GEOPHYSICAL SURVEY OF AREAS ALONG THE ROUTE OF THE PROPOSED A63 SELBY BYPASS, NORTH YORKSHIRE

A programme of research carried out
on behalf of

BHWB Environmental Design and Planning

by

GeoQuest Associates

1 INTRODUCTION

1 1 This report presents the results of a programme of geophysical research which has been carried out on a number of areas within the route of the proposed A63 Selby Bypass, at Selby and Barlby in North Yorkshire (Figure 1) A total area of approximately 7 52 hectares was examined with the aim of providing information concerning the presence and character of subsoil archaeological and geotechnical features for which mitigation may be required prior to constructing the highway

1 2 The research was carried out by GeoQuest Associates (GQA) on behalf of BHWB Environmental Design and Planning, in accordance with technical specifications issued by Mr Ed Dennison of Ed Dennison Archaeological Services (EDAS) A detailed desk-based assessment by EDAS had previously been carried out as the first stage in a process of archaeological evaluation this work highlighted the archaeological potential of the area and identified a number of features that might be revealed by geophysical surveying A potential geotechnical hazard (in the form of a WWI munitions manufaetunng site) was also identified on the proposed bypass route near Barlby, and was hence was included in the present site investigation

1 3 The geophysical surveys took place during September and October 1999 when most of the arable areas were in a suitable condition for this type of investigation

2 LOCATION OF SURVEY BLOCKS

centred at 463 350 433080

2 1 Figure 1 shows the positions of area survey blocks B1, B2 and B3, about 1km E of Barlby village (NGR SE636346) and blocks S1, S2 and S3 which were located about 200m N of the Selby Canal on the A19 1 km S of Brayton (NGR SE598298) These blocks are described as follows

Area B1

2 2 A 200x20m rectangular strip immediately adjacent to the eastern fence of the A19 and 200m N of Magazine Road This field was in cereal stubble at the time of survey and is located north of a pig and poultry farm which formerly was the site of The National Trench Warfare (gas) Filling Factory during WWI Hence one aim of the survey in this area block was to test for the presence of buried tanks, waste pits, wall footings or other debris possibly relating to the factory that might present chemical or geotechnical hazards during the construction of the highway No earthworks were visible in this survey block which was generally level, with a drainage ditch on the western side of the field Heavy traffic was present on both carriageways of the A19 at distances of 15m - 35m from the geophysical surveying instruments

Area B2

2 3 This area compnsed a 100x200m rectangle, bordered to the W by the A19 and to the S by Magazine Road, and was continuous with block B1 in the same field of cereal stubble Block B2 was positioned to encompass the majority of area affected by a roundabout and slip road on the proposed bypass Here survey was again required to test for the presence of subsurface hazardous matenals and structures that may have been associated with the WWI Filling Factory This area was sufficiently large that any features of archaeological interest might also be detected

Area B3

2 4 An area of about 1 7ha in a level field of cereal stubble, centred on the route of the proposed bypass and extending S from Magazine Road towards the Leeds-York railway line This area is bounded on the E by a drain and old hedgeline shown partly in Figure 1 Traffic along the railway was light dunng the survey penod and therefore had a negligible effect on the geophysical survey data

Area S1

2 5 This block measured about 180x80m and was positioned within the SW corner of a pasture field, with hedge and wire fenced borders on the W, S and E Heavy traffic was again present along the A19 dunng the course of the geophysical survey and may have degraded the data quality within a range of about 20m from the highway This survey area was generally flat with no visible earthworks and was positioned (with S2) to test for the presence of archaeological features in the vicinity of a junction roundabout for the proposed bypass

Area S2

2 6 An L-shaped survey block, with 100m long extension, situated in an angle formed by the existing A19 and an E-W onented drainage ditch, designed to test for the presence of subsoil archaeological features At the time of survey the field bore a mature mixed crop of beet and brassica interspersed with weeds up to 1m tall These conditions were a hindrance to the geophysical survey and the data quality may have been reduced as a result of the uneven terrain indeed survey was not possible within a 20m long section with particularly dense vegetation (Figure 1)

Area S3

2 7 A second L-shaped survey block whose baseline was parallel to S2 but with a 3m gap to accommodate a wide held drain This study area was located in a level field

of cereal stubble and was placed to test for subsurface features along the intended route of the bypass, east of the junction roundabout

Setting Out and Map Base

2 8 Baselines for each survey block were established and located with respect geographic features using fibron survey tapes to a general accuracy of ±0 2m (Figure 7) Sets of 20x20m survey grids were then constructed away from each baseline using a precision optical square and fibron tapes Using the tie-in measurements each block was then positioned on an OS digital map within a Computer Aided Drawing system to form the basis for each of the plans presented in this report The geophysical survey archive supplied to BHWB contains AutoCAD dxf file versions of the digital drawings thus created during this project

