National Roads Authority
Archaeological Geophysical Survey Database 2001-2010: Archive Report

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Survey Event No. **147**

Survey Name **Testing Areas 2, 4, 6, 7 & 15, M7 Portlaoise-Castletown / M8 Portlaoise-Cullahill, Contract 1 Gortnaclea To Oldtown**

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NRA Scheme Name Portlaoise to Cullahill/Castletown

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Survey carried out for Laois County Council

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Known problems with this report

There are no known archive issues with this report

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Testing Areas 2, 4, 6, 7 & 15, M7 Portlaoise-Castletown / M8 Portlaoise-Cullahill, Contract 1 Gortnaclea To Oldtown

Archaeological Geophysical Survey

Detection Licence No. A015/002-006

Survey undertaken on behalf of

Archaeological Consultancy Services Limited

J. Bonsall BA (Hons) MSc PIFA
H. Gimson BA (Hons) MSc MIAI

EAG 54

24 April 2005

EARTHSOUND archaeological geophysics

2 SCARLET COURT, DROGHEDA, COUNTY LOUTH, IRELAND
WWW.EARTHSOUND.NET

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Summary of Results

Between the 07-15 March 2005, a geophysical survey commissioned by Archaeological Consultancy Services Limited *was conducted within portions of Testing Areas 2, 4, 6, 7 & 15, on the 13.9 km long route of the proposed M7/M8 Contract 1, between Gortnaclea-Oldtown, County Laois.*

A methodology specified by Laois County Council National Roads Design Office *was adopted. A magnetic susceptibility meter and differential global positioning system formed an integrated hybrid instrument, which collected northing, easting, volume specific magnetic susceptibility and elevation for each sampled data point along the centreline of the survey area. The data were sampled at an interval of 10 m, within national grid co-ordinates and formed Phase A of the survey. Areas of anomalous susceptibility indicating zones of potential archaeological origin were further investigated as Phase B Detailed Areas, using a magnetic gradiometer at a sampling resolution of 1 x 0.125 m.*

The survey was conducted upon a bedrock geology consisting of variable types of Limestone. The survey area was covered in short grass and was comprised of pastureland.

A ring-ditch or barrow has been identified in Testing Area 2. The remaining testing areas contain a large number of magnetic trends that may represent archaeological ditch features or geological trends.

Statement of Indemnity

A geophysical survey is a scientific procedure that produces observations of results which are influenced by specific variables. The results and subsequent interpretation of the geophysical survey presented here should not be treated as an absolute representation of the underlying archaeological features, but as a hypothesis that must be proved or disproved. It is normally only possible to provide verification via intrusive means, such as Test Trench excavations.

1. Introduction

Earthsound Archaeological Geophysics were commissioned by Mr. C. McGuinness of *Archaeological Consultancy Services Limited*, to execute a geophysical survey on sections of the Gortnaclea to Oldtown (Contract 1) section of the M7 Portlaoise-Castletown / M8 Portlaoise-Cullahill motorway scheme. The survey areas have been identified as Testing Areas 2, 4, 6, 7 & 15.

Laois County CouncilArchaeological Consultancy Services Limited is proposing to construct a motorway to the southwest of Cullahill to join another section of motorway at Gortnaclea. The development will consist of 13.9 km of motorway. As part of the archaeological test trenching assessment of the motorway, *Laois County CouncilArchaeological Consultancy Services Limited* Project Archaeologist Sylvia Desmond requested a geophysical survey to be carried out at Testing Areas 2, 4, 6, 7 & 15.

This report is grouped by Testing Area, all details pertinent to Contract 1 that are the same are reported within this introductory section and the methodology (Section 2). A discussion of each Testing Area can be found in Section 3.

Permission for these works was granted by the Minister for Environment, Heritage & Local Government under Section 14A (2) of the National Monuments Acts 1930 to 2004: that geophysical surveys are carried out in accordance with a method statement submitted to the Minister. Permission for fieldwork was sought and given from the landowners and/or their representatives.

The geophysical survey will provide information on the location and extent of geophysical anomalies which may be of archaeological origin and will subsequently be assessed by archaeological test trenching. It is anticipated that test trenching will commence shortly after the completion of the geophysical surveys.

Geography & Topography

Located within the county of Laois, Contract 1 is just over 13.9 km in length (Figure 1). The corridor is located to the southwest of Cullahill to just southeast of Aghaboe.

The road corridor passes across a ridge greater than 100 m OD, which lies between Borris-in-Ossory, Rathdowney, Ballycolla, Aghaboe and Castletown. The topography drops off to the south of Cuffsbourough on to relatively flat land intersected by rivers and streams. The corridor rises in height at its southern extent, just to the north of Oldtown. The scheme crosses the Erkina River and the River Goul.

Aims & Objectives

The aim of the geophysical surveys were to determine the nature of the archaeological resource in advance of test trenching. Specific objectives were to:

- Via geophysical survey, assess the specified portions of Testing Areas 2, 4, 6, 7 & 15 for evidence of hidden or buried archaeological features, objects or deposits, using a Phase A reconnaissance magnetic susceptibility survey.
- To carry out Phase B detailed surveys, based on the Phase A reconnaissance magnetic susceptibility survey results, using detailed magnetometer survey, in selected areas, to be agreed.
- To provide geophysical survey maps to inform a programme of test trenching, which will be undertaken subsequent to the geophysical survey.
- To liaise throughout with *Archaeological Consultancy Services Limited* and *Laois County Council*.
- To report on the results of the geophysical survey.

A methodology was developed to meet the survey specifications to allow a preliminary magnetic susceptibility reconnaissance survey to systematically investigate Testing Areas 2, 4, 6, 7 & 15. This method has been used on the N6 Ballinasloe-Athlone Dual Carriageway (Bonsall & Gimson 2004).

2. Methodology

The fieldwork was carried out from 05 - 21 March 2005 by J. Bonsall and H. Gimson of *Earthsound Archaeological Geophysics*. *Earthsound* have created in-house technology which has enabled a *Bartington* MS2 Magnetic Susceptibility meter and an MS2D search loop to interface with a *Trimble* Pro-XRS Differential GPS. The instrument is known as the *Earthsound* MS-DGPS hybrid sensor and was used as a reconnaissance tool across the specified portions of Testing Areas 2, 4, 6, 7 & 15. A *Geoscan Research* FM256 Fluxgate Gradiometer was used for the Phase B detailed survey to further investigate geophysical anomalies of potential archaeological origin, identified from the Phase A reconnaissance.

2.1 Phase A – Reconnaissance Magnetic Susceptibility Survey

The centreline magnetic susceptibility survey is naturally biased towards the central portion of the route; significant archaeological zones on either side of the centreline may not be identified by the central transect.

A geophysical grid baseline was not established for the Magnetic Susceptibility survey; a Differential Global Positioning System (DGPS) data logger, a *Trimble* TSC1, displayed a graphical representation of the road scheme's centreline as line data joined to points on the Irish National Grid, as supplied by *Archaeological Consultancy Services Limited*. The graphical representation was utilised by the geophysicists to navigate along the centreline and collect data points at pre-determined intervals.

The MS2 was set to a recording sensitivity of 1 SI unit to obtain (infinite) volume specific magnetic susceptibility (Volume MS or κ).

When measured in SI units, the data is expressed as 1 x 10^{-5} κ. The *Earthsound* MS-DGPS hybrid sensor recorded northing and easting within the Irish National Grid to a minimum accuracy of ±0.5 m, and altitude to an accuracy of ±2 m.

Before taking each sample cluster (see below), the MS2 was calibrated according to the manufacturer's guidelines, by 'zeroing' whilst holding the sensor approximately 3 m in the air. The positive and negative data presented in this report are the κ value of the survey area compared to the κ value of the air, being, theoretically, zero. All readings were taken with a 1 second sampling period with the complete field loop placed with uniform pressure on the ground surface where possible (comments are made in the interpretative text where this was not possible).

Data were collected by using a push button trigger on the MS2 and stored automatically in the TSC1 data logger. The geophysicists walked at a constant pace along each traverse, pausing at each survey station to obtain a measurement of magnetic susceptibility. The data were downloaded to a field computer using *Trimble* Pathfinder Office 2.9 software.

The Phase A reconnaissance survey comprised a single transect along the centreline of the road corridor with measurement points at a uniform interval not exceeding 10 m.

At each measurement point along the transect, five individual readings (known as a "sample cluster") were taken and recorded. Reading 1 was taken on the first measurement point with the remainder spaced no more than 1 m north, south, east and west from reading 1. At each measurement point the sample cluster was completed collectively within 10 seconds.

The data were recorded in Irish National Grid format at the time of survey (System: Irish Map Grid; Zone: Ireland 1975). The data were exported to *Trimble* GPS Pathfinder Office 2.90 software and imported to *Microsoft* Excel in xyz format (X=northing, Y=easting, Z=magnetic susceptibility).

During the Phase A centreline transect, the reconnaissance survey was supplemented by a series of magnetic susceptibility surveys on regular grids with a maximum line and station spacing of 5 m, over areas suggestive of varying κ.

To confirm the operational status of the instrumentation on a daily basis, at the start and end of each period of survey activity, the instrument was zeroed in the air and 60 consecutive readings were taken at a single point. The sampling rate was at 1 second and the readings were recorded. These results are annotated with date and time and presented and discussed in Appendix 4.

Magnetic susceptibility anomalies of potential archaeological interest were subsequently investigated with a magnetic gradiometer at a detailed sampling resolution, see Phase B, below.

2.1 Data Processing

2.1.1.1 Preliminary Data Treatment

The data were exported from Pathfinder Office 2.9 to *Microsoft* Excel. The data were analysed for temperature-induced drift, which was not thought to be present given the frequent calibration of the instrument and the 10-second data collection routine (see discussion in Appendix 4). No processing was necessary other than removing spurious data (exceptionally high or low data, which upon being re-measured, was found to be more representative than the first measurement, given the soil conditions). The data were gridded using *Golden Software's* Surfer 8, swapping x and y for easting and northing.

2.1.1.2 Further Processing

No further processing functions were applied due to the high quality of the data collection.

2.2 Graphical Display

Each data point is represented by a solid circle, the diameter of which is proportional to the magnetic susceptibility value at the measurement point. The dot proportional plot presents data on a linear scale, increasing or decreasing dependent on the maximum and minimum values.

2.2 Phase B – Detailed Magnetic Gradiometer Survey

A rectangular grid was laid out using a *Trimble* Pro-XRS Differential Global Positioning System (see Technical Appendix 2), and divided in to 40 × 40 m sub-grids. The geophysical survey grid respected the curvilinear lines of the landtake boundary as far as feasibly possible, ensuring a 100% coverage of the sites, except for inaccessible areas.

A rectangular grid was laid out using a *Trimble* Pro-XRS Differential Global Positioning System (see Technical Appendix 2). In order to achieve 0.1 m accuracy on all detailed survey points, surveyors located each corner of the survey area only when 8 or more satellites were present overhead, which provided enough reference points for the required accuracy.

The survey was undertaken along lines parallel to the sub-grid edges, walking approximately west to east, starting in the northwest corner of each grid. Subsequent lines were surveyed in alternate directions ('zigzag').

Data were recorded using an FM256 at a spatial resolution of 1 m intervals between traverses and 0.125 m intervals along those lines. The instrument was positioned facing north, parallel to the Earth's magnetic field, to allow increased geo-magnetic resolution.

The instrument was set to a recording sensitivity of 0.1 nT. Prior to the beginning of the survey and after the completion of every two sub-grids, the electronic and mechanical set-up of the instrument were examined and calibrated as necessary over a common reference point. The magnetic drift from zero was not logged.

Data were collected automatically using an internal sample trigger while the operator walked at a constant pace along the traverse. The data were stored in an internal data logger and downloaded to a field computer using the *Geoscan Research* Geoplot v.3.00a software.

2.3 Data Processing

2.3.1.1 Preliminary Data Treatment

The data were pre-processed in Geoplot 3.00.

Spurious high intensity anomalies, commonly statistical outliers, are referred to as geophysical 'spikes'. In magnetic data, an 'iron spike' is a response to a buried ferrous object, often in the topsoil. Iron spikes are generally not removed in geophysical data; although often modern in origin, they can be indicative of archaeological material.

The raw data contained some poorly matched sub-grids, caused by the internal drift of the fluxgate gradiometer and the gradual misalignment of the fluxgate sensors between calibration episodes. To compensate for this, a zero mean traverse (ZMT) function was employed. The use of ZMT alters data to adjust the mean of each traverse to zero by increasing or decreasing data as necessary. This alters the statistical properties of the data to give a uniformly bipolar background, centred around zero. Post-ZMT plots were compared with raw data to analyse the potential removal of geophysical anomalies along the line of a traverse.

2.3.1.2 Further Processing

A low pass Gaussian filter was applied, reducing the variability of the data while improving the visibility of weak archaeological features. This also had a smoothing effect on the data.

A sine wave interpolation function was applied to provide a smooth, aesthetically pleasing image for presentation. For a given point x, the contribution of adjacent readings to the interpolated point is given by the function sinc $(x) = \sin \pi x / \pi x$ (Scollar 1990). This function is used as a sliding window along each transect, resulting in an interpolated image, expanding the resolution of the data from 1 m x 0.125 m to 0.5 m x 0.0625 m. This function was chosen as giving a clearer interpolated image than linear interpolation (which assumes a direct linear change between each point) or bicubic interpolation (taking the surrounding sixteen values into account).

2.4 Graphical Display

Pre-processed data are displayed in XY traceplot format in Figure 20. An XY traceplot presents the data logged on each traverse as a single line with each successive traverse incremented on the Y-axis to produce a stacked plot. The data have been clipped at –5 and +5 nT. The main advantage of this display option is that the full range of data can be viewed, dependent on the clip, so that the 'shape' of individual anomalies can be discerned and potential archaeological anomalies differentiated from iron 'spikes'.

Processed data are shown in Greyscale format. The greyscale plot presents data as pixels on a linear grey shaded scale, increasing or decreasing dependent on the values of the maximum and minimum clip. Data values beyond the clip limits are shown as 'pure' black or white. The main advantage of this display option is that the data can be viewed as a base map.

Reporting, Mapping and Archiving

The geophysical survey and report follow the recommendations outlined in the *English Heritage Guidelines* (David 1995) as a minimum standard and those of *IFA Paper No. 6* (Gaffney *et al.* 2002).

Geophysical data, figures and text are archived following the recommendations of the *Archaeology Data Service* (Schmidt 2001).

All figures reproduced from *Ordnance Survey Ireland* mapping are done so with permission from *OSI* copyright (Licence No. AR 0047305).

Technical information on the equipment used, data processing and methodology are given in Appendix 1. Appendix 2 details the survey geo-referencing information. Appendix 3 describes the composition and location of the archive. Appendix 4 is concerned with data quality, repeatability and accuracy.

3. Site Specific Data

3.1 Testing Area 2

Detection Licence

The survey was undertaken under the archaeology works number A015/002 issued by the Project Archaeologist in accordance with the directions issued to *Laois County Council* by the Minister for Environment, Heritage & Local Government under Section 14A(2)of the National Monuments Acts (1930 to 2004).

Geography, Geology & Topography

Located within the townland of Cuffsborough, Testing Area 2 is 0.9 km in length. The centre of the survey area (Figure 2) lies at *Ordnance Survey of Ireland* National Grid (ING) Reference E234365 N183070. Testing Area 2 is located between the R434 and a Third Class Road, 300 m west of Cuffsborough crossroads.

The survey occurred through Fields 153, 157-158, 158-south, 162 & 169, over a length of 900 m, between Chainages 20700-21600.

The survey area is mostly flat although the southern portion of Field 158-south rises sharply. All of the fields were comprised of short grass pastureland.

The bedrock geology for Testing Area 2 is comprised of two geological formations; Waulsortian Limestones and Dolomitization to the south and Waulsortian Limestones to the north. The approximate location of the geological change, as indicated by GSI data, has been indicated on Figure 2. These types of geology are magnetically quiet and are unlikely to have caused problems for the magnetic surveys.

Archaeological Background

There are two Recorded Monuments within the vicinity of Testing Area 2, although these are not precisely located and are not thought to be within the Road Scheme.

The following information has been derived in part from Gowen (2002):

LA022:061/028:082/029:055, the site of a possible megalithic tomb, was recorded as a 'beehive-shaped chamber' under an earthen mound. The chamber measured five feet in diameter and was built with large stones rising about three and a half feet above the ground. These orthostats supported tiers of corbelling on which rested a single large roof stone. The bones of two skeletons were found on the floor of the chamber. The monument was removed at the time and its precise location is now unknown.

LA022:038/028:083/029:071, a Cist, in which a crouched skeleton accompanied by a pottery vessel was discovered somewhere in Cuffsborough.

A Bronze Age Avenue is also reported within the area.

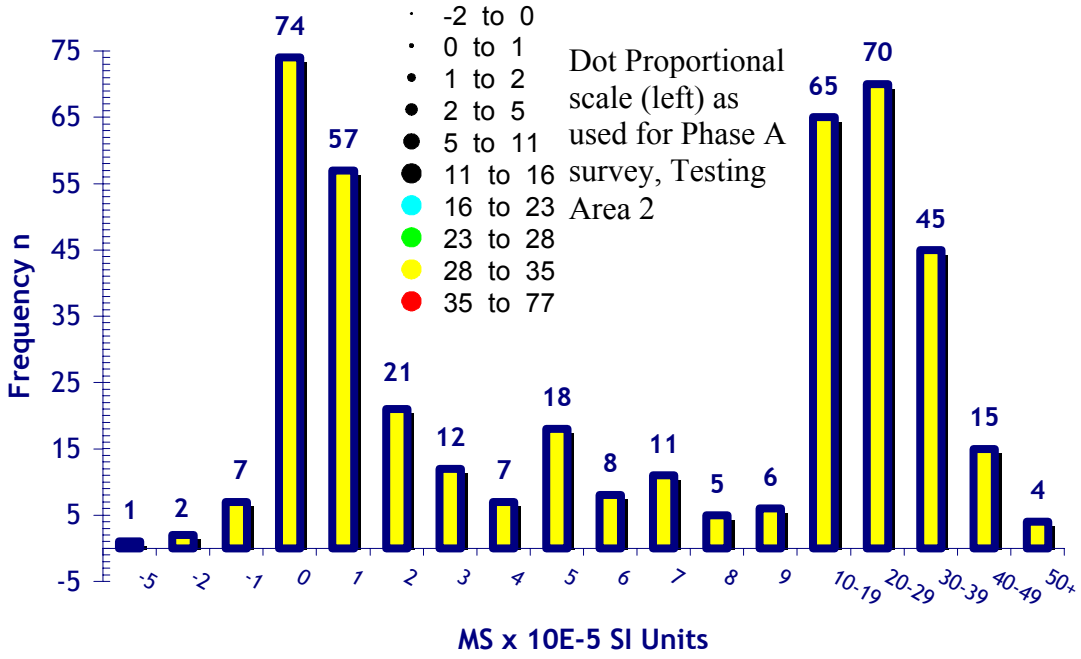
Graphical Display

Phase A centreline data are displayed in dot proportional plot format in Figure 2. Phase A supplemental data are displayed in dot proportional plot format in Figures 3 & 4. Phase B detailed gradiometer data are displayed in Greyscale format in Figures 5 & 7. The Greyscale data have been clipped at –3 (white) and +3 nT (black). Interpretation plots are presented in Figures 6 & 8.

