Geophysical Survey Report

of

Guard 5140: Girvan Archaeological Geophysical Survey, Girvan, South Ayrshire

For

GUARD Archaeology Ltd

On Behalf Of

SGN

Magnitude Surveys Ref: MSNX422

HER Event Number: [TBC]

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Abstract

Magnitude Surveys was commissioned to assess the subsurface archaeological potential of a c. 1 ha area of land at Girvan, South Ayrshire, Scotland. A fluxgate magnetometer survey was successfully carried out and no anomalies of potential archaeological origin have been identified. The geophysical results primarily reflect a broad, varying scatter of strongly magnetic debris across most of the site against what appears to be a quieter magnetic background. This debris is considered to the possible result of construction activity associated with the construction of modern roads at the edges of the site. The responses from this debris may have obscured weaker responses from natural or anthropogenic features, if they were present. Magnetic disturbance was limited to responses from wire fencing at the edges of the survey area, and a buried service in the south of the site.

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1. Introduction

1.1. Magnitude Surveys Ltd (MS) was commissioned by GUARD Archaeology on behalf of SGN to undertake a geophysical survey on a c.1 ha area of land at Girvan, South Ayrshire (NGR: NX 1921 9915).

1.2. The geophysical survey comprised hand-carried 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 was conducted in line with a Written Scheme of Investigation (Nelson, 2019).

1.5. The survey commenced on 04/02/19 and took one day 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. Director Dr. Chrys Harris is a Member of CIfA, has a PhD in archaeological geophysics from the University of Bradford and is the Vice-Chair of ISAP. 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. Reporting Analyst Dr. Kayt Armstrong has a PhD in archaeological geophysics from Bournemouth University, is the Vice Conference Secretary and Editor of ISAP News for ISAP, and is the UK Management Committee representative for the COST Action SAGA.

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 approximately 1.3 km north-east of the centre of the town of Girvan, South Ayrshire (Figure 1). Survey was undertaken over a c. 1ha area comprising a single field of flat pasture immediately south-east of Girvan Mains Farm. The survey area was bounded by the road A57 to the east, the Maybole-Girvan railway line to the south and an unnamed road to the west and the north (Figure 2).

4.2. Survey considerations:

Survey Area	Ground Conditions	Further Notes
1	Flat, even pasture.	The western edge of the field was bounded by a stone wall while its eastern side was bounded by wire fencing. Two raised manholes and a metallic gate were identified in the northern edge of the field; another metallic gate was located in the southern edge of the area.

4.3. The underlying geology comprises Sandstone of the Swanshaw Formation. The superficial deposits are composed of Gravel, Sand and Silt from raised marine beach deposits (British Geological Survey, 2019).

4.4. The soils consist of fluvisols (Canmore, 2019).

5. Archaeological Background

5.1. The following is quoted from a Written Scheme of Investigation produced by Jacobs describing the Girvan Mains Scheduled Monument (SM5596), within which the survey area is located (Dempsey, 2018).

5.2. *"The monument consists of the cropmarks of two Roman temporary camps, various linear cropmarks and a circular enclosure which have been revealed by aerial photographs on gravel subsoil in the level fields to the NW, S and E of Girvan Mains farm steading.*

Of the large, sub-rectangular camp (located at NGR NX192992) much of the E side, about half of the N and W sides and the rounded NE angle have been recorded on aerial photographs. Search has failed to find an E entrance, which may have been destroyed by a railway cutting or recent roadworks, although the W entrance is clear. The camp would have enclosed an area of about 55 acres [approximately 22 hectares]. The second camp (NGR NX188990) is situated immediately W of the first and on a different alignment. Lengths of the NE and SE sides have been located. The topography of the site makes it unlikely that the area will ever have exceeded 15 acres. The discovery of a fragment of first century AD glass vessel in the primary ditch of this camp, has led to the suggestion that these were bases used by the forces of Agricola during the campaigns mentioned by Tacitus as relating to a planned descent upon Ireland. An arc of ditch, part of a small circular enclosure, has been revealed about 20m E of the NE angle of the Roman temporary camp.

