



Inflow & Infiltration Reduction: A Multi-Phased Approach

IEPA # 19765

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Agenda

1. Background Information
2. Estimating I&I and Approach to I&I Reduction – Overview
3. Phase 1 – Flow Monitoring
4. Phase 2 – Sanitary Sewer Evaluation Survey (SSES)
5. Phase 3 – Rehabilitation
6. Phase 4 – (Opt.) Follow-Up Flow Monitoring
7. Closing Thoughts
8. Q&A





BACKGROUND INFORMATION

Typical Components of Sanitary Sewer Flow

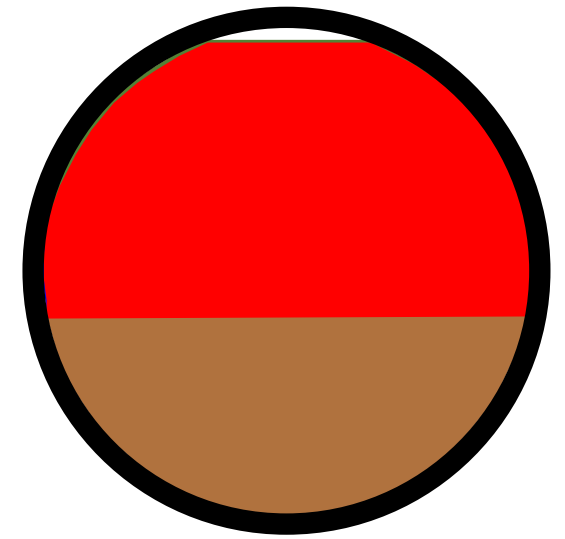


→ Inflow

I&I

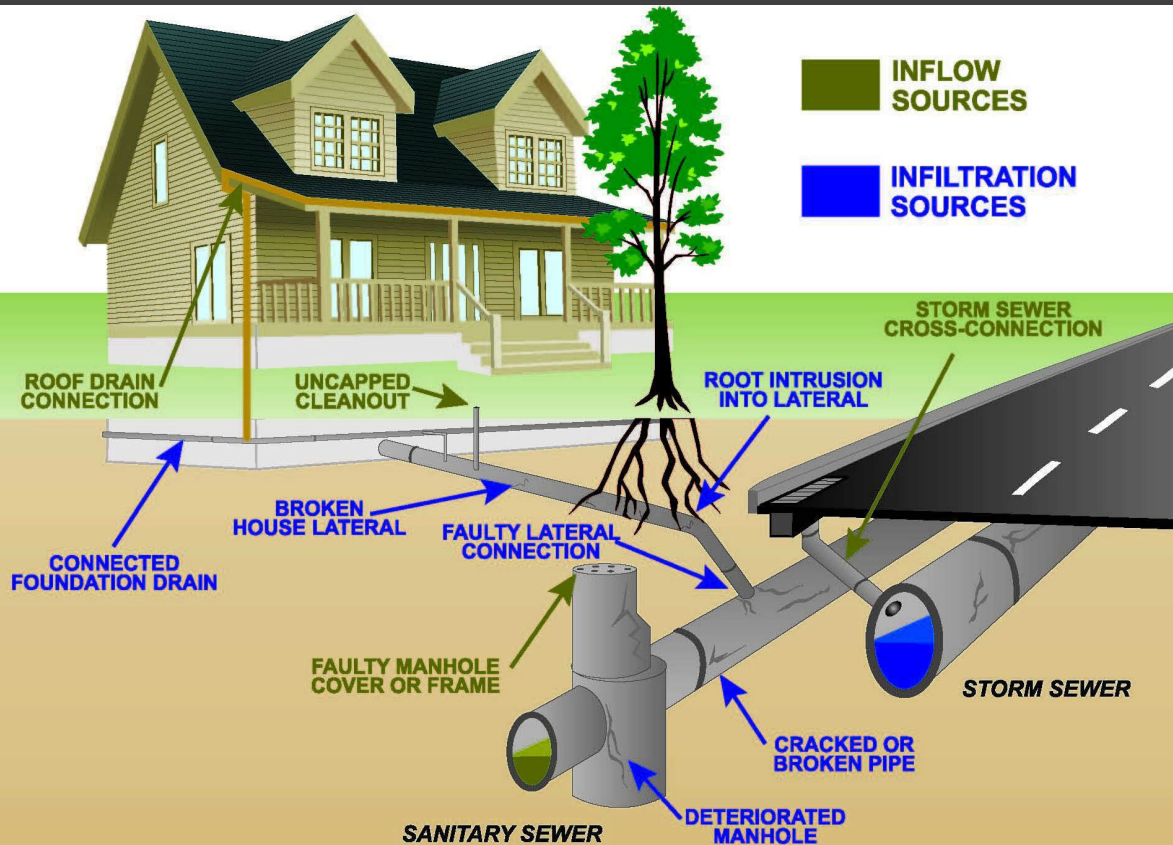
→ Infiltration

→ Wastewater Baseflow



Sanitary Sewer Pipe
Cross Section

Common Inflow and Infiltration Sources:



Inflow & Infiltration (I&I): What Is It?

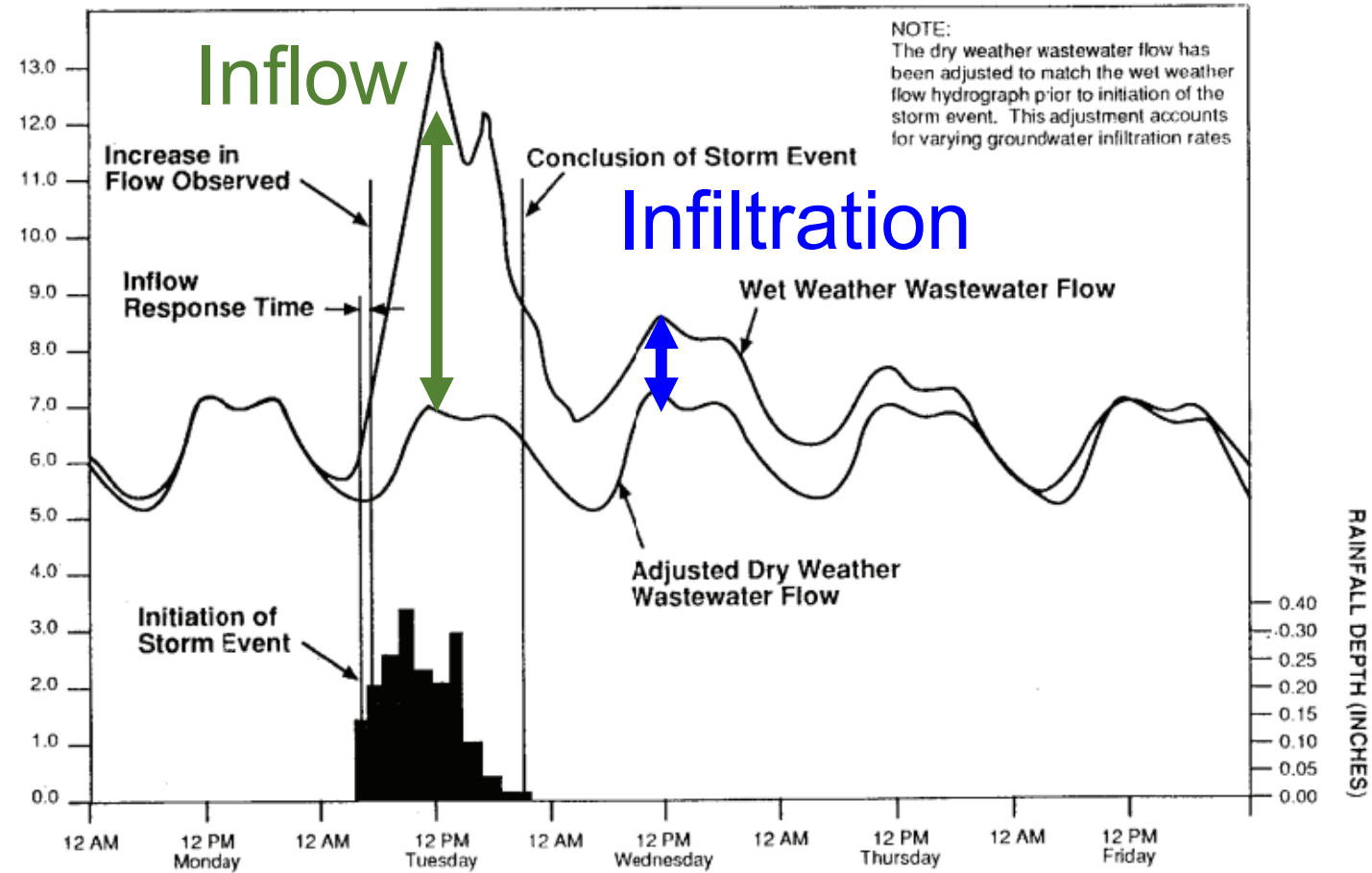
Inflow – Stormwater discharged directly into the sanitary sewer system

