

Tech Brief

A NATIONAL DRINKING WATER CLEARINGHOUSE FACT SHEET

Leak Detection and Water Loss Control

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Summary

Utilities can no longer tolerate inefficiencies in water distribution systems and the resulting loss of revenue associated with underground water system leakage. Increases in pumping, treatment and operational costs make these losses prohibitive. To combat water loss, many utilities are developing methods to detect, locate, and correct leaks.

Old and poorly constructed pipelines, inadequate corrosion protection, poorly maintained valves and mechanical damage are some of the factors contributing to leakage. One effect of water leakage, besides the loss of water resources, is reduced pressure in the supply system. Raising pressures to make up for such losses increases energy consumption. This rise in pressure makes leaking worse and has adverse environmental impacts.

Of the many options available for conserving water, leak detection is a logical first step. If a utility does what it can to conserve water, customers will tend to be more cooperative in other water conservation programs, many of which hinge on individual efforts. A leak detection program can be highly visible, encouraging people to think about water conservation before they are asked to take action to reduce their own water use. Leak detection is an opportunity to improve services to existing customers and to extend services to the population not served.



Photo by Eric Merrill

Shawn Menear, a graduate student in Technology Education at West Virginia University, uses geophones to listen for water main leaks. Similar to a doctor or nurse's stethoscope, geophones are an inexpensive leak detection device used by water utilities.

In general, a 10 to 20 percent allowance for unaccounted-for-water is normal. But a loss of more than 20 percent requires priority attention and corrective actions. However advances in technologies and expertise should make it possible to reduce losses and unaccounted-for-water to less than 10 percent. While percentages are great for guidelines, a more meaningful measure is

volume of lost water. Once the volume is known, revenue losses can be determined and cost effectiveness of implementing corrective action can then be determined.

Benefits of Leak Detection and Repair

The economic benefits of leak detection and repair can be easily estimated. For an individual leak, the amount lost in a given period of time, multiplied by the retail value of that water will provide a dollar amount. Remember to factor in the costs of developing new water supplies and other "hidden" costs.

Some other potential benefits of leak detection and repair that are difficult to quantify include:

- increased knowledge about the distribution system, which can be used, for example, to respond more quickly to emergencies and to set priorities for replacement or rehabilitation programs;
- more efficient use of existing supplies and delayed capacity expansion;
- improved relations with both the public and utility employees;
- improved environmental quality;
- increased firefighting capability;
- reduced property damage, reduced legal liability, and reduced insurance because of the fewer main breaks; and
- reduced risk of contamination.

Causes of Leaks

Water produced and delivered to the distribution system is intended to be sold to the customer, not lost or siphoned from the distribution system without authorization. Not long ago, water companies sold water at a flat rate without metering. As water has become more valuable and metering technology has improved, more and more water systems in the U.S. meter their customers. Although all customers may be metered in a given utility, a fairly sizable portion of the water most utilities produce does not pass through customer meters. Unmetered water includes unauthorized uses, including losses from accounting errors, malfunctioning distribution system controls, thefts, inaccurate meters, or leaks. Some unauthorized uses may be identifiable. When they are not, these unauthorized uses constitute unaccounted-for water. Some unmetered water is taken for authorized purposes, such as fire fighting and flushing and blowoffs for water-quality reasons. These quantities are usually fairly small. The primary cause of excessive unaccounted-for water is often leaks.

There are different types of leaks, including service line leaks, and valve leaks, but in most cases, the largest portion of unaccounted-for water is lost through leaks in the mains. There are many possible causes of leaks, and often a combination of factors leads to their occurrence. The material, composition, age, and joining methods of the distribution system components can influence leak occurrence. Another related factor is the quality of the initial installation of distribution system components. Water conditions are also a factor, including temperature, aggressiveness, and pressure. External conditions, such as stray electric current; contact with other structures; and stress from traffic vibrations, frost loads, and freezing soil around a pipe can also contribute to leaks. All water plants will benefit from a water accounting system that helps track water throughout the distribution system and identifies areas that may need attention, particularly large volumes of unaccounted-for water.

Leak Detection and Repair Strategy

There are various methods for detecting water distribution system leaks. These methods usually involve using sonic leak-detection equipment, which identifies the sound of water escaping a pipe. These devices can include pin-point listening devices that make contact with valves and hydrants, and geophones that listen directly on the ground. In addition, correlator devices can listen at two points simultaneously to pinpoint the exact location of a leak. (See the drawing on page 3.)

Large leaks do not necessarily contribute to a greater volume of lost water, particularly if water reaches the surface; they are usually found quickly, isolated, and repaired. Undetected leaks, even small ones, can lead to large quantities of lost water since these leaks might exist for long periods of time. Ironically, small leaks

are easier to detect because they are noisier and easier to hear using hydrophones. The most difficult leaks to detect and repair are usually those under stream crossings.

