

Substrata

Archaeological Geophysical Surveyors

An archaeological magnetometer survey

**Kennford Reservoir
Kennford, Devon**

Centred on NGR 291982,086767

Report: 1807KEN-R-1

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1 Introduction

This report presents the results of an archaeological geophysical survey at the site listed in Section 4 and shown in Figure 1, hereafter referred to as the 'Survey Area'. The survey was requested by the local authority as part of research to advise a planning application decision for the conversion of a large disused concrete water tank into a self-contained semi-underground holiday unit (Section 4.3). The Survey Area covers the proposed route of an access track to the water tank. The commissioning of this report was in keeping with the National Planning Policy Framework, Chapter 16, Paragraph 189 (Ministry of Housing, Communities & Local Government, 2018). The survey and report were completed in compliance with a Survey Method Statement (Substrata Ltd, 2018).

2 Client

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3 Copyright

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4 Survey type, location and planning information

4.1 Survey

Method:	shallow depth magnetometer survey
Instrument:	twin-sensor fluxgate gradiometer
Date:	20 August 2018
Area:	0.25ha
Survey resolution:	1m by 0.25m

4.2 Location

Name:	Kennford Reservoir
Village:	Kennford
Civil Parish:	Kenn
District:	Teignbridge
County:	Devon
Nearest Postcode:	EX6 8AY
Survey centre NGR:	SX 91982 86767 (point)
Survey centre NGR (E/N):	291982,086767 (point)
Historic environment designation:	None
OASIS ID:	substrat1-328825

4.3 Planning summary

Planning application number:	18/01192/FUL
Proposal:	Conversion of a large disused concrete water tank into a self contained semi underground holiday unit including demolition of part of roof to provide courtyard parking and provision of solar electricity generation.
Type:	Full

5 Summary

A magnetometer survey was selected to provide a relatively fast and cost-effective evaluation of any buried archaeology across the Survey Area (see Section 14). The magnetic anomaly groups pertaining to potential buried archaeology were georeferenced to the Ordnance Survey

National Grid, mapped, characterised and assigned with an appropriate degree of certainty in conformance with the survey aims and objectives set out in Section 7.

The differences in magnetic responses across the Survey Area were sufficient to be able to differentiate between anomalies representing possible buried archaeology and background magnetic responses.

Three magnetic anomaly groups were characterised as reflecting potential buried archaeology. Of these, two may represent archaeological deposits associated with a ring ditch and a ring ditch within a curvilinear enclosure, both recorded in the Devon County Council Historic Environment as being situated just south of the Survey Area. One group represents a linear deposit which may be archaeological but no further classification was possible. The survey data included a strong magnetic response from an iron or steel service on the northern side of the survey area and the Survey Area was shortened on the western side to avoid strong magnetic responses from the reservoir. It is unlikely that any archaeology was missed as the areas masked by these strong responses were probably within the zone of ground disturbance during the building of the reservoir and the cutting of the service trench.

6 Standards

The standards that were used to complete this survey are defined by the Chartered Institute for Archaeologists (2014b) and the Europae Archaeologiae Consilium (undated). The codes of approved practice to be followed are those of the Chartered Institute for Archaeologists (2014) and Archaeology Data Service (undated).

7 Survey aims and objectives

7.1 Aims

1. Within the framework set out in Chartered Institute for Archaeologists (2014b) and Europae Archaeologiae Consilium (undated), complete an archaeological geophysical survey and report which will, as far as possible, establish the presence or absence, extent and character of any buried archaeology within the survey area.
2. Provide sufficient information on the nature of any archaeological remains to facilitate the assessment of their interest prior to the determination of the planning application.

7.2 Objectives

1. Complete a magnetometer survey across the Survey Area.
2. Identify any magnetic anomalies that may be related to buried archaeology.
3. Within the limits of the technique and dataset, archaeologically characterise any such anomalies or patterns of anomalies.
4. Accurately record the location of the identified anomalies.
5. Produce a report based on the survey that is sufficiently detailed to inform any subsequent development on the survey area about the location and possible archaeological character of the recorded anomalies.

8 Methodology

The magnetometer survey was undertaken in accordance a Survey Method Statement (Substrata Ltd, 2018) using the standards specified in Section 6 to achieve the aims and objectives set out in Section 7. The survey method was selected to provide a relatively fast and cost-effective evaluation of any buried archaeology across the Survey Area (see Section 14).

Data processing was undertaken using appropriate software (Table 2), with all anomalies being digitised and geo-referenced. The final report (this document) includes a graphical and textual account of the techniques undertaken, the data obtained and an archaeological interpretation of that data and conclusions about any likely archaeology. The survey and report conform to the Chartered Institute for Archaeologists standard for geophysical survey (Chartered Institute for Archaeologists, 2014b).

9 Survey Area

9.1 Location and description

The Survey Area is a 30m wide corridor within one field situated north-north-west of the village of Kennford on the Old Dawlish Road (Figure 1). The corridor is situated along the length of a proposed access track and runs from a gated access to the Old Dawlish Road to the Kennford reservoir which is the subject of the proposed development. Old Dawlish road lies to the north and east of the field, agricultural fields lie to the south and woodland to the east. The ground rises from approximately 100m aOD at the gate to approximately 105m aOD at the reservoir. At the time of survey the land was under stubble.

9.2 Geology and sub-surface deposits

The solid geology across the Survey Area is breccia of the Heavitree Breccia Formation. Generically, these rocks are locally well cemented, reddish brown, mainly fine-grained, breccia comprising clasts of Culm sandstone, vein quartz, hornfels lava, granite and potassium feldspar. The superficial geology is not recorded in the source used (British Geological Survey, undated).

A number of relevant geological borehole logs of near-surface deposits have been recorded within 500m of the Survey Area and two examples are provided in Table 5 (ibid).

9.3 Soils

The topsoil is 'freely draining slightly acid loamy soil' (LandIS, undated).

10 Archaeological background

10.1 Historic landscape characterisation

'Post-medieval enclosures with medieval elements'

These enclosures are probably based on medieval fields, but the many straight field boundaries suggest they were substantially re-organised in the post-medieval period (Devon County Council, undated).

