

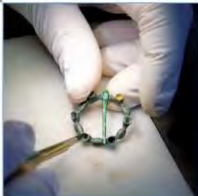
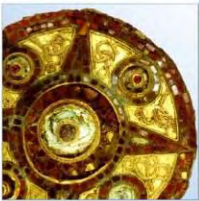
Wymondley Solar Farm Hertfordshire

Archaeological Geophysical Survey

National Grid Reference: TL 22190 28540

AOC Project No: 40205

Date: November 2021



ARCHAEOLOGY

HERITAGE

CONSERVATION

Wymondley Solar Farm, Hertfordshire

Archaeological Geophysical Survey

On Behalf of:	Axis Well House Barns Chester Road Bretton Cheshire CH4 0DH
National Grid Reference (NGR):	TL 22190 28540 (centre)
AOC Project No:	40205
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Date of survey:	15th November 2021
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This document has been prepared in accordance with AOC standard operating procedures.

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Non-Technical Summary

AOC Archaeology Group was commissioned by AXIS PED to undertake an archaeological geophysical gradiometer survey on 15th November 2021 January 2020 to investigate the potential for buried archaeological remains ahead of a proposed development at Wymondley, Hertfordshire (centred at TL 22190 28540).

A total of 85 hectares were surveyed and the results of the survey have identified the following.

There are three concentrations of anomalies of archaeological origin, two smaller ones in the northwest and southeast of the survey area, covering roughly 1ha each, and a more substantial group in the central eastern part of the survey area which covers approximately 8ha. All three anomaly groups potentially date from later prehistory through to the medieval period, on the basis of their spatial arrangement and characteristics. All three activity foci also have evidence for settlement and for some sort of production involving high temperature processes. The northern part of the survey area also contains evidence for extraction, so it seems likely that the inhabitants of these settlements were extracting and processing local raw materials. A large modern utility passes through the eastern half of the survey area on a north-south alignment; this has impacted the survey results and the archaeological features in this area making more certain dating or interpretation of them difficult.

Though there is clear archaeology present within the survey area, it is generally spatially constrained, with anomalies occurring in distinct clusters rather than a more general dispersal. The clarity of the results and the variety of features that can be identified within them lend confidence to the results, especially that there are unlikely to be substantial features of archaeological interest that have not been detected.

In addition to the archaeology and extraction, the survey has also identified former field boundaries, an area of different land use not depicted on available maps, and broad anomalies related to changes in the underlying superficial deposits. A small area of ploughing has also been tentatively interpreted as ridge and furrow, as noted in the HER records for the area. Modern ploughing regimes were also evident, as were drainage systems, especially in the northern part of the survey area.

A number of areas of magnetic disturbance, most likely the result of modern activity were also recorded, principally at field margins and entrances.

1 Introduction

- 1.1 AOC Archaeology Group was commissioned by Axis PED to undertake an archaeological geophysical gradiometer survey of a site at Wymondley in Hertfordshire. The survey was conducted during 15th November to 24th November 2021 as part of a wider scheme of archaeological assessment in advance of the proposed development of the site.
- 1.2 Archaeological geophysical survey uses non-intrusive and non-destructive techniques to determine the presence or absence of anomalies likely to be caused by archaeological features, structures or deposits, as far as is reasonably possible (CIfA, 2014).
- 1.3 The survey was carried out to provide information on the extent and significance of potential buried archaeological remains within the proposed development site.

2 Site Location and Description

- 2.1 The proposed development site (hereafter 'the Site') is located to the east of Great Wymondley (Figure 1) and currently comprises arable farmland. The Site comprises two portions of land to the north and south of Graveley Lane. It is bound to the east by the A1(M) and surrounded by further arable farmland on its other sides and is centred at TL 22190 28540.
- 2.2 The Site covers approximately 85 hectares (ha) across 5 fields consisting of arable fields. The ground level is recorded at approximately 95m Above Ordnance Datum (AOD) in the lowest lying parts of the Site adjacent to the south and west boundary, and at approximately 110m AOD close to the northeast corner of the Site.
- 2.3 The bedrock recorded geology within the site consists of chalk of the Holywell Nodular Formation. The bedrock is overlain by superficial mid-pleistocene glaciofluvial deposits of sand and gravel in the western part of the Site and glaciolacustrine deposits of clay and silt are recorded in the northeast corner of the Site. The bedrock is overlain by superficial diamicton deposits of the Lowestoft Formation in the central part of the site (BGS, 2021). These are in turn overlain by lime-rich loamy and clayey soils with impeded drainage (Soilscapes, 2021).
- 2.4 Gradiometer survey is suggested to provide a good response over limestones, especially over Cretaceous chalk bedrocks (David *et al.* 2008, 15). In this case, the clarity of the geophysical results is good, and the local geology was deemed not to have had a detrimental effect on the visibility of trends within the dataset, despite in places resulting in strong anomalies associated with natural variations in the superficial geology.

3 Archaeological Background

- 3.1 The archaeological background is summarised from the Historic Environment Desk Based Assessment of the Site, produced by AOC Archaeology in September (AOC, 2021). All references are drawn from this report.

Prehistoric (500,000 BC – AD 43)

- 3.2 Undated prehistoric flints including flakes, a scraper, and a blade have been recorded through fieldwalking conducted within the Site in 1993 adjacent to the A1(M) in advance of its widening. Sherds of Iron Age pottery, together with Roman and medieval sherds, have also been recorded within the Site by fieldwalking; these may be associated with the site of a possible Roman farmstead, discussed below. Cropmarks of six parallel linear ditches within the Site that lead towards an asymmetrical multi-

ditched enclosure to the northeast of the Site are also recorded by the HER within the Site; although undated, the features may be prehistoric in date.

- 3.3 The Site lies within a broad glacial valley cut through the scarp of the Chilterns in the last ice age, known as the 'Hitchin-Stevenage Gap'. Lakes formed in hollows left behind following the retreat of the Anglian ice sheet, which were gradually infilled with fine sediments; these sediments have produced Palaeolithic implements discarded by people active around the edges of the lakes (AOC, 2021). Little Wymondley lies at the eastern edge of a large lake under the present town of Hitchin. A further lake has been identified at Fisher's Green, to the south of the Site (Fitzpatrick-Matthews 2020a, 5). The earliest evidence for activity recorded by the HER within 1km of the Site comprises a Palaeolithic flint implement reportedly found at Great Wymondley, although it is not precisely located. A separate Palaeolithic hand axe held by the North Hertfordshire Museum has also been found in the parish of Wymondley, representing part of a large group of similar artefacts recovered from the Hitchin area.
- 3.4 The presence of mid-Pleistocene glaciolacustrine deposits of clay and silt mapped by the BGS in the northeast corner of the Site may suggest an elevated potential for Palaeolithic remains to be encountered within the Site, although such remains are rare.
- 3.5 Holocene prehistoric activity within the wider area is attested by numerous finds of flint implements recorded by the HER within 1km of the Site, including a Mesolithic tranchet axe found at Great Wymondley. Many other prehistoric flint tools have been found to the north of the Site surrounding Willian and Roxley Court, these include: a further Mesolithic tranchet axe; a Neolithic axe; a Neolithic arrowhead; and a Neolithic flint knife and arrowhead. A Bronze Age flint scraper and celt were also reportedly discovered in Willian in 1935.
- 3.6 Further assemblages of prehistoric flint have also been recorded through fieldwalking in fields to the south of the Site, and a possible large penannular enclosure has been identified through aerial photography adjacent to A1(M) Junction 8. Elsewhere within the Study Area, numerous cropmarks of possible prehistoric ring-ditches or round barrows have been recorded through the analysis of aerial photography. Of these, the closest to the Site are two ring ditches identified by aerial photography approximately 200m north of the Site on Jack's Hill. The enclosures are between 30m and 35m in diameter and may represent a pair of plough-raised barrows of possible Bronze Age date. A further possible barrow located approximately 800m to the southeast of the Site was partially investigated in 2016, although produced no dating evidence.
- 3.7 Later prehistoric settlement within the Study Area is suggested by the discovery of five bell-shaped pits containing rubbish, including Late Bronze Age or early Iron Age pottery, which were discovered in 1930 during the construction of a garage at Jacks Hill, around 700m to the northeast of the Site. A Roman coin (Site 149) was recovered from the topsoil above these pits.
- 3.8 Given the frequency and density of prehistoric remains recorded within the Site and in the surrounding landscape by the HER, there is considered a high potential for further remains of this date to be encountered within the Site. Although such remains are most likely to be later prehistoric, the presence of potential Palaeolithic remains associated with Pleistocene deposits recorded within the Site should not be discounted.

Romano-British (AD 43 – AD 410)

- 3.9 The site of a possible Roman farmstead, located partly within the eastern part of the Site, has been suggested by finds of Iron Age and Roman material observed in advance of the laying of a water pipeline in 1975. Correspondence with Letchworth Museum records that Roman pottery was found where topsoil was stripped in advance of the pipe trench. Fieldwalking to the west of the pipeline

revealed further Roman pottery, together with tile, slate, bone, stone, flint and chalk rubble, and one decorated piece of stone. The HER notes that the site may have been partly destroyed by the construction of the A1(M).

