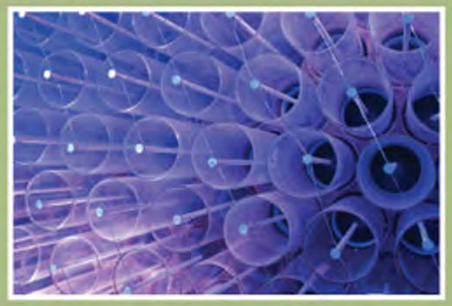
NEW JERSEY
AMERICAN WATER



Module 1.3
Basis and Development of the Water Audit Methodology

DRBC Rule Change & Water Audit Workshop
Rutgers EcoComplex
Bordentown, New Jersey
April 13, 2011

Russell G. Titus

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History of Water Utility Accountability

- **1957 AWWA Committee Report**
  - *Revenue Producing Versus Unaccounted-For Water*
  - Earliest known published mention of the term “unaccounted-for” water and percentage or metered water ratio indicator in technical literature
- **Regulatory structure for water/wastewater industry grew in 1970’s, focus on water quality**
  - National Environmental Policy Act lead to the development of the Council on Environmental Policy and EPA
- **1987 AWWA Water Research Foundation project**

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History of Water Utility Accountability

- **1996 AWWA *Committee Report: Water Accountability***
  - Early advocate in support of expressing loss in terms of water volume rather than a percentage; but had a conflicting message by recommending no more than 10% “true” unaccounted-for water
  - The Committee was still struggling with the best means identify a target level representing best practice performance

System A		System B
10% unaccounted for	?	15% unaccounted for
30 MG/YR volume loss		30 MG/YR volume loss

History of Water Utility Accountability

- **1990's**
  - Five UK water companies fund "National Leakage Initiative" which published *Managing Leaking* in 1994
  - International Water Association (IWA) Water Loss Task Force (WLTF) organized to develop best practice method for water audits
  - AWWA participated in 5-country task force
  - WLTF drew upon best aspects of water auditing approaches in use worldwide
  - Portions of AWWA M36 considered prominently in new water audit method that was developed and published in 2000
  - IWA published *Performance Indicators for Water Supply Services* in 2000

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IWA Best Management Practices considerations

- **All water is accounted for**
- **Rational, standard terminology and definitions**
- **All components of water usage and loss**
  - are presented in terms of volume for the reference period
  - are assigned an appropriate cost that properly reflects their impact to the utility
- **Array of performance indicators**
  - financial
  - operational
  - regulatory

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IWA Performance Indicators

Performance Indicator	Function	Comments
Volume of Non-revenue water as a percentage of system input volume	Financial - Non-revenue water by volume	Can be calculated from a simple water balance; good only as a general financial indicator
Volume of Non-revenue water as a percentage of the annual cost of running the water system	Financial - Non-revenue water by cost	Allows different unit costs for Non-revenue water components
Volume of Apparent Losses per service connection per day	Operational - Apparent Losses	Basic but meaningful indicator once the volume of apparent losses has been calculated or estimated
Real Losses as a percentage of system input volume	Inefficiency of use of water resources	Unsuitable for assessing efficiency of management of distribution systems
Normalized Real Losses - Gallons/service connection/day when the system is pressurized	Operational: Real Losses	Good operational performance indicator for target-setting for real loss reduction
Unavoidable Annual Real Losses (UARL)	UARL (gallons/day) = (5.41Lm + 0.15Nc + 7.5Lp) x P where Lm = length of water mains, miles Nc = number of service connections Lp = total length of private pipe, miles = Nc x average distance from curbstop to customer meter P = average pressure in the system, psi	A theoretical reference value representing the technical low limit of leakage that could be achieved if all of today's best technology could be successfully applied. A key variable in the calculation of the Infrastructure Leakage Index (ILI) It is not necessary that systems set this level as a target unless water is unusually expensive, scarce or both
Infrastructure Leakage Index (ILI)	Operational: Real Losses	Ratio of Current Annual Real Losses (CARL) to Unavoidable Annual Real Losses (UARL); good for operational benchmarking for real loss control.

