Geophysical Survey Report

XC211 (Newtown Townland) & XC215 (Shinanagh Townland), Cork Line Level Crossing Project, County Cork

Client
AMS Ltd. on behalf of Jacobs Engineering

Detection Licenses
20R0016 & 20R0017

TAG Project
2020IE9

Date
June 2020

TARGET Archaeological Geophysics GCV

High spatial resolution archaeological prospection
State-of-the-art geophysical sensors & software

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TARGET REPORT 2020IE9
XC211 (NEWTOWN TOWNLAND) & XC215 (SHINANAGH TOWNLAND), CORK LINE LEVEL CROSSING PROJECT, COUNTY CORK

PROJECT BACKGROUND

As part of the archaeological assessment being undertaken for the Cork Line Level Crossing (CLLC) Project, geophysical surveys were undertaken at 2 locations situated in Newtown and Shinanagh townlands (North Co. Cork), at the southern limits of level crossings XC211 and XC215 on the Dublin-Cork Railway Line between Limerick Junction and Mallow Station. The CLLC Project plans to eliminate/upgrade 7 public road level crossings located on this 24km section of the Dublin-Cork Railway Line, and this work represents a 2nd phase of geophysical survey at XC211 and XC215 to inform the EIAR being prepared for the scheme (Dowling G, 2020, licenses 20R0016 & 20R0017).

This phase of geophysical survey at XC211 (Newtown) examined an investigation corridor c.330m in length and 30-40m in width, extending across 2 adjacent fields located E of the Dublin-Cork Railway Line, c.0.1km S of the level crossing. 0.75 hectares of high resolution magnetic gradiometry was completed at XC211 during this work. The survey at XC215 similarly, focused on an investigation corridor 0.72km in length and 0.03-0.17km in width, extending across 2 adjacent fields immediately SW of the level crossing, W of the Dublin-Cork Railway Line and M20. 3.1ha of high resolution magnetometry was completed at XC215 during this 2nd phase survey.

This 2nd phase geophysical survey at XC211 and XC215 was commissioned by AMS Ltd. on behalf of Jacobs Engineering. The specific geophysical survey objectives were as follows:

- to identify any geophysical anomalies of possible archaeological origin within the proposed development boundary
- accurately locate these anomalies and present the findings in graphical format
- describe the anomalies and discuss their likely provenance in a written report

ITM central coordinates: XC211 554869 618058 / XC215 553524 615004

Townlands: Newtown and Shinanagh

County: Cork

Landuse: Pasture land

Landscape, soils, geology

The investigation areas at XC211 and XC215 lie 2.8km apart, occupying a steep SW facing slope E of the Dublin-Cork Railway Line and low-lying pasture W of the M20 respectively. The soils at both locations are predominantly humic surface water gleys belonging to the Howardstown 760c association, with coarse-fine loamy drift and peat occurring locally (Irish National Soils Map, 1:250,000k, V1b, 2014). Bedrock geology comprises of Ballysteen formation dark muddy limestone and shale at XC211, and yellow-red sandstone and green mudstone of the Kiltorcan formation at XC215 (Geological Survey of Ireland Spatial Resources, Public Data Viewer Series).

Archaeology

The northern perimeter of this 2nd phase investigation zone at XC211 borders the National Monuments Service Zone of Notification for ringfort-rath site CO008-040, which lies c.50m to NE. Phase 1 geophysical survey by AMS Ltd. at XC211 recorded the location of a possible avenue/droveway and small circular enclosure (Dowling G, 2020, license 20R0017). The southern perimeter of XC215 borders the National Monuments Service Zones of Notification for graveyard (CO007-120001), church (CO007-120002) and holy well (CO007-121), located <50m to the E and S/SW. Previous geophysical survey by AMS Ltd. at XC215 recorded an array of linear remains at the periphery of CO007-120001/002 suggesting the location of a probable ecclesiastical site. This 2nd phase geophysical survey at XC215 also extends over earthworks immediately N-NE of CO007-120001/002.

Details of the recorded monuments and places (RMPs) referred to above and further RMPs within a 0.5km radius are included in the following tables:

RMPs in 0.5km proximity to XC211

SMR No.	Class	Townland	ITM East	ITM North
CO008-005----	Ringfort - rath	Farran (Orrery & Kilmore By.)	554519	618299
CO008-034----	Ringfort - rath	Ballycoskery	554656	618092
CO008-039----	Ringfort - rath	Newtown (Fermoy By., Ballyhay Par.)	555100	617742
CO008-040----	Ringfort - rath	Newtown (Fermoy By., Ballyhay Par.)	554953	618246
CO008-041----	Earthwork	Newtown (Fermoy By., Ballyhay Par.)	554994	618381
CO008-069----	Church	Ballycoskery	554437	617719

