NAA

GEOPHYSICAL SURVEY

LAND TO THE SOUTH OF SPA ROAD

GAINFORD, COUNTY DURHAM

prepared for

Lichfields

NAA 19/113
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Archaeological
Associates

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LAND TO THE SOUTH OF SPA ROAD, GAINFORD, COUNTY DURHAM
GEOPHYSICAL SURVEY REPORT

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GEOPHYSICAL SURVEY REPORT

Summary

Northern Archaeological Associates was commissioned by Lichfields to undertake a second phase of geophysical survey in support of a planning application of a housing development to the west of the village of Gainford, County Durham, DL2 3EB (NGR: NZ 16645 16885).

The first phase of geophysical survey concentrated on land to the north of Spa Road (see NAA report NAA_1503_geo_19-34). This second phase of works focused on an area to the south of Spa Road, and was required to assess the archaeological potential of the site in support of a planning application for sustainable drainage systems (SuDS) associated with the proposed residential development to the north of Spa Road. The geophysical survey targeted approximately 3.3ha of agricultural land and was carried out on the 5th November 2019.

Although there is relatively little evidence in Gainford of prehistoric or Roman activity, during the early-medieval period Gainford was probably the site of a monastic settlement, and in the medieval and post-medieval periods it was a relatively prosperous village. There is a walled garden directly to the north-east of the site containing earth works of a holloway and building platforms. Earthworks present in the proposed development area indicate that the site belonged to agricultural land to the west of Gainford during the medieval period. Between 1856 and 1966, a railway line operated between Darlington and Barnard Castle. Remnants of the track beds survive as prominent earthworks running on a north-west to south-east orientation through the north of the site. After the route fell foul of the Beeching cuts in the 1960s, the land reverted to an agricultural function. Otherwise, historic maps show little change to the fabric of the survey area during the 19th and 20th centuries.

The results of the geophysical survey largely correspond with features identified on LiDAR survey data, historic maps and aerial photographs. A bipolar anomaly runs on an east-west orientation through the north of the site that is caused by material belonging to the former railway line. A linear anomaly of unknown origin runs on a north-south orientation in the south-east of the site. Several trends of an unknown origin have also been identified but, given the likely nature of nearby anomalies, it is plausible they are either agricultural or geological in origin. Otherwise, anomalies are considered likely to be agricultural, modern or geological in origin. Ridge and furrow appears on an east-west orientation across most of the site suggesting that the area formed agricultural land in the direct hinterland of Gainford during the medieval period. There are

several broad areas of increased magnetic response that are considered likely to belong to geological or pedological changes within the substrata. The most notable result is a broad negative curvilinear anomaly that runs through the centre of the area on an east-west orientation that corresponds with a natural downward step in topography, likely to be caused by river terracing. Areas of disturbance and bipolar anomalies are considered likely to relate to ferrous material; in particular, along the northern edge of the survey area, there is a linear bipolar anomaly caused by a buried utility.

1.0 INTRODUCTION

1.1 Northern Archaeological Associates (NAA) was commissioned by Lichfields to undertake a geophysical survey on land to the south of Spa Road, Gainford, County Durham, DL2 3EB (NGR: NZ 16645 16885). The survey was required to assess the archaeological potential of the site in support of a planning application for SuDS associated with a residential development to the north of Spa Road. The geophysical survey targeted approximately 3.3ha of agricultural land and was carried out on the 5th November 2019.

1.2 This work forms the second phases of geophysical survey works for a proposed residential scheme to the west of Gainford. Results of the survey works undertaken to the north of Spa Road are detailed in NAA unpublished report NAA_1503_geo_19-34 (NAA 2019). At the time of writing this report, fieldwork for a trial trench evaluation had just concluded in the field to the north of Spa Road. Preliminary results of the evaluation have been used to help inform the interpretation of the current phase of geophysical survey to the south of Spa Road.

1.3 The report details the setting (location, topography, geology) and heritage background of the scheme and sets out the methodology used for the geophysical survey. The interpretation of the geophysical survey is achieved through the analysis of identified anomalies and is often aided by a rapid examination of supporting information. The results of the geophysical survey are discussed below, and the interpretations are supported by appropriate illustrations. Where feasible, a detailed synopsis of anomalies is provided and, if possible, the features that the anomalies are likely to relate to are suggested.

2.0 LOCATION, TOPOGRAPHY AND GEOLOGY

Location

2.1 The proposed development area (PDA) comprised the western part of a field (totalling c.3.3ha) located to the west of the village of Gainford, and on the northern banks of the River Tees in the south of County Durham (Fig. 1). The south-west of the PDA was not defined by a physical boundary and contained agricultural lands; while the north-east of the site was bordered by a walled garden, Spa Road (A67) lay adjacent to the north-west of the PDA, and the River Tees bounded the site to the west.

Topography

2.2 The topography of the survey area has a natural downward slope to the south and south-west. The south-west corner of the PDA forms its lowest point and is recorded at c.72m above Ordnance Datum (aOD); the highest measured value is in the north-west and is recorded at 78m aOD. It should also be noted that several undulations were visible in the PDA during survey works, which are likely to relate to natural river terracing caused by former water levels of the River Tees.

Geology and soils

2.3 The solid geology of the survey area consists of mudstone, siltstone and sandstone of the Stainmore Foundation. The drift geology across the majority of the PDA comprises sand, gravel and silt river terrace deposits (BGS 2019). The soils are mapped as the Wick 1 Association (Soil Survey of England and Wales 1983), consisting primarily of deep well-drained coarse loamy typical brown earths (Jarvis *et al*. 1984, 302).

3.0 AIMS AND OBJECTIVES

Geophysical Survey

3.1 The aim of the geophysical survey was to map and record potential buried features located within the PDA. Through detailed analysis and interpretation of the survey results, NAA's assessment of the site's archaeological potential will inform future archaeological mitigation strategies.

