GSB

PROSPECTION Ltd

GEOPHYSICAL SURVEY REPORT
2007/35

M1 Junction 21-33:
M1-M69 Link

Client:

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Specialising in Shallow and Archaeological Prospection

GSB Survey No. 07/35

M1 Junction 21-33: Geophysical Survey: M1-M69 Link

NGR	SK 542 010 (approximate centre)		
Location	Junction 21 on the M1 motorway: immediately west of the M1 and north of the M69.		
District	Blaby	**Parish**	Lubbesthorpe
Topography	Gently undulating with a steep slope towards the northern end of the application area.		
Current land-use	Some pasture, mainly arable and hay meadows.		
Soils	Salop association (711m) (*Soils of England and Wales Sheet 3, Midland and Western England*. Soil Survey of England and Wales. 1983).		
Geology	Triassic Keuper Marls and Sandstone.		
Archaeology	The application area curves round to the west and south of the scheduled earthworks forming Lubbesthorpe Deserted Medieval Village (DMV).		
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 majority of anomalies of archaeological potential are located in the immediate vicinity of the Lubbesthorpe DMV. These include a sinuous band of responses to the north which may indicate a former boundary, or stream, which has been filled in with waste material. Some regular anomalies and trends to the east could represent trackways and other activity

The possible site of a medieval brick kiln has been located to the east of Lubbesthorpe DMV in Field 8 and further potential industrial activity, of indeterminate age, has been identified to the south of Hopyard Farm in Field 12. However, the possibility that this is motorway debris cannot be discounted

A former field boundary and other agricultural activity such as ridge and furrow cultivation, ploughing and field drains have been identified in many of the survey areas. Although some of the weak trends may have archaeological potential, more recent agricultural practices are most likely to account for these responses

Project Information

Project Co-ordinator: F Chester
Project Assistants: J Adcock, M Brolly, J Gater, M Harrison, J Smith, C Stephens, G Taylor, I Wilkins, E Wood
Date of Fieldwork: 4th - 7th June & 28th - 30th August 2007
Date of Report: 19th September 2007

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

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; tie-in information is included 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	12ha
Resistance – Twin Probe (Appendix 1)	-	-	-	-
Ground Penetrating Radar (GPR) (Appendix 1)	-	-	-	-

Data Processing

	Magnetic	Resistance	GPR
Tilt Correct	Y	-	-
De-stagger	Y	-	-
Interpolate	Y	-	-
Filter	N	-	-

Presentation of Results

Report Figures (Printed & Archive CD):	Location plot, data plots and interpretation diagrams on base map (Figures 1-7)
Reference Figures (Archive CD):	Data plots and interpretations at 1:500 - for reference and analysis 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

General Considerations

The survey was carried out in two phases due to the some of the areas being under mature crop at the time of the initial survey. Therefore the ground conditions comprised hay meadow, some of which had been partially harvested, stubble and pasture

Access could not be gained to a very small area of Field 4 following a fire with a combine harvester. It was also not possible to survey the southern portion of Field 8 as dense woodland occupied this part of the application area.

Results of Survey

1. Magnetic Survey

Field 1

1.1 A linear ferrous anomaly at the southern end of the survey area runs parallel to the field boundary. This response is typical of a pipe and therefore it is considered to be modern in origin

1.2 A few anomalies of archaeological potential have been highlighted in this area, however, they are isolated and given the proximity of other, ferrous anomalies they are unlikely to be significant

1.3 Parallel linear trends in the data are indicative of former ploughing activity.

Field 2

1.4 This area contains no anomalies of archaeological interest The few trends which have been highlighted are likely to be agricultural in origin and may indicate the orientation of former ploughing activity as they lie parallel to the current field boundary

Field 3

1.5 There are few anomalies of archaeological potential in this area; the majority of responses can be assigned to agricultural practices; either field drains or former ploughing activity

1.6 There are a few responses (A) which may have some potential but their close proximity to the boundary, where there is a footpath, and some large ferrous anomalies make such an interpretation tentative

Field 4

1.7 As a result of an incident involving a combine harvester catching fire, this very small area could not be investigated The data from adjacent Fields 3 and 5 suggest that a sinuous anomaly may extend from the south into this area but this could not be confirmed.

Field 5

1.8 The data from this area are dominated by strong responses (which indicate a large ferrous component) forming a sinuous linear anomaly (B). Generally this ferrous response would steer the interpretation towards a modern origin; however, given the proximity of the DMV and the large quantity of early medieval pottery found by fieldwalking in the adjacent field, an archaeological origin for (B) should be considered It may indicate a boundary ditch or stream which has been filled in with industrial waste, such as that produced from industrial type activity.

