A57 Link Roads
TR010034
6.5 Environmental Statement Appendix 6.3 Geophysical Survey Written Scheme of Investigation

APFP Regulation Regulation 5(2)(a)
Planning Act 2008 Infrastructure Planning (Applications: Prescribed

Forms and Procedure) Regulations 2009

June 2021

Written Scheme of Investigation

For a Geophysical Survey

of

Mottram

Greater Manchester

For

Balfour Beatty Atkins

On Behalf Of

Highways England

Magnitude Surveys Ref: MSSK798

February 2021

Unit 17, Commerce Court

Challenge Way

Bradford

BD4 8NW

[redacted]

Version	Purpose/Revision	Author	Figures	Approved By	Date Issued
0.1	WSI	[redacted]	[redacted]	[redacted]	03 February 2021
0.2	Corrections from Client	[redacted]	[redacted]	[redacted]	12 February 2021

Print Name:	Signature:	Role:	Date:

Contents

1. Introduction 4
2. Objective 4
3. Quality Assurance 4
4. Risk Assessment 5
5. Methodology 5
5.1. Data Collection 5
5.2. Data Processing 6
5.3. Data Visualisation and Interpretation 7
6. Reporting 7
7. Archiving 8
8. Copyright 8
9. References 9

Figure 1 – Site Location 1:25,000 @ A4

Figure 2 – Survey Area 1:10,000 @ A3

1. Introduction

1.1. This document details a Written Scheme of Investigation for a geophysical survey by Magnitude Surveys Ltd (MS) for Balfour Beatty Atkins on behalf of Highways England. The survey comprises a c. 18.5ha area of land at Mottram, Greater Manchester (SK 00630 95587).

1.2. The geophysical survey will comprise hand-pulled/quad-towed, cart-mounted or hand-carried GNSS-positioned fluxgate gradiometer survey. Magnetic survey is the standard primary geophysical method for archaeological applications in the UK for its ability to detect a range of different features. The technique is particularly suited to detecting fired or magnetically enhanced features, such as ditches, pits, kilns, sunken featured buildings (SFBs) and industrial activity (David *et al.*, 2008).

1.3. The survey will be conducted in line with the current best practice guidelines produced by Historic England (David *et al.*, 2008), the Chartered Institute for Archaeologists (CIfA, 2020) and the European Archaeological Council (Schmidt *et al.*, 2015).

1.4. The WSI and survey will also support the Cultural Heritage chapter of the Environmental Statement that will be submitted with the Development Consent Order application for the Scheme.

2. Objective

2.1. The objective of this geophysical survey is to assess the subsurface archaeological potential of the survey area. It will also help to inform the archaeological assessment work that would be required to mitigate potential adverse effects the proposed A57 Link Roads Scheme.

3. Quality Assurance

3.1. Project management, survey work, data processing and report production will be carried out by qualified and professional geophysicists to standards exceeding the current best practice (CIfA, 2020; David *et al.*, 2008; Schmidt *et al.*, 2015). All MS managers, field and office staff have degree qualifications relevant to archaeology or geophysics and/or field experience.

3.2. Magnitude Surveys is a Registered Organisation of the Chartered Institute for Archaeologists (CIfA), the chartered UK body for archaeologists, and a corporate member of ISAP (International Society for Archaeological Prospection).

3.3. The directors of MS are involved in cutting edge research and the development of guidance/policy. Specifically, Dr [redacted] has a PhD in archaeological geophysics from the University of Bradford, is a Member of CIfA and is the Vice-Chair of the International Society for Archaeological Prospection (ISAP); [redacted] has an MSc in archaeological geophysics and is a Fellow of the London Geological Society, as well as a member of GeoSIG (CIfA Geophysics Special Interest Group); [redacted] has a PhD in archaeological geophysics from Bournemouth University, is a Member of CIfA, the Editor of ISAP News, and is the UK Management Committee representative for the COST Action SAGA; [redacted] has a PhD in archaeology from the University of Southampton, has been a member of the ISAP Management Committee since 2015, and is currently the nominated representative for the EAA

Archaeological Prospection Community to the board of the European Archaeological Association.

3.4. MS has developed a bespoke geophysical system whereby data is live-streamed from the field back to the office while fieldwork is ongoing. This allows for data to be regularly monitored not only in the field, but by managers in a controlled office environment. Coverage gaps or small errors within the data can be quickly identified and rectified, improving quality control of field survey. The live data streaming allows MS to provide processed data to the client at regular intervals, allowing all parties to be informed of the field survey's progress. Should it become apparent that the survey is being compromised by local conditions, such as the spreading of green waste, this will be reported back to the client and a mitigation strategy can be devised if necessary.