RMPs in 0.5km proximity to XC215

SMR No.	Class	Townland	ITM East	ITM North
CO007-119001-	Castle - unclassified	Ballynageragh	553175	614947
CO007-119002-	Excavation -	Ballynageragh	553303	614934
CO007-120001-	Graveyard	Imphrick	553467	614610
CO007-120002-	Church	Imphrick	553462	614615
CO007-121----	Ritual site - holy	Imphrick	553563	614656
CO007-131001-	Fulacht fia	Shinanagh (Fermoy By.)	553334	615316
CO007-131002-	Fulacht fia	Shinanagh (Fermoy By.)	553334	615303

Fieldwork	3rd& 4th June 2020
Report issue	15th June 2020
Report author	John Nicholls MSc.
Detection License No.	20R0016 (XC215, Shinanagh townland) & 20R0017 (XC211, Newtown Townland)
Client	Archaeological Management Solutions (AMS Ltd.) on behalf of Jacobs Engineering
Geophysical technique	High-resolution magnetic gradiometry (magnetometry)

1 SURVEY METHODOLOGY

1.1 Methodology

1.1.1 High resolution magnetic gradiometer survey was undertaken within the 2nd phase investigation corridors at XC211 and XC215, completing 0.75ha and 3.1ha at XC211 (M1) at XC215 (M2-M4) respectively.

1.1.2 The survey employed an advanced multichannel fluxgate gradiometer system combined with cm precision GPS, recording magnetic gradiometer and GPS data simultaneously at rates of 75Hz and 1Hz respectively, conducting parallel instrument traverses 2.97m in width throughout each investigation area, with the instrumentation installed in 'tow configuration' for use with an ATV.

1.2 Instrumentation

1.2.1 Details of the geophysical instrumentation employed for this project are provided below:

Technique	Sensor spacing	Sample rate	Instrumentation	Sensitivity / precision	No. of measurements recorded
Magnetic gradiometry	0.27m	75Hz	12 x Foerster Ferex CON650 fluxgate gradiometers, 15 channel data logger	<75pT / √Hz at 1Hz (650mm baseline)	425,069
GPS	3.24m	1Hz	Trimble R10 GPS (operating in VRS mode)	<0.05m (vertical & horizontal)	5,189

1.2.2 The instrumentation and software employed in this geophysical survey were configured to apply a spatial resolution of c.80-100 magnetic gradiometer measurements per m^2, which meets with ease the 'Level 3 – Characterisation' EAC Guidelines recommendation for geophysical survey in archaeology (Schmidt et al, 2016).

1.3 Data processing

1.3.1 Post fieldwork magnetic gradiometer data processing was performed as follows:

Process	Description
1	Positioning of magnetic gradiometer data based on real-time GPS measurements
2	Zero median transect processing for multi-sensor magnetometer data collected along parallel transects
3	Gridding (nearest neighbor interpolation)
4	Export of georeferenced greyscale images at optimum range to project CRS (ITM)

1.3.2 To ensure integrity of the processed geophysical data, and maintain close correlation with the original raw on-site measurements, no further processing or filtering of the data was applied proceeding steps 1-4.

1.4 Data display

1.4.1 Figure 1 presents a site location diagram (scale 1:10,000), highlighting the limits of this 2nd phase investigation at XC211 and XC215 in Newtown and Shinanagh townlands.

1.4.2 Figures 2-3 present survey location diagrams for the 2nd phase geophysical investigations at XC211 and XC215, and detail the limits of phase 1 AMS Ltd. geophysical surveys, and RMPs within a 0.5km radius (scale 1:5,000).

1.4.3 Figures 4-6 presents the results from this 2nd phase of geophysical survey at the XC211 and XC215 in greyscale format as areas M1 (Newtown) and M2-M4 (Shinanagh) at a scale of 1:1500.

1.4.4 Figures 7-9 present interpretations of the results from this 2nd phase survey as areas M1 (Newtown) and M2-M4 (Shinanagh) at a scale of 1:1500. Numbers included on figures 7-9 refer to notable anomalies recorded from this survey, which are discussed in the results section of this report.

2 GENERAL CONSIDERATIONS

2.1 Access & ground conditions

2.1.1 The phase 2 investigation corridor at XC211 (M1) extended across steep SW facing pasture land located immediately E of the Dublin-Cork Railway Line. Not all of the area was suitable for survey due to rough, uneven terrain and high vegetation particularly to the W and S-SW. The phase 2 investigation corridor at XC215 (M2-M4) traversed 2 low-lying pasture fields, the northern field sub-divided by post and wire fencing. A small section of the investigation corridor at XC215 remained unavailable to survey due to cattle grazing at the time of fieldwork.

2.2 Modern interference

2.2.1 The results from the phase 2 surveys at XC211 (M1) and XC215 (M2-M4) highlight numerous small-scale ferrous responses throughout. Ferrous responses are a common occurrence in magnetic and electromagnetic survey data, and in most cases represent modern metal debris contained within the topsoil.