3.2 The objectives of the survey were to:

- undertake a geophysical survey across areas deemed suitable for data collection;
- attempt to identify and record any sub-surface remains within the survey boundary;
- characterise the nature of identified anomalies, and where possible suggest the nature of feature they potentially relate to;
- assess the archaeological significance of identified anomalies;
- identify possible concentrations of past activity in order to inform the requirement for any further archaeological investigation at the site; and
- produce a detailed report that includes illustrated results of the geophysical survey.

4.0 METHODOLOGY

Geophysical Survey

4.1 The geophysical survey was undertaken as a gradiometer survey using the Bartington Grad601-2 dual magnetic gradiometer system with data logger. The readings were recorded at a resolution of 0.01nT and data was collected with a traverse interval of 1m and a sample interval of 0.25m. All recorded survey data was collected with reference to a site survey grid of individual 30m x 30m squares. The grid was established using Real Time Kinematic (RTK) differential GPS equipment and marked out using non-metallic survey markers. All grid nodes were set out with a positional accuracy of at least 0.1m as per existing guidelines (CIfA 2014; Schmidt *et al*. 2015) and could be relocated on the ground by a third party. The base lines used to create the survey grids are shown on Fig. 3, and further details are available in Appendix A.

4.2 The processing was undertaken using Geoplot 3.0 software and consisted of standard processing procedures. Details of processing steps applied to collected data are given in Appendix B.

4.3 On the greyscale plot (Figs 4 and 5), positive readings are shown as increasingly darker areas and negative readings are shown as increasingly lighter areas.

4.4 Interpretation of identified anomalies is generally achieved through analysis of anomaly patterning and increases in magnetic response, and is often aided through examining supporting information (including but not limited to historic maps, LiDAR survey data, and aerial photographs). The interpreted data uses colour coding to highlight specific readings in the survey area (see Fig. 6).

5.0 ARCHAEOLOGICAL BACKGROUND

Rapid desk-based cultural heritage summary (Figure 2)

5.1 A rapid desk-based cultural heritage summary was provided in the geophysical survey report assessing land to the north of Spa Road (NAA 2019).

5.2 In summary, the site lies directly to the west of the Gainford Conservation Area and there are no World Heritage Sites, Registered Battlefields or Registered Parks and Gardens within its local environs. The Durham County Council Historic Environment Record (HER) records 12 previous archaeological investigations in the immediate hinterland of the PDA. These largely relate to desk-based studies, and building and

earthwork surveys. A minor amount of fieldwalking and test pitting has also been undertaken but failed to identify any significant evidence of former human activity.

5.3 Gainford boasts two scheduled monuments, two Grade I Listed Buildings, four Grade II* Listed Buildings and 36 Grade II Listed Buildings. None of these lie within the PDA. Directly to the north-east of the PDA is a 17th-century garden wall, 20m south-west of Gainford Hall (NHLE nos 1262592). Gainford Railway Bridge (dated to 1856; H61489) crosses the Tees to the west of the PDA, and Barforth Hall Bailey Bridge (dated to the 1950s; H1599) crosses the Tees to the south-west of the PDA. The nearby Grade II* Listed dovecote (NHLE no. 1121116) also has inter-visibility with the south-east of the PDA.

Prehistoric and Romano-British

5.4 There is little evidence for the prehistoric and Roman periods in the hinterland of the PDA. Early prehistoric finds in the village comprise a Neolithic or Early Bronze Age stone with cup-and-ring marks found during construction of the stables at Gainford House (H1607), and a perforated stone hammer (H1612). Two curvilinear enclosures recorded from aerial photographs near Black Scar at the south-east edge of the study area to the south of the River Tees may date from the Iron Age (H400 and H998).

5.5 Evidence for the Roman period is restricted to finds of a Roman altar and a stone inscribed LEG VI at St Mary's Church (H1603), and a terracotta mask of Medusa found in a garden in the village (H3751). A Roman brooch and a coin have been found by a metal-detectorist at Barforth (PAS IDs DUR-CEB1D5 and DUR-021FD7; not shown on Fig. 2). Although the Roman material may derive from the extensive Roman site at Piercebridge 4km to the east, it is more likely to represent a smaller settlement somewhere in the vicinity of the historic ford across the River Tees.

Medieval

5.6 During the latter part of the early medieval period, Gainford is likely to have been the site of an important monastic settlement. There are several documentary references to a church at *Gegenford* in the 9th century (H1601). A significant assemblage of Anglo-Saxon sculptural fragments, including parts of several crosses and tomb-covers, together with a group of coins from the reign of Alfred, were found during campaigns of restoration at St Mary's Church during the 19th century (Group A). Evidence of the continuing importance of the site during the Anglo-Scandinavian period is

demonstrated by the presence of two hog-back grave covers (Group A), which are unique to areas of northern England dominated by the Vikings in the 9th to 10th centuries. No in situ early medieval archaeological remains have yet been found in Gainford, although a 'great number' of human skulls found on the village green in 1785 (H1609) may hint at the location of a monastic cemetery.

5.7 In the post-Conquest period, Gainford continued to be the centre of a large parish extending along the north bank of the River Tees between Piercebridge and High Shipley, including hamlets such as Langton and Streatlam (H4378). The extant church dedicated to St Mary was constructed in the 12th or early 13th century and is a Grade I Listed Building (NHLE no. 1121114). From documentary sources, the village contained a hospital (H1611), a tower (H1610) and two forges (H1613), although the sites of these are unknown. Physical fabric of the medieval village, other than the church, is restricted to a cross-base (NHLE no. 1159562), earthworks adjacent to Gainford Hall that possibly represent the site of the medieval manor house (H1589), and a pinfold (for holding straying animals which could be recovered upon payment of a fine) that was largely destroyed in 1926 (H1614).

5.8 Beyond the village, there is documentary evidence for a Chapel of St Mary Magdalene at a place called 'Barmore', which is equated with Balmer Hill at the north edge of the study area. This was destroyed by fire in the early 15th century (H1616).

