



Bury College

Peel Health Centre, Bury

Geophysical Report

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RSK



RSK GENERAL NOTES

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Where field investigations have been carried out, these have been restricted to a level of detail required to achieve the stated objectives of the work.

This work has been undertaken in accordance with the quality management system of RSK Environment.

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EXECUTIVE SUMMARY

On the instructions of Alex Gamil of Atkins, acting on behalf of Bury College (the client), RSK Environment Limited, carried out a geophysical site investigation to seek to determine the extents of potential voids beneath the car park and external areas of the Peel Health Centre after a number of depressions have formed in the car park to the East.

Project Findings

Site Setting and Current Usage	The site, located at Bury college is currently the external grounds of the Peel Health Centre and adjacent car park to the East.
Survey Objectives	A number of depressions have formed in the car park and it is unclear what these relate to. It is noted that the area has a history of mining sink hole. The object of the geophysical survey is to determine the possible presence and extents of voids beneath the car park and areas surrounding the buildings.
Geophysical Techniques Employed	The geophysical technique employed was that of a GPR survey using both a 200 MHz and 400 MHz antenna. The geophysical fieldwork was conducted on the 25th June 2020.
Geophysical Investigation Findings	Anomalous reflections indicative of voids/ nonconsolidated ground have been observed in the data which line up with the 3 no. depressions observed at the surface of the Peel Health Centre Car park. These areas are indicative of disturbed ground and may be caused by a loose or unconsolidated material, possibly air or water filled. An intrusive investigation would assist in determining the cause of these reflections so a better understanding of the ground conditions beneath the site can be developed.

1 INTRODUCTION

1.1 Introductions

On the instructions of Alex Gamil of Atkins, RSK Environment Limited, carried out a geophysical site investigation to seek to determine the extent of potential voids beneath the car park and external areas of the Peel Health Centre after a number of depressions have formed in the car park to the East.

1.2 Details of the Project

The project was carried out to an agreed brief as set out in RSK proposal letter of 28th May 2020, and included the following:

- A GPR survey;
- An Interpretative reporting.

1.3 Limitations

Non-intrusive geophysical techniques seek to locate boundaries across which there is a marked contrast in physical properties. Such a contrast may be detected remotely because it gives rise to a geophysical anomaly, which is indicative of variation in a physical property relative to some background value. Insufficient contrast (including high levels of cultural noise) can result in masking of the sought anomaly. Therefore, there may be other conditions prevailing at the site which have not been revealed by this investigation and which have therefore not been taken into account in this report.

The response of the ground to different physical forces can be highly variable. Interpretation of the responses contained in this report is based on experience in similar environments and site conditions.

The materials encountered and samples obtained during on-site intrusive investigations represent only a small proportion of the materials present on-site. It should be accepted, therefore, that the interpretation from remotely sensed geophysical data may be inconsistent with that arising from direct methods of investigation.

2 THE SITE

2.1 Location and Regional Setting

The site, located at Bury college, is currently the external grounds of the Peel Health Centre and adjacent car park to the East.

The site is located at National Grid reference SD 805 104. An extract of the 1:25,000 Ordnance Survey map showing the location of the site is given in **Figure 1**. **Figure 2** illustrates the site layout.

2.2 Geology

The published 1:50,000 scale geological map of the area indicates that the site is underlain the Pennine Lower Coal Measures Formation, formed within the Carboniferous Period 318 - 319 million years ago. This is overlain by Glaciofluvial Sheet deposits formed up to 2 million years ago, composed of coarse-grained detritus associated with melt water.

3 THE SURVEY

3.1 Objective and Geophysical Approach

It is understood that the site covers an area of approximately 0.2 Ha in size and currently comprises of a car park to the East of the Peel Health Centre building and land immediately surrounding the building. A number of depressions have formed in the car park. The object of the geophysical survey is to determine the possible presence and extents of voids beneath the car park and areas surrounding the buildings.

The geophysical techniques employed were that of a GPR Survey using both a 200 MHz and 400 MHz antenna. The geophysical fieldwork was conducted on the 25th June 2020.

