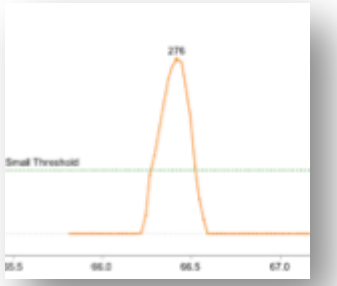
SPECIAL REPORT

Electro Scan Test of a Newly Relined Sewer Main & Laterals

electro scan inc.



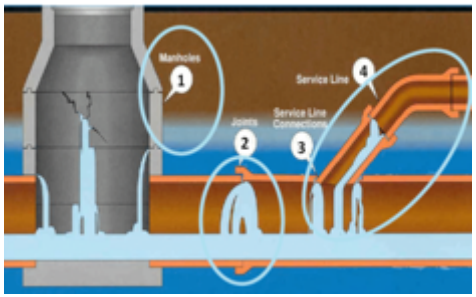
January 2014

Project Goal

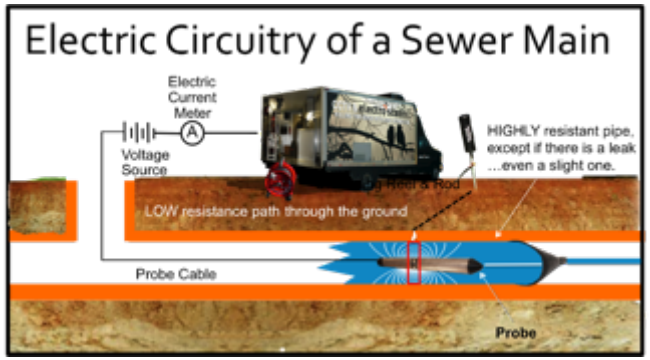
Assess a Recently Re-Lined Sewer Main With Lateral Top Hats

What is Electro Scan?

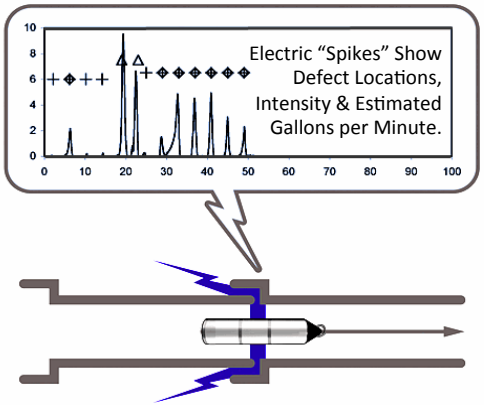
1. **<u>What Does Electro Scan Do, That CCTV Cannot</u>?** Answer: Find sources of infiltration and cracks. Infiltration is a key factor causing Sanitary Sewer Overflows (SSOs) and Combined Sewer Overflows (CSO) caused by cracks & defects found in manholes, sewer mains, service connections, and laterals. Given the limitation of CCTV – i.e. not able to visually find leaks -- Electro Scan automatically finds , locates, and measures (i.e. in gallons per minute) the amount of infiltration (i.e. in gallons per minute) caused by defects. Electro Scan can also certify newly installed, recently repaired and rehabilitated pipe lining.



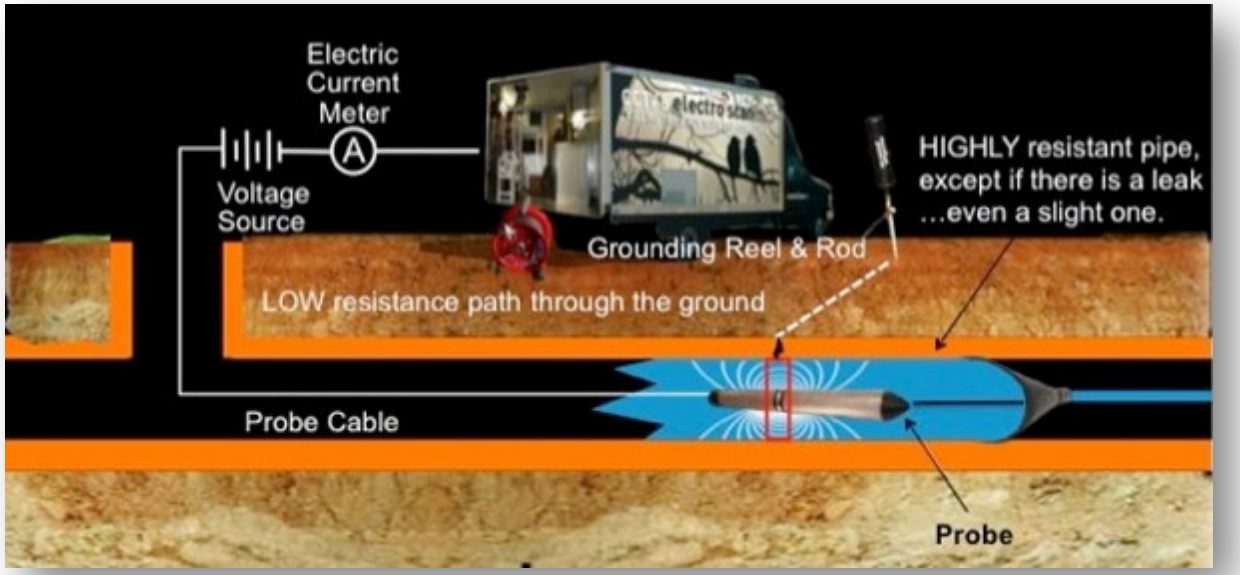
2. <u>How Does It Work</u>? Sewers are made of non-conductive materials (e.g. asbestos concrete, brick, clay, cement, plastic, reinforced concrete, etc.), so no electrical current should ever be able to "leak" or escape into the ground from inside the pipe – unless, of course, there is a crack or break in a pipe. Electro Scan's patent-pending technology releases a focused array of low-voltage high-frequency electrical current that locates and quantifies all defects.

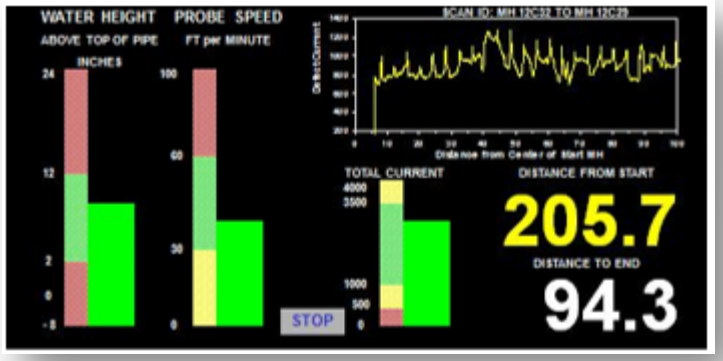


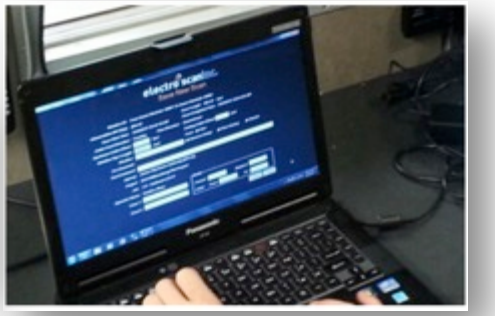
3. <u>Who Has Endorsed or Used Electro Scan</u>? Electro Scan has been tested in numerous U.S. EPA studies and found superior to CCTV in finding the location and quantification of defects that cause leaks. Electro Scan is the only company with products in compliance with ASTM Standard F2550-06, just approved for another five years by ASTM Committee F36. Winning international acceptance, Electro Scan has recorded nearly 1 million feet of scans in the U.S., England, Australia, and New Zealand, and represents the next generation in defect location and certification of pipeline repairs & rehabilitation, able to work in wet weather and dry weather conditions.



