

**Land at Bowerhill Lane
Melksham
Wiltshire**

MAGNETOMETER SURVEY REPORT

for

The Silverwood Partnership

Kerry Donaldson & David Sabin

March 2025

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ARCHAEOLOGICAL SURVEYS LTD

**Land at Bowerhill Lane
Melksham
Wiltshire**

MAGNETOMETER SURVEY REPORT

for

The Silverwood Partnership

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Primary archive location - Archaeological Surveys Ltd, Yatesbury, Wiltshire

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Ordnance Survey Grid Reference – **ST 92160 62060**



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SUMMARY

Archaeological Surveys Ltd carried out a detailed magnetometry survey over a single field of pasture at Bowerhill Lane near Melksham. The site contains a small number of very weakly positive discrete and linear anomalies, but they tend to be indistinct and lack a clearly defined morphology. A low linear bank is evident within the field relating to a former boundary that separates two series of ridge and furrow.

1 INTRODUCTION

1.1 *Survey background*

1.1.1 Archaeological Surveys Ltd was commissioned by Simon Cox of Bristol & Bath Heritage Consultancy, on behalf of The Silverwood Partnership, to undertake a magnetometer survey of an area of land at Bowerhill Lane, near Melksham in Wiltshire. The site has been outlined for a proposed development and the survey forms part of an archaeological assessment.

1.2 *Survey objectives and techniques*

1.2.1 The objective of the survey was to use magnetometry to locate geophysical anomalies that may be archaeological in origin so that they may be assessed prior to development of the site. The methodology is considered an efficient and effective approach to archaeological prospection.

1.2.2 Geophysical survey can provide useful information on the archaeological potential of a site; however, the outcome of any survey relies on a number of factors and as a consequence results can vary. The success in meeting the aims and objectives of a survey is, therefore, often impossible to predetermine.

1.3 *Standards, guidance and recommendations for the use of this report*

1.3.1 Archaeological Surveys Ltd is a Registered Organisation with the Chartered Institute for Archaeologists (CIfA) and both company directors are Members of the Chartered Institute for Archaeologists (MCIfA) and have therefore been assessed for their technical competence and ethical suitability and abide by the CIfA Codes of Conduct. The survey and report follow the recommendations set out by: 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, updated 2020) Standard and Guidance for Archaeological Geophysical Survey.

- 1.3.2 Archaeological Surveys Ltd provide a detailed geophysical survey report and it is recommended that where possible the contents should be considered in full. The Summary provides a brief overview of the results with more detail available in the Discussion and/or Conclusion. The *List of anomalies* within the Results provides a detailed assessment of the anomalies within separate categories which can be useful in inferring a level of confidence to the interpretation. Quality and factors influencing the interpretation of anomalies is also set out within the results.
- 1.3.3 It is recommended that the full report should always be considered when using data and interpretation plots; where this is not possible, in the field for example, the abstraction and interpretation plots should retain their colour coding and be used with a corresponding legend.
- 1.3.4 Where targeting of anomalies by excavation is to be carried out, care should be taken to place trenches over solid lines or features visible on the abstraction and interpretation plots. Archaeological Surveys abstraction and interpretation avoids the use of dashed or dotted line formats, and broken or fragmented lines used in interpretive plots may well correspond closely with truncation of archaeological features.
- 1.3.5 Magnetic anomalies may relate to features within the topsoil, subsoil or within the underlying solid or superficial geology. Anomalies are created by contrasting magnetic susceptibility; however, this is not necessarily consistent with changes in soil texture or colour and may not be contained within well defined features. Magnetic contrast and the magnitude of anomalies does not necessarily correlate with the volume or thickness of magnetic material present. The vertical component of the magnetic field is measured by the magnetometer and this falls rapidly with distance from the sensor, it may not be possible to distinguish weak features within the topsoil from deeper features containing more magnetic material.
- 1.3.6 Interpretation of anomalies relies on detailed analysis of the data. The morphology of anomalies and their magnitude are important factors in the interpretation process. Wherever possible, supporting information is used, e.g. LiDAR, early mapping and desk-based assessments. However, anomalies often cannot be confidently interpreted without intrusive investigation and as such are categorised as of uncertain origin; this classification may include anomalies relating to archaeological features.