- 3.10 Immediately to the west of the northern part of the Site, a Roman settlement and cemetery was discovered in the 19th century to the north of St Mary's Church and Wymondley Castle. A cremation cemetery comprising 43 cinerary urns accompanied with other grave goods, likely dating to the 2nd century AD, was uncovered in 1882. Further extensive Roman remains including pottery, building material, and a ditch were also uncovered in the area to the west of the cemetery in the 19th century. The location of both discoveries has been recorded by Ordnance Survey mapping since 1924. A possible Roman infant feeding bottle and 3rd century Roman pottery held at Letchworth Museum are also likely to have been recovered from the same area.
- 3.11 Structural remains that appear to indicate a settlement associated with the cemetery were excavated in an area to the rear of six cottages built to the north of the Wymondley Castle motte in 1937. The remains included flint and chalk rubble floors, a pit, 1st and 2nd century AD pottery, building material, and animal bones. These remains have been used to suggest that the earthworks surrounding the castle may be Roman in origin. Roman tiles incorporated in the Nave wall of St Mary's Church may have originated in this earlier settlement. The settlement has been interpreted as a possible community of agricultural workers, who may have been the tenants of the owners of the Roman villa at Ninesprings, located approximately 1km to the west of the Site.
- 3.12 The Scheduled Roman villa at Ninesprings was first excavated in 1884, revealing seven rooms, three hypocausts, a tessellated pavement, and painted plaster. Numerous finds of Roman material in the vicinity have been made since; these include: a dump of pottery and building material; bronze earpicks; a bronze figurine of Hercules; and a 3rd century coin hoard. Cropmarks of rectilinear ditches have also been observed in the fields surrounding the villa.
- 3.13 The present B197 follows the probable route of a Roman road, located to the east of the current A1(M) approximately 300m to the east of the Site. A section of the road and associated ditch was exposed during the construction of a pipeline at Jack's Hill in 1975, although was not recorded in detail. Given the location of the Roman settlement at Great Wymondley in relation to this road, it might be assumed that the present Graveley Road that bisects the Site may have originated as a route in the Roman period.
- 3.14 A second possible Roman cemetery within 1km of the Site was discovered in 1849 during the construction of the Great Northern Railway at Little Wymondley approximately 900m west of the southern part of the Site, when finds of vessels containing bones were disturbed by the railway cutting. A further small Roman pot was recovered from the railway cutting in the same area later in the 19th century.
- 3.15 Other Roman remains recorded within 1km of the Site by the HER include the site of a substantial Roman farmstead recorded by archaeological trial trenching along the route of the Wymondley bypass in 1990, around 900m to the southwest of the Site. The site possibly occupied over 3 hectares, with buildings represented by foundations, worked stone, and other building material. Three cobbled surfaces and radiating ditches were also recorded. A later archaeological watching brief in the same area recorded Roman pottery and a pit with a concentration of flint and sandstone.
- 3.16 It is clear that the landscape surrounding the Site was extensively settled and farmed during the Roman period; as such, there is considered a High potential for further Roman remains to be encountered within the Site. Of particular note is material recovered through fieldwalking adjacent to the eastern Site boundary that may indicate the location of a possible farmstead or other Roman

structures within the Site. The proximity of the Roman settlement and cemetery immediately to the west of the Site also suggests an elevated potential for further associated remains to be present within the Site. It might be assumed that the cemetery would have been located at the edge of the Roman settlement at Great Wymondley, and that any associated remains within the Site may therefore be most likely to be agricultural in nature.

Medieval (AD 410 – AD 1540)

- 3.17 The place name Wymondley is first recorded in the 11th century as 'Wilmundeslea', combining an Old English person's name Wilmund with the suffix lea/lēah meaning woodland clearing. The only evidence for early medieval activity recorded by the HER within 1km of the Site is suggested by pottery dating from the 9th century onwards which was recovered from a series of intercutting ditches recorded by trial trenching around 550m west of the Site in 2010. The Portable Antiquities Scheme (PAS) records several finds of 7th to 8th century sceattas at Jacks Hill, to the northeast of the Site; these coins have been used to suggest the possible location of a market in the early medieval period.
- 3.18 The manor of Wymondley is recorded as 'Wimundeslai' by the time of the Domesday Survey in 1086. It is mentioned in four separate entries in the Domesday Book, with the largest landholding containing the village of Great Wymondley held by King William I and granted to Reginald de Argentein. The separate settlements of Great Wymondley and Little Wymondley are not referred to until the late-12th century. A Norman castle was constructed at Great Wymondley, approximately 250m to the west of the Site. The castle comprises of earthwork remains of a small motte and bailey inserted in the southwest corner of a larger rectangular earthwork, surrounded by further earthworks to the east. The earthworks may be consistent with a medieval manorial complex, although some boundaries may originate in the Roman period. St Mary's Church was built immediately to the west of the castle in the 12th century.
- 3.19 The church was held by Wymondley Priory, which was founded as an Augustinian monastic hospital dedicated to St Mary by Richard de Argentein between 1203 and 1207. The medieval history of the priory is documented within its surviving 13th century Cartulary held at the British Museum and has been summarised by Noël Farris within *The Wymondleys*. The priory represented one of the smaller houses at its dissolution in 1537, with the Prior and four cannons living there described as 'of slender report' by the Royal commissioner's. Part of the un-aisled nave of the medieval priory church survives as the taller part of the 16th century house, The Priory. Surrounding garden walls incorporate medieval foundations to the east of house, together with re-used stonework from the priory buildings. The priory and an early post-Dissolution barn are located within an enclosure defined by a moat of possible medieval date, although a detailed survey for the National Monuments Record concluded that it may have instead formed an ornamental feature associated with the post-Dissolution house. Earthwork remains underlying the post-Dissolution parkland survive in the field north of the priory, which appear to form an enclosure relating to a small medieval agricultural complex attached to the priory, and a small area of ridge and furrow survives to the east of the moat.
- 3.20 Water for the priory was supplied by a spring that rose within a conduit head around 450m to the northeast of the priory. The spring fed fish breeding ponds and a stew pond for the priory that still survive to the north and northeast of the moat. Water from the spring was also used for domestic purposes and turned a spit in the priory kitchen as late as 1865. The water was conveyed to the priory (at least in the post-medieval period) by elm pipes, some of which were dug up in 1920. The present conduit head represents a reconstructed ruin, built c.1902, although incorporates an original medieval clunch archway.

- 3.21 The southern part of the Site would have been located within the landholding of Wymondley Priory in the medieval period, and several features of this date are recorded within the Site by the HER. Cropmarks of small enclosures, ditches, ridge and furrow, and general disturbance indicative of medieval settlement are recorded within the area surrounding the southwest part of the Site near to the precinct of the priory. To the east of the priory, within the Site, the HER also records the discovery a few sherds of medieval pottery in 1975, which were collected when topsoil was stripped for a water pipeline running through the southern part of the Site. Most significantly, large quantities of medieval pottery, tile, building stone, animal bone, and slate were recorded along the route of the same pipeline adjacent to the eastern edge of the Site over an area of around 100m by 50m. Following construction of the pipe trench features including the remains of rubbish pits which produced stratified 12th-13th century pottery were revealed. The remains have been interpreted as suggesting the site of a possible medieval farmstead, that may have been related to Wymondley Priory or to the medieval village of Graveley. The HER locates these remains beneath the present A1(M) adjacent to the Site.
- 3.22 The HER also records further finds of medieval pottery uncovered during the construction of the same water pipeline outside the Site. Other medieval remains recorded within 1km of the Site include: earthworks relating to a possible manorial site and settlement earthworks at Graveley; medieval pottery and tile recovered during the construction of the Wymondley Bypass; and medieval buildings.
- 3.23 There is considered a High potential for further medieval remains to be encountered within the Site. Given that the Site is located to the east of the precinct of Wymondley Priory, such remains are most likely to relate to the enclosure and cultivation of the Site in the medieval period. However, the discovery of rubbish pits containing stratified 12th-13th century pottery and medieval building material close to the eastern edge of the Site in 1975 suggests an elevated potential for previously unrecorded settlement or farmstead remains to survive within this area of the Site.