The area to be scheduled measures 940m from its easternmost to its westernmost point and 690m from its northernmost to its southernmost point, to include all the cropmarks and an area around in which associated remains may survive, as marked in red on the attached map extract."

Canmore also records that:

"NX 1918 9900 Two phases of investigation were undertaken on 10 November 2008 and 13 January 2009 in the interior of the Roman temporary camp near Girvan Mains Farm. During the first phase a monitored topsoil strip was carried out on the site of a proposed house plot immediately to the SE of an area designated as a scheduled ancient monument. The second phase of work consisted of a monitored topsoil strip across a belt of land, between 4–6m wide, lying immediately inside the south-easternmost edge of the scheduled area. No features of archaeological significance were recorded."

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-carried GNSS-positioned system.

6.1.3.1. 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.

6.1.3.2. 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 8). 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 (2019) 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) and historic maps (Figure 7).

7.2.2. The geophysical results primary reflect a large spread of dipolar responses varying in density and strength across the site. These likely result from sub-surface scatters of magnetically enhanced material, which may include metallic debris and/or ceramic building material. It is possible that these are associated with the construction of the A77 on an embankment to the east of the site, and with the un-named road than bounds the site to the north and west. The high strength of these anomalies may have 'masked' weaker responses from natural or anthropogenic features, if they were present. This distribution of dipolar anomalies is markedly more dispersed in the south-west of the survey area, where discrete dipolar anomalies have been categorised as 'Ferrous/Debris (Point)' against what appears to be a small area of 'quieter' magnetic background.

7.2.3. A broader 'halo' of magnetic disturbance from metallic fencing has been identified along the northwest, north and northeast limits of the site, and from a buried service along the south.

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. **Magnetic Disturbance** – The strong anomalies produced by extant metallic structures along the edges of the field and by services that cross the survey area have been classified as 'Magnetic Disturbance'.

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. **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. **Service** – A strong, linear dipolar response and a surrounding 'halo' of magnetic disturbance has been identified along the south of the site. This response is characteristic of a subsurface metallic or electrified service.

8. Conclusions

8.1. The fluxgate magnetometer survey was successfully carried out across the site, and anomalies of varying strength have been identified. Magnetic disturbance has been limited to responses from wire fencing and a buried service at the edges of the site. Scatters of debris have been identified across most of the survey are and likely have their origins in the construction of embankments and roads that bound the site. The high strength of these anomalies may have 'masked' weaker responses from natural or anthropogenic features, if they were present. A buried service has also been identified along the south of the site.

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.

