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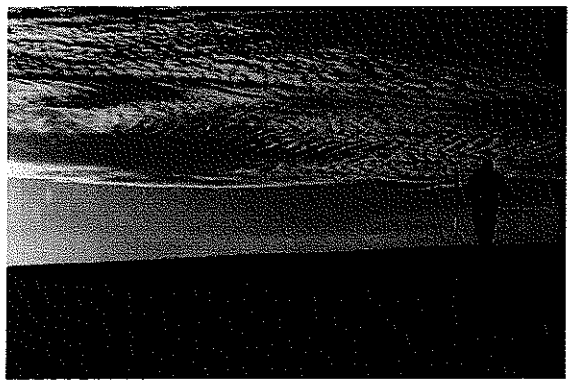
GEOPHYSICAL SURVEY REPORT
2007/67

M1 Junction 21-30 Improvement
Trent Valley



Client:

ARUP

Cowburn Farm, Market Street, Thornton, Bradford, West Yorkshire, BD13 3HW

Tel: +44 1274 835016
Fax: +44 1274 830212
Email: gsb@gsbprospection.com
Web: www.gsbprospection.com

Specialising in Shallow and Archaeological Prospection

GSB Survey No. 07/67

M1 Junction 21-30 Improvement – Report on Geophysical Survey at Trent Valley

NGR	SK 472 338 – SK466 305		
Location	The individual sites which make up the survey area are located immediately to the west of the M1 motorway, between junctions 24a and 25.		
District	Erewash and North West Leicestershire	**Parish**	Breaston and Lockington-Hemmington
Topography	Generally level with some steep slopes locally.		
Current land-use	Pasture, set-aside, and a single ploughed field.		
Soils	Salwick association (572m) and Wharfe association (561a) (*Soils of England and Wales. Sheet 3, Midland and Western England*. Soil Survey of England and Wales. 1983).		
Geology	Triassic Keuper Marls and Sandstone and Mill Stone Grit.		
Archaeology	No information available.		
Survey Methods	Detailed Fluxgate Gradiometer survey.		

Aims

To determine whether any detectable archaeological remains exist within the survey area. The work forms part of a wider archaeological assessment being carried out by **OVE ARUP and Partners Ltd**.

Summary of Results*

The survey identified only a few areas where there are anomalies of archaeological potential. Those that have been noted are generally weak and isolated and are therefore considered unlikely to be of significance. Numerous trends have been highlighted but again they do not conform to any coherent patterns and are more likely to be the result of agricultural activity. An area of potential ridge and furrow cultivation has been revealed at the northern end of the scheme.

A single large bore pipe has been identified running through several of the survey areas and any archaeological anomalies in the vicinity of the massive response produced by this will have been masked.

Other modern interventions, such as tarmac surfaces and other pipes, have also caused ferrous anomalies and magnetic disturbance in the data and are not considered significant.

Project Information

Project Co-ordinator: F Chester
Project Assistants: M Harrison, C Stephens, J Smith, G Taylor & I Wilkins
Date of Fieldwork: 10th October - 29th November 2007
Date of Report: 11th January 2008

***It is essential that this summary is read in conjunction with the detailed results of the survey.**

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Survey Specifications

Method

The survey grid was set out using tapes and tied in to the Ordnance Survey (OS) grid using a Trimble differential GPS. The data have been included on the geo-referenced CAD diagram on the Archive CD.

Technique	Traverse Separation	Reading Interval	Instrument	Survey Size
Magnetometer - Scanning (Appendix 1)	-	-	-	-
Magnetometer – Detailed (Appendix 1)	1m	0.25m	Bartington Grad 601-2	8ha
Resistance – Twin Probe (Appendix 1)	-	-	-	-
Ground Penetrating Radar (GPR) (Appendix 1)	-	-	-	-

Data Processing

	Magnetic	Resistance	GPR
Zero Mean Traverse	Y	-	-
Step Correction	Y	-	-
Interpolation	Y	-	-
Filter	N	-	-

Presentation of Results

Report Figures (Printed & Archive CD):	Location plots, data plots and interpretation diagrams on base map (Figures 1-8)
Reference Figures (Archive CD):	Data plots for reference and analysis at 1:500. Some of the areas have been subdivided for display at this scale (See List of Figures)
Plot Formats:	See Appendix 1: Technical Information, at end of report.
Images (Archive CD):	Photos of the site for reference purposes.

