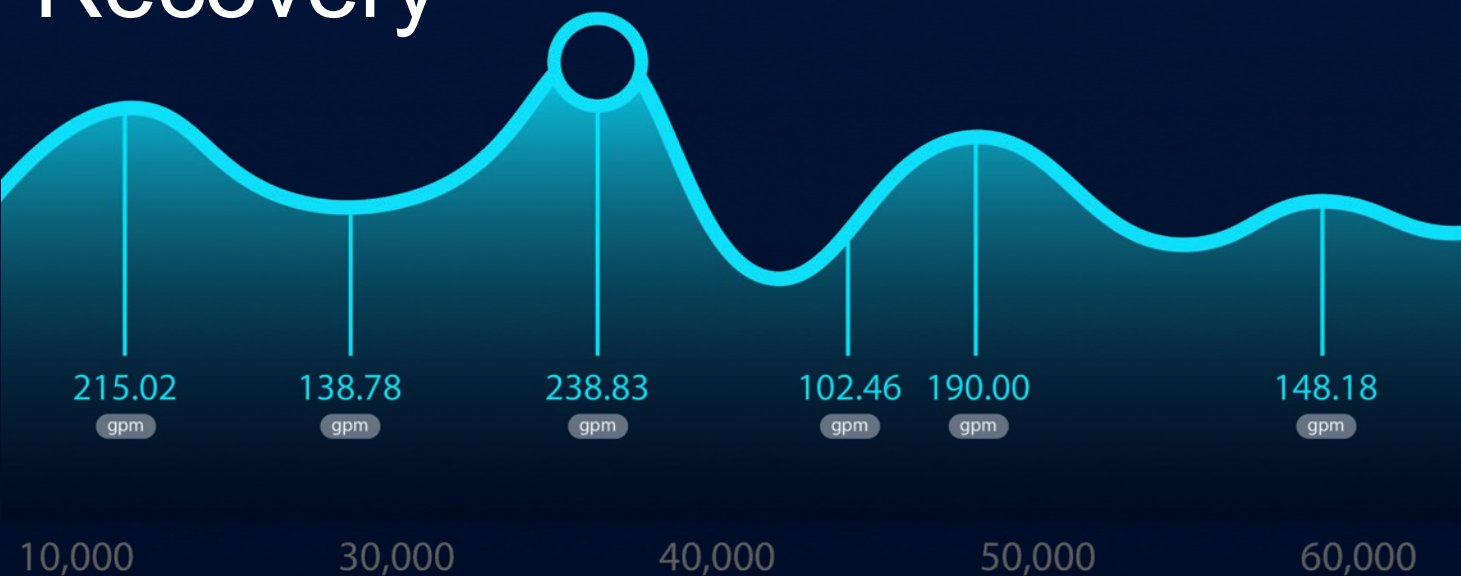


Minimizing Apparent Losses: City of Bend's Analytical Approach to Revenue Recovery



Apparent Water Loss Challenges

Utility managers must optimize their metering program and make informed decisions regarding operational performance without clear visibility of meter performance.

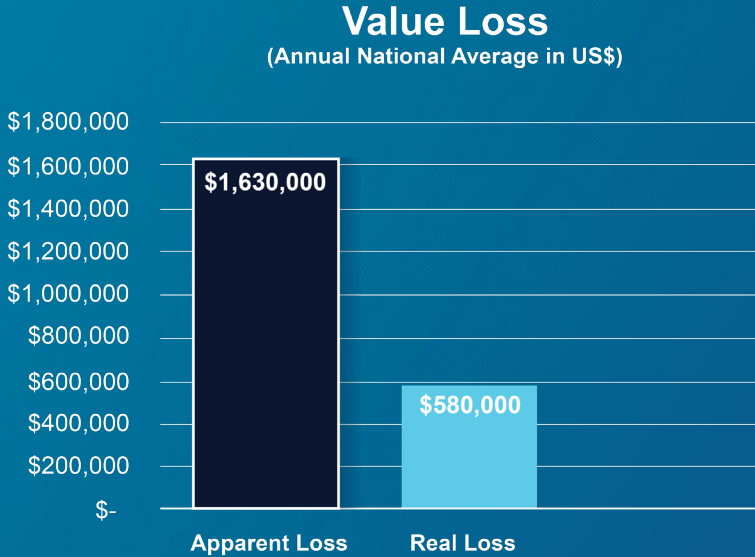
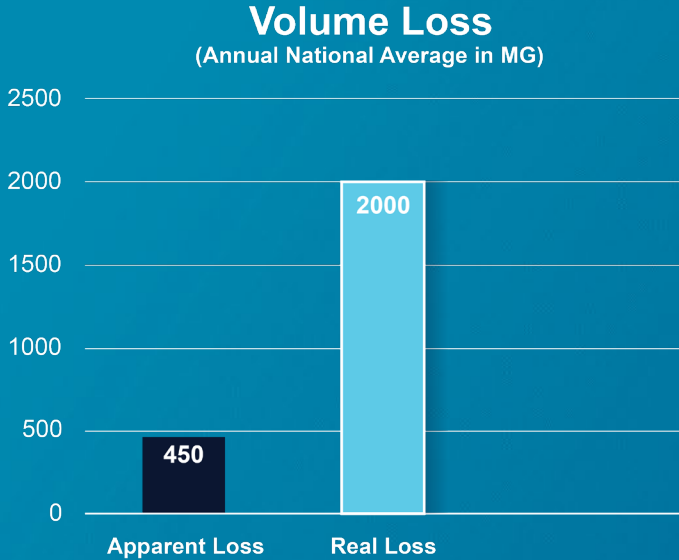
An analytical approach identifies meter underperformance due to degradation on a **meter-by-meter basis**.

