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Geophysics

Silchester Environs Project, Simms's Copse, Mortimer West End, Hampshire
Report on Geophysical Survey, July 2016

Neil Linford, Paul Linford and Andrew Payne

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SILCHESTER ENVIRONS PROJECT, SIMMS'S COPSE, MORTIMER WEST END, HAMPSHIRE

REPORT ON GEOPHYSICAL SURVEY,

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SUMMARY

Caesium magnetometer and Ground Penetrating Radar (GPR) surveys were conducted as part of the University of Reading Silchester Environs Project over two enclosures previously observed as crop marks, at Simms's Copse, Mortimer West End, Hampshire. The vehicle towed caesium magnetometer survey (8.3 ha) detected faint curving ditch anomalies associated with the two known enclosures and provided partial evidence for a third enclosure to the south of the site. The vehicle towed GPR survey (3.6 ha) focused on the two main enclosures and replicated the ditches as with some additional detail suggesting entrance gaps in the east and northeast ditches of the southern enclosure. The response to the dry valley crossing the centre of the site dominates both data sets and appears to have eroded through the north-west portion of the southern enclosure.

CONTRIBUTORS

The geophysical fieldwork was conducted by Neil Linford, Paul Linford and Andrew Payne.

ACKNOWLEDGEMENTS

The authors are grateful to the landowner for allowing access for the survey.

ARCHIVE LOCATION

Fort Cumberland, Portsmouth.

DATE OF SURVEY

The fieldwork was conducted between 27th and 28th July 2016 and the report completed on 29th April 2019. The cover image shows the vehicle towed GPR array in the field during the survey looking towards Simms's Copse (P. Linford).

CONTACT DETAILS

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INTRODUCTION

Caesium magnetometer and Ground Penetrating Radar (GPR) surveys were conducted at Simms's Copse, Mortimer West End, Hampshire, as part of the Historic England contribution to the Silchester Environs Survey (RASMIS 7226), undertaken in partnership with the University of Reading (Barnett and Fulford 2015). This project aims to investigate the origins and early development of the Iron Age and Roman town at Calleva Atrebatum (Silchester, Hampshire), through a study of prehistoric settlement, activity and agriculture in the hinterland of the Iron Age *Calleva* to address the local context for the emergence of the *oppidum*.

The geophysical survey component of the project aims to test the magnetic and GPR response over the varying gravel, clay and chalk geologies of the Silchester area, using a vehicle towed high sensitivity caesium vapour magnetometer array together with a high sample density multi channel GPR system. It is hoped that this will complement the extensive fluxgate magnetometer and GPR coverage conducted by the University of Reading, particularly where the geophysical response has proved indistinct (Creighton and Fry 2016). Trial sites for ground based survey have been identified from aerial photography and lidar coverage within the project area (Figure 1), including the plough truncated remains of long, linear earthwork banks crossing the landscape where these survive in areas of woodland and may extend into the surrounding farmland (Linford 2015).

The survey at Simms's Copse was conducted in advance of the evaluation of two probable later prehistoric enclosures known from cropmarks (AMIE Monument HOB UID 1601340 and 1601345, Wheeler and Pankhurst 2016).

The site is situated on sand and gravel drift deposits of the Silchester Gravel Member, over sand deposits of the London Clay Formation (Geological Survey of Great Britain 1946). Well drained flinty coarse loamy and gravelly soils of the 581c Sonning 2 association have developed over this geology, associated with fine and coarse loamy over clayey soils with slowly permeable subsoils (Soil Survey of England and Wales 1983). The field adjacent to Simms's Copse was covered with recently harvested cereal stubble at the time of the survey, with a steep sided dry valley crossing through the centre of the site. Weather conditions were generally dry during the field work.

METHOD

Magnetometer survey

Magnetometer data was collected along the instrument swaths shown on Figure 2 using an array of six Geometrics G862 caesium vapour sensors mounted on a non-magnetic sledge (Linford *et al.* 2015). The sledge was towed behind a low-impact All-Terrain Vehicle (ATV) which housed the power supply and data logging electronics. Five sensors were mounted 0.5m apart in a linear array transverse to the direction of travel and, vertically, ~0.25m above the ground surface. The sixth was fixed 1.0m directly above the centre of this array to act as a gradient sensor. The sensors sampled at a rate of 25Hz resulting in an along-line sample density of ~0.15m given typical ATV travel speeds of 3.5-4.0m/s. As the five non-gradient sensors were 0.5m apart, successive survey swaths were separated by approximately 2.5m to maintain a consistent traverse separation of 0.5m. Navigation and positional control were achieved using a Trimble R8 Global Navigation Satellite System (GNSS) receiver mounted on the sensor platform 1.65m in front of the central sensor and a second R8 base station receiver established using the Ordnance Survey VRS Now correction service. Sensor output and survey location were continuously monitored during acquisition to ensure data quality and minimise the risk of gaps in the coverage.

After data collection the corresponding readings from the gradient sensor were subtracted from the measurements made by the other five magnetometers to remove any transient magnetic field effects caused by the towing ATV or other nearby vehicles. The median value of each instrument traverse was then adjusted to zero by subtracting a running median value calculated over a 50m 1D window (see for instance Mauring *et al.* 2002). This operation corrects for biases added to the measurements owing to the diurnal variation of the Earth's magnetic field and any slight directional sensitivity of the sensors. A linear greyscale image of the combined magnetic data is shown superimposed over the base Ordnance Survey (OS) mapping in Figure 4 and minimally processed versions of the range truncated data (±100nT/m) are shown as a trace plot and a histogram equalised greyscale image in Figures 6 and 7.

Ground Penetrating Radar survey

A 3d-radar MkIV GeoScope Continuous Wave Step-Frequency (CWSF) Ground Penetrating Radar (GPR) system was used to conduct the survey collecting data with a multi-element DXG1820 vehicle towed, ground coupled antenna array (Linford *et al.* 2010). A roving Trimble R8 Global Navigation Satellite System (GNSS) receiver, together with a second R8 base station receiver established using the Ordnance Survey VRS Now correction service, was mounted on the GPR antenna array to provide continuous positional control for the survey collected along the instrument swaths shown on Figure 3. Data were acquired at a 0.075m x 0.075m sample interval across a continuous wave stepped frequency range from 60MHz to 2.99GHz in 4MHz increments using a dwell time of 2ms. A single antenna element was monitored continuously to ensure data quality during acquisition together with automated processing software to produce real time amplitude time slice representations of the data as each successive instrument swath was recorded in the field (Linford 2013).

