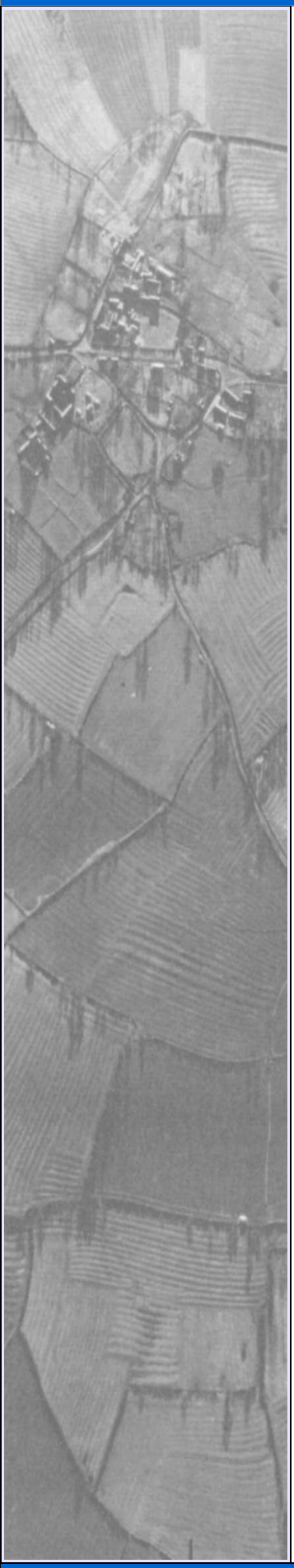


IWM Duxford
Cambridgeshire

MAGNETOMETER SURVEY REPORT

for

Imperial War Museums

Kerry Donaldson & David Sabin

October 2017

Ref. no. J730

ARCHAEOLOGICAL SURVEYS LTD

IWM Duxford
Cambridgeshire

Magnetometer Survey Report

for

Imperial War Museums

Fieldwork by David Sabin BSc (Hons) MCIfA
Report by Kerry Donaldson BSc (Hons)
Report checked by David Sabin
Primary archive location - Archaeological Surveys Ltd, Yatesbury, Wiltshire

Survey date – 14th September 2017
Ordnance Survey Grid Reference – TL 45535 45745

Archaeological Surveys Ltd
1 West Nolands, Nolands Road, Yatesbury, Calne, Wiltshire, SN11 8YD
Tel: 01249 814231 Fax: 0871 661 8804
Email: info@archaeological-surveys.co.uk
Web: www.archaeological-surveys.co.uk

CONTENTS

LIST OF FIGURES

LIST OF PLATES

LIST OF TABLES

SUMMARY

A geophysical survey was carried out by Archaeological Surveys Ltd at IWM Duxford, at the request of the Imperial War Museums, ahead of development of a large object store in the western part of the site. The site was used as an RAF airfield between 1917 and 1961 and contained structures and aircraft dispersal hardstanding from the Second World War as well as hardstandings from the Cold War period. The results of the survey demonstrate the well defined location of one of the Second World War hardstandings, constructed and used by the USAAF for aircraft dispersals within the western part of the site. Close to this a Cold War aircraft dispersal hardstanding also appears to have an association with magnetic debris, but is not clearly defined. An extant Cold War dispersal hardstanding in the eastern part of the site had a magnetic response to metal fragments within the expansion joints in the existing concrete pads, with other zones of magnetic debris to the north that could indicate the presence of further, unrecorded hardstandings. Strong dipolar responses are associated with the edges of the originally Y-shaped Cold War dispersals. In the northern part of the site widespread magnetic debris and strong dipolar responses are likely to be associated with the wartime structures formerly located within this area. The survey also located a previously unrecorded Bronze Age round barrow ditch in the eastern part of the site.

1 INTRODUCTION

1.1 Survey background

1.1.1 Archaeological Surveys Ltd was commissioned by the Imperial War Museums (IWM) to undertake a magnetometer survey of an area of land within the grounds of the IWM Duxford. The site has been outlined for a proposed development of a large object store and conservation facilities. The survey forms part of an archaeological assessment of the site. The survey area contains a number of Second World War and Cold War aircraft dispersal hardstandings as well as the site of a former number of mainly Second World War buildings. The site also contains the Land Warfare Hall which is due to be demolished and the area utilised for the construction of the new large object store.

1.2 Survey objectives and techniques

1.2.1 Consultation between the IWM and Historic England recommended a geophysical survey in order to ascertain the extent of remaining Second World War/Cold War hardstanding as well as the the extent of other potential archaeology within the site. The survey, alongside historic photographs, would allow Historic England to determine the significance of the hardstanding. The objective of the survey was to use magnetometry to help determine the location of geophysical anomalies that may indicate subsurface features of

archaeological significance. The methodology is considered an efficient and effective approach to archaeological prospection.

1.2.2 The survey and report generally follow the recommendations set out by: English Heritage (2008) *Geophysical survey in archaeological field evaluation;* European Archaeological Council (2015) *Guidelines for the Use of Geophysics in Archaeology;* Institute for Archaeologists (2002) *The use of Geophysical Techniques in Archaeological Evaluations*. The work has been carried out to the Chartered Institute for Archaeologists (2014) *Standard and Guidance for Archaeological Geophysical Survey.*

1.3 Site location, description and survey conditions

1.3.1 The site is located at the south-western end of IWM Duxford. It is centred on Ordnance Survey National Grid Reference (OS NGR) TL 45535 45754, see Figs 01 and 02.

1.3.2 The geophysical survey covers approximately 5.5ha within five survey areas (see Fig 02). Areas 1 and 5 lie in the western part of the site and are the location of a Second World War and a Cold War aircraft dispersal hardstanding. Area 2 lies to the south of Area 1, to the south-west of the Land Warfare Hall, with Area 3 occupying the largest area to the west of the American Air Museum. Area 4 lies to the south of the Land Warfare Hall.

1.3.3 The ground cover was mainly short grass although areas of concrete and tarmac were also surveyed where they were not associated with high magnitude magnetic disturbance. A section of modern concrete track to the north of the Land Warfare Hall was avoided as on testing it produced high level magnetic disturbance. Numerous other modern sources of disturbance were encountered and avoided where possible. These included signs, fencing, posts, vehicles, exhibits, etc. Modern inspection chambers and drainage covers were avoided whenever possible.

1.3.4 Although the area is naturally flat, parts of the site immediately adjacent to the American Air Museum and Land Warfare Hall were landscaped. Survey avoided the most raised area near to the entrance of the Land Warfare Hall due to magnetic disturbance and the increased ground level which was considered likely to mask anomalies within the original surface should it exist in an undisturbed state.

1.3.5 The ground conditions across the site were generally considered to be favourable for the collection of magnetometry data. Weather conditions during the survey were windy with occasional heavy showers.

Plate 1: Northern part of Area 1 looking north-east

Plate 2: Northern part of Area 3 looking north-east

1.4 Site history and archaeological potential

1.4.1 The site lies within an area that contains widespread evidence for prehistoric and Roman activity. This includes a number of scatters of Mesolithic, Neolithic and Bronze Age flints to the north of the site, a possible Neolithic causewayed enclosure, 350m to the north, a number of Bronze Age and Iron Age barrows recorded on 19th century mapping and aerial photographs. A scheduled Roman settlement, including a possible bath house is also situated 600m to the north of the site. The density of prehistoric and Roman sites and activity within the wider area may indicate that there is potential for the site to contain similar archaeological features.

1.4.2 A historical report for the site was commissioned by the IWM Duxford which outlines in detail the history and development of the airfield (Francis, 2010a & 2010b).The site was first requisitioned in 1917 for the Royal Flying Corps and from April 1918 it became No. 35 Training Depot Station, specialising in RAF day-bombing along with its twin site at Fowlmere. In March 1918 sections under the 159 US Aero Squadron were stationed at Duxford and helped install eight temporary Bessonneau hangars within the northern part of the site (Area 3). Four large double hangars used as general service sheds were also constructed during the summer of 1918 to the east of the survey area. Three of these survive and are Grade II* listed buildings. Duxford was retained as a post-war training school and a number of buildings were constructed in the inter-war years including a now demolished wooden sports pavilion (Building 52) within the northern part of the survey area.

