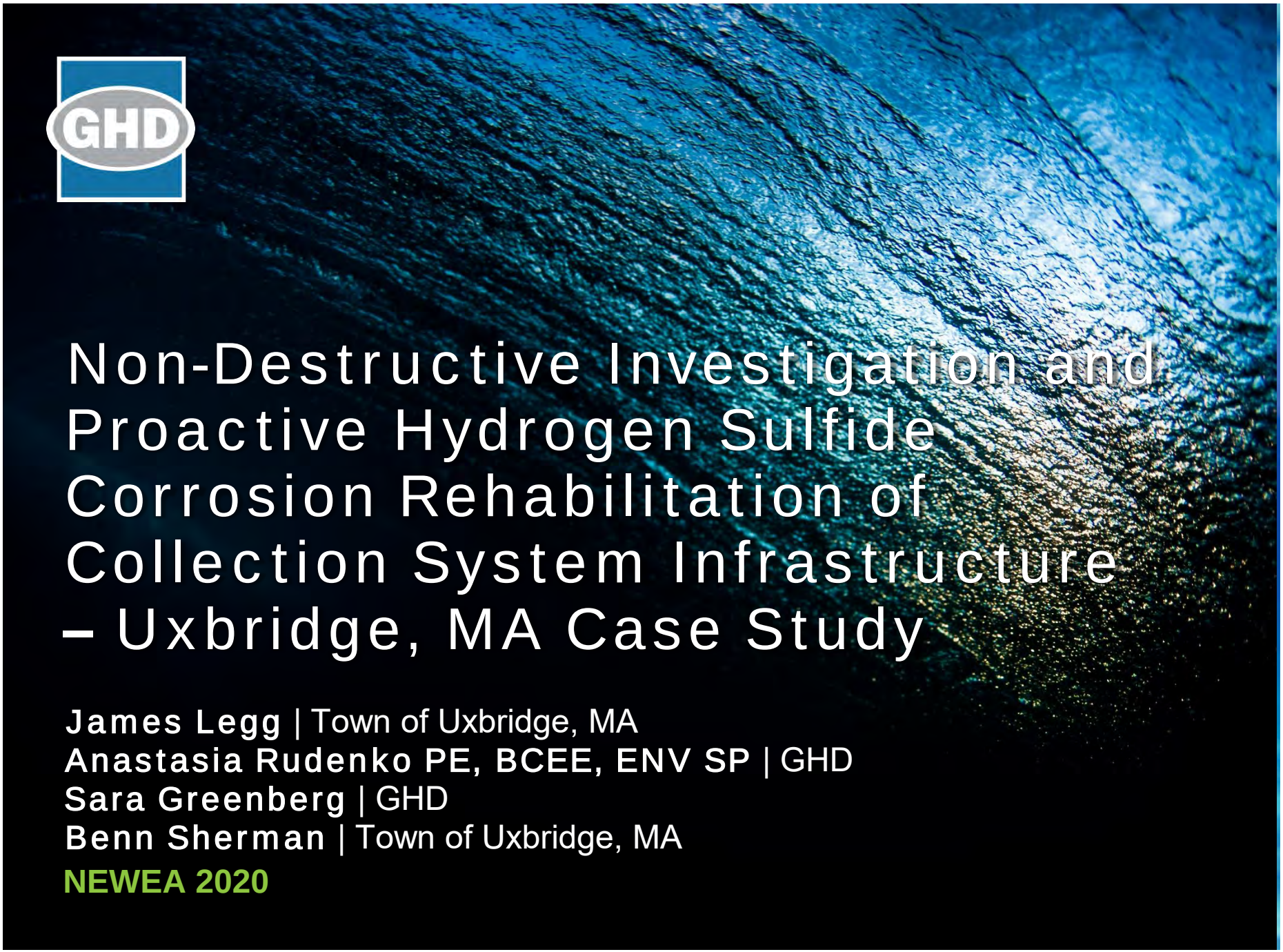

Non-Destructive Investigation and Proactive Hydrogen Sulfide Corrosion Rehabilitation of Collection System Infrastructure – Uxbridge, MA Case Study

