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Site Near Sudbury, Suffolk

Report on Geophysical Surveys, October 2021

Neil Linford, Paul Linford, Andrew Payne, Ashley Cooper and Megan Clements

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Historic England
Fort Cumberland
Fort Cumberland Road
Eastney
Portsmouth PO4 9LD

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Summary

Caesium magnetometer and Ground Penetrating Radar (GPR) surveys were conducted at a site near Sudbury, Suffolk, in response to an East Region casework request to better define the extents of the known Roman villa at the site first discovered by the landowner in 1948. Previous excavations have uncovered remains of several masonry and timber buildings together with evidence for wider settlement activity identified through field walking and an earlier magnetic survey. Vehicle-towed caesium magnetometer survey (18.4ha) revealed a wealth of geophysical anomalies, including the location of both previously known and potentially new buildings and enclosures, together with evidence suggesting semi-industrial activity. The GPR coverage (10.8ha) produced partial evidence of the main villa building, similar to a previous trial survey with this technique, but successfully managed to identify additional masonry building remains in the wider landscape and a possible Roman water supply pipe. Together, the two datasets have provided a clearer picture of the layout and extent of the previously excavated Roman remains and suggested some additional activity beyond the bounds of the scheduled area.

Contributors

The geophysical fieldwork was conducted by Neil Linford, Paul Linford and Andrew Payne and a wealth of information about previous research was provided by the landowner both during and after the field visit. The team are grateful to Landscape Archaeology team colleagues Magnus Alexander and Sarah Newsome for providing the coordinates of recent illicit metal detecting holes. Later editing to anonymise the location of the site was carried out by Megan Clements. The cover image shows a view of the site from the south-west looking towards the main focus of Roman settlement with heavy thunderclouds clearing to the east (photograph taken by Andrew Payne).

Acknowledgements

The authors are grateful to the landowner for allowing access to the site, keen support and interest during both the survey acquisition and interpretation of the results, together with the provision of temporary on-site office, welfare facilities, equipment storage and the loan of an All-Terrain Vehicle while the team were working at the site.

Archive location

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Date of survey/research/investigation

The fieldwork was conducted between 18th and 22nd October 2021, with the report completed on 31st January 2023 and later editions completed by 2nd July 2024.

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

Contents

Introduction

Caesium magnetometer and Ground Penetrating Radar (GPR) surveys were conducted over the remains of a partially excavated Roman villa at a site near Sudbury, Suffolk in response to an East Region casework request. The survey was designed to improve understanding of the surviving archaeological resource addressing Historic England Corporate Plan objective 2.2 “Understand the vulnerabilities, hazards and risks of harm to the historic environment and identify appropriate mitigations, including those associated with climate”, to help define the full extent of the site and inform potential revision of the scheduled area linked to updating of Countryside Stewardship agreements.

The villa was initially discovered after Roman building material and pottery began to appear on the surface after an episode of deep ploughing in the late 1940s. A 9.2ha area containing the Roman villa was subsequently scheduled, of which a third has been investigated using a combination of fieldwalking, geophysical survey and excavation, revealing a complex of masonry and timber-built structures, industrial area, yards and drainage. Artefacts recovered from the site suggest occupation between the first and fourth centuries AD. In the 2010s the site was placed on the Heritage at Risk register having been subject to significant illegal metal detecting.

An application to renew a Countryside Stewardship scheme offered the opportunity to better protect the site by increasing the 1ha area that had been reverted to grass beyond the immediate vicinity of the main villa, and to further review the extent of the current designation. The aim of the current geophysical survey was to extend coverage beyond the scheduled area and improve upon the 1970s magnetic survey through the use of modern instrumentation. Any previously undetected archaeological remains might also be excluded from arable production.

The underlying geology consists of Palaeogene London Clay, silt and sand sedimentary bedrock overlain by superficial Quaternary sand and gravel deposits of the Kesgrave Catchment Subgroup, with primarily slowly permeable calcareous clayey soils of the Hanslope (411d) Association (Soil Survey of England and Wales 1980s; Geological Survey of Great Britain (England and Wales) 1990s). The site was down to recently germinated winter cereal excluding the area reverted to grass over the main villa and a narrow strip of planting for wild bird food along the southern edge of the survey. Weather conditions during data collection were largely dry and settled following initial heavy rainfall on the first day of fieldwork.

Method

Caesium Magnetometer Survey

Magnetometer data were collected along the instrument swaths shown in Figure 1 using an array of six Geometrics G862 caesium vapour sensors mounted on a non-magnetic sledge (Linford et al. 2018). 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, ~0.36m 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 were sampled at a rate of 25Hz resulting in an along-line sample density of ~0.12m given typical ATV travel speeds of 2.5-3.0m/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 any remaining biases added to the measurements owing to the diurnal variation of the Earth's magnetic field. A linear greyscale image of the minimally processed truncated data (±120nT/m) is shown superimposed over the base Ordnance Survey (OS) mapping in Figure 3. Figures 5 and 6 display the truncated data as a trace plot and as a histogram normalised greyscale image respectively.

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 R8s Global Navigation Satellite System (GNSS) receiver was mounted on the GPR antenna array, that together with a second R8s base station was used to provide continuous positional control for the survey collected along the instrument swaths shown on Figure 2. The GNSS base station receiver was adjusted to

the National Grid Transformation OSTN15 using the Trimble VRS Now Network RTK delivery service. This uses the Ordnance Survey's GNSS correction network (OSNet) and gives a stated accuracy of 0.01-0.015m per point with vertical accuracy being half as precise.

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 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 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 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 0.104m/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 therefore represents the variation of reflection strength through successive ~0.13m intervals from the ground surface, shown as individual greyscale images in Figures 4, 8, 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 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).

Results

Magnetometer Survey

A graphical summary of significant magnetic anomalies [**m1**-**55**] discussed in the following text superimposed on the base OS mapping data is provided in Figure 11.

Former land use, modern and geological activity

Previous farm tracks known from historic mapping are evident as curvilinear magnetic disturbance at [**m1**], skirting the northern boundary of a former woodland, and [**m2**] parallel to the current access track north of the villa with both going out of use in the mid-20th century after the land was converted from woodland to arable production. To the west [**m3**] appears to represent a northern spur of [**m1**] back towards the farm and follows the alignment of a former field boundary [**m4**] to the east, removed to create the current larger area of arable.

Parallel ceramic field drains [**m5**], spaced approximately 25m apart on a north-west to south-east alignment, are found to the south of [**m1**] with feeder drains angled in relation to the main pattern of drainage also visible in places. Further, more dispersed drains [**m6**] are found to the north of [**m1**], and at [**m7**] on the sloping ground to the east of the main villa.

The only geomorphological response visible in the data appears to be some amorphous areas of natural soil variation, most likely to be related to variable sand and gravel drift deposits, evident across the site with particular prevalence where the land falls away to the east of the villa [**m8-13**] and bordering the wood to the southwest [**m14-17**]. A similar amorphous anomaly [**m18**] just to the east of the farm may relate to a former pond basin with a drain or outlet [**m19**] extending towards the farm buildings to the west, that was perhaps drained to allow the construction of the overlying track [**m3**].

A pipeline constructed in the 1970s has been mapped as an intense ferrous response [**m20**] on an approximately north-east to south-west alignment in the far eastern part of the survey coverage. The strong magnetic gradients it causes potentially obscure more archaeologically significant anomalies in its vicinity (see Plate 1).

Archaeological anomalies

Magnetic evidence for Roman settlement activity is concentrated towards the west of the scheduled area corroborating results from the 1970s magnetometer survey. The densest clusters of anomalies occur in an area bracketed between parallel linear road or boundary ditches [**m21**] to the west and the diverging pair of boundary ditches [**m22**] to the to the east, coinciding with a part of the scheduled area that is now under grass. Anomaly [**m22**] is likely to correspond to previously excavated Ditches 1 and 2, the differing alignments

suggesting changes to the bounded area during different phases of Roman occupation. The magnitude of response of these bounding ditches varies, approaching values of 15-20nT/m in the vicinity of structural remains that contain evidence of burning and industrial activity while similar anomalies away from the main focus of settlement are typically less than 2nT/m.

The core villa complex appears to contain at least six buildings, [**m23-25**] and [**m27-29**], represented either by regular rectilinear arrangements, for example [**m24**] and [**m25**], or less structured patterns of positive magnetic anomalies, such as [**m23**] and [**m29**]. Three smaller structures [**m30-32**] have also been detected at the peripheries to the west, east and south. In all but one instance the long axes of these building anomalies share the same north-north-east to south-south-west alignment as boundary ditches [**m21**] and [**m22**] although with some variations in precise orientation perhaps reflecting different phases of development at the site.

Where found in excavation trenches, masonry wall footings have been composed of flint and would thus be expected to produce a weak negative magnetic anomaly in clay soil. However, few anomalies of this type have been detected and most of the potential building outlines exhibit positive magnetic contrasts. This suggests what is being detected is, for the most part, trenches infilled with a more magnetic material such as daub, perhaps burnt in places where particularly strong magnetic anomalies have been recorded. The positive magnetic responses relating to building structures are rarely continuous so these may have suffered post-depositional disturbance from either robber trenching seeking to recover flint masonry, later ploughing or the archaeological excavations.

There is little evidence for internal structural detail within the buildings although in some cases rows of discrete positive anomalies are suggestive of large timber-bearing post-holes perhaps indicating a Roman aisled hall type construction.

Building 1

The main villa building, identified in the excavation report as Building 1, described as approximately 35m long by 18.4m wide is found at [**m23**] with some weakly defined negative linear magnetic anomalies perhaps indicative of surviving masonry wall footings. Excavations between the 1950s and 1960s revealed mortared flint wall footings that had been substantially robbed out and a single row of post-holes within and towards the south-eastern wall of the building each about 1.2m in diameter and 1.35m deep. The post holes suggest the building was aisled although, as it was not fully excavated, the corresponding row on the north-western side was not located. In its final form the two narrow ends of the building were divided into rooms with evidence for a hypocaust beneath those at the southern end as well as a bath block in the centre of the north-western wall. The strong magnetic anomalies in the centre of [**m23**] are likely to be caused by thermoremanently

magnetised material associated with the bath block and hypocaust. However, perhaps owing to collapsed superstructure and disturbance caused by the excavations, neither the known nor postulated rows of internal post-holes have been clearly detected.

Two parallel linear anomalies [**m33**] about 5m apart extend from the south-west corner of Building 1 towards the southern edge of the survey area where a pond is situated. One of these may correspond with the excavation report's Ditch 4 and they are perhaps associated with water drainage from the baths block in Building 1.

Abutting the north-western facing wall of Building 1 is what appears to be a second structure [**m24**] defined by a series of strong linear positive magnetic anomalies ranging from 20 to 40nT/m describing three sides of a rectangle. This was also detected in the 1970s magnetometer survey and is likely to represent evidence of the excavation report's putative precursor to Building 1. Evidence for this structure in the form of much burnt material including daub was noted beneath remains of Building 1 but not investigated in detail. The remarkably high peak magnetic responses of [**m24**] would certainly be consistent with ditches filled with fired clay material, suggesting possible destruction by fire. In its centre a strongly magnetised discrete polygonal anomaly about 4m in diameter has been detected by both the present and 1970s magnetic surveys, perhaps caused by the remains of a central hearth or furnace.

Building 2

An area of pronounced magnetic disturbance [**m34**], suggestive of industrial activity, extends east from Building 1. A small structure with flint wall footings, Building 2, was discovered in this area along with evidence for bronze working, pottery and agricultural activities. As with the 1970s magnetometer survey, no clear magnetic response to Building 2 has been detected. This is unsurprising since the faint negative anomalies caused by flint wall footings will be masked by the surrounding strong magnetic disturbance. However, a number of high magnitude discrete anomalies can be discerned likely to be caused by the remains of kilns or furnaces.

