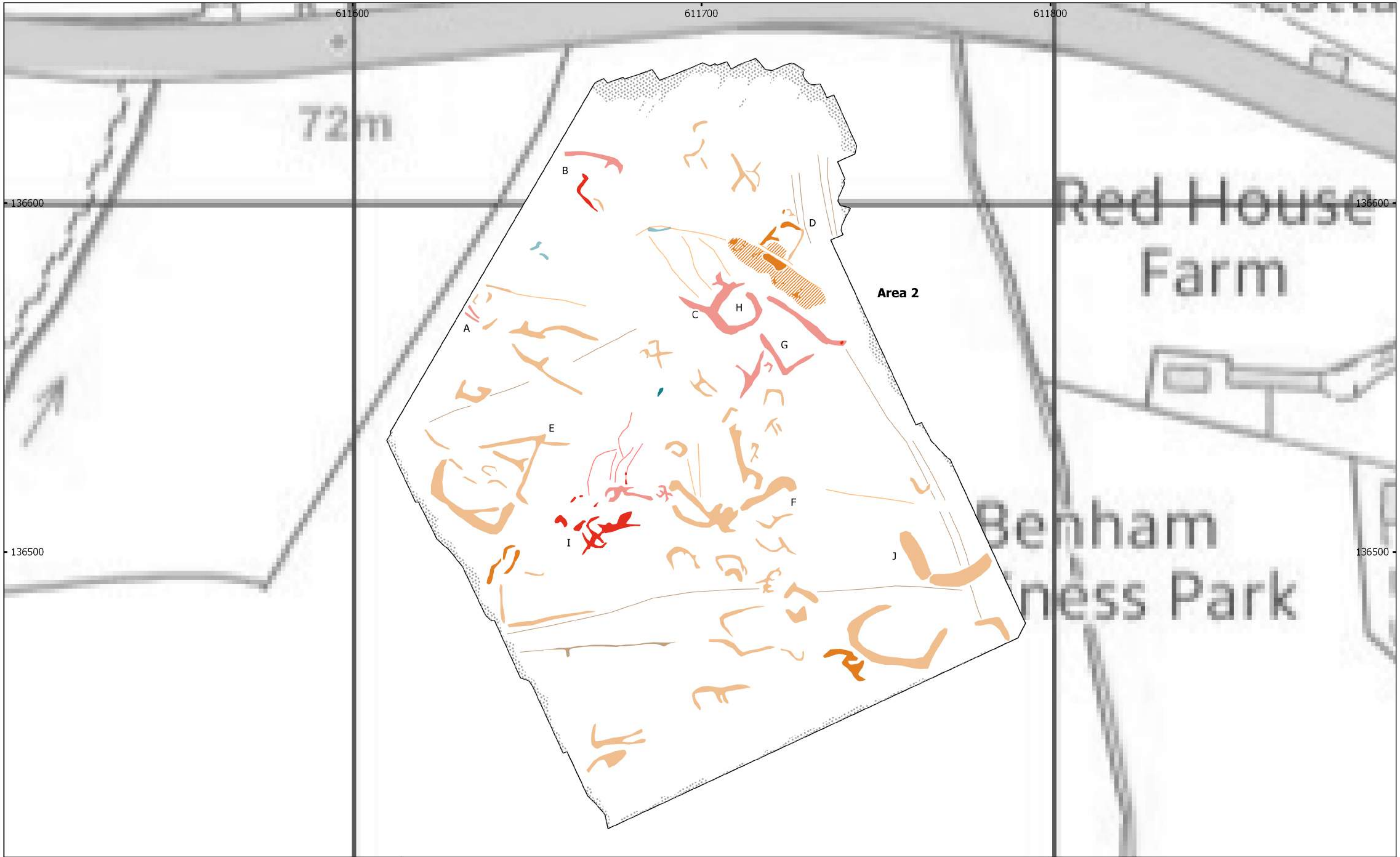
1:2,000 @ A3

magnitude surveys

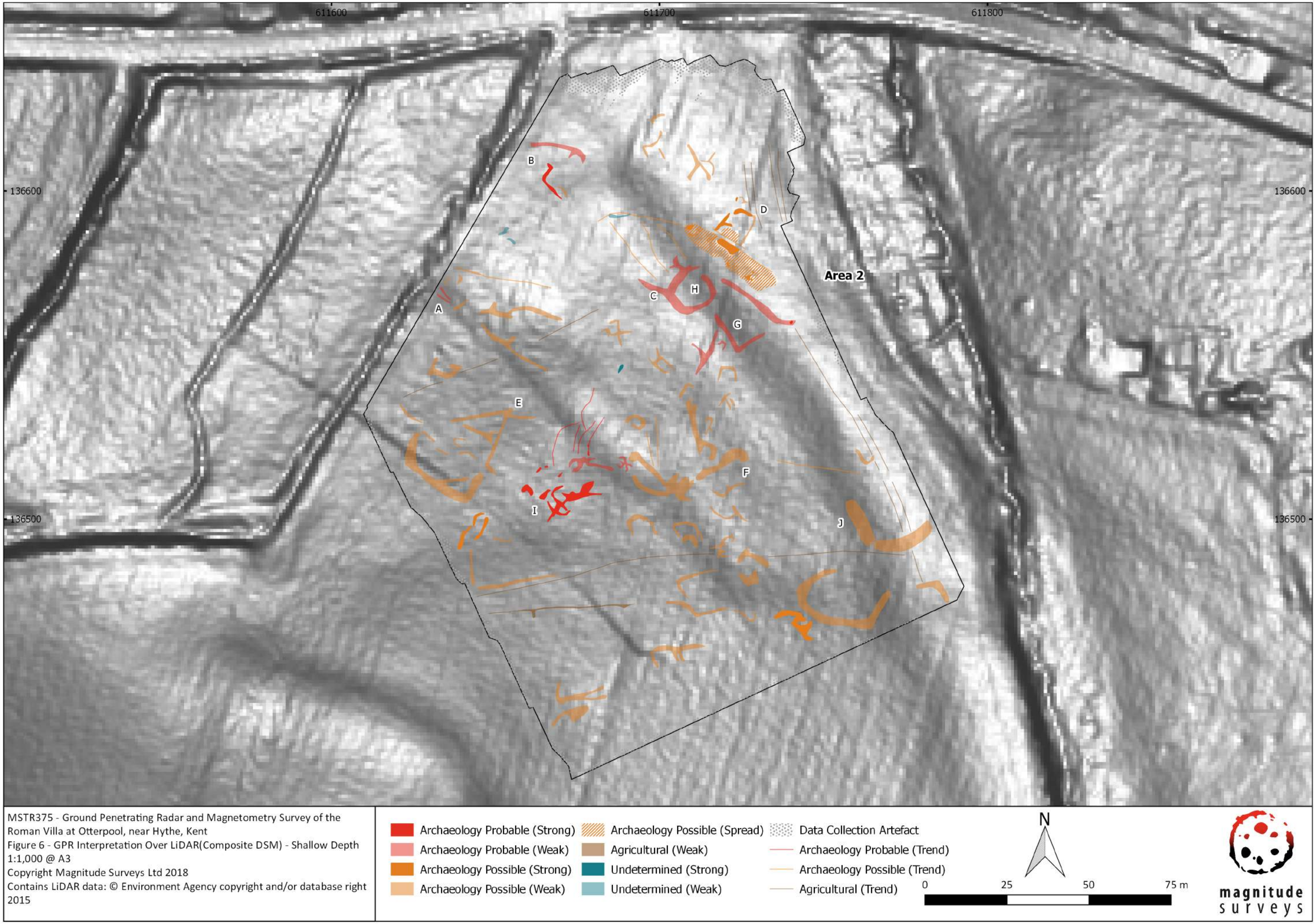


MSTR375 - Ground Penetrating Radar and Magnetometry Survey of the Roman Villa at Otterpool, near Hythe, Kent
Figure 4 - Averaged Timeslice - Shallow Depth
