This presentation premiered at WaterSmart Innovations

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WaterRF 4372

Effective Organization and Component Analysis of Utility Leakage Data

Water Smart Innovations, October 2013

Agenda:

1. Review of Component Analysis Model Features (15)
2. Review of Water RF Project Findings (15)
3. Q & A (5)

WaterRF Project Review: #4372

Effective Organization & Component Analysis of Utility Leakage Data

PROJECT BASICS:

- *Funded by the WaterRF and EPA*
- *Model Release & Report Publishing in Feb/Mar 2014*
- *Webinars in First Quarter 2014*

PROJECT GOALS:

- Provide utilities software model for component analysis of real losses
- Provide informative context for performance indicator results
- Develop the software model to optimize use (prioritizing accessibility and adoption)

PARTICIPATING UTILITIES:

- Eastern Municipal Water District
- Metro Water Services, Nashville TN
- Halifax Regional Water Commission
- City of Folsom Utilities Dept
- San Antonio Water System
- Lake Arrowhead Community Services District
- S. Central CT Regional Water Authority
- City of Phoenix Water Services Dept
- Austin Water Utility
- Water & Wastewater Authority of Wilson County

The AWWA Water Balance

KEY TOOL

SYSTEM INPUT VOLUME	Authorized Consumption	Billed Authorized Consumption	Billed Metered Authorized Consumption
			Billed Unmetered Authorized Consumption
		Unbilled Authorized Consumption	Unbilled Metered Authorized Consumption
			Unbilled Unmetered Authorized Consumption
	Water Losses	Apparent Losses	Consumption Metering Errors
			Unauthorized Consumption
			Systematic Data Handling Errors
		Real Losses	Leakage/Overflow at Reservoirs
			Leakage from Trunk Mains
			Leakage from Distribution Mains
			Leakage from Service Connections

The AWWA Water Balance

KEY TOOL

SYSTEM INPUT VOLUME	Authorized Consumption	Billed Authorized Consumption	Billed Metered Authorized Consumption	REVENUE WATER
			Billed Unmetered Authorized Consumption	
		Unbilled Authorized Consumption	Unbilled Metered Authorized Consumption	NON-REVENUE WATER
			Unbilled Unmetered Authorized Consumption	
	Water Losses	Apparent Losses	Consumption Metering Errors	
			Unauthorized Consumption	
			Systematic Data Handling Errors	
		Real Losses	Leakage/Overflow at Reservoirs	
			Leakage from Trunk Mains	
			Leakage from Distribution Mains	
			Leakage from Service Connections	

Non-Revenue Water Breakdown

REAL LOSSES

APPARENT LOSSES

Water Loss Control Program Next Steps

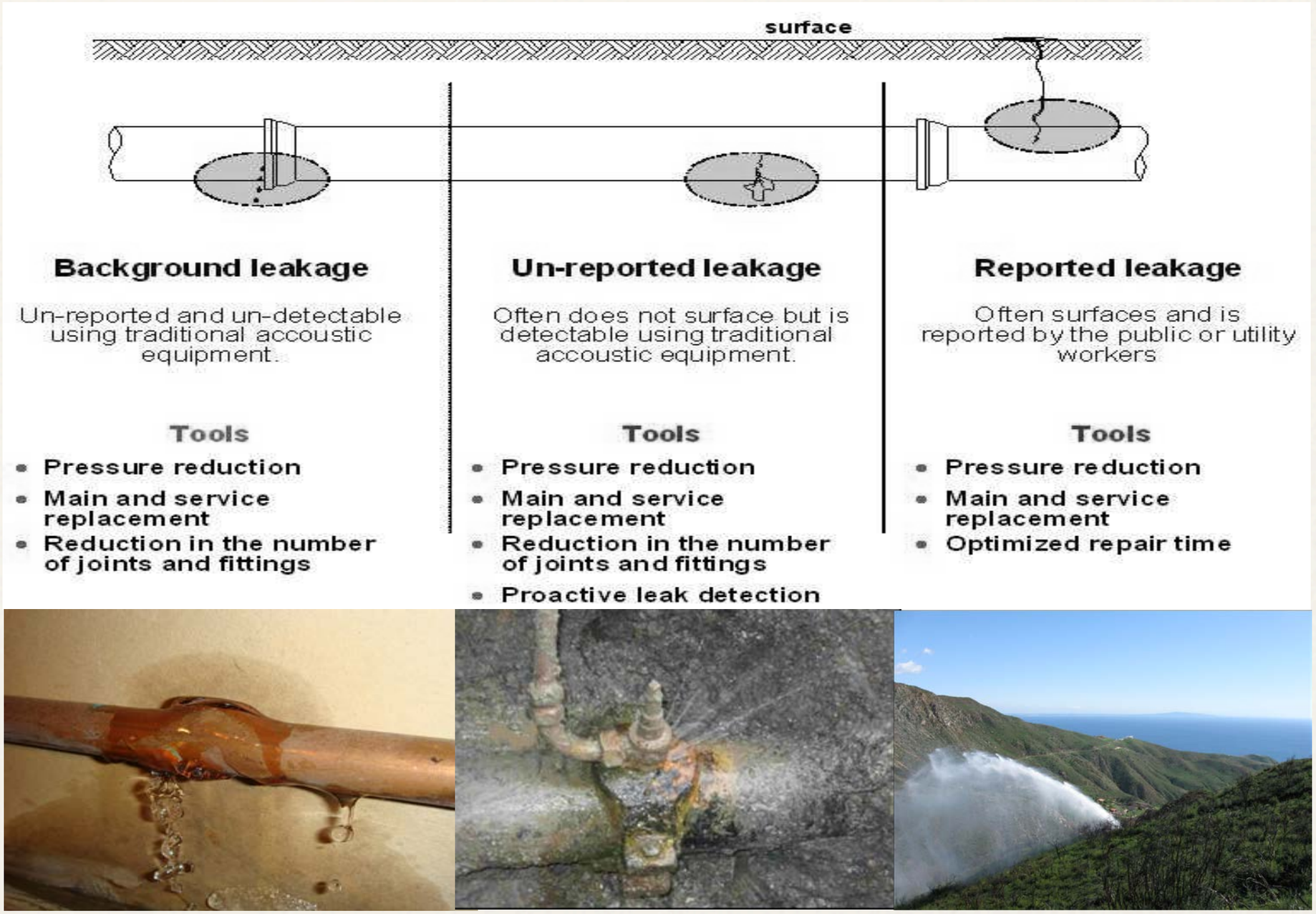
With A Completed AWWA Water Balance:

- ✓ Volume of Apparent Losses
- ✓ Volume of Real Losses
- ✓ Performance Indicators
- ✓ Data Validity Score

Remaining Assessments:

- ➡ Understanding of Real Loss Breakdown (where are these losses occurring? what types of leakage?)
- ➡ Economic Level of Leakage
- ➡ Cost-Effective Non-Revenue Water Reduction Strategies

Component Analysis of Real Losses



Reported Leakage

KEY TERM

Reported Leakage: the water utility became aware of the event because it came about as a complaint or report of a problem caused by visible water from the leak

Reported by:
- Customer
- Public Safety personnel – police, streets/highway, fire dept, etc.
- Meter Reader
- Sewer Inspection, or Other

Un-Reported Leakage

KEY TERM

Un-reported Leakage: the water utility became aware of the event by its own proactive work to seek out and identify hidden leakage

Reported by:

- Leak Detection Crew
- Leak Detection Service

Determining Leakage Volumes

<u>Reported Leakage and Un-reported Leakage</u>
requires the following data:

- # of reported leaks by size
- average Awareness – Location - Repair (ALR) time per leak size group
- average leak flow rate
- average system pressure

Background Losses

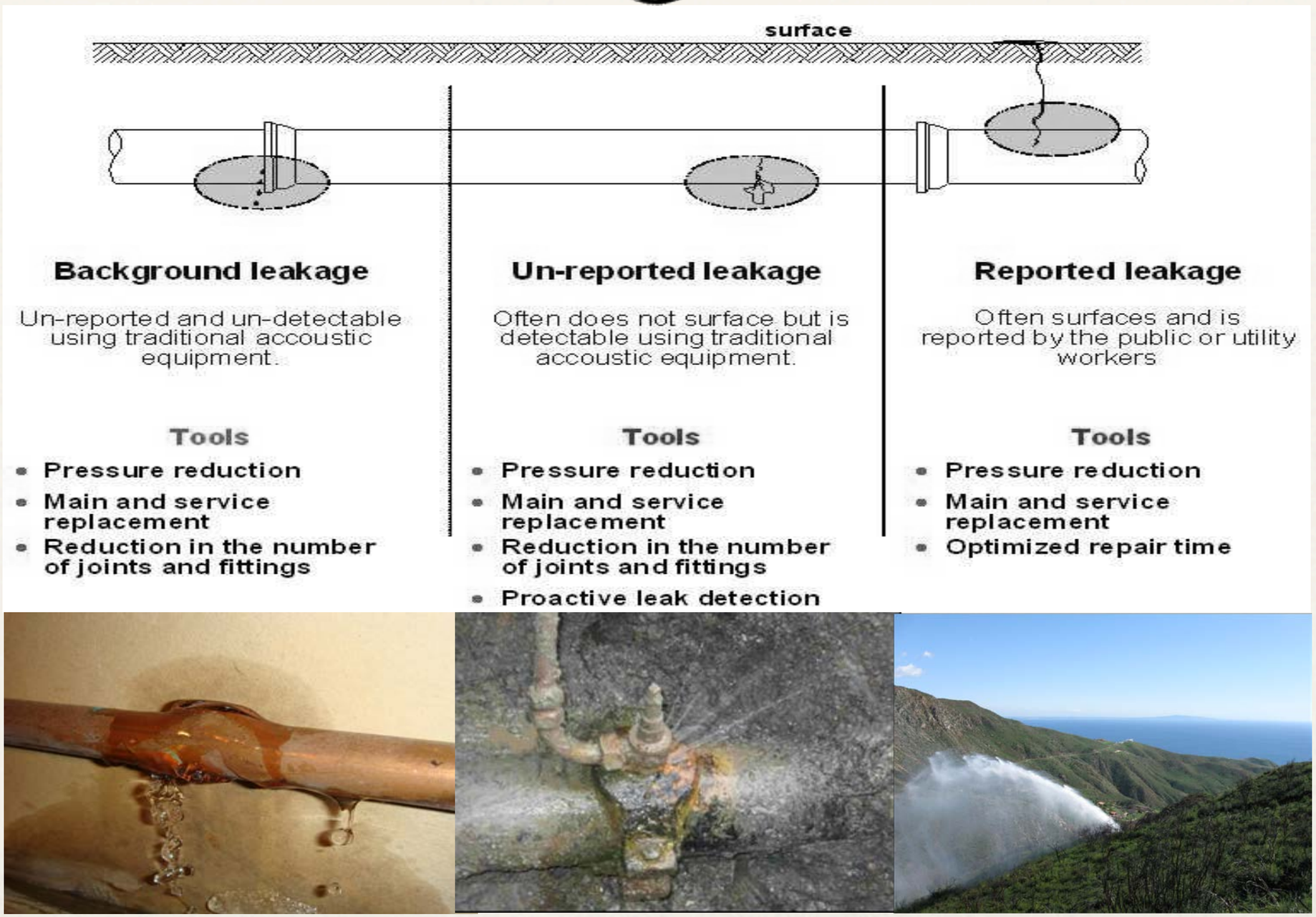
KEY TERM

Background Losses: weeps & seeps at joints & fittings

- Cannot be detected via traditional acoustic leak detection
- Depends on the condition of the infrastructure
- Very pressure sensitive
- Calculated using:
  - Length of mains, # of Service Connections, Avrg System Pressure
  - Unavoidable Annual Real Losses (UARL)
  - Infrastructure Condition Factor (ICF)

