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Audley End, Littlebury and Saffron Walden, Essex
Report on Geophysical Surveys, June and November 2019

Neil Linford, Paul Linford and Andrew Payne

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AUDLEY END, LITTLEBURY AND SAFFRON WALDEN ESSEX

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SUMMARY

Ground Penetrating Radar (GPR) and earth resistance surveys were conducted at Audley End House, Littlebury and Saffron Walden, Essex, following a request from the English Heritage Trust who manage the site. The aim of the geophysical survey was to identify any significant remains surviving in areas of the site where temporary infrastructure, such as car parking and marquees, is required to support visitor events, and to improve visitor information. The GPR survey (8.0ha) was conducted over the Cricket Pitch to the west of the Cam in front of the main house and over the East Park rising up to the Temple of Concord. A number of significant anomalies were revealed in both areas related to the more recent landscaping of the parkland and further evidence for the location of structural remains associated with the former monastery in the vicinity of Place Pond. The earth resistance coverage (0.5ha) targeted areas of the site where it was difficult to operate the GPR system, in the Walled Garden, East Garden of the main house and at the East Gate entrance to the estate. This revealed former garden planting schemes, fishponds and possible structural remains from the monastic phase of the site.

CONTRIBUTORS

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

ACKNOWLEDGEMENTS

The authors are grateful to all of the English Heritage Trust site staff at Audley End who welcomed us to the site and assisted with access and logistical arrangements to help facilitate the field work.

ARCHIVE LOCATION

Fort Cumberland, Portsmouth.

DATE OF SURVEY

The fieldwork in the park and gardens was conducted between 18th to 22nd November 2019, and over the Adam Bridge on 10th June 2019 with the report completed on 11th May 2020. The cover image shows a view of the East Park looking down towards Audley End House from the Temple of Concord.

CONTACT DETAILS

Paul Linford, Head of Geophysics Team, Historic England, Fort Cumberland, Fort Cumberland Road, Eastney, Portsmouth PO4 9LD.
Tel: 02392 856769.
Email: paul.linford@historicengland.org.uk

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INTRODUCTION

Following a request from the English Heritage Trust (EHT), Ground Penetrating Radar (GPR) and earth resistance surveys were conducted at Audley End House, Littlebury and Saffron Walden, Essex (NHLE List Entry Number 1002163). The surveys were conducted over areas of the gardens and parkland used for temporary infrastructure, such as marquees and car-parking, together with a structural survey of the Adam Bridge. The results will contribute to improved visitor information, inform future conservation and management of the site in response to the demands of the visitor events, and help avoid disturbance to sensitive areas. The work was conducted through the shared services agreement and addresses Historic England Action Plan objective 5.6 "Support English Heritage in its care of the National Heritage Collection".

Previous geophysical survey at the site (Alexander *et al.* 2011; Linford and Payne 2011) included earth resistance survey of the Elysian Garden in July 1994 (Figure 18, Area 2), extended in October 2009 to include the lawn between the west front of the house and the River Cam (Area 1), and an area to the north between the main visitor car park and the Elysian garden (Area 2). Further earth resistance survey was conducted in May 2010 over an area of possible Tudor buildings depicted on historical mapping around Place Pond (Area 3), together with GPR coverage over Area 1 (Figure 17).

The current survey extended the GPR coverage over the Cricket Pitch west of the Cam and the East Park (Figure 1, Areas 7 and 8), and included two profiles collected to assist with a study of the load bearing capacity of the Adam Bridge. Further earth resistance survey was conducted in three areas that were not easily accessible for GPR including the walled garden (Area 4), the East Garden (Area 5) immediately north east of the house and near the East Gate into the estate (Area 6).

Audley Park is situated on river terrace deposits bordering the chalkland valley of the River Cam. The solid geology consists of Cretaceous Lower Chalk and chalky drift over which well drained calcareous coarse and fine loamy soils of the Swaffham Prior Association have developed (Geological Survey of Great Britain (England and Wales) 1952; Soil Survey of England and Wales 1983). Alluvial deposits are present along the margins of the rivers and streams, including in the Cricket Ground area covered by GPR. The outlying elements of the designed landscape including the Temple of Concord are found on higher ground formed over deposits of Upper Chalk capped by chalky boulder clay. The November 2019 surveys were all undertaken over grassed lawn areas during mixed weather conditions initially cold and frosty at the start of the survey, becoming unsettled with periods of rainfall for the remainder of the field work. Survey over the deck of the Adam Bridge in June 2019 was conducted during dry, overcast conditions.

METHOD

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; Eide *et al.* 2018). 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 1. Data were acquired at a 0.075m x 0.075m sample interval across a continuous wave stepped frequency range from 40MHz to 2.99GHz in 4MHz increments using a dwell time of 3ms for the November 2019 survey and in 6MHz increments using a dwell time of 2ms for the survey over the Adam Bridge. 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 75ns), 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 synthetic profiles from the full GPR survey data set are shown on Figure 7. 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 0.106m/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 therefore represents the variation of reflection strength through successive ~0.1m intervals from the ground surface, shown as individual greyscale images in Figures 2, 3, 10 and 11. 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 Figures 12 and 13. The algorithm uses edge detection to identify bounded 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 (Linford and Linford 2017).

Earth resistance survey

A series of 30m grids were established with a Trimble R8s GNSS (Figure 1) and surveyed using a Geoscan RM85 resistance meter with an internal multiplexer and a PA5 electrode frame in the Twin-Electrode configuration. This arrangement allowed two separate surveys, with electrode separations of 0.5m and 1.0m, to be collected simultaneously. The 0.5m electrode separation coverage was designed to detect near-surface anomalies in the upper 0.5m of the subsurface whilst the 1.0m separation survey allowed anomalies to a depth of about 1-1.25m to be detected. For the 0.5m electrode separation survey readings were taken at a density of 0.5m x 1.0m whilst for the 1.0m separation survey they were taken at a density of 1.0m x 1.0m.

Extreme values caused by high contact resistance were suppressed from both datasets using an adaptive thresholding median filter with radius 1m (Scollar et al. 1990). The results for the near-surface 0.5m electrode separation survey are depicted as linear greyscale images in Figures 4, 5 and 6 superimposed on the OS mapping data. Figures 8 and 9 show the minimally processed data from both the 0.5m and 1.0m electrode separation datasets presented as trace plots and linear and equal area greyscale images, together with versions of the same data after the application of a high-pass filter. Further linear greyscale images created by overlaying the two electrode spacing datasets from Area 5, East Garden, are shown to accentuate near-surface (Figure 8(M)) and more deeply buried (Figure 9(M)) anomalies.

RESULTS

Ground Penetrating Radar survey

Graphical summaries of the significant GPR anomalies, [**gpr42-91**] discussed in the following text, superimposed on the base OS map data, are provided in Figures 12 and 13. The anomaly numbering sequence continues the scheme used to identify GPR anomalies in Linford and Payne (2011).

Area 7 Cricket Pitch (Figure 12)

Despite damp soil conditions close to the water level of the Cam a good response has been recorded over the site with significant reflections through an approximately 50ns two-way travel time window. Reflections beyond 50ns are more heavily attenuated, but still appear to show a response associated with the underlying geomorphology.

The near-surface response between 0.0 and 7.5ns (0.0 to 0.4m) shows anomalies due to the well maintained cricket square [**gpr42**], tree roots [**gpr43**] and, curiously, several fungus “fairy rings” [**gpr44**] that reverberate through the time window. The strong near-surface response to the “fairy rings” suggest the fungus alters the soil chemistry quite

markedly and has been noted on other sites surveyed during the autumn too, although it is unclear whether this is a seasonal effect (cf Linford and Payne 2019). A series of broadly parallel high amplitude anomalies [**gpr45**] between 10.0 and 20.0ns (0.53 to 1.06m) seem most likely to represent field drains falling towards the Cam. Two other linear anomalies also approach the river bank, but appear to represent a deeper ditch [**gpr46**] on a different alignment to the field drains, and a possible service run [**gpr47**] with a fall to the west away from the Cam in the vicinity of the WW2 pill box to the south of the survey area.

Plate 1 view of Area 7, the Cricket Pitch from the Adam Bridge towards the stable block with the WW2 pill box in the foreground.

The 19th century tree lined avenue appears as a pair of parallel linear anomalies [**gpr48**] separated by ~20m between 7.5 and 30.0ns (0.4 to 1.59m), which passes through a more amorphous area of high amplitude response. The location of the avenue was previously known from parch marks recorded in this area, although the linear anomalies forming [**gpr48**] demonstrate some gentle undulation perhaps indicative of the former planting scheme (Alexander *et al.* 2011, Figure 14). A short length of wall [**gpr49**] is found to the west and, apparently, extends to meet two discrete high amplitude anomalies [**gpr50**], possibly representing gate piers through a boundary on the centre line of the avenue. There is no continuation of [**gpr49**] north of the tentative gate piers [**gpr50**], although a group of, broad more diffuse linear anomalies [**gpr51-55**] between 7.5 and

30.0ns (0.4 to 1.59m) are found on a north-south alignment across the survey area. Anomalies [**gpr51-55**] could represent pathways, service runs or a combination of both, with an apparent confluence of more service type responses at [**gpr55**] presumably meeting utility supplies to the house known immediately south of the access road (Linford and Payne 2011, [gpr2] on Figure 14). There is also a possibility that [**gpr51-55**] are in part associated with the use of this area of the site for additional car parking during visitor events.

A low amplitude anomaly [**gpr56**] may be a data collection artefact as it closely follows one of the acquisition swaths, and perhaps appears prominent as it crosses an area of high amplitude, possibly geomorphological response [**gpr57**].

Area 8 East Park (Figure 13)

The ground rises to the east of the house, possibly resulting in marginally drier soils, and a good response is recorded throughout the time window. The very near-surface response between 0.0 and 7.5ns (0.0 to 0.4m) shows the influence of surface topography, such as vehicle ruts [**gpr58**] where these have crossed the lawn. Deeper slices, from approximately 30ns (1.86m) are dominated by a geological response, most likely due to scour marks [**gpr59**] in the underlying chalk. There are also a number of near-surface services, presumably associated with the main house [**gpr60**] or possibly earlier building phases [**gpr61**], and a system of field drains [**gpr62**] found on the lower ground to the north in the vicinity of Place Pond.

More significant anomalies include the medieval road [**gpr63**] crossing the East Park from north to south known from both Charles Bridgeman's 1725 map, aerial photography and analytical earthwork survey (Alexander *et al.* 2011, Figure 14). Anomaly [**gpr63**] is visible from between approximately 12.5 and 35.0ns (0.66 to 1.86m) and appears as a broad, low amplitude response to the south, apparently cut into the underlying geology [**gpr59**], continuing as a more narrow, high amplitude reflector to the north where, perhaps, the lower lying ground required a metalled road surface.

A similar variation is seen in the aerial photography and, as with the GPR response, there is a slight change in orientation where [**gpr63**] intersects with the 17th century avenue [**gpr64**] approaching down the hill to the house from the east. Immediately to the west of [**gpr63**] the 17th century avenue appears to diverge with a branch heading south towards the main house and a distinctive section curving around to the north. The curving section of [**gpr64**] correlates with a graphical representation of Thomas Audley's Tudor house, which incorporated the preceding abbey buildings and layout, known from an 18th century copy of the original map that appears to date from about 1600 (NMR catalogue number AL0515/009/01/PA), and passes through a more fragmented, rectilinear area of high amplitude response [**gpr65**] with some evidence for building remains at [**gpr66**] and [**gpr67**]. A large low amplitude anomaly [**gpr68**], approximately 40 m x 10 m, possibly represents a robbed out wing of a building and

may be associated with some further structural responses [**gpr69**] and [**gpr70**] found on the course of the road. Together these anomalies appear to support the historic mapping evidence showing a cluster of medieval buildings associated with the abbey and correlate well with the previous earth resistance survey (cf Figures 18 and 19).

