Improve Water Audits and Minimize Nonrevenue Water

Essential Knowledge Briefings

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FRONT COVER: Water utilities have made great strides in the last few years regarding water loss control. It's critical for utilities to reliably audit their supplies and distribution systems as well as assess their water loss standing. A water audit also provides the foundational data a utility needs to plan a cost-effective strategy to control excessive losses. Photographs: M.E. Simpson Co., Inc.

Prepared for AWWA and M.E. Simpson Co., Inc. by EKB editors John R. Hughes, Kimberly Retzlaff, Barb Martin, and Dawn Flancher, designers Linda Yeazel and Gillian Wink; and production manager Diana Aqra.

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FOREWORD

This Essential Knowledge Briefing describes water audits and their application as a tool to assess distribution system performance. Best practices for the detection and control of real and apparent losses are discussed, through ensuring metering and accounting accuracy, as well as innovative technologies to detect and control distribution system leakage. This information provides readers with essential tools to address this common challenge and protect the utility's revenue stream.

M.E. Simpson Co., Inc., recognizes the challenge that water loss can pose to many utilities and the importance of educating the industry on programs, resources, and methods for addressing water loss. That's why we have partnered with the American Water Works Association (AWWA) to sponsor the development of this Essential Knowledge Briefing and provide this key water loss information to the water community.

Our hope is that this Essential Knowledge Briefing can help to highlight the important contributions of AWWA volunteers and committees developing Standards, Manuals of Practice, Committee Reports, and other resources to advance innovations in the science and practices of safe water. Water audit resources offered by AWWA provide sound, consistent definitions for the major forms of water consumption and water loss encountered in drinking water utilities. They also feature a set of performance indicators that utilities can apply to help quantify and evaluate their water loss performance. Additional information can be found at www.awwa.org/waterlosscontrol.

We're pleased to provide this Essential Knowledge Briefing electronically at www.mesimpson.com. For print and PDF copies, please call M.E. Simpson at 800-255-1521. M.E. Simpson appreciates this opportunity to share important information on this topic.

Michael D. Simpson
CEO
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INTRODUCTION

Throughout the history of North America, abundant water resources could be readily and reliably tapped to supply communities. Unfortunately, that security no longer exists in many regions because of a changing climate and other environmental stresses, growing and shifting populations, financial constraints, and evolving regulatory programs. Today's water managers must ensure they're accountable in their practices and highly efficient in their operations.

Water loss is a common challenge for drinking water utilities, the extent of which varies from system to system. Water audits are a useful tool that can help water utilities quantify water loss and the financial impact of such losses to the utility, improving a utility's ability to implement strategies for water loss control. A robust water loss control program, including water audits, can be one of several factors that help inform a utility's asset management practices and, ultimately, programs for infrastructure renewal and replacement on a larger scale.

Fortunately, reliable methods are available to help water utilities understand and communicate the occurrence of water and revenue losses in utility operations and the means to cost-effectively control them. This Essential Knowledge Briefing describes the availability of reliable methods to audit the water distribution system and utility revenue stream as well as innovative technologies that can be used to control leakage losses, metering and accounting errors, and other common system losses.

