98/b

LAND WEST OF LINWOOD ROAD, MARKET RASEN, LINCOLNSHIRE

Gradiometer Survey

(Survey Ref: 1550898/MRL/LAS)

AUGUST 1998

Produced by

OXFORD ARCHAEOTECHNICS LIMITED

under the direction of

A.E. Johnson *BA(Hons)*

Commissioned by

Lindsey Archaeological Services

on behalf of

Montagu Evans

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SUMMARY

A geophysical evaluation programme comprising magnetometer (gradiometer) survey was carried out on 0.6 ha area of land on the southern outskirts of Market Rasen, Lincolnshire (centred on NGR 510750 388600) in advance of proposed development.

The survey was based upon the principle that past human activity and its associated debris usually creates slight but persistent changes in the local magnetic environment which can be sensed from the surface.

The survey was conducted within an area of high potential for the discovery of Romano-British pottery-making remains. The survey identified several magnetic anomalies of potential archaeological significance, including areas of pitting and burning, local concentrations of debris containing possible kiln material, and burnt features, at least two of which may represent kiln bases.

1. INTRODUCTION

1.1 Geophysical survey was commissioned by Lindsey Archaeological Services on behalf of Montagu Evans on land situated on the southern outskirts of Market Rasen, Lincolnshire, in advance of proposed development. The fieldwork was carried out in August 1998.

1.2 The proposed development area (centred on NGR 510750 388600) comprises a rectangular plot of agricultural land, 0.6 ha in extent, situated to the south of the former Cattle Market, and extending between the railway line and the B 1202 Linwood Road. The location is shown on Fig. 1.

1.3 The geology comprises clay overlain by windblown sand. The site was pasture over the obvious earthworks of former (Medieval or later) ridge and furrow cultivation.

1.4 Although no further sites or finds of archaeological significance have been recorded from the survey area, the land lies within an area of clay and cover sands south of the modern town of Market Rasen which has yielded considerable evidence for a Romano-British pottery-making industry (dating from the 2nd - 4th centuries AD). A number of possible kiln sites have been recorded from the field immediately adjacent to the south (centred on NGR 510760 388530), as the result of chance finds following disturbance caused by a plane crash together with fieldwalking and limited excavation (in the 1960s); the remains comprised the bases of individual kilns, items of kiln furniture, pottery wasters, iron working slag, fired clay and burnt deposits, together with some traces of associated structural remains represented by paired postholes (Swan 1984a) (SMR No. 52740). Further kilns sites are known from Linwood Warren, situated approximately 2 km to the southeast of the survey area (Swan 1984a: 455-458; Swan 1984b; Whitwell 1992).

1.5 The geophysical survey comprised magnetometry. An explanation of the techniques used, and the rationale behind their selection, is included in an Appendix to the present report.

2. MAGNETIC SURVEY DESIGN

2.1 Survey control was established by EDM Total Station (Fig. 4).

2.2 Detailed gridded gradiometer survey was carried out over almost the whole of the survey area using a Geoscan Research FM 36 Fluxgate Gradiometer (sampling 4 readings per metre at 1 metre traverse intervals in the 0.1 nT range). The nanotesla (nT) is the standard unit of magnetic flux (expressed as the current density), here used to indicate positive and negative deviations from the Earth's normal magnetic field. The traverse direction was selected to run parallel with the ridge and furrow to ensure as smooth a path as possible for the gradiometer on the undulating ground.

2.4 Magnetometer data have been presented as grey scale and stacked trace (raw data) plots (Fig. 2), and an interpretation of results is shown on Fig. 3.

3. SURVEY RESULTS

3.1 Preliminary magnetometer (gradiometer) scanning suggested that the survey area contained numerous magnetic anomalies, together with a general litter of ferrous material in a concentration slightly above the norm, presumably due to the relatively 'urban' context of the field and its close proximity of the former Market Rasen Cattle Market.

3.2 The gradiometer plot (Fig. 2) shows at least two localities which, judging by the response of the gradiometer, may represent features containing *in situ* burnt deposits, possibly representing residual kiln material.

3.3 Further anomalies are suggestive of a number of hollows or possible pit-like features.

3.4 In addition, several linear anomalies, possibly representing ditch or gully-like intrusions, were also recorded. The response of these features to the gradiometer is relatively weak, suggesting that none contains substantial amounts of burnt (magnetically enhanced) clays. It is possible that amongst this group may be agricultural striations which have incorporated small amounts of residual burnt material.

