The Underground Infrastructure Crisis: Rebuilding Water and Sewer Systems without a Flood of Red Ink

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Introduction: Valuable and Critical Assets

With a $12 trillion national debt looming, U.S. policymakers must insist on the most economical and durable products available to renew public infrastructure.

The life cycle of North America's electricity, water, sewer and transportation infrastructure is expiring simultaneously, according to a 2007 report.[1] Moreover, funding for all four will be required at the same time, representing a total estimated investment of $6.5 trillion for North America over the next 25 years. Some experts put this figure much higher.

Building and replacing water and sewage lines across the U.S. will on its own cost some $660 billion to $1.1 trillion over the next two decades.

To address these challenges, all levels of government will have to reexamine their practices and work more efficiently. In particular, municipalities will have to broaden procurement guidelines to include sustainable, longer-lasting and more cost-effective piping technologies. Pipe represents the single largest component of a utility's infrastructure assets and significantly impacts operations and maintenance costs, which are increasing by 6 percent annually above the rate of inflation.[2]

Washington can play a key role here by taking the lead with high-performance specifications for piping materials used by water and wastewater utilities, and on more competitive bidding as a precondition to allocating funds.

Moreover, federal legislators could facilitate this process by substantially amending S.1005, a measure currently before Congress designed to address water and wastewater infrastructure. In addition to reductions in wasteful or non-performing infrastructure programs, this bill should include stipulations to eliminate corrosion in piping systems, as well as improve their durability, minimize break rates, and reduce operating costs.

By opening municipal procurement and ensuring that more competitive bidding is tied to federal funds for underground infrastructure, the U.S. will save hundreds of billions of dollars in the short term. This would also pave the way to an economy that wastes less energy, utilities that are more efficient, and pipe networks with much longer life cycles.

Life Cycle Costs and Corrosion

A first step in this renewal process would be to consider the life cycle cost of different pipe materials when designing water and sewer systems, since it's essential to determining the performance of underground infrastructure.

Many things affect pipe performance: age, material type (cast iron, ductile iron, concrete, polyvinyl chloride [PVC], polyethylene, fiberglass, clay, etc.), soil conditions, topography and weather. Corrosion, however, is the most significant factor undermining the longevity of water utilities today.

According to the article, *Corrosion, not Age, is to Blame for Most Water Main Breaks*, corrosion is the leading cause of over 700 daily water main breaks throughout North America. Furthermore, a 2002 congressional study found that corrosion costs U.S. drinking water and sewer systems $50.7 billion annually in 2008 dollars.[3]

The total annual direct impact of corrosion in all sectors of the U.S economy is estimated at 3.1 percent of Gross Domestic Product – the most severely affected sector being water and wastewater.

The reason corrosion is so pervasive in North American water networks has to do with the pipe materials used over the last 100 years. At first, cast iron was used, then ductile iron. Both are now deteriorating as a result of corrosion. This has been the leading cause of water main breaks and the crisis in our underground infrastructure.

The former Mayor of Gloucester, Massachusetts has argued that the primary reason for increased water main breaks is the "simultaneous expiration of the useful life of water infrastructure installed at different times." He said this before a U.S. Senate Subcommittee during his March 2001 testimony on behalf of the National League of Cities. The newer the infrastructure, he noted, the more likely it is to be corroding and deteriorating.

A recent report on corrosion of buried pipes says that dealing with this problem will require nothing short of a paradigm shift in municipal infrastructure management. This study by the American Water Works Association Research Foundation (AwwaRF) urges water utilities to select pipes not only on the basis of their mechanical properties, but also on their resistance to corrosion. Doing otherwise, the report says, is irresponsible, since corrosion failure will happen with traditional pipe materials.

Federal government regulation has already tackled corrosion in the energy sector. For example, the Office of Pipeline Safety of the U.S. Department of Transportation has mandated tough requirements for corrosion protection on energy pipelines. Although policymakers should always avoid regulatory overreach, corrosion standards for water and wastewater systems could ultimately pay dividends for taxpayers.

