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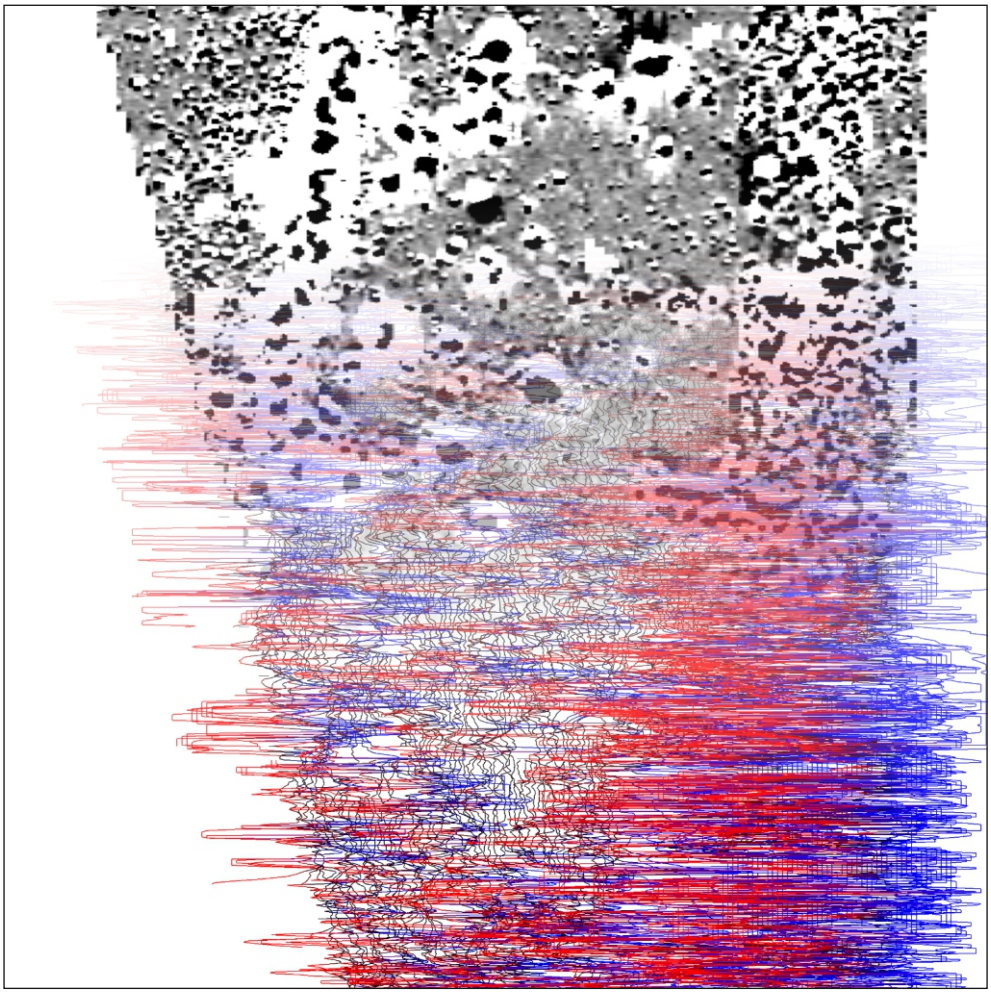
Army Rebasing: Larkhill West Site Salisbury, Wiltshire

Detailed Gradiometer Survey Report



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geoservices

Army Rebasing: Larkhill West Site, Salisbury, Wiltshire

Detailed Gradiometer Survey Report

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* I = Internal Draft; E = External Draft; F = Final

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Detailed Gradiometer Survey Report

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Detailed Gradiometer Survey Report

Summary

A detailed gradiometer survey was conducted over land within the Salisbury Plain Training Area (SPTA), Salisbury, Wiltshire. The project was commissioned by URS Infrastructure & Environment UK Limited, on behalf of the defence Infrastructure Organisation (DIO) with the aim of establishing the presence, or otherwise, and nature of detectable archaeological features on the site ahead of a proposed housing development for Service Family Accommodation (SFA).

The Site currently forms part of Larkhill artillery range, approximately 3km northwest of Amesbury. The Site is located at the head of a dry valley that runs northeast towards the River Avon. The gradiometer survey covered 12ha and has demonstrated the presence of anomalies of likely, probable and possible archaeological interest along with numerous ferrous anomalies and at least two modern services.

