WARREN FIELDS, BRAMPTON, CARLISLE, CUMBRIA

Archaeological Desk-Based Assessment and Geophysical Survey

Client: Trustees of Greenside Estate

NGR 353977 561156 (centre)

March 2023

The Site	
Site Name	Warren Fields, Brampton, Carlisle
County	Cumbria
NGR	353977 561156 (centre)

Client	
Client Name	Trustees of Greenside Estate
Client's architect	Levit Bernstein

Planning	
Pre-planning?	Yes
Planning Application No.	n/a
Plans (e.g. conversion, extension, demolition)	Residential development
Condition number	-
Local Planning Authority	Carlisle City Council
Planning Archaeologist	Jeremy Parsons, Cumbria County Council

Archiving	
Relevant Record Office(s)/Archive Centre(s)	Carlisle
Relevant HER	Cumbria

Staffing	
Desk-based assessment	Dan Elsworth
Site visit	Dan Elsworth
Report writing	Dan Elsworth
Report editing	Jo Dawson
Illustrations	Tom Mace
Date of site visit	04/10/2022

Greenlane Archaeology Ltd,
Lower Brook Street, Ulverston,
Cumbria, LA12 7EE

Tel: 01229 588 500
Email: info@greenlanearchaeology.co.uk
Web: www.greenlanearchaeology.co.uk

Contents

Illustrations and Tables

List of Figures

List of Plates

Tables

Summary

Prior to the submission of a planning application for residential development of land at Warren Fields, Brampton, Greenlane Archaeology was commissioned to carry out an archaeological desk-based assessment and geophysical survey of the site. A magnetic gradient survey was carried out to help establish the presence/absence, extent and character of archaeological features within the survey area.

The site is located on the eastern edge of the market town of Brampton, *c*14km east of Carlisle. The wider area has plentiful evidence for activity in the Roman period, especially within and around Carlisle, which housed an important Roman fort and city, and Hadrian's Wall is around 3km to the north. However, few sites of archaeological interest are recorded within the current study area and none are inside the site boundary. The most significant and closest is perhaps the site of the terminus of an early wagonway, which later became a railway, that was used to transport coal.

The geophysical survey identified a number of linear/curvilinear trends and relatively strong positive isolated responses all of uncertain origin. The majority of these do not form any clear patterns or relationships that would indicate an archaeological origin and they are considered more likely to be associated with natural features or modern activity. There is a suggestion that some responses could indicate an anthropogenic cause, but the diffuse nature of the responses precludes a more definite interpretation. An unusually large number of isolated responses across the site could mask responses from some types of subsurface features (particularly small or discrete features), should any such features be present, and further mitigation would be best carried out via archaeological evaluation. The identification of anomalies and the presence or absence of subsurface features can only be confirmed by intrusive investigation. A site visit revealed no constraints to further archaeological work and no features of archaeological interest.

There is some potential for archaeological remains to be present within the proposed development area, although this is low, and some of the features identified in the geophysical survey could be of archaeological origin. The most efficient way to establish this would be through archaeological investigation in the form of evaluation trenching.

Acknowledgements

Greenlane Archaeology would like to thank the Trustees of Greenside Estate for commissioning the project. Further thanks are due to their architects, Levitt Bernstein, in particular Renzo Campisi, for his information about the site. Thanks are also due to Mark Brennand and Jeremy Parsons at Cumbria County Council's Historic Environment Service for providing the relevant HER data and the staff the Cumbria Archive Centre (Carlisle) for providing access to the relevant documents. The geophysical survey was undertaken by Phase Site Investigations and thanks are particularly due to Mark Whittingham for managing that element of the project. Additional thanks are due to Geoff Brambles and Graham Brooks for their assistance with a particular reference.

1. Introduction

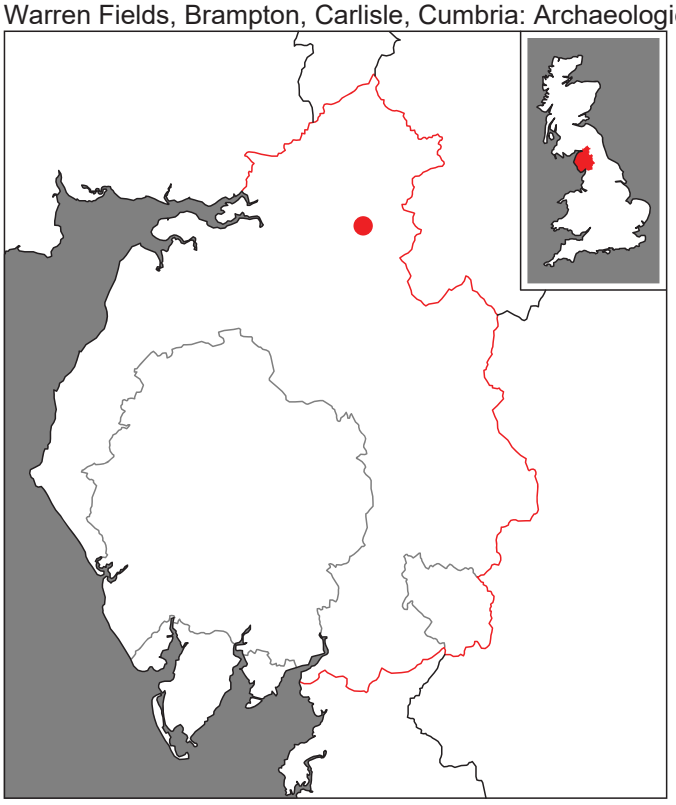
1.1 Circumstances of the Project

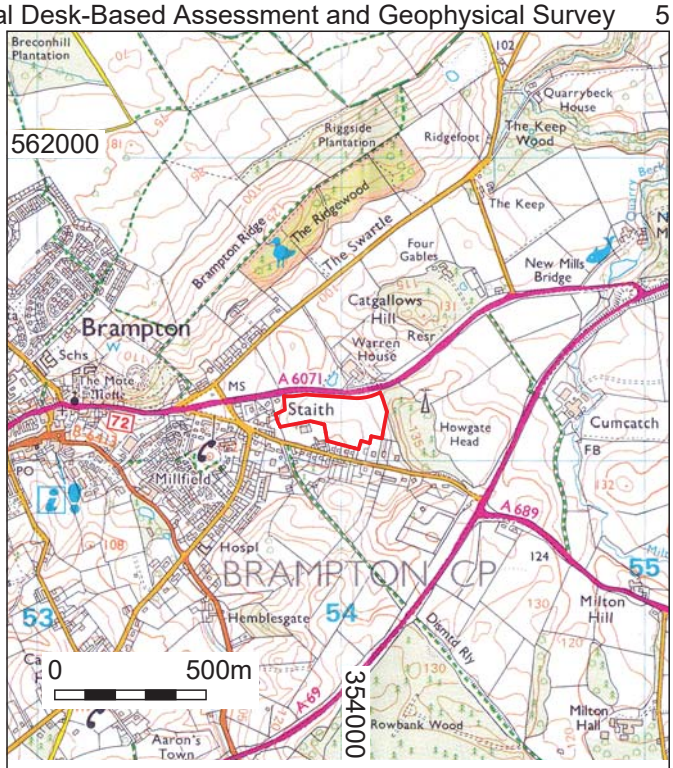
1.1.1 The circumstances of the project are set out in the tables on the inside cover of this report.

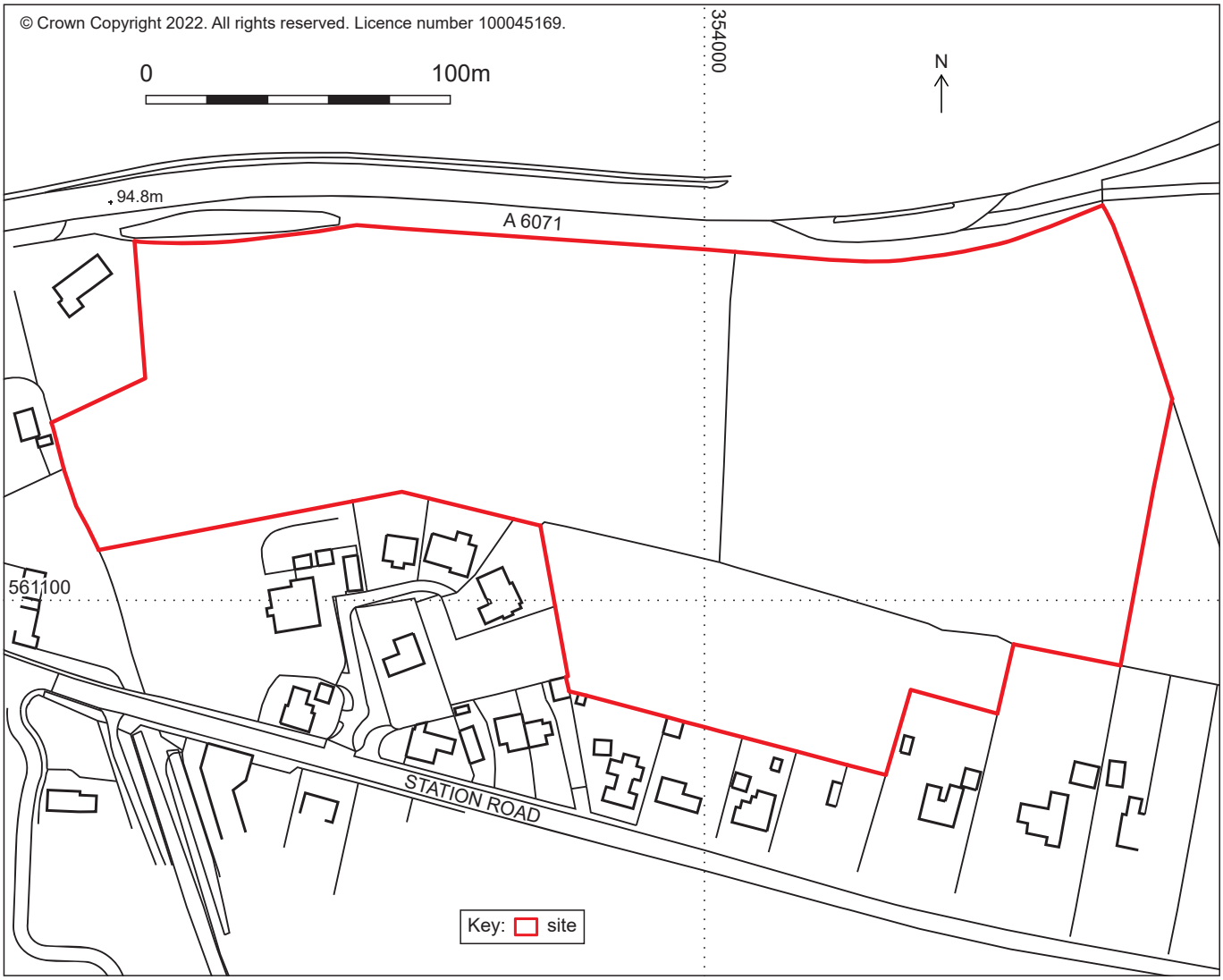
1.2 Location, Geology, and Topography

1.2.1 The site occupies an area of 4.32 hectares approximately 14km east of Carlisle on the east edge of the market town of Brampton. The ground varies from approximately 100 to 115m above sea level from west to east (Ordnance Survey 2007; Figure 1). The solid geology comprises red Permian sandstone of the Penrith group (Moseley 1978, plate 1) overlain by thick deposits of boulder clay (Countryside Commission 1998, 21).

1.2.2 The site is at the north end of the Eden Valley character area, the landscape of which is primarily dominated by '*improved pasture bounded by mature hedgerows and dry stone walls*' and areas of arable cultivation (Countryside Commission 1998, 41).







Client: Trustees of Greenside Estate

Figure 1: Site location

2. Methodology

2.1 Desk-Based Assessment

2.1.1 A desk-based assessment was carried out in accordance with the guidelines of the Chartered Institute for Archaeologists (CIfA 2014a). This principally comprised an examination of early maps of the site and published secondary sources. A number of sources of information were used during the compilation of the desk-based assessment:

- ***Record Office/Archive Centre***: the majority of original and secondary sources relating to the site are deposited in the relevant Record Office(s) or Archive Centre(s), as specified in the cover sheet of this report. Of principal importance are early maps of the site. These were examined in order to establish the development of the site, date of any structures present within it, and details of land use, in order to set the site in its historical, archaeological, and regional context. In addition, any details of the site's owners and occupiers were acquired where available;
- ***Online Resources***: where available, mapping such as Ordnance Survey maps and tithe maps were consulted online;
- ***Greenlane Archaeology***: Greenlane Archaeology's office library includes maps, local histories, and unpublished primary and secondary sources. These were consulted where relevant, in order to provide information about the history and archaeology of the site and the general area.

2.2 Site Visit

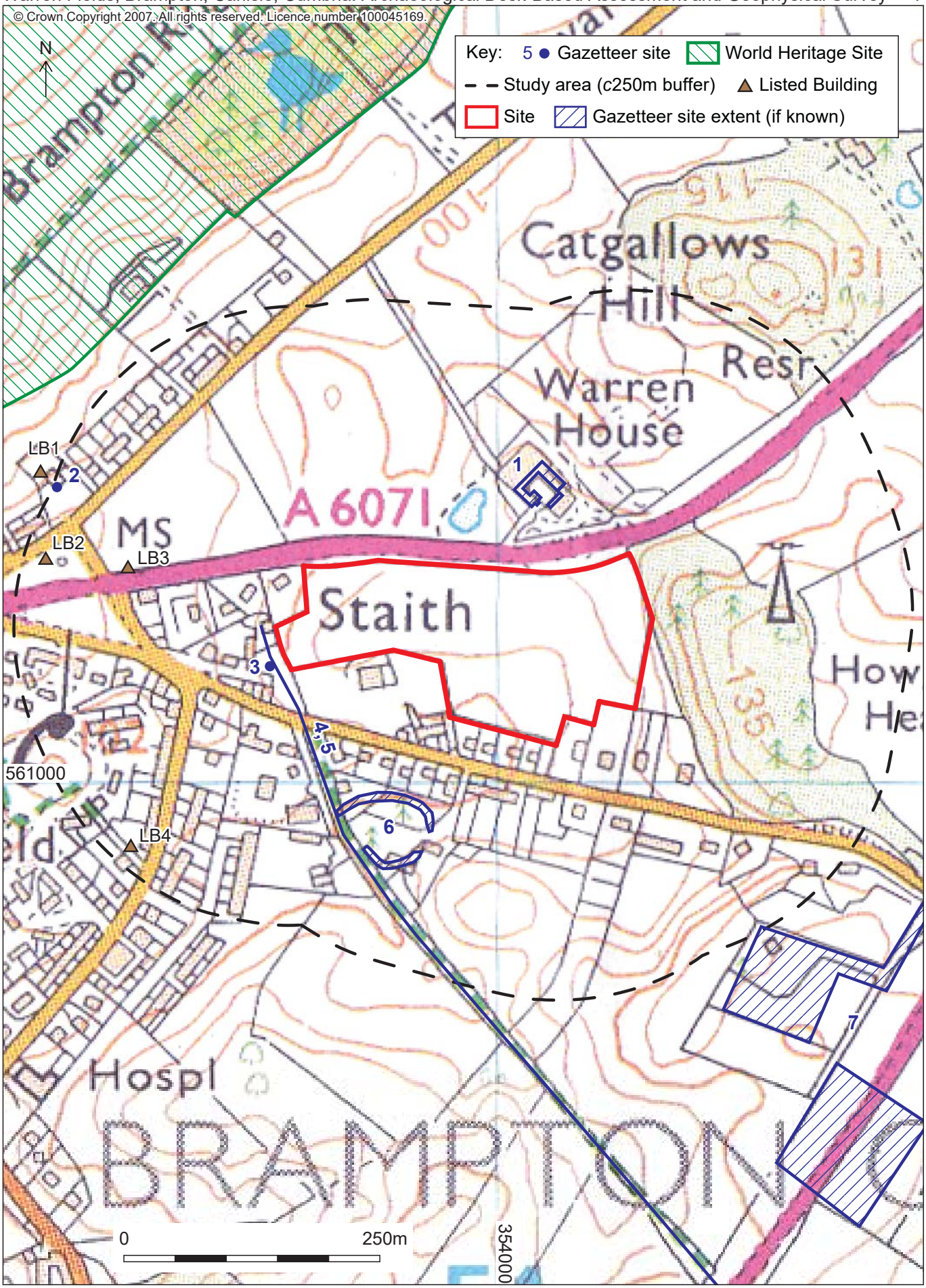
2.2.1 A brief site visit, equivalent to an English Heritage Level 1 survey (Historic England 2016), was carried out covering the proposed development area and other areas that might be affected. Particular attention was paid to the identification of features of historical or archaeological interest, but other relevant features were recorded such as later aspects of the site that may have impacted on the earlier remains or could constrain further investigation. Colour digital photographs showing the general arrangement of the site and any features of interest were taken.