3.1.1 Testing Area 2 - Results & Discussion

The interpretation figures should not be looked at in isolation but in conjunction with the relevant discussion section and with the information contained in the Appendices.

3.1.1.1 Phase A – Reconnaissance Magnetic Susceptibility Survey



The magnetic susceptibility reconnaissance survey was conducted along the centreline of the road corridor. Each data point was sampled five times as detailed in the methodology and is displayed on a dot proportional scale, as shown above; the scale of the figures is so great that only one dot (the largest) can be seen, which effectively averages the data.

During the Phase A centreline transect, areas of variable/strong susceptibility (and topographical anomalies of note), were further investigated over a small area in an attempt to 'define' an anomalous area. These formed the basis of supplemental surveys, some of which were later expanded into detailed survey areas.

The geological change (Waulsortian Limestone with Dolomitization to Waulsortian Limestone) could account for the variation seen in some of the data, although both formations are magnetically quiet.

The data were collected on 5th March 2005. Distinct areas of enhanced values can be seen along the road corridor, compared to the surrounding background values. These data have been grouped in to Magnetic Susceptibility Zones, according to their degree of magnetic enhancement, illustrating continuous areas of similar/anomalous susceptibility.

Magnetic Susceptibility Zone 1 **Chainage 20750-20920**

(Field 158-south)

Figure 2

A strong magnetic susceptibility was noticed within Field 158-south, which slopes downward from south to north. Values ranged between 10-28 x 10^{-5} κ along the centreline.

0.5 ha of supplemental magnetic susceptibility survey were available to investigate anomalous areas identified along the centreline or archaeologically prospective zones as indicated by topographical or environmental conditions. The presence of enhanced data within Zone 1 and the possible influence/interference from a geological slope informed the use of 0.4 ha of supplemental magnetic susceptibility survey, with station spacing between 8-11 m intervals.

The supplemental investigation covered the northern section of the field (Figure 3), an area where the magnetic susceptibility was strongest, lying at the base of the slope and along generally flat land.

The supplemental magnetic susceptibility survey confirmed the presence of the strong enhancement seen in the centreline transect. The enhancement clearly declines towards the south, falling from 28 x 10^{-5} κ in the north to 7 x 10^{-5} κ in the south.

The strong enhancement suggests a possible underlying archaeological/geological cause.

The supplemental magnetic susceptibility survey suggested the need for further investigation. At a meeting between *Earthsound*, *Archaeological Consultancy Services Limited*, *Laois County Council* Project Archaeologist Sylvia Desmond and *Laois County Council* Geophysical Consultant Kevin Barton, it was decided to follow *Earthsound's* recommendations of a 0.83 ha area of Phase B Detailed Magnetic Gradiometer Survey (Area 1) located along the entire centreline in Field 158-south, beyond the supplemental magnetic susceptibility survey to include the topographical slope.

Between Magnetic Susceptibility Zones 1 & 2 (Chainage 20920-21300), the data along the centreline are uniformly weak, between 2-7 x 10^{-5} κ.

Magnetic Susceptibility Zone 2 **Chainage 21300-21450**

(Field 169)

Figure 2

Moderately strong responses were noted in the northern portion of the field (between 7-28 x 10^{-5} κ).

The presence of enhanced data within Zone 2 informed the use of 0.4 ha of supplemental magnetic susceptibility survey, with station spacing between 8-11 m intervals.

The supplemental investigation covered the central-northern section of the field, an area where the magnetic susceptibility was strongest.

The supplemental magnetic susceptibility survey confirmed the presence of moderately strong responses on a peaty soil, that could reflect a high conductance value as opposed to a high susceptibility value.

At a meeting between *Earthsound*, *Archaeological Consultancy Services Limited*, *Laois County Council* Project Archaeologist Sylvia Desmond and *Laois County Council* Geophysical Consultant Kevin Barton, it was decided not to follow the survey with additional geophysical investigations.

Magnetic Susceptibility Zone 3 **Chainage 21500-21620**

(Field 162)

Figure 2

A strong response was noted along the centreline of Zone 3, across Field 162, of average mean response 30 x 10^{-5} κ, which is much stronger than the rest of the Testing Area.

The presence of enhanced data within Zone 3 and a slight topographical expression informed the use of 0.7 ha of supplemental magnetic susceptibility survey, with station spacing between 8-11 m intervals.

The supplemental investigation covered the entire section of the field that contained the proposed road corridor (Figure 4).

The supplemental magnetic susceptibility survey confirmed the presence of the strong enhancement seen in the centreline transect. The strong enhancement suggests a possible underlying archaeological/geological cause.

The supplemental magnetic susceptibility survey suggested the need for further investigation. At a meeting between *Earthsound*, *Archaeological Consultancy Services Limited*, *Laois County Council* Project Archaeologist Sylvia Desmond and *Laois County Council* Geophysical Consultant Kevin Barton, it was decided to follow *Earthsound's* recommendations of a 0.81 ha area of Phase B Detailed Magnetic Gradiometer Survey (Area 2) located along the proposed road corridor.

3.1.1.2 Phase B – Detailed Survey Area

At a meeting between *Earthsound*, *Archaeological Consultancy Services Limited*, *Laois County Council* Project Archaeologist Sylvia Desmond and *Laois County Council* Geophysical Consultant Kevin Barton, it was agreed to investigate the following areas based on the summarised criteria specified, via a Phase B Detailed Magnetic Gradiometer Survey:

Detailed Survey Area	Magnetic Susceptibility Zone	Chainage	Area (metres)	Townland	Survey Criteria	Survey Type
D1	1	20750-20920	200 x 50 (Partial - 0.78 ha)	Cuffsborough	Cluster of strong values across field	MG
D2	3	21500-21620	130 x 80 (Partial - 0.81)	Cuffsborough	Entire road corridor is strongly enhanced	MG

MG = magnetic gradiometer

Total magnetic gradiometer detailed survey area: 1.61 ha

Detailed Area 1 Chainage 20750-20920

Gradiometer Data: Figure 5

Gradiometer Interpretation: Figure 6

During the Phase A reconnaissance survey, a uniform background of strongly enhanced sample points were noticed across Field 158-south. Supplemental magnetic susceptibility traverses across the width of Testing Area 2, over an 110 m length revealed further magnetic enhancement. A 0.78 ha area of detailed magnetic gradiometer survey was located over the centreline in Field 158-south.

The survey indicates the presence of a strongly magnetic circular anomaly at the base of the topographical slope. The anomaly is 18 m in diameter and probably represents a ring-ditched enclosure or barrow. A small number of slightly enhanced isolated points can be seen within the circular anomaly; these may represent internal features such as pits or burnt material.

A ditch can be seen leading to the possible ring-ditch circular anomaly; it is 35-40 m in length and may turn slightly in the vicinity of a borehole, although the boreholes magnetism outweighs that of the ditch and hinders the interpretation.

A series of E-W aligned linear anomalies can be seen across the survey area. The anomalies appear to continue beyond the survey area and probably represent plough furrows.

A possible ditch can be seen amongst the plough furrows; it may represent a field boundary or a drainage ditch. It could be associated with a bend in the present field system, on the western side of Field 158-south.

A number of curvilinear trends of positive magnetism can be seen to the north of the circular ditch anomaly – these could represent narrow ditches, gullies or geological trends.

A negative anomaly traverses the southern portion of the survey area and may represent a wall.

Three geological boreholes have created a strong magnetic anomaly in the north, east and south of the survey area.

Detailed Area 2 Chainage 21500-21620

Gradiometer Data: Figure 7

Gradiometer Interpretation: Figure 8

During the Phase A reconnaissance survey, a uniform background of strongly enhanced sample points were noticed across Field 162. Supplemental magnetic susceptibility traverses across the width of Testing Area 2, revealed further magnetic enhancement. A 0.83 ha area of detailed magnetic gradiometer survey was located over the road corridor in Field 162.

The survey indicates the presence of agricultural plough furrows, which appear as moderately magnetic linear anomalies in a parallel formation.

A small number of linear and curvilinear anomalies of strong magnetism may represent ditches which could represent relict field boundaries.

A possible rectilinear enclosure (17 x 17 m) can be seen in the southeast corner of the field. This could represent an enclosure for a house plot, although the background within the plot is very quiet and does not suggest the presence of a structure or any occupational evidence whatsoever.

Two geological boreholes have created a strong magnetic anomaly on the north side of the survey area.

3.1.1.3 Recommendations for further work at Testing Area 2

No further geophysical investigations are required. Test trenches should be used to assess the geophysical anomalies in Detailed Areas 1 and 2 to determine an underlying geological/archaeological cause.

Detailed Survey Area	Magnetic Susceptibility Zone	Chainage	Townland	Trench Start (NGR E, N)	Trench End (NGR E, N)	Target Description
D1	1	20750-20920	Cuffsborough	234287, 182713	234314, 182706	Ring-ditch/barrow
				234294, 182691	234303, 182726	Ring-ditch/barrow and possible field boundary
				234319, 182705	234317, 182690	Possible ditch/gully, plough furrows
				234279, 182652	234278, 182641	Possible ditch/gully
				234320, 182728	234308, 182735	Ditch
				234330, 182738	234319, 182746	Ditch
				234329, 182758	234324, 182770	Ditch/Possible burning
				234300, 182754	234299, 182766	Ditch
D2	3	21500-21620	Cuffsborough	234453, 183400	234451, 183406	Possible field boundary ditch
				234438, 183413	234441, 183408	Possible gully
				234438, 183418	234447, 183420	Possible enclosure ditch
				234444, 183436	234445, 183427	Possible enclosure ditch
				234423, 183481	234416, 183501	Possible ditch/field boundary
				234417, 183407	234424, 183411	Possible ditch/field boundary
				234409, 183416	234406, 183431	Possible ditch/field boundary
				234400, 183447	234409, 183451	Possible ditch/field boundary

3.2 Testing Area 4

Detection Licence

The survey was undertaken under the archaeology works number A015/003 issued by the Project Archaeologist in accordance with the directions issued to *Laois County Council* by the Minister for Environment, Heritage & Local Government under Section 14A(2)of the National Monuments Acts (1930 to 2004).

Geography & Topography

Located within the townland of Tintore, Testing Area 4 is 200 m in length. The centre of the survey area (Figure 7) lies at *Ordnance Survey of Ireland* National Grid (ING) Reference E234632 N180055.

The survey occurred in Fields 128 & 129, between Chainages 18000-18200.

The survey area lies upon a gentle incline, sloping from north to south. The field were comprised of short grass pastureland.

The bedrock geology for Testing Area 4 is comprised of two geological formations; Crosspatrick Formation (cherty crinoidal limestone) to the north and Aghmacart Formation (shaly micrite, peloidal limestone) to the south. The approximate location of the geological change, as indicated by GSI data, has been illustrated on Figure 9. These types of geology are magnetically quiet and are unlikely to have caused problems for the magnetic surveys.

Archaeological Background

There are no Recorded Monuments present within Testing Area 4 of the road scheme. LA029:015 (ringfort) lies 170 m to the east of the survey area. The site, situated just west of church site LA029:016 (see below), consists of a circular area (diam. *c*.28.5m) defined by an inner bank (Wth *c.* 2.8m, int. H *c.* 0.4m, ext. H *c.* 1.1m), an intervening fosse (Wth *c.* 3.4m) from the NE-SE, and an outer bank (Wth *c.* 2.3m, int. H *c.* 0.9m, ext. H *c.* 0.3m) from the NE-E. The ringfort is situated in a prominent position on a raised ridge that extends to the north; the ground falls away to the south of the monument.

A church site (LA029:016), located 260 m to the east of Testing Area 4, dedicated to St Nicholas, is indicated as 'Eglish Church (in Ruins)' on OS six-inch map editions; the Down Survey also indicates the church by both name and location. The foundations of the church were all that were present at the turn of the twentieth century, and according to tradition the site was that of an early Christian monastery. Situated on a low ridge, in a prominent position, the remains consist of a low rectangular mound of rubble with a wall-facing visible at the W end.

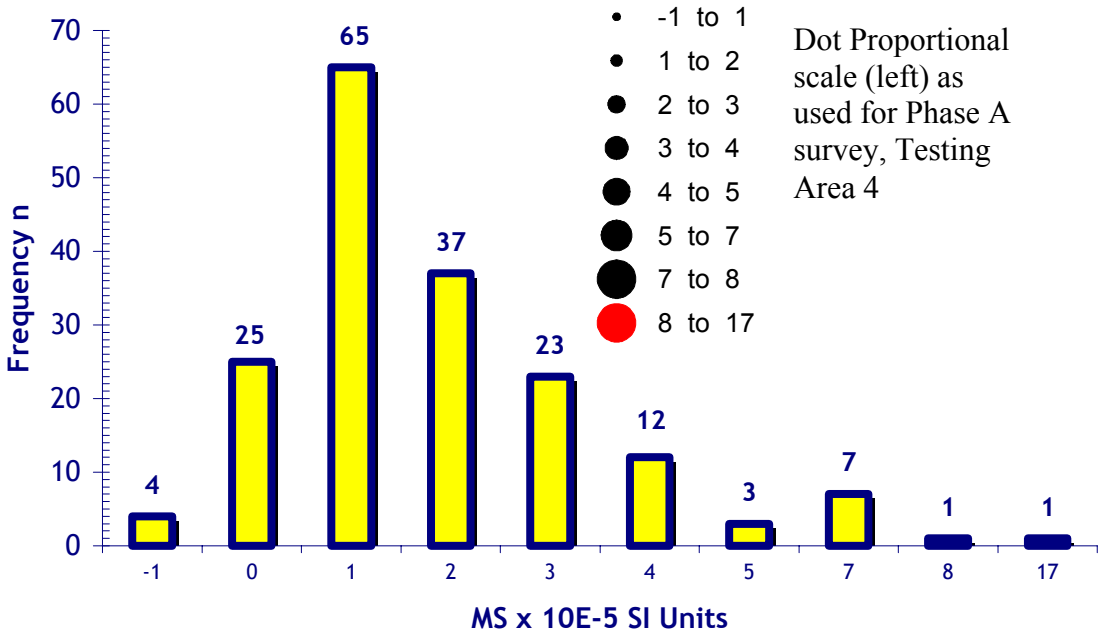
Graphical Display

Phase A centreline data are displayed in dot proportional plot format in Figure 9. Phase B detailed gradiometer data are displayed in Greyscale format in Figure 10. The Greyscale data have been clipped at –3 (white) and +3 nT (black). An interpretation plot is presented in Figure 11.

3.2.1 Testing Area 4 - Results & Discussion

The interpretation figures should not be looked at in isolation but in conjunction with the relevant discussion section and with the information contained in the Appendices.

3.2.1.1 Phase A – Reconnaissance Magnetic Susceptibility Survey



The magnetic susceptibility reconnaissance survey was conducted along the centreline of the road corridor. Each data point was sampled five times as detailed in the methodology and is displayed on a dot proportional scale, as shown above; the scale of the figures is so great that only one dot (the largest) can be seen, which effectively averages the data.

The Phase A survey was undertaken in Field 128 & 129 over a total length of 200 linear metres. The data were collected on 12th March 2005.

Given the small size of the survey area, it was decided to carry out 0.7 ha of supplemental magnetic susceptibility survey throughout the entire area of Testing Area 4, with station spacing between 8-11 m intervals.

Distinct areas of enhanced values can be seen within Testing Area 4, compared to the surrounding background values. These data have been grouped in to Magnetic Susceptibility Zones, according to their degree of magnetic enhancement, illustrating continuous areas of similar/anomalous susceptibility.

Field 129 contained a geological test pit ringed by a post and wire fence (diameter 20 m) which reduced the survey area slightly.

Strongly variable data was noted across the entire Testing Area. The presence of ringfort LA029:015, situated 170 m to the east, suggested that the variation in magnetism seen across Testing Area 4 could have an archaeological influence. The supplemental magnetic susceptibility survey suggested the need for further investigation. At a meeting between *Earthsound*, *Archaeological Consultancy Services Limited*, *Laois County Council* Project Archaeologist Sylvia Desmond and *Laois County Council* Geophysical Consultant Kevin Barton, it was decided to investigate two specific zones of magnetic susceptibility, using the Phase B Detailed Gradiometer Surveys.

3.2.1.2 Phase B – Detailed Survey Area

At a meeting between *Earthsound*, *Archaeological Consultancy Services Limited*, *Laois County Council* Project Archaeologist Sylvia Desmond and *Laois County Council* Geophysical Consultant Kevin Barton, it was agreed to investigate the following areas based on the summarised criteria specified, via a Phase B Detailed Magnetic Gradiometer Survey:

Detailed Survey Area	Magnetic Susceptibility Zone	Chainage	Area (metres)	Townland	Survey Criteria	Survey Type
D3	5	18150-18200	80 x 80 (0.64 ha)	Tintore	Cluster of strong values across field	MG
D4	6	18025-18050	40 x 40 (0.16 ha)	Tintore	Sample of strong enhancement tested	MG

MG = magnetic gradiometer

Total magnetic gradiometer detailed survey area: 0.8 ha

Detailed Area 3 Chainage 18150-18200

Gradiometer Data: Figure 10

Gradiometer Interpretation: Figure 11

During the Phase A reconnaissance survey, a uniform background of strongly enhanced sample points were noticed across Field 129. Supplemental magnetic susceptibility traverses across the width of Testing Area 4 revealed further magnetic enhancement. A 0.64 ha area of detailed magnetic gradiometer survey was located over the centreline in Field 129.

The survey indicates the presence of three parallel anomalies of positive magnetism that could represent ditches and are associated with linear banks visible as low earthworks.

A small number of linear and curvilinear anomalies can be seen across the survey area – these may represent archaeological ditches or geological trends.

A possible rectilinear anomaly can be seen in the SE of the survey area, measuring 8 x 12 m. This could represent a possible enclosure, or simply a coincidental geological trend.

A geological borehole and a fenced geological test pit have created a strong magnetic anomaly in the survey area.

Detailed Area 4 Chainage 18025-18050

Gradiometer Data: Figure 10

Gradiometer Interpretation: Figure 11

During the Phase A reconnaissance survey, a uniform background of strongly enhanced sample points were noticed across Field 128. Supplemental magnetic susceptibility traverses across the width of Testing Area 4, revealed further magnetic enhancement. A 0.16 ha area of detailed magnetic gradiometer survey was located over the road corridor in Field 128.

A small number of parallel anomalies of positive magnetism can be seen aligned east-west across the survey area. These could represent archaeological ditches or geological trends.

Some possible pits or areas of discrete burning can be seen as isolated points of moderate magnetic enhancement.

3.2.1.3 Recommendations for further work at Testing Area 4

Despite the presence of a nearby ringfort and church, no substantial archaeological remains were identified in Testing Area 4. Test trenches should be used to assess the anomalies identified in Detailed Areas 3 & 4.

