UTILITY WATER LOSS

A REVIEW OF CURRENT PRACTICES IN COLORADO, REQUIREMENTS IN OTHER STATES, AND NEW PROCEDURES AND TOOLS

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Colorado Water Conservation Board

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Introduction

Water Loss Control represents the efforts of drinking water utilities to provide stewardship and accountability in their operations by reliably auditing their supplies and keeping their system losses to a reasonable minimal level. With pressures mounting on our water resources, water-efficiency throughout the entire lifecycle of human water use is imperative. New methods of water auditing and loss control give water utilities the potential to recapture large volumes of treated water as well as additional revenues. Water Loss Control – conservation by water suppliers – is an essential function of the drinking water industry and a cornerstone of sustainable water resources management.

The purpose of this document is to review current practices and recommend a standard reporting methodology for utility water loss in Colorado. "Water loss" is the industry standard terminology for unaccounted for water or line loss. There is currently little data on water loss in the State. What data does exist has been developed in such a way that makes it virtually impossible to adequately compare loss between agencies and to determine if loss is significant.

The International Water Association (IWA) and the American Water Works Association (AWWA) have developed a standard methodology for determining water loss for municipal water providers. This methodology is presented in the 2009 AWWA M36 Manual of Practice – *Water Audits and Loss Control Programs (3rd Edition).* This relatively new methodology has not been widely adopted or implemented in Colorado.

This document provides an overview of the AWWA water audit and loss control program methodology and introduces the free Excel spreadsheet tool that greatly simplifies the entire process. It also reviews the current water loss practices of Colorado utilities and proposes a standard reporting methodology for utility water loss in Colorado. The focus of this document is on utility water audit and loss accounting processes and procedures. Actual loss reduction and control programs are briefly discussed, but are covered in tremendous detail in the recommended references.

Water Loss Management in Colorado

In order to get a sense of what loss tracking methods were used around the state, fifteen water agencies were contacted. Of those contacted, eleven responded in time to be included in this report. The surveyed agencies are from diverse locations (four from the greater Colorado River basin, three from the South Platte system, two from the Rio Grande River basin and two from the Arkansas River watershed). Size also varied: Denver Water, with a service population of 1,000,000, was surveyed as well as East Alamosa Water and Sanitation District, which has a population of 1,430.

Nearly every water agency tracks water loss in some form or another. One exception is Mount Werner Water and sanitation District. While Mount Werner does not track water loss, they periodically audit water production versus metered use.

Table 1 presents the water loss performance indicators identified in the AWWA M36 Manual. This is a useful reference when comparing water loss programs among different water agencies.

Table 1: AWWA Water Audit Method Performance Indicators

Function	**Level**	**Performance Indicator**	**Comments**
Financial: Non-revenue water by volume	Basic	Volume of non-revenue water as percentage of system input volume	Easily calculated from the water balance, has limited value in high-level financial terms only; it is misleading to use this as a measure of operational efficiency.
Financial: non-revenue water by cost	Detailed	Value of non-revenue water as a percentage of the annual cost of running the system	Incorporates different unit costs for non-revenue components, good financial indicator.
Operational: Apparent losses	Basic	gal/service connection/day	Basic but meaningful performance indicator for apparent losses. Easy to calculate once apparent losses are quantified.
Operational: Real losses	Basic	[gal/service connection/day] or [gal/mile of mains/day/psi] (only if service connection density is < 32/mi)	Best of the simple "traditional" performance indicators, useful for target setting, limited use for comparisons between systems.
Operational: Real losses	Intermediate	[gal/service connection/day]/psi or [gal/mile of mains/day/psi] (only if service connection density is < 32/mi)	Easy to calculate this indicator if Infrastructure Leakage Index is not yet known. Useful for comparisons between systems.
Operational: Unavoidable annual real losses	Detailed	UARL (gal) = $(5.42 \cdot Lm + 0.15 \cdot Nc + 7.5 \cdot Lc) \cdot P$ Where: Lm=length of mains (miles); Nc=number of service connections Lc = length of private service pipe from mains to meters (mi); P = average pressure in 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 ILI. The UARL calculation is not valid to systems with less than 3,000 service connections.
Operational: Real Losses	Detailed	Infrastructure Leakage Index (ILI)	Ratio of Current Annual Real Losses to Unavoidable Annual Real Losses. Best indicator for comparisons between systems.

None of the agencies surveyed reported differentiating between non-revenue water, water losses and apparent losses. It was hypothesized that smaller agencies in Colorado might not track water loss due to limited resources. However, even the smallest agency contacted for this study monitors water loss to some degree. At this agency, losses are reported as a volumetric value

rather than a percentage. All other agencies report their losses as percentages. The AWWA Water Audit Method Performance Indicators recognizes this as a basic level of water loss tracking.
Based on survey responses, many Colorado water agencies are not differentiating between real and apparent losses. Differentiating among types of loss offers distinct advantages. For example, apparent losses are volumes of water improperly recorded at the point of delivery. The value of these types of losses is the retail value of the water. On the other hand, the values of real losses are based on the production costs, and are frequently lower than apparent losses. Differentiating apparent losses (and knowing their different value) can make loss accounting more accurate – volumetrically and financially.

Of the agencies surveyed, only Denver Water reported trying to implement the new AWWA M36 water loss method for calculating the infrastructure leakage index (ILI). According to Garth Rygh, Superintendent of Water Control for Denver Water, "the results of the efforts were inconclusive and did not spur any further action."

Calculation methods varied considerably among Colorado water agencies in the details of what is included in calculating water loss. A compilation of calculation methods in the agencies surveyed is shown in Table 2.

The basic calculation used by Colorado agencies was system input volume minus billed data (i.e. produced water minus billed consumption). Some agencies track unbilled usage and include this in the calculation. Some agencies track hydrant use. Some agencies track line flushing volumes, some don't, and those that do utilize different methods. Variations in approach make it essentially impossible to perform an "apples to apples" comparison of water loss across Colorado water providers. The lack of consistent calculation methods appears to be a point of consternation, particularly for larger agencies. Representatives from Pueblo Water and Aurora expressed some frustration that losses are not comparable from agency to agency.

Leak detection is a critical part of controlling water loss. Many agencies surveyed reported having in-house leak detection staff. Leak detection is usually performed in response to suspected leaks, either at customer request or when "bubble ups" occur. Small agencies limit leak detection to a reactive rather than proactive approach. Large agencies treat leak detection as a routine part of system maintenance. Pueblo's leak detection program for example, has a target of testing five percent of the system annually for leaks.

The largest components of water loss vary from system to system. Aurora reported that hydrant flushing is their largest component of loss. Denver Water attributed their biggest loss to meter inaccuracies.

Water loss tracking in Colorado is common, but far from uniform. Most water agencies have not yet incorporated the newer and more sophisticated water loss tracking methods (such as the infrastructure leakage index), in place of reporting percentages of unaccounted water. More detailed information on utility survey responses is presented in Appendix A.

Table 2: Water loss calculation methods of selected Colorado water agencies

Agency name	County	Service Population	Water Loss Term used	Reported loss	Calculation method
Alamosa	Alamosa	9,133	Water loss	5%	Production less metered use
East Alamosa Water and Sanitation District	Alamosa	1,430	Un-billed	0.9 to 1.0 MG	System input from city treatment plant minus billed volume
Aurora Water	Arapahoe	300,000	Un-accounted water	Declined *	Treatment plant outputs minus billed volumes minus AW's use, hydrant flushing, firefighting, and street sweeping
Colorado Springs Utilities	El Paso	412,800	Water loss	~8%	Subtract potable water sales for the month from the monthly total of potable water that was put into the distribution system
Denver Water	Denver	1,000,000	Non-revenue water	2% to 5%	Difference between water produced (i.e. water that enters the system) and water sold (DWB has universal metering)
Eagle River Water and Sanitation District	Eagle	32,490	Water loss	Declined. **	Declined to report data. **
Grand Junction	Mesa	26,000	Water loss	7% to 8%	Treatment plant production minus billed volume. Also, track hydrant flushing and some water break data.
Longmont	Boulder	85,000	Water loss	8.2%	System input from treatment minus authorized consumption
Mount Werner Water and Sanitation District	Routt	16,000	Water loss	12%	Water production less metered water use
Pueblo Water	Pueblo	105,500	Un-accounted water	6%	System input from treatment plants minus billed volumes
Ute Water Conservancy District	Mesa	70,000	Un-consumed water	7.6% ***	Raw water, finished water, and consumed water

*A value under 10% was initially reported and then retracted. The interviewer indicated this was not a system-wide number, which he did not readily have.

** Due to ongoing litigation with the CWCB, the representative for ERWSD declined to provide some data.

*** Ute Water reports water loss monthly. This value is for May 2009.

Water Loss Management in Selected Regions of the United States

A number of states and regional agencies in the U.S. have taken up the issue of utility water loss and water efficiency in general and have established minimum reporting requirements and best management practices. This section of the guidance document reviews the most relevant state and local water loss control efforts.

The State of Texas took the lead with the passage of House Bill 3338, requiring water utilities to regularly submit a water audit. Requirements have also been put forward in Washington and New Mexico, as well as the Metropolitan North Georgia Water Planning District, Delaware River Basin Commission, and in California through the California Urban Water Conservation Council (CUWCC). A number of proactive water utilities have launched effective water loss control programs in recent years. The new national Alliance for Water Efficiency also holds promise as an agent of change to promote recognition of the need for a national policy framework for water utility efficiency.[1]

Texas

In 2006 Texas determined that water agencies in the state needed to improve record-keeping, metering, leakage management, and other controls needed to operate a water-efficient utility. Over 2,000 Texas supplier water audits were analyzed in 2006, revealing that many systems do not keep sufficient records to track their losses reliably.

The data deficiencies uncovered through the Texas effort (the first in the US) helped other states such as California to realize that the first step in the process must be to improve the quality and level of the data on utility water loss that is used by water utilities. Only after a sufficient number of providers have collected and analyzed adequate and accurate water loss data will it be possible to set benchmarks for utility water loss. This is an important finding that has influenced other states in their efforts to develop water loss reporting standards and benchmarks.

The Texas Water Development Board (TWDB) has adopted the water audit methodology described in the 2009 AWWA M36 Manual of Practice – *Water Audits and Loss Control Programs (3rd Edition)* discussed in detail later in this document.

Water Loss Audits – Rule §358.6

From State Water Planning Guidelines

> Every five years, a retail public utility that provides potable water, performs a water loss audit. A water loss audit form, computing the utility's most recent annual system water loss, is filed with the executive administrator. The water loss audit shall be performed in accordance with methodologies developed by the board based on the population served

[1] Kunkel, George, Jr. Water Efficiency: The Journal for Water Conservation Professionals. Elements. Water Loss Control. 2009.

by the utility and taking into consideration the financial feasibility of performing the water loss audit, population density in the service area, the retail public utility's source of water supply, the mean income of the service population, and any other factors determined by the board.

