Cressing Solar Farm, Land South of Sheepcote Wood, Essex

Geophysical Survey Report

Client: ESCO NRG LTD

AB Heritage Project No:10716

Date:09/12/2015

Cressing Solar Farm, Land South Of Sheepcote Wood, B1018 Witham Road, White Notley, Essex

Geophysical Survey Report

Client	**ESCO NRG Ltd**
Project Number	**10716**
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AB HERITAGE
ARCHAEOLOGICAL CONSULTANCY

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1. NON TECHNICAL SUMMARY

1.1.1 AB Heritage Limited (herein AB Heritage) undertook a programme of geophysical survey over c. 14 ha of land south of Sheepcote Wood, Essex on Thursday 19th to Wednesday 25th of November 2015, ahead of a proposed solar farm development.

1.1.2 The detailed magnetic geophysical survey concluded that there is a low potential for archaeological features to occur within the site. The majority of the geophysical features identified relate to patterned geology [**GP 2**] likely caused by freeze thaw action. However, the site has also been truncated by field drainage and previous ploughing activity; this is evident, through the identification of possible Ridge and Furrow [**GP 7**].

2. INTRODUCTION

2.1 Project Background

2.1.1 AB Heritage has been asked to undertake a geophysical survey of c.14 ha on behalf of Esco NRG Ltd, for a proposed Solar Farm development at Cressing, on land south of Sheepcote Wood, B1018 Witham Road, White Notley, Essex.

2.1.2 The purpose of this work is to identify any potential surviving archaeological remains.

2.2 Site Location & Description

2.2.1 The proposed development site covers three arable fields centred on NGR TL 79362 18956, it lies between White Notley railway station (to the west), and Cressing Temple (to the east). The south-west side of the site is bordered by a railway. Station Road and Witham Road (B1018) enclose the rest of the site. The site is c.1km north-east of White Notley and c. 5.5km south-east of Braintree.

2.3 Geology & Topography

2.3.1 The underlying bedrock of the site is London Clay Formation (Palaeogene period), sedimentary bedrock formed of clay, silt, and sand. The superficial deposits at the site are Lowestoft Formation (Quaternary period), comprised of Diamicton, the Lowestoft Formation at the south-earn corner of the site is partially made up of sand and gravel instead (BGS 2015).

2.3.2 The response for a magnetometry survey is generally average over London Clay, although over sand and gravels, the response can be variable. The response onclays and flints are good. There are three publically accessible borehole records (BGS 2015) in the vicinity of the site, each include a layer of boulder clay over which magnetometry responses are generally poor (English Heritage, 2008).

2.3.3 The site is situated on the northern side of the valley of the River Brain, on the south facing slope which drops from c. 52mOD to 45mOD alongside the railway line to the south.

3. AIMS & METHODOLOGY

3.1 Aims of Survey Works

3.1.1 Geophysical survey is a programme of non-intrusive archaeological work. The aims of this geophysical survey were to:

- Identify any geophysical anomalies of possible archaeological origin within the specified survey area;
- Accurately locate these anomalies and present the findings in map form; and
- Provide recommendations for any further archaeological work(s) necessary to contribute to the mitigation of the impacts of proposed development on these potential features.

3.2 Methodology of Survey Works Summary

Site Specific Information

3.2.1 A geophysical survey was undertaken covering an area of c. 14 hectares (ha) on the 19th to 25th of November 2015.

3.2.2 The AB Heritage staff members who undertook the works were Glenn Rose (Project Officer), Tom Cloherty (Archaeological Technician),and Peter Bonvoisin (Archaeological Technician).

3.2.3 The weather conditions varied between wet and dry throughout the survey; these conditions had no material impact upon the survey.

Equipment

3.2.4 The magnetic survey equipment used was two Bartington Grad-601 (fluxgate magnetometers).Please see Appendix A, which contains a detailed methodology for the works undertaken; however, briefly, Table 1, below, shows site specific information on how the magnetometer was set up:

Table 1: Setting Parameters of Magnetometer

Grid Size	30x30 metres
Data Capture Distances	1m x 0.25m
Sensors	2
Sensitivity	0.1nT

3.2.5 A Trimble Geo XR GPS was used to setup the geophysical survey. This has sub-centimetre accuracy suitable for this survey.

3.3 Known Constraints

3.3.1 One of the connections routes along north western side of the site was not able to be surveyed. The deep ploughing of the field meant that results could not be accurately recorded

(Plates 1 and 2). The metallic overhead cables are also likely to cause magnetic disturbance creating inaccurate data.

3.3.2 Metallic fences situated around the site can cause magnetic disturbance c.1-2m from the fence.

Plate 1: View of field on north-west side of Station Road looking north-west.

Plate 2: View of field on north-west side of Station Road looking south-west.

4. RESULTS

4.1.1 For the purposes of this detailed magnetic survey, the site has been split into seven different areas (A-G) of varying sizes (Figure1). Areas A-E cover the connection route in the east and Area G covers the connection route in the north east. Area F covers the main area for the solar array. Below is a factual account of the results which are explained in section 4.2.

4.2 Geophysical Survey Results

4.2.1 Results from the magnetometer data can be seen in Figures 2 to 7, with interpretations shown in Figures 8 to 10.

4.2.2 The routes of known field drains have been identified and shown within Figure 11.

Area A

4.2.3 Located in the eastern side of the site along the proposed cable route. Area A contains di-polar anomalies [**GP 5**], magnetic disturbance [**GP 6**], and a small section of a known field drain [**GP 3**].

Area B

4.2.4 Located north of Area A, contains di-polar anomalies [**GP 5**].

Area C

4.2.5 Located north of area B, contains di-polar anomalies [**GP 5**] and a small section of known field drain [**GP 3**].

Area D

4.2.6 Located north of Area C, contains magnetic disturbance [**GP 6**] and a small section of a known field drain [**GP 3**].

Area E

4.2.7 Located to the west of Area D, contains magnetic disturbance [**GP 6**] and a long section of a known field drain [**GP 3**].

Area F

4.2.8 This is main body of the site, and is located to the west of Area E. Within the eastern side of area there is a north to south positive linear, of possible geological origin [**GP 1**], which has a very low positive reading of c. 0.5 nanoteslas (nT). The linear is c. 212m long and it is c. 2m wide.

4.2.9 The northern half of Area F is taken up by a series of sub-angular and irregular features [**GP 1**] created by low positive linears with readings of 0.3 to 0.8 nT, these features cover an area of c. 4.9 ha.

4.2.10 Seven features have been identified as possible quarrying [**GP 2**]; these features have low positive readings and cover small sections of the areas surveyed.

4.2.11 A north east-south west linear, representing a possible field drain [**GP 4**], in the north corner of the area has a very similar appearance to some of the known field drains but does not appear the 1973 Land Drainage Scheme map (Fig. 11). The feature measures c. 60m in length and the readings range from c. 0.2 – 1.3 nT.

4.2.12 Area F also contains known field drains [**GP 3**], with one running on a north east south west alignment continuing from Area E, and c. 350m in length across both areas. Two types of field drain appear in the results. Some drains have a positive reading ranging between c. 0.5 and 3 nT, where as some have more sporadic readings and show up less clearly in the results, this could be related to the depth of the features and make up.

