Haweswater Aqueduct Resilience Programme - Proposed Bowland Section

Environmental Statement

Volume 4

Appendix 10.3: Geophysical Survey of Proposed Newton-in-Bowland Compound

June 2021

United Utilities

Water for the North West

Haweswater Aqueduct Resilience Programme - Proposed Bowland Section

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Jacobs U.K. Limited

5 First Street
Manchester M15 4GU
United Kingdom
T +44 (0)161 235 6000
F +44 (0)161 235 6001
www.jacobs.com

Geophysical Survey of

Proposed Newton-in-Bowland Compound

Haweswater Aqueduct Resilience Programme – Proposed Bowland Section

For

ADAS

On Behalf Of

United Utilities

Magnitude Surveys Ref: MSSD763A

OASIS Number: TBC

October 2020

Unit 17, Commerce Court

Challenge Way

Bradford

BD4 8NW

01274 926020

info@magnitudesurveys.co.uk

Report By:

Leigh A. Garst BFA MSc

Report Approved By:

Finnegan Pope-Carter BSc (Hons) MSc FGS

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Abstract

Magnitude Surveys was commissioned to assess the subsurface archaeological potential of a c.14.58ha area of land at the proposed Newton-in-Bowland Compound located off the road between Newton-in-Bowland and Dunsop Bridge, Lancashire as part of the Haweswater Aqueduct Resilience Programme. A fluxgate gradiometer survey was successfully completed across the survey area. No anomalies suggestive of significant archaeological features were identified, however geophysical anomalies of undetermined classification were identified. The survey identified multiple existing below ground services and areas of disturbance associated with these services. Anomalies related to agricultural use have been identified and interpreted as historic cultivation and modern ploughing and drainage.

Contents

List of Figures

1. Introduction

1.1. Magnitude Surveys Ltd (MS) was commissioned by ADAS on behalf of United Utilites to undertake a geophysical survey on a c.14.58ha area of land at the proposed Newton-in-Bowland Compound located off the road between Newton-in-Bowland and Dunsop Bridge, Lancashire (SD689502) as part of the Haweswater Aqueduct Resilience Programme.

1.2. The geophysical survey comprised hand-carried GNSS-positioned fluxgate gradiometer survey. Magnetic survey is the standard primary geophysical method for archaeological applications in the UK for its ability to detect a range of different features. The technique is particularly suited for detecting fired or magnetically enhanced features, such as ditches, pits, kilns, sunken earth houses, and industrial activity (David *et al*., 2008).

1.3. The survey was conducted in line with the current best practice guidelines produced by Historic England (David et al., 2008), the Chartered Institute for Archaeologists (CIfA, 2014) and the European Archaeological Council (Schmidt et al., 2015).

1.4. It was conducted in line with a Written Scheme of Investigation produced by MS (Adams et al, 2020).

1.5. The survey commenced on 16/09/2020 and took 3 days to complete.

2. Quality Assurance

2.1. Magnitude Surveys is a Registered Organisation of the Chartered Institute for Archaeologists (CIfA), the chartered UK body for archaeologists, and a corporate member of ISAP (International Society of Archaeological Prospection).

2.2. The directors of MS are involved in the cutting edge of research and the development of guidance/policy. Specifically, Dr. Chrys Harris has a PhD in archaeological geophysics from the University of Bradford, is a Member of CIfA and is the Vice-Chair of the International Society for Archaeological Prospection (ISAP); Finnegan Pope-Carter has an MSc in archaeological geophysics and is a Fellow of the London Geological Society, as well as a member of GeoSIG (CIfA Geophysics Special Interest Group); Dr. Kayt Armstrong has a PhD in archaeological geophysics from Bournemouth University, is a Member of CIfA, the Editor of ISAP News, and is the UK Management Committee representative for the COST Action SAGA; Dr. Paul Johnson has a PhD in archaeology from the University of Southampton, has been a member of the ISAP Management Committee since 2015, and is currently the nominated representative for the EAA Archaeological Prospection Community to the board of the European Archaeological Association.

2.3. All MS managers have relevant degree qualifications to archaeology or geophysics. All MS field and office staff have relevant archaeology or geophysics degrees and/or field experience.

3. Objectives

3.1. The objective of this geophysical survey is to assess the subsurface archaeological potential of the survey area.

4. Geographic Background

4.1. The survey area was located c.740m west from Newton-in-Bowland (Figure 1). A fluxgate gradiometer survey was undertaken across 6 pasture fields. The survey area was bounded by the River Hodder to the south and arable fields to the north, east and west (Figure 2). Small sections of the survey area were deemed unsurveyable due to the presence of extant buildings, trees, marsh land and animal feeding stations, together these unsurveyed areas equalled c. 1.5ha.

