1.3 LEGAL FRAMEWORKS AND PLANNING GUIDANCE

1.3.1 Legal frameworks

This HA aims to address the requirements of relevant legal frameworks and planning policy pertinent to the site and its proposed development. The following apply:

National and Regional Planning Framework

- National Planning Policy Framework (DCLG 2012)

Guidance

- National Planning Policy Guidance (NPPG)
- Historic England, 2015. Good Practice Advice in Planning Note 3: The Setting of Heritage Assets

2.0 RESEARCH METHODOLOGY

The HA has been prepared with reference to the Chartered Institute for Archaeologists (2014) *Standard and Guidance for Historic Environment Desk-Based Assessment* and also takes into account Historic England's *Good Practice Advice in Planning Note 3: The Setting of Heritage Assets* (2015).

For the purposes of the assessment, a 1km buffer around the site was used as a study area.

2.1 DESK-BASED RESEARCH

2.1.1 Sources

The following were consulted as part of the process:

- South Yorkshire Historic Environment Record
- Historic England Archive
- Historic maps
- Aerial photographs (Historic England Archives)
- Published and unpublished sources

2.1.2 Gazetteer

Each component or feature of the historic landscape identified within the study area (through desk-based research or on the ground) has been allocated a unique number, and plotted onto Ordnance Survey mapping. Gazetteer entries for each of the features are included as Appendix A.

2.1.3 Aerial photographs

The proposed site has not been covered by the National Mapping Programme, and so cropmark plots did not exist for the site. Aerial photographs held at Historic England Archives were consulted, copies obtained and the visible cropmarks plotted onto Ordnance Survey mapping.

3.0 ASSESSMENT OF SIGNIFICANCE AND IMPACT

3.1.1 Assessment of significance

Heritage significance has been assessed taking into account:

- archaeological interest
- architectural interest
- artistic interest
- historic interest

The following grades of significance have been employed:

- **Exceptional significance** - resources which can be demonstrated to have international or national significance, special relevance to British history or culture, and/or are of extraordinary or unique archaeological, architectural, artistic or historic merit. This will include World Heritage Sites, Scheduled Ancient Monuments (or those monuments which otherwise meet scheduling criteria) all Listed Buildings Grades I and II*, Registered Historic Parks and Gardens grades I and II*, and Registered Historic Battlefields;
- **Considerable significance** - resources with importance within a national or regional context, due to special archaeological, architectural, artistic or historic interest. This category will include Conservation Areas, Grade II Listed Buildings and Registered Parks and Gardens Grade II;
- **Moderate significance** - resources of local importance. This might include heritage assets with archaeological, architectural, historic or artistic interest, but which do not meet the criteria for designation;
- **Some significance** - resources of limited local importance, due to their high frequency, lack of provenance or limited survival. This might include resources of local significance that have been partially destroyed by past land use, whether by agricultural activity or built development;
- **Unknown significance** - resources of uncertain importance based upon their type or condition.

3.1.2 Assessment of impact

The impact of development upon the significance of a heritage asset may be adverse or beneficial. The significance of a heritage asset might be affected by direct physical impact, including destruction, demolition and alteration, but may also be affected by changes to its setting. This could include changes to the historic character of an area, alterations to views to and from a site,

accidental damage from construction work, temporary loss of amenities (largely arising during development work and including air and noise pollution, visual intrusion, increased traffic, changes in the character of a landscape or townscape).

Categories of impact have been graded thus:

- **Substantial** - elements which contribute to the significance of the heritage asset, including its setting, are substantially harmed or lost;
- **Moderate** - elements which contribute to the significance of the heritage asset, including its setting, are harmed;
- **Slight** - there is change to elements which contribute to the significance of the heritage asset or its setting, but that harm is minimal;
- **Beneficial** - those elements which contribute to the significance of the heritage asset, including its setting, are enhanced or better revealed;
- **No change** - no change.

Following consideration of the value of the heritage asset, the attributes which contribute to its significance and the likely magnitude of the impact of development on those attributes, an assessment can be made of the overall effect of the proposed development on each asset and on the heritage resource as a whole. This is broadly based on the assumption that the most significant effect will result in circumstances where the very highest impact occurs to very important remains.

4.0 BASELINE CONDITIONS

4.1 DESIGNATED HERITAGE ASSETS

No designated heritage assets were identified within, or adjacent to, the site boundary.

4.1.1 Scheduled Monument

One Scheduled Monument was identified in the study area, being the early medieval cross at Darfield (HA 3) to the north.