Building 4

North of [**m23**] (Building 1) is what appears to be another rectangular structure [**m25**] about 35m long and 10m wide with its long sides defined by positive linear anomalies on the same alignment. The gap between these is closed at the southern end by a row of four pit-type anomalies but evidence for the north facing side is indistinct. A single row of internal pit-type responses has been detected within [**m25**] parallel with its long axis and west of the structure's longitudinal centre line. While these might represent post holes suggesting an aisled construction, no counterpart row has been detected east of the centre line, so they may instead be a row of pits or indicate an unusual asymmetric single-

aisled construction. It seems likely that [**m25**] relates to Building 4 although its size is larger than the 12m^2 floor area established by trenching and it is possibly somewhat to the north of the position described. As no evidence for walls was uncovered, it is possible that the floor surface found in the excavation represents a postulated yard area, adjacent to the southern end of [**m25**].

Building [**m25**] appears to be superimposed over a rectangular ditched enclosure [**m26**] defined by positive linear magnetic anomalies which share an alignment with a series of other ditch anomalies including [**m35-39**]. This ditch system is aligned at a different angle to [**m23-25**] suggesting, possibly a different phase of occupation. The variation in alignment can be seen most clearly where [**m39**] cuts unconformably across the eastern ditch of [**m21**] at the western side of the villa complex.

A pronounced localised anomaly [**m40**] has been detected 10m west of the centre of building [**m25**]. The strong peak magnitude of 150nT/m suggests thermoremanent magnetisation, so it is likely to represent a hearth, kiln or furnace. A discontinuity in the west facing ditch or wall of [**m25**] where it passes closest to [**m40**] may suggest an opening and thus perhaps an association between the two structures. A further cluster of anomalies immediately south of [**m40**] may also be associated with the activity or process it was used for. About 25m west of [**m40**] another localised anomaly has been detected at [**m41**] with a weaker response of 11nT/m which could represent a well-shaft possibly infilled with occupation derived material.

North-east of [**m25**] a large round pit, around 4.6m in diameter, of unknown purpose has been detected at [**m42**] lying immediately adjacent to ditch [**m36**] potentially relating to the same phase of enclosure layout.

Building 3

Two parallel rows of pit or post-hole anomalies have been detected at [**m27**] that appear to contain intensely magnetised material producing responses with a magnitude of 30-50nT/m. Similar responses were obtained in the 1970s magnetometer survey and were interpreted as probable post holes for posts capable of supporting a substantial aisled building. The excavation report describes Building 3 as having insubstantial masonry footings and a wooden superstructure with a tiled roof. Painted wall plaster and window glass were also found during trial trenching suggesting a building of some sophistication. Anomaly [**m27**] enhances the earlier 1970s survey indicating longer rows of parallel post-pits extending further to the east with a broader rectilinear extension at the east end defined by less substantial pits, that may indicate an outer portico or entrance hall-type structure.

Other buildings in the central area

Two possible further rectangular buildings are found to the west of the villa complex, [**m28**] and [**m29**], both are only partially defined in the magnetic data consistent with the degraded and fragmentary state of preservation recorded from excavation where partial floor and wall deposits were identified suggestive of further buildings. Only the northern end of [**m28**] is clearly defined as this structure is superimposed over elements of the same ditch system as [**m35-39**] on a different alignment and it is possible that at least some of the very fragmentary anomalies at its southern end relate to this, putatively earlier, phase of occupation. Structure [**m29**] has several discrete anomalies within it along with faint linear evidence suggesting internal subdivisions. The northern corner of its outer wall anomaly exhibits a peak magnitude of 69nT/m which may suggest a fired structure, perhaps the heating flue for a hypocaust.

The long axes of buildings [**m23**], [**m24**], [**m27**], [**m28**] and [**m29**] share a broadly common alignment suggesting a unified layout but building [**m27**] to the north is unique in having an almost perpendicular west-north-west to east-south-east orientation. All these buildings are surrounded by extensive spreads of magnetic disturbance, stippled effect in the greyscale images, likely to indicate ceramic building material and burnt deposits being dispersed more widely throughout the soil from areas formerly occupied by the Roman buildings affected by plough damage. This disturbance is particularly intense in the vicinity of [**m23**] and [**m34**] (Buildings 1 and 2), suggesting Roman industrial activity involving fired materials in these locations.

Outlying structures

A probable structure immediately to the west of [**m21**] is found at [**m30**] and coincides with previously excavated features as well as adjacent sections of a ditch with a significantly enhanced magnetic response, up to 20nT/m, suggesting a relationship with high temperature industrial processes. A further well-defined building [**m31**] is situated to the east of the core area and appears to respect a double-ditched north-north-east to south-south-west track or linear boundary [**m43**] on the break of slope at the eastern edge of the plateau occupied by the villa. This raises the possibility that the boundary may originally be of Roman date persisting until recently in the historic mapping and as a still-extant field boundary to the north (Ordnance Survey, Historic County Mapping Series, Essex 1904 to 1939, Epoch 3). The northern end of building [**m31**] appears to include an intense thermoremanent anomaly up to 50nT/m in magnitude, possibly indicative of semi-industrial activity and notably the fill of the ditches of [**m43**] is more intensely magnetised where it passes closest to [**m31**]. Opposite [**m31**] on the southern side of [**m43**] a small rectangular area of enhanced magnetisation has been detected [**m44**] measuring about 6m by 3m which may represent a second building.

To the southeast of the main villa complex a series of rectilinear ditched enclosures, [**m45**] and [**m46**], are possibly indicative of yards or paddocks with some tentative suggestion of more ephemeral structural remains. However, the background magnetic response is more confused in this area, possibly due to former quarrying or natural soil variation [**m12**] and [**m13**]. Enclosures [**m45**] and [**m46**] may coincide with a previously excavated ditch together with a further partially defined rectilinear building [**m32**] possibly associated with a known hearth.

A fragmentary pattern of outlying ditches [**m47**] is visible on the slope to the east of the villa, partially obscured by the intense response to the gas pipeline [**m20**], which hampers the identification of any further settlement activity here (Plate 1). There is also a square-shaped anomaly [**m48**] to the south of the pipeline that may be associated with a more recent brick kiln but might alternatively relate to an outlying element of the Roman villa such as a small shrine or mausoleum.

A previously unidentified enclosure system [**m49-55**] has been revealed in the far western part of the survey coverage approximately 200m from the main villa, perhaps suggesting a separate minor settlement of unknown date, although medieval surface finds have been reported in this area (landowner pers comm). The complex, interlocking character of the ditches forming [**m49-55**] may also suggest multi-phase development of these enclosures.

Ground Penetrating Radar Survey

A graphical summary of the significant GPR anomalies, [**gpr1-46**] discussed in the following text, superimposed on the base OS map data, is provided in Figure 12.

The very near-surface data between 0.0 and 5.0ns (0.0 to 0.19m) is dominated by the site topography, for example demarking the areas reverted to grass [**gpr1**] and the track [**gpr2**] leading to the location of the main villa, with a more complex anomaly [**gpr3**] over the bare earth marking out of the walls of the excavated building in the grass. Due to the attenuative nature of the clay soils at the site these near-surface air-wave responses appear throughout the data set and dominate reflections from approximately 40ns onwards. However, the causative features, primarily either an air-gap between the antenna and the ground surface or the differing compaction of the soil, are restricted to the first few centimetres of the near-surface.

From 7.5ns (0.39m) a series of linear anomalies [**gpr4**] and [**gpr5**] relate to agricultural patterns, presumably relatively recent due to the large areas covered and the very regular spacing. There are also a series of land drains found across the site [**gpr6-9**], generally falling towards the location of the villa where a number of outfalls from mainly stone lined drains are known (landowner pers comm). The gas pipeline [**gpr10**] is also evident to the south of the survey coverage between 12.5 and 20.0ns (0.65 to 1.04m) on a differing

alignment to the field drains [**gpr9**] found here. A diffuse curvilinear anomaly [**gpr11**] is visible between 10.0 and 15.0ns (0.52 to 0.78m), possibly a former field boundary, track or drain associated with the previous extent of the former wood, although there is no record of this on the historic mapping or any corroborating magnetic response.

From 5.0ns (0.26m) onwards amorphous scatters of high amplitude response, possibly ploughed out building debris, may indicate the location of underlying structural remains. Unfortunately, the location of the excavated villa marked out in the grass [**gpr3**] has largely obscured any anomalies due to surviving masonry walls, beyond a section of the south-east end of the villa [**gpr12**] and a more centrally located high amplitude response [**gpr13**]. The semi-circular apse to the south of [**gpr12**] is visible between 12.5 and 22.5 (0.65 to 1.17m) and a similar anomaly was also recorded by a previous trial GPR survey over the main villa, both seem likely to represent Room 4 of Building 1. The wider coverage of the current survey area also shows a linear anomaly [**gpr14**], possibly a drain, falling south from [**gpr12**] to the head of the valley.

It is of interest to note that [**gpr12**] suggests the location of the main villa is currently misrepresented by [**gpr3**] and lies on a revised alignment slightly to the south (Figure 14). This would place the structural remains at [**gpr13**] in an approximate position of the internal bath block within the main villa building (Figure 14, and excavation report Building 1 Rooms 5 and 6), extending west into the adjacent burnt building [**m24**], similar to the magnetic data. In addition, the excavation confirms that Room 4 had footings 0.75m deeper than any other part of villa, except from Rooms 5 and 6. Whilst not entirely conclusive this may partly explain the variable response to the structural remains with only deeper lying wall footings at [**gpr12**] and [**gpr13**] surviving. This slight offset in the position of the villa appears to be confirmed by the location of the excavated Building 2 that appears marked in the grass on the surface at [**gpr15**] and as a rectilinear wall-type response [**gpr16**] between 10.0 and 25.0 (0.52 to 1.3m) to the south-east.

There are further indications of structural remains to the west at [**gpr17-20**], and although these are rather tentative anomalies between 7.5 and 20.0 (0.39 to 1.04m) they do appear to correlate with fragments of walls, floors and possibly Building 3 recorded by the excavation (cf [**m28**] and [**m29**]). As [**gpr17-20**] are found closer to the surface than the main villa and appear less substantial they may well have suffered more plough degradation.

A more tentative rectilinear anomaly [**gpr21**] is found to the north of the survey area where a series of low amplitude ditch-type responses [**gpr22**] partially replicate the magnetic data (cf [**m26**]). There are also several discrete pit-type responses [**gpr23-30**] that may, in part, correlate with thermoremanent magnetic anomalies, for example [**gpr23**] with [**m42**] and [**gpr30**] with [**m40**]. The GPR anomalies in this area appear to be due to causative

features cut into a band of gravel found along the higher ground here, with the low amplitude responses fading in comparison to the magnetic results beyond the extent of the gravel. The boundary ditch identified in the magnetic data at [**m22**] to the east of the villa is replicated as a low amplitude response [**gpr31**], that also contains high amplitude reflectors [**gpr32**] between 7.5 and 22.5 (0.39 to 1.17m) in the central section in the vicinity of the main villa. This may, perhaps, indicate building rubble from the villa accumulating in the section of ditch at [**gpr32**]. It is interesting to note that the most recent metal detector damage to the site recorded in 2022 shows an apparent linear concentration aligned with [**gpr32**], perhaps suggesting the high-amplitude fill of the ditch contains either metal artefacts or waste material from associated manufacturing processes (Figure 14).