Detailed Survey Area	Magnetic Susceptibility Zone	Chainage	Townland	Trench Start (NGR E, N)	Trench End (NGR E, N)	Target Description
D3	5	18150-18200	Tintore	234548, 180160	234570, 180167	Two ditches
				234554, 180140	234574, 180146	Two ditches and a possible ditch/geological trend
				234566, 180107	234584, 180109	Ditch/geological trend
				234587, 180103	234596, 180104	Possible ditch/gully
				234595, 180130	234600, 180127	Possible ditch/gully
				234606, 180132	234604, 180127	Possible ditch/gully
				234623, 180123	234613, 180155	Possible ditch/gully
				234628, 180158	234637, 180129	Possible ditch/gully
				234595, 180176	234607, 180179	Possible ditch/gully
				234601, 180154	234613, 180180	Possible ditch/gully
				234615, 180189	234612, 180157	Possible ditch/gully
				234620, 180147	234628, 180146	Possible ditch/gully
				234620, 180147	234628, 180146	Possible ditch/gully
				234611, 180120	234617, 180123	Possible ditch/gully
				234626, 180119	234640, 180118	Possible enclosure ditch
				234633, 180110	234634, 180127	Possible enclosure ditch
D4	6	18025-18050	Tintore	234634, 180029	234643, 180003	Possible ditch/geological trend
				234655, 180006	234662, 180012	Possible ditch/geological trend

3.3 Testing Area 6

Detection Licence

The survey was undertaken under the archaeology works number A015/004 issued by the Project Archaeologist in accordance with the directions issued to *Laois County Council* by the Minister for Environment, Heritage & Local Government under Section 14A(2)of the National Monuments Acts (1930 to 2004).

Geography, Geology & Topography

Located within the townland of Oldglass, Testing Area 6 is 200 m in length. The centre of the survey area (Figure 2) lies at *Ordnance Survey of Ireland* National Grid (ING) Reference E234687 N179882. The northern end of the survey area was immediately south of Testing Area 4. The survey was carried out in two areas, on two different alignments over a junction.

The survey occurred in Fields 95, 97, 98 & 128, between N-S Chainage 17700-18000 and E-W Chainage 1650-2250.

The survey area gently declines from N-S. The field(s) were comprised of short grass pastureland.

The bedrock geology for Testing Area 6 is comprised of Aghmacart Formation (shaly micrite, peloidal limestone). This type of geology is magnetically quiet and unlikely to have caused problems for the magnetic surveys.

Archaeological Background

There are no Recorded Monuments present within Testing Area 6 of the road scheme. A ringfort (delisted, LA029:027) is located 380 m from Testing Area 6. The site is situated in undulating countryside on the eastern edge of Granston Demesne, to the east of deciduous woodland indicated as 'Robin's Grove' on the revised 1909 edition OS map. The site was deemed to be non-archaeological when last visited by the Archaeological Survey in August 1990, when it was identified as a quarry.

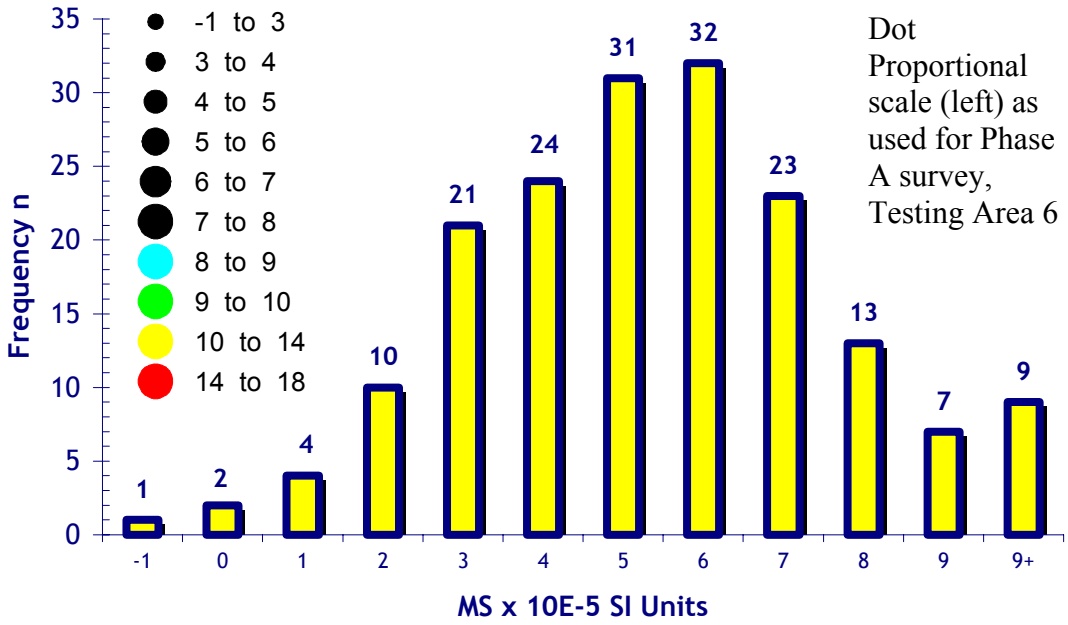
Graphical Display

Phase A centreline data are displayed in dot proportional plot format in Figure 12. Phase B detailed gradiometer data are displayed in Greyscale format in Figure 13. The Greyscale data have been clipped at –2 (white) and +2 nT (black). An interpretation plot is presented in Figure 14.

3.3.1 Testing Area 6 - Results & Discussion

The interpretation figures should not be looked at in isolation but in conjunction with the relevant discussion section and with the information contained in the Appendices.

3.3.1.1 Phase A – Reconnaissance Magnetic Susceptibility Survey



Dot Proportional scale (left) as used for Phase A survey, Testing Area 6

The magnetic susceptibility reconnaissance survey was conducted along the centreline of the road corridor. Each data point was sampled five times as detailed in the methodology and is displayed on a dot proportional scale, as shown above; the scale of the figures is so great that only one dot (the largest) can be seen, which effectively averages the data.

Distinct areas of enhanced values can be seen within Testing Area 6, compared to the surrounding background values. These data have been grouped in to Magnetic Susceptibility Zones, according to their degree of magnetic enhancement, illustrating continuous areas of similar/anomalous susceptibility.

The E-W aligned data were weakly enhanced data that required no further geophysical assessment. The N-S aligned data revealed a wide variation along the centreline, between 40-92 SI units.

0.5 ha of supplemental magnetic susceptibility survey were available to investigate anomalous areas identified along the centreline or archaeologically prospective zones as indicated by topographical or environmental conditions. Given the small size of the survey area, it was decided to carry out 0.37 ha of supplemental magnetic susceptibility survey throughout the entire N-S area of Testing Area 6, with station spacing between 8-11 m intervals.

The supplemental survey revealed similarly enhanced data across two thirds of the proposed landtake. The survey area was investigated further with a detailed magnetic gradiometer survey.

3.3.1.2 Phase B – Detailed Survey Area

At a meeting between *Earthsound*, *Archaeological Consultancy Services Limited*, *Laois County Council* Project Archaeologist Sylvia Desmond and *Laois County Council* Geophysical Consultant Kevin Barton, it was agreed to investigate the following areas based on the summarised criteria specified, via a Phase B Detailed Magnetic Gradiometer Survey:

Detailed Survey Area	Magnetic Susceptibility Zone	Chainage	Area (metres)	Townland	Survey Criteria	Survey Type
D5		17810-17930	55 x 120 (0.66 ha)	Oldglass	Moderate enhancement across the survey area	MG

MG = magnetic gradiometer

Total magnetic gradiometer detailed survey area: 0.16 ha

Detailed Area 5 Chainage 17810-17930

Gradiometer Data: Figure 13

Gradiometer Interpretation: Figure 14

During the Phase A supplemental magnetic susceptibility survey, a broad area of moderate enhancement was noticed across the survey area. A 0.66 ha area of detailed magnetic gradiometer survey was located over the moderate enhancement. The data were collected on 21st March 2005.

The survey area has a variable magnetic background that can probably be attributed to the geology of the site.

A number of linear and curvilinear anomalies of positive enhancement can be seen. These could represent archaeological ditches or geological trends and will require further assessment via test trenching. The geospatial qualities of the anomalies tends to suggest the possibility of an archaeological origin, perhaps even representing relict field systems; however the magnetic enhancement is very weak.

A series of dipolar anomalies – isolated points of strong magnetism – divide the site from E-W. This could represent an in-filled or destroyed field boundary, and may relate to some bends and angles in the extant boundaries of the field.

A small number of other clusters of dipolar anomalies could represent a spread of archaeological material or a geological trend.

A geological borehole has created a strong magnetic anomaly on the NE edge of the survey area.

3.3.1.3 Recommendations for further work at Testing Area 6

No further geophysical investigations are required. Test trenches should be used to assess the anomalies discussed in Detailed Area 5 to determine an underlying geological/archaeological cause.

Detailed Survey Area	Magnetic Susceptibility Zone	Chainage	Townland	Trench Start (NGR E, N)	Trench End (NGR E, N)	Target Description
D5		17810-17930	Oldglass	234679, 179897	234680, 179909	Possible ditch/geological trend
				234660, 179905	234669, 179937	Possible ditch/geological trend
				234684, 179896	234707, 179897	Possible ditch/geological trend
				234688, 179876	234712, 179877	Possible ditch/geological trend
				234715, 179853	234717, 179836	Possible ditch/geological trend
				234691, 179850	234692, 179836	Possible ditch/geological trend
				234679, 179866	234682, 179852	Possible destroyed/in-filled field boundary
				234717, 179877	234719, 179860	Possible destroyed/in-filled field boundary and ditch/geological trend

3.4 Testing Area 7

Detection Licence

The survey was undertaken under the archaeology works number A015/005 issued by the Project Archaeologist in accordance with the directions issued to *Laois County Council* by the Minister for Environment, Heritage & Local Government under Section 14A(2)of the National Monuments Acts (1930 to 2004).

Geography, Geology & Topography

Located within the townland of Oldglass, Testing Area 7 is 300 m in length. The centre of the survey area (Figure 2) lies at *Ordnance Survey of Ireland* National Grid (ING) Reference E23614 N178498.

The survey occurred in Field 79, which appears to contain a number of relict field boundaries, fragments of which can be seen as extant features. The field was comprised of short grass pastureland.

The bedrock geology for Testing Area 7 is comprised of Aghmacart Formation (shaly micrite, peloidal limestone). This type of geology is magnetically quiet and unlikely to have caused problems for the magnetic surveys.

Archaeological Background

There are no Recorded Monuments present within Testing Area 7 of the road scheme. A burial site (LA028:108) may lie within the road scheme although it has not been precisely located. Reference to a twelve acre field called 'Ballina-ghowl' in which large quantities of human remains were found; supposedly the battlefield of the Oulthacha, or Ulstermen, and the O'Phelans in 1156/57. The burials were found close to the old public road during the erection of an ESB pole in the 1970s. Placename 'Ballina-ghowl' is indicated on the revised 1909 edition OS map.

Aerial photography has revealed possible cultivation ridges within the vicinity of the route.

A ringfort (LA029:039) lies 200 m from the road corridor. The site is indicated as hachured on the 1890 and 1909 edition OS maps, and consisted of a circular area (max. diam. *c.* 40m). The site was levelled in the late seventies/early eighties and only a slight indication of the bank survives at the NW and E. There are no other visible surface traces of the site.

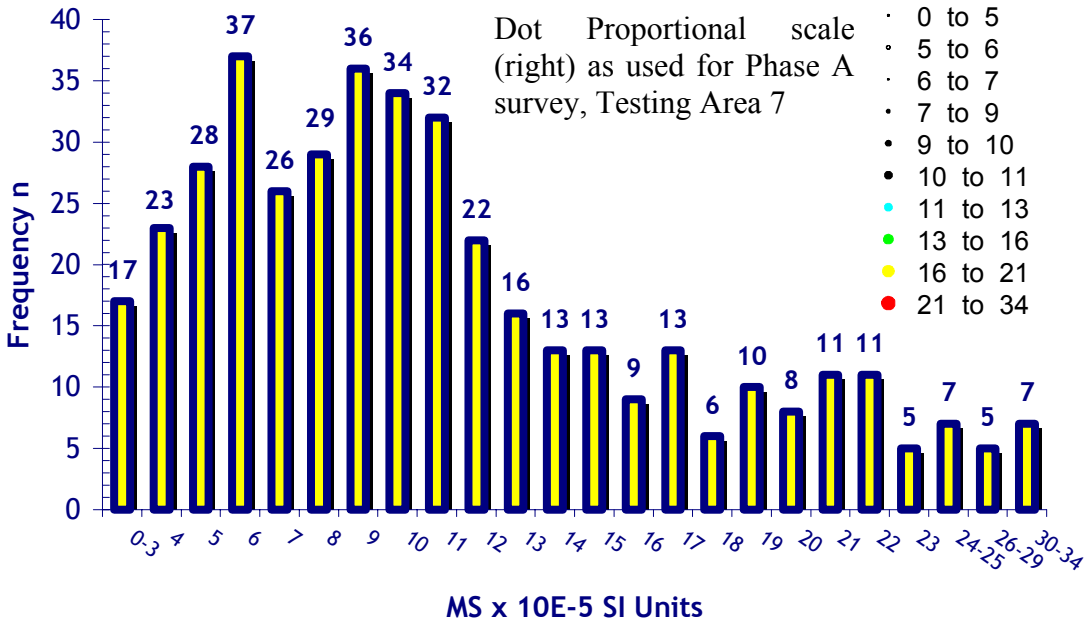
Graphical Display

Phase A centreline data are displayed in dot proportional plot format in Figure 15.

3.4.1 Testing Area 7 - Results & Discussion

The interpretation figures should not be looked at in isolation but in conjunction with the relevant discussion section and with the information contained in the Appendices.

3.4.1.1 Phase A – Reconnaissance Magnetic Susceptibility Survey



The magnetic susceptibility reconnaissance survey was conducted along the centreline of the road corridor. Each data point was sampled five times as detailed in the methodology and is displayed on a dot proportional scale, as shown above; the scale of the figures is so great that only one dot (the largest) can be seen, which effectively averages the data.

During the Phase A centreline transect, areas of variable/strong susceptibility, were further investigated over a small area in an attempt to 'define' an anomalous area. These formed the basis of supplemental surveys, some of which were later expanded into detailed survey areas.

The majority of the centre line data is uniform, with a continuous stream of strongly enhanced data (ranging between 28-153 SI units), averaging at 65 SI units.

The data were collected on 5th March 2005. Distinct areas of enhanced values can be seen along the road corridor, compared to the surrounding background values. These data have been grouped in to Magnetic Susceptibility Zones, according to their degree of magnetic enhancement, illustrating continuous areas of similar/anomalous susceptibility.

Magnetic Susceptibility Zone 4 Chainage 16500-16540

(Field 79)

Figure 15

The data within the zone are variable and contrast strongly with those noted to the north. The statistical mean of the data is 20 SI units. The data clearly change along the line of an extant field boundary that terminates to the northeast of the centreline. The data suggest that the field boundary carries on under the surface of the field; the data could reflect either the enhanced spread of the destroyed field boundary or simply the difference in magnetic enhancement between one field and another. A field boundary feature is likely to be uncovered by the centreline test trenching scheme.

, suggests that a previous field boundary probably continued further north, intercepting another field boundary. The previous relict field boundary would have been encompassed by Zone 9, which suggests that Field 522 was a little bigger than it is today. It is likely that a test trench would locate a former field boundary between the eastern end of Zone 9 and the present division of Field 522 & 523. There were no specific areas of enhancement along the centreline that warranted further investigation.

At a meeting between *Earthsound*, *Archaeological Consultancy Services Limited*, *Laois County Council* Project Archaeologist Sylvia Desmond and *Laois County Council* Geophysical Consultant Kevin Barton, it was decided not to investigate Testing Area 7 with further geophysical surveys.

3.5 Testing Area 15

Detection Licence

The survey was undertaken under the archaeology works number A015/006 issued by the Project Archaeologist in accordance with the directions issued to *Laois County Council* by the Minister for Environment, Heritage & Local Government under Section 14A(2)of the National Monuments Acts (1930 to 2004).

Geography, Geology & Topography

Located within the townland of Oldtown, Testing Area 15 is 900 m in length. The centre of the survey area (Figure 2) lies at *Ordnance Survey of Ireland* National Grid (ING) Reference E233700 N172700. Testing Area 15 is situated to the west of the N8 road.

The survey occurred over the entire length of Fields 3 & 4 and over a Field 6 (Testing Area 14), to provide comparative data for a known archaeological site, see below.

Field 3 was comprised of short grass pastureland, Field 4 was comprised of bare soil which had been strongly disturbed by cattle.

The bedrock geology for Testing Area 15 is comprised of the Durrow Formation of shaly fossiliferous and oolitic limestone. This type of geology is magnetically quiet and is unlikely to have caused problems for the magnetic surveys.

Archaeological Background

There are no Recorded Monuments present within Testing Area 15 of the road scheme. A ringfort (LA034:034) lies 230 m to the west of the road scheme.The hachured circular banks of the monument are marked on all editions of the OS map series. The monument comprises a circular area (diam. *c*. 46m) defined by a stone-faced inner bank (width *c.* 5m), a fosse (max. width *c*. 11m) and outer bank (width *c.* 5m) from the SW–NW. The causewayed entrance (width *c.* 2.1m) is positioned at the E.

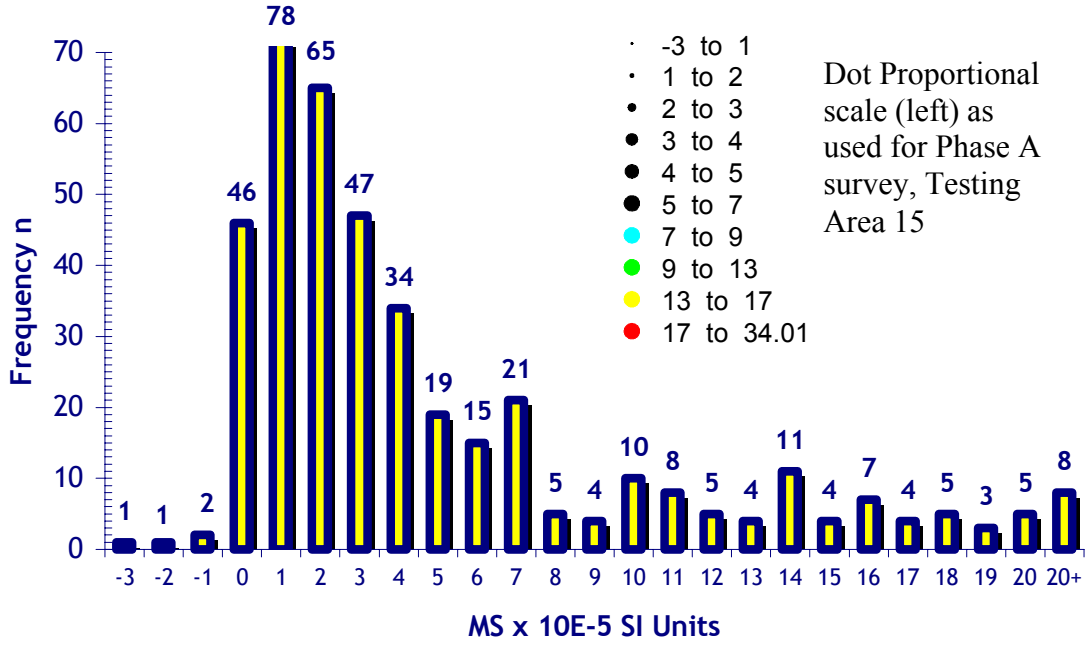
Graphical Display

Phase A centreline data are displayed in dot proportional plot format in Figure 16, supplemental data are displayed in Figure 17. Phase B magnetic gradiometer Greyscale data, clipped to –2 nT (white) and +2 nT (black) is presented in Figure 18. An interpretation of the Phase B data is presented in Figure 19.

3.5.1 Testing Area 15 - Results & Discussion

The interpretation figures should not be looked at in isolation but in conjunction with the relevant discussion section and with the information contained in the Appendices.