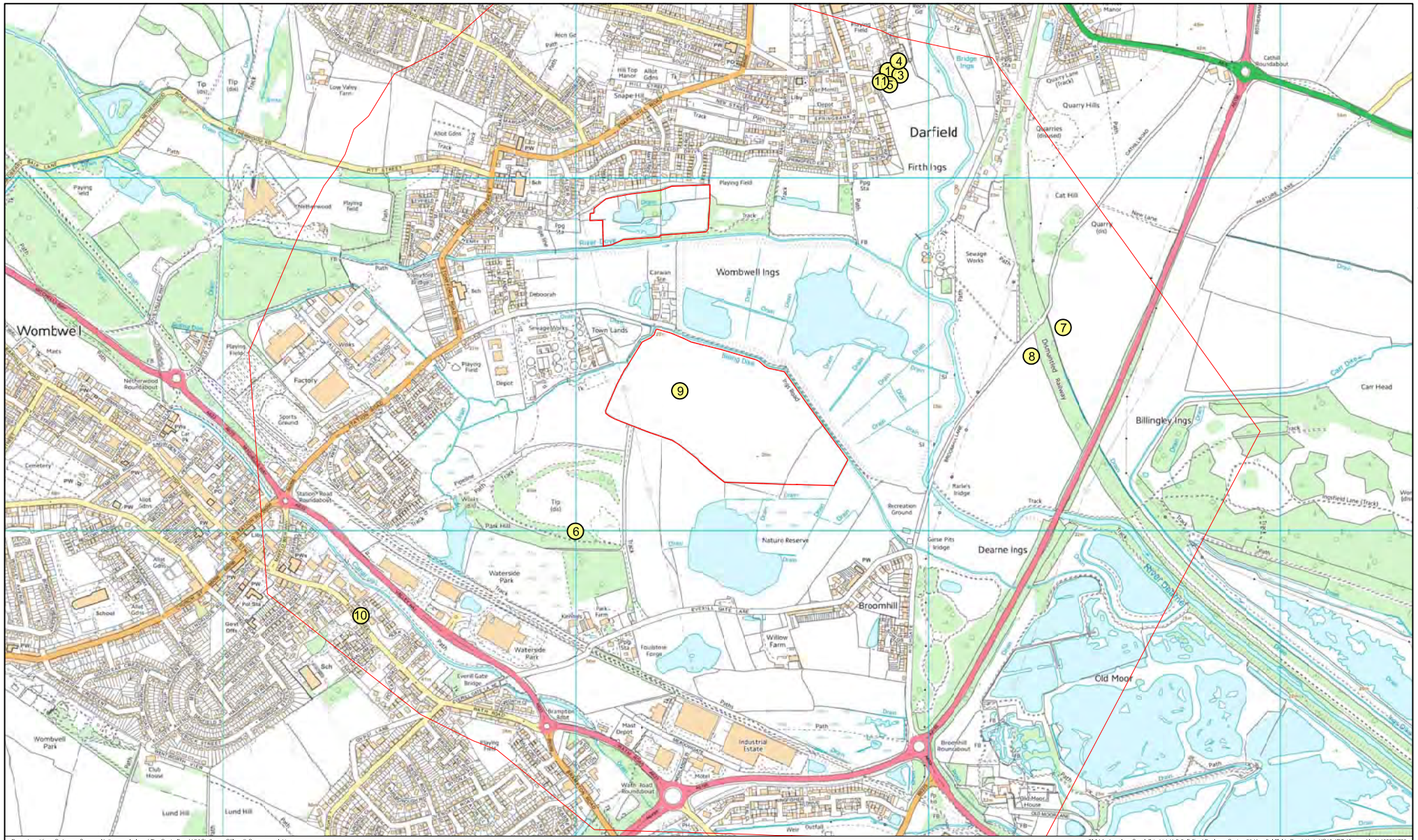
4.1.2 Listed Buildings

Two Listed Buildings were identified in the study area. The church of All Saints, to the north, is Grade I Listed (HA 1), and a 19th-century obelisk in the churchyard is Grade II Listed (HA 5).

It is not anticipated that the proposed work would harm the setting of any heritage assets.

4.2 NON-DESIGNATED HERITAGE ASSETS

The South Yorkshire HER records 11 heritage assets within the study area, ranging in date from prehistory to the modern day (Figure 2).



Location of heritage assets

Scale 1:15000

Figure 2

5.0 ARCHAEOLOGICAL AND HISTORICAL BACKGROUND

The known archaeological and historical background for the area is presented, deriving from a search of the South Yorkshire Historic Environment Record, and subsequent historic map regression and documentary research.

5.1 GEOLOGY

A description of the geological background of the area, and the results of sedimentological analysis of the area to the immediate northeast of the proposed site, are presented in Lillie and Cheetham (1999) 'Sedimentological analysis of the River Dearne Floodplain and its environs, Wombwell Ings, South Yorkshire', which should be referred to for greater detail.

The solid and drift deposits of the area are mapped on Sheet 87, Barnsley (Geological Survey of Great Britain, BGS). The solid geology in the area of Wombwell Ings comprises middle coal measures of Upper Carboniferous age, with sandstone outcrops in areas to the north and south of the River Dearne.

Glacial sands and gravels, and boulder clays survive in limited patches in the surrounding area; an outcrop of glacial sand and gravel is recorded in the vicinity of the proposed site. The BGS records spreads of alluvium flanking the rivers Dove and Dearne.

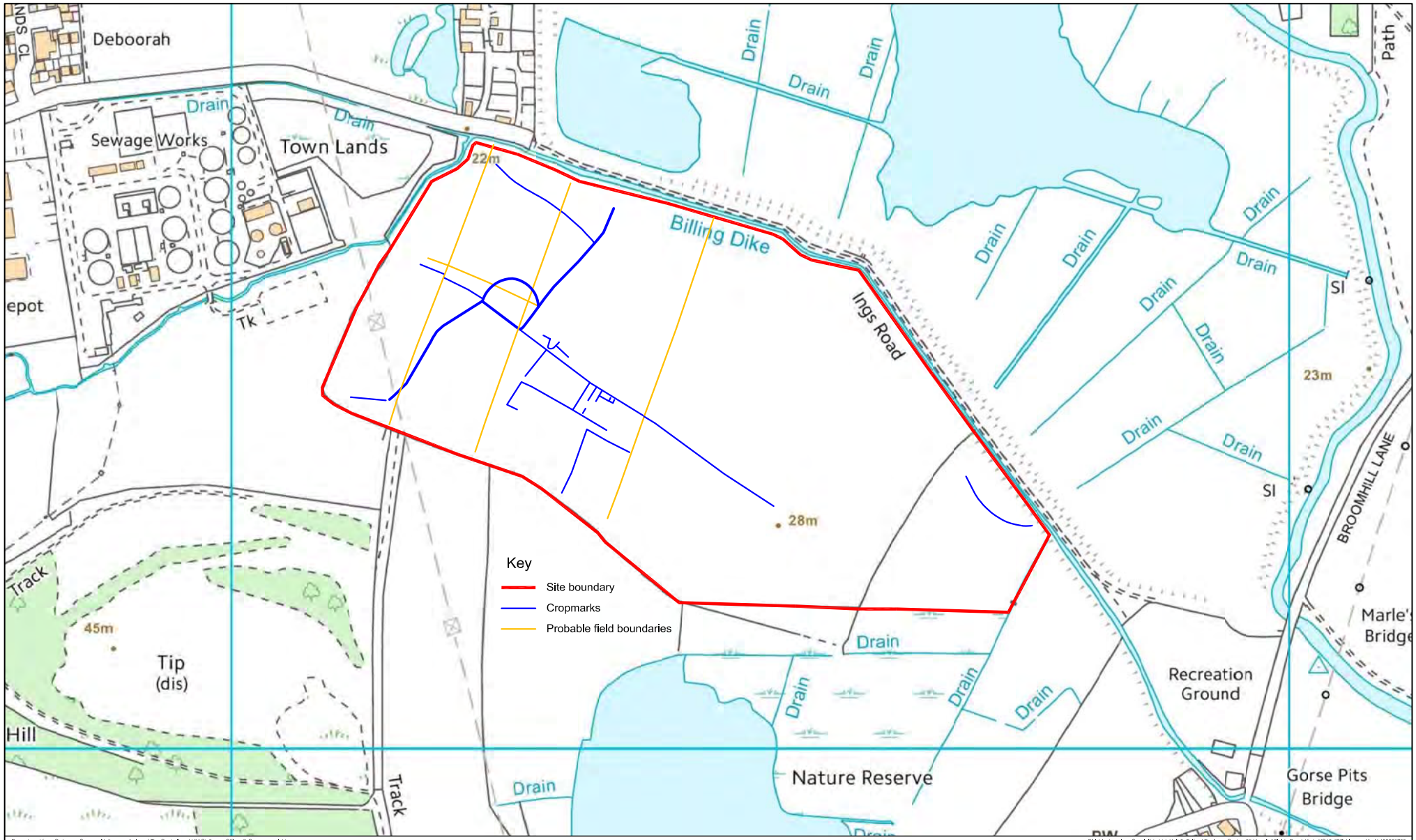
Sediment descriptions are provided based on six boreholes which were excavated across Wombwell Ings, the most southerly example occurring just north of the boundary of the proposed site. A uniform stratigraphy was observed, comprising topsoil derived from meadow grass flora, over alluvium, over fluvio-glacial sands and gravels. The base of the alluvium was encountered at 1.68m BGL, becoming deeper further north (*ie* away from the proposed site).

