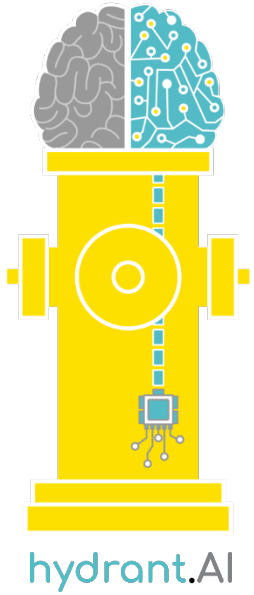
DIGITAL WATER SOLUTIONS

Region of Waterloo



More than Meets the Surface

How Region of Waterloo is Tackling Non-Surfacing Leaks through Machine Learning and Monitoring

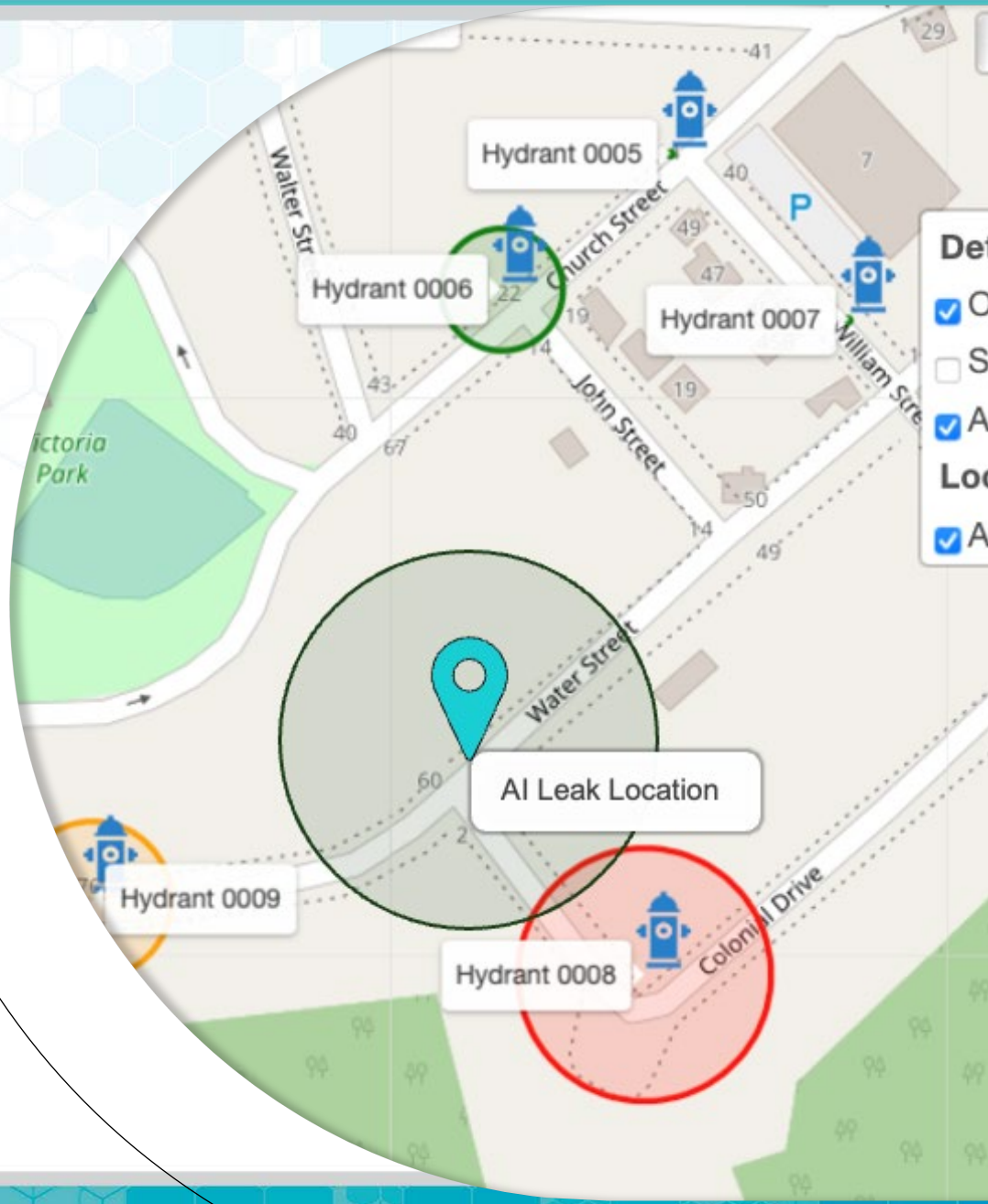
Stan Fong, PhD
Chief Technology Officer
Digital Water Solutions

Kevin Dolishny, P. Eng
Senior Engineer
Water and Wastewater Services
Region of Waterloo

DIGITAL WATER SOLUTIONS

Agenda

1. Introduction/Background
2. Water Loss Challenges: RoW
3. Towards a Solution: DWS
4. Leak Detection through Monitoring and Machine Learning in RoW: Pilot Program
5. Post-Pilot & Next Steps
6. Conclusions + Q & A



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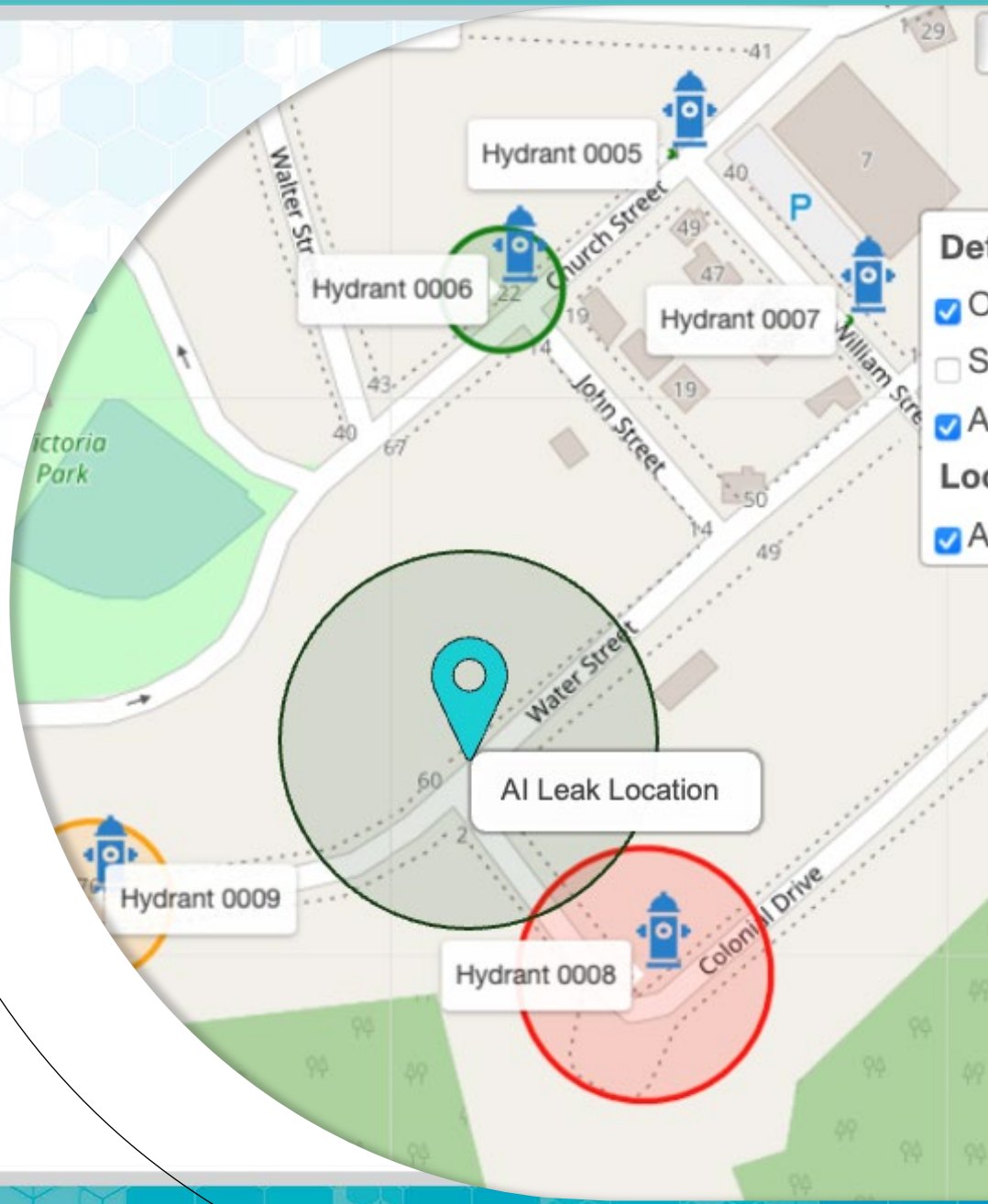


Digital Water Solutions (DWS)

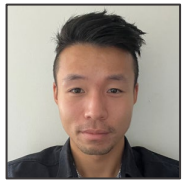
Operators, engineers, data scientists and researchers who recognize the need for better infrastructure.

Develop, and deliver novel solutions for infrastructure management by integrating applied research, engineering consulting and end-to-end product development.

water's next awards 2020 WINNER

SMART WATER SUMMIT VENDOR TO WATCH 2022

hydrant.AI



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Barclay Whittaker, Account Executive
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Region of Waterloo

Upper tier municipality in south-central Ontario servicing approximately 600,00 people.

Responsible for water supply and treatment, and wastewater treatment. In addition, ROW is responsible for the distribution systems and wastewater collection systems in two Townships: Wellesley and North Dumfries. This presentation will focus on Ayr which is our largest community in North Dumfries with a population of approximately 6,500.