10.2 Summary of the archaeological background

This section summarises heritage assets that are thought relevant to the survey data analysis and is not designed to be a comprehensive description of the archaeological background.

The Devon County Council Historic Environment Record was examined via the Heritage Gateway (Historic England, undated) to gain an appreciation of historic assets pertinent to the proposed geophysical survey within approximately 500m of the survey area perimeter. Historic maps were consulted using Devon County Council (undated) and Old-Maps (undated). Whilst providing a useful context for the data analysis, the HER information and maps from the on-line sources are not necessarily comprehensive and detailed publication in commercial reports of the HER information or maps from these sources is not permitted.

Four historic environment assets have been recorded adjacent to the proposed Survey Area and were thought pertinent to the data analysis. These are summarised in Table 2 and mentioned in the data analysis in Table 1.

11 Results

11.1 Scope and definitions

This survey was designed to record magnetic anomalies. A magnetic anomaly is a local variation in the Earth's magnetic field. Such variations can result from differences in the magnetic properties of the underlying solid geology, superficial geology and other near-surface deposits including those altered and created by past human activities. Near-surface artefacts can also create magnetic anomalies.

The dimensions of magnetic anomalies mapped as representing potential buried archaeology do not represent the dimensions of any associated archaeology.

The analysis presented below identifies and characterises anomalies and anomaly groups that

may relate to buried archaeology.

11.2 Analysis

Figure 2 shows the interpretation of the survey data and includes the anomaly groups identified as possibly relating to buried archaeology along with their identifying numbers. Table 1 is an extract of the detailed analysis of the survey data sourced from the attribute tables of the GIS project provided in the project archive.

Figure 2 and Table 1 comprise the analysis of the survey data.

Figures 3 and 4 are plots of the processed data as specified in Table 3. Figure 5 is a plot of minimally processed data as specified in Table 4. Figure 6 shows the location of the survey grid and grid data files.

12 Discussion

12.1 General points

Scope

Not all anomalies or anomaly groups identified in Table 1 are necessarily discussed below. All identified anomaly groups are recorded in the GIS project held in the survey archive.

Data collection

Data collection along the survey area edges was restricted as shown in the figures due to the presence magnetic materials within and adjacent to field boundaries next to Old Dawlish Road and the reservoir. Strong magnetic responses mapped close to the boundaries are likely to relate to the magnetic materials except where otherwise indicated in Figure 2 and Table 1. This is further discussed in Section 12.4.

Anomaly characterisation

There are a number of anomaly groups that could be interpreted as relating to large postholes or pits although most will have natural origins. Anomalies of this sort are mapped as potential archaeology when they are well defined in the data, associated with other significant anomaly groups or otherwise formed recognisable patterns as listed in Table 1.

Anomalies thought to relate to natural features and recent man-made objects such as manholes, water management equipment, drains, cables and other services are only mapped where they comprise significant magnetic responses across the dataset that need clarification.

Numerous dipole magnetic anomalies are present within the dataset. These are likely to represent recent ferrous objects. They are only mapped if they could influence the analysis of anomaly groups thought to have an archaeological origin.

12.2 Data relating to historic maps and other records

Magnetic anomaly groups **1** and **2** lie just to the north of the locations of a ring ditch and a ring ditch within an curvilinear enclosure as recorded in the Devon County Council Historic Environment Record (see Tables 1 and 6). These anomaly groups may represent either elements of the ring ditches or of the enclosure but are characterised as 'possible' rather than 'likely' because, whilst distinct in the data, not enough of the anomaly groups are present within the Survey Area to say with confidence that they have a shape typically associated with a ring ditch or curvilinear enclosure.

12.3 Data with no previous archaeological provenance

Anomaly groups **3** represents a linear deposit which may be archaeological in nature but which cannot be characterised further.

12.4 Data influenced by strong magnetic responses

The survey data included a strong magnetic response from an iron or steel service on the northern side of the survey area (group **301**) and the Survey Area was shortened on the western side to avoid strong magnetic responses from the reservoir. It is unlikely that any archaeology was missed as, in both cases, the areas masked by these strong responses were probably within the zone of ground disturbance during the building of the reservoir and the cutting of the service trench.

13 Conclusions

The differences in magnetic responses across the Survey Area were sufficient to be able to differentiate between anomalies representing possible buried archaeology and background magnetic responses.

Three magnetic anomaly groups were characterised as reflecting potential buried archaeology. Of these, two (1 and 2) may represent archaeological deposits associated with a ring ditch and a ring ditch within a curvilinear enclosure, both recorded in the Devon County Council Historic Environment as being situated just south of the Survey Area. One group (3) represents a linear deposit which may be archaeological but no further classification was possible. The survey data included a strong magnetic response from an iron or steel service on the northern side of the survey area (301) and the Survey Area was shortened on the western side to avoid strong magnetic responses from the reservoir. It is unlikely that any archaeology was missed as the areas masked by these strong responses were probably within the zone of ground disturbance during the building of the reservoir and the cutting of the service trench.

14 Disclaimer

The description and discussion of the results presented in this report are the authors', based on their interpretation of the survey data. Every effort has been made to provide accurate descriptions and interpretations of the geophysical data set. The nature of archaeological geophysical surveying is such that interpretations based on geophysical data, while informative, can only be provisional. Geophysical surveys are a cost-effective early step in the multi-phase process that is archaeology.

15 Archive

15.1 Online Access to the Index of archaeological investigationS (OASIS)

OASIS ID: substrat1-328825

The OASIS entry has been completed and the boundary file and report uploaded with six months delay in publication.

15.2 Substrata Limited archive

A full archive of this survey will be held by Substrata Limited on cloud and local hard drive storage as specified in Appendix 3.

15.3 Archaeological Data Service (ADS)

Depending on local authority policy, an archive may be deposited with the ADS as specified in Appendix 3.

15.4 Historic Environment Record (HER)

Subject to any contractual requirements on confidentiality, a PDF or printed copy of the report will be submitted to the appropriate HER within six months of completion.

