Tech Brief

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Repairing Distribution Line Breaks

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Summary

Occasionally, water systems encounter situations where they must repair distribution system pipes. Corrosion and tuberculation (i.e., buildup of sediment, dirt, or rust) may have caused small leaks in the lines, or worse, a major line break may occur, creating an emergency situation. This Tech Brief *discusses ways to manage these situations and outlines steps a utility may take to repair the distribution system.*

What causes pipes to break?

Distribution lines can break for a variety of reasons. Excessive weight, such as increased traffic continuously running over a buried pipe, can trigger a line break. Also, extremely cold temperatures can cause breaks because when water freezes, it expands. But environmental conditions are not the only reason a line may break.

Sometimes utility workers may unknowingly install pipes that have defects from the manufacturing process, and they are not strong enough to handle high-pressure surges. Consequently, the pipes may split or crack. Other times pipes may not have been properly installed into the trench, creating a situation where it's only a matter of time before a line bursts.

Corrosion and tuberculation are two more reasons that pipe can rupture. Corrosion may cause breaks or leaks because acidic conditions can cause pitting or holes in a metallic pipe. In addition, tuberculation can cause high-pressure pockets in some areas of pipe, because water that's under pressure may not be able to easily move beyond the area of buildup.

When are repairs needed?

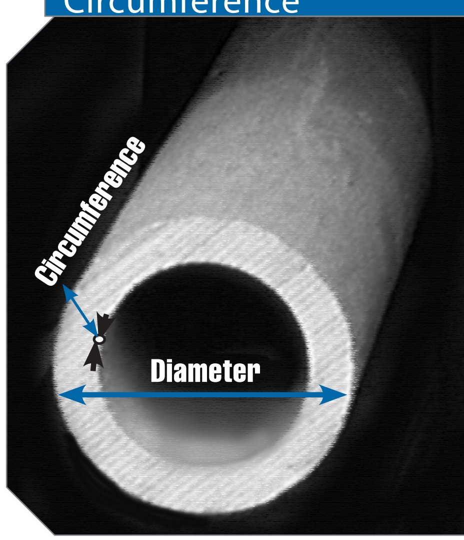
Over time, even small leaks can waste a substantial amount of water, which is expensive. When water system personnel detect a leak, they should repair it immediately—no matter how small it is.

When water comes out of the ground, it is obvious a leak exists nearby and its location is fairly easy to determine. However, scheduling periodic leak detection exercises helps water systems determine where and when they should make repairs in situations that aren't so obvious.

Because most leaks are not visible, all a utility worker may know is that the system is losing water. Someone then has to find the leak. This involves using listening devices, such as Geophones® or other electronic equipment. (For more information about leak detection, see the *Tech Brief* in the Spring 2001 *On Tap*, and the article, "On the Trail of the Elusive Water Leak" in the Summer 2003 *On Tap*.)

One of the best ways to trace water loss is to

Figure 1 - Calculating Diameter from Circumference



This diagram shows how to measure the diameter for a clamp.