General Considerations

The ground conditions varied between the areas selected for survey; the majority of fields were under pasture or "set-aside" and were therefore good for data collection. Survey was carried out in a recently ploughed field which would generally be considered unsuitable for survey and the uneven ground conditions may have introduced an element of soil noise into the data. Several other areas were precluded from survey due to the overgrown nature of the vegetation. Two areas were not surveyed due to the severe quantity of ferrous furniture within the application boundary; this will have masked any archaeological deposits in the vicinity. A narrow strip of land at the northern end of the application area was also not surveyed although this was due to access issues not the current land use. These considerations will be discussed further, where deemed necessary, in the results section of the report.

Results of Survey

1. Magnetic Survey

Area 1

1.1 This survey area comprises a narrow strip of land which is only 10m at its widest point, immediately adjacent to the motorway. The proximity of the motorway is likely to have introduced an element of noise into the data which would extend for several metres into the field and mask any archaeological responses in the vicinity. The combination of these factors suggested little useable data would be collected; therefore, after discussion with the client, it was decided not to survey this area.

Area 2

1.2 An area of magnetic disturbance occupies the majority of this field. Some of this will be due to the iron railings which form the eastern boundary of the field, however, they do not account for the spread of anomalies across the whole area. The nature of these responses is such that a modern origin is likely to account for them, such as debris from the construction of the motorway. Some tarmac was visible in places through the pasture, suggesting this portion of the field had been used as a hardstanding or storage area.

Area 3

1.3 This area covers several fields, bound to the north by Longmoor Lane and to the south by Derby Road. At the northern end of this strip an area of magnetic disturbance has been caused by conslidation around the gateway, involving the laying of a tarmac area and path. This field, covering Areas 3A-C, contains parallel linear anomalies indicative of former agricultural activity. The land is under pasture and currently being used as a showground, therefore it is possible these anomalies are not recent in origin and relate to ridge and furrow cultivation

1.4 A ferrous band bisecting the data and the ferrous responses at the edges of the survey blocks are all the result of the current field boundaries which are constructed from a combination of hedges, electric wires, and post and rail fencing. The positions of the field boundaries on the ground do not correspond precisely to those defined on the map, however, a modern origin for the anomalies is not under dispute

1.5 There are several *?Archaeology* anomalies which have been highlighted on the interpretation diagrams. Their form suggests they may have some archaeological potential but given that the majority are weak and isolated and do not conform to any easily discernible pattern, it is likely they have an alternative origin, such as natural or pedological variations in the subsoil. For the same reasons this conclusion can also be applied to the numerous trends noted in the data

Area 4

1.6 An area of increased magnetic response is situated at the northern end of this survey block. It contains some individual anomalies which are clearly defined and the strength of some of them could suggest an industrial origin. However, they are ferrous in nature and the most likely explanation for these anomalies, and the area of increased magnetic response, is that they are debris associated with the construction of the adjacent roads (the M1 motorway to the west and Derby Road to the north, which is built on an embankment at this point).

1.7 Two areas of magnetic disturbance have also been noted in the data; given the nature of these responses they are probably modern in origin, although there is no supporting evidence on the ground for this conclusion. A large pipe has caused the ferrous response at the southern end of this survey block; a concrete inspection hatch, probably associated with the pipe lies just outside the survey area.

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1.8 Strong responses in the region of the pipe have been identified as having a natural origin, partly due to the topographical variations in this part of the field. It is also possible they have been caused by the construction of the pipe or are related to the nearby area of magnetic disturbance; however, it is clear that with the quantity of modern activity in the surrounding area they are unlikely to be archaeological in origin.

Area 5

1.9 A small portion of the area at the northern end of this strip was not surveyed as the ground had been extensively landscaped for the flood prevention lagoon that lies to the west and was deemed unsuitable for survey.

1.10 The data from the rest of this area have been swamped by the strong response from a pipe. The narrow strip available between the motorway and the lagoon suggests that any archaeological deposits in this region are unlikely to have survived the construction of the pipe.

Area 6

1.11 The large ferrous pipe noted in Area 5 (see Paragraph 1.10 above) continues through this area and the response has totally dominated the data. Despite this, it is possible to discern a few isolated anomalies which may have some archaeological potential, however, this interpretation is tempered by their lack of context and proximity to the pipe; they could equally be associated with the pipe or represent natural variations in the subsoil.