5.2 PREHISTORIC TO ROMAN PERIOD

In discussing the sequence of deposits in this wider area, Lillie and Cheetham note the uniform nature of deposits across the area, and state that 'in effect, the upper 1-2m of alluvium could equate to uniform deposition of minerogenic sediments since the deforestation of the landscape in the post-Roman period *ie* post cal AD 410' (Lillie and Cheetham 1999, 5).

Despite the potential for post-Roman alluvial deposits that might be expected to mask below-ground deposits, several cropmarks of potential Iron Age to Romano-British date have been within the study area, including examples on the site of the proposed works (HA 7, 8, 9).

An aerial photograph held by SYAS (DNR 1091/16), and a number of further aerial photographs obtained from Historic England, have been used to provide a plot of the cropmarks across the main area of proposed works, which appear to describe an enclosure and connected rectilinear features (Figure 3). The date of these features must remain speculative until confirmed by archaeological investigation.



Cropmarks plotted from aerial photographs

Scale 1:5000

Figure 3

Roman activity in the area is hinted at by a 17th-century account of a coin hoard encountered in the fields 'in Darfield'; this is assumed to be Roman in date (HA 2).

5.3 MEDIEVAL PERIOD

Evidence for early medieval activity is found at All Saints' Church in Darfield (HA 1), where fragments of 8th and 9th-century sculpture are reused in the walls of the medieval church (HA 1, 3, 4). The medieval socle, or socket, for a medieval standing cross is located in the churchyard, now supporting a sundial (HA 11). The site of the former Wombell Old Hall (HA 10) represents the site of the medieval manorial seat of the Wombwell family, subsequently converted into residences and demolished.

To the south of the site, LiDAR data (1m DTM) reveals the presence of ridge and furrow earthworks of medieval or more probably post-medieval date, which have been truncated by the later creation of wetland habitats (Plate 2).

5.4 POST MEDIEVAL TO MODERN PERIOD

From the post-medieval period onwards the area surrounding Wombwell Ings became increasingly industrial in character, although the site itself appears to have remained undeveloped. Exploitation of the coal resources of the area saw numerous collieries established, not without tragedy; within the study area, a 19th century obelisk commemorates 189 miners who were killed in an explosion at Lundhill Colliery (HA 5). Local settlement saw an increase in size and population.

During World War I, an area of land between Broomhill and Wombwell was used by the 'A' Flight of 33 Squadron, Royal Flying Corps, as a landing ground.

Plate 3 Extract from OS, 1854

5.4.1 Historic map regression

Available editions of historic Ordnance Survey maps allow more detail on the development of the site to be traced from the mid-19th century onwards (Plates 3 to 7).

The 1854 Ordnance Survey map shows the main, southern site as a series of regular fields extending to the Bulling Dike (Plate 3). The northern, Doveside site is shown as regular fields with an area to the south, immediately adjacent to the Dove, labelled as 'subject to floods'.

Plate 4 Extract from OS, 1893-4

By 1893, a series of buildings were constructed on 'Town Land' to the west of the main site, further

developed in 1905 with the sewage works, and housing had developed at Low Valley, to the northwest, with a Methodist Chapel and school. No change is shown on either of the proposed sites (Plate 4 and 5).

By 1938, the field boundaries had been removed, and the area appears to have taken the open character displayed today (Plate 6). Some of the cropmarks identified within the site may relate to these field boundaries, and have been differentiated as such on Figure 3.

By 1966-7, a large water body had been created to the southeast of the site, cutting across earlier earthworks, and the main site south of Wombwell Ings is depicted as the open field that is extant today. No change is depicted at Doveside from the earlier maps (Plate 7).

Aerial photographs of 1979 show the site to have been bounded by hedgerows (Plate 8). By 2002 much of the northern edge of these fields had been developed, and a substantial water body created in the centre of the proposed site (Plate 9).

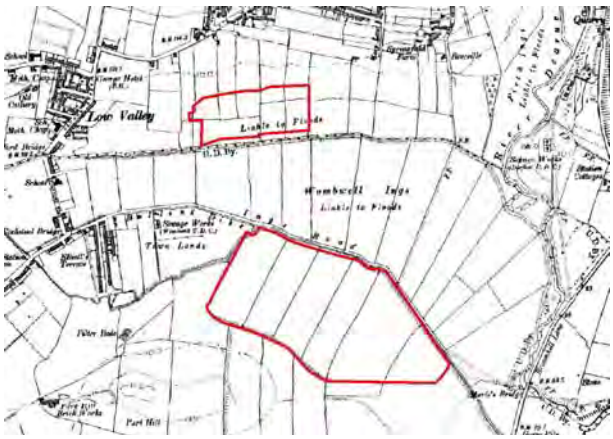


Plate 6 Extract from OS, 1905

Plate 5 Extract from OS, 1938

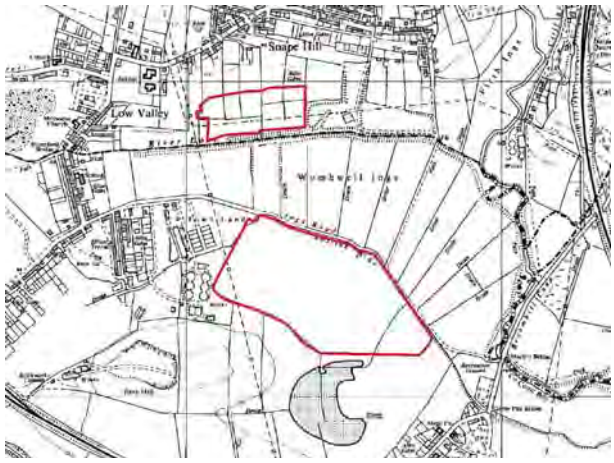


Plate 7 Extract from OS, 1966-7

6.0 ASSESSMENT OF SIGNIFICANCE AND POTENTIAL

6.1 KNOWN HERITAGE ASSETS

The southern site contains one heritage asset record, being the cropmarks that extend across the site, identified in the HER as potentially Iron

Plate 8 Doveside, 1979 (MAL79046/ 050)

Plate 9 Doveside, 2002 © Google Earth

Age or Romano-British in date. The significance of these cropmarks cannot be fully assessed without further investigation to confirm the date, condition and character, but these are likely to be of at least moderate significance.

The northern, Doveside site contains no recorded heritage assets.

6.2 ARCHAEOLOGICAL POTENTIAL

The south site has been agricultural land since at least the 19th century, and other than the historic field boundaries that formerly subdivided the area, there is no cartographic evidence on the Ordnance Survey editions to suggest significant truncation of deposits. This will have facilitated the survival of below-ground remains of prehistoric or Roman date; the presence of cropmarks across the site would further suggest the potential for below-ground remains of archaeological significance.

At Doveside, the creation of the lake in recent decades will have heavily disturbed archaeological remains across much of the site. Below-ground deposits may survive in the eastern part of the site.

7.0 ASSESSMENT OF IMPACT

7.1 DIRECT IMPACT

The proposed works would see the creation of a large cut in the northern part of the main site which would fully remove archaeological deposits. The impact on any archaeological remains would be substantial, and would have to be mitigated through an appropriate programme of archaeological excavation and recording.

