

# This presentation premiered at WaterSmart Innovations

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Water Smart  
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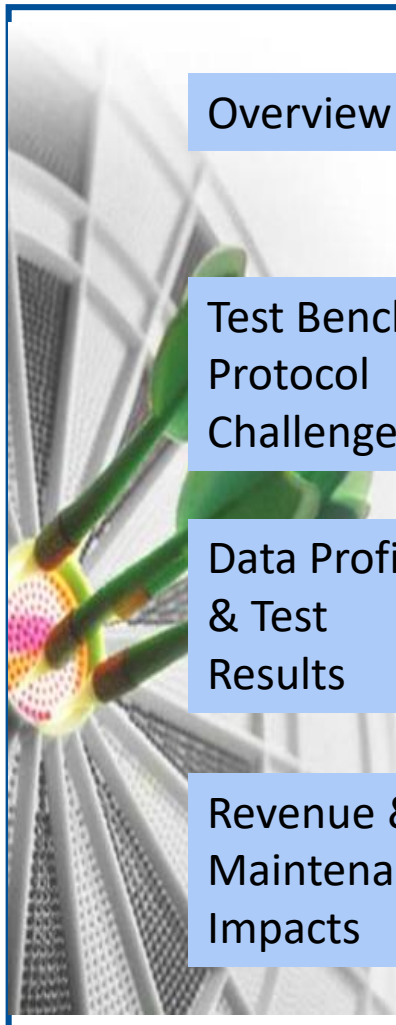


# LADWP Large Meter Management Project

## Accuracy Degradation – The Silent Revenue Thief



# Purpose of today's presentation



■ **LADWP & Veolia collaboration** on large metering program – partnership outcomes

Overview

**Consistent, reliable & repeatable testing data** to improve large meter operations decision making

Test Bench & Protocol Challenges

**User knowledge & impacts on testing results** to better focus maintenance resources

Data Profiling & Test Results

**Improvement actions to address large meter maintenance optimization**

Revenue & Maintenance Impacts

## Overview

# LADWP Metering Program –Optimize 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)

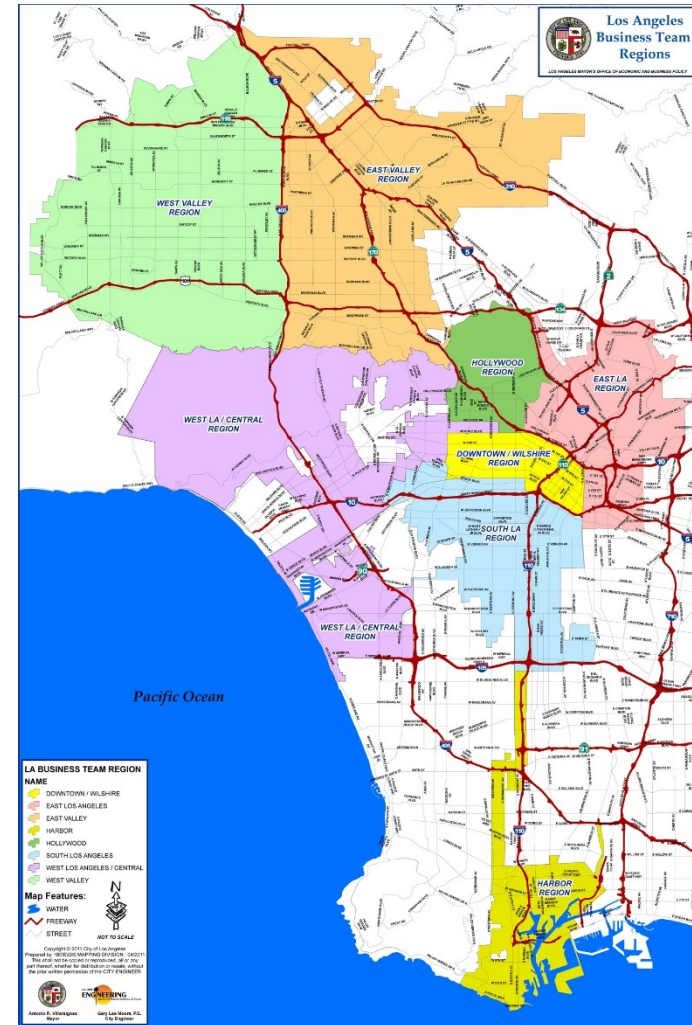
## Operating Challenges

- Travel time significant portion of large meter crew work day – averaging 40 minutes per job
- 84% of large meters are compounds – expensive to purchase & maintain. Wear impacted by usage patterns
- Aging assets now need maintenance
- 2013 - Initiated Unitized Measurement Element (UME) program . Top 400 meters - .75% annual degradation rate
- LM inaccuracy estimated at 1% or 15.5% of total system losses
- No testing on large meter population to support this finding