Area 7

1.12 The two small paddocks which form this area were deemed unsuitable for survey as they were surrounded by high welded mesh wire fencing the response from which would have rendered the data impossible to interpret cogently (see *Site Photographs* on the Archive CD). It was also assumed the pipe noted in Areas 5, 6 and 8 to the north and south would also cover the majority of the data from this area.

Area 8

1.13 The pipe identified in the areas to the north is also apparent in this survey block. The ferrous response has dominated the majority of the data but it can be seen to veer out of the survey area to the west, towards a line of manholes, in the southern portion of the field.

1.14 A few trends have been identified but given the disturbance caused by the pipe it is unlikely they represent any significant deposits, rather they indicate agricultural activity or natural variations in the subsoil. This conclusion may also be applied to the area of magnetic disturbance at the edge of the field as its proximity to the railway suggests a modern origin for this response.

Area 9

1.15 A few anomalies of archaeological potential have been highlighted in this area, they are isolated and do not conform to any recognisable patterns therefore an alternative origin, such as natural or pedological variations in the subsoil, are likely to account for these responses. This conclusion may also be applied to the weak trends in the data.

1.16 The topography of this portion of the survey consisted of a steep slope down from west to east along the majority of the length of the field. Therefore, the strong responses situated on this break of slope have been interpreted as having a natural origin.

1.17 Areas of ferrous and magnetic disturbance are presumed to be modern in origin and are also probably due to the topographical variations, possibly as a result of stabilization of the slope.

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Area 10

1.18 Survey was not carried out in this area due to modern equipement and machinery associated with the water works (see *Site Photographs* on the Archive CD).

Area 11

1.19 Some archaeological type responses have been noted at the eastern end of this survey block, however, they lie in an area of magnetic disturbance in the corner of the field. As a consequence it is more likely that they relate to more recent activity on the site, such as debris from the construction of the adjacent roads.

1.20 A few trends are also visible but they are weak and agricultural activity is likely to account for their presence.

Area 12

1.21 There are no anomalies of archaeological interest in this survey block. The southern portion of the data is dominated by a ferrous pipe type response and the fence forming the western boundary of the field accounts for the other large ferrous anomaly along the survey edge.

Area 13

1.22 The overgrown nature of the vegetation in this area precluded the possibility of any survey work being carried out (see *Site Photographs* on the Archive CD).

Area 14

1.23 The overgrown nature of the vegetation in this area precluded the possibility of any survey work being carried out (see *Site Photographs* on the Archive CD).

Area 15

1.24 The majority of the survey area was under tarmac, which forms a path and two carparks, this can be seen in the data as magnetic disturbance. Two small anomalies and a trend may have some archaeological potential but they are weak and isolated and, given the disturbed nature of the surrounding area, they are unlikely to be significant. A ferrous response bisecting the area is indicative of a pipe.

2. Conclusions

2.1 Few anomalies of archaeological potential have been identified within any the survey areas. Those that have been noted are generally weak and isolated and are therefore considered unlikely to be of significance. This is also applicable to the numerous trends which have been highlighted, many of which are likely to be due to agricultural practices. An area of former agricultural activity, probably ridge and furrow cultivation, has been noted at the northern end of the scheme.

2.2 A single large pipe has been identified running through several of the survey areas and any archaeological anomalies in the vicinity will have been masked.

2.3 Other modern interventions, such as tarmac and other pipes, have also caused ferrous anomalies and magnetic disturbance in the data.