2.3 Geophysical Survey

2.3.1 The geophysical survey was undertaken using a multi-sensor array cart system (MACS). The MACS comprised 8 Foerster 4.032 Ferex CON 650 gradiometers with a control unit and data logger. The MACS data was collected on profiles spaced 0.5m apart with readings taken at between 0.1m and 0.15m intervals.

2.4 Archive

2.4.1 The archive of the project will be deposited with the relevant Record Office or Archive Centre, as detailed on the cover sheet of this report, together with a copy of the report. The archive has been compiled according to the standards and guidelines of the CIfA guidelines (CIfA 2014b). In addition, details will be submitted to the Online AccesS to the Index of archaeological investigationS (OASIS) scheme. This is an internet-based project intended to improve the flow of information between contractors, local authority heritage managers and the general public. A copy of the report will be provided to the client and a digital copy of the report will be provided for the relevant Historic Environment Record, as detailed on the cover sheet of this report.



Client: Trustees of Greenside Estate

Figure 2: Gazetteer site plan

3. Results

3.1 Introduction

3.1.1 A total of seven sites of archaeological interest were identified within the study area during the desk-based assessment and site visit (*Appendix 1*; summarised in Table 1 below) ranging from the prehistoric to post-medieval periods in date. Sites included in the gazetteer that relate to periods of the study area's history are individually mentioned in the site history (see *Section 4* below). It is worth noting that the finds recorded at **Site 2** were not found at this location. The HER states that they were *'found in the Brampton area...taken from old farmhouse at Cumcatch* [c500m east of the site] *to the garden of Ridge House*'. The site marked is Ridge House. It is also worth noting that the date of the earthworks at **Site 6** is unknown.

Site No.	Type	Period
1	Farmstead; horse engine house	Post-medieval
2	Find spot (quern stone)	Roman
3	Railway station	Post-medieval
4	Railway [tramway]	Post-medieval
5	Railway; wagonway	Post-medieval
6	Earthworks (bank, enclosure, motte and bailey)	Unknown (possibly medieval)
7	Military camp	Post-medieval

Table 1: Summary of the gazetteer sites identified within the study area

3.2 Desk-Based Assessment

3.2.1 The results of the heritage assessment have been used to produce two main elements. Firstly, all available maps of the area were compiled into a map regression, demonstrating how the site physically developed (*Section 3.3*). The second purpose of the desk-based assessment is to produce a background history of the site. This is intended to cover all periods, in part to provide information that can be used to assess the potential of the site, but more importantly to present the documented details of any sites that are known (see *Section 4*).

3.2.2 Once this information has been compiled the significance of those sites of archaeological interest within the study area, their potential, and the degree to which they are likely to be affected is considered (*Section 5*) and based on this possible mitigation work is then suggested.

3.3 Map and Image Regression

3.3.1 ***Introduction***: early maps of the area tend to be relatively lacking in detail. The earliest useful maps are therefore only from the mid-19th century.

3.3.2 ***Tithe map, 1850*** (***NA IR 30/7/28 1850)***: the area south of Warren House, between Coal Staith to the west and the wooded area of Howgate Head to the east, is covered by the *Plan of the Titheable Property in the Parish of Brampton* (Plate 1). Coal Staith is at the terminus of a tramline from Milton Station *c*1.7km to the south-east (**Site 3**). The Warren Fields site is not drawn in detail, so was presumably not titheable. The roads north and south of the site are shown and a single field boundary is marked to the north edge of the area. Details of the plots are recorded in the accompanying tithe apportionment. Warren House (plot 534) and the two properties at Coal Staith (plots 532 and 533) were owned by the Earl of Carlisle and occupied by Robert Douglas, Isaac Baty and James Parker, respectively, at the time (NA IR 29/7/28 1849).

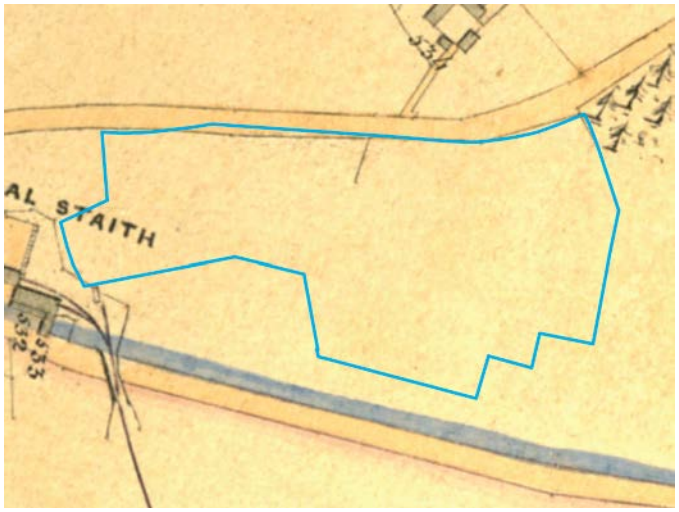
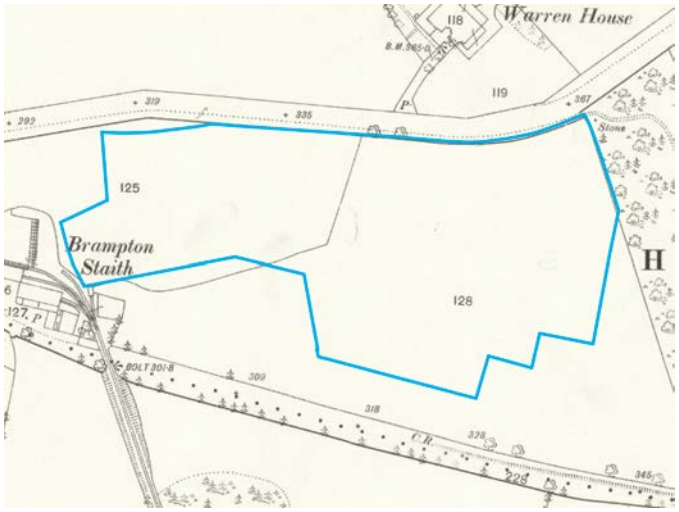


Plate 1: Extract from a tithe map of 1850

3.3.3 ***Ordnance Survey, 1864*** **[surveyed in 1862]**: this map, produced at a scale of 1:2,500, was surveyed in 1862 (Ordnance Survey 1864). The site straddles a field boundary between two fields (Plate 2). The north end of the field boundary is shown on the tithe map (cf. Plate 1). Coal Staith, at the north end of a tramline from Milton Station, is now labelled Brampton Staith, and the tramway is clearly labelled. It appears to connect to the Newcastle and Carlisle Railway from there.

3.3.4 ***Ordnance Survey, 1868*** **[surveyed in 1863]**: this edition, at a scale of 1:10,560, shows much the same information as the 1864 edition (Plate 3; cf. Plate 2).



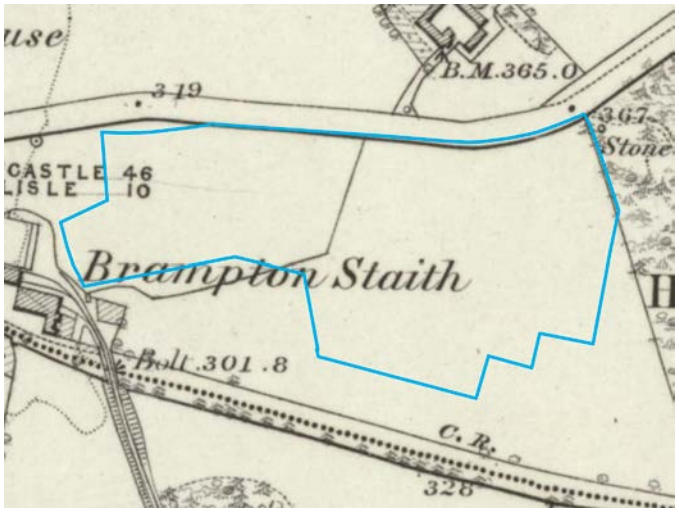


Plate 2 (left) Extract from the Ordnance Survey map of 1864

Plate 3 (right): Extract from the Ordnance Survey map of 1868

3.3.5 ***Ordnance Survey, 1901*** **[revised in 1899]**: various properties have been built outside the area along the southern boundary, including Warren Bank, and the field to the south-east has been further subdivided (Plate 4; cf. Plate 3). Brampton Staith is just called Staith. The tramway had become the Brampton and Hartleyburn Railway by this point, joining the Newcastle and Carlisle line at Brampton Junction (formerly Milton Station).

3.3.6 ***Ordnance Survey, 1926*** **[revised in 1924]**: further development has taken place along Station Road to the south side of the site (Plate 5; cf. Plate 4).

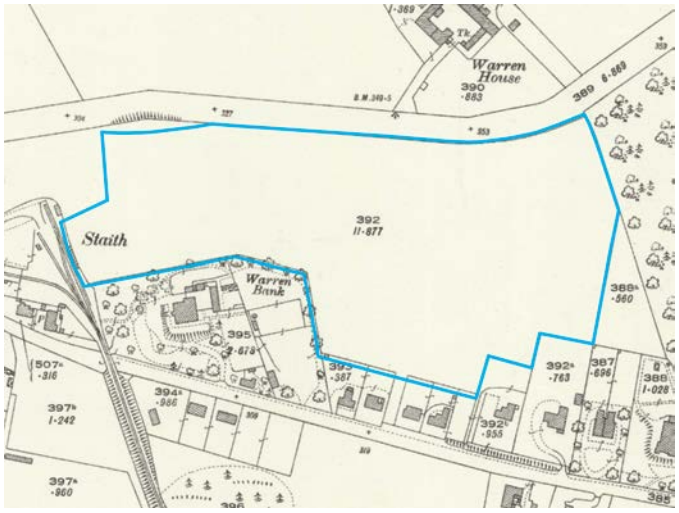
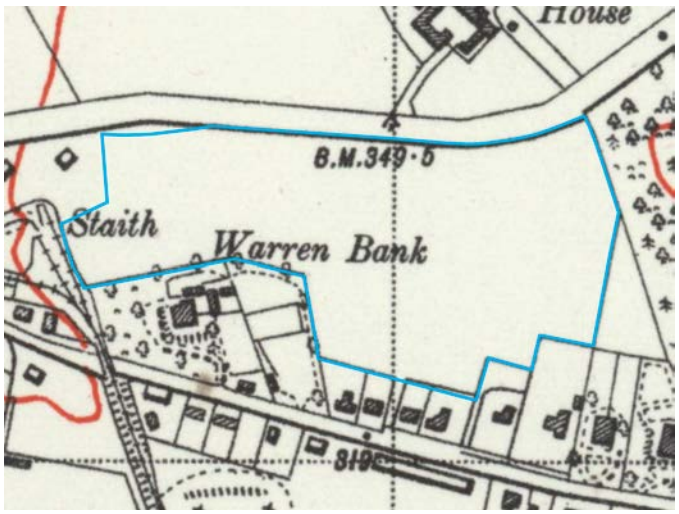


Plate 4 (left): Extract from the Ordnance Survey map of 1901

Plate 5 (right): Extract from the Ordnance Survey map of 1926

3.3.7 ***Ordnance Survey, c1946*** **[with additions in 1938]**: a building has been constructed outside of the area to the west (Plate 6; cf. Plate 5).

3.3.8 ***Ordnance Survey, 1952*** **[with additions in 1946]**: the small building constructed to the west of the area has now been fenced off, setting the current site boundary in place. The sections of railway that used to terminate at Staith appear to have been dismantled north of Station Road at least. The track and embankment still appear to be in place to the south as far as Brampton Junction, but the line is unlabelled.



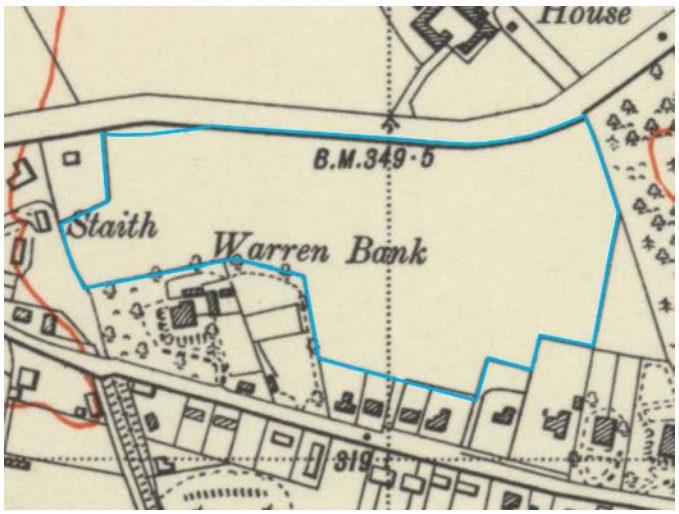


Plate 6 (left): Extract from the Ordnance Survey map of *c*1946

Plate 7 (right): Extract from the Ordnance Survey map of 1952

3.4 Lidar

3.4.1 ***Lidar***: lidar data is freely available online (e.g. National Library of Scotland 2022; houseprices.io 2022). There is very little to see within the site boundary (Plate 8 and Plate 9). Imagery from houseprices.io (2022), although incomplete for the area, shows the direction of ploughing and faint ridge and furrow across the area (Plate 8).

Plate 8 (left): Lidar imagery for the site from the National Library of Scotland (2022) website

Plate 9 (right): Lidar imagery for the site from houseprices.io (2022)

3.5 Site Visit

3.5.1 ***Site Arrangement and Character***: the site now comprises a single irregularly-shaped but broadly linear field running east/west along the south side of the A6071, adjacent to a layby (Plate 10). It is accessed via a gate in the northern boundary (with a disused gate adjacent and a metal water trough; Plate 11) and is surrounded by housing to the south and west (Plate 12 and Plate 13) and an area of woodland to the east (Plate 14), the boundaries typically comprising post and wire fences, but also with hedges and walls between the gardens to the south and west. The entire area has evidently been recently improved and was used as grazing for sheep at the time of the site visit. It is generally undulating, but dropping to the south-east, with a noticeable area of raised ground on the west side (Plate 15).

