CAVANAUGH

Stewardship Through Innovation

Water Audits
One Tool in the Toolbox

Tuesday, May 17, 2016

Presented by:
Steve Cavanaugh, P.E.

steve.cavanaugh@cavanaughsolutions.com

Water Infrastructure Planning & Financing:

A Workshop for Rethinking, Reinvesting & Reinvigorating our Water Systems

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News | March 22, 2016

AWWA Issues Water Audit Challenge For World Water Day

Association's free Water Loss Audit Software v. 5.0 now available

Washington, D.C. -- At today's White House Water Summit in Washington, D.C., the American Water Works Association announced a challenge to its member water utilities and others across the globe to complete 1,000 water audits over the next two years using AWWA's newest Water Audit Software.

The Executive Office of the President

THE WHITE HOUSE
WASHINGTON

March 22, 2016

American Water Works Association
Dedicated to the World's Most Important Resource™

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Home > Resources & Tools > Water Knowledge > Water Loss Control

Water Loss Control
RESOURCE COMMUNITY

Water Loss Control

Water loss control represents the efforts of water utilities to provide accountability in their operation by reliably auditing their water supplies and implementing controls to minimize system losses. Log in to access the Water Audit Software.

Questions? Contact **AWWA's Water Loss Control Committee** directly.

Water Loss Control Essentials

- Natural Resources Defense Council: **Cutting Our Losses - State Policies to Track and Reduce Leakage from Public Water Systems**
- **Center for Neighborhood Technology**
- **Stepping Up Water Loss Control: Lessons from the State of Georgia** (PDF, 2014, CNT)

Hey Students

If you're pursuing a degree in this field, take a look at the wide range of scholarships available from AWWA and our partners.

Full list of scholarships

FREE WATER AUDIT SOFTWARE

As announced on March 22 at the White House Water Summit, AWWA is challenging 1,000 water utilities to conduct a water audit using AWWA's newest software and report their findings to AWWA, their governing boards, and the customers they serve. For those water utilities ready to take it to the next level, AWWA is challenging

WEBINAR

Purpose, Process and Benefits of Completing a Water Audit

"AWWA is challenging 1,000 water utilities to complete a water audit using AWWA's Free Water Audit Software in the next two years and report their findings on AWWA's website."

What's driving change?

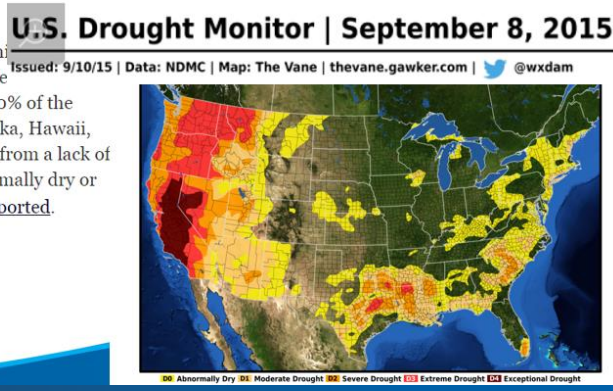
U.S. Has Reached 52 Percent Drought

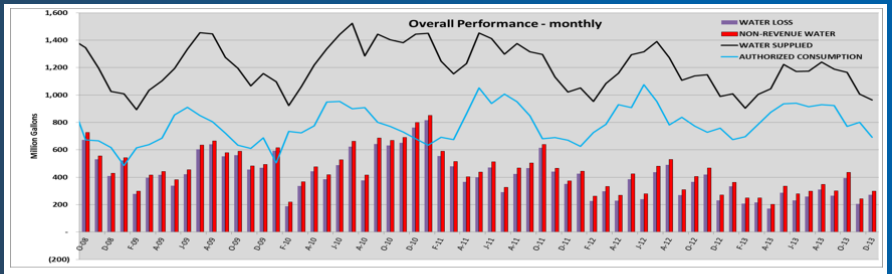
By Sara Jerome
@sarmje

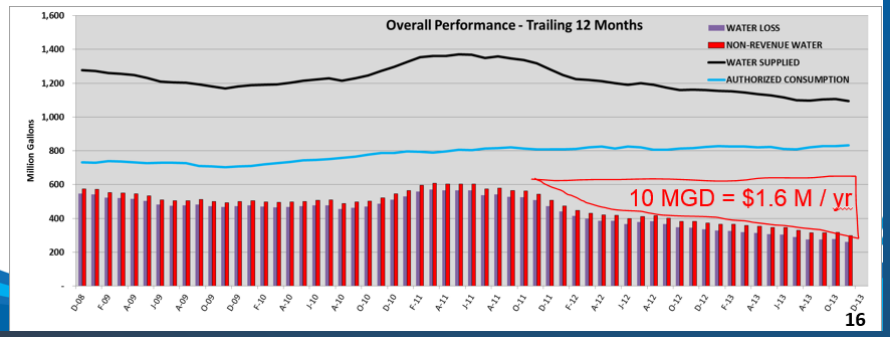
It's official: Most of the U.S. is facing drough conditions.

"The U.S. Drought Monitor, whi analyses every Tuesday and rele every Thursday, says that 52.00% of the United States — including Alaska, Hawaii, and Puerto Rico — is suffering from a lack of precipitation and is now abnormally dry or stuck in a drought," Gawker reported.

More Than Half of the United States Is Abnormally Dry or Officially in a Drought







Senate Bill No. 555

October 9, 2015 Contact: Melissa Jones, (916) 651-4003

Governor signs Wolk drought preparedness, renewable energy bills

Bills improve water management & conservation, increase use of renewable energy programs

SACRAMENTO –Governor Edmund G. Brown Jr. signed into law a measure by Senator Lois Wolk (D-Davis) to improve water management and conservation in California, and another bill to boost participation in programs enabling utility customers to receive part of their electricity from renewable energy sources.

Today, Brown signed Senate Bill 555, which requires all urban water suppliers in California to conduct annual water loss audits to detect leaks and breaks in their water distribution systems and submit the results to the Department of Water Resources for public review. The measure would also require the State Water Resources Control Board to develop performance standards to minimize water loss in the water agencies' distribution systems.

"The fastest and cheapest way to save water is to identify and recover the water lost on a daily basis in our urban areas," Wolk said. "It is estimated that we could save hundreds of thousands of acre-feet this way. Every drop counts."

STANDARD & POOR'S RATINGS SERVICES
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Impact on Bond Ratings

#48 Enterprise Risk Profile Assessment Factors (Table 10)

Strong – Utility has performed a water audit consistent with the AWWA M-36 methodology on an annual basis for the prior five years. The utility has a well-structured and documented Non-Revenue Water Management Program that includes ongoing leak detection work and annual accuracy testing of finished water meters and a representative sample of customer meters.

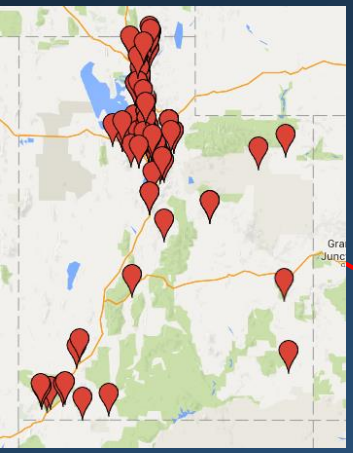
Good – Utility has performed a water audit consistent with the AWWA M-36 methodology on an annual basis for the prior three years. The utility has engaged in specific components of a Non-Revenue Water Management Program such as periodic finished water meter testing, accuracy testing of samples of customer meters and active leak detection.

Standard – Utility has performed a water audit consistent with the AWWA M-36 methodology but does not do so on an annual basis. The utility tracks some basic water loss information on a monthly basis but does not have an active Non-Revenue Water Management Program.

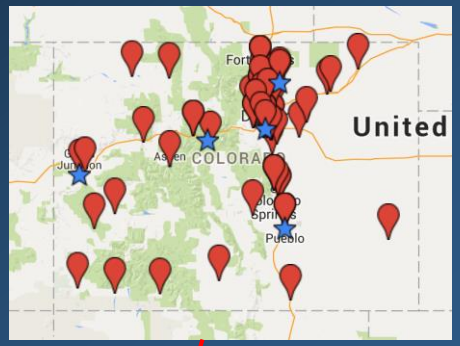
Vulnerable – Utility has not performed a water audit consistent with the AWWA M-36 methodology and does limited tracking of some basic water loss information on a monthly basis. This information is generally reported on a percentage of volume-supplied basis.

*** final review, expected publication – December 2015**

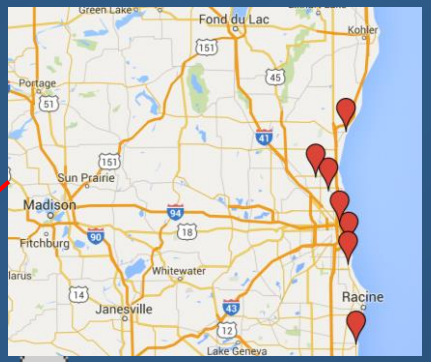
Utah Pilot:
105 systems
4 months

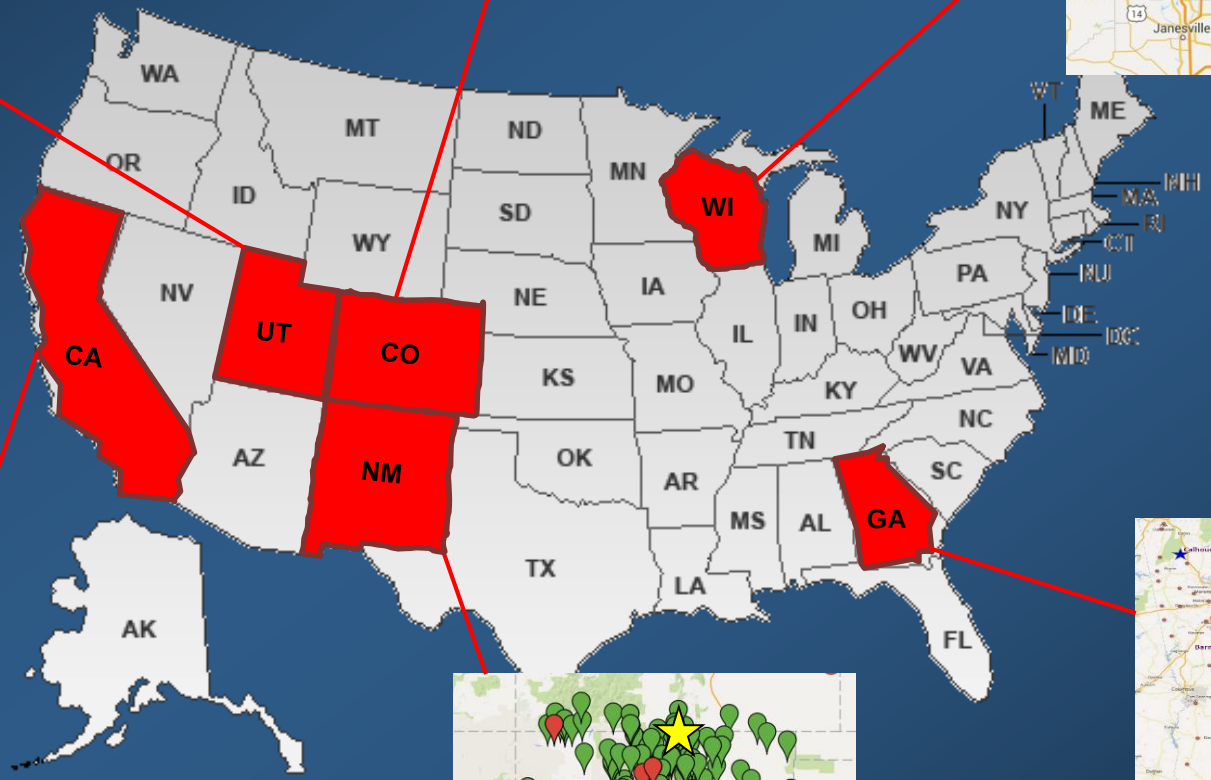


Colorado Pilot:
50 systems
1 month

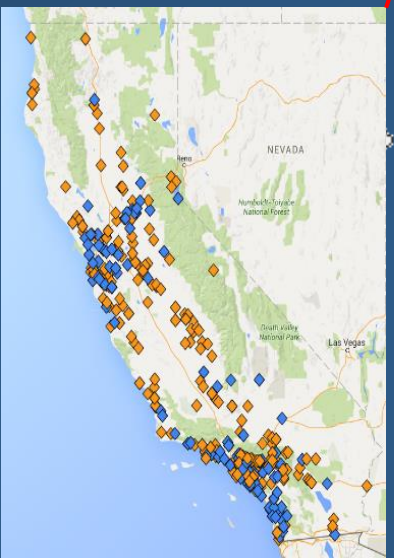


Wisconsin Pilot:
6 systems
6 months

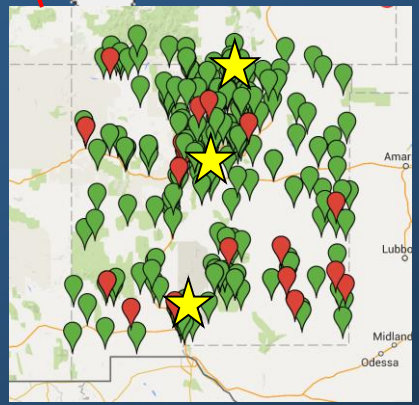




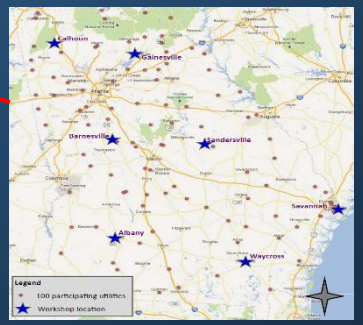
California
Full Scale:
460 systems
2 years



New Mexico
Full Scale:
250 systems
9 months



Georgia Full Scale:
230 systems
4 years



Statewide Water Loss Management Program – Model Implementation

Phase 1

Establish Annual M36 Water Auditing

Auditing
- Establish annual M36 Water Auditing for all utilities

Outreach
- Educate Regulatory Community on M36 Method and appropriate use of performance indicators
- Establish Statewide Water Loss Control Committee

Training & Tech Asst
- Develop State Manual and Training Framework
- Provide extended, progressive training to utilities (funded)

Phase 2

Achieve Minimum Standard of Audit Reliability

Data Manage-ment
- Develop and implement data management system
- Establish posting system and communication protocols

Validation
- Establish minimum standards of validation for quality assurance
- Determine by Agency or 3rd Party
- Establish validation program until certification program is in place

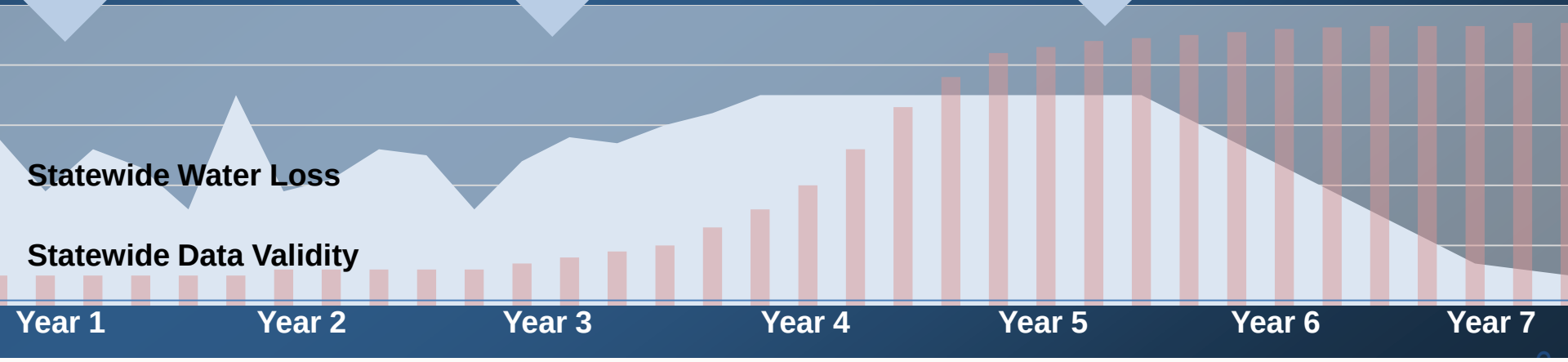
Certification
- Design and implement a Certified Water Audit program for sustained quality control
- Statewide Water Loss Control Committee provides support