An intriguing high-amplitude linear anomaly [**gpr33**] is found between 15.0 and 22.5ns (0.78 to 1.17m) formed of a central axis orientated towards the main villa [**gpr12**] with a branch mid-way to the north. The fall along [**gpr33**] from where it first appears at 15.0ns (0.78m) is both north to the gravel ridge bordering the modern access track and south towards the villa, with no corresponding ceramic or ferrous response in the magnetic data. Other patterns of land drains identified by the GPR [**gpr6-9**] have generally been replicated in the magnetic data suggesting that if [**gpr33**] were a drain it is either stone lined or plastic, although no recent interventions of this type are known here (landowner pers comm). An alternative interpretation of [**gpr33**] could be either a stone lined drain associated with the villa, or even a stone or lead water supply pipe projected to pass through the possible remains of the bath block at [**gpr13**], with a more tentative continuation [**gpr33**] to the south of the villa.

A wider network of ditch-type anomalies [**gpr34-36**] correlate with the track or linear boundary [**m43**] known from the historic mapping and possible ditched enclosures at [**m45**] and [**m46**] respectively. Some of these ditches to the south [**gpr36**] occur in an area of lower lying often wet ground and it is possible that these represent natural channels or unlined drains. There is a highly tentative suggestion of a shared alignment between [**gpr35**] and a linear ditch-type anomaly [**gpr37**] to the west of the villa immediately north of the former wood. Anomaly [**gpr37**] does not appear to correlate with any magnetic response, although there are a series of other possibly associated ditches [**gpr38-40**] in this area. It is, perhaps, more likely that [**gpr36**] and [**gpr37**] represent drainage channels falling into the head of the valley overlooked by the villa, rather than a more continuous network of boundary or enclosure ditches.

Larger, more amorphous low amplitude anomalies [**gpr41-44**] are also found along the course of the old lane on the brow of the hill where the sandy soil is known to be quite variable, possibly suggesting these may be of natural origin. There is little correlation here with the magnetic data, although a similar anomaly [**gpr45**] down the slope to the south

appears to corroborate geological responses [**m9**] and [**m10**]. In addition, the building identified at [**m31**] does not appear to produce any discernible anomalies in the GPR data, although the response here is partially obscured by the background geology and surface plough pattern.

Further south down the slope towards the gas pipeline [**gpr10**] results from the GPR survey have been partially curtailed due to limited GNSS coverage. Although there is some tentative evidence for a land drain [**gpr46**] parallel to [**gpr10**] approximately 10m to the south, this appears to be a very shallow response only visible between 10.0 and 12.5ns (0.52 to 0.65m). No corresponding GPR response is found in the vicinity of [**m48**], however this could be due to increased depth of colluvial overburden at the base of the slope.

Conclusions

As would be expected, results from the magnetic survey have been very successful and generally corroborate anomalies from the previous 1970s geophysics results. There is some improved level of detail, particularly from weaker anomalies, and the extended survey coverage also reveals evidence for additional outlying buildings and a ditched enclosure complex to the west in the vicinity of the farm. The Ground Penetrating Radar (GPR) survey has proved less successful, perhaps due to the soil and general surface conditions at the site, with a more limited and fragmented response to known masonry buildings. Deeper lying wall footings have produced the strongest GPR anomalies and, together with the magnetic results, suggest the position and orientation of the main villa building (Building 1) lies slightly south-east of the location marked on the surface of the field (Figure 14). While the majority of archaeological activity associated with the villa appears to lie within the currently scheduled area, taking further parts of the field out of arable production to the north and north-east would afford better protection to Building 3 (the aisled hall) and a newly identified industrial building [**m31**], that appears to be a target for illegal metal detecting (Figure 13).

More tentative anomalies revealed by the new geophysical survey suggest the presence of fragmentary masonry remains, indicating a wider range of buildings within the scheduled area. There is also some evidence for a small structure south of the gas pipeline at the bottom of the slope to the west of the villa, although it is unclear whether this is related to the Roman settlement or later brick making activity. The GPR data has potentially located a possible water supply to the main villa bath suite, however there is no excavation data to confirm this. Recent damage recorded over the site following illicit metal detecting activity appears to be concentrated to the east of the main villa building on the edge of the plateau defined by the lane removed in late 1940s. Figure 13 suggests this activity is focused over enclosures and possible buildings associated with semi-industrial activity in the areas of the site that are still under arable production. Reversion to grass over the main villa buildings appears to have successfully deterred illicit metal detecting activity, presumably by limiting the replenishment of artefacts in the topsoil through episodic ploughing (Figures 13 and 14). Although the area in the immediate vicinity of the former wood produced few significant anomalies, coverage of this part of the site with both techniques was timely in advance of the proposed tree planting here.

List of Enclosed Figures

References

Eide, E, Linford, N, Persico, R and Sala, J 2018 'Advanced SFCW GPR systems' *in* Persico, R, Piro, S and Linford, N (eds), *Innovation in Near-Surface Geophysics Instrumentation, Application, and Data Processing Methods* Amsterdam: Elsevier, 253-285.

Geological Survey of Great Britain (England and Wales) 1990s England and Wales, Solid and Drift edition. 1:50000 series., Ordnance Survey, Chessington, Surrey.

Linford, N 2004 'From Hypocaust to Hyperbola: Ground Penetrating Radar surveys over mainly Roman remains in the U.K.'. *Archaeological Prospection*, **11** (4), 237-246.

Linford, N 2013. *Rapid processing of GPR time slices for data visualisation during field acquisition*. In Neubauer, W, Trinks, I, Salisbury, R and Einwogerer, C (Editors), Archaeological Prospection, Proceedings of the 10th International Conference, May 29th - June 2nd 2013 2013 (Vienna: Austrian Academy of Sciences Press). 176-78.

Linford, N and Linford, P 2017. *The application of semi-automated vector identification to large scale archaeological data sets considering anomaly morphology*. In Jennings, B, Gaffney, C, Sparrow, T and Gaffney, S (Editors), 12th International Conference of Archaeological Prospection, 12-16th September 2017 2017 (Bradford: Archaeopress Archaeology). 138-9.

Linford, N, Linford, P, Martin, L and Payne, A 2010 'Stepped-frequency GPR survey with a multi-element array antenna: Results from field application on archaeological sites'. *Archaeological Prospection*, **17** (3), 187-198.

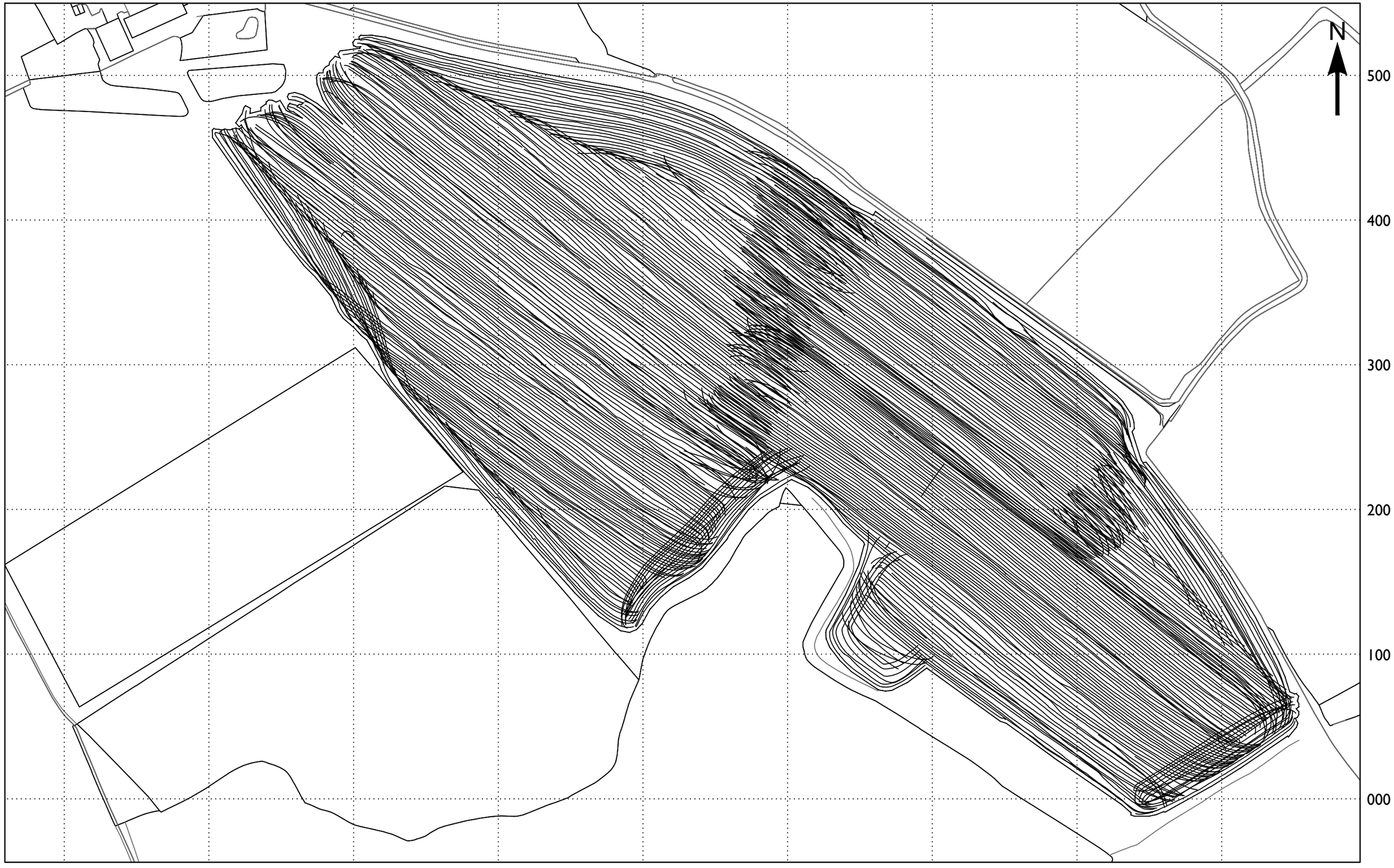
Sala, J and Linford, N 2012 'Processing stepped frequency continuous wave GPR systems to obtain maximum value from archaeological data sets '. *Near Surface Geophysics*, **10** (1), 3-10.

Soil Survey of England and Wales 1980s Soils of England and Wales: Sheet 4 - Eastern England, 1:250,000 soil map. Harpenden, Lawes Agricultural Trust.

