BUCKLAND RINGS

ARCHAEOLOGICAL GPR SURVEY REPORT

On Behalf of New Forest National Park Authority

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AUTHOR: BRETT HOWARD BA (HONS) PCIFA

Unit 3, Waterloo Industrial Estate, Hedge End, Southampton, SO30 2QT +44 020 3931 5759 | info@kbgprsurveys.co.uk

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1. Summary of Results

1.1.1. This survey was carried out on behalf of the New Forest National Park Authority on the 3rd and 4th of September 2018.

1.1.2. The objective was to perform a non-intrusive geophysical survey (in this case GPR) to determine if archaeological features could be detected, positioned and recorded for future research and a better understanding of this site and other similar sites.

1.1.3. The results from the processed Ground Penetrating Radar data have been potentially very positive in revealing archaeological features within the interior of the defensive ramparts at Buckland Rings.

1.1.4. The data provides evidence for the existence and positioning of many different features. Judging by their positions, these features present the potential for different chronological phases on this site. Such features include linear anomalies, circular anomalies – possibly roundhouses and enclosed areas – as well as pits, evidence for the in-turned entrance way with possible post holes and the site of a previous trench excavated by Christopher Hawkes in the 1930's.

2. Introduction

2.1. Survey Purpose

2.1.1. This survey, and its results, are to aid in the greater understanding of this monument and its uses in the context of the wider Iron Age landscape. This survey will compliment other geophysical surveys performed on this site and it is hoped that through the specific expertise of KB GPR Surveys Ltd, more detail revealed through the radar data will allow future research to be better equipped in the interpretation and/or excavation of this site.

2.2. Site Location

2.2.1. The survey area is located to the West of Southampton Road, NNW of Lymington SO41 8NA (NGR: SZ 31487 96850) on grassland and within tree cover. The grassland was used for meadow during the time of survey but did not require being cut back. Where there were trees, the GPR was not able to collect data due to obstruction the trees caused.

2.3. Site Description

2.3.1. The site bedrock geology is of Becton Sand Formations and Chama Sand Formations (British Geological Survey, 2018).

2.3.2. The site is situated on top of a natural hill formation with the banks following the natural topography. The southern banks of the monument have been ploughed flat and lie in a field of meadow grass. Much of the outer circuit of the area is enclosed and covered by trees.

2.3.3. Buckland Rings (Monument Ref. No.: 1008706) is designated as a 'small Multivallate hillfort' of Iron Age construction; internal enclosure measures 3ha and has a maximum width of 225m (Historic England, 2018). Outer banks and ditch survive in most areas except the southern banks which have been mostly destroyed through ploughing.

2.3.4. The site was originally scheduled on 09-10-1981 and the most recent revision was on 16-11-1994 (Historic England, 2018). Reason for scheduling is as follows: '*The small multivallate hillfort at Buckland Rings displays excellent preservation of the defences. Small-scale excavation has indicated that, despite some plough damage, the site contains archaeological and environmental information relating to the construction, use and abandonment of the monument and to human activity pre-dating its construction.'* (Historic England, 2018).

2.3.5. Excavations in some areas of the site have been previously carried out by C. F. C. Hawkes, in partnership with the Hampshire Field Club and Archaeological Society in 1935 which produced an interesting interpretation of the site and helped to solidify its importance within the historical record, specifically as an Iron Age Multivallate Hillfort. The excavation provided detail for the construction and layout of the defences with particular focus on the entrance which Hawkes categorised as "Inturned ramparts and entrance way" (Hawkes, 1936).

2.3.6. Previous Geophysical surveys have produced a mixed group of results. The previous results show some detail but, due to the geology of the area, were very limited in what they could produce with regards to direct archaeological features (Payne, 1993) (Hagan, et al., 2017).

2.3. Survey Objectives

2.3.7. 2.3.1. The objective of this survey was to use non-intrusive geophysical methods, specifically GPR, to establish the presence/position of any features which may be deemed archaeological in nature.

3. Methods

3.1. Survey Techniques Used

3.1.1. The survey technique used was an UTSI Electronics Dual Frequency Antenna (400MHz and 1GHz) Ground Penetrating Radar (GPR) array, composed of 3 antennas.

3.2. Reasons for Survey Technique Choice

3.2.1. This survey technique was used due to the expertise and specialist nature of KB GPR Surveys Ltd in the utilisation of GPR.

3.3. Date(s) of fieldwork

3.3.1. Due to the Scheduled Monument status of Buckland Rings (SMN: 1008706), special permission had to be granted by Historic England in the Form of a Section 42 Licence to gain access to the site.

3.3.2. The licence application was requested on 31 July 2018.

3.3.3. The Section 42 licence was approved for access to be granted between 14 August 2018 to 14 September 2018.

3.3.4. Section 42 Licence Case Number: SL00194621.

3.3.5. The date(s) of fieldwork were the 3rd and 4th of September 2018.

3.4. Grid Location

3.4.1. NGR: SZ 31487 96850

3.5. Geophysical Instruments Used

3.5.1. UTSI GroundVue Multichannel Antenna Array 1GHz and 400MHz.

3.5.2. GNSS Carlson BRx6 GPS

3.6. Sampling Intervals

3.6.1. 0.025m

3.7. Equipment Configuration

3.7.1. UTSI GroundVue Multichannel Array was used in conjunction with a GNSS Carlson BRx6 GPS for highly accurate positioning of data.

