United States Environmental Protection Agency

Using DWSRF Funds for Transmission and Distribution Infrastructure Needs

The Drinking Water State Revolving Fund (DWSRF) program was established by the 1996 Safe Drinking Water Act (SDWA) Amendments and authorizes grants to states to capitalize revolving loan funds. The states provide low-interest loans to eligible systems for infrastructure improvements needed to ensure compliance with the SDWA and protect public health. The DWSRF program can play a significant role in helping systems, especially small systems, meet the challenges of complying with drinking water standards.

According to the Environmental Protection Agency's (EPA's) 1999 Drinking Water Infrastructure Needs Survey, the total 20-year need for transmission and distribution projects is $83.2 billion. Transmission and distribution system needs account for more than half of the infrastructure investments needed nationwide. This reflects the reality that the bulk of a water system's assets are the pipes that move raw water from the source to the treatment plant and distribute treated water to the consumer. Transmission and distribution pipes that should be replaced, rehabilitated, or enlarged are a serious threat to public health. Rehabilitating and replacing transmission and distribution infrastructure can be costly. The DWSRF can provide assistance to systems to help ease this burden, increase compliance, and protect public health.

WHAT IS THE CHALLENGE FACING AMERICA'S TRANSMISSION AND DISTRIBUTION SYSTEMS?

89% of water systems serving more than 10,000 people believe they should rehabilitate or replace their pipes more often

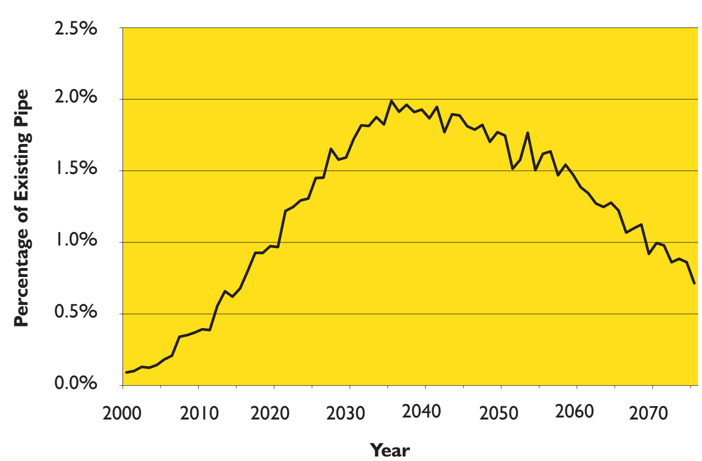
The nation's transmission and distribution systems are aging and deteriorating. Pipes have life cycles that can range from 15 to over 100 years. The majority of the nation's estimated 2 million miles of transmission and distribution pipes were laid after the 1960s. As the pipes age, replacement needs will increase (see Figure 1).

"Out of sight, out of mind" can explain why many water systems have neglected their transmission and distribution systems. Unlike treatment plants and storage tanks (which are a central focus for systems trying to meet applicable maximum contaminant levels (MCLs)), sub-surface pipe networks tend to receive little attention until they fail. When a main breaks and disrupts service, the distribution system typically receives emergency localized maintenance around the failure. These "patches" do little to address a system's long-term transmission and distribution problems.

Most water systems have a general idea of the condition of their delivery network, but detailed evaluation is time-consuming and technologically challenging, especially for older systems. Pipes do not deteriorate at a constant rate. During the initial period following installation, the deterioration rate is relatively slow. As pipes near the end of their life cycle, they begin to deteriorate more rapidly, dramatically increasing the repair and upkeep expenses. In addition, the rate of deterioration of a distribution system is not solely a function of age, but rather a combination of factors including the characteristics of the water, soil conditions, and climate. Some Eastern cities in the United States have well functioning, unlined cast iron pipes that are over 200 years old. Other communities' cast iron pipes may last less than 20 years.

The purpose of transmission and distribution infrastructure is to convey sufficient quantities of water to consumers while keeping the water free from new sources of contamination. When a pipe ruptures or a valve does not close properly, the pressure of the system can drop and intrusion of contaminants can occur, putting water consumers at serious risk. Even well-run water systems with relatively new distribution systems can experience water main breaks.

