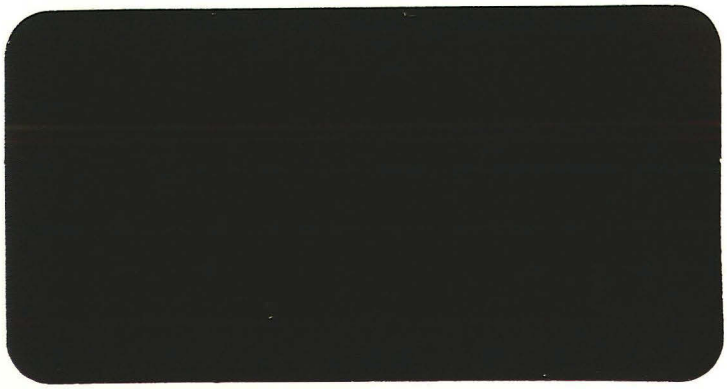
96/8

GeoQuest ASSOCIATES

A GEOPHYSICAL SURVEY AT WASHDYKE LANE, OSGODBY, LINCOLNSHIRE

Site Investigations

Lincolnshire County Council
Archaeology Section
12 Lucars Lane
LINCOLN LN2 5AL
TEL. 0522 545222 FAX: 0522 530724



negative
TF 073 925

A GEOPHYSICAL SURVEY AT WASHDYKE LANE, OSGODBY, LINCOLNSHIRE

A programme of research carried out
on behalf of

The Environmental Geotechnology Co. Ltd.

and

Tradeplant Ltd.

by

GeoQuest Associates

INTRODUCTION

This report presents the results of a geophysical survey on land adjoining Washdyke Lane in the village of Osgodby, West Lindsey district, Lincolnshire, prior to a proposed residential development. It is likely that the proposed development site overlies part of the medieval settlement at Osgodby. The work was therefore undertaken on behalf of The Environmental Geotechnology Co. Ltd. (TEGCL) and David Marchant (of Tradeplant Ltd.) according to instructions supplied by Mr Tim Langdale-Smith of TEGCL, with the aim of locating any sub-surface features of archaeological interest. The area surveyed geophysically for this project is shown yellow in Figure 1.

GEOLOGY, TOPOGRAPHY AND LANDUSE

The study area comprises approximately 0.4ha of pasture which is situated on a gentle north-facing slope. The site lies approximately 21m AOD at NGR: TF073925. A corrugated-iron shed and a metal gate stand in the southeast and southwest corners of the field respectively. As the shed is partly corroded it is likely that there will be ferrous contamination of the ground in this area.

The soils are derived from the local Jurassic rocks which are overlain by Boulder Clay. There are no rock outcrops in the survey area.

THE GEOPHYSICAL SURVEY

Choice of Technique

The primary aim of the geophysical survey was to try to detect any remains of archaeological features that might underly the present land surface. Research has shown that in the majority of cases a significant magnetic susceptibility contrast exists between the undisturbed subsoil and the fill of cut features (such as ditches and pits) as well as between the subsoil and stone features (such as foundations and roads). The main processes at work appear to be iron oxide production in the ploughsoil, due to repeated burning, with further enrichment after burial as a result of microbial activity fuelled by organic material. Geomagnetic surveying should therefore be an appropriate and rapid technique for locating buried archaeological features in this instance.

Field Methods

Due to discrepancies between field observations and features on the OS map which was supplied to GeoQuest the survey area has been located as a 'best-estimate' on

Figure 1, based on field observations. A baseline was set out with its southernmost point 1m from both the western and southern field fences (as shown on Figure 1). The alignment of the baseline extended northwards from this point tangentially touching a slight curve in the western fence approximately midway along its length and continuing to the northern end of the field.

The geomagnetic survey was carried out using an enhanced Geoscan FM36 fluxgate gradiometer with ST1 sample trigger (Appendix A). A zig-zag traverse scheme was employed and data were logged in grid units of 20 x 20m at 1.0 x 0.5m intervals, providing 800 measurements per grid.

Data were downloaded on site into a Sharp PC3000 portable graphics computer for storage and verification. These data were subsequently transferred to a laboratory computer for processing, interpretation and archiving.

Data Processing

The GeoQuest **InSite®** Windows program was used to process the geophysical data and produce a continuous tone grey-scale image of the raw data at a scale of 1:500. These results are shown in Figure 2 on a plan which was digitised from an Ordnance Survey map.

The following basic processing steps were applied to the data:

Removal of Striping Artifacts in the images caused by alternating changes in level between zig-zag traverses.

Removal of Random 'Spikes' present in the data due to small ferrous objects or igneous rocks on or near the ground surface. This process replaces spikes with the mean of near-neighbours.

Adjustment of Grid Mean Values to achieve an optimum match along the lines of contact between data grids.

