

the
infrastructure

is
collapsing!



**Concrete Pipe
Stays In Shape!**





ur infrastructure is deteriorating at an alarming rate. The recent rash of drainage system failures is cause for concern for many reasons, the least of which is major interruption to our public and private thoroughfares.

In addition, failures raise issues of public safety and liability. The stretched budgets of government agencies and private entities are causing many to scramble to find ways to meet their financial obligations. According to the Water Infrastructure Network, between \$300 and \$500 billion will be needed in the next 20 years to fix or replace city pipes nationwide. The general public is being hit with these costs in the manner of fees and taxes, not to mention the costs to the motoring public and industry due to delays in travel time at each occurrence.

The following table* identifies the known costs of some recent drainage structure failures. The use of a more durable pipe with a longer service life, such as Precast Concrete Pipe, in the initial installation would have saved significant long-term costs.

Location	I-70 east of Vail, Colorado	I-480 near Maple Heights, Ohio	SR-79 near Buckeye Lake, Ohio	SR 173 Taylorsville, Utah	I-70 Eisenhower Tunnel, Colorado	I-75 near Prudenville, Michigan	Highway 401 near Milton, Ontario Canada
Pipe Size / Type	66" CMP	60" CMP	30" CMP	81" X 59" Arch CMP	60" CMP	73"x55" Arch CMP	30" (750mm) CMP
Costs of Replacement	\$4,200,000	\$384,000	NA	\$48,000	\$45,000	\$95,000	NA
Length	85-100'	NA	50'	50'	40'	50'	40'
Time to Replace (Days)	49	8	6	5	7	6	1
Impacted AADT	20,950	16,760	4,920	19,338	1,257	5,100	45,000
Detour Delay	120 min	60 min	20 min.	20 min.	30 min	20 min	240 min
User Cost	\$4,046,000	\$3,079,000	\$290,000	\$693,000	\$220,000	\$249,000	\$5,033,000
Total Costs	\$8,246,000	\$3,463,000	NA	\$741,000	\$265,000	\$344,000	NA
Pipe Age (yrs)	35-60	60	30+	20	30	30	25
Number of Replacements (Compared to 100 year design life)	1	1	3	4	2	2	3
Total Costs for 100 yr Horizon	\$8,046,000	\$3,463,000	NA	\$2,964,000	\$530,000	\$688,000	NA
Estimated Cost to change to 100 year pipe	\$12,000	\$13,000	NA	\$6,200	\$4,500	\$6,200	NA
Cost-Benefit Ratio	671	266	NA	478	118	111	NA

All cost rounded to the nearest \$1,000.

NA – Not Available

* A Study Into The Economic Cost of Culvert Failure, Joseph Perrin, Jr., Chintan S. Jhaveri, University of Utah, *Concrete Pipe News*, Summer 2004.

Precast concrete pipe is the recognized leader with a product service life of 100 years or more. The strength of precast concrete pipe increases with time. With precast concrete pipe, 85% to 95% of the structure is delivered to the project site.

One of the most critical factors in project design should be material durability or service life, sometimes referred to as Life Cycle (or Least) Cost Analysis (LCCA or LCA). Every agency using public funds should be required to perform a Life Cycle Cost Analysis on all projects and on all materials, not just pipe. In fact, the American Association of State Highway and Transportation Officials (AASHTO) recommends a life cycle analysis be performed for material selection. A material's ability to perform its intended functions, structural and hydraulic in the case of pipe, becomes irrelevant if the material cannot perform satisfactorily for an economically acceptable period. It is a fact that there is more money available for capital improvement projects than there is for maintenance. Therefore, it is much easier to properly fund the initial installation than it is to find money for maintenance.

Risk and liability are issues that should be in the forefront of the planning and design phases of a project. Likewise, proper "post installation inspection" will help alleviate future problems. Proper design, LCCA, specifications, installation, and inspection are the responsibility and the necessity of a professional engineer.