## Overview

# Other Operating Challenges

- ◆ Large meter benches beyond useful life (60+ years old)
  - ◆ Difficult/costly to maintain and certify-questionable accuracy
- ◆ Two testing facilities
  - ◆ Used different testing protocols & results collection forms
  - ◆ Results not in database for analysis – paper based system
- ◆ Same protocols used for new & in-service meters
  - ◆ Only 3 points tested for compounds - cross over range missed
  - ◆ Purge rates cleaned out debris making results questionable
- ◆ No information on customer usage patterns
  - ◆ Difficult to determine relationship between usage, maintenance, & selection



## Overview

# LADWP is Striving to Improve Operations - Using Public Private Partnership to Co-Build Innovative Solutions

## LADWP Goals

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- Desire to improve and learn new ways to deliver service
- Willingness to identify and address gaps in best practices
- Engage staff in constructive participation – focus on coaching & training

### Leverage Capabilities of Both Parties



## Veolia's Peer Value-Add

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- Experience partnering with utilities to identify & co-build improvements
- NYC DEP engagement resulted in \$ 98 M annual savings - \$40 M in metering
- Experience providing water services to 96 million customers
- Tools & techniques learned from managing over 20 million meters world wide.

## Modifications made to existing test benches to improve accuracy, repeatability and consistency – only temporary/partial fix



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

Ultrasonic meter for lower flow rates



Ultrasonic meter installed on WV test bench

### Central Bench Outcomes

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- Modifications made by staff and Veolia improved bench accuracy; there is now a **high confidence** level in the results
- 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

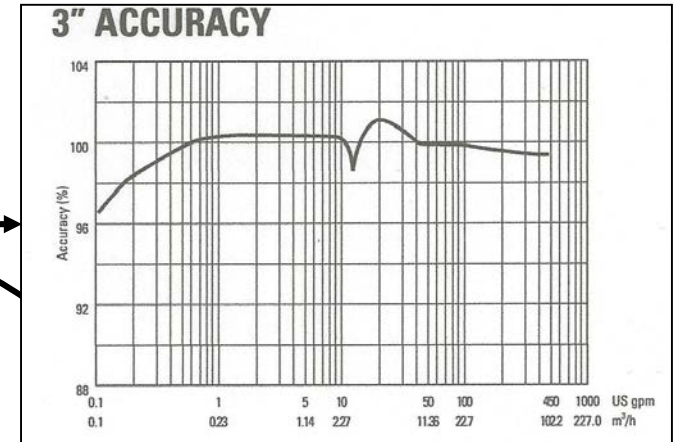
### West Valley Bench Outcomes

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- Despite multiple efforts to improve bench configuration, intermittent air in line from unknown sources affecting results & lowering confidence levels
- **Replacement of bench for 3" and large meters** in planning phase along with benches for 2" & smaller

Test Bench & Protocol Challenges

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



Guidelines for flow rate selection

Test 1	MBT Mainline	MBT Bypass	Test 2	MBT Mainline	MBT Bypass
End Read 6401	46.48		End Read 6401	766.47	
Start Read 6401	45.58		Start Read 6401	746.49	
MBT Read Volume Totals 0	.9		MBT Read Volume Totals 0	19.98	
Reference Meter End Read 4.362			Reference Meter End Read 302.63		
Reference Meter Start Read 3.359			Reference Meter Start Read 282.42		
Reference Meter Total 1.003			Reference Meter Total 20.21		
MBT/Reference Meter x 100 89.73			MBT/Reference Meter x 100 98.86		
Correction Factor +.47			Correction Factor -.61		
Correction Factor Applied 40.7			Correction Factor Applied 98.25		
Total Meter Accuracy (%) 90.7			Total Meter Accuracy (%) 98.3		

Test 3	MBT Mainline	MBT Bypass	Test 4	MBT Mainline	MBT Bypass
End Read 6401	786.51		End Read 6402	806.54	
Start Read 6401	766.47		Start Read 6402	792.5	
Read Volume Totals 0	20.04		Read Volume Totals 16	14.04	
Reference Meter End Read 322.81			Reference Meter End Read 364.81		
Reference Meter Start Read 302.63			Reference Meter Start Read 334.12		
MBT Reference Meter Total 20.18			MBT Reference Meter Total 30.79		
MBT/Reference Meter x 100 99.3			MBT/Reference Meter x 100 97.56		
Correction Factor -.79			Correction Factor -.37		
Correction Factor Applied 98.51			Correction Factor Applied 97.19		
Total Meter Accuracy (%) 98.5			Total Meter Accuracy (%) 97.2		