2.2.2 Broad ferrous responses are also apparent in the results, notably NE of survey centre in M1 (XC211) due to post and wire fencing; and at the eastern limits of M2-M4 (XC215) due to survey in proximity existing boundaries and the railway line to the E.

2.2.3 A broad ferrous response SE of survey centre in M2 (XC215) derives from ground investigations machinery present on site at the time of fieldwork.

2.3 Recent landuse

2.3.1 Responses from several former boundaries are evident in the results, notably NE of survey centre in M1 (XC211), SW of survey centre in M2 (XC215), and at survey centre and to the S in M4 (XC215). The potential that a number of these former boundaries overlie earlier field systems associated with archaeological settlement in the environs of XC211 and XC215 should not be ignored.

2.4 Natural soil/geological variation

2.4.1 Responses indicative of localized variations in soil morphology/underlying geology are also evident in the results, notably at survey centre and to the SW in M1 (XC211), and at the southern survey limit in M2 (XC215). These are generally visible as broad positive/negative fluctuations above the magnetic background.

3 GEOPHYSICAL SURVEY RESULTS

N.B. Read this section of the report in conjunction with the greyscale/interpretation diagrams provided.

3.1 General overview

3.1.1 The data acquired from the phase 2 geophysical investigations at XC211 and XC215 indicate a low-level of background magnetic variation throughout, with responses from former field boundaries, modern ferrous and localized soil/geological variation evident in the results.

3.1.2 No responses of definite archaeological character have been recorded within either investigation area. Numerous linear anomalies, small-scale positives and weak trends are, however, apparent in the data, and a number of these show strong correlation with significant anomalies highlighted from the phase 1 geophysical surveys.

3.1.3 The following tables highlight the most notable anomalies recorded from this 2nd phase of geophysical survey at XC211 (M1) and XC215 (M2-M4):

3.2 XC211

3.2.1 The most notable anomalies recorded from geophysical survey in XC211 M1 are detailed below:

Phase 2 investigation corridor			**Figure(s)**	**Hectares**	**Terrain & landuse**
XC211			4 & 7	0.75	Irregular, triangular and sub-rectangular shaped pasture fields facing steeply SW, with poor terrain to W and S-SW.
Area	**Response(s)**	**Location**	**Interpretation**	**Description**	
M1	1, 2, 3	NE of survey centre	? Archaeology Trend	Weakly negative linear anomalies and trends highlighting continuation of significant linear features recorded during phase 1. These responses are indicative of an early field system.	
M1	4, 5, 6	S-SW of survey centre	? Archaeology Trend	Poorly defined positives and weak trends barely visible above background, likely representing recent landuse and/or natural soil/geological variation. The potential that responses 6 to the SW reflect burnt/fired features of interest should not be ignored.	

3.2.2 No further responses of note are indicated by the results from survey in the 2nd phase investigation corridor at XC211.

3.3 XC215

3.3.1 The most notable anomalies recorded from geophysical survey in XC215 M2-M4 are detailed below:

Phase 2 investigation corridor			**Figure(s)**	**Hectares**	**Terrain & landuse**
XC215			5-6, 8-9	3.1	Low-lying pasture fields sub-divided by post and wire fencing to the N, becoming narrow from survey centre to S.
Area	**Response(s)**	**Location**	**Interpretation**	**Description**	
M2	7, 8	W-SW of survey centre	? Archaeology	Poorly defined positives of uncertain origin. A recent landuse or natural soil/geological origin for anomalies 7-8 should be considered.	

M2	9	Survey centre to E	Trend	Weakly magnetic linear trends of limited significance. These anomalies are expected to derive from former landuse.
M3	10	N of survey centre	? Archaeology	Parallel weakly negative linears oriented NW-SE, probably representing part of a former boundary and/or droveway recorded on similar alignment to the W-SW in M2.
M3	11	W of survey centre	? Archaeology Trend	Poorly defined positive and curving trend of uncertain origin. A recent landuse or natural soil/geological origin for anomalies 11 should be considered.
M4	12-15	Survey centre to S	Archaeology ? Archaeology Trend	Poorly defined negative linears, discrete positives and trends recorded in association with earthworks immediately N of CO007-120001/002. Responses 12-15 likely represent part of an ecclesiastical settlement associated with CO007-120001/002. Response 15 indicates a large burnt/fired deposit, either associated with the site of a former building or fulacht fia.

3.3.2 No further responses of note are indicated by the results from survey in the 2nd phase investigation corridor at XC215.

4 CONCLUSIONS

4.1 This phase of geophysical survey at XC211 and XC215 proceeds previous geophysical investigations completed by AMS Ltd. in connection with the CLLC Project. The results from this 2nd phase geophysical survey at XC211 highlight remnants of a probable field system to the S of phase 1. A concentration of linear anomalies, discrete positives and a large burnt/fired deposit in the southern portion of investigation at XC215 suggests remnants of a probable ecclesiastical settlement associated with church and graveyard CO007-120001/002. These anomalies correspond to surface visible earthworks noted at the time of fieldwork, and likely represent a continuation of the linear remains recorded from the phase 1 survey at the periphery of CO007-120001/002.

