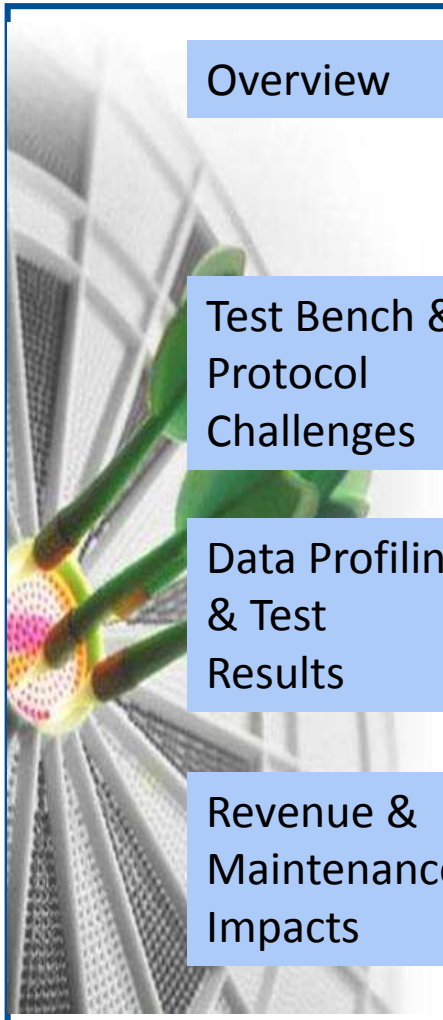
North American Water Loss Conference 2017

The Silent Thief – Large Meter Accuracy Degradation Findings & Impacts

Veolia North America
December 5, 2017

VEOLIA
WATER

Purpose of today's presentation – Apply process to your application



Overview	**LADWP & Veolia** Co-developed solutions to large metering challenges
Test Bench & Protocol Challenges	**Consistent, reliable & repeatable testing data** to improve large meter operations decision making
Data Profiling & Test Results	**User knowledge & impacts on testing results** to better focus maintenance resources
Revenue & Maintenance Impacts	**Improvement actions to address large meter maintenance optimization**

Overview

Setting the Stage for Optimizing Performance

DWP Metering Program Highlights

1. Service territory 465 square miles
2. 6,700 3" & larger meters-1% of meters; 20% of revenues
3. 3" & larger meter (LM) replacement program from 2003-2010 by internal staff
4. Water Loss audit findings – 5.2% overall NRW (2013)

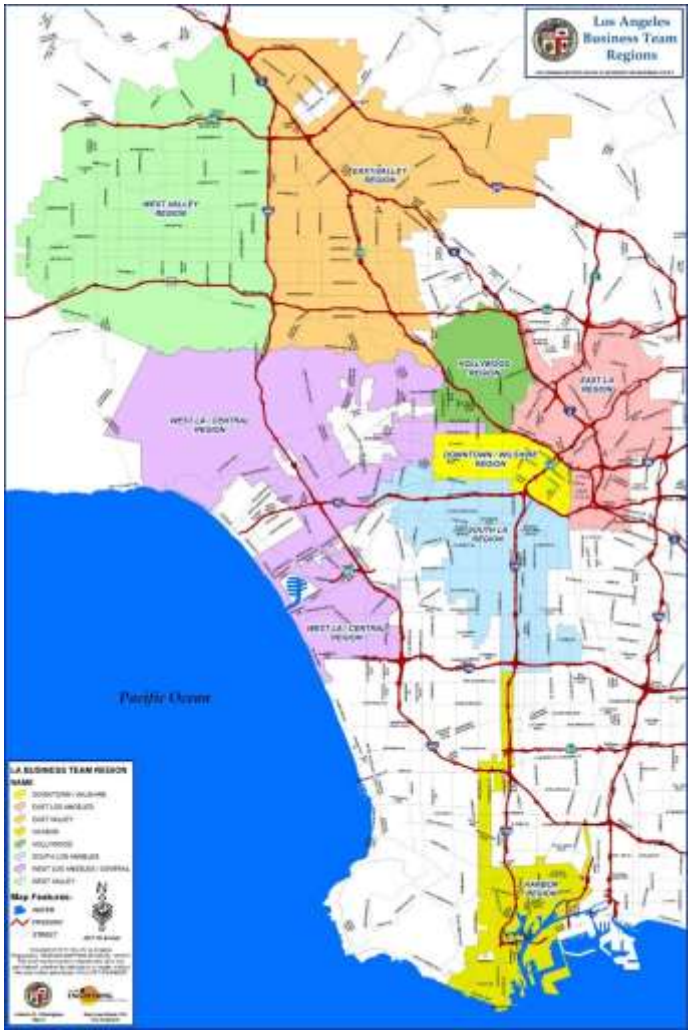
Operating Challenges

- Travel time – averaging 40 minutes per job
- 84% of large meters are compounds – expensive to purchase & maintain. Wear impacted by usage patterns
- Aging assets need maintenance
- Difficult to determine optimum time & level of resources to maintain large meters
- LM inaccuracy estimated at 1% or 15.5% of total system losses – but no testing to validate finding

Overview

Other Operating Challenges – Seem Familiar?

