Historic England

Geophysics Team

Latton Priory Farm, North Weald Bassett, Essex Report on Geophysical Surveys, April 2016

Neil Linford, Andrew Payne and Cara Pearce

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LATTON PRIORY FARM, NORTH WEALD BASSETT, ESSEX

REPORT ON GEOPHYSICAL SURVEYS, APRIL 2016

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SUMMARY

Ground Penetrating Radar (GPR) and earth resistance surveys were conducted at Latton Priory Farm, North Weald Basset, Essex, as casework support to complement conservation works on the surviving elements of the medieval church building, assisted through the Historic England Heritage at Risk programme. The aim of the high sample density GPR survey (4.8ha) was to provide evidence for any surviving structural remains beneath the concrete hard standing of the modern farmyard, and to complement an analytical earthwork survey of the farmhouse garden and across the wider outer wards of the priory. Earth resistance coverage (0.8ha) was targeted over accessible areas of the gardens and in the immediate vicinity of the priory building. Both geophysical survey techniques successfully revealed anomalies associated with former garden layouts and the known course of the moat, together with the tentative location of building remains. Despite the presence of modern structures and services the GPR survey also revealed evidence for surviving structural remains beneath the hard standing in the farmyard, potentially suggesting the original footprint of the nave west wing of the cloister associated with the priory church.

CONTRIBUTORS

The geophysical fieldwork was conducted by Neil Linford, Andrew Payne and Cara Pearce (Historic England Placement).

ACKNOWLEDGEMENTS

The authors are grateful to Mr and Mrs Ian Brown of Latton Priory Farm, who kindly allowed access for the survey to take place, and to our colleague Matthew Bristow who assisted with the interpretation of the results and provision of the analytical earthwork survey data.

ARCHIVE LOCATION

Fort Cumberland, Portsmouth.

DATE OF SURVEY

The fieldwork was conducted between 25th to 28th April 2016 and the report completed on 23rd June 2016. The cover image shows the earth resistance survey in progress, with the Priory church and farmhouse in the background.

CONTACT DETAILS

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INTRODUCTION

Geophysical survey was conducted at Latton Priory Farm, North Weald Bassett, Essex (NGR TL 465 065; Scheduled Monument List Entry 1017386) to support a programme of conservation works assisted by Historic England, through the Heritage at Risk (HAR) programme, aimed at securing the protection of the Medieval standing remains. Historical records of the former Augustinian foundation of St John the Baptist (Latton Priory) date from its inception in the C12th, continuing to and beyond its dissolution in 1536. Whilst parts of the precinct have been obscured by later farm buildings, the full extent of the moated inner precinct containing the original claustral range, is known with foundations and other features relating to the church and claustral buildings surviving beneath the present buildings and surfaces. The standing remains of the church comprise the crossing, elements of the North and South transepts, and a well preserved nave. The outer wards to the south and east of the moat are thought to contain ancillary buildings, paddocks, gardens and cemeteries, reflecting the economy of the community and their dealings with the secular world, separated from the religious life within the inner precinct. Other aspects of communal life are represented by the fishponds which, in addition to providing a sustainable food supply, would have enabled the canons to comply with religious strictures concerning their diet.

The aim of the geophysical survey was to complement a topographic and analytic earthwork survey over both the garden surrounding the C18th listed farm house and the outer wards of the priory (Figure 13), particularly through the use of Ground Penetrating Radar (GPR) over the concrete yard surfaces of the modern farmyard. A previous magnetic survey of the farm house garden did not reveal any significant anomalies (Fisher and Simmonds 2008).

Site conditions consisted of concrete hard standing in the farm yard adjacent to the standing priory remains, well kept lawns interrupted by occasional planting in the farm house garden, and open pasture with an un-mown hay crop in the fields beyond the inner moated precinct. Slowly permeable calcareous clayey soils of the Hanslope (411d) Association have developed over Pleistocene drift deposits of boulder clay above Tertiary (Eocene) London Clay (Geological Survey of Great Britain 1981 ; Soil Survey of England and Wales 1983). Weather conditions were mixed with wintery showers and sunny intervals and low temperatures for the time of year.

METHOD

Ground Penetrating Radar survey

A 3d-Radar MkIV GeoScope Continuous Wave Stepped-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 2. 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 6MHz increments using a dwell time of 3ms. 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 3.2ns (two-way travel time) windows (e.g. Linford 2004). An average sub-surface velocity of 0.0938m/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 ~0.15m 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).

Earth resistance survey

Measurements were recorded over a series of 30m grids established with a Trimble R8 GNNS (Figure 1) using a Geoscan RM15 resistance meter, a PA5 electrode frame in the Twin-Electrode configuration and a MPX15 multiplexer, to allow 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, then the

variation in regional background level across the survey area was reduced using a local contrast enhancing Wallis filter, with 15m window radius and edge-to-background ratio of 0.9 (Scollar *et al.* 1990). The results for the near-surface 0.5m electrode separation survey are depicted as a linear greyscale image in Figure 3 superimposed on the OS map and Figures 6 and 7 show the minimally processed data from both the 0.5m and 1.0m electrode separated data, presented as both an X-Y trace plots and equal area greyscale images.

RESULTS

Ground Penetrating Radar survey

A graphical summary of the significant GPR anomalies, [**gpr1-48**], discussed in the following text, are shown superimposed on the base OS map data on Figure 11.

Some variation in antenna coupling was encountered across the different ground surfaces over the site, with the long vegetation and waterlogged soils in the wider precinct producing the most challenging conditions. Despite these constraints significant reflections were recorded to approximately 30ns before the signal begins to be attenuated. A number of services [**gpr1**] have been detected, particularly within the farmyard, but also include the possible location of the cess-pit soak away drain [**gpr2**] for the farmhouse in the wider precinct. The joints between the individual concrete pavement slabs [**gpr3**] in the farmyard are recorded in the near-surface data between 0 and 3.2ns (0 to 0.15m) and, due to a common orientation with the standing priory remains, have partially confused the interpretation of later, more significant reflections.

Farmyard hard standing

Strong linear reflections from between 6.4 and 38.4ns (0.29 to 1.74m) suggest the survival of wall-footings related to the nave [**gpr4**], potentially extending an additional 15m from the surviving building, and a possible western arm of the cloister [**gpr5**] heading south towards the farmhouse. An area of more complex response [**gpr6**] may, tentatively, provide some evidence for a north aisle although the response here is more fragmented than either [**gpr4**] or [**gpr5**]. Some planar areas of high and low amplitude response may represent floors or voiding respectively within the structural remains associated with both [**gpr5**] and [**gpr6**], although there may be some uncertainty depending on the construction base of the overlying jointed concrete pavement. The wider farmyard area appears to be dominated by a combination of services and the concrete pavement. High amplitude responses at [**gpr7**] may be more significant, although wooden service covers in this area perhaps suggest a more recent origin. Other anomalies in this area, for example at [**gpr8**] and [**gpr9**],

are only partially described in the survey data, and therefore more difficult to fully interpret.

Farmhouse garden within the extant moat

In general, there is a good correlation between the GPR response and the analytical earthwork survey with high amplitude anomalies replicating the linear depressions, [**gpr10**] and [**gpr11**], and scarps [**gpr12-14**]. Some of these anomalies correspond with boundaries [**gpr12**] shown on the historic mapping, together with an in-filled pond [**gpr15**], and the original kerbed, circular turning circle including central ornamental planting outside the house [**gpr16**], (OS Historic County Mapping Series: Essex 1843 - 1939 Epochs 1-3, a5). Family photographs from the 1950s, kindly shown to the authors by the landowners, suggest the turning circle existed until comparatively recently (Mr and Mrs I Brown, pers comm), with the curvilinear anomalies at [**gpr17**] perhaps indicating some remodelling of the driveway. It also seems likely that [**gpr14**] and [**gpr18**] represent more recent drains or services.

Evidence for structural remains is slight, with only fragmentary anomalies associated with the building platform proposed from the earthwork survey at [**gpr19**], and some tentative rectilinear form to the response at [**gpr20**]. More amorphous areas of high amplitude response, [**gpr21**] and [**gpr22**], are found in the vicinity of [**gpr20**], with a similar anomaly in front of the farmhouse at [**gpr23**]. Both [**gpr22**] and [**gpr23**] are comparatively shallow, from between 3.2 and 22.4ns (0.15 to 1.02m), with no apparent topographic expression or well defined rectilinear wall-type reflections, suggesting they are more likely to represent rubble spreads, possibly due to more recent garden landscaping.

Outer wards

The majority of linear earthworks recorded in the outer ward of the priory correspond with high amplitude anomalies that persist throughout the data set, suggesting the response may partially be due to the topography. Whilst in places the GPR has failed to replicate all of the earthworks there are some areas where the radar response has been able to complement the analytical survey coverage, for example at [**gpr23-27**], although it is possible these anomalies relate to a modern land drain.

