highways england

A303 Stonehenge
Amesbury to Berwick Down

Geophysical Survey Report:

Countess East GPR Pilot Survey

April 2019

Table of contents

Table of Figures

Executive Summary

This report details the results of the geophysical survey of land at Countess East, Amesbury (survey area NE1) as part of the A303 Amesbury to Berwick Down road improvement scheme ('the Scheme'). The land is proposed for use as a temporary construction compound and had previously been included in a programme of non-intrusive archaeological geophysical survey and trial trenching in connection with a proposal for a new Stonehenge visitor centre (see the Environmental Statement submitted with the Application for Development Consent dated October 2018 (ES) paragraph 6.6.108). The conclusions of the ES were informed by the results of that previous geophysical survey and trial trenching, allowing a robust assessment of baseline (see ES paragraph 6.6.15 and 6.6.108), approach to mitigation (see ES section 6.8) and likely significant effects (see ES paragraphs 6.4.1 (f) and section 6.9 and tables 6.10 to 6.12).

The purpose of the fieldwork described in this report was to test the ability of geophysical survey to locate features identified by the previous trial trenching, in order to determine whether survey across the whole of the Countess East site would be beneficial in potentially locating any further such features not located by the previous trial trenching. In so doing, it would also confirm the results of the previous survey and trenching and therefore the conclusions of the Environmental Statement. To this end, the survey comprised a ground penetrating radar (GPR) survey of two pilot areas, positioned to examine Anglo-Saxon sunken featured buildings and a Romano-British stone-built structure identified by previous geophysical surveys and trial trenching. The geophysical survey has successfully located the Romano-British building. Three rooms have been identified to the north and south of a large pillared room or courtyard. Whilst several anomalies surrounding this may be evidence of further archaeological activity, such as pit features, it is not clear whether these are associated with the building.

A total of eight anomalies have been identified across both areas that may relate to Anglo-Saxon sunken featured buildings. Whilst it is possible that these do indeed relate to sunken featured buildings, they could equally be evidence of natural solution features in the chalk bedrock.

The remaining anomalies are natural or modern in origin. A large circular anomaly in Area 2 has the appearance of an archaeological enclosure, but evaluation trenching in 2003 found nothing at this location, suggesting it is related to natural variation in the superficial deposits or bedrock. Evidence of various phases of ploughing activity has also been identified across both areas.

In each case, none of these anomalies affects the conclusions of the ES on baseline, approach to mitigation or likely significant effects.

The survey evaluated in this report therefore confirms the results of the previous survey and trenching and therefore confirms the conclusions of the Environmental Statement.

Based on the conclusions of the pilot survey reported here and in particular taking into account of the proposed use of the site as a construction compound to be built above existing levels, following consultation with WCAS there is no requirement for further survey or trial trenching in this location.

1 Introduction

1.1 Project background

1.1.1 Wessex Archaeology Ltd has been appointed as Archaeological Contractor by AECOM Mace WSP Joint Venture (AmW, the Technical Partner) on behalf of Highways England (the Employer) to undertake a programme of archaeological evaluation for the A303 Stonehenge project ('the Scheme').

1.1.2 An Archaeological Evaluation Strategy Report (AESR) [1] sets out the general and specific principles guiding the strategies for field-based investigations. An Overarching Written Scheme of Investigation (OWSI) [2] accompanying the AESR details the methods and techniques employed during the archaeological evaluation. The AESR and OWSI were approved by the Heritage Monitoring and Advisory Group (HMAG: comprising representatives of Wiltshire Council Archaeology Service, the National Trust and Historic England).

1.1.3 The survey comprised a ground penetrating radar (GPR) survey of two pilot areas, positioned to confirm and examine Anglo-Saxon sunken featured buildings and a Romano-British stone-built structure identified by previous geophysical surveys and trial trenching. The land is proposed for use as a temporary construction compound ('the site').

1.2 Scope of the document

1.2.1 The site had previously been included in a programme of non-intrusive archaeological geophysical survey and trial trenching a proposal for a new Stonehenge visitor centre [3] (see ES paragraph 6.6.108). The conclusions of the Environmental Statement were informed by the results of this geophysical survey and trial trenching, allowing a robust assessment of baseline (see ES paragraph 6.6.15 and 6.6.108), approach to mitigation (see ES section 6.8) and likely significant effects (see ES paragraphs 6.4.1 (f) and section 6.9 and tables 6.10 to 6.12). The purpose of the fieldwork described in this report was to confirm the results of the previous survey and trenching and therefore the conclusions of the Environmental Statement.

1.2.2 This document details the results of the geophysical survey. Where relevant, the report notes the limitations of the survey, the data collected and the interpretation put forward: these limitations do not affect the confirmation presented by this document of the baseline conditions, assessment of effects and mitigation approach identified in the ES.

1.2.3 The purpose of the pilot survey described in this report was to test the ability of the Ground Penetrating Radar (GPR) to locate Saxon sunken featured buildings identified by the previous trial trenching, in order to determine whether survey across the whole of the Countess East site would be beneficial in potentially locating any further such features not located by the previous trial trenching. . In so doing, it would also confirm the results of the previous survey and trenching and therefore the conclusions of the Environmental Statement.

1.2.4 Based on the conclusions of the pilot survey reported here and in particular taking into account the proposed use of the site as a construction compound to be built

above existing levels, following consultation with WCAS there is no requirement for further survey or trial trenching.

2 Site Description

2.1 Location, topography and geology

2.1.1 This geophysical survey covers two areas located within the DCO limits ('the Red Line Boundary', or RLB) north of the A303, north-east of Countess Roundabout, centred on NGR 415680, 142270 (Area 1) and 415620, 142460 (Area 2) (**Figure 1**). The areas lie approximately 300 m east of the eastern boundary of the Stonehenge, Avebury and Associated Sites World Heritage Site (WHS), in the north of Amesbury.

2.1.2 The survey comprises 1.3 ha across two areas within the same arable field. The survey areas are bounded by open arable land on all sides.

2.1.3 The areas are situated on the shoulder and bank of a large meander in the River Avon. Area 1 lies on a slight south facing slope, dropping from 73 m above Ordnance Datum (aOD) at the northern boundary to 70 m aOD at the southern boundary. Area 2 is generally flat at about 74 m aOD.

2.1.4 The solid geology underlying the both areas comprises Chalk of the Seaford Chalk Formation with superficial River Terrace Deposits, 4 – sand and gravel. The north-western part of Area 2 has no recorded superficial deposits [4].

2.1.5 The soils underlying both areas are likely to consist of brown calcareous earths of the 511f (Coombe 1) association [5].

2.2 Archaeological background

Introduction

2.2.1 A Historic Environment Baseline Assessment (see ES Appendix 6.2) [6] presented the known and potential archaeological baseline for the proposed A303 Amesbury to Berwick Down road improvement scheme. The study area for this covered a 500 m wide corridor either side of the DCO limits and considered all heritage assets up to and including the 20th century.

Summary of the archaeological resource

2.2.2 The survey areas lie approximately 300m east of the eastern boundary of the Stonehenge part of the Stonehenge, Avebury and Associated Sites World Heritage Site. The surrounding chalk downland, both within and beyond the WHS, contains a large number of structures and sites dating from the prehistoric and historic periods. Areas of archaeological importance in the immediate vicinity include the Neolithic henges at Durrington Walls and Woodhenge 1450 m to the north, the Woodlands Grooved Ware pits 850 m to the west and the Ratfyn pits and burials 500 m to the south, the Iron Age hillfort of Vespasian's Camp 1150 m to the south-west, the Romano-British village at Butterfield Down 1.5 km to south-east, and the Anglo-Saxon and medieval town of Amesbury to the south.

2.2.3 The site is located within a relatively dense concentration of Early Bronze Age round barrows, of which the barrow groups at Earl's Farm Down, New Barn

Down, and Bulford are perhaps the most notable. The nearest Scheduled Monument to the site is the Ratfyn Barrow, which lies 350 m to the south of Area 1. Several further scheduled barrows are recorded 800 m west and north-west of the site, within the WHS.

2.2.4 Test pitting to the south of Area 1 in 1993 recorded a buried flint scatter thought to relate to Neolithic settlement close to the River Avon, the modern channel of which lies 250 m to the south of Area 1 [7]. A later excavation to the north revealed further evidence of Neolithic to Early Bronze Age activity in the form of a pit. Three further pits were identified to the north of Area 2 during the same excavation.