Component Analysis of Real Losses

✓ ✓ ✓



Hidden Losses

KEY TERM

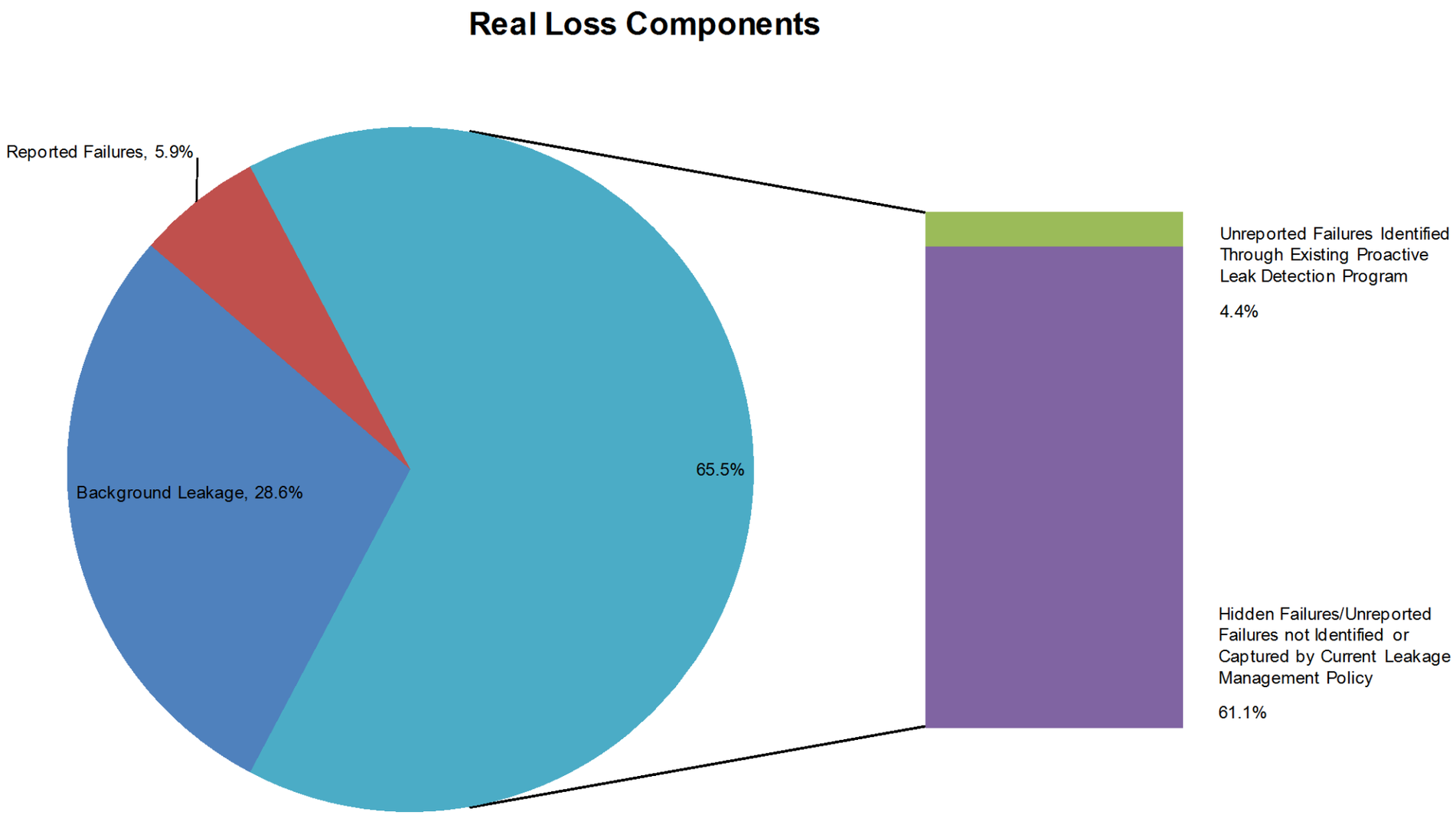
Component of Real Losses	Volume
Background Losses	A
Reported Leakage	B
Unreported Leakage (filed from leak detection)	C
Hidden Losses = remaining unreported leakage the continues to run in the system	D
Total Real Losses *determined by Water Balance	

Hidden Losses = Water Balance Total - (A + B + C)

Component Analysis of Real Losses

WaterRF 4372: Effective Organization and Component Analysis of Water Utility Leakage Data

Water Audit: City of Austin, TX, USA, 2011
REAL LOSSES COMPONENTS CHART



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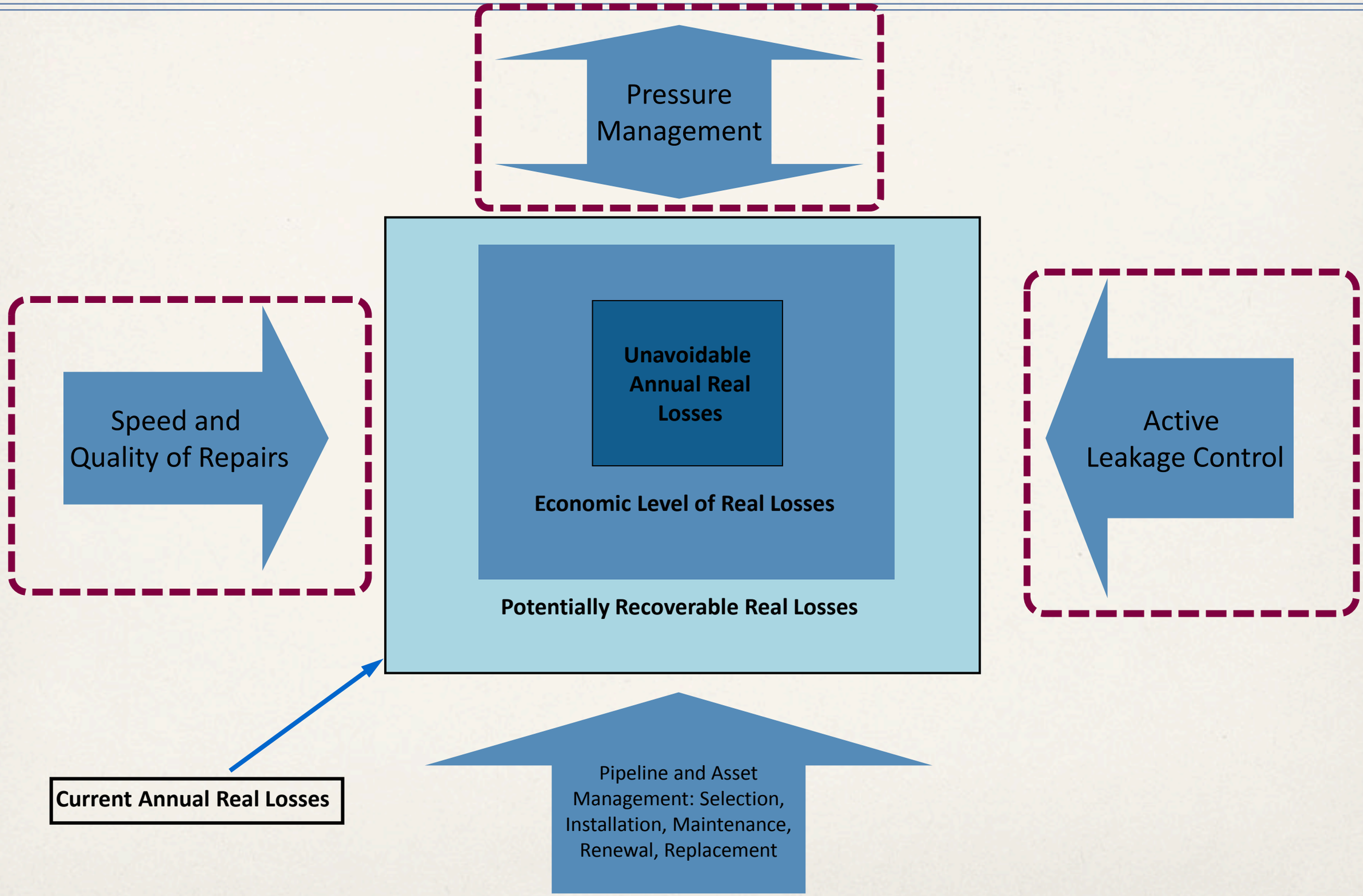
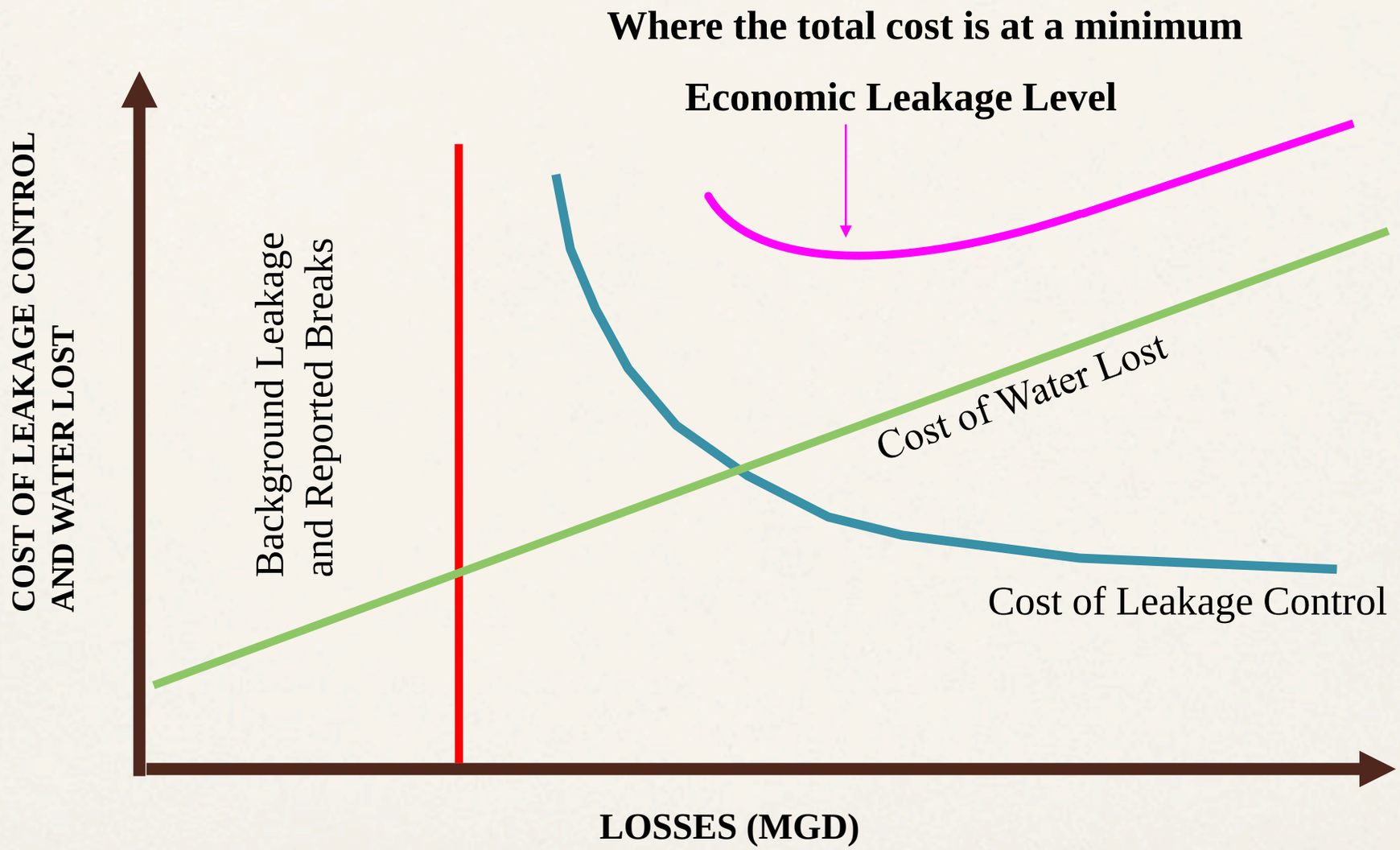
Leakage Management Strategies

