Jacobs Challenging today. Reinventing tomorrow.

Next Generation Water Leakage Management

In The kNOW Webinar

September 22, 2022

Agenda

1. Overview of Water Loss – Brian Skeens, Jacobs
2. Smart Pilot – Steve Seachrist, Gwinnett County (USA)
3. Technology Enabled Solutions – Francis Rainey, Jacobs
4. Smart Water/Digital Twin Approach – Fionn Boyle, Anglian Water (UK)
5. Q&A

Water Loss Overview

Water Loss Worldwide

- 91 billion gallons of water are lost through drinking water supply networks every day
- That's enough drinking water to supply drought-hit states in the U.S. West for an entire week
- According to the US EPA, break rates have increased by 27 percent over the last decade

- Water systems are under pressure
- Infrastructure is aging
- New leaks will occur, even as existing leaks are repaired
- Water efficiency and stewardship expand beyond areas of water scarcity
- Energy prices are increasing
  - Increasing natural gas and coal prices
  - Climate change
  - Geopolitical conditions
  - Supply chain issues

Tracking Water Loss – The Past, Present, and Future

- Unaccounted-for-Water (UAW or UFW)
- No universally accepted definition/calculation
- Everyone calculates it differently
- What does it mean?
- Provides no context for volume or value
- Targets were arbitrary (10%)

- IWA/AWWA M36 Methodology
- Industry Best Practice since 2003
- All water is “accounted for” in a water balance
- Standardized definitions and procedures


financial concerns

BY AWWA WATER LOSS CONTROL COMMITTEE

COMMITTEE REPORT:

Applying worldwide BMPs in water loss control

Water resources today are less expensive and more accessible than they ever will be again, according to participants at a recent AWWA conference workshop on water resources. The North American water industry is facing growing challenges in developing new drinking water supplies, and the demands are stag-

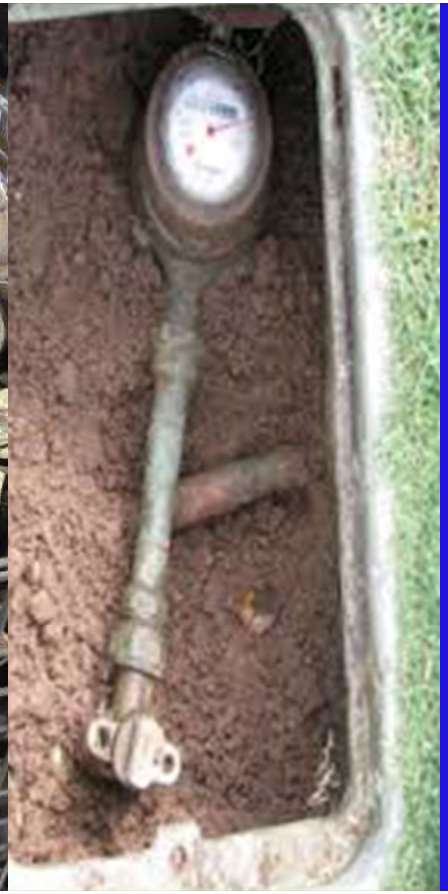
the international water association

American Water Works Association

Non-Revenue Water Terminology

- NRW is the difference between the volume of water supplied and the volume of water billed to customers
- It consists of three volumes with different values in $/gallon:
  - Real Losses
  - Apparent Losses
  - Unbilled Authorized Consumption
- Use this term instead of “unaccounted-for-water”

Apparent Losses Occur on the Usage Side



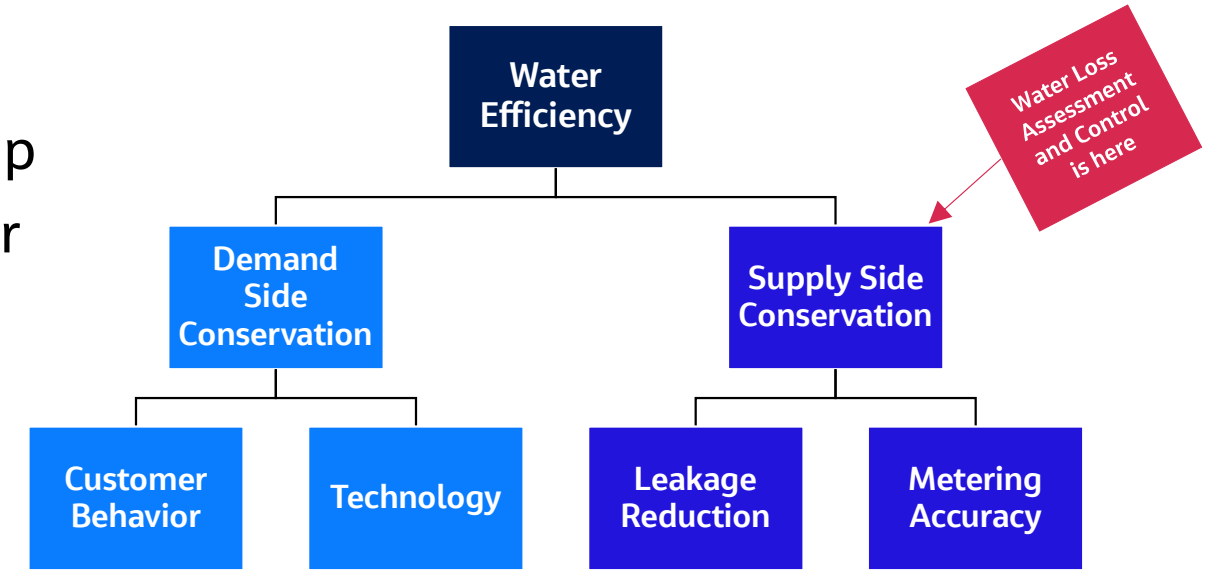
- Also called *Paper* or *Economic* Losses – water that reaches a user, but is not properly measured or paid for
- Includes:
  - Theft
  - Customer metering inaccuracies
  - Data handling errors
- Reducing Apparent losses increases revenue by ensuring you are collecting appropriate revenue for water delivered
  but creates no new water

Real Losses Occur on the Delivery Side

- Also called *Physical* Losses – water that enters the distribution system, but never reaches a user
- Includes:
  - Leakage on transmission and distribution mains
  - Storage tank overflows
  - Service Line leakage up to customer meter
- Reducing real losses extends the resource which reduces operating costs and can be used to defer capital expenditure

Water Quantity Management is a Component of Water Efficiency

- Water quality has stringent requirements, what about quantity
- Water supply efficiency demonstrates water stewardship
- Fits into the big picture of water conservation and efficiency, along with demand management
- Helps to meet One Water Strategies

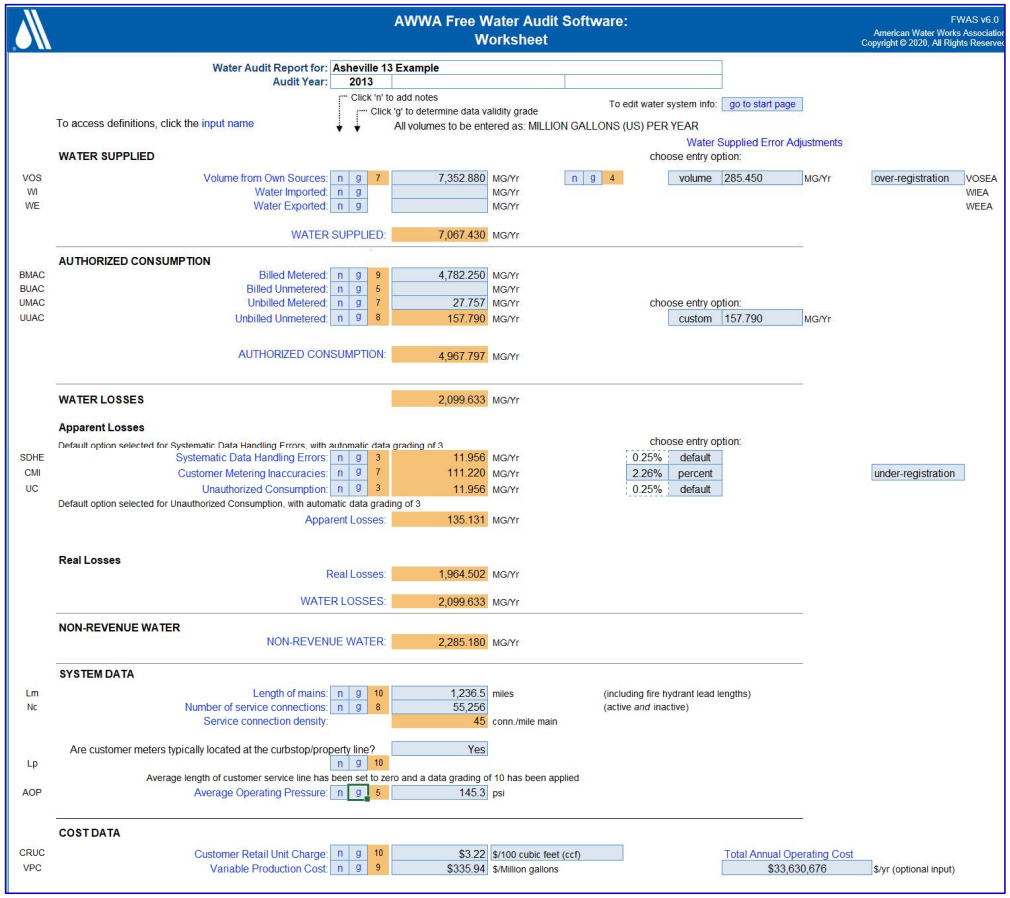


Leakage Reduction and Carbon Reduction

- A single leak of 200 gallons/minute (~1-inch, 70 psi) over one year could save up to 90 tons of CO_2 equivalent (varies by location)
- 90 tons is equivalent to the typical carbon footprint of about 5 Americans

Reducing Water Losses → Reduction in Energy Needed for Extraction, Treatment and Delivery → Reduction in Carbon Use

AWWA M36 Manual, 4th Ed. and Free Water Audit Software, version 6



AWWA Free Water Audit Software: Worksheet

FWAS v6.0
American Water Works Association
Copyright © 2020, All Rights Reserved

Water Audit Report for: Asheville 13 Example
Audit Year: 2013

Click 'n' to add notes
Click 'g' to determine data validity grade

To edit water system info: go to start page

To access definitions, click the input name

All volumes to be entered as: MILLION GALLONS (US) PER YEAR

WATER SUPPLIED

							Water Supplied Error Adjustments				
							choose entry option:				
VOS	Volume from Own Sources:	n	g	7	7,352.880	MG/Yr	n g 4	volume	285.450	MG/Yr	over-registration VOSEA
WI	Water Imported:	n	g			MG/Yr					WIEA
WE	Water Exported:	n	g			MG/Yr					WEEA
	WATER SUPPLIED:				7,067.430	MG/Yr					