Interpolation of the data, using a bilinear function, to generate a regular mesh of values at 0.25 x 0.25m intervals.

Printing of the processed data on a Hewlett Packard HP650C Designjet plotter with 256 grey shades and 600 dpi resolution. A sigmoid function was used to map the data to printed grey tones since this provides a measure of contrast equalisation.

INTERPRETATION

Key to Figures

A number of significant anomalies have been detected in the data and these are presented on a 1:500 geophysical interpretation plan (Figure 3) using coded colours and patterns. An archaeological interpretation plan has not been considered necessary in this instance. Figures 2 and 3 are bound in the report facing each other for ease of comparison. The only type of anomaly which has been distinguished in this instance is depicted as follows:

Red: Strong *dipolar anomalies* (paired positive-negative) whose most probable sources here are near-surface or standing ferrous objects.

Discussion

1 None of the geophysical anomalies that were detected appear to represent archaeological features.

2 A high concentration of magnetic dipoles covers this survey area. Such anomalies almost certainly reflect the presence of ferrous litter in or on the soil. The strong magnetisation which is associated with such objects may be obscuring the much weaker anomalies that are usually associated with archaeological features.

3 Two areas of dipolar magnetic anomalies in the southeastern and southwestern corners of the survey area reflect the magnetic influence of a corrugated iron shed and a metal gate respectively.

4 No sub-surface features of potential geotechnical hazard were detected within the study area.

SUMMARY AND CONCLUSIONS

The results of this research are summarised below:

1 A geomagnetic survey has been carried out over 0.4ha of pasture adjacent to Washdyke Lane, Osgodby, Lincolnshire, prior to a proposed residential development.

2 None of the geophysical anomalies that were detected appear to represent archaeological features.

3 The anomalies that have been detected are generally dipolar in nature and almost certainly reflect the presence of ferrous litter within the soil. Although there could well be features of archaeological interest within the survey area it has not proved possible to identify any geomagnetically due to the dominant effects of near-surface iron objects.

4 No sub-surface features of potential geotechnical hazard were detected within the study area.

NOTE ON SETTING OUT

It should be noted that if it is desired to re-locate any of the anomlies in this survey then the baseline should be re-established from a point in the southwest corner of the field: as described in **Field Methods**, above, a baseline was set out with its southernmost point 1m from both the western and southern field fences (see Figure 1). The alignment of the baseline extended northwards from this point tangentially touching a slight curve in the western fence approximately midway along its length and continuing to the northern end of the field.

CREDITS

Survey: D.N. Hale, P.R. Dungey
Graphics: R. Grove
Report: D.N. Hale
Date: 13th May 1996

