

# BUILDING A WORLD OF DIFFERENCE

## Managing the Useful Life of Your Segmented Block Combined Sewer

BUILDING A WORLD OF DIFFERENCE®



26 July 2017

Presenter

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June 28, 2017



**BLACK & VEATCH**

# Agenda

- Background
- Inspection / Rehabilitation Methods
- Risk Assessment / Investment
- Lessons Learned
- Next Steps
- Questions

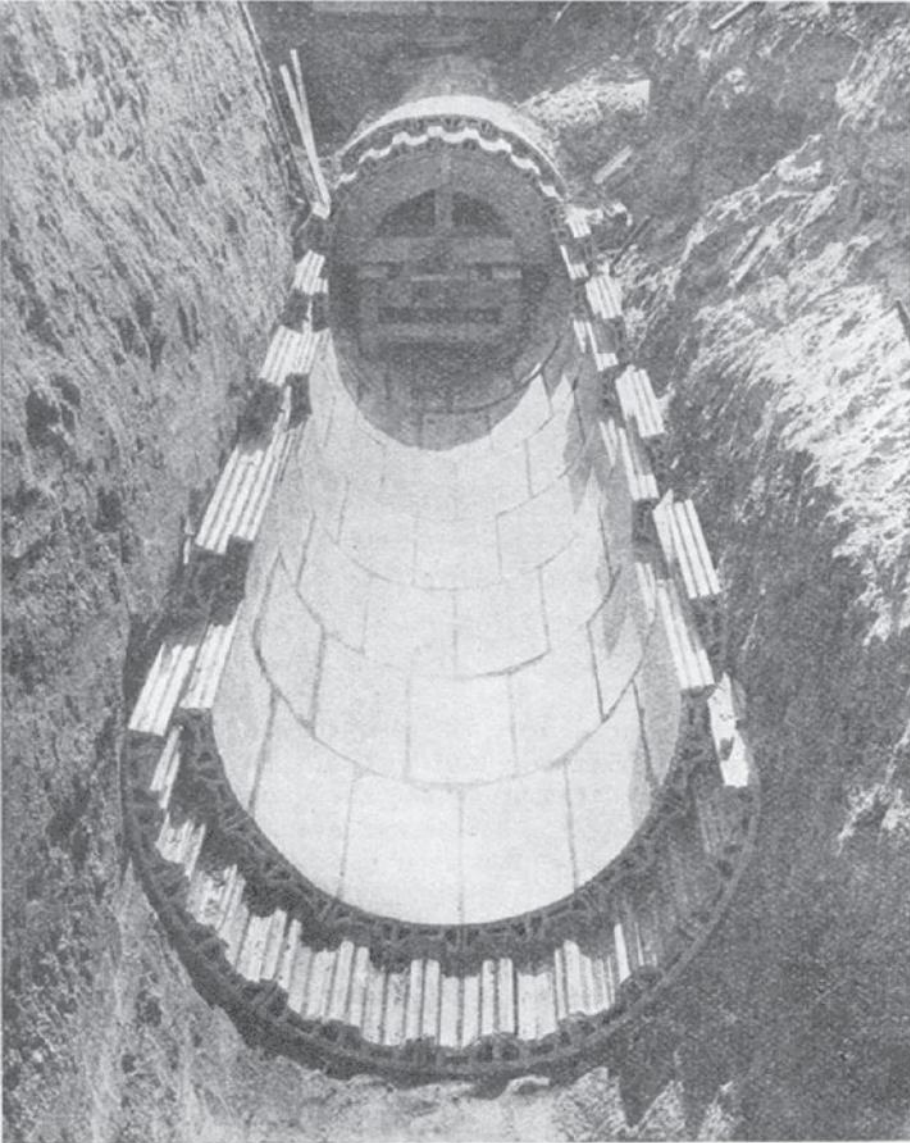


# Background



# Background

- Combined Sewer System
- Over 70 Years Old
- 24"-132" Diameter
- Segmented Block
- No On-Going O&M Program
- Sewer Collapses