- Large meter benches beyond useful life (60+ years old)
  - Difficult/costly to maintain and certify- questionable accuracy
- Lack of data structure & integrity
  - Used different testing protocols & results collection forms
  - Results not in database for analysis – paper based system
- Test protocol issues
  - Same tests used for new & in-service meters
  - Compound meter tests missed cross over range and low flows
  - High purge rates cleaned out debris
- No information on customer usage patterns
  - Difficult to determine relationship between usage, maintenance, & selection



Test Bench & Protocol Challenges

Modifications made to existing test benches to improve accuracy, repeatability and consistency

Ultrasonic meter for lower flow rates

Modification:
Installation of ultrasonic meters on test benches to improve measurement accuracy

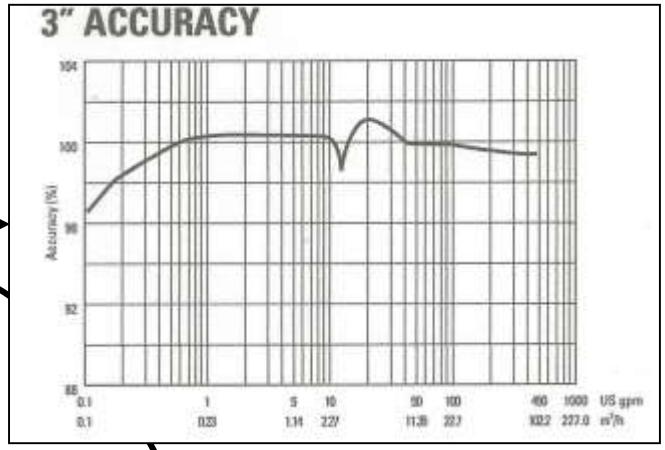
Ultrasonic meter installed on WV test bench

Bench Outcomes

- Central bench reliable & repeatable at all flows
- Now testing most of 3” & 4” meters from West Valley
- Pursuing new bench for 3” to 6” meters & upgrading small benches from volumetric to gravimetric system
- West Valley bench reliable & repeatable at most test flows if properly purged.
  - Inconsistent at high flows due to unknown sources of intermittent air in line
- Replacement of benches recommended

Test Bench & Protocol Challenges

Team designed new testing protocols and results forms. Operators trained together for consistency between facilities.



Guidelines for flow rate selection

Standardized documents

Test Time (Mins)	SIZE: 3" - 5/8"					
61.1	Test 1-Low Flow	Test 2*	Test 3*	Test 4*	Test 5	Test 6-High Flow
Flow Rate (GPM)	0.25	10	12	15	20	300
Test Quantity (CuFt)	1	10	10	10	20	200
Test Tank (CuFt)	1	10	10	10	100	500
Estimated Time (Min)	29.9	7.5	6.2	5.0	7.5	5.0
Acceptable Accuracy-Neptune (%)	95-101	98.5-101.5	98.5-101.5	98.5-101.5	98.5-101.5	98.5-101.5
Acceptable Accuracy-Badger (%)	97-101	98.5-101.5	97-101.5	98.5-101.5	98.5-101.5	98.5-101.5
LADWP-Minimum (%) Acceptable Accuracy	≥97 at .5 gpm	≥90 if cross over	≥90 if cross over	≥90 if cross over	97-102	97-102

Standardized testing protocols & procedures

Test Bench & Protocol Challenges

Accuracy results forms automated & set up in database for analytics.