The highest amplitude anomalies are found along the course of eastern [**gpr28**] and southern [**gpr29**] arms of the in-filled moat, presumably due to nature of the material used to level the ditches, although it is unclear whether the more rectilinear areas of response at [**gpr30**] relates to the moat or to a potential building platform. Some other areas of high amplitude response [**gpr31**] and

[**gpr32**] between 6.4 and 16.0ns (0.29 to 0.73m), suggest further localised in filling of water management features, perhaps originally joining the east arm of the extant moat to the pond immediately south of the survey coverage. The discrete high amplitude anomalies [**gpr33**] represent inspection covers along the course of the modern drain [**gpr34**], although the full course of this drain is not entirely clear from the radar data and it is difficult to establish whether it has been laid within a previously established water course or not.

Linear anomalies, [**gpr35-38**], perhaps represent later field divisions and are partially replicated in the orientation of the earthworks at [**gpr36**] which appear to overlie the water management system. Anomaly [**gpr38**] also appears to pass through the location of two slight depressions, at [**gpr39**], and [**gpr40**] which corresponds with the site of a former pond recorded by the historic mapping (OS Historic County Mapping Series: Essex 1843 - 1893 Epoch 1). A number of semi-circular anomalies [**gpr41-44**], approximately 2.5m in diameter, are found throughout the survey area and are difficult to interpret, although they may be related to either the clay geology or, perhaps, tree throws.

There is little discernible structure in the wider scatter of discrete anomalies found across the outer ward. Some fragmented linear anomalies, for example [**gpr45**], seem most likely to represent modern vehicle routes between the field gate to the large haystack, which is itself surrounded by areas of increased reflectance [**gpr46**] and [**gpr47**] with some discrete, presumably modern, responses possibly related to visible rubble in fill noted during the survey. The more dispersed responses at [**gpr48**] could, however, be more significant given their closer proximity to the priory buildings but again these lack sufficient morphology to propose a more definitive interpretation.

Earth resistance survey

A graphical summary of the significant earth resistance anomalies, [**r1-24**], discussed in the following text, are shown superimposed on the base OS map data on Figure 12.

Farmhouse garden within the extant moat

Rectilinear high and low resistance anomalies [**r1-4**] correspond with the GPR results, together with a weaker linear [**r5**] heading south, and a curvilinear high resistance response [**r6**] that correlates directly with [**gpr21**]. Whilst these anomalies might represent a former garden design, gravel paths or paved surfaces they could, possibly, be indicative of structural remains. A linear anomaly [**r7**] corresponds with [**gpr11**] and a scarp recorded in the earthwork survey, although the building platform immediately to the south is devoid of any earth resistance response to corroborate [**gpr19**].

The driveway or turning circle [**gpr16**] known from historic mapping is replicated by [**r8**] with the central ornamental planting indicated by a low resistance anomaly [**r9**]. Further sub-rectangular anomalies, [**r10-12**], may relate to former garden boundaries and sub-divisions shown on the historic mapping (OS Historic County Mapping Series: Essex 1843 - 1939 Epochs 1-3), although [**r12**] corresponds with [**gpr23**], and could possibly represent more significant structural remains or rubble spreads. A narrow linear anomaly [**r13**] (cf [**gpr18**]) to the east could represent a ditch, planting feature or possibly a drain from the farmhouse heading towards the in-filled rectangular pond, shown as a very slight increase in the background resistance [**r14**], although the magnetic survey data is too disturbed to be able to confirm this latter interpretation (Fisher and Simmonds 2008).

The small kitchen garden, adjacent to the priory church, contains two pronounced high resistance responses [**r15**] and [**r16**], possibly related to structural remains, although these are only partially described in the small area available for survey.

Outer wards

An area of high resistance [**r17**] adjacent to the east wall of the priory church probably relates to rubble deposits and the response to an open exploratory test pit against the side of the building. To the east the former moat is defined by a high resistance response most pronounced at [**r18**], corresponding to [**gpr28**], becoming less well defined to the south [**r19**], and much weaker to the north [**r20**] presumably due to varying deposits of rubble infill along its course. A much weaker response was recorded over the earthworks within the survey area, visible most clearly in the processed data as tentative banks and ditches [**r21**] and [**r22**], and fragmented linear anomalies at [**r23**] and [**r24**] (Figures 7(G) and 7(H)). The high resistance anomalies at [**r25**] correspond to test pits opened to locate drainage.

CONCLUSIONS

Ground Penetrating Radar (GPR) survey has provided evidence for surviving structural remains beneath the hard standing, concrete pavement of the Latton Priory farmyard related to the extant medieval church building. Whilst partially confused by the presence of modern buildings and services, a more complete footprint of the original priory church may be suggested, together with a tentative indication for parts of the cloister originally sited beneath the current C18th farmhouse building. Combined GPR and earth resistance survey in the gardens of farmhouse, enclosed by the extant inner precinct moat, complemented the analytical earthwork survey of the same area and suggested the location of anomalies that may, possibly, be related to destruction deposits

of former monastic buildings. However, the garden area has been subject to significant landscaping, including the removal of the original turning circle and a former ornamental pond that were both detected by the geophysical surveys. Conditions were less favourable in the outer wards, although the GPR and more limited earth resistance coverage confirmed the complex of former water management and known course of the moat revealed by the earthwork survey. The differing geophysical response perhaps indicates areas where more substantial quantities of material have been introduced to level the original earthworks.

LIST OF ENCLOSED FIGURES

Figure 9 GPR amplitude time slices between 0.0 and 25.6ns (0.0 to 1.16m) (1:4000).

Figure 10 GPR amplitude time slices between 25.6 and 48.0ns (1.16 to 2.18m) (1:4000).

Figure 11 Graphical summary of significant GPR anomalies superimposed over the base OS mapping (1:1750).

Figure 12 Graphical summary of significant earth resistance anomalies superimposed over the base OS mapping (1:1750).

Figure 13 Graphical summary of significant geophysical anomalies and recorded earthworks superimposed over the base OS mapping (1:1750).

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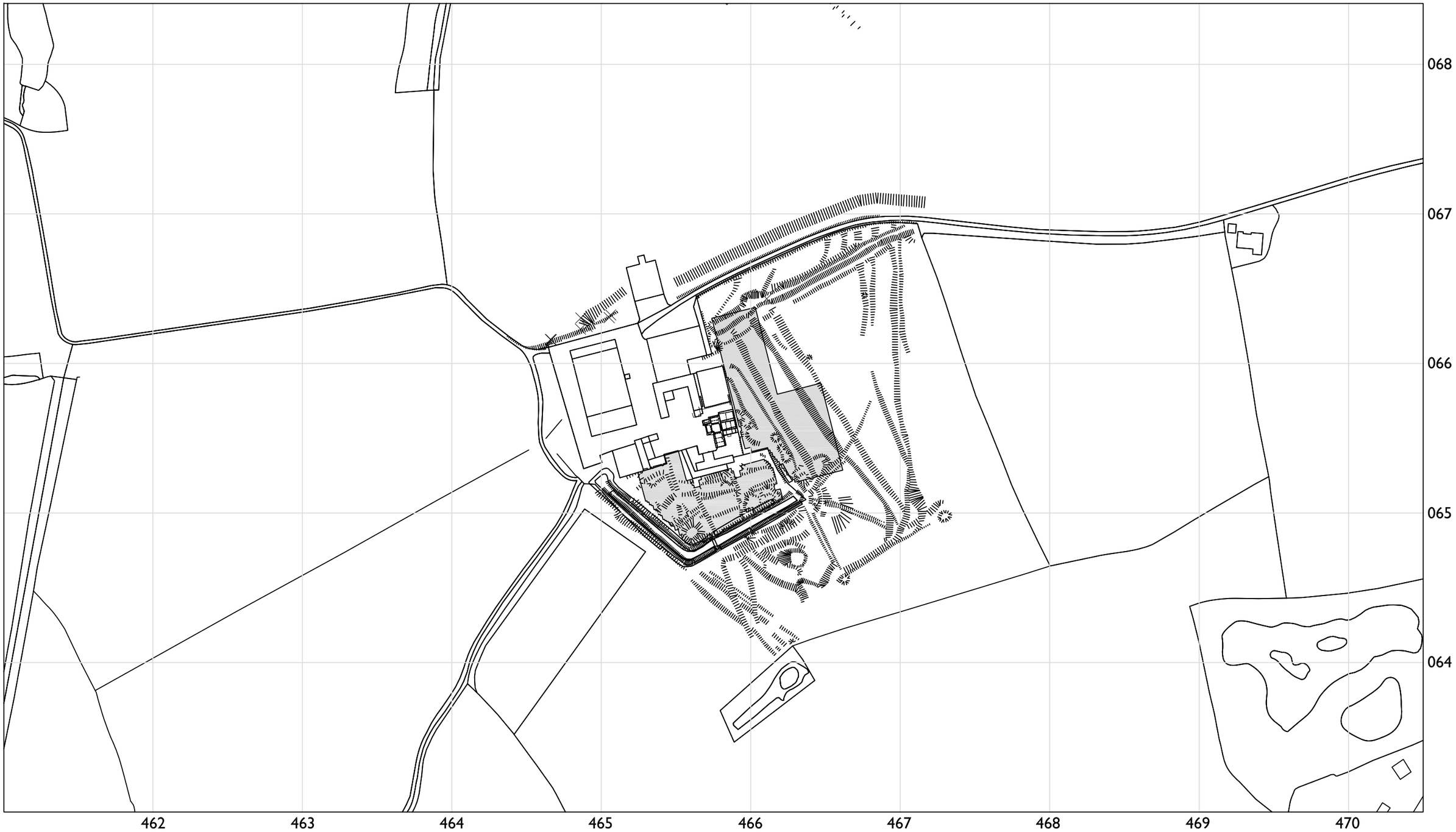
Figure 1

