CRITICAL SEWER & WATER CHRONICLES

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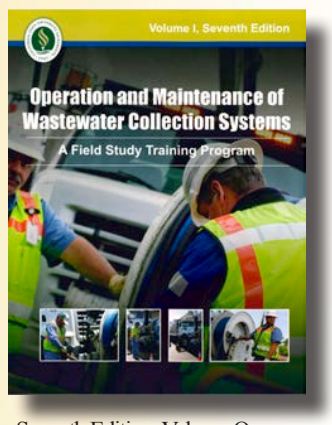
Electro Scan Offers Large Diameter Leak Detection Service With New Probe

Electro Scan Inc. is pleased to announce the availability of its patented technology to automatically assess large diameter pipes (i.e. up to 66 in or 1650 mm). The service is offered exclusively by the Company and represents a new addition to its expanding product line of proprietary machine-intelligent devices.

Once limited to using tethered sonar devices, *able to measure the outline of debris fields, but not locate or estimate the size of leaks*, sewer utilities can now accurately identify pipe specific locations and severity of each defect and total pipe, to accurately prioritize rehabilitation. Data is collected in accordance with the 7th Edition, Volume 1, ***Operation and Maintenance of Wastewater Collection Systems***, written by the late Ken Kerri, Ph.D., P.E., with data integrated with Innovyze® InfoMaster® for Sewer.



Seventh Edition, Volume One,
Operations & Maintenance of Wastewater Collection Systems
ISBN 978-1-59371-066-8

"Some people call it *witchcraft,*" says Chuck Hansen, Chairman of Electro Scan Inc. "I wish it was that simple. But, we wanted to do away with the need for third-party data interpretation and an operator's subjective visual observations."

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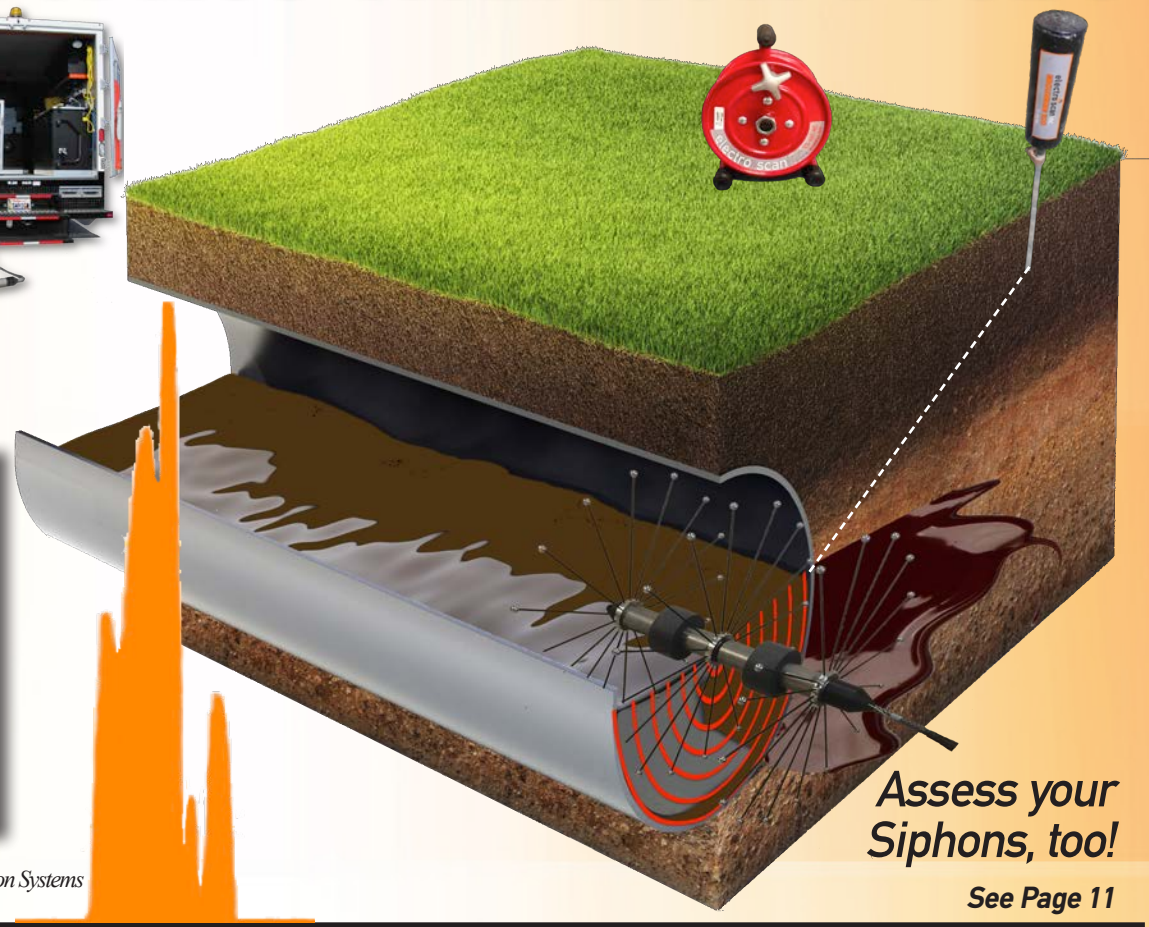

Assess your Siphons, too!

See Page 11

San Francisco Wastewater Bids Adopt New Standards for $10 Million in Projects

Electro Scanning Inspection Specified in Multiple Projects to Certify New Sewer Pipes

So far in 2017, Electro Scan Inc. has responded to nearly $10 million in bids issued by San Francisco Public Utilities Commission (SFPUC) and San Francisco Department of Public Works (SFDPW). Focused Electrode Leak Locator (FELL) Inspection, also know as Electro Scanning Inspection, was required to certify the installation and performance of wastewater rehabilitation.

Two Requests for Proposals (RFPs) closed in January, requesting line-item pricing for FELL Inspection to certify the Contractor's installation of new Vitrified Clay Pipe (VCP) and Culverts throughout the City, totaling over 10,000 linear feet.

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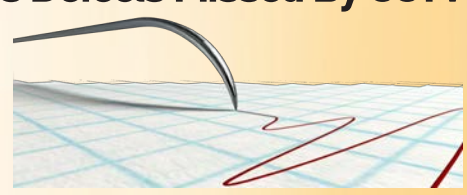
Electro Scan Finds 69% of CIPP Liners Have Leaks

New 'Polygraph Test' Finds Defects Missed By CCTV



We all had hoped that Cured-In-Place Pipe (CIPP) lining could live up to its high expectations and fifty year useful life. But, Electro Scanning Inspection tests are finding a much different story.

Aided by a new technology that automatically finds and measures every leak in pipe walls, determining an estimated gallon per minute or liters per second of defect flow, pipeline owners and operators can now correctly certify and accept newly repaired, relined, and renewed pipes.

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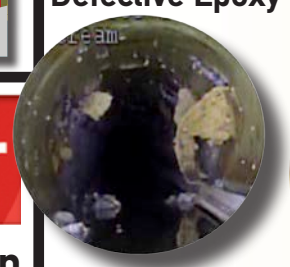
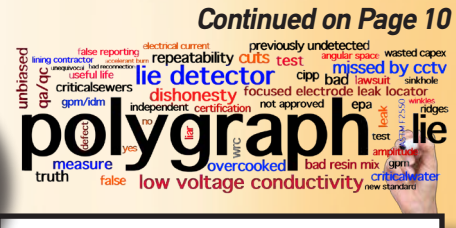




California Sewer Utility Requires Electro Scanning Inspection For Post-CIPP Rehabilitation Acceptance

New Specification Requires Adherence to ASTM F2550-13 & Wastewater Collection O&M Manual

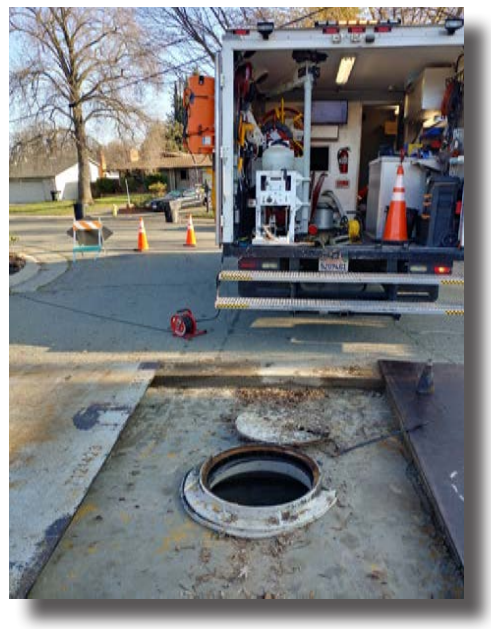
Unable to consistently & accurately find defects in CIPP lining using existing methods, a California sewer agency was looking for a solution that could provide unbiased & unambiguous assessments of a Contractor's work.

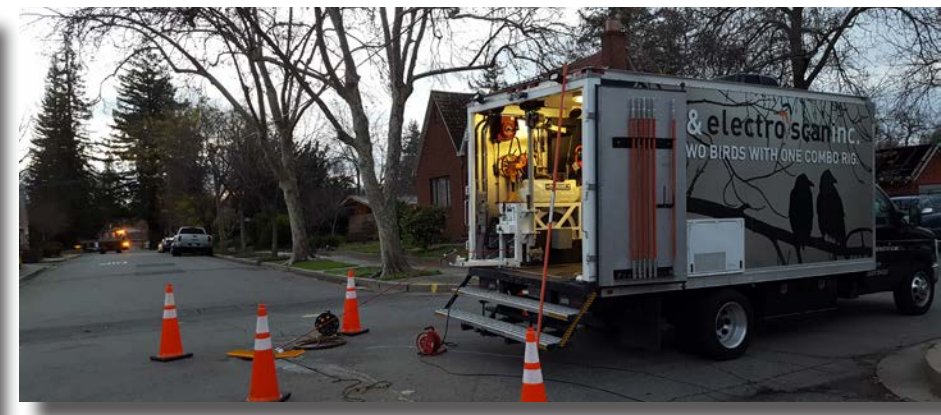
Given the cost per foot of trenchless repairs, Electro Scanning Inspection appeared best positioned to provide a Baseline Defect Flow Rating, measured in gallons per minute or liters per second.

At a cost of $4.00 to $8.00 per foot, sewer agencies and their consulting engineers can use Electro Scanning Inspection to determine a quantified reduction in flow prior to the acceptance of rehabilitation.

Project Highlights

- Post-CIPP work reduced total defect locations from 509 to 25.
- Post-CIPP Estimated Defect Flow was reduced from 660 GPM to 80 GPM, or a reduction of 581 GPM or 88%.
- The majority of Post-CIPP defects were linked to specific service reconnection locations, previously identified as LIVE, i.e. not CAPPED, with other defects noted.
- Two lines experienced larger defect flows AFTER CIPP, in comparison to Pre-CIPP Defect Flows surveyed BEFORE CIPP.





Lessons Learned

1. CCTV should not be used to Certify or Approve Lining Contractor's work. Since CCTV is a visual inspection process it cannot reliably or consistently detect lining defects, quantify openings to ground, or assess service reinstatements.

2. CIPP lining of sewer mains do not always reduce defect flows.

3. Post-CIPP Defect Flows may be higher AFTER lining, than BEFORE, as remote tap cutters may accidentally create collateral openings to the soil.

4. To better manage Capital Expenditures, Lateral Connection Liners should be a Post-CIPP Decision, not an across-the-board Pre-CIPP specification requirement.

5. Since Electro Scan provides a highly precise location and severity for each defect, Post-CIPP CCTV should be done AFTER Electro Scan, with the camera STOPPING at each Electro Scan location to pan, tilt, and zoom, accordingly. Otherwise, CCTV will pass by defect.

6. Electro Scanning Inspection is recommended for all pre- and post-rehabilitation, in accordance with ASTM F2550-13 and the 7th Edition, Volume 1, OPERATIONS AND MAINTENANCE OF WASTEWATER COLLECTION SYSTEMS manual, ISBN 978-1-59371-066-8.

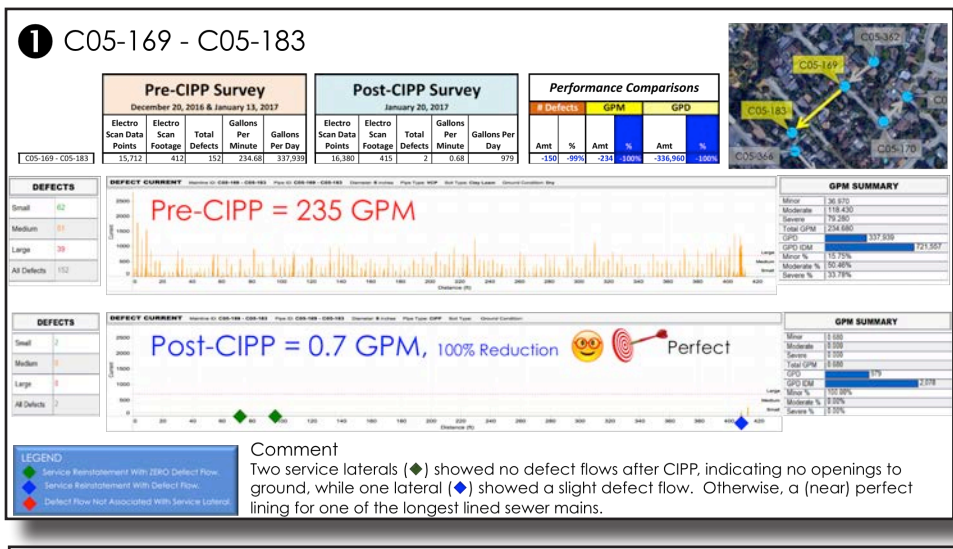
Continued below...

6" pipes requiring rehabilitation.

Ranked By % Reduction in GPM & GPD

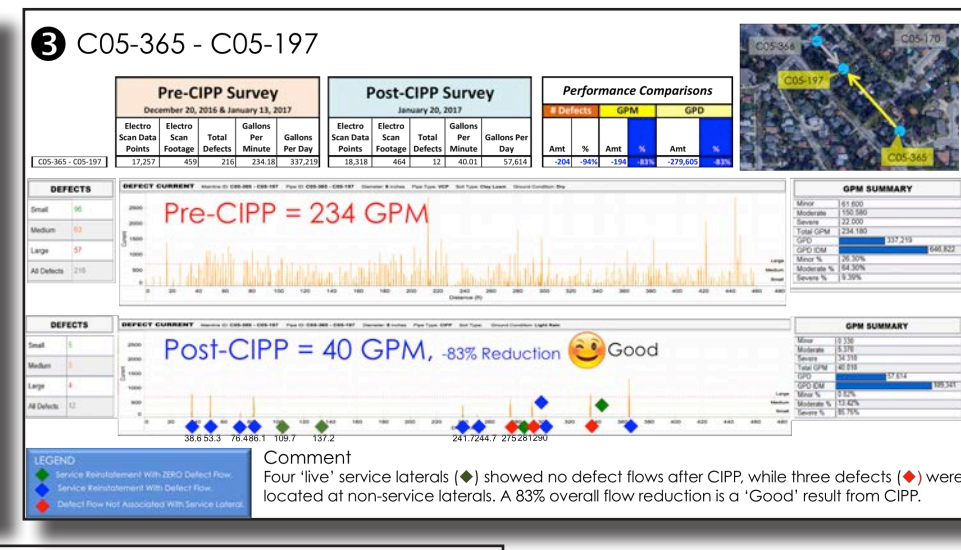
	Sewer Mains	Pre-CIPP Survey Dec 20, 2016 & Jan 13, 2017					Post-CIPP Survey Jan 20, 2017					Performance Comparisons					
												# Defects		GPM		GPD	
		Electro Scan Data Points	Electro Scan Footage	Total Defects	Gallons Per Minute	Gallons Per Day	Electro Scan Data Points	Electro Scan Footage	Total Defects	Gallons Per Minute	Gallons Per Day	Amt	%	Amt	%	Amt	%
		52,596	1,406	509	660.18	950,659	55,731	1,411	25	79.56	114,565	-484	-95%	-581	-88%	-836,094	-88%
1	C05-169 - C05-183	15,712	412.1	152	234.68	337,939	16,380	414.6	2	0.68	979	-150	-99%	-234	-100%	-336,960	-100%
2	C05-362 - C05-169	7,147	188.1	70	174.79	251,698	7,457	188.7	4	11.96	17,222	-66	-94%	-163	-93%	-234,476	-93%
3	C05-365 - C05-197	17,257	458.8	216	234.18	337,219	18,318	463.7	12	40.01	57,614	-204	-94%	-194	-83%	-279,605	-83%
4	C05-210 - C05-198	6,029	166.5	32	7.75	11,160	6,461	163.5	3	10.31	14,846	-29	-91%	2.56	33%	3,686	33%
5	C05-170 - C05-171	6,451	180.2	39	8.78	12,643	7,115	180.1	4	16.60	23,904	-35	-90%	7.82	89%	11,261	89%

❶ C05-169 - C05-183



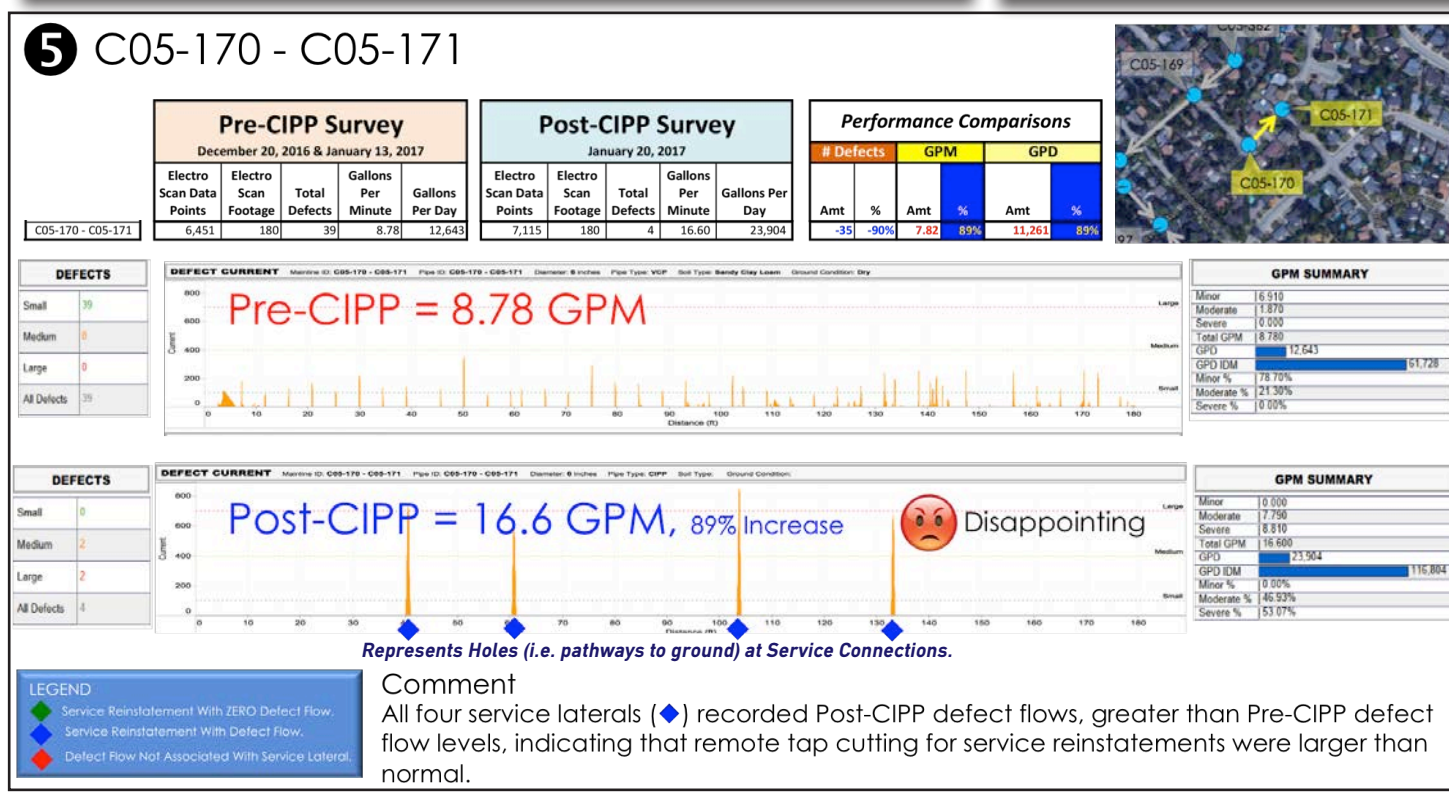
Comment
Two service laterals (◆) showed no defect flows after CIPP, indicating no openings to ground, while one lateral (◆) showed a slight defect flow. Otherwise, a (near) perfect lining for one of the longest lined sewer mains.

❸ C05-365 - C05-197



Comment
Four 'live' service laterals (◆) showed no defect flows after CIPP, while three defects (◆) were located at non-service laterals. A 83% overall flow reduction is a 'Good' result from CIPP.

❺ C05-170 - C05-171



Represents Holes (i.e. pathways to ground) at Service Connections.

Comment
All four service laterals (◆) recorded Post-CIPP defect flows, greater than Pre-CIPP defect flow levels, indicating that remote tap cutting for service reinstatements were larger than normal.

Lessons Learned Continued

7. The city should not just measure success on a Top Down basis of reduction in defect flow; rather, it should assess Contractor performance on a pipe-by-pipe basis.

8. Since many Service Reinstatements measured ZERO DEFECT FLOWS, Contractors should have an incentive to achieve more precise remote tap cutting, eliminating the need for Lateral Connection Liners. Lateral Connection Liners should only be recommended for those services that have unacceptable levels of defect flow.

9. Future wastewater rehabilitation specifications should consider (a) Contractor performance bonus of $250 for every service connection (◆) that registers ZERO DEFECT FLOW, (2) requirement to joint grout all service connections were defect flows are found by Electro Scanning Inspection, (3) require the installation of a lateral connection liner at the cost to the Contractor, where all services show Post-CIPP defect flows greater than Pre-CIPP levels.

South Florida Sewer Agency Conducts Post-CIPP Assessment of Sewer Mains & Service Laterals

Cured-in-Place Pipe (CIPP) rehabilitation projects generally take several years to happen. Once a sewer utility identifies suspicious sewer mains that should be relined, plans must be designed, budgets must be put in place, and public bids must be released to find the lowest qualified bidder.

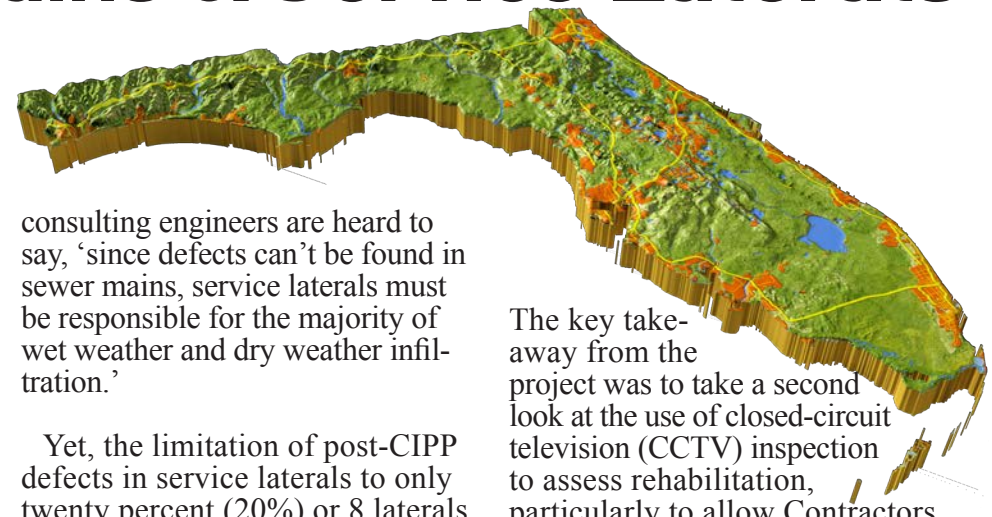
One large metropolitan South Florida sewer agency had been watching Electro Scan with interest and wanted to put their CIPP contractor to the test in a post-rehabilitation assessment of an entire neighborhood that would be relined.

Not limited to just the sewer mainlines, the South Florida utility decided to 'line it all.'

So it was with great surprise when their Electro Scan Services report found over 300 defects (both sewer mains and laterals), each with a specific location and estimated leakage rate shown in gallons per minute to two (2) decimals.

"This is what we would have expected from a pre-CIPP assessment," voiced city staff in disbelief. But with measured flows returning back to pre-rehabilitation levels, especially as crews saw when electro scanning during an infamous King Tide, it was no wonder that greater care would be needed to assess the Contractor's next CIPP project.

Equally surprising were comparative results of sewer mains and lateral defects. Many times,



consulting engineers are heard to say, 'since defects can't be found in sewer mains, service laterals must be responsible for the majority of wet weather and dry weather infiltration.'

Yet, the limitation of post-CIPP defects in service laterals to only twenty percent (20%) or 8 laterals out of a total of 40 laterals investigated, meant either the contractor did a better job in relining the laterals or service laterals were not in as bad of shape as first suspected.

The key takeaway from the project was to take a second look at the use of closed-circuit television (CCTV) inspection to assess rehabilitation, particularly to allow Contractors to use CCTV for liner acceptance. More importantly, the additional cost of Electro Scanning Inspection would have more than paid for itself in rejecting CIPP projects that had leaks, not seen by CCTV inspection.

Post-CIPP of Sewer Mains

	Scans	Footage	Defects	GPM	GPD
'Top 5' Worst Sewer Mains	5	1,563	171	121.8	175,349
Total Project	18	4,306	281	159.3	229,450
Percent	28%	36%	61%	76%	76%

Post-CIPP of Service Laterals

	Scans	Footage	Defects	GPM	GPD
'Top 8' Worst Laterals	8	243	33	13.03	18,763
Total Project	40	1,056	33	13.03	18,763
Percent	20%	23%	100%	100%	100%

Electro Scan Offers Next Generation 4-in-1 Leak Detection Services for Water

Patented Low Voltage Conductivity Technology Finds & Measures Defects in GPM, Missed by Legacy Methods

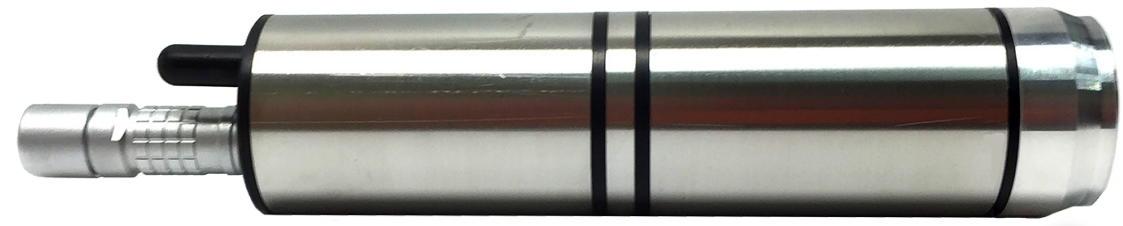
Only one other organization in the world was engaged in research, development, and testing efforts in the field of low voltage conductivity.