4.2. Survey considerations:

Survey Area	Ground Conditions	Further Notes
1	Pasture field sloping down from the north to south.	Bounded by a metal fence to the north, west and south. The field continued to the east and was bounded by a dry-stone wall and hedges to the north.
2	Pasture field sloping down from north to south.	Bounded to the north and east by dry stone walls, to the south by a metal fence and the west and north west by hedges. Areas of the field to the northeast were unsurveyable due to buildings and animal feeding stations.
3	Pasture field sloping from the northeast corner down to the north, west and south.	Bounded to the north, south and east by metal fences and to the west by a trackway.
4	Pasture field with a slope down from the north and west creating a dip in the east and south-eastern corner of the field.	Bounded on the north, east and west by a metal fence and the field continued to the south. Man-hole covers were present to the south-eastern extent of the survey area.
5	Pasture field sloping down from north to southeast.	Bounded to the north by hedges and trees, to the west and south by a ditch and stream. The field continued to the east.
6	Pasture field bisected by a stream with the landscape sloping down to the east and west on either side.	Bounded to the northeast and east by a dry-stone wall and dense vegetation to the west. The field continued to the west. Areas of the field to the south were unsurveyable due to trees.

4.3. The underlying geology comprises predominantly of Hodder mudstone formation, with Chatburn Limestone formation limited to the northern tip of the survey area and Clitheroe limestone formation on the eastern survey extent. Superficial deposits consists of till, Devensian diamicton covering most of the survey area with a small area of river terrace deposits of sand and gravel to the southeast (British Geological Survey, 2020).

4.4. The soils consist of slowly permeable seasonally wet acid loamy and clayey soils to the north and east and loamy and clayey floodplain soils with naturally high groundwater to the south and west (Soilscapes, 2020).

5. Archaeological Background

5.1. The following is a summary of the Historic Environment Record data provided by ADAS.

5.2. There are two archaeological monuments or sites recorded within the survey area: one to the west, a pre-1930s road known as Carriage Road (PRN20325), and to the east a lime kiln which is recorded on 1st edition OS maps (PRN9842). Bounding the southern edge of the survey area is Knowlmere Manor (MLA37180), a landscaped park dating from 1845.

5.3. Roman activity is recorded in the route of a Roman road (MLA26083) which runs from Ribchester to Tebay, c.95m from the western edge of the survey area. Further evidence of Roman activity in close proximity to the survey area is found in the form of earthworks c.220m from the western edge of the survey area. These earthworks (MLA20284) are recorded as a possible Roman settlement.

5.4. Four limestone quarries (MLA31708, MLA9841, MLA24506, MLA9837) are recorded in the first edition map of 1850. These quarries are predominantly located to the north and east of the survey area. One quarry is now no longer extant and bounds the north eastern edge of the survey area.

6. Methodology

6.1. Magnetometer surveys are generally the most cost effective and suitable geophysical technique for the detection of archaeology in England. Therefore, a magnetometer survey should be the preferred geophysical technique unless its use is precluded by any specific survey objectives or the site environment. For this site, no factors precluded the recommendation of a standard magnetometer survey. Geophysical survey therefore comprised the magnetic method as described in the following section.

6.2. Data Collection

6.2.1. Geophysical prospection comprised the magnetic method as described in the following table.

6.2.2. Table of survey strategies:

Method	Instrument	Traverse Interval	Sample Interval
Magnetic	Bartington Instruments Grad-13 Digital Three-Axis Gradiometer	1m	200Hz reprojected to 0.125m

6.2.3. The magnetic data were collected using MS' bespoke hand-carried GNSS-positioned system.

6.2.3.1. MS' hand-carried system was comprised of Bartington Instruments Grad 13 Digital Three-Axis Gradiometers. Positional referencing was through a multi-channel, multi-constellation GNSS Smart Antenna RTK GPS outputting in NMEA mode to ensure high positional accuracy of collected measurements. The RTK GPS is accurate to 0.008m + 1ppm in the horizontal and 0.015m + 1ppm in the vertical.

6.2.3.2. Magnetic and GPS data were stored on an SD card within MS' bespoke datalogger. The datalogger was continuously synced, via an in-field Wi-Fi unit, to servers within MS' offices. This allowed for data collection, processing and visualisation to be monitored in real-time as fieldwork was ongoing.

