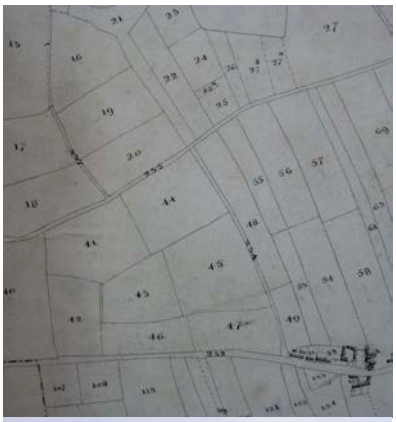
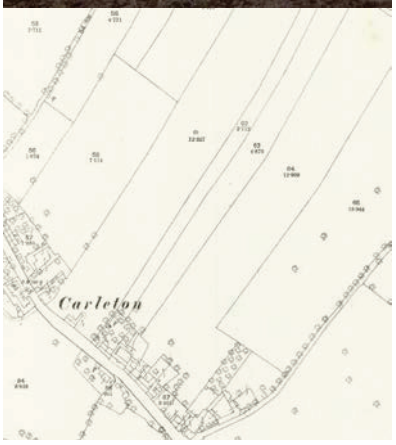
LAND OFF CARLETON ROAD (SPECKLED WOOD), CARLISLE, CUMBRIA

Archaeological Desk-Based Assessment and Geophysical Survey





Client: Persimmon Homes and Charles Church Lancashire

NGR. 342660 553175 (centre)

February 2020

Greenlane ARCHAEOLOGY

The Site	
Site Name	Land off Carleton Road (Speckled Wood), Carlisle
County	Cumbria
NGR	342660 553175 (centre)

Client	
Client Name	Persimmon Homes and Charles Church Lancashire

Planning	
Pre-planning?	Yes
Planning Application No.	N/A
Condition number	-
Summary of development proposals	Residential development
Local Planning Authority	Carlisle City Council
Planning Archaeologist	Jeremy Parsons, Historic Environment Officer, 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
Geophysical survey	Phase Site Investigations
Report writing	Dan Elsworth and Tom Mace
Report editing	Jo Dawson
Illustrations	Tom Mace
Date on site work carried out	4th December 2019 and 7th February 2020

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Summary

As part of pre-planning consultation for a proposed residential development on land off Carleton Road, (Speckled Wood), Carlisle, Cumbria, Greenlane Archaeology was commissioned to carry out a desk-based assessment and geophysical survey of the site. This is intended to identify whether there are any known archaeological remains within the site, and what the potential is for as yet unknown archaeological remains to be present. The project was carried out between December 2019 and February 2020.

The site is situated to the north-west of the village of Carleton and south of Harraby, and on the south-east edge of the urban area of the city of Carlisle. The Historic Environment Record for the area has records of sites of most periods within the study area, but in particular those of prehistoric and post-medieval date, with a number of sites of prehistoric date in the vicinity, including pits of apparently Neolithic date in the adjoining field to the north-east. It is close to the Roman city of Carlisle and Hadrian's Wall and there are a number of certain or probable Roman finds and sites from the immediate area around the site although these have typically seen little investigation. Carleton and Harraby are first recorded in the 12th and 13th centuries but with earlier origins likely, although there is some debate about this in the case of Carleton. Both settlements have names indicating an early medieval origin, and in the adjoining field to the north-east a small kiln dated to the 6th or 7th century AD was discovered during archaeological investigations. Carleton was closely connected to Carlisle Priory, which owned land in the area and whose successors continued to do so. It is likely that the area saw relatively little development until the post-medieval period, following the Dissolution and after the coming of the Newcastle-Carlisle railway, although a number of sites belonging to this period demonstrate the general industrialisation of the area.

The map regression shows that the site has comprised a single small field from at least 1847. The site visit identified few constraints to further archaeological work, although it is likely that there has been some disturbance from modern structures and services along the south-west boundary. The geophysical survey revealed various isolated dipolar anomalies and other areas of magnetic disturbance, probably resulting from modern activity, as well as evidence for former agricultural activity. A few linear anomalies were also identified, but there was nothing to suggest they were of archaeological interest.

In view of the archaeological evidence from the wider area, in particular the adjoining field, there is some potential for similar remains, particularly of prehistoric date, to be present within the proposed development area. This could only be ascertained through further archaeological investigation, such as archaeological evaluation.

Acknowledgements

Greenlane Archaeology would like to thanks Persimmon Homes and Charles Church Lancashire for commissioning and supporting the project, and in particular Katie Pearson for her assistance with providing access to the site. Further thanks are due to the staff of the Cumbria Archive Centre in Carlisle with their help in accessing their records.

1. Introduction

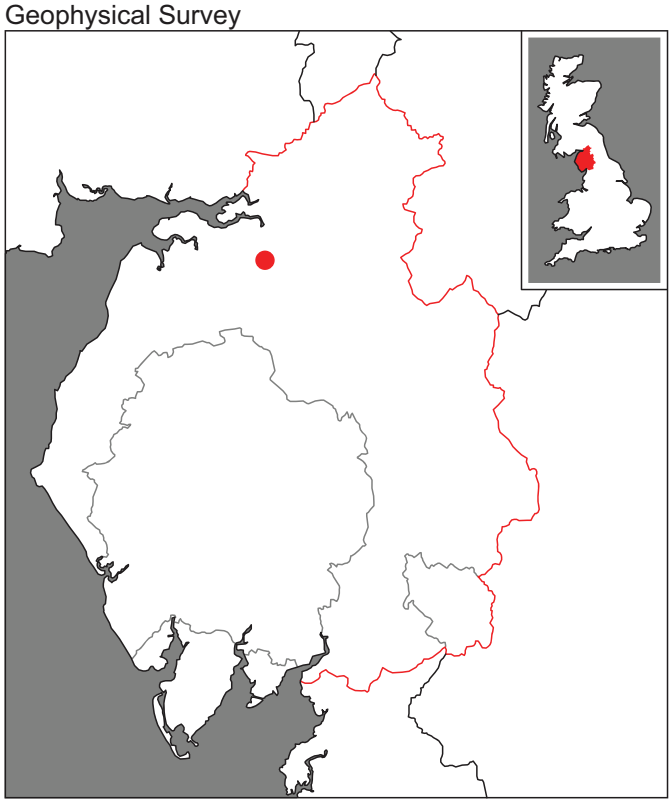
1.1 Circumstances of the Project

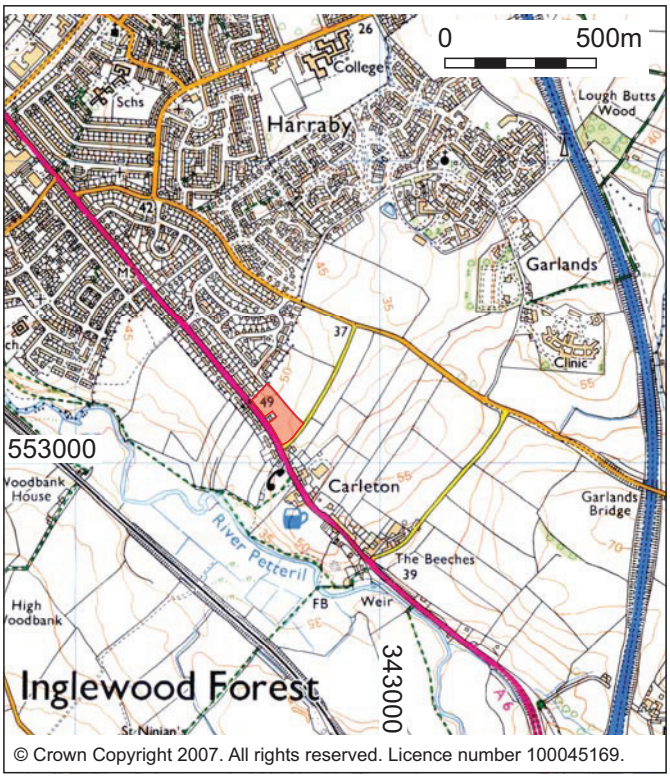
1.1.1 The circumstances of the project are set out in the tables on the inside cover of this report.

1.2 Location, Geology, and Topography

1.2.1 The site occupies an area of *c*1.47 hectares on the south-east edge of modern Carlisle at a height of between approximately 40m and 55m above sea level, with Harraby to the north, Carleton to the south, and Garlands to the north-east (Ordnance Survey 2007; Figure 1). It is to the north-east side of the A6 and bounded on the south-east side by a lane linking the A6 to Cumwhinton Road.

1.2.2 The landscape is situated within the Eden Valley, which is dominated by '*improved pasture bounded by mature hedgerows and dry stone walls*' and areas of arable cultivation (Countryside Commission 1998, 41). 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).