16 Acknowledgements

Substrata would like to thank Robert Lester of Rowan Homes (SW) Ltd for commissioning us to complete this survey.

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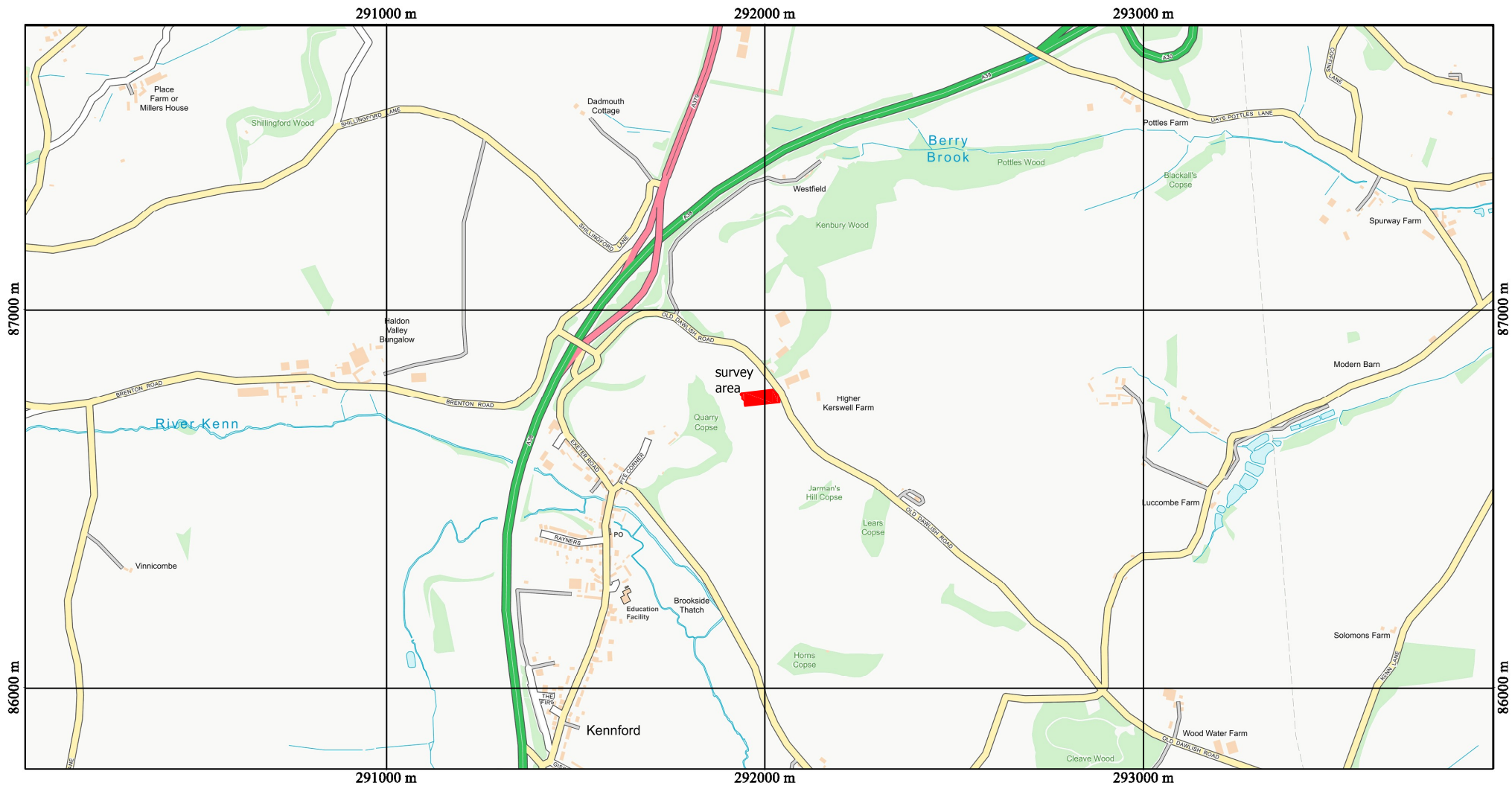
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Appendix 1 Figures

General Guidance

The anomalies represented in the survey plots provided in this appendix are magnetic anomalies. The apparent size of such anomalies and anomaly patterns are unlikely to correspond exactly with the dimensions of any associated archaeological features .

A rough rule for interpreting magnetic anomalies is that the width of an anomaly at half its maximum reading is equal to the width of the buried feature, or its depth if this is greater (Clark, 2000: 83). Caution must be applied when using this rule as it depends on the anomalies being clearly identifiable and distinct from adjacent anomalies. In northern latitudes the position of the maximum of a magnetic anomaly will be displaced slightly to the south of any associated physical feature.