6.2.3.3. A navigation system was integrated with the RTK GPS, which was used to guide the surveyor. Data were collected by traversing the survey area along the longest possible lines, ensuring efficient collection and processing.

6.3.Data Processing

6.3.1. Magnetic data were processed in bespoke in-house software produced by MS. Processing steps conform to Historic England's standards for "raw or minimally processed data" (see sect 4.2 in David et al., 2008: 11).

Sensor Calibration – The sensors were calibrated using a bespoke in-house algorithm, which conforms to Olsen et al. (2003).

Zero Median Traverse – The median of each sensor traverse is calculated within a specified range and subtracted from the collected data. This removes striping effects caused by small variations in sensor electronics.

Projection to a Regular Grid – Data collected using RTK GPS positioning requires a uniform grid projection to visualise data. Data are rotated to best fit an orthogonal grid projection and are resampled onto the grid using an inverse distance-weighting algorithm.

Interpolation to Square Pixels – Data are interpolated using a bicubic algorithm to increase the pixel density between sensor traverses. This produces images with square pixels for ease of visualisation.

6.4.Data Visualisation and Interpretation

6.4.1. This report presents the gradient of the sensors' total field data as greyscale images, as well as the total field data from the lower sensors. The gradient of the sensors minimises external interferences and reduces the blown-out responses from ferrous and other high contrast material. However, the contrast of weak or ephemeral anomalies can be reduced through the process of calculating the gradient. Consequently, some features can be clearer in the respective gradient or total field datasets. Multiple greyscale images of the gradient and total field at different plotting ranges have been used for data interpretation. Greyscale images should be viewed alongside the XY trace plot (Figures 7, 10 & 13). XY trace plots visualise the magnitude and form of the geophysical response, aiding in anomaly interpretation.

6.4.2. Geophysical results have been interpreted using greyscale images and XY traces in a layered environment, overlaid against open street maps, satellite imagery, historic maps, LiDAR data, and soil and geology maps. Google Earth (2020) was consulted as well, to compare the results with recent land usages.

6.4.3. Geodetic position of results - All vector and raster data have been projected into OSGB36 (ESPG27700) and can be provided upon request in ESRI Shapefile (.SHP) and Geotiff (.TIF) respectively.

7. Results

7.1.Qualification

7.1.1. Geophysical results are not a map of the ground and are instead a direct measurement of subsurface properties. Detecting and mapping features requires that said features have properties that can be measured by the chosen technique(s) and that these properties have sufficient contrast with the background to be identifiable. The interpretation of any identified anomalies is inherently subjective. While the scrutiny of the results is undertaken by qualified, experienced individuals and rigorously checked for quality and consistency, it is often not possible to classify all anomaly sources. Where possible an anomaly source will be identified along with the certainty of the interpretation. The only way to improve the interpretation of results is through a process of comparing excavated results with the geophysical reports. MS actively seek feedback on their reports as well as reports of further work in order to constantly improve our knowledge and service.

7.2.Discussion

7.2.1. A fluxgate gradiometer survey was carried out over c.14.58ha area of land at Newton-in-Bowland, Lancashire. The geophysical results are presented in consideration with satellite imagery and historic maps (Figure 4).

7.2.2. The fluxgate gradiometer survey has responded relatively well to the environment of the survey area. However, the import of high ferrous content material into the centre of the survey area, likely related to multiple buried services, may be masking weaker underlying features in some areas. The geophysical survey results are characterized by agricultural anomalies and evidence of disturbance caused by made ground and structural features relating to the services. Although some anomalies were ascribed an 'Undetermined origin', no anomalies which conclusively suggest the presence of significant archaeological activity were identified.

7.2.3. An area of localised disturbance has been detected to the east of the survey area. The area within the trajectory of the services and the strong magnetic infill suggests a correlation. Further to this, possible structural features visible within the made ground suggest elements relating to the construction of the services.

7.2.4. Agricultural activity is visible in the magnetic survey that relates to historic and modern ploughing regimes. The topography of the site combined with seasonably wet soils means that survival of these features is more apparent to the north of the site at the highest datum becoming less visible to the south as the ground becomes more saturated leading to the River Hodder.

7.3.Interpretation

7.3.1. General Statements

7.3.1.1. Geophysical anomalies will be discussed broadly as classification types across the survey area. Only anomalies that are distinctive or unusual will be discussed individually.

