GEOPHYSICAL SURVEY REPORT

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Rochester Cathedral

Client

Rochester Cathedral

Date

December 2017

Incorporating

GSB PROSPECTION LTD

and

STRATASCAN LTD

SUMO Services Ltd
Cowburn Farm
Market Street
Thornton
Bradford
BD13 3HW
T: 01274 835016

SUMO Services Ltd
Vineyard House
Upper Hook Road
Upton upon Severn
Worcestershire
WR8 0SA
T: 01684 592266

geophysics@sumoservices.com
www.sumoservices.com

GEOPHYSICAL SURVEY REPORT

Project name:
Rochester Cathedral

Client:
Rochester Cathedral

Survey date:
25 September 2017

Report date:
4 December 2017

Field co-ordinator:
Richard Fleming

Interpretative advice:
Graham Keevill BA (Hons)
Cathedral Archaeologist for the Dean and Chapter of Rochester

Report written by:
Magdalena Udyrysz MSc
Rebecca Davies BSc

CAD illustrations by:
Magdalena Udyrysz MSc

Project Manager:
Simon Haddrell BEng AMBCS PCIfA

Report approved by:
Peter Barker CEng MICE MCIWEM MCIfA FCInstCES

TABLE OF CONTENTS

LIST OF FIGURES

1 SUMMARY OF RESULTS

A Ground Penetrating Radar (GPR) survey was conducted over approximately 1900m² at the Cloister and Chapter House of Rochester Cathedral, along with the site of the medieval dormitory – now a courtyard to the Old Deanery. Numerous anomalies were identified across the site. They are probably associated with the Chapter House dated between 1080 and 1100, the arrangement of the early Norman Cloister and Garth, the Chapter House dated between 1120 and 1150, the 1805 Prebendal House, Dorter Range and medieval buildings. Evidence of tree roots and potential services were also revealed.

2 INTRODUCTION

2.1 Background synopsis

SUMO Surveys agreed to undertake a geophysical survey at Rochester Cathedral. This survey forms part of an investigation being undertaken by **Rochester Cathedral.**

2.2 Site details

NGR / Postcode	TQ 743 685 / ME1 1SR
Scheduled Monument	ME294 Remains of Rochester Priory cloister. Section 42 licence number SL00166187.
Location	The site is located at the Cloister and Chapter House of Rochester Cathedral, along with the area of the medieval dormitory, currently forming the courtyard to the Old Deanery. The Cloister and Chapter House areas are lawned; Cloister Garth is c 36m long and wide, with brick-paved walkways (c1m below the level of the garth) along the east and north sides. The northern half of the Garth is known to have *c.*0.8-1m of post-medieval (probably Victorian) garden soil over earlier archaeological horizons. Some services may be present. Drains and a large soakaway were inserted as part of the Hidden Treasures; Fresh Expressions (HTFE) project in 2015. A triangular area of lawn to the west of the Cloister measures *c.*20m both north-south and east-west, and slopes down on its north and east sides. This area is *c.*2.5m above the cloister. The Chapter House measures *c.*12.5m east-west by 11m internally. The Old Deanery courtyard (dormitory range) is *c.*35m by 12m at its maximum.
District	Kent
Unitary Authority Ward	Rochester West, Medway
Geology	Solid: Lewes Nodular Chalk Formation – chalk. No superficial deposits recorded (BGS 2017).
Soils	Unsurveyed (U), mainly urban and industrial areas (SSEW 1983).
Archaeology	Information provided by the client: Rochester Cathedral is England's second oldest, having been founded in 604AD by Bishop Justus. The present building dates back to the work of the French monk, Gundulf, in 1080. A watching brief in 2015 revealed early Norman foundations in the north Cloister walk and in the north-east corner of the Garth. These are believed to belong to a Cloister laid out by Bishop Gundulf in the last two decades of the 11th century. The remains clearly continued into the east Cloister walk and northwards into the Garth. The western and full southern extent are unclear. The Chapter House runs east from the north-east corner of the Cloister, and is an exceptional Norman building in its own right. Roofless since soon after

	the Dissolution of the priory c1540, it is known to retain very significant medieval archaeology beneath the current lawn. This includes the footings and probably other remains of a vaulted passage inserted into the west end of the building during the 14th century, to create a night passage from their dormitory to the south (in the east cloister range) into the cathedral; burials (most likely of senior members of the medieval priory); and floors. It is possible that the earlier Cloister ranges or buildings associated with them will have existed here as well, and earlier archaeological remains may be present.
Survey Methods	Ground Penetrating Radar (GPR) survey
Study Area	c1900m² at the Cloister and Chapter House of Rochester Cathedral, with the site of the medieval dormitory.

2.3 Aims and Objectives

The objective of the survey was to provide as much information as possible of the full extent of this Cloister, and its possible relationship with the former Roman city wall which defined the south side of the extant Cloister. There is potential to achieve an increase in understanding of the Cloister area's development, as well as to assess whether any earlier archaeological remains survive (an extensive deposit of Roman tile found in the garth hints at the presence of a major building nearby); whether there are other medieval remains in and around the Garth (eg a Cloister lavatorium); the extent to which the west and east (Dormitory) Cloister ranges might survive below ground; and whether the full plan of the Prebendal House built in the south-west corner of the Garth c1805 (and demolished 1937) can be ascertained.

3 METHODS, PROCESSING & PRESENTATION

3.1 Standards & Guidance

This report and all fieldwork have been conducted in accordance with the latest guidance documents issued by Historic England (EH 2008) (then English Heritage) and the Chartered Institute for Archaeologists (IfA 2002 & CIfA 2014).

3.2 Survey methods

Ground Penetrating Radar was used as an efficient and effective method in detecting archaeological remains and other buried obstructions in an urban environment.

More information regarding this technique is included in Appendix A.

3.3 Data Processing & Interpretation

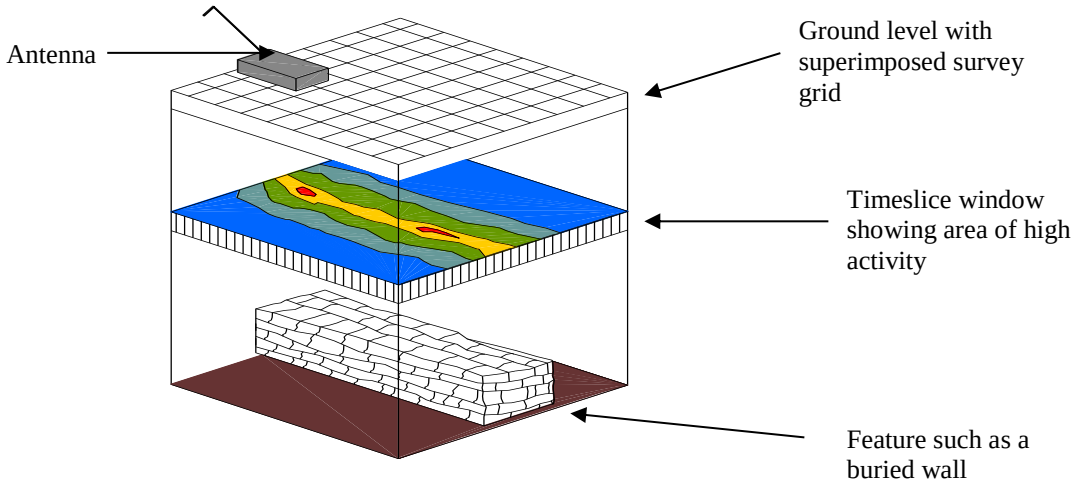
Processing is performed using specialist software (Mala Rslicer). There are a wide range of filters available, the application of which will vary depending on the project. The below table shows the processes used for this data:

Gain	Amplification to correct for weakening of signal with depth.
DC-Shift	Re-establishes oscillation of the radar pulse around the zero point)
Dewow / Ringdown Removal	Removes low frequency, down-trace instrument noise
Bandpass Filtering	Suppresses frequencies outside of the antenna's peak bandwidth thus reducing noise
Background Removal	Can remove ringing, instrument noise and minimize the near-surface 'coupling' effect

Migration	Collapses hyperbolic tails (also known as 'diffractions') back towards the reflection source
Amplitude Envelope	Simplifies pulses for production of time-slice maps by summing peak values, regardless of polarity, over a given time-window.

Timeslice plots

In addition to a manual abstraction from the radargrams, a computer analysis was also carried out. The radar data is interrogated for areas of high activity and the results presented in a plan format known as timeslice plots. In this way it is easy to see if the high activity areas form recognisable patterns.