Plate 10 (left): North boundary, showing the layby, viewed from the south

Plate 11 (right): Gates in the north boundary, viewed from the south

Plate 12 (left): The southern boundary of the site, viewed from the north-west

Plate 13 (right): The western boundary of the site, viewed from the east

Plate 14 (left): General view of the east end of the site, from the west

Plate 15 (right): General view of the west end of the site, from the east

3.5.2 ***Constraints***: no constraints to further archaeological work were visible during the site visit and there was no evidence for modern disturbance.

3.6 Previous Archaeological Work

3.6.1 There have no previous pieces of archaeological work recorded in the HER within the study area.

4. Site History

4.1 Background History

4.1.1 The background history to the site helps our understanding of the development and use of the site, where known, making use of the map evidence presented above (see *Section 3*) where relevant. The background to the site is intended to place the results of the project in its local context and in order to do so discussion of the history of its wider environs is necessary.

4.2 Prehistoric Period (*c*11,000 BC – 1st century AD)

4.2.1 While there is limited evidence for human activity in the county in the period immediately following the last Ice Age, this is typically found in the southernmost part on the north side of Morecambe Bay. Excavations of a small number of cave sites have found the remains of animal species common at the time but now extinct in this country and artefacts of Late Upper Palaeolithic type (Young 2002). Human remains from one of these have also recently been dated to approximately 7,100 BC (Smith *et al* 2013). No remains of this date are known from the immediate area of the site, although a pair of barbed spearheads made from antler were found at Crosby-on-Eden (Hodgson 1895), which, although undated, may belong to the end of the Palaeolithic or early Mesolithic. The county was more densely inhabited during the following period, the Mesolithic (*c*8,000 – 4,000 BC), as large numbers of artefacts of this date have been discovered during field-walking and eroding from sand dunes along the coast, but these are typically concentrated in the west coast area and on the uplands around the Eden Valley (Cherry and Cherry 2002). More recently a particularly large assemblage has been recovered during excavations, directly on the edge of the River Eden in advance of the Carlisle Northern Development Route scheme at Stainton (Clark 2010) and field-walking has found additional scatters of some significance also in the Eden valley near Penrith (Clarke *et al* 2008). Coastal areas and river valleys are notably places where such material is frequently found in the wider region (Middleton *et al* 1995, 202; Hodgkinson *et al* 2000, 151-152; Hodgson and Brennand 2006, 26).

4.2.2 Although there is some considerable overlap in terms of the flint tool technology from the Mesolithic, the following period, the Neolithic (*c*4,000 – 2,500 BC), is significant for the arrival of a more settled way of life and the advent of agriculture. One of the most noticeable changes in terms of archaeological remains is the appearance of large-scale monuments such as burial mounds and stone circles, which begin to appear in the region. One of the most recognisable tool types of this period, the polished stone axe, is found in large numbers across the county, having been manufactured at Langdale in the central Lake District (Hodgson and Brennand 2006, 45). During the Bronze Age (*c*2,500 – 600 BC) monuments, particularly those thought to be ceremonial in nature, become more common still. Examples from the area around Carlisle are not plentiful, but a considerable amount of Bronze Age pottery was found in 1861 when erecting new hospital buildings at Garlands Hospital on the south side of Carlisle, suggesting it was the site of a Bronze Age cemetery (Hodgson 1956; Spence 1940). A flint implement was also found in one of the urns now held at Tullie House (*ibid*). Another feature typical of the Bronze Age, a burnt mound, was also discovered during more recent excavations at Garlands Hospital (LUAU 1996; Neighbour and Johnson 2005) and more were found during the excavations at Stainton.

4.2.3 It is likely that settlement sites thought to belong to the Iron Age have their origins in this period. Sites of this type are typically recorded as crop marks revealed in aerial photographs (Webster and Newman 2007, 7), although they are often undated and not understood in detail. In addition, there is likely to have been a considerable overlap between the end of the Iron Age and the beginning of the Romano-British period; it is evident that in this part of the country, initially at least, the Roman invasion had a minimal impact on the native population in rural areas (Philpott 2006, 73-74).

4.3 Romano-British to Early Medieval Period (1st century AD – 11th century AD)

4.3.1 The site is *c*3km south of Hadrian's Wall and c14km north-east of the important Roman city of Carlisle. The fort at Carlisle was first established in the autumn or winter of AD 72-73 (Zant 2011, 35) but was soon altered, in AD 83-84 (*op cit*, 36-37). It was abandoned for a time, before being rebuilt in the

early 2nd century, *c* AD 105, but its character changed by the AD 120s, probably on account of the construction of Hadrian's Wall, which began in AD 122-123 (*op cit*, 42-43). The site is *c*330m south-east of the World Heritage Site associated with Hadrian's Wall (Historic England 2022a). The 118km wall was built on the orders of the Emperor Hadrian *c* AD 122 at the then northernmost limits of the Roman province of Britannia and bears exceptional testimony to Roman colonization (*ibid*) The construction of Hadrian's Wall in turn led to the construction of a new fort at Stanwix, north of Carlisle itself, but the fort at Carlisle continued and in the early 3rd century AD it was rebuilt in stone (Zant 2011, 48). Both Carlisle and Stanwix continued to be occupied into the 4th century and beyond, along with an extensive civilian settlement at the former.

4.3.2 Two upper quern stones were found in the Brampton area (**Site 2**, but the exact spot where they were found is uncertain). They are similar in form to other examples from Roman sites although were used from the Iron Age.

4.3.3 Evidence for post-Roman habitation is limited and inconclusive (Zant 2011, 50-51), but it is apparent that Carlisle remained an important place into the early medieval period, with an historical account of the 7th century famously describing the extant walls of the Roman town and a working fountain (Zant 2009, 15). In more rural areas, the impact of the Romans, in what would have been a heavily militarised zone, is less clear. The size of the 'military market' to the local area must have been of great importance, but it is likely that many 'natives' initially continued to live in much the way they had before the arrival of the Romans, perhaps supplying them with goods and, as a result, at first benefiting from their arrival (Higham 1986, 216-225).

4.4 Medieval Period (11th century AD – 16th century AD)

4.4.1 The site is located within the parish of Brampton, which formed a caput of the Barony of Gilsland from the 14th century; Gilsland having been granted to Hubert de Vaux in 1157/8 (Winchester 2016, 63). It eventually passed to the Dacres, Lord Howard and eventually to the Lords of Carlisle (*ibid*). The nearest major settlement, Brampton, is first recorded in the late 12th century but the name comes from the Old English meaning 'tun in the brambly place' (Armstrong *et al* 1950, 65). Brampton itself represents a relatively substantial medieval town, which was granted a market charter in 1252 and became '*market centre for Gilsland barony and* [a] *wide area of north-east Cumberland*' (Winchester 2016, 63). Nearby Warren House was in existence from at least 1740 (Armstrong *et al* 1950, 68) but it is not clear if its name suggests the location of a nearby rabbit warren of perhaps medieval origins.

4.4.2 Mote Castle, located on the summit of Castle Hill in Brampton, *c*450m west of site, is a 12th to 13th century medieval motte (Historic England 2022e). The mound was later used as the site of a signalling beacon during the 15th century and connected with a system of beacons which ran along the Tyne valley to the east to warn of impending attack by Scottish invaders. The motte is artificially cut out of the higher end of a long ridge and consists of an oval-shaped plateau measuring *c*36m by 18m. About 12m down slope there is an encircling ditch *c*5m wide and up to 3m deep which is flanked by an outer bank measuring *c*5m wide and up to 2m high (*ibid*). This kidney-shaped platform is thought to be the bailey (English Heritage 2008, 37). To the south-east at Staith there are traces of a sub-circular banked enclosure with a large possible annexe to the north and it is possible that this is a second fortified medieval site (*ibid*; **Site 6**).

4.5 Post-Medieval Period (16th century AD – present)

4.5.1 Brampton continued to prosper into the post-medieval period due to its status as a market town and was described in 1688 by Thomas Denton as '*improved in both building and trade*' (Winchester 2016, 63). The most important development of the post-medieval period was the development of a railway for transporting coal, at the behest of Lord Carlisle, which terminated immediately adjacent to the site at a 'coal staith' (**Site 3**). A section of tramway [see **Site 4**] between Brampton and Milton Station *c*1.7km to the south-east used to terminate immediately adjacent to west side of the site at Staith. This later became the Brampton and Hartleyburn Railway (**Site 5**) and connected to the Newcastle and Carlisle line at Brampton Junction (formerly Milton Station). According to the HER:

'*this stretch of railway line started its life as a wagonway, the vast majority of which was built on the private lands of Lord Carlisle to serve the Naworth coalfields and quarries. It was opened in 1799 with wooden rails but by 1808 it had been re-laid in both cast-iron and wrought malleable iron rails, the first successful application of the latter type of rail in a day to day commercial way. Lord Carlisle's Railway was the first of its kind to be later developed and extended and then converted into Cumberland's first 'mainline standard' railway.*

Much of the credit for the development of Lord Carlisle's Railways is due to James Thompson, Lord Carlisle's colliery agent, and subsequent lessee of the Naworth collieries and rail system. In 1828-9 Thompson built the extension of the wagonway as a proper railway to Midgeholme and to the Stephenson gauge of 4ft 8 1/2 in, soon converting the wagonway to the same gauge afterwards. This was possibly the first non-Stephenson railway to adopt this rail gauge and the wagonway the first conversion to this gauge. Thompson's action was based on his belief that all railways should be made of the same rail gauge to enable subsequent linking-up of railways and the operation of through traffic. This ensured a route permitting operation initially by horses, and in due course by locomotives.

In 1836 the 'new railway' of Lord Carlisle opened to replace the wagonway. From 1837 the 'Rocket' operated on Lord Carlisle's Railway, but between 1838 and 1866 the colliery workshops built their own locomotives. Although primarily a mineral railway, the colliery railway operated a public passenger service, horse-drawn until 1881, but steamworked afterwards, and to the end in the hands of the North Eastern Railway in 1923 (Webb and Gordon 1978)'.

The north end of the line at Staith was dismantled between 1938 and 1946 (see *Section 3*).

4.5.2 Maps show that the site had reached approximately its present state by the mid-19th century, with all the fields enclosed, and the area in general has remained very rural in character (see *Section 3.3*). The current site boundary was effectively in place by the mid-20th century after the extant properties along Station Road and the A6071 were built.

4.5.3 South-east of Brampton at Howgate Head a Second World War military camp (**Site 7**), comprising a number of accommodation blocks, was noted on 1946 RAF photographs (English Heritage 2008, 44).

5. Geophysical Survey Results

5.1 Introduction

5.1.1 Phase Site Investigations Ltd (2022) was commissioned by Greenlane Archaeology to carry out an archaeological geophysical survey at a site. The aim of the survey was to help establish the presence / absence, extent, character, relationships and date (as far as circumstances and the inherent limitations of the technique permit) of archaeological features within the survey area (see *Appendix 4*).

5.1.2 The data quality across the majority of the survey area is very good allowing the data to be viewed at a narrow range of readings to better identify weak anomalies. There is a generally strongly disturbed / variable magnetic background across the site but this is due to a spread of modern magnetic material across the site, rather than low data quality.

5.2 Interpretation

5.2.1 ***Isolated dipolar and bipolar responses***: there are numerous isolated dipolar and bipolar responses across the survey area, indicative of ferrous or fired material on or near to the surface, and in the large majority of cases these two types of isolated responses will be caused by modern material. The smaller isolated dipolar and bipolar responses at this site are assumed not to be of archaeological significance; however, several larger bipolar responses have been shown on the interpretation because they are considered to be more likely to be associated with more significant subsurface features or material, although in this instance they are not thought to be of archaeological interest.

5.2.2 It should be noted that the unusually large number of isolated responses across the site could possibly mask responses from some types of subsurface features (particularly small, discrete features), should any such features be present.

5.2.3 ***Areas of magnetic disturbance and strong responses***: several areas where there is a greater concentration of magnetic disturbance are present. These are usually associated with concentrations of relatively modern magnetic material and, in this case, they are not considered to be archaeologically significant.

5.2.4 ***Linear bipolar anomalies***: linear bipolar anomalies have strong positive and negative components and are usually produced by buried pipes/cables that are usually metallic, although in some instances ceramic pipes can also produce bipolar anomalies.

5.2.5 ***Linear/curvilinear diffuse trends***: several linear/curvilinear trends have been identified; however, these are all too diffuse, weak and/or short to reliably interpret. They could be natural features but it is possible that some are anthropogenic.

- **Anomalies A** stand out slightly and there is a slight suggestion that these could form a sub-rectangular shape. If they do it is possible that they could be related to part of an archaeological enclosure, although it is perhaps more likely that they are caused by natural features, agricultural or other modern activity;
- **Anomalies B** stand out but these are less regular in shape and whilst it is possible that some of them could be related to in-filled subsurface features it is likely that these are natural, rather than archaeological.
- **Anomaly C** comprises a broadly linear trend, although the response is too diffuse to reliably interpret and while it could potentially be related to part of an in-filled subsurface feature it is probably more likely that it is caused by a natural feature or agricultural activity.

5.2.6 ***Isolated positive responses***: there are numerous isolated positive responses across the survey area, some of which are relatively large or strong. It is possible that some of the isolated positive responses are caused by discrete features but it is considered more likely that they are caused by natural variations or deeper buried relatively modern, ferrous or fired material.

- **Anomalies D** could have greater potential to be related to subsurface features, due to their size / strength, but it is more likely that they are related to modern material.