Kevin Dolishny, P.Eng.
kdolishny@regionofwaterloo.ca

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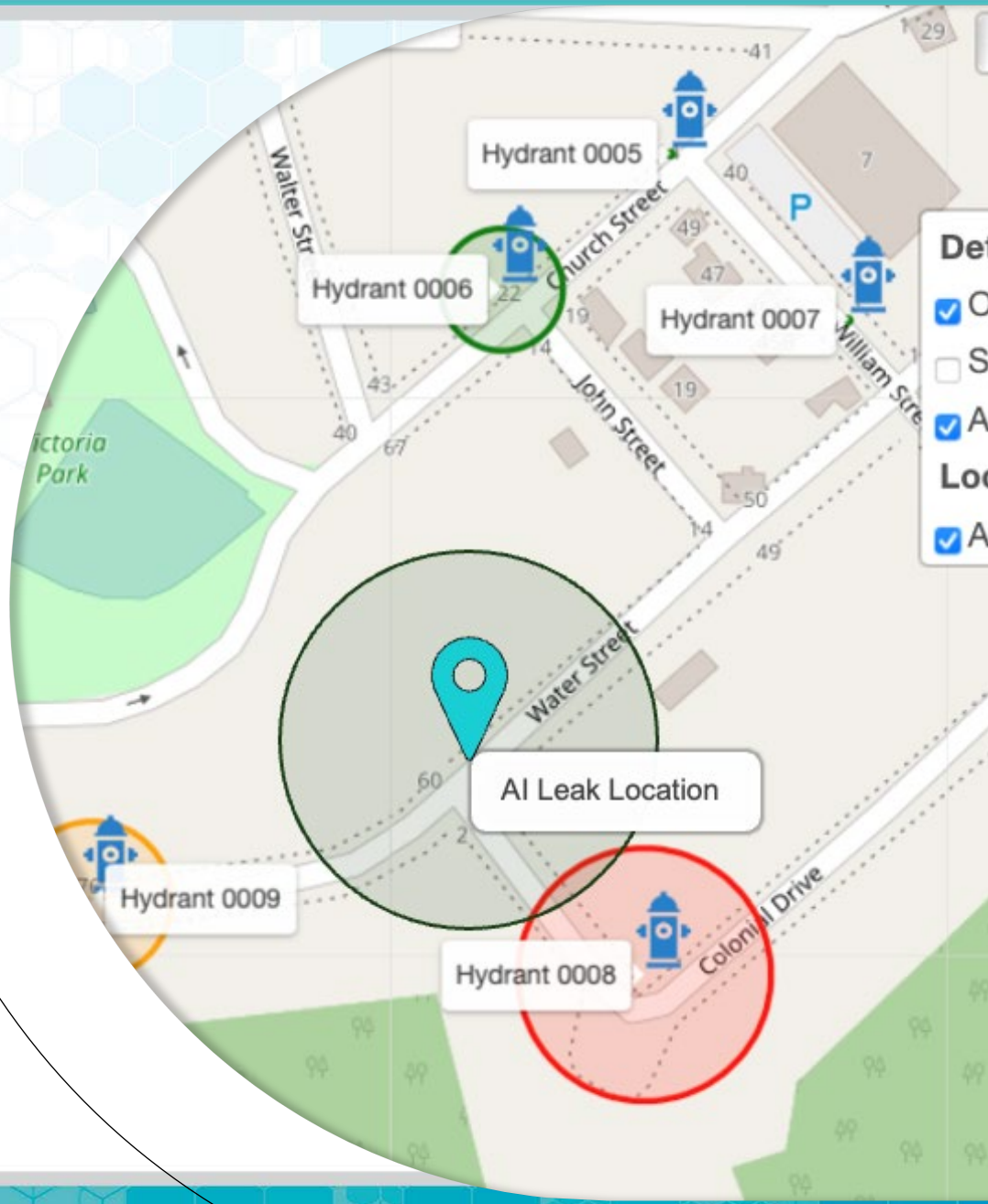
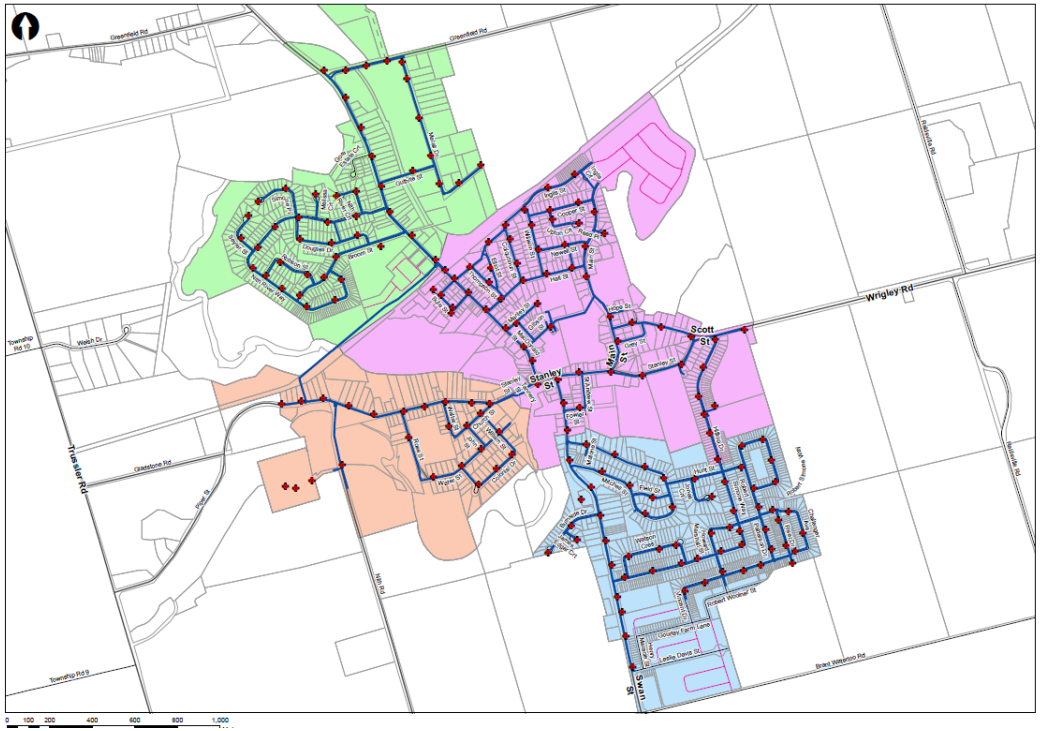
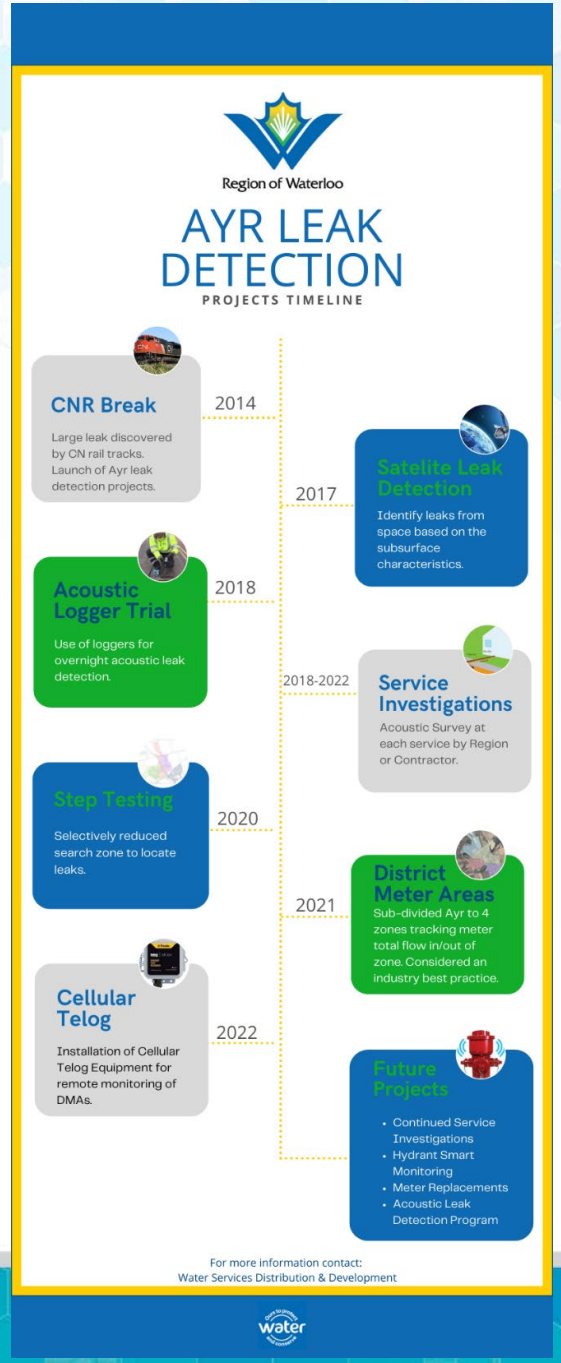


Ayr Water Loss

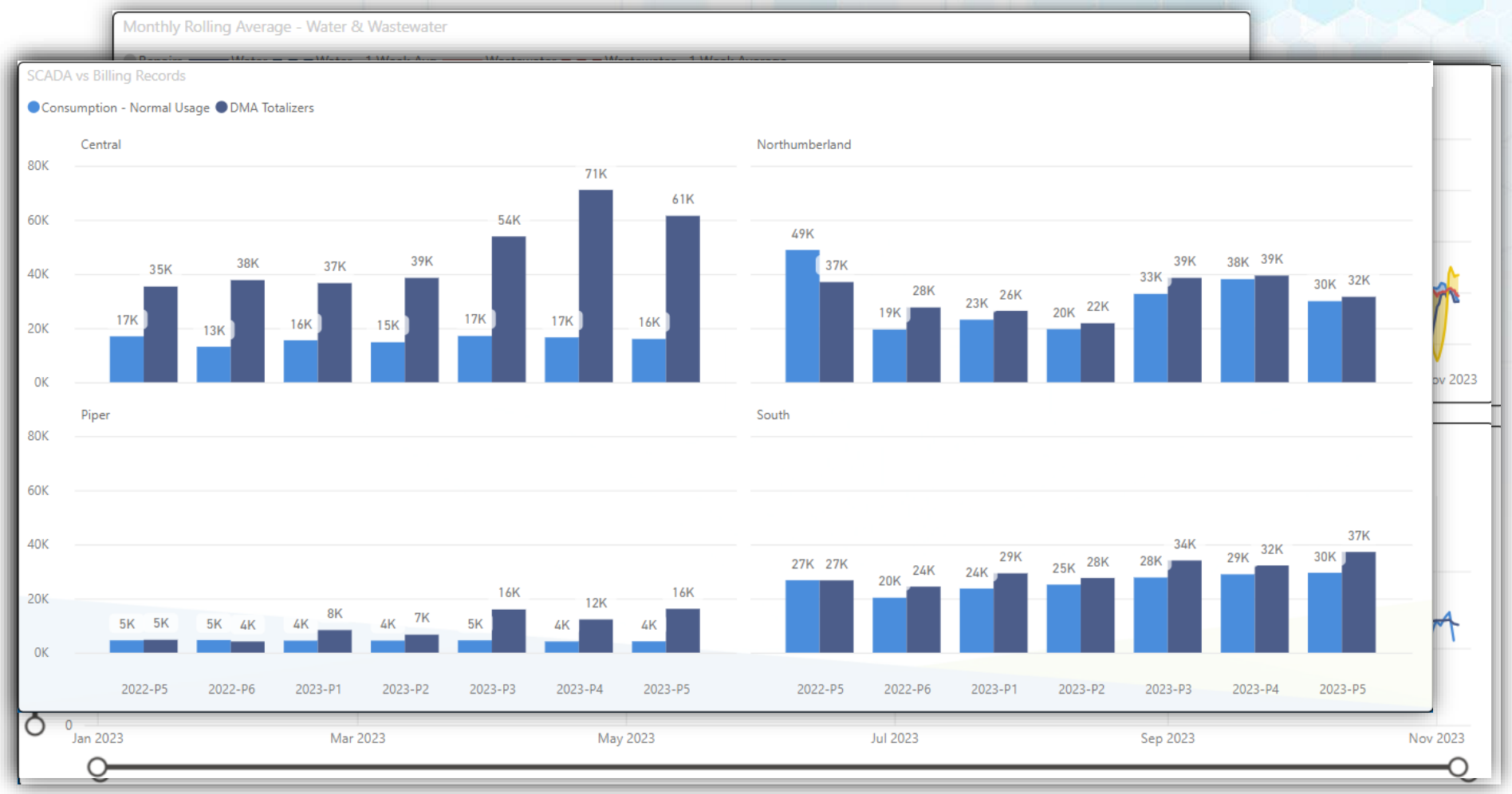
- History of high water loss
- Multi-faceted leak detection program starting in 2015
- Distribution system characteristics (PVC watermains and black polyethylene services) makes traditional leak detection challenging