3.5.1.1 Phase A – Reconnaissance Magnetic Susceptibility Survey



Dot Proportional scale (left) as used for Phase A survey, Testing Area 15

The magnetic susceptibility reconnaissance survey was conducted along the centreline of the road corridor. Each data point was sampled five times as detailed in the methodology and is displayed on a dot proportional scale, as shown above; the scale of the figures is so great that only one dot (the largest) can be seen, which effectively averages the data.

There are very few negative values. The site is generally favourable for a magnetic susceptibility survey.

The Phase A survey was undertaken over a total length of 9100 linear metres. The data were collected on 5th March 2005.

1 ha of supplemental magnetic susceptibility survey were used across Fields 3 & 4, with station spacing between 8-11 m intervals.

Distinct areas of enhanced values can be seen within Testing Area 15, compared to the surrounding background values. These data have been grouped in to Magnetic Susceptibility Zones, according to their degree of magnetic enhancement, illustrating continuous areas of similar/anomalous susceptibility.

The data are highly variable along the centreline of Testing Area 14, which was examined to provide a calibration of the magnetic susceptibility compared to a magnetic gradiometer survey that had been carried out by Margaret Gowen & Company. The magnetic gradiometer survey (Nicholls 2002, under licence 02R068) revealed a large archaeological complex of three circular enclosures, one of which had a double ditch that may represent ringforts or Bronze Age enclosures of average size 25-55 m in diameter. The complex was also revealed by aerial photography. Field 6 was used as a test to confirm the presence of magnetic enhancement caused by the underlying archaeology and to determine precisely how far the site extends, beyond the Nicholls 2002 geophysical survey. The statistical mean of the centreline susceptibility data is 72.6 SI units, which compares well with the 67.1 SI unit average of Testing Area 15.The magnetic susceptibility data indicates the strongly magnetic spread of occupational material across the centreline, which continues in to Testing Area 15, to the south.

The data from Testing Area 15 were strongly enhanced and were followed up with a Phase B magnetic gradiometer survey.

At a meeting between *Earthsound*, *Archaeological Consultancy Services Limited*, *Laois County Council* Project Archaeologist Sylvia Desmond and *Laois County Council* Geophysical Consultant Kevin Barton, it was decided to investigate Testing Area 15 with three panels of Phase B magnetic gradiometer survey.

3.5.1.2 Phase B – Detailed Survey Area

The further investigations suggest that the magnetic susceptibility data is likely to represent a geological influence, as detailed gradiometer surveys revealed no strongly enhanced archaeological deposits.

Detailed Survey Area	Magnetic Susceptibility Zone	Chainage	Area (metres)	Townland	Survey Criteria	Survey Type
D6		10000	40 x 40 (0.16 ha)	Oldtown	Moderate enhancement across the survey area	MG
D7		9950	40 x 40 (0.16 ha)	Oldtown	Moderate enhancement across the survey area	MG
D8		9885	40 x 40 (0.16 ha)	Oldtown	Moderate enhancement across the survey area	MG

MG = magnetic gradiometer

Total magnetic gradiometer detailed survey area: 0.48 ha

Detailed Area 6 Chainage 10000

Gradiometer Data: Figure 18

Gradiometer Interpretation: Figure 19

Some small gullies, possibly continuing into the central panel can be seen. These are represented by curvilinear anomalies, which could also indicate geological trends, given their weak magnetic enhancement.

A strongly magnetic anomaly can be seen, rising up to 6 nT; this could represent a possible hearth or other area of burning, or possibly a deposit of iron.

Detailed Area 7 Chainage 9950

Gradiometer Data: Figure 18

Gradiometer Interpretation: Figure 19

Aside from some weakly enhanced gullies/geological trends, a stronger trend of enhancement can be seen, which is more convincing as a possible archaeological ditch, although it will require further assessment via test trenches to confirm this.

Detailed Area 8 Chainage 9885

Gradiometer Data: Figure 18

Gradiometer Interpretation: Figure 19

Three positive anomalies surround areas of dipolar anomalies and isolated points of magnetic enhancement. This could represent a three-sided enclosure, possibly containing iron deposits that could be argued to be grave goods. The "enclosure" ditches are weakly magnetic and the entire area could be a geological formation. This area requires test trenching in order to determine the presence/absence of a grave enclosure.

3.5.1.3 Recommendations for further work at Testing Area 15

No further geophysical investigations were required by *Laois County Council*. A number of targets for test trenching are summarised below:

Detailed Survey Area	Magnetic Susceptibility Zone	Chainage	Townland	Trench Start (NGR E, N)	Trench End (NGR E, N)	Target Description
D6		10000	Oldtown	233531, 172527	233544, 172523	Three possible gullies/geological trends
				233532, 172531	233546, 172544	Possible ditch/geological trend and hearth/burnt deposit
D7		9950		233514, 172508	233541, 172497	Four possible gullies/geological trends
				233522, 172492	233531, 172486	Possible ditch/geological trend
				233516, 172489	233512, 172482	Possible ditch/geological trend
				233499, 172495	233507, 172489	Possible ditch/geological trend
D8		9885		233501, 172448	233509, 172449	Two possible enclosure ditches/geological trends
				233508, 172432	233518, 172435	Possible enclosure ditch/geological trend
				233506, 172416	233507, 172410	Possible enclosure ditch/geological trend
				233476, 172429	233485, 172433	Possible enclosure ditch & gully/geological trend
				233493, 172423	233501, 172418	Possible hearth/burnt remains
				Corner 1 233492, 172449 Corner 2 233490, 172444 Corner 3 233495, 172442 Corner 4 233497, 172446		Square open area of excavation over a cluster of iron deposits that could represent grave goods

4. Conclusions

4.1 Achievement of Objectives

The proposed road corridor has been assessed via a Phase A reconnaissance geophysical survey for evidence of magnetic enhancement, possibly indicative of anthropogenic activity, using a centreline transect magnetic susceptibility method.

Phase B detailed geophysical surveys were also carried out, based on the results of the Phase A survey. The detailed surveys assessed potential areas of archaeological enhancement for discrete features. A small number of possible archaeological features have been successfully mapped.

This report and the accompanying geophysical survey maps have been presented to inform a programme of test trenching that will be undertaken shortly.

The geophysical surveys have achieved the aims and objectives required by *Archaeological Consultancy Services Limited*.

4.2 Summary of Results

A possible ring-ditch or barrow and associated ditches has been identified in Testing Area 2 (Chainage 20800), and a possible enclosure amongst some relict field systems (Chainage 21550).

Across Testing Areas 4, 6, 7 & 15, a number of linear and curvilinear anomalies of positive magnetism can be seen. These are weakly magnetic and could represent archaeological ditches or geological trends and require further assessment.

4.4 Dissemination

The results of this survey were submitted to *Archaeological Consultancy Services Limited*. *Earthsound* will ensure that copies will be forwarded to the *Department of the Environment, Heritage and Local Government* and the National Museum of Ireland in compliance with the Licence agreement.

5. Acknowledgements

Project Management:	James Bonsall BA (Hons) MSc PIFA
Fieldwork:	James Bonsall Heather Gimson BA (Hons) MSc MIAI
Report:	James Bonsall
Graphics:	Heather Gimson, James Bonsall

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7. Figures

Technical Appendix

Appendix 1

1. Magnetic Survey: Technical Information

1.1 Magnetic Susceptibility and Soil Magnetism

The Earth is comprised of approximately 6% iron. Via geological and pedological processes iron is present in soils and rocks as three main minerals; haematite, magnetite and maghaemite. Haematite is a very common mineral in archaeological soils and is largely responsible for most of the red colouration in the environment. Magnetite is a common mineral found in all igneous rocks, most sedimentary rocks and nearly all soils. These minerals have a weak, measurable magnetic property.

The magnetism observed in a rock is made up of remanent and induced components. In the weak magnetic field due to the earth, the induced component is proportional to the earth's field. The constant of proportionality is called the magnetic susceptibility. The susceptibility of a rock is controlled by the amount of ferrimagnetic material contained in them, their grain size, and mode of distribution.

An enhancement of ferrimagnetic minerals is responsible for the formation of magnetic anomalies in soils at archaeological sites. Magnetic Susceptibility (MS) measures how susceptible a material is to becoming magnetized. A MS survey can identify and classify different types of iron bearing materials in a safe, fast and non-destructive manner either in a laboratory or as a fieldwork component, complementing other archaeological analyses.

Anthropogenic activities can redistribute these minerals and alter others into more magnetic forms by a process of enhancement, such as burning, industrial activity, fermentation and manuring. MS enhancement of antiferromagnetic haematite in the topsoil is caused by the Le Borgne effect of domestic fires on soils and vegetational matter:

> *The burning of organic matter and the heating of non-organic matter above 200°C, allows electrons to be gained through a process of reduction, creating ferrimagnetic magnetite. As the matter cools, or in the case of organic matter, is combusted, electrons are lost through a process of re-oxidation, creating ferrimagnetic maghaemite.*

The decay of organic material associated with areas of human occupation or settlement can be identified by measuring the MS of the topsoil and noting the degree of enhancement. If the enhanced material subsequently comes to fill features, such as ditches or pits, localised isolated and linear magnetic anomalies can result whose presence can be detected by a magnetometer (fluxgate gradiometer).

There are five different types of magnetic behaviour found in Magnetic Susceptibility surveys, dependent upon the sub-atomic properties of the samples:

- *Ferromagnetism*
- *Ferrimagnetism*
- *Antiferromagnetism*
- *Antiferromagnetism*
- *Paramagnetism*
- *Diamagnetism*

Strongest

Weakest

Magnetic susceptibility is a value defined by a combination of all of the above types of magnetic behaviour, so that weaker paramagnetism and diamagnetism will be masked if other, *stronger*, magnetic properties are present. For example, a topsoil magnetic susceptibility survey will introduce additional contributions from colluvial/alluvial covering or a disturbed Ap horizon (cultivation/pasturing disturbance *etc*.) that may mask an archaeologically derived response.

1.2 Types of Magnetic Anomaly

Magnetic anomalies are either are termed **'negative'** or **'positive'** referring to their magnetic properties relative to the bipolar background (theoretically, 'zero').

The types of response mentioned above can be divided into five main categories which are used in the graphical interpretation of the gradiometer data:

Areas of positive/negative enhancement

These responses can be quite widespread, and often caused by rubble or foundations, burning, agricultural disturbance and general occupational induced enhancement.

Linear and curvilinear anomalies

Such anomalies have a variety of origins. They may be caused by agricultural practice (recent ploughing trends, earlier ridge and furrow regimes or land drains), natural geomorphological features such as palaeochannels or by in-filled archaeological ditches or walls.

Isolated positive/negative anomalies

These generally represent small areas of enhancement. They may be caused by exotic geology or by in-filled archaeological pits.

Isolated Ferrous anomalies

Theses are very strong magnetic responses caused by ferrous (iron) debris, often found scattered in fields. These are usually modern in origin, although may represent archaeological material such as coffin nails.

Areas of Disturbance

These are mostly modern in origin, causing widespread magnetic interference, often masking all other magnetic features within the vicinity. These can be caused by nearby structures, metallic fences, road traffic and metallic pipelines.

1.3 Methodology

1.3.1. *Magnetic Susceptibility Survey*

The magnetic susceptibility meter displays the MS value of material when they are brought within the influence of the sensor, such as the field search loop. An oscillator circuit within the *Bartington* MS2 meter generates a low alternating magnetic field. Any material brought within the influence of the field (in the case of the search loop, the field of influence is between 0-18cm beneath the loop, i.e. generally the topsoil), will bring about a change in the oscillator frequency. The frequency information is returned in pulse form to the MS2, where it is converted in to a value of magnetic susceptibility, κ, in SI units.

A topsoil MS survey assumes that the sample size is infinite, as the precise mass of each sample point cannot be calculated in the field. Calibration therefore, is best expressed in units of Volume Specific susceptibility. Repeatability of the survey is dependent upon the uniformity of the surface under investigation. Volume susceptibility is expressed as $\kappa \times 10^{-5}$ SI units.

1.3.2. *Fluxgate Gradiometer Survey*

A detailed survey requires a sample trigger to automatically take readings at predetermined points. These readings are stored in the memory of the instrument and are later dumped to computer for processing and interpretation. Detailed survey allows the visualisation of weaker anomalies that may not have been detected by magnetic scanning or magnetic susceptibility.

2. Data Processing and Presentation

2.1 Interpolation

Interpolation can be defined as the estimation of a value between known values. The data magnetometer data displayed in this project have been interpolated using the sin *x*/*x* function in *Geoplot* 3.0 (Walker 2000).

Gridding methods produce a regularly spaced, rectangular array of Z values from irregularly spaced XYZ data. The term "irregularly spaced" means that the points follow no particular pattern over the extent of the map, so there are many "holes" where data are missing. Gridding fills in these holes by extrapolating or interpolating Z values at those locations where no data exists.

A grid is a rectangular region comprised of evenly spaced rows and columns. The intersection of a row and column is called a grid node. Rows contain grid nodes with the same Y co-ordinate, and columns contain grid nodes with the same X co-ordinate. Gridding generates a Z value at each grid node by interpolating or extrapolating the data values. The *Kriging* gridding method produces visually appealing maps from irregularly spaced data. *Kriging* is a geostatistical gridding method that has proven useful and popular in many fields. *Kriging* attempts to express trends suggested in the data so that, for example, high points might be connected along a ridge rather than isolated by bull's-eye type contours.

Appendix 2

Survey Grid Re-location

1. Each survey grid was laid out using a *Trimble* Pro-XRS Differential Global Positioning System (DGPS), to an accuracy of ±10cm.
2. There was a good correlation between the geophysical survey data and the digital map base and it is estimated that the average 'best fit' error is lower than ±0.25m. It is important to note that local grid north (27/03/05) varies slightly from *Ordnance Survey* north, with an annual decrease of 0.9°3'.

Appendix 3

Geophysical Archive

Earthsound Archaeological Geophysics takes its archiving responsibilities very seriously. Archiving is a necessary measure to maintain a complete record of past research, prevent unnecessary duplication and allow the re-use and re-interpretation of geophysical data as analytical techniques evolve.

The geophysical archive comprises:-

- an archive CD-ROM containing files of the raw data (Geoplot 3.00a, MS-Excel), report text (Word 2000 9.0), and graphics files (AutoCAD 2000).
- a hard (paper) copy of the report

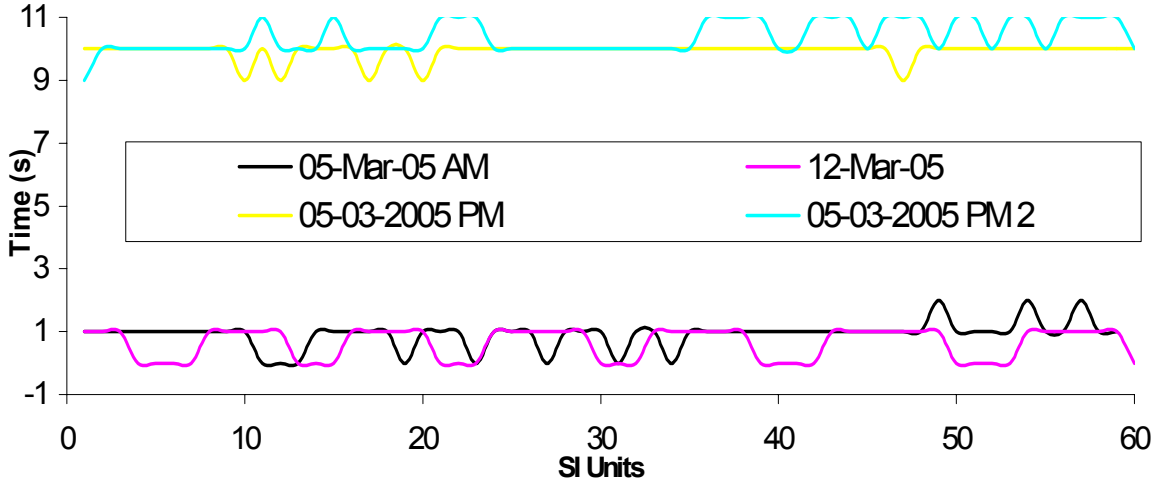
At present, two copies of the archive are held by *Earthsound Archaeological Geophysics*, at separate locations to ensure preservation against accidental damage or theft. The Client, *Archaeological Consultancy Services Limited*Archaeological Consultancy Services LimitedArchaeological Consultancy Services Limited, holds one further copy of the archive. Additional paper copies intended for ultimate deposition with the *Department of the Environment, Heritage and Local Government* are in the guardianship, and are the responsibility of, *Earthsound Archaeological Geophysics*.

Appendix 4

Geophysical Instrument Status

The operational status of the geophysical instruments was confirmed every day by a series of control tests.

To confirm the operational status of the magnetic susceptibility instrument on a daily basis, at the start of each period of survey activity, the instrument was zeroed in the air and 60 consecutive readings were taken at a single point. The sampling rate was at 1 second and the readings were recorded. The magnetic susceptibility results are presented in Graph A.



Graph A: Magnetic Susceptibility variation over a single point for 60 consecutive readings.

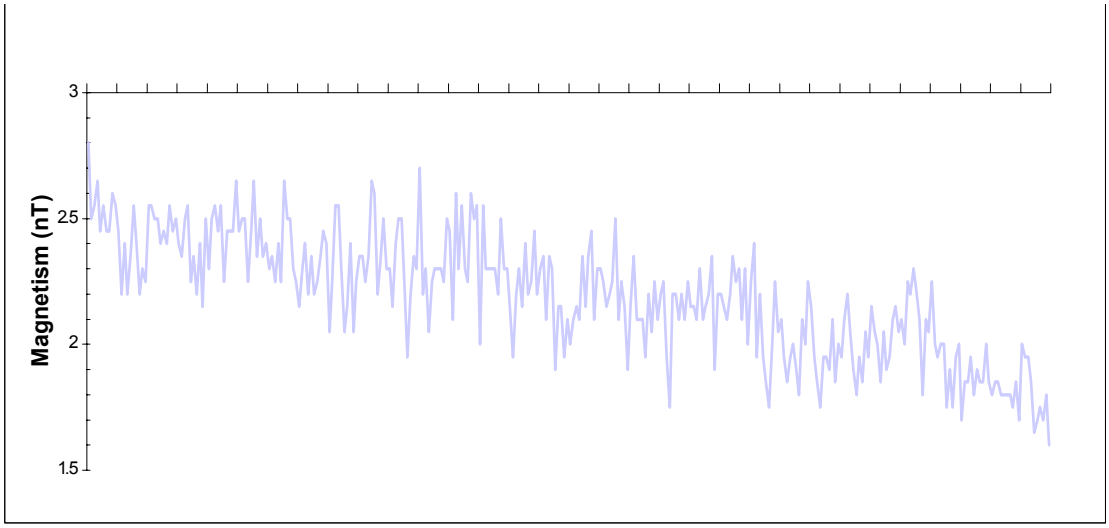
The data drifts occasionally for 05 March 2005 (AM), recording 80% of data as 1 SI units, 5% of data increasing to 2 SI units and the remaining 15% decreasing to 0 SI units. There are no indications of thermal drift. A range of ±1 SI units is unlikely to have radically altered the interpretation of the data.

The data recorded in the afternoon of the same day (05 March 2005 PM), is very stable, with only 8.3% of data deviating from 10 SI units to 9 SI units. Later still that day, (05 March 2005 PM 2), 40% of the data varies by 1 SI unit. The end of the 60 second data stream suggests that thermal drift may occur.

