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Let's Solve Water

Implementing a Proactive Approach to Force Main Asset Management

WHITEPAPER: FORCE MAIN

What happens after a force main installed less than 20 years ago previously fails on a national holiday? In the case of a Missouri utility, a condition assessment project on the critical non-redundant pipeline was launched to get a better understanding of its overall condition and determine if the pipe needed to be replaced.

According to a 2004 WERF survey, 7.5% of wastewater collection systems are force mains, **most of them located in highly critical areas in communities where the consequence of failure (CoF) can be severe.** Even more troublesome for utilities are the operational and technological limitations associated with pressurized pipes.

With advancements in technology and a willingness to develop proactive pipeline integrity programs, utilities can successfully reduce failures, mitigate risk, reduce capital expenditures, and increase confidence in the overall operation of their force mains.

Utilizing inline inspection technologies, the Missouri utility gained a comprehensive understanding of the condition of their force main and was able to pinpoint areas which needed immediate attention. They also identified sections of the pipe with many years of remaining useful life, **saving them the cost and effort of a larger-scale replacement.**

Why is it Important to Manage Pressurized Sewer Pipes?

The high consequence of failure of most force mains equates to a high cost financially, operationally, environmentally, and socially for utilities. Despite this, many utilities have traditionally opted for a reactive approach to managing these assets, often due to the difficulty of the inspection process. Utilities who have implemented proactive programs to manage their force mains along with their entire linear asset inventory have been able to:

- **Reduce failures** – force main failures can cost a utility from $500K to well over $1M[1], as well as negative public sentiment and adverse media exposure.
- **Reduce capital expenditures** – condition assessment programs can be implemented for roughly 5-15% of the cost of full-scale replacement programs.
- **Mitigate risk** – through a comprehensive condition assessment program, a thorough understanding of risk can inform optimized repair, rehabilitation, and replacement strategies.
- **Increase confidence** – in their overall force main operations as well as with their customer base and communities.
- **Optimize operational expenditures** – by implementing a force main management strategy, utilities can move from reactive operation and maintenance to proactive planning, thus optimizing budget allocation.

1. Analysis of Total Cost of Large Diameter Pipe Failures – AWWA Research Foundation Study, 2007

Force Main Pipe Types and Modes of Failure

A survey of the Water Environment Research Foundation (WERF) and the National Association of Clean Water Agencies (NACWA) utility subscriber members found the primary cause of force main failures is internal corrosion, meaning the mains are failing from the inside-out.

The majority of force mains are metallic pipe, which includes cast iron, ductile iron, and steel pipes. Metallic pipe constitutes 63% of the force main network in the U.S. Almost half of metallic force main failures are due to external or internal corrosion with an additional quarter of failures due to surge pressure and joint leakage.[2] **That means nearly 75% of metallic force main failures can be prevented** by implementing a proactive pipeline management program.

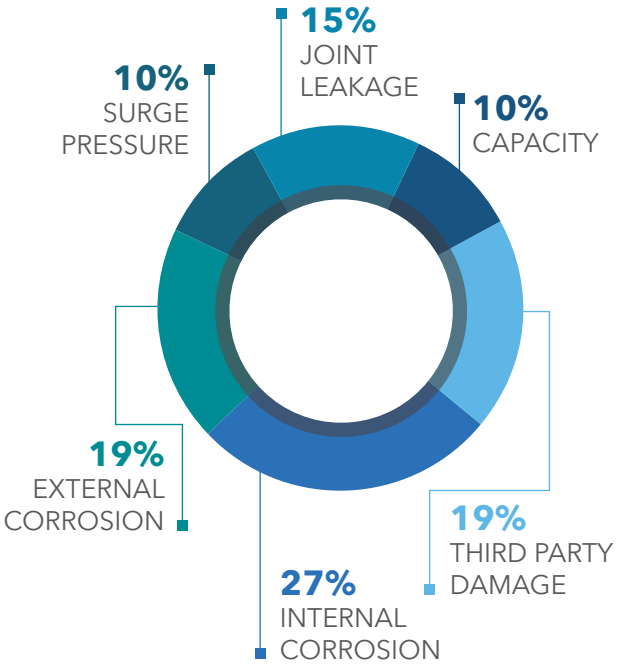
2. WERF's 2010 "Inspection Guidelines for Wastewater Force Mains"

FORCE MAIN FAILURE ON **METALLIC & NON-FERROUS PIPES**

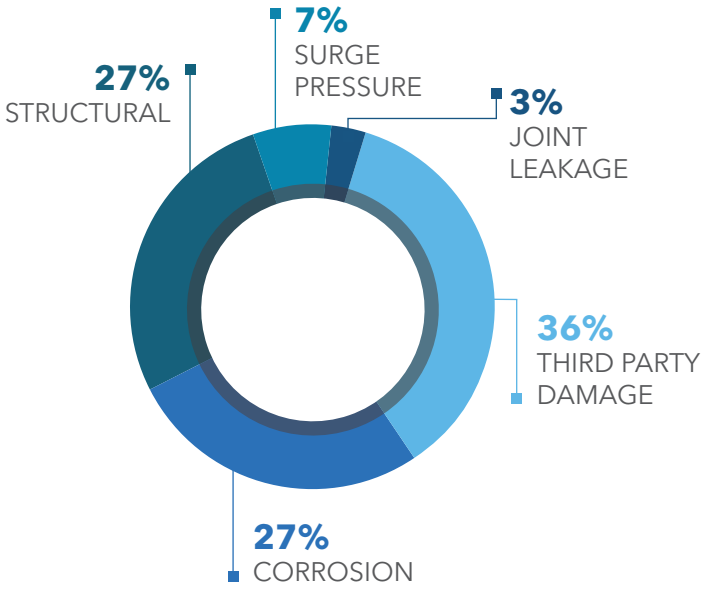
While non-ferrous pipes such as prestressed concrete cylinder pipes (PCCP), reinforced concrete cylinder pipes (RCCP) and bar wire wrapped pipes (BWP) make up a smaller percentage of force main pipes, they dominate in diameters above 36 inches. What's important to note is that failures on these non-ferrous pipes tend to be more catastrophic.