The GPR data is compiled to create a 3D file. This 3D file can be manipulated to view the data from any angle and at any depth within a range. The 3D file can be sampled to produce activity plots at various depths. As the radar is measuring the time for each of the reflections found, these are called "time slice windows". Plots for various time slices have been included in the report. Based on an average velocity calculations have been made to show the equivalent depth into the ground.

The weaker reflections in the time slice windows are shown as light grey colour. The stronger reflections are represented by colours such black and dark grey.

Reflections within the radar image are generated by a change in velocity of the radar from one medium to another. It is not unreasonable to assume that the higher activity anomalies are related to marked changes in materials within the ground such as foundations or surfaces within the soil matrix.

3.4 Presentation of results

The location of the survey area and referencing information is provided in Figure 2. Depth slices of collected data are provided at 0.15m, 0.20m, 0.30m, 0.45m, 0.65m, 0.80m, 0.95m, 1.20m, 1.40m and 1.60m in Figures 3 to 6, 8 to 10, 12 to 13 and 16. Interpretation of data is provided in Figures 7, 11 and 16 to 18.

4 RESULTS

4.1 Complex and linear features have been identified in the north-east corner of the Cloister Garth at depths between 0.40 and 1.60m (marked in purple in Figure 18). These are thought to be associated with the remains of the AD1080-1100 Chapter House with the polygonal apse to the east.

4.2 Linear, complex and discrete anomalies found in the central and eastern part of the Cloister Garth were identified at depths of between 0.30m and 1.70m (marked in light blue on Figure 18). These features are probably related to the earlier Norman Cloister with its eastern range extending south from the Chapter House. It is likely that they are associated with the outer walls of the range, along with the foundations for a central row of columns which would have supported a vaulted ceiling above.

Similar linear, complex and discrete anomalies were found beneath the raised triangular area to the west of the Cloister at depths of between 0.70m and 2.30m. Anomalies along the east side of this area correspond with the outer (i.e. west) wall of the medieval Cellarer's Range. Anomalies on the north side of the area probably relate to a long building attached to and running at a right-angle from the Cellarer's Range, shown on a number of post-medieval illustrations but possibly of medieval origin.

4.3 Several small complex responses in the Old Deanery, between the depths of 0.30m and 1.55m (marked in red on Figure 18). These are believed to be associated with possible foundations to support the vaulted ceiling above.

4.4 Linear and complex features found to the south-west of the Garth, at the depths of 0.25-1.20m (marked in brown on Figure 18). These are probable remains of the 1805 Prebendal House that was demolished in 1937. However, the shallower anomalies may be of modern origin, again including potential services, tree roots and small obstructions.

4.5 Small complex, discrete and linear features found at the Old Deanery courtyard at depths between 0.30 to 2.20m are marked in dark blue on Figure 18. These are probably related to structural remains of the Dormitory range. However, the shallower anomalies may be of modern origin, including potential services, small obstructions and features related to the road.

4.6 A clear rectangular area of anomalies to the south of the triangular area to the west of the Cloister and attached to the Cellarer's Range probably belong to a porch or entrance block for that range (also shown on the post-medieval illustrations and likely to be of medieval origin). These features were found at the depths of 0.40 to 1.60m (marked in light green on Figure 18).

5 DATA APPRAISAL & CONFIDENCE ASSESSMENT

The data across the survey area shows a high contrast between strong linear, complex and discrete responses and that of the background response, suggesting that the underlying geology is conducive to GPR survey. The depth of penetration reaches approximately 2.30m. Potential anomalies of archaeological origin have been detected, along with responses of uncertain origin, services and tree roots, indicating that the survey has been effective.

6 CONCLUSION

The survey at Rochester Cathedral has revealed a number of potential archaeological remains that are probably associated with 11th and 12th century Chapter Houses, early Norman Cloister arrangement, east and west ranges, 19th century Prebendal House, medieval buildings and Dormitory range. Further shallower complex, discrete and linear responses are of uncertain origin. The remaining responses are modern, and include potential services and evidence of tree roots.

7 REFERENCES

BGS 2017 British Geological Survey *website*: (http://www.bgs.ac.uk/opengeoscience/home.html?Accordion1=1#maps) Geology of Britain viewer [Accessed 29/11/2017].

CIfA 2014 *Standard and Guidance for Archaeological Geophysical Survey.* Amended 2016. CIfA Guidance note. Chartered Institute for Archaeologists, Reading http://www.archaeologists.net/sites/default/files/CIfAS%26GGeophysics_2.pdf

EH 2008 *Geophysical Survey in Archaeological Field Evaluation.* English Heritage, Swindon https://content.historicengland.org.uk/images-books/publications/geophysical-survey-in-archaeological-field-evaluation/geophysics-guidelines.pdf/

G. Keevill 2017 *Proposal for a geophysical survey at Rochester Cathedral, Medway, Kent*

SSEW 1983 *Soils of England and Wales. Sheet 6, South East England*. Soil Survey of England and Wales, Harpenden.

Appendix A - Technical Information: Ground Penetrating Radar

Grid locations
The location of the survey traverses has been plotted in Figure 2.

Survey equipment and configuration
Two of the main advantages of radar are its ability to give information of depth as well as work through a variety of surfaces, even in cluttered environments which normally prevent other geophysical techniques being used.

A short pulse of energy is emitted into the ground and echoes are returned from the interfaces between different materials in the ground. The amplitude of these returns depends on the change in velocity of the radar wave as it crosses these interfaces. A measure of these velocities is given by the dielectric constant of that material. The travel times are recorded for each return on the radargram and an approximate conversion made to depth by calculating or assuming an average dielectric constant (see below).

Drier materials such as sand, gravel and rocks, i.e. materials which are less conductive (or more resistant), will permit the survey of deeper sections than wetter materials such as clays which are more conductive (or less resistant). Penetration can be increased by using longer wavelengths (lower frequencies) but at the expense of resolution.

As the antennae emit a "cone" shaped pulse of energy an offset target showing a perpendicular face to the radar wave will be "seen" before the antenna passes over it. A resultant characteristic *diffraction* pattern is thus built up in the shape of a hyperbola. A classic target generating such a diffraction is a pipeline when the antenna is travelling across the line of the pipe. However, it should be pointed out that if the interface between the target and its surrounds does not result in a marked change in velocity then only a weak hyperbola will be seen, if at all.

The Ground Penetrating Impulse Radars used was High Density Array system manufactured by Mala. This system collects data using 400MHz antenna.

Sampling interval
Readings were taken at 0.05m intervals with traverse intervals of 0.08m. All survey traverse positioning was carried out using a Trimble S6 Robotic Total Station.

Depth of scan and resolution
The average velocity of the radar pulse is calculated to be 0.1m/nsec which is typical for the type of sub-soils on the site. With a range setting of 100nsec this equates to a maximum depth of scan of 2m but it must be remembered that this figure could vary by ± 10% or more. A further point worth making is that very shallow features are lost in the strong surface response experienced with this technique.

Under ideal circumstances the minimum size of a vertical feature seen by a 200MHz (relatively low frequency) antenna in a damp soil would be 0.1m (i.e. this antenna has a wavelength in damp soil of about 0.4m and the vertical resolution is one quarter of this wavelength). It is interesting to compare this with the 400MHz antenna, which has a wavelength in the same material of 0.2m giving a theoretical resolution of 0.05m. A 900MHz antenna would give 0.09m and 0.02m respectively.

Data capture
Data is displayed on a monitor as well as being recorded onto an internal hard disk. The data is later downloaded into a computer for processing.