4.2.13 Di-polar anomalies [**GP 5**] are also present in Area F in amorphous pattern.

Area G

4.2.14 North of Area F, Area G contains di-polar anomalies [**GP 5**], magnetic disturbance [**GP 6**], and evident Ridge and Furrow [**GP 7**].

4.2.15 At the north-western end of Area G there appears to be evidence of possible ridge and furrow [**GP 7**]. Four parallel linears c. 18m in length and c. 6m apart run on a NW-SE axis. Above these a c. 38m curved linear. All the above features have a reading of c. 0.5-0.8 nT.

5. INTERPRETATIONS AND DISCUSSION

5.1.1 Interpretation of the results of geophysical survey is based on professional judgement as to the likely/probable cause of an anomaly or reading. For example, strong dipolar discrete anomalies of small size are often associated with ferrous debris or similarly magnetic debris. In addition, where a positive linear anomaly is recorded, which has a negative anomaly associated alongside either side of it, is often likely to relate to the line of a modern service.

5.1.2 GP numbers have been used to place interpretations into categories. Below is a discussion of the results, there has also been applied a confidence rating to the features identified (See Appendix 3). As with English Heritage 2008 guidelines for geophysical survey for archaeological field evaluation, this is an acceptable additional option only on the clear understanding that such ratings are subjective and potentially fallible assessments which can only really be tested through excavation.

Table 2: Interpretation of Geophysical Anomalies

AB No	Appearance	Potential Cause
GP 1	Positive Features	Possible Geology
GP 2	Low Positive Areas	Possible Quarrying
GP3	Positive Linears	Known Field Drainage
GP 4	Positive Linears	Possible Field Drainage
GP 5	Di-polar Anomalies	Amorphous Magnetic Debris
GP 6	Area of strong negative and positive readings	Magnetic disturbance, caused by disturbed ground or nearby metallic objects
GP 7	Low Positive Linears	Evident Ridge and Furrow

5.1.3 The majority of the possible geological features [**GP 1**] within the site are likely to relate to pattern form geology from periglacial deposits formed through freeze and thaw.

5.1.4 The evident ridge and furrow features [**GP 7**] in Area G are related to previous agricultural activity within the site.

5.1.5 The possible geological features in Area F [**GP 2**] could also be due to quarrying as local quarrying pits have also been found within the vicinity (Harpell, 2015).

5.1.6 Many of the linear features on site likely represents field drains [**GP 3**], as they correspond to the field drains shown in Figure 11. A possible field drain [**GP** 4] is visible in Area F; it doesn't correlate to Figure 11 but in the geophysical results it shows the same response and form as some of the known field drains [**GP 3**].

5.1.7 Most of the Di-polar anomalies and magnetic disturbance [**GP 5** and **6**] found on site are probably related to modern features. The Di-polar anomalies [**GP 5**], and the magnetic disturbance [**GP 6**] in Area A, are most likely due to magnetic debris across the site from previous and current agricultural activities. In Areas D and E there are some spots of magnetic disturbance [**GP 6**], this seems to be related to the trackway onto the site and modern disturbance. In Area G the magnetic disturbance [**GP 6**] is a result of the metallic fencing.

6. CONCLUSION

6.1.1 A geophysical survey was undertaken by AB Heritage at the proposed site for Cressing Solar Farm, taking place over 5 days, from the 19^{th} to the 25^{th} of November 2015.

6.1.2 The purpose of this work was to understand the potential for any archaeological remains to survive within the site, and, where possible, identify the form, function and extent of any potential remains.

6.1.3 Based on the geophysical survey it is likely that there is a low potential for the recovery of significant archaeological remains. Most features identified relate to geological variations [**GP1**], with possible quarrying activity [**GP 2**]. However the site has also been extensively farmed with previous [**GP 7**] and modern farming activity having an impact within the site. The implementation of extensive field drainage systems running through the site is also likely to have impacted within the site [**GP 3**].

7. ARCHIVE

7.1.1 The Site Archive will contain the following, as a minimum:

Table 3: Site Archive Data

Archive	Format
Raw Geophysical Data files	XYZ and Text
Processed geophysical data files	JPEG, BMAP
Archaeological Interpretation	Shape Files ARC GIS
Final Report	PDF
Final Images	PDF

7.1.2 A physical and digital archive will be stored in a suitable format at AB Heritage Limited offices in Taunton, Somerset.

8. REFERENCES

BGS (British Geological Society) 2015.*Geology of Britain viewer.* http://mapapps.bgs.ac.uk/geologyofbritain/home.html.

CIFA, 2014.Standard and Guidance for archaeological geophysical survey.

Cranfield Soil and Agrifood Industry, 2015.*Soilscapes viewer*, http://www.landis.org.uk/soilscapes/

Harpell E, 2015. Cressing Solar Farm,. An Historic Desk-Based Assessment. Pre-Construct Archaeology.

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Appendix 1 Technical Information on Geophysical Survey

FLUXAGTE MAGNETOMETRY SURVEY

The magnetic survey is carried out using a fluxgate gradiometer, which is a passive instrument consisting of two sensors mounted vertically 1m apart. The instrument is carried about 30cm above the ground surface and the top sensor measures the Earth's magnetic field, whilst the lower sensor measures the same field but is also more affected by any localised buried field. The difference between the two sensors will relate to the strength of a magnetic field created by a buried feature, if no field is present the difference will be close to zero as the magnetic field measured by both sensors will be the same.

Factors affecting the magnetic survey may include soil type, local geology, previous human activity, disturbance from modern services etc.

Survey equipment

The Bartington Grad 601-2 dual magnetic gradiometer is capable of surveying to an accuracy of 0.1 nanotesla (nT).

Sample interval and depth of scan

The magnetometer data is collected in 30mx30m grids at a resolution of 1m x 0.25m. This sample density is recommended for site evaluation (English Heritage, 2008). This equates to 3600 points per 30mx30m grid. The magnetometer has a typical depth of penetration of 0.5m to 1.0m. This would be increased if strongly magnetic objects are buried within the site.

Data capture

The readings are logged continually by the data logger during the survey, which is then downloaded on site to a site laptop. At the end of each job, data is transferred to the office PC's for processing and presentation.

This 'regular xy' data is then downloaded into specialist data processing software, at user defined sample intervals (in this case 1 m by 0.25 m). This is processed as standard magnetometer data.

Processing

Standard Raw Magnetometer data processing consists of:

Zero mean Traverse- This process sets the background mean of each traverse within each grid to zero, the operation allows for the removal of striping effects.

Destagger- The collection of geophysical data can lead to errors with time due to a slight variation in speed of traverses or time lag within the collection of data. The process corrects the erros of stagger within the data.

Non-Standard Magnetometer processing:

Interpolation- The results of greyscale geophysical data can sometimes appear blocky in nature. Interpolation is a process which calculates and inserts values between existing data to give a smoother grey scale image.