Post-acquisition processing involved conversion of the raw data to time-domain profiles (through a time window of 0 to 50ns), adjustment of time-zero to coincide with the true ground surface, background and noise removal, and the application of a suitable gain function to enhance late arrivals. Representative profiles from the GPR survey are shown on Figure 8. To aid visualisation amplitude time slices were created from the entire data set by averaging data within successive 2.5ns (two-way travel time) windows (e.g. Linford 2004). An average sub-surface velocity of 0.104m/ns was assumed following constant velocity tests on the data, and was used as the velocity field for the time to estimated depth conversion. Each of the resulting time slices, shown as individual greyscale images, therefore represents the variation of reflection strength through successive ~0.13m intervals from the ground surface in Figures 9 and 10. Further details of both the frequency and time domain algorithms developed for processing this data can be found in Sala and Linford (2012).

Due to the size of the resultant data set a semi-automated algorithm has been employed to extract the vector outline of significant anomalies shown on Figure 12. The algorithm uses edge detection to identify bound regions followed by a morphological classification based on the size and shape of the extracted anomalies. For example, the location of possible pits is made by selecting small, sub circular anomalies from the data set.

RESULTS

Magnetometer survey

A graphical summary of significant magnetic anomalies [**m1-16**] discussed in the following text superimposed on base OS map data is provided in Figure 11.

Magnetic contrasts are typical for anomalies formed over London Clay, being extremely weak, and distinguishing potential archaeological activity is further complicated by the stippled pit-like response to the superficial gravel geology. Nevertheless, the partial circuits of the two enclosures observed as crop marks have been detected as faint curving ditch anomalies [**m1**] and [**m2**] with peak magnitudes in the range 0.5-1.0 nT/m, although no entrances have been clearly resolved. In the extreme southern corner of the survey area a further similar partial ditch anomaly [**m3**] can be discerned suggesting a third enclosure, which may continue into the woodland south of the field boundary. Extending north-northeast from this are two parallel linear ditch anomalies [**m4**] about 6 m apart, perhaps suggesting an elongated approach to a banjo enclosure. However, they are indistinct at the point where they join the curving enclosure ditch so this inference is uncertain.

At the northern end of [**m4**] a fourth enclosure was thought to be indicated by a very faint negative curving ditch-type response [**m5**], but subsequent excavation demonstrated this not to be the case.

There are also weak indications of a pair of faint curvilinear funnelling anomalies [**m6**] converging towards the west in the direction of the partially defined southern enclosure [**m2**]. It is possible that these anomalies may relate to the enclosure they are heading towards, such as an approach feature, but their irregular form may also suggest a geomorphological origin. The southern of two curvilinear anomalies [**m6**] intersects with an area of stronger positive response [**m7**] which may represent a large infilled pit or quarrying, possibly associated with occupation activity, but a natural origin such as the formation of valley bottom colluvial sediments where the topography slopes down steeply at this location cannot be discounted.

To the north-east of the survey two further areas of raised response [**m8**] and [**m9**] have been detected, together with a series of weak positive linear anomalies that may represent archaeological or natural fluvial activity associated with the nearby spring and pond located directly to the east. Geomorphological anomalies associated with the sides of a steep sided dry valley can be also discerned at [**m10**] and [**m11**] with, possibly, a line of pits [**m12**] on the southern side. Throughout the whole survey area as well as the speckled very variable response to the gravel geology numerous vague (mostly negative) linear trends occur, for example [**m13-16**], that further confuse the interpretation of the data.

Ground Penetrating Radar survey

A graphical summary of the significant GPR anomalies, [**gpr1-8**] discussed in the following text, superimposed on the base OS map data, is provided in Figure 12.

Significant reflections have been recorded throughout the 50ns two-way travel time window, although later reflections beyond ~40ns become dominated by a response to the underlying sand and gravel beds. The near-surface data between 0 and 7.2ns (0.0 - 04m) has responded to the immediate surface conditions across the site including the most recent cultivation pattern before a more complex response to the prehistoric enclosures and the geomorphology is evident.

The ditches of the two main enclosures are, unusually, replicated in the radar data as high amplitude anomalies [**gpr1**] and [**gpr2**] from approximately 0.5 m to 2.5 m (cf Linford *et al.* 2017). There is some evidence for entrance gaps in the east [**gpr3**] and northeast [**gpr4**] ditches of the southern enclosure, together with a short, linear anomaly [**gpr5**] extending beyond the survey to the south. This may, perhaps, be suggestive of the approach ditches to a banjo style enclosure, although this is not fully described in the area available for survey and was obscured by ferrous disturbance in the magnetic data. The response to the dry valley [**gpr6**] becomes evident from approximately 0.5m onwards and appears to have eroded through the north-west portion of the southern enclosure. Whilst there is some evidence for internal activity within the two enclosures, for example at [**gpr7**] and [**gpr8**], it has proved difficult to separate this from the geomorphological response.

CONCLUSIONS

Despite a very subtle magnetic response significant anomalies corroborate the existing aerial photographic analysis, including the suggestion of third possible enclosure to the south-east. The GPR survey produced a well-defined, high amplitude response over the two main enclosure ditches, most likely due to gravel rich fills. Some additional evidence for entrances and internal activity has also been suggested by the radar, which has enhanced the results of the magnetic data particularly at the extents of the survey where a degree of ferrous disturbance was encountered. The geophysical results from both techniques have, in part, been obscured by a strong geomorphological response particularly from deposits within the dry valley crossing the centre of the site.