Post medieval – Industrial Period (AD 1540 – 1901)

- 3.24 Wymondley Priory was dissolved in 1537 and granted by the Crown to James Needham, who converted it into a private house. Early maps encompassing the Site tend to be schematic and lack detail, although these maps can give some idea of the nature of settlement patterns and land use. Norden and Kip's 1637 map of Hertfordshire (not illustrated) annotates both of the villages of 'Wimley P[arva]' and 'Wimley M[agna]' together with the priory, although provides little detail of the Site itself. Blaeu's 1646 county map (also not illustrated) provides a similar depiction. The earliest detailed map of the Site consulted is a 1731 of the Manor of Wymondley Priory and Graveley Hall Farm plan drawn by Thomas Browne. The map was surveyed a few years before the priory estate was sold from the descendants of James Needham to Samuel Vanderplank in 1734.
- 3.25 Browne's 1731 plan shows the southern portion of the Site enclosed into several small irregular plots and divided between Wymondley Priory and Graveley Hall Farm. Parts of two fields let to a tenant known as Renley are located in the southern part of the Site. The map is likely to represent the medieval enclosure of the land as part of the priory estate.
- 3.26 The plan also provides a detailed depiction of the grounds surrounding the priory in the early 18th century, as they had been altered by the Needham family since its dissolution. Within the moat of the priory (which may have been dug as an ornamental feature following the Suppression), the plan depicts the tithe barn to the south of the enlarged priory. Recent dendrochronology has demonstrated that timbers for the barn were felled in the winter of AD 1540-41, shortly after the priory estate had passed to James Needham, although some re-used timbers in the roof were felled in the period AD 1373-9. The plan also depicts other post-Dissolution buildings associated with the priory: the 17th century barn and attached 18th century stable; the 16th century dovecote; and garden walls. The field

to the north of the moat where earthworks suggest the location of a medieval tenant settlement appears to have been planted as post-medieval parkland, 'The Park'. The map also depicts the location of a windmill in 'Great Mill Field' on the west side of Priory Lane and a pond in 'Little Barn Field' that survives as an earthwork depression visible on LiDAR imagery.

- 3.27 The 1731 plan also depicts the conduit head in the fields to the northeast of the priory, connected to fishponds in 'The Park' by a channel. The western part of the channel and ponds still survive although the eastern part has subsequently been infilled. Two 18th century watercolours by Henry Oldfield (fl. 1785 - 1805) depict the conduit head as it had been reconstructed after the Dissolution, with ornamental brickwork surrounding the medieval clunch arch supporting a thatched roof; numerous internal niches are shown incorporated into the walls surrounding a central stone basin. It is unclear what similarity the structure had to its medieval predecessor, although a handwritten annotation beneath the paintings within Hertfordshire Topography Vol VII (compiled 1889) speculates that:
- 3.28 'it appears also by the benches in the niches etc. to have been a sort of pleasant retreat in the heat of summer for the religious inhabitants of the priory who might here enjoy their wine diluted with the cool crystal spring, rising in the middle of the building'.
- 3.29 By the end of the 19th century the conduit head structure had evidently fallen into disrepair; it is annotated only as 'Old Wall' on the 1884 Ordnance Survey map. An undated photograph of the conduit head possibly taken at the end of the 19th century shows only some remaining 16th century brickwork surrounding the medieval arch. The 1884 Ordnance Survey map also shows that some plot boundaries depicted on the 1731 plan had been removed to create larger fields. The intervening Wymondley Enclosure Act of 1811 did not affect the land within the Site to the south of Graveley Lane, since this had already been enclosed as part of the priory estate in the medieval period. In contrast, the open field system may have endured within the Site to the north of Graveley Lane until its enclosure in 1811. The 1811 enclosure map (Hertfordshire Archives: QS/E81) shows the northern part of the Site divided into enclosed fields held by Walter Adams, Philip Hewes, Mary Hewes, and S.H.U Heathcote (of Shephall Manor). The enclosure map also shows the remainder of the Site, together with much of the land surrounding Great and Little Wymondley, under the ownership of Samuel Heathcote. The priory and its land (including Graveley Hall Farm) had passed to Heathcote in 1806, whose family held it for more than a century after.
- 3.30 The HER records numerous further post-medieval farm buildings not related to the priory within 1km of the Site. Other post-medieval heritage assets recorded within the Study Area include: a Tudor coin hoard discovered in 1973 in Little Wymondley; a lane depicted on the Graveley tithe map; the site of a possible brick-clamp kiln; road and rail bridge; a milestone; a culvert; and finds of post-medieval brick and tile recovered through fieldwalking associated with the widening of the A1(M).
- 3.31 Given that the Site is likely to have been located within undeveloped agricultural land throughout the post-medieval period, the potential for substantial post-medieval remains to be encountered within the Site is considered Low to Medium. Any potential remains dating to the post-medieval period are likely to be agricultural in nature.

Modern (1901 – present)

- 3.32 Ordnance Survey mapping appears to show very little change to the Site during much of the 20th century. The Ordnance Survey map of 1960 depicts the Site in a similar manner to the first edition mapping. The A1 was constructed adjacent to the east Site boundary between 1964 and 1968 (Ordnance Survey 1964 and 1968); at the same time a cutting was created to enable Graveley Lane to pass underneath it. Further field boundaries within the Site were removed to create larger fields within the Site at the end of the 20th century (Ordnance Survey 1980).

- 3.33 The conduit head, located approximately 60m west of the Site, was reconstructed once more in c. 1902 by the East Herts Archaeological Society with permission and financial assistance from Col. Unwin Heathcote. The Victoria County History reports that the design was copied from another old building elsewhere, although it appears loosely consistent with the 18th century depictions of the structure by Henry Oldfield. A contemporary newspaper cutting held by the Gerish Collection in Hertfordshire Archives states that the building 'may in former times have been used for ecclesiastical purposes, and the new erection is finished off with a cross' (Hertfordshire Archives: D/G1/87/2/20).
- 3.34 Given that the Site appears to have remained in agricultural use throughout the 20th century, the potential for previously unrecorded substantial modern remains to be encountered within the Site is considered Low.

Aerial Photographs

- 3.35 The Historic England Archives at Swindon hold 196 vertical and 69 oblique aerial photographs of the Site and Study Area dating from 1945 to 2010.
- 3.36 The National Collection of Aerial Photographs (NCAP) and the Cambridge University Collection of Aerial Photographs (CUCAP) were also consulted through their online resources. A 1952 oblique photograph of Wymondley Priory held by CUCAP (ref: HH62) shows medieval settlement earthworks to the north of the priory and a small area of surviving ridge and furrow, although does not include the Site. A 1982 vertical aerial photograph held by NCAP (Sortie: HSL/HERTS/82/0002, Frame: 2163) encompasses the Site, although does not record any cropmarks apart from the route of a high-pressure gas pipeline that crosses the southern part of the Site.
- 3.37 The Hertfordshire HER records two areas of cropmarks centred within the Site: cropmarks of small-ditched enclosures, ditches, ridge and furrow, and general disturbance indicative of medieval settlement near to the priory; and cropmarks of a rectangular asymmetrical multi-ditched enclosure and associated linear ditches of unknown date near to the eastern boundary of the Site. Both are recorded through an analysis of composite vertical photomaps held by Hertfordshire County Council. An enquiry was sent to the Hertfordshire HER on the 6th September 2021 concerning the possibility of obtaining copies for the purposes of this assessment; these have not yet been consulted.

Previous Investigations

- 3.38 The Hertfordshire HER records numerous previous archaeological investigations within 1km of the Site. Details of previous investigations include archaeological interventions; aerial photographic interpretation and other photographic recording. These have been referred to above where relevant to the Site.

LiDAR

- 3.39 LiDAR DTM 1m data was downloaded from DEFRA in September 2021 and internally processed by AOC Archaeology. The imagery reproduced in the figure has been produced using multiple relief shading outputs by illuminating a surface from multiple directions to enhance visualization of topography; the imagery is composed of 16 individual hillshades combined into a single image.
- 3.40 LiDAR ('light detection and ranging') is a remote sensing technique which describes a method of determining three-dimensional (3D) data points by using a laser (Historic England, 2018). Airborne LiDAR consists of an active laser beam being transmitted in pulses from a fixed-wing or rotary aircraft and the returning reflection being measured. The first returns are considered equivalent to the digital surface model (DSM) and the last being used to help calculate a digital terrain model (DTM). The DSM is a digital elevation model of the land surface; it records the highest points, including buildings and

the woodland canopy. The DTM is a digital elevation model of the bare earth, i.e. the ground beneath any vegetation with other structures such as buildings removed (Historic England 2018, 7).

- 3.41 When processing LIDAR data, it is considered good practice to process both the DTM and DSM datasets – this is because DTMs provides useful information about woodland areas. However, DTM data can remove man made features, so could easily remove archaeological features like walls or designed landscapes. Therefore, in non-wooded areas, a DSM is preferable because of the absence of smoothing effects (Historic England 2018). Both DSM and DTM LiDAR data with a 1m spatial resolution were produced from the Point Cloud (LAZ) and subsequently improved by using the software Relief Visualization Toolbox and SAGA GIS. This has been used to produce a number of visualisations. Resulting visualisations were then compared and further analysed for potential archaeological features.
- 3.42 The LiDAR imagery shows earthwork remains relating to medieval settlement to the north of the priory very clearly, together with watercourses, trackways, and extant areas of ridge and furrow. Within the Site, field boundaries relating to the irregular enclosure of southern and north-eastern part of the Site depicted on the 1731 plan of the Manor of Wymondley Priory and Graveley Hall Farm are visible. In the central part of the Site to the north of Graveley Lane, a long curving earthwork bank representing part of the former parish boundary depicted on the 1811 enclosure map (Hertfordshire Archives: QS/E81) and later Ordnance Survey mapping is also clearly visible, with other former field boundaries radiating from it. Potentially underlying these field boundaries in the northwest part of the Site are broad linear trends that might be tentatively interpreted as indicating the remnants of medieval broad ridge and furrow (centred at TL 22031 28614). Three earthwork depressions (centred at TL 22397 28347, TL 22275 28770, and TL 21974 28524) may represent the location of former ponds or extractive pits not depicted on historic mapping.