The geophysical data revealed a sub-rectangular enclosure along with a number of other features possibly related to use of this area by the military during the 20th century. There are extensive spreads of ferrous anomalies and these are strong enough to have obscured any archaeological anomalies that may exist in these areas.

The survey was undertaken between 7th and 14th August 2014.

Army Rebasing: Larkhill West Site, Salisbury, Wiltshire

Detailed Gradiometer Survey Report

Acknowledgements

The detailed gradiometer survey was commissioned by URS Infrastructure & Environment UK Limited. The assistance of Robert Beaumont and Colin Bush is gratefully acknowledged in this regard.

The fieldwork was undertaken by Alistair Black and Alistair Salisbury. Alistair Salisbury processed the geophysical data which was interpreted by Ross Lefort. This report was written by Genevieve Shaw and Ross Lefort. The geophysical work was quality controlled by Dr. Paul Baggaley. Illustrations were prepared by Ross Lefort and Linda Coleman. The project was managed on behalf of Wessex Archaeology by Dr. Paul Baggaley.

Army Rebasing: Larkhill West Site, Salisbury, Wiltshire

Detailed Gradiometer Survey Report

1 INTRODUCTION

1.1 Project Background

1.1.1 Wessex Archaeology was commissioned by URS Infrastructure & Environment UK Limited, on behalf of the Defence Infrastructure Organisation (DIO), to carry out a geophysical survey on land within the Salisbury Plain Training Area (SPTA), Wiltshire (**Figure 1**), hereafter "the Site" (centred on NGR 414250, 144500). The survey forms part of an ongoing programme of archaeological works being undertaken in advance of the proposed development of Service Family Accommodation (SFA).

1.1.2 The aim of the geophysical survey was to establish the presence/absence, extent and character of detectable archaeological remains within the survey area.

1.1.3 This report presents a brief description of the methodology followed, the detailed survey results and the archaeological interpretation of the geophysical data.

1.2 Site Location and Topography

1.2.1 The survey area currently forms part of the Larkhill artillery range. The survey area is located approximately 3km northwest of Amesbury and 14.5km north of the centre of Salisbury close to the Stonehenge Golf Centre (**Figure 1**). The site comprises an area of pasture that is divided into several paddocks by fencing and access tracks. There were numerous patches of dense vegetation across the eastern half of the Site at the time of the survey along with numerous animal burrows. These obstructions reduced the size of the survey area that could be surveyed safely from 21ha to 12ha.

1.2.2 The Site is located at the head of a dry valley that runs northeast towards the River Avon. The land slopes from just under 130m above Ordnance Datum (aOD) at the western edge of the site to just over 100m aOD at the eastern side of the Site. No small watercourses are recorded on Ordnance Survey (OS) maps close to the Site with the nearest major watercourse being the River Avon located approximately 1km to the northeast.

1.3 Soils and Geology

1.3.1 The bedrock geology under the Site is recorded as Seaford chalk formation that dates to the Cretaceous period. The superficial deposits recorded at the Site are limited to head deposits (clay, silt, sand and gravel) recorded in the dry valley nearby (BGS).

1.3.2 The soils underlying the Site are likely to be a mix of rendzinas with humic rendzinas of the 341 (Icknield) association, grey rendzinas of the 342a (Upton 1) association and brown rendzinas of the 343h (Andover 1) association (SSEW 1983). Soils derived from such geological parent material have been shown to produce magnetic contrasts acceptable for the detection of archaeological remains through magnetometer survey.

2 METHODOLOGY

2.1 Introduction

2.1.1 The detailed magnetometer survey was conducted using a Bartington Grad 601-2 dual fluxgate gradiometer system. The survey was conducted in accordance with English Heritage guidelines (English Heritage 2008).

2.1.2 The geophysical survey was undertaken by Wessex Archaeology's in-house geophysics team between 7th and 14th August 2014. Field conditions at the time of the survey were variable, with parts of the survey area overgrown with numerous animal burrows that made survey in some areas impossible. In total 12ha of the 21ha Site was surveyed.

2.2 Method

2.2.1 Individual survey grid nodes were established at 30m x 30m intervals using a Leica Viva RTK GNSS instrument, which is precise to approximately 0.02m and therefore exceeds English Heritage recommendations (2008).