At least one year prior to the required filing, the executive administrator provides the forms and methodologies approved by the board to the retail public utility via first-class mail, electronic mail, or both. Retail public utilities shall submit the water loss audit form to the executive administrator by the 31st day of March. The executive administrator compiles the information included in the water loss audits according to category of retail public utility and according to regional water planning area.

The executive administrator determines if the water loss audit form is administratively complete. A water loss audit form is administratively complete if all required responses are provided. If the executive administrator determines that a retail public utility's water loss audit form is incomplete, the incomplete audit form will be returned to the utility. The retail public utility will then have 30 days from the new postmark date or electronic mail sent date to complete the items found deficient and return a complete water loss audit form to the executive administrator. A retail public utility that fails to submit a water loss audit form or that fails to timely correct a water loss audit form that is not administratively complete is ineligible for financial assistance for water supply projects. The retail public utility will remain ineligible for financial assistance until a complete water loss audit form has been filed with and accepted by the executive administrator.[2]

Additional Information on the Texas Water Audit Regulations

- Mark Mathis of the TX Water Development Board, said the data they receive from water providers is often suspect. The TWDB has been receiving information on water loss auditing since 2005.
- About 2300 out of 4600 utilities report, but the 2300 that do report represent 80% of the water that is provided in Texas.
- Texas does not have a minimum water loss level or percentage that utilities must meet at this time.
- Each utility in Texas is supposed to report their water audit information annually and can do so online. State grant funding for a water utility is contingent upon successful completion of water loss audit reporting.
- In 2006 Texas passed legislation that mandates the reporting requirement.

[2] http://texinfo.library.unt.edu/texasregister/html/2004/oct-08/PROPOSED/31.NATURAL%20RESOURCES%20AND%20CONSERVATION.html. Title 31. Natural Resources and Conservation. Part 10 Texas Water Conservation Board. Chapter 358. State Water Planning Guidelines. Subchapter B. Data Collection. 31 TAC. § 358.6. Accessed June 19, 2009.

California

California is in the process of revising their best management practices (BMP) related to water audits and leak detection and expects to have a revised BMP in place in Fall 2009. Learning from the Texas experience, California spent the next four years working with water providers to improve data collection and reporting on water loss. Once enough utilities have achieved an adequate audit data validity level (discussed later in this document), then California will consider setting benchmarks for utility water loss. Until the data validity level is improved, it is not possible to determine reasonable benchmarks for utility water loss.

From the California Urban Water Conservation Council (CUWCC):

The CUWCC has proposed a revision to Best Management Practice (BMP) 3 *"Water Audits and Leak Detection"* that will incorporate the recommendations from the American Water Works Association (AWWA) 3rd Edition M36 *Manual Water Audits and Loss Control Programs*. The revised BMP, will be known as CUWCC BMP 1.2, "System Water Audits, Leak Detection and Repair", and is designed to better define "water loss" and incorporate the water loss management procedures laid out in the AWWA manual.

The goals of these methods include both an increase in water use efficiency in the utility operations and proper economic valuation of water losses to support water loss control activities. California agencies are expected to use the AWWA Free Water Audit Software (discussed in detail later in this document) to complete their standard water audit and water balance.

According to the CUWCC, in California, at a minimum, implementing the water audit shall consist of the following steps:

- An audit to determine the volumetric quantification of apparent and real water loss using the AWWA Water Loss software. At a minimum, this audit should be performed annually and should include the impact of the losses on utility operations.
- Agencies should use methods suggested by the AWWA Software to develop an accurate data set used in their water audit and balance. Validation of the data set may take place over a four-year period.
- Use of the CUWCC's Avoided Cost Model (or other similar model) to determine the economic value of real loss recovery based on the avoided cost of water.
- Every four years agencies must identify the volume, value, and cause of water loss by component (e.g. background losses, reported and unreported leaks) which can then be used to support the economic analysis and selection of intervention tools.
- Where cost effective, agencies should reduce real water losses. Programs and recommendations are available in the AWWA 3rd addition M36 publication.
- Advise customers of possible leaks on customer's side of the meters (a separate issue from utility water loss which is the focus of this guidance document).
- Agencies must provide a full BMP 3 report at the end of the first required reporting period and annually thereafter.

California's 10-Year Plan
The CUWCC has a 10-year plan for more fully integrating benchmarking and other elements of water loss control into the BMP reporting process.

The CUWCC plans to adopt performance indicator benchmarks for water loss standards in year six following four years of data collected and reported by the agencies. During the first four years of data collection and BMP implementation, agencies must seek training in the AWWA water audit method and component analysis process from either CUWCC or AWWA. At the end of the fourth year and at 4-year intervals, agencies must complete a component analysis of real losses. During this time period agencies must work to improve the accuracy and completeness of the water balance; estimation of water losses that are not measured directly should be improved using the methodology set forth by the AWWA.

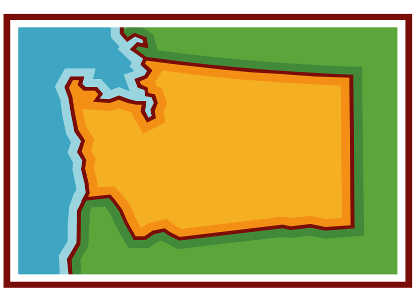
In years five through ten, agencies must demonstrate progress in their water loss control performance through indicators such as "gallons per service connection per day" or "gallons per mile of mains per day" until the reduction in water loss meets or exceeds the benchmarks established by the CUWWC.

Towards that end agencies must repair all reported leaks and breaks and in year two, establish a system of reporting, repair, and tracking. By the end of year four, agencies must include an estimate of leakage volume and repair costs that occur as a result of leakage.

Agencies are required to submit and maintain documentation of BMP 3 implementation by:

- Submitting the AWWA Standard Water Audit and Water Balance worksheets.
- Providing validation of data for the reporting period if necessary.
- Maintaining records and worksheets of relevant audit results and methodologies.
- Incorporating results of each component analysis into annual standard water balances.
- Keeping records of interventions, leak repairs, losses, system surveys, and other additional measures.

Washington



The State of Washington has legislation on the books requiring municipal water providers to audit water loss and report annually to the State. The current AWWA M36 water audit and loss accounting methodology is not referenced, but comparative measures were developed. According to a state official, a 10% water loss level is set as a minimum standard and procedures are in place (described below) for utilities that report losses above 10%. The regulatory environment in Washington is described below.

From Washington Municipal Water Law:

> *"It is the intent of the legislature that the department establishes water use efficiency requirements designed to ensure efficient use of water while maintaining water system*

financial viability, improving affordability of supplies, and enhancing system reliability. The requirements of this section shall apply to all municipal water suppliers and shall be tailored to be appropriate to system size, forecasted system demand, and system supply characteristics.

- *"Evaluation of each system's water distribution system leakage and, if necessary, identification of steps necessary for achieving water distribution system leakage standards developed.*

- *"Develop water distribution system leakage standards to ensure that municipal water suppliers are taking appropriate steps to reduce water system leakage rates or are maintaining their water distribution systems in a condition that results in leakage rates in compliance with the standards. Limits shall be developed in terms of percentage of total water produced and/or purchased and shall not be lower than ten percent. The department may consider alternatives to the percentage of total water supplied where alternatives provide a better evaluation of the water system's leakage performance. The department shall institute a graduated system of requirements based on levels of water system leakage. A municipal water supplier shall select one or more control methods appropriate for addressing leakage in its water system."*

The following comes from an informational interview with Mike Dexel, Water Resources Policy Lead for the Washington State Department of Health, Office of Drinking Water, Policy and Finance Section, conducted by Ben Wade of the CWCB.

- The standard across the State of Washington is a maximum of 10% utility water loss.
- Washington defines water loss based on authorized consumption – each utility is asked to estimate and track authorized uses of water. Any unauthorized use is defined as a leak/loss such as water theft. Anything that cannot be tracked is considered a leak/loss.
- Water loss for fire flow is estimated. Utilities are asked to work with local fire departments to get estimates.
- Washington's policies have led utilities to install service meters on connections that have been traditionally unmetered.
- If a utility's water loss is between 10-19%, they are asked to review their data and make sure it was inputted accurately.
- If a utility's water loss is between 20-30%, the utility is provided 12 months to create a Water Loss Control Action Plan (WLCAP) to actively identify and repair leaks.
- If a utility's water loss is over 30%, the utility has 6 months to actively repair leaks and create a Water Loss Control Action Plan
- If a utility takes the steps of creating a WLCAP and repairing leaks, they are considered to be "in-compliance" even if their water loss still exceeds the 10% threshold.
- Water loss reporting to the State is mandatory and is done annually.
- Every utility submits a Water System Plan every 6 years to the State and approval is withheld until they have reported water loss.

- The Washington water loss reporting procedure was developed by state and local stakeholders who worked together to come up with a set of recommendations that were then put into law.

New Mexico

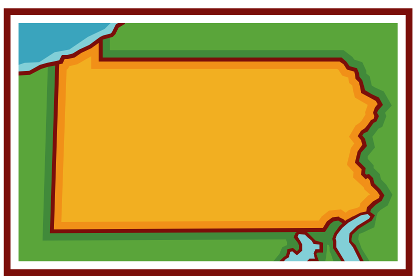
New Mexico has begun the process of collecting utility water loss data based upon the AWWA M36 methodology, but has not established formal reporting requirements or benchmarks.

From the New Mexico Office of the State Engineer:

The State Engineer has partnered with New Mexico drinking water suppliers to assess real water leakage, lost revenue, and conservation potential. The methodology utilized is based on the American Water Works Association, Water Loss Control Committee recommendations and software.[3]

Several New Mexico water providers have participated in water audits and applied the AWWA Water Loss Control Committee recommendations.

Pennsylvania



In Pennsylvania pursuant to statute §3120, water loss and auditing programs and reporting are voluntary. The Pennsylvania statute states, the *"Pennsylvania Infrastructure Investment Authority shall give special consideration to funding projects that address unaccounted-for water loss or that implement water conservation practices by a public water supply agency whose unaccounted-for water loss rate exceeds 20%, provided that, as a condition for such assistance, the applicant shall agree to attempt to recover the true cost of service from ratepayers and adopt and implement a water system management program that conforms to minimum standards established by the department, the Pennsylvania Public Utility Commission or any Compact Basin Commission for water metering, meter testing and replacement, leak detection, unaccounted-for water tracking and reporting and conservation education."*[4]

The Delaware Basin River Commission (DBRC) which regulates a number of water agencies along the Delaware River in Pennsylvania, New York, New Jersey, and Delaware has adopted voluntary water loss reporting standards. A 2008 motion from the DBRC states:

> *"By way of this Motion, we invite our jurisdictional water utilities to voluntarily participate in a pilot program to implement the new IWA/AWWA Water Audit*

[3] http://www.ose.state.nm.us/water-info/conservation/h2o-tech-assist.html. New Mexico Water Conservation Program. Technical Assistance, Research, and Demonstration. Water Use Accounting. Accessed June 23, 2009.

