Geophysical Survey Report

of

Land off Clitheroe Road, Whalley

For

Salford Archaeology

On Behalf Of

Delta-Simons

Magnitude Surveys Ref: MSSD361

August 2018

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Draft	1.0	Peter Turner BSc MSc	Peter Turner BSc MSc	Finnegan Pope-Carter BSc MSc FGS	22 August 2018
First Revision	1.1	Peter Turner BSc MSc	Peter Turner BSc MSc	Finnegan Pope-Carter BSc MSc FGS	23 August 2018

Abstract

Magnitude Surveys was commissioned to assess the subsurface archaeological potential of a c. 10.3ha area of land off Clitheroe Road, Whalley, Lancashire. A fluxgate magnetometer survey was successfully completed and has identified an area of possible quarrying, evidence of historic agricultural activity, and a number of anomalies caused by natural soil or geological variation.

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1. Introduction

1.1. Magnitude Surveys Ltd (MS) was commissioned by Salford Archaeology on behalf of Delta-Simons to undertake a geophysical survey on a c.10.3ha area of land off Clitheroe Road, Whalley, Lancashire (SD 7377 3637).

1.2. The geophysical survey comprised hand-pulled cart-mounted, GNSS-positioned fluxgate magnetometer survey.

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. The survey commenced on 16/08/2018 and was completed on the following day.

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. Director Graeme Attwood is a Member of CIfA, as well as the Secretary of GeoSIG, the CIfA Geophysics Special Interest Group. 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. Director Chrys Harris has a PhD in archaeological geophysics from the University of Bradford and is the Vice-Chair of the International Society for Archaeological Prospection.

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 geophysical survey aimed to assess the subsurface archaeological potential of the survey area.

4. Geographic Background

4.1. The site is located, to the east of the village of Whalley, and approximately 10km from the centre of Blackburn (Figure 1). Survey was undertaken across two areas of grass fields. The site is bounded to the west by a building site along Clitheroe Road, to the east by Accrington Road (A680), to the north and south by further grass fields, and to the south-west by residential buildings along Sydney Avenue and Woodland Park (Figure 2).

4.2. Survey considerations:

Survey Area	Ground Conditions	Further Notes
1	Pasture field; ground sloped gently downwards on either side of a gully in the southern half of the area. A farm track ran east-west across the northern half of the site; a number of patches of disturbed ground were scattered around the area.	Area was bounded to the north and north-west by stone walls, wire fences to the east and south-west, and by trees on the southern side. Small watercourses run along the northern and south-eastern boundaries
2	Pasture field; level ground. A number of patches of disturbed ground were scattered around the area.	Area was bounded by wire fence on all sides, and additionally by a hedge along the eastern boundary. A small stream runs along the northern boundary.

4.3. The underlying geology comprises Bowland shale formation mudstone. Superficial deposits are recorded as Devensian till diamicton (British Geological Survey, 2018).

4.4. The soils consist of slowly permeable, seasonally wet acid loamy and clayey soils in Area 2 and the west of Area 1; in the south-eastern quadrant of Area 1, soils consist of freely draining slightly acid loamy soils (Soilscapes, 2018).

5. Archaeological Background

5.1. The following section summarises information from a 1km radius search on Heritage Gateway.

5.2. Portfield Camp, an Iron Age promontory fort is recorded approximately 1km to the southwest of the Site. Excavation in the 1960s recovered a Bronze Age hoard, as well as pits containing Neolithic, Roman, and Mediaeval pottery.

5.3. Approximately 800m to the south-west of the site are the remains of Whalley Abbey, a 13th century Cistercian monastery which was dissolved in 1536. Upstanding remains include the north-east gatehouse, the north wall with round bastions, the ruins of the east and south ranges of the cloister, the abbot's lodging, the late 13th century Peter of Chester's Chapel, the north-west gateway and the foundations of the nave. Immediately to the east of the abbey is the site of the 17th century Assheton mansion. Immediately to the north of the Abbey is the site of a monastic village enclosure that contained fishponds.