4.2 Elsewhere, the results from this 2nd phase geophysical survey at XC211 and XC215 highlight discrete positives and weak trends of uncertain origin, responses from former boundaries, some of which correspond to historic mapping, localized variations in soil morphology/geology, and modern ferrous.

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LIST OF FIGURES

APPENDICES

MAGNETOMETRY

Introduction

Magnetometry represents one of a suite of geophysical techniques employed in archaeological prospection to inform invasive investigations such as trial trenching and excavation.

Frequently used to determine the often non-visible boundaries of archaeological remains, magnetometer surveys enable archaeologists to identify the location, form and extent of a diverse array of archaeological features no longer visible at the surface.

1. Advanced multi-channel magnetometer survey mapping the buried foundation of a 14th century castle (towed configuration with ATV).

Buried archaeological remains successfully identified using magnetometry include sites such as enclosure systems and deserted villages, hillforts and military encampments, henges and tumuli, villa/castle foundations, and ecclesiastical settlements.

Background to application

The basis for use of magnetometry in archaeological prospection derives from the abundance of natural iron oxides in most soils, and our ability to measure subtle variations in the magnetic properties of these iron oxides caused by human activity. Discrete variations in soil magnetism associated with buried archaeological remains derive typically from in situ burning and organic enrichment of the soil, through activities such as cooking and heating; pottery manufacture and metal working; as well as use of fired building materials such as ceramic tiles and brick. These burnt, fired and organic rich deposits create subtle magnetic contrasts visible as discrete magnetic anomalies superimposed on the earth's geomagnetic field.

2. Results from magnetometer survey presented in greyscale format highlighting pit remains bordering an enclosure site and Roman villa.

3. Burnt & fired debris revealed following excavation of pit remains bordering an enclosure site and Roman villa.

Magnetometer surveys conducted in both commercial and research archaeological investigations enable determination of the location, form and extent of buried archaeological remains. Data acquired from these surveys can be quickly generated into georeferenced images and interpretation layers to inform subsequent trial trenching and excavation.

Technology

TARGET provides precise mapping and characterization of buried archaeological remains by employing an array of highly stable and sensitive fluxgate gradiometers, combined with an advanced data logging system and cm precision GPS. This state-of-the-art geophysical instrumentation, which is capable of collecting extremely dense data sets, permits detailed high resolution survey of archaeological sites from as small as 1ha in size, to larger scale investigation of sites up to 150ha or more.

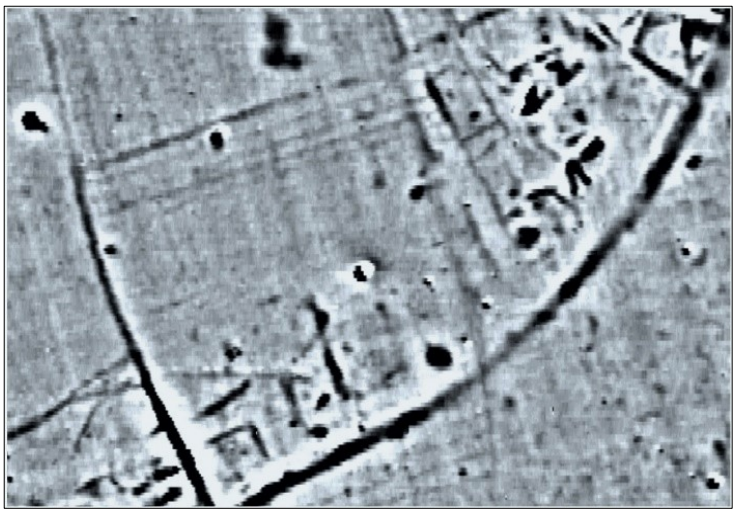
4. Advanced multi-channel gradiometer system for magnetometer survey (manual configuration).

5. GPS tracks (red) highlighting lines of data collection & results from magnetometer fieldwork at a suspected burial ground.

TARGET undertakes high resolution magnetometer surveys as standard, recording data at c.5cm intervals with probe separations of 0.25m for precise measurement and characterization of buried archaeological remains.

Data Display

Greyscale plots are the most common format for displaying magnetometer data. This display format assigns a cell to each datum according to its location on the grid. The display of each data point is conducted at very fine increments, allowing the full range of values to be displayed within a given data set. This display method also enables the identification of discrete responses barely visible above natural 'background' magnetic variation on site.



6. Greyscale from survey at the site of a deserted medieval village.

XY trace plots provide a near-perspective representation of measurements along individual lines of data recorded from each of the magnetometer sensors. The XY trace format is used as a conventional method for identifying responses which derive from modern ferrous debris. The XY trace display is particularly when identifying magnetically strong anomalies indicative of buried hearths, kilns and furnaces.

