ARCHAEOLOGICAL SERVICES
DURHAM UNIVERSITY

on behalf of
Historic Scotland

Land at Palace Green
Durham City
County Durham

geophysical surveys

report 2201
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Durham University

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1. Summary

The project

1.1 This report presents the results of geophysical surveys conducted on land at Palace Green in Durham City. The works comprised geomagnetic and ground-penetrating radar surveys of the Green and the hard-surfaced area to its south.

1.2 The principal aim of the surveys was to determine the presence or absence of geophysical anomalies which could reflect mass graves of Scottish soldiers captured after the Battle of Dunbar on 3rd September 1650 and subsequently held prisoner in Durham Cathedral.

1.3 The works were commissioned by Historic Scotland and conducted by Archaeological Services Durham University.

Results

1.4 No anomalies characteristic of large soil-filled pits, such as mass graves, were identified with either technique. Some small and/or irregular areas of possible disturbance have been detected by the GPR, however, these are either so near-surface as to be within the make-up of the road, or they lack any corresponding positive geomagnetic anomalies; such anomalies are associated with soils and sediments whose magnetic susceptibility has been enhanced by the decay of organic remains or by burning. Some large radar anomalies which are apparent in plan view reflect variations in the sub-surface topography, evident in the profile data

1.5 The geomagnetic data are characterised by many small intense anomalies reflecting near-surface ferrous litter, much of which may be due to the Green's former temporary use as a builders' yard. Some weak positive magnetic anomalies were nevertheless detected. The nature and extent of these is typical of the remains of small or truncated ditches and gullies of unknown date.

1.6 Some of the geomagnetic anomalies appear to form part of a hexagon or octagon. Although the Green was formerly smaller and enclosed with a substantial octagonal kerb, it lay to the south-west of the anomalies detected in this study. These anomalies could possibly reflect an even earlier phase of the Green.

1.7 The water storage tanks associated with the service inspection covers on the southern edge of the Green have almost certainly been detected to the immediate north of the covers. Several probable and possible utilities were detected across both areas.

2. Project background

Location (Figure 1)

2.1 The study area comprised land between the historic cathedral and castle in Durham City in the north-east of England (NGR centre: NZ 2738 4225). Geomagnetic and ground-penetrating radar (GPR) surveys were undertaken over the grassed area of Palace Green and GPR survey was also undertaken over the hard-surfaced road and parking areas to its immediate south. Both areas are within the Durham Castle and Cathedral UNESCO World Heritage Site.

Objective

2.2 The principal aim of the surveys was to determine the presence or absence of geophysical anomalies which could reflect mass graves of Scottish soldiers captured after the Battle of Dunbar on 3rd September 1650 and subsequently held prisoner in Durham Cathedral. Many of the soldiers suffered dysentery and were transferred across to Durham Castle for isolation; it has been suggested that approximately 1600 had died in Durham by the end of October 1650 though it is not known where they may have been buried.

2.3 A subsidiary aim was to assess the nature and extent of any other sub-surface features of potential archaeological significance within the survey area.

Methods statement

2.4 The geomagnetic and ground-penetrating radar surveys have been undertaken in accordance with a methods statement prepared by Archaeological Services and instructions from Historic Scotland, and in accordance with accepted standards and guidelines (para.5.1, below).

Dates

2.5 Fieldwork was undertaken on 12th and 13th May 2009. This report was completed on 29th July 2009.

Personnel

2.6 Fieldwork was conducted by Duncan Hale (the Project Manager) and Paul Cordes (GPR specialist). This report was prepared by Duncan Hale, with a summary of the archaeological and historical background by Andy Platell and illustrations by David Graham.

Archive/OASIS

2.7 The site code is **DPG09**, for **D**urham **P**alace **G**reen 20**09**. The survey archive will be supplied on CD to the client and to the County Durham Sites and Monuments Record. Archaeological Services is registered with the **O**nline **A**cces**S** to the **I**ndex of archaeological investigation**S** project (OASIS). The OASIS ID number for this project is **archaeol3-62581**.

Acknowledgements

2.8 Archaeological Services is grateful to personnel of the following organisations for facilitating the project: Historic Scotland; Durham University; Durham Cathedral Chapter; the Durham Castle and Cathedral UNESCO World Heritage Site Co-ordinator; English Heritage; Durham County Council.

3. Archaeological and historical background

3.1 In addition to the Battle of Dunbar connection above, it was anticipated that the Palace Green area might also contain the remains of 12th-century buildings, an 18th-century kerb around a former Green (removed in 1934), cobbled paths and more recent utilities and storage tanks.

3.2 A large number of archaeological interventions have taken place in this part of the peninsula in recent years. Details of these are presented elsewhere (Archaeological Services 2008). Very little work has been undertaken on the Green itself. Part of the Green was in use as a builder's yard in 1966 when a small excavation was undertaken there (Wheeler 1968). The location and orientation of this 4ft by 20ft trench are uncertain. Parts of the Green were also subject to small earth electrical resistance surveys in 1987 and 1988, which may have detected linear features such as paths (Durham 1988).

3.3 The historical development of Durham has been extensively covered elsewhere (for example Clack 1985; Pevsner and Williamson 1983; Bonney 1990; Lowther *et al*, 1993; Roberts 2003); a summary of the development of the peninsula area is provided here, prepared by Andy Platell (Archaeological Services 2008). Entries in the County Durham Historic Environment Record are referenced with the prefix 'HER'.

The prehistoric and Roman periods (up to 5th century AD)

3.4 There is no firm evidence for prehistoric occupation in Durham. Mesolithic flints (HER 100) have been found at Old Durham, and evidence of prehistoric occupation has been found at Maiden Castle hillfort (HER 1181), both to the south-east of the city, but activity on and near the peninsula itself, with the exception of a questionable prehistoric pit at Jevons House in Hatfield Cottage (Lowther *et al.* 1993, 37), only takes the form of stray finds. A Neolithic stone axe (HER 1017) is recorded as having been found near St Oswald's Church and two Bronze Age axes (HER 992 & 994) are recorded as having been found in the Durham area. Excavations at the northern end of Milburngate (HER 6485) established the presence of a Bronze Age soil deposit, dated through the use of radiocarbon dating. While this was not necessarily a result of human activity (*ibid*. 36, 105), it nevertheless demonstrates that prehistoric deposits have the potential to survive in this area.

3.5 The nearest known Roman site is the presumed villa at Old Durham, 1.8km to the south-east of the city (HER 1260; *ibid.* 105). However, residual finds of Roman pottery and coins have been made at a number of locations to the south of the cathedral, and also at Bailey Court and under Hatfield College gatehouse to the north (*ibid*. 105-7). Enough material has been found to indicate that a Roman-period settlement was present at the central or northern end of the peninsula (*ibid.* 105). It has been suggested that this took the form of a Roman fort (HER 1163), but no evidence has been found to support this hypothesis and it is more likely that a Romanised native settlement was present (*ibid.* 106).

The early medieval period (5th century AD to AD 1066)

3.6 It is possible that there was an early medieval settlement at Elvet (HER 1249). In 762 Peohtwine was consecrated Bishop of Whithorn at a place called Aelfet Island. The suggestion has been made that this is actually Elvet, with the settlement centred around St Oswald's Church (Clack 1985, 21). South Street has also been suggested as

having early medieval origins (HER 5299), but there is no supporting archaeological evidence for either of these claims (Roberts 2003, 16). The first firm evidence for occupation dates to the translation of Cuthbert's remains from Chester-le-Street to Durham in 995.