IWA Component Based Analysis

FIGURE 2 International standard water audit format

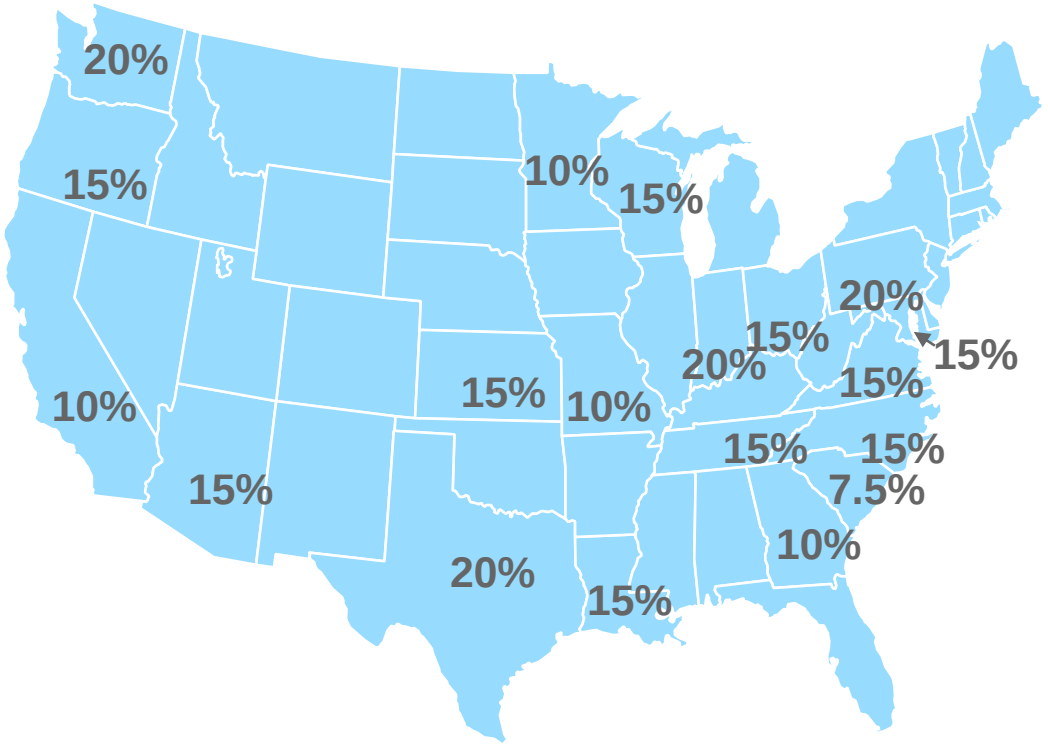
<table>
<tr><td rowspan="2">Own sources</td><td rowspan="10">System input</td><td rowspan="2">Water exported</td><td rowspan="5">Authorized consump-tion</td><td rowspan="3">Billed authorized consump-tion</td><td rowspan="3">Revenue water</td><td>Billed water exported</td></tr>
<tr><td>Billed metered consumption</td></tr>
<tr><td rowspan="8">Water supplied</td><td>Billed unmetered consumption</td></tr>
<tr><td rowspan="2">Unbilled authorized consumption</td><td rowspan="8">Non-revenue water</td><td>Unbilled metered consumption</td></tr>
<tr><td>Unbilled unmetered consumption</td></tr>
<tr><td rowspan="5">Water losses</td><td rowspan="2">Apparent losses</td><td>Unauthorized consumption</td></tr>
<tr><td>Customer metering inaccuracies and data handling error</td></tr>
<tr><td rowspan="4">Water imported</td><td rowspan="3"></td><td>Leakage on mains</td></tr>
<tr><td>Leakage and overflows at storages</td></tr>
<tr><td>Leakage on service connections up to point of customer metering</td></tr>
</table>

Source: Alegre, H. et al, 2000. Manual of Best Practice: Performance Indicators for Water Supply Services. *Published by IWA Publishing, London. www.iwapublishing.com. Used with permission*

All data are in volume, or average volume per day, for the standard reporting period—typically one year.