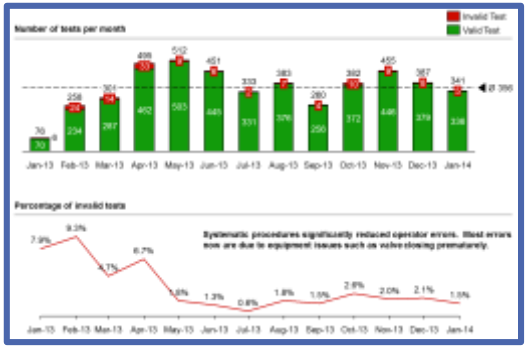
A

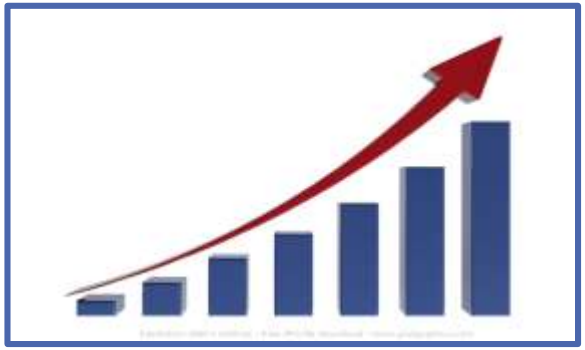
Meter Testing User Interface

LADWP 3" Test		TEST POINT 1		TEST POINT 2		TEST POINT 3	
		MAINLINE	BYPASS	MAINLINE	BYPASS	MAINLINE	BYPASS
TEST UME	START READ	10.00			5.00		
	END READ	12.00			7.00		
	TOTAL VOLUME	2.00		2.00		0.00	
REFERENCE METER	START READ	12.00		11.00			
	END READ	15.00		23.00			
	TOTAL VOLUME	3.00		12.00		0.00	
	ADJUSTMENT FACTOR	50.00%		-0.56%		0.72%	
	TOTAL VOLUME AFTER ADJUSTMENT	4.50		11.93		0.00	
ACCURACY		44.44%		16.76%			
Archive							

Meter Testing Database

Dashboards





Test Bench & Protocol Challenges

New Meter Acceptance tool designed to flag meters that don't meet procurement or vendor's tech specs

B

New Meter Acceptance Tool Example

SN	Test	Test Point 1 - High	Test Point 2	Test Point 3	…
96101241	8" FSAA with M170 Bypass	101.5	100	96.7	100.6
96101242	8" FSAA with M170 Bypass	101.5	100.1	98.1	100
96101243	8" FSAA with M170 Bypass	100.4	100	98	99.4
96101244	8" FSAA with M170 Bypass	101.4	100.1	98.5	99.8
96101631	6" Recordall Compound	99.7	99.5	101.5	100.9
96101632	6" Recordall Compound	99.8	99	101.5	97.6
96101633	6" Recordall Compound	100.2	99.7	99.8	98
96101634	6" Recordall Compound	99.6	99	102.2	99.7
96101635	6" Recordall Compound	101.5	101.1	98.9	100
96101636	6" Recordall Compound	100.8	100.8	97.7	97.9
96101637	6" Recordall Compound	101.1	99.9	101.2	100
96101638	6" Recordall Compound	100.5	99.1	100.3	97.7
96101639	6" Recordall Compound	101.1	99.5	97.9	96
96101640	6" Recordall Compound	101.3	99	99	97.9
96100848	3" Recordall Compound	98.6	101	100.4	100.4
96100847	3" Recordall Compound				
96100846	3" Recordall Compound				
96100845	3" Recordall Compound				
96100844	3" Recordall Compound				

Tool analyzes manufacturer test sheets to flag any meters outside of LADWP or manufacturers acceptable limits of accuracy

Confirm Accuracy

LEGEND	COUNT
Failed both manufacturer and LADWP standards	1
Failed only manufacturer standards	6
Failed only LADWP standards	0

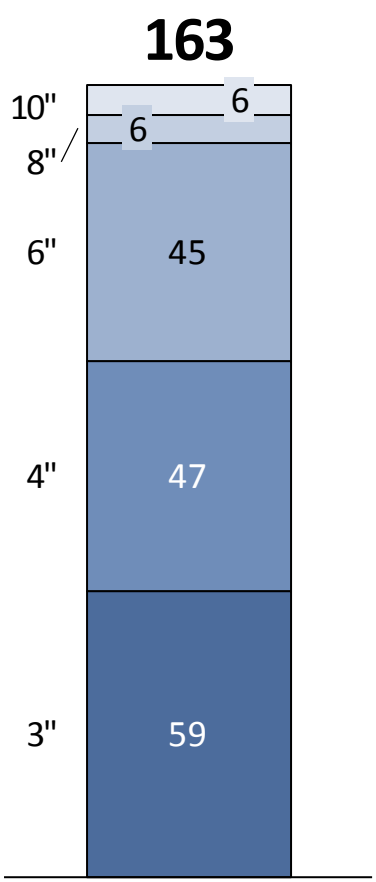
Recommended Approach

Revise specifications to inform bidders that acceptance is based on meeting both procurement specifications and the meter manufacturers' technical document accuracy claims before new meters are deployed.

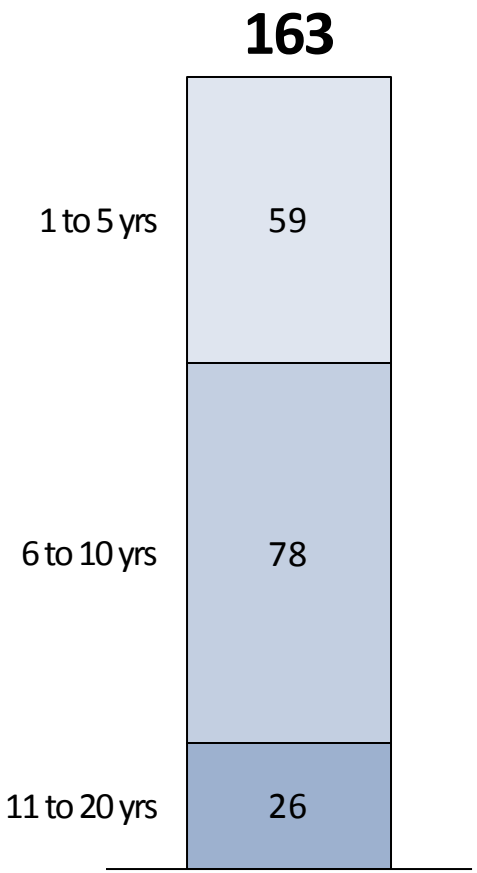
Any failures noted are for illustration and testing of acceptance tool only

