NAA

GEOPHYSICAL SURVEY

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PEEL PLACE

HOLMROOK

CUMBRIA

prepared for

Tendley Quarries Ltd

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PEEL PLACE, HOLMROOK, CUMBRIA
GEOPHYSICAL SURVEY REPORT

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Disclaimer

The results of geophysical survey may not reveal all potential archaeology and do not provide a comprehensive map of the sub-surface, but only responses relative to the environment. Geological, agricultural and modern responses may mask archaeological features. Short-lived features may not give strong responses. Only clear features have been interpreted and discussed in this report.

PEEL PLACE, HOLMROOK, CUMBRIA
GEOPHYSICAL SURVEY REPORT

Summary

Northern Archaeological Associates Ltd was commissioned by Tendley Quarries Ltd to undertake a geophysical survey of land to the west of Peel Place Quarry, Holmrook, Cumbria (NGR: NY 06752 01152). The survey was required to assess the archaeological potential of the site in support of a planning application for an extension to the quarry.

The survey was carried out on 21 February 2018 and covered an area of approximately 1.2 hectares of farmland, which is currently being used as pasture.

Anomalies identified within the survey area are largely likely to relate to either modern or agricultural activity. Several linear anomalies were identified, but weak increases in magnetic response and incomplete patterning resulted in a tentative interpretation. Consequently, it is uncertain if they are of an agricultural, modern, geological or archaeological nature. There were also several amorphous positive responses and weak and diffuse trends of an uncertain origin.

Two alignments of regularly spaced linear anomalies were identified that are potentially indicative of agricultural practices. One weakly enhanced linear anomaly corresponds with the location of a former field boundary recorded on 19th-century historic maps of the site. There are also two informal concentrations of magnetic disturbance. Their positioning may be suggestive that they are in part caused by a build up of magnetically susceptible debris or material along the edges of former field boundaries.

Further magnetic disturbances occurred around the perimeter of the survey area and are considered to be modern in nature and caused by above ground features, such as the metal fencing used as field boundaries.

1.0 INTRODUCTION

1.1 Northern Archaeological Associates Ltd (NAA) was commissioned by Tendley Quarries Ltdto undertake a geophysical survey at Peel Place, Holmrook, Cumbia (NGR: NY 06752 01152).The survey was required to assess the archaeological potential of the site in support of a planning application for an extension to the quarry. The survey was carried out on 21st February and covered an area of approximately 1.2 hectares of agricultural land being used as pasture.

2.0 LOCATION, TOPOGRAPHY AND GEOLOGY

Location

2.1 The proposed development area (PDA) was located to the west of the quarry at Peel Place, which is approximately 0.3km to the east of the village of Hallsenna, 1.96km to the north-west of Holmrook, and 2.46km to the south-west of Gosforth in the west of Cumbria (Fig. 1). The area targeted with geophysical survey was bordered by agricultural land to the west; and Peel Place Quarry to the east.

Geology and soils

2.2 The solid geology of the survey area consists of sandstone of the Wilmslow Sandstone Formation with superficial deposits of Devensian till consisting of sand and gravel (BGS 2017). The soils are mapped as Ellerbeck Association (Soil Survey of England and Wales 1983), which are primarily comprised of free draining soils that are developed on stony glaciofluvial or river terrace drift (Jarvis *et al*. 1984, 145).

Topography and land-use

2.3 The topography of the survey area softly undulated. Generally the north of the site lay at 42m above Ordnance Datum (aOD), whilst the south of the site was at 40m aOD.

3.0 ARCHAEOLOGICAL AND HISTORICAL BACKGROUND

3.1 The following section summarises the Archaeological Review Report completed by Oxford Archaeology North in 2014.

3.2 No activity dating to the prehistoric or Roman periods has been identified within the PDA. Evidence in the wider vicinity of the site is also fairly sparse and limited to isolated find spots of flint, and a Roman coin. The village of Hallsenna, which is located to the west of the PDA, has medieval origins. Numerous medieval field

systems have been recorded surrounding Hallsenna, and are likely to extend into the PDA. A spot find of a medieval stone cross has been also discovered in the PDA's local environ.