AUTHORIZED CONSUMPTION

BMAC	Billed Metered:	n	g	9	4,782.250	MG/Yr				
BUAC	Billed Unmetered:	n	g	5		MG/Yr				
UMAC	Unbilled Metered:	n	g	7	27.757	MG/Yr	choose entry option:			
UUAC	Unbilled Unmetered:	n	g	8	157.790	MG/Yr	custom	157.790	MG/Yr	
	AUTHORIZED CONSUMPTION:				4,967.797	MG/Yr				

WATER LOSSES 2,099.633 MG/Yr

Apparent Losses

Default option selected for Systematic Data Handling Errors, with automatic data grading of 3

							choose entry option:			
SDHE	Systematic Data Handling Errors:	n	g	3	11.956	MG/Yr	0.25%	default		
CMI	Customer Metering Inaccuracies:	n	g	7	111.220	MG/Yr	2.26%	percent		under-registration
UC	Unauthorized Consumption:	n	g	3	11.956	MG/Yr	0.25%	default		

Default option selected for Unauthorized Consumption, with automatic data grading of 3

Apparent Losses: 135.131 MG/Yr

Real Losses

Real Losses: 1,964.502 MG/Yr

WATER LOSSES: 2,099.633 MG/Yr

NON-REVENUE WATER

NON-REVENUE WATER: 2,285.180 MG/Yr

SYSTEM DATA

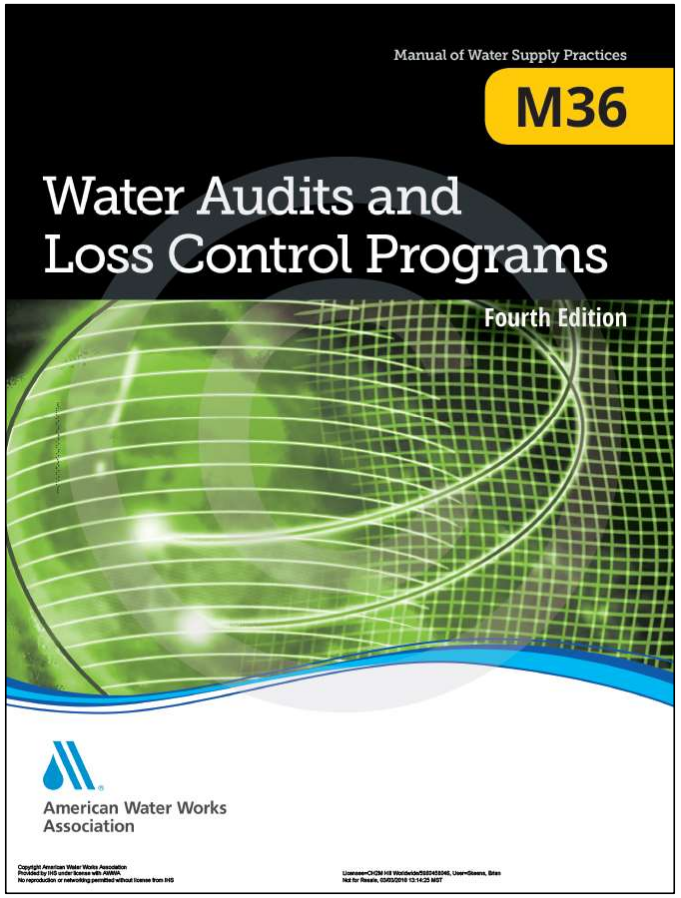
Lm	Length of mains:	n g 10	1,236.5	miles	(including fire hydrant lead lengths)
Nc	Number of service connections:	n g 8	55,256		(active *and* inactive)
	Service connection density:		45	conn./mile main	
	Are customer meters typically located at the curbstop/property line?		Yes		
Lp		n g 10			

Average length of customer service line has been set to zero and a data grading of 10 has been applied

AOP	Average Operating Pressure:	n g 5	145.3	psi

COST DATA

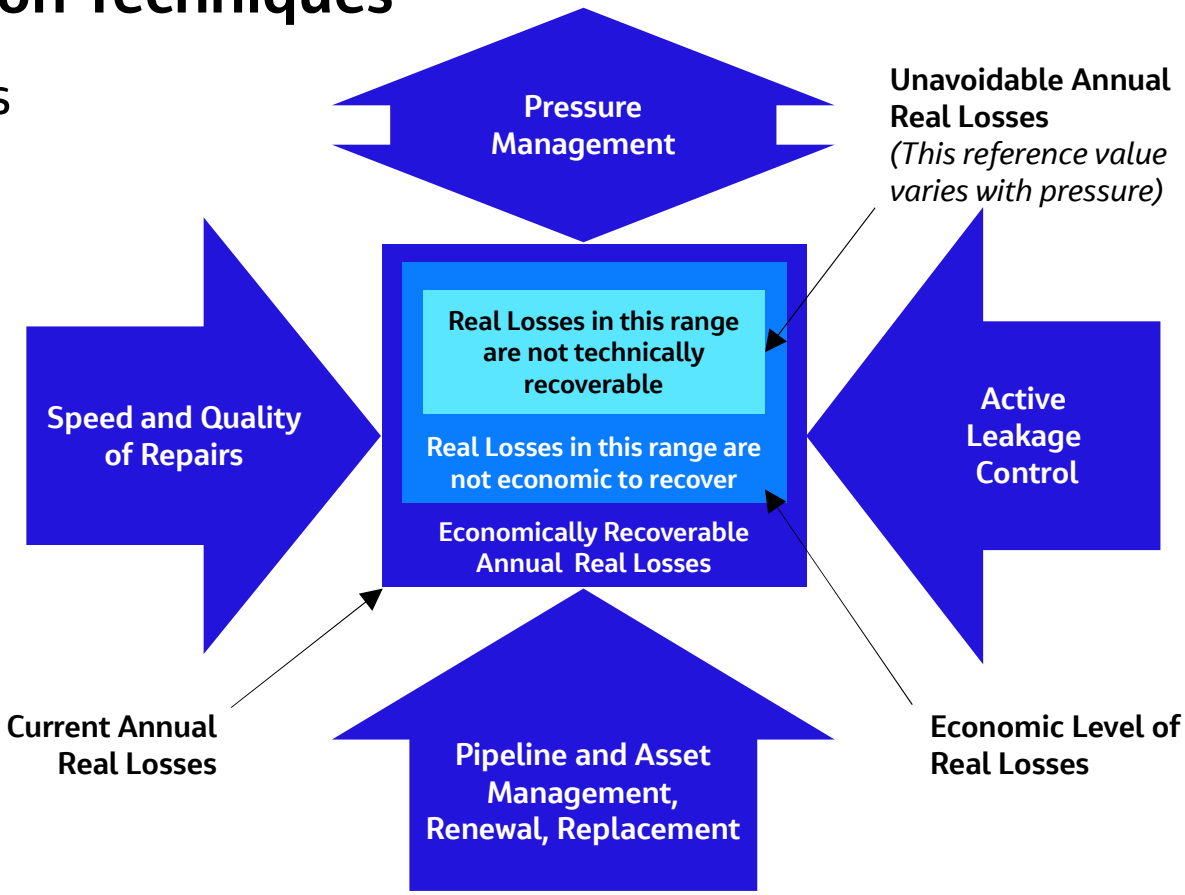
CRUC	Customer Retail Unit Charge:	n g 10	$3.22	$/100 cubic feet (ccf)	Total Annual Operating Cost	
VPC	Variable Production Cost:	n g 9	$335.94	$/Million gallons	$33,630,676	$/yr (optional input)



www.awwa.org/waterlosscontrol

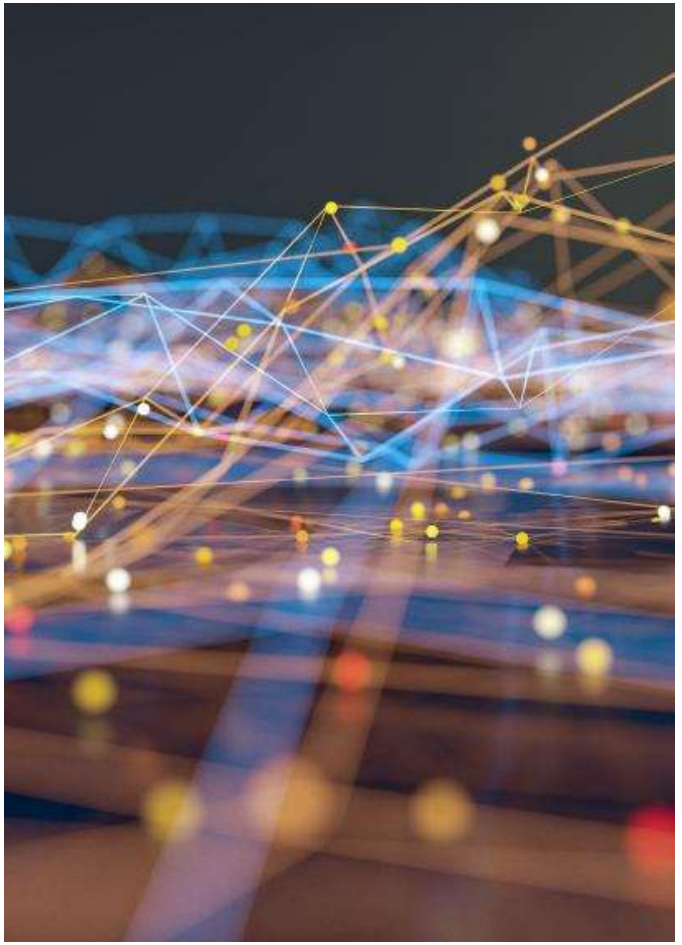
Standard Real Loss Reduction Techniques

- Activities to reduce Real Losses
  - Affected by Infrastructure Conditions
  - Influenced by Variable Production Cost
  - Frequency and technique of Active Leakage Control program
  - Fluctuate by average system pressure



What's Next for Leakage Management?