Today, Electro Scan Inc. and its subsidiaries wholly-owned utilities in Australia, Germany, Republic of Ireland, and the UK, are positioned to help the leading water utilities take a major step forward in utilizing a new class of machine-intelligent diagnostic tools to accurately & dependably locate and measure water losses in gallons per minute (GPM) or liters per second (LPS).

"Our products & services for the pressurized water distribution and transmission market needed to wait," stated Chuck Hansen, Electro Scan founder. "Entry from a hydrant, valve, or meter box, is not like opening a manhole and dealing with gravity flows. But, the wait is definitely worth it if you are a water utility faced with the challenge of accurately identifying water loss locations and their severity."

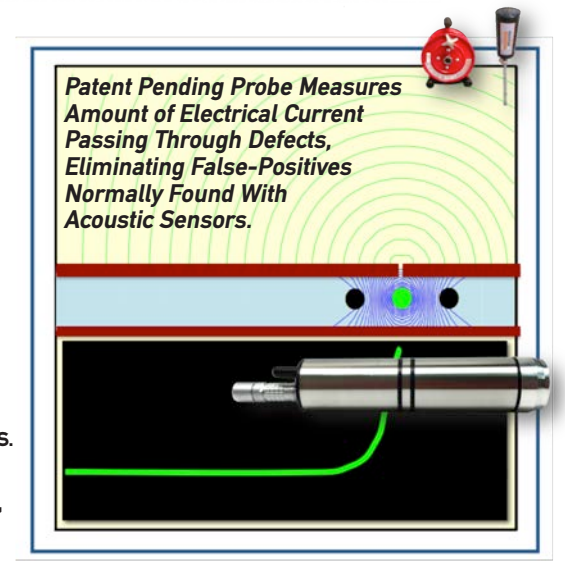
4-in-1 Multi-Sensor Probe

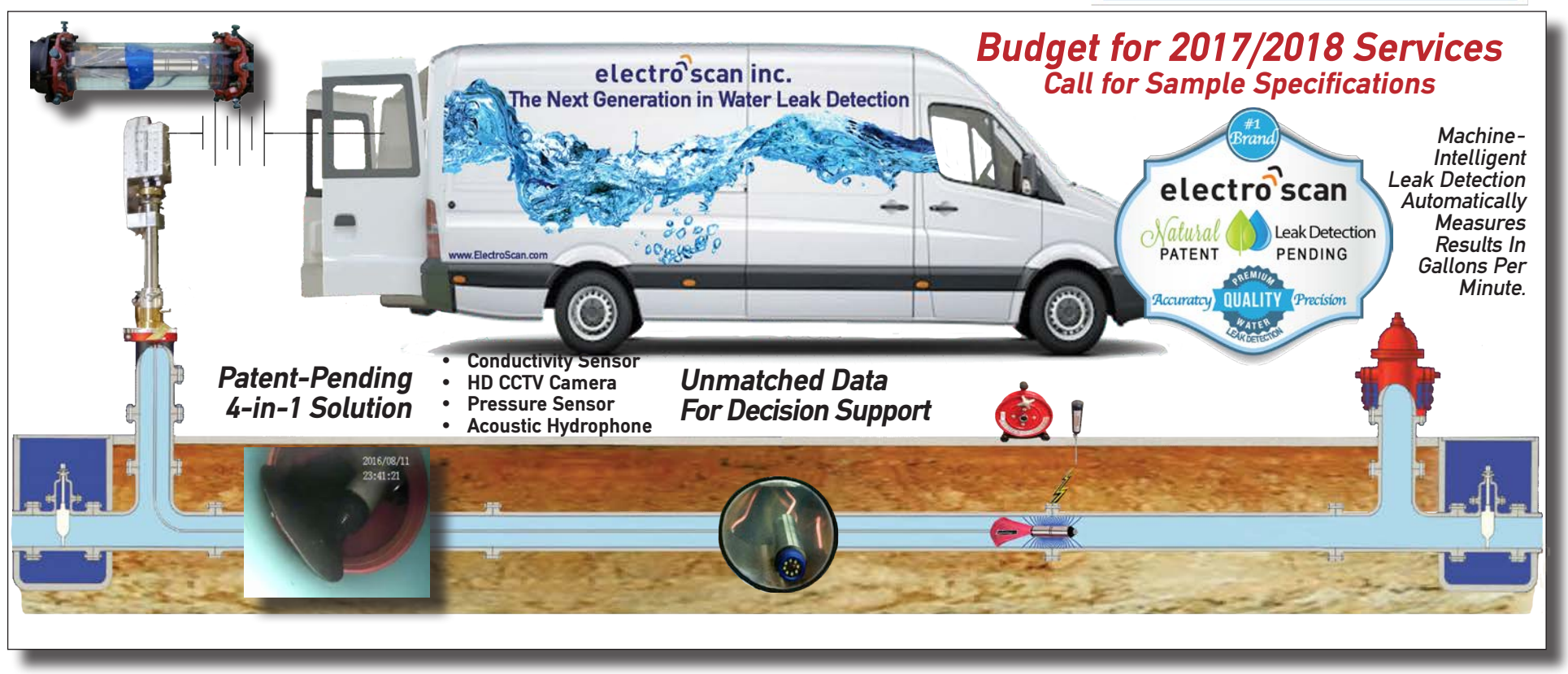
Electro Scan's offering represents a tipping point for the leak detection industry. Prior to Electro Scan's machine-intelligent expert solutions, owners were limited to internal & external acoustic sensors, data loggers, and correlators, that hoped to hear sound vibrations that could be distinguished from false-positive anomalies. But, integrating (1) Conductivity, (2) Acoustic, (3) Video, and (4) Pressure in a single sensor, is a game changer.



Major Advantages

- No Third-Party Data Interpretation.
- Locates Leaks to Closest 0.4 inches (1cm).
- Provides Each Leak with Estimated GPM.
- No False-Positive Readings.
- No Training to Interpret Data.
- Complete Reporting in Minutes, Not Days.
- AWWA M77 Standard of Practice.
- ASTM F2550-13.
- Pressurized and Non-Pressurized Lines.
- ACS, CIPP, HDPE, PE, PCCP, PVC, RCP.
- Lined Cast Iron & Ductile Iron Pipe.
- Hydrophone Sensor Shows What Acoustic Misses.
- Finds & Measures All Silent Leaks.
- High Definition Camera Documents Leak Location, Tuberculation, Debris, and Water Clarity.





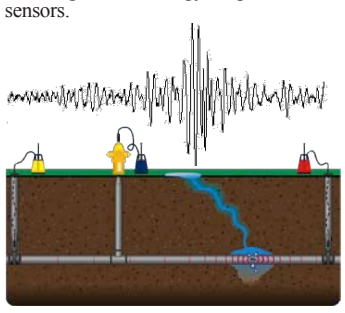
Electro Scan Technology Leapfrogs Acoustic Sensors...

Acoustic Sensor Based Leak Detection Technologies

Time-Based Data Loggers & Correlators

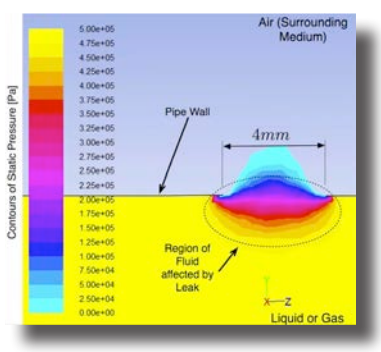
Acoustic methods for finding leaks are mainly based upon correlation analysis, where one sensing device is installed at each side of a leak. The two received acoustic signals are correlated and the arrival time difference represents a measure of the leak position.

The correlation techniques nearly always fail to yield a precise prediction when applied on plastic pipes, and therefore is not a good technology for permanent sensors.



Pressure Transient

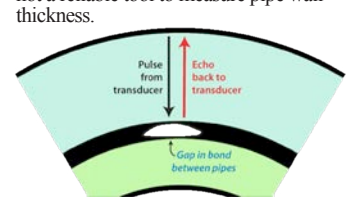
In this method the outputs from simulated pipelines are compared to those measured from flow meters and if their difference goes beyond a threshold value, leak is detected. For leak localization a gradient pressure technique is applied which needs pressure slope measurements at inlet and outlet of the pipeline. Several cases with leak at various positions are studied.



Pulse Echo

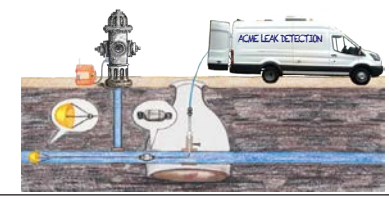
As sound waves travel in water mains, it pushes water molecules toward each other. Because water is incompressible, the molecules push outward on a pipe wall. This places a microscopic flex on the pipe wall — and greater the flex, the weaker the pipe. Pulse Echo inspection uses algorithms to convert data to measure the average minimum remaining wall thickness of the inspected pipe segment. For metallic and asbestos cement pipe, wall thickness is compared to the original thickness of the pipe to determine an average wall loss.

Unfortunately, recent testing by an international consortium of water companies in Australia concluded that Pulse Echo is not a reliable tool to measure pipe wall thickness.



Tethered Probe

Recently, Australian researchers tests of tethered probes, showed the use of internal acoustic sensors were less sensitive for detecting meaningful pipe wall losses/defects in large metallic cast iron and ductile iron pipes. While the supplier claimed to be able to assess pipe wall integrity between two test points that could be related to pipe structure, e.g. average pipe wall thickness, research showed that test results were not straightforward and not yet established by the supplier. Researchers concluded that the condition assessment technique was not promising for large metallic cast iron or ductile iron pipelines and lacked the sensitivity to detect pipe wall losses and defects. Since the system could not capture continuous geometries for pipe failure analysis, the lack of meaningful input prevented it from its use as a screening tool for assessing wall thickness in large metallic pipes for the ongoing project.

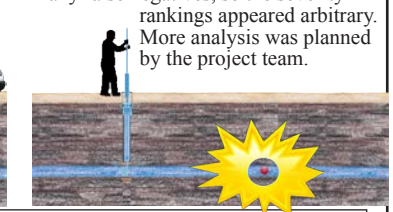


Untethered Probe

One of the oldest tools used by some utilities for leak detection, the use of untethered probes to assess water mains is increasingly be distanced due to its lack of accuracy and limited leak detection capabilities.

Recently, two California water utilities failed to detect any significant leaks after undertaking +100-mile assessment projects. Yet, recently, claims expanded to be an effective tool to determine wall thickness.

Independent researchers reported that while the supplier's tool generated reasonable true positives, it also reported many false negatives, so the severity rankings appeared arbitrary. More analysis was planned by the project team.



Major Disadvantages

1. Ambient noise interference may hamper evaluation.
2. Variable water table heights may affect results.
3. Unable to assess fiberglass, lined, and plastic pipes.
4. Different results for different diameters.
5. Leak sizes may be difficult or unable to determine.
6. Multiple false-positive readings must be manually filtered.
7. Repair clamps on previous leaks will be bypassed by acoustic waves.
8. Inability to quantify defect by severity in gallons per minute (GPM).
9. Customer's continuous water use is similar to a leak, leading to a false reading.
10. Results often vary or are affected by changes in backfill materials.
11. Lengthy data processing and reporting time lag.
12. Lack of data repeatability, by crew(s) and by equipment for same pipe.
13. Often require special training for subjective assessments in the field.
14. Need for specialized training and third-party data interpretation.
15. Unable to detect silent leaks.
16. Plastic repairs in metallic pipes typically cause poor propagation of sound vibrations.
17. Loose or worn components in fittings, such as valves & hydrants, can cause poor readings.
18. Air pockets can heavily attenuate acoustic signals, causing false readings.
19. Heavily tuberculated pipe, particularly old cast iron or unlined ductile iron pipes, can attenuate the acoustic signals to such an extent that correlations can be low quality.
20. Reliance on poor acoustic inspection results leads to inaccurate prioritization of repairs.
21. Sometimes used to report lower than actual distribution-related leaks to shift the burden to ratepayers, shifting leak sources from undetected defects in transmission and distribution to service connections and the customer-side of meter.

State of California Implements Groundbreaking Water Loss Leak Standards & Reporting Requirements

EXECUTIVE ORDER B-37-16

MAKING WATER CONSERVATION A CALIFORNIA WAY OF LIFE

While most urban areas have been spared from water rationing, emergency conservation has provided a critical safeguard against more dire consequences under extended drought conditions.

After Governor Edmund G. Brown, Jr. called for a 25 percent reduction in urban water use in 2015, Californians rose to the challenge and saved over 24 percent during the nine months the mandate was in place.

Executive Order B-37-16, signed by Governor Brown on May 9, 2016, builds on that success to establish long-term water conservation measures and improved planning for more frequent and severe droughts.

The centerpiece of the Executive Order is a requirement for the State's 410 urban water suppliers to meet new water use targets. Rather than measuring water savings as a percentage reduction from a chosen baseline, the new standards will take into account the unique climatic, demographic, and land-use characteristics of each urban water agency's service area.

This approach represents a fundamental shift to a conservation framework that is more durable and that can be applied equitably and uniformly across the enormous variation in local conditions in California.

Five state agencies – the Department of Water Resources, the State Water Resources Control Board, the California Public Utilities Commission, the California Department of Food and Agriculture, and the California Energy Commission (collectively referred to as the "EO Agencies") – are charged with implementing the Executive Order's four inter-related objectives: using water more wisely, eliminating water waste, strengthening local drought resilience, and improving agricultural water use efficiency and drought planning.

Minimizing Water Loss

The EO Agencies will meet the requirements of EO Items 5 and 6 through implementation of Senate Bill 555, along with additional actions to satisfy the Executive Order's directives related to reducing water supplier leaks. Implementation actions include the following:

• Rules for validated water loss audit reports: By October 1, 2017 and annually thereafter, urban retail water suppliers must submit validated water loss audit reports to the Department of Water Resources (DWR). DWR will adopt rules for standardizing water loss audits in early 2017. DWR will also revise funding guidelines so that water suppliers that do not submit reports will be ineligible for DWR grants and loans.

• Water loss performance standards: By July 1, 2020, the Water Board will adopt rules requiring urban retail water suppliers to meet performance standards for the volume of water losses.

• Technical assistance for water loss audits: The Water Board is also funding the California Water Loss Control Collaborative' s Technical Assistance Program to ensure high quality and properly validated water loss audits. For smaller water suppliers addressing water losses, the Water Board will offer financial assistance through the Drinking Water State Revolving Fund beginning in 2017.

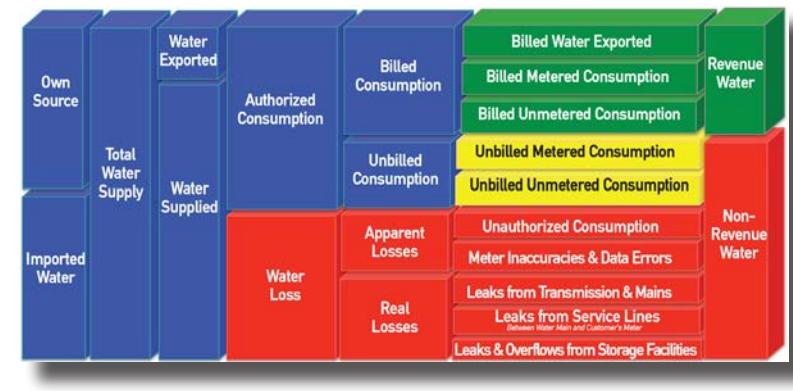
• Minimizing leaks: The California Public Utilities Commission (CPUC) will order large, investor- owned water utilities to accelerate work to minimize leaks. The CPUC may grant financial incentives for minimizing leaks during the review of each utility's upcoming General Rate Case applications.

Eliminating Water Waste

The Water Board and the Department shall direct actions to minimize water system leaks that waste large amounts of water. The Water Board, after funding projects to address health and safety, shall use loans from the Drinking Water State Revolving Fund to prioritize local projects that reduce leaks and other water system losses.

Executive Order B-37-16 contains four inter-related objectives:

- Using Water More Wisely
- Eliminating Water Waste
- Strengthening Local Drought Resilience
- Improving Agricultural Water Use Efficiency and Drought Planning



Prolonged Leaks in Small Diameter Pipes Are Worse Than Main Breaks in Larger Pipes

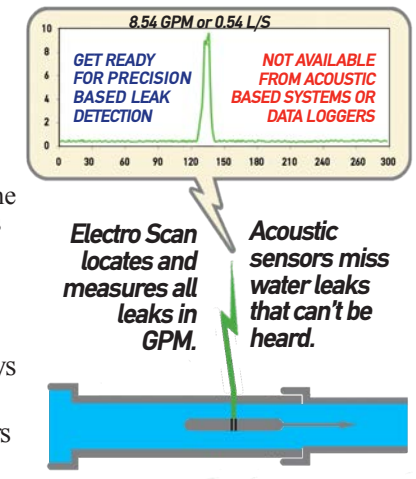
Is your water utility focused more on finding leaks in your transmission mains instead of your distribution system?

Experts agree that the constant flow of low-level leaks causes more water loss than the spectacular water main breaks that are shown on the nightly news.

Do the Math…

= 5-gpm leak running 100 days
= **720,000 gallons**

= 500-gpm leak running 4 hours
= **120,000 gallons**

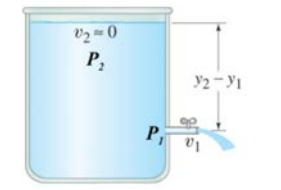


Low voltage conductivity finding defects missed by legacy inspection techniques.

What Makes Electro Scan So Special?

Torricelli's Law

Most suppliers forgot what we were trying to do; find the size of the hole that water is leaking out of a pipe. Instead, Electro Scan Inc.'s patent-pending devices, start with this goal and apply Torricelli's most popular theorems to help calculate GPM and l/s, combined with internal pipe pressure to provide an unrivaled and often illusive metric of leakage, in GPM.



Ohm's Law

Fundamental geophysics provides a direct relationship between the rate of water leakage, relative to the amount of electrical current able to pass through a given orifice. Are you smelling what we are cooking? Accurately measure the amount of current, including its start point, end point, and height of electrode returning to a source, and you have an area under the curve.

$E = IR ; I = E/R ; R = E/I$

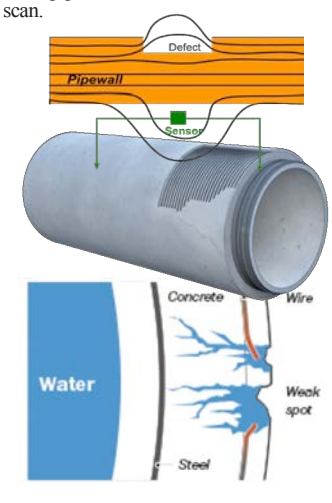
Where:
"E" *volts*
"I" *amps*
"R" *ohms*

LEAK ...and Others to Upgrade Leak Detection Market

Non-Acoustic Sensor Based Leak Detection Technologies

Electromagnetic

Not representing a recognized leak detection technology, instead, electromagentic solutions, attempt to identify internal wire mesh pipe anomalies, similar to a CAT-scan.



Ground Penetrating Radar

Radar generates an image based on reflection of radar waves from changing densities of soil/pipe. In fact it detects variation in bulk physical properties such as voiding or saturation of soil caused by leaked water.

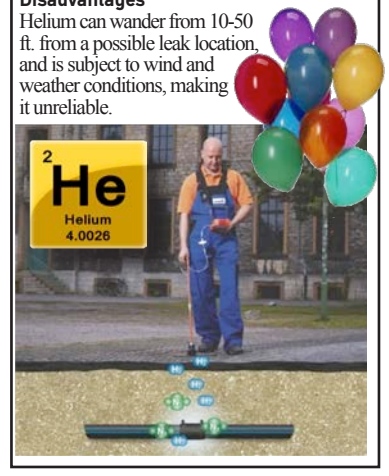
Disadvantages
- Expensive equipment
- Hard to interpret for unmapped services
- Restricted operational range
- Significant operator training

Helium Tracers

Helium gas is injected into live water mains, with no need to isolate a zone, depressurize the system, or shut down the water system. Once gas is injected into the water main, it mixes with the flowing water and travels through the pipe network to the desired survey area.

Similar to smoke testing a sewer main, helium "marked" water leaves through leaks in the pipe wall, bad service connections, meters, or valves, causing the helium gas to separate from the water, float to the surface, and be measured with specialized monitoring equipment.

Disadvantages
Helium can wander from 10-50 ft. from a possible leak location, and is subject to wind and weather conditions, making it unreliable.



Infrared Thermography

Infrared radiation detector locates temperature differences caused by the leaking liquid in near ambient conditions, that has proved valuable for use in restricted areas or short, superficial pipelines.

Disadvantages
- Expensive tool kit
- Significant operator training
- Weather dependent
- Accurate only for near ambient conditions

Video Micrometer

Not able to determine cracks that go through the pipe wall v. cracks that are superficial, video micrometers attempt to use laser capabilities to measure open surfaces and areas of pipe anomalies.

Disadvantages
- Why? We want to find & measure real leaks, not superficial cracks.
- Pipe must be dewatered.
- Limitations in accuracy may occur due to improper lighting, dust, humidity, fog, moisture on dewatered pipe walls, or horizontal/vertical offsets

Leading Missouri Sewer Agency Switches From CCTV Inspection To Electro Scan Inspection

Defect in Creek Crossing: Missed By CCTV Inspection, Found By Electro Scan, & Confirmed By Dye Test

It was a cold Missouri day in early December. The first day of the infamous Arctic Blast that was coming in from Northern Canada. But the Electro Scan Services Team couldn't pass up the opportunity to use its newest addition to the Electro Scan product family – its new Portable ES-620, designed for hard-to-reach remote locations.

With over 3,000 creek crossings in its sanitary sewer network, this municipality needed to try an alternative to its legacy closed-circuit television (CCTV) inspection camera that hadn't been successful in locating or determining the severity of potential leaks that may be causing infiltration.

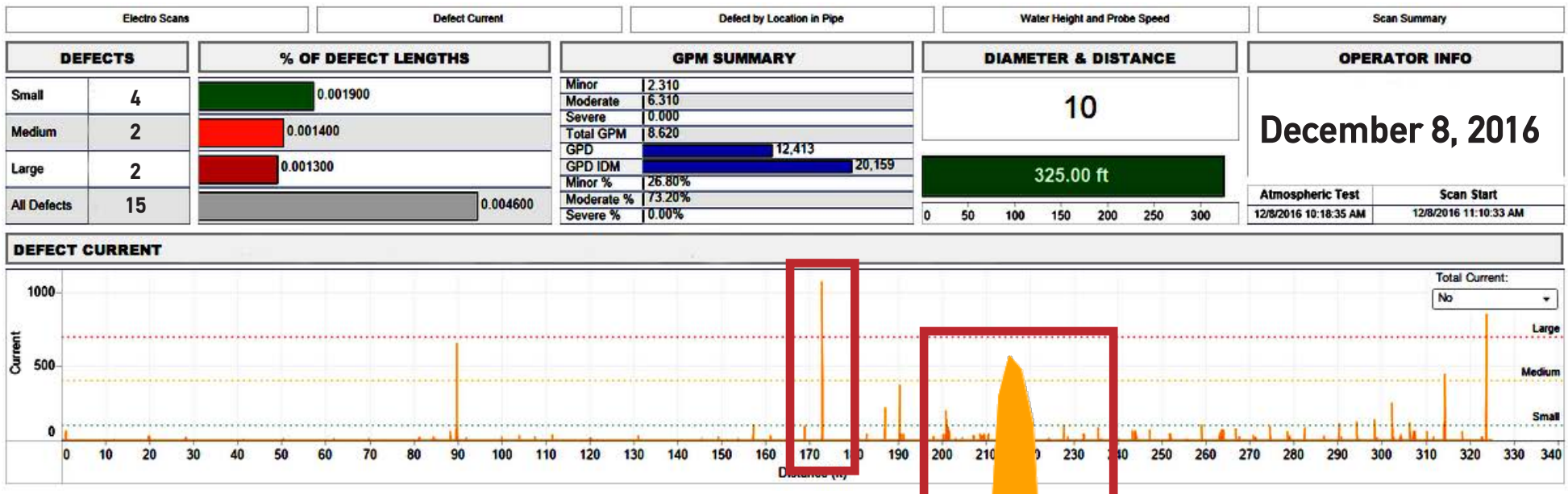
On December 8, 2016, the Electro Scan Services Team, working with a nationally known consulting engineering firm, without the use of jet truck, requiring man entry to set its probe and funnel cones in place, evaluated a number of 10 inch diameter sewer mains.

Making two passes in the sewer mains, recording defect readings both from the upstream manhole, and then downstream manhole, the largest defect was confirmed at 172 ft (into the 325 ft pipe) showing an estimated defect flow rate of 2.28 gallons per minute.

Wondering how to confirm what the Electro Scan Service Team already knew, it was suggested to 'pour some dye into the upstream manhole to see if it came out. And, *voila*!

Additionally, CCTV was not able to see the defects on its first several passes, even after telling the camera operator where to look, due to heavy FOG and steam.

Missed by Repeated CCTV Inspections | Found by Electro Scan | Confirmed by Dye Testing



Modified ES-620 Allows for Mobile Assessment of Difficult to Reach Pipelines

City of Racine, Wisconsin Measures Defect Flows Before & After CIPP Lining to Assess Reductions

In the past, sewer & water managers, consulting engineers, and contractors were limited to visual inspection to certify rehabilitation effectiveness.

Unable to consistently & accurately find defects in CIPP lining using existing methods, a leading consulting engineer was looking for a solution that could provide unbiased & unambiguous assessments of a Contractor's lining.