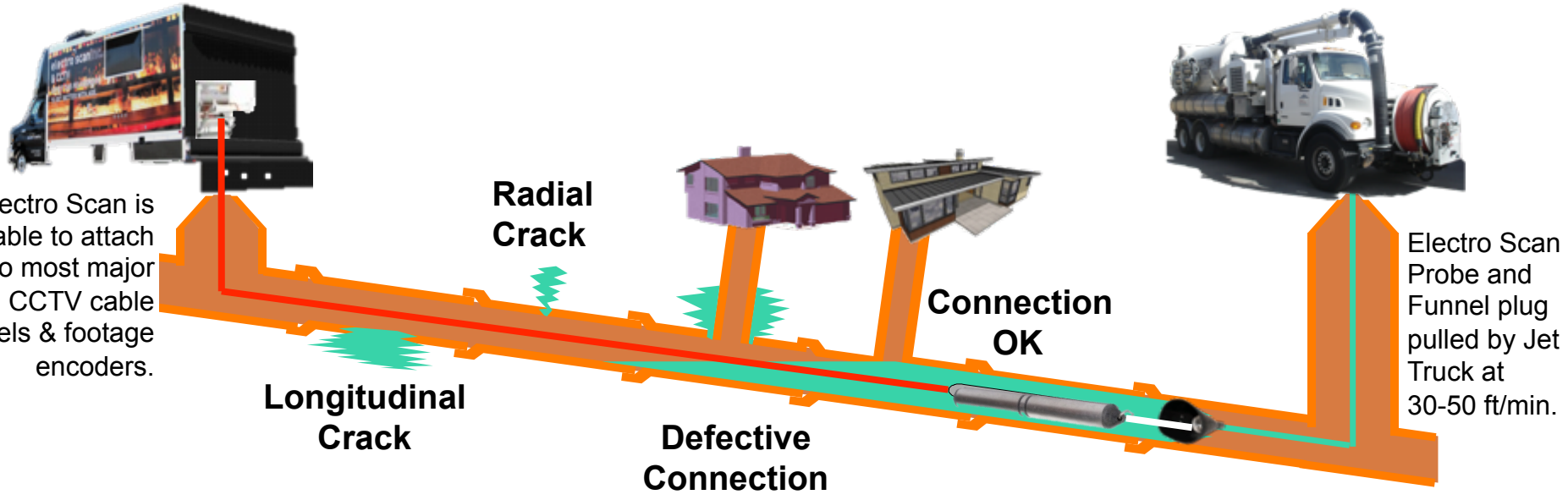
Electro Scan – Key Components

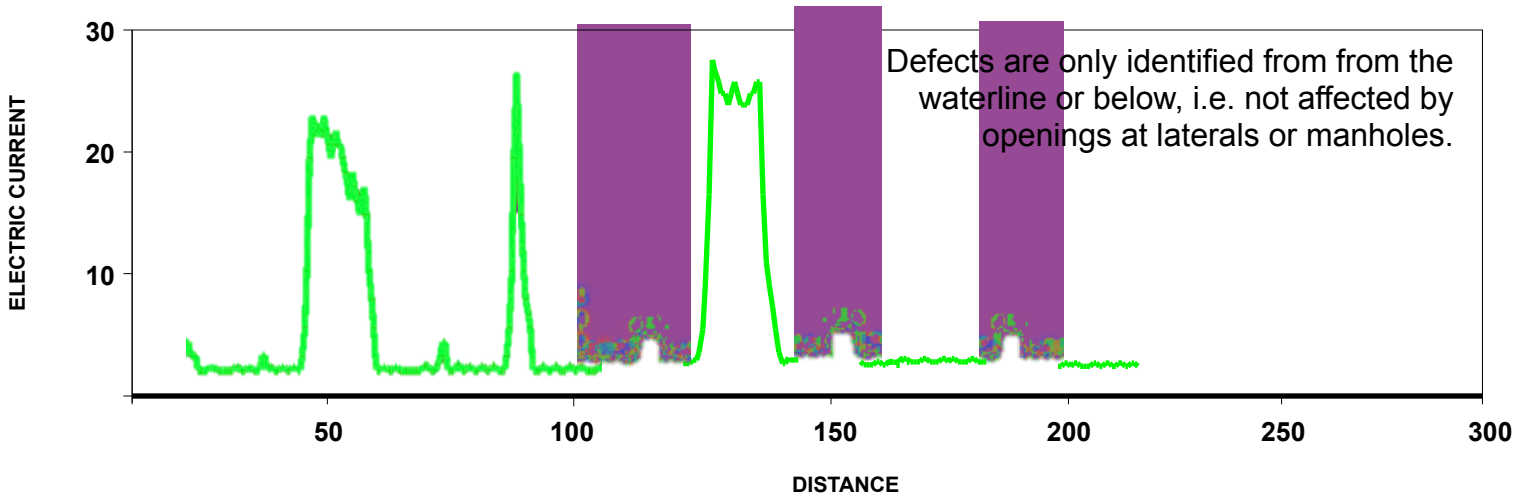






Standard Electro Scanning Field Operation

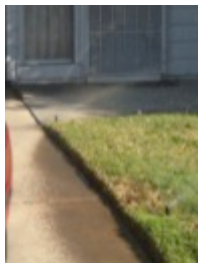


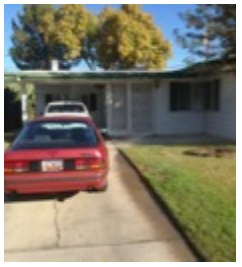


Electro Scan Test on Newly Lined Sewer Main & Laterals

NOTE: Although UPS & DWN MHs were not flow metered, flow rates appeared much higher at the Downstream Manhole, compared to flow at the Upstream Manhole.

Electro Scan Test on Newly Lined Sewer Main & Laterals

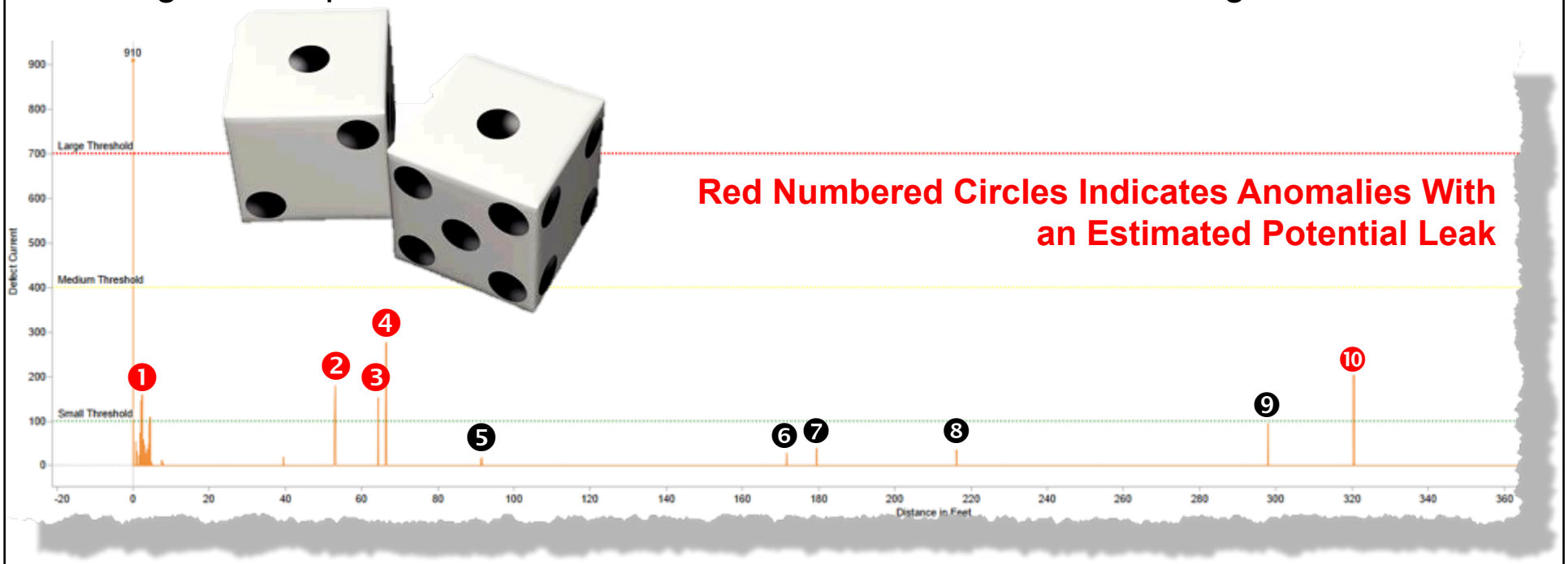




Electro Scan Test on Newly Lined Sewer Main & Laterals

Top Ten Electro Scan Pipeline Defects – POST-REHAB

It is expected that New Pipes, Repairs, and Relining Projects should register ZERO (0) Readings from Upstream Manhole to Downstream Manhole, indicating No Defects.

