Heatherside Junior School
Fleet, Hampshire

Ground Penetrating Radar Survey Report

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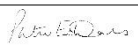
1	13/01/2023	BH	PE 

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Summary

A Ground Penetrating Radar (GPR) survey was conducted over land at Heatherside Junior School, Fleet, Hampshire (centred on NGR 481097 153477). The project was commissioned by Hampshire County Council with the aim of establishing the presence, or otherwise, and nature of detectable archaeological features prior to borehole drilling.

The site comprises a grass school playing field, within the town of Fleet, 6 km west of the town of Farnborough, Hampshire, covering an area of 670 sq. m. The ground penetrating radar survey identified anomalies of archaeological origin, and those associated with modern activity and vegetation.

A rectilinear arrangement of high amplitude anomalies was identified on site. These correspond to the position of a former building, identified on the OS 1:25 000 map from 1937 to 1961. The GPR responses infer foundations, however they do not appear to have substantial depth which suggests it may be a shallow platform or has been largely removed.

Further to the foundations, a series of high amplitude linear responses were apparent within the footprint of the former building. These likely correspond to services, or internal structures, associated with the former building.

An amorphous high amplitude anomaly was identified at the eastern edge of the site. Although there is no clear origin, the anomaly is present in the first two timeslices, suggesting that it is associated with near-surface disturbance. This may be due to ground works or vegetation activity.

Additionally, multiple high and low amplitude anomalies were present in the eastern portion of the site. These likely correspond with tree roots. The high amplitude caused by increased water content in the roots, creating high contrast in the surrounding medium; the low amplitude caused by drier roots, or soil with lower reflective properties than the surrounding medium.

Acknowledgements

Wessex Archaeology would like to thank Hampshire County Council for commissioning the geophysical survey. The assistance of Colin Mack is gratefully acknowledged in this regard.

The fieldwork was undertaken by Brett Howard and Callum Jervis. Brett Howard processed and interpreted the geophysical data, wrote the report, and prepared illustrations. The geophysical work was quality controlled by Patricia Edwards. The project was managed on behalf of Wessex Archaeology by Tom Richardson.

Heatherside Junior School, Fleet, Hampshire

Ground Penetrating Radar Survey Report

1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology was commissioned by Hampshire County Council to carry out a geophysical survey at Heatherside Junior School, Fleet, Hampshire (centred on NGR 481097 153477) (**Figure 1**).

1.2 Scope of document

1.2.1 This report presents a brief description of the methodology followed by the detailed survey results and the archaeological interpretation of the geophysical data.

1.3 The site

1.3.1 The site is located within the town of Fleet, 6 km west of the town of Farnborough, Hampshire.

1.3.2 The survey comprises 700 sq.m of grassland, currently utilised for a school playing field. The site is bounded by a tree line, containing the school perimeter fence, to the north, south, and east, with further fencing and a sports pitch to the west.

1.3.3 The site is flat at 79 m above Ordnance Datum (aOD).

1.3.4 The solid geology comprises Sand, Silt, and Clay of the Windlesham Formation, no overlying superficial deposits were recorded (BGS 2022).

1.3.5 The soils underlying the site have not been recorded due to urban or industrial activity (SSEW SE Sheet 6 1983).

2 ARCHAEOLOGICAL BACKGROUND

2.1 Introduction

2.1.1 The following historical and archaeological background has been compiled using publicly available online resources, combined with the results of Wessex Archaeology's previous investigations in the area, and in-house resources. A search radius of 1 km was established, to determine any archaeological records relevant to the interpretation of the data.

2.2 Summary of the archaeological resource

2.2.1 Fleet Infant School (NHLE 1440165), 900 m to the east of the site, is a Grade II listed building, constructed between 1985 and 1986.

2.2.2 The Basingstoke Canal runs directly adjacent to the north-eastern boundary of the school perimeter.

2.2.3 The Ordnance Survey (OS) 1:25 000 map from 1937 to 1961 presents evidence for a former building, which existed on the site in the current playing fields. The evidence suggests the building existed for a relatively short time, before the current school was constructed.

3 METHODOLOGY

3.1 Introduction

3.1.1 The ground penetrating radar (GPR) survey was undertaken on the 9 April 2022. Field conditions were dry throughout the period of survey. An overall coverage of 670 sq. m was achieved, with reductions attributed at the eastern end by trees and sports equipment, preventing GPR access.

3.1.2 The methods and standards employed throughout the geophysical survey conform to current best practice, and guidance outlined by the Chartered Institute for Archaeologists' (CIfA 2014) and European Archaeologiae Consilium (Schmidt *et al.* 2015).