1:1,000 @ A3

magnitude surveys



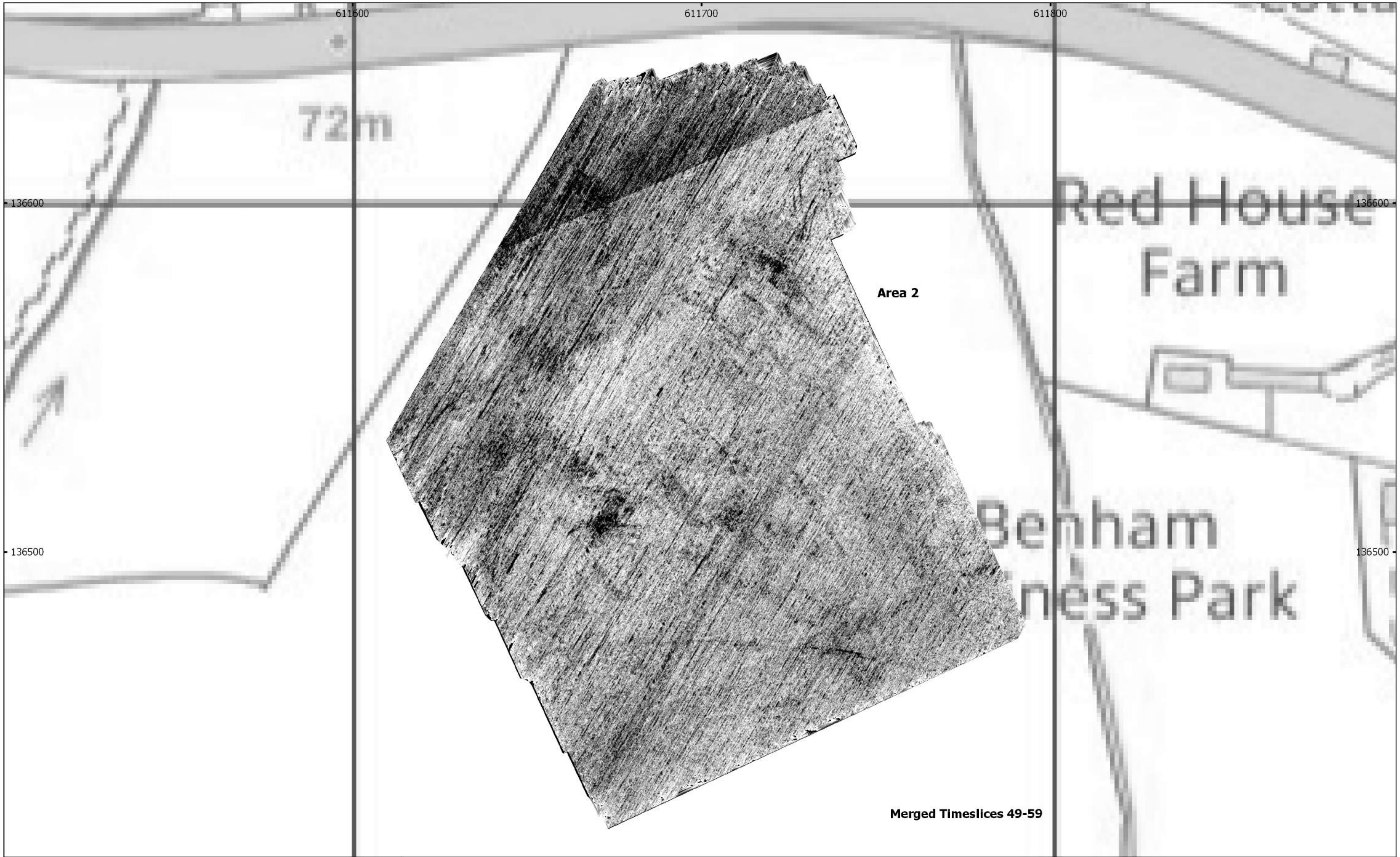
MSTR375 - Ground Penetrating Radar and Magnetometry Survey of the Roman Villa at Otterpool, near Hythe, Kent
Figure 5 - GPR Interpretation - Shallow Depth
1:1,000 @ A3