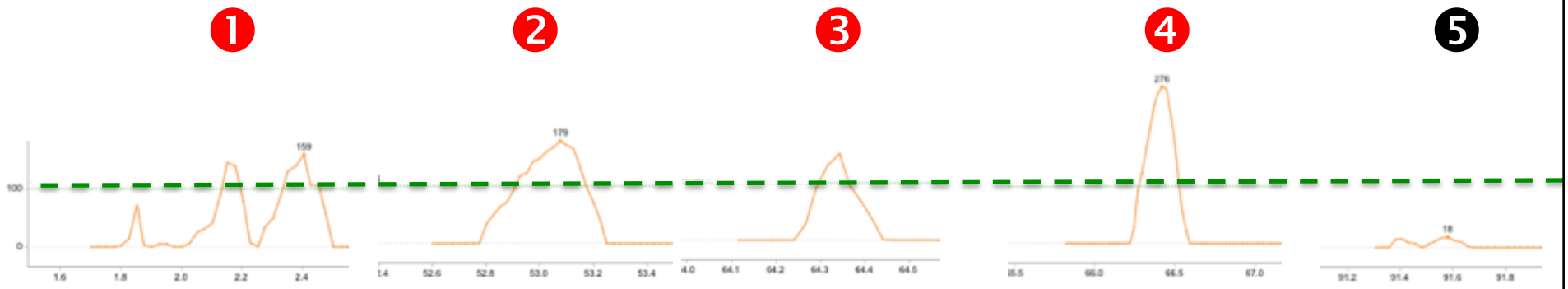


Red Numbered Circles Indicates Anomalies With an Estimated Potential Leak

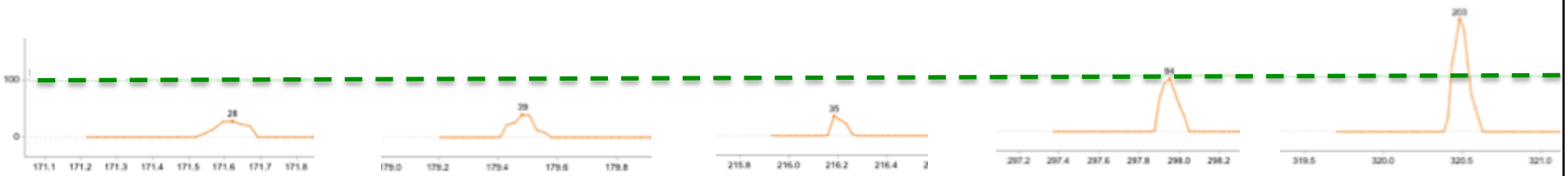
In addition to expanding the original ASTM standard to become an essential input for cost-effective design, testing, and certification of pipe repairs, renewal, and new construction, the revised ASTM F2550-13 standard recommends that "*separate scanning tests be taken before and after any pipe repair, relining, or renewal activity to compare electrode current values, and for closed-circuit television (CCTV) video to re-examine pipes to determine if any visual defects were missed or not recorded during initial examination.*"

Electro Scan Test on Newly Lined Sewer Main & Laterals

Top Ten Electro Scan Pipeline Defects – POST-REHAB
Analysis of Detail Profiles & Estimated GPM*



	1	2	3	4	5
Footage	1.8 to 2.4	53.1	64.3	66.4	91.6
Est GPM	0.350	0.570	0.110	0.780	-



	6	7	8	9	10
Footage	171.6	179.5	216.2	298.0	320.5
Est GPM	-	-	-	-	0.300

* Assumes 1ft head and 1% pipe gradient with estimated gallon per minute leak rates ±40% accuracy.

Electro Scan Test

Top Five Electro Scan Pipeline Defects – POST-REHAB
Detail Profiles & Estimated GPM*

	Defect Grade	Defect Start	Defect End	Defect Length (ft)	GPM Flow (gpm)
1	Small	2.152	2.507	0.128	0.350
2	Small	53.077	53.303	0.226	0.570
3	Small	64.343	64.369	0.026	0.110
4	Small	66.420	66.646	0.226	0.780
5	Small	320.482	320.583	0.102	0.300
TOTAL				**0.708**	**2.11**

2.11 Gallons Per Minute or 3,038 Gallons Per Day

* Assumes 1ft head and 1% pipe gradient with estimated gallon per minute leak rates ±40% accuracy. Calculation may understate infiltration as the full length of each sewer lateral is not considered.

How Much Leakage Is Allowable for a New Precast Concrete Sewer Pipe?

ASTM C969 – Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines states that 200 gallons/inch diameter is an acceptable allowance; however, several State Department of Natural Resources (e.g. Missouri) have lowered this total allowable to 100 gallons/inch diameter.

For example, an 8" diameter, 380ft precast concrete pipe, the allowable leakage rate would be calculated as follows:

100 gal/inch diameter/mile of line/day or 1800 gallons/mile/day (for an 18 inch pipe)
Divided by 5,280 represents 0.3409 gallons/foot allowable leak rate for an 18 inch pipe/day
= 0.3409 divided by 1440 minutes per day, or
= 0.000237 gallons/foot/minute

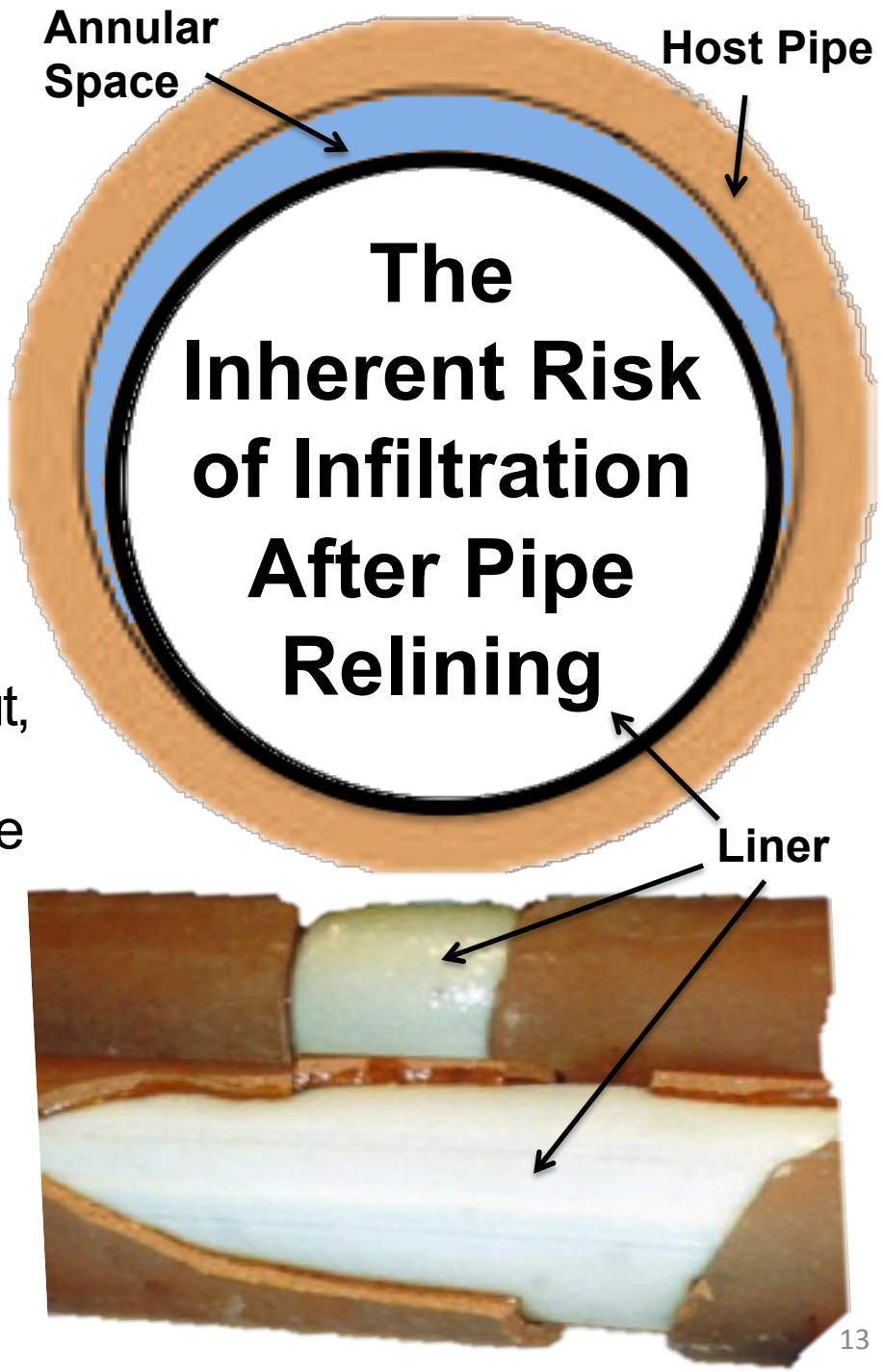
The allowable leak rate for an 18in 380ft precast concrete pipe, is:
= 380 x 0.000237
= **0.09 Gallons Per Minute** or **130 Gallons Per Day**