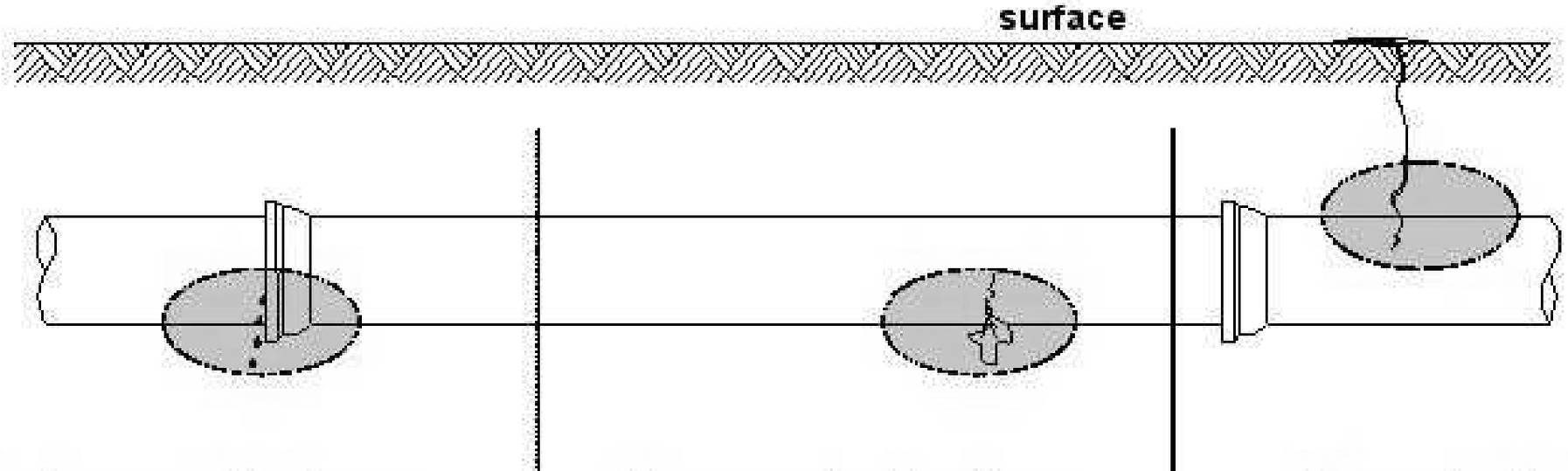


Proactive Leak Detection Strategy



Pressure & Leakage

Pressure & Leakage



Background leakage	Un-reported leakage	Reported leakage
Un-reported and un-detectable using traditional accoustic equipment.	Often does not surface but is detectable using traditional accoustic equipment.	Often surfaces and is reported by the public or utility workers
Tools	**Tools**	**Tools**
• Pressure reduction	• Pressure reduction	• Pressure reduction
• Main and service replacement	• Main and service replacement	• Main and service replacement
• Reduction in the number of joints and fittings	• Reduction in the number of joints and fittings	• Optimized repair time
	• Proactive leak detection	

Summarized Component Analysis

WATER AUDIT PERFORMANCE INDICATORS		
Financial		
Non-revenue water as percent by volume of water supplied:	10.3%	
Non-revenue water as percent by cost of operating system:	3.0%	
Annual cost of Apparent Losses:	$4,376,956	
Annual cost of Real Losses:	$1,429,630	
Operational Efficiency		
Apparent Losses per service connection per day:	13.7	gal/service conn/day
Real Losses per service connection per day*:	56.0	gal/service conn/day
Real Losses per length of main per day:	N/A	gal/mi/day
r service connection per day per 1787.62743734595 pressure:	0.7	gal/service conn/day/psi
Unavoidable Annual Real Losses (UARL):	1,453.52	MG/Yr
Current Annual Real Losses (CARL):	4,332.21	MG/Yr
Infrastructure Leakage Index (ILI) [CARL/UARL]:	3.0	

REAL LOSS COMPONENT ANALYSIS RESULTS				
System Component	Background Leakage	Reported Failures	Unreported Failures	Total
	(MG)	(MG)	(MG)	(MG)
Reservoirs	22.08	-	-	**22.08**
Mains and Appurtenances	372.61	217.12	173.49	**763.22**
Service Connections	844.15	39.55	17.46	**901.15**
Total Annual Real Loss	**1,238.83**	**256.66**	**190.95**	**1,686.44**
Real Losses as Calculated by Water Audit				**4,332.21**
Hidden Losses/Unreported Leakage Currently Running Undetected				**2,645.77**

AWARNESS, LOCATION AND REPAIR TIME REDUCTION RESULTS			
	Reported Failures	Unreported Failures	
Total Potential Savings if Location and Repair Duration is Reduced as Simulated on the A-L-R Times Options Sheet	182.3	32.9	(MG)
Total Potential Cost Savings if Location and Repair Duration is Reduced as Simulated on the A-L-R Times Options Sheet	$ 23,458	$ 10,837	Per Year

ECONOMIC INTERVENTION FREQUENCY FOR PROACTIVE LEAK DETECTION RESULTS		
Percentage of the System to be Surveyed per Year	31	%
Average Annual Budget for Intervention (Proactive Leak Detection)	283,187	$/year
Potentially Recoverable Leakage	1,787.63	MG/year

ALTERNATIVE PRESSURE MANAGEMENT SCENARIO RESULTS		
User-Inputted Reduction in Average System Pressure	5.0	PSI
Assumed % Reduction in Average System Pressure	6%	
Estimated Real Loss Reduction from Pressure Management Program	203.1	MG/Yr
Financial Savings from Pressure Management Program	67,026	$/Year
User-Estimated Cost of Pressure Reduction	100,000	$
Resulting Pressure Management Program Payback Period	1.5	Years

Key Findings from Model Development

- Adoption of AWWA Free Water Audit Software
- Importance of Data Validation
- Contextualized Performance Indicators
- Break Frequency Research

Adoption of Water Loss Software & Data Validation

- Review of statewide regulations and policies regarding water loss and the AWWA Free Water Audit software
- California Urban Water Conservation Council (CUWCC)
  - BMP 1.2: annual water audit submissions
  - Examined FY09-10 data

Table 2.6
CUWCC BMP 1.2 – 2010 Water Audit Data Set Validation Steps

	Count	Percentage
Number of Utilities Reporting Water Audit Result	130	100%
Number of Utilities Reporting Negative Water Losses	5	4%
Number of Utilities Reporting ILI<1	36	28%
Number of Utilities Reporting ILI>20	3	2%
Number of Utilities Reporting Erroneous Infrastructure Data	1	1%
Final Data Set After Removal of Erroneous Water Audit Reports	85	65%