2.2.5 Further test pits and archaeological evaluations have also been undertaken within the area in 2003 [8] [3]. These have identified a substantial masonry building possibly of Romano-British date in the east of Area 1 with walls up to 0.8 m thick. The walls were constructed of compacted chalk with a flint exterior, whilst internal walls were built solely of chalk. Two Anglo-Saxon sunken featured buildings within the survey area were also revealed. However, excavation of these features was kept to a minimum, only establishing their date and character, so as not to compromise the features for any potential future work. A further three Anglo-Saxon sunken featured buildings were also recorded in Area 2.

2.2.6 A 2016 gradiometer survey across the south of the field identified several archaeological features [9]. As well as the aforementioned Romano-British building, several possible ditches have been identified in Area 1. The exact origin of these is not clear, but they may be activity associated with the building. A 20th century haul road associated with gravel and clay quarrying was also identified to the west of Area 1 in both the geophysical survey and archaeological evaluation.

3 Methodology

3.1 Introduction

3.1.1 The geophysical survey adhered to the methodology set out below, prepared in accordance with guidelines and recommendations published by Historic England [10], Europae Archaeologia Consilium [11], and by the Chartered Institute for Archaeologists [12].

3.2 Aims and objectives

3.2.1 The aims of the geophysical survey were:

- To provide information about the nature and interpretation of any anomalies identified;
- To determine the presence, absence and extent of buried archaeological features;
- To contribute to the next stage of the iterative archaeological evaluation strategy and assist in defining suitable targets for the archaeological trial trenching;
- To establish the extent and character of potential archaeological anomalies and provide an interpretation of the results in their local, regional, national or international context; and
- To produce this interpretive report on the findings of the fieldwork and to inform the development of an archaeological mitigation strategy for the Scheme[1].

3.3 Fieldwork methodology

3.3.1 Detailed ground penetrating radar (GPR) survey was undertaken across both areas, targeting potential features identified by previous surveys, and features found in previous excavations.

3.3.2 A brief description of the survey technique is provided below. Further details of the specific geophysical survey equipment, methods and processing are described in **Appendix A**.

3.4 Survey specification

3.4.1 Individual survey grid nodes were established using a Leica Viva RTK GNSS instrument, which is precise to approximately 0.02 m and therefore exceeds European Archaeologiae Consilium recommendations [11].

3.4.2 The GPR survey was conducted using a Malå RAMAC/GPR XV11 monitor and control unit with a shielded antenna. This was mounted on a rough terrain cart which is fitted with an odometer to measure horizontal distance along the ground surface. This was deployed across all of the GPR areas with data collected along traverses spaced 0.5 m apart. Data with the 500 MHz antenna were collected every 0.03 m with an effective time window of 60 ns. This was collected in the zigzag method.

[1] The approach to archaeological mitigation for the Scheme is set out in section 6.8 of the ES

3.4.3 Field tests of the antennae frequency have been undertaken during previous phases of geophysical survey on the Scheme using a 500, 400 and 250 MHz antenna in accordance with European Archaeologiae Consilium [11] and Historic England guidelines [10]. This established that the 500 MHz antenna was likely to provide the suitable information regarding the nature of archaeological remains within each area and therefore no further survey was undertaken using alternative antennae.

3.5 Data processing

3.5.1 Data from the survey were subjected to common GPR correction processes. These comprise amplitude and wobble correction of the radar profile to correct for variance in temperature and soil moisture content; background and bandpass filtering to remove noise in the data from the surrounding area; and XYZ mean line to correct for mosaic effects from variance in the day-to-day conditions during the survey. These steps were applied to all the GPR datasets.

3.5.2 The approximate depth conversions of each area have been calculated using known features found during the 2003 excavation. These have been calculated using the corner of the Roman building found in both the excavation and GPR survey of Area1. Whilst this provides more accurate depth calculations than other methods, they should still be considered approximate. This is due to the likelihood that the velocities will differ across the site with variations in the underlying soil and geology. The approximate depth conversions for each area are shown in **Appendix B** (**Tables 1** to **3**).

4 Geophysical survey results and interpretation

4.1 Introduction

4.1.1 The GPR survey was undertaken on 6th to 7th September 2018. The conditions at the time of survey were generally good across the survey area, being dry and over cut crop. The entire 0.8 ha of Area 1 was surveyed. A total of 0.5 ha of Area 2 was surveyed, with remaining 0.1 ha to the north of the area inaccessible under pallets.

4.1.2 For ease of interpretation, the most representative timeslices have been selected for presentation with the interpretation image detailing the salient results from each relevant timeslice 0.16 – 0.18 m in thickness. This is then followed by a graphical summary of all the timeslices to provide a more complete understanding of how these anomalies may relate to each other.

4.1.3 The GPR survey has identified point reflectors, planar returns, and curvilinear responses, along with anomalous areas of high and low amplitude. Results are presented as a series of greyscale timeslices, and archaeological interpretations at a scale of 1:1000 (**Figures 2** to **5**). The greyscale plots display black representing high amplitude responses and white relating to low amplitude responses.

4.1.4 All features are described in terms of their geophysical character and three-dimensional form. It is important to stipulate that all the depths referred to in this report are approximate levels below the current ground surface. The interpretation of the GPR data highlights the presence of potential archaeological features, possible archaeological features, and high amplitude responses alongside a series of linear trends. Full definitions of the interpretation terms used in this report are provided in **Appendix C**.

4.1.5 It should be noted that small or waterlogged features may produce responses that are below the detection threshold of the GPR antenna. Excessive disturbance can also impede the ability of geophysical techniques to detect archaeology. It may therefore be the case that more archaeological features are present than have been identified through the geophysical survey.

4.2 Survey results and interpretation

Area 1

4.2.1 In the east of Area 1, a series of rectilinear discrete anomalies have been identified at **4000** (**Figure 3**). These are first evident in Timeslice 3 (0.28 – 0.44 m) and continue to Timeslice 15 (1.93 – 2.09 m). The discrete responses identified are indicative of wall features and are associated with a Romano-British building found during trial trenching of the site in 2003 [3]. The building is aligned north to south and is 30 m long by 11.5 m wide, widening to 15.5 m at the northern end. The wider northern end comprises three roughly 4 m square rooms separated by 1 m wide walls. The southern end also comprises three rooms, the central being roughly 3 m square and flanked by 2.5 x 3 m rectangular rooms. The centre of the building is formed by a 17 x 9 m room or courtyard. This contains two rows of four regularly spaced (3.5 m), 1.5 m diameter, discrete anomalies. These are likely the bases of former pillars.

4.2.2 To the east and south of the building, areas of circular and amorphous anomalies have been identified at **4001** and **4002**. These are mostly present in Timeslices 3 to 7 (0.28 – 0.44 m to 0.83 – 0.99 m). The anomalies are between 1 m and 2.5 m in diameter and relate to discrete and hyperbola responses. It is possible that these result from archaeological activity, possibly associated with the Romano-British building, such as pits. However, their response is more indicative of natural features such as rocks or variations in the overlying geological deposits.

4.2.3 Large weak anomalies have been identified across the west of the area at **4003** to **4007**. The anomalies can be seen in Timeslices 3 and 4 (0.28 – 0.44 m to 0.41 – 0.58 m). These are generally sub-oval in shape, varying in size from 3.5 x 3 m (**4006**) to 10 x 5 m (**4003**). These 'quieter' areas in the data are indicative of cut features in the generally 'noisier' background response from the bedrock. It is possible that these relate to Anglo-Saxon sunken featured buildings that have been found in the area by previous excavation. However, it should be noted that the previously-excavated example within the survey area is not visible in the data. It is possible that this is due to the trenches being backfilled with chalk material similar to the surrounding bedrock. It is also possible that anomalies **4003 – 4007** represent natural variation in the chalk bedrock, such as solution features. The anomalies at **4003** and **4004** correspond with anomalies in the previous gradiometer survey, interpreted as natural geological variation. However, the anomalies combined in both surveys present a stronger case for an archaeological origin.

4.2.4 In the north-east of the area, broad amorphous anomalies have been identified at **4008**. These are visible in Timeslices 3 to 5 (0.28 – 0.44 m to 0.55 – 0.72 m). The large (4 – 15 m wide) and amorphous nature of these anomalies suggests that they are likely related to natural variation in the superficial deposits recorded across the area, rather than to any anthropogenic activity.

