Keys to Successful Sewer Rehabilitation

Bryon Livingston, Mark E. Martin, and Saeed Kazemi

Today's buried wastewater infrastructure continues to be of significant concern to many cities and wastewater utilities. The possibility of a catastrophic sewer collapse propels many utilities to pursue aggressive and complete rehabilitation of sewers. However, is the cost for this total rehabilitation always justified?

A methodical approach to implementing a successful and cost-effective rehabilitation program using a multiple-step approach is needed. Using proven and cutting-edge technology for inspection of large-diameter sewer pipe will provide a proper condition assessment and provide critical guidance for repair or rehabilitation. Therefore, design of the rehabilitation is based on the known condition of the pipe so that money is not spent to rehabilitate pipe that is still in good condition.

This approach will extend the available funding to allow utilities to fix larger portions of the system by only repairing what is needed with the appropriate technology, or bidding two alternatives to provide cost competition. This will also allow for a thought-out and correctly designed approach, where repair technology is best used, which will lead to cost-efficient budgeting.

Infrastructure Deterioration

With the condition of infrastructure across the United States continuing to deteriorate, the management of buried pipeline infrastructure is evolving. No longer is it merely about building, operating, and maintaining pipelines; it's an art of balancing performance, risk, and cost, and it requires a comprehensive process. The primary goal of a condition assessment is to prevent catastrophic failure events on critical pipelines.

The poor condition of buried pipeline infrastructure in the U.S. has been emphasized in the news and documented in several agency reports, such as those published by the American Society of Civil Engineers (ASCE) and the U.S. Environmental Protection Agency, that stress the need for increased investment in the nation's pipeline infrastructure. The recent ASCE 2013 Report Card for America's Infrastructure1 rated wastewater systems with a "D" and noted that aging pipes and inadequate capacity lead to the discharge of approximately 900 bil gal of untreated sewage each year. These reports indentify the critical function of these systems to protect public health and for essential economic development and growth. Disruptions and failures in these pipelines hinder the public's ability to meet their everyday needs, exposes them to waterborne contaminants, can cause damage to roadways and structures in the millions of dollars, and can result in personal injury and negative health effects.

A New Approach

In the past, the common approach for utility managers has been to address infrastructure needs crisis to crisis. The lesson now for these managers is that buried pipeline infrastructure is an asset—with a limited lifespan that must be managed. One of the important factors is the knowledge of how these systems deteriorate so utility managers can better evaluate the risks in planning for replacement.

The completion of a condition assessment can help utilities evaluate the condition of existing pipelines. It requires an understanding that the life expectancy for a pipeline is less than the design life. Several factors reduce the lifespan of a pipe, including corrosion, construction/installation practices, and impacts from transient pressures.

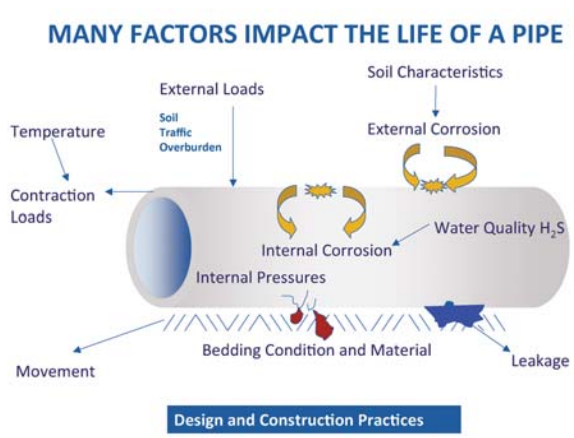
Bryon Livingston is engineering manager with Black & Veatch in Kansas City, Mo. Mark E. Martin is engineering manager and Saeed Kazemi is public works director with City of Fort Myers.

The first step in the process is to develop a plan. This can be part of a master plan or a specific plan for managing infrastructure. An important part of the plan is to identify critical pipelines, which, if they break, would significantly impact the performance of the system. The probability and consequence for failure of infrastructure varies significantly, from routine leaks to catastrophic failure.

Several technologies are available to help in determining the condition of the pipeline. They range from the basic visual or closed-circuit television (CCTV) to sophisticated electromagnetic and ultrasonic evaluations.

The information from a condition assessment provides the necessary data for the prioritization of the replacement of pipes. Instead of replacing the entire segment of pipeline, the utility can then replace only those sections that are close to failure. Therefore, the development of the investment needs for replacement of pipelines can be based on their actual condition. The cost for replacement can be planned in a budget process to manage the impacts from these costs.

The condition-assessment step is a key component of the asset management process, and knowing what technology to use is important. Asset management principles are not a new concept for most utilities, except that using a formalized approach provides a more efficient use of the data collected. The condition assessment will show why it is beneficial to have information on the actual condition of the pipe based on field evaluations, versus information based on statistical methods. The formalized process provides for converting data from condition assessment to implementation of projects based on their priorities.