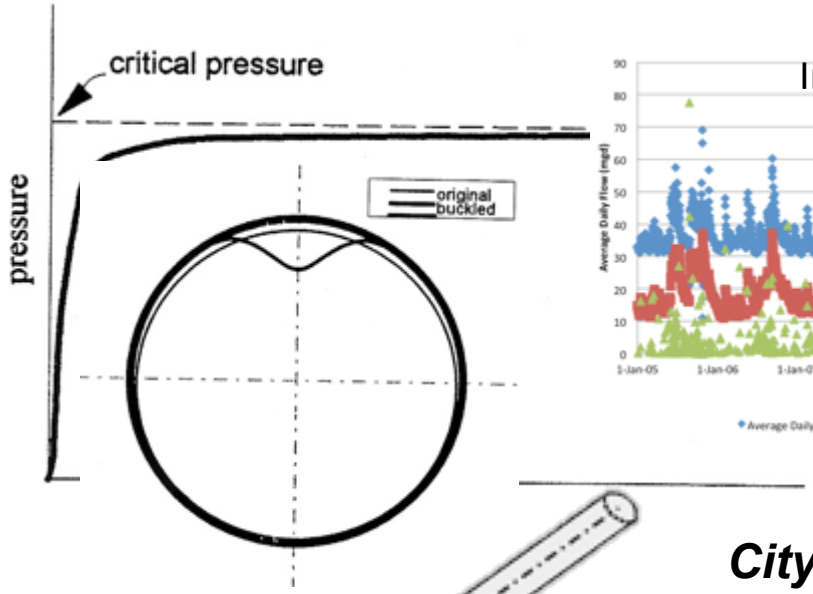
Even Doubled This Sewer Main is 12x Worse Than Max Allowed.

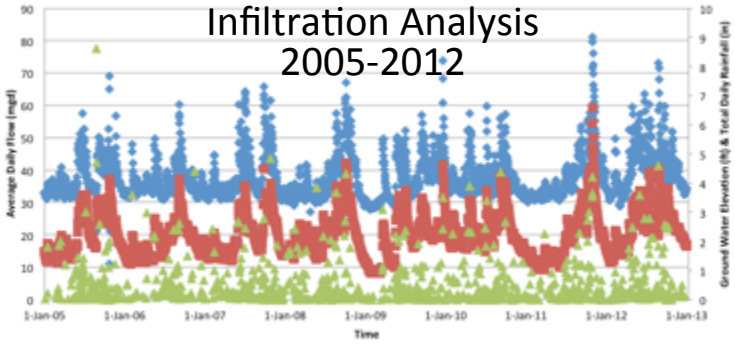
Inherent Problems Using Liners to Fix Sewer Defects

While many pipe lining methods can navigate through major pipe fractures and failures, pathways of infiltration still exist.

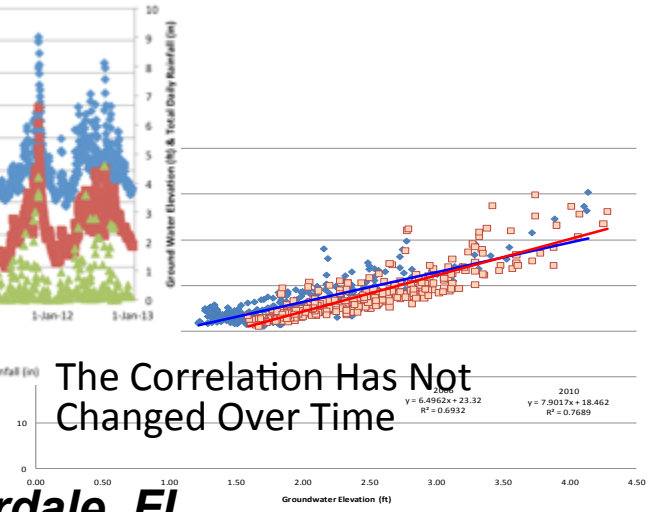
If ground water passages are not filled with composite matter, such as grout, then water will percolate through the soil & flow between the liner & host pipe, seeping into poorly connected services, often returning the sewer main to pre-rehab levels of infiltration.



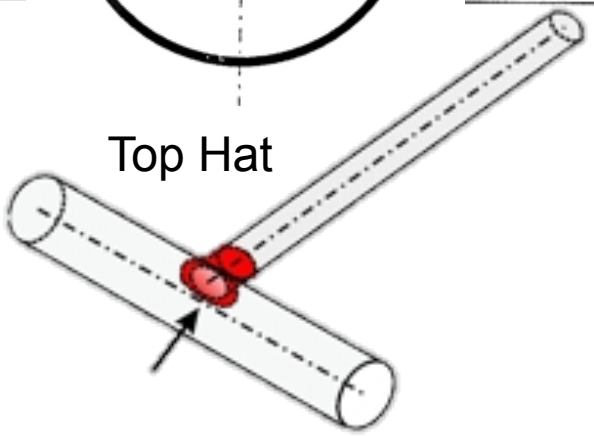




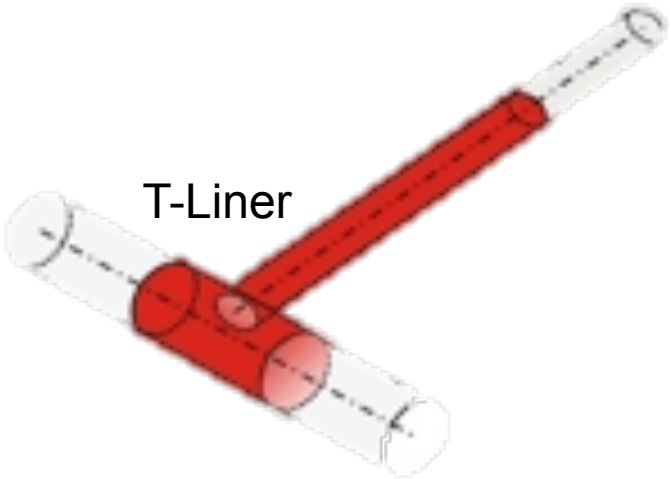
Infiltration Analysis
2005-2012



The Correlation Has Not Changed Over Time



Top Hat



T-Liner

City of Fort Lauderdale, FL

After spending $3 million a year for the last five years on lining their sewers, daily flows at the Treatment Plant in this major South Florida city remain virtually unchanged.