- More monitoring with remote communication
- Smart dashboards
- Data solutions
- Better and faster analytics
- Predictive abilities
- Digital One Water



Audience Poll

- If a ¼-inch (6-mm) leak is repaired, the water saved could serve how many people?
  - 1
  - 20
  - 200
  - 2,000

Audience Poll

- What do you think is the biggest challenge to water leakage management?
  - Finding leaks
  - Fixing leaks
  - Staffing
  - Budget
  - Other

Smart Pilot

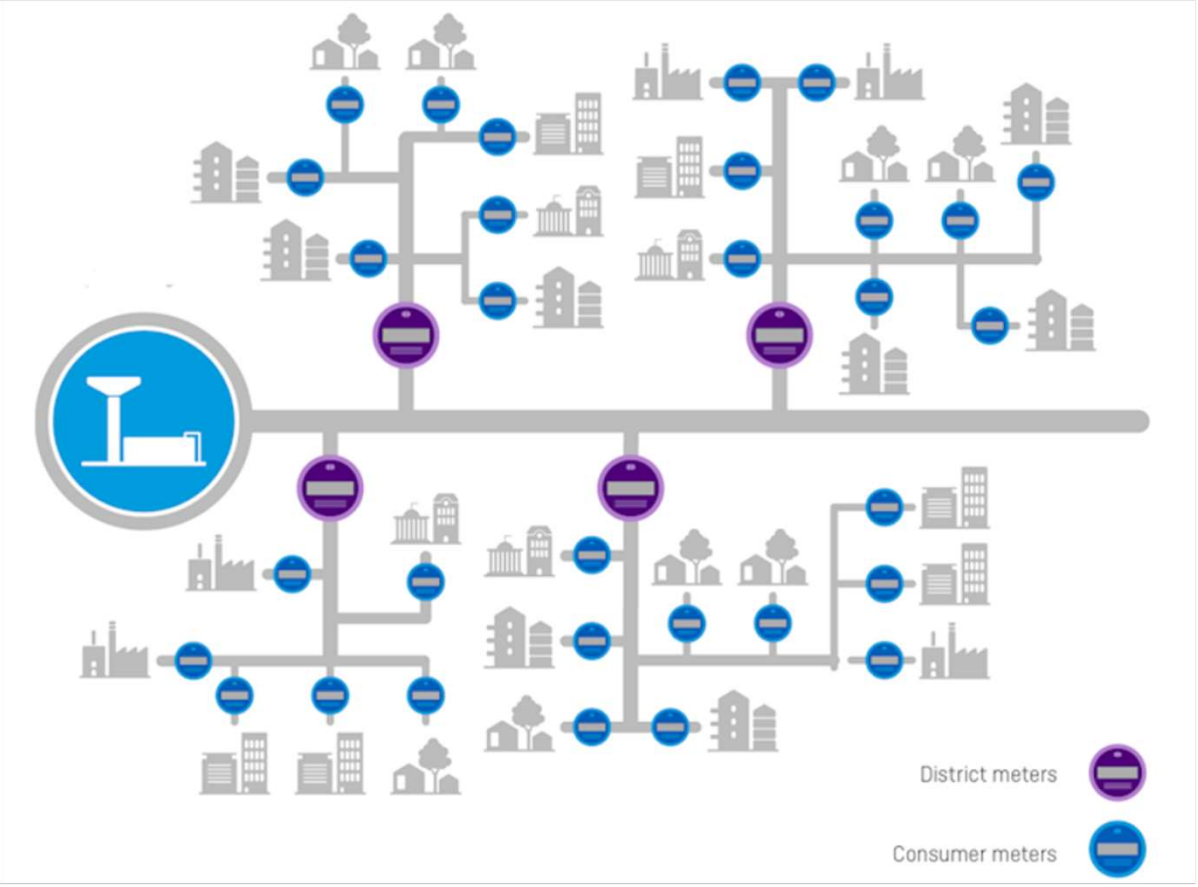
Gwinnett County
Department of Water Resources

Smart Pilot

Steve Seachrist, PE
Engineer V
Water & Sewer Technical Services

Gwinnett

District Metered Area (DMA)



District Metered Area (DMA)

- Customer meters (AMI)
- Master meter(s)
- Other sensors

Pilot Area Development (2017)

Pilot area was selected based on

- Roughly 500 residential connections
- A variety of pipe materials
- System pressure “headroom”
- Proximity to GCDWR office

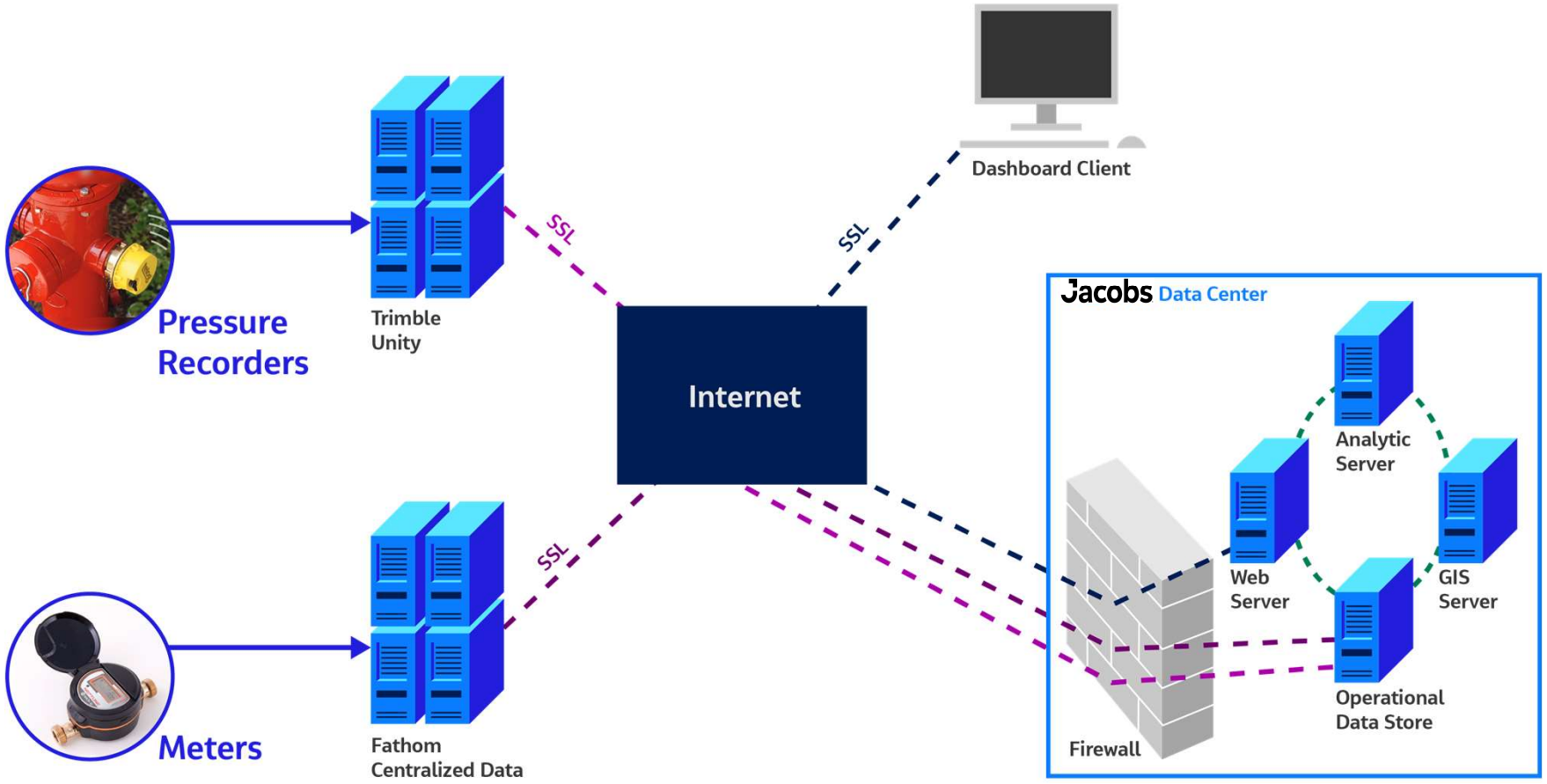
Customer meters were installed, with CMIUs

Master meter was installed, with CMIU

Pressure loggers were installed

Custom online dashboard created

Architecture



Pilot Area

GIS Map (Dashboard)