1.4.3 During 1939 to 1940 the site extended to increase the landing ground and a new 18ft (5.48m) wide concrete perimeter track was constructed, as well as a number of fighter pens at intervals around the track. One still exists within the northern part of the survey area (Area 3) (FP15), with another appearing to be positioned beneath the Land Warfare Hall and just extending into the south-eastern part of the site (Area 4) (FP14). A number of former associated buildings have been recorded in the vicinity and mainly to the north and north-east of Fighter Pen 15, including defence huts (Buildings 49 and 221 to 226), light anti-aircraft defence huts (Buildings 239/2 and 239/3), a field kitchen (Building 291/2) a temporary latrine (Building 271), an ablution block (Building 190) as well a petrol installation and two bulk lubrication installations (Buildings 139, 148 & 149) and an air-raid shelter (ARS27), although the exact locations of most of these buildings is unknown. The ground is now levelled, except for linear earthworks that extend with a north-east to south-west orientation for approximately 50m in the far north of the survey area (Area 3).

1.4.4 By 1943 the arrival of the USAAF required a westwards extension to the site to include a number of aircraft dispersals, which consisted of three finger-like hard surfaced tracks with circular standing points for aircraft at the ends. A pierced steel planking (PSP) runway had also been constructed in 1944 and there is some conjecture whether the dispersals were also constructed from PSP laid onto packed earth (Murray, 2017). One of these dispersal pans is located within the western part of the site (Area 1), mainly beneath a modern

access track, but patches within the grass can also be seen. Photographs from late 1943 to early 1944 show USAAF planes on PSP within the site, but it is not clear if these relate to the dispersal pans. The PSP is laid in a square or rectangular formation, and the dispersal pans indicated on aerial photographs and maps appear rounded.

1.4.5 In the post-war period Duxford was selected for a runway upgrade with a new concrete runway and also a 50ft (15.24m) wide aircraft/vehicle perimeter track constructed in 1950. By 1956 new protected dispersals were constructed in a Y-shape, later with 59ft long (18m), 17ft tall (5.18m) and 5ft 6in (1.67m) wide blast walls constructed on each side of the aircraft standings. These were fixed to a concrete foundation plinth 9ft 6 in (2.9m) long in section and 2ft 6in (0.76m) deep. On the eastern side was a Uni-Seco armoury and between the two arms of the aircraft hardstanding was a standing for a fuel bowser. Protected Type Hardstandings were used which included 10ft by 10ft (3m by 3m) concrete slabs with expansion joints. The standings were arranged in three groups of four and the positions of three of these are located within the survey areas.

1.4.6 The last RAF fighter to fly from Duxford was on the 3rd August 1961 and the station was put on a care and maintenance basis. The blast walls were removed some time between 1961 and 1968 and also most of the concrete hardstandings. One extant hardstanding is visible within the eastern part of Area 3, although this appears to be a modification to the original Y-shaped dispersal pan. The location of another is situated 200ft (61m) to the south-west. The taxi-way of a third extends within Area 4 and remnants of the associated aircraft standing are located within Area 1, close to the USAAF wartime dispersal pan in the western part of the site.

1.4.7 The Imperial War Museum was granted the use of the site for storage in 1969, with the entire site transferred to the museum in 1976. The Land Warfare Hall was opened in 1992 and was constructed over the site of one of the USAAF dispersal pans.

1.4.8 The site has seen several phases of occupation and development during the 20th century. Those likely to have most impact within the survey areas are the wartime aircraft dispersal pans located in the western part of the site (Area 1), the wartime military huts and buildings in the northern part of the site (Area 3) and the Cold War period protected dispersals. The intense military occupation of the site is likely to have resulted in large amounts of magnetic disturbance and debris, but it is possible that these will still relate to structures and areas of hardstanding.

1.5 Geology and soils

1.5.1 The underlying geology is Holywell Nodular Chalk Formation (BGS, 2017).

1.5.2 The overlying soil across the site is from the Moulton association and is a

typical argillic brown earth. It consists of a well drained, coarse and fine, loamy soil over chalk or chalk rubble with patterned ground of stripes or polygons (Soil Survey of England and Wales, 1983). Aerial photographs of the site demonstrate widespread striping in the form of marks showing greener/stronger growth.

1.5.3 Magnetometry carried out over similar geology and soil has produced good results. The site is, therefore, considered suitable for magnetic survey. However, variations in magnetic susceptibility associated with naturally patterned ground will produce weak magnetic anomalies.

2 METHODOLOGY

2.1 Technical synopsis

2.1.1 Magnetometry survey records localised magnetic fields that can be associated with features formed by human activity. Magnetic susceptibility and magnetic thermoremnance are factors associated with the formation of localised fields. Additional details are set out below and within Appendix A.

2.1.2 Iron minerals within the soil may become altered by burning and the break down of biological material; effectively the magnetic susceptibility of the soil is increased, and the iron minerals become magnetic in the presence of the Earth's magnetic field. Accumulations of magnetically enhanced soils within features, such as pits and ditches, may produce magnetic anomalies that can be mapped by magnetic prospection.

2.1.3 Magnetic thermoremnance can occur when ferrous minerals have been heated to high temperatures such as in a kiln, hearth, oven etc. On cooling, a permanent magnetisation may be acquired due to the presence of the Earth's magnetic field. Certain natural processes associated with the formation of some igneous and metamorphic rock may also result in magnetic thermoremnance.

2.1.4 The localised variations in magnetism are measured as sub-units of the Tesla, which is a SI unit of magnetic flux density. These sub-units are nano Teslas (nT), which are equivalent to 10^{-9} Tesla (T).

2.2 Equipment configuration, data collection and survey detail

2.2.1 The detailed magnetic survey was carried out using a SENSYS MAGNETO®MXPDA 5 channel cart-based system. The instrument has 5 fluxgate gradiometers (FGM650) spaced 0.5m apart with readings recorded at 20 Hz. The cart is pushed at walking speed and not towed. Each sensor is not zeroed in the field as the vertical axis alignment is precisely fixed leaving sensor offsets that are removed during data processing. The fixing of the vertical alignment ensures the sensors are not unduly influenced by localised magnetic fields and that the vertical

component of a magnetic anomaly is measured. The gradiometers have a range of recording data between ±0.1nT and ±10,000nT. They are linked to a Leica GS10 RTK GPS with data recorded by SENSYS MAGNETO®MXPDA software on a rugged PDA computer system.

2.2.2 Due to the fixed offsets within the fluxgate sensors, as a result of the manufacturing and tensioning process, the survey data do not provide a visually useful dataset until a zero median traverse algorithm is applied. It is recognised that this has the potential to affect some anomalies detrimentally by removing linear features orientated parallel to survey transects. However, this has not been noted as a particular problem with the system due to the high resolution data collection, generally long length of traverses and variability within the magnetic characteristics of a linear anomaly.

2.2.3 Data are collected along a series of parallel survey transects to achieve 100% coverage of the surveyable land. The length of each transect is variable and relates to the size of the survey area and other factors including ground conditions. A visual display allows accurate placing of transects and helps maintain the correct separation between adjacent traverses. Data are not collected within fixed grids and data points are considered to be random even though the data are collected in a systematic manner covering all accessible areas (Aspinall, Gaffney and Schmidt, 2009).

2.2.4 Fluxgate sensors are highly sensitive to temperature change and this is manifest as drift during the course of a survey. This can be particularly noticeable during the morning as temperatures rise and the equipment warms or cools. Sensor drift within the course of a traverse will appear as a line trending from negative to positive after processing with a zero median traverse algorithm. To remove the potential for temperature drift data were collected after a 20 minute stabilisation period and traverses were limited to a time of generally <100s.

2.3 Data processing and presentation

2.3.1 Magnetic data collected by the MAGNETO®MXPDA cart-based system are initially prepared using SENSYS MAGNETO®DLMGPS software. The software effectively allocates a geographic position for each data point and can compensate for fixed offsets present within the FGM650 sensors. The offsets are positive or negative values present on all fluxgate gradiometer sensors. Some systems use manual or electronic balancing to effectively zero the sensors; however, this is a short term measure that is prone to drift through temperature changes and vibration and can easily be incorrectly set due to localised magnetic fields. The FGM650 sensors are very accurately aligned to the vertical magnetic gradient and are highly stable showing negligible drift on long traverses. The offset values are removed using TerraSurveyor software.

2.3.2 Survey tracks are analysed and georeferenced raw data (UTM Z30N) are then exported in ASCII format for further analysis and display within TerraSurveyor.

The removal of offset values (compensation) of the sensors is also carried out in TerraSurveyor using a zero median traverse function. Data are then considered to be minimally processed. Note: without the zero median traverse function it is not possible to create a meaningful data plot as all sensors have a different offset value. Although a zero median traverse algorithm can remove anomalies aligned with the survey tracks, in practice this rarely occurs due to the use of long traverses, high resolution measurement and variability within the magnetic susceptibility of long linear features.