Contextualized Performance Indicators

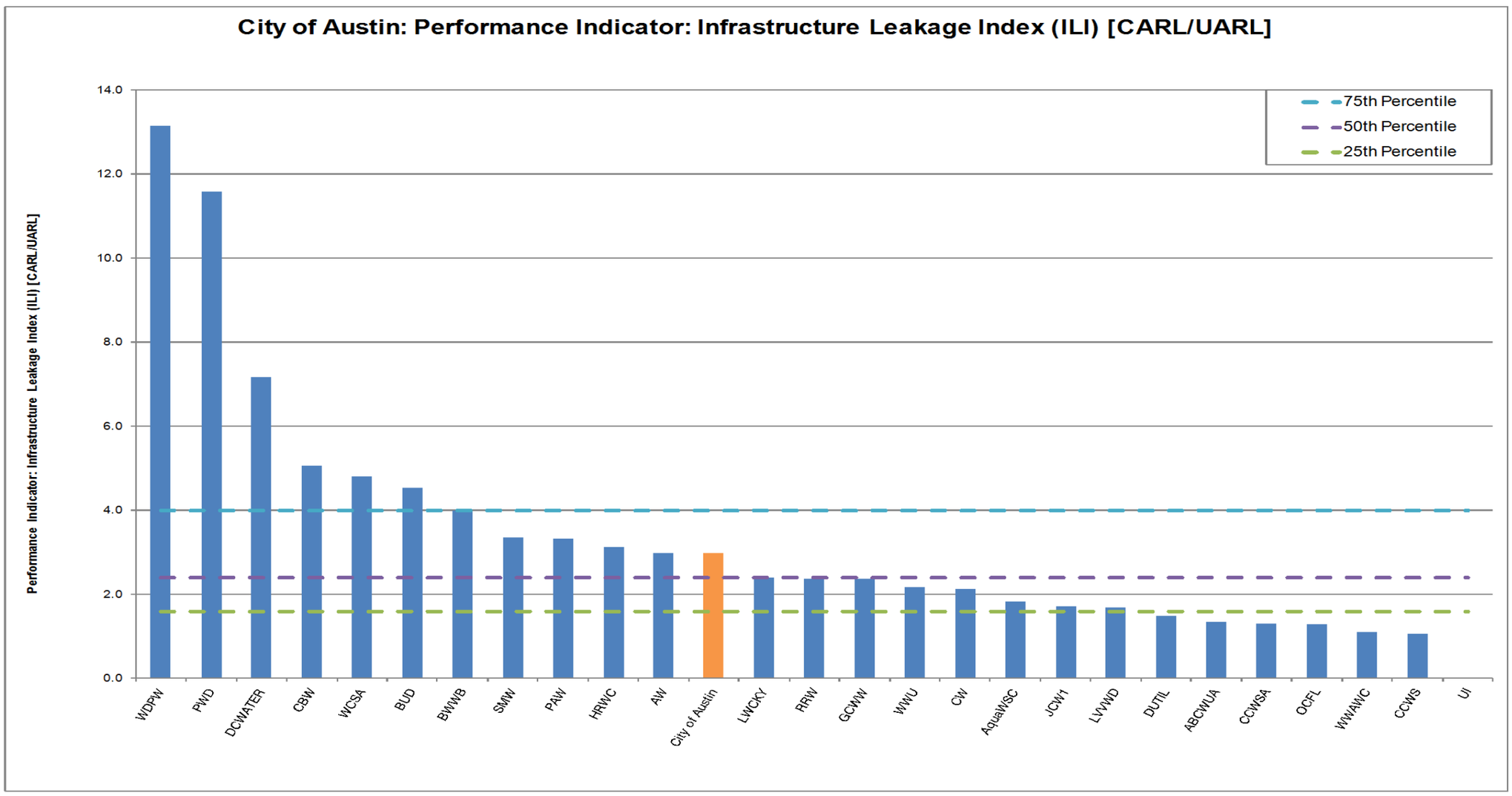
WaterRF 4372: Effective Organization and Component Analysis of Water Utility Leakage Data

Water Audit: City of Austin, TX, USA, 2011
PERFORMANCE INDICATOR COMPARISON

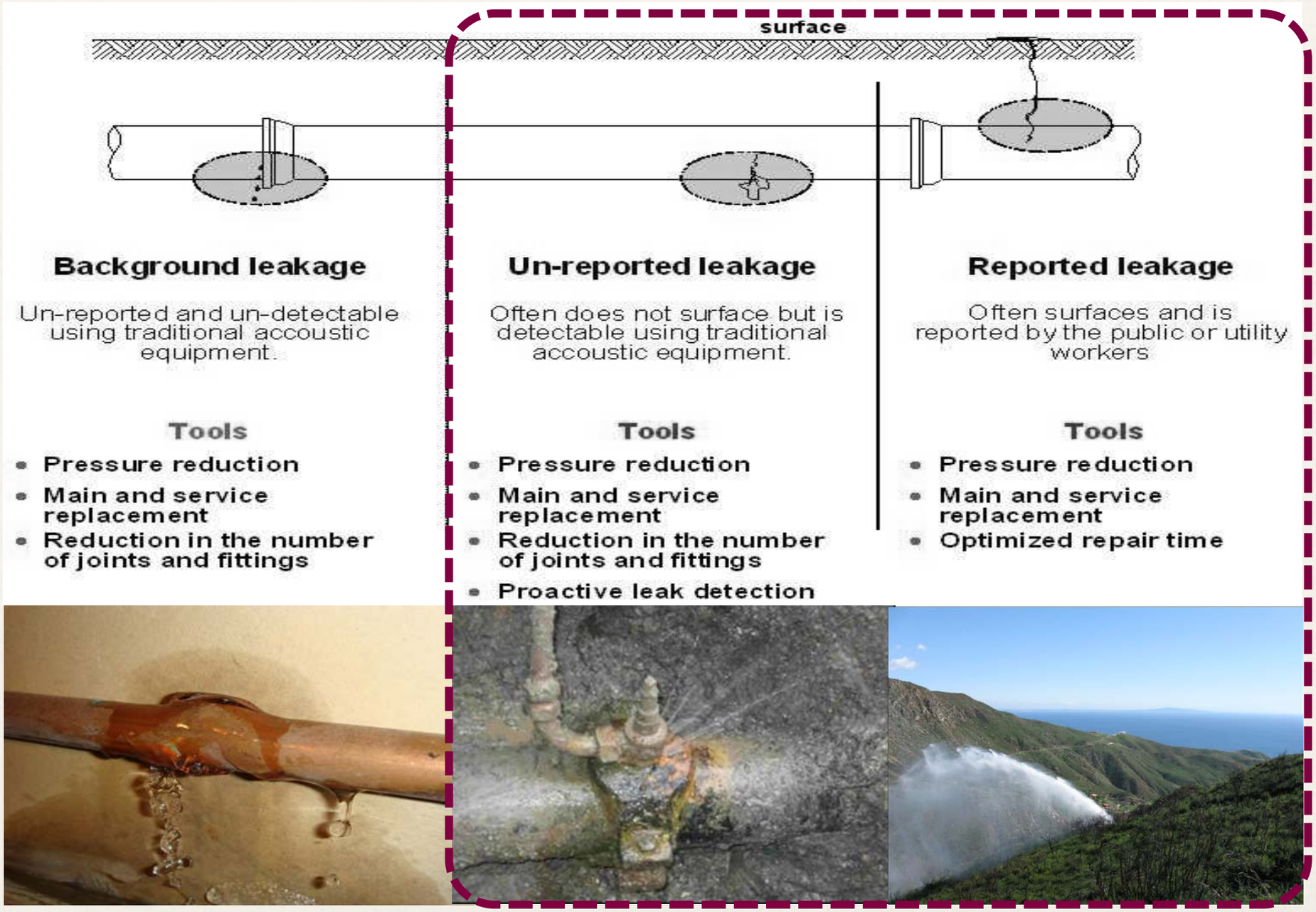
Instructions: Please select a performance indicator from the drop-down box to compare your utility's performance against the AWWA North American Validated Water Audit Data for 2012*. The performance indicator graph also displays the 25th, 50th and 75th percentile of the performance indicators data set.

Utility Name: City of Austin

Performance Indicator: Performance Indicator: Infrastructure Leakage Index (ILI) [CARL/UARL]