3 THE GEOPHYSICAL SURVEYS

Choice of Techniques

3 1 Geophysical surveying provides a rapid method for the detection of subsurface features and can involve the use of many different and complementary techniques Within the context of this project, the aims were to locate archaeological and geotechnical features for which mitigation measures may be required during the construction of the proposed bypass, slip roads and associated services

3 2 Following discussions with EDAS, and an evaluation of the likely characteristics of subsurface targets, it was decided that a combination of electromagnetic and geophysical survey methods would be appropriate for the investigation of Barlby areas B1, B2 and B3 The use of geomagnetic survey alone was considered adequate for characterising possible subsoil archaeological targets in Selby areas S1, S2 and S3

Electromagnetic Survey

3 3 Electromagnetic prospecting employs a portable coil to induce eddy currents within the ground whose magnitude is proportional to the distribution and value of conductivity (ie moisture and dissolved electrolytes) in subsoil layers A second coil records the strength of magnetic fields associated with the eddy currents, providing a direct measure of the conductivity-moisture distribution beneath the point of induction

3 4 The electromagnetic survey employed a Geonics EM31 instrument, in vertical-coplanar coil configuration, to map lateral changes in subsoil conductivity and

magnetic susceptibility Data were recorded at 2m intervals along traverses spaced 2m apart A fixed boom onentation was maintained dunng successive traverses to avoid data artifacts due to possible conductivity or susceptibility anisotropy in subsurface matenals

3 5 The data were logged onto a portable tape recorder and transferred to a laboratory computer for processing, interpretation and archiving

Geomagnetic Survey

3 6 Measurements of vertical geomagnetic field gradient were recorded using a Geoscan FM36 fluxgate gradiometer A zig-zag traverse scheme was employed and data were logged in grid units of 20x20m at 1 0x0 5m intervals, thus providing 800 measurements per gnd Appendix A provides further information about the technique

3 7 Data were penodically downloaded on-site into an IBM Thinkpad computer for processing, pnnting and storage These data were subsequently transferred to a laboratory computer for final processing, interpretation and archiving

Data Processing

3 8 The GeoQuest InSite® software was used to process both sets of geophysical data and to produce continuous tone grey-scale images at a scale of 1 1000 These results are shown in Figures 2, 3 and 4 A convention is used that shows positive anomalies as dark grey and negative anomalies as light grey Figures 2-4 include keys which relates the grey-scale intensities to anomaly values in Seimens and nano Tesla per metre

3 9 The following basic processing steps were applied to the data

Removal of striping artifacts in the geomagnetic images caused by alternating changes in level between zig-zag traverses

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

DeShear corrects for apparent shear in strong geomagnetic anomalies surveyed by zig-zag traversing

Correction for drift in the FM36 magnetometer and EM31 conductivity meter calibration with time

Adjustment of grid mean values to achieve an optimum match along the lines of contact between magnetic and elctromagnetic data gnds

Interpolation of the data, using a bilinear function, to generate a regular mesh of values at 0 25 x 0 25m (geomagnetic data) or 0 5 x 0 5m (electromagnetic data) intervals

3 10 The geophysical images were printed 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 Appendix B provides more information about data processing and itemises the algorithms that were applied to produce the grey-scale images

3 11 A number of significant anomalies have been detected in the data and these are presented on a 1 1000 geophysical interpretation plan using coded colours and patterns (Figure 5) The following types of anomaly have been distinguished

Green Significant regions of anomalously high or positive magnetic field gradient which might be associated with high susceptibility, soil-filled structures such as pits and ditches

Blue Areas of anomalously low or negative magnetic field gradient, corresponding to features of low magnetic susceptibility, such as concentrations of rock rubble

Red Strong dipolar anomalies (paired positive-negative) which almost certainly reflect ferrous debris near the surface Most of these anomalies have been ignored in the subsequent archaeological interpretation

Brown Areas of anomalously low ground conductivity (=high resistivity) which generally will reflect regions of reduced soil moisture such as buried stone or air filled voids

Orange Regions of increased ground conductivity (=low resistivity) where the subsoil has an increased degree of saturation (eg channel fills) or where the instrument detects a buned metallic conductor (eg a metal pipe)

3 12 A physical interpretation plan at 1 2500 scale is presented in Figure 6 and shows geotechical and archaeological features conjectured from the geophysical survey data

4 INTERPRETATION

Area B1

4 1 Geomagnetic anomalies and electromagnetic anomalies within this sample strip were very intense and contain a noise component due to the effects of adjacent traffic Both data sets contain a distinct linear anomaly which runs sub-parallel to the A19 fence along the entire length of the sample strip The buried target is charactensed by high electrical conductivity and high magnetic susceptibility, providing good evidence that the source is a buried ferrous pipe

4 2 The geophysical data provide no evidence for any additional features of archaeological or geotechnical interest within area B1

Area B2

4 3 Figure 3 shows that the electromagnetic survey has detected an intense, high conductivity anomaly adjacent to the A19 which appears to reflect a continuation south of the buried metal pipe located in area B1 (Figure 6) Geomagnetic survey of the remaining area has mapped a number of weak and diffuse anomalies consistent with natural variations in drainage and subsoil character in the em31 depth range (*circa* 0-5m)