Other wall-type anomalies [**gpr71**] closer to the house match the orientation of the gardens to the west of the ha-ha and, perhaps, represent an extension of this formal design. Further to the south a pair of parallel anomalies [**gpr72**] suggests a continuation of the 19th century avenue with the possibility of some structural remains at [**gpr73**] where the avenue meets [**gpr63**]. Other ditch-type anomalies [**gpr74**] are difficult to fully interpret, but may be a further extension of the formal garden design.

Beyond the continuation of [**gpr64**] rising up the hill away from the house there is little further activity to the east of the medieval road [**gpr63**]. For example, the later avenue [**gpr72**] does not appear to extend beyond the road way, but there is evidence for a group of anomalies [**gpr75**] in the vicinity of the Temple of Concord, possible planting pits [**gpr76**], and two water pipes [**gpr77**]. Some curious linear striations are enclosed by a ditch-type anomaly at [**gpr78**] between 12.5 and 17.5ns (0.66 to 0.93m) and whilst this is an area where the geology [**gpr59**] becomes more prominent with depth, the near-surface response seems likely to represent recent landscaping or, perhaps, temporary infrastructure.

To the north of the survey, in the vicinity of Place Pond, there are some possible structural remains [**gpr79**] and [**gpr80**], although these are partially obscured by the network of field drains [**gpr62**] and a service run [**gpr81**] that follows a vehicle route visible in the near-surface data.

Adam Bridge

Figures 20 and 21show results from the survey over the deck of the recently resurfaced Adam Bridge presented as topographically corrected profiles, amplitude time slices and in relation to a structural drawing of the bridge elevation. Due to the complex velocity field within the bridge structure (average estimated velocity 0.149m/ns) an exact match between the GPR profiles through the centre of the carriageway and structural drawing of the external architectural details would not, necessarily, be expected, although it should be possible to determine the approximate depth to the anomalies from the bridge deck.

Two high amplitude reverberating anomalies [**gpr82**] and [**gpr83**] show the location of inspection covers to either side of the bridge and, assuming an air-filled chamber, indicate a depth of approximately 3m. Anomalies due to the arch-air interface are found at [**gpr84-6**], although these are more difficult to distinguish over the central [**gpr85**] and eastern [**gpr86**] arches, possibly due to more rapid signal attenuation. The only air-water reflection is found at [**gpr87**], again suggesting better signal penetration through

the west arch. Areas of high amplitude reflectors are found at [**gpr88**] and [**gpr89**], possibly, indicative of some voiding of the rubble packing within the bridge structure, and linear anomalies at [**gpr90**] and [**gpr91**] show compacted sub-layers beneath the bridge deck. There is also a diffuse linear anomaly [**gpr92**] across the approximate apex of the bridge from between 0.0 and 16.2ns (0.0 to 1.21m) although it is difficult to determine whether this is associated with the construction of the bridge or to the recent resurfacing works. Whilst the anomalous areas indicate varying structural properties within the bridge without some further invasive investigation it is difficult to suggest whether these may potentially compromise the load bearing capacity of the bridge.

Plate 2 view of the Adam Bridge from the east bank of the Cam looking west.

Earth Resistance survey

Graphical summaries of the significant earth resistance anomalies, [**r66-107**] discussed in the following text, superimposed on the base OS map data, are provided in Figures 14, 15 and 16. The anomaly numbering sequence continues the scheme used to identify resistance anomalies in Linford and Payne (2011).

Area 4 Walled Garden (Figure 14)

A weak linear anomaly [**r66**], approximately 3m wide, crosses the Walled Garden on a north-south alignment and may represent the partition of the lawn by either a former pathway or remains of a wall foundation. To the north a short high resistance extension [**r67**] could either be a former pathway to the east, a wall or, perhaps, a buttress to the garden wall. An area of less well defined high resistance at [**r68**] is possibly associated with the semi-circular modern extension of the garden layout and seating area to the north, and two broad areas of lower resistance [**r69**] and [**r70**], to either aide of [**r66**], may indicate former planting beds containing more water retentive soil or, possibly, be associated with the underlying floodplain geology. Within the broader area of lower resistance [**r69**] to the western side of the lawn, a more localised raised response [**r71**] corresponds to the position of an extant mulberry tree planting site.

Further evidence for former tree planting or a plinth for a garden ornament, perhaps, may be associated with the high resistance anomaly [**r72**]. More variable background resistance is found across the lawn with increases in resistance at [**r73**] and [**r74**], possibly related to gravel spreading from the adjacent pathways and becoming mixed with the soil. An area of better drained or gravelly soils may occur in the eastern half of the lawn where the background resistance is generally higher [**r75**], although natural variation in the floodplain soils may again account for these differences in broader background resistance.

Very faint narrow linear anomalies [**r76**] and [**r77**] might tentatively be interpreted as service trenches or drains and a possible association between [**r76**] and [**r70**] may, perhaps, indicate a former pond or water feature. A very weakly resolved high resistance anomaly [**r78**] may also connect to [**r70**], however the indistinct response from [**r76-8**] limits more confident interpretation.

Area 5 East Garden (Figure 15)

The survey is located in an area of modern planting and paths to the north east of Audley End House, immediately beyond the reconstructed formal parterre garden, where the possibility of earlier medieval monastic and post-dissolution Tudor remains seems likely from depictions shown on historic mapping.

In the near surface, high resistance responses [**r79-81**] correspond with a triad of small trees and the wood-bark mulch around their bases to the north west of the survey area. Immediately to the south, localised low resistance anomalies [**r82-84**] associated with extant planting beds close to the reconstructed Victorian period parterre garden have been detected. A broader area of lower response [**r85**] to the north relates to a further modern garden planting, mostly occupied by large evergreen shrubs.

A more significant broad rectilinear alignment of higher resistance anomalies [**r86-91**] on an east west alignment is visible under more recent responses to tree planting [**r80**]. Anomalies [**r86-91**] correspond with the apparent dimensions of an in-filled basin of a large rectangular pond shown on Bridgeman's 1725 map (Alexander *et al.* 2011, Figure 13). This pond is probably of monastic origin, subsequently incorporated into post-dissolution garden schemes contemporary with the early 17th century development of Audley End House and appears to have been removed during the late 18th century remodelling of the Parkland and gardens.

Further high resistance linear anomalies [**r92**] and [**r93**] may indicate traces of buried wall or path alignments, possibly related to the earlier monastic phase or an earlier garden layout, although [**r92**] may be associated with a screen of modern tree planting.

High resistance anomalies [**r94-6**] probably represent buried walls or paths, aligned on the orientation of the house. Although only partially described in the survey area [**r96**] might, possibly, represent the north transept of the monastic church (B Kerr *pers comm*; Bassett 1982, Fig. 54). A narrow, east west aligned, weak linear low resistance anomaly [**r97**] may relate to a service trench, most likely a buried water pipe. Immediately to the east of [**r97**] a large rectilinear very high resistance anomaly [**r98**] extends beyond the survey coverage and seems most likely to represent a deposit of buried rubble, potentially associated with demolished earlier building remains.

A roughly rectangular low resistance anomaly [**r99**] is partially obscured by the modern access path along the front of the house, but may represent an earlier in-filled pond, planting bed possibly related to an earlier garden layout or, perhaps, robbed out building remains associated with earlier medieval activity.

Area 6 East Gate (Figure 16)

An area of hard standing [**r100**] immediately inside the East Gate entrance, where goods vehicles enter the site to support visitor events, could not be surveyed with this technique, and the response immediately adjacent to [**r100**] is characterised by low resistance readings [**r101**], possibly due to the erosion of vegetation or pooling of surface water. This trend is continued as a low resistance anomaly [**r102**] along the likely vehicle route heading north-west from the gate. A lower resistance area [**r103**] to the north of the vehicle access routes may again relate to removal or compaction of surface vegetation.

A further linear low resistance anomaly [**r104**], on an approximately north-south alignment through the middle of the survey area, probably also relates to a route-way, perhaps a former foot-path, although it could also indicate an earlier field boundary. A fainter orthogonal anomaly [**r105**] heading west possibly indicates the line of a former path towards the house or, perhaps, another earlier boundary. Generally higher regions of background resistance, [**r106**] and [**r107**], may represent areas that have been less

disturbed by the impact of vehicle traffic, although **[r106]** might indicate a former earthwork bank marking the eastern boundary of the estate.

Towards the south a much higher increase in resistance [**r108**] relates to a broad raised embankment following the southern boundary of the estate adjacent to the area of woodland where the Ice House is located. This boundary bank may have been created from up-cast material from the woodland which appears to have been subject to quarrying activity, perhaps partly associated with the construction of the Ice House or landscaping of the parkland.

CONCLUSIONS

Both the ground penetrating radar and earth resistance surveys successfully identified significant anomalies throughout the areas covered. The new surveys have enhanced the interpretation of the site known from historic mapping, aerial photography and analytical earth work investigations, particularly with respect to the monastic complex depicted on 17th century estate maps to the east of the main house. The remains of a building range are suggested here by the GPR data set within a wider rectilinear courtyard area and a distinctive curving roadway that correlates directly with the historic depictions and the partial coverage in earlier earth resistance surveys. Later elements of the designed landscape, including a central tree-lined avenue also shown on the aerial photography, approach the house from the east and continue west beyond the river Cam over the Cricket Pitch (Figure 17). Here, the GPR data also suggests a previous course of a pathway and, possibly, an enclosure wall with gate piers at the intersection with the central avenue.

The earth resistance survey was at more confined areas within the site that proved difficult to access with the towed GPR system, but extended previous, far wider, coverage with this technique (Figure 18). Again, this new data has helped confirm the location of fishponds shown on the historic mapping immediately north of the house, and identified possible structural remains associated with the earlier monastic phase of the site.

The GPR survey over the Adam Bridge identified variations likely to relate to its structure and internal composition. However, detailed comparison with any other sources of information available, for example historic plans or some form of invasive investigation would be required to further the interpretation.

When considering the siting of temporary structures for events, the potential for significant subsurface remains is summarised in Figure 19. Areas of highest sensitivity appear to be: the west lawn in front of the house (Area 1) extending into the parts of the Elysian Garden nearest the carpark (south eastern part of Area 2); The East Garden (Area 5); and the area extending south from Place Pond (Area 3 and western half of Area 8). These areas offer the potential for structural remains related to earlier phases in

the history of the site. The Cricket Pitch (Area 7) and the western part of the Elysian Garden (Area 2) appear to be of moderate sensitivity with archaeological remains present at lower density and appearing more likely to be associated with former gardens, roadways and boundaries. Of the areas surveyed, those of lowest sensitivity appear to be the Walled Garden (Area 4), inside the East Gate (Area 6) and the east part of Area 8 as it approaches the Temple of Concord. In these places potential archaeological anomalies are sparse and less amenable to conclusive interpretation.

LIST OF ENCLOSED FIGURES

from Area 5 have been combined (M) to accentuate deeper lying anomalies (1:1000).

Figure 10 GPR amplitude time slices, Area 7, Cricket Pitch, 0.0 and 52.5ns (0.0 to 2.78m) (1:3000).

Figure 11 GPR amplitude time slices, Area 8, East Park, 0.0 and 52.5ns (0.0 to 2.78m) (1:3000).

