American Water Works Association

Water Efficiency in the Water Supply Sector

AWRA – PMAS Philadelphia, PA

February 21, 2013

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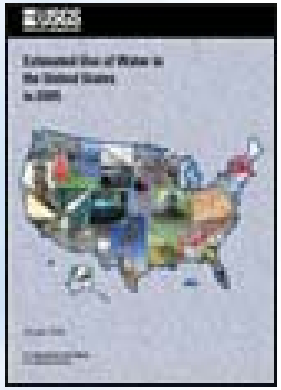
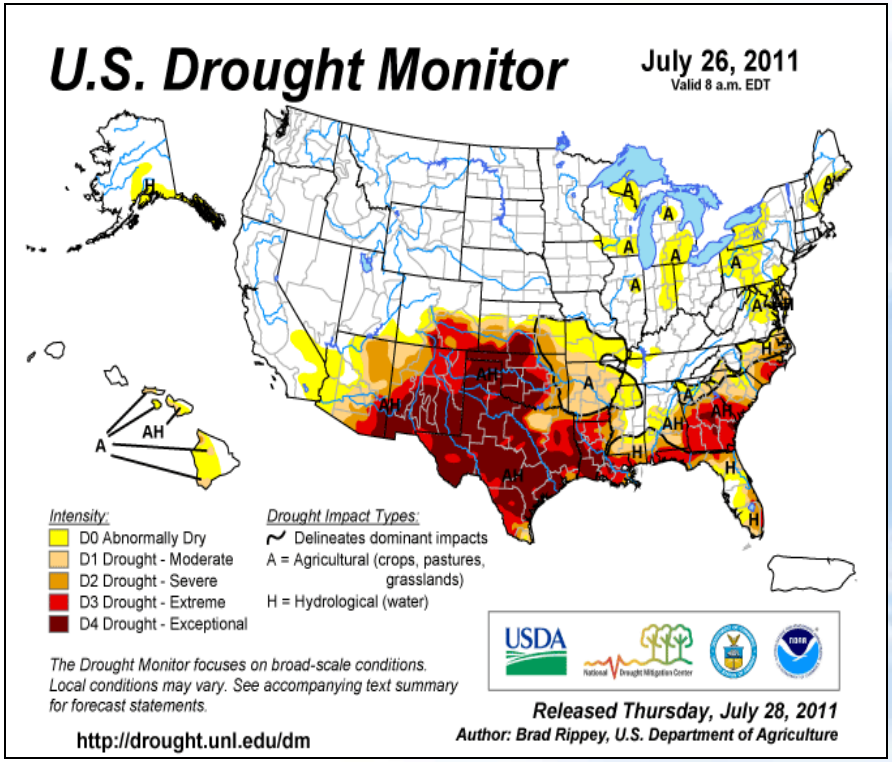
Water Use by Sector in the US

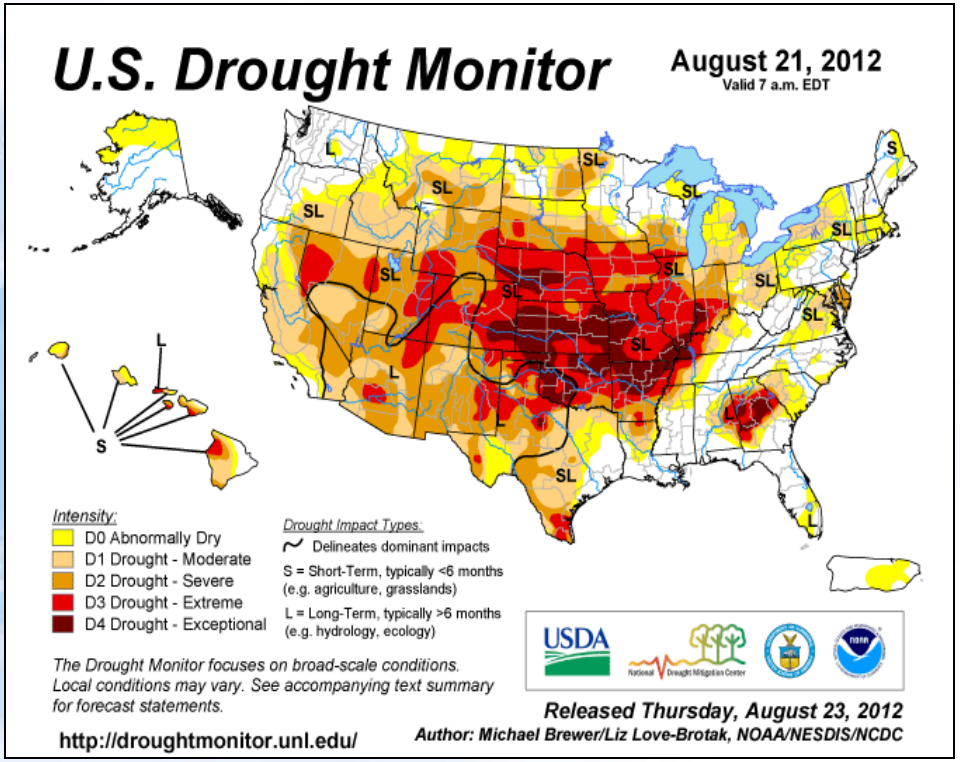
- USGS Water "Use" Reporting (2005)
  - A declining trend of water withdrawals
  - 410 billion gallons/day in US (5% less than 1980 peak year)
  - Pennsylvania 9.47 bgd (94% surface water)
- Largest Water Sectors
  - Power 200 bgd
  - Agriculture 128 bgd
  - Public Water Supply 44.2 bgd (up 2% from 2000, but population has risen 5%)
- **3rd Largest Sector by water "use", but**
  - Serves 258 million Americans (86% of the total population)
  - Water is treated to high quality standards; the only "utility" service consumed by the human body
  - Water is energized for conveyance across widespread water distribution systems
  - Drinking water has the highest value water of any sector
  - 6 bgd of "public use and loss" per 1995 report; Sufficient to supply the 10 largest US cities



Why Control Losses? U.S. Drought Monitor suggests why -

- Drought exists somewhere in the United States virtually always
- 2011 vs. 2012 reflects growing areas of dry conditions
- 2011 Texas drought: “worst ever”





The Value of Water

- What is water?
  - A natural resource?
  - A commodity?
  - Both?
- Who pays for water per metered volume consumed?
  - Most of the US
  - But, a large portion of Canada is unmetered

How is Water Priced?

	Price per 1000 Gallons	Price per Acre/Ft.
Residential	$4 - $6	$1400 - $2300
Reliability to avoid drought	$11	$4,000
Bottled Water	$1,000	$825,851
Agricultural Irrigation	$0.000061 - $0.000767	$20 to $250
Hydropower Generation	$0.000482	$157

Bob Raucher: The Value of Water: Concepts, Estimates, and Applications (Report #91068F)

Pricing of Drinking Water (*2012*)

Typical Water Pricing in United States – 2011/2012

- $4-$5 per 1,000 gallons; roughly $30 per month

Prices range from:

- 2 cents/gallon - Columbus, OH
- 1.2 cents/gallon - Boston, MA
- 1 cent/gallon - New York City
- 0.81 cents/gallon - Denver, CO - Average in US: 0.48 cents/gallon

Strangely, cities in arid western US typically charge less for water than the more water abundant eastern cities

Philadelphia - ½ cent/gallon, Philadelphia Region – up to 1.2 cent/gallon

From "Water is Still Cheap: Demonstrating the True Value of Water", by Steve Maxwell *Journal AWWA*, May 2012

Value of Water Facts - 2012

Price and consumption of water across countries

	Ave Price cent/gal	Ave Consumption, gal/capita day
Denmark	1.64	30.2
Germany	1.26	39.8
France	1.23	61.2
Australia	1.19	160
United Kingdom	0.78	36.7
Canada	0.73	205
Japan	0.56	98.4
Spain	0.56	90.2
Turkey	0.52	62.8
United States	0.48	163
Italy	0.37	127

Value of Water Facts - 2012

Product	Average Price, US dollars per gallon	
Tap water	0.0048	
Coca-Cola	3.00	
Gasoline	4.00	
Tide Liquid Detergent	8.50	
Imported Beer	12.00	
Evian Bottled Water	25.00	(*US Bottled Water Industry: $11 billion in 2010*)
Starbucks latte	22.00	
Pepto-Bismol	65.00	
Vicks Formula 44D cough syrup	100.00	
American Whiskey	150.00	
Visine Eye Drops	750.00	
Revlon nail enamel	1,000.00	
Good French Wine	1,000.00	
Chanel No.5 perfume	45,000.00	

"Dirt Cheap?" Clean fill can cost $25 & higher per ton, but water averages $1.00 per ton