4 Aims

- 4.1 The aim of the geophysical survey was to identify any potential archaeological anomalies that would enhance the current understanding of the archaeological resource within the proposed survey area.
- 4.2 Specifically, the aims of the gradiometer survey were;
- To locate, record and characterise any surviving sub-surface archaeological remains within the survey area,
 - To help determine the next stage of works as per the client's instruction,
 - To provide an assessment of the potential significance of any identified archaeological remains in a local, regional and (if relevant) national context,
 - To produce a comprehensive site archive (Appendix 2) and report.

5 Methodology

- 5.1 The geophysical survey was undertaken between 15th – 24th November 2021.
- 5.2 All geophysical survey work was carried out in accordance with recommended good practice specified in the EAC guideline documents published by Historic England (Schmidt et al. 2016) and the Chartered Institute for Archaeologists Standard and Guidance for archaeological geophysical survey (2014).
- 5.3 Parameters and survey methods were selected that were suitable for the prospective aims of the survey and in accordance with recommended professional good practice (Schmidt et al. 2016).

- 5.4 Digital photographs of every survey parcel were taken before, during and after geophysical survey to show any changes to field conditions following the programme of works. The photos were downloaded and stored off site.
- 5.5 The gradiometer survey was carried out using a Bartington Non-Magnetic Cart. The cart system utilises two Grad-01 fluxgate gradiometer sensors mounted upon a carbon fibre frame, along with data logging equipment and batteries (see Appendix 3). Before each session of use, the cart system was balanced around a single set up point within the Site specifically chosen for being magnetically quiet. In balancing the machine around this point, it produces a more uniform dataset throughout and allows all data to be plotted with ease.
- 5.6 Data was collected using zig-zag traverses alongside a constant stream of GPS data collected through a Trimble R10 GPS, enabling the collected data to be spatially georeferenced without the need for a pre-determined grid system. The data was collected through a laptop mounted to the cart using Geomar MLGrad601 software.
- 5.7 A total of 85ha were surveyed using the Bartington cart.
- 5.8 Care was taken to attempt to avoid metal obstacles present within the survey area, such as metal fencing around hedge boundaries as gradiometer survey is affected by 'above-ground noise' and avoiding these improves the overall data quality and results obtained.
- 5.9 The data was downloaded from MLGrad601 and converted into a .xyz file in Geomar MultiGrad601 before being processed along with the GPS data in TerraSurveyor v3.0.34.10. The details of these processed can be found in Appendices 3 and 4.
- 5.10 Interpretations of the data were created in ArcGIS Pro and the technical terminology used to describe the identified features can be found in Appendix 5.

6 Results and Interpretation

- 6.1 The gradiometer survey results have been visualised as greyscale plots, with the minimally processed data plotted as XY Traces in Figures 3 to 12. The processed data is also plotted at -3nT to 5nT and can be seen in Figures 13-22. An interpretation of the data can be seen in Figures 23 to 32 and an individual characterisation of the identified anomalies can be seen in Appendix 1.
- 6.2 The data were evaluated and interpreted in a layered GIS (geographical information system) environment, in conjunction with historical maps, soils and geology information, and OS mastermap data provided by the AXIS PED.
- 6.3 For the most part, only trends of an archaeological or historical origin have been assigned an anomaly number on the interpretation figures. Trends that are integral to the discussion have also been assigned anomaly numbers. The discussion of the anomalies below is grouped first by their classification, and then by the survey area they are contained within, working from Area 1 to Area 5 (see Figure 2).

Archaeology

- 6.4 Three areas of concentrations of anomalies likely related to archaeological features have been identified in the results (Figures 23, 29,30 and 32), occupying c. 10ha overall, with the main concentration straddling a large service running north-south parallel to the A1-M just east of the survey area, and covering roughly 8ha (Figures 29 &30).
- 6.5 The northern most of these concentrations covers roughly 1ha in the northern and central portion of Area 1 (Figure 23). At the centre of the group is a sub-circular group of associated anomalies

interpreted as a round structure c.15m in diameter (**1A**). This is large for a prehistoric round house, (which would be the usual interpretation for this configuration of anomalies) and so the structure has not been securely interpreted as such: it may be a later structure with a different purpose, or a ring-ditch of the type associated with prehistoric funerary monuments. This circular feature sits off centre (to the south and east) within a D shaped enclosure which is causing strong positive anomalies typical of ditches filled with magnetically enhanced material. This enclosure is double ditched (perhaps, from the layout, over two phases), with the inner enclosure being roughly 50m x 50m, with the 'flat' side along the northern edge. The outer (and therefore overall) enclosure is roughly 80m east-west and 90m north-south, and shares its northern edge with the inner enclosure, which is offset to the north and west (**1B**). There is a possible subdivision of the outer enclosure in the eastern edge. There is a semi-circular extension that adjoins the northern edge of 1B. It is apse-like rather than D shaped and is c40m across at the apex of the curve (**1C**). It very clearly respects and connects with the northern border of 1B, so it is likely that they are contemporary, or if from a different phase than 1B, this feature must still have been visible to the people constructing it.

- 6.6 There are no definite concentrations of archaeological features in Area 2 or Area 3, though both contain anomalies characteristic of quarrying or extraction – in this region, most likely for chalk, but also potentially for clays sands or gravels from the superficial deposits. These cover a reasonably large area of Area 2 (**2A**), with a further smaller example in Area 3 (**3B**). Area 3 also contains an unusual dipolar anomaly, which is characteristic of high temperatures, but morphologically not consistent with a kiln or furnace (**3A**) – this might be the result of a lightning strike or an unusual archaeological feature involved in high temperature processing (Figures 25-28).
- 6.7 Most of the anomalies of archaeological interest are concentrated in Area 4 and cover approximately 8 ha in a reverse 'L' shape (Figure 29, 30). The long edge of the concentration runs parallel to the eastern field boundary and is bisected by a modern service – likely the pipe mentioned in section 3 above. The anomalies that make the shorter part of the L run almost east-west from the main concentration in the lower third of Area 4. Away from this concentration of anomalies, there are few further anomalies of archaeological interest; the activity seems relatively well constrained within the 8ha area.
- 6.8 The northern part of this anomaly group (**4A**) is a complex of rectilinear enclosures formed by ditches with enhanced fills, which are producing strong positive anomalies. They apparently only occur to the east of the service (**4L**), though given the disruption caused by the strong halo associated with the service, it is possible there are anomalies obscured within it. The enclosures are elongated along their north-south axis and show some evidence of internal sub-divisions. There are also anomalies present which are consistent with quarrying or other extraction processes. The amorphous anomalies associated with this do not have a clear relationship to the enclosures, making it difficult to discern the relative phasing of these events. The relative strength and coherence of the linear anomalies lessens to the south, giving way to much more ephemeral linear anomalies (**4G**) which seem to connect the northern anomaly group with a complex consisting of a large square enclosure (**4C**) with a series of related rectilinear enclosures (**4B**).
- 6.9 The anomalies making up this second rectilinear enclosure system are similar in character and form to those to the north at 4A. They are elongated in a north-south direction and occur to the east of the service (**4B**), and adjoin a large square enclosure, agglomerating on its eastern margin (figure 30). Weak ephemeral linear anomalies (4G) connect 4A and 4B.
- 6.10 The focus of the southern concentration of anomalies is a large square enclosure bisected by service (**4C**). This enclosure measures approximately 100m x 100m, though much of the interior and the northern and southern boundaries are obscured by magnetic disturbance from the service. The linear

anomalies that mark the edges are strongly magnetically enhanced, and on the southern edge appear to potentially be multiple rather than single ditches. Large anomalies with strong dipolar signals within the interior of the enclosure strongly suggest heating or burning processes, and potentially slag or other fired material buried within the sub surface. This may be the location of the quantity of tile and pottery mentioned in paragraphs 3.9 and 3.21 above.