MSTR375 - Ground Penetrating Radar and Magnetometry Survey of the Roman Villa at Otterpool, near Hythe, Kent

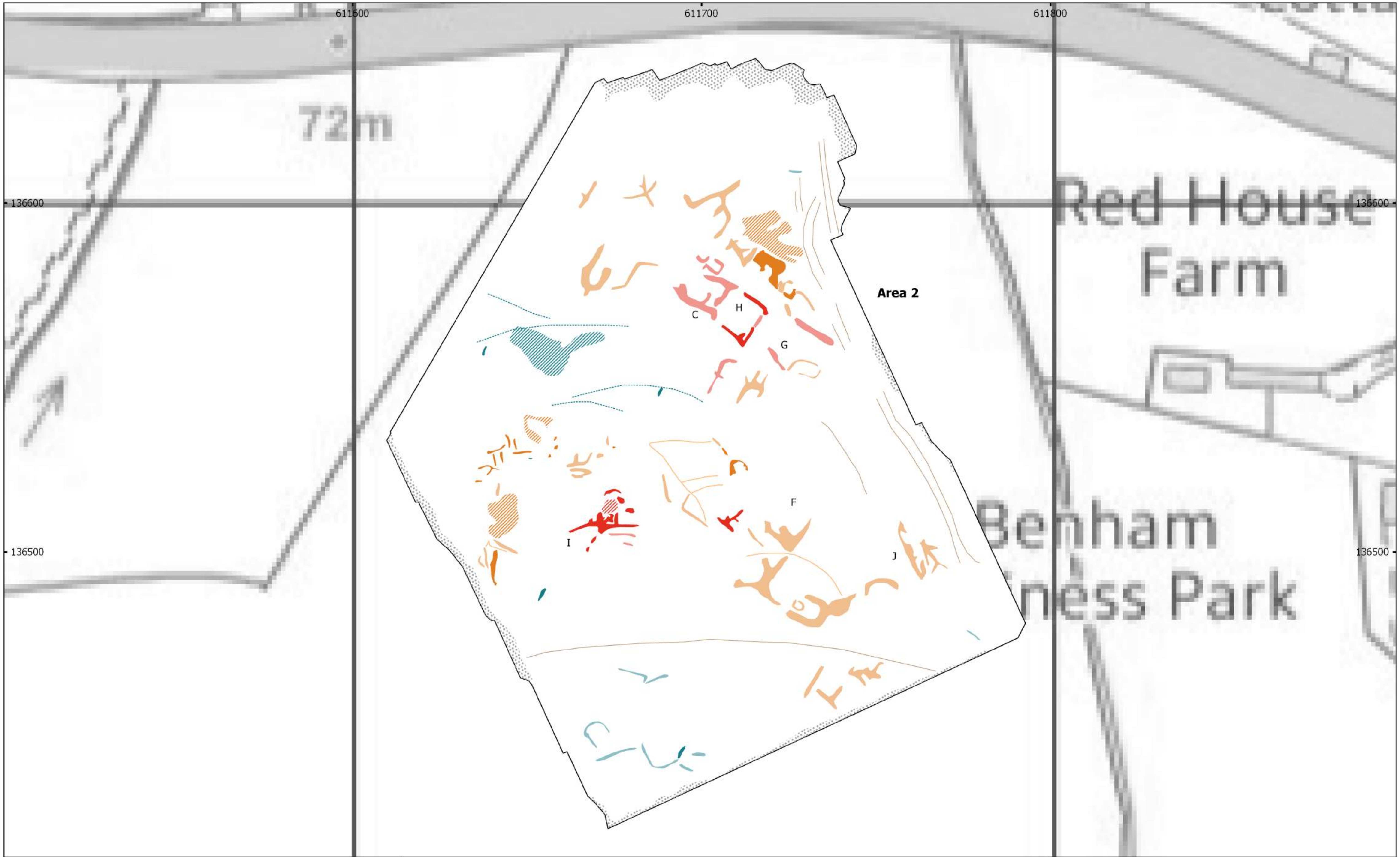
Figure 6 - GPR Interpretation Over LiDAR(Composite DSM) - Shallow Depth