The data alternates after every 3-4 samples for 12 March 2005. In total 38% of the data varies from 1 SI units to 0 SI units. There are no indications of thermal drift. A range of ±0.5 SI units is acceptable for this survey.

For the detailed magnetic susceptibility surveys, the instrument was calibrated before taking a data point. Very little variation occurs and confirms the excellent operational status of the instrument.

The magnetic gradiometer was set to take 320 consecutive readings over a single point, for each day of detailed survey. One data set was recorded for Testing Area 10. The magnetic gradiometer results are presented in Graph B.



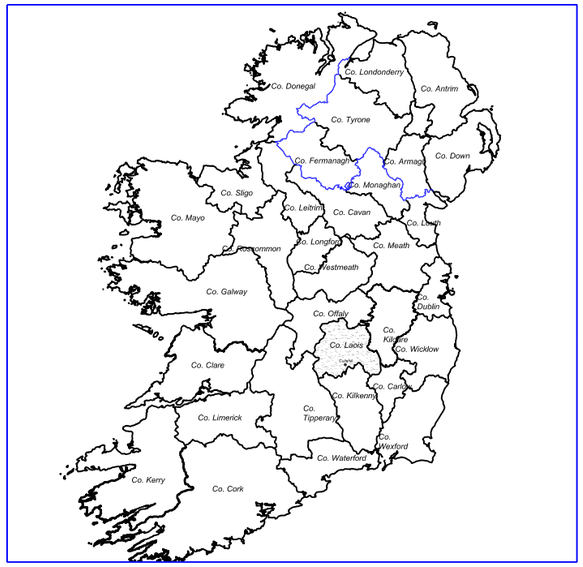
Graph B: Magnetic Gradiometer variation over a single point for 320 consecutive readings (8 readings per 0.64 seconds).

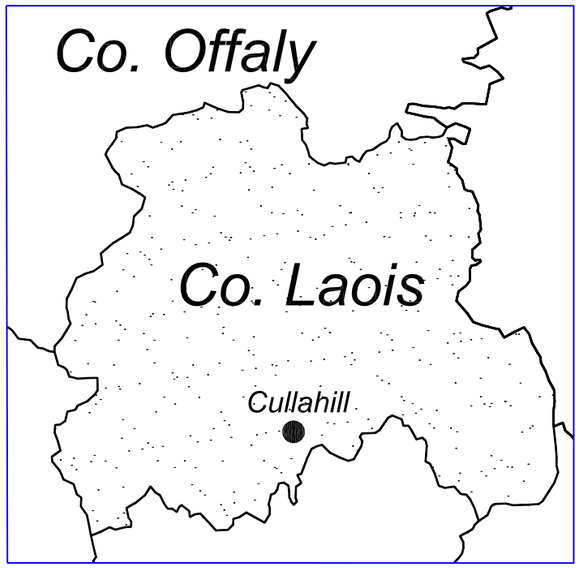
Surprisingly the data, which was collected within 25.60 seconds, indicates a range of 1.35 nT, which is quite wide for a single point. The drift is likely to have been thermal induced and can be seen clearly as mostly downward trend, punctuated by spikes of high or low data.

This thermal drift is expected and is an inherent problem for the magnetic gradiometer. It is regulated by frequent calibration of the instrument during fieldwork. The drift can be easily removed by a Zero Mean Traverse processing function, which makes zero the mean for each traverse or data sample. Drift removal works on the basis that drift is linear, and for a sample such as a 25.60 second traverse, this is appropriate. Each gradiometer plot presented in this report has been subjected to a Zero Mean Traverse function, and comparisons were made with raw and processed data in order to analyse the potential removal of geophysical anomalies.

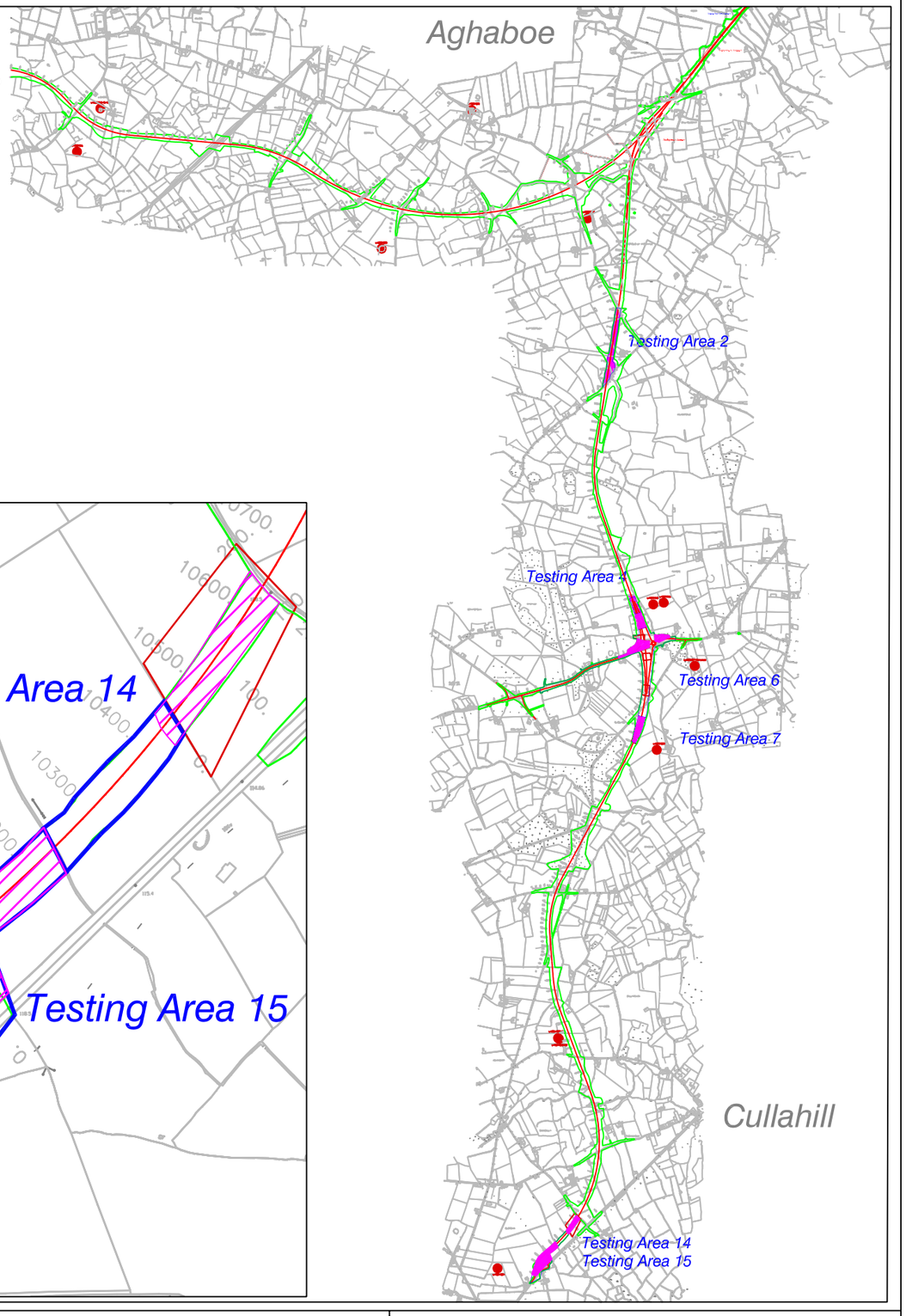
Statistical Breakdown of the Sample:

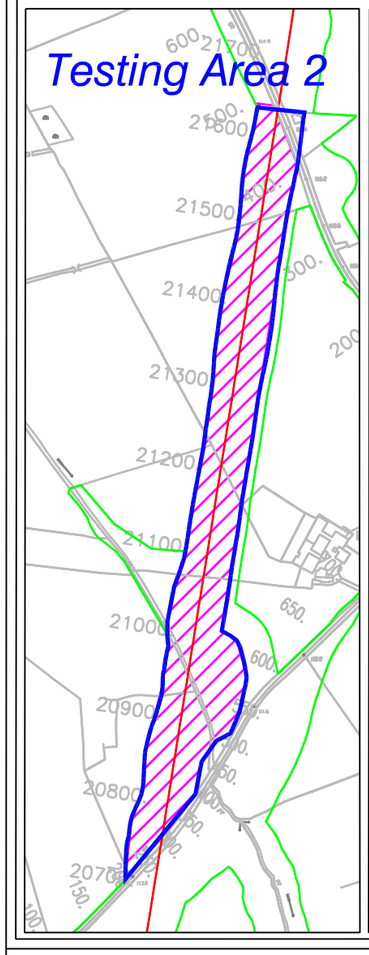
Date	Data Range	Mean	Median	Standard Deviation	Variance
15 March 2005	1.35	1.48	1.50	0.266	0.071

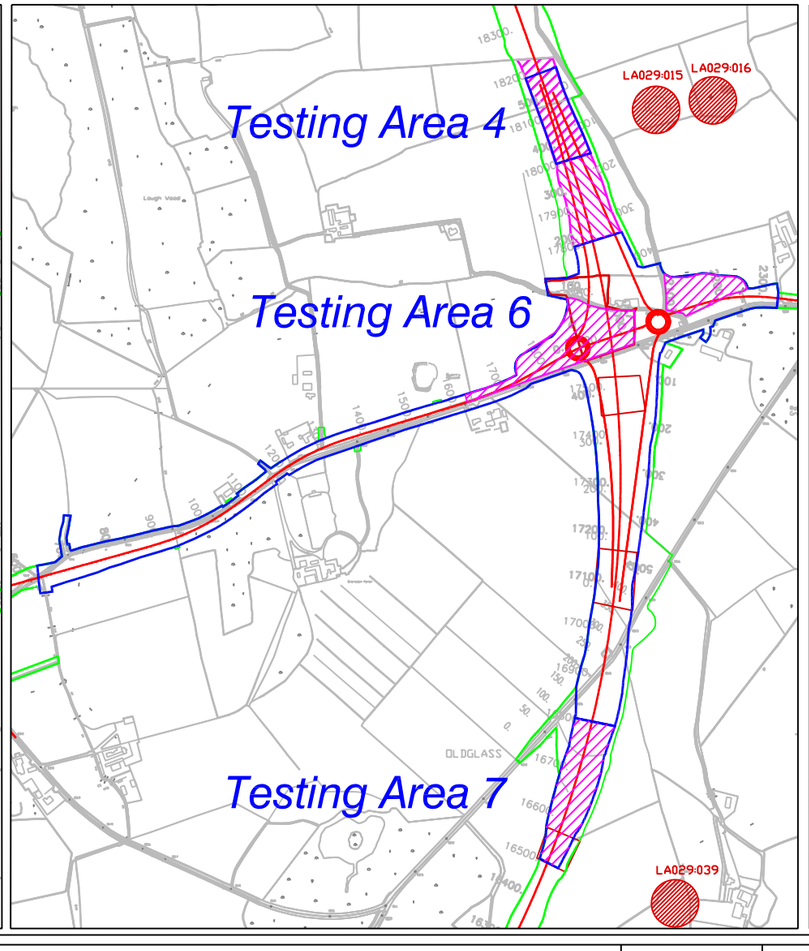




Contract 2







Legend

- Basemap
- Centreline
- Landtake line
- RMP Site
- Archaeological testing area
- Geophysical survey area

Site Location: M7 / M8, Contract 1, County Laois

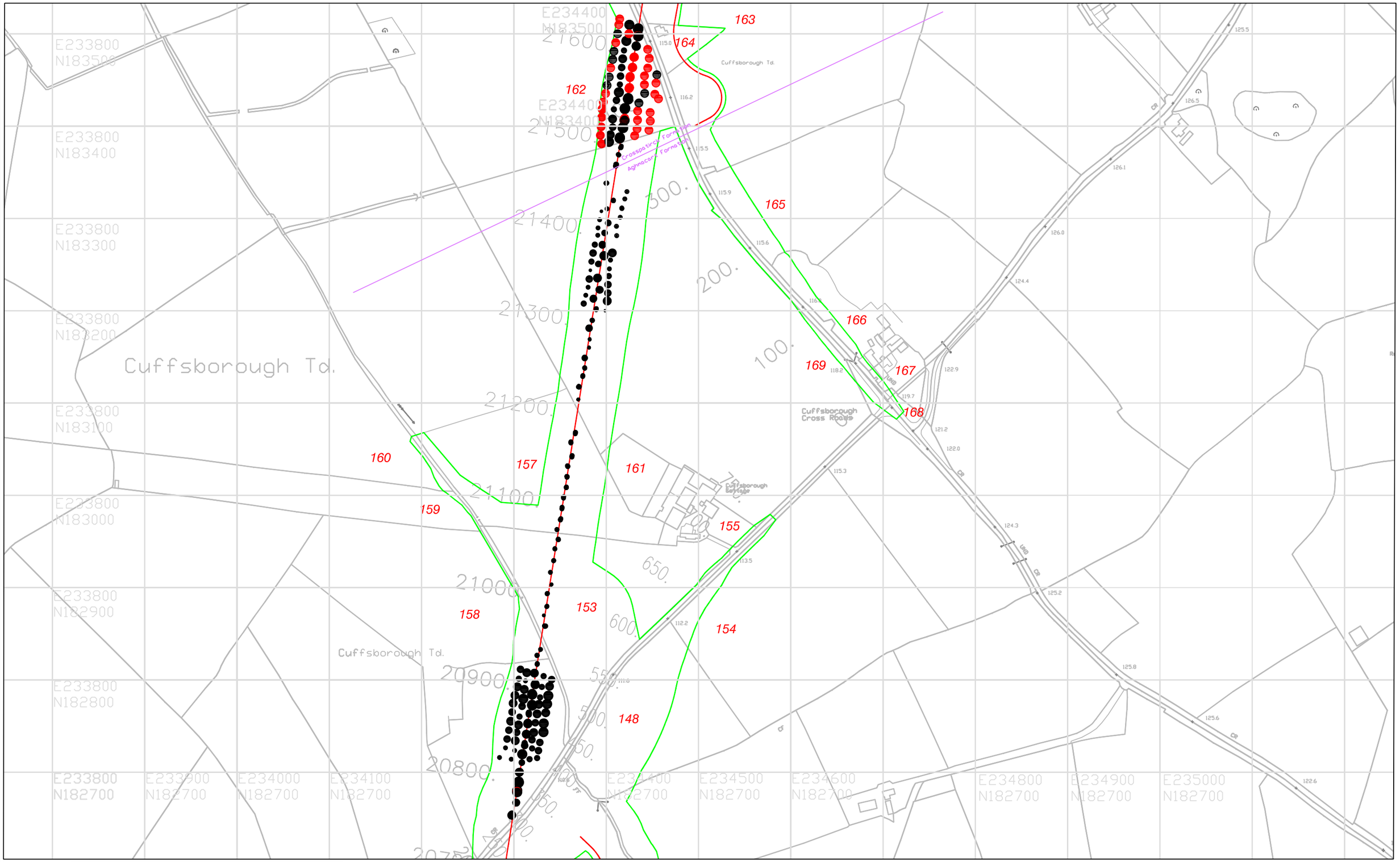
Client: Archaeological Consultancy Services Limited

Drawing Courtesy of: Laois NRDO	Date 08/04/05	Drawing No.: 05-23/01

0m 3000m 6000m

Figure No. 1 Location map

EARTHSOUND archaeological geophysics



Legend

- Basemap
- Centreline
- Landtake line
- 26200 Chainage
- 100 Field Number
- Proposed Phase B survey area
- Magnetic Susceptibility Zones

× 10^{-5} κ

-17 - 1 | 1 - 2 | 2 - 4 | 4 - 7 | 7 - 10 | 10 - 13 | 13 - 19 | 19 - 28 | 28 - 52

Site Location: M7 / M8, Testing Area 2, Contract 1, County Laois

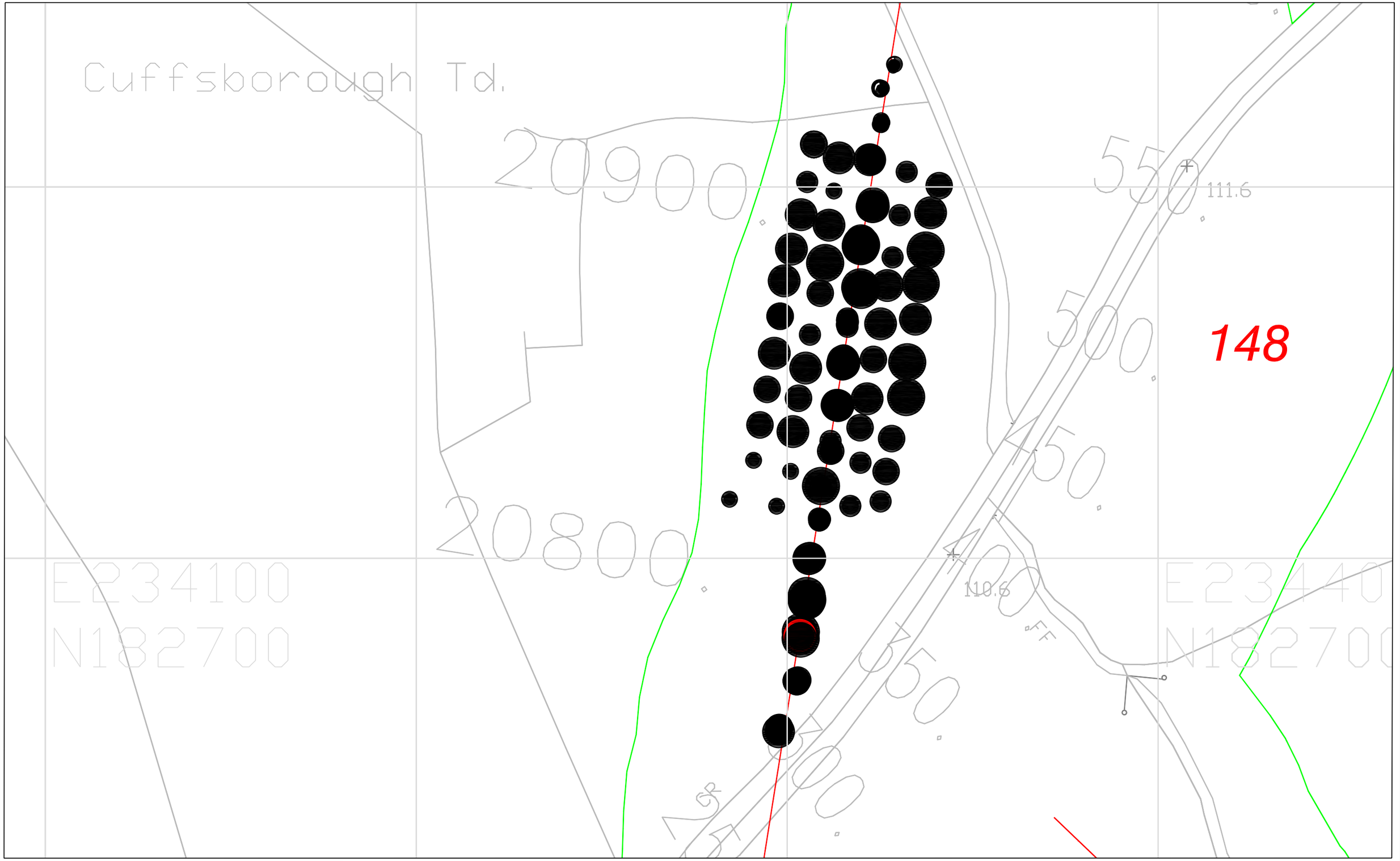
Client: Archaeological Consultancy Services Limited

Drawing Courtesy of: Laois NRDO	Date 07/04/05	Drawing No.: 05-23/02

0m 1000m 2000m

Figure No. 2 Phase A Reconnaissance Survey

EARTHSOUND archaeological geophysics



Legend

- Basemap
- Centreline
- Landtake line
- 26200 Chainage
- 100 Field Number
- Proposed Phase B survey area
- Magnetic Susceptibility Zones

× 10^{-5} κ

-17 - 1 | 1 - 2 | 2 - 4 | 4 - 7 | 7 - 10 | 10 - 13 | 13 - 19 | 19 - 28 | 28 - 52

Site Location: M7 / M8, Testing Area 2, Contract 1, County Laois

Client: Archaeological Consultancy Services Limited

Drawing Courtesy of: Laois NRDO | Date 07/04/05 | Drawing No.: 05-23/03

0m 20m 40m

Figure No. 3 Phase A Supplemental Survey

EARTHSOUND archaeological geophysics

E234400

N183500

21600

21500

163

164

162

115.0

116.2

115.5

Cuffsborough Td.