5.9 Across the Tees at Barforth lay a manorial settlement including St Lawrence's Chapel and a dovecote. These remains are a Scheduled Monument (NHLE no. 1017319), as is the nearby Barforth Bridge (NHLE no. 1002322). The extant Barforth Hall is late medieval in date and is a Grade II* Listed Building (NHLE no. 1121707).

5.10 The Portable Antiquities Scheme has recorded several finds of medieval coins made by metal-detectorists at both Barforth and Gainford, attesting to the relative wealth of the area during this period (not shown on Fig. 2).

Post-medieval to modern

5.11 In the post-medieval period, Gainford continued to be a centre and market for the surrounding area, and the settlement became increasing wealthy. Gainford Hall was built in 1600–1603 and is Listed Grade I (NHLE no. 1323010). The nearby dovecote dates from a similar period and is Listed Grade II* (NHLE no. 1121116).

5.12 In the 18th and 19th centuries, the village remained prosperous and this is reflected in the large number of listed buildings recorded around the green and adjacent streets. The major change in the 19th century was construction of the railway line between Darlington and Barnard Castle, which passed immediately to the north of the village and was opened in 1856.

5.13 The First Edition Ordnance Survey map of 1859 (surveyed 1855 but already showing the new railway line) portrays Gainford village in very much the same form as it remains today, although there has been some development in the 20th century to the north-east of the ancient village core.

5.14 The railway line running between Darlington and Gainford was built in the mid-19th century and is visible in the north of the PDA on the First Edition Ordnance Survey map of 1859. Otherwise, historic maps dated to the 18th and 19th century demonstrate that there was little change to the fabric of the PDA, until the railway closed in 1966 and the land it occupied reverted to an agricultural function.

Investigations to the north of Spa Road (Figs. 3 – 6: Area A)

5.15 To aid in the interpretation of the current phase of works, Figs 3 – 6 show the geophysical survey results on land to the north of Spa Road, and the location of trenches from the first phase of works in Area A.

5.16 In April 2019, NAA undertook a geophysical (gradiometer) survey in the field to the north of Spa Road (NAA 2019). The results of the survey corresponded with earthworks present in the field including a former field boundary in the north of the field, the route of the Darlington to Barnard Castle railway in the south of the field, and ridge and furrow. It was also noted that there was a high level of magnetic disturbance across the survey area that was considered likely to be modern and/or geological in origin.

5.17 Following the results of the geophysical survey, a trial-trench evaluation was undertaken in November 2019. The report for that phase of work was in preparation at the time of writing this report. To aid in the interpretation of the geophysical survey results on the land to the south of Spa Road, a brief preliminary summary of the work is provided below.

5.18 The investigation works carried out to date at Spa Road, Gainford consisted of 28 evaluation trial trenches. These were positioned to test the results of the geophysical survey, as well as the preservation of the dismantled Darlington to Barnard Castle

railway, which survives in the field as a raised linear earthwork. Trenches 1 to 4 were located on a significant topographical rise at the north of the PDA, related to a disused field boundary that was present on historic mapping and visible in the geophysical survey results. Trenches 27 and 19 targeted the earthwork associated with the former railway line. Trench 27 was located central to the field and contained a railway embankment. Trench 19, located in the west of the field, contained a cutting that would have allowed the railway to pass under the road to the south-west of the PDA. Trench 28 had been placed in order to ascertain the survival of a railway siding present on historic mapping; however, no definable evidence of this was encountered. Geophysical anomalies representing medieval ridge and furrow were present across the site. Discernible evidence of this was encountered in trenches 5, 12, 13 and 18. A track consisting of dumped rubble and stone material was observed in trenches 23 and 24. No other archaeological features were observed within the PDA. The finds recovered were minimal, and largely related to post-medieval and modern agricultural use of the PDA. Some railway sleepers and associated iron pins/bolts were encountered in trenches targeting the railway line, but were not retained.

LiDAR

5.19 Environment Agency LiDAR coverage of the area carried out in 2006 was examined at a vertical resolution of both 1m and 2m. The disused railway line appears in Area B as a distinct earthwork. LiDAR survey data also shows evidence of agricultural activity, including rectilinear earthworks and ridge and furrow, which both run on an east-west alignment. The natural changes in topography caused by river terracing are also visible.

6.0 GEOPHYSICAL SURVEY RESULTS

Survey conditions and mitigating factors

6.1 At the time of the survey, the site contained sheep and there were areas of high vegetation around the edges of the survey area.

6.2 Attempts were made to avoid areas affected by above-ground features that were likely to have a high magnetic susceptibility, such as metal fencing, to minimise the potential for their magnetic response to impinge on the survey results and mask potential buried features.

(Figures 5 and 6)

6.3 As with Area A, the disused railway line in the north of Area B appears as a bipolar anomaly (**A**).

6.4 A fragmented linear anomaly (**B**) runs on a north-south orientation in the south-east of Area B. Although this anomaly is composed of clear increases in magnetic value, its origin is unknown as it does not correspond with features identified on historic maps and LiDAR survey data. It is apparent that the anomaly is on the same alignment as a trend identified in the south of Area A. However, it should be noted that trial trenching did not identify any infilled features in this area, and so the trend is likely to relate to ephemeral pedological changes in the substrata or agricultural activity.

6.5 There are several weak and diffuse linear trends. These fail to produce the necessary patterning or increases in magnetic response in order to be interpreted fully, and as a consequence their origin is unknown.

6.6 Regularly spaced linear anomalies on an east-west alignment are indicative of ridge and furrow. Several anomalies with weak increases in magnetic values and/or a narrow spacing have also been identified that are likely to relate to agricultural activity, but it is not clear if they are caused by modern farming intervention or relate to a historic phase of cultivation.

6.7 The strong bipolar linear anomaly running along the northern edge of Area B is caused by a buried utility. It should be noted that the strength and size of the anomaly associated with the buried utility reflect the highly magnetic responses of the ferrous material of the buried pipe rather than actual feature dimensions.

6.8 Several isolated bipolar responses have been identified. These are considered to be modern and caused by highly magnetic material, such as ferrous objects.