LATTON PRIORY FARM, NORTH WEALD BASSETT, ESSEX

Location of earth resistance survey, April 2016



0 150m

1:2500

Earth resistance survey

recorded earthworks

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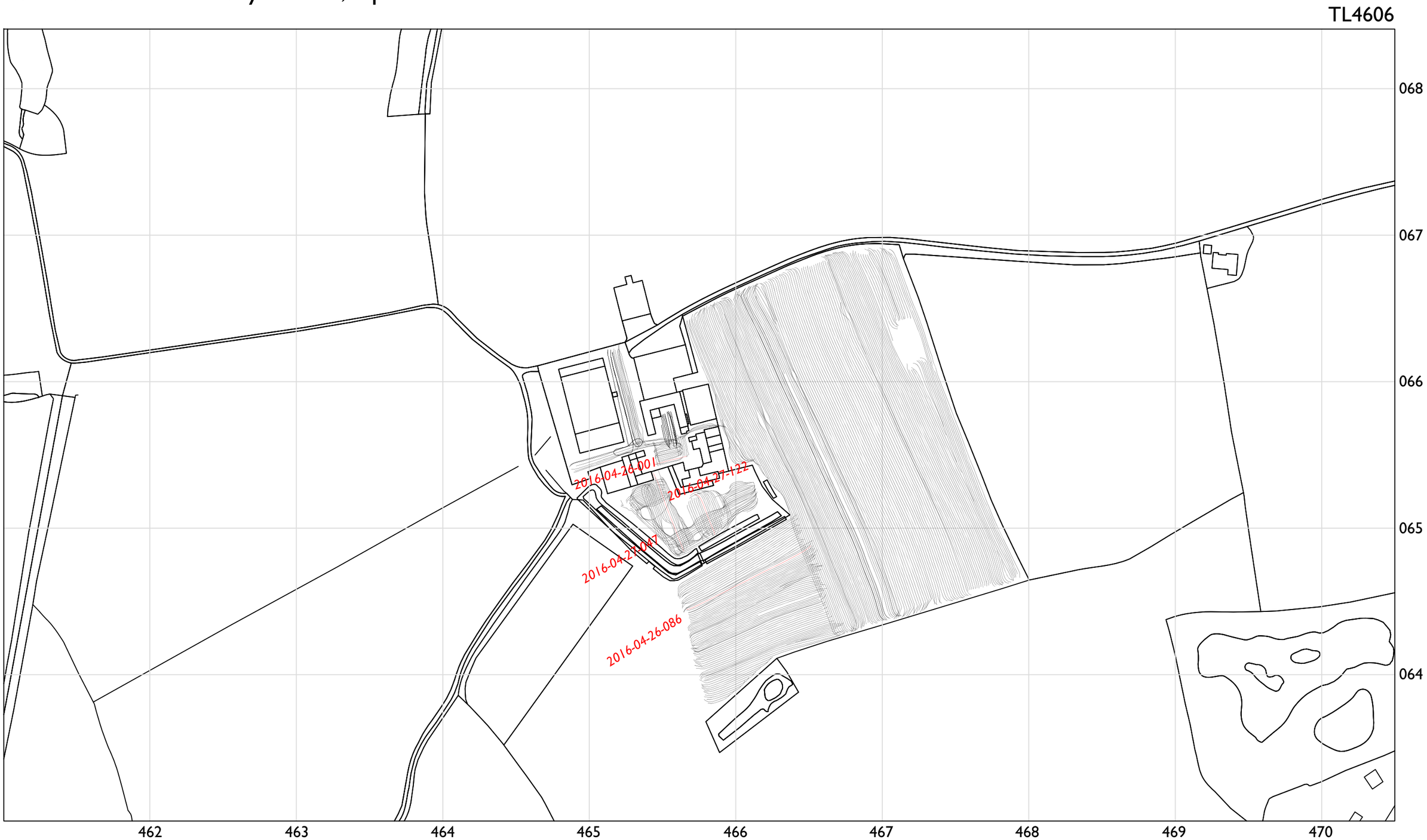
Historic England

Figure 2

LATTON PRIORY FARM, NORTH WEALD BASSETT, ESSEX

Location of GPR survey swaths, April 2016



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1:2500

2016-04-26-001 Location of selected GPR profiles shown on Figure 8

Ground Penetrating Radar survey swaths

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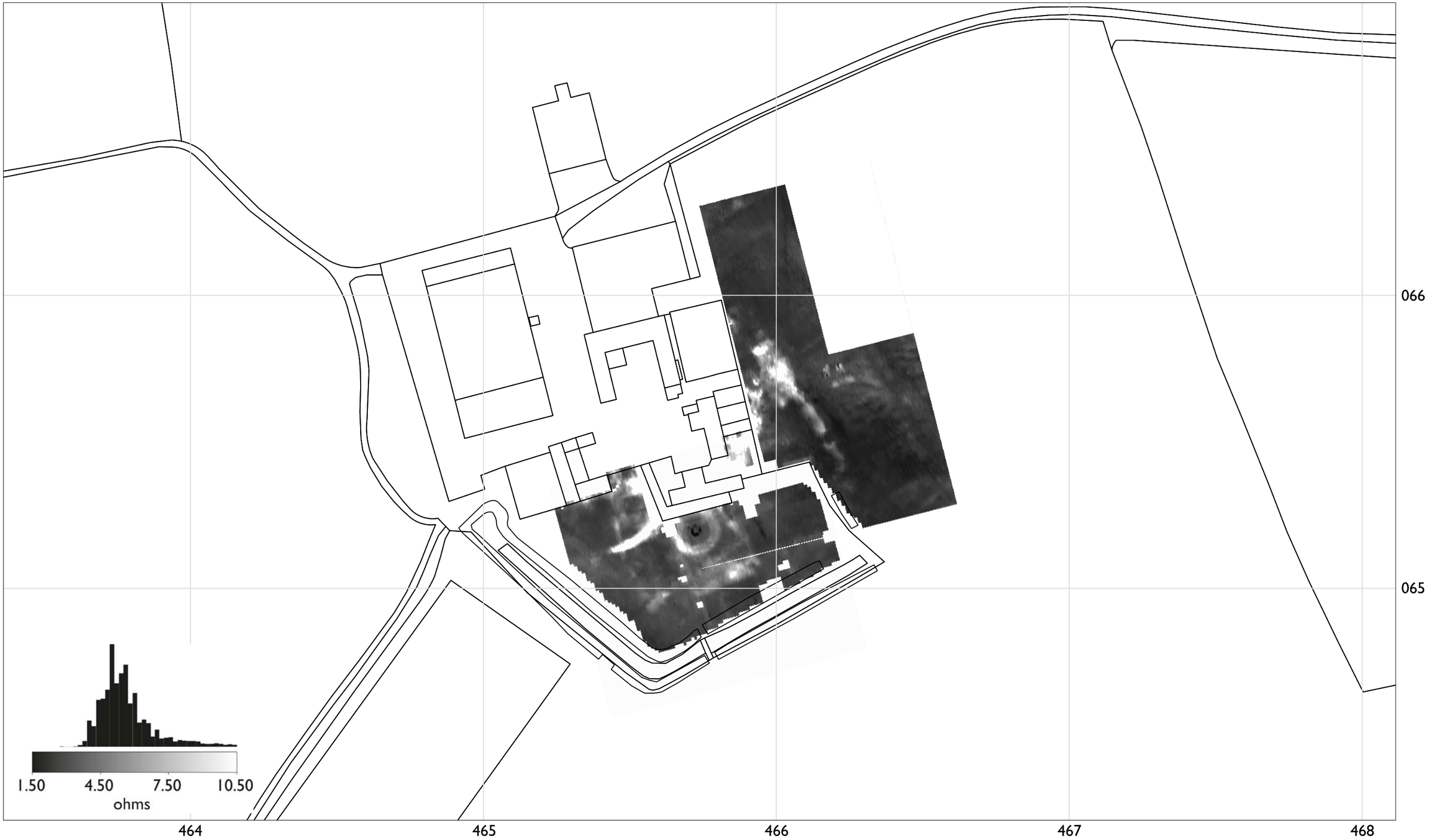
Figure 3

