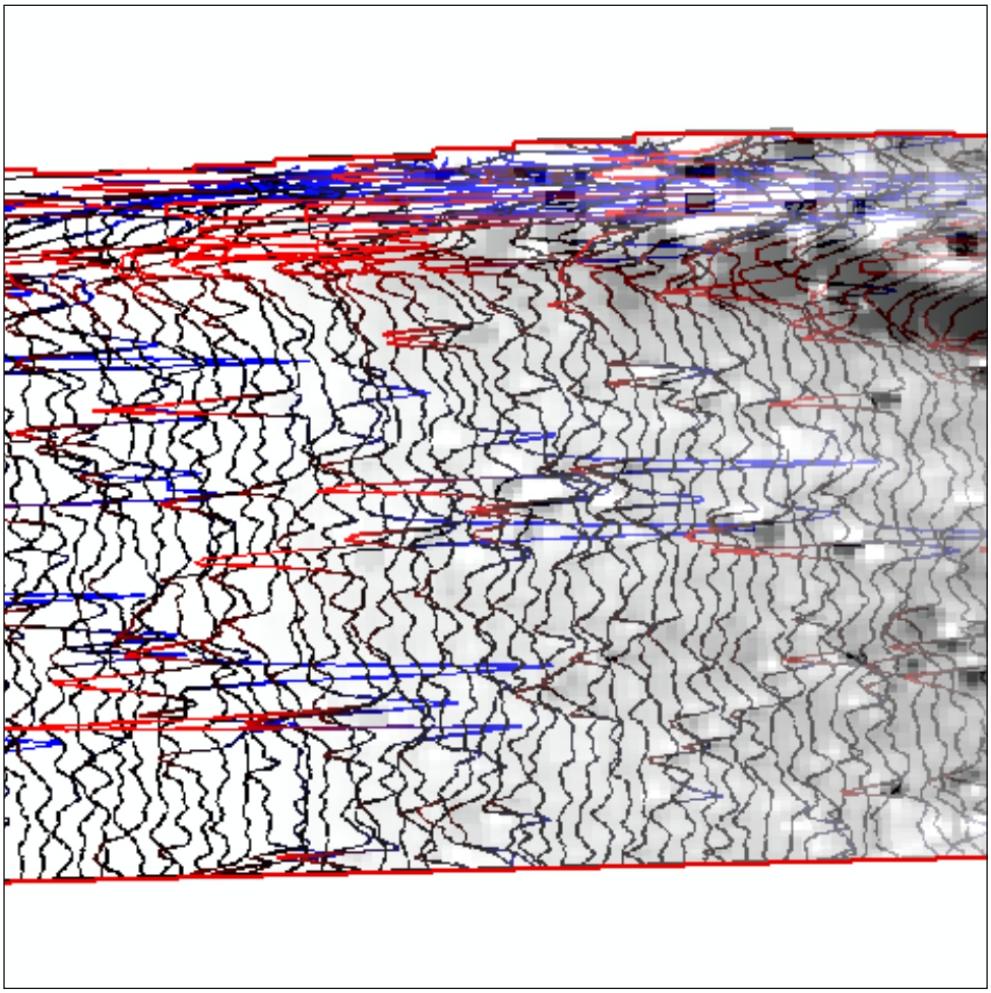
making sense of heritage

Dundry Pipeline, Bristol, North Somerset

Detailed Gradiometer Survey Report



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geoservices

Dundry Pipeline, Bristol, North Somerset

Detailed Gradiometer Survey Report

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

DISCLAIMER

Dundry Pipeline, Bristol, North Somerset

Detail Gradiometer Survey Report

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Detailed Gradiometer Survey Report

Summary

Wessex Archaeology was commissioned by Bristol Water Plc. to undertake a detailed gradiometer survey of land either side of Crabtree Lane and West Dundry Lane (centred on NGR 356050 166600). 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 the proposed installation of a water main.

The proposed pipeline is located a short the south of Dundry, approximately 7.15km SSW of the centre of Bristol and 2.5km northeast of Winford. The site comprises arable fields, pasture land and recreational grounds across 10 separate fields. The survey was targeted over a 30m wide corridor over and adjacent to the projected line of the water main; this is an expansion on the expected 15m easement. This enlargement was undertaken to allow meaningful interpretation of the geophysical data. Due to site conditions it was not possible to survey the entire length of the proposed pipeline.