3.7.2. The Array was towed by a Polaris Ranger 400 H.O. to perform a more time-efficient survey of the extensive area.

3.8. Method of Data Capture

3.8.1. Raw data was captured through GroundVue software for later post-site processing.

3.8.2. The construction of the GPR array allows for close capture data sets with an antenna spacing of 0.3m between 3 antennas. This creates a situation where the antenna is able to more effectively detect objects in both axis whilst travelling in only one.

3.8.3. The physical method of data collection was to be in an orthogonal grid but due to the construction of the GPR and professional experience of KB GPR Surveys, together with time restraints imposed by other ongoing jobs, it was decided to collect the data in parallel circuits of the area. Moving from nearest the tree line inward toward the centre of the monument, the parallel circuits closely mirrored the shape of the interior space. This maximised time efficiency and still collected data in a logical fashion for highly accurate results.

3.8.4. Raw data was processed using GPR-Slice software V7.0.

3.9. Variables used for Data Processing

3.9.1. A multitude of filters were used in the development of the final data set. These included:

- Regain
- Background Removal
    - Migration
    - Bandpass
    - Hilbert
    - Gap Interpolation
    - Smooth
    - Topographic GPS Extraction
    - Tilt and Topo correct

3.9.2. The data provides an overall depth penetration of 2.8m.

3.9.3. The majority of archaeological features were present between 0.3m and 1m depth (4.1-16.9ns) in the standard tomographic view before topography was applied using GPS data.

3.9.4. The depths, and features therein, were determined using a hyperbolic speed calibration of 0.123m/ns. This was done by measuring the shape and angle of the hyperbola in the radargram data. The hyperbolic speed calibration seemed appropriate and accurate due to the dry climatic conditions experienced for some time before the survey was undertaken.

3.10. Method of Data Presentation

3.10.1. The original plan for this survey was to carry out standard orthogonal grids. Due to time restraints this was not deemed suitable for the size of the area.

3.10.2. The data was collected in decreasing parallel circuits of the area with a spacing of 0.3m between Antennas. This was the most time-efficient method for data capture to present an overview of archaeological features which may merit a later return for a more standard approach.

3.10.3. As previously mentioned, the size of the site was relatively large and to cover it in the time available the methodology was adjusted. The size also meant that reproducing scale B-Scan imagery of the radargrams proved pointless as the area was so large any detail is lost in scaling issues. It was decided that using the tomographic view in GPR-Slice provided a better representation of the features of interest. This view was improved by using the 'overlay' function which merges the amplitude responses between depths to accentuate appropriate features.

3.10.4. The data has been represented as a plan view image which has been annotated to better focus attention to specific features.

4. Results

4.1. Description

4.1.1. The results provide an overall depth penetration of 2.8m, with the majority of archaeological features being present between 0.3m and 1m depth (4.1-16.9ns) at a hyperbolic speed calibration of 0.123m/ns.

4.1.2. The presence of archaeological features has been represented through an accumulated data overlay in the tomographic view of GPR-Slice. This method allows for the accumulated responses between depth slices to amalgamate the features through depth into one plan view. The advantage of this approach is that it better displays relationships between shallow and deeper features, such as circular or linear features which may not be apparent at a single depth. It also serves to collect all depth responses of single features to make them more prominent in the data.

4.1.3. Some GPR responses were geological phenomena or modern pathways through the site. Attempts have been made to minimise the impact of these features in the results which focus on potential archaeological layers.

4.1.4. It is clear the results provide evidence of domestic occupation at Buckland Rings, through the presence of circular/rectilinear features, possible pits and the excavation trench of C.F.C. Hawkes in 1935. Areas where there is a lack of GPR responses hints at the possibility of thoroughfares through the occupation or further internal segregation of internal space during Iron Age occupation.

4.2. Interpretation

4.2.1. The overall chronology of this site has been ascribed to multiple phases within the Iron Age (Historic England, 2018). The GPR results tend to support this, due to the presence of Iron Age style features on site.

4.2.2. It was decided that the major features evident in the tomographic view should be highlighted and the lesser features left for future interpretation following any archaeological work which may or may not occur. The tomographic view which displayed the most relevant data was the amalgamation of the major archaeological stratigraphic depth layers in the data; the layers amalgamated ranged from 0.3m to 1m depth from surface (Figure 2). This suggests an archaeological horizon of activity, with less activity present below that, other than geological and potential post/pit holes.

4.2.3. The evidence for tracks through the Iron Age occupation suggests a layout can begin to be formed. There is a marked increase of activity in some areas of the site with these clear trackways running past (Figure 2). This evidence may help researchers to further interpret this site and its uses, but also other examples of Hillfort sites may be cross examined and further understood.

4.2.4. Features highlighted in pink have been interpreted as smaller circular features, in this context smaller is equated with possible roundhouse structures (Figure 5). Some of these can be seen quite clearly in the data and range in size. These have been separated from the larger circular features which have been interpreted as possible enclosures.

4.2.5. Features highlighted in darker blue have been classified in this report as larger circular features. These features could represent enclosures within the hillfort. Some of these enclosures suggest an associated smaller circular structure within them. This could be interpreted as the house within the enclosure, possibly tending to livestock or other activity. Whatever the separation, these could well demarcate individual and specific plots for different people. Further to that, there is one enclosure in particular which is interesting. This circular feature, marked as LC1 (Figure 4) is positioned directly in front of the entrance to the hillfort and could act as either a further level of defence, a method of controlling movement of people/livestock or is just a carefully positioned enclosure taking advantage of the immediate entrance/exit to the site.