6.9 Dipolar anomalies are often likely to relate to ferrous or modern objects buried in the topsoil. Areas of increased magnetic response have been used to highlight concentrations of dipolar anomalies. Generally, there appears to be a high level of magnetic 'noise' across the site. Although this is largely postulated to be geological in nature, there is an area of magnetic disturbance in the north-east of the site that is considered likely to relate to human activity of an unknown date. Interestingly, this band of disturbance conforms to a rectilinear feature identified on LiDAR survey data, which is considered likely to be agricultural in nature, possibly denoting a former headland.

In this case, it is plausible that that magnetic disturbance relates to agricultural activity and either denotes a build-up of magnetic material along the edge of an agricultural boundary or the spread of magnetic soils through cultivation.

6.10 There are several isolated dipolar and bipolar anomalies that are likely to be indicative of ferrous or magnetically susceptible objects buried in the topsoil. As these are considered to be of a modern nature they have not been shown on the interpretation of the survey results.

6.11 Area B is located to the north of the Tees. LiDAR survey data shows clear evidence of river terracing in areas immediately bordering the course of the river in the area surrounding Gainford. Consequently, it is considered likely that much of the variation in background magnetic responses in Area B relates to natural erosion, transportation and deposition. A broad area of negative magnetic values runs on an east-west alignment through the centre of the field that corresponds with a natural step in topography and so is considered likely to be caused by river terracing (**C**).

7.0 CONCLUSIONS

7.1 NAA was commissioned to undertake a geophysical (gradiometer survey) on land to the south of Spa Road, Gainford, to support a planning application for a proposed SuDS associated with a proposed residential development to the north of Spa Road.

7.2 Since the medieval period, Gainford has developed as a fairly prosperous village and this is demonstrated by the high number of heritage assets that shape the modern composition of the village. Directly to the north-east of the PDA is a 17th-century walled garden; and Barton Hall Bailey Bridge crosses the River Tees to the west of the PDA. It is likely that the PDA formed agricultural land directly to the west of Gainford since at least the medieval periods. This is evidenced by the clearly defined ridge and furrow that appears as earthworks within the site and has been recorded through LiDAR and geophysical surveys.

7.3 Historic maps document the evolution of the site from the mid-19th century. Generally, there has been little alteration to composition of the PDA. The only alteration in land use occurs in the north of the site and comprised the Darlington to Barnard Castle railway which functioned between 1866 and 1956. The remnants of the railway line are still visible in the field as a raised bank, and appeared as a bipolar anomaly in the results of the geophysical survey.

7.4 A fragmented linear anomaly along with several trends were identified as being of unknown origin. Given the lack of supporting information and the results in the area to the north of Spa Road, it is plausible that these anomalies relate to either agricultural activity or geological or pedological changes in the substrata.

7.5 It should be noted that there is a high variation in magnetic background readings across the site. Generally, these are considered to be geological in origin and relate to natural soil processes associated with the nearby River Tees. In particular, there is evidence of river terracing. One area of magnetic disturbance has been identified in the east of the field that conforms with features identified through LiDAR survey and, although tentative, it is plausible that the disturbance is of an agricultural nature.

7.6 Other anomalies were considered to relate to modern activity. Several isolated bipolar anomalies were identified that are likely to be indicative of ferrous material, and the linear bipolar anomaly running along the northern edge of the field denotes a buried utility.

8.0 STORAGE AND CURATION

8.1 The records of the geophysical survey are currently held by NAA. All material will be appropriately packaged for long-term storage in accordance with national guidelines (CIfA 2014; Schmidt *et al*. 2015). An online OASIS form will be completed within three months of the completion of the project under the reference number Northern1-374766. This will include submission of a PDF version of the final report to the Archaeology Data Service via the OASIS form.

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APPENDIX A
TECHNICAL INFORMATION

GRADIOMETER SURVEY

Magnetic surveys measure distortions in the earth's magnetic field caused by small magnetic fields associated with buried features (Gaffney and Gater 2003, 36) that have either remnant or induced magnetic properties (Aspinal *et al*. 2008, 21-26). Human activity and inhabitation often alter the magnetic properties of materials (Aspinal *et al*. 2008, 21) resulting in the ability for numerous archaeological features to be detected through magnetic surveys. Intensive burning or heating can result in materials attaining a thermoremanent magnetisation; examples of which include kilns, ovens, heaths and brick structures (Aspinal *et al*. 2008, 27; Gaffney and Gater 2003, 37). When topsoil that is rich with iron oxides fills a man-made depression in the subsoil, it creates an infilled feature, such as a pit or ditch, with a higher magnetic susceptibility compared to the surrounding soil (Aspinal *et al*. 2008, 37–41; Gaffney and Gater 2003, 22–26). Magnetic surveys can also detect features with a lower magnetically susceptibility than the surrounding soil, an example of which is a stone wall.

LIMITATIONS

Poor results can be due to several factors including short-lived archaeological occupation/use or sites with minimal cut or built features. Results can also be limited in areas with soils that are naturally deficient in iron compounds or in areas with soils overlying naturally magnetic geology, which will produce strong responses masking archaeological features.

Overlying layers, such as demolition rubble or layers of made ground, can hide any earlier archaeological features. The presence of above-ground structures and underground services containing ferrous material can distort or mask nearby features.

Particularly uneven or steep ground can increase the processing required, or distort results beyond the capabilities of processing. It is also possible in areas containing dramatic topographical changes that natural weathering, such as hillwash, often in combination with intensive modern ploughing, will reduce the topsoil on slopes and towards the peaks of hills and possibly destroy or truncate potential archaeological features. Conversely, features at the bottom of slopes may be covered by a greater layer of topsoil; so, if buried features are present, they appear faint within the results, if at all.

Over processing of data can also obscure or remove features, especially if they are on the same orientation as the direction of data collection. Consequently, where possible, attempts are made to ensure data is not collected on the same orientation as known potential features and that data quality is sufficient to minimise the required data processing.

