

Sewer Condition Assessment & Rehabilitation

Presented by
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Agenda

- PACP Report (what to expect to receive from CCTV crew)
- PACP Grading System
- Using Grading System and Other Factors to determine sewer replacement/rehabilitation
- Recommendations & Conclusion

PACP Report

Upstream MH Downstream MH Surveyor's Name Certificate Number Date Time

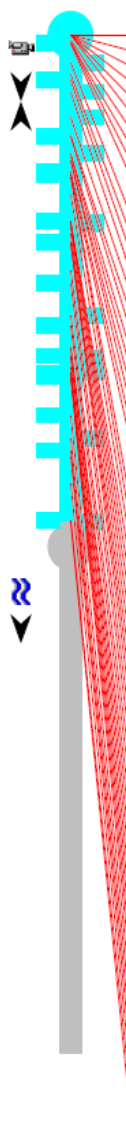
Survey Customer Street Address City Direction Height

Material Weather Total Length Length Surveyed

Additional Information

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			%	At / From					To
					1st	2nd								
0.0	AMH								AMH@0			STARTING MAN HOLE 0004C0359		
0.0	MGO								MGO@0					
0.0	MGO								MGO@0 1					
0.0	DA	E	S01			5	2	4	DAE@0		2			
0.0	TB	A			12				TBA@0					
0.3	TB				10				TB@0.3					
0.3	DA	E				5	8	9	DAE@0.3		2			
5.5	MWL					5			MWL@5.5					
12.2	TB	A			8			9	TBA@12.2					
14.0	DA	E	S02			5	8	11	DAE@14		2			
51.6	TB	B			15			10	TBB@51.6			NO CAP		
58.9	TB	A			15			2	TBA@58.9					
103.6	MMC								MMC@103.6			CONCRETE		
104.6	MGO								MGO@104.6					
107.0	MGO								MGO@107					
107.0	MGO								MGO@107 1					
107.6	MGO								MGO@107.6					
107.6	AOC								AOC@107.6			ENDING AT SPECIAL CHAMBER 0004C0211		

PACP Report



Ftg.	Observation	Category	Comments
0.0	Access Point - Manhole	Access Points	STARTING MAN HOLE 0004C0359
0.0	General Observation	Miscellaneous	
0.0	General Observation	Miscellaneous	
0.0	General Observation	Miscellaneous	
0.0	General Observation	Miscellaneous	
0.0	Water Level	Miscellaneous	
3.7	Deposits Attached: Encrustation	Deposits Attached	
5.5	Tap, Break-in / Hammer: Intruding	Tap	
5.6	Deposits Attached: Encrustation	Deposits Attached	
6.2	Deposits Attached: Encrustation	Deposits Attached	
19.8	Tap, Break-in / Hammer: Active	Tap	
28.3	Water Level	Miscellaneous	
32.3	Tap, Break-in / Hammer	Tap	
40.7	Tap, Break-in / Hammer: Active	Tap	
58.8	Tap, Break-in / Hammer	Tap	
72.0	Infiltration - Weeper	Infiltration	
72.9	Tap, Break-in / Hammer	Tap	
84.8	Tap, Break-in / Hammer: Active	Tap	
86.1	Infiltration - Weeper	Infiltration	
90.1	Deposits Attached: Encrustation	Deposits Attached	
90.1	Deposits Attached: Encrustation	Deposits Attached	
97.8	Tap, Break-in / Hammer: Active	Tap	
99.8	Tap, Break-in / Hammer	Tap	
101.6	Deposits Attached: Encrustation	Deposits Attached	
101.8	Deposits Attached: Encrustation	Deposits Attached	
114.5	Deposits Attached: Encrustation	Deposits Attached	
133.6	Tap, Break-in / Hammer: Intruding	Tap	
134.3	Tap, Break-in / Hammer: Capped	Tap	WITH BRICKS
135.2	Tap, Break-in / Hammer: Active	Tap	
137.6	Infiltration - Weeper	Infiltration	
142.6	Deposits Attached: Encrustation	Deposits Attached	
148.3	Tap, Break-in / Hammer: Defective	Tap	CAPPED, ENCRUSTATION, WEEPING
148.3	Infiltration - Runner	Infiltration	
149.9	Infiltration - Weeper	Infiltration	
168.8	Infiltration - Weeper	Infiltration	
178.0	Tap, Break-in / Hammer: Defective	Tap	CALAPSED
200.9	Tap, Break-in / Hammer	Tap	
208.3	Tap, Break-in / Hammer: Active	Tap	
223.8	Deposits Attached: Encrustation	Deposits Attached	
223.8	Deposits Attached: Encrustation	Deposits Attached	
229.8	Tap, Break-in / Hammer: Intruding	Tap	INTRUDING, ACTIVE
231.0	Tap, Break-in / Hammer: Intruding	Tap	
237.7	Infiltration - Weeper	Infiltration	
241.6	Tap, Break-in / Hammer: Defective	Tap	OFFSET, OPEN AROUND CONNECTION
242.6	Tap, Break-in / Hammer: Active	Tap	
245.0	Tap, Break-in / Hammer: Capped	Tap	WITH BRICKS
245.6	Water Level	Miscellaneous	
272.5	Tap, Break-in / Hammer: Abandoned	Tap	NO CAP
289.1	Tap, Break-in / Hammer	Tap	
297.8	Tap, Break-in / Hammer: Active	Tap	
302.2	Brickwork - Dropped Invert	Brickwork	
321.1	Brickwork - Dropped Invert	Brickwork	
347.6	Tap, Break-in / Hammer	Tap	
348.5	Vermin - Rat	Vermin	

