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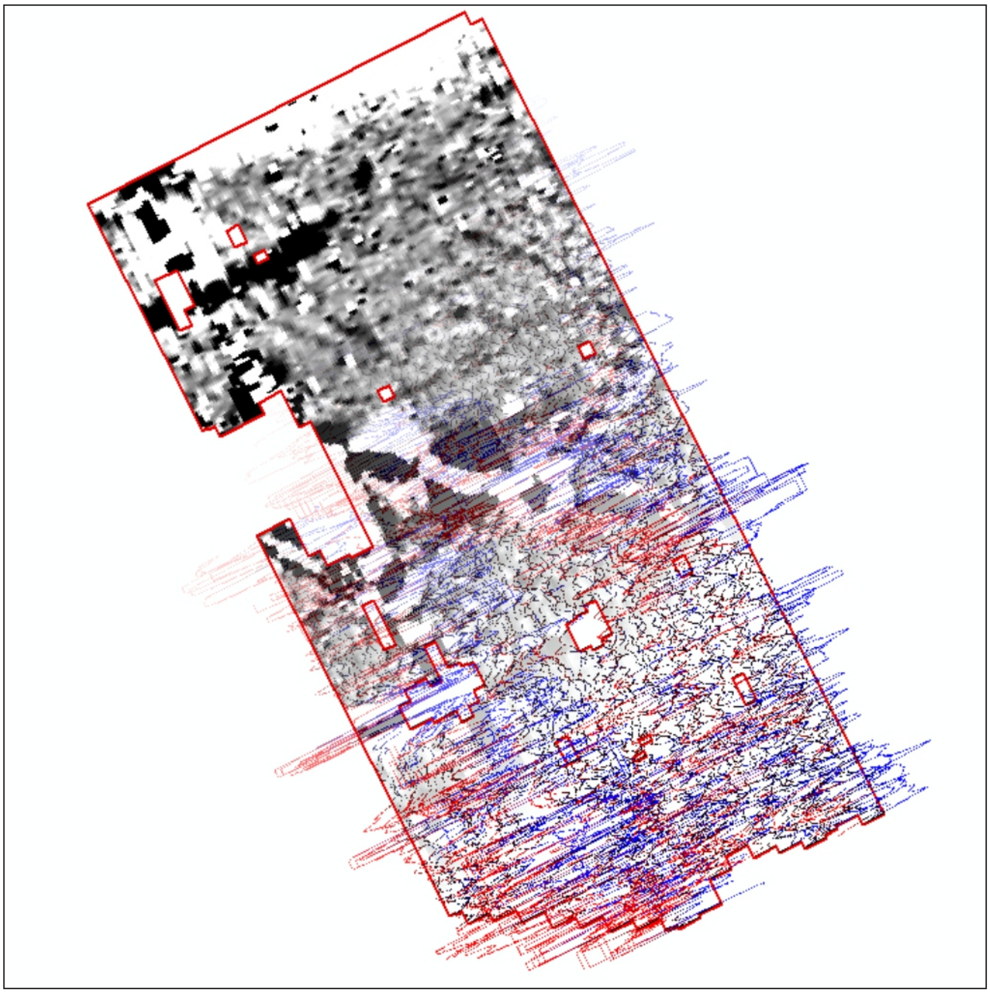
Land at Spen Moor
Bury, Greater Manchester

Detailed Gradiometer Survey Report



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geoservices

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Detailed Gradiometer Survey Report

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

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Summary

Wessex Archaeology was commissioned by CgMs Consulting to undertake a detailed gradiometer and resistivity survey of land south of Bolton Road, Bury, Greater Manchester (centred on NGR 378120, 409520). The aim of the work was to establish the presence, or otherwise, and nature of detectable archaeological features on the site as part of a programme of archaeological works ahead of proposed development at the Site.

The site is located approximately 2.7km southwest of the centre of Bury and 6.3km east of Bolton. The site comprises two arable fields located to the south of Bolton Road on a slightly inclined parcel of land west of Elton Reservoir.

Detailed gradiometer survey was undertaken over all accessible parts of the site, a total of 0.97ha, and has demonstrated the presence of a few anomalies of possible archaeological significance along with some possible ridge and furrow and at least three modern services. Large amounts of ferrous were discovered in the northern parcel of land. It was not possible to carry out the resistivity survey as the waterlogged conditions encountered on Site rendered this technique unsuitable.

The survey was undertaken on the 9th and 10th December 2014.

Land at Spen Moor, Bury, Greater Manchester

Detailed Gradiometer Survey Report

Acknowledgements

The detailed gradiometer survey was commissioned by CgMs Consulting.

The fieldwork was carried out by Laurence Savage and Matthew Tooke. The geophysical data was processed and interpreted by Alistair Salisbury who also wrote this report. The geophysical work was quality controlled by Lizzie Richley and Ross Lefort. Illustrations were prepared by Ross Lefort and Karen Nichols. The project was managed on behalf of Wessex Archaeology by Richard O'Neill.

