Unaccounted for No More

Water Audit Software Assesses Water Loss

by George Kunkel

Water utilities now have a standardized tool to determine water supply efficiency: a spreadsheet software package for compiling a basic audit of water supply operations, developed by AWWA's Water Loss Control Committee. The software, which exists in Microsoft Excel, is available to anyone for free download from the Water Loss Control pages on WaterWiser, the water efficiency clearinghouse, accessible from the AWWA website. It is also accessible from the AWWA Science and Technology Web pages for AWWA members.

With new methods of water auditing and loss control, water utilities hold the potential to recapture large volumes of treated water as well as additional revenues.

Photo courtesy of Halifax Regional Waste Commission.

The software was developed to

- promote the best-practice water audit method developed by the International Water Association and AWWA,
- assess water supply efficiency in a standard, reliable manner, and
- give utilities a simple, user-friendly way to compile and compare their water audit data with other utilities.

The WLC Committee envisions that many utilities will find the software highly useful through defining their water loss standing and revealing the effects of losses on operations and revenue streams.

Why Use Water Audit Software?

Although North American utilities have a solid track record in protecting public health by delivering high-*quality* water, today's water suppliers also need to ensure a sustainable *quantity* of water. Water supplies are stressed by limited water resources and burgeoning populations in many regions of the United States. Water efficiency is taking on greater importance in these locales, as well as in areas that have been historically perceived as "water rich." Many utilities now employ standing programs for water conservation, water reuse, and water loss control.

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Water loss control minimizes lost volumes of treated water, helping to limit unnecessary source water withdrawals, excess infrastructure capacity, and chemical and operating costs. Often, water utilities can recover additional revenue as part of a good loss-control program. Until recently, a lack of proactive, standard methods made it difficult to quantify losses and plan for loss-reduction programs. Several reasonable water-audit approaches exist, including the method in AWWA manual M36, *Water Audits and Leak Detection*, but all fall short by categorizing a portion of the supply as "unaccounted-for" water. Not only is this term inconsistently defined, it has frequently fallen prey to manipulation, with many system managers arbitrarily quoting an "unaccounted-for percentage," without the means to validate the source data and no sense of how implementing water supply efficiency could quantify and better control losses.

The WLC Committee commissioned the comprehensive *Survey of State Agency Water Loss Reporting Practices*, which showed that most state and regional regulators don't require water suppliers to submit routine water audits in a consistent format that can be validated. A better way had to be developed if water suppliers were to be truly accountable for their water and demonstrate effective loss control.

The IWA organized the Water Loss Task Force, a five-member international group

that included AWWA as the North American representative. The purpose of the WLTF was to identify the best features of existing water audit practices from around the world and assemble a single best management practice (BMP) method that would reliably portray water-loss standing and allow effective performance comparisons. The method was published by IWA in 2000 in *Performance Indicators for Water Supply Services*. The WLC Committee formally recommended this method to water utilities in its report, *Applying Worldwide Best Management Practices in Water Loss Control,* in 2003.

The IWA/AWWA Water Audit Method features rational terms and definitions and an array of strong performance indicators. For example, all water supplied to a distribution system is consumed by valid users or wasted through loss. Hence, no water is "unaccounted-for" but instead quantified under some category of consumption or loss. Many water utilities will need to estimate their losses — at least initially — when using the software. However, new quantification techniques exist, such as night-flow analyses to measure leakage volumes in small areas of distribution systems, known as District Metered Areas or DMAs, which generate accurate data that can be plugged into the software, making the water audit more reliable than using purely estimates. The software features a set of rational performance indicators that incorporate both loss-by-volume and loss-by-cost. These indicators are more consistent and reliable than the traditional unaccounted-for water percentage, which the WLC Committee recommends be dropped from the vernacular.

How Does the Method Work?

Recognizing that water cannot be created or destroyed, the IWA/AWWA Water Audit Method breaks down the total water managed by a utility into components of consumption or loss. A water audit looks at the supply operations of a water utility over a period of time, typically one year, as any shorter periods obscure seasonal effects and meter-reading-lag effects. The audit can trace water through untreated raw water transmission mains, treated water distribution systems, and isolated sections of the distribution system, such as DMAs. Commonly, the entire treated water distribution system is audited, taking into account water supplied into the grid, water consumed by customers, and water that does not reach customers. The Water Balance (Figure 2 on page 19) ensures that the water volumes balance, with the total supply to the distribution grid equaling the total water leaving the grid.