LATTON PRIORY FARM, NORTH WEALD BASSETT, ESSEX

Location of earth resistance survey, April 2016

TL4606



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1:1250

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Figure 4

LATTON PRIORY FARM, NORTH WEALD BASSETT, ESSEX

GPR amplitude time slice between 12.8 - 16.0ns (0.55 - 0.73m), April 2016

0 30m

1:750

Low High

relative reflector strength

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Figure 5

LATTON PRIORY FARM, NORTH WEALD BASSETT, ESSEX

GPR amplitude time slice between 12.8 - 16.0ns (0.55 - 0.73m), April 2016

0 90m

1:1750

2016-04-26-001 Location of selected GPR profiles shown on Figure 8

Low High
relative reflector strength

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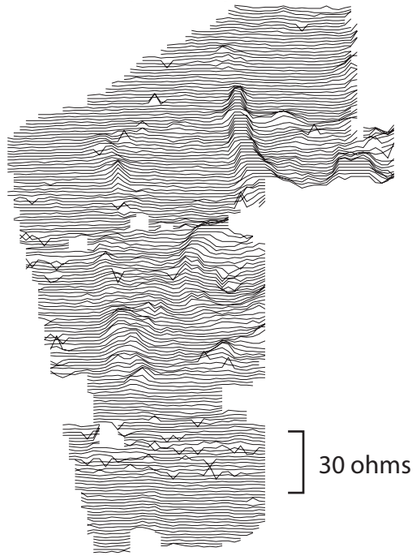
LATTON PRIORY FARM, NORTH WEALD BASSETT, ESSEX

Earth resistance data, Farmhouse Garden, April 2016

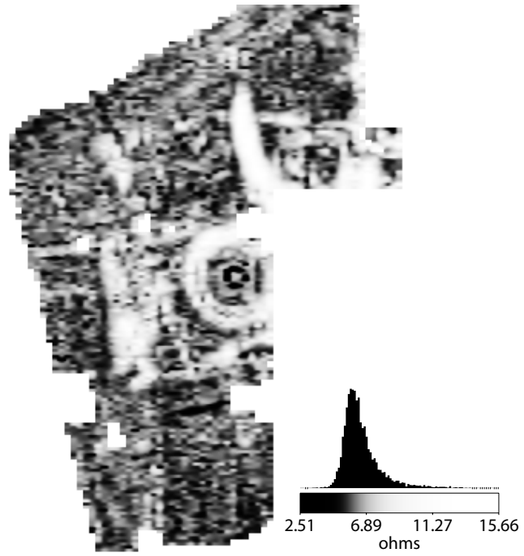
Figure 6

(A) Traceplot of minimally processed 0.5m mobile probe separation data

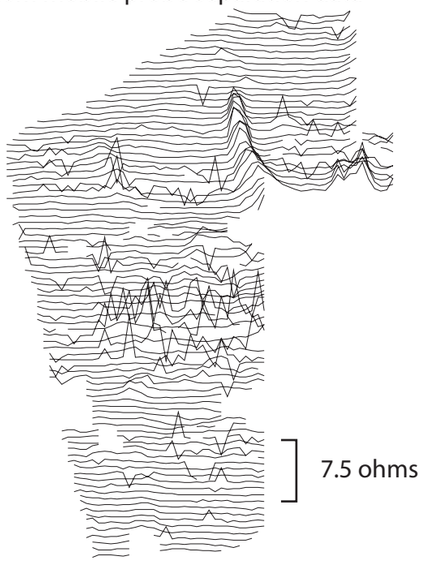


(B) Linear greyscale image of minimally processed 0.5m mobile probe separation data

(C) Equal area greyscale image of Wallis contrast enhanced 0.5m mobile probe separation data

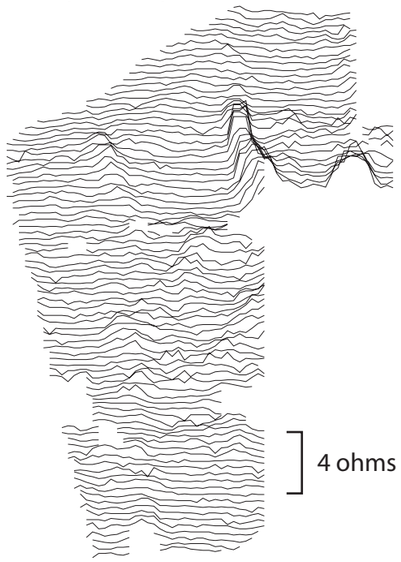


(D) Traceplot of minimally processed 1.0m mobile probe separation data



(E) Linear greyscale image of minimally processed 1.0m mobile probe separation data

(F) Traceplot of 'despiked' 1.0m mobile probe separation data



(G) Linear greyscale image of 'despiked' 1.0m mobile probe separation data

0 90m

1:1000

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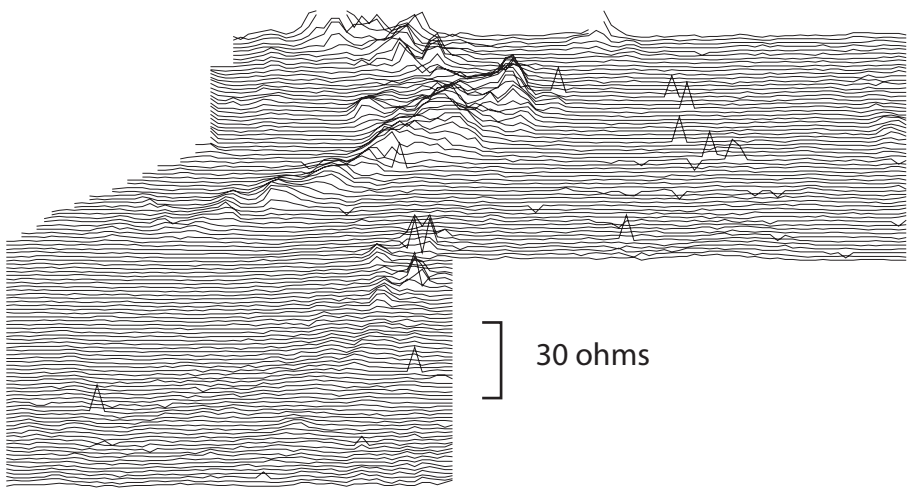
LATTON PRIORY FARM, NORTH WEALD BASSETT, ESSEX
Earth resistance data, Outer Wards, April 2016

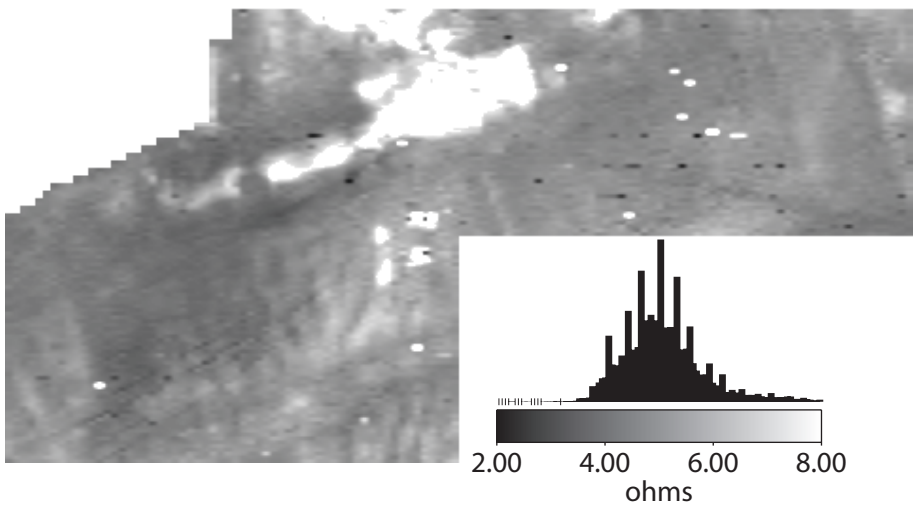
Figure 7

N

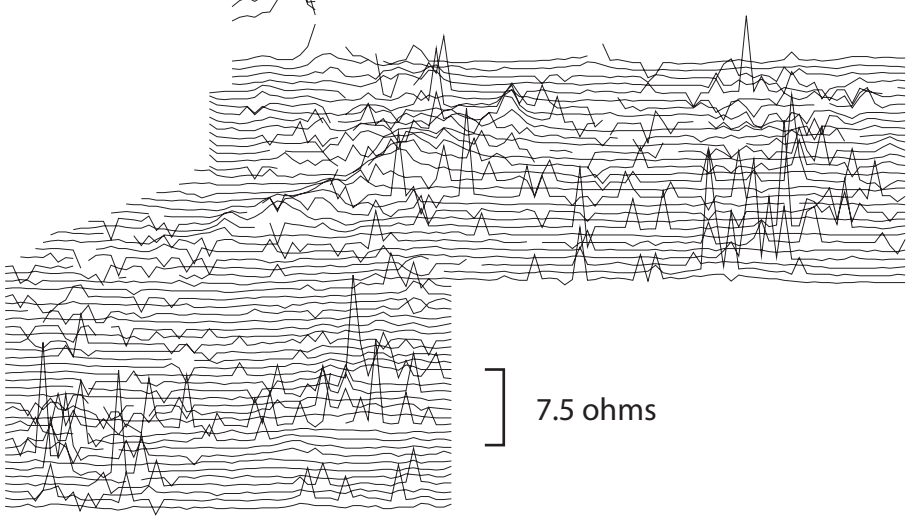
(A) Traceplot of minimally processed 0.5m mobile probe separation data



