Stenson Fields, Derbyshire

Geophysical Survey Report

Produced for WYG

STD121

16th November 2012

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Mapping Our Heritage

Non-Technical Summary

A magnetic survey was commissioned in advance of construction to prospect for any buried structures of archaeological interest within an area known as Stenson Fields. The survey data contains little of obvious archaeological interest apart from evidence for the medieval layout of the land (as ridge and furrow) and former field boundaries. The exception is a small complex of features observed near the eastern edge of the site that might suggest the former presence of structures, perhaps including a pond.

Digital Data

Data	Included?	Format
Survey outlines	Available	Vector: AutoCAD R12 DXF
Interpretation	Available	Vector: AutoCAD R12 DXF
XY Traces	No	Vector: AutoCAD R12 DXF
Contours	Partial	Vector: AutoCAD R12 DXF
Images	Available	Georeferenced raster: GeoTIFF
Catalogue	Available	Database: MS Access 2003

Media	Sent to	Date
E-mail	Kirsten Holland	16th November 2012

Audit

Version	Author	Checked	Date
Draft Final	MJR	MJR	16th November 2012
Final	MJR	MJR	6th December 2012

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1 Introduction

Objective

1.1 An area of land is subject to a planning proposal and a magnetic survey was commissioned by WYG in advance of construction to prospect for any buried structures of archaeological interest.

Location

Country	England
County	Derbyshire
Nearest Town	Derby
Central Co-ordinates	433140, 330980

1.2 Approximately 11.5 hectares was surveyed within one field; a second field was not available.

Constraints and variations

1.3 Survey was only undertaken in the southern field; ground works had already commenced in a second field to the north and conditions were not suitable for magnetic survey.

2 Context

Archaeology

2.1 The following is quoted verbatim from the Written Scheme of Investigation (WSI) (Holland, 2012):

"There is extensive evidence for prehistoric settlement in the region within the Trent valley at Willington, Swarkestone and Ashton-on-Trent. Prehistoric activity in the immediate area is indicated by a small number of find spots. The Neolithic is represented by a Neolithic flint adze or axe (32029-MDR4598) and a late Neolithic polished flint axe (27420-MDR4584). Bronze Age activity in the vicinity of the site is attested to in the form of a ring ditch, which is possibly the remains of a ploughed out ring barrow (27419-MDR4594) and, to the south east of the immediate area at Swarkestone, an upstanding barrow is still in evidence. Bronze Age evidence in the vicinity of the development site is limited to a findspot of Beaker pot sherds and associated coarse ware (27421-MDR4589).

It is thought that the name Derby derives from the Roman name Derventio. The Roman road of Ryknild Street passes to the west, along the line of the modern A38. This road connects Wall (near Lichfield) in the south, with Littlechester (Derby) in the north, passing through Burton upon Trent and then between Willington and Egginton (Ordnance Survey, 1994). The arrival of the Romans in Derbyshire and the Trent valley in particular led to the establishment of new farms alongside newly constructed roads. Excavations at Willington have revealed two Romano-British farmsteads within a landscape of developed field systems which have Iron Age origins (MDR2586). No evidence dating to the Roman period was found in the study area.

The evidence for activity in the early medieval period is affected by a lack of recorded or documented sites of this date. The political and religious core of the Mercian kingdom was centred on the middle Trent valley with key centres at Repton, to the south of Willington, and Lichfield. The study area would therefore have lain within the sway and hinterland of these centres. Other evidence includes the secondary Anglo-Saxon burial found in a Bronze Age barrow at Swarkestone Lowes. Settlement evidence of this period in the immediate area is confined to the multi-period site at Willington (MDR2586) where three sunken floor buildings were excavated, along with a number of pits, postholes and numerous sherds of 6th century pottery.
The medieval in Derbyshire is characterised by further development of towns such as Chesterfield and Derby, alongside the establishment of a number of market towns, the founding of the

planned towns of Castleton and Bolsover and the establishment of a small number of stone castles. Rural development is well attested to in the county. A total of 60 Deserted Medieval Villages (DMV) are recorded in the HER alongside 22 recorded Shrunken Medieval Villages. The majority of these are in the south of the county and are frequently associated with extensive earthwork and field systems.

Stenson is mentioned in the Domesday Book, with the villages of Stenson and Twyford listed together as a joint manor belonging to Henry de Ferrers, the largest landowner in Derbyshire at the time of the Domesday Survey.