The following are examples of recent COLLAPSES.

Michigan Prudenville

The failure of a 30-year old, 73" x 55" Arch (66" round equivalent) CMP culvert on I-75 cost \$95,000 to replace but the estimated user cost due to detour delays was \$249,000. The MDOT inspected other culverts near the initial failure. The condition of those CMP culverts forced the MDOT to spend an additional \$2.8 million to repair 50 to 60 culverts in a 12 mile section of I-75. The final price tag was \$3.14M.

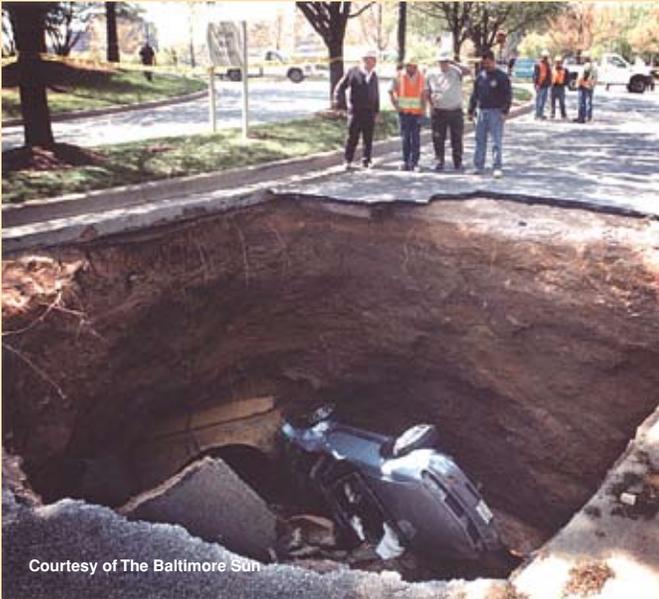


◀ Muskegon

The failure of a 60" diameter CMP culvert caused: a) a street closure of five weeks, b) the shutdown of a 48" diameter water transmission line (which traversed the 20 feet deep excavation), and c) the detour of an 8" diameter water line. Additionally, replacement of the CMP with precast concrete pipe called for the diversion of the creek carried by the culvert. The replacement cost was \$160,000, which did not include the social and economic costs associated with the detours and consequent lost time to commerce and residents.

Virginia

Suffolk – Homeowners are threatening to sue the city because parts of their yards are sinking. There are 52 reported sinkholes caused by the failure of 10 to 15-year old CMP. Sinkholes have been plaguing more than 50 Suffolk property owners for three years. City officials have agreed to begin making repairs but there is much concern as to the final cost.



Courtesy of The Baltimore Sun

Maryland

◀ Owings Mills (Baltimore County)

A mother and daughter were injured when their car fell into a 20' long by 30' wide by 20' deep sinkhole caused by the failure of a 17-year old, 84" diameter CMP. But, it could have been worse. The rescue workers later learned that more than 13,000 volts of electricity coursed through feeder lines just below the car.