- Multiple reports can be generated with software.

PACP Report

- Still photos of every logged defect provided
- Can quickly scroll to any defect or feature in pipe
- Video organization important for future use



PACP Grading System

Index Scores for Pipe Condition

- 5: Immediate attention needed
- 4: Poor; will become Grade 5 in near future
- 3: Fair; moderate
- 2: Good; has not begun to deteriorate
- 1: Excellent; minor defects

Likelihood of Failure as per Defect Grade (from NASSCO)

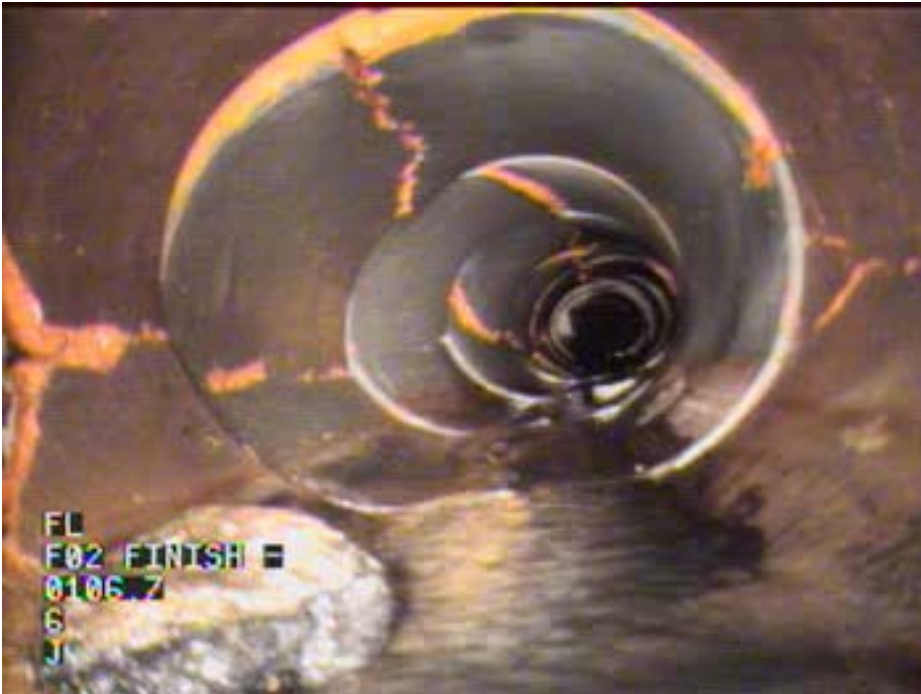
- 5: Pipe has failed or will likely fail within 5 years
- 4: Pipe will probably fail in 5-10 years
- 3: Pipe may fail in 10-20 years
- 2: Pipe unlikely to fail for at least 20 years
- 1: Failure unlikely in foreseeable future

WHAT DEFINES FAILURE?