Land at Spen Moor, Bury, Greater Manchester

Detailed Gradiometer Survey Report

1 INTRODUCTION

1.1 Project Background

1.1.1 Wessex Archaeology was commissioned by CgMs Consulting to carry out a programme of geophysical survey over land to the south of Bolton Road, near Bury, Greater Manchester (**Figure 1**) hereafter “the Site” (centred on NGR 378117, 409524). The survey forms part of an ongoing programme of archaeological works being undertaken ahead of proposed development at the Site.

1.1.2 A Written Scheme of Investigation (WSI) was prepared by CgMs Consulting (2014) that set out the following objectives for the geophysical survey:

- To identify the location, extent and character of archaeological remains within the site; and
- To provide information that will enable an assessment of the impact of the development on any potential archaeological remains identified.

1.1.3 The survey was planned to include both gradiometer and resistivity survey but the waterlogged conditions on Site at the time of survey rendered resistivity unsuitable.

1.1.4 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 Site comprises two separate survey areas in arable fields separated by a small, wooded field boundary south of Bolton Road, near Bury, Greater Manchester some 2.3km north of Radcliffe (**Figure 1**). The survey areas are defined by the limits of the proposed development.

1.2.2 The survey area lies on the east facing slope. The height of the land falls from just under 110m above Ordnance Datum (aOD) at the western end of the Site to under 105m aOD at the eastern end of the Site. The main tributary of the River Irwell lies to the east of the Site and flows towards Manchester then into the River Mersey before entering the sea.

1.3 Soils and Geology

1.3.1 The bedrock geology under the Site is composed of interbedded grey mudstone, siltstone and pale grey sandstone with some thick coal seams from the Pennine Lower Coal Measures (PCM) Formation of the Carboniferous Period. There are few superficial deposits recorded with only some till deposits (BGS).

1.3.2 The soils underlying the Site are mostly recorded as unsurveyed. However, the soils neighbouring and surrounding the Site are recorded as drift from Palaeozoic sandstone and shale of the 713g (Brickfield 3) 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 Bartington Grad601-2 dual fluxgate gradiometer systems. The survey was conducted in accordance with English Heritage guidelines (2008).

2.1.2 The geophysical survey was undertaken by Wessex Archaeology's in-house geophysics team on the 9th and 10th December 2014. Field conditions at the time of the survey were mixed, with soft conditions under foot. In total the geophysical survey covered 0.97ha. It was proposed to carry out a resistivity survey waterlogged conditions encountered on Site rendered this technique unsuitable (**Plates 1** and **2**).

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 were subject to minimal data correction processes. These comprise a Zero Mean Traverse (ZMT) function (±10nT 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. The deslope and multiply functions were used to account for errors in the ZMT function and to remove grid edge discontinuities. These four 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 identified a few anomalies of possible archaeological interest in addition to some possible ridge and furrow and at least three modern services. Results are presented as a series of greyscale and XY plots, and archaeological interpretations, at a scale of 1:1500 (**Figures 2** to **4**). The data are displayed at -2nT (white) to +3nT (black) for the greyscales and ±25nT at 25nT per cm for the XY traces.

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 geophysical survey reveals a relatively noisy magnetic background, especially in the northwest survey area where large amounts of ferrous material are observed. The activity here may be in relation to a dismantled railway line located less than 300m to the south.

3.2.2 The northwest parcel of land is seen to have large amounts of ferrous which may be obscuring small archaeological features as can be seen at **4000** and **4001** where small pit and ditch-like anomalies appear to be partially obscured by the ferrous responses in this area. The linear trends at **4001** appear to be orientated in a NE-SW manner and may represent weakly magnetised ditches. The possible archaeology noted around **4000** may correspond to the position of pits.

3.2.3 Evidence of ploughing activity can be seen right across the dataset although some fairly strong linear trends can be seen around **4002** in the southeast survey area. It is possible that these stronger responses could relate to ridge and furrow with the linear classed as possible archaeology at **4002** representing the strongest linear.

3.2.4 At least three modern services can be seen in the data but these will be discussed in more detail in the next section of the report.

3.3 Gradiometer Survey Results and Interpretation: Modern Services

3.3.1 At least three modern services can be seen spread across the site at **4003** to **4006** in a variety of orientations. All three appear to represent pipes although their exact function is unclear.

3.3.2 It should 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 DISCUSSION

4.1 Summary

4.1.1 The detailed gradiometer survey has been successful in detecting a few anomalies of possible archaeological interest, in addition to possible ridge and furrow and at least three modern services.

4.1.2 The geophysical data has revealed a low concentration of archaeological anomalies with only a few scattered pit-like anomalies and partially obscured ditch sections detected. The majority of detected features relate to agricultural and relatively modern activity. A dismantled railway less than 300m south of the Site may have some bearing on the strong ferrous background.