Managing buried infrastructure requires balancing the performance of the system; the associated risks; and the costs required with operational efficiency, planning requirements, affordable rate structures, security, and regulatory requirements. The decisions made to replace, or repair or rehabilitate, any pipe should be made based on the actual condition of the pipe in the system.

There are several factors that impact the length of the service life of pipe, including:

- Third-party damage
- External loads from overburden and traffic
- External corrosion from soil characteristics
- Internal corrosion from water quality characteristics
- Design and construction practices
- Bedding condition and material
- Ground movement

Understanding that these factors exist and how they affect the service life of pipe is important in knowing how to manage the risk associated with buried infrastructure. Such factors cannot be eliminated, but they can be managed.

Assessing Conditions

Improved condition assessment technologies can help utilities fix larger portions of their systems than in the past. Before the decision is made to rehabilitate any pipe in a buried water distribution or wastewater collection system, it is necessary to determine the current condition of the pipe. Rehabilitation includes repair, relining, replacement, and other methods to restore and extend the service life of the pipe. The key to successful rehabilitation is the "R3" approach. This approach is the proper evaluation of the data from the condition assessment performed on the pipeline, and replacing the *right* pipe at the *right* time with the *right* material[2].

Condition assessment, therefore, becomes more than evaluating the pipe age, material, and overflows, or running a CCTV unit through the pipe. In the last 40 years, remarkable improvements have been made in the tools available to the engineer for evaluating the condition of pipe. The traditional methods of smoke testing, dye testing, and flow monitoring are still useful tools, but newer technologies have been developed.

Condition assessment technologies have improved the quality of the data that can be gathered. Technologies available today for assessing buried piping systems include side-scanning television, zoom cameras, improved CCTV quality, laser scanning, sonar profiling, ultrasonic testing technologies, and electromagnetic technologies. These technologies are on improved robotic or remote controlled platforms; however, no single tool will identify all of the problems that can develop in a deteriorating pipeline. Before the implementation of any of these technologies is done, the following question should be asked: Are utilities spending available funding on the highest priority, critical pipelines? The answer is the assurance that the design of the project is based on known pipe conditions.

An additional factor that must be considered is available funding. In the past, buried infrastructure repair funding has been based on the "management by crisis" approach, which required a significant and obvious failure of the system or a by-chance identification of a significant problem to obtain the required attention. With the changing emphasis on managing buried infrastructure as assets, this approach is being replaced with a more proactive one: to assess pipe conditions in advance of failure and to allow for a scheduled and budgeted approach for anticipated pipe repairs and replacement. It is usually cheaper to rehabilitate a pipeline than replace a failed pipeline, especially considering the intangible costs associated with an emergency repair.

With funding in place and knowledge of the actual pipe condition based on field inspections of the system, the limits and quantities of rehabilitation projects can be planned, organized, and designed more effectively. Project planning requires review of the various methods and technologies available for rehabilitation of pipe, which may include only partial rehabilitation to extend the service life of the pipe.

Methods for pipeline rehabilitation include:

- Slip lining
- Cured-in-place pipe (CIPP) lining
- Spirally wound pipe
- Pipe bursting
- Spray lining

The optimal rehabilitation method should be selected on the basis of its ability to extend the useful life of the pipe cost-effectively. A decision must also be made about whether to renovate or replace the pipe using trenchless or open-cut construction methods. The use of trenchless technology is becoming more widely used for replacement of buried infrastructure, as it usually results in fewer construction impacts to the project site; less pavement removal and replacement; fewer disruptions to traffic, businesses, and residences; and lower project costs—all of which lead to fewer environmental impacts and public concerns.

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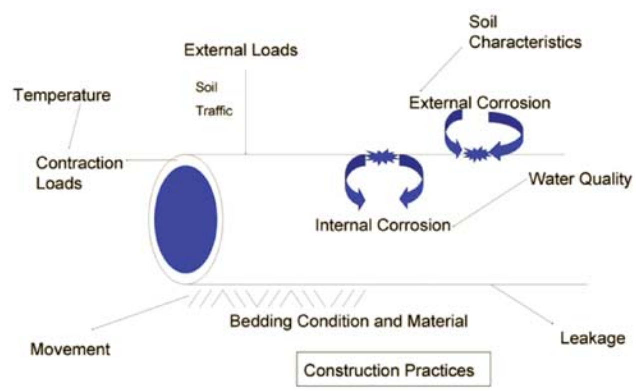
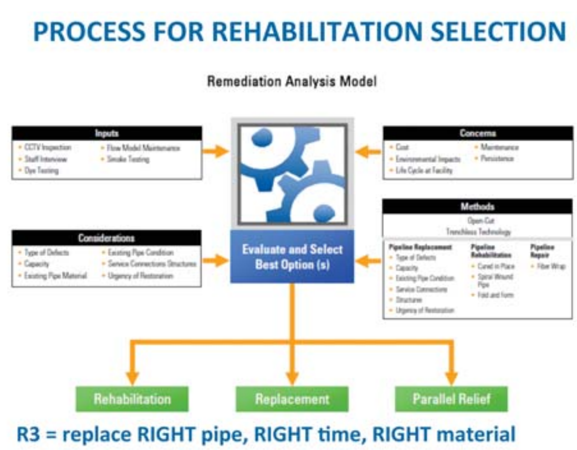


Factors Impacting Life of Pipe



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Case Study

Fort Myers, Florida

As part of improvements at its south Advanced Waste Water Treatment Plant (AWWTP), the City of Fort Myers identified a 54-in. sewer influent pipeline as a critical component of its collection system and requested Black & Veatch to conduct a condition assessment. The pipeline is the primary influent for the AWWTP and cannot be taken out of service, so technologies had to be used to allow for an assessment while the pipeline remained in service.