Sewer Assessment – Defect Grading: Only the Beginning

- Pipe with a structural index score of 3.2 – Pipe is deformed for 50'

- Pipe with a structural index score of 5.0 – Pipe has 20' of dropped invert



WHICH PIPE IS IN WORSE CONDITION?

PACP Structural Index Score: 5



PACP Structural Index Score: 5

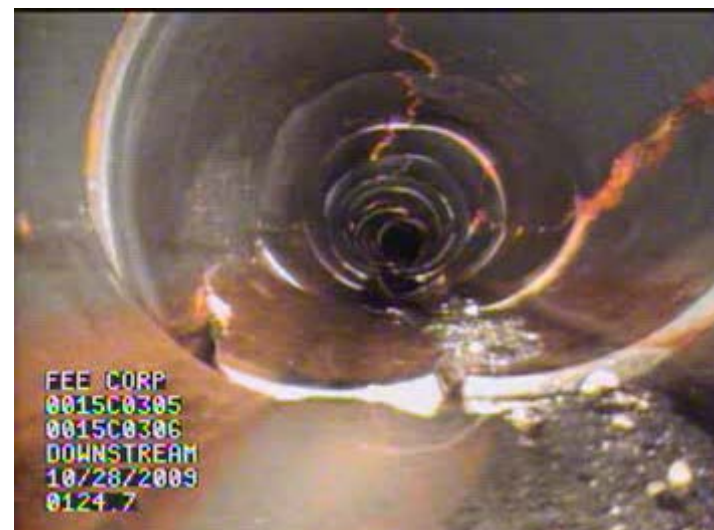
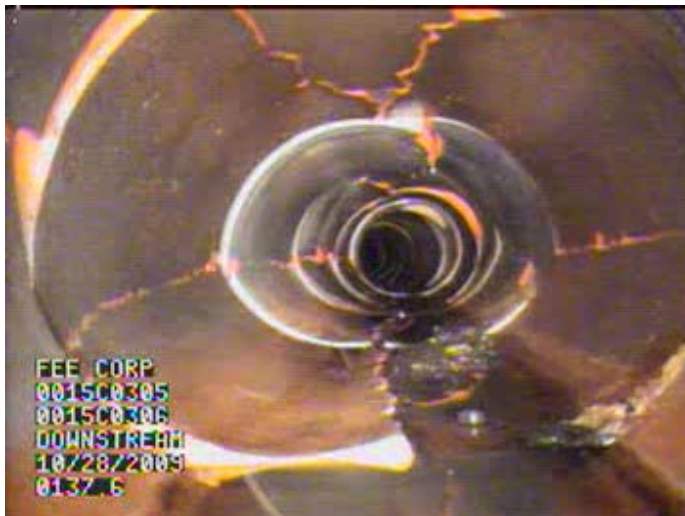
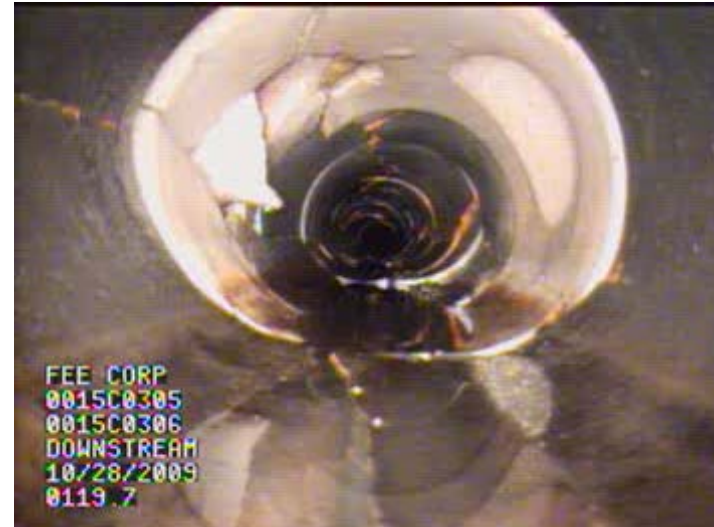
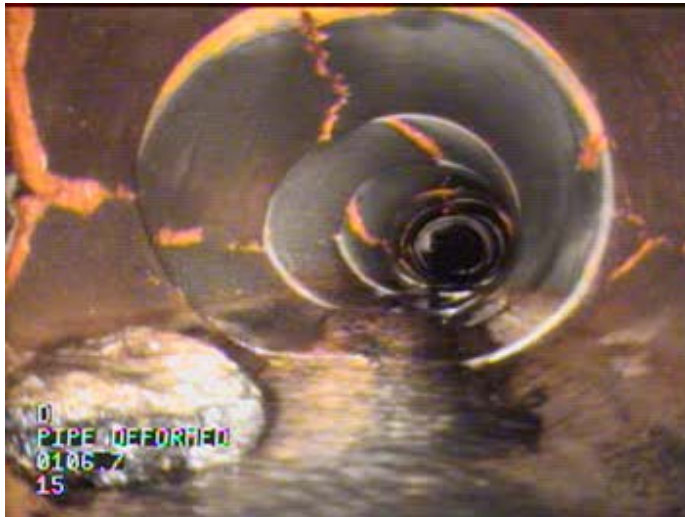