4.2.5 Numerous linear anomalies have been identified across the area on various orientations. These are mostly on north-west to south-east and east-north-east to west-south-west alignments and seen in shallow timeslices. These anomalies are likely related to modern ploughing activity. These are also seen on a curving north – south alignment to the east of the building at **4000**. These anomalies are thought to relate to wheel ruts as they are evident in the topmost timeslice.

4.2.6 There are also several high amplitude anomalies identified across the area. These are generally only seen in individual timeslices or do not form any discernible pattern. It is therefore considered that these are most likely of a natural origin, associated with the river terrace deposits recorded across the area or with naturally occurring flints within the chalk bedrock.

Area 2

4.2.7 Three large weak anomalies have been identified across the area at **4009** to **4011**. These are similar to those in Area 1 at **4003** to **4007**. These are present in Timeslices 4 to 5 (0.45 – 0.63 m to 0.6 – 0.78 m). The anomalies are sub-oval in shape, varying in size from 5.5 x 3.5 m to 8.5 x 4.5 m. As with the anomalies in Area 1, these indicate cut features in the bedrock and could relate to Anglo-Saxon sunken featured buildings. However, the two sunken featured buildings previously excavated in the area do not produce any anomaly in the data. It is equally

possible that these anomalies relate to natural variation in the chalk bedrock, such as solution features.

4.2.8 In the east of the area, a large semi-circular anomaly has been identified at **4012**. This is present in Timeslices 4 to 12 (0.45 – 0.63 m to 1.64 – 1.83 m). The anomaly is 1.5 – 4 m wide and has a diameter of 38 m, with an open south-western side. A trench from previous excavations did not find any archaeological features at these positions, suggesting this feature is likely related to natural variation in the superficial deposits or the bedrock.

4.2.9 Further evidence of natural geological variation is evident in the north of the area, where large amorphous anomalies have been identified. The substantial scale of these anomalies combined with a lack of any clear pattern indicates that they are most likely natural, rather than relating to any archaeological activity.

4.2.10 Numerous parallel linear anomalies have been identified across the area on an east-north-east to west-south-west alignment. These anomalies are likely related to modern ploughing activity.

4.2.11 There are also several high amplitude anomalies identified across the area. These are generally only seen in individual timeslices or do not form any discernible pattern. It is therefore considered that these are most likely of a natural origin, associated with the river terrace deposits recorded across the area or with flints within the chalk bedrock.

5 Discussion

5.1 Summary

5.1.1 The geophysical survey has identified anomalies that can confidently be interpreted as archaeological in origin. A Romano-British building identified by previous excavation has been detected with a high level of clarity within the data. Three rooms have been identified both to the north and south of a large probably pillared room or courtyard. Whilst several anomalies surrounding this may be evidence of further archaeological activity, such as pit-like features, it is not clear whether these are associated with the building.

5.1.2 The clarity of the responses associated with the building suggests that the walls or foundations are in a relatively good state of repair, with masonry likely to still be in place.

5.1.3 A total of eight anomalies have been identified across both areas that may be associated with Anglo-Saxon sunken featured buildings. These all relate to sub-oval shallow (0.28 – 0.78 m) cut features in the chalk bedrock. These have been identified as various sizes from 3.5 x 3 m to 10 x 5 m. While it is possible that these relate to sunken featured buildings, they could equally be evidence of natural solution features in the chalk bedrock. Two of the anomalies correspond with anomalies in the 2016 gradiometer survey [9], interpreted as natural geological variation. The results of the current survey may indicate a stronger case for an archaeological origin.

5.1.4 It is also worth noting that three sunken featured buildings identified by previous excavation within the areas are not identifiable within the geophysical data. It is not clear whether this is an effect of the recent excavation and backfilling, or an indication that sunken featured buildings cannot be detected by GPR in this area, weakening the case for the eight other anomalies suggested above to be of archaeological origin.

5.1.5 The remaining anomalies are thought to be natural or modern in origin. A large circular anomaly in Area 2 has the appearance of an enclosure, but trial trenching in 2003 [3] found no archaeological deposits or features at this location, revealing instead very mixed sands and gravels, suggesting that the anomaly is related to natural variation in the superficial deposits or bedrock. Gradiometer survey [9] indicated a similar varied geology, comparators for which have recently been encountered in trial trenching further west during evaluations for the Eastern Portal [13]. Evidence of various phases of ploughing activity has also been identified across both areas.

5.2 Conclusion

5.2.1 In conclusion, the geophysical survey was successful in fulfilling the overarching aims for the evaluation programme. It has confirmed the extent of archaeological and potentially archaeological features within the survey area, as well as identifying further areas of potential interest, and therefore confirmed the archaeological mitigation strategy for the overall Scheme set out in the ES.

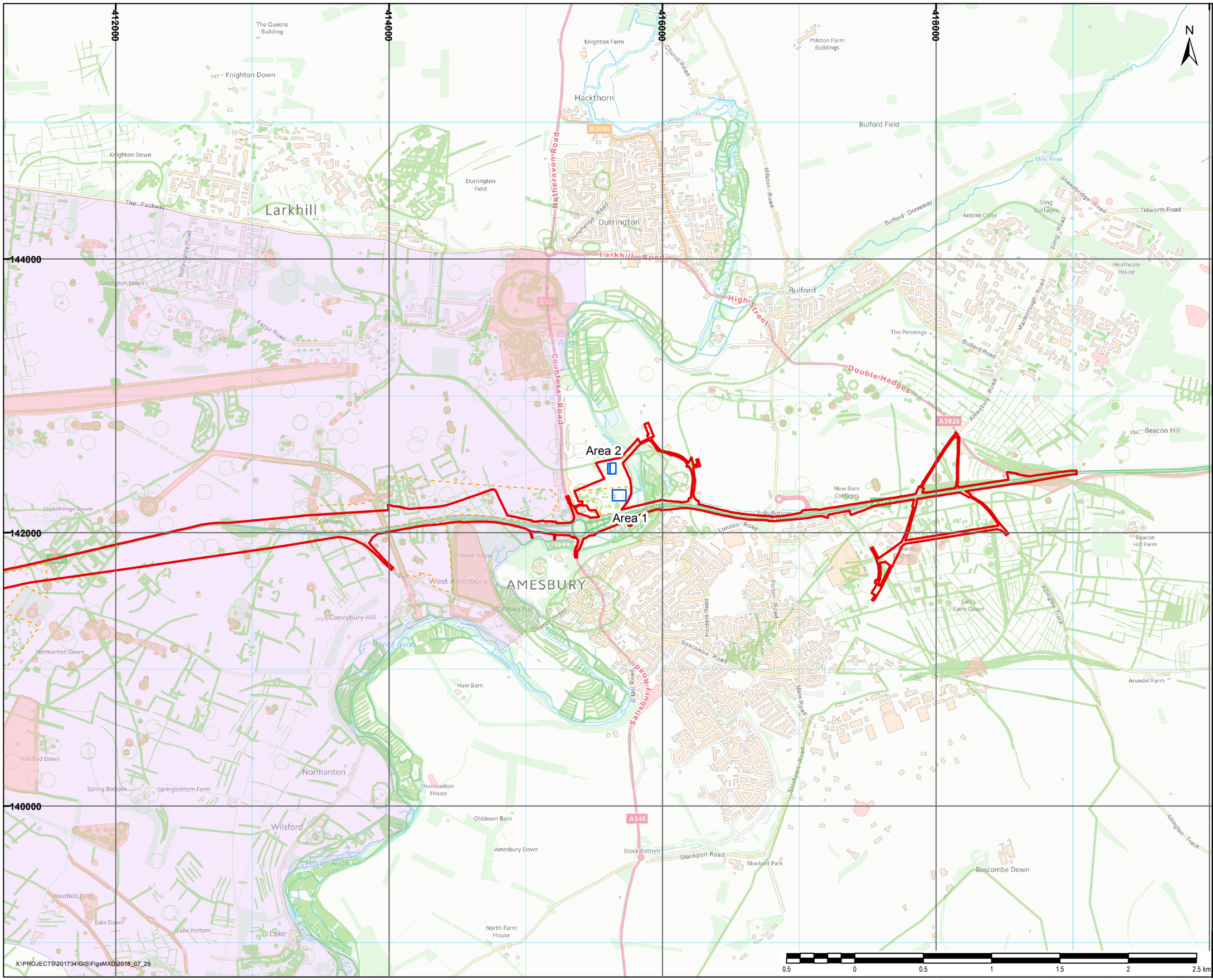
5.2.2 As the survey has identified anomalies thought to relate to archaeological features, in conjunction with the success of earlier surveys in the surrounding

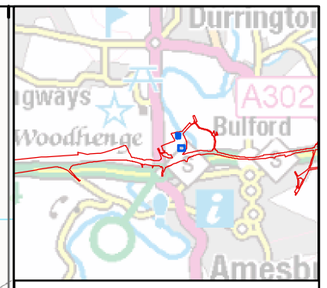
area, it would suggest the method of survey has been appropriate for the site. It is possible that further small or poorly preserved archaeological features are present within the survey areas but remain undetected, however as noted at paragraph 1.2.2 above, this limitation does not affect the confirmation presented by this document of the baseline conditions, assessment of effects and mitigation approach identified in the ES.