Test Time (Mins)	SIZE: 3"			
39.2	Test 1-Low Flow +	Test 2	Test 3	Test 4-High Flow
Flow Rate (GPM)	4	20	45	350
Test Quantity (CuFt)	10	20	40	300
Test Tank (CuFt)	10	100	100	500
Estimated Time	18.7	7.5	6.6	6.4
Acceptable Accuracy-Neptune (%)	>95	98.5-101.5	98.5-101.5	98.5-101.5
Acceptable Accuracy-Badger (%)	>95	98.5-101.5	98.5-101.5	98.5-101.5
LADWP-Minimum (%) Acceptable	≥95	98.5-101.5	98.5-101.5	98.5-101.5

Standardized documents

Standardized testing protocols & procedures



Test Bench & Protocol Challenges

# Veolia is automating accuracy results forms & setting up database for analytics. Dashboard development in progress



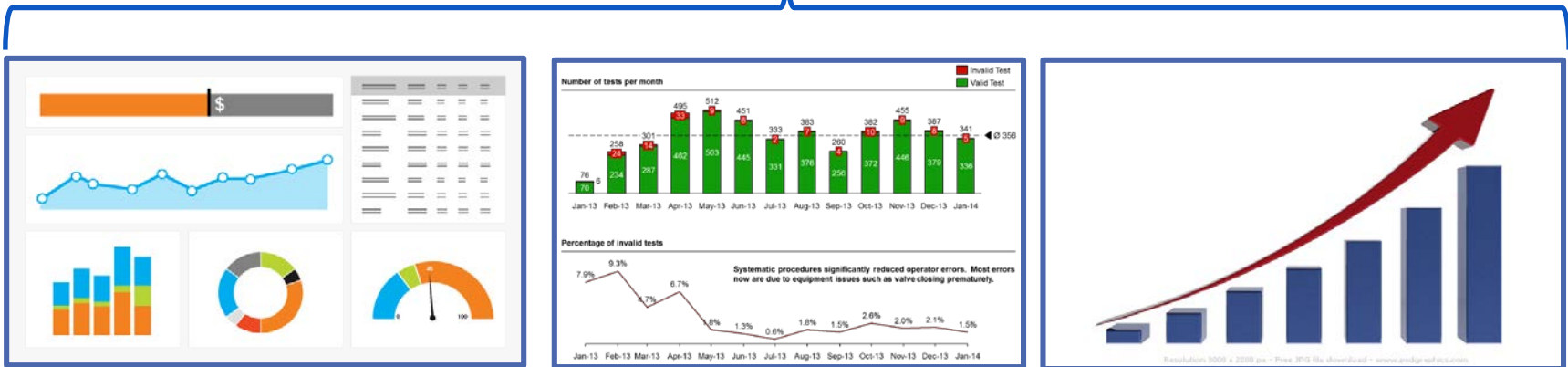
## Meter Testing User Interface

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



Action: develop meter testing dashboards

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



## 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

## New Policy Approach

Even if manufacturers meet LADWP's procurement specifications (largely based on AWWA standards), Meters & Services will also enforce the meter manufacturers' technical document accuracy claims before new meters are deployed

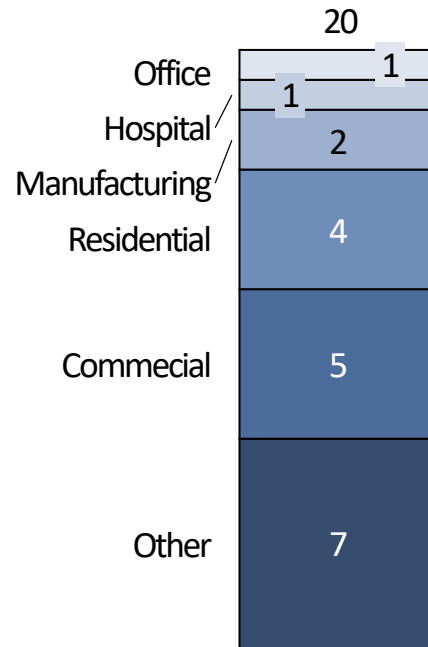
Working with vendors to implement policy and fully understand their technical specs.