Value of Water Facts - 2012

Typical Costs for the US Family per month

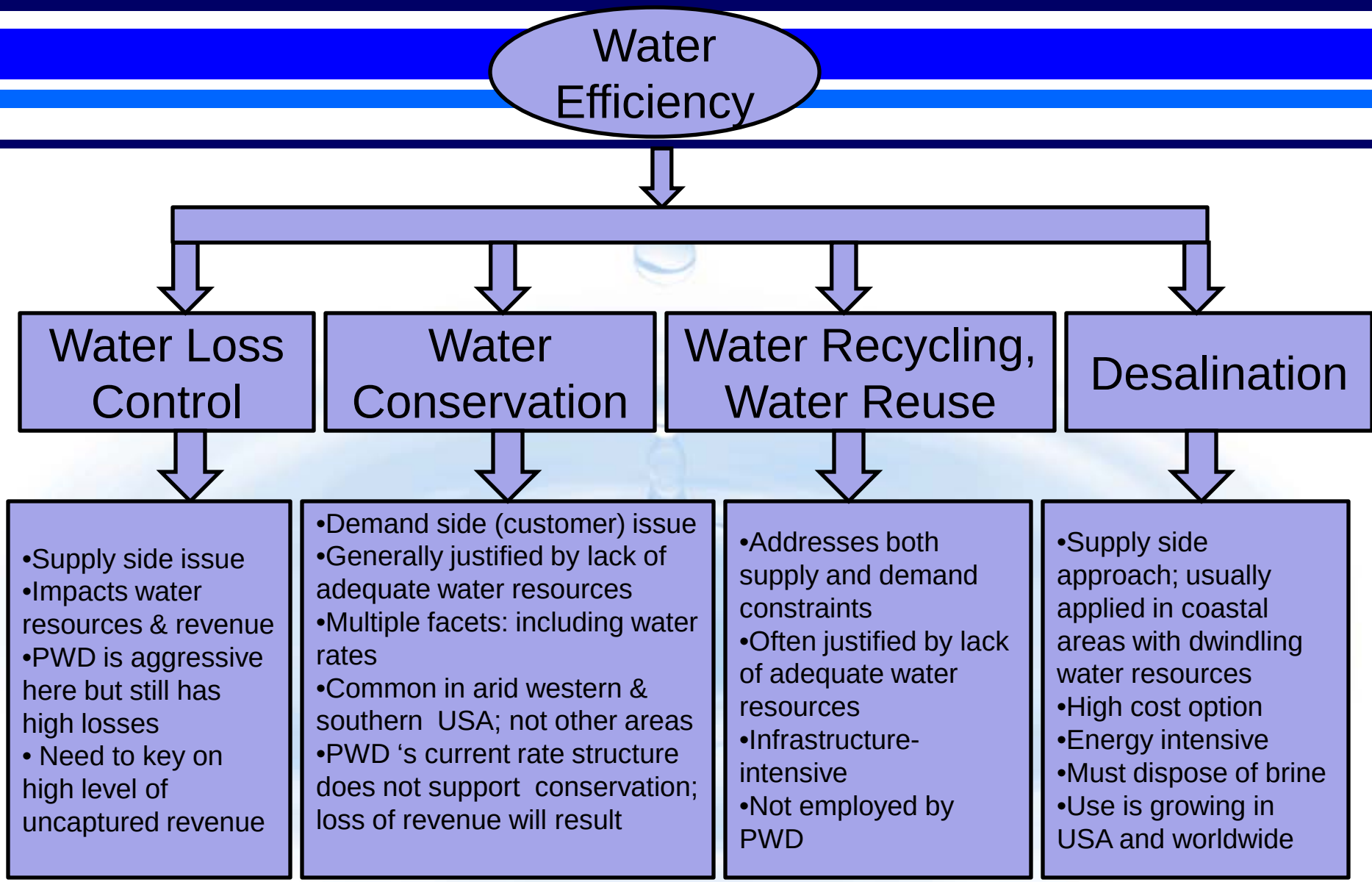
Water	$40
Internet/cable TV	$90
Telephone	$75
Electricity	$104

Collective Annual Spending in the United States

Water	$46 billion
Pets	$52 billion
Tobacco products	$90 billion
Legalized gambling	$93 billion
Alcoholic beverages	$160 billion
Military defense	$720 billion

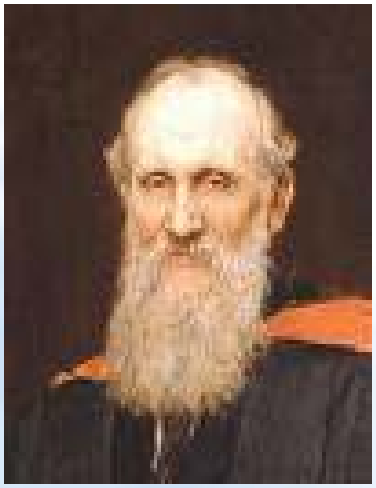
What we don't value – we waste!

Efficient Management of Water in the Drinking Water Supply Sector

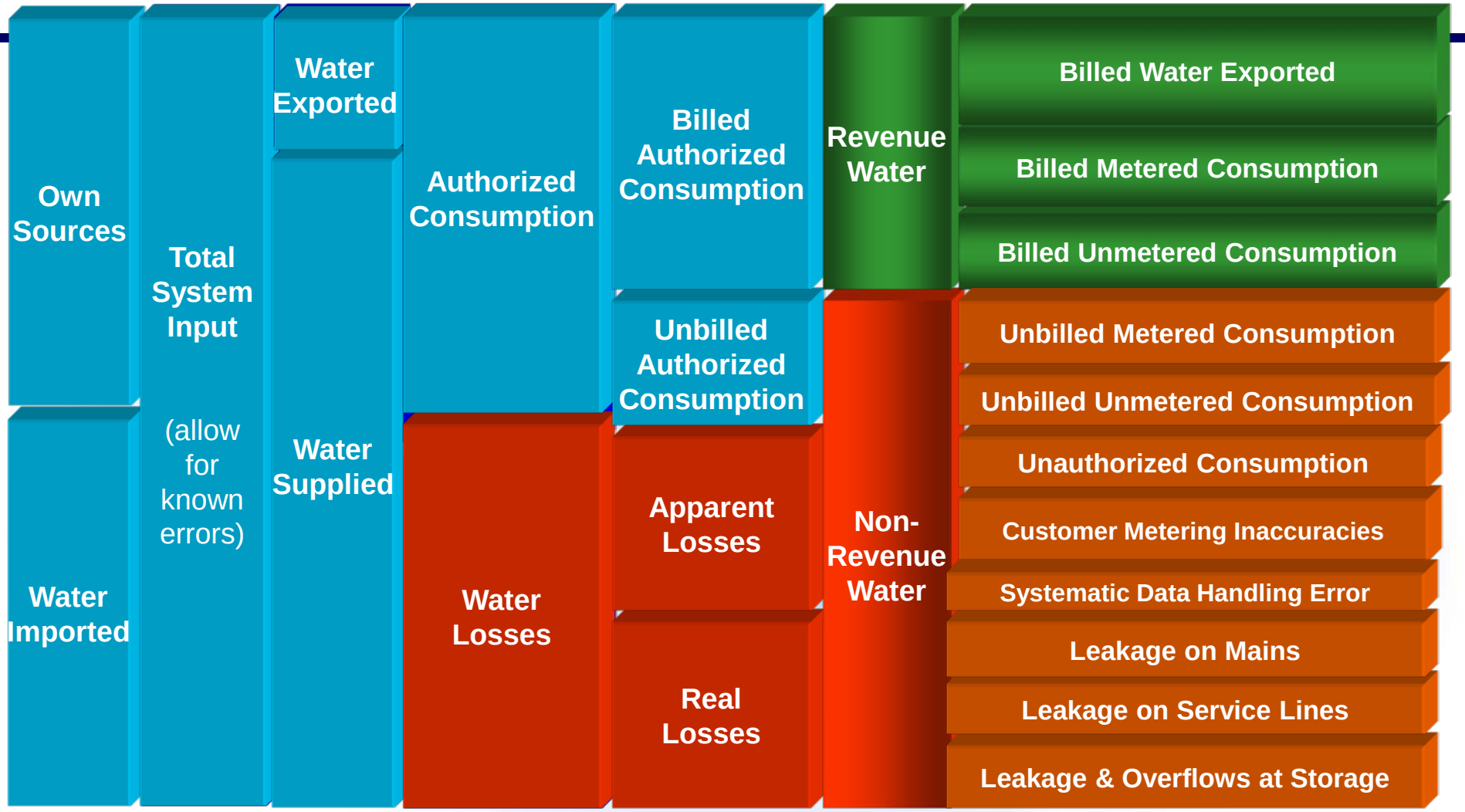


- *You can't manage it if you don't measure it -*

- Lord Kelvin -

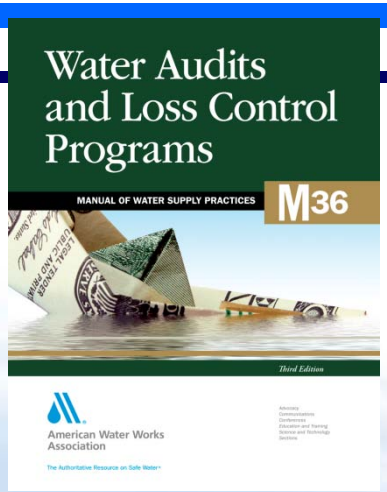


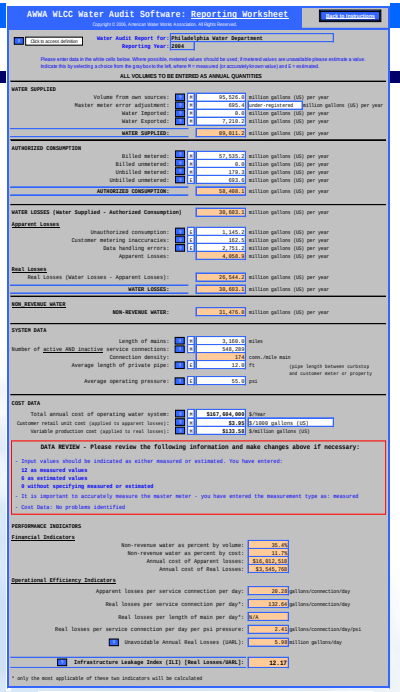
IWA/AWWA Water Audit Method: Water Balance

