electro scan inc.

Comparing CCTV and Electro Scan In Locating Infiltration

March 2013

INFILTRATION SCORECARD

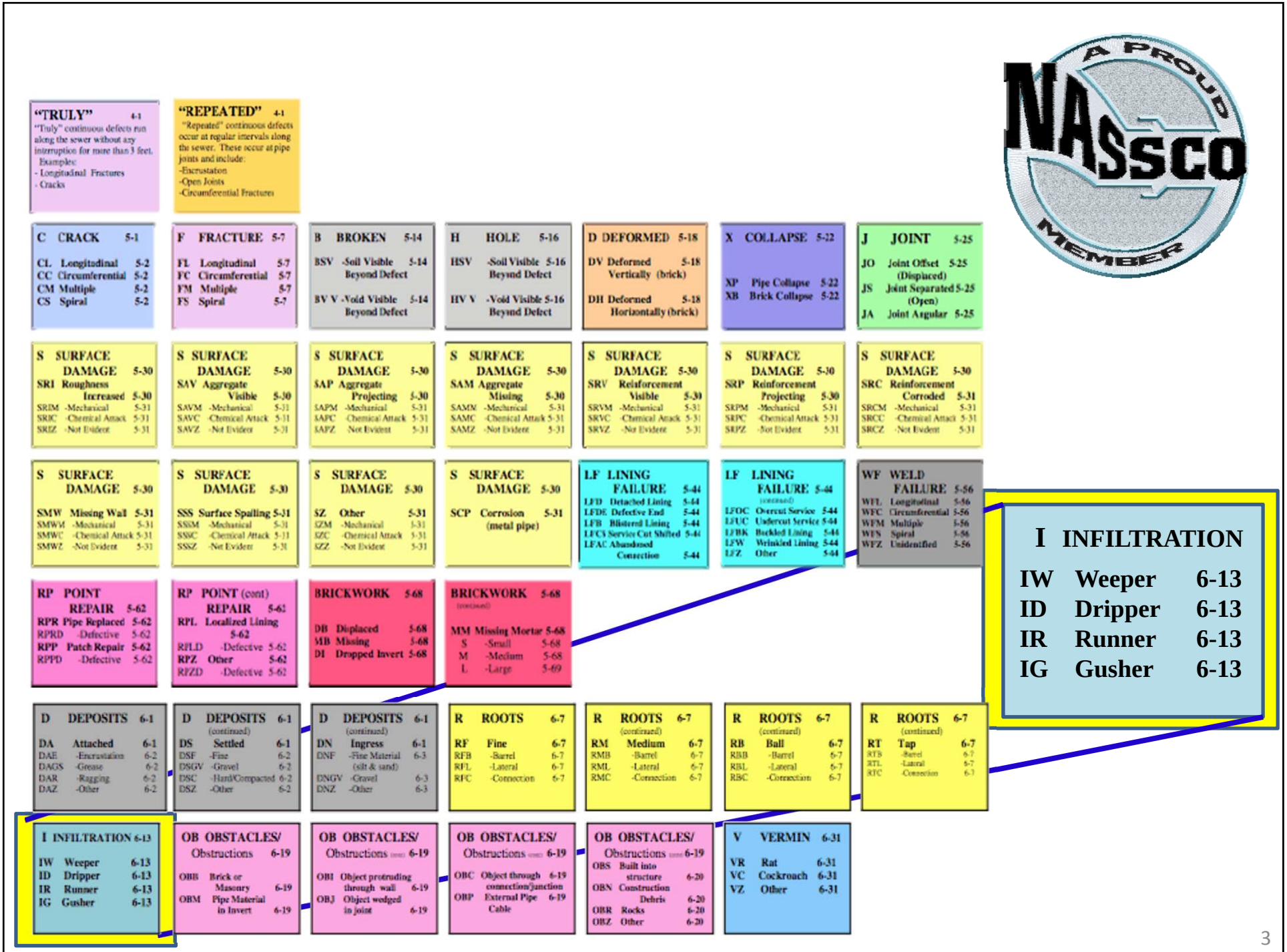
	How Do They Compare?	CCTV	Electro Scan
1	Automatically Finds Potential Sources of Infiltration	N	Y
2	Automatically Finds Leaks Inside Joints	N	Y
3	Automatically Finds Leaks at Service Connections	N	Y
4	Automaticallty Finds Sources of Infiltration at Cracks	N	Y
5	Automatically Finds Leak Locations (within 0.4 in or 1 cm)	N	Y
6	Automatically Measures Size of Leaks (GPM or LPM)	N	Y
7	Automatically Finds Defects That Leak from Bad Couplings	N	Y
8	Automatically Finds Defects That May Still Leak After Repairs	N	Y
9	Automatically Finds Defects That Leak in Liner Projects	N	Y
10	Automatically Finds Defects After Service Re-Connections	N	Y
11	Automatically Finds Leaks, If Silt or Debris on Bottom of Pipe	N	Y
12	Able to Conduct Inspections, If Sewer Pipe Is Full of Water	N	Y
13	Able to Determine Size of Potential Leak, If Roots Are Present	N	Y
14	Automatically Finds Leaks at Joints, If Grease Is Present	N	Y
15	Able to Determine Size of Leaks, If Pipe Has Encrustration	N	Y
16	Requires Active Infiltration to Identify Defect at Source	Y	N
17	Contains Moving Parts That Could Clog from Debris or Silt	Y	N
18	Requires Bypass During Inspection, If Pipe Full	Y	N
19	Requires Special Training and Certification to Identify Defects	Y	N
20	Relies on Visual Observations to Record Defects	Y	N
21	Speed of Inspection	3ft / min	50ft / min

Condition Assessment

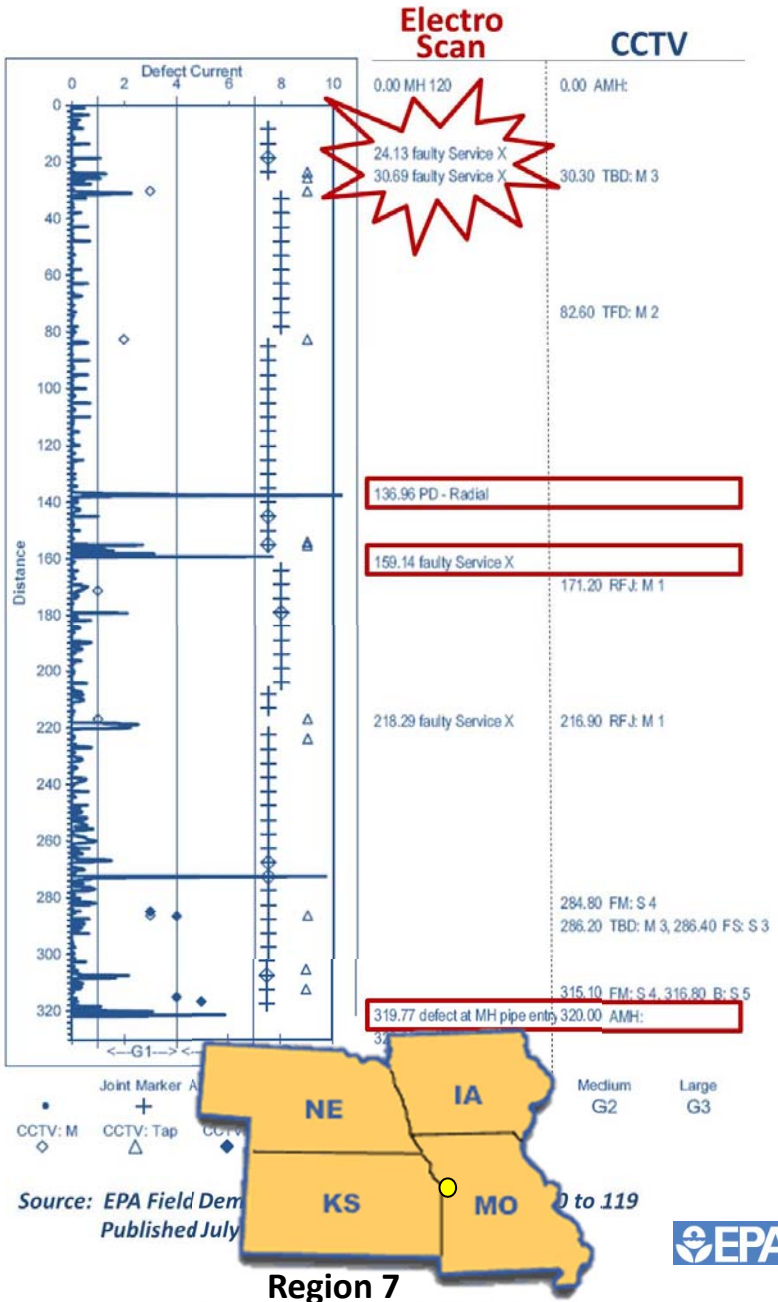
If You Rely on CCTV to Find Leaks, You Will Probably Fix The Wrong Pipe.

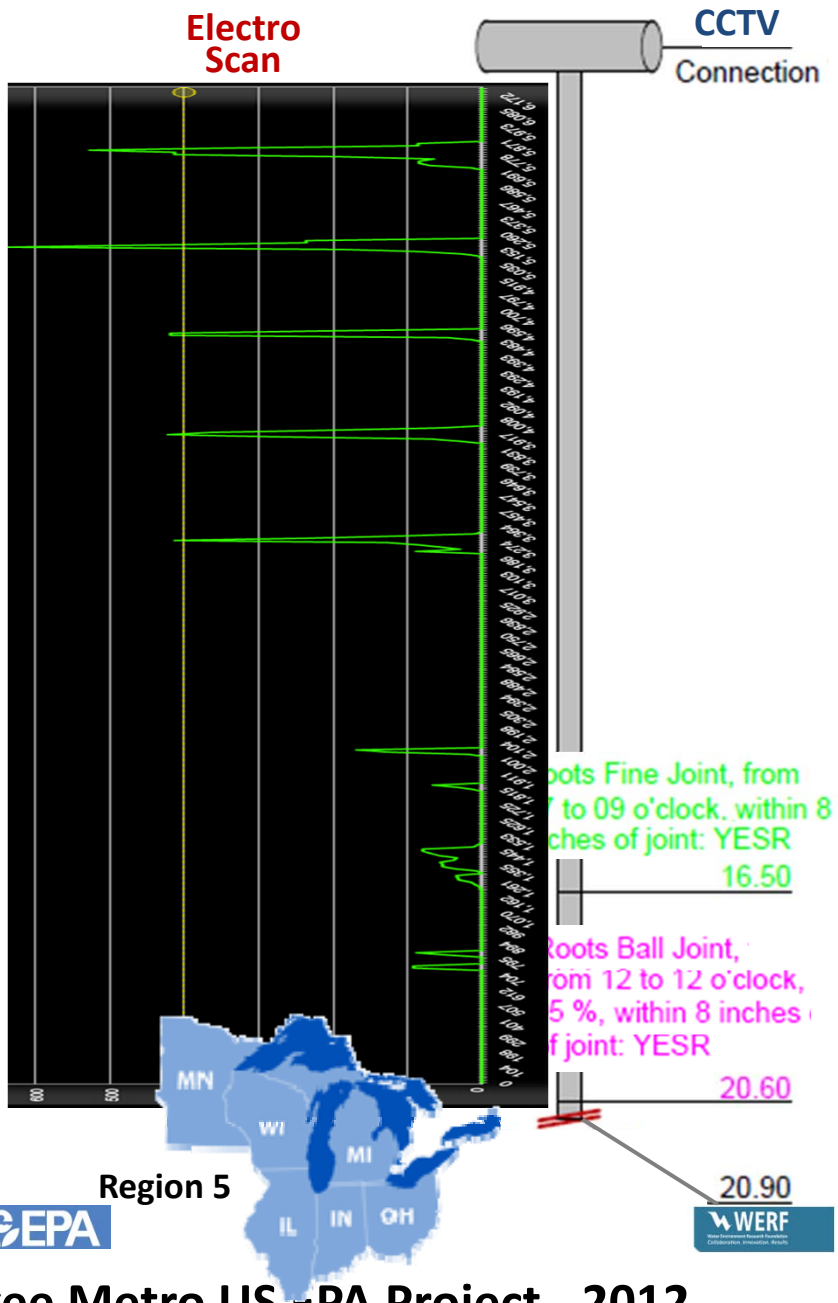
Post-Rehabilitation

If You Rely on CCTV to Certify Your Lining or Repair Project, You Will Probably Have To Fix The Pipe, Again.