History of Water Utility Accountability

- 2001: Many states adopted limited statues around percentage indicator; AWWA “States Survey”



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History of Water Utility Accountability

TABLE 1 **States Survey Project summary of findings***

Issue	Jurisdictions	States *n* = 43	Other *n* = 3	Total *n* = 46
Water loss policy	Ariz., Calif., Conn., Fla., Ga., Hawaii, Ind., Iowa, Kan., Ky., La., Md., Mass., Minn., Mo., N.C., Nev., N.H., N.Y., Ohio, Ore., Pa., R.I., S.C., Tenn., Texas, Utah, Vt., Va., Wash., W. Va., Wis., Wyo., DRBC,† SWFWMD,‡ SJRWMD§	33	3	36
Definition of water loss	Ariz., Calif., Ga., Hawaii, Kan., Md., Mass., Minn., Mo., Ore., Pa., R.I., S.C., Texas, Wis., DRBC, SJRWMD	15	2	17
Accounting and reporting	Ariz., Calif., Ga., Hawaii, Iowa, Kan., Ky., Md., Mass., Minn., Mo., N.Y., Ohio, Ore., Pa., R.I., Texas, W. Va., Wis., Wyo., SWFWMD, SJRWMD	20	2	22
Standards and benchmarks	Ariz., Calif., Ga., Hawaii, Ind., Kan., Ky., La., Md., Mass., Minn., Mo., N.C., Ohio, Ore., Pa., R.I., S.C., Texas, Utah, Wash., W. Va., Wis., DRBC, SWFWMD, SJRWMD	23	3	26
Goals and targets	Ariz., Calif., Fla., Ga., Hawaii, Kan., Ky., Maine, Md., Minn., Mo., N.M., Ohio, Ore., Pa., R.I., Texas, Wis., SWFWMD, SJRWMD	18	2	20
Planning requirements	Ariz., Calif., Conn., Fla., Ga., Hawaii, Iowa, Kan., Md., Mass., Minn., Mo., Nev., N.H., Ore., Pa., R.I., S.C., Texas, Vt., Va., Wash., W. Va., Wis., SWFWMD, SJRWMD, DRBC	24	3	27
Compilation and publication	Ariz., Calif., Hawaii, Kan., Ky., Minn., Pa., R.I., Wis., SWFWMD	9	1	10
Technical assistance	Alaska, Calif., Fla., Ga., Hawaii, Kan., Ky., Maine, Nev., N.D., Ore., Pa., R.I., S.C., Tenn., Texas, Vt., Wis., SWFWMD	18	1	19
Performance incentives	Calif., Ga., Hawaii, Ind., Iowa, La., Minn., N.C., R.I., Texas, Vt., SJRWMD	11	1	12
Auditing and enforcement	Ariz., Ga., Hawaii, Kan., Md., Minn., N.H., Ohio, Ore., Pa., S.C., Texas, Wis., SWFWMD, SJRWMD	13	2	15

*Source: Beecher Policy Research Inc., 2002
†DRBC—Delaware River Basin Commission
‡SWFWMD—Southwest Florida Water Management District
§SJRWMD—St. Johns River Water Management District

Why Percentage is a Poor Performance Indicator

A water utility supplies water to a small community. It supplies an average of 6 million gallons per day (mgd) from its water treatment plant. Over the course of a year, it bills the equivalent of 5 mgd. In this case, it is taken that the sum of unbilled authorized consumption, apparent losses and real losses in the water utility average 1 mgd (6 mgd – 5 mgd). The simple "unaccounted-for" percentage is calculated as:

UAF % = (6-5) / 6 = 16.67%

- Assume that a beverage bottling plant is constructed in the community and launches operation as a very large water consumer that draws an average of 1.5 mgd form the water utility. The water utility now produces an additional 1.5 mgd and bills 1.5 mgd more than previously. The UAF% is calculated as below:

UAF % = (7.5-6.5) / 7.5 = 13.33%

Courtesy: G. Kunkel

Why Percentage is a Poor Performance Indicator (continued)

In comparing the two percentage values, its *appears* that the water utility has improved its water loss standing by 3.34%

Improvement = 16.67% - 13.33% = 3.34%

- **However, the volume of Non-revenue water remains the same at 1 mgd after the bottling plant is established! The volume of Non-revenue water is unchanged but the UAF% misleadingly suggests that the utility's water loss control has improved. Because the volume of customer consumption has changed relative to the loss volume (it has increased) the percentage decreases, despite no change in the Non-revenue water volume of 1 mgd.**

Courtesy: G. Kunkel

Water Utility Accountability Becomes of Age

- **2003: AWWA Water Loss Control Committee Report**
  - Published in *Journal AWWA* in August
  - *Applying Worldwide Best Management Practices in Water Loss Control*
  - See workshop handouts