2.3.3 The minimally processed data are collected between limits of ±10000nT and clipped for display at ±100nT, ±50nT and ±10nT. Data are interpolated to a resolution of effectively 0.5m between tracks and 0.15m along each survey track.

2.3.4 Additional data processing has been carried out for Area 3 in the form of high pass filtering. This effectively removes low frequency variation along a traverse that has been caused by the zero median traverse function failing to compensate the sensors correctly due to the presence of very high magnitude magnetic bodies. The data artefact is visible as a dark band within greyscale plots. Data treated to additional processing has been compared to unprocessed data to ensure that no significant anomalies have been removed. The filtered greyscale for Area 3 has been shown clipped ±3nT in order to enhance weakly magnetic anomalies of archaeological potential (Fig 18).

2.3.5 Appendix C contains metadata concerning the survey and data attributes and is derived directly from TerraSurveyor. Reference should be made to Appendix B for further information on processing.

2.3.6 A TIF file is produced by TerraSurveyor software along with an associated world file (.TFW) that allows automatic georeferencing (OSGB36 datum) when using GIS or CAD software. The main form of data display used in the report is the minimally processed greyscale plot. With regard to the Sensys MXPDA, minimally processed data is considered by the manufacturer to be data that is compensated by SENSYS MAGNETO DLMGPS software, see 2.3.1 and 2.3.2. Note: traceplots are not considered to be appropriate as they do not provide an accurate or useful assessment of the magnetic anomalies due to very high density of data collection.

2.3.7 The raster images are combined with base mapping using ProgeCAD Professional 2016, creating DWG (2010) file formats. All images are externally referenced to the CAD drawing in order to maintain good graphical quality. The CAD plots are effectively georeferenced facilitating relocation of features using GPS, resection method, etc.

2.3.8 An abstraction and interpretation is also drawn and plotted for all geophysical anomalies located by the survey. Anomalies are abstracted using colour coded points, lines and polygons. All plots are scaled to landscape A3 for paper printing.

2.3.9 A brief summary of each anomaly, with an appropriate reference number, is set out in list form within the results (Section 3) to allow a rapid and objective assessment of features within each survey area. Where further interpretation is possible, or where a number of possible origins should be considered, more subjective discussion is set out in Section 4.

2.3.10 The abstraction and interpretation procedure has been supported by analysis of a digital terrain model derived from the Environment Agency's LiDAR data. The DTM was interrogated as a shaded relief greyscale image but has not been plotted with this report.

2.3.11 A digital archive is produced with this report, see Appendix D below. The main archive is held at the offices of Archaeological Surveys Ltd.

3 RESULTS

3.1 General assessment of survey results

3.1.1 The detailed magnetic survey was carried out over a total of five survey areas covering approximately 5.5ha. Areas 1 and 5 are situated in the western part of the site and will be considered together (Figs 07 - 10), with Areas 2 and 4 in the southern part of the site (Figs 11 - 14) and Area 3 in the eastern part of the site (Figs 15 - 19).

3.1.2 Magnetic anomalies located can be generally classified as positive responses of archaeological potential, anomalies relating to military activity, positive anomalies of an uncertain origin, areas of magnetic debris and disturbance, strong discrete dipolar anomalies relating to ferrous objects and strong multiple dipolar linear anomalies relating to buried services or pipelines.

3.1.3 Anomalies located within each survey area have been numbered and are described in 3.4 below with subsequent discussion in Section 4.

3.2 Statement of data quality and factors influencing the interpretation of anomalies

3.2.1 Data are considered representative of the magnetic anomalies present within the site. Widespread magnetic disturbance and debris was encountered and although this may obscure weak anomalies of archaeological potential, the majority relates to former 20th century structures that are relevant to the objectives of the survey.

3.2.2 Within the northern part of Area 3, very high magnitude magnetic anomalies have produced a small zone of banding as a consequence of using a zero median traverse sensor compensation algorithm, see 2.3.4. The banding has been effectively removed by use of a high pass filter, and comparisons with the minimally processed dataset indicate no detrimental effects have

occurred.

3.2.3 Linear and amorphous anomalies have been caused by localised variations in natural soil susceptibility associated with patterned ground, see section 1.5. These anomalies have the potential to be confused with or attributed to features of anthropogenic origin.

3.3 Data interpretation

3.3.1 The list of sub-headings below attempts to define a number of separate categories that reflect the range and type of features located during the survey. A basic explanation of the characteristics of the magnetic anomalies is set out for each category in order to justify interpretation, a basic key is indicated to allow cross referencing to the abstraction and interpretation plot. CAD layer names are included to aid reference to associated digital files (.dwg/.dxf). Sub-headings are then used to group anomalies with similar characteristics for each survey area.

Report sub-heading CAD layer names and plot colour	**Description and origin of anomalies**
Anomalies with archaeological potential AS-ABST MAG POS CURVILINEAR RING DITCH 	Anomalies have the characteristics (mainly morphological) of ring ditch features. Such features can relate to Bronze Age round barrows, or possibly prehistoric round houses if smaller (<18m diameter).
Anomalies relating to military activity AS-ABST MAG DEBRIS WARTIME HARDSTANDING  AS-ABST MAG DEBRIS WARTIME STRUCTURAL AS-ABST MAG STRONG DIPOLAR WARTIME STRUCTURAL  AS-ABST MAG DEBRIS COLD WAR HARDSTANDING  AS-ABST MAG STRONG DIPOLAR COLD WAR 	Anomalies are generally highly magnetic and are associated with former military structures or areas of hardstanding etc.
Anomalies with an uncertain origin AS-ABST MAG POS LINEAR UNCERTAIN  AS-ABST MAG POS DISCRETE UNCERTAIN 	The category applies to a range of anomalies where there is not enough evidence to confidently suggest an origin. Anomalies in this category may well be related to archaeologically significant features, but equally relatively modern features, geological/pedological features and agricultural features should be considered. Positive anomalies are indicative of magnetically enhanced soils that may form the fill of 'cut' features or may be produced by accumulation within layers or 'earthwork' features; soils subject to burning may also produce positive anomalies.
Anomalies associated with magnetic debris AS-ABST MAG DEBRIS  AS-ABST MAG STRONG DIPOLAR 	Magnetic debris often appears as areas containing many small dipolar anomalies that may range from weak to very strong in magnitude. It often occurs where there has been dumping or ground make-up and is related to magnetically thermoremnant materials such as brick or tile or other small fragments of ferrous material. Within the site this material may relate to further areas of hardstanding. Strong discrete dipolar anomalies are responses to ferrous objects within the topsoil.
Anomalies with a modern origin AS-ABST MAG DISTURBANCE  AS-ABST MAG REINFORCEMENT AS-ABST MAG SERVICE 	The magnetic response is often strong and dipolar indicative of ferrous material and may be associated with extant above surface features such lights, aircraft anchor points etc.. Often a significant area around such features has a strong magnetic flux which may create magnetic disturbance; such disturbance can effectively obscure low

	magnitude anomalies if they are present. Fluxgate sensors may respond erratically and with hysteresis adjacent to strong magnetic sources. Strongly magnetic, multiple dipolar linear responses appear to relate to pins or staples used to hold down ground reinforcement mesh.
Anomalies with a natural origin AS-ABST MAG NATURAL FEATURES	Naturally formed magnetic anomalies are are caused by localised variability in the magnetic susceptibility of soils, subsoils and other drift or solid geologies. Anomalies may be amorphous, linear or curvilinear and may appear 'fluvial' or discrete. Sinuous lines relate to patterned ground, stripes which have been formed in a periglacial environment through the action of repeated freezing and thawing of groundwater during the last ice age (Devensian) forming bands of sand filled troughs within the underlying chalk.

Table 1: List and description of interpretation categories

3.4 List of anomalies - Areas 1 and 5

Area 1 centred on OS NGR 545403 245702 & Area 5 centred on OS NGR 545484 245727, see Figs 07 – 10.

Anomalies associated with military activity

(1) - A zone of magnetic debris in the form of two finger-like extensions to the west and north with rounded ends. These relate to the Second World War aircraft dispersal pans constructed by the USAAF in 1943. The magnetic responses forming the debris are dipolar and only moderately high in magnitude suggesting fragments of ferrous or thermoremnant magnetic material. The pans do not appear to contain high magnitude responses typical of Pierced Steel Planking (PSP).