Detailed gradiometer survey was undertaken over all accessible parts of the site, a total of 0.7ha, and has demonstrated the presence of a few anomalies of possible archaeological significance along with agricultural features. The most notable archaeological feature was located in fields 6 & 8 where a large, positive anomaly can be traced through both fields along with several linear trends; assessment of historic maps suggests this is the original line of West Dundry Lane before it was straightened in the early 19th century. There is the possibility for archaeological remains in the areas there were not surveyed given the findings in the current data.

The geophysical survey was undertaken between 17th and 18th November 2014.

Dundry Pipeline, Bristol, North Somerset

Detailed Gradiometer Survey Report

Acknowledgements

This project was commissioned by Bristol Water PLC and Wessex Archaeology is grateful to Gareth Lloyd in this regard.

The fieldwork was carried out by Lizzie Richley and Alistair Salisbury. The geophysical data was processed and interpreted by Alistair Salisbury and Lizzie Richley. This report was written by Lizzie Richley and Alistair Salisbury. The geophysical work was quality controlled by Ross Lefort. Illustrations were prepared by Lizzie Richley, Ross Lefort and Karen Nichols. The project was managed on behalf of Wessex Archaeology by Caroline Budd.

Dundry Pipeline, Bristol, North Somerset

Detailed Gradiometer Survey Report

1 INTRODUCTION

1.1 Project Background

1.1.1 Wessex Archaeology was commissioned by Bristol Water to carry out a programme of geophysical survey over land to the either side of Crabtree Lane and West Dundry Lane in Dundry, near Bristol, Somerset (**Figure 1**) (centred on NGR 356050 166600). The route crosses several parcels of land (**Figure 2**) hereafter referred to by field number (i.e. Field 6). The survey forms part of an ongoing programme of archaeological works being undertaken ahead of proposed installation of a water main.

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 Survey Restrictions

1.2.1 The Route covers *c.*3.0ha, however due to restrictions it was only possible to survey *c.* 0.7ha. Table 1 below details the survey areas that were or were not surveyed and **Figure 2** shows the location of each field for easy of discussion.

Field Number	Condition	Surveyed (Yes/No)
1	Pasture with Cows and Calves	No
2	Tarmac Car Park	No
3	Tarmac, Cistern and Play Area	No
4	Arable with crops planted to the edges of the field – unable to survey due to potential damage	No
5	Arable with crops planted to the edges of the field – unable to survey due to potential damage	No
6	Pasture with Sheep	Yes
7	Pasture with Horses and small paddocks separated by electric fencing	No
8	Pasture	Yes
9	Pasture with cows and calves	No
10	Pasture	Yes

Table 1: Site restrictions

1.2.2 The presence of livestock and crops restricted the size of the area that could be surveyed; **Plates 1** to **8** illustrate many of the encountered obstacles.

1.3 Site Location and Topography

1.3.1 The Site comprises ten fields (six under pasture, two under arable land and two used as recreational grounds) on either side of Crabtree Lane and West Dundry Lane to the south of Dundry. The Route is located approximately 7.15km SSW of the centre of Bristol and 2.5km northeast of Winford (**Figure 1**). The survey area is located less than 2km to the west of the Roman road named Ermine Street (B6403).

1.3.2 The survey area is defined by the limits of the proposed development with a 30m wide corridor added for the geophysical survey to follow. An easement of 15m around the proposed water main was initially calculated however for the geophysical survey this was extended to a 30m buffer area. For geophysical data interpretation, more meaningful interpretations can be attained from larger areas.

1.3.3 The proposed pipeline route runs a northeast facing slope, the eastern limit at an approximate height above Ordnance Datum (aOD) of 190m, and the western limit at approximately 225m aOD. No watercourses run through the Site although a number of springs emerge further downslope to the north that form several streams that all flow north into the River Avon.

1.4 Soils and Geology

1.4.1 The underlying geology is mapped as limestone of the inferior Oolite group that date to the Jurassic period. Mudstone deposits of the Whitby and Charmouth formations are recorded a short distance to the north. No superficial deposits are recorded on the 1:50,000 scale mapping however landslide deposits dating from the Quaternary period are recorded on the 1:625,000 scale mapping (BGS).