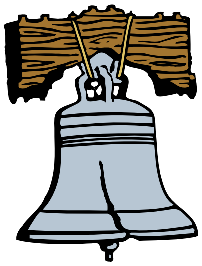
[4] http://law.onecle.com/pennsylvania/environmental-resources/00.031.020.000.html. Water conservation - 27 Pa. Cons. Stat. § 3120. Water Conservation. Grant Approval. Accessed June 23, 2009.

methodology. The voluntary implementation shall be on a pilot basis and will allow ample time for phasing-in the new procedure. This invitation will be issued in a tentative form, enabling the interested parties to file comments, if so desired. It should be noted that while we expect participation by our largest water utilities, any other jurisdictional water utility is invited to participate as well."

The voluntary approach adopted by the DBRC reflects the fact that most member water agencies are not supply constrained at this time and consequently they have not historically placed a high emphasis on demand management and water loss control.

The City of Philadelphia – Water Loss Audit Leader

The City of Philadelphia is a national leader in water loss management and George Kunkel, Assistant Chief of the Water Conveyance Section, has been nothing short messianic in his efforts to develop sound water loss accounting practices in Philadelphia, in Pennsylvania, and across the U.S. George Kunkel was contacted as part of this study and provided invaluable insights into state programs in Texas and California as well as into the current water audit and loss methodology.



Approximately 60 percent of Philadelphia's water distribution system was installed between 1880 and 1930 making it one of the oldest distribution systems in the United States. The City's aggressive leak detection program was established in 1980 and Philadelphia has played an active role in developing the AWWA water audit software (described in detail later in this document).

In addition to traditional water loss reduction (replacing or repairing faulty meters, repairing water main breaks, installing pressure reducing valves) Philadelphia has also achieved success in one unusual source of lost water that has plagued older urban centers in the United States: fire hydrant abuse. With above ground fire hydrants and large inner city populations, hydrants have often been opened illegally as a means of heat relief during hot summer periods. The Philadelphia Water Department achieved success in checking this phenomenon by installing center compression locks (CCLs) on most of its fire hydrants." Although these devices are not foolproof their use has significantly reduced water loss in the City.

Arizona

The Arizona legislature passed a regulatory program in 2007 that requires large municipal providers (cities, towns and private water companies serving more than250 acre-feet per year), not covered by other regulation, to participate in a performance-based water conservation program.

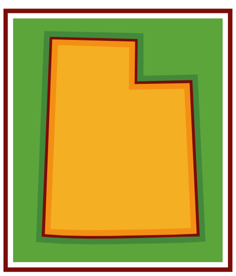
Water Resources staff and interested stakeholders developed the new regulatory program, known as the Modified Non-Per Capita Conservation Program (Modified NPCCP). The new program is designed to take into account the water use characteristics that are unique to a particular municipality (e.g. residential vs. agricultural) and allow water providers to select conservation measures that are effective for their municipality.[5]

Participants regulated under this performance-based program are required to implement water conservation measures. In addition to a Public Education Program the water provider must implement one or more Best Management Practices in one of seven categories:

- Category 1: Public Awareness/Public Relations
- Category 2: Conservation Education and Training
- Category 3: Outreach Services
- Category 4: Physical System Evaluation and Improvement
- Category 5: Ordinances/Conditions of Service/Tariffs
- Category 6: Rebates/Incentives
- Category 7: Research/Innovation Program

Category 4: Physical System Evaluation and Improvement includes leak detection, meter repair and replacement, and comprehensive system audit program – all components of water loss control. The Arizona program does not yet reference the M36 water audit and loss methodology.

Utah



At present there is no statewide water loss program in Utah. Salt Lake City Public Utilities Department performed a water loss audit in 2003 using the AWWA/IWA water audit methodology. The results of the study were presented by Jim Lewis Salt Lake City Department of Public Utilities Finance Administrator and showed that despite the lack of an active leakage control program SLCPUD has an infrastructure leakage index (ILI) of 2 which compares very favorably with the performance of other North American utilizes.[6]

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[5] Arizona Department of Water Resources. Modified Non-Per Capita Conservation Program Background and Rationale for Program Development. 12/2/08 Draft. http://water.az.gov/dwr/WaterManagement/Content/AMAs/files/MNPCCP%20%20Background%20&%20Rationale.pdf. Modified Non-Per Capita Conservation Program Background and Rationale for Program Development. Accessed June 23, 2009.

[6] Lewis, J.M., Fanner, P.V.. Experience of Using the IWA/AWWA Water Audit Methodology in Salt lake City Public Utilities Department. Leakage 2005 – Conference Proceedings. http://waterloss2007.com/Leakage2005.com/pdf/Using%20the%20IWA%20AWWA%20Water%20Audit%20Methodology%20in%20Salt%20Lake%20City.pdf. Accessed June 24, 2009.

Water Loss Guidance Document

Introduction

The long history of water loss control methods begins with the first human efforts to transport water form source to end user via ditches and primitive pipes over 2,000 years ago. During the 1800s, the concept of the municipal water utility emerged as a preferred model and spread throughout the industrialized world. At this time a number of advancements relating to water loss and measurement were made. These new methods included Kuichling's formulas for unavoidable losses, pitot rod district measurements, and simple wooden sounding rods (Thornton 2002).

The early 1900's saw advancements such as simple mechanical geophones for leak detection, mechanical meter recording devices (the precursor to modern magnetic pulse meters), and electronic geophones and listening devices. The computerization of industry in the last quarter of the 20th century saw computerized leak noise correlators and battery-operated flow recorders (data loggers) come into use. Most recently, the 21st century has seen such exciting advances as digital and GIS-linked equipment for leak detection (Thornton, 2002).

However useful many of these physical tools were in helping to detect and curb water losses within supply systems, a comprehensive strategy for identifying and recouping losses at all levels remained elusive. It wasn't until AWWA published the first edition of the M36 manual in 1990 (second edition in 1999) that systematic approaches to evaluate and quantify losses across an entire water distribution system, from both the top-down and bottom-up, were broadly adopted in the United States. The AWWA attempts to "unite the drinking water community by developing and distributing authoritative scientific and technological knowledge," and with the several iterations of the M36 manual for water audits and loss control programs it brings together a wealth of data and strategies for streamlining water distribution systems.

Aside from the AWWA M36 manual, the most important book on utility water loss is Julian Thornton's *Water Loss Control, 2nd Edition* (2008), which covers the topic in a thorough and highly detailed manner. This book along with the M36 manual should be more than sufficient for most water professionals and utilities seeking information on the subject. General books on municipal water supply such as *Water Supply, 5th Edition* (Twort, A. 2000) cover the topic with broad brush, but cannot hope to provide the necessary detail to assist in implementation.

Water Loss Then and Now – Key Differences In Approach

The methodology for water audit and loss control programs developed significantly between the 2nd and 3rd editions of the AWWA M36 manual. There is a great deal more information contained in the newer edition, some of which expands upon sections of the old manual but also contains new considerations. In particular, the process for conducting a water audit for utilities is much more detailed, and there are greatly expanded definitions and information on detection of water losses and information on planning and maintaining the water loss control program.

Important Changes in AWWA M36 Manual of Practice – *Water Audits and Loss Control Programs (3rd Edition)*

- Expanded system-wide water audit procedures.
- Distinction between apparent losses and real losses.
- Costs are assigned to both apparent and real losses providing useful guidance for utility investment.
- "Unaccounted for water" term is no longer relevant as all water is accounted for.
- Free software tool greatly simplifies water audit and accounting process.
- Performance indicators are developed that will eventually allow for comparison between water agencies.

A significant difference in the new edition of M36 is the expanded procedures for conducting a comprehensive, system-wide water audit to assess the delivery efficiency of a distribution system. The first task in the old version is to characterize supply by such methods as identifying and mapping water sources, measuring the water from each source, and adjusting figures for the total supply. Those steps are moved to Task 2 in the new edition, while in the new edition Task 1 is devoted to describing the distribution system including infrastructure, financial, and operational data to get a better sense of how the system works as a whole.

Task 2 of the old edition and Task 3 of the new edition are essentially identical, instructing utilities to quantify the billed authorized consumption (metered use) within the system. The new edition adds an extra step as Task 4 for calculating non-revenue water consumption, which it describes as unbilled authorized consumption (metered and unmetered) plus apparent losses and real losses. This is also the first time the important distinction is made between apparent and real losses.

Apparent losses are described as non-physical losses that occur when water is successfully delivered to the customer but is not measured or recorded accurately. Reasons for these losses can include metering inaccuracies, systematic consumption data handling errors, particularly in customer billing systems, and unauthorized consumption. Real losses are physical, visible losses such as water main breaks, hydrant, and line leaks (AWWA, 1999, 2009).

The step of quantifying unbilled authorized consumption (unmetered use) is quite similar in Task 3 of the old edition and Task 5 of the new edition. These unmetered uses include firefighting and training, flushing mains and sewers, street cleaning, and large scale unmetered irrigation in public areas. Concordantly, Task 6 of the new edition takes largely from Task 4 of the old edition in quantifying water losses. These water losses can cover a wide range of categories, including accounting errors, unauthorized connections, reservoir leakage and overflow, evaporation, and smaller leaks on the customer end. Task 5 of the old edition finalizes the audit by analyzing its results, identifying recoverable leakage and figuring the value therein, calculating the cost of actually recovering said leakage, and calculating the cost of leak detection (AWWA, 1999, 2009).

Tasks 7 and 8 in the new edition deal with identifying and quantifying apparent (non-physical) and real (physical) losses, and Task 9 involves assigning the costs of those losses. Apparent losses stem mostly from meter inaccuracies, data handling errors, and unauthorized consumption.

Steps to alleviate these losses include testing and verifying customer meters as well as the following data transfer and analysis, and evaluating policy and procedure shortcomings. Real losses are much easier to quantify as they are basically water losses minus apparent losses (AWWA, 2009).

Task 10 instructs utilities to calculate the performance indicators. Until recently, a loose measure of "unaccounted-for" water percentage was generally the lone performance indicator used in many parts of the world. This usually entailed taking the amount of water losses over the system input volume. Such an approach contained numerous flaws. First, definitions for the volume of "unaccounted-for" water varied widely, meaning the calculation of the percentage has been widely inconsistent, eliminating any reliable performance comparisons. Also, if consumption in the water utility increases or decreases noticeably, the percentage can change, despite the fact that no change in loss levels may have occurred. Finally, the "unaccounted-for" percentage does not segregate apparent and real losses and includes no information on water volumes and costs, the two most important parameters in assessing water loss (AWWA, 2009).