Allowing a water utility to prioritize meter testing and replacement, maximize revenue recovery and realize operational efficiencies.



In the US, “2% of top-line revenue is lost annually via apparent loss issues, equating to millions of dollars of lost revenue for water utilities.”

(AWWA M36 Water audit and Loss Control Programs, 4th Edition)



Certified Annual Financial Report

City of Bend, Oregon Statement of Activities For the fiscal year ended June 30, 2018

Function/Programs	Program Revenues				Net (Expenses) Revenues and Changes in Net Position		
	Direct Expenses	Charges for Services	Operating Grants and Contributions	Capital Grants and Contributions	Primary Government		Total
					Governmental Activities	Business-type Activities	
Governmental Activities:							
General government	\$ 20,483,979	\$ 10,755,529	\$ 47,786	\$ 290,459	\$ (9,390,205)	-	\$ (9,390,205)
Public safety	49,028,712	5,996,707	10,183,576	-	(32,848,429)	-	(32,848,429)
Public ways and facilities	28,526,138	328,820	5,597,433	20,500,850	(2,099,035)	-	(2,099,035)
Community and economic development	16,172,314	15,851,261	2,365,115	-	2,044,062	-	2,044,062
Permanent maintenance	5,257	4,506	-	-	(751)	-	(751)
Urban renewal	44,839	-	-	-	(44,839)	-	(44,839)
Interest on long-term debt	1,888,295	-	-	-	(1,888,295)	-	(1,888,295)
Total Governmental Activities	116,149,534	32,936,823	18,193,910	20,791,309	(44,227,492)	-	(44,227,492)
Business-Type Activities:							
Water	16,814,561	19,774,369	-	3,714,843	-	6,674,651	6,674,651
Water reclamation	18,392,556	26,930,336	-	2,979,290	-	11,517,070	11,517,070
Airport	1,357,349	923,339	-	3,477,391	-	3,043,381	3,043,381
Cemetery	211,577	60,959	-	-	-	(150,618)	(150,618)
Downtown parking	1,289,951	1,099,870	-	-	-	(190,081)	(190,081)
Stormwater	3,544,155	3,769,657	-	971,847	-	1,197,349	1,197,349
Total Business-Type Activities	41,610,149	52,558,530	-	11,143,371	-	22,091,752	22,091,752
Total Activities	\$ 157,759,683	\$ 85,495,353	\$ 18,193,910	\$ 31,934,680	(44,227,492)	22,091,752	(22,135,740)

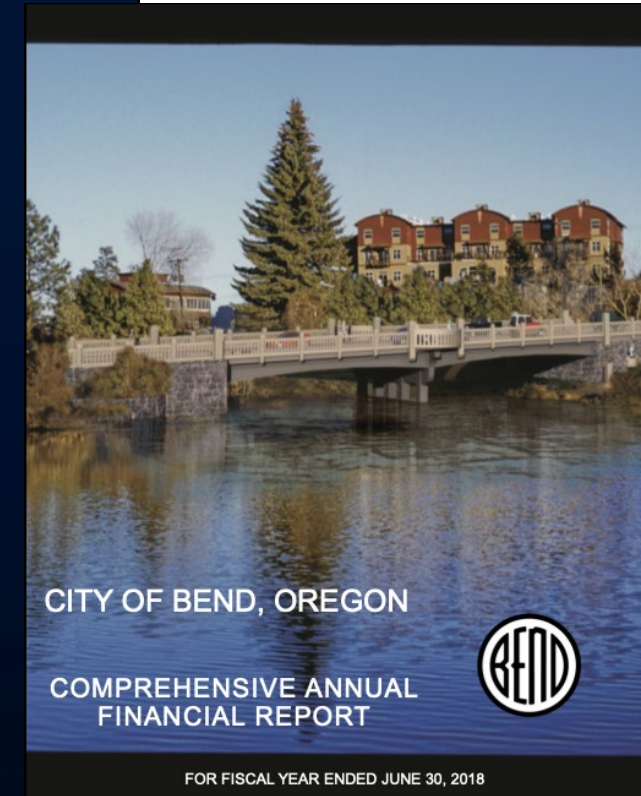
Water / Water Reclamation 2018: \$46,704,705


2% of top line revenue = \$934,094

2018 Comprehensive Annual Financial Report

City of Spokane, Washington

COMPREHENSIVE ANNUAL FINANCIAL REPORT For the Fiscal Year Ended December 31, 2018