Restoration of the lake at Doveside is likely to affect land that has previously been disturbed. Groundworks in the eastern part of the site may affect hitherto unrecorded archaeological remains.

7.2 IMPACT ON SETTING

No impact on the setting of designated heritage assets is anticipated. The proposed works lie almost 1km south of the nearest Scheduled Monuments and Listed Buildings, and no intervisibility is anticipated.

8.0 RECOMMENDATIONS

In order to fully assess the significance of archaeological deposits at the site, and to inform the design of an appropriate scheme of archaeological mitigation, it is recommended that a geophysical survey be undertaken, to further define the below-ground remains suggested by the cropmarks. This will allow the design of a further programme of archaeological evaluation to allow these features to be investigated, and their character, date and significance assessed.

9.0 REFERENCES

Aerial photographs

NMR 17731/47-48 18th July 2002
NMR 17720/11-1 18th July 2002
28754/039
28754/040
28754/041
DNR 1091/16-17 27th July 1977

Secondary sources

Lille, M. and Cheetham, J. 1999. 'Sedimentological analysis of the River Dearne Floodplain and its environs, Wombwell Ings, South Yorkshire' (Centre for Wetland Archaeology report)

APPENDIX A GAZETTEER

Key

NHLE	National Heritage List for England
SM	Scheduled Monument
LB	Listed Building
GI/GII*/GII	Grade I, II*, II
SE12SE 0	NMR Number
NMR 00000	Unique identifier in English Heritage Archives/NMR records
MSY	South Yorkshire Historic Environment Record Monument Number
LB	Listed Building number

HA No	NGR	NHLE	Status	Name	Description	Date
1	SE 4189 0431	MSY 369/1 NHLE 1315015	LB I	All Saints Church	All Saints Church, Darfield. Earliest fabric is early Norman in date on the West Tower; reuses pre-Conquest sculptural fragments.	Medieval
2	SE 41 04	MSY 595/1	-	Roman coin hoard findspot	Findspot of coin hoard of unknown date but likely to be Roman found in the late 17th century while ploughing the fields 'in Darfield'	Roman?
3	SE 4190 0430	MSY3453/1 NHLE 1012929	SM	Early medieval cross fragment	Early medieval cross fragment at Darfield. 8th century, possibly part of grave slab	Early medieval
4	SE 4190 0430	MSY 3452/1	-	Early medieval sculpture fragment	Fragment of early medieval sculpture. 8th to 9th-century cross built into the internal face of the south wall in the chapel	Early medieval
5	SE 4192 0428	MSY 4429/1 NHLE 1293398	LB GII	Lundhill Colliery Memorial	Obelisk memorial at Darfield, to 189 miners killed in an explosion in 1857.	19th C
6	SE 4100 0300	MSY 4351/1	-	Wombwell Landing ground	Wombwell Landing ground, situated between Wombwell and Broomhill, probably just east of Park Hill brickworks. Small site used as a night landing ground by A flight of 33 Squadron, Royal Flying Corps, March to October 1916.	20th C
7	SE 4239 0358	MSY 2894/1	-	IA or RB enclosure	Iron Age or Romano-British enclosure with rounded corners visible on aerial photographs	IA/RB
8	SE 4230 0350	MSY 2542/1	-	IA or RB cropmark	Iron Age or Romano-British cropmark visible on aerial photographs	IA/RB
9	SE 413 034	MSY 2342/1	-	IA or RB enclosure	Enclosure and field system of possible IA or RB date visible on an AP. Sub-rectangular enclosure and fields	IA/RB
10	SE 4039 0276	MSY 373/1	-	Wombwell Old Hall	Medieval home of the Wombwell family, a large medieval manor house. In 1831 it had been developed into a number of dwellings. No remains.	
11	SE 4187 0428	SE 372/1	-	Darfield Churchyard Cross	Socle or socket of a medieval standing cross, and the shaft of a later sundial	Medieval

APPENDIX B EVENTS

Key

ESY South Yorkshire Historic Environment Record

HA No	NGR	Reference	Date	Site	Event description	Contractor
1	SE 40448 02742	ESY 223	1998	Wombwell Hall	Earth Resistance Survey	ASWYAS
2	SE 41993 03305	ESY 224	1999	River Dearne Floodplain	Borehole Sedimentary analysis of the River Dearne floodplain and environs	CWA
3	SE 40154 02965	ESY 509	2000	Land off Park Street/High Street	Archaeological evaluation	Matrix Archaeology
4	SE 4017 0394	ESY 1240	2010	Darfield Main Colliery	Trial trenching	ArcHeritage
5	SE 41863 04152	ESY 508	1998	Land off Vicar Crescent	Geophysical survey	ASWYAS

Appendix C – Geophysical Survey (Magnitude Surveys, Nov 2018)

magnitude surveys

Geophysical Survey Report

of

Wombwell Wetlands Scheme

Barnsley, South Yorkshire

For

FAS Heritage

On Behalf Of

Garganey Trust

Magnitude Surveys Ref: MSSE209

November 2017

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Issued:

20 November 2017

Abstract

Magnitude Surveys was commissioned to assess the subsurface archaeological potential of a c. 18ha area of land in Wombwell, Barnsley, South Yorkshire. A fluxgate gradiometer survey was successfully completed and has detected an area of settlement activity. The settlement is defined by a central ditch that extends along a sand and gravel ridge, east-west across the site. A number of enclosures have been detected abutting the ditch to the north and south. The configuration of the settlement could support a potential Iron Age/Romano-British origin; however, intersecting ditch-like anomalies suggest the potential for multi-phased activity. Subsequent intensive ploughing and the superficial geology has complicated the interpretation of smaller, more discrete features; however, several areas of probable intense burning have been identified that are likely to reflect kilns or similar features. A large area of waste or ferrous debris has been detected towards the north-east of site and will mask the signal of any underlying features, but overall the impact of modern activity on the site is minimal.

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1. Introduction

1.1. Magnitude Surveys Ltd (MS) was commissioned by FAS Heritage on behalf of Garganey Trust to undertake a geophysical survey on a c. 18ha area of land off Wombwell, Barnsley, South Yorkshire (SE 4139 0337).

1.2. The geophysical survey comprised hand-pulled, cart-mounted fluxgate gradiometer survey.

1.3. The survey was conducted in line with the current best practice guidelines produced by Historic England (David et al., 2008), the Chartered Institute for Archaeologists (CIfA, 2014) and the European Archaeological Council (Schmidt et al., 2015).

1.4. The survey commenced on 1/11/2017 and took two days to complete.

2. Quality Assurance

2.1. Project management, survey work, data processing and report production have been carried out by qualified and professional geophysicists to standards exceeding the current best practice (CIfA, 2014; David et al., 2008, Schmidt et al., 2015).