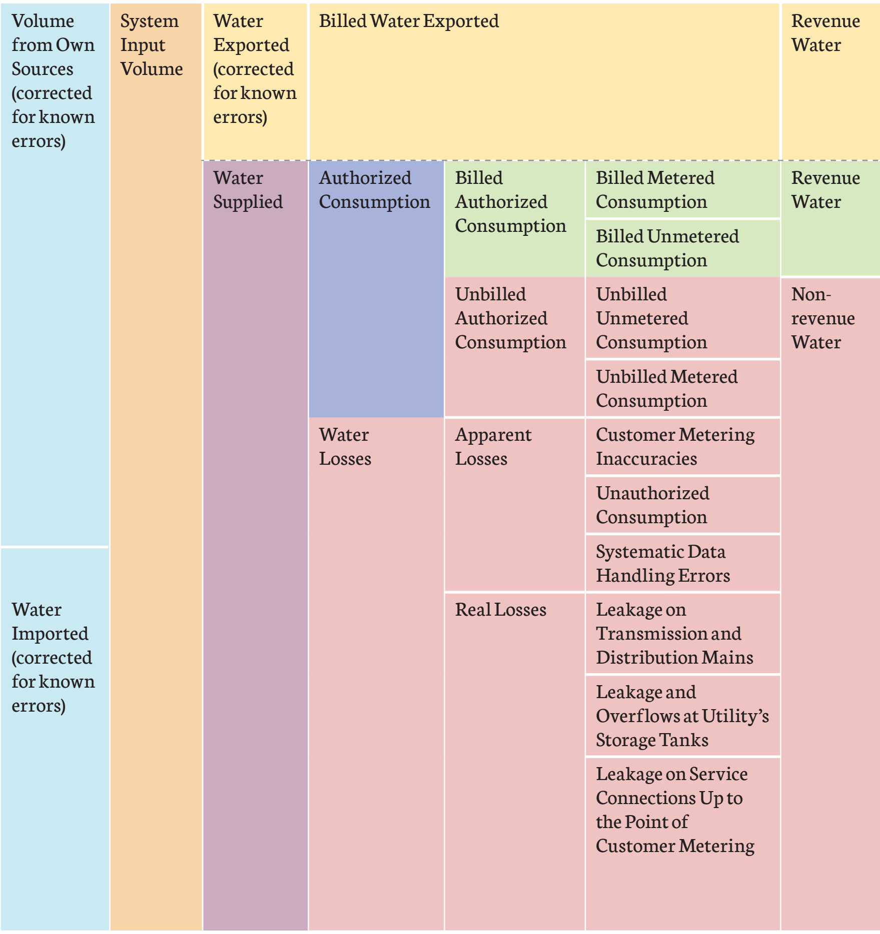
WHAT IS A WATER AUDIT?

Water utilities can incur inefficiencies, or losses, in supply- and customer-related functions of their operations. Such losses include the physical escape of water from the pressurized piping system as leakage—known as ***real losses***. Losses also occur because of inaccurate metering of customer consumption, theft of service, and the utility's own errant billing and accounting practices—collectively known as ***apparent losses***. The term ***nonrevenue water*** encompasses the real plus apparent losses, along with unbilled authorized consumption such as water used in miscellaneous activities like firefighting. In other words, nonrevenue water comprises the volume utilities lose from their water supply infrastructure and the unbilled volumes associated with lost revenue from a portion of the supply that reaches the customer, plus the authorized unbilled usage.

The Water Balance Diagram shown on page 7 portrays all component volumes of water supplied, delivered to customers, or lost during the course of a reporting year. The approach was created by the combined efforts of AWWA and the International Water Association. Each box represents an annual volume of water, and each column totals to the same amount of water. Thus, all columns "balance" as water moves across the system, and all water is accounted for. Accordingly, there is no "unaccounted-for water," a term AWWA recommends against using.

Instead, AWWA recommends use of the term ***nonrevenue water***, as shown in the figure. The Water Balance Diagram provides accountability for water utilities by defining a clear path to quantify the loss volumes and demonstrating how those losses affect utility operations.

Water utilities should track the annual volumes of water they manage, measuring the amount of water supplied to their customers and the water lost. The foundation of a water loss control program is the annual water audit. Audits are common in the world of finance and accounting. Similarly, a utility water audit involves a review of records and data that traces the flow of water from its source, through the treatment process, into the water distribution system, and to customer properties. The water audit usually exists in the form of a worksheet or spreadsheet that details the annual volumes of water supplied, customer consumption, and loss volumes that occurred in a community water system. The standard water audit also tracks various costs and calculates a variety of performance indicators to assess the water utility's efficiency.



The Water Balance Diagram portrays all component volumes of water supplied, delivered to customers, or lost during the course of a reporting year.

USE BEST PRACTICES

AWWA's water audit methodology is a best practice approach North American water utilities can use to develop consistent and reliable performance tracking and benchmarking for and among water utilities. This methodology is embodied in AWWA's Manual of Water Supply Practices M36, ***Water Audits and Loss Control Programs*** (available at www.awwa.org/store), which gives detailed instruction on the water audit process, best practice methods to control real and apparent losses, and helpful case studies on the benefits of these practices for a utility.

