STRATASCAN

Geophysical Survey Report

Roodee, Chester

For

David Mason (Chester Archaeological Society)

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Hannah Heard BSc (Hons)

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Field Team:	Luke Brown and Laurence Chadd MA
Project Manager:	Simon Stowe BSc (Hons)
Report written by:	Hannah Heard BSc (Hons)
CAD draughting by:	Hannah Heard BSc (Hons)
Checked by:	**PPB and Simon Stowe BSc (Hons)**

Stratascan Ltd.

Vineyard House
Upper Hook Road
Upton upon Severn
WR8 0SA

Tel: 01684 592266
Fax: 01684 594142
Email: ppb@stratascan.co.uk

www.stratascan.co.uk

LIST OF FIGURES

1 SUMMARY OF RESULTS

A GPR survey was carried out in an area between the city wall of Chester and Chester racecourse.

Diffractions across the southwestern edge of the survey area constitute weak evidence for surviving structural remains of possible archaeological origin. Two areas of strong complex anomalies have also been identified towards the south of the survey area, which may be of archaeological origin. No clear plan of previous structural remains can be determined due to the complexity of these radar returns, which may mean that they indicate areas of archaeological debris.

Several services have been identified across the site, including a substantially sized service, probably a sewer or drain, at an approximate depth of 1.7m.

2 INTRODUCTION

2.1 Background synopsis

Stratascan were commissioned by Chester Archaeological Society to carry out a GPR survey at Roodee as part of an archaeological research program.

2.2 Site location

The site is located between a section of the city walls of Chester, and the racecourse at Roodee at OS NGR ref. SJ 402 661

2.3 Description of site

The site is located on a car park lying between the city walls and the racecourse. The survey area is 110m long and has a maximum width of 28m and is currently used as a car park. The topography is mainly flat but with sloping sections and terraced areas close to the city wall.

The underlying geology is Permian and Triassic sandstones with overlying Quarternary Alluvium deposits (British Geological Survey South Sheet, Third Edition Solid, 1979, Geological Survey Ten Mile Sheet, South Sheet, First Edition (Quaternary) 1977). The overlying soils are Wisbech soils which are calcareous alluvial gley soils. These consist of deep stoneless calcareous coarse silty soils (Soil Survey of England and Wales, Sheet 3 Midland and Western England).

2.4 Site history and archaeological potential

The survey area is in close proximity to the historic city of Chester with substantial Roman, Anglo-Saxon and medieval occupation therefore the potential for archaeology is high.

2.5 Survey objectives

The objectives of the survey were to locate any anomalies that may be of archaeological significance, in particular to seek a continuation of a possible Roman quay wall and to identify any structures of archaeological origin. A further objective was to locate the original riverbed, and any major services running through the site.

2.6 Survey methods

The survey method used was Ground Probing Radar (GPR).

More information regarding this technique is included in the Methodology section below.

3 METHODOLOGY

3.1 Date of fieldwork

The fieldwork was carried out on the 7th October 2004 when the weather was overcast.

3.2 Grid locations

The location of the survey grids has been plotted in Figure 2.

3.3 Description of techniques and equipment configurations

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 and 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 (see 3.4.2 below).

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 Probing Impulse Radar used was a SIR2000 system manufactured by Geophysical Survey Systems Inc. (GSSI).

The radar survey was carried out with a 200MHz antenna. This mid-range frequency offers a good combination of depth of penetration and resolution.

3.4 Sampling interval, depth of scan, resolution and data capture

3.4.1 Sampling interval

Radar scans were carried out along traverses 2m apart on a parallel grid as shown in Figure 3. Data was collected at 40 scans/metre. A measuring wheel was used to put markers into the recorded radargram at 1m centres.

3.4.2 Depth of scan and resolution

The average velocity of the radar pulse is calculated to be 0.075/nsec which is typical for the type of sub-soils on the site. With a range setting of 150nsec this equates to a maximum depth of scan of 5.6m 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.

3.4.3 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.

3.5 Processing, presentation of results and interpretation

3.5.1 Processing

The radar plots included in this report have been produced from the recorded data using Radan software. High pass (65MHz) and low pass (370MHz) filters were applied to the data to remove background noise.

3.5.2 Presentation of results and interpretation

Manual abstraction

Each radargram has been studied and those anomalies thought to be significant were noted and classified as detailed below. Inevitably some simplification has been made to classify the diversity of responses found in radargrams.

i. Strong and weak discrete reflector.
These may be a mix of different types of reflectors but their limits can be clearly defined. Their inclusion as a separate category has been considered justified in order to emphasise anomalous returns which may be from archaeological targets and would not otherwise be highlighted in the analysis.

ii. Complex reflectors.
These would generally indicate a confused or complex structure to the subsurface. An occurrence of such returns, particularly where the natural soils or rocks are homogeneous, would suggest artificial disturbances. These are subdivided into both strong and weak giving an indication of the extent of change of velocity across the interface, which in turn may be associated with a marked change in material or moisture content.