2.2. Magnitude Surveys is a corporate member of ISAP (International Society of Archaeological Prospection).

2.3. Director Graeme Attwood is a Member of the Chartered Institute for Archaeologists (CIfA), the chartered UK body for archaeologists, as well as the Secretary of GeoSIG, the CIfA Geophysics Special Interest Group. Director Finnegan Pope-Carter is a Fellow of the London Geological Society, the chartered UK body for geophysicists and geologists, as well as a member of GeoSIG, the CIfA Geophysics Special Interest Group. Director Chrys Harris has a PhD in archaeological geophysics from the University of Bradford and is the Vice-Chair of the International Society for Archaeological Prospection.

2.4. All MS managers have postgraduate qualifications in archaeological geophysics. All MS field staff have relevant archaeology or geophysics degrees and supervisors have at least three years' field experience.

3. Objectives

3.1. The geophysical survey aimed to assess the subsurface archaeological potential of the survey area.

4. Geographic Background

4.1. The site is located c. 7km southeast of Barnsley and lies c. 1km to the northeast of the town of Wombwell (Figure 1). The survey area consisted of grassland, though evidence of the field being ploughed previously was recognisable on the field. The field was relatively flat, though it does notably rise towards the south. The survey area was bounded by Bulling dyke to the north, a sewage works to the northwest, and further fields to the south and east (Figure 2).

4.2. Survey considerations:

Survey Area	Ground Conditions	Further Notes
1	Mostly flat grassland, with a slight ridge running along the centre of field. Evidence for ploughing was noted running north-south.	Survey had to avoid a pylon and several small hay bales; the powerline ran roughly north-south through the south-western corner of the field. The field was bounded by wire fences to the south and east. A ditch was located to the west.
2	Mostly flat grassland.	The field was bounded by wire fences to the south, east and west.

4.3. The underlying geology comprises mudstone, siltstone and sandstone of the Pennine Middle Coal Measures formation. The majority of the site lies on a sand and gravel island surrounded by alluvial deposits. Alluvium is recorded extending across the north-eastern edge of the site into the eastern corner (British Geological Survey, 2017).

4.4. The soils consist of slowly permeable, loamy and clayey soils over the majority of the site, surrounded by loamy and clayey floodplain soils with naturally high groundwater to the north and north-eastern and north-western corners (Soilscapes, 2017).

5. Archaeological Background

5.1. The following archaeological background summarises a heritage assessment produced by FAS Heritage (2017). Aerial photographs highlight cropmarks within the survey area, depicting a possible enclosure and rectilinear features connected by a linear feature orientated approximately northeast to southwest. The cropmark features have speculatively interpreted as being Iron Age to Romano-British in origin. Historical map regression details the evolution of the site's configuration. The survey was previously marked by a series of regular field boundaries from 1854 till their removal in 1938. Some of the cropmarks identified in the aerial photographs appear to relate to these field boundaries.

5.2. Aerial photographs to the north of the survey area highlighted either side of the disused railway line a possible Iron Age or Romano-British enclosure and cropmarks potentially of Iron Age or Romano-British origins.

5.3. Lidar data (1m DTM) revealed ridge and furrow of Medieval or most probably Post-Medieval origins in fields immediately to the south of the survey area.

5.4. During the Post Medieval period, the surrounding landscape is noted to become increasingly industrial with Darfield colliery to the northeast, a brickworks to the south east and a quarry to the northwest.

6. Methodology

6.1. Data Collection

6.1.1. Geophysical prospection comprised the magnetic method as described in the following table.

6.1.2. Table of survey strategies:

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

6.1.3. The magnetic data were collected using MS' bespoke hand-pulled cart system.

6.1.3.1. MS' cart system was comprised of Bartington Instruments Grad 13 Digital Three-Axis Gradiometers. Positional referencing was through a Hemisphere S321 GNSS Smart Antenna RTK GPS outputting in NMEA mode to ensure high positional accuracy of collected measurements. The Hemisphere S321 GNSS Smart Antenna is accurate to 0.008m + 1ppm in the horizontal and 0.015m + 1ppm in the vertical.

6.1.3.2. Magnetic and GPS data were stored on an SD card within MS' bespoke datalogger. The datalogger was continuously synced, via an in-field Wi-Fi unit, to servers within MS' offices. This allowed for data collection, processing and visualisation to be monitored in real-time as fieldwork was ongoing.

6.1.3.3. Rows of temporary sight markers were established in each survey area to guide the surveyor and ensure full coverage with the cart. Data were collected by traversing the survey area along the longest possible lines, ensuring efficient data collection and processing.

6.2. Data Processing

6.2.1. Magnetic data were processed in bespoke in-house software produced by MS. Processing steps conform to Historic England's standards for "raw or minimally processed data" (see sect 4.2 in David et al., 2008: 11).

Sensor Calibration – The sensors were calibrated using a bespoke in-house algorithm, which conforms to Olsen et al. (2003).

Zero Median Traverse – The median of each sensor traverse is 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 are 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 are interpolated using a bicubic algorithm to increase the pixel density between sensor traverses. This produces images with square pixels for ease of visualisation.

6.3. Data Visualisation and Interpretation

6.3.1. This report presents 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. 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, come features can be clearer in the respective gradient or total field datasets. Multiple greyscales images at different plotting ranges have been used for data interpretation. Greyscale images should be viewed alongside the XY trace plot (Figure 8). XY trace plots visualise the magnitude and form of the geophysical response, aiding in anomaly interpretation.

6.3.2. Geophysical results have been interpreted using greyscale images and XY traces in a layered environment, overlaid against open street maps, satellite imagery, historic maps, LiDAR data, and soil and geology maps. Google Earth (2017) was consulted as well, to compare the results with recent land usages.

7. Results

7.1. Qualification

7.1.1. Geophysical results are not a map of the ground and are instead a direct measurement of subsurface properties. Detecting and mapping features requires that said features have properties that can be measured by the chosen technique(s) and that these properties have sufficient contrast with the background to be identifiable. The interpretation of any identified anomalies is inherently subjective. While the scrutiny of the results is undertaken by qualified, experienced individuals and rigorously checked for quality and consistency, it is often not possible to classify all anomaly sources. Where possible an anomaly source will be identified along with the certainty of the interpretation. The only way to improve the interpretation of results is through a process of comparing excavated results with the geophysical reports. MS actively seek feedback on their reports as well as reports of further work in order to constantly improve our knowledge and service.

7.2. Discussion

7.2.1. The geophysical results are presented in consideration with satellite imagery (Figure 6), and historic maps (Figure 7).

7.2.2. The fluxgate gradiometer survey has responded well to the environment of the survey area. Numerous anomalous responses have been identified against the magnetic background. The underlying Pennine Coal formation has contributed to the enhancement of anomalies associated with archaeology and ridge and furrow. Towards the north, a decrease in signal strength is apparent. Superficial deposits in this area are alluvial in nature, which may have acted in reducing the signal strength of anomalies for features under greater overburden. Modern interference is generally limited to the perimeter of the site, with broad ferrous responses produced by telegraph poles and other modern features. A discrete area of mixed waste and ferrous debris has been detected towards the north-eastern end and will overwhelm the signal of any underlying features (see Figure 8).