2.2.2 The magnetometer survey was conducted using a Bartington Grad601-2 fluxgate gradiometer instrument, which has a vertical separation of 1m between sensors. Data were collected at 0.25m intervals along transects spaced 1m apart with an effective sensitivity of 0.03nT, in accordance with EH guidelines (2008). Data were collected in the zigzag method.

2.2.3 Data from the survey was subject to minimal data correction processes. These comprise a zero mean traverse function (±5nT thresholds) applied to correct for any variation between the two Bartington sensors used, and a de-step function to account for variations in traverse position due to varying ground cover and topography. These two steps were applied to all survey areas, with no interpolation applied.

2.2.4 Further details of the geophysical and survey equipment, methods and processing are described in **Appendix 1**.

3 GEOPHYSICAL SURVEY RESULTS AND INTERPRETATION

3.1 Introduction

3.1.1 The gradiometer survey has been successful in identifying a few anomalies of likely, probable and possible archaeological interest across the Site, along with at least two modern services and numerous other large ferrous/ceramic features of uncertain origin. Results are presented as a series of greyscale and XY plots, with corresponding archaeological interpretations, at a scale of 1:2000 (**Figures 2** to **4**). The data are displayed at -2nT (white) to +3nT (black) for the greyscale image and ±25nT at 25nT per cm for the XY trace plots.

3.1.2 The interpretation of the datasets highlights the presence of potential archaeological anomalies, ferrous/burnt or fired objects, and magnetic trends (**Figure 4**). Full definitions of the interpretation terms used in this report are provided in **Appendix 2**.

3.1.3 Numerous ferrous anomalies are visible throughout the detailed survey dataset. These are presumed to be modern in provenance and are not referred to, unless considered relevant to the archaeological interpretation.

3.2 Gradiometer Survey Results and Interpretation

3.2.1 The most significant feature detected is a sub-rectangular enclosure around **4000** that is classed as archaeology; this feature is oriented northeast to southwest on the same alignment as a nearby former track observed on historic OS maps and detected in the geophysical data at **4001**. The enclosure has positive magnetic values around +2nT and is considered to represent a ditch, with no associated internal features. The origin of this feature is unclear but may be related to former use of this area for agriculture prior to the development of the Salisbury Plain Training Area (SPTA).

3.2.2 A pair of parallel linear positive anomalies has been detected towards the north of the survey area around **4002**; these features have strong magnetic values in excess of +5nT. These features correspond to a rectangular feature marked on OS maps from the 1920s up to the 1980s. The identity of this feature is not given on the maps consulted but the strength of their response may suggest they are either ditches backfilled with magnetic material or are the foundations of brick walls. These features have been classed as possible archaeology and may relate to military use of this area.

3.2.3 There are wide and dense spreads of ferrous anomalies across the whole site that obscure much of the surveyed area. Some of these spreads contain regular patterns of responses that do not appear to form typical large ferrous structures like modern services. Examples can be found across the whole site from **4003** to **4008**. Some of these features such as those around **4007** and **4008** run parallel to an earthwork recorded on a historic OS map while others like **4005** and **4006** look to define enclosures. It is unclear whether these features relate to agricultural or military activity and have been classed as coherent ferrous.

3.2.4 An isolated weak positive ditch-like anomaly is located at **4009**; it does not appear to correspond to a recorded agricultural feature and has been classed as possible archaeology.

3.2.5 Two modern services have been observed around **4010**; these will be discussed in more detail in the next section of the report.

3.2.6 Agricultural features can be seen in the data including a track at **4011** and ditches running parallel to field boundaries such as at **4012**.

3.2.7 The remaining anomalies detected in all the areas include very small positive anomalies of possible archaeological interest and weak linear trends of uncertain origin. It is unclear whether these features indicate the presence of archaeological features or are of modern or geological in origin.

3.3 Gradiometer Survey Results and Interpretation: Modern Services

3.3.1 Two modern services have been identified around **4010**; both are considered to represent pipes and extend beyond the limits of the geophysical survey.

3.3.2 It is not clear from the geophysical data whether the services identified are in active use. It should also be noted that gradiometer survey may not detect all services present on Site. This report and accompanying illustrations should not be used as the sole source for service locations and appropriate equipment (e.g. CAT and Genny) should be used to confirm the location of buried services before any trenches are opened on Site.