British Grid
centre X: 291985.10 m, centre Y: 86770.01 m

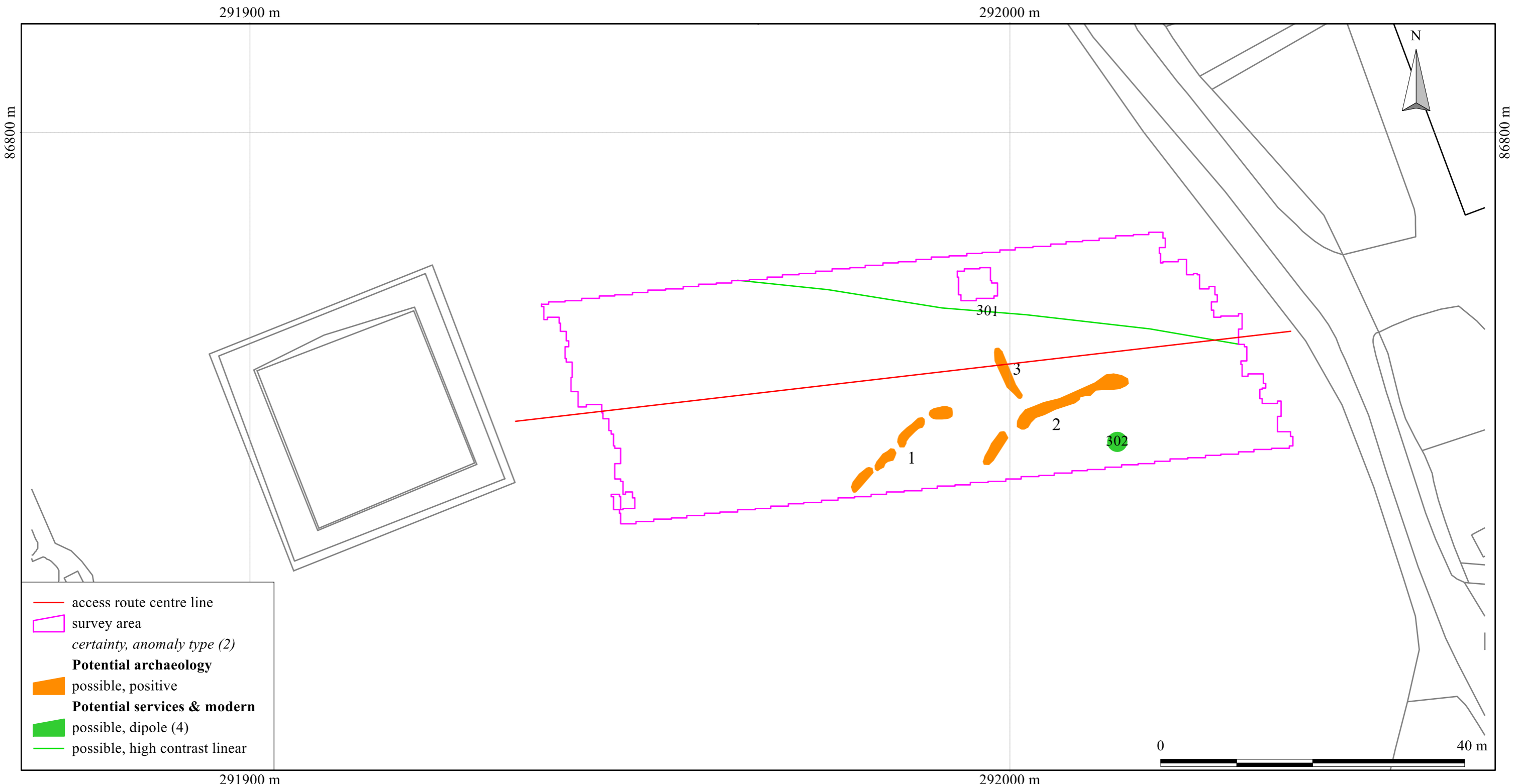
Scale: 1:10000 @ A3. Spatial Units: Meter. Do not scale off this drawing

Geophysical survey: Copyright Substrata Limited.
Base map: Contains Ordnance Survey data
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Figure 1: location map

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British Grid
 centre X: 291966.89 m, centre Y: 86765.18 m

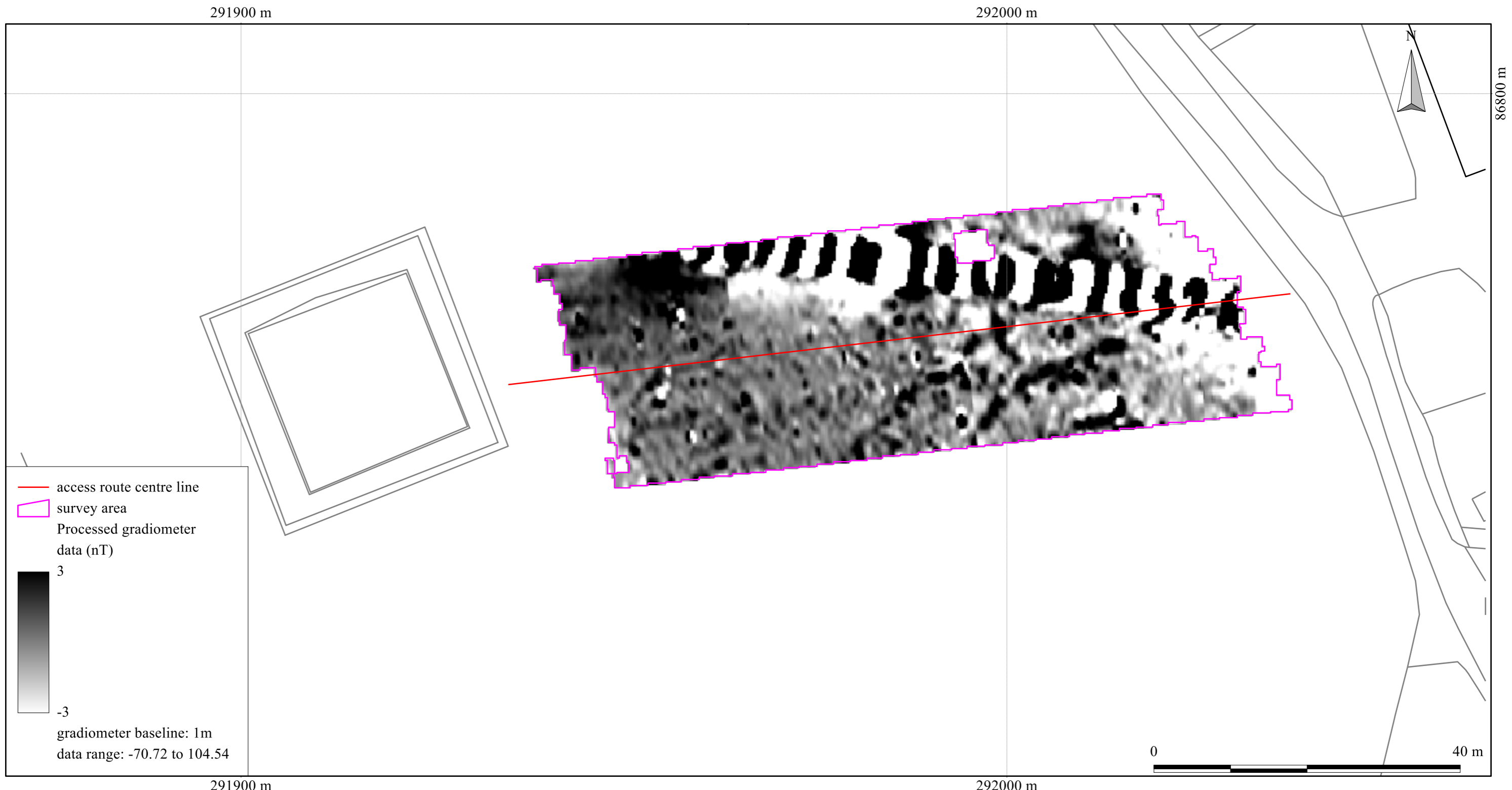
Geophysical survey: Copyright Substrata Limited.
 Base map: Ordnance Survey (c) Crown Copyright 2018.
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- Notes:
1. All interpretations are provisional and represent potential archaeological deposits.
 2. 'Anomaly type' is a description of the magnetic anomaly. See the report text or GIS for an archaeological characterisation.
 3. Anomalies designated "likely archaeology" have supporting evidence e.g. historical maps and or visible earthworks.
 4. Not all instances are mapped.
 5. Anomalies likely to represent recent deposits or ground disturbance, or geological and other natural deposits are not mapped unless relevant to potential buried archaeology.