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NEWEA 2020

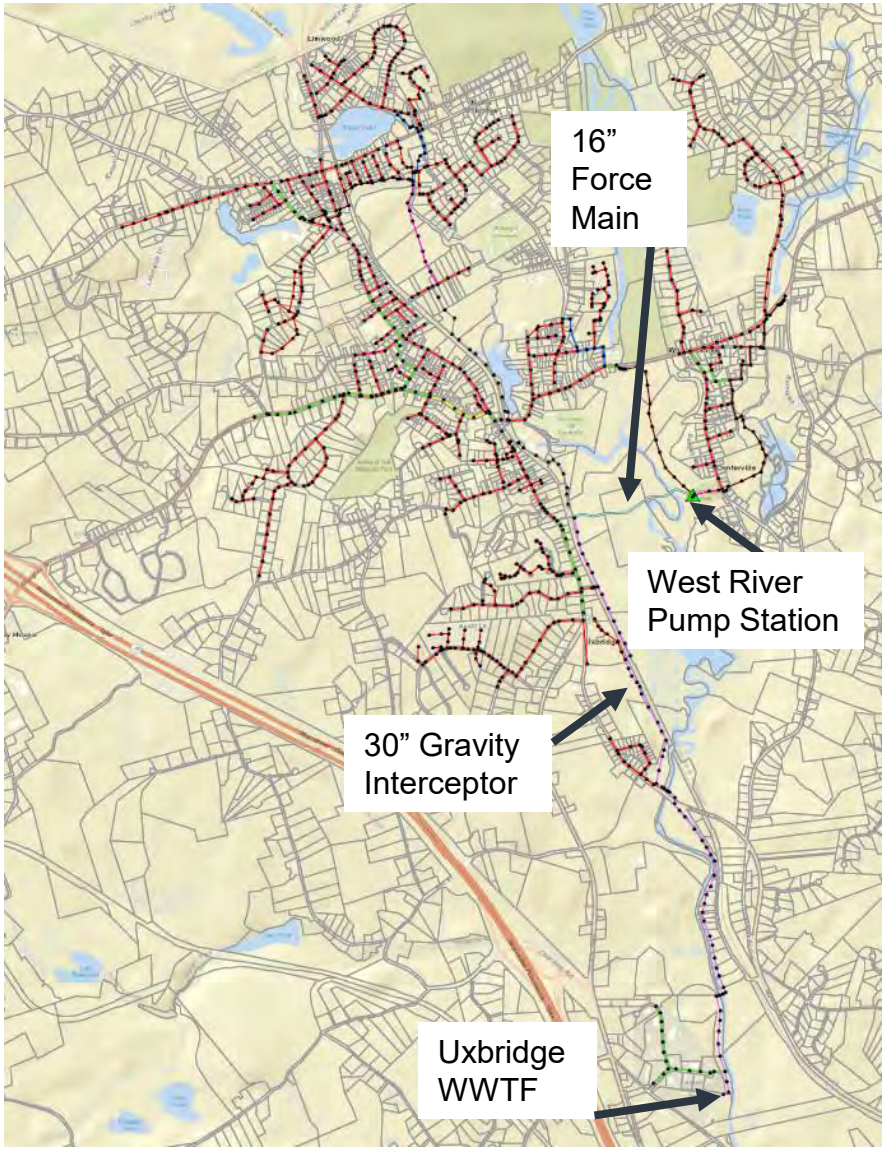
Session overview

1. Background
2. Hydrogen sulfide investigation technologies
3. Non-Destructive Investigation
4. Rehabilitation options
5. Construction