7.2.3. A well-defined settlement area has been detected by the survey, which extends across the site. This is characterised by enclosures and field boundaries that are built off a central ditch feature that acts a spine to the complex. The complex runs along a ridge orientated approximately northwest to southeast and centred on the glaciofluvial sand and gravel island. Anomalies with the strongest enhancement are associated with the enclosures and field boundaries attached to the north-western and south-eastern end of the central ditch. This could be a result of the 'habitation effect', whereby soil-filled features typically produce the strongest magnetic enhancement in areas towards the centre of occupation, due to more intensive anthropogenic use and reuse of these areas (Aspinall *et al*. 2009: 144). Towards the fringe of the central complex, anomalies indicative of intense in-situ burning were interpreted as potential kilns.

7.2.4. Ridge and furrow ploughing has been detected throughout the site. The alignment of these anomalies run roughly parallel to the subdivision field boundaries noted in historic OS maps. This would suggest that like the ploughing noted to the south of the

survey area, this ridge and furrow is likely to be Post-Medieval in date (see 5.4). A weak linear anomaly correlates with the location of a former field boundary in the centre of the north of site (Figure 7) and may reflect the remnants of the feature.

7.2.5. Interpretation of the archaeology is complicated by the presence of strong ploughing responses running along similar orientations as the archaeology, as well as the weak signal strength of anomalies in the north conceivably reflecting potential overburden of fluvial deposits. Several of the potential archaeological anomalies correspond well with the cropmarks noted above (see 5.1), but the geophysical survey greatly expands and enhances the prior knowledge, as new enclosures, field boundaries, and discrete features have been identified in the geophysical results.

7.3. Interpretation

7.3.1. General Statements

7.3.1.1. Geophysical anomalies will be discussed broadly as classification types across the survey area. Only anomalies that are distinctive or unusual will be discussed individually.

7.3.1.2. **Undetermined** – Anomalies are classified as Undetermined when the anomaly origin is ambiguous through the geophysical results and there is no supporting or correlative evidence to warrant a more certain classification. These anomalies are likely to be the result of geological, pedological or agricultural processes, although an archaeological origin cannot be entirely ruled out. Undetermined anomalies are generally not ferrous in nature.

7.3.1.3. **Ferrous (Discrete/Spread)** – Discrete ferrous-like, dipolar anomalies are likely to be the result of modern metallic disturbance on or near the ground surface. A ferrous spread refers to a concentrated deposition of these discrete, dipolar anomalies. Broad dipolar ferrous responses from modern metallic features, such as fences, gates, neighbouring buildings and services, may mask any weaker underlying archaeological anomalies should they be present.

7.3.2. Magnetic Results - Specific Anomalies

7.3.2.1. **Archaeology (Central Ditch)** – A strong, ditch-like linear anomaly [**1a]** follows the length of a ridge, extending nearly c. 470m NW-SE through most of the site. The anomaly appears to form the spine for a complex of enclosures and field boundaries abutting it to the north and south. The western terminus of [**1a**] occurs at a curvilinear ditch-like anomaly at the field's edge, while the signal of [**1a**] abruptly drops off c. 417m to the east. While the response of [**1a**] is severely reduces at this point, a weak trend follows this alignment to further enclosures on similar orientations as the features to the west.

7.3.2.2. **Archaeology (Ditch/Enclosure)** – Running parallel and to the north of [**1a**] is another ditch [**1b**] similar in dimensions, but much weaker in strength. Together, [**1a**] and [**1b**] may form a large enclosure, measuring c. 111m north to south, and in excess of c. 143m east to west (as the feature appears to extend through the western boundary of the survey area). Within this large enclosed

space, two well-defined smaller sub-rectangular enclosures have been identified [**1c**] that appear to respect the boundaries of [**1a**] and [**1b**]. The northern of the small enclosures is bisected by a smaller curvilinear anomaly, which along with other anomalies could form potential smaller enclosures or other ditched features. It is unclear from the geophysical results where these are contemporaneous or indicative of multi-phasing.

7.3.2.3. **Archaeology (Field Boundaries/Enclosures)** – To the east of [**1c**] are a series of further ditch-like anomalies that form enclosed spaces [**1d**], potentially reflecting a configuration of older field systems. These field systems [**1d**] appear to respect a strong ditched feature extending north from [**1a**].

7.3.2.4. **Archaeology (Ditches/Enclosures)** – Along the extent of [**1a**] are numerous strong, ditch-like anomalies that appear to extend northwards and southwards from the main ditch. These may form further large enclosed spaces, although the northern and southern limit of many of these anomalies is ambiguous—potentially a result of alluvial overburden. Small, well-defined enclosures [**1e**] are also apparent along the length of [**1a**]. These are generally sub-rectangular form, ranging in size from c. 21m x 22m (towards the west) to c. 28m x 30m (towards the east).

7.3.2.5. **Archaeology (Internal Components/Discrete Features)** – Understanding any internal components within these enclosures is hampered by the intensive ploughing cutting through these features. Ambiguous discrete responses have been detected within the vicinity of the archaeology, but exhibit geophysical morphologies potentially indicative of natural deposits; however, given the proximity to the archaeological features, an 'Undetermined' origin as anthropogenic features can produce a similar response.

7.3.2.6. **Archaeology (Kilns/Burning)** – Five very strong anomalies, four in the southeast corner and one in the southwest corner of Area 1, exhibit a geophysical response characteristic of intense in-situ burning. Double peaks over the centre of the anomaly are characteristic of the type of responses associated with kilns and are identifiable in the X-Y traces (Figure 8). A possible sixth feature [**1f**] has been identified towards the centre of Area 1. This anomaly though is notably weaker in strength than the other in-situ burning anomalies, which suggests it may reflect an anomaly for a disturbed pit.

7.3.2.7. **Archaeology (Settlement Limits)** – The southern and western extents of the settlement very clearly appear to continue through to the surrounding landscape. The northern extent is less clearly defined. Interrupted weak curvilinear anomalies [**1g**] were identified towards the north of the survey area, potentially reminiscent of a trackway/droveway or old boundaries. Notably these anomalies are only identifiable in the total field plots (Figure 4). This is possibly an effect of a greater depth of overburden in these areas: the deeper the overlying deposits are, the weaker the reading recorded in the lower sensor, which diminishes the difference between the upper and lower sensors readings,

making the anomalies undetectable within the gradient plot (Figure 3). The eastern extent of the settlement appears to diminish in strength into Area 2. This could be a result of different land use in this area or reflect more intensive ploughing. An enhanced configuration of strong-linear responses [**2a**] at the eastern end of Area 2 is distinct from the surrounding ploughing and likely reflects the remnant of an additional sub-rectangular enclosure. The signal of the ploughing responses increases within this area, suggesting the disturbance of enhanced deposits.

7.3.2.8. **Agriculture/Possible Archaeology** – The ploughing in Area 2 terminates part-way through the field, indicating a former field boundary in this location. To the north of the ploughing terminus is a uniquely quiet background, punctuate by a curvilinear alignment of responses [**2b**]. [**2b**] correlates with a cropmark feature identified in aerial photographs, but does not have a clear attachment to the complexes of Area 1.