3.7 The medieval historian Symeon of Durham recorded in his *Historia Ecclesiae Dunelmensis* that the peninsula was being cultivated prior to the arrival of Cuthbert's body, and this indicates that there was certainly occupation nearby, if not on the peninsula: "*…the whole space, with the sole exception of a moderate-sized plain in the midst, was covered with a very dense wood. This had been kept under cultivation, having been regularly ploughed and sown…*" (Stevenson 1855, 673).

3.8 A temporary timber church was initially constructed to hold Cuthbert's remains; three years later a new stone minster church was erected on the site of the current cathedral. The town of Durham grew up around this; excavations in Bailey Court produced 10th- to 12th-century pottery (Lowther *et al*. 1993, 39) while excavations by Martin Carver in 1974 have shown that this settlement extended at least as far as Saddler Street (Carver 1979).

The later medieval period (1066 to 1540)

3.9 Durham Castle formed the stronghold and ecclesiastical palace of the Prince Bishops of the County Palatinate until 1832 when it was handed over from the Bishop as the founding college of Durham University. The beginnings of the present Castle date from about 1072 and are attributed to Waltheof, Earl of Northumberland, and Bishop Walcher, his successor to the earldom. It has been speculated that an earlier fortified structure such as an earthen rampart may have occupied the site, as the city withstood sieges in 1006, 1012 and 1040, suggesting that it had substantial defences (Jones 1922), although no trace of these has yet been identified.

3.10 The earliest known structure is a motte and bailey (HER 1201), a wooden tower on an artificial mound (motte), overlooking timber buildings in a lower courtyard (bailey) surrounded by a ditch. This ditch was crossed by a drawbridge defended by a barbican with towers, as well as an inner gate. The bailey was separated from the motte by another ditch or moat which was crossed by a stairway leading up to the keep. From an early date the wooden structures were replaced with stone. The lower chapel beneath the later more extensive chapel building contains unaltered Norman fabric while the Keep and North Range are attributed to Bishop Flambard (1099-1128). Laurence the Monk in 1144 described the castle as containing a stone shell keep with a wooden tower inside, a gatehouse and drawbridge, two halls, a chapel and a well (Gee 1928).

3.11 Additions and alterations have been carried out at frequent intervals during the building's history. Bishop le Puiset (1153-95) built Constables Hall and what is now the kitchen on the south-west side of the castle. Bishop Bek (1284-1312) built the Great Hall, although little of his work remains. Alterations by Bishop Hatfield (1345-81), included the enlarging of the mound and the rebuilding of the keep, and enlarging the Great Hall. Bishop Fox (1494-1501) made alterations including the conversion of the Norman buildings in the south-west corner into a kitchen. Bishop Tunstall (1530-59) built a chapel on the north side of the courtyard. Bishop Cosin (1660-72) removed the barbican and partially filled the moat. Repairs, including

extensive re-facing, were made in the 18th- and 19th-centuries. In 1840 the keep was extensively rebuilt on the old foundations, as student accommodation.

3.12 Bishop Walcher (1071-1080) began the change from a church to a monastery, although the Benedictine Priory of St Cuthbert at Durham was formally founded by Bishop William de St Calais in 1083. Some of the work in the east and south ranges of the buildings surrounding the cloister is possibly of Walcher's time and may have joined directly onto the south side of the Anglo-Saxon minster, which possibly stood a little to the south of the present building. In 1093 the old church was pulled down and work began on the present cathedral (HER 5561). This was largely constructed between 1093 and 1130. Bishop Rufus (1133-40) finished the building of the Chapter House while Bishop le Puiset (1153-95) added the Galilee Chapel at the west end around 1189. The Chapel of the Nine Altars was built in 1242-1280, while the cloister dates from 1390-1418, the kitchen from 1365-70 and the dormitory on the west side of the cloister from 1388-1406. The central tower was rebuilt around 1470. The monastery at Durham was abolished in 1540 during the Dissolution of the Monasteries and the cathedral was re-founded the following year as a secular cathedral.

3.13 Bishop Flambard enclosed the peninsula with masonry walls between 1099 and 1128. The walls, strengthened with flanking towers and buttress turrets, followed the brow of the hill rising up from the river banks on all sides except the north, where a wall of great strength, varying from 10m to 15m in height, was built to the north of the castle with a moat outside this (along modern Moatside Lane). There was a massive gate in this northern wall, North Gate, at the southern end of Saddler Street. This was strengthened and rebuilt on a number of occasions and incorporated the city gaol from the late 14th century onwards. It was not demolished until 1820. Two other gates were present in the walls, leading to fords across the river: Kings Gate (on modern Bow Lane) and Watergate or Baileygate (at the southern end of South Bailey). There was also a postern gate, 'the Dark Entry' in the Priory, while medieval references to a 'Windishole Gate' suggest another such gate at the modern Windy Gap.

3.14 A second wall was built from the east end of the cathedral to the keep, with gates at its northern and southern ends: Owen Gate (at the west end of modern Owengate) and Lye Gate or Side Gate (on modern Dun Cow Lane). These walls divided the city into a number of wards or baileys. The cathedral and monastery formed one such ward; the Inner Bailey of the castle (the present courtyard) formed another. The Upper Bailey (the 'Placca' or 'Place Green', now Palace Green) formed a third while the Nether Bailey (now North and South Baileys) formed a fourth. This latter area may have in turn been subdivided by a third east-west wall, as foundations of a substantial wall underlie Dun Cow Lane and a tower (known as Church Tower) are shown crossing North Bailey in the area of the later St Mary le Bow Church on Schwytzer's map of 1595. Church Tower is recorded as having collapsed in 1637 (Jones 1922).

3.15 Bishop Flambard cleared Palace Green of domestic buildings in order that, as a chronicler put it 'the church should neither be endangered by fire nor polluted by filth' (Clack 1985) and the Upper Bailey became reserved for administrative buildings of the County Palatinate. The inhabitants were relocated to the north of the city walls, in a new borough around the newly laid out Market Place. Following the

sacking of this part of the city by the Scots in 1312, the curtain walls were expanded to include this area as well. Although this outer wall had little military value, it was sufficient to keep out the raiders (Jones 1922).

3.16 A *valor* written in the first year of Bishop Skirlaw's episcopy (1388) states that '*between the lower gates of the castle and the graveyard of the abbey was a space called 'le Place' containing by estimation two acres with the houses intended for the offices of the Chancery, Exchequer, and Receipt; a hall for the Pleas of Justice; a granary; a large grange; and various other rooms on the west side of the said space pertaining to the old gaol before the lord built anew the tower called 'le Northgate' at the entrance to the castle where his gaols now are by his ordinance; and a house for coining money built on the east side of the said space*' (Gee 1928, 23). Elsewhere, this document also refers to an inn of the Archdeacon of Durham, locating it on Palace Green.

3.17 The Valor stated that the mint (HER 1246) was held by Mulkus of Florence, but seven years later it was recorded that '*William Ward took from the lord a house or place in the Castle of Durham called Moneyer's House together with another room beyond Owen Gate, to hold until some moneyer should come who wishes to make money in the same*' (*ibid*. 24). These two documents together suggest that the moneyer had a house on the north side of Owengate in the area of the current Master's House, while his mint was on the opposite side of that street. The mint continued in operation until at least the end of the 15th century.