3.2 Aims and objectives

3.2.1 The aims of the survey comprise the following:

- To determine, as far as is reasonably possible, the nature of the detectable archaeological resource within a specified area using appropriate methods and practices; and
- To inform either the scope and nature of any further archaeological work that may be required; or the formation of a mitigation strategy (to offset the impact of the development on the archaeological resource); or a management strategy.

3.2.2 In order to achieve the above aims, the objectives of the geophysical survey are:

- To conduct a geophysical survey covering as much of the specified area as possible, allowing for on-site obstructions;
- To clarify the presence/absence of anomalies of archaeological potential; and
- Where possible, to determine the general nature of any anomalies of archaeological potential.

3.3 Fieldwork methodology

3.3.1 The GPR survey was conducted using an Impulse Radar Raptor 45 array. This multi-channel GPR system uses separate shielded transmitter and receiver antennae placed in an arrangement that allows it to be manually pushed across the area. The Raptor system contains eight separate transmitter and receiver antennae with a central frequency of 450 MHz. The data were recorded every 2.5 cm with a horizontal profile spacing of 8 cm within a time window of 100 ns.

3.3.2 Where GPS RTK signal is available, the GPR system is capable of providing real-time positioning, which enables full site coverage. However, grid nodes were established on site to prevent GPS drop out from tree coverage, enabling the GPR survey to be subsequently georeferenced post-processing.

3.4 Data processing

3.4.1 Data from the survey were subjected to common radar signal correction processes. These include amplitude and wobble correction of the radar profile to correct for variance in temperature and soil moisture content, and background and bandpass filtering to remove noise in the data from the surrounding area. Further details of the geophysical and survey equipment, methods and processing are described in **Appendix 1**.

3.4.2 The approximate depth conversion for the 450 MHz antenna is shown in Table 1. These have been calculated on the assumption that the GPR pulse through the ground is 0.101 m/ns for the 450 MHz antenna. It is possible to determine more precisely the average velocity of the GPR pulse through the ground is excavated features at a known depth can be identified in the data. Radargrams were analysed for suitable hyperbolic reflections, which can be used to determine the velocity of the GPR pulse through the subsurface deposits.

Table 1: Relative velocity to depth conversion based on a dielectric constant of 8.87 for the 450 MHz antenna.

Time Slice	Time (ns)	Depth (m)	Time Slice	Time (ns)	Depth (m)
1	0-1.95	0–0.1	**11**	19.44-21.4	0.98-1.08
2	1.94-3.9	0.1–0.2	**12**	21.39-23.34	1.08-1.18
3	3.89-5.84	0.2-0.29	**13**	23.33-25.28	1.18-1.27
4	5.83-7.79	0.29-0.39	**14**	25.28-27.23	1.27-1.37
5	7.78-9.73	0.39-0.49	**15**	27.22-29.17	1.37-1.47
6	9.72-11.67	0.49-0.59	**16**	29.16-31.12	1.47-1.57
7	11.67-13.62	0.59-0.69	**17**	31.11-33.06	1.57-1.67
8	13.61-15.56	0.69-0.78	**18**	33.05-35.01	1.66-1.76
9	15.55-17.51	0.78-0.88	**19**	35-36.95	1.76-1.86
10	17.5-19.45	0.88-0.98	**20**	36.94-38.89	1.86-1.96

4 GEOPHYSICAL SURVEY RESULTS AND INTERPRETATION

4.1 Introduction

4.1.1 The 450 MHz antenna used in this survey has the potential of detecting features to a depth of 2 – 4 m in optimal conditions, however, the total depth reached varies depending on the specific conditions of each area.

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 depth. For this report, it was decided that Timeslice 2, Timeslice 3, Timeslice 5, and Timeslice 7 would be chosen, as these best represent the data. For reference, the depth from the surface for the timeslices are detailed in **Table 1**.

4.1.3 Results are presented as a series of greyscale timeslices, and archaeological interpretations at a scale of 1:500 at A3 (**Figures 2** and **3**).

4.1.4 All features are described in terms of their geophysical character. 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 2**.