- 6.11 Approximately 85m West of 4C, there is another square enclosure (**4D**), though this one lacks the adjoining features that occur with 4C. 4D is 60m east-west and about 50m north-south, though the southern boundary is indistinct. There is a possible internal sub-enclosure in the southeast corner, and possibly associated linear anomalies running south from here.
- 6.12 Linking 4D and 4C, there are a series of linear anomalies and patches of generally enhanced magnetism (**4F**) suggestive of the habitation effect – whereby soils on settlement sites gain overall magnetic enhancement. These occupy a band running roughly east-west from the large enclosure at 4C towards the edge of the survey area closest to the Priory complex. They are interpreted as enclosures and droves or trackways, with some suggestion of settlement activity (albeit without any clearly identified structures).
- 6.13 Overall, this concentration of anomalies within Area 4 is interpreted as a ladder settlement, likely to be Romano British in date given the fieldwalking finds and observations during the construction of the service. However, it is also possible this settlement is medieval in date, given the finds extend into that period, and is thus associated with the priory. Given the differences in layout and character observed, it is also possible that this complex is multi-phase, and rather than being a ladder settlement occupied contemporaneously, the various sub-groupings relate to farmsteads of different dates using the same general location in the landscape. The service neatly bisecting the complex prevents a more definitive interpretation. There are tracks, enclosures and field boundaries, as well as industrial activity of some sort, perhaps using local materials extracted from the surrounding area, including further possible burning identified within Area 4 itself (**4H**), and extraction (**4I**), as well as that already noted to the north in Areas 2 and 3. It is possible that more information about dating could be obtained by careful comparison with the HER records and any available maps: there are two services evident in Area 4, and at this juncture it is not possible to confidently state which is the 1975 water pipeline mentioned in the HER records, and so the relative location of the anomalies to the aforementioned finds and features is unclear.
- 6.14 The third and final group of archaeological anomalies occurs along the southern border of Area 5, and as such, the southern border of the entire survey area (Figures 31 and 32). A series of somewhat concentric curvilinear and branching rectilinear complex of anomalies (**5A**), interpreted as ditches with enhanced fills lies in the south-eastern corner of the area. It is partly obscured / disturbed by the main service (**5E**), and by the field boundary; it likely continues to the south. The main circular enclosure is roughly 70m in diameter and contains multiple subdivisions and discrete positive anomalies interpreted as pits. Further rectilinear enclosures adjoin it to the north and, potentially, west, past the line of the service. The complex also contains anomalies typical of burning or high-temperature processes as well as the generalised enhancement of soils associated with past settlement. The function and period of the complex are unclear, though it likely dates to later prehistory on the basis of the curvilinear morphology of much of the complex.
- 6.15 Further rectilinear anomalies have been detected in association with all of these concentrations, which are more conservatively interpreted as being of possible (rather than definite) archaeological interest (see below).

Possible Archaeology

- 6.16 Immediately west of, and intermingled with, the enclosure complex in Area 1 (1A-C, Figure 23), a series of further magnetically enhanced linear anomalies and broader areas of magnetic disturbance have been classified as possibly being of archaeological interest (**1D**). These anomalies are partially co-located with modern field drains and a removed field boundary (see below); the anomalies these generate have complicated the interpretation of the possible archaeology that they intersect with. These potentially archaeological anomalies are likely to be further boundaries or pits associated with the enclosure complex immediately to their east.
- 6.17 In area 5, in the western part of the survey area, there is a complex of weak positive linear anomalies, which have been classified as being of possible archaeological and uncertain origins (**5B**). These are generally oriented towards priory area and have no strong spatial association with the more definite features at 5A discussed above.
- 6.18 As mentioned in 6.15 above, less certain anomalies occur in spatial association with the definite archaeological anomalies identified within the survey area. These anomalies are less securely interpreted as being of archaeological interest largely on the basis of their magnetic character; they are weaker and less sharply contrasted with the overall background than their more definite counterparts.

Unclear Origins

- 6.19 A number of trends are visible across the dataset which have unclear origins; these are scattered throughout the survey area and generally take the form of weak intermittent linear trends in the data. They have been classified as such because there are no strong indicators of the cause of the anomaly, and it cannot be confidently attributed to past or present human activity, or natural processes within the soils or geology.
- 6.20 Within Area 4, in the north-west corner of that survey area (Figure 29), there is a sharply defined patch of highly speckled signal, distinct even within the geological changes occurring in this part of the survey (**4K**). This type of well-defined change in the background characteristics of the results is suggestive of a different land-use for the area, given its apparent rectilinear borders. However, but no field boundaries or tree cover can be seen on available maps, so an 'uncertain' classification has been given, rather than Agricultural/Historical. It is possible that the change in use pre- or post- dates the 1st edition Ordnance Survey maps.

Agricultural/Historical

- 6.21 Two linear trends formed of discrete and elongated positive anomalies and areas of magnetic disturbance have been identified in Area 1 (**1E**) (Figure 23 and 24). Their magnetic characteristics strongly suggest anomalies caused by the removal of former field boundaries, and these two anomalies are confirmed to co-locate with boundaries depicted on the 1st Edition OS maps of the survey area (NLS 2022) (Figure 23-24).
- 6.22 A short positive linear anomaly in Area 2 (**2C**) is co-located with a boundary depicted on the 1st Edition OS maps of the survey area (NLS 2022) (Figure 25-26).
- 6.23 In Area 4, a faint linear trend in the results (**4E**) (Figures 29 and 30) also corresponds with a mapped former field boundary depicted on the 1st Edition OS maps of the survey area (NLS 2022).
- 6.24 Ploughing trends of recent date run on varied alignments across the dataset, with one orientation persisting over a whole field. Only an indicative sample of these have been drawn. In Area 4 there is a group of anomalies interpreted as ploughing related, but they are closely associated with a group of archaeological anomalies (**4G** – see above and Figure 30). A second group of closely spaced positive

linear trends has been interpreted as ploughing within Area 5 ((**5H**) see Figure 32). It is possible these are a further survival of ridge and furrow cultivation associated with the nearby Priory (see section 3.21 above) and may further relate to the nearby possible archaeological anomalies (**5B**).

Non – Archaeology

- 6.25 The results also contain numerous examples of anomalies not related to archaeological or historical activity. Variations in the superficial geology have resulted in anomalies visible in northern parts as amorphous zone of ‘speckled’ data with many small positive anomalies, which are characteristic of the varied composition of the glaciofluvial sheet deposits recorded in this area (**2B, 3C**)
- 6.26 In southern and central parts of the survey area, the variations in the diamicton till appear as generally slightly enhanced soft & curving bands (**4J, 5C**).
- 6.27 Throughout the survey area linear patterning in occurs in the background of the results and is related to the nodular chalk parent material. In places, it has been difficult to distinguish this from potential archaeology as fissuring in the chalk can occur in rectilinear patterns not dissimilar to enclosures.
- 6.28 A substantial modern service runs through area 3-5, (**3D, 4L, 5E**) and another has been detected along the eastern boundary of areas 4 and 5 (**5G**) – one of these is likely to be the water pipe mentioned in section 3 that was installed in 1975, but it is not immediately clear which of these it is. The western service has a strong halo which is potentially obscuring anomalies of interest in a c 60m wide band running north-south through these three areas. There is a further short service in the southwestern corner of Area 5 (**5F**), which may be a field drain.
- 6.29 Field drains are prevalent in areas 1-3 but especially in Area 1, with a classic herringbone arrangement. Some of the mess of indistinct linear anomalies in the western part of Area 1 are also likely to be drains or former drains.
- 6.30 A moderate level of isolated dipolar anomalies (ferrous / iron spikes) are visible throughout the dataset which are likely modern in origin.
- 6.31 Magnetic disturbance is visible around the periphery of the Site and relates to modern metallic boundary fencing, adjacent infrastructure and modern debris at the field edges.

7 Conclusion

- 7.1 The survey has identified three concentrations of anomalies of archaeological interest; however, these are relatively spatially constrained and cover only 10ha of the survey area, with relatively large areas free of anomalies of interest. Given the breadth of anomaly types identified and the overall clarity of the results, it is unlikely that the survey has missed features of interest in the areas away from the identified archaeology.
- 7.2 The main complex of anomalies in Areas 4 has been affected by the modern service which rather neatly bisects the complex, making a secure interpretation of date or function difficult. It is clear that there is both settlement and productive activity occurring over an approximately 8ha area, but the date of this activity is unclear: morphologically the enclosures identified could date from the Roman period to the medieval period. Close attention to the finds and fieldwalking reports associated with the 1975 water pipe installation (and secure identification of which service this actually is) may help with dating the complex.
- 7.3 The southern group of anomalies in Area 5 is most likely of later prehistoric date, and again contains evidence of both settlement and productive activity. It has also been impacted by the installation of the service.

- 7.4 The northern group of anomalies in Area 1 is least affected by more recent activity on the Site, but the configuration of the features is unusual and therefore difficult to suggest a date or function for.
- 7.5 The northern part of the survey area contains several groups of anomalies interpreted as some sort of extraction; likely quarrying for the sands, gravels and clays in the superficial deposits, or to get to the underlying chalk deposits. The archaeological activity foci also contain evidence of high temperature processes, suggesting the material obtained from the extraction was processed on site by the inhabitants.
- 7.6 Elsewhere, the survey has allowed the identification of multiple classes of activity in the landscape, including historical and recent agriculture, and variations in the superficial and parent geology.
- 7.7 The results have been impacted by modern features in the form of a service which runs through the area from north to south close to the eastern margin. This has produced a strong magnetic halo which has obscured weaker anomalies in a 60m band centred on the service, which has complicated the interpretation of anomalies in the affected area. There are also smaller areas of magnetic disturbance associated with further services and with metal in field boundaries and buildings or infrastructure at the edges of the survey area.
- 7.8 In assessing the results of the geophysical survey against the specific aims set out in Section 4;
- The survey has succeeded in locating, recording and characterising surviving sub-surface remains within the Site, though more remains may be present that are not suitable for detection through magnetometry;
 - The survey will help in determining the next stage of works as it has provided evidence that remains of an uncertain origin are most likely present on site, and has provided a number of targets for further investigation;
 - It is not possible to provide an assessment of the potential significance of the identified remains in a local, regional or national context as it has not been possible to definitively characterise the nature of the anomalies identified through survey alone;
 - The survey has resulted in a comprehensive report and archive.
- 7.9 The geophysical survey has produced good quality gradiometer results which have successfully helped to clarify whether archaeological or uncertain remains are present across the Site. There is a high confidence level that the methodology and survey strategy chosen were appropriate to assess the archaeological potential across the Site.