(2) - Zones of weakly magnetic debris in generally amorphous formation, but which are located in the area of a former Cold War dispersal and are, therefore, likely to be associated. Strong, discrete, dipolar responses are associated, with several relating to aircraft anchor points.

Anomalies with a modern origin

(4) - A strong, multiple dipolar anomaly extends northwards from the southern edge of the survey area. There appears to be a gap, but then it appears to continue northwards. This anomaly relates to a buried service, although its date and function is not known. A second service can be seen in the southern part of the survey area.

Anomalies with a natural origin

(5) - Weakly positive (1.5nT) sinuous linear anomalies relate to sand and soil filled voids formed in periglacial conditions within the underlying chalk during the last glaciation.

3.5 List of anomalies - Areas 2 and 4

Area 2 centred on OS NGR 545431 245533 & Area 4 centred on OS NGR 545570 245630, see Figs 11 – 14.

Area 2 contains two pipes or services extending towards a small building at the south-west corner of the site. Magnetic debris is also evident within two patches, and although the site of the wartime fusing point building (Building 300) is recorded in the vicinity, it is not know if either of the patches are associated.

Area 4 contains magnetic disturbance from nearby fencing and strong, discrete, dipolar responses, but it is not possible to identify any anomalies associated with the Cold War dispersal taxi-ways, two of which are mapped as extending within the survey area.

3.6 List of anomalies - Area 3

Area 3 centred on OS NGR 545484 245727, see Figs 15 – 19.

Anomalies of archaeological potential

(6) - A positive curvilinear anomaly is located in the southern part of the survey area. The anomaly can be seen as a semi-circular feature, but it appears to have been buried by later landscaping and hardstanding on the south-western side. The anomaly has a response of 2-4nT, and relates to a 3m wide ring ditch, enclosing an area with a 38m diameter. This type of response would indicate the remains of a ring ditch associated with a Bronze Age round barrow.

Anomalies associated with military activity

(7 & 8) - The northern part of the survey contains widespread and highly magnetic debris. The response is variable, but generally at least ±500nT and over ±2000nT in several places. Several patches do correspond with buildings seen on 1946 aerial photographs (7), others are not so clearly associated with recorded structures but are highly magnetic (8). The response is to ferrous and other magnetically thermoremnant material, which could have been dumped on site, but is likely to relate to demolished wartime and pre-war structures.

(9) - Strong, discrete, dipolar responses that are often in pairs and in lines. Some can be seen to be associated with the position of buildings seen on 1946 aerial photographs, such as the pre-war sports pavilion (Building 52) towards the east, others are located in the far north close to existing and former fuel installations. Several lines appear in the vicinity of lighter patches within the ground surface visible on the 1946 aerial photographs and so are not clearly identifiable. However, due to the use and development of this area in the early 20th century it is likely that the responses relate to former structures and associated infrastructure.

(10) - A grid of strong dipolar responses relates to the expansion joints associated with the Cold War period protected type hardstanding. This is an extant feature, formed of 10ft by 10ft squares of concrete to form the hardstanding. The origin of the magnetic material appears to relate to a degraded wire fragments and other small metal objects within the bitumen filled expansion joints.

(11) - Pairs of strong, discrete, dipolar responses are formed in lines with five pairs in each. They correspond to the left outer edge of the original Y-shaped Cold War dispersals on the extant hardstanding in the eastern part of the site. Similar responses can also be seen further to the south-west and which correspond to the right outer edge of another Y-shaped dispersal which has since been removed. It is possible that these are associated with the former blast walls.

(12) - Strong, discrete dipolar anomalies relate to aircraft anchor points within the hardstanding.

Anomalies with an uncertain origin

(13) - A positive linear anomaly extends through the centre of anomaly (6). It is possible that it relates to a cut feature; however, given the large amount of military activity within the site, a modern feature, such as a service or drain is also possible.

(14) - A small number of discrete, weakly positive responses are located within the confines of and 27m east of anomaly (6). This type of response could indicate a pit-like feature and given the proximity to the ring ditch (6) an archaeological origin is possible. However, a modern origin is also possible and, therefore, their origin is uncertain.

(15) - A positive linear anomaly, with associated negative response on the southern side, extends through the centre of the survey area. It appears to extend between a fuel tank in the west towards the American Air Museum in the east, although there is an unusual kink along its length. It is possible that this relates to a buried service or pipe that extends from the fuel tank, although this is not certain and a military association is possible.

Anomalies associated with magnetic debris

(16) - Patches of magnetic debris are located to the north of anomaly (10) and could indicate the presence of other areas of former hardstanding. One zone appears circular in form, with the same c17m (56ft) diameter as the rounded ends of the wartime dispersal pans seen in Area 1 as anomaly (1).

(17) - The survey area contains widespread and numerous strong, discrete, dipolar responses. In the north, the majority will relate to the former military structures, although some are likely to relate to modern objects also. Towards the east, many are associated with magnetic debris (16) and in the eastern part of the survey area, several exist in short rows or lines and could also relate to wartime activity, although their date and function cannot be determined.

4 DISCUSSION

4.1.1 The results of the geophysical survey demonstrate the presence of magnetic debris (1) within the western part of the site (Area 1) that relate to the wartime dispersal pans constructed by the USAAF in 1943. The magnetic debris has a moderate response of generally ±40nT which indicates small fragments of ferrous material or magnetically thermoremnant material, such foundry waste or other industrial waste material, which may indicate a sub-base or such material included in ballast within concrete. There are occasional very strong responses (±1000nT) which would relate to discrete ferrous objects, such as aircraft anchor points, but if the surfaces were buried PSP then the entire zone would be expected to be very highly magnetic. It is understood that the PSP was utilised by the USAAF for the runway and hardstanding, but was generally laid directly onto grass in square or rectangular sections, rather than in circles. A similar response can be seen within Area 3 in the eastern part of the site (16), which has a similar magnitude (±20-40nT) and diameter at approximately 17m (56ft) as the rounded ends of the dispersal pans. Although none have been recorded in this part of the site, the magnetic debris within Area 3 could also relate to former areas of hardstanding.

4.1.2 There have been varying magnetic responses to the Cold War period dispersal hardstandings. In the eastern part of the site (Area 3) the extant concrete corresponds to a grid of dipolar responses (10) which is a response to degraded wire mesh and other metal objects within the bitumen in the expansion joints. The layout is slightly different to the original Y-shaped formation which had two areas of hardstanding for two aircraft with central fuel bowser hardstanding and the Uni-Seco armoury on the far left. Two lines of five pairs of strong dipolar responses (11) are positioned on the outer left edges of the former Y-shaped hardstandings. The dispersals would have originally been protected with blast walls on the outer edges of the Y-shaped hardstanding, but is it not possible to determine if the strong dipolar responses are directly associated with the former blast walls, or relate to other ferrous objects or features which may post-date the removal of the walls. A similar line of five pairs of strong dipolar responses can also be seen 70m to the south-west and which correspond to the right outer edge of the Y-shaped dispersal which has since been removed.

4.1.3 The position of the Cold War dispersal within Areas 1 and 5 does appear to correspond to zones of magnetic debris; however, these are not well defined, with strong dipolar responses indicating ferrous objects which relate to other features such as aircraft anchor points. In the southern part of the site (Areas 2 and 4) there is no clear indication of anomalies that can be directly attributed to the Cold War dispersals or taxi-ways.

4.1.4 Within the northern part of the site (Area 3) there is a zone containing widespread magnetic debris (7 & 8) and rows of strong dipolar responses (9).

This part of the site originally contained the 1917 temporary Bessonneau hangars, which stood in a line of eight with the long axis at right-angles to the A505 to the rear. While some of the dipolar responses could be associated there is not a series of parallel responses within this part of the site that can be attributed to them. There are several rows of strong dipolar responses, often seen in pairs, some of which appear in the location of removed structures, (eg Building 52, inter-war sports pavilion), while others may also relate to former structures or their associated infrastructure, it is not clear what the responses relate to. Highly magnetic debris could indicate demolished buildings with a ferrous and brick content. At least fifteen wartime buildings have been listed within this area (Francis, 2010a), including a number of defence huts, latrines and ablution blocks, bulk lubrication oil installations and an air-raid shelter. Several of them can be seen on aerial photographs and some areas of magnetic debris (7) do correspond to the positions of these buildings. Several of the rows of dipolar responses and some zones of highly magnetic debris cannot be clearly attributed to the structures on the surface, with some potentially relating to former structures removed prior to 1946 or possible buried structures, such as the air-raid shelter, but this is not clear.