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Figure 2: survey interpretation

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— access route centre line
 ▭ survey area
 Processed gradiometer data (nT)
 3
 -3
 gradiometer baseline: 1m
 data range: -70.72 to 104.54

British Grid
 centre X: 291966.25 m, centre Y: 86759.95 m

0 40 m

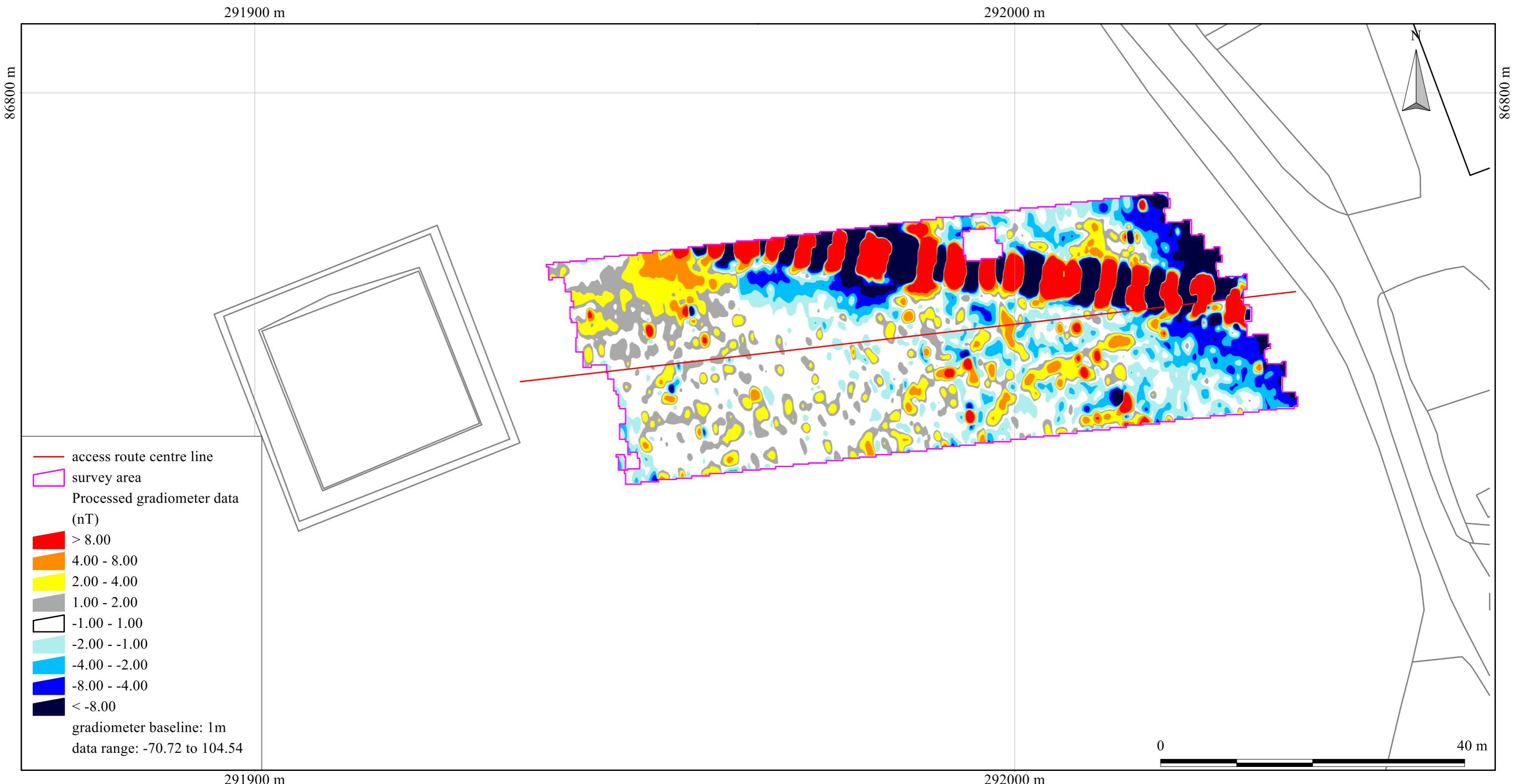
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Scale: 1:500 @ A3. Spatial Units: Meter. Do not scale off this drawing

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Figure 3: shade plot of processed data

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British Grid
 centre X: 291966.25 m, centre Y: 86759.95 m

