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Using Satellite RADAR imaging to detect pipeline leaks in Hilton Head – A Case Study

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The Hilton Head Public Service District (HHPSD), located on Hilton Head Island in South Carolina, has a dedicated program to find leaks and reduce non-revenue real water losses. In 2018, HHPSD retained the services of Utilis to analyze the water system using satellite RADAR imagery to identify likely leak locations for follow-on field leak detection inspection. The team performing the leak inspection included Utility Services Associates (USA), which has been performing traditional field leak inspection services for HHPSD since 2011. This case study will document the Utilis performance and compare it with the six-year history of the USA traditional methodology benchmark results. In addition, it will be shown how the Utilis protocols can find an extremely large previously unknown leak that has been active for years.

Hilton Head Island is located in the far southeast corner of South Carolina on the Atlantic coast. There are three water utility districts on the island – HHPSD is the largest. HHPSD serves 19,000 customers in the north and mid-island areas and maintains over 220 miles of water mains. Average daily demand is 6MGD, with peak delivery of 11MGD in

the summer months. Potable water is supplied from three sources: a 4 MGD RO plant treating brackish groundwater, wholesale purchased treated Savannah River water (which is also used to recharge a 2-mgd ASR facility) and fresh groundwater from the Upper Floridian Aquifer. The fresh portion of the groundwater aquifer is being impacted by saltwater intrusion, which is reducing its capacity to supply water not requiring demineralization.

Utilis collected and analyzed a satellite image of the entire HHPSD service area in November 2018. A total of 143 points of interest (POI) were identified

as likely leak locations. USA crews provided field inspection services for a total of ten days in December 2018 and January 2019. Of the 143 POIs, 79 were physically inspected by USA during the 10-day period. 19 of the POIs identified contained a leak. **Table 1** shows the results from this service.

The Utilis protocol triages a water system and pre-locates the likely leak locations. This allows for the field leak crews to focus their efforts on a small section of the system, in this case about 6% of the total length. USA has previously performed traditional leak detection work for HHPSD.

Table 1: Utilis Service Results

Miles of Pipe Surveyed by Satellite	245
Miles of Pipe Inspected by Leak Crew	15.5
Number of Findings (POIs)	143
Sites Investigated	79
Total Leaks	19
Crew Days (two-man crew)	10
Leaks per Crew Day	1.9
Leaks per Mile Inspected	0.84

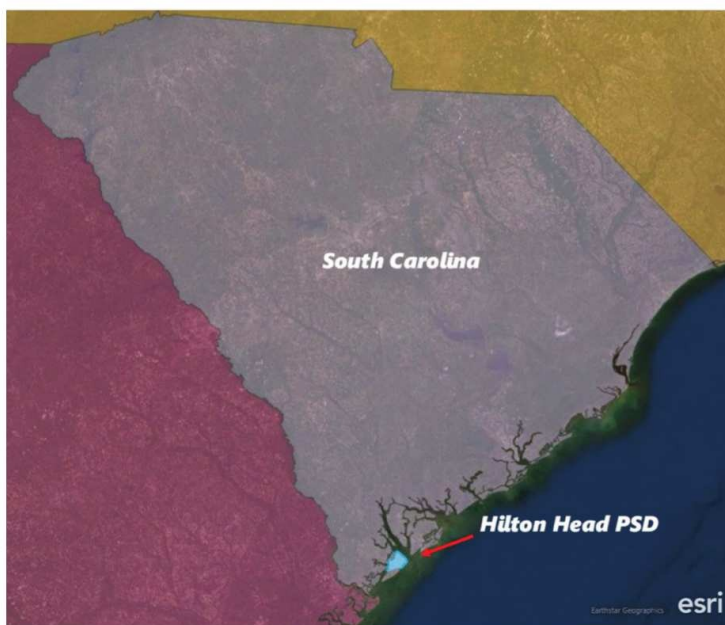


Figure 1.
The Hilton Head Public Service District (HHPSD) is shown in blue within the state of South Carolina.



Figure 2.
The Hilton Head Public Service District (HHPSD) is outlined in red, with the pipe network shown in blue, and POI 88 circled in yellow.