7.3.1.2. Small gaps are present within the dataset due to extant obstacles on the ground surface at the time of survey. On this site, the survey was prevented by extant buildings, trees, marsh land and animal feeding stations, together these obstacles prevented a total of c. 1.5ha of survey.

7.3.1.3. **Ferrous (Spike)** – Discrete ferrous-like, dipolar anomalies are likely to be the result of isolated modern metallic debris on or near the ground surface.

7.3.1.4. **Ferrous/Debris (Spread)** – A ferrous/debris spread refers to a concentrated deposition of discrete, dipolar ferrous anomalies and other highly magnetic material.

7.3.1.5. **Magnetic Disturbance** – The strong anomalies produced by extant metallic structures along the edges of the field have been classified as 'Magnetic Disturbance'. These magnetic 'haloes' will obscure the response of any weaker underlying features, should they be present, often over a greater footprint than the structure they are being caused by.

7.3.1.6. **Undetermined** – Anomalies are classified as Undetermined when the anomaly origin is ambiguous through the geophysical results and there is no supporting or correlative evidence to warrant a more certain classification. These anomalies are likely to be the result of geological, pedological or agricultural processes, although an archaeological origin cannot be entirely ruled out. Undetermined anomalies are generally not ferrous in nature.

7.3.2. Magnetic Results - Specific Anomalies

7.3.2.1. **Services** – Strong, linear dipolar anomalies are visible throughout the southern half of the survey area indicating the path of multiple buried services (Figures 5-13). This interpretation is based on the strong magnetic enhancement visible in the XY traces along the course of these anomalies (Figures 10 & 13), in addition to their orientation in relation to nearby housing and the below ground services. The largest anomaly, [**2a**], visible throughout the eastern half of the survey area, on a north to south alignment, indicates the path of existing underground services (Figures 5-13). A continuation of this service is extant in the landscape directly south of the survey area, crossing the River Hodder, and the manhole covers noted during survey in the southeast of Area 4 follow the same trajectory (Figures 4, 7, 10 & 13).

7.3.2.2. **Disturbance** – Across Area 2 a zone of strongly enhanced magnetic disturbance has been detected, the XY traces show this is comprised of a mixed material with high ferrous content (Figures 8-10). While this type of magnetic signal can be associated with backfill of quarrying activity, such as the limestone quarries

as noted in the Archaeological Background (Section 5.4), it is considered more likely that this relates to the construction of the buried services due to the scale of the disturbance.

7.3.2.3. **Possible Structural Features** – Within the disturbance of Area 2, some anomalies have been detected which appear to be comprised of consolidated positively enhanced magnetic signals, which differ to the mixed background of the area. These linear, and segmented linear anomalies are concentrated within the west of Area 2 (Figures 8-10). Given their proximity to the existing services, and their survival within the made ground around the services, these anomalies may be related to the infrastructure of the service construction.

7.3.2.4. **Ridge and Furrow** – Across Area 6 a series of parallel linear anomalies have been detected which exhibit a mixed magnetic signal (Figures 5-7). These are relatively closely spaced c.1.5-2m and only a few indicative linear trends have been picked out to give an idea of direction and presence across the site. The close spacing, alternating magnetic signature and meandering path are suggestive of cord rig cultivation practices popular in Northern England. This technique of spade cultivation practice was popular from the later prehistoric to the medieval times. However, an early field system is unlikely to have covered such a large area, c.4.5ha, therefore it is more likely that these anomalies relate to later steam powered cultivation.

7.3.2.5. **Natural** – To the south and southwest of Area 6 two areas have been detected which are visible as a change in the underlying soil composition (Figures 5-7). The soils in this area have been identified as loamy and clayey floodplain soils with naturally high groundwater. A stream was present at the time of survey travelling down the centre of the field from the north to south collected in this area of the field which acts as a natural sump. The seasonably wet soils in this area of the survey may have prevented the naturally occurring chemical processes which produce magnetic enhancement within soils; thus making the data appear very "quiet" when compared to the drier areas of the field where the cultivation is easily visible.

7.3.2.6. **Agricultural** – In Areas 3 and 1 parallel linear anomalies have been detected which exhibit a weak magnetic signal (Figures 8-10). The orientation is well matched with modern cultivation visible in recent satellite imagery and are interpreted as agricultural trends caused by modern ploughing (Figure 4). In Areas 3 and 4 a further series of weak anomalies have been detected and interpreted as modern drainage. These anomalies exhibit differences in their magnetic signature, in comparison to the modern ploughing: they are of mixed alignment and have a wider separation (Figure 8 & 11).