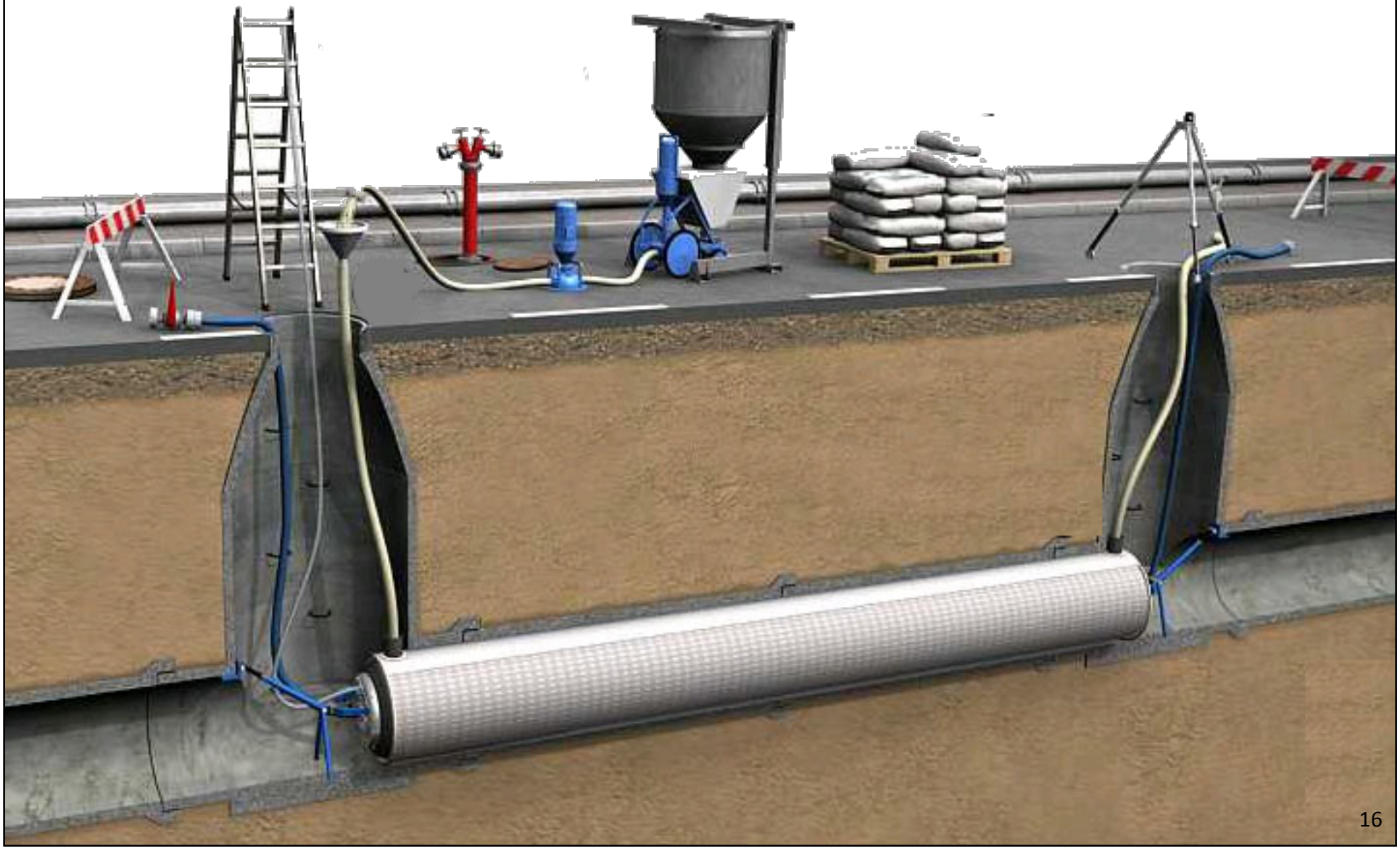
Suspecting problems at their service connections, CDM Smith dug up and inspected ten (10) Top-Hat and T-Liner connections, five each.

Not only were all Top-Hats leaking, but no T-Liners had been installed, although the city had paid for them.

Infiltration still cannot be found by CCTV inspection.

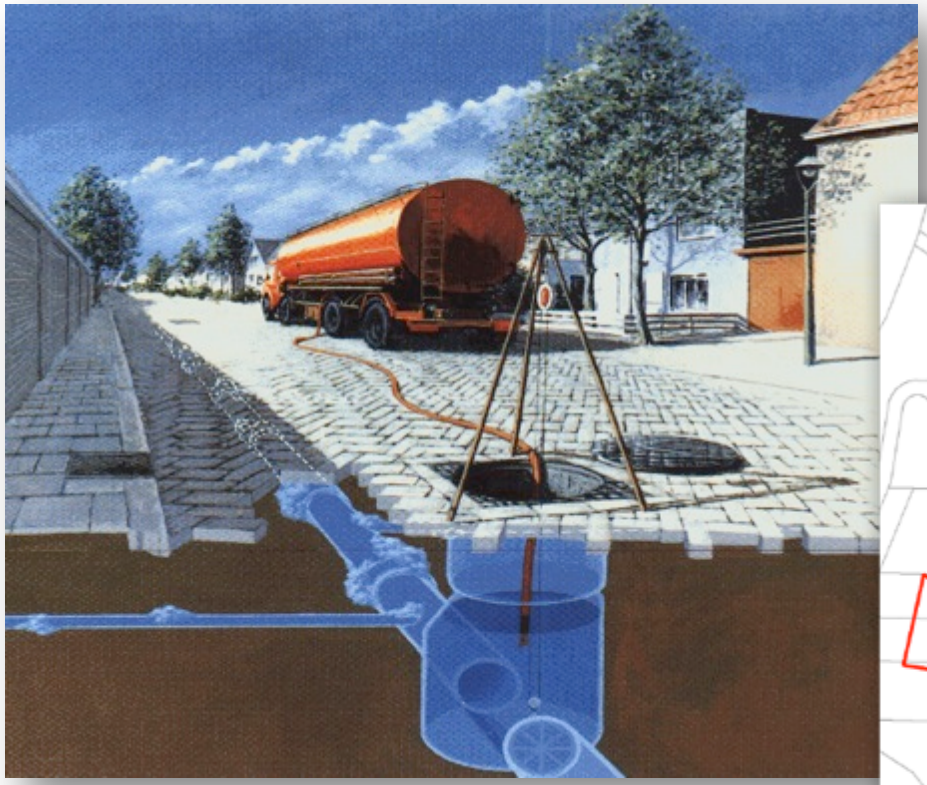
Emerging Renewal Alternatives

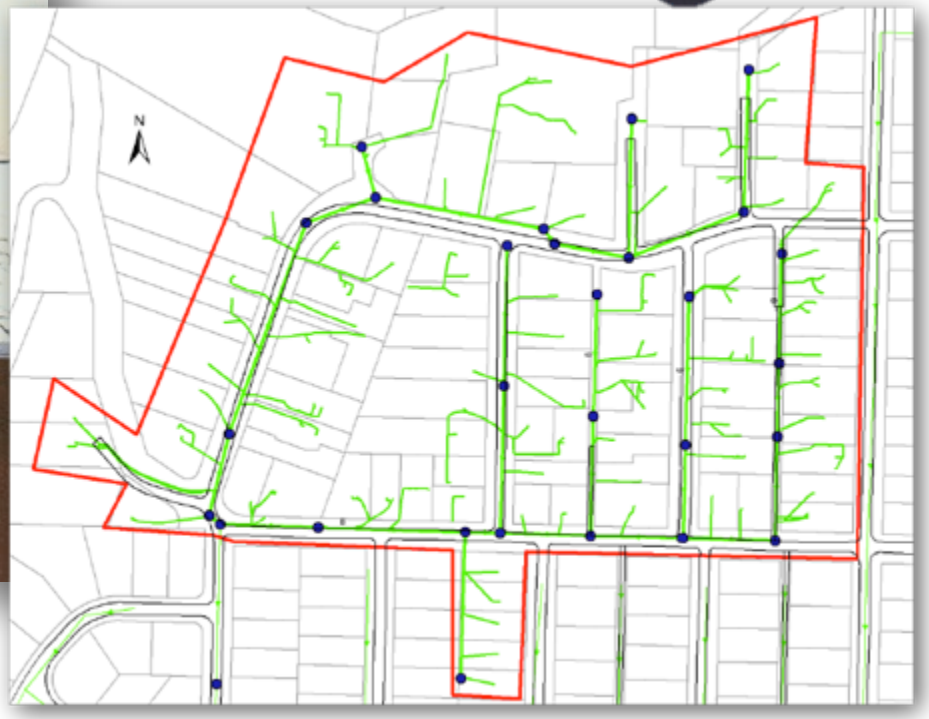
To reduce the risk of leakage and deformation of the liner, grouting of the annular space between the host pipe and liner, and filling of ground water passages, is highly recommended. Use of a low-viscosity hydraulically quick-sealing, high-strength, shrink-free injection grout is best.



Sanipor Flood Grouting

- Silicate solution of sand & potassium that creates a sandstone like, water-tight, durable, non-toxic, geo-technical material,
- Substitutes 3-5 different no-dig techniques, delivering a repeatable, holistic approach to renew sewer mains, laterals, and manholes,
- Seeks out all leaks in the system and fills pathways of infiltration,
- Soil injection process improves the stability of pipe bedding, not available in lining-based solutions,
- Several successful WERF-sponsored trials and projects.