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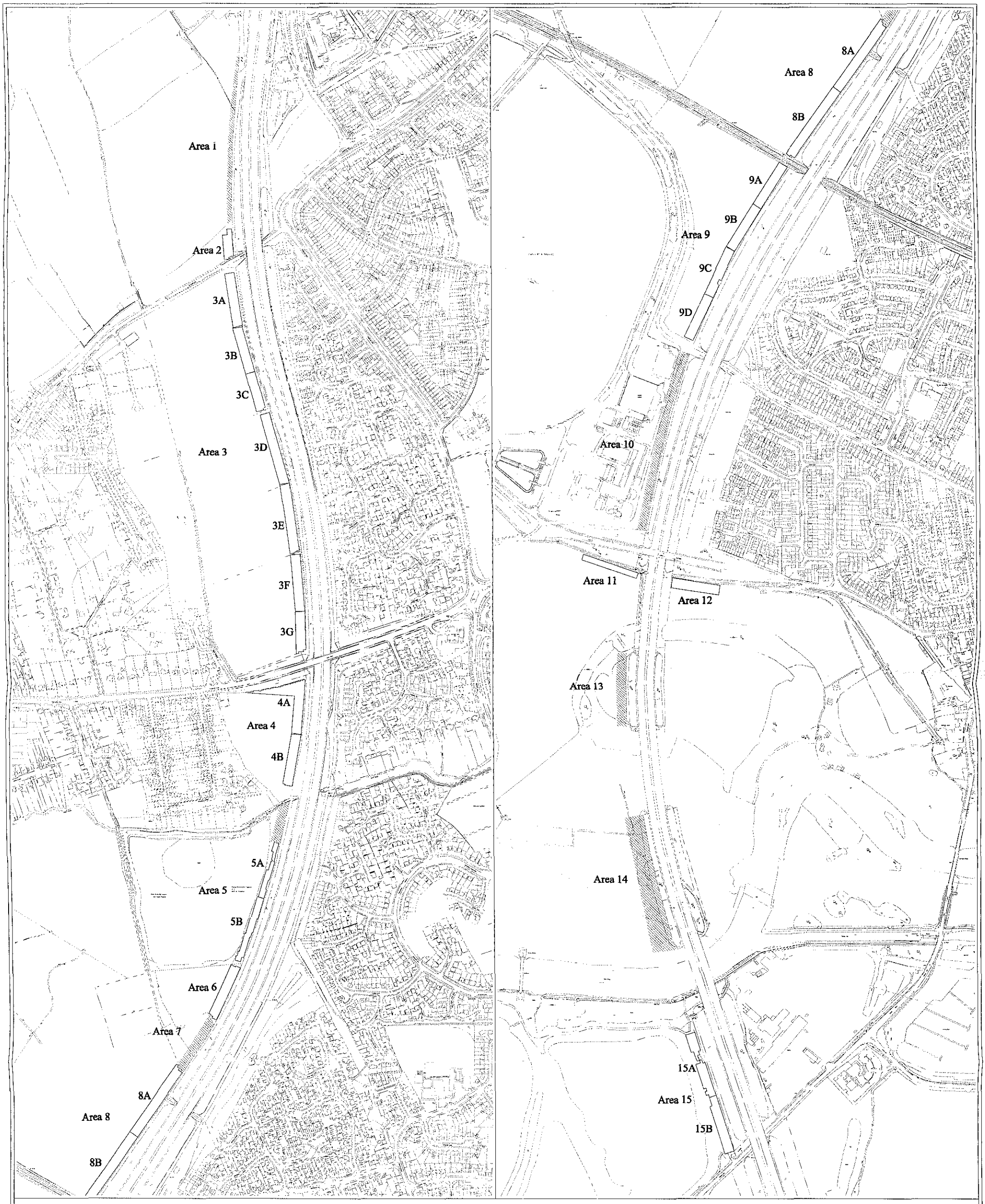

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Location Diagram

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Figure 1

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Summary Greyscales - Areas 2 and 3