"TRULY" 4-1
"Truly" continuous defects run along the sewer without any interruption for more than 3 feet.
Examples:
- Longitudinal Fractures
- Cracks
"REPEATED" 4-1
"Repeated" continuous defects occur at regular intervals along the sewer. These occur at pipe joints and include:
-Encrustation
-Open Joints
-Circumferential Fractures
C CRACK 5-1
CL Longitudinal 5-2
CC Circumferential 5-2
CM Multiple 5-2
CS Spiral 5-2
F FRACTURE 5-7
FL Longitudinal 5-7
FC Circumferential 5-7
FM Multiple 5-7
FS Spiral 5-7
B BROKEN 5-14
BSV -Soil Visible 5-14 Beyond Defect
BV V -Void Visible 5-14 Beyond Defect
H HOLE 5-16
HSV -Soil Visible 5-16 Beyond Defect
HV V -Void Visible 5-16 Beyond Defect
D DEFORMED 5-18
DV Deformed Vertically (brick) 5-18
DH Deformed Horizontally (brick) 5-18
X COLLAPSE 5-22
XP Pipe Collapse 5-22
XB Brick Collapse 5-22
J JOINT 5-25
JO Joint Offset (Displaced) 5-25
JS Joint Separated (Open) 5-25
JA Joint Angular 5-25
S SURFACE DAMAGE 5-30
SRI Roughness Increased 5-30
SRIM -Mechanical 5-31
SRIC -Chemical Attack 5-31
SRIZ -Not Evident 5-31
SAV Aggregate Visible 5-30
SAVM -Mechanical 5-31
SAVC -Chemical Attack 5-31
SAVZ -Not Evident 5-31
SAP Aggregate Projecting 5-30
SAPM -Mechanical 5-31
SAPC -Chemical Attack 5-31
SAPZ -Not Evident 5-31
SAM Aggregate Missing 5-30
SAMM -Mechanical 5-31
SAMC -Chemical Attack 5-31
SAMZ -Not Evident 5-31
SRV Reinforcement Visible 5-30
SRVM -Mechanical 5-31
SRVC -Chemical Attack 5-31
SRVZ -Not Evident 5-31
SRP Reinforcement Projecting 5-30
SRPM -Mechanical 5-31
SRPC -Chemical Attack 5-31
SRPZ -Not Evident 5-31
SRC Reinforcement Corroded 5-31
SRCM -Mechanical 5-31
SRCC -Chemical Attack 5-31
SRCZ -Not Evident 5-31
SMW Missing Wall 5-31
SMWM -Mechanical 5-31
SMWC -Chemical Attack 5-31
SMWZ -Not Evident 5-31
SSS Surface Spalling 5-31
SSSM -Mechanical 5-31
SSSC -Chemical Attack 5-31
SSSZ -Not Evident 5-31
SZ Other 5-31
SZM -Mechanical 5-31
SZC -Chemical Attack 5-31
SZZ -Not Evident 5-31
SCP Corrosion (metal pipe) 5-31
LF LINING FAILURE 5-44
LFD Detached Lining 5-44
LFDE Defective End 5-44
LFB Blistered Lining 5-44
LFCS Service Cut Shifted 5-44
LFAC Abandoned Connection 5-44
LF LINING FAILURE 5-44 (continued)
LFOC Overcut Service 5-44
LFUC Undercut Service 5-44
LFBK Buckled Lining 5-44
LFW Wrinkled Lining 5-44
LFZ Other 5-44
WF WELD FAILURE 5-56
WFL Longitudinal 5-56
WFC Circumferential 5-56
WFM Multiple 5-56
WFS Spiral 5-56
WFZ Unidentified 5-56
RP POINT REPAIR 5-62
RPR Pipe Replaced 5-62
RPRD -Defective 5-62
RPP Patch Repair 5-62
RPPD -Defective 5-62
RP POINT (cont) REPAIR 5-62
RPL Localized Lining 5-62
RPLD -Defective 5-62
RPZ Other 5-62
RPZD -Defective 5-62
BRICKWORK 5-68
DB Displaced 5-68
MB Missing 5-68
DI Dropped Invert 5-68
BRICKWORK 5-68 (continued)
MM Missing Mortar 5-68
S -Small 5-68
M -Medium 5-68
L -Large 5-69
D DEPOSITS 6-1
DA Attached 6-1
DAE -Encrustation 6-2
DAGS -Grease 6-2
DAR -Ragging 6-2
DAZ -Other 6-2
DS Settled 6-1
DSF -Fine 6-2
DSGV -Gravel 6-2
DSC -Hard/Compacted 6-2
DSZ -Other 6-2
DN Ingress 6-1
DNF -Fine Material (silt & sand) 6-3
DNGV -Gravel 6-3
DNZ -Other 6-3
R ROOTS 6-7
RF Fine 6-7
RFB -Barrel 6-7
RFL -Lateral 6-7
RFC -Connection 6-7
RM Medium 6-7
RMB -Barrel 6-7
RML -Lateral 6-7
RMC -Connection 6-7
RB Ball 6-7
RBB -Barrel 6-7
RBL -Lateral 6-7
RBC -Connection 6-7
RT Tap 6-7
RTB -Barrel 6-7
RTL -Lateral 6-7
RTC -Connection 6-7
I INFILTRATION 6-13
IW Weeper 6-13
ID Dripper 6-13
IR Runner 6-13
IG Gusher 6-13
OB OBSTACLES/ Obstructions 6-19
OBB Brick or Masonry 6-19
OBM Pipe Material in Invert 6-19
OBJ Object protruding through wall 6-19
OBJ Object wedged in joint 6-19
OBC Object through connection/junction 6-19
OBP External Pipe Cable 6-19
OBS Built into structure 6-20
OBN Construction Debris 6-20
OBR Rocks 6-20
OBZ Other 6-20
V VERMIN 6-31
VR Rat 6-31
VC Cockroach 6-31
VZ Other 6-31
I INFILTRATION
IW Weeper 6-13
ID Dripper 6-13
IR Runner 6-13
IG Gusher 6-13

PITFALL #1: CCTV ROUTINELY MISSES MAJOR DEFECTS.

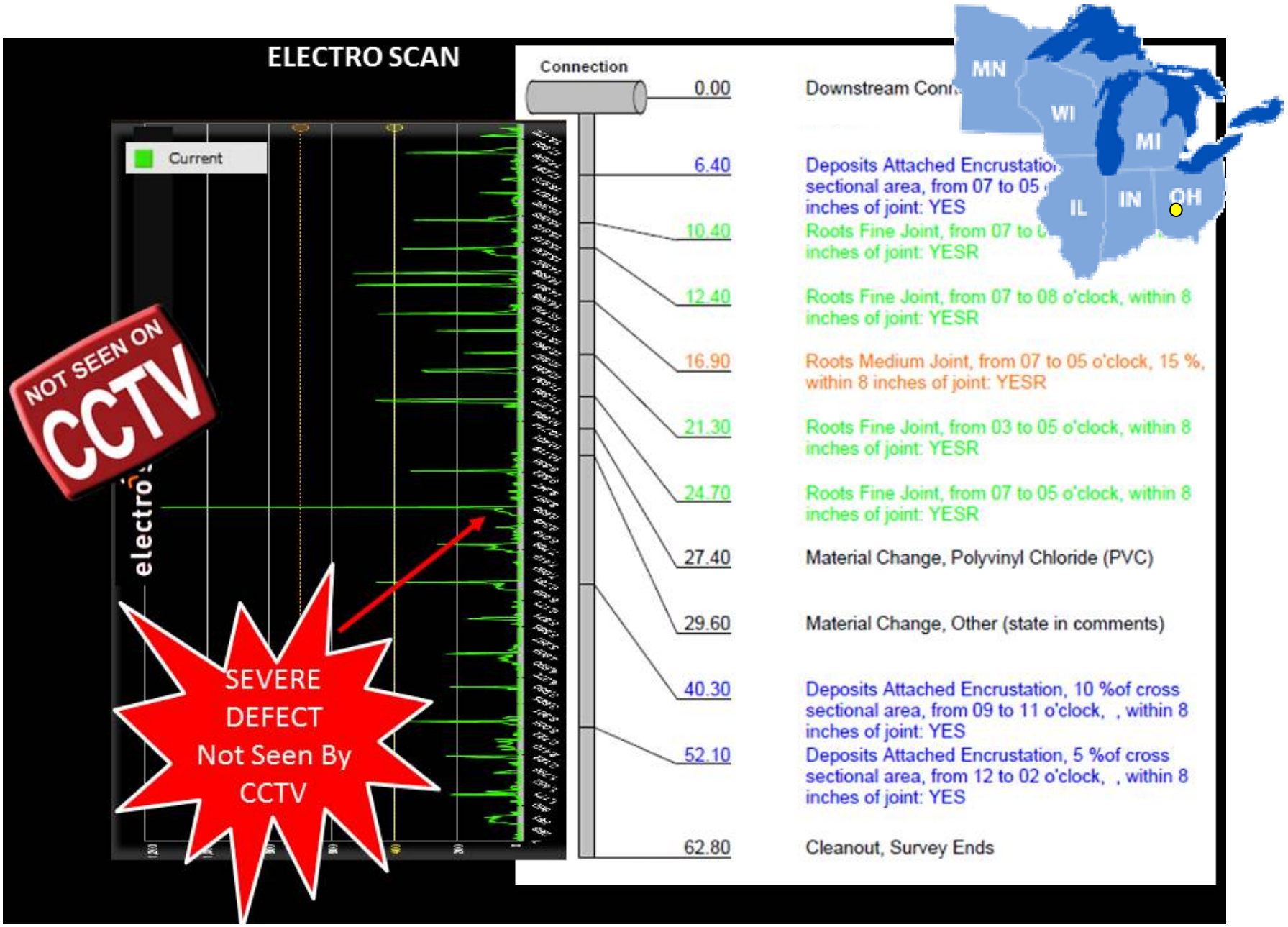




US EPA Report - 2011

Milwaukee Metro US EPA Project - 2012

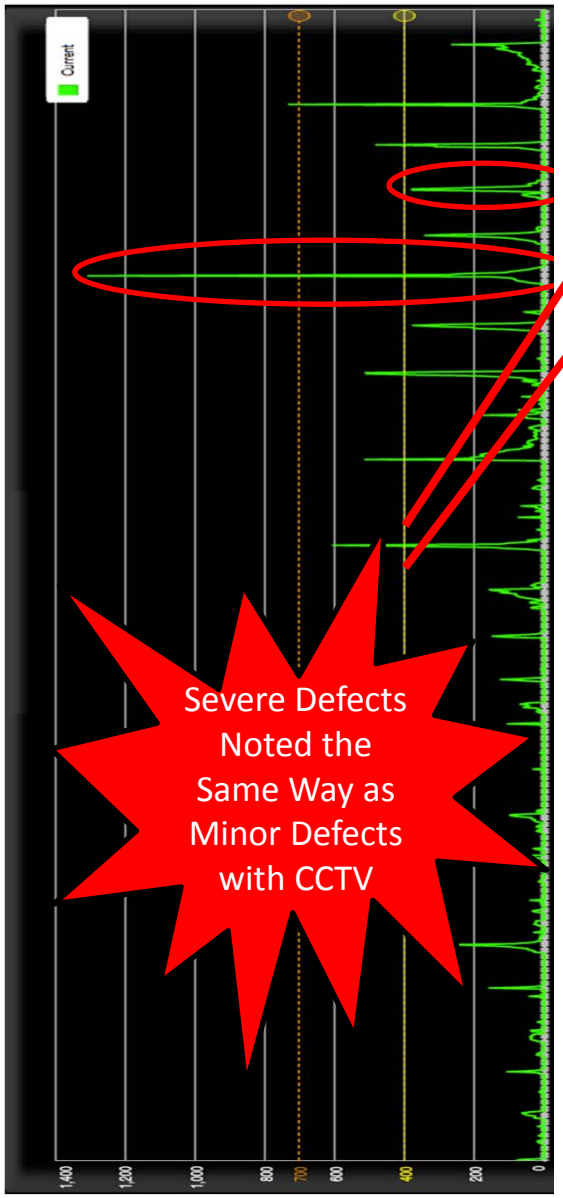
PITFALL #2: CCTV OPERATORS HAS BEEN FOUND TO ROUTINELY CATALOG MINOR DEFECTS, AS MAJOR.



