Hillsborough County's Innovative Pipe Inspection Program Adds Efficiency and Accuracy

Richard Cummings and Michael Condran

Hillsborough County is Florida's fourth largest water utility and faces significant challenges with excessive inflow and infiltration (I/I) in its gravity collection system, consisting of nearly 1,500 mi of pipe. Typically, precipitation events result in immediate flow responses within the collection network, with up to three times the average daily flow rates seen at all its pump stations and treatment facilities.

New legislation, the Florida Clean Waterways Act, was signed into law in 2020 requiring all Florida utilities to focus greater attention on sanitary sewer overflow (SSO) mitigation. The formal rulemaking process is underway and is expected to be finalized this year. New reporting requirements and fine structures mean that Florida water infrastructure managers will need to develop robust asset management programs to, among other things, establish optimal collection system performance. Meanwhile, COVID-19 fiscal realities have caused stark choices to be made regarding capital spending priorities.

Even under pandemic conditions, the county continues to install between 700 and 800 new residential water meters each month. The county's strong population growth means that available wastewater treatment capacity limits are being approached at several plants. Thus, in addition to the new pending SSO regulatory obligations, controlling unwanted I/I is critical for the county to both extend treatment plant capacity to the greatest extent and determine capital spending priorities for pipeline replacement or rehabilitation.

While the county maintains a proactive sewer inspection and rehabilitation program, I/I continues to be a concern in several areas of the collection network. The county uses several inspection methods, including smoke testing, night-flow isolation investigations, and flow monitoring; however, I/I evaluations have, to date, relied heavily on closed-circuit television (CCTV) visual pipe inspection performed by in-house crews and a third-party contractor.

Inspection results have been used substantially to help develop rehabilitation priorities, as well as verifying watertightness after new sewer liners were installed. Significant capital spending for both inspection and rehabilitation work has not seen a suitable corresponding I/I reduction. The county has sought out different inspection methods to develop rehabilitation and repair programs more accurately.

A field demonstration of focused electrode leak location (FELL) technology in November 2018 indicated that this relatively new inspection method held promise to support the county's need for I/I control.

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Focused Electrode Leak Location Technology Pipe Inspection Operating Principles

With FELL technology, a probe is advanced between manholes and emits a continuous alternating current electrical current. If a defect exists in the pipe walls, at joints, or in lateral connections, the current will escape the pipe and travel to a preset grounding source to close a circuit. The intensity and duration of the measured current is plotted, and a horizontal location, accurate to within 3/8 of an in., is documented. An approximate potential I/I flow rate is also calculated and reported in units of gal per day (gpd) and gpd per in. diameter mi (gpd/idm). Figure 1 shows a standard field inspection arrangement.