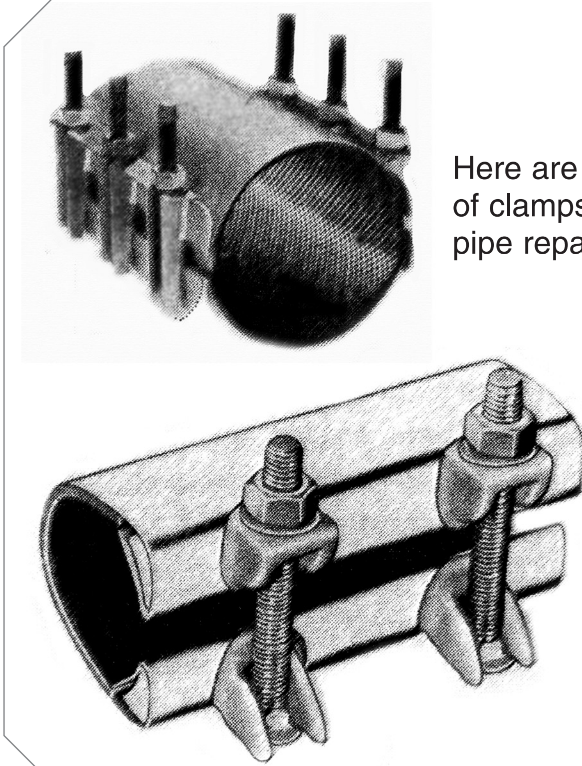
Circumference = 3.14 x Diameter

$$\text{Diameter} = \frac{\text{Circumference}}{3.14}$$

Source: *Water Transmission and Distribution*, AWWA, 2nd Edition conduct a water audit. A water audit helps systems keep unaccounted for water loss to the recommended 15 percent or less of the total water a system produces. Conducting a water audit and following up on the results can help the utility control its water losses. (For more information about water audits, see the Fall 2002 *On Tap* article, "The Economics of Water Loss: What is unaccounted for water?")

To conduct a water audit, utility workers will need to take flow measurements over a 24-hour period. This task will require pressure gauges. Utility workers also should make sure to check meters on main lines first to see if they are accurate and calibrated. As water flows from main lines into smaller lines, utility workers take flow measurements at a number of points in the smaller lines. Large, unaccounted for nighttime flows indicate a leak.

Figure 2 - Types of Clamps



Here are two types of clamps used in pipe repair.

Source: *Water Transmission and Distribution*, AWWA, 2nd Edition

Emergency Repairs

Sometimes leaks aren't small. Sometimes they gush. If a main breaks, utility workers must repair it immediately. To avoid too much stress, utilities need to have a plan of action ready that details the necessary equipment, personnel, and procedures. This plan is usually referred to as an emergency response plan (ERP) and should involve law enforcement, fire protection, and city officials because utility personnel must first figure out if the leak poses a hazard to life or property.

As soon as a major break is detected, utility workers should notify customers that their water will be turned off while workers make repairs. Valves must first be shut off in the area to isolate the break and to prevent further water loss.

More often than not, valves can become hard to close or may even break if they are not used on a regular basis. Systems should have regular valve-exercising and hydrant-flushing programs to alleviate this problem. (For tips about developing a valve-exercising program, see the article, "Why bother with a valve-exercising program?" in the Winter 2004 *On Tap*. For more information about hydrant flushing, see "Fire Hydrant Operation and Maintenance," in the Fall 2002 *On Tap*).

If possible, repair the leak without shutting off the entire water supply. ***Figure 1*** shows a section of a distribution system with an arrangement of four valves. The leak is near a corner before valve 2. Water flow is from left to right through the loop. When making repairs, close valve 4, valve 3, and valve 2, keeping valve 1 open till the very last minute. Valve 1 is then closed slowly. Utility workers then make repairs on the leak and turn the water back on immediately. Closing the valve nearest the leak at the last minute allows the line to remain under pressure, preventing back siphoning and back pressure that can cause contaminants to get sucked in through the leak.

If, however, the valves cannot be opened and, consequently, the water cannot be turned off, one practice is to open several fire hydrants in the area. While this method will not stop the water, it will lower the water pressure enough that utility workers can repair the leak. Once the repairs have been completed, workers then slowly turn the water back on. Turning the water back on slowly ensures that water hammer will not become a problem.

Water hammer is a hydraulic shock that happens when a sudden change in velocity occurs, such as quickly closing a valve. Shock waves occur within the pipes, which travel back and forth and cause a "bang" within the pipe. This bang is the hammer that can cause pipes to burst. (See the *Tech Brief* about water hammer in the Winter 2003 *On Tap*.)

When a line is under pressure, less probability exists for contaminants to get in through the break. But if contamination does occur, the utility should take the appropriate actions to inform the public through local radio, TV, or other new service. Notification should outline steps customers can take to be sure their water is safe. In case of an emergency, utilities should refer to their ERP that should specifically outline what they need to do. For example, they also may need to notify state primacy agencies, depending upon what level of action they need to take.