1.9 Other isolated responses, similar in nature to those forming (B), are present elsewhere in the survey area They are assumed to have some archaeological significance due to their location; however, it is possible all or some of these anomalies are merely deeply buried pieces of modern material. The reverse may be true of some of the anomalies in the '*ferrous*' category on the interpretation diagrams, such as those labelled (C). They are assumed to be modern in origin due to their size and distribution, however, pits filled with burnt material or industrial waste could produce a similar response.

1.10 At the southern end of the survey area some regular linear anomalies (D) are also thought to have some potential; they loosely correspond to a large earthwork ditch which may be associated with the DMV.

1.11 Some trends (E) clearly form a rectangle; this may be an enclosure associated with (B) and/or the DMV; however, the responses are weak and such a conclusion is at best tentative.

Field 6

1.12 The data in this area are dominated by a band of ferrous responses following the edge of a ditch along the northern boundary, and is presumed to be modern in origin. The other ferrous anomalies and magnetic disturbance in this area are also thought to be modern, probably associated with services and their construction.

1.13 The surveyable area in this field was reduced by the presence of a telegraph pole and the surrounding overgrown vegetation. Despite this, archaeological type responses are discernible in the remainder of the data. Anomalies (F), together with some trends, suggest some regularity and given the proximity of the DMV and the other archaeological type activity immediately to the north in Field 5, they are likely to have some archaeological significance. However, this interpretation is tempered by the modern activity in the area, which could also partially account for all or some of these responses

Field 7

1.14 Any archaeological type anomalies in the northeastern portion of this field will have been obscured by the strong ferrous responses which occupy this corner of the data. Several manhole covers were noted in the ground at the time of survey, therefore the ferrous responses are presumed to be related to underground services.

1.15 Extensive earthworks associated with the DMV were also noted in this field and the trends and archaeological type anomalies (G) correspond to some of these, potentially indicating a trackway. The other trends and anomalies in the data are also likely to have an archaeological origin, however, they do not form any coherent pattern, therefore a conclusive interpretation is not possible.

Field 8

1.16 A few anomalies of archaeological potential have been noted in this field, however, they are isolated and natural or geological variations in the subsoil are more probably responsible. The same interpretation, or perhaps agricultural activity, can also be applied to the various trends in the data

1.17 An unsurveyed segment of the survey area, surrounded by a strong ferrous response indicates the location of a large pylon; weaker, archaeological type responses in the vicinity will have been obliterated by the response of the pylon.

Field 9

1.18 A rectangular area of magnetic disturbance (H) lies in the northern portion of this field, it is possible this indicates the site of an early post medieval (1480 – 1699) brick kiln cited in the SMR. The nature of the response supports this interpretation, and the area of increased magnetic response surrounding (H) is indicative of a spread of material from such a structure, possibly caused by ploughing.

1.19 Other, archaeological type anomalies have also been identified in this field. However, they are weak and isolated and given the proximity of the M1 modern activity, such as debris from the motorway or agricultural practices, could equally account for all or some of these responses

1.20 An area of magnetic disturbance close to the corner of the field also coincides with an entrance and it is likely that this is responsible for the anomalies in this area.

Field 10

1.21 The dominant responses in this field are ferrous in nature. Around the edges of the survey area this can be attributed to metal fencing and gates; another pylon has caused the large response (I)

1.22 A few anomalies with some archaeological potential have been identified; however, they do not form any coherent patterns and natural or pedological variations in the subsoil could equally be responsible

Field 11

1.23 Numerous small pit type anomalies are scattered across the survey area. Each individual anomaly is well defined but they do not form any coherent patterns therefore any interpretation remains inconclusive. Weak trends are also present in the data and although they may be of interest an agricultural or natural origin is equally likely

Field 12

1.24 This narrow band of survey along the southern edge of the field contains an interesting type of anomaly shown on the interpretation as: '*?Industrial*'. These anomalies are strong and well-defined, they may indicate kilns or furnaces, or deposits of other industrial waste, however, the possibility they are fragments of modern debris as a result of the construction of the M69, immediately to the south, cannot be discounted. The same caveat can be applied to the other archaeological type anomalies in this area apart from a single linear ditch type response running north-south through the data; this could be a former field boundary.