4 CONCLUSION

4.1.1 The detailed gradiometer survey has been successful in detecting anomalies of likely, probable and possible archaeology as well as ploughing and agricultural trends, a large amount of ferrous and two modern services.

4.1.2 The most interesting anomaly detected is the sub-rectangular enclosure around **4000** although it is possible this feature is related to agricultural use of this land. The remaining features of interest, including many of the coherent ferrous anomalies, look to be related to use of this area for military training. This activity may account for the large concentrations of ferrous responses in these fields.

4.1.3 The remaining anomalies detected appear to be agricultural in origin mainly in the form of ploughing trends, a track and ditches associated with the modern field boundaries.

4.1.4 It is possible that the high concentrations of ferrous responses across many areas of the Site could obscure any archaeological anomalies that may exist in these areas.

4.1.5 The relative dimensions of the modern services identified by the gradiometer survey are indicative of the strength of their magnetic response, which is dependent upon the materials used in their construction and the backfill of the service trenches. The physical dimensions of the services indicated may therefore differ from their magnetic extents in plan; it is assumed that the centreline of services is coincident with the centreline of their anomalies, however. Similarly, it is difficult to estimate the depth of burial of the services through gradiometer survey.

4.1.6 It should be noted that small, weakly magnetised features may produce responses that are below the detection threshold of magnetometers. It may therefore be the case that more archaeological features may be encountered than have been identified through geophysical survey.

5 REFERENCES

5.1 Bibliography

English Heritage, 2008. *Geophysical Survey in Archaeological Field Evaluation*. Research and Professional Service Guideline No 1, 2nd edition.

Institute for Archaeologists, 2011. *Standards and Guidance for Archaeological Geophysical Survey* Unpublished Guidance

5.2 Cartographic Sources

British Geological Survey
http://www.bgs.ac.uk/discoveringgeology/geologyofbritain/viewer.html [accessed July 2014]

Soil Survey of England and Wales, 1983. *Sheet 5, South West England*. Ordnance Survey, Southampton.

APPENDIX 1: SURVEY EQUIPMENT AND DATA PROCESSING

Survey Methods and Equipment

The magnetic data for this project was acquired using a Bartington 601-2 dual magnetic gradiometer system. This instrument has two sensor assemblies fixed horizontally 1m apart allowing two traverses to be recorded simultaneously. Each sensor contains two fluxgate magnetometers arranged vertically with a 1m separation, and measures the difference between the vertical components of the total magnetic field within each sensor array. This arrangement of magnetometers suppresses any diurnal or low frequency effects.

The gradiometers have an effective resolution of 0.03nT over a ±100nT range, and measurements from each sensor are logged at intervals of 0.25m. All of the data are stored on an integrated data logger for subsequent post-processing and analysis.

Wessex Archaeology undertakes two types of magnetic surveys: scanning and detail. Both types depend upon the establishment of an accurate 20m or 30m site grid, which is achieved using a Leica Viva RTK GNSS instrument and then extended using tapes. The Leica Viva system receives corrections from a network of reference stations operated by the Ordnance Survey and Leica Geosystems, allowing positions to be determined with a precision of 0.02m in real-time and therefore exceed the level of accuracy recommended by English Heritage (2008) for geophysical surveys.

Scanning surveys consist of recording data at 0.25m intervals along transects spaced 10m apart, acquiring a minimum of 80 data points per transect. Due to the relatively coarse transect interval, scanning surveys should only be expected to detect extended regions of archaeological anomalies, when there is a greater likelihood of distinguishing such responses from the background magnetic field.

The detailed surveys consist of 20m x 20m or 30m x 30m grids, and data are collected at 0.25m intervals along traverses spaced 1m apart. These strategies give 1600 or 3600 measurements per 20m or 30m grid respectively, and are the recommended methodologies for archaeological surveys of this type (EH, 2008).

Data may be collected with a higher sample density where complex archaeological anomalies are encountered, to aid the detection and characterisation of small and ephemeral features. Data may be collected at up to 0.125m intervals along traverses spaced up to 0.25m apart, resulting in a maximum of 28800 readings per 30m grid, exceeding that recommended by English Heritage (2008) for characterisation surveys.

Post-Processing

The magnetic data collected during the detail survey are downloaded from the Bartington system for processing and analysis using both commercial and in-house software. This software allows for both the data and the images to be processed in order to enhance the results for analysis; however, it should be noted that minimal data processing is conducted so as not to distort the anomalies.