11. References

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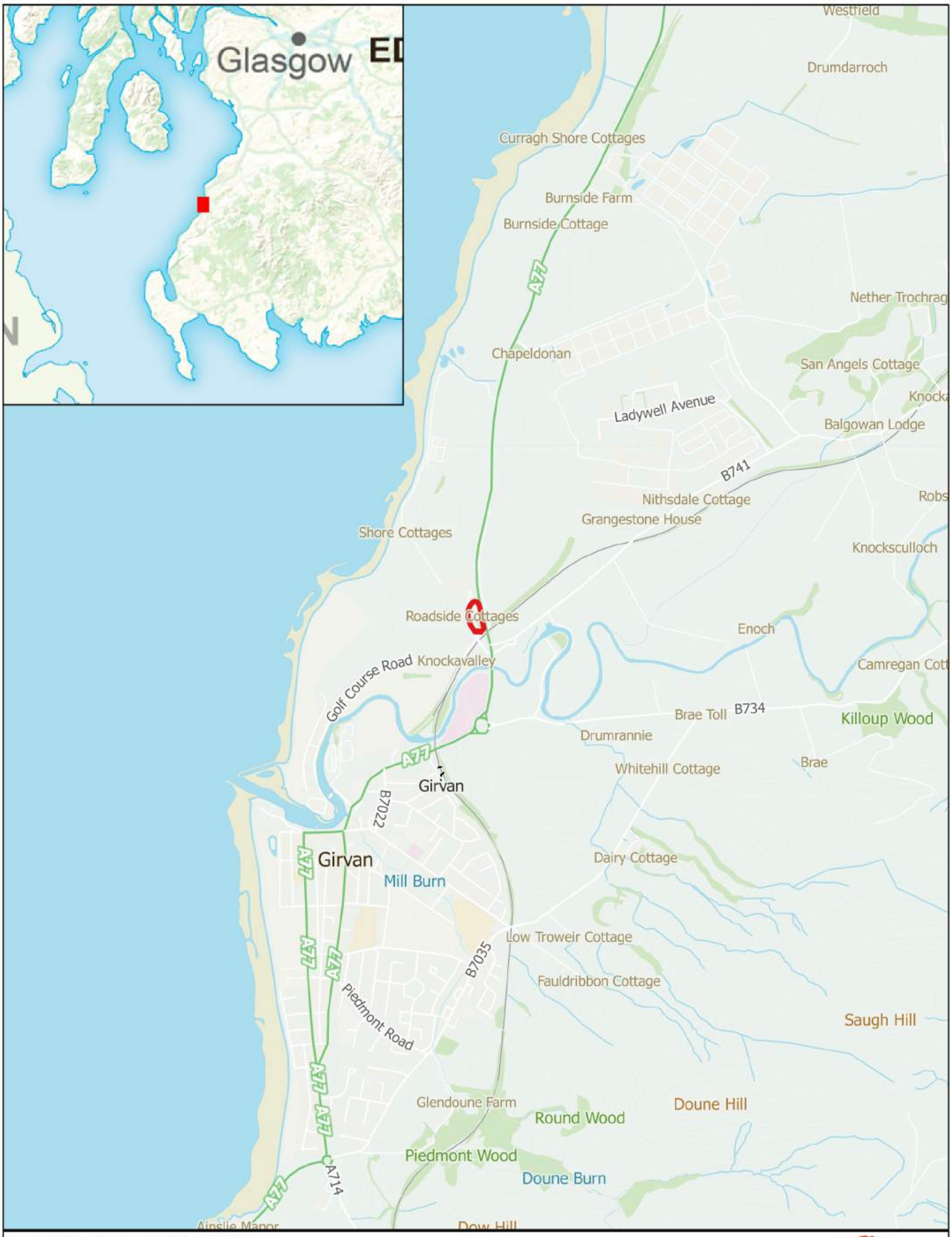