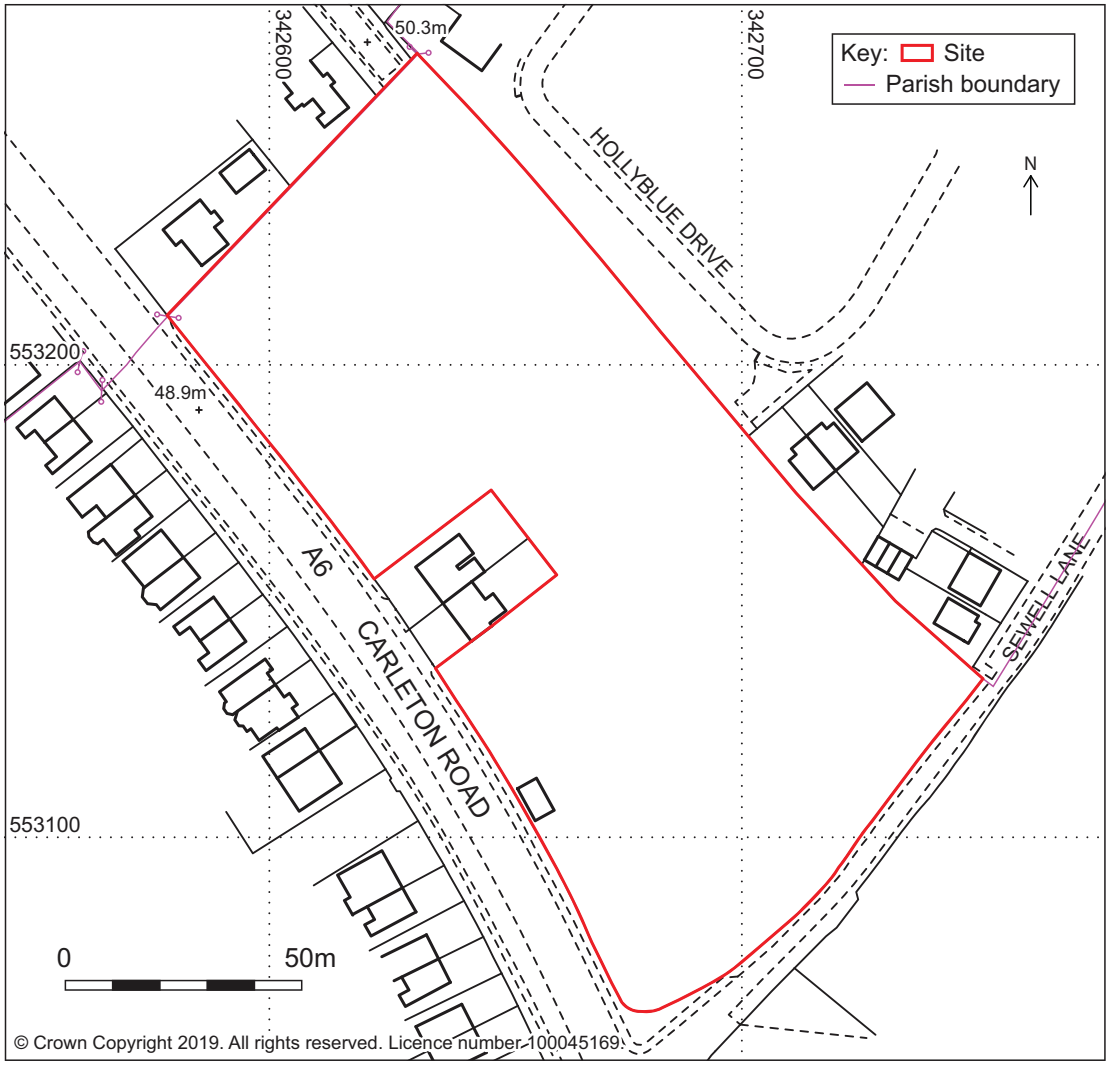


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Figure 1: Site location

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;
- ***Historic Environment Record (HER)***: the relevant HER, as detailed in the cover sheet, was visited in order to gather information about any known sites of archaeological interest within a study area of 500m from the centre of the site. Each site held in the HER is provided with a grid reference, description, and list of relevant sources;
- ***Online Resources***: where available, mapping such as Ordnance Survey 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; 2017), 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 Full details of the methodology used during the geophysical survey are presented in *Appendix 3*. A detailed magnetic survey was carried out using a multi-sensor array cart system (MACS) comprising 8 Foerster 4.032 Ferex CON 650 gradiometers with a control unit and data logger. The sensors have a separation of 0.5m which means that data was collected on profiles spaced at 0.5m apart. Readings were taken at between 0.1m and 0.15m intervals on the 100nT range (0.1nT sensitivity).

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.

3. Results

3.1 Introduction

3.1.1 A total of 16 sites of archaeological interest were identified within the study area during the desk-based assessment and site visit (Figure 2; summarised in Table 1 below) ranging from Bronze Age to post-medieval in date. All of these sites were previously recorded in the HER. None of these sites are located within the proposed development area. However, three of the sites (**Site 11**, **Site 1**, and **Site 10**, marked in red in Figure 2) are not accurately located, so their significance to the study area is uncertain. Indeed, **Site 11**, which is shown within the study area on the HER, relates to an object found at Plumpton, approximately 17.5km to the south and now held at Lowther Castle, so this evidently bears no relation to the proposed development site. 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). The possible trackway (**Site 7**) and earthworks (**Site 5**, **Site 13** and **Site 14**) are of unknown date, although **Site 7** is certainly pre-19th century and **Site 13** and **Site 14** might be Roman.

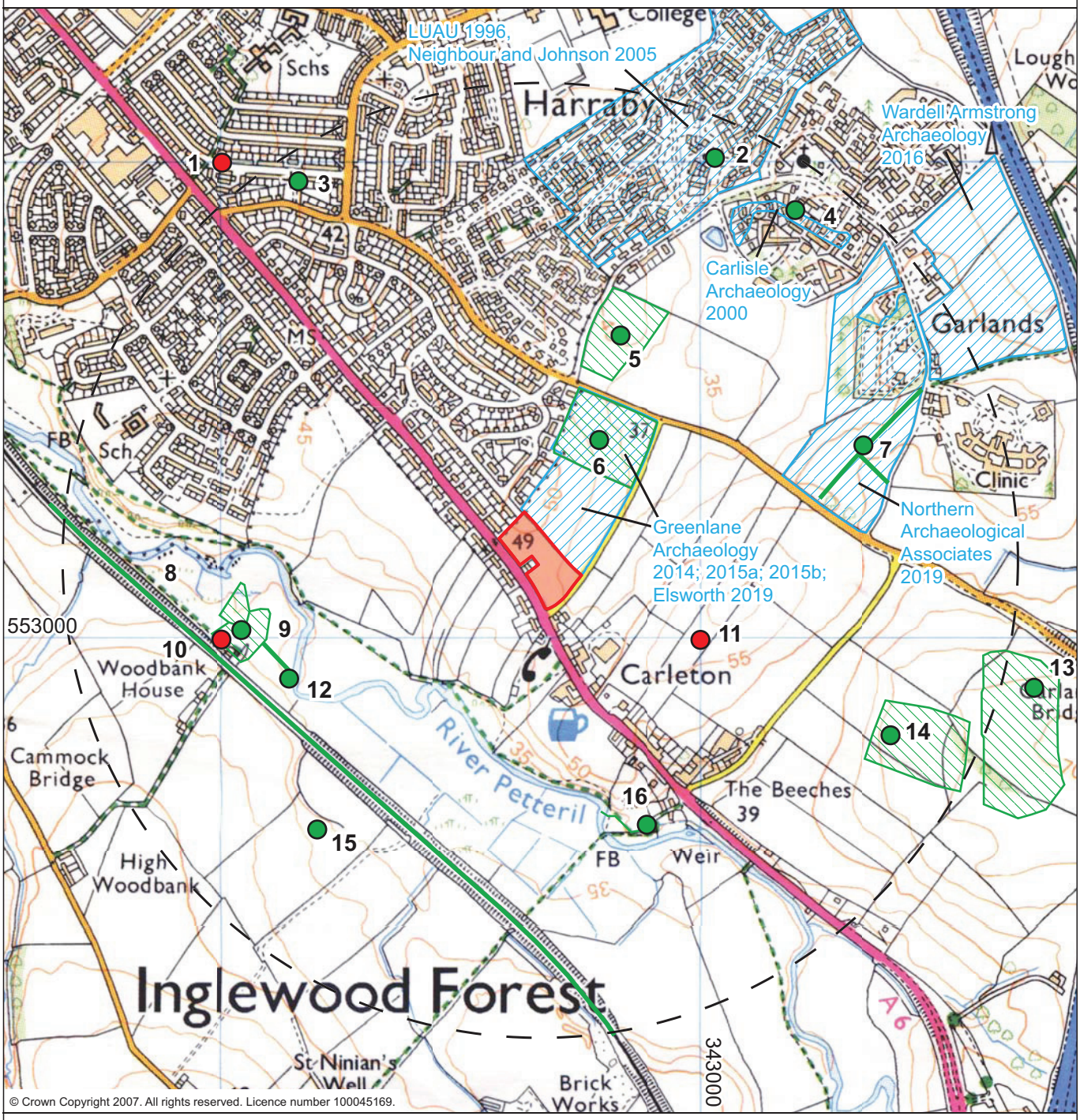
Site No.	Type	Period	Site No.	Type	Period
1	find spot	modern	**9**	earthwork/former ironworks	post-medieval
2	burnt mound	Bronze Age	**10**	find spot	post-medieval
3	church	post-medieval	**11**	find spot	Roman
4	cemetery	Bronze Age	**12**	weir	post-medieval
5	parch marks/earthworks/settlement?	Prehistoric – Romano-British	**13**	earthwork/enclosure	Prehistoric – Romano-British
6	parch marks/enclosure boundary	post-medieval	**14**	earthworks	Prehistoric – Romano-British
7	parch marks/trackway	unknown/pre-19th century	**15**	pillbox	post-medieval
8	railway	post-medieval	**16**	mill complex	post-medieval

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

3.2 Desk-Based Assessment

3.2.1 The results of the desk-based assessment have been used to produce two separate elements. Firstly, all sites of archaeological interest recorded within the study area were compiled into a gazetteer (*Appendix 1*). The gazetteer is used to assess the general type of historic landscape that makes up the study area, contribute to the compilation of the general history of the site (see *Section 4*) and, more importantly, identify sites that are likely to be affected by the proposed development. The significance of each of these sites and the degree to which they are likely to be affected is considered in *Section 5* and from this recommendations for further work have been produced.