3.3 Lancaster University Archaeology Unit and Oxford Archaeology North have completed numerous archaeological investigations in areas surrounding the current PDA, including desk-based assessments, geophysical survey, field walking and trial trenching. None of these investigations have identified any features of archaeological significance.

3.4 OS Maps from the mid-19th century show that the PDA is located within an agricultural landscape to the east of the small village of Hallsenna. The 1867 OS map depicts the former composition for the western part of the site. The present south-western and part of the north-western field boundaries are not present on the 1867 OS Map; instead, the PDA is shown to cover three fields, two of which extend beyond the limits of the present study. The 1900 OS Map shows only one alteration to the layout of the site from the 1867 OS Map, which comprised the removal a field boundary running through the centre of the PDA (National Library of Scotland 2018).

4.0 AIMS AND OBJECTIVES

4.1 The aim of the survey was:

- To attempt to characterise the nature of any sub-surface remains within the survey boundary and to identify possible concentrations of past activity in order to inform the requirement for any archaeological mitigation work at the site; and

- To produce a report including XY-trace plots, raw and processed greyscale images of the survey areas, and interpretations of these results.

5.0 METHODOLOGY

5.1 The geophysical survey was undertaken as a gradiometer survey using the Bartington Grad601-2 dual magnetic gradiometer system with data logger. The readings were recorded at a resolution of 0.01nT and data was collected with a traverse interval of 1m and a sample interval of 0.25m. All recorded survey data was collected with reference to a site survey grid comprised of individual 30m x 30m squares. The grid was established using Real Time Kinematic (RTK) differential GPS equipment and marked out using non-metallic survey markers. All grid nodes were set out with a

positional accuracy of at least 0.1m as per existing guidelines (English Heritage 2008; CIfA 2014) and could be relocated on the ground by a third party. The base lines used to create the survey grids are shown on Figure 2 and further details are available in Appendix A.

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

5.3 On the greyscale plot (Figs. 3 and 4, left), positive readings are shown as increasingly darker areas and negative readings are shown as increasingly lighter areas. The XY-trace plot demonstrates the readings as offsets from a central line (Fig. 3, right). The interpreted data uses colour coding to highlight specific readings in the survey area (Fig. 4, right). In this report, the word anomaly is used to refer to any outstanding high or low readings forming a particular shape or covering a specific area. Appendix C details the terminology and characterisation of anomalies used for interpreting data.

Surface conditions and other mitigating factors

5.4 The survey area comprised one field that was bounded by hedgerow and metal fencing. Metal gates were used for access into the site and were located at the northern, north-western, and southern corners of the field. It was necessary to avoid all metal objects to ensure that magnetic responses did not impinge on the survey results and mask potential buried features.

6.0 RESULTS (Fig. 4)

6.1 Linear anomalies identified within the dataset are generally composed of weak increases in magnetic values and incomplete patterning. Consequently, their exact origin is unknown, and it is difficult to ascertain whether they are of an archaeological nature, or instead denote either agricultural activity, or belong to geological or pedological transformations. **A1** has the most coherent form. Although there are differences in patterning and response strength, it is possible **A1** and **A2** are caused by the same linear feature. **B** is composed of a series of linear anomalies with the same alignment that runs parallel to **A**. The relationship between **A** and **B** is unclear, but it is possible they belong to the same rectilinear feature. A further linear anomaly is located to the north-east of **A** and **B**, and appears on a west-northwest to east-southeast orientation (**C**).

6.2 There are numerous weak isolated anomalies with an amorphous form across the survey area. Those with a coherent pattern or broader form have been identified within the interpretation, but a very tentative interpretation applies and their origin is currently unknown.

6.3 A weak negative linear anomaly was identified within the survey area that corresponds with the location of a field boundary that was first recorded on the 1867 OS Map and which is visible on 1m LiDAR survey coverage of the area (**D**).

6.4 There are several weak and diffuse linear trends. These failed to produce the necessary patterning or increases in magnetic response in order to be interpreted fully. As a result, their origin is currently unknown.

6.5 There are a series of regularly spaced linear anomalies running on a north-northeast to south-southwest alignment that are likely to be indicative of agricultural activity. The fairly narrow spacing of these anomalies is often considered to be indicative of modern ploughing; however, given modern land uses of the field as pasture, it is possible that these anomalies relate to earlier agricultural practices instead, such as ridge and furrow.