71

70

69

68

67

73 74 75 76 77

N

Site Location

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

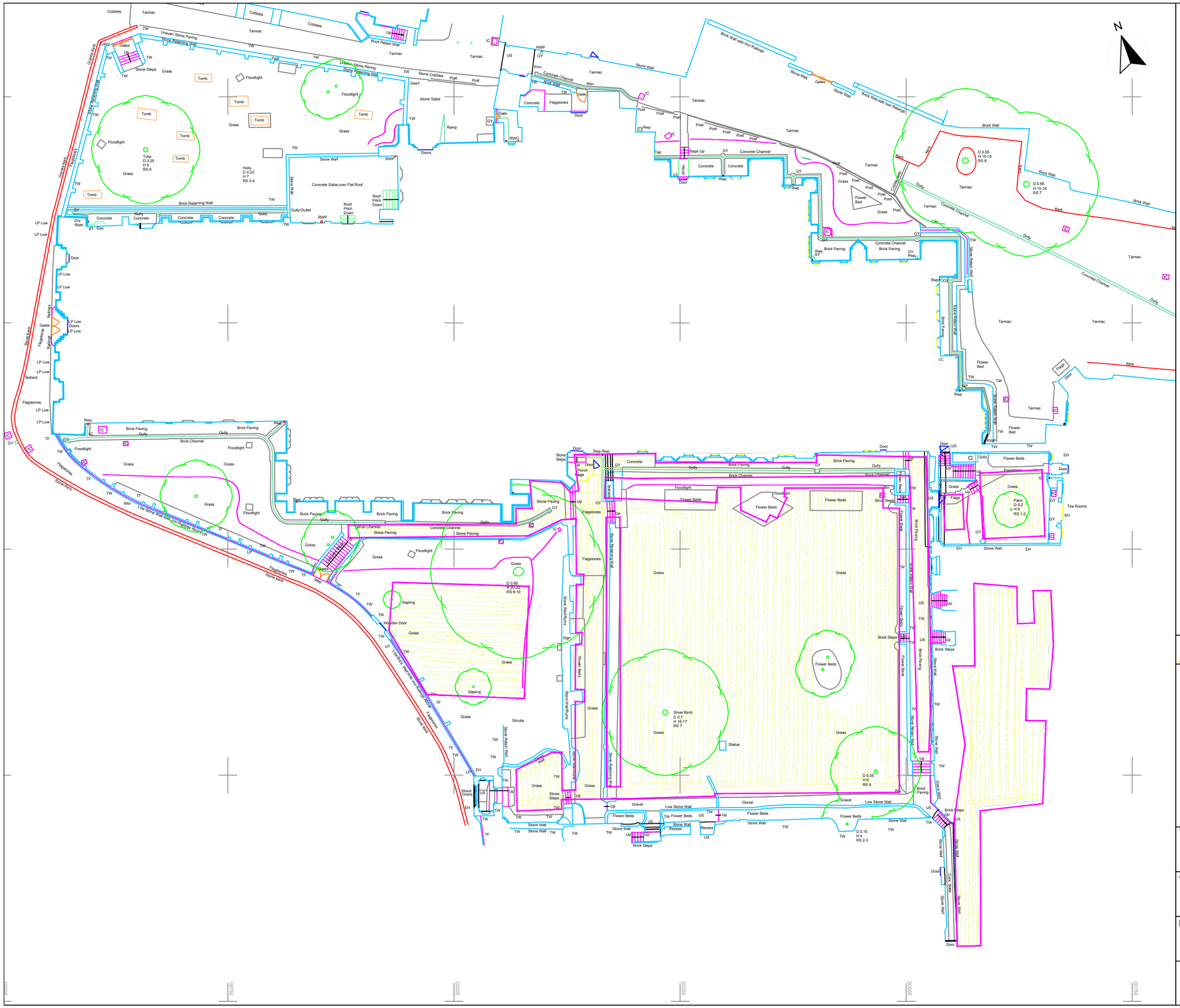
Title:
Site Location Diagram

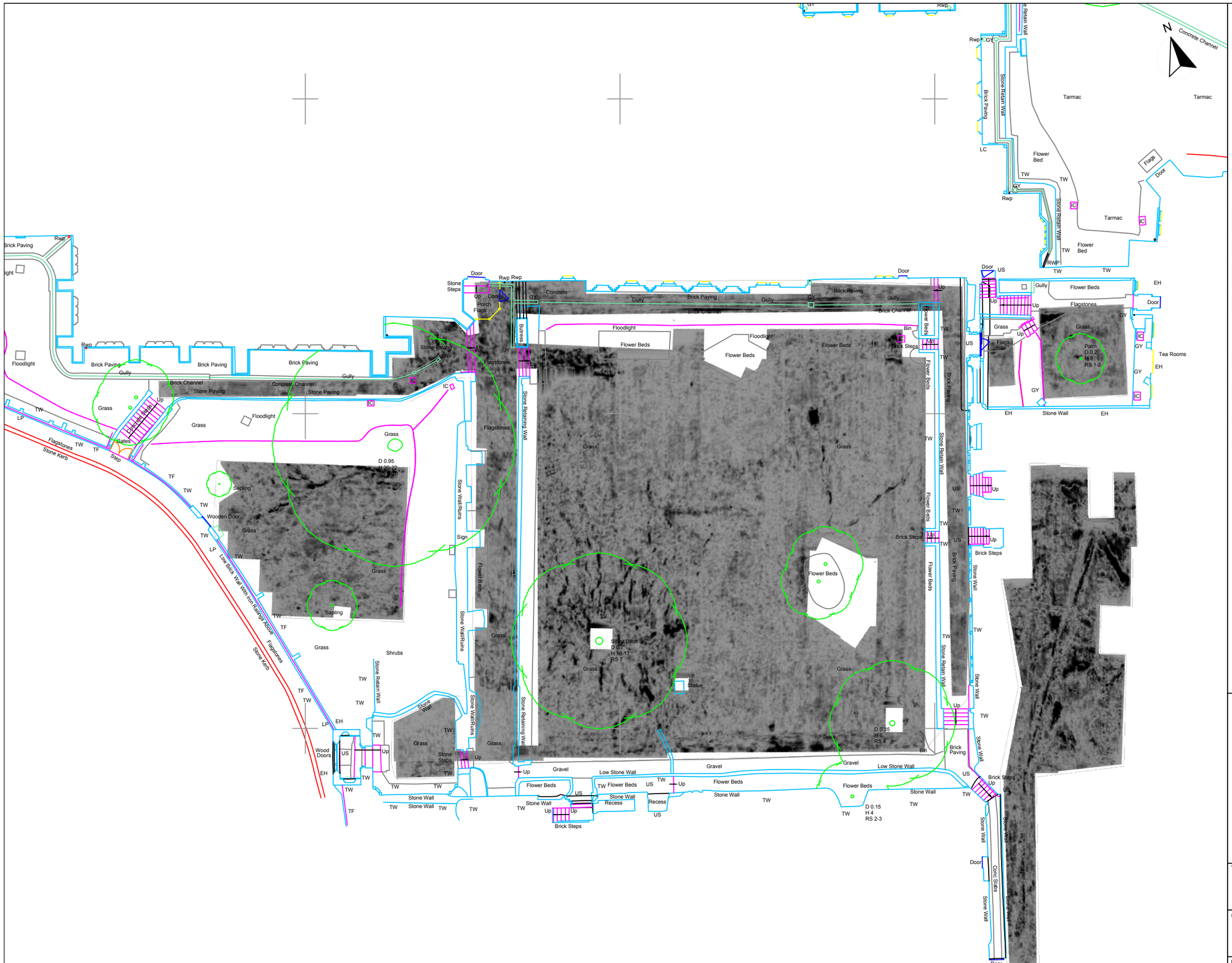
Client:
Rochester Cathedral

Project:
Rochester Cathedral

Scale:
0 metres 1500
1:25000 @ A3

Fig No:
01

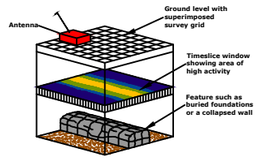

N
Radar traverses
sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING
Title:
Location of Survey Area
Client:
Rochester Cathedral
Project:
Rochester Cathedral
Scale:
0
metres
20
1:400 @ A3
Fig No:
02



Timeslice at 0.15m depth

TIMESLICE PLOTS

In addition to a manual abstraction from the radargrams, a computer analysis was carried out. The radar data is interrogated for areas of high activity and the results presented in a plan format known as timeslice plots. In this way it is easy to see if the high activity areas form recognisable patterns.

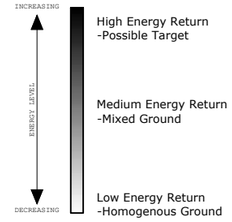


The GPR data is compiled to create a 3D file. This 3D file can be manipulated to view the data from any angle and at any depth within range. The data was then modelled to produce activity plots at various depths. As the radar is actually measuring the time for each of the reflections found, these are called "time slice windows". Plots for various time slices have been included in the report. Calculations, based on an average velocity, have been made to show the equivalent depth into the ground. The data was sampled between different time intervals effectively producing plans at different depths into the ground.

The weaker reflections in the time slice windows are shown as light grey. The stronger reflections are represented by dark grey and black.