3.2.2 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 (particularly for the presence of remains that are otherwise not recorded in the study area), but more importantly to present the documented details of any sites that are known (see *Section 4*).



Site Gazetteer

N

0 500m

When the exact location is not given the site is marked red

— Study area (500m radius)
Site ● Gazetteer site (exact location)
Area of previous archaeological work
Gazetteer site extent (if known)
● Gazetteer site (exact location unknown)

Figure 2: Gazetteer site plan

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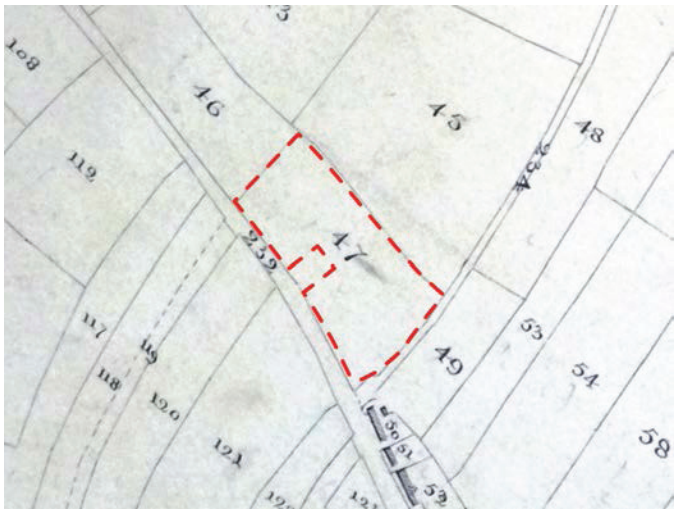
3.3 Map Regression

3.3.1 ***Tithe map for Carleton Township (CAC(C) DRC/8/43 1847)***: this is the earliest detailed map of the area, and it shows the site occupying a large field bounded by roads to the south-west and south-east sides and fields to the north-west and north-east (Plate 1). The proposed development area comprises the bulk of plot 47. The accompanying apportionment provides details of the owner and occupier as well as the name of the field and describes its state of agriculture, as outlined in Table 2 below.

Plot No.	Owner	Occupier	Name	Description
47	Jeremiah Cowper	Mary Fisher	Gooseland	Arable

Table 2: Details of the plots within the site as given in the tithe apportionment (CAC(C) DRC/8/43 1847)

3.3.2 ***Ordnance Survey 1867***: the site is unchanged (Plate 2; cf. Plate 1).



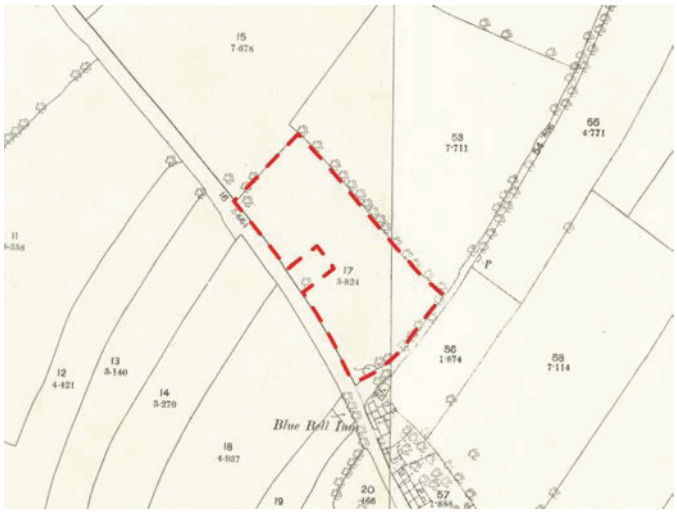
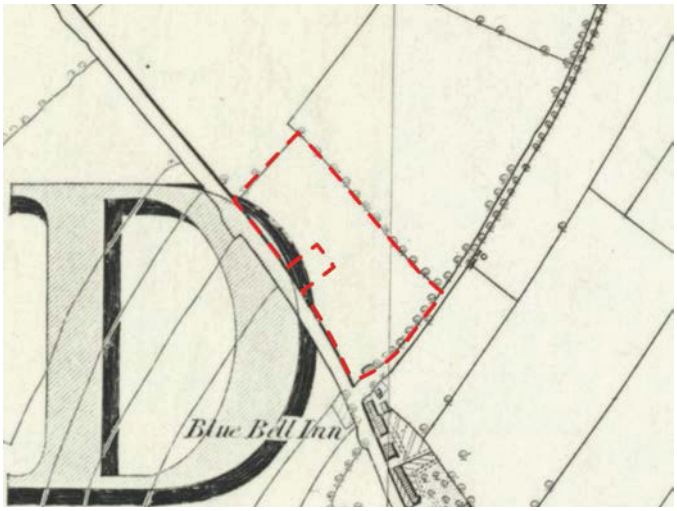


Plate 1 (left): Extract from the tithe map for Carleton township (CAC(C) DRC/8/43 1847)

Plate 2 (right): Extract from the Ordnance Survey map of 1867

3.3.3 ***Ordnance Survey 1868***: the site remains undeveloped (Plate 3).

3.3.4 ***Ordnance Survey 1901***: the site remains the same (Plate 4; cf. Plate 3).



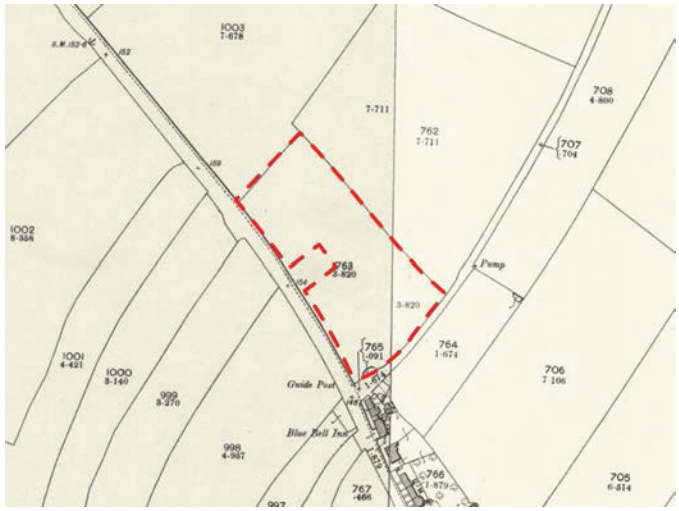


Plate 3 (left): Extract from the Ordnance Survey map of 1868

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

3.3.5 ***Ordnance Survey 1925***: there is no change at the site (Plate 5).

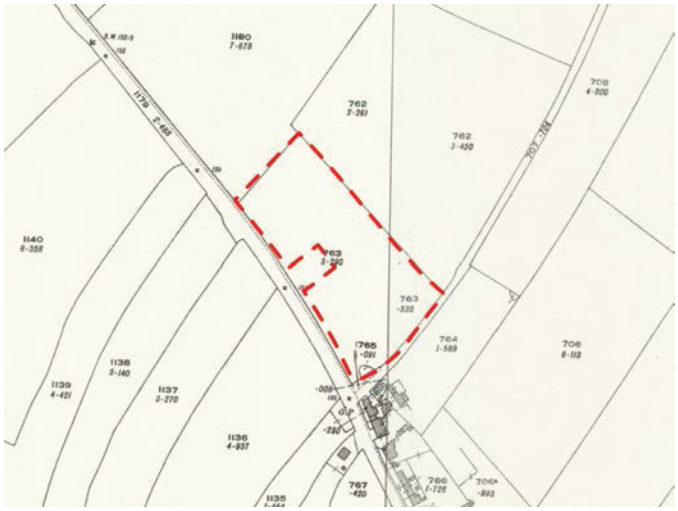
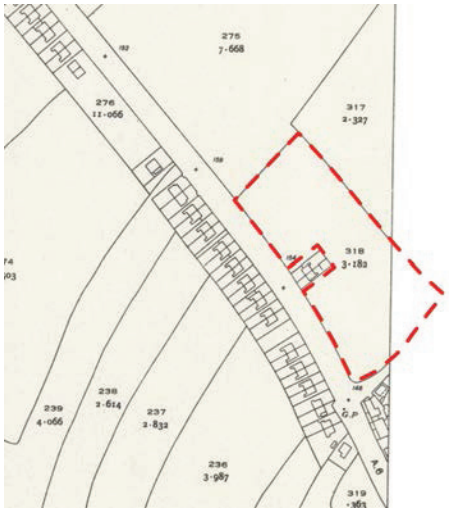


Plate 5: Extract from the Ordnance Survey map of 1925

3.3.6 ***Ordnance Survey 1946***: two attached properties have been built against the road on the south-west side of the area (Plate 6; cf. Plate 5). The area on the opposite side of the road to the south-west of the site is also substantially developed (Plate 6).

3.3.7 ***Ordnance Survey 1952***: there is no change (Plate 7; cf. Plate 6).