This page has been deliberately left blank

94.8m
A 6071
Lay-by
N
Ramleh
Staith
Huff N Puff
Sycamore
Bank
Warren
Garth
Warren Bank
Edgewood
Holly Glen
Archways
Ashcroft
Heatherlea
Glendhu
Belmore
The
Knowe
Howgate
Milton
Villas
site boundary
STATION ROAD
Track
El
Garage
Oaklea
Stanehie
5
-5
nT
0
50m
561200
561100
561000
353800
353900
354000
354100

Client: Trustees of Greenside Estate

Figure 3: Greyscale plot of magnetic gradient data

94.8m

A 6071

Lay-by

N

561200

Ramleh

Staith

Warren Bank

Huff N Puff

Sycamore Bank

Warren Garth

Archways

Oaklea

Stanehie

Ashcroft

Heatherlea

Glendhu

Belmore

The Knowe

site boundary

Milton Villas

Howgate

561100

561000

353900

354000

354100

0

50m

- THE MAGNETIC BACKGROUND IS GENERALLY STRONGLY DISTURBED / VARIABLE WITH A VERY LARGE NUMBER OF ISOLATED RESPONSES. THESE WILL BE RELATED TO A SPREAD OF MODERN MATERIAL ACROSS THE SITE.
- DUE TO THE VERY LARGE NUMBER OF ISOLATED RESPONSES IT HAS NOT BEEN POSSIBLE TO RELIABLY DIFFERENTIATE ISOLATED ANOMALIES THAT COULD, POSSIBLY, BE RELATED TO DISCRETE FEATURES FROM RESPONSES CAUSED BY MODERN MATERIAL. FOR THIS REASON THE MAJORITY OF THE ISOLATED RESPONSES HAVE NOT BEEN SHOWN ON THE INTERPRETATION

ANOMALY TYPE	INTERPRETATION
ISOLATED BIPOLAR RESPONSE	SURFACE / NEAR-SURFACE FERROUS OR FIRED MATERIAL (PROBABLE MODERN)
AREA OF STRONG DIPOLAR / BIPOLAR RESPONSES (MAGNETIC DISTURBANCE)	SURFACE / NEAR-SURFACE FERROUS OR FIRED MATERIAL (PROBABLE MODERN)
BIPOLAR LINEAR RESPONSE	MODERN LINEAR MAGNETIC FEATURE. PROBABLE PIPE, DRAIN OR CABLE
LIMIT OF VERY STRONG RESPONSE	INTERFERENCE CAUSED BY MODERN MAGNETIC FEATURE (FEATURE MAY BE LOCATED BEYOND THE SURVEY AREA)
LINEAR / CURVI-LINEAR TREND (WEAK OR DIFFUSE RESPONSE)	UNCERTAIN ORIGIN. COULD BE RELATED TO DRAINAGE OR AGRICULTURAL ACTIVITY BUT SOME COULD BE CAUSED BY A SUB-SURFACE FEATURE / REMNANT OF FEATURE
ISOLATED POSITIVE RESPONSE	PROBABLE FERROUS / FIRED MATERIAL OR VARIATION OR DEEPER BURIED BUT COULD ALSO BE ISOLATED FEATURE

Figure 4: Interpretation of magnetic gradient data

Client: Trustees of Greenside Estate

6. Discussion

6.1 Introduction

6.1.1 The discussion of the results of the desk-based assessment, geophysical survey and site visit is intended to determine the archaeological significance and potential of any known remains (above or below ground) and the potential of these remains and for any further, as yet unidentified, remains being present. The system used to judge the significance of the remains identified within the development area, or those thought to have the potential to be present within the development area, is based on the criteria used to define Scheduled Monuments (DCMS 2013, Annex 4; *Appendix 2*).

6.2 Significance

6.2.1 The site is *c*330m south-east of the World Heritage Site associated with Hadrian's Wall (Historic England 2022a). Hadrian's Wall is inscribed on the UNESCO World Heritage list as one of the frontiers of the Roman Empire (*ibid*).

6.2.2 The motte on the summit of Castle Hill, Brampton, *c*450m west of the site, is a Scheduled Monument (Historic England 2022e).

6.2.3 There are four Listed Buildings within the study area, all of which are Grade II (see *Appendix 3*; summarised in Table 2). None of these feature in the HER dataset.

Site	Entry number	Address	Listed Building Grade
LB1	1335553	Ridge House, Lanercost Road	II
LB2	1087647	Howard Memorial Shelter, The Sands	II
LB3	1087660	Milestone at NGR NY 53650 61210	II
LB4	1312219	Tree House, Tree Road	II

Table 2: Listed Building summary

6.2.4 None of the other heritage assets listed in the gazetteer (*Appendix 1*) have any formal designation and none are recorded within the proposed development area.

6.2.5 The majority of the anomalies identified through interpretation of the geophysical survey data relate to modern material (including buried services or drains), and possible geological variations (*Appendix 4*).

6.3 Potential for Unknown Archaeological Remains

6.3.1 Details of the archaeological remains present within the study area are presented in the results of the desk-based assessment (*Section 3*; *Appendix 1*). The potential for as yet unidentified archaeological remains to be present, however, is based on the known occurrence of such remains in the study area and also in the local environs (see *Section 4*). Where there are no remains known within the study area the potential is based on the known occurrence within the wider local area. The degree of potential is examined by period and the results are presented in Table 3 below; in each case the level of potential is expressed as low (L), medium (M), or high (H).

Period	Present in study area?	Potential
Late Upper Palaeolithic	N	L
Mesolithic	N	L
Neolithic	N	L
Bronze Age	N	L
Iron Age	N	L
Roman	Y	L
Early Medieval	N	L
Medieval	Y?	L
Post-medieval	Y	H

Table 3: Degree of potential for unknown archaeological remains by period

6.3.2 In consideration of Table 3 it is worth noting that the exact find spot of the two Roman quern stones marked at **Site 2** is uncertain; however, the wider area is certainly well-known for its Roman heritage. The earthworks at **Site 6** are of uncertain date and may be medieval. Certainly, a motte and bailey castle of 12th to 13th century date is Scheduled *c*450m west of the site. Three of the gazetteer sites relate in one way or another to the Brampton and Hartleyburn Railway (**Sites 3**, **4** and **5**), all of which are of post-medieval date.

6.3.3 It should be noted that the geophysical survey identified a number of linear/curvilinear trends and relatively strong positive isolated responses all of uncertain origin (*Appendix 4*). Although the majority of these do not form any clear patterns or relationships that would indicate an archaeological origin, there is a suggestion that some responses could indicate an anthropogenic cause. It should also be noted that not all features will produce a measurable geophysical anomaly; it is not possible to guarantee that a geophysical survey will identify all subsurface features, and the unusually large number of isolated responses across the site could mask responses from some types of subsurface features (particularly small, discrete features), should any such features be present (Phase Site Investigations Ltd 2022).

6.4 Disturbance

6.4.1 No extensive disturbance is known at the site or was observed during the site visit, with the exception of evident improvement to the ground in the form of ploughing and drainage. The geophysical survey showed up two modern services running essentially north/south across the site. These are possibly water pipes connecting to the water trough placed against the northern boundary (Plate 10).

6.5 Impact

6.5.1 It is extremely likely that the proposed development would require considerable groundworks and that this would have a severe impact on any archaeological remains that might be present.

6.5.2 The impact of the proposed development on Listed Buildings within the study area is likely to be minimal.

6.6 Conclusion and Recommendations

6.6.1 There is clearly the potential for previously unknown archaeological remains to be present, including Roman and medieval remains, although this potential is low. The geophysical survey has identified a range of anomalies, some of which might be of archaeological interest, however, the interpretation of geophysical anomalies is often subjective and confirmation of the identification of anomalies and the presence or absence of subsurface features can only be achieved by intrusive investigation. This could most readily be achieved through the excavation of archaeological evaluation trenches

7. Bibliography

7.1 Primary and Cartographic Sources

Donald, T, 1770 *The County of Cumberland Surveyed*

NA IR 29/7/28, 1849 *Tithe Apportionment of Brampton Parish, Cumberland*

NA IR 30/7/28, 1850 *Plan of the Titheable Property in the Parish of Brampton in the County of Cumberland in Three Parts: Part I*

Ordnance Survey, 1864 *Cumberland Sheet* **XVIII.5.**, 1:2,500, surveyed in 1862

Ordnance Survey, 1868 *Cumberland Sheet* **XVIII**, 1:10,560, surveyed in 1863

Ordnance Survey, 1901a *Cumberland Sheet* **XVIII.5.**, 1:2,500, surveyed in 1862, revised in 1899

Ordnance Survey, 1901b *Cumberland Sheet* **XVIII.N.W.**, 1:10,560, surveyed in 1862, revised in 1899

Ordnance Survey, 1926 *Cumberland Sheet* **XVIII.5.**, 1:2,500, surveyed in 1862, revised in 1924

Ordnance Survey, *c*1946 *Cumberland Sheet* **XVIII.N.W.**, 1:10,560, surveyed in 1862, revision of 1924 with additions in 1938

Ordnance Survey, 1952 *Cumberland Sheet* **XVIII.N.W.**, 1:10,560, surveyed in 1862, revision of 1924 with additions in 1946

Ordnance Survey, 2007 *Carlisle: Brampton, Longtown and Gretna Green*, **315**, 1: 25,000

7.2 Secondary Sources

Armstrong, AM, Mawer, A, Stenton, FM, and Dickins, B, 1950 *The Place-Names of Cumberland Part I: Eskdale, Cumberland and Leath Wards*, English Place-Name Society, **20**, Cambridge

Chartered Institute for Archaeologists (CIfA), 2014a *Standards and Guidance for Historic Desk-Based Assessment*, revised edn, Reading

CIfA, 2014b *Standard and Guidance for the Creation, Compilation, Transfer and Deposition of Archaeological Archives*, revised edn, Reading

Cherry, PJ, and Cherry, J, 2002 Coastline and Upland in Cumbrian Prehistory – A Retrospective, *Trans Cumberland Westmorland Antiq Archaeol Soc*, 3rd ser, **2**, 1-20

Clark, P, 2010 Excavations at Stainton, Carlisle, Ahead of the Carlisle Northern Development Route, *CWAAS Newsletter*, **64**, 4-5

Clarke, J, Watson, A, Dickson, A, and Hamilton-Gibney, A, 2008 *Fieldwalking in the Vale of Eden*, interim report **01**, Penrith

Countryside Commission, 1998 *Countryside Character, Volume 2: North West*, Cheltenham

Cossons, N, 1978 *The BP Book of Industrial Archaeology*, 3rd edn, London

Curwen, EC, 1937 Querns, *Antiquity* **11:42**, 133-151

DCMS, 2013 *Scheduled Monuments & Nationally Important but Non-Scheduled Monuments*, London https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/249695/SM_policy_statement_10-2013__2_.pdf

English Heritage, 2008 Hadrian's Wall NMP Project: Brampton to Birdoswald National Mapping Programme Report, *Research Department Report Series* **69**, Swindon

Higham, NT, 1986 *The Northern Counties to AD 1000*, London

Historic England, 2016 *Understanding Historic Buildings: A Guide to Good Recording Practice*, unpubl rep

Historic England, 2022a *Frontiers of the Roman Empire (Hadrian's Wall)*, https://historicengland.org.uk/listing/the-list/list-entry/1000098?section=official-list-entry

Historic England, 2022b *Howard Memorial Shelter, The Sands*, https://historicengland.org.uk/listing/the-list/list-entry/1087647?section=official-list-entry

Historic England, 2022c *Milestone at NGR NY 53650 61210*, https://historicengland.org.uk/listing/the-list/list-entry/1087660?section=official-list-entry

Historic England, 2022d *Ridge House, Lanercost Road*, https://historicengland.org.uk/listing/the-list/list-entry/1335553?section=official-list-entry

Historic England, 2022e *The Mote Castle mound, medieval motte castle and site of late medieval beacon*, https://historicengland.org.uk/listing/the-list/list-entry/1013967?section=official-list-entry

Historic England, 2022f *Tree House, Tree Road*, https://historicengland.org.uk/listing/the-list/list-entry/1312219?section=official-list-entry

Hodgkinson, D, Huckerby, E, Middleton, R, and Wells, CE, 2000 *The Lowland Wetlands of Cumbria*, North West Wetlands Survey **6**, Lancaster Imprints **8**, Lancaster

Hodgson, TH, 1895 Bone Spear or Harpoon Heads from Terra del Fuego, Found on Peat Near Crosby-on-Eden, *Trans Cumberland Westmorland Antiq Archaeol Soc*, 1st ser, **13**, 402

Hodgson, KS, 1953 Four Querns from the Brampton Area, *Trans Cumberland Westmorland Antiq Archaeol Soc*, 2nd ser, **53**, 209-211

Hodgson, KS, 1956 Three Unpublished Collections of Bronze Age Pottery: Netherall, Garlands and Algionby, *Trans Cumberland Westmorland Antiq Archaeol Soc*, 2nd ser, **56**, 1-17

Hodgson, J, and Brennand, M, 2006 'The Prehistoric Period Resource Assessment', in M Brennand (ed) *The Archaeology of North West England: An Archaeological Research Framework for the North West Region, Volume 1: Resource Assessment*, Manchester, 23-58

Houseprices.io, 2022 *Lidar Map of England and Wales*, https://houseprices.io/lab/lidar/map?ref=NY5397761156

Lancaster University Archaeology Unit (LUAU), 1996 *Garlands Hospital, Carlisle, Cumbria: Archaeological Report*, unpubl rep

Linley, SM, 1990 Industrial Archaeology Sites in East Cumberland, *CIHS Bulletin January 90*, 10-11

Mannix and Whellan, 1847 *History, Gazetteer, and Directory of Cumberland*, Beverley

Middleton, R, Wells, CE, and Huckerby, E, 1995 *The Wetlands of North Lancashire*, North West Wetlands Survey **3**, Lancaster Imprints **4**, Lancaster

Moseley, F (ed), 1978 *The Geology of the Lake District*, Yorkshire Geological Society, occ publ **3**, Leeds

National Library of Scotland, 2022 *Map images: Map Finder Explore Georeferenced Maps Side by Side*, https://maps.nls.uk/geo/explore/side-by-side/#zoom=17.0&lat=54.94292&lon=-2.71996&layers=6&right=LIDAR_DSM_1m

Neighbour, T, and Johnson, M, 2005 A Bronze Age Burnt Mound in Lowland Cumbria: Excavations at Garlands Hospital, Carlisle, 1997, *Trans Cumberland Westmorland Antiq Archaeol Soc*, 3rd ser, **5**, 11-24

Phase Site Investigations Ltd, 2022 *Warren Fields, Brampton, Carlisle, Cumbria: Archaeological Geophysical Survey*, unpubl rep

Philpott, R, 2006 The Romano-British Period Resource Assessment, in Brennand, M, (ed) *The Archaeology of North West England: An Archaeological Research Framework for the North West Region – Volume 1, Resource Assessment*, Archaeology North West **8**, Manchester, 59-90

Smith, I, Wilkinson, DM, O'Regan, HJ, 2013 New Lateglacial Fauna and Early Mesolithic Human Remains from Northern England, *J Quaternary Science*, **28:6**, 542-544

Spence, JE, 1940 Report of the Committee for Prehistoric Studies, 1937-1939, *Trans Cumberland Westmorland Antiq Archaeol Soc*, 2nd ser, **40**, 99-117

Webb, B, and Gordon, G, 1978, *Lord Carlisle's Railways*, Cheam

Webster, A, and Newman, R, 2007 Earthworks, Parchmarks and Cropmarks: Results of Cumbria County Council's 2006 Aerial Photographic Survey, *Trans Cumberland Westmorland Antiq Archaeol Soc*, 3rd ser, **7**, 1-14

Winchester, AJL (ed), 2016 *Cumbria: An Historical Gazetteer*, Lancaster

Young, R, 2002 The Palaeolithic and Mesolithic Periods in Northern England: An Overview, in Brooks, C, Daniels, R, and Harding, A, (ed), *Past, Present and Future: The Archaeology of Northern England*, Architect Archaeol Soc Durham Northumberland, res rep **5**, 19-36

Zant, J, 2009 *The Carlisle Millennium Project Excavations in Carlisle, 1998-2001 Volume 1: the Stratigraphy*, Lancaster Imprints **14**, Lancaster

Zant, J, 2011 The Roman Army in Carlisle, in M Brennand and KJ Stringer (ed), *The Making of Carlisle: From Romans to Railways*, CWAAS extra ser, **35**, Kendal

Appendix 1: Site Gazetteer

N.B. Coordinates for HER sites are those supplied by the HER

Site Number: **1**
NGR: 354050 561310
HER No: 41517
Sources: CCC HER; Ordnance Survey 1864; 1868
Designation: none
Type: farmstead; horse engine house
Description: Warren House, Brampton; farmstead shown on first edition Ordnance Survey map of *c*1865 (Ordnance Survey 1864; 1868). Apsidal gin case shown against north-eastern elevation (now demolished).
Period: post-medieval