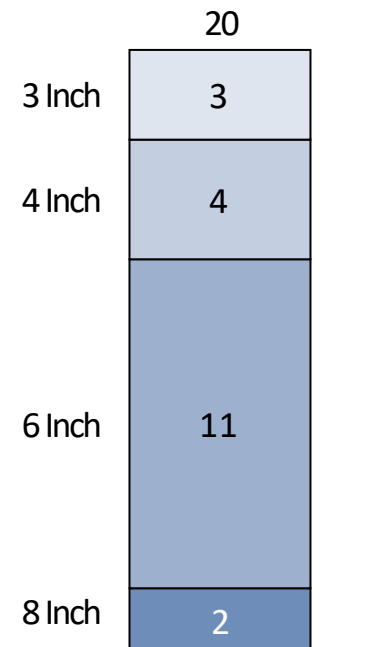
**Any failures noted are for illustration and testing of acceptance tool only**

Data Profiling & Test Results

# During UME Pilot to test new protocols, field crews trained on logging to learn how customers are using water



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.***

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

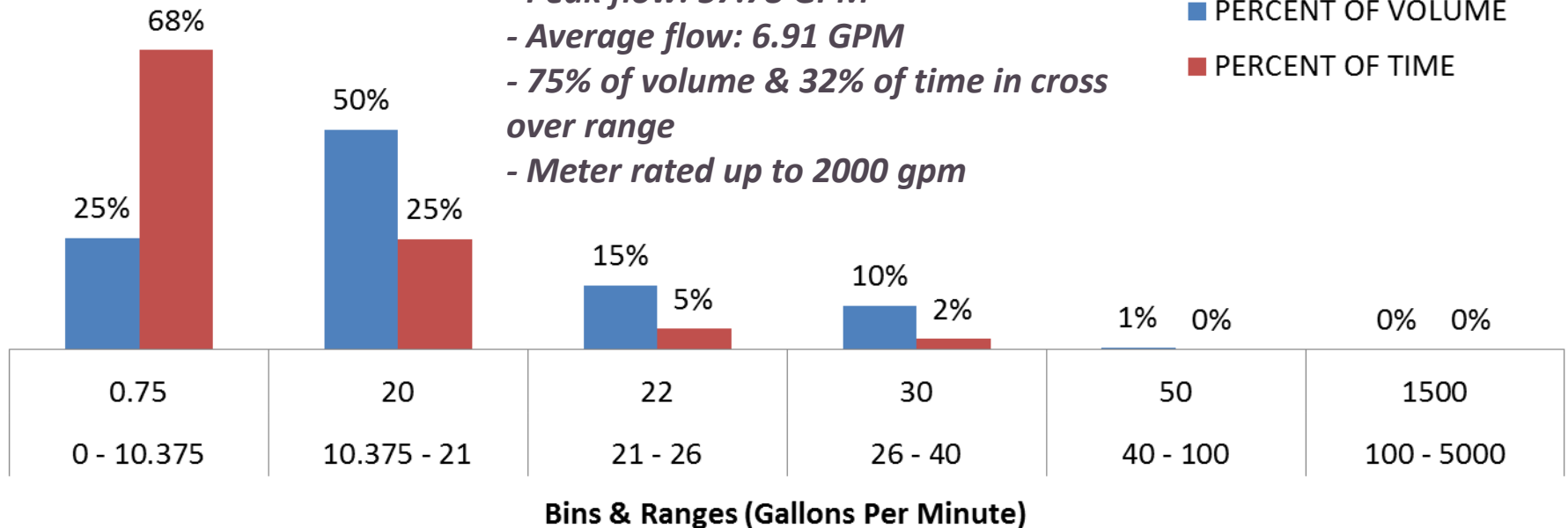
## LOGGING CHARACTERISTICS

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



- Peak flow: 57.78 GPM  
 - Average flow: 6.91 GPM  
 - 75% of volume & 32% of time in cross over range  
 - Meter rated up to 2000 gpm

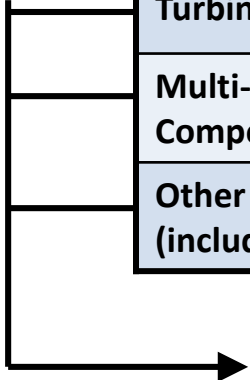
■ PERCENT OF VOLUME  
 ■ PERCENT OF TIME



# 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%



When the weighted average for each customer usage pattern group is applied to each corresponding test result, a more accurate calculation of meter accuracy & revenue potential is derived

