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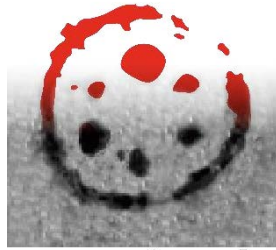
**Land at Church Bank
Burton-in-Kendal, Cumbria**

Geophysical Survey Report MSSD21

**For
Lake District Developments Ltd**

Magnitude Surveys Ref: MSSD21

May 2016



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Abstract

Magnitude Surveys was commissioned to assess the archaeological potential of c. 1 ha are of land at Church Bank, Burton-in-Kendal, Cumbria. A full coverage cart-based fluxgate gradiometer survey was successfully completed; no anomalies of probable or possible archaeological origin were detected. The geophysical results primarily reflect modern site activity, including nearby structures, ferrous waste and pedestrian activity.

Contents

1. Introduction	1
2. Quality Assurance	1
3. Objectives.....	1
4. Geographic Background	2
5. Archaeological Background.....	2
6. Methodology.....	2
6.1. Data Collection	2
6.2. Data Processing.....	3
6.3. Data Visualisation	3
7. Survey Considerations	4
8. Results	4
8.1. Qualification.....	4
8.2. Discussion.....	4
8.3. Interpretation.....	5
9. Conclusions	5
10. Archiving	6
11. Copyright.....	6
12. References	6

List of Figures

Figure 1:	Site Location	1:25,000 @ A4
Figure 2:	Survey Area	1:10,000 @ A4
Figure 3:	Magnetic Greyscale	1:1000 @ A3
Figure 4:	Magnetic Interpretation	1:1000 @ A3
Figure 5:	Magnetic Interpretation – Satellite	1:1000 @ A3
Figure 6:	Magnetic Interpretation - Historic	1:1500 @ A3



1. Introduction

- 1.1. Magnitude Surveys Ltd (MS) was commissioned by Lake District Development (LDD) to undertake a geophysical survey on land at Church Bank, Burton-in-Kendal, Cumbria (SD 532 768). The geophysical survey comprised:
 - 1.1.1. Hand-pulled, cart-mounted fluxgate gradiometer survey.
- 1.2. The survey was conducted in line with the current best practice guidelines produced by Historic England (David et al., 2008), the Chartered Institute of Field Archaeologists (CIfA, 2014) and the European Archaeological Council (Schmidt et al., 2015).
- 1.3. The survey was also conducted in line with the written scheme of investigation submitted to the Historic Environment Team at Cumbria County Council prior to the survey.
- 1.4. The survey commenced on 10 May 2016 and took one day to complete.

2. Quality Assurance

- 2.1. Project management, survey work, data processing and report production have been carried out by qualified and professional geophysicists to standards exceeding the current best practice (CIfA, 2014; David et al., 2008, Schmidt et al., 2015).
- 2.2. Magnitude Surveys is a corporate member of ISAP (International Society of Archaeological Prospection).
- 2.3. Director Graeme Attwood is a Member of the Chartered Institute for Archaeologists (CIfA), the chartered UK body for archaeologists, as well as a member of GeoSIG, the CIfA Geophysics Special Interest Group.
- 2.4. Director Finnegan Pope-Carter is a Fellow of the London Geological Society, the chartered UK body for geophysicists and geologists, as well as a member of GeoSIG, the CIfA Geophysics Special Interest Group.
- 2.5. All MS staff members have postgraduate qualifications in archaeological geophysics.

3. Objectives

- 3.1. The geophysical survey aimed to assess the potential archaeological landscape of the survey area.
- 3.2. The survey forms part of the archaeological mitigation recommended by the Cumbria County Council Historic Environment Officer.

4. Geographic Background

- 4.1. The underlying geology comprises Great Scar Limestone Group with no recorded superficial deposits (BGS, 2016). Historic England guidelines state the average magnetic response over limestone is good (David et al., 2008: 15).
- 4.2. The soils consist of freely draining slightly acid loamy soils (Soilscapes, 2016).
- 4.3. Survey was undertaken over a single field, which sloped gently from NW – SE. At the time of survey, the field had been used subject to regular pedestrian activity, evidenced by footpaths traversing the site. The survey area's grass had recently been cut, but not cleared. Evidence for modern rubbish was present on site, including barbed wire and remnants of fencing. Thicker brush around the site's edges precluded survey in some areas.

