International No-Dig 2019
37th International Conference and Exhibition
Florence, Italy
30th September – 2nd October 2019

WRc's Use of Focused Electrode Leak Location (FELL) to Assess Gravity Sewers in the United Kingdom, United States, and Germany, Before & After Trenchless Rehabilitation

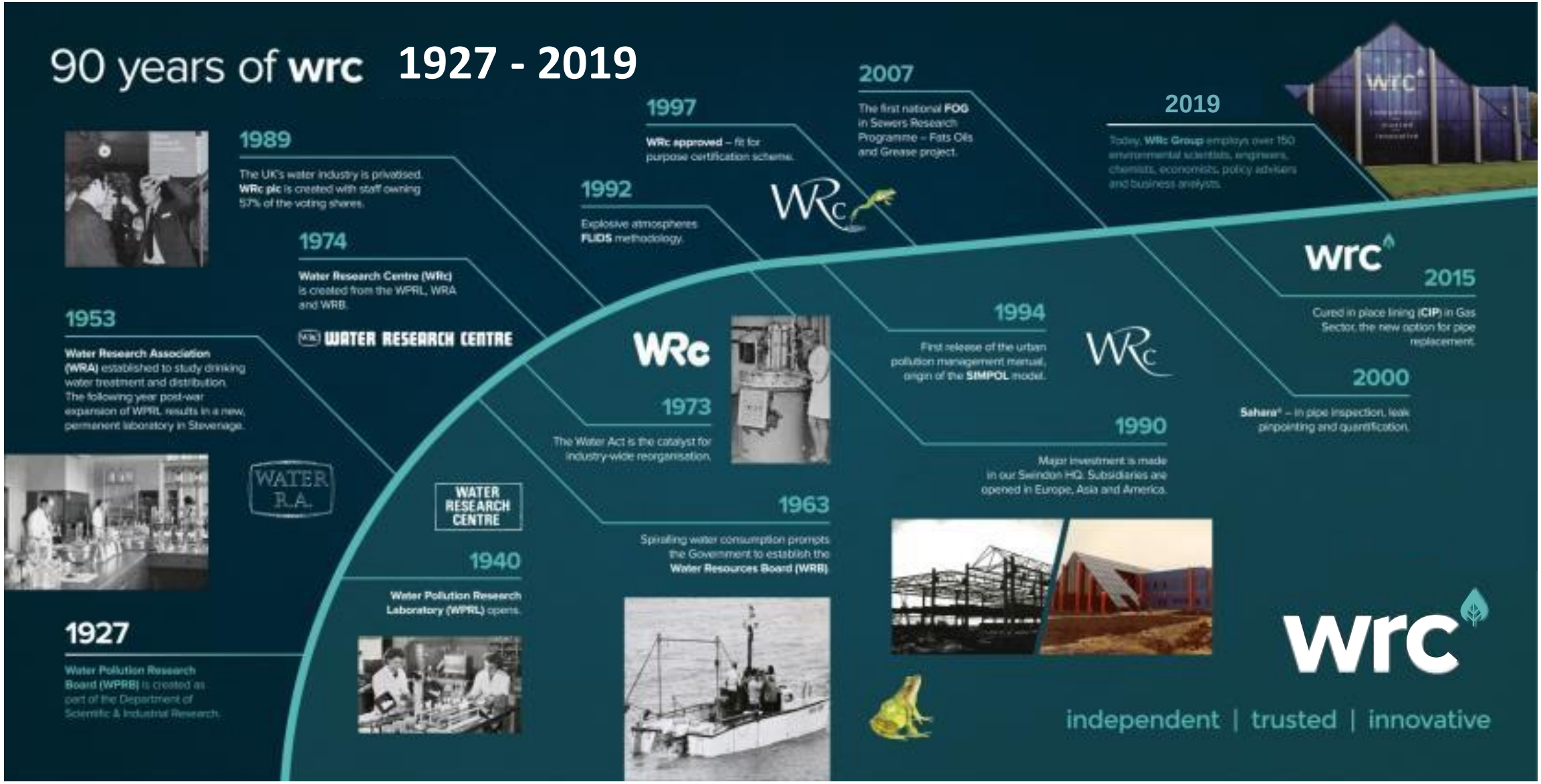
Paper Ref #2299

Peter Henley
Special Consultant
WRc plc

Chuck Hansen
Chairman
Electro Scan Inc.

British Perspective – Peter Henley

WRc – Our long history



group

Established leaders in innovation, we are trusted by a wide range of stakeholders to add value at every level.

water

Sustainable and robust solutions for water utilities, industry and regulators and their customers.

gas

Facilitating transformational change for the UK's gas distribution networks in the path to a low carbon future.

environment

Generating valuable evidence that transforms resource recovery in an evolving circular economy. Strategic consultancy, solutions and technologies to meet a wide range of environmental challenges.

network

Deployment of innovative technologies for inspection, monitoring and management of pipeline infrastructure.

The wrc Vision & Values

independent

Our independence is valued by all our stakeholders. Regardless of the changing demands of the commercial world, our independence is never compromised.

trusted

We have earned the trust of industry, government, academia and the public as a centre of excellence. This drives our continued commitment to deliver world class technical and scientific expertise.

innovative

Throughout our history, we have built our business upon science and engineering excellence, and a foundation of innovation. Whatever the challenge, we nurture and encourage collaboration and new ways of thinking.

"At WRc, we aim to add value in all that we do. We work with our clients to develop innovative and effective outcomes to help them meet their technical challenges and provide a world-class service to their customers"

Mark Smith
CEO, WRc plc

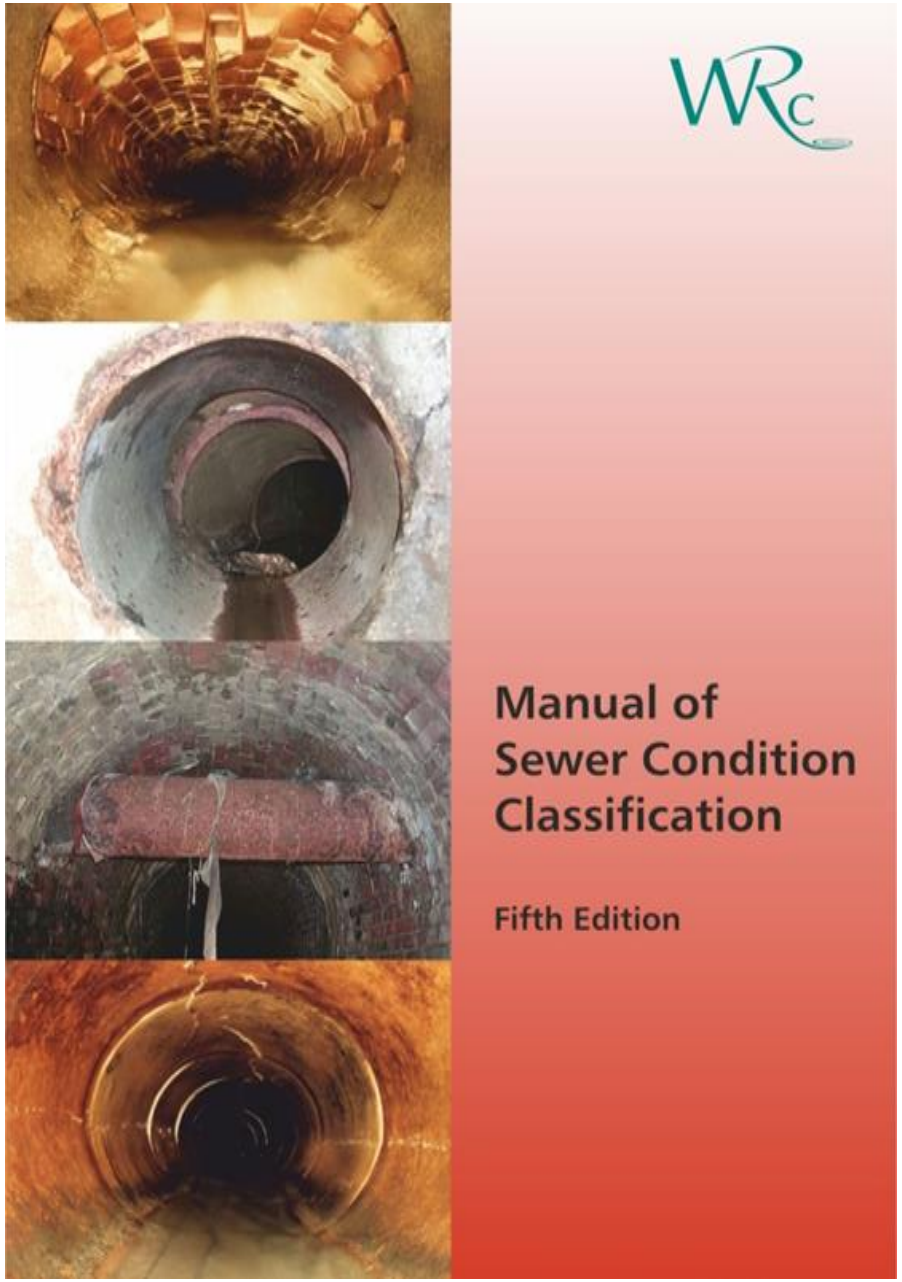
wrc

wrcplc.co.uk

independent | trusted | innovative

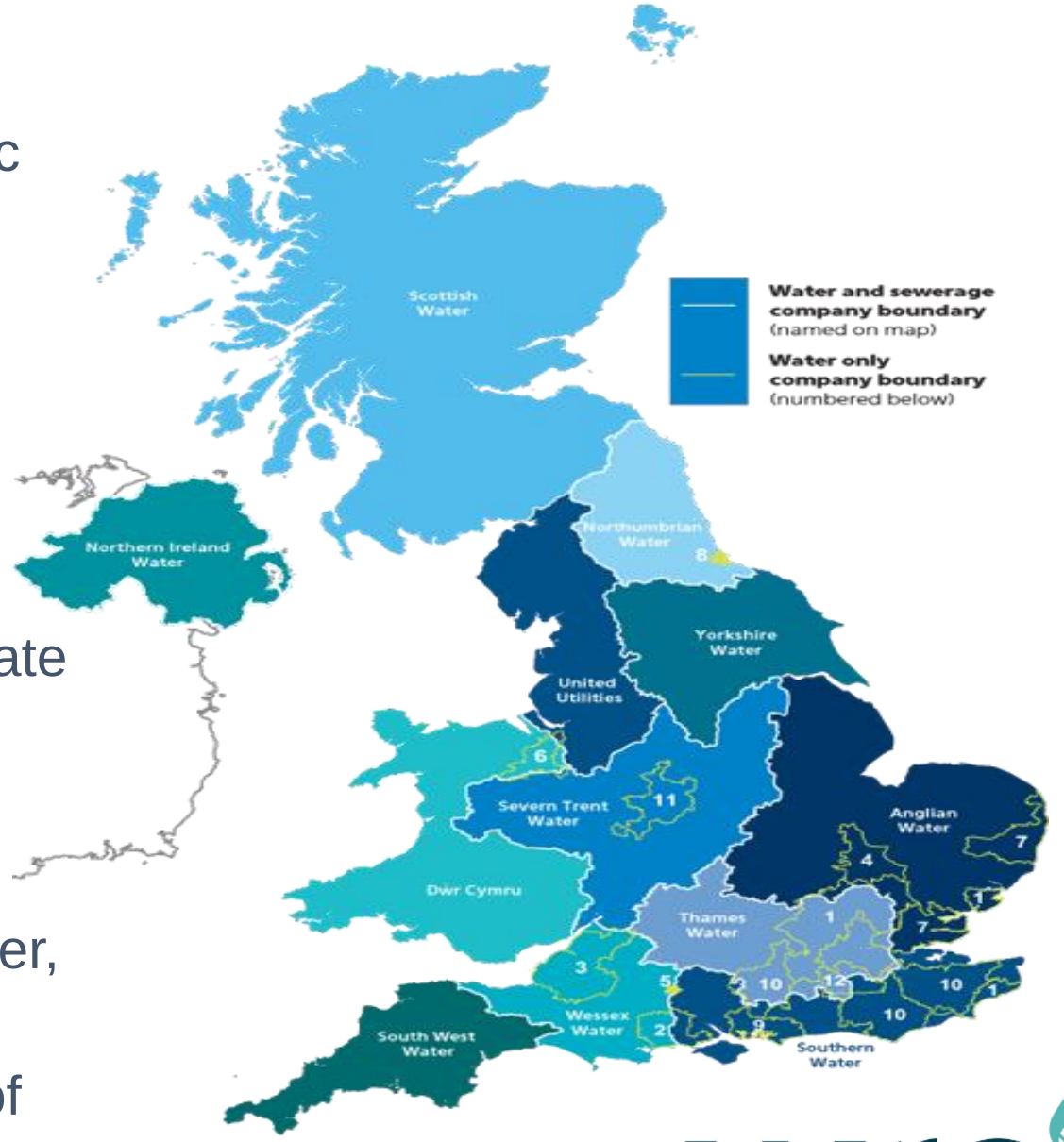
Manual of Sewer Condition Classification

- WRc have a long history of in assessing the condition of sewers using CCTV
- First MSCC published in 1980 most recent update published in 2013
- Globally recognised and amended for use in the US as the NASSCO PACP standard
- WRc took the step in 2015 to work with Electro Scan Inc. to tackle infiltration

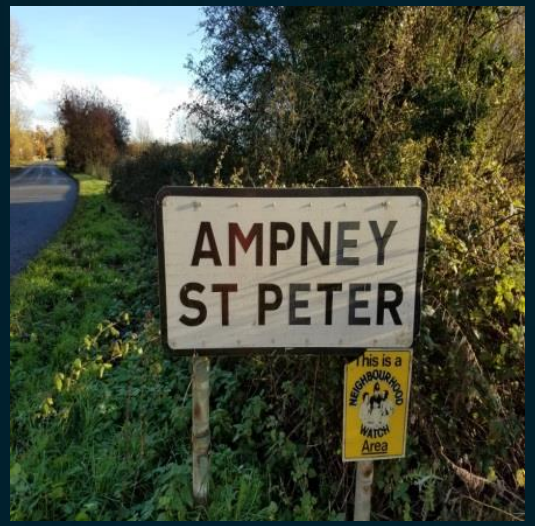


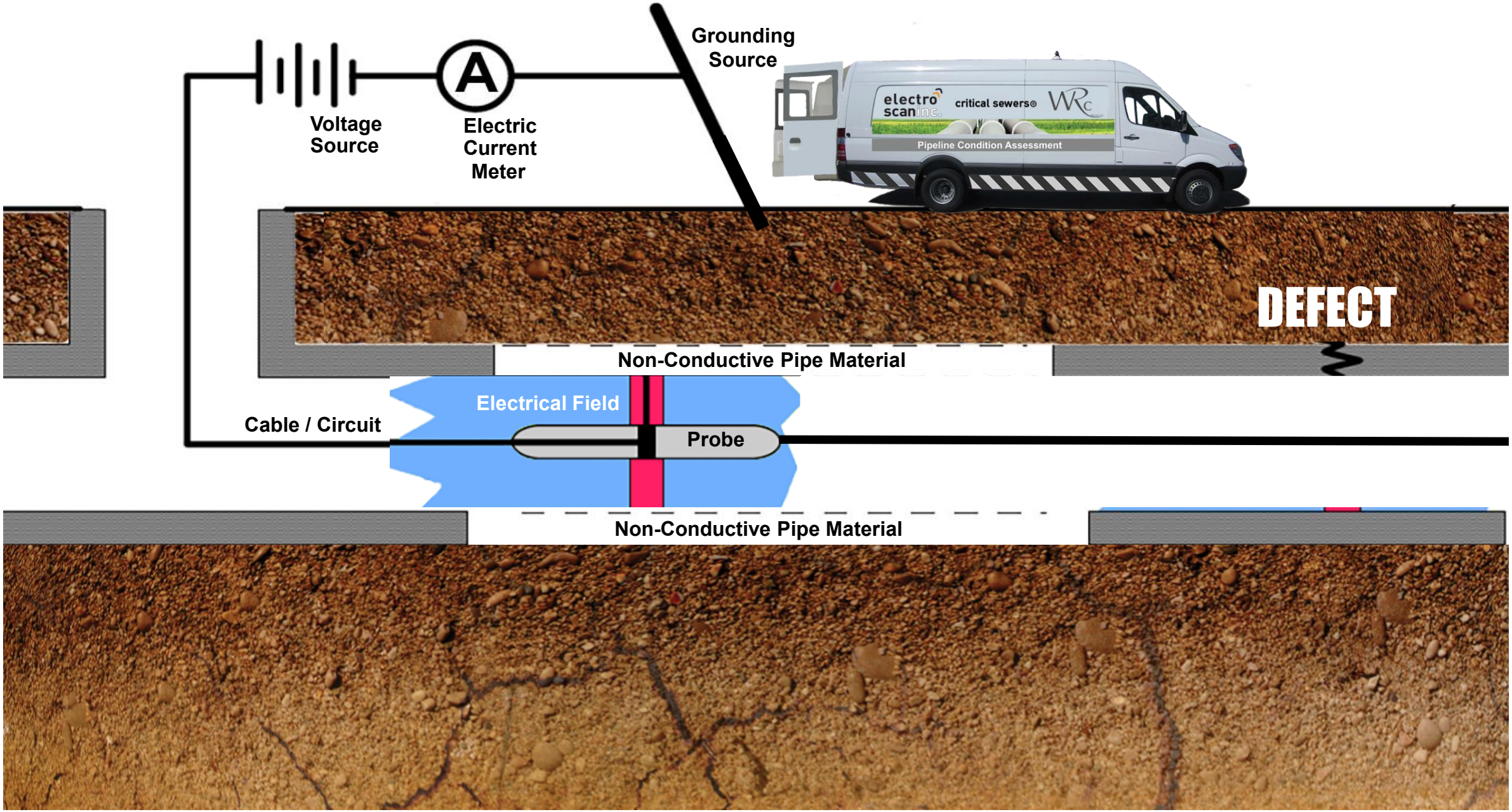
Infiltration in the UK

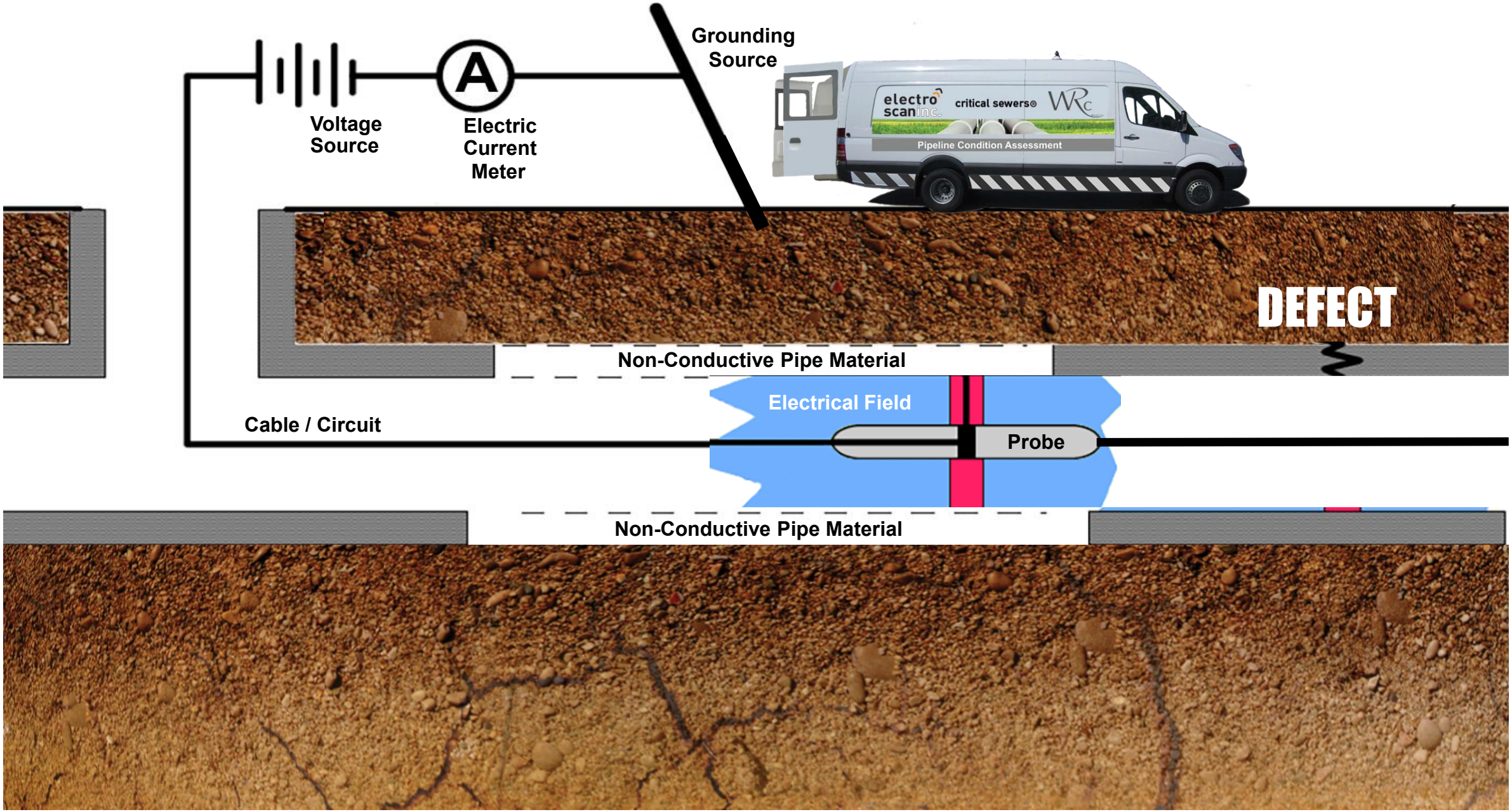
- Wet winters in 2012 and 2013 flagged to WRc the need to tackle ground water infiltration
- CCTV provides some of the answers to pinpointing infiltration
- WRc researched the market and decided Electro Scan provided the best inspection solution
- Strategic alliance announced in 2015 to operate Electro Scan exclusively in the UK
- To date we have completed 15 surveys and have scanned in excess of 40kms
- Key clients are Thames Water, Southern Water, Wessex Water and Anglian Water
- Future surveys planned in 2018 for 100kms of sewer inspection



