

# A Look Beneath the Surface

Collection system rehabilitation  
begins with the right camera system

*Stephane Joseph and Bill Di Tullio*

**A**fter decades of underfunding, U.S. water and sewer pipelines have suddenly become an urgent national concern. Nearly 80% of a city's assets are typically underground. Restoring or replacing this aging buried infrastructure will represent by far the largest capital investment for most municipal utilities in the coming decades.

Limited resources have forced collection system owners across the country into a reactive management style, with most operational resources allocated to emergency response and repair. Meanwhile, sewers that have not exhibited problems continue to age and, if left unchanged, will become the operational and structural problems of the future.

To reverse this trend, owners are looking for new and more effective inspection and diagnostic technologies to determine the actual condition and cause of buried infrastructure problems. With these tools they can identify existing operational and structural issues and schedule maintenance work and capital improvements in a timely, efficient way. The data gathered can support long-term planning, life-cycle costing, and proactive operation and maintenance that help to reduce customer complaints and enhance capital replacement planning.

But with so many options available for inspecting collection systems, it is difficult to choose the right one. By comparing the benefits and limitations of the most commonly used cameras, collection system owners can make better informed choices in selecting the right tool or combination of tools.

## Choosing the Best Option

Innovative inspection technologies can quickly provide information on both the physical asset inventory (pipe size, material, and location) as well as the structural condition for a reasonable cost. Camera technologies often are supported by condition-reporting software with a wide range of features, including the ability to store digital images,

In-line CCTV system



inventory, physical characteristics, and service and structure condition data in a database that can be linked to a digital mapping software program. With standards for condition rating, such as that of the NASSCO (Baltimore) Pipeline Assessment and Certification Program, collection system operators can create a comprehensive and reliable database to describe the condition of the system and manage TV inspection results. Owners, engineers, and contractors also can use this database and speak the same “language” for prioritizing, planning, and rehabilitating buried infrastructure.

Because some technologies require the pipeline to be cleaned prior to inspection, it is important to identify the objectives for inspection before selecting a method. As cleaning may remove important clues to the initial cause of a structural or operational problem, it often is best to leave the area untouched before inspection. Knowing the location and amount of deposits and debris, grease, and tree roots also are useful when preparing a cleaning program.

Closed circuit television (CCTV) inspection systems are available in two options, each using a CCTV camera, video monitor, and video recorder. The first option consists of a stationary camera lowered into a manhole or structure. The second option, also known as conventional in-line CCTV, uses a mobile robotic camera that travels within the sewer. The table (p. 55-57) compares these options.

### Hand-held CCTV Systems

Hand-held CCTV camera systems are maneuvered by either a pole or a telescopic boom with an electric winch and cable. Sometimes referred to as a “camera on a stick,” the hand-held camera is one of the least expensive tools for developing an inventory of manholes and sewer system elements. This lightweight camera can be quickly lowered into a manhole to a depth of about 22 ft (6.7 m) and can take still pictures and video footage. While cost-effective, the hand-held CCTV camera can view only a limited area adjacent to the manhole.