Figure 12 Graphical summary of significant GPR anomalies from Area 7, Cricket Pitch, superimposed over the base OS mapping (1:1500).

Figure 13 Graphical summary of significant GPR anomalies from Area 8, East Park, superimposed over the base OS mapping (1:1500).

Figure 14 Graphical summary of significant earth resistance anomalies from Area 4, Walled Garden, superimposed over the base OS mapping (1:750).

Figure 15 Graphical summary of significant earth resistance anomalies from Area 5, East Garden, superimposed over the base OS mapping (1:750).

Figure 16 Graphical summary of significant earth resistance anomalies from Area 6, East Gate, superimposed over the base OS mapping (1:750).

Figure 17 Greyscale image of the GPR amplitude time slice between 15.0 and 17.5ns (0.88-1.02m), May 2010 and November 2019 (1:2500).

Figure 18 Equal area greyscale images of the earth resistance surveys, 1994, 2009, 2010 November 2019 (1:2500).

Figure 19 Combined graphical summary of most significant geophysical anomalies 1994, 2009, 2010 and 2019 superimposed over the base OS mapping (1:3000).

Figure 20 Topographically corrected profiles from the GPR survey over the Adam Bridge shown as greyscale images with annotation denoting significant anomalies. The locations of the selected profiles can be found on Figure 21.

Figure 21 Greyscale image of the GPR amplitude time slice from the Adam Bridge, between 6.5 and 9.7ns (0.48 - 0.72m) superimposed over the base OS mapping data (1:150). The location of the profiles shown on Figure 20 is also indicated, together with an inset profile superimposed over the architectural details of the bridge (not to scale).

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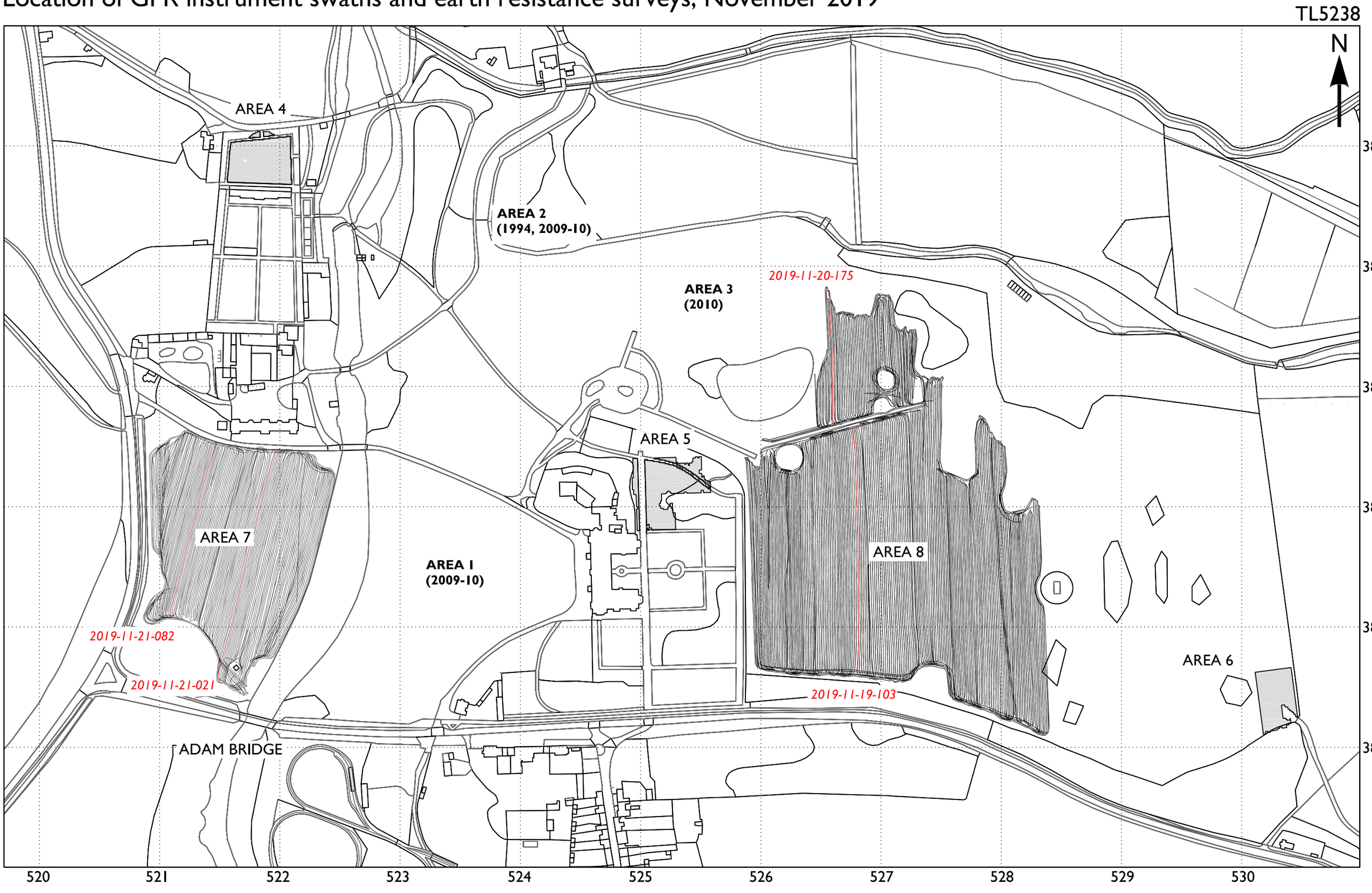
Figure 1

AUDLEY END, LITTLEBURY AND SAFFRON WALDEN, ESSEX

Location of GPR instrument swaths and earth resistance surveys, November 2019



0 300m

1:3000

2019-11-21-021 Location of selected GPR profiles shown on Figure 7

Ground Penetrating Radar survey swaths

Earth resistance survey

Historic England

Geophysics Team 2020

Figure 2

AUDLEY END, LITTLEBURY AND SAFFRON WALDEN, ESSEX

GPR amplitude time slice between 15.0 and 17.5ns (0.88 - 1.02m), Area 7, Cricket Pitch, November 2019

0 90m

1:1500

2019-11-21-021 Location of selected GPR profiles shown on Figure 7

Low *High*
relative reflector strength

Geophysics Team 2020

Historic England

AUDLEY END, LITTLEBURY AND SAFFRON WALDEN, ESSEX

Figure 3

GPR amplitude time slice between 15.0 and 17.5ns (0.88 - 1.02m), Area 8, East Park, November 2019