Figure 1

SITE NEAR SUDBURY, SUFFOLK

Location of caesium magnetometer instrument swaths, October 2021



0 150m

1:2500

Caesium magnetometer survey swaths

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Historic England

Figure 2

SITE NEAR SUDBURY, SUFFOLK
Location of GPR swaths, October 2021

0 150m

1:2500

Ground Penetrating Radar survey swaths

2021-10-19-001 Location of selected GPR profiles shown on Figure 7

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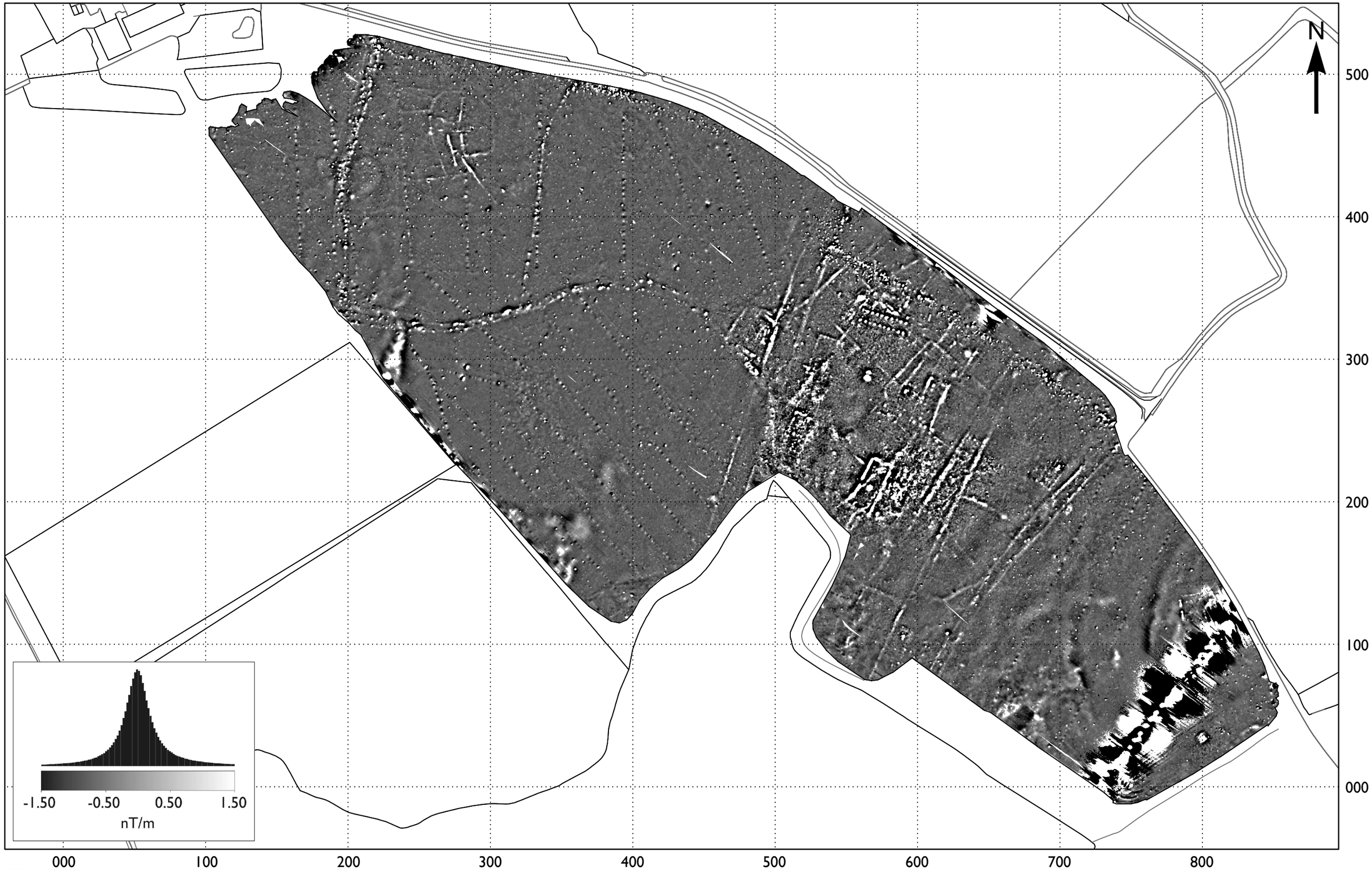
Historic England

Figure 3

SITE NEAR SUDBURY, SUFFOLK

Linear greyscale image of the caesium magnetometer data, October 2021



0 150m

1:2500

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Figure 4

SITE NEAR SUDBURY, SUFFOLK

GPR amplitude time slice between 15.0 and 17.5ns (0.78 to 0.91m), October 2021

0 150m

1:2500

Low *High*

relative reflector strength

2021-10-19-001 Location of selected GPR profiles shown on Figure 7

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Figure 5

SITE NEAR SUDBURY, SUFFOLK
Caesium magnetometer survey, October 2021

Trace plot of range (-120 to +120 nT/m) truncated and interpolated minimally processed data

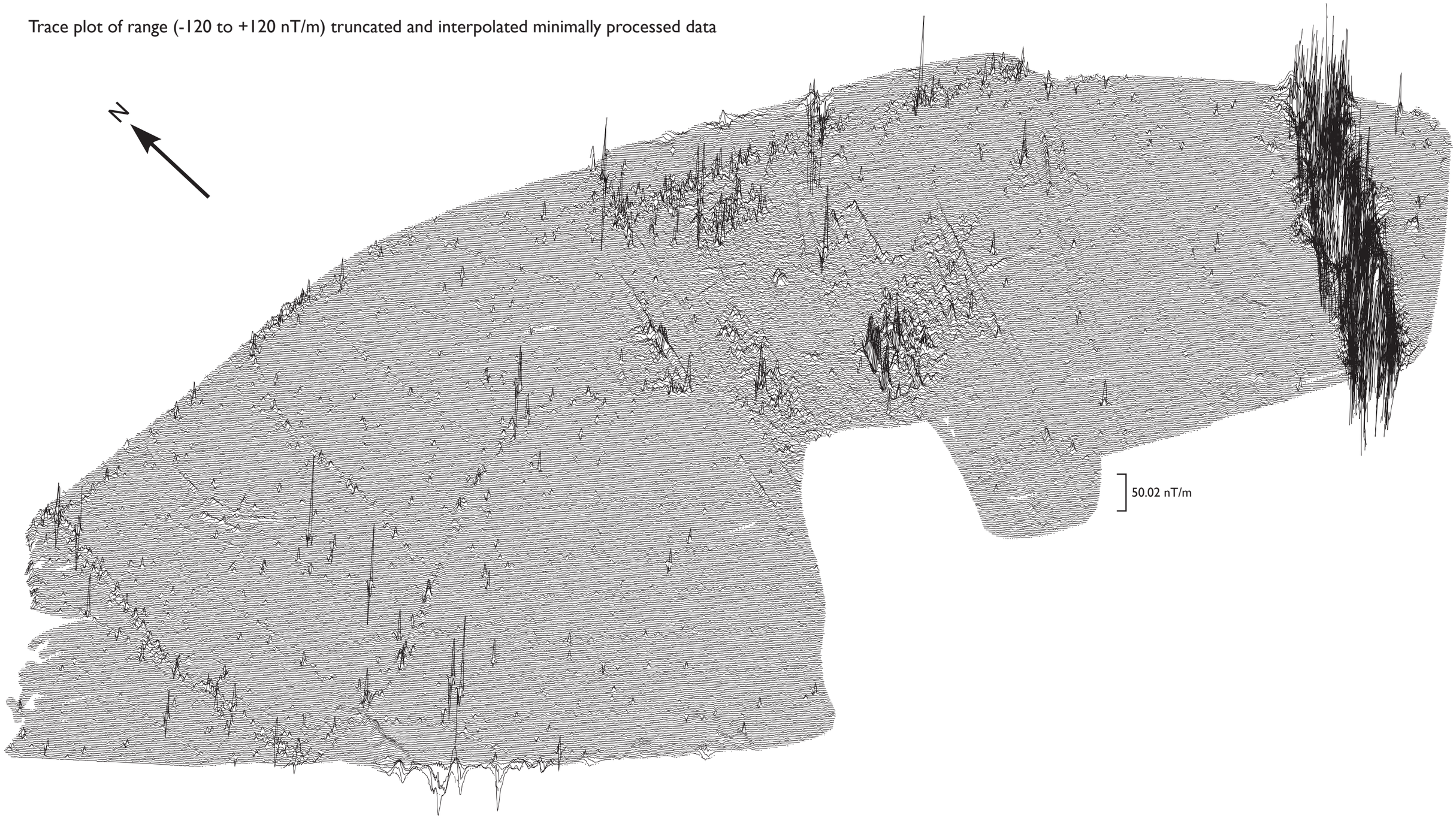

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Figure 6

SITE NEAR SUDBURY, SUFFOLK
Caesium magnetometer survey, October 2021

Histogram normalised greyscale image of minimally processed data

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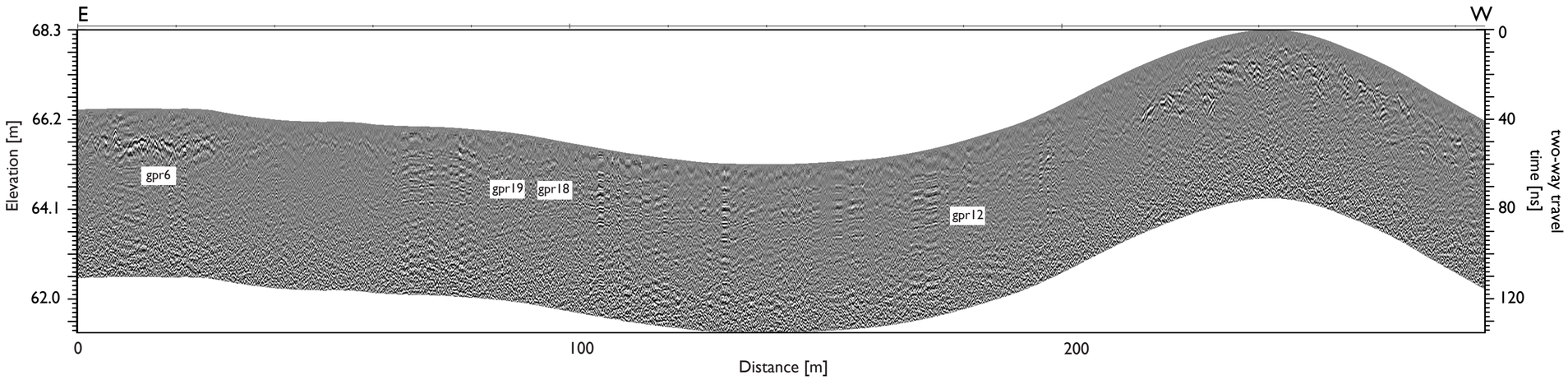
SITE NEAR SUDBURY, SUFFOLK