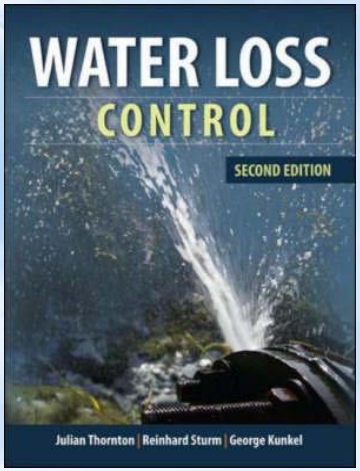


Best Practice Tools for Water Loss Control

- AWWA M36 Publication
  - Water Audits and Loss Control Programs (2009), 3rd Edition features the IWA/AWWA Water Audit Methodology
- AWWA Water Loss Control Committee's Free Water Audit Software©
  - Current version is 4.2 in English and French languages
  - Includes data grading capability
- Water Research Foundation Reports
- Textbooks
- **www.awwa.com** - type "water loss control" in search box; select first item in list







AWWA WLCC Free Water Audit Software: Reporting Worksheet

WAS v4.0

Back to Instructions

? Click to access definition

Water Audit Report for: Philadelphia Water Department

Reporting Year: 2008 | 7/2007 - 6/2008

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 (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

WATER SUPPLIED

<< Enter grading in column 'E'

Volume from own sources:	?	7	94,536.900	Million gallons (US)/yr (MG/Yr)	
Master meter error adjustment:	?	10	2,779.300	over-registered	MG/Yr
Water imported:	?	n/a		MG/Yr	
Water exported:	?	10	7,100.400	MG/Yr	
WATER SUPPLIED:			84,657.200	MG/Yr	

AUTHORIZED CONSUMPTION

Click here: ? for help using option buttons below

					Pcnt:	Value:
Billed metered:	?	7	57,242.400	MG/Yr		
Billed unmetered:	?	n/a		MG/Yr		
Unbilled metered:	?	n/a		MG/Yr		
Unbilled unmetered:	?	8	764.200	MG/Yr	○ ◉	764.200
AUTHORIZED CONSUMPTION:	?		58,006.600	MG/Yr		

Use buttons to select percentage of water supplied

OR

value

WATER LOSSES (Water Supplied - Authorized Consumption)

26,650.600 MG/Yr

Apparent Losses

					Pcnt:	Value:
Unauthorized consumption:	?	8	2,086.300	MG/Yr	○ ◉	2,086.300
Customer metering inaccuracies:	?	8	190.300	MG/Yr	○ ◉	190.300
Systematic data handling errors:	?	5	4,674.400	MG/Yr		
Apparent Losses:	?		6,951.000	MG/Yr		

Choose this option to enter a percentage of billed metered consumption. This is NOT a default value

?

Real Losses

Real Losses = Water Losses - Apparent Losses:	?		19,699.600	MG/Yr
WATER LOSSES:			26,650.600	MG/Yr

NON-REVENUE WATER

NON-REVENUE WATER:	?		27,414.800	MG/Yr

= Total Water Loss + Unbilled Metered + Unbilled Unmetered

SYSTEM DATA

Length of mains:	?	9	3,137.0	miles
Number of active AND inactive service connections:	?	7	547,932	
Connection density:			175	conn./mile main
Average length of customer service line:	?	7	12.0	ft (pipe length between curbstop and customer meter or property boundary)
Average operating pressure:	?	10	55.0	psi

COST DATA

Total annual cost of operating water system:	?	10	$219,182,339	$/Year
Customer retail unit cost (applied to Apparent Losses):	?	9	$4.97	$/1000 gallons (US)
Variable production cost (applied to Real Losses):	?	9	$215.50	$/Million gallons

PERFORMANCE INDICATORS

Financial Indicators

Non-revenue water as percent by volume of Water Supplied:	32.4%
Non-revenue water as percent by cost of operating system:	17.8%
Annual cost of Apparent Losses:	$34,546,470
Annual cost of Real Losses:	$4,245,264

Operational Efficiency Indicators

Apparent Losses per service connection per day:	34.76	gallons/connection/day
Real Losses per service connection per day*:	98.50	gallons/connection/day
Real Losses per length of main per day*:	N/A	
Real Losses per service connection per day per psi pressure:	1.79	gallons/connection/day/psi
? Unavoidable Annual Real Losses (UARL):	2,178.15	million gallons/year
? Infrastructure Leakage Index (ILI) [Real Losses/UARL]:	9.04	

* only the most applicable of these two indicators will be calculated

WATER AUDIT DATA VALIDITY SCORE:

***** YOUR SCORE IS: 82 out of 100 *****

A weighted scale for the components of consumption and water loss is included in the calculation of the Water Audit Data Validity Score

PRIORITY AREAS FOR ATTENTION:

Based on the information provided, audit accuracy can be improved by addressing the following components:

1: Volume from own sources

2: Billed metered

3: Systematic data handling errors

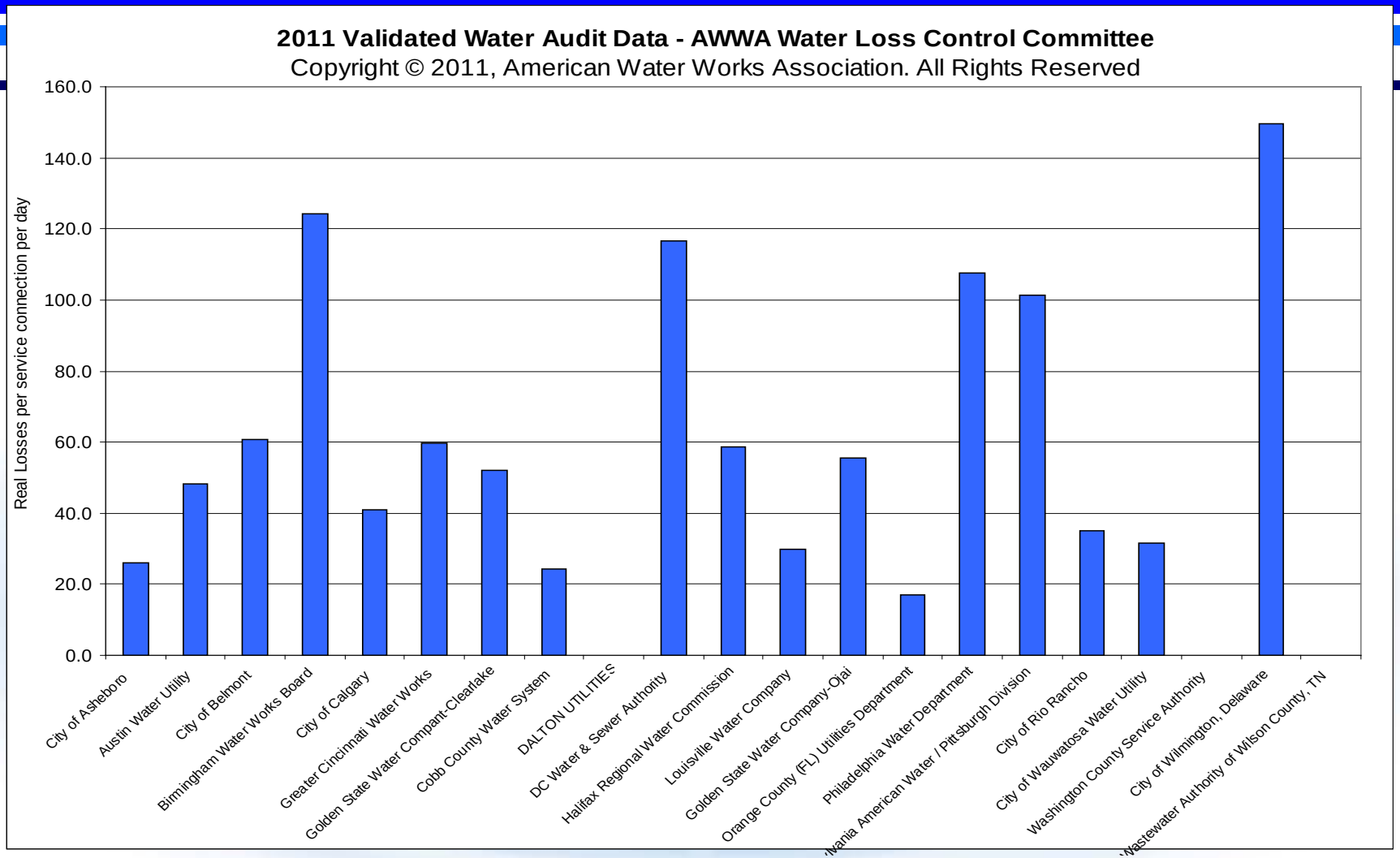
For more information, click here to see the Grading Matrix worksheet

AWWA Free Water Audit Software© Companion "Compiler" Software & Water Audit Dataset

- EXCEL spreadsheet tool that allows data from multiple water audits to be "compiled" into one spreadsheet
- Date can be copied to user's EXCEL files
- Available for free download from AWWA website
- Water Audit data for 21 utilities (2011) and 26 utilities (2012) is available