Several new terms and definitions introduced in the method replace the inconsistent terminology used in the variety of earlier methods:

Water Supplied represents the treated water delivered to the distribution system.

Authorized Consumption includes the volumes that reach beneficial use. *Water Losses* are comprised of *Apparent Losses* and *Real Losses*. Apparent Losses are the "paper" losses that occur from customer meter inaccuracies, unauthorized consumption, and data handling error in the meter reading and billing process. These losses corrupt the integrity of customer consumption data and cost the utility revenue because they represent underbilling and unauthorized consumption.

Real Losses are the "physical losses" of leakage and tank overflows. These losses cause the water utility to withdraw, treat, and deliver more water than the customer population requires, resulting in excess production costs, oversized infrastructure, and unneeded source water withdrawals.

Non-revenue Water is the total of Apparent Losses, Real Losses, and the unbilled portions of Authorized Consumption, such as fireflow,

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Audit (from page 17)

maintenance flushing, and withdrawals for municipal uses like park watering. This component represents the water that does not generate billings for the water utility. The term Non-revenue Water is preferred to "unaccounted-for" water.

The method also includes an array of new performance indicators. The most powerful is the Infrastructure Leakage Index, which is the ratio of a utility's actual Real Losses over its Unavoidable Annual Real Losses. The UARL is a new measure that represents the theoretical technical low level of leakage that could be achieved if the best of today's leakage control technologies could be employed by the utility. This value is different for every utility, because the calculation takes into account the utility's number of service connections, average pressure, miles of water mains, and average distance of service lines from the curbstop to the customer meter. Utilities with excellent leakage control have an ILI value near 1.0. Typically, these systems exist in parts of the world where water is scarce, expensive, or both. Figure 1 provides general guidelines on setting leakage reduction targets using the ILI.

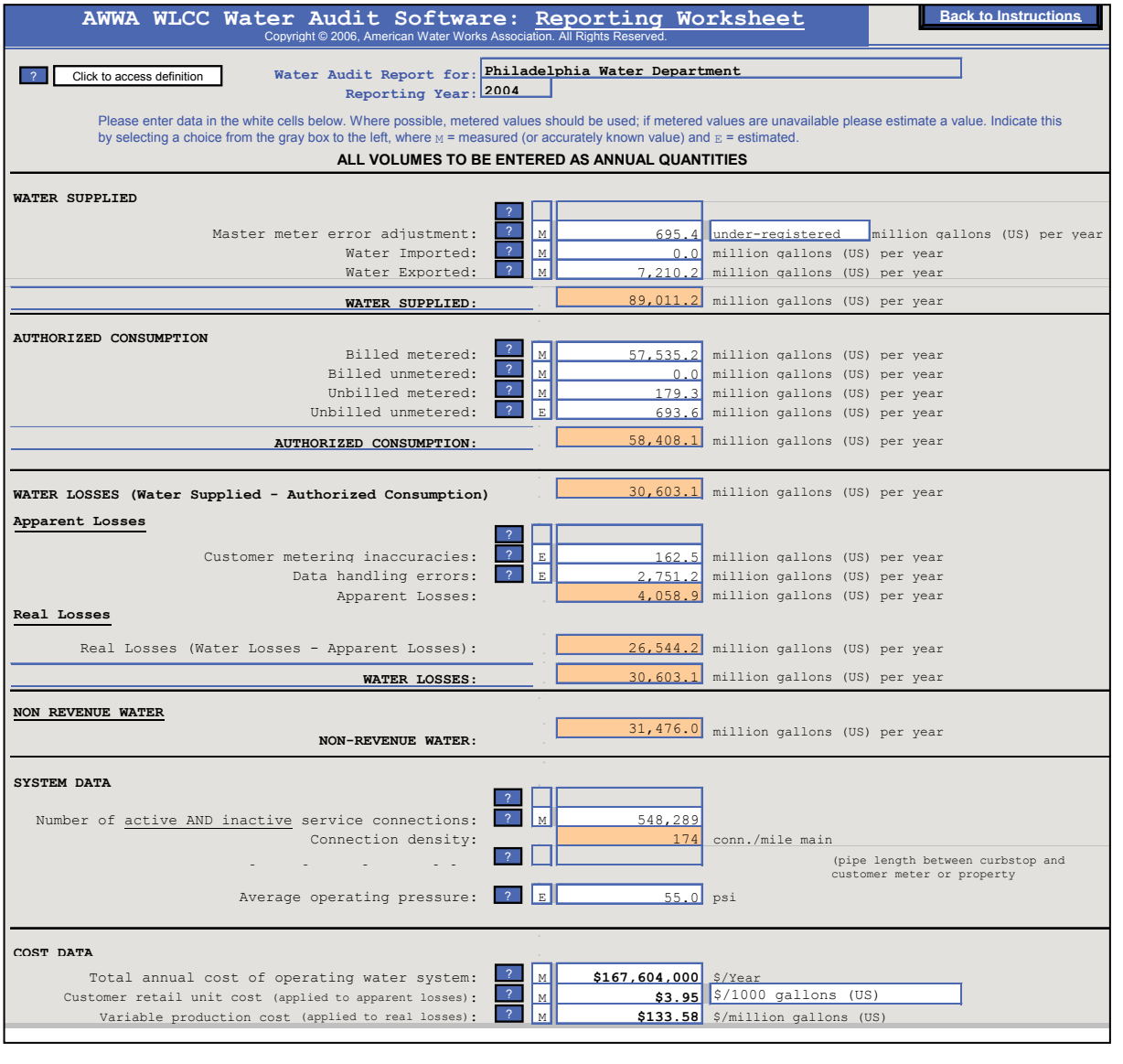
How Does the Software Work?