Cliping – The clipping process will clip extreme values from the data set and increase the contrast in the data values closer to the mean. As most data within a data set is concentrated around the mean clipping can produce a better visualisation of standard data sets, particularly very weak signals that tend to be lost in a myriad of grey shades.

Some degree of heading error is inevitable when using a fluxgate gradiometer with such an acute sensitivity to the direction of travel in bi directional manner i.e. zigzag traverses. The error displays as a series of alternating lighter and darker stripes in the traverse direction and the function asses and corrects the mean for each line of data to bring them in to the same mean range and remove any visible artefacts.

Display of data

Greyscale-This is display takes a range of reading and divides into a set number of classes. Each class is represented by a specific shade of grey and the higher the positive reading the darker the grey.

Colour- Colour can be applied to Greyscale plots to show high and low data collection points in a more direct way.

XY Trace Plot- Data is represented by a line, which is incremented along the Y axis. This produces a stepped effect, thus the data can be viewed to show a possible shaping of a feature. Typically features are clipped to limit odd readings.

Assigned ranges can be adjusted to give the best display of the data.

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GPS METHODOLOGY

An RTK GPS (Real-time Kinematic Global Positioning System) can locate a point on the ground to sub-cm accuracy, a far greater accuracy than a standard GPS unit. An RTK system uses a base station receiver and a number of mobile units (rovers). The base station takes measurements from satellites in view and then broadcasts them along with its known position to the rover receivers. The rover receiver also collects measurements from the satellites in view and processes them with the base station data. The rover then computes its location relative to the base.

During such a survey a Trimble GeoXR Differential Global Positioning System (dGPS), capable of Real Time Kinematic (RTK) is used to set out a nominal grid prior to the survey. This increases the accuracy and efficiency of the survey. The data is then downloaded from the unit on the day, using a USB stick.

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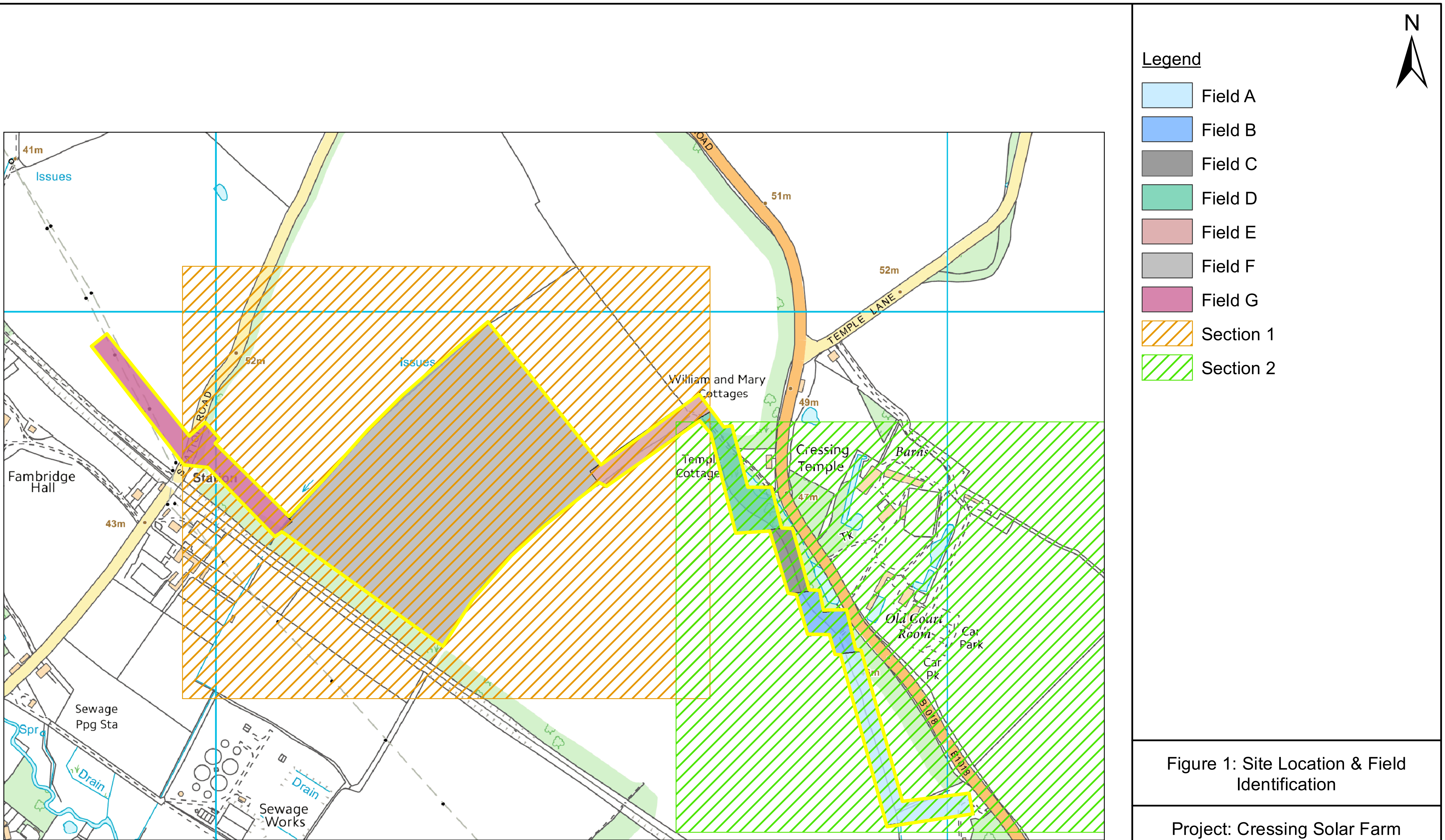

Figure 1: Site Location & Field Identification

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Drawn by: ZE	Approved by: GR