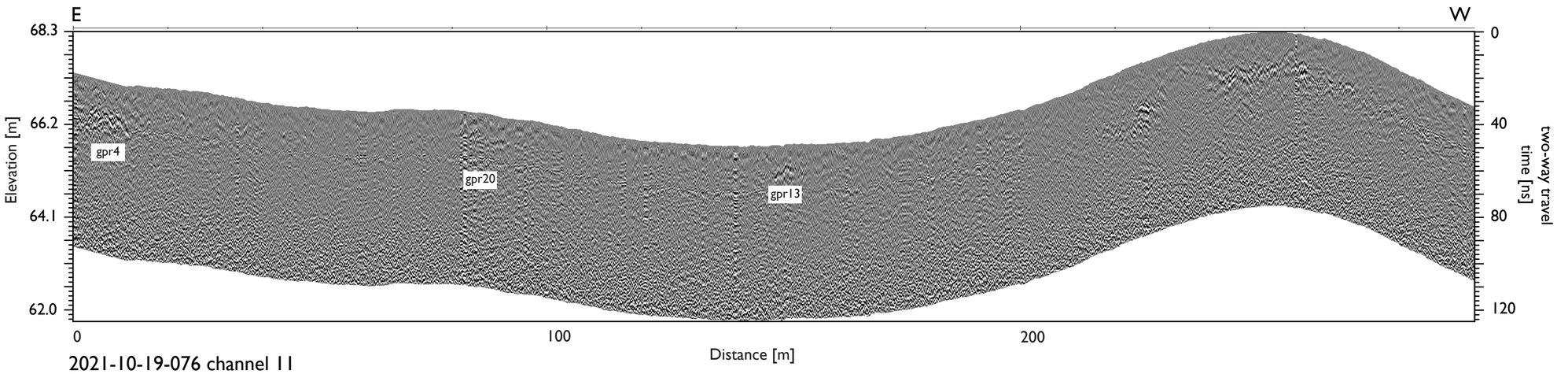
Figure 7

Topographically corrected GPR profiles, October 2021

2021-10-19-022 channel 11



2021-10-19-027 channel 10



2021-10-19-076 channel 11

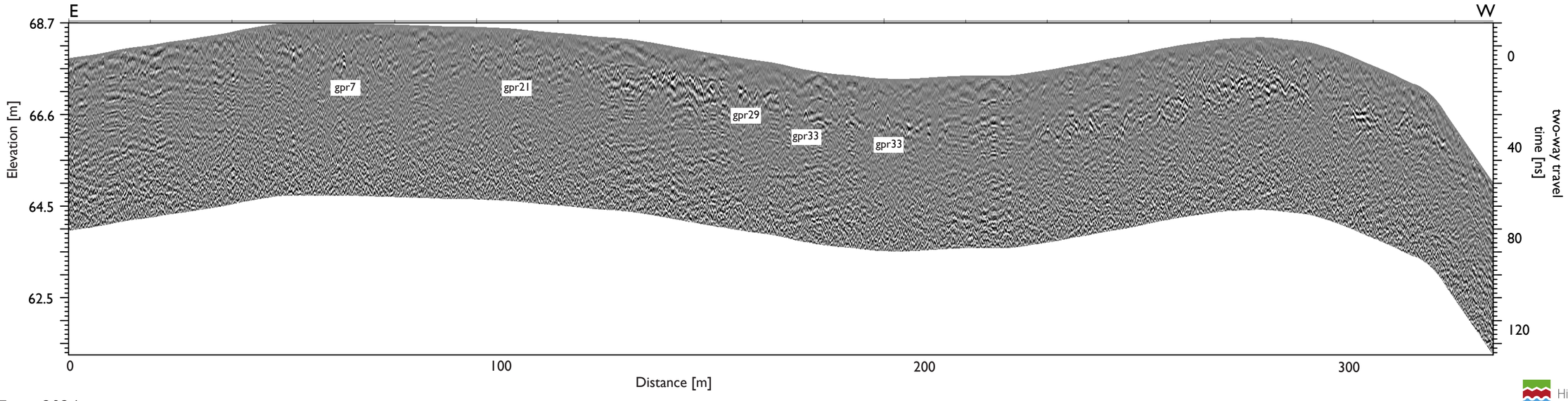


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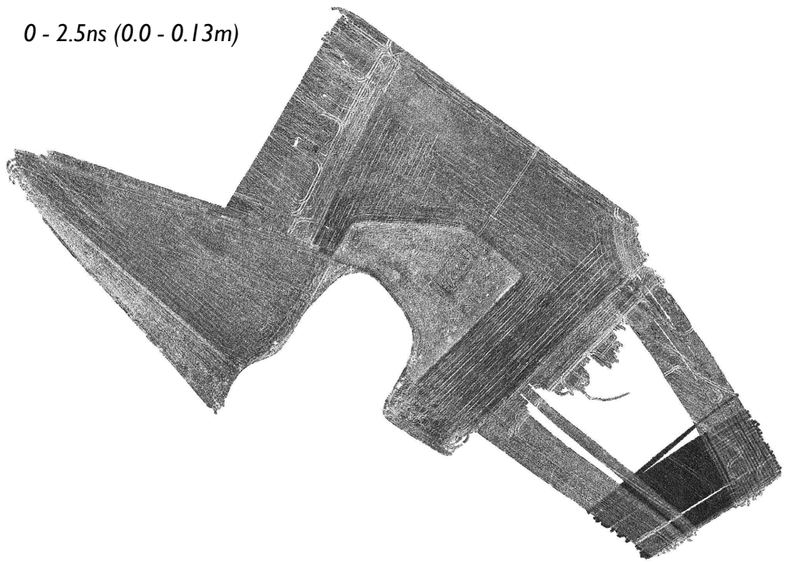
Figure 8

SITE NEAR SUDBURY, SUFFOLK

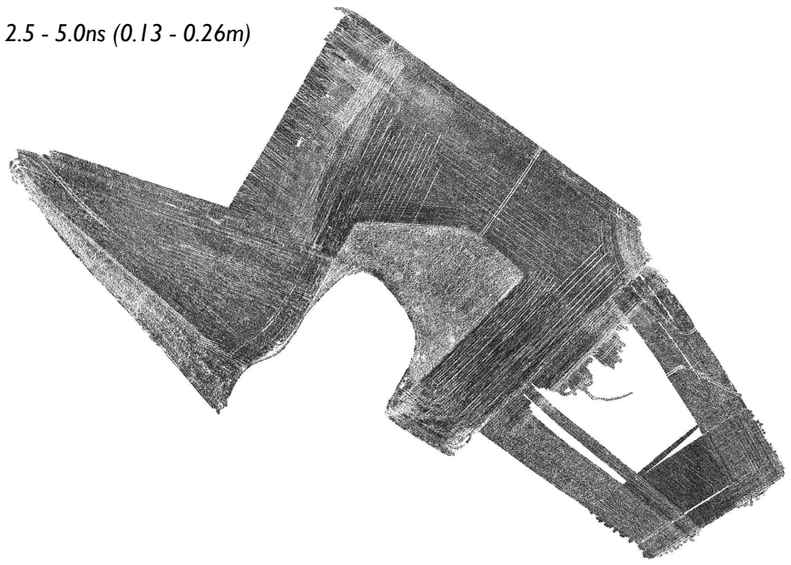
GPR amplitude time slices between 0.0 and 22.5ns (0.0 to 1.16m), October 2021

N

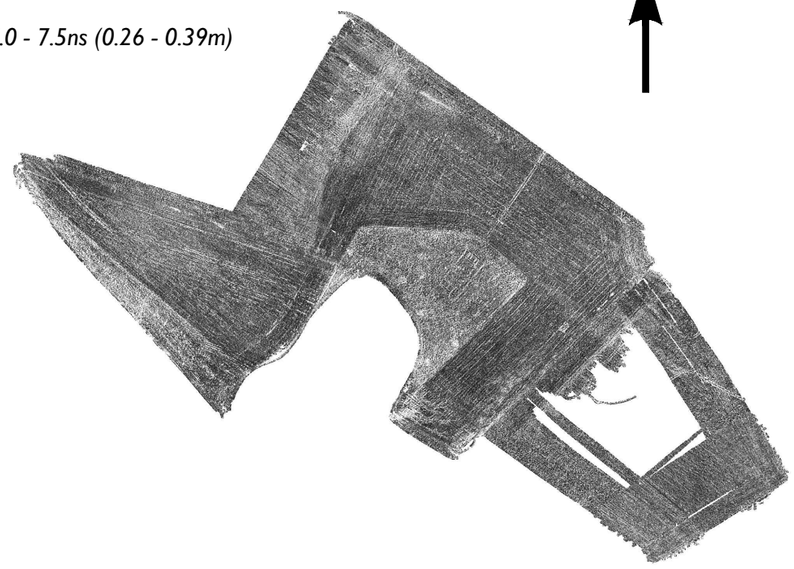
0 - 2.5ns (0.0 - 0.13m)



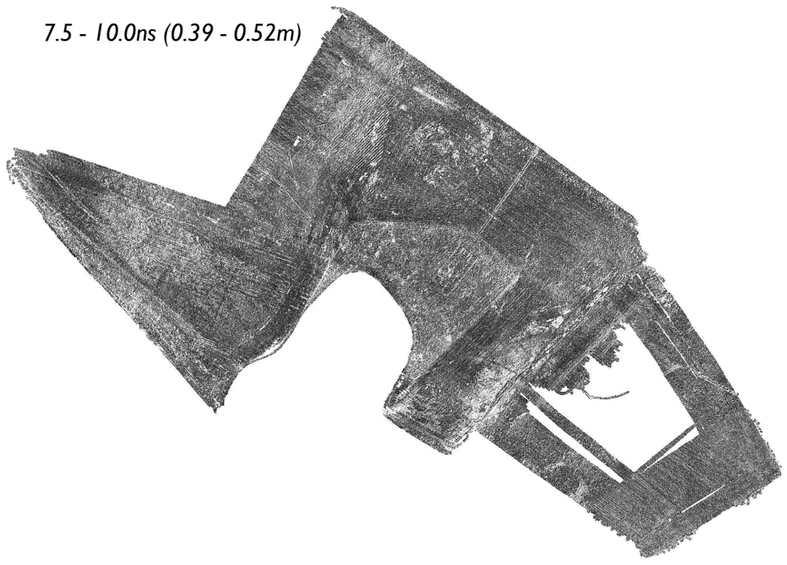
2.5 - 5.0ns (0.13 - 0.26m)



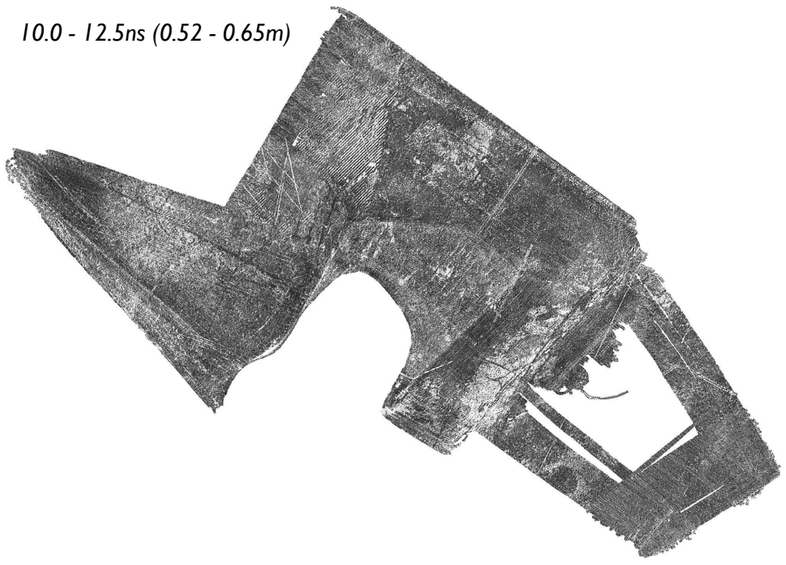
5.0 - 7.5ns (0.26 - 0.39m)



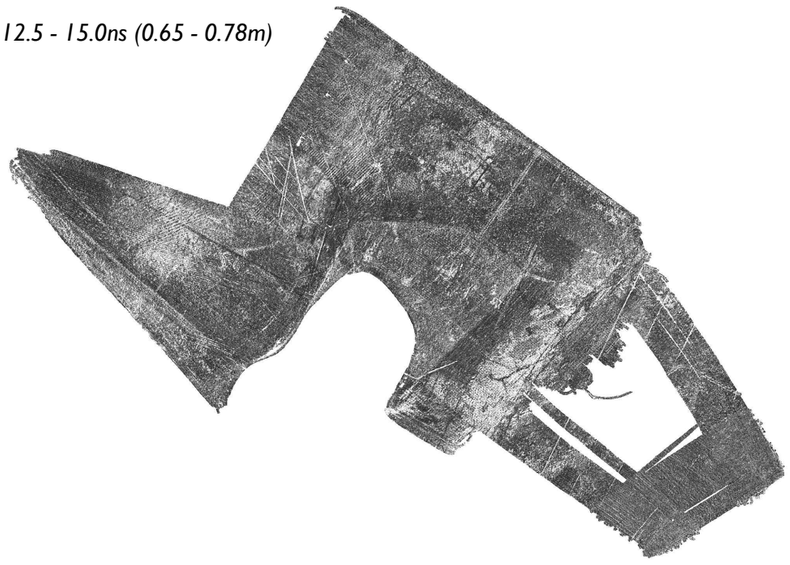
7.5 - 10.0ns (0.39 - 0.52m)



10.0 - 12.5ns (0.52 - 0.65m)



12.5 - 15.0ns (0.65 - 0.78m)