The WLC Committee's Water Audit Software includes five Excel worksheets:

Instructions. On this worksheet the user enters demographic information that includes the name of the water utility, the person completing the water audit, contact information, and the year of the audit, including start and end dates. This worksheet also includes instructions for using the software package.

Reporting Worksheet. This is the audit's core worksheet. All operational and financial data is entered here, and all loss components and performance indicators are calculated and displayed on one page (Figure 1).

Water Balance. The water balance is a summary that shows the totals of each component of the audit in columns that balance — with all water entering the system equaling all water leaving the system. The water balance,



AWWA WLCC Water Audit Software: Reporting Worksheet

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Back to Instructions

Click to access definition

Water Audit Report for: Philadelphia Water Department

Reporting Year: 2004

Please enter data in the white cells below. Where possible, metered values should be used; if metered values are unavailable please estimate a value. Indicate this by selecting a choice from the gray box to the left, where M = measured (or accurately known value) and E = estimated.

ALL VOLUMES TO BE ENTERED AS ANNUAL QUANTITIES

WATER SUPPLIED				
Master meter error adjustment:	M	695.4	under-registered	million gallons (US) per year
Water Imported:	M	0.0	million gallons (US) per year	
Water Exported:	M	7,210.2	million gallons (US) per year	
WATER SUPPLIED:		89,011.2	million gallons (US) per year	
AUTHORIZED CONSUMPTION				
Billed metered:	M	57,535.2	million gallons (US) per year	
Billed unmetered:	M	0.0	million gallons (US) per year	
Unbilled metered:	M	179.3	million gallons (US) per year	
Unbilled unmetered:	E	693.6	million gallons (US) per year	
AUTHORIZED CONSUMPTION:		58,408.1	million gallons (US) per year	
WATER LOSSES (Water Supplied - Authorized Consumption)		30,603.1	million gallons (US) per year	
Apparent Losses				
Customer metering inaccuracies:	E	162.5	million gallons (US) per year	
Data handling errors:	E	2,751.2	million gallons (US) per year	
Apparent Losses:		4,058.9	million gallons (US) per year	
Real Losses				
Real Losses (Water Losses - Apparent Losses):		26,544.2	million gallons (US) per year	
WATER LOSSES:		30,603.1	million gallons (US) per year	
NON REVENUE WATER				
NON-REVENUE WATER:		31,476.0	million gallons (US) per year	
SYSTEM DATA				
Number of active AND inactive service connections:	M	548,289		
Connection density:		174	conn./mile main	
			(pipe length between curbstop and customer meter or property	
Average operating pressure:	E	55.0	psi	
COST DATA				
Total annual cost of operating water system:	M	$167,604,000	$/Year	
Customer retail unit cost (applied to apparent losses):	M	$3.95	$/1000 gallons (US)	
Variable production cost (applied to real losses):	M	$133.58	$/million gallons (US)	

