

### Inflow/Infiltration Reduction and Sewer Rehabilitation Project: A Patient, Comprehensive Approach to Remove Inflow and Infiltration

Steve Perdios, PE Project Manager



Katie Pratka Project Engineer

### City of Beverly, Massachusetts

# **Reasons for Project**

- Aging infrastructure is leading to:
  - System leaks
  - Sewer backups
  - Inflated treatment costs
- Previous Inflow and Infiltration studies show problem areas throughout the city of Beverly
- Study in 1993-1995 shows 3 areas of concern: Subsystems J, M, and D
- Updates to Regulations



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# Mother's Day Storm 2006

#### "Once in a lifetime"

- 17+ inches of rainfall over 3 days (Friday May 12-Monday May 15<sup>th</sup>)
- Additional rainfall that Wednesday





# Mother's Day Storm - 2006



- Subsystem M was overwhelmed:
  - Sewer backups
  - Street flooding
  - Basement flooding



# The Sewershed – Subsystem M



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#### Mass DEP Guidelines for Performing Infiltration/Inflow Analyses And Sewer System Evaluation Survey, 1993

#### Some Definitions:

- Infiltration Water other than wastewater that enters a sewer system through defective pipes, pipe joints, connections, or manholes. UNINTENTIONAL *from defects*
- Inflow Water other than sanitary flow that enters a sewer from roof leaders, cellar drains, yard drains, area drains etc. INTENTIONAL *someone built it this way* 
  - "Total Inflow volume" inflow from a single storm event including both direct and delayed inflow. It is the area between the storm event hydrograph and the dry weather hydrograph.
  - "Direct Inflow Volume" direct connections to the collection system such as catch basins, roof leaders, manhole covers, etc. A rapidly impact to the collection system and produce an inflow hydrograph which *sharply increases soon after the start of the storm and decreases swiftly upon conclusion of the rainfall event*.
- Private Infiltration/Inflow Source I/I from a private source



# **Prevalent in Subsystem M**

- "<u>Delayed Inflow</u>" that portion of total inflow which is generated from connections which produce inflow after a significant time delay from the beginning of a storm. Sump pumps.
- "<u>Rainfall-Induced Infiltration</u>" the short-term increase in infiltration which is the direct result of stormwater percolation into the ground and through collection system *defects* in pipes, joints, connections, or manhole walls which lie near or are readily reached from the ground surface. Through the analysis of metering data, rainfallinduced infiltration can not be distinguished from delayed inflow and is therefore part of delayed inflow.

# Sewer Flow and Rainfall Coloration











# Inflow vs Rainfall



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# Further Study of Subsystem M

- Flow Isolation (2007)
  - 12am-6am
- Manhole inspections (2007)







# Leaking Manhole



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# Worst manhole after lining





# **Rehabilitation Options**

- Cured in Place
- Fold and Form
- Pipe Bursting
- Open Cut
- Chemical Grouting
- Cementitious vs. Epoxy Manhole Liner
- Poly Vinyl vs Epoxy Lateral Liner



# **Rehabilitation Plan**

- Trenchless Technology:
  - Cleaning and CCTV
  - CIPP Main Lining
  - MH repair and lining
  - Epoxy lateral lining









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## Main Line CIPP



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## **Service Laterals**





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# **Lining Service Laterals**



- Lining from main or manhole
- "Full Wrap"
- Seals connection to main



## **Lining Service Laterals**



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# **Lining Service Laterals**





## **Importance of Lateral Lining**







# **Importance of Lateral Lining**







# **Lining Lessons Learned**

- Cannot line laterals in high groundwater
- Impacts to Homeowners
  - Can't use water during lining (4 hours)
  - Possible splashing at basement sinks/toilets
  - Communication issues
- Re-instating taps that are capped
- Data management



## **Construction Schedule**





# Work completed by end of Spring 2016

Work	Work Completed by May	Percent of Work Completed by May	Percent of Sewershed Rehabilitated		
Sewer Mains Lined	11,181 feet	100%	46%		
Laterals Lined	94	50%	46%		
Manholes Lined	17 (130 VF)	18% (130/737 VF)	46%		

Private Inflow = Sump Pumps							
231 Doors knocked	78 Basements Inspected	8 Sump Pumps Found to Enter Sewer System					
Approximately 400 homes in sewershed. Extrapolate this ratio to assume 41 homes requiring sump pumps to be redirected away from the sewer. About 10%.							

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## **Historical Rain Data**

	2011		2012		2013		2014		2015		2016	
	Rain Fall	Infiltration										
Feb	4.29	0.16-0.23	1.0	0.22-0.30	2.92	0.13-0.22	1.26	0.14-0.21	0.23	0.12	3.50	0.24-0.30
March	2.16	0.24	1.88	0.22-0.25	1.62	0.38	3.55	0.19-0.24	2.94	0.14-0.40	4.11	0.24-0.30
April	5.46	0.20-0.30	2.89	0.16-0.20	1.10	0.21	2.28	0.21-0.25	3.15	0.37-0.60	2.42	0.20-0.25
May	3.17	0.13-0.20	3.53	0.22-0.24	1.57	0.15-0.17	2.25	0.13-0.21	1.27	0.20-0.30	2.86	0.18-0.22
June	5.27	0.06-0.13	4.71	0.20-0.29	6.61	0.14-0.24	2.27	0.10-0.14	4.13	0.14-0.22	2.06	0.10-0.17
	20.35		14.0		13.8		11.6		11.7		15.0	

Rainfall in inches Infiltration in millions of gallons per day



# Questions

- Any questions?
- What is the answer to life, the universe, and everything?
- 42
- No really. Any other questions?
- There are no dumb questions.
- Except that one. Really? You're going to really ask <u>that</u>?

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