Phase 3

Manage Water Loss Performance for Long-Term Reduction

Benchmarking
- Suite of Performance and Process Measures
- System specific improvement over time in a cost-effective manner
- No universal targets
- Excessive thresholds established

Improvement
- Annual audit submission threshold exceedances
- System specific progress review at designated regulatory touchpoints

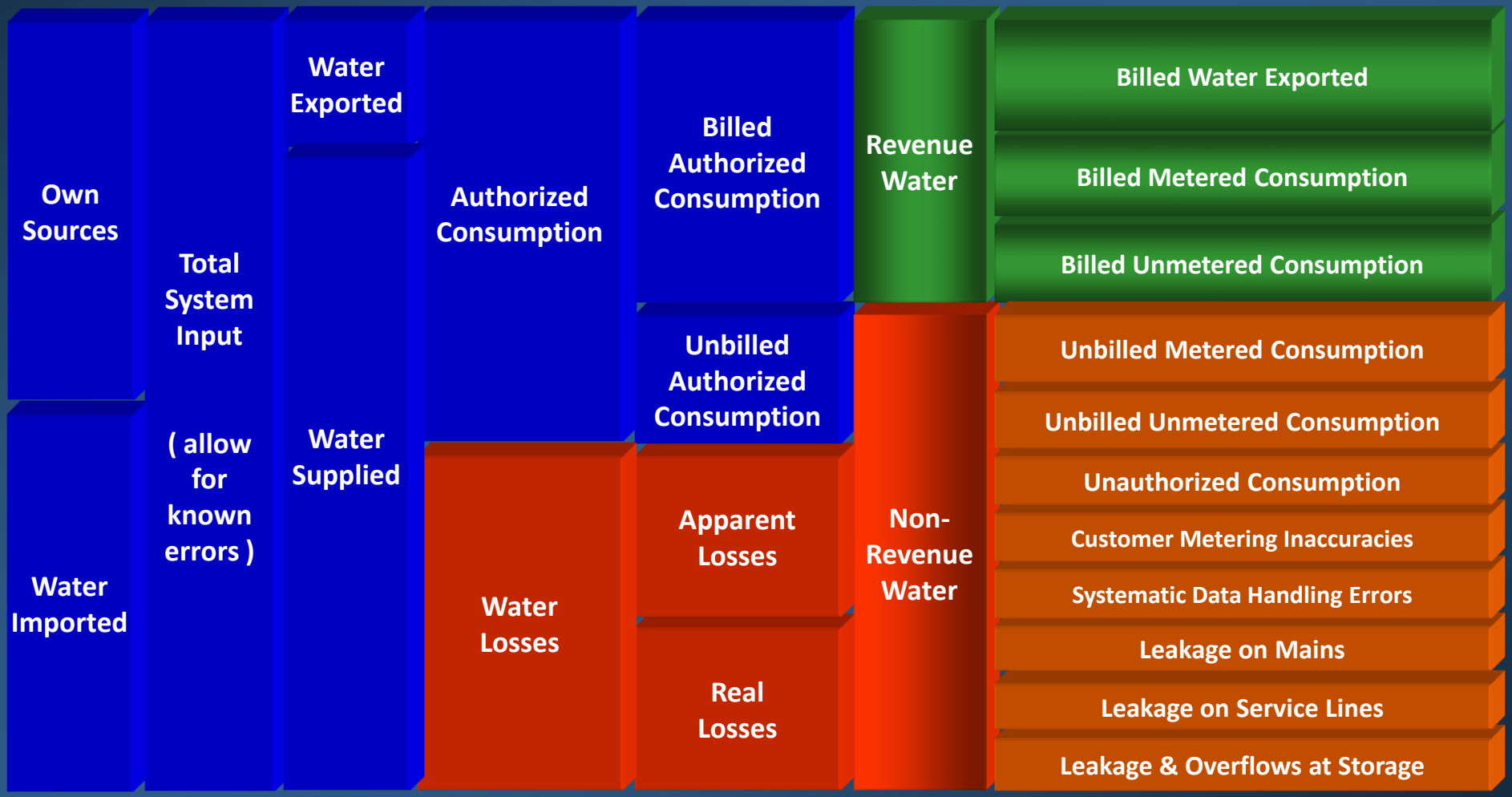


Resource Management Grade C | Resource Management Grade B | Resource Management Grade A

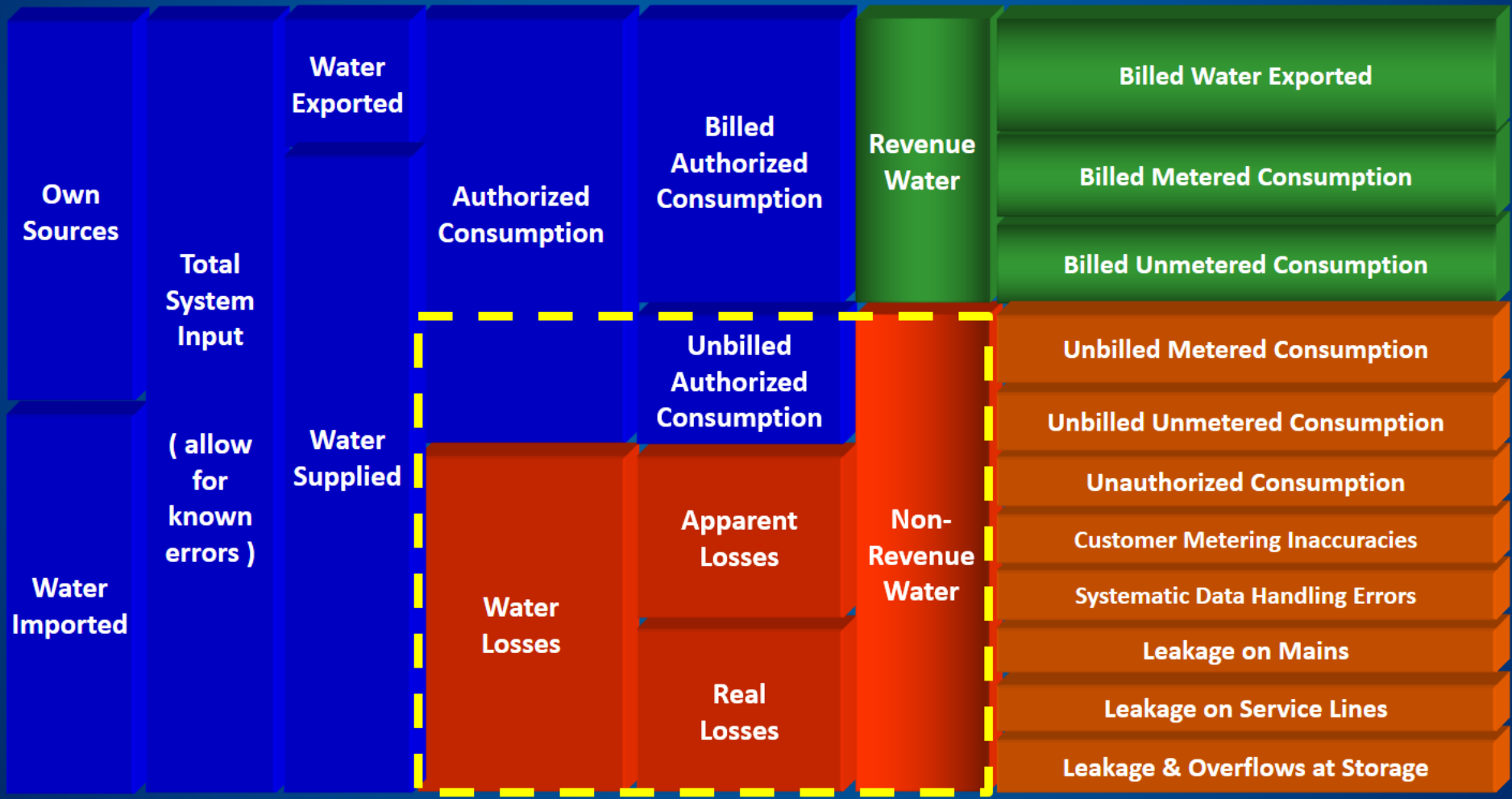
Are We Healthy?

Performance Indicators	
Non-Revenue Water	gal/conn/year and $/conn/year
Apparent Losses	gal/conn/day
Real Losses	gal/conn/day or gal/length of main
Real Losses (normalized for pressure)	gal/conn/day or gal/length of main/psi
Infrastructure Leakage Index (ILI)	
Data Validity Score	
Practices	
Water Auditing	
Level of Validation (1, 2, 3)	
Customer Meter Testing (CMT)	
Large	
Small	
NRW Component Analysis	
Active vs Reactive Leak Detection	
Utilization of District Metered Areas for Night Flow Analysis	
Pressure Management	
Meter Replacement Revenue Protection Programs	

IWA/AWWA Standard Water Balance



Management of NRW



- Fire Dept Usage
- Operational Flushing
- Tools for control include efficient flushing practices and awareness campaigns

Unbilled Authorized Consumption

- Non-physical / revenue loss - slow meters, billing issues and theft
- Cost impacts at 'retail' rate.
- Tools for control include data management, quality control policies/practices, & meter testing & repair

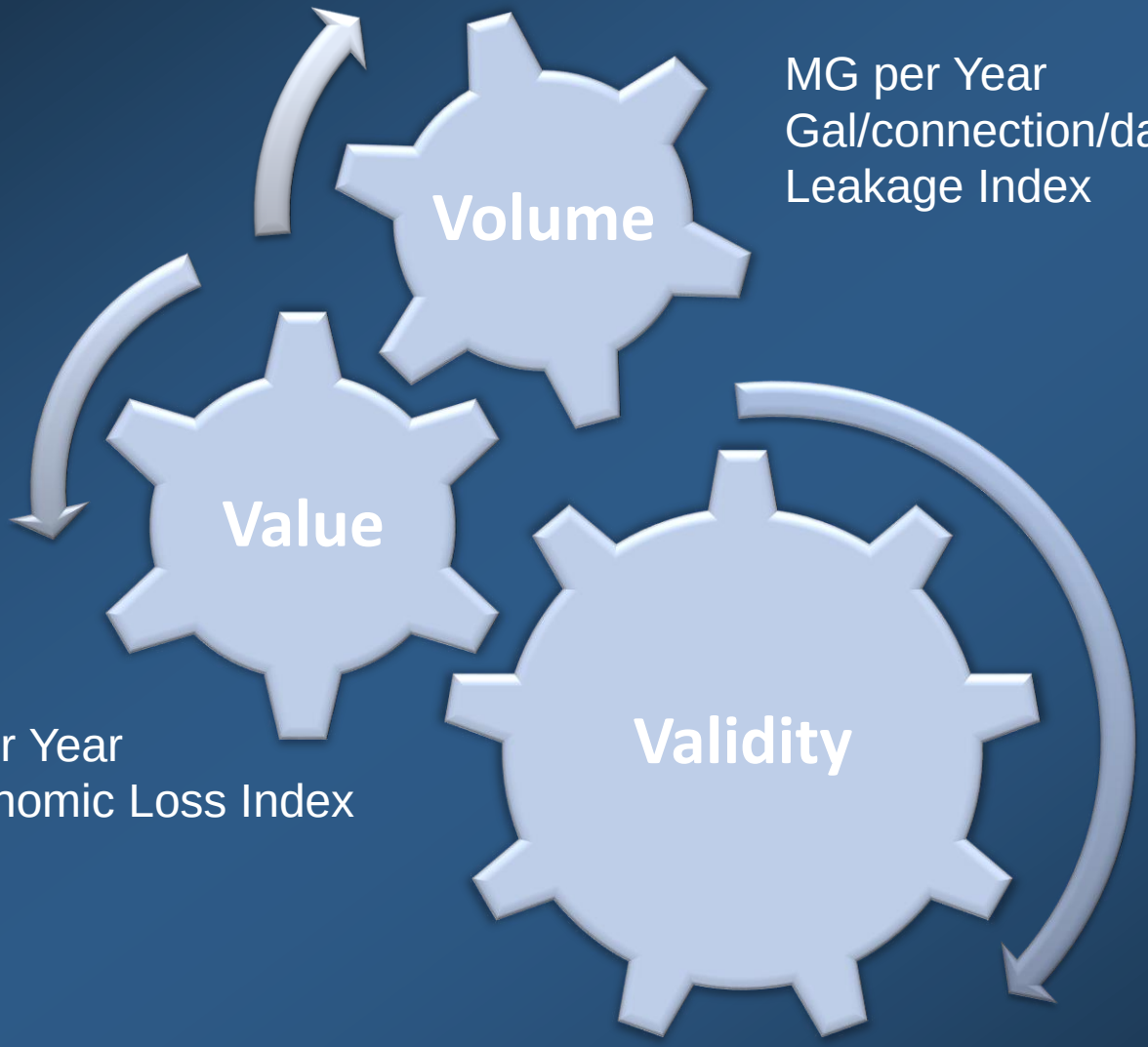
Apparent Losses

- Physical loss - leakage
- Cost impacts at 'wholesale' rate
- Tools for control include leakage and pressure management

Real Losses

Non-Revenue Water

3-V's



MG per Year
Gal/connection/day
Leakage Index

$ per Year
Economic Loss Index

Water Audit Data Validity Score
95% Confidence Limits
Key Data Input Grades

AWWA Free Water Audit Software

American Water Works Association

AWWA Free Water Audit Software: Reporting Worksheet

WAS v5.0

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Click to access definition
Click to add a comment

Water Audit Report for: Northern San Leandro Combined Water Sewer Storm Utility District (0007900)
Reporting Year: 2013 1/2013 - 12/2013

Please enter data in the white cells below. Where available, metered values should be used; if metered values are unavailable please estimate a value. Indicate your confidence in the accuracy of the input data by grading each component (n/a or 1-10) using the drop-down list to the left of the input cell. Hover the mouse over the cell to obtain a description of the grades

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

To select the correct data grading for each input, determine the highest grade where the utility meets or exceeds all criteria for that grade and all grades below it.

Master Meter Error Adjustments

WATER SUPPLIED

<---------- Enter grading in column 'E' and 'J' ----------> Pcnt: Value:

				Pcnt:	Value:	
Volume from own sources:	5	1,000.000	MG/Yr		100.000	MG/Yr
Water imported:	1		MG/Yr			MG/Yr
Water exported:	9	100.000	MG/Yr		25.000	MG/Yr

Enter negative % or value for under-registration
Enter positive % or value for over-registration

WATER SUPPLIED: 825.000 MG/Yr

AUTHORIZED CONSUMPTION

Click here: ? for help using option buttons below

			Pcnt:	Value:	
Billed metered:	8	700.000	MG/Yr		
Billed unmetered:	9	50.000	MG/Yr		
Unbilled metered:			MG/Yr		
Unbilled unmetered:		10.313	MG/Yr	1.25%	MG/Yr

Default option selected for Unbilled unmetered - a grading of 5 is applied but not displayed

AUTHORIZED CONSUMPTION: 760.313 MG/Yr

Use buttons to select percentage of water supplied **OR** value

WATER LOSSES (Water Supplied - Authorized Consumption) 64.688 MG/Yr

Apparent Losses

			Pcnt:	Value:	
Unauthorized consumption:	10	3.000	MG/Yr	3.000	MG/Yr

Unauthorized consumption volume entered is greater than the recommended default value

			Pcnt:	Value:	
Customer metering inaccuracies:	5	7.071	MG/Yr	1.00%	MG/Yr
Systematic data handling errors:	4	5.000	MG/Yr	5.000	MG/Yr

Apparent Losses: 15.071 MG/Yr

Real Losses (Current Annual Real Losses or CARL)

Real Losses = Water Losses - Apparent Losses: 49.617 MG/Yr

WATER LOSSES: 64.688 MG/Yr

NON-REVENUE WATER

NON-REVENUE WATER: 75.000 MG/Yr

= Water Losses + Unbilled Metered + Unbilled Unmetered

SYSTEM DATA

Length of mains:	7	100.0	miles
Number of active AND inactive service connections:	6	1,000	
Service connection density:		10	conn./mile main

Are customer meters typically located at the curbstop or property line? Yes

Average length of customer service line: (length of service line, beyond the property boundary, that is the responsibility of the utility)

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

Average operating pressure: 6 60.0 psi

COST DATA

Total annual cost of operating water system:	5	$1,000,000	$/Year
Customer retail unit cost (applied to Apparent Losses):	7	$3.50	$/1000 gallons (US)
Variable production cost (applied to Real Losses):	7	$3,000.00	$/Million gallons

Use Customer Retail Unit Cost to value real losses

Industry Standard (M36)

Free

Defaults provided

~10 Volume Inputs
~7 System Data Inputs

awwa.org/waterlosscontrol

Water Supplied

t data grading for each input, determine the highest grade where
eets or exceeds all criteria for that grade and all grades below it.

