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Geophysical survey report

Rochester Cathedral, January 2018

Keevill, G. and SUMO Survey

Abstract:

A Ground Penetrating Radar (GPR) survey was conducted over approximately 2550m² of the interior of Rochester Cathedral. A section of street and footway outside the west end of the cathedral was also surveyed where the remains of the Anglo-Saxon church are known to be located.

To cite this report:

Keevill, G. and SUMO Survey (2018) *Geophysical survey report;* Rochester Cathedral, January 2018. Rochester: Rochester Cathedral Research Guild.

To link to this article:

https://rochestercathedralresearchguild.org/bibliography/2018-12

Published online: 23rd March 2018

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Rochester CATHEDRAL

GEOPHYSICAL SURVEY REPORT

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Incorporating

GSB PROSPECTION LTD

and

STRATASCAN LTD

Rochester Cathedral

Client
Rochester Cathedral

Survey Report
12287

Date
March 2018

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GEOPHYSICAL SURVEY REPORT

Project name:
Rochester Cathedral

SUMO Job reference:
12287

Client:
Rochester Cathedral

Survey date:
23-26 January 2018

Report date:
21 March 2018

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Peter Barker CEng MICE MCIWEM MCIfA FCInstCES

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1 SUMMARY OF RESULTS

A Ground Penetrating Radar (GPR) survey was conducted over approximately 2550m² of the interior of Rochester Cathedral. A section of street and footway outside the west end of the cathedral was also surveyed where the remains of the Anglo-Saxon cathedral church are known to be located.

Numerous anomalies were identified across the site. Many are related to both known and unmarked graves. Evidence for the Saxon church was found as well as the earlier southern transept which had been found in a previous survey. Other anomalies could be associated with possible earlier foundations including the remains of a possibly later Anglo-Saxon or very early Norman phase in the Cathedral's construction.

The known vaulting system in the crypt was clearly imaged with anomalies possibly related to an altar or shrine. Other small fragmented complex, discrete and linear anomalies could be of archaeological or modern origin but their interpretation is unclear.

Evidence of potential services and buried surfaces was also revealed.

2 INTRODUCTION

2.1 Background synopsis

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

2.2 Site details

NGR / Postcode	TQ 743 685 / ME1 1SR
Location	The site is located at Rochester Cathedral and comprises of Nave, North and South Aisles, North and South Transepts, Quire and Presbytery. The street and footway to the west of the cathedral was also part of the survey area.
District	Kent
Unitary Authority Ward	Rochester West, Medway
Geology	Solid: Lewes Nodular Chalk Formation – chalk. No superficial deposits recorded (BGS 2018).
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. Parts of his cathedral survive within the present walling of the nave aisles along with the formerly detached Gundulf's tower and parts of the crypt. Rebuildings between C12 and C16. Major restorations by Cottingham (1825), Scott (1870s, mainly east end repairs and internal refurbishing), Pearson (1888, especially the west front), and C Hodgson-Fowler (1904-5 rebuilding of central tower, Historic England website). The western end of the Crypt dates back to the Cathedral's Norman origins, whilst the remainder is of a later construction. The east end of the Norman Cathedral is believed to lie beneath

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the later Crypt. Little is known about what might be beneath the South Quire Aisle but Medieval stratigraphy was recorded during 19th century excavations in the Quire (G.Keevil).

Survey Methods	Ground Penetrating Radar (GPR) survey
Study Area	c2550m² of the cathedral including the street and pavement to the west of the cathedral.

2.3 Aims and Objectives

The objective of the survey was to provide as much information as possible about the extent of the Saxon church, the Anglo Saxon and Norman cathedrals as well as any other archaeological remains including graves.

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.

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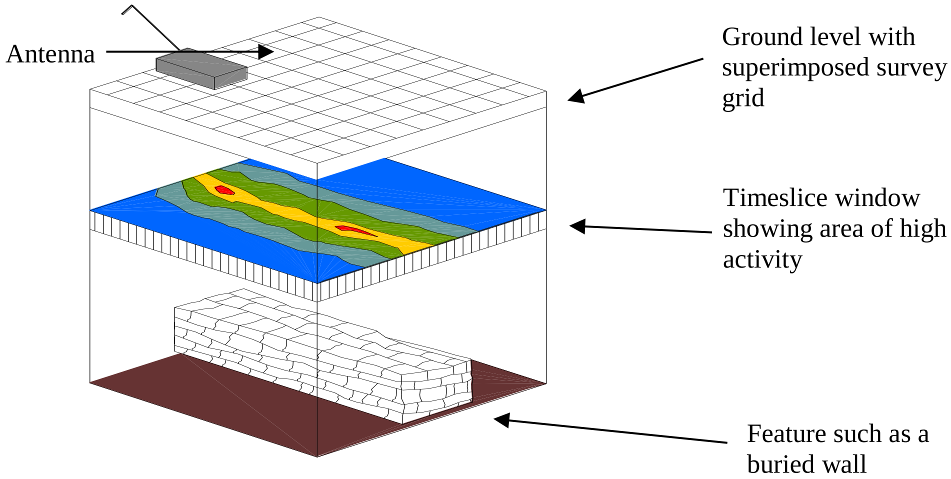
Timeslice plots

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 1. Depth slices of collected data are provided at 0.20-25m, 0.30-0.35m, 0.45-0.50m, 0.60-0.65m, 0.85-0.90m, 1.00-1.05m, 1.25-1.30m, 1.60-1.65m, 1.75-1.80m and 2.20-2.25m in Figures 2 to 4, 6 to 7, 9 to 10 and 12 to 14. Interpretation of data is provided in Figures 5, 8, 11 and 15 to 20.

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4 RESULTS

4.1 Discrete features have been identified at depths between 0.10 and 0.85m, and are thought to be related to probable and possible backfilled burials as well as stone ledgers without graves beneath (**1** on Figure 17). These features were marked brown, green and dark blue in the abstraction. The spatial dimensions of many of these anomalies are approximately 1m x 2m, and appear to be aligned with the east-west ecclesiastical compass of the cathedral. Some of the anomalies have strong responses and may contain voids or more substantial features such as associated masonry structures. Smaller responses indicative of possible graves have also been detected. Differences in the responses of the graves could be due to differing size, age, the presence or lack of backfill material, depth, preservation state, and the presence of a coffin and/or a grave slab.

4.2 Weak complex features have been identified at depths between 0.30-0.35m both outside and in the western end of the cathedral and marked with a brown cross hatch. These correspond well with the known location of the early Saxon church (**2** on Figure 17).

4.3 Discrete and complex features found at the west end of the cathedral at depths of 0.60-1.25m are believed to be possible remains of the late Saxon or early Norman cathedral. The features found between the columns in the Nave at the depths of 0.80-1.80m are possibly related to sleeper foundations for columns. However, they could also be associated with an earlier phase of the cathedral (**3** on Figure 17). These features are marked in red and purple.

4.4 Linear and complex features were found in the south quire aisle, at depths of 0.55 to 1.55m and are marked in purple (**4** on Figure 17). These are probable remains of the early south transept and correspond with the results of the GPR survey carried out in 2011.

4.5 Linear and discrete responses at depths between 0.20 to 1.50m are marked with a dark blue cross hatch between the depths of 0.30 to 1.50m. These are possible earlier walls or foundations (**5** on Figure 17).

4.6 A clear pattern of anomalies related to the vault system of the crypt was found at the depths between 0.55 and 1.80m and in marked in light blue and dark green (**6** on Figure 17).

4.7 Three small anomalies at the depths of 0.30-0.35m marked in red in Area 9 are possibly related to an old altar or shrine (**7** on Figure 17).

4.8 A number of small complex, discrete and linear features were found across the survey area at the depths between 0.20 and 2.20 and are marked with either an orange cross hatch, light green hatch or cyan lines (**8** on Figure 17). These fragmented and separated anomalies could be part of archaeological remains or be more modern. Their origin remains uncertain.

4.9 Potential services, manholes and buried surfaces related to the construction of the road were found outside the cathedral at depths between 0.20-2.05m (**9** on Figure 17).

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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 2.50m. Potential anomalies of archaeological and possibly modern origin have been detected, along with responses of uncertain origin, services and buried surfaces, indicating that the survey has been effective.

6 CONCLUSION

The survey at Rochester Cathedral has revealed a number of significant anomalies of archaeological origin. Probable remains of the Saxon church both within the west end of the cathedral and outside to the west were found as well as possible later Anglo-Saxon or early Norman cathedral remains between the columns in the Nave and at the west end of the cathedral. The survey identified possible foundations of the early Norman cathedral in the early south quire aisle (these had also been found in a previous survey). Further features are associated with known and unmarked graves, the vaulting system of the crypt and of possible remains of an altar to a shrine. Other small fragmented complex, discrete and linear anomalies could be of archaeological or modern origins but their interpretation is unclear

The survey revealed evidence of more modern features such as potential services and buried surfaces.

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7 REFERENCES

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HE 2018 *Cathedral Church of Christ and the Blessed Virgin Mary of Rochester* https://historicengland.org.uk/listing/the-list/list-entry/1086423

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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.

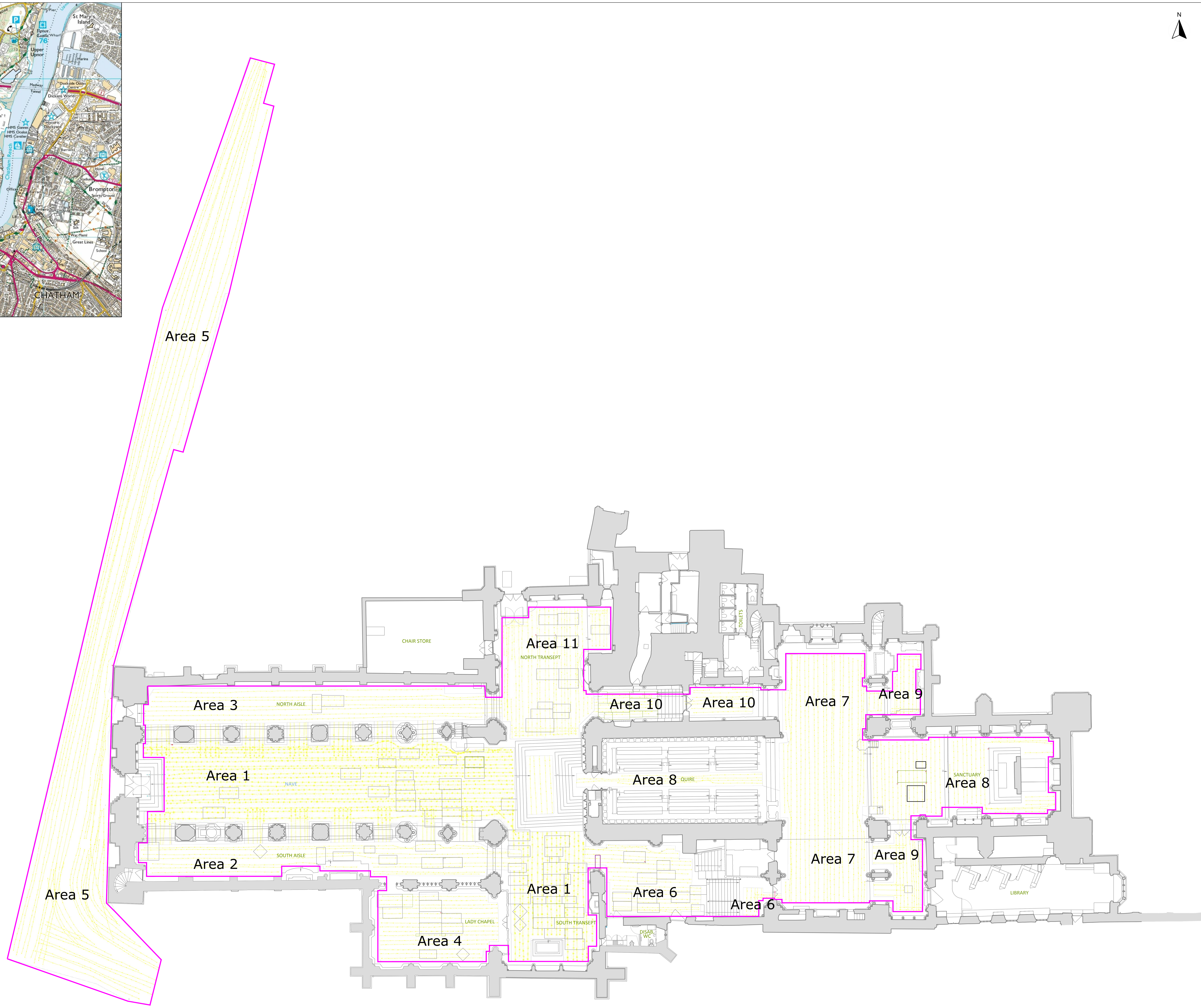
The Ground Penetrating Impulse Radars used was High Density Array system manufactured by Mala. This system collects data using 400MHz antenna.