Figure 1 illustrates part of the Water Audit Method reporting worksheet, where sample data from the Philadelphia Water Department show non-revenue water use of nearly 31,500 mil gal/yr.

read from left-to-right, follows the path of the water supply from delivery to customer consumption (Figure 2).

Definitions. This page provides definitions and guidelines for use of all terms established in the IWA/AWWA method. The user can easily toggle from the Reporting Worksheet to the Definitions Worksheet to access definitions as the audit is compiled.

Water Loss Standing. This worksheet offers guidance in the assessment of the ILI value and its use as an approximate leakage-reduction, target-setting tool. After entering data and determining the performance indicators, utility personnel can refer to this sheet to obtain a sense of how their ILI value ranks with a self-selected target ILI.

The software package is designed to be downloaded at no cost by individual users without outside support. The formulas for the calculations are displayed so the user can track how the quantities and performance indicators are determined. The software is programmed with basic proofreading checks to flag illogical data, such as the customer consumption recorded as greater than the water supplied to the distribution system. All worksheets may be printed on a single sheet of paper, and the software file can be saved to create different versions of the water audit for each year. The website download page provides an opportunity for users to provide feedback and comments to the WLC Committee.

Promoting Better Accountability

The state of Texas has taken a lead role in the United States by legislating the use of water audits by water utilities. Throughout 2006, the Texas Water Development Board will be collecting and analyzing water audit data submitted by utilities using a format similar to the IWA/AWWA method. As other water resource agencies adopt the IWA/AWWA method, water system accountability will be improved, because this consistent method allows reliable comparisons with water utilities in other states, provinces, and countries. The software tool compiles water audit information in a standard format, with meaningful performance indicators that provide policy makers with better information to gauge water loss standing and create improvements.

For More Information

The WLC Committee is also in the process of rewriting M36, *Water Audits and Leak Detection,* using the IWA/AWWA method. Many features of the present edition of M36 will be retained in the new edition, which is expected to be published in 2007.

Acknowledgments

The Water Audit Software Subcommittee reviewed this article and includes Andrew Chastain-Howley, Water Prospecting and Resource Consulting, Fort Worth, Texas (chair); Alain Lalonde, Veritec Consulting, Mississauga, Ont.; David Sayers, Delaware River Basin Commission, West Trenton, N.J.; David Goff, PE, Goff Water Audits and Engineering, East Haven, Conn.; and contribution from Andrew Day, Water Prospecting and Resource Consulting, Fort Worth.

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AWWA WLCC Water Audit Software: Water Balance

Water Audit Report For: Philadelphia Water Department | Report Yr: 2004

Own Sources (Adjusted for known errors) 96,221.4	Water Exported 7,210.2	Billed Water Exported			
		Authorized Consumption 58,408.1	Billed Authorized Consumption 57,535.2	Billed Metered Consumption (inc. water exported) 57,535.2	Revenue Water 57,535.2
				Billed Unmetered Consumption 0.0	
			Unbilled Authorized Consumption 872.9	Unbilled Metered Consumption 179.3	Non-Revenue Water (NRW) 31,476.0
				Unbilled Unmetered Consumption 693.6	
	Water Supplied 89,011.2	Water Losses 30,603.1	Apparent Losses 4,058.9	Unauthorized Consumption 1,145.2	
				Customer Metering Inaccuracies 162.5	
				Data Handling Errors 2,751.2	
Water Imported 0.0			Real Losses 26,544.2	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	

Figure 2, the Water Balance worksheet, breaks down the authorized consumption and water losses into individual components.