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SATELLITE LEAK DETECTION:

A Data-Driven Business Case Analysis

By Paul Gagliardo

Water utilities are constantly looking for new technologies and tools to ensure potable water is produced and delivered in a cost effective and safe manner. Due to ageing linear underground assets, transmission and distribution pipelines, utilities must invest a significant amount of money in their repair and replacement. Utilities will proactively repair pipelines where leaks surface and are visible. These are only the tip of the iceberg when it comes to active leaks. Many leaks are non-surfacing and may remain so for many months or even years, leading to a large loss of non-revenue water. Locating and repairing these background leaks is one of the main challenges for water utilities.

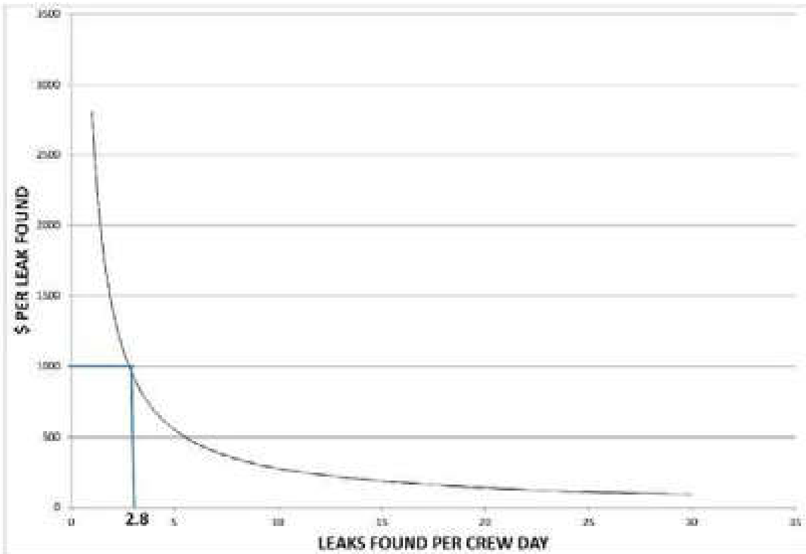

Figure 1: This graph shows the relationship between leaks found per day and cost per leak found.

In the April 2016 issue of *Water Finance & Management,* an article introduced satellite leak detection and Utilis to the industry. Utilis uses L-band radar from to detect underground pipe leaks. The now-patented technology was developed in 2013 and the first commercial application was launched in 2015. Since that time, more than 200 projects have been executed around the world. The technical efficacy of the imaging analysis has steadily improved over time. This article will present a data driven business case analysis showing the value proposition of using the technology to triage the distribution system and lower the cost to find background leaks.

When introducing a new technology, it must be proven to produce results that meet or exceed the current standard procedures for the same activity. When a truly new and different technology is developed, performance metrics must be created to accurately compare technical efficacy and value proposition, and thus prepare a business case. Once the performance metric is defined, benchmarking can be used to assess the competitive position of the new technology. Benchmarking is most used to measure performance of a specific indicator, such as cost or productivity per unit of measure, or cycle time, resulting in a metric of performance that is then compared to competing processes.

The traditional method utilities use to look for background leaks is a point-to-point acoustic inspection of the pipeline route using field leak detection staff. This work is typically performed in a linear fashion, from one end of the system to the other. Inspecting the entire system in this way is time consuming because most of the pipeline is not leaking, and thus, a lot of resources are spent inspecting pipe that does not exhibit a leak. Another widely used leak detection method is to deploy fixed base acoustic leak listening devices. This option is very capital intensive and, once installed, provides a rapid notification of newly audible leaks.

Data was collected and analyzed to calculate a benchmark for the traditional boots-on-the-ground (BOTG) method, for the fixed based acoustic systems and for the Utilis satellite imagery program.

A compilation of projects from the period 2009 to 2018, using traditional leak detection services and covering 1,600 jobs, was analyzed to understand performance of this standard procedure. The performance metrics developed from this meta-analysis are 1.4 leaks per crew day found, and, 0.36 leaks per mile physically inspected. A compilation of Utilis' satellite imagery-driven leak detection projects from between 2016 and 2018 was analyzed and found to identify 3.8 leaks per crew day and 3 leaks per mile physically inspected.

In order to compare these two techniques, some standard assumptions were made. These variables were selected based on averages observed from the many projects analyzed. A crew day cost of $1,400 was used in the financial analysis. This was calculated based on a two-person crew plus truck roll, and an eight-hour work day. For the Utilis projects, an average performance of 0.5 leaks per point of interest identified by the satellite imagery was used in the financial analysis.

In Figure 1, a curve is plotted showing the cost per leak found using the assumptions listed above, varying only the leaks found per crew day. As can be seen from the plot, the break-even point between the traditional boots-on-the-ground (BOTG) and the satellite-directed approach is 2.8 leaks per day. The satellite method can be more cost effective at finding leaks than the traditional method when more than 2.8 leaks per crew day are found. The leak per day metric is a good indicator of cost effectiveness of leak detection programs. The more leaks found per day, the lower the cost per leak found. The breakeven point is calculated when the satellite imagery service cost is added to the BOTG field inspection costs and divided by the leak per day found. It is important to note that the full cost of finding a leak must include the field leak inspector costs. This is the only cost associated with traditional BOTG, but must be added to fixed base acoustic system capital costs as well as the satellite imagery service cost. Using the average of 3.8 leaks per day found using satellite leak detection, the cost to find a leak is $728. This is a savings of $272 per leak found, or over a 25 percent cost reduction, from the traditional leak detection methodology.