Infiltration – Groundwater seeping into the sanitary sewer system

Source: <http://www.oregonohio.org/Engineering/inflow-infiltration.html>



Rainfall Derived Inflow & Infiltration



Source:
Guidelines for Performing Infiltration/Inflow Analyses And Sewer System Evaluation Survey -
<http://www.mass.gov/eea/docs/dep/water/laws/i-thru-z/iiguidln.pdf>



Why Does I&I Matter?



Source: <https://atsinnovawatertreatment.com/blog/flood-proof-wastewater-treatment-plant/>



- Can overwhelm collection system and treatment works
- Higher energy usage and costs
- May require capital upgrades to increase capacity
- Can cause sanitary backups/SSOs and basement flooding



Flooding in the Chicago area has been so bad in the past decade that only places ravaged by hurricanes sustain more damage

By Michael Hawthorne and Morgan Greene
Chicago Tribune • May 10, 2019 at 9:15 am

Source: <https://www.chicagotribune.com/news/breaking/ct-met-chicago-flooding-basement-sewage-20190506-story.html>



Inflow & Infiltration (I&I)



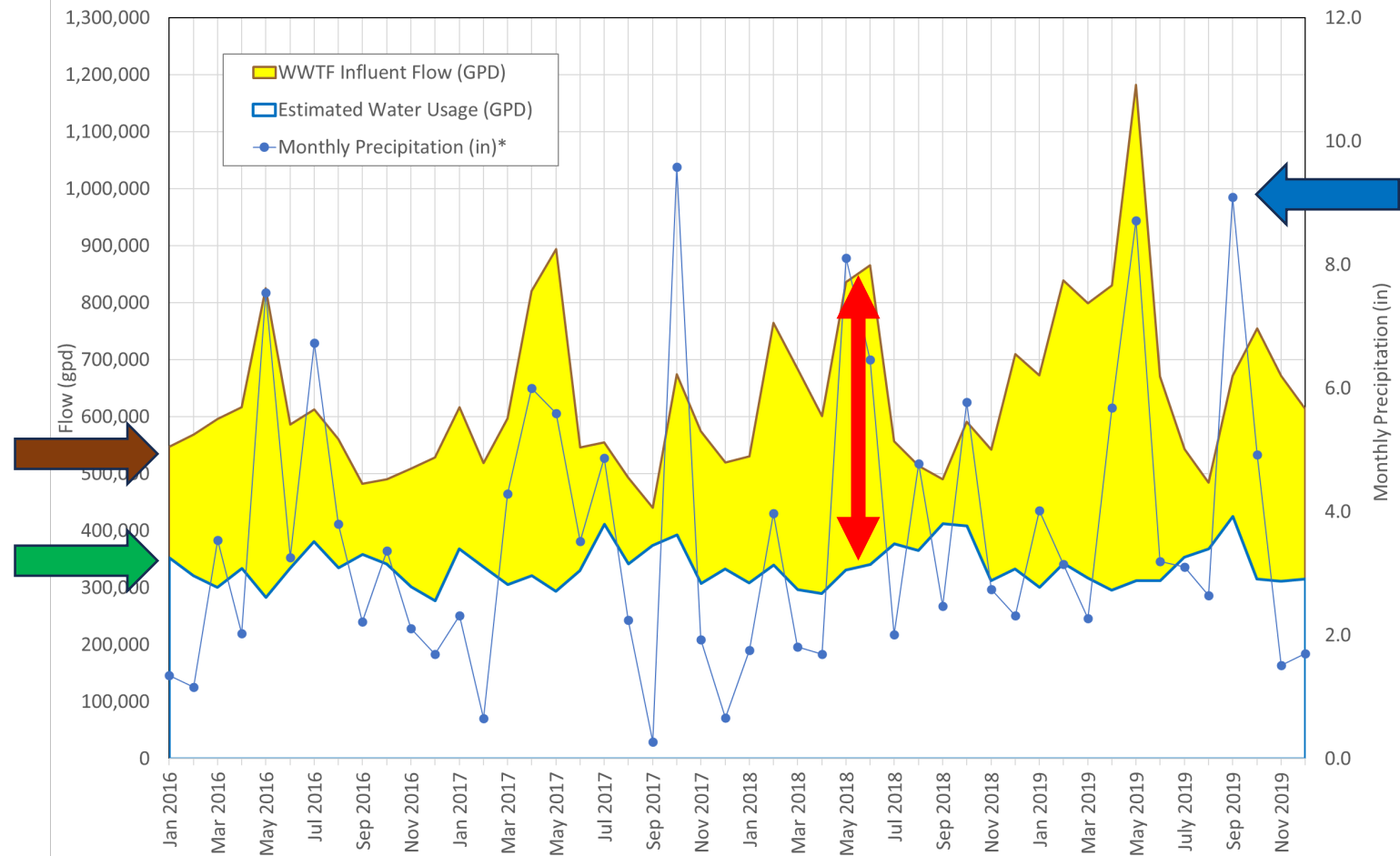
Source: <https://medium.com/@ScottDoyleM/understanding-floods-and-how-your-home-will-be-effected-94ac42574dfe>

The background of the slide is a grayscale photograph of a large stack of dark-colored pipes. The pipes are arranged in multiple rows, receding into the distance, creating a strong sense of perspective. The ends of the pipes are visible, showing their circular openings.

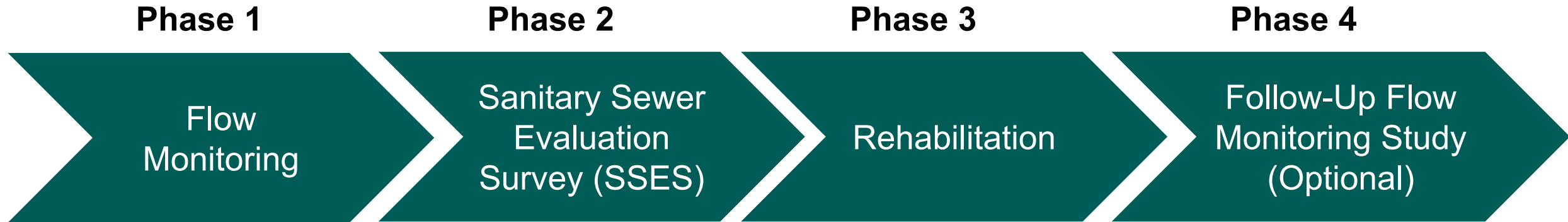
Estimating I&I and Approach to I&I Reduction – Overview

Estimating I&I in the Sanitary System

- Compare **Water Usage** to **WWTF Influent Flow**
- Difference Between the Two is **I&I** (in theory..)
- Can Also Compare to **Precipitation**



Approach to I&I Reduction – Overview



- Typically, complete one phase per year per basin
- Can complete different or same phases simultaneously in multiple basins



Phase 1 – Flow Monitoring

Phase 1 – Flow Monitoring

Purpose:

Subdivide Sanitary Sewer System, Monitor Flows, and Identify Areas with High I/I for Further Investigation



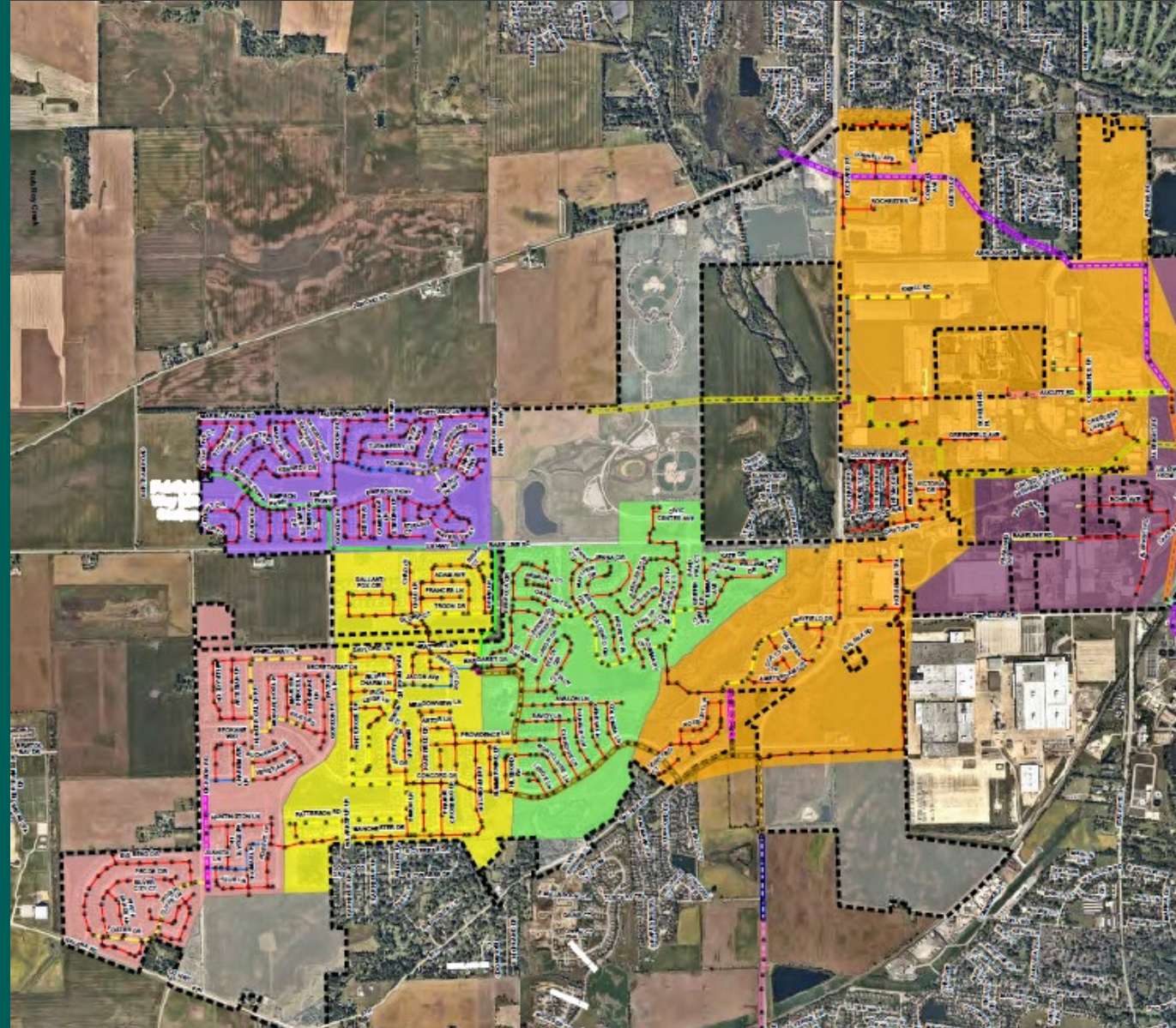
Source: <https://climate.state.mn.us/heavy-rains-health-water-quality-risk>



Phase 1 – Flow Monitoring

Approach:

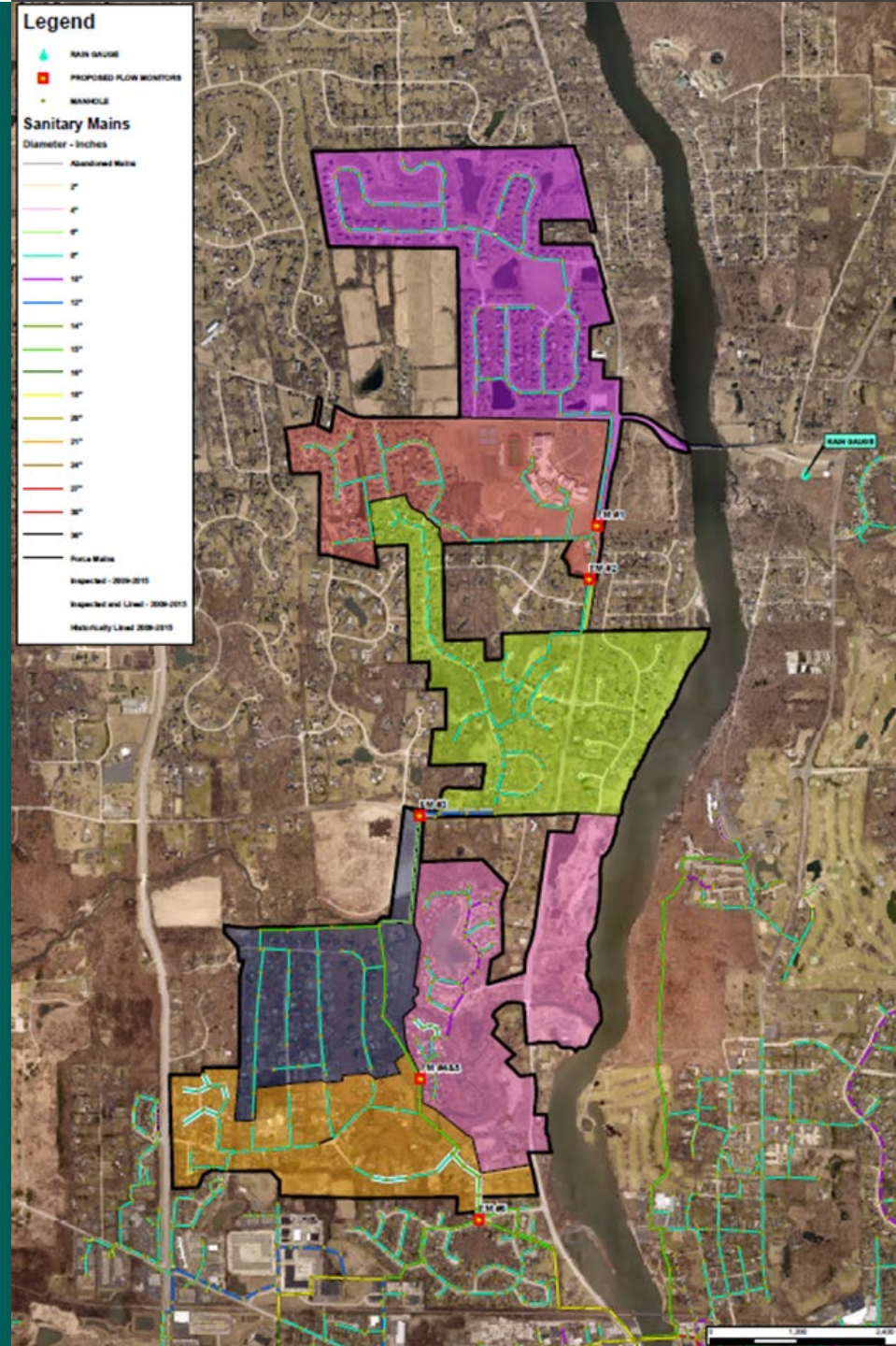
- Update Sanitary Sewer Network / GIS
- Subdivide Sanitary System into Basins
- Prioritize Basins
 - Historic / Known Issues
 - Review Records (SSOs, Log of Resident Complaints, etc.)