Source: Milwaukee Metro US EPA Project - 2012

PITFALL #3: CCTV OPERATORS ROUTINELY CATALOG MULTIPLE DEFECTS USING THE SAME CODE FOR DIFFERENT-SIZED DEFECTS.

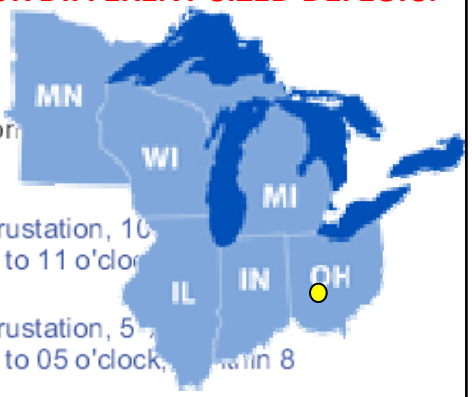
ELECTRO SCAN



Severe Defects Noted the Same Way as Minor Defects with CCTV

CCTV

Connection	Downstream Connection
0.00	
2.50	Deposits Attached Encrustation, 10 sectional area, from 07 to 11 o'clo inches of joint: YES
7.00	Deposits Attached Encrustation, 5 sectional area, from 04 to 05 o'clock, in 8 inches of joint: YES
8.70	Deposits Attached Encrustation, 10 %of cross sectional area, from 12 to 02 o'clock, , within 8 inches of joint: YES
10.70	Deposits Attached Encrustation, 10 %of cross sectional area, from 07 to 12 o'clock, , within 8 inches of joint: YES
14.80	Deposits Attached Encrustation, 10 %of cross sectional area, from 02 to 05 o'clock, , within 8 inches of joint: YES
16.30	Roots Medium Joint, from 07 to 11 o'clock, 25 %, within 8 inches of joint: YESR
20.80	Roots Medium Joint, from 07 to 05 o'clock, 10 %, within 8 inches of joint: YESR
25.00	Roots Medium Joint, from 07 to 05 o'clock, 25 %, within 8 inches of joint: YESR
40.90	Roots Fine Joint, from 08 to 10 o'clock, within 8 inches of joint: YESR
61.60	Cleanout , Survey Ends



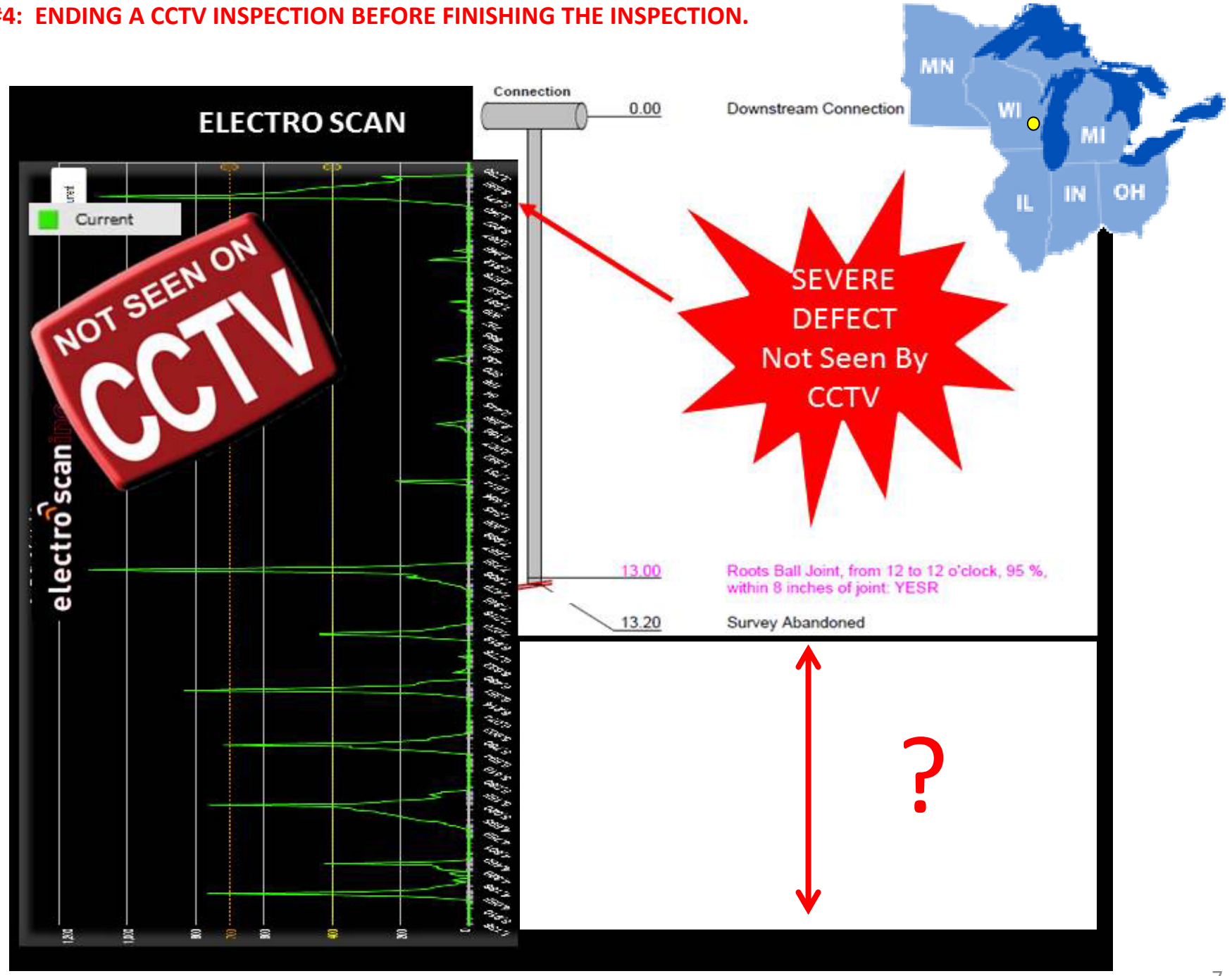
WERF Water Environment Research Foundation Collaboration. Innovation. Results.

MMSD Preserving The Environment • Improving Water Quality

EPA

Source: Milwaukee Metro US EPA Project - 2012

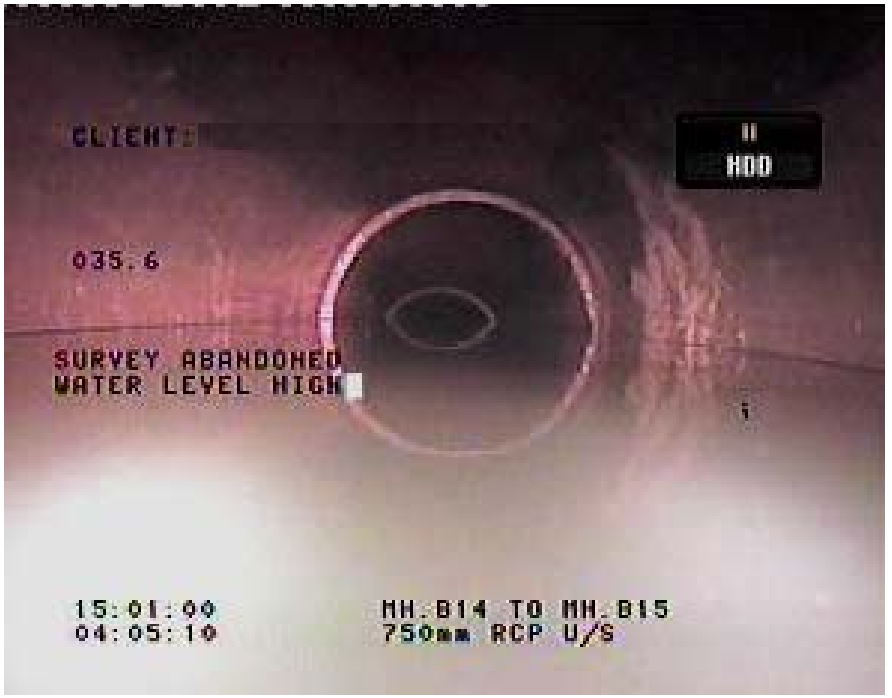
PITFALL #4: ENDING A CCTV INSPECTION BEFORE FINISHING THE INSPECTION.



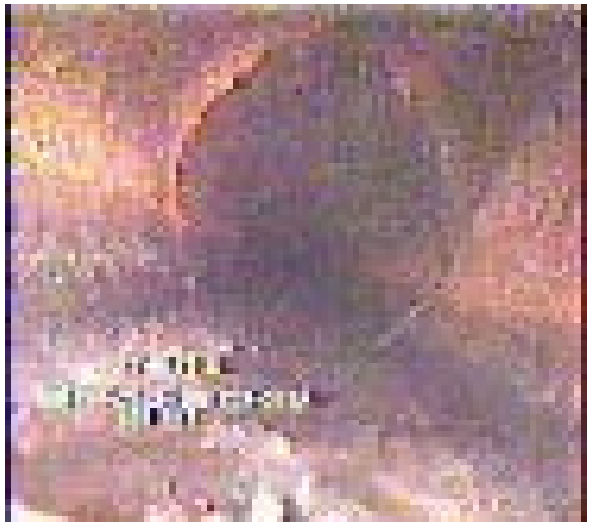
Source: Milwaukee Metro US EPA Project - 2012

PITFALL #5: CCTV UNABLE TO INSPECT PIPES THAT ARE EITHER 'FULL' OR 'PARTIALLY FULL' OF WATER.

CCTV Cannot Be Used When Sewer Mains Are Either Full or Partially Full of Water; However Electro Scan Can.