4.1.3 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.

4.1.4 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

CgMs Consulting, 2014. *Land at Spen Moor, Bolton Road, Bury: Archaeological Written Scheme of Investigation.* Unpublished client report. CgMs ref. RS/18646.

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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:

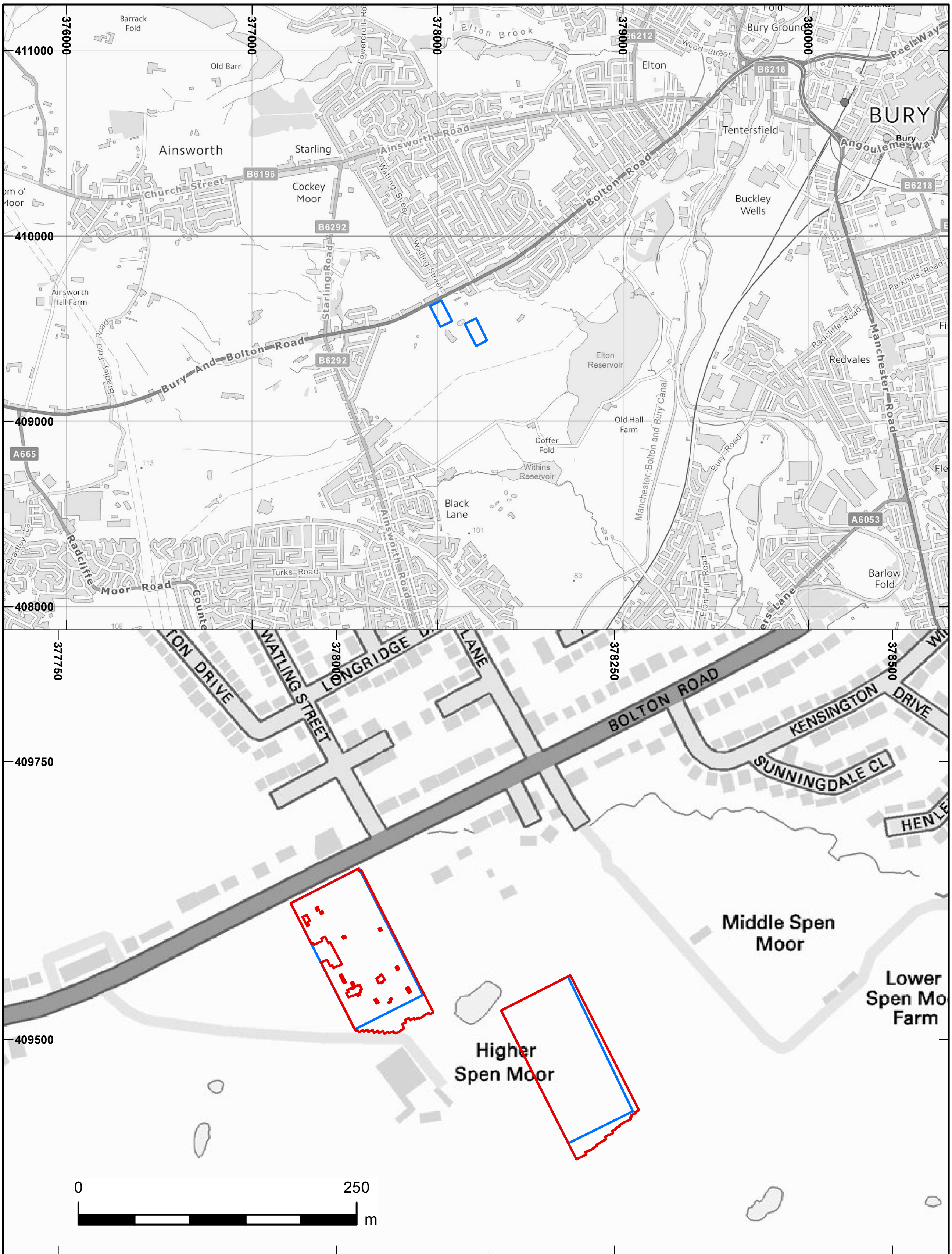
- Ferrous – used for responses caused by ferrous material. These anomalies are likely to be of modern origin.
- Modern service – used for responses considered relating to cables and pipes; most are composed of ferrous/ceramic material although services made from non-magnetic material can sometimes be 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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Date:	12/01/2015	Revision Number:	0
Scale:	1:30000 and 1:5000 at A4	Illustrator:	RDL
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Site location and detailed survey extents

Figure 1

Detailed Survey Extents

+3nT

-2nT

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Greyscale plot

Figure 2

Detailed Survey Extents	
+25nT	
-25nT	

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XY trace plot

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Interpretation

Figure 4

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Photographs demonstrating the extent of waterlogging on Site at the time of the survey

Plates 1 and 2