WRc | Electro Scan – Ampney St Peter




Grounding Source
Voltage Source
A
Electric Current Meter
electro scan inc.
critical sewers®
WRc
Pipeline Condition Assessment
DEFECT
Non-Conductive Pipe Material
Electrical Field
Cable / Circuit
Probe
Non-Conductive Pipe Material


Grounding Source
Voltage Source
A
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electro scan inc.
critical sewers®
WRc
Pipeline Condition Assessment
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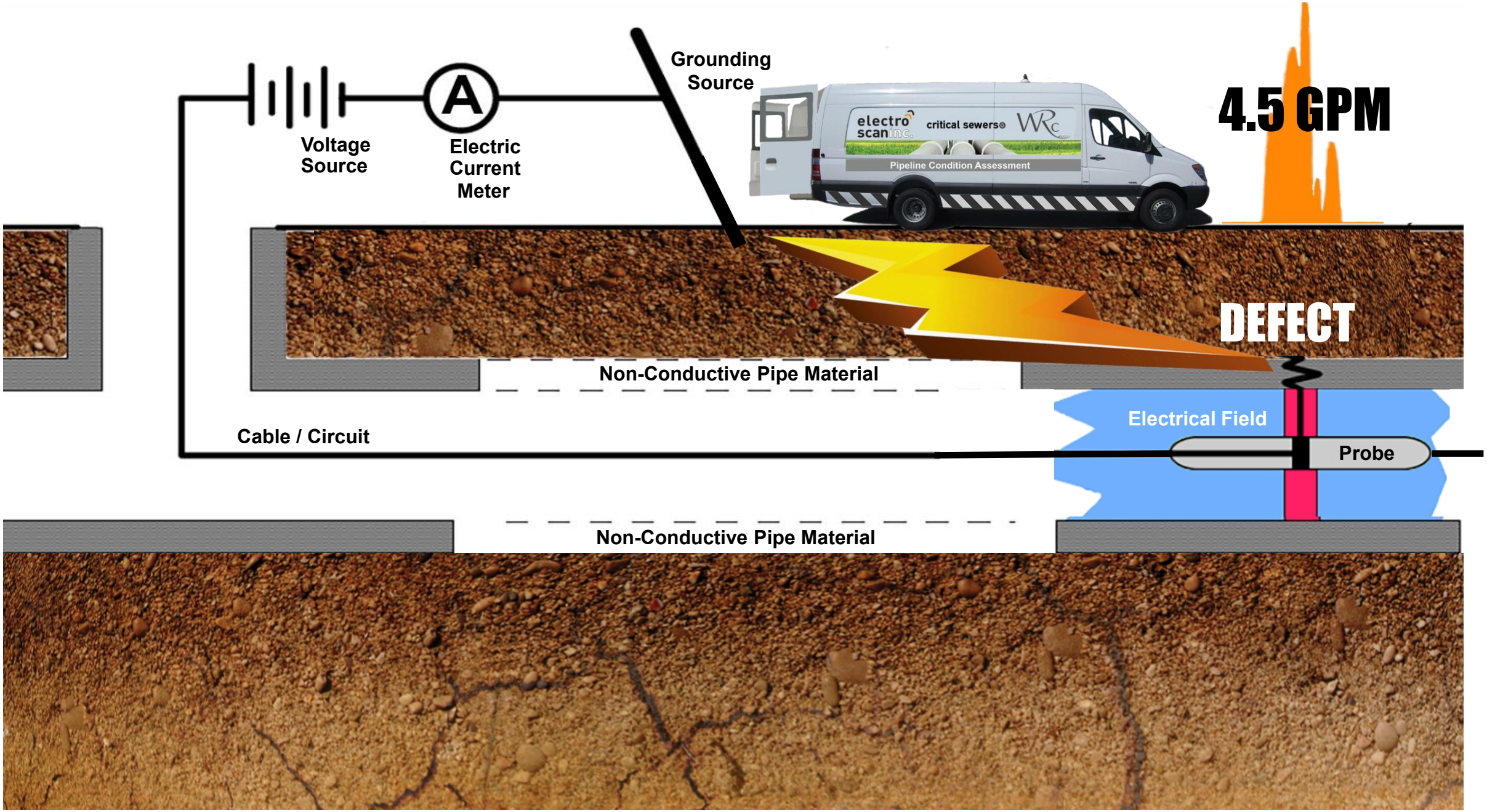
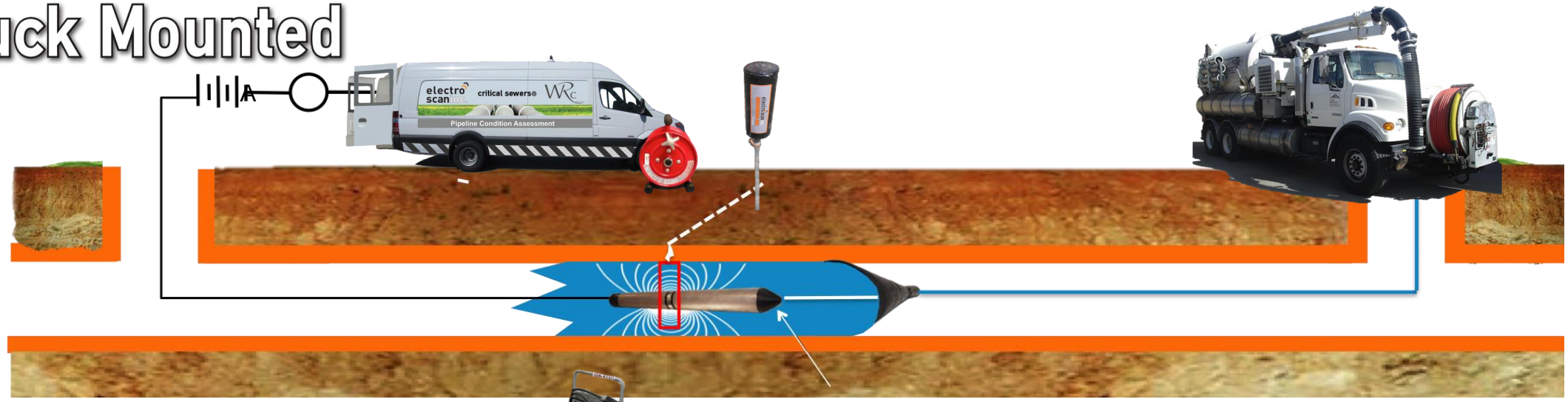
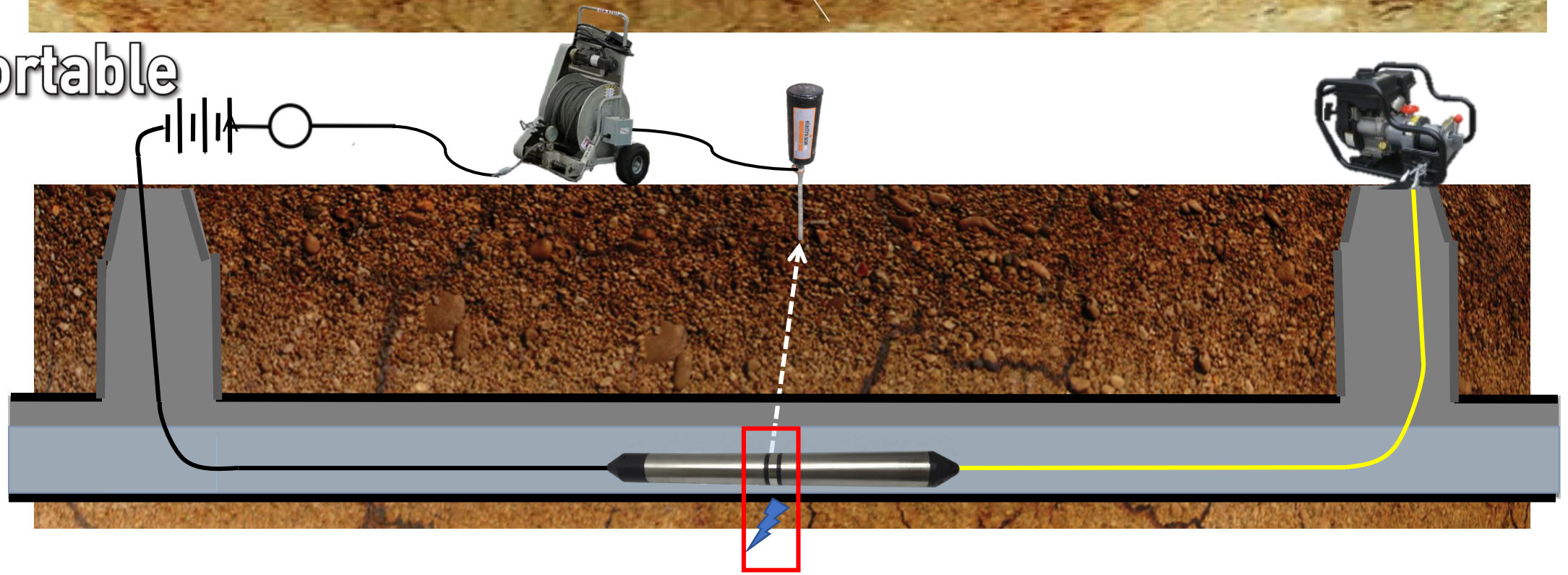

Grounding Source
Voltage Source
A
Electric Current Meter
electro scan inc.
critical sewers®
WRc
Pipeline Condition Assessment
4.5 GPM
DEFECT
Non-Conductive Pipe Material
Electrical Field
Probe
Cable / Circuit
Non-Conductive Pipe Material

Common Field Set-Ups for Electro Scanning

A Truck Mounted



B Portable



Project Highlights

- 614 metres of survey completed
- 60 individual defects identified using Electro Scan FELL
- CCTV survey initially failed to identify any major defects
- 155,606 litres per day of inflow

Electro Scanning Inspection
Ampney St. Peter Project Results from Nov. 18, 2016

Number of Defects				Liters Per Minute					
Small	Medium	Large	Total	Minor Defect Flow	Moderate Defect Flow	Severe Defect Flow	Total Defect Flow	% of Total Defect Flow	Total LPD
57	0	3	60	0.85	0.97	0.00	1.80	100%	155,606

DEFECTS	
S	7
M	0
L	3

% OF DEFECT LENGTHS	
Small Defects	0.000800
Medium Defects	0.000000
Large Defects	0.003200
All Defects	0.004000

LPS SUMMARY	
Minor LPS	0.07
Moderate LPS	0.54
Severe LPS	0.00
Total LPS	0.62
LPD	53,311
LPD IDM	6,085
Minor LPS %	11.76%
Moderate LPS %	88.24%
Severe LPS %	0.00%

DIAMETER & DISTANCE

150

94

0 20 40 60 80

Distance (m)

OPERATOR INFO

WRc

Project

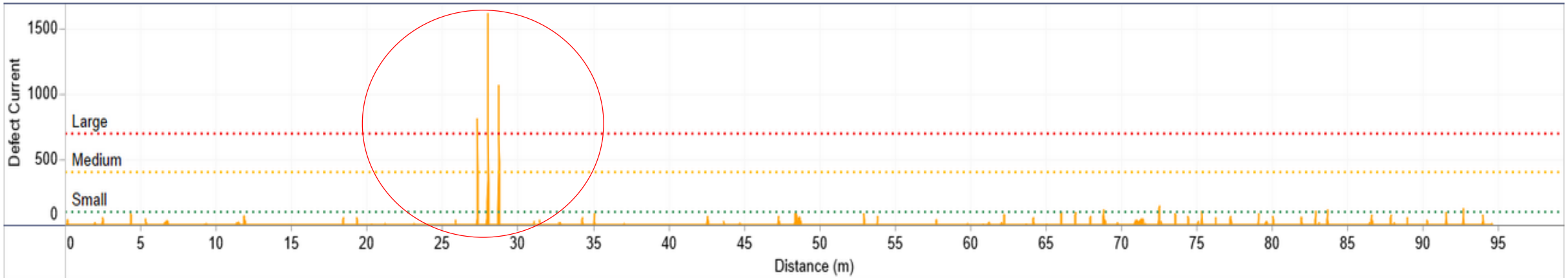
Ampney St. Peter

Job

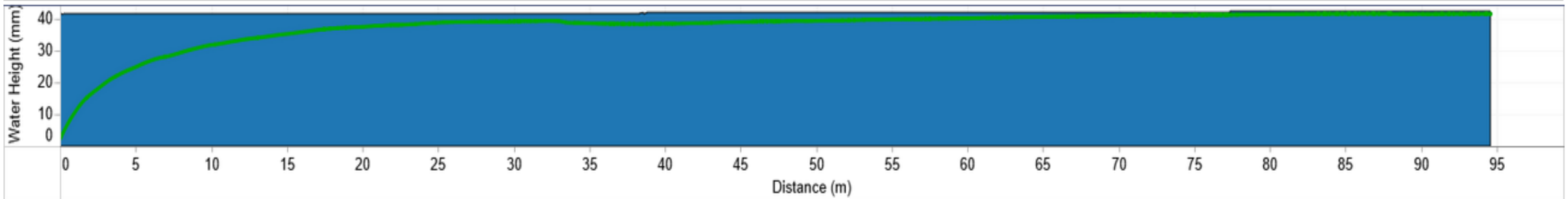
Ampney St. Peter

Atmospheric Test	Scan Start
11/18/2016 7:28:24 AM	11/18/2016 7:30:35 AM

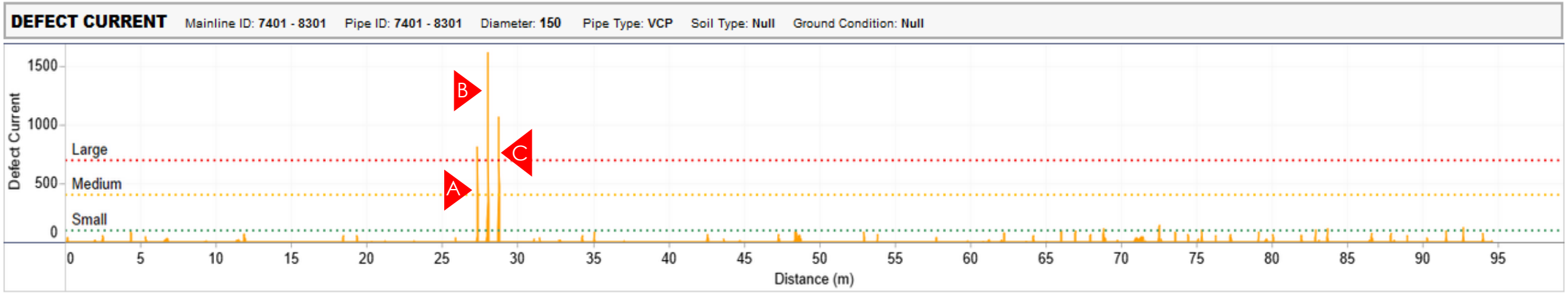
DEFECT CURRENT Mainline ID: **7401 - 8301** Pipe ID: **7401 - 8301** Diameter: **150** Pipe Type: **VCP** Soil Type: **Null** Ground Condition: **Null**

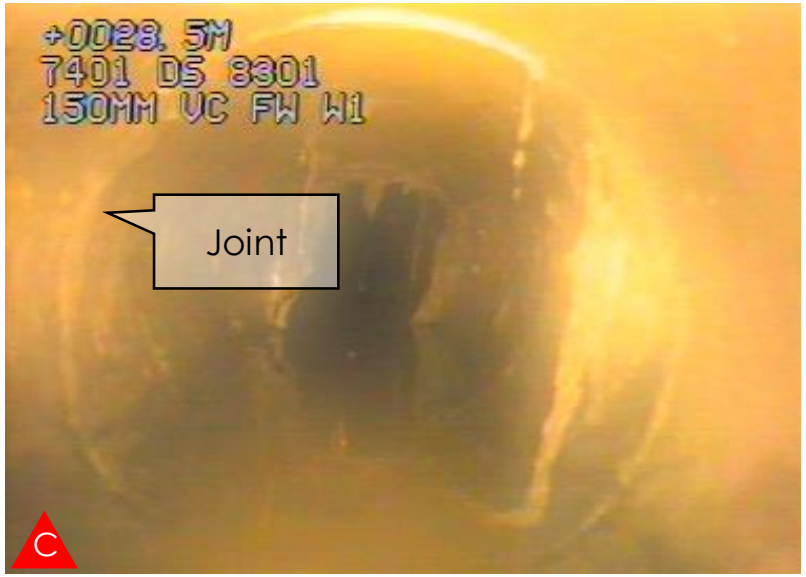


WATER HEIGHT AND PROBE SPEED Mainline ID: **7401 - 8301** Pipe ID: **7401 - 8301** Diameter: **150** Pipe Type: **VCP** Soil Type: **Null** Ground Condition: **Null**