3.18 In 1414 Bishop Langley founded two schools on the east side of Palace Green, one for the teaching of plainsong and one for the teaching of grammar. Following the Dissolution of the Monasteries, both schools were re-founded by Henry VIII in 1541. In 1640 they were burnt by an invading Scots army (see below).

3.19 In the north-west corner of Palace Green, Bishop Neville built a new Exchequer around 1438. This is now part of Palace Green Library and is the oldest surviving building on the Green, with the exceptions of the Castle and the Cathedral.

3.20 The post-medieval period (1541 to 1899)

The earliest map on which Durham is depicted is the 1576 map by Saxton, which gives an approximate location of the city in relation to other settlements in the county. However, the map is drawn at a small scale, and so lacks any detail regarding the layout of the city. Schwytzer's map of 1595 and Speed's map of 1611 are the first large-scale plans of the city. They show the buildings in a pictorial rather than a plan view and are almost identical, indicating that they are derived from the same source. There are a few slight differences between them, such as the number of arches on Elvet Bridge and the number of small houses around the Market Place. However these features are likely to have been drawn schematically to convey the impression of tightly-packed streets and are not particularly reliable indicators of the townscape.

3.21 The plans do show the layout of the early post-medieval town. On the peninsula the Cathedral dominates the area. To its north Palace Green is shown as open ground, with the castle to the north of that. The castle keep is clearly shown on its mound, with the other castle buildings (slightly inaccurately) shown to the south-west. A group of buildings are present along the west side of Palace Green. These are

smaller than the buildings in the castle but bigger than the houses on the east side of the Green and elsewhere in the town. Lines of small buildings are present along North and South Baileys and Owengate. Part of the wall along the east side of Palace Green survives and there is open ground between this and the buildings on North Bailey. Owen Gate has been removed and possibly Lye Gate (although this would be obscured by the cathedral in this view). The remainder of the city walls are complete with the North Gate being clearly shown. Tower Gate crosses North Bailey between St Mary the Bow Church (here named as S. Maria Boreal) and the cathedral, although there is no other evidence for the east-west wall in this area. Outside the peninsula the Market Place is shown, together with Silver Street, Saddler Street and Framwellgate and Elvet Bridges. Beyond these are Claypath, Old and New Elvet, Hallgarth Street, Church Street, South Street, Crossgate, Allergate and Milburngate.

3.22 In 1588 the County House was built on the west side of Palace Green, to the north of Windy Gap (Gee 1928, 32). This wooden building, later replaced by a stone one, was used as the county court until it was demolished and replaced by the diocese Register Office (now part of Palace Green Library) in 1820.

3.23 Durham suffered badly during the English Civil War. In 1640 the city was captured by the Scots, although it was restored to England the following year after a peace settlement. Many of the city's buildings were burnt during this occupation. In 1646 Parliament abolished the episcopy of Durham and took over the revenues of the see. Durham Castle was bought by the Lord Mayor of London in 1649 and was severely damaged during the next 10 years. Following the Battle of Dunbar in 1650, many Scottish prisoners were held in the cathedral, where they removed most of the interior woodwork for firewood and defaced much of the interior masonry. Following the restoration of the monarchy in 1660, the County Palatine and Bishopric of Durham were restored to Bishop John Cosin, who carried out much restoration work to the castle, cathedral and the city in general. On Palace Green this included construction of the grammar school (now Divinity House) in 1661, replacement of the County House with a new building in 1664, Cosin's Almshouses in 1666, Cosin's Library (now part of Palace Green Library) around 1667-8 and Bishop Cosin's Hall around 1700. Of similar age to these buildings is Abbey House in the south-east corner of the Green.

3.24 Following the burning of the old grammar school by an invading Scots army in 1640 (see above), Bishop Cosin had a new school house built in the south-west corner of Palace Green in 1661 (the current Divinity House). When his almshouses were built on the site of the original school in 1666, they were provided with a school room at either end. The southern room, the plainsong school, soon lapsed into a preparatory for the grammar school and came to an end around 1690. Both rooms were then used as additional space for the main grammar school to the west. The whole school (now Durham School) was moved off the peninsula to its current position in Quarryheads Lane in 1844 (Clack 1985, 123). Recent archaeological work has suggested that Cosin's almshouses were largely a restoration of the earlier grammar school, rather than a completely new build (Archaeological Services 1997).

3.25 Forster's map of 1754 is a much more accurate representation of Durham. However, Forster does not depict individual buildings, except for churches, town gates, the castle and the cathedral, and these are represented pictorially rather than in the plan view of the remainder of the map. The cathedral again dominates the

peninsula. Palace Green is shown as open ground with a line of trees along its northern edge. The castle is shown to the north of this, with a formal garden between the Green and the keep. Along the west side of Palace Green are buildings named as 'the County House' and 'the Exchequer and Bishop's Library', together with 'the Grammar School' in the north-west corner of the cathedral precinct. Behind these buildings are 'the Castle Bowling Green', 'a walk' and 'a yard before the castle walls'. The buildings around this yard are not named and are presumably regarded as part of the 'County House'.

3.26 Most of the ground between Palace Green and North Bailey is shown as being built-up, although there are a couple of small open yards in the centre. None of the buildings in this area is individually identified, although both Owengate and Dun Cow Lane are named. The city's North Gate (named as 'the gaol') is shown but the Kingsgate that once stood next to St Mary le Bow Church has been removed. Many of the buildings on the riverbank side of North and South Baileys (including those on the site of the future Hatfield College) have ornamental gardens running down towards the river.

3.27 Wood's map of 1820 provides further detail, with all buildings individually marked. Again Palace Green is shown as open space between the castle and the cathedral. The buildings on the west side are named from south to north as the Grammar School, the Register Office, the Library and the Exchequer. The Register Office was built for Bishop Barrington in 1820 on the site of the County House (which had been rendered obsolete by the construction of the new Assizes Courts and jail in Old Elvet). It has two annexes to the rear. These appear to be different to the buildings shown on Forster's map. Otherwise this side of the Green is unaltered. The east side of the Green is shown as individual buildings for the first time. The almshouses are named as 'Bishop Bales Houses' and Cosin's Hall is described as being the property of GH Wilkinson. There are a number of yards between Palace Green and North Bailey, although these are all partly infilled with buildings. Hatfield Hall is shown as being the property of Rev Scruton and is still largely open ground. The North Gate is still present and is named as the old jail, although it was removed in the same year that the map was produced (Gee 1928, 51).

3.28 A guidebook to the city, 'A Brief Sketch of Durham' (Anon 1825) was first produced in the early 19th century. This proved very popular and was reprinted with additions and amendments at least 11 times through the remainder of the century. These guides included sketch illustrations by Joseph (Nicholas) Bouet, the son of a French refugee resident in Britain. Several of these sketches show the cathedral, castle and other buildings around Palace Green. One illustration shows Palace Green from the south-west, with the corner of Divinity House (at the time the Grammar School) in the left foreground. The windows of this building had not been replaced by the current ones at the time this illustration was made. In the background, Bishop Cosin's Hall and the almshouses are little altered in appearance today. Another shows the same view from slightly further east. Cosin's Hall and the almshouses are visible on the right, while the castle keep (still in a ruinous state) is visible on the left, with the Master's House to its right. Smaller two-storey houses are present on the south side of Owengate. On the west side of the green, another sketch shows the Diocesan Registry Office and Bishop Cosin's Library with a small building between them. This building has a steeply-sloping gable roof and no windows or doors on its

Palace Green face. This is possibly part of the former barrack yard that was attached to the County House.