7.3.2.9. **Natural** – Weak, linear negative bands along the ridge follow the topography of the landscape and could be reflective of natural changes.

7.3.2.10. **Ferrous (Spread)** – A large spread of ferrous responses is noted along the north-eastern edge of Area 1. This anomalous spread abuts the flood defences of the river, suggesting it may be relate to the dyke's construction. The anomalous spread is also notably restricted to the eastern most subdivisions of Area 1 highlighted in the historic OS maps.

8. Conclusions

8.1. A fluxgate gradiometer survey has been successfully completed across the site. Overall the magnetic technique has responded well to the environment of the survey area; although an area of mixed waste or ferrous material towards the north-eastern end has impacted the detection of any underlying features. The underlying geology likely contributed to the increased enhancements of cut features, including plough furrows, boundaries, and ditch features. However, discrete superficial anomalies of a natural origin can demonstrate a similar response to isolated pit-like anomalies of an archaeological origin. Therefore, some caution has been applied in the interpretation of such features.

8.2. The survey has detected several strong, ditch-like anomalies that correlate with cropmark features previously identified on aerial photographs. However, the geophysical survey has greatly expanded on the detail and extent of this settlement area. The settlement area is defined by ditch feature extending NW-SE along the sand and gravel ridge across the site. Numerous enclosures, ditches, and field systems abut the ditch to the north and south. Overall, the configuration of the anomalies detected in the geophysical survey could support a potential Iron Age/Romano-British origin for these features. However, the detection of intercutting ditch-like anomalous responses suggests the potential for multi-phased activity.

8.3. Several probable kiln or other fired features have been identified around the fringes of the apparent settlement area. The fringes of the settlement exhibit a weaker magnetic signal than the activity along the ridge. This could be a combination of a 'habitation effect', combined with potential alluvial overburden to the north. Interpretation of smaller pit-like and ephemeral features is complicated somewhat by intensive ridge and furrow ploughing through the archaeology.

8.4. Agricultural activity has primarily been identified in the form of ploughing, both modern and ridge and furrow. The potential remnants of a former field boundary have been identified as well.

9. Archiving

9.1. MS maintains an in-house digital archive, which is based on Schmidt and Ernenwein (2013). This stores the collected measurements, minimally processed data, georeferenced and un-georeferenced images, XY traces and a copy of the final report.

9.2. MS contributes all reports to the ADS Grey Literature Library subject to any time embargo dictated by the client.

9.3. Whenever possible, MS has a policy of making data available to view in easy to use forms on its website. This can benefit the client by making all of their reports available in a single repository, while also being a useful resource for research. Should a client wish to impose a time embargo on the availability of data, this can be achieved in discussion with MS.

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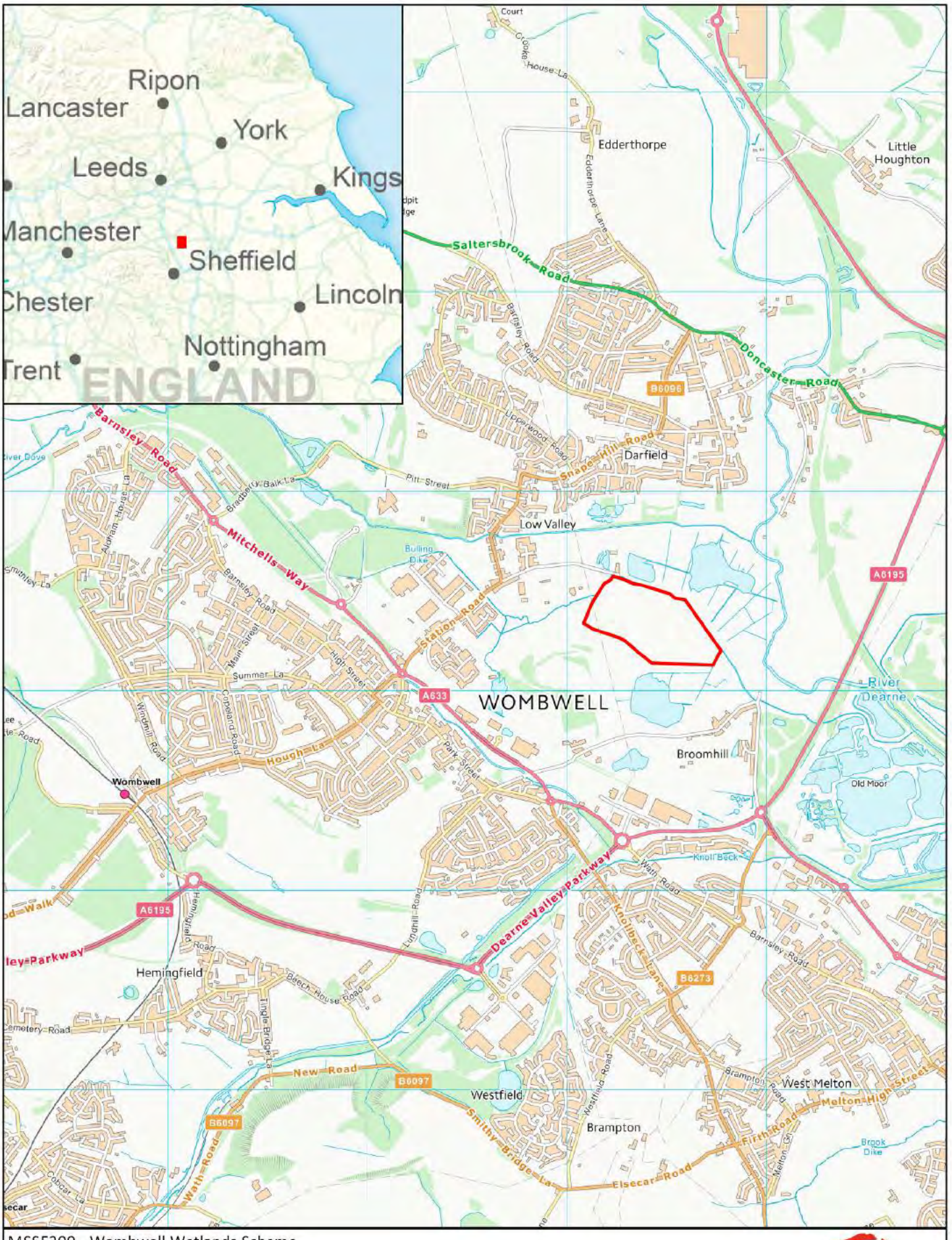


MSSE209 - Wombwell Wetlands Scheme
Figure 1 - Site Location
1 : 25,000 @ A4

Site Boundary

N

0 0.5 1 km

magnitude surveys

403600
441200
441400
441600
441800
403400
403200

Area 1

Area 2

MSSE209 - Wombwell Wetlands Scheme
Figure 2 - Location of Survey Areas
1:2500 @ A3