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 5m 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.



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KEY	
	Radar traverse
	Survey area

SUMO Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

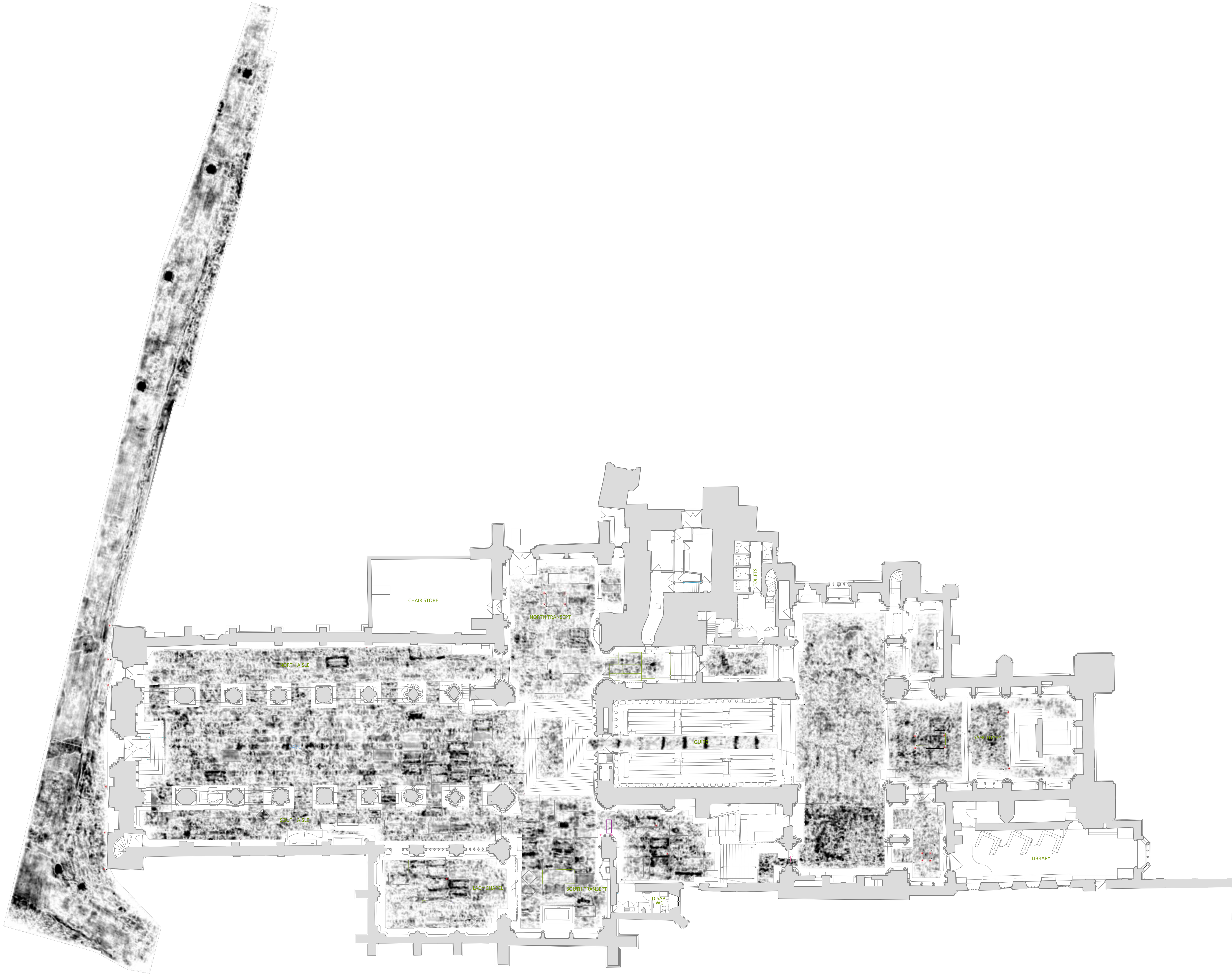
Title: Location of Survey Area

Client: ROCHESTER CATHEDRAL

Project: SOR12287 - ROCHESTER CATHEDRAL

Scale: 1:200 @ A1
0m 2 4 6 8 10m

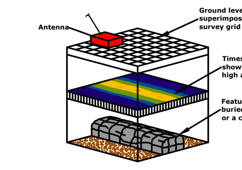
Fig No: 01



Timeslice at 0.20-0.25m 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.



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The weaker reflections in the time slice windows are shown as white and 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

INCREASING
ENERGY LEVEL
DECREASING

High Energy Return
-Possible Target

Medium Energy Return
-Mixed Ground

Low Energy Return
-Homogenous Ground

SUMO Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

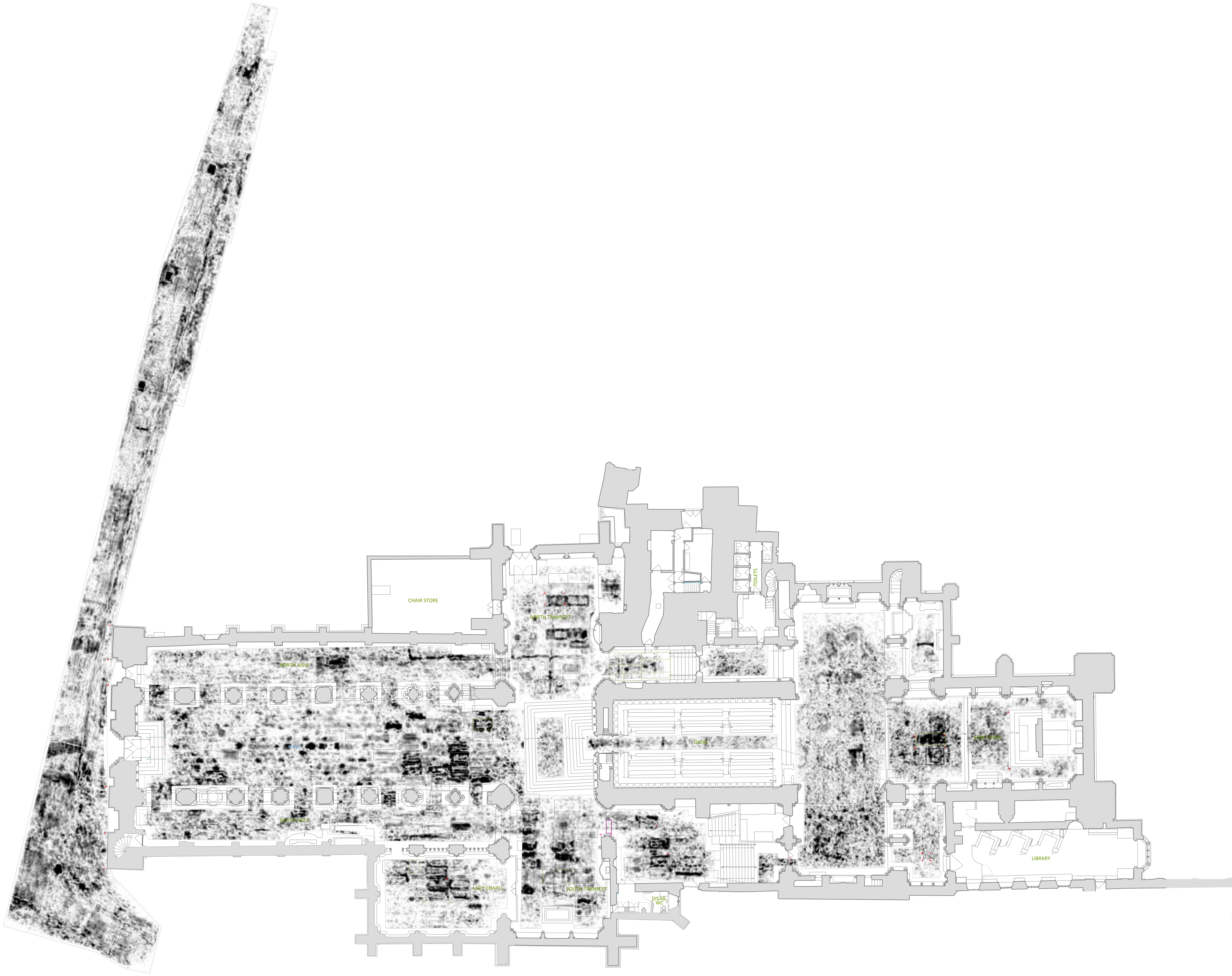
Title:
GPR Survey - Timeslice at 0.20-0.25m

Client:
ROCHESTER CATHEDRAL

Project:
SOR12287 - ROCHESTER CATHEDRAL

Scale: 1:200 @ A1
0m 2 4 6 8 10m

Fig No:
02



Timeslice at 0.30-0.35m depth

TIMESLICE PLOTS

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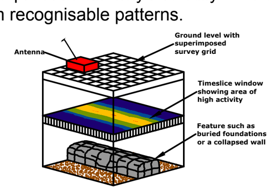

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Colour Scale for Timeslice 'Activity' Plots and Simplified Key

INCREASING
ENERGY LEVEL
DECREASING

High Energy Return
-Possible Target

Medium Energy Return
-Mixed Ground

Low Energy Return
-Homogenous Ground

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

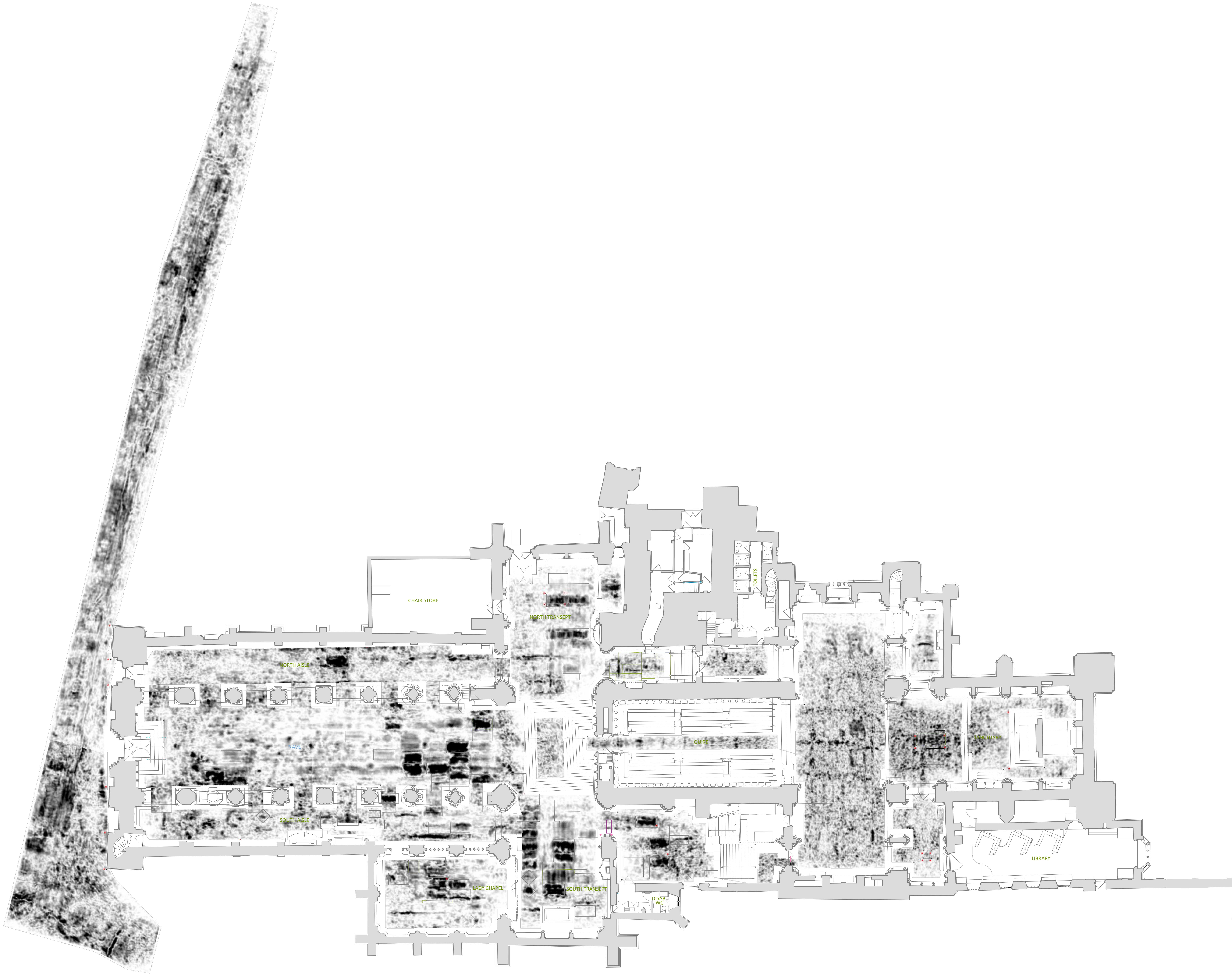
Title:
GPR Survey - Timeslice at 0.30-0.35m