Background

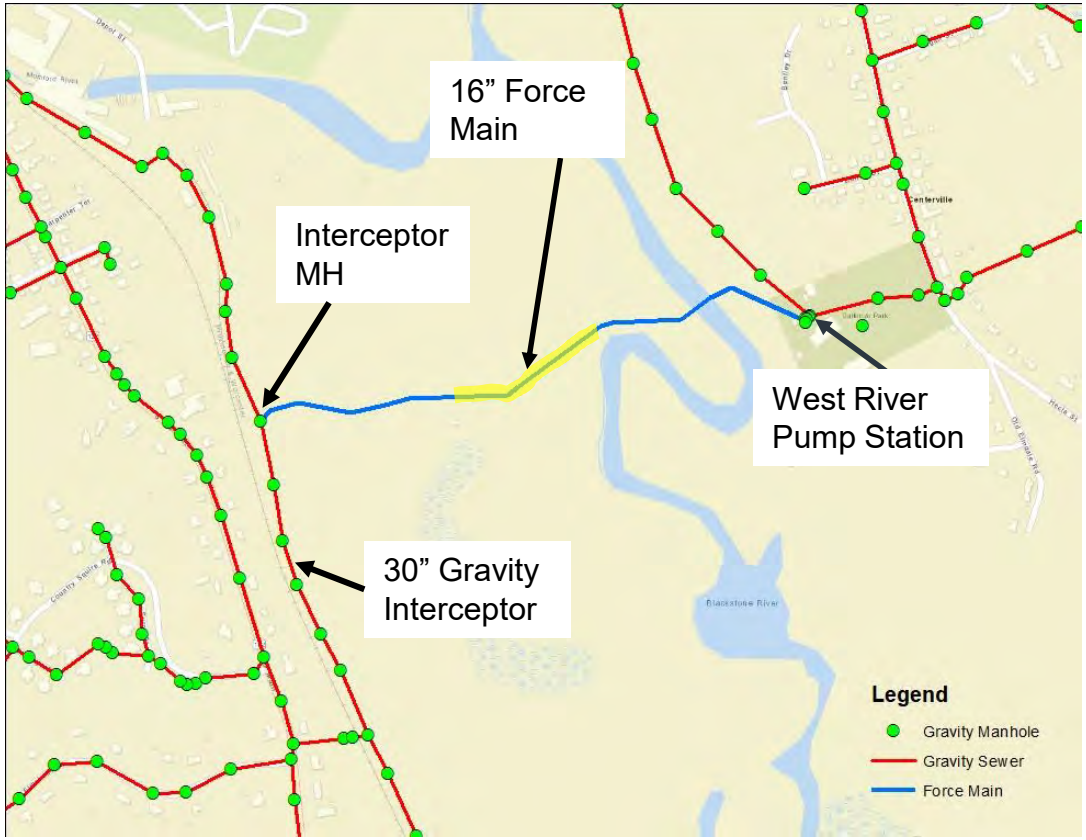
Uxbridge collection system

- Original sewer system constructed in the late1970s
  - RCP, AC, PVC, and DI Pipe
  - ~ 189,000 LF of gravity sewer
  - ~ 6,000 LF of Force Main
  - Five pump stations



Force main

- Class 52 DI Pipe
- Force main route
  - Inverted siphon
  - Easement
  - Wellfield (lined)
- Access Points
  - Two air release valves
  - Manhole (entry point for lining)



Initial investigations

- Visual inspection of interceptor manhole indicated hydrogen sulfide degradation

- Turbulent conditions at this location indicated high hydrogen sulfide corrosion vulnerability:
  - Interceptor manhole
  - Downstream Reinforced Concrete Pipe (RCP) gravity sewer
  - Upstream Ductile Iron (DI) force main

The Concern

Plymouth bypassing 3 miles of sewer main

Plymouth responds to sewer main break no. 2

Plymouth sewer problems could cost millions

By: Robert Goulston

Updated: Apr 1, 2016 - 6:40 PM

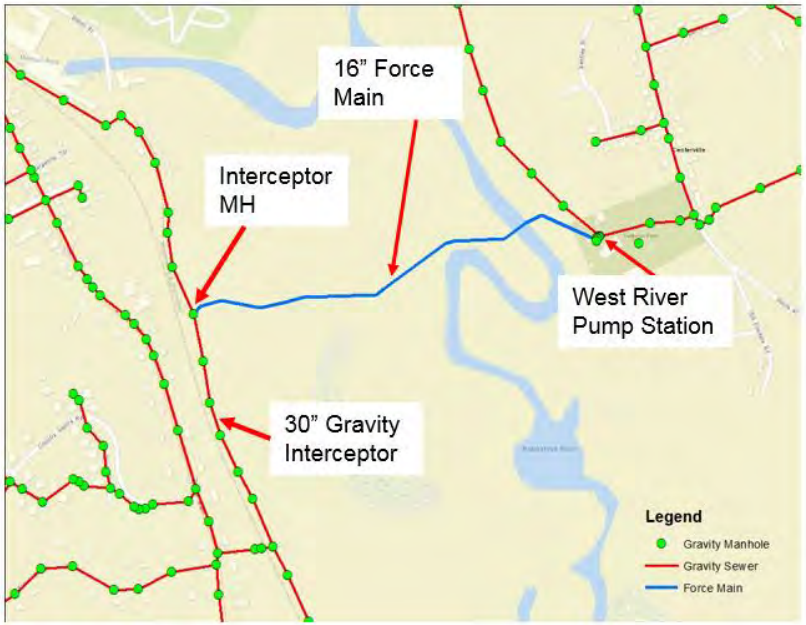
Closed Circuit Television (CCTV) inspection

- Inspected
  - 1 upstream pipe segment
  - 2 downstream pipe segments
- CCTV indicated minor defects upstream of the interceptor manhole
- CCTV of downstream gravity interceptor found:
  - Aggregate visible
  - Intruding Sealing Ring
  - Infiltration gusher at broken joint

CCTV inspection video

Project components

- Town concerned about structural integrity of:
  - Gravity Sewer – CCTV
  - Interceptor MH – Visual Inspection
  - Force Main
- Needed non-destructive testing method to assess force main integrity



Hydrogen Sulfide Investigation Technologies

Technology summary

Acoustic Technologies

- EchoLogics
- Pure Technologies – Smart Ball

Electro-Magnetic Technologies

- EchoLogics

Ultrasonic

- LPI, Inc.