1:1,000 @ A3



MSTR375 - Ground Penetrating Radar and Magnetometry Survey of the Roman Villa at Otterpool, near Hythe, Kent
Figure 7 - Averaged Timeslice - Deep Depth
1:1,000 @ A3

magnitude surveys



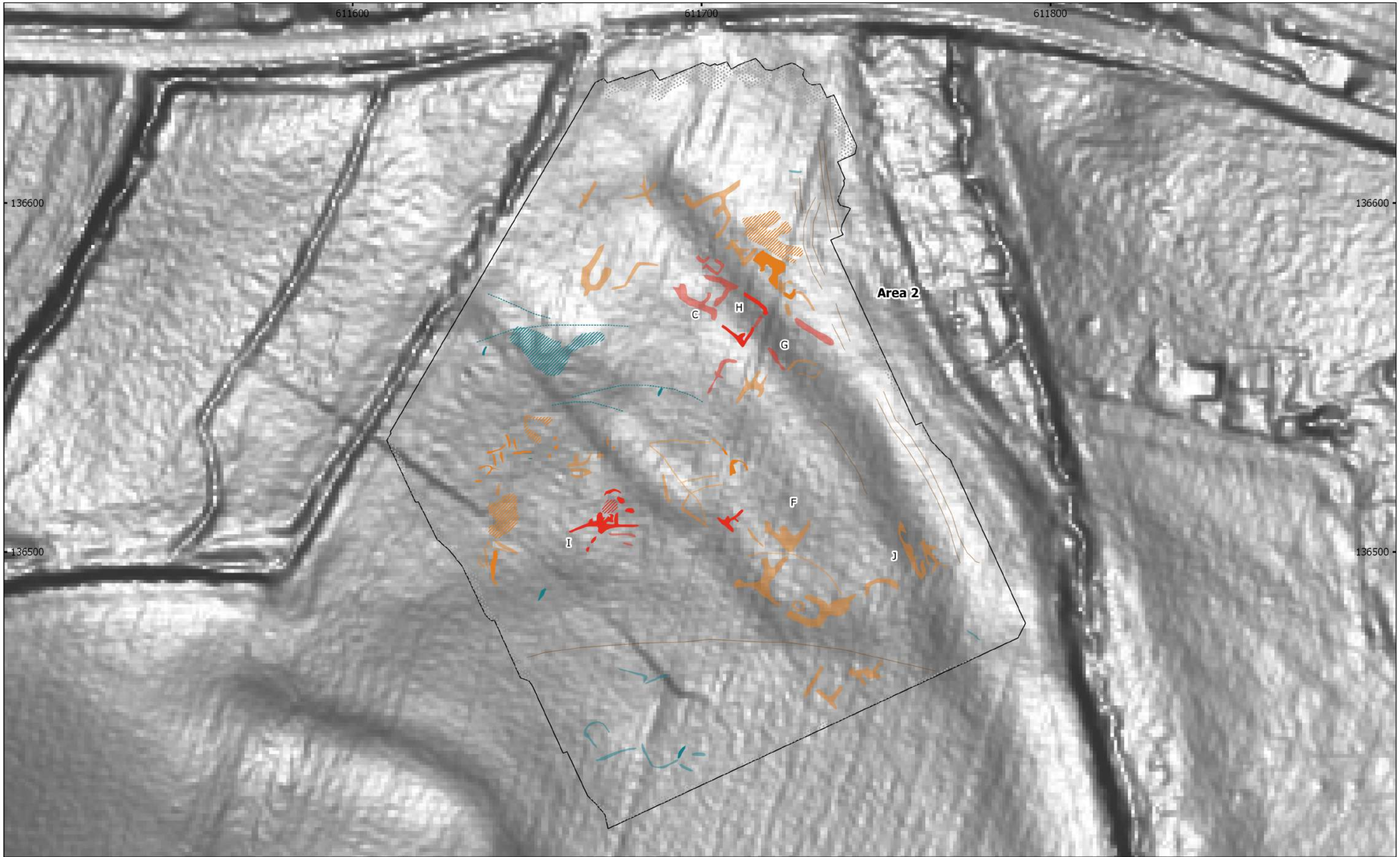
MSTR375 - Ground Penetrating Radar and Magnetometry Survey of the Roman Villa at Otterpool, near Hythe, Kent
Figure 8 - GPR Interpretation - Deep Depth
1:1,000 @ A3

Archaeology Probable (Strong)
Archaeology Probable (Weak)
Archaeology Probale (Spread)
Archaeology Possible (Strong)
Archaeology Possible (Weak)
Archaeology Possible (Spread)
Undetermined (Strong)
Undetermined (Weak)
Undetermined (Spread)
Data Collection Artefact
Archaeology Possible (Trend)
Agricultural (Trend)
Undetermined (Trend)

N

0 25 50 75 m

magnitude surveys



MSTR375 - Ground Penetrating Radar and Magnetometry Survey of the Roman Villa at Otterpool, near Hythe, Kent
Figure 9 - GPR Interpretation Over LiDAR(Composite DSM) - Deep Depth
1:1,000 @ A3

Archaeology Probable (Strong)
Archaeology Probable (Weak)
Archaeology Probale (Spread)
Archaeology Possible (Strong)
Archaeology Possible (Weak)
Archaeology Possible (Spread)
Undetermined (Strong)
Undetermined (Weak)
Undetermined (Spread)
Data Collection Artefact
Archaeology Possible (Trend)
Agricultural (Trend)
Undetermined (Trend)