Site Number: **2**
NGR: 353570 561290
HER No: 41517
Sources: CCC HER; Hodgson 1953
Designation: none
Type: find spot (quern stone)
Description: quern find, Brampton; two upper quern stones found in Brampton area were taken from old farmhouse at Cumcatch (NGR 3547 5610) to garden of Ridge House. Similar in shape, they seem to be near Curwen's "Roman Legionary" type (Curwen 1937).
Period: Roman

Site Number: **3**
NGR: 353780 561120
HER No: 6995
Sources: CCC HER; Ordnance Survey 1868; 1901a; 1901b; Linley 1990
Designation: none
Type: railway station
Description: Brampton Town Railway Station; Brampton Station House mentioned by S Linley (1990) as a good example. Present condition unknown.
There is no building here [NGR 353700 561100] with that name. The station house may have been where the CCC Highways Depot is now situated. If so, then it has been demolished.
Railway station clearly shown on the first and second edition Ordnance Survey maps (Ordnance Survey 1868; 1901a; 1901b) at NGR 35378 56112. The site has now been partially built on by modern housing and/or commercial properties.
The tithe map describes this as ‘coal staith’ and it is later called ‘Brampton Staith’ and just ‘Staith’. ‘Staith’ is a term describing a place where goods were deposited, typically coal, initially used in connection to wharves in the North East (Cossons 1978, 143).
Period: post-medieval

Site Number: **4**
NGR: 353810 561070
HER No: 10011
Sources: CCC HER; Ordnance Survey 1868; 1901a
Designation: none
Type: railway; tramway

Description: Brampton and Hartleyburn Railway; old tramway at Brampton [see **Site 5**]. The 1901 Ordnance Survey map (1901a) shows site as the Brampton and Hartley Burn Railway over the same route as this tramway. It is later marked as 'dismantled railway'.
The railway banks survive, and are now in use as a public footpath.
Period: post-medieval

Site Number: **5**
NGR: 353890 560900
HER No: 11228
Sources: CCC HER; Webb and Gordon 1978
Designation: none
Type: railway; wagonway
Description: Lord Carlisle's Railway, Brampton to Midgeholme; this stretch of railway line started its life as a wagonway, the vast majority of which was built on the private lands of Lord Carlisle to serve the Naworth coalfields and quarries. It was opened in 1799 with wooden rails but by 1808 it had been re-laid in both cast-iron and wrought malleable iron rails, the first successful application of the latter type of rail in a day to day commercial way. Lord Carlisle's Railway was the first of its kind to be later developed and extended and then converted into Cumberland's first 'mainline standard' railway.
Much of the credit for the development of Lord Carlisle's Railways is due to James Thompson, Lord Carlisle's colliery agent, and subsequent lessee of the Naworth collieries and rail system. In 1828-9 Thompson built the extension of the wagonway as a proper railway to Midgeholme and to the Stephenson gauge of 4ft 8 1/2 in, soon converting the wagonway to the same gauge afterwards. This was possibly the first non-Stephenson railway to adopt this rail gauge and the wagonway the first conversion to this gauge. Thompson's action was based on his belief that all railways should be made of the same rail gauge to enable subsequent linking-up of railways and the operation of through traffic. This ensured a route permitting operation initially by horses, and in due course by locomotives.
In 1836 the 'new railway' of Lord Carlisle opened to replace the wagonway. From 1837 the 'Rocket' operated on Lord Carlisle's Railway, but between 1838 and 1866 the colliery workshops built their own locomotives. Although primarily a mineral railway, the colliery railway operated a public passenger service, horse-drawn until 1881, but steamworked afterwards, and to the end in the hands of the North Eastern Railway in 1923 (Webb and Gordon 1978).
Period: post-medieval

Site Number: **6**
NGR: 353898 560993
HER No: 45686
Sources: CCC HER; English Heritage 2008, 37; Historic England 2022e
Designation: none
Type: earthworks (bank, enclosure, motte and bailey)
Description: Station Road linear earthwork, Brampton; a curvilinear bank mapped by Hadrian's Wall NMP (English Heritage 2008, 37), and interpreted as possibly part of a motte and bailey earthwork.
As there is a motte and bailey castle 500m to the west (HER 1013967; Historic England 2022e) this seems unlikely. The bank may be of some antiquity, however, forming part of an enclosure. Part of the site as mapped (from 1946 RAF vertical images) has now been built upon, and truncated by a railway (**Site 4**). The feature is not easily discernible on LiDAR.
Period: unknown (possibly medieval)

Site Number: 7
NGR: 354272 560792
HER No: 45687
Sources: CCC HER; English Heritage 2008, 44

Designation: none
Type: military camp
Description: Howgate Military Camp, Brampton; a relatively small collection of military buildings and a road mapped by Hadrian's Wall NMP from 1946 aerial images (English Heritage 2008, 44).
No visible trace is evident on modern aerial imagery.
Period: post-medieval

Appendix 2: Significance Criteria

After DCMS 2013, Annex 1: '*Principals of Selection for Scheduled Monuments*'

i) *Period*: all types of monuments that characterise a category or period should be considered for preservation;

ii) *Rarity*: there are some monument categories which in certain periods are so scarce that all surviving examples which retain some archaeological potential should be preserved. In general, however, a selection must be made which portrays the typical and commonplace as well as the rare. This process should take account of all aspects of the distribution of a particular class of monument, both in a national and regional context;

iii) *Documentation*: the significance of a monument may be enhanced by the existence of record of previous investigation or, in the case of more recent monuments, by the supporting evidence of contemporary written records;

iv) *Group Value*: the value of a single monument (such as a field system) may be greatly enhanced by its association with related contemporary monuments (such as a settlement and cemetery) or with monuments of different periods. In some cases, it is preferable to protect the complete group of monuments, including associated and adjacent land, rather than to protect isolated monuments within the group;

v) *Survival/Condition*: the survival of a monument's archaeological potential both above and below ground is a particularly important consideration and should be assessed in relation to its present condition and surviving features;

vi) *Fragility/Vulnerability*: highly important archaeological evidence from some field monuments can be destroyed by a single ploughing or unsympathetic treatment; vulnerable monuments of this nature would particularly benefit from the statutory protection which scheduling confers. There are also existing standing structures of particular form or complexity whose value can again be severely reduced by neglect or careless treatment and which are similarly well suited by scheduled monument protection, even if these structures are already listed historic buildings;

vii) *Diversity*: some monuments may be selected for scheduling because they possess a combination of high quality features, others because of a single important attribute;

viii) *Potential*: on occasion, the nature of the evidence cannot be specified precisely but it may still be possible to document reasons anticipating its existence and importance and so to demonstrate the justification for scheduling. This is usually confined to sites rather than upstanding monuments.

Appendix 3: Listed Building Information

From north to south:

Site name: **RIDGE HOUSE, LANERCOST ROAD** (**LB1**; Historic England 2022d)
Heritage Category: Listed Building
Grade: II
List Entry Number: 1335553
Date first listed: 01-Apr-1957
Statutory Address: RIDGE HOUSE, LANERCOST ROAD
County: Cumbria
District: Carlisle (District Authority)
Parish: Brampton
National Grid Reference: NY 53571 61303
Details: house formerly Inn. Dated 1835 over entrance. Red sandstone ashlar with plain cornice, slate roof with lead hips, rendered chimney stacks. Two storeys, three bays. Six-panel door with glazed fanlight and pilastered surround, has prostyle Tuscan porch with moulded entablature and cornice. Sash windows with glazing bars with plain stone surrounds. Blind window to south-west wall has painted glazing bars. In 1847, this was the Ridge House Inn (Mannix and Whellan 1847).

Site name: **HOWARD MEMORIAL SHELTER, THE SANDS** (**LB2**; Historic England 2022b)
Heritage Category: Listed Building
Grade: II
List Entry Number: 1087647
Date first listed: 16-Jan-1984
Statutory Address: HOWARD MEMORIAL SHELTER, THE SANDS
County: Cumbria
District: Carlisle (District Authority)
Parish: Brampton
National Grid Reference: NY 53575 61221
Details: memorial shelter. Circa 1930, inscribed TO GEORGE JAMES HOWARD 9th EARL OF CARLISLE, 1843-1911, AND TO ROSALIND FRANCES, HIS WIFE, 1845-1921. Snecked calciferous sandstone ashlar, stone-slate roof. Octagonal single storey building with partly open sides. Squared columns are carried on inside to form vaulted roof, with central circular column. Oak lintels and open timber roof. Floor has stepped flagged surround with small herringbone brickwork inside. Stone seats around central column and along inside of filled arches, with internal inscription stone.

Site name: **MILESTONE AT NGR NY 53650 61210** (**LB3**; Historic England 2022c)
Heritage Category: Listed Building
Grade: II
List Entry Number: 1087660
Date first listed: 16-Jan-1984
Statutory Address: MILESTONE AT NGR NY 53650 61210, A69 (EAST OF THE SANDS BRAMPTON)
County: Cumbria
District: Carlisle (District Authority)
Parish: Brampton
National Grid Reference: NY 53654 61212
Details: milestone. Probably 1758, for the Carlisle-Newcastle Military Road. Sandstone, cast-iron plates. Chamfered stone to give two faces in direction of traffic, one face with cast plate TO CARLISLE 10 MILES, other face TO NEWCASTLE 46 MILES, both in four lines. Whitewashed over and lettering

picked out in black. This became the Carlisle-Temon Turnpike in 1811. Each milestone is clearly drawn on Donald's map of Cumberland and Westmorland, surveyed in 1770.

TREE HOUSE, TREE ROAD (**LB4**; Historic England 2022f)
Heritage Category: Listed Building
Grade: II
List Entry Number: 1312219
Date first listed: 16-Jan-1984
Statutory Address: TREE HOUSE, TREE ROAD
County: Cumbria
District: Carlisle (District Authority)
Parish: Brampton
National Grid Reference: NY 53653 60947
Details: house. Late 18th century. Red sandstone rubble walls with painted V-joint quoins and plain painted cornice; slate roof, brick chimney stacks. Two storeys, three bays. Entrance has six-panel door with radial fanlight, plain painted stone surround with impost blocks and false keystone. Sash windows with glazing bars have plain painted stone surrounds.

Appendix 4: Geophysical Survey

Warren Fields, Brampton
Carlisle
Cumbria

Archaeological geophysical survey

Project No. ARC/3362/1292

November 2022

Warren Fields, Brampton
Carlisle
Cumbria

Archaeological geophysical survey

Project No. ARC/3362/1292

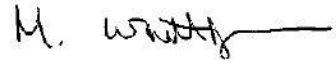
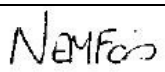
Report prepared by		**Report checked by**	
Name	Mark Whittingham BSc MA MCIfA	Name	Nicola Fairs BSc MSc DIC CGeol FGS
Signature		Signature	
Date	17/11/22	Date	17/11/22

Table of Contents

1. SUMMARY

Phase Site Investigations Ltd was commissioned to carry out a magnetic gradient survey at a site at Warren Fields, Brampton, Carlisle, Cumbria. The aim of the survey was to help establish the presence / absence, extent, character, relationships and date (as far as circumstances and the inherent limitations of the technique permits) of archaeological features within the survey area.

The survey was undertaken using a Phase Site Investigations Ltd multi-sensor array cart system (MACS). The MACS comprised 8 Foerster 4.032 Ferex CON 650 gradiometers with a control unit and data logger. The MACS data was collected on profiles spaced 0.5 m apart with readings taken at between 0.1 and 0.15 m intervals.

The majority of the anomalies identified by this survey relate to modern material / objects (including buried services / drains), and possible geological / pedological variations. There are a number of linear / curvi-linear trends and relatively strong / large positive isolated responses all of uncertain origin. The majority of these do not form any clear patterns or relationships that would indicate an archaeological origin and they are considered more likely to be associated with features / variations or modern activity. There is a suggestion that some responses could form a return and if this is the case this could indicate an anthropogenic cause but the diffuse nature of the responses precludes a more definite interpretation.

There is a generally strongly disturbed / variable magnetic background across the site that is due to a spread of modern magnetic material. It should be noted that the unusually large number of isolated responses across the site could possibly mask responses from some types of sub-surface features (particularly small / discrete features), should any such features be present.

2. INTRODUCTION

2.1 Overview

Phase Site Investigations Ltd was commissioned by Greenlane Archaeology Limited to carry out an archaeological geophysical survey at a site Warren Fields, Brampton, Carlisle, Cumbria utilising magnetic gradiometers.

The aim of the survey was to help establish the presence / absence, extent, character, relationships and date (as far as circumstances and the inherent limitations of the technique permits) of archaeological features within the survey area.

The location of the site is shown in drawing ARC_3362_1292_01.

2.2 Site description

The site is located on the eastern edge of the market town of Brampton (approximate centre at NGR NY 540 612), approximately 15 km to the east of Carlisle and covered an area of approximately 4.3 ha.

The site encompassed a pasture field. The field was undulating with some relatively steep slopes in places. The ground was generally lower to the south-east with a noticeable area of raised ground on the west side. The field was bounded by post and wire fencing and hedges.

The geology of the site consists of sandstone of the St Bees Sandstone Member overlain by sand and gravel Glaciofluvial Deposits (British Geological Survey, 2022).

2.3 Archaeological background

A desk-based assessment (Greenlane Archaeology Limited, *in prep.*) highlights that the site is approximately 330 m south-east of the World Heritage Site associated with Hadrian's Wall and that the motte on the summit of Castle Hill, Brampton, a Scheduled Monument, is approximately 450 m west of the site.

The desk-based assessment concludes that,

'*There is clearly the potential for previously unknown archaeological remains to be present, including Roman and medieval remains, although this potential is low*'.

The desk-based assessment highlights that cartographic evidence indicates the site reached its present state by the mid-19th century and has remained rural in character since then.

2.4 Scope of work

The survey area was specified by the client based.

Due to the presence of dense vegetation around the perimeter of the site the area accessible / suitable for survey was reduced to approximately 4 ha, the extents of which are shown in drawing ARC_3362_1292_02.

No other problems were encountered during the survey which was carried out on 25th October 2022.

3. SURVEY METHODOLOGY

3.1 Magnetic survey

The survey was undertaken using a Phase Site Investigations Ltd multi-sensor array cart system (MACS).

The MACS comprised 8 Foerster 4.032 Ferex CON 650 gradiometers with a control unit and data logger. The Foerster gradiometers do not require balancing as each sensor is automatically 'zeroed' using the control unit software.

The MACS utilises an RTK GNSS system which means that survey grids do not have to be established. Instead an area is surveyed over a series of continuous profiles and the position of each data point is recorded using an RTK GNSS system. The sensors have a separation of 0.5 m which means that data was collected on profiles spaced at 0.5 m apart. Readings were taken at between 0.1 m and 0.15 m intervals.

Data is collected on zig-zag profiles along the full length or width of a field, although fields can be sub-divided if they are particularly large. Marker canes are set-out along field boundaries at set intervals and these are used to align the profiles. The survey profiles are usually offset from field boundaries, buildings and other metallic features by several metres to reduce the detrimental effect that these surface magnetic features have on the data. The location of the MACS data is converted direct to Ordnance Survey co-ordinates using the UK OSTN15 projection. As the survey is referenced direct to Ordnance Survey National Grid co-ordinates temporary survey stations are not established.