1.4.2 The soils underlying the Site are mostly recorded as brown rendzinas of the 343d (Sherborne) 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.

1.5 Archaeological Background

1.5.1 A Heritage Statement has been prepared by Wessex Archaeology to determine, as far as is possible from existing information, the nature, extent and significance of the historic environment and to assess the potential impact of development on the heritage assets (Wessex Archaeology 2014). The results of this assessment were cross referenced during the interpretation of the survey data.

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 between 17th and 18th November 2014. Field conditions at the time of the survey were good, with firm conditions under foot. In total the geophysical survey covered 0.7ha.

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 (±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. The deslope and add 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 Method

3.1.1 The gradiometer survey has identified a few anomalies of possible archaeological interest; these anomalies include a possible section of the old line of West Dundry Lane and a few small sub-oval shaped positive anomalies. Results are presented as a series of greyscale plots, XY trace plots, and archaeological interpretations at a scale of 1:1250 (**Figures 3** to **5**). 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 5**). 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 noticeable feature in Field 6 is a broad positive anomaly at **4000** that crosses the field east to west and can be seen continuing into Field 8 at **4001**. This feature has magnetic values over +3nT with a parallel negative anomaly running to the north. To the north of this feature the area is characterised by several ferrous responses likely related to the modern metal field boundary. This anomaly looks to correspond to the former line of West Dundry Road that took a less straight route in the early 19th century. An 1810 map of the area shows a slight kink towards the south that appears to match this anomaly closely; this kink is no longer visible by the 1826 map drawn by Robert Dawson.

3.2.2 South of **4001** runs a weak and diffuse positive anomaly at **4002**; this anomaly runs parallel to the modern road and is considered likely to relate to agricultural use of this area.

3.2.3 A number of very small sub-oval positive anomalies can be seen scattered across the data such as around **4003** and to the east of **4002**. These anomalies have smooth profiles in the XY trace plots which suggests they could represent cut features such as postholes. It should be noted that a geological explanation for these anomalies is also possible and as they form no clear anthropogenic patterns in their spatial distribution have been classed as possible archaeology.

3.2.4 There are numerous weak linear anomalies running through the data, most are considered to be caused by ploughing but some others have a curved form or run in an opposing direction to the dominant plough direction. These trends are considered to be of uncertain origin although it is possible some may prove to be of archaeological significance.

3.3 Gradiometer Survey Results and Interpretation: Modern Services

3.3.1 No modern services have been identified in the geophysical data however 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; these include a possible section of the old line of West Dundry Lane and a few small sub-oval shaped positive anomalies.

4.1.2 The clearest feature detected is a broad positive linear anomaly in Fields 6 and 8. A brief assessment of historic mapping suggests this feature may prove to be the former line of West Dundry Lane prior to it's straightening some time before 1826.

4.1.3 A large proportion of the anomalies detected relate to relatively recent use of this area for agriculture with numerous ploughing trends and ferrous anomalies detected.

4.1.4 The total coverage with gradiometer survey was severely reduced due to access restrictions within several of the fields that the route crosses. Given the findings of the current data there is a possibility of archaeological remains to be present in the areas that were not surveyed.

4.1.5 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.

Wessex Archaeology, 2014. *Dundry Pipeline, North Somerset: Heritage Statement* unpublished client Report 104650.01

5.2 Cartographic Sources

British Geological Survey
http://www.bgs.ac.uk/discoveringgeology/geologyofbritain/viewer.html

Dawson, R. 1810. *Bristol 9*. From the British Library Online Collection. Available at: http://www.bl.uk/onlinegallery/onlineex/ordsurvdraw/b/002osd000000009u00126000.html [Accessed: 28th November 2014].

Soil Survey of England and Wales (SSEW), 1983: *Sheet 5, Soils of South West England*. Ordnance Survey: Southampton.

Unknown, 1810. *Bedminster*. From the British Library Online Collection. Available at: http://www.bl.uk/onlinegallery/onlineex/ordsurvdraw/b/002osd000000007u00033000.html [Accessed: 28th November 2014].