The results from six years of data were used to create a benchmark to compare to the Utilis-informed inspection program. The fact that the same company performed the field leak inspections in the traditional manner and again using the satellite pre-location eliminates any potential crew bias. The same company used the same people, equipment and inspection protocols in all field inspections discussed herein. The previous USA work entailed the traditional method of inspecting a system for leaks. A pre-selected area of interest was inspected linearly from one end to the other. A total of 133 miles of pipe was inspected during these six years, about half of the HHPSD system. 44 leaks were found during 55 days of field inspection. **Table 2** lists data and performance metrics on this work.

The Utilis service is compared to the benchmark metrics derived from the traditional USA results from a technical efficacy perspective. As can be seen from **Table 2**, the Utilis directed methodology was able to identify 1.9 leaks per crew day compared to the traditional service methodology, which found 0.8 leaks per crew day. This is a 240% improvement over the traditional methodology benchmark. The Utilis method was also shown to direct the field inspection crews much more efficiently as noted by the fact that it identified 0.84 leaks per mile inspected versus 0.33 for the traditional method. This is almost a 250% improvement in this operational metric.

Table 3 shows these summary metrics.

HHPSD has several attributes that contribute to a low number and rate of leaks found in the service area. USA, based on a meta-analysis of 10 years of projects, identifies 1.4 leaks per day when following the traditional field inspection protocol. During the previous six years when USA is working at HHPSD using the traditional method, a rate of 0.8 leaks per day was found. There are three main reasons for this discrepancy. Firstly, the HHPSD system is almost totally PVC or other plastic. It is much more difficult to acoustically find and pinpoint a leak on plastic pipe than it is on metal pipe. Secondly, there is a direct correlation between the number of listening points accessed and the number of leaks identified. HHPSD has a low number of available listening points within the distribution system and a low number of leaks were found compared to the benchmark. In a typical Utilis driven program, 40-60 listening points per POI are found and inspected.

Table 2: USA – Leak Detection Performance – HHPSD Benchmark

Miles of Pipe Inspected	133
Total Leaks	44
Crew Days	55
Leaks per Crew Day	0.8
Leaks per Mile Inspected	0.33

Table 3: Utilis Service Comparison to Traditional Benchmark

	Benchmark	Utilis Trial
Leaks Found per Crew Day	0.8	1.9
Leaks Found per Mile Inspected	0.33	0.84

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In the HHPSD system only 15-20 listening points per POI could be found and accessed. An average Utilis driven leak detection project achieves 3.8 leaks per crew day. When there is a significant reduction in the number of listening points that can be accessed there is typically a significant lowering of the number of leaks found. Thirdly, many of the potential listening points are covered with vegetation, soil or pine needles and are difficult to locate. This adds time to the inspection or, these potential listening points are just ignored. 20 meters and four valves could not be located within the 79 POIs investigated. Many meter lids are plastic and thus are harder to find when covered than metal lids. This reality decreased further the number of listening points and thus lowered the number of leaks found.

Notwithstanding these facts, the Utilis directed program outperformed the HHPSD benchmark from a technical efficacy perspective.

The Utilis methodology specializes in identifying leaks that have not yet surfaced. Customers usually report surface leaks and the utility responds through work order requests. Non-surfacing leaks can remain active for many months or years and contribute to large physical loss of water and revenue. Finding and repairing these leaks provide a very attractive return on investment when using the Utilis services. One POI identified by Utilis in HHPSD is a prime example of this occurring.

POI 88 was identified along a 12-inch HDPE water main that crosses a tidal flat and serves customers in the far western portion of the service area. The main is approximately 25 years old and was installed by sinking the

pipe with concrete collars. The area is submerged during high tide and partially exposed during low tide. The zone being served by this water main had no indication of a problem. There were no low-pressure events or water outages. In addition, the main is served by a booster pump station and elevated tank near the tidal flat crossing, and just south of that is the Upper Floridan Aquifer freshwater production well ('Wild Horse Well') that provides daily water (0.600 MGD average). It is a perfect storm of circumstances that kept the leak hidden for years.

The POI was inspected during a low tide period. There are no listening points available due to the nature of the main, a regional transmission pipe, so the crew relied on a visual inspection. The site was visited and there were noticeable animal footprints in the tidal marsh leading to a specific location. Upon inspection of that location a 'blue lagoon' was discovered. This blue lagoon was the surfacing of a potable water leak from the twelve-inch main. The main had a hole near one of the concrete collars as big as a softball. Because the leak was proximate to the source of pressure there was no indication of a problem. A clamp was installed to temporarily fix the leak, while a permanent leak fix could be planned and executed.