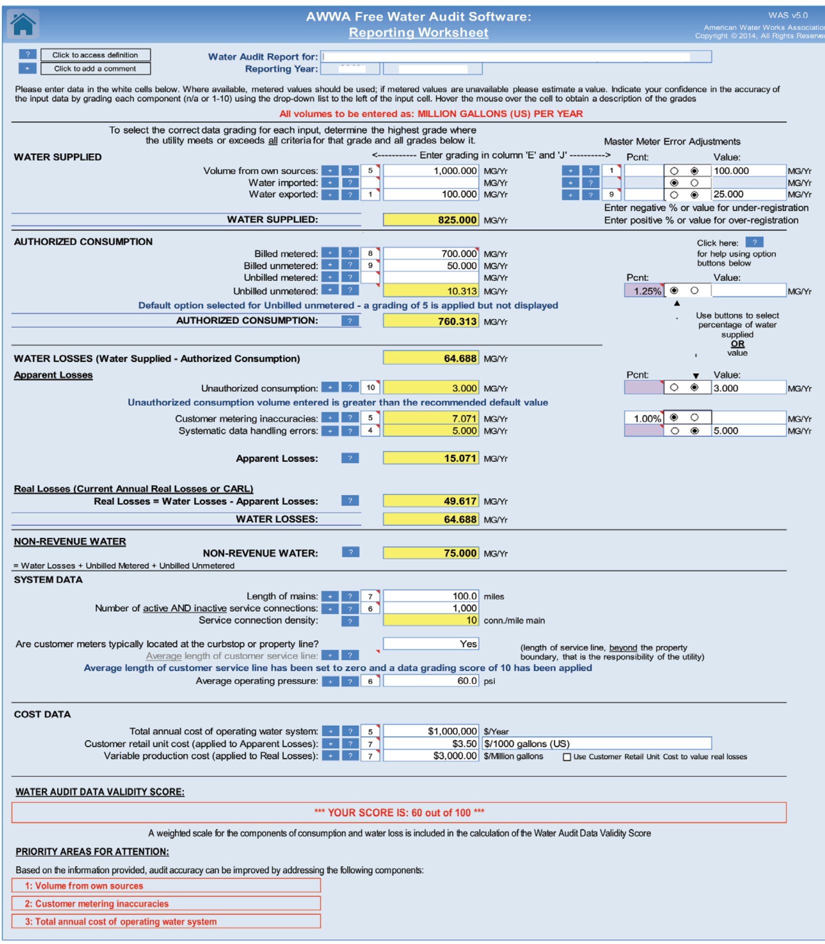
Additionally, AWWA provides a free spreadsheet software tool, AWWA Free Water Audit Software, which utilities can use to perform a standardized water audit. First released in 2006, the Excel-based tool has been upgraded several times, with the current Version 5.0 released in 2014.

Since its release, thousands of water utilities and industry practitioners have downloaded the software to compile a water audit. The software includes inputs for volumes of water supplied by the utility, water consumed by customers, and the difference between these two numbers, which amounts to water losses. Other inputs include data about the water system and the pertinent costs. All of these data are used to calculate a series of performance indicators that give an effective rating of a system's efficiency. The software also includes a unique data grading capability that allows the user to rate, or grade, the trustworthiness of the data input into the audit. A Data Validity Score calculated by the software represents the water audit's overall trustworthiness.

The audit is only as good as the data available, and data validation is a means of verifying data accuracy. In 2011, the AWWA Water Loss Control Committee launched the Water Audit Data Initiative, which enlists dozens of volunteer water utilities to submit their annual water audit to be posted on the AWWA website. These audits must first undergo a validation process to ensure quality control of the data. Only audits with validated data are posted online. The data may be accessed on the AWWA Water Loss Control resource page at www.awwa.org/waterlosscontrol and clicking on the Validated Water Audit Data link.

The state of Georgia followed this practice by implementing a data validation requirement for its water utilities' audits. All audits in Georgia have been validated since 2011. The state of California followed suit, and the submission of validated utility water audit data is now required. During the past few years, assessments of validated water audit data showed that some water utilities are reporting substantial volumes of real and apparent losses with significant costs.

With the development of the AWWA methodology and implementation tools, all of which can be accessed at the association's Water Loss Control resource page, water utilities have available to them all they need to reliably audit their supply and distribution systems and assess their water loss standing. The water audit also provides the foundational data a water utility needs to plan a cost-effective strategy to control excessive losses.



Utilities can use AWWA's Free Water Audit Software to compile a standardized water audit.