The technology has been the subject of numerous United States and international

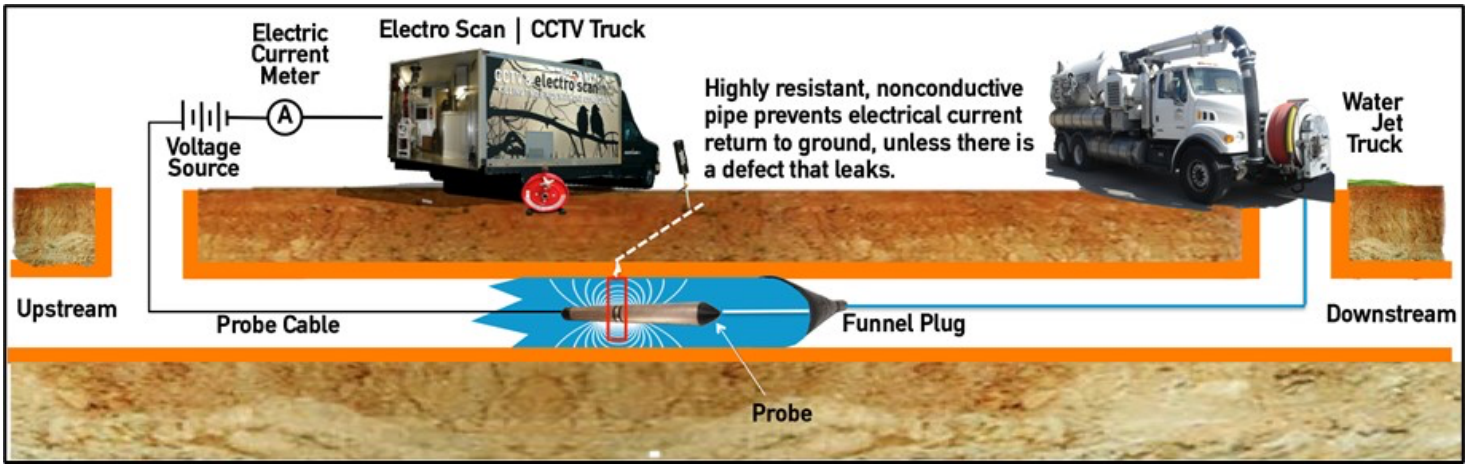

Figure 1. Typical focused electrode leak location pipe inspection equipment arrangement.

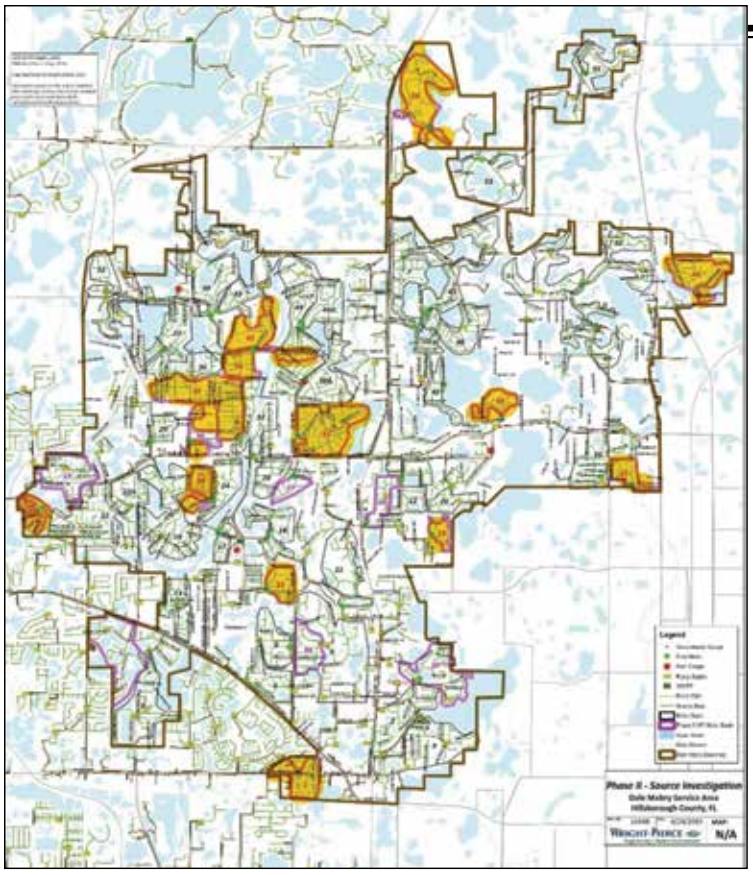

Figure 2. Dale Mabry Collection Basin, indicating 14 sub-basins where focused electrode leak location inspection was performed.

studies and benchmarking investigations since the early 2000s. Third-party evaluation work was performed by the U.S. Environmental Protection Agency (EPA), Water Environment and Reuse Foundation (WERF), American Society of Civil Engineers (ASCE), American Society of Testing and Materials (ASTM), American Water Works Association (AWWA), COMSOL Inc., German institute of Underground Infrastructure (IKT), United Kingdom-based Water Research Centre (WRc), and the Japan Sewer Collection System Maintenance Association (JASCOMA).

The ASTM Standard F2550, Standard Practice for Locating Leaks in Sewer Pipes by Measuring the Variation of Electric Current Flow Through the Pipe Wall, defines how field work is conducted and results are reported.