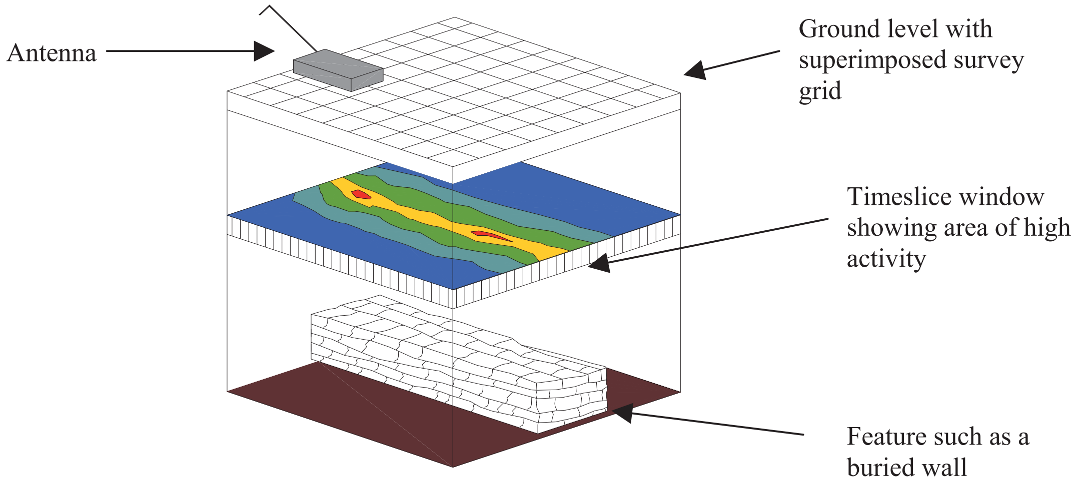
iii. Point diffractions.
These may be formed by a discrete object such as a stone or a linear feature such as a small diameter pipeline being crossed by the radar traverse (see also the second sentence in 4. below).

iv. Convex reflectors and broad crested diffractions.
A convex reflector can be formed by a convex shaped buried interface such as a vault or very large diameter pipeline or culvert. A broad crested diffraction as opposed to a point diffraction can be formed by (for example) a large diameter pipe or a narrow wall generating a hybrid of a point diffraction and convex reflector where the central section is a reflection off the top of the target and the edges/sides forming diffractions.

v. Planar returns.
These may be formed by a floor or some other interface parallel with the surface. These are subdivided into both strong and weak giving an indication of the extent of change of velocity across the interface which in turn may be associated with a marked change in material or moisture content.

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 (Figures 3,4 and 5). 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. Based on an average velocity calculations 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 dark colours namely blues and greens. The stronger reflections are represented by brighter colours such as light green, yellow, orange, red and white (see key provided in Figures 3,4 and 5).

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.