ENSURE ACCURATE WATER AUDITS

Water resources have been monitored for thousands of years. The first few pages of AWWA's Manual of Water Supply Practices M6, ***Water Meters—Selection, Installation, Testing and Maintenance*** (available at www.awwa.org/store), are dedicated to the early attempts at flow measurement and the development of water meters. Today, water supply monitoring is critical. In the past several years, many US regions have faced droughts so serious that water use restrictions are now the norm, and water auditing and tracking accountability have become mandated practices.

The ability to accurately measure the water conveyed to a water utility's distribution system poses a significant challenge for many utilities for various reasons, but it's an important aspect of a water audit. Water audits begin with the total amounts that have been pumped into a distribution system. The term ***water production*** is used to denote the bulk water volumes that constitute the overall water supply managed by a water utility, including the water audit components. If the production volume number is wrong, the audit will be wrong, too. Every water system that meters the input of water into its system has this concern, regardless of system size.

In addition, many water systems export, or sell, water to neighboring water systems. To receive fair compensation for the water sold wholesale, connection points must be metered correctly. The term ***export meters*** denotes the water supply meters designated for the receiving water system. Here, too, supply meter accuracy is essential for a proper water audit.

AWWA's Free Water Audit Software calculates Water Supplied Volume in the Reporting Worksheet as follows:

Water Supplied Volume = Volume From Own Sources
+ Imported Water Volume – Exported Water Volume

What this means is water-supplied volume is made up of three components: water that has been produced at a water treatment plant by a utility and put into the distribution system, water a utility may purchase wholesale from a supplier (e.g., a neighboring water utility or water commission), and any water sold wholesale to another water utility. Some water utilities perform all three functions, whereas others may only perform one or two of them. Water that's bought and sold wholesale is termed ***custody transfer volume***.

The water meters used to monitor effluent flow at a water treatment plant or at the custody transfer points between water utilities measure flow and record that flow—the same functions of a water meter inside a home or business. Therefore, the meters need to accurately measure flows and total the flows over specific periods.

A flowmeter must be chosen carefully to ensure it can perform those two functions (measuring and recording flow) correctly. Also, the meter's size must be matched to the anticipated volume flowing past the meter's location, and the chosen location for flow measurement must have the correct layout to properly measure the flow. Finally, the selected meter must allow for periodic testing and calibration to ensure it performs within accepted accuracy limits specific to its type.

It's imperative that water operators and managers become familiar with the flowmeter types used at their treatment plants or custody transfer locations. Sources of information for larger flowmeters include AWWA's Manual of Water Supply Practices M33, ***Flowmeters in Water Supply*** (available at www.awwa.org/store), as well as the previously mentioned M6 manual.

Several types of meters are used in water production and wholesale applications. These can be classified as differential pressure meters (Venturi meters, Dall tubes—a modified Venturi—orifice plates, and others), mechanical meters (turbine and propeller), insertion meters (Pitot tubes and insertion magnetic meters), magnetic-style flow-through meters, and ultrasonic meters (strap-on and flow-through). Each style has certain characteristics related to use, accuracy, ranges, and costs. When meters are chosen for installation, certain tradeoffs have to be considered, as no meter will be completely accurate across the full range of flows to which it may be subjected. As a result, meter selection becomes even more important.

To measure flow properly, a meter should be set in a location where conditioned flow enters the meter's measuring element. Accurate meter readings depend on unobstructed flow, and the required lengths of straight, unobstructed flow upstream and downstream of the meter setting vary with meter type and manufacturer. If this isn't considered during meter selection, meters may be installed in compromised settings, causing them to perform inaccurately. Moreover, without a proper setting evaluation, a utility may not even know about a faulty meter setting before conducting its water audit.

As detailed in the next section, water utilities should have their production meters flow-tested regularly, according to applicable regulatory requirements. In the absence of any rule that stipulates testing frequency, it makes good business sense to perform the testing so it coincides with the water audit process. It's also important to conduct meter calibration and maintenance activities according to the manufacturer's recommendations. This helps to ensure water utilities have reliable numbers. How the water audit process ends will ultimately depend on how it's started. That's why it's critical to perform production meter testing and wholesale meter testing accurately and regularly.