6.6 In the south of the survey area there are numerous broadly spaced linear anomalies on a west-southwest to east-northeast alignment that have been depicted as 'agriculture?'. These anomalies appear to be composed of weak increases in magnetic response and, in part, have fairly broad forms. Although their exact origin is unknown, a series of consistently spaced anomalies is generally considered to be caused by agricultural activity. Therefore, it is possible that they either depict plough, ridge and furrow or land drains. It is also possible that the occasional broad response of these anomalies is in part indicative of buried geological or pedological changes within the substrata.

6.7 An amorphous isolated bipolar response was identified to the north-west of the site (**E**) that is considered to be modern and caused by highly magnetic material, such as a ferrous object. Given its location, it is likely that **E** was caused by a metallic gate providing access into a field to the west of the survey area.

6.8 Areas of increased magnetic response have been used to highlight concentrations of dipolar anomalies. Often such concentrations as these are considered to be caused by modern magnetic debris in the topsoil or near the surface of the site. However,

historic maps have suggested that two field boundaries formerly ran parallel on a west-northwest to east-southeast alignment through the south-west of the field. Consequently, given the form and positioning of the concentrations of dipolar anomalies, it is possible that they in part relate to magnetic material and debris that has collected along the edges of the former field boundaries (**F** and **G**).

6.9 Strong responses caused by above ground features external to the survey area, such as metal fencing, have been characterised as external interference.

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

7.0 CONCLUSIONS

7.1 Anomalies detected through the geophysical survey are generally considered to be of an agricultural or modern nature.

7.2 Several linear anomalies were identified that lack the necessary patterning to be conclusively characterised. Therefore, although they may be indicative of infilled buried features caused by human activity, it is equally plausible that they instead are of an agricultural, geological or pedological nature.

7.3 There are also numerous amorphous positive responses and weak and diffuse trends across the survey area that are of an unknown origin.

7.4 The survey has identified evidence of potential agricultural activity in the form of regularly spaced linear anomalies; as well as possible evidence of the former field boundaries recorded on 19th-century OS Maps.

7.5 Modern disturbance is evident within the site and defined as either isolated or concentrations of dipolar or bipolar anomalies, and likely to be caused by ferrous material within the topsoil of the site or above ground feature external to the site.

8.0 STORAGE AND CURATION

8.1 The records of the geophysical survey are currently held by NAA. All material will be appropriately packaged for long-term storage in accordance with national guidelines

(English Heritage 2008; CIfA 2014). An online OASIS form will be completed on the results of the works within three months of the completion of the project under the reference number northern1-310810. This will include submission of a pdf version of the final report to the Archaeology Data Service via the OASIS form.

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APPENDIX A

TECHNICAL INFORMATION

GRADIOMETER SURVEY

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

LIMITATIONS

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

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

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

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

INSTRUMENTATION

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

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

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

SURVEY DETAILS

Table 1: Survey summary

Item	**Detail**
grid size	30mx30m
traverse interval	1m
reading interval	0.25m
direction of 1st traverse	North-west
number of Grids	22
area covered	1.2ha

Table 2: Baseline co-ordinates (baseline shown on Figure 2)

Grid point (gp) A	**Grid point (gp) B**
NGR: 306530.2740 501174.2243	NGR: 306516.8411 501147.3998

Table 3: Site information and conditions

Item	**Detail**
geology	Wilmslow Sandstone Formation
superficial deposits	Devensian sand and gravel of Glaciofluvial Deposits
soils	Ellerbeck Association
topography	Approximately 40 – 42m aOD
land use	Pasture
weather / conditions prior to and during survey	Sunny

APPENDIX B

DATA PROCESSING INFORMATION

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

Table 4: Commonly applied processes

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

Table 5: Processing steps

Minimal Processing	**Increased Processing**
• zero Mean Traverse +5/-5 • destagger: - All: 2	• low Pass Filter • interpolate Y, Expand - Linear ,x2

APPENDIX C

DATA VISUALISATION INFORMATION

FIGURES

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

- Greyscale/Colourscale Plot: This visualised the results as a shaded drawing with highest readings showing as black, running through different shades to lowest showing as white.

- XY-trace Plot: This creates a line drawing showing the peaks and troughs of the readings as vertical offset from a centreline.

