Innovating for Electrical Distribution Asset Management, Asset Protection and Safety.

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1.0 Introduction

The standards based PAL-GPR service (http://www.countiespower.com/pal-gpr.htm) owned and operated by Counties Power is a national service that creates subsurface plans and maps useful for entities working in road, berm and off-road environments. The service offers deeper detail of the subsurface zone to 2 metres.

A lifeline network operator with power and optical fibre networks, Counties Power Ltd is a mid-size company headquartered in Franklin District.

The power network contains approximately 3,100 km of lines up to 110,000 volts within an area spanning 2,220 sq. km. Customers and end users for power include all businesses and residents of Franklin County and national power retailers. Its wholesale open access fibre network has approximately 150 km of fibre routes that connect towns and major power substations. Telecommunications carriers and service providers, plus, organisations like NZ Police and Kiwirail use this network to provide telecommunications services.

These networks are managed by a Networks group, augmented and maintained by a Construction group. The Construction group comprises about 116 staff skilled in building and maintaining the power and fibre networks – overhead and underground.

Other businesses include a Mechanical Workshop offering vehicle maintenance and mechanical design and build services to the Franklin area and Telecommunications Relay services to the Australian market.

The company is focussed on safety. It nurtures a rapid development and practical improvement culture spanning the past 13 years. The development of the national PAL-GPR service is a direct result of these attributes.

2.0 Background

Approximately 30 months ago, Counties Power recognised the potential for network disruption due to underground construction from the looming Ultrafast Broadband network build programme that forecast building 34,000 km of optical fibre network to the premises to 75% of New Zealanders, which was in its first year of construction. Strike avoidance was a key factor in network management and maintenance, where utilities have substantial subsurface assets in the targeted construction zones – including Counties Power.

At that time methods for locating and mapping subsurface assets in order of improving detail and increased complexity included as-built plans and anecdotal information, electromagnetic (CAT & JENY) surveys, Ground Penetrating Radar (GPR) and other non-invasive methods like electric resistivity tomography, and physical survey. Standards were being contemplated for subsurface survey (or subsurface engineering) primarily in the USA, Britain and Australia. The New Zealand code of practice in place mandated “all reasonable steps” as the operational standard.

These methods were characterised by a number of constraints, which may be summarised as manual operations in the road and reliance on skilled operators of complex technology. Outcomes included strikes from false negatives, unreliable mapping and resolution of potential targets from survey efficiency considerations, electronic data capture and storage, plus, a trend to standardisation with a draft NZ/AS subsurface engineering standard in preparation.

Figure 1 – Single (left hand image) and multichannel GPR capture solutions

A period of research indicated GPR as a viable solution – with a number of critical improvements needed to enable a reliable, high resolution subsurface mapping technology.

Other trends included an increasing reliance on accurate Geographic Information Systems as a network management tool, rapidly evolving field computing systems and vehicular platforms for rapid data capture e.g. Google's Streetview initiative extended into smartphones.

Figure 2 – Plan of complex utilities from array GPR

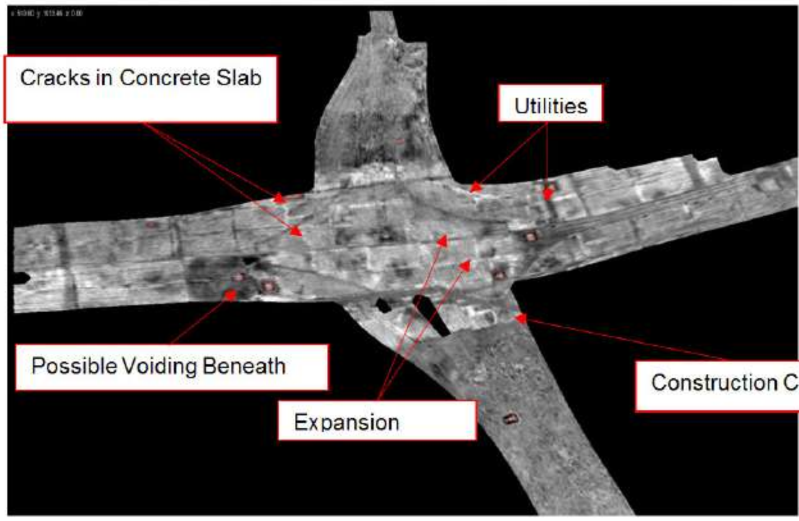
Critical improvement factors included the fact that GPR technologies were onerous to operate ("From" column in Table 1 over); that capture platforms as in figure 3 were single purpose, either road going or off-road and potentially unsafe in NZ; survey grade (Robotic Total Station) location sensing in use limited the coverage per unit time; and unlikely to be cost effective in New Zealand.

