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***PERFORMANCE ANALYSIS
ASTERRA SATELLITE LEAK DETECTION SERVICES***

North Kingstown, RI
June 2023

North Kingstown
Rhode Island

Executive Summary Report

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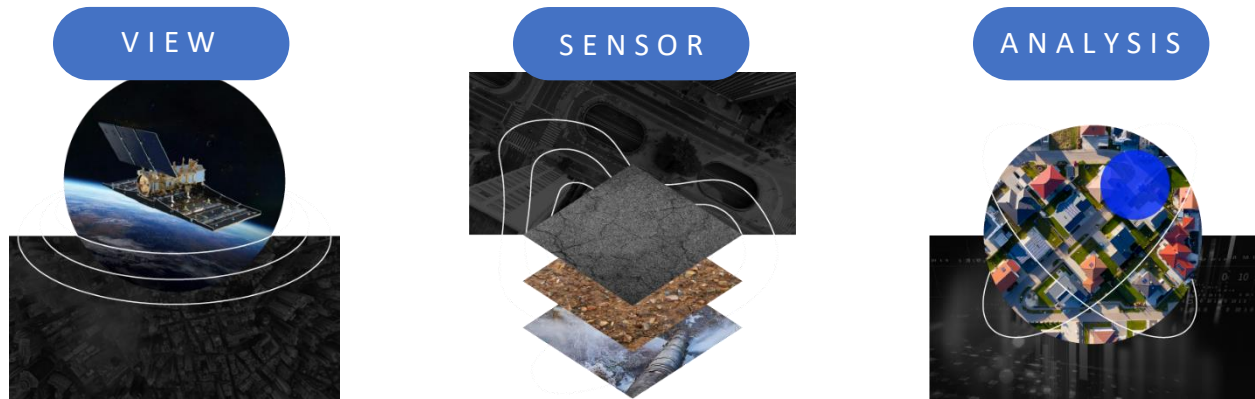
SUMMARY

This executive summary paper analyzes the ASTERRA satellite leak detection services performed in June 2022 – May 2023 for the North Kingstown, RI. Performance will be compared to benchmark results achieved in other ASTERRA projects around the world and North American traditional boots-on-the-ground (BOTG) leak detection projects.

- A total of 18 leaks were found pursuant to the satellite directed field inspection; 14 leaks were on the utility side, 4 leaks were on the customer side of the meter.
- The water loss value identified is \$130,332 per year of water loss savings.
- The total real water loss volume found by this program was 0.11 MGD or 39.7 MGY.
- Each crew field day identified 1.8 MGY of water loss volume. A total of 22 field crew days identified 39.7 MGY of potential recovered water supply.
- The total service cost, ASTERRA satellite surveys plus BOTG field leak inspection, mobilization and report preparation was \$85,500.

The simple payback period is 7.9 months.

ASTERRA TECHNOLOGY



ASTERRA utilizes specialized radar signals taken from a satellite to scan the area of interest and collect the resulting reflected signals. These signals are analyzed and processed to identify specific indicators of wet soil saturated with potable water, screening out the signal noise and other interferences. The result is a map showing points of interest. The ASTERRA analysis typically highlights 5-10% of the entire system length, and only these locations, where there is expected to be a leak, are inspected by BOTG leak detection teams. Thus, the time and resource cost of leak detection is much lower than traditional leak detection approaches (e.g., full-system, random, systematic, or block map).

NORTH KINGSTOWN, RI PROJECT AREA RESULTS

The satellite image for the North Kingstown, RI service collected on June 8th, 2022, June 18th, 2022, and September 6th, 2022, and covered the entirety of its service area. Table 2 shows the results from the work performed. A grand total of 18 leaks were found during this effort. Of the 18 leaks found by ASTERRA direction, 14 were on the utility side of the meter, and thus are non-revenue water leaks, while 4 were on the customer side of the meter. The 18 leaks were found in 22 crew inspection days. A total of 19.0 miles of pipeline were physically inspected by the BOTG crews. This resulted in a performance metric of 0.8 leaks per day found and 0.9 leaks found per mile inspected.

The breakdown of the 14 utility side leaks found by subtype is listed below in Table 1.

Table 1

Leak Type Identified via ASTERRA Directed Field Investigation

ASTERRA – North Kingstown, RI LEAK TYPE							
Pipe Main	Service Pipe	Service Connection	Valve	Meter	Hydrant	Backflow Preventer	Curb Stop
1	4	1	0	0	6	0	2

Further, Table 2, below, lists the AWWA M36 leak flow size by subtype. AWWA Manual M36 is silent on the size of meter, curb stop and backflow preventer leaks, so these were estimated based on a meta-analysis of over 1800 traditional boots-on-the-ground projects performed in North America between 2009 and 2018.