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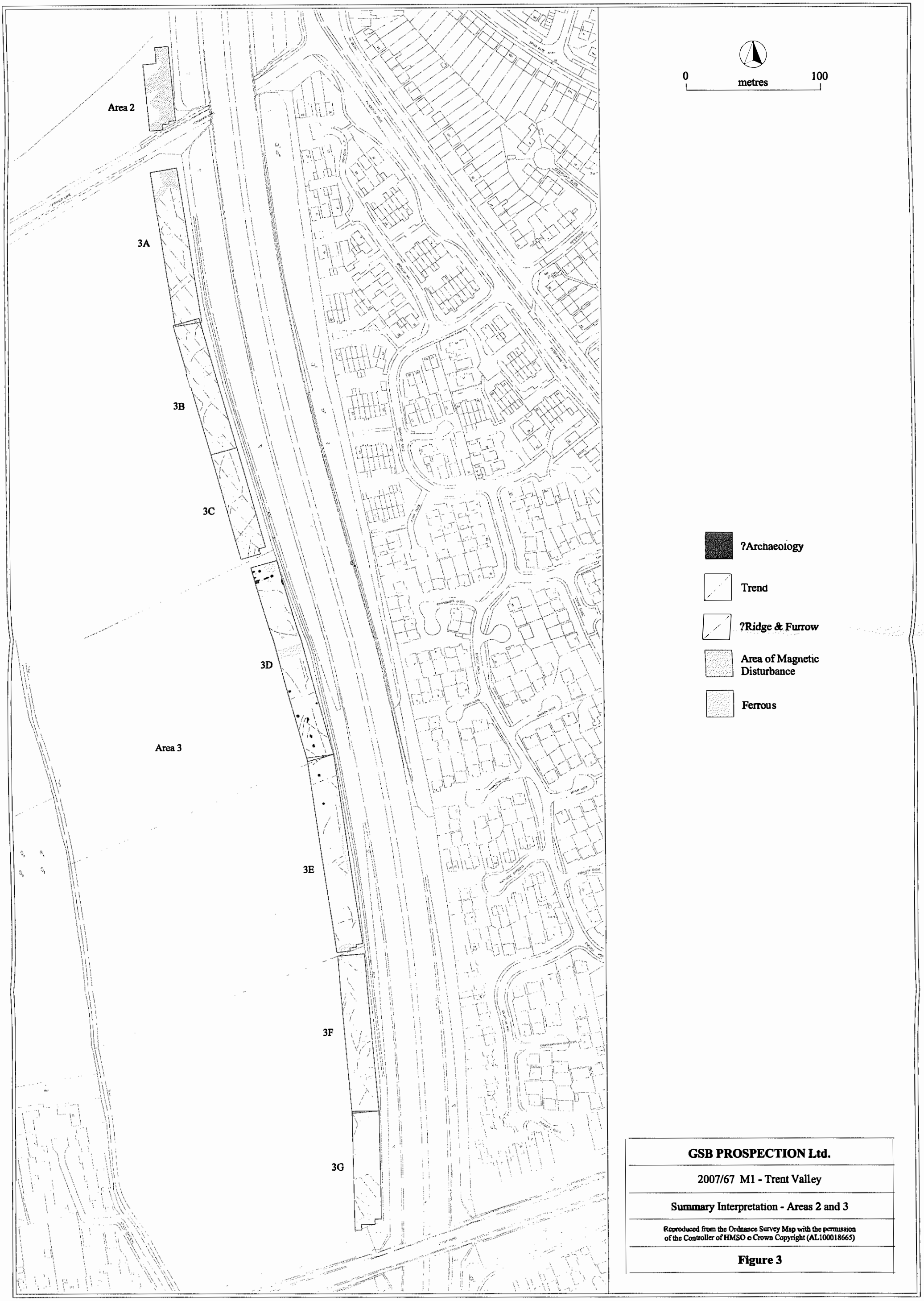
Figure 2



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Summary Interpretation - Areas 2 and 3

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Figure 3

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Summary Greyscales & Interpretation - Areas 4 to 6

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Figure 4

0 metres 100

2 nT -1

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Summary Greyscales - Areas 8 and 9