magnitude surveys

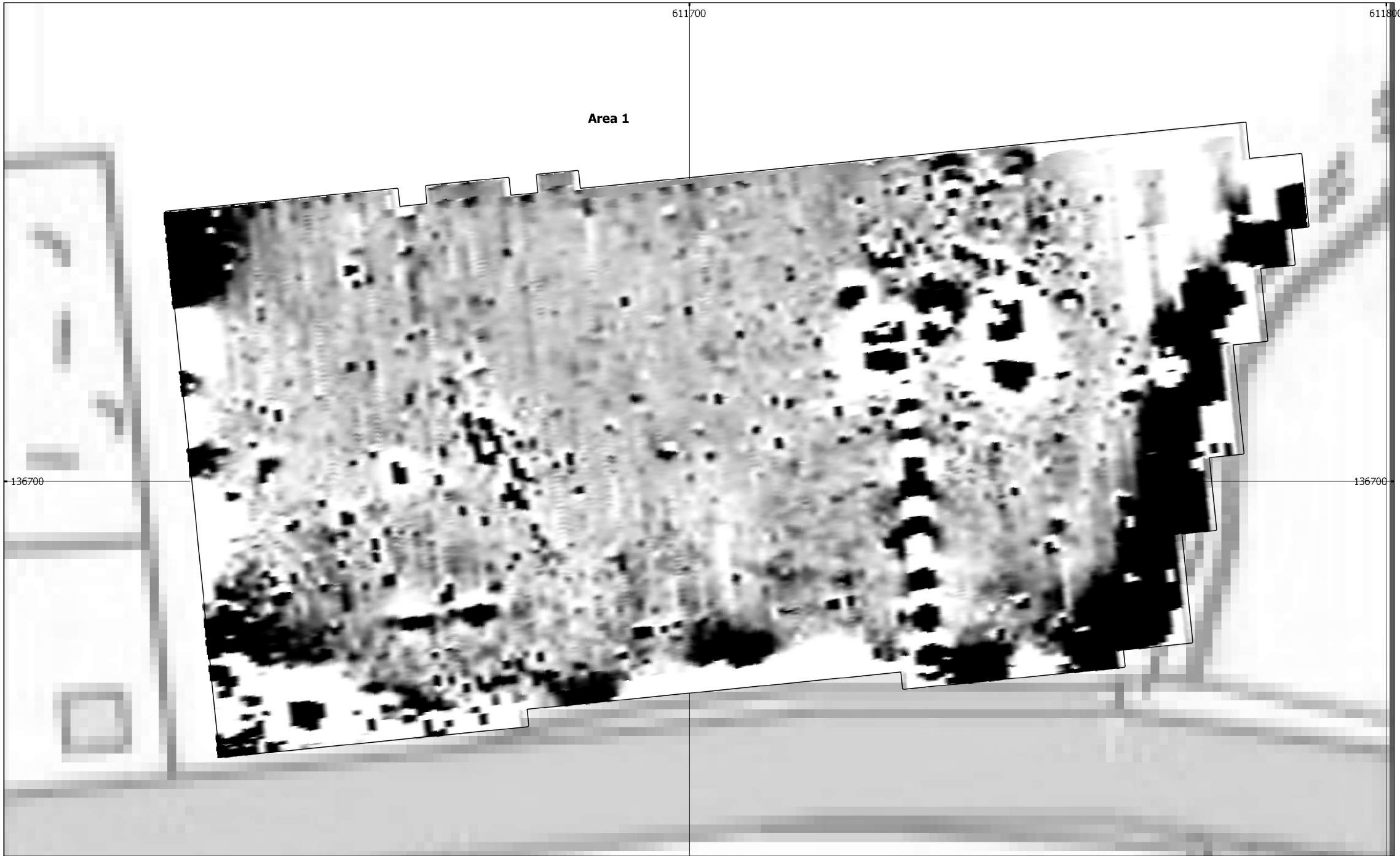
MSTR375 - Ground Penetrating Radar and Magnetometry Survey of the Roman Villa at Otterpool, near Hythe, Kent
Figure 10 - GPR Combined Interpretation Over Satellite Imagery
1:1,000 @ A3

Archaeology Probable (Strong)
Archaeology Probable (Weak)
Archaeology Probale (Spread)
Archaeology Possible (Strong)
Archaeology Possible (Weak)
Archaeology Possible (Spread)
Undetermined (Strong)
Undetermined (Weak)
Undetermined (Spread)
Data Collection Artefact
Archaeology Possible (Trend)
Agricultural (Trend)
Undetermined (Trend)