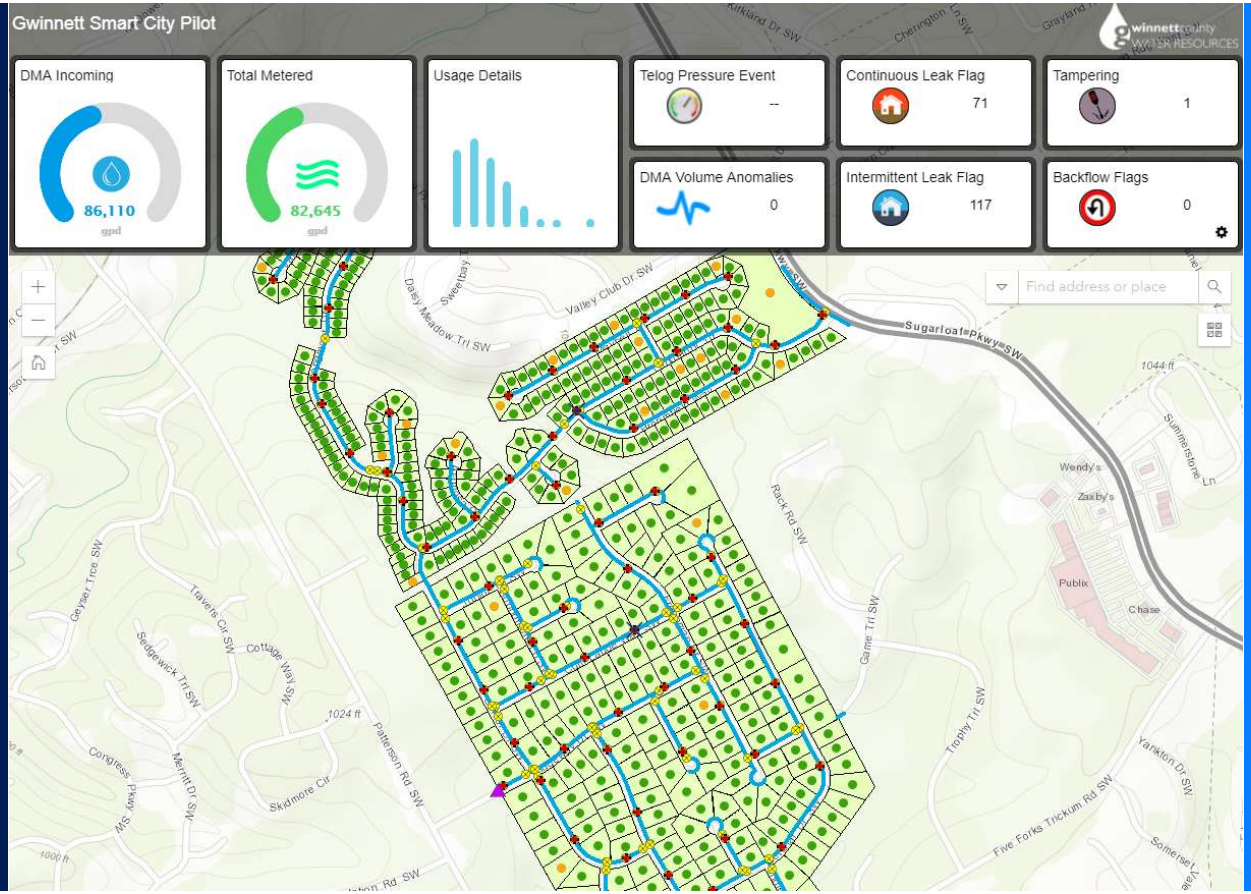
Shows northern sector of the DMA pilot

Color coded for various alerts

Installed Devices

- Residential Meters (AMI)
  - Ultrasonic residential meters (448 units) + PD residential meters (56 units)
  - Collect data every 15 minutes (flow, detect: backflow, tampering, customer side leaks)
  - All meters outfitted with cellular MIU on 4G Network
  - Pushes data out every 6 hours – data available in data accumulation layer (layer 4) within 15 minutes
- Pressure Sensors
  - Hydrant pressure monitor (4)
  - Impulse/transient monitoring capabilities
    - Store and forward up to 100 pressure events
    - High sampling interval - 32 samples/sec
    - Configurable event thresholds
    - Time synchronized
  - Cellular enabled and battery powered
- DMA Meter
  - Electromagnetic meter (DMA Monitoring)
  - Multiple power sources (including battery)
  - CMIU – 15 minute measurement interval
  - Pushes data out every 6 hours – data available in data accumulation layer (layer 4) within 15 minutes

Project Dashboard



Tiles at the top show usage and alerts

- Pressure events
- DMA volume anomalies
- Continuous flows
- Intermittent flows
- Tampering
- Backflow

Review once or twice daily

DMA Meter – Magnetic 8-inch with Cellular Endpoint (CMIU)

DMA meter vault

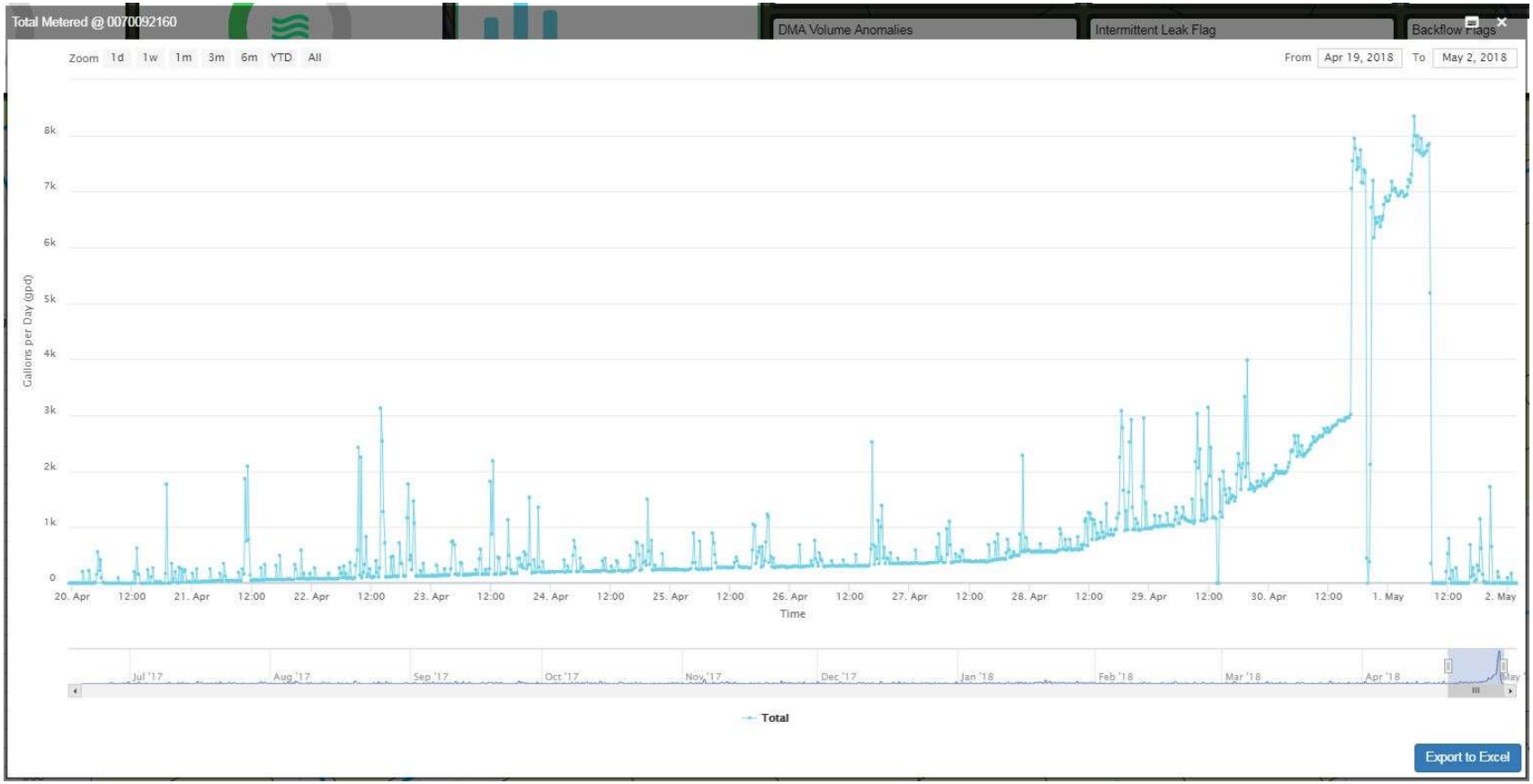
8-inch mag meter with CMIU

Bypass for maintenance

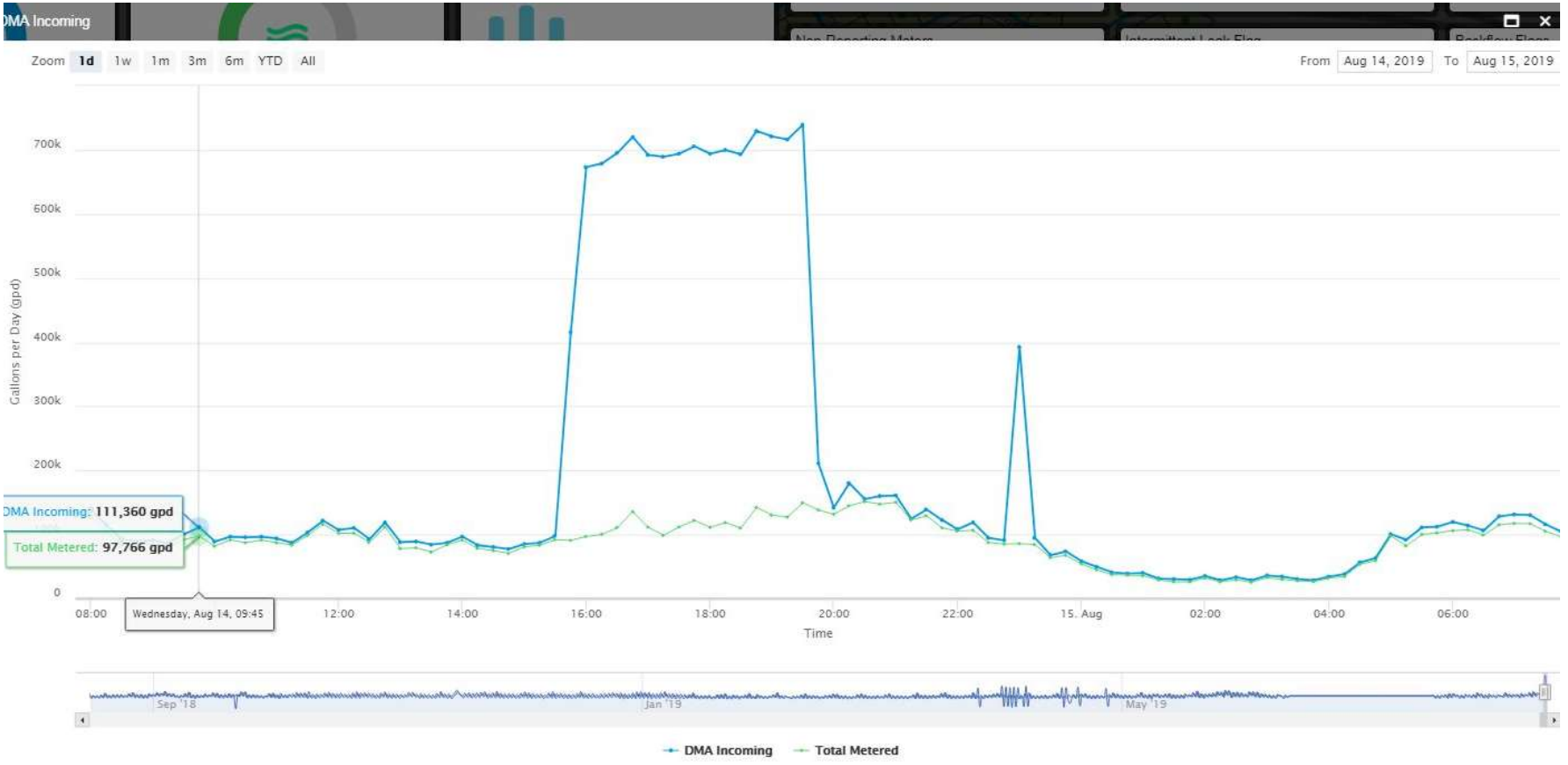
Master Flow (blue) and Customer Flow (green)