Region of Waterloo

Ayr Water Loss



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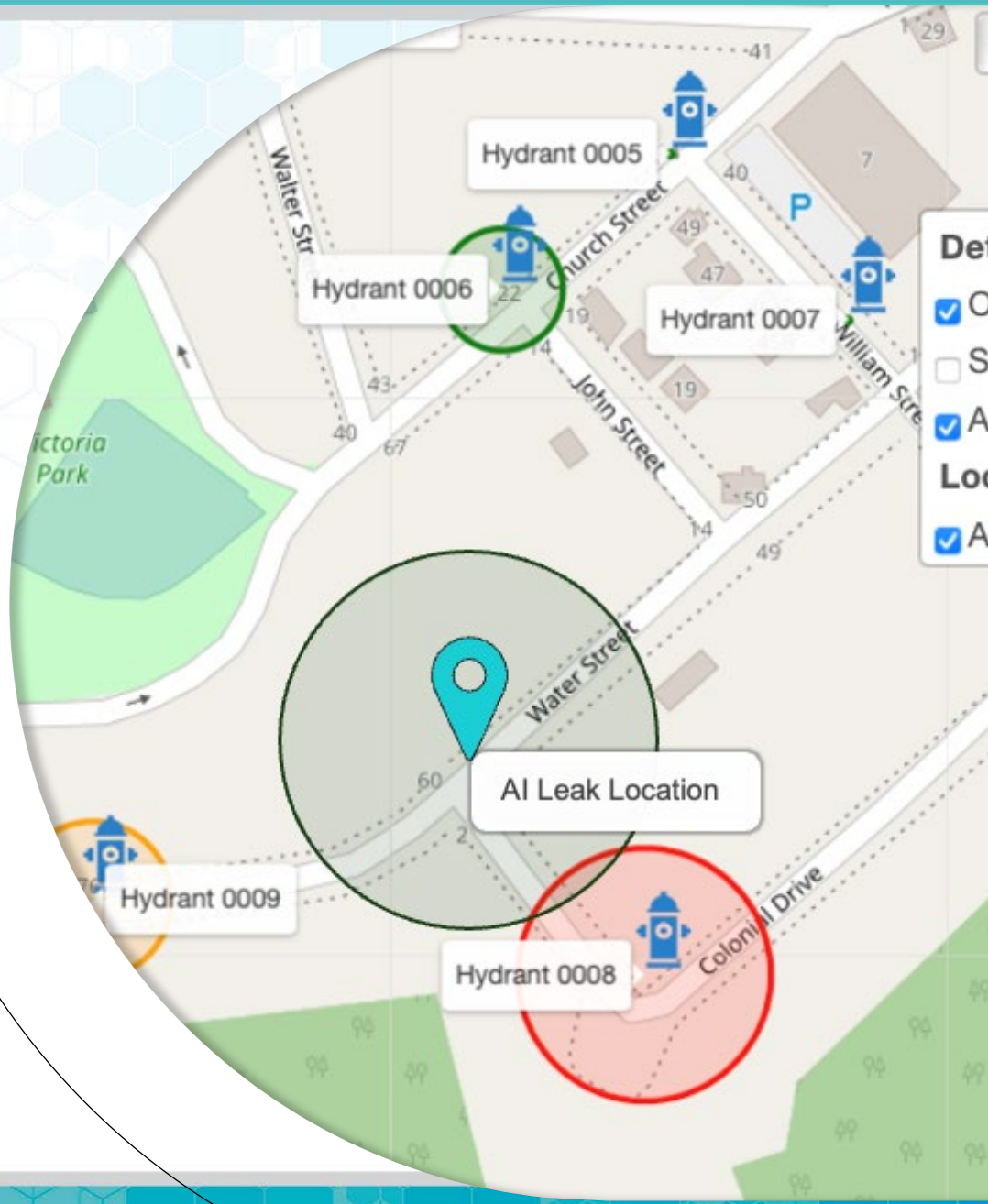


DIGITAL WATER SOLUTIONS

The road to hydrant.AI is a long road…

Self-sufficient Models that don't rely on pipe info, GIS or user inputs

2022

FINISH

Adaptable Machine Learning Models that learn from each unique WDN to reliably detect & locate leaks in hydrophone data.

2022

Hydrophone to listen for leaks directly in water column.

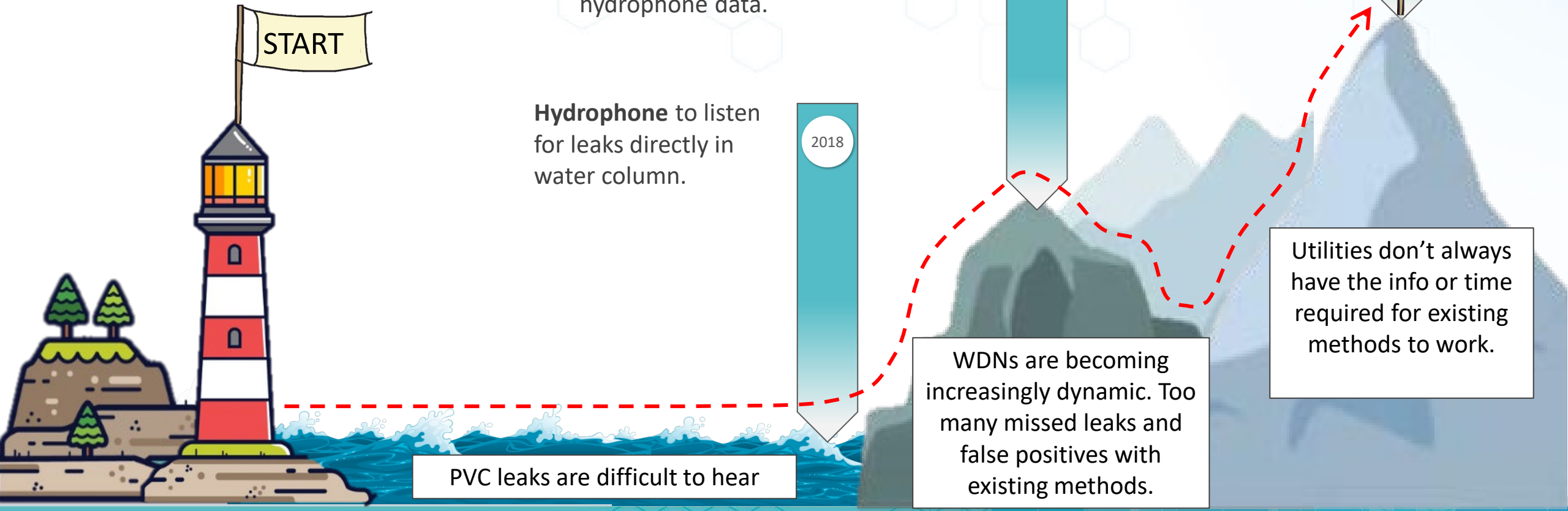
2018

START

Utilities don't always have the info or time required for existing methods to work.

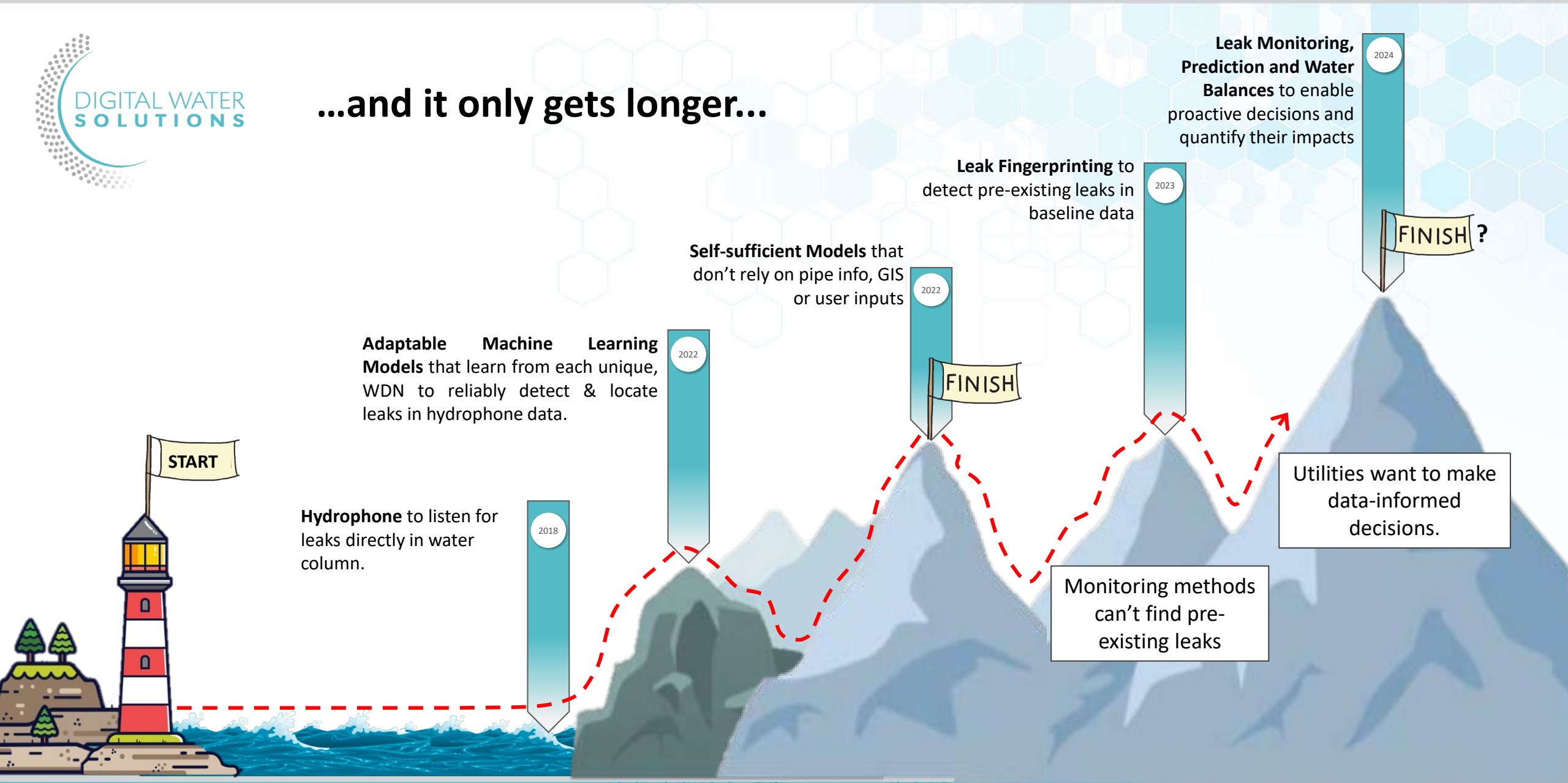
WDNs are becoming increasingly dynamic. Too many missed leaks and false positives with existing methods.

PVC leaks are difficult to hear



DIGITAL WATER SOLUTIONS

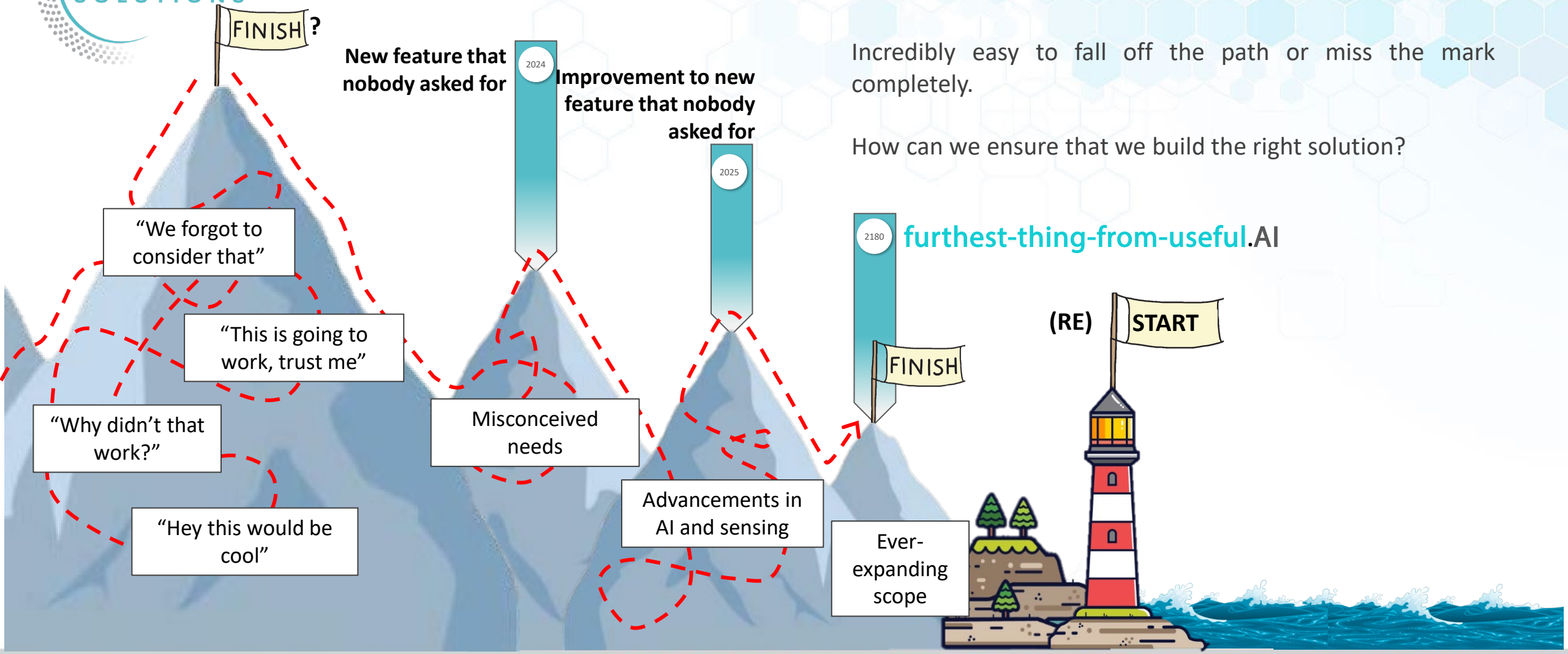
…and it only gets longer...