INSTRUMENTATION

The data was collected using handheld Bartington Grad 601-2 fluxgate gradiometers. The Bartington 601-2 is a single axis, vertical component fluxgate gradiometer comprising a data logger battery cassette and two sensors. The sensors are Grad-01-1000L cylindrical gradiometer sensors mounted on a rigid carrying frame; each sensor contains two fluxgate magnetometers with 1m vertical separation.

The difference in the magnetic field between the two fluxgates in each sensor is measured in nanoTesla (nT). NAA gradiometer data is recorded with a range of ±100nT, which equates to a resolution of 0.01nT. It should be noted that the actual resolution is limited to 0.03nT as a consequence of internal instrumental noise (Bartington Instruments Ltd, 23).

The gradiometer records two lines of data on each traverse, the grids are walked in a zig-zag pattern amounting to 15 traverses. The gradiometers are calibrated at the start of every day and recalibrated whenever necessary.

SURVEY DETAILS

Table A1: survey summary.

		Survey
Grid size Traverse interval Reading interval Direction of 1st traverse Number of Grids Area covered		30m x 30m 1m 0.25m N 57 3.3ha

Table A2: baseline co-ordinates (baseline is shown on Fig. 2).

Grid point (gp) A	Grid point (gp) B
NGR: 416584.9247 516942.7528	NGR: 416614.9247 516942.7528

Table A3: site information and conditions.

Item	Detail
Geology Superficial deposits Soils Topography Land use Weather conditions prior to and during survey	Mudstone, siltstone and sandstone of the Stainmore Foundation Sand, gravel and silt river terrace deposits Wick 1 Highest: 78m aOD Lowest: 72m aOD Agricultural - pasture Overcast

APPENDIX B

DATA PROCESSING INFORMATION

Gradiometer survey data is downloaded using the Bartington Grad 601 software and the processing was undertaken using Geoplot 3.0 software.

Table B1: commonly applied techniques.

Process	Effect
Zero mean traverse	Removes stripping that can occur as a consequence of using multi-sensor arrays or a 'zigzag' data collection method by setting the mean reading for each traverse to zero.
Destagger	Removes stagger in the data introduced through inconsistence data collection pace and often exacerbated through the 'zigzag' methodology.
Clip	Clips data above or below a set value to potentially enhance potential weaker anomalies.
Despike	Removes random spikes or high readings to reduce the appearance of dominant readings, often created by modern ferrous objects that can distort the results.
Low pass filter	Removes low-frequency waves or broad anomalies such as those caused by strong or large gradual variations in the soil's magnetic susceptibility often caused by geological or natural changes in the substrata.
Interpolation	Used to smooth or reduce the blocky appearance of data by improving the spatial density and balance the quantity of data points in the X and Y directions.

Table B2: processing steps.

Minimal Processing	Increased Processing
• Zero mean traverse +5/-5 • Destagger: - Grids 20 and 50: -4 - Grids 37 and 52: -3 - Grids 28, 31, 32, 38, 42, and 81: -2 - Grids 30, 39, 58, 59 and 70: -1 - Grids 36, 47, 67, 69, 93, 104 and 114: 1 - Grids 10, 19, 29, 48, 60, 63, 71 and 72: 2 - Grids 11, 41, 61, 80, 82 and 103: 3 - Grids 51 and 62: 4 - Grids 40 and 68: 5	• Low Pass Filter • Interpolate Y, Expand - Linear, x2

APPENDIX C

DATA VISUALISATION INFORMATION

FIGURES

The data was used to produce a series of images to demonstrate the results of surveys these are detailed below:

- Greyscale/Colourscale Plot – This visualised the results as a shaded drawing with highest readings showing as black, running through different shades to lowest showing as white.
- XY-trace Plot – This creates a line drawing showing the peaks and troughs of the readings as vertical offset from a centreline.
- Interpreted Plot – Through detailed analysis, anomalies have been interpreted and possible features identified. Interpretation drawings are used to show potential features and in particular to reinforce and clarify the written interpretation of the data. Anomalies have been characterised using the terminology detailed in the following section, and have been assigned colour coding shown in keys on the relevant figures associated with this report.

MAGNETIC ANOMALIES AND TERMINOLOGY

Table C1: lexicon of terminology.

Terminology	Detail
Anomaly	Any outstanding high or low readings forming a particular shape or covering a specific area with the survey results.
Feature	A man-made or naturally created object or material that has been detected through investigation works and has sufficient characteristics or supporting evidence for positive identification.
Magnetic susceptibility	The ability of a buried feature to be magnetically induced when a magnetic field is applied.
Magnetic response	The strength of the changes in magnetic values caused by a buried feature with either a greater or lesser ability to be magnetised compared with the soil around it. Anomalies are considered to either have strong/weak or positive/negative responses. The strength of magnetic response (along with patterning) can be essential in determining the nature of an anomaly, but it should be noted that the size or strength of the magnetic response does not correlate with the size of the buried feature.
Patterning of an anomaly	The shape or form of an individual anomaly.
Thermoremanence	The affect caused when a material has been magnetically altered through a process of heating. Thermoremanent magnetisation occurs when an object or material is heated passed the Curie Point and acquires a permanent magnetisation that is associated with the magnetic field that they cooled within (Gaffney and Gater 2003:37).

Different anomalies can represent different features created by human, agricultural or modern activity, or natural pedological or geological changes in the substrata.

Anomalies interpreted with a 'greater' categorisation are considered more likely to be of the interpreted characterisation; whereas a more tentative interpretation is applied to those with a 'lesser' categorisation as a consequence of weaker increases in magnetic response or the anomalies incomplete patterning or irregular form.

The strength and size of anomalies can vary depending on the magnetic properties of the feature, the magnetic susceptibility of the soil, the depth to which the feature is buried, and the state of preservation.

Table C2: characterisation of anomalies.