4. Risk Assessment

4.1. MS has a Risk Assessment and Method Statement (RAMS) for survey that can be provided on request and will be updated to reflect any site conditions we are notified of in advance. Before geophysical survey commences, a brief walkover will be undertaken to identify any additional hazards of an unusual or site-specific nature. If any additional hazards are identified, an additional site-specific risk assessment will be updated to include these hazards and all surveyors will be informed of the risk. If appropriate mitigation factors cannot be put in place, then the field or part thereof will not be surveyed.

4.2. Field staff will attend a site induction if required. Necessary PPE will be supplied and worn. Wet and cold/hot weather protection is also supplied.

4.3. All surveyors have been issued company mobile phones. Survey teams are expected to make regular contact with the office to keep all parties updated with survey progress. Any change in conditions that may affect the health and safety of the survey team must be reported immediately.

4.4. The survey van contains suitable welfare facilities. Antiseptic hand gel is provided, as is bottled drinking water. A first aid kit is stored in the cab of the van, with a second kit near personnel within the survey area.

4.5. The nearest NHS urgent care centre is at Tameside & Glossop Integrated Care NHS Foundation Trust, Fountain St, Ashton Under Lyne, Lancashire, OL6 9RW. Should toilets be unavailable on site, the nearest public accessible toilet is located at t Market Pl, Mottram in Longdendale, Hyde SK14 6JD.

5. Methodology

5.1. Data Collection

5.1.1. Magnetometer surveys are generally the most cost effective and suitable geophysical technique for the detection of archaeology in England. Therefore, a magnetometer survey should be the preferred geophysical technique unless its use is precluded by any specific survey objectives or the site environment. For this site, no factors precluded the recommendation of a standard magnetometer survey.

5.1.2. For this reason, geophysical survey will comprise the magnetic method as described in the following table.

5.1.3. Table of survey strategies:

Method	Instrument	Traverse Interval	Sample Interval
Magnetic	Bartington Instruments Grad-13 Digital Three-Axis Gradiometer	1 m	200 Hz reprojected to 0.125 m

5.1.4. MS employs a modular cart system, which can easily be configured to be towed by quad, pulled by hand, or carried depending on what is most suitable for the site configuration and conditions. The system can be hand-carried so that survey can be undertaken should conditions preclude survey with the wheels. The hand carried system retains all of the advantages of a cart system because it is still GNSS positioned and the sensors are maintained at a consistent height.

5.1.5. Magnetic data will be collected using MS' bespoke, hand-pulled/quad-towed cart system or hand-carried GNSS-positioned system. MS' cart or hand-carried system will be comprised of Bartington Instruments Grad 13 Digital Three-Axis Gradiometers. Positional referencing will be through a multi-channel, multi-constellation GNSS Smart Antenna RTK GPS outputting in NMEA mode to ensure high positional accuracy of collected measurements. The RTK GPS is accurate to 0.008m + 1ppm in the horizontal and 0.015m + 1ppm in the vertical.

5.1.6. Magnetic and GPS data will be stored on an SD card within MS' bespoke datalogger. The datalogger is continuously synced, via an in-field Wi-Fi unit, to servers within MS' offices. This allows data collection, processing and visualisation to be monitored in real-time as fieldwork is ongoing (see Section 3.4).

5.1.7. A navigation system integrated with the RTK GPS will be used to guide the surveyor, whether the system is being quad towed, hand pulled or carried. Where possible, allowing for terrain, crops and obstacles, data will be collected by traversing the survey area along the longest possible lines, ensuring efficient collection and processing.

5.2. Data Processing

5.2.1. Magnetic data will be processed in bespoke in-house software produced by MS. Processing steps conform to the EAC and Historic England guidelines for 'minimally enhanced data' (see Section 3.8 in Schmidt *et al.*, 2015: 33 and Section IV.2 in David *et al.*, 2008: 11). Data plots contained within the report also conform to these guidelines.

<u>Sensor Calibration</u> – The sensors will be calibrated using a bespoke in-house algorithm, which conforms to Olsen *et al.* (2003).

Zero Median Traverse – The median of each sensor traverse will be calculated within a specified range and subtracted from the collected data. This removes striping effects caused by small variations in sensor electronics.