Reflections within the radar image are generated by a change in velocity of the radar from one medium to another. It is not unreasonable to assume that the higher activity anomalies are related to marked changes in materials within the ground such as buried foundations or surfaces within the soil matrix.

Colour Scale for Timeslice 'Activity' Plots and Simplified Key



sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title: GPR Survey - Timeslice at 0.15m

Client: Rochester Cathedral

Project: Rochester Cathedral

Scale: 0 metres 15
1:300 @ A3

Fig No: 03

Timeslice at 0.20m depth

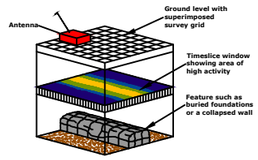
2000E

2025E

2050E

TIMESLICE PLOTS

In addition to a manual abstraction from the radargrams, a computer analysis was carried out. The radar data is interrogated for areas of high activity and the results presented in a plan format known as timeslice plots. In this way it is easy to see if the high activity areas form recognisable patterns.

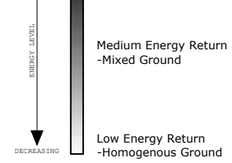


The GPR data is compiled to create a 3D file. This 3D file can be manipulated to view the data from any angle and at any depth within range. The data was then modelled to produce activity plots at various depths. As the radar is actually measuring the time for each of the reflections found, these are called "time slice windows". Plots for various time slices have been included in the report. Calculations, based on an average velocity, have been made to show the equivalent depth into the ground. The data was sampled between different time intervals effectively producing plans at different depths into the ground.

The weaker reflections in the time slice windows are shown as light grey. The stronger reflections are represented by dark grey and black.

Reflections within the radar image are generated by a change in velocity of the radar from one medium to another. It is not unreasonable to assume that the higher activity anomalies are related to marked changes in materials within the ground such as buried foundations or surfaces within the soil matrix.

Colour Scale for Timeslice 'Activity' Plots and Simplified Key



sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title: GPR Survey - Timeslice at 0.20m

Client: Rochester Cathedral

Project: Rochester Cathedral

Scale: 0 metres 15
1:300 @ A3

Fig No: 04

Timeslice at 0.30m depth

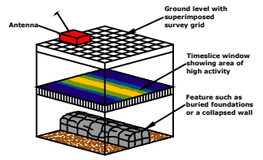
2000E

2025E

2050E

TIMESLICE PLOTS

In addition to a manual abstraction from the radargrams, a computer analysis was carried out. The radar data is interrogated for areas of high activity and the results presented in a plan format known as timeslice plots. In this way it is easy to see if the high activity areas form recognisable patterns.

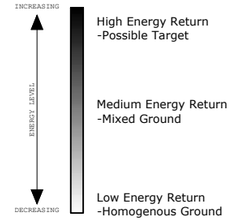


The GPR data is compiled to create a 3D file. This 3D file can be manipulated to view the data from any angle and at any depth within range. The data was then modelled to produce activity plots at various depths. As the radar is actually measuring the time for each of the reflections found, these are called "time slice windows". Plots for various time slices have been included in the report. Calculations, based on an average velocity, have been made to show the equivalent depth into the ground. The data was sampled between different time intervals effectively producing plans at different depths into the ground.

The weaker reflections in the time slice windows are shown as light grey. The stronger reflections are represented by dark grey and black.

Reflections within the radar image are generated by a change in velocity of the radar from one medium to another. It is not unreasonable to assume that the higher activity anomalies are related to marked changes in materials within the ground such as buried foundations or surfaces within the soil matrix.

Colour Scale for Timeslice 'Activity' Plots and Simplified Key



sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
GPR Survey - Timeslice at 0.30m

Client:
Rochester Cathedral

Project:
Rochester Cathedral

Scale:
0 metres 15
1:300 @ A3

Fig No:
05

Timeslice at 0.45m depth

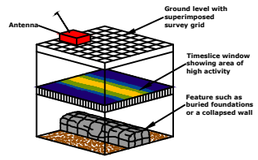
2000E

2025E

2050E

TIMESLICE PLOTS

In addition to a manual abstraction from the radargrams, a computer analysis was carried out. The radar data is interrogated for areas of high activity and the results presented in a plan format known as timeslice plots. In this way it is easy to see if the high activity areas form recognisable patterns.

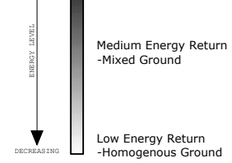


The GPR data is compiled to create a 3D file. This 3D file can be manipulated to view the data from any angle and at any depth within range. The data was then modelled to produce activity plots at various depths. As the radar is actually measuring the time for each of the reflections found, these are called "time slice windows". Plots for various time slices have been included in the report. Calculations, based on an average velocity, have been made to show the equivalent depth into the ground. The data was sampled between different time intervals effectively producing plans at different depths into the ground.

The weaker reflections in the time slice windows are shown as light grey. The stronger reflections are represented by dark grey and black.

Reflections within the radar image are generated by a change in velocity of the radar from one medium to another. It is not unreasonable to assume that the higher activity anomalies are related to marked changes in materials within the ground such as buried foundations or surfaces within the soil matrix.