PACP Structural Index Score: 5



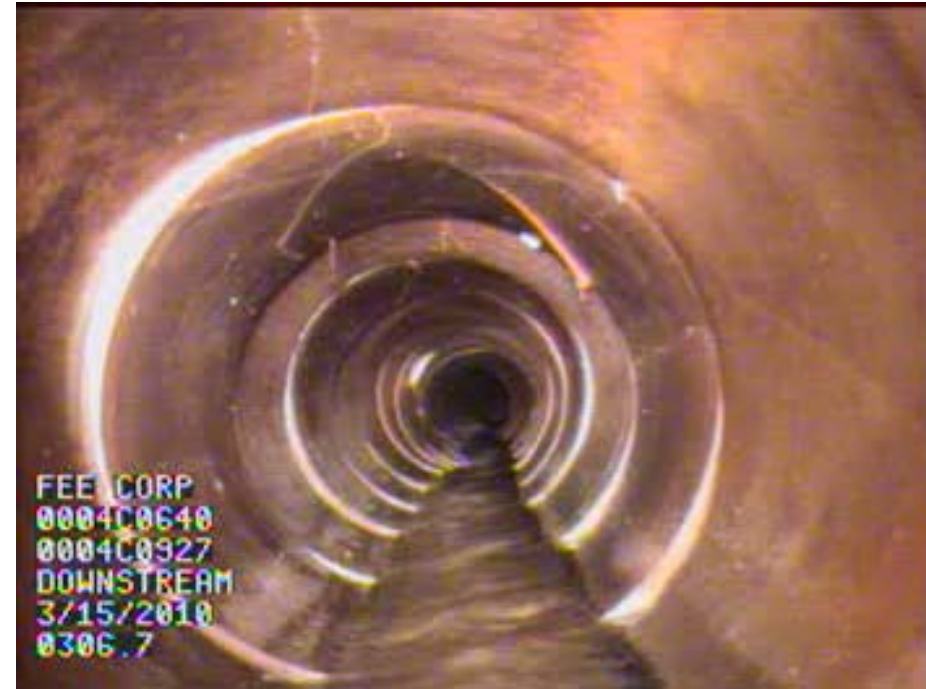
PACP Structural Index Rating: NOT 5

Structural Index Rating: 3.2



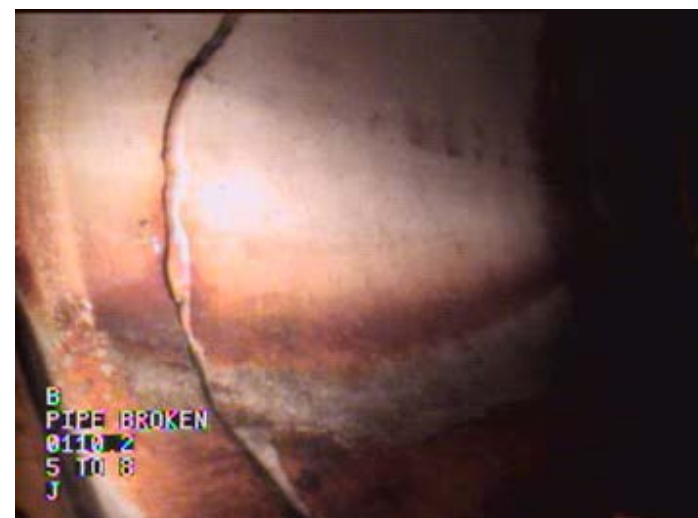
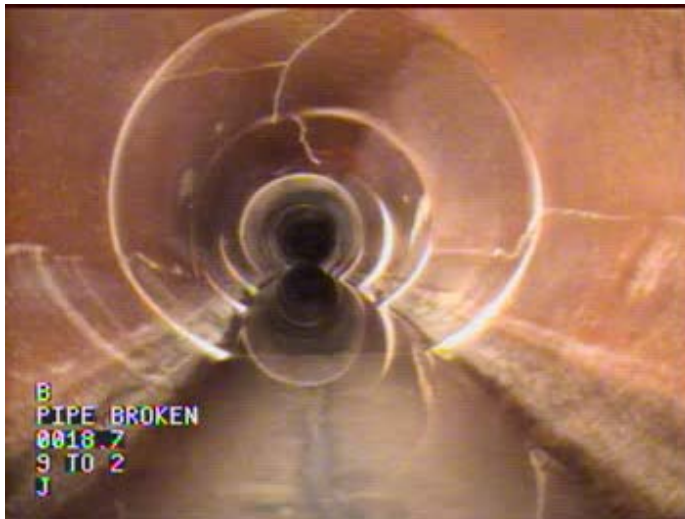
PACP Structural Index Rating: NOT 5

Structural Index Rating: 2.6



PACP Structural Index Rating: NOT 5

Structural Index Rating: 3.4



What do defect grades mean for rehab/replacement?

- NASSCO notes that “Condition Grading System alone is inadequate for determining if a pipe segment should be rehabilitated or replaced”.
- Blanket statements have been rejected by municipalities looking to get the best value for their rehab dollars