0 90m

1:1500

2019-11-19-103 Location of selected GPR profiles shown on Figure 7

Geophysics Team 2020

Historic England

Figure 4

AUDLEY END, LITTLEBURY AND SAFFRON WALDEN, ESSEX

Location of earth resistance survey, Area 4, Walled Garden, November 2019

0 60m

1:750

Geophysics Team 2020

Historic England

Figure 5

AUDLEY END, LITTLEBURY AND SAFFRON WALDEN, ESSEX

Location of earth resistance survey, Area 5, East Garden, November 2019

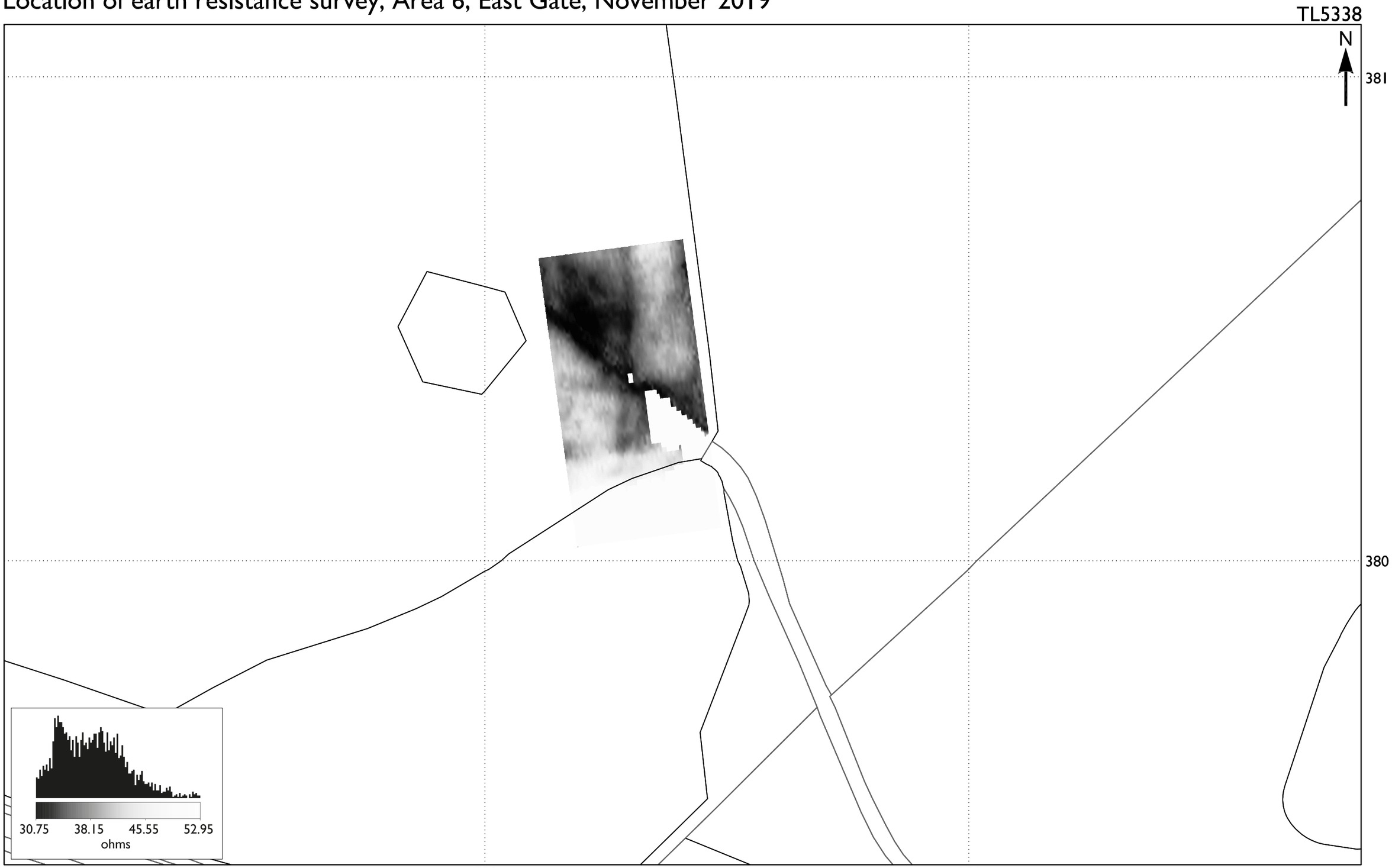
Geophysics Team 2020

Historic England

Figure 6

AUDLEY END, LITTLEBURY AND SAFFRON WALDEN, ESSEX

Location of earth resistance survey, Area 6, East Gate, November 2019



0 60m

1:750

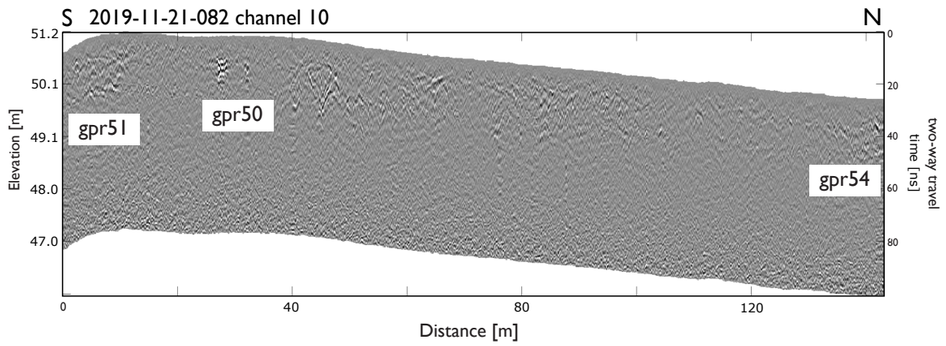
Geophysics Team 2020

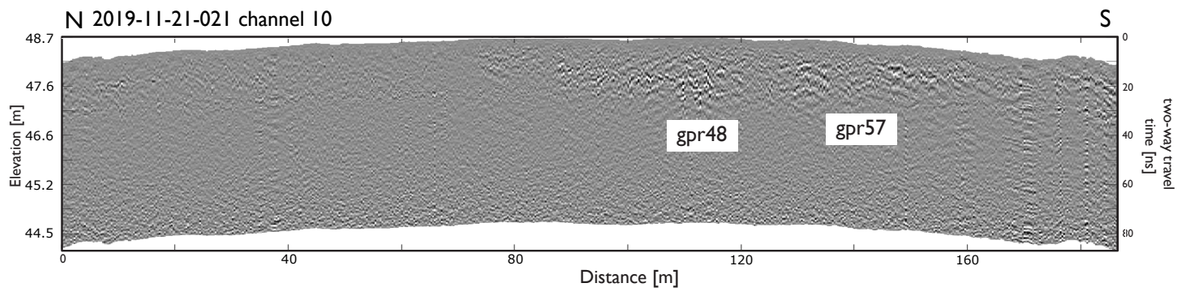
Historic England

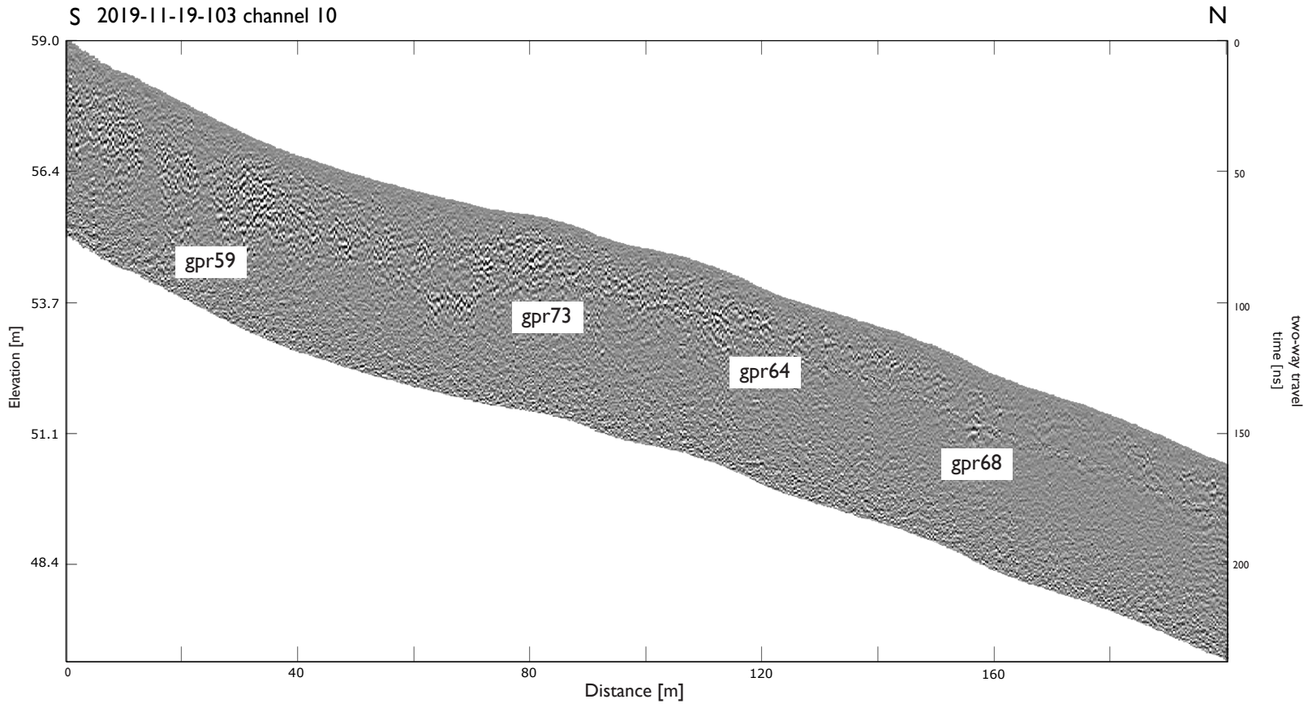
AUDLEY END, LITTLEBURY AND SAFFRON WALDEN, ESSEX

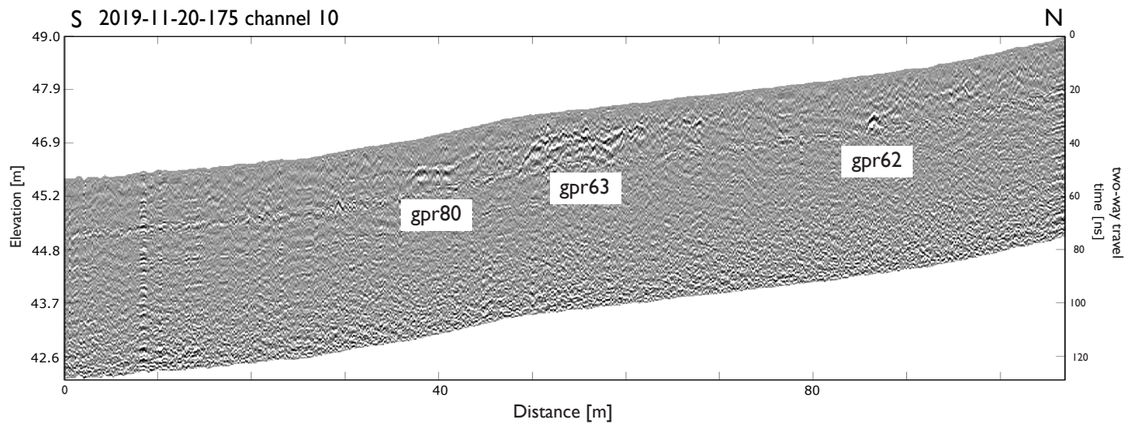
Topographically corrected GPR profiles, November 2019

Figure 7









Geophysics Team 2020

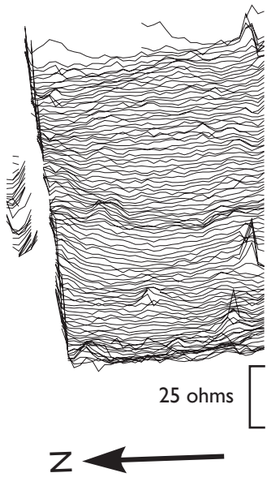
Historic England

Figure 8

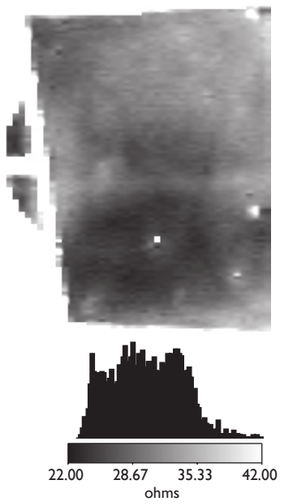
AUDLEY END, LITTLEBURY AND SAFFRON WALDEN, ESSEX
Earth resistance surveys, 0.5m mobile probe separation data, November 2019

Area 4, Walled Garden

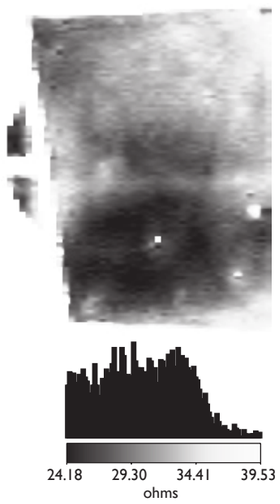
(A) Trace plot of minimally processed data



(B) Linear greyscale of minimally processed data



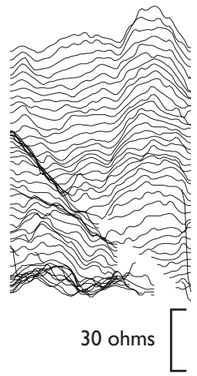
(C) Equal area greyscale of minimally processed data



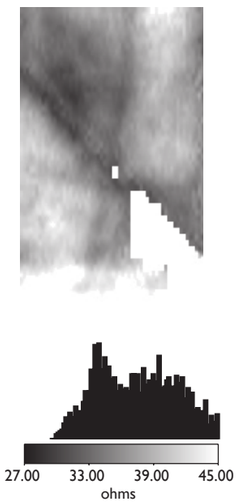
(D) Linear greyscale of high-pass filtered data

Area 6, East Gate

(I) Trace plot of minimally processed data



(J) Linear greyscale of minimally processed data

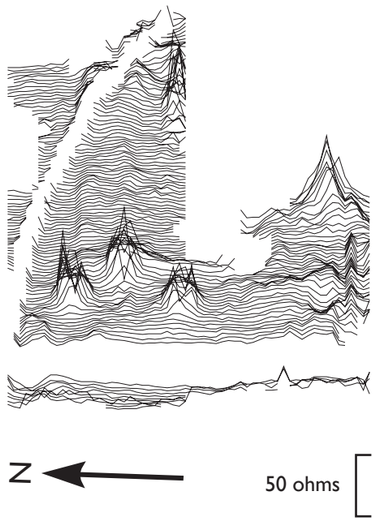


(K) Equal area greyscale of minimally processed data

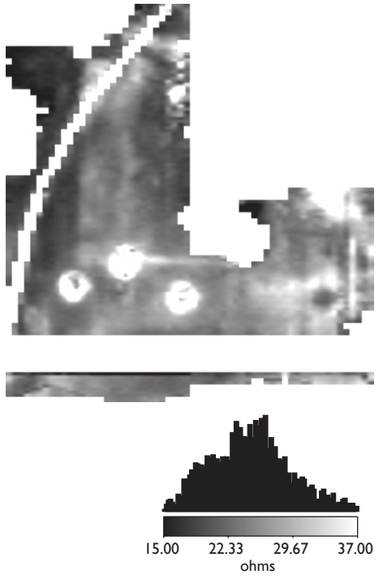
(L) Linear greyscale of high-pass filtered data

Area 5, East Garden

(E) Trace plot of minimally processed data



(F) Linear greyscale of minimally processed data



(G) Equal area greyscale of minimally processed data

(H) Linear greyscale of high-pass filtered data

Overlay data for Area 5

(M) Linear greyscale with near-surface anomalies accentuated

0 90m

1:1000

Geophysics Team 2020

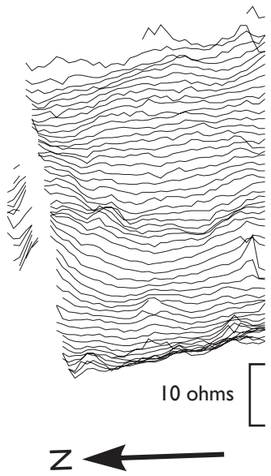
Historic England

Figure 9

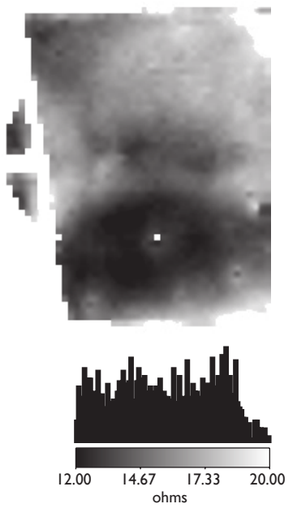
AUDLEY END, LITTLEBURY AND SAFFRON WALDEN, ESSEX
Earth resistance surveys, 1.0m mobile probe separation data, November 2019