**Comparison of Inspection Tools for Collection Systems**

	<b>Hand-held CCTV*</b>	<b>Zoom CCTV</b>	<b>In-line CCTV</b>
<b>Method</b>	Camera held manually from road surface	Camera lowered into manhole using telescopic boom on rigid platform	Camera enters pipeline and is self-propelled or pulled or pushed with tractor
<b>Extent of inspection</b>	Inspection of pipe close to manhole	Inspection of pipe up to 350 ft (107 m) from manhole	Complete inspection from manhole to manhole
<b>Manhole inspection?</b>	Yes	Yes	No
<b>Site preparation</b>	No preparation required	<ul style="list-style-type: none"> <li>● No preparation required</li> <li>● Can inspect pipe under operating conditions</li> </ul>	<ul style="list-style-type: none"> <li>● Precleaning often required</li> <li>● May require flow control</li> </ul>
<b>Safety concerns</b>	<ul style="list-style-type: none"> <li>● Confined space entry not required</li> <li>● Minimal traffic disruption</li> </ul>	<ul style="list-style-type: none"> <li>● Confined space entry not required</li> <li>● Minimal traffic disruption</li> </ul>	<ul style="list-style-type: none"> <li>● Confined space entry often required</li> <li>● Potential traffic safety concerns</li> </ul>
<b>Program objectives</b>	<ul style="list-style-type: none"> <li>● Manhole inspection</li> <li>● Inspect limited length of pipeline from manhole</li> </ul>	<ul style="list-style-type: none"> <li>● Overall inventory, mapping, and assessment of collection system to quickly identify cleaning and structural improvement requirements</li> <li>● Inspect structural and service conditions of pipe 40 to 350 ft (12 to 107 m) of each manhole</li> <li>● Assess system to prioritize pipe sections requiring in-line CCTV inspection and cleaning</li> <li>● Determine type of cleaning required</li> </ul>	<ul style="list-style-type: none"> <li>● Complete pipeline inspection</li> <li>● Inspect service connections</li> </ul>

Another type of stationary camera system, the zoom-lens CCTV, uses a telescopic boom and electric winch for a greater scope of inspection since it can support the weight of additional lighting and camera casing to a depth of about 175 ft (53 m). While the video quality from a zoom-lens camera is similar to that of an in-line CCTV camera, it takes a different approach. Because no preliminary preparation work such as pipe cleaning and confined space entry is required, field crew productivity increases while costs and safety concerns are reduced.

Fixed to a telescopic boom or crane, the zoom-lens camera is lowered into a vertical structure or manhole. While descending into the structure, the camera records high-quality video of the manhole condition. The camera and lights, entirely remote-controlled, rotate 360 degrees for a clear inspection of the entire manhole. The camera also can be positioned in front of pipe connections while making its descent. With pan, tilt, and position controls, the camera viewpoint can be precisely positioned to record the internal pipe condition and defects

for a distance of up to 350 ft (107 m). The entire video is then recorded directly onto a CD-ROM, DVD, or computer hard drive in the inspection truck.

However, the camera cannot inspect past bends, and it is not a replacement for in-line CCTV inspection. Rather, it is a screening tool used to identify areas that require immediate maintenance or structural improvements. The software program also rates and ranks the pipelines and manholes using recognized standards such as that of the Pipeline Assessment and Certification Program and the Water Research Center PLC (Swindon, Wiltshire, United Kingdom). The zoom-lens camera is an excellent tool for developing operations and maintenance, and capital improvement programs.

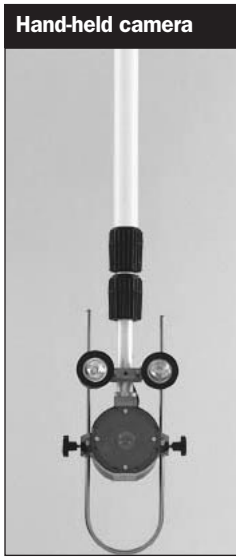
### In-line CCTV Systems

Traditionally, utilities have relied on in-line CCTV inspections to assess the condition of a collection system. Covering the entire section of pipe between two manholes or structures, in-line CCTV systems use pan-and-tilt cameras that can pinpoint the location and extent of defects and