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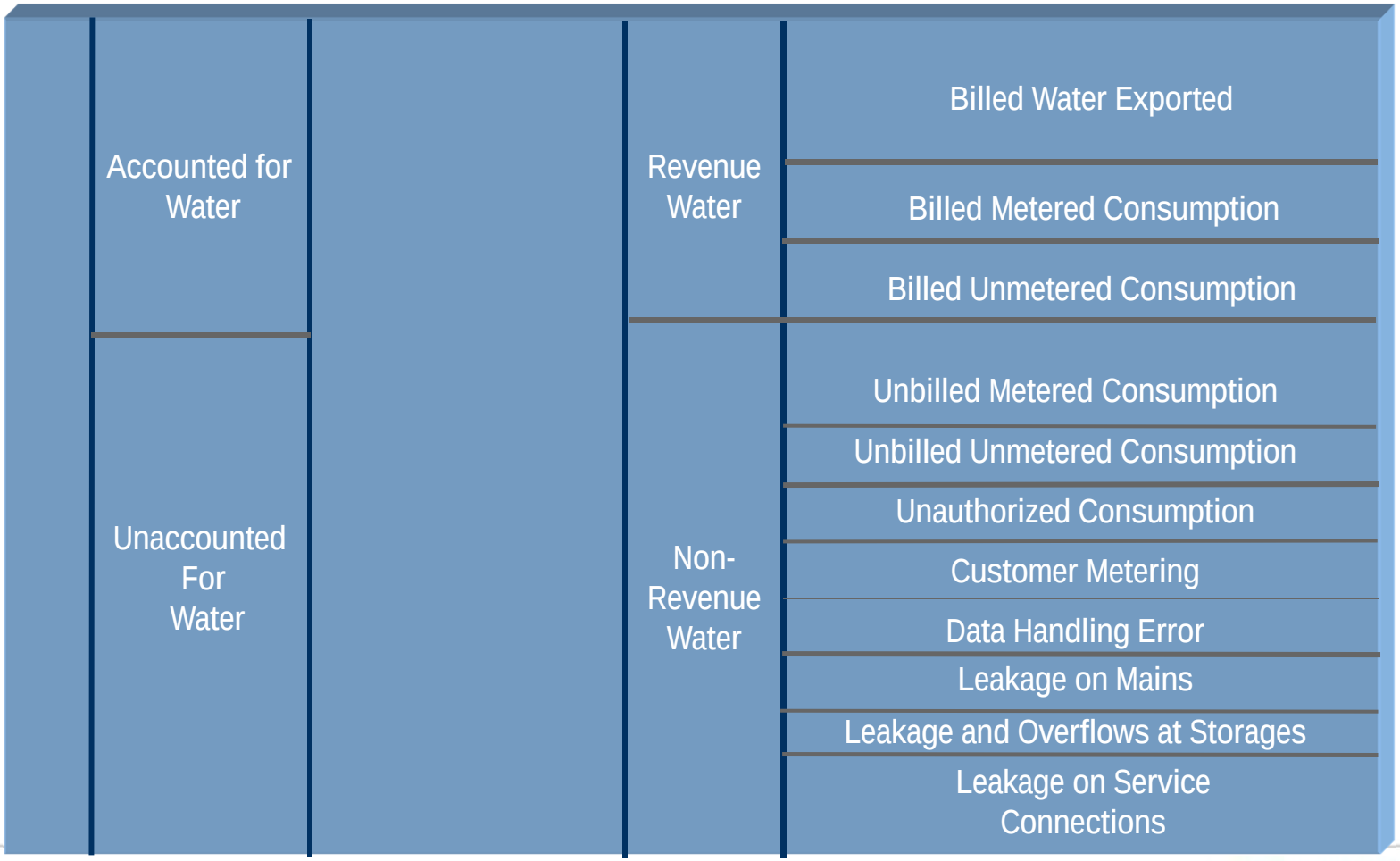