For water utilities to ensure the accuracy of their water audits, production volumes are the most important quantities to consider. Photograph: AWWA

RECOVER UTILITY REVENUE WITH METER TESTING

A water meter is like a utility's cash register. Without proper metering, water utilities can lose money because they aren't receiving fair compensation for what they provide to their customers. In addition, because more water utilities are conducting water audits, ***apparent losses*** have gained prominence at utilities. Apparent losses express a utility's loss of revenue because of potential meter inaccuracy as well as other issues such as accounting and billing errors, unauthorized water use, and improper meter settings (which eventually result in inaccurate meters).

Equipment maintenance issues have a long-lasting effect on a utility's operational efficiency. This is especially true regarding how a water utility derives revenue from its daily use of equipment because revenue generation is tied to a utility's water meters.

Historically, meters measured water flow by mechanical means and thus have been subject to wear. Mechanical water meters can eventually lose the ability to correctly measure and record flow. Over time, water quality and how a meter is used in a particular setting can cause meters to wear out. Water's chemical makeup and hardness, as well as abrasive materials in the water, can affect meter performance.

More recently, electronic meters with no moving parts have gained widespread acceptance in the meter marketplace. Although electronic meters aren't subject to the wear that traditional mechanical meters may be subject to over time, other potential problems can cause electronic meters to misread and inaccurately measure flow, leading to potential apparent losses for the utility. For example, batteries may run down or a lightning strike can inflict damage.

Other factors—such as the meter setting, type, and size—also affect revenue generation, so water utilities need to periodically test their meters to verify their accuracy and make sure customers are being charged fairly so the utility receives proper revenue for its service. A meter that overregisters flow can also become a serious cause for concern. Some rare incidents of a water utility overcharging customers have made headline news. However, most of the time, water meters don't overregister. Instead, they tend to under read, resulting in customers paying for less water than they use. This can have a serious effect on a utility's revenue, which a regular utility meter maintenance program can help to prevent.

In the case of inaccurate meters, a meter's size is important, as smaller and larger meters affect a utility's revenue differently. The meter population of most water utilities commonly includes a variety of meter sizes. Usually, smaller residential meters are used in greater numbers than larger commercial and industrial meters. However, as a rule, the larger commercial and industrial meters bring in more overall revenue. Large meters may only make up 10–15 percent of a utility's meter population, but they account for up to 60 percent of the revenue generated. Meter accuracy is a critical issue in these cases because the failure of a few large meters can cause serious revenue losses.

Determining when it's easier or more cost-effective to replace meters instead of repairing them is another factor in the decision-making process. Years ago, most meters were rebuilt because the components were made of brass and could be rebuilt. Today, a lot of meters are made of plastic or composite materials and don't get rebuilt if they fail testing. In some utilities, the cost of removing meters from their settings, testing and repairing them, and reinstalling them are too high (large commercial and industrial accounts are a notable exception), so new meters are installed instead.

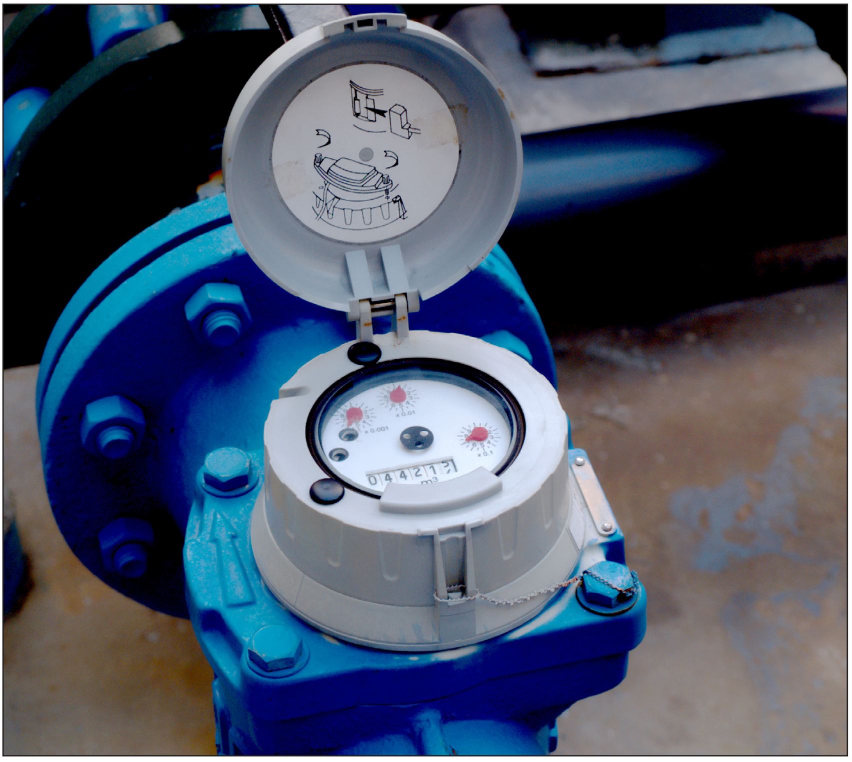
A water utility should test its meters periodically because that's the only way to know if a meter works correctly and thereby protect utility revenues. How often a utility should test its meters varies, typically depending on meter size and how the utility functions. Water rates and the cost of implementing and maintaining a meter testing program are factors that influence the operation, frequency, and efficiency of a meter testing program, so the savings identified can help to balance out the implementation costs. If no meter testing program is in place, the utility simply will not know whether it's being fairly compensated for its water.