Given the cost per foot of trenchless repairs, Electro Scanning Inspection appeared best positioned to provide a Baseline Defect Flow Rating, measured in gallons per minute or liters per second.

At a cost of $4.00 to $8.00 per foot, sewer agencies and their consulting engineers can use Electro Scanning Inspection to determine a quantified reduction in flow prior to the acceptance of rehabilitation.

1,067 LF or 19% of Sewer Mains Had More Defect Flow AFTER CIPP LINING Than BEFORE CIPP

As shown in a recent 5,600 LF project, managed by a large consulting engineer, Electro Scan performed both pre- and post-assessment evaluation of a Cured-In-Place Pipe (CIPP) project. Formerly relying on Closed-Circuit Television (CCTV) inspection, the agency had noticed flows in some of its pipes that had only recently been relined.

While the Contractor provided CCTV video for each of the lines, the City followed new guidelines in the Seventh Edition, Volume 1, of the new Wastewater O&M manual, to require Electro Scanning Inspection to be done for both pre- and post-CIPP.

While the overall project achieved a 75% reduction in defect flow, an individual line-by-line assessment of the twenty-eight (28) sewer mains showed that four (4) segments, totaling 1,067 LF or 19% of the 5,563 LF, had defect flows greater AFTER CIPP, than BEFORE CIPP.

Critical Sewers® CIPP Lining Assessment	Feet	Percent
Post-CIPP Liners with 99-100% Reduction	1,061	19%
Post-CIPP Liners with 75-99% Reduction	1,692	31%
Post-CIPP Liners with 65-75% Reduction	1,743	31%
Sewers That Leaked More After CIPP Lining	1,067	19%

Pre-Rehabilitation

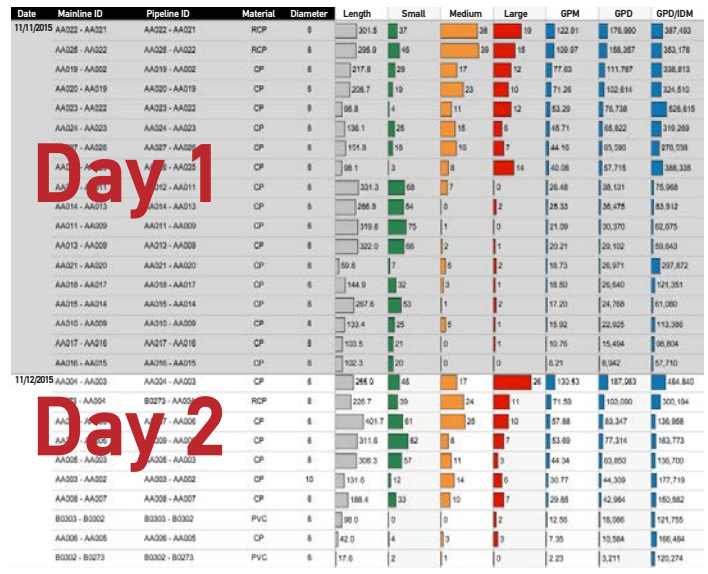
Total Feet: 5,559 **1,708,171 GPD**
Total Segments: 28

New Standard Provides an Estimated Baseline Defect Flow for Each Pipe & Each Defect Location

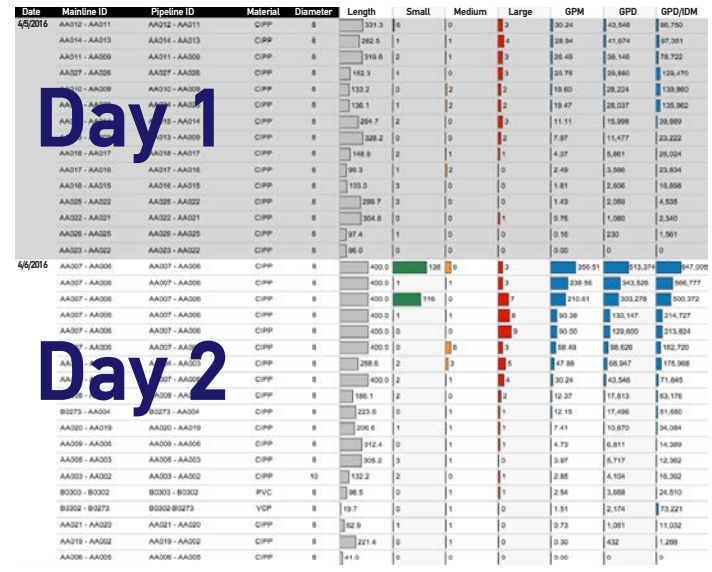
Post-Rehabilitation

Total Feet: 5,563 **434,822 GPD**
Total Segments: 28

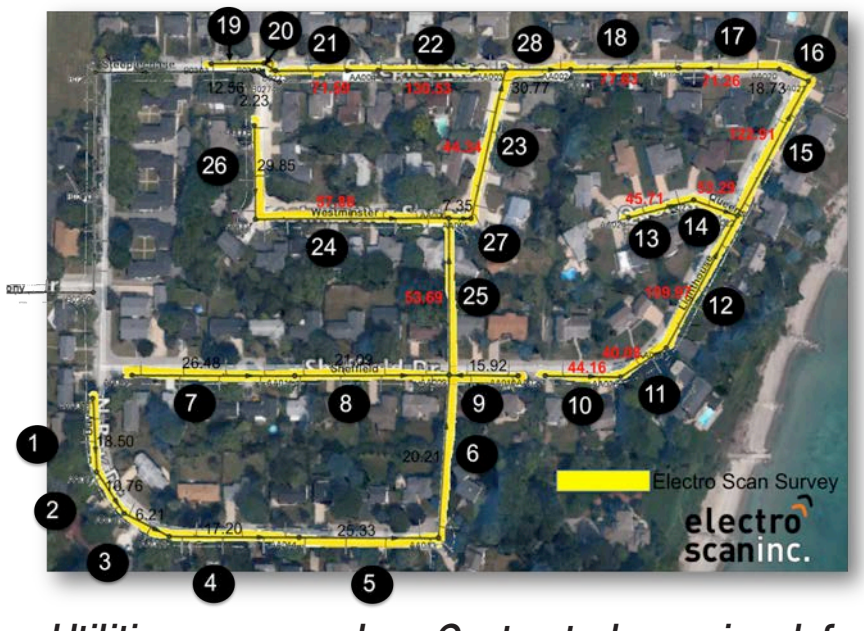
Total Reduction in Flow of 75% or 1,273,349 GPD But, Fixing Major Post-CIPP Defects Is Required

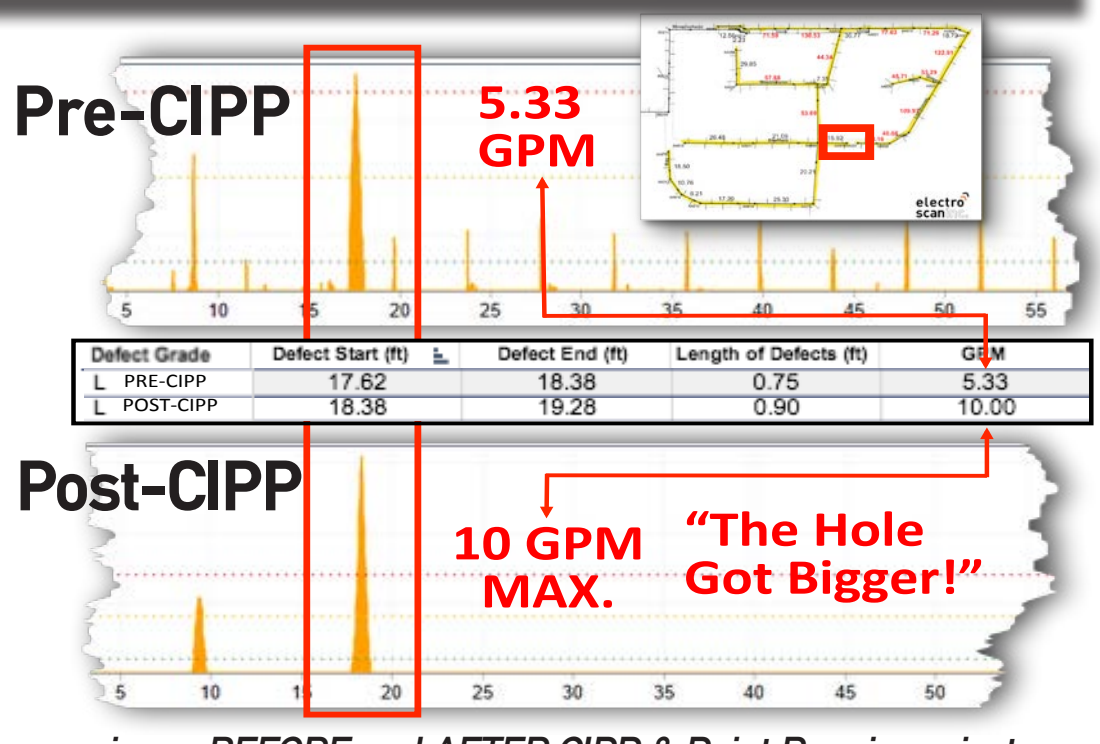


Date	Mainline ID	Pipeline ID	Material	Diameter	Length	Small	Medium	Large	GPM	GPD	GPD/IDM
11/11/2015	AA022 - AA021	AA022 - AA021	RCP	8	301.5	37	38	19	122.91	176,990	387,493
	AA026 - AA022	AA026 - AA022	RCP	8	295.9	46	39	15	109.97	158,357	353,178
	AA019 - AA002	AA019 - AA002	CP	8	217.8	29	17	12	77.63	111,787	338,813
	AA020 - AA019	AA020 - AA019	CP	8	206.7	19	23	10	71.26	102,614	324,510
	AA023 - AA022	AA023 - AA022	CP	8	86.8	4	11	12	53.29	76,738	528,615
	AA024 - AA023	AA024 - AA023	CP	8	136.1	26	15	6	45.71	65,822	319,269
	AA027 - AA026	AA027 - AA026	CP	8	151.8	18	16	7	44.16	63,590	270,536
	AA025 - AA024	AA025 - AA024	CP	8	98.1	3	8	14	40.06	57,715	388,335
	AA012 - AA011	AA012 - AA011	CP	6	331.3	68	7	0	26.48	38,131	75,968
	AA014 - AA013	AA014 - AA013	CP	6	286.9	64	0	2	25.33	36,475	83,912
	AA011 - AA009	AA011 - AA009	CP	8	319.8	75	1	0	21.09	30,370	62,575
	AA013 - AA009	AA013 - AA009	CP	8	322.0	66	2	1	20.21	29,102	59,643
	AA021 - AA020	AA021 - AA020	CP	6	59.6	7	5	2	18.73	26,971	297,672
	AA018 - AA017	AA018 - AA017	CP	6	144.9	32	3	1	18.50	26,640	121,351
	AA015 - AA014	AA015 - AA014	CP	6	267.6	53	1	2	17.20	24,768	61,060
	AA010 - AA009	AA010 - AA009	CP	8	133.4	25	5	1	15.92	22,925	113,386
	AA017 - AA016	AA017 - AA016	CP	8	103.5	21	0	1	10.76	15,494	98,804
	AA016 - AA015	AA016 - AA015	CP	8	102.3	20	0	0	6.21	8,942	57,710
11/12/2015	AA004 - AA003	AA004 - AA003	CP	6	265.9	66	17	26	130.53	187,963	484,840
	AA004 - AA004	B0273 - AA004	RCP	8	226.7	59	24	11	71.59	103,090	300,194
	AA007 - AA006	AA007 - AA006	CP	8	401.7	81	26	10	57.88	83,347	136,968
	AA009 - AA008	AA009 - AA008	CP	8	311.6	82	8	7	53.69	77,314	163,773
	AA006 - AA003	AA006 - AA003	CP	8	306.3	57	11	3	44.34	63,850	136,700
	AA003 - AA002	AA003 - AA002	CP	10	131.6	12	14	6	30.77	44,309	177,719
	AA008 - AA007	AA008 - AA007	CP	8	188.4	33	10	7	29.85	42,984	160,582
	B0303 - B0302	B0303 - B0302	PVC	8	98.0	0	0	2	12.56	18,086	121,755
	AA006 - AA005	AA006 - AA005	CP	8	42.0	4	3	0	7.35	10,584	166,484
	B0302 - B0273	B0302 - B0273	PVC	8	17.6	2	1	0	2.23	3,211	120,274



Date	Mainline ID	Pipeline ID	Material	Diameter	Length	Small	Medium	Large	GPM	GPD	GPD/IDM
4/5/2016	AA012 - AA011	AA012 - AA011	CIPP	8	331.3	6	0	3	30.24	43,546	98,750
	AA014 - AA013	AA014 - AA013	CIPP	8	282.5	1	1	4	28.94	41,674	97,351
	AA011 - AA009	AA011 - AA009	CIPP	8	319.8	2	1	3	26.49	38,146	78,722
	AA027 - AA026	AA027 - AA026	CIPP	8	152.3	1	0	3	23.75	39,980	139,470
	AA010 - AA009	AA010 - AA009	CIPP	8	133.2	0	2	2	19.60	28,224	139,860
	AA025 - AA024	AA025 - AA024	CIPP	8	136.1	1	2	2	19.47	28,037	135,962
	AA013 - AA009	AA013 - AA009	CIPP	8	204.7	2	0	3	11.11	15,998	39,699
	AA018 - AA017	AA018 - AA017	CIPP	8	326.2	0	0	2	7.97	11,477	23,222
	AA017 - AA016	AA017 - AA016	CIPP	8	148.9	2	1	1	4.37	5,861	26,024
	AA016 - AA015	AA016 - AA015	CIPP	8	99.3	1	2	0	2.49	3,586	23,634
	AA025 - AA022	AA025 - AA022	CIPP	8	103.0	3	0	0	1.81	2,606	16,698
	AA022 - AA021	AA022 - AA021	CIPP	8	298.7	3	0	0	1.43	2,059	4,535
	AA026 - AA025	AA026 - AA025	CIPP	8	304.6	3	0	1	0.75	1,080	2,540
	AA023 - AA022	AA023 - AA022	CIPP	8	97.4	1	0	0	0.16	230	1,561
			CIPP	8	96.0	0	0	0	0.00	0	0
4/6/2016	AA007 - AA006	AA007 - AA006	CIPP	8	400.0	136	6	3	356.51	513,374	947,006
	AA007 - AA006	AA007 - AA006	CIPP	8	400.0	1	1	3	238.86	343,626	566,777
	AA007 - AA006	AA007 - AA006	CIPP	8	400.0	116	0	7	210.61	303,278	500,372
	AA007 - AA006	AA007 - AA006	CIPP	8	400.0	1	1	8	90.38	130,147	214,727
	AA007 - AA006	AA007 - AA006	CIPP	8	400.0	0	0	9	90.00	129,600	213,824
	AA007 - AA006	AA007 - AA006	CIPP	8	400.0	0	6	3	68.49	98,626	162,720
	AA027 - AA026	AA027 - AA026	CIPP	8	268.6	2	3	5	47.88	68,947	175,968
	AA008 - AA007	AA008 - AA007	CIPP	8	400.0	2	1	4	30.24	43,546	71,845
	B0273 - AA004	B0273 - AA004	CIPP	8	186.1	2	0	2	12.37	17,813	63,176
	AA020 - AA019	AA020 - AA019	CIPP	8	223.6	0	1	1	12.15	17,496	51,650
	AA009 - AA006	AA009 - AA006	CIPP	8	206.6	1	1	1	7.41	10,670	34,084
	AA006 - AA003	AA006 - AA003	CIPP	8	312.4	0	1	1	4.73	6,811	14,389
	AA003 - AA002	AA003 - AA002	CIPP	10	305.2	3	1	0	3.97	5,717	12,362
	B0303 - B0302	B0303 - B0302	PVC	8	132.2	2	0	1	2.85	4,104	16,392
	B0302 - B0273	B0302-B0273	VCP	8	96.5	0	1	1	2.54	3,658	24,510
	AA021 - AA020	AA021 - AA020	CIPP	8	19.7	0	1	0	1.51	2,174	73,221
	AA019 - AA002	AA019 - AA002	CIPP	8	62.9	1	1	0	0.73	1,051	11,032
	AA006 - AA005	AA006 - AA005	CIPP	8	221.4	0	1	0	0.30	432	1,288
			CIPP	8	41.0	0	0	0	0.00	0	0

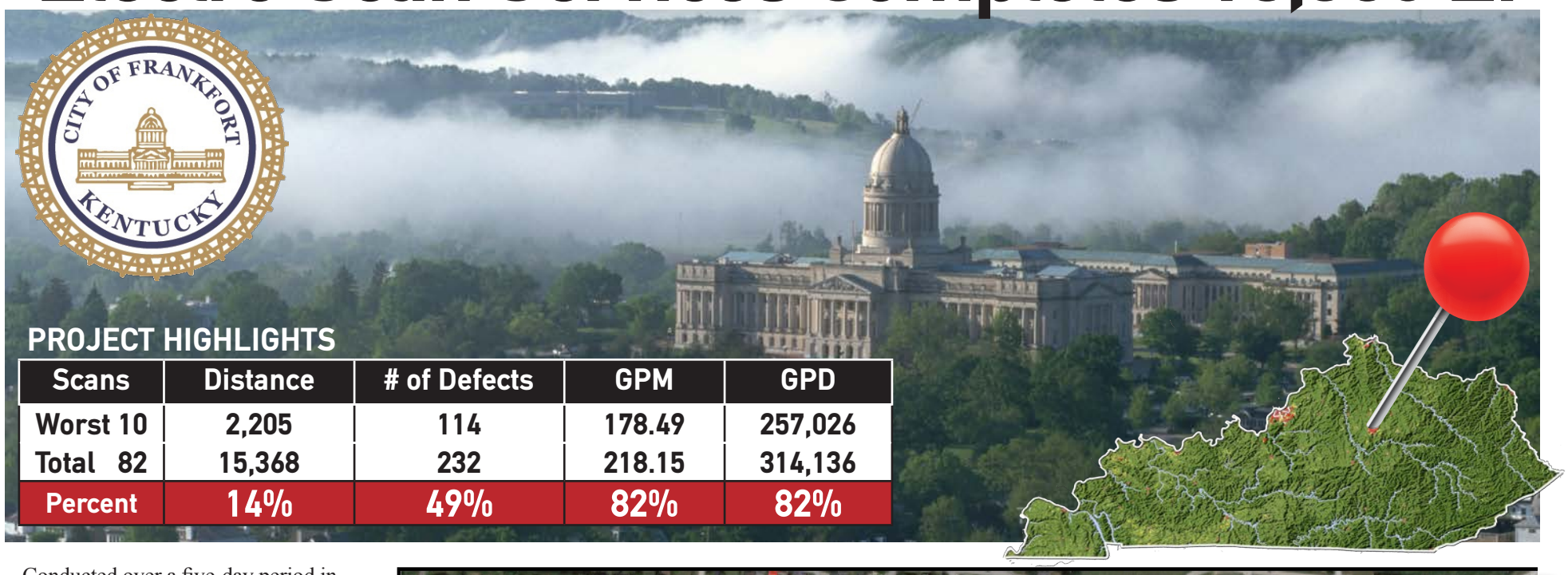




Defect Grade	Defect Start (ft)	Defect End (ft)	Length of Defects (ft)	GPM
L PRE-CIPP	17.62	18.38	0.75	5.33
L POST-CIPP	18.38	19.28	0.90	10.00

Utilities can now show Contractor's precise defect comparisons BEFORE and AFTER CIPP & Point Repair projects.

Electro Scan Services Completes 15,368 LF



PROJECT HIGHLIGHTS

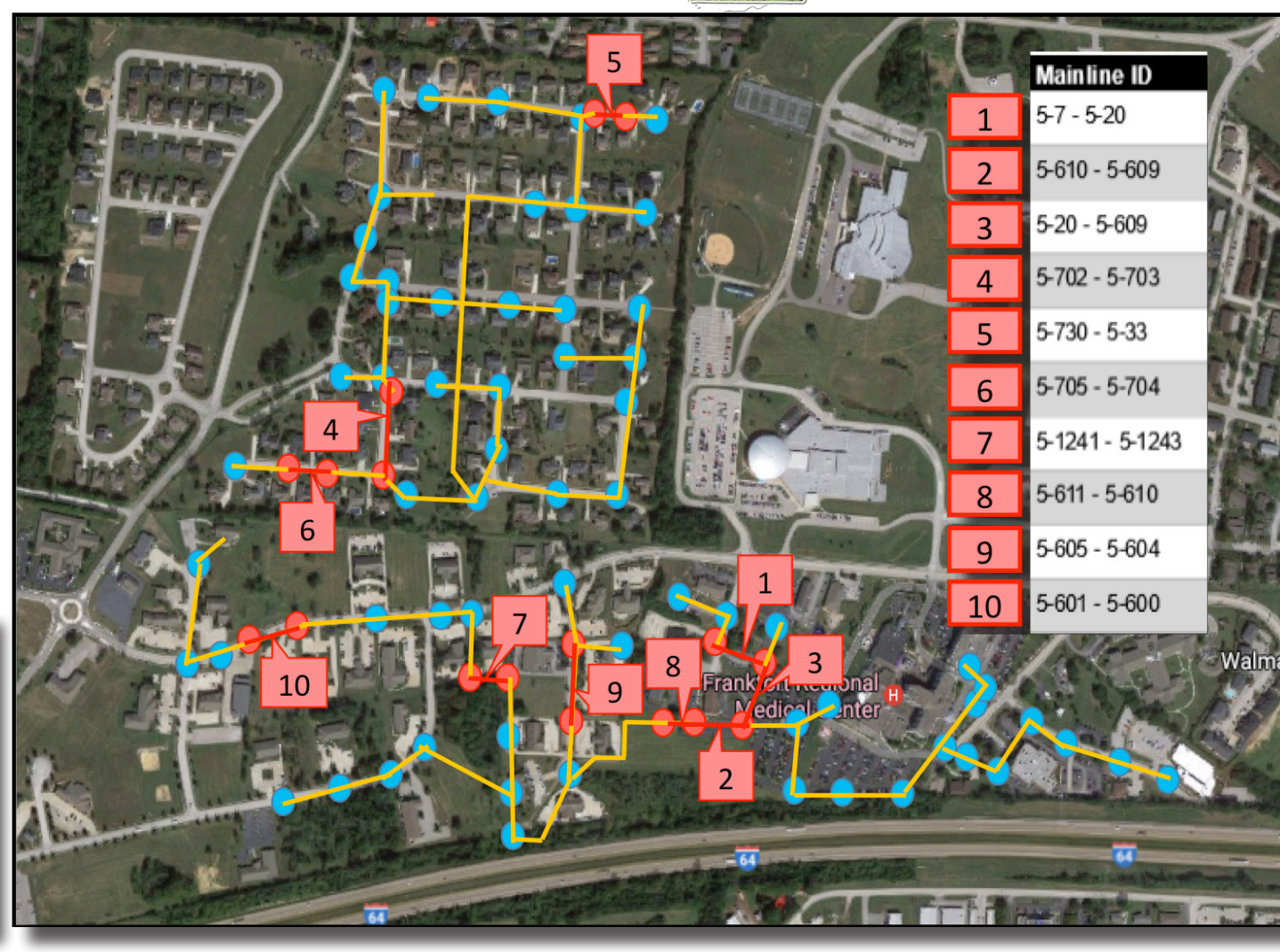
Scans	Distance	# of Defects	GPM	GPD
Worst 10	2,205	114	178.49	257,026
Total 82	15,368	232	218.15	314,136
Percent	14%	49%	82%	82%

Conducted over a five-day period in December 2016, Electro Scan's survey of eighty-two (82) sewer mains or 15,368 linear feet, found a total of 232 defect locations contributing an estimated 218.15 gallons per minute (GPM) of defect flow or 314,136 gallons per day (GPD).

More importantly, the ten (10) worst sewer mains contributed eighty-two percent (82%) of the total defect flow rate. Over 612,000 data points were captured as part of the Critical Sewers® cloud application.

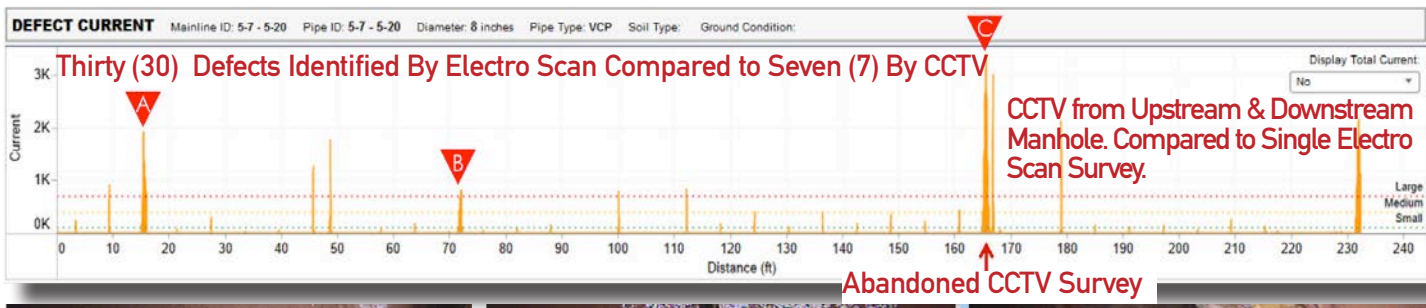
William Scalf, Jr. PE, Director, Katie Beard, PE, Water Quality Engineer, Robert Peterson, PE, Deputy Director of Collections, for the City of Frankfort, knew they had a problem, but finding the specific sewer mains contributing the most infiltration was elusive until Electro Scan was able to identify the 10 worst mains for further investigation and rehabilitation decision-making.