LIST OF ENCLOSED FIGURES

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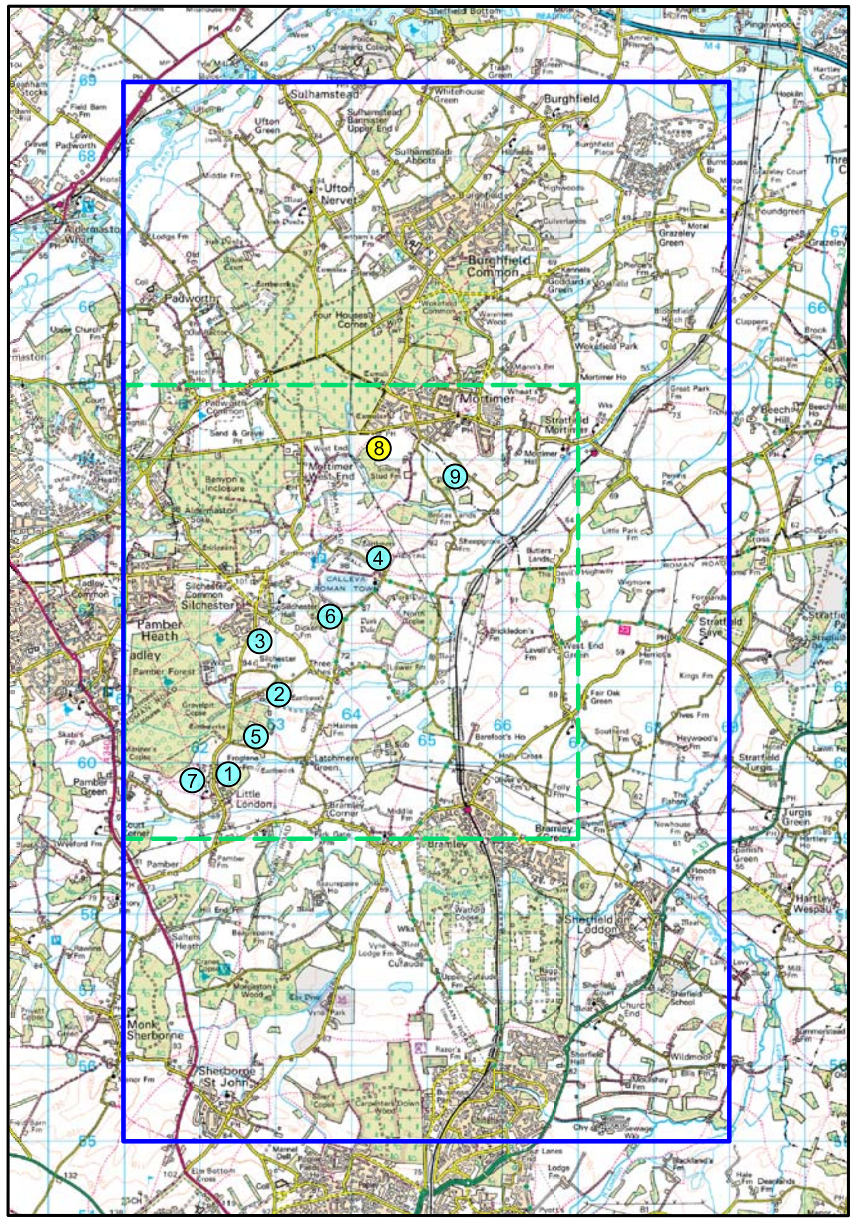
Figure 1

SILCHESTER ENVIRONS PROJECT, SIMMS'S COPSE, MORTIMER WEST END, HAMPSHIRE

Location of survey

(A)



- Core project area
- Detailed OS mapping area (B)

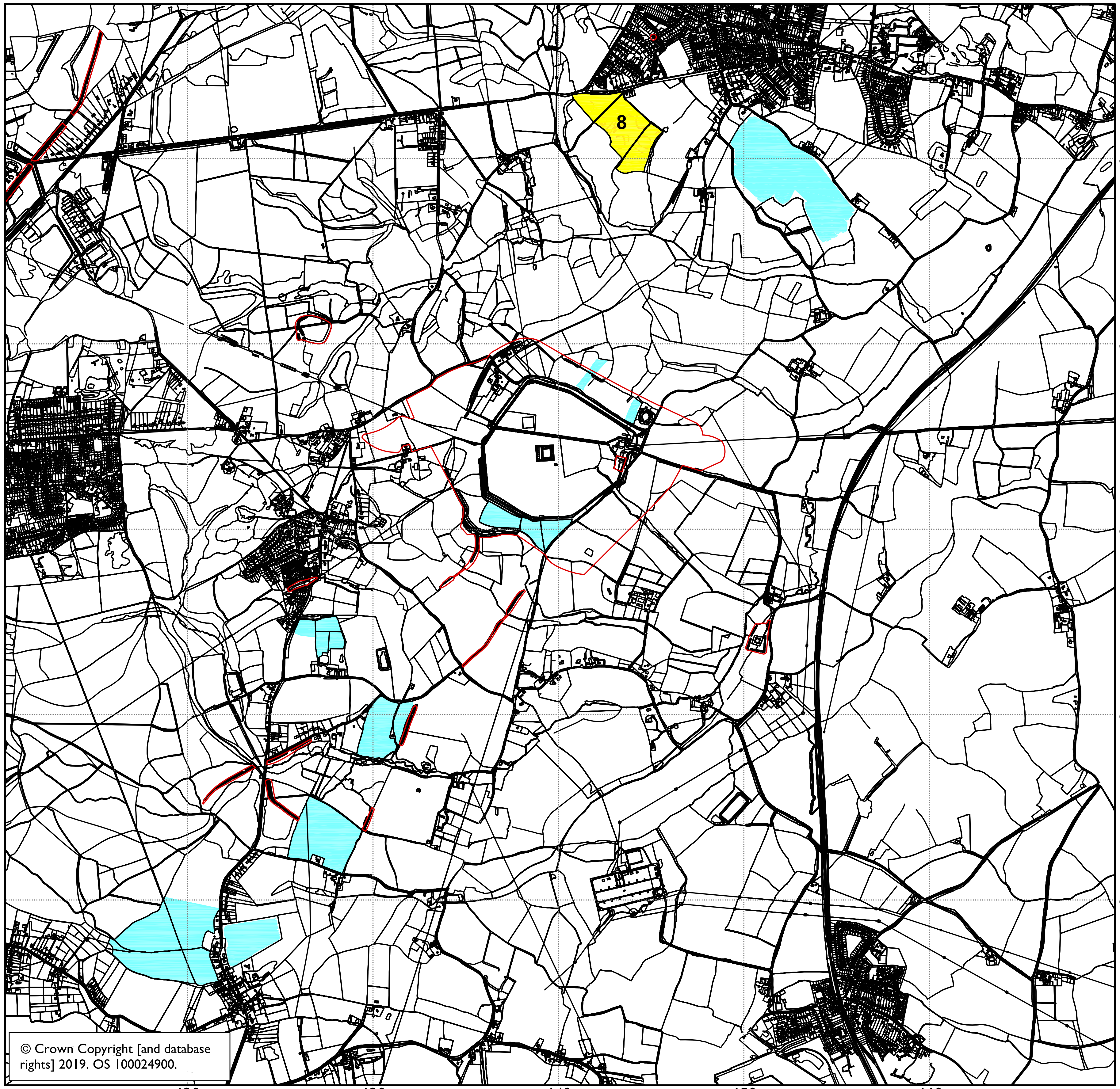
0 — 3km
1:100000

HE geophysical survey locations:

1. Little London Roman tilery
2. Woods Farm Dyke
3. Silchester Farm
4. Chitty Farm
5. Bridle's Copse
6. Rampier Copse
7. King's Hogsty Copse
8. Simms's Copse
9. Windabout Copse

(B)

SU6159



0 — 1500m
1:25000

- 8 Simms's Copse survey area
- Other HE geophysical survey areas
- Scheduled areas

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Figure 2

SILCHESTER ENVIRONS PROJECT, SIMMS'S COPSE, MORTIMER WEST END, HAMPSHIRE

Location of caesium magnetometer instrument swaths, July 2016

SU6463

0 90m

1:2500

Caesium magnetometer survey swaths

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Figure 3

SILCHESTER ENVIRONS PROJECT, SIMMS'S COPSE, MORTIMER WEST END, HAMPSHIRE

Location of GPR instrument swaths, July 2016

0 90m
1:2500

2016-07-27-033 Location of selected GPR profiles shown on Figure 8

Ground Penetrating Radar survey swaths

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Figure 4

SILCHESTER ENVIRONS PROJECT, SIMMS'S COPSE, MORTIMER WEST END, HAMPSHIRE

Location of caesium magnetometer survey, July 2016

0 90m

1:2500

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Figure 5

SILCHESTER ENVIRONS PROJECT, SIMMS'S COPSE, MORTIMER WEST END, HAMPSHIRE
GPR amplitude time slice between 25.4 - 28.8ns (1.45 - 1.58m), July 2016

SU6463

0 ▬▬ 90m

1:2500

2016-07-27-033 Location of selected GPR profiles shown on Figure 8

Low *High*
relative reflector strength

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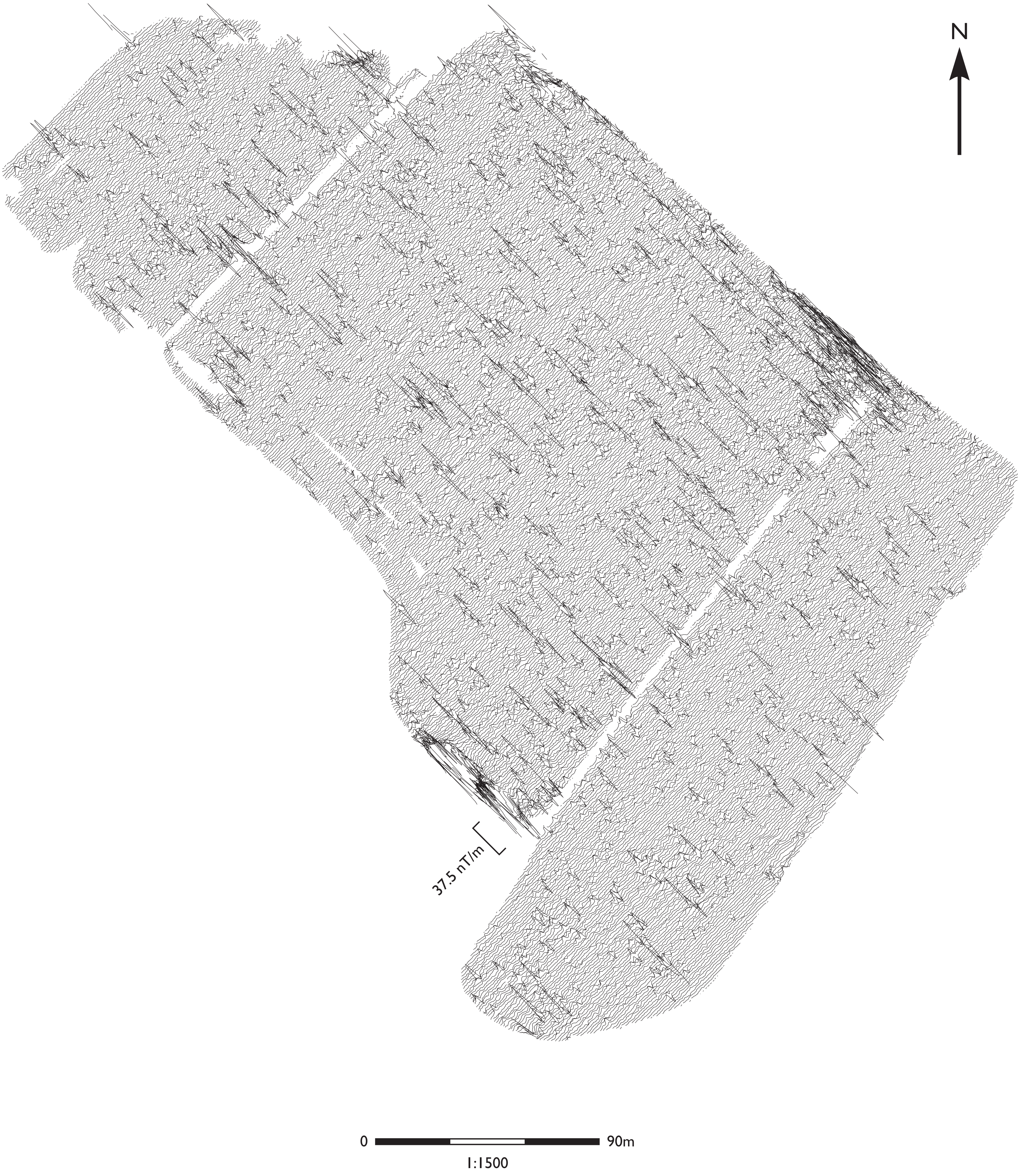
Figure 6

SILCHESTER ENVIRONS PROJECT, SIMMS'S COPSE, MORTIMER WEST END, HAMPSHIRE
Trace plot of minimally processed caesium magnetometer data, July 2016



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Equal area greyscale image of minimally processed caesium magnetometer data, July 2016