3.2 The Ground Penetrating Radar Technique

In GPR surveys, electromagnetic waves of frequencies between 50 MHz and 1.5 GHz are transmitted into the ground or structure. This energy is reflected back to the surface when it encounters significant contrasts in dielectric properties.

3.2.1 Theory

Both surface and borehole GPR techniques use electromagnetic waves of frequencies between 50 MHz and 1.5 GHz to probe the subsurface (**Figure 3A**). A radio wave transmitter (Tx) is used to generate a short (<20ns) pulse of radio waves of specific frequency (depending on the antenna selected). These radio waves penetrate into the subsurface. Some of the energy carried by these waves is transmitted to greater and greater distances, while some of the energy is reflected back towards the receiver (Rx) whenever a contrast in electrical properties is encountered. The amount of energy reflected is dependent on the contrast in electrical properties encountered by the radio waves.

The receiver measures the variation in strength of the reflected signals with **time**. The resulting profile is called a 'trace' and is a one-dimensional representation of the subsurface beneath the transmitter and receiver. To build up a two-dimensional section of the subsurface (a radargram), the transmitter and receiver are traversed across the surface at a controlled speed.

In order to present time sections as **depth** sections, some form of calibration is required through borehole or core information, or through an assessment of the electrical (dielectric) properties of the surveyed materials. It is important to note that such conversions are not always practical.

The higher frequency antennas provide high resolution data over shallow depths (< 0.5m) and are mostly employed for near surface structural investigations (e.g., characterising rebar in concrete, **Figure 3B**). The lower frequency antennas can probe

to greater depths (up to 30m, depending on subsurface conditions) but exhibit a reduced degree of resolution. These antennas are typically employed in geological/hydrogeological investigations (e.g., locating cave systems and sinkholes).

3.2.2 Application to Site

Theoretically, the presence of voids within an otherwise homogeneous material will generate anomalous reflections within the radargrams. The nature and strength of these reflections will be dictated by their size/orientation, and to some extent, their respective contrast in dielectric properties with the surrounding structure. Voids can be detected using several criteria:

- Velocity “pull-up” – The speed of radio waves in air is significantly faster than in solid materials, thus giving an apparently earlier reflection time in the radargram associated with a significant void.
- Resonance – This will occur if the wavelength of the incident radio wave is equal to or smaller than the dimensions of the void. This gives rise to discrete reflections which reverberate down through the radargram.
- Quiet Zones – Air characteristically displays a near zero attenuation coefficient and therefore does not cause significant energy loss. This may give rise to a relatively strong reflection at the air/material interface below this zone.
- Polarity reversal – This occurs when a radio wave passes from a slow to fast medium (e.g. rock to air) and then from a fast to slow medium (e.g. air to rock).

3.2.3 Equipment

SIR 4000

The equipment used was the SIR (Subsurface Interface Radar) System-4000 manufactured by Geophysical Survey Systems Inc. See equipment specifications in **Appendix A**. The serial no. of the control unit was 228, the 400 MHz antenna was 2480, and the 200 MHz antenna was 5106.

3.3 Survey Design

The layout of the geophysical survey is shown in **Figure 2**.

GPR data have been collected on a series of parallel survey lines spaced 1m apart in two orthogonal directions. A series of survey grids have been positioned across the car park to provide full coverage as access allowed.

For the 400 MHz and 200 MHz data a distance calibration was undertaken on site. Here a horizontal distance is defined on site from which the odometer attached to the antenna is calibrated daily and saved on the GPR console. An on-site check of 10m was conducted and found to be accurate.

The location of the survey grids were surveyed using a Leica GS08 GPS system, providing accurate location data referenced to the Ordnance Survey OSGB36 National Grid system. Depressions observed at the surface were also recorded.

3.4 Data Processing and Presentation

Raw collected GPR data have been processed as described in **Table 1**.

Examples of the 400 MHz and 200 MHz data is presented in **Figure 4**.

Table 1: Summary of GPR processing methods

<i>Method</i>	<i>Justification</i>
Depth calibration	A dielectric constant of 6.25 (typical of concrete) has been assumed in order to give the most accurate indication of depth. The calculated depths are expected to be typically $\pm 20\%$ accuracy.
Zero-offset	To correct the signal to the actual ground surface level.
Gain control	To compensate for the signal attenuation with depth and enhance the signals from deeper reflectors to aid interpretation. Each profile was enhanced with the same gain parameters.
Filtering	High and low pass filters were set at frequencies of 400 MHz and 100 MHz for the 200 MHz antenna and 800 MHz and 200 MHz for the 400 MHz antenna. This removes noise from the data, and isolates "legitimate" signals from reflections of the pulse from the instrument.