7401 – 8301: CCTV Comparisons





Project Summary

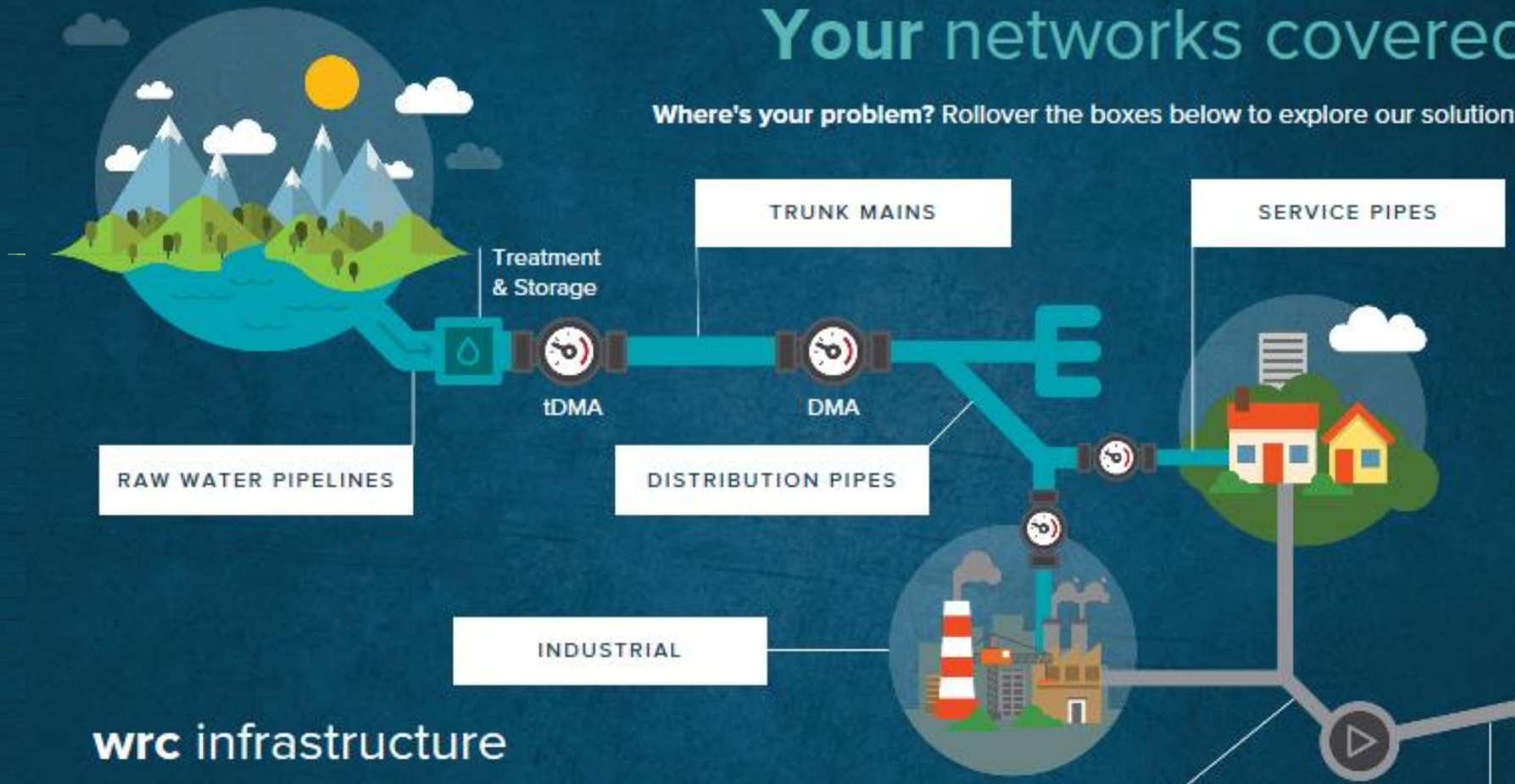
- Electro Scan was easy to use and has few operational issues
- Results are consistent and show repeatability
- Identifies Infiltration sources where CCTV fails
- Not dependent on weather or ground water levels
- Doesn’t replace Visual Inspection but provides an addition to the engineers tool box to find & quantify leaks.

wrc infrastructure

Networks Solutions Technologies Resources About Contact

Your networks covered

Where's your problem? Rollover the boxes below to explore our solutions.

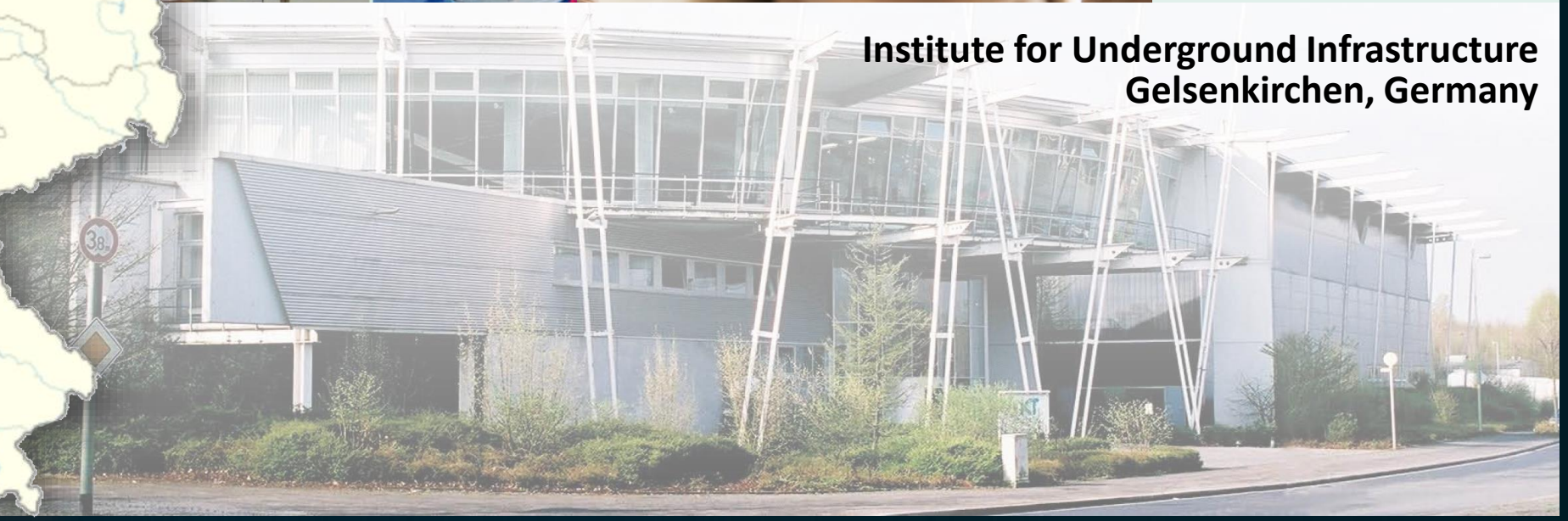


wrc infrastructure

We are a world leader in the development and application of innovative technologies for the inspection, assessment monitoring and management of pipeline infrastructure.

wrc

WRc | Electro Scan Testing



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Short Liner Lateral CIPP Testing

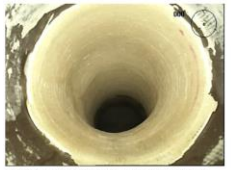


Bild 21 Dicht saniertes Schadensbild (keine Auffälligkeiten)

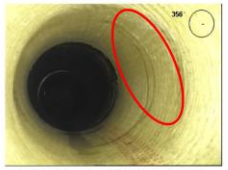


Bild 22 Feuchtigkeit ohne Infiltration

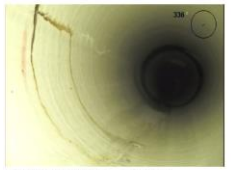


Bild 23 Verfärbung, Beispiel 1


Bild 24 Verfärbung, Beispiel 2


Bild 25 Fließen

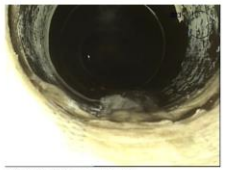


Bild 26 Wasserschwall

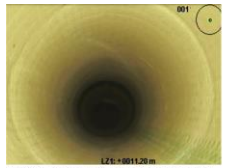


Bild 15 Dicht saniertes Schadensbild (keine Auffälligkeiten)

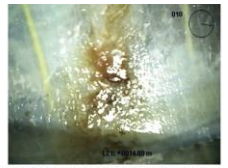


Bild 16 Feuchtigkeit und Verfärbung

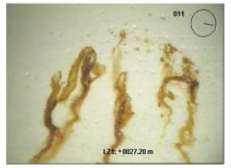


Bild 17 Verfärbung


Bild 18 Tropfen


Bild 19 Fließen

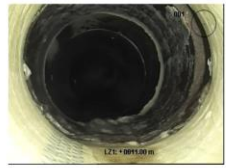


Bild 20 Wasserschwall

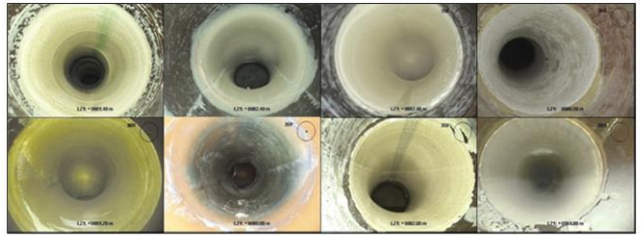
IKT - Institut für Unterirdische Infrastruktur,
Gelsenkirchen
www.ikt.de

neutral
unabhängig
gemeinnützig

IKT-Warentest

„Kurzliner für Hausanschlüsse“

- Auszug aus dem Forschungsbericht -



Gelsenkirchen, Oktober 2018

Field Photos: 19 & 20 September 2017

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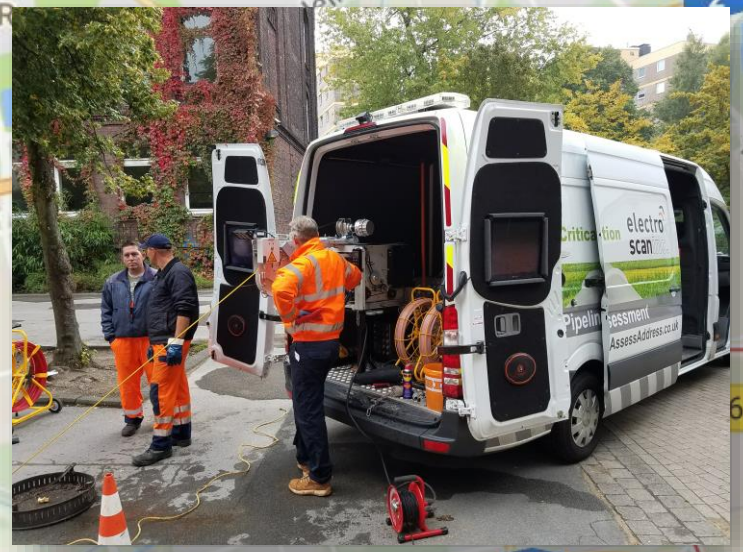
electro scan inc.

wrc

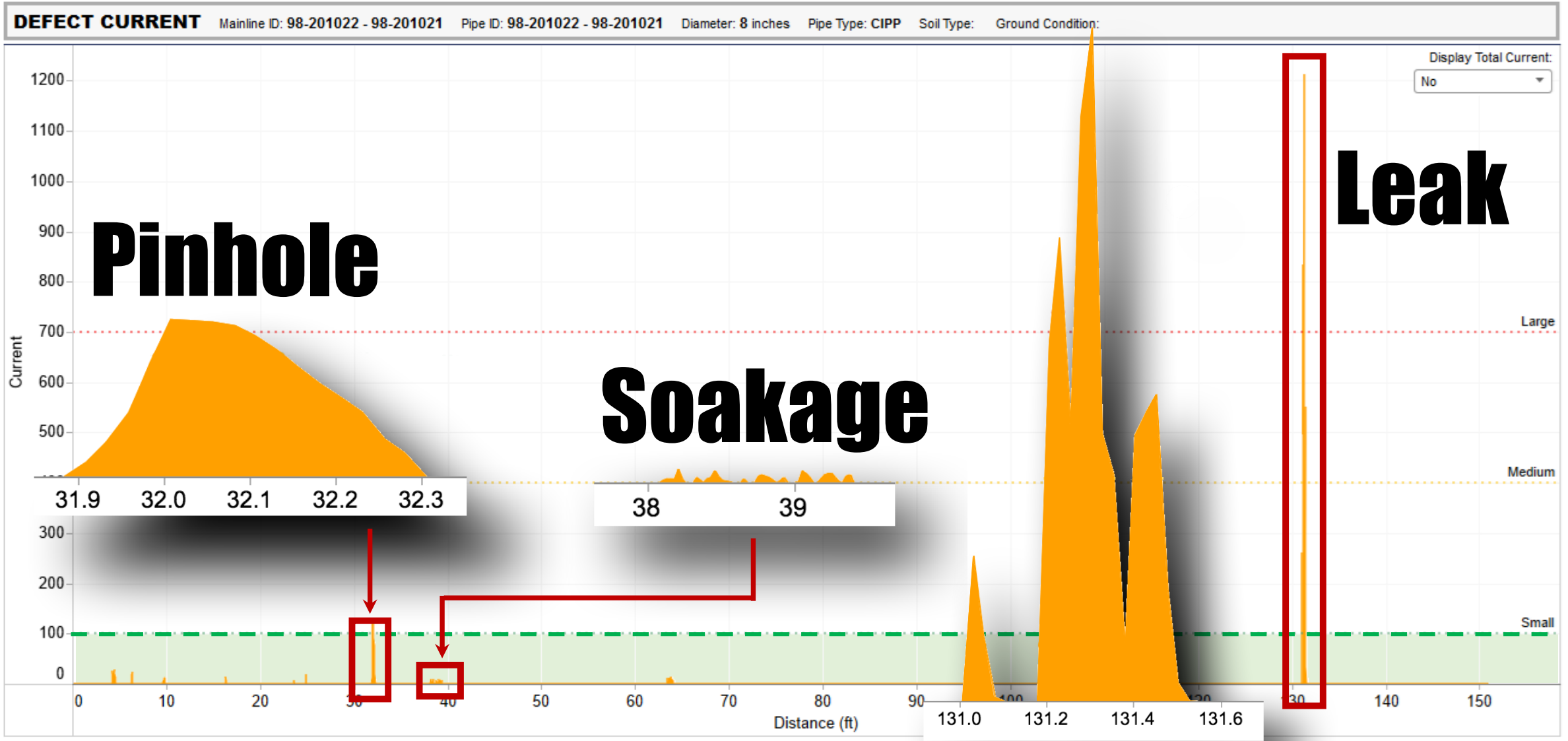
Day One – Herne, Germany – “Local Sectional CIPP”



Ewaldstraße
Wiedehopfstraße
Cranger Str.
Bochumer Str.
Marienstraße
Victorstraße
Baukau
Crange
Wanne
Herne
Westring
Hölkeskampring
Gysenbergpark
Uferstraße
Berliner Str.
Hauptstraße
L639
Gelsenkirchen
BULMKE-HÜLLEN
ALTSTADT
Hofstraße
HOFSTEDE
RIEMKE
Herner Str.
Poststraße
Harpener
2
42
227
43
226

Day Two – Gelsenkirchen, Germany – “Lab CIPP Testing”

3 Kinds of Defects Found During Testing



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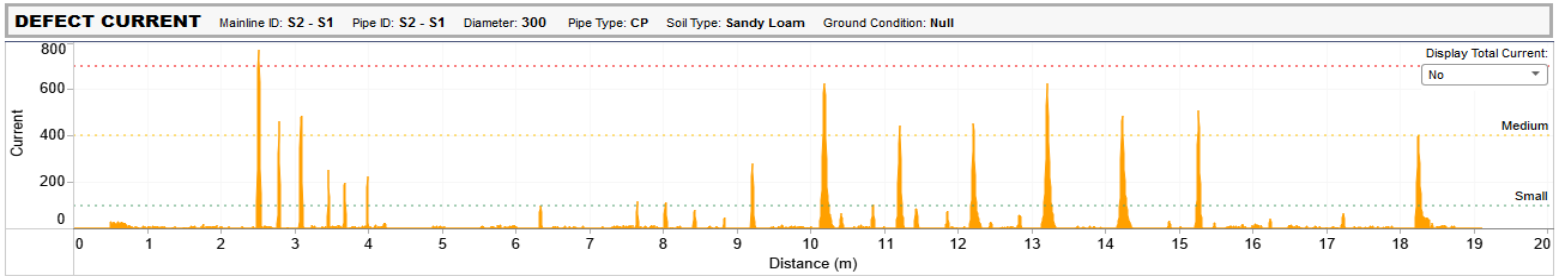
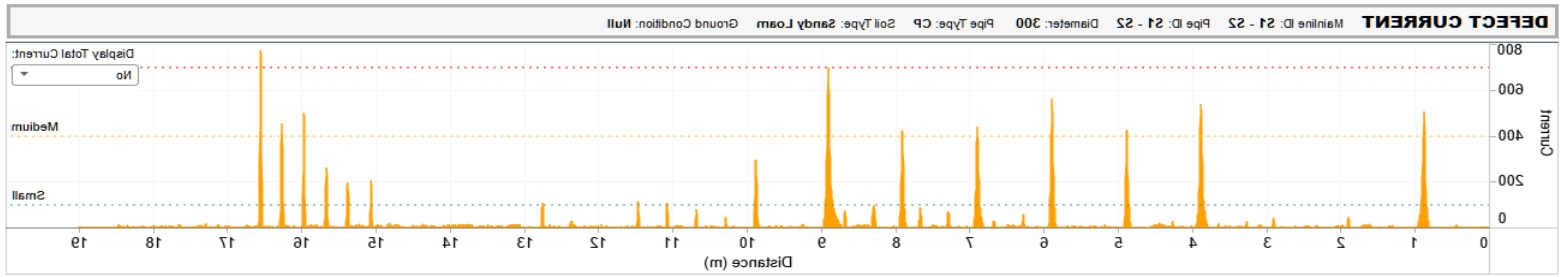
Each Survey Tested for Repeatability