Figure 3 – Existing single purpose capture platforms

From	To
Radargrams + Markout	Offline availability (GIS/CAD)
1,000s metres daily capture	10,000s metres daily capture
Decimeter accuracy	Centimeter accuracy

Table 1 – Constraints and improvements needed for existing GPR technology solutions

A number of other uses and potential markets were noted during this research period and captured during the requirements phase of the development programme. These included road pavement and bridge-deck analysis (in conjunction with aboveground pavement data capture) and non-invasive archaeological investigations.



Road construction and Archaeology

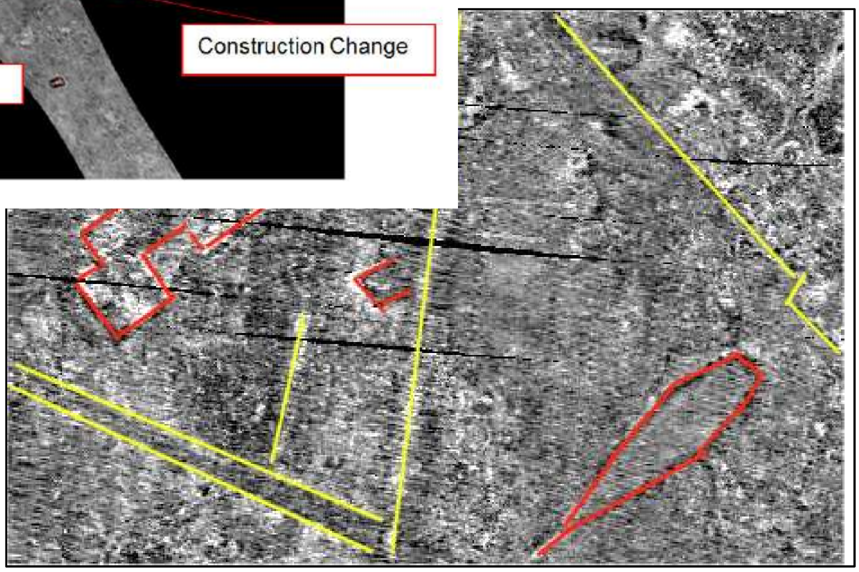


Figure 4 – Other possible uses for array GPR

The resulting service development programme was phased as:

1. Technology Selection: Engage partners (not just suppliers) through transparent process to provide GPR, accurate location sensing, all-terrain vehicle, GPR analysis software, utility survey skills and geo-physics skills – who are versed in GPR as a commercial utility location tool;

2. Technology Proving and Service Creation: Craft the service offerings for the prioritised markets on a national basis, using selected national customers to hone the requirements and outputs of the service for each type of customer;

3. Soft Launch: Market the service into the wider community of asset owners and entities operating in the road, enhancing the outputs as needed to meet customer needs and making the transition from start-up to business-as-usual. Build the business through projects; and

4. Expansion: Grow the markets on an opportunistic basis targeting NZ then further afield for services and product sales growth.

The outputs from the first two phases are documented in the web video on the PAL-GPR site along with representative projects, from Franklin, Wellington and Timaru. We are currently in the Soft Launch Phase and have completed over 100,000 sq. m. of data capture and analysis around NZ.

Figure 5 – PAL-GPR capture vehicle in operation

3.0 Outputs – More examples

A number of case studies have been posted into the website and video.

We illustrate the capabilities and outputs with the following additional projects:

3.1 Glenbrook Steel Mill 33,000 Volt extension to new BOC plant.

Counties Power Construction was awarded the contract to build a 33 kV cable from substation to new BOC Gas plant along an existing overhead 33 kV route.

The construction planning issues for the horizontally drilled cable route included:

1. Difficult terrain for detailed investigations and construction
2. An existing gantry style 33 kV line ran along the major part of the proposed route that required careful routing of the drill path through the centre line of the gantry to ensure the existing line remained undisturbed following installation
3. As-built information for existing underground High Tension cables and critical privately owned fibre optic cables that crossed the proposed route were in the form of plans – and the fibre cable did not contain copper trace for safety making location difficult
4. Anecdotal evidence indicated cables of unknown status along the route.