Crosspatrick Formation

Knocart Formation

Legend

- Basemap
- Centreline
- Landtake line
- 26200 Chainage
- 100 Field Number
- Proposed Phase B survey area
- Magnetic Susceptibility Zones

× 10^{-5} κ

-17 - 1 | 1 - 2 | 2 - 4 | 4 - 7 | 7 - 10 | 10 - 13 | 13 - 19 | 19 - 28 | 28 - 52

N

Site Location: M7 / M8, Testing Area 2, Contract 1, County Laois

Client: Archaeological Consultancy Services Limited

Drawing Courtesy of: Laois NRDO | Date 07/04/05 | Drawing No.: 05-23/04

0m 1000m 2000m

Figure No. 4 Phase A Supplemental Survey

EARTHSOUND archaeological geophysics

Legend

- Basemap
- Centreline
- Landtake line
- 100 Field Number

nT
-2 0 1

Site Location: M7 / M8, Testing Area 2, Contract 1, County Laois

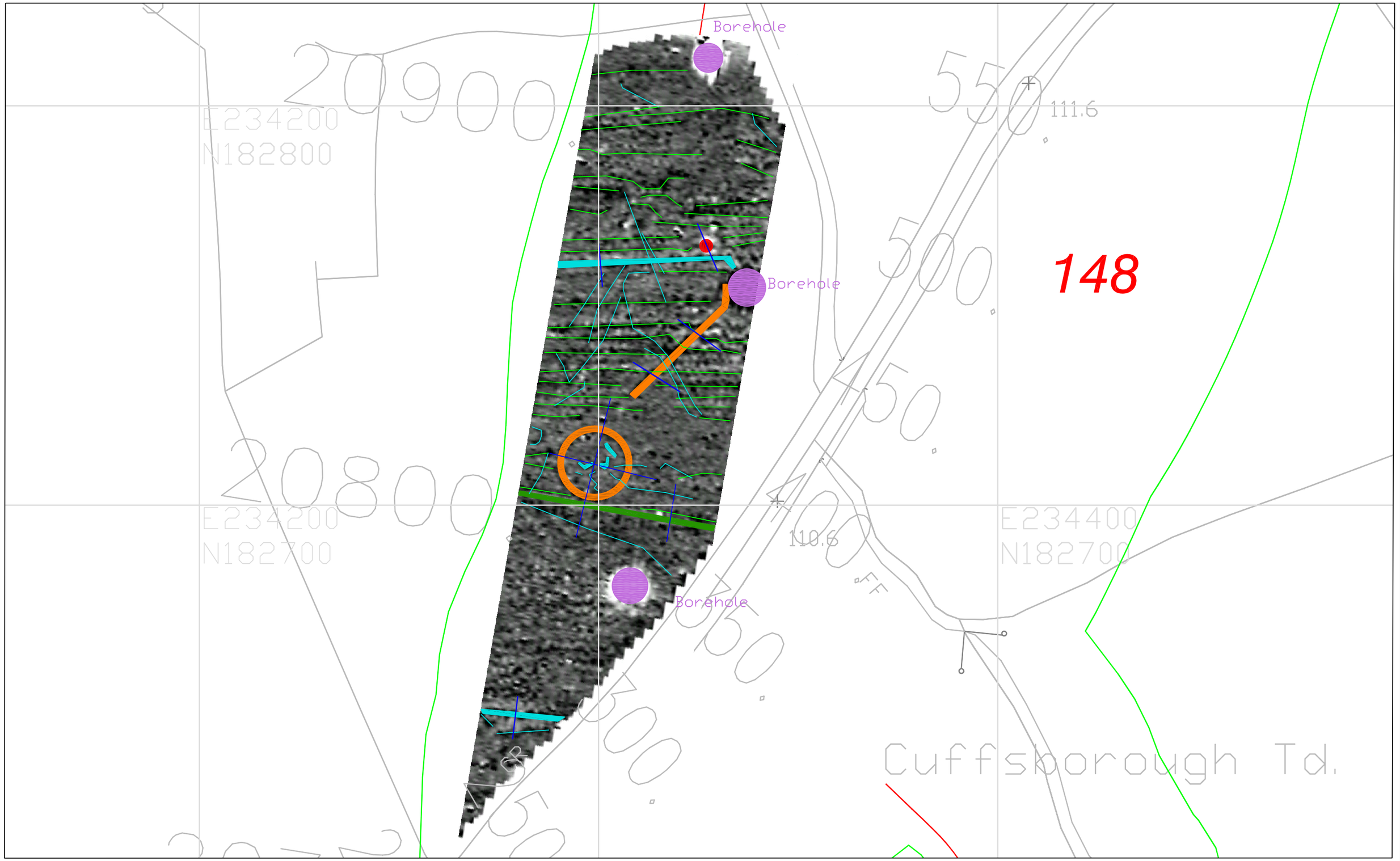
Client: Archaeological Consultancy Services Limited

Drawing Courtesy of: Laois NRDO	Date 07/04/05	Drawing No.: 05-23/05

0m 20m 40m

Figure No. 5 Phase B Detailed Magnetic Gradiometer data

EARTHSOUND archaeological geophysics



Legend

- Basemap
- Centreline
- Landtake line
- 100 Field Number
- Proposed Test Trenches
- Ditch
- Possible Ditch / Gully
- Agricultural Furrows
- Wall
- Possible Hearth

nT
-2 0 1

Site Location: M7 / M8, Testing Area 2, Contract 1, County Laois

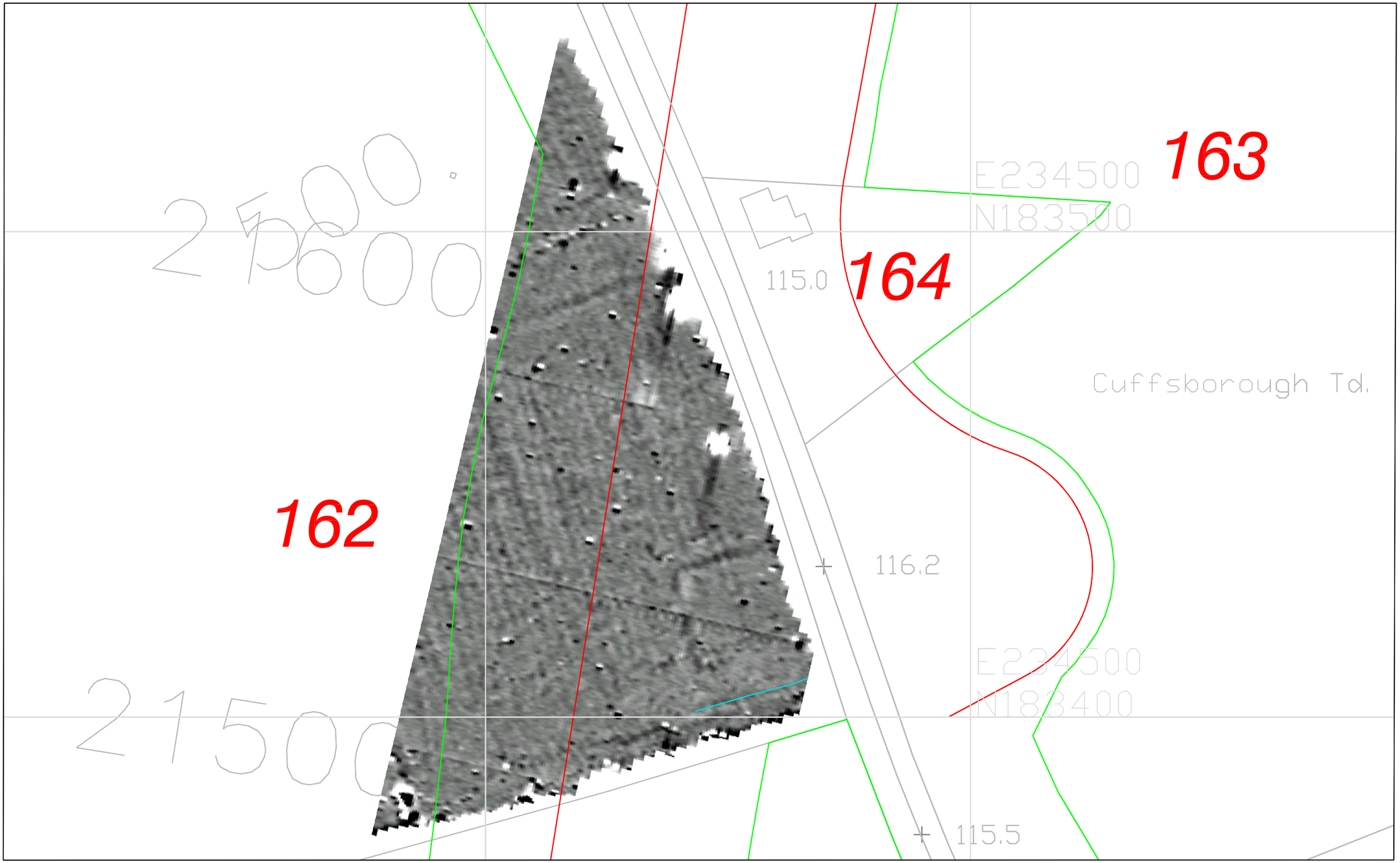
Client: Archaeological Consultancy Services Limited

Drawing Courtesy of: Laois NRDO	Date 07/04/05	Drawing No.: 05-23/06

0m 20m 40m

Figure No. 6 Phase B Detailed Magnetic Gradiometer Interpretation

EARTHSOUND archaeological geophysics



Legend

- Basemap
- Centreline
- Landtake line
- 100 Field Number

nT

-3 0 3

Site Location: M7 / M8, Testing Area 2, Contract 1, County Laois

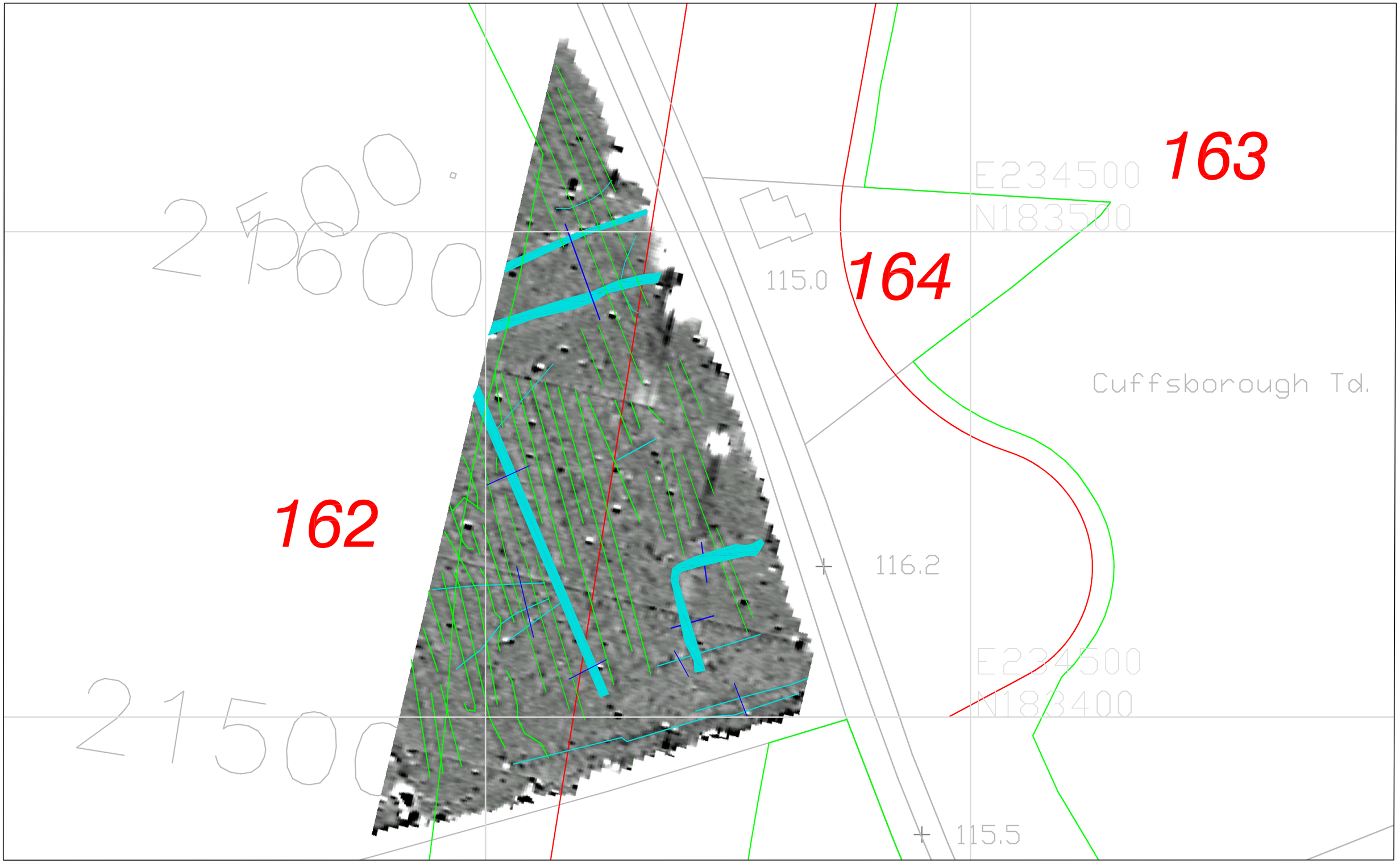
Client: Archaeological Consultancy Services Limited

Drawing Courtesy of: Laois NRDO	Date 07/04/05	Drawing No.: 05-23/07

0m 20m 40m

Figure No. 7 Phase B Detailed Magnetic Gradiometer data

EARTHSOUND archaeological geophysics



Legend

- Basemap
- Centreline
- Landtake line
- 100 Field Number
- Proposed Test Trenches
- Possible Ditch / Gully
- Agricultual Furrows

nT

-3 0 3

Site Location: M7 / M8, Testing Area 2, Contract 1, County Laois

Client: Archaeological Consultancy Services Limited

Drawing Courtesy of: Laois NRDO	Date 07/04/05	Drawing No.: 05-23/08

0m 20m 40m

Figure No. 8 Phase B Detailed Magnetic Gradiometer Interpretation

EARTHSOUND archaeological geophysics

Tintore Td.

LA029:015

129

Crosspatirck Formation

Aghmacart Formation

E234500
N180100

E234600
N180000

E234700
N180000

E234800
N180000

18200

18100

500

400

Legend

- Basemap
- Centreline
- Landtake line

26200 Chainage
100 Field Number
Proposed Phase B survey area
Magnetic Susceptibility Zones

× 10^{-5} κ

-4 - 46 | 46 - 53 | 53 - 56 | 58 - 61 | 61 - 63 | 63 - 66 | 66 - 69 | 66 - 69 | 69 - 73 | 73 - 88

N

Site Location: M7 / M8, Testing Area 4, Contract 1, County Laois

Client: Archaeological Consultancy Services Limited

Drawing Courtesy of: Laois NRDO	Date 07/04/05	Drawing No.: 05-23/09

0m 20m 40m

Figure No. 9 Phase A Reconnaissance Survey

EARTHSOUND archaeological geophysics

Legend

- Basemap
- Centreline
- Landtake line
- 100 Field Number

nT
-2 0 2

Site Location: M7 / M8, Testing Area 4, Contract 1, County Laois

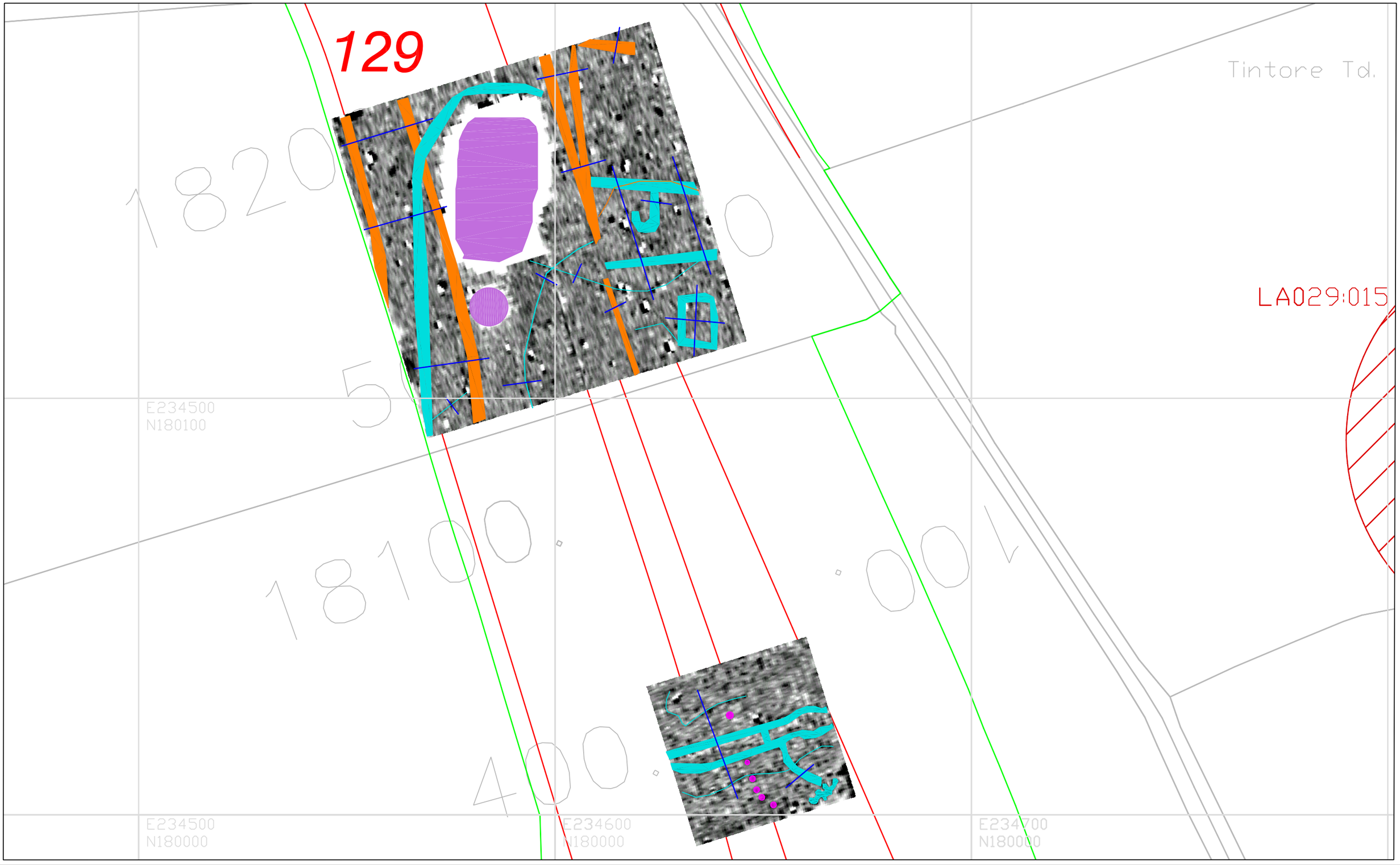
Client: Archaeological Consultancy Services Limited