Projection to a Regular Grid – Data collected using RTK GPS positioning requires a uniform grid projection to visualise data. Data will be rotated to best fit an orthogonal grid projection and are resampled onto the grid using an inverse distance-weighting algorithm.

Interpolation to Square Pixels – Data will be interpolated using a bicubic algorithm to increase the pixel density between sensor traverses. This produces images with square pixels for ease of visualisation.

5.3. Data Visualisation and Interpretation

5.3.1. The report will present the gradient of the sensors' total field data as greyscale images, as well as the total field data from the upper and/or lower sensors, where appropriate. The gradient of the sensors minimises external interferences and reduces the blown-out responses from ferrous and other high contrast material. However, the contrast of weak or ephemeral anomalies can be reduced through the process of calculating the gradient. Consequently, some features can be clearer in the respective gradient or total field datasets. Multiple greyscale images at different plotting ranges will be used for data interpretation.

5.3.2. Geophysical results will be interpreted using greyscale images and XY traces in a layered environment, overlaid against OS Open Data, satellite imagery, historical maps, LiDAR data, and soil and geology mapping. Google Earth (2021) will also be consulted, to compare the results with recent land use.

5.3.3. Geodetic position of results – All vector and raster data will be projected into OSGB36 (ESPG27700) and provided upon request in ESRI Shapefile (.SHP) and Geotiff (.TIF) respectively. Figures will be provided with raster and vector data projected against

6. Reporting

6.1. A detailed report of the survey will be produced after data collection is completed. The final report will include as standard:

- Abstract
- Introduction – Details survey location and client details.
- Quality Assurance – Details the expertise of Magnitude Surveys and Magnitude Surveys employees undertaking the work.
- Objectives – Details survey objectives.
- Geographic Background – Details the soils and geology of the survey area, as well as providing a general summary of site conditions at time of survey.
- Survey Considerations – Details specific points of note for each survey area, including topography, upstanding obstructions or neighbouring objects.

- Archaeological Background – Details a brief summary of the archaeological and historical background of the survey area and its immediate environs. While this will not be an exhaustive assessment, it will draw on elements relevant to the results obtained during survey.

- Methodology – Details survey strategy employed, instruments used, data collection strategy, data processing and visualisation methods.

- Results – Details the results and interpretation of the geophysical survey, both in a general context and in terms of specific anomalies of archaeological interest. Geophysical results will be discussed in combination with satellite imagery, historical mapping and LiDAR data - if freely available - as supporting interpretative evidence.

- Conclusions

- Archiving

- Copyright

- References

- Figures – The survey location and individual survey areas will be presented. Georeferenced greyscale images of the minimally enhanced data, XY traces and corresponding interpretations will be displayed at appropriate scales. Interpretations will also be displayed over satellite imagery, historical mapping and LiDAR - as applicable - to provide further context for the interpretations. All figures will include a detailed scale bar, north arrow and key.

7. Archiving

7.1. MS maintains an in-house digital archive, which is based on Schmidt and Ernenwein (2013). This archive stores the collected measurements, minimally processed data, georeferenced and un-georeferenced images, XY traces and a copy of the final report. A copy of this archive will be included on a disk with a final printed report.

7.2. MS contributes reports to the ADS Grey Literature Library upon permission from the client, subject to any dictated time embargoes.

7.3. An OASIS form will be filled in on completion of the survey, providing permission has been granted by the client.

8. Copyright

8.1. Copyright and the intellectual property pertaining to all reports, figures and datasets produced by Magnitude Services Ltd is retained by MS. The client is given full licence to use such material for their own purposes. Permission must be sought by any third party wishing to use or reproduce any IP owned by MS.

9. References

Chartered Institute for Archaeologists, 2020. Standard and guidance for archaeological geophysical survey. CIfA.