4.2.6. Green features highlighted in the data provide evidence for linear structures running through the site. These linear features could be categorised as further enclosures. However, the interesting thing to note is that some are rectilinear, and others are circular. This could be evidence for different enclosure phases on the site. In several areas the two different features cut across one another, for example LC5 and LC6 have overlapping features which is unlikely to have occurred in a single chronological phase (Figure 5). This different chronology could also help date the site when comparing to other, already excavated, examples on other pre/post Iron Age sites.

4.2.7. The red area on the interpreted data is presumed to be part of the excavation carried out by C.F.C Hawkes in 1935 (Hawkes, 1936). It is presumed because there is no direct positioning evidence for his trenches, but as it is positioned on/adjacent to the entrance to Buckland, it is safe to assume this is the excavation.

4.2.8. There is an area on the entrance way (highlighted in light green) (Figure 6) which provides evidence for whatever structure may have stood there when the hillfort was in use. Some of the evidence is post holes which were remarked upon by Hawkes in his excavations (Hawkes, 1936). Linear features run along the trackway entering the site. These could have been fences, palisades or walls of a structure such as a gate house of some description but from the GPR data alone it is just interpretation. Hawkes mentions rampart structures turning inward at the entrance with a hollow entrance way running up into the site (Hawkes, 1936). Previous surveys onsite have revealed evidence for an in-turned entrance way (Hagan, et al., 2017). This in-turned feature is evident at the entrance way in the GPR data and connects with the other trackway features. However, what is clear is that there was a means of funnelling movement in a specific direction past the defences and into the site. This could have been defensive or for farming purposes to herd livestock more effectively.

4.2.9. Previous surveys carried out on site include the magnetometry survey conducted by Bournemouth University and New Forest National Park Authority. This survey presented the possibility of roundhouses and other features in the data. Specifically, A2 and A5 (Hagan, et al., 2017) (See Figure 7 and 8) could tally up with some of the responses in the GPR data but not exactly. The magnetometry could represent the position of roundhouse features which the GPR is unable to detect. The mutual use of the GPR and Magnetometry as cooperative methods in feature detection on this site could provide the most comprehensive set of results.

5. Conclusions

5.1. Assessment of Achievement of Survey Objectives

5.1.1. The survey's objective was to perform a non-intrusive GPR survey to determine the presence/position of features deemed archaeological in nature.

5.1.2. The survey has met all aspects of this objective and has provided evidence for occupation of this site in the data.

5.1.3. It may be prudent to use these results and perform another, more intensive GPR survey of specific areas of this site to attempt to glean some more information without the use of excavation.

5.2. Results Summarised

5.2.1. Overall interpretation of the data provides evidence of a community/communities living on this site. These people constructed circular and rectilinear features which could be interpreted as structures designed to provide the necessary infrastructure for controlling the movement of people and animals. It suggests that there were specific purposes to these areas and that they evolved over time. There are clear routes through the site, suggested by the lack of activity in them and increased activity out of them. The defences were a clear statement of some description and it is evident that much effort was taken to create an entrance which controlled the physical movement of individuals but also could have served as an additional psychological factor in the overall impact of the site.

5.3. Implications

5.3.1. This survey has revealed data which may prove invaluable to future research and interpretation of this site and others like it. The GPR has created a window into some of the potential features existing on this site without the need for intrusive excavation. The features represented in the data have helped to augment the previous surveys with other geophysical techniques to create a fuller picture of what activities may have occurred on this site.

5.4. Geophysical Research Value

5.4.1. The value of this survey is highly significant. To the author's knowledge, no other survey has so far produced results as clear as these and as such should help future research into this site greatly. Through these results, an understanding of some of the occupational processes can be added to the plethora of other studies to create a more solid foundation of knowledge.

5.5. Recommendations

5.5.1. It is recommended that a return to site for a more intensive survey with the GPR set up for increased data acquisition should occur. This is due to the time constraints of this survey and the potential it has produced regardless. A more intensive non-intrusive GPR survey may produce an even better set of results and that can only ever have a positive impact on the context and understanding of this site in general.

6. Acknowledgements

6.1.1. I would very much like to thank the New Forest Park Authority, in particular Lawrence Shaw, for the support throughout this project. I would also like to thank Historic England for their prompt responses and granting access for this survey to occur.

7. Statement of Indemnity

7.1.1. This report is for information purposes only. The information in this document was produced from using non-intrusive geophysical survey methods and has not been physically verified. Data quality of geophysical surveys is subject to variations in local ground conditions and cannot be guaranteed. *ALWAYS EXERCISE CAUTION WHEN BREAKING GROUND*

7.1.2. All surveys are subject to our disclaimer, for the full text please see: www.kbgprsurveys.co.uk.

7.1.3. KB GPR Surveys Ltd holds an OFCOM licence to operate the GPR.

7.1.4. Through consultation with Historic England, a Section 42 Licence was obtained before any work commenced. Section 42 licences are required in conjunction with the Ancient Monuments and Archaeological Areas Act 1979 for geophysical practices including GPR.

7.1.5. KB GPR Surveys Ltd holds CHAS Accreditation (Contractors Health and Safety Scheme) as well as having a company health & safety policy. All our health & safety processes are subject to the approval of our accredited external health & safety consultant.

7.1.6. KB GPR Surveys Ltd carry out a Risk Assessment as standard. Within this, site access, ground conditions, potential dangers of using equipment/ATV and dangers therein to members of the public is included.

7.1.7. Survey work was carried out to the satisfaction and standards of the Forestry Commission, NFNPA and Historic England. KB GPR Surveys Ltd adheres to high standards of professional conduct at all times and ensure all licences and permissions are in place before beginning any survey work.