5. Archaeological Background

- 5.1. The following archaeological background summarises record archaeological features within a 1 km radius of the survey area. Most of the recorded archaeological activity in this area comprises medieval and post-medieval activity. However, the remains of a Roman road have been recorded out with this area, lying approximately 1.7 km south of the survey area (43018).
- 5.2. The survey area is within Burton-in-Kendal, a medieval town mentioned in the Domesday book (931865). Further medieval activity has been recorded in the area, including field systems and lynchets (1578026). A shrunken medieval village has been recorded approximately 700 m NE of the survey area (43021).
- 5.3. The Burton House, a post-medieval building of special interest, lies approximately 700 m SW of the survey area (43022). Further post-medieval activity has been recorded in the area, including ridge and furrow (1577792) and field boundaries (1578011), some of which may be of medieval origin (1578047).

6. Methodology

6.1. Data Collection

6.1.1. Geophysical prospection comprised magnetic methods as described in the following table.

6.1.2. Table of survey strategies:

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

6.1.3. Magnetic data were collected using MS' bespoke hand-pulled cart system.

6.1.3.1. The cart system supports the magnetic and GPS instruments with a bespoke datalogger. The magnetic instrument comprises four Bartington Instruments Grad-13 Digital Three-Axis Gradiometer operating in NMEA mode. Positional referencing is through a Hemisphere S321 RTK GPS outputting in NMEA mode. Corrections were made through Topcon TopNet. Data from both instruments were logged in a bespoke datalogger. Data were transferred to a laptop computer for processing.

6.1.3.2. A series of temporary sight markers were established in each survey area to guide the surveyor and ensure full coverage with the cart. Data were collected by traversing the survey area along the longest possible lines, to ensure that the data was efficiently collected and processed.

6.2. Data Processing

6.2.1. Magnetic data were processed in bespoke in-house software produced by MS. Processing steps were limited to:

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.

6.3. Data Visualisation

6.3.1. Geophysical results have been interpreted using greyscale images and XY traces in a layered environment.

6.3.2. This report presents geophysical results as greyscale images. Greyscale images should be viewed alongside the XY trace plots, found on the archive disk. XY trace plots visualise the magnitude and form of the geophysical response, aiding in anomaly interpretation.

7. Survey Considerations

Survey Area	No. Survey Blocks	Surveyed Y/N	Ground Conditions	Further Notes
1	1	Y	Gently slopes down from NW - SE previously covered by long grass that was cut, but not cleared, before survey. Thicker brush around the site's edges precluded survey in some areas.	Houses around the site's perimeter have produced overwhelming magnetic responses. At the site's northeast corner, trailers and digging equipment have produced overwhelming magnetic responses.

8. Results

8.1. Qualification

8.1.1. Geophysical techniques 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.

8.2. Discussion

8.2.1. The geophysical results were interpreted in consideration with satellite imagery (Bing, 2016; Figure 5) and historic mapping (Ordnance Survey, 6" 2nd edition c.1882-1913; Figure 6).

8.2.2. The magnetic survey has responded well to the survey area's environment. No anomalies of probable or possible archaeological have been identified. The geophysical results primarily reflect modern site activity. Nearby structures, machinery and modern waste have produced overwhelming ferrous responses that may mask any weaker archaeological anomalies, should they be present. Pedestrian activity across the site contributes to the presence of discrete, ferrous-like anomalies ("ferrous spikes") and linear anomalies that likely represent natural footpaths.

8.3. Interpretation

8.3.1. General Statements

- 8.3.1.1. Geophysical anomalies will be discussed broadly as classification types across the survey area. Only anomalies that are distinctive or unusual will be discussed individually.
- 8.3.1.2. **Ferrous** – A number of discrete, ferrous-like anomalies (“spikes”) have been mapped throughout the survey area. These responses are likely to be the result of modern metallic disturbance on or near the ground surface. Broad ferrous responses from modern metallic features, such as fences, gates and neighbouring buildings may mask any weaker underlying archaeological anomalies should they be present.