8 Statement of Indemnity

- 8.1 Although the results and interpretation detailed in this report have been produced as accurately as possible, it should be noted that the conclusions offered are a subjective assessment of collected data sets.
- 8.2 The success of a geophysical survey in identifying archaeological remains can be heavily influenced by several factors, including geology, seasonality, field conditions and the properties of the features being detected. Therefore, the geophysical interpretation may only reveal certain archaeological features and not produce a complete plan of all the archaeological remains within a survey area.

9 Archive Deposition

- 9.1 In accordance professional standard practice an 'Online Access to the Index of archaeological investigations' ('OASIS') record will be completed for submission to the HER and Archaeological Data Service (ADS) (Appendix 2).
- 9.2 One digital and hard copy of the report and data will be submitted to the relevant Historic Environment Record (HER) at the Client's discretion.
- 9.3 A digital copy of the report and data will also be submitted to the ADS at the Client's discretion.

10 Bibliography

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11 Plates



Plate 1 - Field 1 South facing north



Plate 2 – Field 1 south facing northwest



Plate 3 – Field 2 south east facing north



Plate 4 – Field 2 south east facing northwest



Plate 5 – Unsurveyable terrain field 2, southeast corner



Plate 6 – Field 4 west facing east



Plate 7 – Field 4 west facing southeast



Plate 8 – Field 5 west facing east



Plate 9 – Field 5 south facing east including service marker

12 Figures

Appendix 1: Characterisation of Anomalies

Gradiometer survey

Anomaly	Type of Anomaly
1A	Archaeology (linear trends, enhanced magnetism)
1B	Archaeology (linear trends, enhanced magnetism)
1C	Archaeology (linear trends, enhanced magnetism)
1D	Possible Archaeology (linear trends, enhanced magnetism)
1E	Historic Feature (linear trend)
2A	Probable Extraction
2B	Geology/Natural
2C	Historical Feature (linear trend)
3A	Area of Burning
3B	Probable Extraction
3C	Geology/Natural
3D	Utility
4A	Archaeology (linear trends, enhanced magnetism, probable extraction)
4B	Archaeology (linear trends, enhanced magnetism)
4C	Archaeology (linear trends, enhanced magnetism, areas of burning)
4D	Archaeology (linear trends, enhanced magnetism)
4E	Historical Feature (linear trend)
4F	Archaeology (linear trends, enhanced magnetism)
4G	Archaeology (enhanced magnetism)
4H	Area of Burning
4I	Probable Extraction
4J	Geology/Natural
4K	Uncertain (linear trends, enhanced magnetism)
4L	Utility
5A	Archaeology (linear trends, enhanced magnetism)
5B	Possible Archaeology (linear trends, enhanced magnetism)
5C	Geology/Natural
5D	Area of Burning
5E	Utility
5F	Utility
5G	Utility
5H	Ploughing – possible ridge and furrow?

Appendix 2: Survey Metadata**Oasis ID: aocarcha-1503159**

Field	Description
Surveying Company	AOC Archaeology
Data collection staff	Alistair Galt, Sasha O'Connor, Rhys Martin & Marguerite Hall
Client	AXIS PED
Site name	Wymondley
County	Hertfordshire
NGR	TL 22190 28540
Land use/ field condition	Crop & stubble
Duration	15/11/21- 24/11/21
Weather	Overcast/Sunny/drizzle
Survey type	Gradiometer Survey
Instrumentation	Bartington cart survey: Bartington Non-Magnetic Cart, two Bartington Grad 601-2, Trimble R10 GNSS System
Area covered	Approx 85 ha
Download software	MLGrad601
Processing software	Geomar, MultiGrad601 and TerraSurveyor
Visualisation software	ArcGIS Pro
Geology	Bedrock: Holywell Nodular Chalk Formation Superficial: Glaciofluvial deposits of sand and gravel to the north and west; Diamicton (BGS, 2021)
Soils	Lime-rich loamy and clayey soils with impeded drainage (Soilscapes, 2021)
Scheduled Ancient Monument	No
Known archaeology on site	Crop Marks, Hertfordshire historic environment record number (HHER): 4485 22 sherds of late Iron Age, Roman and Medieval pottery from fieldwalking, HHER Number: 6654 Possible Roman settlement based on finds during pipe laying in 1975, HHER Number: 101 Iron Age pottery sherd, HHER Number 121
Historical documentation/ mapping on site	OS 1 st Ed consulted in GIS environment
Report title	Wymondley Solar Farm (40205): Archaeological Geophysical Survey
Project number	40205
Report Author	Kayt Armstrong & Alistair Galt
Quality Checked by	James Lawton

Appendix 3: Archaeological Prospection Techniques, Instrumentation and Software Utilised

Gradiometer Survey

Gradiometer surveys measure small changes in the earth's magnetic field. Archaeological materials and activity can be detected by identifying changes to the magnetic values caused by the presence of weakly magnetised iron oxides in the soil (Aspinall et al., 2008, 23; Sharma, 1997, 105). Human inhabitation often causes alterations to the magnetic properties of the ground (Aspinall et al, 2008, 21). There are two physical transformations that produce a significant contrast between the magnetic properties of archaeological features and the surrounding soil: the enhancement of magnetic susceptibility and thermoremanent magnetization (Aspinall et al., 2008, 21; Heron and Gaffney 1987, 72).

Ditches and pits can be easily detected through gradiometer survey as the topsoil is generally suggested to have a greater magnetisation than the subsoil caused by human habitation. Areas of burning or materials which have been subjected to heat commonly also have high magnetic signatures, such as hearths, kilns, fired clay and mudbricks (Clark 1996, 65; Lowe and Fogel 2010, 24).

It should be noted that negative anomalies can also be useful for characterising archaeological features. If the buried remains are composed of a material with a lower magnetisation compared to the surrounding soil, the surrounding soil will consequently have a greater magnetization, resulting in the feature in question displaying a negative signature. For example, stone materials of a structural nature that are composed of sedimentary rocks are considered non-magnetic and so will appear as negative features within the dataset.

Ferrous objects – i.e. iron and its alloys - are strongly magnetic and are typically detected as high-value peaks in gradiometer survey data, though it is not usually possible to determine whether these relate to archaeological or modern objects.

Although gradiometer surveys have been successfully carried out in all areas of the United Kingdom, the effectiveness of the technique is lessened in areas with complex geology, particularly where igneous and metamorphic bedrock is present or thick layers of alluvium or till. All magnetic geophysical surveys must therefore take the effects of background geological and geomorphological conditions into account.

Bartington Non-Magnetic Cart Instrumentation and Software

AOC Archaeology's cart-based surveys are carried out using a Bartington Non-Magnetic Cart. The cart enables multiple traverses of data to be collected at the same time, increasing the speed at which surveys may be carried out and offers the benefits of reduced random measurement noise and rapid area coverage (Schmidt et al 2015, 60-62, David et al. 2008, 21).

The cart uses a configuration of four Grad-01-1000L sensors mounted upon a carbon fibre frame along with two DL601 dataloggers and one BC601 battery cassette. The sensors are normally positioned at 1m intervals on a horizontal bar, with the datalogger taking readings every 12.5cm along each traverse, though this can be altered to increase / reduce resolution if required. The data is georeferenced via a Trimble R10 Real Time Kinematic (RTK) VRS Now GNSS GPS which streams data throughout survey and allows the data to be recorded relative to a WGS1984 UTM coordinate system.

The gradiometer data is collected through Geomar MLGrad601 software on a laptop in real-time during the survey. The data is downloaded and converted into a .xyz file in Geomar MultiGrad601 before being processed along with the GPS data in TerraSurveyor v3.0.34.10 (see Appendix 4 for a summary of the processes used in Geoplot to create final data plots).