Infrastructure Profile	
Miles of Sewer Main	248.6
Miles of Gravity Main	222.5
Miles of Force Main	26.1
Miles of Combined Sewers	20
Number of Manholes	5,944
Number of Pump Stations	49
Treatment Plant Capacity (MGD)	9.9

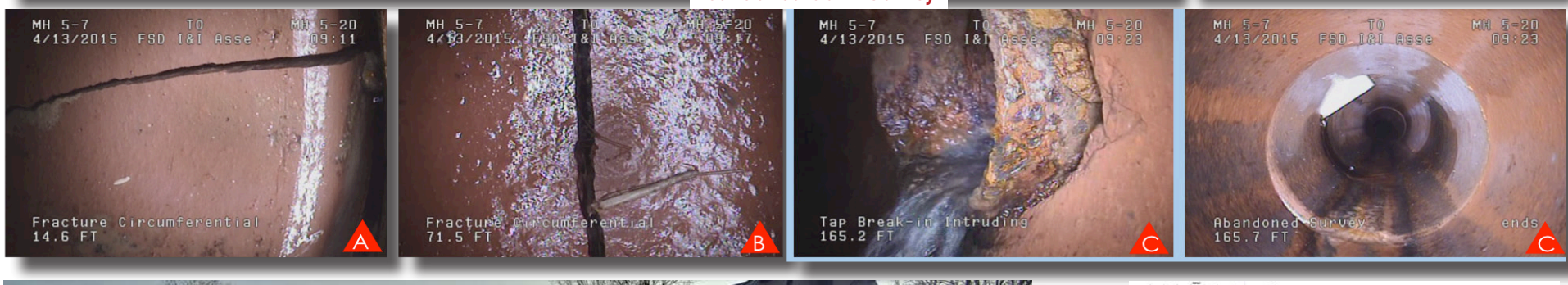


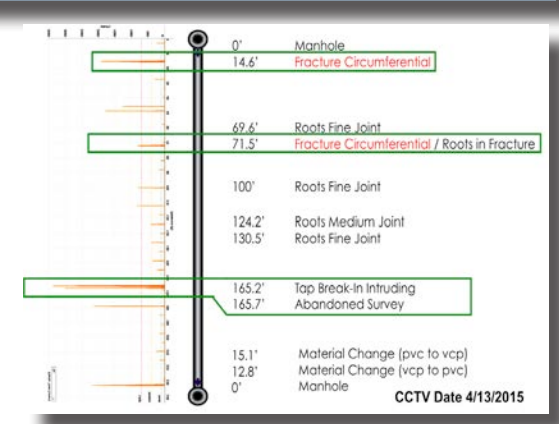
How Does Electro Scanning Inspection Compare to Closed-Circuit Television Inspection?

Mainline ID	Pipe ID	Pipe Material	Diameter	Footage	Small	Medium	Large	GPM	GPD	GPD/IDM
12/20/2016 5-7 - 5-20	5-7 - 5-20	VCP	8	232.6	15	3	12	63.94	92,074	261,304



GPM SUMMARY	
Minor	6.120
Moderate	10.700
Severe	47.120
Total GPM	63.940
GPD	92,074
GPD IDM	261,304
Minor %	5.96%
Moderate %	10.41%
Severe %	83.63%





SSES for the City of Frankfort, Kentucky

Electro Scan Inspection

No.	Mainline ID	Pipe Material	Pipe Diameter	Pipe Length	# of Defects: Small	Medium	Large	Total	Gallons Per Minute: Minor Defect Flow	Moderate Defect Flow	Severe Defect Flow	Total Defect Flow	Total GPD	Total GPD/IDM
TOTAL METRICS				15,368	172	28	32	232	51.86	54.49	111.80	218.15	314,136	1,009,109
1	5-712 - 5-711	PVC	8	108.9	1	0	0	1	0.19	0	0	0.19	274	1,758
	5-610 - 5-609	VCP	8	193.6	7	4	5	16	3.21	12.43	27.43	43.07	62,021	211,428
2	5-716 - 5-32	PVC	8	154.2	1	0	0	1	0.21	0	0	0.21	302	1,295
3	5-977 - 5-616	PVC	8	200.6	1	0	0	1	0.1	0	0	0.1	144	474
4	5-725 - 5-724	PVC	8	46.8	0	0	0	0	0	0	0	0	0	0
5	5-20 - 5-609	VCP	8	250.4	13	2	4	19	3.5	2.58	14.24	20.32	29,261	77,129
6	5-612 - 5-20	PVC	8	114.3	2	0	0	2	0.95	0	0	0.95	1,368	7,898
7	5-7 - 5-20	VCP	8	232.6	15	3	12	30	6.12	10.7	47.12	63.94	92,074	261,304
8	5-611 - 5-610	VCP	8	145.8	10	2	1	13	3.87	1.82	0	5.69	8,194	37,081
9	5-737 - 5-725	PVC	8	230.1	0	0	0	0	0	0	0	0	0	0
10	5-7 - 5-20													
11	5-702 - 5-703	PVC	8	348.9	2	0	1	3	0.41	0	10	10.41	14,990	28,355
12	5-730 - 5-33	PVC	8	138	7	6	1	14	6.19	3.75	0	9.94	14,314	68,470
13	5-705 - 5-704	PVC	8	177.6	0	0	1	1	0	0	7.78	7.78	11,203	41,644
14	5-1241 - 5-[illegible]	PVC	8	116	4	0	2	6	[illegible]	[illegible]	0	6.29	9,058	[illegible]
[illegible]	[illegible]	[illegible]	8	306.6	0	1	1	2	[illegible]	[illegible]	[illegible]	[illegible]	7,992	[illegible]

CCTV Inspection

No.	Mainline ID	Date	Pipe Material	Pipe Diameter	Surveyed Length	Direction	# of Factory Taps	# of Cracks/Fractures	# of Roots	# of Broken/Holes/Collapse	# of Deposits	Structural: OVERALL	Number of Observations	Pipe Rating	Pipe Rating Index	O&M: OVERALL	Number of Defects	Pipe Rating	Pipe Rating Index	OVERALL: OVERALL	Number of Defects	Pipe Rating	Pipe Rating Index	Infiltration Callouts	Zero Defect Rating
TOTAL METRICS					15,496.6		198	12	6	2	0	53	16		33	83	25		56	136	41		82	11	60
1	5-712 - 5-711	3/20/15	PVC	8	106.3	D	2	0	0	0	0	5	1	5100	5	0	0	0	0	5	1	5100	5	0	
	5-610 - 5-609	4/6/15	VCP	8	192.7	D	2	2	1	1	0	12	3	5141	4	1	1	1100	1	13	4	5141	3	0	
2	5-716 - 5-32	3/19/15	PVC	8	158	D	2	1	0	0	0	4	1	4100	4	0	0	0	0	4	1	4100	4	0	
3	5-977 - 5-616	4/1/15	PVC	8	202	D	0	1	0	0	0	4	1	4100	4	0	0	0	0	4	1	4100	4	0	
4	5-725 - 5-724	3/16/15	PVC	8	48.2	D	0	1	0	1	0	7	2	4131	4	0	0	0	0	7	2	4131	4	0	
5	5-20 - 5-609	4/13/15	VCP	8	250.9	U	1	3	0	0	0	10	3	4221	3	8	2	4200	4	18	5	4421	4	2	
6	5-612 - 5-20	4/10/15	VCP	8	117.8	U	1	1	0	0	0	3	1	3100	3	0	0	0	0	3	1	3100	3	0	
7	5-7 - 5-20	4/13/15	VCP	8	165.7	D	1	2	4	0	0	4	2	2200	2	9	5	3213	2	13	7	3222	2	0	
8	5-611 - 5-610	4/6/15	VCP	8	147.9	U	1	1	0	0	0	2	1	2100	2	0	0	0	0	2	1	2100	2	0	
9	5-737 - 5-725	3/16/15	PVC	8	233.4	U	5	0	0	0	0	2	1	2100	2	0	0	0	0	2	1	2100	2	0	
10	5-7 - 5-20	4/10/15	VCP	8	63.3	U	1	0	0	0	0	0	0	0	0	3	1	3100	3	3	1	3100	3	0	
11	5-702 - 5-703	3/24/15	PVC	8	352.2	U	7	0	0	0	0	0	0	0	0	2	1	2100	2	2	1	2100	2	0	
12	5-730 - 5-33	2/10/15	PVC	8	137.7	D	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
13	5-705 - 5-704	3/25/15	PVC	8	175.4	D	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
14	5-1241 - 5-[illegible]	[illegible]	PVC	8	[illegible]	[illegible]	3	0	1	0	[illegible]	0	0	0	0	2	1	2100	2	2	1	2100	2	0	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Electro Scan Inspection

No.	Mainline ID	Pipe Material	Pipe Diameter	Pipe Length	# of Defects: Small	Medium	Large	Total	Gallons Per Minute: Minor Defect Flow	Moderate Defect Flow	Severe Defect Flow	Total Defect Flow	Total GPD	Total GPD/IDM
TOTAL METRICS				15,368	172	28	32	232	51.86	54.49	111.80	218.15	314,136	1,009,109
1	5-601 - 5-600	PVC	8	295.4	7	3	0	10	2.57	2.93	0	5.5	7,920	17,692
	5-20 - 5-609	VCP	8	250.4	13	2	4	19	3.5	2.58	14.24	20.32	29,261	77,129
2	5-721 - 5-720	PVC	8	45	1	0	0	1	0.4	0	0	0.4	576	8,445
3	5-598 - 5-599	PVC	8	101.8	3	0	0	3	0.92	0	0	0.92	1,325	8,591
4	5-608 - 157-PS	PVC	8	211.4	2	0	0	2	0.15	0	0	0.15	216	674
5	5-604 - 5-608	PVC	8	227.6	2	0	0	2	0.08	0	0	0.08	115	334
6	5-602 - 5-601	PVC	8	167.4	0	0	0	0	0	0	0	0	0	0
7	5-7 - 5-20	VCP	8	232.6	15	3	12	30	6.12	10.7	47.12	63.94	92,074	261,304
8	5-7 - 5-20													
9	5-610 - 5-609	VCP	8	193.6	7	4	5	16	3.21	12.43	27.43	43.07	62,021	211,428
10	5-702 - 5-703	PVC	8	348.9	2	0	1	3	0.41	0	10	10.41	14,990	28,355
11	5-730 - 5-33	PVC	8	138	7	6	1	14	6.19	3.75	0	9.94	14,314	68,470
12	5-705 - 5-704	PVC	8	177.6	0	0	1	1	0	0	7.78	7.78	11,203	41,644
13	5-1241 - 5-1243	PVC	8	116	4	0	2	6	1.05	5.24	0	6.29	9,058	51,539
14	5-611 - 5-610	VCP	8	145.8	10	2	1	13	3.87	1.82	0	5.69	8,194	37,081
15	5-605 - 5-604	PVC	8	306.6	0	1	1	2	0.32	0	5.23	5.55	7,992	17,203
	5-599 - 5-1241	PVC	8	214	7	0	1	8	1.68	3	0	4.68	6,739	20,788
16	5-600 - 5-598	PVC	8	268	8	3	0	11	3.09	1.13	0	4.22	6,077	14,965
17	5-735 - 5-733	PVC	8	154.3	1	1	0	2	0.24	3.71	0	3.95	5,688	24,322
18	5-683 - 5-[illegible]	PVC	8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.76	2.7	0	3.4[illegible]	4,982	[illegible]67

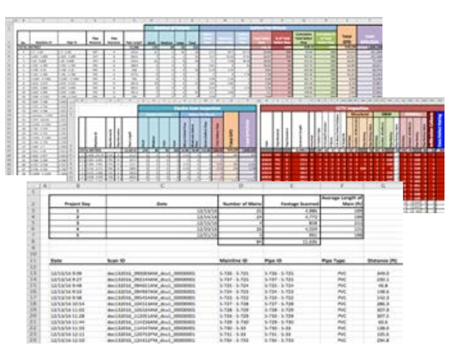
CCTV Inspection

No.	Mainline ID	Date	Pipe Material	Pipe Diameter	Surveyed Length	Direction	# of Factory Taps	# of Cracks/Fractures	# of Roots	# of Broken/Holes/Collapse	# of Deposits	Structural: OVERALL	Number of Observations	Pipe Rating	Pipe Rating Index	O&M: OVERALL	Number of Defects	Pipe Rating	Pipe Rating Index	OVERALL: OVERALL	Number of Defects	Pipe Rating	Pipe Rating Index	Infiltration Callouts	Zero Defect Rating
TOTAL METRICS					15,496.6		198	12	6	2	0	53	16		33	83	25		56	136	41		82	11	60
1	5-601 - 5-600	4/20/15	PVC	8	295.7	D	6	0	0	0	0	0	0	0	0	12	3	4300	4	12	3	4300	4	3	
	5-20 - 5-609	4/13/15	VCP	8	250.9	U	1	3	0	0	0	10	3	4221	3	8	2	4200	4	18	5	4421	4	2	
2	5-721 - 5-720	3/16/15	PVC	8	46.4	D	0	0	0	0	0	0	0	0	0	9	2	5141	4	9	2	5141	4	2	
3	5-598 - 5-599	4/20/15	PVC	8	105.5	U	1	0	0	0	0	0	0	0	0	6	2	4121	3	6	2	412	3	1	
4	5-608 - 157-PS	4/15/15	PVC	8	219.1	D	4	0	0	0	0	0	0	0	0	5	1	5100	5	5	1	5100	5	1	
5	5-604 - 5-608	4/15/15	PVC	8	231.1	U	5	0	0	0	0	0	0	0	0	4	1	4100	4	4	1	4100	4	1	
6	5-602 - 5-601	4/20/15	PVC	8	175.6	U	2	0	0	0	0	0	0	0	0	5	1	5100	5	5	1	5100	5	1	
7	5-7 - 5-20	4/13/15	VCP	8	165.7	D	1	2	4	0	0	4	2	2200	2	9	5	3213	2	13	7	3222	2	0	
8	5-7 - 5-20	4/10/15	VCP	8	63.3	U	1	0	0	0	0	0	0	0	0	3	1	3100	3	3	1	3100	3	0	
9	5-610 - 5-609	4/6/15	VCP	8	192.7	D	2	2	1	1	0	12	3	5141	4	1	1	1100	1	13	4	5141	3	0	
10	5-702 - 5-703	3/24/15	PVC	8	352.2	U	7	0	0	0	0	0	0	0	0	2	1	2100	2	2	1	2100	2	0	
11	5-730 - 5-33	2/10/15	PVC	8	137.7	D	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
12	5-705 - 5-704	3/25/15	PVC	8	175.4	D	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
13	5-1241 - 5-1243	4/21/15	PVC	8	120.3	D	3	0	1	0	0	0	0	0	0	2	1	2100	2	2	1	2100	2	0	
14	5-611 - 5-610	4/6/15	VCP	8	147.9	U	1	1	0	0	0	2	1	2100	2	0	0	0	0	2	1	2100	2	0	
15	5-605 - 5-604	4/15/15	PVC	8	309.4	U	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	5-599 - 5-1241	4/21/15	PVC	8	216.1	U	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
16	5-600 - 5-598	4/20/15	PVC	8	271.2	U	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
17	5-735 - 5-733	3/12/15	PVC	8	152.2	U	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
18	5-683 - 5-[illegible]	4/[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	[illegible]	1

DATA RICH DELIVERABLES - Field Work End Date: Thurs. 12/22/2016; Report Date: Wed. 12/28/2016

City Staff Received Individual Reports For All Eighty-Two (82) Sewer Mains, Including:

For each project, Electro Scan provides a data rich portfolio of information, with unsurpassed user-friendly reports that compare prior inspection work. Let us or one of our Certified Data Providers re-do your latest rehabilitation plans using Innovyze's InfoMaster or GIS.



Summary ES Defect Flow Report | Pipe Type | Daily Production | ES v CCTV Ranked By Defect Flow | ES v CCTV Ranked by TV Rating | ES v CCTV Ranked by TV Infil

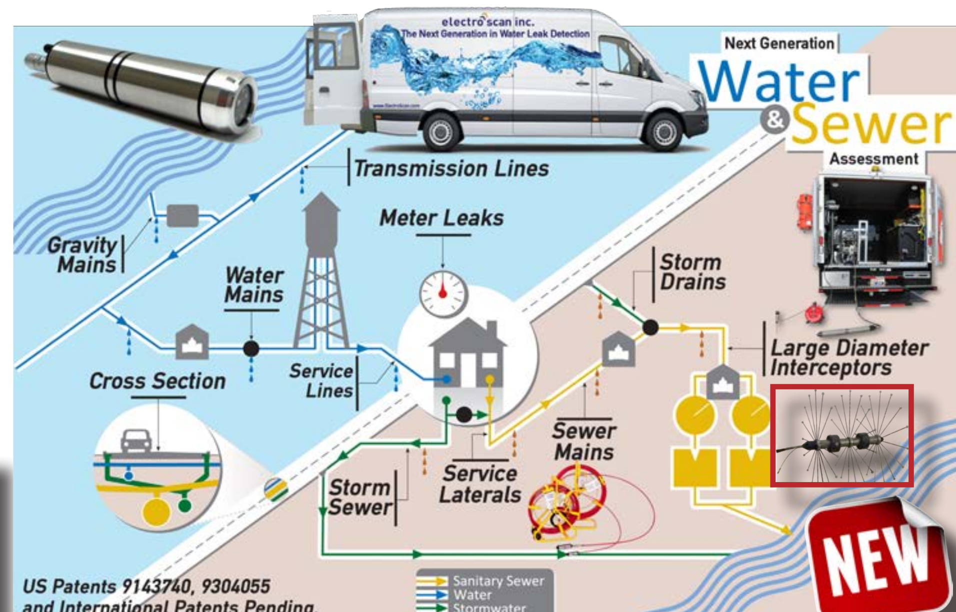
Large Diameter Assessment To Locate & Measure Leaks in GPM

Continued From Page 1

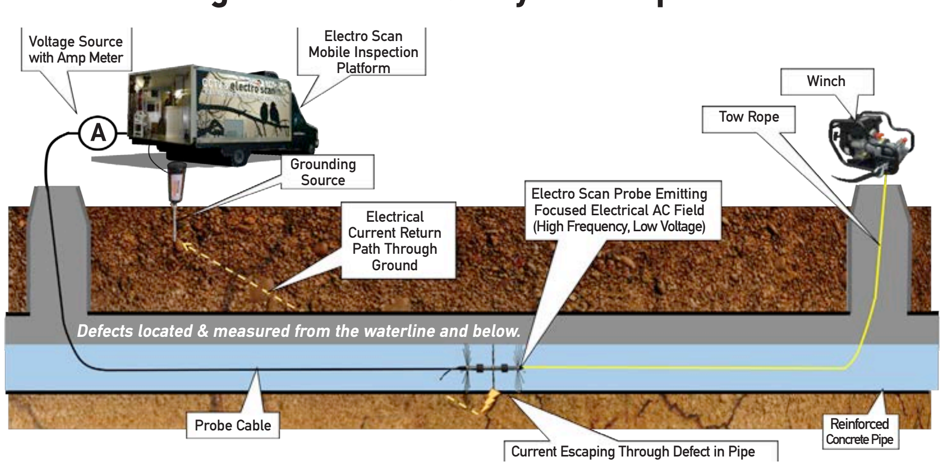
"We needed to make our code extremely smart and able to interpret tens of thousands of data points in a matter of seconds," continued Hansen, "delivering a GPM estimate within minutes of completing any survey."

Hansen should know. As former Founder of Hansen Software, sold to Infor Global for $100 million in 2007, Hansen has developed solutions to capture every major pipeline condition assessment technique since 1983. "This represents a new day for assessing large diameter pipes," continued Hansen. "Whether a high density plastic, cured-in-place, reinforced concrete, clay, or fiberglass pipe, our service is recommended for new pipe acceptance at installation, repair, and rehabilitation."

2017/2018 budgets should plan on a $10-$25 per foot basic service charge, with mobilization, difficult access, and reporting, separately priced. Call to learn how to sole source bid your project this year.



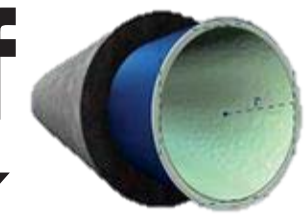
Large Diameter Survey Field Operation



Wastewater Collection Inspection Probes By Pipe Diameter

3" to 6"	6" to 30"	24" to 66"
76mm to 150mm	150mm to 800mm	600mm to 1650mm

Electro Scan Finds 69% of CIPP Have Defects That Leak



Surveyed 1/1/2016 to 12/31/2016.

Projects completed between January 1 and December 31, 2016 have shown that sixty-nine percent (69%) of Cured-In-Place Pipe (CIPP) lining had defects. While representing an improvement in the overall inspection of CIPP liners, results show an increase in the percent of liners experiencing more than 10 and 20 Gallons Per Minute (GPM) of defect flow, in many cases leaking more than pre-rehabilitation levels.

A surprise to many that have long relied on trenchless lining to repair, rehabilitate, and renew sewer and water mains and laterals, 2016 results confirm previous findings by Ken Kerri, Ph.D., P.E., that led him to recommend Electro Scanning Inspection for both pre- and post-rehabilitation, published in the 7th Edition, Volume 1, ***Operation and Maintenance of Wastewater Collection Systems*** manual.

RECOMMENDED BID STANDARD FOR REHABILITATION ACCEPTANCE

Agencies are recommended to require Contractors to deliver a Maximum Leakage Acceptance Rate not to exceed 100 Gallons Per Day Per Inch Diameter Mile (GPD/IDM).

Assuming an 8" Cured-In-Place Pipe (CIPP), the Allowable Leakage Rate for a 100ft, 8in Diameter Pipe Divided by 5,280ft, representing 0.151515 gallons per foot.

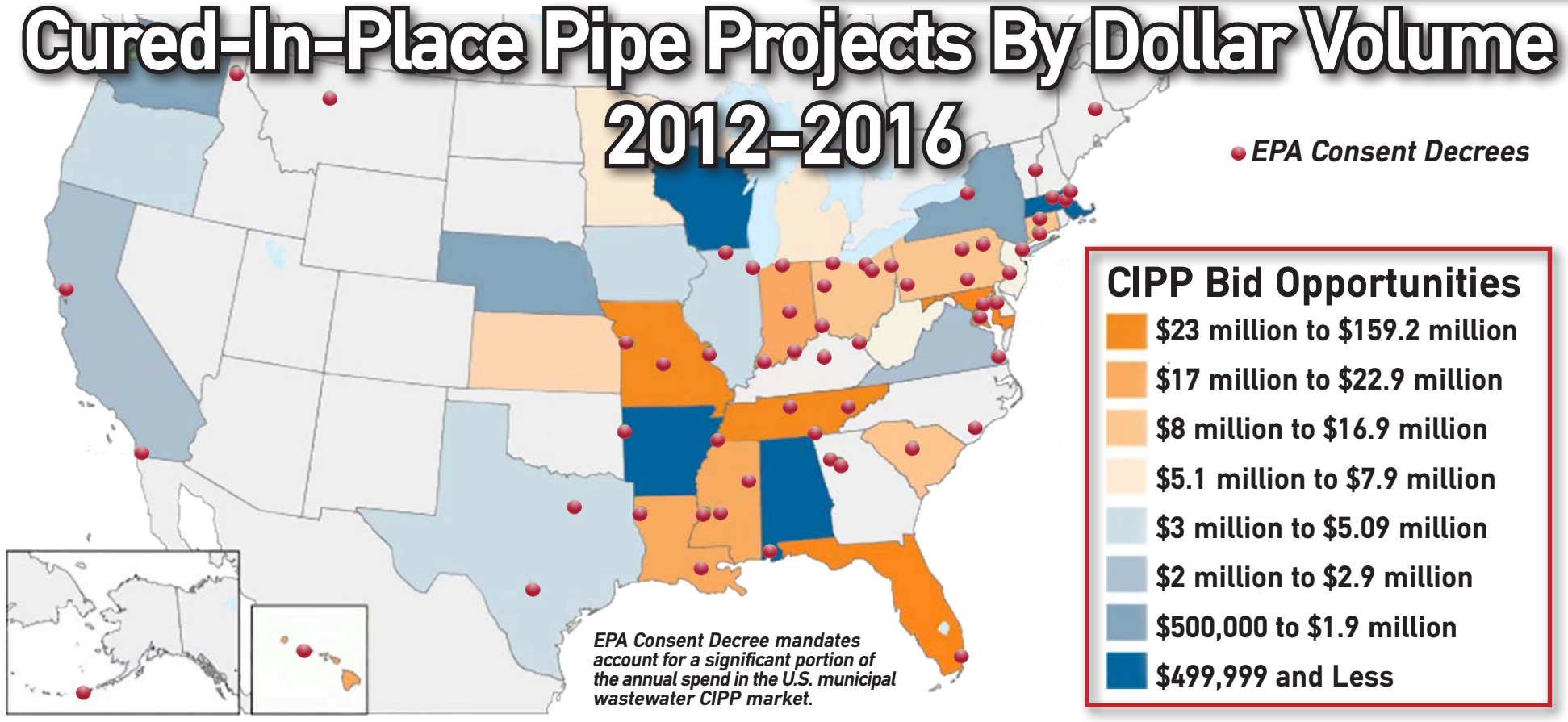
Computation,
= 0.151515
Divided By 1440 minutes per day
= 0.00010522 gallons/foot/minute

Computation (Continued)
= 0.00010522 or G/F/M x 300ft Sewer Main
= 0.03156 Gallons Per Minute
= 45.5 Gallons Per Day

Electro Scanning Inspection For CIPP Certification & Acceptance	Twelve Months 2016	Life to Date 2011 -2016
CIPP Liners with Defect Flows	**69%**	**76%**
CIPP Liners with ZERO Defect Flow (*Leak-Free*)	31%	24%
Defect Flow By Severity		
More than 1 GPM	57%	62%
More than 2 GPM	46%	51%
More than 3 GPM	43%	46%
More than 4 GPM	40%	43%
More than 5 GPM	39%	39%
More than 10 GPM *More Leakage Than Pre-CIPP*	**32%**	**31%**
More than 20 GPM *More Leakage Than Pre-CIPP*	**21%**	**19%**

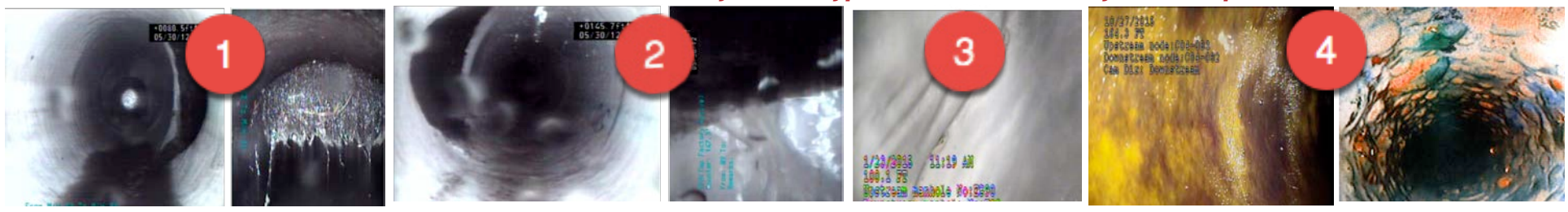
Source: Electro Scan Inc., CriticalSewers® Cloud Application, December 31, 2016.