Digging Up the Pipe

Once utility workers detect the leak, they have to dig up the pipe. The trench must be parallel to the pipe on both sides and be deep enough that a person can work around the pipe to repair it. Workers must calculate the trench's depth and width based on pipe size. Water will collect in the pit and will have to be pumped out.

Utility workers also should remember that it's an Occupational Safety and Health Administration (OSHA) rule to shore the trench if it's five feet or deeper—or less than five feet if the conditions warrant it, such as extremely sandy or muddy soil.

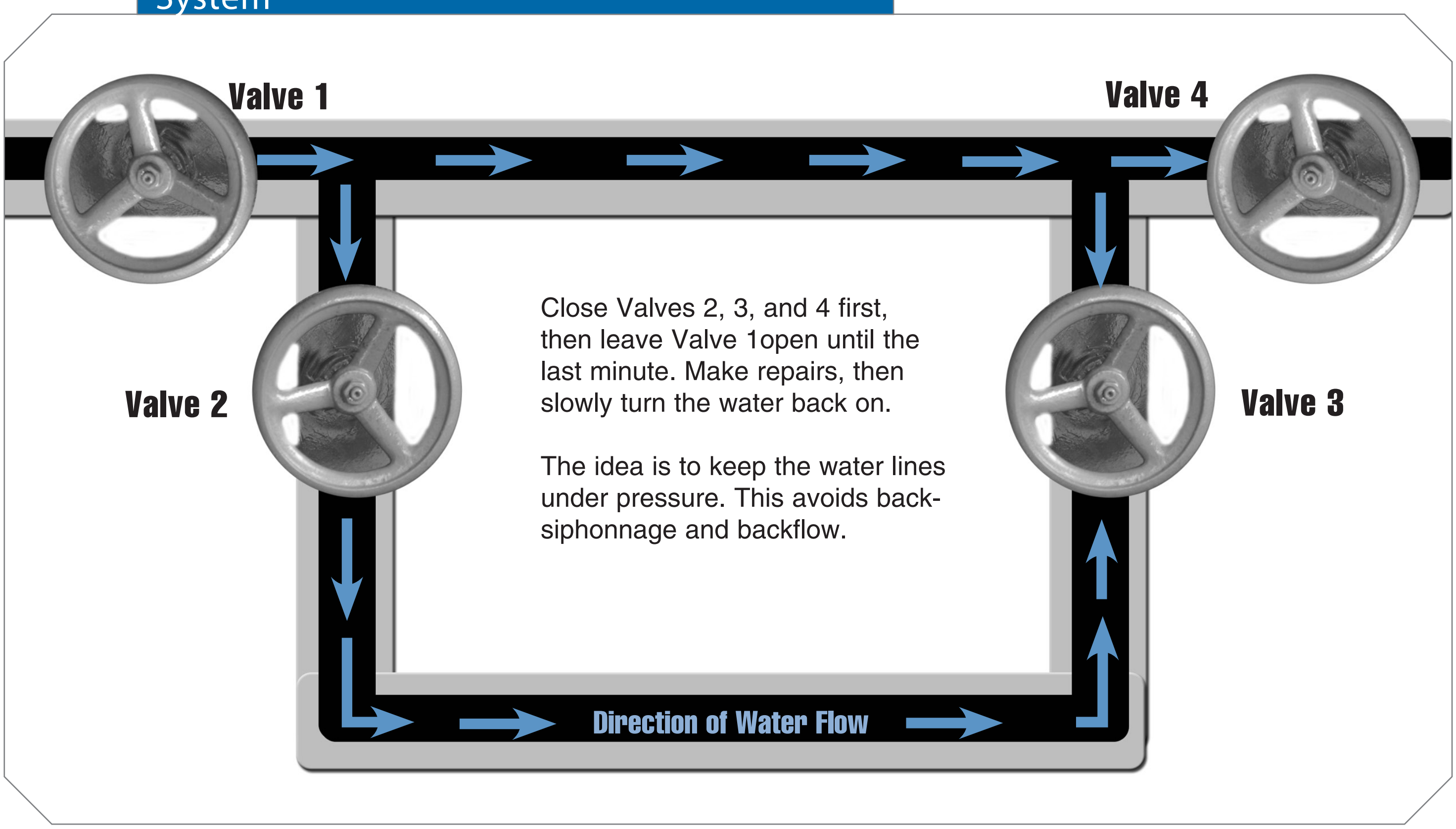
Repair Method

If the break in the pipe is very large, that portion of the pipe will have to be cut off and a new section put in place. Cutting a pipe re-quires saws, pipe cutters, welding equipment
(if the pipes are made of steel), pipe wrenches, couplings, and other hand tools.

If the break in the pipe is small, such as a rupture across the pipe, utility workers can wrap a flexible clamp or sleeve on it, which acts like a bandage for the pipe. Wrapping a coupling around the pipe, which is a device that holds two separate pieces of the pipe together in a "covering" device, is another way to repair a small break. (See ***Figure 2***.)

A clamp installed on the pipe has a gasket (usually made of rubber) that covers the ruptured section and helps to maintain a secure fitting. There is an arrangement of screws (preferably stainless steel) that are tightened around the clamp. Utility workers will need to clean and scrape corrosion and dirt from the

Figure 3 - Overhead View of a Distribution System



Source: *Operator Basics* CD, Montana Water Center pipe surface and then disinfect it with bleach. In addition, they should measure the outside circumference of the pipe to determine the exact diameter of a coupling. (The diameter is equal to the circumference divided by 3.14159.)

After the pipe is repaired, workers should turn on the water slowly to check if there are any remaining leaks. The trench is typically covered with filling material, such as sand, crushed stone, or processed material, and compacted. The workers should ask system customers to turn on their taps and allow the water to run for some time because the water may or may not have sediment in it.

Being Prepared