Appendix 4: Summary of Data Processing

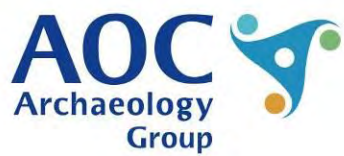
Process	Effect
Clip	Limits data values to within a specified range
De-spike	Removes exceptionally high readings in the data that can obscure the visibility of archaeological features. In resistivity survey, these can be caused by poor contact of the mobile probes with the ground. In gradiometer survey, these can be caused by highly magnetic items such as buried ferrous objects.
De-stagger	Corrects a misalignment of data when the survey is conducted in a zig-zag traverse pattern.
Discard Overlap (TerraSurveyor)	Removes datapoints which occur too closely together and can cause digital artefacts in the data which are caused by the overlapping of parallel traverses.
Edge Match	Counteracts edge effects in grid composites by subtracting the difference between mean values in the two lines either side of the grid edge.
High pass filter	Removes low-frequency, large scale detail in order to remove background trends in the data, such as variations in geology.
Interpolate	Increases the resolution of a survey by interpolating new values between surveyed data points, creating a smoother overall effect.
Low Pass filter	Uses a Gaussian filter to remove high-frequency, small scale detail, typically for smoothing the data.
Periodic Filter	Used to either remove or reduce the appearance of constant and reoccurring features that distort other anomalies, such as plough lines.
Remove Turns (TerraSurveyor)	Uses analysis of the direction of travel derived from the GNSS data to break continuous streams of data into individual traverses.
Zero Mean Grid	Resets the mean value of each grid to zero, in order to counteract grid edge discontinuities in composite assemblies.
Zero Mean Traverse	Resets the mean value of each traverse to zero, in order to address the effect of striping in the data and counteract edge effects.

Processing Steps

Bartington Cart survey	
Process	Extent
Base Settings	Interval 0.121m, Track Radius 1.06m
Remove Turns	Threshold Angle 90°, Cut Length 5m
Discard Overlap	Threshold Distance 0.2m, Minimum Track 5, Newest
Despike	Mean Diameter 3 Threshold 1
Destripe	Mean Traverse, -absolute values -10nT to 10nT
Clip	-30/30nT

Appendix 5: Technical Terminology

Type of Anomaly	Description
Archaeology	<i>Interpretation is supported by the presence of known archaeological remains or by other forms of evidence such as HER records, LiDAR data or cropmarks identified through aerial photography.</i>
Trend	Linear / curvilinear / rectilinear anomalies either characterised by an increase or decrease in values compared to the magnetic background.
Area of enhanced magnetism	A zone of enhanced magnetic responses over a localised area. These anomalies do not have the high dipolar response which are manifested in an 'iron spike' anomaly and likely have a relationship with nearby archaeological trends.
Pit	An anomaly composed of an increase in magnetic values with a patterning on the XY trace plot that is pit-like in appearance.
Possible Archaeology	<i>Trends are likely to have an archaeological origin, however without supporting evidence from known archaeological remains, HER records, LiDAR or aerial photography, they can only be classed as having a possible archaeological origin.</i>
Trend	Linear / curvilinear / rectilinear anomalies either characterised by an increase or decrease in values compared to the magnetic background.
Area of enhanced magnetism	A zone of enhanced magnetic responses over a localised area. These anomalies do not have the high dipolar response which are manifested in an 'iron spike' anomaly but lacks definitive records to be classed as being archaeological.
Probable Extraction	An anomaly composed of an increase in magnetic values with a characteristic sharp outer edge and a more amorphous internal character, usually irregular in outline.
Burnt area	An anomaly with a patterning on the XY trace plot that is suggestive of industrial activity such as a kiln or hearth.
Unclear Origin	<i>Trends are magnetically weak, fractured or isolated and their context is difficult to ascertain. Whilst an archaeological origin is possible, an agricultural, geological or modern origin is also likely.</i>
Trend	Linear / curvilinear / rectilinear anomalies which are composed of a weak or different change in magnetic values. The trends do not appear to form a patterning that is suggestive of archaeological remains, such as enclosures or trackways.
Area of enhanced magnetism	A zone of enhanced magnetic responses which lack context for a conclusive interpretation. They do not appear to have a relationship with nearby trends of an archaeological origin. Can often be caused by areas of former woodland, geological variations or agricultural activity.
Agricultural	<i>Trends associated with agricultural activity, either historical or modern.</i>
Old Field Boundary	These isolated long linear anomalies, most often represented as a negative or fractured magnetic trend, relate to former field boundaries when their positioning is cross referenced with historical mapping.
Historical Features	Features observed on historical mapping that correspond with anomalies or trends in the data. Areas of enhanced magnetism could relate to former buildings, trackways, quarries or ponds.
Ridge and Furrow / Rig and Furrow	A series of regular linear or curvilinear anomalies either composed of an increased or decreased magnetic response compared to background values. The wide regular spacing between the anomalies is consistent with that of a ridge and furrow / rig and furrow ploughing regime. The anomalies often present as a positive 'ridge' trend adjacent to a negative 'furrow' trend.
Ploughing Trends	A series of regular linear anomalies either composed of an increased or decreased magnetic response compared to background values. Anomalies seen parallel to field edges are representative of headlands caused by ploughing.
Field Drainage	A series of magnetic linear anomalies of an indeterminate date, usually with a regular or herringbone patterning.
Non - Archaeology	<i>Trends which are likely to have derived from non-archaeological processes or activities.</i>
Geology / Natural	An area of enhanced magnetism that is composed of irregular weak increases or decreases in magnetic values compared with background readings. It is likely to indicate natural variations in soil composition or reflect variations in the bedrock or superficial geology.
Possible Modern Service	Anomalies of a linear form often composed of contrasting high positive and negative dipolar values. Such anomalies usually signify a feature with a high level of magnetisation and are likely to belong to modern activity such as pipes or modern services.
Magnetic Disturbance	A zone of highly magnetic disturbance that has been caused by or is a reflection of modern activity, such as metallic boundary fencing, gateways, roads, boreholes, adjacent buildings, rubbish at field edges or a spread of green waste material.
Isolated Dipolar Anomalies / Ferrous (iron spikes) and Ferrous Zones	A response caused by ferrous materials on the ground surface or within the subsoil, which causes a 'spike' in the data representing a rapid variation in the magnetic response. These generally represent modern material often re-deposited during manuring.