 - E.g. “All sewers with an index score of 3 or higher must be rehabilitated/replaced”

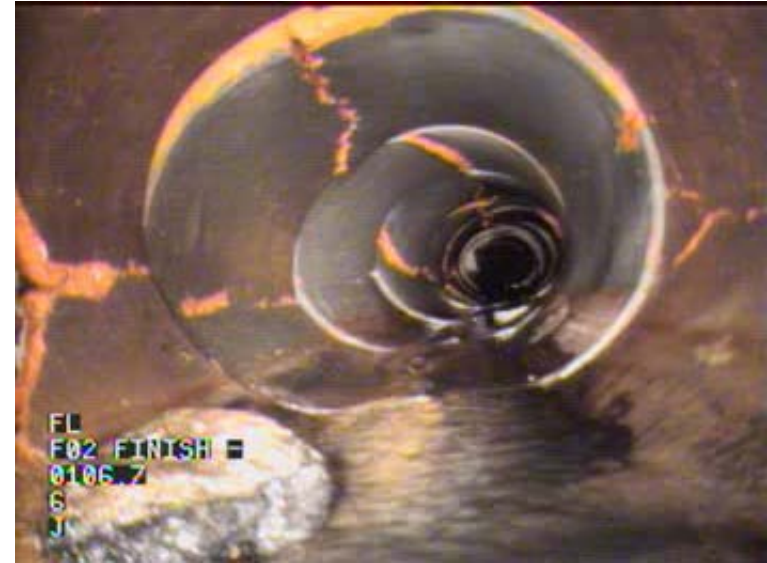
How to align these seemingly different pipe scores?

- Engineering Judgment
 - All video should be reviewed by a qualified, experienced engineer
- Remaining Useful Life Estimate (RUL)
 - Based on defects (NOT scores), estimate the RUL of each pipe segment
 - Little data exists on this; there is difficulty in reaching a consensus on these values
- Likelihood of Failure & Consequence of Failure
 - Determine the value of each and adjust pipe rehabilitation recommendations accordingly
 - What value is “probably fail”? “may fail”?