Test Bench & Protocol Challenges

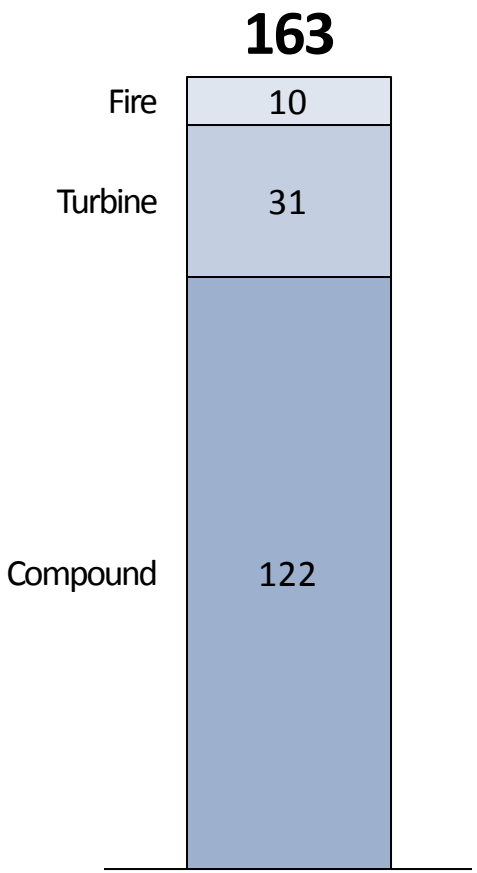
UME Pilot conducted to obtain UMEs to test modified benches, new protocols & improve field operations



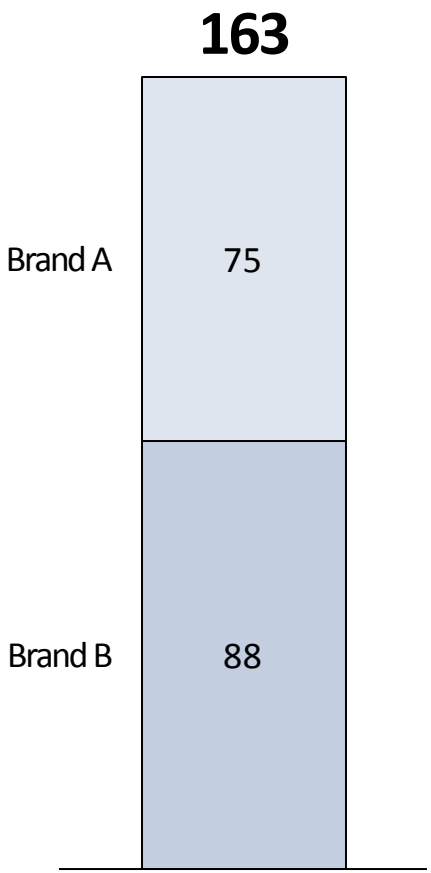
Overhauled Meters by Size



Overhauled Meters by Age



Overhauled Meters by Type

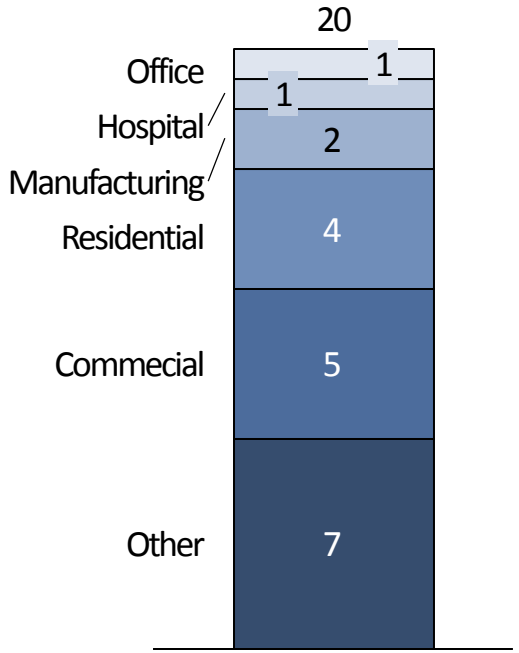


Overhauled Meters by Vendor

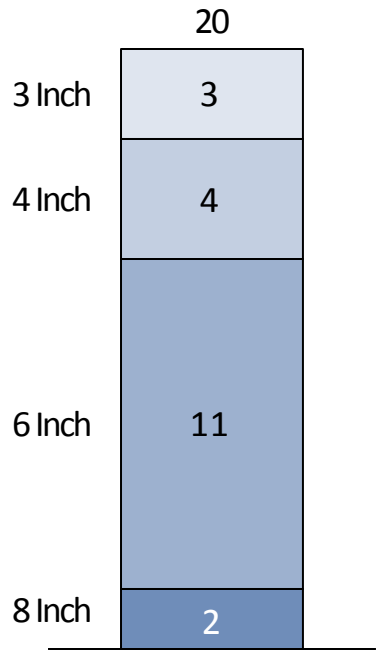
Overhauled UMEs corresponded well with demographics of entire meter population