5.2.3 The survey evaluated in this report confirms the results of the previous survey and trenching and therefore confirms the conclusions of the Environmental Statement.

5.2.4 The purpose of the pilot survey described in this report was to test the ability of the Ground Penetrating Radar (GPR) to locate sunken featured buildings identified by previous trial trenching, in order to determine whether survey across the whole of the Countess East site would be beneficial in potentially locating any further such features not located by the previous trial trenching. Based on the conclusions of the pilot survey reported here and in particular taking into account the proposed use of the site as a construction compound to be built above existing levels, following consultation with WCAS there is no requirement for further survey or trial trenching.

6 Figures





NOTES / LEGEND

- DCO boundary
- GPR site boundary
- Previous Survey Area
- World Heritage Site
- Scheduled Monument
- Non-Designated Heritage Assets

Revision Details	By / Check	Date	Suffix

Purpose of issue

Client: Highways England

Working on behalf of: highways england

Project Title

A303 AMESBURY TO BERWICK DOWN

Drawing Title

GPR SURVEY COUNTESS EAST

FIGURE 1

SITE LOCATION AND DETAILED SURVEY EXTENTS

Designed	Drawn	Checked	Approved	Date
RM	TR			18/03/2019

Internal Project No.

Scale @ A3: 1:25,000

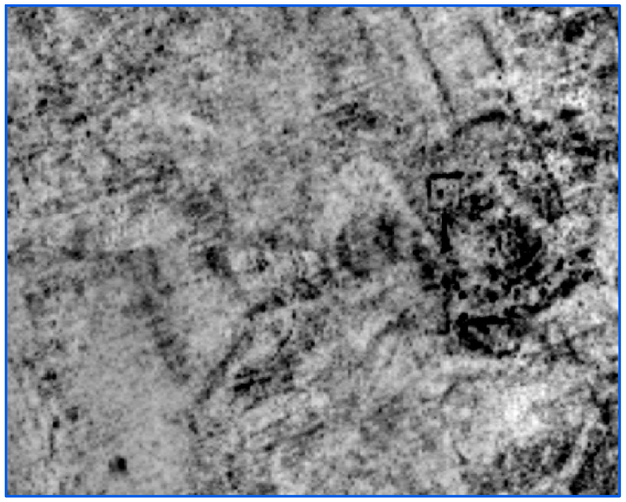
Zone

Highways England
Temple Quay House
2 Temple Quay
Bristol
BS1 6PN

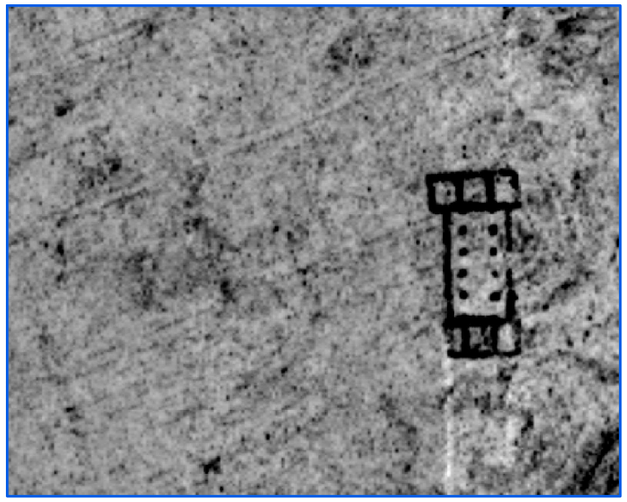
AECOM + mace + WSP

Drawing Number
Highways England PIN | Originator | Volume | Location | Type | Role | Number | Rev

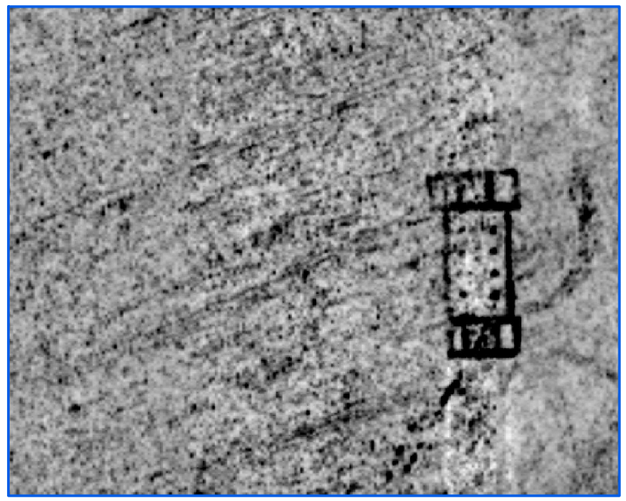
Timeslice 3: 6.26 - 10.0 ns (0.28 - 0.44 m)



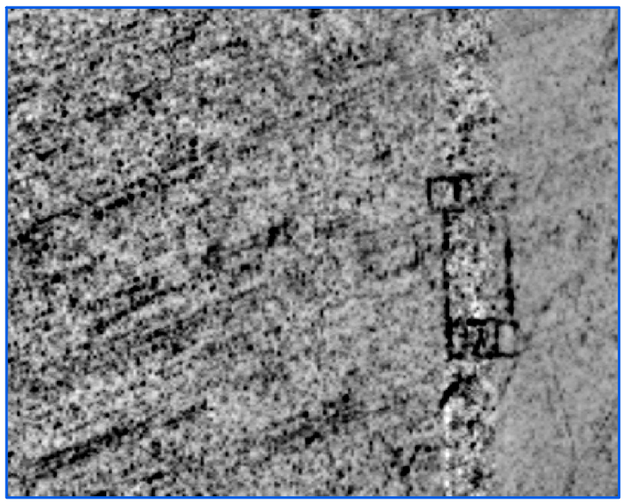
Timeslice 5: 12.52 - 16.26 ns (0.55 - 0.72 m)



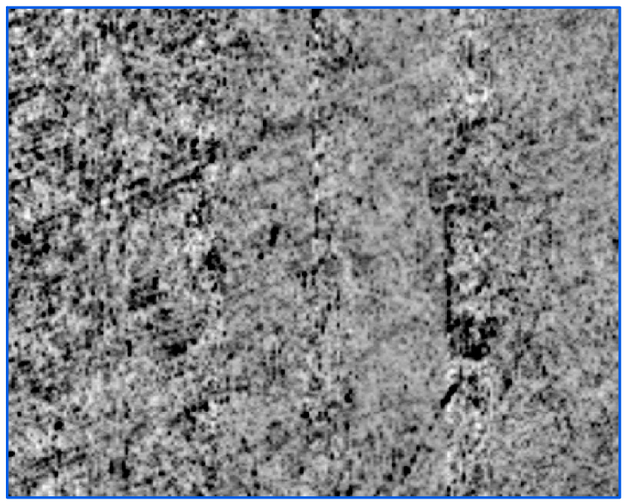
Timeslice 7: 18.78 - 22.52 ns (0.83 - 0.99 m)