- Interpreted Plot: Through detailed analysis anomalies have been interpreted and possible features identified. Interpretation drawings are used to show potential features and in particular to re enforce and clarify the written interpretation of the data. Anomalies have been characterised using the terminology detailed in the following section, and have been assigned colour coding outlined in keys found on the relevant figures associated with this report.

MAGNETIC ANOMALIES AND TERMINOLOGY

Table 5: Lexicon of terminology

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

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

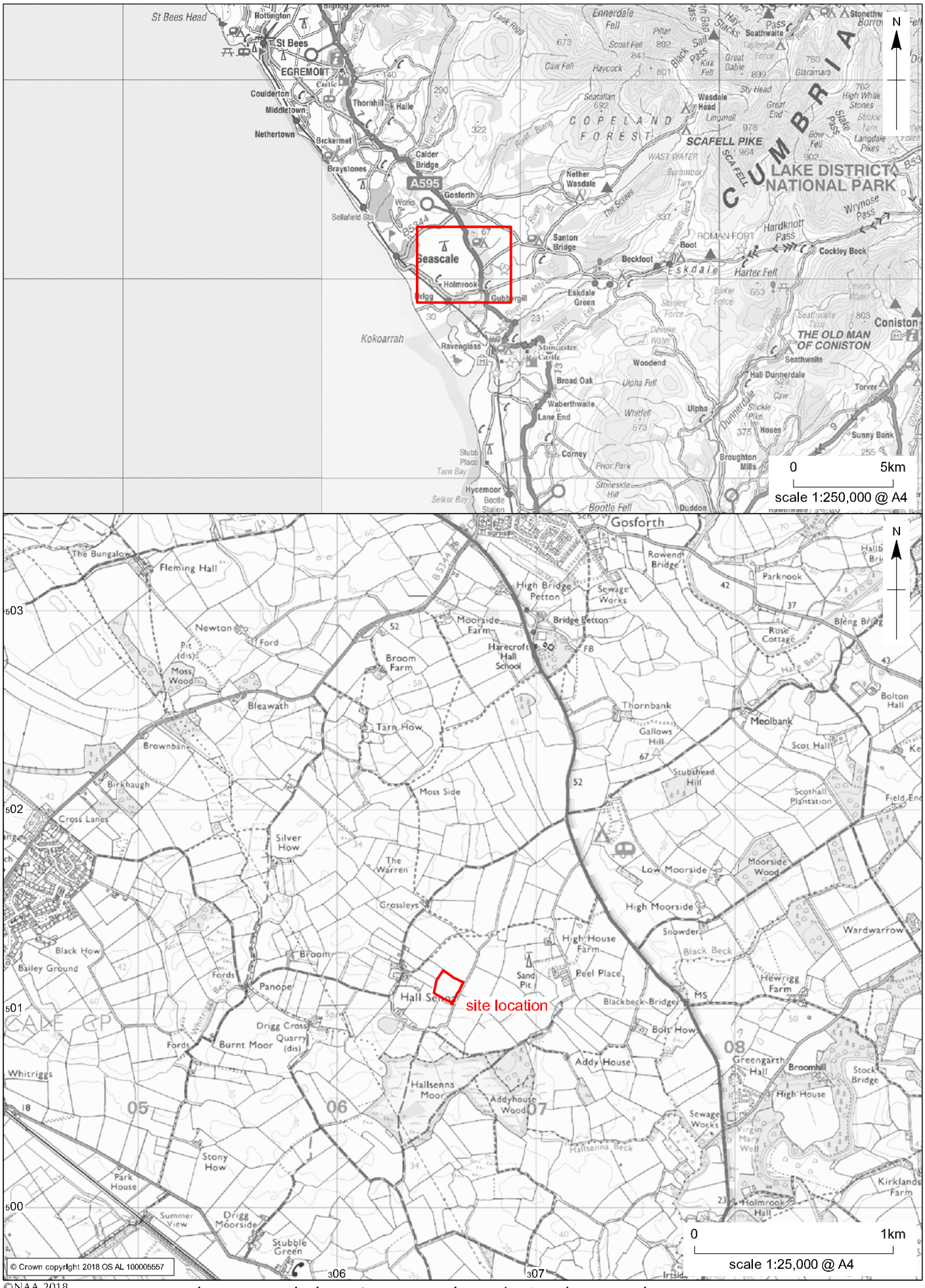
Anomalies interpreted with a 'greater' categorisation are considered more likely to be of the interpreted characterisation; whereas a more tentative interpretation is applied to those with a 'lesser' categorisation as a consequence of weaker increases in magnetic response or the anomalies incomplete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