7. XY trace from survey at the site of a deserted medieval village.

Project	Cork Line Level Crossing Project	**Drawing**	Site locations: XC211 (Newtown Townland) & XC215 (Shinanagh Townland), Co. Cork		
Client	AMS Ltd. on behalf of Jacobs Engineering	**Fig.** 1	**Scale** 1:10,000 @ A3	**TAG.**	2020IE9

N

0 m 400

TARGET
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Project	Cork Line Level Crossing Project	**Drawing**	Survey location XC211 (Newtown Townland, Co. Cork), previous AMS Ltd. geophysical surveys & RMPs in 0.5km proximity				
Client	AMS Ltd. on behalf of Jacobs Engineering	**Fig.**	2	**Scale**	1:5000 @ A3	**TAG.**	2020IE9

N

0 m 200

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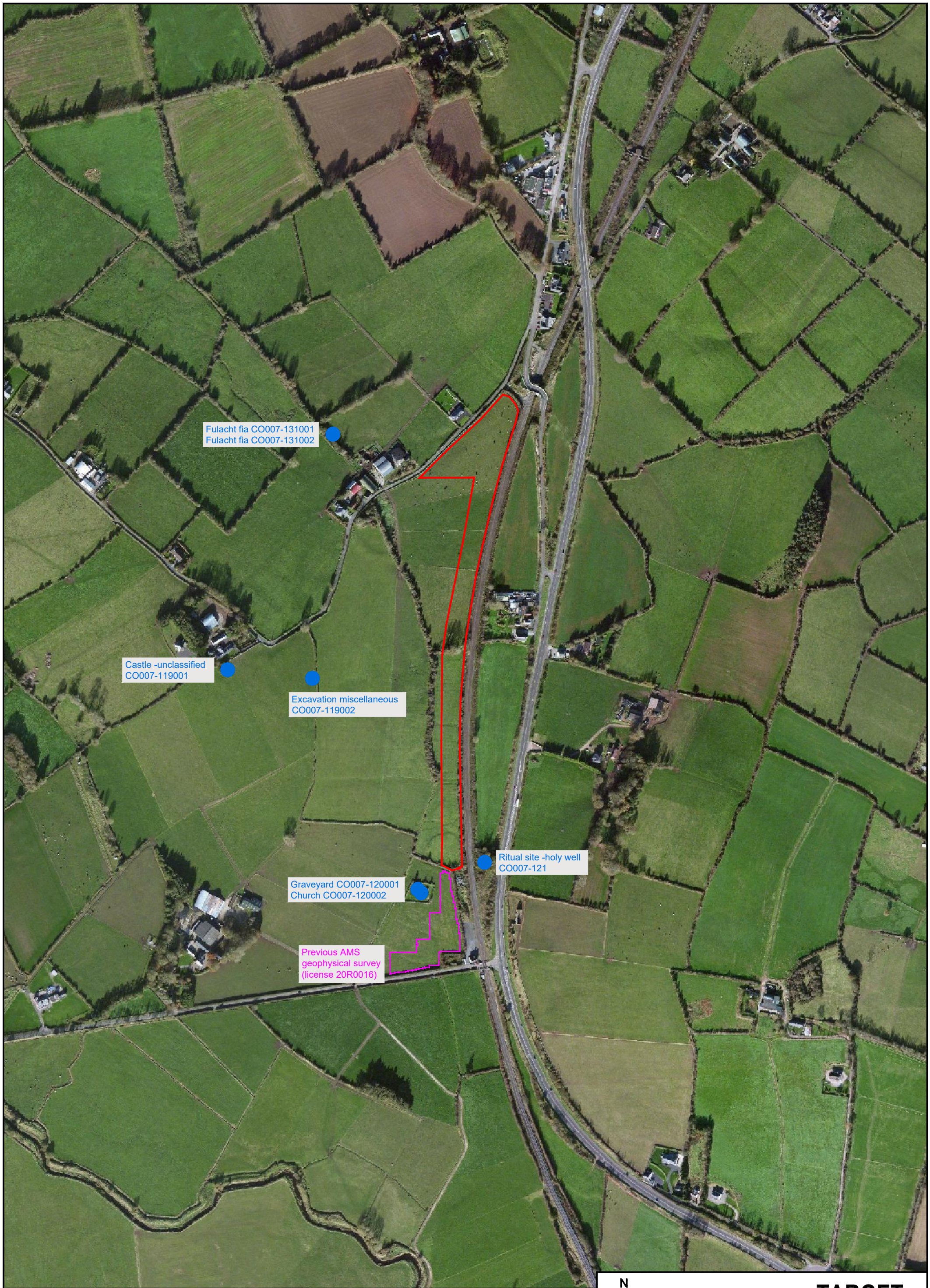

Project	Cork Line Level Crossing Project	**Drawing**	Survey location at XC215 (Shinanagh Townland, Co. Cork), previous AMS Ltd. geophysical investigations & RMPs in proximity				
Client	AMS Ltd. on behalf of Jacobs Engineering	**Fig.**	3	**Scale**	1:5000 @ A3	**TAG.**	2020IE9