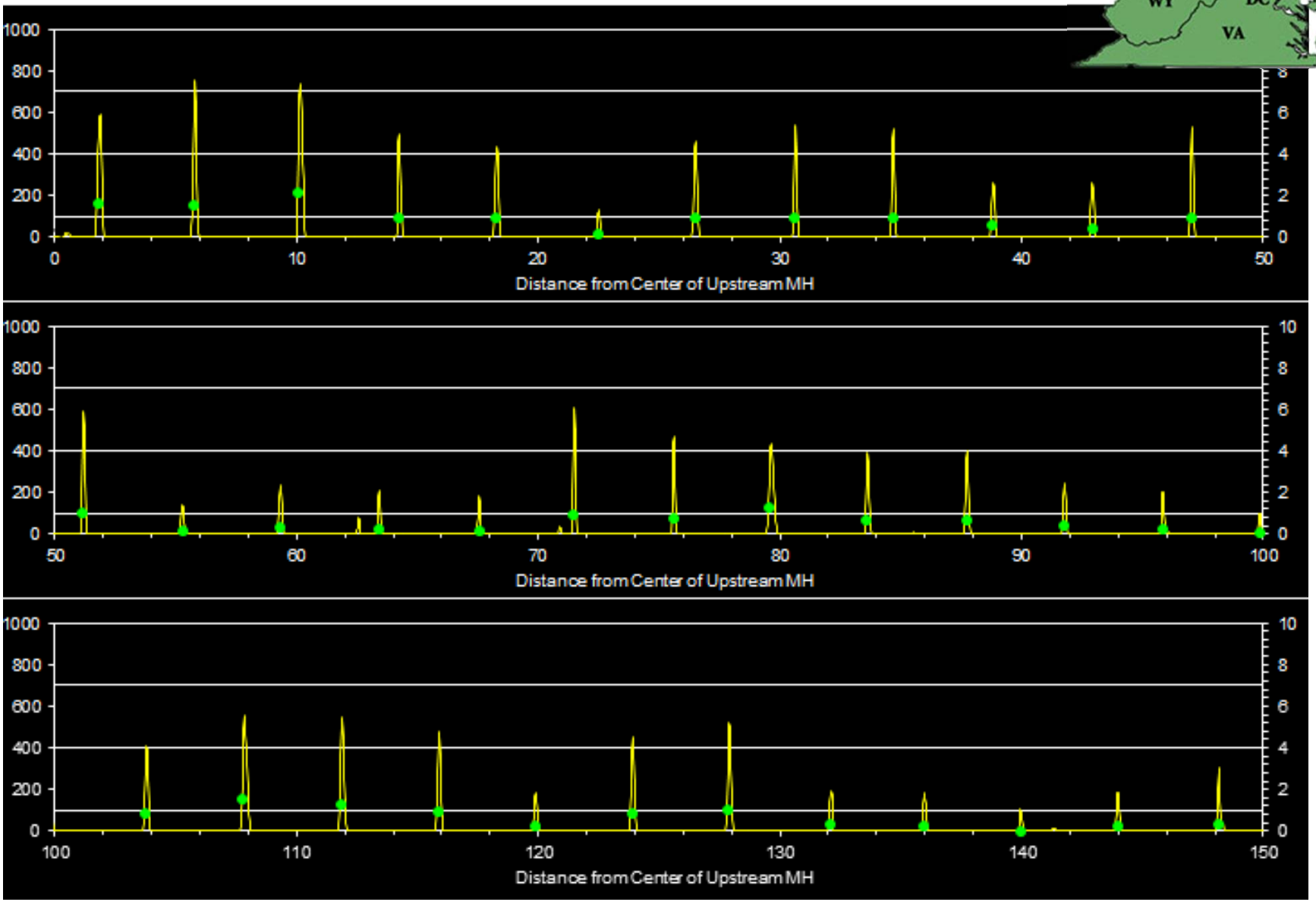
PITFALL #6: CCTV UNABLE TO INSPECT PIPES THAT HAVE DEBRIS OR SILT ON THE BOTTOM OF THE PIPE.



Silt at the bottom of sewer pipes will hide leaks, and will not be found by CCTV.

PITFALL #7: CCTV IS UNABLE TO PROVIDE A 'QUANTIFICATION OF DEFECTS'

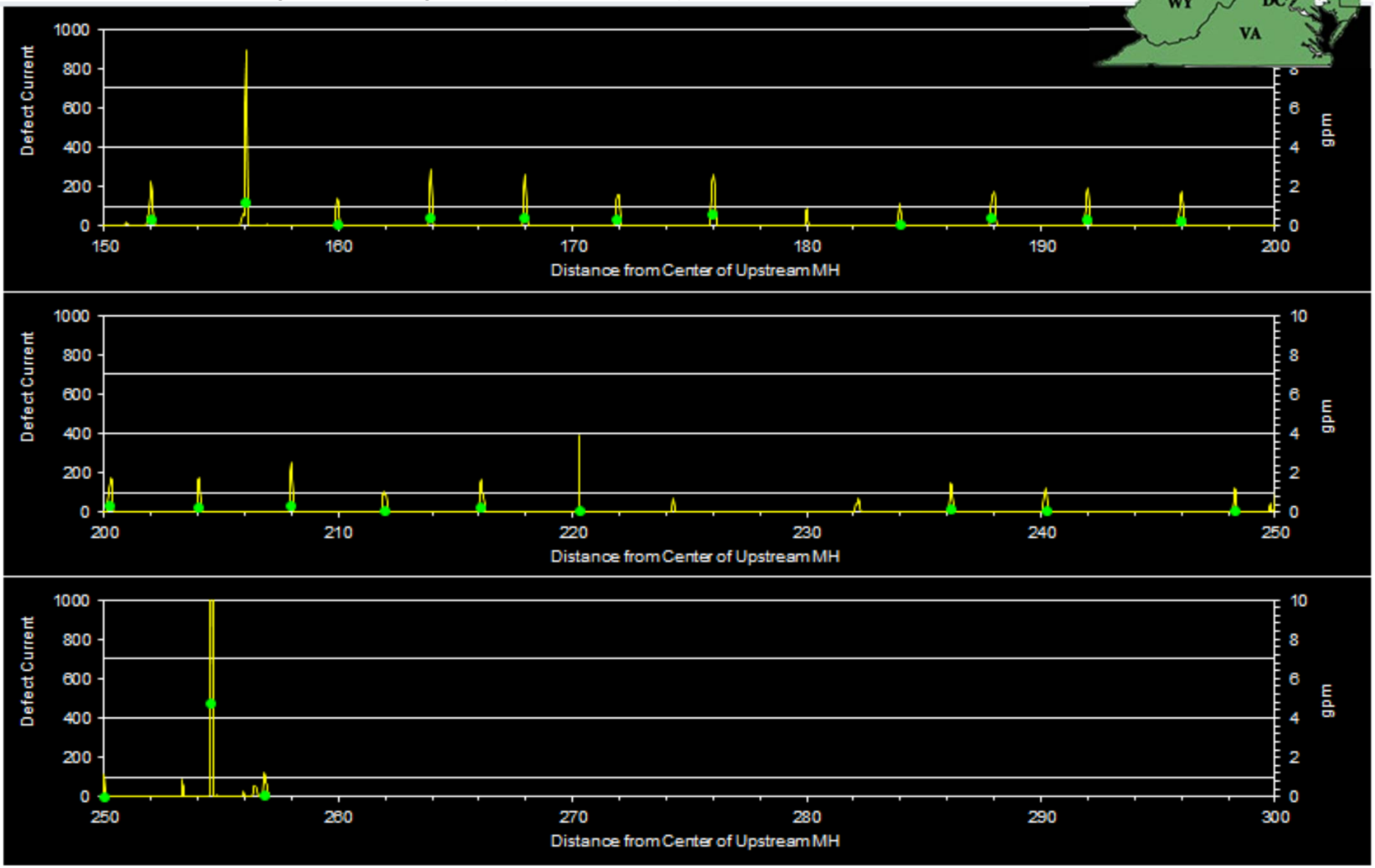
Electro Scan Graphical Report – Joint Defects



Source: Large US EPA Region 3 Sewer Utility

PITFALL #7: CCTV IS UNABLE TO PROVIDE A 'QUANTIFICATION OF DEFECTS' (Continued)

Electro Scan Graphical Report *(Continued)*



Source: Large US EPA Region 3 Sewer Utility

PITFALL #7: CCTV IS UNABLE TO PROVIDE A 'QUANTIFICATION OF DEFECTS' (Continued)

Region 3

Data Files

Start of Anomaly	End of Anomaly	Length of Anomaly	Maximum Current Level of Anomaly	Max. Current Anomaly Grading	Defect Flow	Defect Flow Grading
1.73	1.98	0.25	592.00	M	1.69	M
5.68	5.91	0.23	756.00	L	1.58	M
10.04	10.31	0.28	734.00	L	2.19	M
14.17	14.35	0.18	493.00	M	0.98	S
18.20	18.38	0.17	431.00	M	0.99	S
22.46	22.53	0.08	128.00	S	0.18	S
26.44	26.61	0.18	459.00	M	0.96	S
30.54	30.72	0.17	538.00	M	1.00	S
34.63	34.77	0.15	520.00	M	0.95	S
38.73	38.91	0.18	262.00	S	0.59	S
42.86	42.99	0.12	264.00	S	0.47	S
46.97	47.14	0.17	532.00	M	1.01	M
51.13	51.27	0.15	589.00	M	1.11	M
55.23	55.31	0.08	144.00	S	0.20	S
59.28	59.39	0.10	239.00	S	0.37	S
63.37	63.47	0.10	208.00	S	0.31	S
67.52	67.57	0.05	182.00	S	0.18	S
71.43	71.58	0.15	608.00	M	1.01	M
75.53	75.69	0.15	469.00	M	0.77	S
79.54	79.82	0.28	439.00	M	1.30	M
83.55	83.69	0.15	391.00	S	0.71	S
87.68	87.83	0.15	404.00	M	0.75	S
91.71	91.83	0.13	247.00	S	0.43	S
95.81	95.89	0.08	200.00	S	0.26	S
99.84	99.87	0.03	101.00	S	0.08	S
103.72	103.90	0.18	405.00	M	0.87	S
107.73	108.01	0.28	557.00	M	1.57	M
111.78	112.01	0.23	549.00	M	1.31	M
115.82	115.99	0.17	481.00	M	0.98	S
119.85	119.95	0.10	187.00	S	0.29	S

Start of Anomaly	End of Anomaly	Length of Anomaly	Maximum Current Level of Anomaly	Current Anomaly Grading	Defect Flow	Defect Flow Grading
123.83	124.00	0.17	454.00	M	0.92	S
127.81	128.01	0.20	517.00	M	1.08	M
132.07	132.19	0.12	190.00	S	0.37	S
135.92	136.02	0.10	181.00	S	0.29	S
139.95	139.95	0.00	102.00	S	0.06	S
143.93	144.03	0.10	186.00	S	0.29	S
148.11	148.22	0.10	307.00	S	0.41	S
151.95	152.07	0.12	226.00	S	0.41	S
156.00	156.13	0.12	892.00	L	1.22	M
159.93	159.98	0.05	137.00	S	0.14	S
163.89	164.01	0.12	288.00	S	0.47	S
167.89	168.02	0.13	260.00	S	0.44	S
171.87	172.02	0.15	161.00	S	0.38	S
175.90	176.08	0.18	264.00	S	0.63	S
183.94	183.97	0.03	111.00	S	0.08	S
187.87	188.04	0.17	177.00	S	0.45	S
191.93	192.05	0.12	195.00	S	0.36	S
195.96	196.08	0.12	175.00	S	0.32	S
200.19	200.34	0.15	174.00	S	0.37	S
203.99	204.09	0.10	176.00	S	0.27	S
207.92	208.05	0.13	255.00	S	0.41	S
211.93	211.96	0.03	109.00	S	0.08	S
216.04	216.14	0.10	163.00	S	0.25	S
220.29	220.29	0.00	389.00	S	0.14	S
236.14	236.21	0.07	153.00	S	0.20	S
240.20	240.25	0.05	120.00	S	0.13	S
248.28	248.31	0.02	124.00	S	0.09	S
250.01	250.01	0.00	111.00	S	0.04	S
254.54	254.67	0.13	3380.00	L	4.78	L
256.82	256.87	0.05	127.00	S	0.13	S

Source: Large US EPA Region 3 Sewer Utility

PITFALL #7: CCTV IS UNABLE TO PROVIDE A 'QUANTIFICATION OF DEFECTS' (Continued)

Findings and Conclusions

Electro Scan located **60** total defects – 38 small, 18 medium, and 4 large. Based on the size and quantity of those defects, it is estimated that this pipe length could infiltrate **40.3 gallons per minute.**

Anomaly Picking Threshold	100.00	Grade Current Levels	Number	Length	% Length of Pipe Tested	% of Total Anomaly Length	Grade Flow Levels	Number	Flow gpm	Flow per 100ft of pipe	% of Total Flow
Grade	Large	>700	4	0.8	0%	10%	>4	1	4.8	1.9	12%
	Medium	700 to 400	18	3.4	1%	44%	4 to 1	11	15.1	5.9	37%
	Small	<400	38	3.5	1%	46%	<1	48	20.5	8.0	51%
	Total		60	7.6	3%	100%	<1	60	40.3	15.7	100%

The first 1/3 of this pipe is responsible for just about half of the total possible infiltration. However, just like with the pipe segment on Snow Acres Dr, there are enough defects spread throughout the entire pipe to justify a complete relining or replacement.