Phase 1 – Flow Monitoring

Subdivide Each Basin into Sub-Basins

- Logical Dividing Points
- Target Size
- Land Use & Age
- Consider Flow Monitor Placement



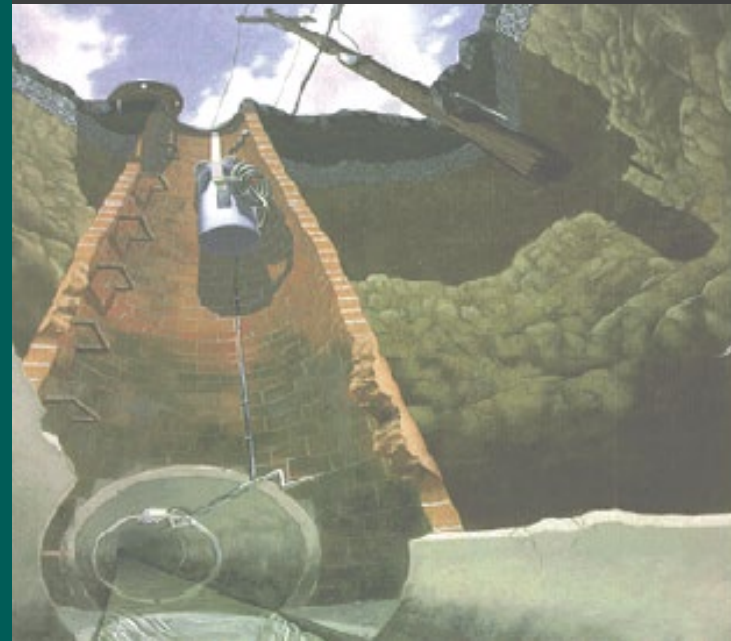
Phase 1 – Flow Monitoring

Flow Monitor Placement

- Hydraulics
- Be cognizant of potential influence from lift stations and force mains
- Be prepared to make adjustments
- Don't forget rain gauges!