5.4. Immediately to the west of Area 1 is the location of an 18th century manor. Historic mapping shows little change within the site; the exception is a field boundary recorded as a row of trees

in the 1st edition OS map of 1848. This boundary is still visible as a pronounced ridge both on the ground surface, and in the LiDAR data.

6. Methodology

6.1. Data Collection

6.1.1. Geophysical prospection comprised the magnetic method 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	1m	200Hz reprojected to 0.125m

6.1.3. The magnetic data were collected using MS' bespoke hand-pulled, GNSS-positioned cart system.

6.1.3.1. MS' cart 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.

6.1.3.2. 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.

6.1.3.3. 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.

6.2. Data Processing

6.2.1. 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.

6.3.Data Visualisation and Interpretation

6.3.1. This report presents the gradient of the sensors' total field data as greyscale images, as well as the total field data from the upper and/or 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 at different plotting ranges have been used for data interpretation. Greyscale images should be viewed alongside the XY trace plot (Figure 9). XY trace plots visualise the magnitude and form of the geophysical response, aiding in anomaly interpretation.

6.3.2. 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 (2018) was consulted as well, to compare the results with recent land usages.

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. The geophysical results are presented in consideration with satellite imagery (Figure 6), historic maps (Figure 7), LiDAR (Figure 8), and XY trace plots (Figure 9)

7.2.2. The fluxgate magnetometer survey has responded well to the survey area's environment in spite of large ferrous responses scattered across the site; both the background and the detected anomalies at the site show relatively low magnetic enhancement, and this may limit the detection of subtle features. A large rectilinear anomaly (potentially the result of quarrying) has been detected in Area 1 along with some evidence of historic agricultural activity and a small group of weak linear anomalies that may form a small enclosure.

7.2.3. In the southern half of Area 1, the survey has detected an anomaly immediately to the south of the rectilinear feature that is roughly coincident with a gully visible on the LiDAR data; it has therefore been interpreted as natural in origin.

7.2.4. Modern disturbance is visible across the site as strong dipolar anomalies, as well as strong negative anomalies representing magnetic disturbance. Many of these are coincident with patches of disturbed ground visible at the site and may be related to nearby building activity. A large service feature crosses the southern part of Area 1.

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. **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.

7.3.1.3. **Ferrous (Discrete/Spread)** – Discrete ferrous-like, dipolar anomalies are likely to be the result of modern metallic disturbance on or near the ground surface. A ferrous spread refers to a concentrated deposition of these discrete, dipolar anomalies. Broad dipolar ferrous responses from modern metallic features, such as fences, gates, neighbouring buildings and services, may mask any weaker underlying archaeological anomalies should they be present.

7.3.2. Magnetic Results - Specific Anomalies

7.3.2.1. **Possible Quarrying –** In the southern half of area 1, near the building site at the western boundary of the survey area is a large rectilinear anomaly [**1a**]. This anomaly is approximately 25m by 18m and shows evidence of internal structure. The strength of this anomaly is comparatively weak, which argues against it being the result of a substantial structure. A more likely explanation is that this is the result of quarrying activity.

7.3.2.2. **Natural -** Immediately to the south and south-east of [**1a**] are a series of weak natural anomalies [**1b**] that are roughly coincident with the sides of a shallow gully visible on the LiDAR data; they have therefore been interpreted as a natural feature.

7.3.2.3. **Agricultural** – A number of historic field boundaries and areas of ridge and furrow agriculture are visible in the LiDAR data; some of these can be detected in the magnetometer data, especially in the north-west of Area 1 [**1c**].

7.3.2.4. **Undetermined –** In the northern half of Area 1 is a small group of faint linear anomalies [**1d**] suggestive of a small enclosure, perhaps associated with the earthwork visible in the LiDAR data immediately to the west (Figure 8). Near the northern boundary of Area 2 is a region of slightly enhanced material containing moderately strong, scattered anomalies [**2a**]. Some of these anomalies show apparent patterning, but without further context these cannot be confidently distinguished from scattered magnetic material common near agricultural field boundaries; they have therefore been classified as ‘undetermined’.