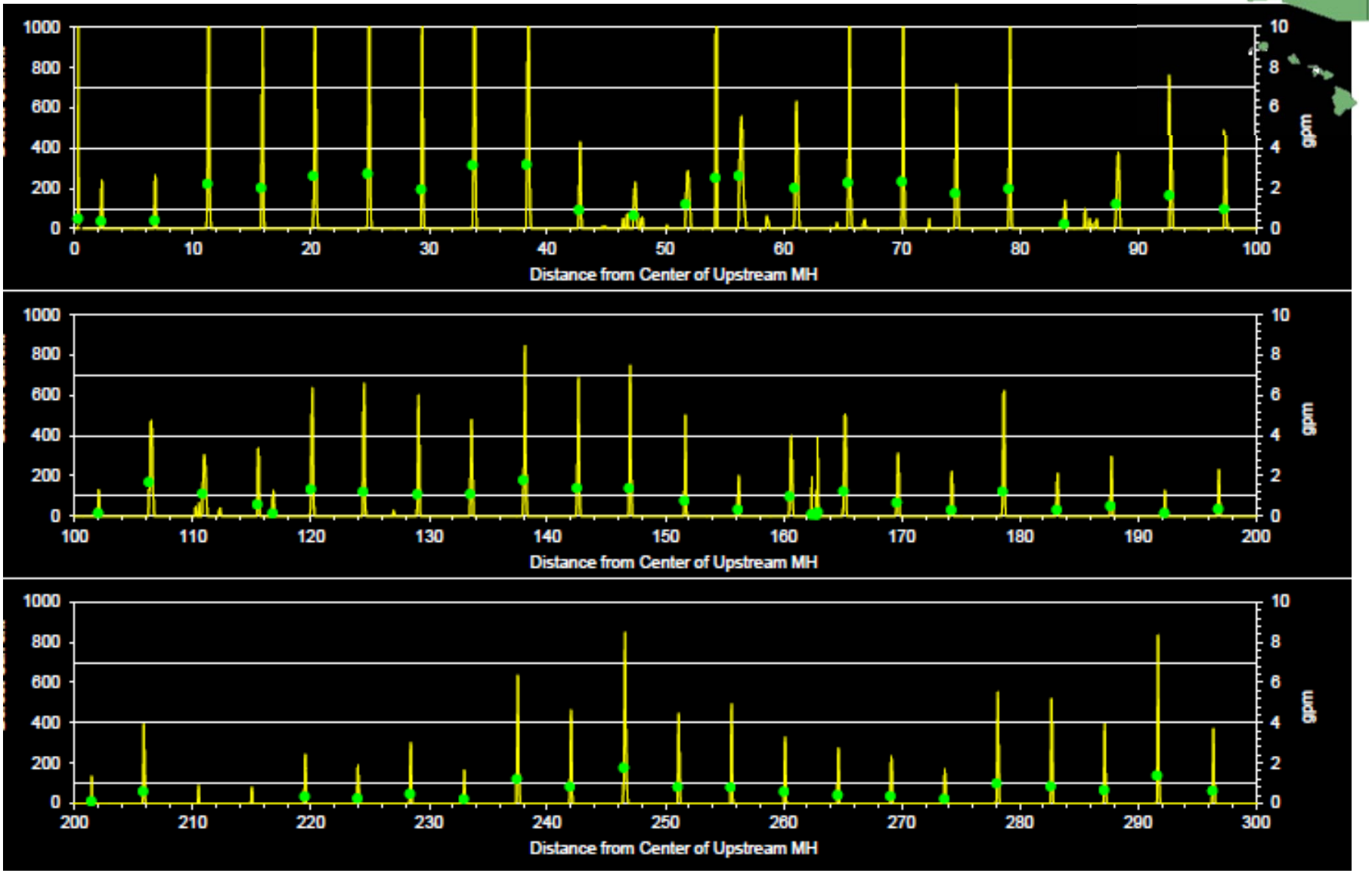
GPM estimates ±40%, assume a 1 ft of water head over pipe.

Source: Large US EPA Region 3 Sewer Utility

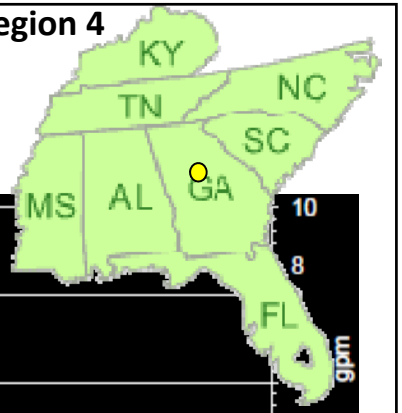
PITFALL #8: CCTV IS UNABLE TO TELEVISE SEWERS DURING RAINFALL EVENTS.

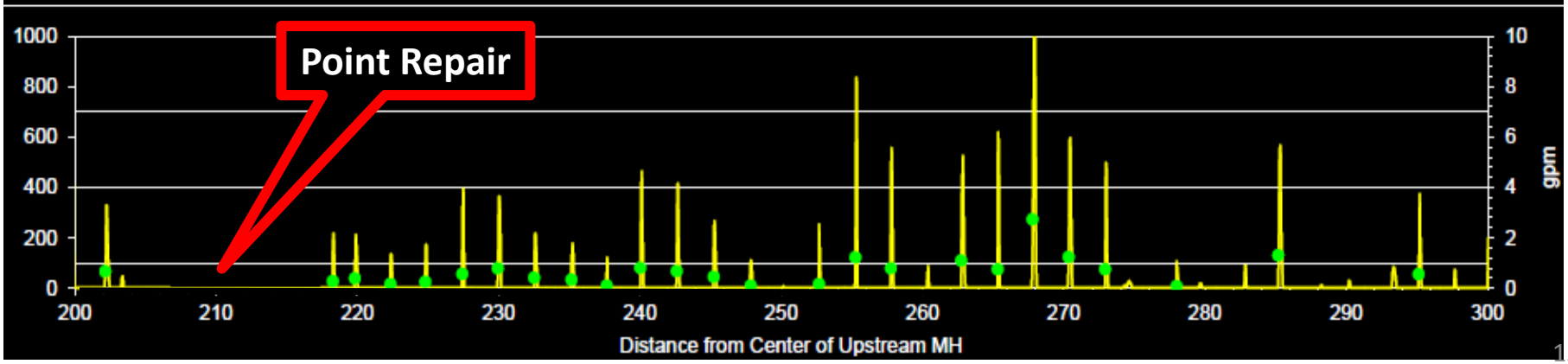
Northern California Sewer Agency unable to CCTV due to unexplained 'around the clock' surcharging.

Region 9

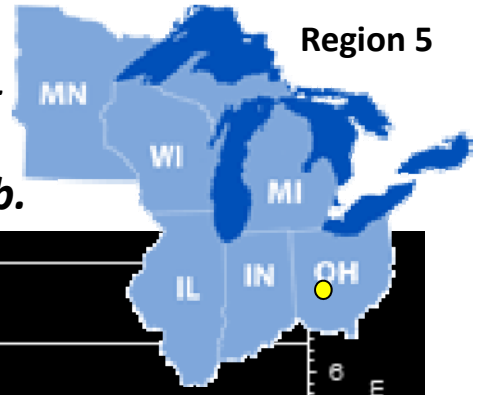


PITFALL #9: CCTV NOT ABLE TO CONFIRM REPAIRS AFTER REHABILITATION.