A number of examples of ridge and furrow and possible DMV sites are recorded within the vicinity of the development site. Nine known sites are recorded within the vicinity of the proposed development site. These include three possible DMV's. Two of these DMV's are located approximately 1.4km south southwest of the proposed development at Arleston (16715-MDR4296) and Arleston Farm House (16722-MDR8093). A third, recorded with ridge and furrow, is located at Sinfin, 1.3km to the east of the development site (18930-MDR4591). Also identified were four sites of ridge and furrow (27419-MDR4594, 27430-MDR4605, 27429-MDR4606 & 16721-MDR8092), which are probably associated with the DMV's and possibly form remnants of village in- and out-field systems. Potential ridge and furrow remains were also detected within the development site during the geophysical survey of 2007 (ASWYAS, 2007)."

Environment

Superficial 1:50000 BGS	None recorded
Bedrock 1:50000 BGS	Triassic Gunthorpe Member – Mudstone (GUN)
Topography	A continuum of flat land
Hydrology	Moderately well drained, presumed naturally
Current Land Use	Fallow, weedy mixed agricultural land
Historic Land Use	Mixed agricultural
Vegetation Cover	Various
Sources of Interference	Adjacent road and railway line, fencing, etc

2.2 Non-Devonian mudstone-based geological contexts tend to produce soils with variable magnetic susceptibility depending upon the actual geological member, hydrology and land use. Soils beneath pasture tend to present an apparently lower magnetic susceptibility than beneath arable land and seasonally wet areas of land can be associated with strong anomalies through cyclic redox processes changing the form of natural iron minerals.

2.3 Structures buried within these soils tend also to be variably magnetic and therefore to appear and disappear across a survey depending upon environmental factors. These can both pre- and post-date deposition of the actual soil units associated with the measured anomaly. Linear fills may appear as irregular or discontinuous anomalies in plan with marked variations in strength along their length. The visibility of small discrete magnetic fills cannot be assumed.

3 Methodology

Survey

Hardware

Measured Variable	Magnetic flux density / nT
Instrument	Array of Geometrics G858 Magmapper caesium magnetometers
Configuration	Non-gradiometric transverse array (4 sensors, ATV towed)
Sensitivity	0.03 nT @ 10 Hz (manufacturer's specification)
QA Procedure	Continuous observation
Resolution	1.0m between lines, 0.3m mean along line interval

Monitoring and quality assurance

3.1 The system continuously displays all incoming data as well as line speed and spatial data resolution per acquisition channel during survey. Rest mode system noise is therefore easy to inspect simply by pausing during survey and the continuous display makes monitoring for quality intrinsic to the process of undertaking a survey. Rest mode test results (static test) are available from the system.

3.2 A suitably qualified Project Geophysicist was in the field at all times and fieldwork and technical considerations were guided by the Senior Geophysicist.

Processing

Procedure

3.3 All data processing is minimised and limited to what is essential for the class of data being collected, e.g. reduction of orientation effects from magnetic sensors, suppression of single point defects (drop-outs or spikes), etc. The process stream for this data is as follows:

Process	**Software**	**Parameters**
Measurement and GNSS receiver data alignment	Proprietary	
Temporal reduction and regional field suppression	Proprietary	10s highpass median filter
Gridding	Surfer	Kriging, 0.25m x 0.25m
Imaging and presentation	Manifold GIS	

3.4 The initial processing uses proprietary software developed in conjunction with the multisensor acquisition system. Surfer is used for gridding and initial study before the data is ported as data surfaces (not images) into Manifold GIS for final imaging and detailed analysis. Specialist analysis is undertaken using proprietary software.

3.5 General information on processes commonly applied to data can be found in standard text books and also in the 2008 English Heritage Guidelines "*Geophysical Survey in Archaeological Field Evaluation*" at http://www.helm.org.uk/upload/pdf/Geophysical_LoRes.pdf.

3.6 ArchaeoPhysica uses more advanced processing for magnetic data using potential field techniques standard to near-surface geophysics. Details of these can be found in Blakely, 1996, "*Potential Theory in Gravity and Magnetic Applications*", Cambridge University Press.

3.7 All archived data includes process metadata.

Interpretive framework

Resources

3.8 Numerous sources are used in the interpretive process which takes into account shallow geological conditions, past and present land use, drainage, weather before and during survey, topography and any previous knowledge about the site and the surrounding area. Old Ordnance Survey mapping is consulted and also older sources if available.