4 DATA INTERPRETATION

4.1 Data Quality

The 400 MHz GPR data were generally of good quality, with reflections visible to a depth of 2.0 mbgl. The 200 MHz returned coherent reflections to a depth of approximately 5.0 mbgl.

4.2 Results

The results of the geophysical survey are highlighted in **Figure 5**.

The GPR data identified a number of hyperbolic reflections. These have been traced through the data set and represent a number of linear features on site. Comparing these to the service plans provided, it is likely these are related to the abandoned electrical cable, the combined water drainage and outlets from the gullies. The linear GPR features have been marked on the interpretative drawing as dark green dashed lines.

Several anomalous areas have been highlighted in the car park to the East of the Peel Health Centre, where the data displayed chaotic reflections with no obvious anomaly to be picked. An example of this is shown in the GPR data in **Figure 4**. The locations of this type of response are marked by the orange shading on **Figure 5**. These areas line up with the 3 no. depressions observed at the surface of the car park where the possible voids are thought to be. These anomalous responses within the GPR data are indicative of voids or unconsolidated ground beneath the car park.

5 CONCLUSIONS

On the instructions of Alex Gamil of Atkins, RSK Environment Limited, carried out a geophysical site investigation to seek to determine the extents of potential voids beneath the car park and external areas of the Peel Health Centre after a number of depressions have formed in the car park to the East.

It is understood that the site covers an area of approximately 0.2 Ha in size and currently comprises of a car park to the East of the Peel Health Centre building and land immediately surrounding the building. A number of depressions have formed in the car park. The object of the geophysical survey is to determine the possible presence and extents of voids beneath the car park and areas surrounding the buildings.

The geophysical technique employed was that of a GPR survey using both a 200 MHz and 400 MHz antenna. The geophysical fieldwork was conducted on the 25th June 2020.