3.29 In 1831 the Dean and Chapter, by an Act of Chapter, approved the foundation of a university; the bill received royal assent in 1832. The castle and many of the buildings on Palace Green were handed over for use by the university. In 1839-40 the old ruinous keep was demolished and replaced with the current standing structure, built on the old foundations and in similar style to the original. The grammar school was moved off the peninsula in 1844 and the buildings taken over by the university. The almshouses on the east side of the Green were taken over by the university in 1837, following construction of new almshouses in Owengate to replace the original ones.

3.30 The 1st edition Ordnance Survey map of 1857 shows many of these changes, together with an early, octagonal, kerbed Green. The Grammar School is now described as 'old grammar school'. It has an extension to its western end. Only the part of the Register Office that fronts onto Palace Green is now described as such. Buildings north and to the rear are described as lecture rooms. The Library is now described as Bishop Cosin's Library and the former exchequer is now named as Doctor Routh's Library. A new Exchequer building has been constructed to the east, on the corner of Owengate and North Bailey (Wood's earlier map has shown a terrace of small houses here). This is now the Law Department building. There are some minor changes to the other buildings between Palace Green and North Bailey (although differences in style between the two maps makes it hard to tell whether these are real changes or not). Bishop Cosin's Hall is named, as are Cosin's Hall Chapel (on the site of the current Bailey House), the 'Old Almshouses' on Palace Green and the 'New Almshouses' on Owengate. Hatfield Hall has been extended to the south and its chapel has been built.

3.31 The 2nd edition Ordnance Survey of 1895 shows a number of changes. The lecture rooms on the west side of Palace Green have been extended towards the rear. The houses on the south side of Dun Cow Lane have been removed, opening up the prospect of the cathedral from this side. The old almshouses are now a museum and there are some small extensions to the north end of Hatfield Hall.

The modern period (1900 to present)

3.32 The 3rd edition Ordnance Survey of 1919 shows no significant differences, although the South African War memorial has been erected in the cathedral grounds and the presumed site of the Bishop's Mint is shown as an antiquity for the first time. The 4th edition of 1939 shows the Palace Green in its larger, present form (since 1934) and some further building changes: the lecture rooms on the west side of Palace Green have been extended to join the earlier Cosin Library while the Pemberton Lecture Rooms, which were constructed in 1929, are shown on the east side of the Green.

3.33 A number of changes have taken place since 1939. The Pace Wing was added to the rear of Palace Green Library in 1965. Buildings to the rear of Cosin's Hall and the Old Almshouses were removed and replaced by the new student accommodation blocks of Bailey Court in 1973. In Hatfield College the gatehouse was rebuilt in 1961 following collapse of the original building a few years earlier. The boiler house for the old district heating system was built to the south of the gatehouse, and Jevons House and the Pace Building have been constructed as student accommodation

blocks to the north of the college chapel. Jevons House was built in 1967 and replaces an earlier building along the road frontage of North Bailey, while the Pace Building was constructed in 1951 on previously open ground.

4. Landuse, topography and geology

4.1 The study area comprised the lawn of Palace Green and the tarmac-covered road and parking areas to its immediate south. Two steel inspection covers were located at the southern end of the Green, believed to be associated with underground water storage tanks.

4.2 The survey area occupied predominantly level ground with a mean elevation of approximately 64m OD.

4.3 The site lies on Westphalian sandstone of the Pennine Middle Coal Measures Formation and Devensian glaciofluvial sand and gravel deposits.

5. Geophysical survey

Standards

5.1 The surveys and reporting were conducted in accordance with English Heritage guidelines, *Geophysical survey in archaeological field evaluation 2nd edition* (David, Linford & Linford 2008); the Institute for Archaeologists Technical Paper No.6, *The use of geophysical techniques in archaeological evaluations* (Gaffney, Gater & Ovenden 2002); the Archaeology Data Service *Geophysical Data in Archaeology: A Guide to Good Practice* (Schmidt 2002); and the European GPR Association's Code of Practice (www.eurogpr.org/codeofpractice.htm).

Technique selection

5.2 Geophysical survey enables the relatively rapid and non-invasive identification of sub-surface features of potential archaeological significance and can involve a suite of complementary techniques such as magnetometry, earth electrical resistance, ground-penetrating radar, electromagnetic survey and topsoil magnetic susceptibility survey. Some techniques are more suitable than others in particular situations, depending on site-specific factors including the nature of likely targets; depth of likely targets; ground conditions; proximity of buildings, fences or services and the local geology and drift.

5.3 Given the anticipated shallowness of targets and the non-igneous geological environment of the study area a geomagnetic technique, fluxgate gradiometry, was considered appropriate for the grassed area. Ground-penetrating radar (GPR) survey was considered suitable for both survey areas, given the relatively even surfaces and sandy nature of the soils. Electrical resistance survey would also be suitable on the lawned area, though parts of this have been surveyed previously.

5.4 Fluxgate gradiometry involves the use of hand-held magnetometers to detect and record anomalies in the vertical component of the Earth's magnetic field caused by variations in soil magnetic susceptibility or permanent magnetisation; such anomalies can reflect, for example, ferrous, stone, brick and soil-filled features. GPR generates a short high-frequency radar pulse which is transmitted into the ground via an antenna; the energy is reflected by buried interfaces and the return signal is received by a second antenna. The amplitude of the return signal relates to the electromagnetic responses of different sub-surface materials and conditions, which can be features of archaeological or historic interest. The time which elapses between the transmission and return of energy to the surface can be used to provide depth information.

Field methods

5.5 A regular grid was established across each survey area and tied-in to known, mapped Ordnance Survey points.

5.6 Measurements of vertical geomagnetic field gradient were determined across Area A using Geoscan Research FM256 fluxgate gradiometer. A zig-zag traverse scheme was employed and data were logged in 20m grid units. The instrument sensitivity was set to 0.1nT, the sample interval to 0.25m and the traverse interval to 1.0m, thus providing 1600 sample measurements per 20m grid unit. Data were downloaded on site into a laptop computer for initial processing and storage and subsequently transferred to a desktop computer for processing, interpretation and archiving.

5.7 The GPR surveys were conducted across Areas A and B using a Malå Ramac X3M radar unit with 500MHz antenna (centre frequency) and Object Mapper software. This antenna enables radial resolution of 50mm and a maximum penetration depth of about 6m. Returned energy wavelets were recorded from many depths in the ground to produce a series of reflections generated at one location, called a reflection trace. Data traces were collected at 50mm intervals along parallel transects spaced 0.5m apart to create a series of radar profiles across the survey area. This sampling method and interval was considered appropriate for detecting larger features such as mass grave pits, rather than small features such as post-holes or narrow linear features such as cables, for example.

6. Geophysical data processing

Geomagnetic data

6.1 Geoplot v.3 software was used to process the geomagnetic data and to produce both a continuous tone greyscale image and trace plot of the raw (unfiltered) data. The greyscale image and geophysical interpretation are presented in Figures 2 and 3; the trace plot is provided in Figure 4. In the greyscale image, positive magnetic anomalies are displayed as dark grey and negative magnetic anomalies as light grey. A palette bar relates the greyscale intensities to anomaly values in nanoTesla.