Customer Leak Success Story 1

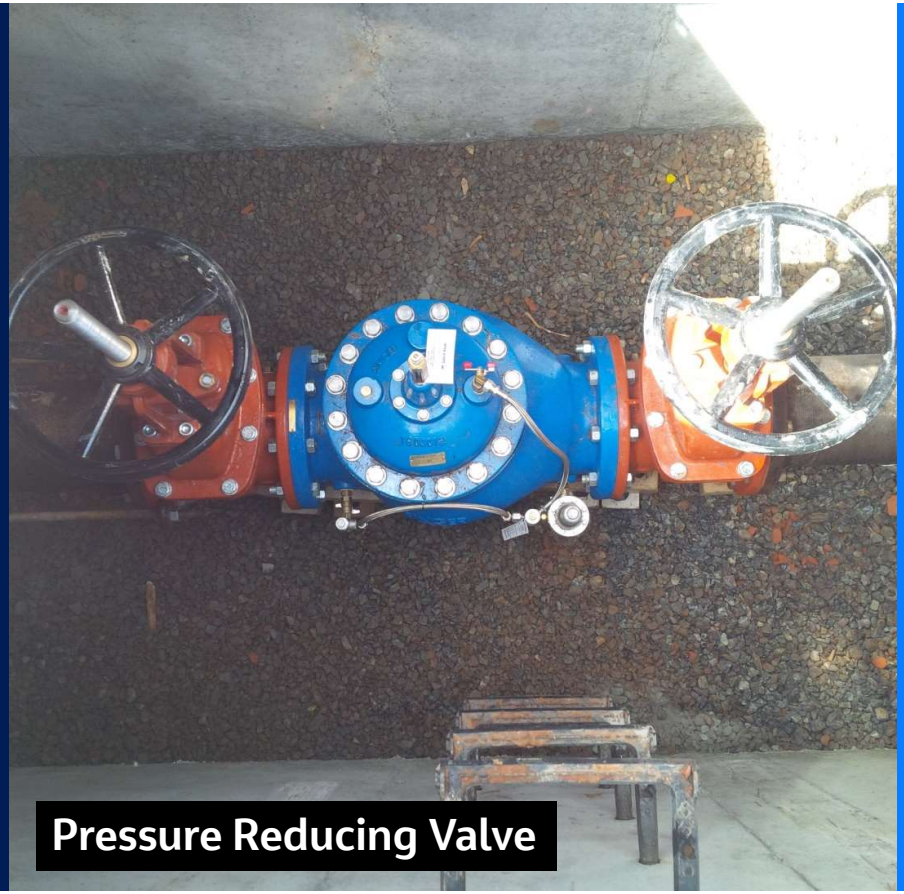
Customer Leak Success Story 2



Leak in Distribution System



Added Value



Pressure Reducing Valve

- Utility decided to add pressure management
- Pressure reducing valve was installed
- Opportunity to reduce pressures 19 psi
- Establish baseline
- Reduce pressures incrementally
- Observe changes in losses and consumption
- Quantify using water audit tools


Telog Pressures
Non-Reporting Meters
Intermittent Leak Flag
Backflow Flags
Zoom 1d 1w 1m 3m 6m YTD All
From May 12, 2018 To Jun 11, 2018
PSI
135
132.5
130
127.5
125
122.5
120
117.5
115
112.5
110
107.5
105
14. May
16. May
18. May
20. May
22. May
24. May
26. May
28. May
30. May
1. Jun
3. Jun
5. Jun
7. Jun
9. Jun
11. Jun
Time
Jan '18
Feb '18
Apr '18
May '18
Meter# 472959
Meter# 472958
Meter# 472957
Meter# 472956
Export to Excel

Reduction in Losses & Consumption

- Losses were reduced by 7.5% and consumption was reduced by 8.5% due to pressure reduction

Results

Over 30 customer “success stories”

Utility alerted customers to continuous flows

Customers responded with plumbing fixes

If implemented county-wide, alerts would be automated

Pressure management reduced NRW

Lessons Learned

Data is generally reliable and accessible

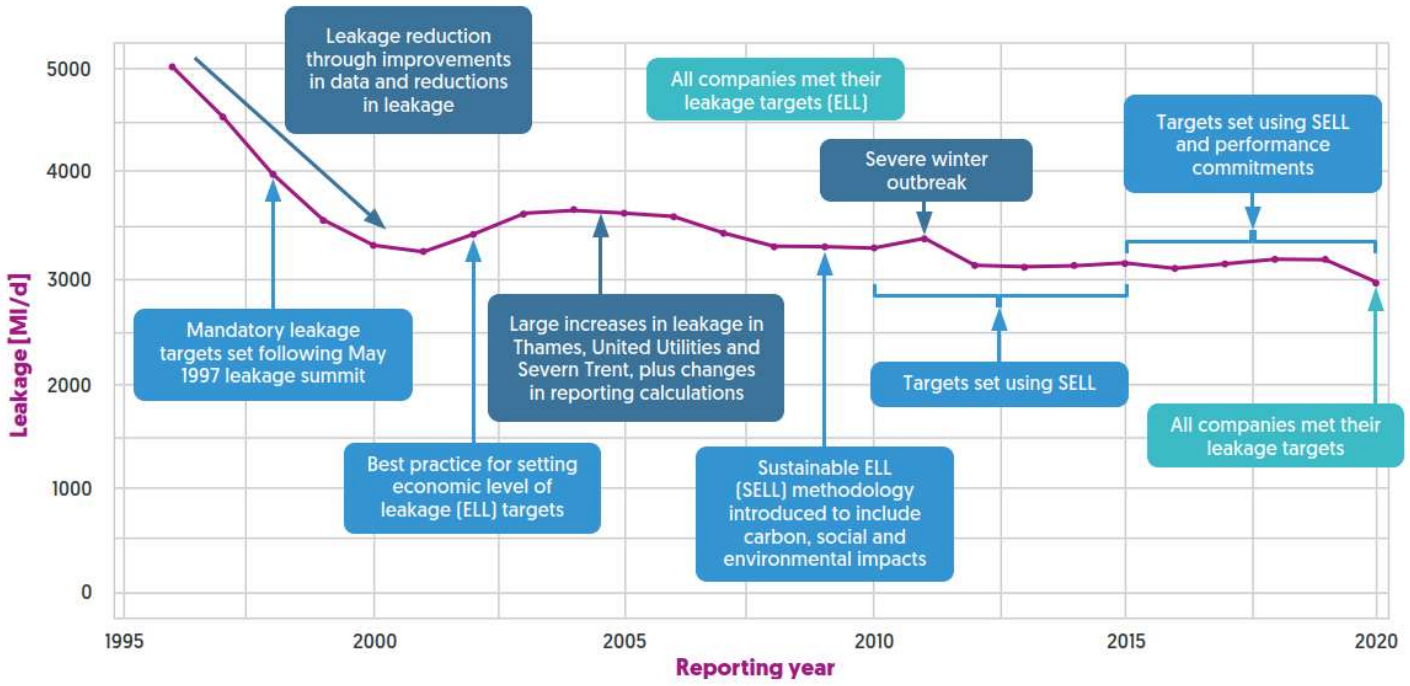
County's water loss is quantifiable

Water use "events" are quickly detected

Modest pressure reductions reduce loss & consumption measurably

Technology-Enabled Solutions

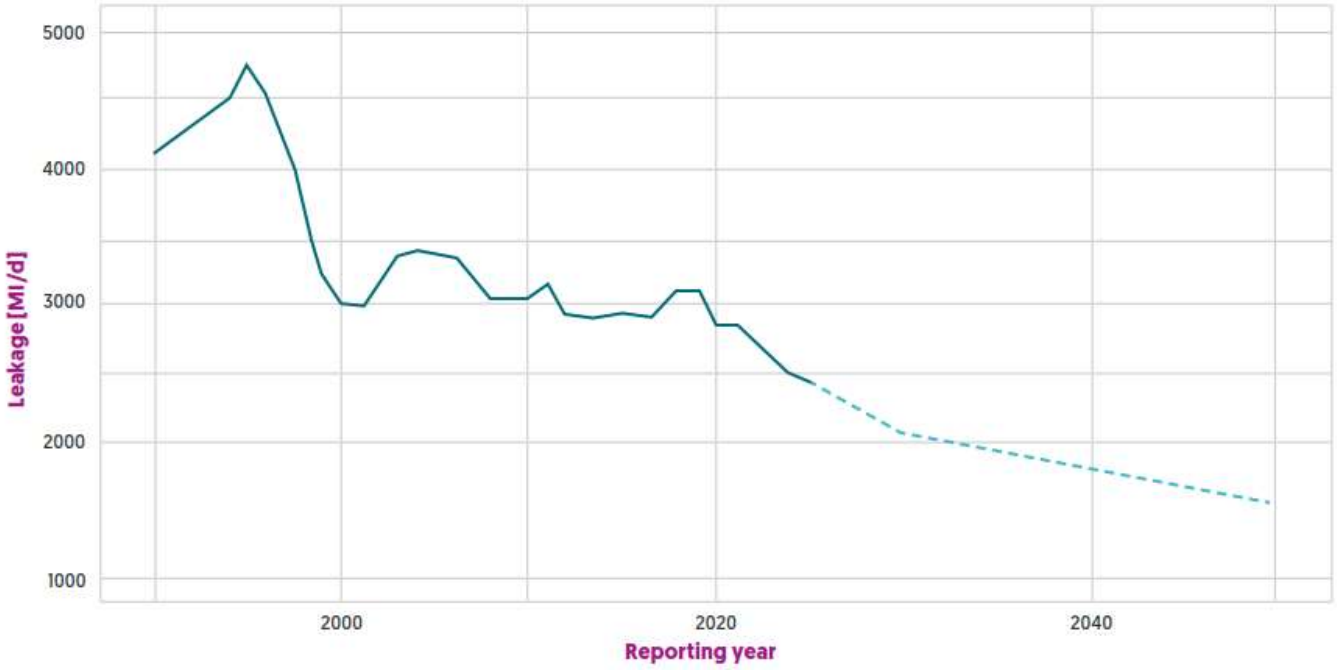
Where are we now?