Effective metering programs address the major causes of apparent water loss

Under-registration

Meters registering less water than the actual flow rate

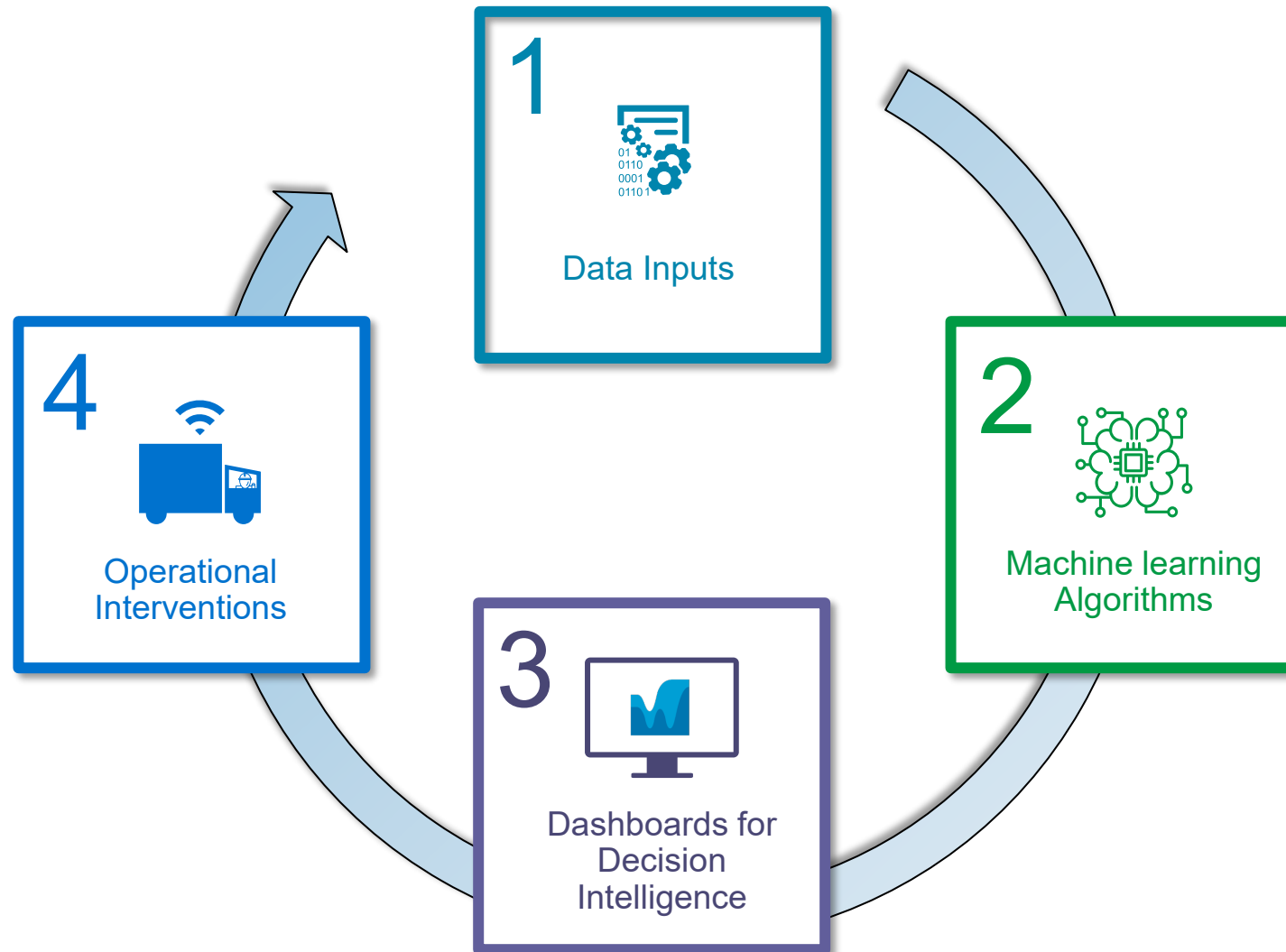
Read errors

Meters reporting negative flow rates, anomalous consecutive zeroes, and other implausible meter read results