Client:
ROCHESTER CATHEDRAL

Project:
SOR12287 - ROCHESTER CATHEDRAL

Scale: 1:200 @ A1
0m 2 4 6 8 10m

Fig No:
03



Timeslice at 0.45-0.50m depth

TIMESLICE PLOTS

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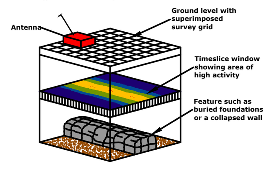

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Colour Scale for Timeslice 'Activity' Plots and Simplified Key

INCREASING
ENERGY LEVEL
DECREASING

High Energy Return
-Possible Target

Medium Energy Return
-Mixed Ground

Low Energy Return
-Homogenous Ground

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

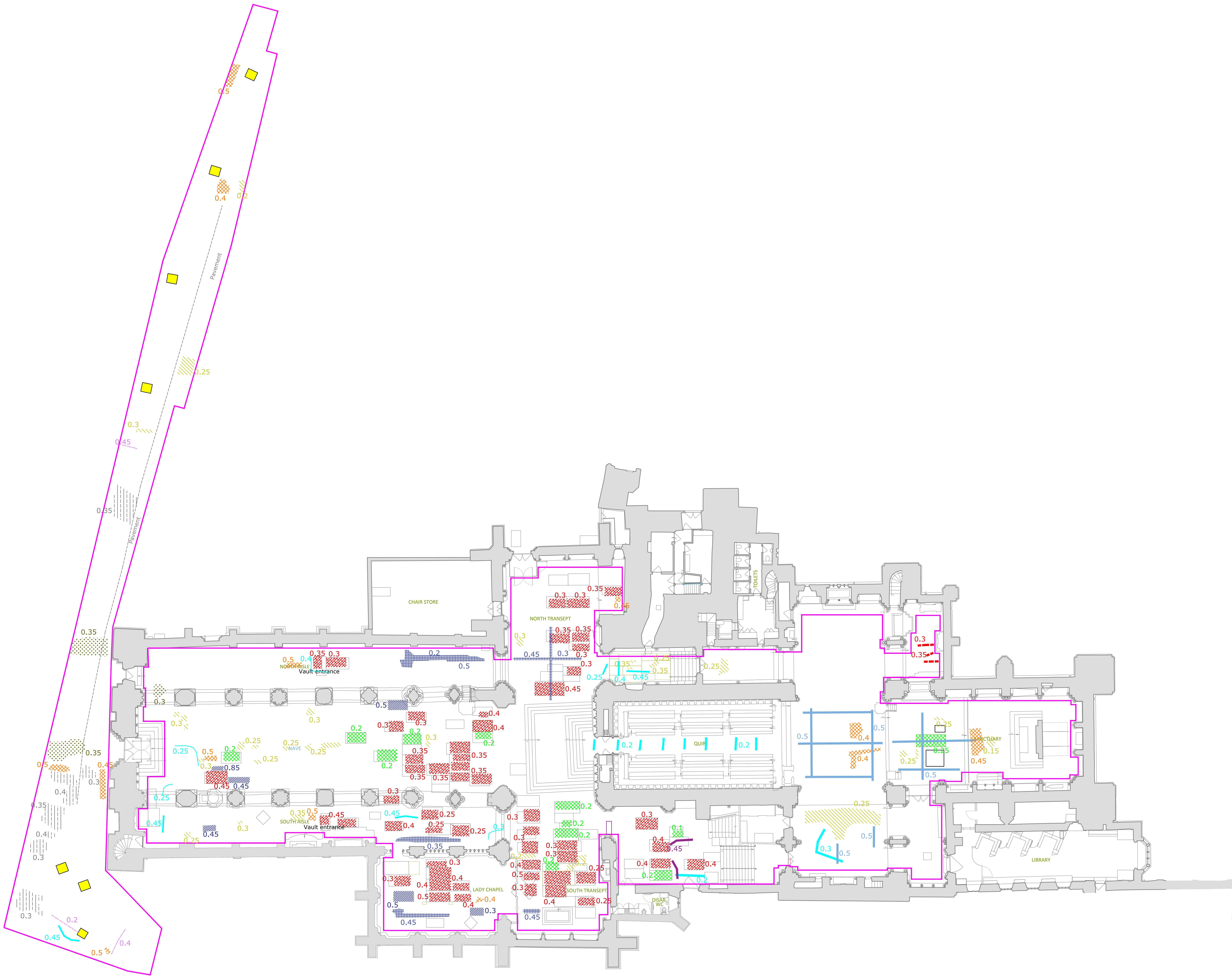
Title:
GPR Survey - Timeslice at 0.45-0.50m

Client:
ROCHESTER CATHEDRAL

Project:
SOR12287 - ROCHESTER CATHEDRAL

Scale: 1:200 @ A1
0m 2 4 6 8 10m

Fig No:
04



The performance of the technologies employed in non-invasive surveys can be adversely affected by factors outside of Sumo's control. Whilst Sumo uses all due diligence and reasonable endeavours it does not warrant that 100% detection can be achieved. Irrespective of the information provided by a geophysical survey, any ground works should be undertaken with extreme caution.

KEY

	Probable grave
	Possible grave
	Ledger without grave beneath
	Weak anomaly probably related to Saxon church
	Anomalies possibly related to early west end of the cathedral
	Anomalies associated with remains of Anglo-Saxon cathedral or sleeper walls
	Anomalies related to earlier southern transept
	Anomalies associated with archaeological remains - possible earlier walls or foundations
	Linear anomaly related to vaulted ceiling / top of the column
	Anomaly probably related to vaulting
	Anomaly possibly associated with old altar or shrine
	Anomaly of uncertain origin - possibly archaeological remains
	Linear anomaly of uncertain origin - possible structural remains
	Anomaly of uncertain origin - possibly modern
	Buried surface
	Potential service
	Manhole
0.60	Depth to the top of the feature (in m)

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

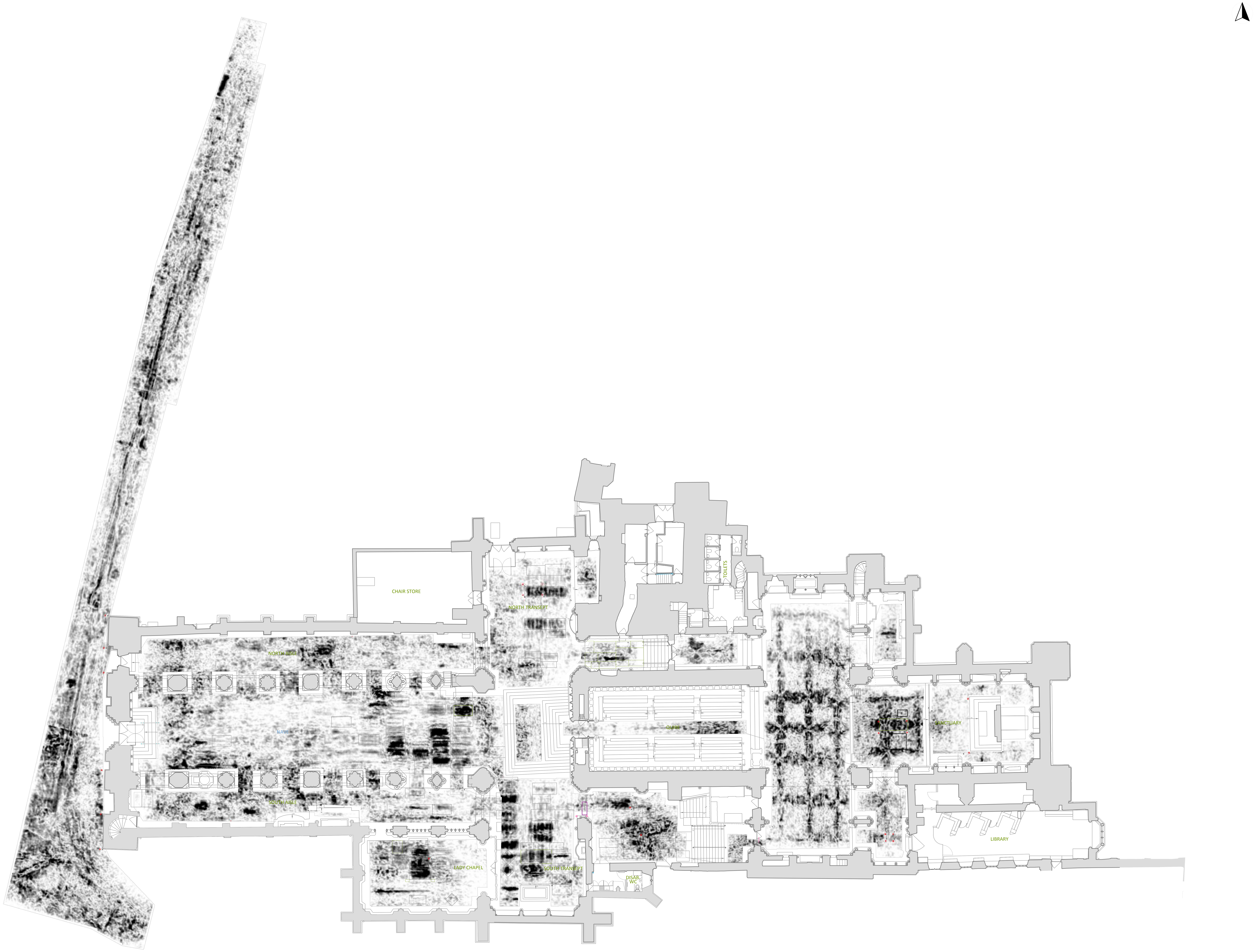
Title:
GPR Survey - Interpretation 0.00m - 0.50m

Client:
ROCHESTER CATHEDRAL

Project:
SOR12287 - ROCHESTER CATHEDRAL

Scale: 1:200 @ A1
0m 2 4 6 8 10m

Fig No:
05



Timeslice at 0.60-0.65m depth

TIMESLICE PLOTS

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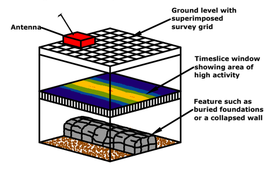

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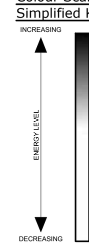
Reflections within the radar image are generated by a change in velocity of the radar from one medium to another. It is not unreasonable to assume that the higher activity anomalies are related to marked changes in materials within the ground such as buried foundations or surfaces within the soil matrix.

