An Examination of Innovative Methods Used in the Inspection of Wastewater Systems

As infrastructure ages, there is growing pressure on owners of wastewater collection systems to undertake more extensive and detailed inspections of their underground pipes. Unexpected failures, especially of a large diameter sewer force main, can be disastrous. In addition, new industry regulations, including GASB 34 (Government Accounting Standard Board) and the U.S. EPA’s CMOM, are placing greater emphasis on a utility’s ability to manage their assets. Inventorying, assessing the condition, and predicting life-cycle performance along with appropriate future rehabilitation and replacement of these assets is now of paramount importance.

This report provides a comprehensive review of inspection technologies for gravity and force mains, a detailed analysis of the characteristics of the wastewater pipe network, and an investigation of the most common defects encountered. The report should serve as a useful resource document to inform engineers and aid them in undertaking a more effective condition assessment.

Gravity Systems

The research identified closed-circuit TV (CCTV) as the first level of inspection for gravity pipes which is often coupled with flow monitoring. This approach can be a cost-effective means of identifying defects and service problems in a wastewater collection system. New advances in digitizing the video stream have made this tool more user friendly. However, CCTV still requires an operator’s subjective interpretation of observed defects and is limited to the pipe surface located above the flow surface. Moreover, CCTV is mainly qualitative in nature.

New optical scanners, however, provide much the same information as digital CCTV, with the added benefit of being able to unwrap the pipe image and measure the size of defects. The cost for this level of inspection is nearly the same as CCTV, but it does have the benefit of providing a measurable analysis.

The report also found leak locators to be beneficial. Technologies such as the Focused Electrode Leak Location system (FELL) are capable of locating leaks not detectable by CCTV, as well as providing a relative indication of the size of the leak.

But before embarking on a more ambitious inspection program—one designed to not only identify defects and service problems in the wastewater collection system, but also to quantify them—the utility should first make an inventory of the type of pipes in their system and the nature of the defects they expect to encounter. For example, if a utility has primarily PVC pipes it would be pointless to invest in an inspection system designed to measure the amount of wall loss due to corrosion. This system would definitely be a consideration for an unlined concrete pipe, however. Armed with this information and the contents of this report, a utility can then

**BENEFITS**

- Reviews characteristics of gravity and pressure pipe wastewater network.
- Summarizes experiences of wastewater utilities and identifies common defects.
- Reviews current investigation technologies along with the application of these technologies to defect identification.
- Reviews innovative inspection technologies and methods for both gravity sewers and force mains.
- Provides information needed to determine the suitability of these innovative technologies to specific problems.

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decide what further inspection technologies may be appropriate for their situation.

The second level of inspection would therefore focus on quantifying the defects and service problems uncovered during the first level of inspection. Laser and sonar profilers can aid in estimating the amount of internal wall corrosion that has taken place in a concrete pipe, as well as silt build up. For concerns about the adequacy of the bedding or soil surround, a wave impedance probe or ground penetrating radar can be run from within a pipe and used to investigate the conditions outside the pipe wall.

**Pressure Systems**

Force mains are rarely inspected from the inside unless there is a failure. Typically, test pits are dug and force mains are visually inspected from the exterior. For metallic mains, subject to corrosion, ultrasonic measurements can also be taken to determine remaining wall thickness. Leak detection, via new technologies such as Sahara, also offers a relatively inexpensive method of assessing the condition of a force main. Leaks can be indicators of more significant problems.

Large diameter prestressed concrete cylinder force mains, if internal inspection is viable, can be visually inspected for cracks and sounded using either primitive tools or more sophisticated impact-echo equipment. If man entry is not feasible, then acoustic emission monitoring for wire breaks, the most common cause of failure of PCCP could be considered.

A second level of inspection for ferrous mains would be the use of electromagnetic methods to ascertain the amount of pitting, corrosion, or graphitization that has taken place. The broadband electromagnetic (BEM) technology can be used on the exterior or interior of a ferrous main.

In the case of PCCP, where internal access is possible, the remote field eddy current (RFEC/TC) technology will locate and quantify the existing wire breaks in each section of pipe.

There are several new technologies on the horizon that are close to commercialization. Many of these involve combining different inspection technologies into one platform. The idea is to make one pass through the line and pick up all needed data at the same time. Manufacturers are also developing automatic defect recognition (ADR) software that would theoretically eliminate the human error associated with subjective judgment on classifying observed defects. There is a risk, however, that other errors will be introduced into the process as no computer program based on manmade algorithms is ever going to surpass the capability of the human brain.

**Stay Informed**

Given the relatively higher cost for some of the newer inspection technologies and their focus on detecting and quantifying specific types of anomalies in a wastewater pipe, it appears sensible that engineers should consider what level of information they require when inspecting a wastewater collection system.

To do so, the report offers a multi-tier approach for carrying out an inspection of a wastewater collection system. The first level is designed to identify problem areas in the system qualitatively, at minimal cost. The second, or more thorough level would then be applied only to those areas where problems were observed, or leaks measured, during the first level of inspection. In this manner, the utility uses the most appropriate technology to quantify the anomaly observed during the initial inspection, and limits expenditure in the process.

But what is apparent when reviewing the latest technologies, is that a number of the perceived unmet needs can in fact be met with existing technologies, as described under the current state of the art. The problem may, in fact, lie in utilities and their staff not being abreast of current equipment and methods development. Should that be the case, this report will prove to be an invaluable guidance document.

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