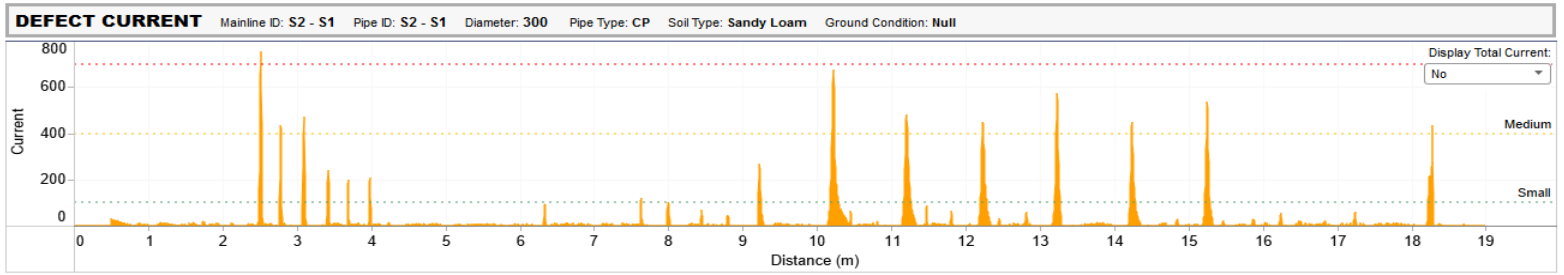
Scan 1
Upstream



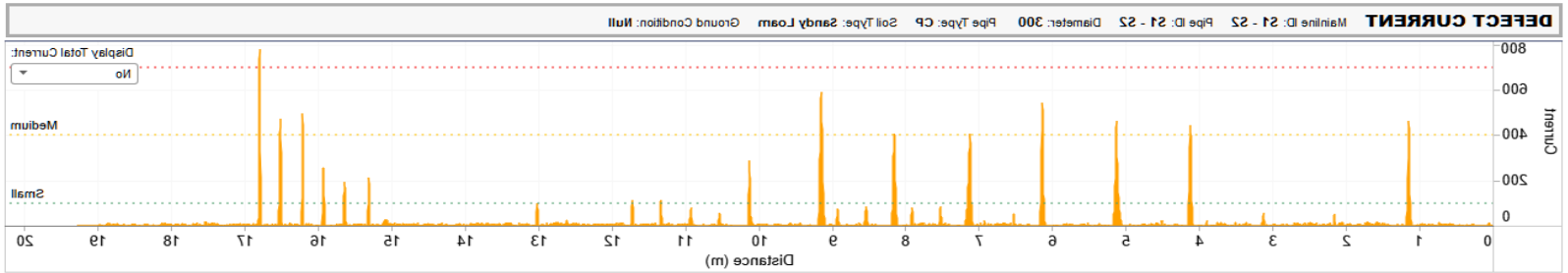
Scan 2
Downstream

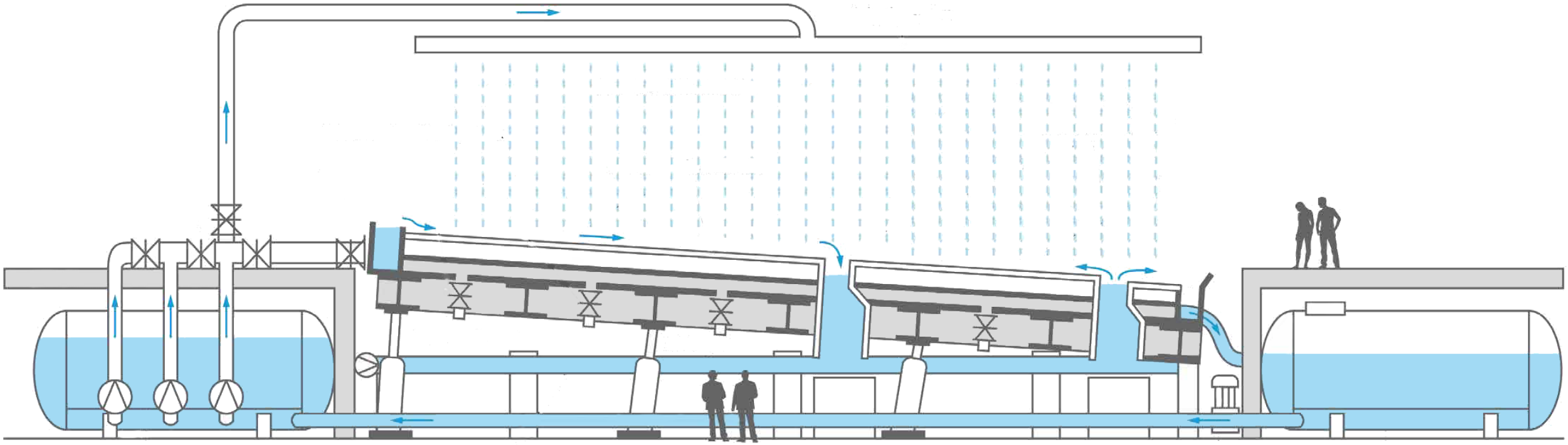


Scan 3
Upstream



Scan 4
Downstream





American Perspective – Chuck Hansen

electro scan inc.

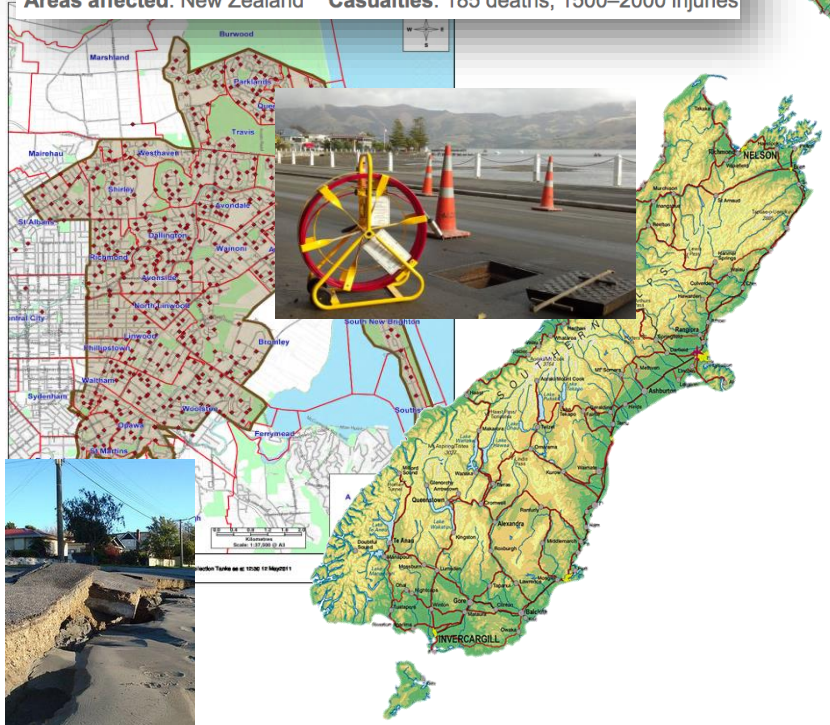
HANSEN
Hansen Analytics, LLC

2012

New Zealand

Magnitude: 6.3 M_L **Date**: 22 February 2011, 12:51 pm NZDT

Areas affected: New Zealand **Casualties**: 185 deaths; 1500–2000 injuries



England

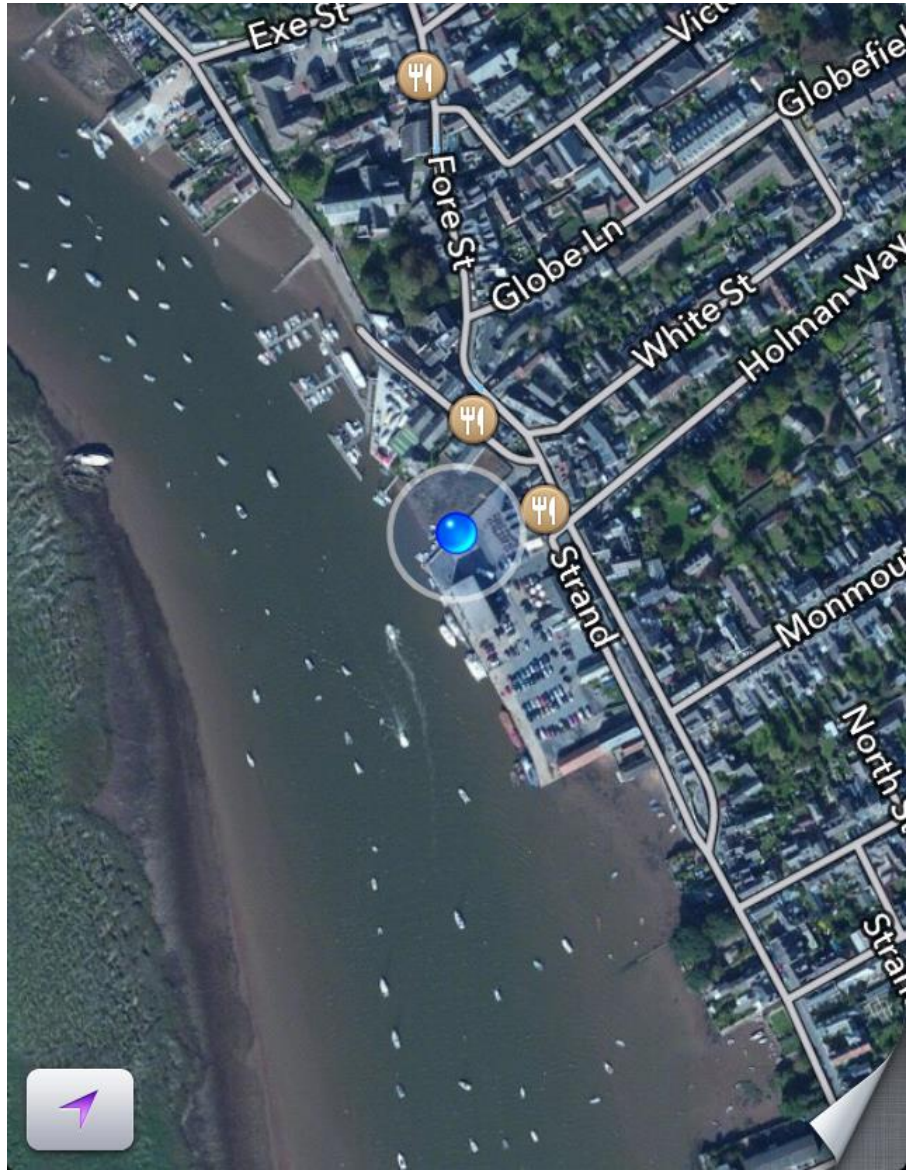
Wessex Water
a YTL company

SOUTH WEST WATER

Japan

株式会社カンツール

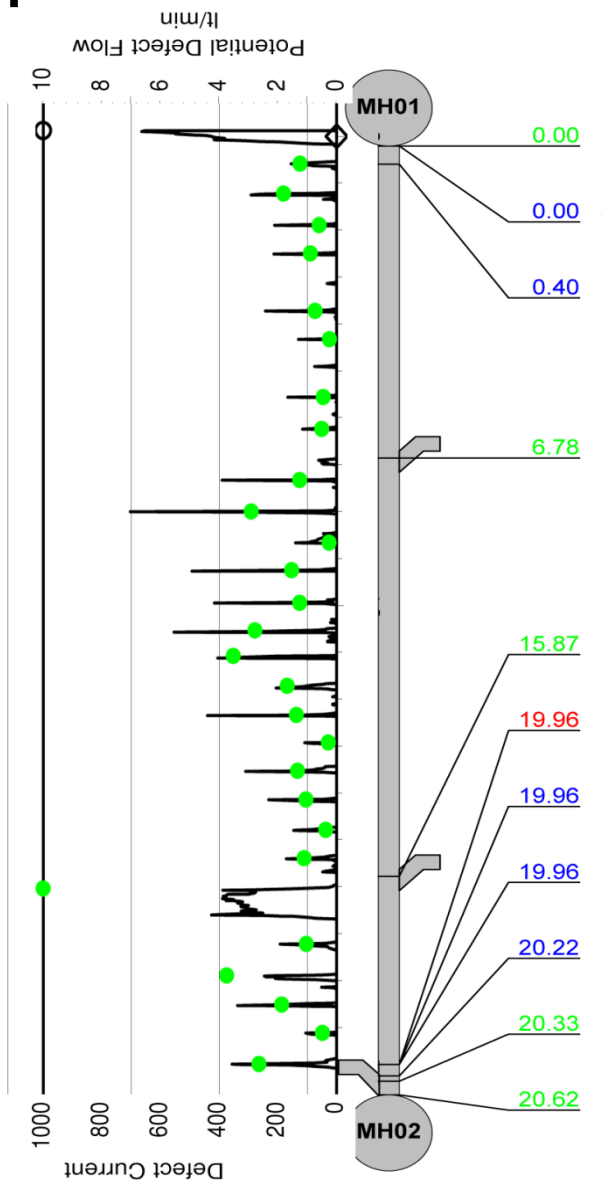
Topsham Demonstration 8 Nov 2012



Topsham Demonstration 8 Nov 2012

Topsham Demonstration 8 Nov 2012

Electro Scan and CCTV Comparison



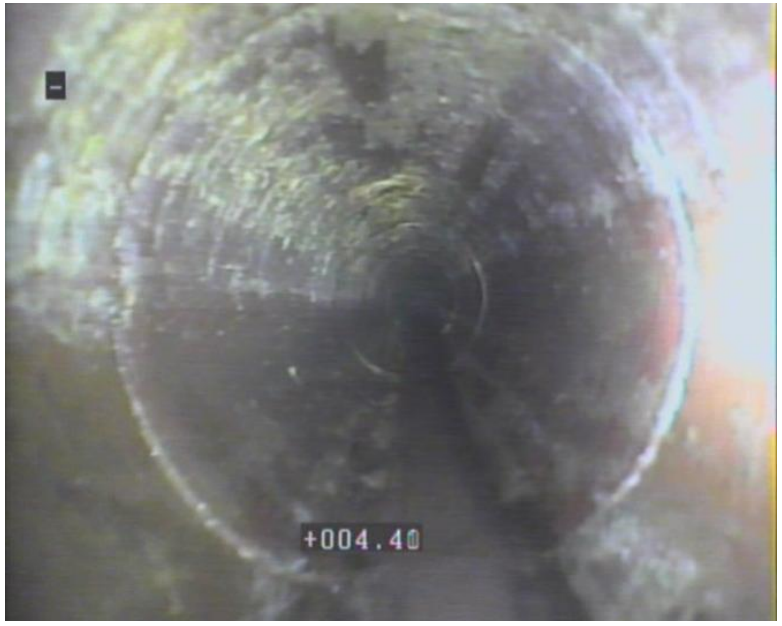
0.00		MH	Start node type, manhole, reference number : MH01	00:00:00	(Constr) 0
0.00	S01	DEG	Attached deposits, grease, from 6 to 5 o'clock, 5% cross-sectional area loss, Start	00:00:00	(Serv) 3
0.40		WL	Water level, 5% of the vertical dimension	00:00:12	(Serv) 0
6.78		JN	Junction, at 9 o'clock, diameter 100mm	00:01:58	(Constr) 0
15.87		JN	Junction, at 10 o'clock, diameter 100mm	00:04:22	(Constr) 0
19.96		OJM	Open joint, medium	00:05:33	(Struct) 1
19.96		DEE	Attached deposits, encrustation, from 7 to 11 o'clock, 5% cross-sectional area loss	00:05:33	(Serv) 3
19.96		DEE	Attached deposits, encrustation, from 3 to 5 o'clock, 5% cross-sectional area loss	00:05:33	(Serv) 3
20.22	F01	DEG	Attached deposits, grease, from 6 to 5 o'clock, 5% cross-sectional area loss, End	00:06:22	(Serv) 3
20.33		JN	Junction, at 3 o'clock, diameter 100mm	00:06:22	(Constr) 0
20.62		MHF	Finish node type, manhole reference number: MH02	00:06:47	(Constr) 0

Topsham Demonstration 8 Nov 2012

Defect Identified: Joint Defect
CCTV Call Out: None

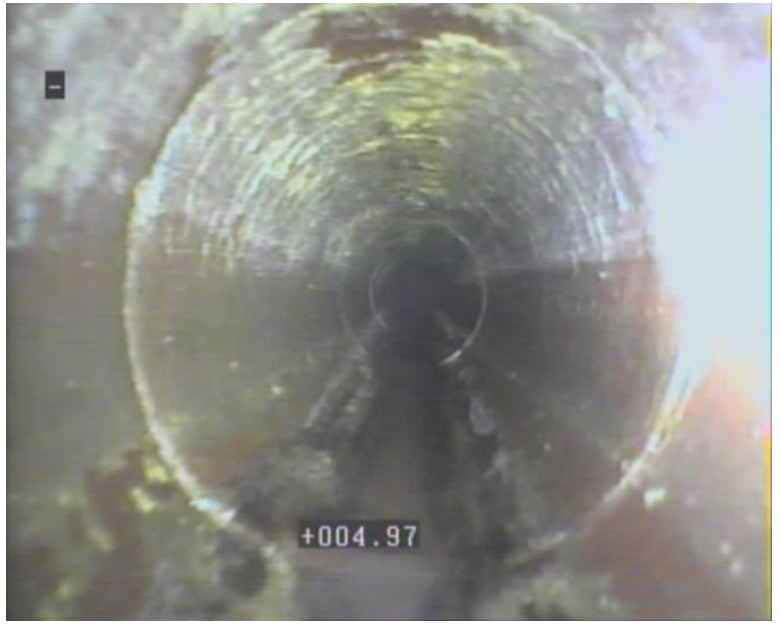
Defect Start (m)	Defect End (m)	Defect Length (mm)	Defect Max Current	Defect Severity
3.951	3.951	0	161	S

Defect Identified: Joint Defect
CCTV Call Out: None



Defect Start (m)	Defect End (m)	Defect Length (mm)	Defect Max Current	Defect Severity
4.563	4.563	0	116	S

Defect Identified: Joint Defect
CCTV Call Out: None



Defect Start (m)	Defect End (m)	Defect Length (mm)	Defect Max Current	Defect Severity
5.072	5.072	0	112	S

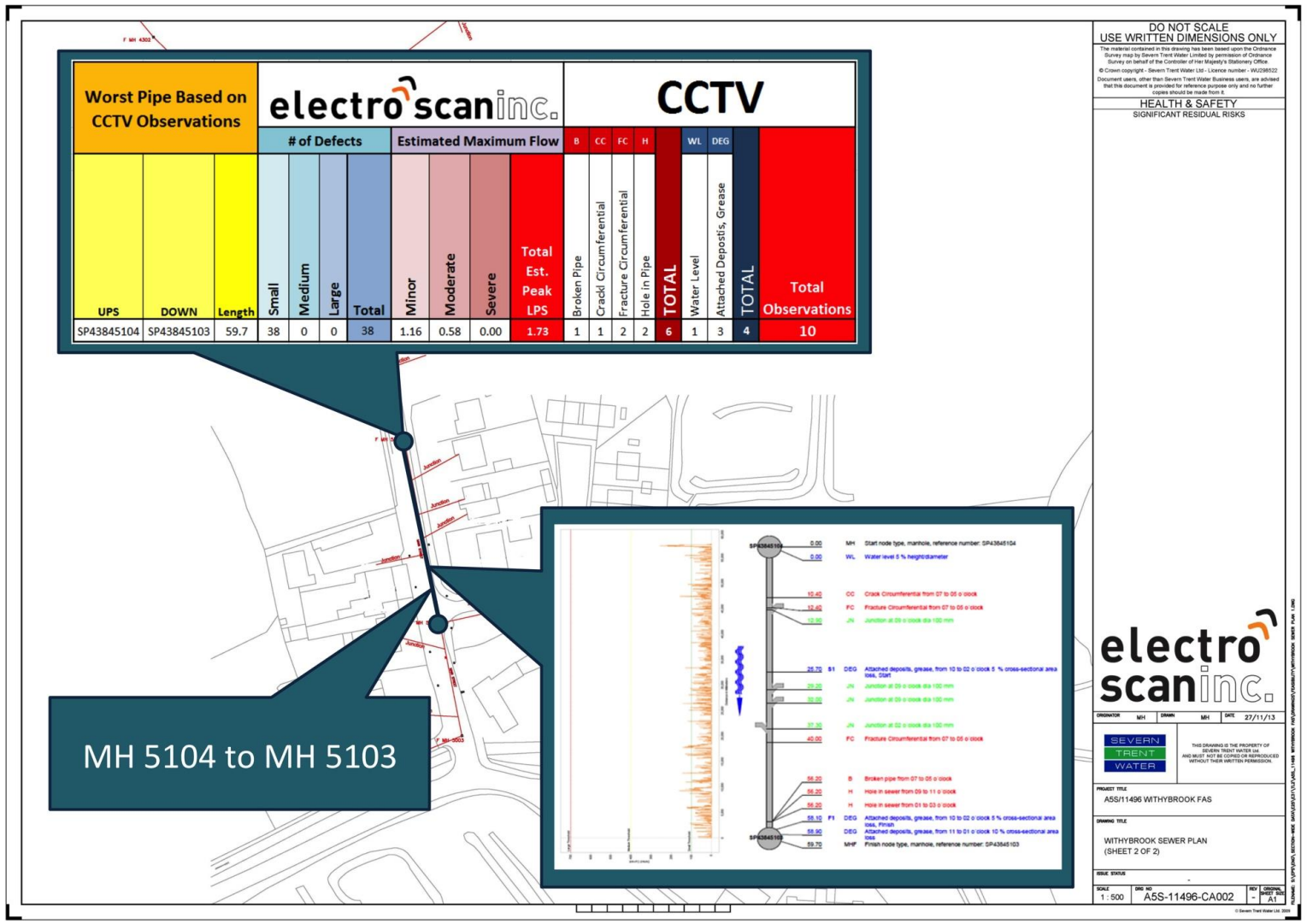
Withybrook, England

Electro Scan Product Trial

Presented to Severn Trent Services

Birmingham, England

‘Worst Pipe’ Based on CCTV Observations



Worst Pipe Based on CCTV Observations — electro scan inc. — CCTV

UPS	DOWN	Length	# of Defects: Small	Medium	Large	Total	Estimated Maximum Flow: Minor	Moderate	Severe	Total Est. Peak LPS	CCTV: B Broken Pipe	CC Crackl Circumferential	FC Fracture Circumferential	H Hole in Pipe	TOTAL	WL Water Level	DEG Attached Deposits, Grease	TOTAL	Total Observations
SP43845104	SP43845103	59.7	38	0	0	38	1.16	0.58	0.00	1.73	1	1	2	2	6	1	3	4	10

MH 5104 to MH 5103

DO NOT SCALE
USE WRITTEN DIMENSIONS ONLY

HEALTH & SAFETY
SIGNIFICANT RESIDUAL RISKS

electro scan inc.

