MICROMETERING FOR BETTER MANAGEMENT

By Patrick L. Stevens

Effective sewer analysis with flow metering

Advances continue to be made in flowmeter sensors and software. Together, they open up new opportunities for collection system managers to extract even more performance information from their sewers. Most notably, the miniaturization of depth and velocity sensors is allowing flowmeters to operate more accurately in shallower flows. Ultrasonic depth sensors, for example, can function in depths as shallow as 1 in. These advances open up the possibility of measuring infiltration and inflow (I&I) in micro basins that can be as small as a few city blocks.

Precise Flow Metering

In the past 30 years, sewer flow metering has become an increasingly important part of sewer wet weather analysis. The original I&I studies, spawned by the Clean Water Act in the 1970s, included minimal flow metering, followed by an extensive sewer system evaluation survey (SSES). The flow measurement utilized rudimentary, depth-only measurement technology and provided a coarse assessment of the magnitude of I/I severity.

The act of locating sources of I/I was accomplished through SSES activities, which entailed physical inspection techniques such as smoke testing, dye water flooding and closed-circuit televising (CCTV). This approach earned a bad reputation due to the poor correlation between discovered defects and I/I magnitude. In many cases, the repair of all discovered defects resulted in no more than a 30% reduction of I/I.

As open-channel flow metering technologies advanced, introducing smaller sensors and more precise depth measurements, flow metering could be conducted in smaller pipes (and smaller basin sizes) with greater accuracy. An I/I study with smaller basin sizes (around 10,000 ln ft) revealed that I/I often conforms to the Pareto 80/20 rule: 80% of I/I volume originates within 20% of the collection system.

Basin sizes of 10,000 ln ft can isolate 80% of I/I volume into approximately 20% of the system. Knowing where I/I is concentrated allows traditional physical inspection techniques to be focused in areas that are known to leak. This means that precise flow metering can reduce subsequent costs for physical inspection.

When presented with the 80/20 findings, many collection system managers say, "That is not how my system performs in wet weather." But without measuring system performance in small basins, it would be hard to make a proper judgement.

Traditional tools such as smoke testing, dye water flooding and CCTV can provide false positives and false negatives. They are surrogates for finding actual leaks. They can spot defects that likely leak, but they cannot determine the magnitude of the leak associated with the defect. In a world with no limitations of technology or cost, a flow measurement at every manhole would provide all the information needed to locate sources of I/I. Physical inspection techniques would be used as a visual tool to select the type of rehabilitation.

Two recent developments are increasing opportunities for micrometering, or metering in segments of just a few manholes (micro basins). Consulting firm Stantec has developed a micromonitoring weir that incorporates a preshaped flume affectionately referred to as the "Smurf Butt" flume. It is designed to measure low flows; a conventional depth-velocity probe measures high flows. The Smurf Butt also backs up the flow deep enough to allow conventional probes to operate.

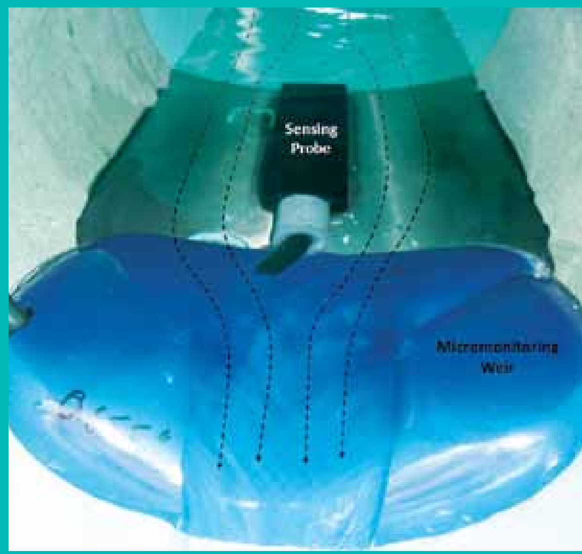
ADS has developed a low-profile up-looking ultrasonic sensor that can operate in flows as shallow as 1 in., which can facilitate measurement in micro basins. New up-looking ultrasonic technology in low-profile sensors makes it possible to obtain accurate, drift-free depth measurements in a configuration that can be installed from the street surface. The low-profile ultrasonic sensor has many benefits, including:

- The ability to operate in very shallow flows;
- Drift-free depth measurements; and
- High precision in depth measurements.

The benefit of micrometering is that it can, with certainty, isolate sources of I/I into smaller segments of the system. This means that traditional SSES activities will be deployed in only those pipe segments that are known to be leaking.

For example, a case study from Stantec showed completely different responses from two adjacent micro basins. Each micro basin included approximately 50 homes with nearly the same base flow. One micro basin exhibited a distinctive and large response to a rainfall, while the other exhibited no response. The investigator, as

New technology is enabling collection system managers to extract more information from their sewers.



The flume measures low flow and backs it up enough to keep the conventional probe submerged.

a result, knew exactly which micro basin required additional investigation.

This I/I response would have looked quite different by the time it reached a flowmeter in a traditionally sized meter basin with a single meter farther downstream. As a fraction of total flow, this response would be smaller and it would be blended with the responses from any other micro basins that leaked. Physical inspection tools would have deployed over the entire basin and would have been wasted in the first micro basin and all other micro basins that did not exhibit I/I.

Relative vs. Absolute Accuracy

To make micrometering acceptable to I/I practitioners requires reduction in the cost of installation and operation. This may require new technology, and perhaps require that current practices be made more efficient, be reduced or be eliminated. One possible improvement to current practices is to recognize that the micrometering concept can function with "relative accuracy" as opposed to "absolute accuracy."

Absolute accuracy is achieved in current I/I studies in which key performance indicators are calculated. Indicators include percentage of rainfall entering the sewers as I/I (capture coefficient) or gallons of I/I per inch of rainfall per linear foot of sewer length. These absolute measurements not only allow managers to identify poorly performing basins, they also allow modelers to conduct model calibration. This type of metering is conducted over periods of six months or longer.

Micrometering can be effective with lower accuracy because the purpose is to identify which micro basins are good or bad. After just a few significant storms, there may be enough data to direct follow-up SSES work.

Cost Savings

Cost savings can be realized from the following practices:

- Installing meters from the street surface instead of entering a manhole;
- Eliminating manual confirmations to verify meter accuracy;
- Reducing expectations of absolute meter accuracy in favor of relative changes in flow during storm events;
- Understanding that uptime may suffer when meters operate in very shallow flow, such that depth and velocity data are collected only during daytime flows or during a rain response; and
- Reducing the amount of time spent data scrubbing.

The trend in I/I reduction programs since the 1970s has given flow metering a larger role in locating sewer defects. Traditional SSES activity has taken a smaller role in quantifying I/I. Ideally, if a technology existed to observe flow-rainfall response at every sewer segment (between manholes) or, better yet, at every individual pipe segment, the role of SSES activities would be to merely locate the problem visually and allow engineers to determine the necessary repairs or replacements.

Nevertheless, the preceding innovations are moving the industry toward greater reliance on flow measurement and less reliance on the surrogate SSES activities. WWD

Patrick L. Stevens, P.E., is vice president of engineering for ADS Environmental Services. Stevens can be reached at pstevens2@idexcorp.com.

For more information, write in 1109 on this issue's reader service form on page 53.