N

0 m 200

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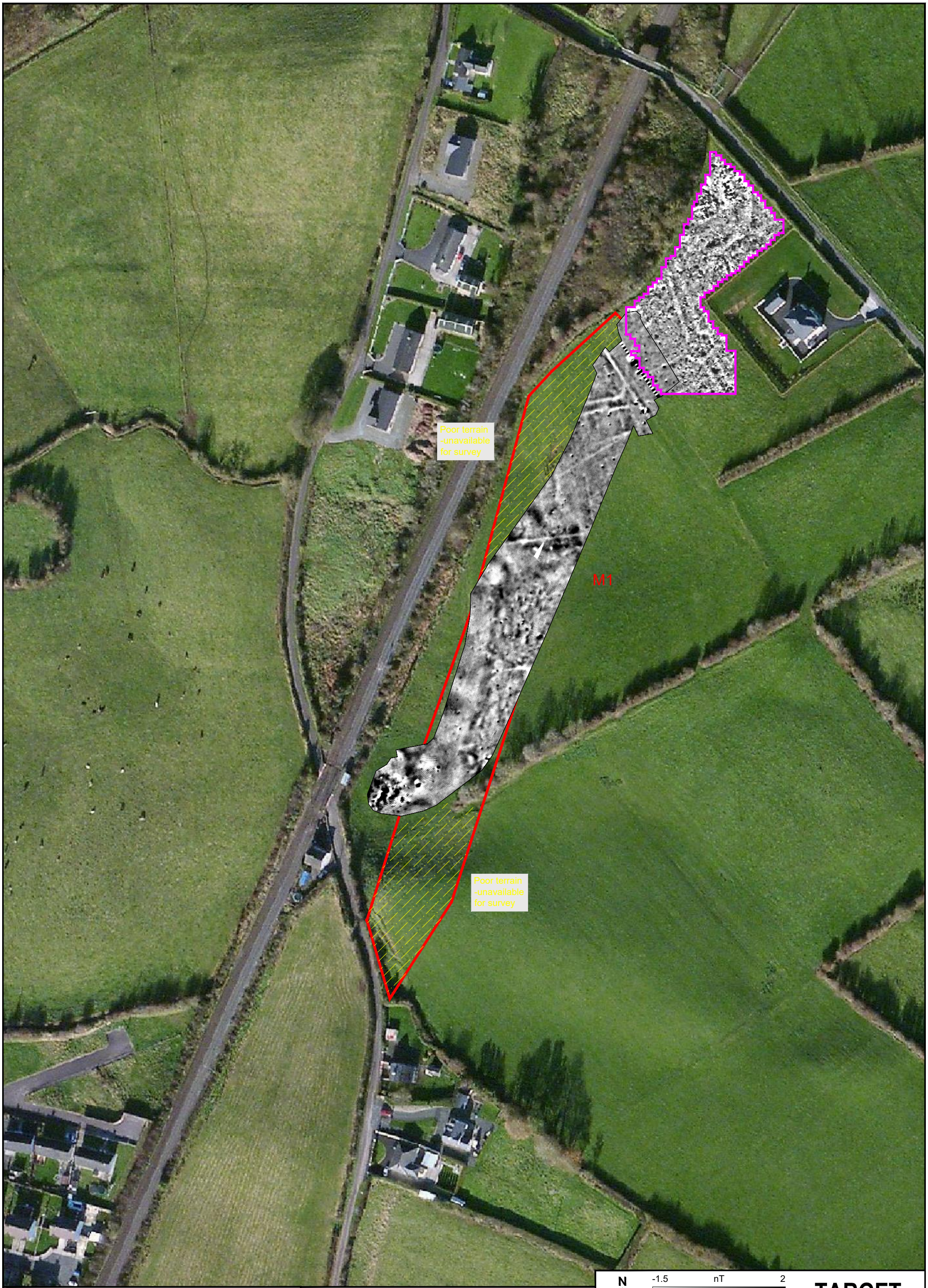
ARCHAEOLOGICAL GEOPHYSICS GCV



Project	Cork Line Level Crossing Project	**Drawing**	Greyscale M1 XC211 (Newtown townland, Co. Cork)				
Client	AMS Ltd. on behalf of Jacobs Engineering	**Fig.**	4	**Scale**	1:1500 @ A3	**TAG.**	2020IE9