Drawing Courtesy of: Laois NRDO	Date 07/04/05	Drawing No.: 05-23/10

0m 20m 40m

Figure No. 10 Phase B Detailed Magnetic Gradiometer data

EARTHSOUND archaeological geophysics



Legend

- Basemap
- Centreline
- Landtake line
- 100 Field Number
- Proposed Test Trenches
- Ditch
- Possible Ditch / Gully
- Possible Pits / Geological Anomalies
- Geological Boreholes

nT
-2 0 2

Site Location: M7 / M8, Testing Area 4, Contract 1, County Laois

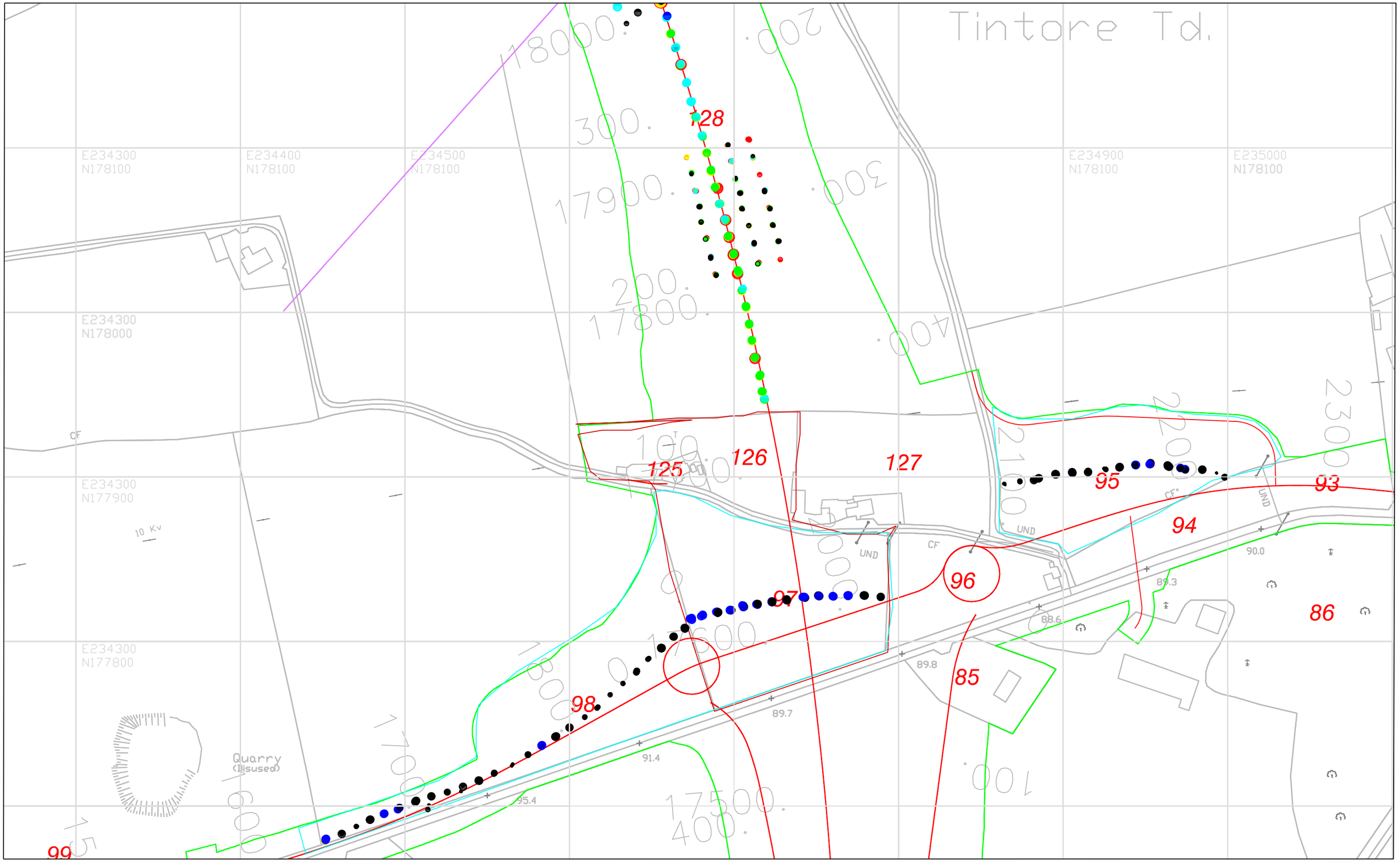
Client: Archaeological Consultancy Services Limited

Drawing Courtesy of: Laois NRDO	Date 07/04/05	Drawing No.: 05-23/11

0m 20m 40m

Figure No. 11 Phase B Detailed Magnetic Gradiometer Interpretation

EARTHSOUND archaeological geophysics



Legend

- Basemap
- Centreline
- Landtake line
- 26200 Chainage
- 100 Field Number
- Proposed Phase B survey area
- Magnetic Susceptibility Zones

× 10^{-5} κ

0 - 3 · 3 - 4 · 4 - 5 · 5 - 6 · 6 - 7 · 7 - 9 · 9 - 40 · 40 - 60 · 60 - 75 · 75 - 86 · 86 - 92

Site Location: M7 / M8, Testing Area 6, Contract 1, County Laois

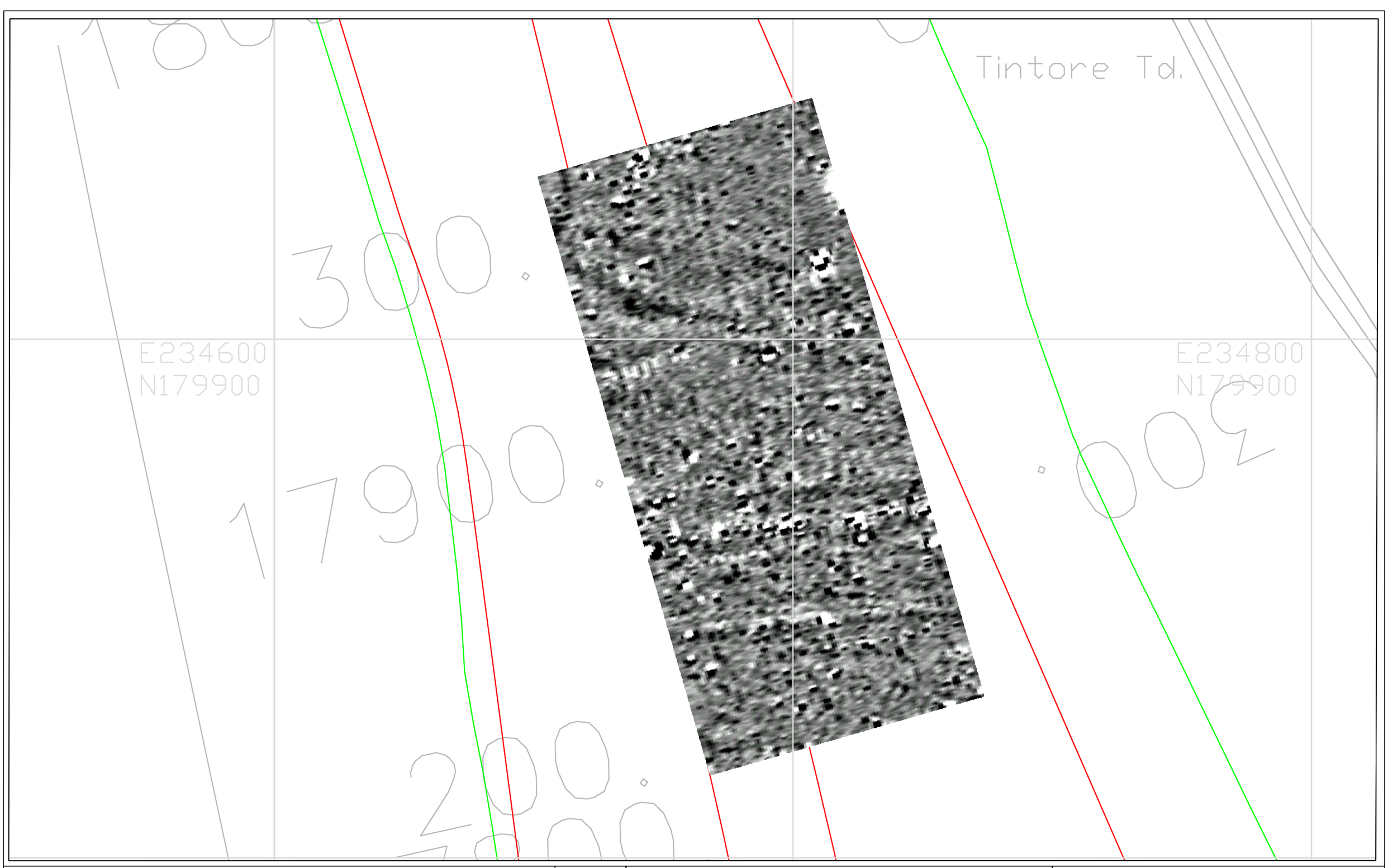
Client: Archaeological Consultancy Services Limited

Drawing Courtesy of: Laois NRDO	Date 07/04/05	Drawing No.: 05-23/12

0m 100m 200m

Figure No. 12 Phase A Reconnaissance Survey

EARTHSOUND archaeological geophysics



Legend

- Basemap
- Centreline
- Landtake line
- 100 Field Number

nT
-2 0 2

N

Site Location: M7 / M8, Testing Area 6, Contract 1, County Laois

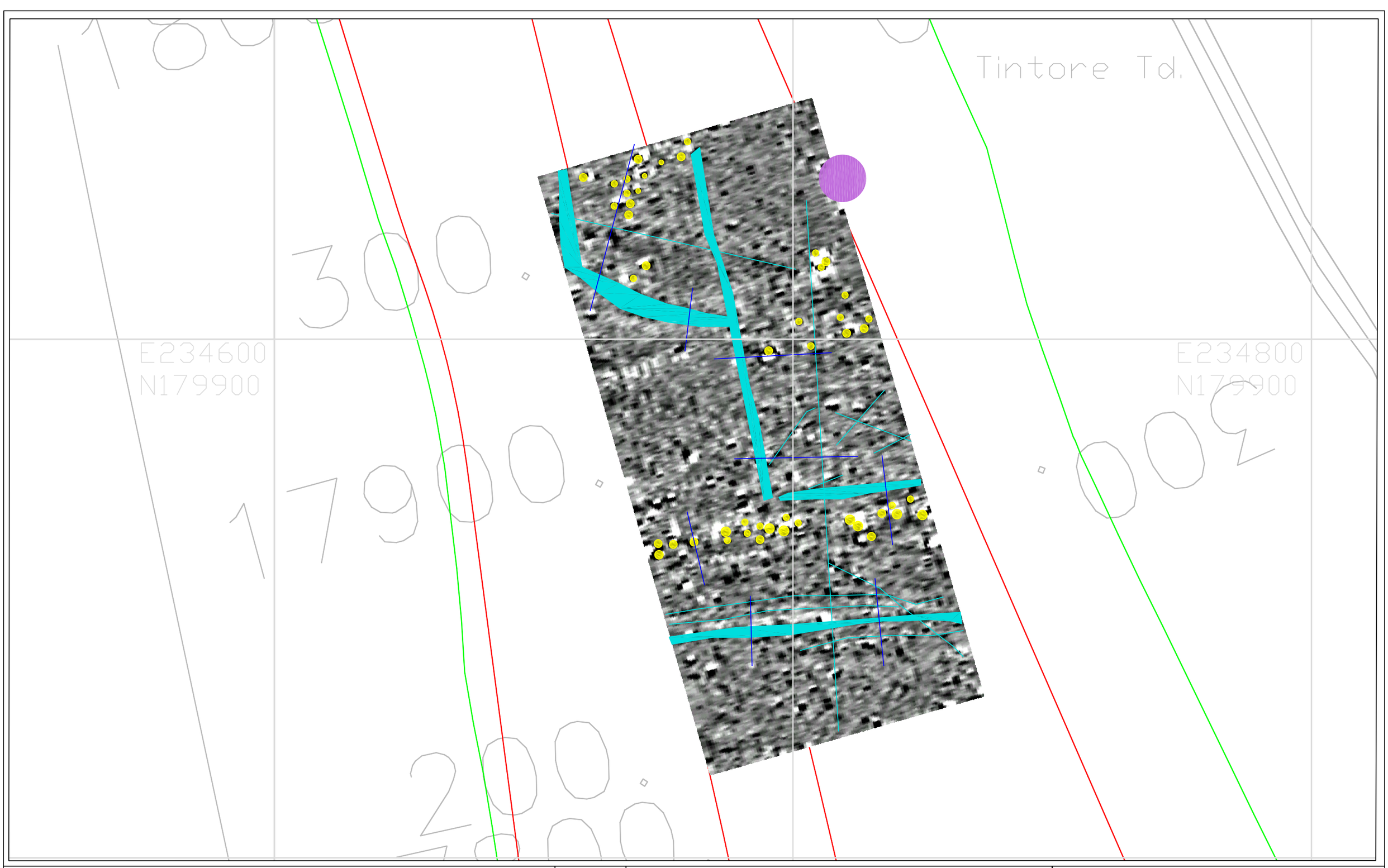
Client: Archaeological Consultancy Services Limited

Drawing Courtesy of: Laois NRDO	Date 07/04/05	Drawing No.: 05-23/13

0m 20m 40m

Figure No. 13 Phase B Detailed Magnetic Gradiometer data

EARTHSOUND archaeological geophysics



Legend

- Basemap
- Centreline
- Landtake line
- 100 Field Number
- Proposed Test Trenches
- Geological Boreholes
- Possible Ditch / Gully
- Dipolar Anomalies

nT
-2 0 2

Site Location: M7 / M8, Testing Area 6, Contract 1, County Laois

Client: Archaeological Consultancy Services Limited

Drawing Courtesy of: Laois NRDO	Date 07/04/05	Drawing No.: 05-23/14

0m 20m 40m

Figure No. 14 Phase B Detailed Magnetic Gradiometer Interpretation

EARTHSOUND archaeological geophysics

80

Oldglass Td.

83.4

83.2

84.4

E234500 N178700

E234600 N178700

E234700 N178700

E234800 N178700

E234900 N178700

E234500 N178600

E234500 N178500

16700

16600

16500

79

T

10Kv

Legend

- Basemap
- Centreline
- Landtake line

26200 Chainage

100 Field Number

- Proposed Phase B survey area
- Magnetic Susceptibility Zones

$\times 10^{-5}$ SI

2 - 5 | 5 - 6 | 6 - 7 | 7 - 9 | 9 - 11 | 11 - 13 | 13 - 14 | 14 - 15 | 15 - 17 | 17 - 28 | 28 - 60 | 60 - 100

N

Site Location: M7 / M8, Testing Area 7, Contract 1, County Laois

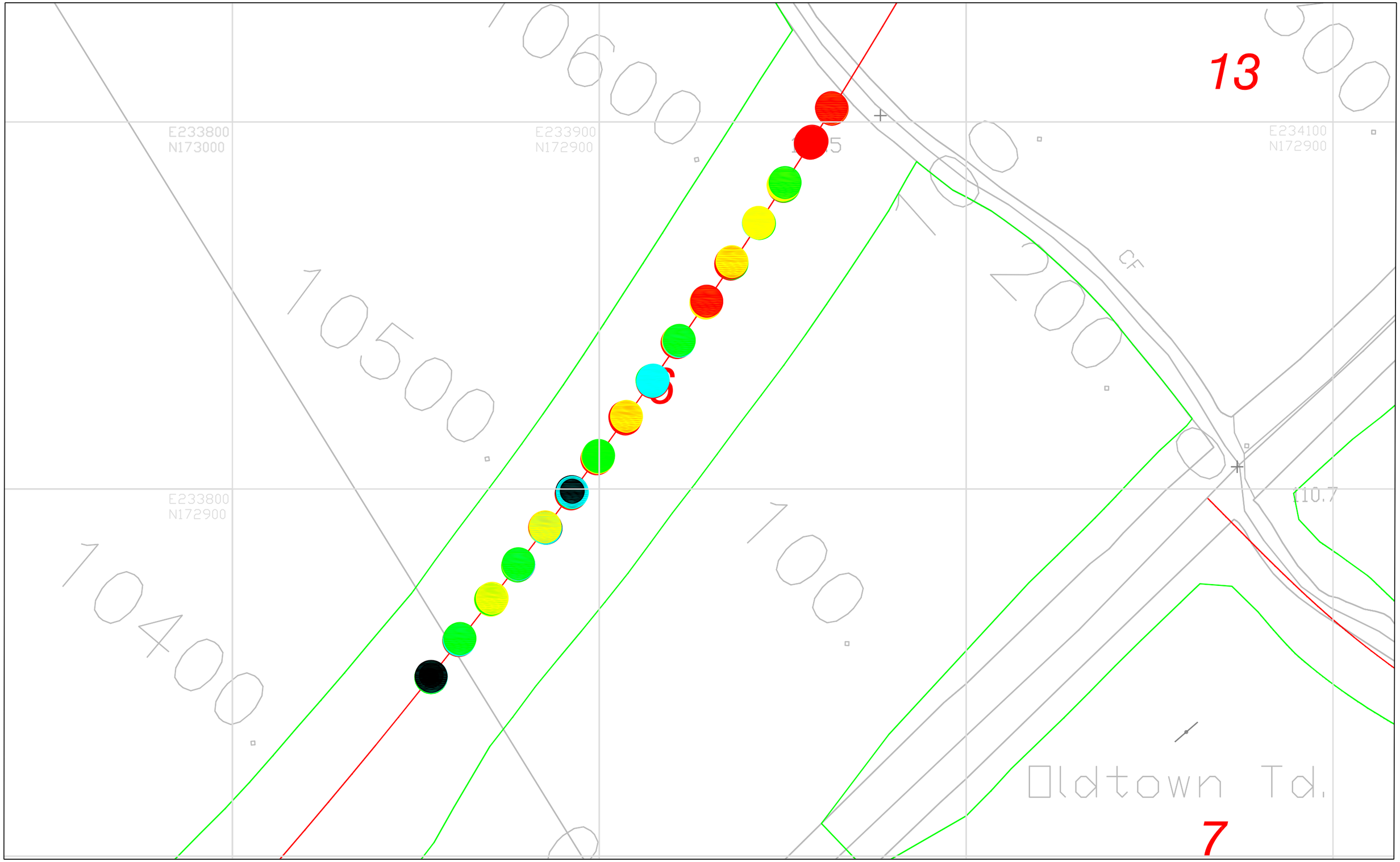
Client: Archaeological Consultancy Services Limited