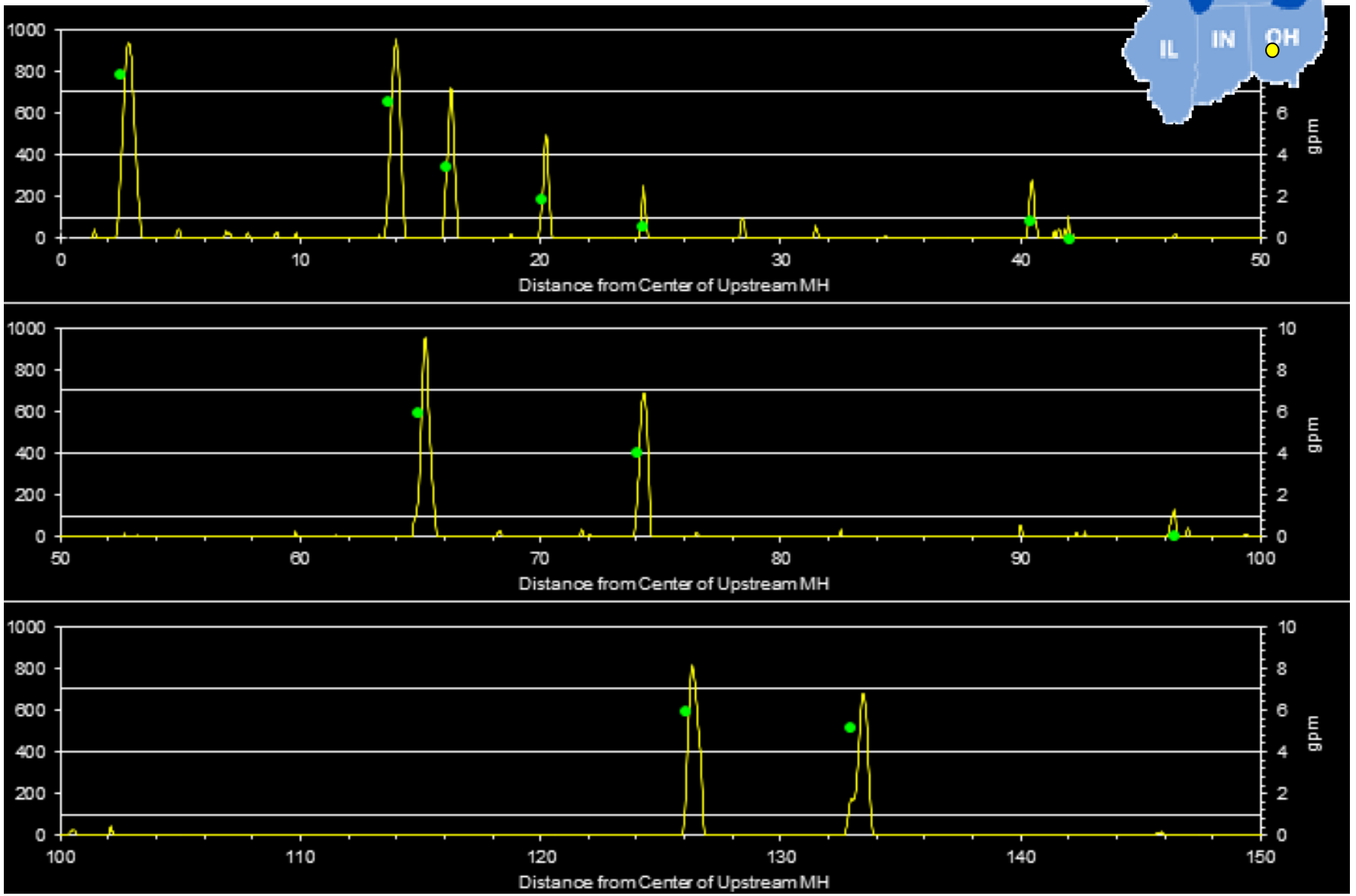




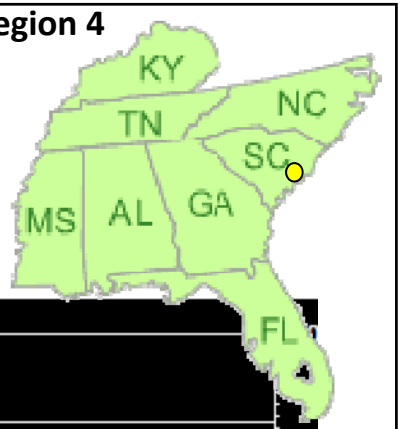
PITFALL #10: CCTV UNABLE TO PERFORM QUALITY ASSURANCE ON PIPE LINING PROJECTS.



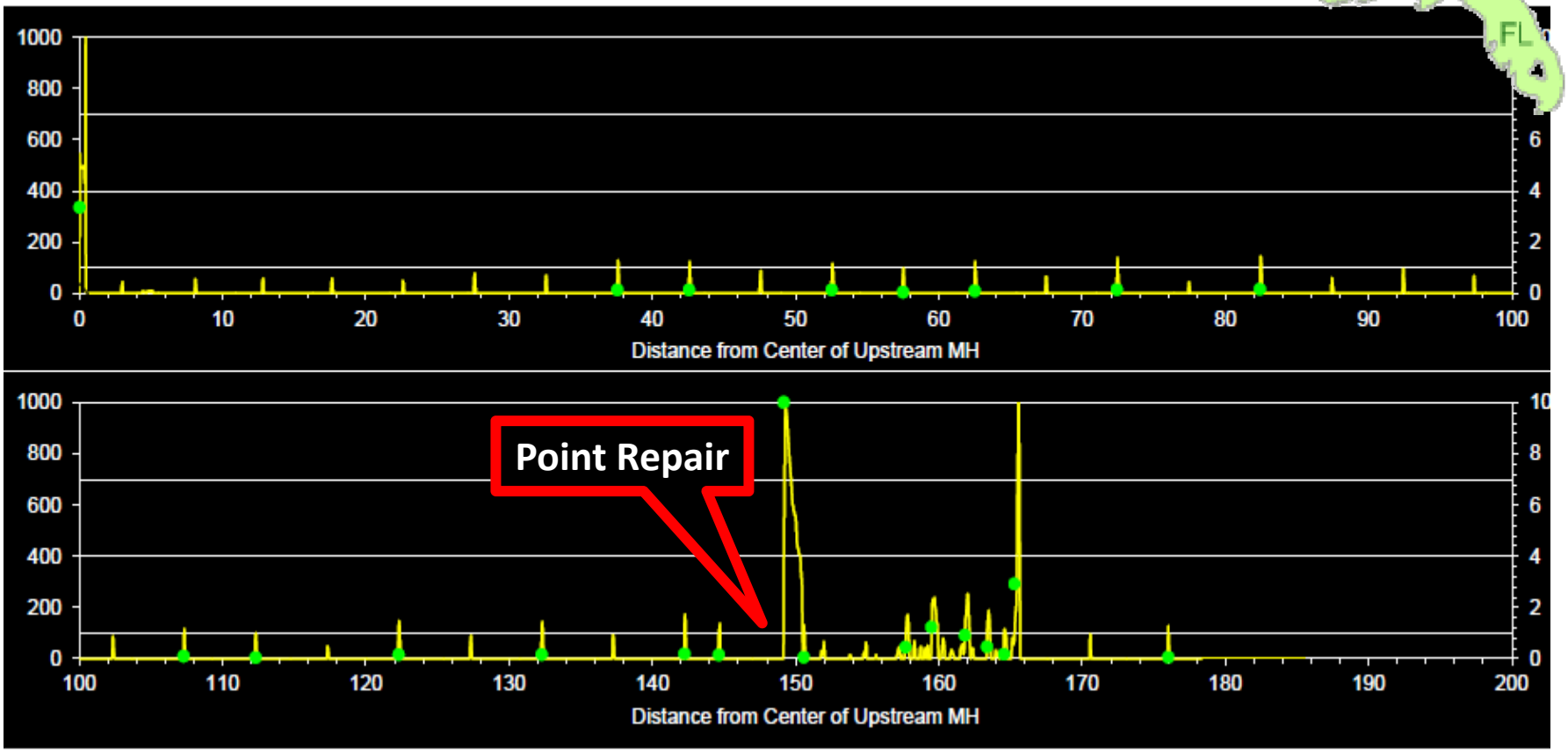
Agency's contractor had used CCTV to certify a recent pipe lining job at this Ohio sewer utility. According to Electro Scan multiple service defects were found causing more infiltration than before original rehab.



PITFALL #11: CCTV IS NOT ABLE TO PERFORM QUALITY ASSURANCE ON POINT REPAIRS.

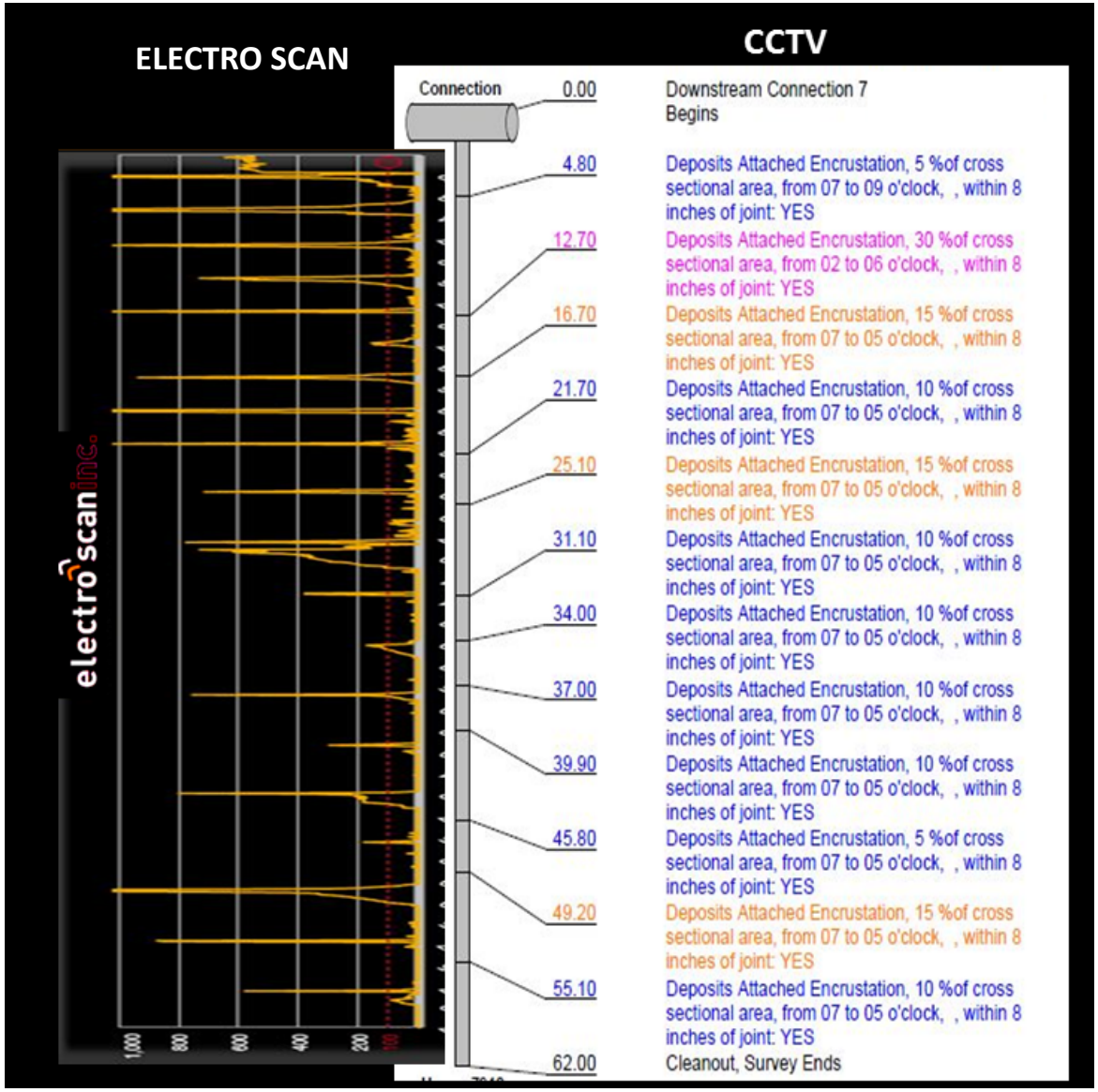


Agency's contractor had used CCTV to certify a recent point repair. It did not work.



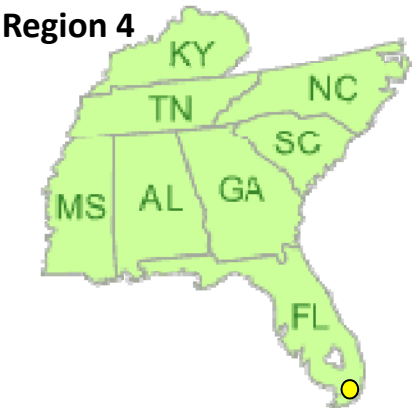
PITFALL #12: CCTV MAY MISS DEFECTS DUE TO 'ENCRUSTATION' -- *NOT (YET) AN APPROVED METHOD OF REPAIR.*

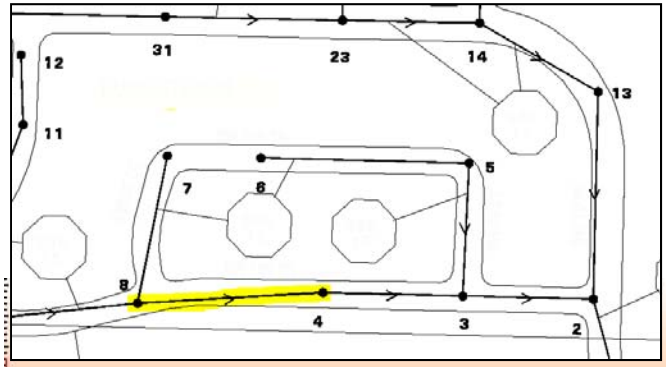
This Sewer Main (Below) was Televised and PASSED its Water Pressure Test (i.e. able to hold water for 5 minutes). Yet, the Electro Scan Current was able to accurately show defects as Encrustation is non-conductive.