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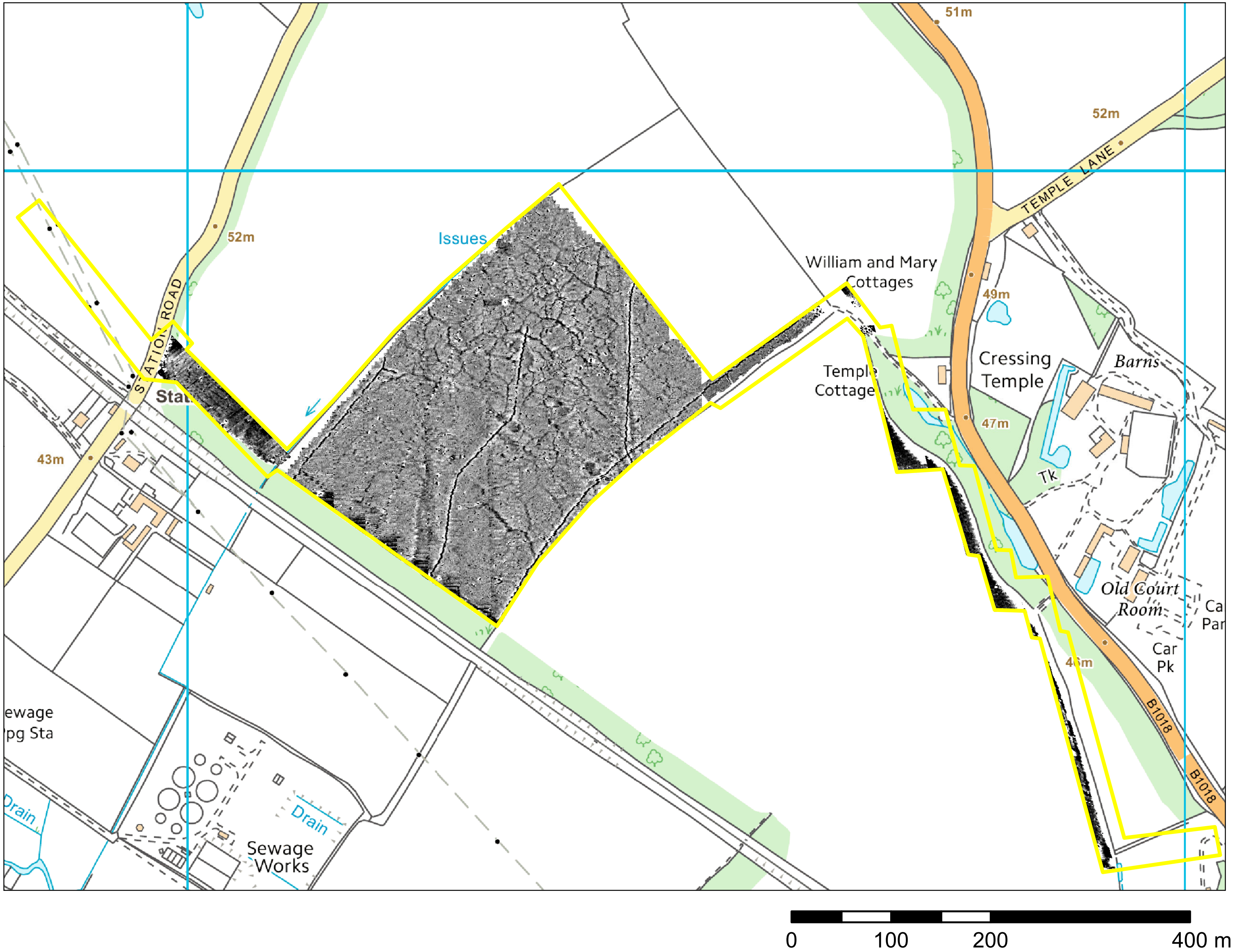

Legend

- Site Boundary
- Unsurvyed

+1
Plotting Perameters
-1

Figure 2: Raw Geophysical Data, Full Extent

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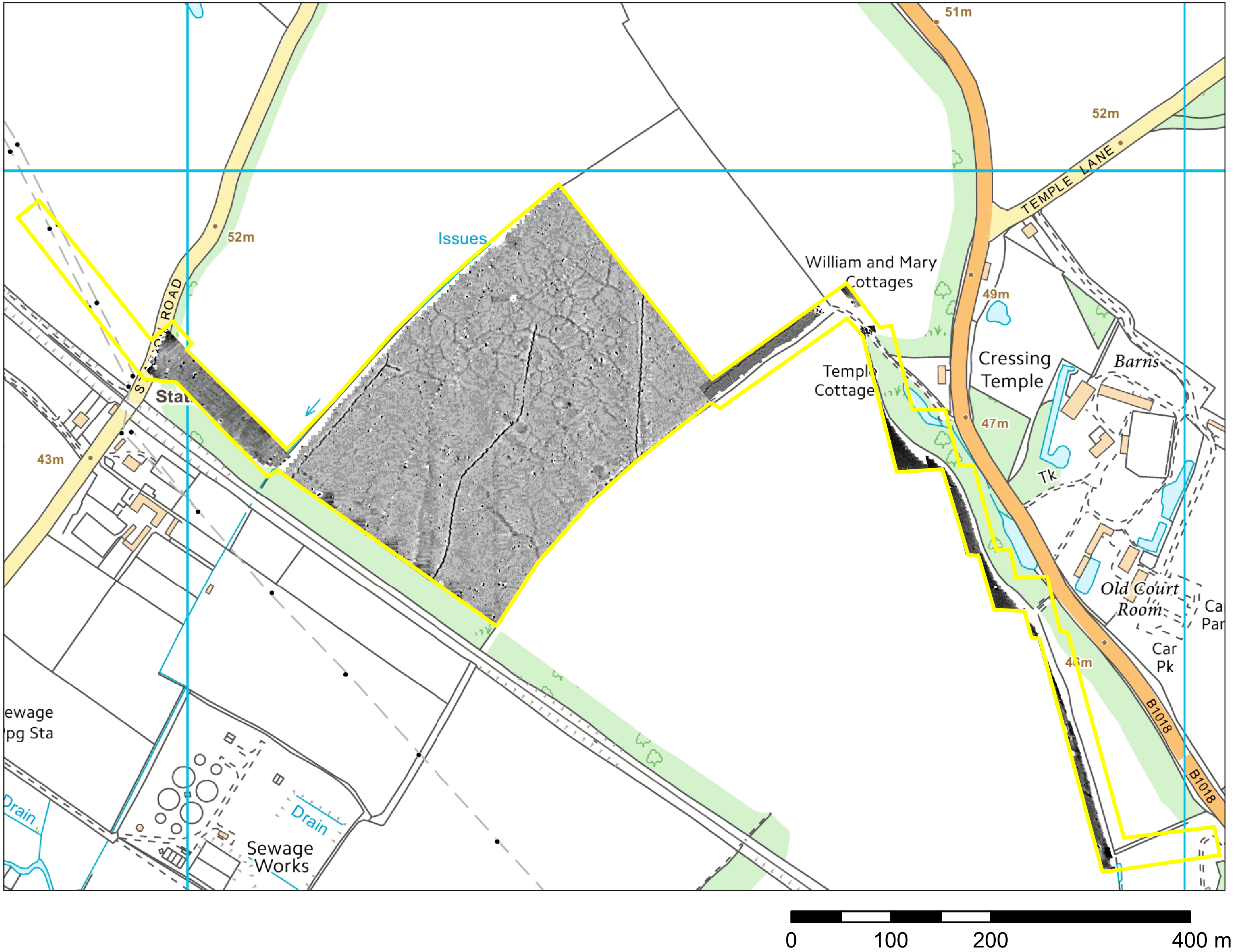