7.3.2.7. **Undetermined** – Anomalies classified as "Undetermined" within the survey area have weak, positive magnetic signals (Figures 8-13). There is no corroborative evidence to confirm an agricultural or archaeological origin for these features: as they do not correspond with any mapped features on

available historic maps (Figure 4). Whilst these do not present an identifiable pattern, the defined edges of the anomalies suggest they should be considered to have anthropogenic potential; however, no confident interpretation can be provided.

8. Conclusions

8.1. A fluxgate gradiometer survey has been undertaken across the survey area. The geophysical survey has detected anomalies relating to existing below ground services and of agricultural origin. The topography of the site predominantly sloping down from the north to the south/southeast along with the seasonably wet and permeable soil overlying limestone bedrock means that the north of the site which is well draining allows for stronger magnetic visibility as opposed to the south leading down the river where the permeability of the soils means that the magnetic background appears quieter. The anomalies ascribed an 'Undetermined' classification lack any distinctive archaeological shape or pattern; as such, no anomalies indicative of significant archaeological activity has been identified. Modern interference consists of ferrous 'haloes' caused by the multiple buried services and disturbance caused by proximity to properties bordering the site and metal boundary fences.

8.2. An area of disturbance has been detected to the centre of the survey area. This area is most likely related to the construction of multiple below ground services. Possible structural features have also been detected within the made ground believed to correlate with the services and their wider construction.

8.3. Historic agricultural methods have been detected to the north of the site in the form of possible cord rig or later steam powered cultivation. Modern ploughing and drainage features are visible throughout the south of the survey area.

9. Archiving

9.1. MS maintains an in-house digital archive, which is based on Schmidt and Ernenwein (2013). This stores the collected measurements, minimally processed data, georeferenced and un-georeferenced images, XY traces and a copy of the final report.

9.2. MS contributes reports to the ADS Grey Literature Library upon permission from the client.

10. Copyright

10.1. Copyright and the intellectual property pertaining to all reports, figures, and datasets produced by Magnitude Services Ltd. is retained by MS. The client is given full licence to use such material for their own purposes. Permission must be sought by any third party wishing to use or reproduce any IP owned by MS.

11. References

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12. Project Metadata

MS Job Code	MSSD763A
Project Name	Newton-in-Bowland Compound
Client	ADAS
Grid Reference	SD689502
Survey Techniques	Magnetometry
Survey Size (ha)	14.58ha (Magnetometry)
Survey Dates	2020-09-16 to 2020-09-18
Project Lead	Dr Paul S. Johnson BA MA PhD
Project Officer	Leanne Swinbank, BA ACIfA
OASIS No	TBC
Report Version	1.0

13. Document History

Version	Comments	Author	Checked By	Date
0.1	Initial draft for Project Lead to Review	LAG	LS	23 September 2020
0.2	Draft for Director Sign off	LAG	PJ	24 September 2020
0.3	Draft for Client	LAG	FPC	25 September 2020
1.0	Issued as final following client corrections. Sent to director sign off.	LS	FPC	13 October 2020

MSSD763 - Newton-in-Bowland
Figure 1 - Site Location
1:25,000 @ A4

Site Boundary

N

0 0.5 1 km

magnitude surveys

MSSD763 - Newton-in-Bowland
Figure 2 - Location of Survey Areas
1:5,000 @ A3

Survey Extent

N

0 100 200 300 m

magnitude surveys

368900

450450

450450

Back Lane

Cemetery

The Coach House

Area 6

Area 3

Area 2

Area 1

Area 5

Area 4

Forber Plantation

Fober Farm

Fober Barn

Knoll Wood

MSSD763 - Newton-in-Bowland
Figure 3 - Magnetic Total Field (Lower Sensor) (Overview)
1:3,000 @ A3

48,990 nT 49,020

N

0 100 200 300 m

magnitude surveys

368900

450450

450450

Area 1

Area 2

Area 3

Area 4

Area 5

Area 6

MSSD763 - Newton-in-Bowland
Figure 4 - Magnetic Interpretation Over Satellite Imagery and Historic Maps (Overview)
1:3,000 @ A3

- Agricultural (Weak)
- Possible Structural Feature
- Disturbance
- Natural (Weak)
- Natural (Zone)
- Magnetic Disturbance
- Ferrous/Debris (Spread)
- Undetermined (Strong)
- Undetermined (Weak)
- Agricultural (Trend)
- Service
- Ridge and Furrow (Trend)
- Drainage Feature
- Ferrous (Spike)