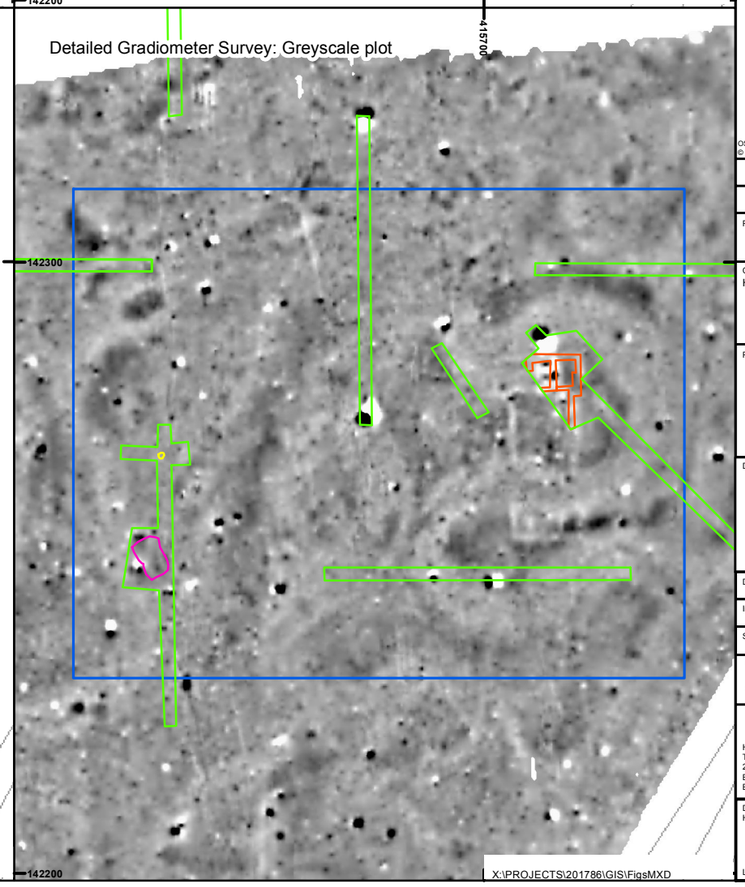
Timeslice 10: 28.17 - 31.91 ns (1.24 - 1.4 m)

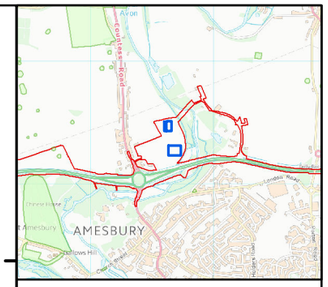


Timeslice 13: 37.57 - 41.3 ns (1.65 - 1.82 m)



Detailed Gradiometer Survey: Greyscale plot





N

GPR survey boundary
2003 Excavation trench
2003 Excavation Neolithic
2003 Excavation Roman
2003 Excavation Saxon

High Amplitude

Low Amplitude

Revision Details	NLC / Check	31/07/18	Suffix

Purpose of issue

Client
Highways England

Working on behalf of
highways england

Project Title

A303 Stonehenge: Amesbury to Berwick Down

Drawing Title

GPR SURVEY COUNTESS EAST

FIGURE 2

GPR SURVEY RESULTS
NE1 Area 1

Designed	Drawn	Checked	Approved	Date
NLC	TR	??	??	18/03/2019

Internal Project No. WA Reference: 201786

Scale @ A3 1:1,000 | Zone

Highways England
Temple Quay House
2 Temple Quay
Bristol
BS1 6PN

AmW
AECOM + mace + WSP

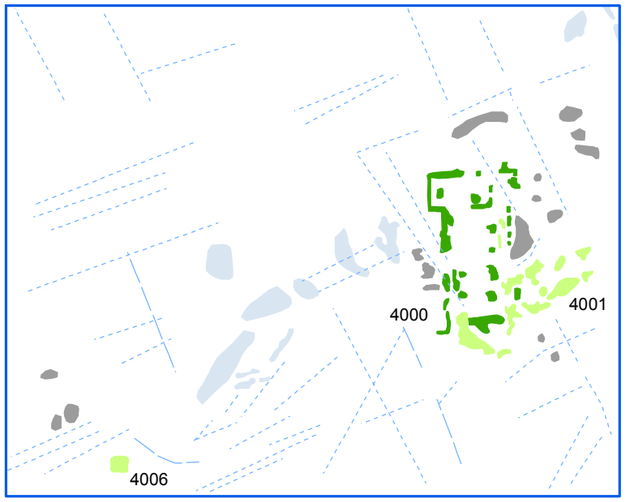
Drawing Number
Highways England PIN | Originator | Volume | Rev

Location | Type | Role | Number

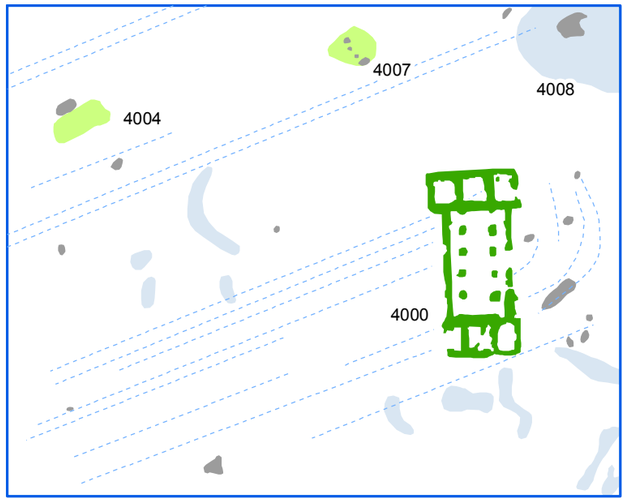
X:\PROJECTS\201786\GIS\FigsMXD

415700
142300
142200

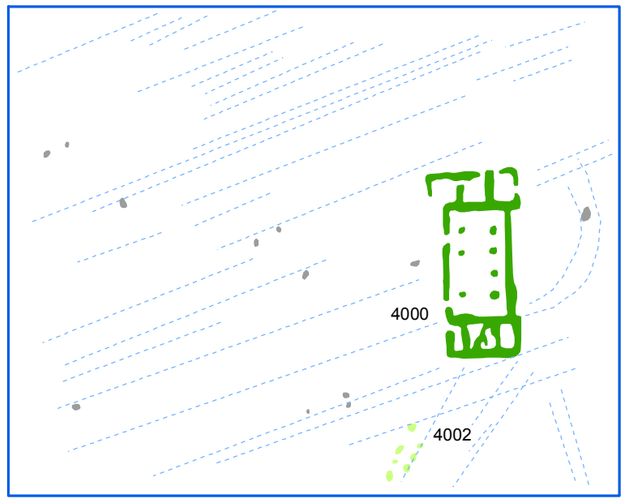
Timeslice 3: 6.26 - 10.0 ns (0.28 - 0.44 m)



Timeslice 5: 12.52 - 16.26 ns (0.55 - 0.72 m)



Timeslice 7: 18.78 - 22.52 ns (0.83 - 0.99 m)



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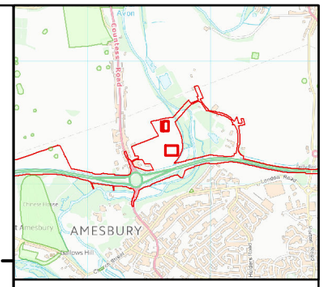
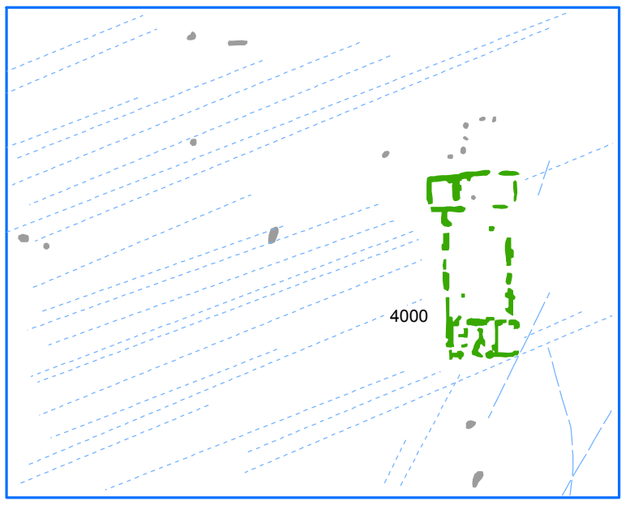


GPR survey boundary
Archaeology
Possible archaeology
Superficial geology
Increased response
Ploughing
Trend

Timeslice 10: 28.17 - 31.91 ns (1.24 - 1.4 m)