*Water UK: A Leakage Routemap to 2050

- Leakage Profile for England & Wales: 1995 to 2020
  - Significant success pre-2000
  - Plateaued since 2000. . . . .
    . . despite continuous efforts, increased investment and new approaches
  - ***How can we make a step-change?***

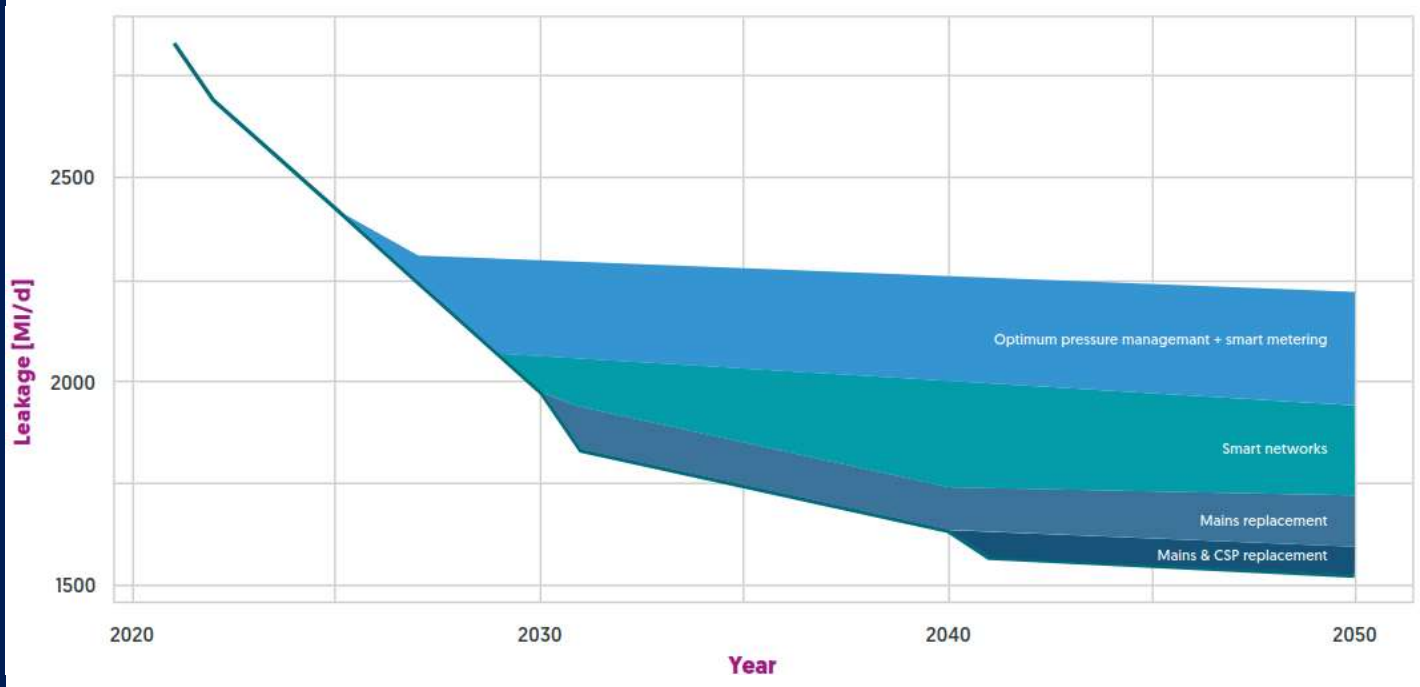
Where do we want to get to?



*Water UK: A Leakage Routemap to 2050

- Leakage Performance and Commitments through to 2050
  - By 2025;
    - Reduce Leakage by at least 15%
  - By 2030;
    - Triple the rate of Leakage reduction
    - ***Achieve net-zero carbon emissions***
  - By 2050;
    - Reduce Leakage by 50%

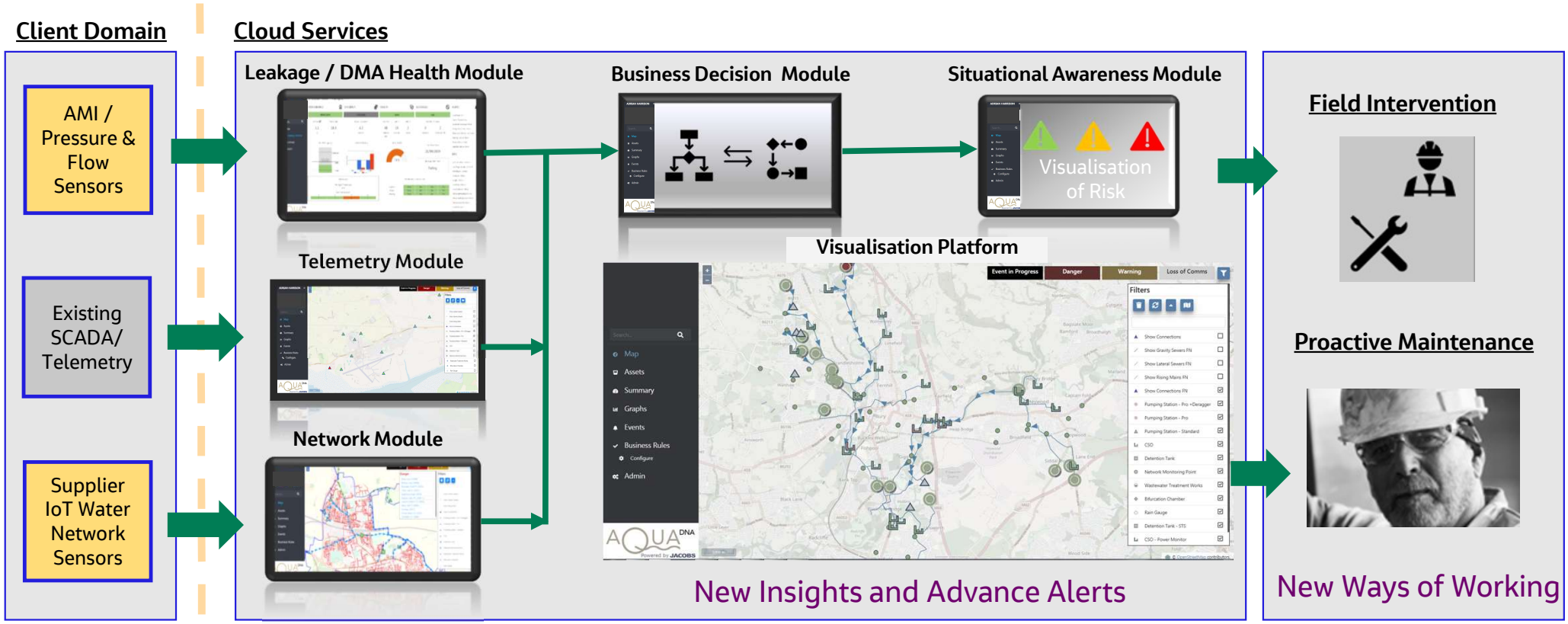
How can we get there?



*Water UK: A Leakage Routemap to 2050

- Roadmap to 2050?
  - Adaptive pathways
    - "One size fits all" approach won't work
  - Enhanced Information and Knowledge sharing
    - Reduce duplicated effort, enable innovations to be benefitted by all, *and quickly!*
  - Supply Chain Resource Constraints ***and Opportunities!!***

Digital Transformation: AquaDNA . . . . *from Reactive to Proactive*



Safe Smart Systems

Anglian Water

The Shop Window & Smart

Fionn Boyle, Strategic Innovation & Shop Window Lead

Who we are

Anglian Water is the largest water and water recycling company in England and Wales by geographic area. We employ more than 5,000 people and supply water and water recycling services to more than six million customers in the East of England and Hartlepool.

We are an intelligent organisation made up of inspiring people who love every drop.

Every drop of water is precious and we believe it's everyone's responsibility to look after it.

So we never stop looking for new ways to improve what we do, to keep us ahead in a changing world.

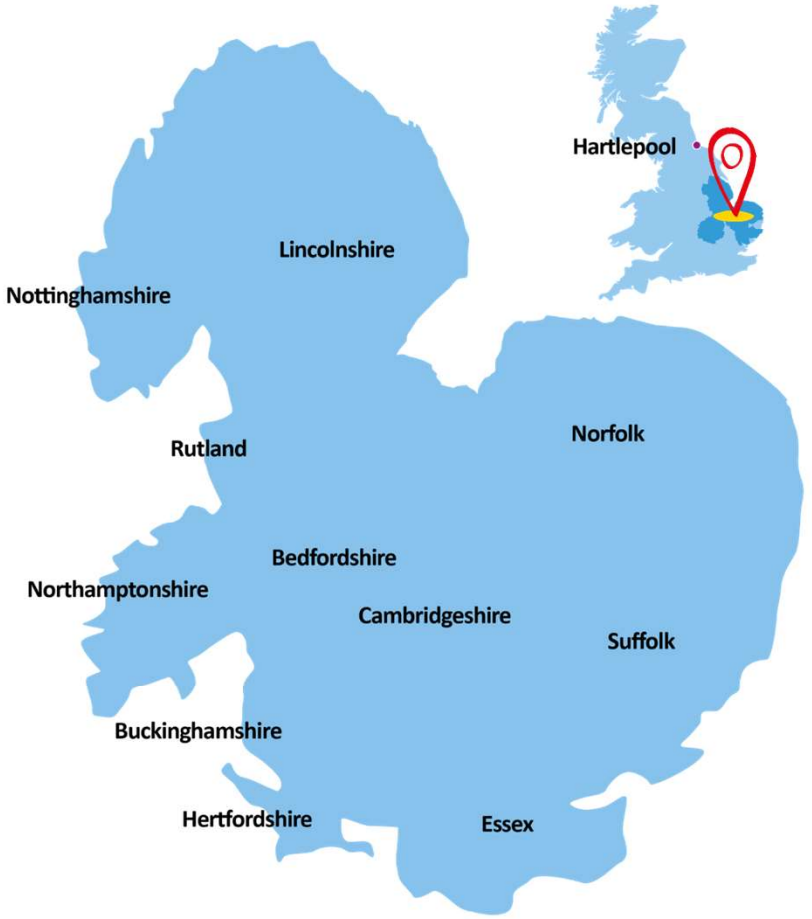
love every drop
anglianwater

Where we do it

Our huge region stretches from Humber to Thames estuaries, from Buckinghamshire to Lowestoft

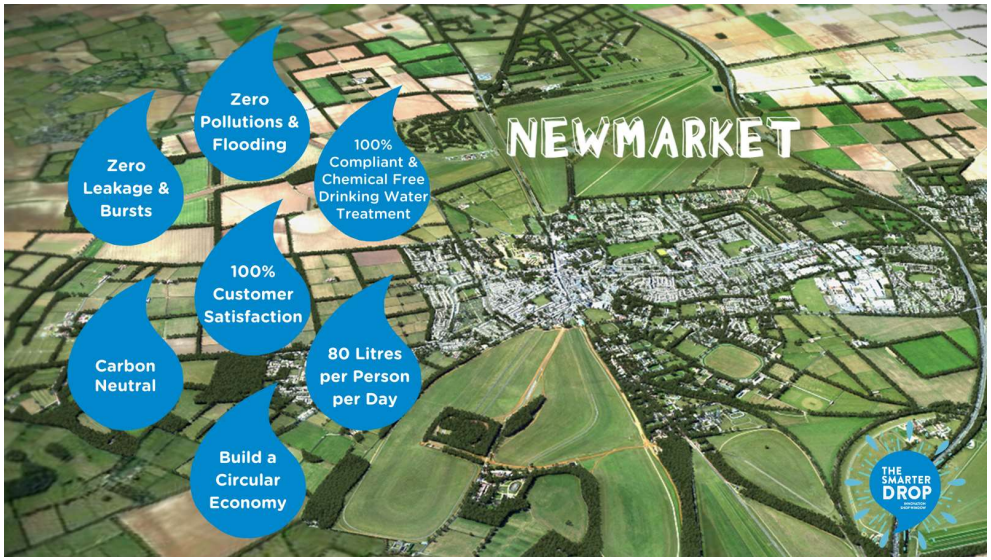
We have distant challenges in our region:

- We have a high proportion of flat and low-lying areas - including The Fens and the Norfolk Broads - and a quarter of our region lies below sea level, so we are at a higher risk of flooding.
- Our population is growing - we run more water and water recycling treatment works than elsewhere in order to serve our growing customer base.
- We're one of the driest regions in the country, receiving, on average, a third less rain than the rest of England - so it's vital we look after the water we've got.



love every drop
anglianwater

What it was



Create a **vision** of what the **future water company could be**, today

Our Shop Window presents a unique opportunity for us to trial new ideas, working collaboratively across business units. By creating an innovation hub in the Newmarket catchment, we will accelerate our learning around the synergies between different innovations.