Characterisation	Detail
Archaeology	
Bipolar response (railway)	Positive anomalies with associated negative 'halo' (bipolar) that correspond with features recorded on historic maps associated with railway activity.
Linear anomaly	Linear anomalies with positive or negative magnetic responses, and composed of a patterning or shape that is suggestive of a buried feature. Depending on the strength, form and available supporting information. These anomalies can be indicative of structural remains or infilled features such as ditches. The strength of anomaly signal can be suggestive of the properties of the feature. Negative linear anomalies represent upstanding or infilled features that are less magnetically susceptible than background readings. Bipolar linear anomalies considered to be of an archaeological nature are indicative of material with a high magnetic susceptibility, such as a brick wall.
Magnetic disturbance (archaeology?)	Isolated anomalies or anomalies with a more amorphous or fragmented form possibly represent archaeological features with a high magnetic susceptibility.
Trends	Weak and diffuse anomalies with an uncertain origin are denoted by trends. It is possible that these belong to archaeological features but, given their weak signatures or incomplete patterning, it is equally plausible that they relate to agricultural features or natural soil formations.
Agriculture	
Field boundary	Isolated linear anomalies that are likely to be indicative of former land divisions. A more conclusive interpretation is given to linear anomalies that correspond with the location of field boundaries recorded on historic maps, aerial photos or LiDAR coverage of the site.
Ridge and furrow	Broadly spaced linear anomalies that are likely to be indicative of earlier forms of agriculture, such as ridge and furrow. These often correspond with the location of earthworks visible on the ground or identified on aerial photos or LiDAR survey coverage.
Agriculture?	Weak, irregularly spaced or isolated linear anomalies that possibly relate to agricultural activity. Given the tentative interpretation, the agricultural process they are caused by is also likely to unknown.
Modern	
Bipolar response (modern?)	Generally positive anomalies with associated negative 'halo' (bipolar) denote features with a strong magnetic response that are likely to be of a modern origin. It should be noted that, given the high number of anomalies

Characterisation	Detail
	with bipolar responses associated with the former railway activity, interpretation on this site is tentative. Isolated bipolar responses of a modern nature are likely to relate to buried ferrous material or objects, such as metallic agricultural debris. If a trend is noted in the alignment or spacing of isolated bipolar responses, it is possible that it is indicative of ferrous fittings or connectors used on non-magnetic buried utilities. Linear bipolar anomalies are likely to be indicative of modern services.
Dipolar response	Dipolar anomalies relate to individual spikes within the data and tend to be caused by ferrous objects. These responses have been shown only when located near archaeological features. When the site is located in a mining landscape it is possible that identified dipolar anomalies relate to mining activity and are indicative of further pits or mine shafts.
Area of increased magnetic response	Areas of increased magnetic response denote areas of disturbance containing a high concentration of dipolar and/or bipolar responses. These are generally considered to be caused by modern debris in the topsoil, although it is possible that the disturbance is in part also caused by isolated archaeological material or geological or pedological changes in the substrata.
Natural	
Area of disturbance (geology)	Areas of variable magnetic responses can demonstrate natural features or changes in geology or soil type that often correspond with topographical variations.

APPENDIX D

OASIS FORM

OASIS DATA COLLECTION FORM: England

OASIS ID: northern1-374766

Project details

Project name	Land to the south of Spa Road, Gainford
Short description of the project	Geophysical survey report
Project dates	Start: 05-11-2019 End: 05-11-2019
Previous/future work	No / Not known
Type of project	Field evaluation
Site status	None
Current Land use	Grassland Heathland 4 - Regularly improved
Monument type	NONE None
Significant Finds	NONE None
Methods & techniques	"Geophysical Survey"
Development type	Housing estate
Prompt	Planning condition
Position in the planning process	Pre-application
Solid geology (other)	Stainmore Foundation
Drift geology (other)	Sand, gravel and silt river terrace deposits
Techniques	Magnetometry

Project location

Country	England
Site location	DURHAM TEESDALE GAINFORD Land to the south of Spa Road
Postcode	DL2 3EB
Study area	3.3 Hectares
Site coordinates	NZ 16645 16885 54.546819911817 -1.742660787403 54 32 48 N 001 44 33 W Point
Height OD / Depth	Min: 72m Max: 78m

Project creators

Name of Organisation	Northern Archaeological Associates
Project brief originator	Consultant
Project design originator	Northern Archaeological Associates
Project director/manager	Alice James
Project supervisor	Oskar Sveinbjarnarson
Type of sponsor/funding body	Developer