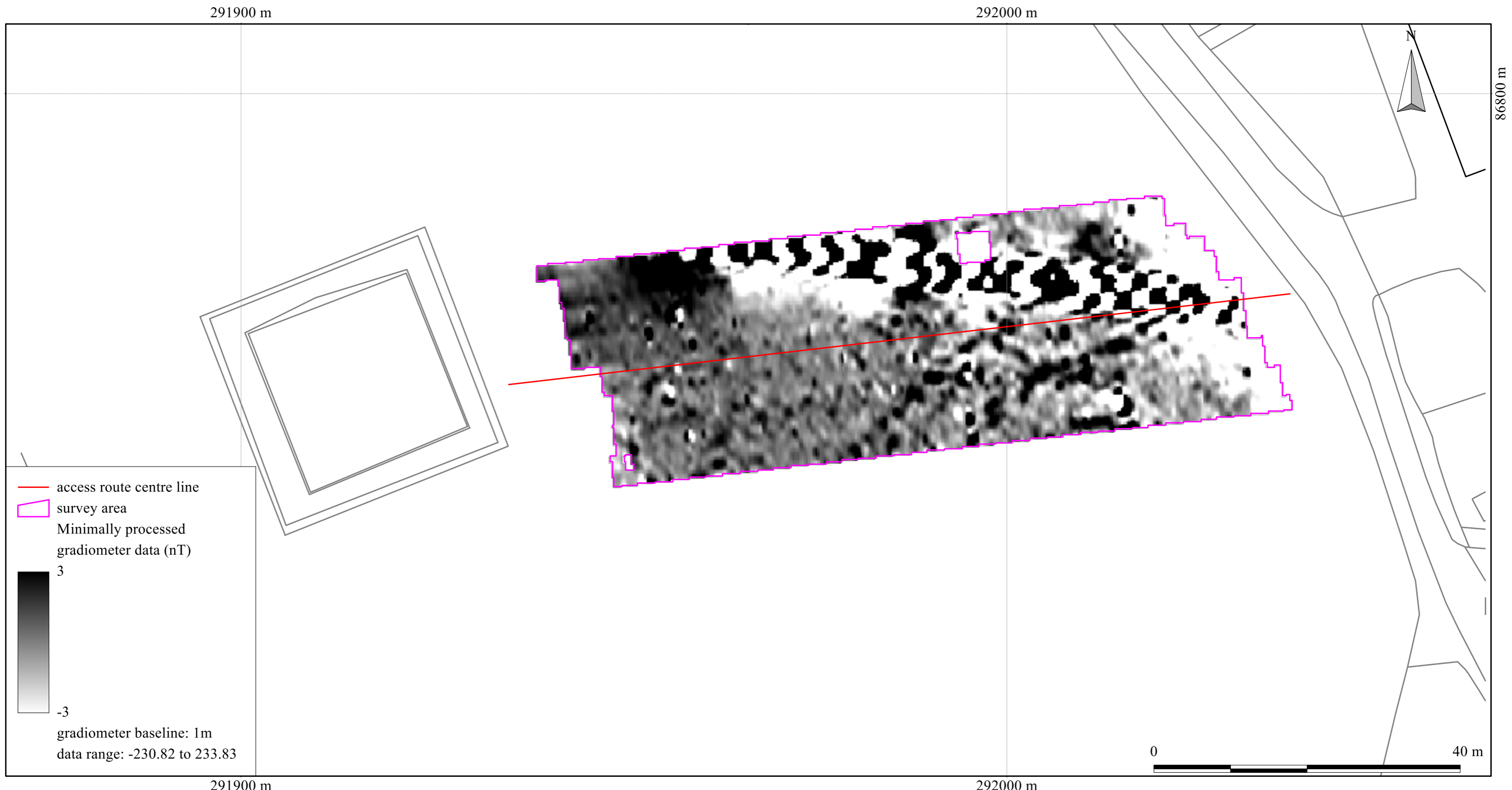
Geophysical survey: Copyright Substrata Limited.
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Scale: 1:500 @ A3. Spatial Units: Meter. Do not scale off this drawing

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Figure 4: contour plot of processed data

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British Grid
 centre X: 291966.25 m, centre Y: 86759.95 m

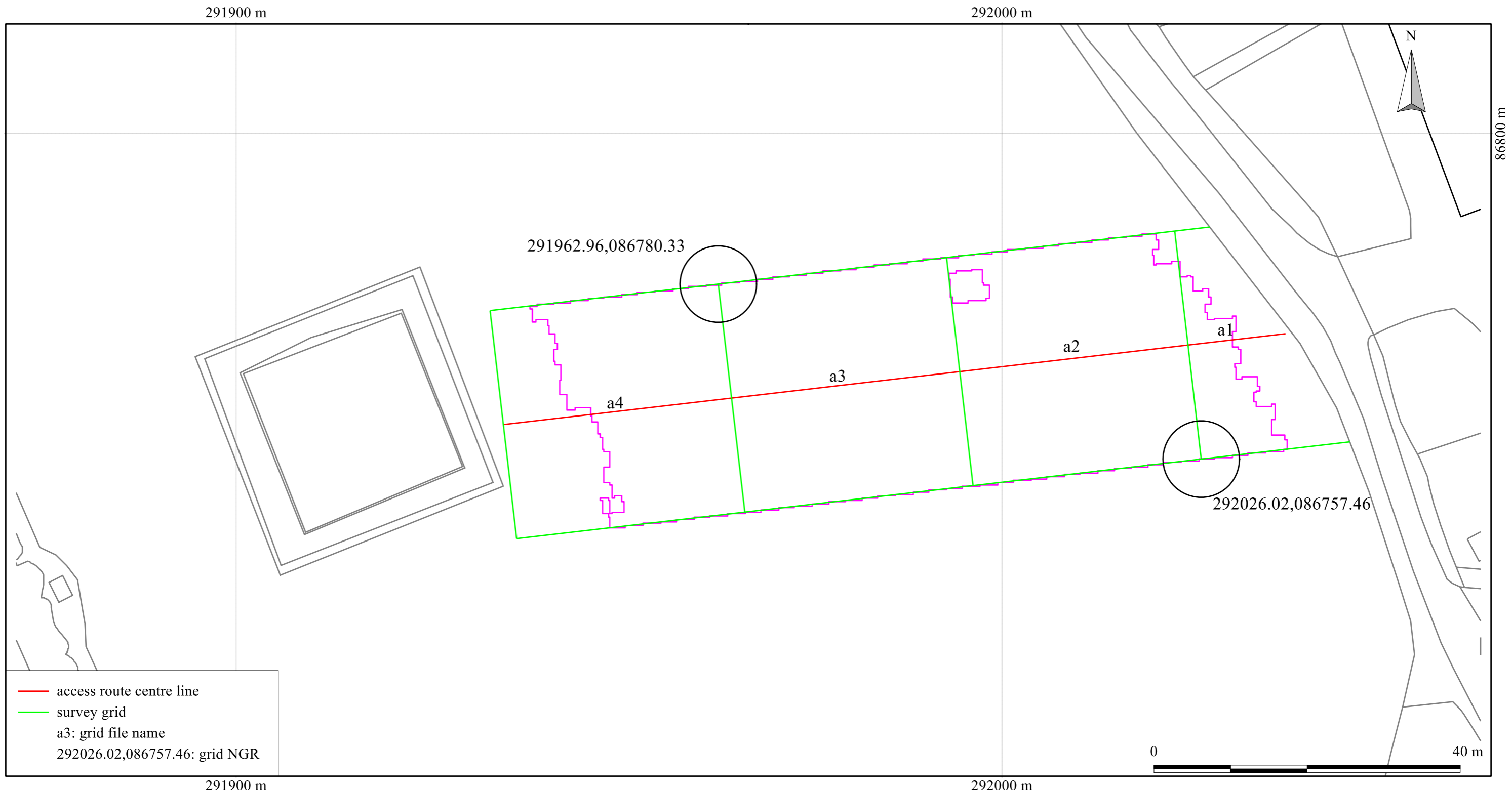
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Scale: 1:500 @ A3. Spatial Units: Meter. Do not scale off this drawing