4.1.5 It should be noted that small features and 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 Gradiometer survey results and interpretation

4.2.1 A rectilinear high amplitude anomaly is evident in the western portion of the site, identified at **4000**, **4001**, and **4002** (**Figure 3**). The anomaly at **4000** is 12 m long south-west to north-east, 12 m long north-west to south-east, before potentially extending south-east past the extent of the survey area, and is 1.5 m wide. The anomaly is best represented in Timeslice 2 (0.1 m – 0.2 m depth from surface), however it is visible down to Timeslice 4 (0.29 m – 0.39 m depth from surface). Continuing a north-east trajectory, the anomaly at **4001** is 18 m long south-east to north-west, and 1.5 m wide at its widest extremity. The anomaly is best represented in Timeslice 3 (0.2 m – 0.29 m depth from surface), however is visible in Timeslice 4 (0.29 m – 0.39 m depth from surface). On a south-east to north-west orientation, the anomaly at **4002** is 10 m long and 1.5 m wide at its widest extremity. The anomaly is visible in Timeslice 7 (0.59 m – 0.69 m depth from surface). Combined these high amplitude anomalies are the result of planar reflectors, inferring building foundations. Cartographic evidence from 1937 to 1961 supports this interpretation, as it demonstrates these anomalies correspond to the position of a former building.

4.2.2 Numerous high amplitude linear responses have been identified on the site, at **4003** (**Figure 3**). These anomalies are most prevalent within the footprint of the former building. They vary in length but are on average 0.5 m wide. The anomalies are evident in Timeslices 3 (0.2 m – 0.29 m depth from surface) to Timeslice 9 (0.78 m – 0.88 m depth from surface) but are perhaps best represented in Timeslice 7 (0.59 m – 0.69 m depth from surface). These anomalies are likely services associated with the former building. However, they may correspond to further construction, or demolition, material.

4.2.3 An amorphous high amplitude response is evident at the north-eastern edge of the site, at **4004** (**Figure 3**). The anomaly is 6 m long south-east to north-west, and 2 m wide at its extremity. The anomaly is evident in Timeslice 1 (0 m – 0.1 m depth from surface) and Timeslice 2 (0.1 m – 0.2 m depth from surface). This anomaly may be the result of disturbed ground, such as excavation or ground works. Equally, however it may be the result of variation in geology.

4.2.4 Multiple high and low amplitude linear responses are present in the eastern portion of the site, at **4005** (**Figure 3**). These anomalies are present in Timeslice 2 (0.1 m – 0.2 m depth from surface) and Timeslice 3 (0.2 m – 0.29 m depth from surface) and likely correspond to tree roots.

5 DISCUSSION

5.1.1 The GPR survey identified a rectilinear arrangement of anomalies that relate to a former building identified on OS mapping from 1937 to 1961. The GPR responses infer foundations, however they do not appear to have substantial depth which suggests it may be a shallow platform or has been largely removed.

5.1.2 Further to the foundations, a series of high amplitude linear responses are apparent within the footprint of the former building. These likely correspond to services, or internal structures associated with the former building.

5.1.3 The remaining anomalies likely relate to modern groundworks or landscaping and tree roots.

REFERENCES

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Chartered Institute for Archaeologists [CIfA] 2014 *Standards and guidance for archaeological geophysical survey*. Reading, CIfA

Cartographic and documentary sources

Ordnance Survey 1983 *Soil Survey of England and Wales Sheet 6, Soils of Midland and Western England.* Southampton.

Online resources

British Geological Survey Geology of Britain Viewer (accessed June 2022) http://mapapps.bgs.ac.uk/geologyofbritain/home.html

Historic England (accessed June 2022) https://historicengland.org.uk/listing/the-list/map-search

National Library of Scotland (NLS) (accessed June 2022) https://maps.nls.uk/

Old Maps (accessed June 2022) https://www.old-maps.co.uk

APPENDICES

Appendix 1: Survey equipment and data processing

The ground penetrating radar (GPR) data was collected using a cart-mounted shielded antenna with central frequency suitable for the types of targets 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. The exact make and model of equipment varies.

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 of approximately 2.5 m with the GPR signal having a velocity of approximately 0.1 m/ns.

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.

The vertical resolution is similarly dependent upon the central frequency; for a 300 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.

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 0.05 m between traces is collected for all surveys, in accordance with European Archaeologiae Consilium recommendations (Schmidt *et al.* 2015).

Post-Processing

The radar data collected during the detail 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.

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.

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 greyscale 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 2: Geophysical interpretation

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

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.

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

- Ferrous – used for responses caused by ferrous material. These anomalies are likely to be of modern origin.

- Modern service – used for responses considered relating to cables and pipes; most are composed of ferrous/ceramic material although services made from non-magnetic material can sometimes be observed.

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.

- Drainage – used to define the course of ceramic field drains that are visible in the data as a series of repeating bipolar (black and white) responses.