MSNX442 - Girvan, South Ayrshire
Figure 1 - Site Location
1:25,000 @ A4

Site Boundary

N

0 0.5 1 km

magnitude surveys

219000

599000

599000

Roadside Cottages

A77

B741

Bridgemill Cottage

Knockavalley

Golf Course Road

Water of Girvan

Golf Course

MSNX442 - Girvan, South Ayrshire
Figure 2 - Location of Survey Area
1:3,000 @ A3

Survey Extent

N

0 50 100 150 m

magnitude surveys

219100
219200
219300
599200
599100
Roadside Cottages
A77
Golf Course Road
B741

MSNX442 - Girvan, South Ayrshire
Figure 3 - Magnetic Gradient
1:1,000 @ A3

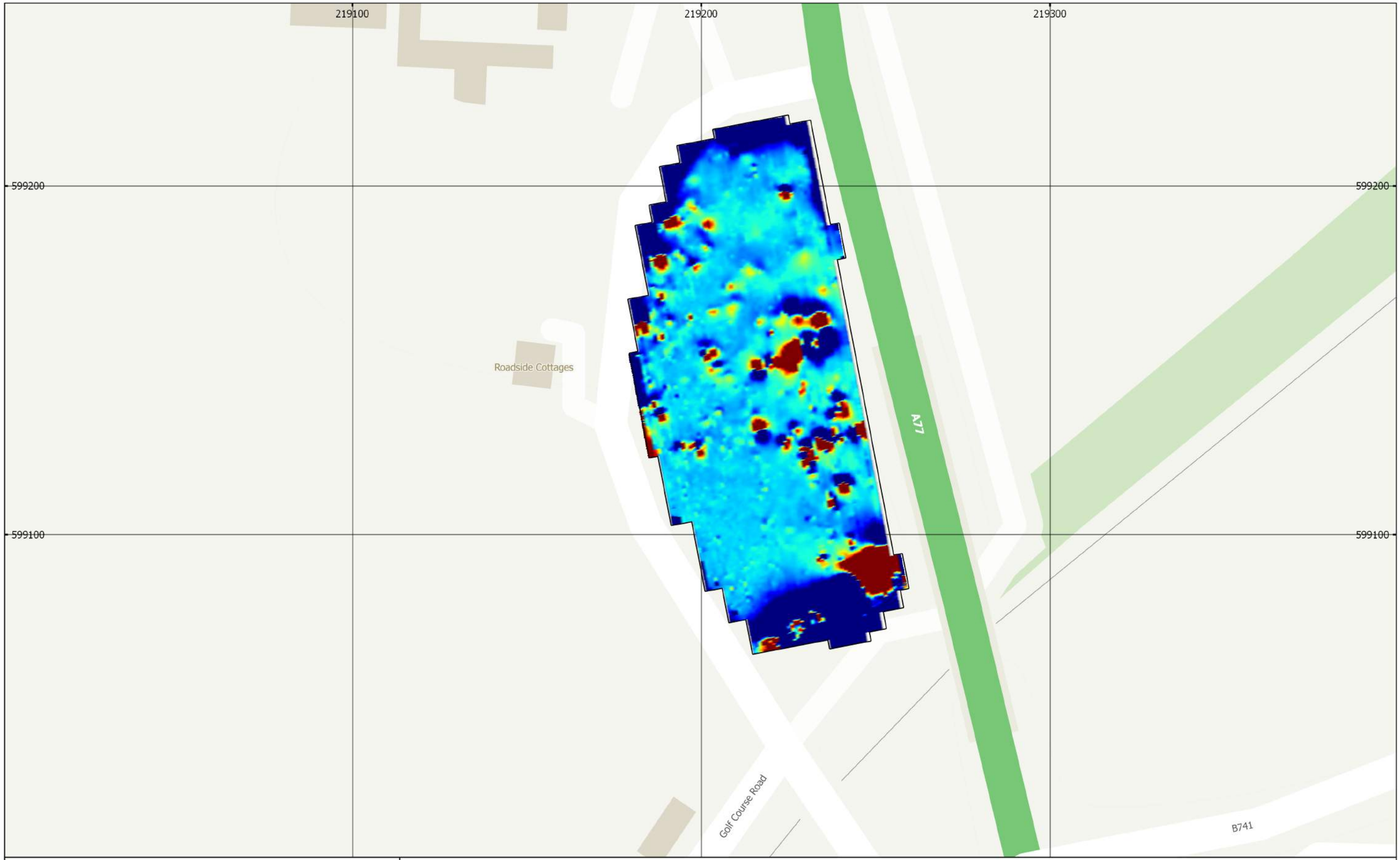
Contains OS OpenData

-1 nT 2

N

0 25 50 75 m

magnitude surveys



MSNX442 - Girvan, South Ayrshire
Figure 4 - Magnetic Total Field (Lower Sensor)
1:1,000 @ A3