0 180m

1:5000

Low *High*

relative reflector strength

Geophysics Team 2022

Historic England

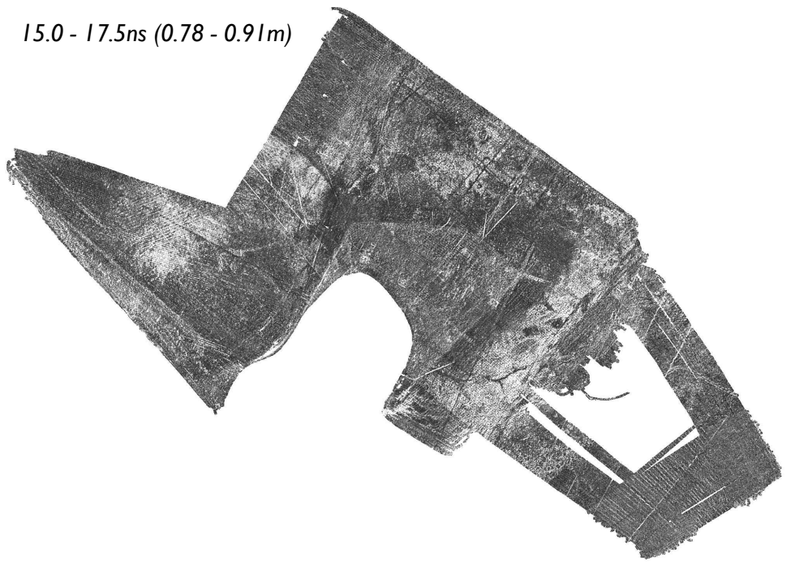
Figure 9

SITE NEAR SUDBURY, SUFFOLK

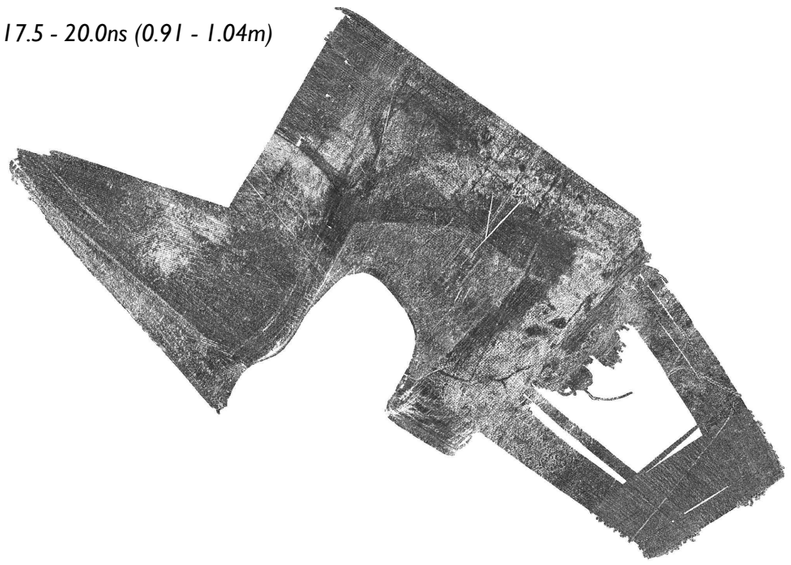
GPR amplitude time slices between 15.0 and 30.0ns (0.78 to 1.56m), October 2021

N

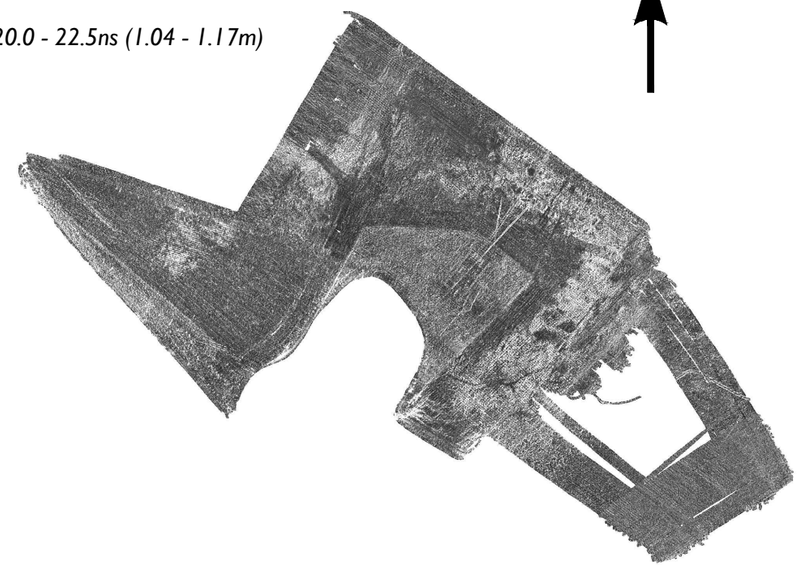
15.0 - 17.5ns (0.78 - 0.91m)



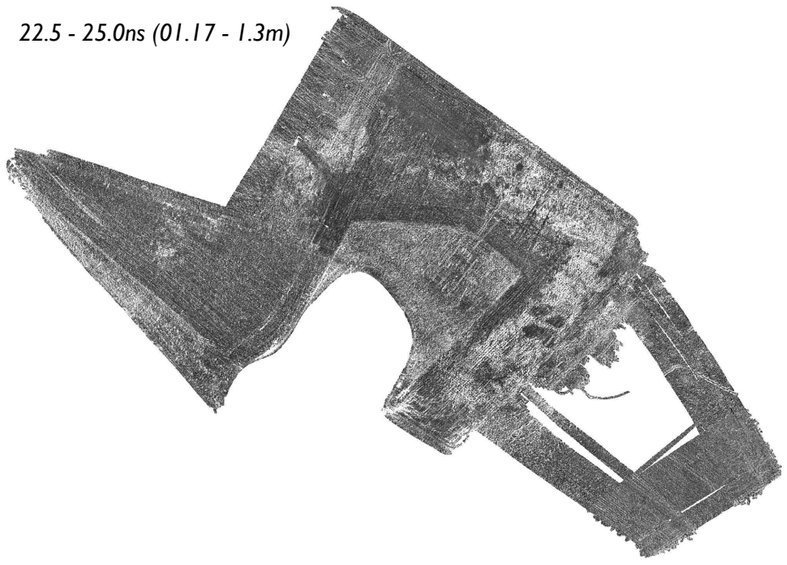
17.5 - 20.0ns (0.91 - 1.04m)



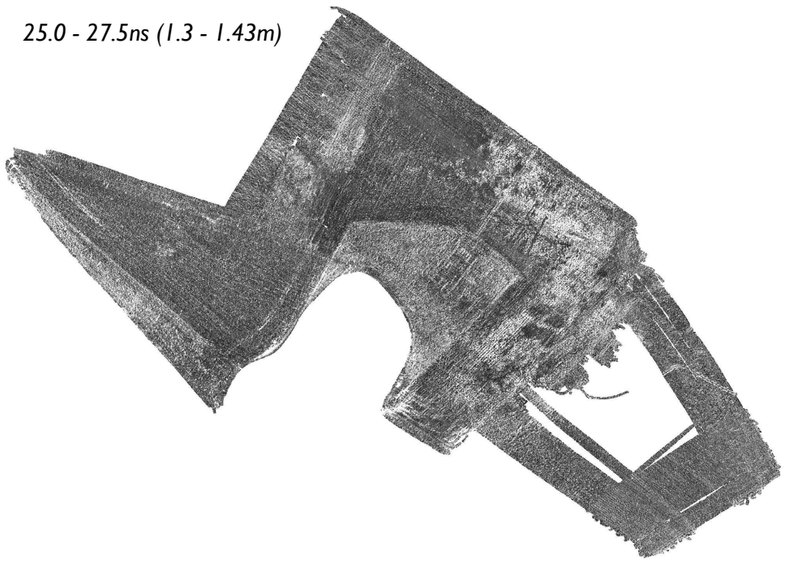
20.0 - 22.5ns (1.04 - 1.17m)



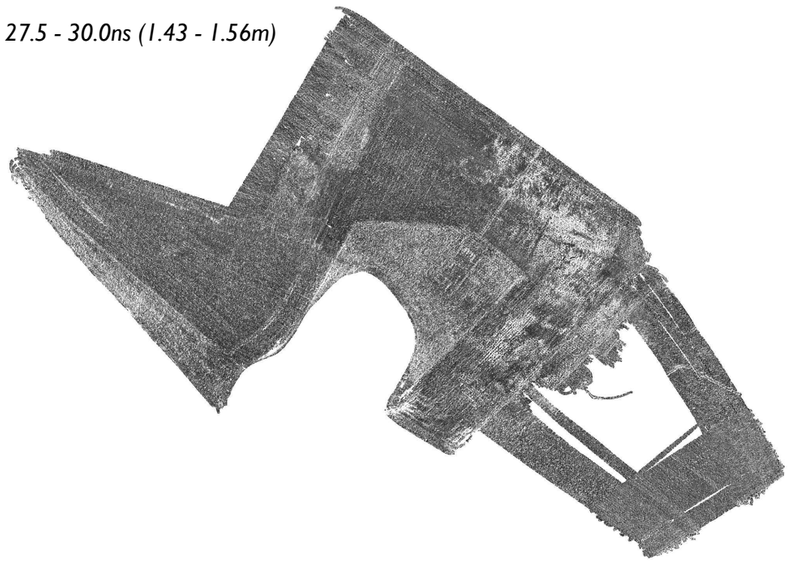
22.5 - 25.0ns (01.17 - 1.3m)



25.0 - 27.5ns (1.3 - 1.43m)



27.5 - 30.0ns (1.43 - 1.56m)



0 180m

1:5000

Low *High*

relative reflector strength

Geophysics Team 2022

Historic England

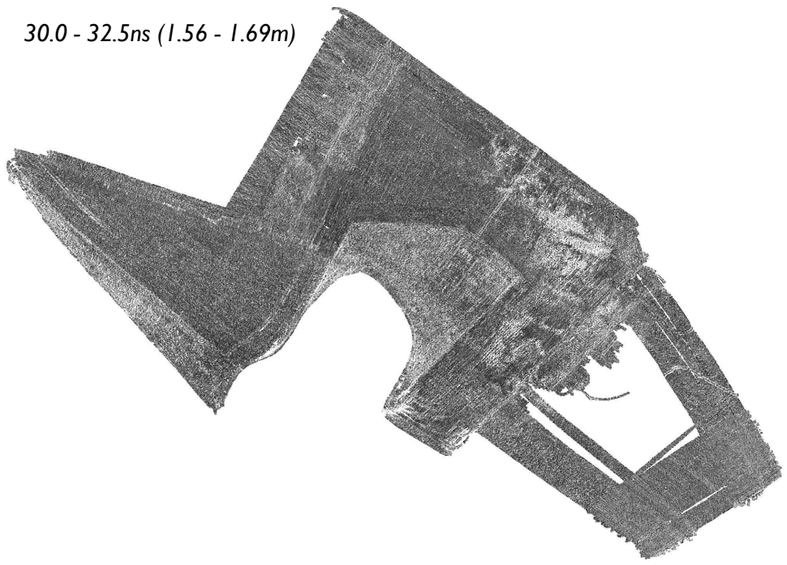
Figure 10

SITE NEAR SUDBURY, SUFFOLK

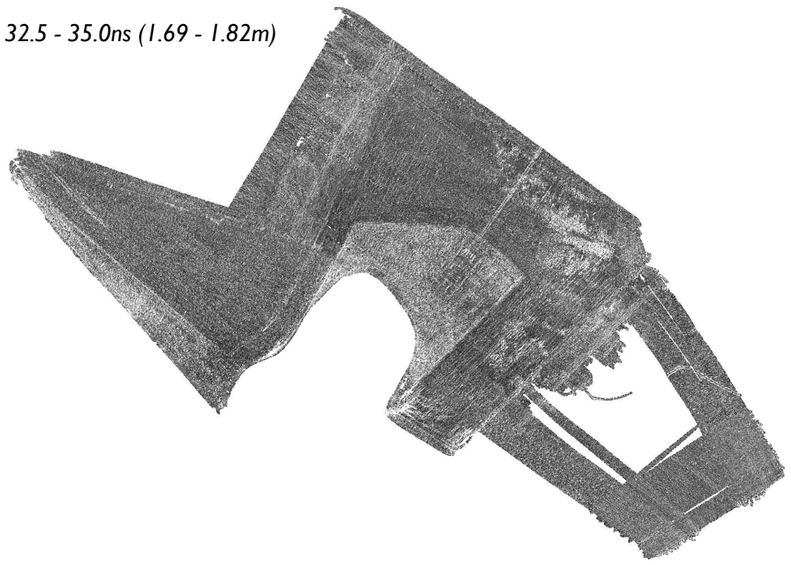
GPR amplitude time slices between 30.0 and 45.0ns (1.56 to 2.43m), October 2021