Drawing Courtesy of: Laois NRDO | Date 09/04/05 | Drawing No.: 05-23/15

0m 50m 100m

Figure No. 15 Phase A Reconnaissance Survey

EARTHSOUND archaeological geophysics



Legend

- Basemap
- Centreline
- Landtake line

26200 Chainage
100 Field Number
Proposed Phase B survey area
Magnetic Susceptibility Zones

$\times 10^{-5}$ κ

26 - 48 | 48 - 56 | 56 - 60 | 60 - 65 | 65 - 70 | 70 - 77 | 77 - 82 | 82 - 86 | 86 - 93 | 93 - 111

Site Location: M7 / M8, Testing Area 14, Contract 1, County Laois

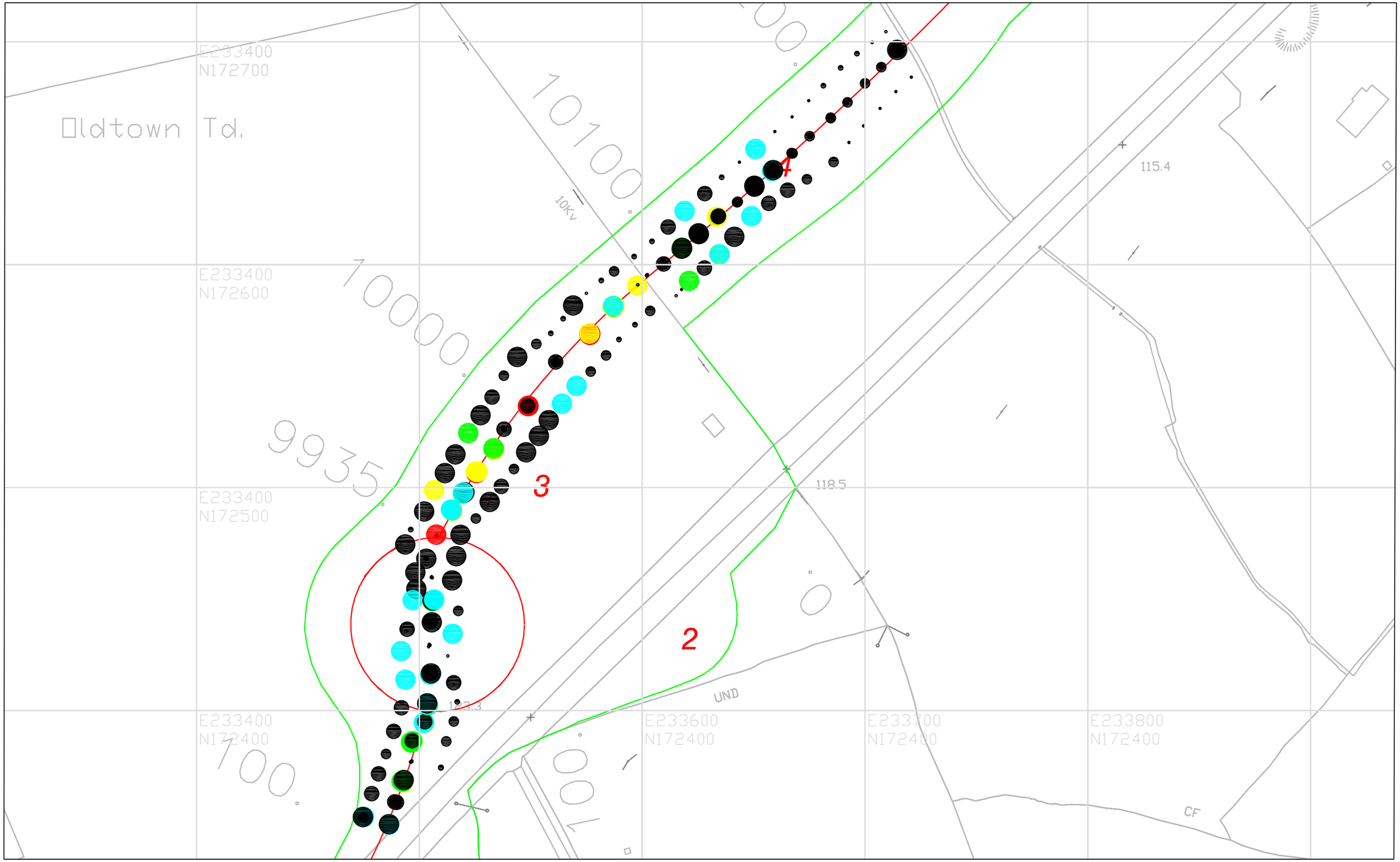
Client: Archaeological Consultancy Services Limited

Drawing Courtesy of: Laois NRDO | Date 09/04/05 | Drawing No.: 05-23/16

0m 50m 100m

Figure No. 16 Phase A Reconnaissance Survey

EARTHSOUND archaeological geophysics



Legend

- Basemap
- Centreline
- Landtake line

26200 Chainage
100 Field Number
Proposed Phase B survey area
Magnetic Susceptibility Zones

× 10^{-5} κ

26 - 48 | 48 - 56 | 56 - 60 | 60 - 65 | 65 - 70 | 70 - 77 | 77 - 82 | 82 - 86 | 86 - 93 | 93 - 111

Site Location: M7 / M8, Testing Area 14, Contract 1, County Laois

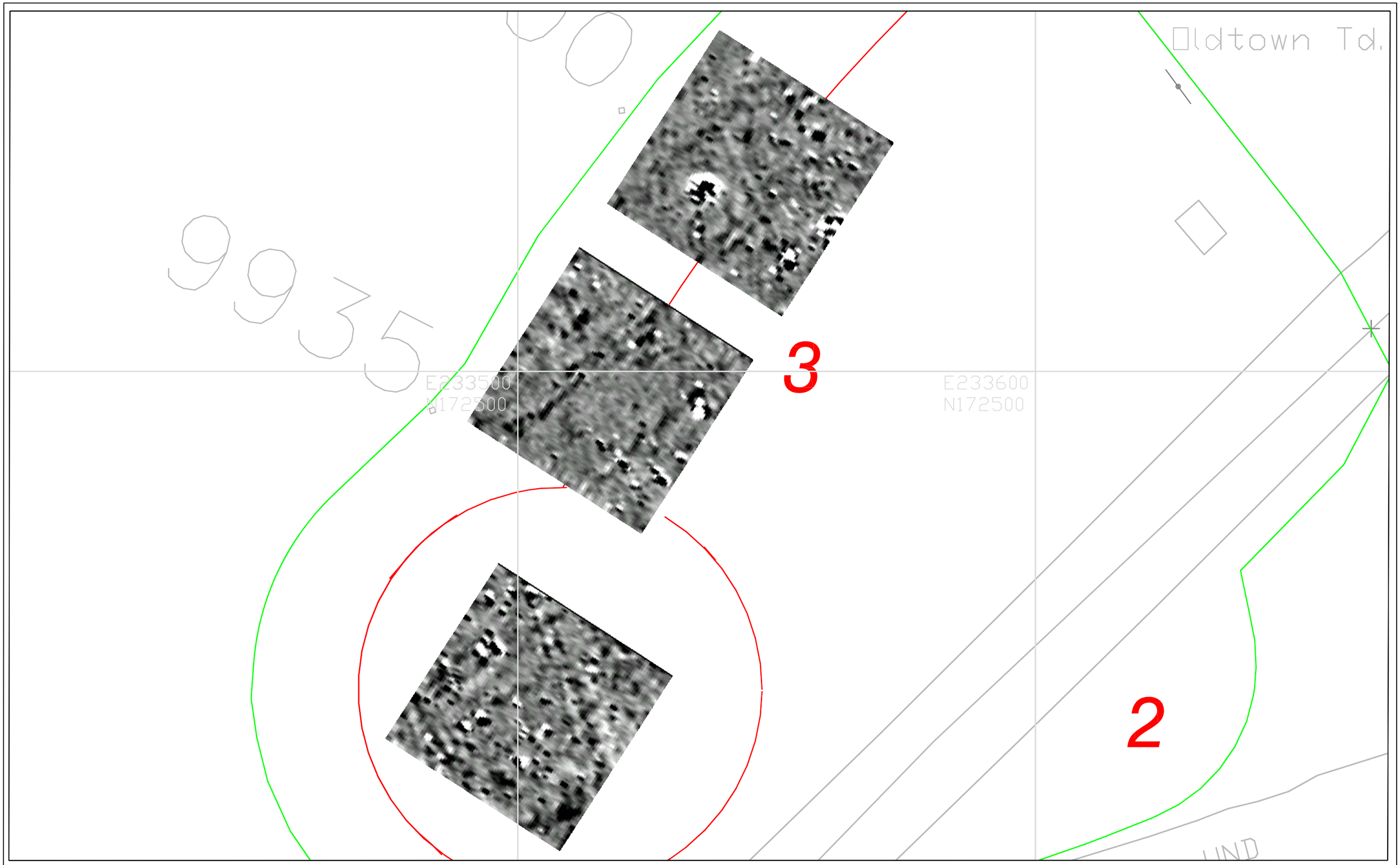
Client: Archaeological Consultancy Services Limited

Drawing Courtesy of: Laois NRDO | Date 09/04/05 | Drawing No.: 05-23/16

0m 50m 100m

Figure No. 16 Phase A Reconnaissance Survey

EARTHSOUND archaeological geophysics



Legend

- Basemap
- Centreline
- Landtake line
- 100 Field Number

nT

-2 0 2

Site Location: M7 / M8, Testing Area 15, Contract 1, County Laois

Client: Archaeological Consultancy Services Limited

Drawing Courtesy of: Laois NRDO	Date 07/04/05	Drawing No.: 05-23/18

0m 20m 40m

Figure No. 18 Phase B Detailed Magnetic Gradiometer data

EARTHSOUND archaeological geophysics

Legend

- Basemap
- Centreline
- Landtake line
- 100 Field Number
- Proposed Test Trenches
- Ditch
- Possible Hearth
- Diopolar Anomalies
- Possible Ditch / Gully

nT: -2 0 2

Site Location: M7 / M8, Testing Area 15, Contract 1, County Laois

Client: Archaeological Consultancy Services Limited

Drawing Courtesy of: Laois NRDO	Date 07/04/05	Drawing No.: 05-23/19

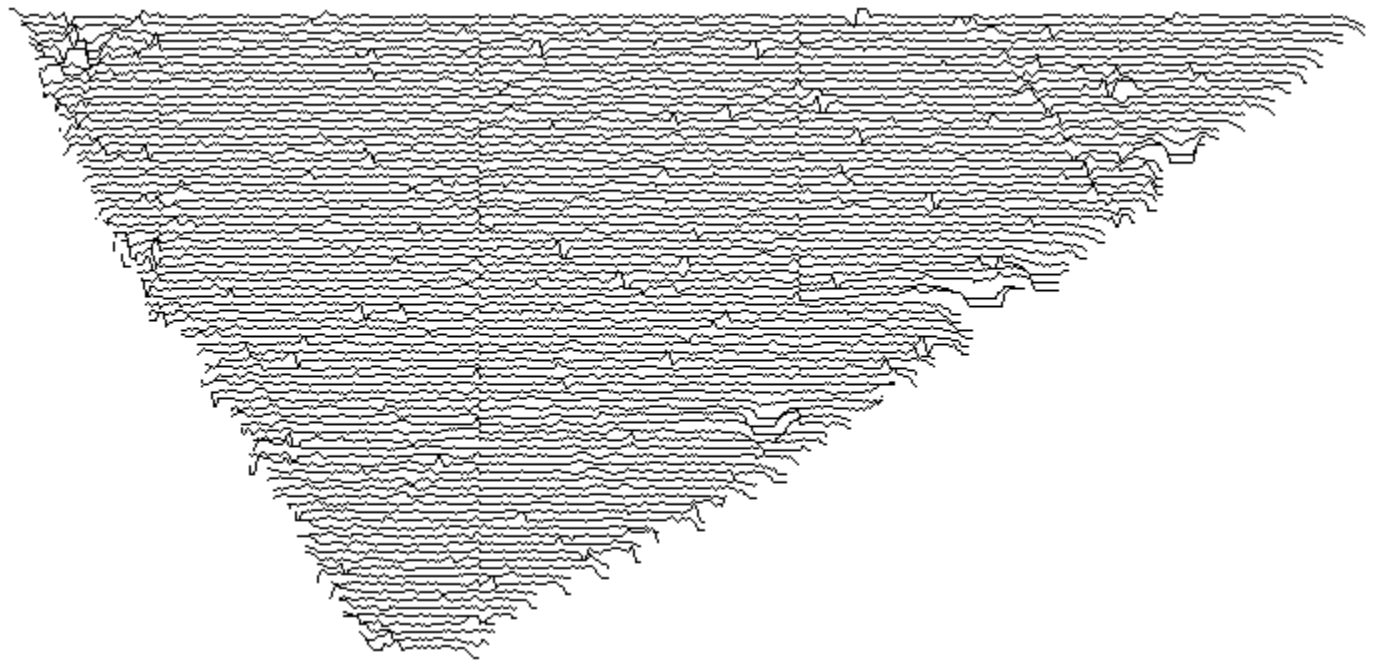
0m 20m 40m

Figure No. 19 Phase B Detailed Magnetic Gradiometer Interpretation

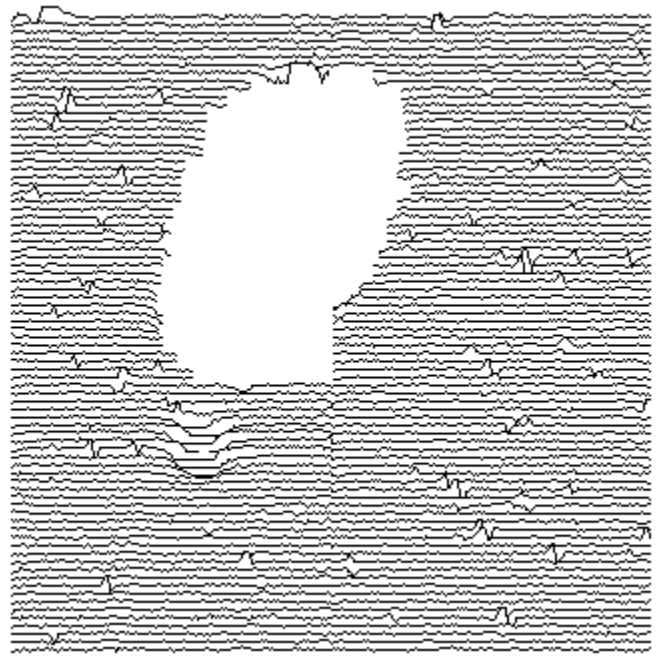
EARTHSOUND archaeological geophysics

M7 / M8, Testing Areas 2, 4, 6 and 15, Contract 1, County Laois

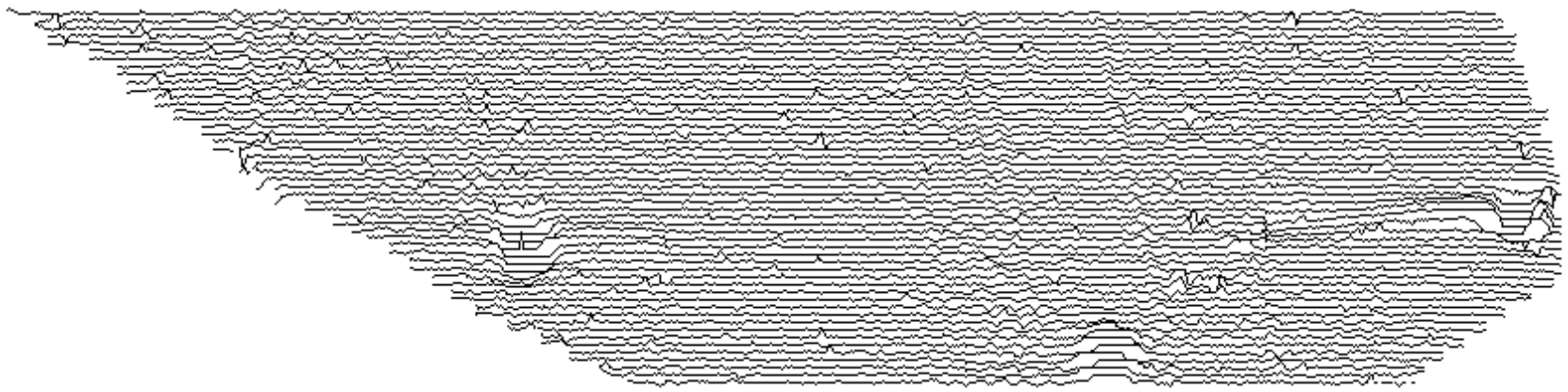
Figure 20: Pre-processed Fluxgate Gradiometer XY Traceplots



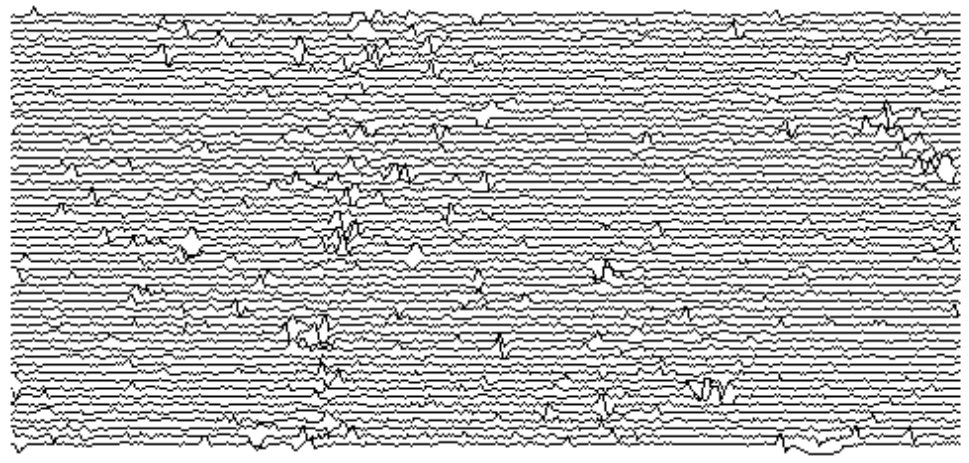
Testing area 2 north



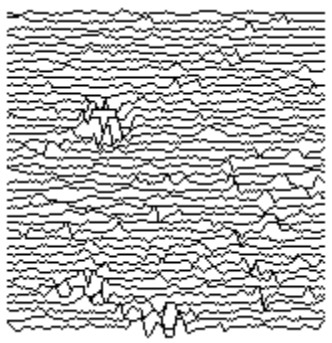
Testing area 4 north



Testing area 2 South

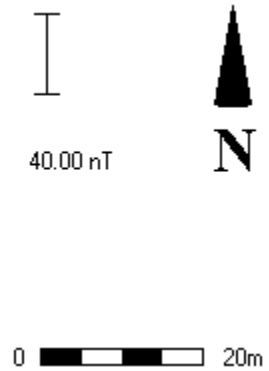


Testing area 6



Testing area 15

Testing area 4 South



Resolution 1nT,
Data Clipped to ± 5nT
1m x 0.125m Sample Interval

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Drawing No.:05_23/20