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:

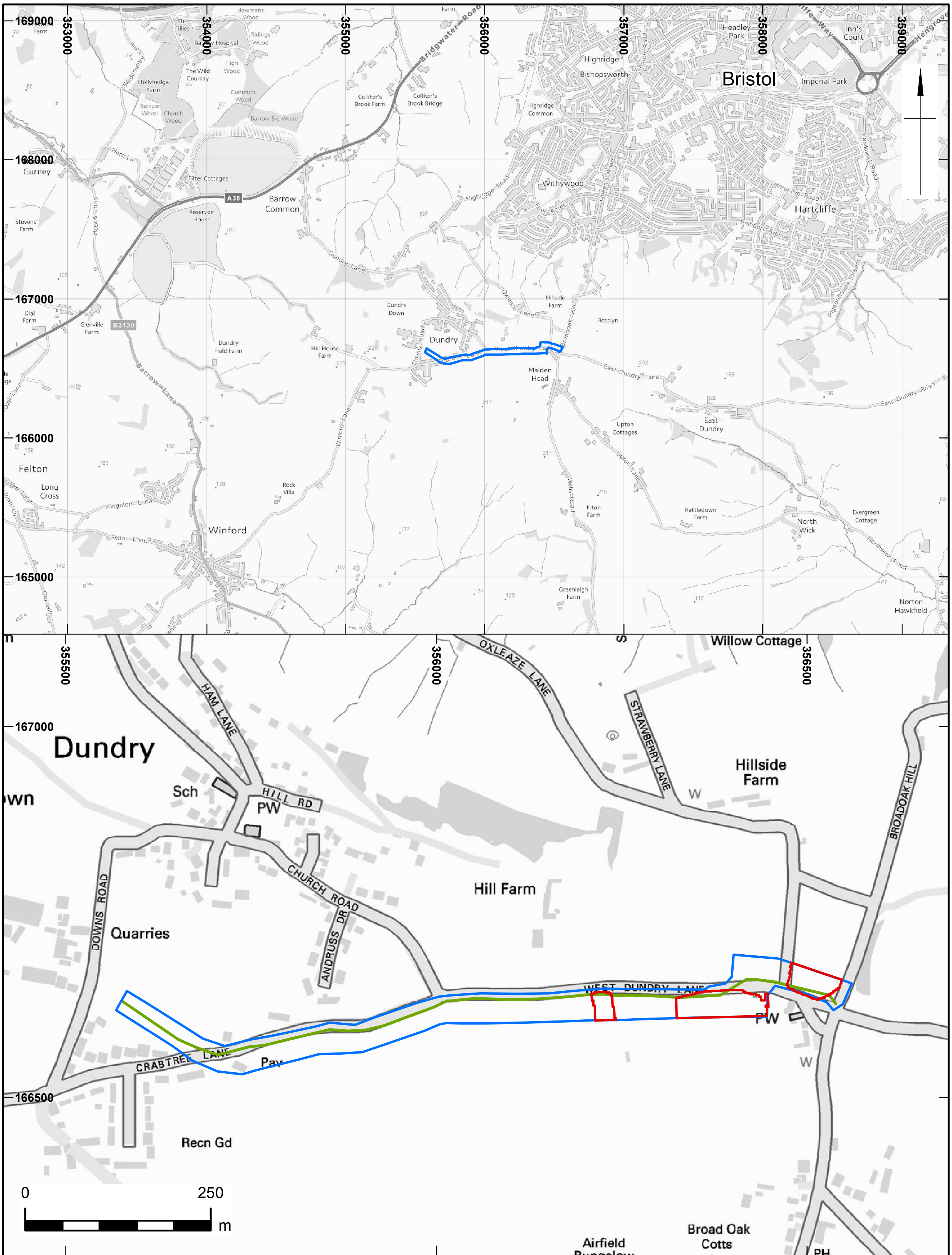
- Ferrous – used for responses caused by ferrous material. These anomalies are likely to be of modern origin.
- Modern service – used for responses considered relating to cables and pipes; most are composed of ferrous/ceramic material although services made from non-magnetic material can sometimes be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