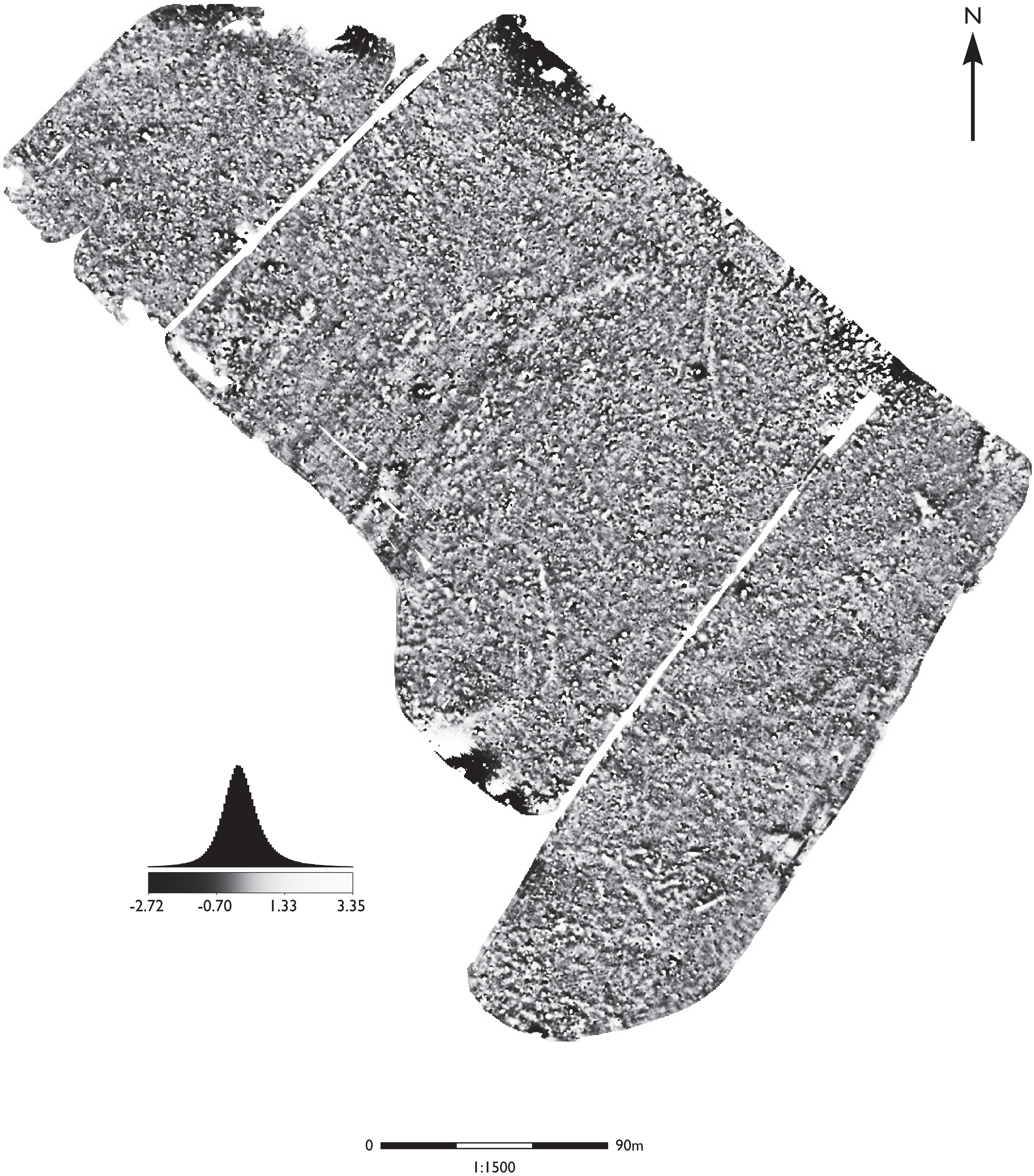

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