Trenchless TECHNOLOGY

THE CITY OF RACINE

ORDERS AN "MRI" FOR CIPP TESTING & ACCEPTANCE

By Carissa Boudwin

"LOW VOLTAGE CONDUCTIVITY provides points of inflow and infiltration (I/I) not readily visible to the human eye," states John Rooney, P.E., city engineer and assistant commissioner of public works, City of Racine, Wis. "Or even the keen eye of PACP-certi-fied CCTV camera operator."

"Using Low Voltage Conductivity to inspect a sewer — a machine-intelligent probe that automatically scans 360 degrees of a pipe wall for openings — is like performing magnetic resonance imaging (MRI)," continues Rooney. "By comparison, using closed-circuit television (CCTV) inspection is like using an X-ray."

Just like you hope your doctor uses the right medical diagnostic tool before scheduling a major surgery, engineers must use the right tools to properly locate defects and their severity along a pipe wall to determine the best approach for a cost-effective repair, rehabilitation, or renewal program.

FINDING, FIXING & FINAL ACCEPTANCE

Finding sources of infiltration has remained elusive at the City of Racine. Like many other cities, Racine had long suspected problems with how it was developing a comprehensive list of defects that would help prioritize sewers that need fixing. More importantly, Racine was having growing suspicions on approving trench construction, point repairs, sliplining and cured-in-place pipe (CIPP) lining projects, based on visual inspection.

Often unable to confirm or dispute a CCTV operator's subjective assessment of pre-and post-rehabilitation of sewers, the City of Racine decided to propose a new approach to find and measure the severity of defects, before and after rehabilitation.

Electro Scanning equipment easily modified to be added to standard CCTV Trucks.

The ability to locate and estimate amounts of I/I is an important goal for Racine. Presented to Racine's Public Works and Services Committee, it was agreed to pilot the use of Low Voltage Conductivity on an upcoming 5,600-lf CIPP lining project.

Located on the shore of Lake Michigan, and having high groundwater conditions, the Greater North Bay Neigh-borhood was the perfect site to test and assess a new way to quantify un-wanted flows, both before and after rehabilitation.

With help from Racine's consulting engineering firm, St. Paul-based Short Elliott Hendrickson Inc. (SEH), a key objective of its CIPP project would be to quantify specific defect flow rates, for each sewer main, estimated flow reductions from the rehabilitation program and a cost/benefit analysis.

MOVING FROM "X-RAY" TO "MRI"

Many of the pipes in Racine's pilot area often surcharged during dry or wet-weather events, while some only surcharged during wet-weather events. As a result, CCTV observations were often inconclusive or unable to locate specific sources of active infiltration.

While metered flows at pump stations could identify peak flows, entry paths for water entering the network at specific joints, bad service connections, defective manholes or internal cracks in the wall of the pipe, were not apparent.

A new level of diagnostic tool, akin to what can be found in modern day MRI readings, compared to old style X-Ray, was about to be put to the test. Working with the only ASTM-compliant supplier of low voltage conductivity,

THE ABILITY TO LOCATE AND ESTIMATE AMOUNTS OF I&I IN GPM IS AN IMPORTANT GOAL FOR RACINE.

Sacramento-based Electro Scan Inc. was contracted to locate and measure all of the potential leak sources, before and after CIPP. Using the same coax cable and reel typically used for a high-resolution CCTV camera, a focused array of low voltage electric current (i.e. 40 milli-amps or 5AA batteries) measured the variation of electricity that escaped through openings (i.e. defects) in a pipe's wall.

Given a surface located grounding stake, any opening in a pipe means that electric current inside the pipe would always take "the path of least resistance" to seek out the above-ground stake to complete its circuit. And, since a common footage reading is available using the same footage en-coder, defect locations could be easily compared between CCTV & Electro Scanning Inspection.

In contrast to CCTV inspection, the new approach would be able to locate and measure defects inside the bell and spigot of each joint, defects at lateral connections, cracks often hidden by fats, oil and grease (FOG), and defects beneath silt — not typically visible by CCTV operators.