4.1.5 The site also contains evidence for archaeology that pre-dates the use of the site as an airfield. Within Area 3 is a positive curvilinear response, seen as a semi-circular feature, which relates to the north-eastern part of a ring ditch with a 38m diameter. It is likely that the south-western side lies beneath modern landscaping, with the site of a Uni-Seco armoury of a removed Cold War dispersal also formerly overlying the ring ditch. This type of response would relate to a Bronze Age round barrow ditch, several of which have been recorded from aerial photographs in the wider vicinity.

5 CONCLUSION

5.1.1 The detailed magnetometry survey has located evidence for a previously unrecorded ring ditch that is likely to relate to a Bronze Age round barrow. Although the south-western part may lie under modern landscaping, the north-eastern part can clearly be seen in the results.

5.1.2 The northern part of the site contains widespread very strongly magnetic debris and rows of strong dipolar responses. This part of the site is understood to have contained at least fifteen structures during the Second World War and the majority of the responses are likely to be associated.

5.1.3 Other evidence for wartime activity includes magnetic debris in the western part of the site that relates to material used in the construction of the aircraft dispersals during 1943. Although the material is magnetic, it does not appear to be strongly magnetic possibly indicating that magnetically thermoremnant material has been used within the hardstanding or as a sub-base to it. Magnetic debris is also associated with the position of a Cold War

hardstanding also in the western part of the site, but the response is not clearly defined like the wartime hardstanding. Zones of similar magnetic debris have also been located in the eastern part of the site which may also relate to unrecorded zones of former hardstanding.

6 REFERENCES

Aspinall, A., Gaffney, C. and Schmidt, A. 2009. *Magnetometry for Archaeologists*. Lanham (US), AltaMira Press.

British Geological Survey, 2017. *Geology of Britain viewer, 1:50 000 scale [online]* available from http://mapapps.bgs.ac.uk/geologyofbritain/home.html [accessed 27/9/2017].

Chartered Institute for Archaeologists, 2014. *Standard and Guidance for archaeological geophysical survey*. IfA, University of Reading.

English Heritage, 2008. *Geophysical survey in archaeological field evaluation. Research and Professional Service Guideline No.1.* 2nd ed. Swindon: English Heritage.

European Archaeological Council, 2015. *EAC Guidelines for the Use of Geophysics in Archaeology: Questions to Ask and Points to Consider.* Europae Archaeologia Consilium and Association Internationale sans But Lucratif, Belgium.

Francis, P., 2010a. *RAF Duxford Historic Appraisal 1917-1961, Part 1: Report.* Unpublished typescript document.

Francis, P., 2010b. *RAF Duxford Historic Appraisal 1917-1961, Part 2: Gazetteer of Extant Buildings*. Unpublished typescript document.

Institute for Archaeologists, 2002. *The use of Geophysical Techniques in Archaeological Evaluations*. IfA Paper No. 6. IfA, University of Reading.

Murray, C., 2017. *Historic use of West end of Duxford site North of Land Warfare Hall (LWH).* Unpublished typescript document.

Schmidt, A., 2013. *Geophysical Data in Archaeology: A Guide to Good Practice.* Oxbow Books.

Soil Survey of England and Wales, 1983. *Soils of England and Wales, Sheet 4 Eastern England.*

Appendix A – basic principles of magnetic survey

Iron minerals are always present to some degree within the topsoil and enhancement associated with human activity is related to increases in the level of magnetic susceptibility and thermoremnant material.

Magnetic susceptibility is an induced magnetism within a material when it is in the presence of a magnetic field. This can be thought of as effectively permanent due to the presence of the Earth's magnetic field.

Thermoremnant magnetism occurs when ferrous material is heated beyond a specific temperature known as the Curie Point. Demagnetisation occurs at this temperature with re-magnetisation by the Earth's magnetic field upon cooling.

Enhancement of magnetic susceptibility can occur in areas subject to burning and complex fermentation processes on biological material; these are frequently associated with human settlement. Thermoremnant features include ovens, hearths, and kilns. In addition thermoremnant material such as tile and brick may also be associated with human activity and settlement.

Silting and deliberate infilling of ditches and pits with magnetically enhanced soil can create an area of enhancement compared with surrounding soils and subsoils into which the feature is cut. Mapping enhanced areas will produce linear and discrete anomalies allowing an assessment and characterisation of hidden subsurface features.

It should be noted that areas of negative enhancement can be produced from material having lower magnetic properties compared to the topsoil. This is common for many sedimentary bedrocks and subsoils which were often used in the construction of banks and walls etc. Mapping these 'negative' anomalies may also reveal archaeological features.

Magnetic survey or magnetometry can be carried out using a fluxgate gradiometer and may be referred to as gradiometry. The SENSYS gradiometer is a passive instrument consisting of two fluxgate sensors mounted vertically 65cm apart. The instrument is carried about 10-20cm above the ground surface and the upper sensor measures the Earth's magnetic field as does the lower sensor but this is influenced to a greater degree by any localised buried field. The difference between the two sensors will relate to the strength the magnetic field created by the buried feature.

There are a number of factors that may affect the magnetic survey and these include soil type, local geology and previous human activity. Situations arise where magnetic disturbance associated with modern services, metal fencing, dumped waste material etc., obscures low magnitude fields associated with archaeological features.

Appendix B – data processing notes

Clipping

Minimum and maximum values are set and replace data outside of the range with those values. Extreme values are removed improving colour or greyscale contrast associated with data values that may be archaeologically significant. It has been found that clipping data to ranges between ±5nT and ±3nT often improves the appearance of features associated with archaeology. Different ranges are applied to data in order to determine the most suitable for anomaly abstraction and display.

Zero (destripe) Median/Mean Traverse

The median (or mean) of each traverse is calculated ignoring data outside a threshold value, the median (or mean) is then subtracted from the traverse. The process is used to equalise differences between the baseline value of gradiometer sensors.

High Pass Filtering

A mathematical process used to remove low frequency anomalies relating to survey tracks, modern agricultural features and other large magnetic bodies within or adjacent to survey areas.

Low Pass Filtering

A mathematical process used to remove high frequency anomalies relating to uneven ground, vibration, etc.

Appendix C – survey and data information

Area 1 minimally processed data

Filename: J730-mag-Area1-proc.xcp
Description: Imported as Composite from: J730-mag-Area1.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 31U
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 545323.105998553, 245821.625980758 m
Southeast corner: 545518.255998553, 245569.025980758 m
Collection Method: Randomised
Sensors: 5
Dummy Value: 32702
Source GPS Points: 453100
Dimensions
Composite Size (readings): 783 x 1013
Survey Size (meters): 196 m x 253 m
Grid Size: 196 m x 253 m
X Interval: 0.25 m
Y Interval: 0.25 m
Stats
Max: 110.50
Min: -110.00
Std Dev: 22.92
Mean: -0.35
Median: -0.01
Stats
Max: 55.25
Min: -55.00
Std Dev: 16.63
Mean: -0.54
Median: -0.02
Stats
Max: 11.05
Min: -11.00
Std Dev: 5.00
Mean: -0.23
Median: -0.03
PROGRAM
Name: TerraSurveyor
Version: 3.0.23.0
Processes: 1
1 Base Layer
GPS based Proce5
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 DeStripe Median Traverse:
4 Clip from -100.00 to 100.00 nT
5 Clip from -50.00 to 50.00 nT
6 Clip from -10.00 to 10.00 nT

Area 2 minimally processed data

Filename: J730-mag-Area2-proc.xcp
Description: Imported as Composite from: J730-mag-Area2.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 31U
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 545389.692353488, 245576.789003288 m
Southeast corner: 545479.992353488, 245494.289003288 m
Source GPS Points: 68500
Dimensions
Composite Size (readings): 602 x 550
Survey Size (meters): 90.3 m x 82.5 m
Grid Size: 90.3 m x 82.5 m
X Interval: 0.15 m
Y Interval: 0.15 m
Stats
Max: 110.50
Min: -110.00
Std Dev: 21.72
Mean: 0.93
Median: 0.00
Composite Area: 0.74498 ha
Surveyed Area: 0.25972 ha
Stats
Max: 3.32
Min: -3.30
Std Dev: 2.04
Mean: 0.06
Median: 0.03
Composite Area: 0.74498 ha
Surveyed Area: 0.25972 ha
Dimensions
Composite Size (readings): 363 x 332
Survey Size (meters): 90.8 m x 83 m
Grid Size: 90.8 m x 83 m
X Interval: 0.25 m
Y Interval: 0.25 m
Stats
Max: 55.25
Min: -55.00
Std Dev: 15.13
Mean: 0.87
Median: -0.10
Composite Area: 0.75323 ha
Surveyed Area: 0.26781 ha
Stats
Max: 11.05
Min: -11.00
Std Dev: 4.98
Mean: 0.27
Median: 0.03
Composite Area: 0.74498 ha
Surveyed Area: 0.25972 ha
Processes: 1
1 Base Layer
GPS based Proce8
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 DeStripe Median Traverse:
4 Clip from -100.00 to 100.00 nT
5 Clip from -50.00 to 50.00 nT
6 Clip from -20.00 to 20.00 nT
7 Clip from -10.00 to 10.00 nT
8 Clip from -3.00 to 3.00 nT