Area 4, Walled Garden

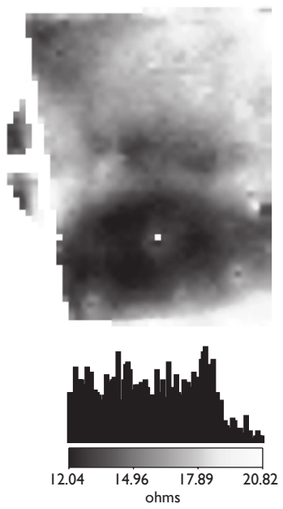
(A) Trace plot of minimally processed data



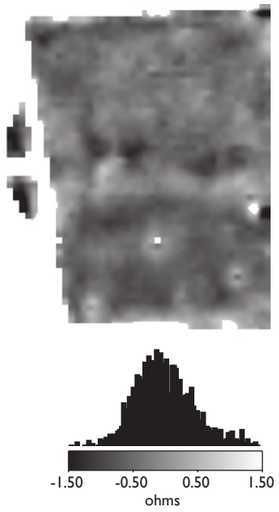
(B) Linear greyscale of minimally processed data



(C) Equal area greyscale of minimally processed data

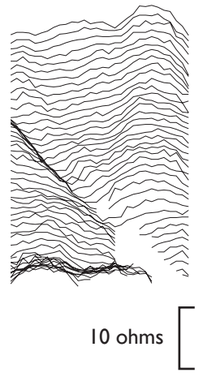


(D) Linear greyscale of high-pass filtered data



Area 6, East Gate

(I) Trace plot of minimally processed data



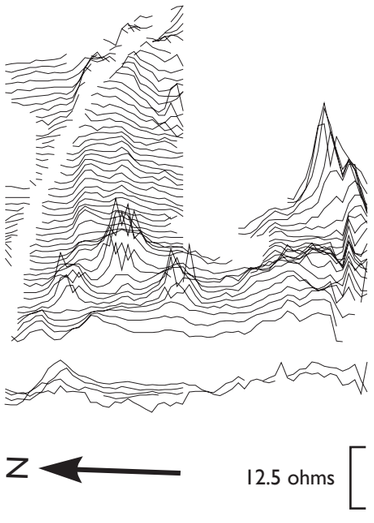
(J) Linear greyscale of minimally processed data

(K) Equal area greyscale of minimally processed data

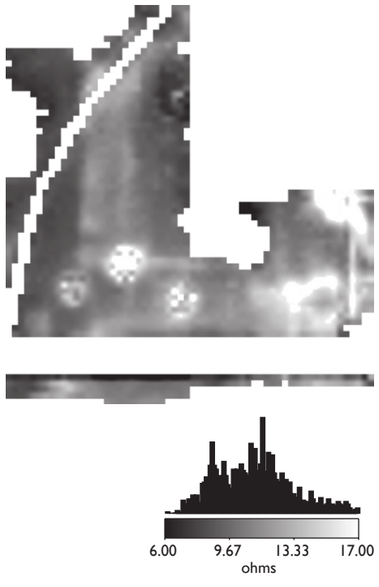
(D) Linear greyscale of high-pass filtered data

Area 5, East Garden

(E) Trace plot of minimally processed data



(F) Linear greyscale of minimally processed data

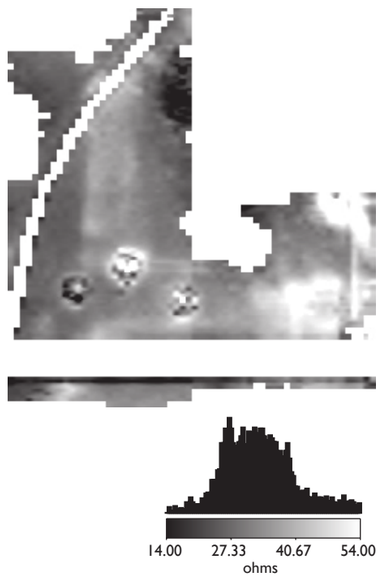


(G) Equal area greyscale of minimally processed data

(H) Linear greyscale of high-pass filtered data

Overlay data for Area 5

(M) Linear greyscale with deeper anomalies accentuated



0 90m

1:1000

Geophysics Team 2020

Historic England

AUDLEY END, LITTLEBURY AND SAFFRON WALDEN, ESSEX

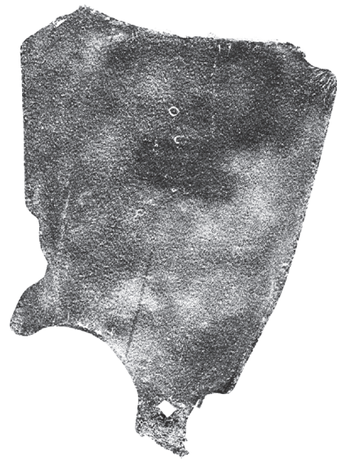
Figure 10

GPR amplitude time slices between 0.0 and 52.5ns (0.0 to 2.78m), Area 7, Cricket Pitch, November 2019

0.0 - 2.5ns (0.0 - 0.13m)

2.5 - 5.0ns (0.13 - 0.27m)

5.0 - 7.5ns (0.27 - 0.4m)

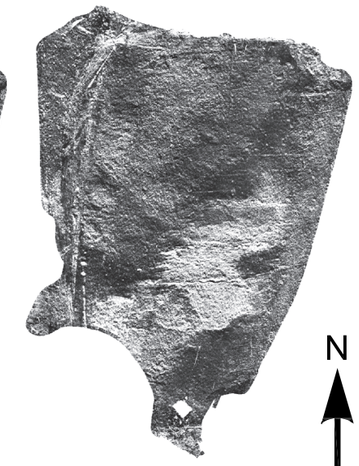


7.5 - 10.0ns (0.4 - 0.53m)

10.0 - 12.5ns (0.53 - 0.66m)

12.5 - 15.0ns (0.66 - 0.8m)

15.0 - 17.5ns (0.8 - 0.93m)



N

17.5 - 20.0ns (0.93 - 1.06m)

20.0 - 22.5ns (1.06 - 1.19m)

22.5 - 25.0ns (1.19 - 1.33m)

25.0 - 27.5ns (1.33 - 1.46m)

27.5 - 30.0ns (1.46 - 1.59m)

30.0 - 32.5ns (1.59 - 1.72m)

32.5 - 35.0ns (1.72 - 1.86m)

35.0 - 37.5ns (1.86 - 1.99m)

37.5 - 40.0ns (1.99 - 2.12m)

40.0 - 42.5ns (2.12 - 2.25m)

42.5 - 45.0ns (2.25 - 2.39m)

45.0 - 47.5ns (2.39 - 2.52m)

47.5 - 50.0ns (2.52 - 2.65m)

50.0 - 52.5ns (2.65 - 2.78m)

Low — *High*

relative reflector strength

0 — 150m

1:3000

Geophysics Team 2020

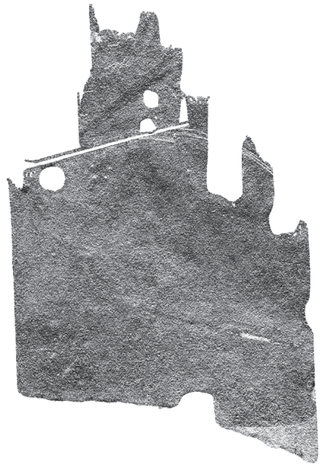
Historic England

AUDLEY END, LITTLEBURY AND SAFFRON WALDEN, ESSEX

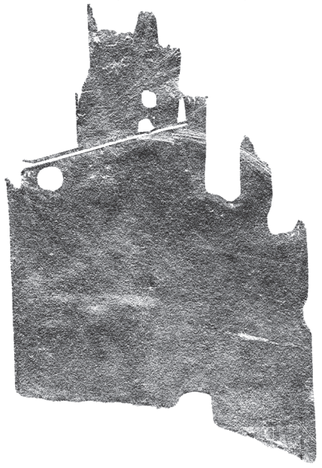
Figure 11

GPR amplitude time slices between 0.0 and 52.5ns (0.0 to 2.78m), Area 8, East Park, November 2019

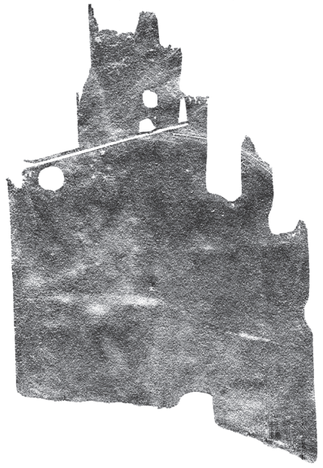
0.0 - 2.5ns (0.0 - 0.13m)



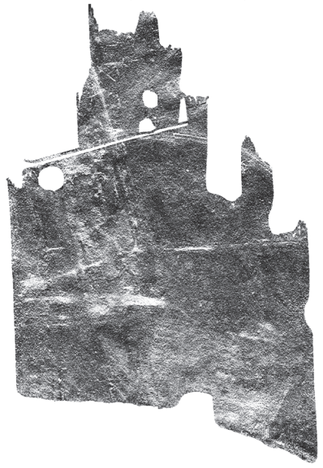
2.5 - 5.0ns (0.13 - 0.27m)



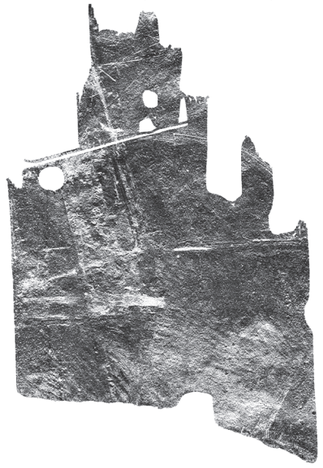
5.0 - 7.5ns (0.27 - 0.4m)



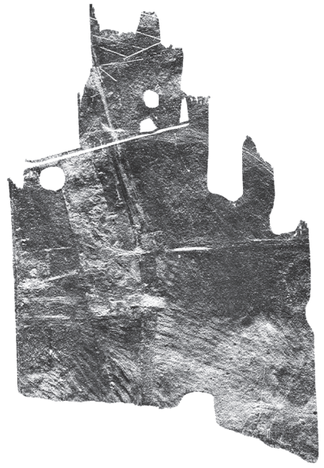
7.5 - 10.0ns (0.4 - 0.53m)



10.0 - 12.5ns (0.53 - 0.66m)



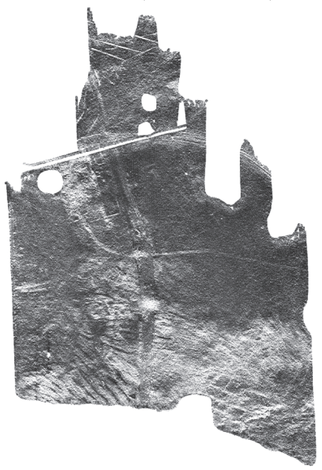
12.5 - 15.0ns (0.66 - 0.8m)



