Water Audits & Water Loss Control for Drinking Water Utilities: Costs and Benefits

Summary

This document provides a summary of available information on the financial costs of, and savings realized through, drinking water utilities' performance of water loss audits. At the end of the memo, contact information is provided for two of the leading state programs that are working with utilities to successfully implement this approach. State agency staff may be able to provide more specific examples of costs and savings based on their most recent experience.

Water loss audits are essential to allow utilities to identify "economically recoverable" water losses (*i.e.*, losses for which investments in corrective actions have a reasonable payback period). The audits do not, by themselves, result in savings to utilities. Rather, it is the corrective actions following the audits that yield the savings.

The costs of an initial audit based on data readily available to any utility are relatively low, and these audits often lead to corrective actions with short payback period that generate ongoing savings for the utility. The costs of improving the reliability of data sources that provide the "inputs" for an audit are higher, but still modest. The costs of corrective actions to reduce water losses – including leak repair and improved metering/billing – can be higher, but decisions to undertake these efforts can be based specifically on payback periods for the investment.

All of these costs can be defrayed by state financial assistance available for water efficiency projects, including from the Drinking Water State Revolving Fund (and, potentially, through the Clean Water State Revolving Fund).[1]

Corrective actions following an audit often have short payback periods that generate ongoing savings for the utility. These payback periods are typically based on annual savings including, primarily: (i) the marginal production cost of water lost to leakage, such as energy and chemical costs of treatment and pumping; and (ii) the retail cost of "apparent loss," which is water that is under-counted due to issues such as poorly calibrated meters and is, therefore, under-billed. A third category of savings is based on deferred or avoided capital costs for water supply expansion, for systems experiencing growing demand that can be met in part by water loss reduction. All of these savings accrue to the drinking water utility.

Additional savings can be realized by wastewater utilities serving the same customers, although these have not been routinely factored in to cost-benefit analyses of water loss control efforts by drinking water utilities.[2] Further, the energy savings from reducing unnecessary water production can contribute to climate emissions reduction goals.

Cost and savings information from case studies

1. Auditing costs, generally

A 2013 EPA report explains:

> Although it requires an investment in time and financial resources, management of water loss can be cost-effective if properly implemented. The time to recover the costs of water loss control is typically measured in days, weeks, and months rather than years.[3]

The first step in the water loss accounting process is often called a "top down" or "desktop" audit, which is basically a paper audit of the utility's operating system. To help a utility understand how to conduct this audit, a utility can purchase the American Water Works Association's (AWWA) Manual M36, "Water Audits and Loss Control Programs," which costs between $84 and $133.[4] However, there is **no cost to using the AWWA Free Water Audit online software** which follows the methodology outlined in Manual M36.[5] Online introductory webinars are offered, some of them free.[6] In some states, the state chapter of AWWA offers in-person training seminars.

A more significant, but still modest, cost can be represented by the time spent by employees to gather available data and input it into the audit tool. In Illinois, the Chicago Metropolitan Agency for Planning and Center for Neighborhood Technology recently walked through the M36 audit process with three utilities. The utilities estimated that it would take about the same number of person hours in-house to complete the M36 methodology as it takes to fill out the state's current 2-page audit form,[7] and that no new municipal relationships (e.g., coordination with other departments) would be necessary to perform an audit of this nature.

Similarly, utilities regulated by the Delaware River Basin Commission reported that, even though most were unfamiliar with the M36 audit methodology before new Commission regulations required submission of annual audits, most utilities completed the M36 audit in 1 to 3 days without outside help.[8]

Once the initial audit is done, validation of the results is very important. This data validation may require outside assistance (at least following the initial audit); if so, there will likely be a cost to bringing in a third-party.

Additional activities and associated costs can come into play if a utility wishes to ramp up its data gathering abilities to improve inputs into the tool over time or to address the problems identified in the initial audit. For example, a utility will likely incur additional costs if it carries out leak detection monitoring, valve testing, pressure management assessments, etc. These types of programs typically focus on water losses that are cost-effective to identify and eliminate within a set period of time.

It is difficult to generalize about the costs associated with additional data gathering and other water loss control activities, as they are utility-specific and dependent on the size of the utility, the extent of the follow-up programs, and whether or not consultants are used.[9]

However, EPA reports that up to 75 percent of water loss is [economically] recoverable."[10] It is expected that water loss rates would be higher in older drinking water distribution systems, potentially in climates where cold winter conditions can increase the stress on distribution pipes, and in systems where excess and transient pressures are not well managed.