Inappropriate sizing

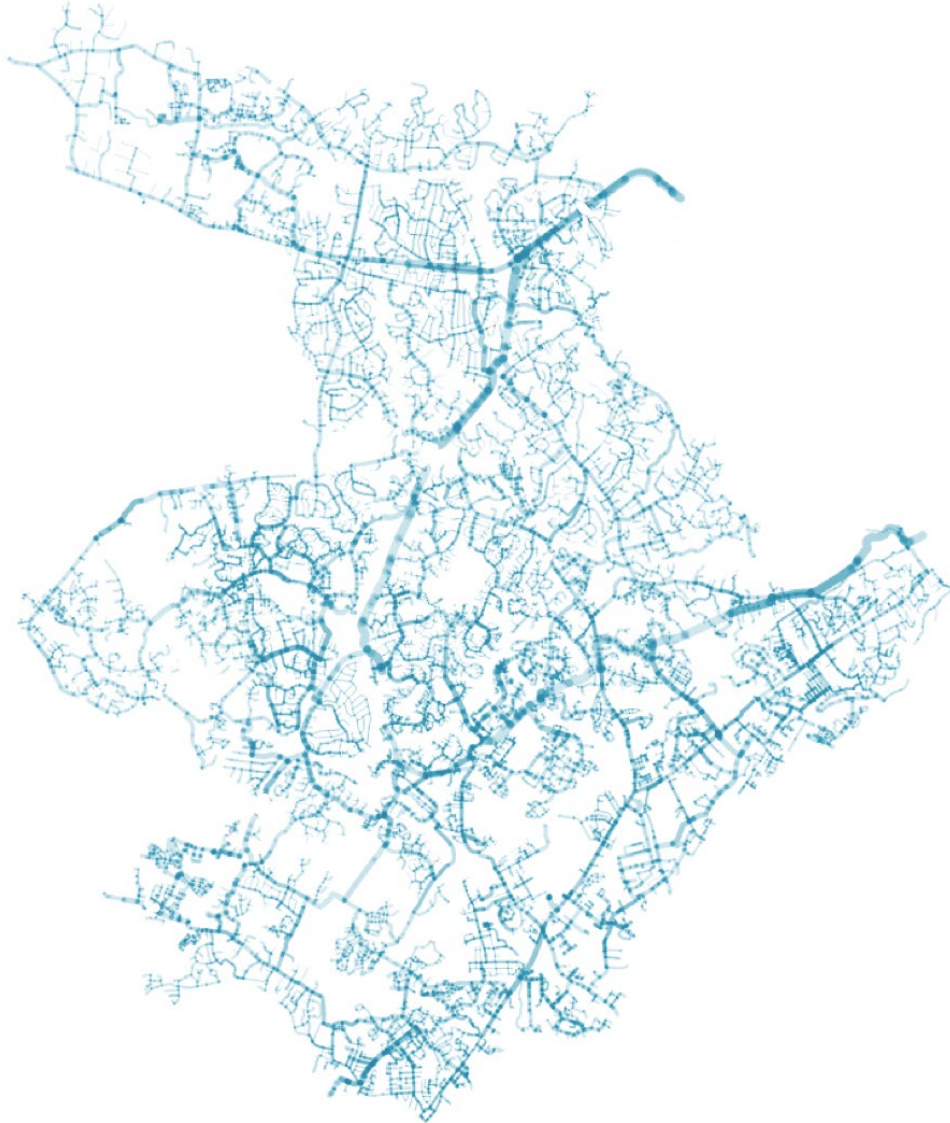
Meters that are either too large or small for water demand

We use **machine learning** and **analytics** to inform **operational interventions**.





Information Disconnect



Thousands, tens-of-thousands, or even hundreds-of-thousands of meters in a water system.

How do I know which meters are underperforming and losing revenue?

The Status Quo

TRADITIONAL METHODS



AGE-BASED

Age alone doesn't accurately predict failure.