N

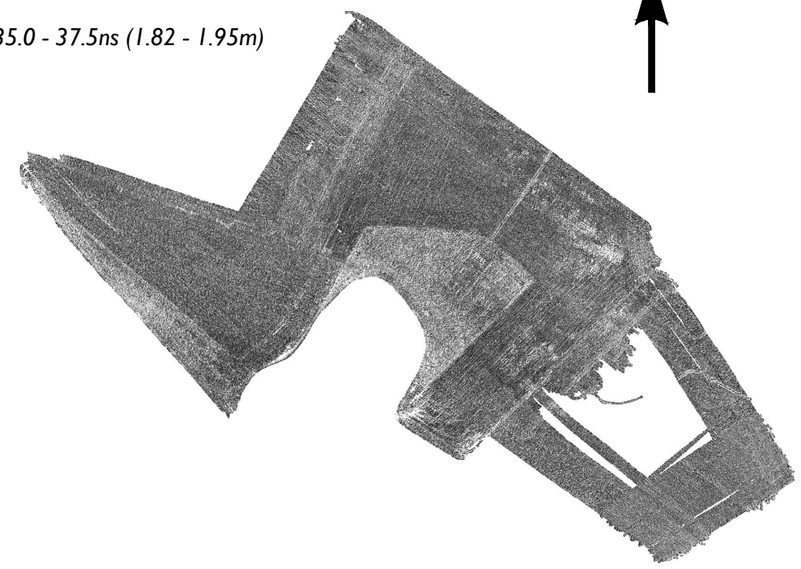
30.0 - 32.5ns (1.56 - 1.69m)



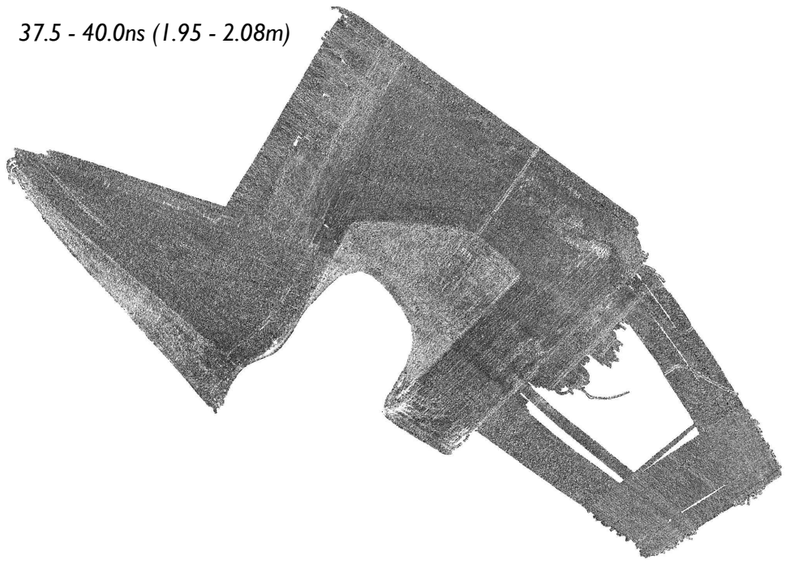
32.5 - 35.0ns (1.69 - 1.82m)



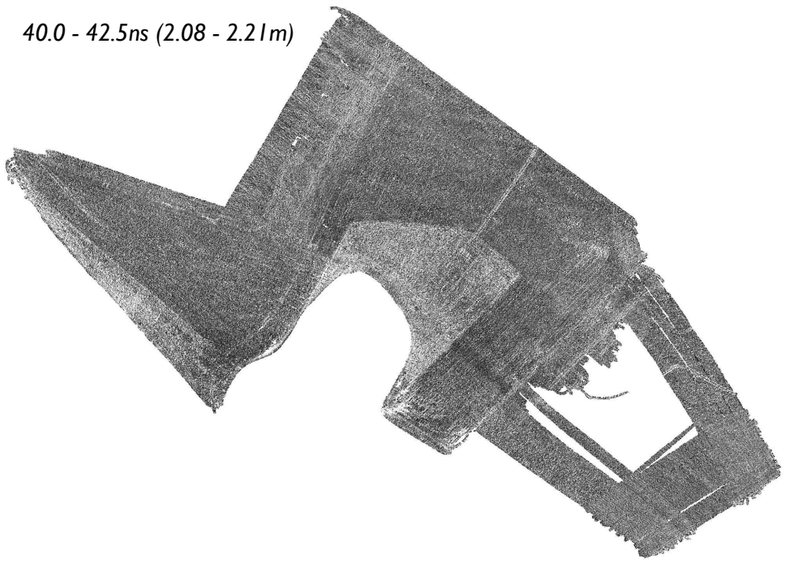
35.0 - 37.5ns (1.82 - 1.95m)



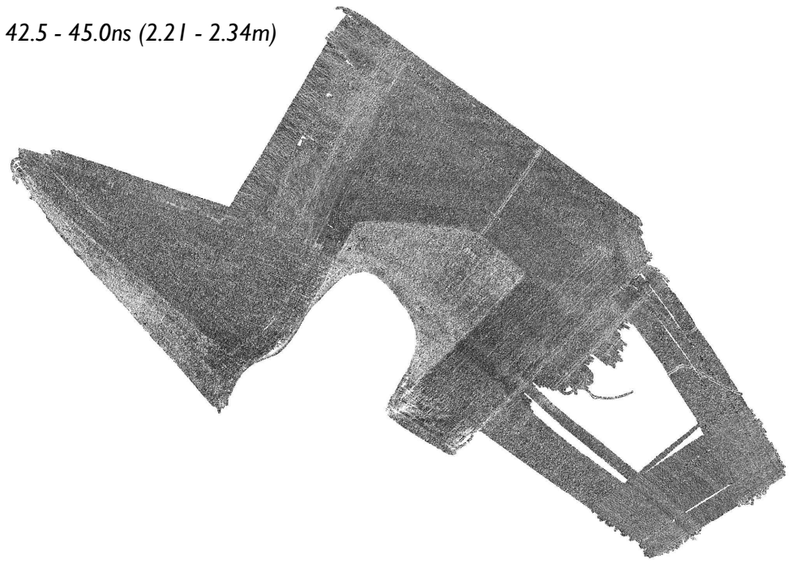
37.5 - 40.0ns (1.95 - 2.08m)



40.0 - 42.5ns (2.08 - 2.21m)



42.5 - 45.0ns (2.21 - 2.34m)



0 180m

1:5000

Low *High*

relative reflector strength

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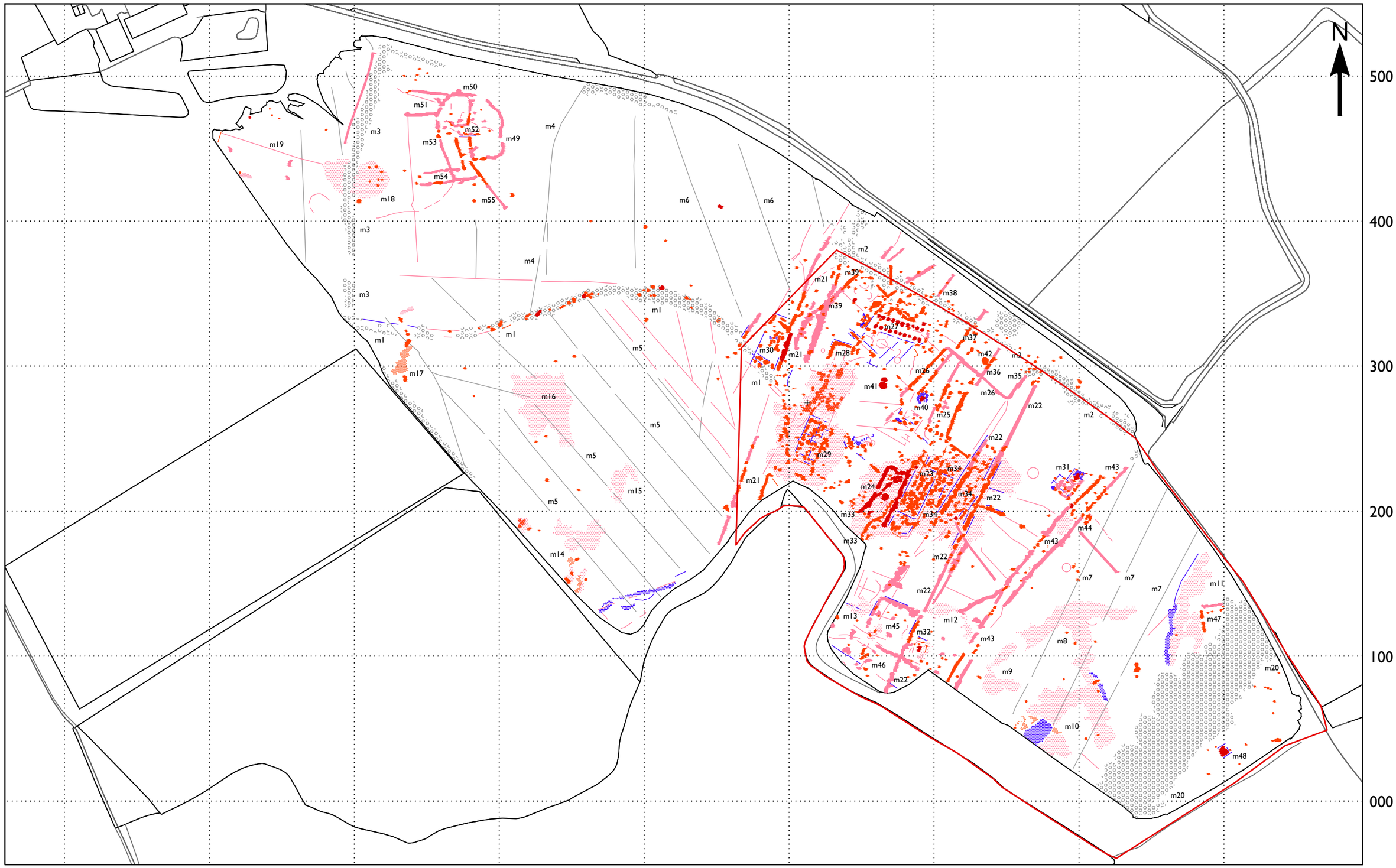
Historic England

Figure 11

SITE NEAR SUDBURY, SUFFOLK

Graphical summary of significant magnetic anomalies, October 2021



0 150m

1:2500

positive magnetic
raised magnetic
negative magnetic
magnetic noise
strong positive magnetic
extent of scheduled monument