Colour Scale for Timeslice 'Activity' Plots and Simplified Key



High Energy Return
-Possible Target

Medium Energy Return
-Mixed Ground

Low Energy Return
-Homogenous Ground

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

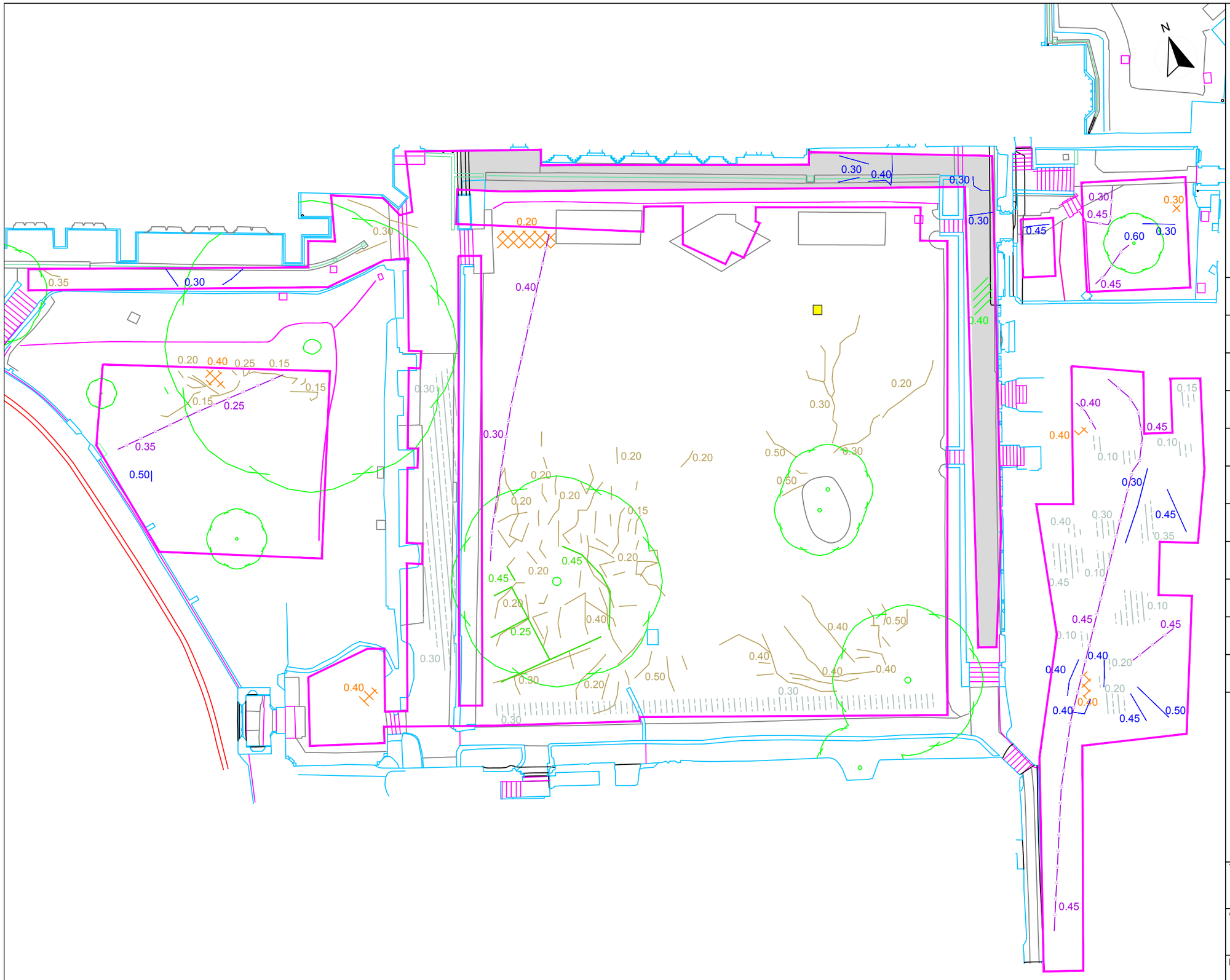
Title:
GPR Survey - Timeslice at 0.45m

Client:
Rochester Cathedral

Project:
Rochester Cathedral

Scale:
0 metres 15
1:300 @ A3

Fig No:
06



KEY

	Linear anomaly probably related to archaeology
	Complex and discrete anomaly possibly related to archaeological remains
	Linear feature of uncertain origin
	Weak discrete and complex anomaly of uncertain origin
	Buried surface
	Potential service
	Probable 19th century soakaway
	Tree root
	Area set 0.8-1.0m below the level of the Cloister Garth
0.60	Depth to the top of the feature (in m)

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
GPR Survey - Interpretation - 0.0-0.5m

Client:
Rochester Cathedral

Project:
Rochester Cathedral

Scale:
0 metres 12.5
1:250 @ A3

Fig No:
07

Timeslice at 0.65m depth

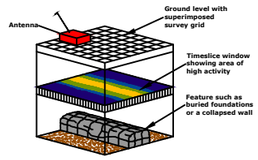
2000E

2025E

2050E

TIMESLICE PLOTS

In addition to a manual abstraction from the radargrams, a computer analysis was carried out. The radar data is interrogated for areas of high activity and the results presented in a plan format known as timeslice plots. In this way it is easy to see if the high activity areas form recognisable patterns.

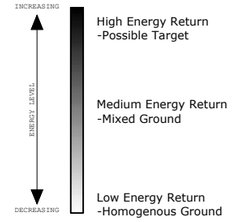


The GPR data is compiled to create a 3D file. This 3D file can be manipulated to view the data from any angle and at any depth within range. The data was then modelled to produce activity plots at various depths. As the radar is actually measuring the time for each of the reflections found, these are called "time slice windows". Plots for various time slices have been included in the report. Calculations, based on an average velocity, have been made to show the equivalent depth into the ground. The data was sampled between different time intervals effectively producing plans at different depths into the ground.

The weaker reflections in the time slice windows are shown as light grey. The stronger reflections are represented by dark grey and black.

Reflections within the radar image are generated by a change in velocity of the radar from one medium to another. It is not unreasonable to assume that the higher activity anomalies are related to marked changes in materials within the ground such as buried foundations or surfaces within the soil matrix.

Colour Scale for Timeslice 'Activity' Plots and Simplified Key



sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title: GPR Survey - Timeslice at 0.65m

Client: Rochester Cathedral

Project: Rochester Cathedral

Scale: 0 metres 15
1:300 @ A3

Fig No: 08

Timeslice at 0.80m depth

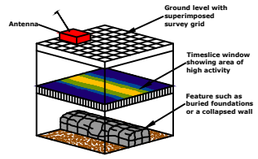
2000E

2025E

2050E

TIMESLICE PLOTS

In addition to a manual abstraction from the radargrams, a computer analysis was carried out. The radar data is interrogated for areas of high activity and the results presented in a plan format known as timeslice plots. In this way it is easy to see if the high activity areas form recognisable patterns.

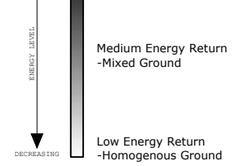


The GPR data is compiled to create a 3D file. This 3D file can be manipulated to view the data from any angle and at any depth within range. The data was then modelled to produce activity plots at various depths. As the radar is actually measuring the time for each of the reflections found, these are called "time slice windows". Plots for various time slices have been included in the report. Calculations, based on an average velocity, have been made to show the equivalent depth into the ground. The data was sampled between different time intervals effectively producing plans at different depths into the ground.

The weaker reflections in the time slice windows are shown as light grey. The stronger reflections are represented by dark grey and black.

Reflections within the radar image are generated by a change in velocity of the radar from one medium to another. It is not unreasonable to assume that the higher activity anomalies are related to marked changes in materials within the ground such as buried foundations or surfaces within the soil matrix.

Colour Scale for Timeslice 'Activity' Plots and Simplified Key



sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title: GPR Survey - Timeslice at 0.80m

Client: Rochester Cathedral

Project: Rochester Cathedral

Scale: 0 metres 15
1:300 @ A3

Fig No: 09

Timeslice at 0.95m depth

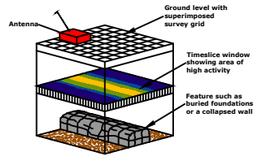
2000E

2025E

2050E

TIMESLICE PLOTS

In addition to a manual abstraction from the radargrams, a computer analysis was carried out. The radar data is interrogated for areas of high activity and the results presented in a plan format known as timeslice plots. In this way it is easy to see if the high activity areas form recognisable patterns.

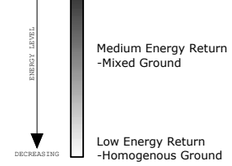


The GPR data is compiled to create a 3D file. This 3D file can be manipulated to view the data from any angle and at any depth within range. The data was then modelled to produce activity plots at various depths. As the radar is actually measuring the time for each of the reflections found, these are called "time slice windows". Plots for various time slices have been included in the report. Calculations, based on an average velocity, have been made to show the equivalent depth into the ground. The data was sampled between different time intervals effectively producing plans at different depths into the ground.

The weaker reflections in the time slice windows are shown as light grey. The stronger reflections are represented by dark grey and black.

Reflections within the radar image are generated by a change in velocity of the radar from one medium to another. It is not unreasonable to assume that the higher activity anomalies are related to marked changes in materials within the ground such as buried foundations or surfaces within the soil matrix.