Administrative	Name of City or Utility	City of Asheboro	Austin Water Utility	City of Belmont
	Country	USA	United States	USA
	Reporting Year	FY08-09	2010	FY 09-10
	Start Date	7/1/2008	10/1/2009	7/1/2009
	End Date	6/1/2009	9/1/2010	6/30/2010
	Name of Contact Person	Michael Rhoney	Dan Strub	Chuck Flowers
	E-Mail	mrhoney@ci.asheb	dan.strub@ci.austi	cflowers@cityofbel
	Telephone	336-626-1234	512-972-0349	704-825-0512
	Telephone Ext			
Audit Data				
Water Supplied	Volume Units	Million gallons (US)	Million gallons (US)	Million gallons (US)
	Volume From Own Sources	1,491.690	43,786.936	593.075
	Master meter error adjustment	138.572	893.611	12.104
	Water imported	-	-	-
	Water exported	-	-	-
	WATER SUPPLIED	1,630.262	44,680.547	605.179
Authorized Consumption	Billed metered	1,311.441	39,367.872	438.054
	Billed unmetered	-	311.434	-
	Unbilled metered	35.791	90.417	-
	Unbilled unmetered	113.521	191.471	45.612
	Unbilled unmetered (1 = Default; 2 = Value)	2	2	2
	AUTHORIZED CONSUMPTION	1,460.753	39,961.194	483.665
Water Losses	**WATER LOSSES (Water Supplied - Authorized Consumption)**	169.509	4,719.353	121.513
	Unauthorized consumption	4.076	125.480	1.513
	Unauthorized consumption (1 = Default; 2 = Value)	1	2	1
	Customer metering inaccuracies	41.667	857.613	18.252
	Systematic data handling errors	-	24.885	-
	Apparent Losses	45.743	1,007.978	19.765
	Real Losses = (Water Losses - Apparent Losses)	123.766	3,711.375	101.748
	WATER LOSSES	169.509	4,719.353	121.513
Non-Revenue Water	**NON-REVENUE WATER**	318.821	5,001.241	167.125
System Data	Length of mains	237	3,639	95
	Number of active AND inactive service connections	13,000	210,893	4,600
	Connection density	54.9	58.0	48.4
	Average length of customer service line	20	0	20
	Average operating pressure	75	77.3	66
Cost Data	Total annual cost of operating water system	$3,048,480	$168,249,678	$1,357,542
	Customer retail unit cost (applied to Apparent Losses	$5.90	$3.91	$6.98
	Customer retail unit cost (units)	$/100 cubic feet (cc	$/1000 gallons (US	$/1000 gallons (US
	Variable production cost (applied to Real Losses)	$510.00	$341.00	$330.00
Performance Indicators				
Financial Indicators	Non-revenue water as percent by volume	19.6%	11.2%	27.6%
	Non-revenue water as percent by cost	16.4%	3.2%	13.7%
	Annual cost of Apparent Losses	$360,779	$3,941,194	$137,961
	Annual cost of Real Losses	$63,121	$1,265,579	$33,577
Operational Efficiency Indicators	Apparent Losses per service connection per day	9.640	13.095	11.772
	Real Losses per service connection per day*	26.084	48.215	60.600
	Real Losses per length of main per day*	N/A	N/A	N/A
	Real Losses per service connection per day per psi pressure	0.348	0.624	0.918
	Unavoidable Annual Real Losses (UARL)	98.591	1,447.995	32.151
	Infrastructure Leakage Index (ILI) [Real Losses/UARL]	1.255	2.563	3.165

AWWA Water Audit Compiler© features readily displayed graphs



losses in gal/service connection/day; good for perform

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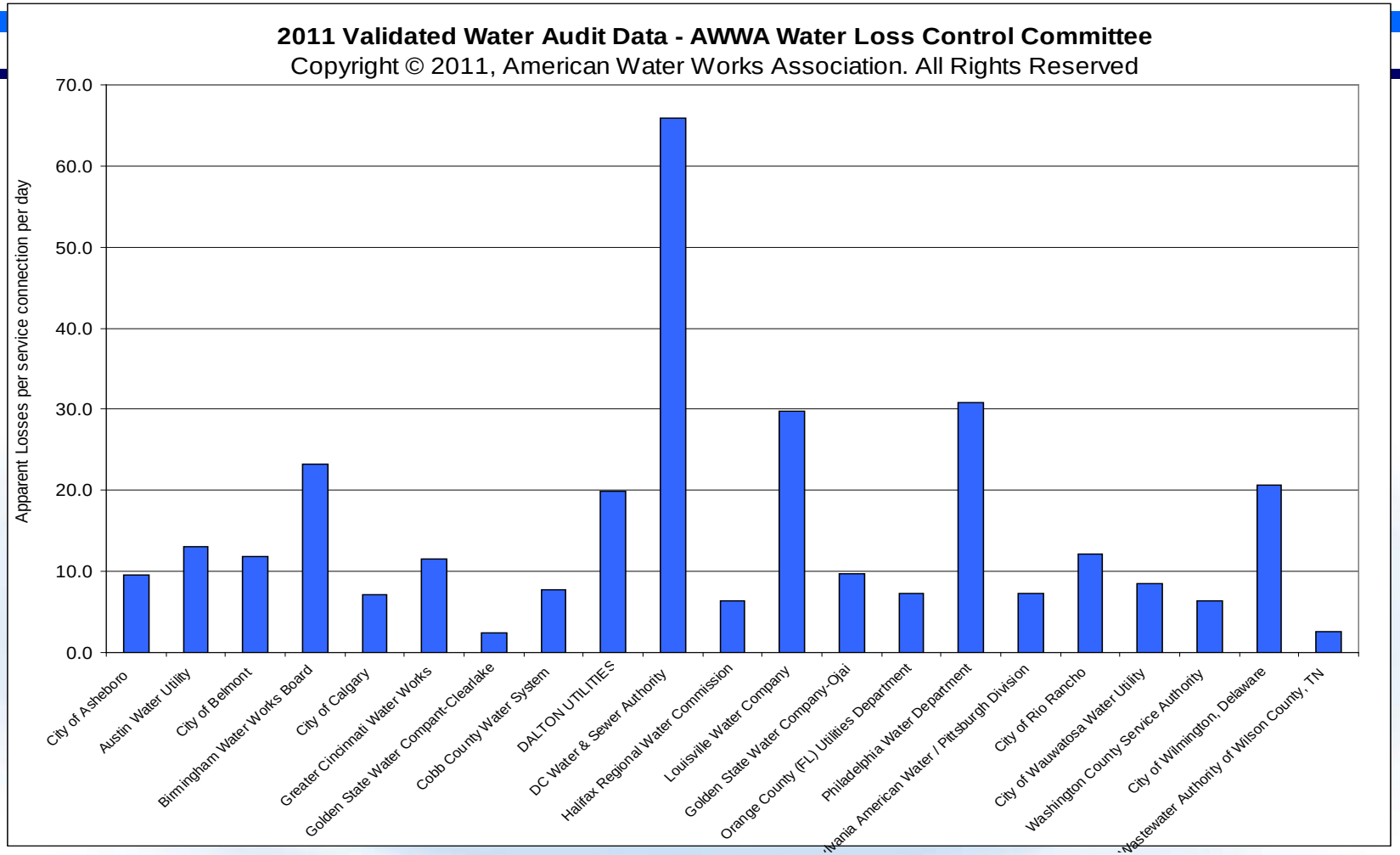
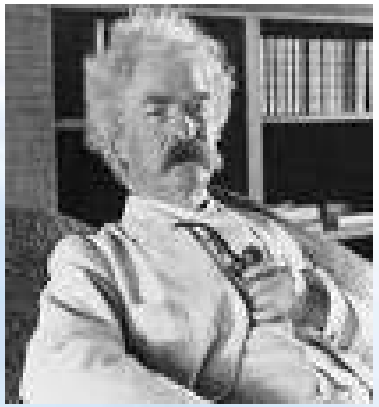


physical) losses in gal/service connection/day: good for performance

Policy and Regulatory Developments in Water Utility Water Efficiency

- *"Whiskey is for drinkin'; Water is for fightin'"*

  - Mark Twain

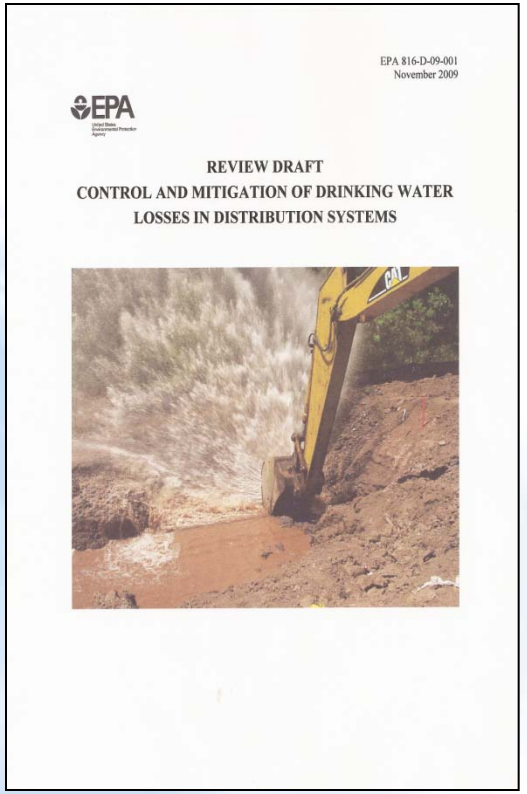


US Environmental Protection Agency

- ***Currently no national regulations on water accountability/loss control***

- US EPA regulates water quality and has programs for water conservation (*WaterSense*) as well as infrastructure and energy

- Report issued in 2010 "*Control and Mitigation of Drinking Water Losses in Distribution Systems*"