A GPR only survey of approximately 1,000 square metres was conducted along with minimal subsequent pot holing resulted in a successful project delivered on time. The survey plus analysis consumed 2 man-weeks effort in a 4 week period. The survey located previously un-identified subsurface artefacts able to be avoided during drilling.

Sponsor Jason Hazelwood, GM Construction "We initiated the PAL-GPR programme to improve safety of our staff and the network. The service delivers an additional level of comfort to existing methods of location in hazardous areas in which we work – from the result in this project and other route proving projects"

3.2 Jervois Quay Pavement Layer Analysis

The second project for Wellington City Council (WCC) was a GPR only survey of approximately 20,000 square metres of Jervois Quay. The data was analysed for two outputs, utility location to 2 metres and pavement analysis to 400 millimetres.

Amongst the artefacts discovered and noted:

- The large variety of anomalous areas probably from construction works in the road that indicate areas of possible weakness in the pavement and evidence for reconstruction project planning

- The areas of probable salt water contamination shown at depths of about 1 metre indicating tidal encroachment of water into the base course

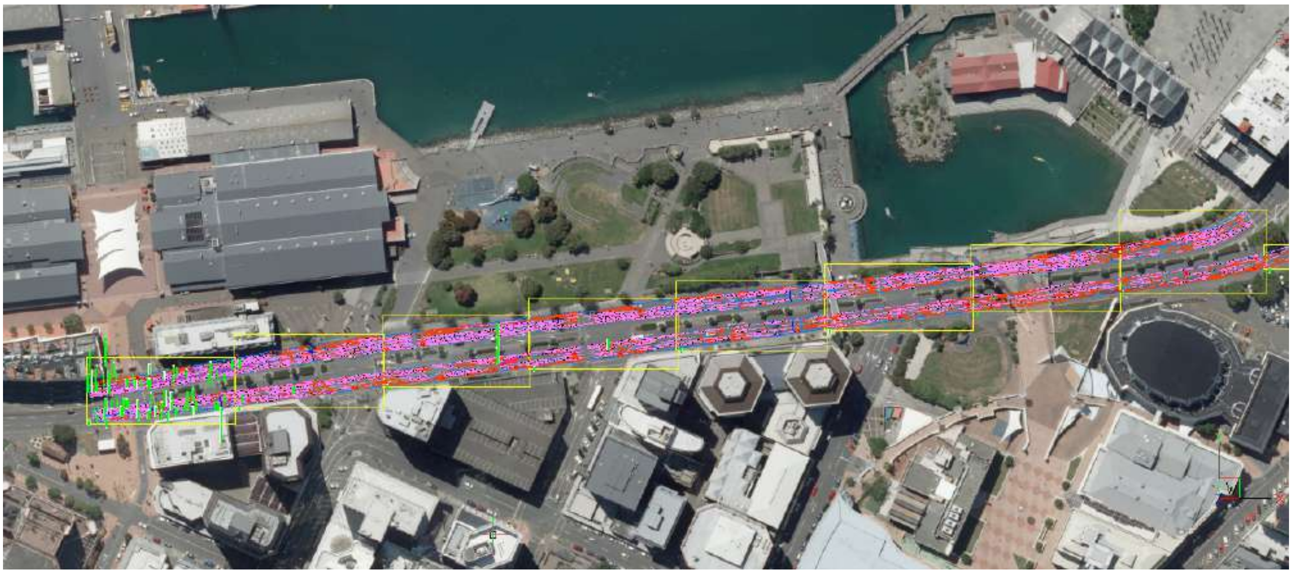


Figure 6 – Jervois Quay overview indicating Area 1 which is expanded in Attachment 1

This very complex analysis took 4 man-weeks effort for each type of output following a 2 man-day capture deployment.

A simplified view of the some of the detail is shown in A3 format as Attachment 1, where the mauve lines indicate anomalies along direction of radar travel and red bounded areas anomalous areas at 100 mm depth (areas for further investigation).

To ease the visualisation issue imposed by CAD and GIS software available today, Counties Power is working to enhance its products. An early example is shown in figure 7 overleaf.

Further analysis by the WCC roading team is expected to reveal more detail about the anomalies and their cause assisting analysis and decision making into the future.