IV. A 48-INCH SEGMENTAL BLOCK SEWER UNDER CONSTRUCTION IN WAUSAU, WIS.



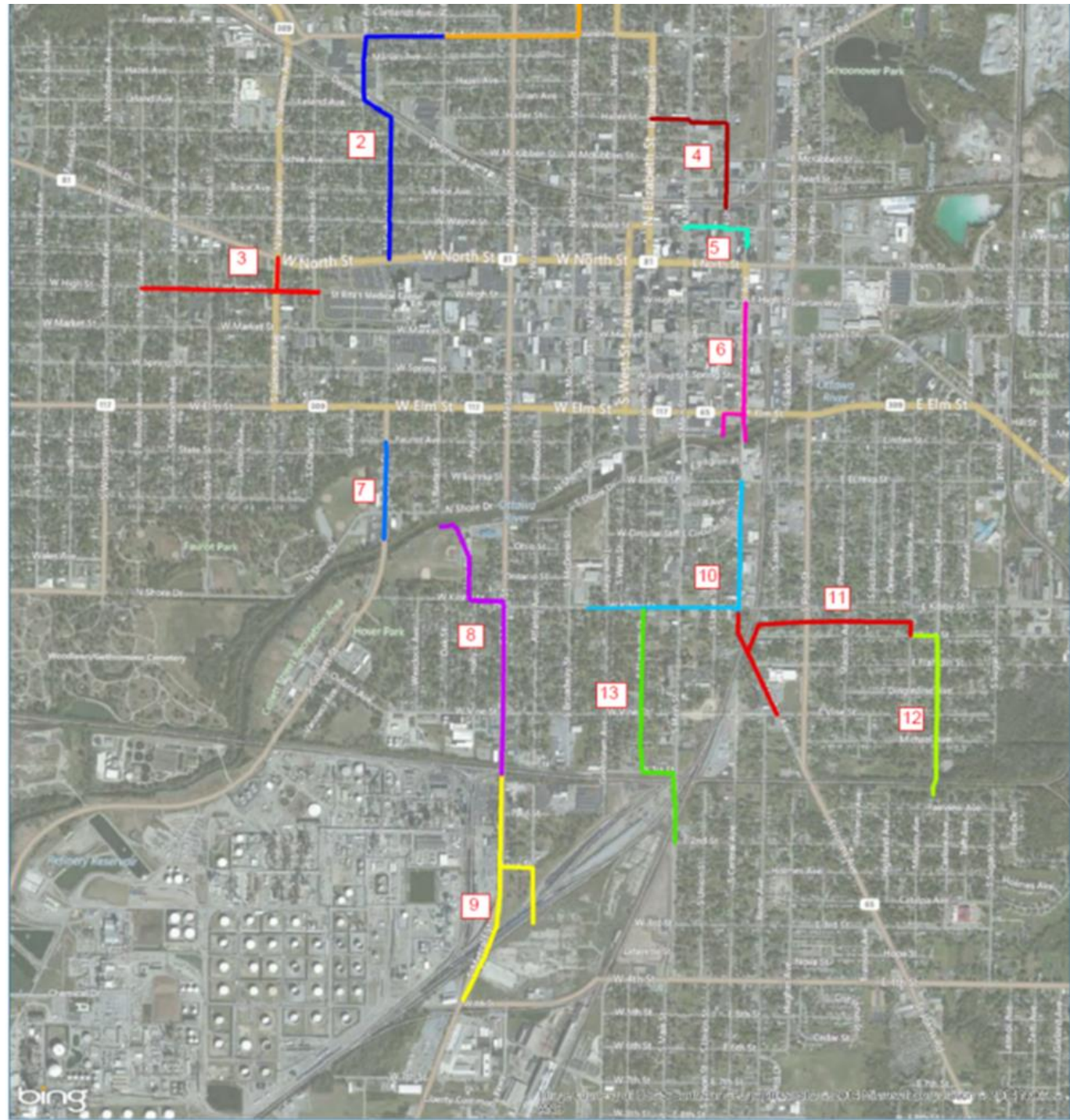
# Sewer Collapse



# Inspection / Rehabilitation Methods



# Inspection Divided into 13 Sub Areas



# Used NASSCo Grading

Pipeline Grade	Classification	General Description	Guideline Relating to Failure
5	Immediate Attention	Defects requiring immediate attention	Has failed or will likely fail within 5 years
4	Poor	Severe defects that will become grade 5 within the foreseeable future	Pipe will probably fail in 5 to 10 years
3	Fair	Moderate defects that will continue to deteriorate	Pipe may fail in 10 to 20 years
2	Good	Defects that have not begun to deteriorate	Pipe unlikely to fail for at least 20 years
1	Excellent	Minor defects	Failure unlikely in the foreseeable future