<b>Comparison of Inspection Tools for Collection Systems (continued)</b>			
	<b>Hand-held CCTV*</b>	<b>Zoom CCTV</b>	<b>In-line CCTV</b>
<b>Camera capabilities</b>	<ul style="list-style-type: none"> <li>● 18x optical zoom and 4x digital zoom; total 72x</li> <li>● Can reach depth up to 22 ft (7 m)</li> <li>● Two 20-W halogen lights</li> </ul>	<ul style="list-style-type: none"> <li>● 22x optical zoom and 8x digital zoom; total 176x</li> <li>● Can reach depth of 32 ft (10 m) with standard setup, and up to 200 ft (61 m) with special equipment</li> <li>● Four 35-W halogen lights and four 50-W halogen lights</li> <li>● Addition of high beams for inspection of large tunnels</li> </ul>	<ul style="list-style-type: none"> <li>● 22x optical zoom and 8x digital zoom; total 176x</li> </ul>
<b>Inspection capabilities</b>	<ul style="list-style-type: none"> <li>● Inspection from road surface</li> </ul>	<ul style="list-style-type: none"> <li>● Use of telescopic boom for paved road access</li> <li>● Use of tripod when manhole up to 175 ft (53 m) from paved road</li> <li>● Use of crane truck for elevated manholes</li> <li>● Use of all-terrain vehicle for cross-country locations</li> </ul>	<ul style="list-style-type: none"> <li>● Inspection at pipe level</li> </ul>
<b>Productivity</b>	Approximately 30 manholes per day	<ul style="list-style-type: none"> <li>● Approximately 20 to 25 manholes and pipelines per day when located on paved road (about 6250 linear ft, or 1900 linear m)</li> <li>● Approximately 12 manholes and pipelines per day when off-road or cross-country (about 3000 linear ft, or 914 linear m)</li> </ul>	Approximately 3 to 5 manholes (1500 ft, or 457 m, of pipe per day)

inspect service laterals with a self-propelled robotic camera (see Figure 2, right).

However, for a preliminary collection system evaluation, the in-line CCTV system can be excessive. It has been shown that only about 25% of a collection system's pipes need regular cleaning, and in-line CCTV inspection may be necessary for less than 20% of the entire system, primarily where structural integrity problems exist. Also, since sewers must be cleaned before an in-line CCTV inspection, the cost of the practice can outweigh its benefits. For these reasons, utilities can save significant time and resources by limiting in-line CCTV use to only where it is most needed prior to repairs or for detailed investigations.



system is useful when obstructions prevent the camera from moving down the pipe.

As any informed collection system manager knows, a variety of tools are available besides camera technologies to assess collection systems, including scanners, ground-penetrating radars, and flow-monitoring equipment. These tools are useful for more detailed diagnostics than in-line CCTV can provide. Utility needs may be different, but everyone wishes to achieve timely, expected results at the lowest cost. The answer for many utilities may simply be a combination of two or more technologies that will enable

- an overall assessment of the entire collection system that is quick and cost effective,
- rating and ranking the collection system using recognized standards, and
- more attention to structural and operational deficiencies.

### In-line CCTV With Zoom Capability

Yet another option for assessing buried infrastructure is an in-line CCTV camera with a zoom lens. The entire in-line CCTV rig is placed inside a pipe, and the camera is equipped with a zoom lens that allows the user to see farther down the pipe without having to move the camera. This

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**Comparison of Inspection Tools for Collection Systems (continued)**

	<b>Hand-held CCTV*</b>	<b>Zoom CCTV</b>	<b>In-line CCTV</b>
<b>Reports and recording capabilities</b>	<ul style="list-style-type: none"> <li>● Text document outlining observed deficiencies</li> <li>● Mostly photos and limited video footage</li> </ul>	<ul style="list-style-type: none"> <li>● Interpretation and analysis of all videos by certified technicians</li> <li>● Videos and photos recorded onto CD, DVD, or computer hard drive</li> <li>● Videos and photos graphically linked to geographical information system maps for easy retrieval</li> <li>● Classification of defects using recognized standards</li> <li>● Pipe ratings for internal structural condition and potential for blockage grades</li> <li>● Manhole ratings for structural condition and blockage and safety grades</li> <li>● Preparation of database of inventory and system condition</li> </ul>	<ul style="list-style-type: none"> <li>● Text document outlining observed deficiencies</li> <li>● Videos and photos recorded onto CD or DVD</li> </ul>
<b>Mapping capability?</b>	No	Yes	No
<b>Cost</b>	From \$50 to \$80 per manhole	From \$0.60/linear ft (\$2/linear m) for basic service and up to \$3/ft (\$10/m) for cross-country locations	From \$1 to \$5/linear ft (\$3 to \$16/linear m) for larger pipes

\* Closed circuit television