The identification of performance indicators is one of the most important additions to the new M36 manual as it allows for comparison of performance between different water agencies, as well as providing much improved accountability for utilities. The inconsistencies in "unaccounted-for" water prevalent is many water providers accounting procedures make it nearly impossible to compare performance on almost any level. Happily, utilities using the new methodology can now fairly benchmark their efficiency with one another (AWWA, 2009).

The final task for the water audit in the new edition provides instructions for compiling the water balance. This balance should show that all water managed by the utility is accounted for in the various categories of consumption and loss. Doing this erases any need for the "unaccounted-for" water category (AWWA, 2009).

Another notable addition to the new manual is the introduction of "top-down" and "bottom-up" approaches. The top-down approach is the initial desktop process of compiling information from existing records, procedures, data and other information systems. This is the best way to get the audit process started, as all of the information is readily available. The bottom-up approach involves validating the top-down results with actual field measurements such as leakage losses. Physical inspections of customer properties can also uncover apparent losses from defective or vandalized meters, or unauthorized consumption. In addition, the newer audit methodology uses component analysis, a technique which models leakage volumes based upon the nature of leak occurrences and durations. This technique can also be used to model various occurrences of apparent losses by looking at the nature and duration of the occurrence (AWWA, 2009).

M36 Water Audits and Loss Control Programs

The AWWA M36 Manual of Water Supply Practices – *Water Audits and Loss Control Programs* is an essential document that should has a prominent place in the library of every water provider in Colorado and the United States. There are two fundamental parts of the M36 Manual. The first part describes the utility water audit and water balance process and the proper methods for measuring (and estimating) water loss. The free AWWA water audit software (described later in this document) is an essential companion piece to this portion of the M36 Manual. The second part of the M36 manual describes utility water loss control programs and how water loss can be effectively reduced once it is identified through the audit process.   This document focuses on the utility water audit and loss determination process and only touches on water loss control programs.

The Water Audit and Water Balance

"The *water audit* typically traces the flow of water from the site of withdrawal or treatment, through the water distribution system, and into customer properties," (AWWA 2009). The water audit is essentially an accounting of all water finished water from the time it leaves the treatment plant until it passes through the customer meter. The accounting is typically done using a spreadsheet and the Free AWWA water loss accounting software eases the process of identifying all of the areas of water consumption and loss the occur in a municipal water system.

"The *water balance* summarizes the components and provides accountability, as all of the water placed into a distribution system should – in theory – equal all of the water taken out of the distribution system," (AWWA 2009).

The combination of the system water audit and the water balance provide a variety of useful measures of utility water loss. Of particular interest to water agencies is the ability to quantify to costs of real and apparent water losses and to use this information to improve the bottom line.

<table>
<tr><td rowspan="9">Water From Own Sources (corrected for known errors)</td><td rowspan="11">System Input Volume</td><td>Water Exported</td><td rowspan="5">Authorized Consumption</td><td rowspan="3">Billed Authorized Consumption</td><td>Billed Water Exported</td><td rowspan="3">Revenue Water</td></tr>
<tr><td rowspan="10">Water Supplied</td><td>Billed Metered Consumption</td></tr>
<tr><td>Billed Unmetered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption</td><td>Unbilled Metered Consumption</td><td rowspan="8">Non-revenue Water</td></tr>
<tr><td>Unbilled Unmetered Consumption</td></tr>
<tr><td rowspan="6">Water Losses</td><td rowspan="3">Apparent Losses</td><td>Unauthorized Consumption</td></tr>
<tr><td>Customer Metering Inaccuracies</td></tr>
<tr><td>Systematic Data Handling Errors</td></tr>
<tr><td rowspan="3">Real Losses</td><td>Leakage on Transmission and Distribution Mains</td></tr>
<tr><td rowspan="2">Water Imported</td><td>Leakage and Overflows at Utility's Storage Tanks</td></tr>
<tr><td>Leakage on Service Connections Up to Point of Customer Metering</td></tr>
</table>

Note: All data in volume for the period of reference, typically one year.

Figure 1: Water balance for water loss audit accounting (AWWA 2009)

Figure 1 shows the key components of the water balance and water loss accounting in the 2009 M36 methodology. The shaded area represents water losses. Developing a utility water audit using the M36 methodology involves developing measurements or estimates of all of the values shown in Figure 1. Utilities first implementing this methodology are encouraged to start with a desktop audit where existing data and estimates are used as inputs to the water balance. This process is called the "top-down" audit. The "bottom-up" approach involves replacing estimated values with actual measurements and generally takes planning and effort of a number of years for a utility to fully implement. Both the top-down and bottom-up approaches are made much easier with the free software described in the next section of this document which automatically performs the required water balance calculations.

The water audit and water balance process is an essential tool for utilities seeking to quantify water use and water loss in the distribution system and brought about by the management processes of the agency. Many utilities that undertake the auditing effort find it a revealing process that provides important insight into overall distribution system management and management processes.

Table 3 comes straight from the 2009 M36 manual and defines the key water loss and water balance elements. Water loss is divided into two pieces: real losses and apparent losses. This is an important distinction that has not be broadly utilized prior to the introduction of this water loss accounting methodology. The distinction between revenue and nonrevenue water is also important and be quite useful for utilities seeking to quantify the economic impacts of water loss. Nonrevenue water is the term that effectively replaces the now antiquated "unaccounted-for-water' concept.

Table 3: Water balance terms and definitions (AWWA 2009)

Water Balance Element	**Description/Definition**
System input volume	Volume input to the water supply system.
Authorized consumption	Annual volume of metered and/or unmetered water taken by registered customers, the water supplier, and other authorized users.
Water losses	System input volume – Authorized consumption = Water losses Water losses = Apparent losses + Real losses
Apparent losses	Annual unauthorized consumption, all types of customer metering inaccuracies and systematic data handling errors.
Real losses	Annual volumes lost through all types of leaks in the distribution system, line breaks, and overflows on mains, service reservoirs, and service connections, up to the point of customer meter.
Revenue water	Those components of System input volume that are billed and produce revenue for the utility.
Nonrevenue water	The sum of unbilled authorized consumption, apparent losses, and real losses. This value can also be determined as the difference between system input volume and billed authorized consumption.

The 10 steps for conducting a water audit presented in the M36 manual are outlined in Table 4 below. The water audit and water balance processes are perhaps best described and understood through implementation of the free AWWA water audit software. This enables a step by step journey through the entire process and the software also helps water provider gauge the quality of the data inputs of the audit which is extremely helpful when trying to determine what steps need to be taken to improve the audit on an annual basis. The water audit steps are covered in detail in the 2009 M36 Manual. Although the intent of the M36 manual is to present a methodology that water utilities can complete in-house, some agencies have found it more convenient to contract the water loss reporting effort to consulting engineers.

Table 4: Ten fundamental tasks in the water audit and water balance process

Water Audit Step	Brief Description
1. Collect distribution system information	Includes infrastructure, financial, and operational data. Most info should be readily available to a utility.
2. Measure water supplied to the distribution system	This task identifies how much water enters the distribution system and where it originates.
3. Quantify billed authorized consumption	Identifies the amount of water delivered to customers that have accounts in the customer billing system.
4. Calculate nonrevenue water	Nonrevenue water is amount remaining after billed authorized consumption is deducted.
5. Quantify unbilled authorized consumption	Includes unmetered fire hydrant use, flushing, street cleaning, etc.
6. Quantify water losses	Water losses are made up of apparent and real losses.
7. Quantify apparent losses	Comprised of customer meter inaccuracy, systematic data handling errors, and unauthorized consumption.
8. Quantify real losses	In the "top-down" approach, this is calculated total water loss minus apparent losses. In "bottom-up" approach, physical measurements improve the measurement of real losses.
9. Assign costs of apparent and real losses	Apparent losses should be valued at the prevailing retail rate charged to customers. Real losses are typically as the variable production costs to treat and deliver water.
10. Calculate performance indicators	This task (along with many others) is done automatically through the free AWWA software.

Water Audit Software

AWWA Water Loss Control Committee has developed free, Excel-based water audit software that greatly eases the process of implementing the M36 water audit methodology. The software is free for download on the AWWA website - http://www.awwa.org/Resources/WaterLossControl.cfm?ItemNumber=48511&navItemNumber=48158.

This software is essentially a data-entry form in a Microsoft Excel workbook and all necessary calculations are automatically made by the software.

Data Quality Assessment

The software provides an important assessment of the quality of the data entered. The data rating component is based on users' assessment of their own data. With guidance from comments in the spreadsheet, users score their data inputs on a scale from 1 to 10 (where 1 is a wild guess and 10 is a perfectly measured value). The software then tallies a validity score. This validity score affects water loss planning recommendations throughout the software.

Figure 2 shows the five levels of data grading developed in the software. Tracking the quality of data is a critical piece of water loss control planning. If the combined data validity score is low, improving data quality takes precedence over some water loss control activities.

The saying, “garbage in equals garbage out,” applies here, but the software recognizes this; data quality is tracked and recommendations for improving data quality are a major component of this software. Data validation is one of the software’s most useful features, from a regulatory perspective. The quality of data available to Colorado agencies is not known at this time. However, the software’s method for determining and tracking data quality could play a significant role in helping the CWCB learn about agencies’ data quality.

Water Loss Control Planning Guide

	Water Audit Data Validity Level / Score				
Functional Focus Area	**Level I** (0-25)	**Level II** (26-50)	**Level III** (51-70)	**Level IV** (71-90)	**Level V** (91-100)
Audit Data Collection	Launch auditing and loss control team; address production metering deficiencies	Analyze business process for customer metering and billing functions and water supply operations. Identify data gaps.	Establish/revise policies and procedures for data collection	Refine data collection practices and establish as routine business process	Annual water audit is a reliable gauge of year-to-year water efficiency standing
Short-term loss control	Research information on leak detection programs. Begin flowcharting analysis of customer billing system	Conduct loss assessment investigations on a sample portion of the system: customer meter testing, leak survey, unauthorized consumption, etc.	Establish ongoing mechanisms for customer meter accuracy testing, active leakage control and infrastructure monitoring	Refine, enhance or expand ongoing programs based upon economic justification	Stay abreast of improvements in metering, meter reading, billing, leakage management and infrastructure rehabilitation
Long-term loss control		Begin to assess long-term needs requiring large expenditure: customer meter replacement, water main replacement program, new customer billing system or Automatic Meter Reading (AMR) system.	Begin to assemble economic business case for long-term needs based upon improved data becoming available through the water audit process.	Conduct detailed planning, budgeting and launch of comprehensive improvements for metering, billing or infrastructure management	Continue incremental improvements in short-term and long-term loss control interventions
Target-setting			Establish long-term apparent and real loss reduction goals (+10 year horizon)	Establish mid-range (5 year horizon) apparent and real loss reduction goals	Evaluate and refine loss control goals on a yearly basis
Benchmarking			Preliminary Comparisons - can begin to rely upon the Infrastructure Leakage Index (ILI) for performance comparisons for real losses (see below table)	Performance Benchmarking - ILI is meaningful in comparing real loss standing	Identify Best Practices/ Best in class - the ILI is very reliable as a real loss performance indicator for best in class service

For validity scores of 50 or below, the shaded blocks should not be focus areas until better data validity is achieved.