15.0 - 17.5ns (0.8 - 0.93m)

17.5 - 20.0ns (0.93 - 1.06m)

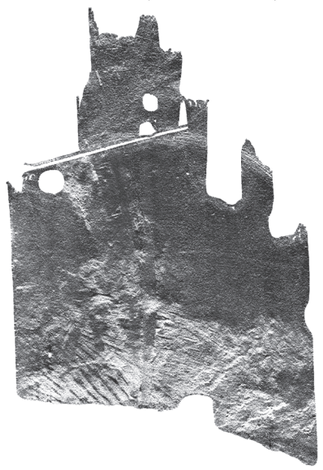
20.0 - 22.5ns (1.06 - 1.19m)



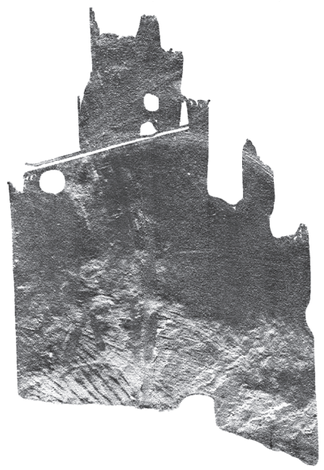
22.5 - 25.0ns (1.19 - 1.33m)

25.0 - 27.5ns (1.33 - 1.46m)

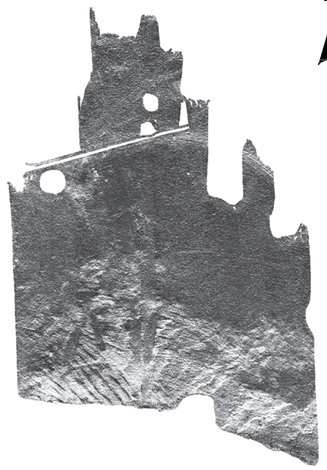
27.5 - 30.0ns (1.46 - 1.59m)



30.0 - 32.5ns (1.59 - 1.72m)

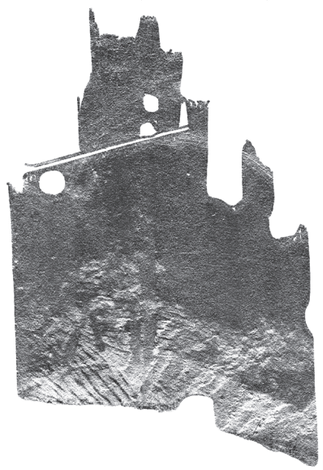


32.5 - 35.0ns (1.72 - 1.86m)

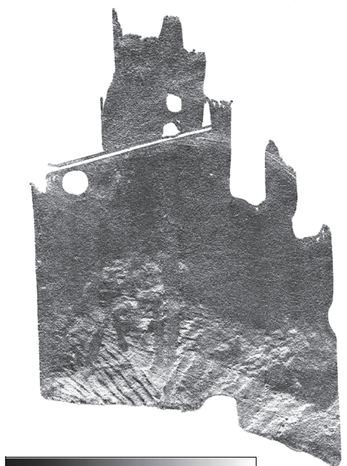


N

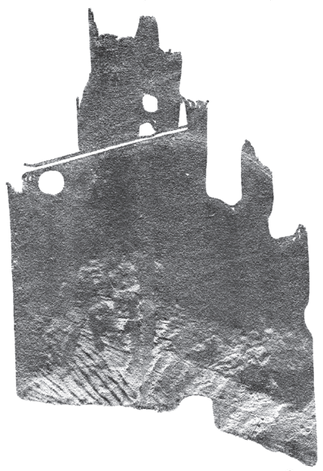
35.0 - 37.5ns (1.86 - 1.99m)



37.5 - 40.0ns (1.99 - 2.12m)



40.0 - 42.5ns (2.12 - 2.25m)

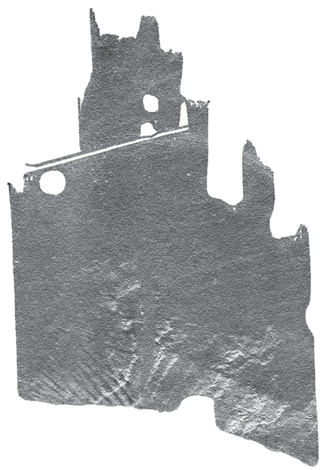


42.5 - 45.0ns (2.25 - 2.39m)

45.0 - 47.5ns (2.39 - 2.52m)

47.5 - 50.0ns (2.52 - 2.65m)

50.0 - 52.5ns (2.65 - 2.78m)



Low *High*

relative reflector strength

0 300m

1:5000

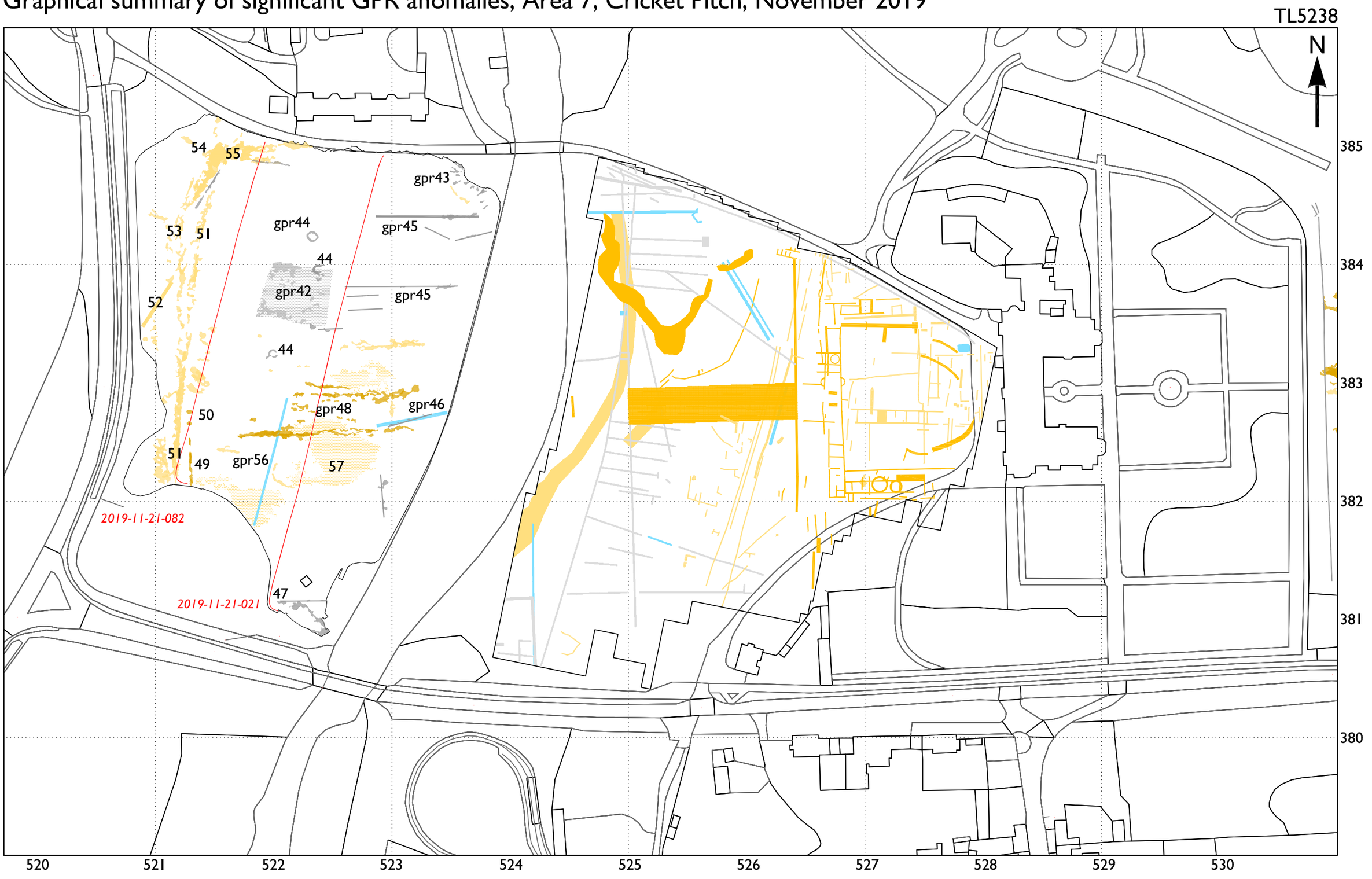
Geophysics Team 2020

Historic England

Figure 12

AUDLEY END, LITTLEBURY AND SAFFRON WALDEN, ESSEX

Graphical summary of significant GPR anomalies, Area 7, Cricket Pitch, November 2019