Data Profiling & Test Results

During UME Pilot field crews trained on customer profiling to learn flow rates use by customers and how to use info



Loggings by Premise



Loggings by Size

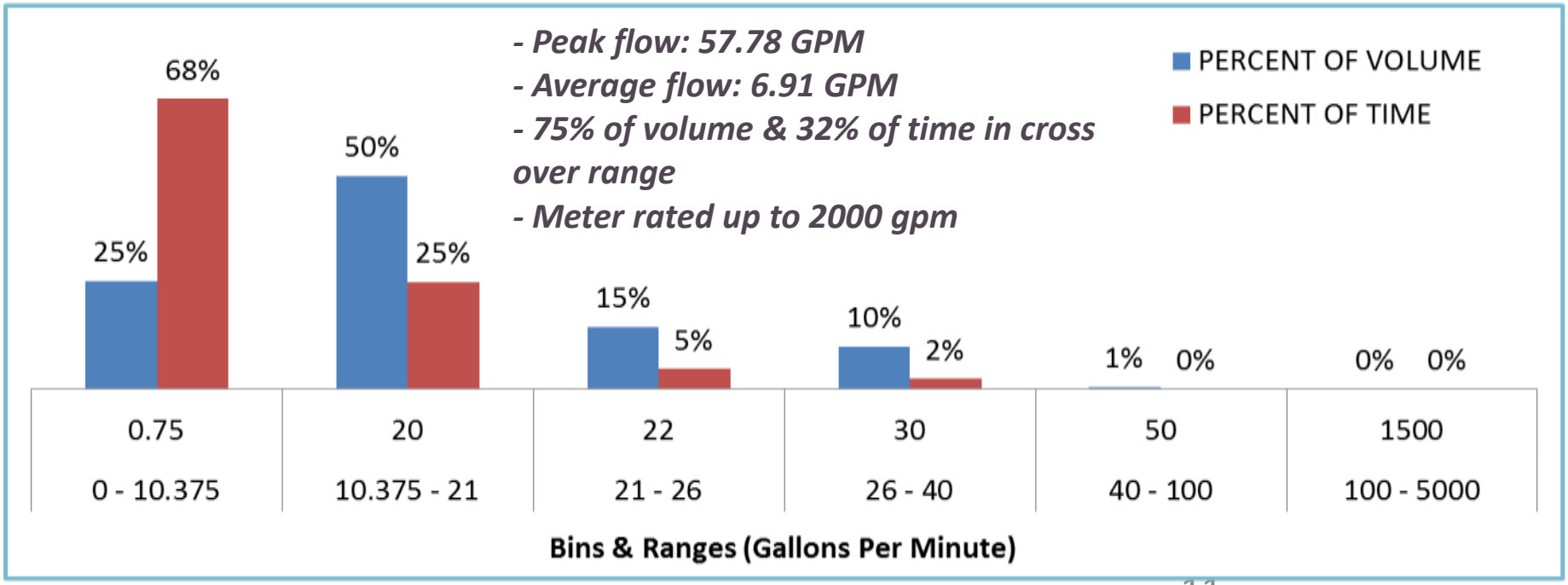
Though limited in scope, results compared to NYC program to help confirm initial findings. More logging would be beneficial, especially for industrial accounts.

Data Profiling & Test Results

Profiling indicated oversized meters & significant usage in cross over range where accuracy is reduced

LOGGING CHARACTERISTICS

- Meter: 90154239
- Meter size: 6”
- Meter type: Compound
- Premise: Office Building
- Date: 8/11/15 – 8/17/15 – Before restrictions implemented



Data Profiling & Test Results

Analysis of limited logging data determined three customer usage pattern groupings for weighting usage allocation

Data Logging Usage Pattern - Weighted vs Arithmetic Averages

Usage Pattern Groupings	Flow Rate 1	Flow Rate 2	Flow Rate 3	Flow Rate 4	Flow Rate 5	Flow Rate 6	Ave-Old Protocols	Ave-New Protocols
Turbine	6%	31%	48%	15%			33.3%	25%
Multi-Residential Compounds	14%	48%	22%	15%	1%	0%	33.3%	16.7%
Other Compounds (including fire lines)	36%	26%	9%	13%	16%	0%	33.3%	16.7%

Applying the weighted average of usage patterns to each accuracy test result derives a more accurate calculation of overall meter accuracy & revenue potential.