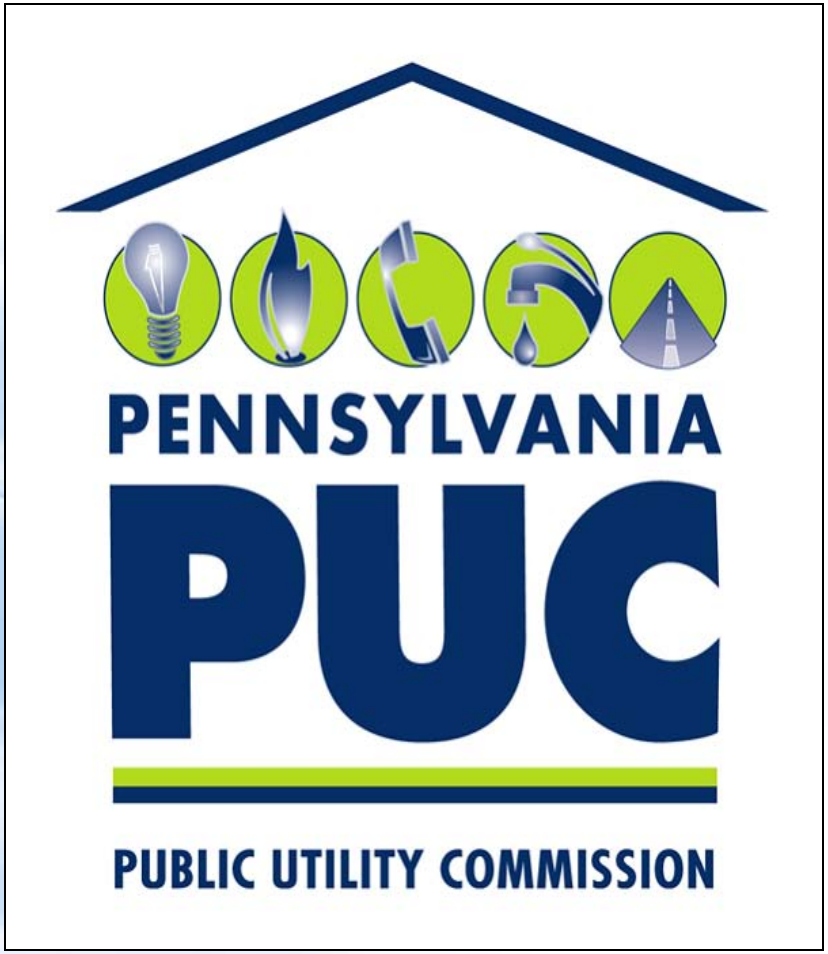
Delaware River Basin Commission

- DRBC's Water Management Advisory Committee motivated DRBC Water Code change in March 2009 to incorporate the IWA/AWWA Water Audit Method.
- Water audit data for 2012 must be submitted on a mandatory basis by March 31, 2013
- Several hundred utilities now required to submit data

Delaware River Basin Commission
DELAWARE · NEW JERSEY
PENNSYLVANIA · NEW YORK
UNITED STATES OF AMERICA

Pennsylvania Public Utility Commission

- Regulates private water companies in Pennsylvania; approximately 130 systems
- Approved a motion on September 10, 2008 that lead to a two year pilot program employing water audits via the IWA/AWWA methodology
- The pilot program has now become mandatory on a phased-in basis based upon system size
- PUC now considering a regulation change



State of Georgia

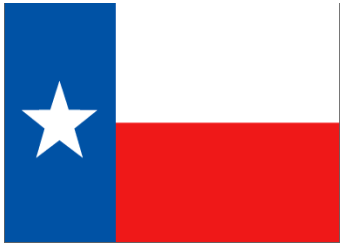
- Decades long struggle for use of water from Lake Lanier; 2009 court ruling went against the City of Atlanta's continued level of withdrawals for water supply
- Landmark ***Water Stewardship Bill*** passed March 18, 2010: requires IWA/AWWA water audit by all water utilities by 2013
- Georgia Association of Water Professionals (GAWP) lead effort to implement a guidance manual
- State-wide water audit data collection initiated in 2012; included rigorous validation process
- Validated water audit data for 100 largest water utilities should become available in spring 2013

http://www1.legis.ga.gov/legis/2009_10/pdf/sb370.pdf

http://gawp.org/audits.php

Other States

The State of Texas was the first state to adopt a water auditing requirement (2005).

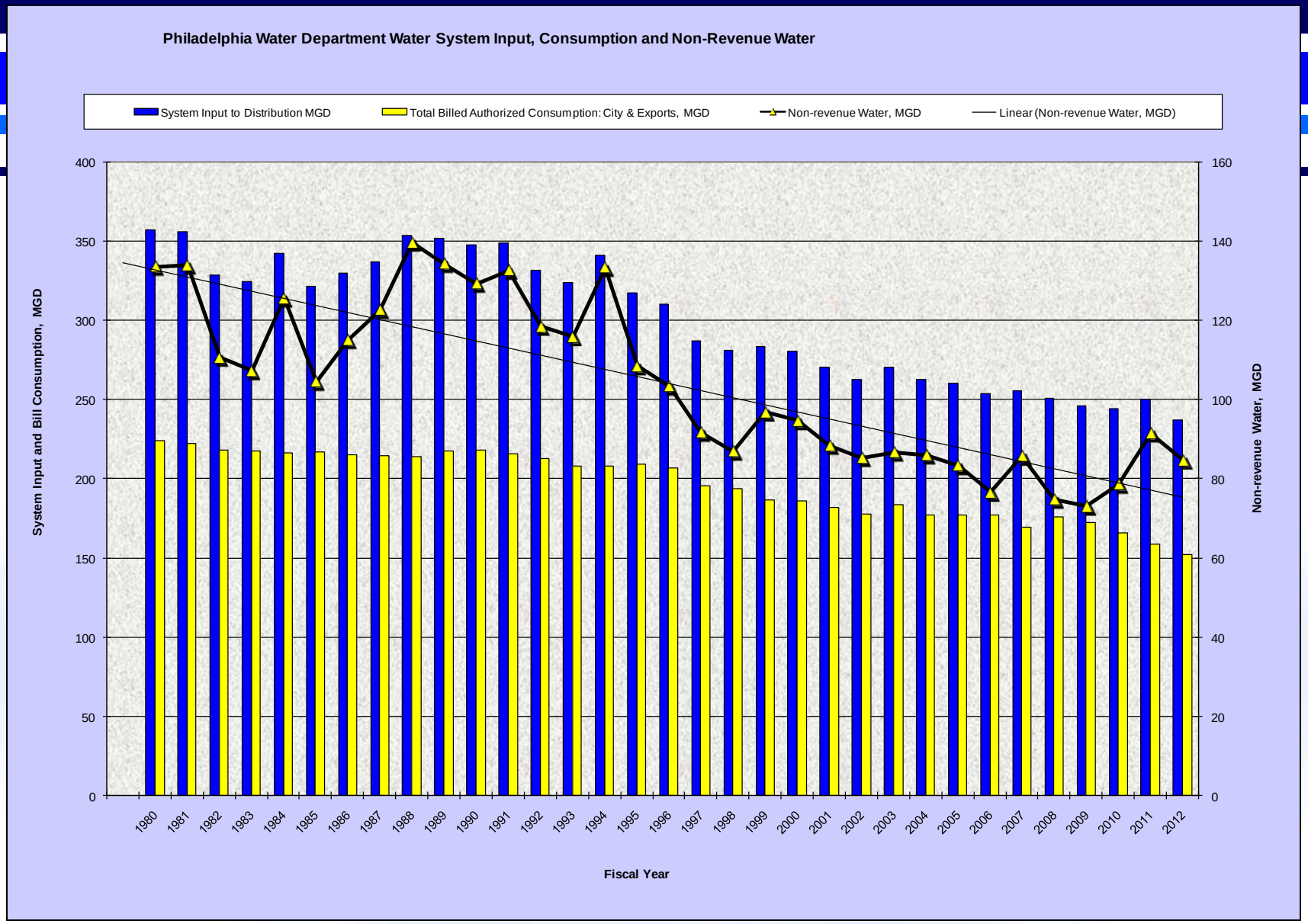


Tennessee Comptroller of the Treasury – Uses the IWA/AWWA Water Audit Methodology to track financial performance
http://www.comptroller.tn.gov/wwfb

California Urban Water Conservation Council: water auditing and leakage reduction

- Four Year Validation Phase: advance utilities to high validation level
- Years 4-6: conduct component analysis, select KPI & & target level
- Final four years: must meet level for leakage control by year 10 (2019)

Philadelphia's Long-term Water Supply Trend



Philadelphia's Water Audit Summary

July 1, 2010 - June 30, 2011 in Million Gallons Per Day (mgd)

Water into Supply -	250.0	mgd	
Customer Billed Consumption -	158.4	mgd	
Unbilled Water	91.6	mgd	
Unbilled Auth. Consumption	2.1	mgd	$ 857,000
Apparent Losses	22.8	mgd	$42,838,000
Real Losses	66.7	mgd	$ 7,387,000
Non-revenue Water	91.6	mgd	$51,082,000

Apparent Loss indicator = 22.8 mgd / 524,413 connections = **43.6 gallons/connection/day**

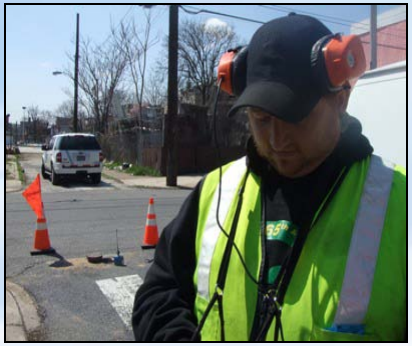
Real Loss indicator = 66.7 mgd / 524,413 connections = **127.0 gallons/connection/day**

NRW by volume = 91.6 mgd /230.8 mgd = **39.7%**

NRW by cost = $US 51.1 million/ $US 224 million = **22.8%**

Real Losses: Leakage

- Leakage is Detected in two primary manners:
  - Acoustically – pinpointing of individual leaks
  - Flow Measurement – inferred presence of leakage
- Water utilities should practice some type of leakage management but most don't