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%



# 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**

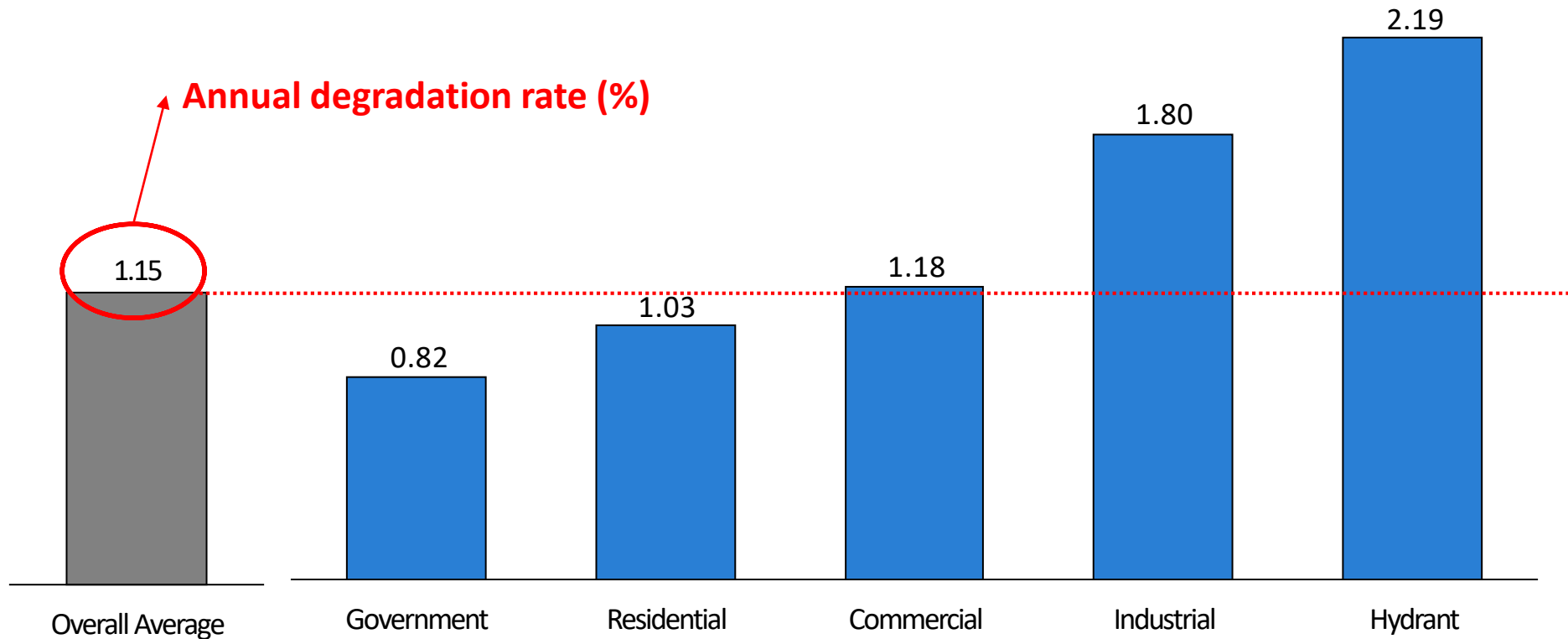
Type	3"	4"	6"	8"	10"
Compound	94%	95%	95%		
Fire				94%	95%
Turbine	98%	98%	94%	98%	

- 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

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

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



# 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...

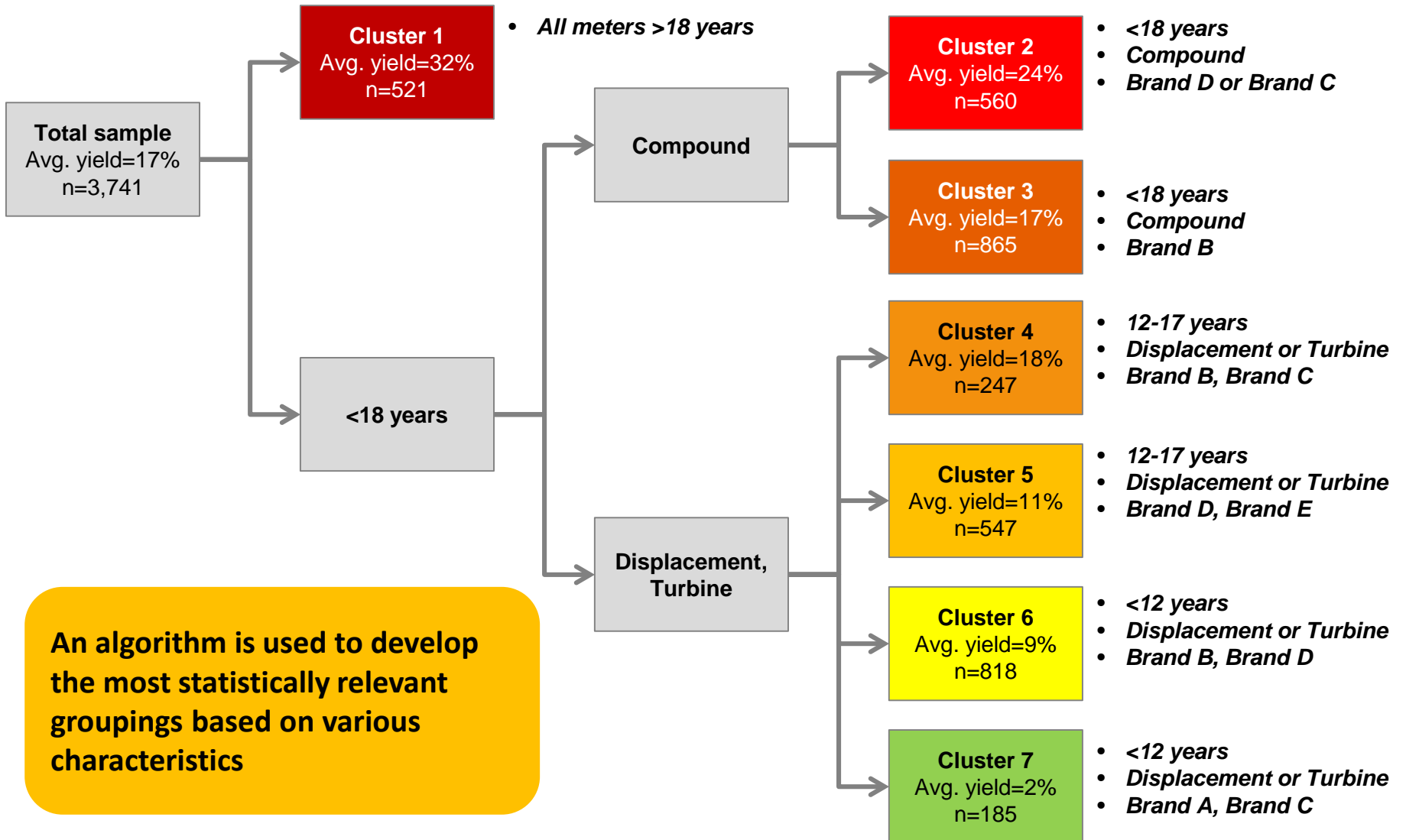
Brand	Age
Size	Consumption
Type	Maintenance frequency