More importantly, the technology would also be able to identify leaks in CIPP liners, such as accidental cuts, accelerant burns, bad resin mixtures, degraded epoxy, fins and folds, poor service reinstatements, overcooking, ridges, and wrinkles.

				PRE-CIPP					POST-CIPP				
Mainline Segment				Number of Defects				Defect Flow	Number of Defects				Defect Flow
From ID	To ID	Pipe Type	Pipe Dia.	Small	Med	Large	Total	GPM	Small	Med	Large	Total	GPM
AA004	AA003	CP	8	46	17	26	89	130.5	2	3	5	10	47.9
AA022	AA021	RCP	8	37	38	19	94	122.9	0	0	1	1	0.8
AA025	AA022	RCP	8	46	39	15	100	110.0	3	0	0	3	1.4
AA019	AA002	CP	8	29	17	12	58	77.6	0	1	0	1	0.3
B0273	AA004	RCP	8	39	24	11	74	71.6	0	1	1	1	12.2

Automatic reports available within minutes after each scan.

Similar to the display of video images, data from the low voltage probe is sent via cable to an onboard computer. Once collected and stored on a laptop computer, data is uploaded to the cloud where expert algorithms instantly process and deliver estimated gallons per minute defect flows, for each specific defect location, including start footage, end footage and maximum defect current levels, with all results in minutes.

Each leak is graphically displayed for each mainline having a location accuracy of 0.4 inches (1 cm).

PRE-REHABILITATION DIAGNOSIS

On Nov. 11 and 12, 2015, Electro Scan Inc. completed the pre-rehabilitation portion of the assessment on approximately 5,550 ft of sanitary sewer mains. The diameters ranged from 8 to 10 in. and pipe material was primarily concrete. The results of pre-CIPP Electro Scanning Inspection include:

- 28 pipe segments were assessed to have an estimated infiltration rate of 1,186 gpm or 1,707,840 gpd, (+/- 40 percent), with 133 gpm from "severe" flows (4.0 gpm to 10.0 gpm).
- 1,286 leak locations were detected, with 180 rated as "large" (700 to 4,000 mA)
- Almost all potential leaks occurred at joints, with a handful of exceptions.

POST-REHABILITATION DIAGNOSIS

On April 5 and 6, 2016, Electro Scan completed the post-rehabilitation assessment on the same pipes, after CIPP liners were installed. The results of the post-CIPP Electro Scanning Inspection include:

- 28 CIPP pipes assessed have a potential to infiltrate 301.96 gpm or 434,823 gpd, (+/- 40 percent); 230 gpm came from "severe" flows (4.0 gpm to 10.0 gpm).
- 96 potential leak locations were detected, with 40 rated as "large" (700 to 4,000 mA).

When SEH compared the pre-rehabilitation scans to the post-rehabilitation scans, the total potential infiltration was reduced by an estimated 75 percent or 1.273 million gpd and defects were reduced by 93 percent. While 24 of the 28 pipes had defects, there were four of the 28 pipes, or 19 percent of total linear feet, showed minor increases in defect flow. The Electro Scan results of these four pipes corresponded with the post-lining videos which showed significant interstitial flow, which was now concentrated at the lateral reinstatements.

GOING FORWARD

The City of Racine is continually monitoring I/I reductions using flow monitoring and comparing to the estimated reduction provided by the low voltage conductivity results. Thus far, it is showing promising results. The reduction in I/I will be used to help in decision-making on the most cost effective rehabilitation strategies in the future.

Additionally, the data gathered will be used to make judgments on lateral rehabilitation strategies, so flows will not be higher after a pipe has a CIPP liner installed. Racine can use the information to repair lateral reinstatements which leak the most, and avoid rehabilitating lateral reinstatements that are leak-free. Lastly, Racine intends to use results from its project as a measure of effectiveness (MOE) when reporting I/I reductions in its annual CMOM report and to demonstrate I/I reduction to Racine's sanitary sewer treatment provider.

Carissa Boudwin is director of marketing at Electro Scan.