Reporting Worksheet / Water Balance / Grading Matrix / Service Connection Diagram / Definitions / **Loss Control Planning** / Ex. Audit 1 (Million Gallons)2

Figure 2: Water audit data validity level/score worksheet (AWWA 2009)

The software recommends actions to improve data quality and overall validity scores. A sample data validity score is shown in Figure 3. Tables of recommendations are found in different worksheets. Based on a given water agency’s data, different recommendations are highlighted. The AWWA Water Loss Control Committee recommends that utilities achieve a validity level of 3 or higher before using the results to compare across water agencies. This recommendation is reflected in California’s plan to require water loss reporting for four years before developing minimum standards for water utilities. These considerations are important for the State of Colorado to consider as it moves forward with water loss reporting requirements and minimum performance standards.

Water Audit Software Output

The AWWA water audit software takes input data and calculates an agency's water balance, including differentiating between real and apparent losses and calculating the data validity score. Figure 3 shows the sample output information and data validity score for the Philadelphia Water Department. Even after 10 years of implementing this water audit approach, Philadelphia has only achieved a data validity level of 4, which is an indication of how difficult it can be to obtain highly accurate input data.

As shown in Figure 3, the software calculates both financial indicators and operational efficiency indicators. Based on these values, the software highlights recommended water loss planning actions.

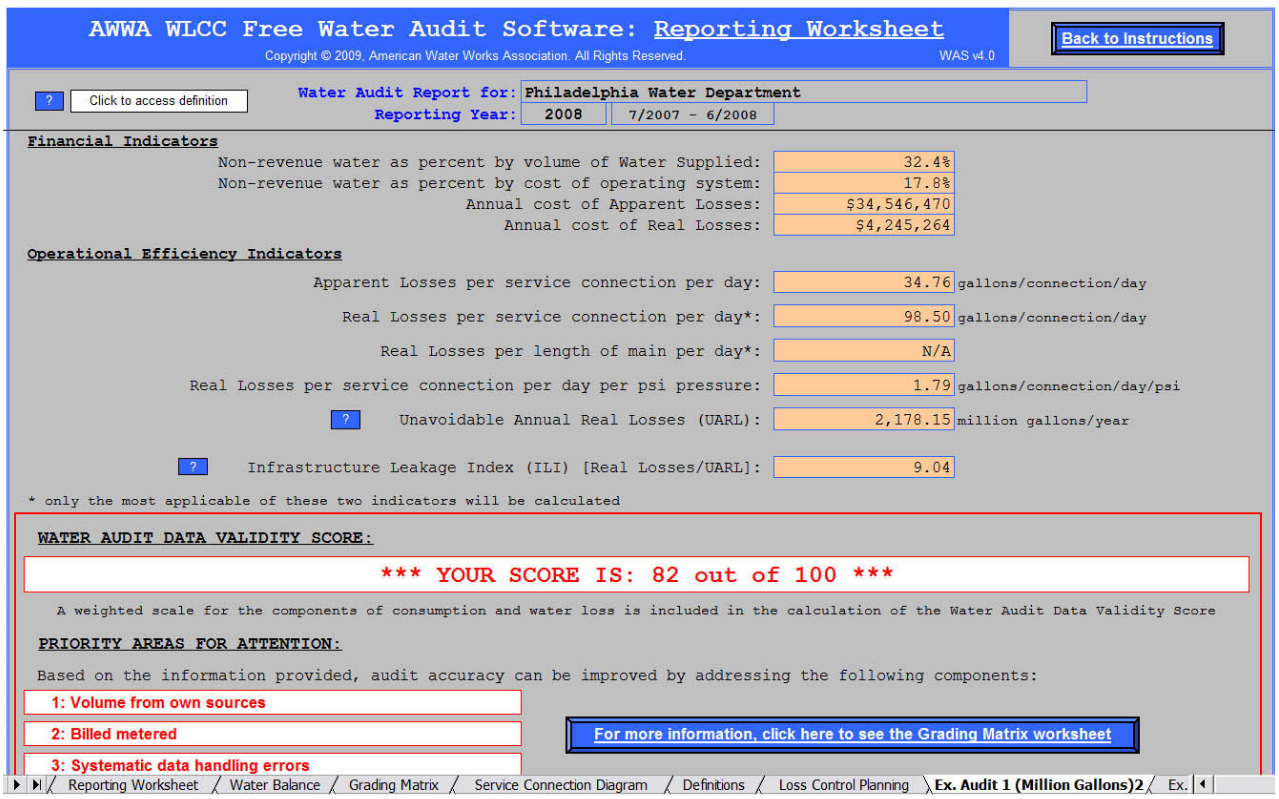

Figure 3: AWWA Water Loss software screen capture showing output results (peach-colored) fields and data validity score (red-outline box) (AWWA 2009).

The financial metrics incorporated into the M36 methodology and the free water audit software may prove to be the most valuable component for water agencies. Financial indicators are based on user-entered variable production costs and water retail costs. The software automatically calculates costs of real and apparent losses. From this data, agencies can make rational cost-benefit decisions on prioritizing water loss control. Many utilities who have implemented this methodology were surprised to learn that the cost of their apparent losses were more significant (financially) than the cost of their real losses. In Philadelphia, (Figure 3) the apparent losses were valued at $34.5 million and the real losses at $4.2 million.

Several design choices make the software user friendly. First, cells containing calculated values clearly show how the calculations are made (as opposed to having the calculations performed in hidden cells or macros). This show-your-work approach allows the user to quickly understand the methods for computing given values. Second, the cells are write protected, users can only change input cells, which protects the workbook from users inadvertently over writing critical cells. If invalid data are entered, the workbook alerts the user.

Input parameters, Output Results

The workbook requires 16 distinct input data points. Table 5 provides a list of all sixteen input requirements. Some of these input values are further subdivided into component pieces within the software.

Table 5: AWWA Water Audit Software Input Data Requirements

AWWA Software Input Data Requirements
1. Volume from own sources
2. Master meter error adjustment
3. Volume of water imported
4. Volume of water exported
5. Billed metered water
6. Billed unmetered water
7. Unbilled metered water
8. Systematic data handling errors
9. Real Losses
10. Length of mains (typically in miles)
11. Number of active and inactive service connections
12. Average length of customer service line
13. Average operating pressure
14. Total annual cost of operating water system
15. Customer retail unit cost (applied to Apparent Losses)
16. Variable production cost (applied to Real Losses)

Using these input values, the AWWA water audit software calculates:

- Apparent losses
- Authorized consumption
- Total water losses (real + apparent)
- Connection density
- Nonrevenue water volume

The software package also provides default values for three key values that are more challenging for a water utility to measure or even estimate. The three parameters for which default values are offered are:

- Unbilled and unmetered water percentage
- Unauthorized consumption percentage
- Customer metering inaccuracies percentage

When a utility first embarks on a water audit using this software and methodology, these default parameters will probably be utilized. Over time, the utility should work to develop better, more accurate numbers that reflect the reality of their water system.

As discussed above, data validity is a key component of the water loss software and the user must assign a validity score to each piece of input data. The validity score is a scale from 1 to 10 where 1 is a wild guess and 10 is a perfectly measured value. As water agencies conduct their annual water audit, an emphasis should be placed on improving the overall data validity score each year. Ideally, only water audit results with a validity score of 70 or higher (certainly no lower than 50) should be used to establish water loss benchmarks for other agencies.

Software Structure
The AWWA water loss software is an Excel workbook containing 10 separate worksheets. Users need only be familiar with the basics of Excel to utilize this software. Advanced spreadsheet skills are not required. A user simply works through the worksheets as specified. Significant effort has been made to provide tips and information about each required data input.

Instructions
The first worksheet of the software workbook is titled *Instructions.* This sheet gives the user a key to which cells are for inputting data, which cells show calculations, and which cells contain default values. This worksheet asks users to input their agency name and contact information and also contains a table of contents with a brief explanation of each worksheet in the workbook. Buttons on the Instructions worksheet can be used to navigate to different worksheets. The worksheets may also be accessed in typical Excel fashion by clicking on the tabs at the bottom of the workbook.

Reporting Worksheet
The second worksheet, titled *Reporting Worksheet* is the essential input form in the AWWA water audit software package. In the *Reporting Worksheet,* users enter all of the key data identified in Table 5 above including water supplied, authorized consumption, apparent losses, nonrevenue water, system data, and cost data. The software calculates a variety of information including financial indicators and operational efficiency indicators.

As users progress through the worksheet, different color schemes denote input parameters and calculated results. Buttons with question marks are located next to specific input fields and terms. Clicking these buttons takes the user to the corresponding definition on the *Definitions* worksheet.

When users enter data, they are prompted to score the data for validity. The scoring process is aided by comments that guide the user to select appropriate values from a pull-down list. As discussed above, the data grading scale ranges from 1 to 10 where 1 is a wild guess and 10 is a perfectly measured value. Data grading is not required for the software to function, but should be considered a mandatory element of completing the water audit process. At the end of the *Reporting Worksheet*, users also receive feedback about the quality of their data, based on their cumulative data validity scores. Scoring the validity of the data is used later in the fourth worksheet, where suggestions are made to improve data accuracy. The seventh worksheet, *Loss Control Planning*, also uses data validation to determine recommended loss control actions. Meeting data quality thresholds takes priority over some loss actions.

As the user enters data into the *Reporting Worksheet*, running calculations provide results. The quick feedback and visible calculations enforce the straightforward nature of computing a water balance. The *Reporting Worksheet* also has prompts and warnings if invalid data are entered. For example, in the nonsensical case where the volume of exported water exceeds the sum of the agency's sources and imported water (i.e. a negative water balance), input cells turn red and red-lettered error boxes appear. However, the error messages do not always pinpoint precisely which cell entry is causing the problem.

Figure 4 shows a portion of the *Reporting Worksheet* completed for the Philadelphia Water Department. The user input data and data grading (white cells) and the calculated results (peach cells) can be clearly seen. For certain fields such as Unbilled unmetered water, the user may specify that the software calculate either a percentage or a volume.