PWD's Leakage Management Program

- PWD has determined its Economic Level of Leakage (ELL) to be 45 mgd vs. current level of 66 mgd
- PWD addresses leakage via:
  - Regular acoustic surveys
  - Service line repairs customer assistance program
  - Inline transmission pipeline leak detection
  - Select district metered areas
  - Pressure management
  - Pipeline replacement

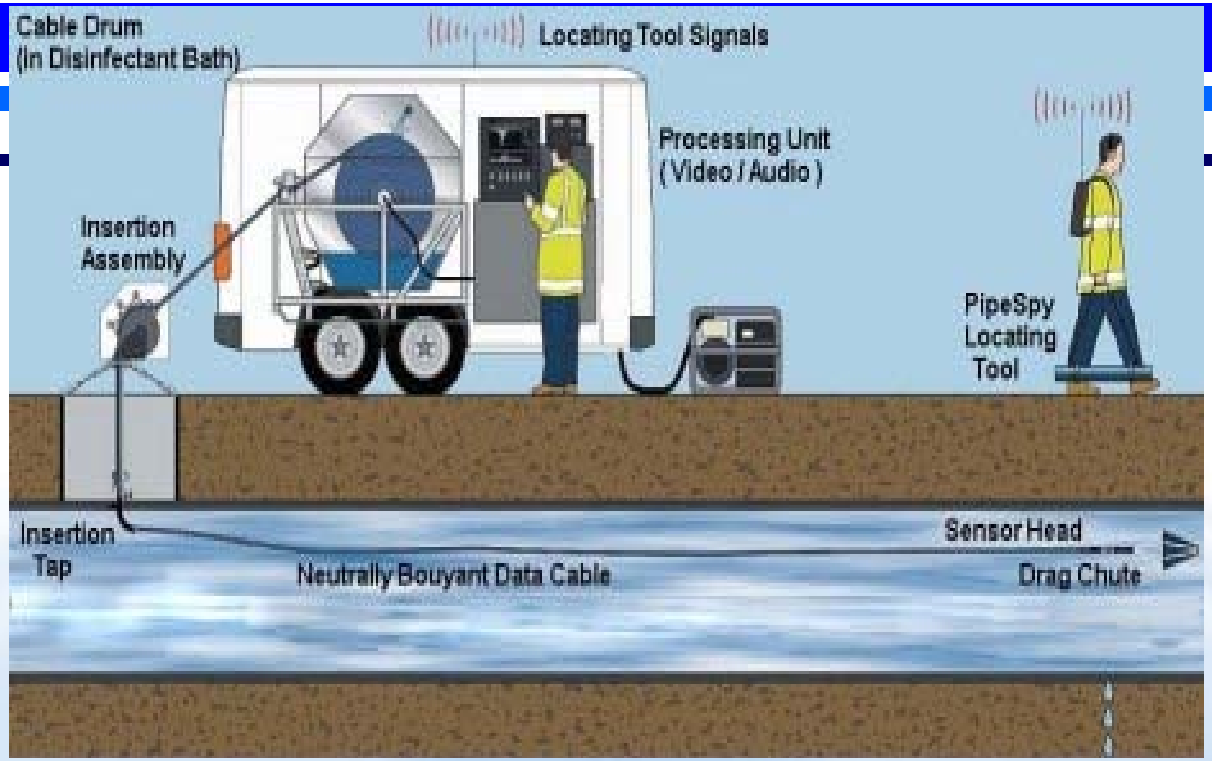
Pipeline replacement

Traditional leak detection survey

Traditional above-ground acoustic leak detection - Limitations

- **All utilities should conduct an acoustic leak detection survey on at least a periodic basis**
  - However, most water utilities practice reactive leakage management: “wait ‘til it breaks and then fix it!
- **Traditional acoustic leak detection is less effective on:**
  - Plastic pipe
  - Large diameter transmission piping: few or no service connections and limited appurtenances make above-ground leak detection difficult
  - Noisy, dense, urban areas
  - Piping in hard-to-access locations

PWD utilizes Sahara® Leak Detection – for large diameter transmission mains



- Six-year program
- Scanned 40 miles of large diameter pipeline
- Identified 82 leaks
- Cost: $770,000

PWD's District Meter Area

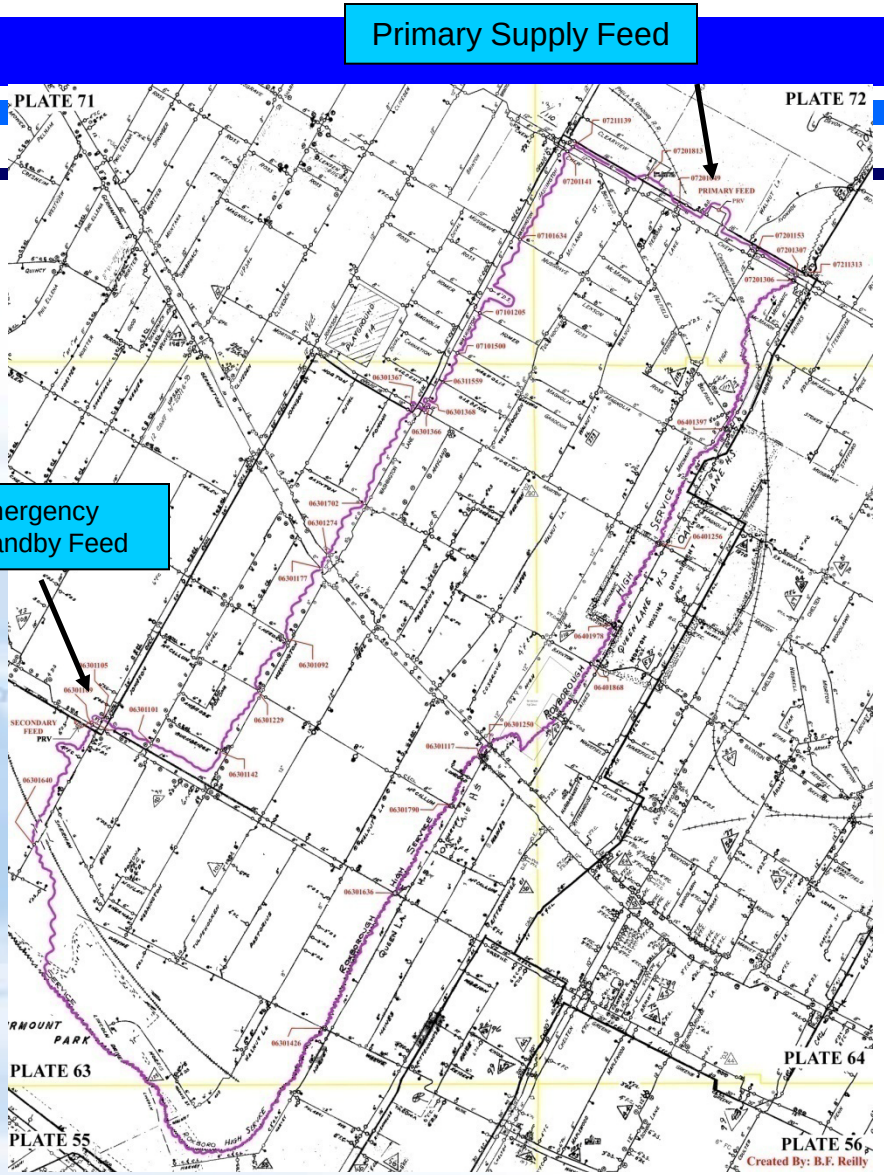
A District Metered Area is a discrete area of the water distribution system isolated by closing valves in a connect-the-dot fashion, to form an "island" in the grid, which is supplied by one or more open water mains

Supply into the DMA is regularly tracked and the flow profile is analyzed

A DMA is sized sufficiently small that higher flows into the DMA evident of newly emerging leakage can be distinguished from normal customer demand

Close monitoring of the DMA allows leak detection crews to be deployed efficiently