4. CONCLUSIONS

4.1 Soils formed over sandy substrates generally display low topsoil magnetic susceptibility. However, the highly contrasting levels of magnetic enhancement recorded within the survey area indicate the probable incorporation of burnt material (probably an admixture of burnt clays and other 'exotic' material) into the topsoil, and an association with the known Romano-British pottery making and other industrial activity known from this part of Market Rasen is strongly suggested.

4.2 The strongest magnetic anomalies undoubtedly represent either discrete local burning events, kilns, dispersed kiln material, or pits/hollows incorporating fired material.

4.3 The survey gives the general impression that the industrial activity is concentrated towards the western and southern parts of the site, becoming relatively magnetically 'quiet' towards the east. Although this may be a true reflection of a relative lack of archaeological features in this area, the possibility that some features infilled with material of lower magnetic susceptibility (i.e. lacking input from burnt and exotic material) may be present cannot be entirely discounted.

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APPENDIX - MAGNETIC TECHNIQUES: GENERAL PRINCIPLES

A1.1 It is possible to define areas of human activity (particularly soils spread from occupation sites and the fills of cut features such as pits or ditches) by means of *magnetic survey* (Clark 1990; Scollar et al. 1990). The results will vary, according to the local geology and soils (Thompson & Oldfield 1986; Gale & Hoare 1991), as modified by past and present agricultural practices. Under favourable conditions, areas of suspected archaeological activity can be accurately located and targeted for further investigative work (if required) without the necessity for extensive random exploratory trenching. Magnetic survey has the added advantages of enabling large areas to be assessed relatively quickly, and is non-destructive.

A1.2 Topsoil is normally more magnetic than the subsoil or bedrock from which it is derived. Human activity further locally enhances the magnetic properties of soils, and amplifies the contrast with the geological background. The main enhancement effect is the increase of *magnetic susceptibility*, by fire and, to a lesser extent, by the bacterial activity associated with rubbish decomposition; the introduction of materials such as fired clay and ceramics - and, of course, iron and many industrial residues - may also be important in some cases. Other agencies include the addition and redistribution of naturally magnetic rock such as basalt or ironstone, either locally derived or imported.

A1.3 The tendency of most human activity is to increase soil magnetic susceptibility locally. In some cases, however, features such as traces of former mounds or banks, or imported soil/subsoil or non-magnetic bedrock (such as most limestones), will show as zones of lower susceptibility in comparison with the surrounding topsoil.

A1.4 Archaeologically magnetically enhanced soils are therefore a response of the parent geological material to a series of events which make up the total domestic, agricultural and industrial history of a site, usually over a prolonged period. Climatic factors may subsequently further modify the susceptibility of soils but, in the absence of strong chemical alteration (e.g. during the process of podzolisation or extreme reduction), magnetic characteristics may persist over millions of years.

A1.5 Both the magnetic contrast between archaeological features and the subsoil into which they are dug, and the magnetic susceptibility of topsoil spreads associated with occupation horizons, can be measured in the field.

A1.6 There are several highly sensitive instruments available which can be used to measure these magnetic variations. Some are capable, under favourable conditions, of producing extraordinarily detailed plots of subsurface features. The detection of these features is usually by means of a *magnetometer* (normally a fluxgate gradiometer). These are defined as passive instruments which respond to the magnetic anomalies produced by buried features in the

presence of the Earth's magnetic field. The gradiometer uses two sensors mounted vertically, often 50 cm apart. The bottom sensor is carried some 30 cm above the ground, and registers local magnetic anomalies with respect to the top sensor. As both sensors are affected equally by gross magnetic effects these are cancelled out. In order to produce good results, the magnetic susceptibility contrast between features and their surroundings must be reasonably high, thereby creating good local anomalies; a generally raised background, even if due to human occupation within a settlement context, will sometimes preclude meaningful magnetometer results. The sensitive nature of magnetometers makes them suitable for detailed work, logging measurements at a closely spaced (less than 1 metre) sample interval, particularly in areas where an archaeological site is already suspected. Magnetometers may also be used for rapid 'prospecting' ('scanning') of larger areas (where the operator directly monitors the changing magnetic field and pinpoints specific anomalies).