N

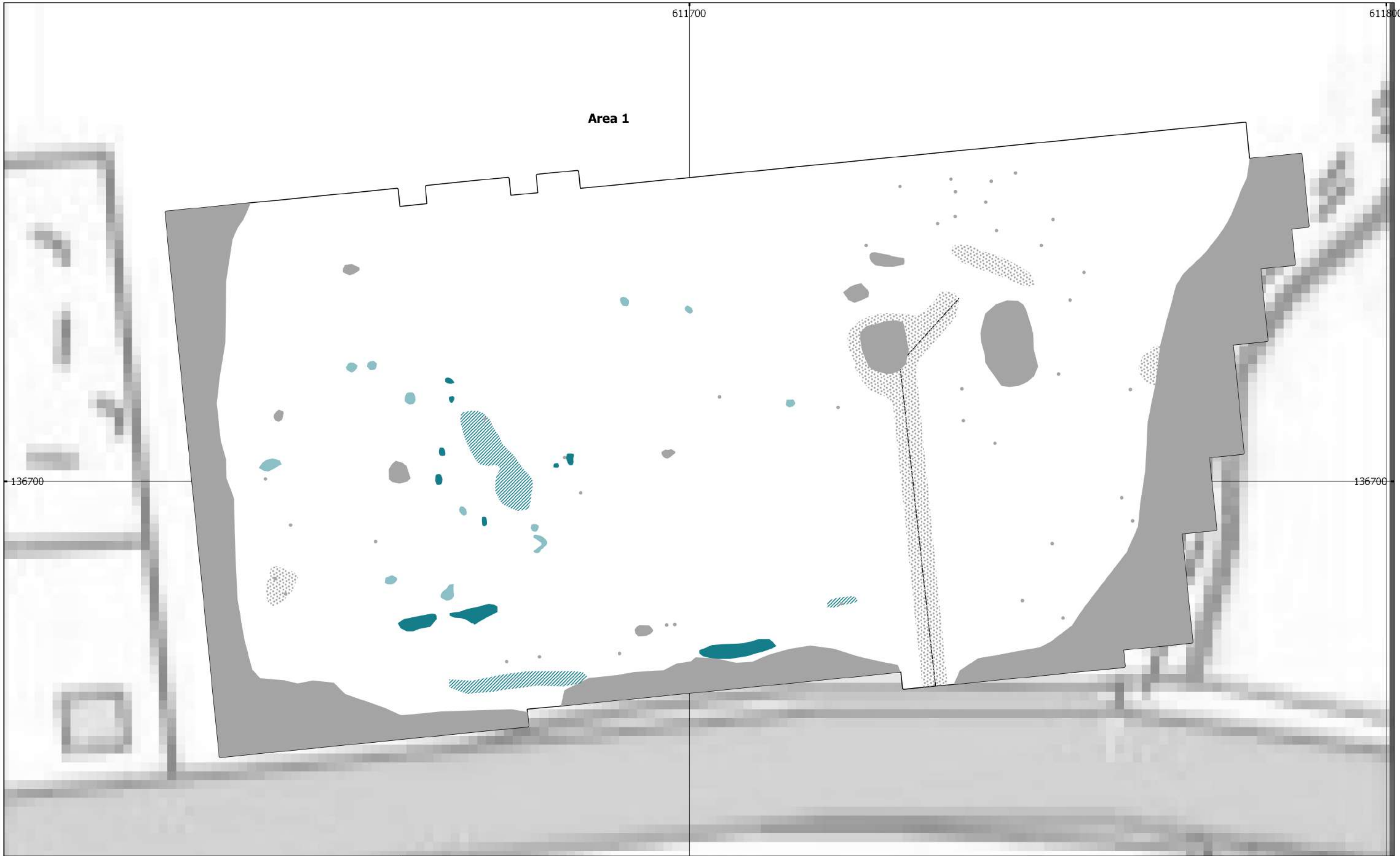
0 25 50 75 m

magnitude surveys



MSTR375 - Ground Penetrating Radar and Magnetometry Survey of the Roman Villa at Otterpool, near Hythe, Kent
Figure 11 - Magnetic Gradient
1:500 @ A3