0 90m

1:1500

low amplitude reflectors

high amplitude reflectors

anomalies of known or recent origin

2019-11-21-021 Location of selected GPR profiles shown on Figure 7

Historic England

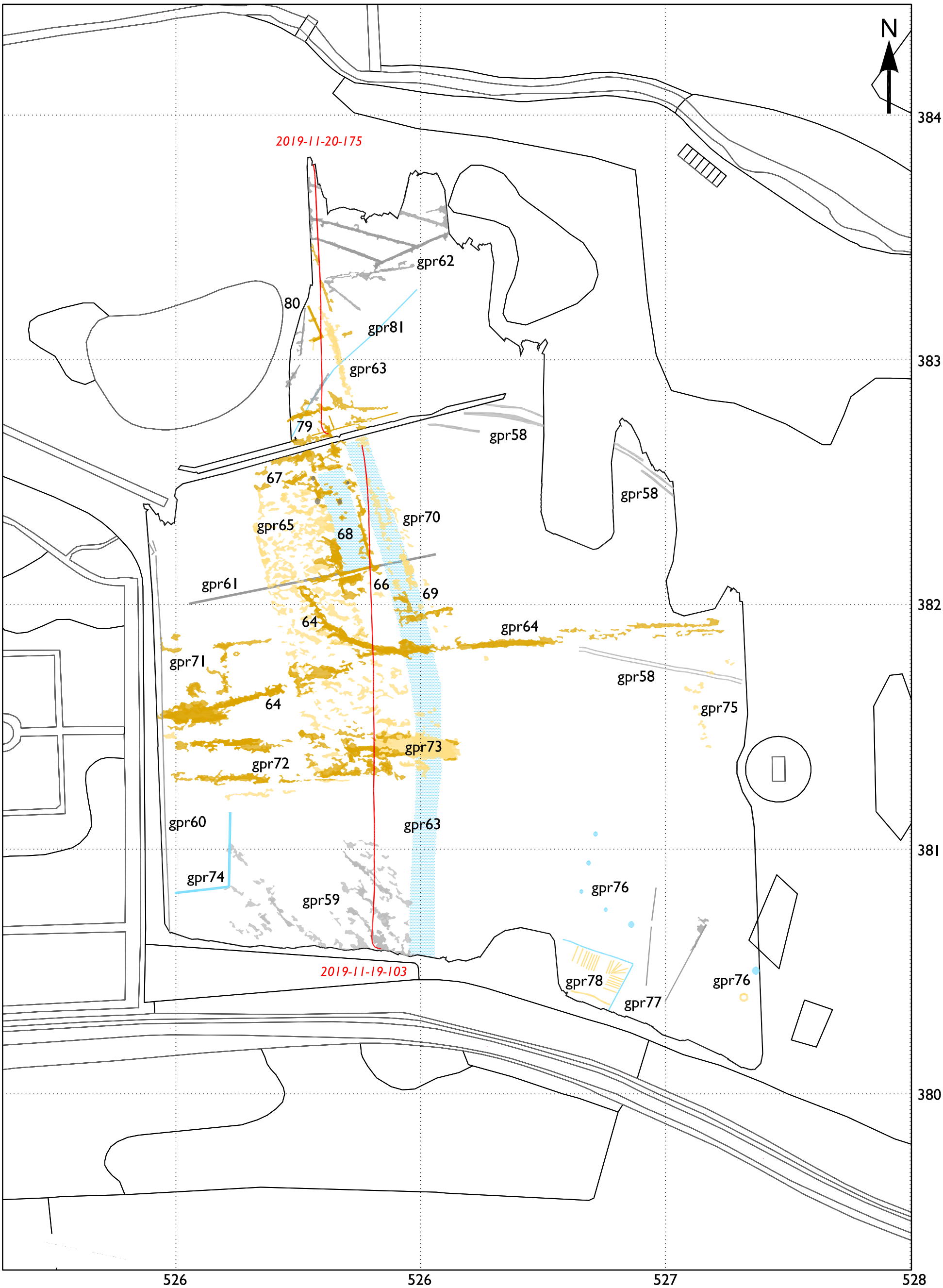
Geophysics Team 2020

Figure 13

AUDLEY END, LITTLEBURY AND SAFFRON WALDEN, ESSEX

Graphical summary of significant GPR anomalies, Area 8, East Park, November 2019

TL5238



0 90m

1:1500

low amplitude reflectors

high amplitude reflectors

anomalies of known or recent origin

2019-11-19-103 Location of selected GPR profiles shown on Figure 7

Historic England

Geophysics Team 2020

Figure 14

AUDLEY END, LITTLEBURY AND SAFFRON WALDEN, ESSEX

Graphical summary of significant earth resistance anomalies, Area 4, Walled Garden, November 2019

0 60m

1:750

very high resistance

high resistance

low resistance

Historic England

Geophysics Team 2020

Figure 15

AUDLEY END, LITTLEBURY AND SAFFRON WALDEN, ESSEX

Graphical summary of significant earth resistance anomalies, Area 5, East Garden, November 2019

TL5238

N

382

525

526

r85
r85
r79
r91
r87
r88
r80
r90
r86
r89
r99
r81
r92
r93
r94
r95
r82
r97
r98
r83
r96
r84

0 60m

1:750

modern response
very high resistance
high resistance
low resistance

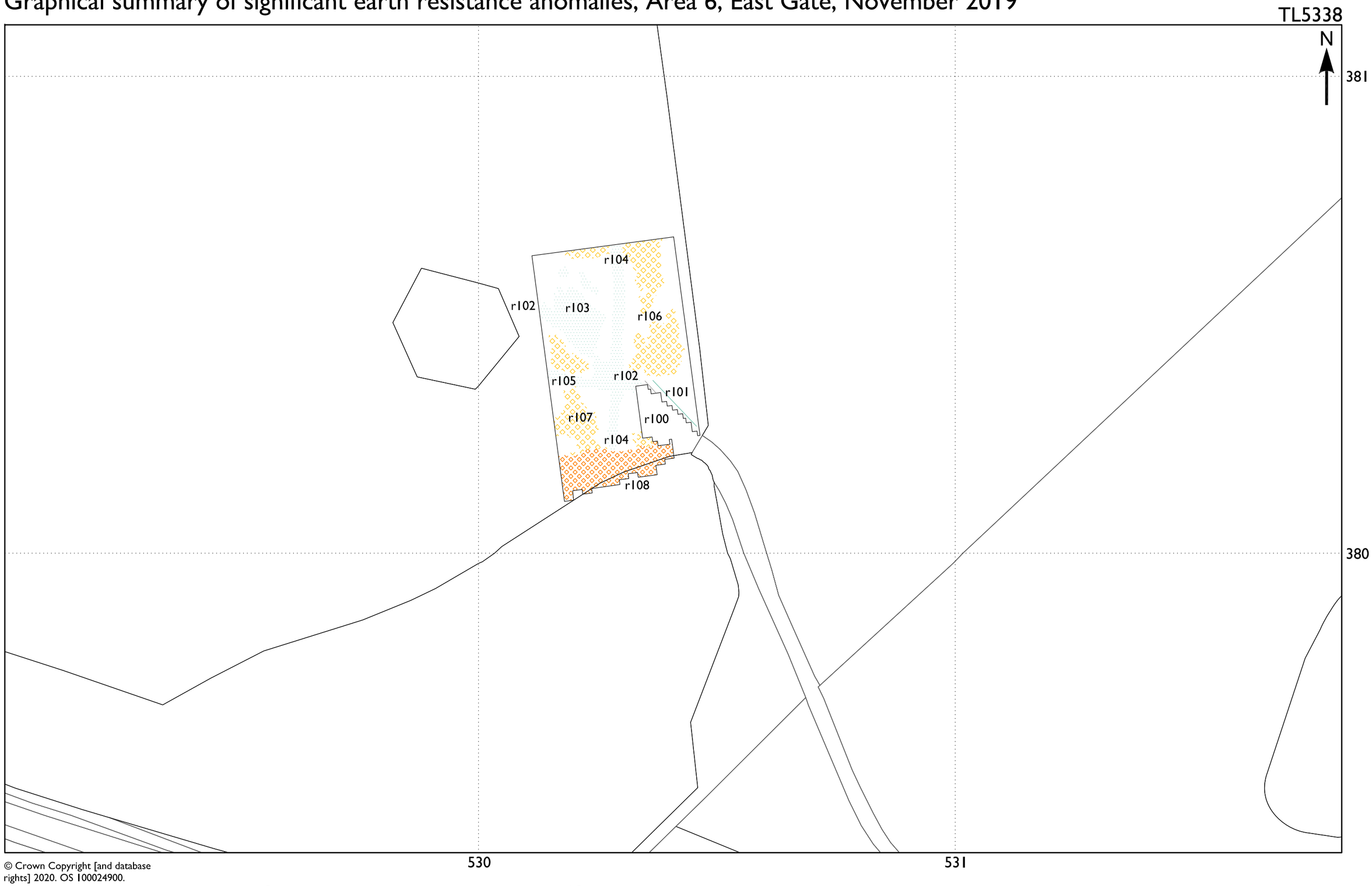
Historic England

Geophysics Team 2020

Figure 16

AUDLEY END, LITTLEBURY AND SAFFRON WALDEN, ESSEX

Graphical summary of significant earth resistance anomalies, Area 6, East Gate, November 2019



0 60m

1:750

very high resistance

high resistance

low resistance

Historic England

Geophysics Team 2020

Figure 17

AUDLEY END, LITTLEBURY AND SAFFRON WALDEN, ESSEX

GPR amplitude time slice between 15.0 and 17.5ns (0.88 - 1.02m), May 2010 and November 2019

0 180m

1:2500

Low *High*

relative reflector strength

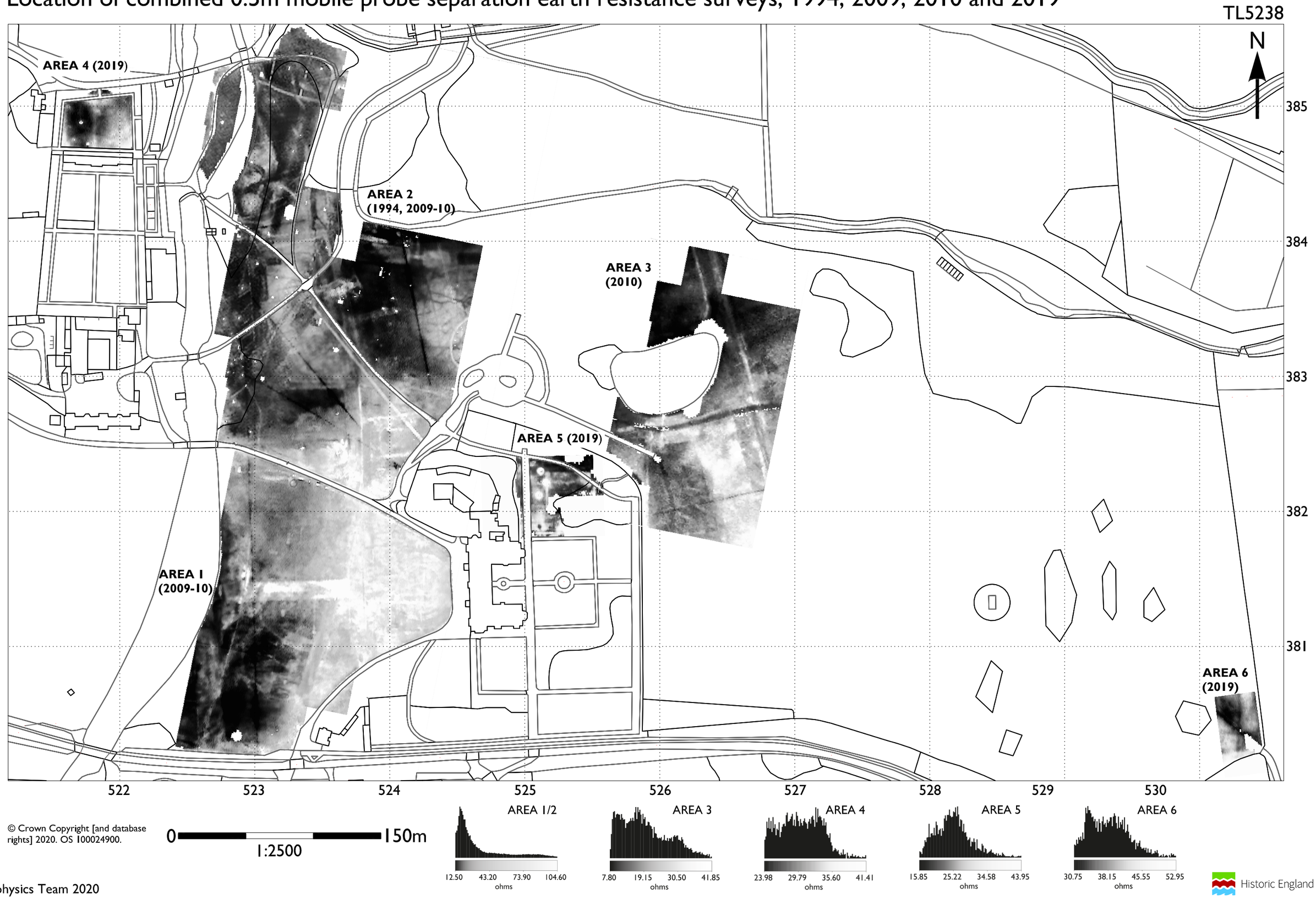
Geophysics Team 2020

Historic England

Figure 18

AUDLEY END, LITTLEBURY AND SAFFRON WALDEN, ESSEX

Location of combined 0.5m mobile probe separation earth resistance surveys, 1994, 2009, 2010 and 2019



