



ARDURRA

STOP THE SNEAKY LEAKS

The Strategy Behind Fort Lauderdale's
Cost-Effective I&I Reduction for a
Resilient Future





Inflow and Infiltration Program

“The Investigators”



LOCAL

Founded in FLORIDA **47** Years Ago



THE TOP 500 DESIGN FIRMS

#75

#12 Water Supply

#13 Sewer & Waste

#11 Water Treatment & Desal Plants

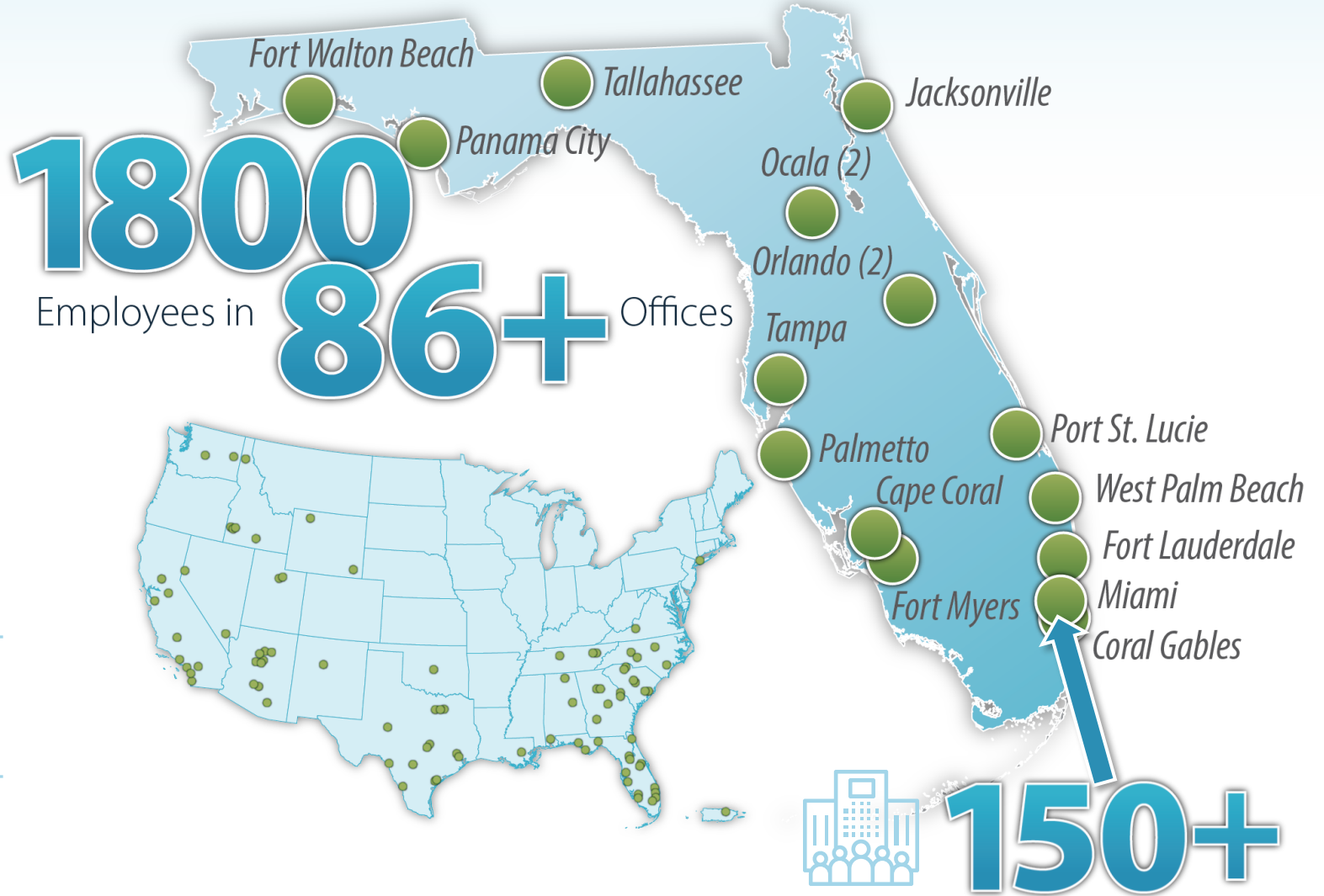
#10 Wastewater Treatment Plants

#13 Transmission Lines & Aqueducts

#19 Sanitary & Storm Sewers

+60K Sanitary Sewer Manholes Inspected in Last 5 Years

+6.5M Linear Feet of Sanitary Sewer Piping Inspected in Last 5 Years



I/I Team – Presenters



PAOLA DAVALOS, PE

GROUP LEAD SF PUBLIC WORKS
SENIOR PROJECT MANAGER



HECTOR GOMEZ

SENIOR CONSTRUCTION MANAGER

I/I Team

Planning & Engineering / Corrective Action Plans

Joseph Carothers (Project Manager)
Jhonny Montano (Project Engineer)
Jeff Duplantis (QA/QC Repair Calls)
Reinaldo Rivera-Sanabria (Technical
Advisor)