N

-1.5 nT 2

0 m 60

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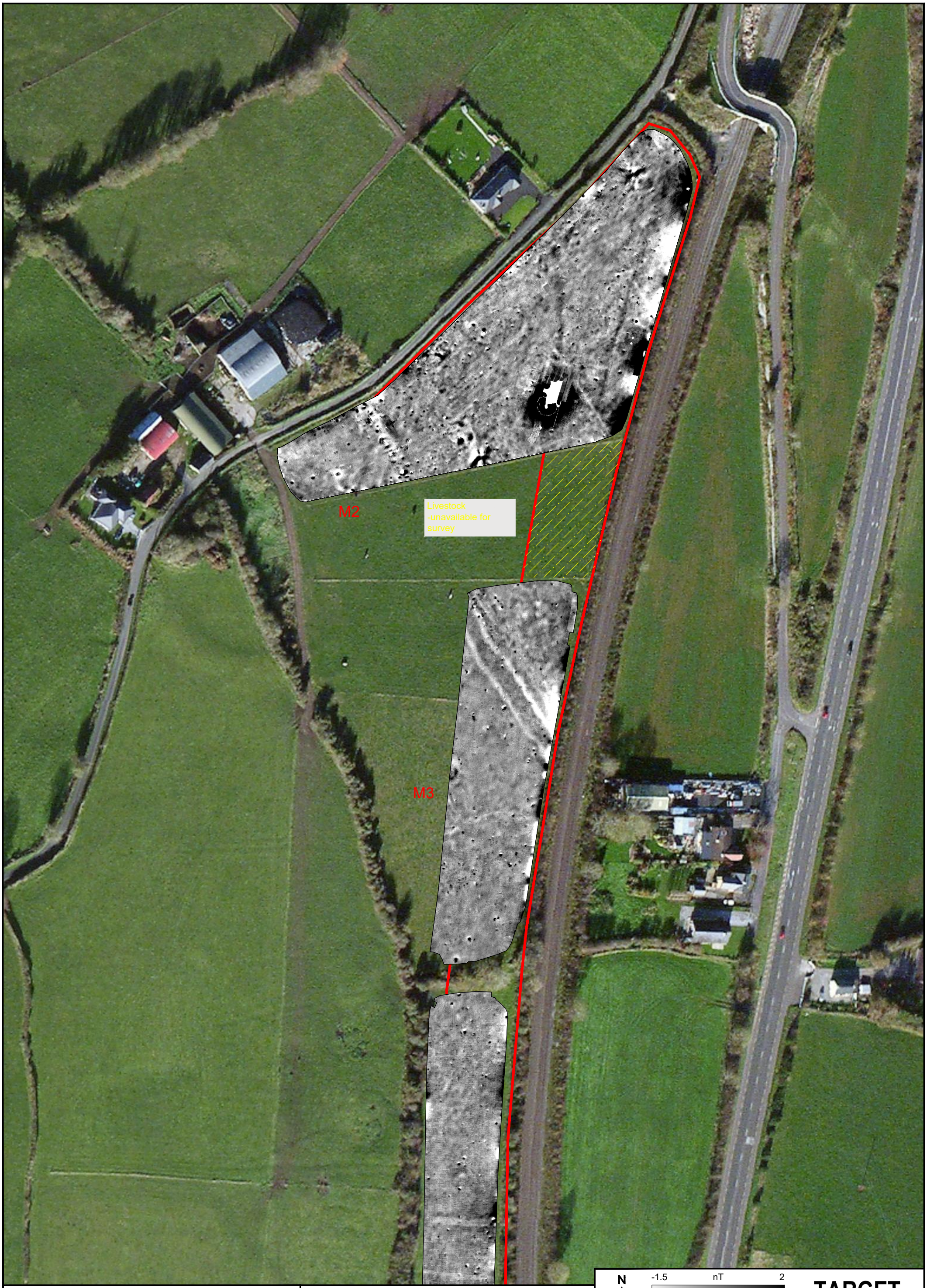
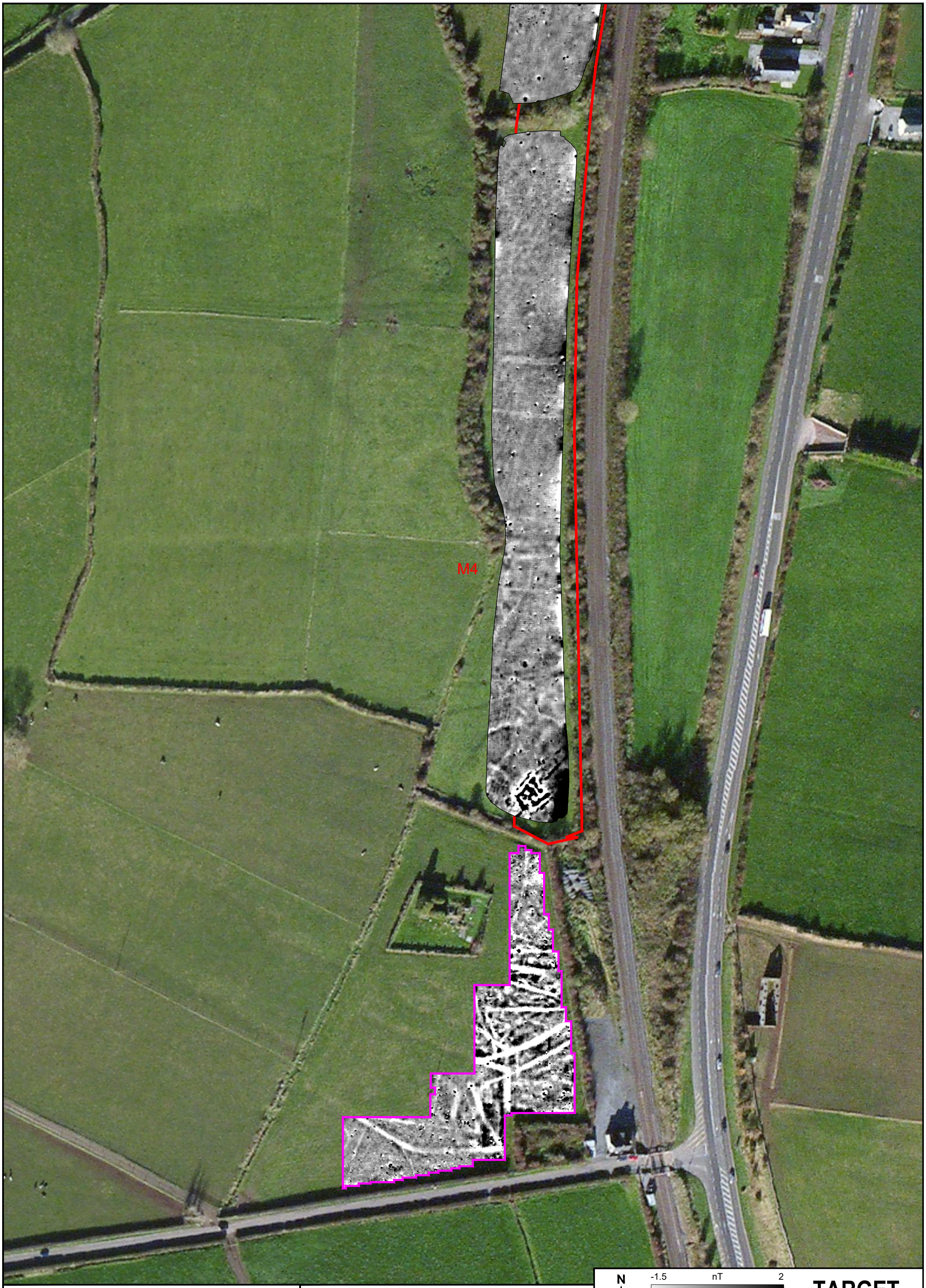
ARCHAEOLOGICAL GEOPHYSICS GCV