Field 13

1.25 No anomalies of archaeological potential have been identified in this survey area. The ferrous responses can be attributed to fencing and modern debris from the adjacent M69; the weak trends are also unlikely to have an archaeological origin and are probably the result of agricultural practices or natural variations in the subsoil

2. Conclusions

2.1 The majority of anomalies of archaeological potential are located in the immediate vicinity of the Lubbesthorpe DMV. These comprise a sinuous band of responses to the north which may indicate a boundary or possibly a former stream which has been filled in with waste material, and some regular anomalies and trends to the east which could represent trackways and other activity.

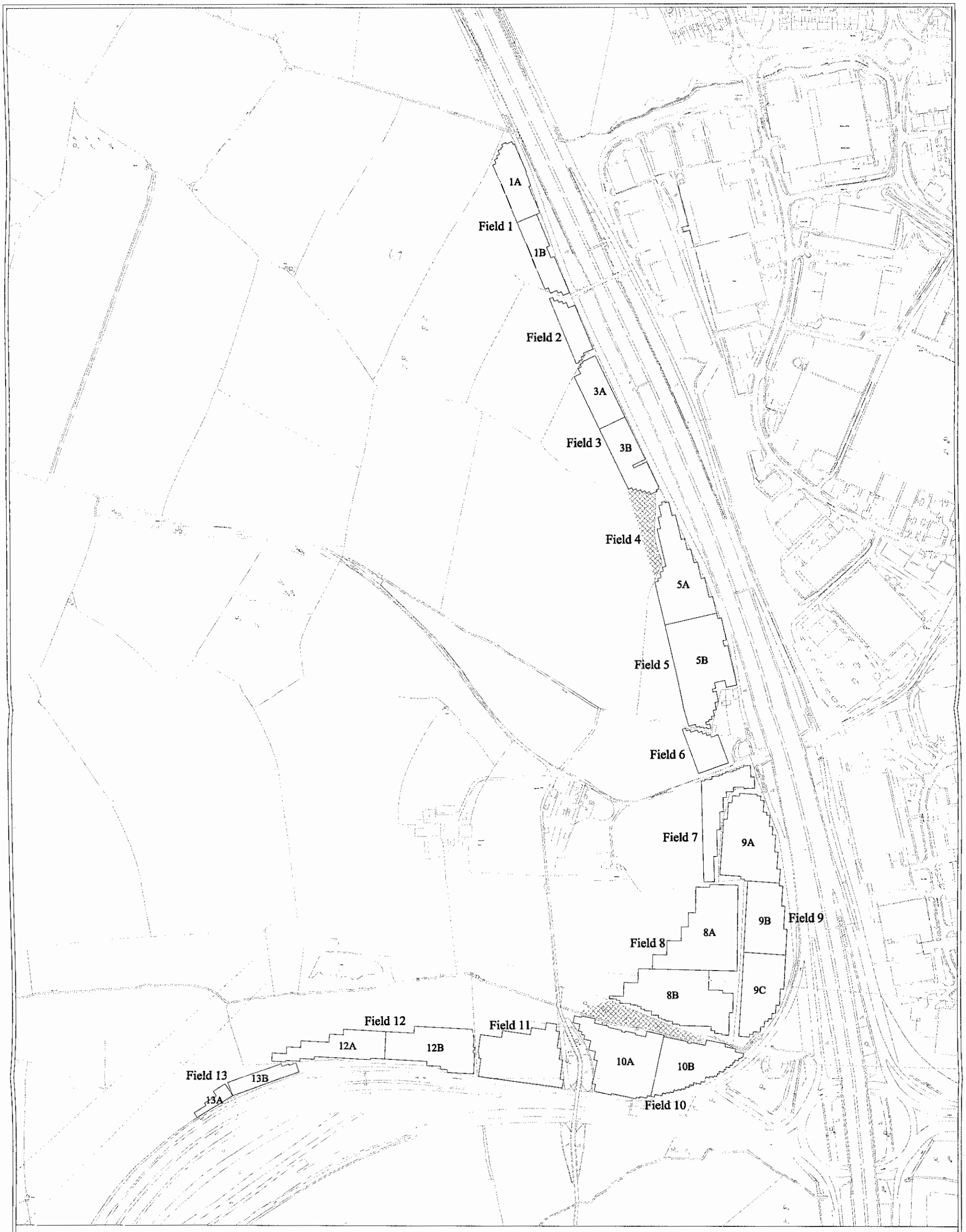
2.2 The possible site of a medieval brick kiln has been located to the east of Lubbesthorpe DMV in Field 9. Further potential industrial activity, of indeterminate age, has been identified to the south of Hopyard Farm in Field 12, although the possibility that this is associated with motorway debris cannot be discounted

2.3 A former field boundary and other agricultural activity such as ridge and furrow cultivation, ploughing and field drains have all been identified. Although some of the weak trends may have some archaeological potential, this interpretation is at best tentative.