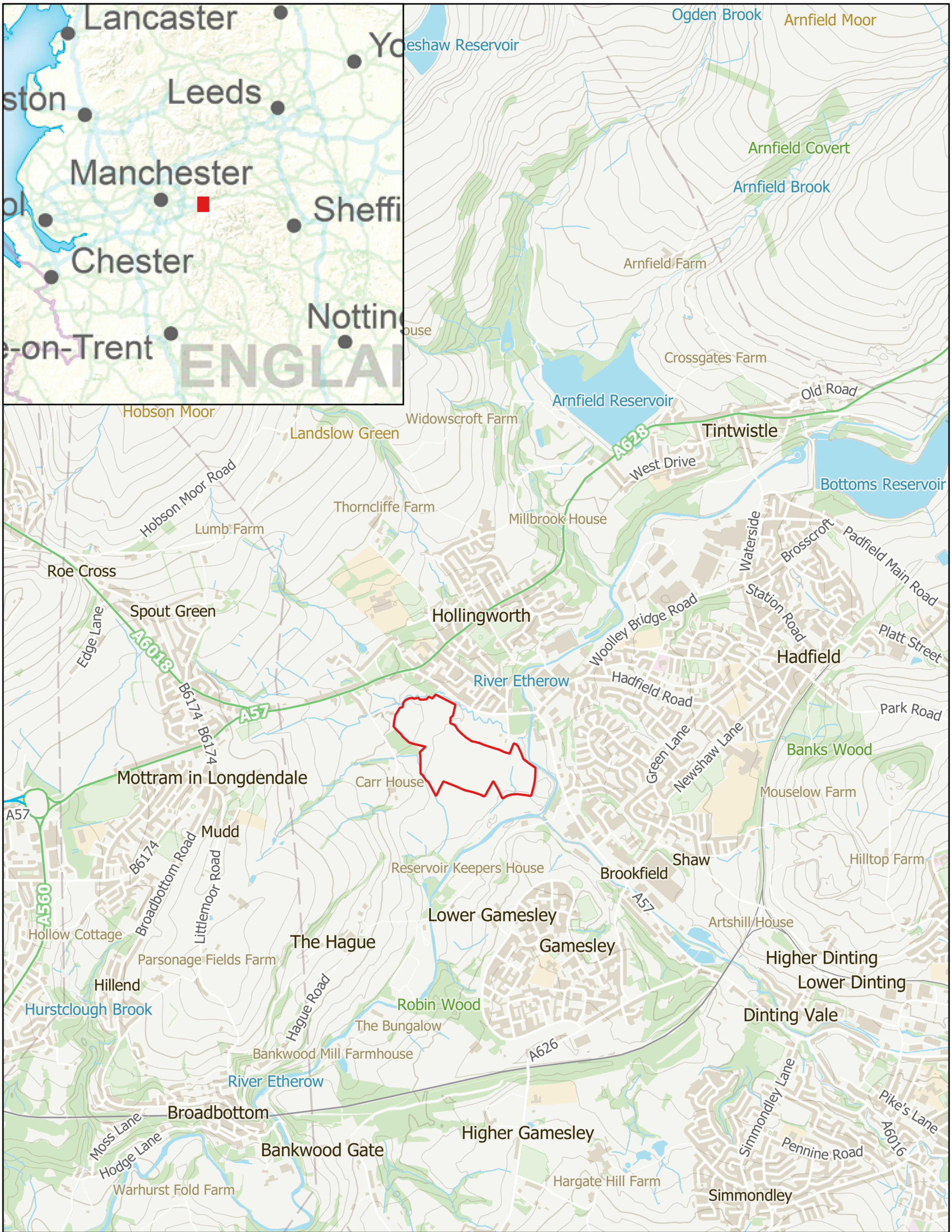
David, A., Linford, N., Linford, P. and Martin, L., 2008. Geophysical survey in archaeological field evaluation: research and professional services guidelines (2nd edition). Historic England.

Google Earth, 2021. Google Earth Pro V 7.1.7.2606.

Olsen, N., Toffner-Clausen, L., Sabaka, T.J., Brauer, P., Merayo, J.M.G., Jorgensen, J.L., Leger, J.M., Nielsen, O.V., Primdahl, F., and Risbo, T., 2003. Calibration of the Orsted vector magnetometer. Earth Planets Space 55: 11-18.

Schmidt, A. and Ernenwein, E., 2013. Guide to good practice: geophysical data in archaeology. (2nd edition). Oxbow Books: Oxford.

Schmidt, A., Linford, P., Linford, N., David, A., Gaffney, C., Sarris, A. and Fassbinder, J., 2015. Guidelines for the use of geophysics in archaeology: questions to ask and points to consider. EAC Guidelines 2. European Archaeological Council: Belgium.



MSSK798B - Mottram
Figure 1 - Site Location
1:25,000 @ A4

N

0 0.5 1 km

Site Boundary

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MSSK798B - Mottram
Figure 2 - Location of Survey Area
1:10,000 @ A3

Survey Area

N

0 250 500 750 m

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