...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.

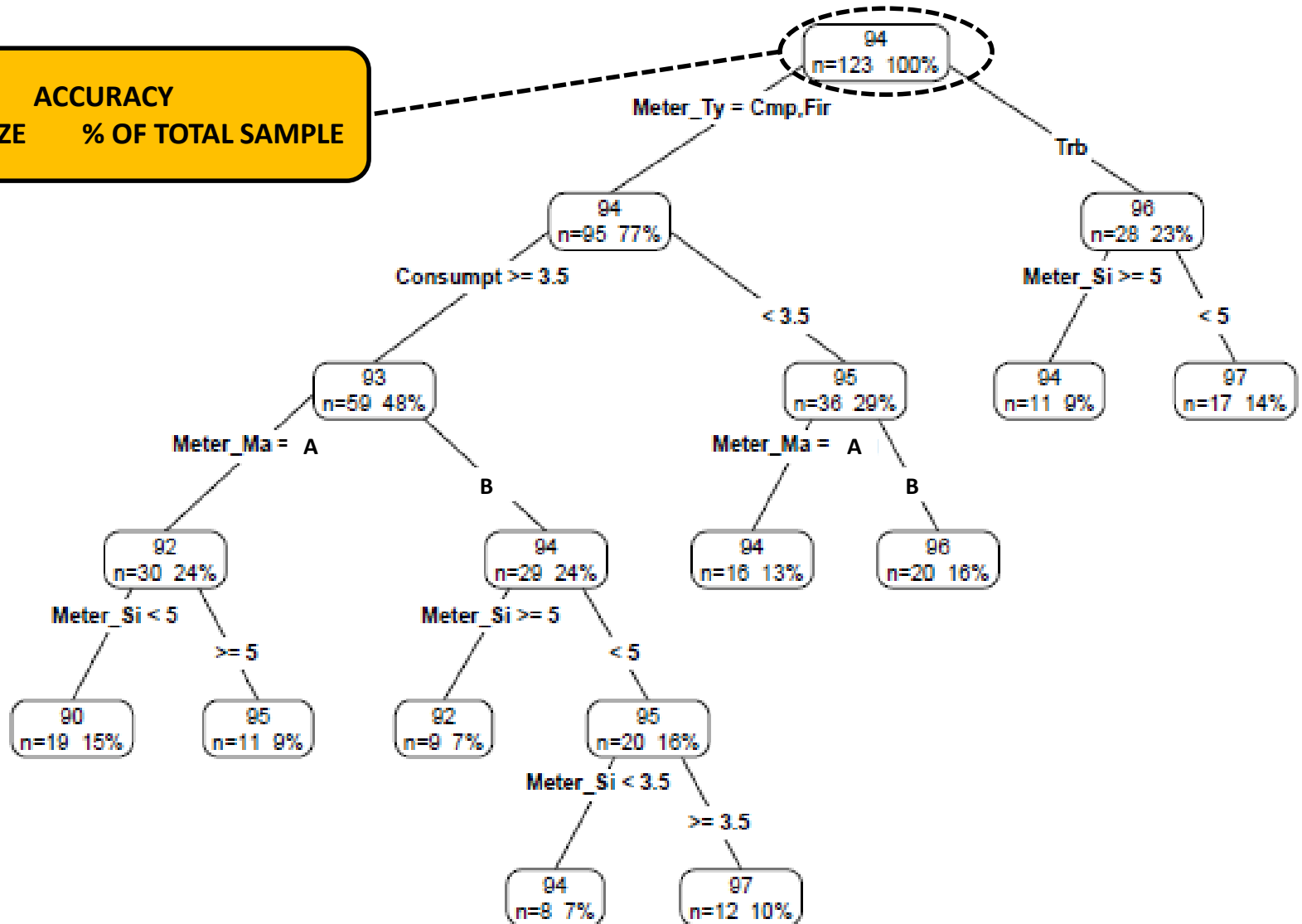


# This approach help us target 26,000 2" & larger meters for NYC DEP to replace – “found” \$40 M in annual revenues

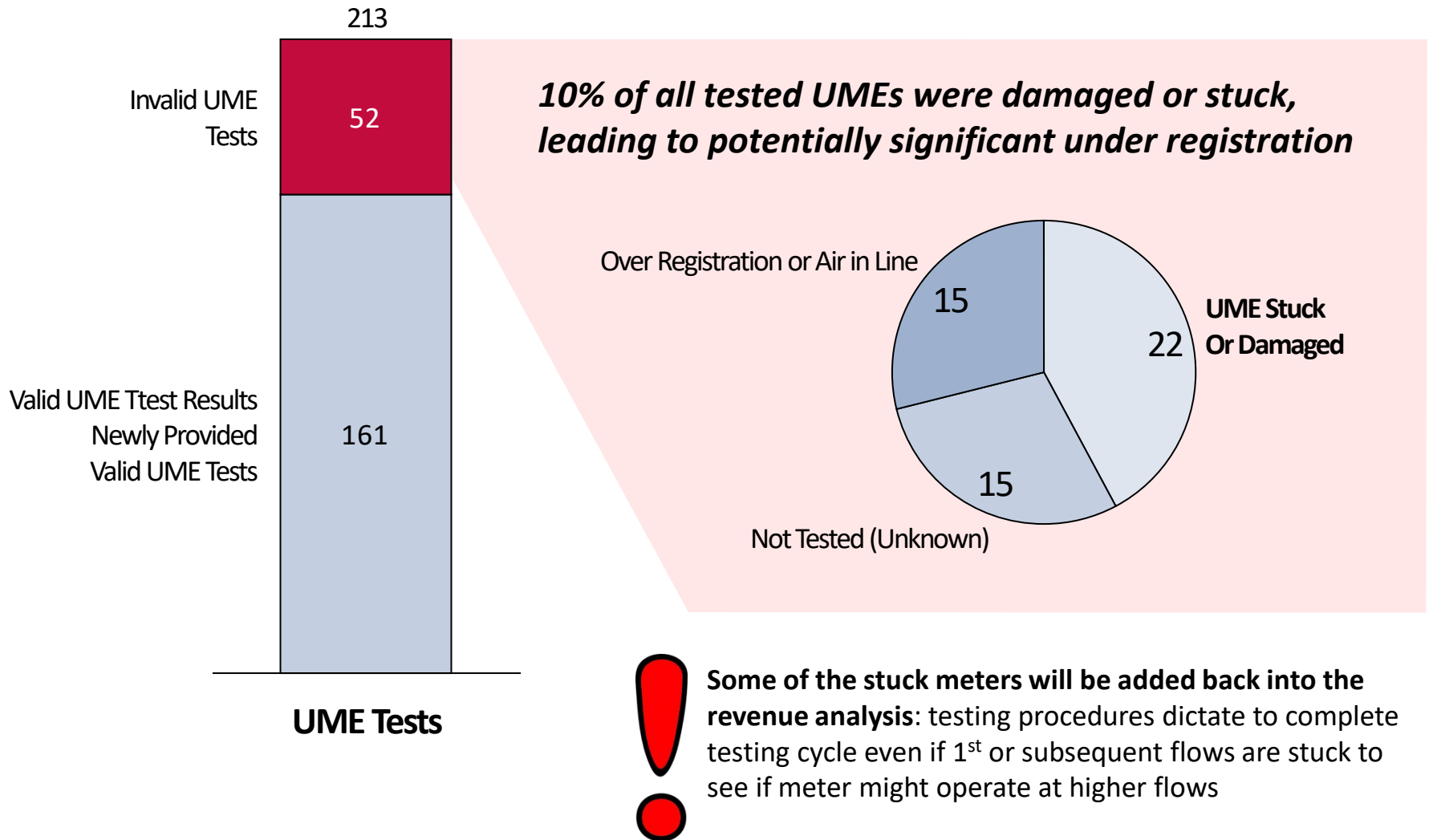


# Used Multivariate Regression to Calculate the Expected Accuracies of Different Meter Groups

**ACCURACY**  
**SAMPLE SIZE**    **% OF TOTAL SAMPLE**



# To increase the confidence level of the decision tree, we continuously rerun the analysis as new results come in



## Changed slightly compared with the previous decision tree; better focus maintenance efforts to meter age & type

### The Current tree has:

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- A **1% improvement** in overall accuracy (before applying stuck meters back in)

- **Age** as the most strongly correlated factor with meter accuracy



- A **drop of 1%** for the worst performing meter group – *89% for 3" Brand A meters that are between 4 and 10 years of age*