Proposed Pipeline

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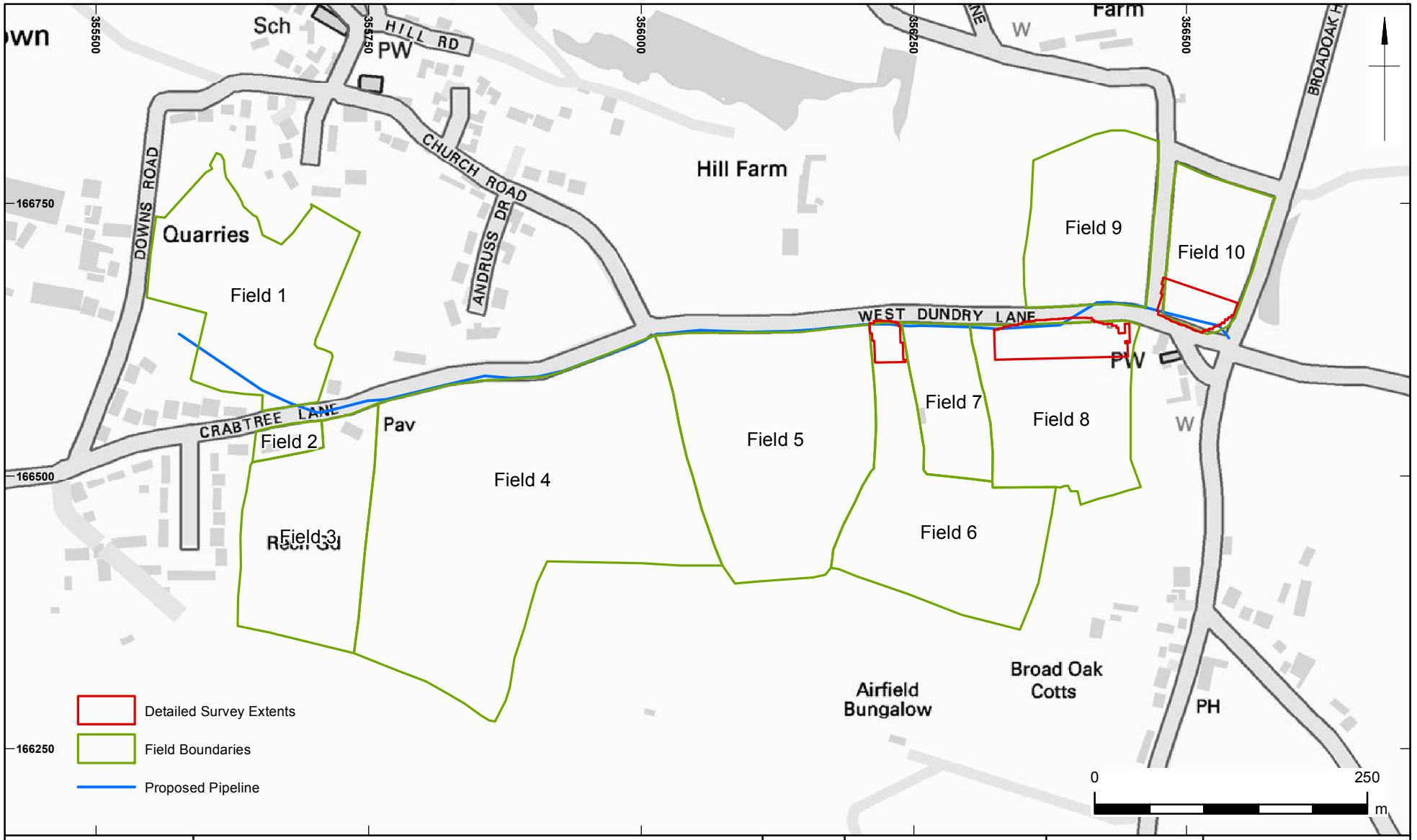
Site location and detailed survey extents

Figure 1



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Plan showing fields crossed by the proposed pipeline