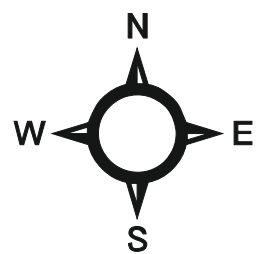
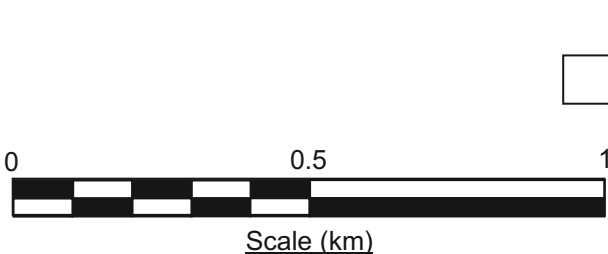
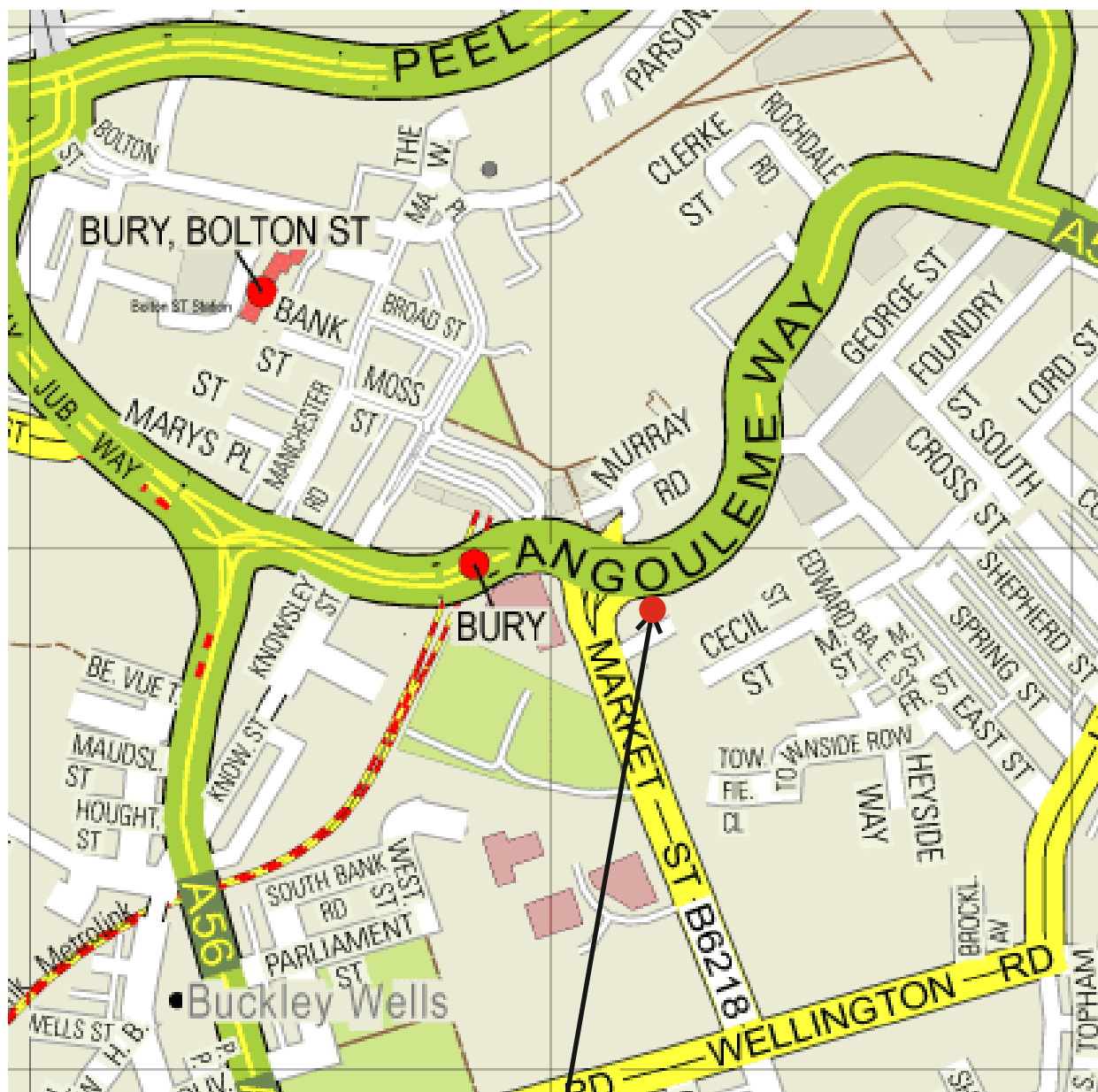
The results of the GPR survey are displayed on **Figure 5**.

The GPR data identified a number of linear features possibly associated with services on site.

Anomalous reflections indicative of voids/ unconsolidated ground have been observed in the data which line up with the 3 no. depressions observed at the surface of the Peel Health Centre Car park. These areas are indicative of disturbed ground and may be caused by a loose or unconsolidated material, possibly air or water filled. An intrusive investigation would assist in determining the cause of these reflections so a better understanding of the ground conditions beneath the site can be developed.

FIGURES

Figure 1	Site Location Plan
Figure 2	Survey Layout
Figure 3	The GPR Technique
Figure 4	Example GPR Data
Figure 5	Results of the Geophysical Survey



Site Location

Notes
 Extract from Ordnance Survey 1:5,000 scale map
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SITE LOCATION MAP

