A47 Wansford to Sutton Dualling

Scheme Number: TR010039

Volume 6
6.3 Environmental Statement Appendices
Appendix 6.3 – Geophysical and Metal Detector Survey

APFP Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

July 2021

Infrastructure Planning

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

A47 Wansford to Sutton Development Consent Order 202[x]

ENVIRONMENTAL STATEMENT APPENDICES
Appendix 6.3 - Geophysical and Metal Detector Survey

Regulation Number:	Regulation 5(2)(a)
Planning Inspectorate Scheme Reference	TR010039
Application Document Reference	TR010039/APP/6.3
BIM Document Reference	HE551494-GTY-EHR-000-RP-LE-30002
Author:	A47 Wansford to Sutton Project Team, Highways England

Version	Date	Status of Version
Rev 0	July 2021	Application Issue

Geophysical Survey Report

of

A47 Wansford to Sutton

Evaluation

For

Cotswold Archaeology

Magnitude Surveys Ref: MSTL712

July 2020

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Issue Date:

28 July 2020

Abstract

Magnitude Surveys was commissioned to assess the subsurface archaeological potential of a c. 0.5ha area of land just south of the A47 between Wansford and Sutton. A fluxgate gradiometer survey was successfully completed across most of the survey area, with an area of c. 0.2ha unsurveyable due to trees and dense vegetation. Magnetic disturbance originating from a road along the northern boundary and a pylon within the survey area have produced broad magnetic haloes which limited the interpretation of underlying anomalies, and an extant electricity line has contributed to the noisy magnetic background of the site. Despite this, agricultural trends have been detected.

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1. Introduction

1.1. Magnitude Surveys Ltd (MS) was commissioned by Cotswold Archaeology to undertake a geophysical survey on a c. 0.5ha area of land at the A47 between Wansford and Sutton (TL 08631 99625), an area of c. 0.2ha could not be surveyed due to trees and dense vegetation.

1.2. The geophysical survey comprised hand-carried GNSS-positioned fluxgate gradiometer 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 WSI produced by MS (Magnitude Surveys, 2020).

1.5. The survey commenced on 21.07.20 and was completed on the same 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. 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 was to assess the subsurface archaeological potential of the survey area.

4. Geographic Background

4.1. The survey area was located c.1.2km northeast of Wansford (Figure 1). Survey was undertaken across a single field under pasture. The survey area was bounded by the A17 to the north, a stream to the south and further fields to the east and west (Figure 2). An area of c. 0.2ha could not be surveyed due to the presence of trees and dense vegetation.

4.2. Survey considerations:

Survey Area	Ground Conditions	Further Notes
1	The area consisted of grassland pasture sloping down from northwest to southeast.	Bounded by hedgerow and the A47 to the north, and to the south by a small river. The field continued to the east and west. Overhead powerlines crossed between Area 1 and 2 in an east to west orientation. A pylon was present in the northwest corner. Dense vegetation on the slope rendered the central portion of the site unsurveyable.
2	The area consisted of grassland pasture sloping down from northwest to southeast. Three areas of disturbed ground from unfilled trenches were present in the southwest corner.	Bounded by hedgerow and the A47 to the north, and to the south by a small river. The field continued to the east and west. Overhead powerlines crossed between Area 1 and 2 in an east to west orientation.

4.3. The underlying geology comprises Whitby Mudstone Formation with superficial river terrace deposits of sand and gravel in the north and alluvium consisting of clays, silts, sand and gravel in the south (British Geological Survey, 2020).

4.4. The soils consist of loamy and clayey floodplain soils with naturally high groundwater (Soilscapes, 2020).

5. Archaeological Background

5.1. The following is a summary of an Archaeological Evaluation produced by Highways England (Highways England, 2020) and provided by Cotswold Archaeology.

5.2. Prehistoric activity has been recorded in the wider environs consisting of prehistoric cropmarks many of which are ring ditches close to the River Nene, and a Neolithic and Bronze Age flint findspots c. 710m northwest of the survey area (CHER 01976).

5.3. Bronze age and Iron Age activity was also recorded in the environs of the survey area. A scheduled monument (NHLE 1006796) is recorded c. 420m northeast of the survey area identified as Bronze Age barrows, just west of this Bronze Age human remains in a cist were identified (PCCHER 00176). Evidence for Iron Age occupation has been identified c. 930m east of the survey area in the form of an Iron Age pit alignment (CHER 08368).