7.1.8. All personnel are fully trained in the use of the GPR equipment. Brett Howard is also a Practitioner for the Chartered Institute for Archaeologists (Membership Number 9766) so all/any archaeological material observed is treated with the highest professional standards.

7.1.9. Standards and Codes of Conduct of the Chartered Institute for Archaeologists are adhered to.

7.1.10. KB GPR Surveys Ltd holds professional indemnity insurance of £2000000; public liability insurance of £5000000 and employer's liability insurance of £10000000.

8. References

Hagan, J., Shaw, L. & Brown, J., 2017. *Report of Results from Geophysical Survey at Buckland Rings,* Lymington, Hampshire: New Forest National Park Authority.

Hawkes, C. F. C., 1936. The Excavations at Buckland Rings, Lymington, 1935. *Papers and Proceedings of the Hampshire Field Club and Archaeological Society*, pp. 124-164.

Historic England, 2018. *Hillfort at Buckland Rings.* [Online]
Available at: https://historicengland.org.uk/listing/the-list/list-entry/1008706

Payne, A., 1993. *Buckland Rings, Lymington, Hampshire, Report on Geophysical Survey,* London: Ancient Monuments Laboratory.

ProMap, 2018. *OS 1:25k Raster Map (OS Licence Number: 100022432),* Reading: Landmark Information Group Ltd.

UTSI Electronics, 2018. *GroundVue 3 - Multi Channel.* [Online]
Available at: http://www.utsielectronics.co.uk/groundvue-3-multi-channel
[Accessed 04 10 2018].

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10. Appendices

10.1. Technical details of GPR System (UTSI Electronics, 2018)

Groundvue 3 - Multi Channel

Like all Groundvue Ground Probing Radars, Groundvue 3 is user friendly and uses easy to operate dedicated software. Operating depth (measured in travel time) and the distance between samples must be defined accurately. All other parameters can be reset after survey. This is the original 4 channel multi-channel version of Groundvue 3. It can be used as a single channel or with any number of antennas up to the system maximum of 4 transmitters and 4 receivers.

Frequencies can be used in any combination. Because the antennas are simultaneously triggered (without cross channel interference), one transmitter can be used with up to 3 receivers. This is very useful for automatic velocity calibration. See Unique GPR Tools.

Frequency Ranges

4GHz (using Groundvue 5 as 1 channel), 1.5GHz, 1GHz, 400MHz, 250MHz

Depth Range

Dependent on Frequencies used –

- 4GHz: up to 0.5m in dry conditions
- 1.5GHz: up to 2m in dry conditions
- 1GHz: up to 2m in dry conditons
- 400MHz: up to 5m in dry conditions or up to 3m in wet conditions
- 250MHz: up to 10m in dry conditions or up to 5m in wet conditions.

Special Features

- Simultaneous multi-channel
- High Speed Operation (4 channel equivalent of 1000 scans/second)
- Arrayed Antennas
- Fully Screened
- Suitable for towing behind or attachment to a survey vehicle
- Simultaneous recording of GPS/Total Station data
- Versatility – the same system can be used in different combinations for a range of tasks (multi channel multi frequency/multi channel same frequency)

Data Storage

Direct to solid disk

Resolution

High to very high (80mm @ 250MHz;
40mm @ 400MHz; 20mm @ 1GHz;
15mm @ 1.5GHz; 1mm @ 4GHz)

Ancillaries

- Data Logger required for operation and initial data storage
- A long term data storage system is essential
- A basic 12V battery charger is needed to charge the radar batteries

Optional

- Cable connector with vehicle cigarette lighter connection for saving datalogger batteries (not essential)
- Analytical software – the ReflexW package – is also available. Details on request.
- Groundvue 3 is also available as a single channel system with the same range of frequencies

FIGURE 1 LOCATION MAP OF BUCKLAND RINGS 1:25000 SCALE (PROMAP, 2018)