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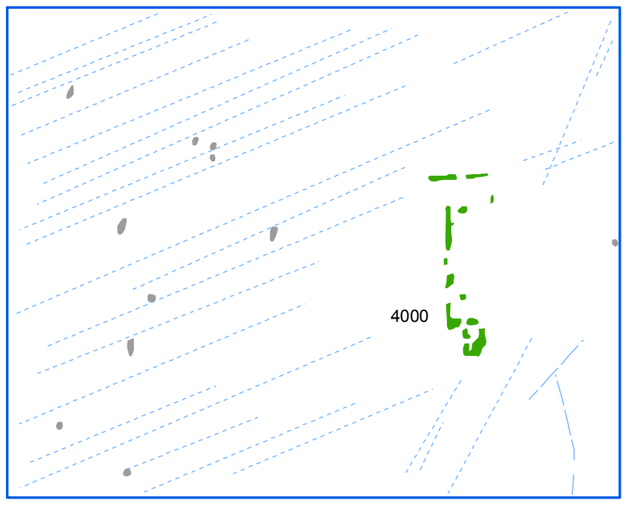
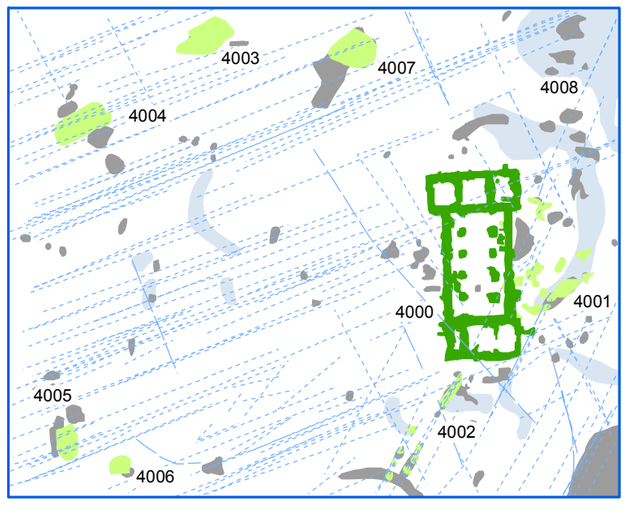


Combined Interpretation



Revision Details	NLC / Check	31/07/18	Suffix

Purpose of issue

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Project Title

A303 Stonehenge: Amesbury to Berwick Down

Drawing Title

GPR SURVEY COUNTESS EAST

FIGURE 3

GPR SURVEY INTERPRETATION
NE1 Area 1

Designed	Drawn	Checked	Approved	Date
NLC	TR	??	??	18/03/2019

Internal Project No. WA Reference: 201786

Scale @ A3 1:1,000 | Zone

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Location | Type | Role | Number

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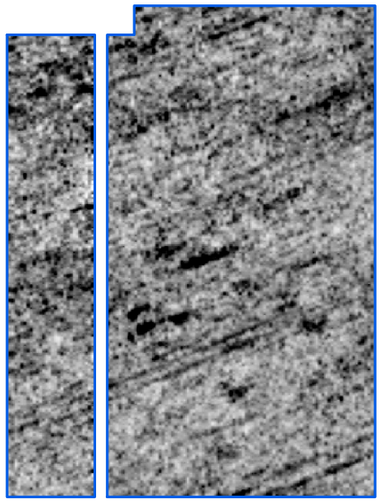
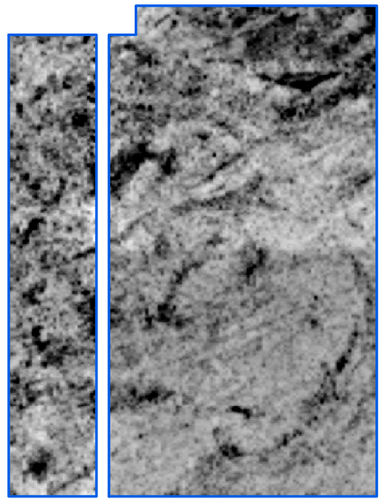
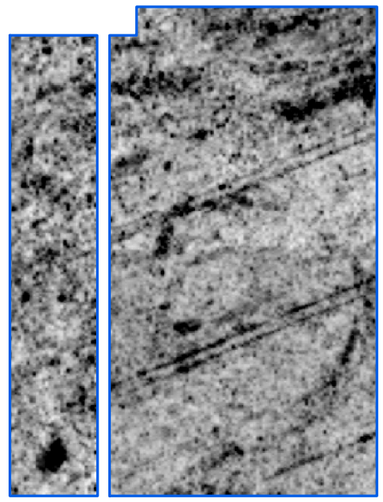
Timeslice 3: 6.79 - 10.93 ns (0.3 - 0.48 m)



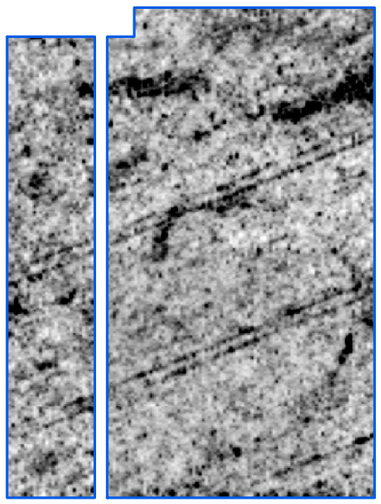
Timeslice 5: 13.59 - 17.73 ns (0.6 - 0.78 m)



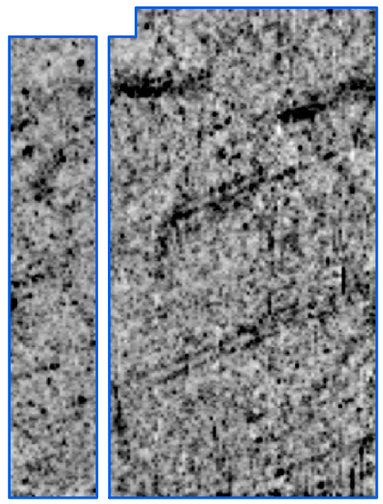
Timeslice 7: 20.38 - 24.52 ns (0.9 - 1.08 m)



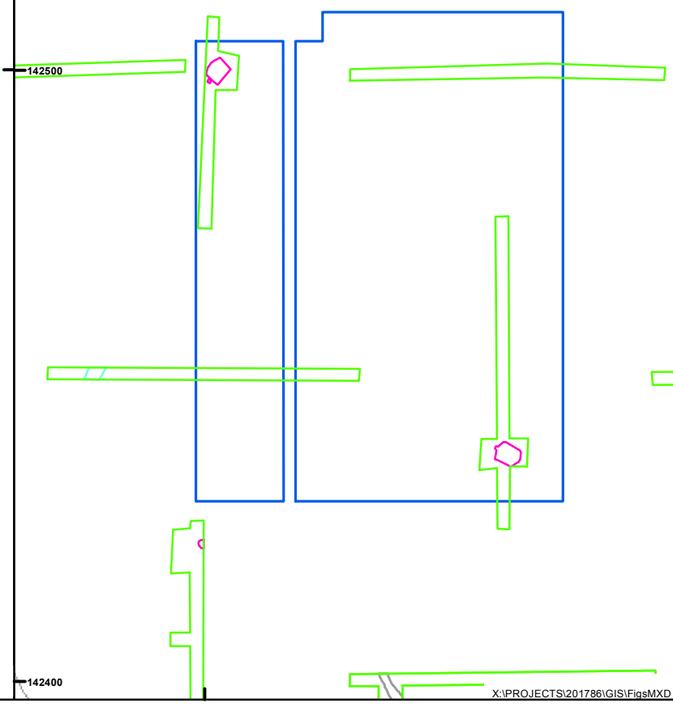
Timeslice 9: 27.18 - 31.32 ns (1.2 - 1.38 m)



Timeslice 14: 44.17 - 51.7 ns (1.94 - 2.13 m)



2003 Excavation Trenches



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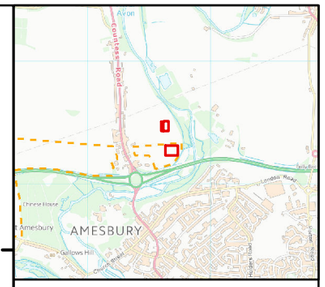