As the scanning data are not as closely distributed as with detailed survey, they are georeferenced using the GPS information and interpolated to highlight similar anomalies in adjacent transects. Directional trends may be removed before interpolation to produce more easily understood images.

Typical data and image processing steps may include:

- Destripe – Applying a zero mean traverse in order to remove differences caused by directional effects inherent in the magnetometer;
- Destagger – Shifting each traverse longitudinally by a number of readings. This corrects for operator errors and is used to enhance linear features;
- Despike – Filtering isolated data points that exceed the mean by a specified amount to reduce the appearance of dominant anomalous readings (generally only used for earth resistance data)

Typical displays of the data used during processing and analysis:

- XY Plot – Presents the data as a trace or graph line for each traverse. Each traverse is displaced down the image to produce a stacked profile effect. This type of image is useful as it shows the full range of individual anomalies.
- Greyscale – Presents the data in plan view using a greyscale to indicate the relative strength of the signal at each measurement point. These plots can be produced in colour to highlight certain features but generally greyscale plots are used during analysis of the data.

APPENDIX 2: GEOPHYSICAL INTERPRETATION

The interpretation methodology used by Wessex Archaeology separates the anomalies into four main categories: archaeological, modern, agricultural and uncertain origin/geological.

The archaeological category is used for features when the form, nature and pattern of the anomaly are indicative of archaeological material. Further sources of information such as aerial photographs may also have been incorporated in providing the final interpretation. This category is further sub-divided into three groups, implying a decreasing level of confidence:

- Archaeology – used when there is a clear geophysical response and anthropogenic pattern.
- Probable archaeology – used for features which give a clear response but which form incomplete patterns.
- Possible archaeology – used for features which give a response but which form no discernible pattern or trend.

The modern category is used for anomalies that are presumed to be relatively modern in date:

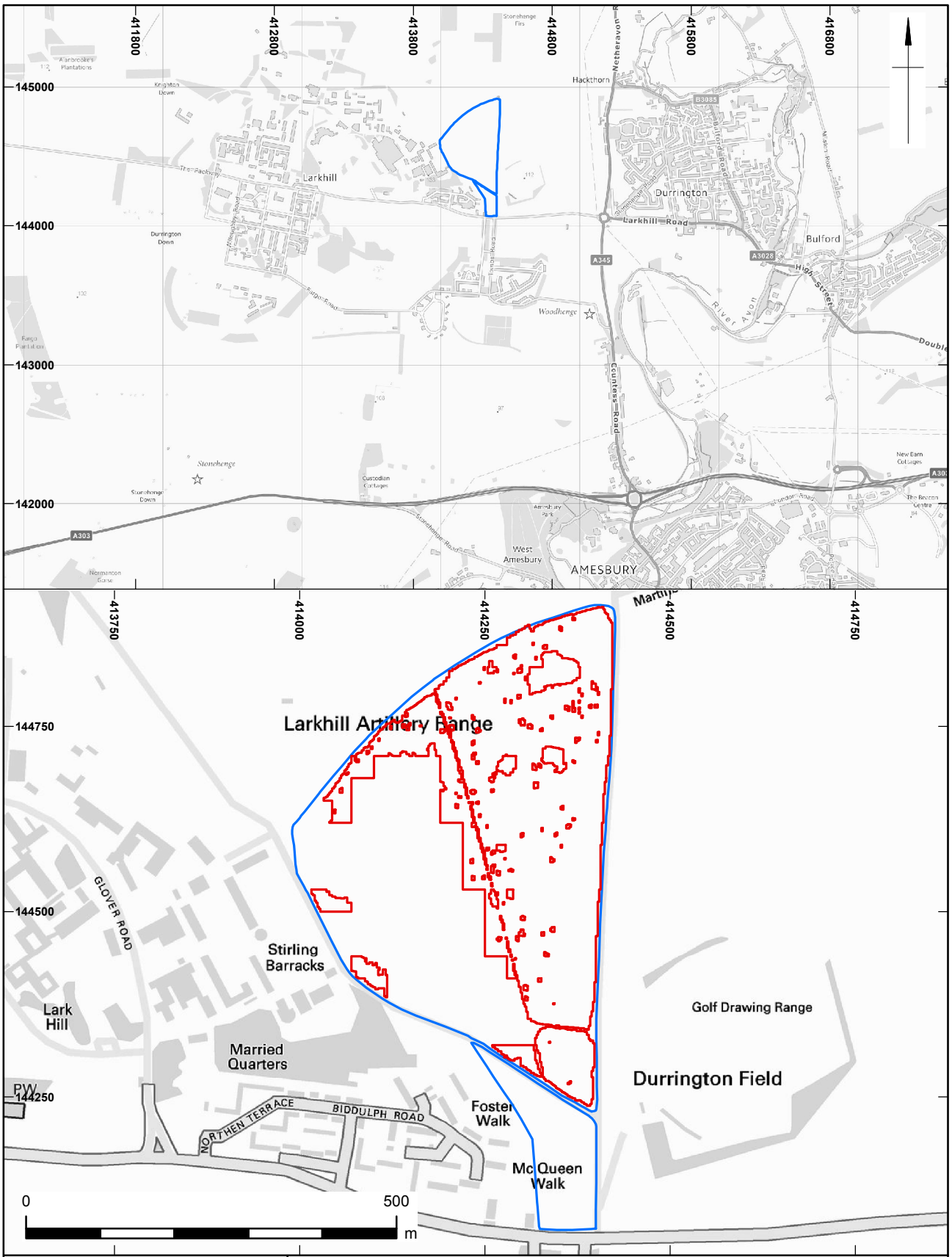
- Ferrous – used for responses caused by ferrous material. These anomalies are likely to be of modern origin.
- Modern service – used for responses considered relating to cables and pipes; most are composed of ferrous/ceramic material although services made from non-magnetic material can sometimes be observed.