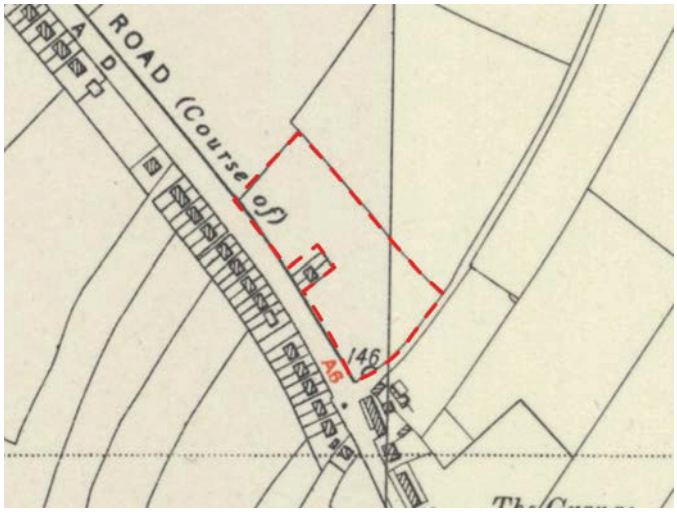


Plate 6 (left): Extract from the Ordnance Survey map of 1946

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

3.4 Site Visit

3.4.1 ***Site Arrangement and Character***: the site comprises a single essentially rectangular field orientated approximately north-west/south-east, although a small section has been removed on the south-west side facing onto Carleton Road where a pair of semi-detached houses have been built (Plate 8). The field comprises rough pasture and is largely bounded by hedges (Plate 9). There is a metal shelter in against the south-east end of the south-west boundary and a water trough against the south-east boundary.

Plate 8 (left): The houses facing onto Carleton Road, viewed from the west

Plate 9 (right): The south-east end of the site, viewed from the south

3.4.2 ***Constraints***: there are few obvious constraints to any further archaeological work across most of the site. However, the south corner of the field has evidently also seen some disturbance, presumably as a result of being modified to improve visibility at the junction of Carleton Road and Sewell Lane for the housing estate recently constructed to the north-east (Plate 10). The trough against the south-eastern boundary is presumably supplied with piped water, which may run across the site. The scar of a utility trench was visible in the pavement alongside the south-west boundary, which seemed to turn into the site (Plate 11) and ran from a group of manholes further north-west (Plate 12).

Plate 10: The modified corner at the junction of Carleton Road and Sewell Lane, viewed from the west

Plate 11 (left): Utility trench in adjoining pavement where it appears to run into the site

Plate 12 (right): Manholes against the south-west boundary to which the utility trench connects

3.5 Geophysical Survey

3.5.1 The full geophysical report is presented in *Appendix 3*. In summary, evidence for relatively modern activity in the form of stray metal objects and ridge and furrow ploughing as well as variations in the local soil and geology was present across the whole area. There are some more distinct anomalies, one in particular seemingly at right angles to the general agricultural regime, but these do not form any obvious patterns or structures.

3.6 Conclusion

3.6.1 The map regression shows that the site has comprised a single small field from at least 1847 by which time the roads to the south-west and south-east of the site were already established. The field was named 'Gooselands' on the tithe map, presumably in reference to geese being kept in it at one time. Between 1925 and 1946 a pair of houses was built in part of the original field, facing onto Carleton Road.

3.6.2 The site visit revealed relatively little disturbance to the area, apart from the presence of small temporary structures along the south-west boundary. There are also possibly utilities located along the south-west boundary, which may extend into the field.

3.6.3 The geophysical survey did not record any features of apparent archaeological significance, with the whole area showing evidence for ridge and furrow, occasional dipolar anomalies, and some linear anomalies that do not form any obvious patterns. These are likely to be of modern origin or relate to differences in geological deposits.

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Figure 3: Site plan showing magnetic gradient data

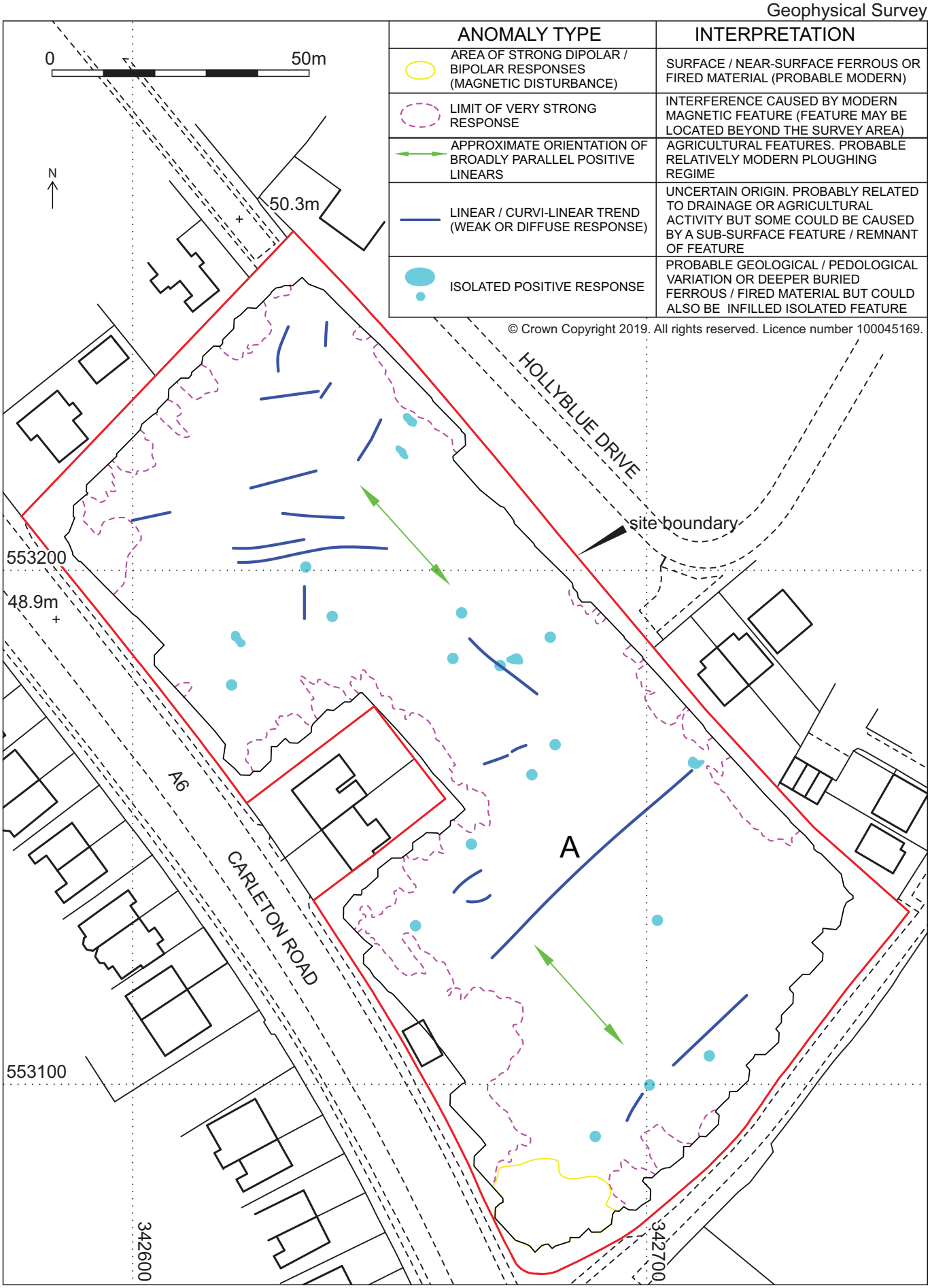

Figure 4: Site plan showing interpretation of the magnetic gradient data

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4. Site History

4.1 Introduction

4.1.1 The history of the local landscape is arguably dominated by three significant elements: its proximity to the villages of Carleton and Harraby, which have at least medieval origins, connections to Carlisle Priory, the extensive Roman remains associated with the city of Carlisle and Hadrian's Wall to the north and west, and the extensive prehistoric remains discovered largely to the north of the site. In addition, an important coin and bullion hoard of early 10th century date was discovered at Scotby, *c*1.6km to the north-east. Information relating to specific sites recorded during the desk-based assessment (see *Section 3* above) is included where relevant.

4.2 Prehistoric Period (c11,000BC – 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 clearly 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, outside Carlisle (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 In the following period, the Neolithic (*c*4,000 – 2,500 BC), large scale monuments such as burial mounds and stone circles begin to appear in the region, such as the possible cursus near Scotby (Webster and Newman 2007, 8), and 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. The burnt mound (**Site 2**) recorded during excavations at Garlands Hospital dates from the Bronze Age (LUAU 1996; Neighbour and Johnson 2005) and a considerable amount of Bronze Age pottery was found nearby in 1861 when erecting new hospital buildings at the site of a suspected Bronze Age cemetery (**Site 4**). Hodgson lists 15 urns, but Spence says there were 13 cinerary urns of overhanging rim type, five burial urns of food vessel type, four incense cups, and one beaker (Hodgson 1956, 6-12; Spence 1940, 101-4). A flint implement was also found in one of the urns now held at Tullie House (*ibid*).