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Figure 5: shade plot of minimally processed data

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— access route centre line
 — survey grid
 a3: grid file name
 292026.02,086757.46: grid NGR

British Grid
 centre X: 291966.89 m, centre Y: 86765.18 m

0 40 m

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Scale: 1:500 @ A3. Spatial Units: Meter. Do not scale off this drawing

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Figure 6: survey grid plan and location

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Appendix 2 Tables

Site: Kennford Reservoir, Kennford, Devon
 Centred on NGR: 291982,086767

anomaly group	anomaly characterisation certainty & class	anomaly form	additional archaeological characterisation	comments	supporting evidence
1	possible, positive	disrupted curvilinear	possible archaeological deposits associated with a nearby enclosure and ring ditches	anomaly group lies to the north of, and may coincide with, the location of one ring ditch at approximately SX91968675 and one ring ditch within a sub-circular enclosure at approximately SX92018674	HER MDV17715, MDV112745, MDV112746
2	possible, positive	disrupted curvilinear	possible archaeological deposits associated with a nearby enclosure and ring ditches	anomaly group lies to the north of, and may coincide with, the location of one ring ditch at approximately SX91968675 and one ring ditch within a sub-circular enclosure at approximately SX92018674	HER MDV17715, MDV112745, MDV112746
3	possible, positive	linear			
301	possible, high contrast linear		ferrous service pipe or cable		
302	possible, dipole		relatively modern ferrous material		

Table 1: data analysis

<p>Grid <i>Method of Fixing:</i> DGPS set-out using pre-planned survey grids and Ordnance Survey coordinates. <i>Composition:</i> 30m by 30m grids <i>Recording:</i> Geo-referenced and recorded using digital map tiles. <i>DGPS used:</i> Spectra Precision PM5V2 GPS with external antenna and survey pole and DigiTerra Explorer 7 as the survey control program.</p>	
<p>Equipment <i>Instrument:</i> Bartington Instruments grad601-2 <i>Firmware:</i> version 6.1</p>	<p>Data Capture <i>Sample Interval:</i> 0.25m <i>Traverse Interval:</i> 1 metre <i>Traverse Method:</i> zigzag <i>Traverse Orientation:</i> GN263</p>
<p>Data Processing, Analysis and Presentation Software IntelliCAD 8.4 DW Consulting TerraSurveyor3 Manifold System 8 GIS Microsoft Corp. Office 365: Excel, Publisher, Word Adobe Systems Inc Adobe Acrobat 9 Pro Extended</p>	

Table 2: methodology information

Instrument Type:	Bartington Grad 601
Units:	nT
Direction of 1st Traverse:	263 deg
Collection Method:	ZigZag
Sensors:	2 @ 0.00 m spacing.
Dummy Value:	32702
Dimensions	
Composite Size (readings):	960 x 240
Survey Size (meters):	120 m x 30 m
Grid Size:	30 m x 30 m
X Interval:	0.125 m (surveyed @ 0.25 m)
Y Interval:	0.125 m (surveyed @ 1 m)
Stats	
Max:	104.54
Min:	-70.72
Std Dev:	13.74
Mean:	0.13
Median:	0.01
Surveyed Area:	0.25235 ha
PROGRAM	
Name:	TerraSurveyor
Version:	3.0.33.6
Processes: 9	
1	Base Layer
2	Clip at 1.00 SD
3	Clip at 1.00 SD
4	Clip at 1.00 SD
5	De Stagger: Grids: All By: 0 intervals, 75.00cm
6	Mask for All layers
7	DeStripe Median Traverse: Grids: All
8	Interpolate: Match X & Y Doubled.
9	Interpolate: X & Y Doubled.
Processes 8 and 9 are designed to reduce coarsening of the data pixels during subsequent data block rotation within the GIS (not required for standard N-S or E-W surveys)	

Table 3: processed data metadata

Instrument Type:	Bartington Grad 601
Units:	nT
Direction of 1st Traverse:	263 deg
Collection Method:	ZigZag
Sensors:	2 @ 0.00 m spacing.
Dummy Value:	32702
Dimensions	
Composite Size (readings):	960 x 240
Survey Size (meters):	120 m x 30 m
Grid Size:	30 m x 30 m
X Interval:	0.125 m (surveyed @ 0.25 m)
Y Interval:	0.125 m (surveyed @ 1 m)
Stats	
Max:	233.83
Min:	-230.82
Std Dev:	40.13
Mean:	-1.07
Median:	-0.06
Composite Area:	0.36 ha
Surveyed Area:	0.2549 ha
PROGRAM	
Name:	TerraSurveyor
Version:	3.0.33.6
Processes: 5	
1	Base Layer
2	Clip at 1.00 SD
3	Clip at 1.00 SD
4	Interpolate: Match X & Y Doubled
5	Interpolate: X & Y Doubled.
All processes designed to reduce coarsening of the data pixels during subsequent data block rotation within the GIS (not required for standard N-S or E-W surveys)	