6.2 The following basic processing functions have been applied to the data:

clip	clips, or limits data to specified maximum or minimum values; to eliminate large noise spikes; also generally makes statistical calculations more realistic.
zero mean traverse	sets the background mean of each traverse within a grid to zero; for removing striping effects in the traverse direction and removing grid edge discontinuities.
destagger	corrects for displacement of anomalies caused by alternate zig-zag traverses.
interpolate	increases the number of data points in a survey to match sample and traverse intervals. In this instance the data have been interpolated to 0.25m x 0.25m intervals.

6.3 A colour-coded geomagnetic interpretation plan is provided. Two types of geomagnetic anomaly have been distinguished in the data:

positive magnetic — regions of anomalously high or positive magnetic field gradient, which may be associated with high magnetic susceptibility soil-filled structures such as pits and ditches.

dipolar magnetic — paired positive-negative magnetic anomalies, which typically reflect ferrous or fired materials (including fences and service pipes) and/or fired structures such as kilns or hearths.

Geomagnetic data

6.4 Malå Object Mapper and Easy 3D software packages were used to view, process and present the GPR results. The following basic processing functions have been applied to the data:

DC-correction — removes a constant offset in each trace, caused by imperfections in the radar electronics.

time gain — time varying gain is applied to the trace to compensate for amplitude loss due to spreading and attenuation.

6.5 The radar profiles have been stacked and interpolated to form a 3D model, which can then be examined in plan view at selected depths; such plan views are called 'time-slices', since all depth calculations are based on the time taken for transmitted energy to be returned from different reflectors in the ground. Selected radar profiles are presented, as well as time-slices from 0.38m and 0.77m depths for Area A and 0.38m depth for Area B (Figures 5 & 6).

7. Interpretation

Area A

7.1 A colour-coded archaeological interpretation plan is provided in Figure 7.

7.2 The magnetic data are relatively 'noisy', indicating some probable ground disturbance, as might be expected in this built-up environment and given its temporary use as a builders' yard in 1966. Many small, discrete dipolar magnetic anomalies have been detected scattered across Area 1, some in a band aligned broadly east-west. These almost certainly reflect items of near-surface ferrous and/or fired debris, such as bolts and brick fragments, and in most cases have little or no archaeological significance. Some of these anomalies in the central part of the Green may correspond to backfill from Wheeler's 1966 trench. A sample of the anomalies is shown on the geophysical interpretation plan, however, they have been omitted from the archaeological interpretation plan.

7.3 A number of larger intense magnetic anomalies have also been detected in Area 1, mostly corresponding to modern and recent features. For example, large dipolar magnetic anomalies in the north-eastern corner of the Green correspond to metal signs there. Other intense dipolar magnetic anomalies mid-way along the southern edge correspond to service inspection covers. The large, intense anomalies to the immediate north of the covers almost certainly reflect one or more water storage tanks, whose precise locations were unknown but presumed to be near the access covers. Radar reflections here may indicate the top of the tanks at relatively shallow depth. An intense geomagnetic anomaly to the south-east of the tanks probably reflects a vehicle which was parked nearby.

7.4 Chains of intense dipolar magnetic anomalies have been detected across Area 1. These almost certainly reflect ferrous service pipes and drains or other utilities with ferrous components.

7.5 Several very weak positive magnetic anomalies have been recorded across the area. These anomalies reflect relative increases in high magnetic susceptibility materials, typically sediments in cut archaeological features (such as furrows, ditches or pits) whose magnetic susceptibility has been enhanced by decomposed organic matter or by burning. However, the weak nature of these anomalies and their limited extents inhibit further interpretation.

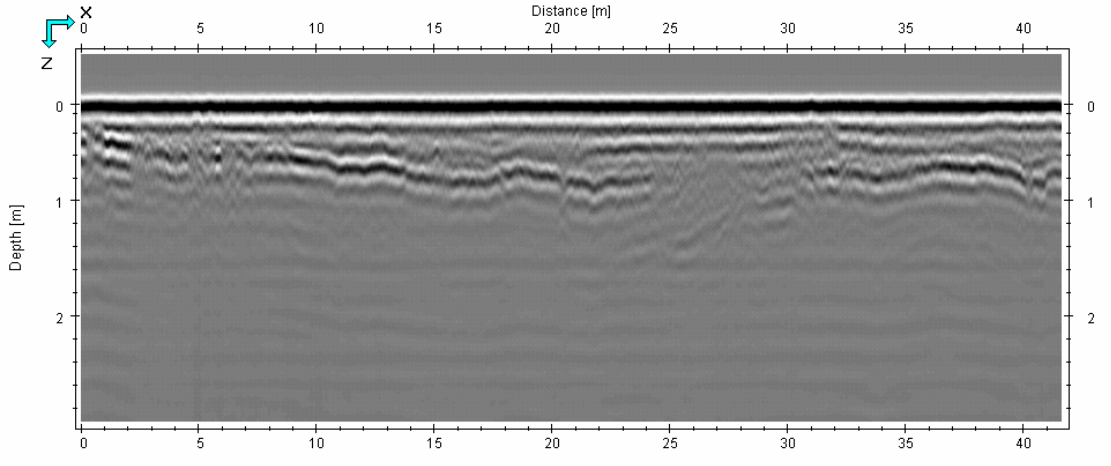
7.6 Several positive and dipolar magnetic anomalies in the eastern part of the Green together appear to form one side of an octagon, or possibly a hexagon. All the early Ordnance Survey editions up to 1919, and photographic prints from the 1840s and later, show an octagonal kerb around a small grassed area. The location of that feature is shown several metres south-west of the present anomalies, though its shape is similar. These anomalies could possibly reflect the remains of an earlier layout of the Palace Green, or indeed the association between the anomalies could be coincidental, apparent rather than real.

7.7 In the Area A radar time-slice for 0.38m depth, relatively strong reflections have been recorded over an apparent sub-rectangular structure measuring approximately 20m by 12m in the northern part of this survey. This structure has no corresponding magnetic anomalies and appears to represent shallow, subtle variations in the subsoil topography, when viewed through successive time-slices, rather than a man-made structure.

7.8 A probable service has been recorded in the gpr data, evident in the shallow time-slice, crossing the southern part of the area.

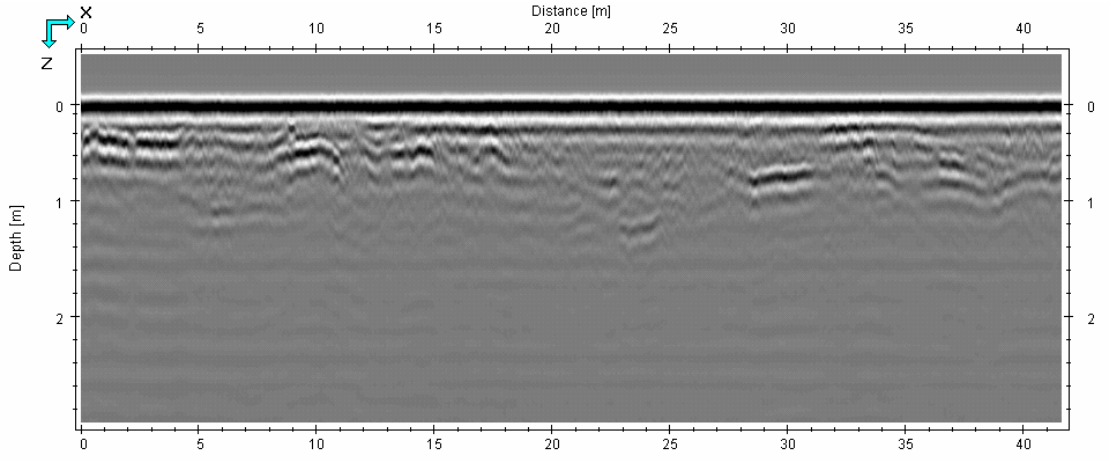
7.9 In the 0.77m time-slice for this area, very strong linear reflections have been detected crossing the area on two alignments. Both features are relatively well defined and could reflect possible former metalled paths or tracks. These features also broadly correspond to high electrical resistance anomalies recorded in an undergraduate dissertation (Durham 1988). One of these is illustrated in profiles 10032 and 10046 below.