Area 3 minimally processed data

Filename: J730-mag-Area3-proc.xcp
Description: Imported as Composite from: J730-mag-Area3.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 31U
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 545500.881393435, 245975.628038294 m
Southeast corner: 545745.531393435, 245707.428038294 m
Source GPS Points: 770000
Dimensions
Composite Size (readings): 1631 x 1788
Survey Size (meters): 245 m x 268 m
Grid Size: 245 m x 268 m
X Interval: 0.15 m
Y Interval: 0.15 m
Stats
Max: 3.32
Min: -3.30
Std Dev: 2.40
Mean: -0.04
Median: 0.00
Composite Area: 6.5615 ha
Surveyed Area: 2.9354 ha
Processes: 1
1 Base Layer
GPS based Proce8
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 DeStripe Median Traverse:
4 Clip from -100.00 to 100.00 nT
5 Clip from -50.00 to 50.00 nT
6 Clip from -20.00 to 20.00 nT
7 Clip from -10.00 to 10.00 nT
8 Clip from -3.00 to 3.00 nT
Stats
Max: 110.50
Min: -110.00
Std Dev: 39.56
Mean: -1.84
Median: -0.07
Composite Area: 6.5615 ha
Surveyed Area: 2.9354 ha
Stats
Max: 11.05
Min: -11.00
Std Dev: 6.93
Mean: -0.27
Median: 0.02
Composite Area: 6.5615 ha
Surveyed Area: 2.9354 ha
Stats
Max: 3.32
Min: -3.30
Std Dev: 2.37
Mean: -0.03
Median: -0.01
Composite Area: 6.5615 ha
Surveyed Area: 2.9354 ha
Dimensions
Composite Size (readings): 981 x 1075

Survey Size (meters): 245 m x 269 m
Grid Size: 245 m x 269 m
X Interval: 0.25 m
Y Interval: 0.25 m
Stats
Max: 55.25
Min: -55.00
Std Dev: 24.48
Mean: -1.36
Median: -0.29
Composite Area: 6.5911 ha
Surveyed Area: 2.9758 ha
Processes: 1
1 Base Layer
GPS based Proce9
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 DeStripe Median Traverse:
4 Clip from -100.00 to 100.00 nT
5 Clip from -50.00 to 50.00 nT
6 Clip from -20.00 to 20.00 nT
7 Clip from -10.00 to 10.00 nT
8 High pass Uniform (mean) filter: Window dia: 300
9 Clip from -3.00 to 3.00 nT

Area 3 filtered data

Filename: J730-mag-Area3-proc-hpf.xcp
Description: Imported as Composite from: J730-mag-Area3.asc
Stats
Max: 3.32
Min: -3.30
Std Dev: 2.37
Mean: -0.03
Median: -0.01
Composite Area: 6.5615 ha
Surveyed Area: 2.9354 ha
Processes: 1
1 Base Layer
GPS based Proce9
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 DeStripe Median Traverse:
4 Clip from -100.00 to 100.00 nT
5 Clip from -50.00 to 50.00 nT
6 Clip from -20.00 to 20.00 nT
7 Clip from -10.00 to 10.00 nT
8 High pass Uniform (mean) filter: Window dia: 300
9 Clip from -3.00 to 3.00 nT

Area 4 minimally processed data

Description: Imported as Composite from: J730-mag-Area4.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 31U
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 545530.253344478, 245693.741965576 m
Southeast corner: 545613.203344478, 245563.241965576 m
Source GPS Points: 47700
Dimensions
Composite Size (readings): 553 x 870
Survey Size (meters): 83 m x 131 m
Grid Size: 83 m x 131 m
X Interval: 0.15 m
Y Interval: 0.15 m
Stats
Max: 110.50
Min: -110.00
Std Dev: 33.35
Mean: 1.59
Median: 0.13
Composite Area: 1.0825 ha
Surveyed Area: 0.19382 ha
Stats
Max: 11.05
Min: -11.00
Std Dev: 7.58
Mean: -0.01
Median: 0.16
Composite Area: 1.0825 ha
Surveyed Area: 0.19382 ha
Dimensions
Composite Size (readings): 334 x 524
Survey Size (meters): 83.5 m x 131 m
Grid Size: 83.5 m x 131 m
X Interval: 0.25 m
Y Interval: 0.25 m
Stats
Max: 55.25
Min: -55.00
Std Dev: 23.54
Mean: 0.41
Median: 0.03
Composite Area: 1.0939 ha
Surveyed Area: 0.20384 ha
Processes: 1
1 Base Layer
GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 DeStripe Median Traverse:
4 Clip from -10.00 to 10.00 nT

Area 5 minimally processed data

COMPOSITE
Path: C:\Business\Jobs\J730 IWM Duxford\Data\Area 5\comps\
Filename: J730-mag-Area5-proc.xcp
Description: Imported as Composite from: J730-mag-Area5.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 31U
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 545468.293309654, 245738.038188907 m
Southeast corner: 545501.593309654, 245713.738188907 m
Source GPS Points: 17900
Dimensions
Composite Size (readings): 222 x 162
Survey Size (meters): 33.3 m x 24.3 m
Grid Size: 33.3 m x 24.3 m
X Interval: 0.15 m
Y Interval: 0.15 m
Max: 110.50
Min: -110.00
Std Dev: 50.90
Mean: 1.65
Median: 0.33
Composite Area: 0.080919 ha
Surveyed Area: 0.049509 ha
Stats
Max: 11.05
Min: -11.00
Std Dev: 8.25
Mean: -0.04
Median: -0.07
Composite Area: 0.080919 ha
Surveyed Area: 0.049509 ha
Dimensions
Composite Size (readings): 136 x 100
Survey Size (meters): 34 m x 25 m
Grid Size: 34 m x 25 m
X Interval: 0.25 m
Y Interval: 0.25 m
Stats
Max: 55.25
Min: -55.00
Std Dev: 32.40
Mean: -0.31
Median: 0.04
Composite Area: 0.085 ha
Surveyed Area: 0.052206 ha
Processes: 1
1 Base Layer
GPS based Proce7
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 DeStripe Median Traverse:
4 Clip from -100.00 to 100.00 nT
5 Clip from -50.00 to 50.00 nT
6 Clip from -20.00 to 20.00 nT
7 Clip from -10.00 to 10.00 nT

Appendix D – digital archive

Archaeological Surveys Ltd hold the primary digital archive at their offices in Wiltshire. Data are backed-up onto an on-site data storage drive and at the earliest opportunity data are copied to CD ROM for storage on-site and off-site.

A PDF copy will be supplied to the Cambridgeshire Historic Environment Record with printed copies on request. The report will also be uploaded to the Online AccesS to the Index of archaeological investigationS (OASIS).