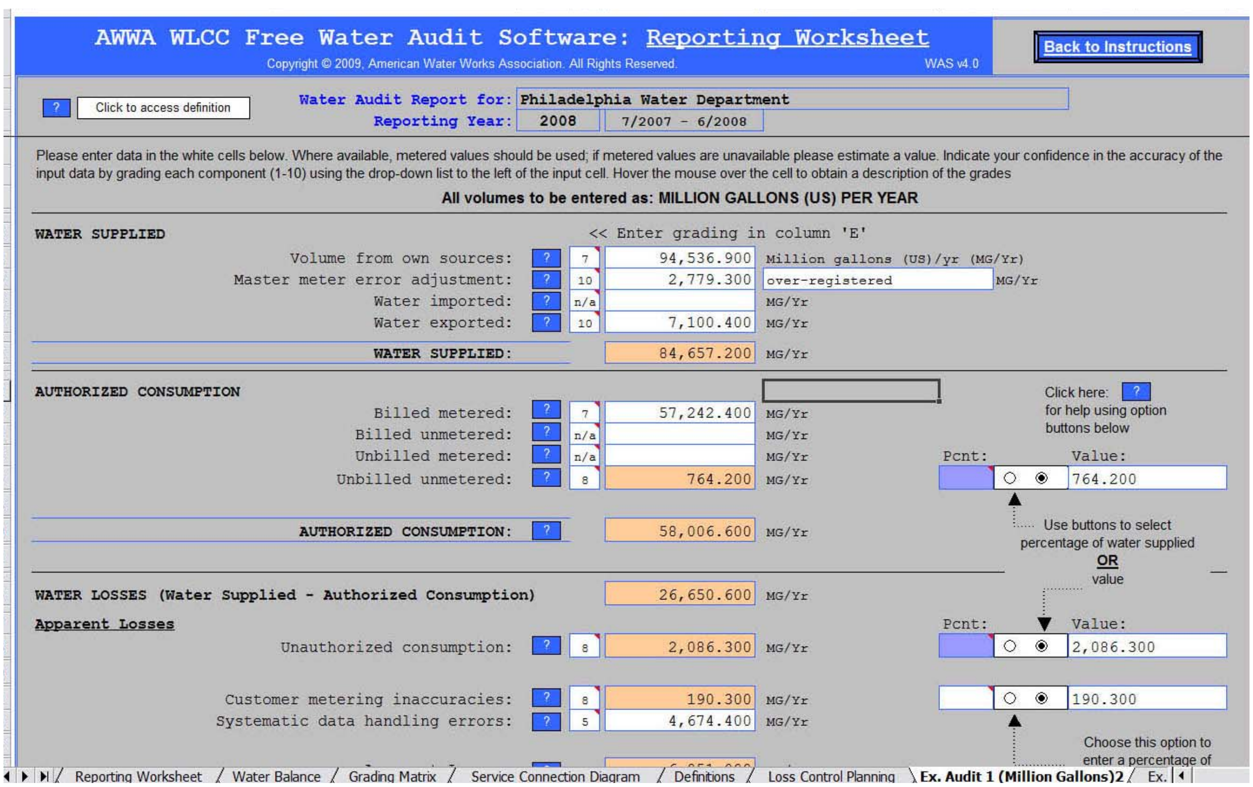

Figure 4: Sample portion of the *Reporting Worksheet* (AWWA 2009)

Water Balance

The third worksheet, *Water Balance*, is a tabular breakdown of how water is consumed and lost in the water system. Volumes determined in the *Reporting Worksheet* are shown in the water balance worksheet. The layout of this table closely follows the IWA/AWWA "Best Practice" water balance from the 2009 M36 manual.   An example of the Water Balance worksheet is shown in Figure 5.

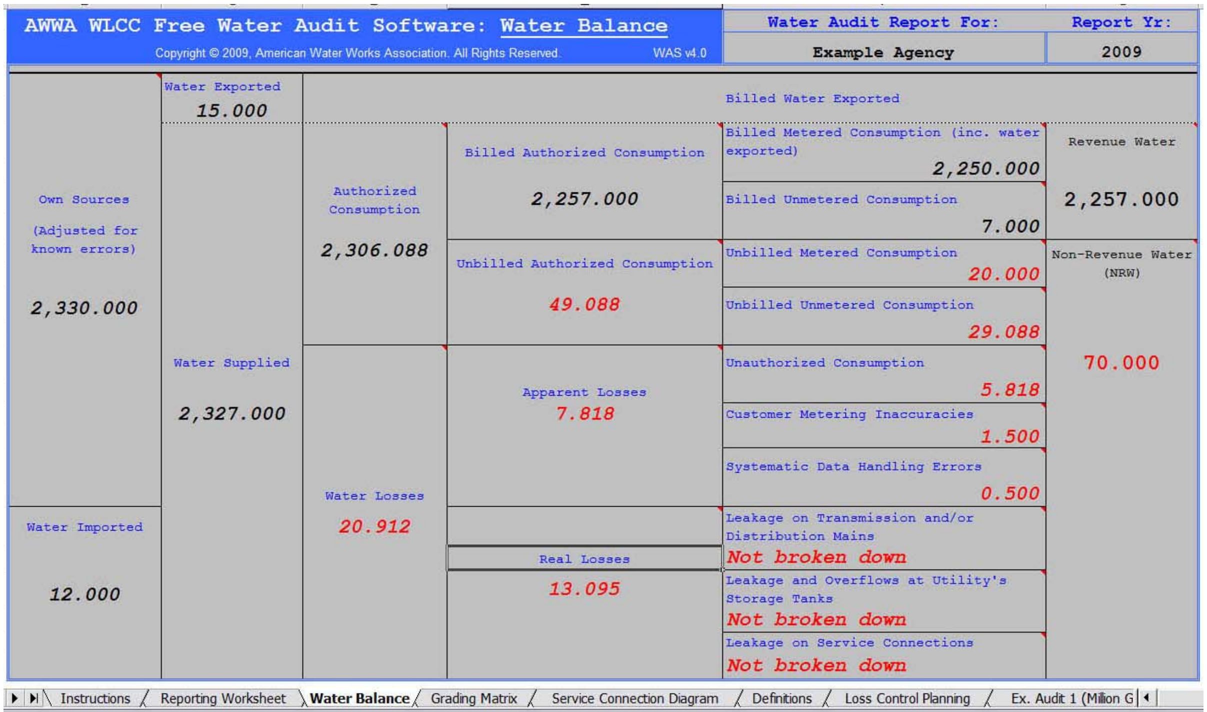

Figure 5: Sample Water Balance worksheet (AWWA 2009)

Grading Matrix

Data validation is the focus of the fourth worksheet, the *Grading Matrix*. Users get information about how to improve the grading score for different input parameters. This 37- by 12- matrix highlights scores given to each datum entered in the *Reporting Worksheet.* Directly below the scored datum (and also highlighted) is a cell with recommendations for improving the quality of that datum. Table 6 provides an example of the content in the *Grading Matrix* and shows all possible scores for the "billed unmetered" parameter. The second row gives guidelines for scoring and what criteria must be met for each score level. The third row in this table shows actions that can be taken to improve the validity of the data.

Service Connection Diagram

The fifth worksheet, *Service Connection Diagram*, clarifies input parameters. In this case, the worksheet provides several diagrams for different configurations of customer connection line. This parameter is used to calculate unavoidable annual real losses (UARL).

Definitions

The sixth worksheet provides essential definitions of input parameters and output values. A *find* button located next to each term takes the user to the location where the defined term is actually input in the *Reporting Worksheet.*

Table 6: Data validity and improvement recommendations for the AWWA water audit software

	n/a	1	2	3	4	5	6	7	8	9	10
Billed unmetered:	Select n/a if it is the policy of the water utility to meter all customer connections and it has been confirmed by detailed auditing that all customers do indeed have a water meter; i.e. no unmetered accounts exist	Water utility policy does not require customer metering; flat or fixed fee billed. No data collected on customer consumption. Only estimates available are derived from data estimation methods using average fixture count multiplied by number of connections, or similar approach.	Water utility policy does not require customer metering; flat or fixed fee billed. Some metered accounts exist in parts of the system (pilot areas or District Metered Areas) with consumption recorded on portable data loggers. Data from these sample meters are used to infer consumption for the total customer population. Site-specific estimation methods are used for unusual buildings/water uses.	Conditions between 2 and 4	Water utility policy does require metering and volume based billing but lacks written procedures and employs casual oversight, resulting in up to 20% of billed accounts believed to be unmetered. A rough estimate of the annual consumption for all unmetered accounts is included in the annual water audit, with no inspection of individual unmetered accounts.	Conditions between 4 and 6	Water utility policy does require metering and volume based billing but exemption exist for a portion of accounts such as municipal buildings. As many as 15% of billed accounts are unmetered due to this exemption or meter installation difficulties. Only a group estimate of annual consumption for all unmetered accounts is included in the annual water audit, with no inspection of individual unmetered accounts.	Conditions between 6 and 8	Water utility policy requires metering and volume based billing for all customer accounts. Metering is prevalent in the service area with less than 5% of billed accounts unmetered and existing because meter installation is hindered by unusual circumstances. The goal is to minimize the number of unmetered accounts. Reliable estimates of consumption are obtained for unmetered accounts via site-specific estimation methods.	Conditions between 8 and 10	Water utility policy requires metering and volume based billing for all customer accounts. Less than 2% of billed accounts are unmetered and exist because meter installation is hindered by unusual circumstances. The goal exists to minimize the number of unmetered accounts to the extent that is economical. Reliable estimates of consumption are obtained at these accounts via site-specific estimation methods.
Improvements to attain higher data grading for "Billed Unmetered Consumption" component:		To qualify for 2: Investigate a new water utility policy to require metering of the customer population, and a reduction of unmetered accounts. Conduct pilot metering project by installing water meters in small sample of customer accounts and data logging the water consumption.	To qualify for 4: Implement a new water utility policy requiring customer metering. Expand pilot metering study to include several different meter types, which will provide data for economic assessment of full scale metering options. Assess sites with access difficulties to devise means to obtain water consumption volumes.		To qualify for 6:Budget for staff resources to review billing records to identify unmetered properties. Specify metering needs and funding requirements to install sufficient meters to significant reduce the number of unmetered accounts		To qualify for 8:Install customer meters on a full-scale basis. Refine metering policy and procedures to ensure that all accounts, including municipal properties, are designated for meters. Implement procedures to obtain reliable consumption estimate for unmetered accounts awaiting meter installation.		To qualify for 10:Continue customer meter installation throughout the service area, with a goal to minimize unmetered accounts. Sustain the effort to investigate accounts with access difficulties to devise means to install water meters or otherwise measure water consumption.		To maintain 10: Continue to refine estimation methods for unmetered consumption and explore means to establish metering, for as many billed unmetered accounts as is economically feasible.