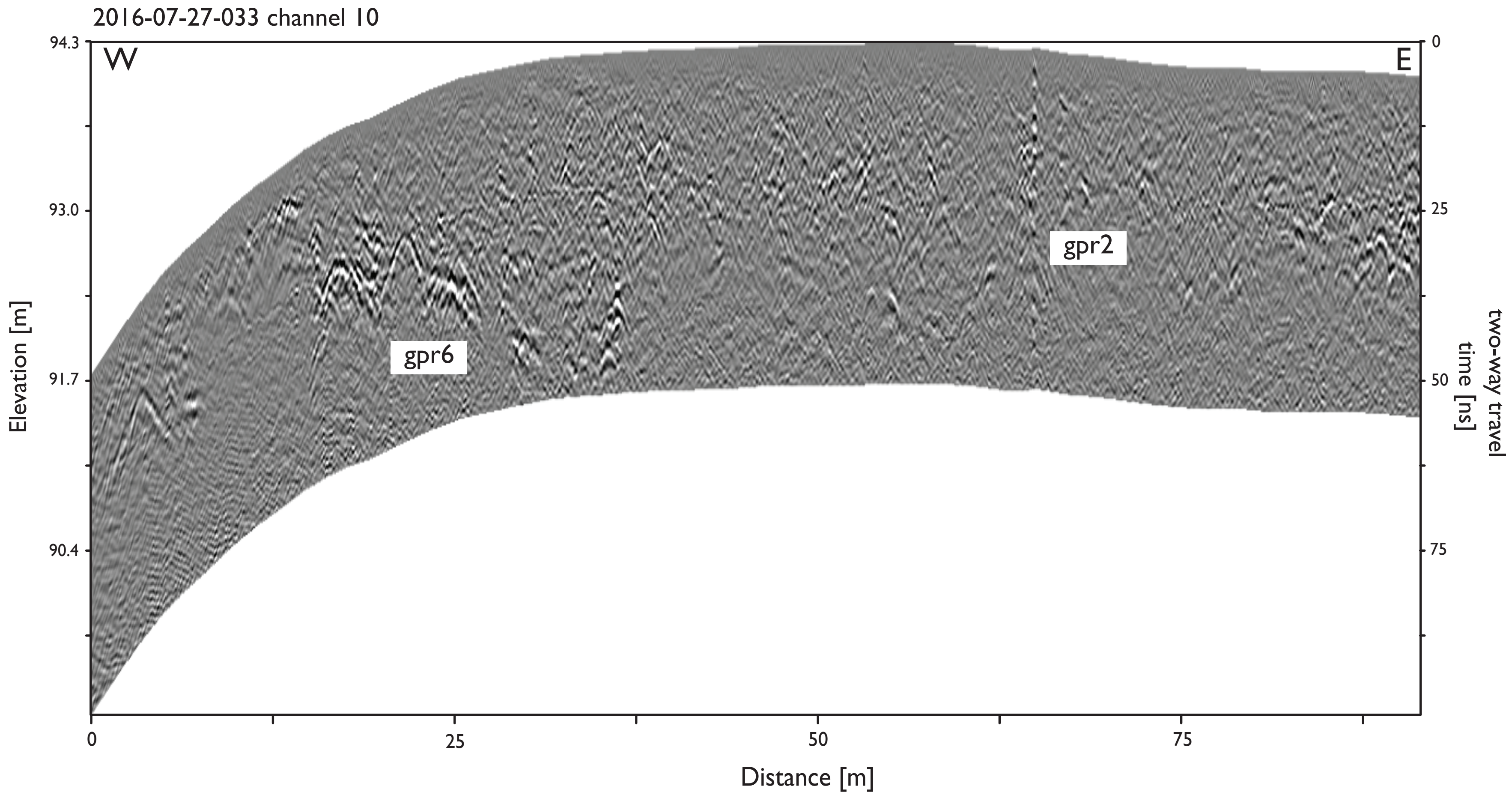
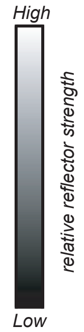
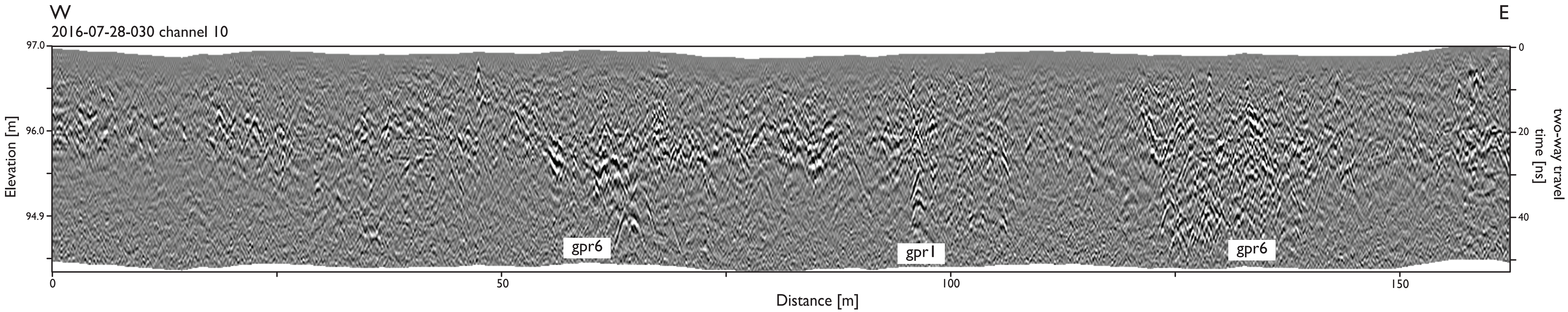
Figure 8