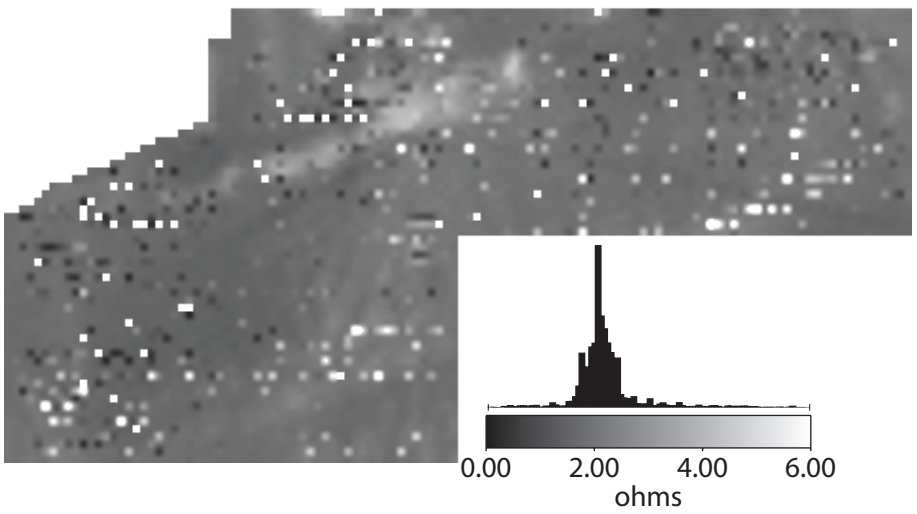
(B) Linear greyscale image of minimally processed 0.5m mobile probe separation data



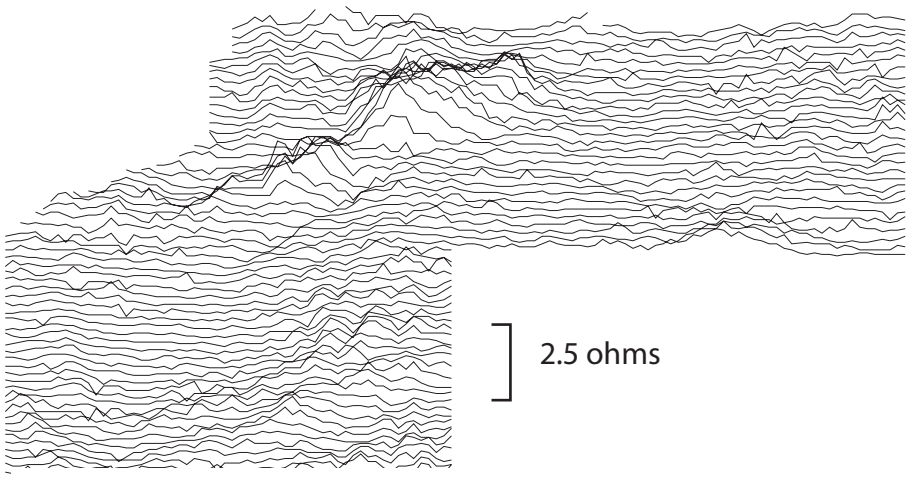
(C) Traceplot of minimally processed 1.0m mobile probe separation data



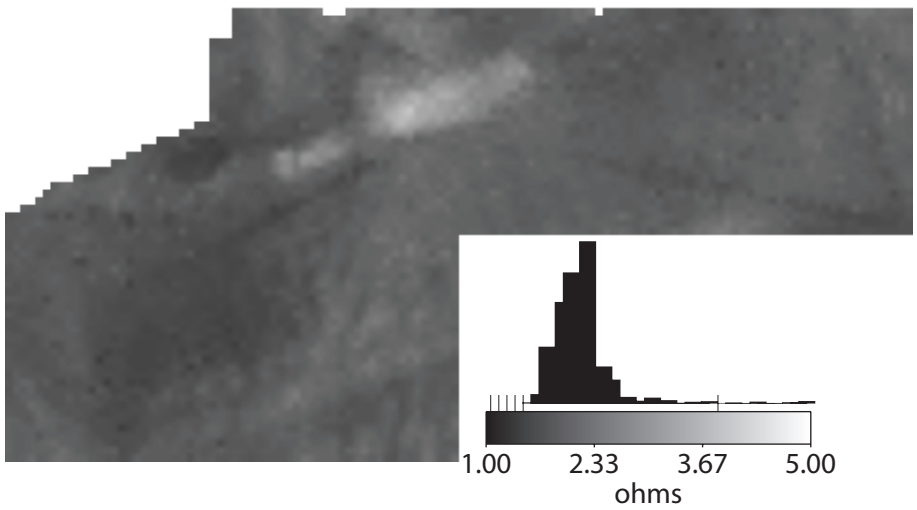
(D) Linear greyscale image of minimally processed 1.0m mobile probe separation data



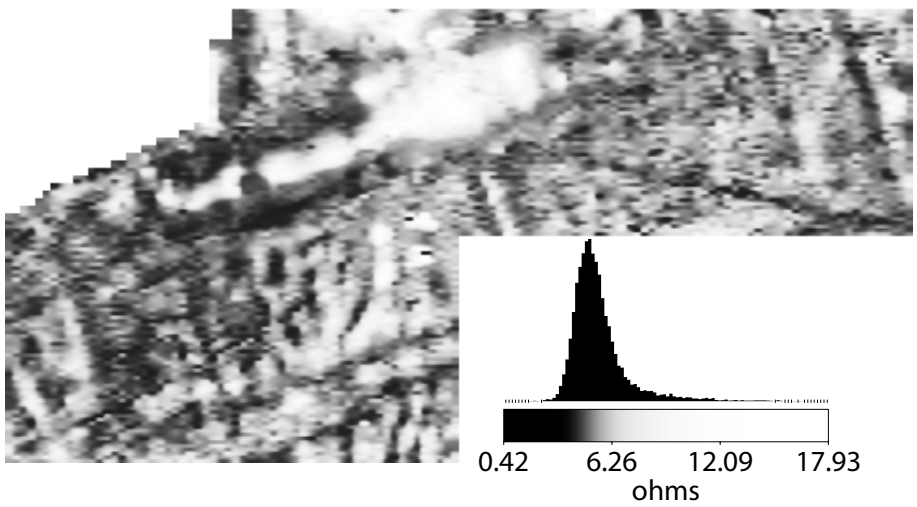
(E) Traceplot of 'despiked' 1.0m mobile probe separation data



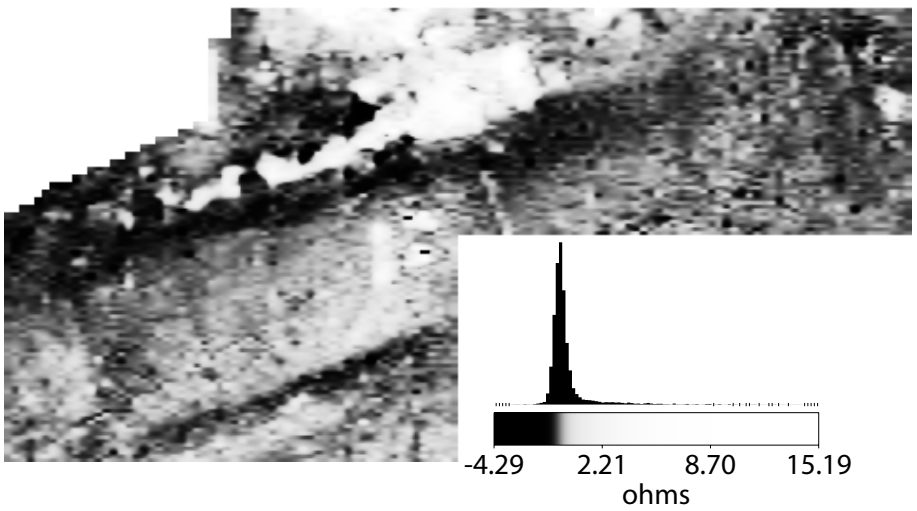
(F) Linear greyscale image of 'despiked' 1.0m mobile probe separation data