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

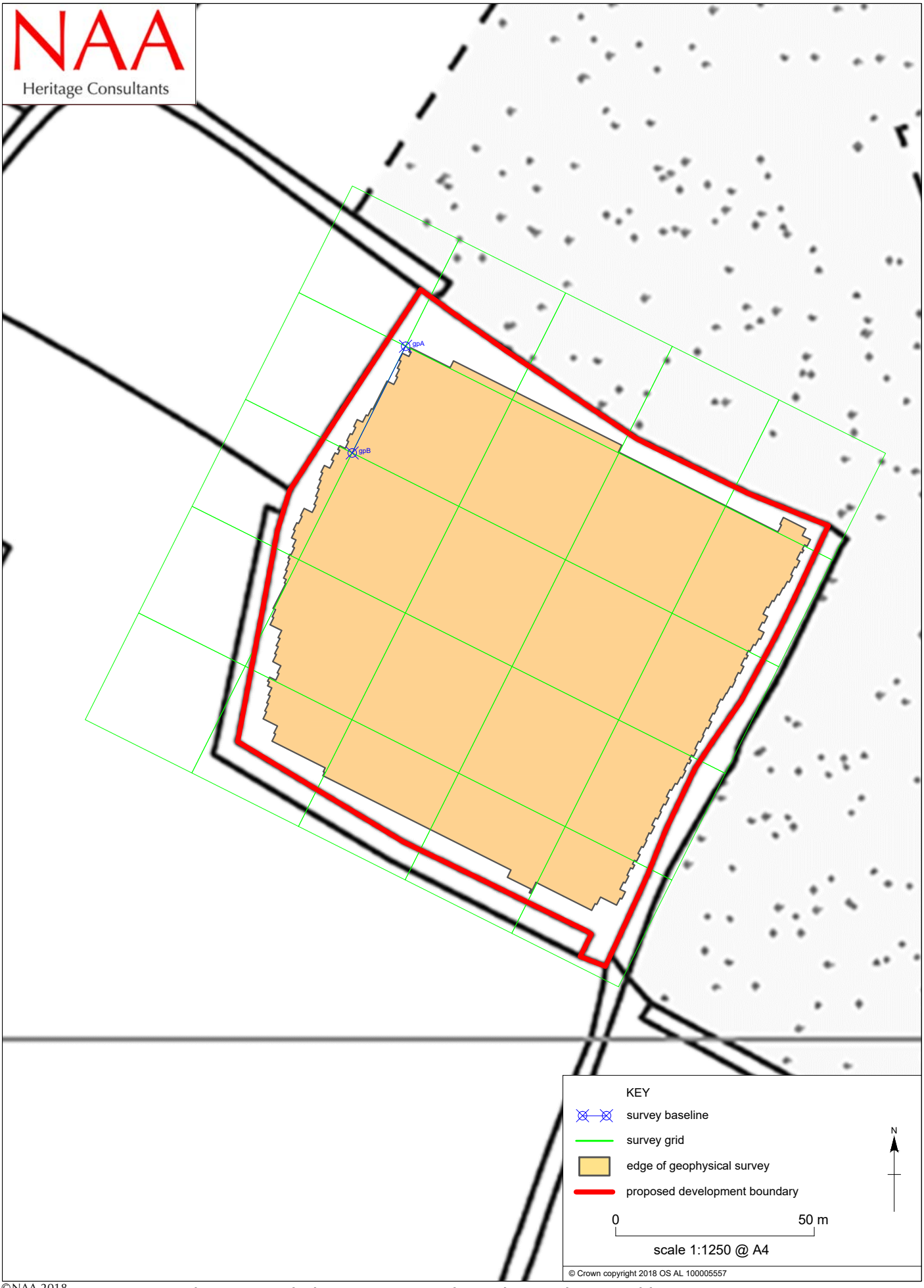
Table 6: Characterisation of anomalies

Characterisation	**Detail**
Archaeology	
linear anomaly (archaeology)	Linear anomalies with a positive or negative magnetic responses, and composed of a patterning or shape that is suggestive of a buried archaeological feature. These are often indicative of structural remains or infilled features such as ditches. The strength of anomaly signal can be suggestive of the properties of the feature. Negative linear anomalies represent upstanding or infilled features that are less magnetically susceptible than background readings, for example structures or ditches composed of a non-igneous stone material. Bipolar linear anomalies considered to be of an archaeological nature are indicative of material with a high magnetic susceptibility, such as a brick wall.
isolated anomaly (unknown)	Isolated anomalies or anomalies with a more amorphous form possibly represent infilled features or thermomagnetic features such as areas of heating/burning of an archaeological origin. Unless associated with conclusively identified archaeological remains, such as linear anomalies, absolute identification of positive responses can be problematic as it is often not possible to decipher if they are of an archaeological, modern or agricultural origin. Consequently isolated positive responses are not shown within the interpretation unless composed of a broad form or belonging to a series of isolated positive responses. Bipolar responses considered likely to be of an archaeological are also interpreted as isolated anomaly (archaeology). These are considered to relate to material with a very strong magnetic susceptibility or thermoremanent magnetisation.
trends	Weak and diffuse anomalies with an uncertain origin are denoted by trends. It is possible that these belong to archaeological features, but given their weak signatures or incomplete patterning it is equally plausible that they relate to agricultural features or natural soil formations.
Agriculture	
Agriculture	Regularly spaced linear anomalies that are likely to be of an agricultural nature. However the lack of supporting information, weak responses, or non-uniform distribution means that it is unclear as to the nature or origin

	of the agricultural process they are caused by.
Agriculture?	Weak, irregularly spaced or isolated linear anomalies that possibly relate to agricultural activity. Given the tentative interpretation, the agricultural process they are caused by is also likely to unknown.