A1.7 *Magnetic susceptibility measuring systems*, whilst responding to basically the same magnetic component in the soil, are 'active' instruments which subject the sample area being measured (according to the size of the sensor used) to a low intensity alternating magnetic field. Magnetically susceptible material within the influence of this field can be measured by means of changes which are induced in oscillator frequency. For general work, measuring topsoil susceptibility *in situ*, a sensor loop of around 20 cm diameter is convenient, and responds to the concentration of magnetic (especially ferrimagnetic) minerals mostly in the top 10 cm of the soil. Magnetically enhanced horizons which have been reached by the plough, and even those from which material has been transported by soil biological activity, can thus be recognised.

A1.8 Whilst only rarely encountering anomalies as graphically defined as those detected by magnetometers, magnetic susceptibility systems are ideal for detecting magnetic spreads and thin archaeological horizons not seen by magnetometers. Using a 10 m interval grid, large areas of landscape can be covered relatively quickly. The resulting plot can frequently determine the general pattern of activity and define the nuclei of any occupation or industrial areas. As the intervals between susceptibility readings generally exceed the parameters of most individual archaeological features (but not of the general spread of enhancement around features), the resulting plots should be used as a guide to areas of archaeological potential and to suggest the general form of major activity areas; further refinement is possible using a finer mesh grid or, more usually, by detailing underlying features using a gradiometer.

A1.9 Magnetic survey is not successful on all geological and pedological substrates. As a rule of thumb, in the lowland zone of Britain, the more sandy/stony a deposit, the less magnetic material is likely to be present, so that a greater magnetic contrast in soil materials will be needed to locate archaeological features; in practice, this means that only stronger magnetic anomalies (e.g. larger accumulations of burnt material) will be visible, with

weaker signals (e.g. from the fillings of simple agricultural ditches) disappearing into the background. Similar problems can arise when the natural background itself is very high or very variable (e.g. in the presence of sediments partially derived from magnetic volcanic rocks).

A1.10 The precise physical and chemical processes of changing soil magnetism are extremely complex and subject to innumerable variations. In general terms, however, there is no doubt that magnetic enhancement of soils by human activity provides valuable archaeological information.

A1.11 As well as locating specific sites, topsoil magnetic susceptibility survey frequently provides information relating to former landuse. Variations in the soils and subsoils, both natural and those enhanced by anthropogenic agencies, when modified by agriculture, give rise to distinctive patterns of topsoil susceptibility. The containment of these spreads by either natural or man-made features (streams, hedgerows, etc.) gives rise to a characteristic chequerboard or strip pattern of varying enhancement, often showing the location of former field systems, which persist even after the physical barriers have been removed. These patterns are often further amplified in fields containing underlying archaeological features within reach of the plough. More subtle landuse boundaries and indications of former cultivation regimes are often suggested by topsoil magnetic susceptibility plots.

A1.12 Where a general spread of magnetically enhanced soils contained within a long-established boundary becomes admixed over a long period by constant ploughing, it can be diffused to such a point that the original source is masked altogether. Magnetically enhanced material may also be moved or masked by natural agencies such as colluviation or alluviation. Generally, it appears that the longer a parcel of land has been under arable cultivation, the greater is the tendency for topsoil susceptibility to increase; at the same time there is increasing homogeneity of the magnetic signal within the soils owing to continuous agricultural mixing of the material. Some patterns of soil enhancement derived from underlying archaeological features are, however, apparently capable of resisting agricultural dispersal for thousands of years (Clark 1990).

FIGURE CAPTIONS

Figure 1. Location maps. Based upon OS 1:50,000 Map 121, and OS 1:2500 Sheet TF 1088, reduced to 1:5000 scale.