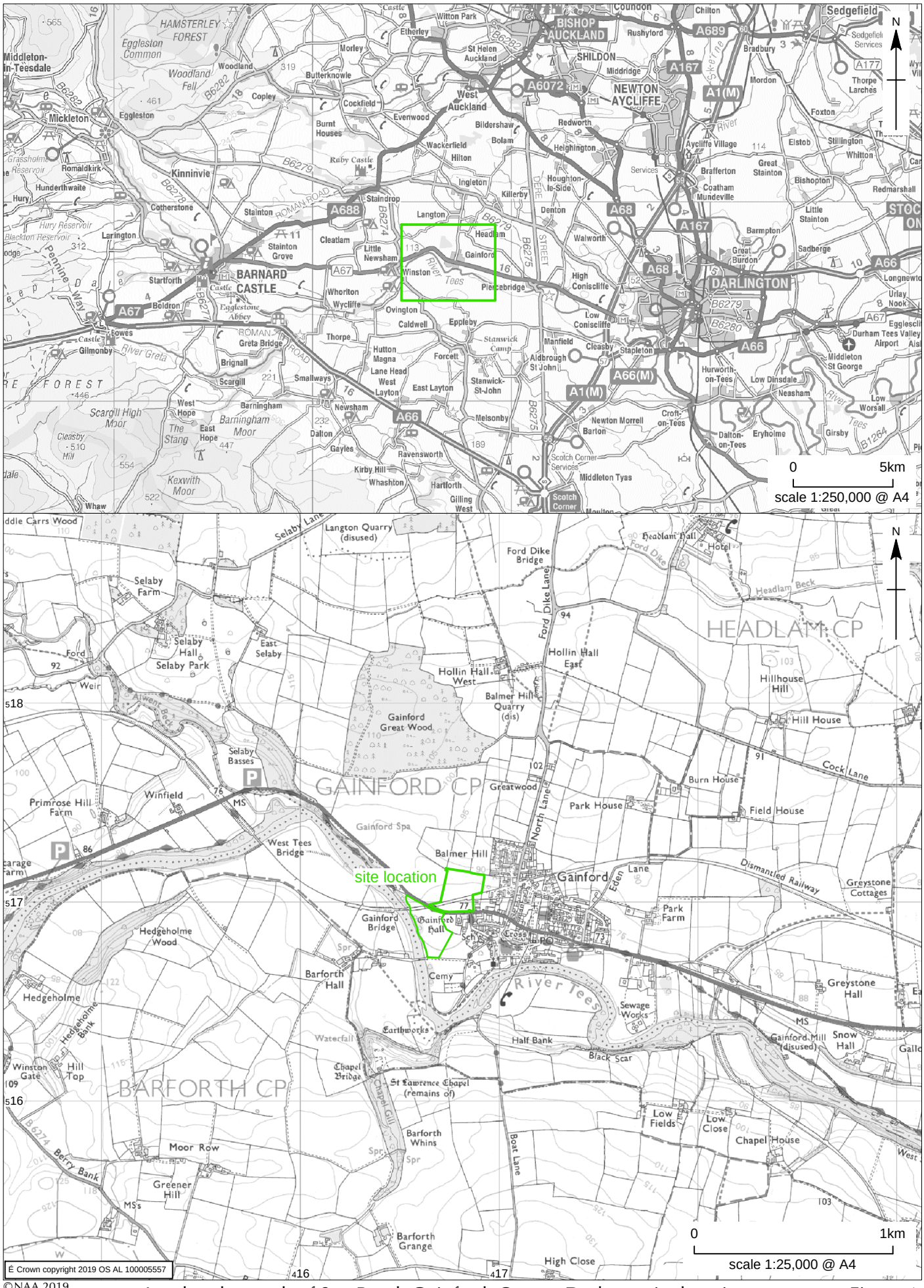
Project archives

Physical Archive Exists?	No
Digital Archive recipient	Northern Archaeological Associates
Digital Contents	"none"
Digital Media available	"Geophysics"
Paper Archive Exists?	No

Project bibliography 1

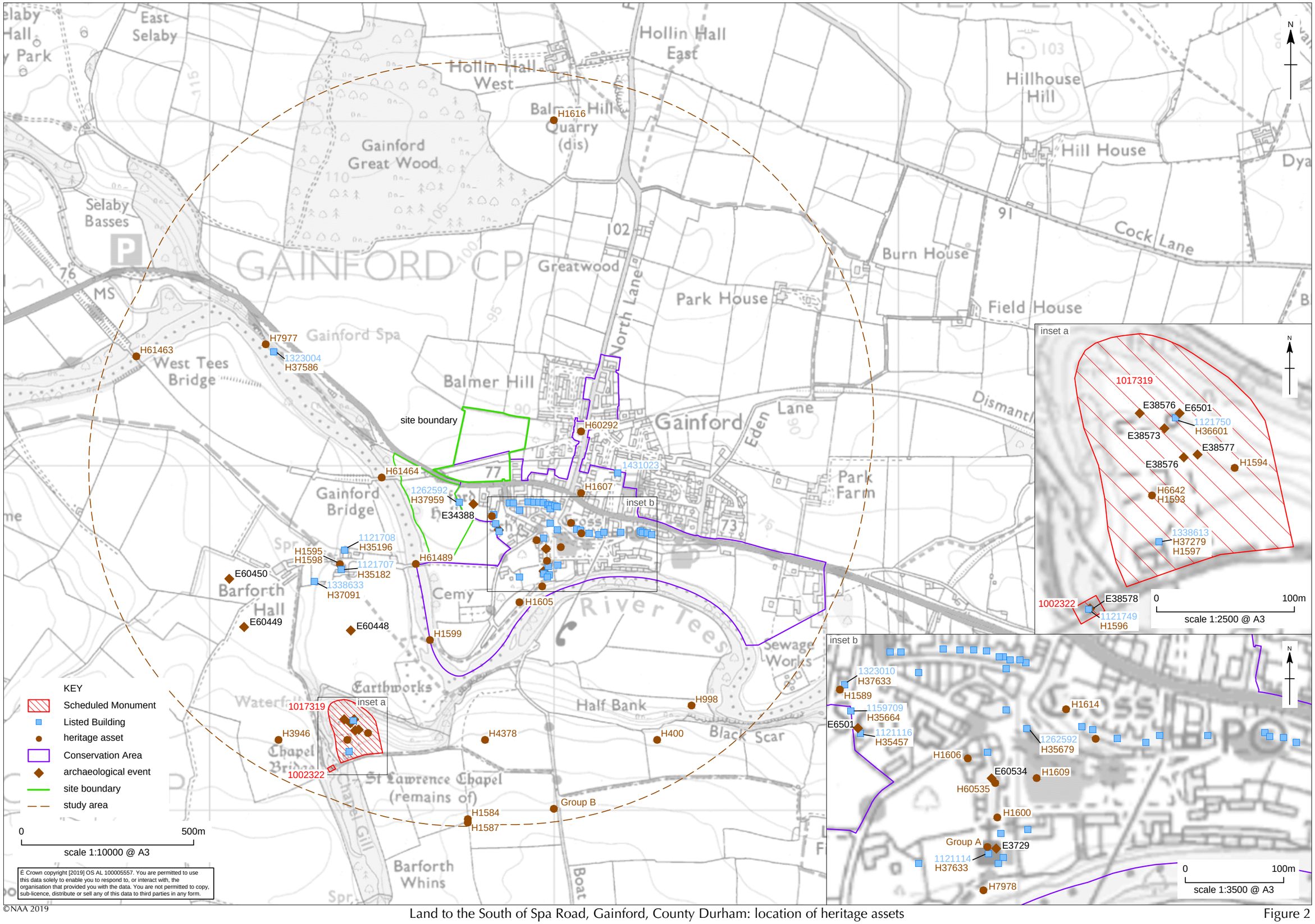
Publication type	Grey literature (unpublished document/manuscript)
Title	Land to the South of Spa Road, Gainford:Geophysical Survey Report, NAA unpublished report 19/113
Author(s)/Editor(s)	James, A
Other bibliographic details	19-113
Date	2019
Issuer or publisher	NAA
Place of issue or publication	Barnard Castle
Description	blue spine