# CCTV and Physical Inspections

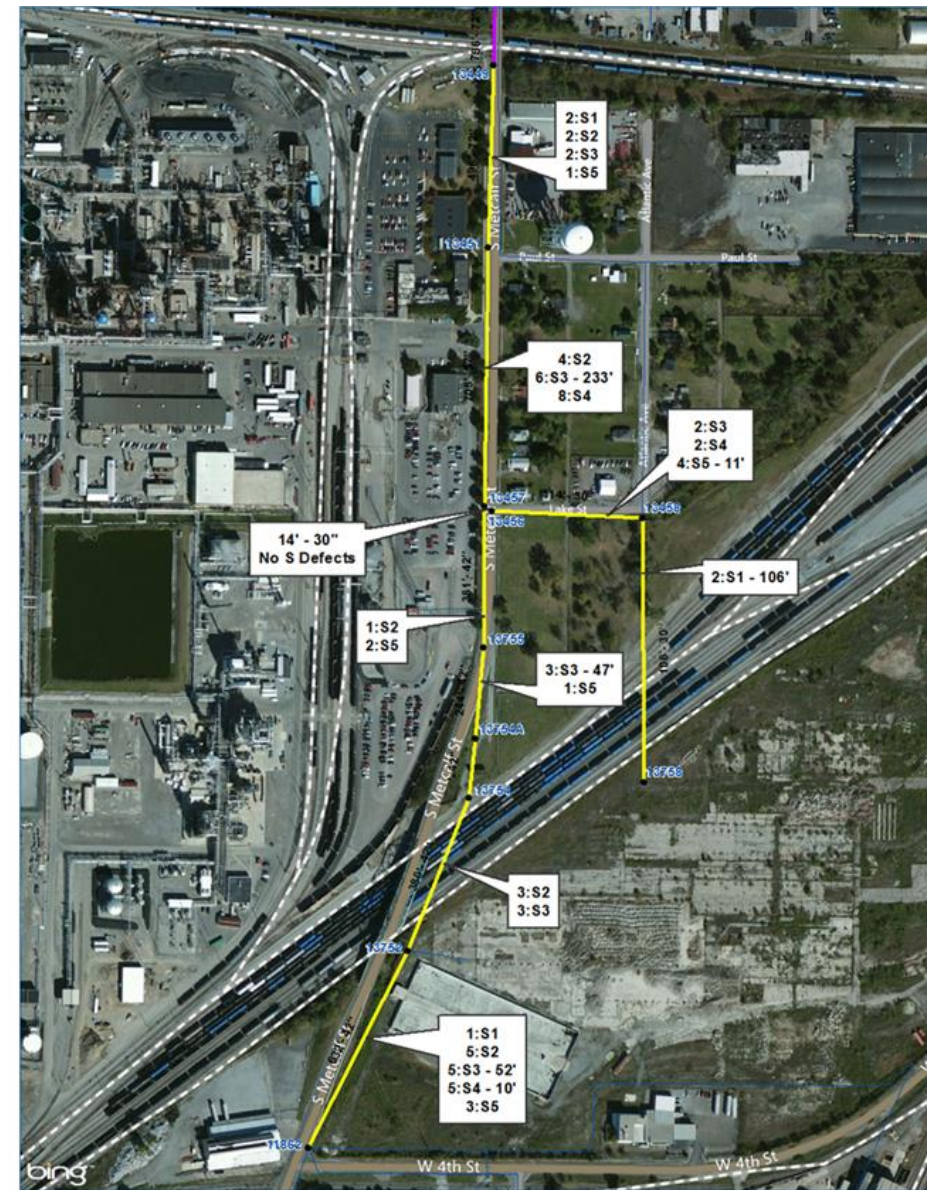
- **CCTV**
  - < 72" Mainline Sewer: Mounted on Robotic Platform, IBAK CCTV
  - < 42" Main line Laterals
  - NASCCo PACP Coding
- **Physical**
  - > 72" IBAK Man-Cam System
  - Laterals (54" and larger)
  - NASCCo PACP Coding



# Area 9 Inspection Results

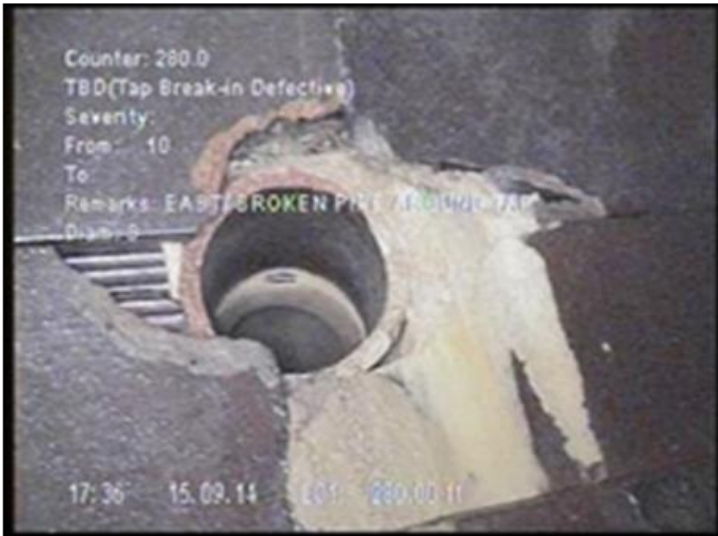
**SUMMARY OF INSPECTION RESULTS BY SEGMENT**

Segments			Number of Defects by Grade					
From MH	To MH	Size	Grade 5	Grade 4	Grade 3	Grade 2	Taps	
13458	13456	30	4	2	2	0	10	
11862	13752	42	3	2	7	5	0	
13457	13755	42	2	0	0	1	11	
13755	13754A	42	1	0	3	0	4	
13449	13451	72	1	0	2	2	0	
13752	13754	42	0	0	3	3	0	
13457	13451	57	0	8	6	4	20	
13458	13758	30	0	0	0	0	1	
13456	13457	30	0	0	0	0	0	