1.4 Site location, description and survey conditions

- 1.4.1 The site is located on land to the east of Bowerhill Lane and to the south of Bath Road, Melksham, Wiltshire. It is centred on Ordnance Survey National Grid Reference (OS NGR) ST 92165 62070, see Figs 01 and 02.
- 1.4.2 The geophysical survey covers approximately 2.5ha of pasture within a single field. The area is generally flat ground at approximately 45m AODN. The site

is bounded to the north by residential dwellings including Old Loves Farmhouse, to the west is Bowerhill Lane with residential estates of eastern Bowerhill beyond, several other residential dwellings are located to the south and agricultural land to the east. Field boundaries are mainly hedgerows with wire fencing along part of the northern boundary and enclosing a small part of the field for sheep in the southern part of the site.

- 1.4.3 The ground conditions across the site were generally considered to be suitable for survey although deeply rutted ground close to the field entrance in the southern boundary was difficult to traverse. Parts of the field were also waterlogged. Weather conditions during the survey were overcast with occasional light rain.



Plate 1: Survey area looking north

1.5 Site history and archaeological potential

- 1.5.1 The site lies within an area that contains ridge and furrow, headlands and associated field boundaries recorded from aerial photographs and LiDAR imagery (MWI73967). It lies just north of Bowerhill, which is a settlement with medieval origins (MWI3627) with Loves Farm to the north of Bath Road being a farmstead with medieval origins (MWI3628). Old Loves Farmhouse is an early to mid 18th century Grade II listed building (NHLE no. 1194682). The field boundaries have remained unchanged since the 1840 tithe map, although more recent mapping shows a fence in the northern part of the site separating the field into two.

1.6 *Geology and soils*

- 1.6.1 The underlying geology is Oxford Clay Formation – Mudstone with overlying superficial Head deposits (BGS, 2025).
- 1.6.2 The overlying soil across the site is from the Denchworth (712b) association and is a pelo-stagnogley. It consists of a slowly permeable, seasonally waterlogged, clayey soil (Soil Survey of England and Wales, 1983).
- 1.6.3 The underlying geology and soils are frequently associated with low magnetic contrast and low levels of magnetic susceptibility. However, cut features of archaeological potential may be located where human activity has altered the magnetic characteristics of the soil sufficiently.

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 (also known as thermoremanence) are factors associated with the formation of localised magnetic fields.
- 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 positive magnetic anomalies that can be mapped by magnetic prospection. In addition, where soil is displaced by material of comparatively low magnetic susceptibility, such as many types of sedimentary rock, anomalies of negative value may occur which could be indicative of structural remains.
- 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). Additional details are set out in 2.2 below and within Appendix A.

2.2 *Equipment configuration, data collection and survey detail*

- 2.2.1 The detailed magnetic survey was carried out using a SENSYS MAGNETO® MX

V3 6 channel cart-based system. The instrument has 6 fluxgate gradiometers (FGM650) spaced 0.5m apart with readings recorded at 20Hz. 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 recorded range of $\pm 3000\text{nT}$, and resolution is approximately 0.1nT . They are linked to a Leica GS10 RTK GNSS with data recorded by SENSYS MonMX software on a rugged notebook 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 manifests 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 $<100\text{s}$.

2.3 *Data processing and presentation*

2.3.1 Magnetic data collected by the MAGNETO® MX V3 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 the 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 $\pm 3000\text{nT}$ and clipped for display at $\pm 3\text{nT}$. Data are interpolated to a resolution of effectively 0.5m between tracks and 0.15m along each survey track.
- 2.3.4 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.
- 2.3.5 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. Minimally processed data are considered by the manufacturer to be data that are 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 the very high density of data collection.
- 2.3.6 The raster images are combined with base mapping using ProgeCAD Professional 2021, creating DWG (2018) 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 GNSS, resection method, etc.
- 2.3.7 An abstraction and interpretation is 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.
- 2.3.8 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 the survey area.
- 2.3.9 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 approximately 2.5ha within a single pasture field.
- 3.1.2 Magnetic anomalies located can be generally classified as anomalies associated with land management, positive anomalies of an uncertain origin, linear anomalies of an agricultural origin, areas of magnetic debris and disturbance, strong discrete dipolar anomalies relating to ferrous objects and linear anomalies relating to buried services or pipelines. Anomalies located within each survey area have been numbered and are described in 3.4 below.