Archive contents:

Geophysical data - path: J730 IWM Duxford\Data				
Path and Filename	**Software**	**Description**	**Date**	**Creator**
duxford1\MX\.prm,.dgb,.disp duxford2\MX\.prm,.dgb,.disp duxford3\MX\.prm,.dgb,.disp duxford4\MX\.prm,.dgb,.disp duxford5\MX\.prm,.dgb,.disp	Sensys MXPDA	Proprietary data formats representing magnetometer survey traverses logged to a PDA.	13/09/17	D.J.Sabin
duxford1\MX\J730-mag-Area1.asc duxford2\MX\J730-mag-Area2.asc duxford3\MX\J730-mag-Area3.asc duxford4\MX\J730-mag-Area4.asc duxford5\MX\J730-mag-Area5.asc	Sensys DLMGPS	ASCII CSV (tab) file representing survey Area 1 in eastings, northings (UTM Z30N), magnetic measurement, traverse file and sensor number.	19/09/17	K.T.Donaldson
Area1\comps\J730-mag-Area1.xcp Area2\comps\J730-mag-Area2.xcp Area3\comps\J730-mag-Area3.xcp Area4\comps\J730-mag-Area4.xcp Area5\comps\J730-mag-Area5.xcp	TerraSurveyor 3.0.23.0	Composite data file derived from ASCII CSV.	19/09/17	K.T.Donaldson
Area1\comps\J730-mag-Area1-proc.xcp Area2\comps\J730-mag-Area2-proc.xcp Area3\comps\J730-mag-Area3-proc.xcp Area4\comps\J730-mag-Area4-proc.xcp Area5\comps\J730-mag-Area5-proc.xcp	TerraSurveyor 3.0.23.0	Processed composite data file (zmt and clipping to ±100nT).	19/09/17	K.T.Donaldson
Area1\comps\J730-mag-Area1-proc-50nT-rb.xcp Area2\comps\J730-mag-Area2-proc-50nT-rb.xcp Area3\comps\J730-mag-Area3-proc-50nT-rb.xcp Area4\comps\J730-mag-Area4-proc-50nT-rb.xcp Area5\comps\J730-mag-Area5-proc-50nT-rb.xcp	TerraSurveyor 3.0.23.0	Processed composite data file (zmt and clipping to ±50nT).	21/09/17	K.T.Donaldson
Area1\comps\J730-mag-Area1-proc-hpf.xcp Area3\comps\J730-mag-Area3-proc-hpf.xcp	TerraSurveyor 3.0.23.0	Processed composite data file (zmt and high pass filtered and clipping to ±3nT).	26/09/17	K.T.Donaldson
Graphic data - path: J730 IWM Duxford \Data				
Area1\graphics\J730-mag-Area1-proc-100nT.tif & tfw Area2\graphics\J730-mag-Area2-proc-100nT.tif & tfw Area3\graphics\J730-mag-Area3-proc-100nT.tif & tfw Area4\graphics\J730-mag-Area4-proc-100nT.tif & tfw Area5\graphics\J730-mag-Area5-proc-100nT.tif & tfw	TerraSurveyor 3.0.23.0	TIF file showing a minimally processed greyscale plot clipped to ±100nT and World file for georeferencing TIF to OSGB36.	19/09/17	K.T.Donaldson
Area1\graphics\J730-mag-Area1-proc-50nT-rb.tif Area2\graphics\J730-mag-Area2-proc-50nT-rb .tif Area3\graphics\J730-mag-Area3-proc-50nT-rb .tif Area4\graphics\J730-mag-Area4-proc-50nT-rb .tif Area5\graphics\J730-mag-Area5-proc-50nT-rb .tif	TerraSurveyor 3.0.23.0	TIF file showing a minimally processed greyscale plot clipped to ±50nT with values between 35nT and 50nt shown in red and between -35 and -50nT shown in blue and World file for georeferencing TIF to OSGB36.	19/09/17	K.T.Donaldson
Area1\graphics\J730-mag-Area1-proc-10nT.tif Area2\graphics\J730-mag-Area2-proc-10nT.tif Area3\graphics\J730-mag-Area3-proc-10nT.tif Area4\graphics\J730-mag-Area4-proc-10nT.tif Area5\graphics\J730-mag-Area5-proc-10nT.tif	TerraSurveyor 3.0.23.0	TIF file showing a minimally processed greyscale plot clipped to ±10nT and World file for georeferencing TIF to OSGB36.	19/09/17	K.T.Donaldson
Area1\graphics\J730-mag-Area1-proc-3nT-hpf.tif Area3\graphics\J730-mag-Area3-proc-3nt-hpf.tif	TerraSurveyor 3.0.23.0	TIF file showing a high pass filtered greyscale plot clipped to ±3nT and World file for georeferencing TIF to OSGB36.	26/09/17	K.T.Donaldson
CAD data - path: J730 IWM Duxford\CAD				
J730 version 2.dwg	ProgeCAD 2016	CAD file for creating plots of greyscales, abstraction, interpretation and mapping. Grid coordinates as OSGB. AutoCAD 2010 format.	19/09/17	K.T.Donaldson
Text data - path: J730 IWM Duxford\\Documentation				
J730 report.odt	OpenOffice.org 3.0.1 Writer	Report text as an Open Office document.	26/09/17	K.T.Donaldson

Appendix E – copyright and intellectual property

This report may contain material that is non-Archaeological Surveys Ltd copyright (eg Ordnance Survey, Crown Copyright) or the intellectual property of third parties, which we are able to provide for limited reproduction under the terms of our own copyright licences, but for which copyright itself is non-transferable by Archaeological Surveys Ltd. Users remain bound by the conditions of the Copyright, Design and Patents Act 1988 with regard to multiple copying and electronic dissemination of this report.

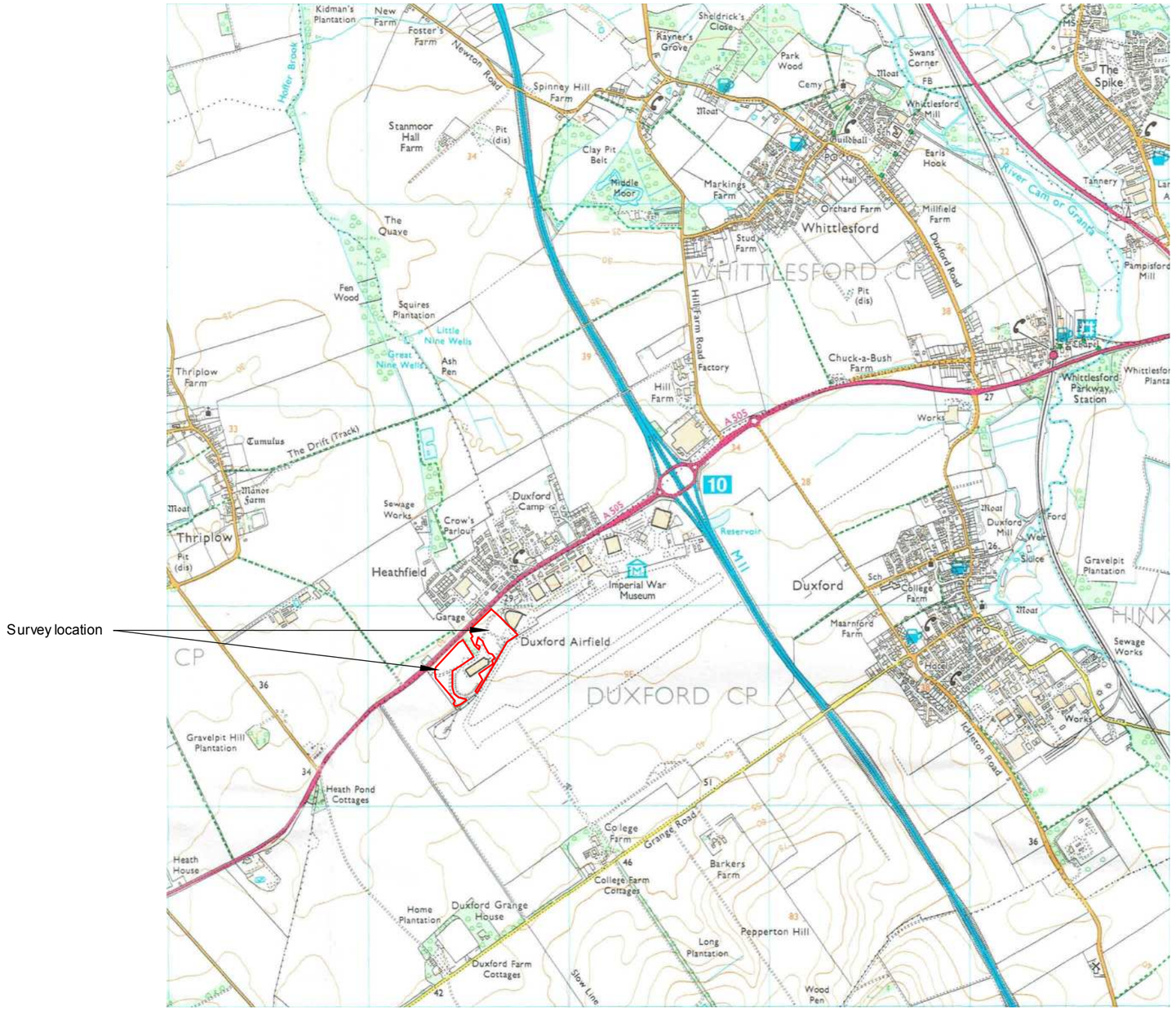
Archaeological Surveys Ltd shall retain intellectual property rights for the materials and records created as part of this project. A non-exclusive, transferable, sub-licensable, perpetual and royalty-free licence shall be granted to the client on full payment of works in order for them to use, reproduce and enhance the reports, documentation, graphics and illustrations produced as part of this project for the purpose for which they were commissioned. Copyright licence will also be granted to the local authority for planning use and within in the Historic Environment Record for public dissemination upon payment by the client. Any document produced to meet planning requirements may be freely copied for planning, development control, research and outreach purposes without recourse to the originator, subject to all due and appropriate acknowledgements being provided and to the terms of the original contract with the client. Archaeological Surveys Ltd shall retain the right to be identified as the author and originator of the material.