SAMPLING

Often leads to good meters being replaced prematurely

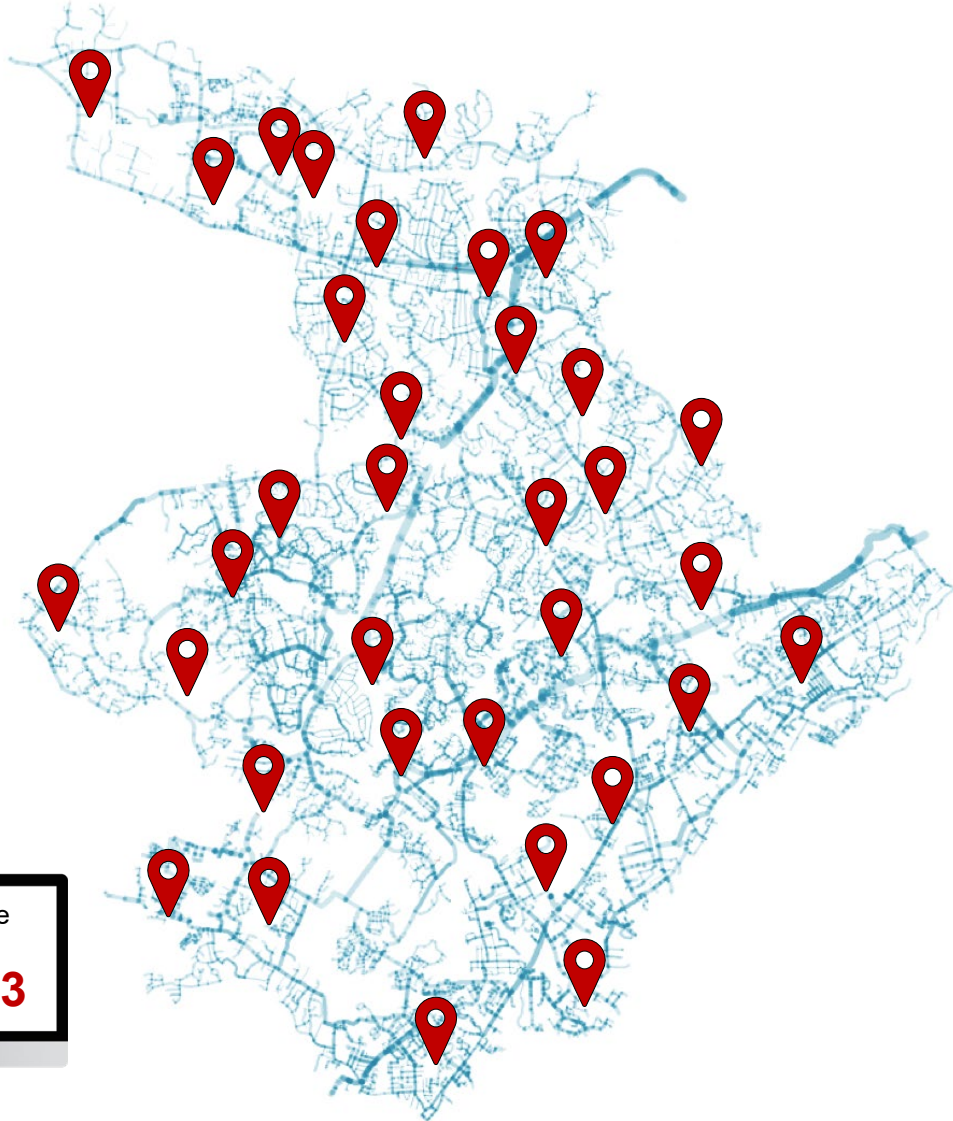


REPLACEMENT AT FAILURE

Largest possible negative impact when issue meters are left in place



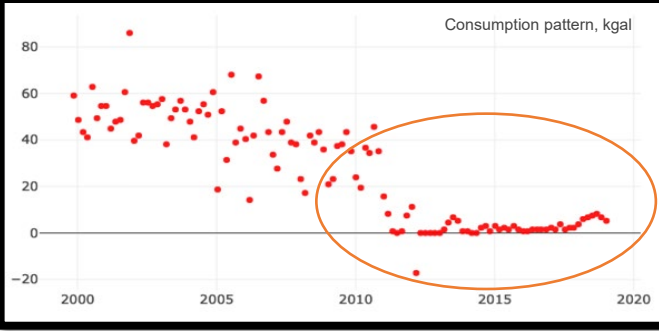
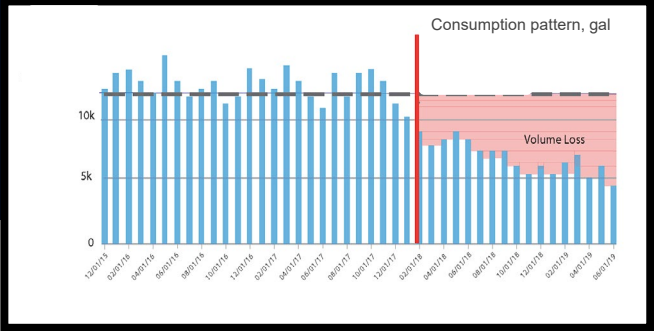
Performance Based Meter Management Through Analytics



By analyzing historical and current billing and water meter data, Revenue Locator software will identify the exact meters with apparent loss issues.

- Locates meter under registration
- Empowers proactive revenue recovery and operational efficiency.
- Quantifies the apparent loss for prioritization. **Meter-by-meter.**