Master Meter Error Adjustments

<---------- Enter grading in column 'E' and 'J' ---------->

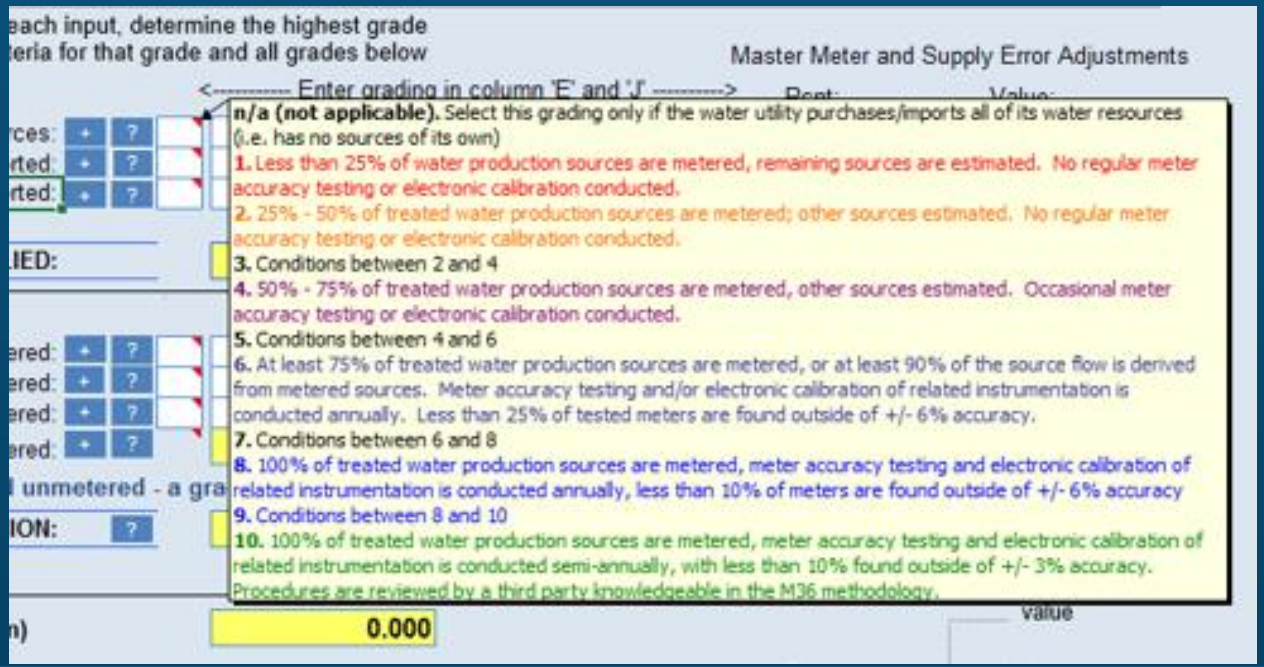
						Pcnt:	Value:	
Volume from own sources:	+ ?	5	1,000.000	MG/Yr	+ ?	1	100.000	MG/Yr
Water imported:	+ ?			MG/Yr	+ ?			MG/Yr
Water exported:	+ ?	1	100.000	MG/Yr	+ ?	9	25.000	MG/Yr

Enter negative % or value for under-registration

Enter positive % or value for over-registration

WATER SUPPLIED:	**825.000**	MG/Yr

Data Validity



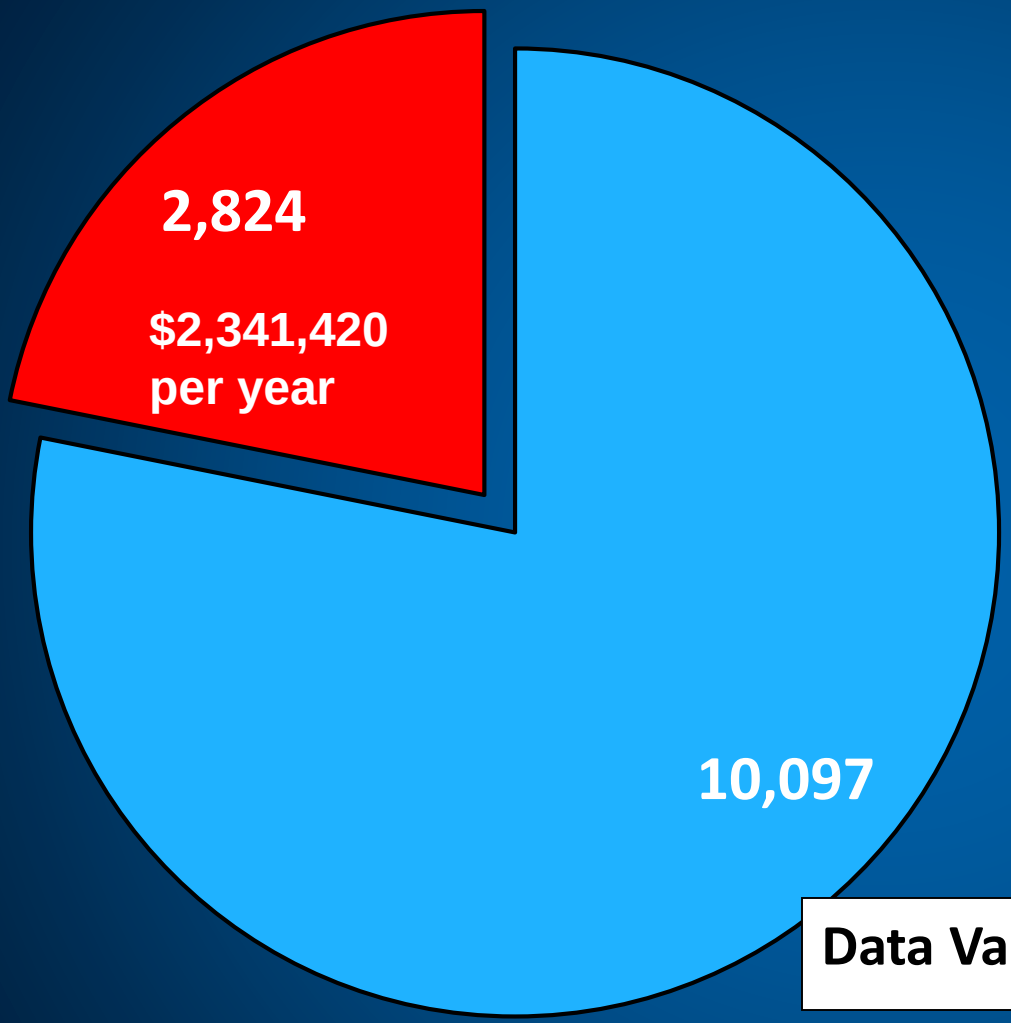
AWWA M36 Water Audit Validation Level Summary

American Water Works Association

Dedicated to the World's Most Important Resource™

Level	Descriptor	Validation Focus	Typical Activities	Level of Effort	Effort Depends on:
1	Top down review validation	Data grades, data validity score, gross errors and anomalies in the metrics	Desktop review of what is immediately available – supply reports, consumption reports, testing reports, etc. 1 to 2 hour phone call to interview utility staff, plus preparatory and documentation time. Interview questions are focused on practices to make sure the data grades have been applied correctly and consistently. Through this discussion, anomalies are discussed and either confirmed, corrected, or noted for needing further investigation.	Small	System size & complexity
2	Top down data mining validation	Supply and consumption volumes from existing data that is mined, at the component and sub-component levels	Data mining for desktop analysis of non-revenue water components. Analysis of available data, including production database and reports from SCADA system to identify gaps in the data chain. Data mining in the billing system to confirm and cleanse consumption volumes to remove redundancies from the data mining process which can come about from record duplications. Also validates exclusion of non-potable volumes in the totals. Validates that consumption volumes from low mid and high level detail extractions are corroborated. Analysis of available meter testing data for audit calculations. Applies 95% confidence limits to the AWWA water balance.	Medium	Complexity of supply setup, metering setup and billing setup. Analysis could be limited to only 1 or 2 of the 3 between supply, metering and billing.
3	Bottom up field investigation validation	Supply and consumption volumes from new data that is gathered or mined	Field investigations and extensive data mining. Supply meter testing and in-field verification of meter-transmitter-SCADA data chain. In field customer meter testing. Night flow testing & analysis for leakage. Pressure data collection & analysis.	Large	Varies widely by system, largely on how much field work is involved