Size	Type	Accuracy 1	Flow Rate 1	Accuracy 2	Flow Rate 2	Accuracy 3	Flow Rate 3	Accuracy 4	Flow Rate 4	Meter Accuracy
4”	Turbine	20%	6%	64%	31%	81%	48%	93%	15%	74%

Data Profiling & Test Results

The new protocols provided better insight into In-Service meter accuracy

Accuracy of 188 Meters Tested Using Old Protocols & Arithmetic Averages

Type	3”	4”	6”	8”	10”
Compound	100%	100%	99%		
Fire			98%	99%	99%
Turbine	100%	96%	99%	100%	98%

Accuracy of 123 Meters Using New Protocols & Data Logging Weights

Type	3”	4”	6”	8”	10”
Compound	94%	95%	95%		
Fire				94%	95%
Turbine	98%	98%	94%	98%	

- Designed for new meters. Missed low flow & cross over ranges where in-service meters are weaker
- Used Uniform allocation to 3 test points - skewed results to high flow rates where meters tend to be more accurate
- Annual accuracy degradation averaged .2%/year. Well below .75% program plan. Difficult to justify maintenance program.
- Average age of meters 6.0

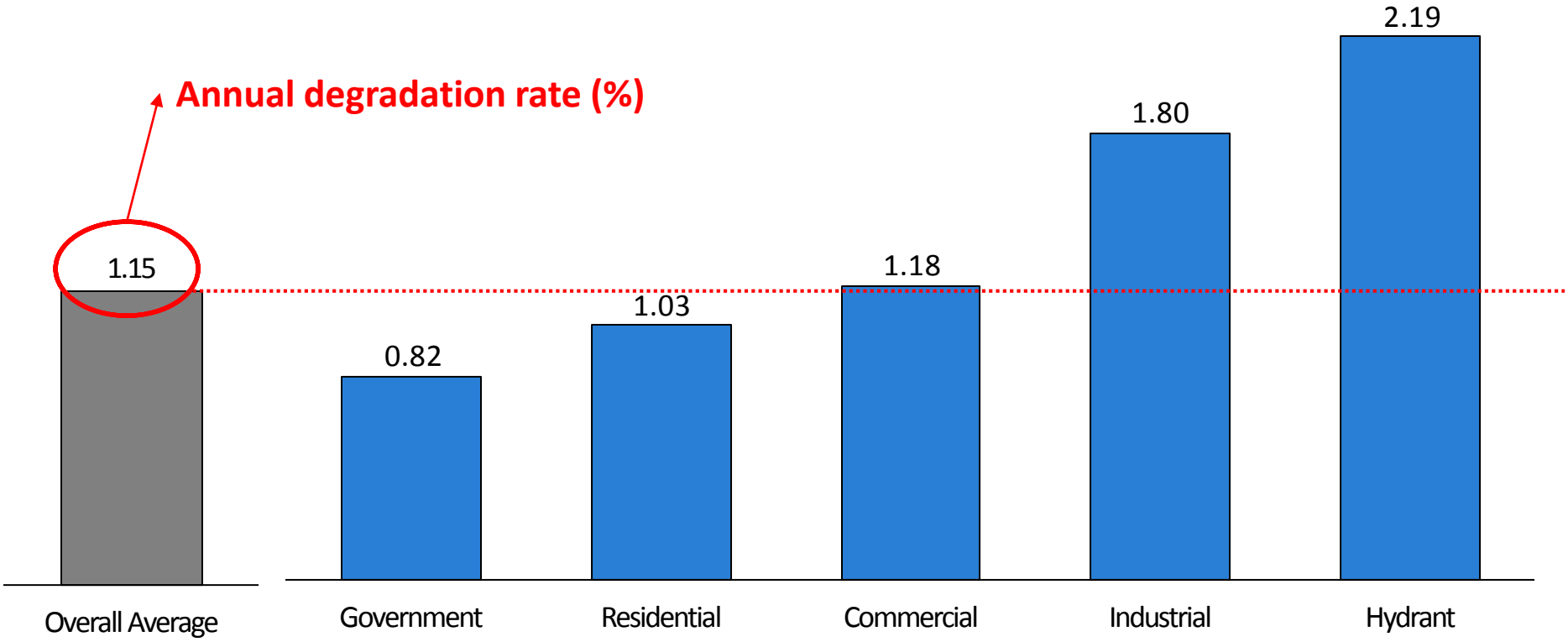
- 6 test points for compound/FS meters & 4 for turbines more granular- more tests at meter’s weak spots – 15 to 30 minutes more testing time
- Data logging combined with more granular accuracy tests - better indicator of revenue loss/potential
- Average annual accuracy degradation 1.15%
- Average age of meters 6.7 years

Revenue & Maintenance Impacts

$1.4 M potential revenue found by more accurate testing & weighting of 123 UMEs. Disaggregation focused efforts.

An average has been defined as the worst of the best & the best of the worst!

By disaggregating annual accuracy degradation rate by account classifications found more optimal accounts to target.