▼ Timonium ▶

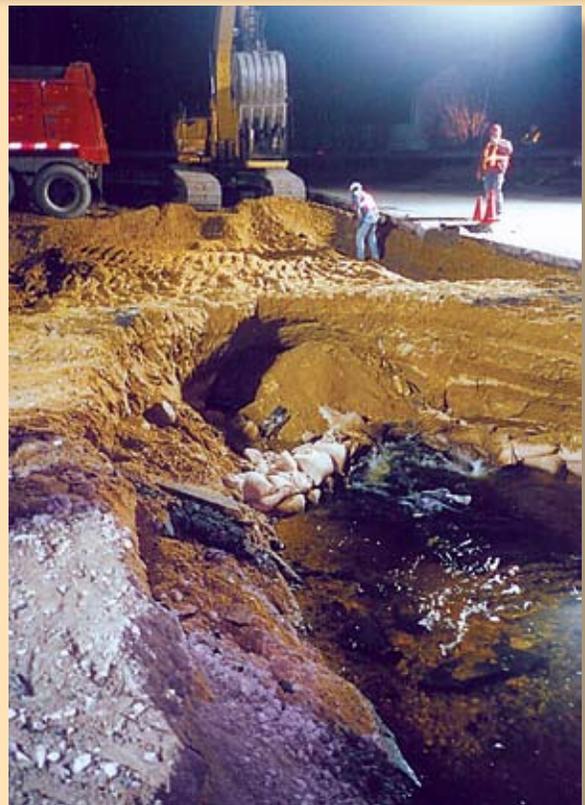
A 4-year old, 48" diameter HDPE pipe collapsed in the parking lot at the Lowe's Home Improvement Warehouse. At a cost of \$500,000, the contractor replaced the failed pipe with precast concrete pipe.



New Hampshire

Nashua ▶

NH Route 101A, a major artery carrying nearly 50,000 vehicles per day, was closed due to the collapse of a 25-year old, 108" diameter CMP which carried Pennichuck Brook under the roadway. After two temporary repairs, the waters had receded to the point where permanent construction could take place. The CMP was replaced with precast concrete box culverts at a cost of \$889,500.



Colorado

Arvada ▶

911 Emergency equipment was tied up for hours when a dog had to be rescued by fire and rescue personnel after getting stuck in a 24" diameter HDPE pipe that had collapsed to about one half (12") its height. The pipe was part of a residential storm sewer installed through backyards with only three feet of earth load and no traffic load.



Courtesy of CO State DOT, Rob Beck

◀ Vail

\$8.2M was the final price tag after a 66" diameter CMP collapsed on I-70. The cost of replacement was \$4.2 million. The time required for this replacement was 49 days, which resulted in an estimated user cost of an additional \$4 million.



◀ British Columbia, Canada

Approximately three years after installation, the "World's Largest Corrugated Steel Arch" collapsed on the Alaska Highway. The 100' wide gaping hole was temporarily replaced with a one-lane Bailey bridge. Delays were expected to be experienced for years before a new bridge would be built.

Georgia

DeKalb County – In July 2003, after experiencing three large CMP collapses within 4 weeks, and repair costs approaching \$176,000, DeKalb County officials estimated that the cost to repair their aging drainage basins, construct new pipes, and dredge creeks and streams would be \$800 million. Fees of \$4 per month for homeowners and \$4 per 3000 square feet per month for businesses were approved to generate the necessary funds.



◀ **Gwinnett County** – A rash of CMP failures and road closures has caused the county to reconsider its specifications and to look for ways to fund the costs of repairs. The cost to repair one such collapse of a 102” diameter CMP could reach up to six figures while the nearby 48” diameter concrete pipe is fine.

The estimated cost for repairs from the collapse of a 10 to 12-year old, 60” diameter CMP is \$475,000. The maximum depth of this pipe is approximately forty feet. In addition to the commercial/residential street closure, an exposed water line, which crossed the hole on one side, burst before the drainage repairs were made and caused additional damages (not included in the initial estimate).

Lilburn –Due to the high replacement costs associated with other types of pipe, the City of Lilburn’s drainage pipe policy now ONLY allows concrete pipe.

North Carolina

▼ Charlotte ►

A massive sinkhole, formed by a failed 20-year old, 126” diameter CMP swallowed a Mustang and flooded the lobby and ground floor of a hotel. The cost of replacement was approximately \$300,000.



Hickory

Failure of a 30-year old, 96” diameter CMP created massive sinkholes in a restaurant’s property and forced the closure of the restaurant. In addition, one of the sinkholes swallowed a Corvette. The sinkholes affected the safety of U.S. Highway 70 and caused debate between the property owner, city, and the NCDOT as to liability and responsibility for damages. Repairs were estimated to cost \$1.5 M.