8.3.2. Magnetic Results - Specific Anomalies

- 8.3.2.1. **Natural** – A number of magnetically weak linear and rectilinear anomalies traverse across the survey area. Given the weak strength of the geophysical response and their comparable proximity and orientation to footpaths visible in satellite imagery (Figure 5), these anomalies are likely caused by pedestrian traffic.

9. Conclusions

- 9.1. The geophysical survey has responded well to the survey area’s modern environment. The geophysical results primarily reflect modern site activity, including nearby structures, ferrous waste and pedestrian activity. No anomalies of probable or archaeological origin have been identified.

10. Archiving

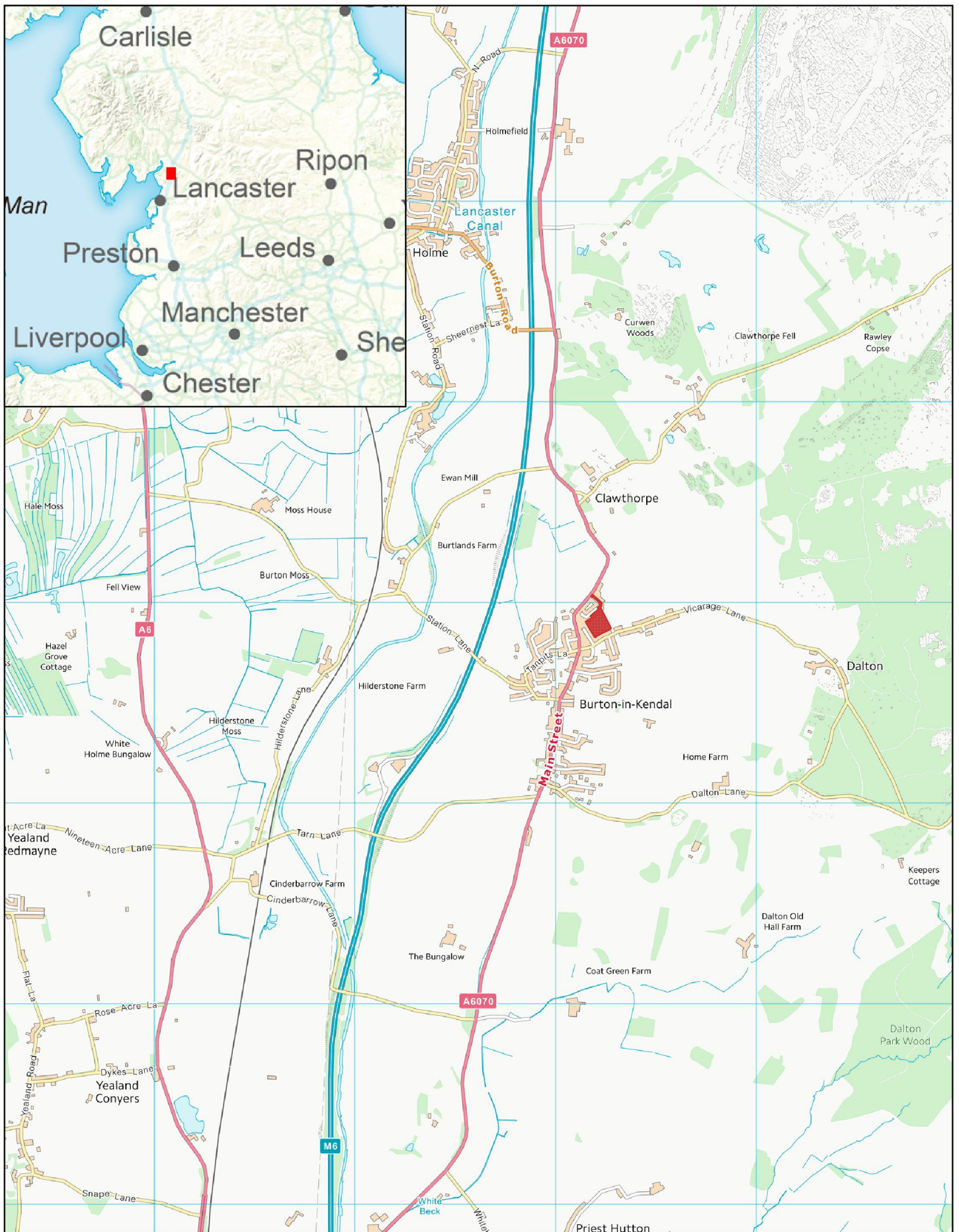
- 10.1. MS maintains an in-house digital archive, which is based on Schmidt and Ernenwein (2013).
- 10.2. MS contributes all reports to the ADS Grey Literature Library subject to any time embargo dictated by the client.
- 10.3. Whenever possible, MS has a policy of making data available to view in easy to use forms on its website. This can benefit the client by making all of their reports available in a single repository, while also being a useful resource for research. Should a client wish to impose a time embargo on the availability of data this can be achieved in discussion with MS.