FIGURE 2 OVERLAY VIEW HIGHLIGHTING ARCHAEOLOGICAL GPR RESPONSES

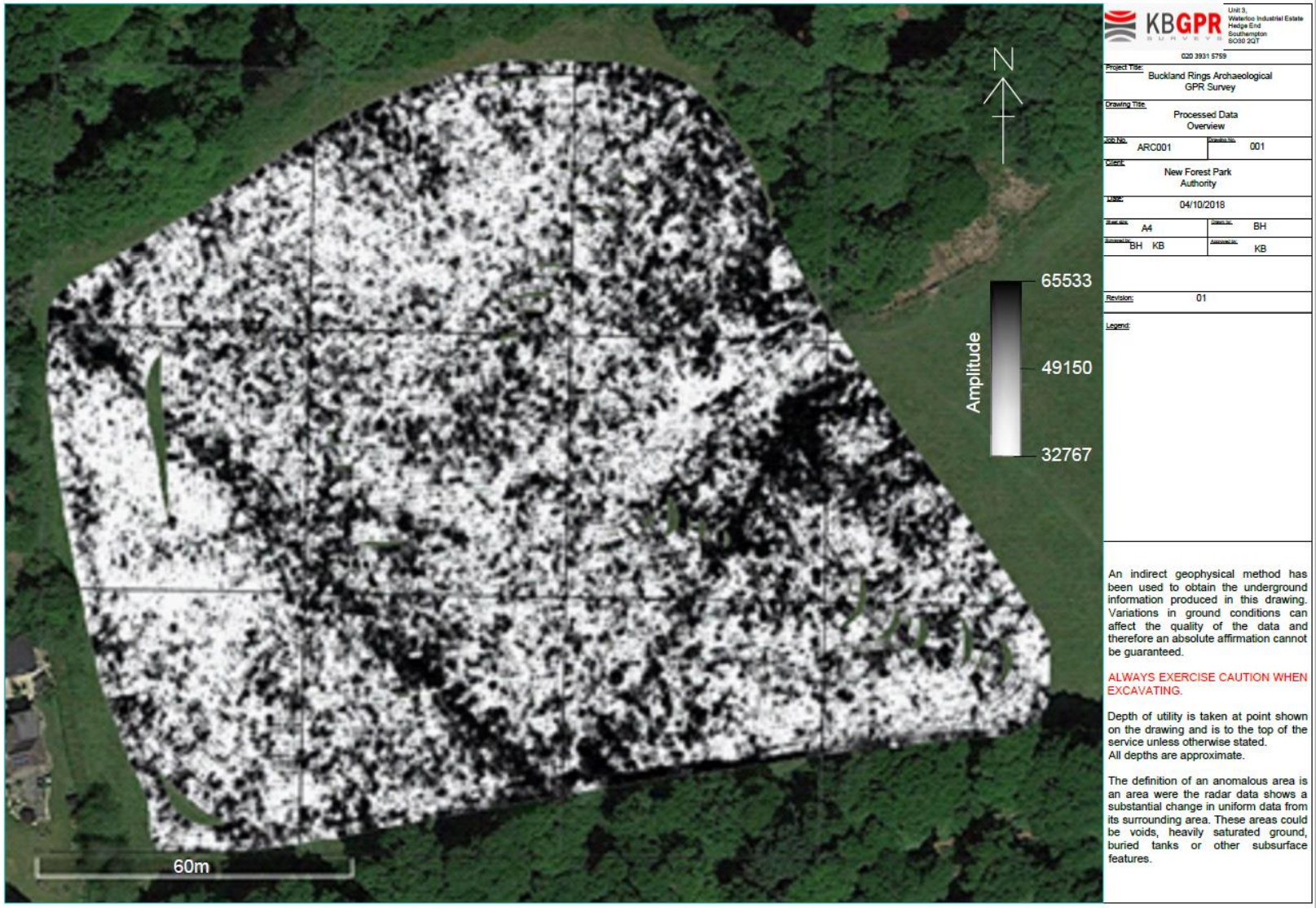

FIGURE 3 OVERVIEW OF ARCHAEOLOGICAL FEATURES