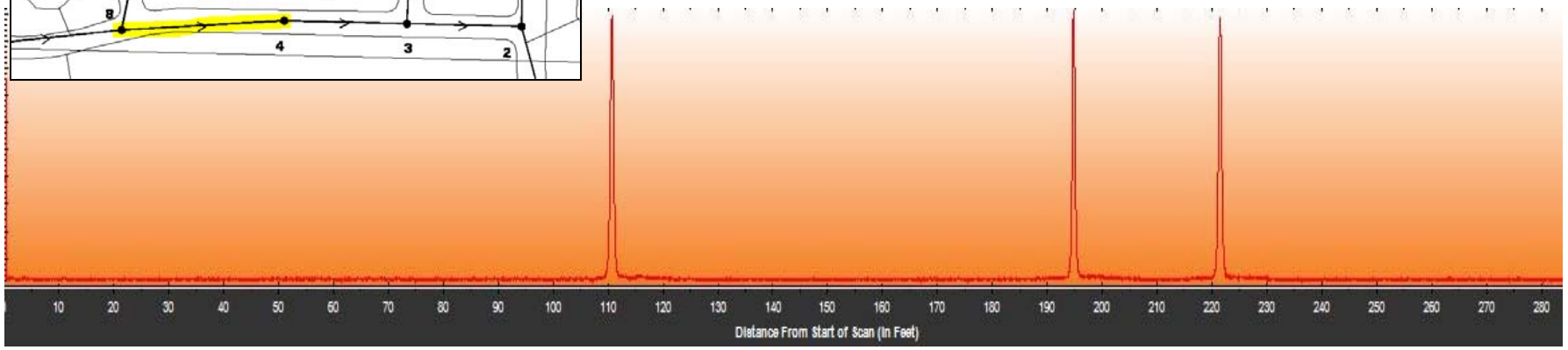


PITFALL #13: CCTV UNABLE TO QA/QC PIPE LINING FOR AGENCIES OPERATING UNDER A 'US EPA CONSENT ORDER.'

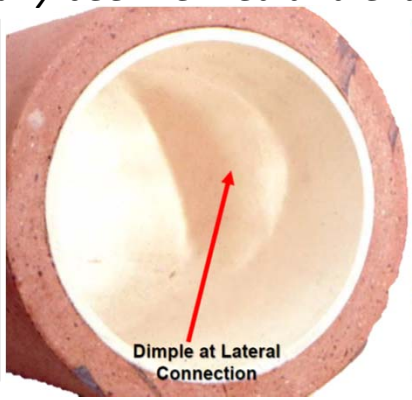
Agency's contractor had used CCTV to certify a recent pipe lining job at this Southern Florida sewer utility. According to Electro Scan three major service connection defects were found.



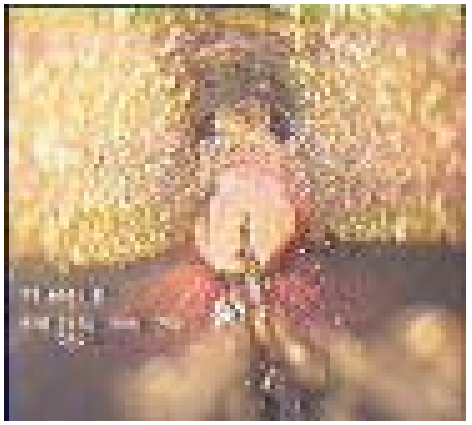


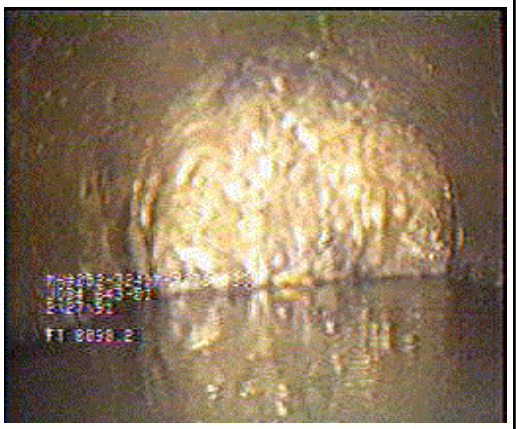


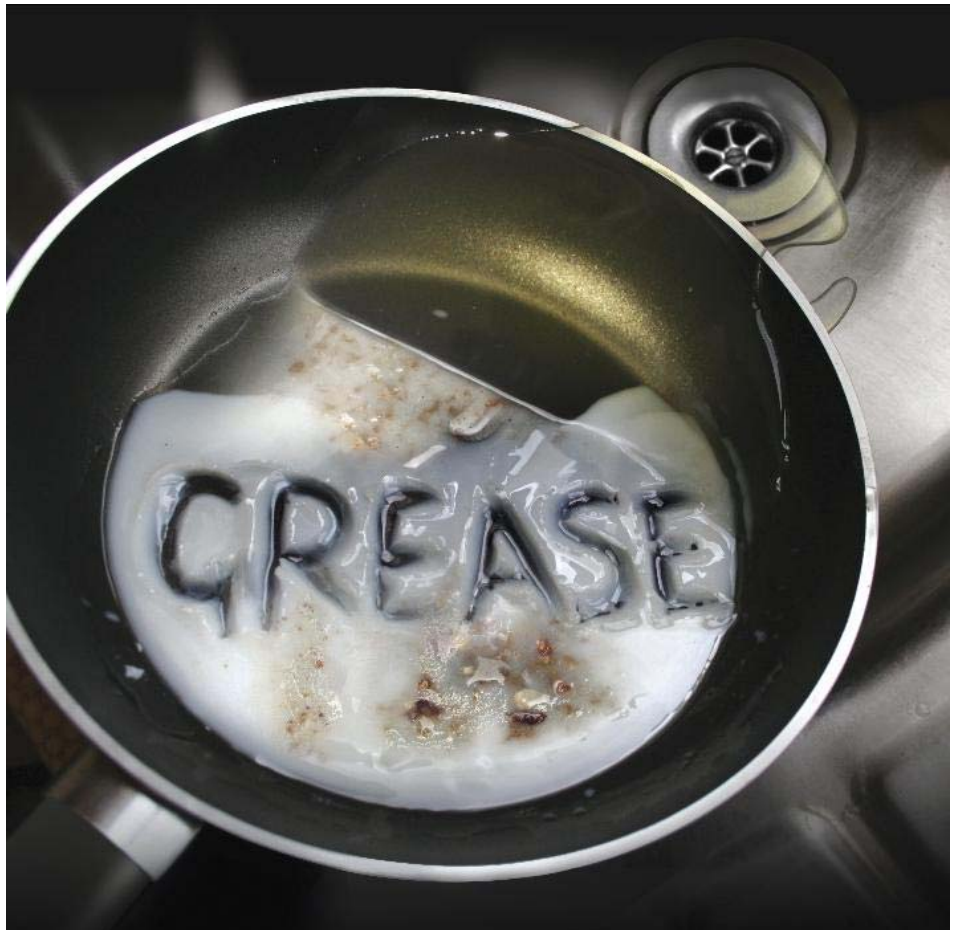
How sewers have traditionally been relined and evaluated with CCTV – missing defect locations.



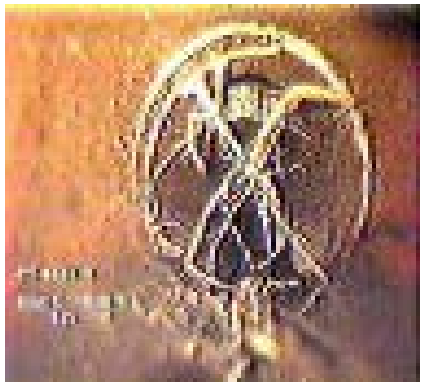
PITFALL #14: CCTV MAY MISS POTENTIAL LEAKS IF GREASE IS PRESENT AND COVERS DEFECT.

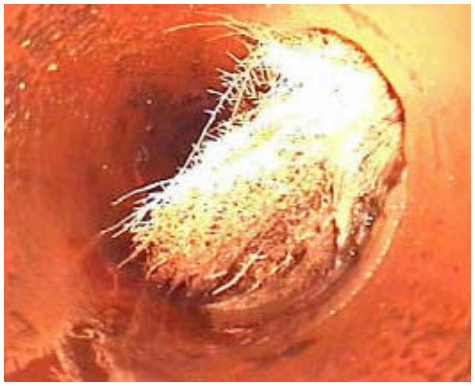


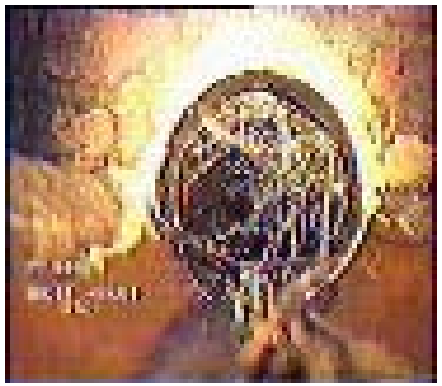


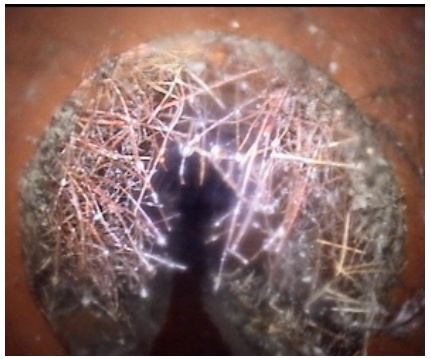


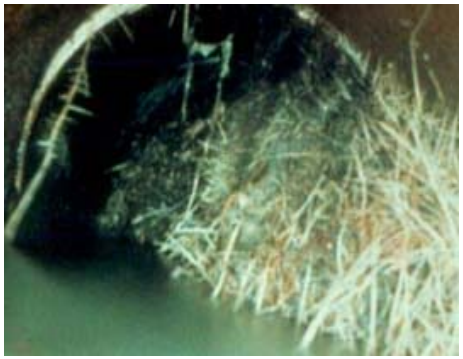
PITFALL #15: CCTV MAY MISS POTENTIAL LEAKS IF SEWER HAS BEEN CLEANED, AND ROOTS REMOVED, MAKING IT MORE DIFFICULT TO DETERMINE POTENTIAL LEAK LOCATION AND SEVERITY.











PITFALL #16: INCOMPLETE, INCONSISTENT, AND INCORRECTLY CATALOGED DEFECTS ARE SUMMARIZED INTO CCTV's Overall Pipe Rating Index(OPRI) GRADING SYSTEM, RANKING PIPES AS 1-5. BY USING SUBJECTIVE STANDARDS, PIPES MAY EITHER BE INCORRECTLY IDENTIFIED AS 'BAD' WHEN THEY ARE GOOD, OR IDENTIFIED AS 'GOOD' WHEN THEY ARE BAD.