Does this tell the whole story? The right story?

Revenue & Maintenance Impacts

No! There's More - Multivariate Regression Analysis. What is it?

- Statistical methodology for understanding the relationships between variables and their relevance to the issue under analysis
- It tests various parameters simultaneously to determine how they relate to each other and which relationships are statistically relevant.

Which of these variables…

Brand	Age
Size	Consumption
Type	Maintenance frequency

…have the strongest relationship to meter accuracy degradation

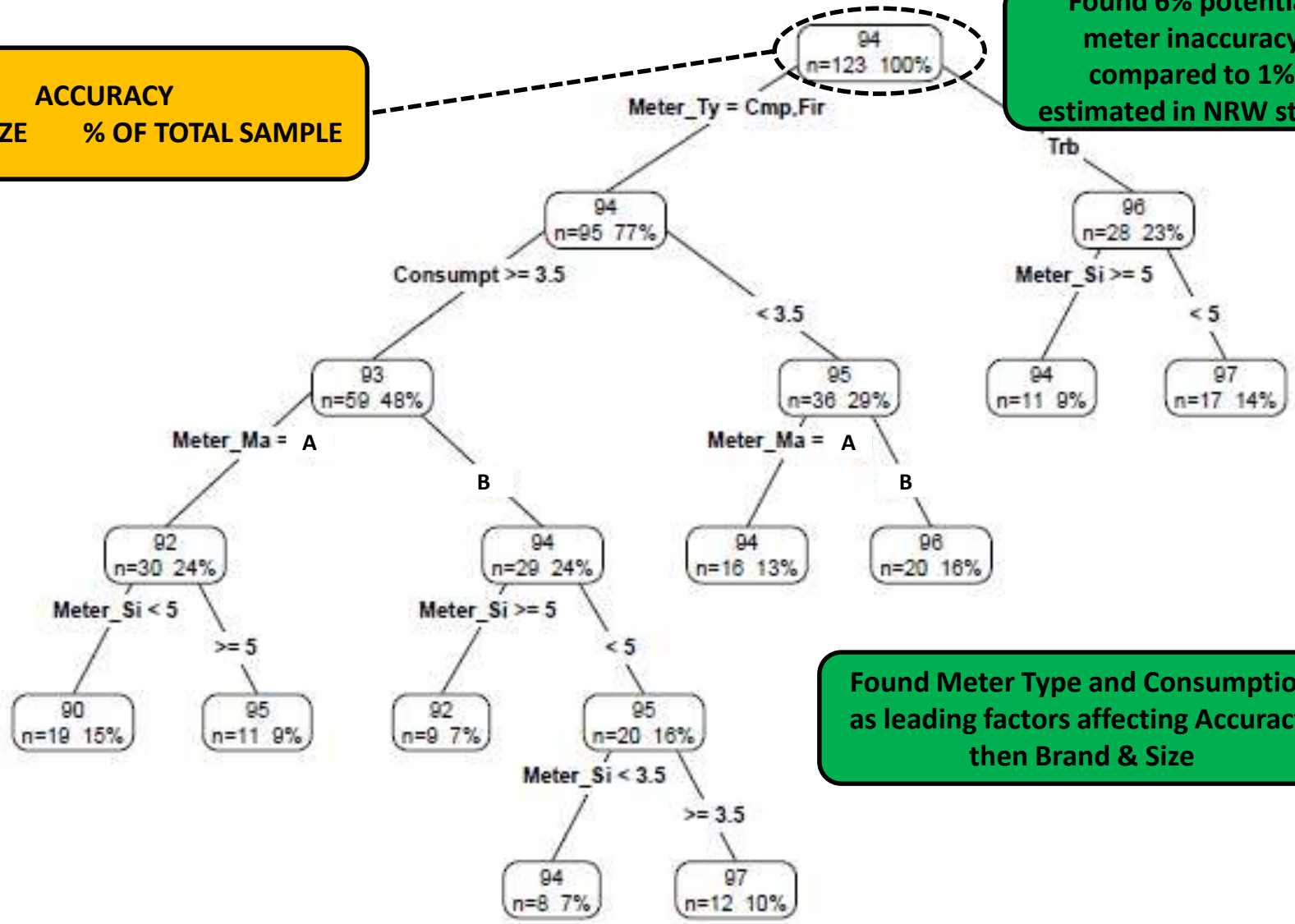
- The more parameters tested, the higher the sample rate needs to be. More data can confirm initial findings or modify which factors are driving results.