4 RESULTS

4.1 Overview

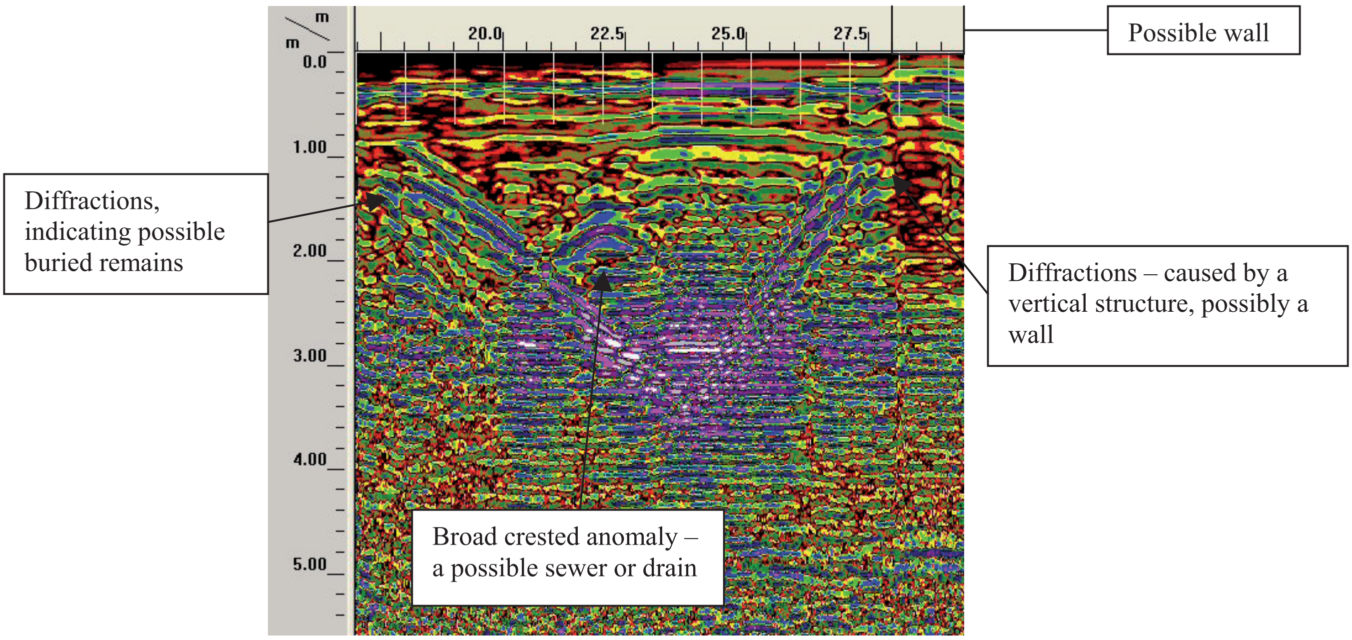
The GPR survey has produced a wide range of anomalies. Generally the data contained a large number of point diffraction and weak planar features (often at depth), with an area of near surface weak complex anomalies. Strong discrete anomalies tended to be confined to small areas and little evidence for previous structures can be identified within the timeslice data (Figures 3-5).

The anomalies observed can be categorized into four areas:

- Evidence for buried structures of archaeological origin
- Strong complex and discrete anomalies of possible archaeological origin
- Services
- Near surface anomalies likely to be caused by modern disturbance

4.2 Evidence for buried structures

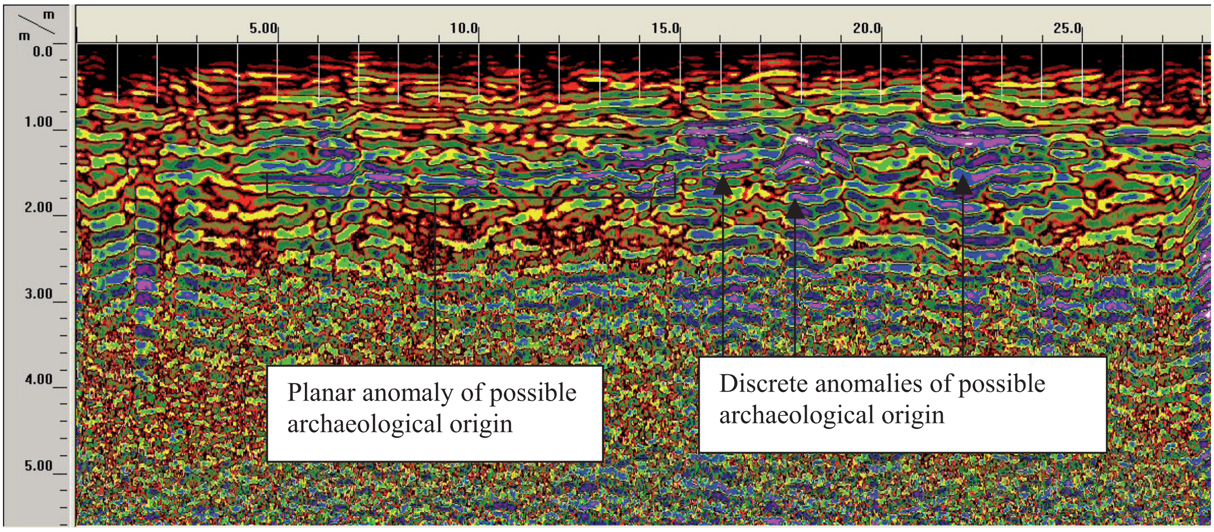
Although there is little evidence for substantial remains indicating a previous wall within the survey area, evidence for a possible wall structure appears as a number of diffractions (68N-80N) that have been produced at a vertical interface within the ground towards the eastern edge of the survey area, running parallel with the present wall (see Figures 6 and 7 and Example Radargrams 1, 2 and 4). When extending the possible route of this interface it appears to run under the eastern edge of the terraced survey area (30E), where a weak planar feature and complex anomalies can be seen which may indicate structural remains. It is possible that the series of diffractions mark the edge of a structure that has similar properties to the surrounding soils, or has been robbed out in the past. Little evidence of this anomaly is visible within the timeslice data (see Figure 3-5)