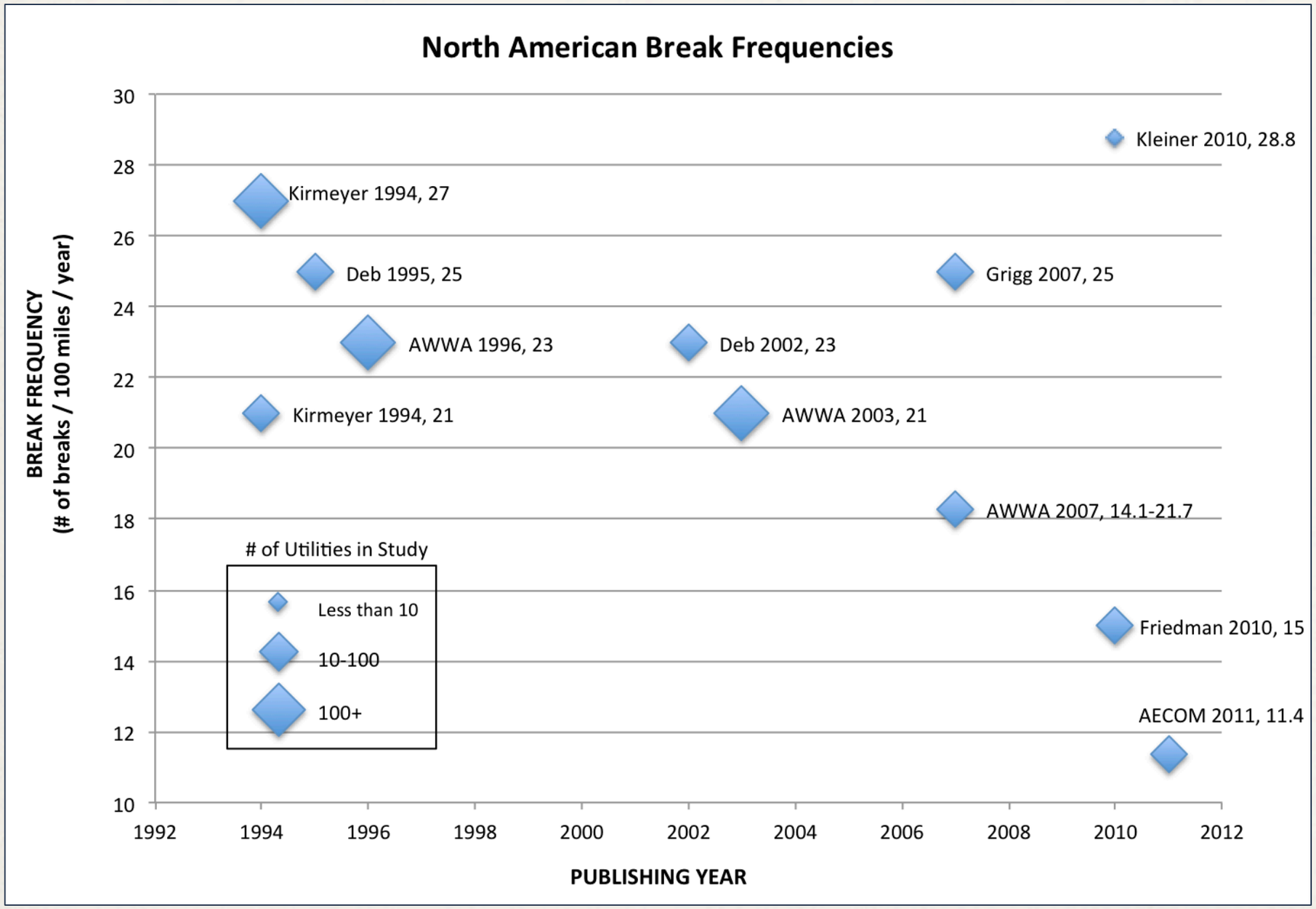
Importance of Failure Repair Data



Failure Documentation Guide

Failures on Water Mains - See Worksheet "Mains"		
Minimum Required Information: This information must be provided in order to compile a reliable leakage component analysis		
	Failure Event Type	Reported-via complaints, or Unreported-from leak detection
	Network Category of Failure	Distribution-small diameter mains, or Transmission-large diameter mains
	General Location of Failure Event	List a very basic description of the failure location by street name, map number, etc.
	Size information	List the size of the water main, typically by diameter in inches
	Failure Event Reported	Date and Time that the failure became known
	Failure Event Pinpointed	Date and Time that the source of lost water was indentified
	Failure Event Contained/Valved off/Repaired	Date and Time that the flow of lost water was halted
Additional Information: Optional information that will enhance the picture of failure trends within the distribution system; however this information is not necessary to conduct the leakage component analysis.		

Break Frequency Research



- Focus on Predictive Models
- Terminology
- Data Collection Completeness

Break Frequency Research

WaterRF 4372: Effective Organization and Component Analysis of Water Utility Leakage Data

Water Audit: City of Austin, TX, USA, 2011
INFRASTRUCTURE FAILURE FREQUENCY ANALYSIS

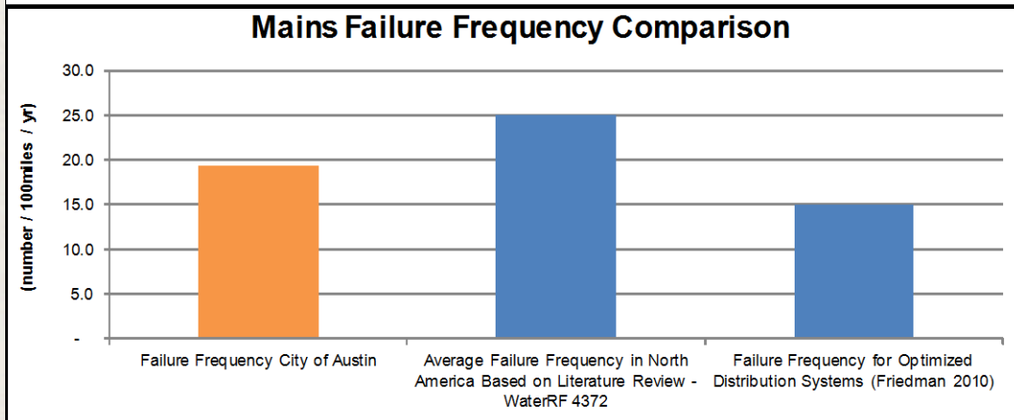
	Value to be entered by the user
	Value is automatically filled in/calculated by Model
	Recommended default value

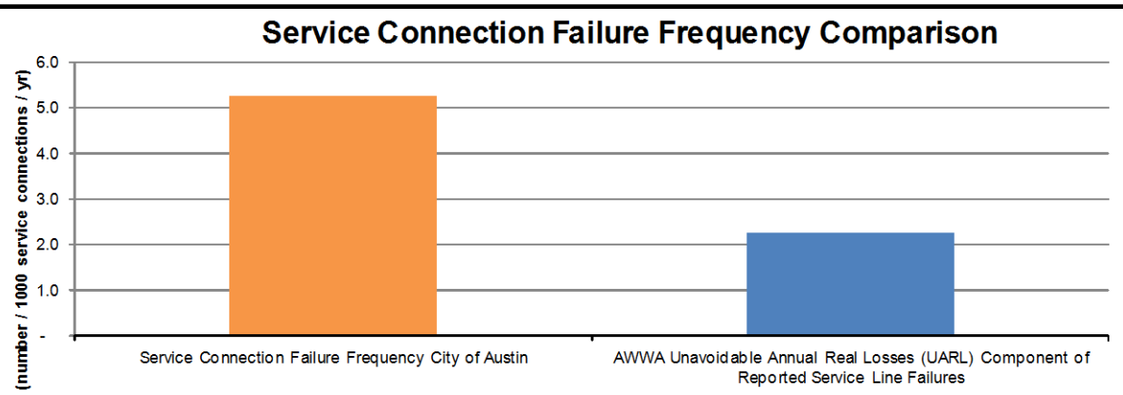
City of Austin

Total Number of Mains Failures Reported for Water Audit: City of Austin, TX, USA, 2011	707	
Total Length of Mains	3,649.0	(miles)
Failure Frequency City of Austin	19.4	(number / 100miles / yr)
Average Failure Frequency in North America Based on Literature Review - WaterRF 4372	25.0	(number / 100miles / yr)
Failure Frequency for Optimized Distribution Systems (Friedman 2010)	15.0	(number / 100miles / yr)

City of Austin

Total Number of Service Connection Failures Reported for Water Audit: City of Austin, TX, USA, 2011	1,114	
Total Number of Service Connections	211,839	(service connections)
Service Connection Failure Frequency City of Austin	5.3	(number / 1000 service connections / yr)
AWWA Unavoidable Annual Real Losses (UARL) Component of Reported Service Line Failures	2.25	(number / 1000 service connections / yr)
Ratio of Failure Frequency to UARL Break Frequency	2.3	





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Participating Utility Insight

- Integrity and completeness of failure data
- Readiness of average utility
- Comfort with estimation/assumption
- Presentation of software as a TOOL not a REPORT!

Please be in touch!

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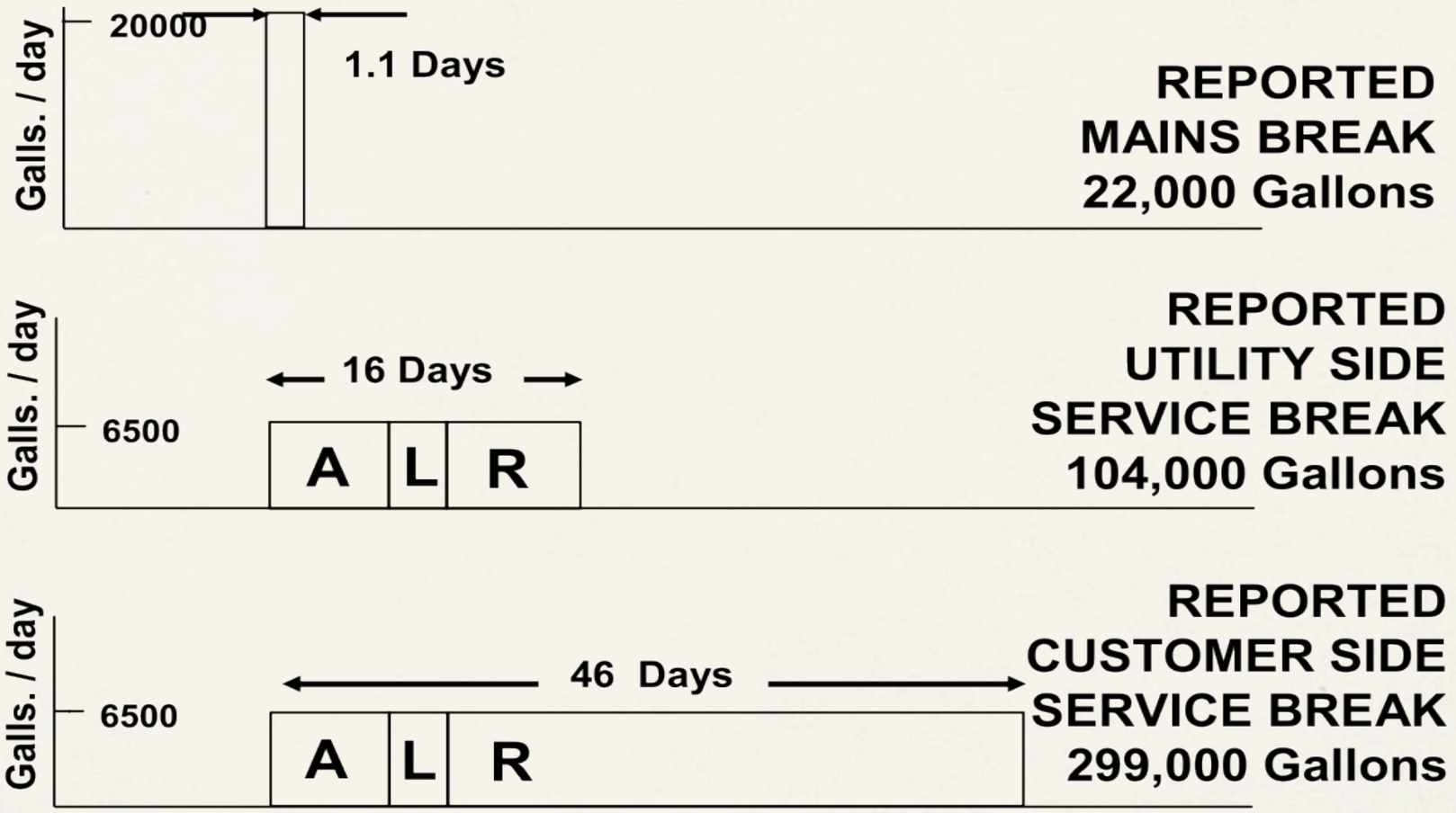
- Program Manager, Water Systems Optimization
- e: kate.gasner@wsoglobal.com
- p: 415.533.0419

Appendix

Impact of Run-Time



Total Response Time = Awareness Time + Location Time + Repair Time

Real Losses Calculation for Reported & Un-Reported Leakage

Annual Real Loss Volume from Reported Leaks =

*# of leaks by size * average run time * average flow rate (at average system pressure)*

Leakage Occurrence	Pipe Diameter	# of Events	Flow Rate (gpm)	Average Run Time (hrs)	Annual Leakage (MG)
Mains Breaks	8”	6	46	8.25	3.3