What's happening underground?

DIGITAL WATER SOLUTIONS

…and longer…



Incredibly easy to fall off the path or miss the mark completely.

How can we ensure that we build the right solution?

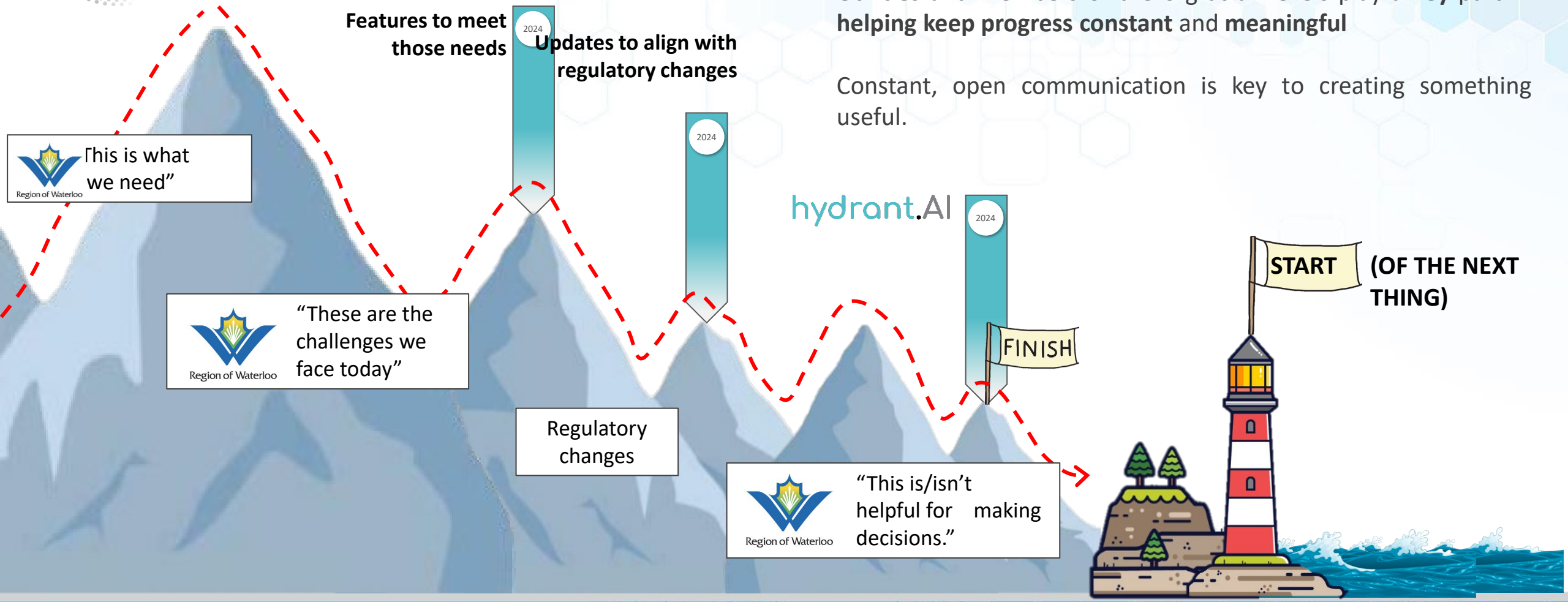
furthest-thing-from-useful.AI

DIGITAL WATER SOLUTIONS

…unless you have help.

Utilities and members of the org at all levels play a **key** part **in helping keep progress constant** and **meaningful**

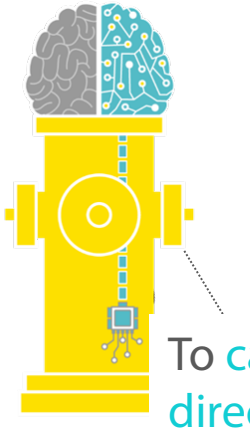
Constant, open communication is key to creating something useful.



DIGITAL WATER SOLUTIONS

hydrant.AI

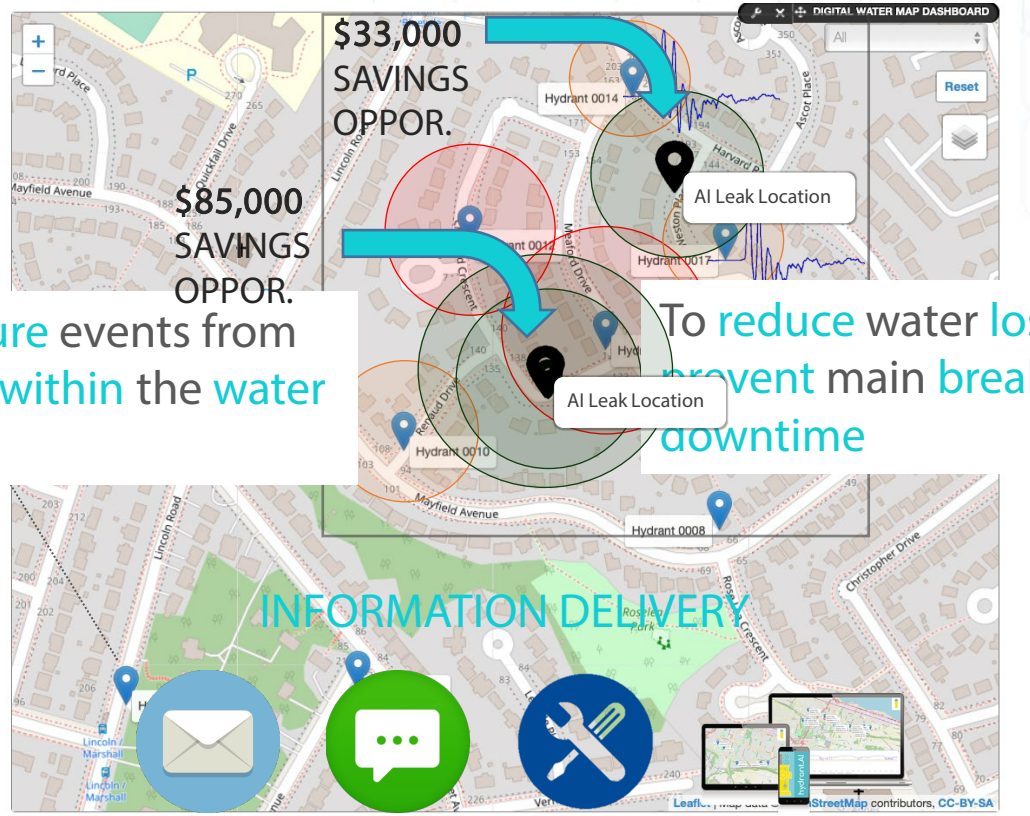
TURNKEY real-time monitoring for water distribution networks



hydrant.AI Dev

To capture events from directly within the water column

DIRECT VISIBILITY
Pressure,
Acoustics,
Temperature



hydrant.AI Platform

ACTIONABLE INSIGHTS
Leak detection,
Leak localization

To reduce water losses, GHGs, prevent main breaks and downtime

nts
anning

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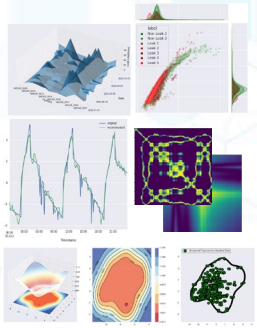
hydrant.AI

Key differentiators

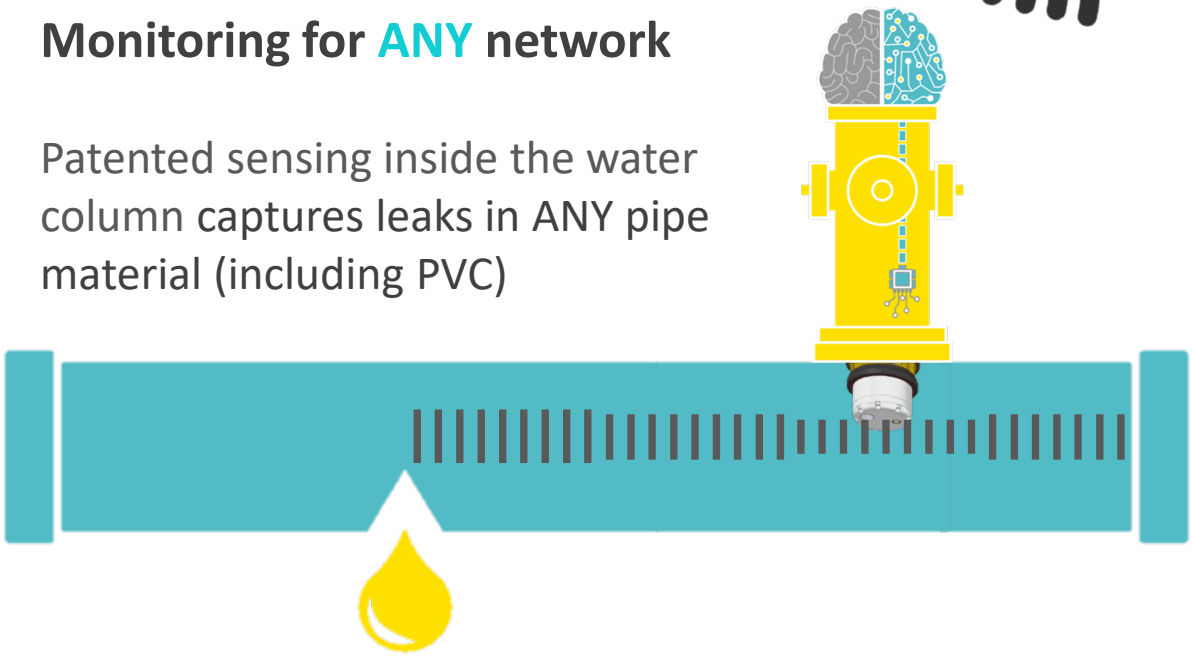


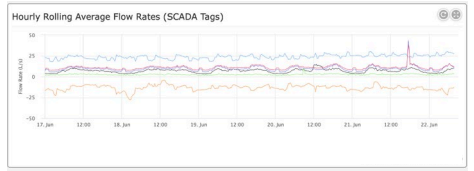
Self-sufficient AI

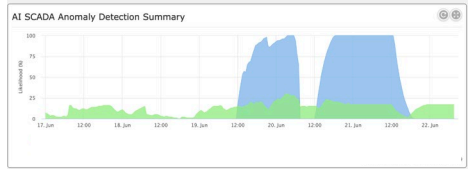
No time? No GIS? No problem. Leak detection and localization models that self-train with no need for GIS, pipe information, etc.