Figure 1: Projected Annual Percentage of Transmission Lines and Distribution Mains Requiring Replacement, 2000 - 2075



Source: *EPA Clean Water and Drinking Water Infrastructure Gap Analysis, 2002.*

HOW DOES A TRANSMISSION AND DISTRIBUTION SYSTEM FAIL?

A transmission and distribution system fails when the system is no longer able to transport water or potable water degrades to the point at which the health of consumers is threatened. There are several means by which the transmission and distribution system can fail (see Exhibit 1):

1. External contamination from intrusion and permeation.
2. Contamination from transmission and distribution pipes.
3. Contamination from cross-connections and backflow.

Two major pipe breaks caused an outbreak of *E. coli* in Cabool, Missouri from December 1989 to January 1990. Four people died and another 240 became sick from the distribution system failure.

Exhibit 1: Causes of Transmission and Distribution System Failures

FAILURE	DEFINITION	CAUSES/SOURCE	CONTAMINATION
External Contamination			
Intrusion	The flow of nonpotable water into mains through leakage points, submerged air valves, faulty seals, or other openings. The volume of intrusion can range from milliliters to hundreds of gallons.	• Main breaks • Sudden changes in water demand or flow • Uncontrolled pump starting or stopping • Opening and closing of fire hydrants • Power failures • Fire flow (in systems with inadequate storage or supply) • Faulty joints • Pipes below the water table • Improper water main installation or repair	• Microbiological • Chemical • Excess disinfectants • Loss of disinfectant residual • pH & alkalinity instability
Permeation	The passage of external contaminants through porous plastic pipe.	• Interaction of plastic pipes with substances in the external environment • Stagnation of water in localized areas	• Volatile organic contaminants • Vinyl chloride • pH & alkalinity instability
Contamination from Infrastructure			
Leaching	The dissolution of metals, solids, and chemicals into drinking water.	• Aggressive water reacting with pipe linings • Stagnation of water in localized areas	• Metals • Asbestos
Nitrification	Oxidation of nitrogen compounds to nitrate or nitrite.	• Use of chloramines • Presence of nitrifying bacteria and ammonia • Stagnation of water in localized areas	• Nitrite and nitrate • pH & alkalinity instability • Loss of disinfectant residual • Biofilm growth
Corrosion	External or internal deterioration of the chemical integrity of the piping material.	• Microorganisms • Reactions of pipe lining with water • Stagnation of water in localized areas	• Chemical • Biofilm growth
Contaminations from Cross-Connections and Backflow			
Cross-Connections	Points in the distribution system where nonpotable water can come into contact with potable water, providing a pathway for backflow of nonpotable water into potable supplies.	• Connection of heating/cooling, waste disposal, or industrial manufacturing systems to potable water supplies when the pressure in the external system exceeds the pressure in the distribution system • Intentional contamination	• Microbiological • Chemical • Excess disinfectants • Loss of disinfectant residual • pH & alkalinity instability • Biofilm growth
Backflow	Either reduced pressure in the distribution system (backsiphonage) or the presence of increased pressure from a nonpotable source (backpressure) that reverses the flow so nonpotable water flows into the potable water system.	• Main breaks, pump failure, firefighting, or opening fire hydrants for recreation in a system with inadequate storage or supply • Improperly operating valves, loose-fitting service meter connections, surge or feed tank draining, a sudden change in demand, hilly terrain, limited pumping capacity, high customer demand, and power loss • Pressure transient (also called surge or water hammer) • Intentional contamination	

WHAT PUBLIC HEALTH THREATS ARE CREATED BY SYSTEM FAILURES?

Contamination introduced into the transmission and distribution network can cause many problems for a water system. EPA has published several National Primary Drinking Water Regulations (NPDWRs) that address public health issues related to potential chemical and microbial contamination in the distribution system, including the Total Coliform Rule, the Lead and Copper Rule, the Surface Water Treatment Rule, and the Stage 1 Disinfectants and Disinfection Byproducts Rule.