7.10 A series of radar reflections in a broad U-shape to the east of the probable paths correspond to variations in sub-soil or rockhead topography (see profile 10032 below).



Area A profile 10032, 16m from North end of survey, shown East to West. Sub-surface topographic variation is evident; the probable track surface is between 36-39m.

7.11 Many small hyperbolic reflections in the radar data almost certainly reflect small objects such as stones in the topsoil. A concentration of radar anomalies in the central-southern part of Area A probably reflect near-surface disturbance.

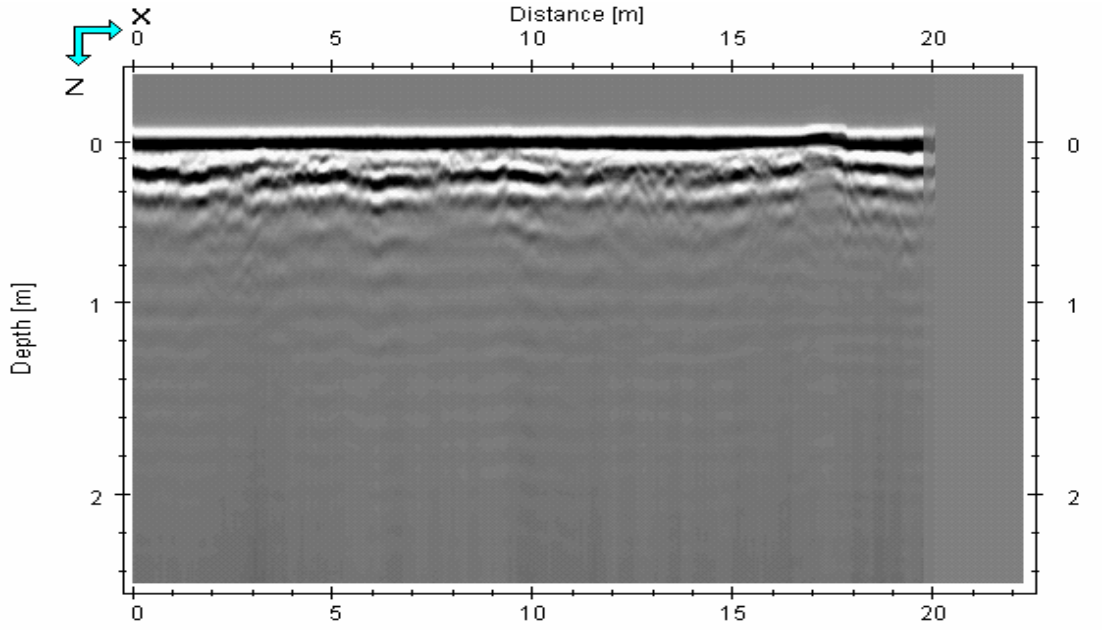


Area A profile 10046, 23m from North end of survey, shown East to West. Slightly further south than the above example, the probable track surface is evident between 28-31m.

7.12 Several other small areas of probable disturbance have also been detected. These areas have not been detected geomagnetically and so are unlikely to reflect soil-filled pits, nor sediments whose magnetic susceptibility has been enhanced by decomposed organic matter or by burning.

Area B

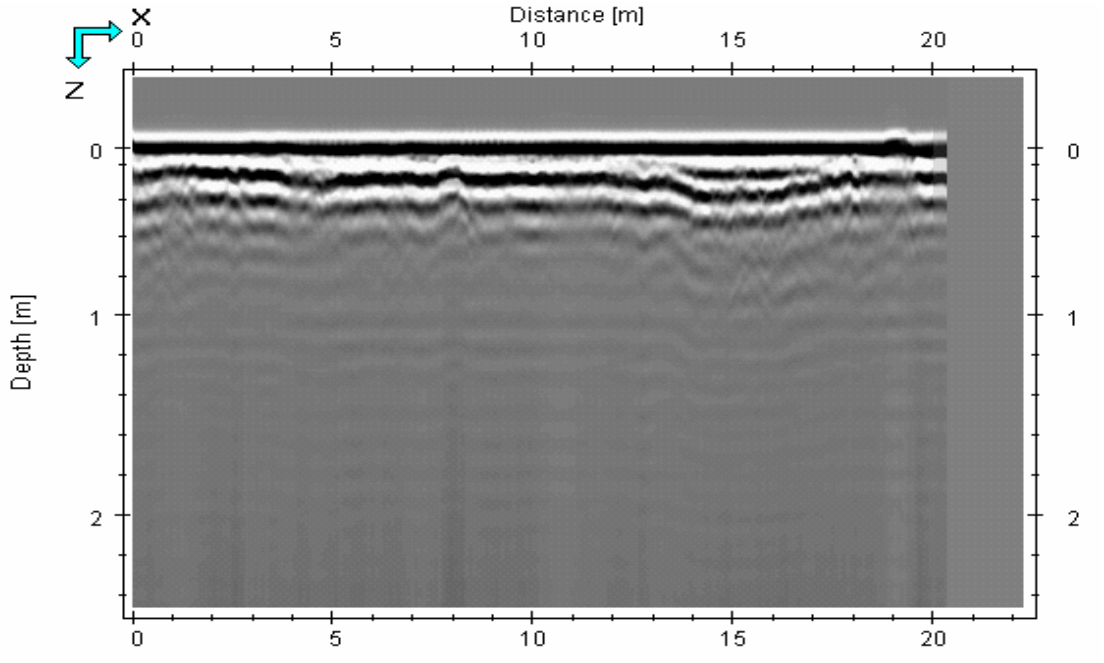
7.13 A probable service has been recorded in the gpr data for Area B, crossing the western part of the area (profile 20023 below).