Engineering Judgment

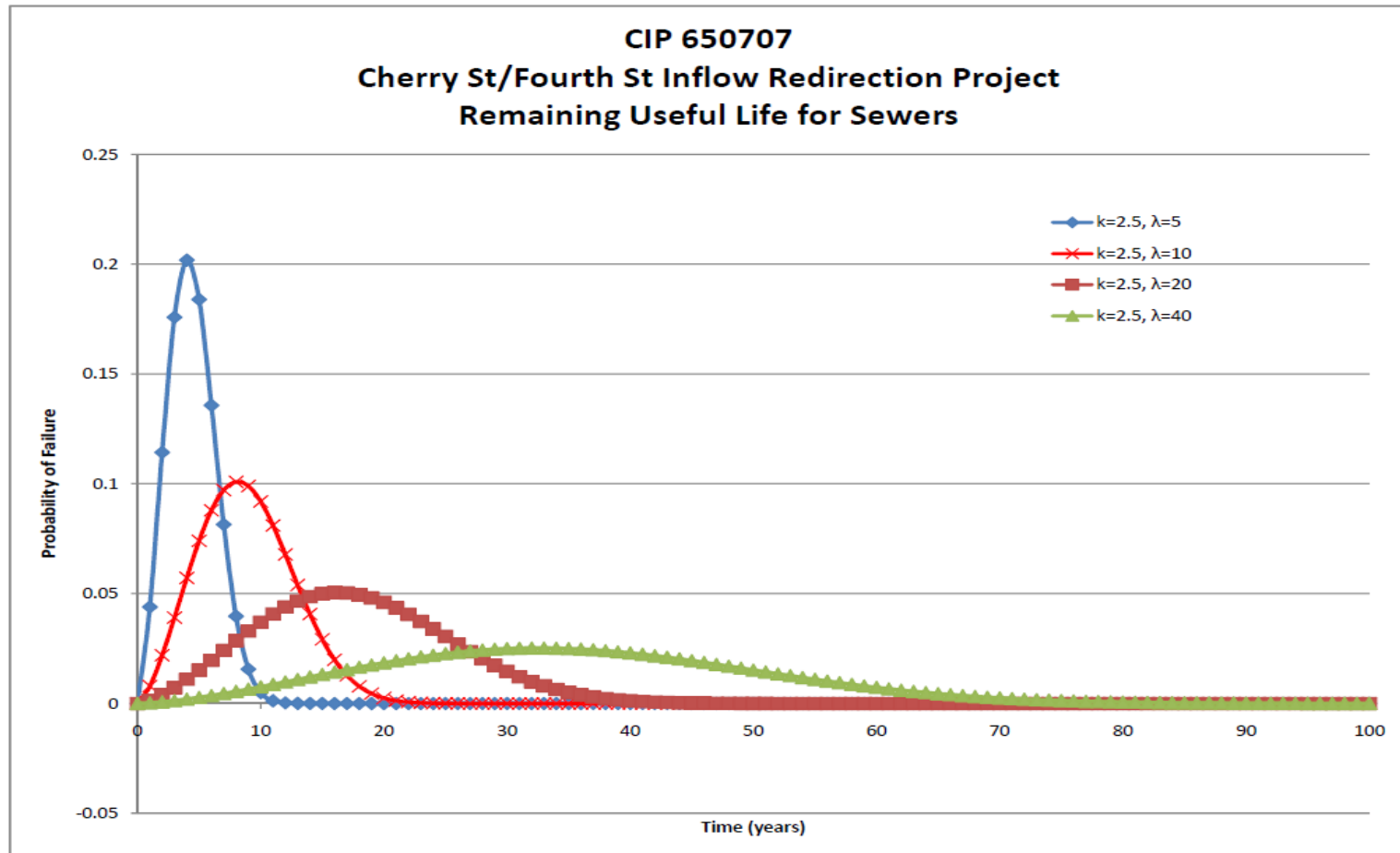
- The top pipe is the priority for rehabilitation. Why?
 - There are many structural defects in this pipe section, including cracks, fractures, holes, etc.
 - Brick sewer is over 100 years old ... not likely to catastrophically collapse soon

Applying values to these statements is the challenge!