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Site Boundary

Unsurvyed

N

+3

-3

Plotting Perameters

Figure 3: Processed Geophysical Data, Full Extent

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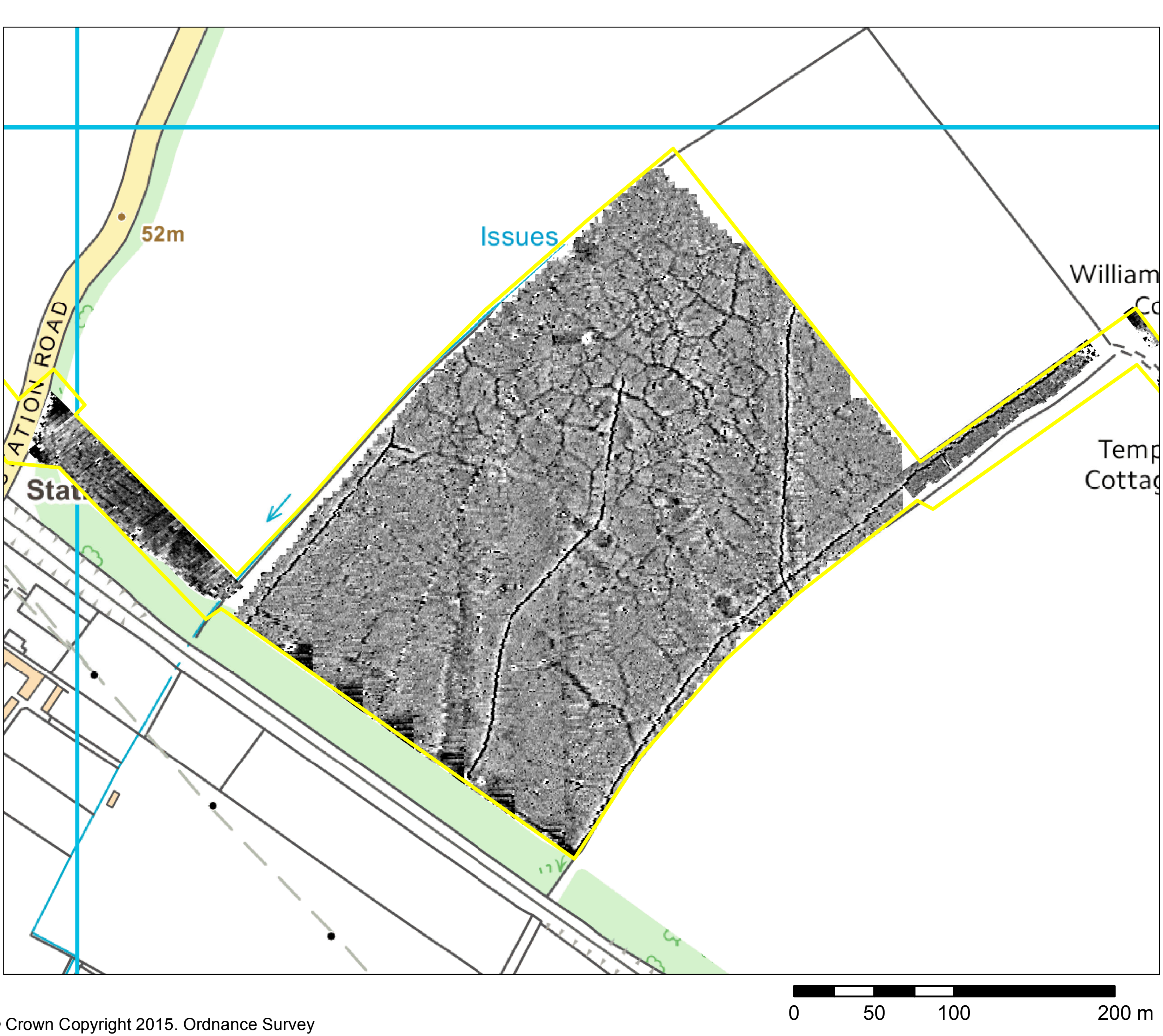

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Site Boundary

Unsurvyed

+1

Plotting Perameters

-1

Figure 4: Raw Geophysical Data, Section 1

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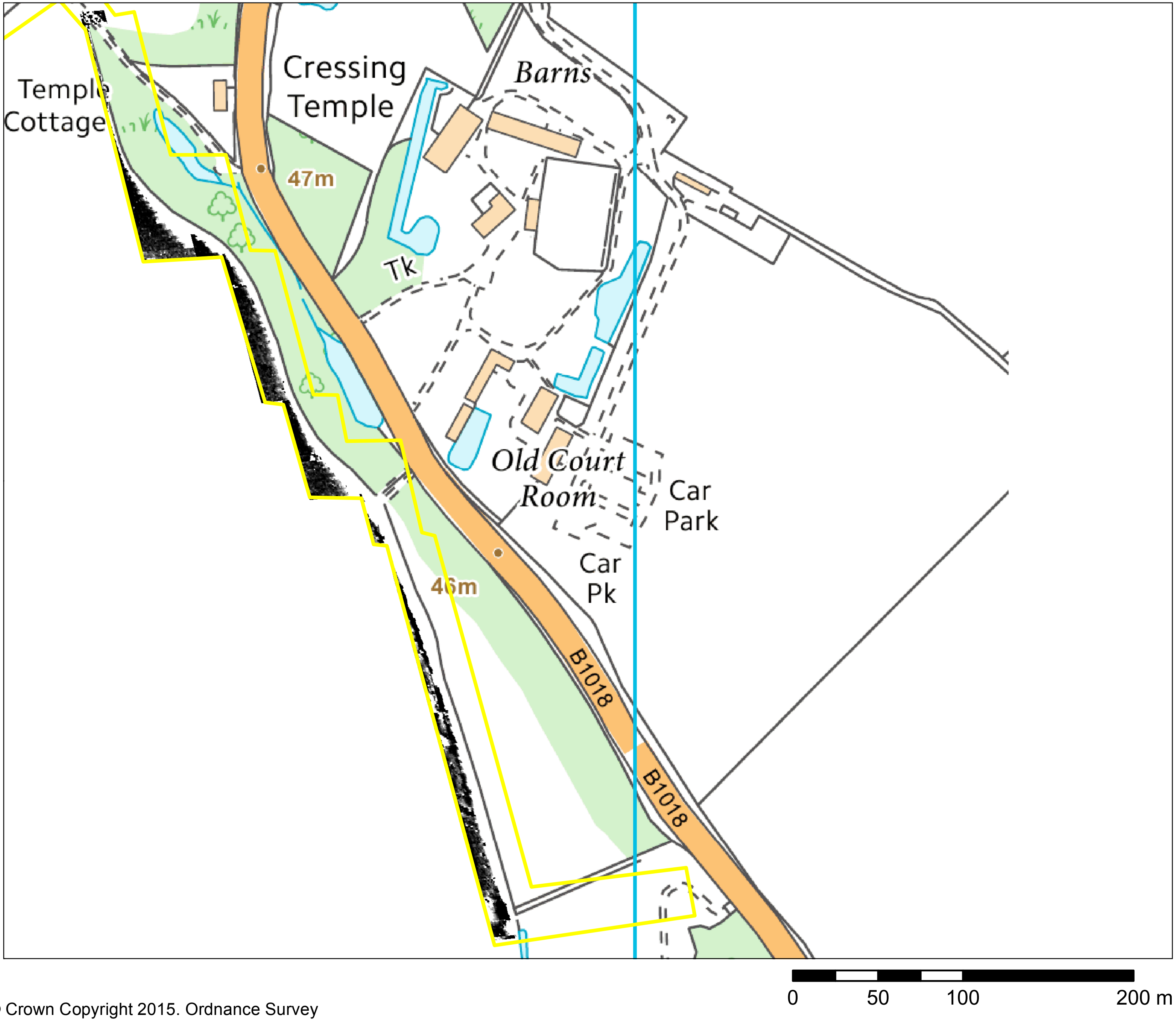