While CCTV is an important inspection tool, especially to offer insights about structural and operation and maintenance pipe features, such as alignment; debris presence; silt; fats, oils, and grease (FOG); protruding service laterals; crossbores; encrustation; roots; separated joints; and collapses, the county identified several specific advantages of FELL inspection, including:

1. Documenting conditions contributing to pipe and/or liner failures, including accidental cuts, bad service reconnections, delamination, defective epoxy, etc.
2. Inspecting individual joint watertightness, including potential infiltration pathways.
3. Determining watertightness of customer service connections.
4. Providing consistently repeatable results without human judgment or bias.

Dale Mabry Collection Basin

Based on the successful November 2018 field demonstration, the county decided to use FELL as part of an ongoing I/I investigation for the Dale Mabry Collection Basin, which is located in the northwestern part of the county's service area and generally incudes Tampa's Carrollwood neighborhood.

There are 59 sub-basins across the Dale Mabry network. Of these, 14 sub-basins were identified during the county's phase one study, done by a consulting engineer, as first priority for FELL inspection. Figure 2 shows the Dale Mabry basin and highlights the 14 sub-basins where FELL inspection was performed. Several pipe material types were included in the FELL inspection scope, including fold-and-form polyvinyl chloride (PVC), vitrified clay pipe (VCP), and cured-in-place pipe (CIPP). After each scan was complete for individual pipe segments, data were immediately uploaded to a cloud-based processing application for reporting to the county.

Continued on page 26

Table 1. Focused Electrode Leak Location Inspection Summary by Sub-Basin, Ranked by Greatest to Least Inflow and Infiltration Potential

Sub Basin	FELL Length (LF)	% Total FELL Length (LF)	% Potential I/I (GPD)
42	13,679	11%	24%
31	23,903	19%	20%
25	5,174	4%	11%
1	6,541	5%	8%
33	13,447	11%	8%
14	8,444	7%	7%
41	5,573	5%	7%
19	4,832	4%	3%
15	4,984	4%	3%
30	6,488	5%	3%
21	6,094	5%	2%
49	12,578	10%	2%
54	9,717	8%	1%
34	1,664	1%	1%
TOTAL	**123,117**	**100%**	**100%**

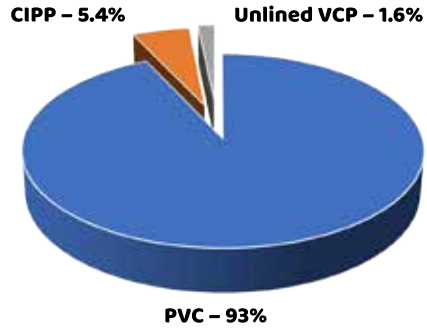

Figure 3. Dale Mabry Collection Basin focused electrode leak location inspection length by pipe material type.

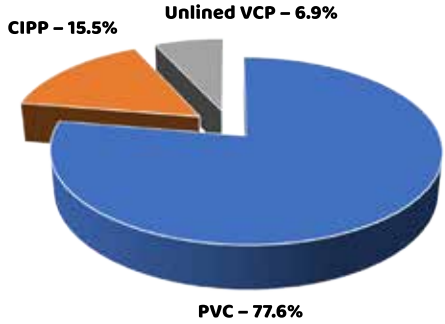

Figure 4. Dale Mabry Collection Basin focused electrode leak location inspection potential inflow and infiltration by pipe material type.

