Gaelscholáiste Phort Láirge

GPR Survey for Underground Services

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SUMMARY

1. A survey for underground services was carried within the area highlighted on the *Survey Area* as indicated in the appendix A. The survey was done to provide information for future development works.

2. The survey area consists of a school site and sports grounds, public roads, access roads & footpaths

3. The objective of the survey was to map as many underground utilities and services as possible and to overlay that information onto a background map to produce a utility map.

4. The utility survey consisted of using existing third party supplied utility maps, opening and logging manholes, using Cable Avoidance Tool (CAT) and Generator detectors, rodding drains for tracing purposes, a Ground Penetration Radar (GPR) survey and interpreting the results.

5. The results are displayed on the map of underground services: L_01552_01.

6. This report summarises the work carried out and comments on some of the utilities found.

7. The survey for underground services cannot guarantee that all services have been found and that they are accurately located in the horizontal and vertical position. Due to interpretations of the detection equipment signals made it is not guaranteed that all traces found have been allocated to the correct type of service. Other services may exist under the site. LENMAR does not accept any liabilities arising from the survey. All excavations should be done with care and the relevant health and safety standards have to be followed.

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List of Tables, Drawings and Appendices:

1. INTRODUCTION

1.1 Background

LENMAR carried out a survey to locate and identify as far as practicable underground services for future works. The survey was done by gathering existing information, opening and logging manholes, tracing expected services with Ground Penetrating Radar (GPR), Cable Avoidance Tool (CAT) scanning of the survey area for unknown services.

1.2 Objectives

The objective of the survey for underground services is to identify the location and identity as many underground services and utilities as possible and to clarify and confirm the utility information provided by utility companies, records and/or previous investigations.

1.3 Site Description

The site comprises 21,800m2 and consists of the following areas within the survey area boundary map highlighted in red – Survey Area (Appendix A)

- School Building and Surrounds, Sports Fields
- Roads, Footpaths & Grassed Areas

1.4 Report

This report includes the results and interpretation of the survey for underground services. The result is the drawing of underground services, overlaid over a background drawing. All information gathered and processed by LENMAR is organised in descriptive layers within the survey drawing layering system.

The results of the survey are subject to the resolution of the detection devices. The interpretative nature and the non-intrusive survey methods must be taken into account when considering the results of this survey and LENMAR, while using appropriate practice to execute, interpret and present the data give no guarantees in relation to the existing subsurface, underground services and utilities. More detailed descriptions of geophysical and utility surveying methods and measurements can be found in GSEG (2002), Milsom (1989), Radio-detection (1986) and Reynolds (1997).

2. UTILITY SURVEY

2.1 Methodology

The survey for underground services was carried out on all accessible areas within the survey area boundary (Survey Area). The applied methodology consisted of:

- Reviewing all available utility information as supplied by utility providers and previous investigations
- Studying obtained maps with known/expected services indicated
- Opening manholes and noting the content, sizes and depth levels
- Tracing existing services with the detection devices
- Roding accessible drains from manholes with sewer rods/cobra wire and the sonde signal transmitter
- Scanning the survey area with the Ground Penetrating Radar (GPR) and Cable Avoidance Tool (CAT) in the Power, Radio and Generator mode
- Surveying in all traces and noting depths where they could be obtained
- Making some interpretations and assumptions about services that were not traceable (These are explained in the following section)
- Overlaying all information over the topographical survey drawing and annotating depths and pipe diameters.

2.2 Detection Methods

Table A shows a summary of the methods, the detection devices, the physical basis underlying the devices and some comments about the resolution of the methods. Further information can be obtained through the manufacturer's information for the devices.

The Ground Penetrating Radar (GPR) measurements were carried out along orthogonal parallel lines with a nominal spacing of 2.5 m and the data was viewed and interpreted on site. An IDS system with a dual 200-600MHz central frequency antenna for utility detection was used. This antenna has a useful frequency range of 200MHz – 600MHz. In areas where more clarification was needed the line spacing was reduced.

The depth penetration on the site of the GPR wave with a 400 MHz antenna is approx. 1 m bgl. A conversion velocity of 0.1 m/ns was used which is an average velocity for the EM GPR wave but it must be kept in mind that the velocity varies in the subsurface and that the depths obtained by GPR are therefore estimates. The conversion velocity was checked at some visible pipes/cables/ducts at manholes and inspection chambers.

Depths obtained from the GPR screen were noted and later annotated on the drawing. GPR with a 200-600 MHz antenna generally detects objects larger than 100 mm in diameter but the detection is not guaranteed and depends on the reflection coefficient between the object and surrounding material and many other parameters.

A Radio-detection CAT, Cable Avoidance Tool, with Power, Radio and Generator Mode was used. A sonde (mouse) signal generator was attached to sewer rods or cobra wire and then inserted into drainage pipes. The sonde signal was followed on the ground with the CAT in the Genny detection mode and the trace was marked and surveyed in. All openings into the ground like manholes, inspection chambers and Armstrong junctions were investigated and logged (where they could be opened). The sizes of pipes were measured directly by levelling staff or tape measure into the manhole and taking a reading of the diameter. In some cases a laser distance meter was used for pipe depth and pipe diameter. Because of the irregularities of manholes the accuracy of measuring the width of pipes is approx. 0.1 m for small pipes less than 500mm and 0.2 m for pipes larger than 500mm. The accuracy of the depth measurement is approx. 0.05m, but it must be kept in mind that many manholes have an irregular or inclined bottom.