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:

- Increased magnetic response – used for areas dominated by indistinct anomalies which may have some archaeological potential.

- 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 positive, negative, or broad bipolar (positive and negative) anomalies.

Appendix 3: OASIS form

Project Details:

Project name		Heatherside Junior School, Fleet, Hampshire			
Type of project		Ground Penetrating Radar survey (Field evaluation)			
Project description		A detailed Ground Penetrating Radar survey was conducted over land at Heatherside Junior School, Fleet, Hampshire (centred on NGR 481097 153477). The project was commissioned with the aim of establishing the presence, or otherwise, and nature of detectable archaeological features prior to borehole drilling. A rectilinear arrangement of high amplitude anomalies was identified on site. These correspond to the position of a former building, identified on the OS 1:25 000 map from 1937 to 1961. The GPR responses infer foundations, however they do not appear to have substantial depth which suggests it may be a shallow platform or has been largely removed.			
Project dates		**Start:** 09-04-2022		**End:** 09-04-2022	
Previous work		Not known			
Future work		Not known			
Project Code:	263530	**HER event no.**	N/A	**OASIS form ID:**	wessexar1-507538
		NMR no.	N/A		
		SM no.	N/A		
Planning Application Ref.		Unknown			
Site Status		None			
Land use		Playing Field			
Monument type		None	**Period**	None	

Project Location:

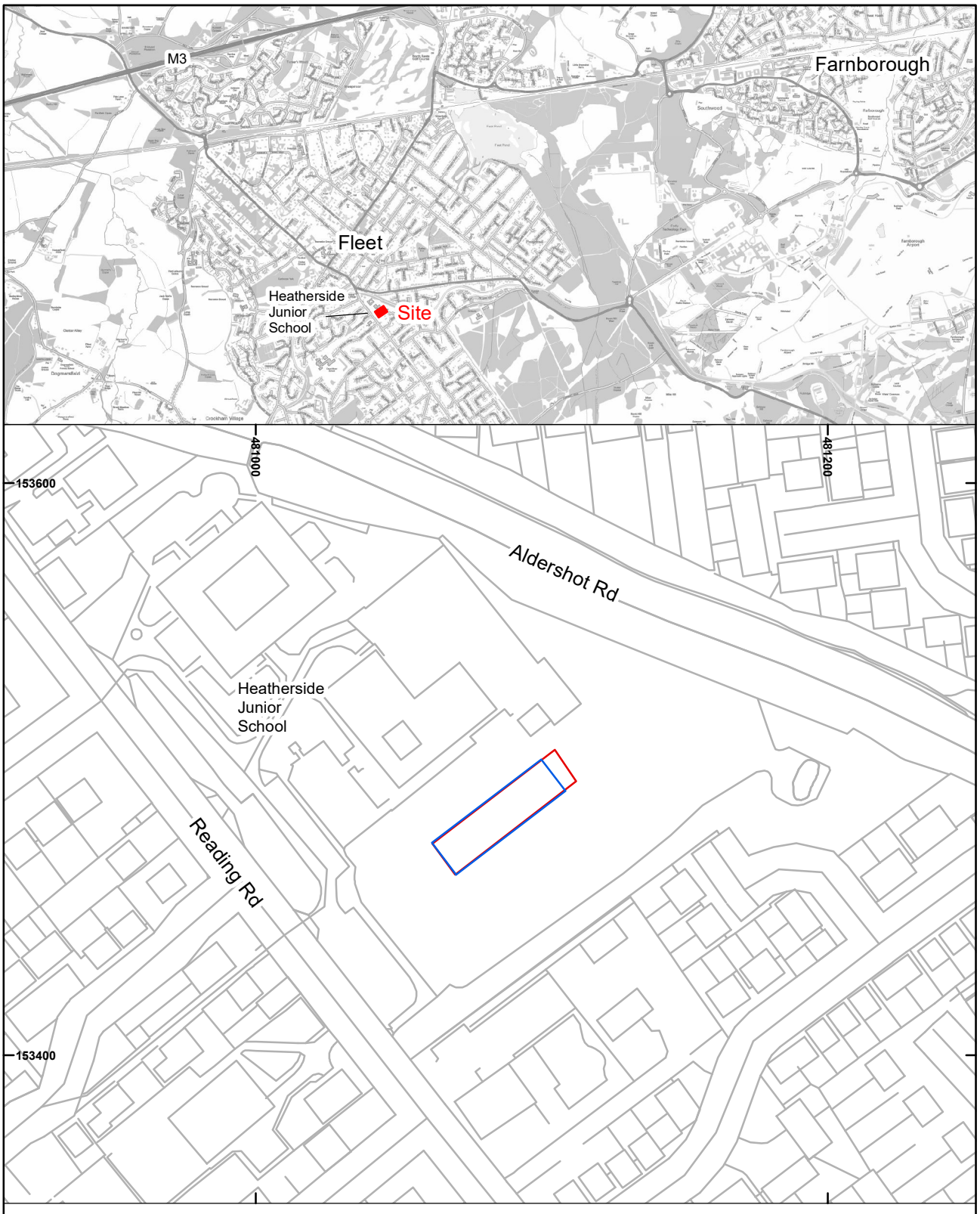
Site Address	Heatherside Junior School, Reading Road			**Postcode**	GU52 7TH
County	Hampshire	**District**	Hart	**Parish**	Fleet
Study Area	670 sq.m	**Height OD**	79 m aOD	**NGR**	481097 153477