PROJECT TITLE: A5S/11496 WITHYBROOK FAS

DRAWING TITLE: WITHYBROOK SEWER PLAN (SHEET 2 OF 2)

SCALE 1 : 500 | DRG NO A5S-11496-CA002 | REV - | ORIGINAL SHEET SIZE A1

Severn Trent Water Ltd

OnSite

OnSite Central Limited
Blackpole, Worcester
Worcestershire WR3 8TJ
Tel: , Fax:

Project-information

Project name:	Contract number:	Contact:	Date:
A5S/11496 Withybrook FA	C52021	Gary Kinley	03/07/2013

Client: Severn Trent Water Ltd
Contact: Gary Kinley
Position:
Road
Town
County: Longbridge Office, Stratford Road
Telephone:
Fax:
Mobile:
E-Mail:

Site
Contact:
Position:
Road
Town
County
Telephone:
Fax:
Mobile:
E-Mail:

Contractor
Contact:
Position:
Road
Town
County
Telephone:
Fax:
Mobile:
E-Mail:

Inspection report

Date:	Job N°:	Weather:	Operator:	section number:	PLR:
05/06/2013	C52021	No rain or snow	MH	4	SP43845403X
Video Volume No.:	Flow Ctrl:	Temperature:	Year laid:	Cleaned:	Strat. Drain:
00001	No flow control	above freezing	Z	No	not known

Road:	OVERSTONE ROAD	Div/Dist:	start MH: SP43845403
Place:	WHITHYBROOK	Drain. Area:	end MH: SP43845301
Location:	Road	Standard: BS EN 13508-2:2003	Total length: 47 m
Purpose:	Other	Shape/Size:	Circular 150
Type:	Gravity drain/sewer	Material:	Vitrified clay (i.e. all clayware) Pipe length: 1.8m
Use:	Foul	Lining:	
Comment:		Lining Type:	

Severn Trent Water Ltd

OnSite

OnSite Central Limited
Blackpole, Worcester
Worcestershire WR3 8TJ
Tel: , Fax:

Inspection report

Date:	Job N°:	Weather:	Operator:	section number:	PLR:
05/06/2013	C52021	No rain or snow	MH	14	SP43844301X
Video Volume No.:	Flow Ctrl:	Temperature:	Year laid:	Cleaned:	Strat. Drain:
00001	No flow control	above freezing	Z	No	not known

Road:	MAIN STREET	Div/Dist:	start MH: SP43844301
Place:	WHITHYBROOK	Drain. Area:	end MH: SP43844302
Location:	Road	Standard: BS EN 13508-2:2003	Total length: 42.8 m
Purpose:	Other	Shape/Size:	Circular 150
Type:	Gravity drain/sewer	Material:	Vitrified clay (i.e. all clayware) Pipe length: 1m
Use:	Foul	Lining:	
Comment:		Lining Type:	

1:275 positi

Depth: 1.42

SP43845403

Structural Defects
Service Defects

Severn Trent Water Ltd

OnSite

OnSite Central Limited
Blackpole, Worcester
Worcestershire WR3 8TJ
Tel: , Fax:

Inspection report

Date:	Job N°:	Weather:	Operator:	section number:	PLR:
05/06/2013	C52021	No rain or snow	MH	14	SP43844301X
Video Volume No.:	Flow Ctrl:	Temperature:	Year laid:	Cleaned:	Strat. Drain:
00001	No flow control	above freezing	Z	No	not known

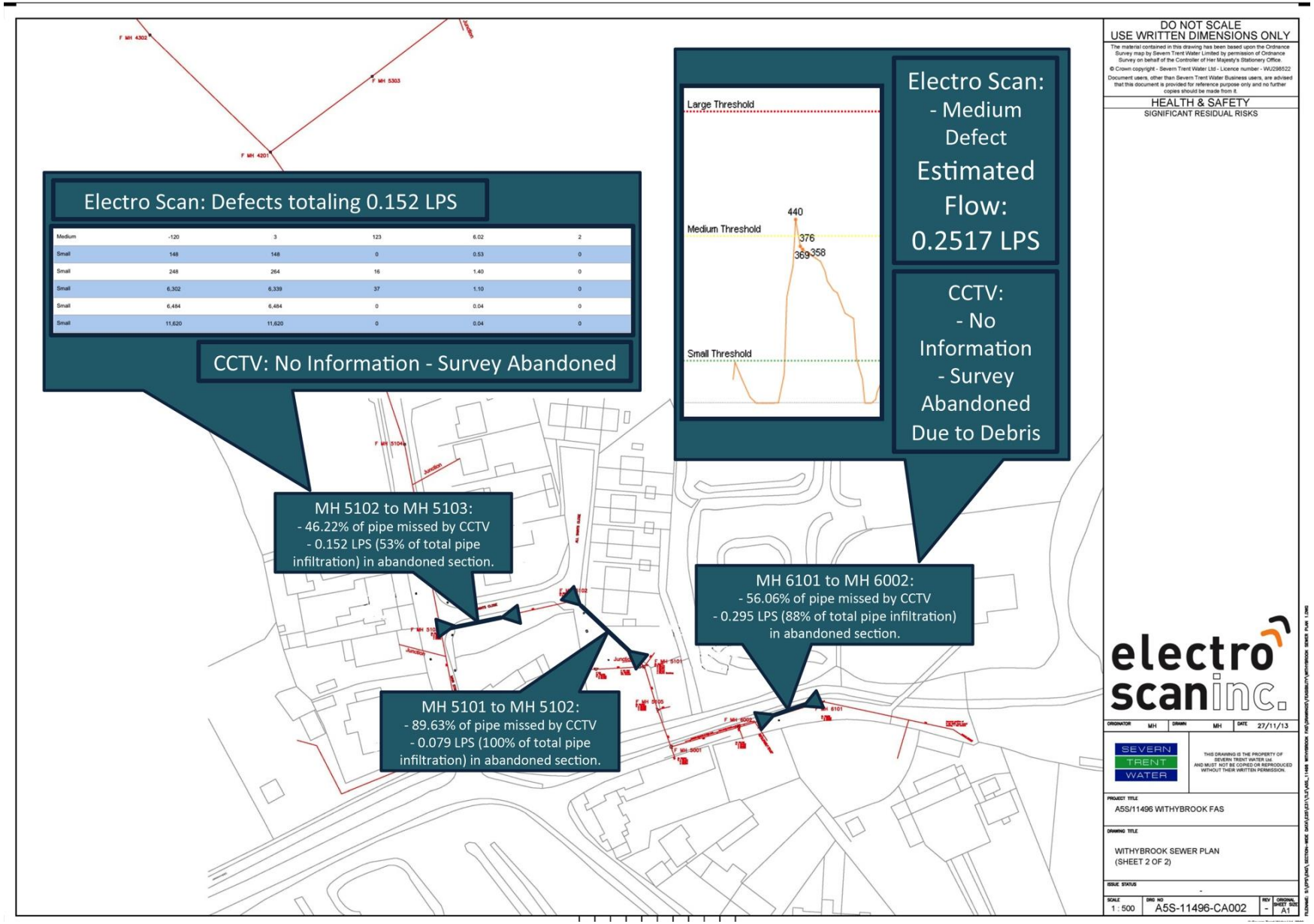
Road:	MAIN STREET	Div/Dist:	start MH: SP43844301
Place:	WHITHYBROOK	Drain. Area:	end MH: SP43844302
Location:	Road	Standard: BS EN 13508-2:2003	Total length: 42.8 m
Purpose:	Other	Shape/Size:	Circular 150
Type:	Gravity drain/sewer	Material:	Vitrified clay (i.e. all clayware) Pipe length: 1m
Use:	Foul	Lining:	
Comment:		Lining Type:	

Depth: 1.49

1:325 position	code	observation	MPEG	photo	grade
SP43844301 0.00	MH	Start node type, manhole, reference number: SP43844301	00:00:00		(Misc) 0
0.00	WL	Water level 5 % height/diameter	00:00:00		(Serv) 0
11.30	RFJ	Fine Roots at joint	00:01:19		(Serv) 1
12.40	RFJ	Fine Roots at joint	00:01:38		(Serv) 1
13.90	RFJ	Fine Roots at joint	00:01:58		(Serv) 1
16.60	RMJ	Mass Roots at joint 5 % cross-sectional area loss	00:02:28		(Serv) 5
17.00	CC	Crack Circumferential from 07 to 05 o'clock	00:02:40		(Struct) 2
30.60	FC	Fracture Circumferential from 07 to 05 o'clock	00:04:33		(Struct) 3
SP43844302 42.80	MHF	Finish node type, manhole, reference number: SP43844302	00:06:32		

Structural Defects | Construction Features
Service Defects | Miscellaneous Features

‘Defect Flows’ Missed by Prior CCTV ‘Abandoned Surveys’



Electro Scan and CCTV Inspection Comparison

Withybrook

				# of Defects				Estimated Maximum Flow						CCTV Inspection																																							
No.	UPS	DOWN	Length	Small	Medium	Large	Total	Minor	Moderate	Severe	Total Flow	Total Est. Peak GPM	Peak Max. Gallons Per Day (GPD)	RM Mass Roots	B Broken Pipe	CC Crackl Circumferential	CCJ Crackl Circumferential @ JT	CL Crack Longitudinal	CS Cracks Spiral	D Deformed Drain/Sewer	FC Fracture Circumferential	FL Fracture Longitiduinal	H Hole in Pipe	TOTAL	CXD Connection Defective	CXI Connection Intruding	CN Connection	JN Junction	MCCO Material Change to Concrete	VV Visible Void Beyond Defect	TOTAL	WL Water Level	DEE Attached DepositEncrustation	DEEJ Encrustation	DEG Attached Depostis, Grease	DER Settle Deposits	DES Settled Deposits	DEX Other Settle dDeposits	ID Infiltration Dripping	ISJ Infiltratoin Seeping	OBP Other Ostacles	RM Mass Roots	RMJ Mass Roots	RFJ Other Settle dDeposits	RF Fine Roots	TOTAL	LL Deviates Left	LD Deviates Down	LR Deviates Right	CUW Loss of Vision	SA Survey Abandoned	TOTAL	Total Observations
1	SP43843301	SP43844301	54.0	77	0	0	77	57.16	27.33	16.54	101.03	101.03	145,487	0	0	11	1	0	0	0	0	0	0	12	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	3	7	12	0	0	0	0	0	0	24
2	SP43843403	SP43843301	36.2	80	3	0	83	61.40	18.70	0.00	80.10	80.14	115,387	0	0	6	0	0	0	0	0	1	0	7	0	1	1	0	0	0	2	1	1	2	0	0	0	1	1	1	0	0	1	5	0	13	0	0	0	0	0	0	22
3	SP43846001	SP43846101	41.7	17	4	7	28	18.89	57.39	0.00	76.28	76.28	108,837	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	2	0	0	0	2	0	1	0	0	0	0	0	0	0	5	0	0	0	0	0	0	6
4	SP43844301	SP43844302	92.6	99	1	0	100	49.59	25.48	0.00	75.07	75.06	108,093	0	0	4	0	1	0	0	1	0	0	6	0	0	0	0	0	0	0	3	0	0	0	0	0	1	0	0	0	0	1	5	1	11	0	0	0	0	0	0	17
5	SP43843401	SP43843402	28.1	17	2	0	19	12.87	0.00	36.34	49.21	49.21	70,863	0	0	2	0	3	0	0	0	1	0	6	1	0	0	3	0	0	4	1	0	0	0	0	0	1	0	0	0	0	3	0	1	6	0	0	0	0	0	0	16
6	SP43845201	SP43845104	46.7	69	0	0	69	30.78	0.00	0.00	30.78	30.78	44,317	0	0	1	0	0	0	0	0	0	0	1	0	0	0	2	0	0	2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	5
7	SP43845104	SP43845103	59.7	38	0	0	38	18.32	9.12	0.00	27.44	27.44	38,520	0	1	1	0	0	0	0	2	0	2	6	0	0	0	4	0	0	4	1	0	0	3	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	14
8	SP43846101	SP43846002	50.5	14	0	1	15	5.11	15.10	0.00	20.21	20.21	29,108	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	2	0	0	0	0	0	0	0	0	0	5	0	0	0	0	1	1	6
9	SP43845103	SP43845102	45.0	24	1	0	25	11.39	6.02	0.00	17.41	17.38	25,020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	2	0	0	0	0	0	0	0	0	6	0	0	0	1	1	2	8
10	SP43843402	SP43843403	36.2	17	0	0	17	14.20	0.00	0.00	14.20	14.20	20,411	0	0	5	0	3	0	0	0	0	0	8	0	0	0	2	0	0	2	1	0	0	2	0	0	0	0	0	0	0	1	3	0	7	0	0	0	0	0	0	17
11	SP43845401	SP43845402	61.6	34	0	0	34	12.04	0.00	0.00	12.04	12.04	17,334	0	0	0	0	0	0	0	1	0	0	1	1	0	1	2	0	0	4	1	0	0	0	1	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	8
12	SP43845101	SP43845105	14.5	11	0	0	11	7.68	0.00	0.00	7.68	7.68	11,066	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	1	0	0	0	0	0	0	0	4	0	0	0	0	0	0	4
13	SP43845301	SP43845302	37.4	8	0	0	8	7.15	0.00	0.00	7.15	7.15	10,302	0	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	3	0	0	0	0	0	0	5
14	SP43845302	SP43845303	47.9	11	0	0	11	5.30	0.00	0.00	5.30	5.30	7,631	0	0	2	0	0	0	0	0	0	0	2	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	5
15	SP43845102	SP43845101	27.0	6	0	0	6	4.73	0.00	0.00	4.73	4.73	6,814	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	2
16	SP43845501	SP43845401	32.2	8	0	0	8	4.66	0.00	0.00	4.66	4.66	6,705	2	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	4
17	SP43845402	SP43845403	73.3	5	1	0	6	4.08	0.00	0.00	4.08	4.08	5,887	0	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	4	0	1	0	0	0	2	0	0	0	0	0	0	2	9	0	0	0	0	2	2	13
18	SP43844201	SP43844202	28.7	1	0	0	1	8.04	0.00	0.00	8.04	8.04	5,451	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	3
19	SP43844202	SP43845201	31.5	1	0	0	1	3.63	0.00	0.00	3.63	3.63	5,233	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	3
20	SP43845303	SP43844201	41.0	4	0	0	4	2.08	0.00	0.00	2.08	2.08	2,998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	4	0	0	0	1	1	2	6
21	SP43845003	SP43845103	35.5	5	0	0	5	2.08	0.00	0.00	2.08	2.08	2,998	0	0	3	0	0	0	0	0	0	0	3	0	0	0	2	0	0	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	7
22	SP43845001	SP43845105	12.1	4	0	0	4	1.55	0.00	0.00	1.55	1.55	2,235	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	5	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	6
23	SP43843501	SP43843401	43.4	2	0	0	2	0.34	0.00	0.00	0.34	0.34	491	0	0	5	0	0	1	0	0	0	0	6	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	8
TOTALS			976.8	552	12	8	572	343.07	159.14	52.88	555.09	555.09	791,187.6	2	1	45	1	8	1	0	4	2	2	66	2	1	2	18	0	0	23	32	2	6	14	5	2	11	1	1	0	0	6	18	13	111	0	0	0	2	7	9	209

Innovation Bulletin

SEVERN TRENT WATER

18th February 2014
Ref: ABC 0000
(for completion by Standards Team)

Electro Scan

The Next Generation in Sewer Leak Detection | Finding Infiltration Missed by CCTV

Brief description

Electro Scan is a revolutionary technology that locates defects having the potential for causing infiltration into sewers and other pipes. Not dependant upon any visual identification of infiltration at the time of the survey, the solution provides an estimated liters per second (l/s) for each defect. Most sewer pipe materials such as clay, plastic, concrete, reinforced concrete, resin linings, and brick are poor conductors of electrical current. As a result, if a defect exists in the wall of a pipe, then the leakage of electrical current will indicate the source of a potential water leak, whether or not water infiltration or exfiltration actually occurs at the time of the Electro Scan.

Electro Scan has been in the UK for just over a year, and has been adopted by two other UK water companies, after multiple catchment studies. Recently, Severn Trent Services completed two successful trial projects.

Benefits

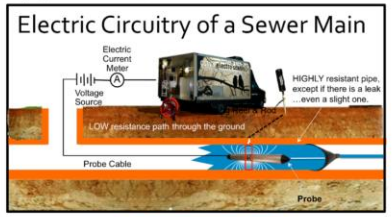
The Electro Scan technology is able to:

- *Automatically locates sources of infiltration, whether visible or not, in pipes 75mm to 600mm*
- *Measure and quantify each defect found (estimated LPS of infiltration), no matter the weather conditions*
- *Provide repeatable, objective data*
- *Performed without specialized certification*
- *Help prioritize rehabilitation programs*
- *Certify relined pipes and repairs as "leak-free"*
- *Evaluate surcharged pipes (including siphons) without the need to bypass or empty*
- *Maintain an almost-zero survey abandonment rate*
- *Perform scans in pipes filled with fats, oils, and grease (FOG)*
- *Immediately processes data and presents it in a cloud-based application*

With treatment works processing from 10-40% of water that should drain into rivers & streams, contributes to the reduction of our carbon footprint by reducing pump runtimes. CCTV Truck add-on for large mains or push rod versions available.

Details

Electro-scanning is carried out by applying an electrical potential (voltage) between an electrode (probe) in an electrically nonconductive pipe and an grounding stake on the surface. The water in the pipe is at a level that ensures that the pipe is full at the probe location, during the survey. The probe is pulled through the pipe at a speed of 10 m/minute and the variation of electric current flowing between the probe and the fixed electrode on the surface is measured. When the probe is close to a pipe defect the electric current increases because the defect decreases the electrical resistance of the pipe wall. All data is automatically collected and sent to a web-based cloud platform for instant processing and display.