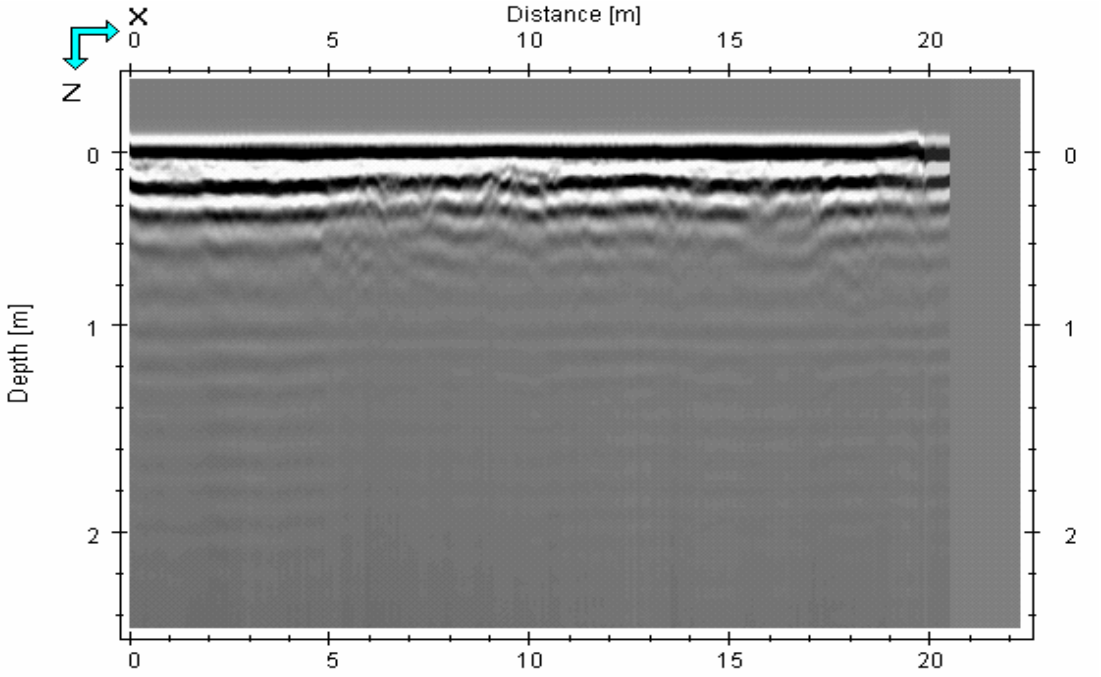
Area B profile 20023, 11m from West end of survey, shown North to South. The probable service is recorded at about 3m; the existing kerb is at 17m.

7.14 The existing kerb has been detected in the Area B data, as have indications that the tarmac was laid in several parallel strips aligned north-west/south-east. There is a great deal of near-surface variation in the radar data across this area. This is almost all within the top 0.4m and almost certainly reflects variation within the hardcore layer beneath the tarmac surface.

7.15 Slight variations in the former land surface beneath the make-up of the road have been detected, however, beneath about 0.45m there are virtually no anomalies characteristic of buried objects or disturbed ground.



Area B profile 20077, 38m from West end of survey, shown North to South. An apparent shallow depression at around 15m is very near-surface, likely to be within the make-up of the road; the existing kerb is at 19m.



Area B profile 20105, 52m from West end of survey, shown North to South. Many small hyperbolic responses, point reflectors, reflect individual items within the road make-up; the existing kerb is at almost 20m.

8. Conclusions

8.1 Geomagnetic and ground-penetrating radar (GPR) surveys have been conducted over two areas at Palace Green in Durham City with the principal aim of determining the presence or absence of possible mass graves.

8.2 No anomalies characteristic of large soil-filled pits, such as mass graves, were identified with either technique. Some small and/or irregular areas of possible disturbance have been detected by the GPR, however, these are either so near-surface as to be within the make-up of the road, or they lack any corresponding positive geomagnetic anomalies; such anomalies are associated with soils and sediments whose magnetic susceptibility has been enhanced by the decay of organic remains or by burning. Some large radar anomalies which are apparent in plan view reflect variations in the sub-surface topography, evident in the profile data.

8.3 The geomagnetic data are characterised by many small intense anomalies reflecting near-surface ferrous litter, much of which may be due to the Green's former temporary use as a builders' yard. Some weak positive magnetic anomalies were nevertheless detected. The nature and extent of these is typical of the remains of small or truncated ditches and gullies of unknown date.

8.4 Some of the geomagnetic anomalies appear to form part of a hexagon or octagon. Although the Green was formerly smaller and enclosed with a substantial octagonal kerb, it lay to the south-west of the anomalies detected in this study. These anomalies could possibly reflect an even earlier phase of the Green.

8.5 The water storage tanks associated with the service inspection covers on the southern edge of the Green have almost certainly been detected to the immediate north of the covers. Several probable and possible utilities were detected across both areas.

9. Sources

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Land at Palace Green, Durham City, County Durham

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Figure 1: Location of surveys

magnetic survey

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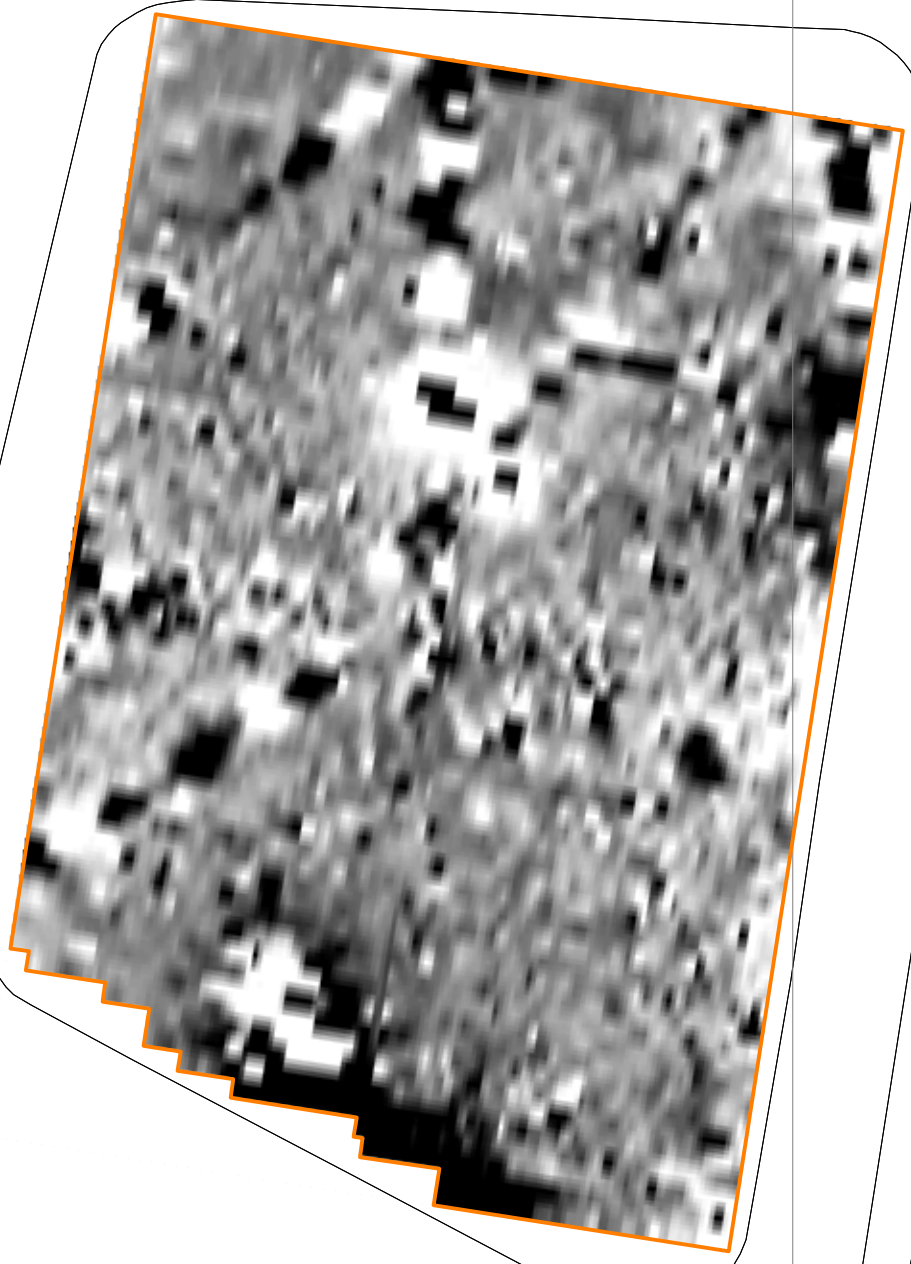
423