Project Creators:

Name of Organisation	Wessex Archaeology		
Project brief originator	Mace Group UK	**Project design originator**	Wessex Archaeology
Project Manager	Tom Richardson	**Project Supervisor**	Brett Howard
Sponsor or funding body	Mace Group UK	**Type of Sponsor**	Developer

Project Archive and Bibliography:

Physical archive	N/A	**Digital Archive**	Geophysical survey and report	**Paper Archive**	N/A
Report title	Heatherside Junior School, Fleet, Hampshire Ground Penetrating Radar Report			**Date**	2022
Author	Wessex Archaeology	**Description**	Unpublished report	**Report ref.**	263530.03



Coordinate system:
OSGB36

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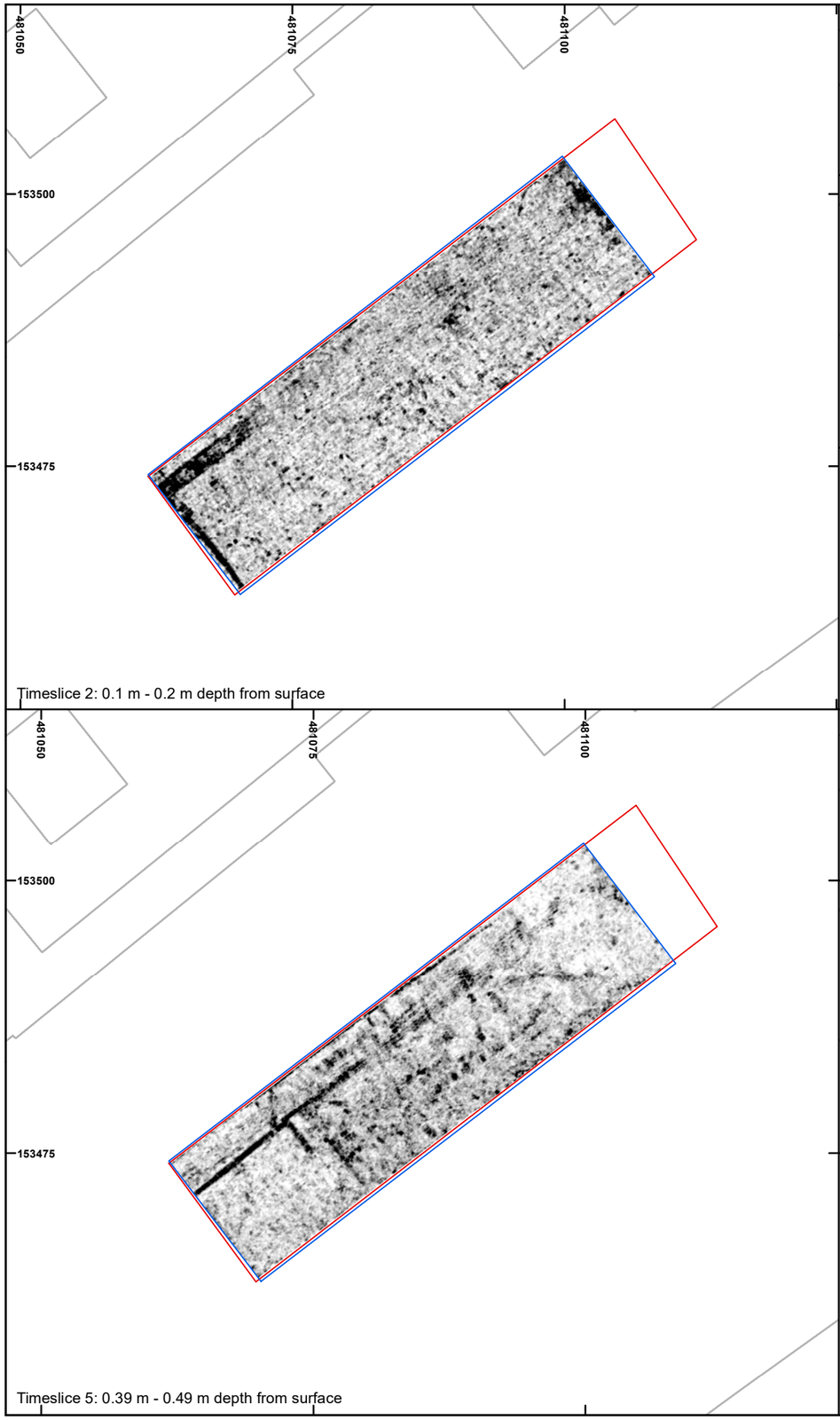
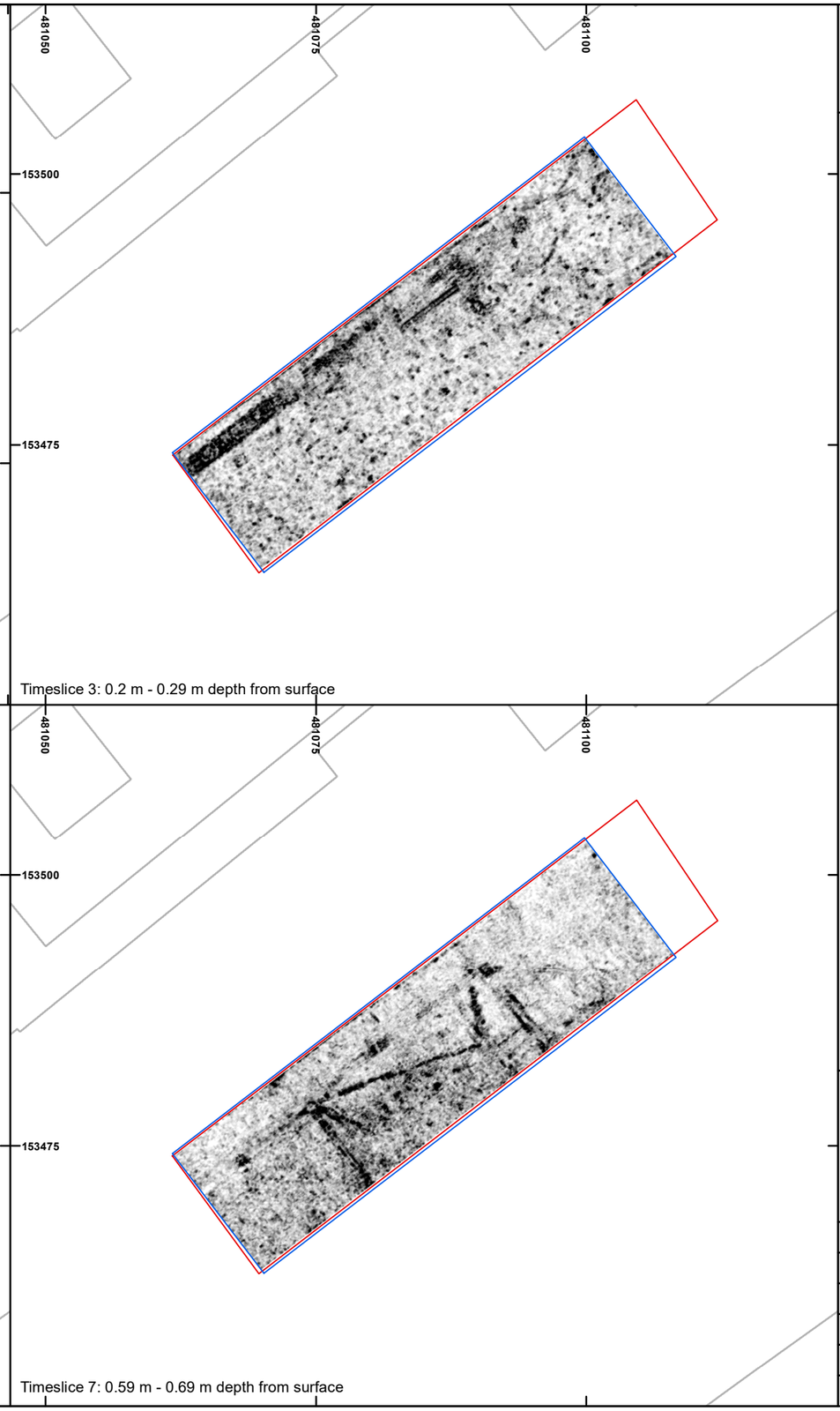
Site location and survey extents