As you can see in **Figure 3**, Utilis POI 88 (highlighted red) and surrounding area, including the locations of the 'blue lagoon' (visible in the pop-out image as a small blue pond), the booster pump station/elevated tank (yellow star), the Upper Floridan Aquifer freshwater production well (orange circle), and the 12" distribution main and 24" inch transmission pipeline (teal line).

The discovery of the leak also uncovered geolocation errors in the department's pipe map layer.

HHPSD uses an AMI system that can effectively act as a DMA. By comparing demand in the area before and after the leak was fixed it was determined that the leak flow rate was 1 to 1.5 MGD, or 700 to 1000 GPM. Based on the cost of procurement and production of potable water for HHPSD this is valued at \$500,000 per year. Because the leak is on the utility side of the meter it is a non-revenue water loss and thus a direct cost to HHPSD.

This leak had probably been active for multiple years. It is speculated that the leak could have been exacerbated by the King Tides of 2016. A quick analysis using Google Earth visible base map imagery shows the 'blue lagoon' as early as October 2016, but it does not appear in the preceding image in 2014 – bolstering the speculation of the leak forming sometime between 2014 and 2016. This one leak could have been responsible for the loss of over \$1.5 million to HHPSD during its lifetime. It may have continued to be hidden without the Utilis satellite imagery services that could differentiate between saltwater and fresh water in the tidal flat.

Mr. Pete Nardi, General Manager Hilton Head PSD, described the leak location as 'a perfect storm of circumstances that allowed the leak to stay hidden, and without Utilis, could have kept going.'

"For us, Utilis found leaks as small as leaking meters to one as large as a distribution main buried in the marsh and fixing that one saved the PSD and our customers about half a million dollars per year."

This shows the power and value of the Utilis methodology. 🌊

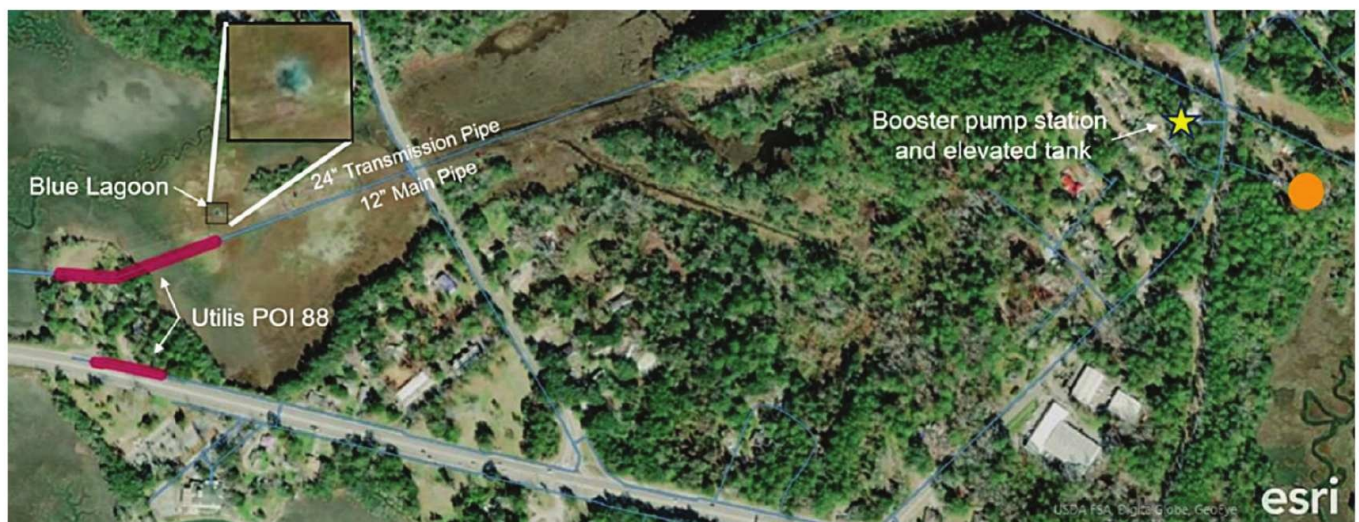


Figure 3