The second major background leak detection methodology includes the installation of a fixed base acoustic leak system. Multiple acoustic loggers are permanently installed in a distribution system to continuously monitor for leaks. In order to compare the technical efficacy and value proposition of this type system with the satellite method, a side-by-side study was recently completed by pursuant to a California Energy Commission (CEC) grant. The report is in press. This study included the monitoring of 100 miles of potable water pipeline using both a fixed base system and the Utilis method. Permanent loggers were installed in this area of interest, and, monthly satellite images were taken and analyzed over a one year comparison period. The results of this study are listed in Table 1 below.

As can be seen from the data, almost six times as many leaks were found using the Utilis triage methodology than the fixed base acoustic triage methodology during the 12-month test period. The satellite method yielded 0.8 leaks per POI investigated, where the fixed base system yielded 0.4 leaks per POI investigated. The number of POI's investigated per crew day using the fixed base acoustic system program was 8 as compared to 4.2 using the Utilis program. The Utilis program found twice as many leaks per POI but was only able to inspect half the POI's per day. The leaks found per crew day are the same at 3.3. The overall value proposition then depends on the capital (fixed base system) and/or service (Utilis) costs to obtain the intelligence as to where to effectively search for leaks.

Figure 2 shows a graphic of the cost to find a leak using both the satellite method and the fixed base acoustic method. The cost per leak found is compared with the capital cost of device installation or the cost of a twelve month satellite image service. The capital cost is amortized over a five-year period to calculate a yearly cost per mile. In order to normalize the satellite method and the fixed base method, a series of 12 monthly images were considered in the service cost calculations.

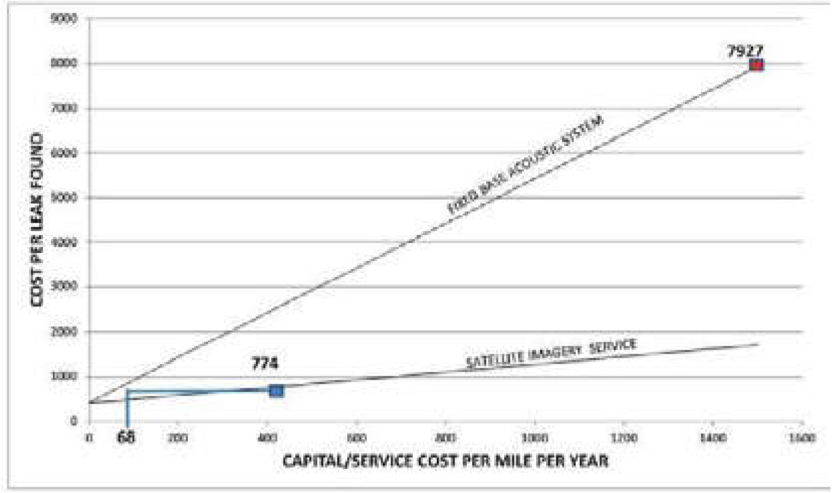

Figure 2: This graph shows the relationship between cost of data acquisition and cost per leak found.

Based on the performance achieved in this year-long study the satellite method almost always has a lower cost per leak found. Using a Utilis service cost of $420 per mile per year for the twelve images the cost of finding a leak is $774. In order for the fixed base system to achieve a cost to find a leak of $774 the capital cost of the fixed base system must be below $68 per mile per year. At a similar capital/service cost per mile per year the satellite method is always less expensive at finding leaks. For example, from Figure 2, at a capital/service cost of $420, Utilis is $1,750 per leak less expensive than the fixed base system. At typical capital/service cost parameters the Utilis satellite method would allow a utility to find and fix a leak for the same cost as the fixed base system to only find the leak.

The data from the meta-analysis of traditional BOTG projects and from the Utilis project database show that the Utilis method is more cost effective at finding leaks when 2.8 leaks per crew day or more are found. The average Utilis project achieves 3.8 leaks per crew day.

The data from the California Energy Commission study shows that the Utilis triage method is less costly at finding leaks than a fixed base acoustic system when capital/service costs are taken into account.

When specifically looking at the cost per leak found metric, the Utilis technology is more cost effective and provides more value to the utility than either the traditional BOTG or conventional fixed base acoustic system.

Table 1: Results from CEC grant study.

	UTILIS	FIXED BASE ACOUSTIC
# POI's GENERATED	504	77
# POI's INVESTIGATED	146	49
LEAKS FOUND	117	20
LEAKS per POI	0.8	0.4
LEAKS per CREW DAY	3.3	3.3
POI's INVESTIGATED per DAY	4.2	8.0

Paul Gagliardo, MPH, P.E., has more than 25 years of experience in the water utility business and most recently worked for American Water as innovation director.