2. Tennessee case study

In January 1988, the Energy Division of Tennessee's Department of Economic and Community Development conducted a two-phase program to identify energy and water loss and to make recommendations for corrective action.[11] The project was divided into two phases: (I) to identify energy and water loss and to make recommendations for corrective action; (II) to conduct a leakage detection/pinpointing survey of the distribution system. Phase II was scheduled to be initiated if the benefit-to-cost ratio was favorable.

It was estimated that the **project saved $24.4 million per year at a cost of $2.7 million for 278 water utility companies** in the state of Tennessee as of January 1991. Included in the avoidable cost is 72,698,052,000 avoidable Btu's, representing **$1,496,860 of energy savings**. (Note: all cost figures and savings are as of 1991.) This is a **benefit-cost ratio of 9.5:1 and represents a payback period of just 38 days.** The **average system savings was $91,398 per year.**

Currently, Tennessee, led by the state comptroller's office, is undertaking a new water loss audit initiative, using the AWWA standardized methodology. The state has created a data collection process and defined (and then tightened) high performance thresholds that identify struggling water utilities, who are then provided assistance to improve their operations.[12]

3. AWWA case studies: small and medium-sized systems

The AWWA manual M36 *Water Audits and Loss Control Programs (Third Edition)* includes case studies of four water utilities, of varying sizes, that have implemented water audits and water loss control programs. These case studies provide at least partial information on costs and savings:

- A small rural utility in Virginia, serving a population of about 50,000, implemented a multi-faceted program that **saved almost 10 percent of its operating budget**. Among the financial losses from leakage prior to program implementation were $340,000 in annual production costs of water that leaked from the distribution system (plus unquantified costs of distribution). Total costs of a capital improvement plan were $12.6 million. (Costs of the audits that led to development of the water loss reduction program are not included in the case study.)

- A utility in California serving approximately 37,000 customers implemented a two-year, two-phase water audit and water loss reduction program at a **cost of $200,000**. The first phase was a water audit using the AWWA method; the second phase was leak detection and interventions in the field. The program **identified "apparent losses" (*i.e.*, unbilled water due to faulty metering) valued at $300,000 annually**.

- A medium-sized utility in Halifax, Nova Scotia, had experienced water loss on the order of 35%. By reducing leakage (beginning with an audit using the AWWA method), the utility **saved $550,000 annually**. The case study notes that, in addition to these direct savings, the utility improved public health protection (since a leaking system has more potential for contamination) and reduced service disruption and property damage because leaks are now addressed in more timely manner.

4. Philadelphia case study

From 2000-2011, Philadelphia saved $23 million through its water loss control efforts (including reduction of real losses (*i.e.*, leakage) and apparent losses (*i.e.*, under-billing and unauthorized use).[13]

Leak detection and repair efforts have cut leakage levels from 96 million gallons per day (mgd) in the early 1990s to roughly 53 mgd in 2008, **saving approximately $3.4 million/year in chemical treatment and electrical costs**. As of 2010, the city's water utility was spending **approximately $800,000 annually on its active leak detection program**, and estimated that the water recovered from this program corresponded to **$2.5 million in recovered revenue for 2008**.[14]

The water utility's most recent annual water loss audit provides some additional information on costs and benefits associated with water loss control. The utility's water audits have showed economically recoverable rates of actual loss (i.e., leakage), prompting the utility to set a target of reducing leakage by about one-third from current levels (which already reflect a decline from historic highs). Current leak reduction efforts include a range of approaches that vary in complexity. Cost information is reported for one aspect of this program, which is more technologically complex than others, but the utility believes the higher costs pay off in avoided costs of catastrophic water main breaks. Specifically, for harder-to-find leaks, in large-diameter transmission piping, the utility used an acoustic inline leak detection technology to examine 42 miles of pipeline from 2007-2013. This leak detection method found **80 leaks over a 6 year period, at an average cost of $10,600 per leak detected. The audit report states: "It is very likely that some of [these] leak repairs have prevented catastrophic ruptures of large piping."**[15]

5. Georgia case study[16]

   a. Statewide programmatic and technical assistance costs

Over the last several years, Georgia has leveraged **approximately $1.9 million in Drinking Water State Revolving Fund (DWSRF) monies** (from the 2% small system set-aside and the 15% local assistance set-aside), **along with pro-bono assistance from professional associations**, to implement a training and technical assistance program for utilities, including a training manual, detailed data validation of all submitted water audits, and advanced leak detection and water meter testing.

- The Environmental Protection Division (EPD) of the state's Department of Natural Resources developed a state water loss manual, modeled on the AWWA M36 manual, and drawing from consultations with other states (including Texas) that had already developed similar manuals and programs. The manual was largely compiled by pro-bono assistance from Georgia's AWWA section. The state DWSRF program provided an estimated $20,000 to the Georgia Association of Water Professionals (GAWP) for facilitation of this effort. Two years after the initial manual was released, GAWP provided pro bono work to update the manual. (See GAWP resources at http://www.gawp.org/?page=WaterLossAudits.)