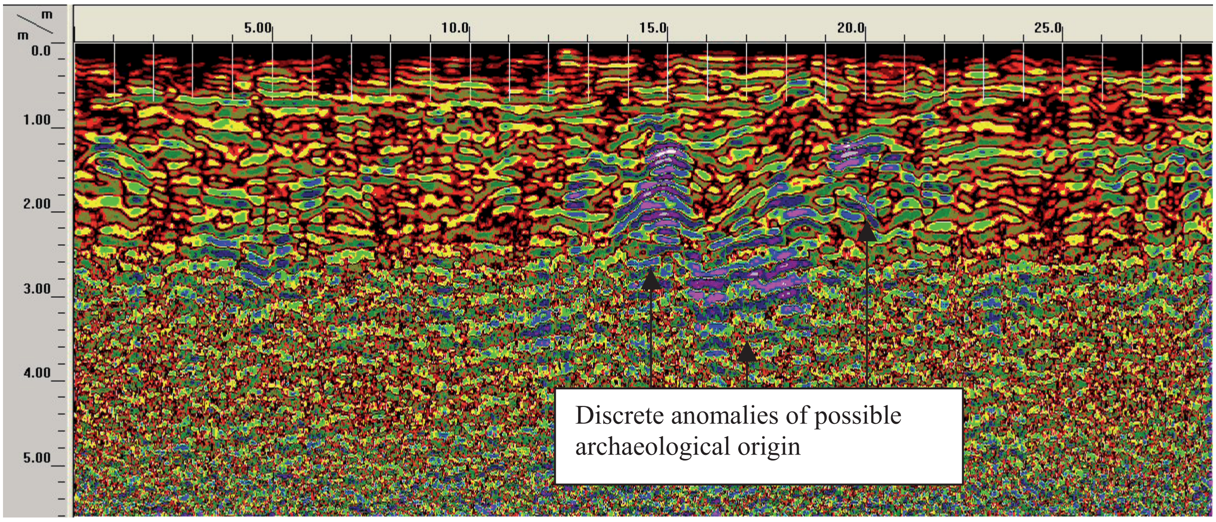
Example Radargram 1: Along traverse 80N: Showing diffractions caused by buried structures and a large service

4.3 *Anomalies of possible archaeological origin*

Within the terraced (30E-36E) area a number of discrete anomalies are visible up to a maximum depth of 2.8m, these anomalies may be of archaeological origin (see Figures 6 and 7 and Example Radargrams 2 and 3). Due to the different heights of the radar traverses upon the terraced area, timeslice data could not be produced.