Cured-In-Place Pipe Projects By Dollar Volume 2012-2016

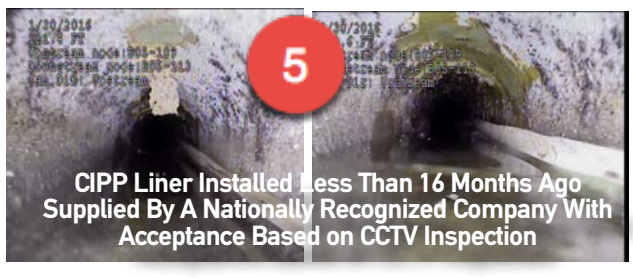


Common CIPP Defects Not Seen By CCTV

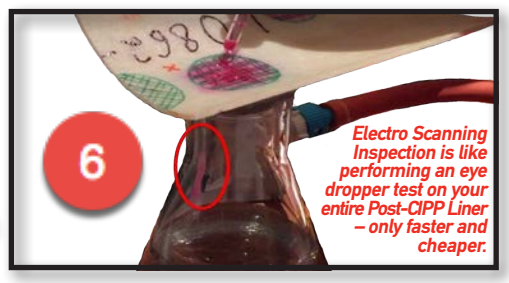
Make Sure You Use Electro Scan to Find Your Contractor's 'Dirty Dozen' Typical Defects Missed by CCTV Inspection!



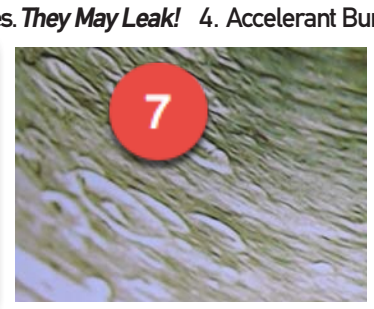
1. Post-CIPP, Bad Service Reconnection. ***Heavy Roots.***
2. Post-CIPP, Bad Service Reconnection. ***Infiltration.***
3. Wrinkles. ***They May Leak!***
4. Accelerant Burns, Called Out As 'Discolored' But Leaks.



5. Bad Resin. Installed less than 20 months ago.



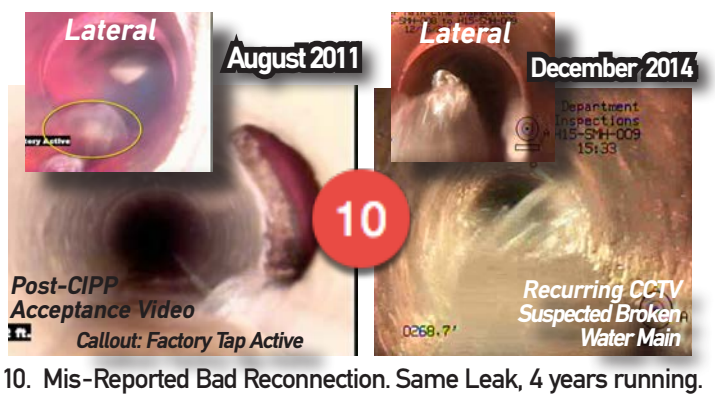
6. Defective/Weak Liner.



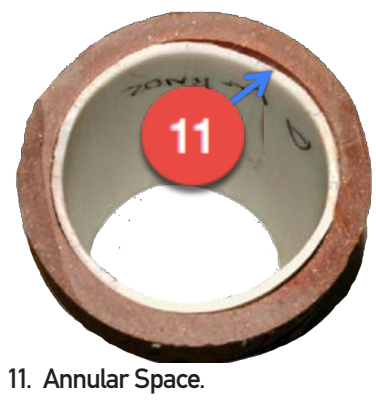
7. Overcooking of CIPP Liner.

8. Unreported Equipment Damage.

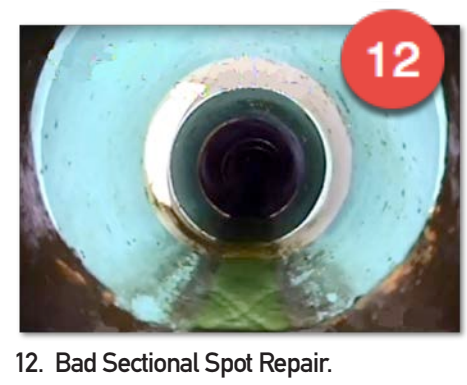
9. Defective Epoxy.



10. Mis-Reported Bad Reconnection. Same Leak, 4 years running.



11. Annular Space.



12. Bad Sectional Spot Repair.

Rely on CCTV to Certify CIPP & Likely Accept Moderate-to-Severe Leaks

San Francisco Specifies Focused Electrode Leak Location To Certify $10 Million Wastewater Projects

Recent RFP

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
WASTEWATER ENTERPRISE

Various Locations Sewer Replacement No.2
Contract No. WW-633
December 2016

Page 33 33 00-14

Contractor shall perform a FELL inspection of all six (6) inch diameter up to and including thirty (30) inch diameter mainline sewers and culverts that have been installed, repaired, grouted, or lined. The purpose of the FELL Inspection ("Inspection") will be to identify all potential leaking defects as accurately, efficiently, and as quickly as possible.

The contractor shall:

- Furnish all necessary labor, equipment, materials, services, and incidentals required to record inspection by means of FELL technology in newly installed and rehabilitated gravity sewer line sections from manhole to manhole.
- Inspect one sewer line section (i.e. manhole to manhole) at a time. Flow within the section is irrelevant except within the area of the inspection probe, which will be 100 percent flooded using reclaimed water to within three (3) feet of the probe in both directions. Precautions shall be taken by the contractor to prevent flooding of properties connected to the sewer system and those properties adjacent to or in the general vicinity of the inspection.

  Pull the probe through the line a uniform rate in compliance with operator discretion. The rate of inspection should not be greater than 60 feet per minute, and the rate should not exceed the capability of encapsulating the probe with water.
- Comply with ASTM F2550-13 Standard Practice for Locating Leaks in Sewer Pipes by Measuring the Variation of Electric Current Flow Through the Pipe Wall.
- Follow the FELL Inspection practices outlined in the Seventh Edition of the Operations and Maintenance of Wastewater Collection Systems Manual, published by the Office of Water Programs, California State University Sacramento, California.

Within the same day of the scan being performed, the Contractor shall upload the scan files to the City's Critical Sewers cloud platform via the pre-assigned registration code for the FELL Inspection software application.

Files shall include:
- The City's asset number system to identify the assets being inspected.
- Date of Inspection.
- Location of Inspection.
- Pipeline size, type, and overall length.

The results of the FELL inspection will be reviewed on CriticalSewers® by the City Representative. Individual leaks calculated to have the potential to be in excess of 0.05 Gallons per Minute, and/or pipelines exceeding a total 0.20 gallons per minute shall be repaired by the contractor prior to final acceptance. Post processing GPM calculation shall be done to the results on the city's Critical Sewers platform and will be done assuming a theoretical variable of one (1) foot of ground water head pressure over the entire pipe length.

Leaks determined to be excessive by the City Representative shall be repaired by the contractor at no cost to the City prior to final acceptance.

NOTE: SFPUC Contract No. WW-633 had estimated cost of $7.3 million Due Date: 1/12/2017.

NOTE: SFDPW Contract No. 2501J, University Street and Sunnydale Avenue Pavement Renovation & Sewer Replacement had estimated cost of $2.4 million, Due Date: 1/18/2017.

CIPP Specification Updated to Adopt *Electro Scanning Inspection* to Certify & Accept Contractor's Performance

Acceptance testing and certification of all repairs, relining, and renewal, shall be performed using electro scanning inspection and shall be performed by an independent third-party contractor experienced in the use of the electro scanning system, in accordance with the ***MAINTENANCE AND OPERATION OF WASTEWATER COLLECTION SYSTEMS, Volume 1, Seventh Edition, 2015, ISBN 978-1-59371-066-8*** and ***ASTM F2550, Standard Practice for Locating Leaks in Sewer Pipes By Measuring the Variation of Electric Current Flow Through the Pipe Wall***. The City shall select (and pay for the services of) the independent 3rd party contractor to conduct this pre and post testing.

The electro scanning inspection test shall be conducted on one hundred percent (100%) of the total linear footage of mainline pipe, including a Pre-CIPP and Post-CIPP survey, with all results available to the City immediately following the test completion. Testing shall be performed on all non-conductive lined and host pipes, including but not limited to, **Asbestos Cement Pipe**, **Brick**, **Cement Mortar Lined Ductile Iron** or **Steel Pipe**, **Ceramic Epoxy**, **Clay**, **Concrete**, **Fiberglass Pipe**, **High-Density Polyethylene Pipe**, **Polyvinyl Chloride Pipe**, **Reinforced Concrete Pipe**, and **Vitrified Clay Pipe**, among others.

The following limits shall be used to determine the significance of detected defects.

- Defects below the "Small Threshold" (<100 mA) are considered acceptable, but may be eligible for investigation at no cost to City. This excludes anomalies detected at the beginning and end of pipe at manholes.
- Defects above the "Small Threshold" >100 mA, will be initially considered "unacceptable." Defects need to be further investigated and reviewed. If deemed unacceptable, the pipe will be failed.
- Defects that occur at the beginning and end of a lined pipe, where the probe is exiting or entering a manhole, will not be the responsibility of the Contractor and will be accepted by City.
- If no lateral connection rehabilitation will take place, contractor will not be held liable for any anomalies detected at lateral reinstatements. However, lateral reinstatements must be performed to City specification.
- City will have full access to all automatically recorded testing conditions via a cloud-based portal and will be verifying all tests are being performed within the manufacturer's recommended parameters. All scans must be performed within the following testing parameters:

  1. Pipe must be fully surcharged with water at the location of the probe to ensure a full 360-degree inspection of the pipe. This can be achieved in whatever means the Contractor chooses, but City and manufacturer recommend using a Sliding Funnel Plug or Cone, in conjunction with a hydraulic jet truck or portable jetter. If chosen, probe must remain a minimum of three (3) feet from funnel plug.
  2. Total Current readings must be a MINIMUM of 2800mA when probe is in a concrete manhole when starting the scan, and must not drop below 1000 mA after entering the lined pipe.
  3. Probe speed must range from 30-60 feet per minute.
  4. All pipes with Defects above the "Small Threshold" shall be retested after Contractor has addressed the defect at no additional cost to City.
  5. The Electro Scan Contractor shall provide same day fully analyzed results to both the Contractor and City representative within 1 hour of testing each section of pipe via uploading each scan to the City's licensed viewing platform. NOTE: Contractor will not have any access to the City's viewing platform to maintain independent testing and certification of all tests.

Contact Electro Scan for Sample Specifications in Microsoft Word format.

CIPP-Related ASTM Standards

ASTM D543 Test Method for Resistance of Plastics to Chemical Reagents

ASTM D638 Test Method for Tensile Properties of Plastics

ASTM D790 Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

ASTM D883 Definitions and Terms Relating to Plastics

ASTM D1600 Abbreviations, Acronyms, and Codes for Terms Relating to Plastics

ASTM F412 Definitions of Terms Relating to Plastic Piping Systems

ASTM F1216 Rehabilitation of Existing Pipelines and Conduits by Inversion and Curing of a Resin Impregnated Tube

ASTM F2550-13 Standard Practice for Locating Leaks in Sewer Pipes By Measuring the Variation of Electric Current Flow Through the Pipe Wall

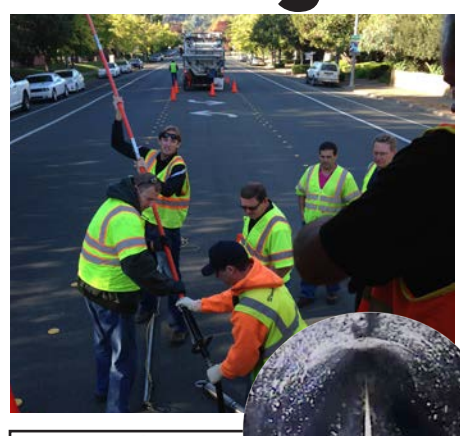
Electro Scan Testing Recommended for Siphons

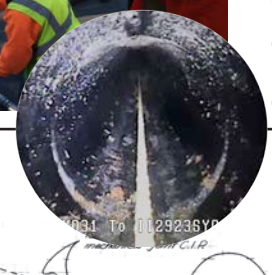
Topping the list for *most difficult sewer mains to inspect* are sewer siphons.

Included in his earliest drafts of his Electro Scanning Inspection Chapter/Lesson, in the 7th Edition, Volume 1, Wastewater Collection O&M manual, Ken Kerri, Ph.D., P.E., recommended the use of Electro Scanning Inspection, in place of CCTV Inspection or Sonar devices.

Siphons, sometimes called depressed sewers or sags, allow wastewater to flow through a pipe under low lying areas or obstructions such as highways, creeks, rivers, utilities, or other obstructions, where gravity flow is impossible.

In addition to the tendency for low lying piping to be surcharged, almost on a continuous basis, normal debris, including sand, grit, and gravel, is often built-up at the bottom.





Typical Sewer Siphon

Lined ductile iron or blackened walls make CCTV problematic.

While CCTV inspection requires lines to be bypassed and sonar may be used to determine debris or sedimentation levels, neither are useful to locate or measure the severity of leaking joints, cracks, or openings to ground that may be found – especially if pipe walls are darker colors.

Not limited to low flow pipes or light debris, Electro Scan's probe can easily navigate bends, turns, and surcharged pipes, to deliver fast, accurate defect locations and severity.

Adding Electro Scan to TV Truck

Retrofit Your CCTV Truck to Find Defects

Integrate Electro Scan with Leading American

Recommended by O&M Manual

In accordance with 7th Edition, Vol. 1, Operations and Maintenance of Wastewater Collection Systems manual, pages 231-257

ELECTRO SCANNING

11. Position Probe

a. Layout Probe

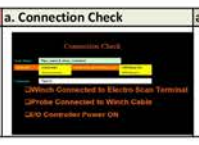
b. Insert Probe

c. Single Pulley

d. Side Wedge Pulley
OPTIONAL

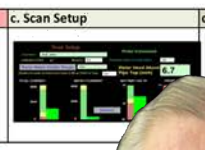
12. Final Checks

a. Connection Check



b. Connection Check

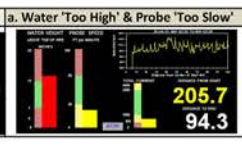
c. Scan Setup



1. Total Current
2. Defect Current
3. Battery Volts
4. Probe Volts

13. Key Indicators

a. Water 'Too High' & Probe 'Too Slow'

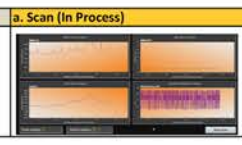


b. Probe Speed 'Too Fast'

c. Total Current 'Too Low'

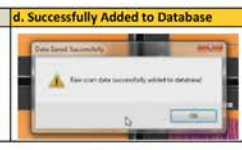
14. "Live" Scanning

a. Scan (In Process)



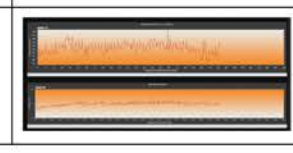
c. Save Scan

d. Successfully Added to Database

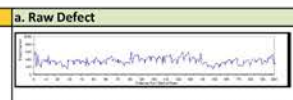


e. Display Scan Data?

15. Completed Scan

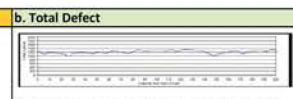


a. Raw Defect



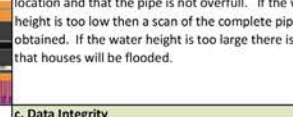
Shows Operator that scan is being recorded. Provides information on possible pipe defects.

b. Total Defect



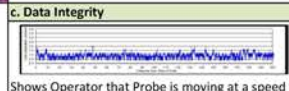
Shows Operator that there is adequate current flowing through the probe to obtain an effective scan. This is important because the Raw Defect Current may show low values and very little variation (good pipe) and this is the only way the operator can be sure that the system is running properly.

c. Water Height



Shows Operator that the pipe is full at the probe location and that the pipe is not overfull. If the water height is too low then a scan of the complete pipe is not obtained. If the water height is too large there is a risk that houses will be flooded.

c. Data Integrity



Shows Operator that Probe is moving at a speed that enables the system to collect data every 10mm (0.394 inch). Plotted data represents distance (i.e. Data separation) between each defect current measurement. If the speed it too fast, the scan looses data fidelity (i.e. integrity) and will miss pipe defects. If the speed is too slow then too much time is taken to carry out the scan.

GEAR REMOVAL & CLEAN-UP

16. Gear Removal

a. Stop Retraction When Funnel in Downstream MH

b. Carefully Pull Probe Into Downstream Manhole

c. Unhook Funnel Plug from Rope

d. Pull Probe & Rope Back Through Pipe

17. Clean-Up

a. Clean-Up Equipment
b. Pack-Up Tools

REPORTING

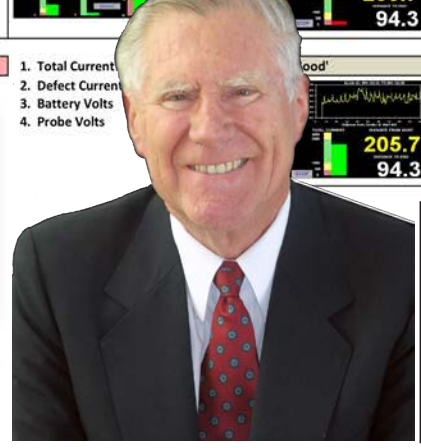
18. Cloud Reporting

Critical Sewers®

a. www.CriticalSewers.com

b. Data Display; Subject To Licensing

b. GPM for Advanced Data Management Only



Asked 'why' Ken Kerri wanted to write the new chapter on Electro Scanning Inspection for the 7th Edition of the O&M manual, Ken replied "Because you figured out how the technology could be used by a Sewer Operator, and since we can't rely on CCTV to judge which pipes to fix first."

Change from CCTV to Electro Scan, and back, in minutes.

Missed By Visual Inspection

& European TV Vans!

Don't let your wastewater collection agency get left behind in adopting new guidelines for Pre- and Post-Rehabilitation Condition Assessment. The new 7th Edition, Volume 1, with its standalone chapter on Electro Scanning Inspection, dramatically changes how to assess, prioritize, and certify repairs.

Seventh Edition, **2015**

Add to your 2017/18 budget today!

Sixth Edition, **2003**

Make sure you can tell a citizen's lawyer, municipal bond holders, and city insurance carrier that your sewer utility has adopted the latest recommended guidelines to inspect, rate, fix, and certify your pipeline rehabilitation program.

BUDGET

Electro Scan Inspection CCTV Retrofit Cost

$130,000 - $210,000

Range depends on...

1. CCTV Manufacturer
2. # Field & Office Users
3. Annual Support Plan

CONTACT ELECTRO SCAN FOR A CUSTOMIZED BUDGET QUOTE

- or -

A SERVICES QUOTE TO CERTIFY YOUR NEXT LINING PROJECT AS *LEAK-FREE*

EPA Region 3 Township Managing 120-Miles of Sewer Finds Ten Year Old CIPP In Worse Condition Than VCP

	Pipe Material	Pipe Length	Total Defect Locations	Gallons Per Minute	Gallons Per Day
LP004-LP003	VCP	332.7	61	18.24	26,266
LP003-LP002	CIPP	344.3	8	52.45	75,528
TOTAL		677.0	69	70.69	101,794

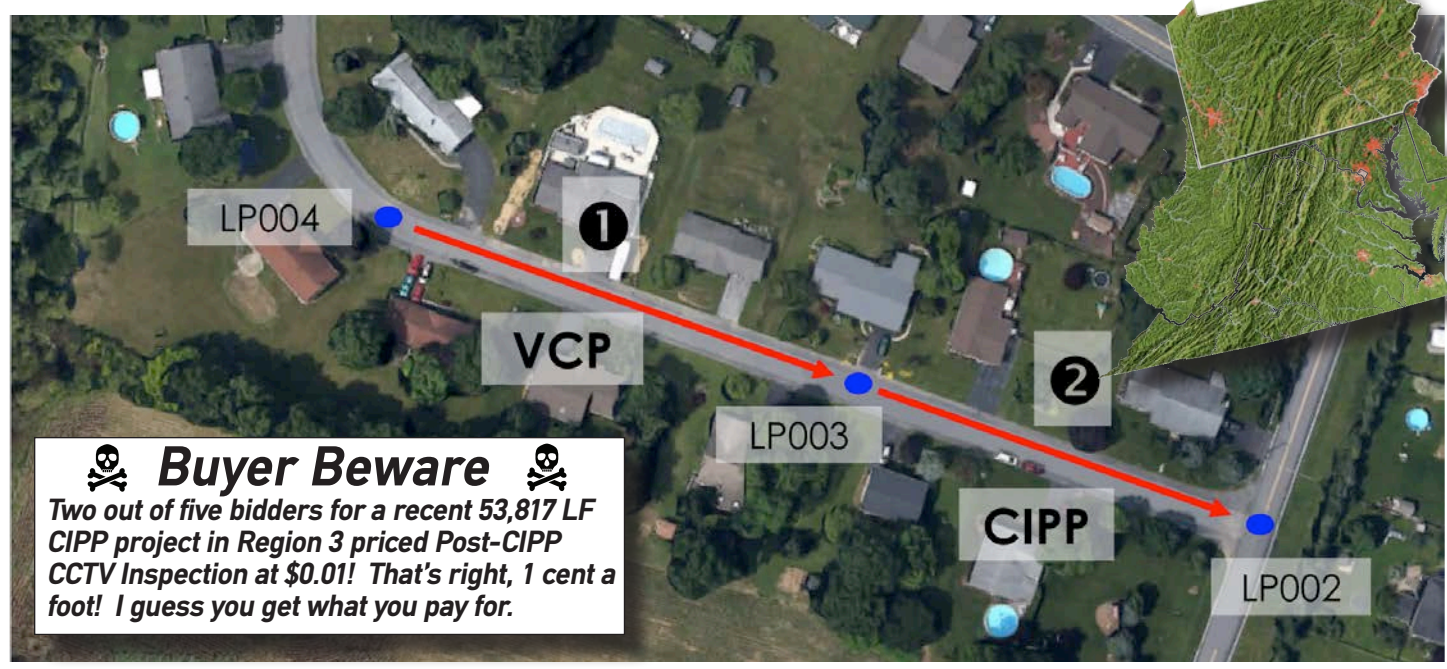
Managing a 120-mile sewer network, with 3,000 manholes and 6 pump stations, this PA-based township experiences an average flow of 5,800,000 GPD, that may double during wet weather events.

In November 2016, Electro Scan Services conducted a field demonstration on the same street, evaluating one (1) VCP and one (1) CIPP, with some surprising results.

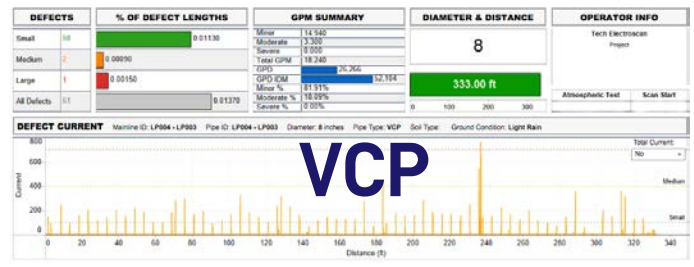
As shown above, Electro Scan surveyed 677 linear feet of pipe, finding 69 individual defect locations contributing an estimated 70.69 gallons per minute (GPM) of defect flow or 101,794 gallons per day (GPD).

All work was completed in accordance with the Seventh Edition, Volume 1, of the *Operations and Maintenance of Wastewater Collection Systems* manual, with all locations accurate to within 1 cm (0.4 in) and ±30% accuracy of its defect flow calculations which assume a 1ft head and 1% pipe gradient.

All reporting was prepared in accordance with ASTM F2550-13, *Standard Practice for Locating Leaks in Sewer Pipes By Measuring the Variation of Electric Current Flow Through the Pipe Wall.*

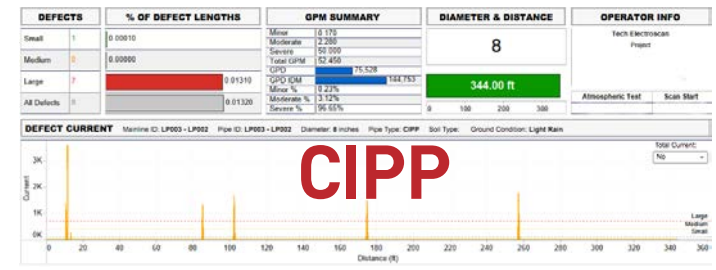


"We have continued to accept the shortcomings of CCTV inspection since the 1950s," states Mark Grabowski, Electro Scan Vice President. "The only difference today is that we see the shortcomings of CCTV inspection in higher resolution."



Vitrified Clay Pipe: 18.24 GPM Defect Flow

VCP had a total of 61 defects which contributed an estimated 18.24 GPM or 26,266 GPD, with the 10 worst defects contributing 47% of defect flow. Defect spacing shows a pathway to the soil at almost every joint.



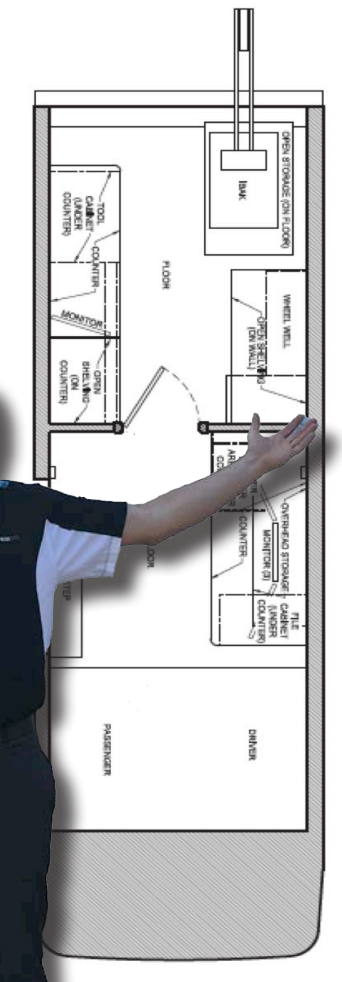
Cured-In-Place Pipe: 52.45 GPM Defect Flow

Electro Scan identified 8 defect locations in this ten year old relined pipe, with the majority of defect flow coming from bad service reinstatements. Fewer, but larger, defects result in a 52.45 GPM or 75,528 GPD defect flow rate.