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 cropmarks revealed in aerial photographs, possibly including earthworks to the north of the site (**Site 5**; 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 within a few kilometres of Hadrian's Wall, to the north, and the Roman city of Carlisle, to the west. 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). A Roman coin of 2nd century date (an illegible *Sestertius* of Antoninus Pius (AD 138-161)) is recorded as having probably been found at Harraby (HER 18940), although the exact find spot is unknown (Shotter 1986, 256; 1989, 42). The construction of Hadrian's Wall in turn led to the construction of a new fort at Stanwix, 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. Evidence for post-Roman habitation is limited and inconclusive (*op cit*, 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 such as that around Scotby 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 clear 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). Two possible Roman encampments have been tentatively identified within the study area (**Site 13** and **Site 14**), although their exact date is uncertain. In addition, a pair of Roman inscriptions formerly situated in the cliff face south of Wetheral, to the east of the site, but now loose and stored in Tullie House Museum (Perriam and Ramshaw 2008, 4), have been taken as evidence for the military quarrying the local stone (Collingwood and Wright 1965, 335-336). The current A6, immediately to the south-west of the site, is also considered likely to be on the line of the original Roman road connecting the forts at Brougham and Old Penrith to the south with Carlisle, perhaps from as early as the late 1st century AD (Shotter 2004, 27).

4.3.2 Physical and archaeological evidence from the post-Roman early medieval period is considerably less common in rural areas. The general area was clearly inhabited, however, with Carlisle remaining an important urban centre (see *Section 4.3.1* above) and Wetheral, approximately 3.75km to the east, having evidence for a perhaps monastic, certainly religious, community before the 8th or 9th century (Phythian-Adams 1996, 67). Direct evidence for activity during this period is found in the hoard of approximately 100 Anglo-Saxon coins and 10 to 12 silver ingots, which was found at Scotby in June 1855 during the cutting of a field drain, approximately 1.6km to the north-east of the site (HER No. 541; Anon 1855; Blunt 1974; Kruse 1986). The hoard included coins of Edward the Elder (AD 901-925) and Athelston (AD 925-941) and an iron billhook and a small horseshoe were found nearby (*ibid*). Its historical significance remains uncertain, however, although the likely deposition date of the hoard, AD 935-940 (Blunt 1974, 156), places it in a period of particularly intense conflict potentially sandwiched between the treaty of Eamont Bridge in 927 and the battle of *Brunanburh* in 937 (Kruse 1986, 82). The place-name evidence most directly relevant to the site is problematic. While Harraby to the north is of entirely medieval origin although with a Norse influence (Armstrong *et al* 1950, 43-44). Carleton, to the south is more complex; the name ought to indicate an early medieval settlement, the name being Norse and meaning the 'farm of the free men or peasants', a Scandinavianisation of the Old English *Ceorlatūn* (Armstrong *et al* 1952, 481). This theme has been further elaborated, with Winchester noting the frequent association between such sites and royal estates, settlements named 'Carleton' being those occupied by '*bond men who tilled the royal demesne*' and of pre-Norman Conquest and pre-Norse origin (Winchester 1987, 19). Summerson too took the name to have a similar implication, suggesting that the settlement served the lords of Carlisle (Summerson 1993, 11). However, a more recent consideration has expressed '*reservations about the antiquity of Cumberland place-names in Carleton*' for a number of reasons, and concluded that they were post-Norman Conquest in date, representing the use of a term already existing elsewhere in the country and relating to deliberately planted settlers serving demesne lands (Phythian-Adams 1996, 16-17). The adjoining field to the north-east of the site a small kiln of early

medieval date was encountered during archaeological work (Greenlane Archaeology 2015b; Elsworth 2019). This was considered likely to be an outlying feature relating either to the village of Carleton to the south or to the cropmark enclosure to the north, assuming this had remained occupied into this period.

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

4.4.1 Whatever its origins, the village of Carleton is first recorded in documentary sources in 1212 (Armstrong *et al* 1950, 148), while Harraby is recorded from the 1170s (Armstrong *et al* 1950, 43-44). Carleton was evidently connected to Carlisle Priory and the majority of Carleton and Harraby were held by the priory as part of the Manor of Botchergate (Cumbria County History Trust 2014). Land at Carleton was granted to it in 1316 and further land was acquired there in 1476 (Summerson 1993, 350 and 595). The priory also had a mill, recorded in 1535, said to have been at Harraby but probably on the River Petteril at Carleton (*op cit*, 694). The nearest religious house apart from Carlisle Priory, is probably Wetheral Priory, approximately 3km to the east. This was founded as a Benedictine house and cell of the Abbey of St Mary in York by Ranulph Meschin and subsequently received gifts from Henry I, Henry II, Henry III and Richard I, and also the future David I of Scotland (Armstrong *et al* 1950, 239-240). The priory also had fishing rights in the River Eden which later passed to Corby Castle (Railton and Davies 2007, 97).

4.4.2 There are no recorded sites of medieval date within the study area, although the mill recorded in 1535 may correspond with **Site 16**.

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

4.5.1 The map evidence (see *Section 3.3*) demonstrates that the site had reached approximately its present state by the mid-19th century, with all the fields enclosed, and it is likely that relatively little changed in the area following the end of the medieval period. Following the Dissolution much of the lands and properties formerly held by the priories at Carlisle and Wetheral passed into the hands of local families, the Tullie family acquiring the lease of Wetheral Manor from the Dean and Chapter of Carlisle Cathedral (Perriam and Ramshaw 2008, 16), although the Dean and Chapter probably retained Carleton (Cumbria County History Trust 2014). The area in general remained very rural in character and probably saw little substantial change until the coming of the Lancaster-Carlisle Railway (**Site 8**). The Lancaster and Carlisle Railway was secured by an Act of Parliament on 6th June 1844 and opened on 17th December 1846 (Robinson 2011, 177). It was then leased to the London and North Western Railway in 1859 (*ibid*). This heralded a new period of industrialisation seen at a national and local level, with nearby Carlisle developing a substantial range of industries, particularly those relating to textiles (Newman 2011). The Ordnance Survey maps show a mill complex located nearby at Carleton, consisting of a corn mill and mill race (**Site 16**), and a former ironworks (**Site 9**) and associated weir (**Site 12**) to the south and west of the proposed development area. A ceramic crucible of 'probably recent date' used for casting copper or copper alloys was found nearby (**Site 10**; Richardson 1990, 87). One of the most significant developments in the local area was the creation of the Garlands Mental Hospital (see **Site 4**). The site was originally an estate of at least 18th century origin belonging to a John Armstrong (CAC(C) DX 154/7 1818; CAC(C) DX 2090 1849-1881; CAC(C) THOS 8/5 1796-1953) but following the purchase of land in 1856, for under £6,500, construction of the hospital began in 1858 (Pitts nd). The initial phase of building was opened in 1862 at a cost of £53,019; it was intended to accommodate 'pauper inmates', who had previously had limited provision for help, and was considerably extended in 1866 and 1880 (*ibid*). The settlement at Carleton was described in 1860 as having '*several neat houses*' and a willow tree '*raised from a cutting taken from a tree which overhung the grave of Napoleon at St Helena*' (Whellan 1860, 187).

4.5.2 Other sites within the study area of post-medieval date include the Harraby Methodist Church (**Site 3**), which closed in 2008, and a World War II pillbox (**Site 15**). Various enclosure boundaries (**Site 6**) within the proposed development area are also thought to be post-medieval in date. The double-ditched probable trackway and enclosure boundary south of the former Garlands Hospital (**Site 7**) pre-date the 19th century but are at present undated.

4.5.3 An almost certainly modern terracotta female head was also found in a field at Harraby (**Site 1**), although the exact location where it was found is unknown (Richardson 1990, 57-58).

4.6 Previous Archaeological Work

4.6.1 There have been several phases of previous archaeological work around Harraby and in the vicinity of Garlands Hospital, to the north-east of the site. Evaluation trenching carried out in advance of a residential development to the north of the hospital revealed an undated ditch and a burnt mound (**Site 2**) (LUAU 1996). The latter was subject to full excavation (CFA 1997) and subsequently published (Neighbour and Johnson 2005). In addition, further evaluation trenching was carried out in advance of new building at the hospital, in the area where cremations had previously been found in the 19th century (**Site 4**), but this did not reveal any features of archaeological significance (Carlisle Archaeology 2000). An archaeological evaluation was also undertaken in fields adjacent to the M6 in 2016 (WAA 2016). This comprised the excavation of 22 trenches, which targeted anomalies identified by geophysical survey as well as blank areas in the survey (see WAA 2015), but no significant archaeological finds or features were found. The geophysical anomalies resulted from variations in the geology and/or modern field drains (WAA 2016). In 2019, a geophysical survey on land at the NHS Carleton Clinic, formerly the Cumberland and Westmorland Lunatic Asylum, identified several rectilinear and linear anomalies as being likely to belong to a series of trackways and enclosures that correspond with a cropmark that is assumed to represent an Iron Age enclosure (NAA 2019). Other linear and curvilinear anomalies and trends could denote buried features, some of which may relate to modern and agricultural activity (*ibid*).

4.6.2 A desk-based assessment and geophysical survey was carried out in February 2014 of fields immediately north-east of the current site on land to the south-west of Cumwhinton Road (Greenlane Archaeology 2014). The nearby villages of Carleton and Harraby both have at least medieval origins, and the site is close to the Roman city of Carlisle and Hadrian's Wall, but the area saw relatively little development until the post-medieval period. The geophysical survey revealed large numbers of anomalies and the potential for remains of prehistoric date to be present within the proposed development area was identified. Archaeological evaluation of two areas was recommended and the subsequent evaluation in February 2015 recorded a small number of features confined to the north side of the proposed development area, comprising a short ditch or elongated pit, a possible posthole, and two further pits of uncertain date (Greenlane Archaeology 2015a). The subsurface linear features identified by geophysical survey related to 19th century field drains and naturally occurring variations in the underlying geology, so at the time no further work was recommended. However, a fragment of chert and a possible flint tool suggested a prehistoric date was possible, so a further programme of archaeological strip and record was carried out that focussed on these two areas in May 2015 (Greenlane Archaeology 2015b). Two more small pits, again of uncertain date, were revealed, and it was speculated that they may have been connected to ironworking or possibly the production of charcoal. Only two of the features from the site were radiocarbon dated: one provided a date in the mid-4th millennium BC and the other dated to the 6th to 7th century AD (Elsworth 2019). The presence of these features show that outlying areas around Carlisle have some archaeological potential (*ibid*).