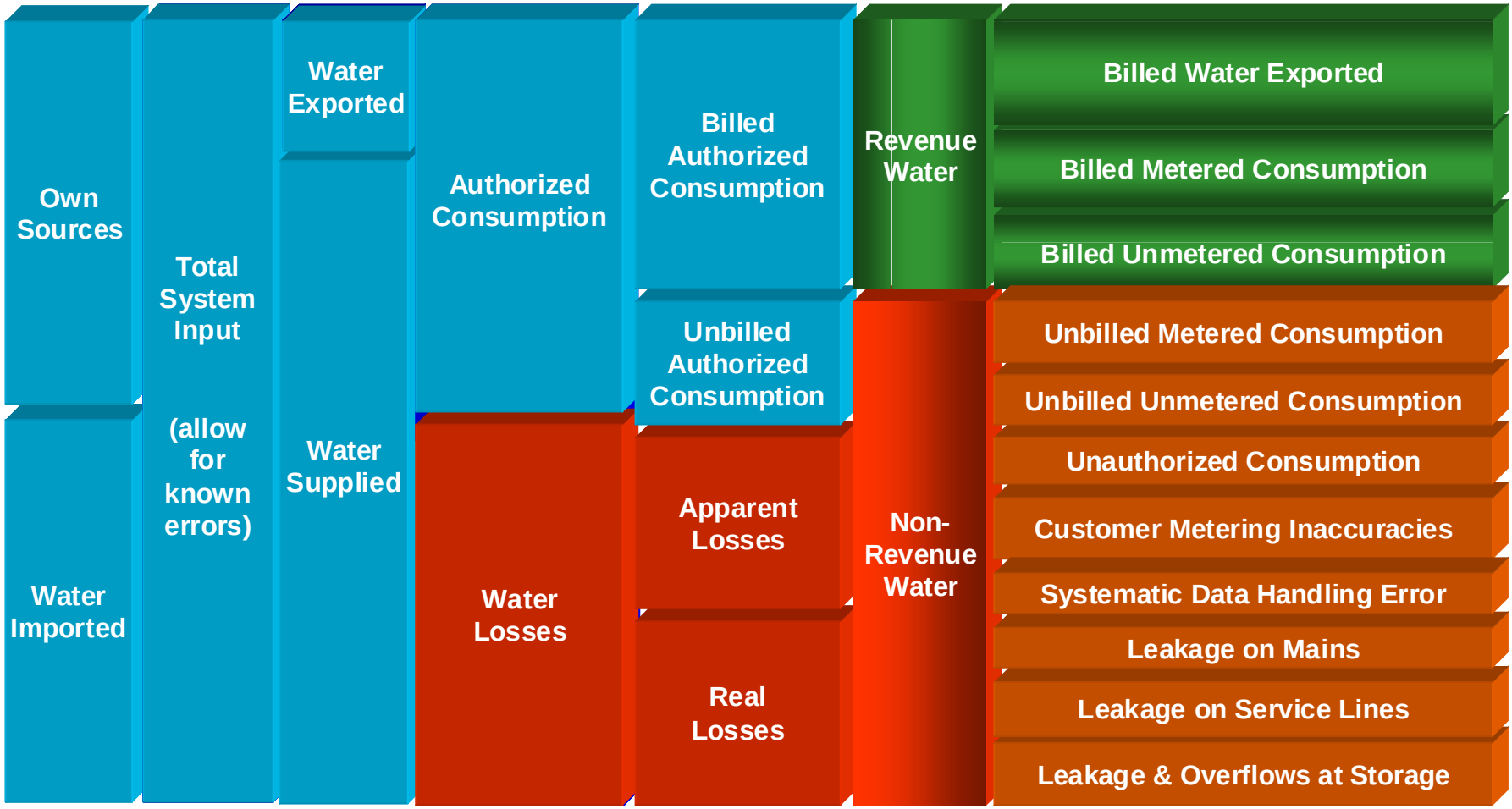
Bridging the Gap: from Unaccounted for to Non-Revenue