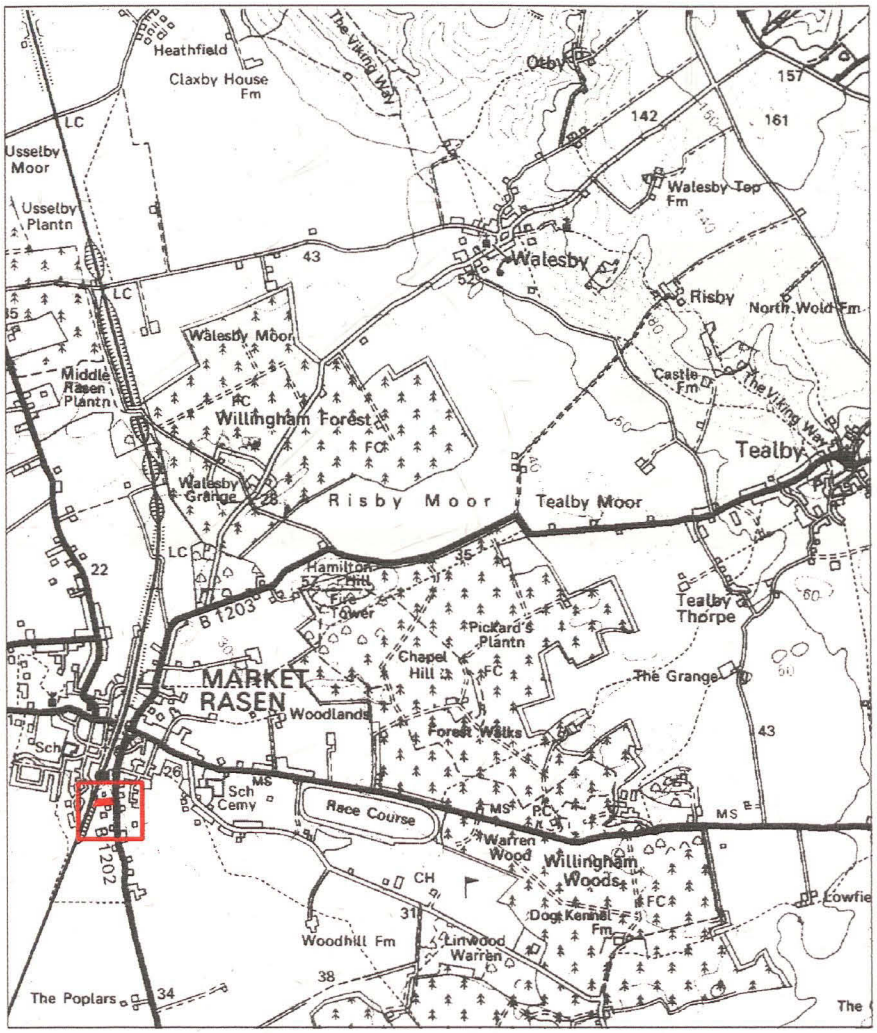
Figure 2. Magnetometer (gradiometer) survey: grey scale and stacked trace (raw data) plots. Scale 1:1000.

Figure 3. Magnetometer (gradiometer) survey: interpretation. Scale 1:1000.

Figure 4. Survey area fenceline in relation to the gradiometer survey grid. Scale 1:500.

Land West of Linwood Road, Market Rasen, Lincolnshire

Magnetometer survey: location



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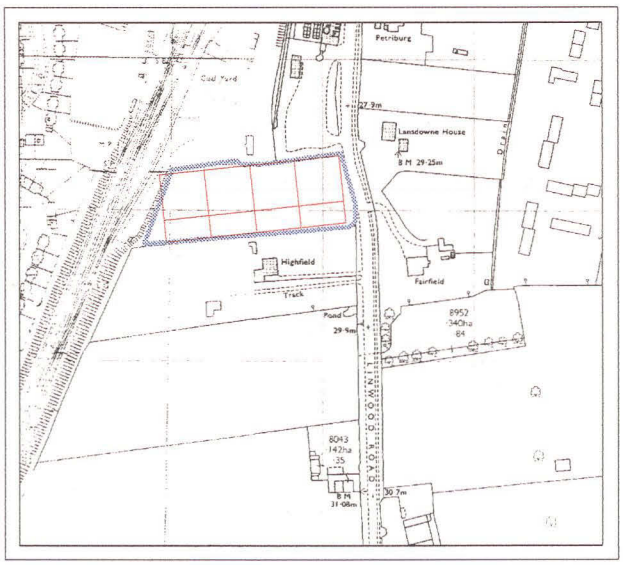