A water utility should have an emergency vehicle, such as a pickup truck, stocked with essential tools, including pipe cutters, wrenches, shovels, traffic control equipment, barricades, flashers, cones, and flashlights. This preparation will save time in an emergency. They should keep the truck's gas tank full and not loan out tools or equipment. Qualified individuals should be on call for emergency response at all times, including scheduled holidays.

Laying New Pipes

In some situations, a utility may have to re-place an entire pipeline. New pipes may have to be hauled in and installed. Care must be taken to prevent pipes from breaking during shipping or storage, and the pipes must be installed correctly. Approvals or permits from the relevant state or local agency must be obtained before starting a new project.

Pipes should be placed where they will be installed before digging out the trench. One end of a pipe is shaped like a bell, and the other end is straight. Pipes are joined together straight end into bell end and secured with a gasket. Pipes should have their bell-shaped ends placed in the direction in which the installation of the pipe will proceed.

Excavating the earth to install pipes is the most expensive part of many replacement projects. Before beginning the repair project, other utility installations, such as sewer and gas lines, must be located. In addition, utility workers must notify nearby property owners and the general public.

Once the project is underway, utility workers must:

- determine the trench's width according to the pipe size required,
- lower pipes carefully into the trench using ropes,
- dig out additional soil at the bell ends so that the pipe is supported along its entire length, and
- add some backfill material or bedding to the trench to support the pipe.

Pipes have gaskets on the bell-shaped ends. When laying new pipelines:

- the gasket must be clean, and
- pipes must be pushed all the way into the bell of an adjoining pipe to make a tight fit.

Completing Repairs

Once workers have completed repairs, they should turn the water back on and check for leaks before backfilling the trench. The new lines should be disinfected and thoroughly flushed to remove all sediment and dirt.

According to the American Water Works Association's standards, water samples should be taken every 1,200 feet following a new installation. Samples must be bacteria free before the line can be put back into service. Workers should be sure to keep a record of where the repair needed to be made and its cause.

Where can I find more information?

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