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- Site Boundary
- Unsurvyed

N

+1
Plotting Perameters
-1

Figure 5: Raw Geophysical Data, Section 2

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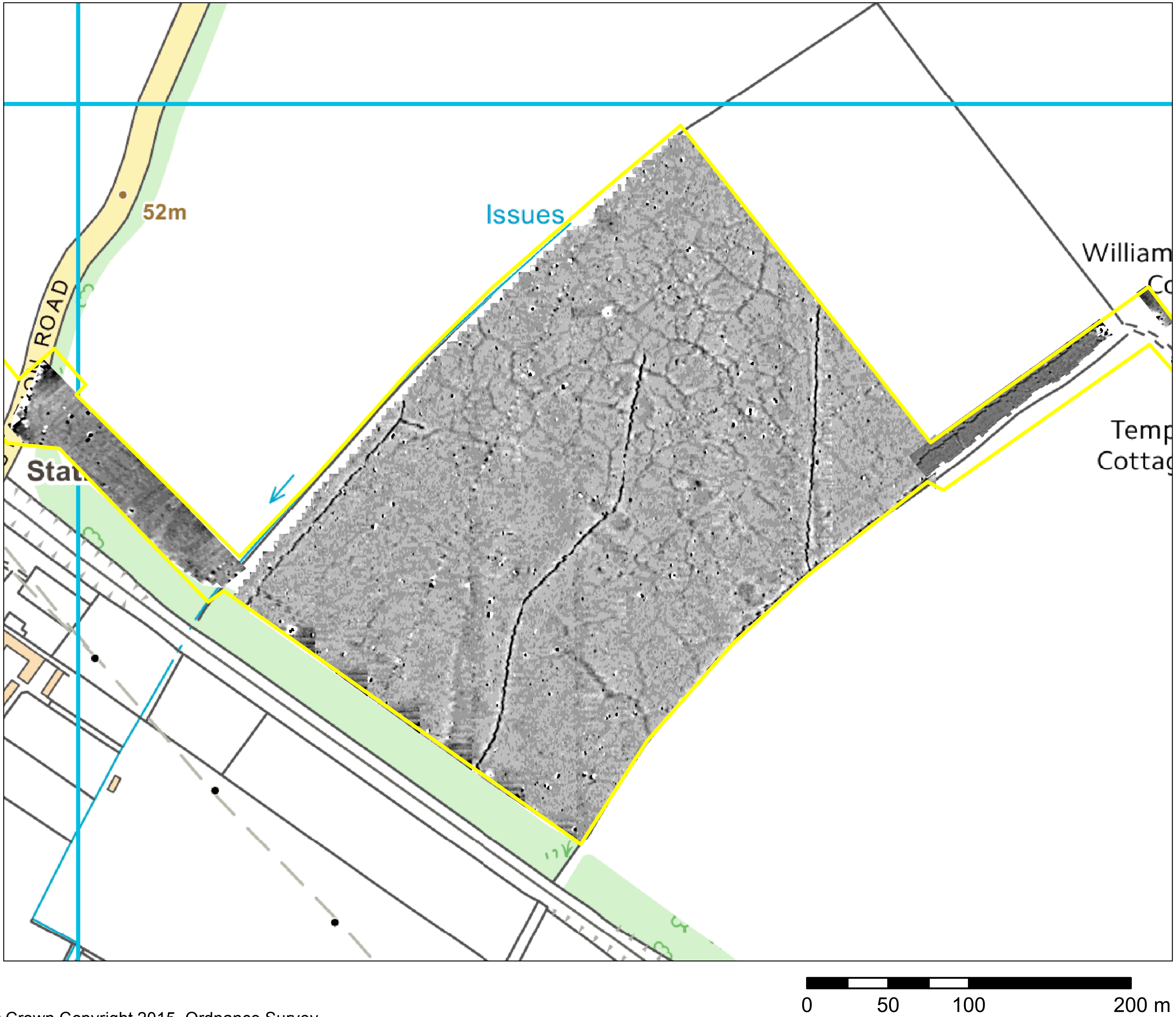

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Site Boundary

Unsurvyed

+3

Plotting Perameters

-3

Figure 6: Processed Geophysical Data, Section 1

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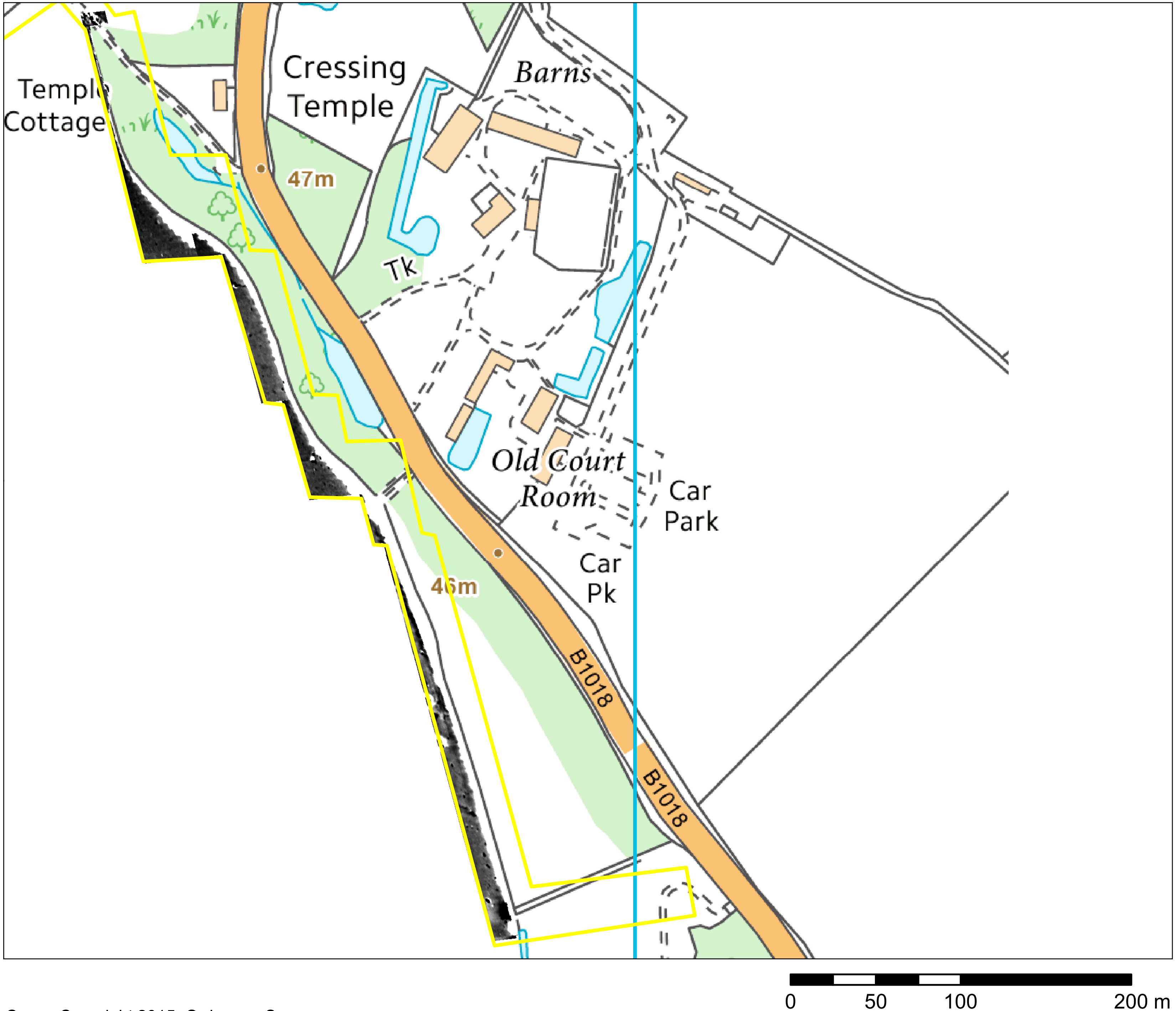