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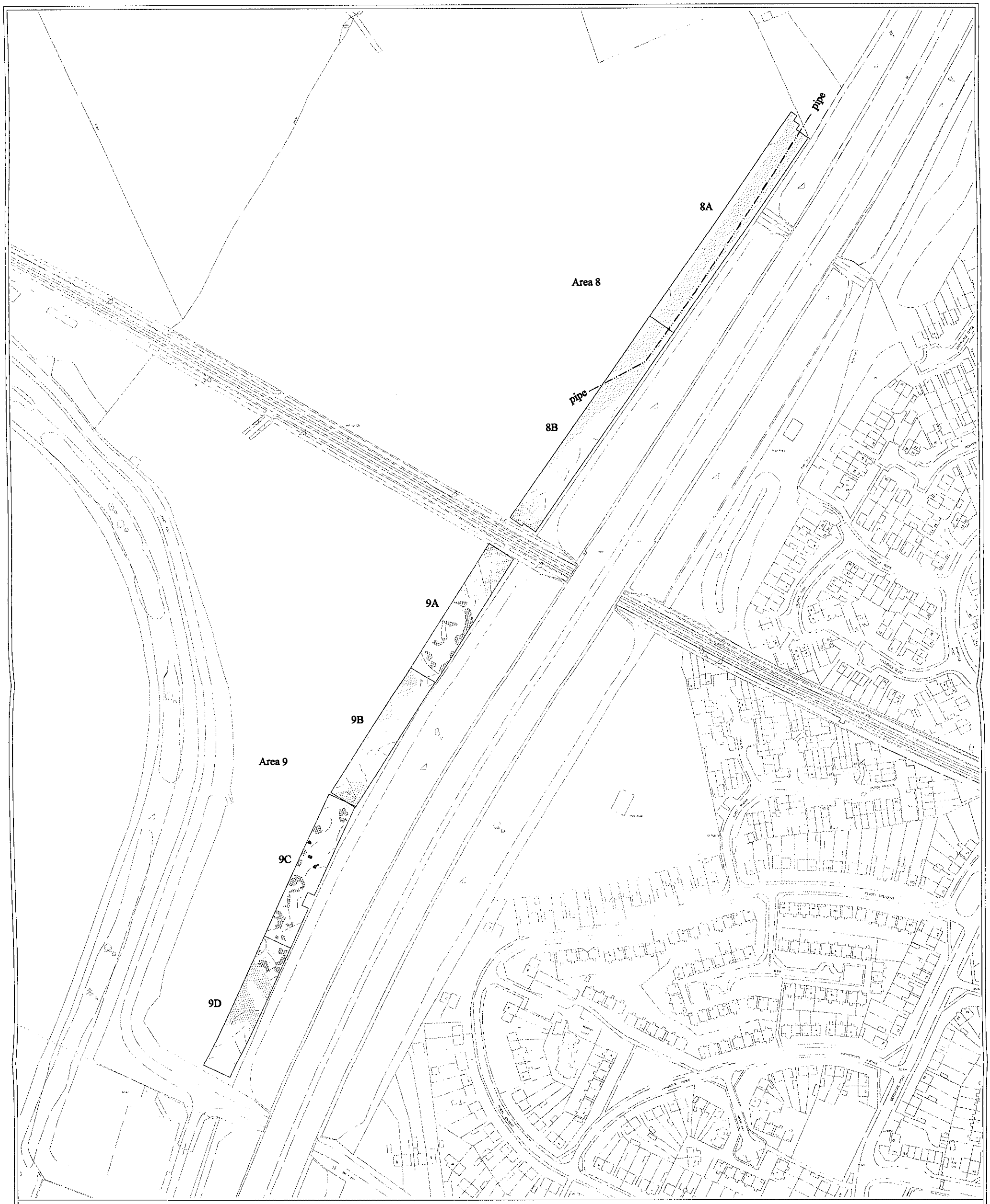
Figure 5



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Summary Interpretation - Areas 8 and 9

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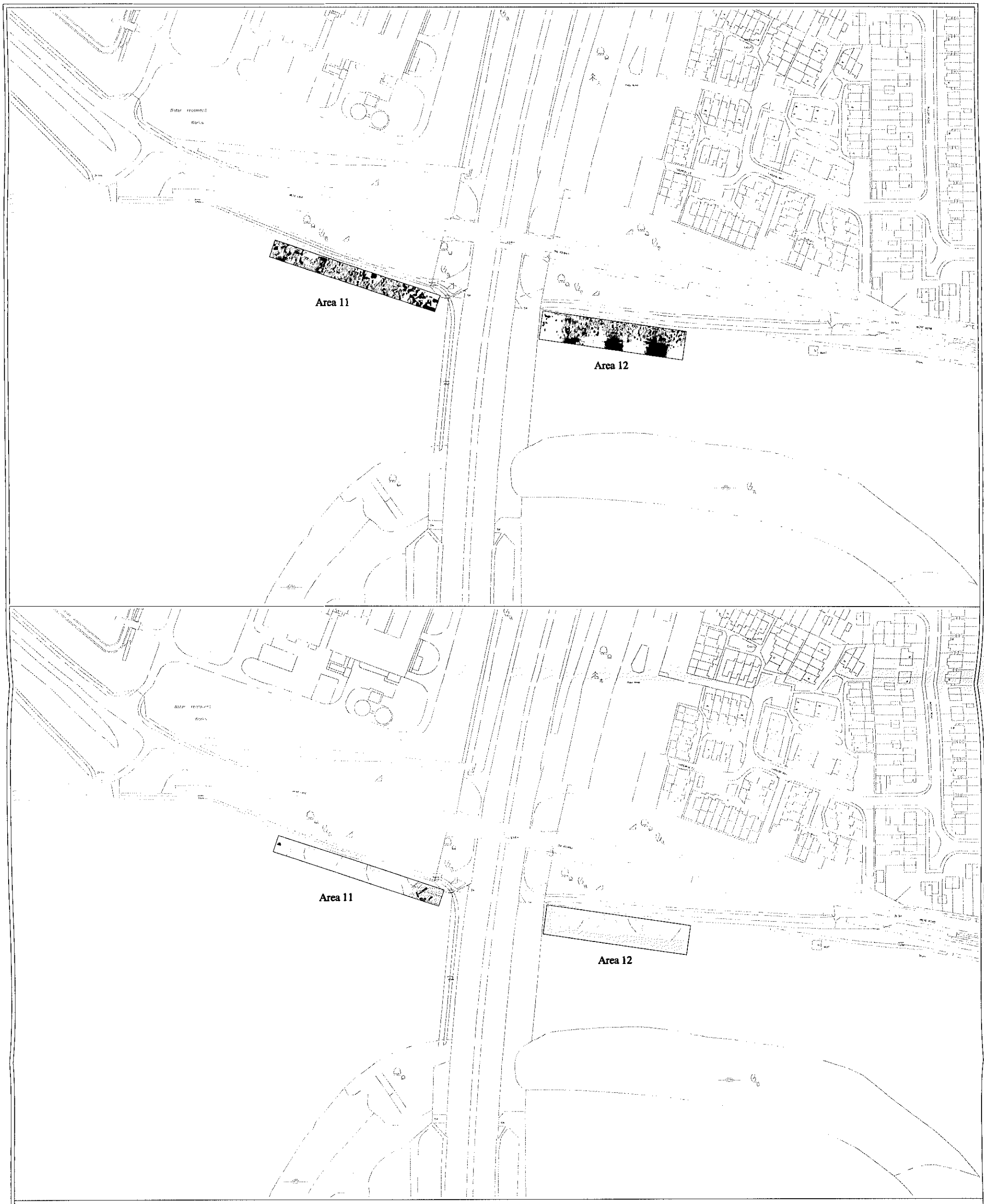
Figure 6