48,900 nT 49,200

N

0 25 50 75 m

magnitude surveys

219100
219200
219300
599200
599100
Roadside Cottages
A77
Golf Course Road
B741

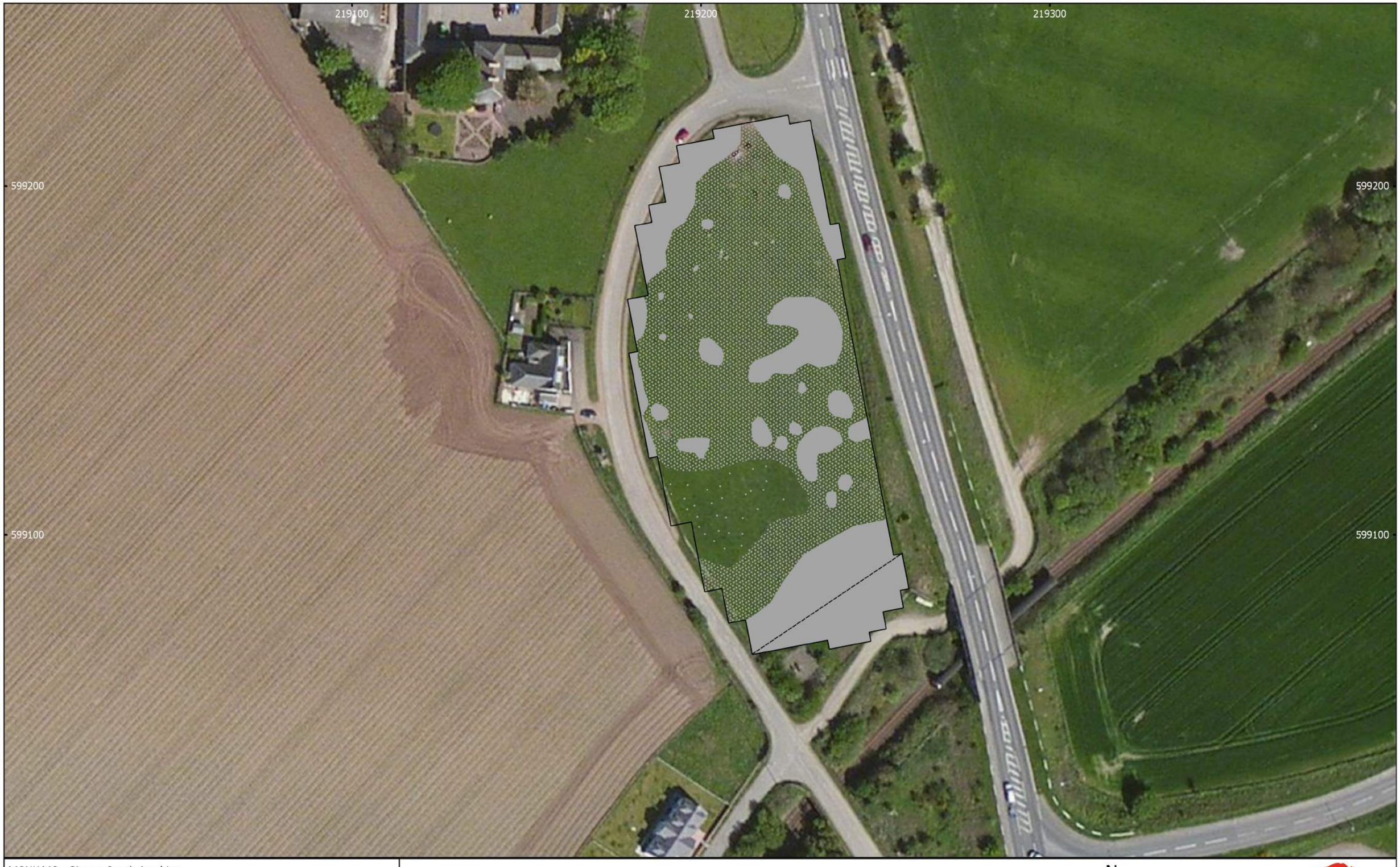
MSNX442 - Girvan, South Ayrshire
Figure 5 - Magnetic Interpretation
1:1,000 @ A3

Contains OS OpenData

Magnetic Disturbance
Ferrous/Debris (Spread)
Service
Ferrous/Debris (Point)