Table A: Summary of Detection Methods

Item	**Methodology**	**Comment**
Manhole Lifting and Logging	Open the MH, IC, AJ or fitting (HYD, SC, SV, WM, GV, ER) for visual inspection to record the type, size and depth to services. Log MH, IC and AJ. Draw and label the fittings on map	A large range of specialist lifting equipment is available to survey personnel to ensure the maximum number of manholes were surveyed. All Health and Safety Protocols were adhered to during this process.
Ground Penetrating Radar (GPR) for detection	The GPR transmits and receives an electromagnetic pulse. This is reflected in the subsurface if a change in electrical parameters occurs. A continuous section of reflections made of many traces is visible on a radargram on the GPR computer screen when surveying a line and the data is interpreted in terms of underground services and other objects	GPR is the only method that can detect non-metal objects from the ground surface. The depth penetration of the EM pulse is dependent on the rock physics properties of the subsurface. The greater the level of absorption of the EM energy the less depth penetration is achieved. Despite its limitations it is an absolute must for underground services detection and surveying.
Ground Penetrating Radar (GPR) for depth estimation	The GPR determines the two way travel time between the ground surface and a reflecting object. If the one way time is converted with the velocity of the electromagnetic wave then a depth estimate to the top of that object is obtained	The typical velocity in Ireland is 0.1m/ns. It is locally calibrated over objects of known depth. This exercise is done adjacent to open manholes or inspection chambers. The velocity can vary greatly within short distances, therefore a GPR depth *is always an estimate*
Cable Avoidance Tool (CAT) – general tool	Works only on electrical conductors (cables and metal pipes) with the exception of the Mouse Mode (inserted into hollow	This system locates alternating magnetic fields associated with cables and metal pipes rather than the cables and pipes themselves. The accuracy of this system depends on the ability of

	pipes from a manhole)	the receiver to pinpoint the exact location of the magnetic field's max (or min) and deformation or distortion of the field. Most cables and conductors can be detected but some do not radiate signals and cannot be detected. The CAT will also not determine if a signal is from one or several cables. Conductors which are very short or have a small cross sectional area may also be difficult to locate (From Radio-detection).
CAT-Power Mode	CAT indicating the presence of an electrical current flowing through a power cable (electrical conductor) in the subsurface.	The Cat-P signal has to be strong enough in order to be detected. Detects 50 – 60 Hz energy present on most buried conductors. If a live cable is not loaded or if it is well balanced it may not be detectable in the Power Mode (From Radio-detection)
CAT-Radio Mode	CAT indicating the presence of a radio frequency electromagnetic wave that is inducted into the metal cable or pipe (electrical conductor) in the subsurface.	The Cat-R signal has to be strong enough in order to be detected. Detects re-radiated radio energy if present on a buried conductor (From Radio-detection).
CAT-Genny Mode	A signal generator (Genny) inducts a signal into a metal pipe or cable in the subsurface and the radiated signal is then traced with the CAT	The Cat-G signal has to be strong enough in order to be detected
CAT-Mouse Sonde Signal Transmitter Mode	A special sonde signal generator(Mouse) is attached to sewer rods or cobra wire and inserted into drains at a manhole or gully. When it is pushed along the drain it can be traced with the CAT above the surface.	The Cat-M signal has to be strong enough in order to be detected, though usually works to 5 m depth. Not all visible drains are automatically accessible for this method. Does not work in metal pipes. This method is not used in ducts with cables because of danger of electrocution or damaging the installations
Flow	Foul drain flow can be seen when in use and surface water flow can be best detected in rainy conditions. Colour tracers are used when necessary.	Drainage pipes that run between gullies, traps, manholes and outflows can be proven in terms of their connectivity
Logically assumed	Logically assumed by making observations in manholes and reasonable deductions	Drainage pipes that run straight from manhole to manhole maintaining pipe size and a gradient for water flow are often logically assumed

2.3 Considerations and Constraints

The observations, interpretations and devices have many benefits but also constraints and some considerations must be applied:

- GPR data can show an abundance of reflections in the subsurface that can be either from services or from other objects like boulders, concrete, fill material etc. Therefore it is difficult to trace small or weakly reflective services through a site.

- The ground surface (antenna coupling) and the subsurface material (depth penetration, resolution) have a large impact on the GPR method and they can vary rapidly across the site.

- It is increasingly difficult to trace cables and pipes when they are closer together, cross each other, lie in close proximity or are fully or partially blocked by vegetation, fences, street furniture or obstacles such as parked vehicles. Therefore the survey drawings of underground services should be treated with care, especially in areas where many services and cables occur close together. Also services laid in a trenches backfilled with lean mix concrete are difficult to detect.