Real Losses Calculation for Reported & Un-Reported Leakage

Annual Real Loss Volume from Reported Leaks =

*# of leaks by size * average run time * average flow rate (at average system pressure)*

Leakage Occurrence	Pipe Diameter	# of Events	Flow Rate (gpm)	Average Run Time (hrs)	Annual Leakage (MG)
Mains Breaks	8”	6	46	8.25	3.3

Failure Repair Records

Estimated based on pipe size using BABE methodology

Awareness Time Estimation + Failure Repair Records for Location & Repair Time

Failure Repair Entry Sheet

Mains by Size	Number of Failures per Year	Length of Main	Failure Frequency (number / 100miles / yr)	Average Failure Flow Rate @ 70psi	Average Pressure	N1 (Leakage-Pressure Exponent) Value	AverageFailure Duration			Average Annual Loss per Failure	Total Annual Loss		Use Default Average Leak Flow Rate	Use Utility Specific Average Failure Flow Rate	Average Failure Flow Rate @ average system pressure
							Average Awareness Duration (days)	Average Duration for Location and Repair/Shutoff Failure (days)	Total Duration (days)						
		miles		(gpm)	(psi)					(MG)	(MG)				(gpm)
Diameter 2"	60	53.3	113	13.90	77.3	0.50	3.00	1.00	4.00	0.08	5.05		⊙	○	-
Diameter 3"	-	2.4	-	13.90	77.3	0.50	-	-	-	-	-		⊙	○	-
Diameter 4"	29	74.8	39	44.00	77.3	0.50	0.50	1.10	1.60	0.11	3.09		⊙	○	-
Diameter 6"	385	941.8	41	92.00	77.3	0.50	0.25	1.30	1.55	0.22	83.08		⊙	○	-
Diameter 8"	147	1,100.7	13	92.00	77.3	0.50	0.25	1.19	1.44	0.20	29.47		⊙	○	-
Diameter 10"	1	4.1	24	92.00	77.3	0.50	0.25	1.15	1.40	0.19	0.19		⊙	○	-
Diameter 12"	46	585.6	8	222.00	77.3	0.50	0.25	1.03	1.28	0.43	19.78		⊙	○	-
Diameter 14"	-	8.5	-	222.00	77.3	0.50	-	-	-	-	-		⊙	○	-
Diameter 16"	-	47.4	-	222.00	77.3	0.50	-	-	-	-	-		⊙	○	-
Diameter 18"	-	0.2	-	222.00	77.3	0.50	-	-	-	-	-		⊙	○	-
Diameter 20"	1	24.8	4	222.00	77.3	0.50	0.10	5.43	5.53	1.86	1.86		⊙	○	-
Diameter 24"	4	171.9	2	222.00	77.3	0.50	0.10	28.21	28.31	9.51	38.04		⊙	○	-
Diameter 30"	-	-	-	222.00	77.3	0.50	-	-	-	-	-		⊙	○	-
Diameter 36"	-	-	-	222.00	77.3	0.50	-	-	-	-	-		⊙	○	-
Diameter 42"	-	-	-	222.00	77.3	0.50	-	-	-	-	-		⊙	○	-
Diameter 48"	-	-	-	222.00	77.3	0.50	-	-	-	-	-		⊙	○	-
Diameter 54"	-	-	-	222.00	77.3	0.50	-	-	-	-	-		⊙	○	-
Diameter 60"	-	-	-	222.00	77.3	0.50	-	-	-	-	-		⊙	○	-
Diameter > 60"	-	-	-	222.00	77.3	0.50	-	-	-	-	-		⊙	○	-
Other Diameter	34	-	-	10.00	77.3	0.50	0.10	1.30	1.40	0.02	0.69		Enter avg flow rate		10.0
										SUB-TOTAL REPORTED FAILURES ON MAINS	181.24				

Calculation of Background Losses

Background Loss Allowances - UARL Formula

Infrastructure Component	Background Leakage	Reported Leaks and Breaks	Unreported Leaks and Breaks	UARL Total	Units
Mains, gal/mile of main/day/psi	2.87	1.75	0.77	5.4	Gals/mile of main/day/psi
Service Connections, main to curb-stop, gal/service connection/day/psi	0.112	0.007	0.030	0.15	Gals/service connection/day/psi
Service Connections, curb-stop to meter, gal/service connection/day/psi	4.78	0.57	2.12	7.5	Gals/mile of service connection/day/psi

Source: AWWA

Calculation of Background Losses

Background Losses (kGal/day) = ICF * (0.20 x Lm + 0.008 x Nc + 0.34 x Lp) * (Pav/70)^1.5

Where Lm = total length of water mains (miles) = 2,000 miles

Nc = number of service connections (main to curb-stop) = 150,000

Lp = total length of private pipes, curbstop to customer meter, (converted to miles) = 0

Pav = average system pressure in psi = 75psi

ICF = Infrastructure Condition Factor = 1.2

Background Losses (kGal/day) = 1.2 * (0.20 x 2,000 + 0.008 x 150,000 + 0.34 x 0) * (75/70)^1.5

= 2,129 kGal/day

= 2,129 kGal/day * 365 = 777,210 kGal/year = 777.2 MG/year

Proactive Leak Detection Model

WaterRF 4372: Effective Organization and Component Analysis of Water Utility Leakage Data

Water Audit: City of Austin, TX, USA, 2011
CALCULATION OF ECONOMIC INTERVENTION FREQUENCY FOR PROACTIVE LEAK DETECTION

	Value to be entered by the user
	Value is automatically filled in/calculated by Model
	Recommended default value

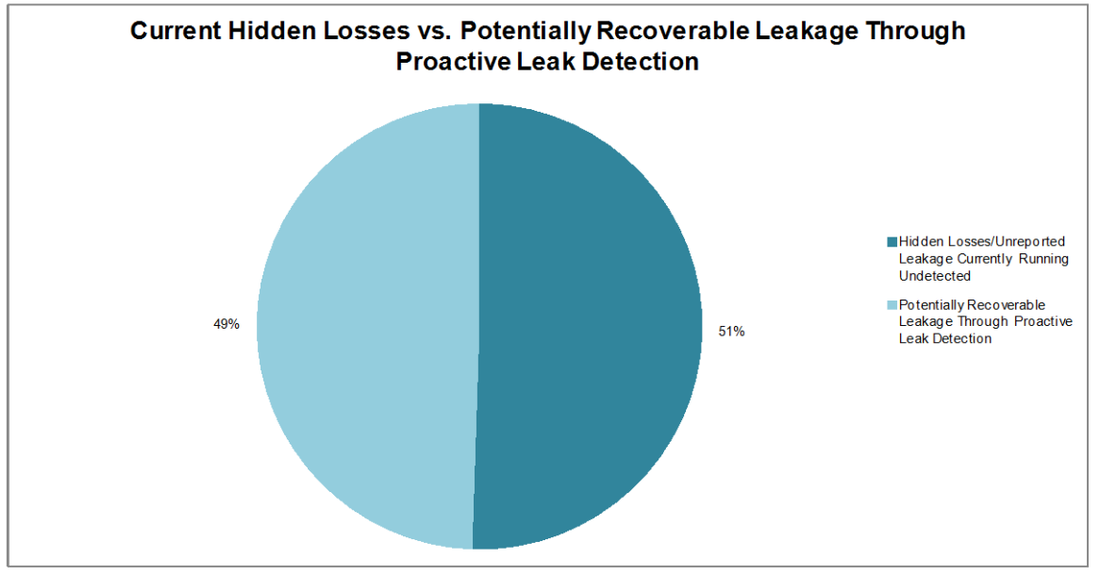
	System Characteristics		
	Total Length of Mains	3,649.0	miles
	Number of Service Connections	211,839	service connections
	Service Connection Density	58.1	conn./mile main
	Average System Pressure	77.3	PSI

	Water Balance Results		
TBL	Current Annual Background Leakage	1,238.83	MG/Yr
CRL	Real Losses from Current Reported Leakage	256.66	MG/Yr
UL	Unreported Failures Identified Through Existing Proactive Leak Detection Program	190.95	MG/Yr
	Hidden Failures/Unreported Failures not Identified or Captured by Current Leakage Management Policy	2,645.77	MG/Yr
CARL	Current Annual Real Losses	4,332.21	MG/Yr
UARL	Unavoidable Annual Real Losses	1,453.52	MG/Yr
	Infrastructure Leakage Index (ILI) [CARL/UARL]	3.0	

	Variable Cost of Real Losses		
CV	Variable Production cost (applied to Real Losses):	0.33	$/per kgal
		330.00	$/MG
CI	Cost of comprehensive leak detection survey (excluding leak repair cost)	1.00	$/per mile
		3,649	$/for entire system
RR	Average Rate of Rise of Unreported Leakage	0.40	kgal/mile of mains/day in a year
		1.46	MG/day in a year
	CI/CV	3.0	kgal/mile
EIF	Economic Intervention Frequency [0.789 * (CI/CV)/RR] ^ 0.5	2.4	months
		74.4	days
	Economic Intervention Frequency - Average Leak Run Time	37.2	days
	Economic Percentage of System to be Surveyed per Year	491	%
ABI	Average Annual Budget for Intervention (Proactive Leak Detection)	17,910	$/year
EUL	Economic Unreported Real Losses	54,274	kgal/year
		54.3	MG/year
	Economic Infrastructure Leakage Index (ILI)	1.2	
PRL	Potentially Recoverable Leakage (CARL-CRL-EUL-TBL-UL)	2,591.5	MG/year

Instructions: Use this sheet to establish a preliminary schedule for proactive leak detection surveys and the corresponding necessary budget. Once the results from consecutive leak surveys are available, the Rate of Rise of Unreported Leakage should be updated and the proactive leak detection schedule should be refined taking into consideration these findings.

In order to establish a preliminary schedule for proactive leak detection or to review the currently utilized proactive leak detection schedule enter the cost for undertaking proactive leak detection ($/mile or $/km) in cell D31. Next enter the Average Rate of Rise of Unreported Leakage in cell D34. The Average Rate of Rise of Unreported Leakage is the rate at which leakage increases with time. The rate of rise is not necessarily linear since it can quickly change due to seasonal effects and other system specific impacts. The AWWA M36 Manual recommends assessing The Average Rate of Rise of Unreported Leakage either by comparing water balance results of several consecutive years and calculating the Average Rate of Rise of Unreported Leakage based on the increase n Real Loss volume from year to year (if utility does not employ proactive leak detection), or by analysis of District Metered Area night flow data or repair records of leaks detected through proactive leak detection (if utility employs proactive leakage control). Further details about how to assess the Average Rate of Rise of Unreported Leakage are provided in the AWWA M36 Manual.