Modern	
Bipolar response (modern)	Positive anomalies with associated negative 'halo' (bipolar) denote features with a strong magnetic response are likely to be of a modern origin. Isolated bipolar responses of a modern nature are likely to relate to buried ferrous material or objects, such as metallic agricultural debris. If a trend is noted in the alignment or spacing of isolated bipolar responses, it is possible that they are indicative of ferrous fittings or connectors used on buried non-magnetic buried utilities. Linear bipolar anomalies are likely to be indicative of modern services.
Dipolar response	Dipolar anomalies relate to individual spike within the data and tend to be caused by ferrous objects. These responses have only been shown when located near to archaeological features. When the site is located in a mining landscape it is possible that identified dipolar anomalies relate to mining activity and are indicative of further pits or mine shafts.
Area of increased magnetic response	Areas of increased magnetic response denote areas of disturbance containing a high concentration of dipolar and / or bipolar responses. These are generally considered to be caused by modern debris in the top soil, although it is possible that the disturbance is in part also caused by isolated archaeological material or geological or pedological changes in the substrata.
External interference	Areas of magnetic disturbance, often along the edges of survey areas are caused by standing metal structures such as fencing and buildings.



Phase 4, Peel Place Quarry, Holmrook, Cumbria: site location *Figure 1*



Phase 4, Peel Place Quarry, Holmrook, Cumbria: grid location *Figure 2*

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KEY
edge of geophysical survey
proposed development boundary

0 50 m
scale 1:1250 @ A4

N

5nT
-4nT
Pallette:grey55.ptt

XY scale
35 nT

Phase 4, Peel Place Quarry, Holmrook, Cumbria: unprocessed greyscale and XY-trace plots of gradiometer survey results

Figure 3

NAA
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0 50 m
scale 1:1250 @ A4

N

3nT
-2nT
Pallette:grey55.ptt

KEY

positive linear response (archaeology?) (greater / lesser)
positive response (unknown)
field boundary
trends
agriculture
agriculture?
bipolar response (modern)
area of increased magnetic response
external interference (e.g. fencing)
edge of geophysical survey
Proposed development area

E
C
D
B
G
A1
F
G
A2
G

Phase 4, Peel Place Quarry, Holmrook, Cumbria: processed greyscale plot and interpretation of gradiometer survey results

Figure 4