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12. References

- Bing, 2016. Burton-in-Kendal. 54°11'09.88N, 2°43'04.55"W. ©Bing. [Accessed 11/05/2016].
- British Geological Survey, 2016. Geology of Britain. Burton-in-Kendal, Cumbria, LA6 1NR. [<http://mapapps.bgs.ac.uk/geologyofbritain/home.html/>]. [Accessed 11/05/2016].
- Chartered Institute for Archaeologists, 2014. Standards and guidance for archaeological geophysical survey. ClfA.
- David, A., Linford, N., Linford, P. and Martin, L., 2008. Geophysical survey in archaeological field evaluation: research and professional services guidelines (2nd edition). Historic England.
- Ordnance Survey, 6th 2nd edition c.1882-1913. National Library of Scotland, 2016 [<http://maps.nls.uk>]. [Accessed 11/05/2016].
- Schmidt, A. and Ernenwein, E., 2013. Guide to Good Practice: Geophysical Data in Archaeology. 2nd ed., Oxbow Books, Oxford.
- Schmidt, A., Linford, P., Linford, N., David, A., Gaffney, C., Sarris, A. and Fassbinder, J., 2015. Guidelines for the use of geophysics in archaeology: questions to ask and points to consider. EAC Guidelines 2. European Archaeological Council: Belgium.
- Soilscapes, 2016. Burton-in-Kendal, Cumbria, LA6 1NR. Cranfield University, National Soil Resources Institute [<http://landis.org.uk>]. [Accessed 11/05/2016].