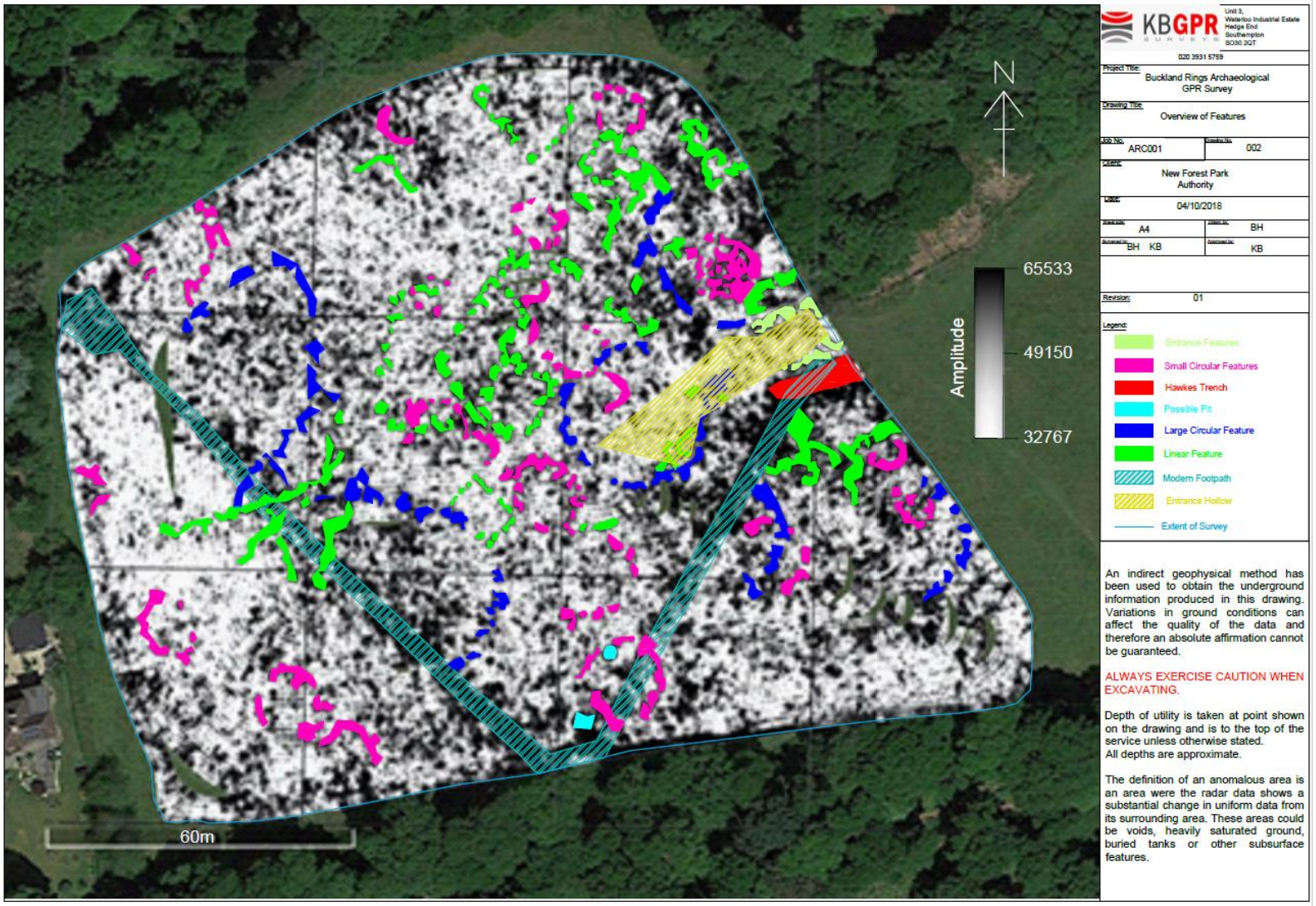

FIGURE 4 LARGE CIRCULAR FEATURES

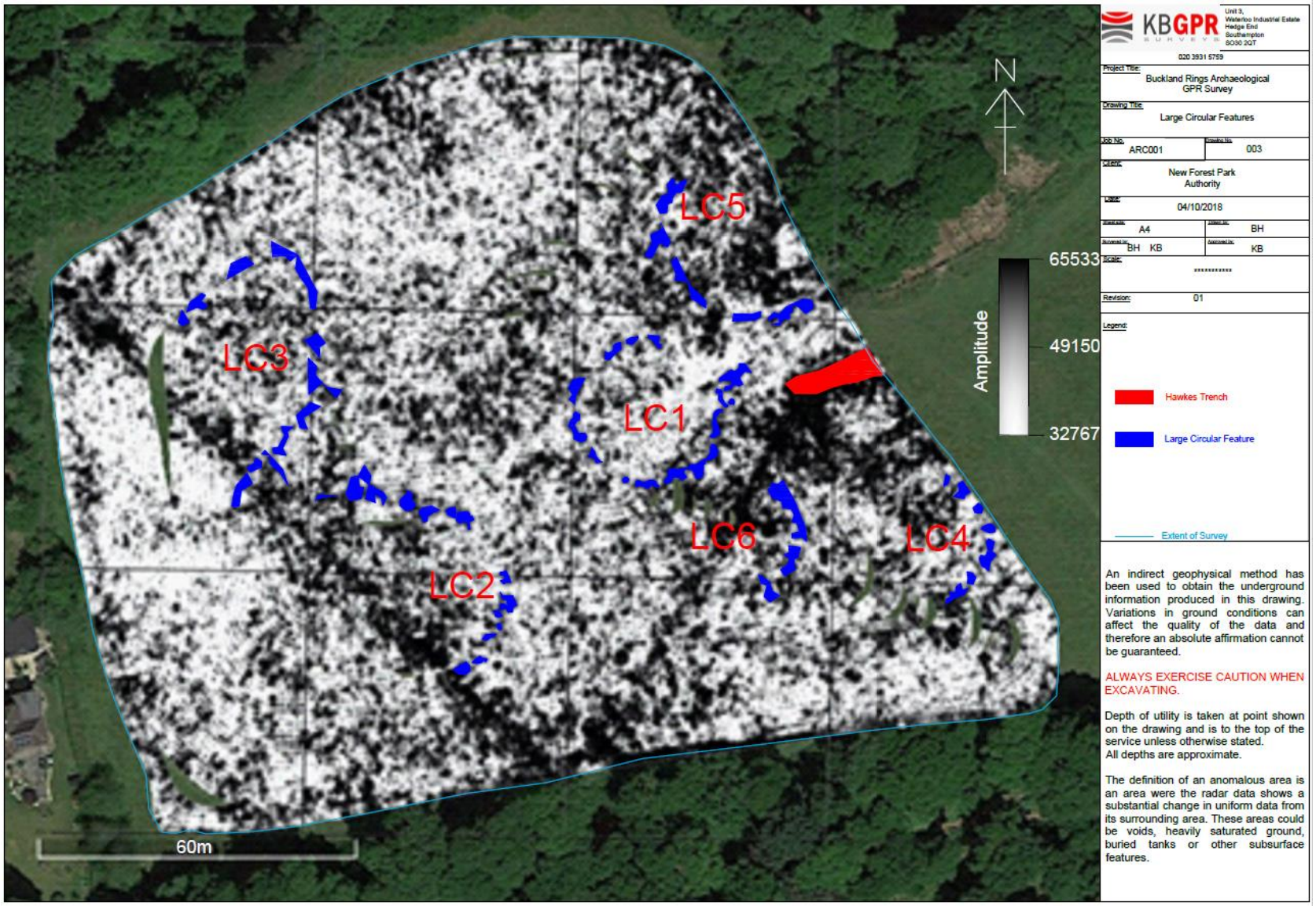

FIGURE 5 CIRCULAR AND RECTILINEAR FEATURE INTERACTION