Total Non-Revenue Water Volume (MG) Level 1

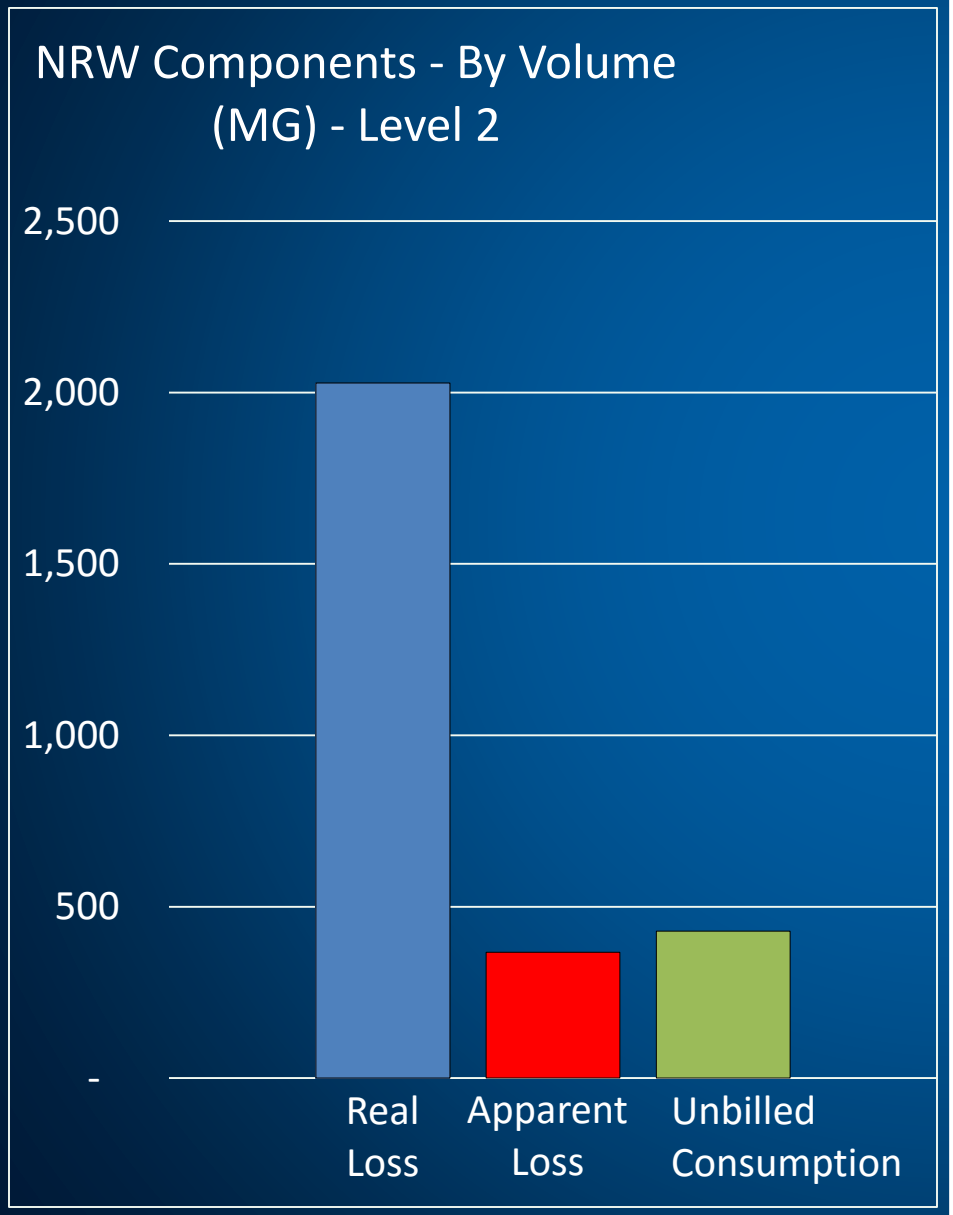


Billed Consumption

NRW

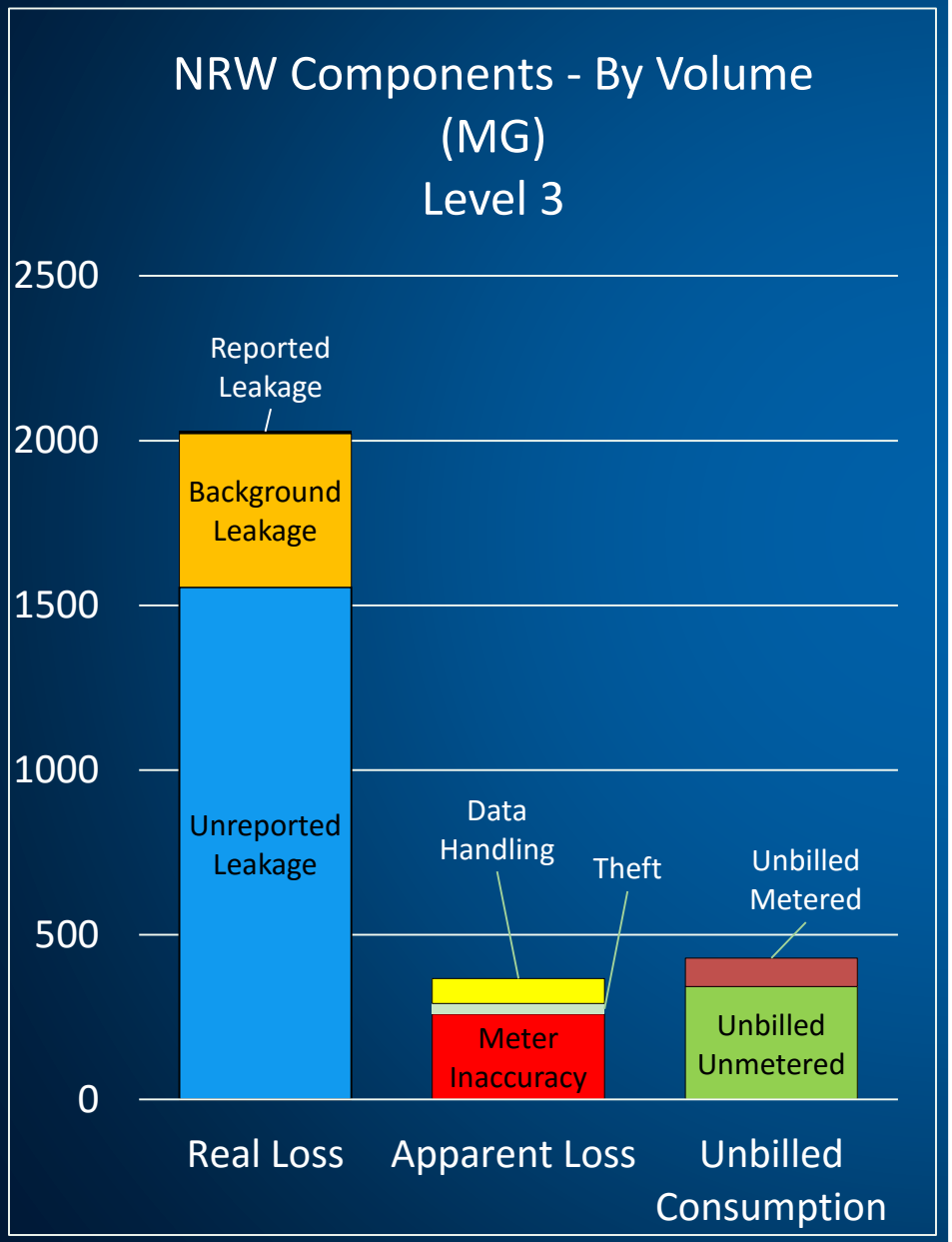
Data Validity Score: 75 out of 100

Volume



Value

Volume



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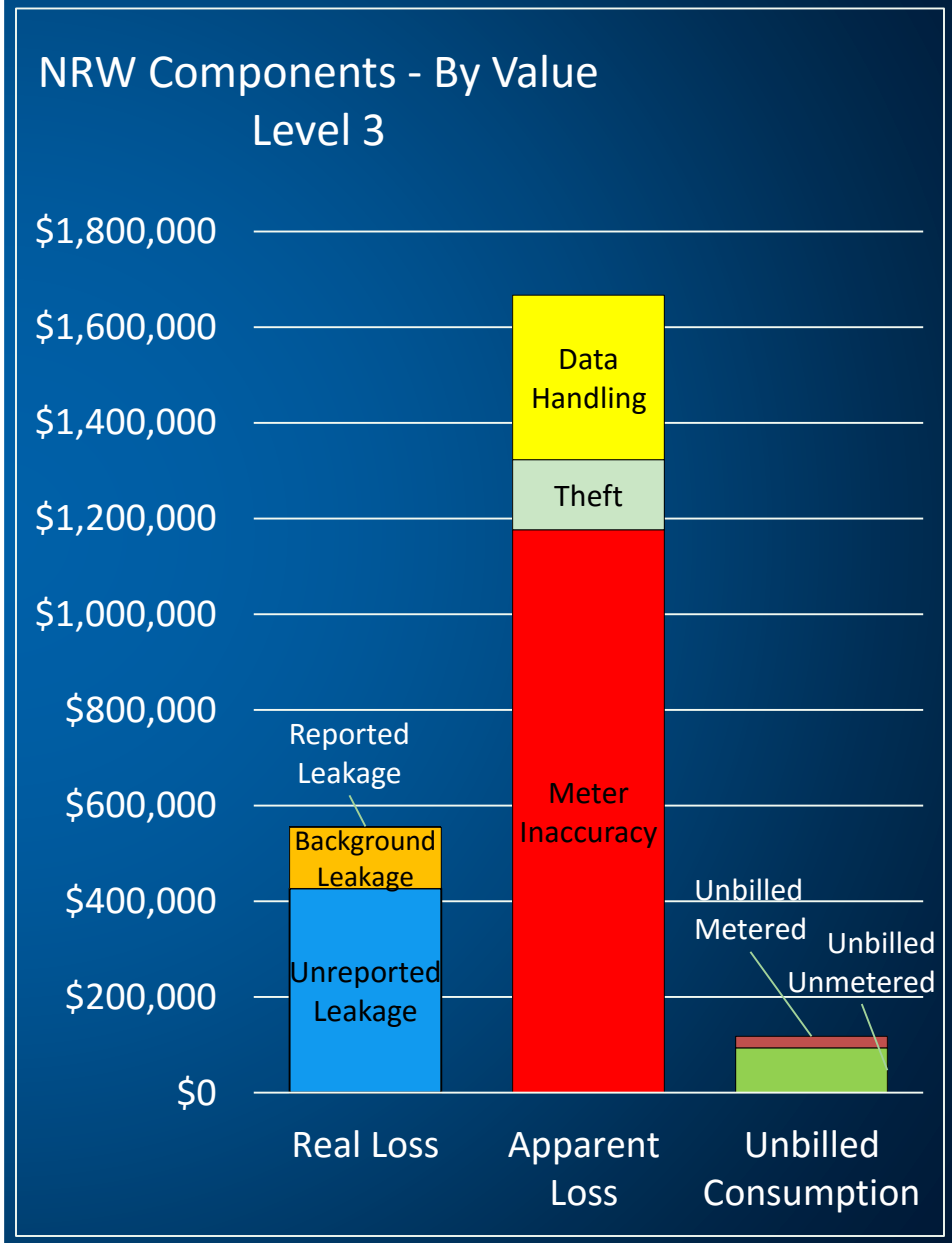
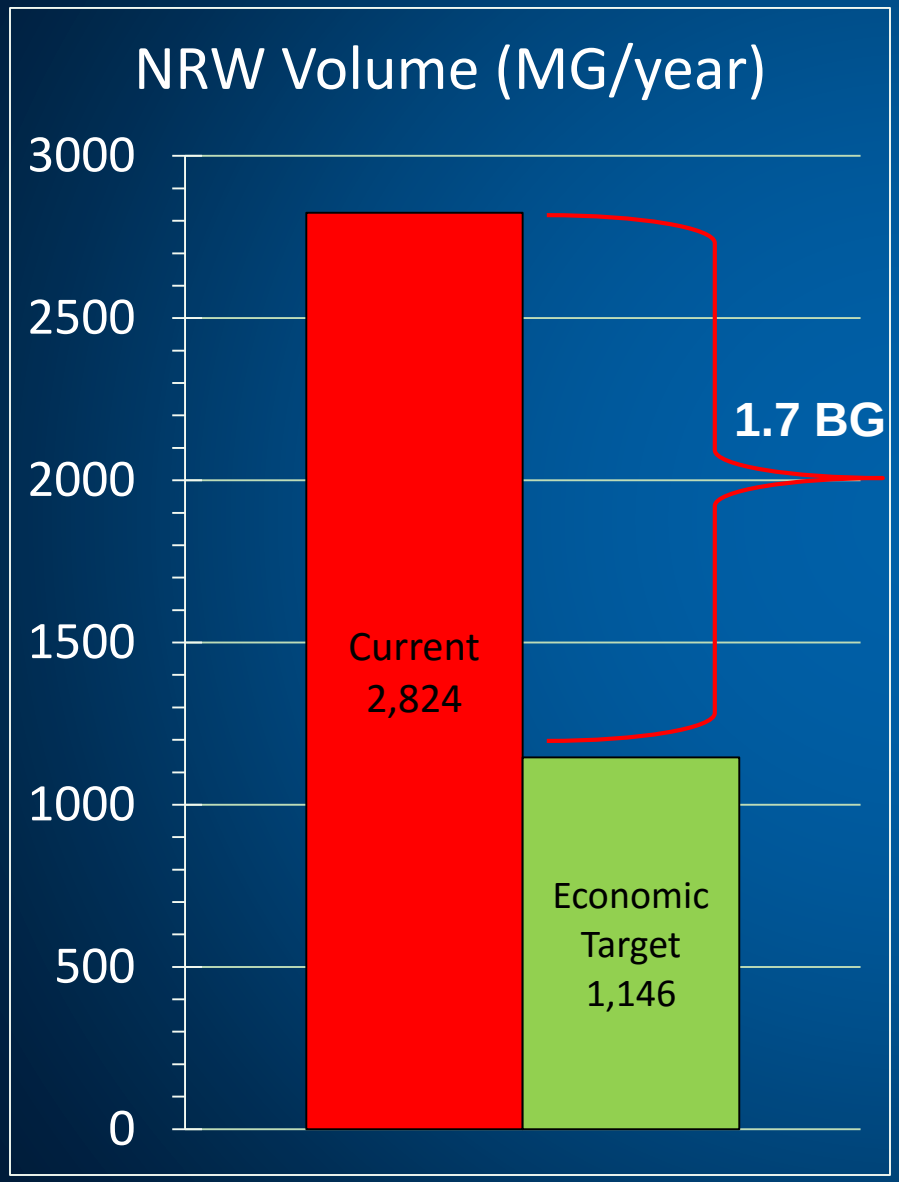


Volume



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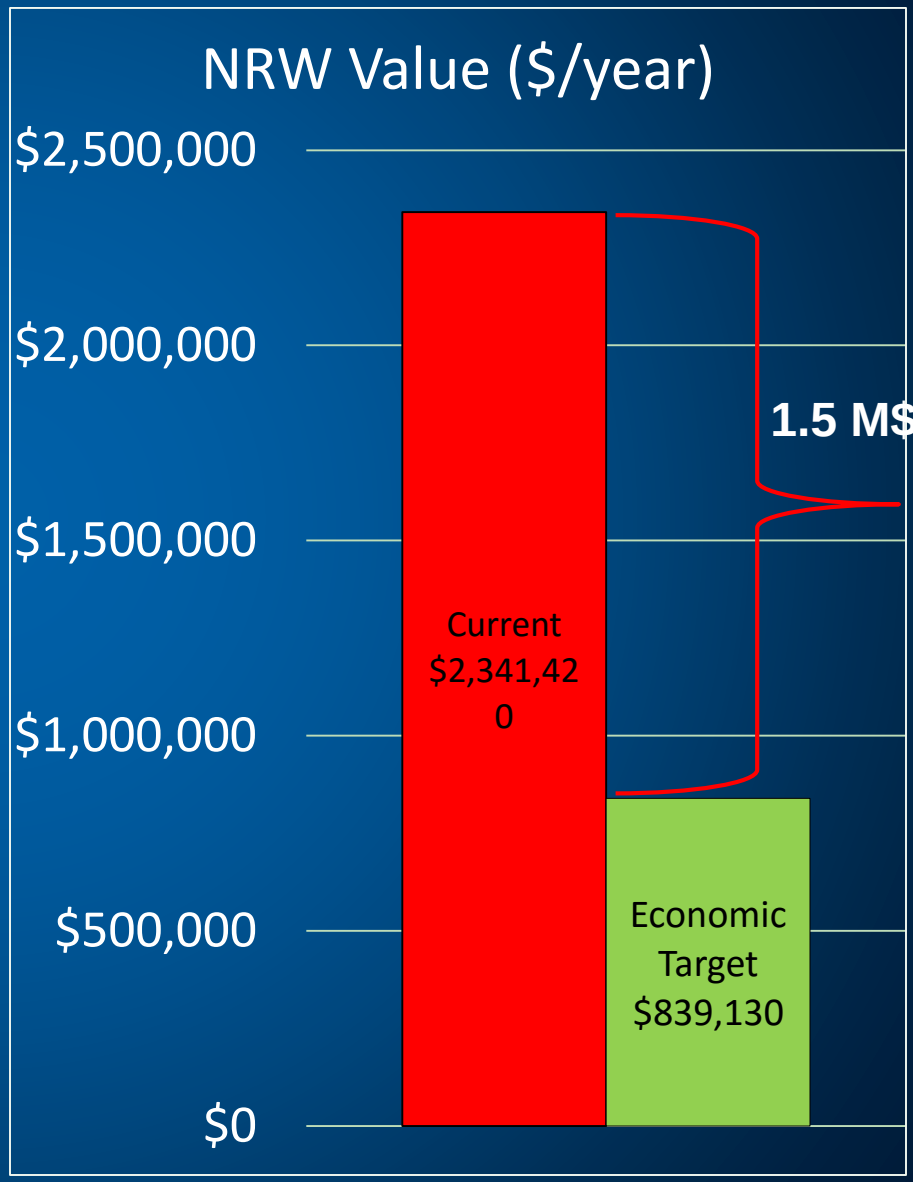


Basic Concepts

1. Create a water balance: separate Non-Revenue Water into Unbilled Consumption, Apparent Loss and Real Loss.

2. Test the validity: Data Validity Score & Metrics screening, gremlin hunting

3. Analyze the components of Unbilled Consumption, Apparent Loss and Real Loss. Use volumes & values.

4. Prioritize the components to make a plan of attack.

Own Sources

Water Imported

Total System Input

(allow for known errors)