4 4 Geomagnetic survey of this area has also located the buried ferrous pipe which appears to continue south towards the start of Magazine Road

4 5 Three sub-circular areas of low magnetic susceptibility have been detected close to the approximate positions of the electricity poles (from field notes), suggesting that these extant structures are set in foundations of concrete or stone, about 4m in diameter

4 6 Of possible archaeological interest is the presence of a number of exceptionally weak and diffuse, positive magnetic lineations which appear to form a rectilinear network within the NE corner of this survey area These anomalies have been examined on a high resolution computer monitor in order to construct the interpretation shown in Figure 6 which conjectures a set of soil-filled ditches that may compnse one or more enclosures

4 7 The geomagnetic survey has mapped a set of positive anomalies that form a sinuous branching pattern in the SE corner of this area A similar pattern has been located in the northern half of area B3 (see below) These features almost certainly reflect a system of infilled palaeochannels whose axis of flow was in a generally N-S (or S-N) direction

4 8 A 5m diameter, positive magnetic anomaly has been located about 15m NNE of the southernmost electricity pole and may represent a pit of archaeological or geotechnical significance

4 9 The geophysical data provide no evidence for any additional features of archaeological or geotechnical interest within area B2

Area B3

4 10 A very intense N-S oriented, positive anomaly has been mapped by the electromagnetic survey within the eastern half of this survey area This anomaly correlates with a linear chain of dipoles detected by the fluxgate magnetometer suggesting that a buried ferrous pipe is present in this position (Figure 6) This pipe would appear to pass close to the entrance gate to the present pig farm and may thus once have been related to the WWI Trench Warfare Filling Factory

4 11 The geomagnetic survey has mapped a set of sinuous, positive anomalies of similar character to those revealed in Area B2 These features are therefore interpreted as representing a continuation of the silted palaeomeanders described in paragraph 4 5 above It is interesting to note that the electromagnetic survey has also detected a weak pattern of anomalies in this area, suggesting that the palaeochannel stratigraphy may include components at greater depths than those seen in area B2 (to circa 5m)

4 12 An intense magnetic dipole has been located close to the SE corner of this survey area The geomagnetic orientation of this anomaly is consistent with acquisition of thermoremanent magnetisation as a result of a burning, raising the possibility that the survey has detected a buried fired structure, such as a kiln or hearth

4 13 The geophysical data provide no evidence for any additional features of archaeological or geotechnical interest within area B3

Area S1

4 14 A spread of intense magnetic dipoles has been detected within the western third of this survey area suggesting that the ground here has been contaminated with brick rubble or metal debris This has had the effect of masking more subtle geomagnetic anomalies of possible archaeological interest

4 15 Two further areas of magnetic dipoles have been mapped along the northern and southern boundaries of this area and are again interpreted as reflecting concentrations of recent ferrous or brick debris

4 16 A 20m long chain of intense magnetic dipoles near the eastern limit of the survey area provides good evidence for the presence of a short length of ferrous pipe in this position (Figure 6)

4 17 No further geophysical anomalies of archaeological or geotechnical interest have been located within area S1

Area S2

4 18 Positive and negative arcuate magnetic lineations have given a 'swirling' texture to the geophysical image of the southern half of this area Part of this pattern appears to connect with a weak positive lineation that extends NNE for a 40m through the north central part of the area Possible interpretations of these anomalies include a set of minor silted palaeochannels or several small ditched enclosures

4 19 The geophysical data provide no evidence for any additional features of archaeological or geotechnical interest within area S2 However, it should again be noted that the data quality has been somewhat reduced by the difficult ground conditions (see paragraph 2 5) to the extent that more subtle anomalies of possible archaeological interest may have gone undetected

Area S3

4 20 Two linear chains of intense magnetic dipoles provide good evidence for the presence of buned iron pipes in the positions shown in Figure 6 One of these pipes runs parallel to the field boundary that forms the eastern edge of this survey area

4 21 The geophysical data provide no evidence for any additional features of archaeological or geotechnical interest within area S3

5 SUMMARY AND CONCLUSIONS

5 1 Electromagnetic and geomagnetic surveys have been earned out on six areas of land along the proposed route of the A63 Selby Bypass in North Yorkshire The aims of the survey were to identify features of archaeological interest, and to test for structures, waste pits or sites of contamination associated with a WWI munitions plant near the proposed route east of Barlby

5 2 Few subsoil features of archaeological interest have been located by the geophysical surveys However a number of anomalies of geotechnical importance were detected these include metal pipelines and a system of silted palaeochannels beneath the Barlby study area

6 CREDITS

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Report	M J Noel PhD, FRAS
Date	4th December 1999

Note Whilst every effort has been taken in the preparation and submission of this report in order to provide as complete an assessment as possible within the terms of the brief GeoQuest Associates cannot accept any responsibility for consequences arising as a result of unknown and undiscovered sites or artifacts or features of geotechnical significance