Program Controls Management

Rudy Martinez (Database Manager)
Stanley David (GIS Specialist)
Elizabeth Savon Leyva (GIS Technician)
Adam Faschan (Grants Support)
Ramon Betancourt (Cost
Estimator/Scheduler)
Manal Alduraibi(Data Management)

SSES Inspections

Bill Rivera (Senior Field Rep)
William Scally (Field Engineer)
Albert Hernandez (Field Rep)
Luis Flores (Field Engineer)
Rudy Gonzalez (Project Engineer)
Alex Maldonado (Project Engineer)
Jhonny Montano (Project Engineer)
Justyn Deguzman (Junior Engineer)
Luis Manuel Jimenez (Engineer)

Community Outreach

Silvia Beltre
Veronica Paredes
Marjorie Kirby
Lindsay Guthrie

Construction Mgmt. Admin. & Inspections

Hector Gomez (Senior
Construction Manager)
Bill Rivera (Senior Field Rep)
David Brown (Construction
Manager)
Cary Smith (Senior Inspector)
William Scally (Field Engineer)
William Rivera (Field Rep)
Lester Sanchez (Senior Field Rep)

Program Management

Paola Davalos
Ana Dvorak
Nicholas Fernandez

A decorative graphic on the left side of the slide. It features a large green hexagon in the center containing a black icon of a lightbulb with rays emanating from it. Surrounding this central hexagon are four other hexagons: a blue one at the top, a white outline one at the bottom-left, and a smaller green one at the bottom. The background is a dark blue gradient.

Inflow and Infiltration Overview

“The Crime”



Infiltration

I&I OVERVIEW



Inflow

Infiltration

- Clean water enters the sanitary sewer system through
 - Pipeline cracks/breaks
 - Manhole structural defects
 - Defects caused by plant roots
- Typical sources
 - Groundwater
 - Tidal waters

Inflow

- Clean water enters the sanitary sewer system through
 - Missing cleanout caps
 - Damaged/missing manhole covers
 - Storm water system cross connections
- Typical sources
 - Rainfall events
 - Irrigation

EFFECTS OF I&I

Operational



- Burdened PS runtimes
- Increase in WWTs pressures
- Reduced hydraulic capacity
- Cascading effect

- Higher O&M costs
- Increased power to re-pump
- Overdesigned infrastructure



Economic

Environmental



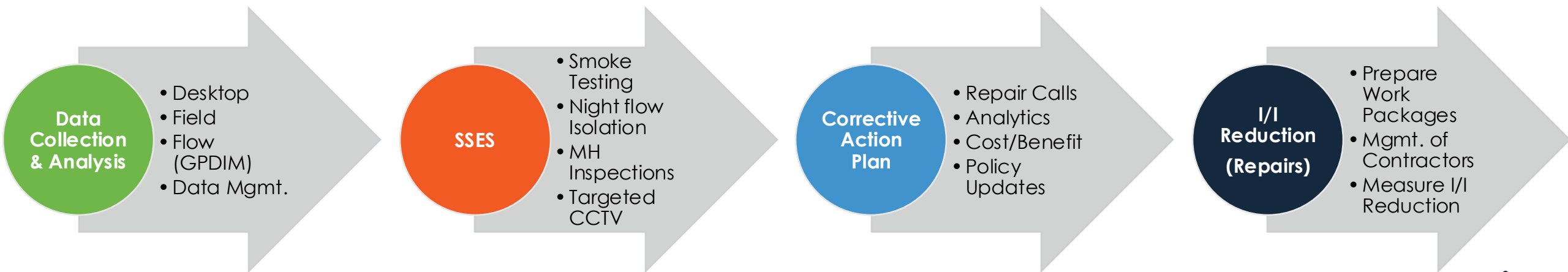
- Risk of SSOs
- Loss of fresh groundwater
- Saltwater intrusion
- Difficulty meeting regulatory requirements