**Sewer Condition Assessment for Lima, OH**  
**S Metcalf St & Lake St**  
 Inspection Area 9  
 105015

# Lateral Connections



# Advantages and Disadvantages of Rehabilitation Methods Considered

	ADVANTAGES	DISADVANTAGE
Spot Repairs	<ul style="list-style-type: none"> <li>• Reconnection of laterals may not be required.</li> <li>• Reduces overall cost of repairs.</li> </ul>	<ul style="list-style-type: none"> <li>• Repair to defective laterals would be additional work.</li> <li>• Only repairs a portion of the pipe segment.</li> <li>• Repairs typically have a shorter design life.</li> </ul>
Full Replacement	<ul style="list-style-type: none"> <li>• Does not require bypass and system out of service.</li> <li>• Reconnection of laterals requires minimal disruption to service.</li> </ul>	<ul style="list-style-type: none"> <li>• Requires closing of the road and greater impacts to traffic.</li> <li>• Requires larger areas of restoration of site.</li> <li>• Acquisition of easement, right of way or relocation of other utilities is typically required.</li> </ul>
Sliplining	<ul style="list-style-type: none"> <li>• Bypass pumping requirements are minimized.</li> <li>• No special equipment for installation is required.</li> <li>• Provides new pipe.</li> </ul>	<ul style="list-style-type: none"> <li>• Loss of cross sectional area reduces flow capacity.</li> <li>• Grouting of annular space is required.</li> <li>• Requires access and retrieval sites for completing the work.</li> <li>• Requires excavation to reconnect laterals.</li> </ul>



# Advantages and Disadvantages of Rehabilitation Methods Considered

	ADVANTAGES	DISADVANTAGE
Spray Applied Cementitious	<ul style="list-style-type: none"><li>• Requires small access openings or pits.</li><li>• Thin wall minimizes loss of cross sectional area and hydraulic impact.</li><li>• Suitable for uneven wall surface</li></ul>	<ul style="list-style-type: none"><li>• Requires bypass and system out of service.</li><li>• Requires specific design and installation to repair defects.</li><li>• Requires several days to cure</li></ul>
Spiral Pipe Renewal	<ul style="list-style-type: none"><li>• Installation can repair segments of pipe between manholes without excavation</li><li>• The requirements for bypass pumping are minimized</li><li>• Provides new pipe</li></ul>	<ul style="list-style-type: none"><li>• Installation is a proprietary process and requires specialized equipment and certified installers.</li><li>• Installation requires grouting of annular space</li><li>• Reconnection of laterals and connection to other pipe requires special fittings</li></ul>



# Risk Assessment / Investment



# Risk Assessment Evaluations

- **Consequence of Failure (CoF)**
- **Likelihood of Failure (LoF)**
- **Business Risk Exposure (BRE)**

# Consequences of Failure

- Previous studies used a 1-3 score
- Expanded to 1-5 due to wide range of pipe sizes, potential consequences

CONSEQUENCE OF FAILURE	
	Proposed Score
<b>Critical Customers</b>	
Hospital	3
City Service Facilities	2
School	2
Public Facilities	2
None Identified	0
<b>Environmental</b>	
Park	3
Lake	3
Surcharge	3
Storage	2
River	2
Wetland	2
Stream	2
Potential Surcharge	1
None Identified	1

<b>Traffic Impacts</b>	
Highway, Railroad	3
Major Roadways	2
Minor Roadways	1
No impact	0
<b>Business Impacts</b>	
Commercial	3
Industry	2
None Identified	0
<b>Residential Impacts</b>	
High density land use	3
Medium density land use	2
Low density land use	1
None Identified	0





# Likelihood of Failure

- Determination of the Likelihood a failure would occur
  - Structural
  - Operational
- Rated on a 1-5 Score

# Structural Rankings by Business Risk Exposure

ID (From-To)	Area	Length (ft)	Adjusted CoF	Combined Structural LoF	Structural BRE
11944-11952	2	382	4.05	5.00	20.24
11944-11933	2	350.2	4.05	4.48	18.13
13250-13266	3	432.7	3.50	5.00	17.51
12034-11948	2	573	3.70	4.65	17.21
11876-14458	1	336.5	3.33	5.00	16.67
13198-13250	3	545.3	3.70	4.19	15.49
14899-13266	3	415.1	3.33	4.46	14.87
11933-11948	2	494	3.70	3.99	14.76
12036-12035	1	463	3.50	3.23	11.32
12036-14453	1	859.9	3.50	3.02	10.56
13250-13146A	3	205	3.33	2.43	8.11
12035-12034	1	423.4	3.50	2.26	7.92
13240-13236	7	452.1	4.21	1.77	7.45
12582-12581	12	137.1	3.20	2.21	7.07
12136-12143	4	486.1	3.08	2.03	6.25
14456-14454	1	447.4	3.50	1.77	6.18

# BRE Structural Failure Risk Profile: Segments

Likelihood of Failure

5	0	0	0	5	2
4	0	0	0	3	0
3	0	0	0	4	0
2	0	0	0	8	2
1	0	0	0	77	8
	1	2	3	4	5

Consequence of Failure



# Business Risk Exposure- Structural

- Immediate Risk (Red): 8.4%
- High Risk (Orange): 5.1%
- Medium Risk (Yellow): 14.2%
- Low Risk/Main (Green): 69.1%
- Not Inspected 3.2%