Topographically corrected GPR profiles, July 2016



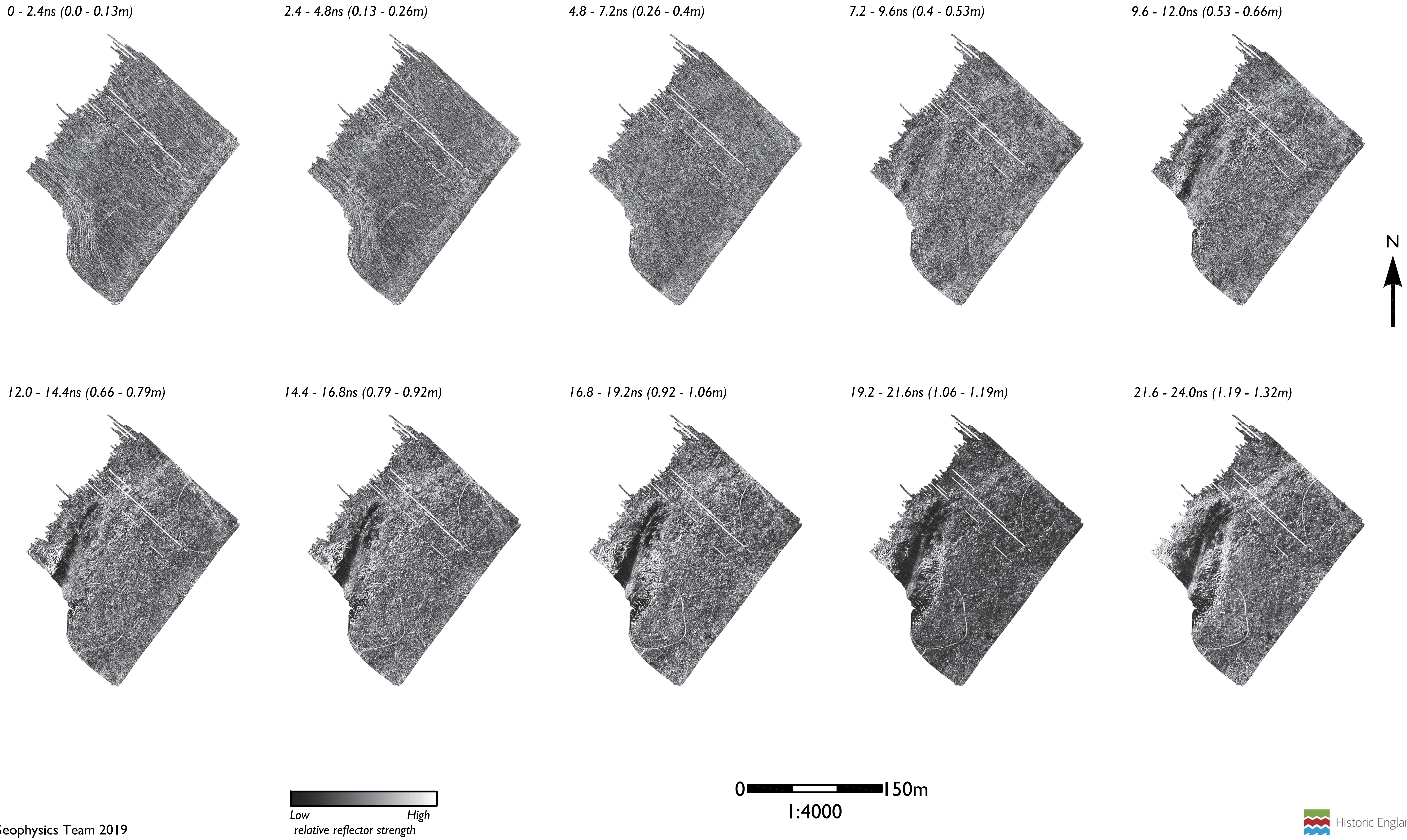




SILCHESTER ENVIRONS PROJECT, SIMMS'S COPSE, MORTIMER WEST END, HAMPSHIRE

Figure 9

GPR amplitude time slices between 0.0 and 24.0ns (0.0 - 1.32m), July 2016



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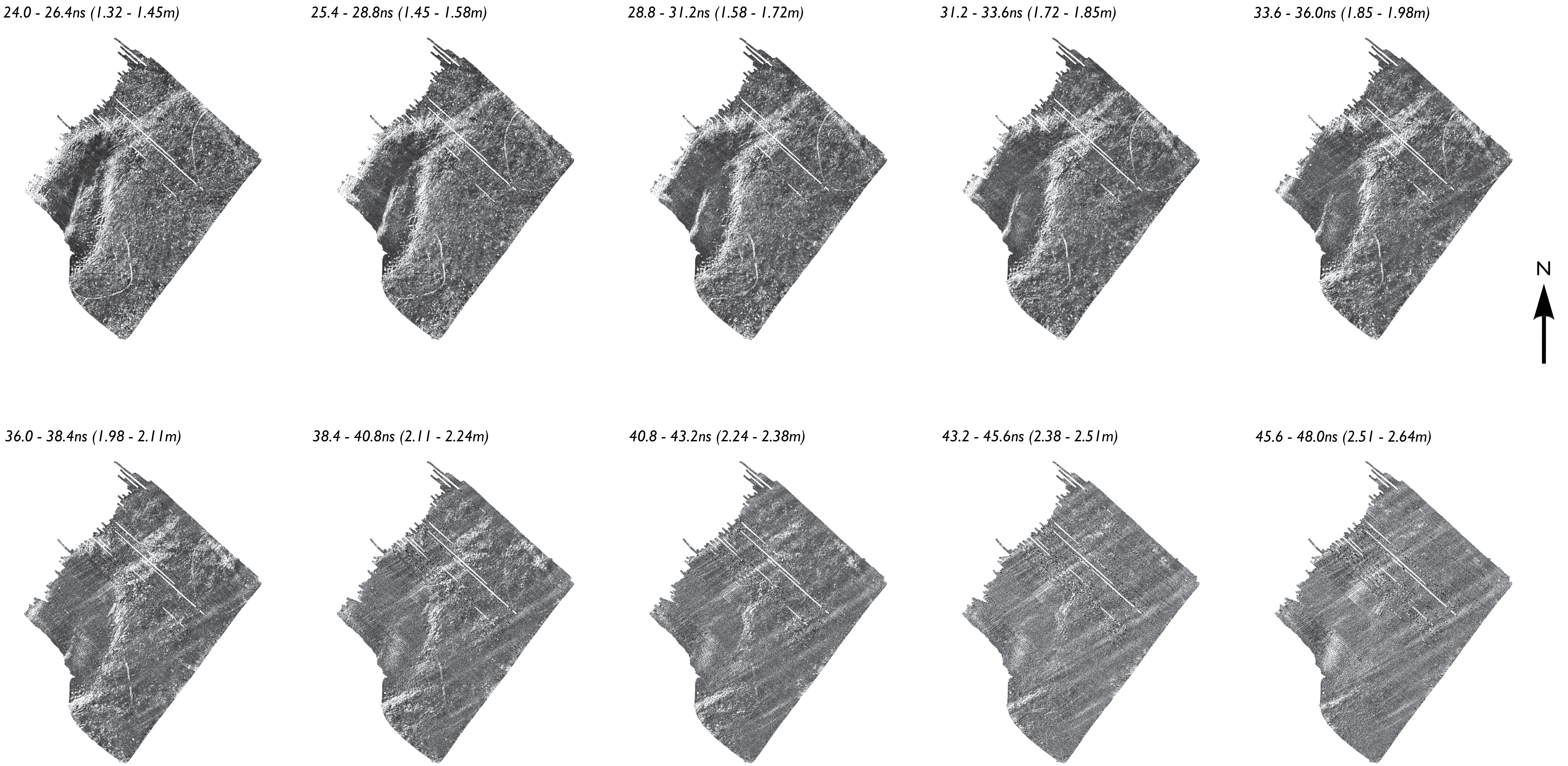
SILCHESTER ENVIRONS PROJECT, SIMMS'S COPSE, MORTIMER WEST END, HAMPSHIRE
GPR amplitude time slices between 24.0 and 48.0ns (1.32 - 2.64m), July 2016