Photos from Pure Technologies (Smartball)

Photo from EchoLogics

Acoustic technologies

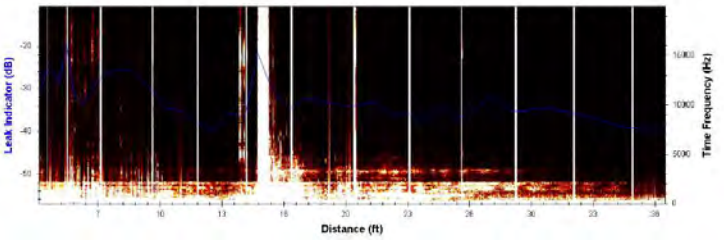
Method 1 (Echologics)

- Acoustic sensors applied to exterior of pipe
- Detects gas pockets between sensors
- Excavations needed at periodic intervals

Method 2 (Smartball)

- Free-swimming tool inserted into pipeline
- Acoustic sensors applied to exterior of pipe
  - Collects acoustical data from within pipeline
  - Detects sound of pressure change in a leak

Photos from Pure Technologies (Smartball)



Both methods recommended pipe pressurization to improve accuracy of inspection

- Not recommended for this project

Electro-Magnetic technologies

- Broadband electromagnetic pipe scanning
- Recommended <u>following acoustic testing</u>
- Measures remaining thickness of metal
- Pipe thickness loss detected through signal distortion
- Not recommended for this project

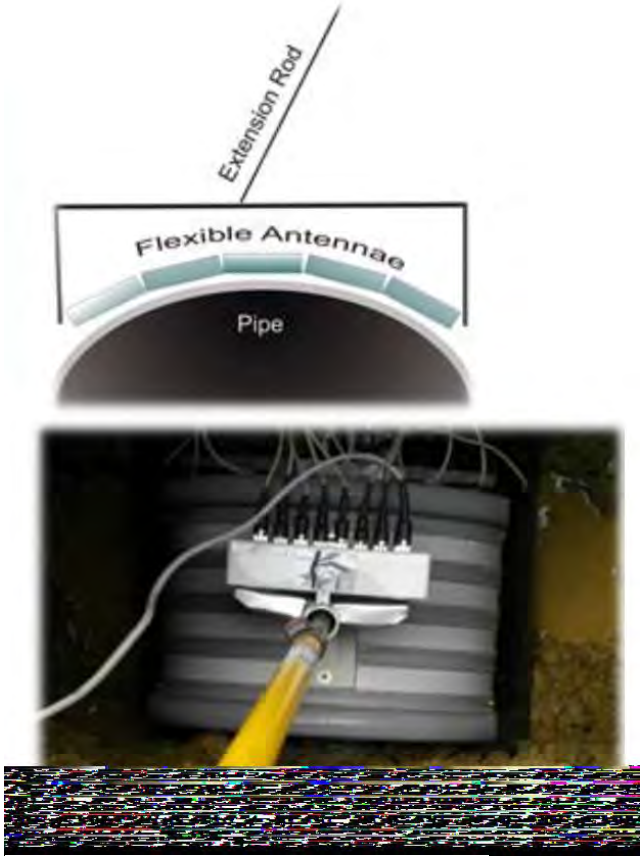


Photo from EchoLogics

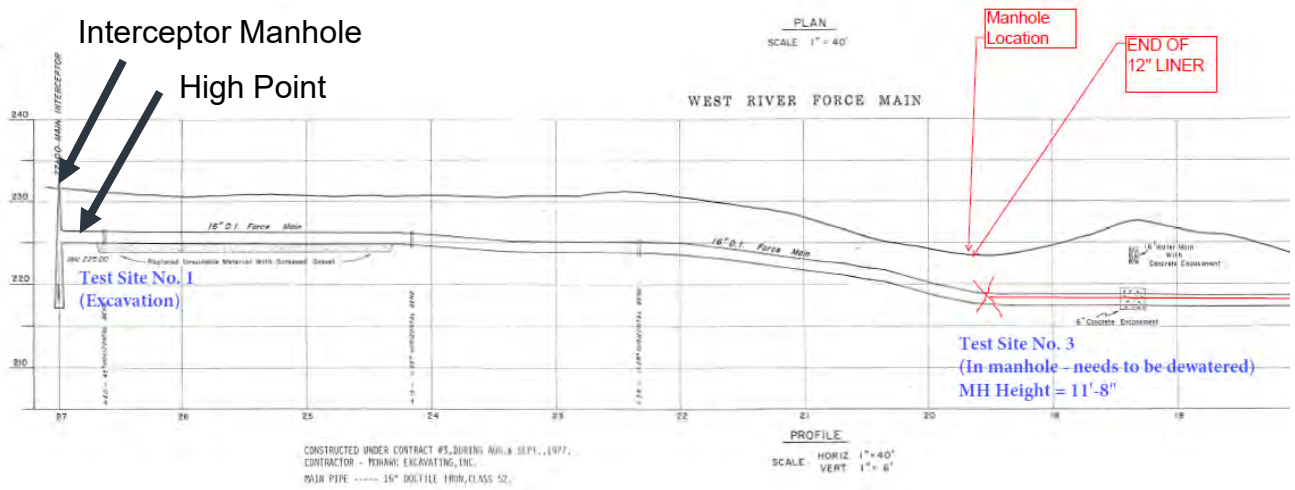
Ultrasonic technologies

- Thickness measurements taken using ultrasonic soundwaves at equally spaced positions around exterior pipe circumference
- Provides readings at limited locations
  - Not capacity of continuous readings down a length of pipe
  - Requires strategic testing locations (high points)
- Can be used without taking pipe out of service
- Does not require pipe pressurization
- Considered least risky and cost effective option
  - **Recommended for this project**