0 150m

1:2500

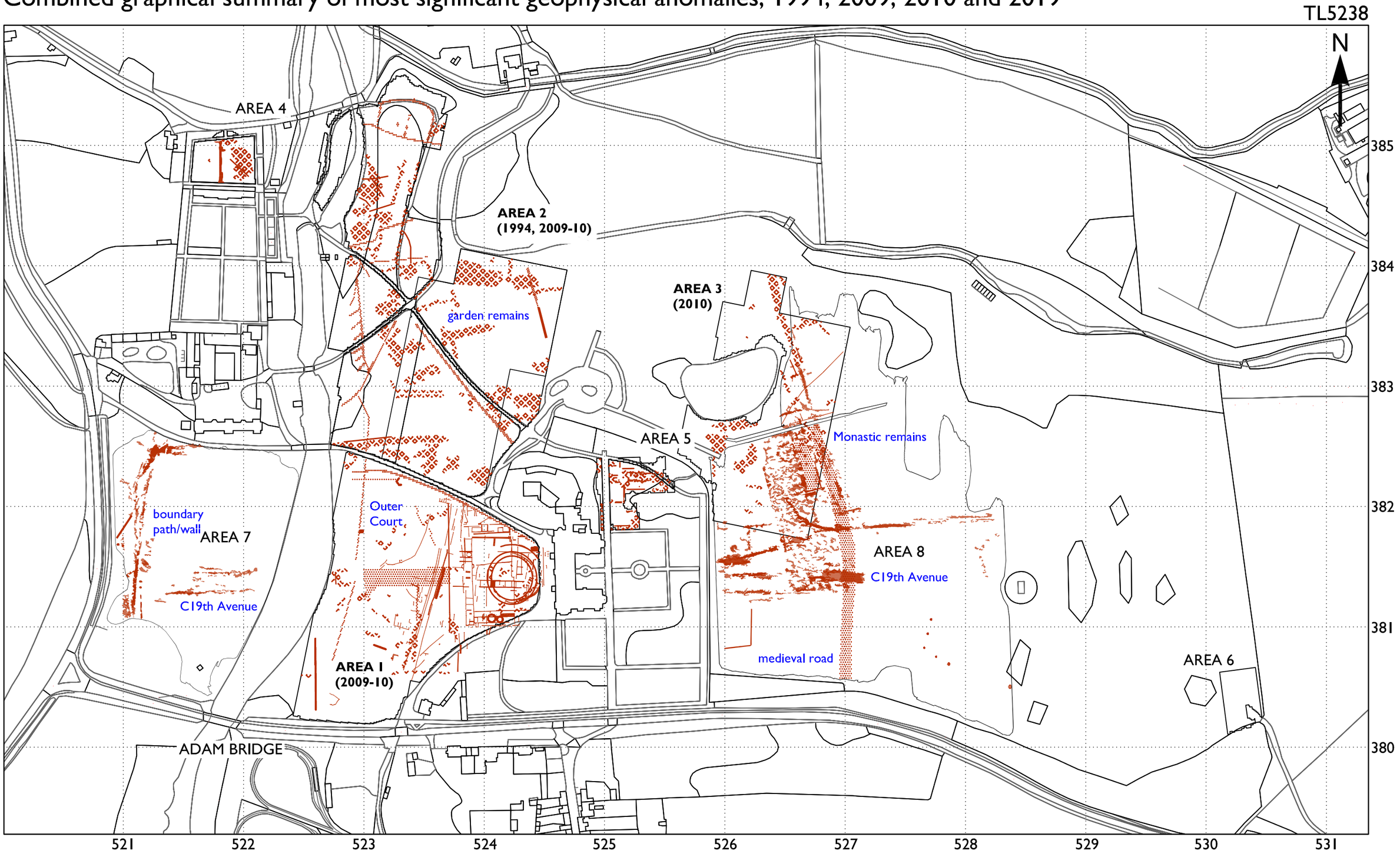
Geophysics Team 2020

Historic England

Figure 19

AUDLEY END, LITTLEBURY AND SAFFRON WALDEN, ESSEX

Combined graphical summary of most significant geophysical anomalies, 1994, 2009, 2010 and 2019



0 300m

1:3000

structural remains / garden paths

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Figure 20

Topographically corrected GPR profiles, Adam Bridge, June 2019

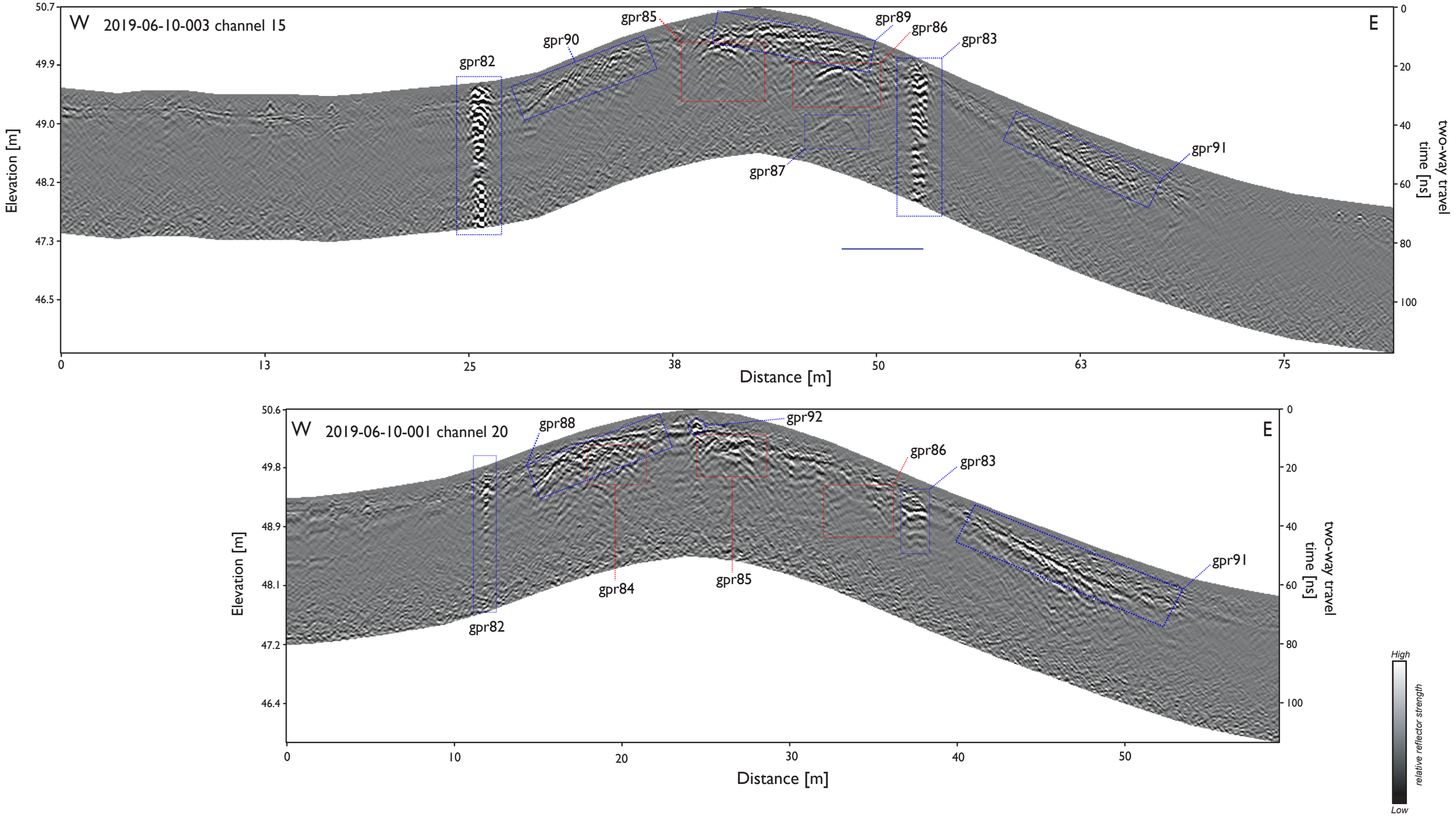

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Figure 21

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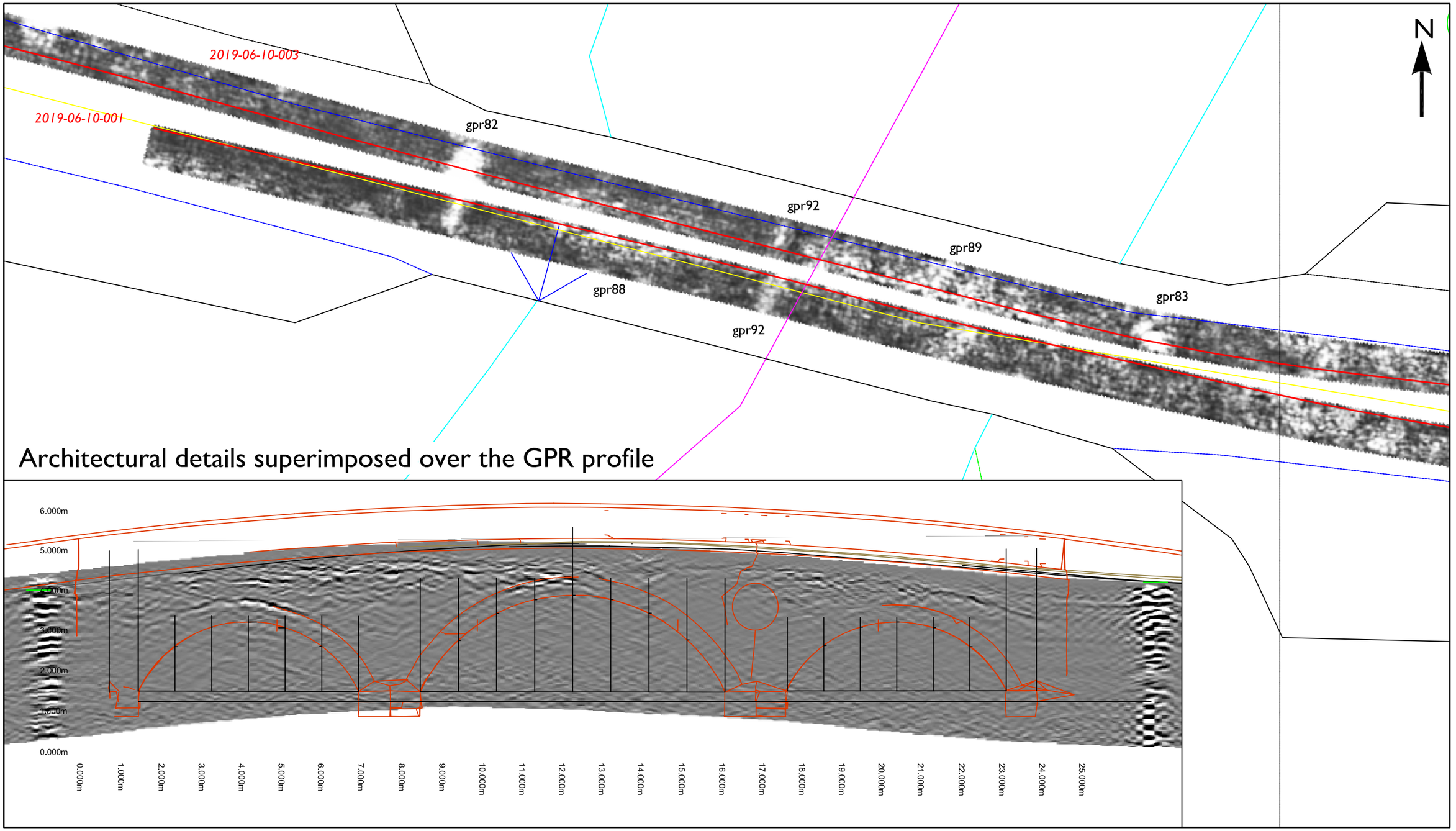
GPR amplitude time slice between 6.5 and 9.7ns (0.48 to 0.72m), Adam Bridge, June 2019

TQ2687



200

0 10m

1:150

2019-06-10-001 Location of selected GPR profiles shown on Figure 20

Low *High*
relative reflector strength

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