3.2 Data processing and presentation

The MACS data was stored direct to a laptop using in-house software which automatically corrects for instrument drift and calculates a mean value for each profile. A positional value is assigned to each data point based on the sensor number and recorded GNSS co-ordinates. The data is gridded using in-house software and parameters are set based on the sensor spacing and mean values. No additional processing is required. The gridded data is then displayed in Surfer 9 (Golden Software) and image files of the data are created.

The data is relatively 'noisy' and so greyscale plots of the data have been shown at two ranges; a range of -2 nT to 3 nT, which is 'standard' for archaeological surveys and a relatively wide (for archaeological surveys) range of -5 to 5 nT. The latter smooths out the data and can make it easier to identify some anomalies but very weak responses may not be visible in the wider range. The data was exported as raster images (PNG files). A greyscale plot is presented at a clip of -2 nT to 3 nT in drawing ARC_3362_1292_02, at a clip of -5 nT to 5 nT in drawing ARC_3362_1292_03, with an accompanying interpretation in drawing ARC_3362_1292_04 (all at a scale 1:1250). Greyscale plots have been 'smoothed' using a visual interpolation but the data itself has not been interpolated. The two different ranges that the data has been displayed at show that the magnetic disturbance, although present across the majority if the site, is less noticeable in the wider range (-5 nT to 5 nT). This indicates that much of the magnetic disturbance is probably caused by relatively small surface / near surface material.

The data has been displayed relative to a digital Ordnance Survey base plan provided by the client as drawing '*Promap -2112307-2215392-720-0.dwg*'. The base plan was in the Ordnance Survey National Grid co-ordinate system and as the survey grids / data were referenced directly to National Grid co-ordinates the data could be simply superimposed onto the base plan in the correct position.

X-Y trace plots were examined for all of the data and overlain onto the greyscale plot to assist in the interpretation, primarily to help identify dipolar and bipolar responses that will probably be associated with surface / near-surface iron objects. However, X-Y trace plots have not been presented here as they do not show any additional anomalies that are not visible in the greyscale data. A digital drawing showing the X-Y trace plot overlain on the greyscale plot is provided in the digital archive.

All isolated responses have been assessed using a combination of greyscale and X-Y trace plots. There are a very large number of 'iron spike', isolated dipolar anomalies present in the data. There is no evidence to suggest that they are associated with archaeological features and so these smaller isolated responses have not been shown in the interpretation.

The data was examined over several different ranges during the interpretation to ensure that the maximum information possible was obtained from the data.

The anomalies have been categorised based on the type of response that they exhibit and an interpretation as to the cause(s) or possible cause(s) of each anomaly type is also provided.

A general discussion of the anomalies is provided for the entire site . A discussion of the general categories of anomaly which have been identified by the survey is provided in Appendix 1.5.

The geophysical interpretation drawing must be used in conjunction with the relevant results section and appendices of this report.

4. RESULTS

4.1 General

The data quality across the majority of the survey area is very good allowing the data to be viewed at a narrow range of readings to better identify weak anomalies. There is a generally strongly disturbed / variable magnetic background across the site but this is due to a spread of modern magnetic material across the site, rather than low data quality.

4.2 Anomaly types and further discussion

4.2.1 Isolated dipolar and bipolar responses – probable modern features / activity / material

There are numerous **isolated dipolar** responses (iron spikes) across the survey area. These contain a strong positive and negative component and are indicative of ferrous or fired material on or near to the surface. **Isolated bipolar** responses are also present. These have strong positive and negative components but are not technically magnetic dipoles. They tend to be caused by ferrous or fired material on or near to the surface and are usually produced from larger, or more strongly magnetic, objects (compared to dipolar anomalies) or a concentration of strongly magnetic smaller objects. In the large majority of cases these two types of isolated responses will be caused by modern material. However, the potential for some of these to be associated with archaeological features / material may be increased slightly by their proximity to other anomalies / features.

The smaller isolated dipolar and bipolar responses at this site are all assumed not to be of archaeological significance and have not been shown on the interpretation.

Several larger bipolar responses have been shown on the interpretation because they are considered to be more likely to be associated with more significant sub-surface features or material (although in this instance they are not thought to be of archaeological interest). For these responses the main positive component(s) of the response is shown (as this will better represent where an underlying feature / material may be located) and the overall extent of the response is also shown. The latter will usually extend well beyond the underlying feature but may indicate an area where the strong bipolar anomaly could mask responses from any other underlying features.

It should be noted that the unusually large number of isolated responses across the site could possibly mask responses from some types of sub-surface features (particularly small / discrete features), should any such features be present.

4.2.2 Areas of magnetic disturbance and strong responses – probable modern features / activity / material

Several areas where there is a greater concentration of **magnetic disturbance** are present. These are areas of strong bipolar and dipolar responses and are usually associated with concentrations of relatively modern magnetic material. In this case they are not considered to be archaeologically significant.

4.2.3 Linear bipolar anomalies – modern features

Linear bipolar anomalies have strong positive and negative components and are usually produced by buried pipes / cables that are usually metallic, although in some instances ceramic pipes can also produce bipolar anomalies. In many cases the anomaly can extend for a significant distance beyond the feature that produces the anomaly.

4.2.4 Linear / curvi-linear diffuse trends – uncertain cause

Several linear / curvi-linear **trends** have been identified. These are all too diffuse, weak and / or short to reliably interpret. The diffuse nature of some of the trends could suggest that that they are caused by natural features / variations but it is possible that some of them are caused by anthropogenic features.

Anomalies A stand out slightly and there is a slight suggestion that these could form a sub-rectangular shape. If they do it is possible that they could be related to part of an archaeological enclosure, although it is perhaps more likely that they are caused by natural features / variations, agricultural or other modern activity.

Anomalies B also stand out but these are less regular in shape and whilst it is possible that some of them could be related to infilled sub-surface features it is likely that these are natural, rather than archaeological.

There is a suggestion of a broadly linear trend in the east of the area (**Anomaly C**). Again the response is too weak / diffuse to reliably interpret and whilst it could potentially be related to part of an infilled sub-surface feature it is probably more likely that it is caused by a natural feature or agricultural activity.

4.2.5 Isolated positive responses

There are numerous **isolated positive responses** across the survey area, some of which are relatively large or strong. This type of anomaly can have a variety of causes including natural features / variations, deeper buried ferrous or fired material, accumulations of topsoil related to agricultural activity, infilled features or areas of burning. At this site it is possible that some of the isolated positive responses are caused by discrete features but there is no obvious pattern or relationship to their distribution that would indicate an archaeological origin and it is considered more likely that they are caused by natural variations or deeper buried relatively modern, ferrous or fired material.

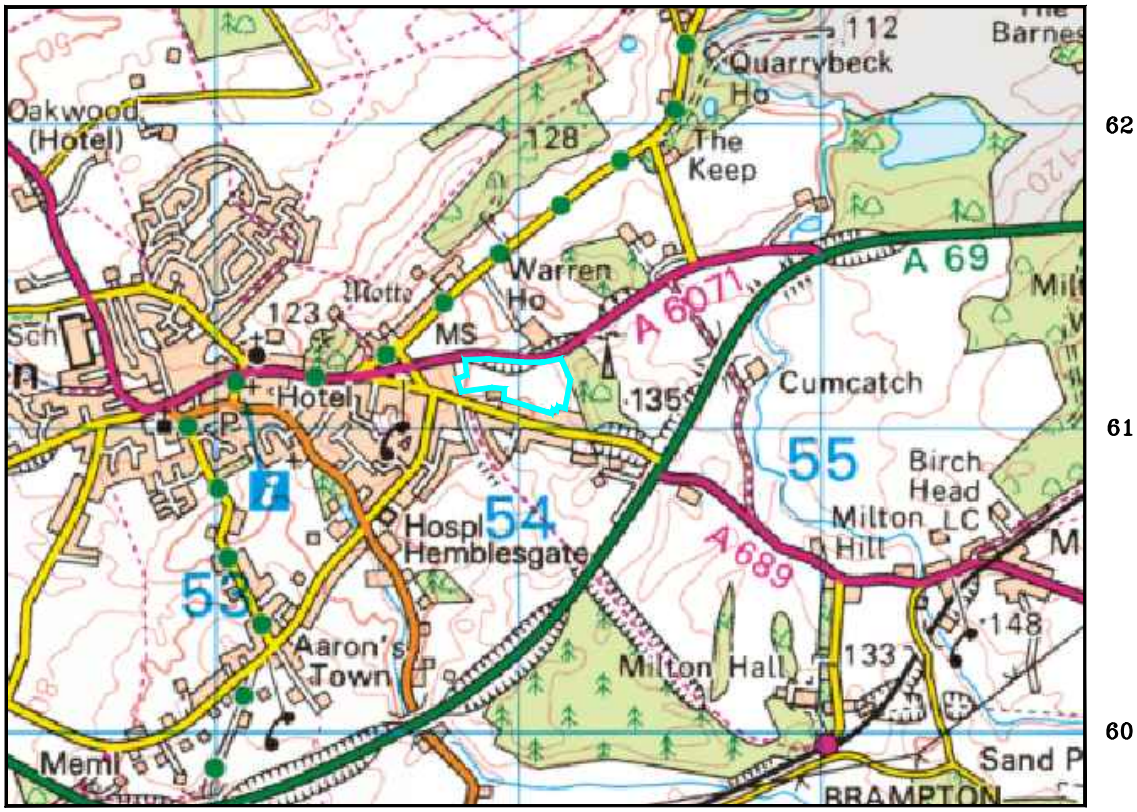
Several larger / stronger isolated positive (**Anomalies D**) stand out. These could have greater potential to be related to a sub-surface feature, due to their size / strength, but it is more likely that they are related to modern material.

5. DISCUSSION AND CONCLUSIONS

The majority of the anomalies identified by this survey relate to modern material / objects (including buried services / drains), and possible geological / pedological variations. There are a number of linear / curvi-linear trends and relatively strong / large positive isolated responses all of uncertain origin. The majority of these do not form any clear patterns or relationships that would indicate an archaeological origin and they are considered more likely to be associated with features / variations or modern activity. There is a suggestion that some responses could form a return and if this is the case this could indicate an anthropogenic cause but the diffuse nature of the responses precludes a more definite interpretation.

There is a generally strongly disturbed / variable magnetic background across the site that is due to a spread of modern magnetic material. It should be noted that the unusually large number of isolated responses across the site could possibly mask responses from some types of sub-surface features (particularly small / discrete features), should any such features be present.

It should be noted that a geophysical survey does not directly locate sub-surface features - it identifies variations or anomalies in the background response caused by features. The interpretation of geophysical anomalies is often subjective and it is rarely possible to identify the cause of all such anomalies. Not all features will produce a measurable anomaly and the effectiveness of a geophysical survey is also dependant on the site-specific conditions. The main factors that may limit whether a feature can be detected are the composition of a feature, its depth and size and the surrounding material. It is not possible to guarantee that a geophysical survey will identify all sub-surface features. Confirmation on the identification of anomalies and the presence or absence of sub-surface features can only be achieved by intrusive investigation.



SITE LOCATION

SCALE

0m 500m 1000m

NOTE

PHASE SITE INVESTIGATIONS

Phase Site Investigations Ltd, 703A Whinfield Drive, Aycliffe Business Park, Newton Aycliffe, County Durham, DL5 6AU

T: +44 [0] 01325 311 751
E: enquiries@PhaseSI.com
W: www.PhaseSI.com

Scale [A4 Sheet]	Drawing	Status
AS SHOWN	ARC_3362_1292_01	FINAL

Client: GREENLANE ARCHAEOLOGY LTD ULVERSTON

Site: WARREN FIELDS, BRAMPTON CARLISLE, CUMBRIA

Title: SITE LOCATION MAP

Job No: ARC_3362_1292

		Drawn	CW
Chk.	NF	Date	02/11/2022

NOTES

1. THIS DRAWING MUST BE USED IN CONJUNCTION WITH THE ACCOMPANYING REPORT (ARC_3362_1292_RPT.PDF) WHICH PROVIDES DETAILS OF THE TECHNIQUES EMPLOYED, THEIR INHERENT LIMITATIONS AND ANY SITE SPECIFIC ISSUES.
2. THIS DRAWING IS BASED UPON DRAWING 'Promap-2112307-2215392-720-0.dwg' PROVIDED BY THE CLIENT. THE ORDNANCE SURVEY CO-ORDINATES OBTAINED FOR THIS SURVEY WERE MEASURED USING THE UK OSTN15 PROJECTION. THIS PROJECTION SHOULD BE TAKEN INTO ACCOUNT IF THE SURVEY GRID IS RELOCATED.
3. PHASE SITE INVESTIGATIONS CANNOT ACCEPT RESPONSIBILITY FOR THE RELIABILITY OR ACCURACY OF ANY INFORMATION PROVIDED BY A THIRD PARTY.
4. THIS DRAWING AND THE INFORMATION CONTAINED THEREIN IS ISSUED IN CONFIDENCE AND IS THE COPYRIGHT OF PHASE SITE INVESTIGATIONS LIMITED. DISCLOSURE OF THIS INFORMATION TO THIRD PARTIES AND UNAUTHORISED COPYING OR REPLICATION OF THIS DATA WITHOUT APPROVAL IS FORBIDDEN.