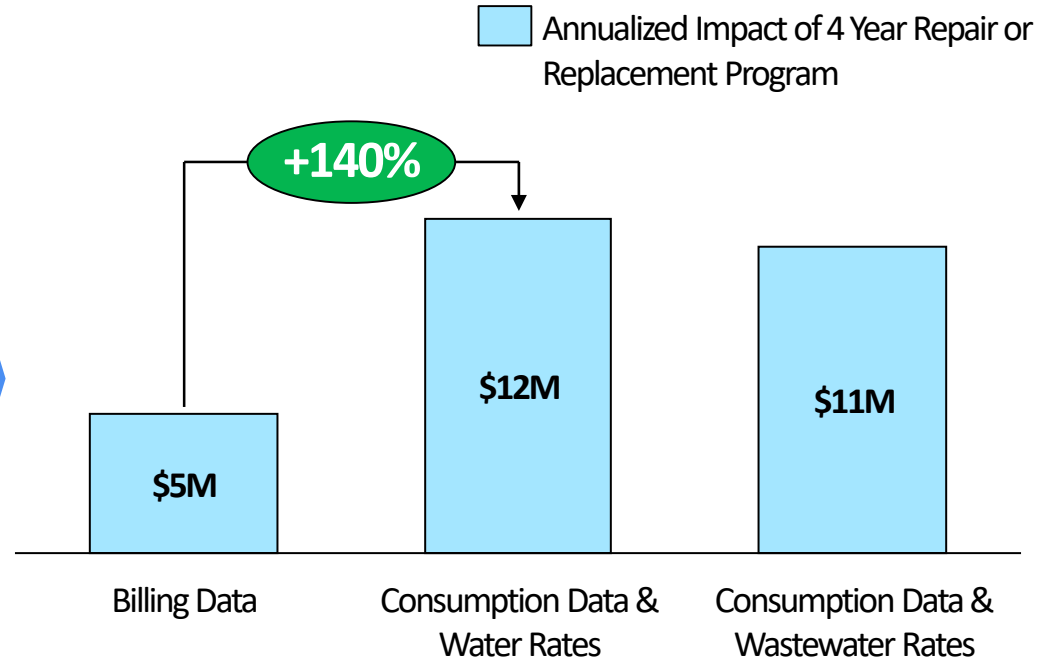


- An **increase of 1%** for the better performing meter groups – *98% for compound meters that are younger than 4 years*



# 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



▪ **Water**

- Extracted from LADWP Water System Rate Action Report

▪ **Wastewater**

- Extracted from City of Los Angeles Sewer Rates Code Sections & Website
- *Default % Discharge = 90%*

▪ **All calculations are based off of potentially compromised 2013 data**

- Many accounts have large consumption but a billed amount of \$0
- Dividing the annual billed amount by the annual consumption gives a wide spectrum of rates

# Presentation Summary

- 💧 Meter accuracy/performance validation requires many support tools
  - Need accurate testing equipment
  - Need experienced/well trained bench operators
  - Need testing protocols that check weak areas of meters' accuracy curve
  - Need customer usage profile information to determine how to best allocate against accuracy test results
- 💧 Application of statistical tools – find those factors that most influence meter accuracy
  - Add more data as it becomes available to strengthen decision tree
- 💧 Develop priorities and business case that support them
- 💧 Take action

## Next Steps

- 💧 Secure improved testing equipment
- 💧 Continue testing and add to database – strengthen tree
- 💧 Research new metering technologies
  - Developed research methodology
  - Selected meters that don't have cross over issues to validate revenue gain potential
  - Use technology for meter sizing
- 💧 Revise operating rules to support new procedures and other efficiencies
- 💧 Validate revenue potential estimates
- 💧 Consider targeted meter replacement program

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# LADWP Large Meter Management Project



## Accuracy Degradation Findings & Impacts

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