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Site Boundary

Unsurvyed

N

+3

Plotting Perameters

-3

Figure 7: Processed Geophysical Data, Section 2

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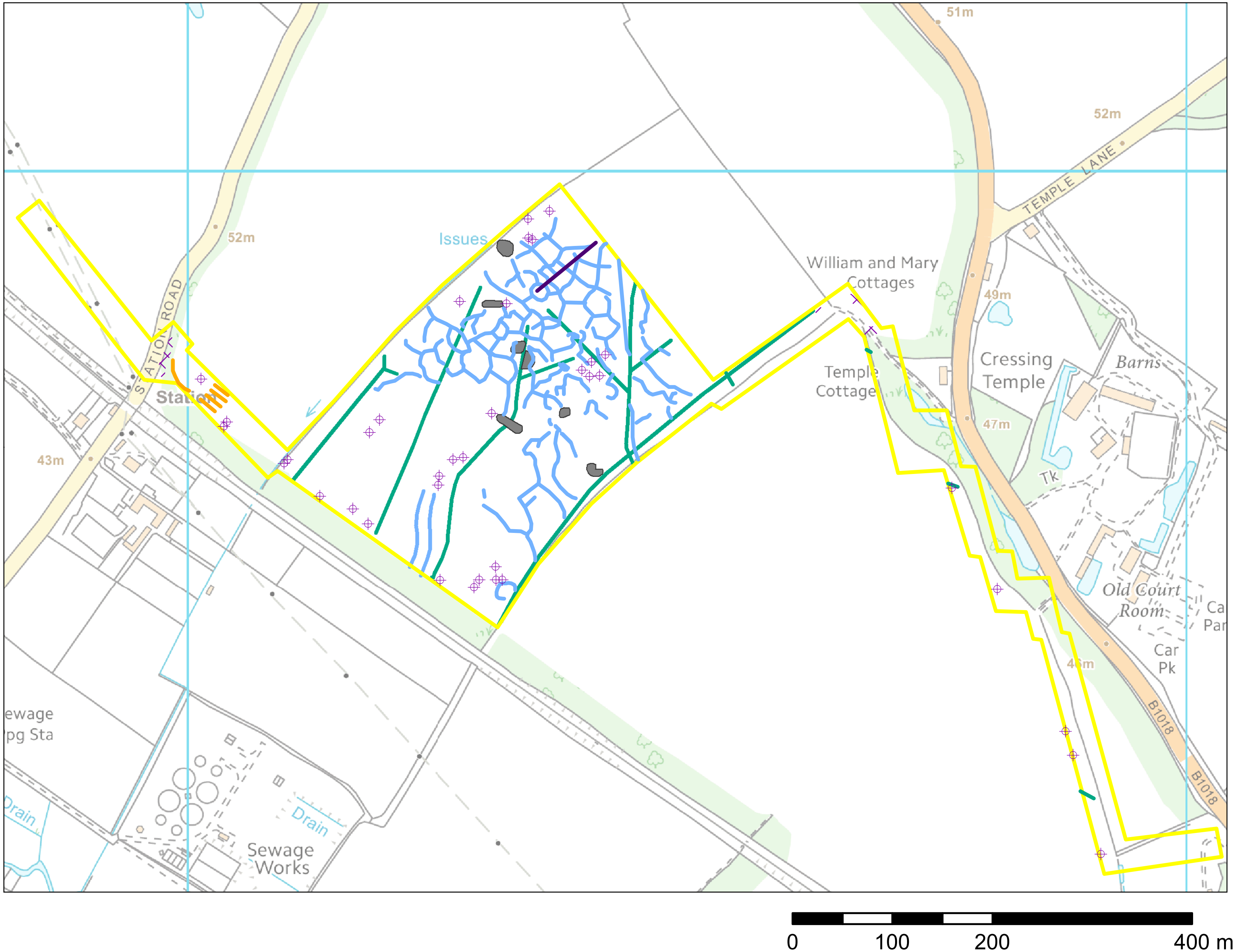

N

Legend

- Possible Geology [GP1]
- Possible Quarrying [GP2]
- Known Field Drains [GP3]
- Possible Field Drains [GP4]
- Di-polar Anomalies
- Magnetic Disturbance [GP6]
- Possible Ridge & Furrow [GP7]
- Site Boundary