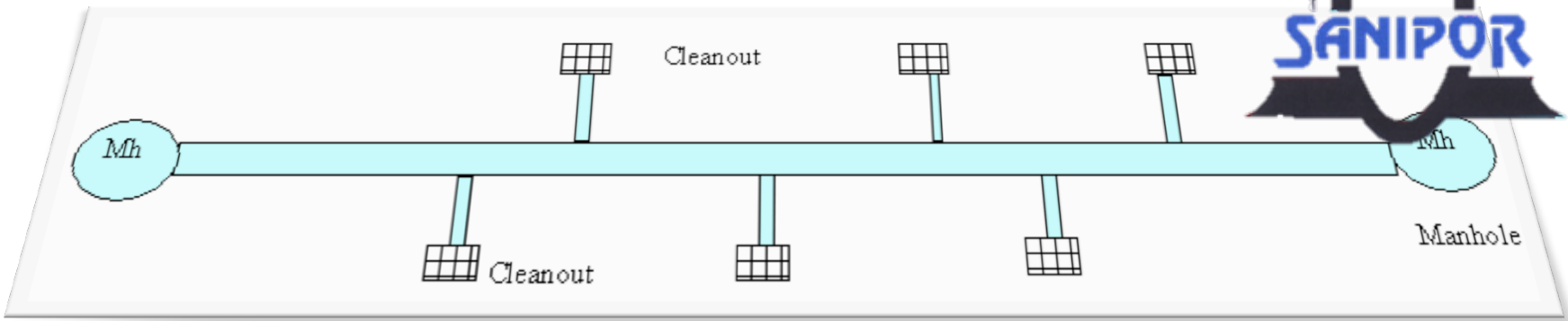
Significant Publications

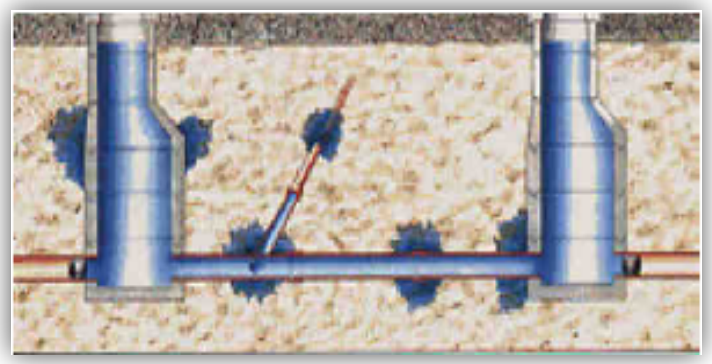
WERF Report 2013: Flood Grouting for Infiltration Reduction On Private Sie Sewers

EPA 832-R-06-004 July 2006 Emerging Technologies for Conveyance Systems

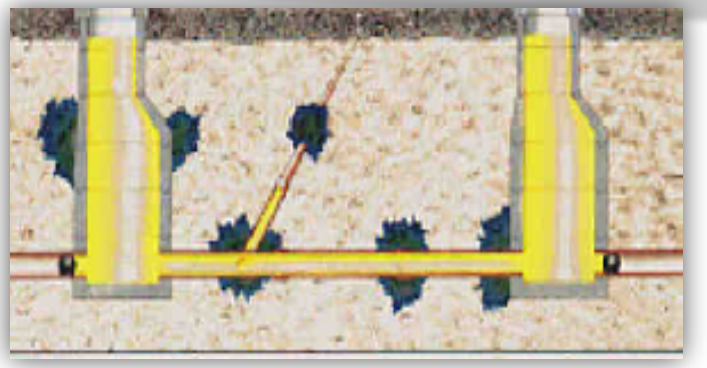
New Installations and Rehabilitation

WERF Report 2005: Methods for Cost-Effective Rehabilitation of Private Lateral Sewers (02-CTS-5)

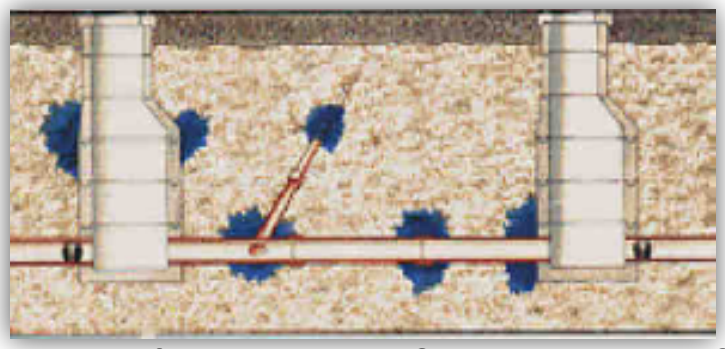




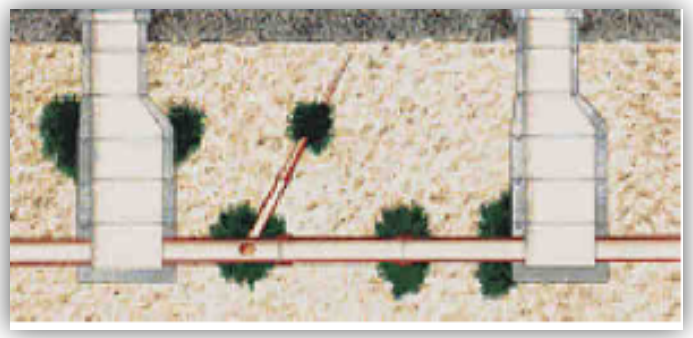
Sewer, laterals and manholes are filled with solution S1 which penetrates through defects into the surrounding ground.



When optimum penetration has been achieved Solution S1 is pumped out, leaving defect zones saturated.



The section is refilled with solution S2 which reacts with S1 in the ground to form a concrete-like matrix, binding soil particles and sealing all leaks with solidified ground around all defects.



When the reaction is complete and water-tightness established, Solution S2 is pumped out. After flushing , the sewer is returned to service and protected from further deterioration.

About Electro Scan

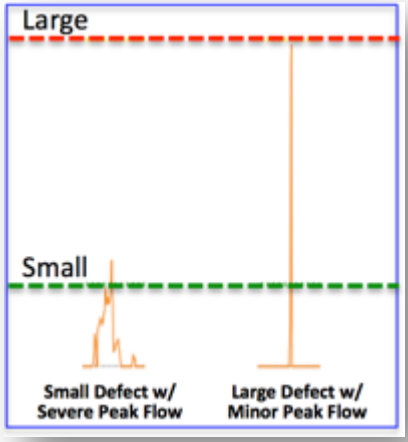
How Electro Scan Estimates GPM?

While Electro Scan's standard graphs display the Maximum Defect Current, Electro Scan's estimated Gallon per Minute (Defect Flow) is based on the Defect Area and the Electric Current sustained over that Area.

Start of Anomaly	End of Anomaly	Length of Anomaly	Maximum Current Level of Anomaly	Max. Current Anomaly Grading	Est. GPM Flow	Est. GPM Grading
1.23	1.30	0.08	146.00	S	0.19	S
1.43	1.43	0.00	115.00	S	0.05	S
3.33	3.33	0.00	104.00	S	0.04	S
8.26	8.44	0.18	291.00	S	0.60	S
13.12	13.20	0.08	216.00	S	0.28	S
18.15	18.20	0.05	137.00	S	0.15	S
18.95	19.10	0.15	328.00	S	0.61	S
20.95	21.11	0.15	544.00	M	0.95	S
23.84	24.26	0.42	698.00	M	1.93	M
24.51	24.56	0.05	245.00	S	0.22	S
28.02	28.14	0.12	330.00	S	0.56	S
31.87	32.05	0.18	536.00	M	1.02	M
35.52	35.75	0.23	559.00	M	1.26	M