Figure 2

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Greyscale plot

Figure 3

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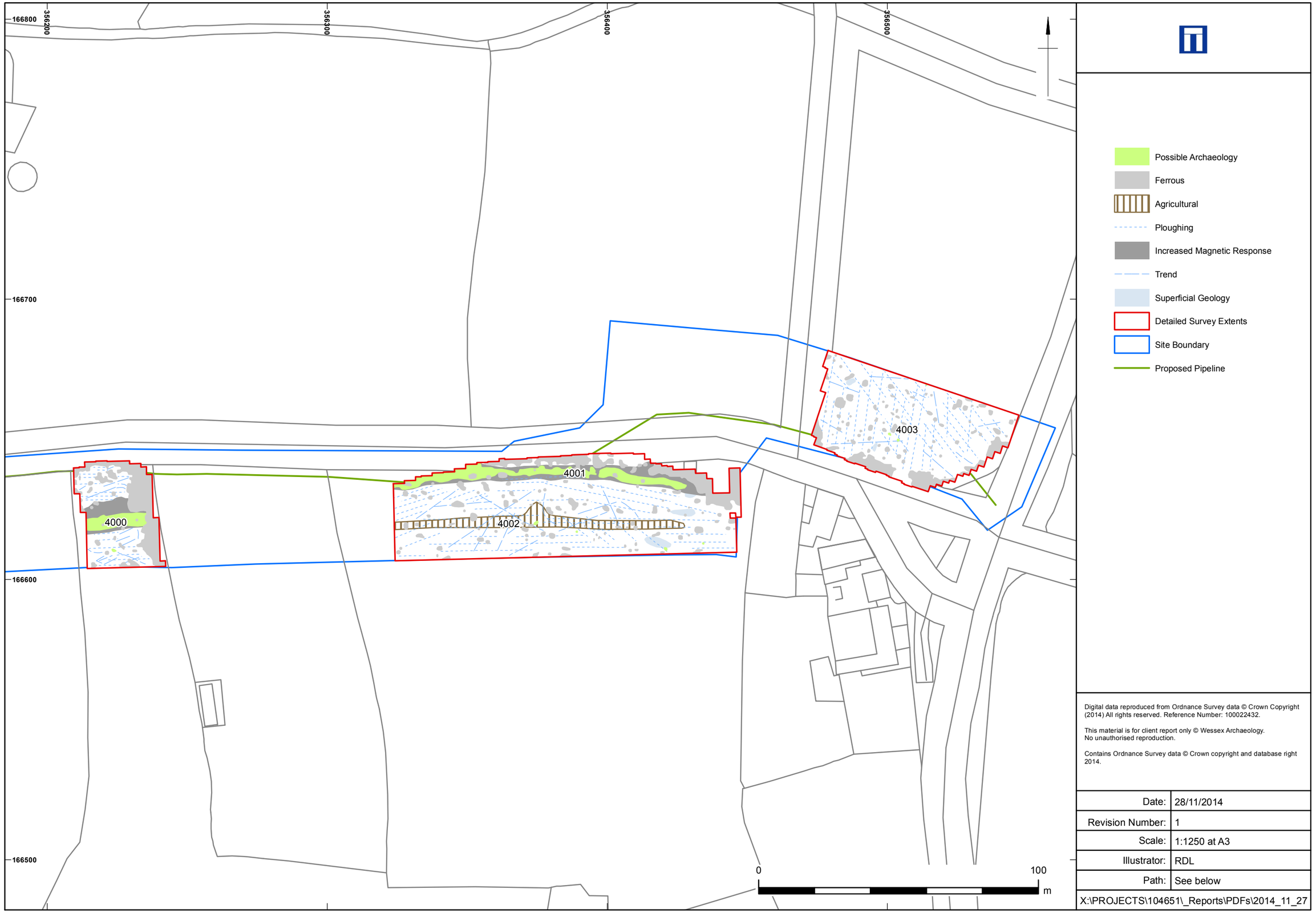
XY trace plot

Figure 4



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Interpretation

Figure 5

Plate 1: Livestock with calves in Fields 1 & 9

Plate 2: Tarmac and cars in Field 2

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Plate 3: Play equipment in Fields 2 & 3

Plate 4: Tarmac and Septic Tank/man hole covers in Field 3

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Plate 5: Man hole covers over septic tanks in Field 3 behind Sports Hall

Plate 6: Turnip Crops right up to hedgeline in Fields 5 & 6

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Plate 7: Horses in small paddocks with electric fences in Field 7

Plate 8: Padlocked gate to Field 7

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