Area A



Palace Green

Durham Cathedral

422

274

Almshouses

Bishop Cosin's Hall

Abbey House

DUNCOW LANE

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0 20m

scale 1:400 for A3 plot

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Figure 2: Geomagnetic survey results

magnetic survey

positive magnetic anomaly

dipolar magnetic anomaly

423

Area A

Palace Green

Bishop Cosin's Hall

Almshouses

422

Durham Cathedral

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Figure 3: Geomagnetic interpretation

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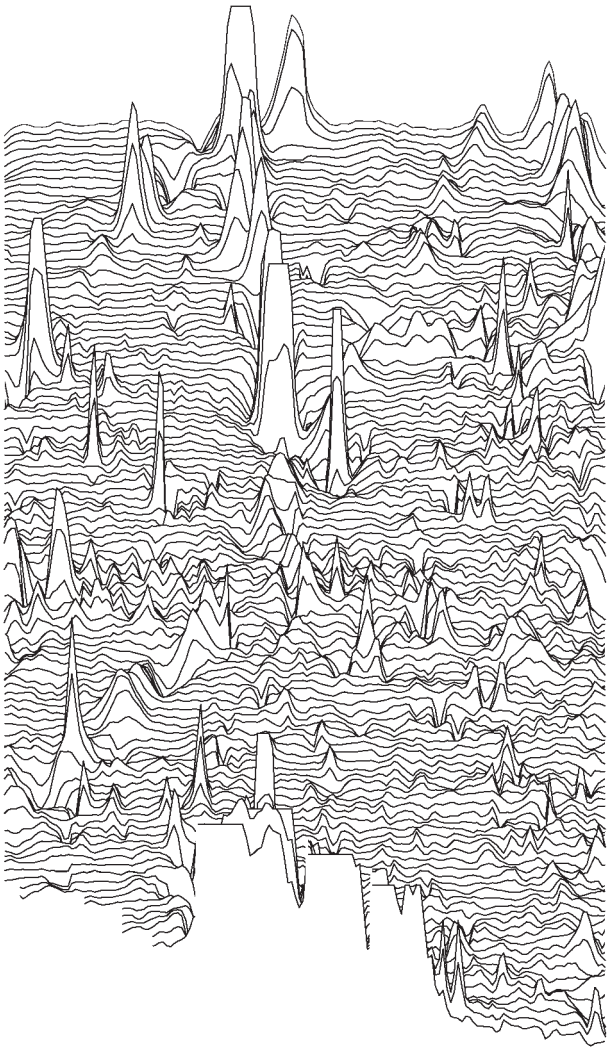
Figure 4:
Trace plots of geomagnetic data

Area A

111.70nT/cm

0 25m
scale 1:500



radar survey

423

Area A

Area B

422

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Almshouses

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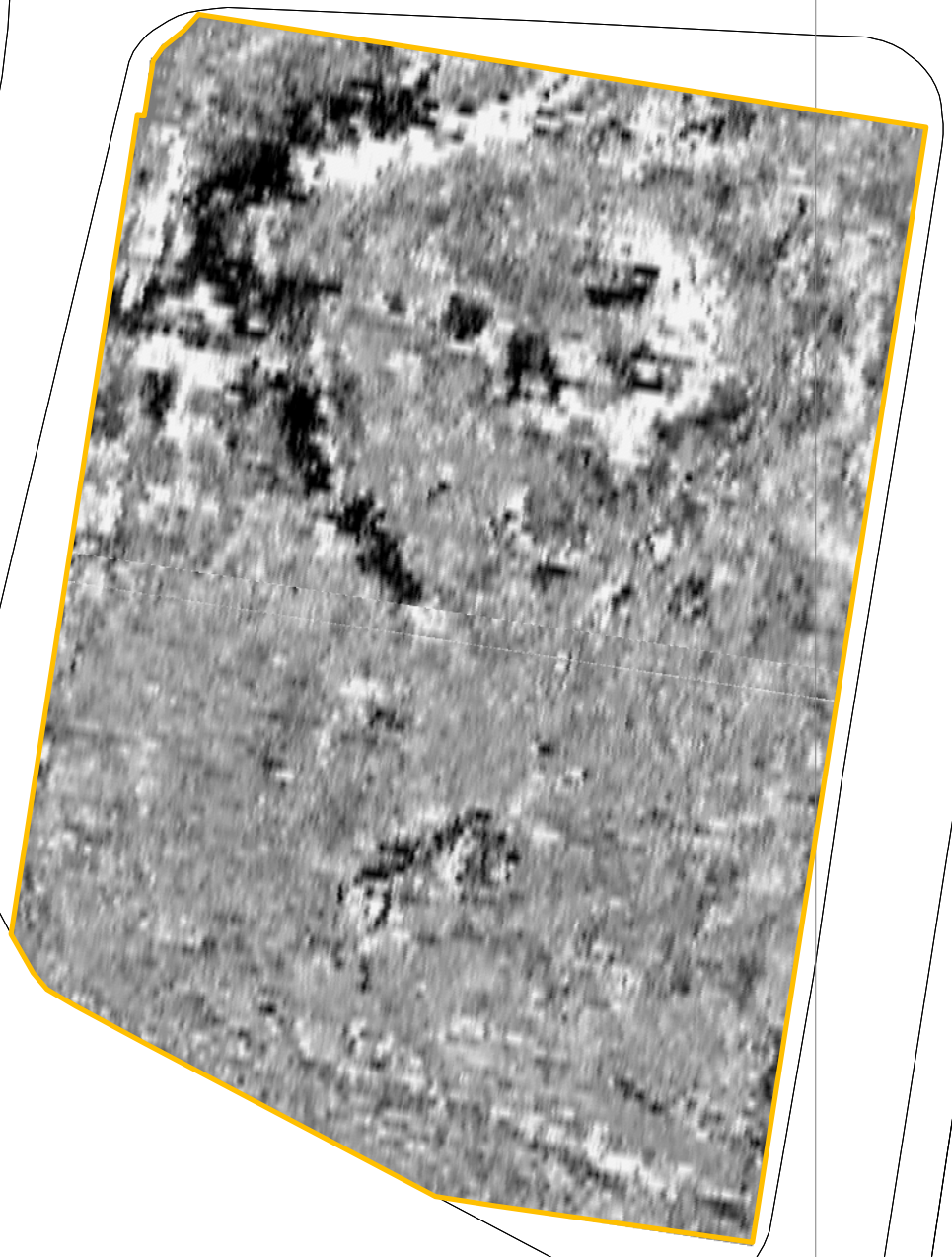
Figure 5: GPR time-slice at 0.38m, Areas A and B

radar survey

423

Area A



Palace Green

Bishop Cosin's Hall

Almshouses

422

Durham Cathedral

DUNCOW LANE

Abbey House

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scale 1:400 for A3 plot

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Figure 6: GPR time-slice at 0.77m, Area A

radar survey

services

disturbed area

possible soil-filled features

possible former feature

former Palace Green outline

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Area A

possible former paths/tracks

water tanks

inspection covers

Palace Green

Area B

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Durham Cathedral

Bishop Cosin's Hall

Almshouses

DUNCOW LANE

Abbey House

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0 20m

scale 1:400 for A3 plot

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Figure 7: Archaeological interpretation