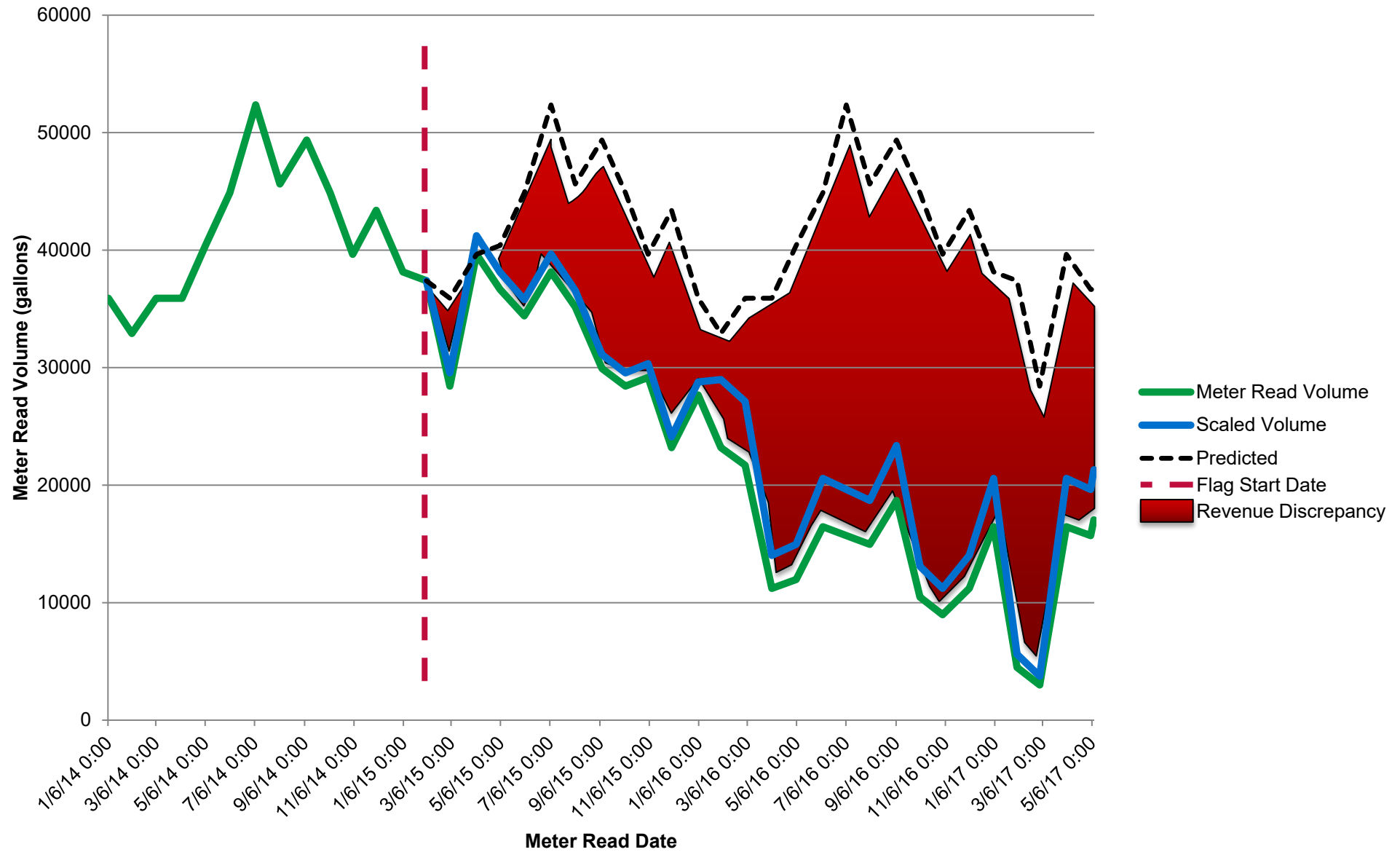
Meter Under-Registration



This issue type identifies meters that exhibit a significant gradual decrease in consumption, normalized for at least twelve months, exhibiting a characteristic under-registration read pattern.

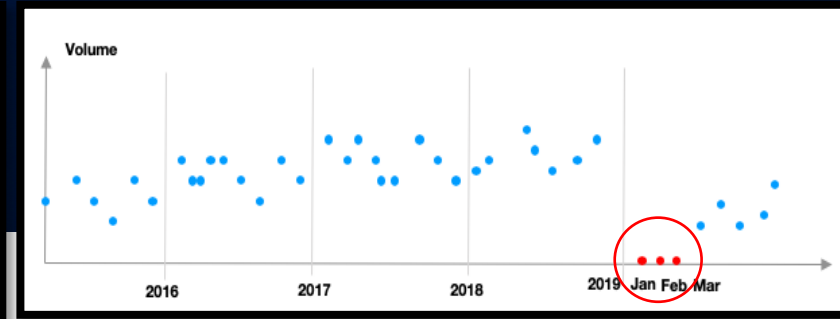
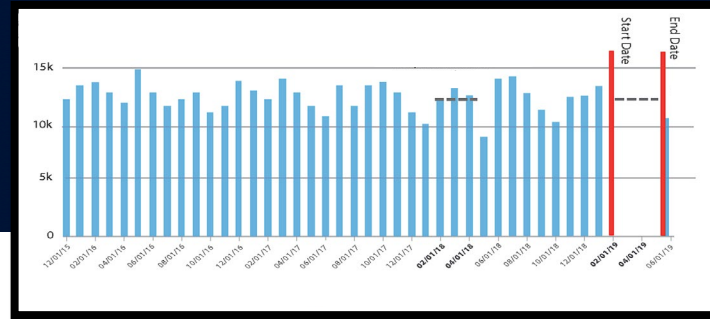
Start/End Dates	Algorithm Criteria	False Positive Differentiation	Volume Loss Calculation
<ul style="list-style-type: none">• Starts when age, throughput, and downward trend all reach a learned confidence threshold• The issue stops when the meter is replaced or performs well in a reported flow test	<p>Weighted average of:</p> <ul style="list-style-type: none">• Statistically significant downward trend• Age• Throughput	<p>The algorithm considers:</p> <ul style="list-style-type: none">• Sudden behavior changes (ex. vacation property, a family member going to college)• Individual meter changes as distinct from community consumption changes (area-wide conservation efforts, weather events, etc.)• Occupancy changes	<p>The ongoing difference between projected trend based on historical reads and reads since the point at which mechanical degradation was detected</p>