5.4. Extensive Roman activity was identified in the environs of the survey area. The A47 along the northern boundary of the survey area is reported to run along the alignment of a Roman road. An ironworking site was identified C. 650 northwest of the survey area (CHER 50343) and a Roman fort is reported c. 300m east of the survey area. A Romano-British settlement site was identified c. 1km north of the survey area (NHLE 1006880) and excavations c.650m northwest of the survey area have recorded a Roman building (CHER 01991).

5.5. A. fluxgate gradiometer survey has been undertaken by WYAS Archaeological Services over 50ha of land surrounding the survey area. That survey detected anomalies of archaeological origin relating to occupational areas, prehistoric enclosures, trackways, pit alignments and former field boundaries.

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. 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. Multiple greyscale images at different plotting ranges have been used for data interpretation. Greyscale images should be viewed alongside the XY trace plot (Figure 5). 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 (2020) was consulted as well, to compare the results with recent land usages.

6.3.3. 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. The geophysical results are presented in consideration with historic maps (Figure 5).

7.2.2. The small size of the survey area provides only a limited context for the detected anomalies; this complicates interpretation of the anomalies and in some cases prevents a specific categorisation from being ascribed. Magnetic disturbance resulting from extant electricity lines, pylons and possibly from excavation trenches have created broad ferrous anomalies across the majority of the survey area, which may have masked weaker magnetic anomalies, had any been present.

7.2.3. The geophysical survey has primarily detected linear agricultural trends that cross the survey area on an east to west orientation (Figure 4). These are parallel to the field boundary and appear to be in line with crop direction visible on recent satellite imagery (Google Earth Pro, 2020).

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 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.

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

7.3.2. Magnetic Results – Specific Anomalies

7.3.2.1. **Agricultural (Trend) –** Linear anomalies have been identified that exhibit a weak positive magnetic signal and are recorded running on an east to west alignment (Figure 4).

8. Conclusions

8.1. A fluxgate gradiometer survey has been undertaken across the majority of the survey area. No anomalies suggestive of significant archaeological features were identified. The geophysical survey has detected anomalies of agricultural origin. Broad ferrous anomalies caused by the road along the northern boundary, extant electricity lines and pylons may have masked more ephemeral anomalies, if any were present.

8.2. Agricultural activity has been detected across the survey area in the form of linear trends which are parallel to the field boundary and in line with crop direction visible on recent satellite imagery and are likely the result of recent ploughing activity.

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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12. Project Metadata

MS Job Code	MSTL712
Project Name	A47 Wansford to Sutton Evaluation
Client	Cotswold Archaeology
Grid Reference	TL 08631 99625
Survey Techniques	Magnetometry
Survey Size (ha)	0.5ha (Magnetometry)
Survey Dates	2020-07-21
Project Lead	Leanne Swinbank, BA ACIfA
Project Officer	Leanne Swinbank, BA ACIfA
HER Event No	N/A
OASIS No	N/A
S42 Licence No	N/A
Report Version	0.2

13. Document History

Version	Comments	Author	Checked By	Date
0.1	Initial draft for Project Lead to Review	SP	LS	24 July 2020
0.2	Draft for Director Sign off	SP	KA	28 July 2020

MSTL712 - A47 Wansford to Sutton Evaluation
Figure 1 - Site Location
1:25,000 @ A4

Site Location

N

0 0.5 1 km

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MSTL712 - A47 Wansford to Sutton Evaluation
Figure 2 - Location of Survey Area
1:5,000 @ A3

Survey Extent
Unsurveyable Area

N

0 100 200 300 m

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MSTL712 - A47 Wansford to Sutton Evaluation
Figure 3 - Magnetic Gradient
1:500 @ A3

-2 nT 3

N

0 10 20 30 m

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MSTL712 - A47 Wansford to Sutton Evaluation
Figure 4 - Magnetic Interpretation
1:500 @ A3

Magnetic Disturbance
Agricultural (Trend)
Ferrous (Spike)