Non-Destructive Investigation

Overview

- Ultrasonic testing does not provide continuous reading
- Targeted testing at:
  - Localized high points
  - Easily accessible locations (manholes)



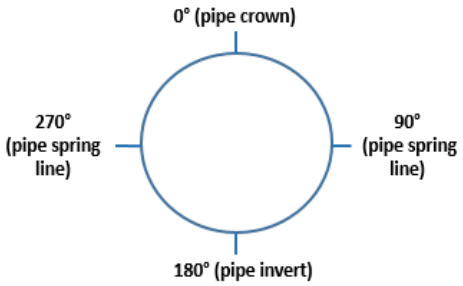
Ultrasonic testing

6 locations tested by LPI, Inc.

- 4 localized high points
- 2 easily accessible locations (manholes)

Ultrasonic testing

- Grinder used to remove small portion of exterior pipe coating at equally-spaced measurement locations
- Thickness measurements taken at multiple points along each length of exposed pipe

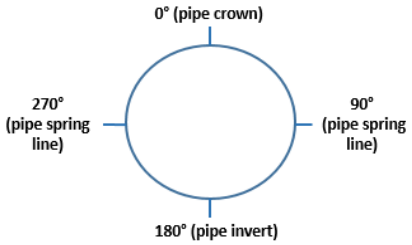


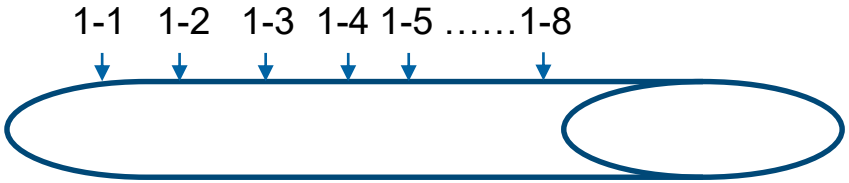
Testing results

- Testing results indicated wall thickness losses between 0% - 49%
- Largest percentage of wall thickness loss immediately upstream of interceptor manhole (high point)
  - This section of pipe is partially empty at times
  - Highest corrosion rate along pipe spring-line

Force main – High point (Location 1)

Test #	Crown (0°)	Spring Line (90°)	Invert (180°)	Spring Line (270°)
1-1	6%	24%	13%	0%
1-2	11%	0%	0%	22%
1-3	2%	23%	15%	-3%
1-4	10%	31%	10%	37%
1-5	13%	46%	33%	41%
1-6	14%	36%	6%	46%
1-7	14%	49%	10%	44%
1-8	22%	17%	13%	29%





Minimum Thickness Calculations

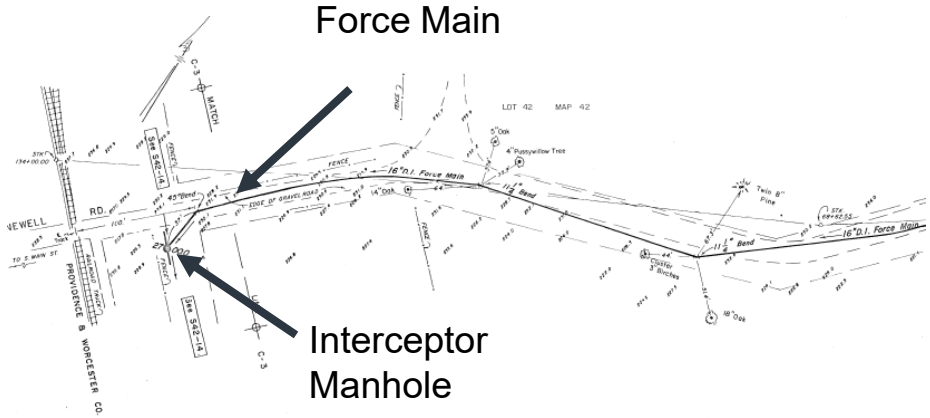
Testing results compared to ANSI/AWW C150 minimum thickness calculations for Class 52 DI Pipe – based on:

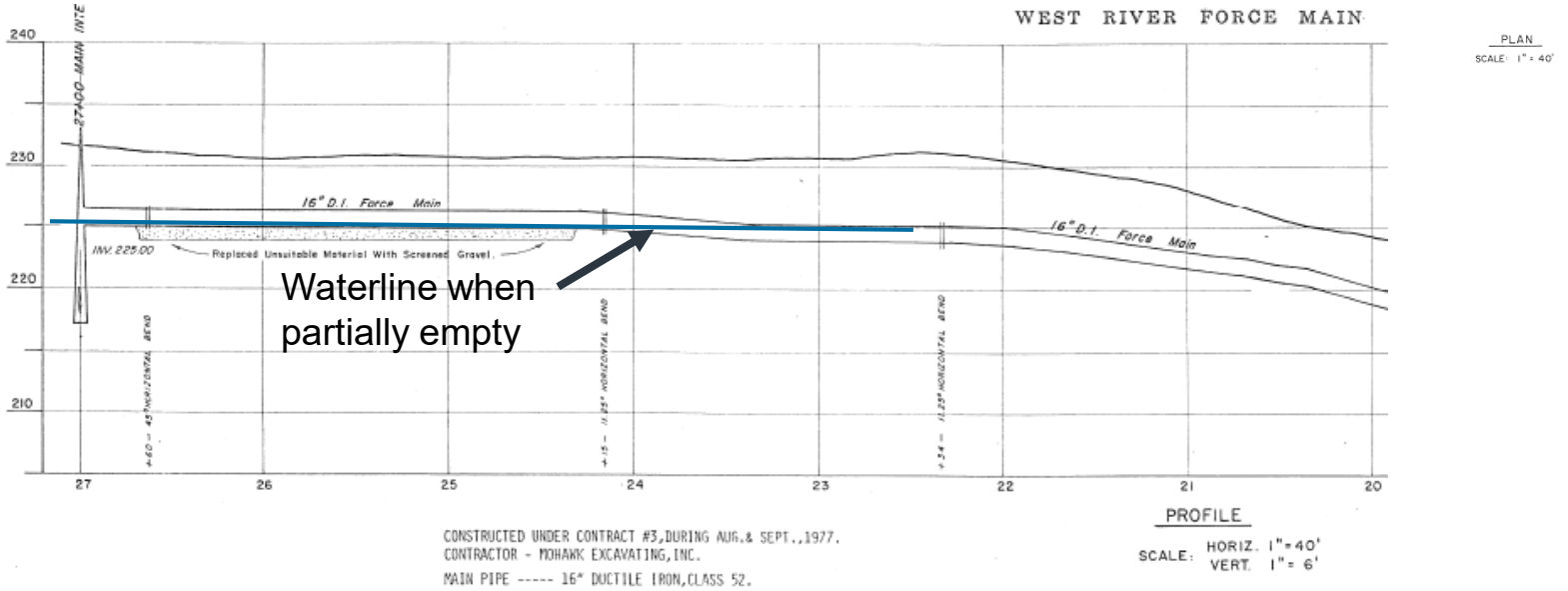
- Trench load (typically controlling parameter in buried pipe)
- Internal pressure (typically controlling parameter in manholes)

Location Number	Design Thickness Parameter	% Wall Thickness Loss Detected	ANSI/AWWA C150 Calculated Minimum Allowable Thickness Loss
1	Buried – Trench Load	0% - 49%	29%
2	Manhole – Internal Pressure	0%	87%
3	Manhole – Internal Pressure	0% - 19%	87%
4	Buried – Trench Load	0% - 6%	29%
5	Manhole – Internal Pressure	1% - 21%	87%
6	Manhole – Internal Pressure	0% - 6%	87%

Rehabilitation recommendations

Rehabilitate portion of force main suspected of periodically sitting partially empty





Rehabilitation Options

Scope of project

Rehabilitation needed for:

- 30” Reinforced Concrete Pipe downstream of interceptor manhole
- Interceptor manhole
- 16” Force Main immediately upstream of interceptor manhole

Gravity interceptor rehabilitation options

Structural Epoxy

- Rebuilt pipe crown
- Apply epoxy with carbon fiber layer for structural reinforcement