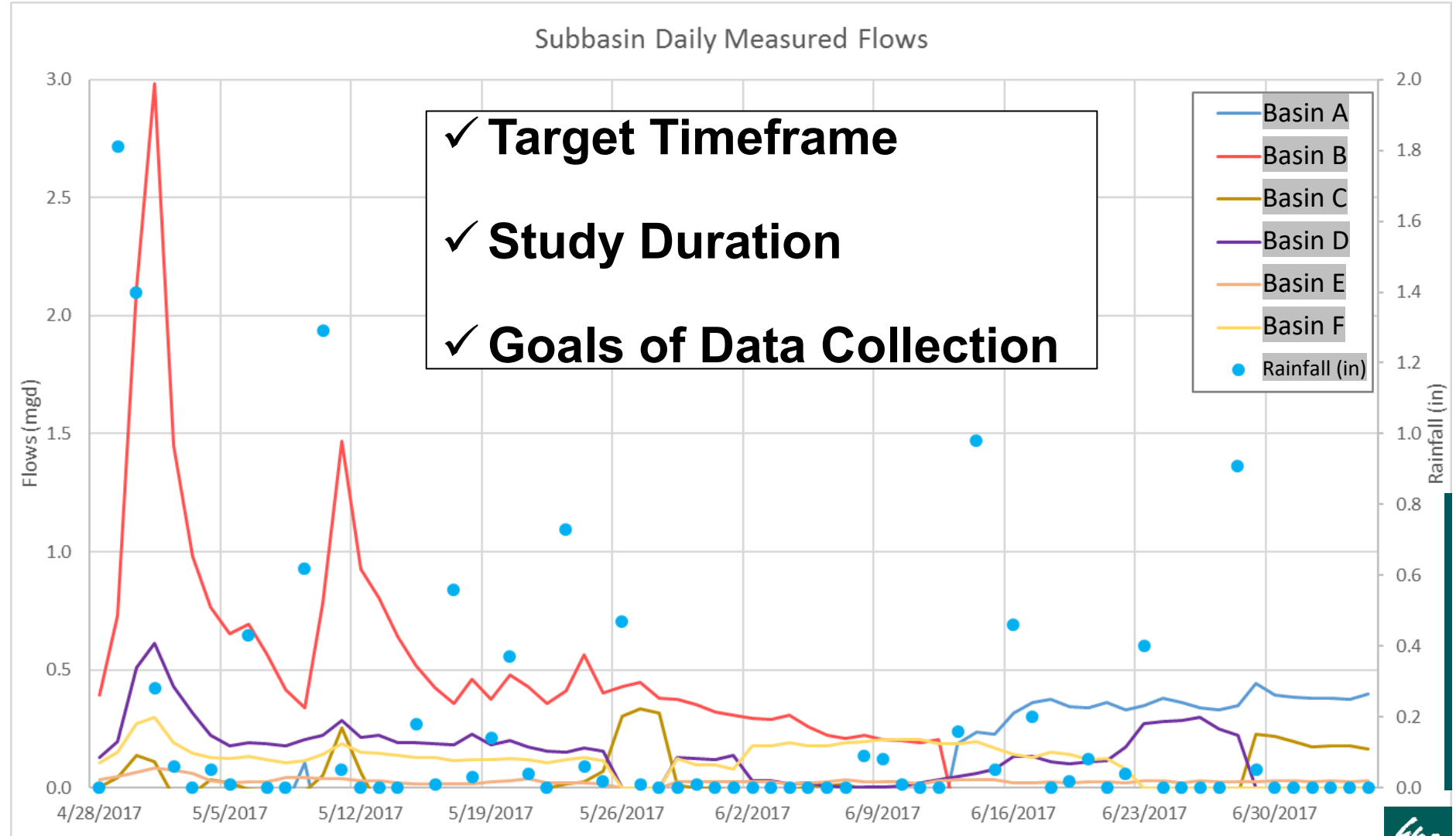
Rain Gauge



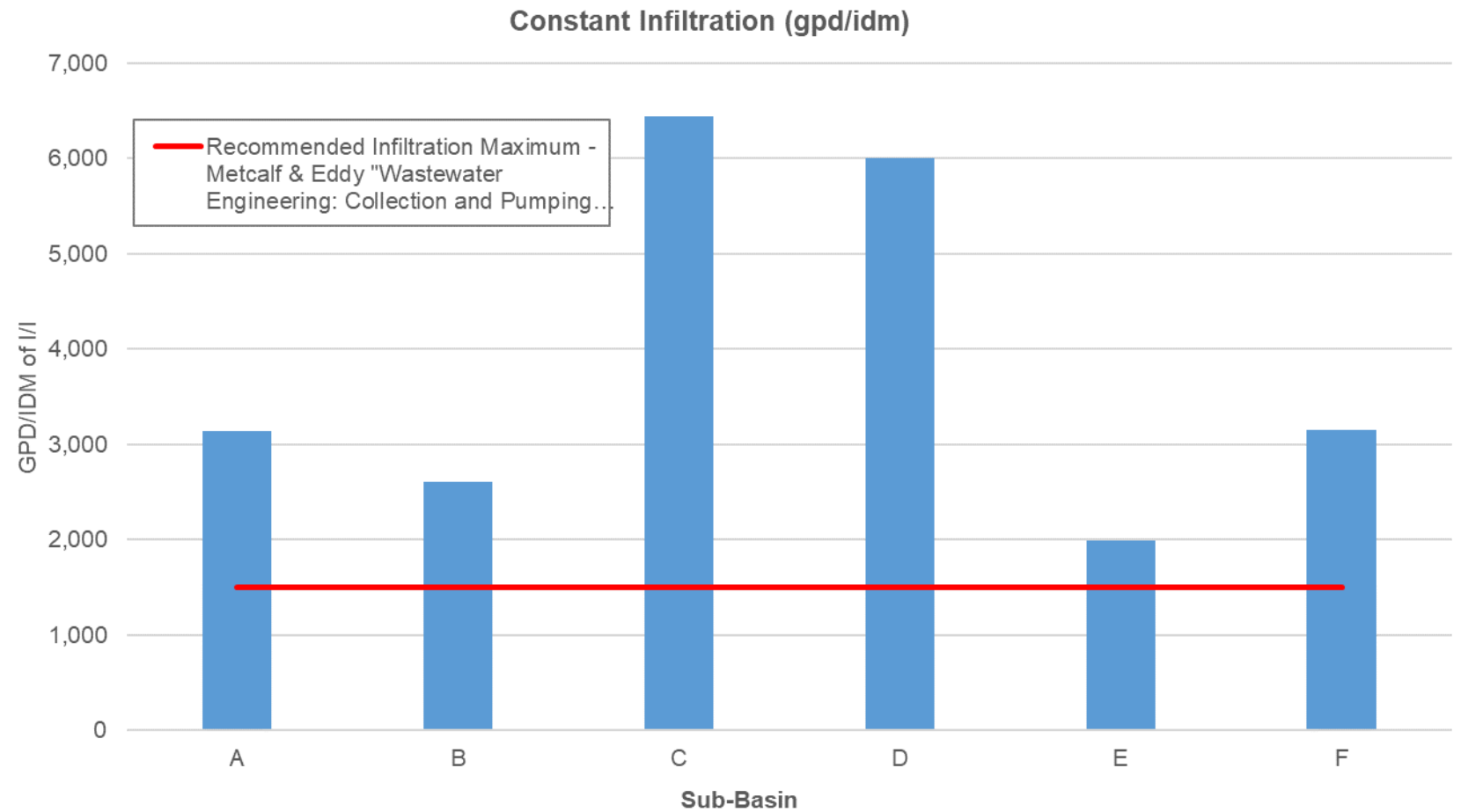
Flow Monitoring Equipment

Source:
https://www.cleanwaterprofessionals.org/docs/2017_1212_KYTNW_EA_Webinar.pdf

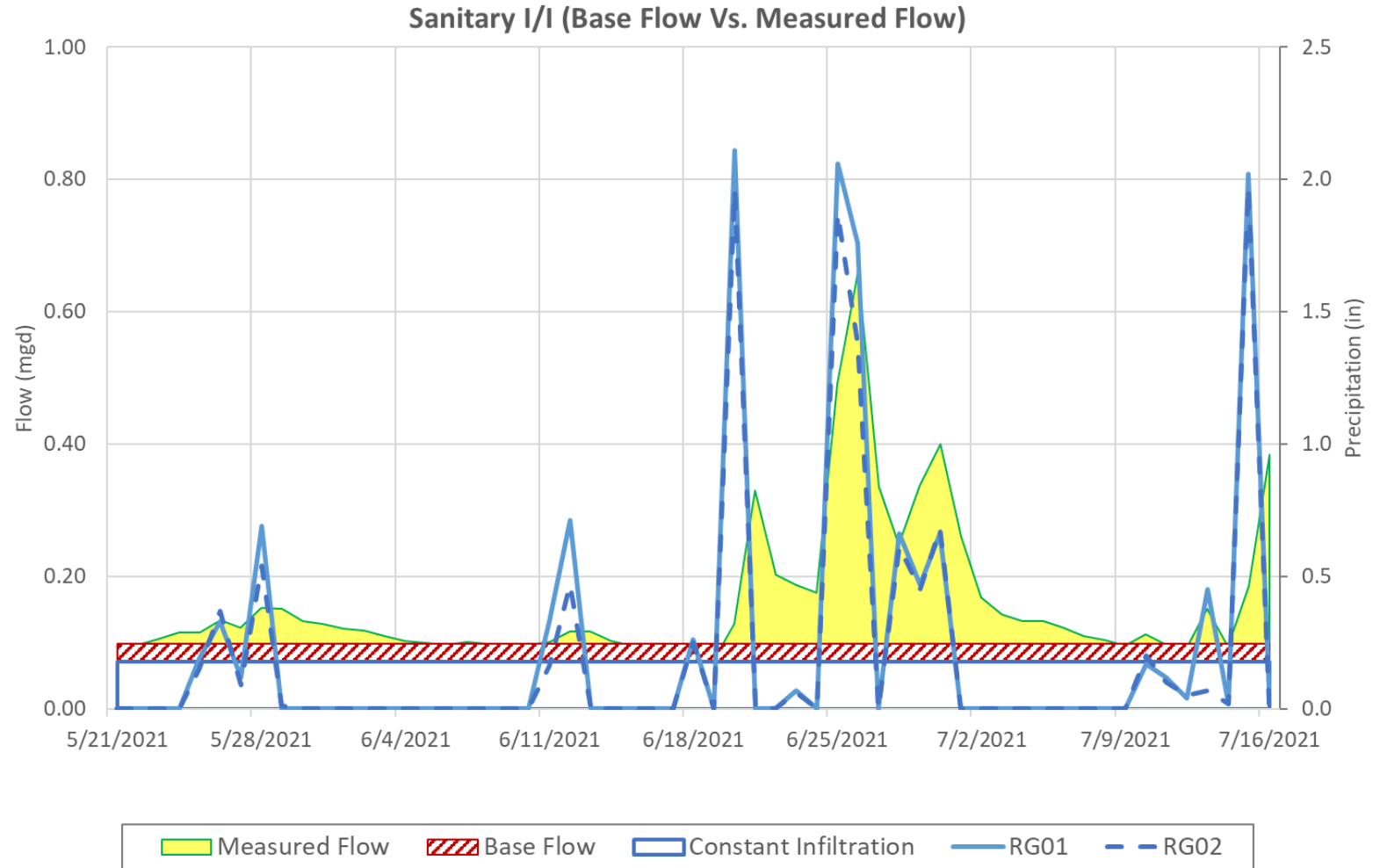
Phase 1 – Flow Monitoring Data Analysis



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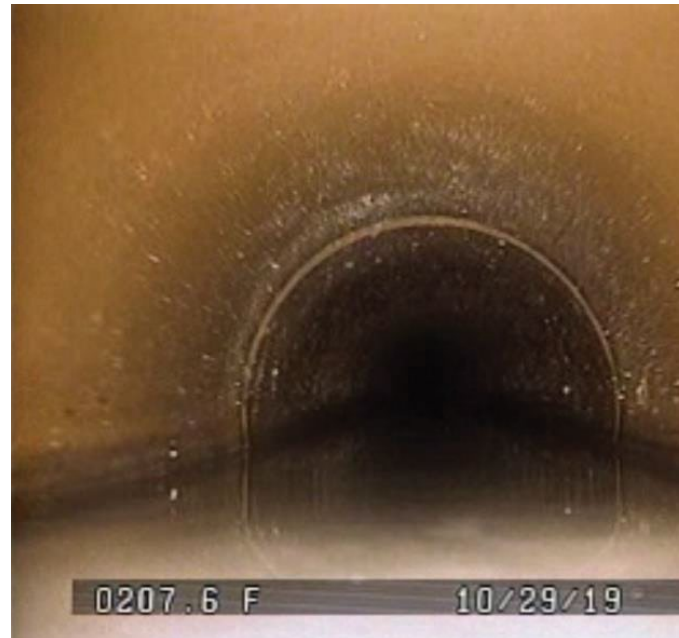


Phase 1 – Flow Monitoring Data Analysis



Phase 1 – Flow Monitoring

- ✓ **Compare Base Flows to I/I Flow**
 - Determine Areas with High Rainfall-Derived Inflow(/Infiltration) (RDII) and High Constant Infiltration and Prioritize Further Evaluation
- ✓ **Develop Phase 2 Recommendations**
 - High RDII: MH Inspections and Smoke Testing
 - High Constant Infiltration: Main Televising
 - Additional Options including, but not limited to, Lateral Televising, Nighttime Flow Isolation



A large stack of black, corrugated pipes, likely for sanitary sewer use, arranged in multiple rows and receding into the distance. The pipes are the primary visual element of the background.