5. Discussion

5.1 Introduction

5.1.1 The discussion of the results of the desk-based assessment, site visit and geophysical survey is intended to determine the archaeological significance and potential of any known remains (above or below ground) and the potential for any 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; *Appendix 2*). Of the 16 sites identified within the study area, none are situated within the proposed development area (although the exact location of **Site 11**, **Site 1**, and **Site 10** is uncertain) and they are therefore unlikely to be affected by any subsequent groundworks.

5.2 Significance of Affected Sites

5.2.1 There are no known sites of archaeological interest within the proposed development area.

5.3 Potential for Unknown Archaeological Remains

5.3.1 Although no known sites of archaeological interest are present within the proposed development area, there is the potential for as yet unidentified archaeological remains to be present. This is based on the known occurrence of such remains elsewhere in the study area and 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, medium, or high:

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

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

5.3.2 In consideration of Table 3 it is worth noting that the possibility of finding Mesolithic remains could perhaps be assessed as medium because they are often associated with sites adjacent to watercourses and the River Petteril is a short distance to the south of the site (Middleton *et al* 1995, 202; Hodgkinson *et al* 2000, 151-152). Areas along the River Eden in particular have also recently been the site of significant and large-scale discoveries of finds and sites of Mesolithic date (Clark 2010; Clarke *et al* 2008). Features of certain or probable Neolithic date were found during archaeological work in the adjoining field and so there is some likelihood of similar remains being present (Elsworth 2019). The numerous possible enclosures and other features recorded as parch marks are undated but could arguably belong to the late prehistoric (perhaps as early as the Bronze Age, especially as there are other sites of Bronze Age date that have been excavated nearby) to Romano-British periods.

5.3.3 There are no certain sites of Roman date from the study area, although again many of the crop mark sites could be of Roman date, and the probable line of the Roman road from the south into Carlisle runs immediately alongside the south-west edge of the site. While there is a single site of early medieval date, which was discovered during archaeological investigations of the adjacent field (Elsworth 2019), the likelihood of similar remains being discovered is probably limited.

5.4 Disturbance

5.4.1 The area appears to have seen relatively little disturbance apart from that associated with agriculture, such as ploughing, which the geophysical survey shows has taken place across the site. However, the presence of areas of high magnetic disturbance are suggestive of some modern activity or disturbance across parts of the site, particularly around the edges.

5.5 Impact

5.5.1 Although no detailed plans were available regarding proposed developments it is likely that any building on site would substantially impact on any archaeological remains that might be present.

5.6 Discussion

5.6.1 It is clear from the preceding sections that while the map evidence and geophysical survey do not indicate the presence of any remains of archaeological interest, the wider area has seen the discovery of numerous finds from the Neolithic onwards. Indeed, the adjoining field, when subject to archaeological evaluation, contained features of Neolithic and early Medieval date, none of which had been picked up on the geophysical survey. It is entirely possible, therefore, that archaeological remains could be present, but this could only be determined through further archaeological investigation such as evaluation trenching.

6. Bibliography

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6.3 Aerial Photographs

CCC, 2006, **NY4253/A-C** and **NY4353/A-C**

St Joseph, JK, nd, **NY4352/A-B** (formerly STJ AGO 59-60)

Appendix 1: Site Gazetteer

Site Number: **1**
NGR: 342000 554000
HER No: 19190
Sources: HER; Richardson 1990, 57-58
Designation: none
Description: a terra-cotta female head found in a field at Harraby, in April 1984. 'The head is almost certainly modern, perhaps an "art class reject", badly fired and then discarded' (Richardson 1990, 57-58)
Period: modern

Site Number: **2**
NGR: 343030 554010
HER No: 17004
Sources: HER; LUAU 1996; Neighbour and Johnson 2005
Designation: None
Description: Trial trenching at Garlands Hospital revealed traces of a burnt mound comprising small burnt stone fragments in a black silty matrix. This site was subsequently excavated and dated to the Bronze Age.
Period: Bronze Age

Site Number: **3**
NGR: 342160 553960
HER No: 42058
Sources: HER
Designation: none
Description: Harraby Methodist Church built in 1948 and closed in 2008.
Period: post-medieval

Site Number: **4**
NGR: 343200 553900
HER No: 484
Sources: HER; Hodgson 1956, 6-12; Spence 1940, 101-4; Carlisle Archaeology 2000
Designation: none
Description: Garlands Hospital Bronze Age cemetery: considerable amounts of Bronze Age pottery found in 1861 when erecting new hospital buildings, either under the bowling green, in pit sand, or on sites now occupied by buildings. Hodgson lists 15 urns, but Spence says there were 13 cinerary urns of overhanging rim type, five burial urns of food vessel type, four incense cups, and one beaker. The beaker found in 1893 was intact. A flint implement was also found in one of the urns now held at Tullie House. The pottery was published in 1956, but the precise location of the finds was not recorded.
An evaluation was undertaken at Garlands Hospital for a proposed housing development. In 1997, the Centre for Field Archaeology, University of Edinburgh, carried out an excavation on a prehistoric burnt mound approximately 500m to the north of the hospital (SMR 17004). Aerial photography suggests the presence of ring ditches, perhaps burial mounds, in the vicinity. The primary aim of the evaluation was to determine whether or not archaeological remains exist within the footprint of the proposed development.

A total of nine trenches were excavated. In each trench the topsoil and modern deposits were removed until the natural subsoil or bedrock was revealed, to a maximum depth of 1.20m. No archaeological features were present and there were only a few finds which were all post-medieval (Carlisle Archaeology 2000).
Period: Bronze Age

Site Number: **5**
NGR: 342834 553638
HER No: 41117
Sources: HER; Cumbria County Council 2006: **NY4253/A-C**; Webster and Newman 2007, 7
Designation: none
Description: enclosures north of Poplar House. Two curvilinear enclosures revealed as parch marks, one of which is approximately 60 to 75m with the other slightly smaller. They are probably prehistoric settlements, though no internal features are visible.
Period: prehistoric

Site Number: **6**
NGR: 342790 553418
HER No: 41118
Sources: HER; Cumbria County Council 2006: **NY4253/A-C**; Webster and Newman 2007, 7
Designation: none
Description: parch marks including enclosure boundary parallel to the road, with two other smaller boundaries running off it at 90 degrees to the road. These parch marks are all considered to relate to former field boundaries and most likely to be post-medieval in date.
Period: post-medieval

Site Number: **7**
NGR: 343343 553408
HER No: 41119
Sources: HER; Cumbria County Council 2006: **NY4353/A-B**; Webster and Newman 2007, 7
Designation: None
Description: a double-ditched probable track way south of the former Garlands Hospital showing as a parch mark aligned north-east/south-west with an enclosure boundary at right angles and attached to its southern side and a possible double-ditched line at right angles on its northern side. It likely predates the extant enclosure boundaries of 19th century date.
Period: unknown

Site Number: **8**
NGR: -
HER No: 41005
Sources: HER; Robinson 2011, 177
Designation: none
Description: Lancaster and Carlisle Railway/London and Nortwestern Railway. The Lancaster and Carlisle Railway was secured by an Act of Parliament on 6th June 1844 and opened on 17th December 1846 (Robinson 2011, 177). It was then leased to the London and North Western Railway in 1859 (ibid).

Period: post-medieval

Site Number: **9**
NGR: 342040 553020
HER No: 10143
Sources: HER; Ordnance Survey 1868a
Designation: none
Description: site of former Cowan and Sheldon's Iron Works, Low Woodbank. There are no traces apart from earthworks.
Period: post-medieval

Site Number: **10**
NGR: 342000 553000
HER No: 19611
Sources: HER; Richardson 1990, 87
Designation: none
Description: a ceramic crucible of probably recent date was found near the River Petteril reportedly from an 'ash-heap'. The vessel is of medium hard clay with opaque quartz incisions and with traces of green glaze on the exterior. It was probably used for casting copper or copper alloys. Maximum height 77mm, external mouth diameter 66mm, internal mouth diameter 56mm, base diameter 41mm. Reported in 1978.
Period: post-medieval

Site Number: **11**
NGR: 343000 553000
HER No: 5799
Sources: HER; article in *Carlisle Patriot* 19 April 1851; *RIC* 932
Designation: none
Description: red sandstone Roman altar dug up at Plumpton, inscribed 'DIS MAN B MCOCC NON AVVORVI HIC SIIUS EST'; now held at Lowther Castle. Note in paper file from newspaper reads 'There is at Lowther Castle a Roman Altar, in excellent preservation, which was dug up at Plumpton'.
Period: Roman

Site Number: **12**
NGR: 342140 552920
HER No: 10146
Sources: HER; Ordnance Survey 1868a
Designation: none
Description: Lower Woodbank weir: short artificial waterway, apparently a weir connected with Cowan and Sheldon's Iron Works (**Site 9**)
Period: post-medieval