Based on 35,946 LF inspected



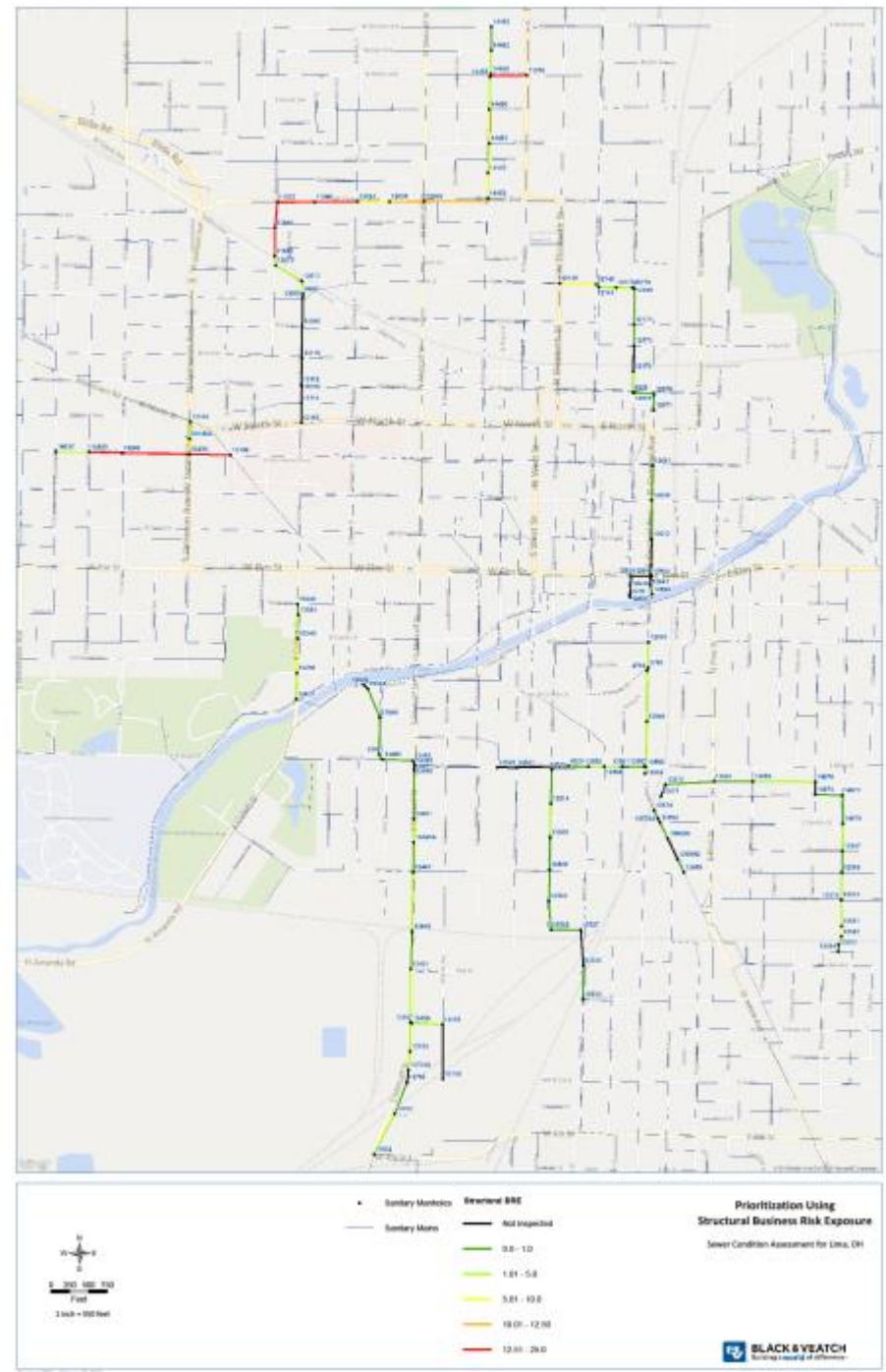
# BRE Prioritization of Projects: Structural

- Based on Combined Structural Risk and CoF
  - Immediate Risk (Red): 3,035 LF
  - High Risk (Orange): 1,817 LF
  - Medium Risk (Yellow): 5,089 LF
  - Low Risk (Green): 25,000 LF

Likelihood of Failure	5	0	0	0	2,303	732
	4	0	0	0	1,817	0
	3	0	0	0	1,252	0
	2	0	0	0	2,985	852
	1	0	0	0	23,125	1,738
		1	2	3	4	5