N
0 25 50 75 m

magnitude surveys



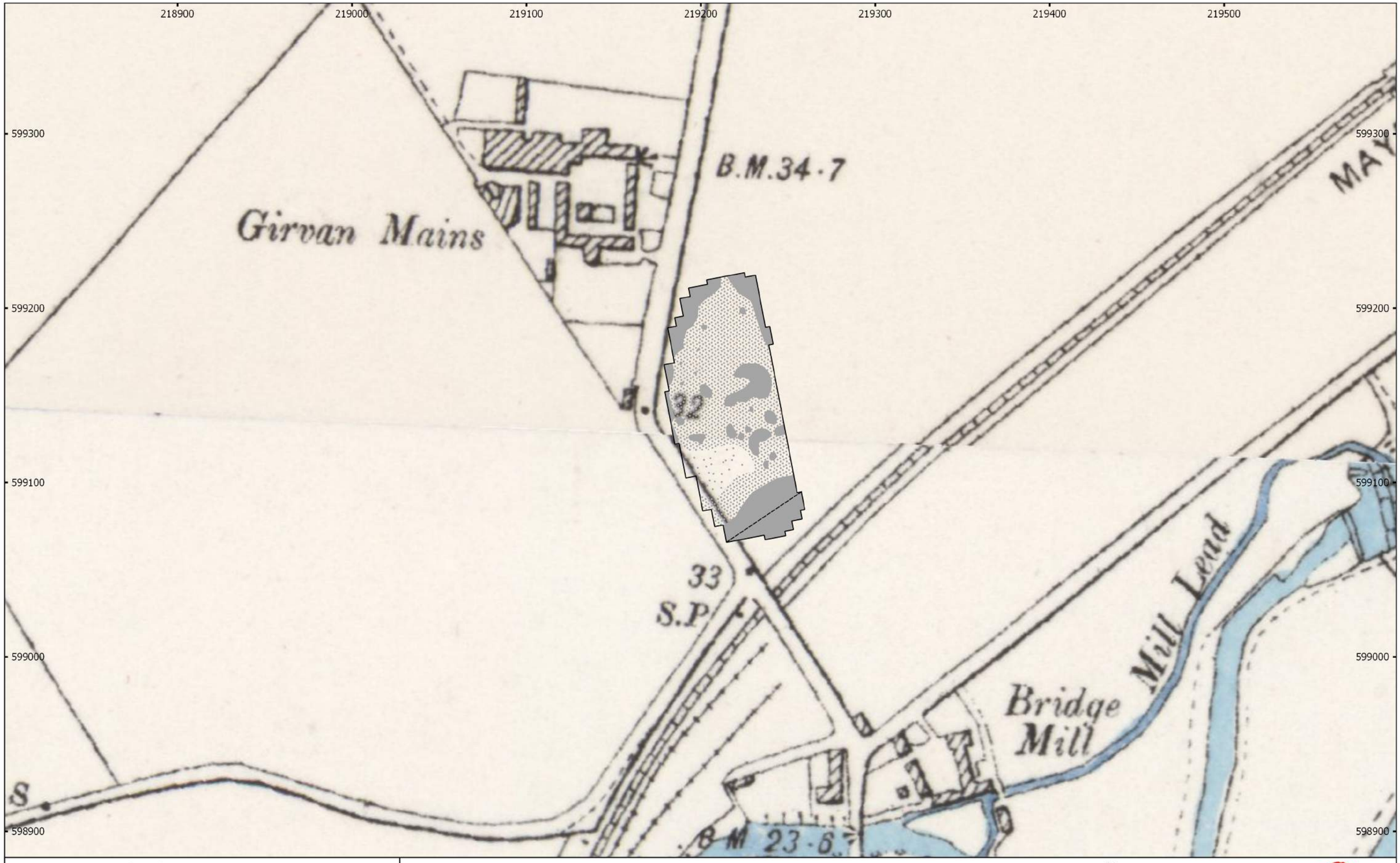
MSNX442 - Girvan, South Ayrshire
Figure 6 - Magnetic Interpretation Over Satellite Imagery
1:1,000 @ A3

Magnetic Disturbance
Ferrous/Debris (Spread)
Service
Ferrous/Debris (Point)

N

0 25 50 75 m

magnitude surveys



MSNX442 - Girvan, South Ayrshire
Figure 7 - Magnetic Interpretation Over Historic Maps
1:2,000 @ A3

Magnetic Disturbance
Ferrous/Debris (Spread)
Service
Ferrous/Debris (Point)

N
0 25 50 75 m

magnitude surveys

MSNX442 - Girvan, South Ayrshire
Figure 8 - XY Trace Plot
20nT/cm at 1:1,000 @ A3

N

0 25 50 75 m

magnitude surveys