"Why Did My City Purchase a New Electro Scan Van?"

Field Production of 2,000-to-4,000 Ft/Day, More Accurate Than CCTV & Need to Certify Rehabilitation

Retrofit Your CCTV Van With a New Electro Scan Dedicated Reel



"We put a lot of tender loving care into all the Electro Scan Vans we build or retrofit – delivered with or without a kegerator."

Mark Grabowski, VP and General Manager, Electro Scan Inc.

Cory Peters, Electro Scan Project Engineer, shows off Electro Scan's latest customized addition.

CIPP Contractors Undergo Electro Scanning Pre-Certification Testing, Prior to New Contracts

CIPP Electro Scan Tests Show Lining Defects At Northern California Sewer Agency

CIPP contractors are finally getting the message – get ready for more stringent acceptance standards for cured-in-place pipe.

Already working with European lining manufacturers and contractors, North American CIPP contractors and suppliers have contacted Sacramento-based Electro Scan Inc. to contract with the company's services division to undergo sample testing on liners, in most cases already installed for other cities, that have less stringent requirements, like visual inspection, to approve and accept trenchless rehabilitation.

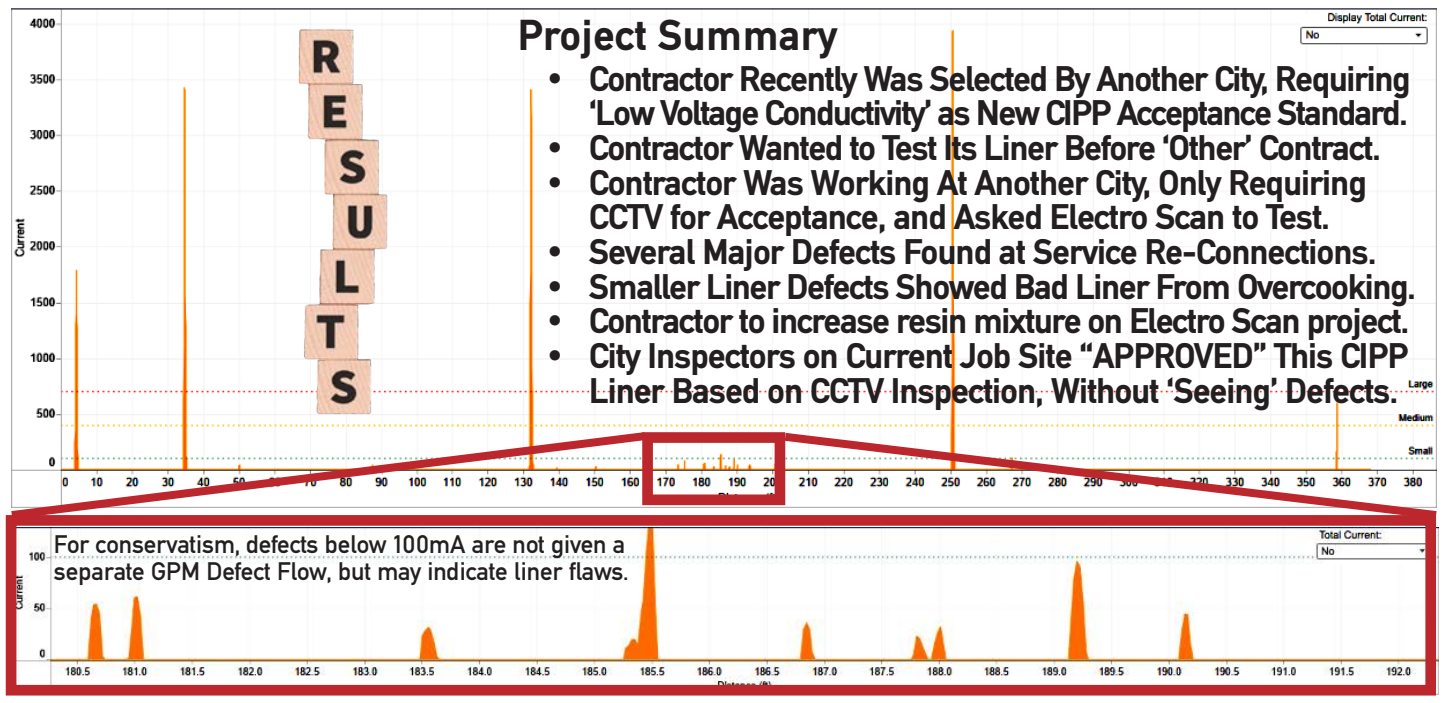
With the condition of not disclosing Electro Scan results to current test agencies, Contractors most often want to see both Pre- and Post-CIPP assessments.

By providing a roadmap of specific locations and severity of pre-existing defects, Contractors can quickly see where it must successfully line a pipe in order to achieve a Zero Defect Flow Rating.

Material	Diameter	Length of Pipe	Total Defect Locations	Gallons Per Minute	Gallons Per Day
CIPP	6 inches	368 feet	7	41.61	59,918

DEFECTS	% OF DEFECT LENGTHS	GPM SUMMARY	DIAMETER & DISTANCE	OPERATOR INFO
Small	0.000200	Minor 0.230	6	
Medium	0.000600	Moderate 1.380		
Large	0.008700	Severe 40.000		
All Defects	0.009500	Total GPM 41.610		
		GPD 59,918		
		GPD IDM 143,222		
		Minor % 0.29%		
		Moderate % 1.74%		
		Severe % 97.97%		

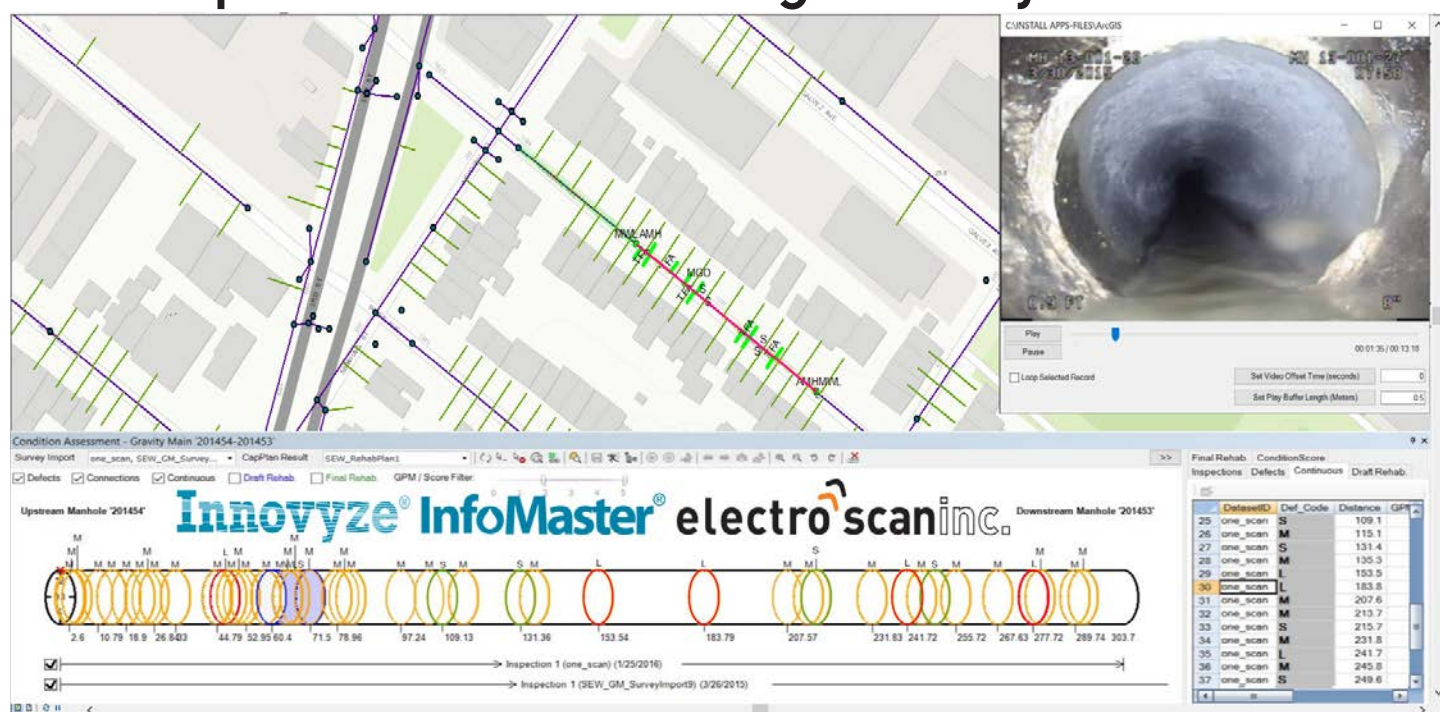
Atmospheric Test	Scan Start
10/6/2016 12:13:53 PM	10/6/2016 12:30:53 PM



Defect Grade	Defect Start (ft)	Defect End (ft)	Length (ft)	GPM	% of GPM	GPD	GPD/IDM
L	4.38	5.19	0.81	10.00	24.03%	14,400	34,420
L	34.78	35.57	0.78	10.00	24.03%	14,400	34,420
L	132.14	133.01	0.86	10.00	24.03%	14,400	34,420
S	185.48	185.53	0.05	0.15	0.36%	216	516
L	250.67	251.42	0.76	10.00	24.03%	14,400	34,420
S	267.30	267.32	0.03	0.08	0.19%	115	275
M	358.71	358.91	0.20	1.38	3.32%	1,987	4,750

Risk Assessment Using Electro Scan Replaces CCTV for Better Decision Making

Recent Engineering Reports Worth a Second Look By Certified Electro Scan Data Providers As Visual Inspection Found to Recognize Only 1 in 10 Defects



Innovyze Asset Mgmt Prioritization User Group Meeting Unveils Electro Scan Technology

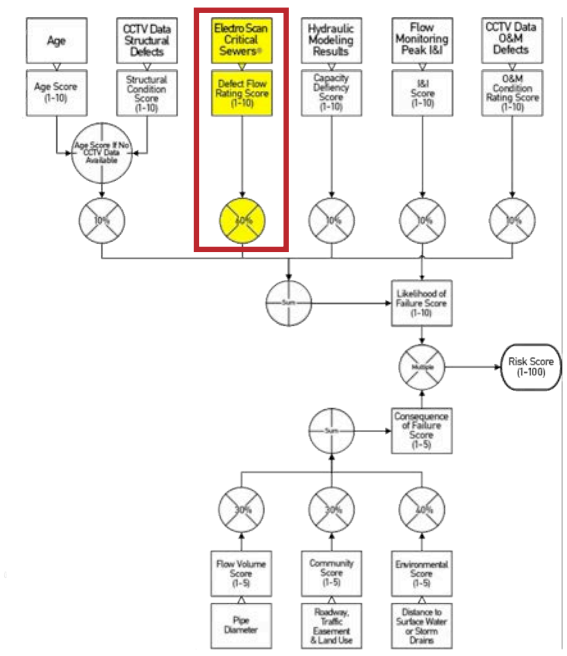
If you or your consulting engineer relies on visual Closed-Circuit Television (CCTV) inspection, your agency may be fixing the wrong pipe. Even worse, you may be accepting new or rehabilitated pipes as leak-free that could be leaking the same or more than before repair.

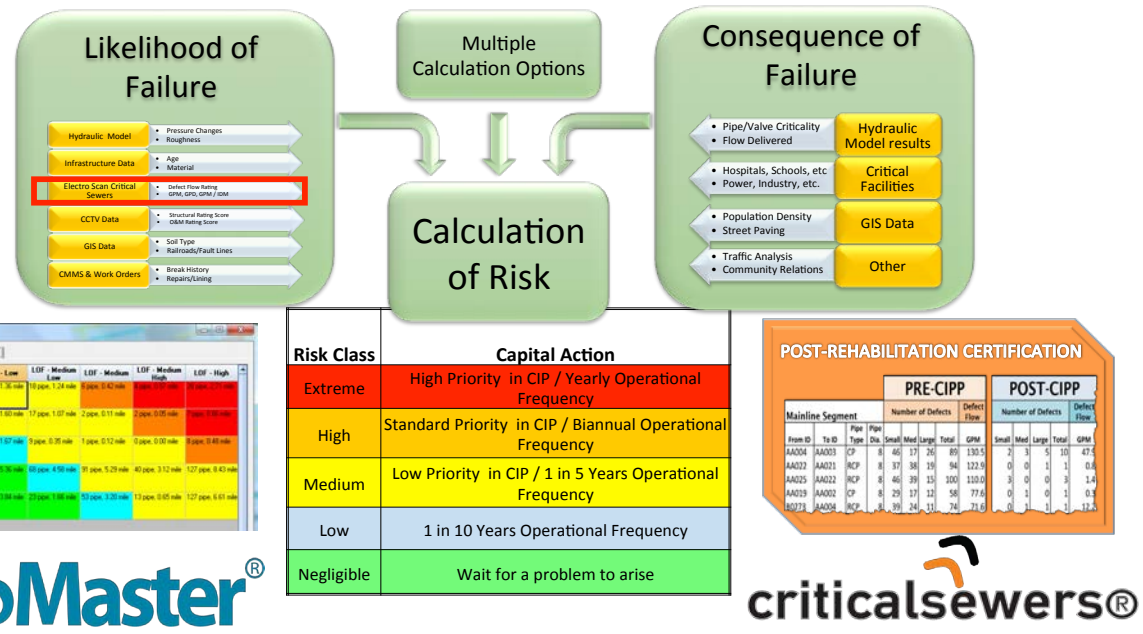
Those are the undisputed findings of leading water and sewer utilities, consulting engineers, and educators that are upgrading their rehabilitation selection recommendations and certifications to Electro Scanning Inspection.

"CCTV compromises 'risk of failure' calculations and is often the leading cause of misapplication of scarce CAPEX."

Chuck Hansen. Chairman & Founder, Electro Scan Inc.

Former Chairman & Founder, Hansen Information Technologies Inc.





Risk Class	Capital Action
Extreme	High Priority in CIP / Yearly Operational Frequency
High	Standard Priority in CIP / Biannual Operational Frequency
Medium	Low Priority in CIP / 1 in 5 Years Operational Frequency
Low	1 in 10 Years Operational Frequency
Negligible	Wait for a problem to arise

And, a key decision support tool has been Electro Scan's integration with the Innovyze® InfoMaster for Sewer product.

Recommended to assess and certify pre- and post-rehabilitated pipes, a new chapter was recently added on Electro Scanning Inspection to the industry's leading training manual, ***Operation and Maintenance of Wastewater Collection Systems, Seventh Edition, Volume One*** (2015), in accordance with ASTM F2550.

"We are delighted to integrate our game changing pipe condition assessment solution with the leading business analytics solution for the wastewater industry," states Chuck Hansen, CEO, Electro Scan Inc.

Electro Scan's Critical Sewers® cloud application allows for up-to-the-minute monitoring of sewer evaluations, lining projects, point repairs, and new construction projects, while crews are still in the field.

Clients can identify pipe-specific problems before rehabilitation project acceptance.

Wirelessly transmitted to the Company's award winning cloud application, defect flows are reported in minutes and incorporated into Innovyze® InfoMaster® for Sewer product for display and analysis.

Since Electro Scan's advanced low voltage conductivity technology does not rely on operator interpretation, third-party data analysis, or independent judgment, a key advantage is its ability to automatically provide specific location, size, and estimated flow for each defect and total pipe.

Customers wishing to utilize Electro Scan's decision support data must be licensed users of Innovyze® InfoMaster® for Sewer and Electro Scan's Critical Sewers® cloud application, including associated integration module. Once data is accessible, Electro Scan defect flows may be highlighted by location and severity by Innovyze® InfoMaster for Sewer.

After 1 Million CCTV Inspections, Chuck Hansen Recommends A Better Way

"No one was ever happy using CCTV inspections to rank and prioritize critical sewers," says Chuck Hansen, former Chairman and Founder of Hansen Information Technologies and developer of some of the most comprehensive models for sewer rehabilitation, "but it was the best thing we had at the time. But, Electro Scan's Defect Flow has re-written models to dramatically improve pre- and post-assessment."

Upgraded Likelihood of Failure Model

Likelihood Category	Indicator	Weight (%)	Likelihood Score 1 (Low)	3	5	8	10 (High)
Defect Flow Rating	Critical Sewers® Score[a] (Electro Scan)	60	<= 1	>1 to 3	>3 to 6	>7 to 9	> 9
Structural Condition	Structural Grade Score[b] (from CCTV)	10	<= 2	>2 to 4	>4 to 7	>7 to 9	>9
	Pipe Age[c]		< 20 years	20 to < 40 years	40 to < 60 years	60 to < 80 years	≥ 80 years
O&M Condition	O&M Grade Score[b] (from CCTV)	10	<= 2	>2 to 4	>4 to 7	>7 to 9	> 9
Capacity Deficiency	Model-Predicted Surcharge[d]	10	No surcharge or not in model	Throttled pipe resulting in surcharge under future growth conditions only	Throttled pipe resulting in some surcharge, freeboard ≥ 5 feet	Throttled pipe resulting in significant surcharge, freeboard < 5 feet	Throttled pipe resulting in overflow
Inflow / Infiltration Contribution	Relative Peak I/I Rate[e]	10	Low	N/A	Medium	N/A	High

Contact Electro Scan Inc. for certified engineering firms to re-tool your model.

(Above) Screens from early expert system (1990) developed by Chuck Hansen using CCTV inspection data to recommend and prioritize rehabilitation.. Says Hansen,"It's time to take bolder action using intelligent-machine data, like Electro Scan, to accurately find & fix our pipelines. Otherwise we're going to spend more money to fix the same pipe that was misdiagnosed by legacy CCTV inspection."

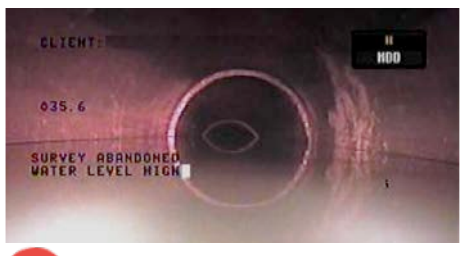
Smart Cities Limit Use of CCTV Due to Major Drawbacks

1 Reliance on Dry Weather Pipes

A key reason for curtailing CCTV inspection is that it is primarily used during dry weather conditions – when pipes are less likely to leak.

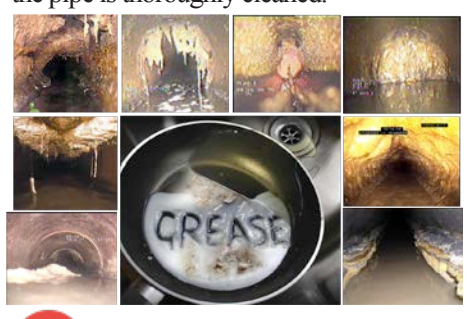
2 Pipe Half Full or Half Empty?

TV cameras are not effective in full or half-full pipes, missing any defects below the waterline.



3 Fats, Oil, and Grease

While grease is a frequent call out for certified TV operators, it often disguises structural problems that may only be assessed if the pipe is thoroughly cleaned.



4 Roots

Representing a clear pathway between the inside of a pipe and surrounding ground, roots are an obvious potential source of infiltration, yet national coding standards recommend that operators rate the level of roots, and not identify or measure the potential defect flow resulting from roots.

5 Encrustations

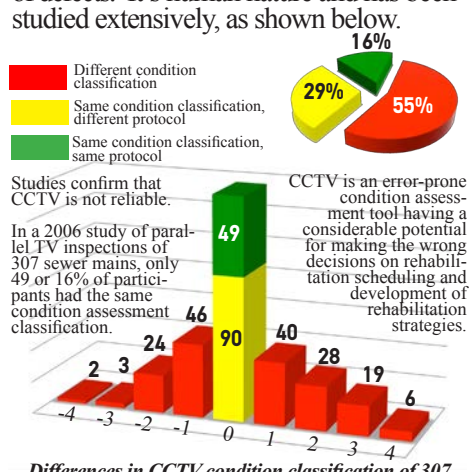
Often referred to as self-healing defects – *at last check encrustations are still not an approved rehab method* – encrustations can harden and cover-up cracks and fissures to the point of passing some pressure tests; but its non-conductive feature still can be positively passed through to determine the location and size of a potential defect flow.

6 Same Code, Different Defects

A corollary for using different codes indicating the same defect, is finding that TV operators frequently use the *same codes* to describe *different defects*. As confirmed in the EPA/WERF sponsored study in Milwaukee, Wisconsin, it was found that certified TV operators frequently used the same code for widely different defects, creating highly questionable Overall Pipe Rating Index (OPRI) metrics frequently used to determine rehabilitation priorities.

7 Different Codes, Same Defect

It is unfortunate, but true: train and certify two TV operators on the *same* day, using the *same* course instructor, utilizing the *same* materials (i.e. videos, photographs, etc.), test both using the *same* video, and you may get completely different interpretations of defects, not to mention a different number of defects. It's human nature and has been studied extensively, as shown below.

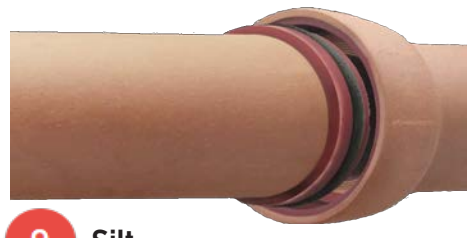


Differences in CCTV condition classification of 307 sewer reaches after parallel inspections (Müller, 2006).

The introduction of Electro Scan has not only shed light on defects not found by television inspection, but also highlights why CCTV inspection is not recommended to certify post-CIPP rehabilitation.

8 Can't Record What You Don't See

CCTV is not good at assessing the condition of pipe joints, primarily due to the basic design of joints. No matter how close an operator zooms into the surface of a joint, there is no possible way to assess the integrity or remaining useful life of the mortar. That is, unless pressure testing the joint or using Electro Scan.

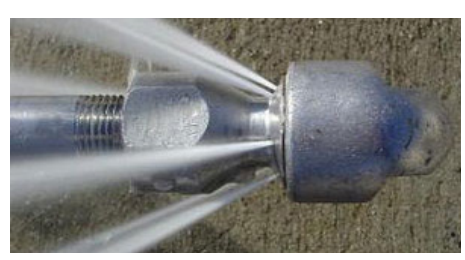


9 Silt

Silt is a dangerous thing to find in a sewer as it oftentimes represents the liquefaction of bedding surrounding a pipe that may indicate the early start of a void -- a warning to all sewer utilities that have an over-reliance on vac trucks to routinely remove silt. But while TV cameras cannot see through silt on the bottom of a pipe, Electro Scan can. When wet, silt is a conductive material, allowing Electro Scan's low voltage current to go right through silt to find defects where leaks can occur.

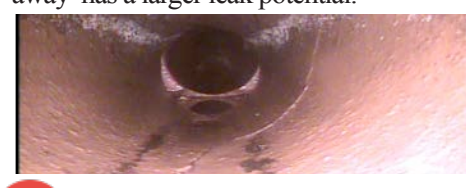
10 Clean v. Dirty Pipe Assessments

In 2010, the EPA arranged a benchmark in Kansas City, MO to compare Electro Scan and CCTV. While Electro Scan found 40% more defects and selected critical pipes that were rated in *good condition* by a nationally certified CCTV operator, comparisons were also evaluated on whether the pipe had been cleaned or not, prior to evaluation. While cleaning may eliminate fats, oils, and grease, roots, debris, and silt, it also eliminates key evidence of water leaks. As a result, TV inspections in the study did find fewer defects after cleaning, as clues to locating leaks were removed, and therefore more difficult to see with a camera.



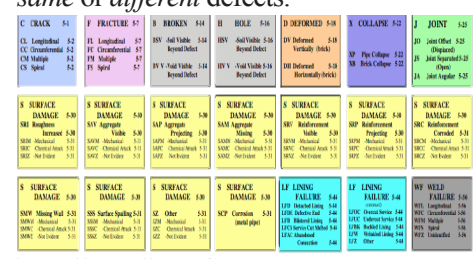
11 Cracks

Unfortunately, CCTV cameras are not able to tell the difference between a superficial surface crack and a crack that goes completely through the pipe wall. Too often, cracks are blamed for the infiltration, when in reality, the unsealed joint, a few inches away has a larger leak potential.



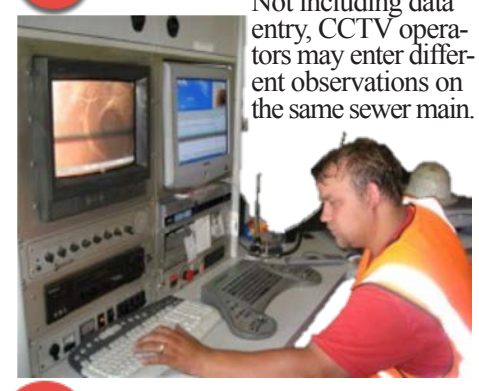
12 'Favorite' Code, Different Defects

Some operators often use 'favorite' codes that may or may not relate to the *same* or *different* defects.



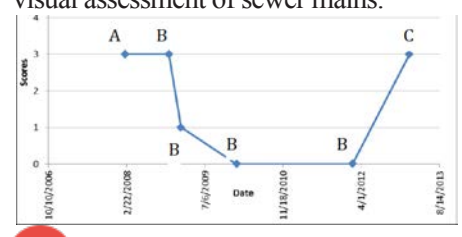
13 Different Codes, Same Operator

Not including data entry, CCTV operators may enter different observations on the same sewer main.



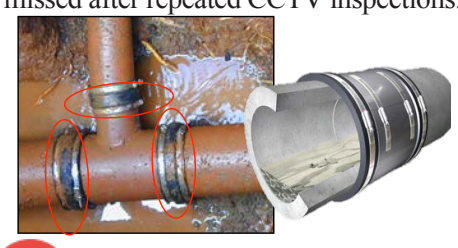
14 Repeatability

Recent studies suggest that certified TV operators are often unable to repeat the same CCTV observations, when evaluating the same pipe at different times – undermining development of an accurate visual assessment of sewer mains.