Meter Under Registration For Individual Meter



Water Meter Read Errors

Consecutive Zeros (AMI & Monthly)



This issue type flags meters with unexpected consecutive zero reads that are not consistent with similar time periods in previous years. (*Monthly – two or more months of unexpected consecutive reads; AMI – 5 or more days of unexpected consecutive reads*)

Start/End Dates	Algorithm Criteria	False Positive Differentiation	Volume Loss Calculation
<ul style="list-style-type: none">• Starts with the first anomalous zero read• Ends with the most recent anomalous zero read• If a zero read is the most recent read of the meter, the issue is ongoing	<ul style="list-style-type: none">• Frequency of zero reads in a certain period of time• Recent zero reads that do not appear in similar time periods in previous years	<ul style="list-style-type: none">• Short-term and long-term expected periods of zero use are considered• Customer behavior patterns• Seasonal/Community patterns	<p>The expected usage based on similar historical periods</p>

City of Bend

City of Bend

- 26,000 meters
- Aclara AMI started in 2009 and fully implemented in 2013
- Meters not changed at the time of AMI implementation
- WaterSmart Customer for customer notifications, conservation and leaks
- Test 3-inch and up every year by third-party contractor
- 2-inch and smaller not regularly tested
- Have had issues with the Hersey meters, many of the registers have been replaced, do not know exact throughput
- Pilot analyzed all meters and gave the city of bend 50 meters to go test and verify



Bend, Oregon



26k+

Meters Analyzed

\$392,000

Of annual apparent
loss identified

45 Million

Gallons of annual
water loss identified

CHALLENGE

The City of Bend wanted to quantify Apparent Losses and needed help with their meter replacement strategy

SOLUTION

Xylem Revenue Locator is a data-powered approach to meter management that helps identify metering inaccuracies and optimize revenue.

Overall Flag Counts

Dataset	Count
Total Meters in Dataset	26,375
Total / Ongoing Consecutive Zeros Flags	4,242 / 52
Total / Ongoing Negative Reads Flags	9,077 / 5
Total Under-Registration Flags	1,973
Meter Under-Registration Flags Provided in Pilot	50

Pilot Meter Results: Under-Registration

Under-Registration Only	Count
Pilot Meters Flagged	50
Meters Investigated	45
Total Under-Performing Meters	22
Total False Positives	23
Total Unverifiable	5

- 49% of tested meters were correctly predicted, using CIS and meter data alone, to have an under-registration issue. Under-registration is assumed based on AWWA M6 criteria for low flow (< 95% accuracy) and medium and high flow (< 98.5% accuracy) criteria.
- Note that 39 meters were flow tested. The 49% includes 6 “To Review” meters. Per City of Bend, these meters were under-performing and replaced and therefore were unable to be tested.

Pilot Meter Flow Tests: Historical Revenue and Volume Loss

Historical revenue and volume loss from the **22** Under-Performing meters.

Issue Type	Flag Count	Time Range	Historical Revenue Loss			Historical Volume Loss (gal)		
			Potable	Sewer	Total	Potable	Sewer	Total
Under-Registration	22	All Time*	\$65,779	\$137,469	\$203,248	19,424,811	N/A	19,424,811

*Historical revenue loss from the start of the issue to date of replacement/repair. Issues here started in 2012 or later and are assumed to have ended in 2/2021.

Pilot Meter Flow Tests: Projected Revenue and Volume Savings

Projected Revenue and Volume savings from the Total 22 under-performing meters.

Issue Type	Flag Count	Time Range	Projected Revenue Savings			Projected Volume Savings (gal)		
			Potable	Sewer	Total	Potable	Sewer	Total
Under-Registration	22	Monthly	\$1,828	\$1,775	\$3,603	521,846	N/A	521,846
		1-year	\$21,936	\$21,300	\$43,236	6,262,152	N/A	6,262,152
		3-year	\$65,808	\$63,900	\$129,708	18,786,456	N/A	18,786,456
		5-year	\$109,680	\$106,499	\$216,179	31,310,760	N/A	31,310,760

Pilot Meter Flow Tests: General Findings

Projected Savings by Meter Size and Brand
(22 Under-Performing meters, potable + sewer)

	Badger		Hersey					Grand Total
	¾ in	Total	¾ in	1 in	1-½ in	2 in	Total	
Monthly	\$54	\$54	\$256	\$80	\$1,035	\$2,176	\$3,548	\$3,603
Yearly	\$654	\$654	\$3,072	\$964	\$12,420	\$26,115	\$45,571	\$43,225

- No >= 3” meters in pilot test program

Pilot Meter Flow Tests: Test Results Summary

- **49%** of meters (22 of 45) were under-registering and identified based on CIS and meter data alone.
- **5** unverifiable meters due to testing outside of AWWA recommendations (i.e. low to high testing, flow recommendations)
- **\$216,179 (31,310,760 gal)** in projected revenue savings identified over 5-years from only 22 meters.
- The pilot represents less than 5% of identified under-registering meter flags which will lead to more revenue savings opportunities.
- *No correlation with age* and meter under-performance.
- **2" Hersey meters** confirmed to have highest projected revenue savings
- Similarly, **Commercial and multi-family residential** meters have the highest project revenue savings