The most acute threat from transmission and distribution system failure is that old pipe, weak and brittle from hard-to-detect internal or external corrosion, will break, causing the pressure in the distribution system to plummet. Any break or leak in a distribution system can potentially draw chemical and microbial contaminants into the distribution system. Sewer pipes are often installed adjacent to drinking water mains. Even short periods of exposure to acute contaminants, like bacteria and viruses, can threaten public health. From 1981 to 1998, the Centers for Disease Control documented 57 waterborne disease outbreaks related to cross-connections, resulting in 9,734 illnesses. The American Water Works Association estimates that 78% of all waterborne disease outbreaks in recent history were caused by cross-connections and backflow.

Williamsburg, Pennsylvania

The Borough of Williamsburg has served its residents and parts of neighboring Woodbury and Catherine Townships with its water system for more than 90 years. In the 1980s, two reservoirs used by the system had to be abandoned due to Giardia contamination and the poor condition of the system's transmission lines. Even after the reservoirs were abandoned, the existing lines remained undersized and in poor condition, resulting in pressure, flow, and leak problems in some areas. In May 1997, Williamsburg received a $4.2 million DWSRF loan. The project included the installation of a booster pumping station, new storage tank, eight miles of mains, and the replacement of every meter in the system. The project was completed in 1998.

WHAT INFRASTRUCTURE INVESTMENTS ARE NEEDED?

Clinton, Oklahoma

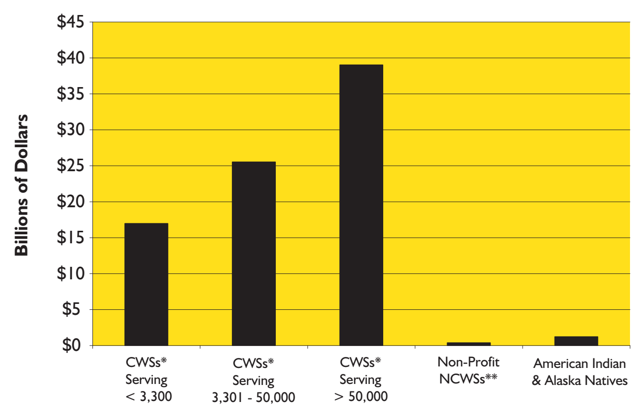
Many homes in the six subdivisions served by the Clinton Public Works Authority were served by cast iron, dead end lines with leaded joints. Clinton's problems included inadequate water availability, stale water caused by dead-ends, and lead contamination. A $644,000 DWSRF loan financed the majority of the project, which included: replacing existing substandard lines with new PVC water lines; constructing a loop trunk line to supply the area; and replacing fire hydrants, valves, and appurtenances.

The 1999 Drinking Water Infrastructure Needs Survey determined that water systems need to invest $83.2 billion by 2018 to improve the nation's drinking water transmission and distribution infrastructure (see Figure 2). Transmission and distribution infrastructure accounts for more than 55% of the total water infrastructure investment needed nationwide. At least $65.6 billion is needed immediately to rehabilitate or replace pipes to adequately protect public health. As water systems modernize their treatment capability, they are becoming increasingly aware of the need to upgrade their distribution systems so that they can reliably deliver safe water. This attention should continue to increase—EPA estimates the transmission and distribution infrastructure need will be even greater after 2019 as more pipes and valves reach the end of their useful life.

Rehabilitating and replacing transmission and distribution infrastructure can be costly because of the difficulty in accessing pipes and valves that are below ground (and often under streets). The majority of water main replacement is still performed using open-cut or open-trench methods. These methods maximize the public burden both in terms of cost and public nuisance. Recent technological advances in trenchless technologies, which have become commonplace in Europe, are being considered by more water systems across the country because they minimize the need for excavation and can save 20 percent to 60 percent in overall costs.

Besides infrastructure investment, there are many other actions water systems can take to improve their transmission and distribution systems. Many threats can be minimized by modeling the transmission and distribution network to identify problem areas, inspecting the infrastructure for leakage and corrosion and the plumbing of customers for cross-connections, and properly selecting the materials used in the transmission and distribution system infrastructure. In addition, water systems can utilize tools such as facility improvement plans and asset management. By developing a comprehensive strategic plan, a water system can potentially improve the process for building, maintaining, and improving its transmission and distribution infrastructure.

Figure 2: Total Transmission & Distribution Infrastructure Need by System Size (in billions of 1999 $)



Source: *EPA 1999 Drinking Water Infrastructure Needs Survey, 2001.*
*CWSs = Community Water Systems
**NCWSs = Non-Community Water Systems

HOW CAN THE DWSRF ASSIST SYSTEMS?