Loss Control Planning

The seventh worksheet, *Loss Control Planning*, provides guidance for water loss control planning and setting Infrastructure Leakage Index (ILI) goals. This sheet updates and change recommendations based upon the results from data entered into the *Reporting Worksheet.* Some of the different recommendations are highlighted in Figure 6. A key element of the methodology is that the validity of the data drives the planning recommendations. Achieving a threshold validity of over 50% is a priority over some loss control actions.

The loss control planning page also contains general guidelines for setting ILI performance benchmarks. A screen capture from this portion of the software is shown in Figure 6. In Colorado, the water resources consideration presented in this table are likely to be of primacy (you either have enough water to meet forecast future demand or you don't and are trying to do something about it). Financial considerations and operational considerations discussed in Figure 6 will often be secondary to water availability.

General Guidelines for Setting a Target ILI
(without doing a full economic analysis of leakage control options)

Target ILI Range	Financial Considerations	Operational Considerations	Water Resources Considerations
1.0 - 3.0	Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability.	Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet the demand.	Available resources are greatly limited and are very difficult and/or environmentally unsound to develop.
>3.0 -5.0	Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population.	Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place.	Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management, water conservation) are included in the long-term planning.
>5.0 - 8.0	Cost to purchase or obtain/treat water is low, as are rates charged to customers.	Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to supply shortages.	Water resources are plentiful, reliable, and easily extracted.
Greater than 8.0	Although operational and financial considerations may allow a long-term ILI greater than 8.0, such a level of leakage is not an effective utilization of water as a resource. Setting a target level greater than 8.0 - other than as an incremental goal to a smaller long-term target - is discouraged		
Less than 1.0	If the calculated Infrastructure Leakage Index (ILI) value for your system is 1.0 or less, two possibilities exist. a) you are maintaining your leakage at low levels in a class with the top worldwide performers in leakage control. b) A portion of your data may be flawed, causing your losses to be greatly understated. This is likely if you calculate a low ILI value but do not employ extensive leakage control practices in your operations. In such cases it is beneficial to validate the data by performing field measurements to confirm the accuracy of production and customer meters, or to identify any other potential sources of error in the data.		

Grading Matrix / Service Connection Diagram / Definitions / **Loss Control Planning** / Ex. Audit 1 (Million Gallons)2 / Ex. Audit 2 (Megalitres) / Acknowledgements

Figure 6: Water loss control planning. ***Note emphasis on data validity.*** **(AWWA 2009)**

For most water providers in Colorado an ILI of 3.0 to 5.0 might appear to be a reasonable ILI level to try and attain, but until empirical data from actual audits conducted in Colorado using this methodology are obtained it is not possible to set reasonable benchmarks. The initial focus of state water loss efforts in Colorado should be to encourage water utilities to undertake the new AWWA M36 methodology and report results to a central location. Furthermore, only after a number of utilities have achieved a reasonable level of data validity should they be used to set minimum performance standards for Colorado municipal water providers.

Additional Software Worksheets

Two additional worksheets provide examples of completed *Reporting Worksheets* that are instructive for better understanding the water audit and water balance process. The workbook also contains a final sheet acknowledging authors and supporters.

Utility Water Loss Control

In addition to completing the water audit and water balance process, utilities must also work to reduce real and apparent losses in their system. Accounting for the losses is valuable, but reducing the level of loss is the ultimate goal. It is beyond the scope of this guidance document to detail all possible water loss control measures. The 2009 M36 manual contains several chapters on the methods and procedures for reducing real and apparent losses. A brief summary of the most important and effective measures is provided here.

Apparent Losses

Apparent losses are the nonphysical losses that result when delivered water volumes are not measured accurately or when utility data systems introduce some systematic errors. Apparent losses can be thought of as “paper” losses since no physical water is actually leaked. Ironically, apparent losses can have a significant impact on a utility’s bottom line and in many cases the financial impact of apparent losses exceeds that of real losses.

Apparent losses are composed of three primary components (AWWA 2009):

- Customer metering inaccuracies (i.e. water meters that do not register the correct volume. Underreporting meters are most common.)
- Systematic data handling errors (i.e. billing corrects that improperly adjust volumes, rounding errors, etc.)
- Unauthorized consumption.

Customer Meter Accuracy

As water flows through a water meter, the device wears and loses measurement accuracy. Water meters must be tested, repaired, and/or replaced on a regular schedule. The best way to reduce apparent losses due to metering inaccuracy is to have a rigorous meter testing and replacement regime in place.

Proper Meter Sizing

Meters are traditionally sized based on the anticipated peak flow requirements of the customer. Unfortunately, this traditional approach has resulted in many over-sized water meters – particularly for non-residential customers. The problem with over-sized water meters is that they are far less accurate at low flow rates and may significantly underreport water consumption for some customers. Utilities must carefully examine their meter sizing policies to ensure that water meters are right-sized to provide sufficient flow capacity and needed measurement accuracy.

Systematic Data Handling Errors

An accurate, right-sized water meter is only the beginning. Next the utility must read that meter properly and ensure that the measurement is processed, maintained, and stored in a way that maintains integrity. Errors in data transfer, billing, or archival efforts can result in erroneous data being represented as actual physical consumption. The 2009 M36 manual lists some of the major data handling problems that might be encountered at a water utility. The M36 manual states, "While data handling errors can be subtle and require considerable investigative time to detect, corrections are often quick and inexpensive, sometime requiring only minor procedural or programming changes," (AWWA 2009).

Unauthorized Consumption

The issue of unauthorized consumption impacts nearly every water provider. When water is deliberately used and not paid for it is considered unauthorized consumption. Unauthorized consumption can occur as the result of: illegal connections, open bypasses, buried or lost meters, misuse of hydrants, vandalism, tampering, and other means.

The 2009 M36 manual states:

> *"The water audit should quantify the component of unauthorized consumption occurring in the utility. For initial water audits, or where unauthorized consumption is not believed to be excessive, the auditor should use the default value of 0.25 percent of water supplied. This percentage has been found to be representative of this component of loss in water audits compiled worldwide. For water utilities with well established water audits, or those believing that unauthorized consumption is excessive, the extent and nature of unauthorized consumption should be specifically identified" (AWWA 2009).*

Real Losses

Real losses are actual physical losses of treated water from the distribution system such as the water main break pictured here. Real losses include: line breaks, leaks from mains, service connection pipes, joints, and fittings, leaks from treated water storage tanks and reservoirs, and overflows. For most water providers, leakage is the greatest portion of real losses as overflow events are infrequent.

Real losses are eliminated primarily through detection, maintenance, and repair work, but also via pressure management regimes. Many utilities own or lease sophisticated listening equipment that helps find leaks. Once the water audit and water balance is complete, it is easy for a water agency to determine the economic impact of real losses in the system and to determine what level of investment is justified to reduce leakage.

The 2009 M36 manual contains extensive information about real losses and pressure management. A variety of other publications from AWWA and elsewhere also address the maintenance and repair of treated water infrastructure.

Recommendations for Colorado Water Providers

Every public water supplier in Colorado should obtain a copy of the 2009 M36 manual and the free AWWA water audit software. Colorado water providers can greatly benefit from implementing the new IWA/AWWA water loss audit procedures described in this document. The free AWWA software developed by the Water Loss Control Committee makes the both the top-down and bottom-up audit processes as easy and straightforward as possible. Even if a water utility wishes to continue its old water loss accounting procedures, implementing the new method concurrently will not require a significant time investment and may prove to be extremely valuable to the water agency.

The straight forward, top-down auditing process can be completed by any agency – small, medium, or large – and requires a very small investment of time and resources. Colorado water providers should be encouraged to routinely compile a simply monthly water statistics report showing system input, billed consumption, nonrevenue water, and the number of customer accounts. Once a year, a full water audit and water balance should be compiled using the monthly reports as fundamental input data. For many water providers, an annual top-down audit will be sufficient to determine the economic levels of water loss and to help inform decisions about future water loss control efforts.

It is clear that under current water loss accounting procedures documented through the survey presented earlier in this report, there are some misunderstanding of the nature and economic impact of water loss in their systems on the part of some Colorado water users. The new 2009 M36 methodology provides useful economic analysis that will help utilities determine what areas require the most improvement (i.e. meter testing and accuracy or water main rehabilitation).

Some water providers, having completed a top-down audit, will wish to embark on the bottom-up audit approach. This will result in improved information and data validity and hence will improve a utilities ability to respond appropriately to the level of real and apparent losses in the water system. Even if a utility only uses the top-down approach, efforts should be made to improve the level of data validity each year.

Finally, Colorado water providers should eventually be required to submit their compiled water audit results to a central location (logically housed at the Colorado Water Conservation Board). Once a sufficient number of utilities have achieved a reasonable level of data validity, then it should be possible to establish minimum water loss standards (i.e. benchmarks) for Colorado providers to work towards.

Recommendations for the State of Colorado

Based on the findings from this study, it is recommended that the State of Colorado take the following actions:

- Educate Colorado water providers about the 2009 M36 manual update, the IWA/AWWA water audit and water balance procedures, and the free AWWA water audit software.
- Encourage (and perhaps incent) Colorado water providers to immediately begin implementing and to eventually adopt the M36 water audit procedures into their standard practice.
- Grant funds could be used to help agencies conduct their first IWA/AWWA water audits, but implementing the top down approach is not an expensive procedure and the grants could easily be for less than $10,000.
- The CWCB should begin collecting water audit results from all covered entities in the state and storing these data so that they can be used to help develop minimum water loss standards. A web-based reporting mechanism could be established for this purpose, or providers could simply submit their complete water audit accounting spreadsheet (based on the free AWWA software) each year.
- The State should over a 1-3 year period mandate adoption and implementation of the IWA/AWWA water loss accounting procedures for all CWCB covered entities and should also mandate water audit data reporting.
- Following California's lead, Colorado should collect water audit data for a period of 4 to 5 years. After that time, the reported data and level of data validity should be assessed. If sufficient audit data from utilities with a validity score greater than 50 is obtained, then a stakeholder group should be convened for the purpose of determining appropriate minimum water loss standards for Colorado utilities.
- Default values used in the software may not be suitable for Colorado water agencies. Percentages for unbilled, unmetered consumption and unauthorized consumption can be set to default values initially, but as soon as possible should be evaluated through a measurement study.

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APPENDIX A

COLORADO UTILITY SURVEY RESPONSES

EMAIL RESPONSES:

Alamosa, Don Koskelin

I have always defined water loss as that water that is produced and introduced into the distribution system but does not exit a tap, that is leaks and breaks. With our new water plant, we also "lose" water to backwash and cleaning cycles but this water is returned to the river via our wastewater treatment plant. Unaccounted for water in contrast is that water that flows through an un-metered tap, used for fire protection, and construction draws on hydrants (though most of the latter is metered).