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Pressure Management in the Model

Pressure Management Opportunities

	Existing Pressure Management Policy	
Current Average System Pressure	77.3	PSI
Total Annual Real Losses	4,332.2	MG/Yr
Value of Real Losses	1,429,630	$/year

FAVAD N1 Value Used for Calculation of Real Loss Reduction Due to Reduction of Average System Pressure

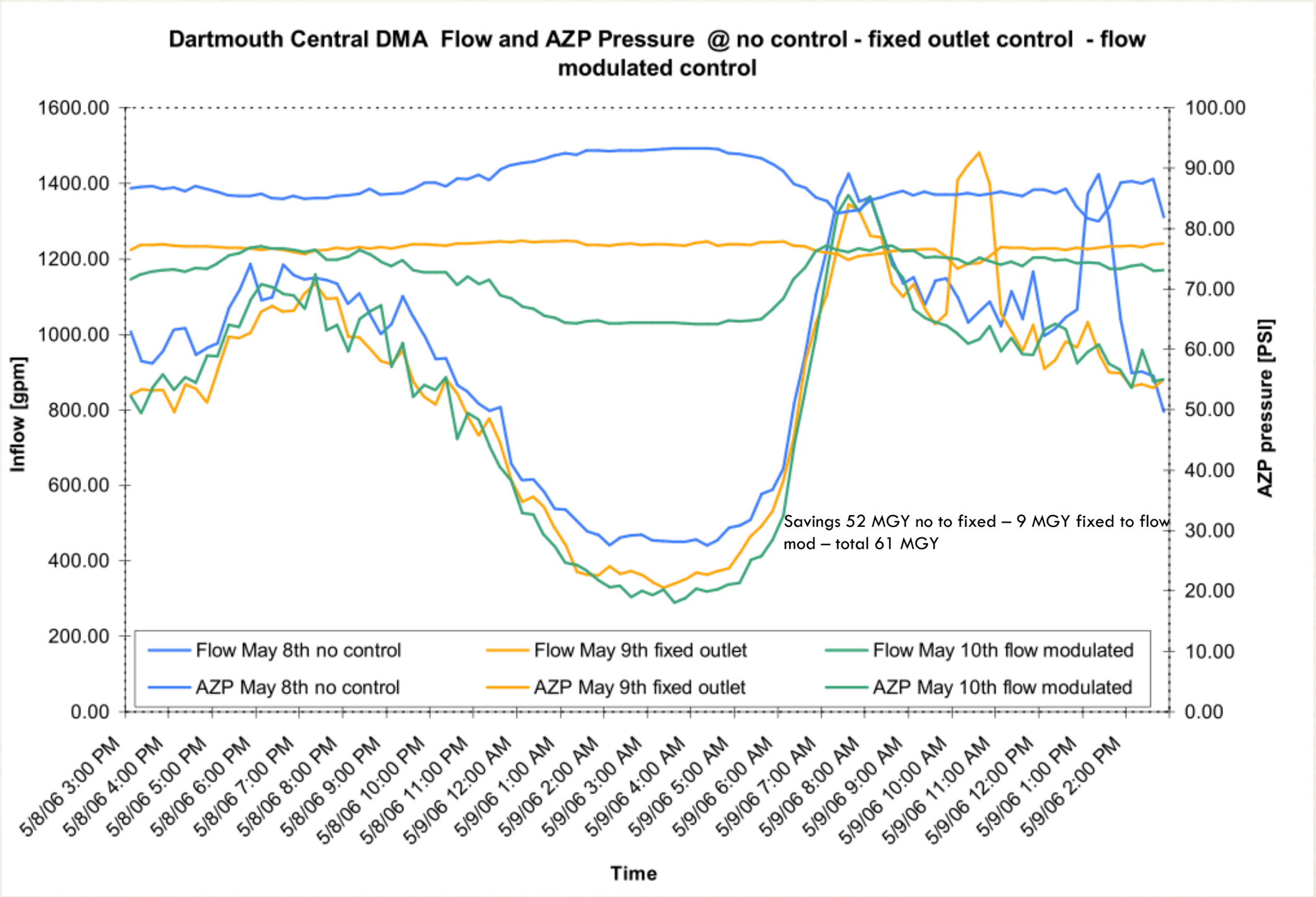
	○ Use Default N1	1.0
	◉ Use System Specific N1	0.7
Enter % of rigid pipes and service connections in system	100%	
ILI	3.0	

	Alternative Pressure Management Policy	
Assumed Reduction in Average System Pressure	5.0	PSI
Assumed % Reduction in Average System Pressure	6%	
Real Loss Volume Saved Through Alternative Pressure Management Policy	203.1	MG/Yr
Value of Real Loss Volume Saved Through Alternative Pressure Management Policy	67,026	$/Year
Enter Estimated Cost of Implementing Alternative Pressure Management Policy	100,000	$
Simple Payback Period for Implementing Alternative Pressure Management Policy	1.5	Years

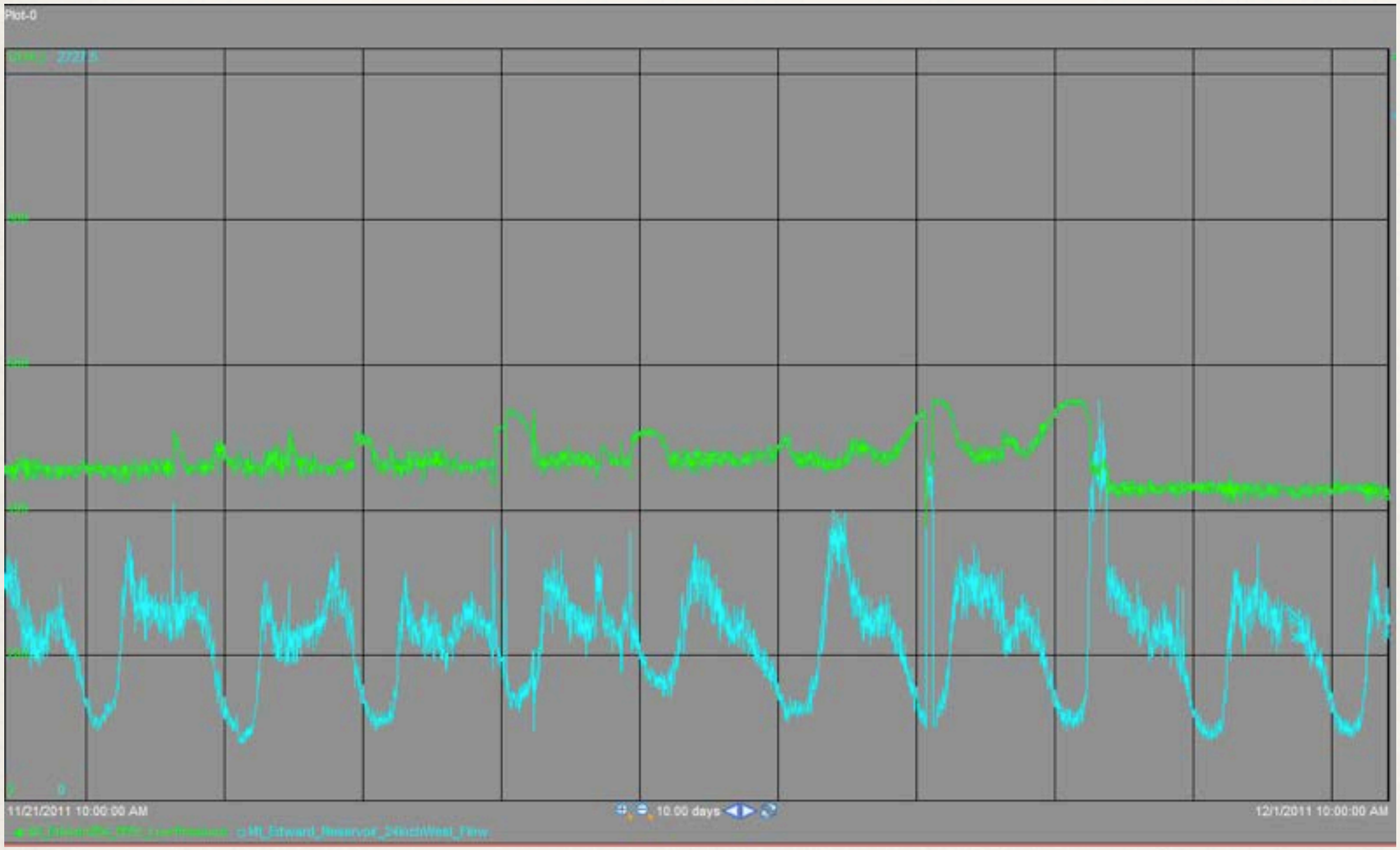
Tools for Pressure Management

- Introduction of pressure controlled areas (pressure zones)
- Fixed outlet pressure control
- Advanced flow-modulated pressure control
- Altitude and level control
- Transient control