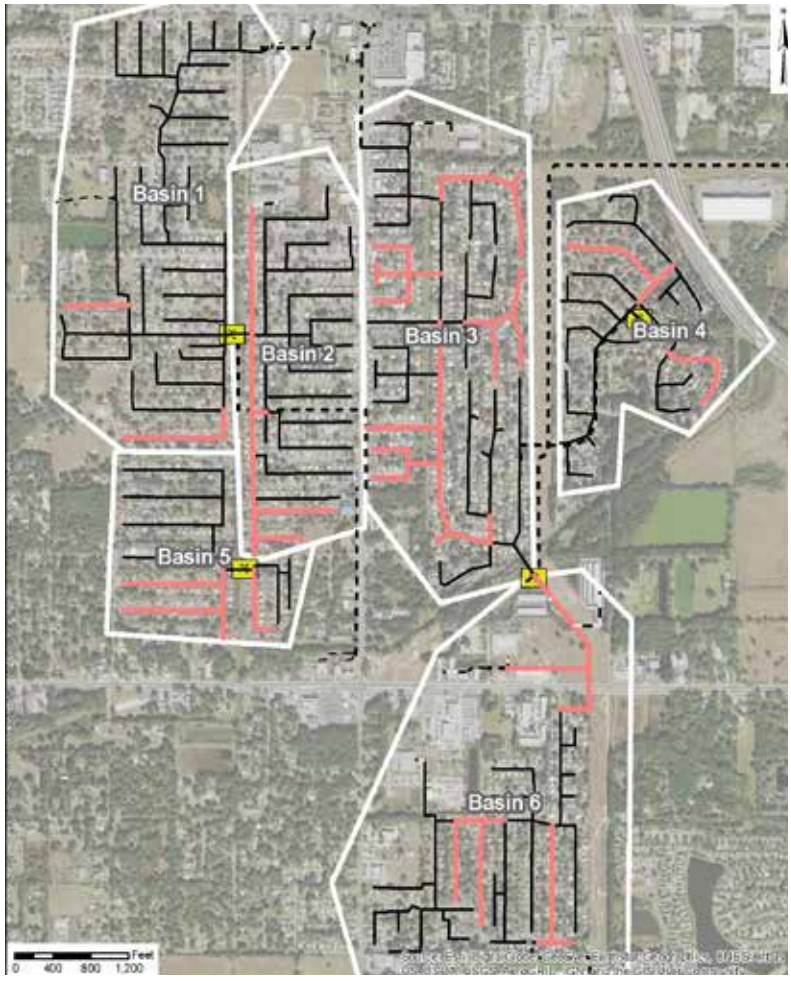

Figure 5. Clair-Mel Collection Network indicating the portion of the network where focused electrode leak location inspection was performed.

Table 2. Focused Electrode Leak Location Inspection Summary by Pipe Material Type

Pipe Material	FELL Length, LF	% Total FELL Length	% Potential I/I, GPD
PVC	22,749	69.5	72.1
CIPP	5,058	15.4	19.5
VCP	4,951	15.1	8.4
TOTAL	**32,757**	**100%**	**100%**

Figure 6. Clair-Mel electrode leak location inspection results showing individual pipes with greatest potential defect flow rates contributing to inflow and infiltration.