Water Exported

Water Supplied

Authorized Consumption

Billed Authorized Consumption

Revenue Water

Billed Water Exported

Billed Metered Consumption

Billed Unmetered Consumption

Unbilled Authorized Consumption

Unbilled Metered Consumption

Unbilled Unmetered Consumption

Water Losses

Apparent Losses

Non-Revenue Water

Unauthorized Consumption

Customer Metering Inaccuracies

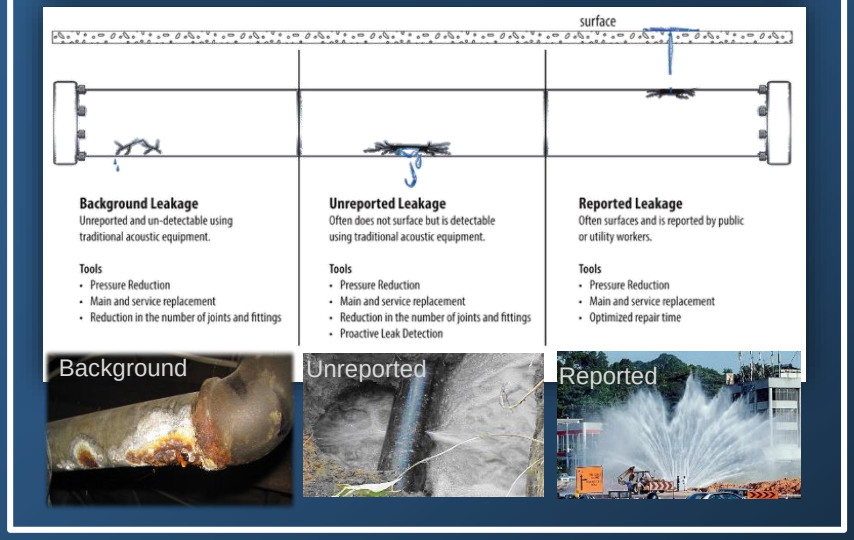
Systematic Data Handling Errors

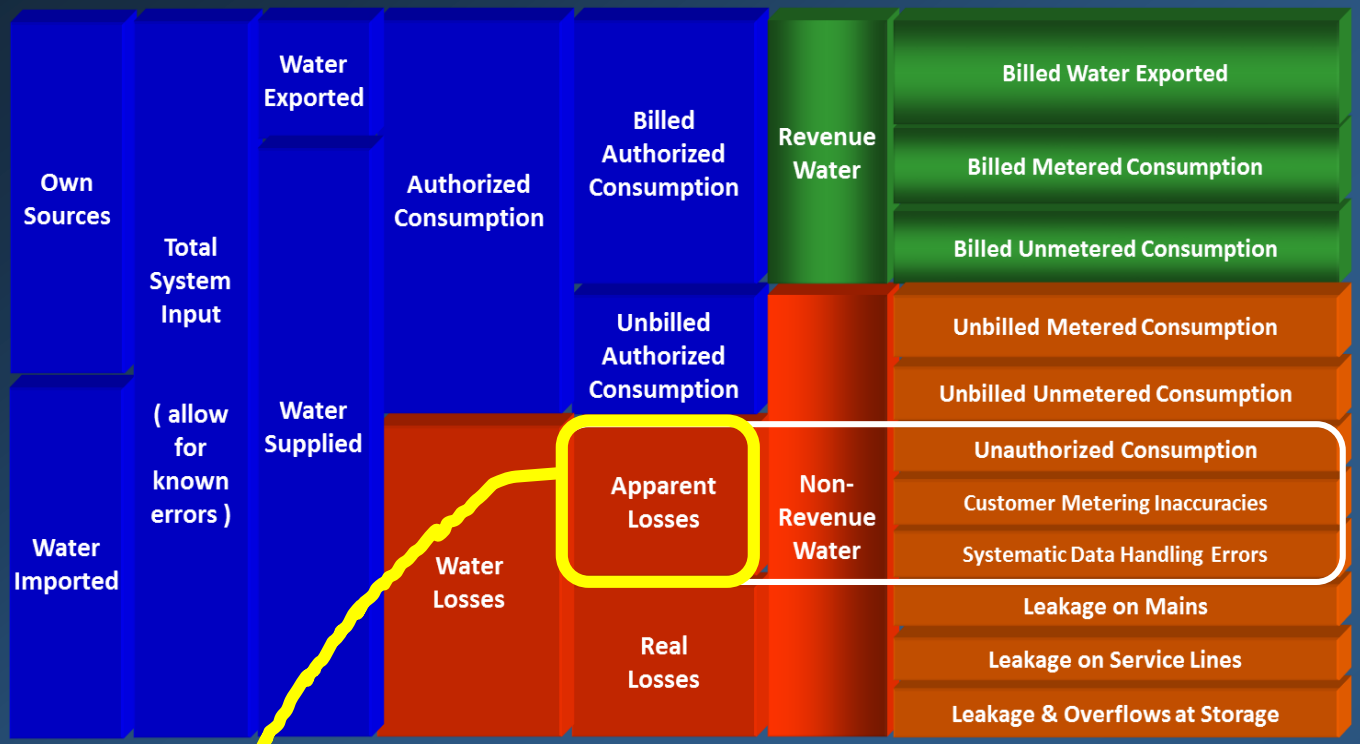
Real Losses

Leakage on Mains

Leakage on Service Lines

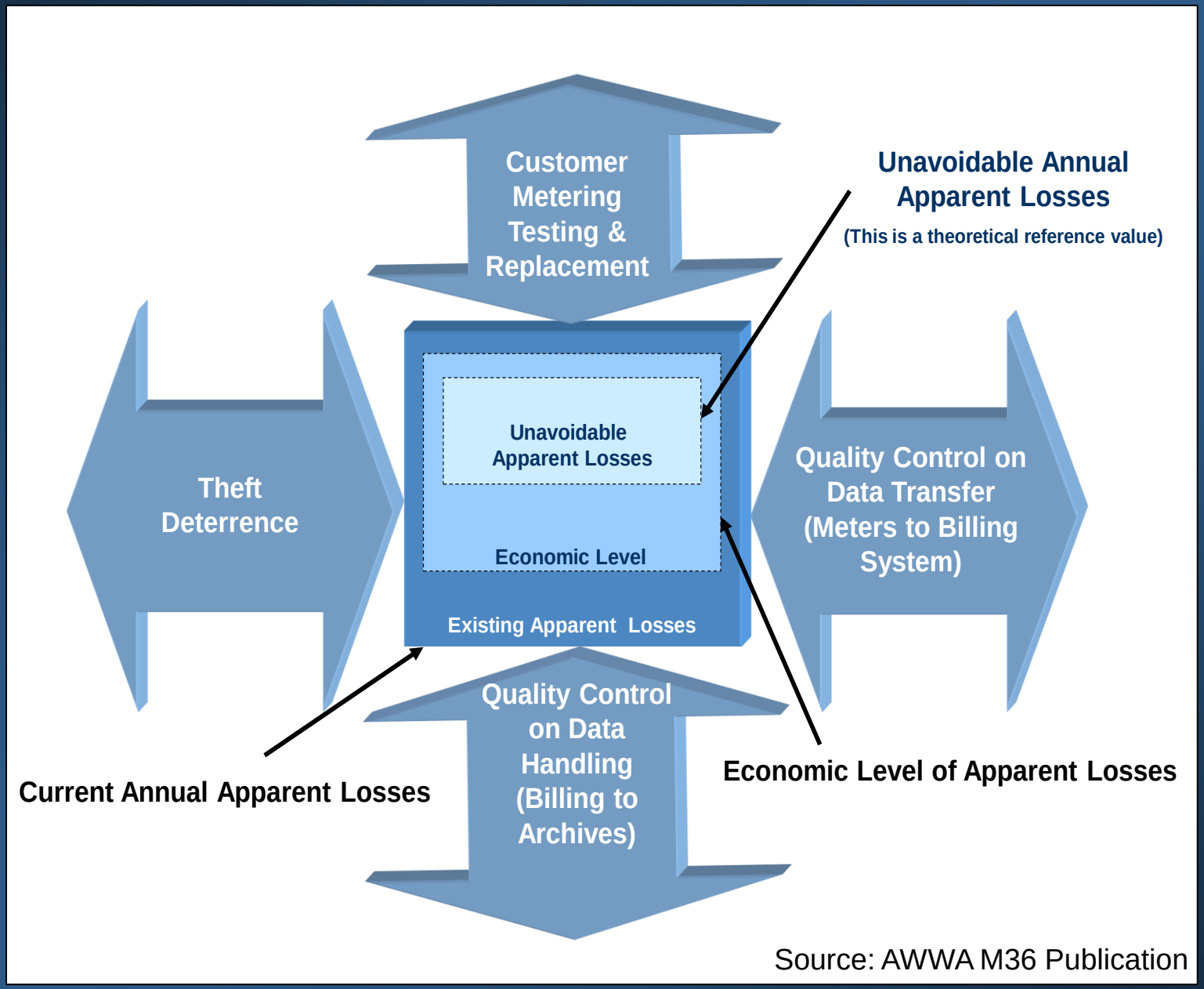
Leakage & Overflows at Storage





Apparent Losses =

The Four Pillars of Apparent Losses Control



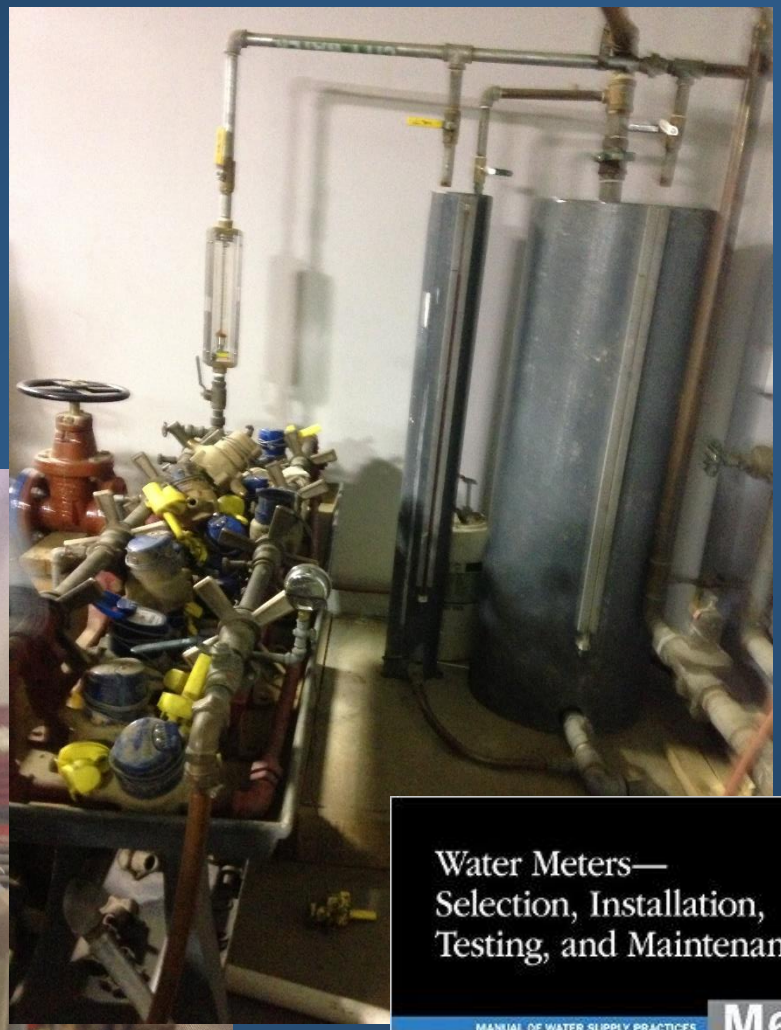
Source: AWWA M36 Publication

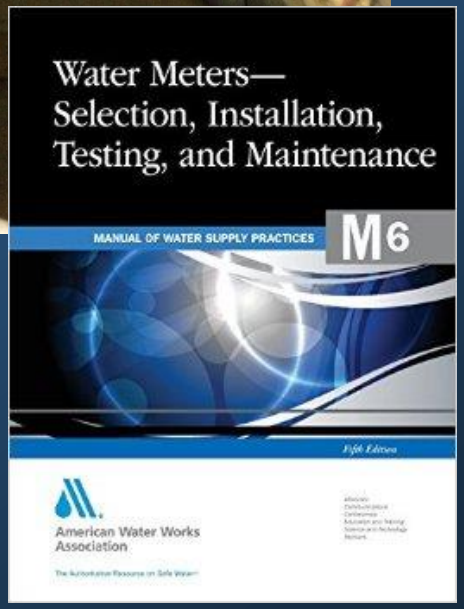
Customer Meter Accuracy Testing

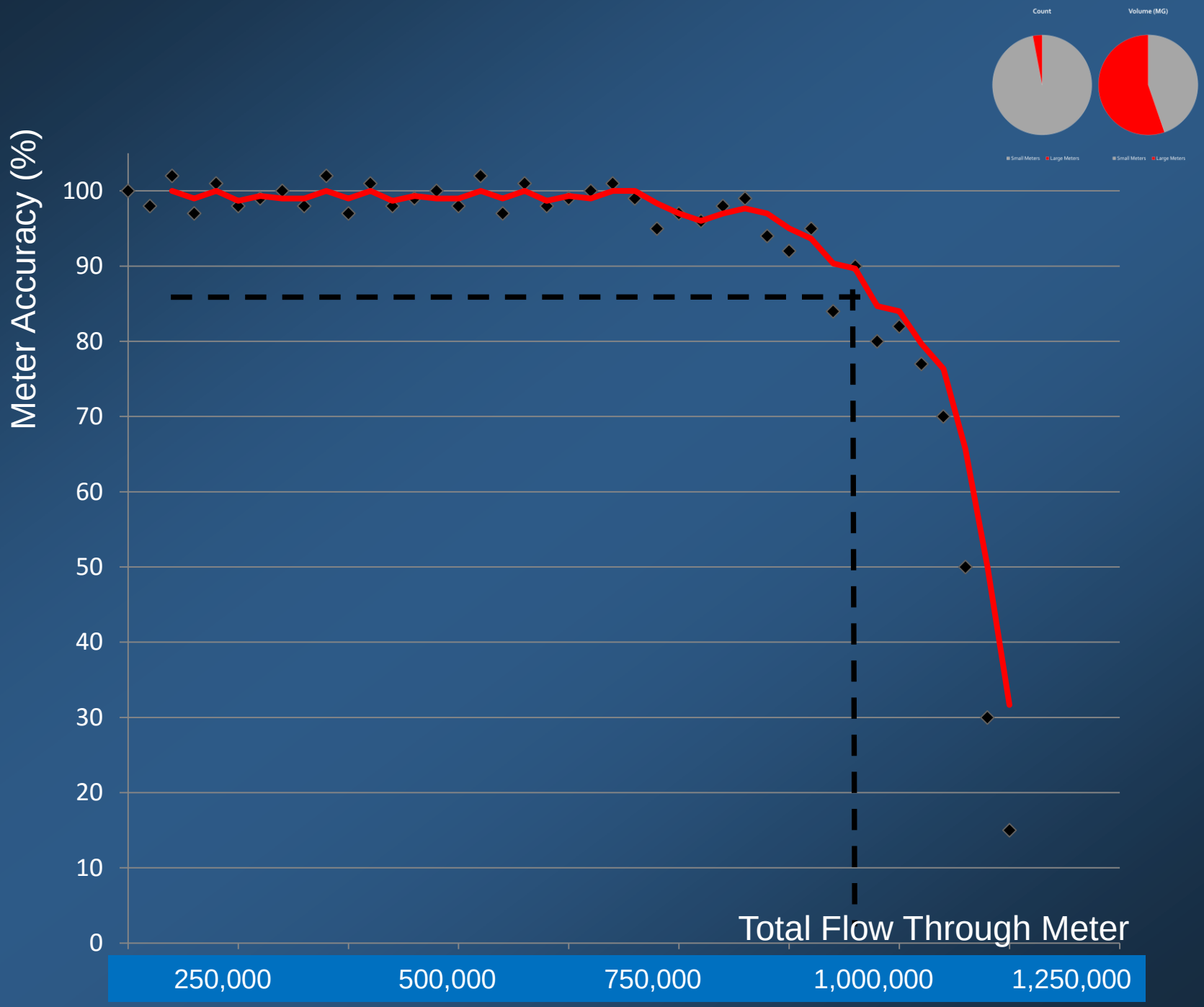
- Routine or periodic meter accuracy testing will quantify the accuracy level of the meter population
- Meter testing can be performed by testing companies or in-house by utilities with a test bench or portable test equipment
  - Only skilled personnel should do testing; meter testing is a precision activity
  - Make sure procedures are followed – ***always test at the low flowrate first***
- Set clear meter testing goals, such as:
  - Test for high bill complaints
  - Meters serving high water using customers
  - Test a sample of meters retired from service
  - Test high through-put meters (longevity)
  - Test samples of newly purchased meters
  - Suspect meters

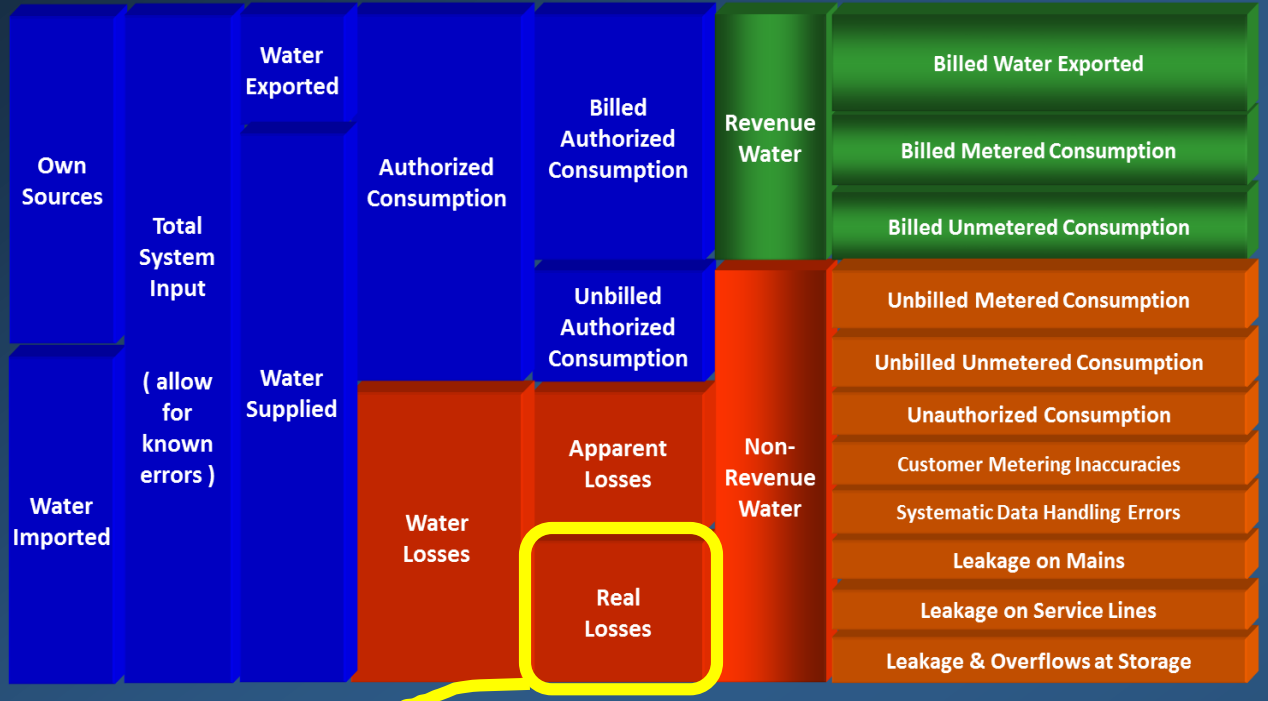
Utility Test Bench for testing water meters of size less than 3-inch

Sample Testing for Small Meters

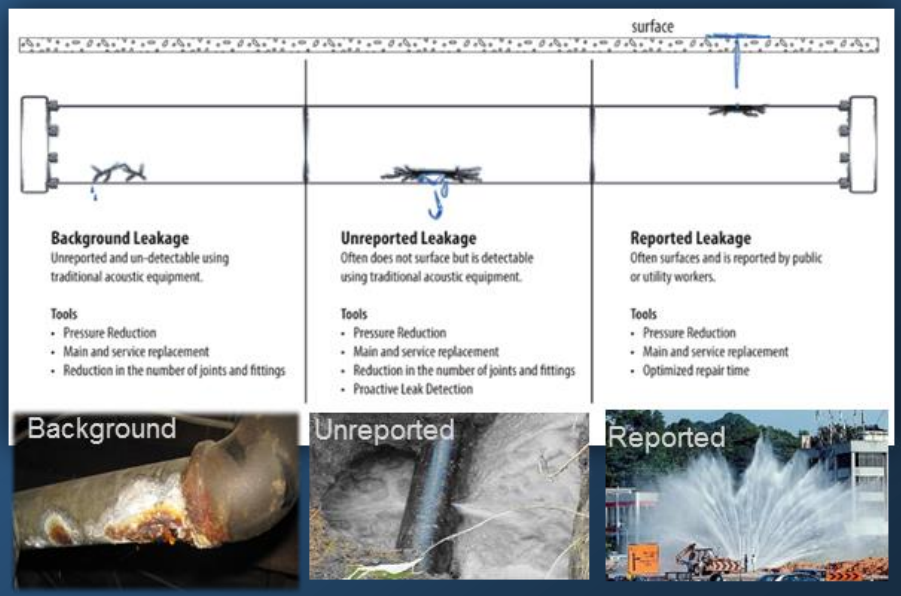





Count
Volume (MG)
Small Meters
Large Meters
Small Meters
Large Meters
Meter Accuracy (%)
100
90
80
70
60
50
40
30
20
10
0
Total Flow Through Meter
250,000
500,000
750,000
1,000,000
1,250,000


Own Sources
Water Imported
Total System Input
(allow for known errors)
Water Exported
Water Supplied
Authorized Consumption
Water Losses
Billed Authorized Consumption
Unbilled Authorized Consumption
Apparent Losses
Real Losses
Revenue Water
Non-Revenue Water
Billed Water Exported
Billed Metered Consumption
Billed Unmetered Consumption
Unbilled Metered Consumption
Unbilled Unmetered Consumption
Unauthorized Consumption
Customer Metering Inaccuracies
Systematic Data Handling Errors
Leakage on Mains
Leakage on Service Lines
Leakage & Overflows at Storage