Magnetic survey

3.9 Interpretative logic is based on structural class and examples are given below. For example a linear field or gradient enhancement defining an enclosed or semi-enclosed shape is likely to be a ditch fill, if there is no evidence for accumulation of susceptible material against a non-magnetic structure. Weakly dipolar discrete anomalies of small size are likely to have shallow non-ferrous sources and are therefore likely to be pits. Larger ones of the same class could also be pits or locally-deeper topsoil but if strongly magnetic could also be hearths. Strongly dipolar discrete anomalies are in all cases likely to be ferrous or similarly magnetic debris, although small repeatedly heated and *in-situ* hearths can produce similar anomalies. Reduced field strength (or gradient) linear anomalies without pronounced dipolar form are likely to be caused by relatively low susceptibility materials, e.g. masonry walls, stony banks or stony or sandy ditch fills.

Standards & guidance

3.10 All work was conducted in accordance with the following standards and guidance:

- David et al, "Geophysical Survey in Archaeological Field Evaluation", English Heritage 2008
- "Standard and Guidance for Archaeological Field Evaluation", Institute for Archaeologists 2008.

3.11 In addition, all work is undertaken in accordance with the high professional standards and technical competence expected by the Geological Society of London and the European Association of Geoscientists and Engineers.

3.12 All personnel are experienced surveyors trained to use the equipment in accordance with the manufacturer's expectations. All aspects of the work are monitored and directed by fully qualified professional geophysicists.

4 Catalogue

4.1 The numbers in square brackets in this report refer to the catalogue below and DWG 05.

Label	Anomaly Type	Feature Type	Description	Easting	Northing
1	Linear reduced field (group)	Free space	Major wheel ruts from agricultural plant, anomaly caused by increased distance of rut bottom from sensors	433192.5	331241.8
2	Linear reduced field (group)	Free space	See [1]	433238.2	331241.0
3	Linear enhanced field	Fill - Ditch	Former field boundary	433163.1	331214.4
4	Linear enhanced field	Fill - Ditch	See [3]	433246.1	331125.1
5	Linear reduced field (group)	Free space	See [1]	433156.0	331125.1
6	Various	Fills	Probable site of a pond, also visible as a soil mark	433273.5	331088.2
7	Linear enhanced field	Fill - Ditch? / Cultivation	This is close (< 20m) and nominally parallel to the southern side of [6], however, how they relate is unclear. This linear looks like an anomalously magnetic section of former furrow, presumably filled with relatively magnetic material	433269.5	331065.2
8	Linear enhanced field	Fill - Ditch	See [3]. This boundary appears to cut across the central region of ridge and furrow, unlike, for example, [10] to the south	433152.0	331043.8
9	Linear enhanced field	Fill - Ditch	See [3]	433090.1	330948.5
10	Linear enhanced field	Fill - Ditch	See [3]. This example bounds the northern end of the southern set of ridge and furrow and perhaps occupies a former headland	433198.5	330974.3
11	Area enhanced (group)	Fills - Cultivation	The southern set of ridge and furrow cultivation, with boundary ditch [10] to the north	433185.0	330922.3
12	Discrete dipolar (sample)	Debris	A typical anomaly from a (in this case a fairly deeply buried) item of ferrous debris, normal within cultivated fields in particular	433070.7	331107.7
13	Texture	Land use	A smooth uniform magnetic character caused by relatively low soil magnetic susceptibility	433057.2	331042.6

Label	Anomaly Type	Feature Type	Description	Easting	Northing
14	Texture	Land use	Within this area there is a large number of moderately strong dipolar responses caused by debris within the soil. The nature of this is unknown, however, fired ceramics, brick and tile introduced to improve drainage can produce this texture	433099.2	330908.0

5 Discussion

Introduction

5.1 The sections below first discuss the geophysical context within which the results need to be considered and then specific features or anomalies of particular interest. Not all will be discussed here and the reader is advised to consult the catalogue (*ibid*) in conjunction with the graphical elements of this report.

Principles

5.2 In general, topsoil is more magnetic than subsoil which can be slightly more magnetic than parent geology, whether sands, gravels or clays, however, there are exceptions to this. The reasons for this are natural and are due to biological processes in the topsoil that change iron between various oxidation states, each differently magnetic. Where there is an accumulation of topsoil or where topsoil has been incorporated into other features, a greater magnetic susceptibility will result.