Colour Scale for Timeslice 'Activity' Plots and Simplified Key



High Energy Return
-Possible Target

Medium Energy Return
-Mixed Ground

Low Energy Return
-Homogenous Ground

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

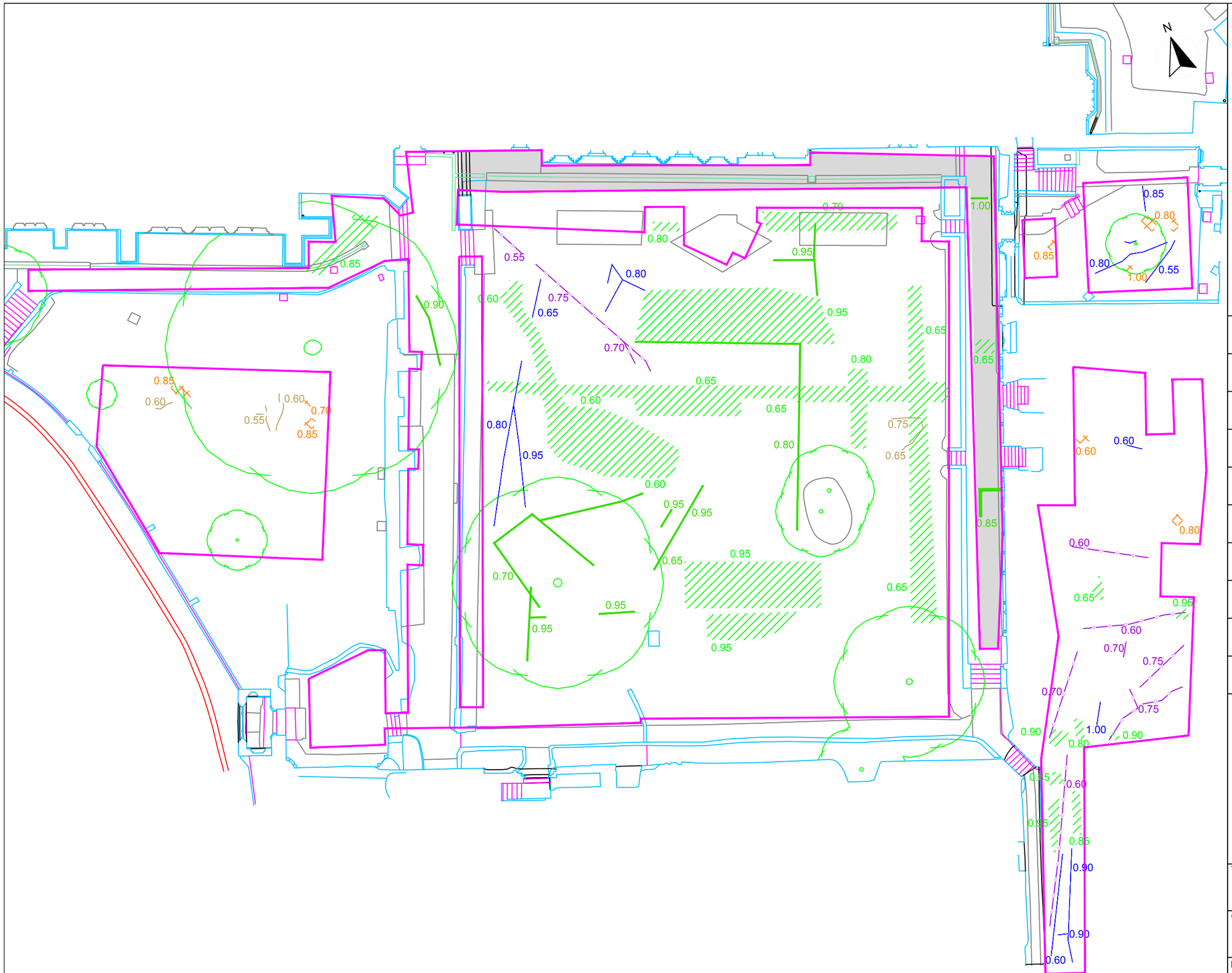
Title:
GPR Survey - Timeslice at 0.95m

Client:
Rochester Cathedral

Project:
Rochester Cathedral

Scale:
0 metres 15
1:300 @ A3

Fig No:
10



KEY

	Linear anomaly probably related to archaeology
	Complex and discrete anomaly possibly related to archaeological remains
	Linear feature of uncertain origin
	Weak discrete and complex anomaly of uncertain origin
	Buried surface
	Potential service
	Tree root
	Area set 0.8-1.0m below the level of the Cloister Garth
0.60	Depth to the top of the feature (in m)

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
GPR Survey - Interpretation - 0.5-1.0m

Client:
Rochester Cathedral

Project:
Rochester Cathedral

Scale:
0 metres 12.5
1:250 @ A3

Fig No:
11

Timeslice at 1.20m depth

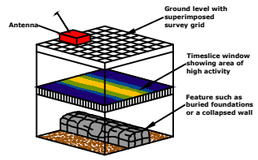
2000E

2025E

2050E

TIMESLICE PLOTS

In addition to a manual abstraction from the radargrams, a computer analysis was carried out. The radar data is interrogated for areas of high activity and the results presented in a plan format known as timeslice plots. In this way it is easy to see if the high activity areas form recognisable patterns.

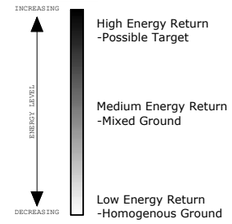


The GPR data is compiled to create a 3D file. This 3D file can be manipulated to view the data from any angle and at any depth within range. The data was then modelled to produce activity plots at various depths. As the radar is actually measuring the time for each of the reflections found, these are called "time slice windows". Plots for various time slices have been included in the report. Calculations, based on an average velocity, have been made to show the equivalent depth into the ground. The data was sampled between different time intervals effectively producing plans at different depths into the ground.

The weaker reflections in the time slice windows are shown as light grey. The stronger reflections are represented by dark grey and black.

Reflections within the radar image are generated by a change in velocity of the radar from one medium to another. It is not unreasonable to assume that the higher activity anomalies are related to marked changes in materials within the ground such as buried foundations or surfaces within the soil matrix.

Colour Scale for Timeslice 'Activity' Plots and Simplified Key



sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
GPR Survey - Timeslice at 1.20m

Client:
Rochester Cathedral

Project:
Rochester Cathedral

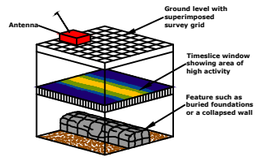
Scale:
0 metres 15
1:300 @ A3

Fig No:
12

Timeslice at 1.40m depth

TIMESLICE PLOTS

In addition to a manual abstraction from the radargrams, a computer analysis was carried out. The radar data is interrogated for areas of high activity and the results presented in a plan format known as timeslice plots. In this way it is easy to see if the high activity areas form recognisable patterns.

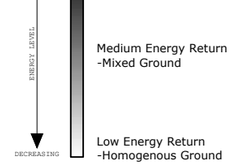


The GPR data is compiled to create a 3D file. This 3D file can be manipulated to view the data from any angle and at any depth within range. The data was then modelled to produce activity plots at various depths. As the radar is actually measuring the time for each of the reflections found, these are called "time slice windows". Plots for various time slices have been included in the report. Calculations, based on an average velocity, have been made to show the equivalent depth into the ground. The data was sampled between different time intervals effectively producing plans at different depths into the ground.

The weaker reflections in the time slice windows are shown as light grey. The stronger reflections are represented by dark grey and black.

Reflections within the radar image are generated by a change in velocity of the radar from one medium to another. It is not unreasonable to assume that the higher activity anomalies are related to marked changes in materials within the ground such as buried foundations or surfaces within the soil matrix.