Figure 10



Low High
relative reflector strength

0 150m
1:4000

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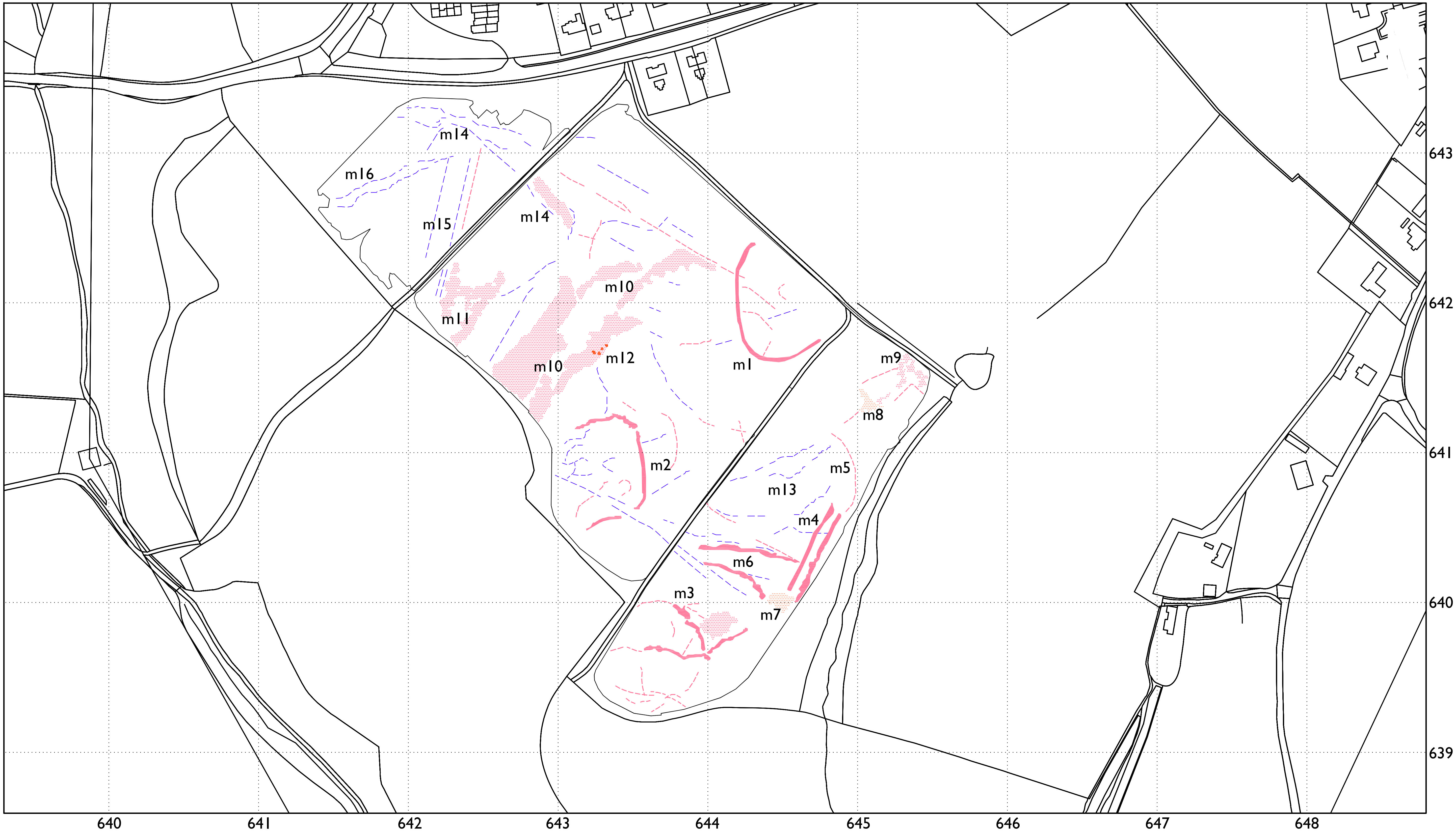
Figure 11

SILCHESTER ENVIRONS PROJECT, SIMMS'S COPSE, MORTIMER WEST END, HAMPSHIRE

Graphical summary of significant magnetic anomalies, July 2016

SU6463



0 90m
1:2500

positive magnetic
negative magnetic
raised magnetic
magnetic noise

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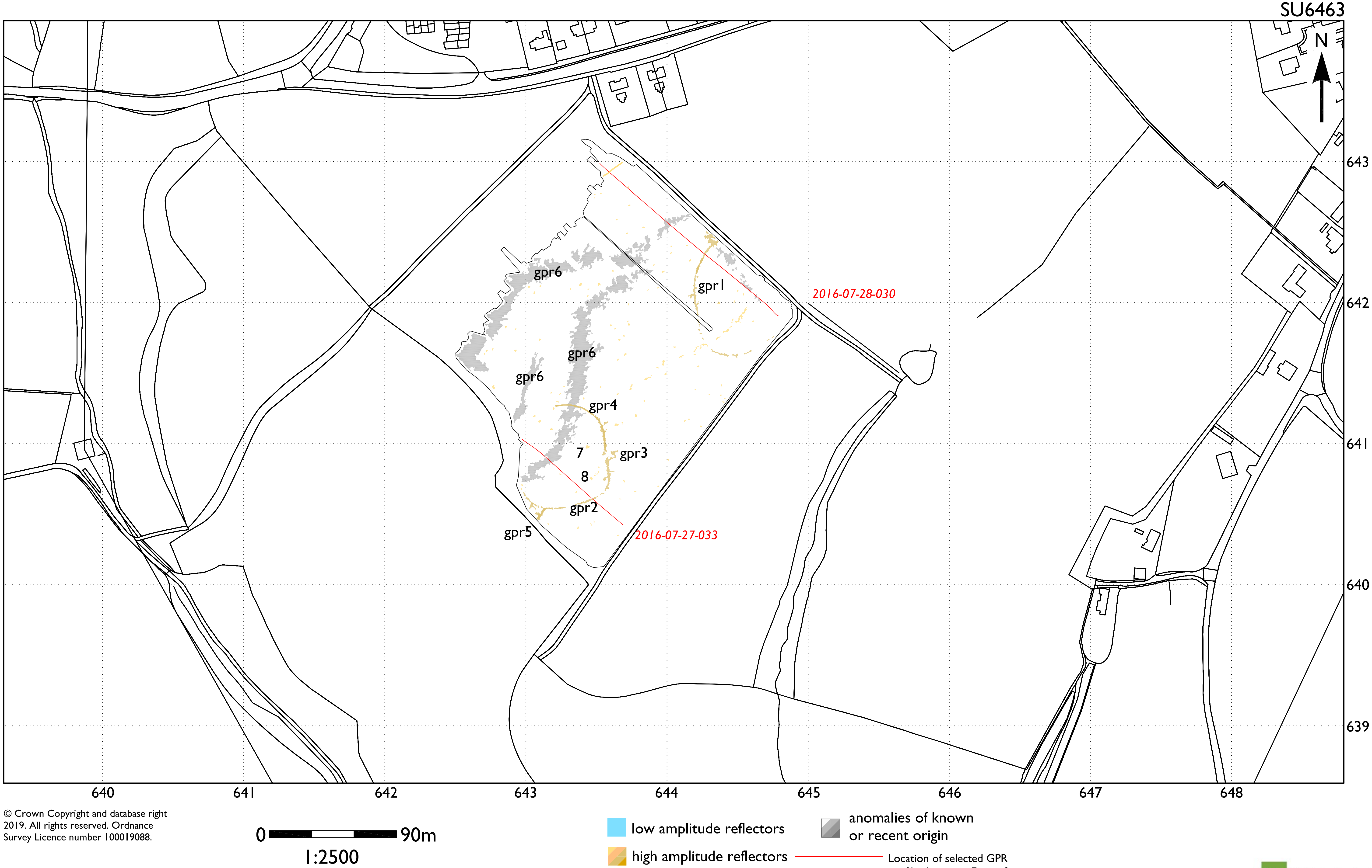
Figure 12

SILCHESTER ENVIRONS PROJECT, SIMMS'S COPSE, MORTIMER WEST END, HAMPSHIRE

Graphical summary of significant GPR anomalies, July 2016



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