Table 2

AWWA M36 Leak Flow Rates (GPM)

AWWA MANUAL M36 LEAK SIZE BY TYPE - GPM							
Pipe Main	Service Pipe	Service Connection	Valve	Meter	Hydrant	Backflow Preventer	Curb Stop
10.4	6.9	6.9	6.9	0.4	3.5	1.0	0.7

Table 3, below, calculates the real water loss identified by the ASTERRA directed field work using the utility side leaks in Table 2 and the leak flow rates in Table 3. Additionally, the leak found in POI 00046 was included individually as it was recorded as being notably higher than the average flow rate above.

Table 3

Real Water Losses Identified

REAL WATER LOSS IDENTIFIED BY LEAK TYPE - GPM			
Leak Type	Number	Flow Rate (GPM)	Total Flow (GPM)
Main Pipe	1	10.4	10.4
Service Pipe	3	6.9	20.7
Service Connection	1	6.9	6.9
Valve	0	6.9	0.0
Hydrant	6	3.5	21.0
Meter	0	0.4	0.0
Backflow Preventer	0	1.0	0.0
Curb Stop	2	0.7	1.4
POI 00046 – Notable Leak	1	15.0	15.0
Total	14		75.4

DISCUSSION

The following analysis will focus on the real water loss value identified by the ASTERRA directed field leak inspection work.

Real water loss value found by this program are 0.11 million gallons per day, or 39.7 million gallons per year, and the data is listed in table 4. This is calculated by multiplying the number of each type of leak (e.g., main, service, and other) found by the ASTERRA directed field inspections by its estimated leak flow rate as defined in the AWWA M36 Water Audits and Loss Control Programs Manual. This resulted in an average leak flow rate of 5.4 GPM. This factor was applied to the 14 utility side leaks found via the ASTERRA directed program. 4 leaks were on the customer side of the meter and were not used to calculate real, non-revenue water loss.

Table 4

Water Loss Recovered

ASTERRA DIRECTED LEAKS - WATER LOSS				
	Number of Utility Leaks	Average Leak Flow Rate	Daily Water Loss Rate	Yearly Water Loss Reduction
Total	14	5.4 GPM	108,864 GPD	39.7 MGY

A total of 22 crew days were spent inspecting the points of interest (POIs) for leaks that contribute to the lost water. A total of 39.7 MGY of potential water loss was identified based on the leak estimates. Thus, each day a crew spent searching for leaks generated 1.8 MGY of potential water loss reduction, or effectively new supply. This lost water could be used to meet additional demand in the system without the need for additional aquifer withdrawals, or new capital improvements. These results show that crews spending days in the field searching for leaks, pursuant to the ASTERRA satellite program, generate valuable results.

The amortized cost of this new supply averages \$2,152 per million gallons. The total cost of service, including ASTERRA satellite imagery, BOTG field leak inspection, mobilization and report preparation, is \$85,500 which can be divided by the total gallons per year real water loss reduction of 39.7 MGY to determine the cost of this new, recovered water supply. This cost can be compared directly to the cost of water production, which is estimated to be \$3,280 per million gallons. This marginal cost of the newly recovered water supply is an attractive investment as it is significantly lower than the marginal cost of production.

Approximately 94% of the leaks found by field inspections (17 of 18) resulting in water loss are due to leaks that have not yet surfaced. These leaks potentially can last for many months or even years before they are discovered without the ASTERRA survey program.

The overall yearly value of the ASTERRA satellite program to North Kingstown, RI is \$130,332 for the services provided. The total investment in this program including ASTERRA satellite surveys and field leak inspection crew costs was \$85,500 netting a simple payback of 7.9 months.

Table 5 below, details the 18 leaks found through the program.

Table 5

List of Leaks *Italicized addresses are approximate

POI	Leak Type	Sub Type	Surfaced	Address
00046	Service	Connections-Fittings	No	71 Woodmist Way
00015	Service	Connections-Fittings	No	190 Brookside Dr
00061	Service	Curb stop-Stop tap	No	363 Congdon Hill Rd
10064	Service	Curb stop-Stop tap	No	<i>601 Day Bridge Rd</i>
10055	Service	Pipe	No	175 W Allenton Rd
10054	Service	Pipe	No	554 Oak Hill Rd
10077	Service	Pipe	No	<i>71 Dale Hill Dr*</i>
10028	Main	Fire hydrant	No	110 Wickford Point Rd
00018	Main	Fire hydrant	No	232 Shores Acres Ave
10075	Main	Fire hydrant	No	905 Indian Corner Rd
00042	Main	Fire hydrant	No	141 Oak Hill Rd
00025	Main	Fire hydrant	No	<i>Mayflower Ct*</i>
10074	Main	Fire hydrant	No	<i>166 Railroad Ave*</i>
00025	Main	Pipe	No	Cole Dr & Mayflower Ct
00028	Customer-Side	Pipe	No	95 Long Ln
00048	Customer-Side	Pipe	No	67 Butternut Dr
00046	Customer-Side	Pipe	No	171 Woodmist Way
00049	Customer-Side	Pipe	Yes	55 Pinecrest Dr