Table 4: minimally processed data metadata

Site: Kennford Reservoir, Kennford, Devon
 Centred on NGR: 291982,086767

BGS ID	BGS reference	NGR (E/N)	method	strata	depth (m)	level (m aOD)	thickness (m)
762466	SX98NW23	291540,86860	borehole rotary drilling	desiccated red brown silty CLAY with some fine gravel	0.50	45.43	0.50
				red BRECCIA	0.60	45.33	0.10
				friable red brown sandy CLAY with angular gravel (weathered breccia)	1.69	44.24	1.09
				firm red brown clayey SILT and SAND with fine gravel (weathered breccia)			
				end of borehole	3.46	42.47	
19892284	SX98NW295	291653,87084	borehole core	grass over reddish brown gravelly silt with rootlets. Gravel is angular to subangular fine to coarse of various lithologies	0.05	51.45	
				reddish brown, very silty sandy GRAVEL. Gravel is angular to subangular fine to coarse of various lithologies. Possible bedrock	0.50	51.00	0.45
				Medium strong reddish brown mottled cream thickly bedded to massive polymict sedimentary BRECCIA. Discontinuities are generally medium to wide spaced dipping sub horizontally to 15 degrees, stepped and rough. From 0.50-1.50m: discontinuities are closely spaced. From 1.50-2.40m: strata is very weak to extremely weak (breccia appears to be saturated)			
				Other information outwith gradiometer depth range and not included here			
				end of borehole	9.85		

Table 5: example geological borehole logs within 500m of Survey Area (British Geological Survey, undated).

Kennford Reservoir, Kennford, Devon
 Centred on NGR: 291982,086767

County: Devon
 District: Teignbridge
 Parish: Kenn
 Source: Heritage Gateway

HER number	grid reference		type	period	description
MDV17715	SX 919 867	Geological Cropmarks, Enclosures and Ring Ditches to the North-East of Kennford	GEOLOGICAL MARKS ENCLOSURE RING DITCH	Unknown Prehistoric - 698000 BC to 42 AD Prehistoric - 698000 BC to 42 AD	A possible enclosure surrounding two ring ditches & other features to the northeast of Kennford is broad and amorphous, and interpreted as more likely to be of geological origin This is the parent record for the three entries listed below.
MDV112744	SX 919 868	Ring Ditch Within Rectilinear Enclosure East of Quarry Copse	RECTILINEAR ENCLOSURE RING DITCH	Early Bronze Age to Roman - 2200 BC to 409 AD Early Bronze Age to Roman - 2200 BC to 409 AD	dark rectilinear and a curvilinear cropmark, visible on aerial photographs taken between 1947 and 1991, are interpreted as having formed over the buried remains of an infilled ring ditch within a larger enclosure. There may be linear features to north & south. are interpreted as having formed over the buried remains of an infilled ring ditch, within a larger enclosure,
MDV112745	SX92018674	Ring Ditch East of Quarry Copse	RING DITCH	Early Bronze Age to Roman - 2200 BC to 409 AD	On Cambridge Air Photograph, two ring ditches are shown to the northeast of Kennford. This is the smaller, western one and appears to be a single ditch It shows as a positive cropmark, approximately 15 meters diameter. There may be linear features to north & south.
MDV112746	SX91968675	Ring Ditch and Curvilinear Enclosure East of Quarry Copse	CURVILINEAR ENCLOSURE RING DITCH	Early Bronze Age to Roman - 2200 BC to 409 AD Early Bronze Age to Roman - 2200 BC to 409 AD	On Cambridge Air Photograph, two ring ditches are shown to the northeast of Kennford. This is the larger, eastern one which lies within a curvilinear enclosure. Only part of a circle is visible. This is either a double or triple ditch approximately 30 meters diameter. There may be linear features to north & south.

Table 6: Historical Environment Record entries within or close to the Survey Area

Appendix 3 Project archive contents

A3.1 Substrata Limited archive

A full archive of this survey will be held by Substrata Limited on cloud and local hard drive storage as follows:

Report:	Adobe PDF (.pdf), Microsoft Publisher (.pub)
Raw grid data files:	DW Consulting TerraSurveyor 3 (.xgd) and CSV (.xyz)
Raw data composite files:	CSV (.xyz)
Minimally processed data composite files:	DW Consulting TerraSurveyor 3 (.xgd) and CSV (.xyz)
Final data processing composite files:	DW Consulting TerraSurveyor 3 (.xgd) and CSV (.xyz)
GIS project:	GIS project Manifold 8 (.map)
Survey interpretation:	ESRI shape files
AutoCAD version of the survey interpretation: (if generated)	AutoCAD (.dwg)
All project working files:	IntelliCAD 8.4 Microsoft Corp. Office 365: Excel, Publisher, Word Adobe Systems Inc Adobe Acrobat 9 Pro Extended

A3.2 Online Access to the Index of archaeological investigationS (OASIS)

Metadata:	online form
Georeferenced survey boundary file:	ESRI shape file
Report:	Adobe PDF (.pdf)

A3.3 Archaeological Data Service

Depending on local authority policy, an archive may be deposited with the ADS as follows:

Raw data composite file:	CSV (xyz)
Processed data plot:	rendered images in TIFF format
Survey grid plot:	image in TIFF format
Details of data processing:	image in TIFF format
Interpretation plot:	rendered images in TIFF format
Metadata:	Microsoft Excel format

A3.4 Historic Environment Record (HER)

Subject to any contractual requirements on confidentiality, a PDF copy of the report will be submitted to the appropriate HER within 6 months of the completion of this report via the OASIS process or by other means, depending on the relevant HER process.