Phase 2 – Sanitary Sewer Evaluation Survey (SSES)

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Common SSES Techniques:

- Smoke Testing
- MH Inspection
- Sanitary Sewer Main Televising
- Additional Technologies: Lateral Launcher, Focused Electrode Leak Location, etc.



Smoke Testing



MH Inspection



Sanitary Sewer Main Televising

Source: <https://waterfm.com/eyes-underground-advances-in-sewer-inspection-cameras-software-help-us-know-whats-below/>

Phase 2 – Communication Plan

Developing Communication Plan Before, During, and After Field Work:

- Door Hangers, Direct Mailers, Website/Social Media Updates, Daily Email Communications, Moving Signage
- Coordinate with Emergency Personnel (Police/Fire), Administrative Staff, Elected Officials
- Develop Plan of Action for Addressing Resident or Business Questions or Concerns



Source: <https://ibxnews.com/stories/640014001-city-of-elizabeth-notice-of-smoke-testing-sewer-lines>

Phase 2 – Smoke Testing

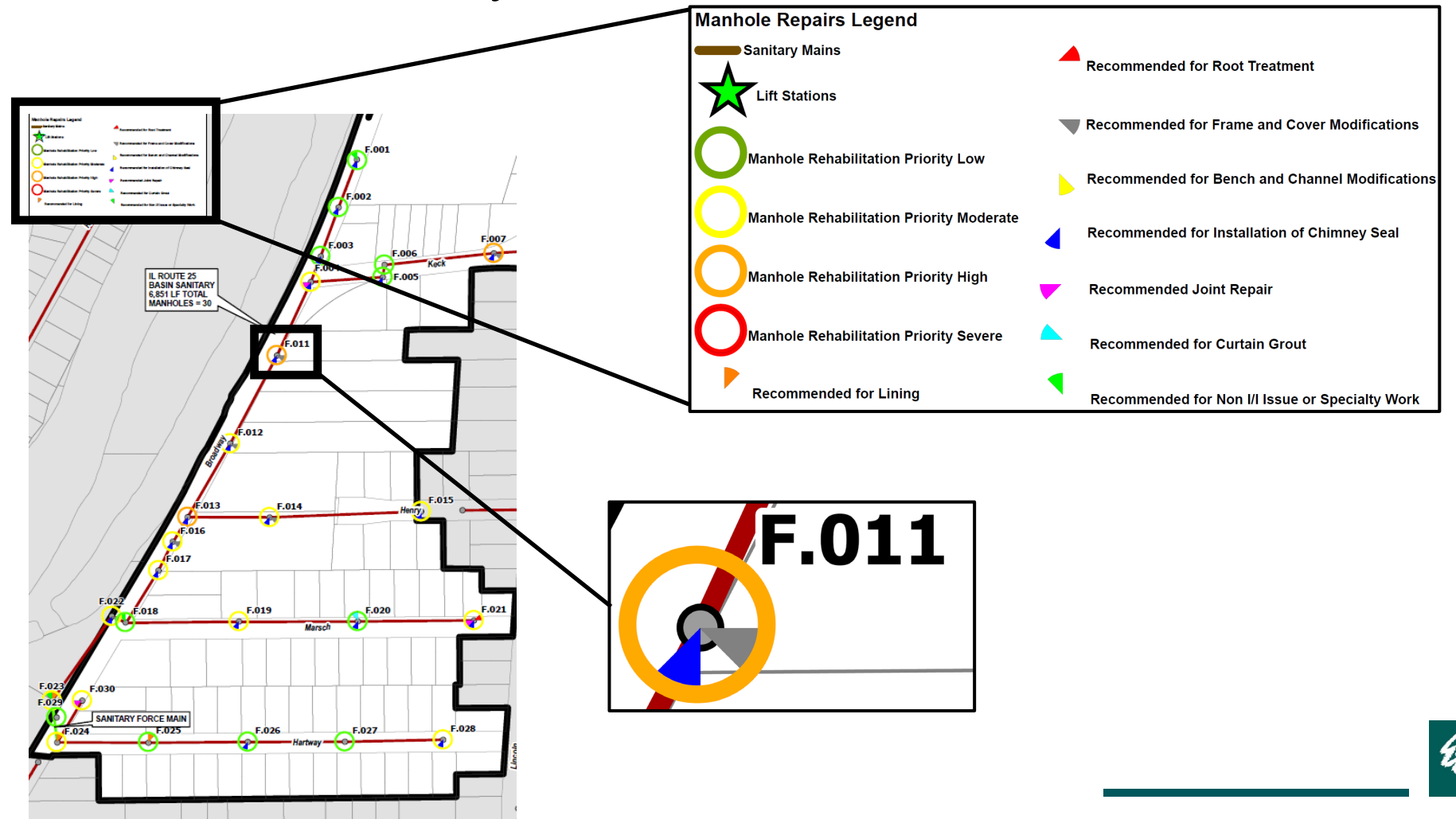
Identifies the following defects:

- Storm Sewer Connections
- Cleanout Cover Defects
- Defects In Sewer Service
- Building Foundation Defect



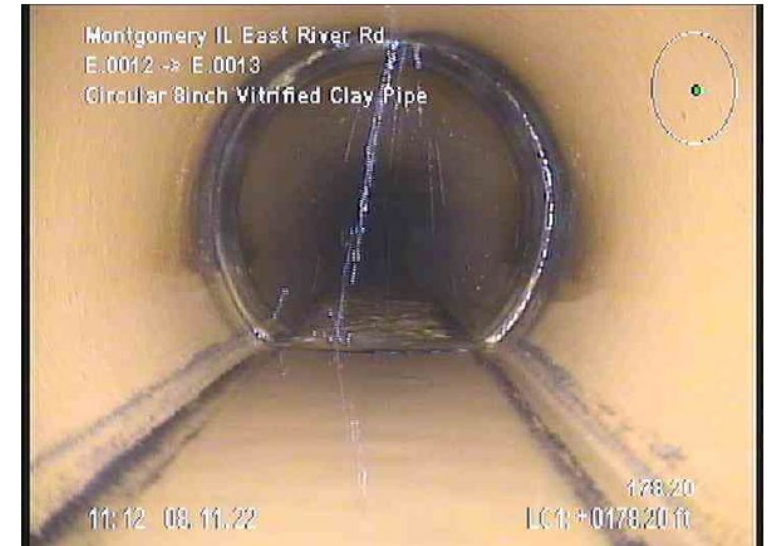
Phase 2 – Manhole Inspections

Identifies defects in the manhole components including the frame, cover, chimney, wall, bench, and channel.