The Water Audit Balance



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Software and Spreadsheets Assist in Compiling Data

W1. ANNUAL WATER BALANCE DATA (in mil gal/yr)

Essex Passaic (Short Hills)

Own Sources 9578	System Input 14624	Water Exported 0	Authorised Consumption 11423	Billed Authorised Consumption 11306	Revenue Water 11306	Billed Water Exported	0
						Billed Metered Consumption	11306
						Billed Unmetered Consumption	0
Water Imported 5046.3		Supplied Water 14624		Unbilled Authorised Consumption 117	Non-Revenue Water 3318	Unbilled Metered Consumption	0
						Unbilled Unmetered Consumption	117
			Water Losses 3201	Apparent Losses 508		Unauthorised Consumption	282
						Customer Metering Inaccuracies	226
				Real Losses 2693		Real Losses at Storage Reservoirs, on Mains and on service connections (main to customer meter)	2693

BenchLoss, courtesy: R. McKenzie

Associated Revenue Losses

	Actual Data			
Components of Non-Revenue Water	**Volume Mil gal**	**Unit Value $/1000 gal**	**Value $**	**% of Annual Running Costs**
Unbilled Authorised Consumption	117	0.65	76,050	**0.32**
Apparent Losses:	508	3.42	1,736,700	**7.24**
Real Losses:	2,693	0.65	1,750,479	**7.29**
Total Unbilled:	**3,318**		**3,563,229**	**14.85**

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Software and Spreadsheets Assist in Compiling Data

Awwa Research Foundation Project #2811 - Water Balance Software

New | Open | Save | Save As | Print

All Annual Volumes: million U.S. gallons Period: 2004

System Data | Water Balance | Performance Indicators

Water Utility | System Pressure | Mains | Connections

Name of water utility

New Jersey American Water

Supply area reference

Raritan

Reference Year

2004

Awwa Research Foundation SM

Advancing the Science of Water®

Awwa Research Foundation project #2811

Standardized Annual Water Balance Software
Version 4.04 - February 2004

Software Designed by Bristol Water Services Ltd. and Ronnie McKenzie (GWR Ltd.)

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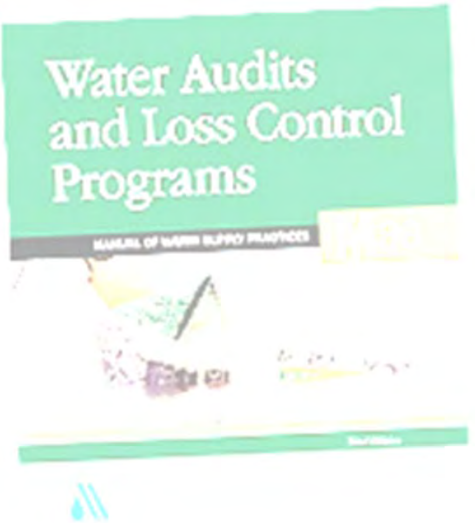
AWWA recommended methodology

- In April, 2009, AWWA published the third edition of Manual 36 entitled Water Audits and Loss Control Programs
- Manual was prepared under the guidance of the Water Loss Control Committee (WLCC)
- Concurrently, a WLCC subcommittee developed water audit software
- The software was made available through AWWA on their website



M36 3rd Edition Table of Contents

Chapter 1 – Introduction: Auditing Water Supply Operations and Controlling Losses

Chapter 2 – Conducting the Water Audit

Chapter 3 – Identifying and Controlling Apparent Losses

Chapter 4 – Understanding Real Losses: The Occurrence and Impacts of Leakage

Chapter 5 – Controlling Real Losses: Leakage and Pressure Management

Chapter 6 – Planning and Sustaining the Water Loss Control Program

Chapter 7 – Considerations for Small Systems

Glossary of Terms and Definitions for Water Loss Control

Appendix – Blank Forms, Assessing Water Resource Management, AWWA WLCC Free Water Audit Software, Case Studies

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AWWA Audit Software

AWWA WLCC Free Water Audit Software: Water Balance

WAS v4.2

Water Audit Report For:	Report Yr:
District	2010

Own Sources (Adjusted for known errors) 9,486.015	Water Exported 0.000	Billed Water Exported			
	Water Supplied 13,614.933	Authorized Consumption 10,662.895	Billed Authorized Consumption 10,492.708	Billed Metered Consumption (inc. water exported) 10,492.708	Revenue Water 10,492.708
				Billed Unmetered Consumption 0.000	
			Unbilled Authorized Consumption 170.187	Unbilled Metered Consumption 0.000	Non-Revenue Water (NRW) 3,122.225
				Unbilled Unmetered Consumption 170.187	
		Water Losses 2,952.038	Apparent Losses 359.819	Unauthorized Consumption 200.000	
				Customer Metering Inaccuracies 132.819	
				Systematic Data Handling Errors 27.000	
Water Imported 4,128.918			Real Losses 2,592.219	Leakage on Transmission and/or Distribution Mains Not broken down	
				Leakage and Overflows at Utility's Storage Tanks Not broken down	
				Leakage on Service Connections Not broken down	

Questions?

Don’t play possum with Water Loss Management