MSSD21 - Land at Church Bank, Burton-in-Kendal

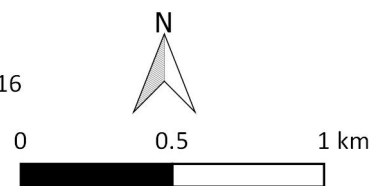
Figure 1 - Site Location

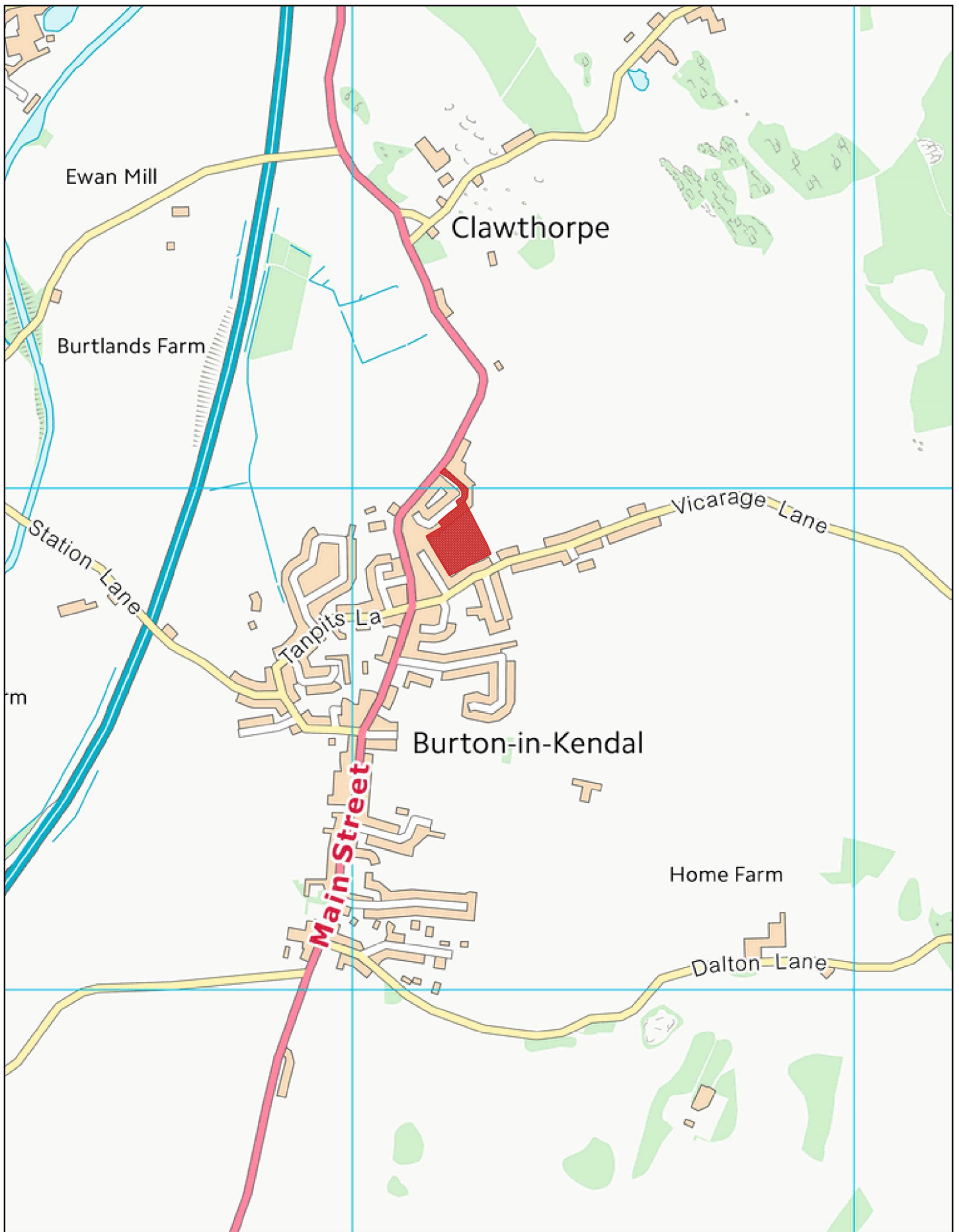
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 Survey Area





MSSD21 - Land at Church Bank, Burton-in-Kendal

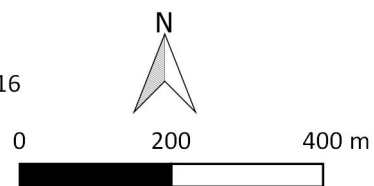
Figure 2 - Location of Survey Area

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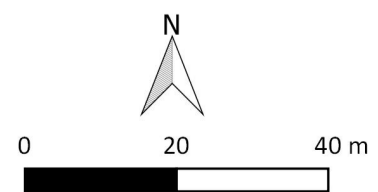
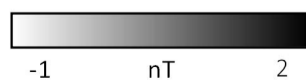
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 Survey Area









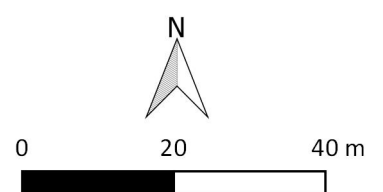
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Figure 3 - Magnetic Greyscale
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



MSSD21 - Land at Church Bank, Burton-in-Kendal
Figure 4 - Magnetic Interpretation
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-  Survey Border
-  Natural (Weak)
-  Ferrous (Dipolar)
-  Ferrous Spike