8. Conclusions

8.1. The magnetometer survey has identified a number of anomalies of possible archaeological origin as well as historic agricultural features, in spite of weak magnetic contrast and ferrous noise at the site.

8.2. A large rectilinear anomaly in the southern half of Area 1 shows some internal structure; while this may be suggestive of a building, the strength and character of the anomaly makes quarrying a more likely explanation. ; natural anomalies are associated with a gully at the southern end of the rectilinear feature.

8.3. A group of linear ditch-like anomalies in the northern half of area 1 may suggest the presence of a small enclosure, but these cannot be confidently classified without further information.

8.4. Scattered anomalies near the northern boundary of Area 2 appear to show some degree of patterning, but cannot be confidently distinguished from random deposition of material near the field boundary.

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, subject to the any dictated time embargoes.

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.

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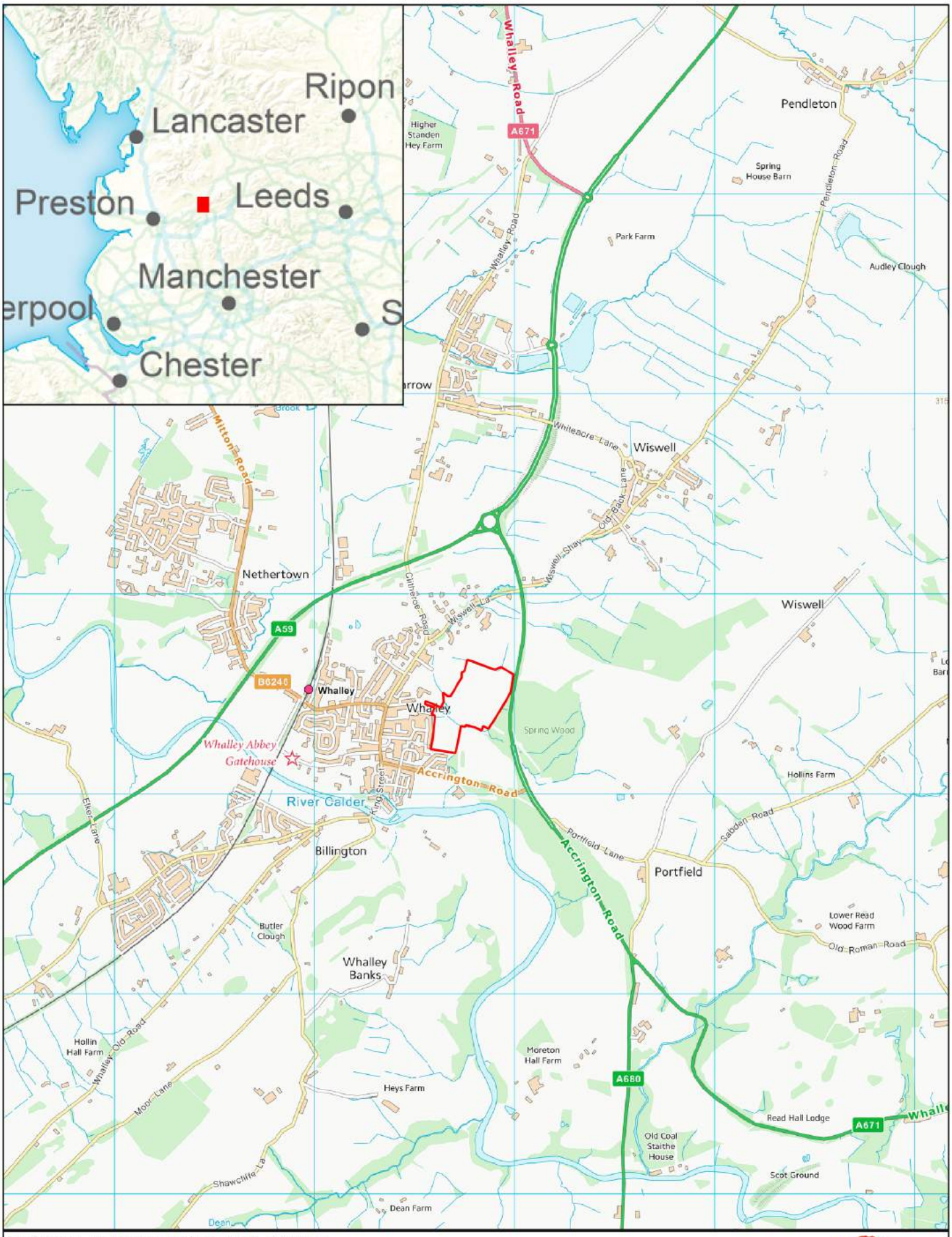