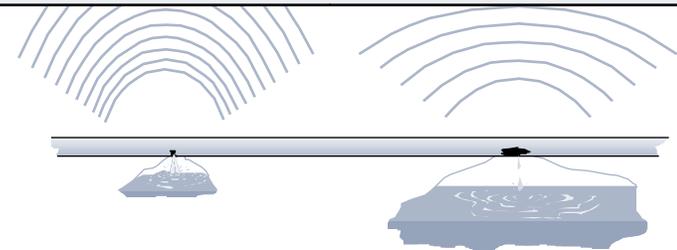
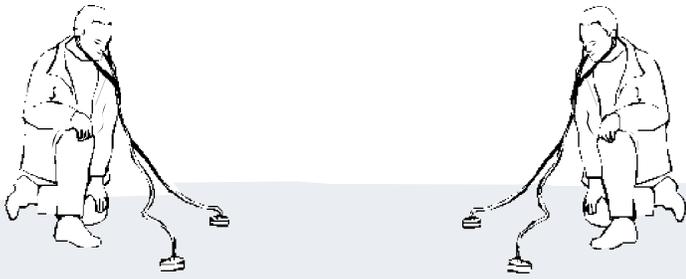
Leak detection efforts should focus on the portion of the distribution

Calculating Unaccounted-for Water

Unaccounted-for water is the difference between water produced (metered at the treatment facility) and metered use (i.e., sales plus non-revenue producing metered water). Unaccounted-for water can be expressed in millions of gallons per day (mgd) but is usually discussed as a percentage of water production:

$$\text{Unaccounted-for water (\%)} = \frac{(\text{Production} - \text{metered use}) \times 100\%}{(\text{Production})}$$

Listening for Leaks



An important goal of leak detection is to find exactly where a leak is located. Typically, the louder the noise, the closer you are to the leak. Small leaks under high pressure usually make more noise than larger leaks under low pressure. In fact, many large leaks make almost no sound whatsoever.

system with the greatest expected problems, including:

- areas with a history of excessive leak and break rates;
- areas where leaks and breaks can result in the heaviest property damage;
- areas where system pressure is high;
- areas exposed to stray electric current and traffic vibration;
- areas near stream crossings; and
- areas where loads on pipe exceed design loads.

Of course, detecting leaks is only the first step in eliminating leakage. Leak repair is the more costly step in the process. Repair clamps, or collars, are the preferred method for repairing small leaks, whereas larger leaks may require replacing one or more sections of pipe.

On average, the savings in water no longer lost to leakage outweigh the cost of leak detection and repair. In most systems, assuming detection is followed by repair, it is economical to completely survey the system every one to three years.

Instead of repairing leaking mains, some argue it is preferable to replace more leak-prone (generally older) pipes. Selecting a strategy depends upon the frequency of leaks in a given pipe and the relative costs to replace and repair them.

Deciding whether to emphasize detection and repair over replacement depends upon site-specific leakage rates and costs. In general, detection and repair result in an immediate reduction in lost water, whereas replacement will have a longer-lasting impact to the extent that it eliminates the root cause of leaks.

The most important factor in a leak detection and repair program is the need for accurate, detailed records that are consistent over time and easy to analyze. Records concerning water production and sales, and leak and break costs and benefits, will become increasingly important as water costs and leak and break damage costs increase and as leak detection and rehabilitation programs become more important. In order to optimize these programs by allocating funds in such a way that results in the greatest net benefits, adequate information is needed on which to base decisions and determine needs. Three sets of records should be kept: (1) monthly reports on unaccounted-for water comparing cumulative sales and production (for the last 12 months, to adjust discrepancies caused by the billing cycle); (2) leak-repair report forms; and (3) updated maps of the distribution system showing the location, type, and class of each leak.

Coordinating Leak Detection and Repair with Other Activities

In addition to assisting with decisions about rehabilitation and replacement, the leak detection and repair program can further other water utility activities, including:

- inspecting hydrants and valves in a distribution system;
- updating distribution system maps;
- using remote sensor and telemetry technologies for ongoing monitoring and analysis of source, transmission, and distribution facilities. Remote sensors and monitoring software can alert operators to leaks, fluctuations in pressure, problems with equipment integrity, and other concerns; and
- inspecting pipes, cleaning, lining, and other maintenance efforts to improve the distribution system and prevent leaks and ruptures from occurring. Utilities might also consider methods for minimizing water used in routine water system maintenance.

Beyond Leak Detection and Repair

Detecting and repairing leaks is only one water conservation alternative; others include: meter testing and repair/replacement, rehabilitation and replacement programs, installing flow-reducing devices, corrosion control, water pricing



policies that encourage conservation, public education programs, pressure reduction, requests for voluntary cutbacks or bans on certain water uses, and water recycling.

Where can I find more information?

Jeffs, C., C. Lloyd, and D. Pospishill. 1989. *An Introduction to Water Loss and Leak Detection*. Duncan OK: National Rural Water Association.

Mays, W. L. 2000. *Water Distribution Systems Handbook*. American Water Works Association. New York: McGraw-Hill.

Moyer, E. M. 1985. *Economics of Leak Detection: A Case Study Approach*. Denver: American Water Works Association

Pask, David. "50 Percent Loss? How to Detect Small Utility Water Leaks." *On Tap*. Winter 1993. Morgantown WV: National Drinking Water Clearinghouse.

U.S. Environmental Protection Agency. 1998. *Water Conservation Plan Guidelines*. Washington, D.C.: Office of Water. EPA-832-D-98-001

For further information, comments about this fact sheet, or to suggest topics, contact Lahlou via e-mail at lahloum@hotmail.com.



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- Tech Brief: Disinfection, item #DWBLPE47;
- Tech Brief: Filtration, item #DWBLPE50;
- Tech Brief: Corrosion Control, item #DWBLPE52;
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- Tech Brief: Organics Removal, item #DWBLPE59;
- Tech Brief: Package Plants, item #DWBLPE63;
- Tech Brief: Water Treatment Plant Residuals Management, item #DWBLPE65;
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- Tech Brief: Ozone, item #DWBLPE84.
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