- The locations of cables are indicated where the detection device traced them or where they showed in manholes. Connectivity of cables cannot be established by detection devices. In many inspection chambers a large number of cables and ducts are present and these may only have one common signal that can be traced.

- Due to the limitations of the detection devices this survey cannot guarantee that all services under the site have been located.

2.4 Utility Information obtained

Information was obtained from utility and service provider companies such as Local authority, Eir, Bord Gais & ESB for this part of their networks.

2.5 Site Work

The survey field work was carried out from Monday 31st Jul to Wed 2nd Aug 2023. The survey was carried out within the survey boundary area – Survey Area. In some instances, utilities were traced outside the boundary. Health and safety standards were adhered to at all times.

3. RESULTS AND CONCLUSIONS

The main result of the survey for underground services is the drawing of underground services (L_01552_01). It is derived from surveying of visible features, by observation and interpretation of the responses of the detection devices and through the experience of the site operators and report author.

3.1 Drawing Compilation

The results of the survey are displayed on L_01552_01. Each type of service indicated on the legend is drawn in its own layer in the CAD layering system. Most services were traced with the detection devices mentioned in Table A. In manholes and inspection chambers notes of depths were made and these depths are annotated on the drawing. For drainage manholes a cover level and invert level or depth is given. Inverts are annotated on pipes draining into manholes while the invert level indicates the elevation of the manhole bottom. Where services were not accessible but could be detected by GPR the depth was taken from the GPR. The GPR depths are labelled along the services. Where cables or metal pipes were only detected by CAT the mode is annotated and the type is interpreted. Where these traces run to inspection chambers the type from the chamber was used. Great care must be executed and all relevant health and safety regulations must be observed when excavating on the site.

3.2 Underground Services

The following section comments on and discusses some results sorted by the type of services.

- **Drainage:** Storm and foul drainage was identified within the site. Storm drains gather run off from hard surfaces and outfall to soakaways at various locations throughout the site. Foul drainage lines were encountered within the site gathering toilets and sinks and falling towards MH26, from where it is pumped out of the site as shown. There seems to be an abandoned septic tank and percolation area from the septic tank adjacent MH26.

- **Comm. Cabling:** Various cable runs were identified within the site. These comprised EIR cabling, comm. Cabling between cabins.

- **Electrical Cabling:** Electrical cabling was detected within the school site emanating from the electrical pole at the northern part of the site. This was traced around the building as shown. Public lighting cabling and electrical cabling was also identified within the access road adjacent the school building.

- **Watermain:** Watermains were located using GPR within the public roads. Watermains were identified entering the site adjacent the access road as shown.

- **Gas Pipe:** The gasmain pipe was determined to be in the same alignment as other utilities and was not isolated and identified separately. The gasmain information was included on the drawing from Bord Gais record drawings.

- **Unidentified GPR Anomalies:** GPR Anomalies were encountered within the survey area. These describe regions of varying density which could indicate buried objects or utilities. These areas should be exposed with trial hole/ slit trench to determine the identity of the anomaly.

- **Unidentified Em Signals:** Unidentified EM signals were encountered within the grassed area to the north of the site. It is recommended that these anomalies are exposed prior to works commencing to confirm their positions and determine their use.

4. EQUIPMENT AND PERSONNEL

4.1 Equipment Used – All equipment has calibration certificates

- Interragator II 300MHz Antenna GPR
- IDS Dual Antenna GPR System
- RD7000 Radio Detection Generator and Receiver
- C-Scope CAT Detector and Generator
- Topcon GTS 212 (Total Station)
- Topcon GRS1 (GPS system)
- Pentax Dumpy Level
- RD Sonde
- Hydraulic Manhole Lifting Equipment

4.2 Personnel:

Surveyors

- Brendan Dalton (Senior Surveyor)
- Ciaran Wilson
- Wayne Kenny

4.3 Clients Responsibilities:

In order to provide the company's representative with the site, the client will be responsible for the following:

- Providing the site access.
- Any excavations found to be necessary for the purpose of carrying out the survey and their subsequent re-instatement. Any overgrown areas to be cleared and ready for scanning.
- Ensuring that manhole and chamber covers are located and available for lifting prior to work commencing.
- The client shall assist in identifying the detected services indicating to the survey crew the electrical and communication cable identities for annotation onto the survey drawing.
- The client shall assist the contractor where possible in removing parked cars or other mobile obstructions to facilitate carrying out of the survey.
- The client shall provide a clear copy of the survey extents.

5. REFERENCES

1. **GSEG 2002.** Geophysics in Engineering Investigations. Geological Society Engineering Geology Special Publication 19, London, 2002.

2. **Milsom, 1989.** Field Geophysics. John Wiley and Sons.

3. **Radiodetection.** CAT and Genny User Guide. Radiodetection.

4. **Radiodetection, 1986.** The theory of buried pipe and cable location. Radiodetection.

5. **Reynolds, 1997.** An Introduction to Applied and Environmental Geophysics. John Wiley and Son.

6. **GSSI, 2004.** TerraSIRch SIR system-3000 User's Manual. Geophysical Survey Systems Inc.

APPENDIX A

Survey Area (Highlighted Red)