Thank you

Christine E Boyle, PhD

Vice President, Product Development

Xylem Inc

Inventor of Revenue Locator Technology

Christine.boyle@xylem.com

San Francisco, CA

Aggregate Insights for System-wide HRL Meter Flags

System-wide Results: Projected Revenue Savings

- 1,973 total Under-Registration flags
- 1,923 Under-Registration flags excluding the 50 pilot meters

Issue Type	Flag Count	Time Range	Projected Revenue Savings			Projected Volume Savings (gal)		
			Potable	Sewer	Total	Potable	Sewer	Total
Under-Registration	1,923	Monthly	\$29,709	\$37,081	\$66,790	7,726,254	N/A	7,726,254
		1-year	\$356,508	\$444,972	\$801,480	92,715,048	N/A	92,715,048
		3-year	\$1,069,524	\$1,334,916	\$2,404,440	278,145,144	N/A	278,145,144
		5-year	\$1,782,540	\$2,224,860	\$4,007,400	463,575,240	N/A	463,575,240

System-wide Results: Projected Revenue Savings (Hit Rate)

- 1,973 total Under-Registration flags
- 1,923 Under-Registration flags excluding the 50 pilot meters
- Assume 49% “Hit Rate” based on pilot tests
- Revenue and Volume predictions incorporate expected Hit Rate


Issue Type	Flag Count	Time Range	Projected Revenue Savings			Projected Volume Savings (gal)		
			Potable	Sewer	Total	Potable	Sewer	Total
Under-Registration	942+/-	Monthly	\$14,557	\$18,170	\$32,727	3,785,864	N/A	3,785,864
		1-year	\$174,689	\$218,036	\$392,725	45,430,374	N/A	45,430,374
		3-year	\$524,067	\$654,109	\$1,178,176	136,291,121	N/A	136,291,121
		5-year	\$873,445	\$1,090,181	\$1,963,626	227,151,868	N/A	227,151,868


General Summary


- HRL provides Bend with the tools to improve operational efficiencies related to selecting, testing, and replacing under-performing meters.
- HRL provides key revenue and volume loss analytics for both potable water and sewer.
- With HRL, Bend can prevent approximately **\$392,725** in annual revenue loss (**45,430,374 gallons**) due to Apparent Water Loss. A 5-year payback is approximately **\$1,963,626** in revenue loss (**227,151,868 gallons**)
- With HRL, Bend validated 22 Under-Performing meters. These meters have been replaced and Bend can expect an approximate **\$43,236** in annual revenue loss savings (**6,262,152 gallons**) due Apparent Water Loss from those 22 meters. A 5-year payback is approximately **\$216,179 in revenue loss savings (31,310,760 gal)**.
- With further data refinement and feedback from Bend, the HRL program can guide Bend's future replacement schedules and budgets.

Meters for Investigation

Filtered by: Ongoing, Meter Under-registration, To Review, Selected For Investigation

REVENUE LOSS TO DATE
\$737,999

VOLUME LOSS TO DATE
150,200,828 GAL

ONGOING ISSUES
333

Issues

Showing 1 to 10 of 333 results

Download All

Change Status

Edit Column Display

<input type="checkbox"/>	Investigation Status	Issue Type	Monthly Volume Risk (GAL)	Monthly Revenue Risk (USD)	↓ Meter Id	Address	Meter Install Date	Meter Size	Customer Type
<input type="checkbox"/>	Selected	Meter Under-Registration	553,317	\$2,327 *	62248697	5006 Olevia Expressway, Port Adriene	Unknown	6 in	Irrigation
<input type="checkbox"/>	Selected	Meter Under-Registration	580,019	\$1,974 *	72441041	76671 Tyler Square, Port Adriene	02/18/2011	3 in	Institutional
<input type="checkbox"/>	To Review	Meter Under-Registration	222,282	\$786 *	68643472	7504 Reginald Throughway, Port Adriene	10/27/2010	3 in	Multi Family Residential
<input type="checkbox"/>	To Review	Meter Under-Registration	82,473	\$524	58340196	61739 Chelsie Mills, Port Adriene	12/07/2009	4 in	Industrial
<input type="checkbox"/>	To Review	Meter Under-Registration	171,696	\$463 *	71435810	8404 Alonso Course, Port Adriene	Unknown	3 in	Commercial
<input type="checkbox"/>	To Review	Meter Under-Registration	87,407	\$385 *	62240417	190 Crona Loop, Port Adriene	04/28/2008	2 in	Irrigation
<input type="checkbox"/>	To Review	Meter Under-Registration	63,365	\$300 *	62248662	99366 Aundrea Villages, Port Adriene	05/11/2009	3 in	Irrigation
<input type="checkbox"/>	To Review	Meter Under-Registration	71,941	\$276 *	63769785	74431 Maurice Fort, Port Adriene	06/11/2009	2 in	Irrigation