A Solution to Corrosion

The burden of old-technology pipe materials is not limited to the cost of repairing and replacing failed pipelines. It also includes the cost of treated water leaking from the system. In most large U.S. cities, 1,000 annual water main breaks are common. For example, in Detroit, where 35 billion gallons leak from the water system each year, residents pay about $25 million annually for water that never reaches homes or businesses.

According to the American Society of Civil Engineers, leaking pipes lose an estimated 2.6 trillion gallons of drinking water every year, or 17 percent of all water pumped in the U.S. In many distribution systems, the amount of water lost or unaccounted for can be as high as 40 to 50 percent. This problem also wastes a great deal of energy.

Pumping water represents as much as seven percent of the U.S.'s total electricity consumption, or $24 billion annually. And $4.1 billion of this is wasted every year because of leaky and broken pipes. Worse still, as traditional pipe materials age and deteriorate through corrosion, water losses will increase – along with pumping costs.

A solution to corrosion exists. PVC pipe has been used in the U.S. since the 1950s, and according to the Environmental Protection Agency, plastic pipe has an unsurpassed resistance to corrosion.[4]

Installing PVC pipe could represent trillions of dollars in savings over the long term for the country if communities everywhere expanded its use. A 2007 Vinyl Institute study estimates the total yearly savings of PVC pipe currently used in the North American water and wastewater sector to be upwards of $4.2 billion.[5]

Unfortunately, prohibitive municipal procurement practices are hindering its wider adoption. And this is where Washington could again step in.

Cost-Effectiveness

In the past, the federal government has had an impact on the development and broader use of new piping materials. For example, in the 1950s the Department of Agriculture worked with the plastic pipe industry to develop engineering standards and specifications for irrigation systems. Today, PVC is the principal pipe material used in U.S. agriculture.

Moreover, in the 1960s, most rural communities in the U.S. lacked water distribution networks and were in desperate need of affordable, high quality pipe materials to develop them. Because of the long distances involved and lower tax bases, old-technology pipe materials were not cost-effective. So in 1965, the Farmers Home Administration expanded the urban water system specifications that had applied to rural areas, developing engineering standards that were more practical and economical. This opened the door for PVC, which had previously been excluded from bidding.

As a result, PVC rapidly became vital to rural water and wastewater systems because it satisfied the need for tough, durable, and corrosion resistant pipe. And there is no reason the same logic should not have applied in urban settings at the time, or today for that matter. What's more, these rural pipe systems are not succumbing to the costly ravages of corrosion deterioration. Shouldn't we learn from this positive experience?

Plastic pipe industry experts had argued in the 1960s that tougher federal standards regarding water and wastewater pipe material would not only promote greater use of PVC, it would also provide longer lasting and more cost-effective infrastructure to taxpayers. Leaving it up to public utility officials and engineers, who are generally slow to adopt new methods, would simply delay its broader use.

This dynamic is still in effect today and is reinforced by local decision-making and traditional business networks, which often act as barriers to competition and innovation.

A Sustainable Solution

The federal government again opened the door for PVC pipe in the 1970s, this time through the Water Pollution Control Act. This move tightened environmental regulations on inflow and infiltration, i.e., water entering sanitary sewer systems through poor connections, cracks or leaks.

Overloaded sanitary sewers can cause significant environmental damage and flooding in homes, as well as higher water treatment costs. By reducing inflow and infiltration, capital and operating expenditures can be lowered. This increases the lifetime-capacity of treatment facilities and wastewater systems.

As a result of more rigorous federal regulations in this area, municipalities receiving federal Construction Grants Program funding expanded their procurement specifications to allow pipe materials that met new environmental guidelines. These higher performance standards promoted the widespread adoption of more efficient and durable technologies like PVC pipe, reducing or eliminating inflow and infiltration altogether.