1:5,000

Magnetometer (Gradiometer) survey

30m grids

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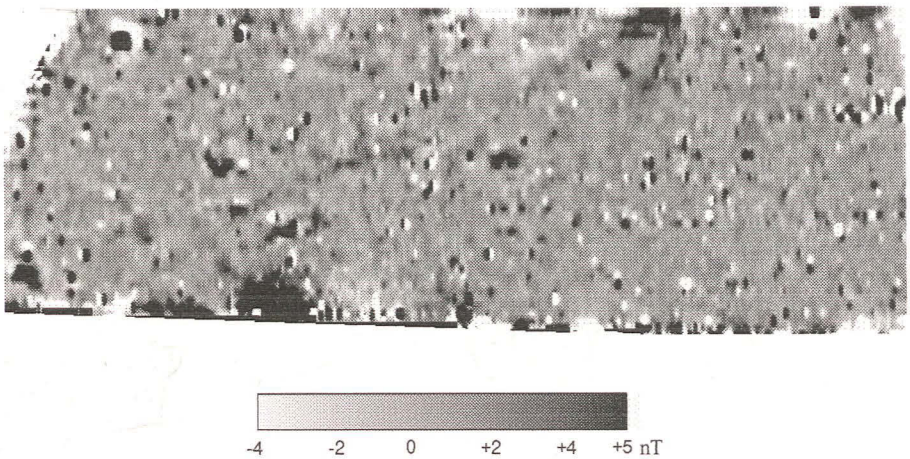
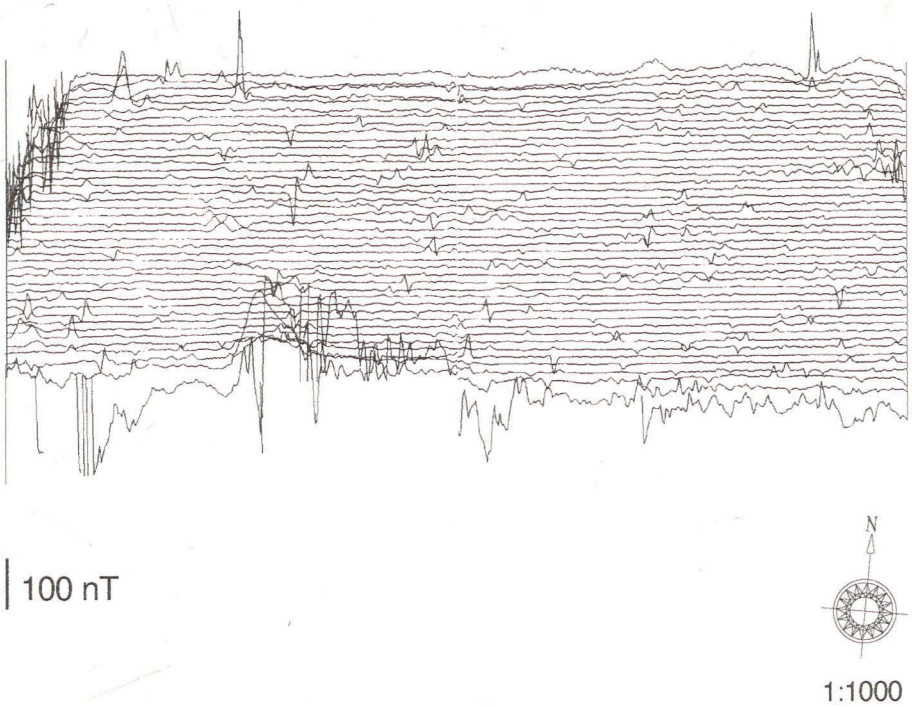
FIG. 1

Land West of Linwood Road, Market Rasen, Lincolnshire

Magnetometer survey: grey shade plot



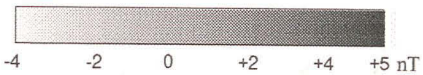
Magnetometer survey: stacked trace plot (raw data)



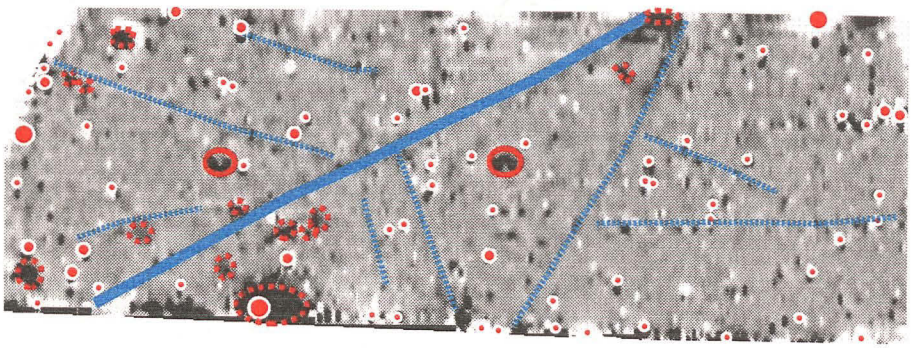
OXFORD ARCHAEOTECHNICS FIG. 2

Land West of Linwood Road, Market Rasen, Lincolnshire

Magnetometer survey: grey shade plot

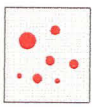


1:1000

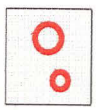


Interpretation

Linear and curvilinear features
Positive anomaly
Negative anomaly



Ferrous material



Probable burnt features/kilns

Weak linear and curvilinear features, including agricultural striations

Possible pits (burnt material present)