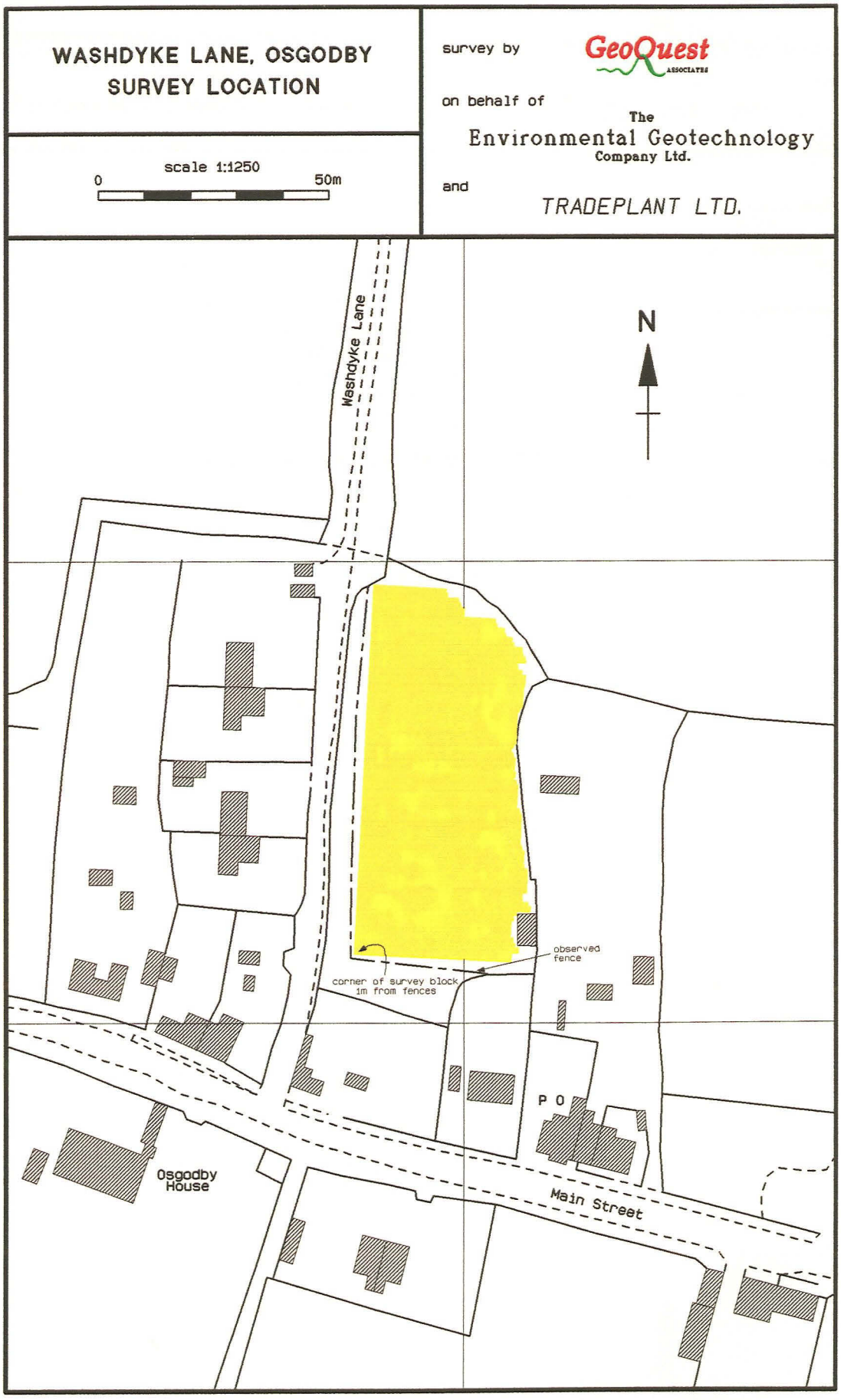


FIGURE 1

OSGODBY: SURVEY LOCATION

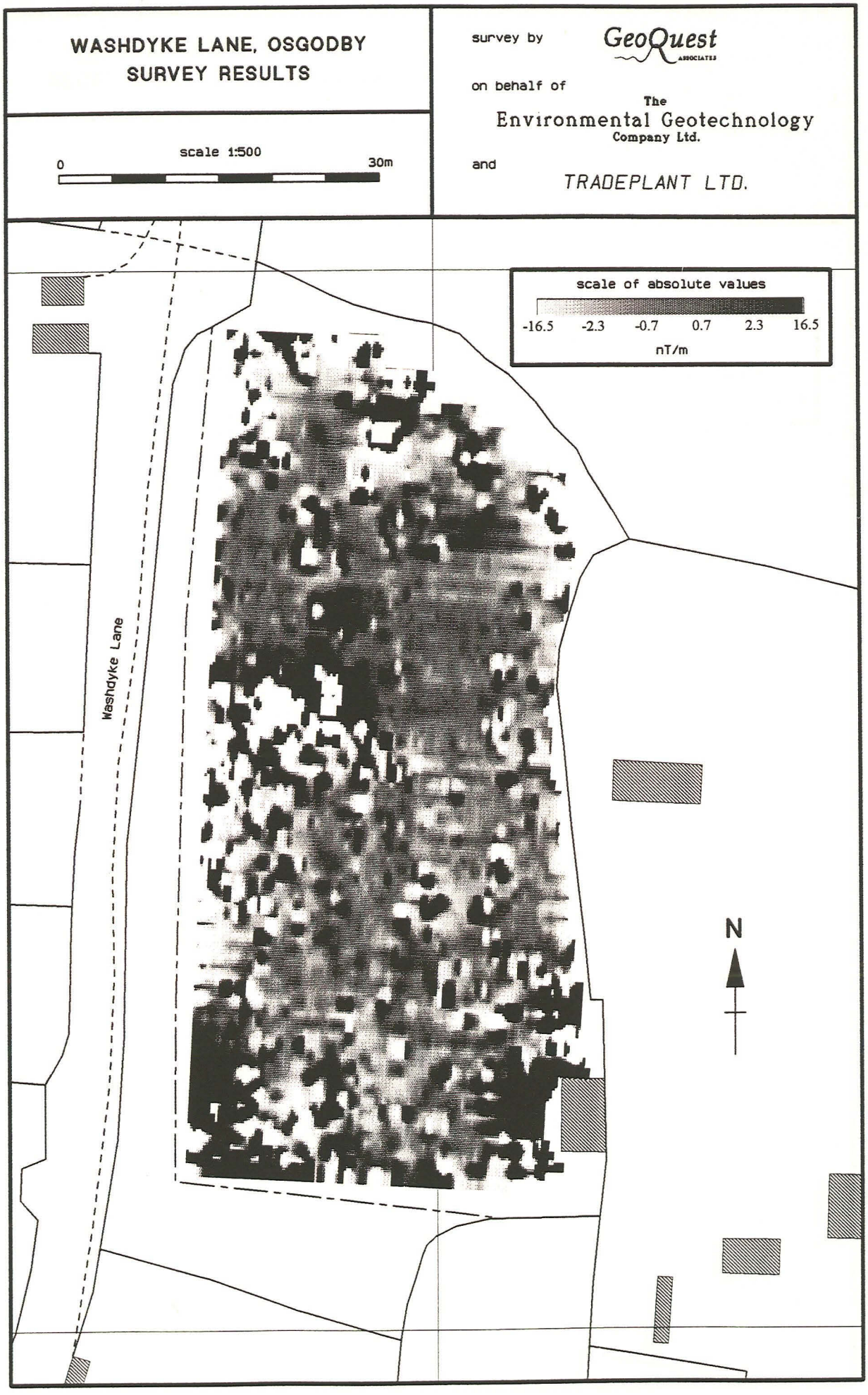


FIGURE 2

OSGODBY: SURVEY RESULTS

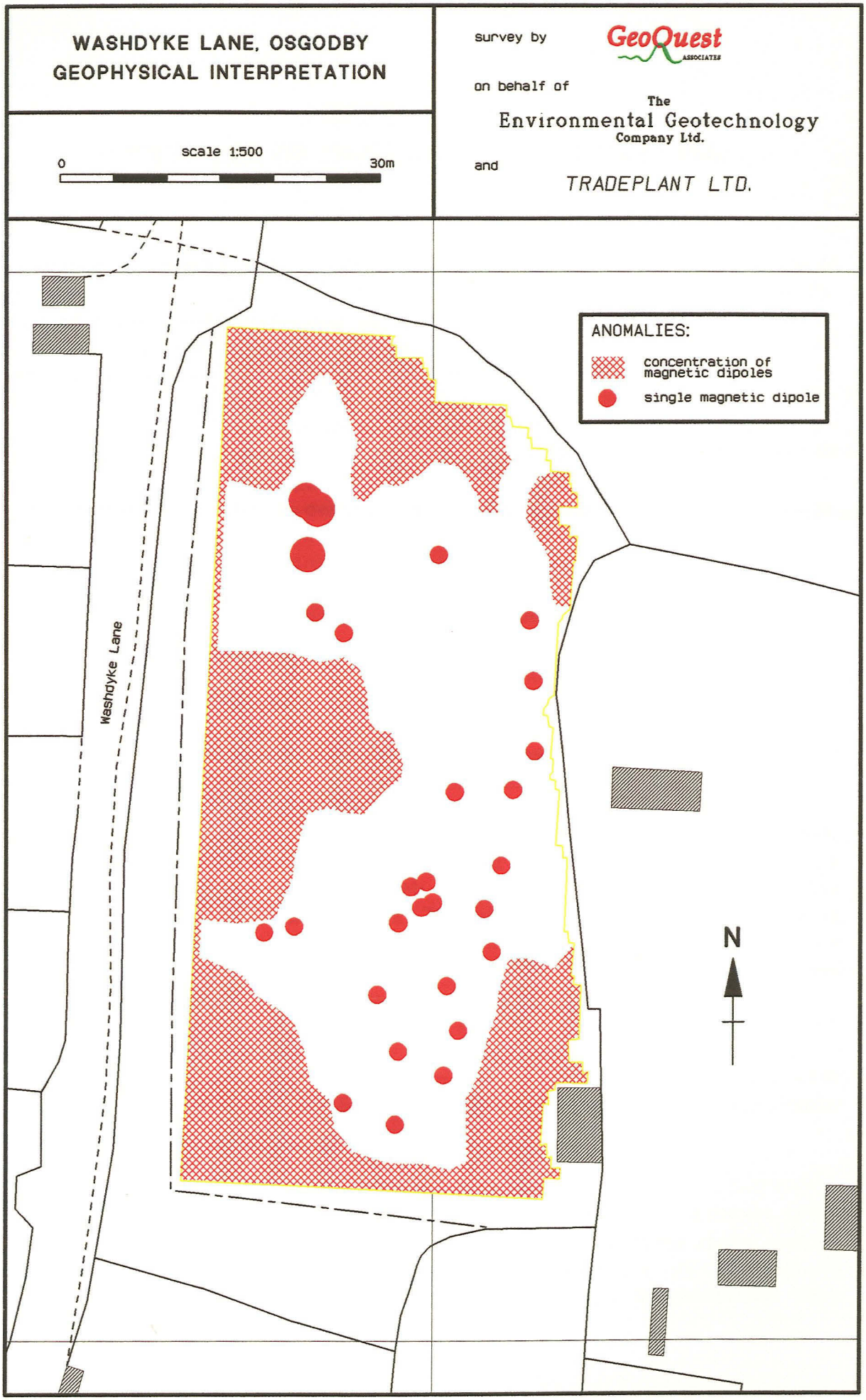


FIGURE 3

OSGODBY: GEOPHYSICAL INTERPRETATION

APPENDIX A
PRINCIPLES OF GEOMAGNETIC SURVEYING

Geomagnetic prospecting detects subsurface features in terms of the perturbations or 'anomalies' that they induce in the Earth's magnetic field. In contrast to resistivity, seismic or electromagnetic surveying, no energy is injected into the subsoil and hence this is one of a class of *passive* geophysical techniques that includes gravity and thermal surveying. Two types of magnetic anomalies can be distinguished:

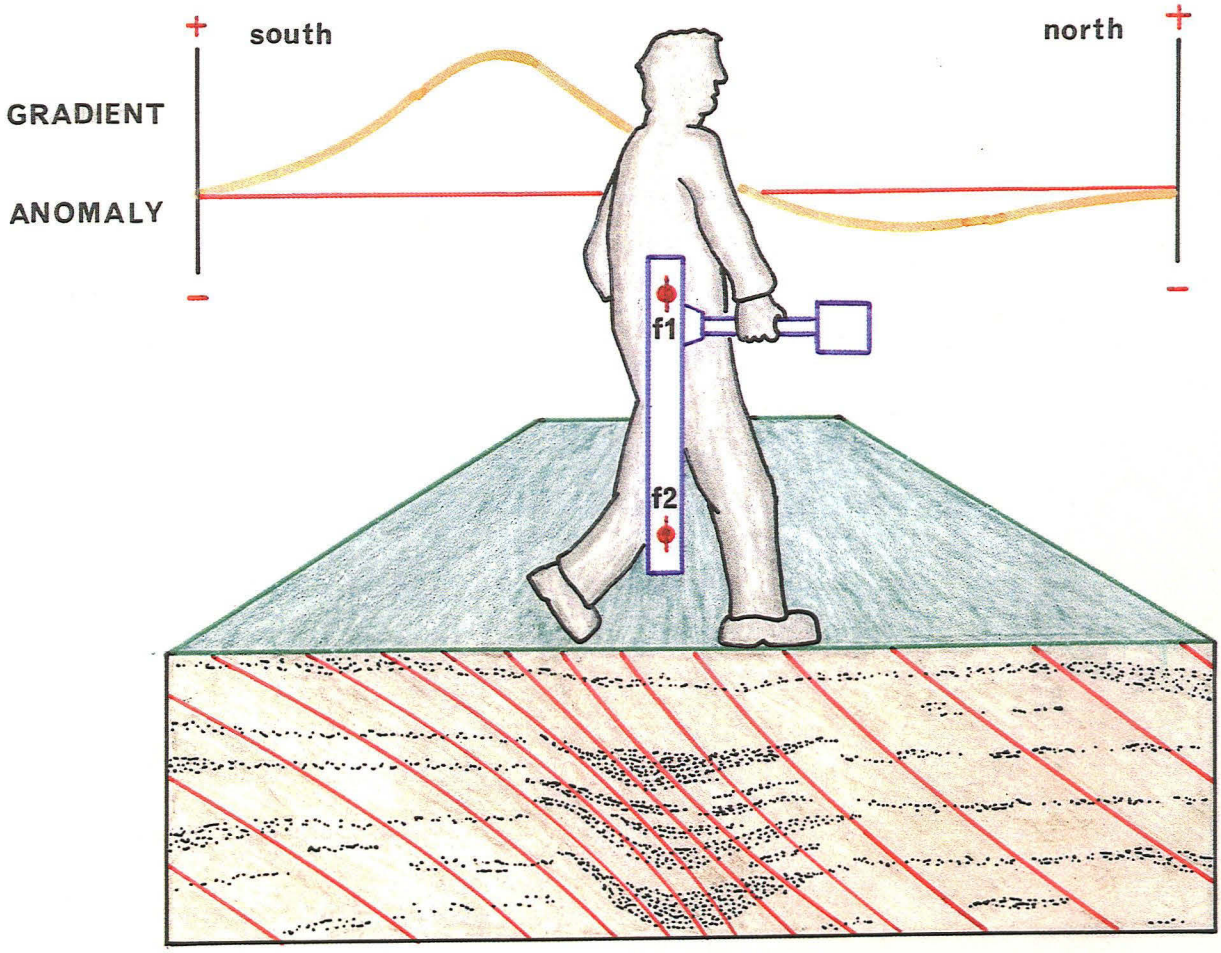
1 Anomalies arising from variations in *magnetic susceptibility* which will modulate the component of magnetisation *induced* in the subsurface by the Earth's magnetic field. For most archaeological sites, this is the dominant factor giving rise to geomagnetic anomalies. In general, susceptibility is relatively weak in sediments, such as sandstones and enhanced in ingeous rocks and soils, especially those which have been burnt or stratified with organic material.