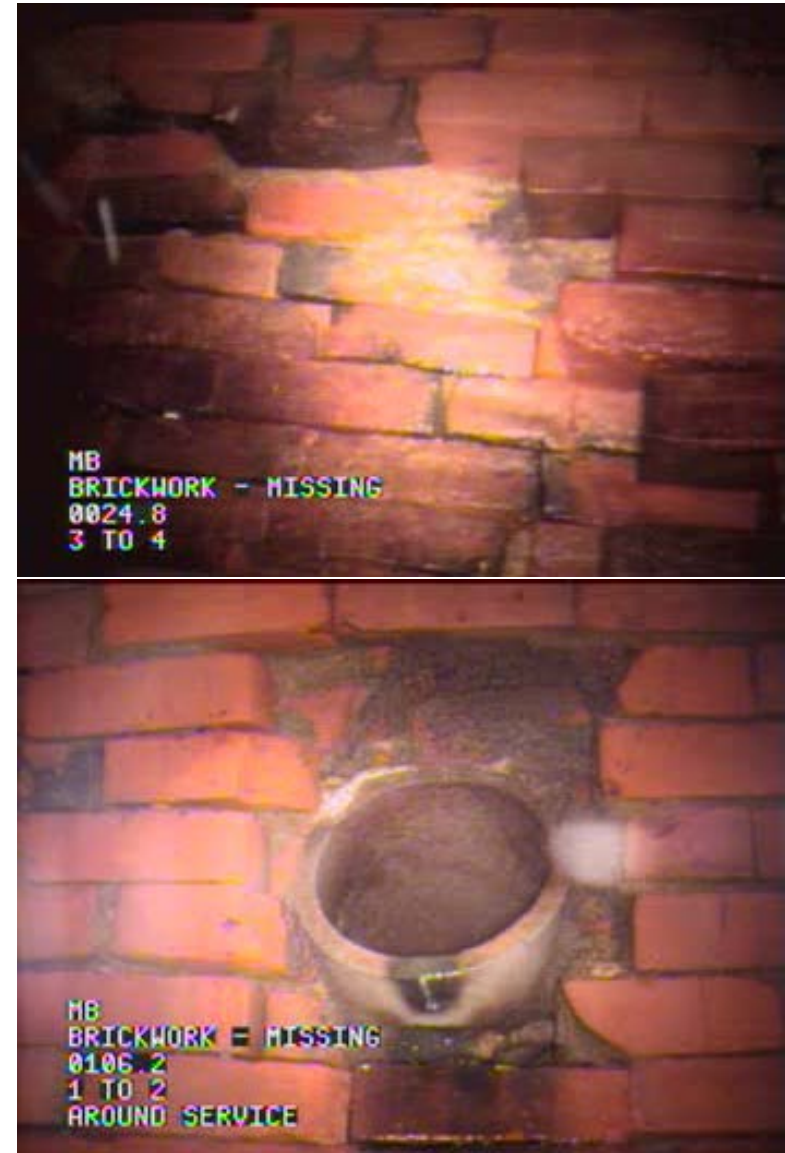
Remaining Useful Life Estimate

- Estimate RUL based on number and severity of defects
- Clearly define pipe failure to determine when a pipe has failed
- No existing data on RUL for sewer defects; must be developed by engineer & accepted by client (how to accept with no numerical backup?)