ALWAYS EXERCISE CAUTION WHEN EXCAVATING

KEY

SITE BOUNDARY

PHASE SITE INVESTIGATIONS

Phase Site Investigations Ltd, 703A Whinfield Drive, Aycliffe Business Park, Newton Aycliffe, County Durham, DL5 6AU

T: +44 [0] 01325 311 751
E: enquiries@PhaseSI.com
W: www.PhaseSI.com

Scale [A3 Sheet]	Drawing	Status
1:1250	ARC_3362_1292_02	FINAL

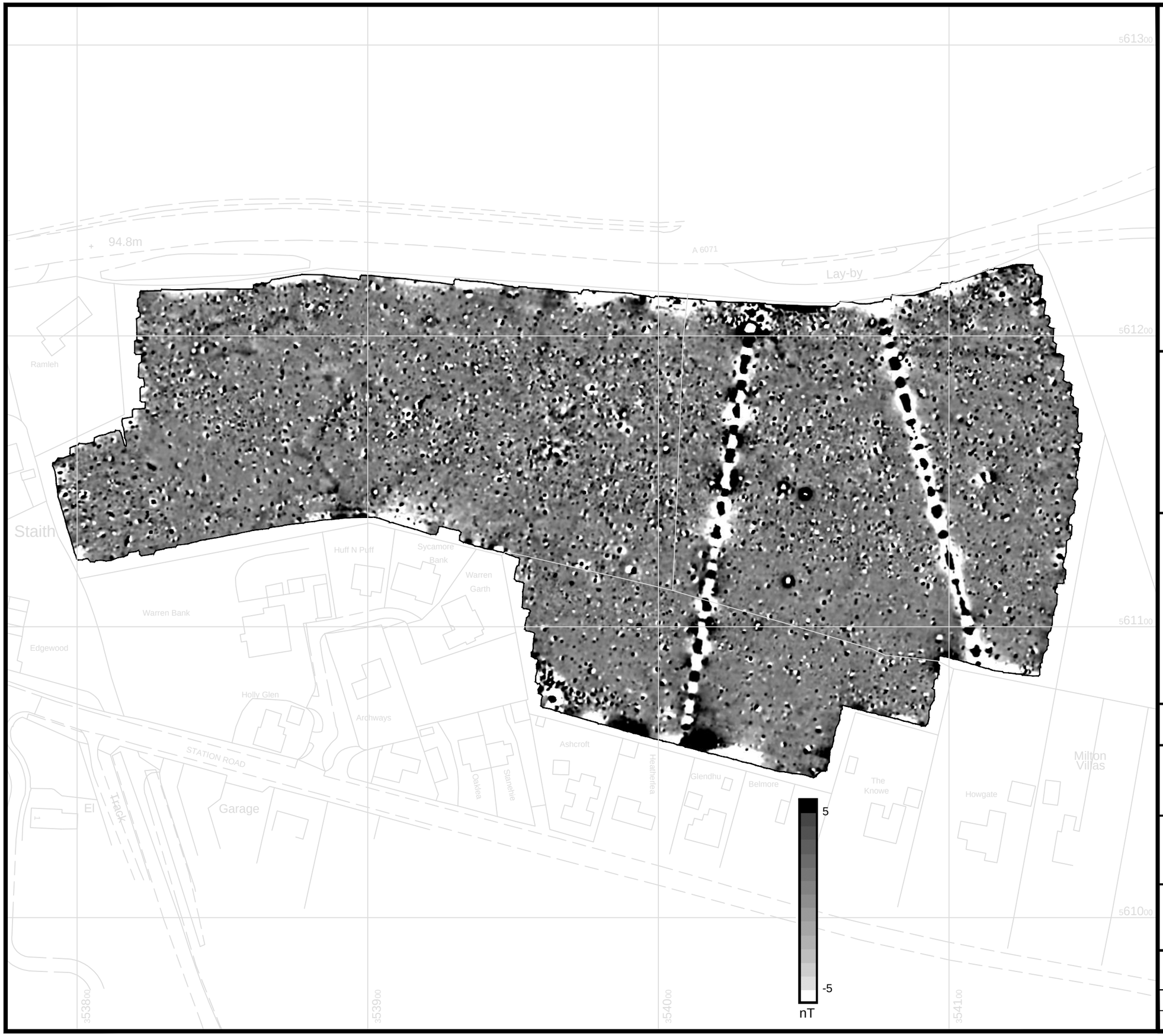
Client
GREENLANE ARCHAEOLOGY LTD
ULVERSTON

Site
WARREN FIELDS, BRAMPTON
CARLISLE, CUMBRIA

Title
LOCATION OF SITE SHOWING MAGNETIC GRADIENT DATA ('STANDARD' RANGE)

Job No
ARC_3362_1292

Surveyed	JW, RS	Drawn	JW
Chk.	MW	Date	25/10/2022



NOTES

1. THIS DRAWING MUST BE USED IN CONJUNCTION WITH THE ACCOMPANYING REPORT (ARC_3362_1292_RPT.PDF) WHICH PROVIDES DETAILS OF THE TECHNIQUES EMPLOYED, THEIR INHERENT LIMITATIONS AND ANY SITE SPECIFIC ISSUES.
2. THIS DRAWING IS BASED UPON DRAWING 'Promap -2112307-2215392-720-0.dwg' PROVIDED BY THE CLIENT. THE ORDNANCE SURVEY CO-ORDINATES OBTAINED FOR THIS SURVEY WERE MEASURED USING THE UK OSTN15 PROJECTION. THIS PROJECTION SHOULD BE TAKEN INTO ACCOUNT IF THE SURVEY GRID IS RELOCATED.
3. PHASE SITE INVESTIGATIONS CANNOT ACCEPT RESPONSIBILITY FOR THE RELIABILITY OR ACCURACY OF ANY INFORMATION PROVIDED BY A THIRD PARTY.
4. THIS DRAWING AND THE INFORMATION CONTAINED THEREIN IS ISSUED IN CONFIDENCE AND IS THE COPYRIGHT OF PHASE SITE INVESTIGATIONS LIMITED. DISCLOSURE OF THIS INFORMATION TO THIRD PARTIES AND UNAUTHORISED COPYING OR REPLICATION OF THIS DATA WITHOUT APPROVAL IS FORBIDDEN.

ALWAYS EXERCISE CAUTION WHEN EXCAVATING

N

PHASE SITE INVESTIGATIONS

Phase Site Investigations Ltd, 703A Whinfield Drive, Aycliffe Business Park, Newton Aycliffe, County Durham, DL5 6AU

T: +44 [0] 01325 311 751
E: enquiries@PhaseSI.com
W: www.PhaseSI.com

Scale [A3 Sheet]	Drawing	Status
1:1250	ARC_3362_1292_03	FINAL

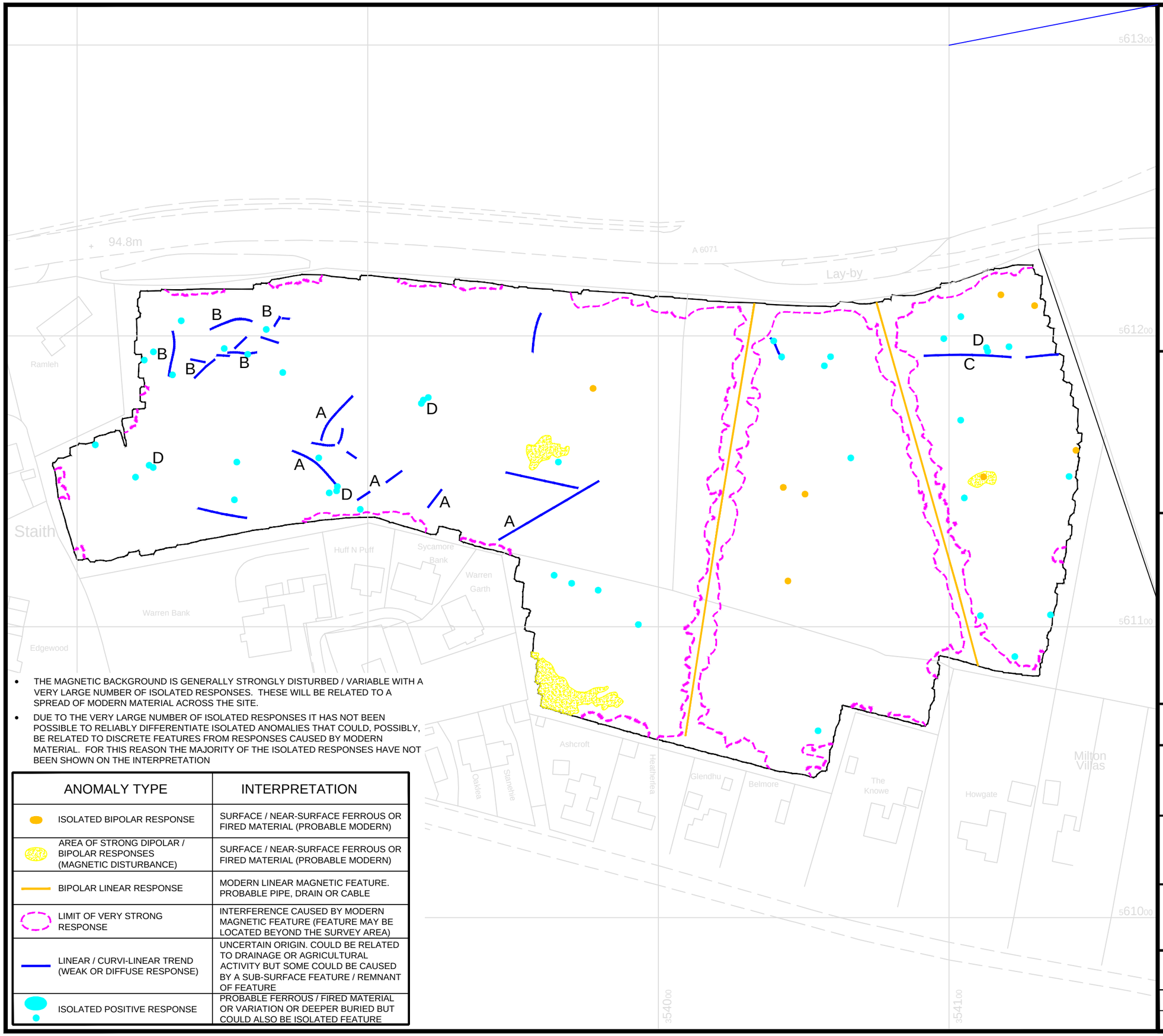
Client
GREENLANE ARCHAEOLOGY LTD
ULVERSTON

Site
WARREN FIELDS, BRAMPTON
CARLISLE, CUMBRIA

Title
GREYSCALE PLOT OF MAGNETIC GRADIENT DATA
(WIDER RANGE)

Job No
ARC_3362_1292

Surveyed	JW, RS	Drawn	JW
Chk.	MW	Date	25/10/2022



- THE MAGNETIC BACKGROUND IS GENERALLY STRONGLY DISTURBED / VARIABLE WITH A VERY LARGE NUMBER OF ISOLATED RESPONSES. THESE WILL BE RELATED TO A SPREAD OF MODERN MATERIAL ACROSS THE SITE.
- DUE TO THE VERY LARGE NUMBER OF ISOLATED RESPONSES IT HAS NOT BEEN POSSIBLE TO RELIABLY DIFFERENTIATE ISOLATED ANOMALIES THAT COULD, POSSIBLY, BE RELATED TO DISCRETE FEATURES FROM RESPONSES CAUSED BY MODERN MATERIAL. FOR THIS REASON THE MAJORITY OF THE ISOLATED RESPONSES HAVE NOT BEEN SHOWN ON THE INTERPRETATION

ANOMALY TYPE	INTERPRETATION
ISOLATED BIPOLAR RESPONSE	SURFACE / NEAR-SURFACE FERROUS OR FIRED MATERIAL (PROBABLE MODERN)
AREA OF STRONG DIPOLAR / BIPOLAR RESPONSES (MAGNETIC DISTURBANCE)	SURFACE / NEAR-SURFACE FERROUS OR FIRED MATERIAL (PROBABLE MODERN)
BIPOLAR LINEAR RESPONSE	MODERN LINEAR MAGNETIC FEATURE. PROBABLE PIPE, DRAIN OR CABLE
LIMIT OF VERY STRONG RESPONSE	INTERFERENCE CAUSED BY MODERN MAGNETIC FEATURE (FEATURE MAY BE LOCATED BEYOND THE SURVEY AREA)
LINEAR / CURVI-LINEAR TREND (WEAK OR DIFFUSE RESPONSE)	UNCERTAIN ORIGIN. COULD BE RELATED TO DRAINAGE OR AGRICULTURAL ACTIVITY BUT SOME COULD BE CAUSED BY A SUB-SURFACE FEATURE / REMNANT OF FEATURE
ISOLATED POSITIVE RESPONSE	PROBABLE FERROUS / FIRED MATERIAL OR VARIATION OR DEEPER BURIED BUT COULD ALSO BE ISOLATED FEATURE

NOTES

1. THIS DRAWING MUST BE USED IN CONJUNCTION WITH THE ACCOMPANYING REPORT (ARC_3362_1292_RPT.PDF) WHICH PROVIDES DETAILS OF THE TECHNIQUES EMPLOYED, THEIR INHERENT LIMITATIONS AND ANY SITE SPECIFIC ISSUES.
2. THIS DRAWING IS BASED UPON DRAWING 'Promap-2112307-2215392-720-0.dwg' PROVIDED BY THE CLIENT. THE ORDNANCE SURVEY CO-ORDINATES OBTAINED FOR THIS SURVEY WERE MEASURED USING THE UK OSTN15 PROJECTION. THIS PROJECTION SHOULD BE TAKEN INTO ACCOUNT IF THE SURVEY GRID IS RELOCATED.
3. PHASE SITE INVESTIGATIONS CANNOT ACCEPT RESPONSIBILITY FOR THE RELIABILITY OR ACCURACY OF ANY INFORMATION PROVIDED BY A THIRD PARTY.
4. THIS DRAWING AND THE INFORMATION CONTAINED THEREIN IS ISSUED IN CONFIDENCE AND IS THE COPYRIGHT OF PHASE SITE INVESTIGATIONS LIMITED. DISCLOSURE OF THIS INFORMATION TO THIRD PARTIES AND UNAUTHORISED COPYING OR REPLICATION OF THIS DATA WITHOUT APPROVAL IS FORBIDDEN.

ALWAYS EXERCISE CAUTION WHEN EXCAVATING

N

PHASE SITE INVESTIGATIONS

Phase Site Investigations Ltd, 703A Whinfield Drive, Aycliffe Business Park, Newton Aycliffe, County Durham, DL5 6AU

T: +44 [0] 01325 311 751
E: enquiries@PhaseSI.com
W: www.PhaseSI.com

Scale [A3 Sheet]	Drawing	Status
1:1250	ARC_3362_1292_04	FINAL

Client
GREENLANE ARCHAEOLOGY LTD
ULVERSTON

Site
WARREN FIELDS, BRAMPTON
CARLISLE, CUMBRIA

Title
INTERPRETATION OF MAGNETIC GRADIENT DATA

Job No
ARC_3362_1292

Surveyed	JW, RS	Drawn	JW
Chk.	MW	Date	25/10/2022

BIBLIOGRAPHY AND REFERENCES

British Geological Survey, 2022, online resource - www.bgs.ac.uk

Greenlane Archaeology Limited, *in prep.*, Warren Fields, Brampton, Carlisle, Cumbria, Archaeological Desk-Based Assessment

APPENDIX 1

Magnetic survey: technical information

1.1 Theoretical background

1.1.1 Magnetic instruments measure the value of the Earth's magnetic field; the units of which are nanoTeslas (nT). The presence of surface and sub-surface features can cause variations or anomalies in this magnetic field. The strength of the anomaly is dependent on the magnetic properties of a feature and the material that surrounds it. The two magnetic properties that are of most interest are magnetic susceptibility and thermoremnant magnetism.

1.1.2 Magnetic susceptibility indicates the amount of ferrous (iron) minerals that are present. These can be redistributed or changed (enhanced) by human activity. If enhanced material subsequently fills in features such as pits or ditches then these can produce localised increases in magnetic responses (anomalies) which can be detected by a magnetic gradiometer even when the features are buried under additional soil cover.

1.1.3 In general, it is the contrast between the magnetic susceptibility of deposits filling cut features, such as ditches or pits, and the magnetic susceptibility of topsoils, subsoils and rocks into which these features have been cut which causes the most recognisable responses. This is primarily because there is a tendency for magnetic ferrous compounds to become concentrated in the topsoil, thereby making it more magnetic than the subsoil or the bedrock. Linear features cut into the subsoil or geology, such as ditches, that have been silted up or have been backfilled with topsoil will therefore usually produce a positive magnetic response relative to the background soil levels. Discrete feature, such as pits, can also be detected. Less magnetic material such as masonry or plastic service pipes which intrude into the topsoil may give a negative magnetic response relative to the background level. The strength of magnetic responses that a feature will produce will depend on the background magnetic susceptibility, how rapidly the feature has been infilled, the level and type of human activity in the area and the size and depth of a feature. Not all infilled features can be detected and natural variations can also produce localised positive and negative anomalies.