magnitude surveys

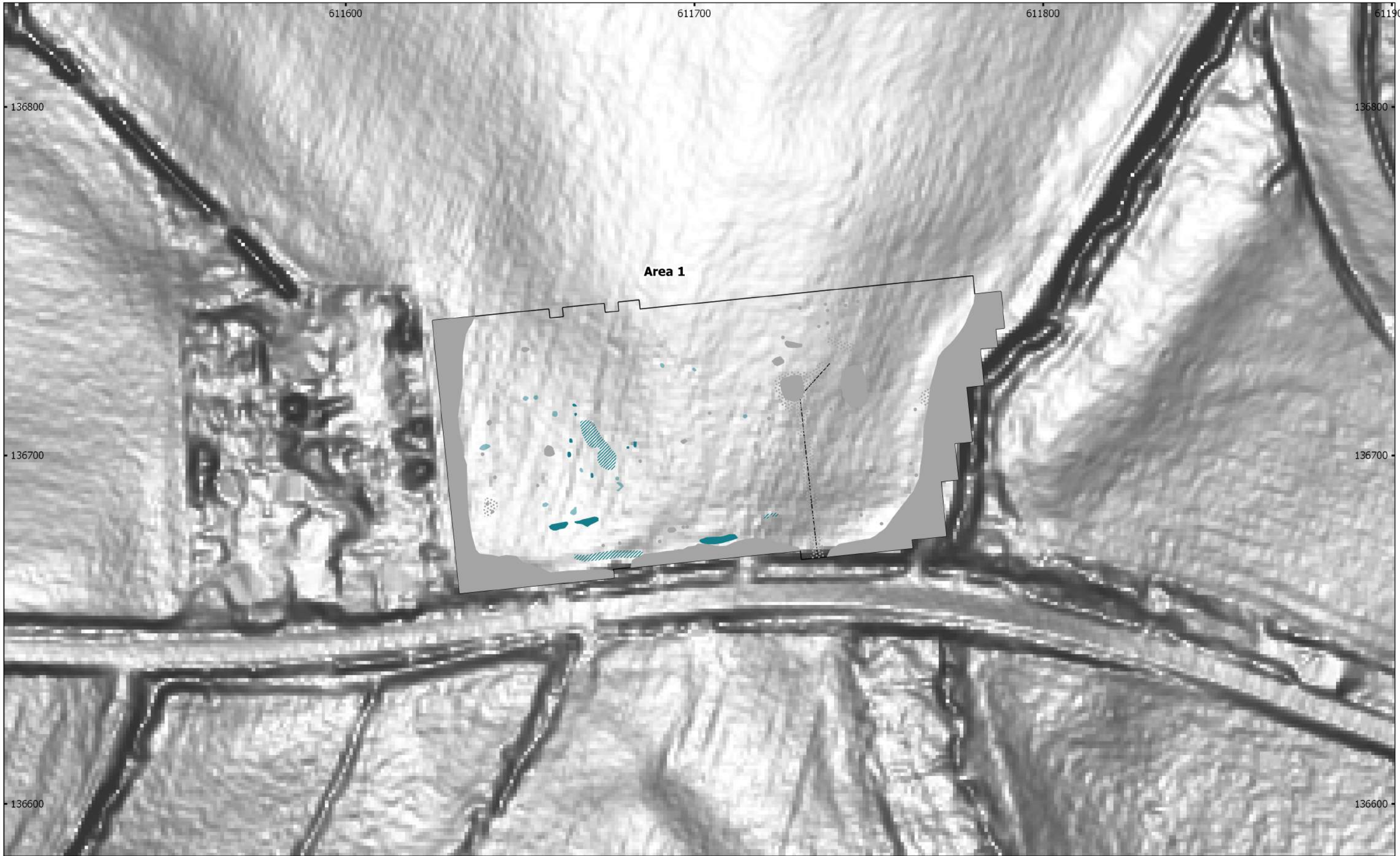


Undetermined (Strong)
Undetermined (Weak)
Undetermined (Spread)
Ferrous (Dipolar)
Ferrous (Spread)/Magnetic Disturbance
Service

N
0 10 20 30 m

MSTR375 - Ground Penetrating Radar and Magnetometry Survey of the Roman Villa at Otterpool, near Hythe, Kent
Figure 12 - Magnetic Interpretation
1:500 @ A3

magnitude surveys



MSTR375 - Ground Penetrating Radar and Magnetometry Survey of the Roman Villa at Otterpool, near Hythe, Kent
Figure 13 - Magnetic Interpretation Over LiDAR(Composite DSM)
1:1,000 @ A3

Undetermined (Strong)
Undetermined (Weak)
Undetermined (Spread)
Ferrous (Dipolar)
Ferrous (Spread)/Magnetic Disturbance
Service

N

0 10 20 30 m

magnitude surveys

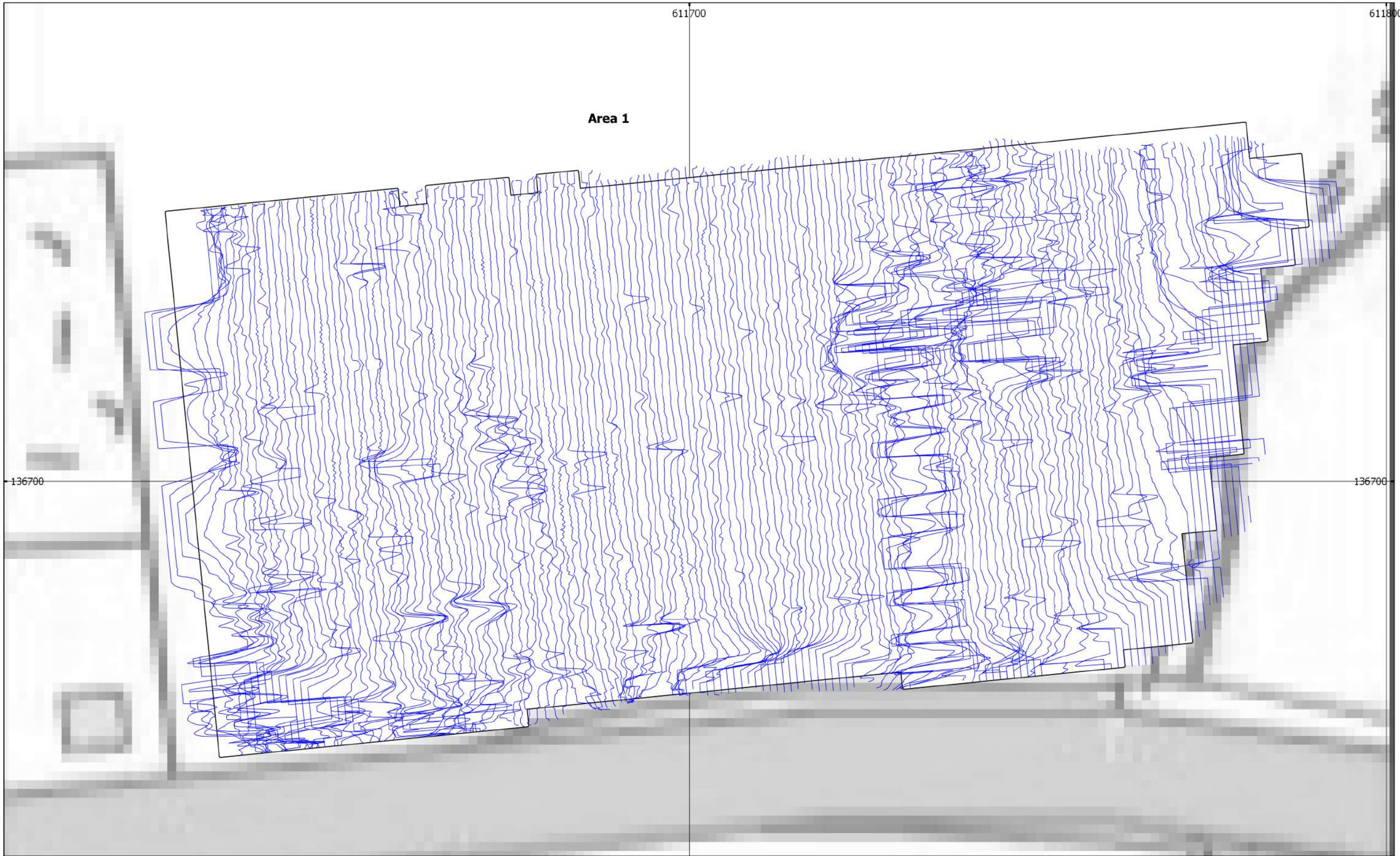
MSTR375 - Ground Penetrating Radar and Magnetometry Survey of the Roman Villa at Otterpool, near Hythe, Kent
Figure 13 - Magnetic Interpretation OverSatellite Imagery
1:1,000 @ A3