3.2 Data quality and factors affecting the interpretation or formation of anomalies

- 3.2.1 Data are considered representative of the magnetic anomalies present within the site. There are no significant defects within the dataset.
- 3.2.2 A qualitative assessment of magnetic contrast is not possible due to a lack of clear anomalies across the site. The small number of anomalies located may in itself be an indication of low soil magnetic susceptibility and poor conditions for the formation of magnetic anomalies. In the wider area magnetometry has successfully located anomalies on similar soils and underlying geology; however, damp conditions and waterlogging can be factors that may suppress the magnetic susceptibility and formation of anomalies within former cut features for example.

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 general explanation of the characteristics of the magnetic anomalies is set out for each category in order to justify interpretation, see Table 1.

Interpretation category	Description and origin of anomalies
Anomalies with an uncertain origin	The category applies to a range of anomalies where <u>there is not enough evidence to confidently suggest an origin</u> . Anomalies in this category <u>may well be related to archaeologically significant features, but equally relatively modern features, geological/pedological features and agricultural features should be considered</u> . Morphology may be unclear or uncharacteristic and there may be a lack of additional supporting information. 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. Negative anomalies are produced by material of comparatively low magnetic susceptibility such as stone and subsoil.
Anomalies relating to land management	Anomalies are mainly linear and may be indicative of the magnetically enhanced fill of cut features (i.e. ditches). The anomalies may be long and/or form rectilinear elements and they may

	relate to topographic features or be visible on early mapping. Associated agricultural anomalies (e.g. headlands, plough marks and former ridge and furrow) may support the interpretation.
Anomalies with an agricultural origin	The anomalies are often linear and form a series of parallel responses or are parallel to extant land boundaries. Where the response is broad, former ridge and furrow is likely; narrow response is often related to modern ploughing. This category <u>does not include</u> agricultural features of early date or considered to be of archaeological potential (e.g. animal stockades, enclosures, farmsteads, etc).
Anomalies associated with magnetic debris	Magnetic debris often appears as areas containing many small dipolar anomalies that may range from weak to very strong in magnitude. They often occur where there has been dumping or ground make-up and are related to magnetically thermoremanent materials such as brick or tile or other small fragments of ferrous material. This type of response is occasionally associated with kilns, furnace structures, hearths and nail spreads from former wooden structures or rooves and <u>may, therefore, be archaeologically significant</u> . It is also possible that the response may be caused by natural material such as certain gravels and fragments of igneous or metamorphic rock. Strong discrete dipolar anomalies are responses to ferrous objects within the topsoil.
Anomalies with a modern origin	The magnetic response is often strong and dipolar indicative of ferrous material and may be associated with extant above surface features such as wire fencing, cables, pylons etc. Often a significant area around these 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 adjacent to strong magnetic sources. Buried services may produce characteristic multiple dipolar anomalies dependant upon their construction.

Table 1: List and description of interpretation categories

3.4 List of anomalies

Area centred on OS NGR 392165 162070, see Figs 03 – 04.

Anomalies associated with land management

(1) – A broad linear anomaly extends through the eastern part of the survey area. This corresponds to a low bank in the field and it relates to a former headland or boundary separating two series of ridge and furrow (5 & 6).

Anomalies with an uncertain origin

(2) – A number of weakly positive short linear and discrete responses are located in the north eastern part of the site. While such anomalies can relate to cut features, they are very indistinct and lack a clearly defined morphology.

(3) – The central part of the survey area contains a very small number of weakly positive discrete anomalies. It is possible that they relate to pit-like features, but it is not possible to determine their origin.

(4) – A small group of weakly positive linear anomalies are located in the south eastern part of the survey area. They are not generally parallel with the ridge and furrow or any other extant boundary surrounding the site.

Anomalies with an agricultural origin

(5 & 6) – Former ridge and furrow crosses the main part of the site from west to east (5), with some evidence for a different orientation (6) to the east of (1).

Anomalies associated with magnetic debris

(7) – Patches of magnetic debris are evident generally close to the margins of the site. This is likely to relate to dumped, burnt material.

(8) – The site contains a large number of discrete, strong dipolar anomalies which are a response to ferrous and other magnetically thermoremanent objects within the topsoil.

Anomalies with a modern origin

(9) – A linear anomaly crosses the northern part of the site. It corresponds to the location of a buried water main, although it is not certain if the response is to the pipe or to the disturbed soil and subsoil in the trench.