The agricultural category is used for the following:

- Former field boundaries – used for ditch sections that correspond to the position of boundaries marked on earlier mapping.
- Agricultural ditches – used for ditch sections that are aligned parallel to existing boundaries and former field boundaries that are not considered to be of archaeological significance.
- Ridge and furrow – used for broad and diffuse linear anomalies that are considered to indicate areas of former ridge and furrow.
- Ploughing – used for well-defined narrow linear responses, usually aligned parallel to existing field boundaries.
- Drainage – used to define the course of ceramic field drains that are visible in the data as a series of repeating bipolar (black and white) responses.

The uncertain origin/geological category is used for features when the form, nature and pattern of the anomaly are not sufficient to warrant a classification as an archaeological feature. This category is further sub-divided into:

- Increased magnetic response – used for areas dominated by indistinct anomalies which may have some archaeological potential.
- Trend – used for low amplitude or indistinct linear anomalies.
- Superficial geology – used for diffuse edged spreads considered to relate to shallow geological deposits. They can be distinguished as areas of positive, negative or broad bipolar (positive and negative) anomalies.



Detailed Survey Extents

Site Boundary

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Scale:	1:40000 and 1:7500 at A4	Illustrator:	RDL
Path:	X:\PROJECTS\104151\GIS\Figs PDF\Geophysics_2014_10_29		

Site location and detailed survey extents

Figure 1

414000

414250

144750

144500

144250

Detailed Survey Extents

+3nT

-2nT

0 100 m

Date:	31/10/2014	Revision Number:	0
Scale:	1:2000 at A3	Illustrator:	RDL
Path:	X:\PROJECTS\104151\GIS\Figs PDF\Geophysics_2014_10_29		

Greyscale plot

Figure 2

414000

414250

144750

144500

144250

Detailed Survey Extents

+25nT

-25nT

0 100 m

Date:	31/10/2014	Revision Number:	0
Scale:	1:2000 at A3	Illustrator:	RDL
Path:	X:\PROJECTS\104151\GIS\Figs PDF\Geophysics_2014_10_29		

XY trace plot

Figure 3

414000

412500

144750

144500

144250

4012

4002

4004

4003

4010

4009

4005

4006

4001

4007

4000

4008

4011

Archaeology

Probable Archaeology

Possible Archaeology

Modern Service

Coherent Ferrous

Ferrous

Agricultural

Ploughing

Trend

Increased Magnetic Response

Detailed Survey Extents

0

100

m

Date:	31/10/2014	Revision Number:	0
Scale:	1:2000 at A3	Illustrator:	RDL
Path:	X:\PROJECTS\104151\GIS\Figs PDF\Geophysics_2014_10_29		

Interpretation

Figure 4

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