Figure 1



Timeslice 2: 0.1 m - 0.2 m depth from surface



Timeslice 3: 0.2 m - 0.29 m depth from surface

Timeslice 5: 0.39 m - 0.49 m depth from surface

Timeslice 7: 0.59 m - 0.69 m depth from surface

Site boundary

Detailed survey extents

Low High

0 25 m

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Revision Number:	0
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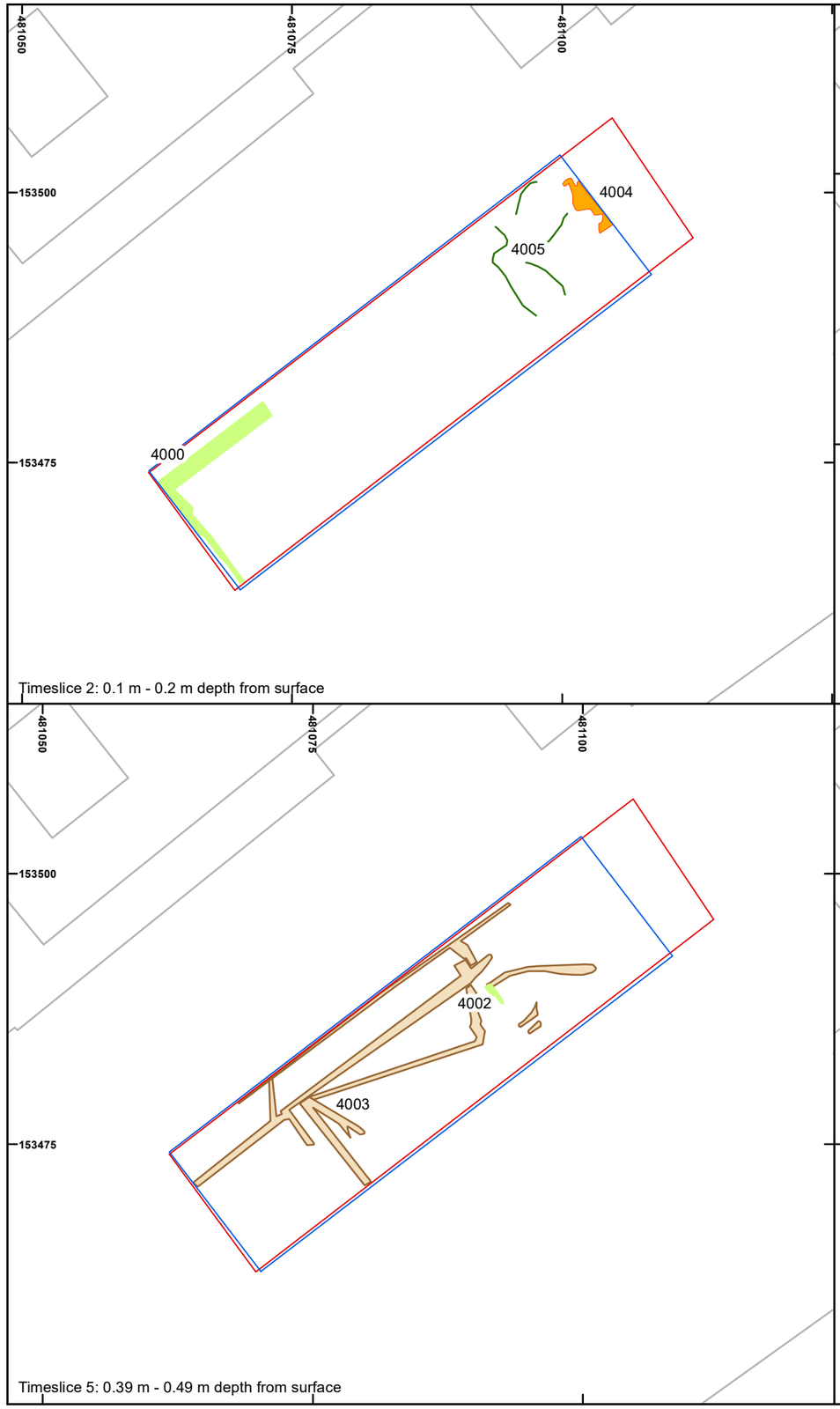
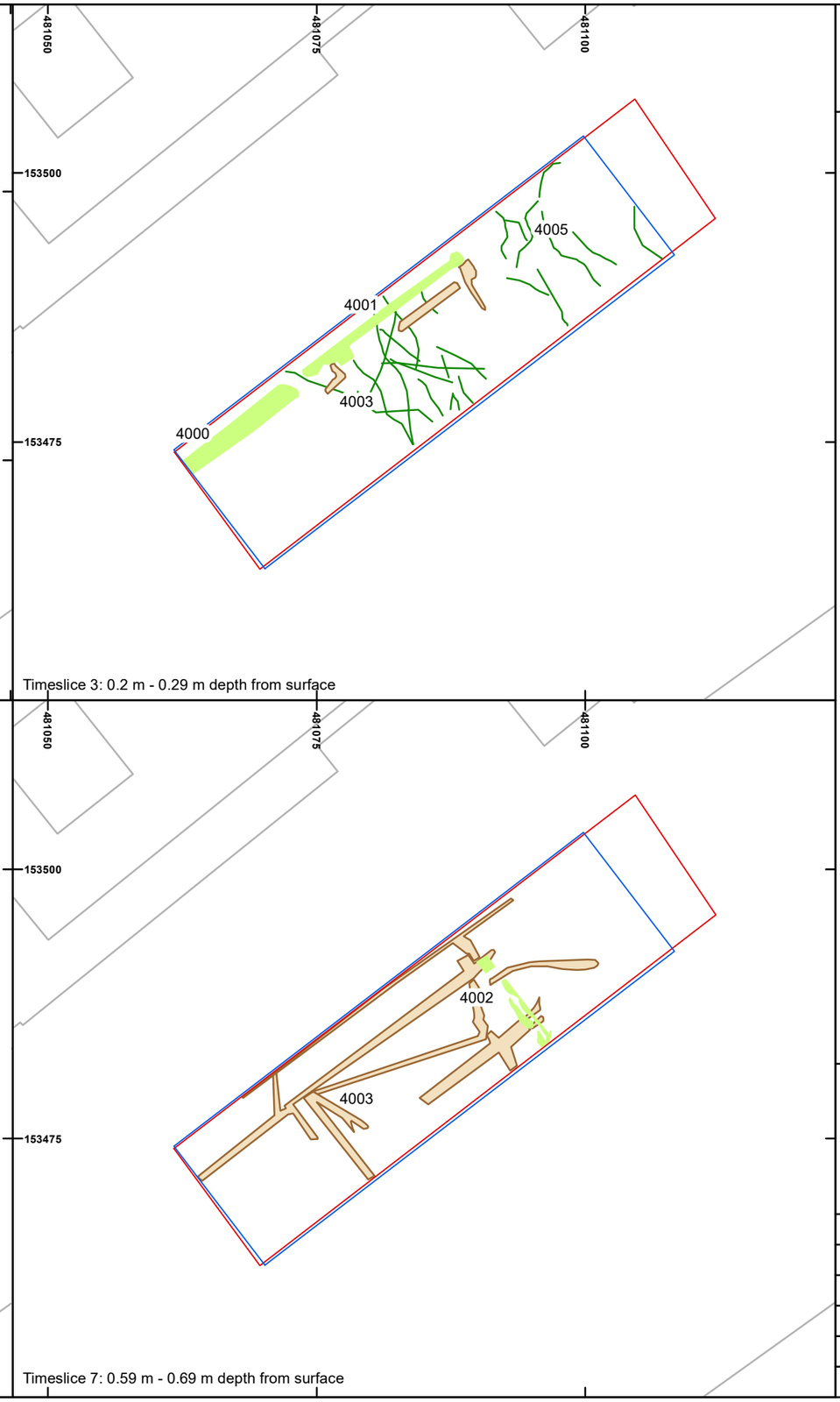
Ground penetrating radar survey results: greyscale plot

Figure 2



Timeslice 2: 0.1 m - 0.2 m depth from surface



Timeslice 3: 0.2 m - 0.29 m depth from surface

Timeslice 5: 0.39 m - 0.49 m depth from surface

Timeslice 7: 0.59 m - 0.69 m depth from surface

Site boundary
Detailed survey extents
Possible archaeology
High amplitude anomaly
Modern service
Tree root

0 25 m

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Revision Number:	0
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Illustrator:	BH
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Ground penetrating radar survey results: interpretation

Figure 3

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