Real Losses =


surface
Background Leakage
Unreported and un-detectable using traditional acoustic equipment.
Tools
• Pressure Reduction
• Main and service replacement
• Reduction in the number of joints and fittings
Unreported Leakage
Often does not surface but is detectable using traditional acoustic equipment.
Tools
• Pressure Reduction
• Main and service replacement
• Reduction in the number of joints and fittings
• Proactive Leak Detection
Reported Leakage
Often surfaces and is reported by public or utility workers.
Tools
• Pressure Reduction
• Main and service replacement
• Optimized repair time
Background
Unreported
Reported

Leakage in Water Distribution Systems: Myths and Truths

THE MYTH

- "We have no leakage"
- Leakage rates can't be measured
- Leakage has no cost

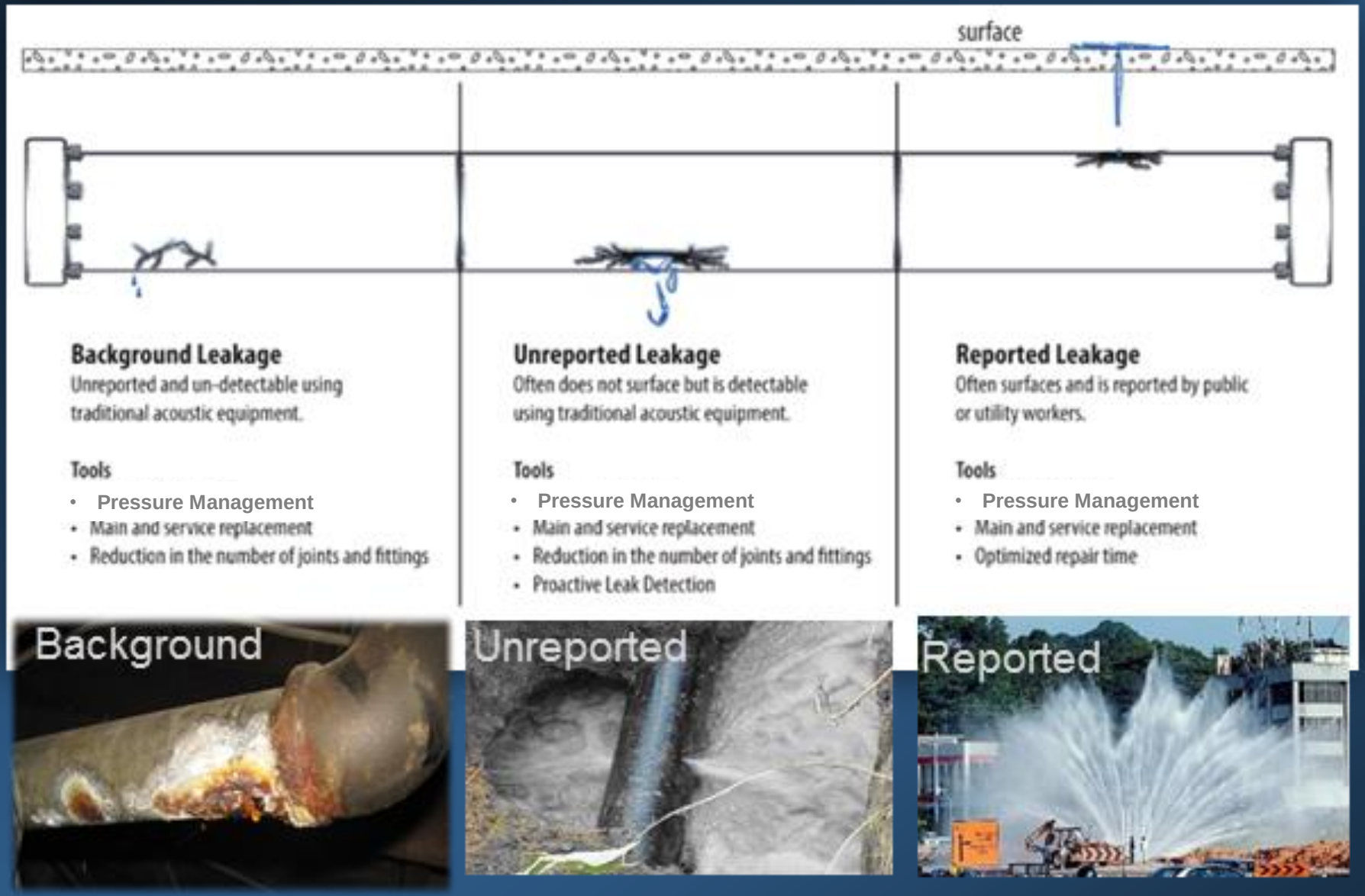
THE TRUTH

- All systems leak; only the volume varies
- Leakage can be measured (in District Metered Areas or DMAs)
- Leakage has distinct cost impacts, that are often masked

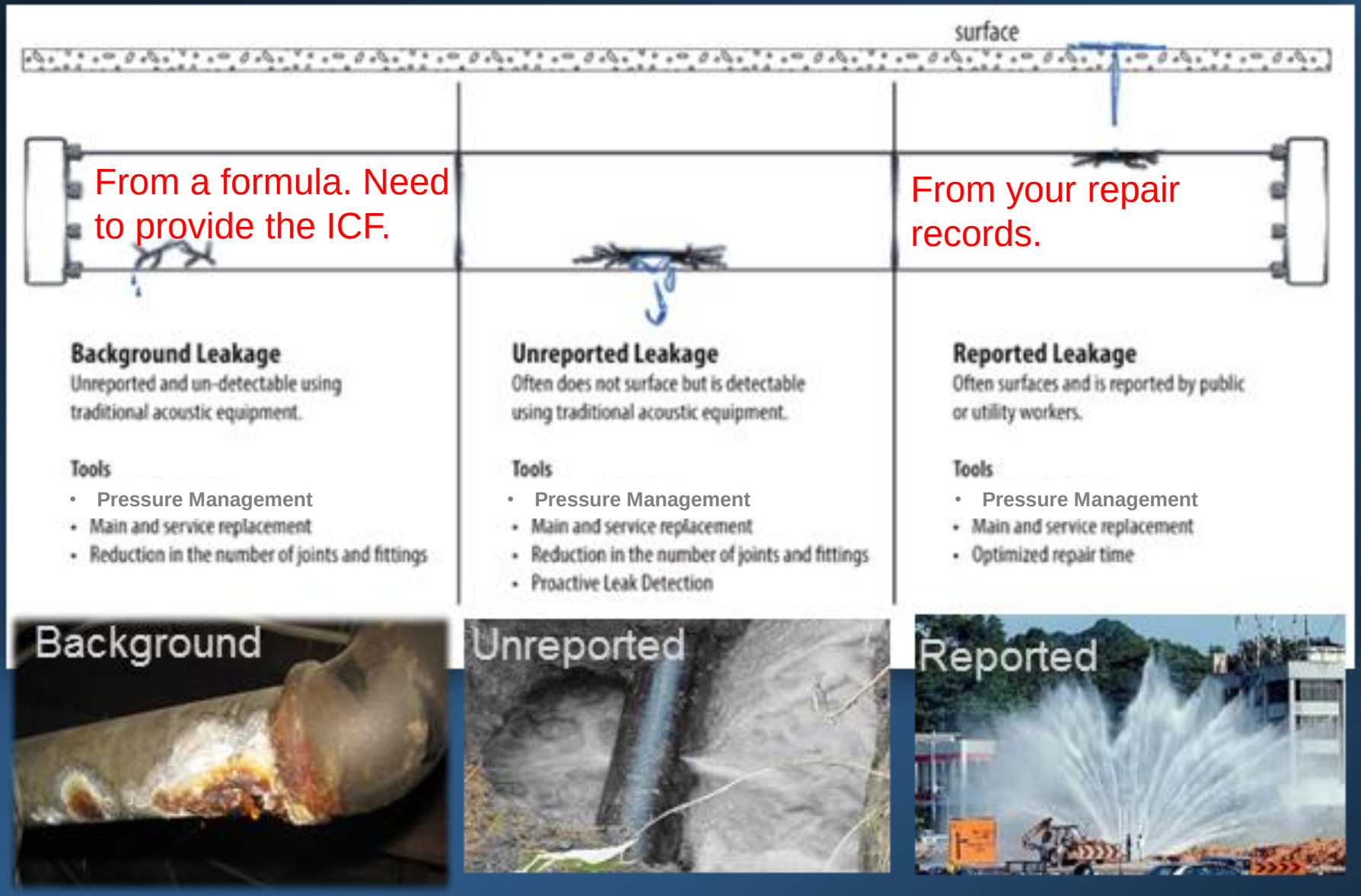
Also:

Leakage runs 24/7/365 until it is abated; savings potential can be much greater than optimizing intermittent wastes of water

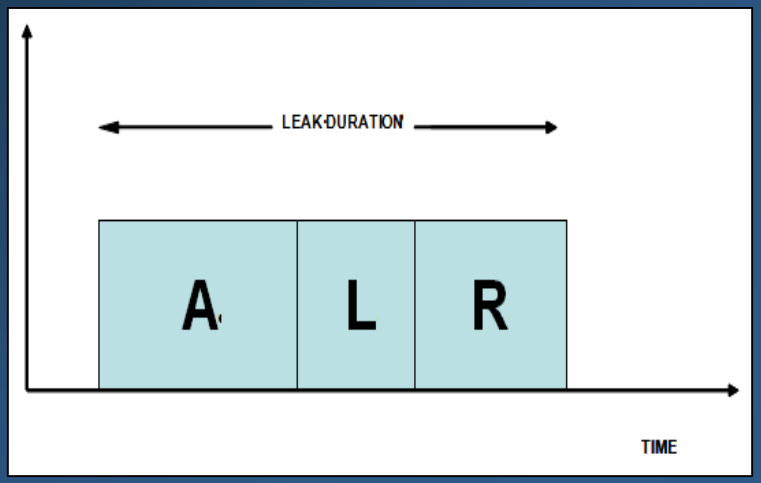
Graphic Courtesy WRF

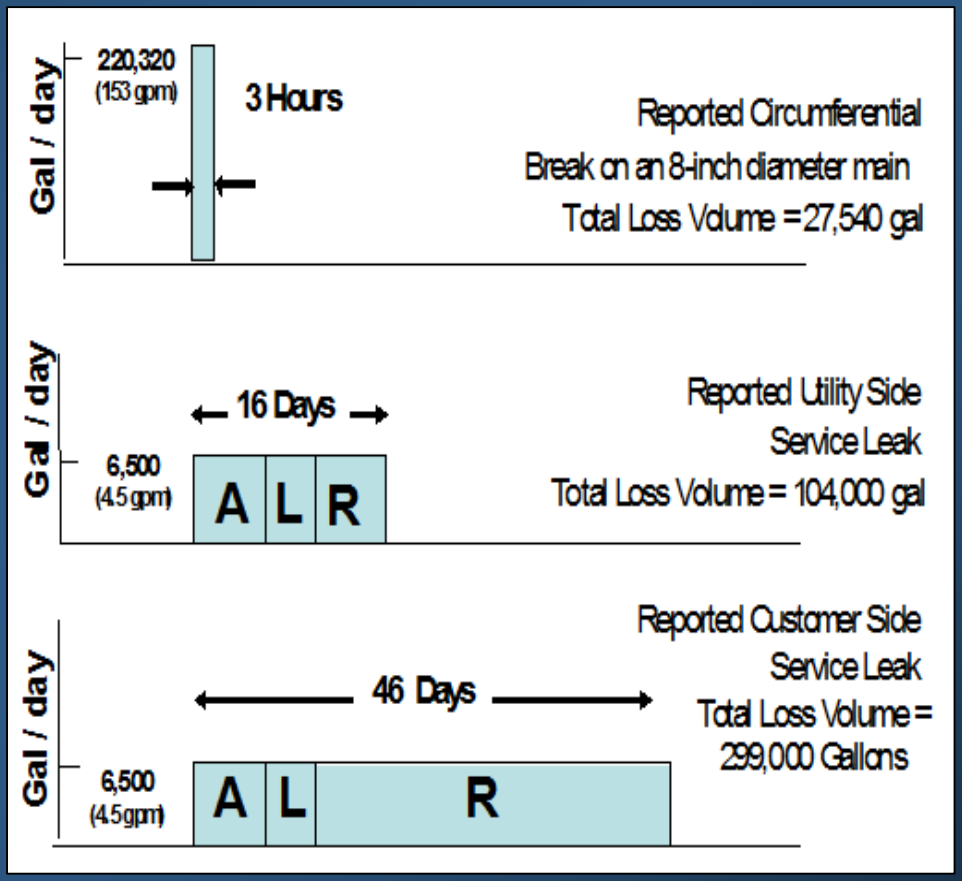


Graphic Courtesy WRF



The Life of a Leak: Awareness, Location & Repair Times





This is the basis for *Leakage Component Analysis*

Basic Data Needed for Component Analysis

Failure Data

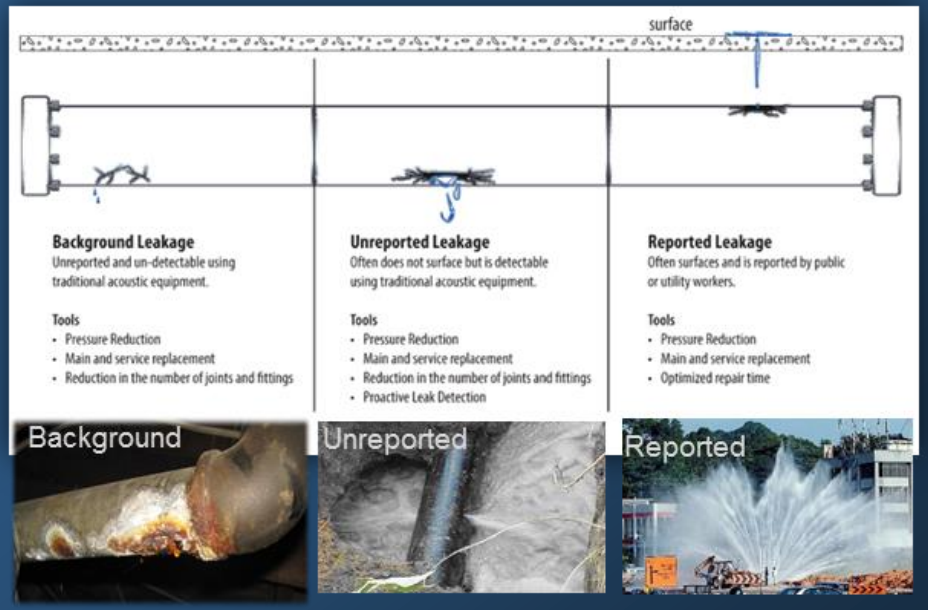
1. Break type: reported or unreported
2. Main or service
3. Location
4. Line size
5. Date/time the break became known
6. Date/time the break was fixed