Sponsor Vaughan McEwen, Assets - Data Manager, Strategic AM Planning, Wellington City Council "Once proven locally, we expect the output to be useful in informing our utilities teams of underground infrastructure and other obstacles when constructing or maintaining assets; providing evidential information for our roading asset teams; and providing our customers and the general public with a richer information set of WCC underground and roading infrastructure."

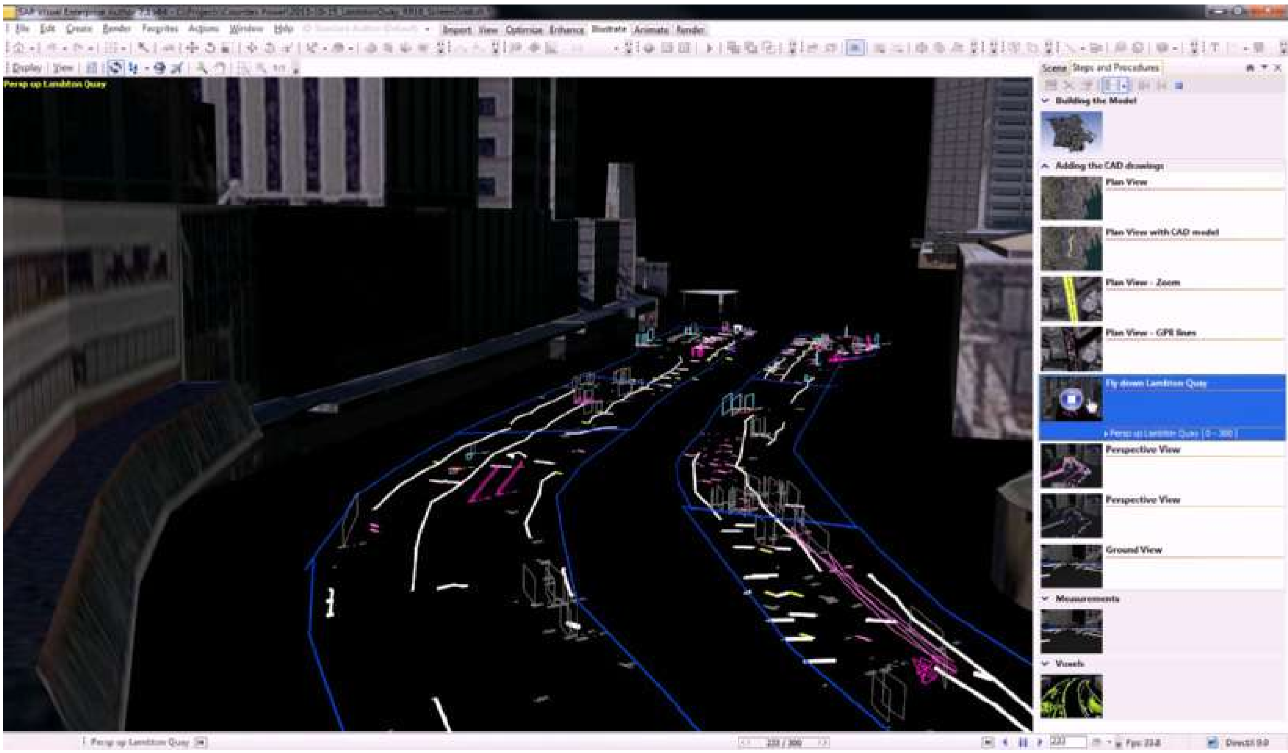


Figure 7 – Example of 3d visualisation output, including measurement and location capability

3.3 Seddon St cemetery

A local church needed to identify the available space for new graves in an old cemetery and challenged by inconclusive records and a volcanic rocky area for digging new graves. A GPR survey project was executed to discover unmarked graves and other anomalies to 2 metres.

Usable space and possible unmarked graves were mapped in a period of 3 man-weeks following a 1 man-day survey, to the satisfaction of church personnel.

Attachment 2 contains a detail view of the output in A3 format.

Sponsor, Paul Brown, Pukekohe Catholic Church & Director, Counties Power "We realised one outcome of identifying usable space in the crowded cemetery and expect to prove or disprove the location possible graves when digging new graves."

4.0 Conclusions

Counties Power has built a capability in high-volume utility location beginning to prove itself technically and commercially. We expect to achieve outcomes of

- Improved safety through improved evidence of hazardous subsurface assets;
- Lower planning and construction costs through reductions in design changes and improved utility location capability;
- Improved asset TCO through reduced maintenance and elongated asset life from reduced strikes.