Mapping Provided by Client

Survey Extent
Cropmarks

N

0 50 100 150 m

magnitude surveys

403600
441200
441400
441600
441800
403400
403200

Area 1

Area 2

MSSE209 - Wombwell Wetlands Scheme
Figure 3 - Magnetic Gradient
1:2000 @ A3

Mapping Provided by Client

-2 nT 3

N

0 50 100 150 m

magnitude surveys

403600
441200
441400
441600
441800
403400
403200

Area 1

Area 2

MSSE209 - Wombwell Wetlands Scheme
Figure 4 - Magnetic Total Field (Lower Sensor)
1:2000 @ A3

Mapping Provided by Client

-48,990 nT 49,020

N

0 50 100 150 m

magnitude surveys

403600 441100 441200 441300 441400 441500 441600 441700 441800

403500

403400

403300

403200

Area 1

Area 2

1a 1b 1c 1c 1d 1e 1e 1e 1f 1g 1k 2a 2b

MSSE209 - Wombwell Wetlands Scheme
Figure 5 - Magnetic Interpretation
1:2000 @ A3

- Archaeology Probable (Strong)
- Archaeology Probable (Weak)
- Archaeology (Kiln?)
- Archaeology Probable (Trend)
- Archaeology Possible (Strong)
- Archaeology Possible (Weak)
- Archaeology Possible (Trend)
- Ridge and Furrow (Trend)
- Agricultural (Trend)
- Natural (Weak)
- Ferrous (Dipolar)
- Ferrous (Spread)
- Undetermined (Strong)
- Undetermined (Weak)
- Undetermined (Trend)

N

0 50 100 150 m

magnitude surveys

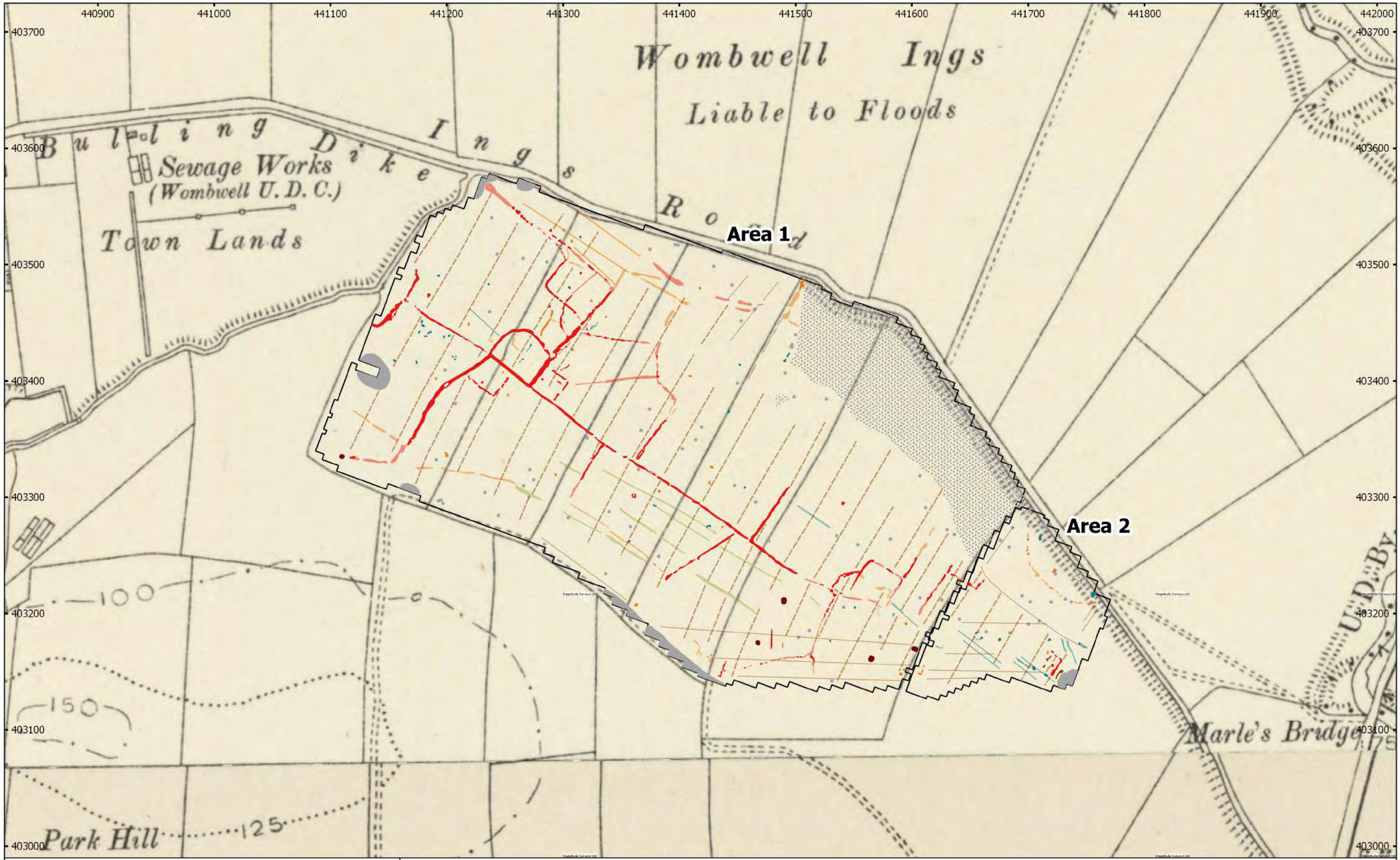
MSSE209 - Wombwell Wetlands Scheme
Figure 6 - Magnetic Interpretation Over Satellite Imagery
1:2000 @ A3

- Archaeology Probable (Strong)
- Archaeology Probable (Weak)
- Archaeology (Kiln?)
- Archaeology Probable (Trend)
- Archaeology Possible (Strong)
- Archaeology Possible (Weak)
- Archaeology Possible (Trend)
- Ridge and Furrow (Trend)
- Agricultural (Trend)
- Natural (Weak)
- Ferrous (Dipolar)
- Ferrous (Spread)
- Undetermined (Strong)
- Undetermined (Weak)
- Undetermined (Trend)

N

0 50 100 150 m

magnitude surveys



MSSE209 - Wombwell Wetlands Scheme
Figure 7 - Magnetic Interpretation Over Historic Maps
1:3000 @ A3

Contains historic maps: Ordnance Survey, 6" 2nd edition c. 1882-1913 © National Library of Scotland

- Archaeology Probable (Strong)
- Archaeology Probable (Weak)
- Archaeology (Kiln?)
- Archaeology Probable (Trend)
- Archaeology Possible (Strong)
- Archaeology Possible (Weak)
- Archaeology Possible (Trend)
- Ridge and Furrow (Trend)
- Agricultural (Trend)
- Natural (Weak)
- Ferrous (Dipolar)
- Ferrous (Spread)
- Undetermined (Strong)
- Undetermined (Weak)
- Undetermined (Trend)

N

0 50 100 150 m

magnitude surveys

441100
441200
441300
441400
441500
441600
441700
441800
403500
403400
403300
403200
Area 1
Area 2
MSSE209 - Wombwell Wetlands Scheme
Figure 8 - XY Trace Plot
120nT/cm at 1:2000 @ A3

N
0
50
100
150 m
magnitude surveys