We will ensure that we are prepared to meet future challenges, as defined by the seven aspirational goals we set out for our Shop Window.

Focused around technologies to start looking for synergies between them, through working with the Innovation team and the reaching via the water innovation network a strategic partnership with Allia.

love every drop
anglianwater

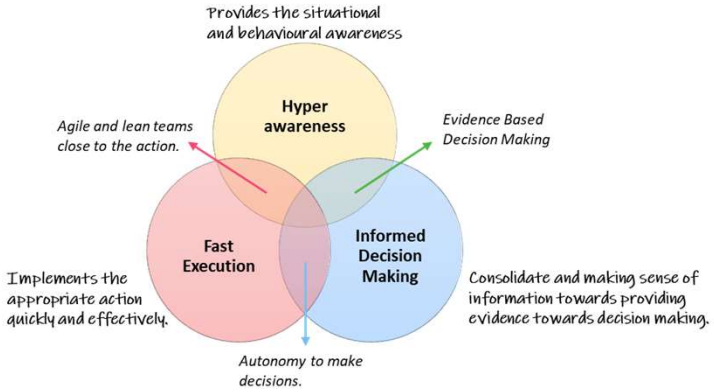
What is it?

An Enterprise Incubator Framework

The incubator will provide the means for exploring opportunities to dynamically re-engineer our business, radically changing how we work to build the future water company, today.

Delivering efficiencies, improvements across key performance commitments and relationships with our regulators, we continually build trust with our employees and our partners.

We work at pace to explore and inform how we work, executing innovation at scale and embedding new ways of working at a system level to make today great while loving every drop.



love every drop
anglianwater

Smart Water Systems (£5m)

Optimising and automating routine operations

Near Real Time Performance Reporting

Visualisation Suite

Non Infra Digitisation | Near Real Time Modelling | Near Real Time System Monitoring | Condition Based Monitoring | Flow Balancing | SMART Asset Control Model

Data and technical architecture for SWS | Implementing enabling technologies including OT platform and IP Enablement

Focus on adapting our operating model to run a Smart Water System

Safe Smart Systems (£8.7m, OFWAT Funded)

Optimising and automating in response to predicted or detected faults

Implement AI models which advise action → Build next-gen infra and sensing required for control → Implement AI models which automatically control the system

Data and technical architecture for an Intelligent System | Implementing any changes required to enabling technology

Smart Programme

Condition Based Maintenance | Calm, Controlled and Monitored Systems | Alarm Rationalisation | Process / Activity Automation | Digital Twin of Major Pipeline & STC | Technology, Innovation, Resource Alignment | Scale & Integrate

Safe Smart Systems

Active Partners

Supporting Partners

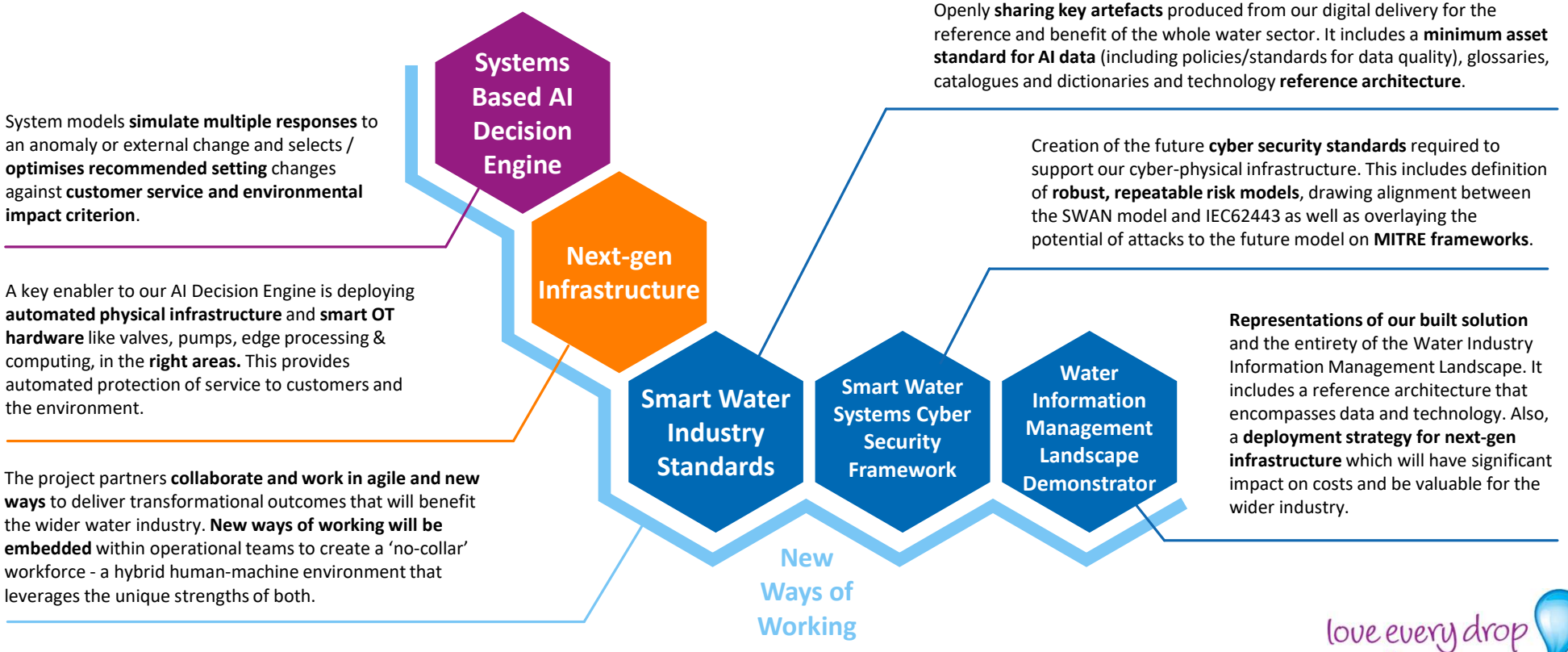
Water Breakthrough Challenge

What is the Ofwat Innovation Fund?

- Ofwat is the UK's water industry regulator
- £200m Innovation Fund launched in January 2021
- Aim: deliver transformational benefits for consumers, society and the environment

love every drop anglianwater

Breaking down Safe Smart Systems



System models **simulate multiple responses** to an anomaly or external change and selects / **optimises recommended setting** changes against **customer service and environmental impact criterion**.

A key enabler to our AI Decision Engine is deploying **automated physical infrastructure** and **smart OT hardware** like valves, pumps, edge processing & computing, in the **right areas.** This provides automated protection of service to customers and the environment.

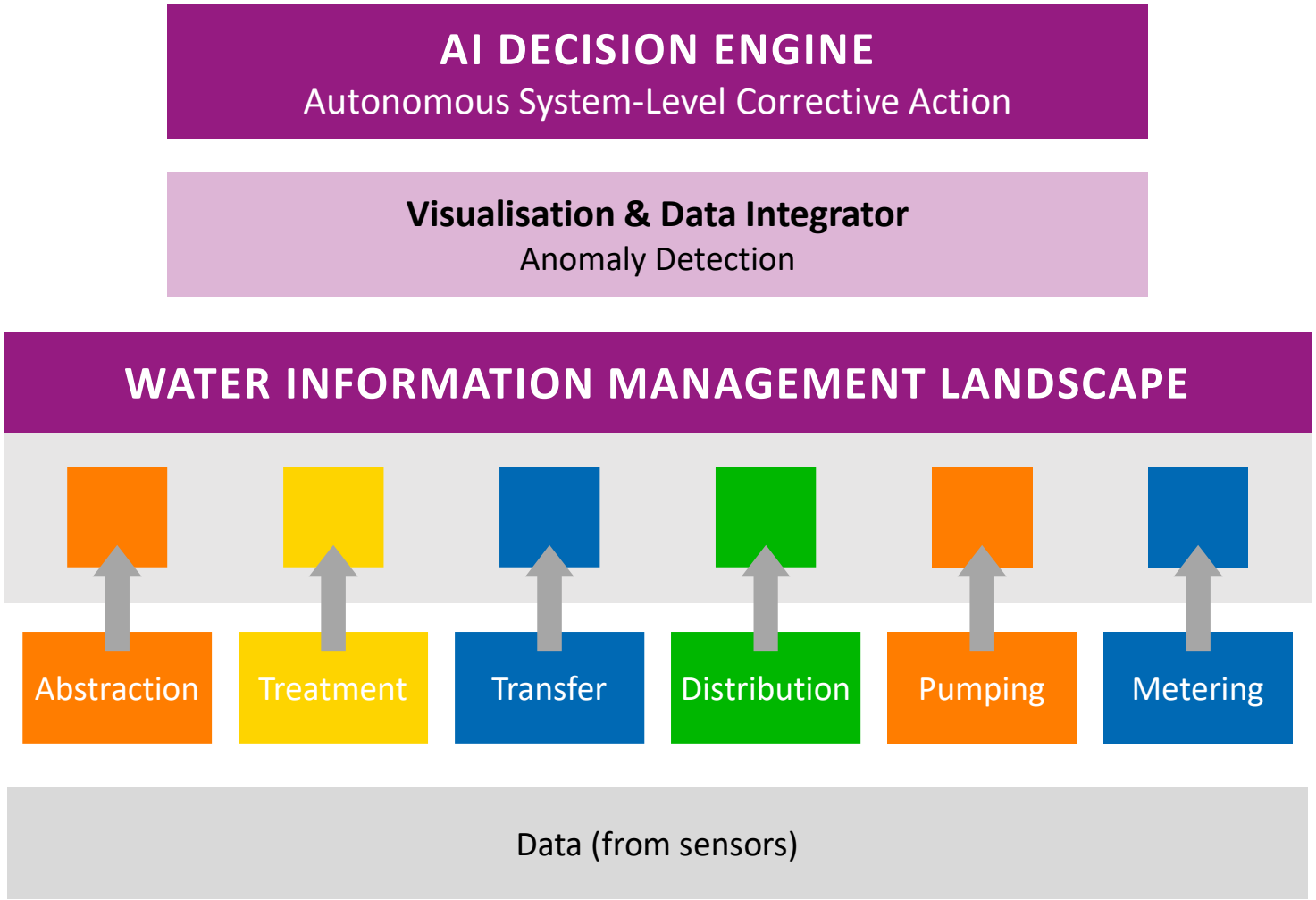
The project partners **collaborate and work in agile and new ways** to deliver transformational outcomes that will benefit the wider water industry. **New ways of working will be embedded** within operational teams to create a 'no-collar' workforce - a hybrid human-machine environment that leverages the unique strengths of both.