Site Number: **13**
NGR: 343700 552900
HER No: 3813
Sources: HER; St Joseph nd: **NY4352/A**
Designation: none
Description: Carleton enclosure cropmark on rising ground. Aerial photographs show two cropmark lines meeting at roughly 90 degrees in a rounded corner. The northern lines appear to be very straight and meet at a very neat rounded corner at NY 4372 5287. If the site is proved to be a Roman camp it would be three times the size of the nearby example at the Golden Fleece (SMR 510). The southern lines meet at a less perfect corner at NY 4368 5277 and the north to south line of the pair looks quite sinuous. The site is improved pasture, hay meadow. There were no obvious archaeological features on the ground when visited in April 2000. Not dated but before the motorway.
Period: unknown

Site Number: **14**
NGR: 343400 552800
HER No: 3814
Sources: HER; St Joseph nd: **NY4352/B**
Designation: Roman
Description: cropmarks, possibly representing a temporary Roman camp, occupying the natural ridge top. This would have afforded good visibility over the surrounding terrain. There is reputedly a curvilinear single-ditched enclosure, approximately 35m diameter with an entrance to the south and a possible second entrance in the east side. The enclosure apparently appears to be within a larger rectilinear enclosure, only parts of the north and west sides of which are visible. A linear feature, narrower than the enclosure ditches, runs northeast to southwest across the enclosure and is probably not associated. Some 100m northeast of the enclosure is a rectilinear field system which may be associated with the enclosure. However, the site had recently been reseeded and there were no traces of any archaeological features when visited in April 2000. The field is subject to ploughing most years and there are drains across site.
Period: Roman

Site Number: **15**
NGR: 343200 552600
HER No: 16863
Sources: HER
Designation: none
Description: there is a World War II pillbox recorded at this location, although recent investigations have not been able to locate it.
Period: post-medieval

Site Number: **16**
NGR: 342890 552610
HER No: 10185
Sources: HER; CAC(C) DRC/8/43 1847; Ordnance Survey 1868b
Designation: none
Description: mill complex consisting of corn mill (centred on 34286 55260) and mill race. The majority of the mill has been converted to a house and that portion is in good condition. The southern portion is not lived in and is semi-derelict. Windows were covered and it is not known if any machinery survives. The

mill is brick built and has a small chimney stack on its west side which is intact. Various millstones have been incorporated into the boundary wall of the property which has fallen down in places. Below the mill the leat has been filled in and above the mill the water appears to have been diverted away.
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: Geophysical Survey Results

Land off Carleton Road (Speckled Wood) Carlisle, Cumbria

Archaeological geophysical survey

Project No. ARC/2771/1038

February 2020

Land off Carleton Road (Speckled Wood) Carlisle, Cumbria

Archaeological geophysical survey

Project No. ARC/2771/1038

Report prepared by		Report checked by	
Name	Mark Whittingham BSc MA MCIfA	Name	Nicola Fairs BSc MSc DIC CGeol FGS
Signature	M. Whittingham	Signature	NEMFairs
Date	17/02/20	Date	18/02/20

Table of Contents

1. SUMMARY

Phase Site Investigations Ltd was commissioned to carry out a magnetic gradient survey at land off Carlton Road, 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, agricultural activity and geological / pedological variations. There are several anomalies of uncertain origin but 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 agricultural activity, drainage features or natural features / variations.

2. INTRODUCTION

2.1 Overview

Phase Site Investigations Ltd was commissioned by Greenlane Archaeology Ltd to carry out an archaeological geophysical survey at land off Carleton Road, 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_2771_1038_01.

2.2 Site description

The site is situated on the south-eastern edge of Carlisle, Cumbria (centred at NGR NY 427 532) and covered an area of approximately 1.4 ha.

The site encompassed a rough pasture field. The site sloped up to the north-east and was bounded on all sides by hedges with metal wire fencing. A house and garden was located along the south-western boundary.

The geology of the site consists of the Helsby Sandstone Formation overlain by Diamicton Till (British Geological Survey, 2020). The soils of the site are described as slightly acid loamy and clayey soils with impeded drainage (Soilscapes, 2020).

2.3 Archaeological background

A draft of an archaeological desk-based assessment (Greenlane Archaeology Ltd, in prep) highlights that the site does not contain any known archaeological features. However, previous investigations in nearby fields have found evidence of prehistoric, possible Iron Age and Roman and early and post-medieval activity. It concludes that,

'in view of the archaeological evidence from the wider area, there is some potential for similar remains, particularly of prehistoric date, to be present within the site area.'

A previous geophysical survey immediately to the north-east of the site (Phase Site Investigations Ltd, 2014) identified a number of anomalies of uncertain origin. Subsequent intrusive investigations (Greenlane Archaeology, 2015a and 2015b) identified that the linear anomalies were related to post-medieval agricultural activity or natural features but the excavations did identify a number of potential prehistoric pits.

Historic maps shown in the archaeological desk-based assessment indicate that the site has been in use as a single agricultural field since before 1847.

2.4 Scope of work

The survey area was specified by the client.

Due to the presence of dense vegetation and metallic objects within the field the area accessible for survey was reduced to 1.2 ha, the location of which is shown in drawing ARC_2771_1038_02.

No other problems were encountered during the survey which was carried out on 7th February 2020.

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 OSTN 02 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 was exported as greyscale raster images (PNG files) and is shown with an accompanying interpretation at a scale of 1:1000. All greyscale plots were clipped at -2 nT to 3 nT. Greyscale plots have been 'smoothed' using a visual interpolation but the data itself has not been interpolated.

The data has been displayed relative to a digital Ordnance Survey base plan provided by the client as drawing *'Promap-572054-680518-720-0.dxf'*. 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 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 have not been shown in the interpretation.

Anomalies associated with agricultural regimes are present in the data but each individual anomaly has not been shown on the interpretation. Instead the general orientation of the regime is indicated.

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 are several areas that have a more disturbed magnetic background but this is due to the presence of magnetic material in the topsoil or sub-surface, rather than low data quality.

The categories of anomaly, and their possible causes, which have been identified by the survey are discussed in detail below.

4.2 Anomaly types and further discussion

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 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.

An area of **magnetic disturbance** is present adjacent to the southern field boundary. These types of anomaly are made up of strong bipolar and dipolar responses and are usually associated with concentrations of relatively modern magnetic material. This will be the cause of this anomaly at the site.

The very strong responses around the perimeter of the survey area are associated with adjacent strongly magnetic modern features. The extent of these areas is usually shown 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.

A series of **broadly parallel positive linear anomalies** are present that are probably associated with a relatively modern ploughing regime.

Numerous **linear / curvi-linear trends** have been identified. One trend (**Anomaly A**) stands out as, although it is diffuse, it is slightly stronger than other linear responses in the area. The response could be related to an infilled linear feature but it is considered more likely that it is related to agricultural activity. There is a much weaker trend to the south-east with a similar orientation and very faint suggestions of other broad variations with similar alignments so it is possible that these are the very faint responses from a regime of ridge and furrow.

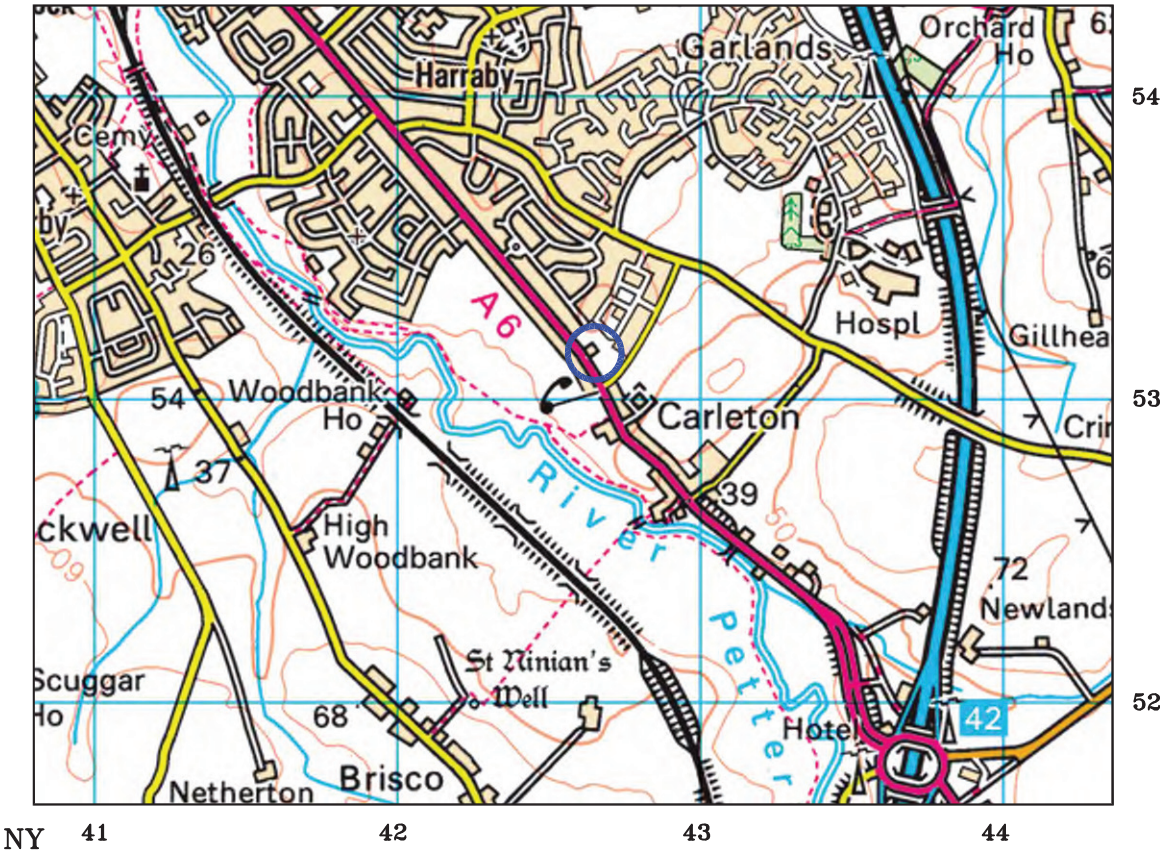
The remaining trends are all too weak and short to reliably interpret. They do not form any patterns or relationships that would suggest they are associated with archaeological features / activity. Similar responses in the geophysical survey to the north-east were confirmed to relate to agricultural or natural features and it is likely that the majority of the trends at this site have a similar cause.