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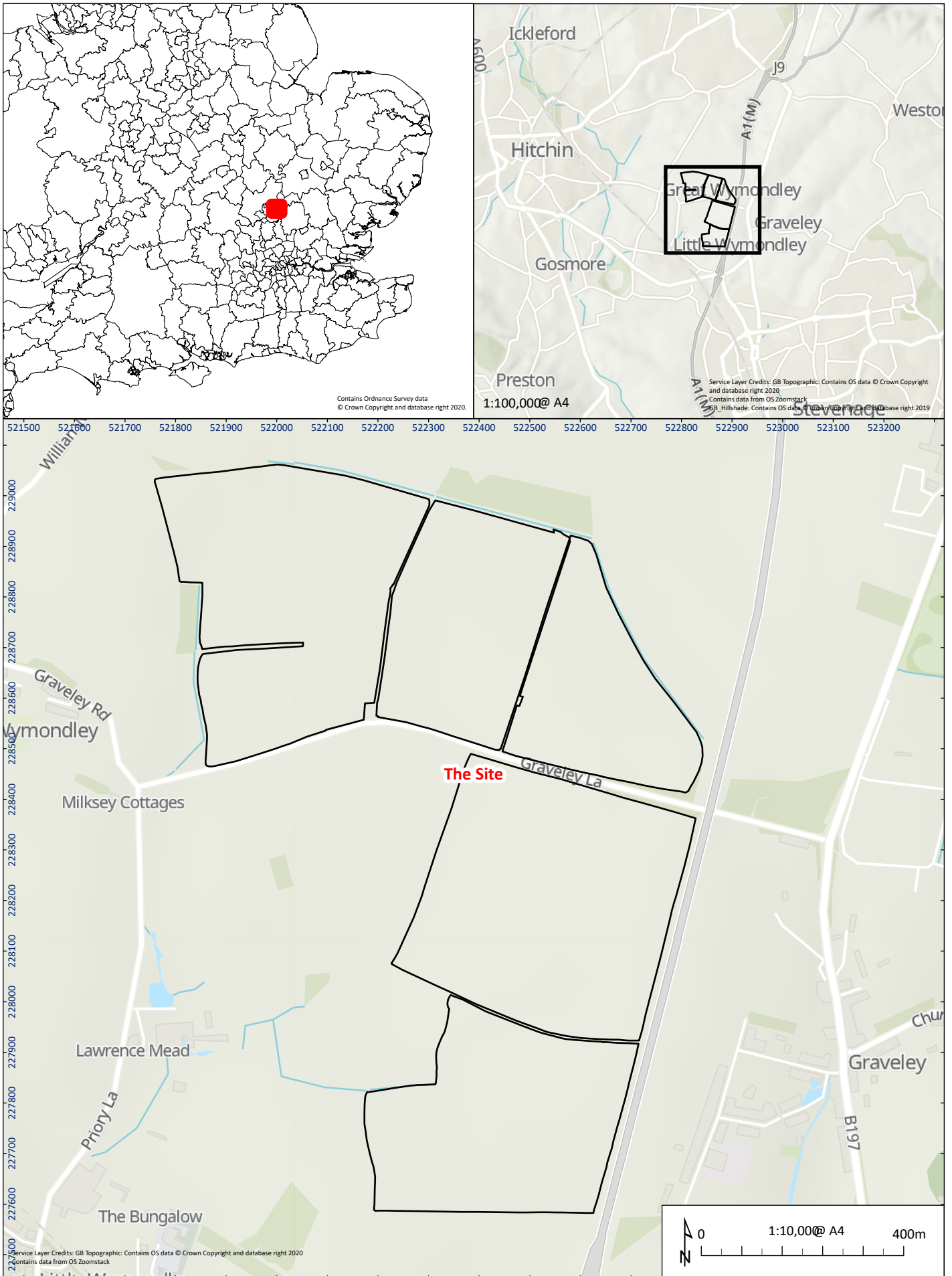
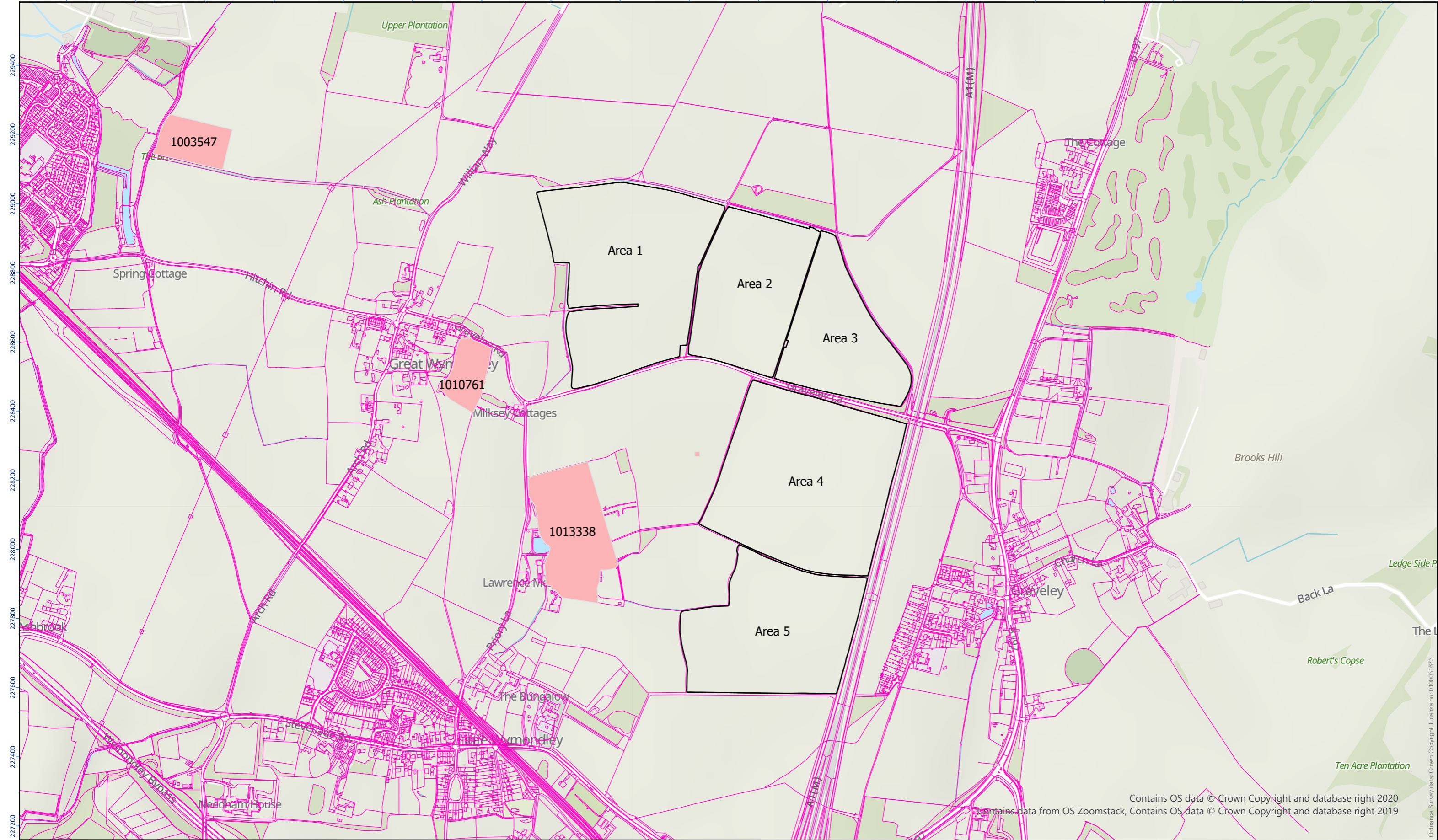


Figure 1: Site Location

05/40205/GEO/01/01

520400 520600 520800 521000 521200 521400 521600 521800 522000 522200 522400 522600 522800 523000 523200 523400 523600 523800 524000 524200



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Survey Areas

<p>Figure 02</p>	<p> Scheduled Monuments</p>	<p>Scale: 1:10,000@ A3</p>	<p>Drawing Number: 05/40205/GEO/02/01</p>		
	<p> Survey Outline</p>		<p>Created by: KA Date: 11/02/2022</p>		
	<p> OS MasterMap Provided by Client</p>		<p>Checked by: JL Date: 11/02/2022</p>		
			<p>Approved by: JL Date: 11/02/2022</p>		

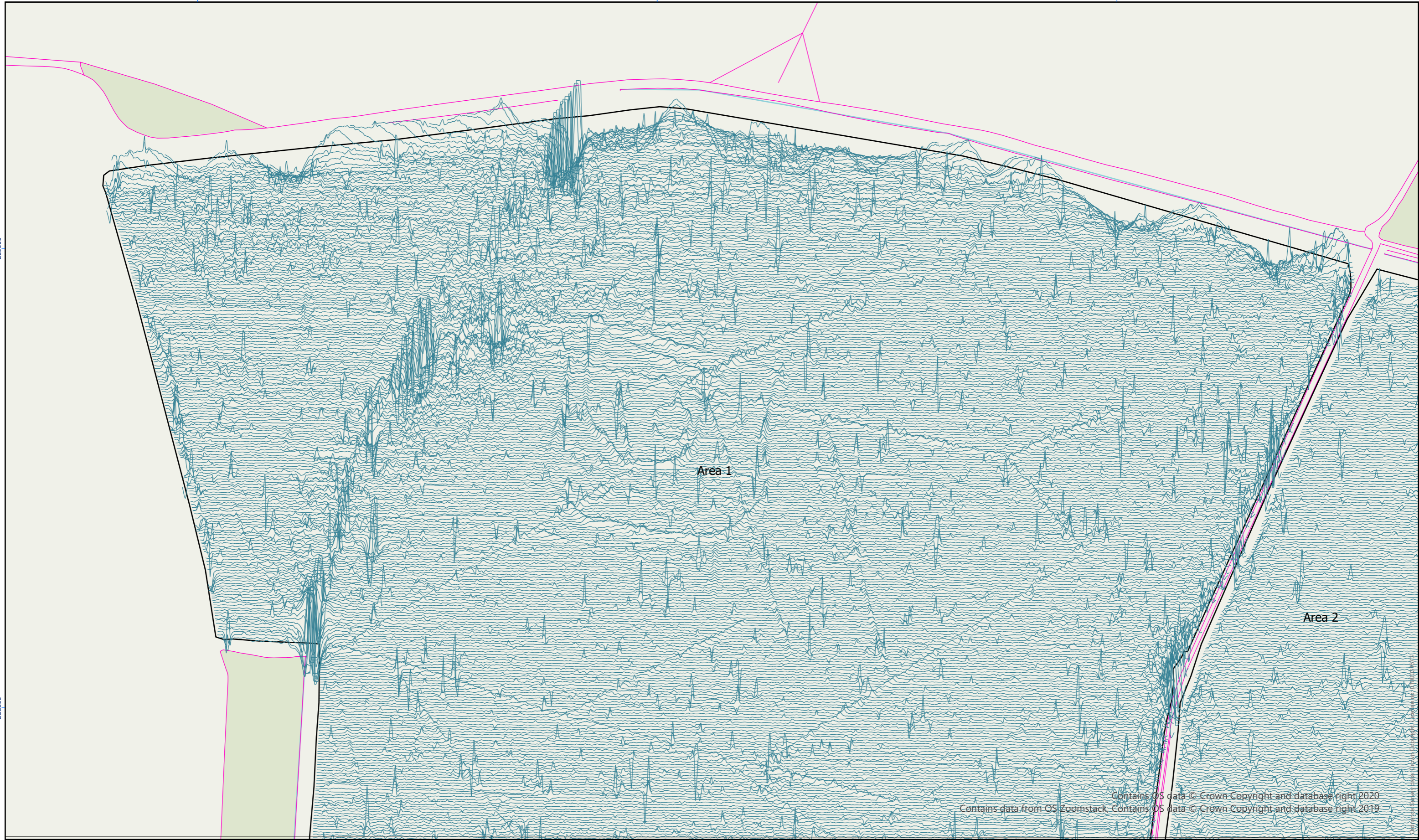
521800

522000

522200

229000

228800



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Minimally Processed Magnetic Survey Results presented as XY Traces

Figure
3

80nT

N

0 60m

Scale: 1:1,500 @ A3

Drawing Number: 05/40205/GEO/3/01
Created by: KA Date: 11/02/2022
Checked by: JL Date: 11/02/2022
Approved by: JL Date: 11/02/2022