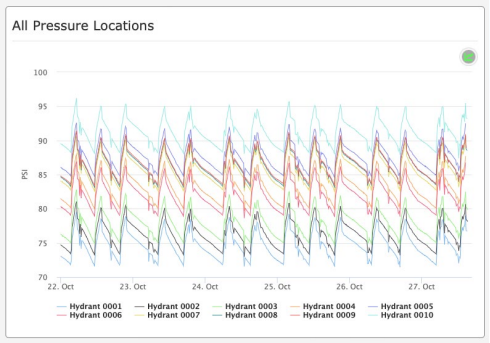
Monitoring for ANY network

Patented sensing inside the water column captures leaks in ANY pipe material (including PVC)





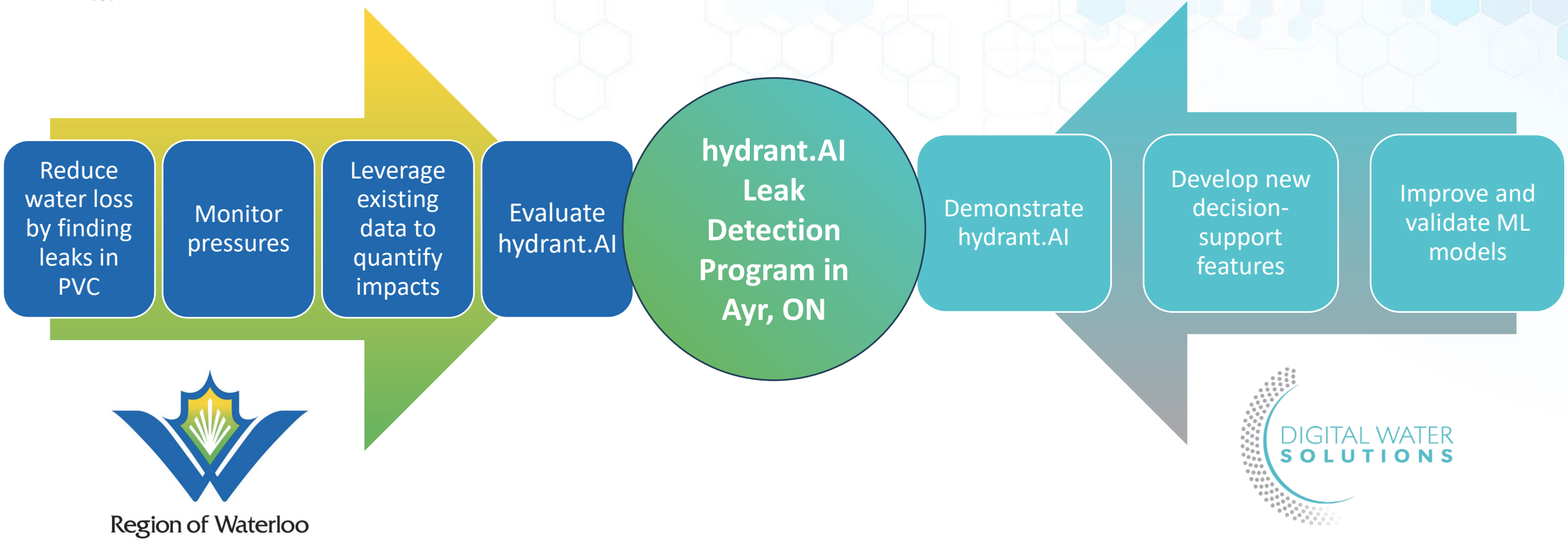




AI for ANY data

Leverage autonomous AI to turn existing data sources into smart sensors with the push of a button.

Arriving at a Leak Detection Pilot for RoW



Region of Waterloo

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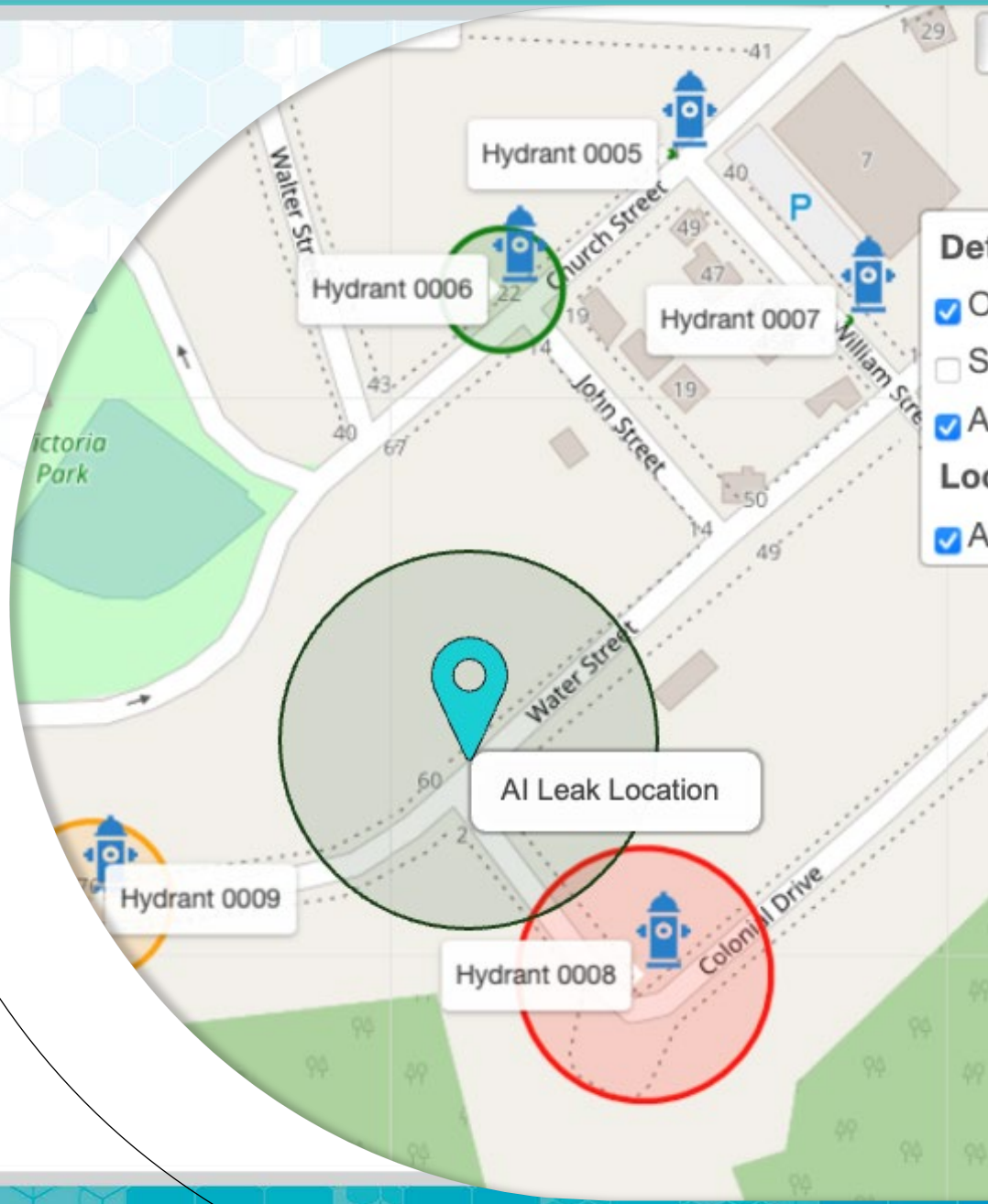


Leak Detection & Monitoring using Machine Learning

RoW Program Overview

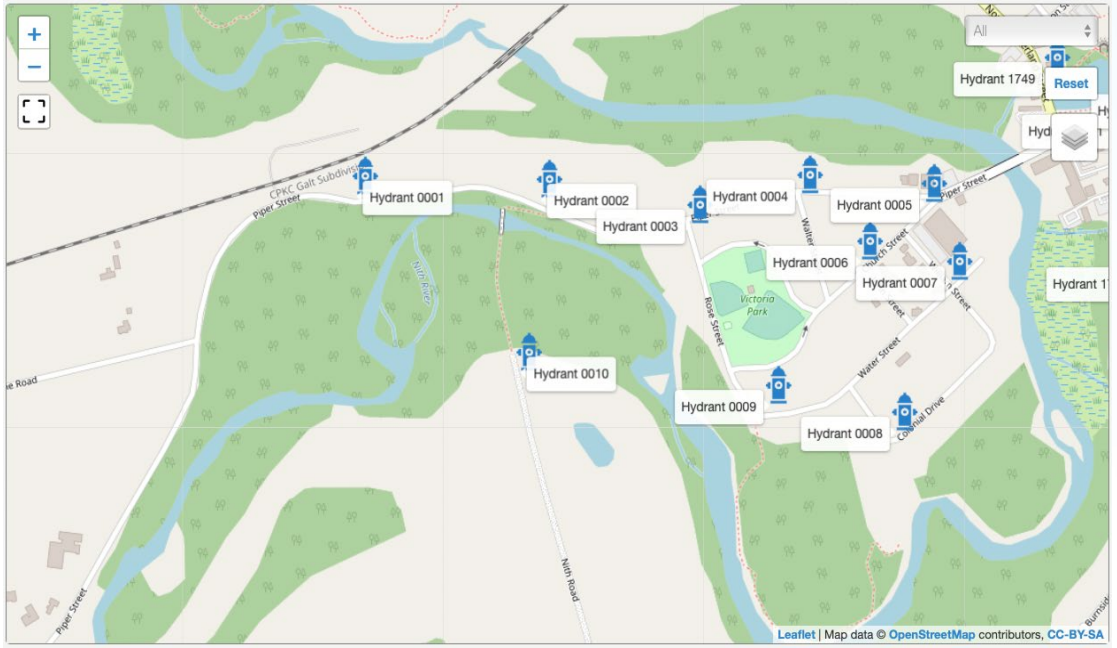
Pilot (Nov 2022 – Jun 2023): Test hydrant.AI in Piper Area

Phase II (Jul 2023 – present): Expansion to Central Area

Phase III (TBD): Addition of decision support

RMOW Program Overview

Parameter		Total
Mains (km)		32.7
Services (km)		24.6
Pipe Material		Mixed
Num. of Units		31
Coverage:	Mains	44%
	Services	30%



Phase II (Overall Deployment Central)

Pilot Deployment (Piper)

Detection of Small Service Leaks in Piper

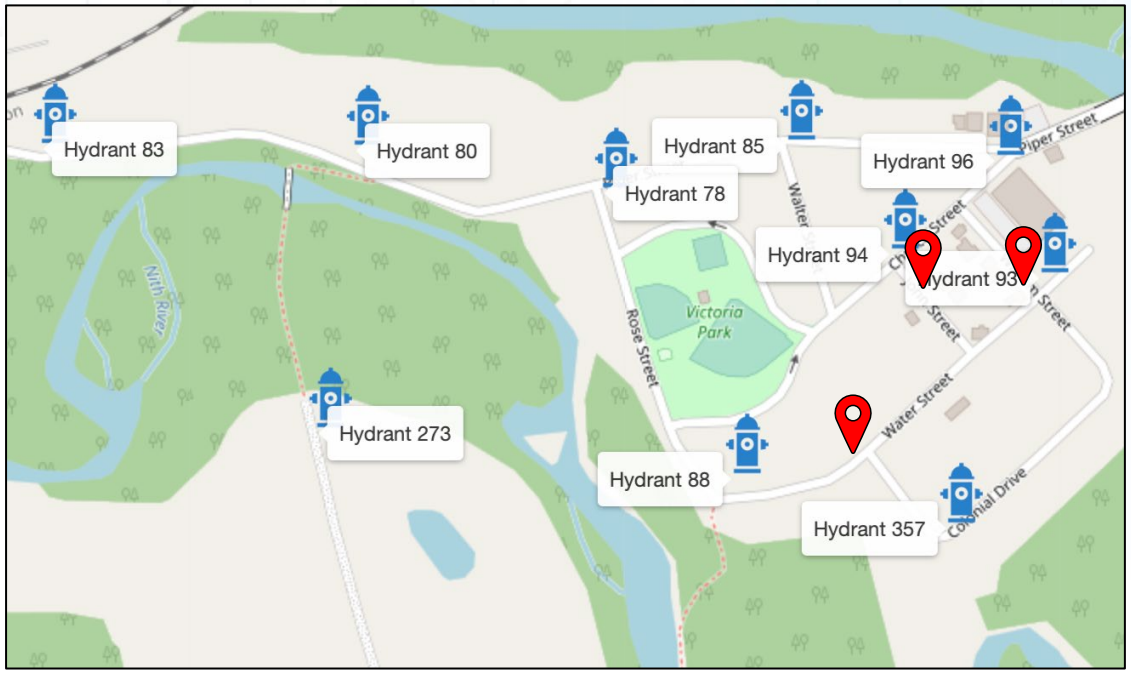
Phase I Overview

Overview:

- PVC mains; HDPE services
- Area leak survey & repairs performed pre-pilot
- **Can we reconcile remaining unaccounted-for water using hydrant.AI?**

Summary:

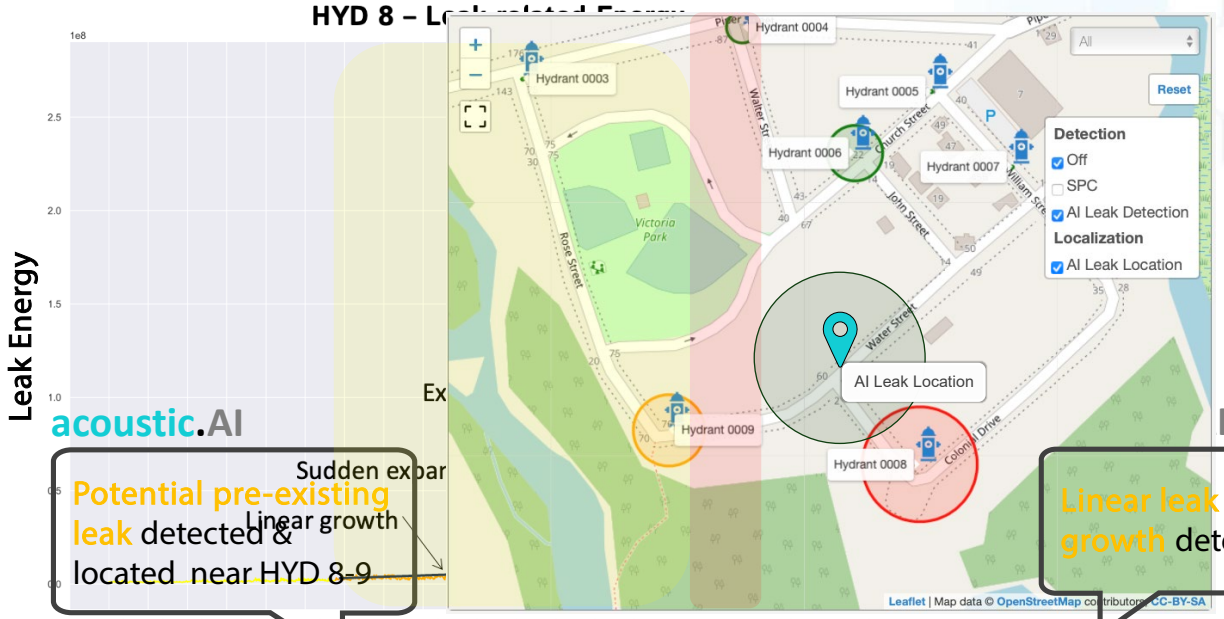
- 3 service leaks detected; 2/3 determined to be pre-existing
- Valuable validation and feedback from RoW used to improve models



Piper Deployment

Detection of Small Service Leaks in Piper

Service Leak 1: A to Z



acoustic.AI

Potential pre-existing leak detected & located near HYD 8-9

Sudden exbar

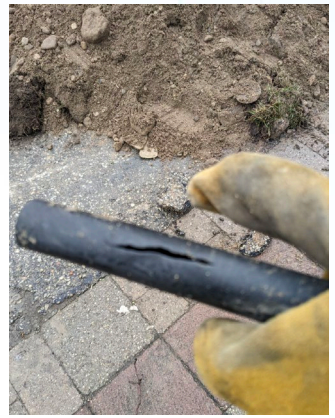
Linear growth

Linear leak growth detected

acoustic.AI

Exponential leak growth detected

Leak repaired



Nov 2022

Nov 16-18

Dec 2022

Dec 2 – Jan 9

Jan 2023

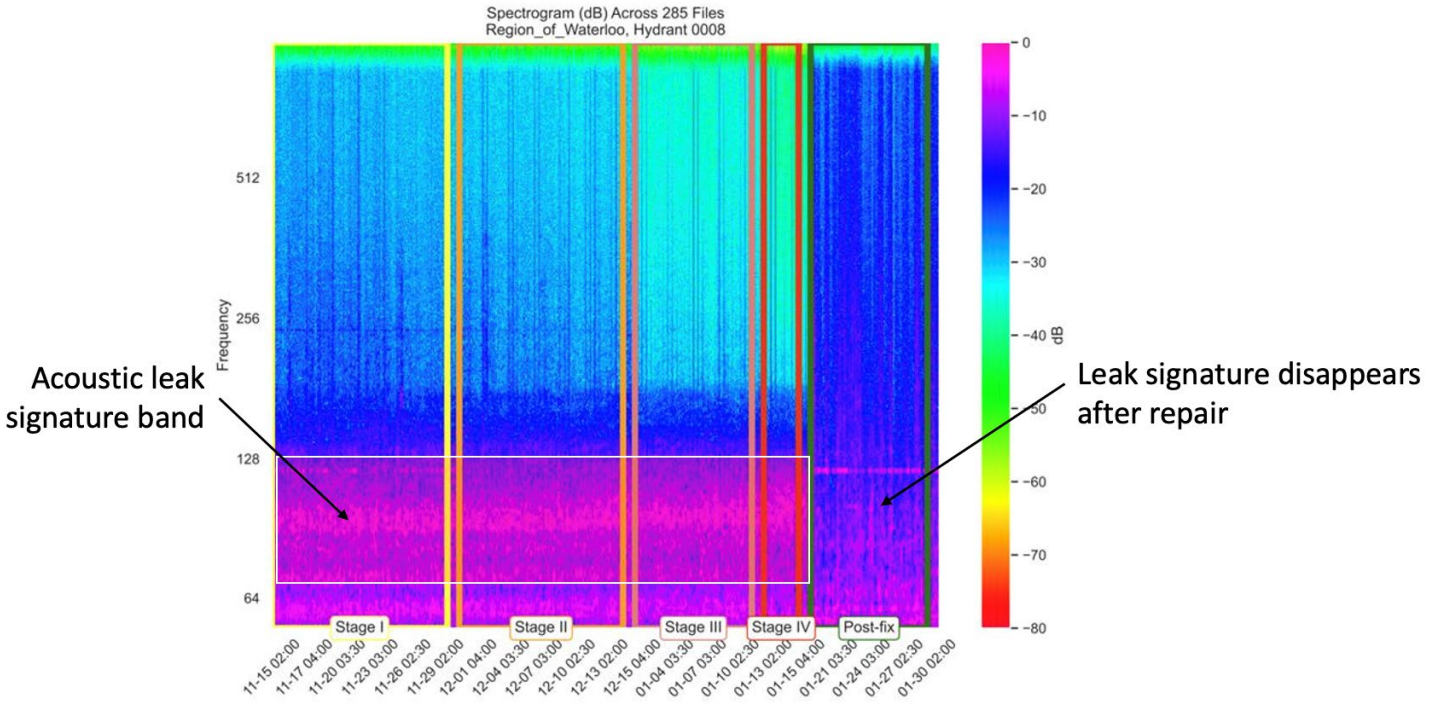
Jan 13

Jan 17

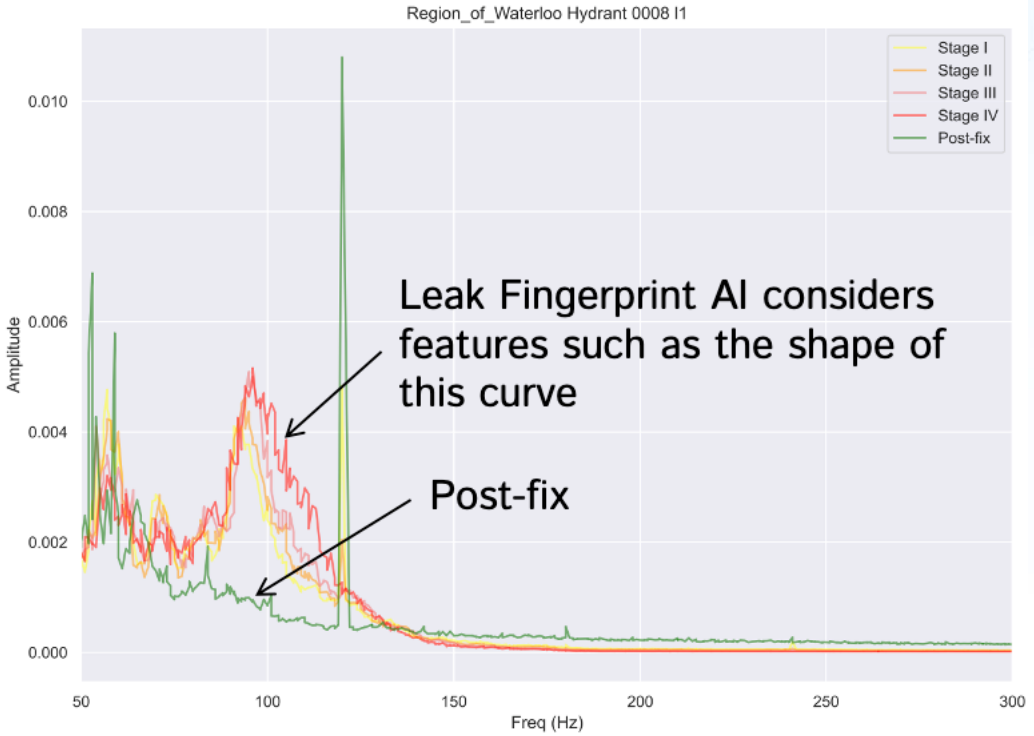
DIGITAL WATER SOLUTIONS

Detection of Small Service Leaks in Piper

A Closer Look at Leak Fingerprinting for Pre-Existing Leak Detection



HYD8 – Time-Frequency Representation

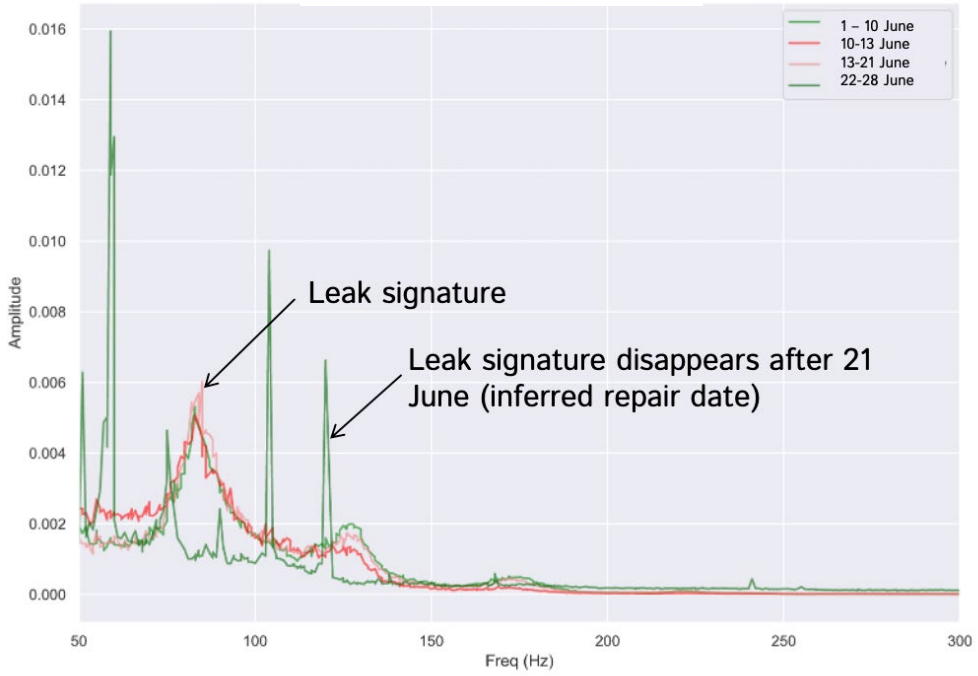


HYD8 – Frequency Representation

Detection of Small Service Leaks in Piper

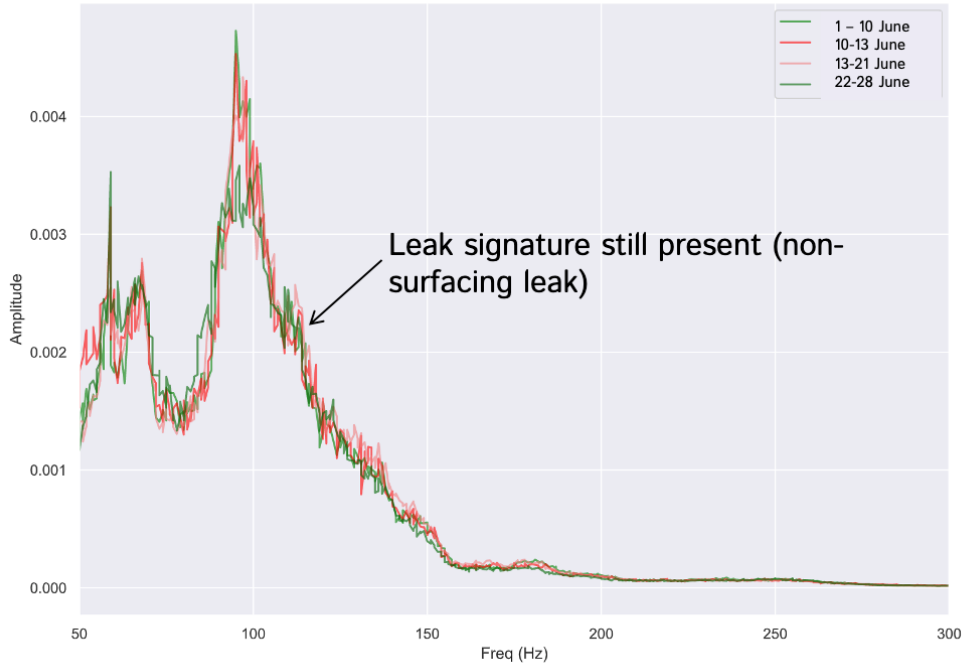
Leak Fingerprinting for Service Leaks 2 & 3

Service Leak 2



HYD6 – Frequency Representation

Service Leak 3



HYD7 – Frequency Representation

Detection of Small Service Leaks in Piper

What's it worth?