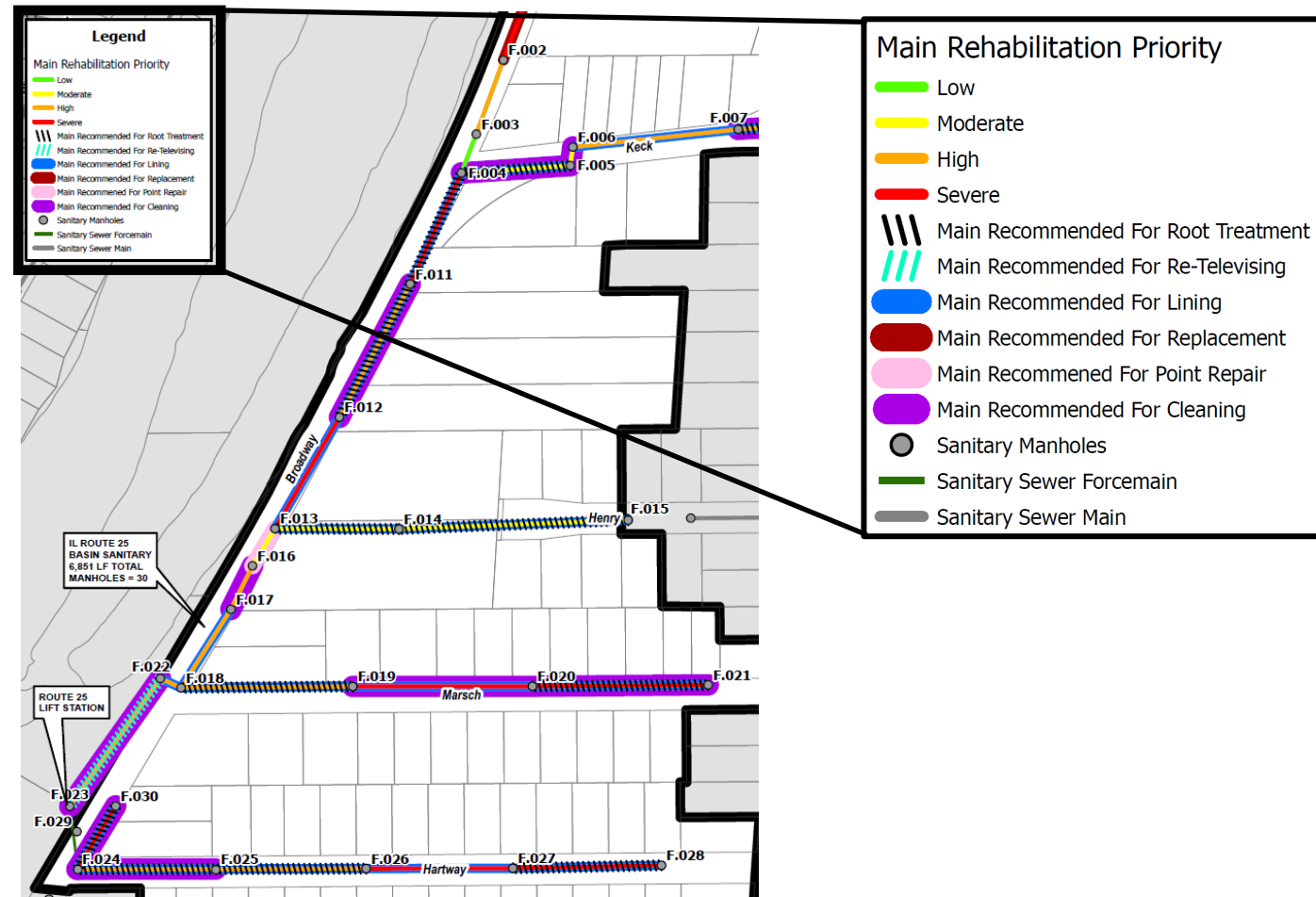
Phase 2 – Sanitary Sewer Main Televising

Identifies defects in sanitary sewer mains including: leaking joints, broken pipes, roots, debris, blockages



Phase 2 – Sanitary Sewer Main Televising

Proposed Main Rehabilitation Summary Exhibit



Phase 2 – Data Analysis

Analysis

- NASSCO (National Association of Sewer Service Companies)
- Review and Identification, Coding of Defects by Type and Severity
- Develop Repair Recommendations

C CRACK 4-3 CL Longitudinal CC Circumferential CM Multiple CS Spiral CH Hinge (2, 3, 4)	F FRACTURE 4-9 FL Longitudinal FC Circumferential FM Multiple FS Spiral FH Hinge (2, 3, 4)	B BROKEN 4-17 BSV Soil Visible BVV Void Visible	H HOLE 4-21 HSV Soil Visible HVV Void Visible	D DEFORMED 4-25 (Rigid) DR Deformed Rigid No modifiers used.	D DEFORMED 4-25 (Flexible) DFBR Bulging Round DFBI Bulging Inv.Curv. DFC Creasing DFE Elliptical	D DEFORMED 4-25 (Brick) DTBR Bulging Round DTBI Bulging Inv.Curv.
X COLLAPSE 4-37 X Collapse No descriptors and no modifiers used.	J JOINT 4-43 JOS Offset Small JOM Offset Medium JOL Offset Large	J JOINT 4-43 JOSD Offset Small Defect JOMD Offset Medium Defect JOLD Offset Large Defect	J JOINT 4-43 JSS Separation Small JSM Separation Med. JSL Separation Large	J JOINT 4-43 JAS Angular Small JAM Angular Medium JAL Angular Large	S SURFACE DAMAGE 4-51 SRI Roughness Increased SAV Aggregate Visible SAP Aggregate Projecting SAM Aggregate Missing	S SURFACE DAMAGE 4-51 SRV Reinforcement Visible SRP Reinforcement Projecting SRC Reinforcement Corroded SMW Missing Wall
S SURFACE DAMAGE 4-51 SSS Surface Spalling SSC Surface Spalling Coating SCP Chemical Attack SZ Other	LF LINING FEATURES 4-67 LFAC Abdn'd Connection LFAS Annular Space LFB Blistered Lining LFCS Service Cut Shifted	LF LINING FEATURES 4-67 LFD Detached LFDC Discoloration LFDE Defective End LFDL Delamination	LF LINING FEATURES 4-67 LFOC Overcut Service LFRS Resin Slug LFUC Undercut Service LFW Wrinkled LFZ Other	WF WELD FAILURE 4-85 WFC Circumferential WFL Longitudinal WFM Multiple WFS Spiral WFZ Other	RP POINT REPAIR 4-89 RPL Liner RPLD Liner Defective RPP Patch RPPD Patch Defective	RP POINT REPAIR 4-89 RPR Replacement RPRD Replmt. Defective RPZ Other RPZD Other Defective
BRICKWORK 4-97 DB Displaced MB Missing DI Dropped Invert	BRICKWORK 4-97 MMS Mortar Missing Small MMM Mortar Missing Med. MML Mortar Missing Large					



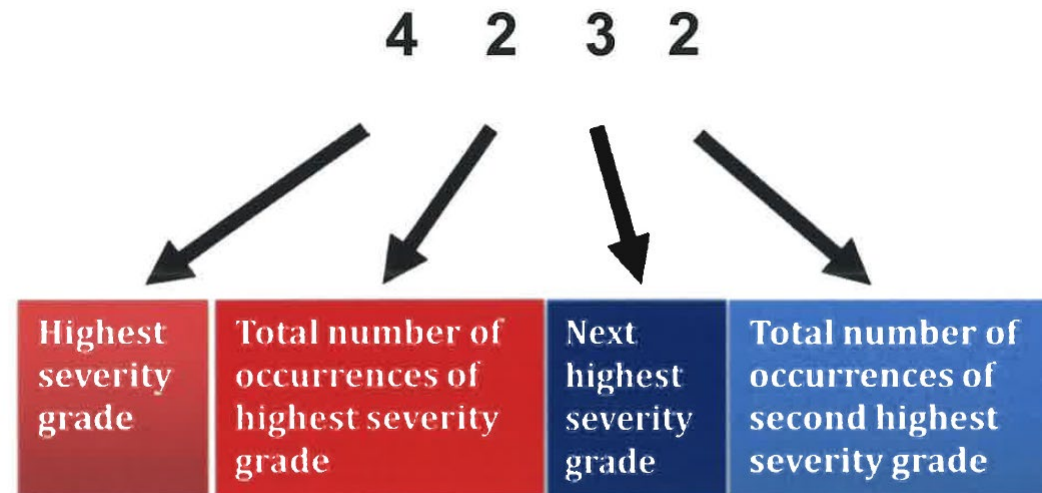
Phase 2 – Ranking of Defects

Classification and Prioritization System

Rehabilitation Priority List

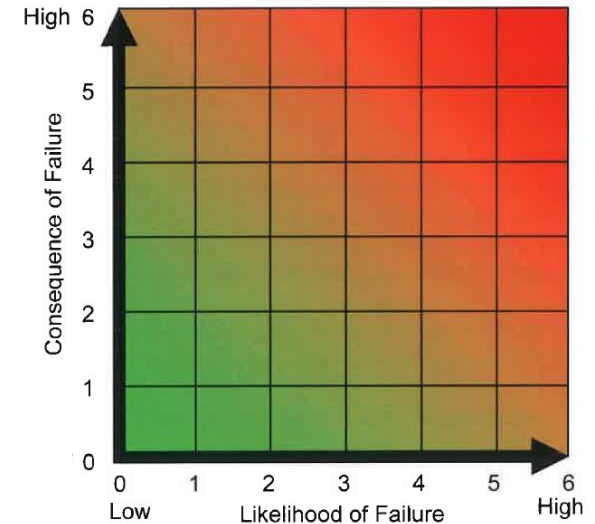
- Severe (within 1 year)
- High (within 1 – 3 years)
- Moderate (within 3 – 5 years)
- Low (within 5 – 10 years)

Many factors such as location of defect, type of repair, and budget can impact selection and prioritization of repair recommendations.