Colour Scale for Timeslice 'Activity' Plots and Simplified Key



High Energy Return
-Possible Target

Medium Energy Return
-Mixed Ground

Low Energy Return
-Homogenous Ground

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

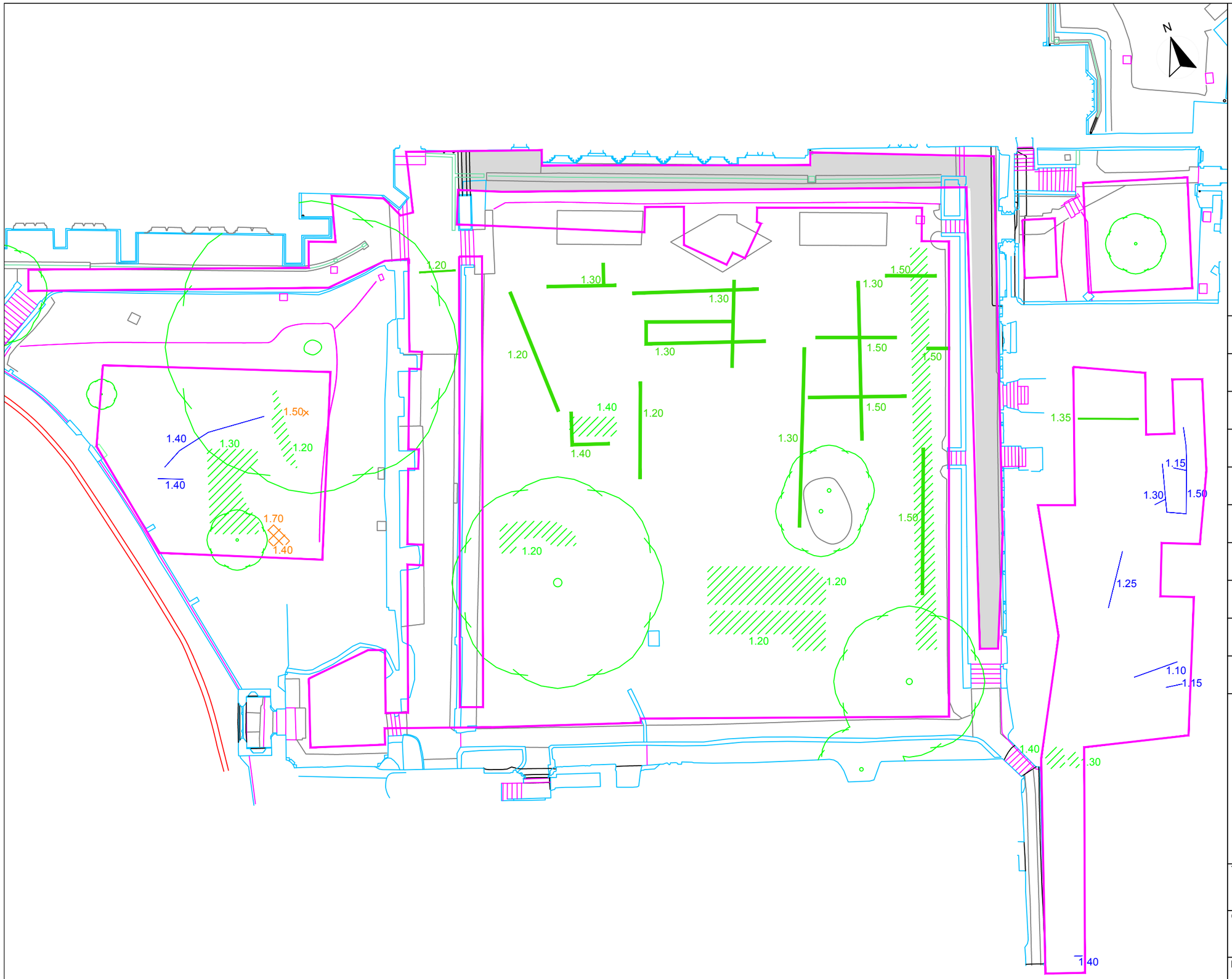
Title:
GPR Survey - Timeslice at 1.40m

Client:
Rochester Cathedral

Project:
Rochester Cathedral

Scale:
0 metres 15
1:300 @ A3

Fig No:
13



KEY

	Linear anomaly probably related to archaeology
	Complex and discrete anomaly possibly related to archaeological remains
	Linear feature of uncertain origin
	Weak discrete and complex anomaly of uncertain origin
	Buried surface
	Potential service
	Tree root
	Area set 0.8-1.0m below the level of the Cloister Garth
0.60	Depth to the top of the feature (in m)

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
GPR Survey - Interpretation - 1.0-1.5m

Client:
Rochester Cathedral

Project:
Rochester Cathedral

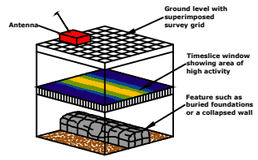
Scale:
0 metres 12.5
1:250 @ A3

Fig No:
14

Timeslice at 1.60m depth

TIMESLICE PLOTS

In addition to a manual abstraction from the radargrams, a computer analysis was carried out. The radar data is interrogated for areas of high activity and the results presented in a plan format known as timeslice plots. In this way it is easy to see if the high activity areas form recognisable patterns.

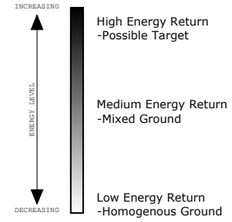


The GPR data is compiled to create a 3D file. This 3D file can be manipulated to view the data from any angle and at any depth within range. The data was then modelled to produce activity plots at various depths. As the radar is actually measuring the time for each of the reflections found, these are called "time slice windows". Plots for various time slices have been included in the report. Calculations, based on an average velocity, have been made to show the equivalent depth into the ground. The data was sampled between different time intervals effectively producing plans at different depths into the ground.

The weaker reflections in the time slice windows are shown as light grey. The stronger reflections are represented by dark grey and black.

Reflections within the radar image are generated by a change in velocity of the radar from one medium to another. It is not unreasonable to assume that the higher activity anomalies are related to marked changes in materials within the ground such as buried foundations or surfaces within the soil matrix.

Colour Scale for Timeslice 'Activity' Plots and Simplified Key



sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

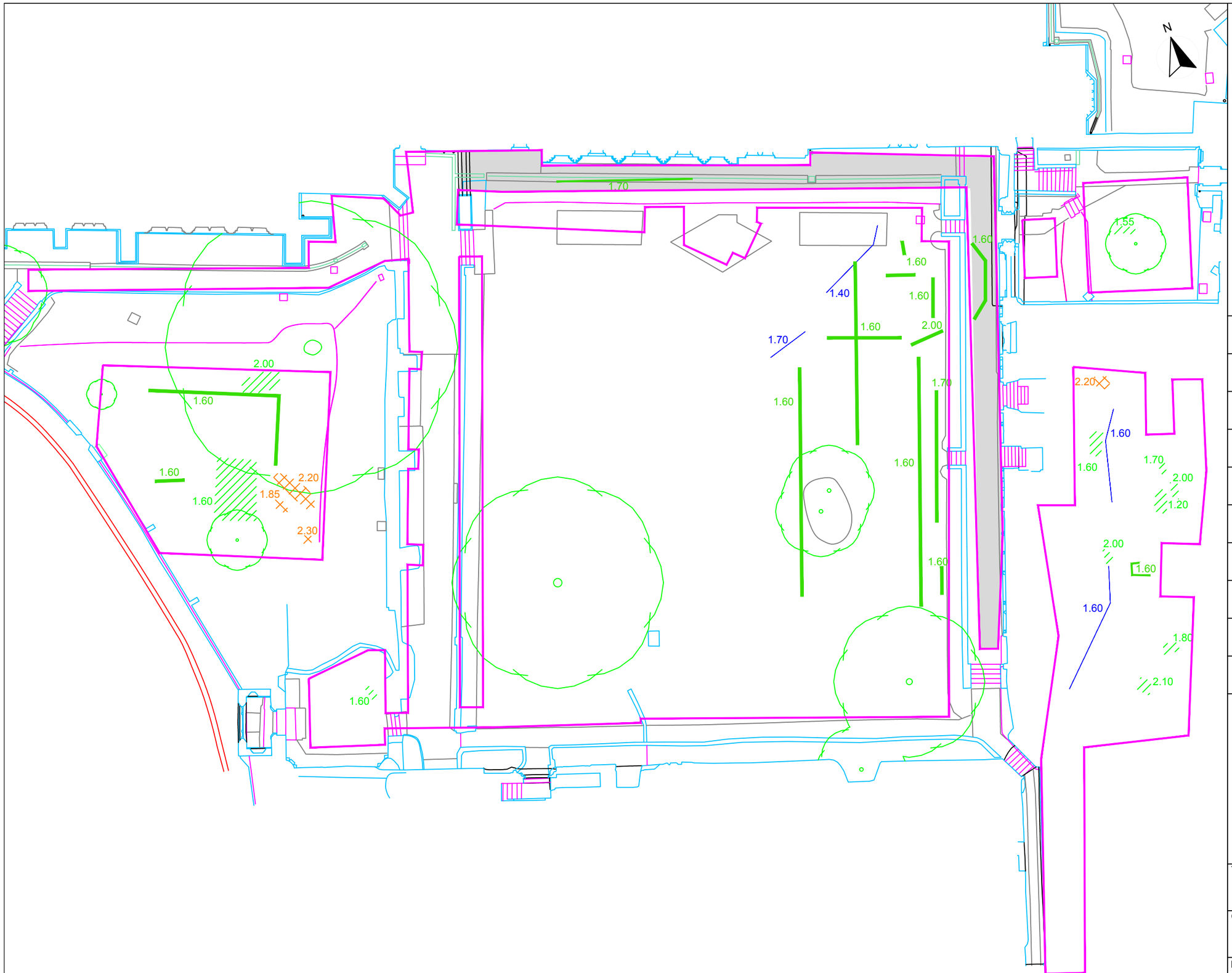
Title:
GPR Survey - Timeslice at 1.60m

Client:
Rochester Cathedral

Project:
Rochester Cathedral

Scale:
0 metres 15
1:300 @ A3

Fig No:
15



KEY

	Linear anomaly probably related to archaeology
	Complex and discrete anomaly possibly related to archaeological remains
	Linear feature of uncertain origin
	Weak discrete and complex anomaly of uncertain origin
	Buried surface
	Potential service
	Tree root
	Area set 0.8-1.0m below the level of the Cloister Garth
0.60	Depth to the top of the feature (in m)