5.3 Within landscapes soil tends to accumulate in negative features like pits and ditches and will include soil particles with thermo-remanent magnetization (TRM) through exposure to heat if there is settlement or industry nearby. In addition, particles slowly settling out of stationary water will attempt to align with the ambient magnetic field at the time, creating a deposit with depositional remanent magnetization (DRM).

5.4 As a consequence, magnetic survey is nearly always more a case of mapping accumulated magnetic soils than structures which would not be detected unless magnetic in their own right, *e.g.* built of brick or tile. As a prospecting tool it is thus indirect. Fortunately, the mechanisms outlined above are commonplace and favoured by human activity and it is nearly always the case that cut features will alter in some way the local magnetic field.

Instrumentation

5.5 The use of the magnetic sensors in non-gradiometric (vertical) configuration avoids measurement sensitisation to the shallowest region of the soil, allowing deeper structures, whether natural or otherwise to be imaged within the sensitivity of the instrumentation. However, this does remove suppression of ambient noise and temporal trends which have to be suppressed later during processing. When compared to vertical gradiometers in archaeological use, there is no significant reduction in lateral resolution when using non-gradiometric sensor arrays and the inability of gradiometers to detect laminar structures is completely avoided.

5.6 Caesium instrumentation has a greater sensitivity than fluxgate instruments, however, at the 10 Hz sampling rate used here this increase in sensitivity is limited to about one order of magnitude.

5.7 The array system is designed to be non-magnetic and to contribute virtually nothing to the magnetic measurement, whether through direct interference or through motion noise. There is, however, some limited contribution from the towing ATV.

Character & principal results

Geology

5.8 There are no major anomalies from geological sources and indeed, the character of the magnetic field is uniform across much of the site. The site is therefore fairly typical of a moderately deep soil (observed in a pipe trench) over a uniform bedrock.

Land use

5.9 There is increased apparent magnetic susceptibility in the former southern field [14] with stronger anomalies from ridge and furrow cultivation [11]. This is likely to reflect a difference in historic land use between the former fields, i.e. to predate their opening out into the present layout. There is also a much greater incidence of small items of magnetic debris in the former southern field.

5.10 The smooth character [13] of the former western field compared with the southern [14] is notable and again may reflect historic differences in land use, there being no known changes in geological context. Anomalies from ridge and furrow enter the field from the east and become markedly weaker, to disappear completely near the western field margin. This could represent a longer period of possible use as pasture post disuse of the ridge and furrow but it could also be caused by an increase in the depth of burial of relict furrows.

5.11 Within the former eastern field anomalies from ridge and furrow cultivation are fairly clear, more so than to the west and are superimposed upon a fairly uniform magnetic background. It may be that this field has seen increased cultivation before removal of the field boundaries with consequently a greater quantity of magnetic material within the topsoil.

5.12 The former field boundaries are all apparently ditches, their anomalies [3], [4], [8] – [10] typical of buried fills. They cross former ridge and furrow cultivation, with the exception of [10] which appears to coincide with a former cultivation headland and the implication is that they are all late additions to the landscape.

Archaeology

5.13 The only anomalies of possible archaeological interest and ignoring former field boundaries, are [6] and [7]. The former appears to be the site of a former pond, perhaps with traces of an artificial lining and measuring approximately 30m x 15m. However, it is not possible to discount some other form of similar buried structure and the presence of possible ditch fill [7] approximately 15m to the south might hint at the existence of some sort of complex of structures.

Conclusions

5.14 With the exception of anomalies [6] and [7] and the former field boundaries the survey data appears to contain little of archaeological interest. There is good evidence for ridge and furrow cultivation throughout the area but nothing that might suggest earlier field systems or complexes of ditch fills that might indicate former foci within the landscape.

Caveats

5.15 Geophysical survey is a systematic measurement of some physical property related to the earth. There are numerous sources of disturbance of this property, some due to archaeological features, some due to the measuring method, and others that relate to the environment in which the measurement is made. No disturbance, or ‘anomaly’, is capable of providing an unambiguous and comprehensive description of a feature, in particular in archaeological contexts where there are a myriad of factors involved.