- EPD, in partnership with GAWP, hosted a series of workshops for the large utility systems serving over 10,000 customers. The total cost was an estimated $15,000 to hold five full-day workshops, drawn from the DWSRF 15% local assistance set-aside.

- After the first round of large system audits, it became clear that data validation was needed to address widespread anomalies. EPD used $110,000 from the DWSRF's 15% local assistance set-aside for a contract with three private firms who are experts in the field of water loss auditing, and for other costs associated with validation of data from 107 large systems. In 2014, EPD conducted the same data validation process for all small and large utilities for their 2012 and 2013 audits, at a cost of approx. $350,000, funded from a combination of the DWSRF's 15% local assistance set-aside and 2% small systems set-aside.

- To roll out the program with smaller utilities (3,300-10,000 customers), EPD used $500,000 from the DWSRF's 2% small system technical assistance set-aside to retain a consulting firm, which led a 10-month utility training and data validation program.

- EPD is using an additional $1,000,000 from the DWSRF's 2% small system technical assistance set-aside for contractors to assist approximately 100 small water systems, in two sequential phases, with advanced customer water testing, leak detection, and finished water meter testing.

Although the water loss audits are mandatory, EPD worked to ensure utilities did not perceive it simply as an unfunded state mandate. EPD presented it as a step forward in water infrastructure efficiency and provided a technical manual and ongoing technical assistance to each utility, as well as education through conferences, public information meetings and workshops to help utilities understand the benefits they can realize by engaging in the process. EPD also partnered with the Georgia Association of Water Professionals (a state affiliate of several national trade associations, including AWWA, the Water Environment Federation, and the American Water Resources Association) to enable utilities to convene with one another, see and hear the tangible benefits, and share learning lessons and information.

b. Technical assistance to small utilities for meter testing and leak detection

A state-funded technical assistance program provided in-the-field water loss control assistance, over the course of two phases, to 98 participating utilities. These were all small systems serving between 3,300 to 10,000 population, but the state's consultant believe the results described below would be applicable to many larger systems.

Three project types were performed:

1. Finished Water Meter Testing/Verification: This is not a water loss control activity (*i.e.*, an intervention). Thus, in a narrow sense, it is not an activity with a "return on investment" (ROI). But it is an essential activity to improve the reliability of the water loss audit. If unknown errors exist in the supply numbers, then the true loss levels will remain uncertain, and the utility can neither make fully informed decisions on corrective actions, nor gauge the effectiveness of those actions.

2. Customer Meter Testing/Repair: This activity functions both as an improvement in audit reliability <u>and</u> a corrective action. This activity can have an ROI.

3. Pilot Leak Detection: This functions as a corrective action. This activity can have an ROI.

The results of each category of projects are summarized below.

"Finished water" meter testing: Of the 73 finished water meters (*i.e.*, meters that measure water produced by drinking water treatment plants) examined at 30 utilities, <u>half</u> failed to pass AWWA's recommended accuracy specification for in-service meters. Of those that failed, the average error (*i.e.*, under-counting of water) was 17% inaccuracy. Another <u>third</u> of the meters could not be tested, due to inadequate piping configurations, which calls into question the reliability of the existing Finished Water Meter measurements in those situations. **The typical cost to verify a finished water meter is a few thousand dollars.**

Commercial meter testing: For 25 participating utilities:

- Failure rate for the customer meters was 42%, with the average error (*i.e.*, under-counting of water) of those failures being 22% inaccuracy. That means one-quarter of the water delivered to high volume customers is not being measured or billed.
- ROI calculations were not performed as part of the project, but one might look at it, on an individual system basis, as follows:
    - A large meter customer is typically commercial or industrial; from a revenue perspective, that could range from, for example, $1,000 per year for a small to mid-sized retail establishment to $1,000,000 per year for a very water intensive industrial facility (*e.g.*, a bottled beverage producer).
    - For many utilities, a significant share of commercial/industrial large meter customers generate at least $10,000 in annual revenue each. Applying Georgia's observed meter error frequency (42%) and inaccuracy (22%), correcting the metering error for all accounts with annual water bills of at least $10,000 would yield at least $924 recovered revenue per account annually ($10,000 x 0.42 x 0.22). The typical test and repair cost is for a large meter less than $1,000. **This yields a payback period to the utility of about 1 year or less for testing and**

repairing the meters of all customers with annual water bills of at least $10,000.

Pilot leak detection results: 800 MG/yr of leaks were found and fixed, yielding **direct savings (energy and chemical costs for drinking water treatment) of about $500,000 annually**. The **one-time cost of this leak detection was about $410,000**. (Repair costs are presently unavailable. But it can be safely assumed that the utilities found it in their interest to make the repairs.)