(G) Equal area greyscale image of Wallis contrast enhanced 0.5m mobile probe separation data



(H) Equal area greyscale image of enhanced near-surface response



0 90m

1:1000

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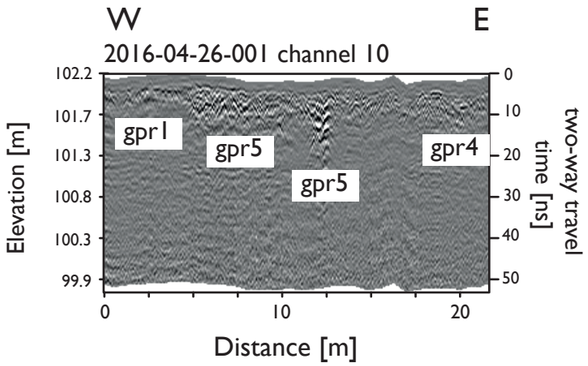
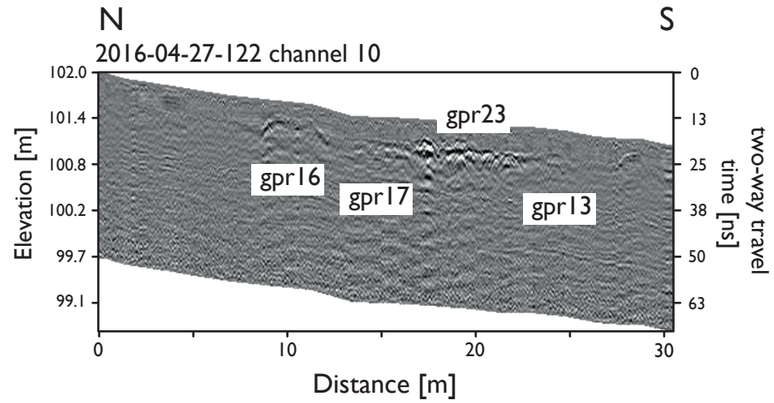
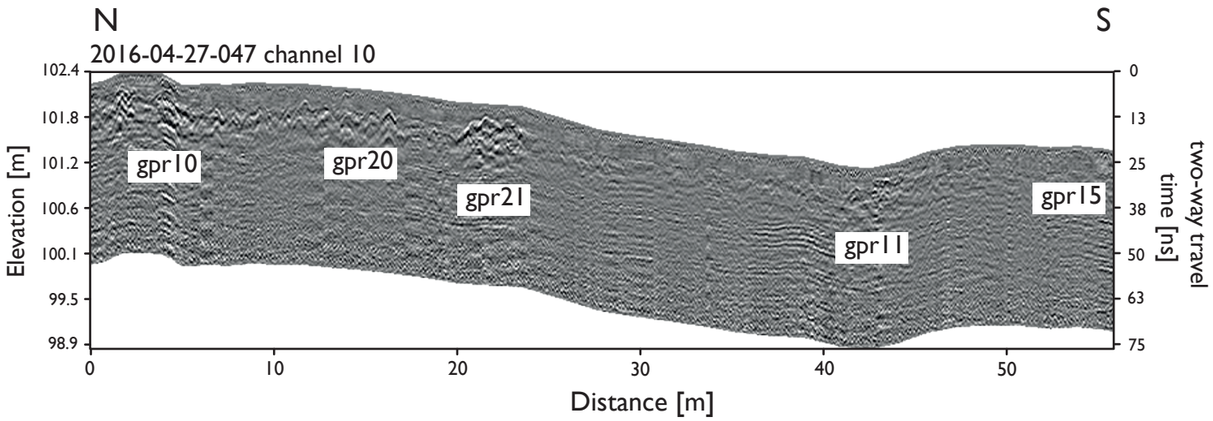
LATTON PRIORY FARM, NORTH WEALD BASSETT, ESSEX

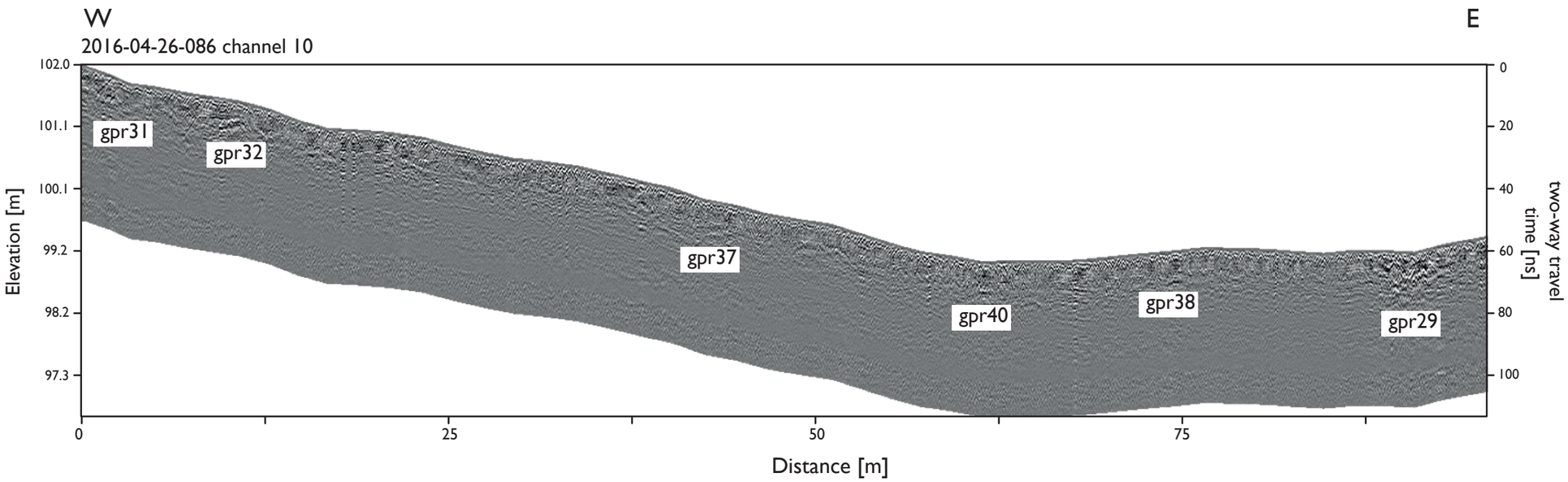
Figure 8

Topographically corrected GPR profiles, April 2016









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Historic England

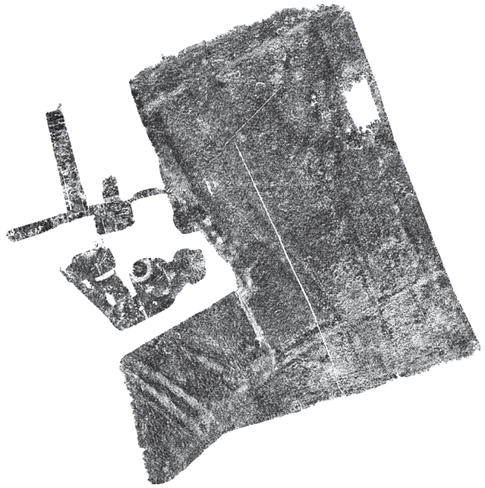
LATTON PRIORY FARM, NORTH WEALD BASSETT, ESSEX

GPR amplitude time slice between 0.0 - 25.6ns (0.0 - 1.16m), April 2016

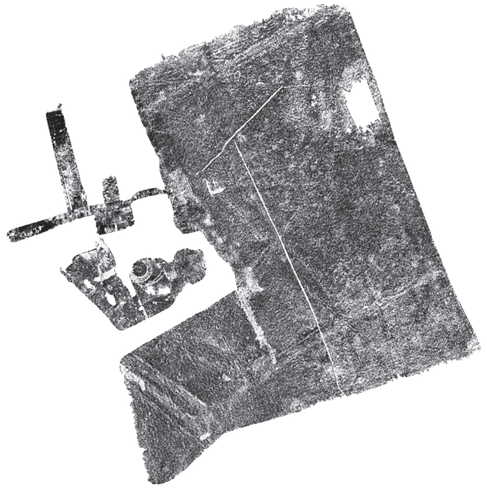
Figure 9

0 - 3.2ns (0.0 - 0.15m)