Nearly 55% of failures of non-ferrous pipes are from corrosion and structural defects. Another 10% for surge pressure and joint leakages means **nearly 65% of non-ferrous force main failures are also preventable**.[3]

FORCE MAIN FAILURE
METALLIC PIPES



FORCE MAIN FAILURE
NON-METALLIC PIPES



3. WERF's 2010 "Inspection Guidelines for Wastewater Force Mains"

Developing a Proactive Risk-Based Condition Assessment Program

Reducing risk is the goal of most condition assessment programs and is central to a focused and balanced management strategy. Implementing a strategy that focuses on gathering data through condition assessment is crucial to ensure the safe operation of wastewater infrastructure, and to optimize capital expenditures.

Understand

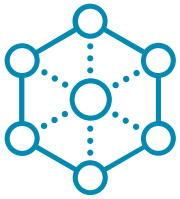
COLLECT
PRIORITIZE
PLAN

Assess

INSPECTION
ANALYSIS
RISK EVALUATION

Address

RISK MITIGATION
REMEDIATION
STRATEGIES



Manage

CONDITION MONITORING
ASSET MANAGEMENT
CAPITAL PLANNING

Depending on the history, context, and risk associated with a pipeline, different levels of Assessment are available, either on a pipeline of concern or as part of a comprehensive program.

How To Assess Force Mains

Inspecting force mains is significantly more challenging than inspecting gravity mains.

New standards of best practice for force main management involve a variety of methods and technologies to provide data and information with which to make decisions. Utilities can now often perform a detailed condition assessment while the force main remains in service.

There is no "one-size-fits-all" way of assessing force mains. Any approach should be tailored to risk tolerance, material, diameter and past failure history. Savvy utility managers are turning to programs that reduce damage to assets, prioritize investment to minimize community impact of asset failure, and reduce the consequence of failure by enabling system control. Below are three general assessment approaches for varying degrees of risk and effort.

CHALLENGES OF INSPECTING FORCE MAINS

- Lack of redundancy
- Lack of or limited access points
- Cost of inspection
- Environmental concerns related to the nature of sewer systems
- Technology limitations

Health Check

Outcome:

- Justify more action
- Prioritize a pipe within your system or section of a long pipeline
- Reduce consequence of failure

Approaches to Assessment:

COULD INCLUDE THE FOLLOWING:

- Review maintenance and failure history
- Design check for today's loading conditions
- Monitor for transient pressures
- Assess critical control valves
- Hydrogen sulfide monitoring

"High concentrations of hydrogen sulfide gas within wastewater is of significant concern as this gas may be released into the atmosphere and subsequently cause corrosion and eventual breakdown of the pipe's exposed surface"

Effort

Outcome

Pipeline Screening

Outcome:

- Identify any red flags which may indicate problems
- Reduce risk through obtaining actionable data
- Understand if your pipeline might need more attention
- Take first steps toward condition assessment inspections

Approaches to Assessment:

COULD INCLUDE THE FOLLOWING:

- Review maintenance and failure history
- Design check for today's loading conditions
- Monitor for transient pressures
- Assess critical control valves
- Hydrogen sulfide monitoring
- Perform inline, accurate leak and gas pocket detection

*"Research conducted as part of the Water Environment Research Foundation: **2010 Guidelines for the Inspection of Wastewater Force Mains**, shows that the most common failure mode for force mains is internal hydrogen sulfide corrosion which starts as a gas pocket forming in a pipeline"*

Effort

Outcome

Engineering Assessment

Outcome:

- Make a high confidence decision
- Identify today's problems
- Prevent tomorrow's failures
- Make repair-replacement decisions
- Make long-term capital plans

Approaches to Assessment:

COULD INCLUDE THE FOLLOWING:

- Review maintenance and failure history
- Design check for today's loading conditions
- Monitor for transient pressures
- Assess critical control valves
- Perform inline, accurate leak and gas pocket detection
- Perform inline, pipe wall assessment
- Advanced structural assessment
- Remaining Useful Life (RUL) projections

"Inline inspection tools provide utility owners with an easy, less costly alternative to inspection methods that require shutdown"

Effort  Outcome 

Conclusion

Faced with deteriorating buried sewer infrastructure and challenges associated with the complexity of force mains, proactive utilities are taking the important step to perform condition assessments on these assets. Information gained allows utilities to take action on critical assets and to better understand the condition of their pipelines. This approach enables a powerful, cost-effective strategy for asset management with significant operational, financial and community benefits.

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1) The tissue in plants that brings water upward from the roots;
2) a leading global water technology company.

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