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 0.60-0.65m

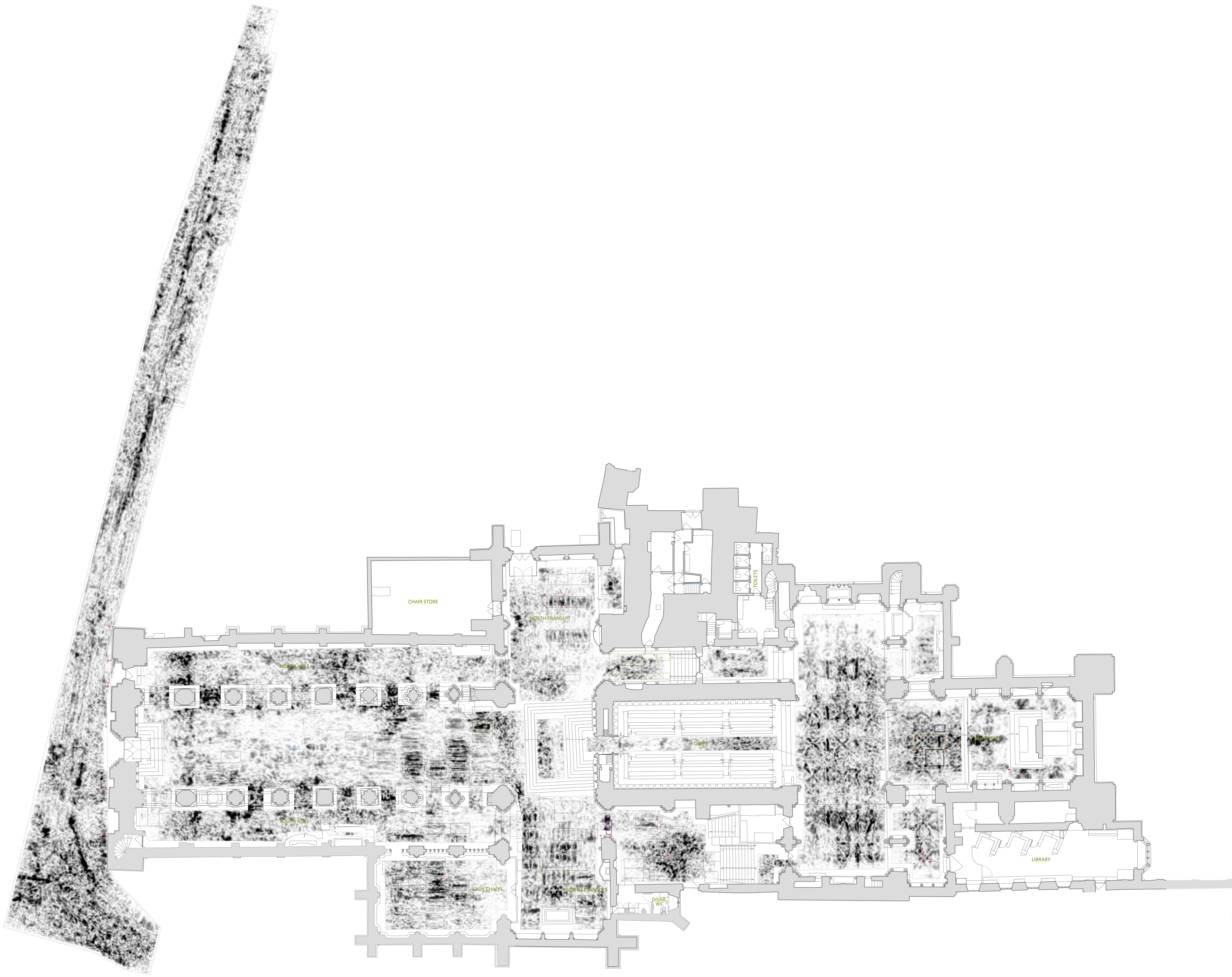
Client:
ROCHESTER CATHEDRAL

Project:
SOR12287 - ROCHESTER CATHEDRAL

Scale: 1:200 @ A1

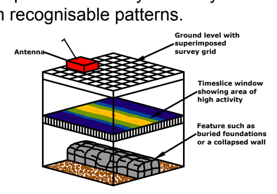
0m 2 4 6 8 10m

Fig No:
06



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 white and 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

INCREASING

ENERGY LEVEL

DECREASING

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 0.85-0.90m

Client:
ROCHESTER CATHEDRAL

Project:
SOR12287 - ROCHESTER CATHEDRAL

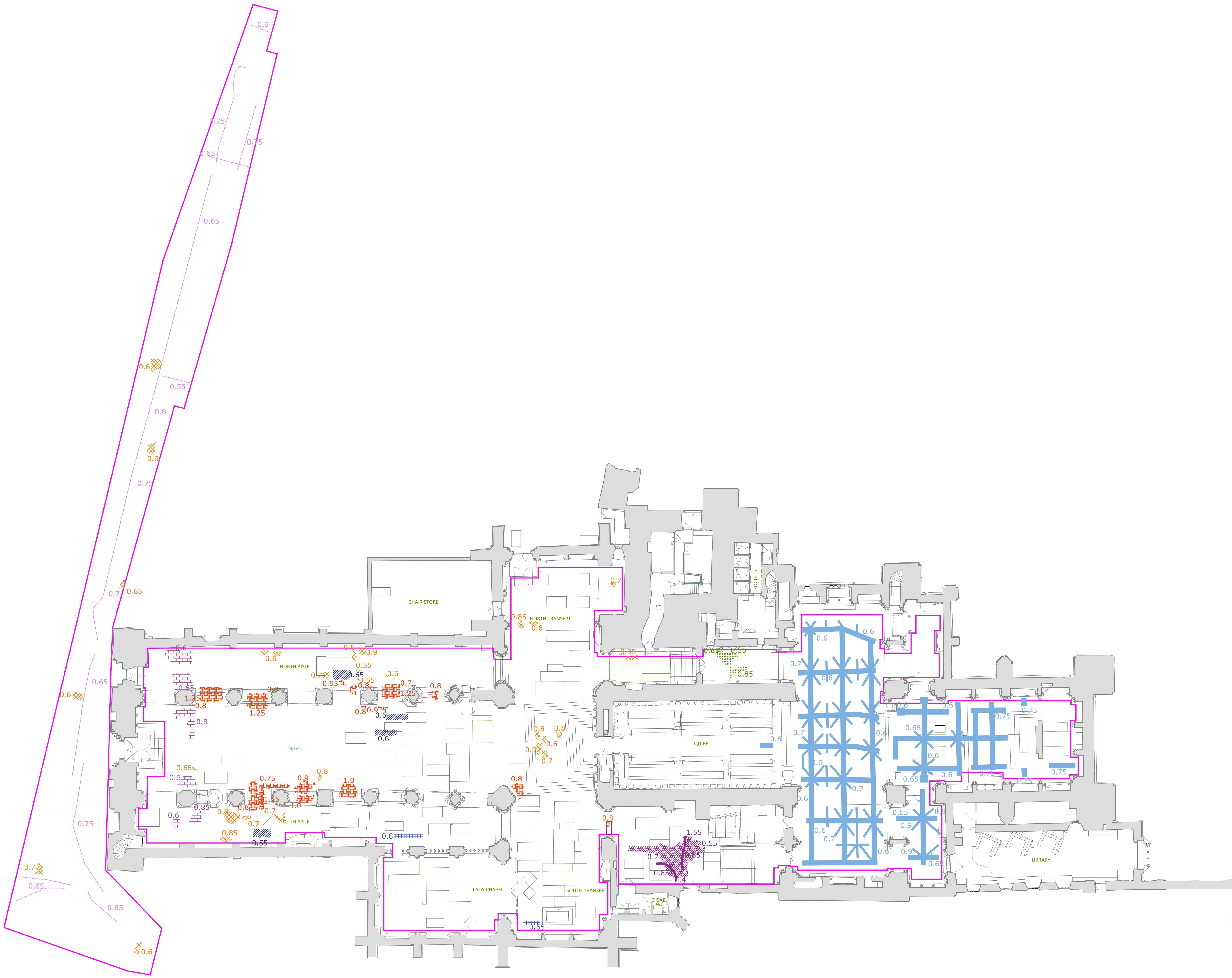
Scale: 1:200 @ A1
0m 2 4 6 8 10m

Fig No:
07

Timeslice at 0.85-0.90m depth

N

The performance of the technologies employed in non-invasive surveys can be adversely affected by factors outside of Sumo's control. Whilst Sumo uses all due diligence and reasonable endeavours it does not warrant that 100% detection can be achieved. Irrespective of the information provided by a geophysical survey, any ground works should be undertaken with extreme caution.



KEY

	Probable grave
	Possible grave
	Ledger without grave beneath
	Weak anomaly probably related to Saxon church
	Anomalies possibly related to early west end of the cathedral
	Anomalies associated with remains of Anglo-Saxon cathedral or sleeper walls
	Anomalies related to earlier southern transept
	Anomalies associated with archaeological remains - possible earlier walls or foundations
	Linear anomaly related to vaulted ceiling / top of the column
	Anomaly probably related to vaulting
	Anomaly possibly associated with old altar or shrine
	Anomaly of uncertain origin - possibly archaeological remains
	Linear anomaly of uncertain origin - possible structural remains
	Anomaly of uncertain origin - possibly modern
	Buried surface
	Potential service
	Manhole
0.60	Depth to the top of the feature (in m)

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
GPR Survey - Interpretation 0.50m - 1.00m

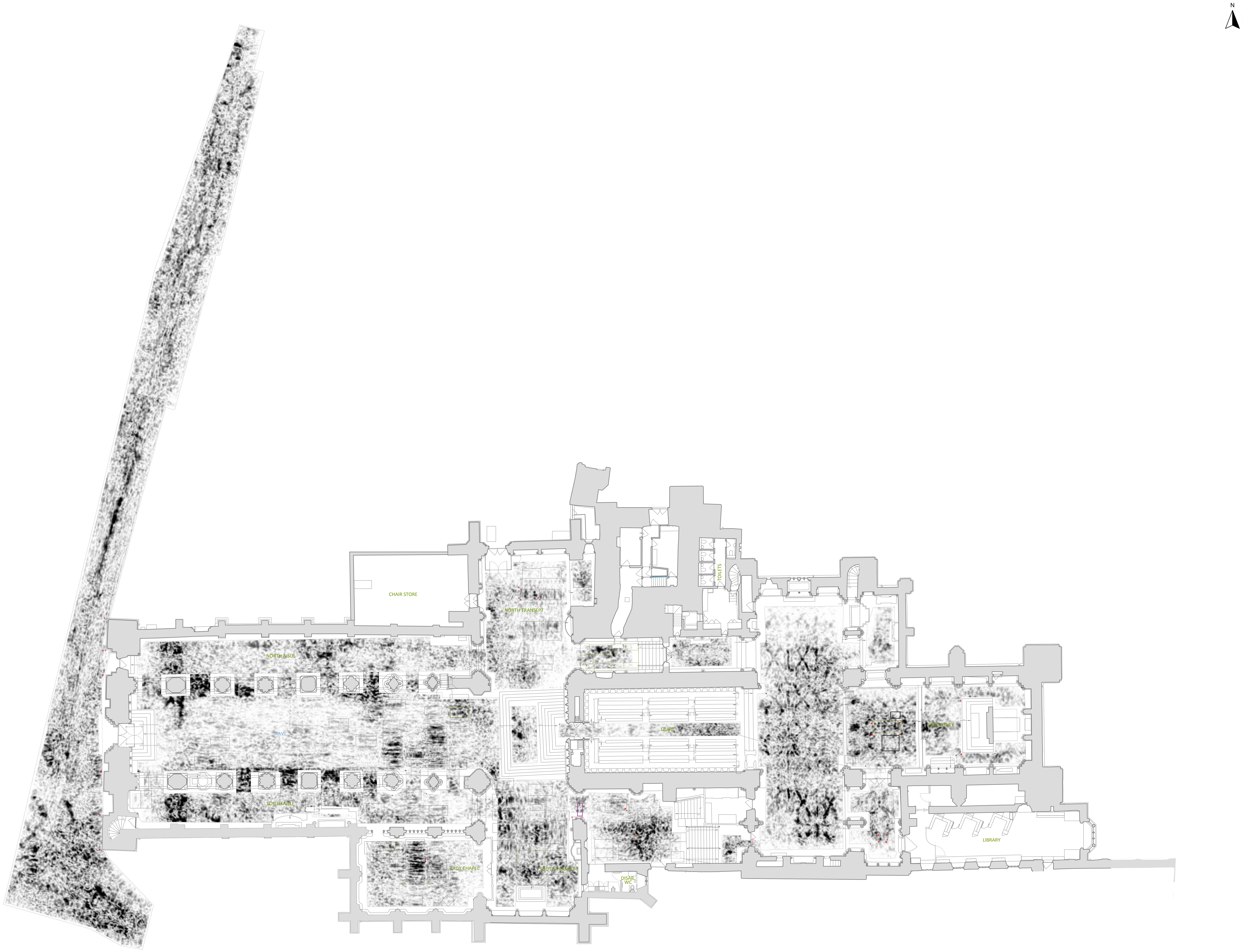
Client:
ROCHESTER CATHEDRAL

Project:
SOR12287 - ROCHESTER CATHEDRAL

Scale: 1:200 @ A1

0m 2 4 6 8 10m

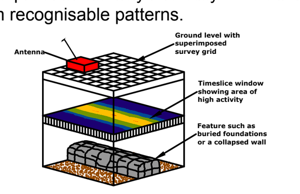
Fig No:
08



Timeslice at 1.00-1.05m 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 white and 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

INCREASING / ENERGY LEVEL / DECREASING

High Energy Return
-Possible Target

Medium Energy Return
-Mixed Ground

Low Energy Return
-Homogenous Ground

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:

GPR Survey - Timeslice at 1.00-1.05m

Client:

ROCHESTER CATHEDRAL

Project:

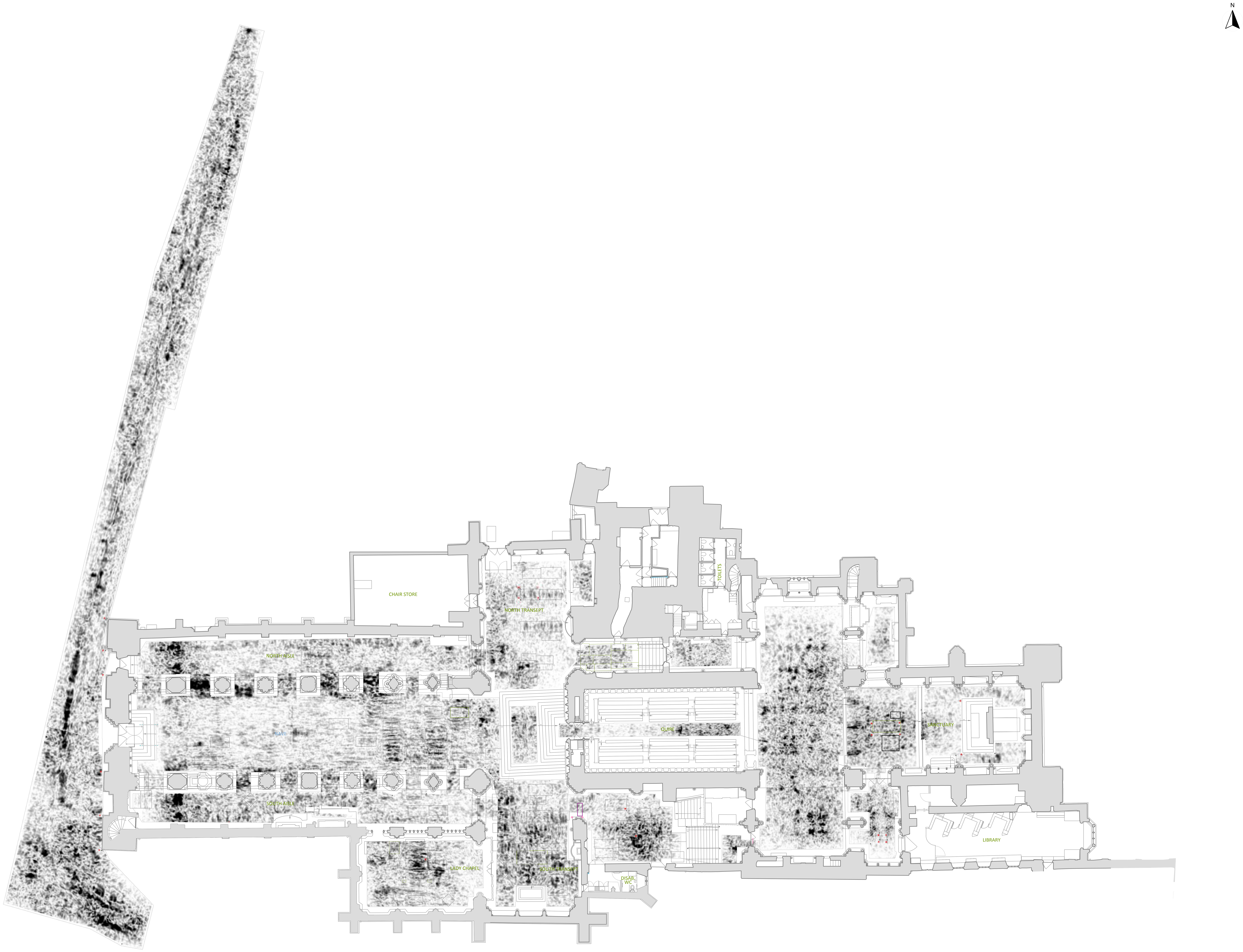
SOR12287 - ROCHESTER CATHEDRAL

Scale: 1:200 @ A1

0m 2 4 6 8 10m

Fig No:

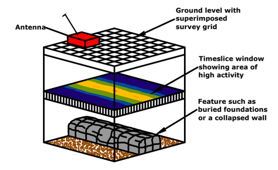
09



Timeslice at 1.25-1.30m 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 white and 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

INCREASING
ENERGY LEVEL
DECREASING

High Energy Return
-Possible Target

Medium Energy Return
-Mixed Ground

Low Energy Return
-Homogenous Ground

SUMO Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

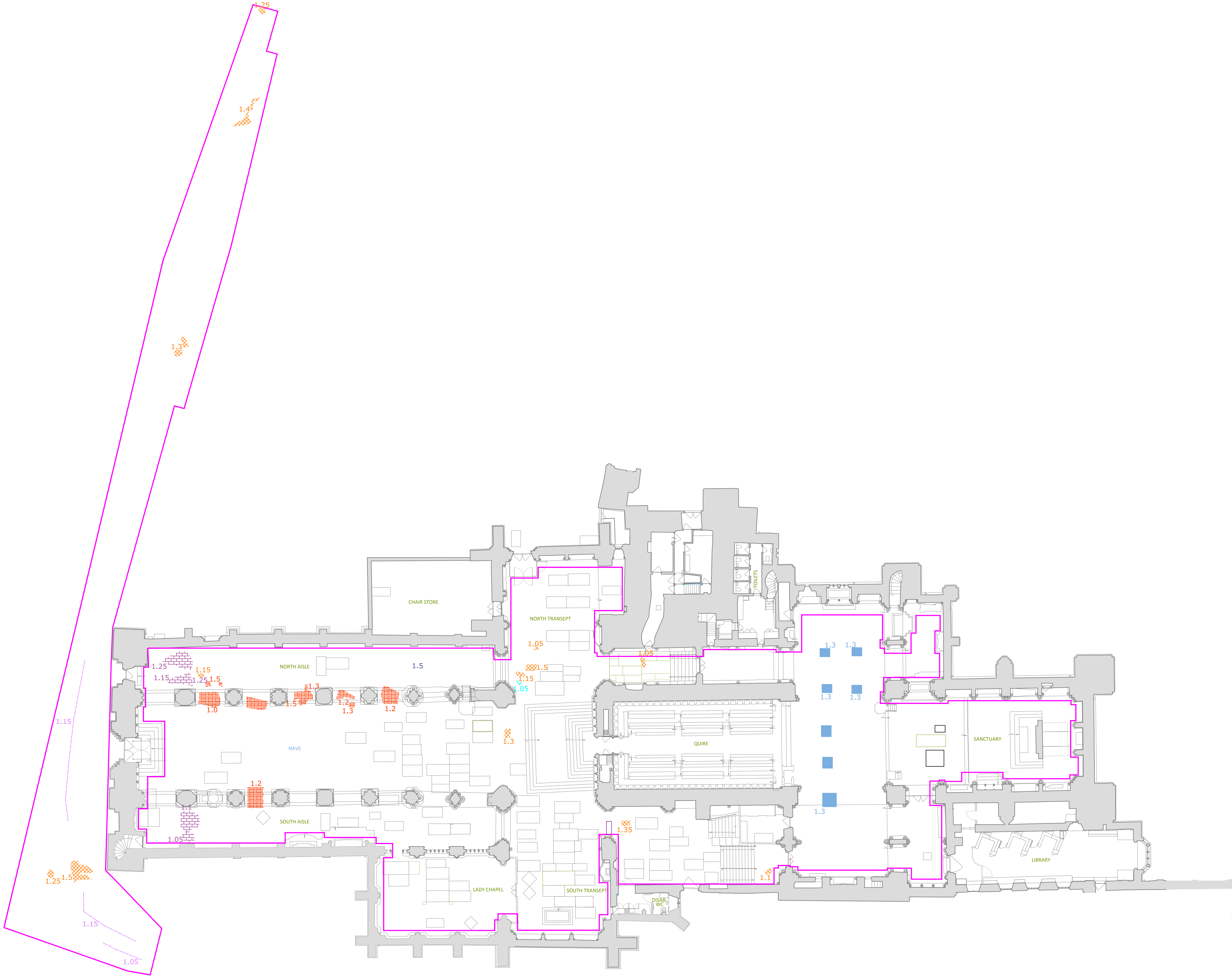
Title:
GPR Survey - Timeslice at 1.25-1.30m

Client:
ROCHESTER CATHEDRAL

Project:
SOR12287 - ROCHESTER CATHEDRAL

Scale: 1:200 @ A1
0m 2 4 6 8 10m

Fig No:
10



N

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KEY

	Probable grave
	Possible grave
	Ledger without grave beneath
	Weak anomaly probably related to Saxon church
	Anomalies possibly related to early west end of the cathedral
	Anomalies associated with remains of Anglo-Saxon cathedral or sleeper walls
	Anomalies related to earlier southern transept
	Anomalies associated with archaeological remains - possible earlier walls or foundations
	Linear anomaly related to vaulted ceiling / top of the column
	Anomaly probably related to vaulting
	Anomaly possibly associated with old altar or shrine
	Anomaly of uncertain origin - possibly archaeological remains
	Linear anomaly of uncertain origin - possible structural remains
	Anomaly of uncertain origin - possibly modern
	Buried surface
	Potential service
	Manhole
0.60	Depth to the top of the feature (in m)

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

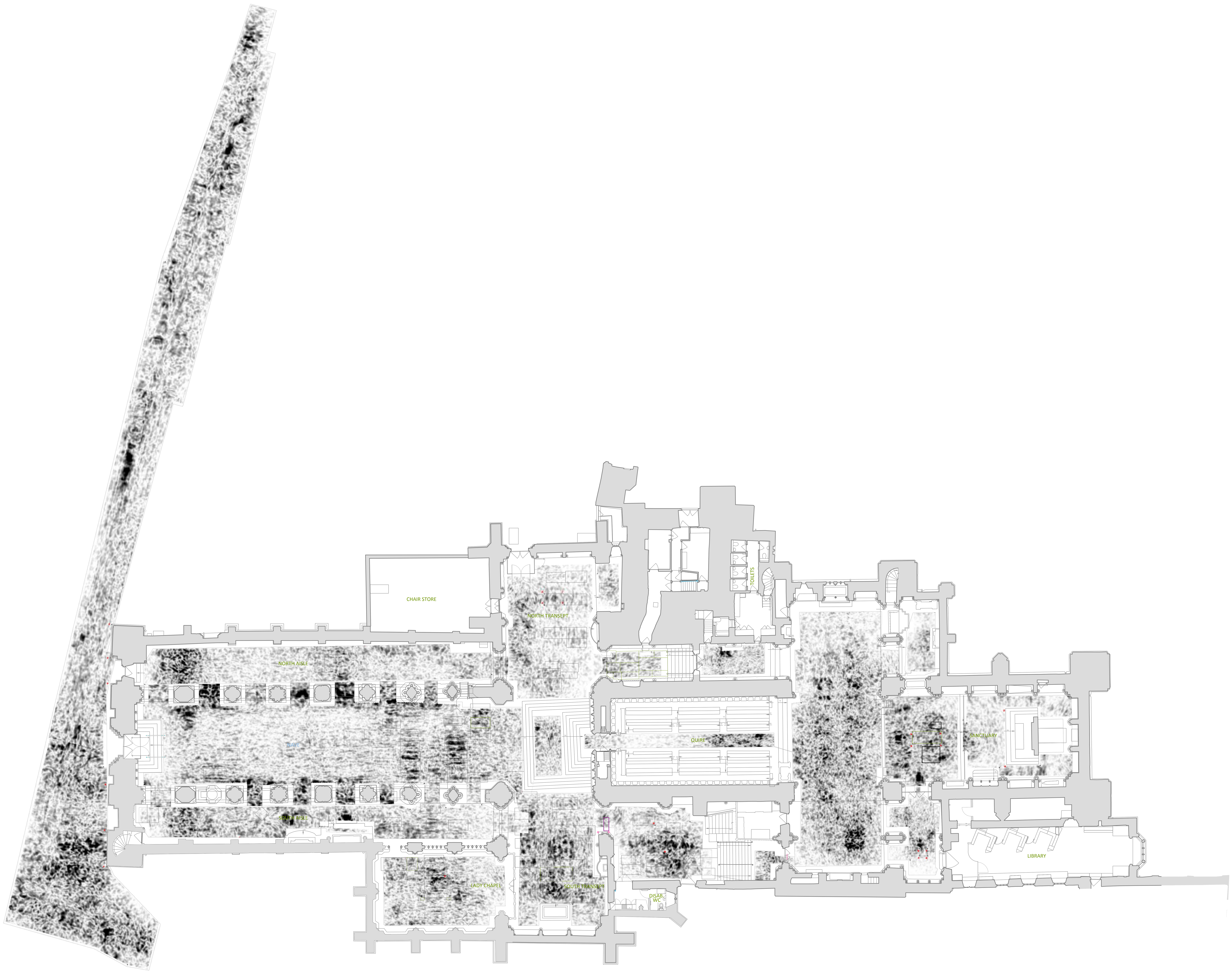
Title:
GPR Survey - Interpretation 1.00m - 1.50m

Client:
ROCHESTER CATHEDRAL

Project:
SOR12287 - ROCHESTER CATHEDRAL

Scale: 1:200 @ A1
0m 2 4 6 8 10m

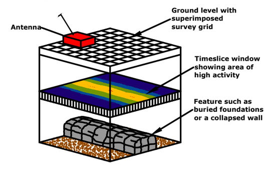
Fig No:
11



Timeslice at 1.60-1.65m 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.