5.16 The measured anomaly is generated by the presence or absence of certain materials within a feature, not by the feature itself. Not all archaeological features produce disturbances that can be detected by a particular instrument or methodology. For this reason, the absence of an anomaly must never be taken to mean the absence of an archaeological feature. The best surveys are those which use a variety of techniques over the same ground at resolutions adequate for the detection of a range of different features.

5.17 Where the specification is by a third party ArchaeoPhysica will always endeavour to produce the best possible result within any imposed constraints and any perceived failure of the specification remains the responsibility of that third party.

5.18 Where third party sources are used in interpretation or analysis ArchaeoPhysica will endeavour to verify their accuracy within reasonable limits but responsibility for any errors or omissions remains with the originator.

5.19 Any recommendations are made based upon the skills and experience of staff at ArchaeoPhysica and the information available to them at the time. ArchaeoPhysica is not responsible for the manner in which these may or may not be carried out, nor for any matters arising from the same.

Bibliography

Holland, 2012, "*Stenson Fields, Derbyshire – Written Scheme of Investigation for Geophysical Survey",* WYG Planning & Environment, job number A076927, unpublished

Appendices

Survey metadata

Project information

Project Name	Stenson Fields, Derbyshire
Project Code	SFD121
Client	WYG
Fieldwork Dates	25th – 26th October 2012
Field Personnel	ACK Roseveare, D Rouse
Processing Personnel	ACK Roseveare
Reporting Personnel	MJ Roseveare
Draft Report Date	16th November 2012
Final Report Date	6th December 2012

Qualifications & experience

5.20 All work is undertaken by qualified and experienced geophysicists who have specialised in the detection and mapping of near surface structures in archaeology and other disciplines using a wide variety of techniques. There is always a geophysicist qualified to post-graduate level on site during fieldwork and all processing and interpretation is undertaken under the direct influence of either the same individual or someone of similar qualifications and experience.

5.21 ArchaeoPhysica meets with ease the requirements of English Heritage in their 2008 Guidance "Geophysical Survey in Archaeological Field Evaluation" section 2.8 entitled "Competence of survey personnel". The company is one of the most experienced in European archaeological prospection and is a key professional player. It only employs people with recognised geoscience qualifications and capable of becoming Fellows of the Geological Society of London, the Chartered UK body for geophysicists and geologists.

Safety

5.22 Safety procedures follow the recommendations of the International Association of Geophysical Contractors (IAGC).

5.23 Principal personnel have passed the Rescue Emergency Care – Emergency First Aid course and CSCS cards are being sought for those members of staff currently without them.

5.24 All personnel are issued with appropriate PPE and receive training in its use. On all sites health and safety management is performed by the Project Geophysicist under supervision by the Operations Manager.

5.25 Health and safety policy documentation is reviewed every 12 months, or sooner if there is a change in UK legislation, a reported breach of such legislation, a reported Incident or Near Miss, or changes to ArchaeoPhysica's activities. Anne Roseveare, Operations Manager, has overall responsibility for conducting this review and ensuring documentation is maintained.

5.26 We are happy to confirm that ArchaeoPhysica has suffered no reportable accidents since its inception in 1998.

Archiving

5.27 ArchaeoPhysica maintains an archive for all its projects, access to which is permitted for research purposes. Copyright and intellectual property rights are retained by ArchaeoPhysica on all material it has produced, the client having full licence to use such material as benefits their project.

5.28 Archive formation is in the spirit of Schmidt, A., 2001, "Geophysical Data in Archaeology: A Guide to Good Practice", ADS.

5.29 Access is by appointment only. Some content is restricted and not available to third parties. There is no automatic right of access to this archive by members of the public. Some material retains commercial value and a charge may be made for its use. An administrative charge may be made for some enquiries, depending upon the exact nature of the request.

5.30 The archive contains all survey and project data, communications, field notes, reports and other related material including copies of third party data (e.g. CAD mapping, etc) in digital form. Many are in proprietary formats while report components are available in PDF format.

5.31 In addition, there are paper elements to some project archives, usually provided by the client. Nearly all elements of the archive that are generated by ArchaeoPhysica are digital.

5.32 It is the client's responsibility to ensure that reports are distributed to all parties with a necessary interest in the project, e.g. local government offices, including the HER where present. ArchaeoPhysica reserves the right to display data from projects on its website and in other marketing or research publications, usually with the consent of the client. Information that might locate the project is normally removed unless otherwise authorised by the client.