Figure 8: Interpretation of Geophysical Survey Data, Full Extent

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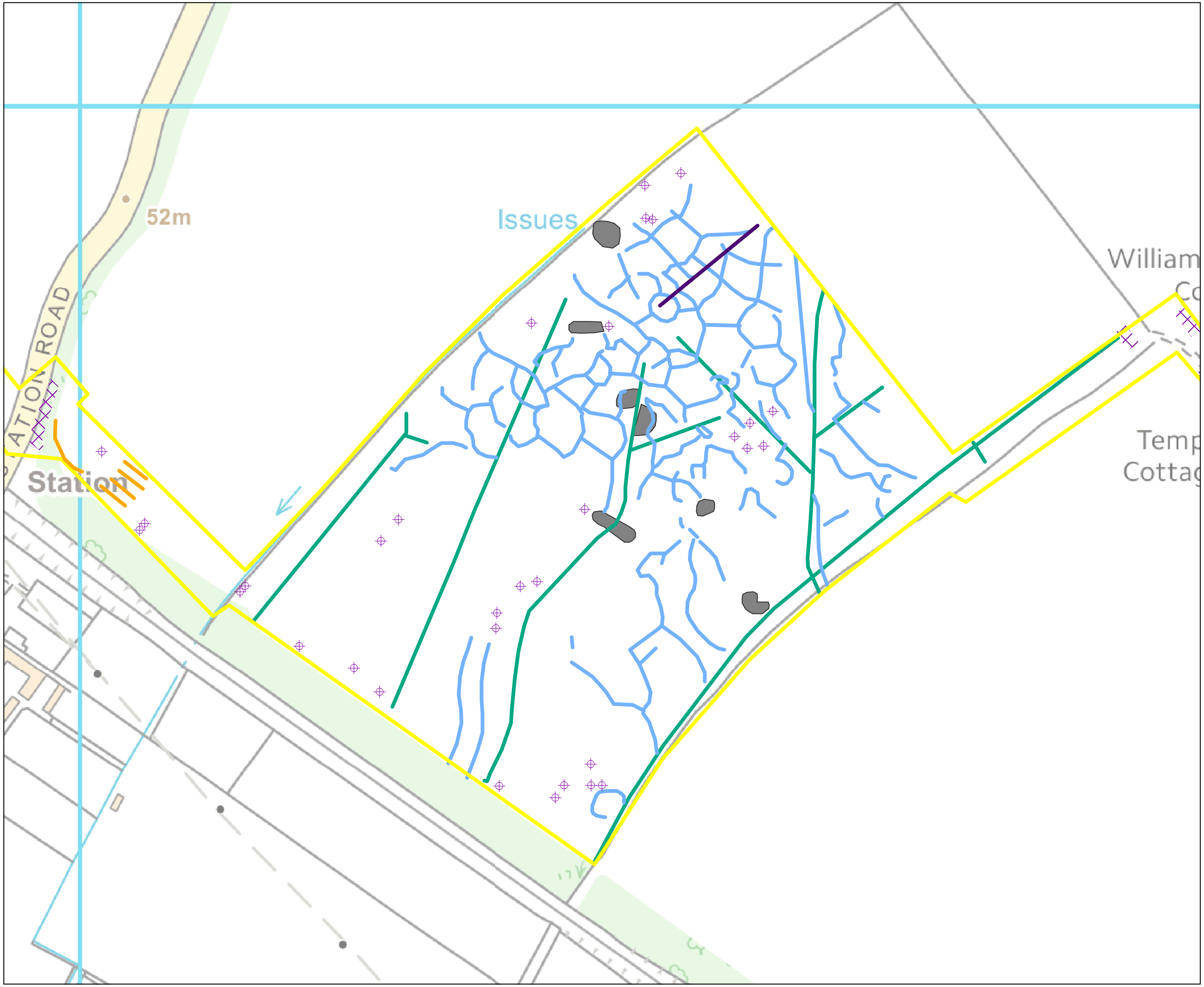

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Legend

- Possible Geology [GP1]
- Possible Quarrying [GP2]
- Known Field Drains [GP3]
- Possible Field Drains [GP4]
- Di-polar Anomalies [GP5]
- Magnetic Disturbance [GP6]
- Possible Ridge & Furrow [GP7]
- Site Boundary

0 50 100 200 m

Figure 9: Interpretation of Geophysical Survey Data, Section 1

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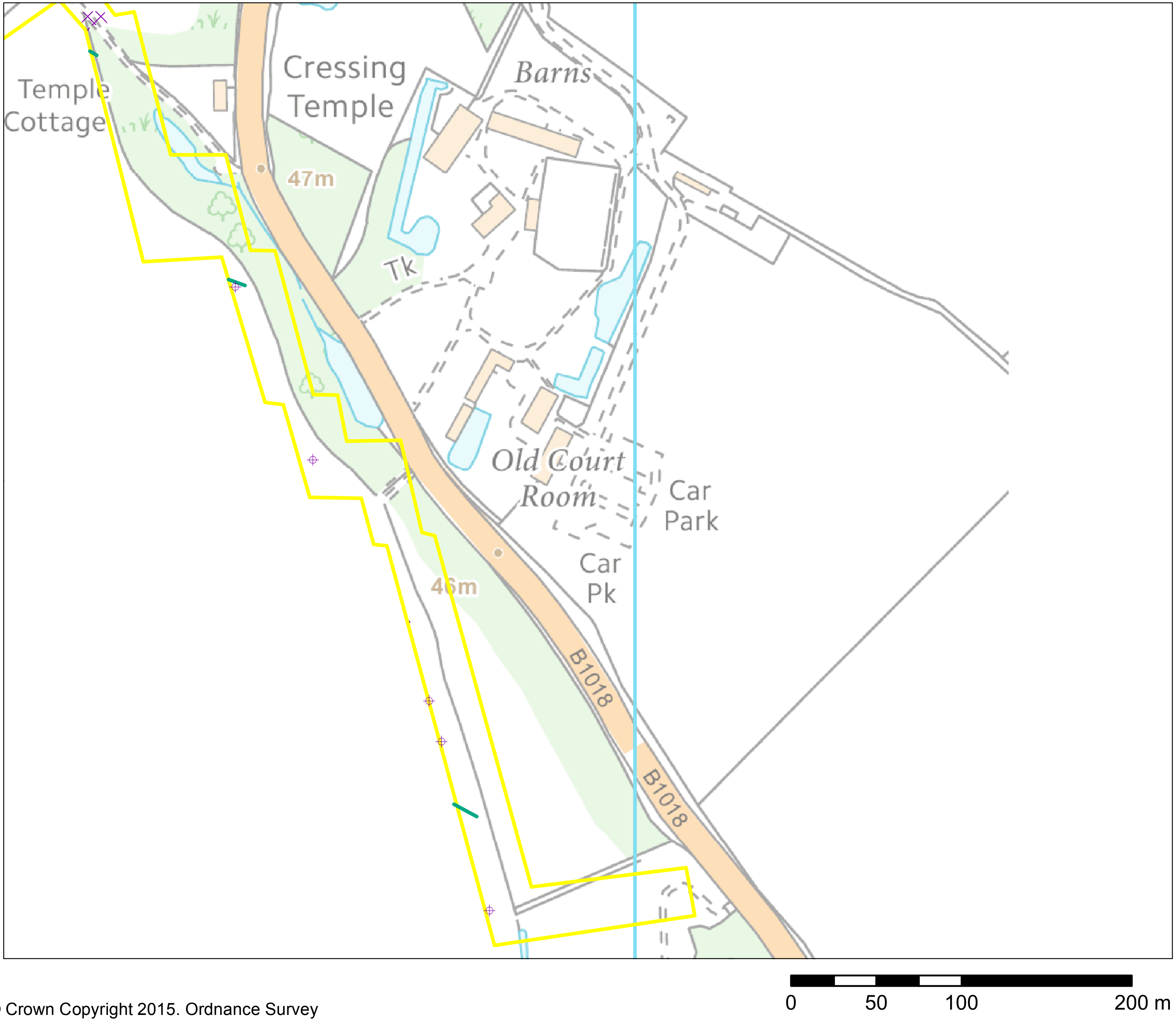

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- Possible Geology [GP1]
- Possible Quarrying [GP2]
- Known Field Drains [GP3]
- Possible Field Drains [GP4]
- Di-polar Anomalies [GP5]
- Magnetic Disturbance [GP6]
- Possible Ridge & Furrow [GP7]
- Site Boundary

Figure 10: Interpretation of Geophysical Survey Data, Section 2

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Legend

Site Boundary

0 100 200 400 m

Figure 11: Land Drainage Scheme, 1973

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