# Prioritization Using Structural Business Risk Exposure



From-To)	Area	Length (ft)	Adjusted CoF	Combined O&M LoF	O&M BRE
08-13250	3	545.3	3.70	5.00	18.49
10-12632	6	510.6	3.62	5.00	18.10
16-14453	1	859.9	3.50	4.88	17.07
14-11948	2	573	3.70	4.39	16.24
19A-13609B	11	299	3.41	4.39	14.98
14-11952	2	382	4.05	3.35	13.57
13-13075	2	399.9	4.05	3.23	13.08
19-13461	8	490.2	3.15	3.96	12.48
16-14458	1	336.5	3.33	3.66	12.20
14-14452	1	400.8	3.50	3.48	12.16
19-13447	8	785.7	3.89	2.87	11.16
18-13758	9	105.8	3.15	3.48	10.97
11-13466	8	649.5	3.60	2.99	10.74
11A-13447	8	396.8	3.60	2.99	10.74
18-12644	6	272	3.22	3.25	10.48
11-13558	10	262.2	3.40	2.93	9.94
13-11948	2	494	3.70	2.62	9.70
19-2793	10	670	3.60	2.62	9.43
12-14899	3	385.1	3.40	2.77	9.42
11-13567	10	288	3.15	2.87	9.04
16-12845	8	65.6	3.15	2.85	8.97
12-13581	11	650	3.41	2.62	8.95
13-14452	1	326.5	3.75	2.38	8.92
18-4310	6	273.4	3.22	2.75	8.86
17-13451	9	707.5	3.37	2.62	8.84
10-13266	3	432.7	3.50	2.50	8.76
17-13755	9	381.4	3.20	2.62	8.40
11A-13491	8	303.5	3.60	2.32	8.33
15-13581	11	515.7	3.41	2.38	8.12
12-13752	9	631.9	3.20	2.50	8.01
10-13243	7	310.4	4.21	1.89	7.97
12-13527	13	393.4	3.33	2.38	7.93

## O&M Rankings by Business Risk Exposure



# BRE O&M Failure Risk Profile : Length of Pipe

Likelihood of Failure	5	0	0	0	2,788	0
	4	0	0	0	1,605	782
	3	0	0	0	12,714	0
	2	0	0	0	7,187	1,431
	1	0	0	0	7,188	1,109
		1	2	3	4	5
Consequence of Failure						





# BRE O&M Failure Risk Profile : Segments

Likelihood of Failure	5	0	0	0	5	0
	4	0	0	0	5	2
	3	0	0	0	29	0
	2	0	0	0	24	5
	1	0	0	0	34	5
	-1	1	2	3	4	5

Consequence of Failure



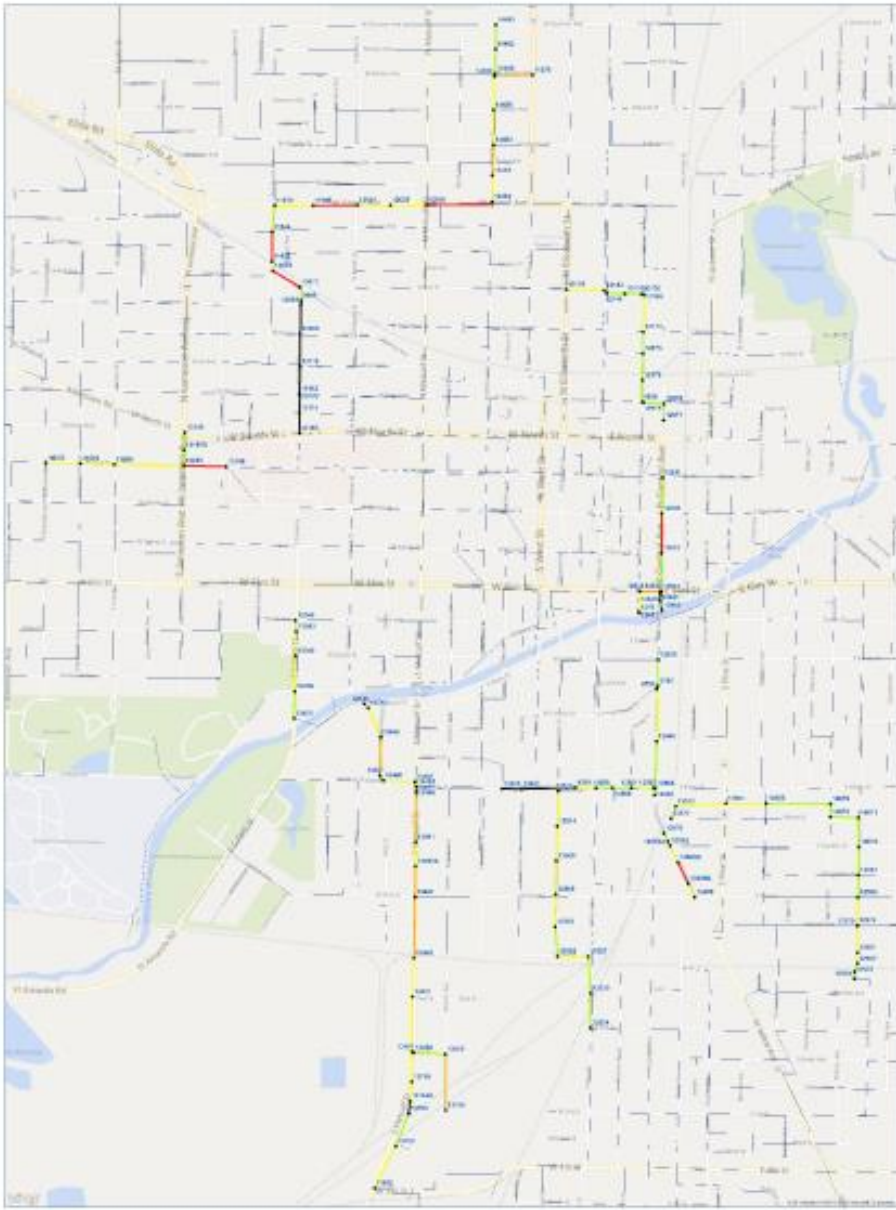
# Business Risk Exposure- O&M

- Immediate (Red): 9.9%
- High Risk (Orange): 4.5%
- Medium Risk (Yellow): 59.3%
- Low Risk/Main. (Green): 23.1%
- Not Inspected (Due to Issues): 3.2%