Wisconsin

Eau Claire

A 15-foot deep sinkhole caused by the failure of a CMP storm sewer resulted in the drowning death of a 34-year old man whose car plunged into the sinkhole. The CMP was replaced with precast concrete pipe at a cost of approximately \$800,000.



South Dakota

◀ Sioux Falls

The failure of a 20-year old, 84" diameter CMP resulted in a parking lot sinkhole approximately 75' wide, 250' long, and 25' deep. Fortunately there were no casualties or injuries since the culvert, which extended to a busy street crossing, collapsed just one hour prior to employees being present in the parking lot. The CMP was replaced with precast concrete pipe and the project cost was about \$.5 M.



Felix Adamo / The Bakersfield Californian

California

◀ Bakersfield

As a result of the following incident, CMP is no longer permitted. The collapse of a 30-year old CMP in the downtown area caused a commuter headache and precipitated the inspection of other road crossings by the city. Most of the failed pipe and the balance of the line were replaced with concrete box culvert and precast concrete pipe.



Courtesy of Fred Greaves

▲ San Diego

A section of a busy roadway collapsed into a sinkhole approximately 8 feet deep and 24 feet wide. The collapse, in an area concentrated with retail businesses, was caused by the failure of multiple lines of large CMP that carried the San Diego River under the street. The street was closed and the time for repairs was estimated to be one month. The corrugated metal pipe was replaced with precast concrete pipe. City officials estimate the cost of replacing metal pipe throughout the city to be at least \$37 M.



Courtesy of The Daily Journal

New Jersey

◀ Vineland

A corroded 54" diameter aluminum pipe caused an enormous sinkhole in a city roadway. Luckily, a local couple reported the sinkhole after peering through a crack in the road. Closer inspection revealed that a substantial section of the roadway was merely a layer of asphalt spanning a deep cavern.



Ocean County ▶

A 60" diameter CMP failure was the cause of a huge sinkhole in the Ocean County Mall parking lot.



Utah

Taylorsville – An 81" x 59" Arch (72" round equivalent) CMP collapsed on busy SR-173. The pipe was estimated to be only 20-years old and the replacement cost was \$48,000.

◀ West Bountiful

A 30-year old, 96" diameter CMP collapsed in a church parking lot, causing a sinkhole, which swallowed a pickup truck and flooded a nearby home. Fortunately, the teenagers in the truck were not injured. The pipe was replaced with concrete box culvert.

Ontario, Canada

One of North America's busiest roads was closed when a 25-year old, 30" diameter CMP failed. The large sinkhole was in the center lane of Highway 401, just west of Toronto, Ontario.

Alabama

Pelham ▶

After only a few years in a new subdivision, the 42" and 48" diameter HDPE pipe collapsed in the backyards between houses. The HDPE pipe, which had approximately three feet to seven feet of earth cover, was replaced with precast concrete pipe.



◀ Florence ▼

A 23-year old, 90" diameter CMP collapsed in an auto dealership lot. Fortunately, a customer noticed a small hole in the pavement and notified the dealership, who moved the new automobiles before the huge sinkhole appeared.



▲ Elmore County ▶

A 24" diameter HDPE pipe collapsed under a new subdivision street causing a sinkhole. The HDPE pipe, which had only been installed two years earlier, was replaced with precast concrete pipe.



Kansas

Topeka – A sinkhole developed under the weight of an asphalt – milling machine (working on a street resurfacing project) because of the failure of an approximately 38-year old 72” x 44” Arch (60” round equivalent) CMP. While replacing that pipe with precast concrete pipe, a newer but badly corroded section of CMP was thought to be close to complete failure and it also had to be replaced. The pipe replacement cost was approximately \$60,000. The 42-year old concrete pipe in this same street was in perfect condition.