To implement a meter testing program, a utility needs to make a complete inventory of its meters by size and type. This information is usually entered in accounting and billing records and may be stored in a utility's asset management system. Also, a utility should review past consumption records for each account to look for a drop in consumption that can indicate a malfunctioning meter. Because utilities often have different types and models of meters that have been purchased over time, meter testing and recording must account for the idiosyncrasies of each type and model.

AWWA's M6 manual has advice and instruction on meter testing and the two essential methods used. A utility can remove a meter and bring it to a meter testing facility, or the meter can be tested in-place.

Small residential meters can be set up on a random sampling testing program so a selected percentage of the utility's meters are regularly tested. That way the utility has some idea how the smaller meters are functioning. Large meters should be tested more frequently than smaller meters because, as stated, they provide a larger portion of revenue for the utility. Some states also have requirements for testing based on a meter's size.

The loss of revenue from large meters can cause many problems. Each utility should look at the expected revenue generated from its large-metered accounts and set test-frequency parameters based on the revenue amount. The idea is to catch any drop in meter accuracy and revenue loss early and before it becomes a more significant problem. To this end, water utilities should dedicate a specific percentage of total annual revenue to meter testing and maintenance. It may be a good idea to involve area wastewater utilities as well, because they also derive their revenue from water meter readings. Remember, water meters are a utility's "cash registers," so they need to be accurate.



Water meters should be tested to protect customers against inaccuracies that could result in overcharges from overregistration and to protect water utilities from revenue losses resulting from underregistration. Photograph: krungchingpixs/Shutterstock

CONSIDER LEAK DETECTION OPTIONS

Leakage from the pipes that convey a utility's water from source to final point of use is a common challenge. Costs to water utilities are high in terms of lost water and hidden damage from leaks that go undetected for a long time, until suddenly a large hole opens to reveal catastrophic conditions that threaten public safety and health.

As discussed previously, such water losses are termed ***real losses***. According to AWWA's Manual of Water Supply Practices M36, ***Water Audits and Loss Control Programs***, real losses are "the physical losses of treated pressurized water from the distribution system due to breaks and leaks from the water mains and customer service connection pipes, joints, and fittings."

Real losses equate to the volume of water supplied to a distribution system minus all authorized uses (metered and unmetered), apparent losses (metering issues, billing, and accounting issues), and estimates of unauthorized uses. Real losses include leaks from water storage, distribution mains, and service connections up the point of customer metering.

Water leakage in a distribution system occurs for many reasons, including leaks from fittings and appurtenances such as hydrants and valves, seasonal incidents such as frost heaving, pressure problems from transient and operational issues, poor pipe materials and installations, corrosive conditions in the soil or bedding in which a pipe is laid, and more. Loss volume will vary depending on each system's characteristics and operational procedures. Loss control also varies from system to system. The ability to control these losses depends on several variables, some of which utilities can control and others, like the weather, they can't.

The volume of annual leakage losses in a distribution system depends on the number of leaks occurring, their magnitude, operating pressure, and—perhaps most important—the total time the leaks go unaddressed. Small leaks that run for a long time without being detected can actually pass more water than large leaks that run for a short time. Small leaks can run for years without being detected, because the water will find a path of least resistance and run until a void is filled or a path is carved out. Most leaks eventually surface through cracks in the ground or street pavement, at the wastewater treatment plant, or at a creek or river.