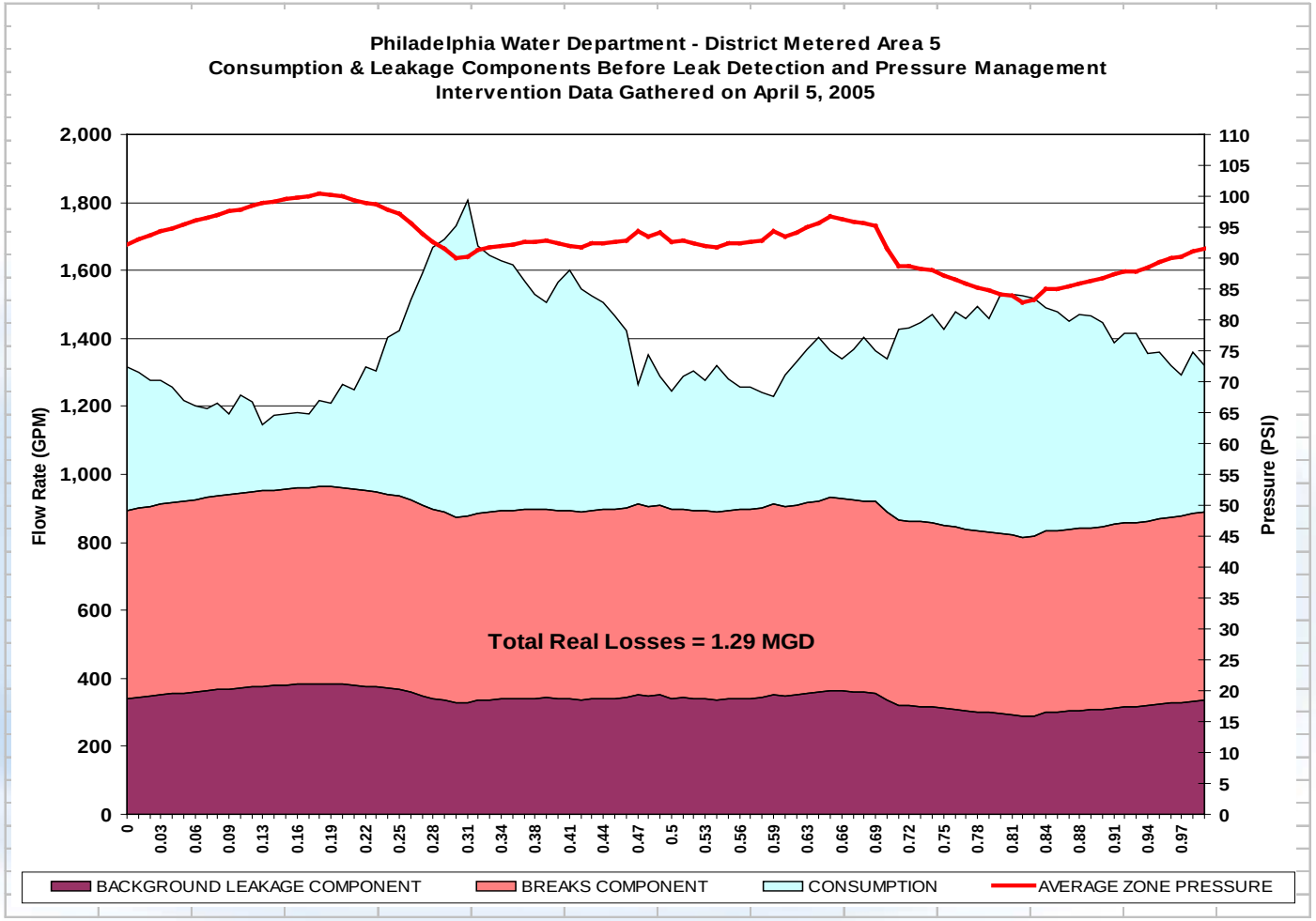
Pressure management is incorporated into this DMA



DMA5 – Baseline Flow Profile; before DMA equipment installed

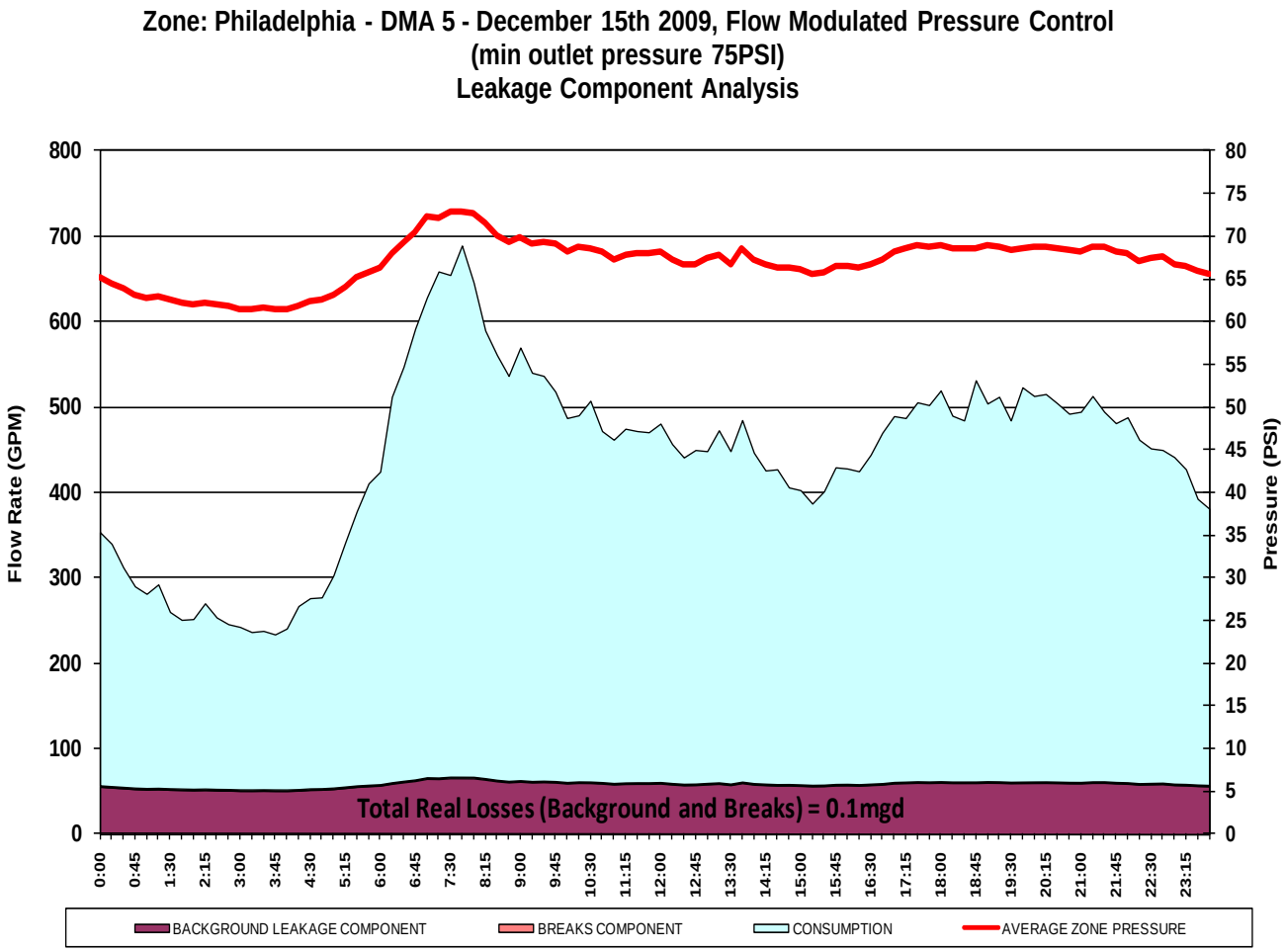
Leakage within the entire DMA is quantified

High leakage rate measured despite periodic leak detection surveys – almost 1.3 MGD



DMA5 – Flow Profile after Leak Detection, water main replacement & optimized pressure control

- **By the close of 2009, DMA5 had reached the optimized state**
- **Unreported leakage had been removed and the only remaining leakage is background leakage**
- **Leakage stood at = 44 gal/conn/day**
- **Optimized pressure control: pressure is paced with water demand**
- ***Better pressure control preserves infrastructure***



Apparent Loss Components

Apparent Losses: cause uncaptured revenue and distort the integrity of customer consumption data

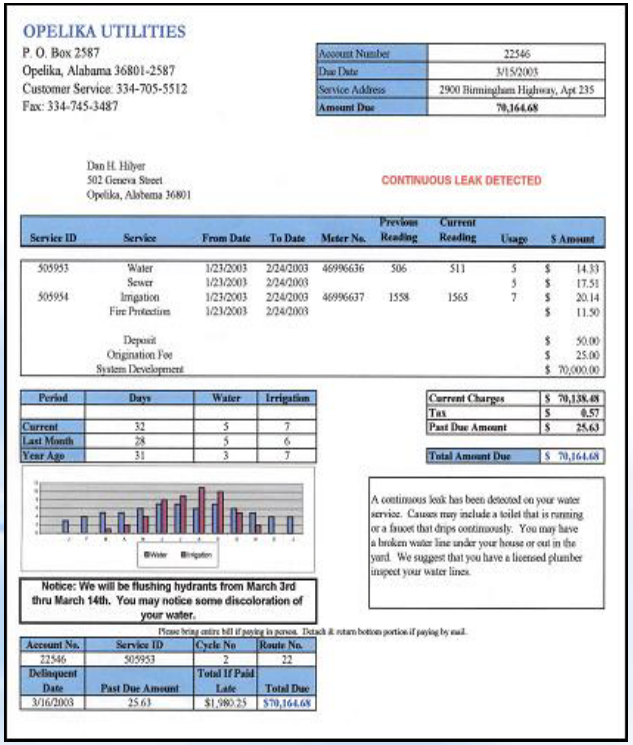
- Customer Metering Inaccuracies
  - Assemble meter demographics from records
  - Conduct regular meter accuracy testing, small samples of meters will suffice
- Unauthorized Consumption
  - A non-issue for many water utilities; but a huge problem for others, esp. urban areas
- Systematic Data Handling Errors
  - Data issues in the billing system

Data-logging consumption on a 4-inch compound meter in an urban high school

AMR/AMI – Innovative Technology

AMI – Fixed Network AMR offers:

- Granular consumption data
- Two-way communications: can activate remote shut-off valves
- Useful data for water conservation & loss control for water utility and customers



OPELIKA UTILITIES
P. O. Box 2587
Opelika, Alabama 36801-2587
Customer Service: 334-705-5512
Fax: 334-745-3487

Account Number	22546
Due Date	3/15/2003
Service Address	2900 Birmingham Highway, Apt 235
Amount Due	70,164.68

Dan H. Hilyer
502 Geneva Street
Opelika, Alabama 36801

CONTINUOUS LEAK DETECTED

Service ID	Service	From Date	To Date	Meter No.	Previous Reading	Current Reading	Usage	$ Amount
505953	Water	1/23/2003	2/24/2003	46996636	506	511	5	$ 14.33
	Sewer	1/23/2003	2/24/2003				5	$ 17.51
505954	Irrigation	1/23/2003	2/24/2003	46996637	1558	1565	7	$ 20.14
	Fire Protection	1/23/2003	2/24/2003					$ 11.50
	Deposit							$ 50.00
	Origination Fee							$ 25.00
	System Development							$ 70,000.00