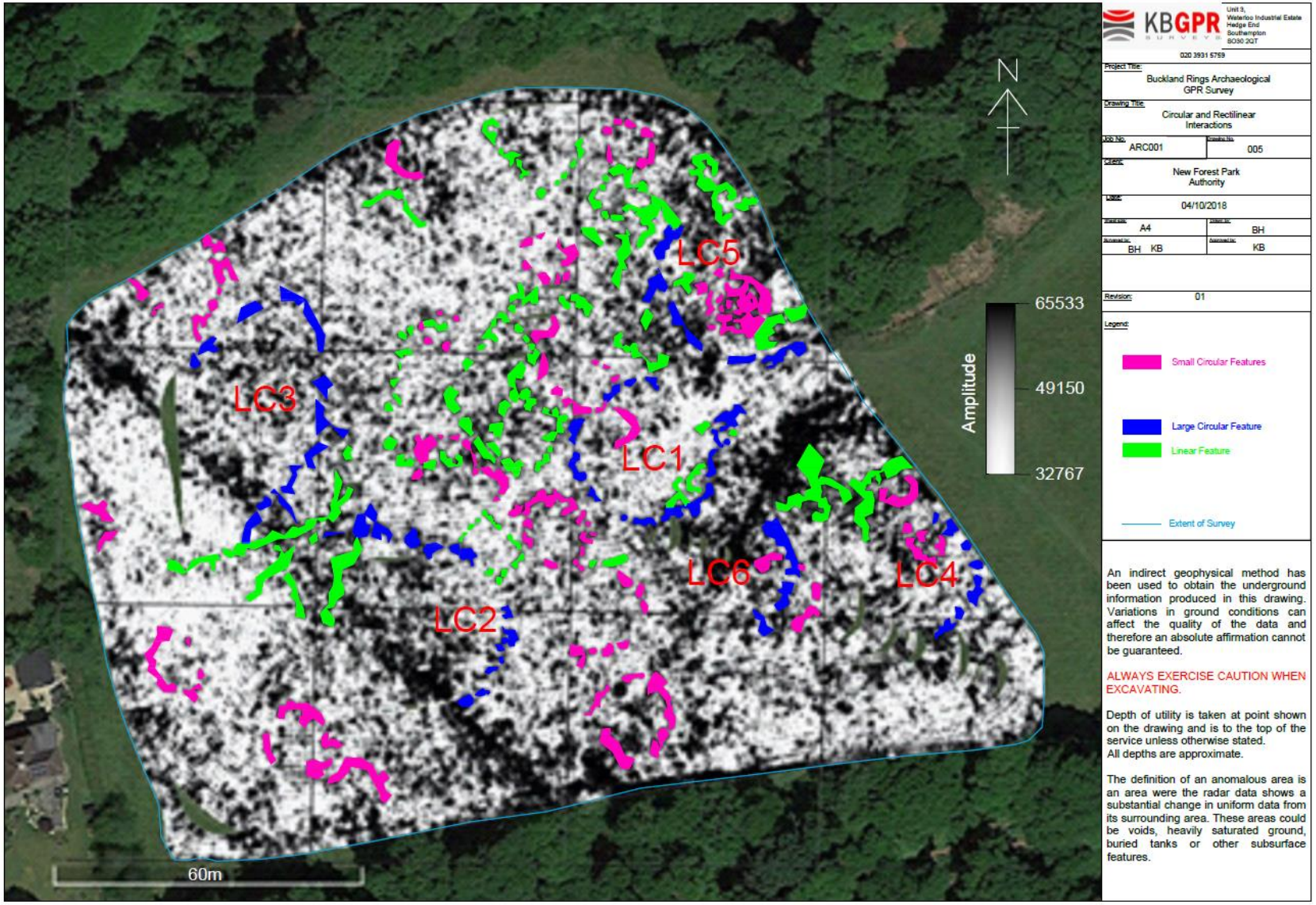

FIGURE 6 ENTRANCE WAY AND HOLLOW WITH HAWKES' TRENCH

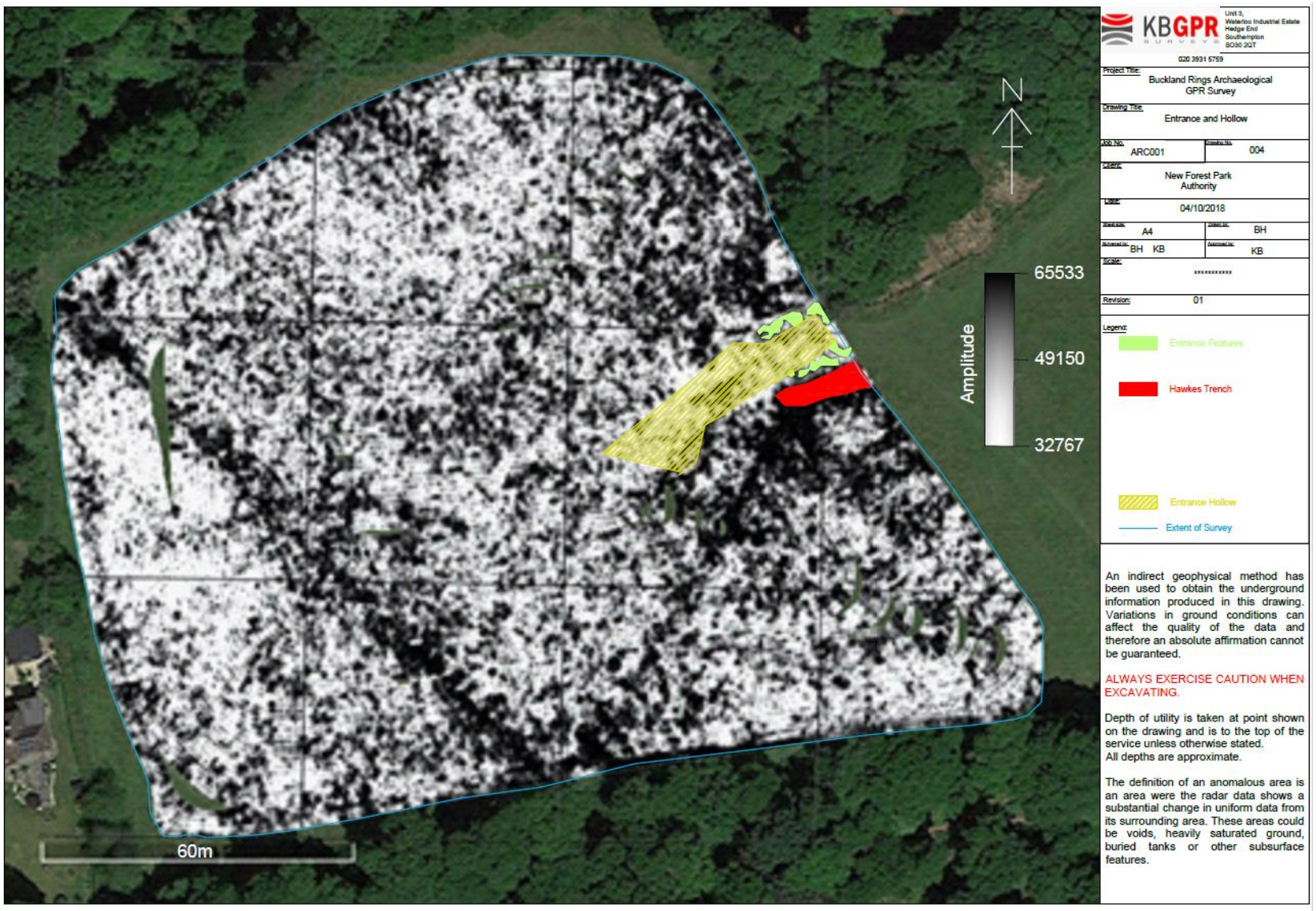

FIGURE 7 POSITIONS OF PROPOSED