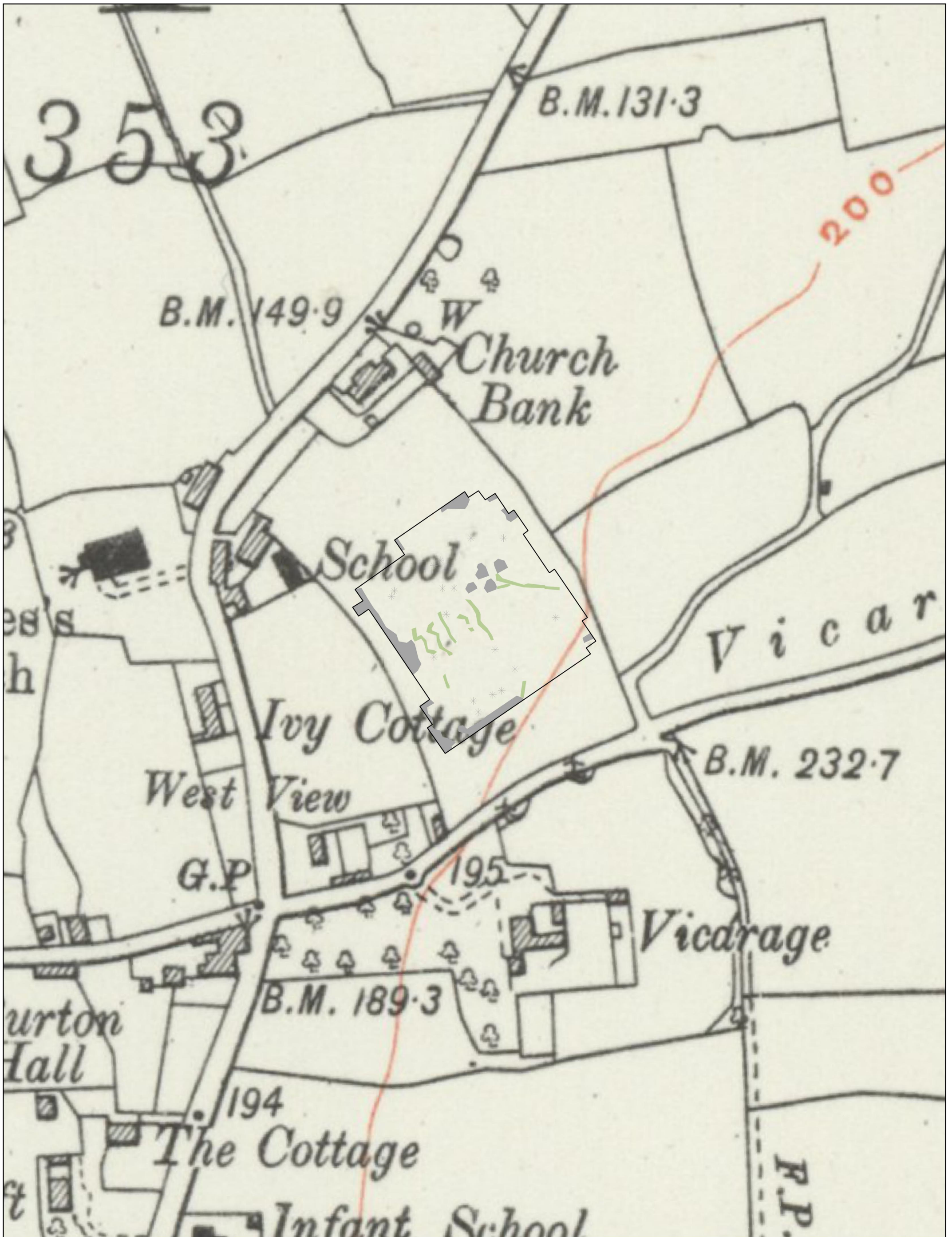








MSSD21 - Land at Church Bank, Burton-in-Kendal
 Figure 5 - Magnetic Interpretation - Satellite
 1 : 1000 @ A3
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 Satellite Imagery © Bing 2016

-  Survey Border
-  Natural (Weak)
-  Ferrous (Dipolar)
-  Ferrous Spike





MSSD21 - Land at Church Bank, Burton-in-Kendal
 Figure 6 - Magnetic Interpretation - Historic Mapping
 1 : 1500 @ A3
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 Historic mapping Ordnance Survey, 6" 2nd edition
 c.1882-1913. National Library of Scotland

-  Survey Border
-  Natural (Weak)
-  Ferrous (Dipolar)
-  Ferrous Spike