4 CONCLUSION

4.1.1 The geophysical survey located a small number of weakly positive discrete and linear anomalies, with a group towards the north eastern corner. They are very weak and lack a coherent morphology which prevents confident interpretation. A low earthwork bank in the field relates to a former boundary with evidence for ridge and furrow either side.

5 REFERENCES

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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 thermoremanent 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. Thermoremanent 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. Thermoremanent features include ovens, hearths, and kilns. In addition thermoremanent 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 magnetic field. The difference between the two sensors will relate to the strength of 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. Different ranges are applied to data in order to determine the most suitable for anomaly abstraction and display.

Zero Median/Mean Traverse

The median (or mean) of data from 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 offset values of the gradiometer sensors. The process can remove archaeological features that run along a traverse but with the high resolution datasets created by the Sensys FGM650 sensors and the method of data collection this has not been a notable problem. In fact, the removal of offsets using software avoids carrying out a balancing procedure on site, which inevitably can never be done in magnetically clean conditions and results in improperly aligned fluxgate sensors and/or electronic adjustment values.

Appendix C – survey and data information

Filename:	J1038-mag-proc.xcp	Dimensions	Composite Area:	3.6527 ha
Instrument Type:	Sensys DLMGPS	Survey Size (meters):	Surveyed Area:	2.2024 ha
Units:	nT	X&Y Interval:	PROGRAM	
UTM Zone:	30U	Source GPS Points:	Name:	TerraSurveyor
Survey corner coordinates (X/Y):	OSGB36	784157	Version:	3.0.37.0
Northwest corner:	392071.10 162152.02 m	Stats	GPS based Proce4	
Southeast corner:	392272.85 161970.97m	Max:	1 Base Layer.	
Collection Method:	Randomised	Min:	2 Unit Conversion Layer (UTM to OSGB36).	
Sensors:	6	Std Dev:	3 DeStripe Median Traverse:	
Dummy Value:	32702	Mean:	4 Clip from -3.00 to 3.00 nT	
		Median:		

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 Wiltshire Historic Environment Record with greyscale images and abstraction layers made available on request. The report will also be uploaded to OASIS, the online system for reporting archaeological investigations and linking research outputs and archives and the digital data archived with the Archaeology Data Service.

Archive contents:

File type	Naming scheme	Description
Data	J1038-mag.asc J1038-mag.xcp J1038-mag-proc.xcp	Raw data as ASCII CSV TerraSurveyor raw data TerraSurveyor minimally processed data
Graphics	J1038-mag-proc.tif	Image in TIF format
Drawing	J1038-[version number].dwg	CAD file in 2018 dwg format
Report	J1038 report.odt	Report text in LibreOffice odt format

Table 2: Archive metadata

Appendix E – copyright and intellectual property

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**Geophysical Survey
Land at Bowerhill Lane
Melksham
Wiltshire**