Service leak at time of repair

Service leak 1:

- ✓ 1.5" longitudinal crack on ¾" service
- ✓ Est. flow rate for non-surfacing leak (5 - 15 gpm)
- ✓ Est. water loss between 18 Nov 2022 – 17 Jan 2023 is **1,012,000 gal** (approx. **$16,800 in lost revenue**)
- ✓ If pre-existing leak → **$3,600/month**
- ✓ CO_2 offset equivalent to planting 6 trees/month
- ✓ Building a case for ROI:
  - ✓ **3 service leaks** found during pilot (**2 pre-existing**)
  - ✓ **Several new service leaks** identified post-pilot

Detection of Small Service Leaks in Piper

Key Takeaways & Lessons Learned

1. hydrant.AI leak detection:
    - Validated leak detection in PVC
    - Pre-existing leak detection & earlier detection added in post-pilot update
    - POC for energy-based leak monitoring

2. Identified focal points and areas for improvement from RoW feedback:
    - Detection alone is not enough: localization confidence and decision support is key
    - Strategy for solution adoption (how to continue building RoW confidence in solution?)

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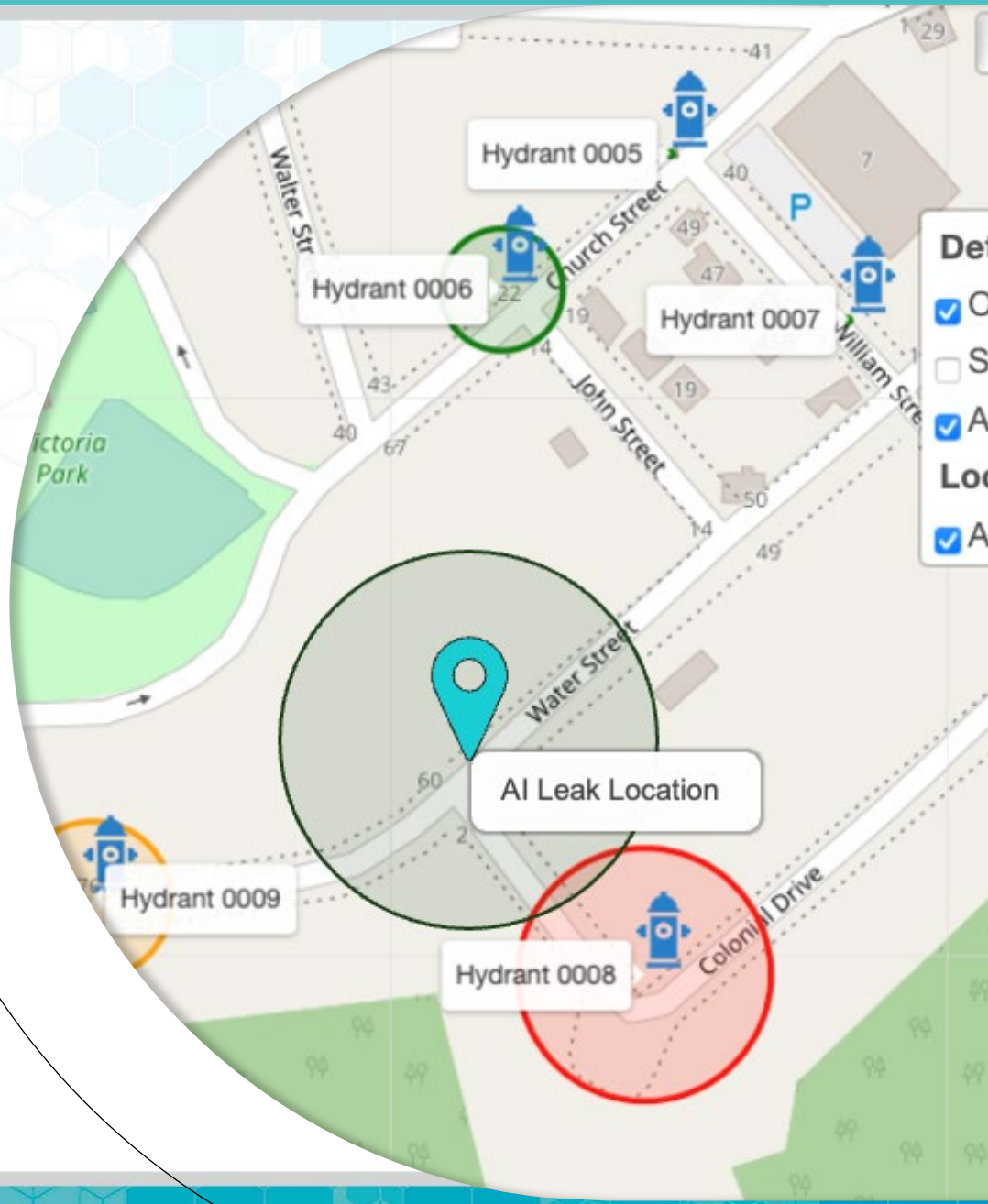


Leak Detection & Monitoring in Central

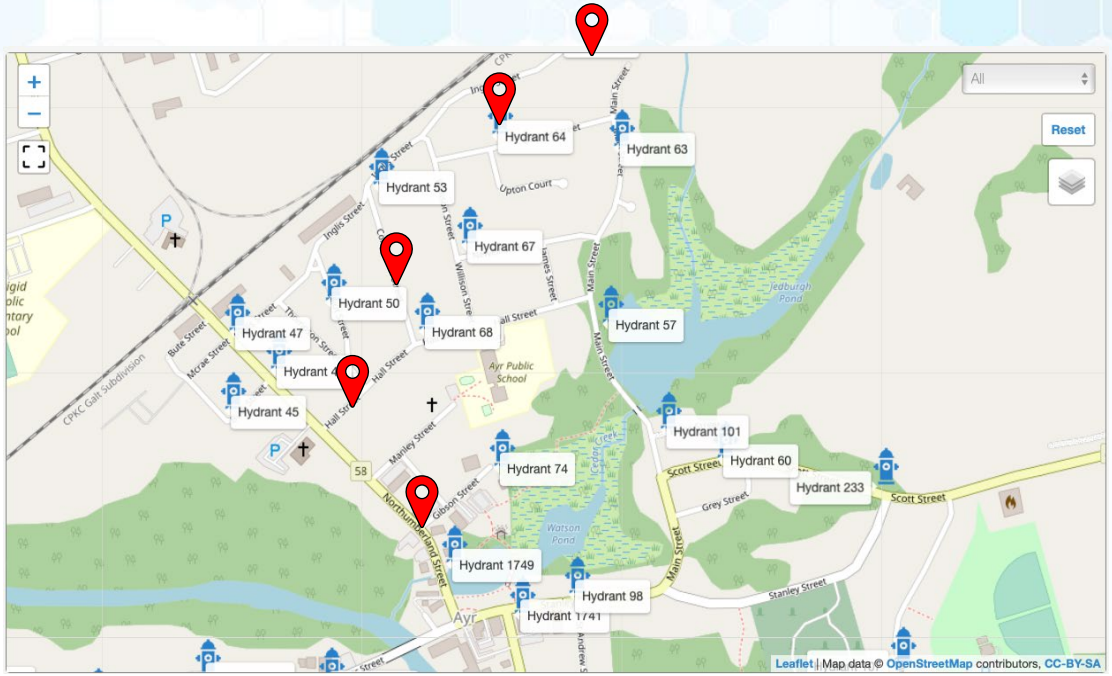
Phase II Overview

Overview:

- PVC mains; HDPE services (2-3x more pipe than Piper)
- Significant distribution-related noise (added challenge)
- **Blind testing of hydrant.AI**

Summary:

- Several service leaks detected/repaired
- Successes and areas of improvement identified from blind testing
- Evaluated impacts of repaired leaks using flow data
- Continue to build on long-term plan for solution adoption



Central Deployment

0 500 1000 1500 ft

Confirmed leak locations

Leak Detection & Monitoring in Central
Blind Testing

RoW/DWS Matching Leak Locations

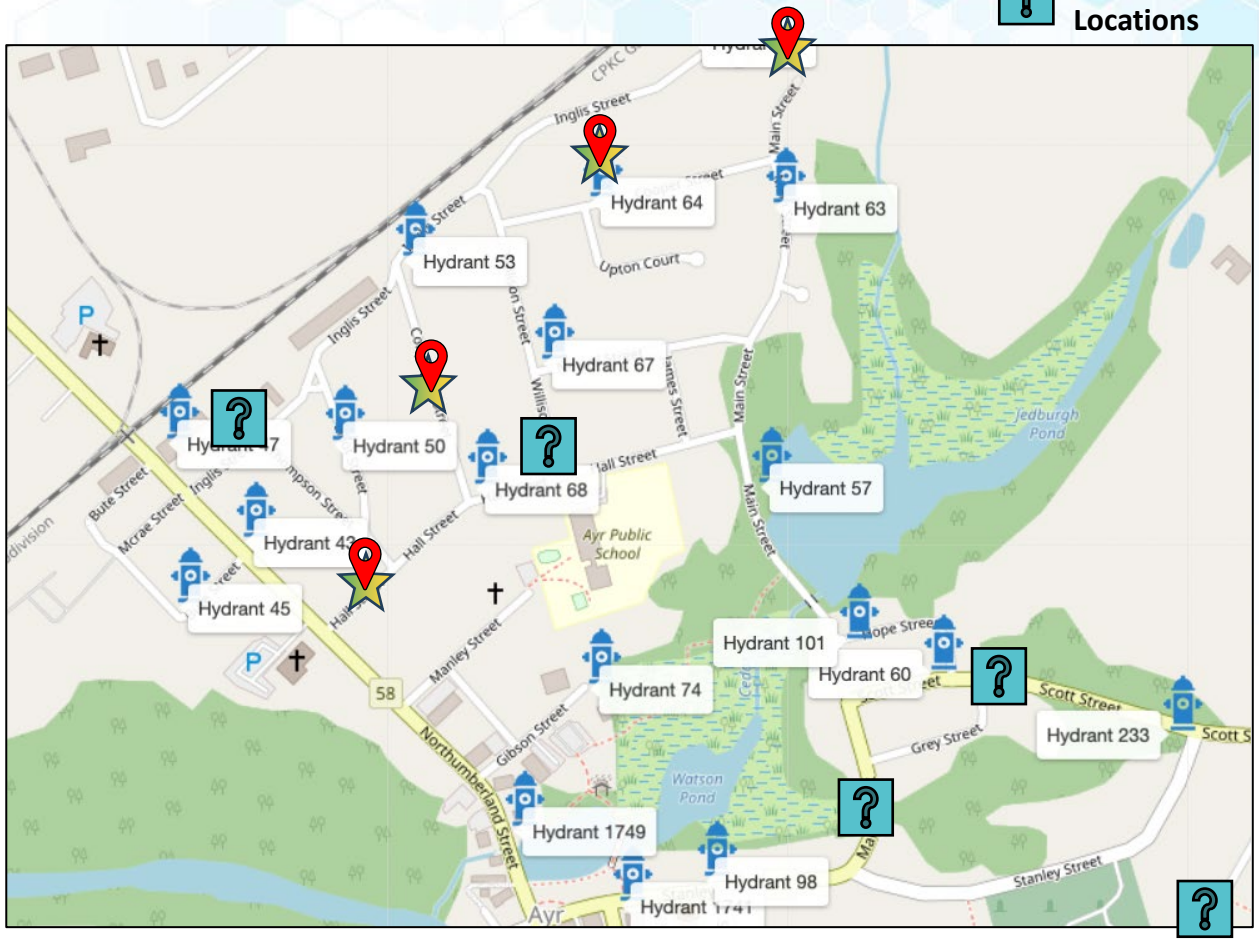
Add. DWS Leak Locations

Overview:

- RoW discovered (4) leaks in Central from a leak survey in Aug 2023:
  - (2) hydrant leaks
  - (2) service leaks
- DWS was asked to detect and determine the location and nature of the 4 leaks.