2 Anomalies due to large, *permanently magnetised* structures. Such permanent magnetisation or 'remanence' arises when earth materials are heated to above ~600°C and cooled in the geomagnetic field. Thus kilns and hearths are often detected as strong permanent magnets causing highly localised anomalies that dominate effects due to background susceptibility variations. Remanence can result from other physical and chemical processes but these give rise to anomalies that are usually unimportant for geophysical prospecting.

There are several approaches towards the practical measurement of geomagnetic anomalies. In this study measurements were made using a Geoscan FM36 fluxgate gradiometer which records the change with height in the vertical component of the Earth's magnetic field, as shown overleaf. This method has the advantage of being insensitive to diurnal variations while the Geoscan instrument also benefits from an integrated data logger. Note that in mid northern latitudes the magnetic anomaly will be asymmetric with the main peak displaced to the south of the archaeological feature. Thus, a ditch filled with a soil of enhanced susceptibility, for example, will generate a positive anomaly to the south, mirrored by a weak negative anomaly north of the feature. When portrayed as an area map of grey tones this gives rise to a 'shadowing' or pseudo relief effect which must be borne in mind when making an archaeological interpretation.

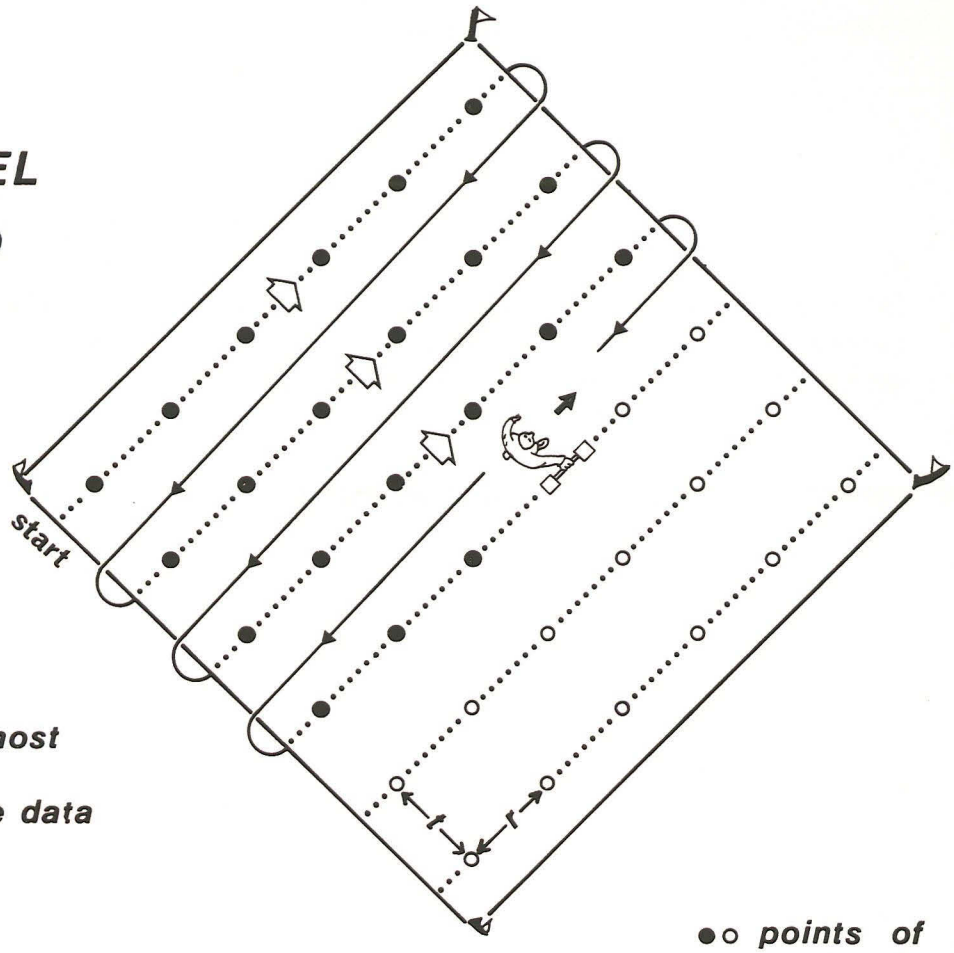
Two techniques can be used to survey gridded areas using the fluxgate magnetometer. In the parallel method the instrument is used to scan the area along traverses which are always in the same direction. This method minimises 'heading errors' due to operator and instrument magnetisation but is time consuming. The alternative zig-zag method is significantly faster and suitable for areas where anomalies are large compared to these and other sources of error.