1.1.4 Thermoremnant magnetism indicates the amount of magnetism inherent in an object as a result of heating. Material that has been heated to a high temperature (fired), such as brick, can acquire strong magnetic properties and so although they may not appear to have a high iron content they can produce strong magnetic anomalies

1.1.5 The magnetic survey method is highly sensitive to interference from surface and near-surface magnetic 'contaminants'. Surface features such as metallic fencing, reinforced concrete, buildings or walls all have very strong magnetic signatures that can dominate readings collected adjacent to them. Identification of anomalies caused by sub-surface features is therefore more difficult, or even impossible, in the vicinity of surface magnetic features. The presence of made ground also has a detrimental effect on the magnetic data quality as this usually contains magnetic material in the form of metallic scrap and brick. Identification of features beneath made ground is still possible if the target feature is reasonably large and has a strong magnetic response but smaller features or magnetically weak features are unlikely to be identified.

1.1.6 The interpretation of magnetic anomalies is often subjective and it is rarely possible to identify the cause of all magnetic anomalies. Not all features will produce a measurable magnetic response and the effectiveness of a magnetic survey is also dependant on the site-specific conditions. The main factors that may limit whether a feature can be detected are the

composition of a feature, its depth and size and the surrounding material. It is not possible to guarantee that a magnetic survey will identify all sub-surface features.

1.1.7 Most high resolution, near surface magnetic surveys utilise a magnetic gradiometer. A gradiometer is a hand-held instrument that consists of two magnetic sensors, one positioned directly above the other, which allows measurement of the magnetic gradient component of the magnetic field. A gradiometer configuration eliminates the need for applying corrections due to natural variations in the overall field strength that occur during the course of a day but it only measures relative variations in the local magnetic field and so comparison of absolute values between sites is not possible.

1.1.8 Features that are commonly located using magnetic surveys include archaeological ditches and pits, buried structures or foundations, mineshafts, unexploded ordnance, metallic pipes and cables, buried piles and pile caps. The technique can also be used for geological mapping; particularly the location of igneous intrusions.

1.2 Instrumentation

1.2.1 A multi-sensor array cart system (MACS) utilising 8 Foerster 4.032 Ferex CON 650 gradiometers, spaced at 0.5 m intervals, with a control unit and data logger was used for the magnetic survey.

1.3 Survey methodology

1.3.1 The MACS utilises an RTK GNSS system which means that survey grids do not have to be established. Instead an area is surveyed over a series of continuous profiles and the position of each data point is recorded using an RTK GNSS system. The sensors have a separation of 0.5 m which means that data was collected on profiles spaced at 0.5 m apart. Readings were taken at between 0.1 m and 0.15 m intervals.

1.3.2 Data is collected on zig-zag profiles along the full length or width of a field, although fields can be sub-divided if they are particularly large. Marker canes are set-out along field boundaries at set intervals and these are used to align the profiles. The survey profiles are usually offset from field boundaries, buildings and other metallic features by several metres to reduce the detrimental effect that these surface magnetic features have on the data. The location of the MACS data is converted direct to Ordnance Survey co-ordinates using the UK **OSTN15** projection. As the data is related direct to Ordnance Survey National Grid co-ordinates temporary survey stations are not established.

1.3.3 The Foerster gradiometers have a resolution of 0.2 nT but the stability of the cart system significantly reduces noise caused by instrument tilt and movement when compared with a traditional hand-held gradiometer system and the increased data intervals provide a higher resolution data set. The sensors have a range of ± 10,000nT and readings are taken at 0.1 nT resolution.

1.4 Data processing and presentation

1.4.1 The MACS data is stored direct to a laptop using in-house software which automatically corrects for instrument drift and calculates a mean value for each profile. A positional value is assigned to each data point based on the sensor number and recorded GNSS co-ordinates. The data is gridded using in-house software and parameters are set based on the sensor spacing and mean values. No additional processing is required. The gridded data is then displayed in Surfer 9 (Golden Software) and image files of the data are created.

1.4.2 The data is relatively 'noisy' and so greyscale plots of the data have been shown at two ranges; a range of -2 nT to 3 nT, which is 'standard' for archaeological surveys and a relatively wide (for archaeological surveys) range of -5 to 5 nT. The latter smooths out the data and can make it easier to identify some anomalies but very weak responses may not be visible in the wider range. The data was exported as raster images (PNG files). A greyscale plot is presented at a clip of -2 nT to 3 nT in drawing ARC_3362_1292_02, at a clip of -5 nT to 5 nT in drawing ARC_3362_1292_03, with an accompanying interpretation in drawing ARC_3362_1292_04 (all at a scale 1:1250). Greyscale plots have been 'smoothed' using a visual interpolation but the data itself has not been interpolated. The two different ranges that the data has been displayed at show that the magnetic disturbance, although present across the majority if the site, is less noticeable in the wider range (-5 nT to 5 nT). This indicates that much of the magnetic disturbance is probably caused by relatively small surface / near surface material.

1.4.3 The data has been displayed relative to a digital Ordnance Survey base plan provided by the client as drawing '*Promap -2112307-2215392-720-0.dwg'*. The base plan was in the Ordnance Survey National Grid co-ordinate system and as the survey grids / data were referenced directly to National Grid co-ordinates the data could be simply superimposed onto the base plan in the correct position.

1.5 Interpretation

1.5.1 The anomalies have been categorised based on the type of response that they have and an interpretation as to the cause(s) or possible cause(s) of each anomaly type is also provided. The following anomaly types may be present within the data:

Dipolar, bipolar and strong responses

Dipolar and bipolar responses are those that have a sharp variation between strongly positive and negative components.

In the majority of cases these responses are usually caused by modern ferrous features / objects, although fired material (such as brick), some ferrous or industrial archaeological features and strongly magnetic gravel could also produce dipolar and bipolar responses.

Isolated dipolar responses are those that have a single positive and negative element. They are usually caused by isolated, ferrous or fired material on or near to the surface. The objects that cause dipolar responses are usually relatively small, such as spent shotgun cartridges, iron nails and horseshoes (hence they are often referred to as 'iron spikes') or pieces of modern brick or pot. Some types of archaeological artefacts can also produce this type of response but unless there is strong supporting evidence to the contrary they are assumed not to be of archaeological significance.

Bipolar anomalies have strong positive and negative components but are not technically magnetic dipoles. The majority of **isolated bipolar responses** are caused by ferrous or fired material on or near to the surface. These responses tend to be produced from larger objects, compared to dipolar anomalies, or a concentration of smaller objects. Some archaeological features/ activity, including areas of burning or industrial activity can also produce this type of response but unless there is strong supporting evidence to the contrary they are assumed not to be of archaeological significance.

Smaller isolated dipolar and bipolar responses have not been shown on the interpretation as there is no evidence to suggest that they are related to archaeological activity. Several larger isolated bipolar responses have been shown as these could be associated with more

significant sub-surface features or material (although in this instance they are not thought to be of archaeological interest).

Bipolar linear anomalies are usually produced by metallic buried pipes / cables, although some ceramic pipes or features containing fired material, such as brick structures or foundations, can also produce bipolar anomalies. In some instances the anomaly can extend for a significant distance beyond the feature that produces the anomaly. Bipolar anomalies are often very strong and can potentially mask responses from other sub-surface features in the vicinity of the underlying feature.

Areas containing numerous **strong dipolar / bipolar responses** (**magnetic disturbance)** are usually caused by greater concentrations of ferrous or fired material and are often found adjacent to field boundaries where such material tends to accumulate. Above ground metallic or strongly magnetic features, such as fences, gates, pylons and buildings can also produce very strong bipolar responses. If an area of magnetic disturbance is located away from existing field boundaries then it could indicate a former field boundary, several large isolated objects in close proximity, an area where modern material has been tipped or an infilled cut feature, such as a quarry pit. Areas of dipolar / bipolar response can occasionally be caused by features / material associated with archaeological industrial activity or natural deposits that have varying magnetic properties but they are usually caused by modern activity. Responses in areas of magnetic disturbance can sometimes be so strong that archaeological features located beneath them may not be detected.

Very strong responses, notably bipolar anomalies, from modern features can dominate the data for a significant distance beyond the feature. The extent of these areas is usually shown either as part of the bipolar anomaly or as a **limit of very strong response.** It should be noted that this effect extends beyond the feature and so the limit of the response does not correspond to the actual size or location of the feature within it. In many cases where these strong responses are present at the edge of survey area the feature causing the anomaly be actually be located beyond the survey area. It should be recognised that other sub-surface features located within these areas may not be detected.

Negative linear / curvi-linear anomalies

Negative linear / curvi-linear anomalies occur when a feature has lower magnetic readings than the surrounding material and can often be associated with ploughing regimes or plastic / concrete pipes or natural features.

They can also indicate the presence of a feature that cuts into magnetic soils or bedrock and which is infilled with less magnetic material and in certain geologies can be associated with archaeological features.

Any negative linear anomalies in this data set are thought to relate to agricultural or other relatively modern activity.

Linear / curvi-linear anomalies (probable agricultural)

In many geological / pedological conditions agricultural features / regimes can produce magnetic anomalies due to the accumulation / alignment of magnetic topsoil. In most cases these are exhibited as a series of **broadly parallel positive linear** anomalies. The majority of these responses are associated with modern ploughing regimes but in some instances, where the responses are broader and more widely spaced, they can indicate the presence of the remnants of ridge and furrow.

Field drain systems can also produce linear anomalies, usually where the drains are made from fired ceramic or infilled with magnetic gravels.

Where a series of parallel anomalies are present then the approximate orientation of the anomalies are shown on the interpretation drawing to indicate the direction of the agricultural regime but for the sake of clarity individual anomalies have not been shown.

Individual anomalies may be shown if the response is not part of a regime.

There are no anomalies suggestive / indicative of agricultural activity / features in this data set.

Broad area of positive / negative responses

Broad areas of positive / negative responses can have a variety of causes. If the areas are generally quite large and irregular in shape then they are usually suggestive of natural features, such as lenses of sand and gravel deposits, palaeochannels or other natural features / variations where the natural material differs from the surrounding sub-surface. In some instances anomalies of this type can be associated with anthropogenic (usually modern) activity.

There are no anomalies of this type in this data set.

Linear / curvi-linear trends

An anomaly is categorised as a **trend** if it is not certain that the response is associated with an extant sub-surface feature. Trends are usually weak, irregular, diffuse or discontinuous and it is usually not certain what their cause is, if they represent significant sub-surface features or even if they are associated with definite features.

It is possible that some of the trends are associated with geological / pedological variations. Others may be produced by artificial constructs within the data, either caused by processing or in some instances by intersecting anomalies (usually different agricultural regimes) that give the appearance of curving or regular shapes. Many trends are a product of weak, naturally occurring responses that happen to form a regular pattern but which are not associated with a sub-surface feature.

In some instances former features that have been severely truncated can still produce broad, diffuse or weak responses even if the underlying feature has been removed. This is due to the presence of magnetic soils associated with the former feature still being present along its route. In other instances the magnetic properties of the soils filling a feature may vary and so the magnetic signature of the feature can change, even if the sub-surface feature itself remains uniform. If a response from a feature becomes significantly weak or diffuse then part of the anomaly may be shown as a trend as it is uncertain if the feature is still present or has been severely truncated or removed.

Isolated positive responses

Isolated positive responses can occur if the magnetism of a feature, area or material has been enhanced or if a feature is naturally more magnetic than the surrounding material. It is often difficult to determine which of these factors causes any given responses and so the origin of this type of anomaly can be difficult to determine. They can have a variety of causes including geological variations, infilled archaeological features, areas of burning (including hearths), industrial archaeological features, such as kilns, or deeper buried ferrous material and modern fired material.

The large number of isolated responses and lack of an obvious pattern to their distribution suggests that the majority of these anomalies are probably associated with geological / pedological variations or deeper buried ferrous or fired material. Only the larger or stronger areas of positive response have been shown on the interpretation. The majority, if not all of these responses, will be related to natural variations or relatively modern material but have been shown as their exact cause cannot be determined with certainty.

Positive linear / curvi-linear anomalies

Positive magnetic anomalies indicate an increase in magnetism and if the resulting anomaly is linear or curvi-linear then this can indicate the presence of a man-made feature. **Positive or enhanced linear / curvi-linear** anomalies can be associated with agricultural activity, drainage features but they can also be caused by ditches that are infilled with magnetically enhanced material and as such can indicate the presence of archaeological features. Some natural infilled features can also produce positive anomalies.

There are no significant positive linear anomalies in this data set.

1.5.2 Several different ranges of data were used in the interpretation to ensure that the maximum information possible is obtained from the data.

1.5.3 X-Y trace plots were examined for all of the data and overlain onto the greyscale plot to assist in the interpretation, primarily to help identify dipolar / bipolar responses that will probably be associated with surface / near-surface iron objects. X-Y trace plots have not been used in the report as they do not show any additional anomalies that are not visible in the greyscale data. A digital drawing showing the X-Y trace plot overlain on the greyscale plot has been provided in the digital archive.

1.5.4 All isolated responses have been assessed using a combination of greyscale and X-Y trace plots.

1.5.5 The greyscale plots and the accompanying interpretations of the anomalies identified in the magnetic data are presented as 2D AutoCAD drawings. The interpretation is made based on the type, size, strength and morphology of the anomalies, coupled with the available information on the site conditions. Each type of anomaly is displayed in separate, easily identifiable layers annotated as appropriate.

1.6 Limitations of magnetic surveys

1.6.1 The magnetic survey method requires the operator to walk over the site at a constant walking pace whilst holding the instrument. The presence of an uneven ground surface, dense, high or mature vegetation or surface obstructions may mean that some areas cannot be surveyed.

1.6.2 The depth at which features can be detected will vary depending on their composition, size, the surrounding material and the type of magnetometer used for the survey. In good conditions large, magnetic targets, such as buried drums or tanks can be located at depths of more than 4 m. Smaller targets, such as buried foundations or archaeological features can be located at depths of between 1 m and 2 m.

1.6.3 A magnetic survey is highly sensitive to interference from surface and near-surface magnetic ‘contaminants’. Surface features such as metallic fencing, reinforced concrete, buildings or walls all have very strong magnetic signatures that can dominate readings collected adjacent to them. Identification of anomalies caused by sub-surface features is therefore more difficult or even not possible in the vicinity of surface and near-surface magnetic features.

1.6.4 The presence of made ground also has a detrimental effect on the magnetic data quality as this usually contains magnetic material in the form of metallic scrap and brick. Identification of features beneath made ground is still possible if the target feature is reasonably large and has a strong magnetic response but smaller features or magnetically weak features are unlikely to be identified.

1.6.5 It should be noted that anomalies that are interpreted as modern in origin may be caused by features that are present in the topsoil or upper layers of the subsoil. Removal of soil to an archaeological or natural layer can therefore remove the feature causing the anomaly.

1.6.6 A magnetic survey does not directly locate sub-surface features - it identifies variations or anomalies in the local magnetic field caused by features. It can be possible to interpret the cause of anomalies based on the size, shape and strength of response but it should be recognised that a magnetic survey produces a plan of magnetic variations and not a plan of all sub-surface features. Interpretation of the anomalies is often subjective and it is rarely possible to identify the cause of all magnetic anomalies. Geological or pedological (soil) variations or features can produce responses similar to those caused by man-made (anthropogenic) features.

1.6.7 Anomalies identified by a magnetic survey are located in plan. It is not usually possible to obtain reliable depth information on the features that cause the anomalies.

1.6.8 Not all features will produce a measurable magnetic response and the effectiveness of a magnetic survey is also dependant on the site-specific conditions. It is not possible to guarantee that a magnetic survey will identify all sub-surface features. A magnetic survey is often most-effective at identifying sub-surface features when used in conjunction with other complementary geophysical techniques.