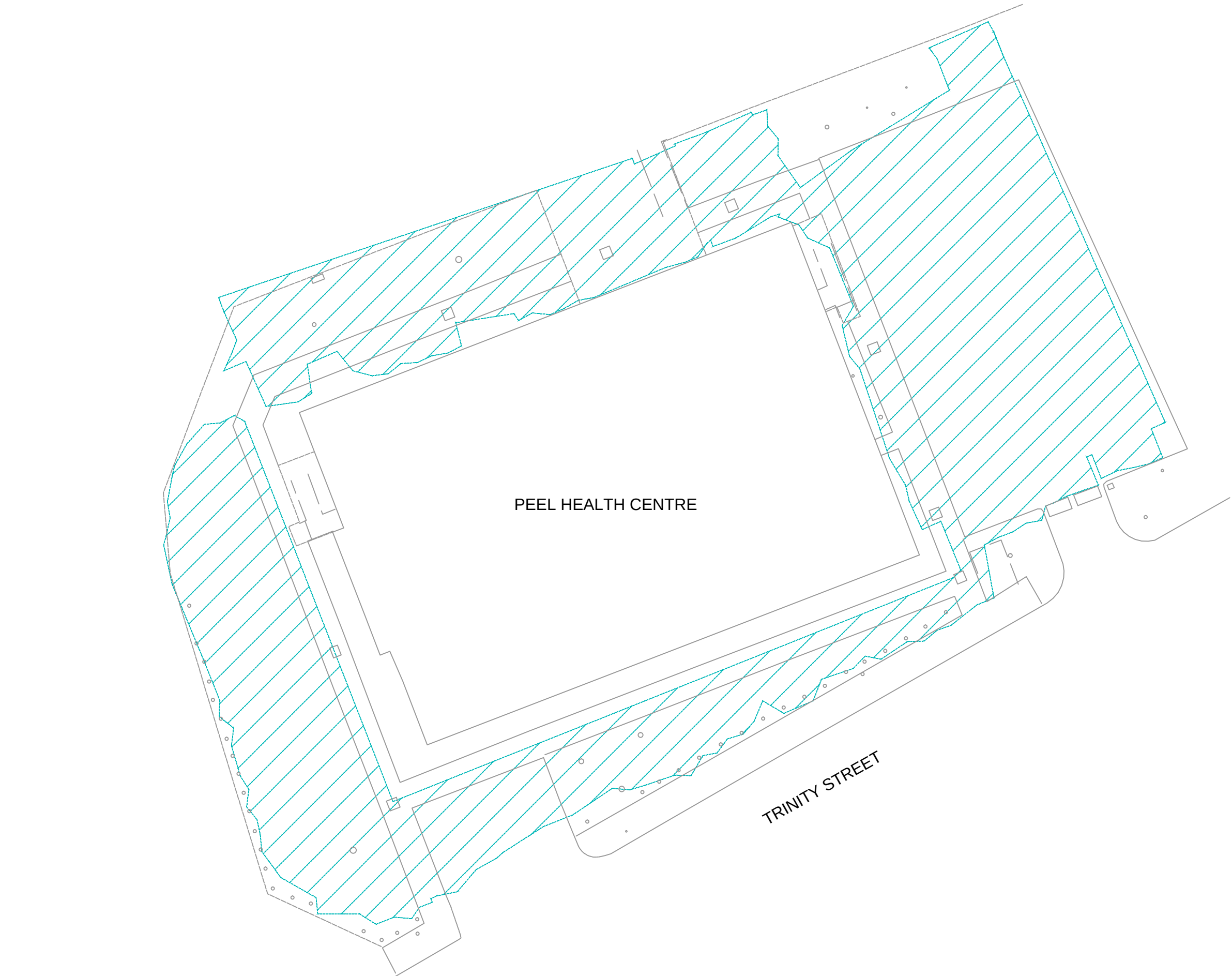
National Grid Reference: SD 806 104

Client:
 BURY COLLEGE

Figure: 1 **Job:** 55547

Site/Project:
 PEEL HEALTH CENTRE, BURY

Scale: AS SHOWN (@A4) **Date:** JULY 2020



NOTES

The specific risks associated with the content of this drawing are considered to be:-

(1) The topographical baseplan has been supplied by the client and has not been checked for accuracy.

KEY

 AREA COVERED BY GPR SURVEY





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Client

BURY COLLEGE

Project Title

PEEL HEALTH CENTRE, BURY

Drawing Title

SURVEY LAYOUT

Drawn	Date	Checked	Date	Approved	Date
CL	03/07/20	SRO	03/07/20	SRO	03/07/20
Scale	1:250	Orig Size	A3	Dimensions	
Project No.	55547	Drawing File	55547-Figure-2		
Drawing No.	55547-Figure-2 Sheet 1 of 1				Rev.