Entered by	Alice (aj@naaheritage.com)
Entered on	22 November 2019



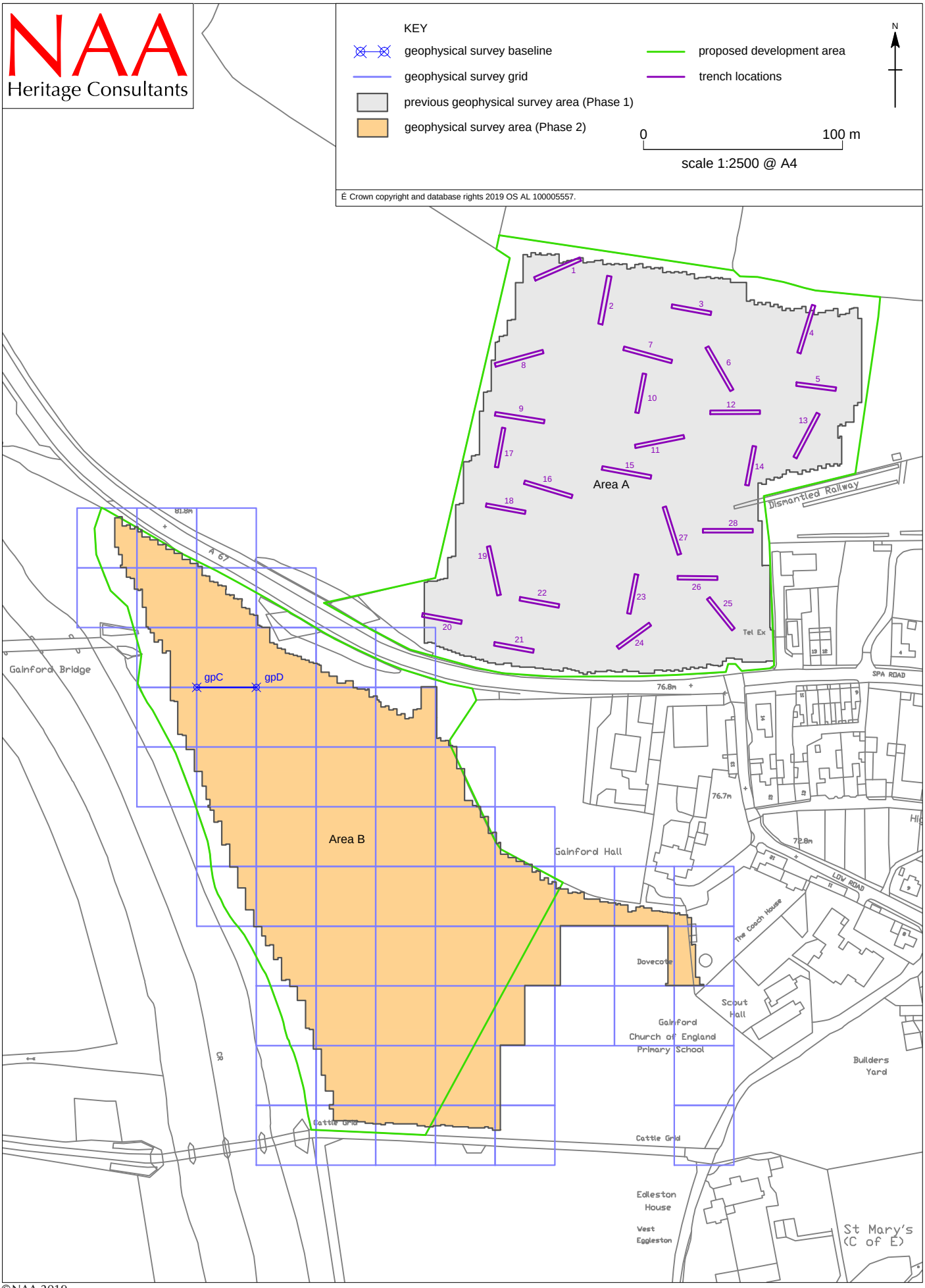
Land to the south of Spa Road, Gainford, County Durham: site location

Figure 1



Land to the South of Spa Road, Gainford, County Durham: location of heritage assets

Figure 2



Land to the South of Spa Road, Gainford, County Durham: location of gradiometer survey

Figure 3

NAA
Heritage Consultants

KEY
proposed development area
trench locations
0 50 m
scale 1:1500 @ A3

N

5nT
-4nT
Pallette:grey55.ptt

Land to the South of Spa Road, Gainford, County Durham: unprocessed greyscale plot of gradiometer survey results *Figure 4*

NAA
Heritage Consultants

KEY
proposed development area
trench locations
0 50 m
scale 1:1500 @ A3

N

3nT
-2nT
Pallette:grey55.ptt

Land to the South of Spa Road, Gainford, County Durham: processed greyscale plot of gradiometer survey results *Figure 5*

NAA
Heritage Consultants

KEY

positive linear anomaly (unknown origin)
bipolar anomaly (railway)
magnetic disturbance (archaeology?) (greater / lesser)
field boundary
trends
ridge and furrow
agriculture?
bipolar anomaly (modern?)
area of increased magnetic response
geology
edge of geophysical survey
proposed development area
trench locations

N

0 50 m

scale 1:1500 @ A3

Land to the South of Spa Road, Gainford, County Durham: interpretation of gradiometer survey results

Figure 6