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Summary Greyscales & Interpretation - Areas 11 and 12

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Figure 7

15A

Area 15

15B

15A

Area 15

15B

0 metres 100

2
nT
-1

?Archaeology

Trend

Area of Magnetic Disturbance

Ferrous

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Summary Greyscales & Interpretation - Area 15

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Figure 8

Appendix 1: Technical Information

Instrumentation

Fluxgate Gradiometer: Geoscan FM36/256 and Bartington *Grad*601-2

Both the Geoscan and Bartington instruments comprise two fluxgate sensors mounted vertically apart; the distance between the sensors on the former is 500mm, on the latter 1000mm The gradiometers are carried by hand, with the bottom sensor approximately 100-300mm from the ground surface At each survey station, the difference in the magnetic field between the two fluxgates is measured in nanoTesla (nT) The sensitivity of the instrument can be adjusted; for most archaeological surveys the most sensitive range (0 1nT) is used The fluxgate gradiometer suppresses any diurnal or regional effects Generally, features up to 1 m deep may be detected by this method Having two gradiometer units mounted laterally with a separation of 1000mm, the Bartington instrument can collect two lines of data per traverse.

Resistance Meter: Geoscan RM15

This instrument measures the electrical resistance of the earth, using a system of four electrodes (two current and two potential.) Depending on the arrangement of these electrodes an exact measurement of a specific volume of earth may be acquired This resistance value may then be used to calculate the earth resistivity The most common arrangement is the Twin Probe configuration which involves two pairs of electrodes (one current and one potential): one pair remain in a fixed position, whilst the other measures the resistance variations across a grid The resistance is measured in ohms and, when calculated, resistivity is in ohm-metres The resistance method as used for standard area survey employs a probe separation of 0.5m, which samples to a depth of approximately 0.75m. The nature of the overburden and underlying geology will cause variations in this depth.

GPR: Sensors & Software Noggin Smartcart

The Noggin system includes an onboard digital video logger (DVL III), 250 MHz or 500MHz antenna, an odometer wheel and battery It is, therefore, a fully integrated system The built-in software uses the integrated odometer to provide an accurate distance measurement to the response The data are recorded in digital format and can be processed to produce depth slice maps, 2D sections or 3D cubes.

Display Options

XY Trace

This involves a line representation of the data Each successive row of data is equally incremented in the Y axis, to produce a stacked profile effect This display may incorporate a hidden-line removal algorithm, which blocks out lines behind the major peaks and can aid interpretation The advantages of this type of display are that it allows the full range of the data to be viewed and shows the shape of the individual anomalies The display may also be changed by altering the horizontal viewing angle and the angle above the plane The output may be either colour or black and white.