States use DWSRF capitalization grant monies to provide low-interest loans to publicly- and privately-owned public water systems for infrastructure improvements needed to continue to ensure safe drinking water. States may offer principal forgiveness, reduced interest rates, or extended loan terms to systems identified by the state as serving disadvantaged communities. States also have the ability to reserve a portion of their grants (i.e., set-asides) to finance activities that encourage enhanced water system management and help prevent contamination problems through source water protection measures. Based on the Fiscal Year 2002 appropriation of $850 million, capitalization grants ranged from $8.0 million to $82.4 million per state.

Most capital projects needed to upgrade a transmission and distribution system—including replacing fragile water mains and worn-out valves—are eligible for funding under the DWSRF (see Exhibit 2). Consolidation and restructuring of systems can be a cost-effective option for small systems that need massive infrastructure investment. The DWSRF can fund consolidation, including situations where a system is unable to maintain compliance for technical, financial, or managerial reasons.

States can use set-aside funds from the DWSRF to assist systems directly as well as to enhance their own program management activities (see Exhibit 2). A state may use set-asides to make administrative improvements to the entire drinking water program, which faces increased costs in ensuring the integrity of transmission and distribution systems across the state. States can also train small systems on how to better manage and maintain their water delivery network, as well as provide technical assistance to help systems identify the most cost-effective upgrade strategy (i.e., replacement versus rehabilitation). In addition, states can provide assistance to small systems to cover the costs of project planning and design for infrastructure improvements.

Since the DWSRF program is managed by states, project and set-aside funding varies according to the priorities, policies, and laws within each state. Given that each state administers its own program differently, the first step in seeking assistance is to contact the state DWSRF representative, who can be found on the EPA DWSRF website.

Exhibit 2: Transmission and Distribution Projects/Activities Eligible for DWSRF Funding

Type of Project/Activity	Eligible Under Infrastructure Fund	Eligible Under Set-Asides
Treatment		
Pigging	Yes*	No
Lining	Yes**	No
Corrosion Control	Yes	No
Backflow Prevention Devices	Yes	No
Backup Power	Yes	No
Backup Pumps	Yes	No
Disinfectant Booster Stations	Yes	No
Flushing Hydrants	Yes	No
Surge Control Devices	Yes	No
Pump Replacement	Yes	No
Valve Replacement	Yes	No
Water Main Replacement	Yes	No
Water Main Expansion	Yes	No
Looping Dead-end Mains	Yes	No
Water Meters	Yes***	No
System Consolidation	Yes	No
System Restructuring	Yes	Yes
System Administrative Improvements		
Hire Staff	No	No
Staff Training	No	Yes
Public Outreach	No	Yes
Monitoring	No	No
Rate Increase Process	No	Yes
State Administrative Improvements		
Hire Staff	No	Yes
Staff Training	No	Yes
Public Outreach	No	Yes
Compliance Oversight	No	Yes
Enforcement	No	Yes
Pilot Studies	No	Yes
Sanitary Surveys	No	Yes
Distribution System Assessments	No	Yes

*Capital expenditures only.
** Structural lining only.
***Must be owned and maintained by system.

Vermont

Vermont used $150,000 in Fiscal Year 1999 DWSRF set-aside funds to contract with engineering firms to develop facility improvement plans for 79 small water systems that serve less than 500 people. On behalf of the state, a consultant helped Kountry Trailer Park, serving 44 mobile homes in the town of Bristol, identify ways to overcome the occasional bacteriological and pressure related problems from which they had been suffering. The consultant suggested installing several flushing hydrants, replacing sections of main, and working with the town to maintain an adequate disinfection residual at the park entrance. The consultant also documented the costs and helped identify potential sources of funding.

FOR MORE INFORMATION...

DWSRF Website:
http://www.epa.gov/safewater/dwsrf.html

Transmission & Distribution Fact Sheets:
http://www.epa.gov/safewater/tcr/tcr.html

General Information

SDWA Hotline
1-800-426-4791

EPA's Ground Water & Drinking Water Website:
http://www.epa.gov/safewater/

Office of Ground Water and Drinking Water (4606M)

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