MSSD361 - Land off Clitheroe Road, Whalley
Figure 1 - Site Location
1:25,000 @ A4
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OS (100056946)

Site Boundary

0 0.5 1 km

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Figure 2 - Location of Survey Area / Areas (DELETE AS APPROPRIATE)
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Survey Extent

N

0 100 200 300 m

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373400 373500 373600 373700 373800 373900 374000 374100

436600 436500 436400 436300 436200

Area 1

Area 2

Whalley

Spring

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Figure 3 - Magnetic Total Field (Upper Sensor)
1:2,000 @ A3
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-48,999 nT 49,002

N

0 50 100 150 m

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373400 373500 373600 373700 373800 373900 374000 374100

436600 436500 436400 436300 436200

Area 1

Area 2

Whalley

Spring

MSSD361 - Land off Clitheroe Road, Whalley
Figure 4 - Magnetic Gradient
1:2,000 @ A3
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-0.5 nT 1

N

0 50 100 150 m

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MSSD361 - Land off Clitheroe Road, Whalley
Figure 5 - Magnetic Interpretation
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Possible Quarrying
Agricultural (Strong)
Agricultural (Weak)
Agricultural (Trend)
Natural (Weak)
Undetermined (Strong)
Undetermined (Weak)
Undetermined (Trend)
Ferrous (Dipolar)
Ferrous (Spread)/Magnetic Disturbance
Service

N

0 50 100 150 m

magnitude surveys

MSSD361 - Land off Clitheroe Road, Whalley
Figure 6 - Magnetic Interpretation Over Satellite Imagery
1:3,000 @ A3
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Possible Quarrying
Agricultural (Strong)
Agricultural (Weak)
Agricultural (Trend)
Natural (Weak)
Undetermined (Strong)
Undetermined (Weak)
Undetermined (Trend)
Ferrous (Dipolar)
Ferrous (Spread)/Magnetic Disturbance
Service

N

0 50 100 150 m

magnitude surveys

MSSD361 - Land off Clitheroe Road, Whalley
Figure 7 - Magnetic Interpretation Over Historic Maps
1:3,000 @ A3
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Contains historic maps: Ordnance Survey, 6" 2nd edition c. 1882-1913 © National Library of Scotland

Possible Quarrying
Agricultural (Strong)
Agricultural (Weak)
Agricultural (Trend)
Natural (Weak)
Undetermined (Strong)
Undetermined (Weak)
Undetermined (Trend)
Ferrous (Dipolar)
Ferrous (Spread)/Magnetic Disturbance
Service

N

0 50 100 150 m

magnitude surveys

373200 373300 373400 373500 373600 373700 373800 373900 374000 374100 374200 374300

436700 436600 436500 436400 436300 436200 436100

1c 1d Area 1 1a 1b 2a Area 2

MSSD361 - Land off Clitheroe Road, Whalley
Figure 8 - Magnetic Interpretation Over LiDAR (Hillshaded DTM)
1:3,000 @ A3
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Contains LiDAR data: © Environment Agency copyright and/or database right 2015

Possible Quarrying
Agricultural (Strong)
Agricultural (Weak)
Agricultural (Trend)
Natural (Weak)
Undetermined (Strong)
Undetermined (Weak)
Undetermined (Trend)
Ferrous (Dipolar)
Ferrous (Spread)/Magnetic Disturbance
Service

N

0 50 100 150 m

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MSSD361 - Land off Clitheroe Road, Whalley
Figure 9 - XY Trace Plot
20nT/cm at 1:2,000 @ A3
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N

0 50 100 150 m

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