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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

INCREASING
ENERGY LEVEL
DECREASING

High Energy Return
-Possible Target

Medium Energy Return
-Mixed Ground

Low Energy Return
-Homogenous Ground

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

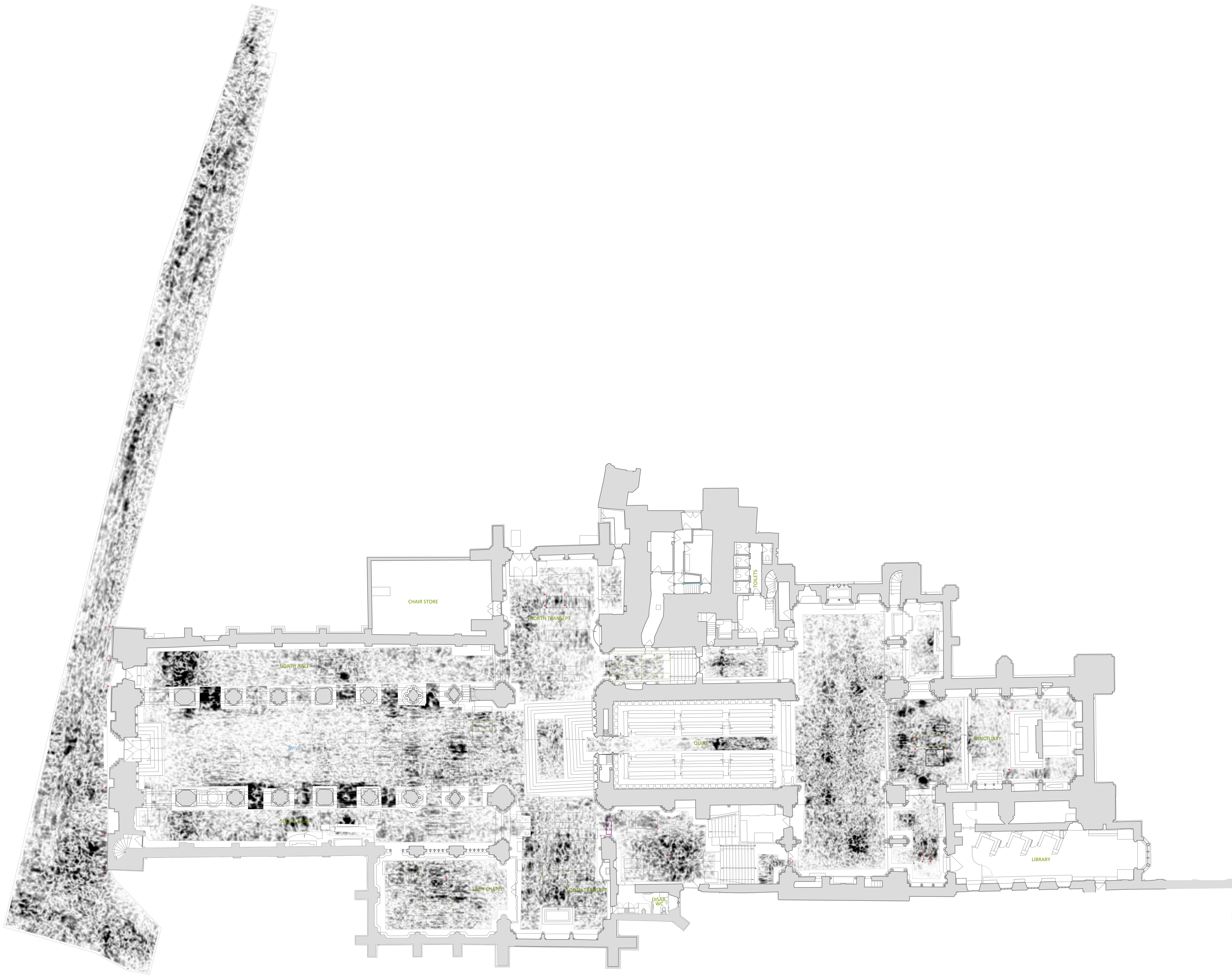
Title:
GPR Survey - Timeslice at 1.60-1.65m

Client:
ROCHESTER CATHEDRAL

Project:
SOR12287 - ROCHESTER CATHEDRAL

Scale: 1:200 @ A1
0m 2 4 6 8 10m

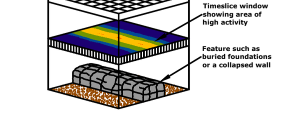
Fig No:
12



Timeslice at 1.75-1.80m 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 white and 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

INCREASING

ENERGY LEVEL

DECREASING

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 1.75-1.80m

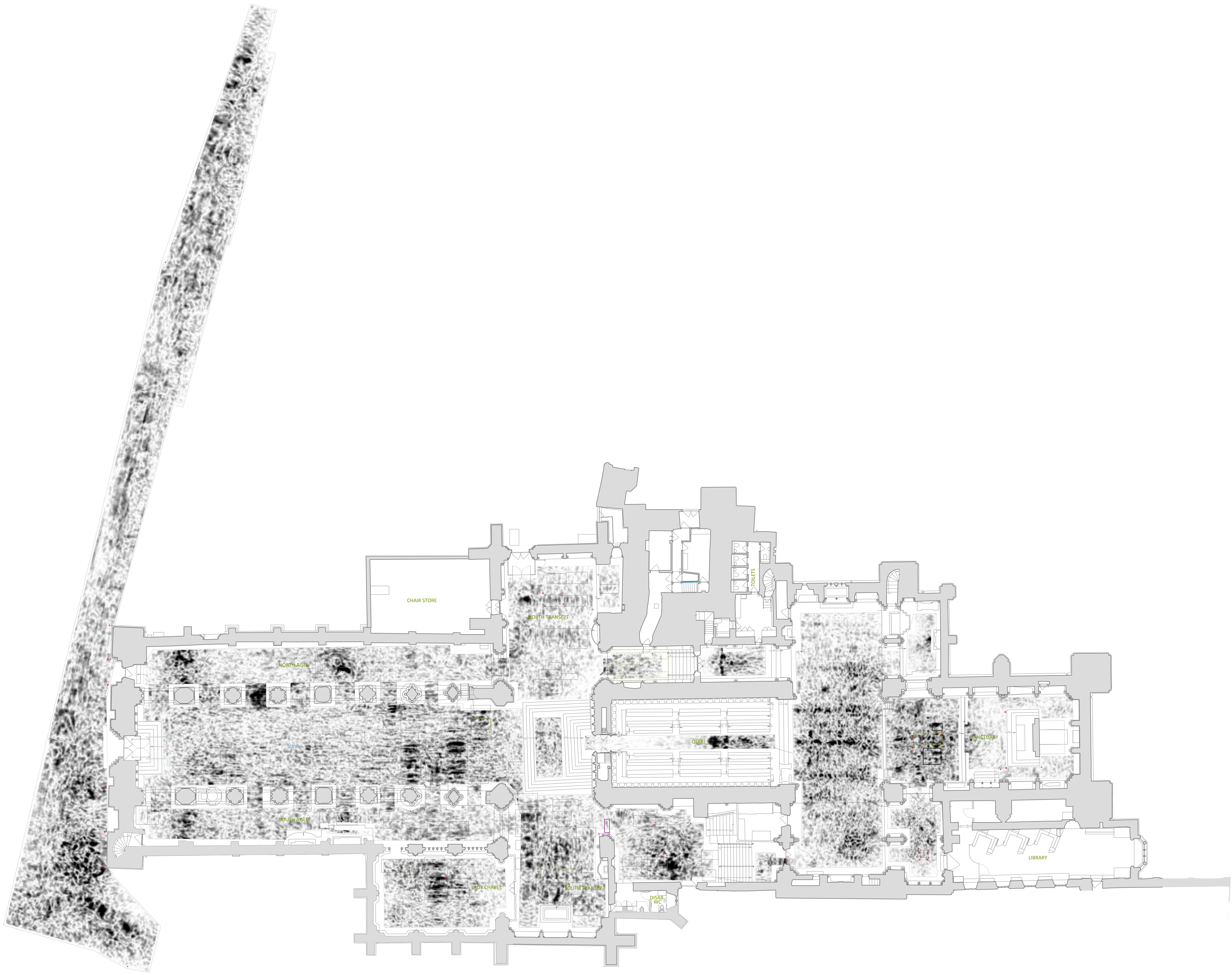
Client:
ROCHESTER CATHEDRAL

Project:
SOR12287 - ROCHESTER CATHEDRAL

Scale: 1:200 @ A1

0m 2 4 6 8 10m

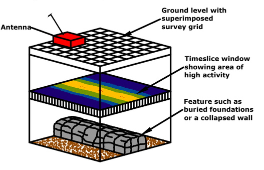
Fig No:
13



Timeslice at 2.20-2.25m 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.

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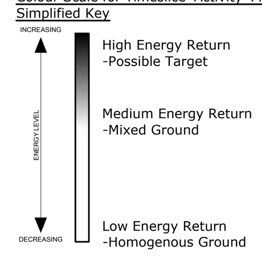
Reflections within the radar image are generated by a change in velocity of the radar from one medium to another. It is not unreasonable to assume that the higher activity anomalies are related to marked changes in materials within the ground such as buried foundations or surfaces within the soil matrix.

Colour Scale for Timeslice 'Activity' Plots and Simplified Key



sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

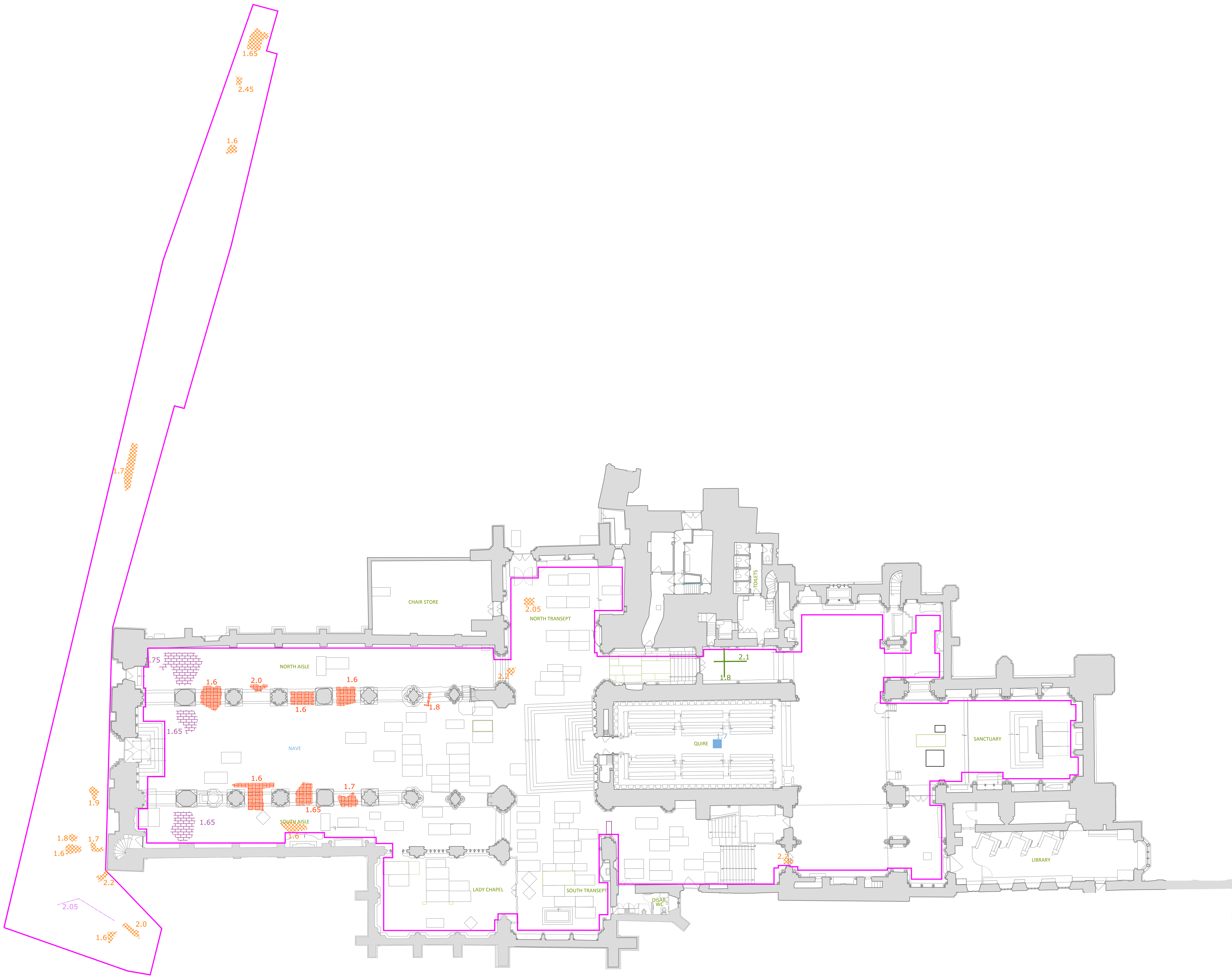
Title:
GPR Survey - Timeslice at 2.20-2.25m

Client:
ROCHESTER CATHEDRAL

Project:
SOR12287 - ROCHESTER CATHEDRAL

Scale: 1:200 @ A1
0m 2 4 6 8 10m

Fig No:
14



The performance of the technologies employed in non-invasive surveys can be adversely affected by factors outside of Sumo's control. Whilst Sumo uses all due diligence and reasonable endeavours it does not warrant that 100% detection can be achieved. Irrespective of the information provided by a geophysical survey, any ground works should be undertaken with extreme caution.