Undetermined (Strong)
Undetermined (Weak)
Undetermined (Spread)
Ferrous (Dipolar)
Ferrous (Spread)/Magnetic Disturbance
Service

N

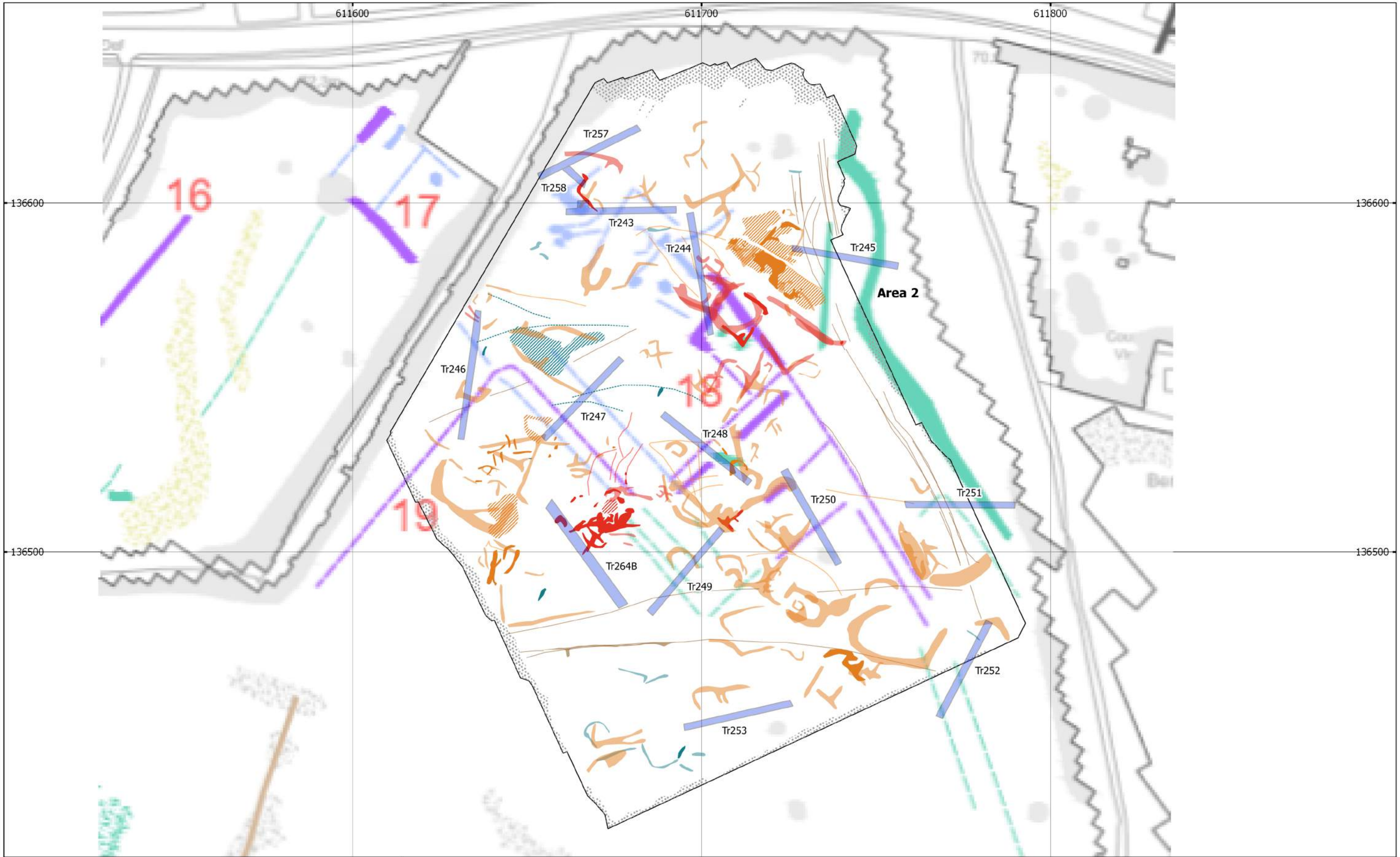
0 10 20 30 m

magnitude surveys



MSTR375 - Ground Penetrating Radar and Magnetometry Survey of the Roman Villa at Otterpool, near Hythe, Kent
Figure 15 - XY Trace Plot
10nT/cm @ 1:500 @ A3

magnitude surveys



MSTR375 - Ground Penetrating Radar and Magnetometry Survey of the Roman Villa at Otterpool, near Hythe, Kent
Appendix 1 - GPR Combined Interpretation Over Magnetic Interpretation Results
1:1,000 @ A3

Archaeology Probable (Strong)
Archaeology Probable (Weak)
Archaeology Probale (Spread)
Archaeology Possible (Strong)
Archaeology Possible (Weak)
Archaeology Possible (Spread)
Undetermined (Strong)
Undetermined (Weak)
Undetermined (Spread)
Data Collection Artefact
Archaeology Possible (Trend)
Agricultural (Trend)
Undetermined (Trend)
Trial Trench

N

0 25 50 75 m

magnitude surveys