ROUNDHOUSE FEATURES IN MAGNETOMETRY RESULTS (HAGAN, ET AL., 2017)

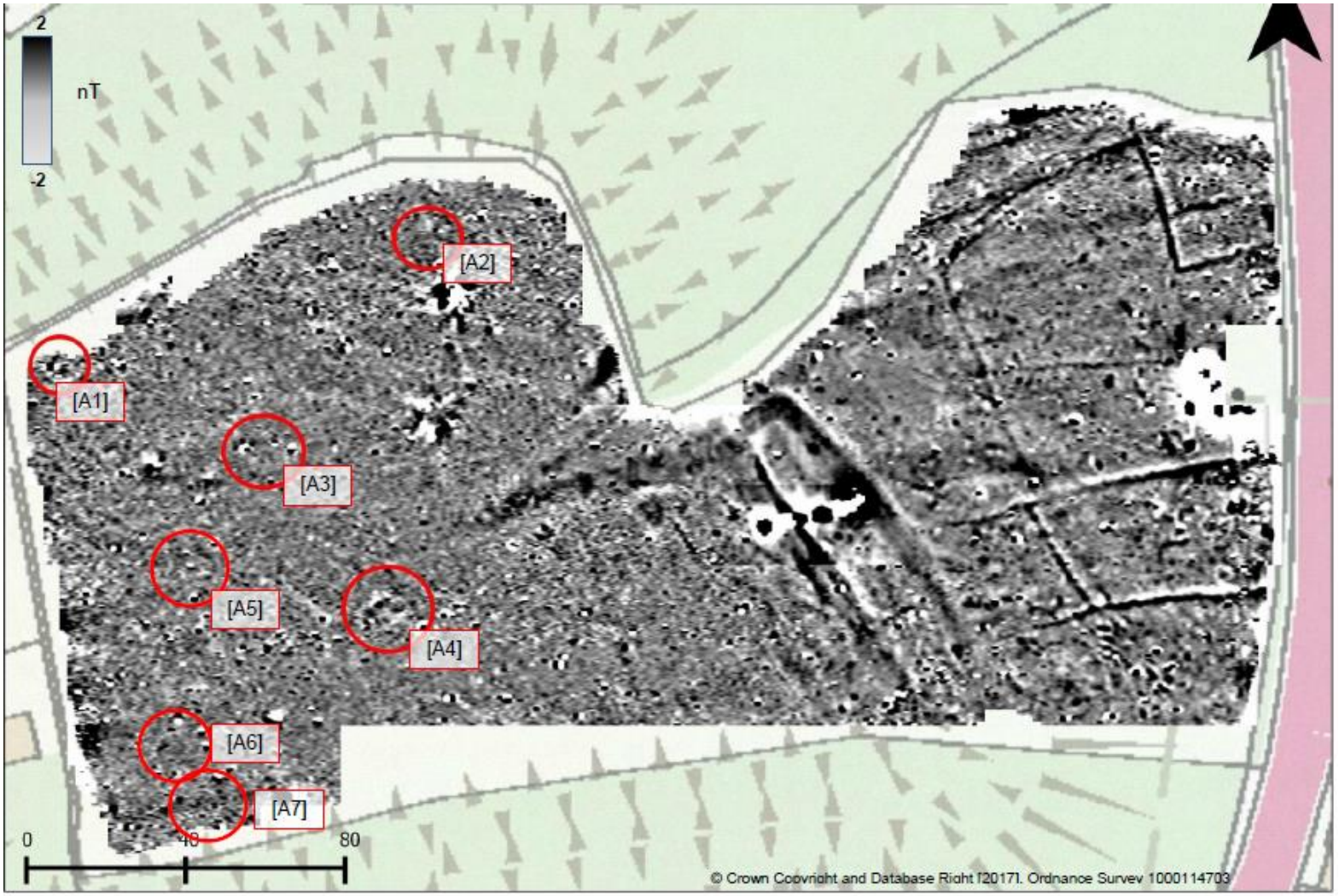

FIGURE 8 OVERLAY OF GPR FEATURE DRAWING ON MAGNETOMETRY RESULTS