Benefits of Pressure Management



Risks of High Pressure

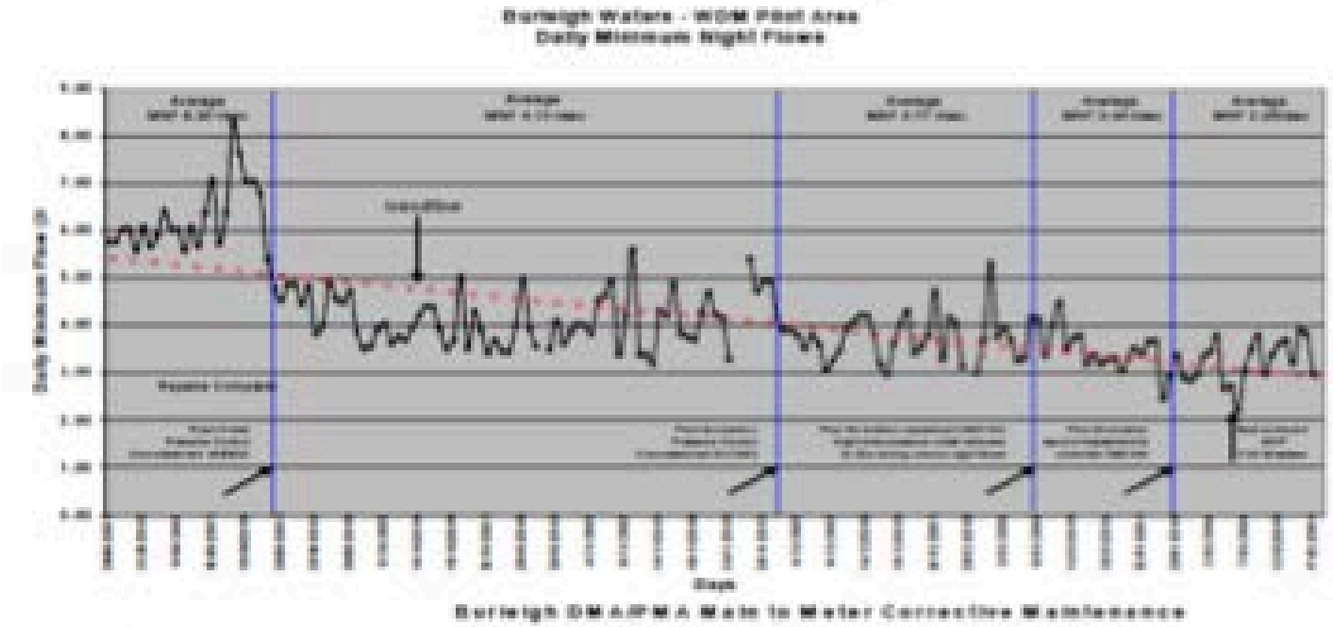


PRESSURE

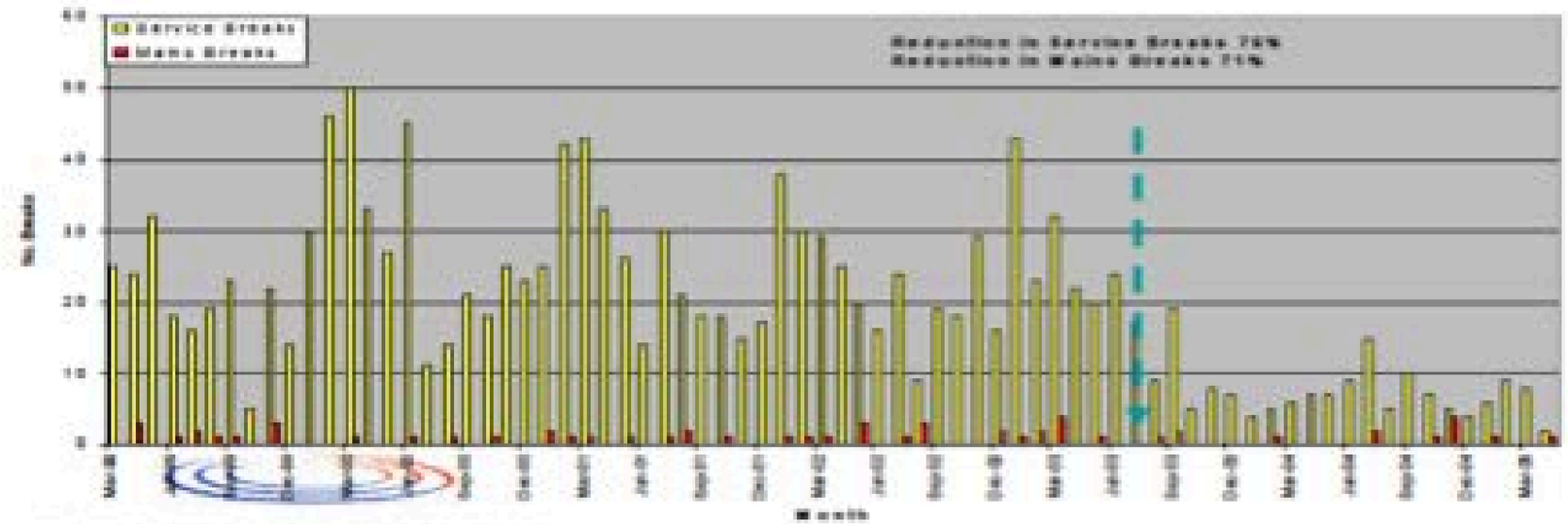
FLOW

Benefits of Pressure Management

2003: Gold Coast, Burleigh Heads Pilot Scheme: Gravity System, 3300 services, Inlet pressure reduced by 30% (72 metres to 50 metres)



Night flow reduced from 6 litres/sec to 3 litres/sec

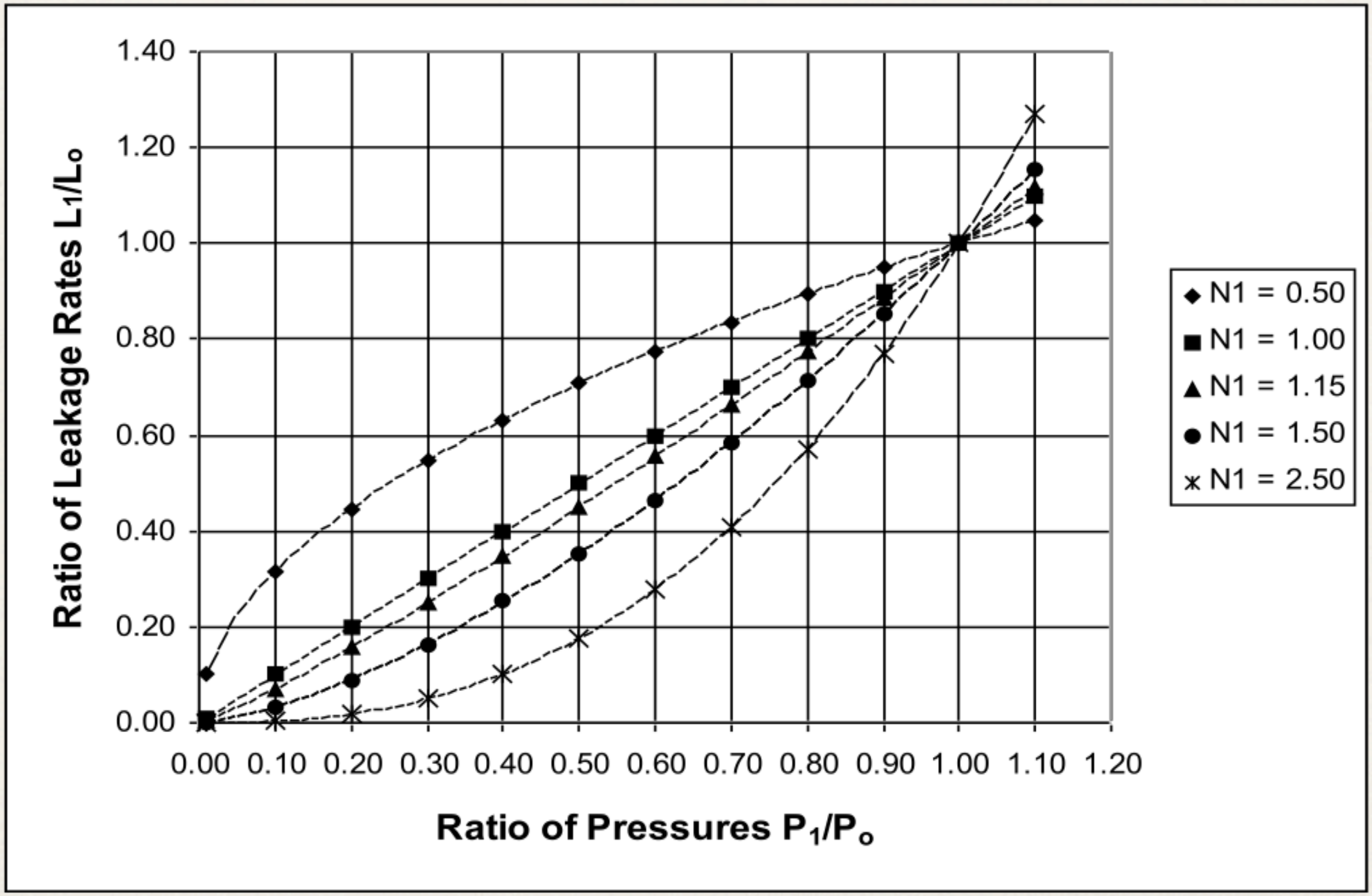


Mains repairs reduced by 71%

Service pipe repairs reduced by 75%

Intervening Only When Cost-Effective (a DMA example)

Pressure & Leakage



Response Time Improvement

Reported and Unreported Failure Events			
Failures on Mains	***Reported***	***Unreported***	
Total Number of Failures on Mains in 2011	707	1	
Average location and repair duration	1.4	1.0	days
Total Volume lost (stemming from location and repair duration)	153.9	0.1	(MG)
Total Cost of Volume lost (stemming from location and repair duration)	$ 50,785	$ 23	
What IF Location and Repair Duration is Reduced to	1	0.5	days
Percent Reduction	28%	50%	
Potential Related Savings in Leakage Volume	42.7	0.0	(MG)
Potential Related Savings in Leakage Volume Cost	$ 14,085	$ 11	
Service Line Failures	***Reported***	***Unreported***	
Total Number of Failures on Service Connections in 2011	1,114	11	
Average location and repair duration	1.4	2.0	days
Total Volume lost (stemming from location and repair duration)	16.3	0.2	(MG)
Total Cost of Volume lost (stemming from location and repair duration)	$ 5,374	$ 76	
What IF Location and Repair Duration is Reduced to	1	1	days
Percent Reduction	29%	50%	
Potential Related Savings in Leakage Volume	4.65	0.1	(MG)
Potential Related Savings in Leakage Volume Cost	$ 1,535	$ 38	
Failures on System Appurtenances	***Reported***	***Unreported***	
Total Number of Failures on System Appurtenances in 2011	1,867	127	
Average location and repair duration	17.2	49.0	days
Total Volume lost (stemming from location and repair duration)	25.2	33.4	(MG)
Total Cost of Volume lost (stemming from location and repair duration)	$ 8,323	$ 11,013	
What IF Location and Repair Duration is Reduced to	1	1	days
Percent Reduction	94%	98%	
Potential Related Savings in Leakage Volume	23.8	32.7	(MG)
Potential Related Savings in Leakage Volume Cost	$ 7,838	$ 10,788	
Total Potential Savings if Location and Repair Duration is Reduced as Simulated in the Above Sections	**182.3**	**32.9**	**(MG)**
Total Potential Cost Savings if Location and Repair Duration is Reduced as Simulated in the Above Sections	**$ 23,458**	**$ 10,837**	**Per Year**