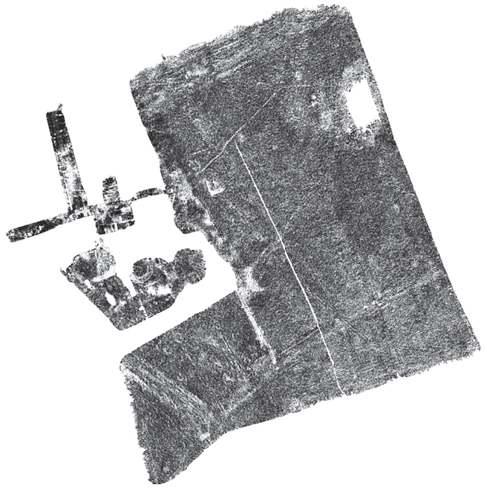
3.2 - 6.4ns (0.15 - 0.29m)



6.4 - 9.6ns (0.29 - 0.44m)



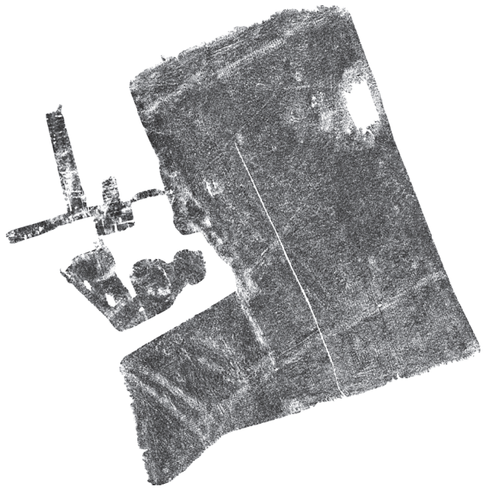
9.6 - 12.8ns (0.44 - 0.58m)



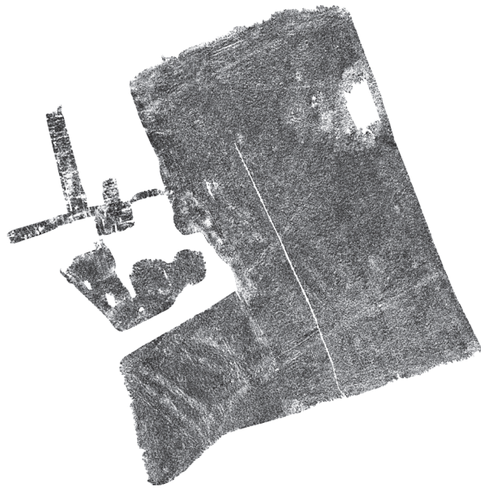
N

12.8 - 16.0ns (0.58 - 0.73m)

16.0 - 19.2ns (0.73 - 0.87m)



19.2 - 22.4ns (0.87 - 1.02m)



22.4 - 25.6ns (1.02 - 1.16m)

0 150m

1:4000

Low *High*

relative reflector strength

Geophysics Team 2016

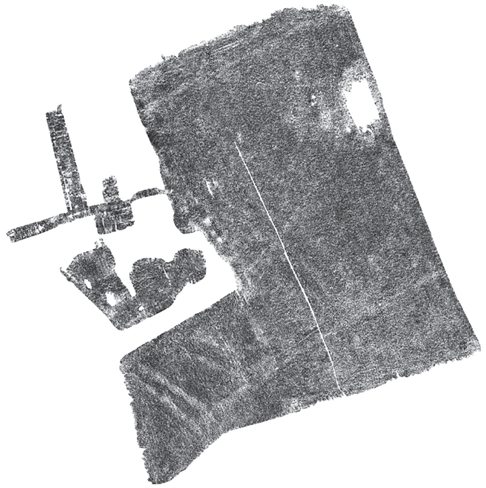
Historic England

LATTON PRIORY FARM, NORTH WEALD BASSETT, ESSEX

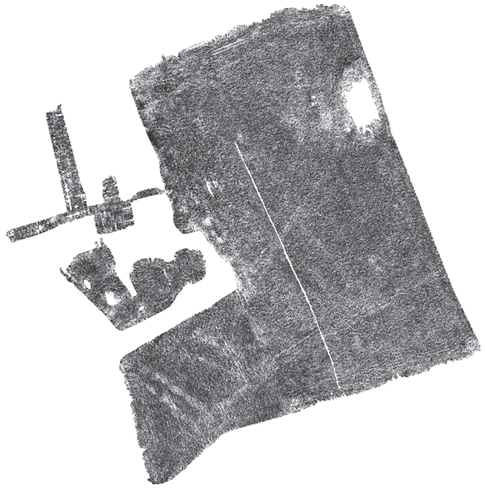
Figure 10

GPR amplitude time slice between 25.6 - 48.0ns (1.16 - 2.18m), April 2016

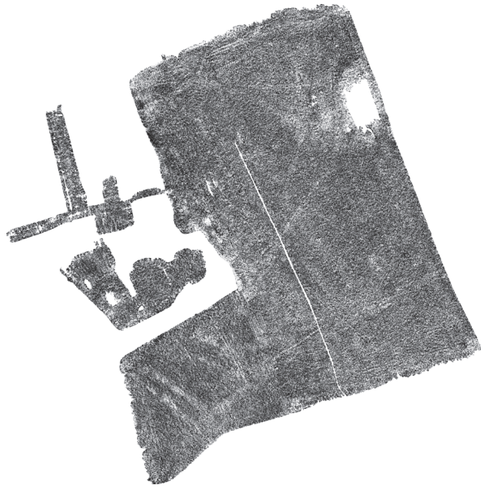
25.6 - 28.8ns (1.16 - 1.31m)



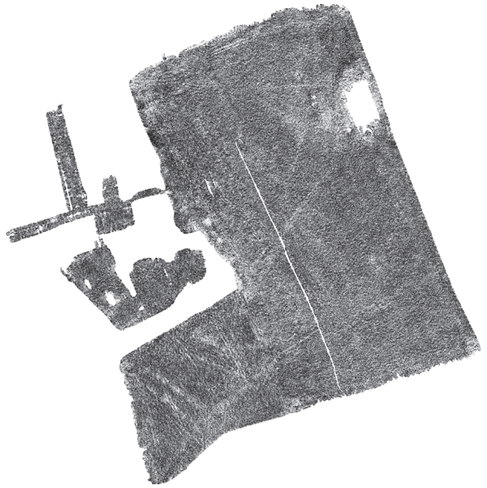
28.8 - 32.0ns (1.31 - 1.45m)



32.0 - 35.2ns (1.45 - 1.60m)

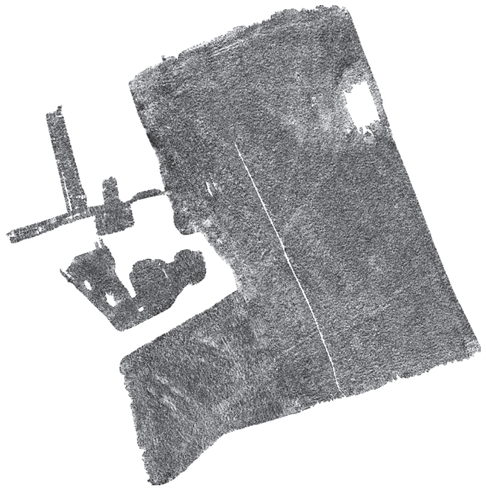


35.2 - 38.4ns (1.60 - 1.74m)

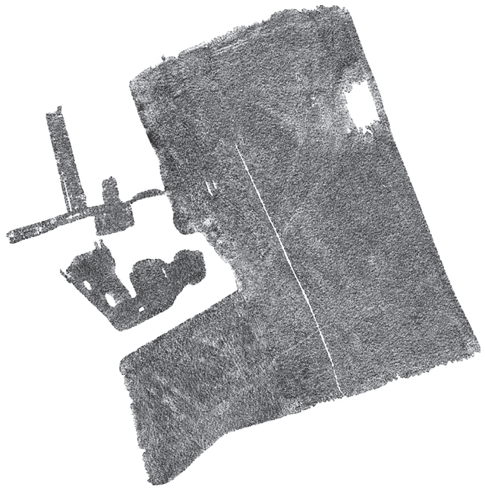


N

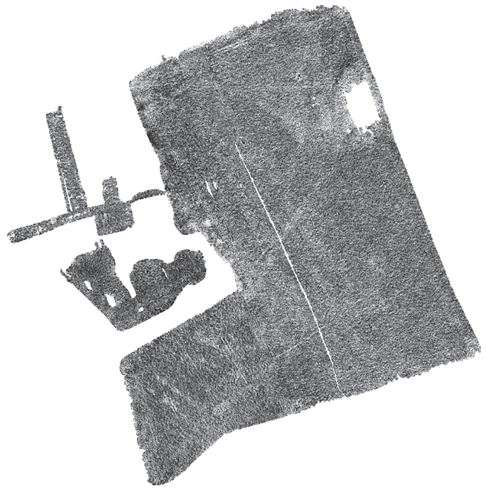
38.4 - 41.6ns (1.74 - 1.89m)