MAGNETIC SURVEYING



SURVEY SCHEMES

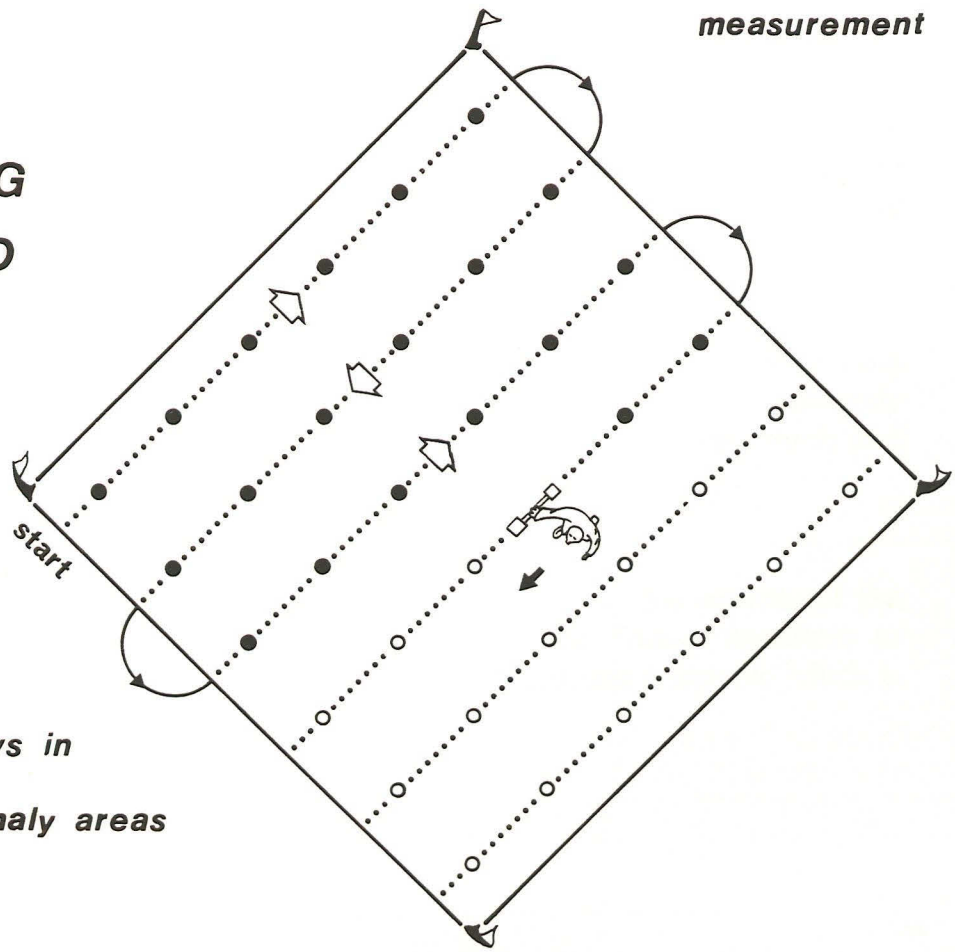
PARALLEL METHOD



slower but minimises most errors in the data

●○ *points of measurement*

ZIG-ZAG METHOD



suitable for rapid surveys in strong anomaly areas

APPENDIX B
DATA PROCESSING

PROCESSING THE SURVEY DATA

The geophysical images contained in this report were prepared within Microsoft Windows® using the **InSite®** program published by GeoQuest Associates. Geophysical images were then placed onto a map which was digitised from the Ordnance Survey, edited and then plotted using a computer aided drafting (CAD) system and colour inkjet printer.

Data were downloaded from the meter to a portable computer in the field for storage, visualisation and quality control (QC) assessment. These data were then transferred to a laboratory computer for final processing, printing and archiving.

A number of process steps have been applied to the geophysical data obtained during the survey and those which have been used are linked to the main flow path by arrows. Steps were applied in the order shown and are designed to reduce artifacts in the data and enhance geophysical features of archaeological interest. The following sections describe each step in more detail.

REMOVE STRIPING

Reduces a data artifact comprising alternating changes in level in readings logged along zig-zag traverses. This artifact is common in fluxgate magnetometer data. InSite uses a proprietary algorithm to reduce this error.

INFILL SMALL BLANK AREAS

Fills isolated blank data cells with the mean of near-neighbours or a suitable approximation entered manually. Small blank areas will have been logged if it was not possible to obtain a geophysical reading over, for example, a manhole cover in the case of a resistivity survey.

REMOVE SPIKES

Replaces isolated, anomalously high or low values with the mean of near neighbours or a suitable approximation entered manually. 'Spike' readings are commonly associated with ferrous litter or poor electrical contact in the case of geomagnetic and resistivity data, respectively.

REDUCE WALK HARMONICS

Reduces a regular oscillation in traverse data caused by walking movements of the operator during a geomagnetic survey. InSite employs a fast Fourier transform to determine the optimum amplitude and phase of the walk-induced harmonic which is then subtracted from each traverse.