Leak awareness time can have a significant influence on how quickly a leak is repaired and the resulting water loss volume. Typically, main breaks have a short awareness time because they surface quickly and are located and repaired quickly.

Smaller leaks are more likely to have longer awareness times because they don't get discovered unless they've surfaced or are identified through a leak detection program; however, once discovered and located, they usually get repaired quickly. Leaks on the customer side of a service can have a longer awareness time, and once discovered and located, may have a long repair time because the customer typically has to take care of the repair.

There are many types of leak detection technologies available to help shorten leak awareness time and minimize a utility's real losses. Two general categories are acoustic and nonacoustic leak detection.

Acoustic leak detection is probably the most common and easiest form of leak detection used today. Water leaking from a pipe that's under pressure creates a sound wave of energy that travels along the pipe walls and water column. If the leak is large, part of the sound wave will be transmitted to the surrounding soil or, in some cases, the hard pavement of a street or sidewalk.

As the sound wave travels along the pipe wall and water column, it loses energy as the wave encounters pipe joints and other fittings. ***Rectilinear propagation*** is a term that means waves travel in straight lines or a path. That's what a sound wave (energy) from leakage does: it travels in a straight line. When the sound wave encounters a tee, four-way cross, or service connection, part of the wave splits off and travels up the line while the rest of the wave continues traveling along the pipe-wall path or water column. Elbows can also have an effect on how sound waves travel. At each point where the sound wave is "forced" to change direction, it loses energy, and the wave can become slightly distorted.

The ability to use acoustic detection depends on several variables that every utility needs to consider to effectively pinpoint leaks, including pressure, pipe materials, soil types, water table, groundcover, and pipe size. A range of acoustic technologies are available for different applications.

Hydrophones. Hydrophones, the sensors used for detecting sound waves in a water column, don't depend on pipe material or pipe size for the sound waves to be sensed. However, the hydrophones must be in full contact with the water column. This is usually accomplished by "charging" fire hydrants and installing the hydrophones at the hydrants. The hydrant can't leak or the sound of the leaky hydrant will be picked up.

Transducers. Because they enable better sensitivity in detecting noise, electrical-mechanical transducers were developed to convert mechanical sound waves to electrical signals that amplify and transmit to earphones to help the listener hear sounds. Modern transducers used for leak detection are extremely sensitive and can pick up noise that's faint and far away.

Leak Correlators. Created in the 1970s, leak correlators use two transducer microphones placed in contact with the water pipe, valve, hydrant, or service connection at the point at which the leak noise was heard. When correlators were first developed, this area would be bracketed, with one transducer microphone mounted on each side of the suspected leak area. The correlator would receive the electronic signal from each transducer by hard wire or radio and compare the time-delay difference for the leak soundwave to arrive at each sensor, and then it would calculate the position of the leak based on the time delay. Leak-detection correlator technology has improved greatly since its introduction and is one of the main tools for leak pinpointing by leak-detection specialists.

Leak Loggers. Transducer technology for leak detection has been incorporated into what's now known as leak loggers. The transducer is connected to a recorder that can be programmed to turn on and off at different times to listen to pipes. The recorded sounds can be downloaded and further analyzed for the presence of a leak. Some loggers can be left in place for long periods and send a radio signal to a receiver, similar to automated water meter reads, allowing for longer periods of leak-noise listening.

Several nonacoustic leak detection approaches also have been developed, each with advantages and disadvantages. Such techniques currently are used commercially to varying degrees.

Tracer Gas Method. For small leaks that can't be detected or pinpointed by traditional acoustic methods, tracer gas leak detection may be effective. The tracer gas method uses one of two potential gases: hydrogen or helium. Gas is injected into the pressurized pipeline through standard pipe fittings (tap or fire hydrant), and the gas travels with the flow of the water in pressured pipelines, or toward a vented outlet on dewatered pipelines. As the liquid exits the leak, it returns to a gaseous form. While walking directly over the test section of pipe, the operator uses a specialized instrument that continuously senses the atmosphere at grade. When gas is detected at the surface, the instrument's variable sensitivity setting can quickly verify and pinpoint the leak's location.

Infrared Imaging. Infrared imaging was developed in the 1950s and improved in the 1960s to produce line images. Infrared allows users to identify temperature differences. The advent of digital technology has made it possible to create isothermic images. Water leaks can be identified by calculating temperature differences. This technique became useful for leak detection associated with building inspections.