Map of survey area



Survey location



● Survey location

Site centred on OS NGR
ST 92165 62070

SCALE 1:25 000



SCALE TRUE AT A3

**Geophysical Survey
Land at Bowerhill Lane
Melksham
Wiltshire**

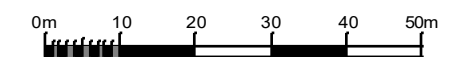
Referencing information

Referencing grid to OSGB36 datum at 50m intervals

- 392150 162050
- Survey tracks
- Survey track start
- Survey track stop



SCALE 1:1000

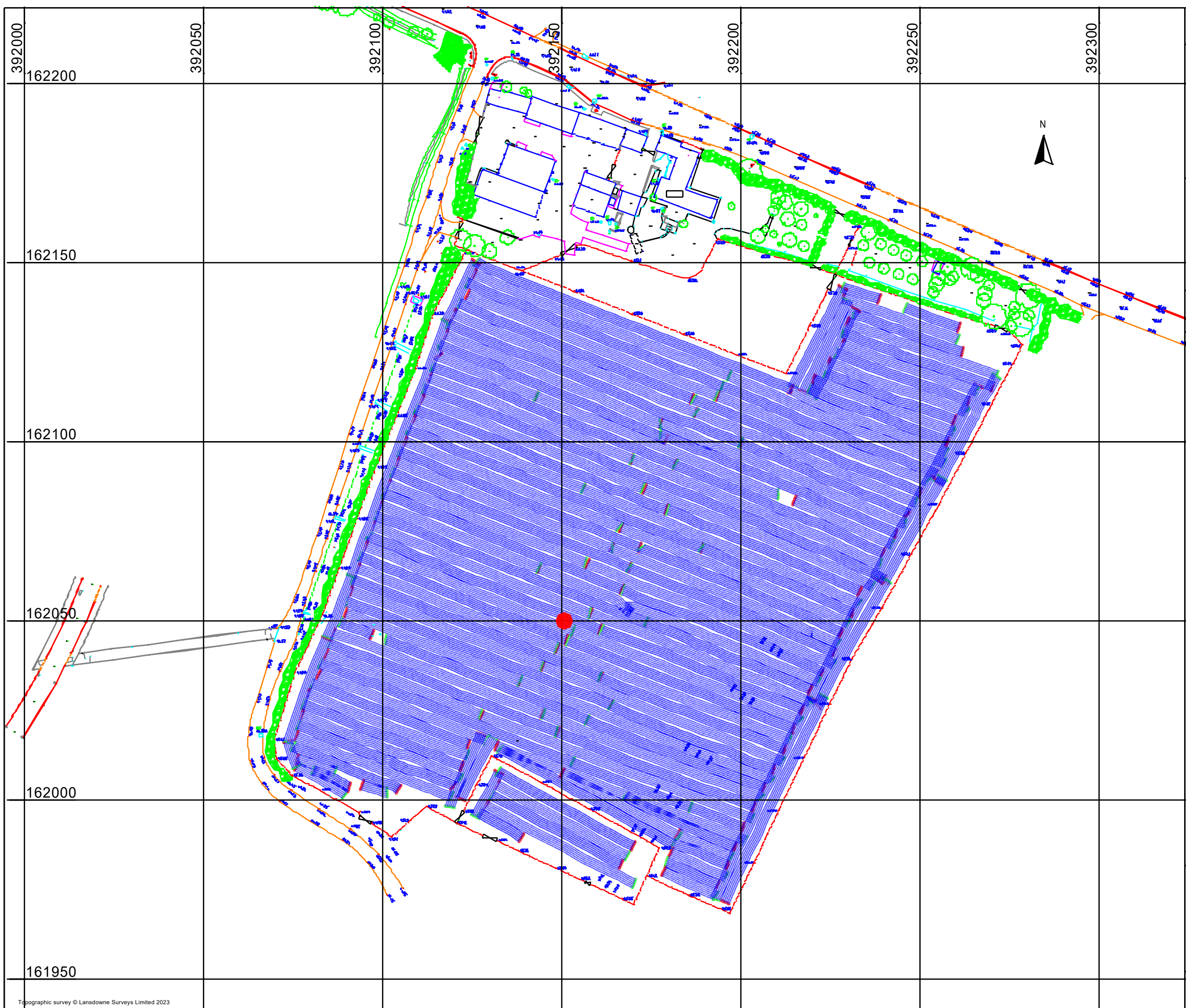


SCALE TRUE AT A3

DRAWN BY
KTD

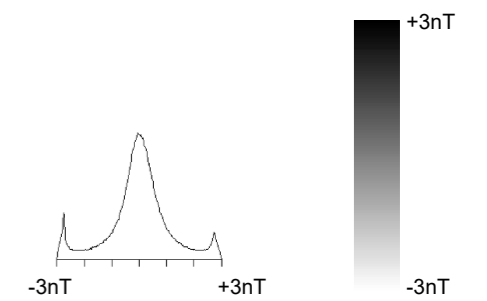
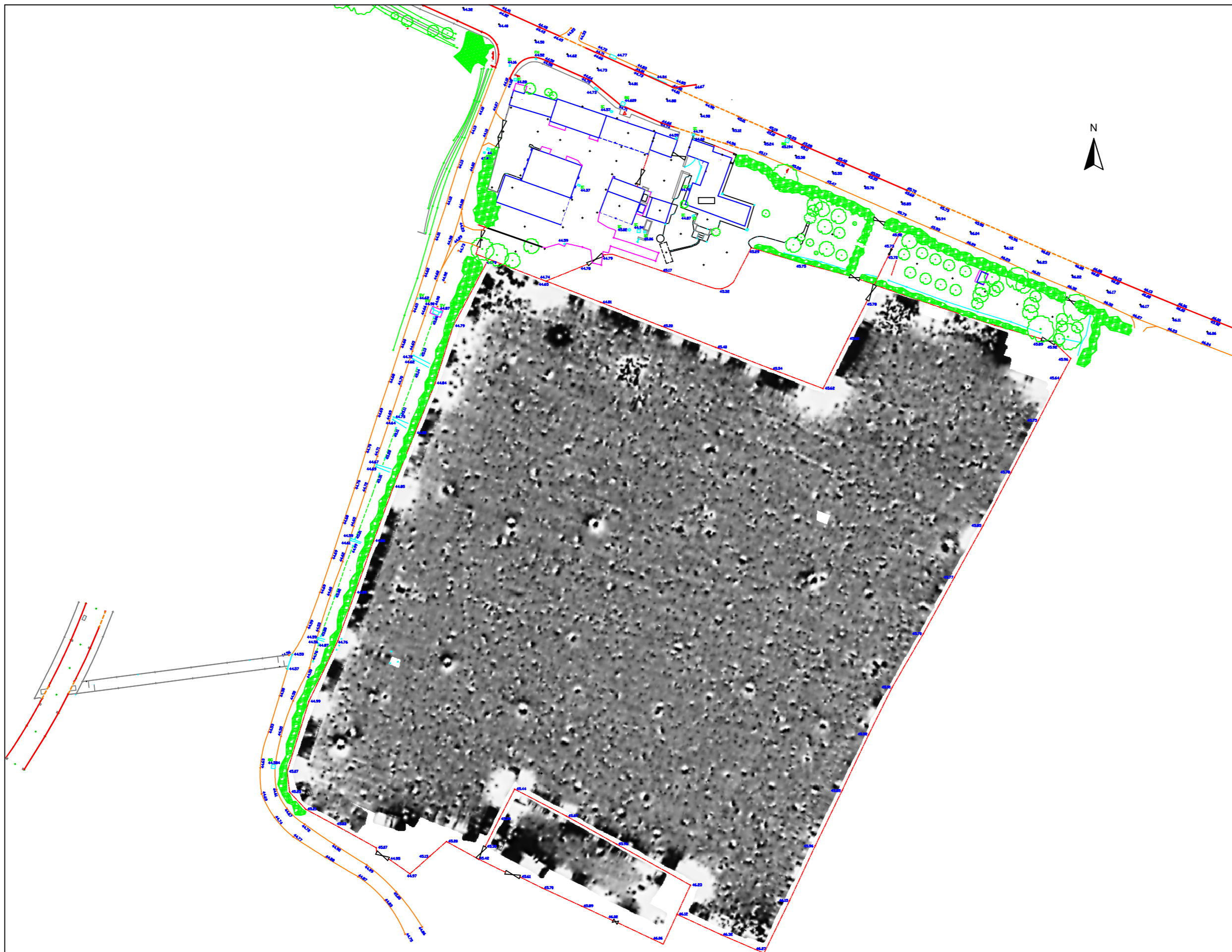
CHECKED BY
DJS

FIG 02

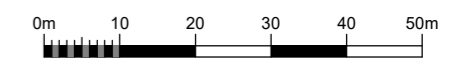


Geophysical Survey
Land at Bowerhill Lane
Melksham
Wiltshire

Greyscale plot of minimally
processed magnetometer data



SCALE 1:1000



SCALE TRUE AT A3









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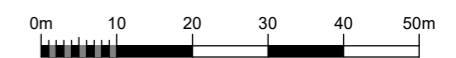
FIG 03

**Geophysical Survey
Land at Bowerhill Lane
Melksham
Wiltshire**

**Abstraction and interpretation of
magnetic anomalies**

-  Positive linear anomaly - possible ditch-like feature
-  Linear anomaly - ridge and furrow
-  Discrete positive response - possible pit-like feature
-  Negative anomaly - boundary bank
-  Magnetic debris - spread of magnetically thermoremnant/ferrous material
-  Magnetic disturbance from ferrous material
-  Strong multiple dipolar linear anomaly - pipeline / cable / service
-  Strong dipolar anomaly - ferrous object

SCALE 1:1000



SCALE TRUE AT A3

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FIG 04