Appendix 1

Magnetic Survey Technical Information

1 Magnetic Susceptibility and Soil Magnetism
Iron makes up about 6% of the Earth's crust and is mostly present in soils and rocks as minerals such as maghaemite and haemetite These minerals have a weak, measurable magnetic property termed magnetic susceptibility Human activities can redistribute these minerals and change (enhance) others into more magnetic forms so that by measuring the magnetic susceptibility of the topsoil, areas where human occupation or settlement has occurred can be identified by virtue of the attendant increase (enhancement) in magnetic susceptibility If the enhanced material subsequently comes to fill features, such as ditches or pits, localised isolated and linear magnetic anomalies can result whose presence can be detected by a magnetometer (fluxgate gradiometer)

In general, it is the contrast between the magnetic susceptibility of deposits filling cut features, such as ditches or pits, and the magnetic susceptibility of topsoils, subsoils and rocks into which these features have been cut, which causes the most recognisable responses This is primarily because there is a tendency for magnetic ferrous compounds to become concentrated in the topsoil, thereby making it more magnetic than the subsoil or the bedrock Linear features cut into the subsoil or geology, such as ditches, that have been silted up or have been backfilled with topsoil will therefore usually produce a positive magnetic response relative to the background soil levels Discrete feature, such as pits, can also be detected Less magnetic material such as masonry or plastic service pipes which intrude into the topsoil may give a negative magnetic response relative to the background level

The magnetic susceptibility of the soil can also be enhanced significantly by heating This can lead to the detection of features such as hearths, kilns or burnt areas

2 Types of Magnetic Anomaly
The types of response mentioned above can be divided into five main categories

Isolated Dipolar Anomalies (Iron Spikes)
These responses are typically caused by ferrous objects on the surface or in the topsoil Whilst they could be caused by archaeological artefacts, unless there is supporting evidence for an archaeological interpretation, then little emphasis is given to such anomalies, as modern ferrous objects are common on rural sites, often being present as a consequence of manuring

Areas of Magnetic Disturbance
These responses can have several causes and are often associated with burnt material, such as industrial waste or other strongly magnetised/fired material They are usually assumed to have a modern origin unless there is other supporting information Ferrous fencing can be a major source of magnetic disturbance as they produce very strong magnetic responses that can mask weaker archaeological anomalies

Positive Curvi/Linear Anomalies

They are commonly caused by infilled ditches which may be archaeologically significant Former or current agricultural practice can also result in these anomalies

Isolated Positive Anomalies

These anomalies can exhibit a magnitude of response of between 2nT and 300nT and can be caused by pits or post holes, ovens or kilns They can also be caused by natural/geological features on certain geologies It can often be very difficult to establish an anthropogenic origin without intrusive investigation

Negative Linear Anomalies

These are normally very faint and are commonly caused by features such as plastic water pipes which are less magnetic than the surrounding soils and geology They too can be caused by natural features on some geologies

3 Methodology

Magnetic Susceptibility Survey

There are two methods of measuring the magnetic susceptibility of a soil sample The first involves the measurement of a given volume of soil, which will include any air and moisture that lies within the sample, and is termed volume specific susceptibility This method results in a bulk value that it not necessarily fully representative of the constituent components of the sample The second technique overcomes this potential problem by taking into account both the volume and mass of a sample and is termed mass specific susceptibility However, mass specific readings cannot be taken in the field where the bulk properties of a soil are usually unknown and so volume specific readings must be taken Whilst these values are not fully representative they do allow general comparisons across a site and give a broad indication of susceptibility changes This is usually enough to assess the susceptibility of a site and evaluate whether enhancement has occurred Magnetic susceptibility readings were not taken as part of this evaluation

Gradiometer Survey

There are two main methods of using the fluxgate gradiometer for commercial evaluations The first of these is referred to as ***scanning*** and requires the operator to visually identify anomalous responses on the instrument display panel whilst covering the site in widely spaced traverses, typically 10-15m apart The instrument logger is not used and there is therefore no data collection Once anomalous responses are identified they are marked in the field with bamboo canes and approximately located on a base plan This method is usually employed as a means of selecting areas for detailed survey when only a percentage sample of the whole site is to be subject to detailed survey In favourable circumstances scanning may be used to map out the full extent of features located during a detailed survey

The second method is referred to as ***detailed survey*** and employs the use of a sample trigger to automatically take readings at predetermined points, typically at 0 5m intervals, on zig-zag traverses 1m apart These readings are stored in the memory of the instrument and are later dumped to computer for processing and interpretation

The Geoscan FM36 fluxgate gradiometer and ST1 sample trigger were used for the detailed gradiometer survey Readings were taken, on the 0 1nT range, at 0 5m intervals on zig-zag traverses 1m apart within 20m by 20m square grids

4 Data Processing and Presentation

The detailed gradiometer data has been presented in this report in X-Y trace and greyscale formats The former option shows the 'raw' data with no processing other than grid biasing whilst in the latter the data has been selectively filtered to remove spurious errors such as striping effects and edge discontinuities caused by instrument drift and inconsistencies in survey technique caused by poor field conditions

An X-Y plot presents the data logged on each traverse as a single line with each successive traverse incremented on the Y-axis to produce a 'stacked' plot A hidden line algorithm has been employed to block out lines behind major 'spikes' and the data has been clipped at 10nT The main advantage of this display option is that the full range of data can be viewed, dependent on the clip, so that the 'shape' of individual anomalies can be discerned and potentially archaeological anomalies differentiated from 'iron spikes' In-house software (XY3) was used to create the X-Y trace plots

In-house software (Geocon 9) was used to interpolate the data so that 1600 readings were obtained for each 20m by 20m grid Contors software was used to produce the greyscale images All greyscale plots are displayed in the range −1nT to 2nT, unless otherwise stated, using a linear incremental scale

Appendix 2

Survey Location Information

A Geotronics Geodimeter 600 series total station theodolite was used to set out grid points at 20m intervals on each site and to tie in the resultant grid to permanent landscape features such as field boundaries and road edges and to semi-permanent marker pegs, at least two of which were left at each individual site These features were then matched to the digital map base as a 'best fit'

Due to the inherent inaccuracy in Ordnance Survey mapping these co-ordinates are only considered to be accurate to +/-1 00m but this error may be greater in certain instances If greater accuracy is required for locating anomalies Archaeological Services WYAS will provide Local Grid co-ordinates for the reference points These co-ordinates will be accurate to +/- 0 05m

Archaeological Services WYAS does not accept responsibility for any locational errors that may result from measuring Ordnance Survey co-ordinates from figures in this report or for errors of fact or opinion resulting from data supplied by a third party

Appendix 3

Geophysical Archive

The geophysical archive comprises -

- an archive disk containing the raw data, grid location information, report text (Word 6), and compressed (AutoCAD 2000) files of the graphics
- a full copy of the report

At present the archive is held by Archaeological Services WYAS although it is anticipated that it will eventually be lodged with the Archaeology Data Service (ADS) Brief details will also be forwarded for inclusion on the English Heritage Geophysical Survey Database (no information on the client shall be included) after the contents of the report are deemed to be in the public domain (*i e* available for consultation in the relevant Sites and Monument Record Office)