REDUCE SHEAR ARTIFACTS

Corrects for apparent shear in geomagnetic anomalies surveyed by zig-zag traversing in a geomagnetic survey. The shearing effect arises from the interaction of the operator + magnetometer with the geomagnetic field and also from the lag in the instrument response to changes in the field. InSite uses a proprietary algorithm to reduce this error.

CORRECT FOR METER DRIFT

Corrects for a linear drift in the meter calibration with time. Such drift is a common problem with fluxgate magnetometers, particularly during periods of rapid air temperature change. InSite uses least-squares regression on the mean of data along each traverse to estimate the change in calibration level across each grid. This gradient is then removed from the data.

ADJUST GRID MEAN LEVELS

Adjusts for differences in the mean level in data grids due to changes in instrument calibration (fluxgate magnetometer survey) or alteration in remote electrode spacing (resistivity survey).

INTERPOLATE AND COMBINE

Combines grids to form an array of regularly-spaced data on a square mesh. InSite uses bilinear interpolation to accomplish this.

LOW PASS FILTER

If this process task is indicated then a 3x3 or 5x5 boxcar filter has been used to smooth the data and reduce noise or 'speckle' seen in the original image.

HIGH PASS FILTER

If this process task is indicated then a 3x3 or 5x5 filter, with appropriate coefficients, has been used to pass short-wavelength information into the resulting image.

EDGE DETECT FILTER

Signifies that a Sobel, Laplace or other specialised filter has been applied to enhance significant lateral transitions in the geophysical image.

DIRECTIONAL FILTER

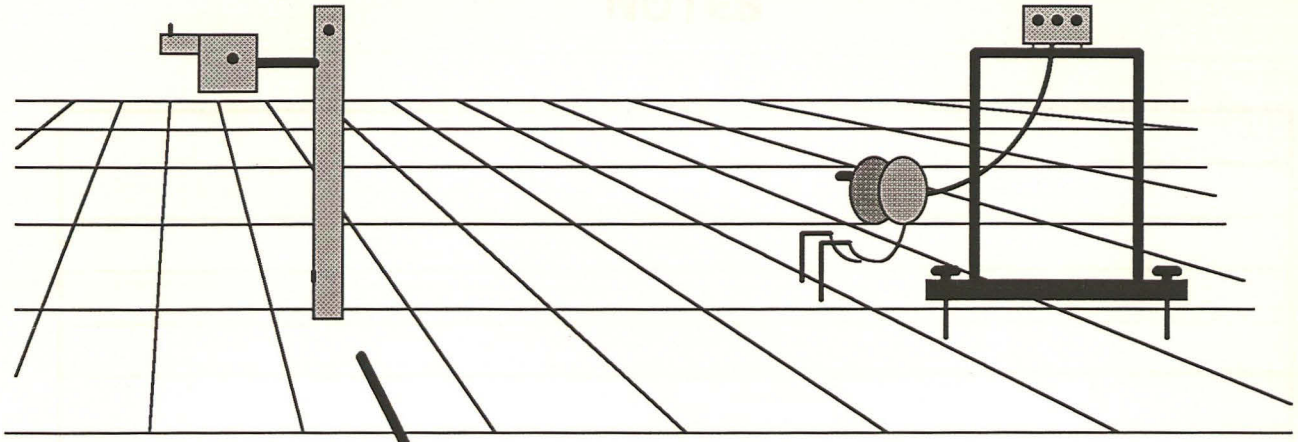
This filter is equivalent to illuminating the data from one direction to produce a pseudo-relief image. Directional filtering is usually employed to aid the identification of subtle anomalies in resistivity data. This filter highlights features trending at right angles to the direction of illumination.

NOTE

GeoQuest Associates can supply the geophysical images presented in this report in a variety of digital formats for visualisation on microcomputers running Microsoft Windows. These formats include the TIFF, BMP and PCX standards. Please complete the request form at the rear of this report if you would like to receive such image files.

InSite

APPENDIX B
DATA PROCESSING



FIELD PC

LAB PC

QC

DATA ARCHIVE

IMAGE RAW GRID DATA

REMOVE STRIPING

INFILL SMALL BLANK AREAS

REMOVE SPIKES

REDUCE WALK HARMONICS

REPORT FIGURE 2

INTERPOLATE AND COMBINE

ADJUST GRID MEAN LEVELS

CORRECT FOR METER DRIFT

REDUCE SHEAR ARTIFACTS

PROJECT: OSGODBY

SITE: WASHDYKE LANE

NOTES

GeoQuest Associates
The Old Vicarage
Castleside
Co. Durham
DH8 9AP
Tel 01207 583576, Fax 01207 583577, Mobile 0850 782368