Seek and Share Standards

For further Information contact:

sean@anthire.com

or

info@electroscan.com

UKSTT

Monterey, California

July 2015

	Scans	Distance	S	M	L	GPM	GPD	GPD/IDM
Total:	3	1,032	40	5	5	40.84	58,810	123,261

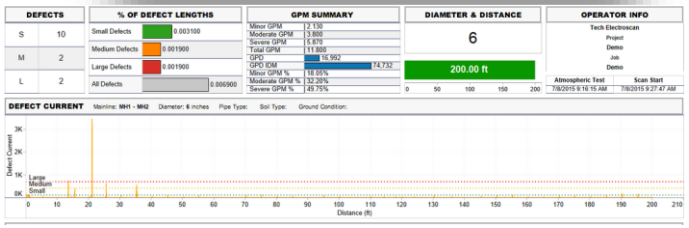
Date	Mainline (From-..	Pipe Type	Diameter							
7/8/2015	G12-015 to G12-007	VCP	1	200.1	10	2	2	11.80	16,992	74,732

AMERICAN WATER

CITY OF Monterey CALIFORNIA

WRC

G12-015 to G12-007



Total Defect Flow: 11.8 GPM

July 8, 2015

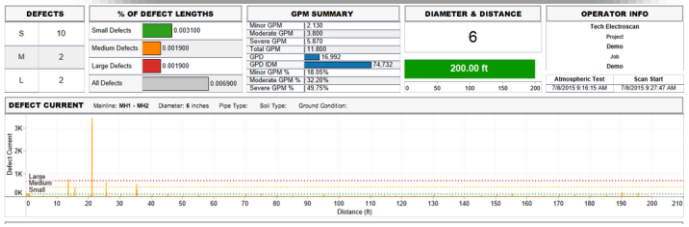
	Scans	Distance	S	M	L	GPM	GPD	GPD/IDM
Total:	3	1,032	40	5	5	40.84	58,810	123,261

Date	Mainline (From-..	Pipe Type	Diameter	Distance (ft)	Small	Medium	Large	GPM	GPD	GPD/IDM
7/8/2015	G12-015 to G12-007	VCP	1	200.1	10	2	2	11.80	16,992	74,732
	D08-049 to D08-020	CIPP	2	331.4	12	2	2	17.93	25,819	27,428
	D08-019 to D08-020	CIPP	3	500.4	18	1	1	11.11	15,998	21,101

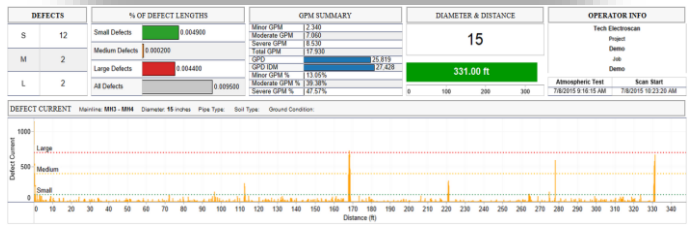
G12-015 to G12-007

D08-049 to D08-020

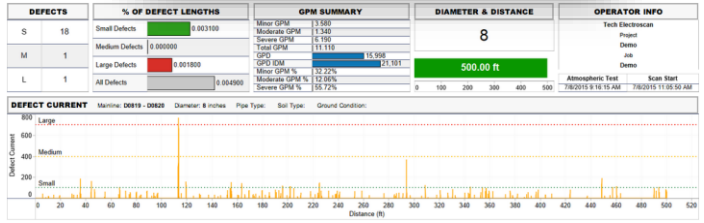
D08-019 to D08-020



Total Defect Flow: 11.8 GPM



Total Defect Flow: 17.93 GPM



Total Defect Flow: 11.11 GPM

July 8, 2015

CIPP Acceptance Video By Contractor

P/O No.	Pipeline Segment Reference	Date	Time	Location (Street Name and number)	Locality
14077	Shot 12 CITY ID L12	20150205	06:18	DELA VINA AVENUE	Monterey CA

Further Location d

Rim to Grade

Downstream Manh
D08-020

Height
8

Width

Sha
Cir

/ Media Number

Purpose
C

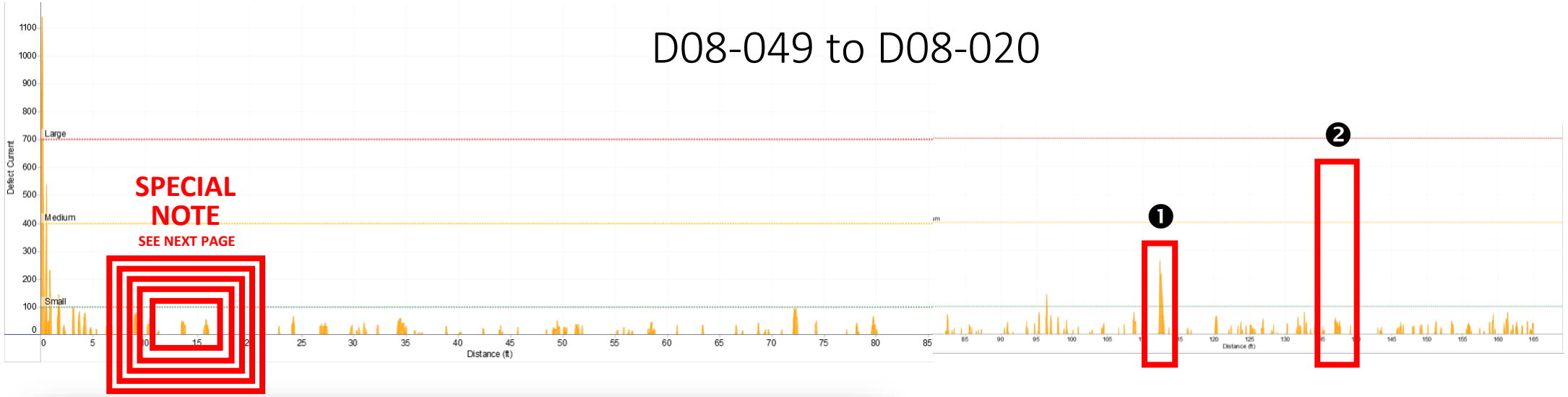
Overall

Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Rating	Quick	Index
0	0	0	0	0	0	0000	

Distance (Feet)	Group/ Descript				
0.0	AMH				
0.0	MWL				
33.6	TB				
37.8	TF				
117.4	TF				
123.4	TB				
140.7	TB				
255.3	TF	A	6	10	
286.5	TF	A	6	12	
332.3	TB	A	4	10	
358.3	TB	A	4	10	
390.6	TB	A	6	2	
506.7	AMH				End Inspection MH D08-020

	Structural								O & M								Overall							
Segment	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Rating	Quick	Index	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Rating	Quick	Index	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Rating	Quick	Index
14077_D08-019_D08-020_20150205_06 18	0	0	0	0	0	0	0000		0	0	0	0	0	0	0000		0	0	0	0	0	0	0000	

D08-049 to D08-020



D08-049 to D08-020

Surveyors name	Certificate Number	System Owner	Survey Customer	Drainage Area	Sheet
Jose Aguilar	0	City of Monterey CA	City of Monterey CA		1

P/O No.	Pipeline Segment Reference	Date	Time	Location (Street Name and number)	Locality
14077	Shot 13 POST. City ID L15	20150203	05:39	Del Monte Ave	Monterey CA

Further Location details	Upstream Manhole Number	Rim to Invert	Grade to Invert	Rim to Grade
	D08-049			

Downstream Manhole Number	Rim to Invert	Grade to Invert	Rim to Grade	Use of Sewer	Direction	Flow Control	Height
D08-020				Sanitary	Downstream		15

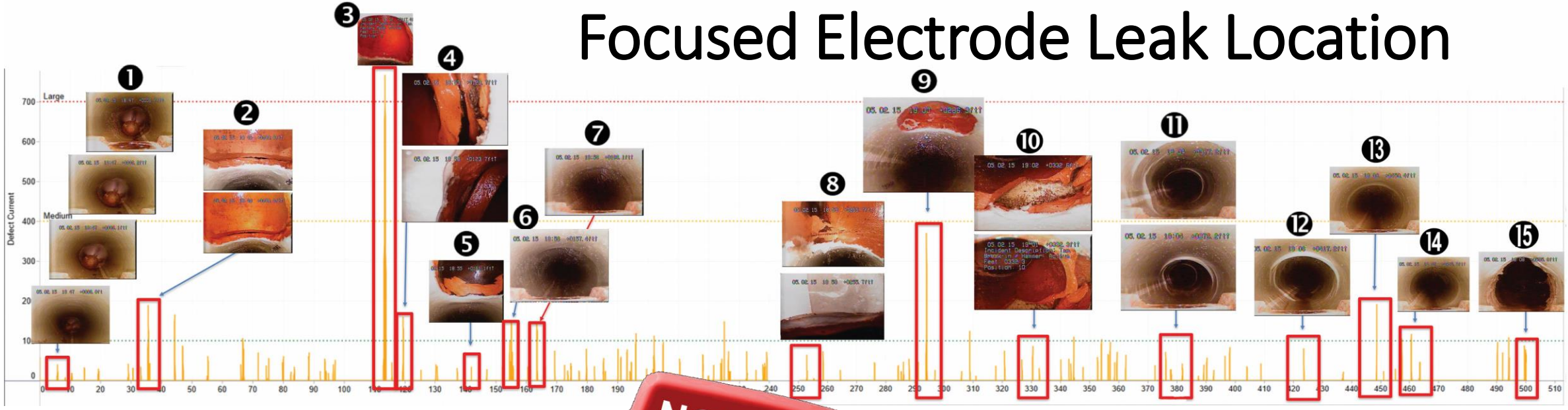
Width	Shape	Material	Ln. Method	Pipe Joint Length	Total Length	Length Surveyed	Year Laid	Year Rehabilitated	Tape / Media Number
	Circular	VCP	CP		344	338.3			

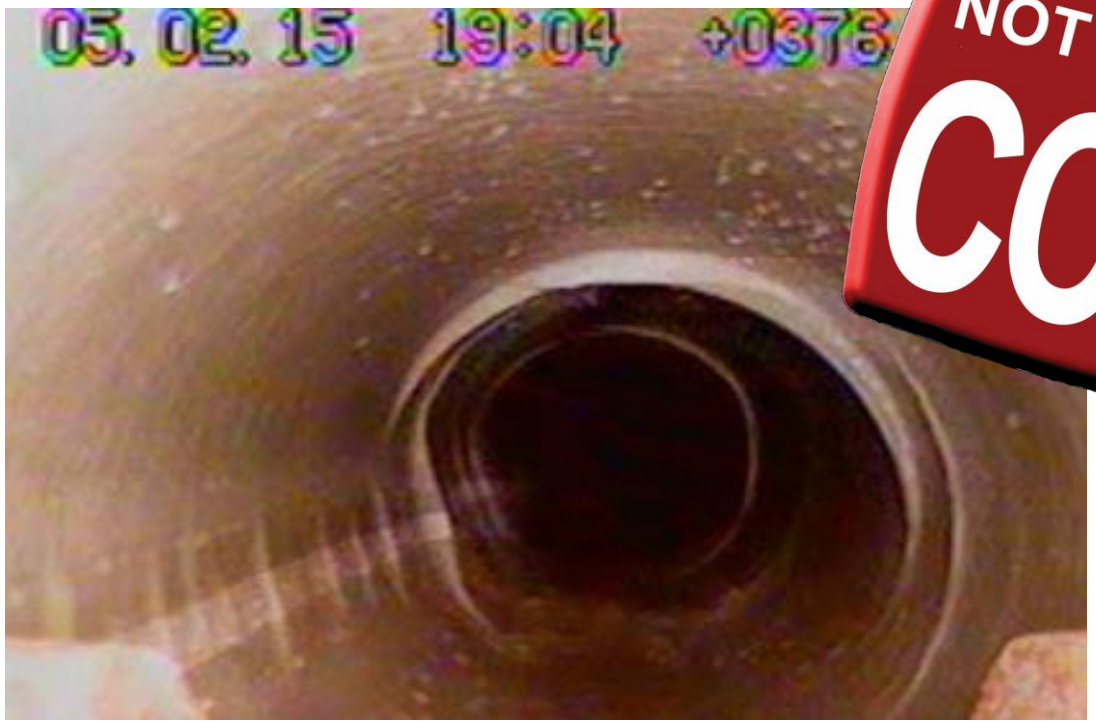
Purpose	Sewer Category	Pre-Cleaning	Cleaned	Weather	Additional Information
C		Jetting			

Distance (Feet)	Code		Continuous defect	Value				Joint	Circumferential Location		Image Ref.	Struct. Grade	O&M Grade	Remarks
	Group/ Descriptor	Modifier/ severity		S/M/L	Inches 1st	Inches 2nd	%		At / From	To				
0.0	AMH													Starting Manhole: D08-049
0.0	MWL						0							
28.9	TF	A			6				10					
76.2	TF	A			6				10					
107.2	TB	A			4				10					
112.9	TB	A			4				10					
124.6	TF	A			6				10					
172.1	TF	A			6				10					
195.7	TB	A			4				10					
214.2	TB	A			6				12					
224.0	TB	A			4				10					
272.4	TB	A			4				10					
338.3	AMH													End Inspection MH D08-020

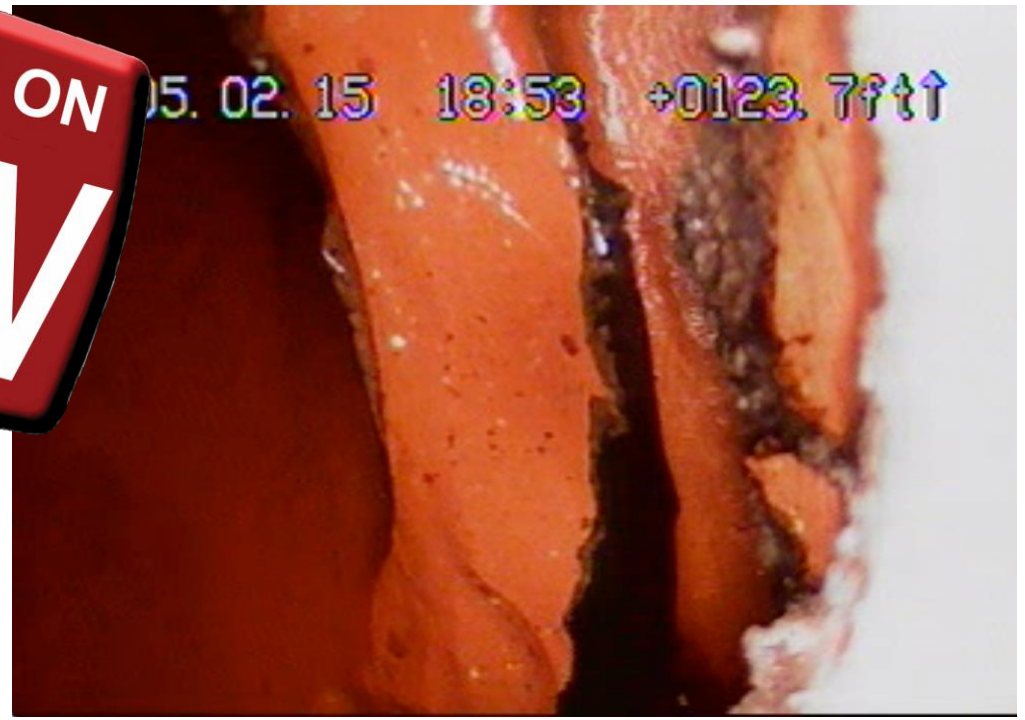
	Structural								O & M								Overall							
Segment	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Rating	Quick	Index	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Rating	Quick	Index	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Rating	Quick	Index
14077_D08-049_D08-020_20150203_05 39	0	0	0	0	0	0	0000		0	0	0	0	0	0	0000		0	0	0	0	0	0	0000	

Focused Electrode Leak Location





NOT SEEN ON CCTV



Total # of Defects

% of Pipe Defective by Length

Estimated Leakage Rate

electroscan

DEFECTS		% OF DEFECT LENGTHS
Small	12	0.0135
Medium	6	0.0104
Large	28	0.1023
All Defects	46	

GPM SUMMARY	
Minor	5.000
Moderate	26.800
Severe	188.650
Total GPM	220.450
GPD	317,448
GPD IDM	969,697
Minor %	1.90%