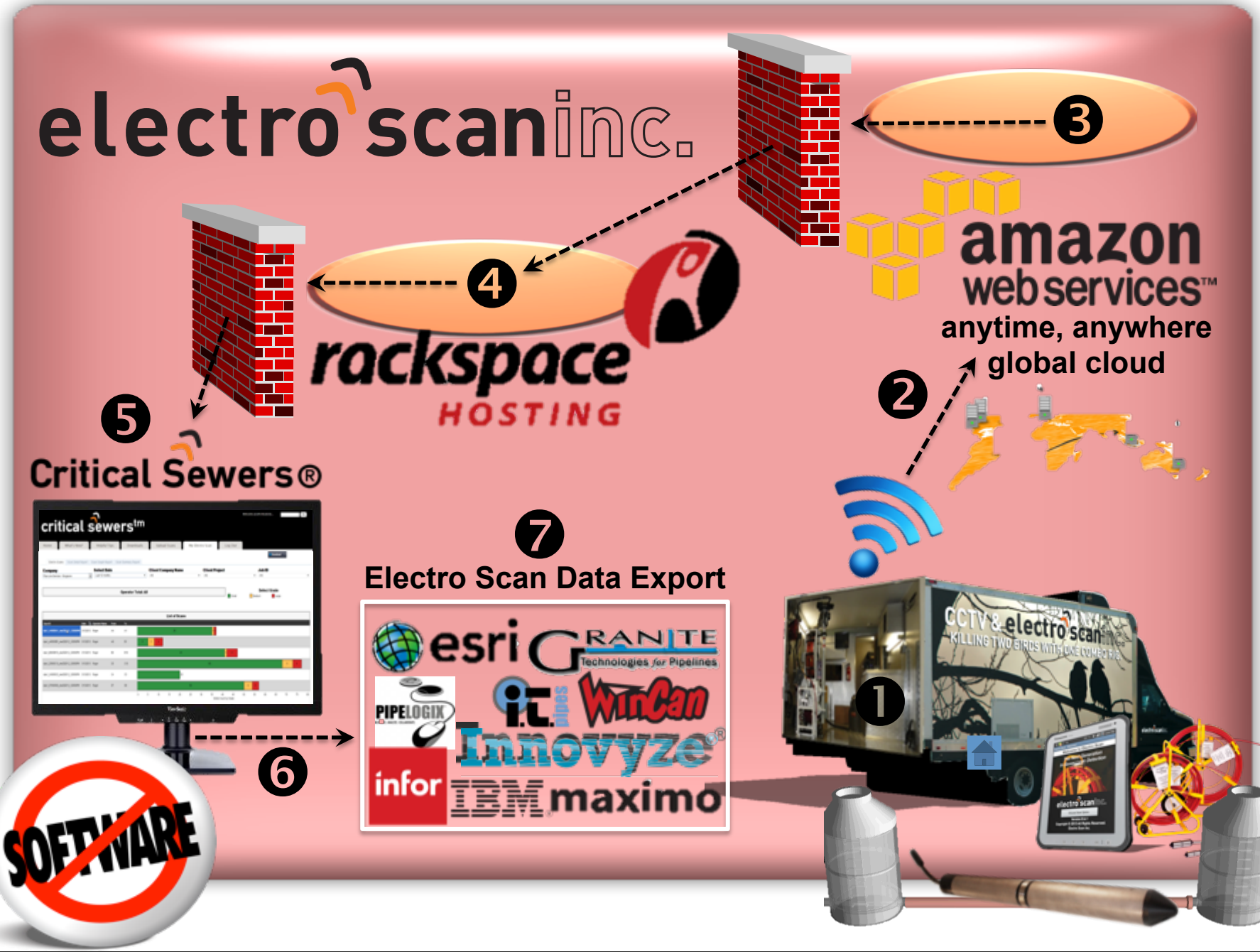
Sample Processed Data

'**Large Current Readings over a Large Area**' often result in a large GPM or Defect Flow, frequently found in defects at a service connection. In other cases '**Large Current Readings over a Small Area**' result in small and medium GPMs, frequently showing defects at joints.



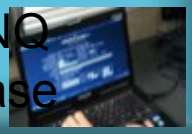
Electro Scan measures height and width of defect in accordance with F2550-13.

Global Cloud Service Architecture



electro scaninc.

- Real Time Data Capture
- Raw, Unprocessed Data
- 1 Data Point, Every ¼ in,every 14 milliseconds
- Visual Studio 2012, .NET 4.5, C#, LINQ
- SQL Server 2008R2 Backend Database



amazon web services™

- Global Service – Anytime, Anywhere
- Amazon S3 Platform
- Unlimited Scalability
- Receives Uploaded Data from the Field

rackspace HOSTING

- Five (5) 64-bit Electro Scan Cloud Servers
- Windows SQL Server 2012, Hosted Tableau
- Web Services, C# Programming
- Database Retrieval, Processing, and Storage

Critical Sewers®

- HTML 5.0
- Python
- PHP
- Embedded Tableau

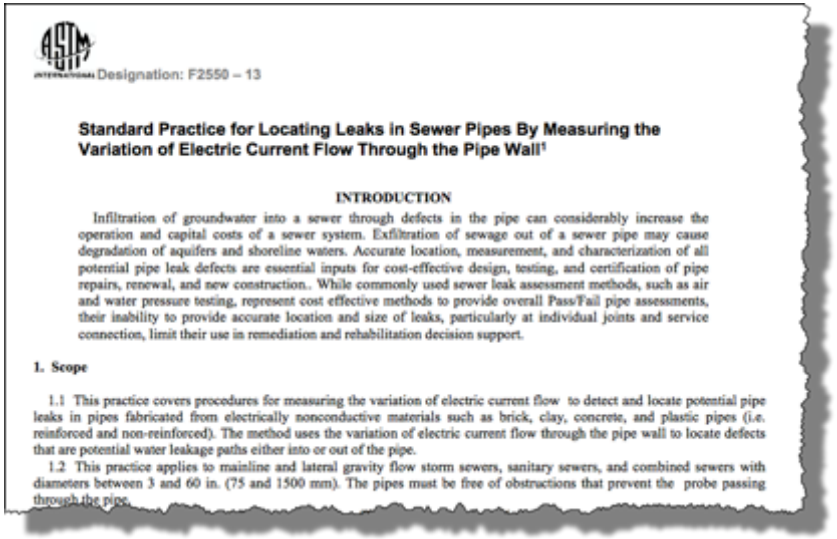
Conclusions

Electro Scan does not replace CCTV; however, Electro Scan is superior to CCTV in certifying post-rehabilitation pipe renewal projects. While Electro Scan is not able to locate defects to a specific clock position or identify pipe sags or alignment problems, Electro Scan confirms the limited use of TV cameras to find sources of waterways to ground, i.e. leak locations. By locating anomalies to the closest 1 cm (0.4 in) recording data at the rate of one (1) data point, every ¼ inch, i.e. every 14 milliseconds, Electro Scan can accurately locate and measure defects in non-conductive pipes (e.g. asbestos cement, brick, clay, plastic, reinforced concrete, resin, etc.) in accordance with ASTM F2550-13.

Recommended use of Electro Scan include the ability to:

- Identify and measure all sources of infiltration from cracks, bad joints, and defective service connections,
- Rank & prioritize sewer mains and laterals that should be repaired, relined, or renewed,
- Integrate with hydraulic modeling programs to re-calibrate model assumptions based on its estimated gallons per minute (GPM) of flow from defects,
- ***Certify point repairs, relining, and new construction to ensure that projects performed by third-party contractors are delivered without defects or leaks, prior to Acceptance***. While Electro Scan may not be able to distinguish whether leaks are occurring at a service connection or internal to a service lateral, it will consistently identify gaps allowing electrical current to pass from inside the sewer system to ground.

*Originally approved in 2006, ASTM F2550 was recently modified to expand its use to include **'testing and certification of pipe repairs, renewal, and new construction.'** The revised standard was approved October 1, 2013, Committee F36 and renamed F2550-13.*



Designation: F2550 – 13

Standard Practice for Locating Leaks in Sewer Pipes By Measuring the Variation of Electric Current Flow Through the Pipe Wall[1]

INTRODUCTION

Infiltration of groundwater into a sewer through defects in the pipe can considerably increase the operation and capital costs of a sewer system. Exfiltration of sewage out of a sewer pipe may cause degradation of aquifers and shoreline waters. Accurate location, measurement, and characterization of all potential pipe leak defects are essential inputs for cost-effective design, testing, and certification of pipe repairs, renewal, and new construction. While commonly used sewer leak assessment methods, such as air and water pressure testing, represent cost effective methods to provide overall Pass/Fail pipe assessments, their inability to provide accurate location and size of leaks, particularly at individual joints and service connection, limit their use in remediation and rehabilitation decision support.

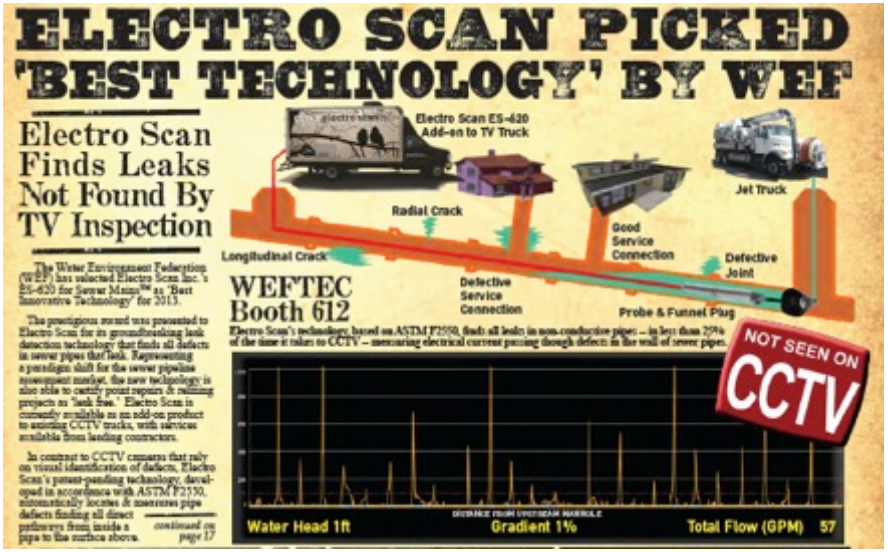
1. Scope

1.1 This practice covers procedures for measuring the variation of electric current flow to detect and locate potential pipe leaks in pipes fabricated from electrically nonconductive materials such as brick, clay, concrete, and plastic pipes (i.e. reinforced and non-reinforced). The method uses the variation of electric current flow through the pipe wall to locate defects that are potential water leakage paths either into or out of the pipe.