Camera Inspection. Camera inspection has been used for leak detection almost as long as closed-circuit TV has existed. Today's fiberoptic technology makes it possible to get inside water pipes to look for leaks. Camera inspection, combined with trenchless technology, allows for repairs to be made to leaky pipes in extremely difficult locations without digging.

Ground-Penetrating Radar. Using radar pulses, ground-penetrating radar (GPR) creates subsurface images. When the radar senses water, a profile is produced that maps the location. GPR has been around since the 1970s. Utilities have used it to map pipes and utility lines under city streets as well as to detect leaks.

Microwave Remote Sensing. A new form of leak detection on the market is the use of microwave remote sensing via satellite imagery. Satellite images of an area are analyzed to identify spots that have a potential for leakage. After areas are narrowed down, a leak detection team can be sent to a specific location to search for a suspected leak and pinpoint it. This method can shorten the surveying time for larger water systems.

In the end, leakage remains a common challenge for water utilities. By using the AWWA Free Water Audit Software, utilities can calculate their real-loss amounts so a realistic leak detection program can be developed. Such a program can help a utility optimize its return on investment. Private leak detection firms can provide this type of service for smaller utilities. Larger water systems often will have their own leak detection teams that can be sent to reactive situations and can conduct proactive surveys. To learn more about leak detection, water loss control, and appropriate options for your utility, read AWWA Manual M36, *Water Audits and Loss Control Programs.*

Acoustic devices allow users to detect the presence of leak noise and accurately pinpoint leak locations quickly. Photograph: M.E. Simpson

DETERMINE WATER LOSS CONTROL CHALLENGES

Although each water utility has unique characteristics, some water loss characteristics are common to all systems; others affect systems of specific sizes. It's impossible to consider every combination of issues, but it's worth comparing the water loss challenges of smaller water systems with those of medium-sized and larger systems.

Anyone interested in developing a water loss control program should begin with the Water Balance Diagram shown on page 7. The approach provides the basis for understanding how utilities are able to track water loss and considers how water gets into a water system, is consumed, and where it can be "lost," or not consumed but still accounted for or tracked. However, depending on a water utility's size, there are issues to consider regarding how utilities track water uses.

To determine water supplied for a utility, large or small, water flow needs to be measured correctly. The water volume supplied comprises three components: water that has been produced at a water treatment plant and put into the distribution system, water a utility may purchase wholesale from a supplier, and any water sold wholesale to another water utility. Some water utilities perform all three functions; others perform one or two of the functions. The key here is to ensure each point of final production, wholesale purchase, or resale to another wholesale customer is metered correctly.

Small water systems can have as little as one well or one small surface water treatment plant. Some small systems purchase water wholesale from a supplier. In such cases, it's generally easy for a utility to determine correct water-production volumes; however, water meters should be tested regularly to verify their accuracy. The meter at the well or treatment plant may not be in a good setting in some small systems, so testing for meter accuracy is critical to verify amounts produced.

Medium-sized water utilities typically have more staff, resources, and water sources. However, the more source meters, the bigger the potential for source meter issues. The accounting becomes a bit more complicated with an increasing number of meters and often more complex rate structures, but meter accuracy still needs to be regularly verified. In addition, water volumes for each meter need to be weighted to get an overall accuracy number for total annual input.

Larger water systems have more complex production systems. Cities can have large water production meters located in older treatment plant settings that can be more challenging to test and verify to ensure proper water flow measurement, causing difficulty in accurately confirming water production volumes. Also, many larger systems export water to smaller systems. Some larger systems may have several wholesale customers and water commissions that transport water over long distances. As a result, determining an annual total water system input can be a big job! This is one of the biggest challenges for larger water utilities.

With the development of the AWWA methodology and implementation tools, water utilities have the resources they need to reliably audit their supplies and distribution systems and assess their water loss standing. A water audit also provides the foundational data a utility needs to plan a cost-effective strategy to control excessive losses and help inform broader decisions related to asset management and infrastructure replacement.

Historically, the motivation for a water utility to compile an annual water audit was voluntary. However, since 2005, several states have enacted requirements for annual water audits, and the number of water utilities routinely compiling water audits is growing. The important step is to get started—then build on the results.

FURTHER READING

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Essential Knowledge Briefings

American Water Works Association