DIAMETER & DISTANCE

8

216.00 ft

OPERATOR INFO

Tech Electroscan

Project

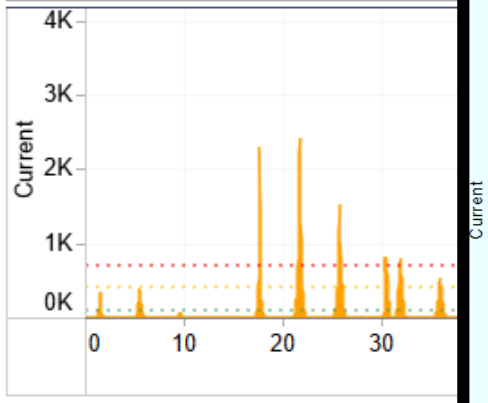
Demo

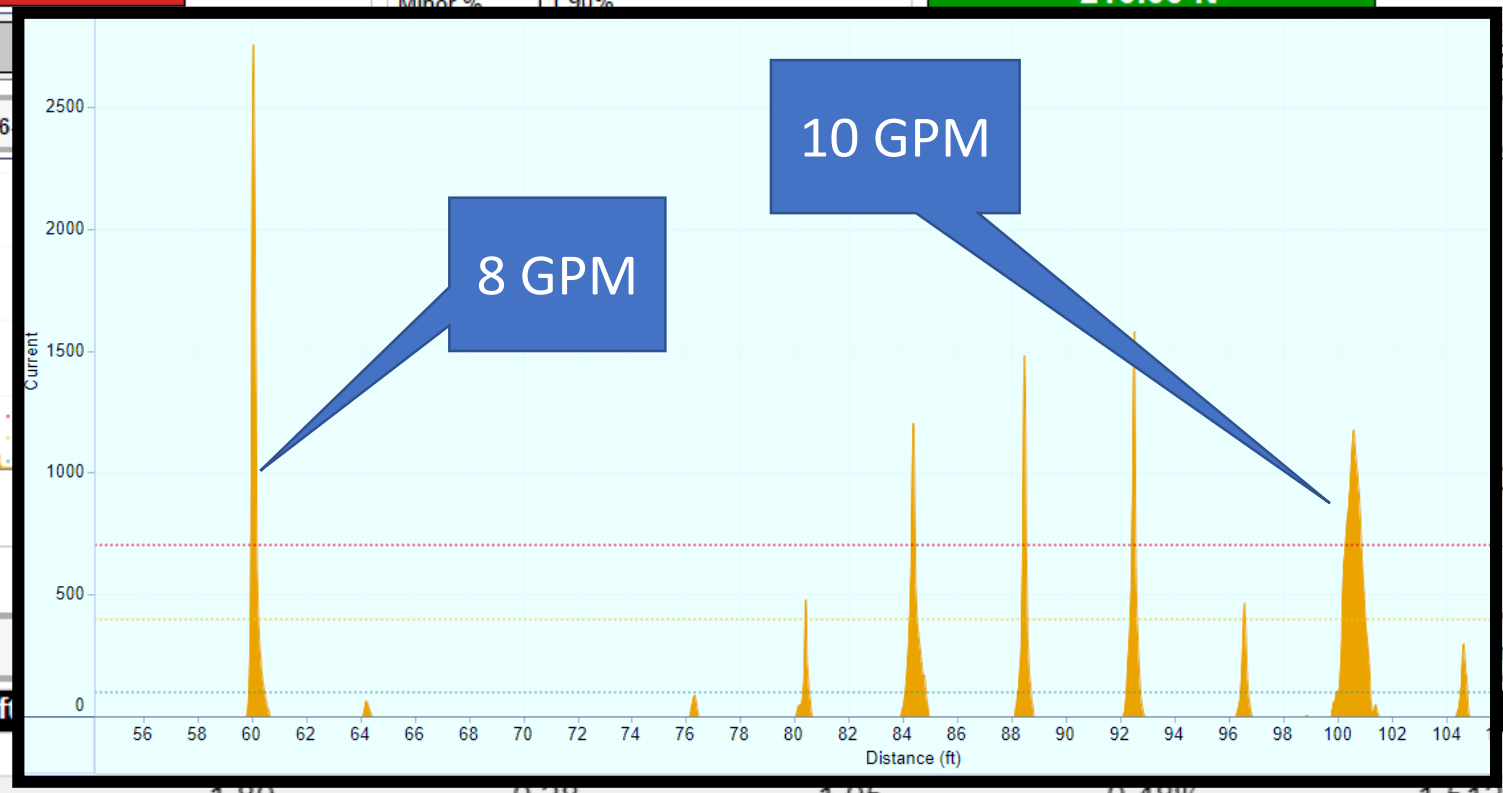
Job

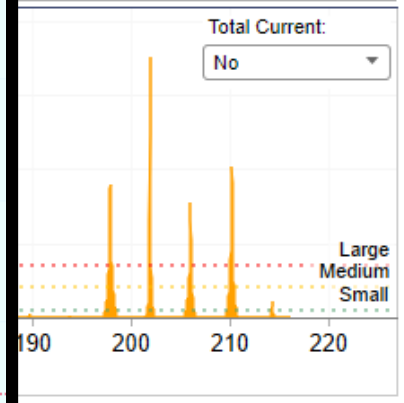
Demo

spheric Test	Scan Start
017 9:13:52 AM	7/25/2017 12:03:06 PM

DEFECT CURRENT Mainline ID: 16





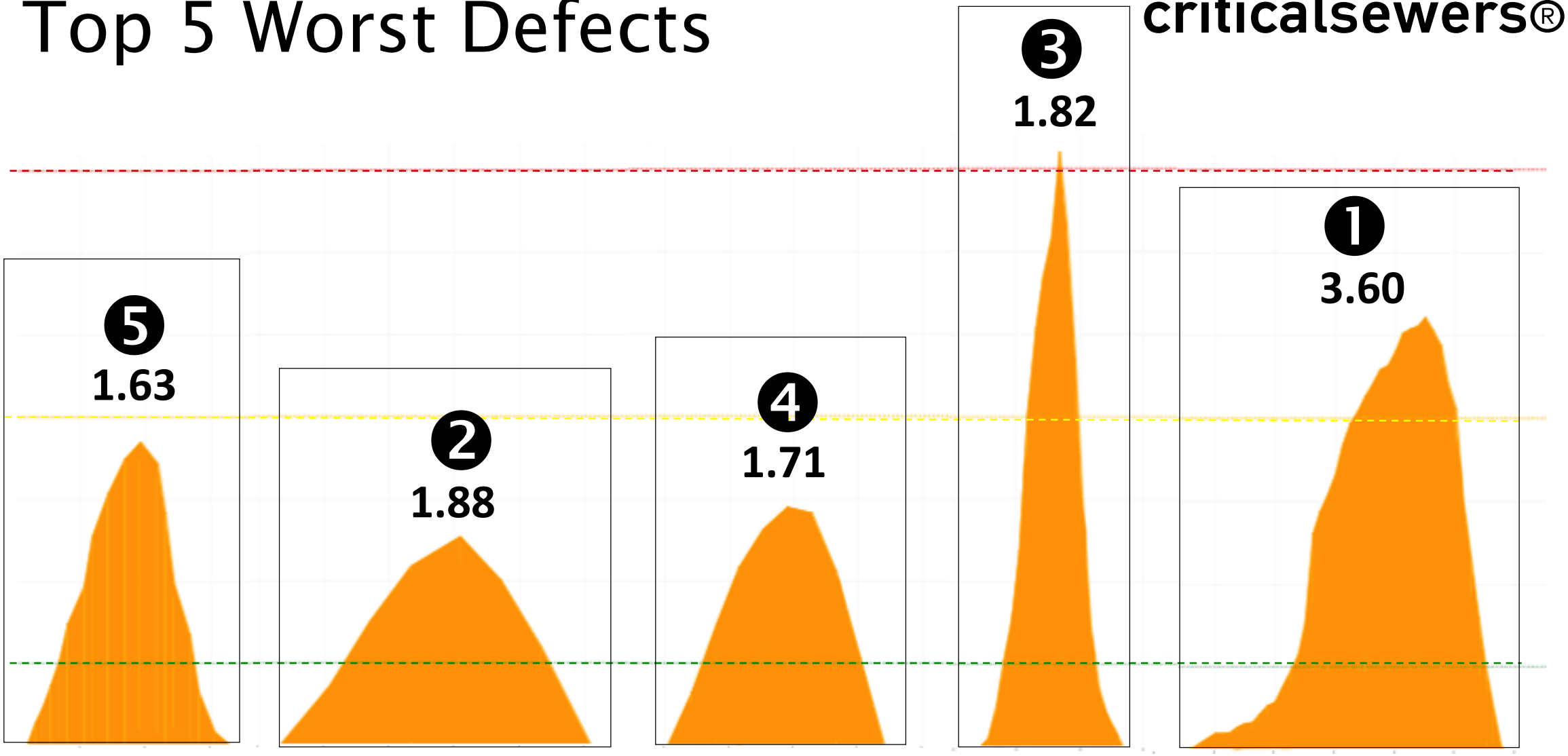


DEFECT BY LOCATION

Defect Grade	Defect Start (ft					GPD/IDM
S	0.05					704
S	1.53	1.80	0.28	1.05	0.48%	1,512	4,619
S	5.51	6.01	0.50	1.93	0.88%	2,779	8,490
L	17.70	18.35	0.65	6.23	2.83%	8,971	27,404
L	21.75	22.76	1.00	10.00	4.54%	14,400	43,987

Top 5 Worst Defects

criticalsewers®

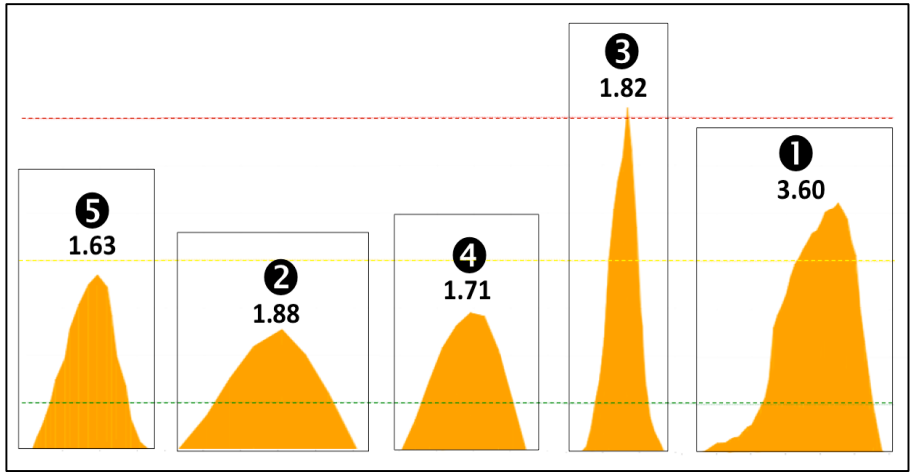


Top 5 Defects = 3.60 + 1.88 + 1.82 + 1.71 + 1.63 = **10.64 GPM**

Defect Start, End, and Length

criticalsewers®

- No Visual Interpretation
- No Third Party Data Analysis
- GPM, GPD, GPD/IDM



				% of GPM	GPD	GPD/IDM
Total:			24.870	99.96%	35,813	56,480

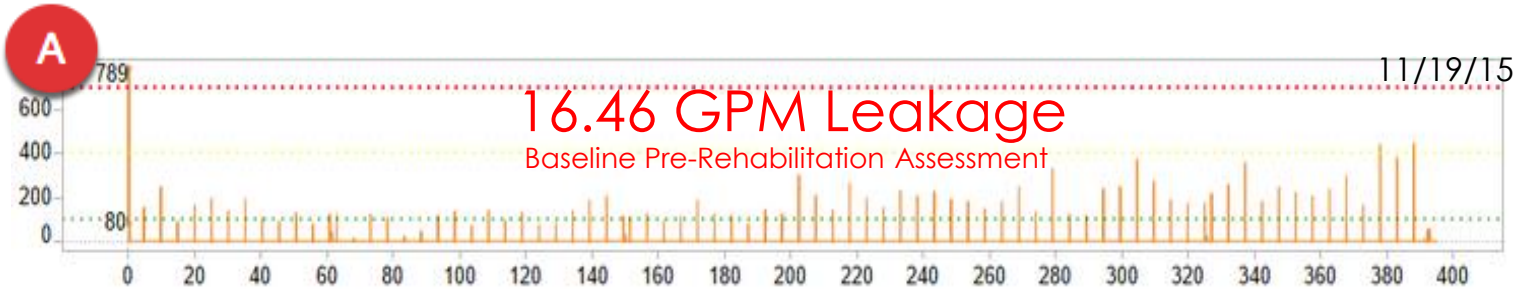
DEFECT BY LOCATION Mainline ID: 20BC-15 - 20BC-8 Pipe ID: 20BC-15 - 20BC-8 Diameter: 8 inches Pipe Type: Not Known Soil Type: Ground Condition:

Defect Grade	Defect Start (ft)	Defect End (ft)	Length of Defects (ft)		GPM	% of GPM	GPD	GPD/IDM
M	342.10	342.73	0.62	❶	3.60	0.14	5,184	8,176
S	13.22	13.74	0.52	❷	1.88	0.08	2,707	4,270
L	207.34	207.61	0.28	❸	1.82	0.07	2,621	4,133
S	22.78	23.23	0.45	❹	1.71	0.07	2,462	3,883
S	8.59	8.99	0.40	❺	1.63	0.07	2,347	3,702
S	107.39	107.87	0.48		1.09	0.04	1,570	2,475
S	98.33	98.76	0.43		1.07	0.04	1,541	2,430
S	391.52	391.85	0.32		0.79	0.03	1,138	1,794
S	141.49	141.72	0.23		0.72	0.03	1,037	1,635
S	212.19	212.49	0.30		0.68	0.03		
S	12							

How To Find Leaks & Certify Rehab As Watertight?

Date		Pipe ID	Diameter	Pipe Type	Distance (ft)	Small Defects	Medium Defects	Large Defects	GPM	GPD	GPD/IDM
11/19/2015	A	1-35 - 1-34	8	VCP	395.1	64	2	1	16.46	23,702	39,592

1. INSPECT

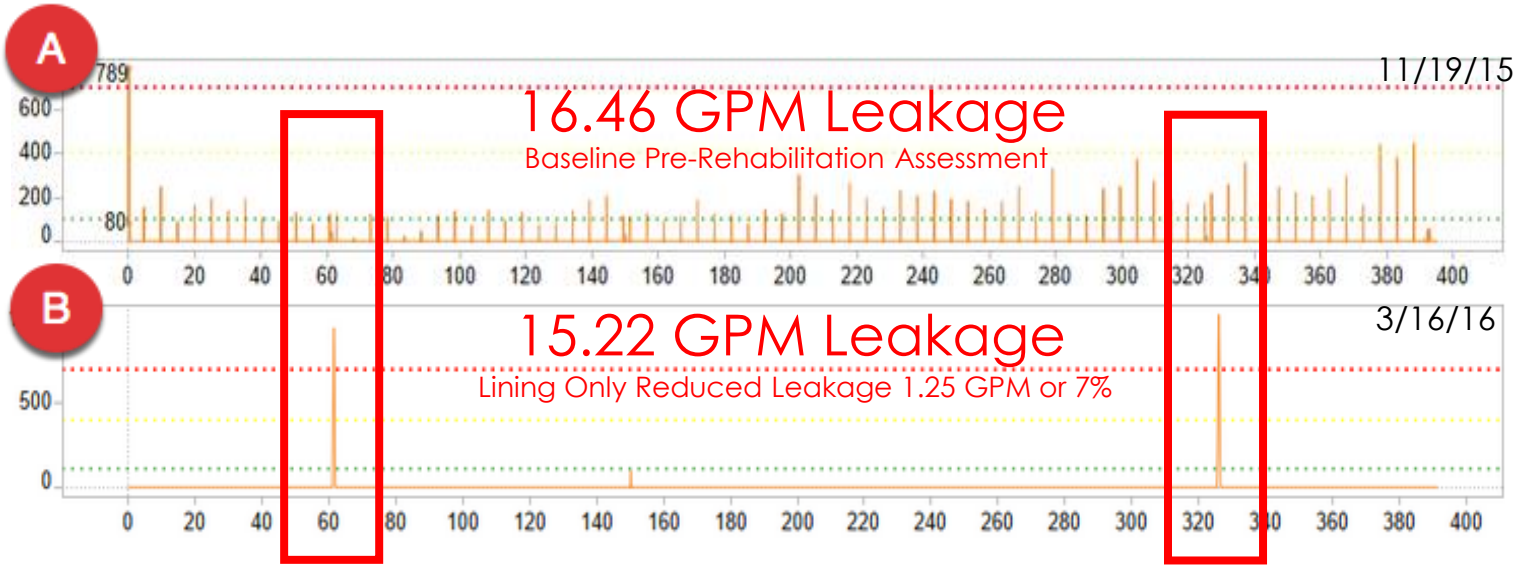


How To Find Leaks & Certify Rehab As Watertight?

Date		Pipe ID	Diameter	Pipe Type	Distance (ft)	Small Defects	Medium Defects	Large Defects	GPM	GPD	GPD/IDM
11/19/2015	A	1-35 - 1-34	8	VCP	395.1	64	2	1	16.46	23,702	39,592
3/16/2016	B	1-35 - 1-34	8	CIPP	391.3	0	0	2	15.22	21,917	36,968

1. INSPECT

2. TEST



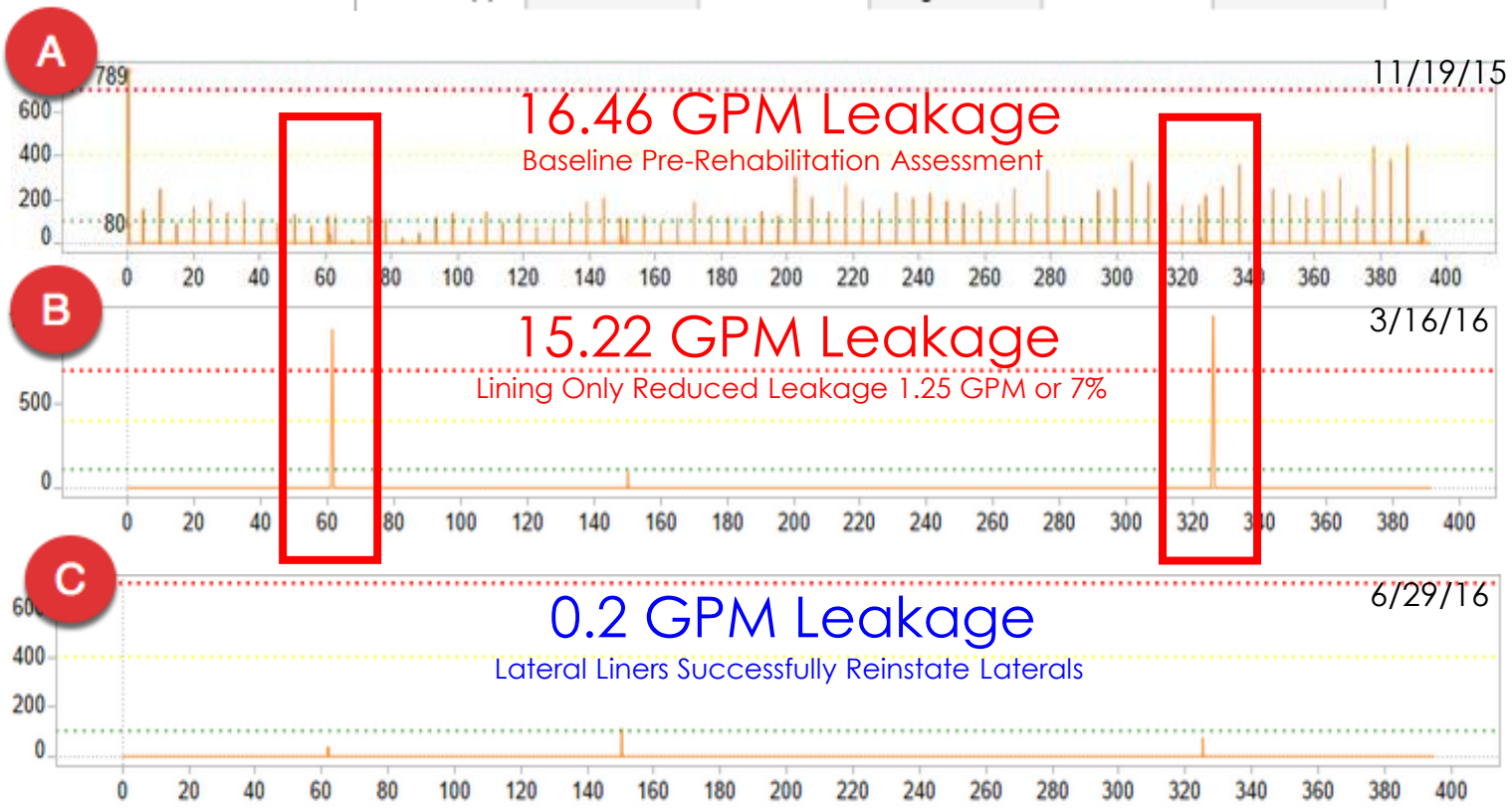
How To Find Leaks & Certify Rehab As Watertight?