The report, data and any associated material produced by Archaeological surveys Ltd cannot be freely used for any commercial activity other than those set out above. Any unauthorised use will be considered to be in breach of copyright.

Title of Goods remains with Archaeological Surveys Ltd until payment has cleared. Late payment may jeopardise any planning decision as there will be no transfer of title, licensing or any other right of copy or use of this report. Archaeological Surveys Ltd do not give permission for use of the report and associated data in cases of late payment. Any such use will be considered to be in breach of copyright. Late payment may also incur interest at 8% over the Bank of England base rate. Non-payment will be pursued by legal action.

Archaeological Surveys Ltd

Geophysical Survey
IWM Duxford
Cambridgeshire



Survey location

Survey location

Site centred on OS NGR
TL 45535 45745

Map of survey area

SCALE 1:25 000

0m 500m 1000m

SCALE TRUE AT A3

FIG 01

Archaeological Surveys Ltd

Geophysical Survey
IWM Duxford
Cambridgeshire

Referencing information

Referencing grid to OSGB36 datum at 50m intervals

Data collected at 20Hz and georeferenced to ETRS89 zone 30 with conversion to OSGB36 using OSTN02

545350 245700

Survey tracks

Survey track start

Survey track stop

Survey scope boundary

SCALE 1:2000

0m 20 40 60 80 100m

SCALE TRUE AT A3

FIG 02

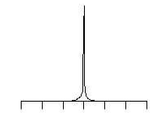
Archaeological Surveys Ltd

Geophysical Survey
IWM Duxford
Cambridgeshire

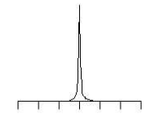
Greyscale plot of minimally processed magnetometer data clipped at ±100nT

+100nT

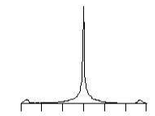
-100nT



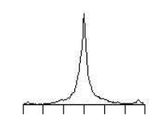
-100nT Area 1 +100nT



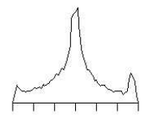
-100nT Area 2 +100nT



-100nT Area 3 +100nT



-100nT Area 4 +100nT



-100nT Area 5 +100nT

SCALE 1:2000

0m 20 40 60 80 100m

SCALE TRUE AT A3

FIG 03

Archaeological Surveys Ltd

Geophysical Survey
IWM Duxford
Cambridgeshire

Greyscale plot of minimally processed magnetometer data clipped at ±50nT

+50nT

-50nT

-50nT Area 1 +50nT

-50nT Area 2 +50nT

-50nT Area 3 +50nT

-50nT Area 4 +50nT

-50nT Area 5 +50nT

SCALE 1:2000

0m 20 40 60 80 100m

SCALE TRUE AT A3

FIG 04

N

Garage

American Air Museum

RINGSTONE

Cottages

310m

War Memorial

Area 3

Long Plantation

Tank

El Sub Sta

FB

Area 5

Land Warfare Hall

Area 4

Area 1

Area 2

Wind Sack

Ward Bdy

CR

31.5m

Archaeological Surveys Ltd

Geophysical Survey
IWM Duxford
Cambridgeshire

Greyscale plot of minimally processed magnetometer data clipped at ±10nT

+10nT

-10nT

-10nT Area 1 +10nT

-10nT Area 2 +10nT

-10nT Area 3 +10nT

-10nT Area 4 +10nT

-10nT Area 5 +10nT

SCALE 1:2000

0m 20 40 60 80 100m

SCALE TRUE AT A3

FIG 05

N

American Air Museum

Garage

Cottages

RINGSTONE

310m

War Memorial

Area 3

Long Plantation

Tank

El Sub Sta

FB

Area 5

Land Warfare Hall

Area 4

Area 1

Area 2

Wind Sack

Ward Bdy

CR

31.5m

Archaeological Surveys Ltd

Geophysical Survey
IWM Duxford
Cambridgeshire

Abstraction and interpretation of magnetic anomalies

- Positive curvilinear anomaly - ring ditch
- Positive linear anomaly - of uncertain origin
- Magnetic debris - associated with wartime hardstanding/dispersal pans
- Magnetic debris - associated with interwar/wartime structures
- Magnetic debris - associated with Cold War hardstanding/dispersal pans
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Strong dipolar response - associated with interwar/wartime structures
- Strong dipolar response - associated with Cold War hardstanding/dispersal pans
- Discrete positive response - possible pit-like feature
- Strong dipolar anomaly - ferrous object
- Magnetic material - within expansion joints of Cold War protected hardstanding
- Magnetic disturbance from ferrous material
- Strong multiple dipolar linear anomaly - associated with grass reinforcement mesh
- Strong multiple dipolar linear anomaly - pipeline / cable / service
- Positive linear anomaly - of natural origin (patterned ground)

SCALE 1:2000

0m 20 40 60 80 100m

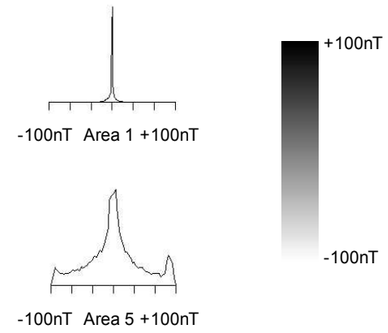
SCALE TRUE AT A3

FIG 06

Archaeological Surveys Ltd

Geophysical Survey
IWM Duxford
Cambridgeshire

Greyscale plot of minimally processed magnetometer data clipped at ±100nT - Areas 1 & 5



SCALE 1:1000

0m 10 20 30 40 50m

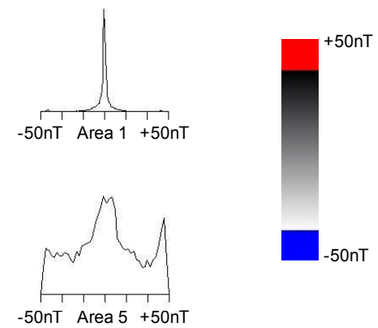
SCALE TRUE AT A3

FIG 07

Archaeological Surveys Ltd

Geophysical Survey
IWM Duxford
Cambridgeshire

Greyscale plot of minimally processed magnetometer data clipped at ±50nT - Areas 1 & 5



SCALE 1:1000

0m 10 20 30 40 50m

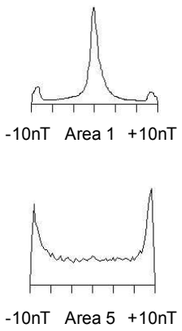
SCALE TRUE AT A3

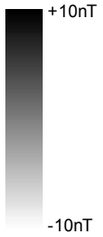
FIG 08

Archaeological Surveys Ltd

Geophysical Survey
IWM Duxford
Cambridgeshire

Greyscale plot of minimally processed magnetometer data clipped at ±10nT - Areas 1 & 5





SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

FIG 09

Archaeological Surveys Ltd

Geophysical Survey
IWM Duxford
Cambridgeshire

Abstraction and interpretation of magnetic anomalies - Areas 1 & 5

- Magnetic debris - associated with wartime hardstanding/dispersal pans
- Magnetic debris - associated with Cold War hardstanding/dispersal pans
- Magnetic disturbance from ferrous material
- Strong multiple dipolar linear anomaly - associated with grass reinforcement mesh
- Strong multiple dipolar linear anomaly - pipeline / cable / service
- Strong dipolar anomaly - ferrous object
- Positive linear anomaly - of natural origin (patterned ground)

SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

FIG 10

Area 1
Area 3
Area 4
Area 5
Long Plantation
Ward Bay
CR
Tank
El Sub Sta
F B
Land Warfare Hall
N
1
2
3
4
5
6
11
13