KEY

	Probable grave
	Possible grave
	Ledger without grave beneath
	Weak anomaly probably related to Saxon church
	Anomalies possibly related to early west end of the cathedral
	Anomalies associated with remains of Anglo-Saxon cathedral or sleeper walls
	Anomalies related to earlier southern transept
	Anomalies associated with archaeological remains - possible earlier walls or foundations
	Linear anomaly related to vaulted ceiling / top of the column
	Anomaly probably related to vaulting
	Anomaly possibly associated with old altar or shrine
	Anomaly of uncertain origin - possibly archaeological remains
	Linear anomaly of uncertain origin - possible structural remains
	Anomaly of uncertain origin - possibly modern
	Buried surface
	Potential service
	Manhole
0.60	Depth to the top of the feature (in m)

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

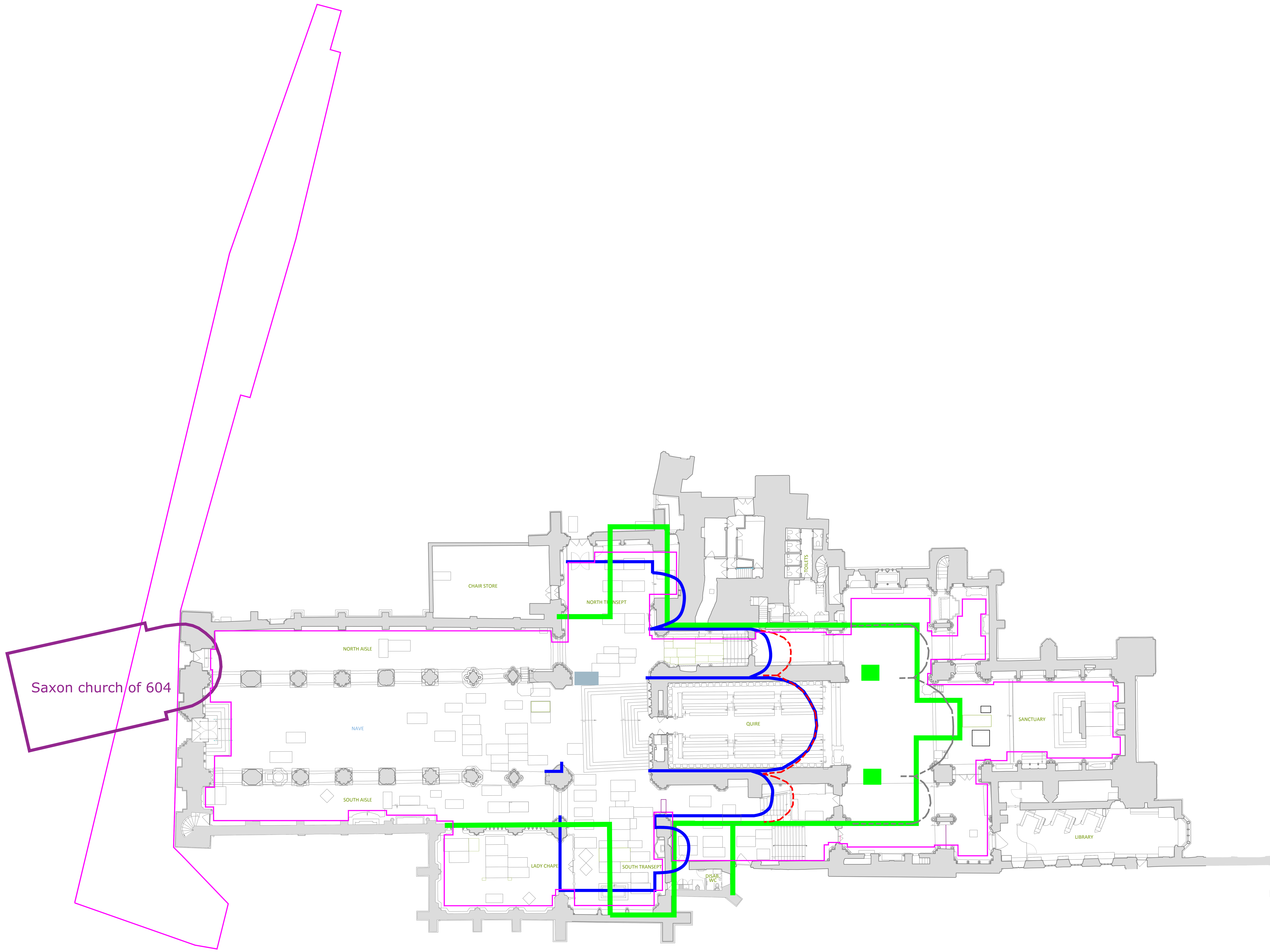
Title:
GPR Survey - Interpretation 1.50m - 2.50m

Client:
ROCHESTER CATHEDRAL

Project:
SOR12287 - ROCHESTER CATHEDRAL

Scale: 1:200 @ A1
0m 2 4 6 8 10m

Fig No:
15



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KEY

	Saxon church
	Proposed by Fairweather
	Proposed by St John Hope
	Proposed by Flight
	An alternative apsod structure on Hope's foundations
	Walls discovered by Radford

Sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

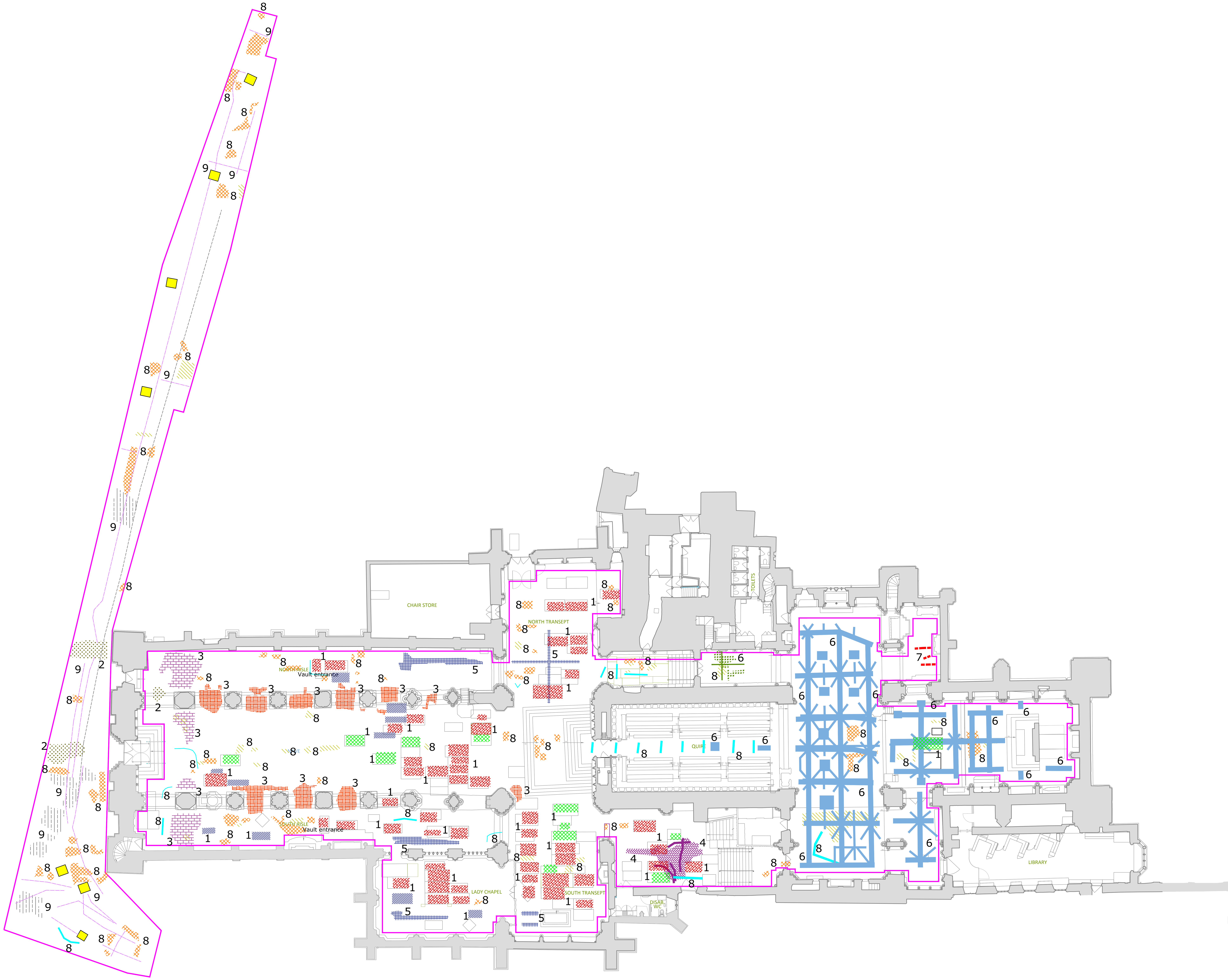
Title:
Reconstructions of Rochester Cathedral

Client:
ROCHESTER CATHEDRAL

Project:
SOR12287 - ROCHESTER CATHEDRAL

Scale: 1:200 @ A1
0m 2 4 6 8 10m

Fig No:
16



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KEY
Probable grave
Possible grave
Ledger without grave beneath
Weak anomaly probably related to Saxon church
Anomalies possibly related to early west end of the cathedral
Anomalies associated with remains of Anglo-Saxon cathedral or sleeper walls
Anomalies related to earlier southern transept
Anomalies associated with archaeological remains - possible earlier walls or foundations
Linear anomaly related to vaulted ceiling / top of the column
Anomaly probably related to vaulting
Anomaly possibly associated with old altar or shrine
Anomaly of uncertain origin - possibly archaeological remains
Linear anomaly of uncertain origin - possible structural remains
Anomaly of uncertain origin - possibly modern
Buried surface
Potential service
Manhole

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title: GPR Survey - Interpretation