1.2 This practice applies to mainline and lateral gravity flow storm sewers, sanitary sewers, and combined sewers with diameters between 3 and 60 in. (75 and 1500 mm). The pipes must be free of obstructions that prevent the probe passing through the pipe.

2013 Awards

Best Innovative Technology, WEF



ELECTRO SCAN PICKED 'BEST TECHNOLOGY' BY WEF

Electro Scan Finds Leaks Not Found By TV Inspection

The Water Environment Federation (WEF) has selected Electro Scan Inc.'s ES-620 for Sewer Mains℠ as 'Best Innovative Technology' for 2013.

The prestigious award was presented to Electro Scan for its groundbreaking leak detection technology that finds all defects in sewer pipes that leak. Representing a paradigm shift for the sewer pipeline assessment market, the new technology is also able to certify postrepairs & relining projects as 'leak free.' Electro Scan is currently available as an add-on product to existing CCTV trucks, with services available from leading contractors.

In contrast to CCTV cameras that rely on visual identification of defects, Electro Scan's patent-pending technology, developed in accordance with ASTM F2550, automatically locates & assesses pipe defects finding all direct pathways from inside a pipe to the surface above. continued on page 17

Electro Scan ES-620 Add-on to TV Truck

Jet Truck

Radial Crack

Good Service Connection

Defective Joint

Longitudinal Crack

WEFTEC Booth 612

Defective Service Connection

Probe & Funnel Plug

Electro Scan's technology, based on ASTM F2550, finds all leaks in non-conductive pipes – in less than 25% of the time it takes to CCTV – measuring electrical current passing through defects in the wall of sewer pipes.

NOT SEEN ON CCTV

Water Head 1ft

Gradient 1%

Total Flow (GPM) 57

Best Water & Sewer Company

Best Innovative Product, No-Dig NASTT

North American Society for Trenchless Technologies Names Electro Scan's ES-620 'Best Innovative Product' of 2013

Award Presented at No-Dig Conference

INNOVATIVE PRODUCT AWARDS

NASTT annually recognizes two companies with state-of-the-art products in either new installation or rehabilitation for their achievements in advancing the trenchless industry — called the Joseph L. Abbott Jr. Innovative Product Awards. This year, Electro Scan Inc. and HammerHead Trenchless Equipment were the recipients of this honor.

The award is given in memory of the late Joseph L. Abbott Jr., who was an active member of the society since its inception in 1990. Electro Scan Inc. and HammerHead were formally recognized at the Gala Dinner.

Electro Scan Inc. received the Rehabilitation Award for its Electro Scan ES-620 for Sewer Mains technology. Using patent pending technology that measures the variation of electrical current inside pipes, electro scanning is now available to independently test and certify newly relined and rehabilitated sewer mains and laterals as leak free. While CCTV inspection is often conducted when a pipe is dry, Electro Scan assesses a pipe's performance under wet conditions. Electro Scan is designed to more accurately find defects in newly relined pipes.

Best Clean Tech Company

Electro Scan Inc. Named 'Best Cleantech' Company for 2013

Electro Scan Inc. was selected as 'Cleantech Company of the Year' at the 2013 Innovation Challenge held at the Sierra Nevada Brewing Company in Chico, California, June 27, 2013.

The Sierra Nevada Innovation Challenge is the only statewide competition focused primarily on California businesses located outside of San Francisco, Silicon Valley, Los Angeles and San Diego. Each finalist had six (6) minutes to present their company's product features and competitive position; more importantly, '*explain how their product changes the world, an industry, people's lives, or the environment, in a positive, meaningful way.*'

Over 70 industry experts from throughout California were on hand to serve as judges including CEOs, media representatives, angel investors, venture capitalists, university and government officials and corporate executives. The event marked Chuck Hansen's first financial presentation since selling Hansen Information Technologies to Infor Global in 2007 for a reported $100 million.

Field Tech, Marc Lyons (pictured below), wasted no time in celebrating Electro Scan's latest award.

"Electro Scan has proved it belongs in our new edition by finding leaks that CCTV can't and renewing their ASTM Standard*."

Kenneth Kerri, Ph.D.

Coming…
October 2014
7th Edition

ASTM INTERNATIONAL Designation: F2550 – 13

Standard Practice for Locating Leaks in Sewer Pipes By Measuring the Variation of Electric Current Flow Through the Pipe Wall[1]

INTRODUCTION

Infiltration of groundwater into a sewer through defects in the pipe can considerably increase the operation and capital costs of a sewer system. Exfiltration of sewage out of a sewer pipe may cause degradation of aquifers and shoreline waters. Accurate location, measurement, and characterization of all potential pipe leak defects are essential inputs for cost-effective design, testing, and ce ion of pipe repairs, renewal, and new construction.. While commonly used sewer leak assessment uch as air and water pressure testing, represent cost effective methods to provide overall Pass/F ssments, their inability to provide accurate location and size of leaks, particularly at individual service connection, limit their use in remediation and rehabilitation decision support.

1. Scope

1.1 This practice covers procedures for measuring the variation of electric current flow to detect an leaks in pipes fabricated from electrically nonconductive materials such as brick, clay, concrete, a reinforced and non-reinforced). The method uses the variation of electric current flow through the pipe

* *Original ASTM F2550-06 published February 2006.*

electro scan inc.
Hall B5, Booth #111-120

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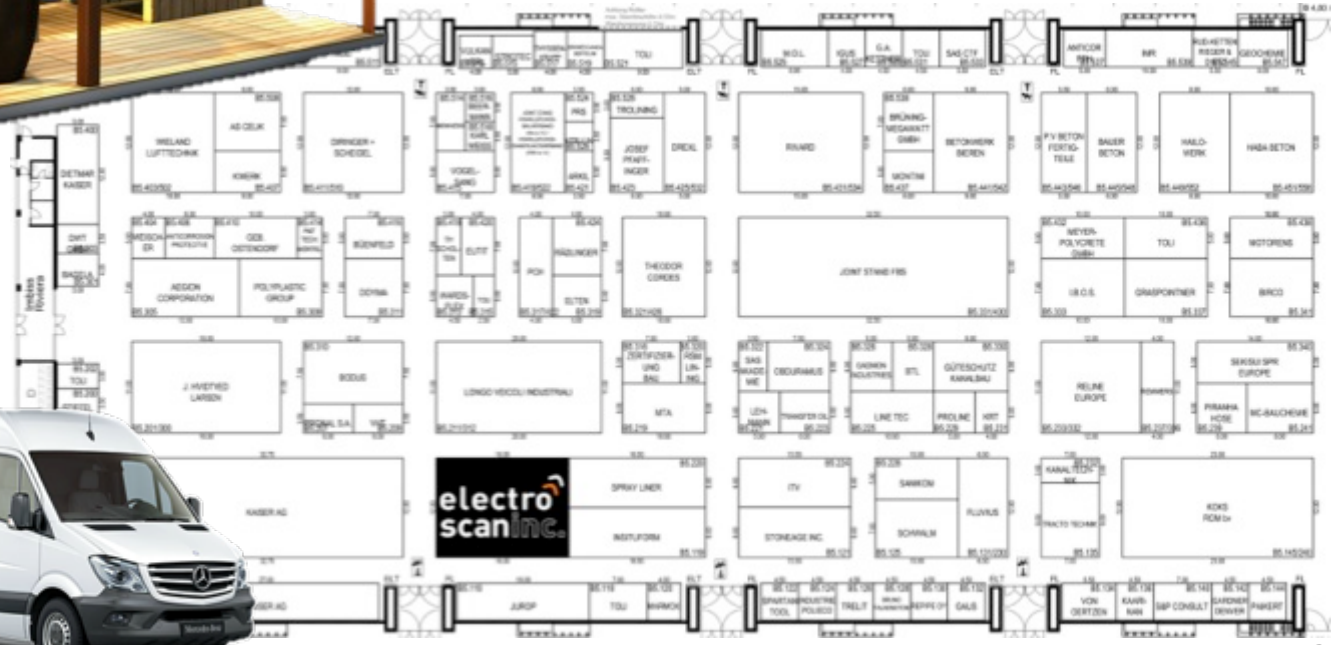

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