Based on 35,946 LF inspected



# Prioritization Using O & M Business Risk Exposure



**Prioritization Using O&M Business Risk Exposure**  
Source: Condition Assessment for Lines, OH

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Engineering • Consulting • Construction

# Summary of O & M Cost

YEAR	1	2	3	4
Cleaning	\$412,000	\$412,000	\$169,000	\$231,000
Inspection	\$134,000	\$112,000	\$0	\$0
TOTAL	\$546,000	524,000	\$169,000	\$231,000



# Investment Table

	YEARS 1-3	YEARS 2-5	YEARS 6-10	TOTAL
CIP	\$13.7 M	\$5.2 M	\$2.4 M	\$21.3 M
O&M	(*)	\$0.924 M	TBD	\$0.924 M +
TOTAL	\$13.7 M	\$6.124 M	\$2.4 M ++	\$22.22 M +

\* Year 1 cost included in CIP Projects



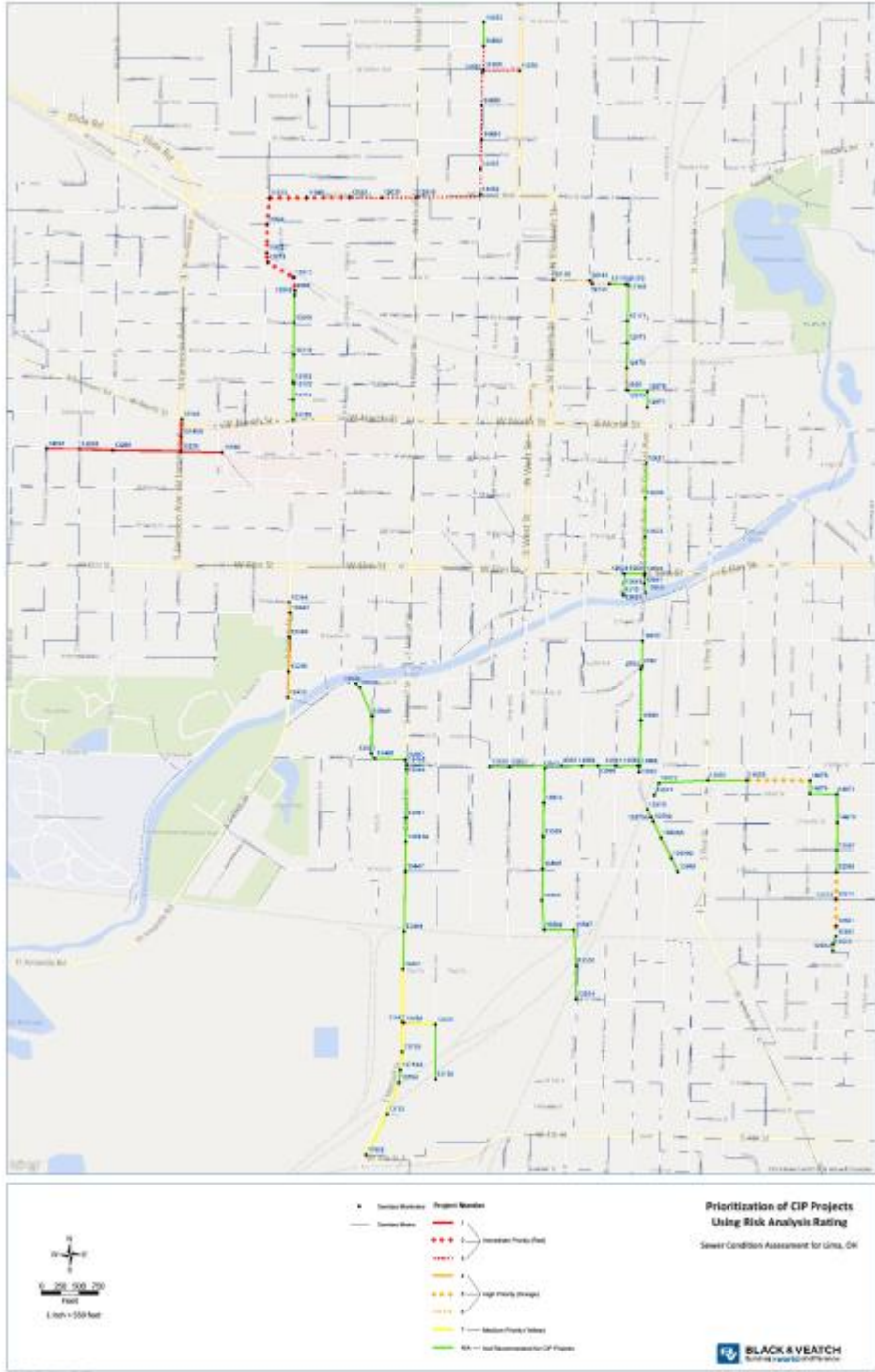
# Lessons Learned

- **Benefits of a Regular O&M Program**
- **Challenges in Using the NASSCo PACP Coding for Segmented Block Sewers**
- **Limited Resources**
- **Competing Programs (i.e. Wet Weather Program)**
- **Installation of Laterals**
- **Spring Line Failure Point**