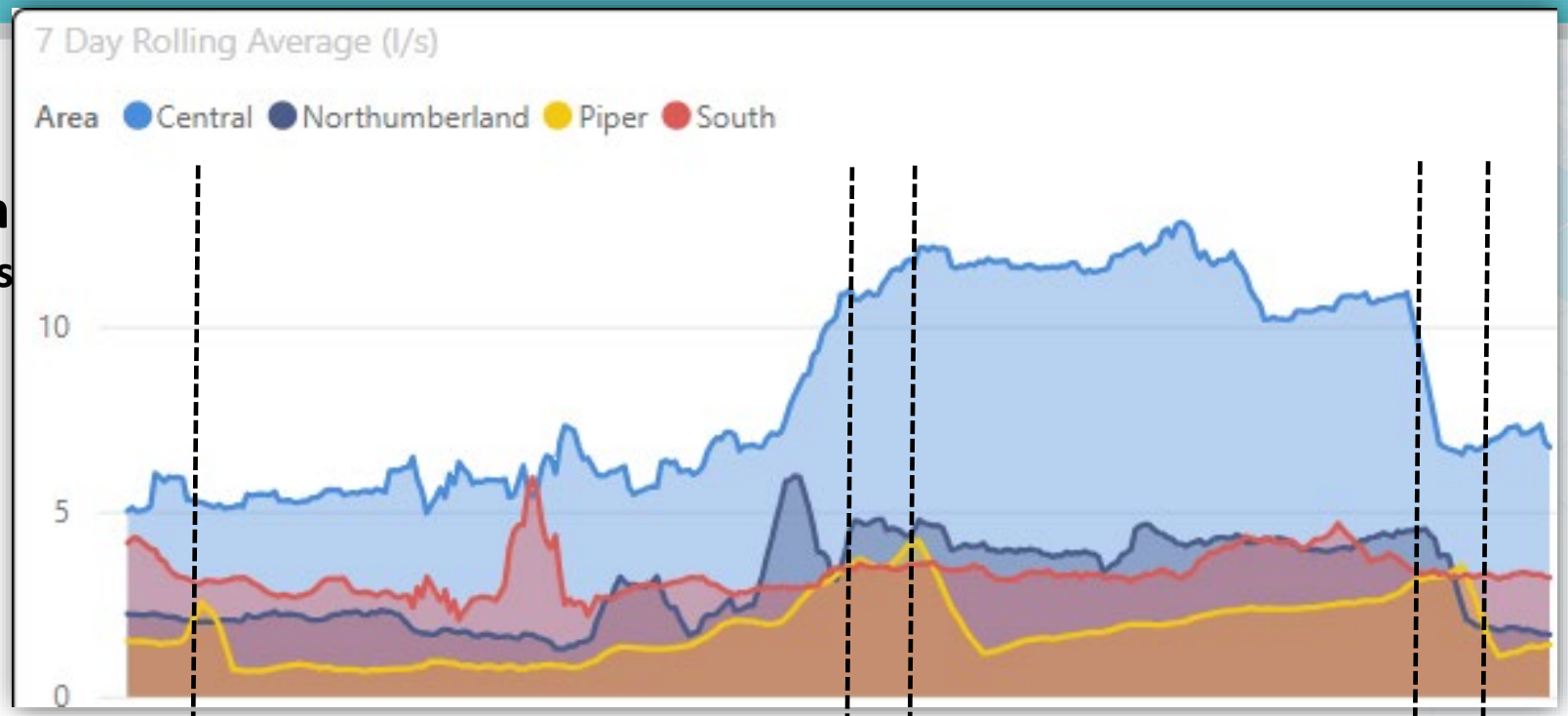
Results:

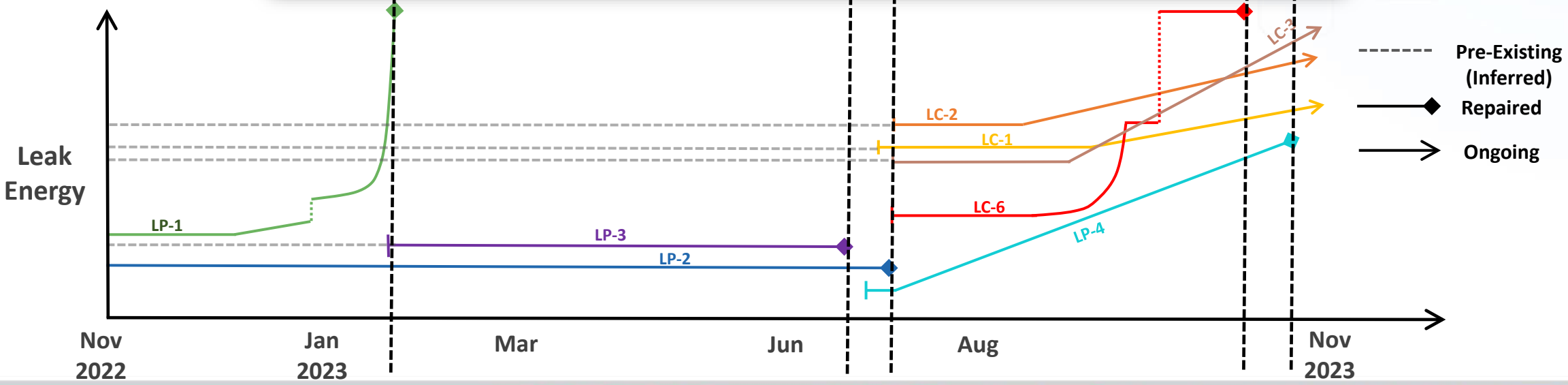
- DWS (5) potential leaks, encompassing the (4) target leak locations.
- Uncertainty in precise location of 3/5 leaks
  - Challenge for self-sufficient AI
- One hydrant leak misidentified as service leak
- Additional, unverified leak locations from hydrant.AI:
  - How to confirm?
- How to make models more decisive?



DIGITAL WATER SOLUTIONS

Leak En
Examples





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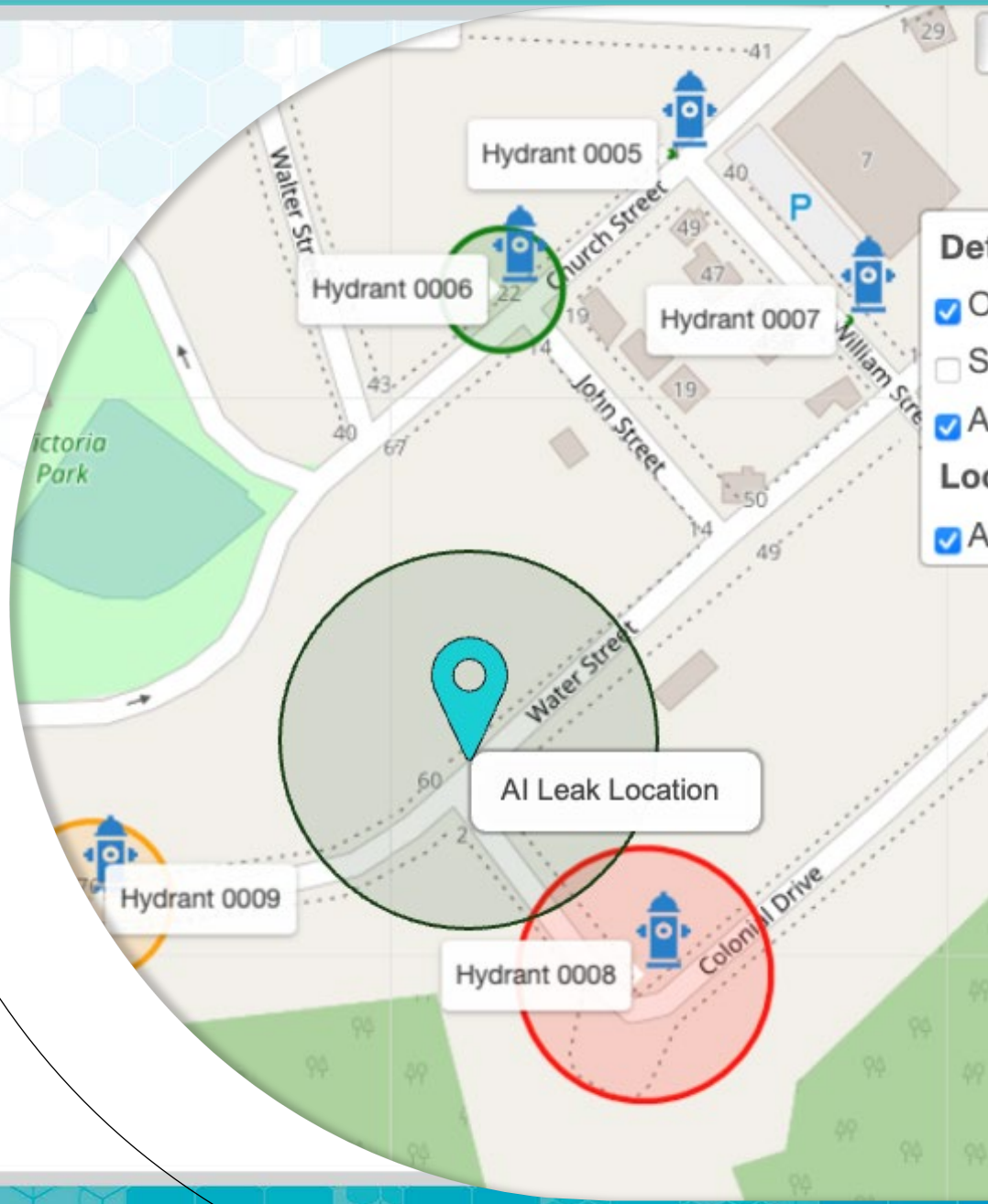


Key Takeaways & Lessons Learned

1. **The challenges with water loss:**
   - Existing leak detection methods ineffective for PVC
   - Resource constraints

2. **Communication is key:**
   - Needs and capabilities can and will change over time.
   - Building/implementing an effective solution requires iteration on both sides.
   - Keep proof of progress (document and provide WIP AI results regularly)

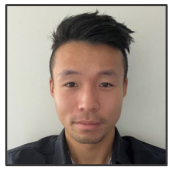
2. **From viable to useful:**
   - Pilot was instrumental in demonstrating viability in PVC:
     - Several service leaks captured and repaired during pilot
     - Results help inform future updates for DWS
   - Trust and adoption of a new solution will not happen overnight:
     - Transparency helps keep expectations aligned
     - A dedicated strategy for trust-building and technology adoption is key

3. **Leaks here, leaks there…so now what?**
   - Detection is only the first step → which leaks to prioritize?
   - Decision support to capture impacts of proactive maintenance (leak forecasting, risk, ROI/GHGs)
   - Next steps: Automated M36 water balance

Thank You!

DWS would like to thank Kevin Dolishny, Lena Nguyen and David Nguyen at Region of Waterloo for all their hard work continued support and feedback throughout the project.

Questions?



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