List of Figures

Report Figures

Reference Figures on CD



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Location of Survey Areas
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Figure 1

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Summary Greyscales - Fields 1 to 5
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Figure 2

Field 1

Field 2

Field 3

Field 4

Field 5

A

B

C

C

C

D

E

0 metres 100

?Archaeology

Trend

Ploughing

?Drain

?Natural

Ferrous

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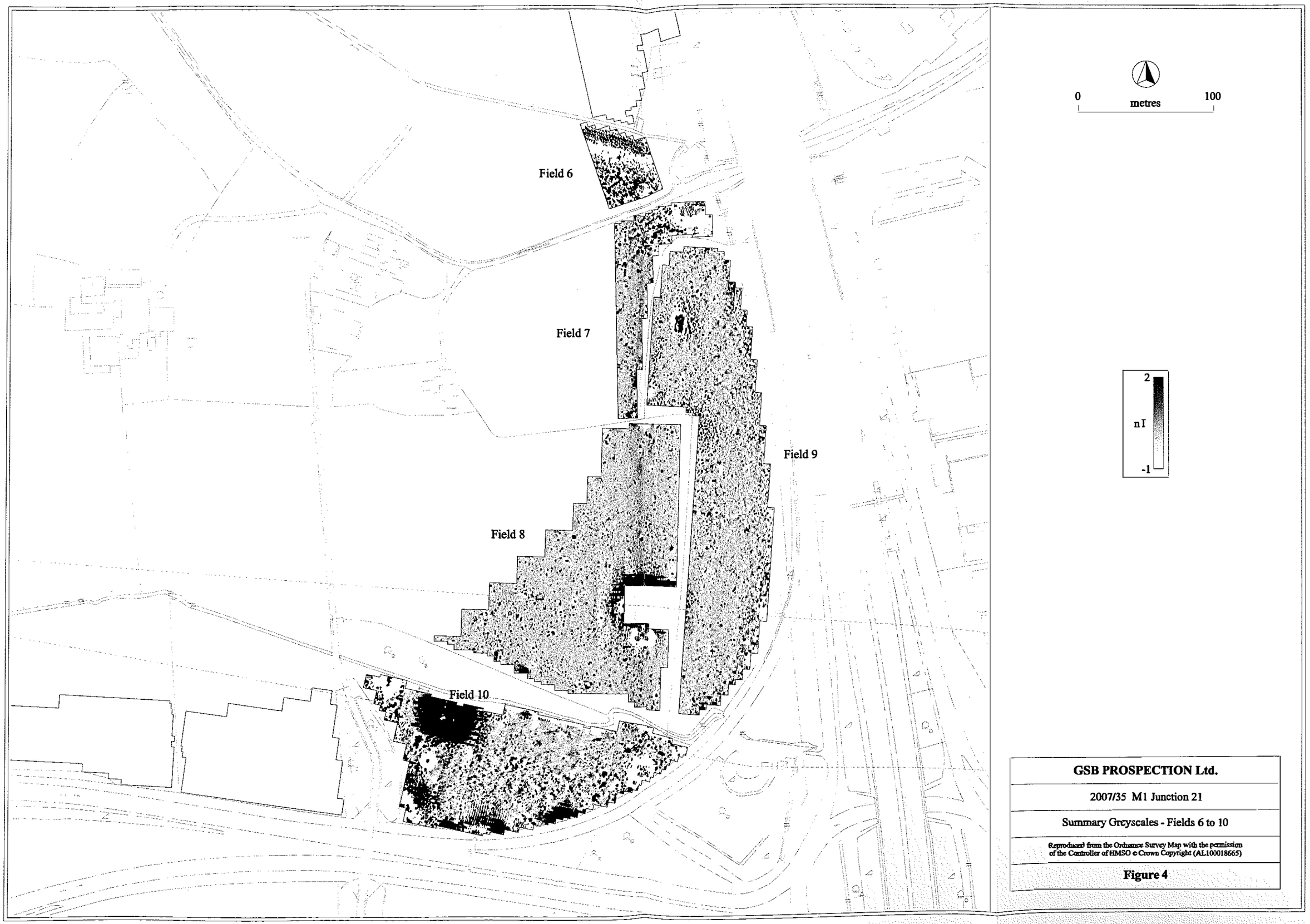
Summary Interpretation - Fields 1 to 5