# Next Steps



# Prioritization of CIP Projects Using Risk Analysis Ratings





# Capital Projects

Project No.	Project Priority	Total Project Cost	Length (ft)	Diameter (in.)	Structural BRE			Maintenance		Recommended Method of Restoration
					Immediate Risk (ft)	High Risk (ft)	Medium Risk (ft)	Low Risk Priority	Lowest Priority	
1	< 1-yr	\$ 2,700,000	2,106	48, 54, 78	1,393	0	205	508	0	Rehabilitation
2	< 1 - 2-yr	\$ 5,400,000	2,549	78	1,799	0	0	749	0	Rehabilitation
3	< 1 - 3-yr	\$ 5,600,000	4,028	30, 54, 66	337	1,323	1,197	1,143	28	Rehabilitation
<b>Total</b>	<b>&lt; 1 - 3-yr</b>	<b>\$ 13,700,000</b>	<b>8,682</b>		<b>3,529</b>	<b>1,323</b>	<b>1,402</b>	<b>2,400</b>	<b>28</b>	
4	2 - 5-yrs	\$ 2,900,000	1,254	78, 84	0	0	452	657	145	Rehabilitation
5	2 - 5-yrs	\$ 1,700,000	1,672	42, 60	0	0	137	1,535	0	Rehabilitation
6	2 - 5-yrs	\$ 600,000	1,051	27, 30, 36	0	0	486	565	0	Rehabilitation
<b>Total</b>	<b>2 - 5-yrs</b>	<b>\$ 5,200,000</b>	<b>3,977</b>		<b>0</b>	<b>0</b>	<b>1,075</b>	<b>2,757</b>	<b>145</b>	
7	6 - 10-yrs	\$ 2,400,000	2,846	30, 42, 57	0	0	0	2,379	467	Rehabilitation



# O&M Future Laser / Sonar / CCTV Inspection Schedule

FROM -TO/ AREA	LENGTH (FT)	DIAMETER	INSPECTION COST (\$9/LF)
YEAR 1 INSPECTION PROJECT			
36 - 12169 (4)	1,009	27" & 30"	\$9,081
76 - 12971 (5)	773	36" & 42"	\$6,957
23 - 13249 (7)	1,109	78" & 84"	\$9,981
52 - 13754 (9)	1,085	42"	\$9,765
74A - 13449 (9)	1,829	42" & 54"	\$16,461
56 - 13458 (9)	414	42"	\$3,726
25 - 13567 (10)	2,044	30" & 48"	\$18,400
58 - 12938 (10)	1,647	72"	\$14,823
34 - 14674 (12)	2,427	42" & 54"	\$21,843
TOTAL (*)	12,337 LF		\$133,244
YEAR 2 INSPECTION PROJECT			
50 - 12611 (6)	1,640	54" & 60"	\$14,760
51 - 12849 (8)	3,201	72" & 108"	\$28,809
76 - 13572 (11)	2,000	54" & 60"	\$17,991
34 - 13515 (13)	3,477	48", 54" & 60"	\$31,293
TOTAL			\$111,423



# O&M Future Cleaning Schedule

(FROM -TO)/ AREA	PROJECT NO.	LINEAL FEET	SIZE	CLEANING (24-36") \$80/LF	CLEANING (42-102") \$150/LF	TOT
INCLUDED IN PROJECTS IDENTIFIED FOR YRS 1-3 REHABILITATION						
13250-13198 (3)	1	545	78"			
12034-11948 (2)	2	573	78			
11944-11952 (2)	2	382	78			
13073-13075 (2)	2	400	78"			
12036-14453 (1)	3	860	66			
TOTAL		2760			\$414,000	\$496,
YEAR 1 CLEANING PROJECT						
13449-13447 (8)		786	72			
13447-13491A (8)		397	72			
13491A-13491 (8)		304	72			
13491-13466 (8)		650	72			
13466-13465 (8)		66	72			
13465-13467 (8)		84	108			
TOTAL		2287			\$343,050	\$411,
YEAR 2 CLEANING PROJECT						
13467-13460 (8)		404	108			
13460-13461 (8)		20	78			
13461-12849 (8)		490	36			
12849-12845 (8)		409	36			
12845-12846 (8)		66	36			
TOTAL		1389		\$77,200	\$63,600	\$168,
YEAR 3 CLEANING PROJECT						
13451-13457 (9)	7	708	57			
13456-13458 (9)		414	30			
13458-13758 (9)	4	106	30			
12651-4310 (6)		10	36			
4310-12638 (6)		273	36			
12638-12640 (6)		272	36			
TOTAL		1783		\$86,000	\$106,200	\$230,



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26 July 2017

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