Project	Cork Line Level Crossing Project	**Drawing**	Greyscales M2-M3 XC215 (Shinanagh townland), Co. Cork				
Client	AMS Ltd. on behalf of Jacobs Engineering	**Fig.**	5	**Scale**	1:1500 @ A3	**TAG.**	2020IE9



Project	Cork Line Level Crossing Project	**Drawing**	Greyscale M4 XC215 (Shinanagh townland), Co. Cork				
Client	AMS Ltd. on behalf of Jacobs Engineering	**Fig.**	6	**Scale**	1:1500 @ A3	**TAG.**	2020IE9

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-1.5 nT 2

0 m 60

TARGET

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? Archaeology -probable burnt/fired deposit

? Archaeology

Trend

? Former boundary/land division

Soil morphological/geological variation

Ferrous

1

2

3

4

5

6

M1

Project	Cork Line Level Crossing Project	**Drawing**	Interpretation M1 XC211 (Newtown Townland), Co. Cork				
Client	AMS Ltd. on behalf of Jacobs Engineering	**Fig.**	7	**Scale**	1:1500 @ A3	**TAG.**	2020IE9

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TARGET

ARCHAEOLOGICAL GEOPHYSICS GCV

? Archaeology -probable burnt/fired deposit

? Archaeology

Trend

? Former boundary/land division

Soil morphological/geological variation

Ferrous

8

9

7

M2

10

11

M3

N

-1.5 nT 2

0 m 60

TARGET

ARCHAEOLOGICAL GEOPHYSICS GCV

Project	Cork Line Level Crossing Project	**Drawing**	Interpretations M2-M3 XC215 (Shinanagh Townland), Co. Cork				
Client	AMS Ltd. on behalf of Jacobs Engineering	**Fig.**	8	**Scale**	1:1500 @ A3	**TAG.**	2020IE9

? Archaeology -probable burnt/fired deposit

? Archaeology

Trend

? Former boundary/land division

Soil morphological/geological variation

Ferrous

M4

12

13

14

15

Project	Cork Line Level Crossing Project	**Drawing**	Interpretation M4, XC215 (Shinanagh Townland), Co. Cork				
Client	AMS Ltd. on behalf of Jacobs Engineering	**Fig.**	9	**Scale**	1:1500 @ A3	**TAG.**	2020IE9

N

-1.5 nT 2

0 m 60

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