N

0 10 20 30 m

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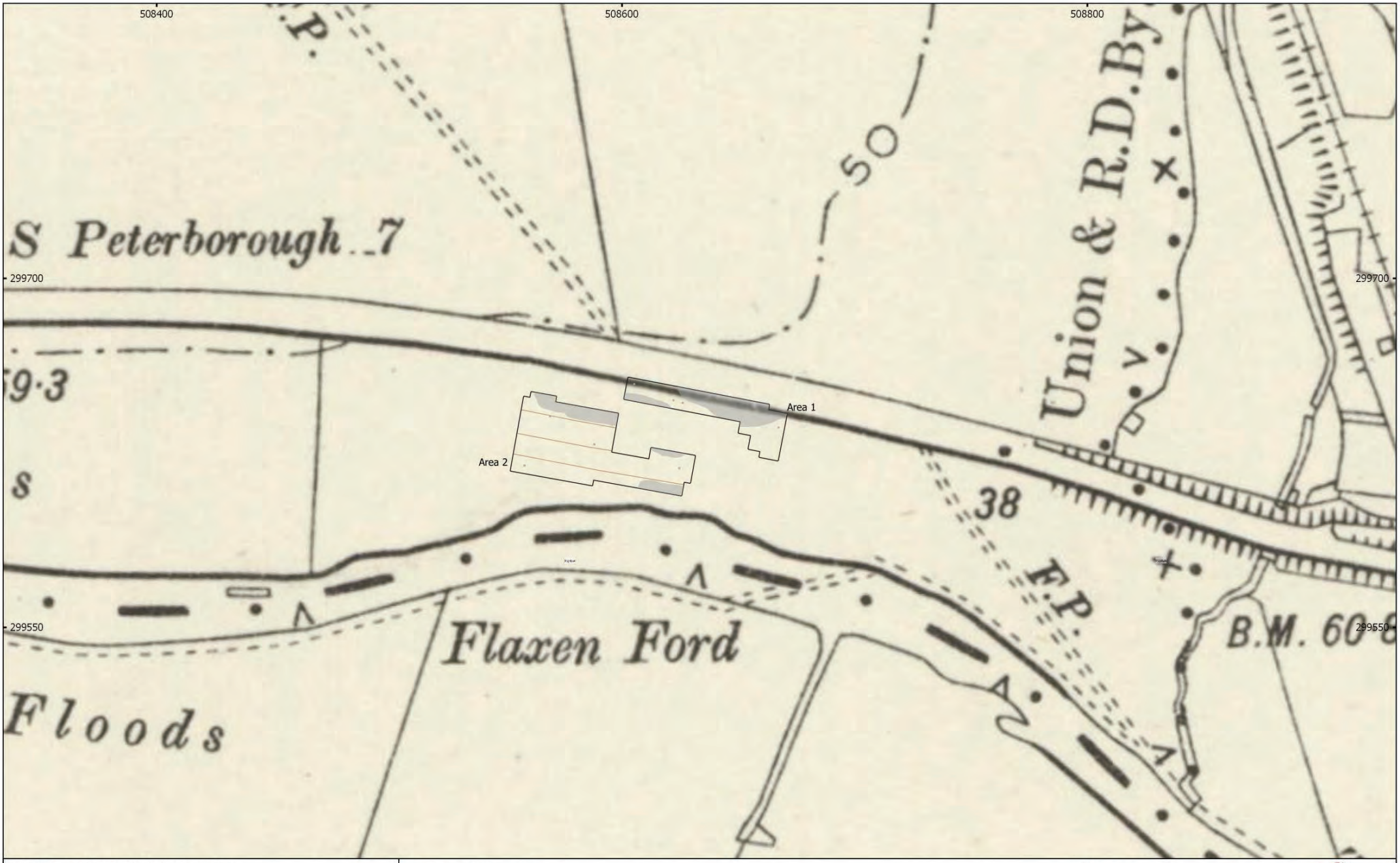

MSTL712 - A47 Wansford to Sutton Evaluation
Figure 5 - Magnetic Interpretation Over Historic Maps
1:1,500 @ A3

Magnetic Disturbance
Agricultural (Trend)
Ferrous (Spike)

N

0 50 100 150 m

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MSTL712 - A47 Wansford to Sutton Evaluation
Figure 6 - XY Trace Plot
30nT/cm at 1:500 @ A3

N

0 10 20 30 m

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