Our water loss is minimal. Our lines are relatively shallow and for the most part in soils that transmit the water to the surface so leaks are detected in pretty short order. We do have line breaks from time to time but as you can imagine, measuring the water loss for these is difficult. Our loss rates are less than 5% as measured by production less metered use.

Unaccounted water has been an issue before we started a major push to install meters on all municipal uses, especially irrigation, about five years ago. Only in the past year have we integrated these meters into our billing system so that we can have all metered use measured and recorded in one place. Before that, we tracked municipal use separately and had to integrate this data with the billing data to get one number for metered water. At the end of the year, we should have a much better picture, or at least a picture that is easier to develop on a monthly basis. Historically we have had unaccounted water use of approximately 18% (which includes water loss). Going forward, I expect that number to be reduced substantially.

Yes, we are aware of AWWA M36.

We do not perform leak detection as such, but as mentioned above, leaks in our system soon manifest themselves due to our soil types and shallow lines, generally less than six feet bury.

In the past, our greatest water losses were due to line breaks. Currently with a more aggressive flushing program, this is probably our greatest water loss at this point. I do hope to be able to account for this loss more accurately by metering the flushing. We have very few un-metered taps still in the system.

Colorado Springs Utilities, Jeanne Slaven

1) Do you track unaccounted water or water loss? **Yes**
a. How do you define water loss? **The difference between water sales and production**
b. How do you determine the amount of water loss in your water agency**? Subtract potable water sales for the month from the monthly total of potable water that was put into the distribution system**
c. If you do track water loss, what method(s) do you use? **See b above**
2) What is your water loss? **Approximately 8%**
3) How often do you calculate your losses? **Monthly**
4) Are you aware of new edition of the AWWA M36 water loss control manual? **No**
5) Do you perform leak detection in your distribution system? **Yes, but this is handled by a different department**
a. If yes then how often? **Leak detection and search is comprised of; Development (new) infrastructure installation 50% and Existing system Detection 25% and Search.25%.**
b. Do you do this internally or contract with a leak detection firm? **Yes, this process is done internally (one man)**
c. Is leak detection a real problem in your distribution system**? Leaks are a problem due to an average system age of 39 years and 1900 miles of system to cover.**
6) What are the biggest components of water loss in your system?
a. Lines losses? **Damage due to hit infrastructure.**
b. Main breaks? **Yes. (400 leaks on average per year.)**
c. Un-metered demands? (i.e. customers without meters, hydrant tests, etc.) **Some un-metered for flushing of system. Stringent policing and Hydrant meter process in place has reduced un-metered use by diversion or non-approved means.**
d. Accounting or metering errors. **This category is currently being reviewed due to new software implementation**
e. Something completely different.

Denver Water, Garth Rygh

1) Do you track unaccounted water or water loss? **Yes**

a. How do you define water loss? **I'm not aware that DWB has a specific definition of water loss, however, my definition would be any amount of water that we put into the system that we aren't paid for.**

b. How do you determine the amount of water loss in your water agency? **Difference between water produced (i.e. water that enters the system) and water sold (DWB has universal metering).**

c. If you do track water loss, what method(s) do you use? **Nothing formal. The difference between production and water sales is easy to calculate. We have attempted once or twice in the past to perform a water audit and to calculate the Infrastructure Leak Index (ILI) as developed by IWA/AWWA. The results of the efforts were inconclusive and did not spur any further action.**

2) What is your water loss? **Over the last 5 years our water loss or "non-revenue water" has varied between 2 and 5%.**
3) How often do you calculate your losses? **Annually**

4) Are you aware of new edition of the AWWA M36 water loss control manual? **No**
5) Do you perform leak detection in your distribution system? **Yes**
    a. If yes then how often? **It is a continuous, on-going program.**
    b. Do you do this internally or contract with a leak detection firm? **Internally.**
    c. Is leak detection a real problem in your distribution system? **Not sure of the meaning of the question. Performing leak detection activities is not a problem for DWB. We do not appear to have a significant problem with system leaks.**
6) What are the biggest components of water loss in your system?
    a. Lines losses?
    b. Main breaks?
    c. Un-metered demands? (i.e. customers without meters, hydrant tests, etc.)
d. Accounting or metering errors. **If I had to guess, I would think that accounting and/or metering errors are probably the biggest unknown.**

As a side note, Elizabeth Gardener, the Suburban Conservation Coordinator for Denver Water expressed curiosity in the CWCB's interest in water loss.

Grand Junction, Terry Franklin

1) Do you track unaccounted water or water loss? **Yes**
    a. How do you define water loss? **Any water that cannot be tracked or measured.**
    b. How do you determine the amount of water loss in your water agency? **The difference between treatment plant production and metered consumption less hydrant flushing.**
    c. If you do track water loss, what method(s) do you use? **Have developed reports from billing system for metered consumption. Compare these to treatment plant production records. Also, track hydrant flushing and some water break data. As far as we know system is 100% metered.**
2) What is your water loss? **7 - 8%**
3) How often do you calculate your losses? **Monthly but numbers don't make sense due to staggered meter readings compared to plant production.**
4) Are you aware of new edition of the AWWA M36 water loss control manual? **Yes**
5) Do you perform leak detection in your distribution system? **Not very often. Only if we have a leak in a line we can't locate readily.**
    a. If yes then how often?
    b. Do you do this internally or contract with a leak detection firm? **We have some equipment but may contract out if they are in area.**
    c. Is leak detection a real problem in your distribution system? **No**
6) What are the biggest components of water loss in your system?
    a. Lines losses? **Yes**
    b. Main breaks? **No**
    c. Un-metered demands? (i.e. customers without meters, hydrant tests, etc.) **No**
    d. Accounting or metering errors. **Very little**

Mount Werner Water and Sanitation District, James R.L. Gallagher
We do not employ an active water loss tracking system.

If we suspect a location, we will monitor valves for running water.

Periodically, we will audit our water production vs. metered water use. The last audit showed a 12% loss, which is within the typical system loss range of 10-20%.

We have just received a copy of the new AWWA manual and intend to develop a more active program as a component of our conservation program.

PHONE INTERVIEW RESPONSES:

Aurora Water, Robert Morphis

Aurora tracks water loss by subtracting billed consumption from treated volumes. They also subtract internal water use, which includes: hydrant flushing and testing, storm water system flushing and maintenance, wastewater line flushing, estimated volume from line and main breaks, de-chlorination flushing, in-house equipment cleaning and maintenance, meter shop testing, valve operations, and contractor services and testing. Aurora also tracks un-metered external use from street sweeping, fire fighting and fire fighter training. Data is captured daily, but formal reporting is done annually (usually in February).

Morphis mentioned said losses in 2008 were 9.81%, but he retracted that number because it was not representative of their system-wide losses.

Morphis said he is aware of AWWA’s Water Loss Control Manual (M36). In fact, he had just ordered a copy and was expecting to receive it the day we talked.

Aurora has a leak detection crew. This team, whose full-time purpose is leak detection, does systematic checks as well as responds to customer reports of leaks.

At 22 million gallons per year, hydrant flushing is the biggest component of water loss in Aurora’s system. Meter inaccuracies are not a big factor due to an aggressive replacement program, Morphis said. Because of replacement, meters in the system are typically not older than 10 years.

Eagle River Water and Sanitation District, Dianne Johnson

Note: Because of ongoing litigation with CWCB, Johnson said she was not comfortable sharing information. Not all of the questions were answered.

Eagle River Water and Sanitation District does track water loss, but they were not willing to release information on how they calculate it. They are also going through an upgrade on their accounting system, so some data is currently difficult to access.

Johnson said they were aware of AWWA's Water Loss Control Manual M36.

She also said Eagle River performs leak detection in house.

East Alamosa Water and Sanitation District, Sally Salazar

East Alamosa Water and Sanitation District is new to water loss monitoring. It should be noted that this agency is quite small; at 1,430 people, they would probably not be considered a covered entity. Nonetheless, they are tracking their losses. They track water pumped from their wells to the City of Alamosa's treatment facilities. They also monitor water returned from treatment. Losses are calculated as treatment less billed volumes (all customers are metered.). The resulting value is reported in gallons, not percent. It is reported to the board of directors annually.

East Alamosa does not perform leak detection. As would be expected with a new program and a small system, the major component of loss is not known.

Longmont, Jon Robb

Longmont tracks water loss on a multi-year basis. Robb is promoting the term "water loss" in line with the IWA/AWWA standards. The calculation used by Longmont is system input measured at treatment less authorized consumption. Authorized consumption includes billed, metered accounts as well as unbilled metered accounts. Longmont reports that they are fully metered.

Loss data for 2008 have not been calculated yet, but data for 2006 and 2007 were readily available. Losses for those years were 8.3% and 8.2%, respectively. Losses have reportedly dropped over the last few years, Robb said.

Longmont staff performs leak detection, but generally, it is in response to customer concerns about unusual consumption.

Line losses are assumed to be the major component of loss in the system, but this idea comes from a process of elimination about other sources of loss. Main breaks are reportedly minimal, no accounts are un-metered, tests on replaced meters indicate that meter inaccuracy is not a problem, and changes to customer bills are handled without adjusting volumes recorded in the accounts database.

Pueblo Water, Terry Book

Pueblo Water uses the term “unaccounted water.” They define this as the amount of water pumped from treatment into the system minus the volume of billed water. The system is 100% metered, Book said.

He estimated the loss was 6% to 7%

They collect readings monthly, but volumes do not necessarily match due to lags in billing data, etc. The primary metric is the yearly loss, but they also look at a five-average of losses.

Pueblo Water staff is aware of the AWWA M36 manual.

Leak detection is performed on the system. This is sometimes done via contractor, but they also have the capability to do leak detection in house. They also do leak detection after mains are replaced.

The biggest component of water loss is under metering. Although the system is fully metered, inaccuracies were the largest point of loss, Book said.

Ute Water Conservancy District, Joe Burtard

Ute Water, one of the western slope’s largest water providers, tracks unaccounted water.

They track raw water, finished water, and consumed water. Consumed water is defined as water that travels through a water meter – and all accounts are metered. Unaccounted water includes differences from raw water and finished water as well as differences between finished water and consumed water.

Several individuals are responsible for different loss parameters. The plant superintendent gathers raw water and finished water data. These data are given to Ute Water’s finance director, who completes the water loss calculation.

Unaccounted water is tracked monthly, not annually. As an example, water May 2009 water loss was 7.13%.

Butard said he was not aware of AWWA’s Water Loss control Manual (M36).

Leak detection is handled by staff rather than contracted to outside service providers. Ute Water performs leak detection in response to customer calls. In addition, their billing system flags accounts that have higher than expected water use. These flags may prompt leak detection, if investigations indicate it is warranted.