GPR survey boundary

2003 Excavation trench

2003 Excavation Saxon

2003 Excavation undated

2003 Excavation modern

High Amplitude

Low Amplitude

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GPR SURVEY COUNTESS EAST

FIGURE 4

GPR SURVEY RESULTS
NE1 Area 2

Designed	Drawn	Checked	Approved	Date
NLC	TR	??	??	18/03/2019

Internal Project No. WA Reference: 201786

Scale @ A3 1:1,000 | Zone

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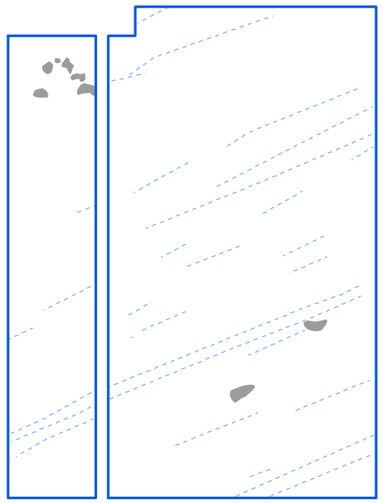
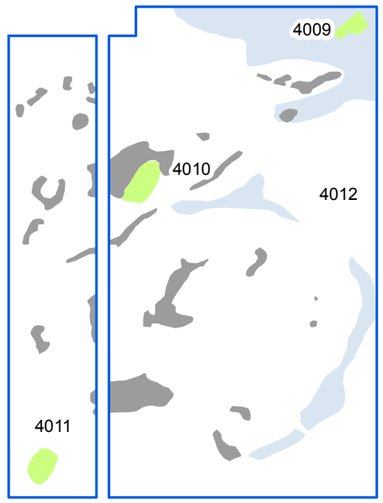
Highways England PIN | Originator | Volume | Location | Type | Role | Number | Rev

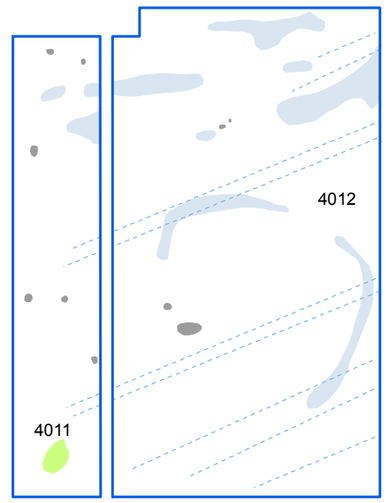
Timeslice 3: 6.79 - 10.93 ns (0.3 - 0.48 m)



Timeslice 5: 13.59 - 17.73 ns (0.6 - 0.78 m)



Timeslice 7: 20.38 - 24.52 ns (0.9 - 1.08 m)



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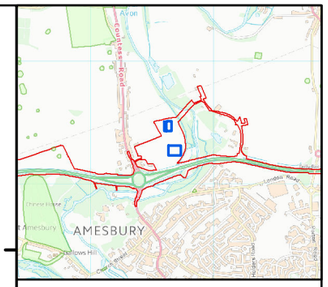
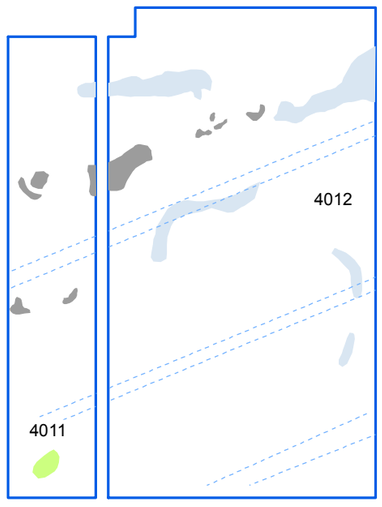
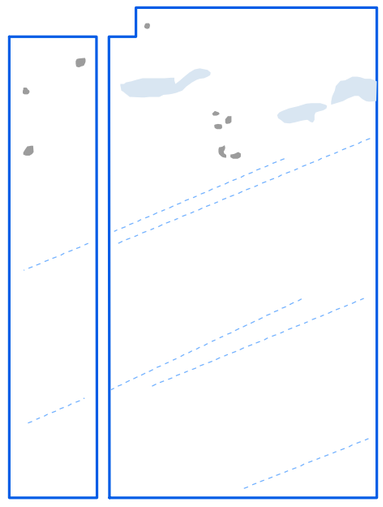


GPR survey boundary
Possible archaeology
Superficial geology
Increased response
Ploughing
Trend

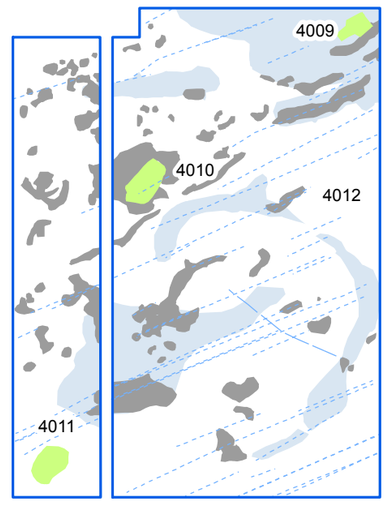
Timeslice 9: 27.18 - 31.32 ns (1.2 - 1.38 m)



Timeslice 14: 44.17 - 51.7 ns (1.94 - 2.13 m)



Combined Interpretation



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142500
415500
415600

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GPR SURVEY COUNTESS EAST

FIGURE 5

GPR SURVEY INTERPRETATION
NE1 Area 2

Designed	Drawn	Checked	Approved	Date
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Internal Project No. WA Reference: 201786

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Rev

Abbreviations List

AESR	Archaeological Evaluation Strategy Report
AmW	AECOM, Mace, WSP Joint Venture
CIfA	Chartered Institute for Archaeologists
DCO	Development Consent Order
EIA	Environmental Impact Assessment
GNSS	Global Navigation Satellite System
GPR	Ground Penetrating Radar
GPS	Global Positioning System
HIA	Heritage Impact Assessment
HMAG	Heritage Monitoring and Advisory Group
NGR	National Grid Reference
NHLE	National Heritage List for England
NMP	National Mapping Programme
nT	Nanotesla
OS	Ordnance Survey
OUV	Outstanding Universal Value
OWSI	Overarching Written Scheme of Investigation
RTK	Real-Time Kinematic
WCAS	Wiltshire County Archaeology Service
WHS	World Heritage Site

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Appendices

Appendix A GPR Survey: Equipment and Data Processing

A.1 Survey Methods and Equipment

A.1.1.1 The ground penetrating radar (GPR) data were collected using a cart-based shielded antenna with central frequencies suitable for the types of target being investigated. Lower frequency antennae can acquire data from deeper below the surface, whereas higher frequencies allow high resolution imaging of near-surface targets at the expense of deep penetration.

A.1.1.2 The depth of penetration of GPR systems is determined by the central frequency of the antenna and the relative dielectric permittivity (RDP) of the material through which the GPR signal passes. In general, soils in floodplain settings may have a wide range of RDPs, although around 8 may be considered average, resulting in a maximum depth of penetration *c.* 2.5 m with the GPR signal having a velocity of approximately 0.1 m/ns.

A.1.1.3 The GPR beam is conical in shape, however, and whilst most of the energy is concentrated in the centre of the cone, the GPR signal illuminates a horizontal footprint which becomes wider with increasing depth. At the maximum depth of the antenna, it becomes impossible to resolve any feature smaller than the horizontal footprint for the corresponding depth. The size of the footprint is dependent upon central frequency, and its size increases as the central frequency decreases.

A.1.1.4 The vertical resolution is similarly dependent upon the central frequency; for the 500 MHz antenna, features of the order of 0.05 m may be resolved vertically. Antennae with lower frequencies can therefore penetrate more deeply but are less resolute in both horizontal and vertical directions. Choice of antenna frequency is guided largely by the anticipated depth to the target and the required resolution.

A.1.1.5 GPR data for detailed surveys are collected along traverses of varying length separated by 0.5 m with cross lines collected running perpendicular to these traverses at wider separations. The data sampling resolution is governed by the data logger and a minimum separation of 0.05m between traces is collected for all surveys.

A.2 Post-Processing

A.2.1.1 The radar data collected during the survey are downloaded from the GPR system for processing and analysis using commercial software (GPR Slice). This software allows for both the data and the images to be processed to enhance the results for analysis; however, it should be noted that minimal data processing is conducted so as not to distort the anomalies.

A.2.1.2 Typical data and image processing steps may include:

- Gain – Amplifies GPR data based upon its position in the profile, which boosts the contrast between anomalies and background. A wobble correction is also applied during this step;

- Background Filter - is used to remove banding noises that are seen across the radargrams
- Bandpass – Removes GPR data lying outside a specified range, which removes high- and low-frequency noise.

A.2.1.3 Typical displays of the data used during processing and analysis:

- Timeslice – Presents the data as a series of successive plan views of the variation of reflector energy from the surface to the deepest recorded response. The variation in amplitude is represented using a grey scale with black indicating high amplitude and white indicating low amplitude responses.
- Radargram – Presents each radar profile in a vertical view with distance along the profile expressed along the x axis and depth along the y axis. The amplitude variation is expressed using a greyscale.