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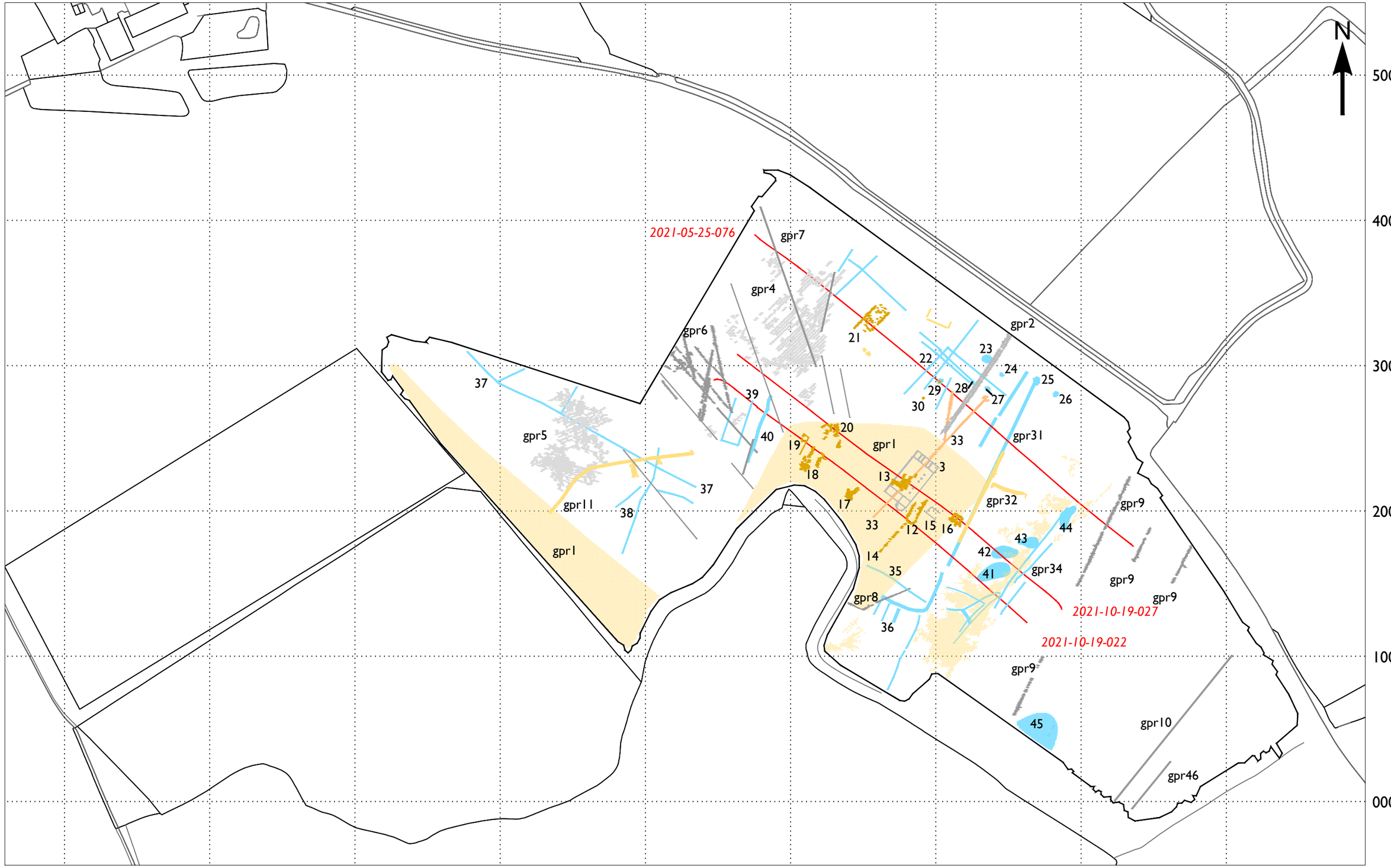
Historic England

Figure 12

SITE NEAR SUDBURY, SUFFOLK

Graphical summary of GPR anomalies, October 2021



0 150m

1:2500

low amplitude reflectors

high amplitude reflectors

anomalies of known or recent origin

2021-05-25-001 Location of selected GPR profiles shown on Figure 7

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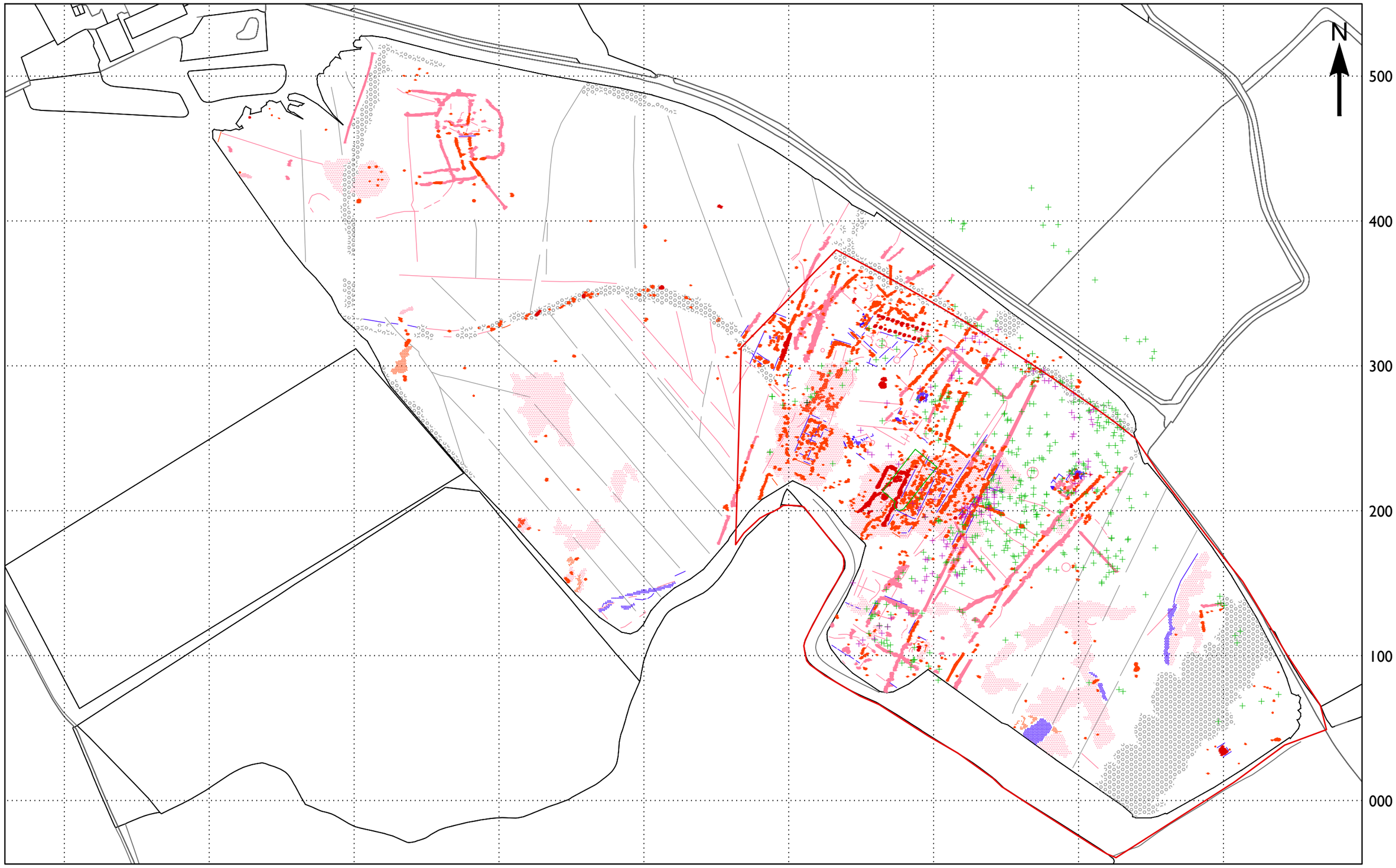
Historic England

Figure 13

SITE NEAR SUDBURY, SUFFOLK

Location of recorded 2014 and 2022 metal detecting holes in relation to significant magnetic anomalies



0 150m

1:2500

positive magnetic
raised magnetic
negative magnetic
magnetic noise
strong positive magnetic
extent of scheduled monument
2014 metal detecting holes
2022 metal detecting holes

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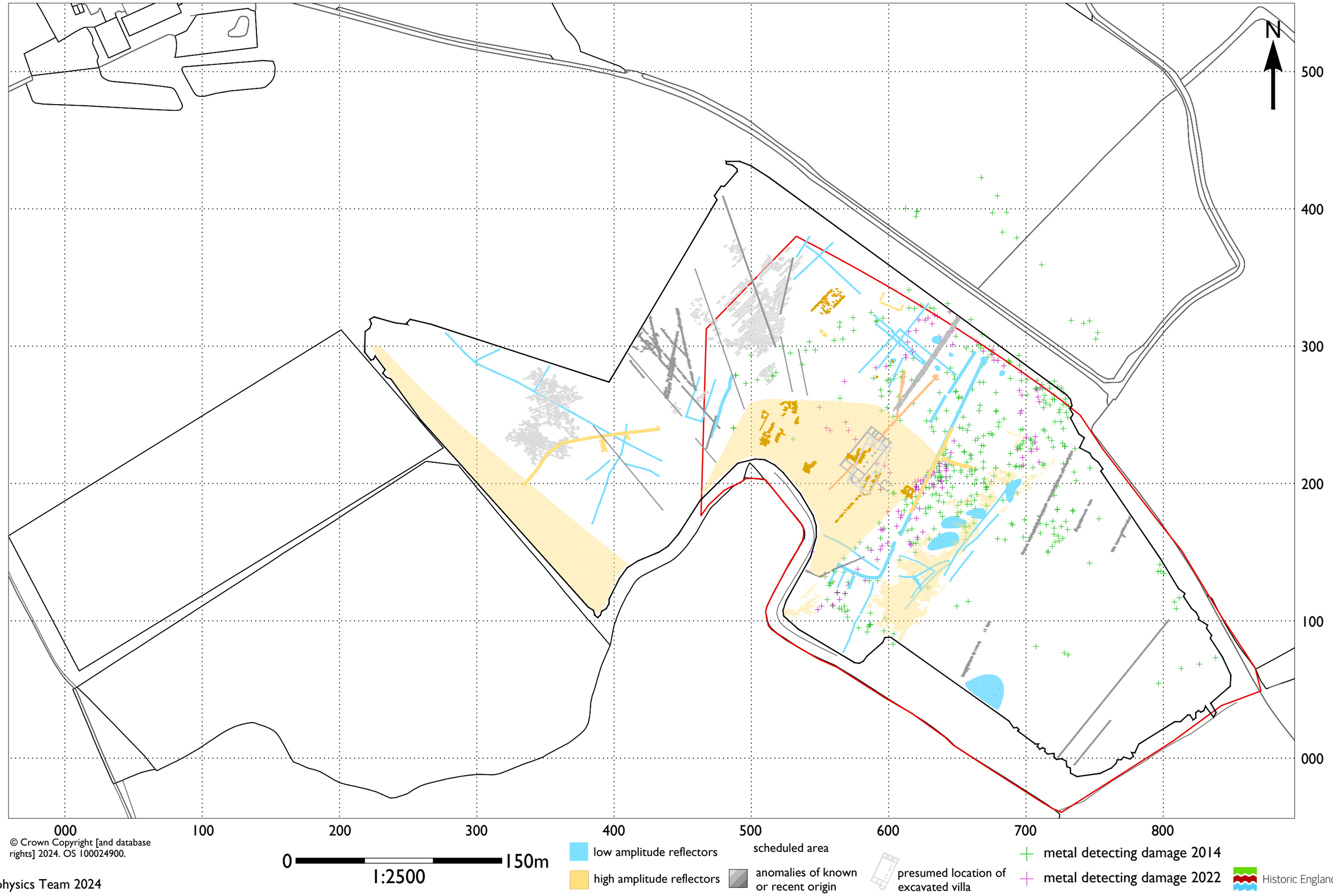
Figure 14

SITE NEAR SUDBURY, SUFFOLK

Metal detecting activity 2014 and 2022 superimposed over GPR anomalies , October 2021



0 150m

1:2500

low amplitude reflectors

high amplitude reflectors

scheduled area

anomalies of known or recent origin

presumed location of excavated villa

metal detecting damage 2014

metal detecting damage 2022

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