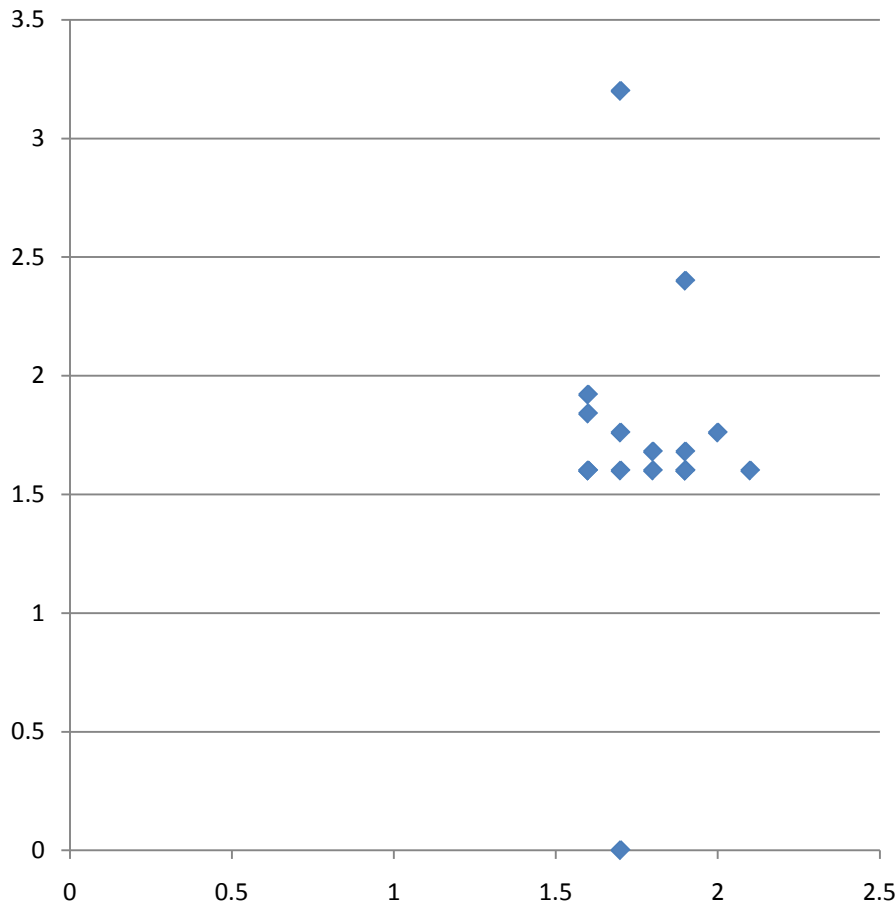
RUL Estimating

- Existing data is scarce
- Very few studies have been done that accurately compare the condition of sewer segments over time
- The affect a defect has on RUL is largely unknown at this time as there is little to no data



Likelihood of Failure (LOF) vs. Consequence of Failure (COF)

Likelihood of Failure vs. Consequence of Failure



- Calculate Likelihood of Failure
 - Factors include
 - Velocity, Deficiency Rating
- Calculate Consequence of Failure
 - Factors include
 - Diameter, Depth
 - Surface Access, Social Consequence
 - # Taps, # Complaints, # WIBs
 - Cleaning required, Trib WW Characteristics

LOF/COF

- Consult with owner on what constitutes LOF and COF
- Consult with owner on weights to be given to each factor

Upstream MH	Downstream MH	# of Taps	Tap Score	Weighting Factor - Taps	Cleaning Score	Weighting Factor - Cleaning	Access Score	Weighting Factor - Access	Complaints	Complaint Score	Weighting Factor - Complaints	WIBs	WIB Score	Weighting Factor - WIBs	Tributary WW Score	Weighting Factor - Trib. WW	Consequence of Failure Score
0015C033 2	0015C033 1	18	2	0.1	5	0.2	5	0.1	0	0	0.1	0	0	0.4	1	0.1	1.8
0015C033 1	0015C031 0	25	3	0.1	5	0.2	5	0.1	5	1	0.1	0	0	0.4	3	0.1	2.2
0015C031 0	0015C028 3	10	1	0.1	5	0.2	5	0.1	2	1	0.1	3	1	0.4	5	0.1	2.6

Recommended Sewer Assessment Method

- Define “Pipe Failure”
- Decide which factors to include in LOF/COF analysis
- Agree on reasonable RUL for pipe segment scores
- Decide what % constitutes “probably fail” and “may fail”

Recommended Sewer Assessment Method

- Use all 4 factors:
 - PACP Score
 - Engineering Judgment
 - RUL Estimate
 - Likelihood of Failure vs. Consequence of Failure
- Communicate with owner throughout project
- Make a balanced, clear recommendation for sewer rehabilitation.

QUESTIONS



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