Appendix B Relative Velocity to depth conversion for GPR Areas

Table 1 Velocity values for all GPR Areas

Area	Velocity m/ns
NE1 Area 1	0.088
NE1 Area 2	0.088

Table 2 Relative velocity to depth conversion based on a dielectric constant of 11.62 for the 500 MHz antenna at NE1 Area 1

Time Slice	Time (ns)	Depth (m)
1	0.0 – 3.74	0 – 0.16
2	3.13 – 6.87	0.14 – 0.3
3	6.26 – 10.0	0.28 – 0.44
4	9.39 – 13.13	0.41 – 0.58
5	12.52 – 16.26	0.55 – 0.72
6	15.65 – 19.39	0.69 – 0.85
7	18.78 – 22.52	0.83 – 0.99
8	21.91 – 25.65	0.96 – 1.13
9	25.04 – 28.78	1.1 – 1.27
10	28.17 – 31.91	1.24 – 1.4
11	31.3 – 35.04	1.38 – 1.54
12	34.44 – 38.17	1.52 – 1.68
13	37.57 – 41.3	1.65 – 1.82
14	40.7 – 44.43	1.79 – 1.96
15	43.83 – 47.56	1.93 – 2.09
16	46.96 – 50.7	2.07 – 2.23
17	50.09 – 53.83	2.2 – 2.37
18	53.22 – 56.96	2.48 – 2.51
19	56.35 – 60.09	2.48 – 2.64
20	59.48 – 62.61	2.62 – 2.75

Table 3 Relative velocity to depth conversion based on a dielectric constant of 11.62 for the 500 MHz antenna at NE1 Area 2

Time Slice	Time (ns)	Depth (m)
1	0 – 4.14	0 – 0.18
2	3.4 – 7.54	0.15 – 0.33
3	6.79 – 10.93	0.3 – 0.48
4	10.19 – 14.33	0.45 – 0.63
5	13.59 – 17.73	0.6 – 0.78
6	16.99 – 21.13	0.75 – 0.93
7	20.38 – 24.52	0.9 – 1.08
8	23.78 – 27.92	1.05 – 1.23
9	27.18 – 31.32	1.2 – 1.38
10	30.58 – 34.72	1.35 – 1.53
11	33.97 – 38.11	1.49 – 1.68
12	37.37 – 41.51	1.64 – 1.83
13	40.77 – 44.91	1.79 – 1.98
14	44.17 – 48.31	1.94 – 2.13
15	47.56 – 51.7	2.09 – 2.27
16	50.96 – 55.1	2.24 – 2.42
17	54.36 – 58.5	2.39 – 2.57
18	57.76 – 61.9	2.54 -2.72
19	61.15 – 65.29	2.69 – 2.87
20	64.55 – 67.95	2.84 – 2.99

Appendix C Geophysical interpretation

C.1.1.1 The interpretation methodology used by Wessex Archaeology separates the anomalies into four main categories: archaeological, modern, agricultural and uncertain origin/geological.

C.1.1.2 The archaeological category is used for features when the form, nature and pattern of the anomaly are indicative of archaeological material. Further sources of information such as aerial photographs may also have been incorporated in providing the final interpretation. This category is further sub-divided into three groups, implying a decreasing level of confidence:

- Archaeology – used when there is a clear geophysical response and anthropogenic pattern.
- Possible archaeology – used for features which give a response but which form no discernible pattern or trend.

C.1.1.3 The modern category is used for anomalies that are presumed to be relatively modern in date:

- Modern service – used for responses considered relating to cables and pipes. GPR is known to be very effective at locating buried utilities and they are often identifiable within the radargrams as strong hyperbolic reflectors.

C.1.1.4 The agricultural category is used for the following:

- Former field boundaries – used for ditch sections that correspond to the position of boundaries marked on earlier mapping.
- Ridge and furrow – used for broad and diffuse linear anomalies that are considered to indicate areas of former ridge and furrow.
- Ploughing – used for well-defined narrow linear responses, usually aligned parallel to existing field boundaries. These can sometimes repeat or 'ring' through GPR datasets, particularly if there are ploughing furrows on the surface.

C.1.1.5 The uncertain origin/geological category is used for features when the form, nature and pattern of the anomaly are not sufficient to warrant a classification as an archaeological feature. This category is further sub-divided into:

- Trend – used for low amplitude or indistinct linear anomalies.
- Superficial geology – used for diffuse edged spreads considered to relate to shallow geological deposits. They can be distinguished as areas of high and/or low amplitude response, but are commonly amorphous in form.

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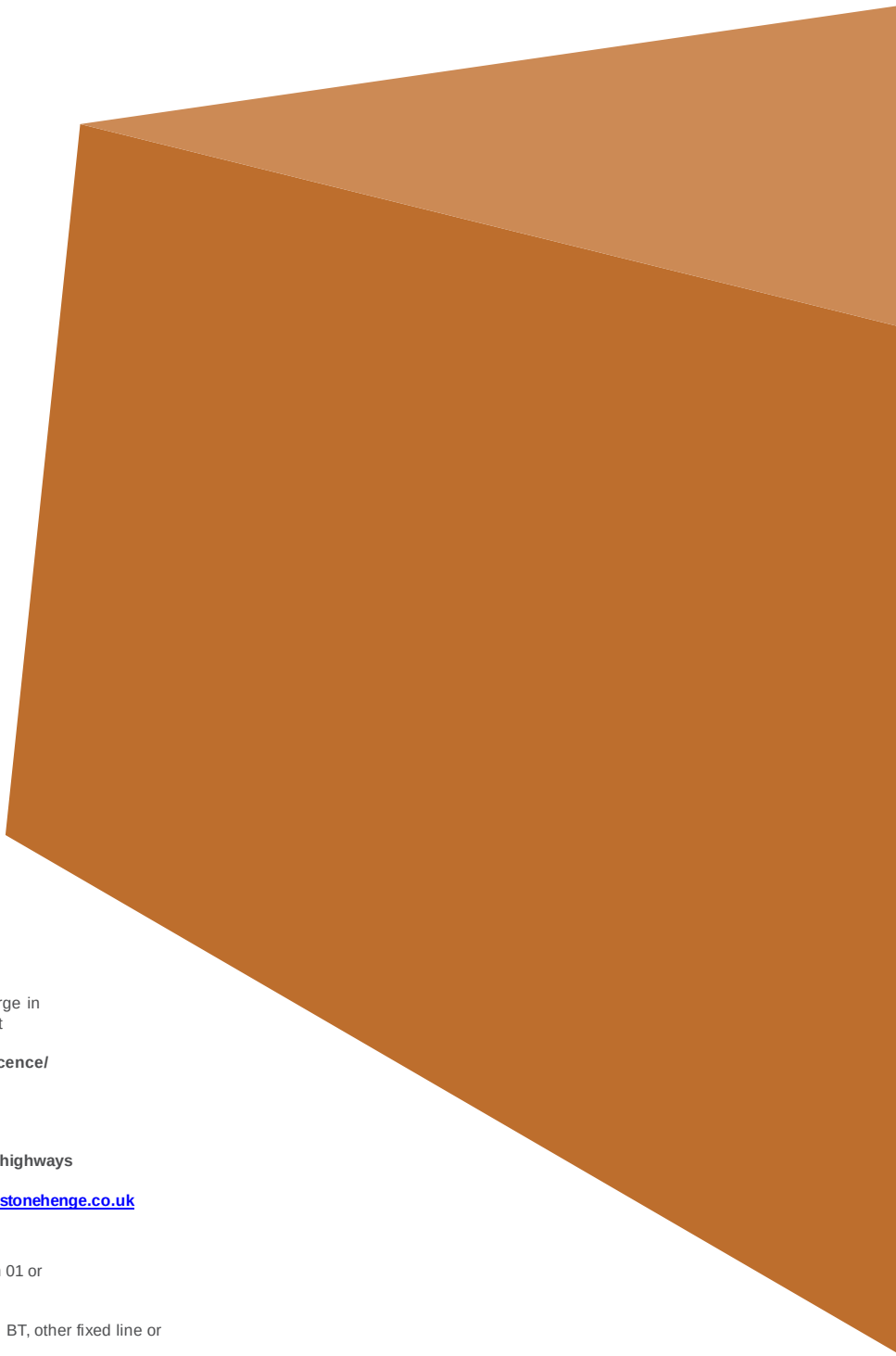

This document is also available on our website at **www.gov.uk/highways**

If you have any enquiries about this document email **info@a303stonehenge.co.uk** or call **0300 123 5000***.

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