15 Fittings & Ferncos

CCTV cameras do not have the ability to test or validate the water tightness of fittings or Ferncos often used in VCP pipes, and located outside the pipe. The subject of an open trench smoke testing benchmark, Electro Scan accurately found defective ferncos (shown below), missed after repeated CCTV inspections.

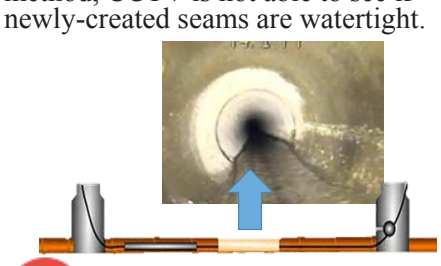


16 Dark-Colored Pipe

Darkened pipe walls not only mask visual signs of defects, but dark colors typically absorb a camera's lighting, further reducing the chance of a proper inspection. Ductile iron pipe, polyethylene, and high density polyethylene pipes are just some of the materials that may have darkened surfaces that are difficult to observe and assess.

17 Point Repairs

CCTV is not a reliable tool to certify point or spot repairs. Whether completed with a trenchless or open-cut method, CCTV is not able to see if newly-created seams are watertight.



18 Pre-Rehabilitation Selection

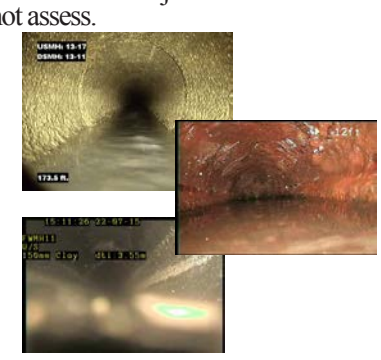
Too often, a rehabilitation program is deemed "unsuccessful" when flows are not reduced. Unfortunately, since CCTV cameras cannot properly assess pipes for leakage potential, TV programs should not be used to rank or prioritize needed repairs, rehabilitation, or renewals.

*OPRI Grading	Structural Performance Grade (SPG)	Pipe Failure
5	Immediate Attention	Collapse or collapse imminent	Pipe has failed or will likely fail within the next 5 years
4	Poor	Collapse likely in foreseeable future	Pipe will probably fail in 5 to 10 years
3	Fair	Collapse unlikely in near future	Pipe may fail in 10 to 20 years
2	Good	Minimal collapse risk	Pipe unlikely to fail for at least 20 years
1	Excellent	Acceptable structural condition	Failure unlikely in the foreseeable future

CCTV 1-5 RATING SYSTEM NOT RECOMMENDED FOR REHABILITATION SELECTION

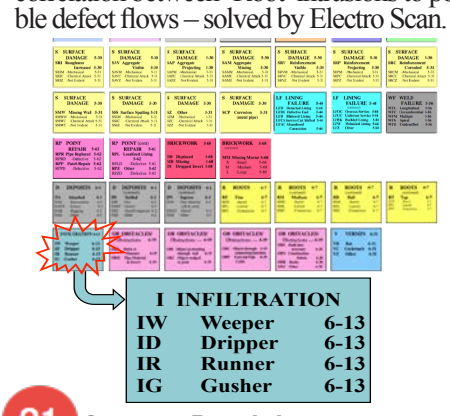
19 Missed Defects

Relying on a visual technology results in missed defects more often than not. Smudges on the lens, build up of debris and effluent on pipe walls, high flows, and operator inattentiveness, all contribute to missed defects. Not to mention the most common missed source for leaks – unsealed joints – which cameras cannot assess.



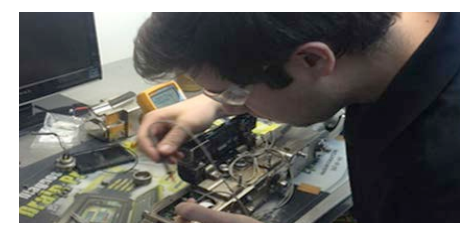
20 Infiltration

The requirement to have an empty pipe during CCTV inspection and inability to readily quantify openings in a pipe make identification of "infiltration" difficult, if not impossible. Further complicating the accurate identification of infiltration, is the lack of any correlation between 'Root' intrusions to possible defect flows – solved by Electro Scan.



21 Camera Breakdown

A multitude of moving parts coupled with considerable heat build up while inside a pipe, results in a treacherous environment for cameras and their crawlers. As a result, breakdowns may occur for a variety of reasons including entanglements from roots & debris, getting stuck in thick silt, or caught in a broken joint, all contributing to compromised video quality or an abandoned survey.



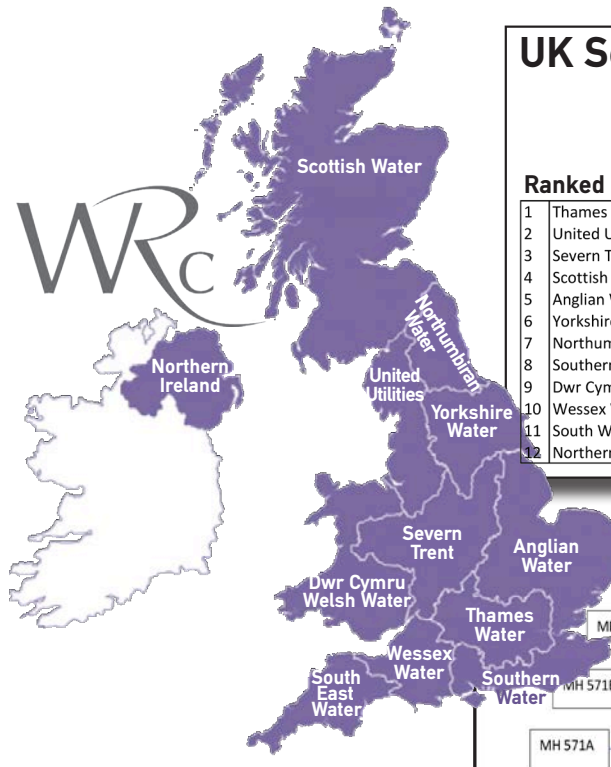
If Your Agency or Consulting Engineer Relies on CCTV for Rehabilitation Selection, You Are Likely Fixing the Wrong Pipe & Accepting *Moderate-to-Severe Liner Defects*

Large British Water Utility Conducts Post-CIPP Liner Assessment With WRc and Electro Scan

America still has a few behemoth water and sewer utilities, like publicly-traded New York City's Department of Environmental Protection (Revenue: $3.9 Billion), American Water Company (Revenue: $3.3 Billion), Metropolitan Water District of Southern California (Revenue: $1.7 Billion), and Aqua America Inc. (Revenue:$1.3 Billion).

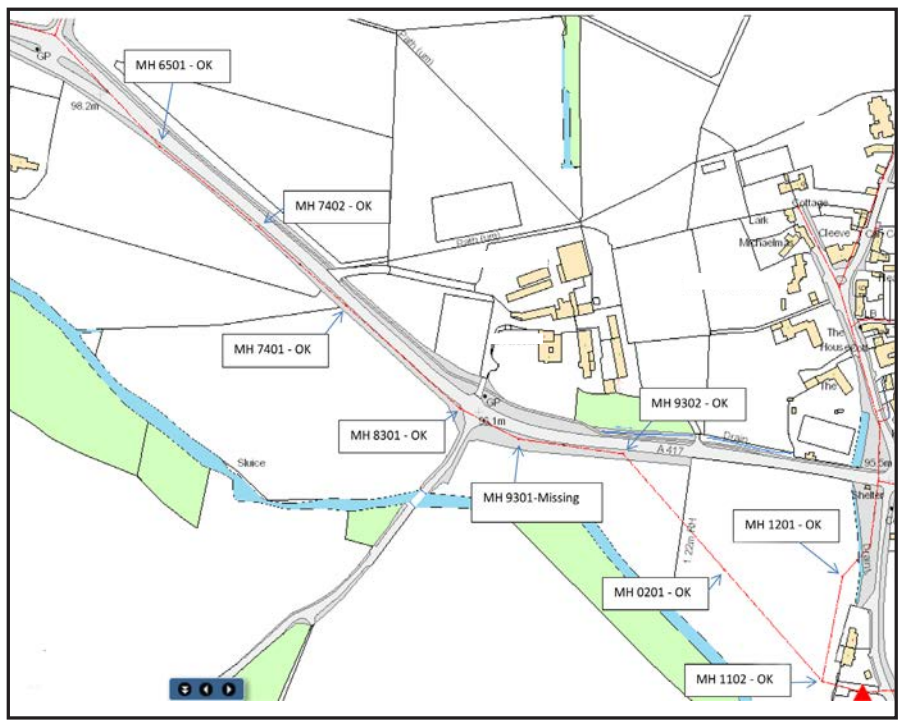
But, in the United Kingdom (England, Wales, Scotland, and Northern Ireland) sewerage and water services are concentrated among only twelve companies. The majority once former publicly-traded companies, now controlled by large hedge funds, private equity, and pension funds, the British water companies have been a model for innovation and customer care.

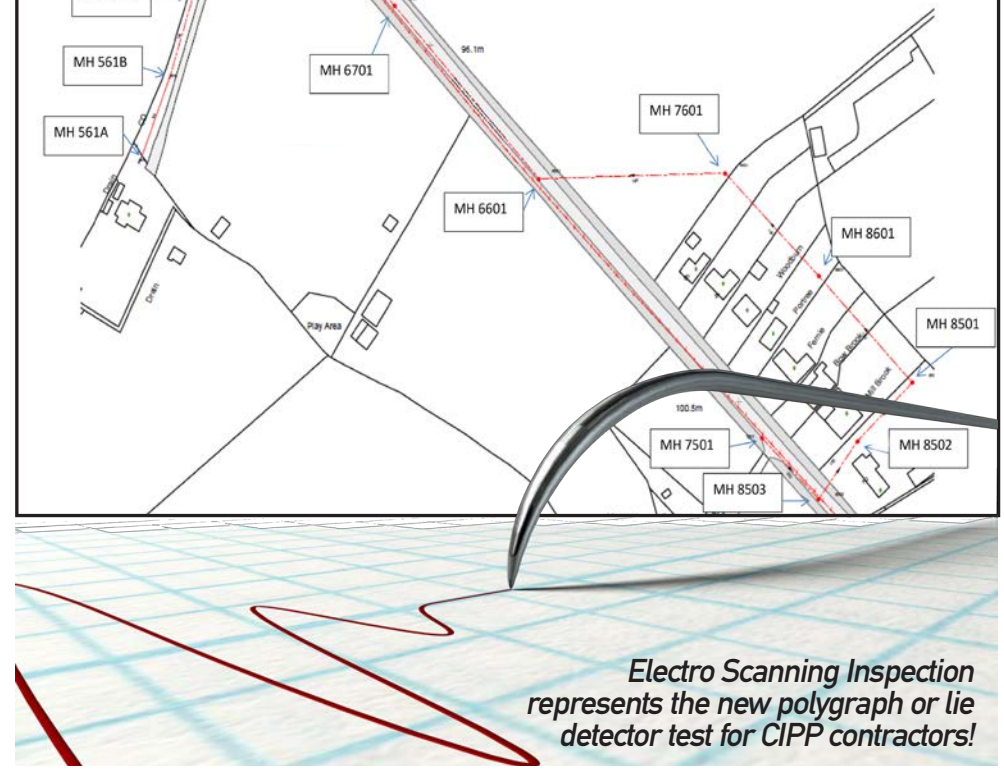
In November 2016, WRc working with Electro Scan Inc., completed its first Post-Rehabilitation Condition Assessment focused on Cured-In-Place Pipe (CIPP) lining. As shown below, 3 out of 10 sewer mains, representing 72m of 426m, or 17% of post-CIPP has no registered defects. Meaning 80% had defects, and more importantly, 3 out of 10 sewer mains, representing 125m of 426m, 29% of sewers, had leakage of 10,000 liters per day of defect flow.



UK Sewerage Services

Ranked By Revenue		Ownership: Private Equity	Ownership: Listed Company	Ownership: Government	Ownership: Private	Revenue £ Millions	Revenue $ Millions	Customers	Sewer km	Sewer mi
						£12,187.2	$14,868.4	49,505,000	608,275	377,739
1	Thames Water	X				1,800.0	2,196.0	15,000,000	109,400	67,937
2	United Utilities Group Plc		X			1,730.0	2,110.6	3,000,000	72,000	44,712
3	Severn Trent plc		X			1,506.1	1,837.4	4,300,000	91,000	56,511
4	Scottish Water			X		1,196.8	1,460.1	2,460,000	50,000	31,050
5	Anglian Water Services Holdings	X				1,185.4	1,446.2	4,200,000	75,931	47,153
6	Yorkshire Water	X				975.8	1,190.5	5,000,000	52,000	32,292
7	Northumbian Water Limited				X	805.5	982.7	2,700,000	29,923	18,582
8	Southern Water	X				803.7	980.5	4,600,000	39,600	24,592
9	Dwr Cymu Welsh Water			X		743.2	906.7	3,000,000	30,000	18,630
10	Wessex Water				X	520.8	635.4	2,800,000	34,700	21,549
11	South West Water Limited	X				506.4	617.8	1,700,000	9,221	5,726
12	Northern Ireland Water Limited			X		413.5	504.5	745,000	14,500	9,005





WRc Project						Number of Defects				Liters Per Minute				Total LPD
No.	Mainline ID	Pipe ID	Pipe Material	Pipe Diameter	Pipe Length (m)	Small	Medium	Large	Total	Minor Defect Flow	Moderate Defect Flow	Severe Defect Flow	Total Defect Flow	
TOTAL METRICS					426	21	1	4	26	0.33	0.35	1.56	2.23	193,020
1	8501 - 7601	8501 - 7601	CIPP	150	88	6	1	3	10	0.07	0.15	1.56	1.76	152,900
2	5702 - 5701	5702 - 5701	CIPP	150	9	6	0	0	6	0.15	0	0	0.15	13,246
3	8502 - 8501	8502 - 8501	CIPP	150	28	1	0	1	2	0.01	0.12	0	0.13	11,175
4	561B - 571B	561B - 571B	CIPP	100	68	3	0	0	3	0.03	0.08	0	0.11	9,594
5	7501 - 8503	7501 - 8503	CIPP	150	32	2	0	0	2	0.03	0	0	0.03	2,889
6	6601 - 6701	6601 - 6701	CIPP	150	77	1	0	0	1	0.02	0	0	0.02	1,853
7	7601 - 6601	7601 - 6601	CIPP	150	52	2	0	0	2	0.02	0	0	0.02	1,363
8	571B - 5701	571B - 5701	CIPP	100	17	0	0	0	0	0	0	0	0	0
9	6701 - 5702	6701 - 5702	CIPP	150	29	0	0	0	0	0	0	0	0	0
10	8503 - 8502	8503 - 8502	CIPP	150	26	0	0	0	0	0	0	0	0	0

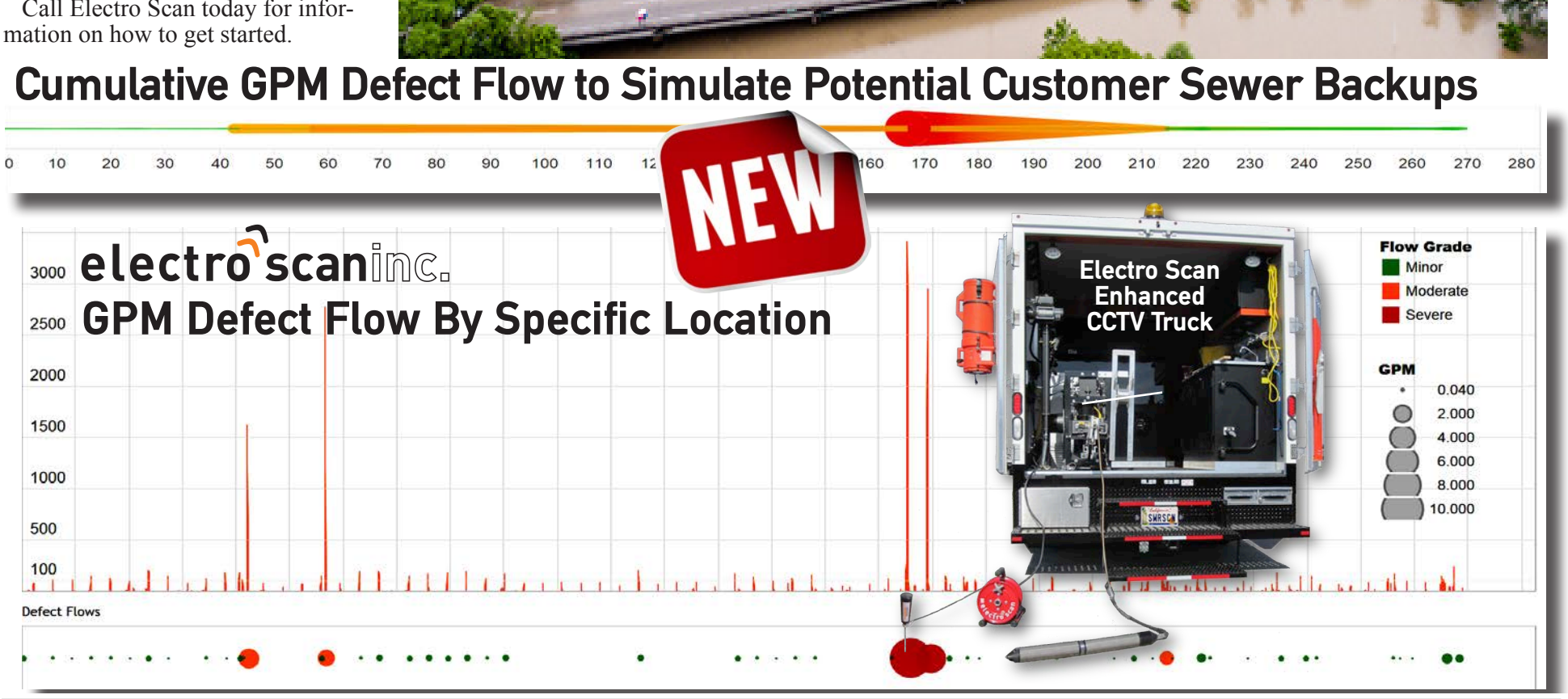
Climate Change Brings Prolonged Severe Weather

Sewer back-ups in homes and businesses are a sewer utility's worst fear. But, without a way to identify the most at-risk properties and parcels, managers are forced to play a seemingly endless game of whack-a-mole to fix sewer mains that experience the greatest infiltration rates.

Today, new tools are now available in a city's arsenal. Able to identify every source of infiltration in today's sewer mains and laterals, Electro Scan, working in association with the Innovyze® InfoMaster® for Sewer product to provide better prioritize decision-making.

By combining the ability to provide cumulative defect flow rates in gallons per minute and display Electro Scan data on GIS, connected properties, parcels, and people, most at risk to flooding, can be identified before the next storm, instead of afterwards.

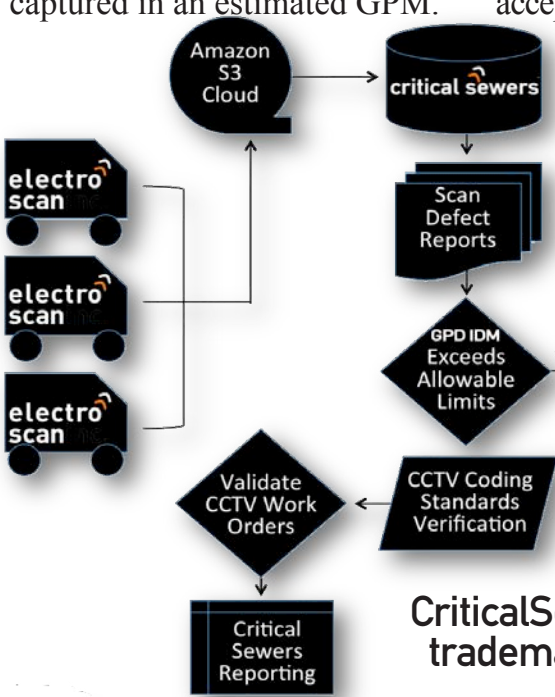
Call Electro Scan today for information on how to get started.



If You're Going to Use CCTV, New Guidelines Recommend CCTV AFTER Electro Scan Inspection

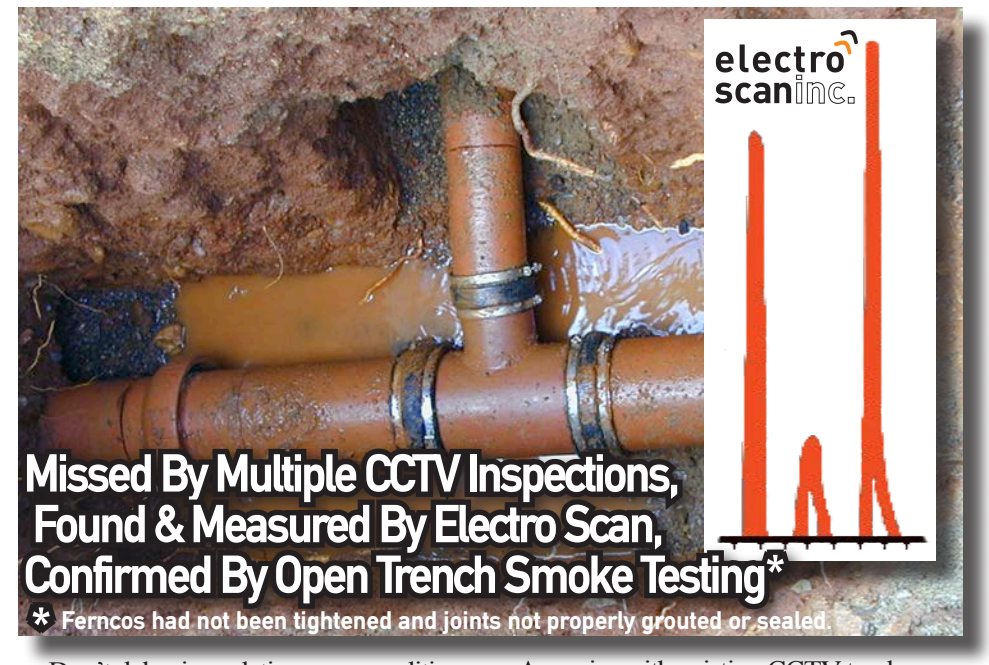
Unfortunately, certified operators don't know where to look to catalog sewer condition assessment (See Page 22). But fortunately, new published guidelines recognize that Electro Scan tells agencies precisely where defects are located and their severity, captured in an estimated GPM.

There was a simple reason that new guidelines replace CCTV with Electro Scanning Inspection as the recommended tool to assess sewers. People didn't fix what they couldn't see, but since they consistently missed 90% of defects, past rehabilitation, including CIPP acceptance, could be in error.



New Sewer Condition Assessment Standard Recommended By ASTM F2550-13 & O&M Manual

CriticalSewers® is a registered trademark of Electro Scan Inc.



Don't delay in updating your condition assessment program because relying on incomplete and inaccurate visual inspection data means the risk of mis-prioritizing your critical infrastructure and accepting rehabilitation, that in fact, may leak more than before you fixed it. Agencies that know their network leaks, can now use the 80:20 rule to find the 20% of the pipes that are causing 80% of infiltration.

Agencies with existing CCTV trucks can easily add Electro Scanning Inspection to operate both, interchangeably, but rehabilitation models and capital expenditure plans should be revised as soon as possible. Call Electro Scan and schedule a small pilot project to re-look at a few of your most recent CIPP liners to find leaks and defects, missed by CCTV.

テレビカメラ調査では発見できない下水管の破損を検出する新技術

New Technology Finds Sewer Pipeline Defects Not Seen By CCTV Inspection

Electro Scan Inc. is delighted with the results from Japan, extending the influence of low voltage conductivity abroad.

Working with Japan's most prestigious distributor of wastewater collection products, Electro Scan is gaining a wide reputation for consistent, repeatable results.

Using Electro Scan products since 2013, Japanese users have benefited from their own Japanese version of the Critical Sewers® cloud application.

We look forward to transition of the Japanese wastewater industry from the exclusive use of CCTV inspection to the newer and more precise low voltage conductivity technology.

Electro Scan Expands to Gulf Countries

Focus on Water Loss, High Groundwater, and Tidal Infiltration Drives Demand

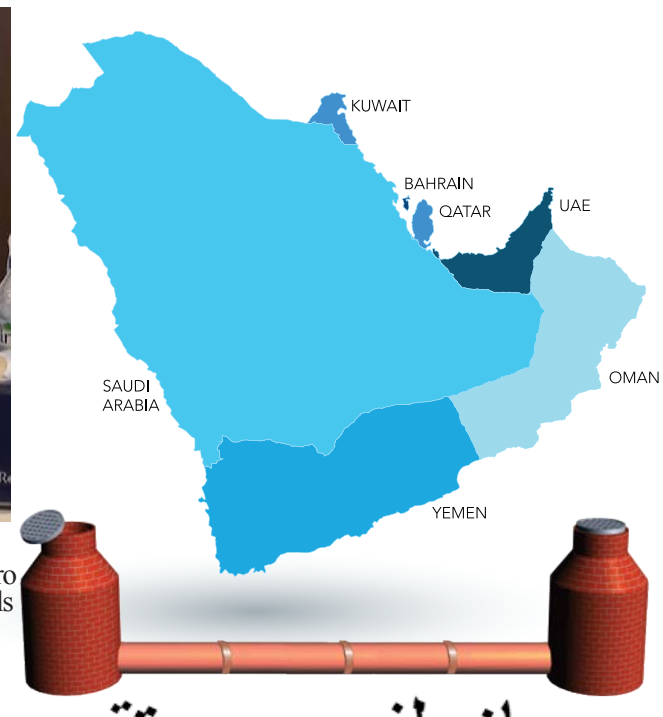
It started out by combining a brief vacation to the Gulf with the biennial TRENCHLESS MIDDLE EAST Conference held at Jumeirah Beach Hotel in Dubai, UAE, 7-8 March 2015.

Attended by Chuck & Deborah Hansen, conference meetings with a number of companies led to follow-up discussions with Riyadh-based International Aramoon Company, Ltd. (IAC).

Rapidly expanding through the Gulf, IAC invited Chuck Hansen to attend a private company seminar in Abu Dhabi in October 2016, learning more about the challenges in the region and key players.

"Finding the right partner is so important in the Gulf," states Hansen. "While we have so many differences, including language, culture, and customs, I quickly saw similar issues experienced by coastal and desert cities in the United States, and other parts of the world."