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. Possible archaeological pits have been identified to the north-east and it is possible that some of the isolated positive responses at this site are caused by similar features. However, there is no obvious pattern to their distribution that would suggest which if any could have an archaeological origin. Stronger isolated positive responses have been shown on the interpretation but it should be noted that it is likely that that the majority, if not all, of the responses are caused by natural variations or deeper buried relatively modern, ferrous or fired material.

5. DISCUSSION AND CONCLUSIONS

The majority of the anomalies identified by this survey relate to modern material / objects, agricultural activity and geological / pedological variations. There are several anomalies of uncertain origin but 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 agricultural activity, drainage features or natural features / variations.

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

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Scale [A4 Sheet]	Drawing	Status
AS SHOWN	ARC_2771_1038_01	FINAL

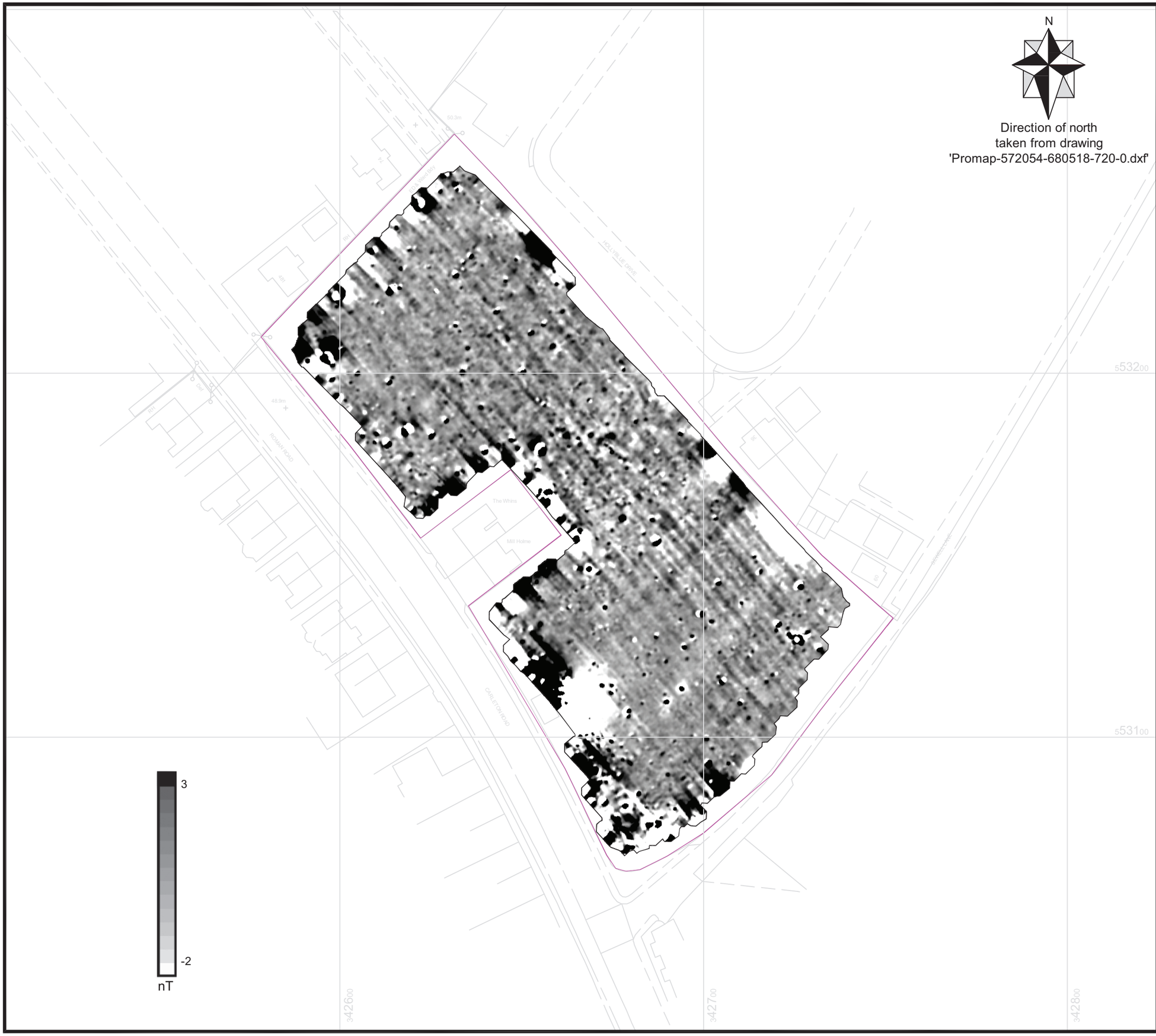
Client: GREENLANE ARCHAEOLOGY LTD ULVERSTON

Site: LAND OFF CARLETON ROAD (SPECKLED WOOD), CARLISLE, CUMBRIA

Title: SITE LOCATION MAP

Job No: ARC_2771_1038

		Drawn	JW
Chk.	MW	Date	10/02/2020



NOTES

1. THIS DRAWING MUST BE USED IN CONJUNCTION WITH THE ACCOMPANYING REPORT (ARC_2771_1038_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-572054-680518-720-0.dxf' PROVIDED BY THE CLIENT. THE ORDNANCE SURVEY CO-ORDINATES OBTAINED FOR THIS SURVEY WERE MEASURED USING THE UKOSTN02 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.

ALWAYS EXERCISE CAUTION WHEN EXCAVATING

KEY

SITE BOUNDARY

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Scale [A3 Sheet]	Drawing	Status
1:1000	ARC_2771_1038_02	FINAL

Client
GREENLANE ARCHAEOLOGY LTD
ULVERSTON

Site
LAND OFF CARLETON ROAD (SPECKLED WOOD), CARLISLE, CUMBRIA

Title
LOCATION OF SITE SHOWING MAGNETIC GRADIENT DATA

Job No
ARC_2771_1038

Surveyed	CA, MP	Drawn	MW
Chk.	NF	Date	07/02/2020

N

Direction of north
taken from drawing
'Promap-572054-680518-720-0.dxf'

A

5532 00

5531 00

3427 00

3428 00

ANOMALY TYPE	INTERPRETATION
AREA OF STRONG DIPOLAR / BIPOLAR RESPONSES (MAGNETIC DISTURBANCE)	SURFACE / NEAR-SURFACE FERROUS OR FIRED MATERIAL (PROBABLE MODERN)
LIMIT OF VERY STRONG RESPONSE	INTERFERENCE CAUSED BY MODERN MAGNETIC FEATURE (FEATURE MAY BE LOCATED BEYOND THE SURVEY AREA)
APPROXIMATE ORIENTATION OF BROADLY PARALLEL POSITIVE LINEARS	AGRICULTURAL FEATURES. PROBABLE RELATIVELY MODERN PLOUGHING REGIME
LINEAR / CURVI-LINEAR TREND (WEAK OR DIFFUSE RESPONSE)	UNCERTAIN ORIGIN. PROBABLY RELATED TO DRAINAGE OR AGRICULTURAL ACTIVITY BUT SOME COULD BE CAUSED BY A SUB-SURFACE FEATURE / REMNANT OF FEATURE
ISOLATED POSITIVE RESPONSE	PROBABLE GEOLOGICAL / PEDOLOGICAL VARIATION OR DEEPER BURIED FERROUS / FIRED MATERIAL BUT COULD ALSO BE INFILLED ISOLATED FEATURE

NOTES

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Scale [A3 Sheet]	Drawing	Status
1:1000	ARC_2771_1038_03	FINAL

Client
GREENLANE ARCHAEOLOGY LTD
ULVERSTON

Site
LAND OFF CARLETON ROAD (SPECKLED WOOD), CARLISLE, CUMBRIA

Title
INTERPRETATION OF MAGNETIC GRADIENT DATA

Job No
ARC_2771_1038

Surveyed	CA, MP	Drawn	MW
Chk.	NF	Date	07/02/2020

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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 OSTN 02 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 was exported as raster images (PNG files), and are presented in greyscale format at 1:1000.

1.4.3 The data has been displayed relative to a digital Ordnance Survey base plan provided by the client as drawing *'Promap-572054-680518-720-0.dxf'*. The base plan was in the Ordnance Survey National Grid co-ordinate system and as the survey grids were set-out 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 buried pipes / cables that are usually metallic, although in some instances ceramic pipes can also produce popular anomalies. In some instances the anomaly can extend for a sigfncaint 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 pipe or cable.

There are no bipolar linear anomalies in this data set.

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 anomalies

Negative 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.

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

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.

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 these anomalies are probably associated with geological / pedological variations or deeper buried ferrous or fired material.

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 Anomalies associated with agricultural regimes are present in the data. The general orientation of these regimes has been shown on the interpretation but, for the sake of clarity, each individual anomaly has not been shown.

1.5.6 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.