Greyscale

This format divides a given range of readings into a set number of classes Each class is represented by a specific shade of grey, the intensity increasing with value All values above the given range are allocated the same shade (maximum intensity); similarly all values below the given range are represented by the minimum intensity shade. Similar plots can be produced in colour, either using a wide range of colours or by selecting two or three colours to represent positive and negative values The assigned range (plotting levels) can be adjusted to emphasise different anomalies in the data-set.

Relief Plot

This is a method of display that creates a three dimensional effect by directing an imaginary light source on a given data set Particular elements of the results are highlighted depending on the angle of strike of the light source This display method is particularly useful when applied to resistance data to highlight subtle changes in resistance that might otherwise be obscured.

3D Surface Plot

This is similar to the XY trace, but in 3 dimensions. Each data point of a survey is represented in its relative position on the x and y axes and the data value is represented in the z axis. This gives a digital terrain, or topographic effect.

Radargram

Radar data comprise a record of reflection intensity against the time taken for the emitted energy to travel from the transmitter down to the reflector and back to the receiver The resultant plot is effectively a vertical section through the ground along the line of the traverse, with time (depth) on the vertical axis, displacement on the horizontal axis and reflection intensity as a grey or colour scale.

Time Slice

If a number of radargrams are collected over a grid, or in conjunction with GPS data, it is possible to reconstruct the entire dataset into a 3D volume This can then be resampled to compile 'plan' maps of response strength at increasing time (or depth) offsets, thus simplifying the visualisation of how anomalies vary beneath the surface across a survey area.

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Terms Commonly used in the Interpretation of Results

Magnetic

Archaeology	This term is used when the form, nature and pattern of the response are clearly or very probably archaeological These anomalies, whilst considered anthropogenic, could be of any age.
? Archaeology	The interpretation of such anomalies is often tentative, with the anomalies exhibiting either weak signal strength or forming incomplete archaeological patterns They may be the result of variable soil depth, plough damage or even aliasing as a result of data collection orientation.
Areas of Increased Magnetic Response	These responses show no visual indications on the ground surface and are considered to have some archaeological potential.
Industrial	Strong magnetic anomalies that, due to their shape and form or the context in which they are found, suggest the presence of kilns, ovens, corn dryers, metal-working areas or hearths. It should be noted that in many instances modern ferrous material can produce similar magnetic anomalies.
Natural	These responses form clear patterns in geographical zones where natural variations are known to produce significant magnetic distortions e g palaeochannels or magnetic gravels.
? Natural	These are anomalies that are likely to be natural in origin i e geological or pedological.
Ridge and Furrow	These are regular and broad linear anomalies that are presumed to be the result of ancient cultivation In some cases the response may be the result of modern activity.
Ploughing Trend	These are isolated or grouped linear responses They are normally narrow and are presumed modern when aligned to current field boundaries or following present ploughing.
Trend	This is usually an ill-defined, weak, isolated or obscured linear anomaly of unknown cause or date.
Areas of Magnetic Disturbance	These responses are commonly found in places where modern ferrous or fired materials are present e.g. brick rubble. They are presumed to be modern.
Ferrous Response	This type of response is associated with ferrous material and may result from small items in the topsoil, larger buried objects such as pipes, or above ground features such as fence lines or pylons. Ferrous responses are usually regarded as modern Individual burnt stones, fired bricks or igneous rocks can produce responses similar to ferrous material.

Resistance

Archaeology	High or low res responses are clearly or very probably archaeological These anomalies, whilst considered anthropogenic, could be of any age.
? Archaeology	The interpretation of such anomalies is often tentative, with the anomalies exhibiting either weak signal strength or forming incomplete archaeological patterns They may be the result of variable soil depth plough damage or even aliasing as a result of data collection orientation.
Natural	These responses form clear patterns in geographical zones where natural variations are known to produce significant magnetic distortions e g palaeochannels or magnetic gravels.
? Natural	These are anomalies that are likely to be natural in origin i e geological or pedological.
? Landscaping / topography	These are regular and broad linear anomalies that are presumed to be the result of ancient cultivation In some cases the response may be the result of modern activity.
Vegetation	These are isolated or grouped linear responses They are normally narrow and are presumed modern when aligned to current field boundaries or following present ploughing.
Trend	This is usually an ill-defined, weak, isolated or obscured linear anomaly of unknown cause or date.

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