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

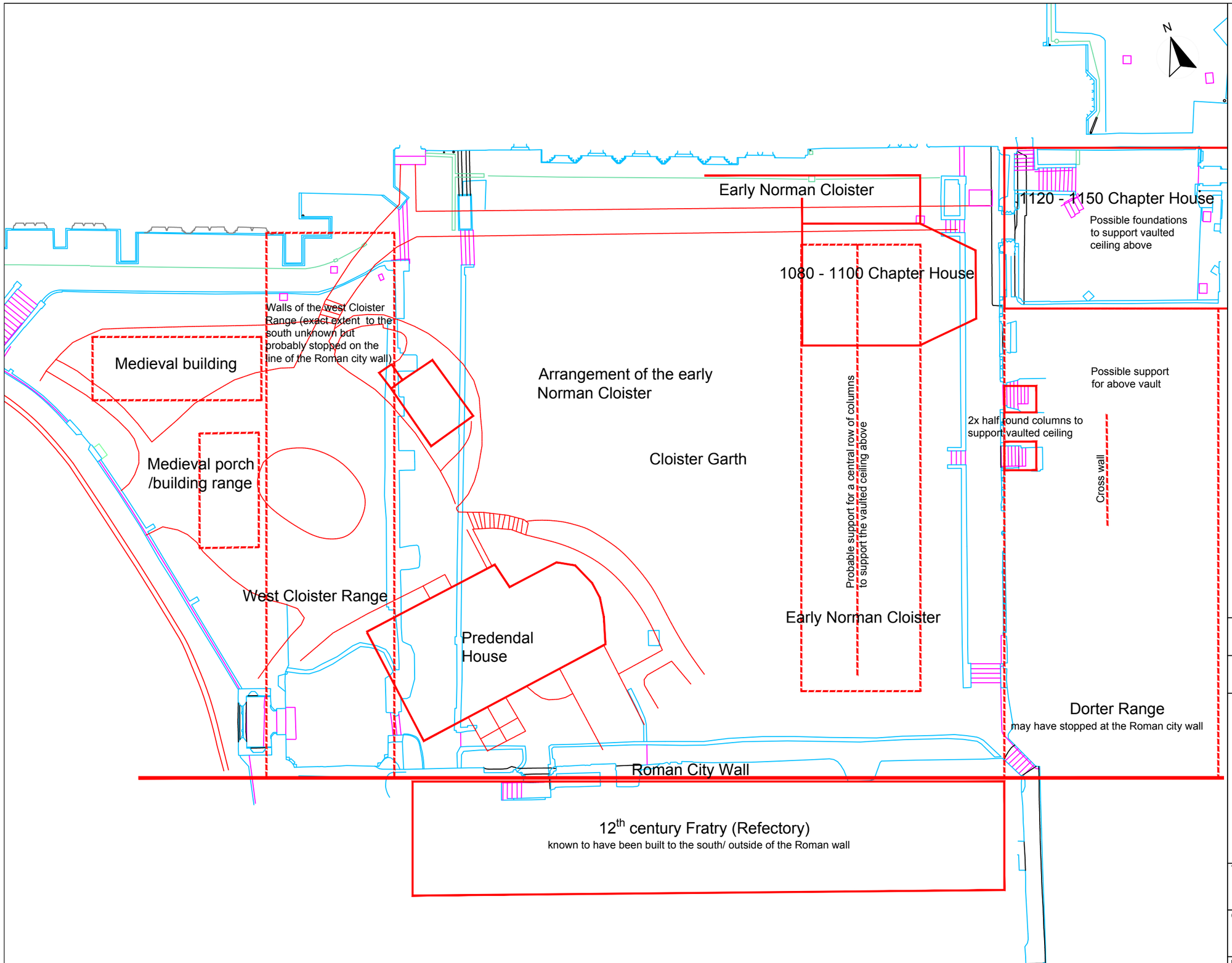
Title:
GPR Survey - Interpretation - 1.5-2.3m

Client:
Rochester Cathedral

Project:
Rochester Cathedral

Scale:
0 metres 12.5
1:250 @ A3

Fig No:
16



KEY

Information provided by the client and from 1867 OS Map

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

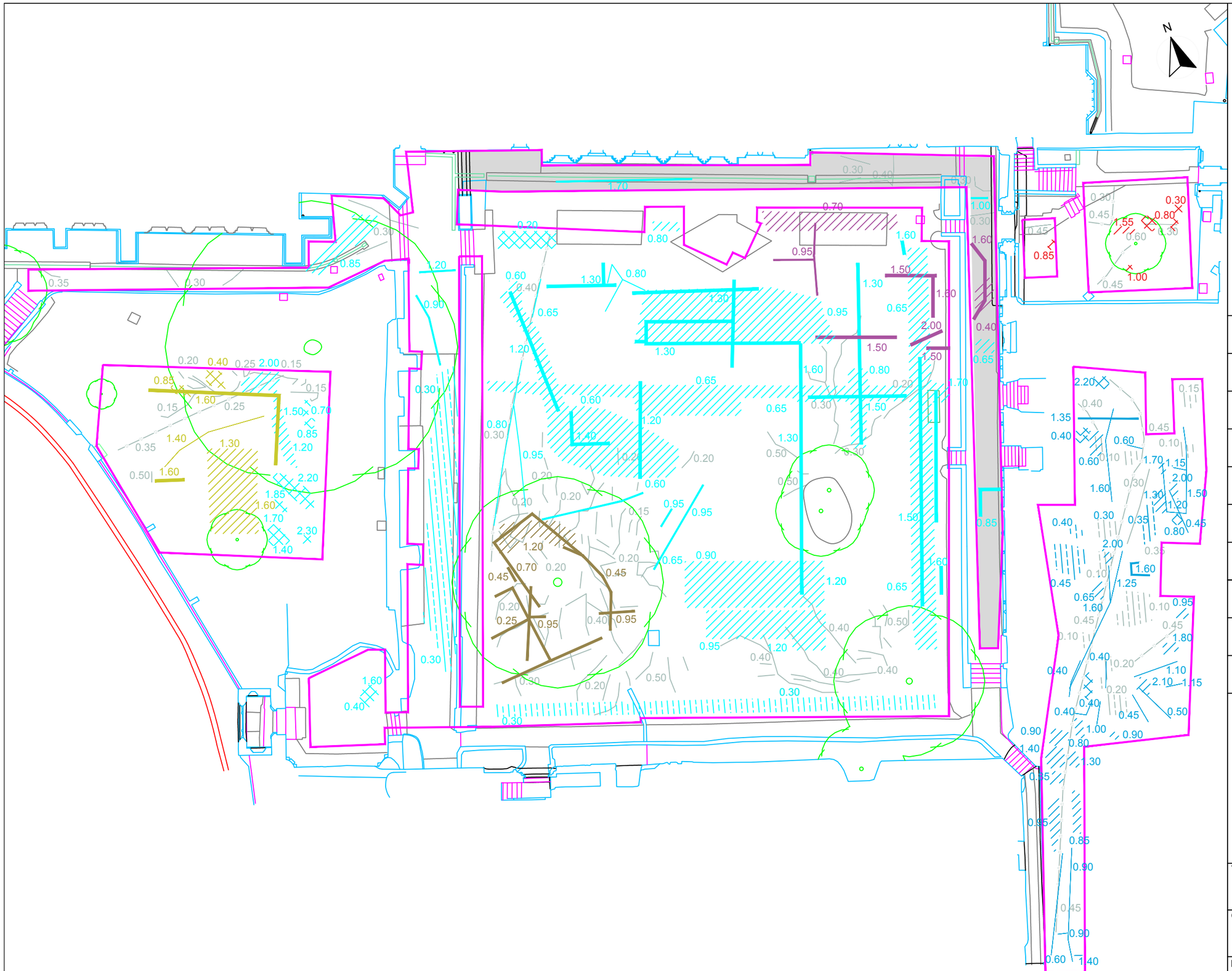
Title:
Known Archaeological Remains

Client:
Rochester Cathedral

Project:
Rochester Cathedral

Scale:
0 metres 12.5
1:250 @ A3

Fig No:
17



KEY

	Anomalies related to 1080-1100 Chapter House
	Anomalies related to Early Norman Cloister and Garth
	Anomalies related to 1120-1150 Chapter House
	Anomalies related to 1805 Prebendal House
	Anomalies related to Dorter Range
	Anomalies related to medieval buildings (porch)
	Anomalies of modern origin (tree roots, services, buried surfaces)
	Area set 0.8-1.0m below the level of the Cloister Garth
0.60	Depth to the top of the feature (in m)

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

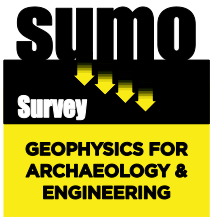
Title:
GPR Survey - Combined Interpretation

Client:
Rochester Cathedral

Project:
Rochester Cathedral

Scale:
0 metres 12.5
1:250 @ A3

Fig No:
18



- Archaeological
- Geophysical
- Laser Scanning
- Measured Building
- Topographic
- Utility Mapping

SUMO Services Ltd, incorporated under the laws of England and Wales,
Company Registration No.4275993.
Registered Office Unit 8 Hayward Business Centre, New Lane, Havant, Hampshire, PO9 2NL