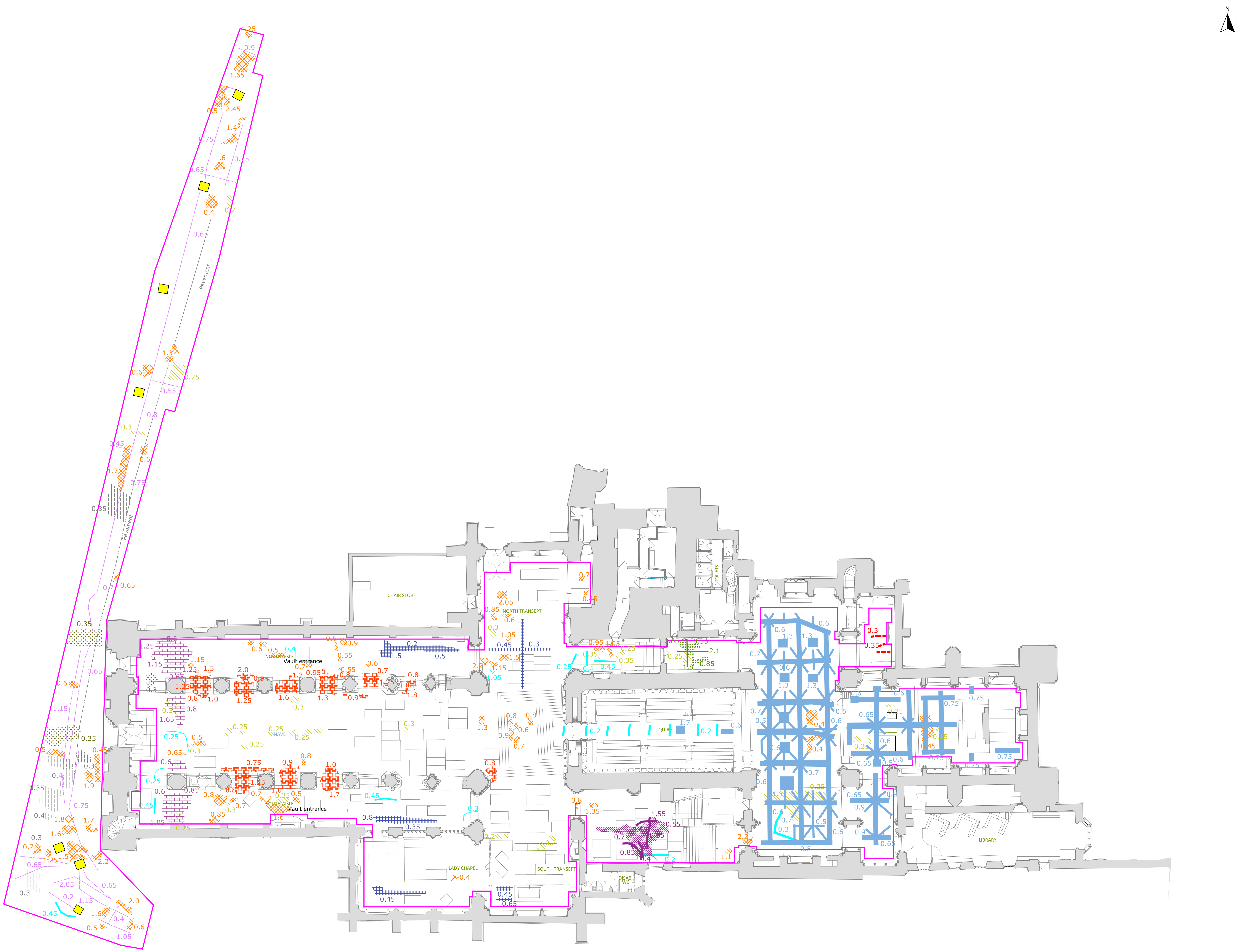
Client: ROCHESTER CATHEDRAL

Project: SOR12287 - ROCHESTER CATHEDRAL

Scale: 1:200 @ A1

0m 2 4 6 8 10m

Fig No: 17



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KEY

	Probable grave
	Possible grave
	Ledger without grave beneath
	Weak anomaly probably related to Saxon church
	Anomalies possibly related to early west end of the cathedral
	Anomalies associated with remains of Anglo-Saxon cathedral or sleeper walls
	Anomalies related to earlier southern transept
	Anomalies associated with archaeological remains - possible earlier walls or foundations
	Linear anomaly related to vaulted ceiling / top of the column
	Anomaly probably related to vaulting
	Anomaly possibly associated with old altar or shrine
	Anomaly of uncertain origin - possibly archaeological remains
	Linear anomaly of uncertain origin - possible structural remains
	Anomaly of uncertain origin - possibly modern
	Buried surface
	Potential service
	Manhole
0.60	Depth to the top of the feature (in m)

Sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
GPR Survey - Interpretation without graves

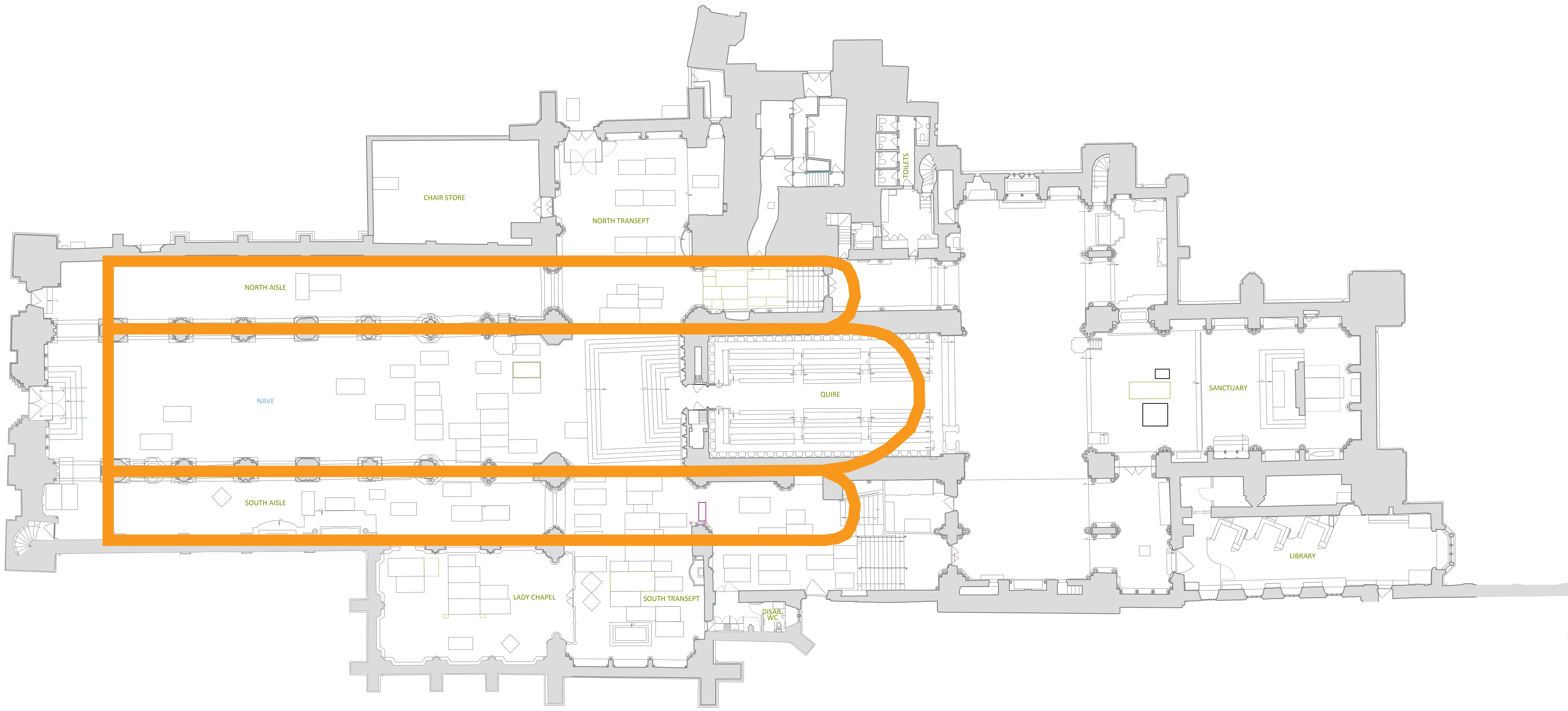
Client:
ROCHESTER CATHEDRAL

Project:
SOR12287 - ROCHESTER CATHEDRAL

Scale: 1:200 @ A1
0m 2 4 6 8 10m

Fig No:
18

The performance of the technologies employed in non-invasive surveys can be adversely affected by factors outside of Sumo's control. Whilst Sumo uses all due diligence and reasonable endeavours it does not warrant that 100% detection can be achieved. Irrespective of the information provided by a geophysical survey, any ground works should be undertaken with extreme caution.



sumo Survey GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Conjectural Reconstruction of the Nave and Aisles of the Anglo-Saxon Cathedral

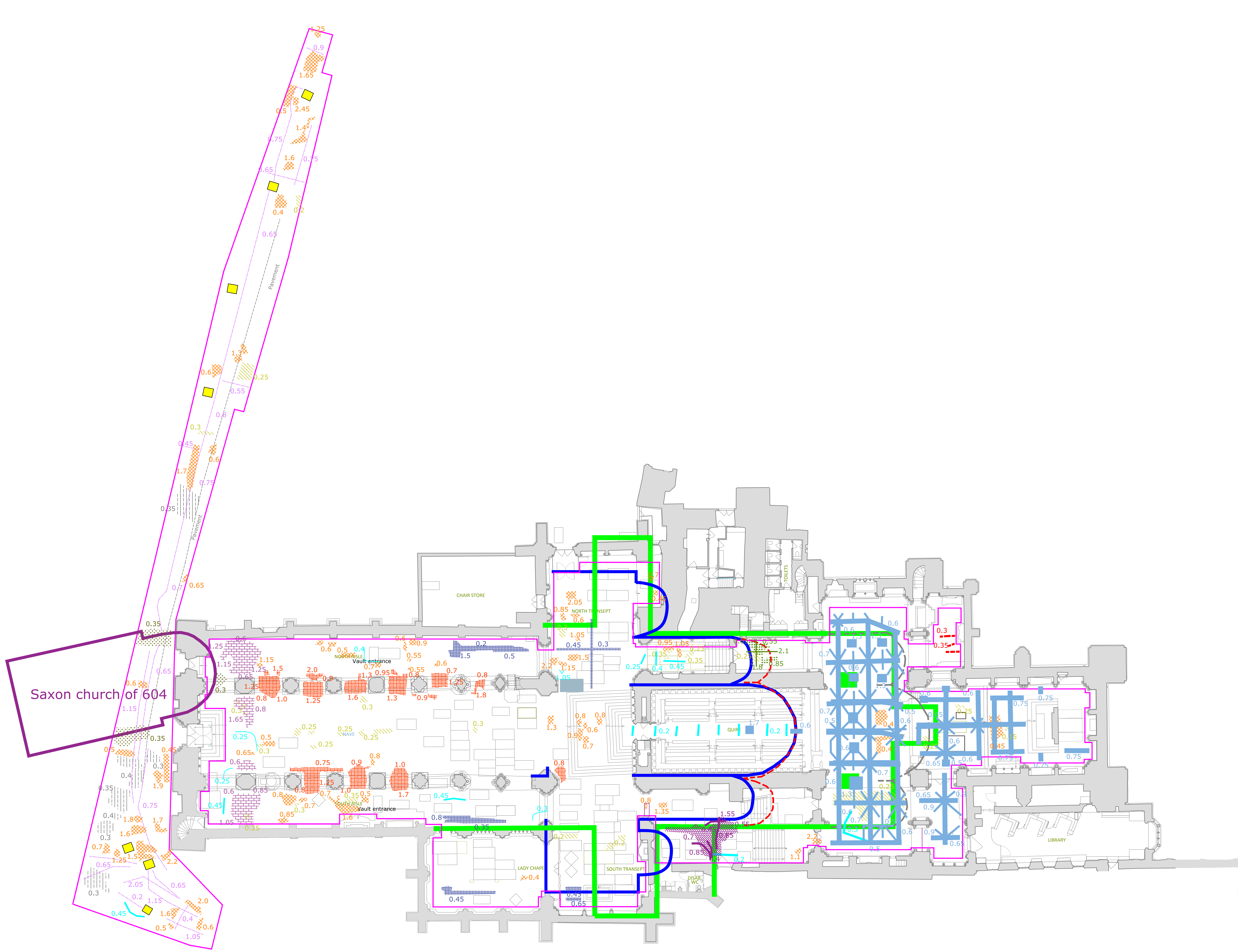
Client:
ROCHESTER CATHEDRAL

Project:
SOR12287 - ROCHESTER CATHEDRAL

Scale: 1:200 @ A1

0m 2 4 6 8 10m

Fig No:
19



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KEY

	Saxon church
	Proposed by Fairweather
	Proposed by St John Hope
	Proposed by Flight
	An alternative apsod structure on Hope's foundations
	Walls discovered by Radford
	Probable grave
	Possible grave
	Ledger without grave beneath
	Weak anomaly probably related to Saxon church
	Anomalies possibly related to early west end of the cathedral
	Anomalies associated with remains of Anglo-Saxon cathedral or sleeper walls
	Anomalies related to earlier southern transept
	Anomalies associated with archaeological remains - possible earlier walls or foundations
	Linear anomaly related to vaulted ceiling / top of the column
	Anomaly probably related to vaulting
	Anomaly possibly associated with old altar or shrine
	Anomaly of uncertain origin - possibly archaeological remains
	Linear anomaly of uncertain origin - possible structural remains
	Anomaly of uncertain origin - possibly modern
	Buried surface
	Potential service
	Manhole
0.60	Depth to the top of the feature (in m)

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
GPR Survey - Interpretation and historical reconstructions

Client:
ROCHESTER CATHEDRAL

Project:
SOR12287 - ROCHESTER CATHEDRAL

Scale: 1:200 @ A1
0m 2 4 6 8 10m

Fig No:
20

- 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