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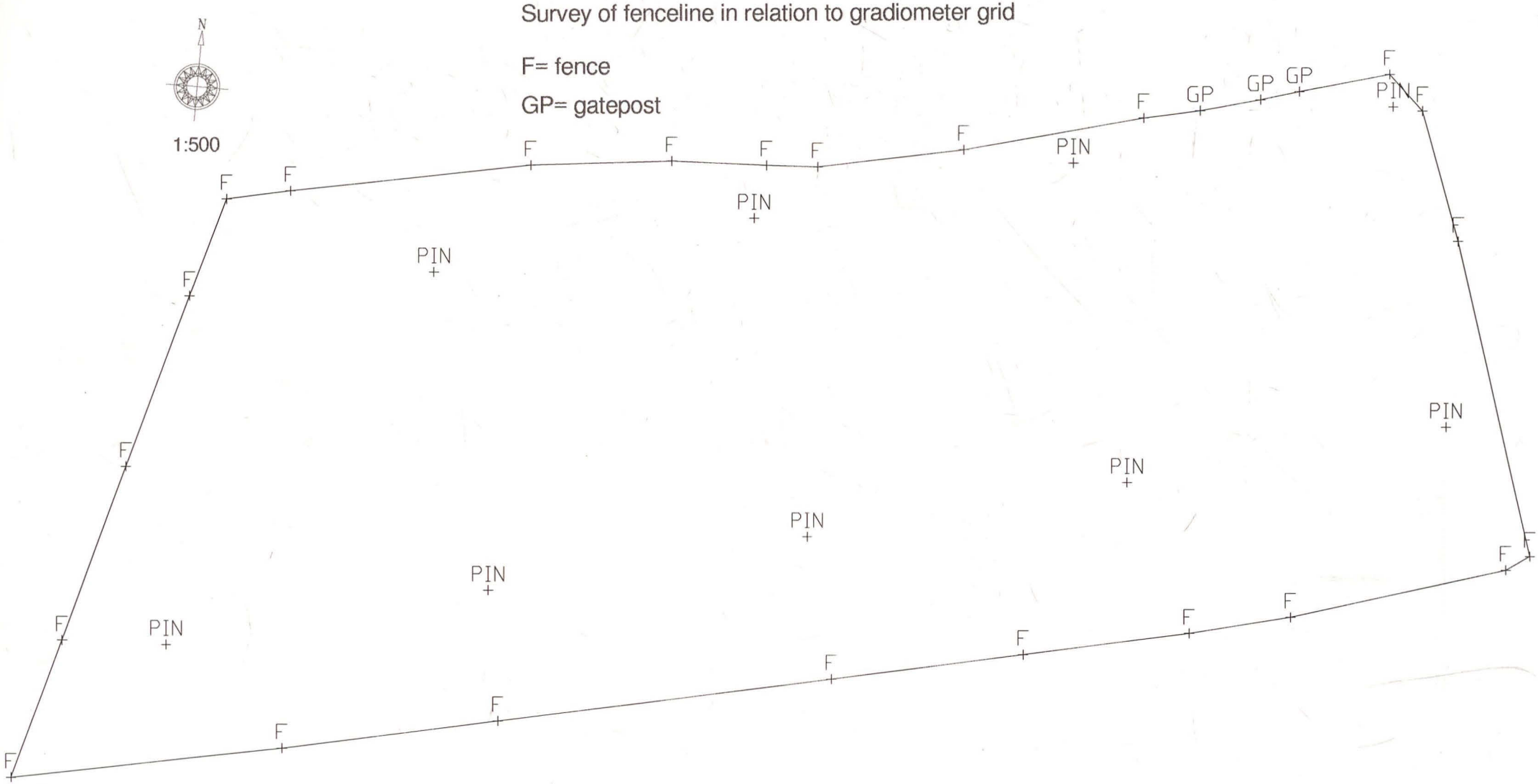
FIG.3

Land West of Linwood Road, Market Rasen, Lincolnshire

Survey of fenceline in relation to gradiometer grid

F= fence

GP= gatepost



OXFORD ARCHAEOTECHNICS FIG. 4

INTERNAL QUALITY CHECK

Survey Reference	1550898 |MRL |LAS		
Primary Author		Date	
Checked By	APJ	Date	2.9-98
Checked By		Date	
Further Corrections		Date	

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