Other Data

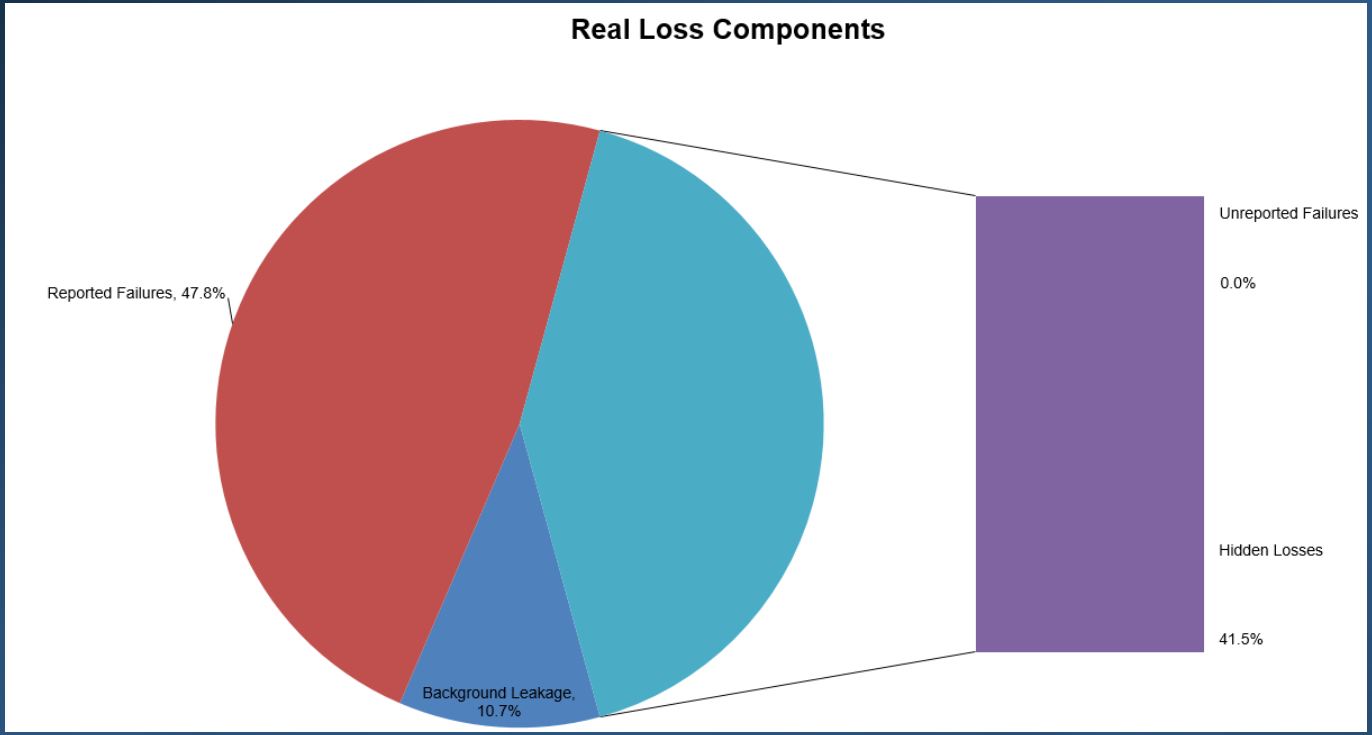
7. Storage tank volume (total)
8. Average age of pipe network (approx.)
9. Data from your AWWA water audit

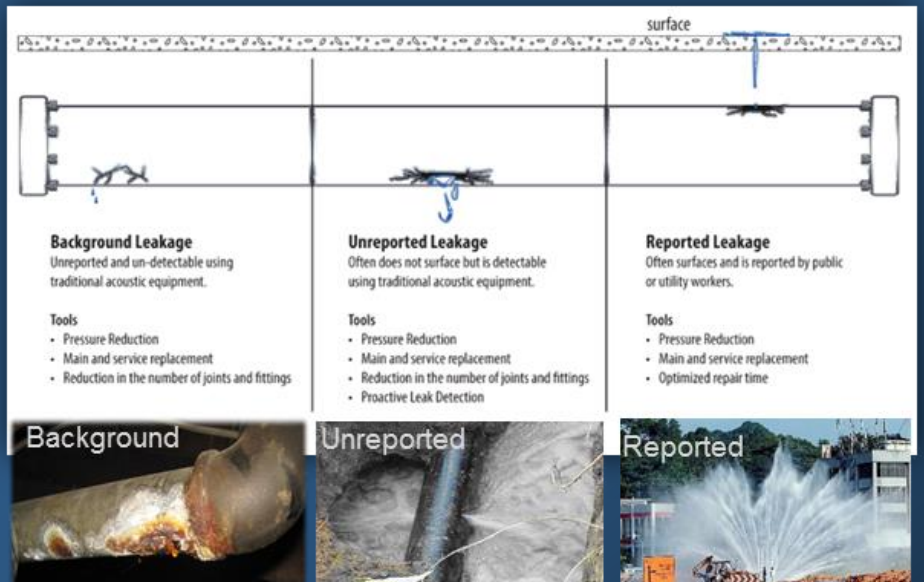
Real Loss Component Analysis Results

REAL LOSS COMPONENT ANALYSIS RESULTS				
System Component	Background Leakage	Reported Failures	Unreported Failures (Hidden Losses)	Total
	(MG)	(MG)	(MG)	(MG)
Reservoirs	3	-	-	**3**
Mains and Appurtenances	77	574	-	**651**
Service Connections	144	11	-	**154**
Total Annual Real Loss	**224**	**584**	**-**	**808**
Real Losses as Calculated by Water Audit				**1,612**
Hidden Losses/Unreported Leakage Currently Running Undetected				**804**



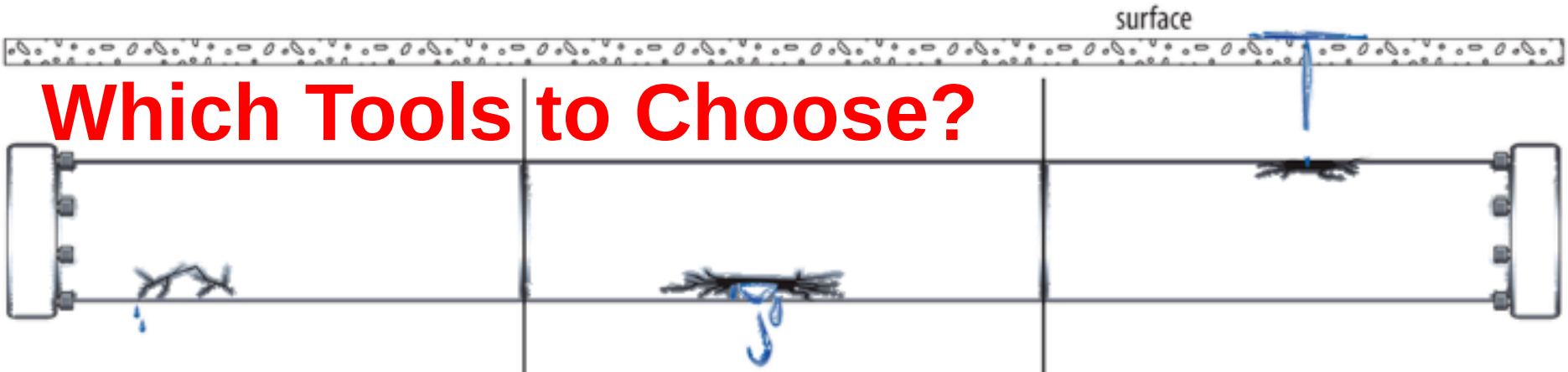
Real Loss Component Analysis Results





Graphic Courtesy WRF

Which Tools to Choose?



Background Leakage
Unreported and un-detectable using traditional acoustic equipment.

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Unreported Leakage
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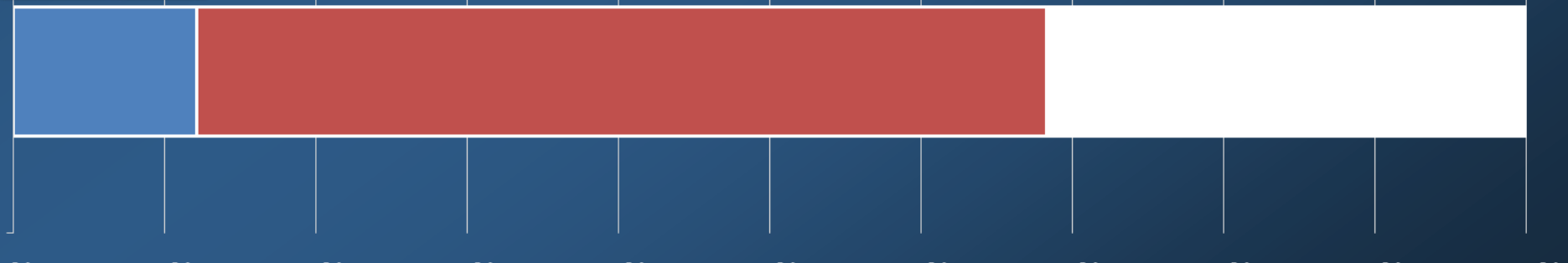

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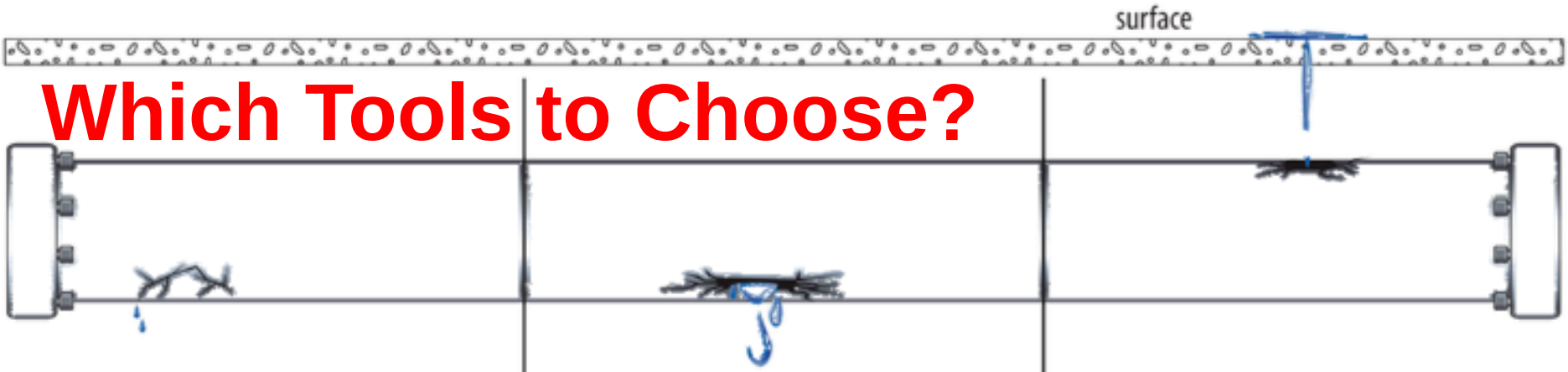
Which Tools to Choose?



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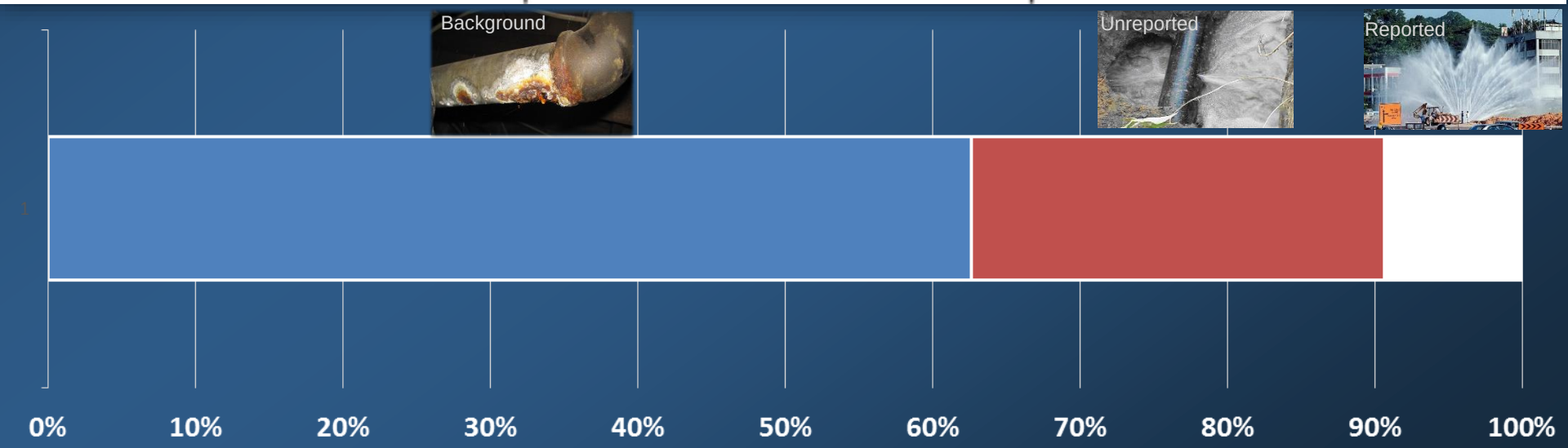

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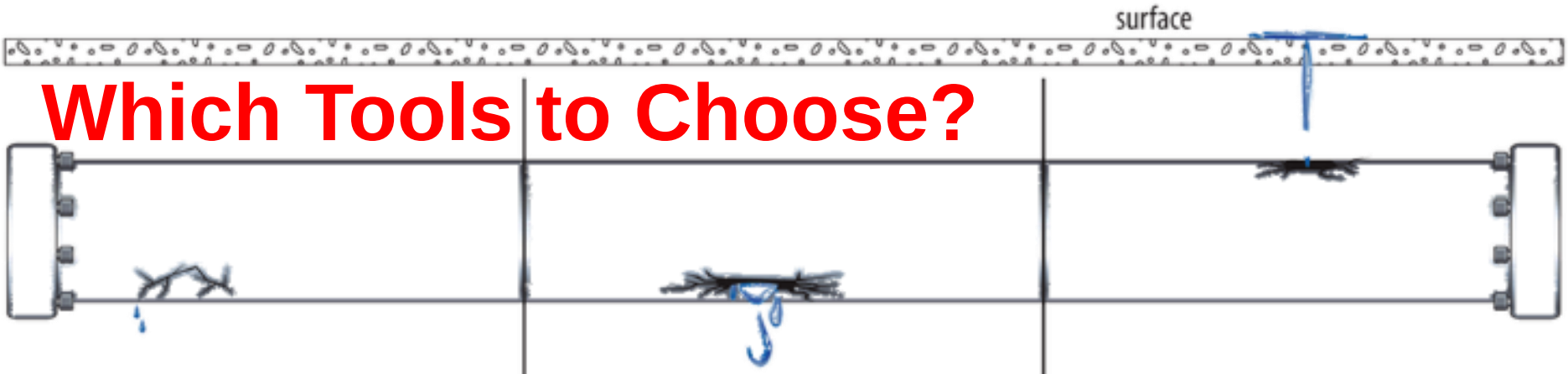

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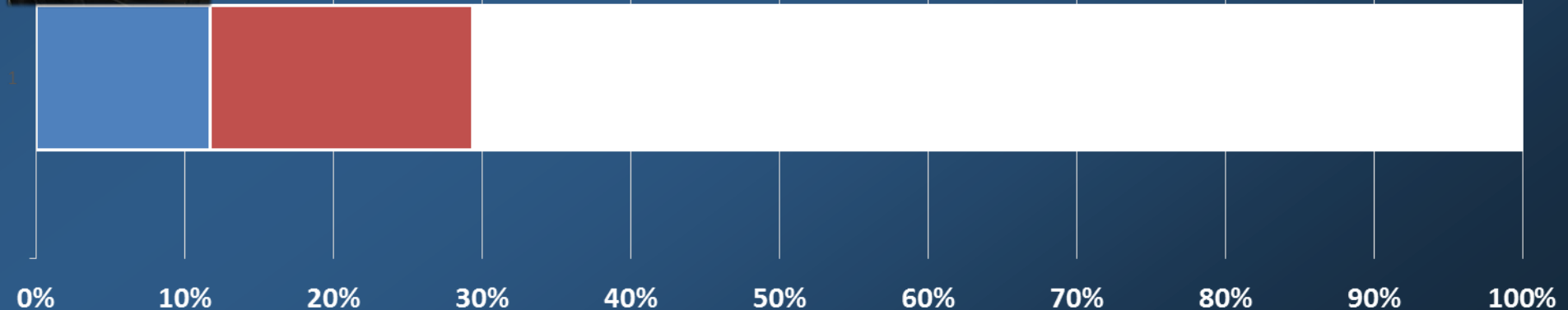


Utilize The Audit - Examples

1. Create a water balance: separate Non-Revenue Water into Unbilled Consumption, Apparent Loss and Real Loss.

2. Test the validity: Data Validity Score & Metrics screening, gremlin hunting

3. Analyze the components of Unbilled Consumption, Apparent Loss and Real Loss. Use volumes & values.

4. Prioritize the components to make a plan of attack.

The Toolbox (Basic)	Helps to Address	Level of Cost
1 - Validation of supply & consumption volumes	Low Data Validity Score, Gremlins	Low-Mid
2 - Estimating and tracking unmetered use	Validity, Unmetered Use	None-Low
3 - Installing meters on unmetered connections	Unmetered Use	Mid
4 - Billing system audit	Systematic Data Handling Errors	Low-Mid
5 - Meter testing & replacement	Customer metering inaccuracy	Mid-High
6 - Unidirectional flushing program	Unbilled unmetered	Low
7 - Acoustic leak survey	Unreported leakage	Mid
8 - Improve speed/quality of repairs	Unreported, Reported leakage	Low
9 - Locate & eliminate pressure transients (surges, hammers)	All 3 types of leakage	Low-Mid
10 - Reduce peak and overall pressure	All 3 types of leakage	Mid-High

Water Audit Report for: EXAMPLE - Tallapoosa (1430002)
Reporting Year: 2014 | 1/2014 - 12/2014

*** YOUR WATER AUDIT DATA VALIDITY SCORE IS: 69 out of 100 ***

System Attributes:

	Apparent Losses:	3.787	MG/Yr
+	Real Losses:	47.362	MG/Yr
=	**Water Losses:**	**51.149**	MG/Yr
?	Unavoidable Annual Real Losses (UARL):	See limits in definition	MG/Yr
	Annual cost of Apparent Losses:	$18,860	
	Annual cost of Real Losses:	$123,614	Valued at

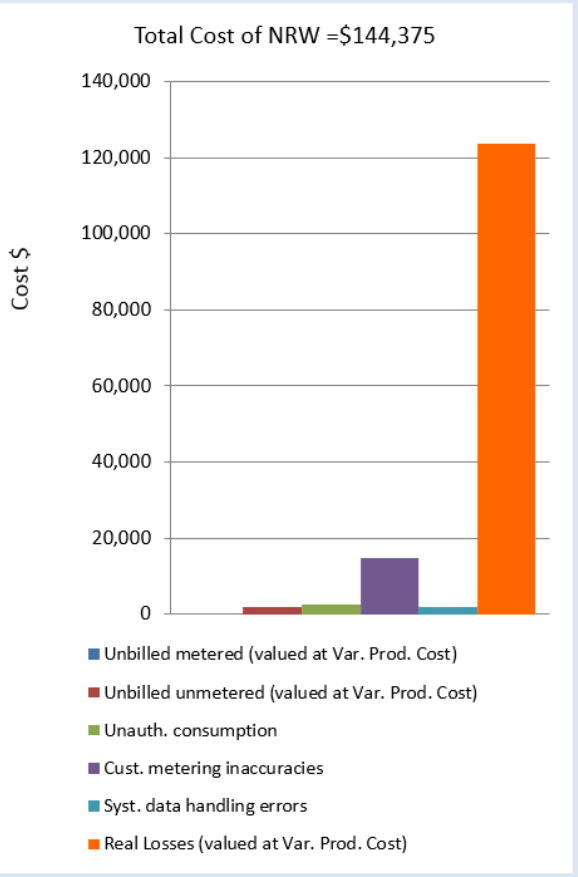
Return to Repo

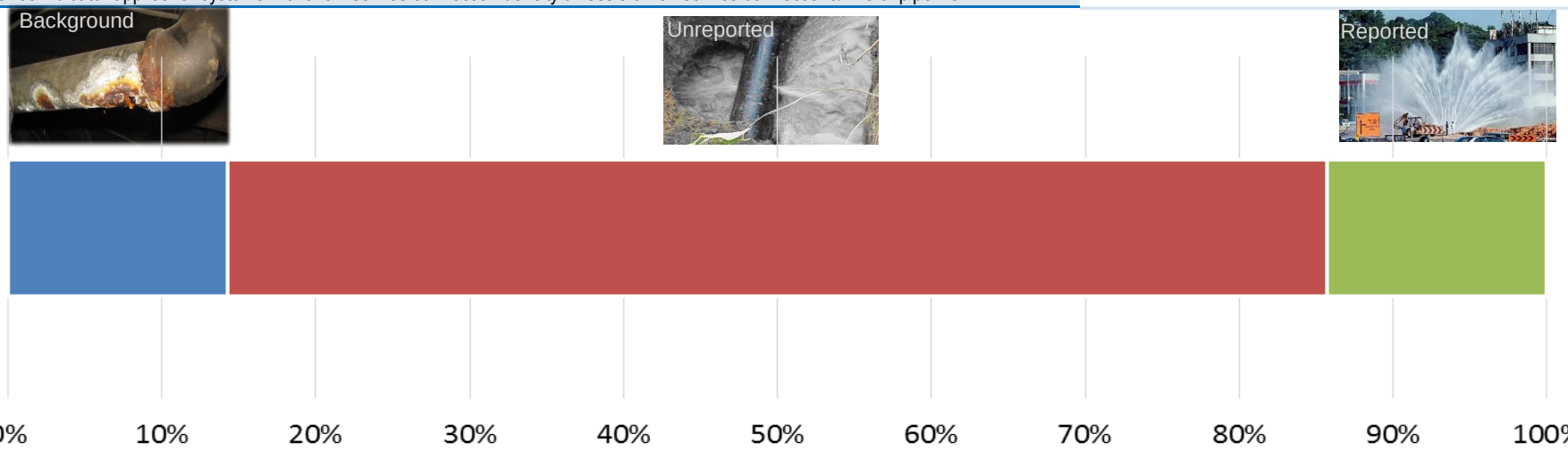
Performance Indicators:

Financial:	Non-revenue water as percent by volume of Water Supplied:	26.5%	
	Non-revenue water as percent by cost of operating system:	16.5%	Real Losses
Operational Efficiency:	Apparent Losses per service connection per day:	6.05	gallons/conn
	Real Losses per service connection per day:	75.66	gallons/conn
	Real Losses per length of main per day*:	N/A	
	Real Losses per service connection per day per psi pressure:	0.95	gallons/conn
	From Above, Real Losses = Current Annual Real Losses (CARL):	47.36	million gallons
?	Infrastructure Leakage Index (ILI) [CARL/UARL]:		

This performance indicator applies for systems with a low service connection density of less than 32 service connections/mile of pipeline

○ Show me the VOLUME of Non-Revenue Water
◉ Show me the COST of Non-Revenue Water





The Toolbox (Basic)	Helps to Address	Level of Cost
1 - Validation of supply & consumption volumes	Low Data Validity Score, Gremlins	Low-Mid
2 - Estimating and tracking unmetered use	Validity, Unmetered Use	
3 - Installing meters on unmetered connections	Unmetered Use	Mid
4 - Billing system audit	Systematic Data Handling Errors	Low-Mid
5 - Meter testing & replacement	Customer metering inaccuracy	Mid-High
6 - Unidirectional flushing program	Unbilled unmetered	Low
7 - Acoustic leak survey	Unreported leakage	Mid
8 - Improve speed/quality of repairs	Unreported, Reported leakage	Low
9 - Locate & eliminate pressure transients (surges, hammers)	All 3 types of leakage	Low-Mid
10 - Reduce peak and overall pressure	All 3 types of leakage	Mid-High

Water Audit Report for: #1 - CITY OF ADEL (GA0750000)
Reporting Year: 2014 | 1/2014 - 12/2014

*** YOUR WATER AUDIT DATA VALIDITY SCORE IS: 60 out of 100 ***

System Attributes:

Apparent Losses:	15.100	MG/Yr
+ Real Losses:	93.737	MG/Yr
= **Water Losses:**	**108.837**	MG/Yr
? Unavoidable Annual Real Losses (UARL):	15.26	MG/Yr
Annual cost of Apparent Losses:	$47,869	
Annual cost of Real Losses:	$297,145	Valu

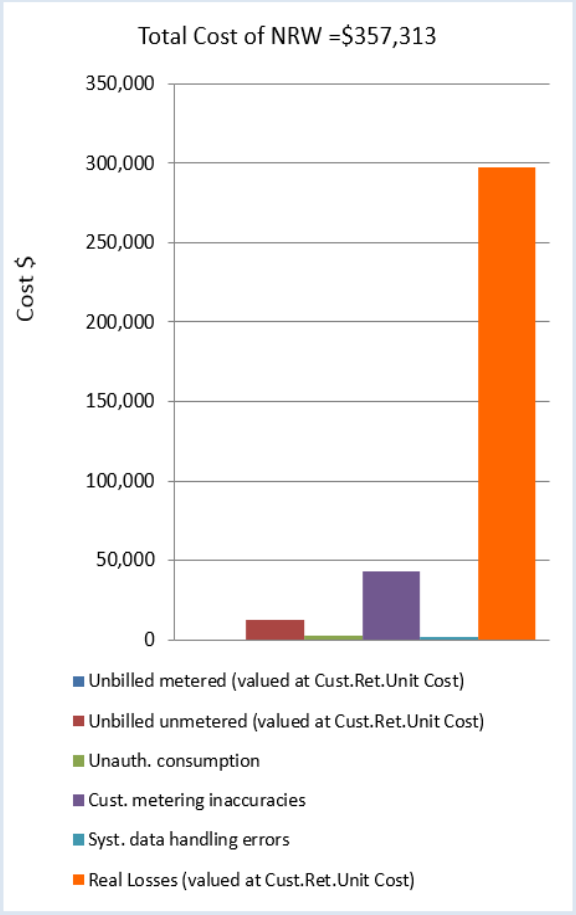
Return to

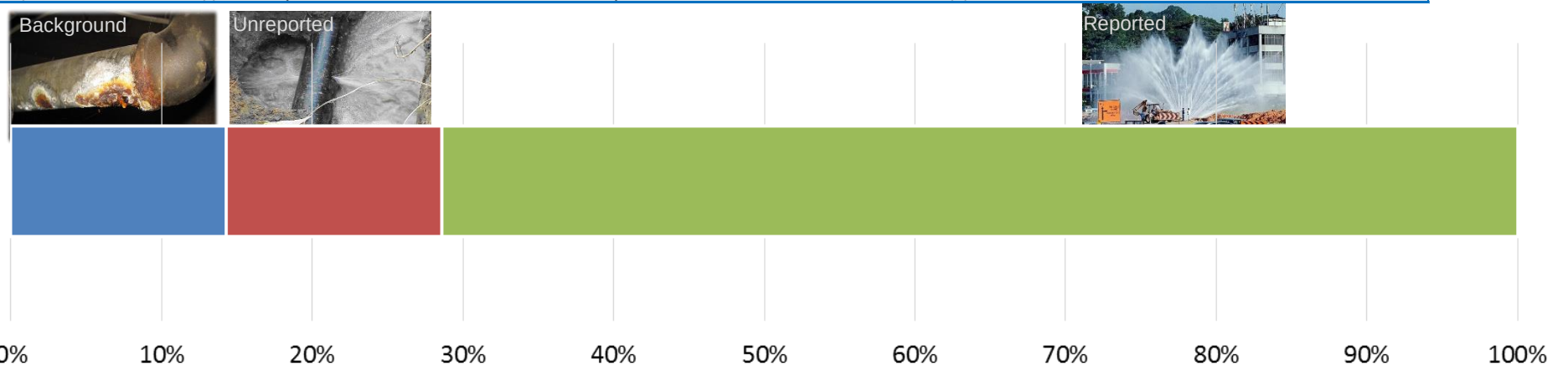
Performance Indicators:

Financial: Non-revenue water as percent by volume of Water Supplied:	30.5%	
Non-revenue water as percent by cost of operating system:	43.3%	Real Lo
Operational Efficiency: Apparent Losses per service connection per day:	17.24	gallons/
Real Losses per service connection per day:	107.01	gallons/
Real Losses per length of main per day*:	N/A	
Real Losses per service connection per day per psi pressure:	1.95	gallons/
From Above, Real Losses = Current Annual Real Losses (CARL):	93.74	million g
? Infrastructure Leakage Index (ILI) [CARL/UARL]:	6.14	

* This performance indicator applies for systems with a low service connection density of less than 32 service connections/mile of pipeline

○ Show me the VOLUME of Non-Revenue Water
◉ Show me the COST of Non-Revenue Water





The Toolbox (Basic)	Helps to Address	Level of Cost
1 - Validation of supply & consumption volumes	Low Data Validity Score, Gremlins	Low-Mid
2 - Estimating and tracking unmetered use	Validity, Unmetered Use	
3 - Installing meters on unmetered connections	Unmetered Use	Mid
4 - Billing system audit	Systematic Data Handling Errors	Low-Mid
5 - Meter testing & replacement	Customer metering inaccuracy	Mid-High
6 - Unidirectional flushing program	Unbilled unmetered	Low
7 - Acoustic leak survey	Unreported leakage	Mid
8 - Improve speed/quality of repairs	Unreported, Reported leakage	Low
9 - Locate & eliminate pressure transients (surges, hammers)	All 3 types of leakage	Low-Mid
10 - Reduce peak and overall pressure	All 3 types of leakage	Mid-High

Water Audit Report for: #2 - City of Cave Spring (GA 150000)
Reporting Year: 2014 | 1/2014 - 12/2014

○ Show me the VOLUME of Non-Revenue Water
◉ Show me the COST of Non-Revenue Water

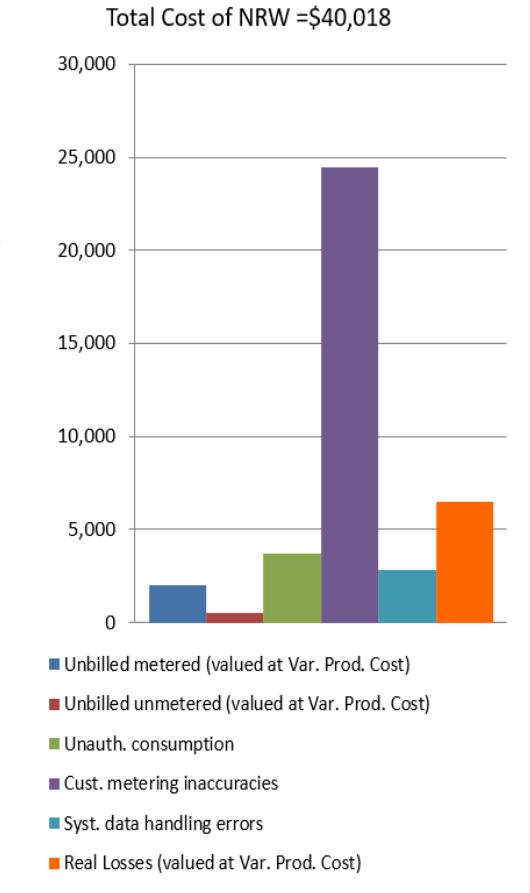
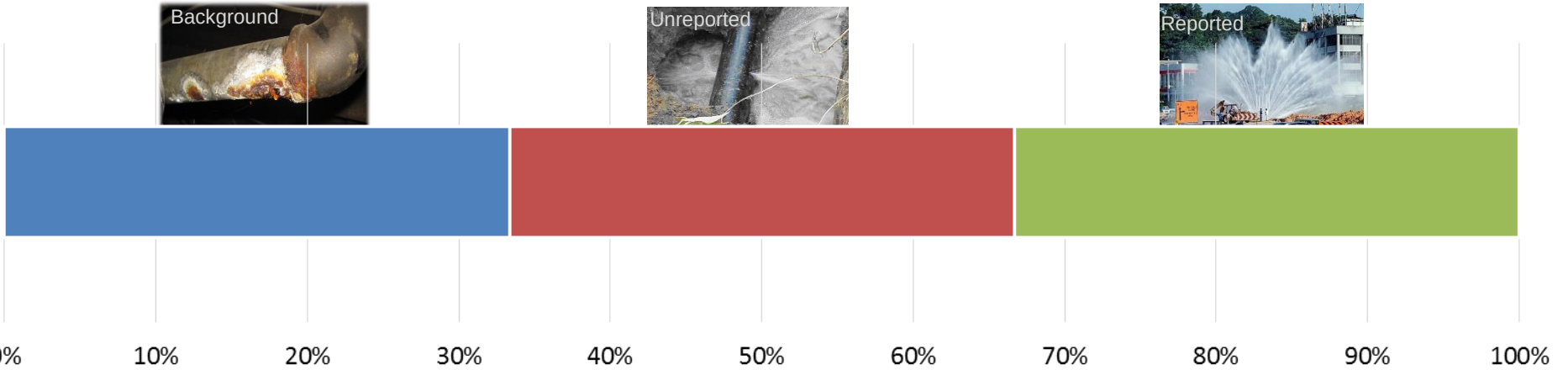
*** YOUR WATER AUDIT DATA VALIDITY SCORE IS: 52 out of 100 ***

System Attributes:

	Apparent Losses:	4.041	MG/Yr
+	Real Losses:	29.998	MG/Yr
=	**Water Losses:**	**34.039**	MG/Yr
?	Unavoidable Annual Real Losses (UARL):	28.55	MG/Yr
	Annual cost of Apparent Losses:	$30,992	
	Annual cost of Real Losses:	$6,476	Val

Return t

Performance Indicators:

Financial:	Non-revenue water as percent by volume of Water Supplied:	23.8%	
	Non-revenue water as percent by cost of operating system:	4.8%	Real L
Operational Efficiency:	Apparent Losses per service connection per day:	6.91	gallons
	Real Losses per service connection per day:	N/A	gallons
	Real Losses per length of main per day*:	944.67	gallons
	Real Losses per service connection per day per psi pressure:	N/A	gallons
	From Above, Real Losses = Current Annual Real Losses (CARL):	30.00	million
?	Infrastructure Leakage Index (ILI) [CARL/UARL]:	1.05	

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