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VALUE PROPOSITION

To calculate the value proposition of the ASTERRA satellite leak detection services, the cost of the work must be compared to the value of the water loss reduction. The value of the water is considered to be the nominal cost of production as opposed to the price to the customer. The cost of service is comprised of the satellite imagery collection and analysis cost plus the leak crew cost. The value of water loss reduction is calculated by estimating the volume of water lost, the duration of the leak and the cost of water procurement, treatment, and delivery.

Nominal Cost of Production (Procurement, Pumping, Treating, Distributing)

Vs

Cost of Service (ASTERRA Data Analysis + Leak Detection Crew days)

To calculate the amount of water lost per leak, a number of options are available. The estimates in AWWA Manual M36, Water Audits and Loss Control Programs are used in this analysis to be consistent with other project reports. Customer side leaks and work order leaks will not be used to calculate non-revenue water loss reduction. The daily leak loss rate will be normalized to a yearly value for the purposes of calculating the value benefit to North Kingstown, RI.

To determine the value of the lost water, a cost of production must be calculated or assumed. The cost of production is comprised of the cost of procurement, pumping, treatment, and distribution. When water is purchased wholesale from other entities, the unit cost is high. Groundwater is more costly than surface water as a source due to pumping costs. The cost of water production is estimated to be \$3.28 per 1000 gallons based on the retail price of water to customers.

These factors generate the dataset used to create the individual figures and thus calculate the financial savings to North Kingstown, RI. Overall total cost of service was \$85,500, and the total value accrued was \$130,332. This generates a simple payback period of 7.9 months.



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Another way to benchmark the value proposition of the ASTERRA service is to calculate the cost to recover water supply through the identification of non-revenue water leaks. This is calculated by dividing the total cost of service by the recovered water volume.

$$\text{Cost of Recovered Water Supply} = \text{Cost of Service} / \text{Recovered Water Volume}$$

When the cost of the recovered water is lower than the cost of production this signifies a low marginal cost of new supply. 39.7 MGY of water loss was identified at a cost of service of \$85,500, resulting in a cost of recovered water supply of \$2,152 per MG. Thus, the cost of the recovered water supply is significantly lower than the cost of production at \$3,280 per MG. This shows the value of the program.

Finally, reducing NRW will directly impact the utility's bottom line because production costs are avoided.

RECOMMENDATION

It is recommended that North Kingstown, RI continue to pursue leak detection monitoring with ASTERRA. Leaks continue to arise even as non-surfacing leaks are found and repaired. By continuing with ASTERRA monitoring, real water loss levels will stabilize and ultimately reduce. Furthermore, renewing the ASTERRA monitoring service, and switching to our new subscription model generates a consistent and proactive leak assessment solution.

Having a proactive method of identifying high risk points in the system mitigates the risk and incurred costs of deploying emergency repair crews to customer identified leaks, all the while facilitating a planned response to subsurface leaks otherwise not identified. By utilizing ancillary services for planning their response to leaks within the system, this also reduces crews working over the weekend and creates safer excavations. It is recommended that North Kingstown, RI continues proactive leak detection monitoring with ASTERRA by subscribing to the Prevent or Advise package.

Benefits/Advantages to the Prevent and Advise Packages:**Temporal/Spatial Analysis:**

Often utilities deprioritize proactive leak detection and standard maintenance efforts due to resource constraints. In most cases, utilities are forced to use limited resources in response to call-ins or work orders. This results in falling further behind the curve and increased pipe breakage and non-revenue water losses. In order to re-invest in proactive system maintenance and leak detection, Recover provides a highly efficient means to survey points of interest and avoid blindly surveying an entire utility's system of pipes. Temporal and Spatial analysis identifies clusters of leaks whereby the client can better focus its efforts in the future. These clusters of leaks can be used for asset management purposes, e.g., capital improvement and replacement planning. Leaks are continuously arising and enlarging, thus temporal/spatial analysis over the course of a year, or over a period of years, will continue to generate a significant number of leaks even in areas previously inspected.