The annual savings derived from PVC pipe now used in sanitary sewer systems in the U.S. is estimated to be $270 million, or $1.5 trillion over the next 100 years. If the entire sanitary sewer infrastructure in the U.S. consisted of PVC, estimated annual savings would be $540-$810 million, while savings over the next century would be $3-$4.5 trillion.

A 2004 report presented in Milan showed that vinyl pipe installed 70 years ago in Germany could easily see its 170th anniversary. As well, an AwwaRF study recently quantified the life expectancy of PVC pipe at more than 110 years. According to the study, PVC failure rates increase gradually with age, rather than accelerating, as is the case with corrosion-prone metal pipes – making PVC pipe excellent for long-term asset management and sustainability.[6]

In the area of drinking water, sustainability requires efficient and long-lasting piping systems, so encouraging water utilities to use newer, truly green pipe technologies makes sense. PVC pipe is more efficient to manufacture: it takes 400 percent more energy to make concrete pressure pipe and twice the energy to produce iron pipe. Furthermore, PVC's light weight reduces transportation and installation costs, yielding additional greenhouse gas reductions.

Currently, only 45 percent of the largest 100 cities in the U.S. use PVC in their water distribution networks. In contrast, 85 percent use it for wastewater applications, partly as a result of tougher federal environmental guidelines adopted in the 1970s. Similar figures apply to small- and medium-sized cities.

Clearly, more rigorous performance standards in the drinking water sector would encourage more widespread adoption of PVC pipe.

Conclusion: More Competition Needed

Unfortunately, prohibitive municipal procurement is hindering the wider use of corrosion-proof materials like PVC. The durability, effectiveness and sustainability of our water systems would improve markedly if there was more competition for pipe materials in municipal bidding.

The reasons municipalities use to exclude PVC pipe range from the need to further "study" the material, a reluctance to try new technologies, to myths about performance. Yet it has been recognized by all required state, national and international agencies and standards organizations, and is used by thousands of municipalities worldwide. It should therefore be a mainstay of municipal bids.

There are no valid technical reasons why municipalities should exclude products like PVC pipe from their municipal infrastructure projects. Instead, with municipal budgets under stress, local decision-makers should be selecting the most durable, economical and corrosion-resistant materials possible.

Before simply pouring more dollars into infrastructure, U.S. policymakers must examine how to better spend the money already set aside for municipal water and wastewater initiatives. Trillions of dollars could be saved on future underground infrastructure renewal. A significant step in that direction would be to amend S. 1005 to ensure it includes measures to emphasize elimination of corrosion from America's water and wastewater networks and encourage a material bidding process that will deliver maximum value for taxpayers.

Sound management, smart planning, and cost efficiency will also demand that Washington call for open procurement policies as a key condition of any funds allocated to infrastructure.

In the coming years, public finances will be stretched beyond the breaking point. It is time municipalities removed barriers to innovation and efficiency and took advantage of corrosion-proof piping materials and their many attributes.

About the Author

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Notes

[1] Doshi,Viren et al., "Lights! Water! Motion!" *Strategy and Business*, Issue 46, Spring 2007.

[2] Water Infrastructure Network, *Clean & Safe Water for the 21st Century: A Renewed National Commitment to Water and Wastewater Infrastructure*, April 2000.

[3] U.S. Department of Transportation and the National Association of Corrosion Engineers: *Corrosion Costs and Preventive Strategies in the United States*, March 2002.

[4] U.S. Environmental Protection Agency, Office of Water (4601M), Office of Ground Water and Drinking Water Distribution System Issue Paper, *Deteriorating Buried Infrastructure Management Challenges and Strategies*, May 2002.

[5] American Chemistry Council and The Vinyl Institute, *The Economic Benefits of Polyvinyl Chloride in the United States and Canada*, December 2008.

[6] American Water Works Association Research Foundation, *Long-Term Performance Predictions for PVC Pipe, no. 2879*, 2005.