The influent pipe is a gravity pipeline, which is about 550 ft of reinforced concrete pipe that was installed in 1983 as part of the original plant construction. It begins where two 36-in. ductile iron pipes combine in a manhole just outside the AWWTP property and ends at the raw wastewater pump station wet well. The slope of the pipe is 0.0008 percent, which makes the pipe nearly flat.

Sewer Condition Evaluation

An inspection plan was developed in coordination with the City operations staff to identify specific roles and responsibilities for the inspection. The inspection plan confirmed that the upstream manhole could be used as access to the pipeline. In order to float the equipment through the pipeline the pipe needed to be less than half full, and the City identified the times in which the flows in the pipe would be less than half full as 1:00 a.m. to7:00 a.m. The inspection plan also addressed safety concerns, including the potential for H_2S gas, confined space entry requirements, and exposure to traffic.

Granite Technologies was subcontracted by Black & Veatch to perform the condition assessment. The inspection equipment used included a floating platform that was capable of carrying a CCTV, and laser and sonar equipment. This platform allowed for simultaneous data collection in order to accurately determine the existing condition of the pipe. The platform provided sufficient lighting to illuminate the pipe to provide high-quality digital CCTV images. The CCTV images were transmitted live to a screen to allow the technician to review the images and reinspect areas of potential defects as needed.

The laser was a light detection and ranging (LIDAR) system that was configured for pipe profiling and used "time of flight" principles, which measures the range of each point individually and does not suffer from loss of accuracy as the pipe diameter increases.

The sonar unit provided for accurate data collection below the water surface. The system was specifically designed for pipe profiling and used high-frequency sound waves to obtain profiles from the submerged section of the pipe. The sonar was capable of transmitting the data to a screen similar to the CCTV to allow the technician to review the data and re-inspect it as needed.

During the inspection, the flow was actually less than half of the pipe and the platform would not move in the flow. It was determined that there was approximately 12 in. of sludge buildup on the bottom of the pipe. The sonar unit, which is suspended below the platform, was getting stuck in the sludge because of the low flow. The sonar unit was removed to allow the platform to proceed with the inspection.

The condition assessment did not identify any significant defects of immediate concern. The pipeline appeared to be in good condition based upon review of the CCTV and LIDAR information from the inspection. The corrosion detected by the LIDAR system did not appear to be a major concern and was limited to around 1 percent, or less than 0.5 in., and only in scattered locations. The observed defect of material hanging was consistent throughout the pipeline at about every 20 ft, which appeared to be an indication that the joints were leaking. This could be a source of inflow/infiltration, but none was observed during this inspection. The other observed concern was the amount of sludge buildup that limited the use of the floating platform. The slope of the pipe was nearly flat, which could allow sediment to build up and restrict the flow.

Rehabilitation Recommendations

Recommendations for rehabilitation were made upon review of the CCTV video, condition assessment data, and field observations. Because this pipe is critical to operations at the AWWTP, the City decided to extend the design life by rehabilitating the pipe. The recommendations, based on the existing condition of the pipeline, were to clean the sludge buildup, remove hanging material, and provide a nonstructural rehabilitation of the pipe. The recommended nonstructural rehabilitation method was CIPP and spray allied cementitious liners. Construction specifications will be prepared and bid for both alternatives, and the City will make a selection based on cost.

Summary and Conclusions

The design and prioritization for the rehabilitation of pipelines based on actual condition of the pipe results in the most cost-effective extension of the service life of a pipeline: replace the right pipe. To the operations staff members, the buried utility infrastructure is never out of mind because it's out of sight; they know that, like aboveground and visible facilities, buried infrastructure does not last forever and needs to be replaced at the right time. Proper condition assessment of buried pipe systems using a variety of assessment technologies will lead to better design, planning, scheduling, and budgeting for when repairs and rehabilitation should occur, and result in replacement with the right material. Using the R3 approach will allow for planning and design of the best rehabilitation repair, which will lead to cost-effective budgeting and spending of available funds.

The simple statement "out of sight, out of mind" therefore does not apply to buried municipal utility infrastructure. Utilities need to take an active approach to manage and determine the condition of buried infrastructure to prevent catastrophic failure of critical pipelines.

References

1) American Society of Civil Engineers 2013 Report Card for America's Infrastructure, pg. 30.
2) Livingston, B. L. and Vidikan, D.C., "The Right Pipe at the Right Time." Water Environment & Technology, November 2009, pg. 29-33.