Revenue & Maintenance Impacts

Used Multivariate Regression to Calculate the Expected Accuracies of Different Meter Groups – Decision Tree

ACCURACY
SAMPLE SIZE % OF TOTAL SAMPLE

Found 6% potential meter inaccuracy compared to 1% estimated in NRW study



Found Meter Type and Consumption as leading factors affecting Accuracy, then Brand & Size

Revenue & Maintenance Impacts

New electronic registers have flow rate function - provides new insights for optimizing maintenance

Flow Rate Charting Result for 6" Compound Meter with ¾ Bypass Chamber

FLOW RATE	HIGH	LOW	HIGH	LOW
GPM	GPM	GPM	LOAD (%)	LOAD (%)
1500	1502	13.20	101.68	0.95
200	176	29.46	87.14	14.95
120	96	29.46	75.17	27.11
80	56	29.51	53.17	39.03
40	13	28.19	27.63	72.11
35	6	27.70	18.81	86.4
28	3	26.54	4.51	92.94
25	0	25.01	0.00	100.00
22	0	22.30	0.00	100.00
20	0	20.38	0.00	100.00
18	0	18.17	0.00	100.00
15	0	15.22	0.00	100.00
10	0	10.17	0.00	100.00
3	0	3.10	0.00	100.00
0.75	0	0.76	0.00	100.00
0.25	0	0.25	0.00	100.00

Opportunities

(1) Better understand how compound meter is operating – load factors on bypass & mainline meter

(2) Better identify cross over range of meter. Find weakest points to test and check for vendor compliance.

(3) Use in conjunction with consumption data to better target maintenance frequency & prioritize type of work.

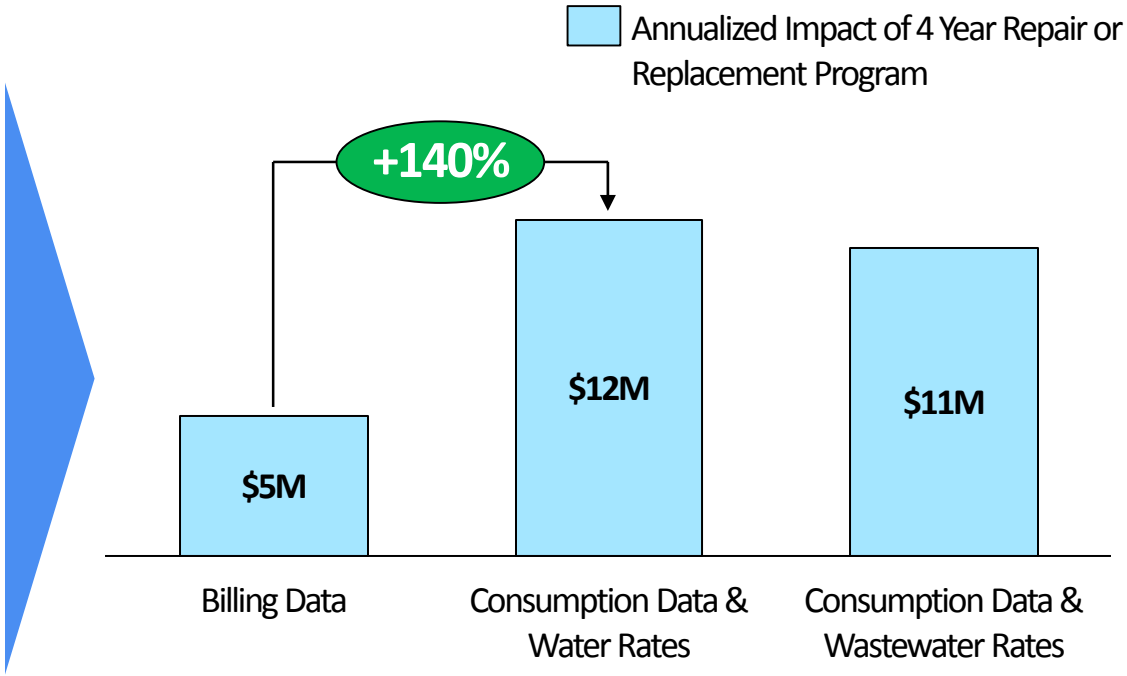
Max Intermittent flow -35 gpm

Max continuous flow - 25 gpm

Revenue & Maintenance Impacts

Business case developed to identify potential revenue gain by focusing replacement on under recording meters – Up to $12 M

System Average Rate ($/HCF)		
Year	**Water**	**Waste**
2016	$5.26	$4.51
2017	$5.77	$4.80
2018	$5.71	$5.11
2019	$5.94	$5.44
2020	$6.39	$5.80



Provided launching point for additional work to verify and validate findings. More work needed before initiating target replacement program.

Presentation Summary – Application to Meter Operations Improvements

- Know your operating challenges & issues. Benchmark best practices
- Meter accuracy/performance validation requires many support tools
  - Accurate testing equipment
  - Experienced/well trained bench operators
  - Well targeted testing protocols
  - Usage profiling for weighting allocation & meter selection
  - Databases for storing & analyzing results

Found 7 times more annual accuracy degradation.

Found likely causes of degradation & how to prioritize work.

Found insights into meter's operations to better target maintenance

- Application of statistical tools – find those factors that most influence meter accuracy
- Research & apply newer metering technologies that improve revenue performance & lower operating costs
- Develop business cases/prove performance/adjust operations

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