Graciously hosted in Abu Dhabi, then in Qatar, by **Faiz Alelweet**, IAC Chairman & CEO, **Saad Al-Zahrani,**. Vice President and Business Director, Mujeeb Kasim, Business Development Manager, and David Henderson, Aramoon-Qatar, IAC Limited, Electro Scan looks forward to upcoming trials of the Electro Scanning Inspection Technologies.



جهاز لفحص وتقييم شبكات المياه والصرف الصحي بدون حفر

Device to check and assess the water and sanitation systems without digging

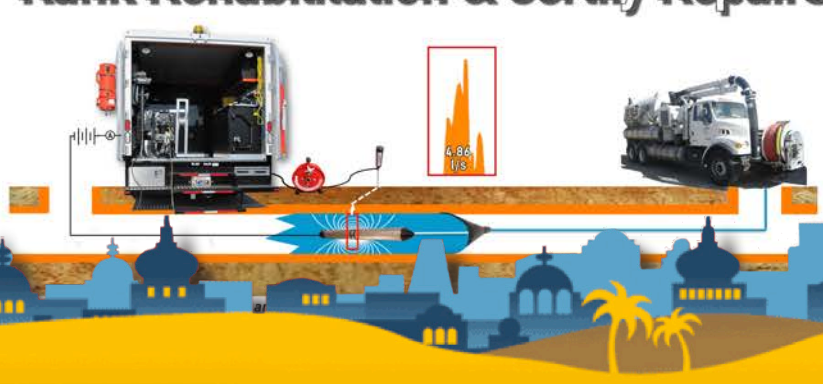
جهاز لفحص وتقييم شبكات المياه والصرف الصحي بدون حفر

Find & Measure Defects In Trenchless Rehabilitation* Before Contractor Acceptance

** and New Pipe Installations!*

PINPOINT LOCATION & QUANTITY
- Salt Water Infiltration.
- Overflows, Backups, Flooding.
- Leaks or Contamination of Groundwater.

Electro Scan Replaces CCTV Rating To Rank Rehabilitation & Certify Repairs



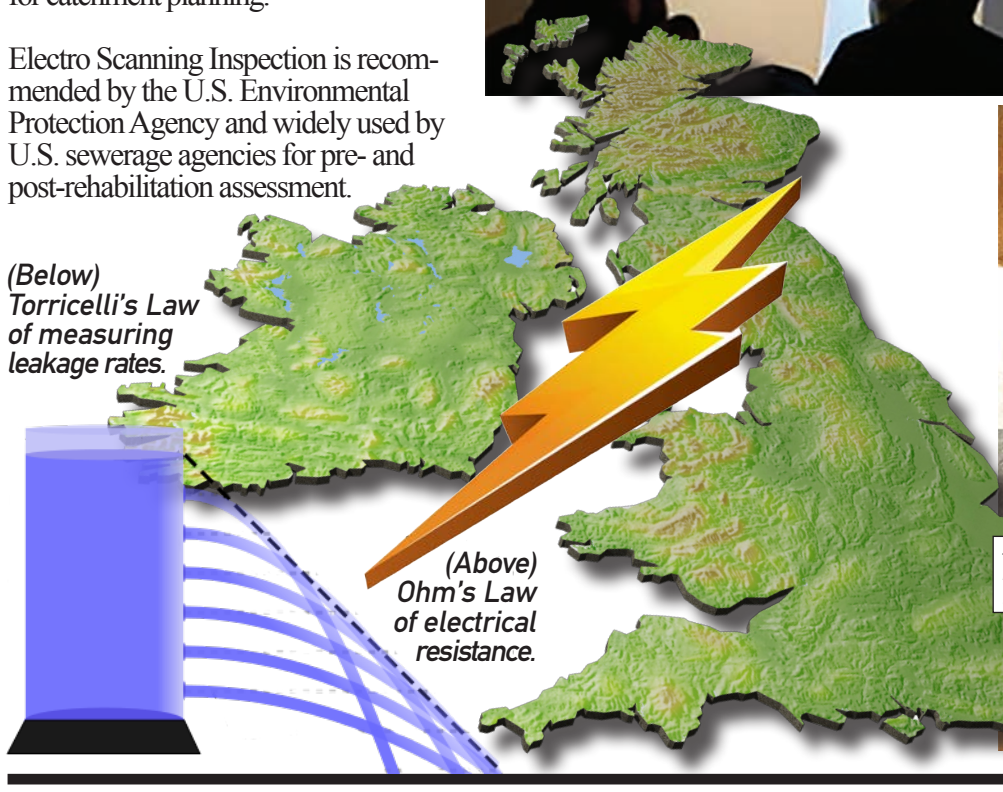
US +1 916 779 0660 UK +44 (0) 20 7692 8729 GERMANY +49 69 6655 4132 AUSTRALIA +61 3 8609 1246 The Next Generation in Pipe Condition Assessment

WRc Masterclass on Electro Scanning Inspection

WRc's Services Business Group is delighted to showcase their recently launched Electro Scanning Services for sewerage condition assessment at No-Dig Live 2016 in the UK.

Results are reliable, repeatable, and unambiguous, with results available within minutes after completing each survey. No operator coding or third party interpretation is required, often finding faults not identified by visual inspections. Unlike CCTV, it does not rely upon a subjective visual observation of the pipe – so even pipes that are fully surcharged can be assessed. Data can also be integrated with the Innovyze® InfoMaster® for Sewer hydraulic modeling program for catchment planning.

Electro Scanning Inspection is recommended by the U.S. Environmental Protection Agency and widely used by U.S. sewerage agencies for pre- and post-rehabilitation assessment.



(Below) Torricelli's Law of measuring leakage rates.

(Above) Ohm's Law of electrical resistance.

Manual of Sewer Condition Classification

Since 2004 NASSCO has based its Pipeline Assessment and Certification Program (PACP) on WRc's Manual of Sewer Condition Classification (MSCC).

Come See Electro Scan at WRc's Innovation Day 27 April 2017

Peter Henley WRc plc

Finding Leaking Pipes in Airport Sewers & Storm Drains

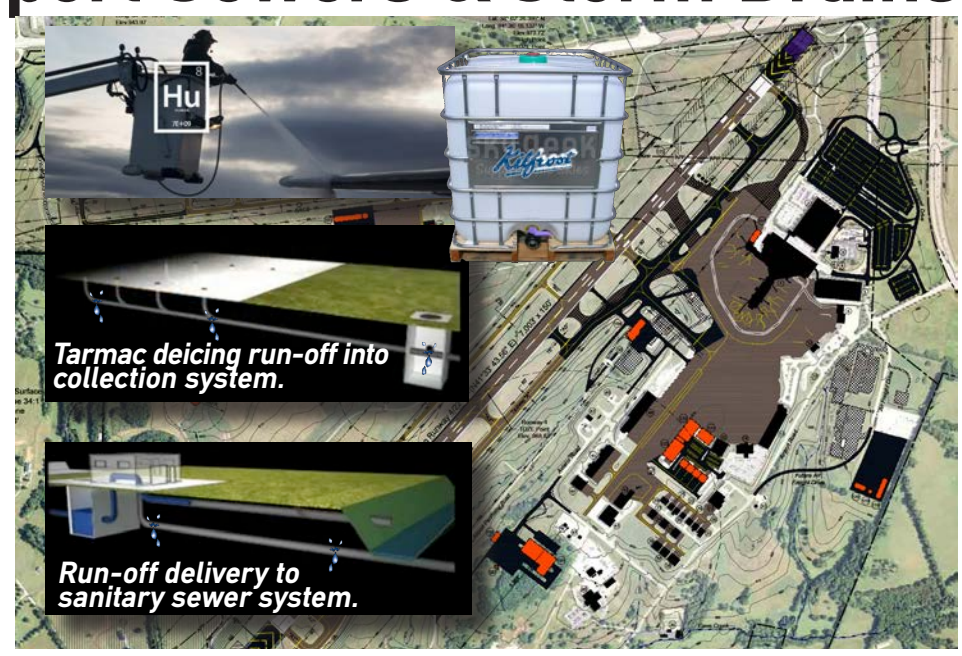
Deicing airplanes is a hazardous process. So it was no surprise to read that three flight attendants on an Alaska Airlines flight from Seattle to San Jose Thursday, January 12 were sickened due to fume exposure from deicing their airplane.

That's why glycol and other chemicals used in the deicing process must be separately pre-treated before entering the sanitary sewer system at the nation's airports. The challenge arises from trace chemicals being found in treatment plants. And while many airports have sophisticated systems for properly disposing of the chemical-laden storm water at the outfall, there is still a major Achilles heel in the system – that being, exfiltration occurring in the pipes that transport the run-off, prior to treatment.

Given that CCTV misses 9 out of 10 defects, airport managers are recommended to suspend all CCTV contracts and contact Electro Scan Inc.

Electro Scan's patented and patent-pending solutions are the only products capable of reliably finding leaks in an airport's storm drain, sanitary sewer, or water network, where deicing fluids may be exfiltrating into sewer or water networks. And not just airports – ports, harbors, brownfields, landfill leachate pipes, industrial plants, or anywhere contaminated water risks seeping out into environmentally-sensitive areas.

Make sure your consulting engineer is certified in Electro Scan data, or contact Electro Scan's Field Technicians for a complimentary review of your project.



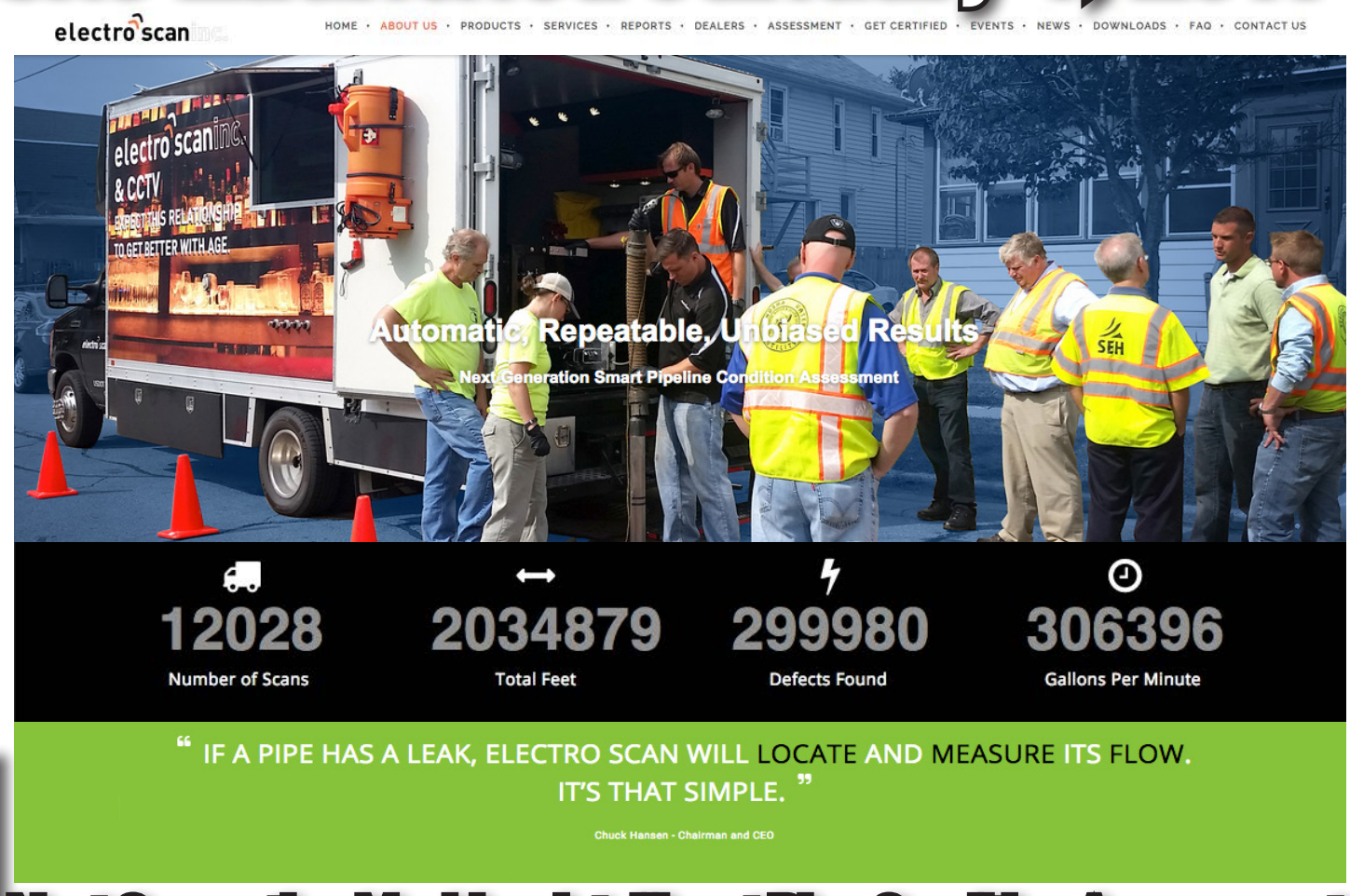
Electro Scan Inc. Sponsors 2017 Jammin' 4 Water

Jammin'4Water celebrates its 5th year in Chicago, Illinois, the weekend prior to WEFTEC, with Electro Scan Inc. as a Gold Sponsor. Past charities benefiting from this event have included WEF Service Project, Water For People, GlobalH2O, Engineers Without Borders, Charity:Water, World Water Relief, Ecoloodi, and Kids Connection Haiti. This year's event is expected to host more than 1,000 pre-WEFTEC conference attendees with performers on two stages.

New Website Launched January 1, 2017

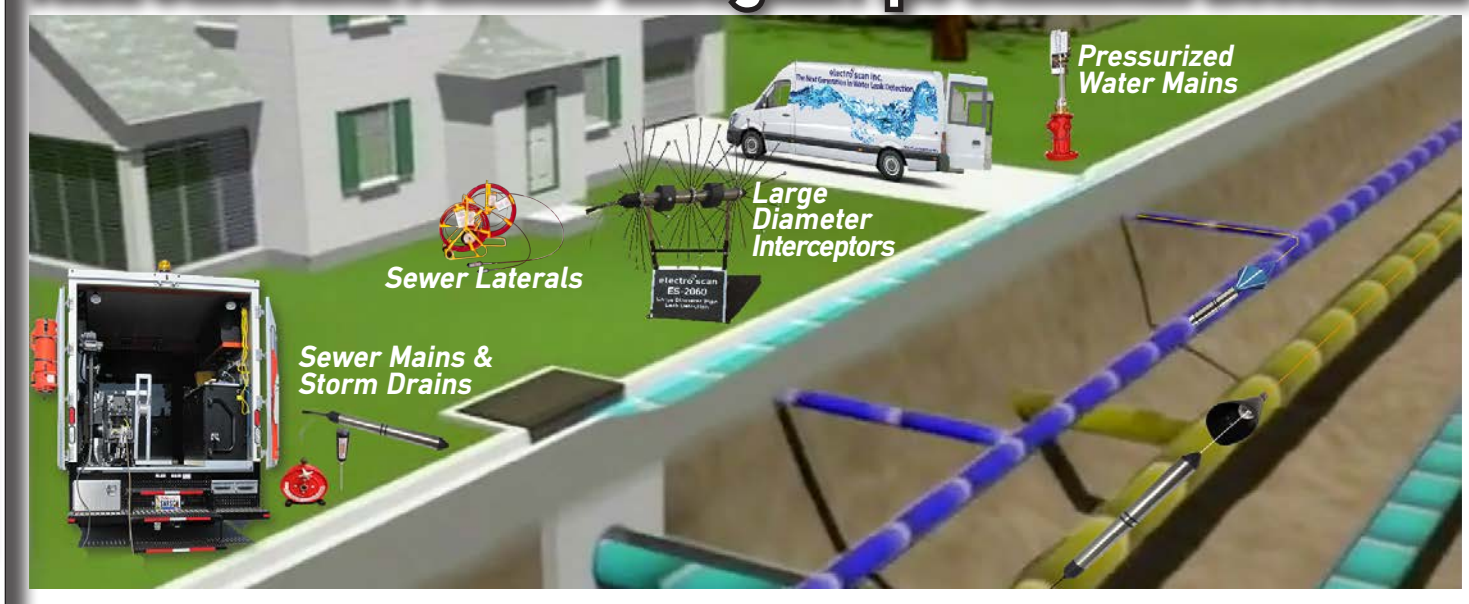
After a series of upgrades to our CriticalSewers® cloud application and In-Vehicle Data Management systems, we finally had a few weeks to update and upgrade our Home Page, representing our first complete re-write of our corporate website.

Managed by Kenny Alaron, Electro Scan's, IT Application Developer, Electro Scan's new website was developed using the latest web standards, such as HTML 5 and Python, allowing our web pages to be fully displayed on multiple media and mobile platforms.



...And, Follow Us On Social Media!

Next Generation Machine-Intelligent Pipe Condition Assessment



Sinkholes Resulting From Bad Sewer Joints Not Seen By CCTV Inspection

Christmas Eve 2016 on 15 Mile Road at Utica Road in Fraser, Michigan was not a pretty sight. But years of relying on visual inspection of sewers, using closed-circuit television cameras finally caught up with this neighborhood. This time, causing a house on the corner of 15 Mile and Eberlein, between Utica and Hayes Roads, to buckle.

So goes another sinkhole caused by erosion of the ground above a sewer pipe, where liquified ground slowly seeped into the sewer where crews would call out a build-up of silt, but miss the defective joints not seen by CCTV cameras.

The sinkhole was deja vu for Macomb County, since a 2004 sinkhole occurred at the Villa Fontana subdivision where a 30 ft deep, 160 by 60 ft sinkhole happened at the intersection of 15 Mile Road and Fontana Blvd in Sterling Heights.

Thank goodness new Sewer Condition Assessment standards have been published recommending Electro Scanning Inspection. ***CAUTION: We hear that several law firms have already bought their own copies!***

An aging sewer...
A 50-year old sewer has been televised multiple times in the past 20 years, with no visible defects.

allows soil to leak through bad joints creating a void...
Defective joints, not seen by CCTV inspection, periodically surcharge and systematically liquifies soil above the sewer pipe, creating a void. City crews have a PM to remove silt, without knowing that a void is being created.

so the pavement gives way...
Without a base under it, the pavement collapses, opening a hole wide enough and deep enough to swallow a car.

& swallows house or car.
An unsuspecting car plunges into the sinkhole as the hole continues to widen.

CCTV Misses 9 out of 10 Defects That Leak

CIPP Lining, New Construction, & SSES Programs Adopt New Standards to Improve Pre- and Post-Rehabilitation Projects

Since the 1950's, we continue to accept CCTV and its shortcomings as been the norm; but, now we can see the short comings in higher resolution. Given that a 300ft pipe has approximately 100 joints, its is nearly impossible for an operator to correctly identify defective or leaking joints, that can be depended on to base long-term capital improvement plans. Yet, we try.

Difficulties in accurately & dependably locating, quantifying, and prioritizing sewer main defects has been a major challenge to the wastewater collection industry.

The problem is not just limited to the initial assessment of sewer mains.

Based on recent testing of post-rehabilitated sewers, particularly Cured-In-Place Pipe (CIPP) and Point Repairs, sewer municipalities appear to be severely challenged in ensuring that pipe relining and renewals are being properly done.

Given the increasing frequency of repairs to the same sewer mains and return of flows to pre-rehabilitation levels, data is pointing to improper use and over-reliance on Closed-Circuit Television (CCTV) inspection results, that either do not adequately 'see' defects or are unable to judge the severity of leaks -- either before or after rehabilitation.

Fortunately, Sacramento, Calif-based Electro Scan has introduced a new set of tools to assess sewer & water mains.
Representing a next generation in condition assessment, ***Electro Scanning Inspection*** is now recommended to accurately and reliably inspect sewer mains and to certify rehabilitation, finding defects missed by TV.

Life Cycle of Troubled CIPP Lining Projects

Severe Weather Linked to Floods & EPA Fines Spotlights Limitation of CCTV 1-5 Rating

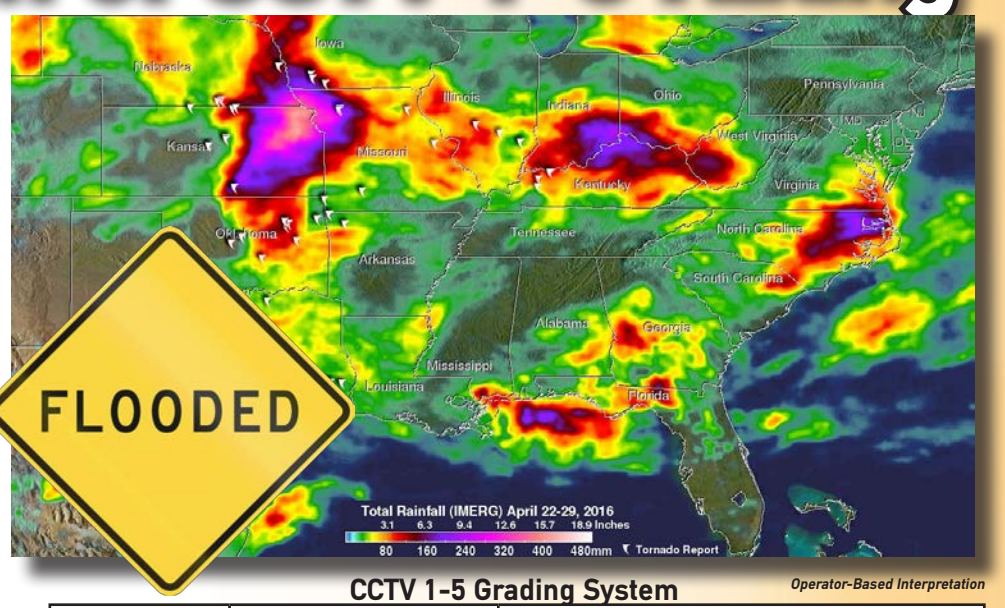
After several years of drought, and lower reported sanitary sewer overflows (SSOs), the pendulum is swinging back with some communities reporting record sewer back-ups and overflows, even after millions spent on rehabilitation.

Ken Kerri, Ph.D., P.E. saw this cycle before and after seeing numerous CCTV reports with ZERO defects observed by certified operators and many large defects found by Electro Scan, and wanted to make sure to include Electro Scan in the latest manual.

A major concern: sewer mains with little or no defects identified by CCTV inspection that are located in flood zones.

As shown below, a municipality that owns four (4) CCTV trucks in the midst of a multi-million dollar rehabilitation program agreed to compare a pipe that had ZERO CCTV defects with Electro Scanning Inspection. Mirroring other results around the country, Dr. Kerri concluded that CCTV should no longer be used to prioritze Critical Sewers®.

Instead, Electro Scanning Inspection is recommended before and after all rehabilitation, repairs, and new pipe installations, moving away from subjective observations to intelligent machine-based analytics.

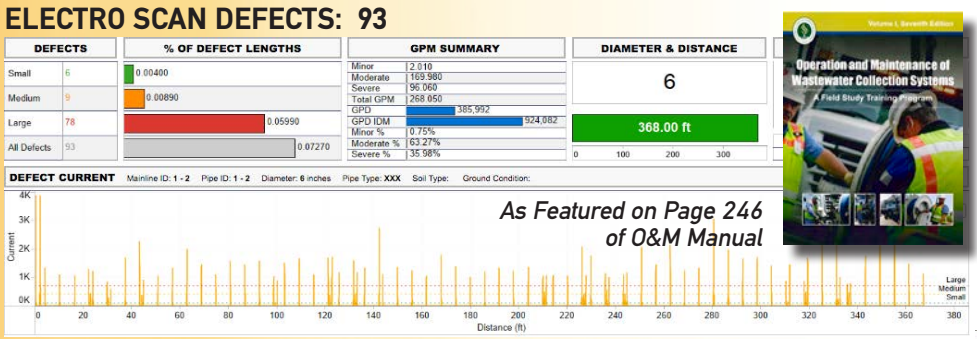


As Featured in 7th Edition, Vol. 1, O&M of Wastewater Collection Systems Manual

CCTV DEFECTS: 0

Grade	Amount of Structural Defects	Structural Segment Grade	Structural Pipe Rating	Structural Quick Rating	Structural Pipe Rating Index	Amount of O&M Defects	O&M Segment Grade	O&M Pipe Rating	O&M Quick Rating	O&M Pipe Rating Index	Overall Pipe Rating	Overall Pipe Rating Index
1	0	0				0	0					
2	0	0				0	0					
3	0	0	0	0000	0	0	0	0	0000	0	0	0
4	0	0				0	0					
5	0	0				0	0					

ELECTRO SCAN DEFECTS: 93



As Featured on Page 246 of O&M Manual

CCTV 1-5 Grading System

Operator-Based Interpretation

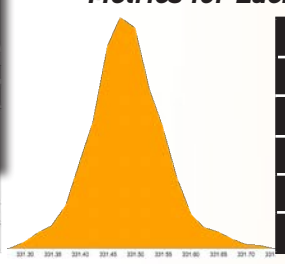
OPRI Grading	Structural Performance Grade	Pipe Failure
5 Immediate Attention	Collapse or collapse imminent	Pipe has failed or will likely fail within the next 5 years
4 Poor	Collapse likely in foreseeable future	Pipe will probably fail in 5 to 10 years
3 Fair	Collapse unlikely in near future	Pipe may fail in 10 to 20 years
2 Good	Minimal collapse risk	Pipe unlikely to fail for at least 20 years
1 Excellent	Acceptable structural condition	Failure unlikely in the foreseeable future

CCTV DEFECT GRADE 0

Machine-Based Intelligence

DEFECT FLOW 1-5 Grading System

Metrics for Each Defect



Start	331.47
End	331.82
Length	0.35
GPM	5.26
GPD	7,574
GPD/IDM	18,133

Metrics for Total Pipe

Minor	331.47
Moderate	331.82
Severe	0.35
GPM	5.26
GPD	7,574
GPD/IDM	18,133

Minor %	331.47
Mod. %	331.82
Severe %	0.35

DEFECT FLOW GRADE 5

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Sacramento, CA 95825-4026

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Electro Scan Achieves Re-Certification For ISO 9001, ISO 14001, and ISO 18001

Congratulations to Electro Scan's Janine Mullinix, Vice President, Administrations for the successful renewal of its ISO certifications. A professional distinction that separates Electro Scan Inc. from other manufacturers and service providers, we recommend that cities and utilities require vendors to be ISO certified, especially ISO9001, ISO14001, and ISO18001. Well done!