PACP CCTV OPRI Standards

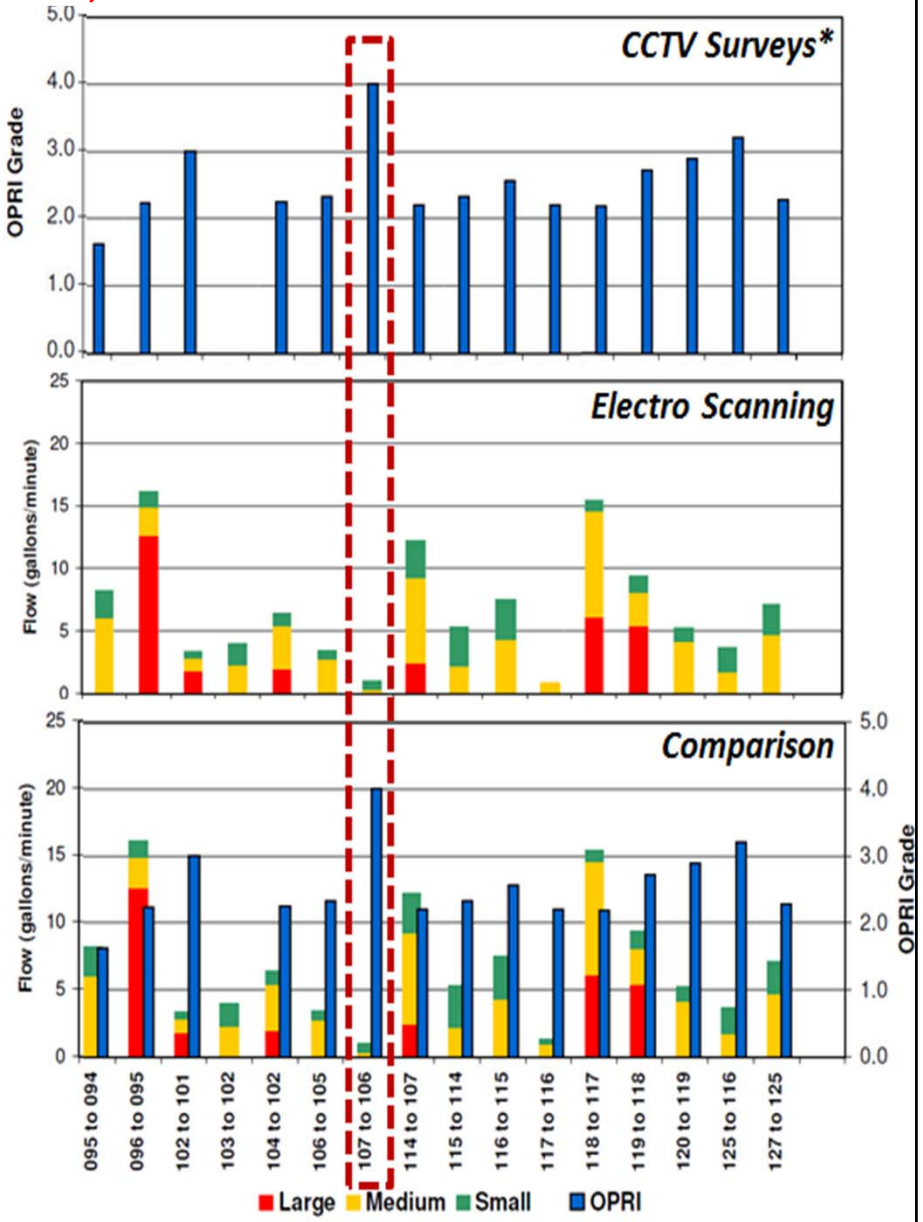
1: EXCELLENT: MINOR DEFECTS.
Failure unlikely in the foreseeable future.

2: GOOD: DEFECTS THAT HAVE NOT BEGUN TO DETERIORATE.
Pipe unlikely to fail for at least 20 years.

3: FAIR: MODERATE DEFECTS THAT WILL CONTINUE TO DETERIORATE. Pipe may fail in 10 to 20 years.

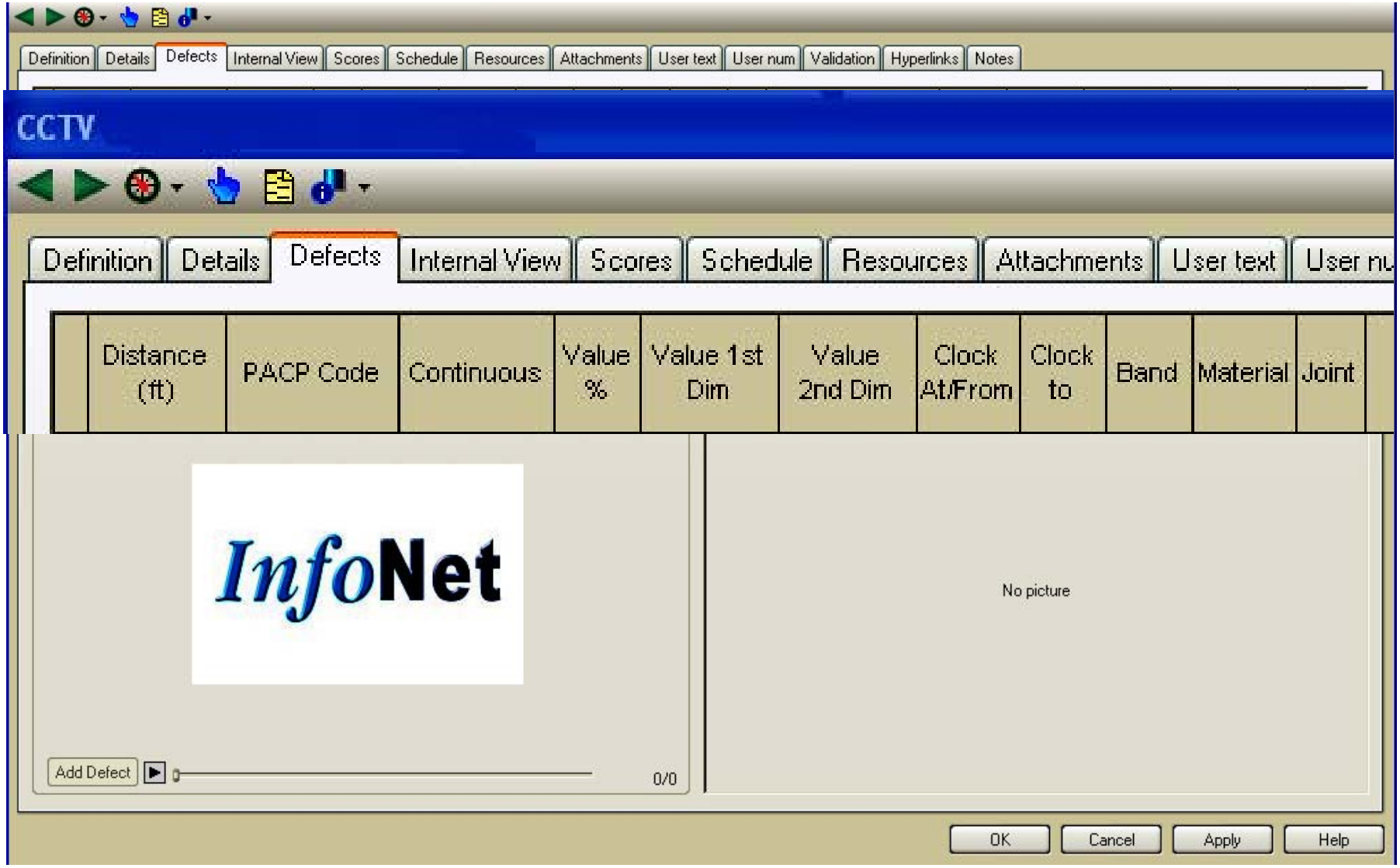
4: POOR: SEVERE DEFECTS THAT WILL BECOME GRADE 5 DEFECTS WITHIN THE FORSEEABLE FUTRE. Pipe will probably fail in 5 to 10 years.

5: IMMEDIATE ATTENTION: DEFECTS REQUIRING IMMEDIATE ATTENTION. Pipe has failed or will likely fail within the next 5 years.

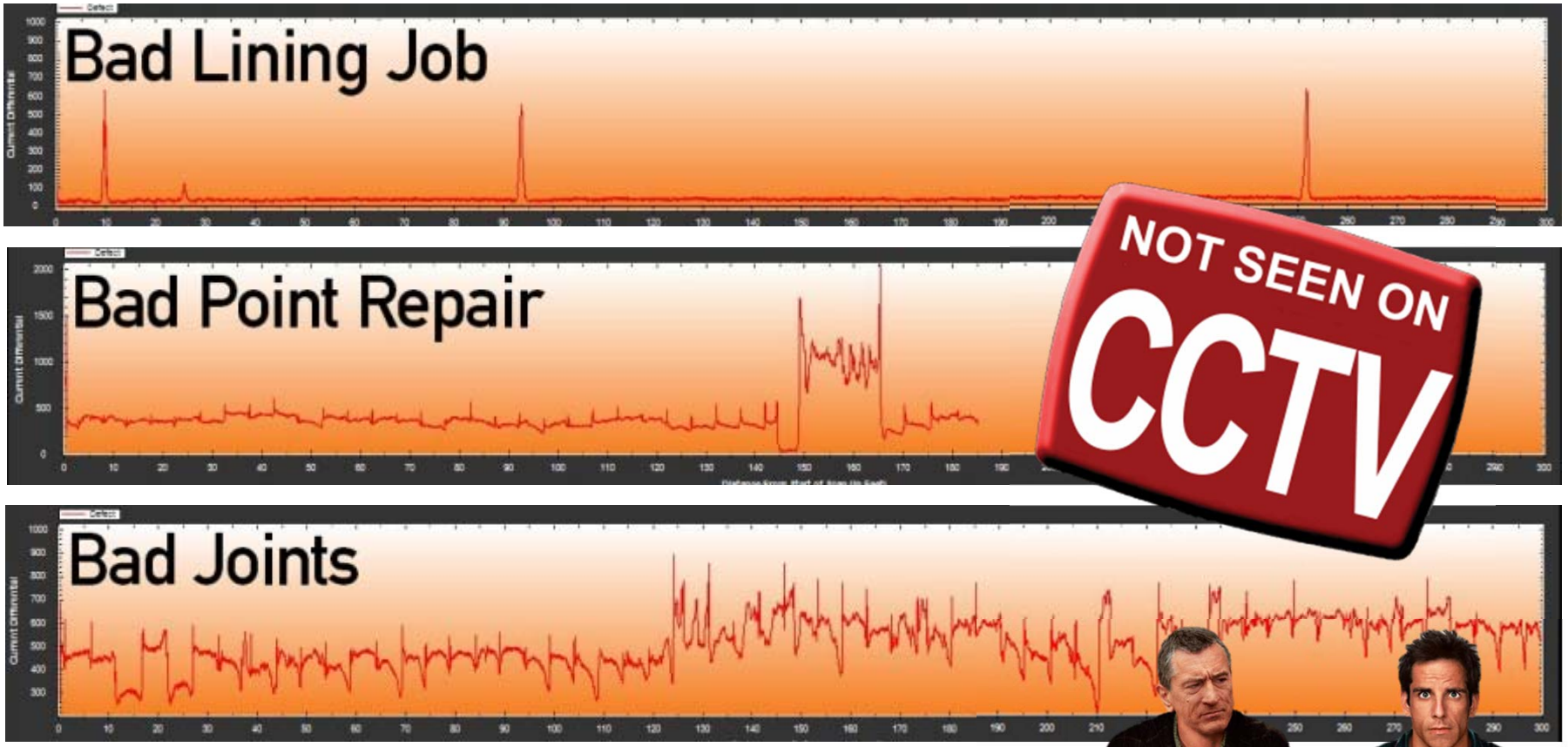


Source: EPA/600/R-11/078 | July 2011

PITFALL #17: FLAWED GRADING OF SEWER MAINS BY CCTV OPERATORS MAY BE TRANSFERRED INTO HYDRAULIC MODELING PROGRAMS GIVING INCORRECT OR INACCURATE PORTRAYAL OF BASINS AND SUB-BASINS REQUIRING REHABILITATION.



CCTV Cannot Identify & Quantify Defects, It Cannot See.



Electro Scan is the new Polygraph Test for Sewer Pipe Lining Jobs & Repairs.