For example: 4B27

Increase
Aggressiveness of
Assessment



Source: NASSCO Pipeline Assessment Certification Program





Phase 3 – Rehabilitation

Phase 3 – Rehabilitation

Define Scope of Rehab to be Completed – Prioritization based on Severity of Defects
Planned to Address, Available Budget



Manhole Rehabilitation



**Sanitary Sewer Main
Rehabilitation**

Phase 3 – Rehabilitation

Manhole Rehabilitation Techniques:

- Manhole Lining
- Root Treatment
- Frame and Cover Modifications
- Bench/Channel Modifications
- Chimney Seal Installation
- Joint Repair



Internal Chimney Seal



External Chimney Seal

Source:
<https://ccipipe.com/products/wrapidseal-manhole-encapsulation-system/>



Manhole Lining

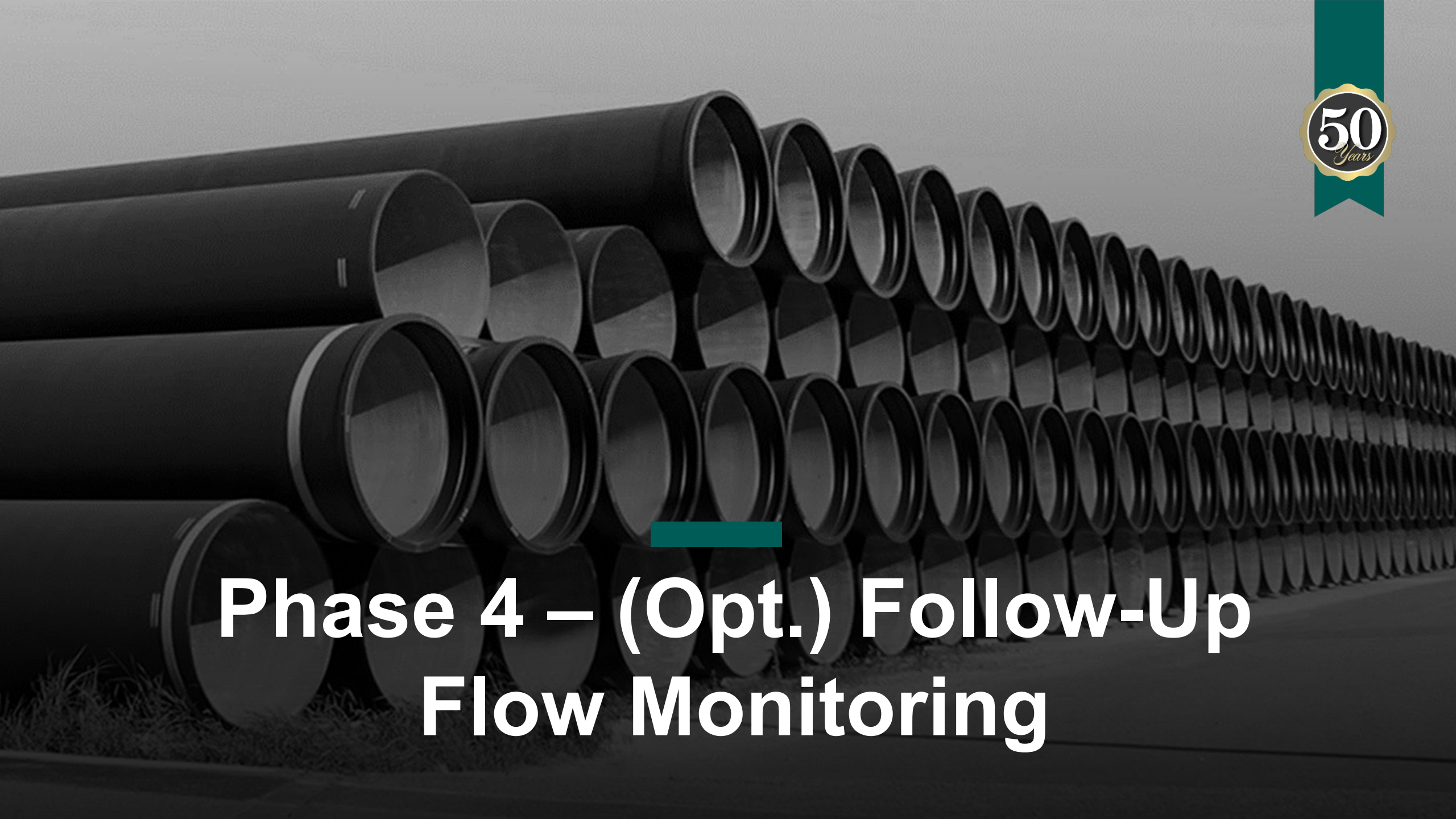
Phase 3 – Rehabilitation

- Main Rehabilitation up to and including Replacement – Highest Cost
- Sanitary Sewer Lining – Most Common Technique to Rehabilitate Sanitary Mains, but not an end-all solution
- Root Mitigation: Chemical Treatment or Cutting of Roots
- Preparation is Crucial



Source:
<https://www.waterworld.com/environmental/article/16191655/chemical-treatment-helps-control-roots>



A large stack of black pipes, likely for water or wastewater treatment, arranged in multiple rows and receding into the distance. The pipes are stacked horizontally, with their circular ends facing the viewer. The background is a light, overcast sky.

Phase 4 – (Opt.) Follow-Up Flow Monitoring

Phase 4 – Flow Monitoring (Optional)

Repeat Flow Monitoring Post-Rehabilitation

- ✓ Same Monitor Locations
- ✓ Same Time of Year
- ✓ Repeat Phase 1 Analysis and Compare Results

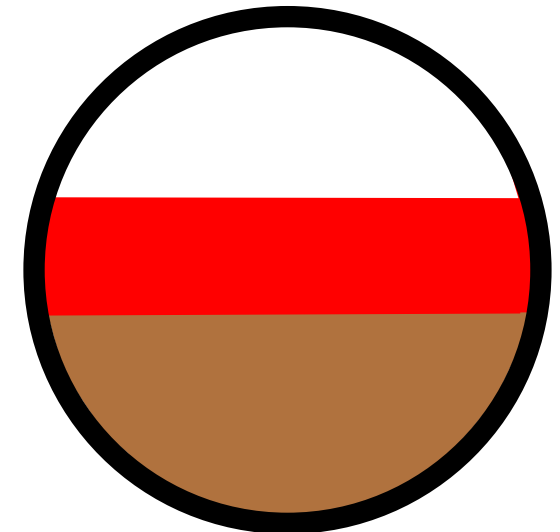




CLOSING THOUGHTS

CLOSING THOUGHTS

- **Multi-Phased Approach Can Help Reduce I/I (!)**
- Restores Capacity in the Collection and Treatment System
- Benefits to Developing a Comprehensive Plan and Phased Approach
- All Phases are Weather Dependent
- Communication is Key
- Multiple Factors to Consider When Prioritizing Studies and Rehabilitation





QUESTIONS?



THANK YOU!



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