Key contacts for leading state programs

State agency contacts for additional information about the Georgia and Tennessee programs can be found here:

Georgia

http://www.conservewatergeorgia.net/documents/water_loss_audits.html

https://epd.georgia.gov/ga-water-system-audit-and-water-loss-control-manual

https://gefa.georgia.gov/sites/gefa.georgia.gov/files/related_files/press_release/1mil%20Grant%20Program%20Water%203.2.2012.pdf

Tennessee

http://www.comptroller.tn.gov/umrb/ (Click on "Contact the Board")

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[1] See NRDC, *Using State Revolving Funds to Build Climate-Resilient Communities* (2014), http://www.nrdc.org/globalwarming/state-revolving-funds.asp.

[2] Benefits for wastewater utilities include: (i) reduction of infiltration of leaking drinking water into wastewater collection systems, which results in unnecessary pumping and treatment costs for the wastewater utility; and (ii) reduction in water demand resulting from the conservation incentive created by accurate billing of drinking water customers (*i.e.*, reduction in "apparent losses"), which in turn reduces customer flows into the wastewater system. See NRDC, *Waste Less, Pollute Less* (2014), http://www.nrdc.org/water/clean-water-act-urban-conservation.asp.

[3] EPA, "Water Audits and Water Loss Control for Public Water Systems" (2013), p. 1, http://water.epa.gov/type/drink/pws/smallsystems/upload/epa816f13002.pdf.

[4] http://www.awwa.org/store/productdetail.aspx?productid=39311984

[5] http://www.awwa.org/home/awwa-news-details/articleid/2641/awwa-free-water-audit-software-version-5-0-now-available.aspx

[6] For example, see an archived 2014 EPA webinar on water loss audits here: http://www.epa.gov/region9/waterinfrastructure/waterlosscontrol/index.html.

[7] http://www.dnr.illinois.gov/waterresources/documents/lakemichigano-2form_2012.pdf.

[8] Delaware River Basin Committee, Water Management Advisory Committee, Meeting Summary (June 16, 2015), http://www.nj.gov/drbc/library/documents/WMAC/06162015/wmac_june15.pdf.

[9] For example, following the top-down audit, the AWWA M36 recommended best practice is to undertake "component analysis" of leakage. The Water Research Foundation has also a free tool (WRF 4372) that utilities can use to do this. Following this, M36 best practices move to 'bottom-up' validation activities, which accomplish 3 things:

1) They improve the reliability of the audit to a level sufficient to justify basing spending decisions.
2) They provide supplemental data necessary to determine economic targets.
3) They provide supplemental data necessary to develop strategy to achieve/maintain economic targets.

Bottom-up activities include finished water meter verification, customer meter testing, billing data analytics, night flow and pressure measurements. The cost of performing bottom up activities will vary widely, dependent upon system size and complexity. It can be anywhere from just a few thousand dollars to hundreds of thousands for a range of most systems.

[10] EPA, *supra* note 2, p. 1.

[11] Information about this program is taken from a water loss study prepared by Southern California Edison electric utility, which summarized a case study contained in the 2nd Edition of the AWWA Water Loss Control Manual (2002). The Southern California Edison Study is available here http://docs.nrdc.org/water/files/wat_14021401a.pdf.

[12] See http://www.comptroller.tn.gov/wwfb/.

[13] Baird, G., "Who Stole My Water? The Case for Water Loss Control and Annual Water Audits," *Journal AWWA* (Oct. 2011), http://www.agingwaterinfrastructure.org/SiteResource/Site_109155/Customize/Image/file/Management_Conservation_Leak_Water_Audits/AWWA%20October%202011%20Who%20Stole%20My%20Water%20The%20Case%20for%20Water%20Loss%20Control%20and%20Annual%20Water%20Audits.pdf

[14] Environmental Financial Advisory Board, "Water Loss Reduction Financing Mechanisms for Drinking Water Distribution Systems" (2010), http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P100AAA5.txt.

[15] Philadelphia Water Department – Water Revenue Bureau, "Water Audit Report for Fiscal Year 2013," p. 4, http://docs.nrdc.org/water/files/wat_14111801ao.pdf.

[16] Information on Georgia's program is from: Center for Neighborhood Technology, "Stepping Up Water Loss Control: Lessons from the State of Georgia" (2014) http://www.cnt.org/sites/default/files/publications/CNT_GeorgiaWaterStewardship.pdf; and pers. comm. with Will Jernigan of Cavanaugh & Associates, the principal consultant to EPD on this program. Links to official information on Georgia's program can be found at www.gawp.org/?page+WaterLossAudits.