Period	Days	Water	Irrigation
Current	32	5	7
Last Month	28	5	6
Year Ago	31	3	7

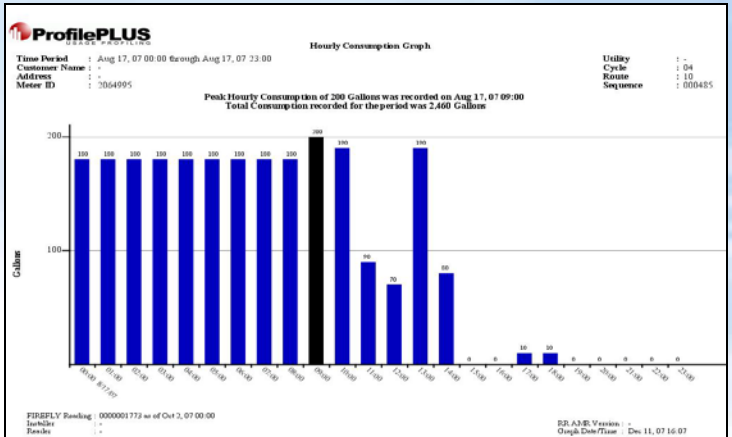
Current Charges	$ 70,138.48
Tax	$ 0.57
Past Due Amount	$ 25.63
Total Amount Due	$ 70,164.68

A continuous leak has been detected on your water service. Causes may include a toilet that is running or a faucet that drips continuously. You may have a broken water line under your house or out in the yard. We suggest that you have a licensed plumber inspect your water lines.

Notice: We will be flushing hydrants from March 3rd thru March 14th. You may notice some discoloration of your water.

Please bring entire bill if paying in person. Detach & return bottom portion if paying by mail.

Account No.	Service ID	Cycle No	Route No.
22546	505953	2	22
Delinquent Date	Past Due Amount	Total If Paid Late	Total Due
3/16/2003	25.63	$1,980.25	$70,164.68



Plumbing leak trend and notice on water bill.

In home display

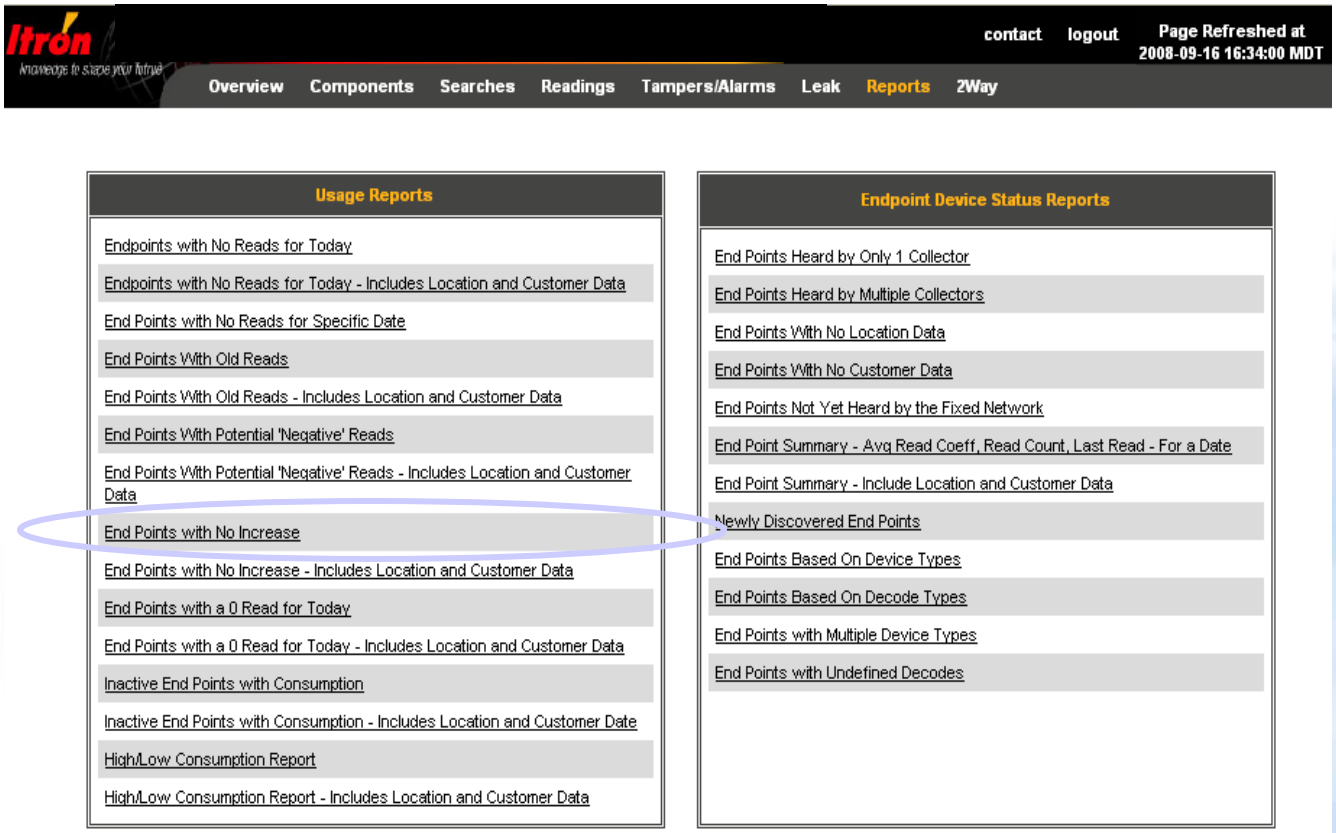
AMI: Fixed Network AMR can provide granular customer data, a variety of alerts and two-way communications

- *Customer consumption readings can be obtained as often as every 15 minutes – gives a consumption profile*
- *Tamper alerts*
- *Leak alerts*
- *Two-way communications can allow automatic shutoff valves, and other capabilities*
- *Fixed network AMI also assists other water loss control activities such as leakage measurements and improved water auditing*

Data Collection units are one approach to establish a fixed communication network

AMI Special Reports – Zero Usage on Active Accounts

Courtesy: Itron



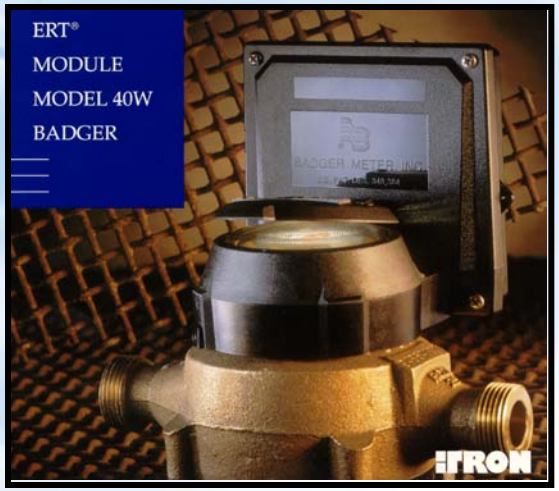
- **In addition to inactive accounts with usage, the converse can also be monitored, i.e. active accounts with no usage**
- **This can be a good indication of a stuck meter, or can indicate a meter that has been disconnected**
- **There have been cases where meters are repeatedly bypassed throughout the month, this can be detected very rapidly**
- **Strong revenue retention applications when coupled with Tamper report**

Revenue Protection & Reinspection Programs

PWD - WRB Revenue Recovery History							
PWD Revenue Protection Program					**Water Revenue Bureau Reinspection Program**		**Total**
Fiscal Year	Accounts Recovered	Water Recovered, mgd	Revenue Recovered	Categories of Greatest Recovery	Reinspection Recoveries	Reinspections Revenue Recovery	Total Recovered Revenue
2011	3,973	2.3	$3,683,600	Investigation of Zero Consump	1,620	$206,075	$3,889,675
2010	2,467	1.49	$2,384,528	Investigation of Zero Consump	1,516	$169,733	$2,554,261
2009	1,659	1	$1,603,540	Investigation of Zero Consump	1,632	$199,732	$1,803,272
2008	n/a	0.4	$636,250	n/a	2,597	$390,670	$1,026,920
2007	449	0.36	$531,400	NB9 (Vacant properties) & NB3	2,984	$340,380	$871,780
2006	1,436	1.01	$1,413,000	Estimated Accounts (#1), Non-	2,513	$209,768	$1,622,768
2005	2,397	1.74	$2,835,000	NB3 & Zero consumption	2,553	$249,261	$3,084,261
2004	1,941	1.67	$2,003,000	Zero consumption accounts	1,991	$446,327	$2,449,327
2003	1,360	1.14	$1,782,000	Zero Consumption Accounts	2,221	$604,379	$2,386,379
2002	932	0.69	$1,037,000	Zero Consumption Accounts	2,721	$668,932	$1,705,932
2001	711	5.81	$2,900,000	Missing Accounts, Hand	3,261	$498,952	$3,398,952
2000	716	1.39	$2,100,000	NB6 accounts	2,737	$393,949	$2,493,949
Total	**18,041**	**19**	**$22,909,318**		**28,346**	**$4,378,158**	**$27,287,476**

Summary

- *Water resources are becoming more stressed due to climate change and population shifts*
- *Society needs to properly value water if it is to become water efficient*
- *Drinking water utilities can become more water efficient by:*
  - *Compiling annual water audits*
  - *Instituting leakage management*
  - *Controlling apparent losses*
  - *Investing in water infrastructure*
- *Customers can help by keeping an objective perspective on water rates and water service*



george.kunkel@phila.gov