41.6 - 44.8ns (1.89 - 2.03m)



44.8 - 48.0ns (2.03 - 2.18m)



0 150m

1:4000

Low *High*

relative reflector strength

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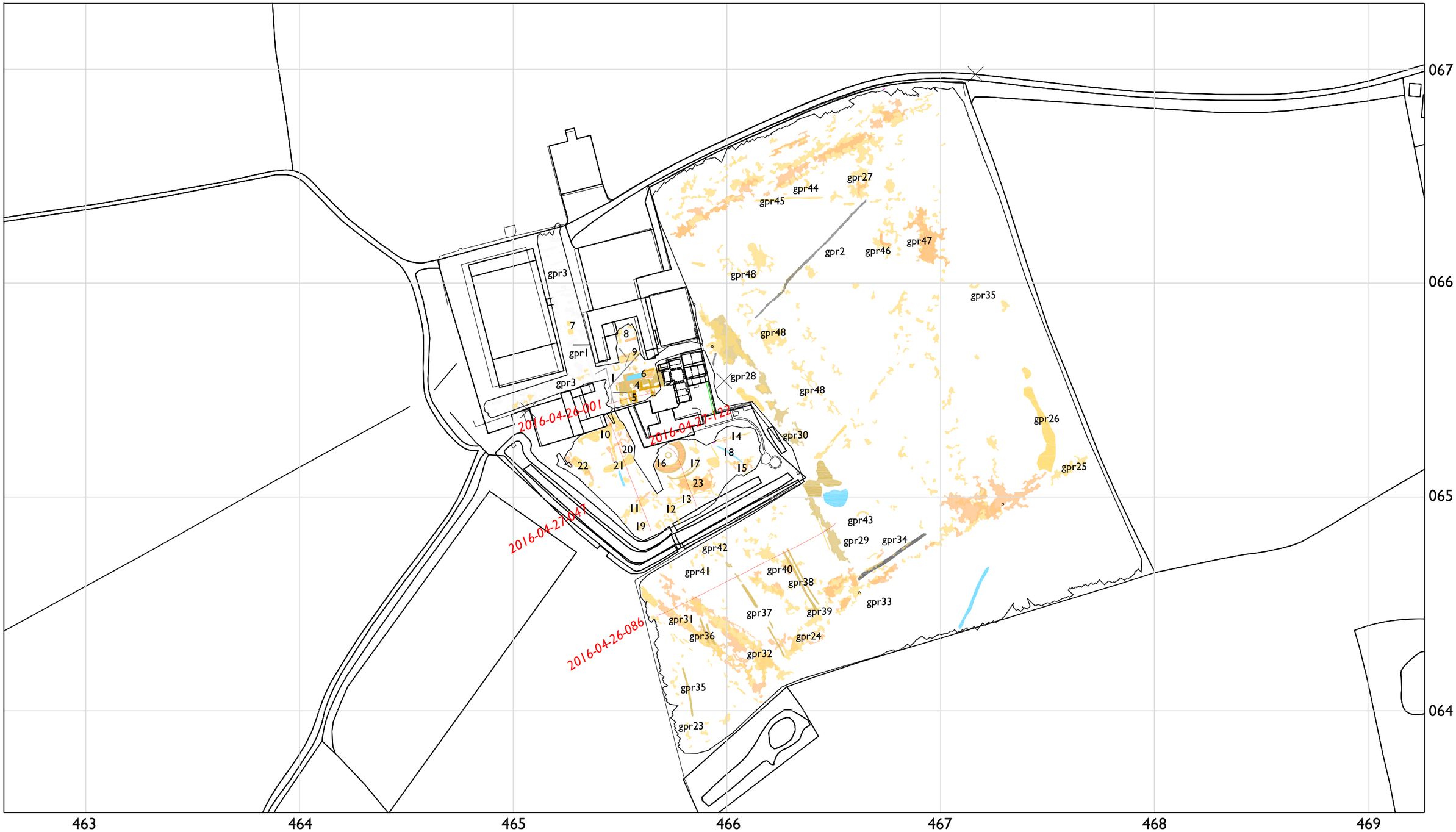
Figure 11

LATTON PRIORY FARM, NORTH WEALD BASSETT, ESSEX

Summary of significant GPR anomalies, April 2016

TL4606



0 90m

1:1750

low amplitude reflectors

high amplitude reflectors

anomalies of known or recent origin

2016-04-26-001 Location of selected GPR profile shown on Figure 8

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Figure 12

LATTON PRIORY FARM, NORTH WEALD BASSETT, ESSEX

Summary of significant earth resistance anomalies, April 2016

0 90m

1:1750

very high resistance

high resistance

low resistance

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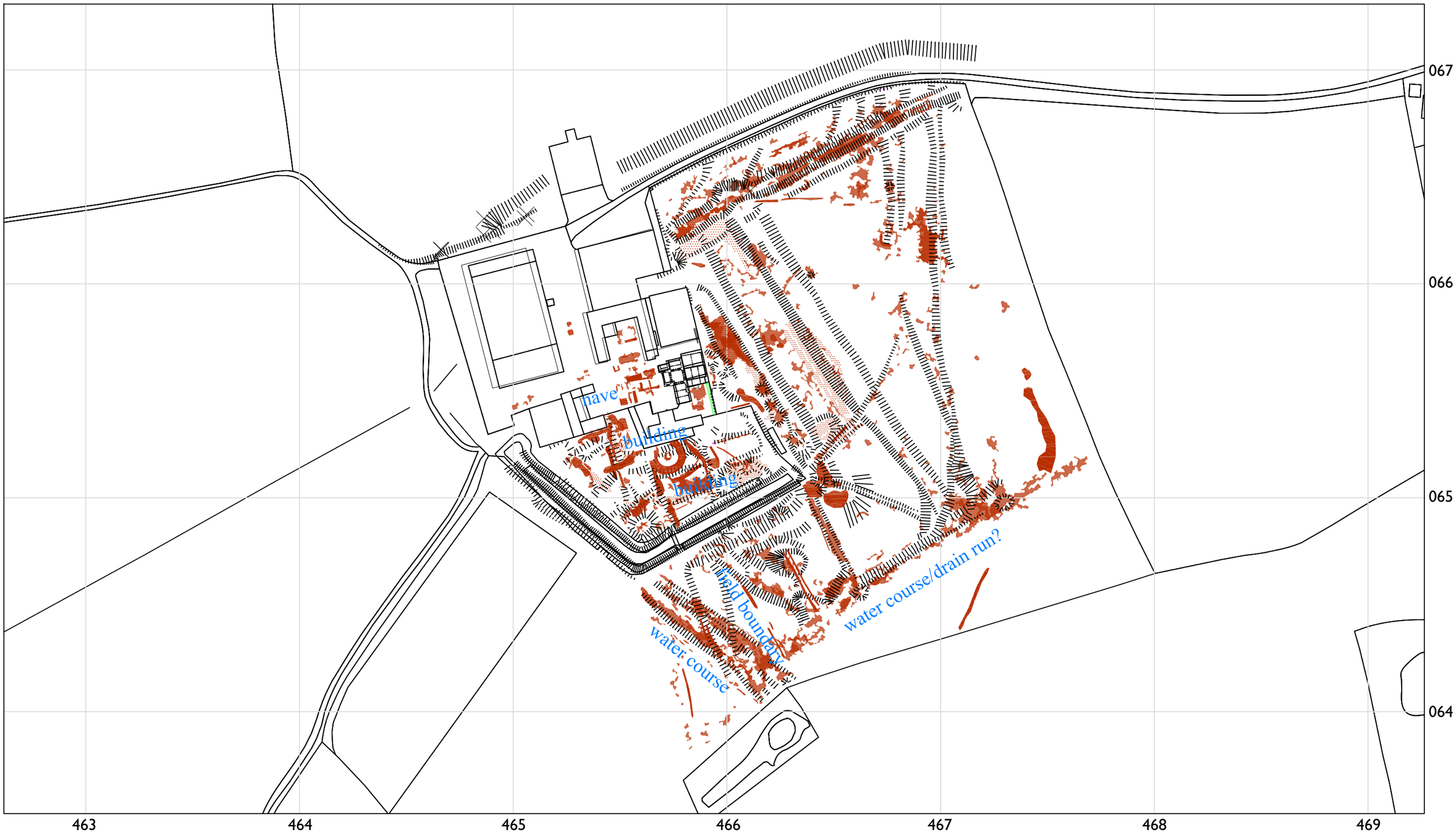
Figure 13

LATTON PRIORY FARM, NORTH WEALD BASSETT, ESSEX

Summary of significant geophysical anomalies and earthwork survey, April 2016



0 90m

1:1750

geophysical anomalies

recorded earthworks

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