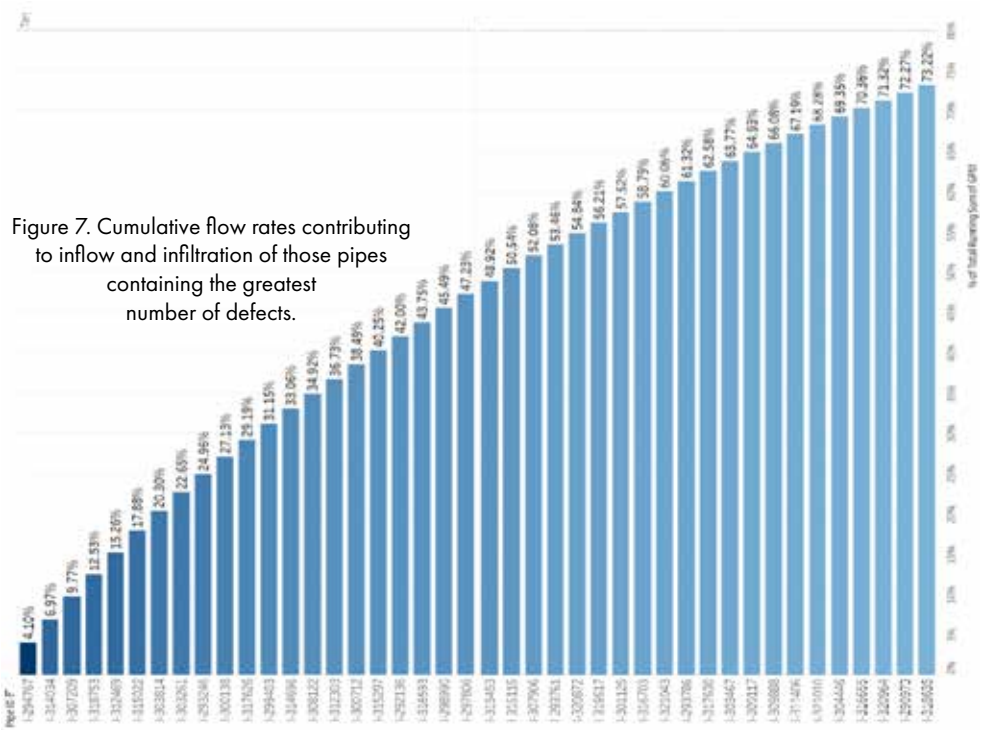

Figure 7. Cumulative flow rates contributing to inflow and infiltration of those pipes containing the greatest number of defects.

Continued from page 25

Summary inspection data for the 14 sub-basins inspected are shown in Table 1.

The county was especially interested in the straightforward FELL data organization, which documented that 34 percent of the inspected pipes, by length, represented 55 percent of the potential I/I flow rates. In this way, an organized set of priorities were able to be quickly identified, with a focus on addressing only those pipes contributing to the greatest potential I/I. This approach allowed the county to avoid costs associated with unnecessary pipeline rehabilitation or replacement.

Figures 3 and 4 summarize the breakdown of pipe material type inspected and the corresponding potential I/I flow rates, respectively.

These summary data show that unlined VCP installed in the 1970s and '80s, and relatively newer CIPP liners, represented only 7 percent of the total inspected length, but contributed over 22 percent of the potential I/I for the pipes inspected. Targeted rehabilitation can now be focused on these pipe classes as a priority.

Clair-Mel Collection Network

The Clair-Mel Collection Network was originally a developer-installed franchise collection system in the county's southeast service area east of downtown Tampa, and the county is ultimately responsible for its operation and maintenance. The entire Clair-Mel network consists of approximately 120,000 lin ft (LF) of gravity pipes. An initial desktop evaluation and night-flow isolation work by the county's engineering consultant identified 33,000 LF for FELL inspection, or approximately 28 percent of the Clair-Mel network.

Figure 5 shows the Clair-Mel network and the portion of the area where the FELL inspection was performed.

Table 2 summarizes FELL inspection results by pipe material type and includes the corresponding length, the length inspected as a percentage of the entire project, and potential I/I rates as a percentage for each. Notably, only the unlined VCP pipes showed a lower total potential I/I relative to its relative percentage of length inspected.

Figure 6 shows individual pipe segments using a color-coded summary. It indicates the potential I/I defect flow rates relative to all the pipe inspections ranked into the following five flow rate categories:

- Potential I/I rate more than 50 gal per min (gpm)
- Between 25 – 50 gpm
- Between 15 – 25 gpm
- Between 7.5 – 15 gpm
- Potential flow rate less than 7.5 gpm

Figure 7 graphically depicts the cumulative potential I/I flow rate for the 35 percent of all pipe inspections and reveals that these pipes collectively contribute nearly 75 percent of the potential I/I of those inspected across the Clair-Mel network. This allows the county to make targeted decisions on how to focus a rehabilitation program to maximize I/I reduction at the lowest possible cost.

Summary

Based on results from two studies totaling 30 mi of gravity pipe inspection, the county has been able to identify those pipes contributing the greatest potential I/I, and thereby optimize its capital spending for pipe rehabilitation and repair work. Given the inspection results, the county has now adopted FELL inspection for its rehabilitation strategy development and will be retrofitting one of its in-house CCTV inspection trucks to add FELL inspection equipment so that collections staff members can self-perform pipe inspections going forward.