Figure 3



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Summary Greyscales - Fields 6 to 10

Figure 4

0 metres 100

?Archaeology

Trend

Increased Magnetic Response

?Natural

Magnetic Disturbance

Ferrous

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Summary Interpretation - Fields 6 to 10

Figure 5

0 metres 100

2
nT
-1

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Summary Greyscales - Fields 11 to 13

Figure 6

0 metres 100

?Archaeology

?Industrial

Trend

Ferrous

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Summary Interpretation - Fields 11 to 13

Figure 7

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 1m 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.

Terms Commonly used in the Interpretation of Resnlts

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.

GPR

Wall /Foundation/ /Vault /Culvert etc.	High amplitude anomaly definitions used when other evidence is available that supports a clear archaeological interpretation
Archaeology	Anomalies whose form, nature and pattern indicate archaeology but where little or no supporting evidence exists If a more precise archaeological interpretation is possible, for example the responses appear to respect known local archaeology, then this will be indicated in the accompanying text As low amplitude responses are less obvious features it is unlikely that they would have a definitive categorisation.
? Archaeology	When the anomaly could be archaeologically significant, given its discrete nature, but where the distribution of the responses is not clearly archaeological. Interpretation of such anomalies is often tentative, exhibiting either little contrast or forming incomplete archaeological patterns.
Historic	Responses showing clear correlation with earlier map evidence.
?Historic	Responses relating to features not directly recorded on earlier maps but which appear to respect features that are May form patterns suggestive of formal gardens, landscaping or footpaths.
Area of Anomalous Response	An area in which the response levels are very slightly elevated or diminshed with respect to the 'background'. Where no obvious surface features or documentary evidence can explain this spread of altered reflectivity it is assumed to denote some kind of disturbance, though the origins could be of any age and either anthropogenic or natural Possible explanations are changes in subsurface composition and groundwater 'ponding'.
Natural	Anomalies relating to natural sub-surface features as indicated by documentary sources, local knowledge or evidence on the surface.
?Natural	Responses forming patterns akin to subsoil/geological variations either attenuating or reflecting greater amounts of energy An archaeological origin such as rubble spreads or robbed out remains cannot be dismissed.
Trend	An ill defined, weak or isolated linear anomaly of unknown cause or date.
Modern	Reflections that indicate features such as services, rebar or modern cellars correlating with available evidence (maps, communications with the client, alignment of drain covers etc.).
?Modern	Reflections appearing to indicate buried services but where there is no supporting evidence Also applies to responses which form patterns, or are at a depth which suggests a modern origin. An archaeological source cannot be completely dismissed.
Surface	Responses clearly due to surface discontinuities, the effects of which may be seen to 'ring' down through radargrams and so incorrectly appearing in the deeper time-slices.

Data Processing

Zero Mean Traverse	This process which sets the background mean of each traverse within each grid to zero The operation removes striping effects and edge discontinuities over the whole of the data set It is usually only applied to gradiometer data.
Step Correction	When gradiometer data are collected in 'zig-zag' fashion, stepping errors can sometimes arise These occur because of a slight difference in the speed of walking on the forward and reverse traverses. The result is a staggered effect in the data which is particularly noticeable on linear anomalies. This process corrects these errors
Interpolation	When geophysical data are presented as a greyscale, each data point is represented as a small square The resulting plot can sometimes have a 'blocky' appearance The interpolation process calculates and inserts additional values between existing data points The process can be carried out with points *along* a traverse (the *x* axis) and/or *between* traverses (the *y* axis) and results in a smoother greyscale image.
Despike	In resistance survey, spurious readings can occasionally occur, usually due to a poor contact of the probes with the surface This process removes the spurious readings, replacing them with values calculated by taking the mean and standard deviation of surrounding data points It is not usually applied to gradiometer data.
High Pass Filter	Carried out over the whole a resistance data-set, the filter removes low frequency, large scale spatial detail, such as that produced by broad geological changes. The result is to enhance the visibility of the smaller scale archaeological anomalies that are otherwise hidden within the broad 'background' change in resistance. It is not usually applied to gradiometer data.