Pennsylvania

◀ East Greenville

The failure of a 15” diameter CMP cross-drain caused the roadway to crack. Fortunately, after notice of the cracking, repairs were initiated to avoid a collapse.



Hollidaysburg ▶

The southbound lane of I-99 was closed after the collapse of 18-year old, 42” and 48” diameter CMP. The CMP was replaced with precast concrete pipe at a cost of \$150,000.

South Carolina

Hilton Head Island

The collapse of a 72” diameter aluminum pipe caused a sinkhole that forced the closure of Highway 278, the major thoroughfare to downtown Hilton Head Island. To complicate matters, the failure occurred in the middle of hurricane season on the evacuation route. The contractor, battling tidal water, worked around the clock to replace the failed aluminum pipe with precast concrete pipe.

▼ Anderson and Spartanburg Counties

Spartanburg County has had four road collapses in a seven month period that were caused by failures of steel culverts installed during the 1970's. The estimate to replace more than 40 culverts in the next decade amounts to \$2.6M. The county plans to apply a \$25 fee on vehicles to fund this road maintenance. Concrete culverts, which the county anticipates will last 75 to 100 years, are the primary choice now in Spartanburg County. The majority of road closures in Anderson County in recent years have resulted from collapsed steel culverts. The estimate to replace corroded culverts in Anderson County over the next several years also amounts to millions of dollars. As quoted by the Spartanburg Herald-Journal, the Anderson County transportation director stated that “It was an immediate, cheaper solution, (to install steel culverts) but, in the long run, it was not a good solution.”



Courtesy of Spartanburg Herald-Journal



Tennessee

◀ **Knoxville** – The failure of a 24-year old, 84” diameter CMP culvert located in a shopping center parking lot cost \$1.3M to replace. The user cost due to detour delays and the impact on the businesses has not been finalized. Because of continued flooding, many of the businesses relocated. The pipe was replaced with approximately 1900 linear feet of precast concrete pipe.

Ohio

Licking County

An alert driver notified the State Highway Patrol about a hole in the middle of Route 79. The sinkhole, caused by the collapse of a CMP culvert, snarled rush-hour traffic when the road was closed in both directions. The culvert was no longer in service because the stream had been diverted to another location. However, this is a good example of the perpetual nature of our drainage systems and the need for long-term service life.



New York

◀ **Corning** – Failure of a 60” diameter HDPE pipe line at the Youth Sports Complex has caused three sink holes in the past three years. The pipe had only been installed for two years before the first sink hole appeared. Specimens of the pipe failed the stress crack resistance test and the carbon black content requirement. HDPE pipe was chosen for the project as it represented an initial savings of \$3000 versus precast concrete pipe. Repairs have cost approximately \$70,000 and the entire line will be replaced with precast concrete pipe.

Resources

The Economic Costs of Culvert Failures, Joseph Perrin, Jr., Chintan S. Jhaveri, University of Utah, Transportation Research Board, January 2004.

ASTM C 1131, *Standard Practice for Least Cost (Life Cycle) Analysis of Concrete Culvert, Storm Sewer, and Sanitary Sewer Systems*

American Concrete Pipe Association Publications *

County Counts on Concrete When Metal Pipes Fail, YSK #114

CMP Failure Closes Canada’s Busiest Highway; Confirms Need for Life Cycle Analysis, YSK #118

HDPE Pipe Showcased on Web Site Fails, YSK #120

Installation Anomalies? You Be the Judge, YSK #121

World’s Largest Corrugated Steel Arch Collapses on Alaska Highway, YSK # 122

A New Dinnertime Subject: Concrete, YSK #125

When is the Correct Pipe Material Important, YSK #131

Durability: Too Important to Ignore, Concrete Pipe Insights

A Case in Point for Choosing Concrete Pipe, Dispatch

Precast Concrete Pipe Durability, CP Info

* Available on the ACPA web site at www.concrete-pipe.org



American **Concrete Pipe** Association

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www.concrete-pipe.org