Date		Pipe ID	Diameter	Pipe Type	Distance (ft)	Small Defects	Medium Defects	Large Defects	GPM	GPD	GPD/IDM
11/19/2015	A	1-35 - 1-34	8	VCP	395.1	64	2	1	16.46	23,702	39,592
3/16/2016	B	1-35 - 1-34	8	CIPP	391.3	0	0	2	15.22	21,917	36,968
6/29/2016	C	1-35 - 1-34	8	CIPP	394.8	1	0	0	0.20	288	481

1. INSPECT

2. TEST

3. CERTIFY

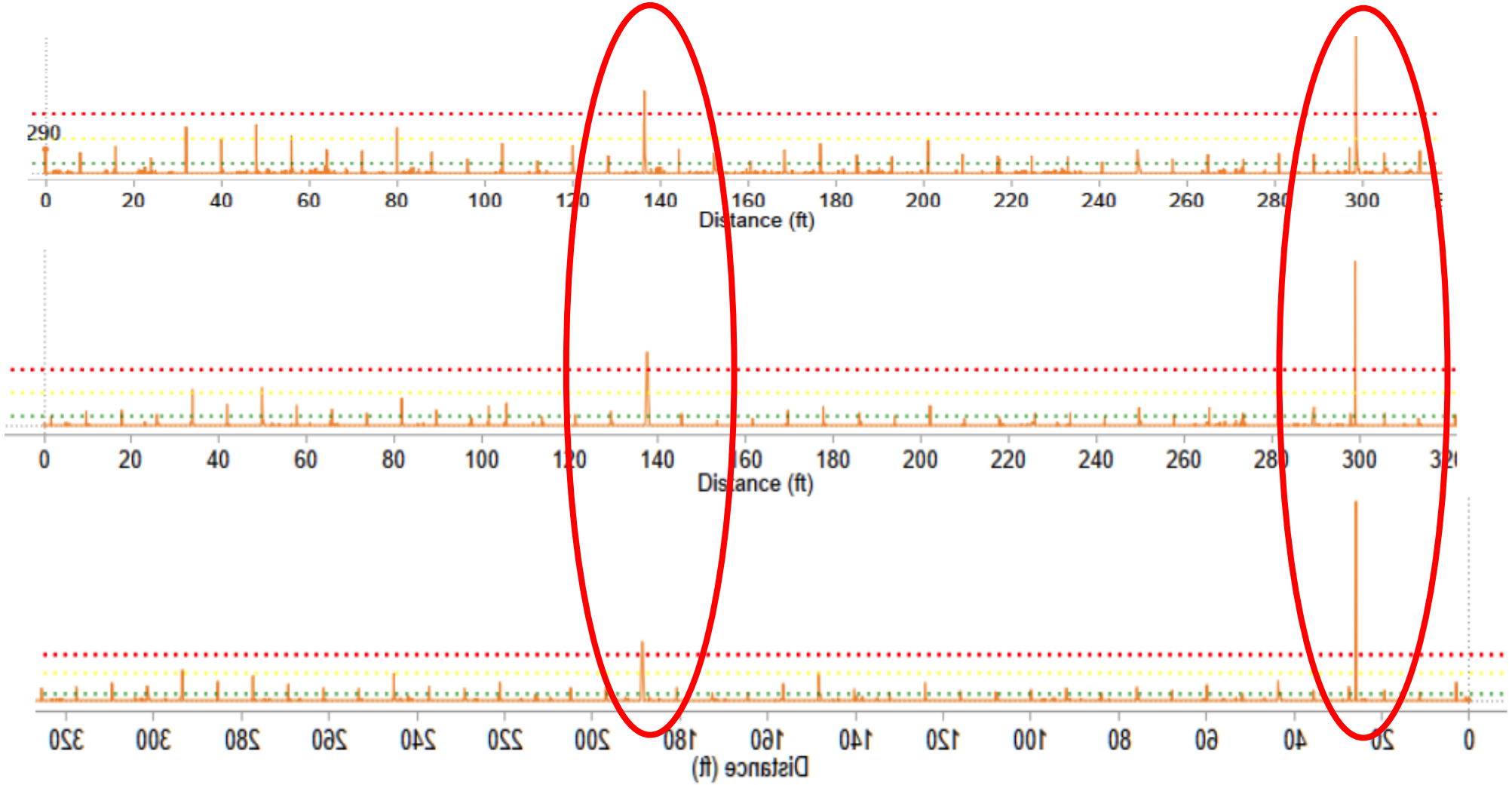


Repeatability Test
Same Pipe, Same Equipment, Same Day

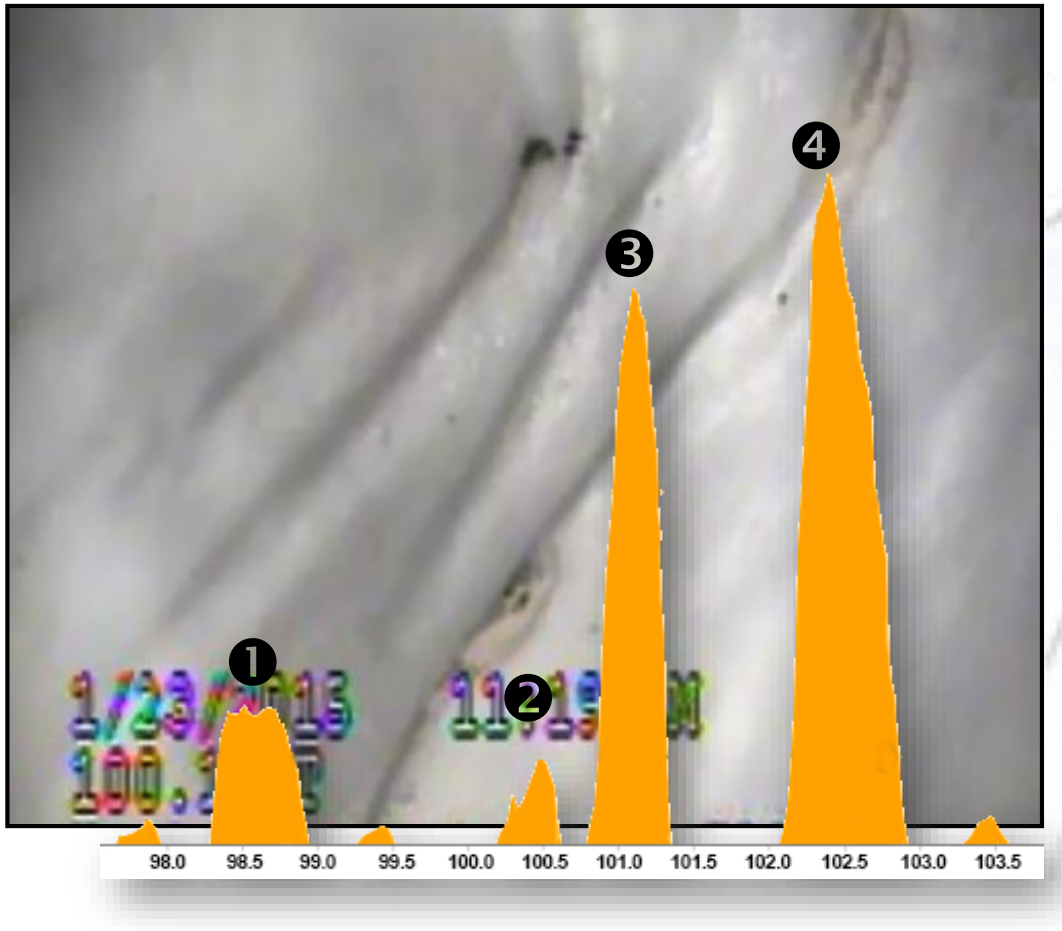
Scan 1

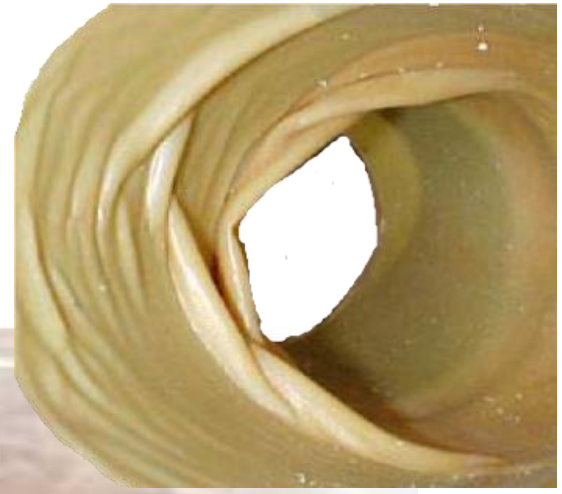
Scan 2

Scan 3



Blisters, Buckling, Cuts, Fins, Folds, Ridges, Wrinkles

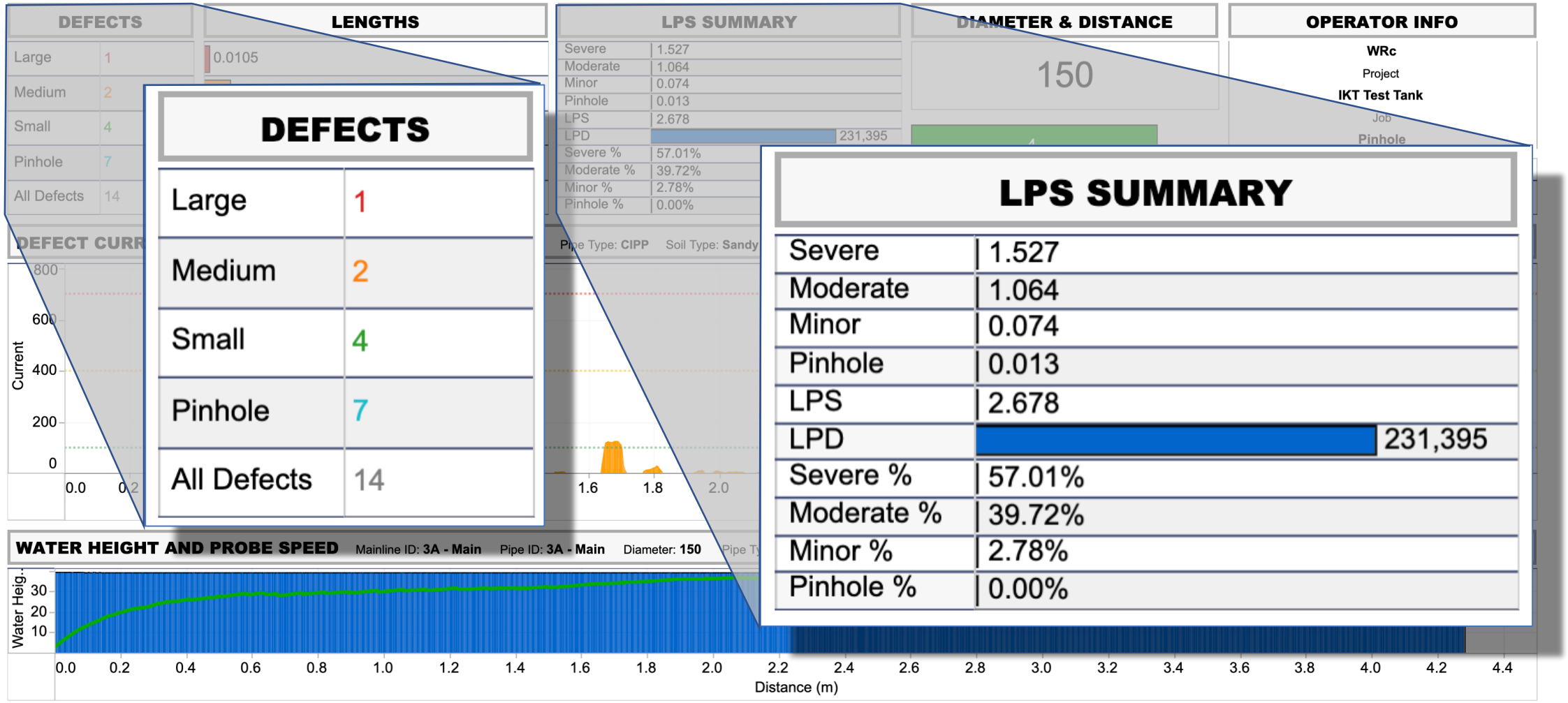




…Leak.

neutral
independent
non-profit institute
IKT - Institute for Underground Infrastructure

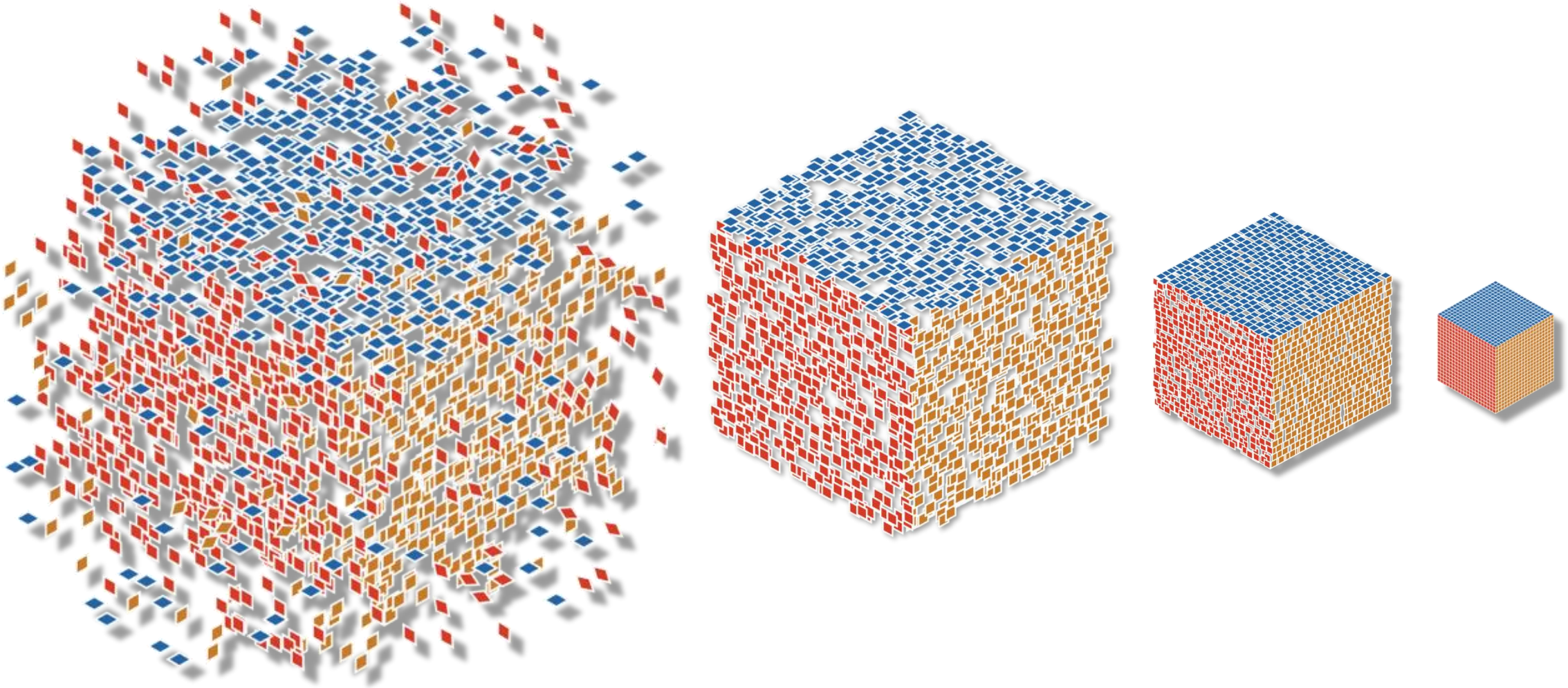
Since Pinholes Were Not Originally Calculated New Software Was Developed



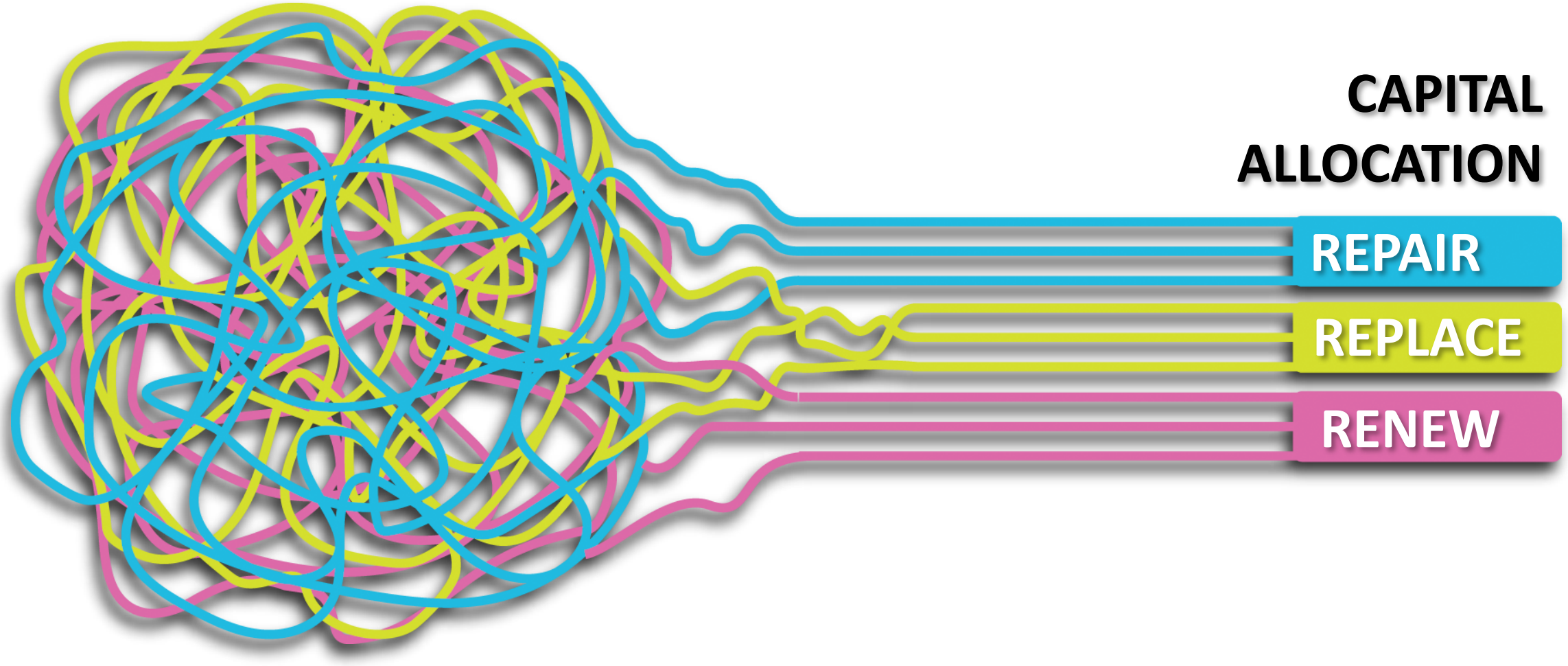
DEFECTS	
Large	1
Medium	2
Small	4
Pinhole	7
All Defects	14

LPS SUMMARY	
Severe	1.527
Moderate	1.064
Minor	0.074
Pinhole	0.013
LPS	2.678
LPD	231,395
Severe %	57.01%
Moderate %	39.72%
Minor %	2.78%
Pinhole %	0.00%

Electro Scan is Only One Piece of the Puzzle



Electro Scan is Only One Piece of the Puzzle


CAPITAL
ALLOCATION
REPAIR
REPLACE
RENEW

Predictive Capital Investments

Sensors, AI, & Smart Machines

Age-Based Renewal

Age → Size → Material

Risk Group	Length of Pipe (miles)
A	27.32
B	49.39
C	341.96
D	452.33
E	6.54
F	17.07
G	0.14
H	140.92
Z	1827.26

Predictive Capital Investments

Sensors, AI, & Smart Machines

Age-Based Renewal

Age → Size → Material

Risk Group	Length of Pipe (miles)
A	2.52
B	49.39
C	341.96
D	452.33
E	6.64
F	17.07
G	0.14
H	140.92
Z	1827.26

Condition-Based Renewal

Likelihood of Failure

Hydraulic Model	Pressure Changes; Roughness
Infrastructure Data	Age; Material
Electro Scan Critical Sewers	Defect Flow Rating; GPM, GPD, GPM / IDM
CCTV Data	Structural Rating Score; O&M Rating Score
GIS Data	Soil Type; Railroads/Fault Lines
CMMS & Work Orders	Break History; Repairs/Lining

Multiple Cohorts & Weighting

Calculation of Risk

Consequence of Failure

Pipe/Valve Criticality; Flow Delivered	Hydraulic Model results
Hospitals, Schools, etc; Power, Industry, etc.	Critical Facilities
Population Density; Street Paving	GIS Data
Traffic Analysis; Community Relations	Other

International No-Dig 2019
37th International Conference and Exhibition
Florence, Italy
30th September – 2nd October 2019

Thank You

Peter Henley
Special Consultant
WRc plc

Chuck Hansen
Chairman
Electro Scan Inc.


ANSWER
QUESTION