Cured In Place (CIPP) Pipe

- “Pipe within a pipe”
- Structurally Independent

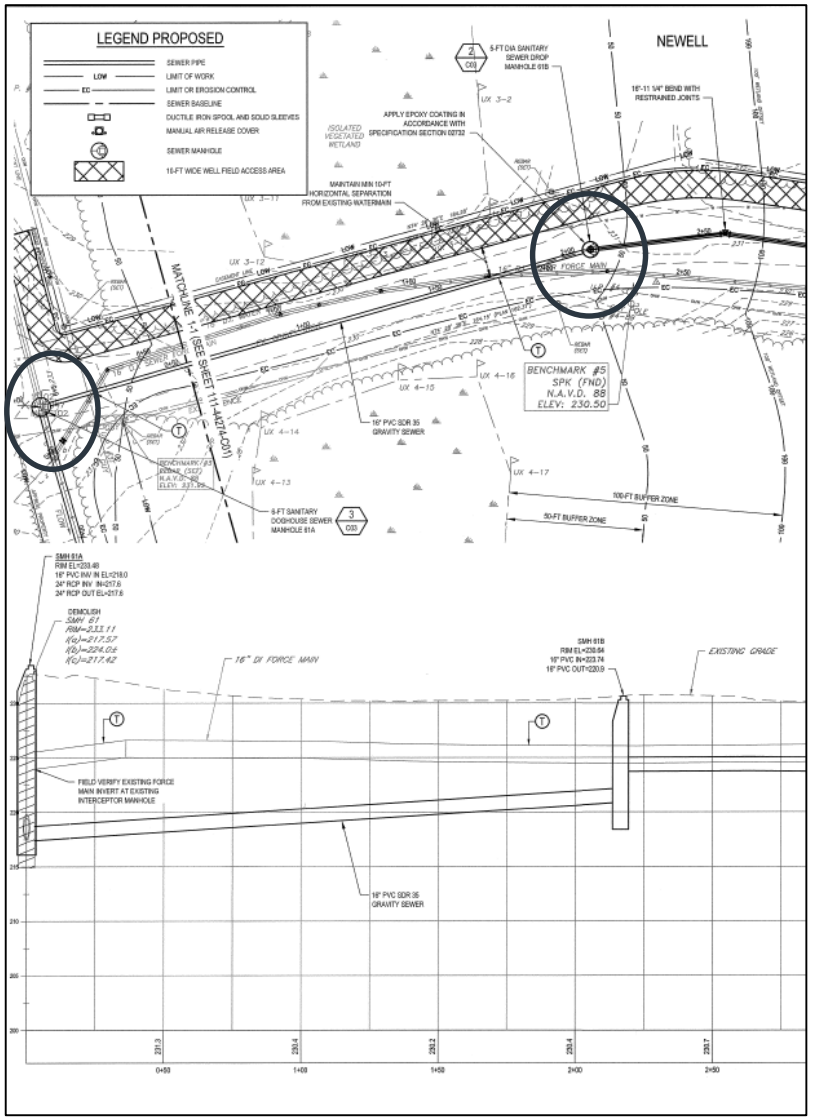
Pipe Replacement

- Removal and excavation
- Replacement with corrosion resistant pipe

Pipe replacement determined to be most cost effective option

Interceptor manhole

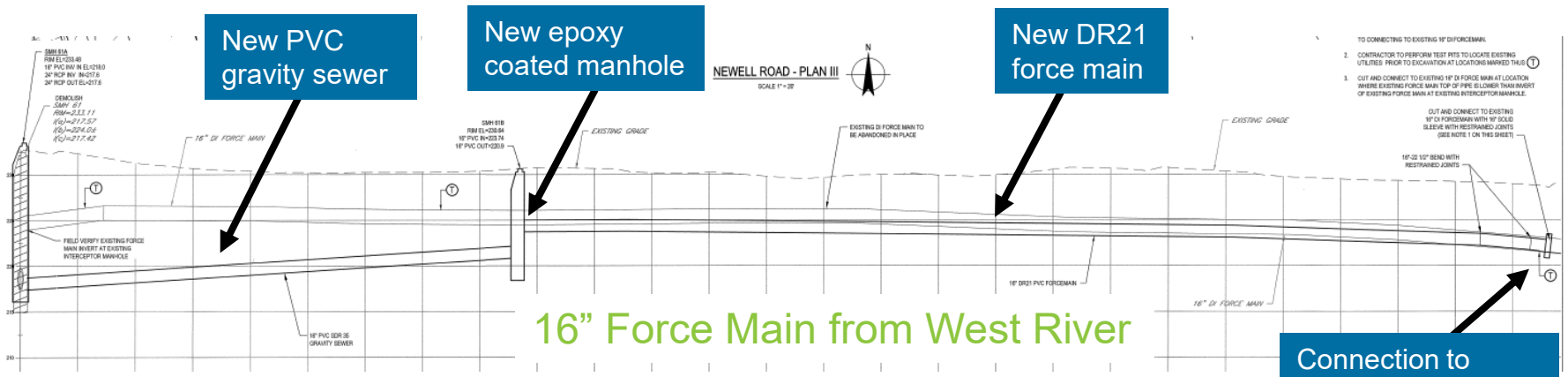
- Main interceptor manhole replacement
- Installation of a new force main discharge manhole
  - Split function
  - Allows for easier future bypassing
  - Minimizes force main shutdown during construction
- Epoxy coat both manholes