N

0 100 200 300 m

magnitude surveys

368600
368800
369000
450600
450600
Area 6
450400
450400
MSSD763 - Newton-in-Bowland
Figure 5 - Magnetic Gradient (Area 6)
1:1,500 @ A3

-1 nT -2
N
0 40 80 120 m
magnitude surveys

368600 368800 369000

450600 450600

Area 6

450400 450400

MSSD763 - Newton-in-Bowland
Figure 6 - Magnetic Interpretation (Area 6)
1:1,500 @ A3

- Agricultural (Weak)
- Possible Structural Features
- Disturbance
- Natural (Weak)
- Natural (Zone)
- Magnetic Disturbance
- Undetermined (Strong)
- Undetermined (Weak)
- Agricultural (Trend)
- Service
- Ridge and Furrow (Trend)
- Drainage Feature
- Ferrous (Spike)

N

0 40 80 120 m

magnitude surveys

368600

368800

369000

450600

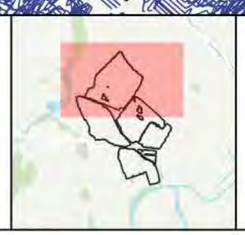
450600

Area 6

450400

450400

MSSD763 - Newton-in-Bowland
Figure 7 - XY Trace Plot (Area 6)
30nT/cm at 1:1,500 @ A3



N

0 40 80 120 m

magnitude surveys

368600
368800
369000
450400
450400
Area 6
Area 3
Area 2
450200
450200
Area 1
Fober Farm
Area 5

MSSD763 - Newton-in-Bowland
Figure 8 - Magnetic Gradient (Areas 1, 2 & 3)
1:1,500 @ A3

-1 nT -2

N

0 40 80 120 m

magnitude surveys

368600
368800
369000
450400
450200
Area 6
Area 3
Area 2
2a
Area 1
Area 5
Fober Farm

MSSD763 - Newton-in-Bowland
Figure 9 - Magnetic Interpretation (Areas 1, 2 & 3)
1:1,500 @ A3

- Agricultural (Weak)
- Possible Structural Features
- Disturbance
- Natural (Weak)
- Natural (Zone)
- Magnetic Disturbance
- Undetermined (Strong)
- Undetermined (Weak)
- Agricultural (Trend)
- Service
- Ridge and Furrow (Trend)
- Drainage Feature
- Ferrous (Spike)

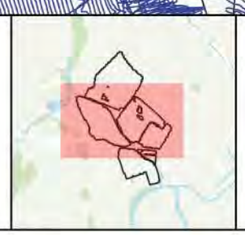
N

0 40 80 120 m

magnitude surveys

368600
368800
369000
450400
450200
Area 6
Area 3
Area 2
Area 1
Area 5
Fober Farm

MSSD763 - Newton-in-Bowland
Figure 10 - XY Trace Plot (Areas 1, 2 & 3)
30nT/cm at 1:1,500 @ A3



N

0 40 80 120 m

magnitude surveys

368600

368800

450200

450200

Area 1

Fober Farm

Area 5

450000

450000

Area 4

Fober Barn

MSSD763 - Newton-in-Bowland
Figure 11 - Magnetic Gradient (Areas 4 & 5)
1:1,500 @ A3

-1 nT -2

N

0 40 80 120 m

magnitude surveys

368600
368800
369000
450200
450000
2a
Area 1
Area 5
Area 4
Fober Farm
Fober Barn

MSSD763 - Newton-in-Bowland
Figure 12 - Magnetic Interpretation (Areas 4 & 5)
1:1,500 @ A3

Agricultural (Weak)
Possible Structural Features
Disturbance
Magnetic Disturbance
Ferrous/Debris (Spread)
Undetermined (Weak)
Agricultural (Trend)
Service
Drainage Feature
Ferrous (Spike)

N
0
40
80
120 m

magnitude surveys

368600

368800

369000

450200

450200

Area 1

Fober Farm

Area 5

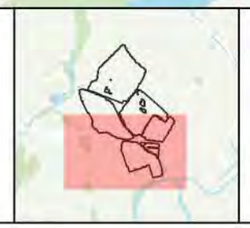
450000

450000

Area 4

Fober Barn

MSSD763 - Newton-in-Bowland
Figure 13 - XY Trace Plot (Areas 4 & 5)
30nT/cm at 1:1,500 @ A3



N

0 40 80 120 m

magnitude surveys