Openly **sharing key artefacts** produced from our digital delivery for the reference and benefit of the whole water sector. It includes a **minimum asset standard for AI data** (including policies/standards for data quality), glossaries, catalogues and dictionaries and technology **reference architecture**.

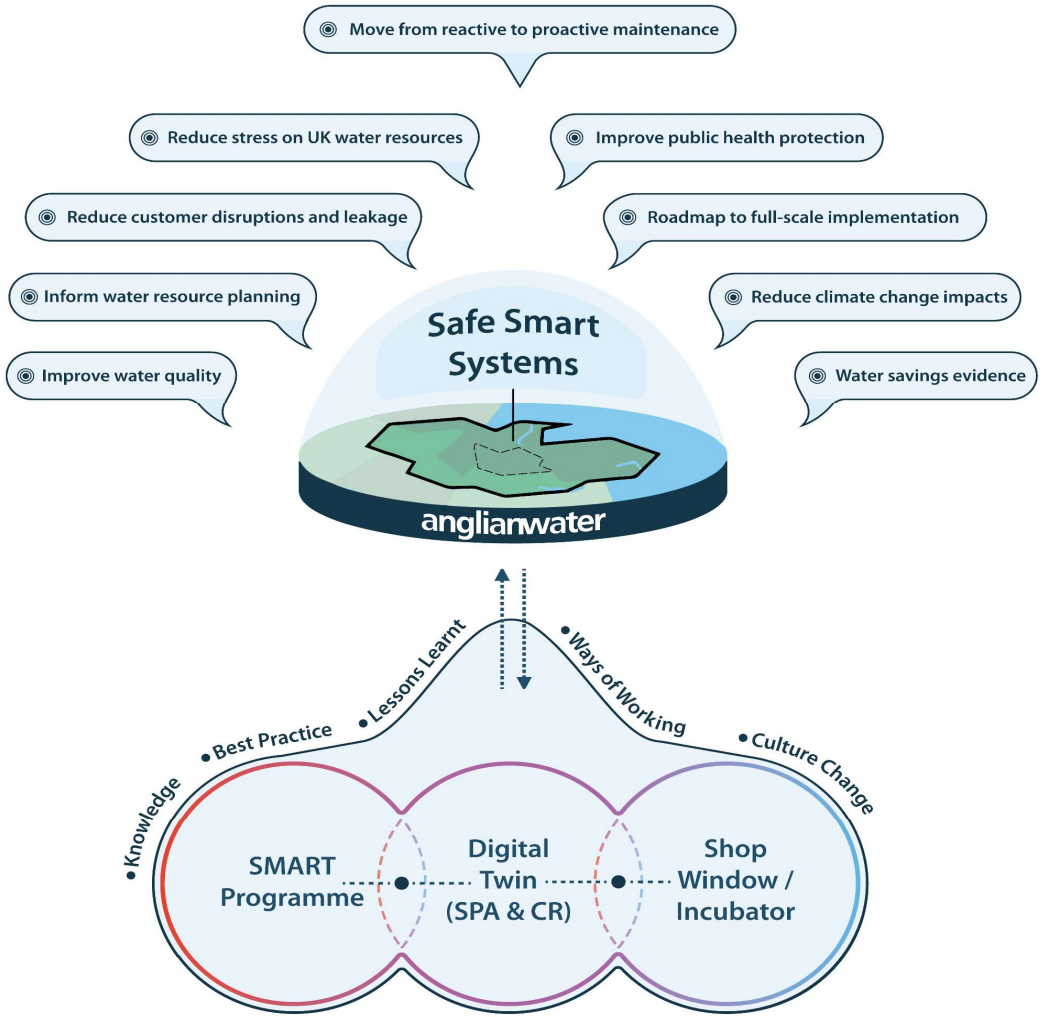
Creation of the future **cyber security standards** required to support our cyber-physical infrastructure. This includes definition of **robust, repeatable risk models**, drawing alignment between the SWAN model and IEC62443 as well as overlaying the potential of attacks to the future model on **MITRE frameworks**.

Representations of our built solution and the entirety of the Water Industry Information Management Landscape. It includes a reference architecture that encompasses data and technology. Also, a **deployment strategy for next-gen infrastructure** which will have significant impact on costs and be valuable for the wider industry.

love every drop
anglianwater



AI – Artificial Intelligence


Move from reactive to proactive maintenance
Reduce stress on UK water resources
Improve public health protection
Reduce customer disruptions and leakage
Roadmap to full-scale implementation
Inform water resource planning
Reduce climate change impacts
Improve water quality
Water savings evidence
Safe Smart Systems
anglianwater
Knowledge
Best Practice
Lessons Learnt
Ways of Working
Culture Change
SMART Programme
Digital Twin (SPA & CR)
Shop Window / Incubator

Outcomes

Reduce customer disruptions and leakage

Water **savings** evidence

Improve water quality

Move from reactive to **proactive** maintenance

Roadmap for full-scale implementation

Reduce stress on UK water resources

Inform water resource planning

Improve public health protection

Reduce climate change impacts

love every drop
anglianwater

Q&A

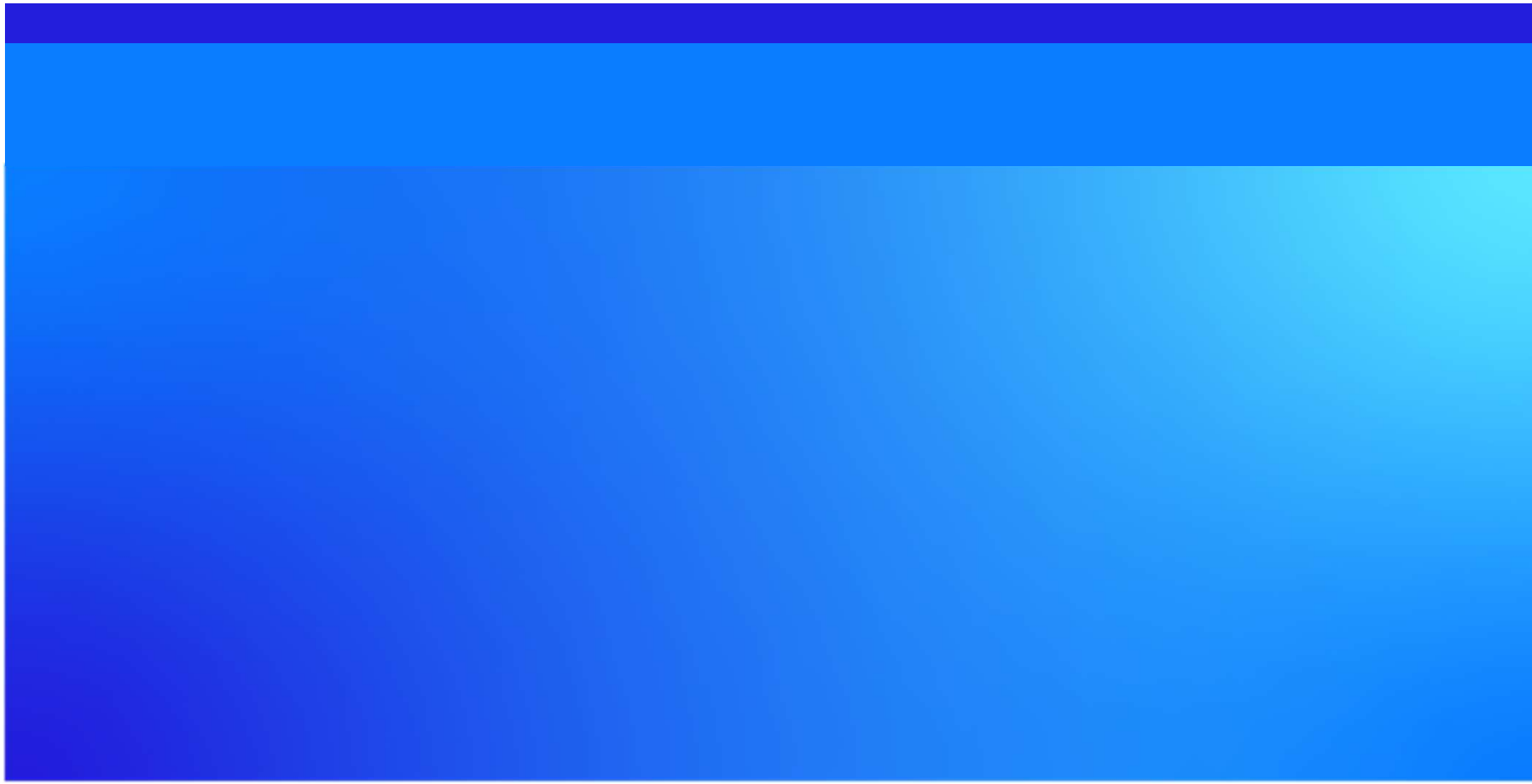
Prepared Questions

- How much leakage reduction is reasonable to expect? Or what's a reasonable goal?
- I can't make the economics work because our water is so cheap, this looks expensive to implement.
- There are lots of good solutions and capabilities out there, but how do I know which one / more are right for me? (FR)

Copyright Notice

Important

The material in this presentation has been prepared by Jacobs®.



Jacobs

Challenging today.
Reinventing tomorrow.