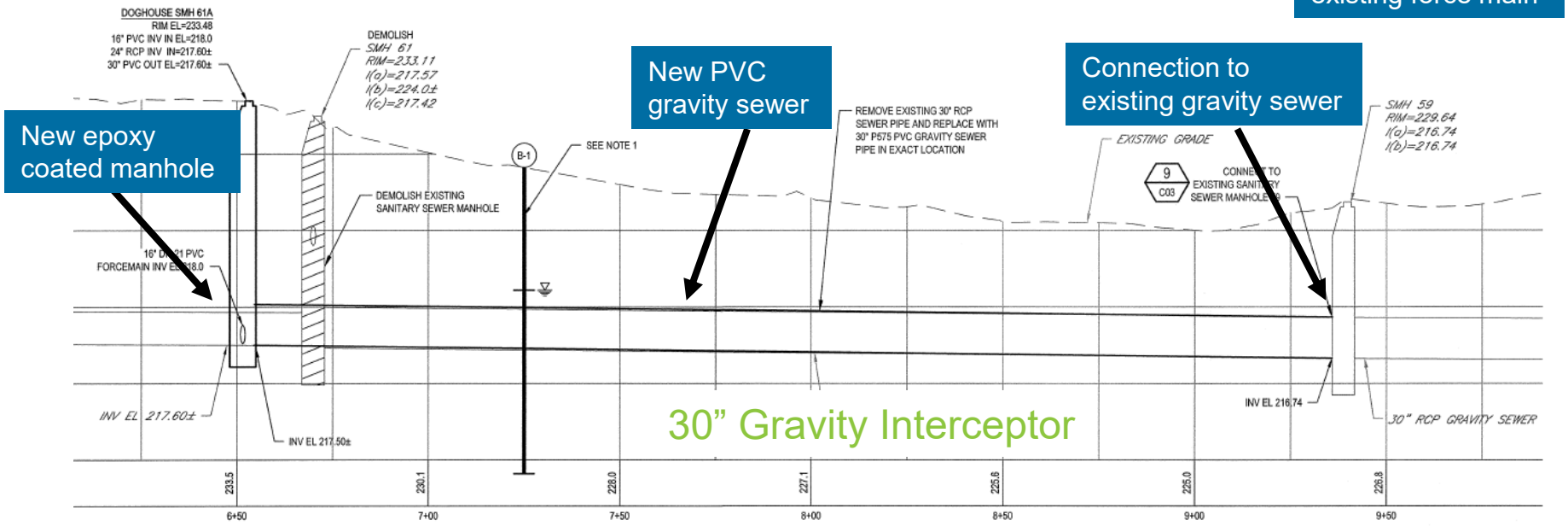


Force main

- Lining
  - Manufacturer indicated lining can only be inverted through one 45° bend
  - Excavation needed for additional bends
  - Multiple bends, not considered further
- Pipe replacement
  - Removal and excavation
  - Replacement with corrosion resistant pipe
- Pipe replacement determined to be most cost effective option
- Air release valve replacement

Design drawing



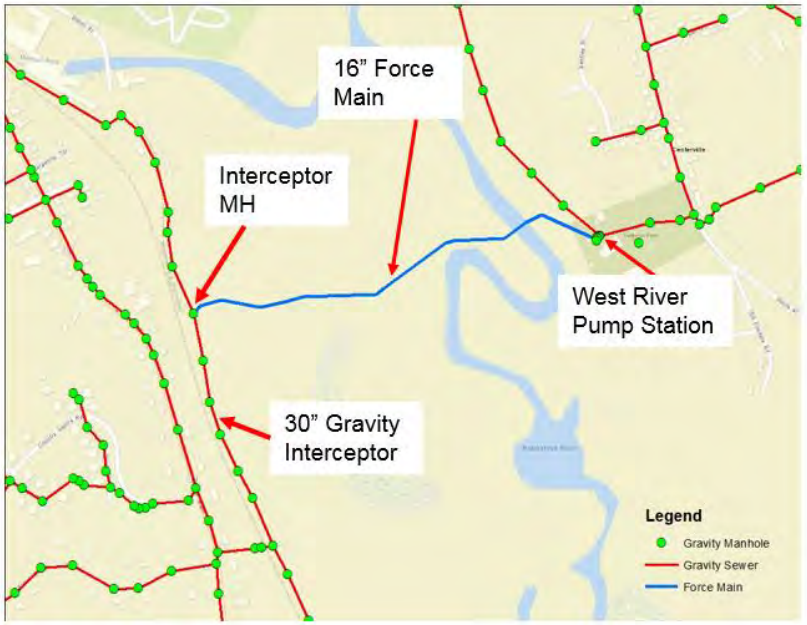


Construction

Sequencing

Two bypasses

- Gravity sewer
  - Bypass set up during gravity sewer construction
  - Upstream manhole to downstream manhole
  - Doghouse manhole
- Pump Station
  - Existing force main active during new force main installation
  - Specified pump station shutdowns for tie ins
  - When needed, Town trucked flow to manhole upstream of bypass



Construction

Bypass Pumping

Catastrophe avoided

Construction Costs

- Engineer's Estimate = $575,000
- Low Bid = $520,000 (and final construction cost)

Summary

- Town proactive assessment of vulnerable infrastructure indicated multiple corroded components
  - Force Main
  - Interceptor Manhole
  - Downstream Gravity Interceptor
- Ultrasonic thickness testing provided a non-destructive method of diagnosing force main condition without taking it offline
- Use of corrosion resistant materials in construction reduced vulnerability of infrastructure

Questions

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