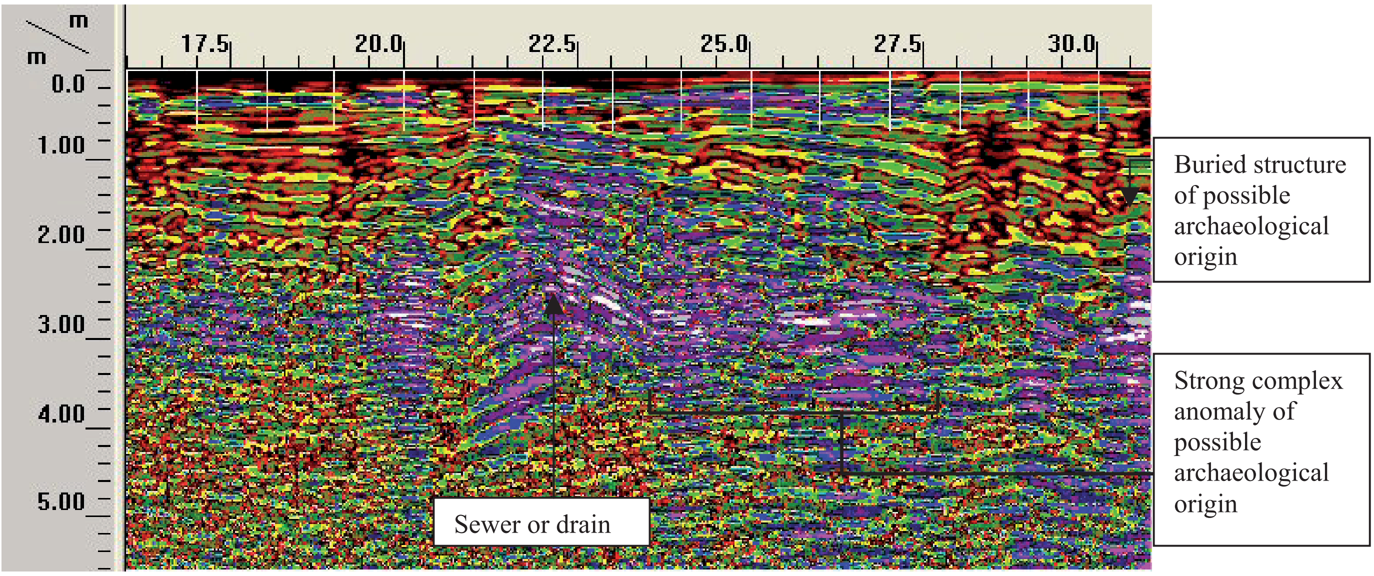


Example Radargram 2: Along traverse 30E showing discrete and planar anomalies of possible archaeological origin



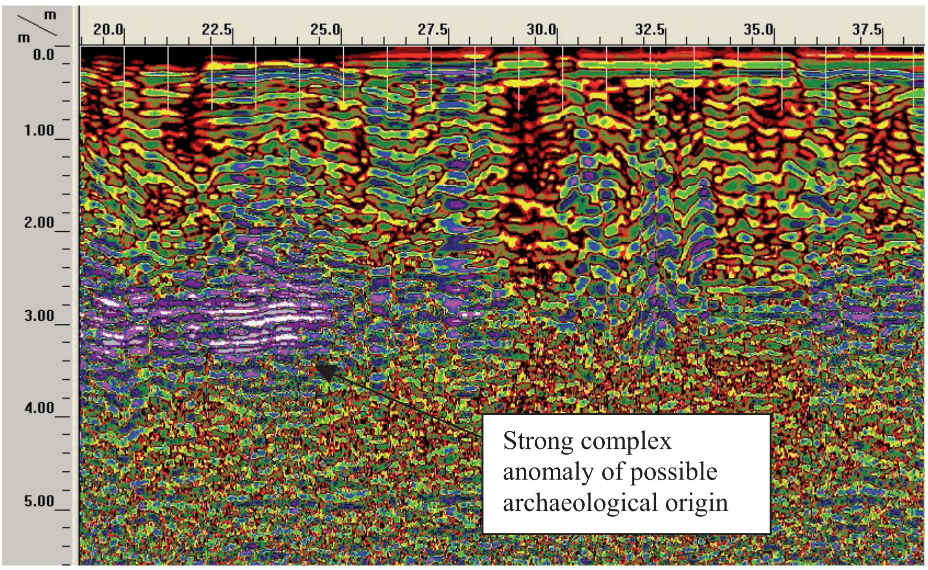
Example Radargram 3: Along traverse 33E showing discrete anomalies that may be of archaeological origin

An area of strong complex returns is visible to the southeastern edge of the survey area (84-86N) at a depth of 1.4m (see Figure 4) which may indicate an area of possible archaeological interest. No detailed structure is visible within the anomalies due to the complexity of the returns, meaning it is possible that these anomalies represent structural debris (see Figures 6 and 7 and Example Radargram 4).



Example Radargram 4: Along traverse 84N showing strong complex anomalies of possible archaeological origin

A further area of strong complex returns has been identified in the south of the survey area (50N-60N) at an approximate depth of 2.6m, which may be of archaeological origin (see Figures 5 - 7 and Example Radargram 5).



Example Radargram 5: Along traverse 60N showing complex anomalies of possible archaeological origin at a depth of 2.6m

4.4 Services

A number of services have been identified across the survey area, all in an approximate northwest to southeast alignment. A substantially sized service, possibly a sewer, appears running through the centre of the survey area, at an approximate depth of 1.7 metres (See Example Radargram 1 and 4 and Figures 6 and 7).

4.5 Modern disturbance

An area of near surface anomalies (approximately 0.25m deep) is present towards the eastern edge of the survey area and can be seen clearly in Figure 6. These are likely to be related to modern activity, possibly the construction of the car park and terraces (see Figure 7).

5 CONCLUSION

A number of areas across the site have been targeted as potential areas of archaeological interest, mainly towards the south of the survey area. Diffractions across the southeastern edge of the survey area constitute evidence for surviving structural remains of archaeological origin. Radar transects across the terraced area close to the city wall show little evidence of substantial structural remains, but have identified small discrete anomalies that may be of archaeological origin. No detailed structures are visible within the areas of strong discrete and complex anomalies of possible archaeological origin due to the complexity of the returns, meaning that these regions may indicate areas of archaeological debris.

Several services have been identified across the site, running in a northwest to southeast direction. A substantial service, possibly a sewer, has been identified running down the centre of the survey area at an approximate depth of 1.7m.