PROGRAM GOALS

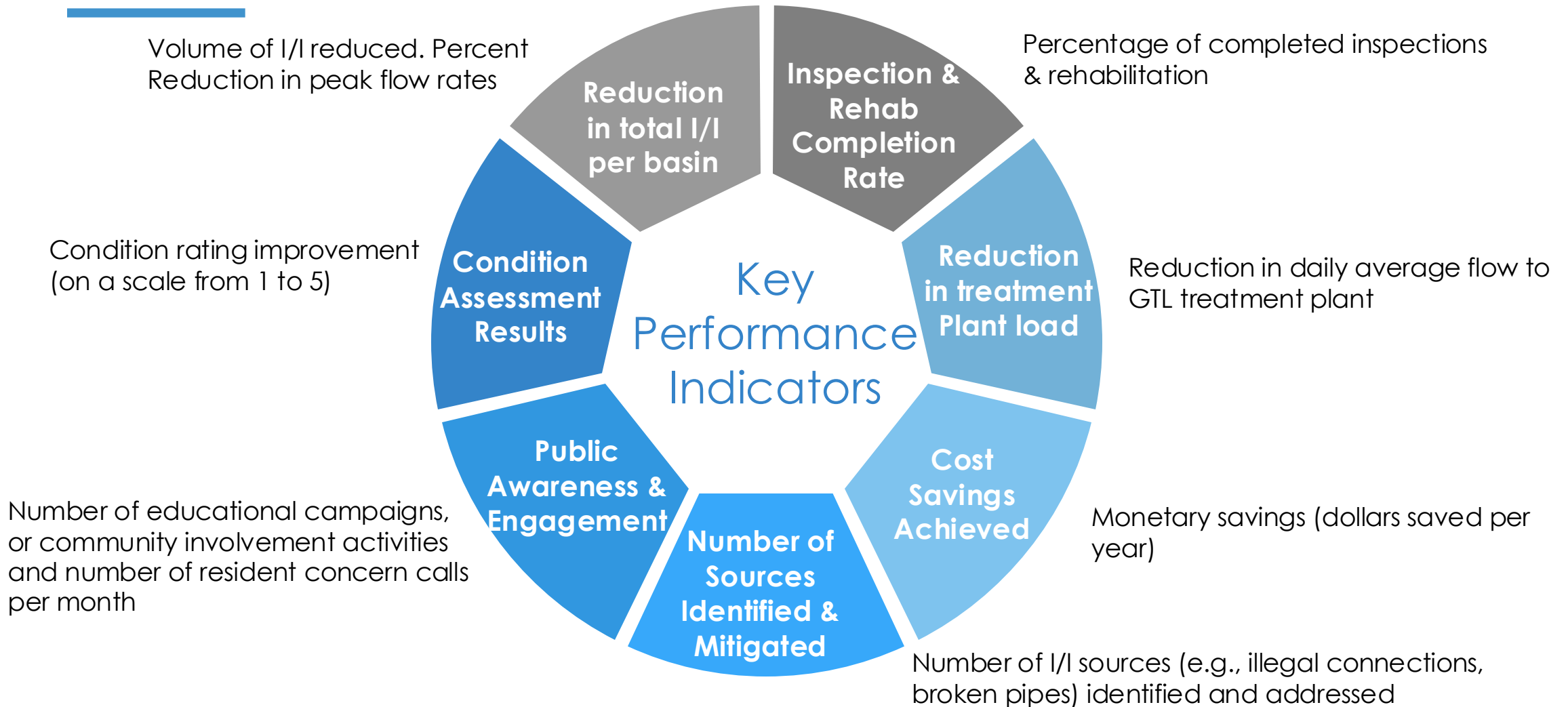
- Reduce non-sewer water entering the City's collection system (I&I)
- Effectively and efficiently reduce the loading of the G.T. Lohmeyer Wastewater Treatment Plant by reducing I&I in the Sanitary Sewer Collection System
- Compliance with FDEP
- Ensure cost-effective management of available funds for I/I reduction efforts.

GTL Plant Capacity (MGD)	Estimated System-wide I/I (MGD)	Min. Target I/I Reduction (MGD)
55.7	20 - 40	6 - 12

*MGD = Million Gallons per Day



KEY PERFORMANCE INDICATORS (KPI'S)

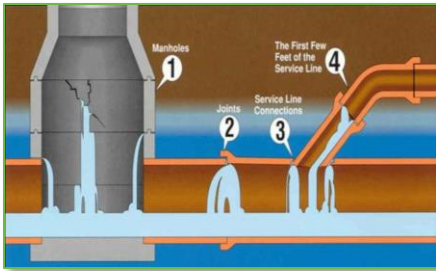




Inflow and Infiltration Sources

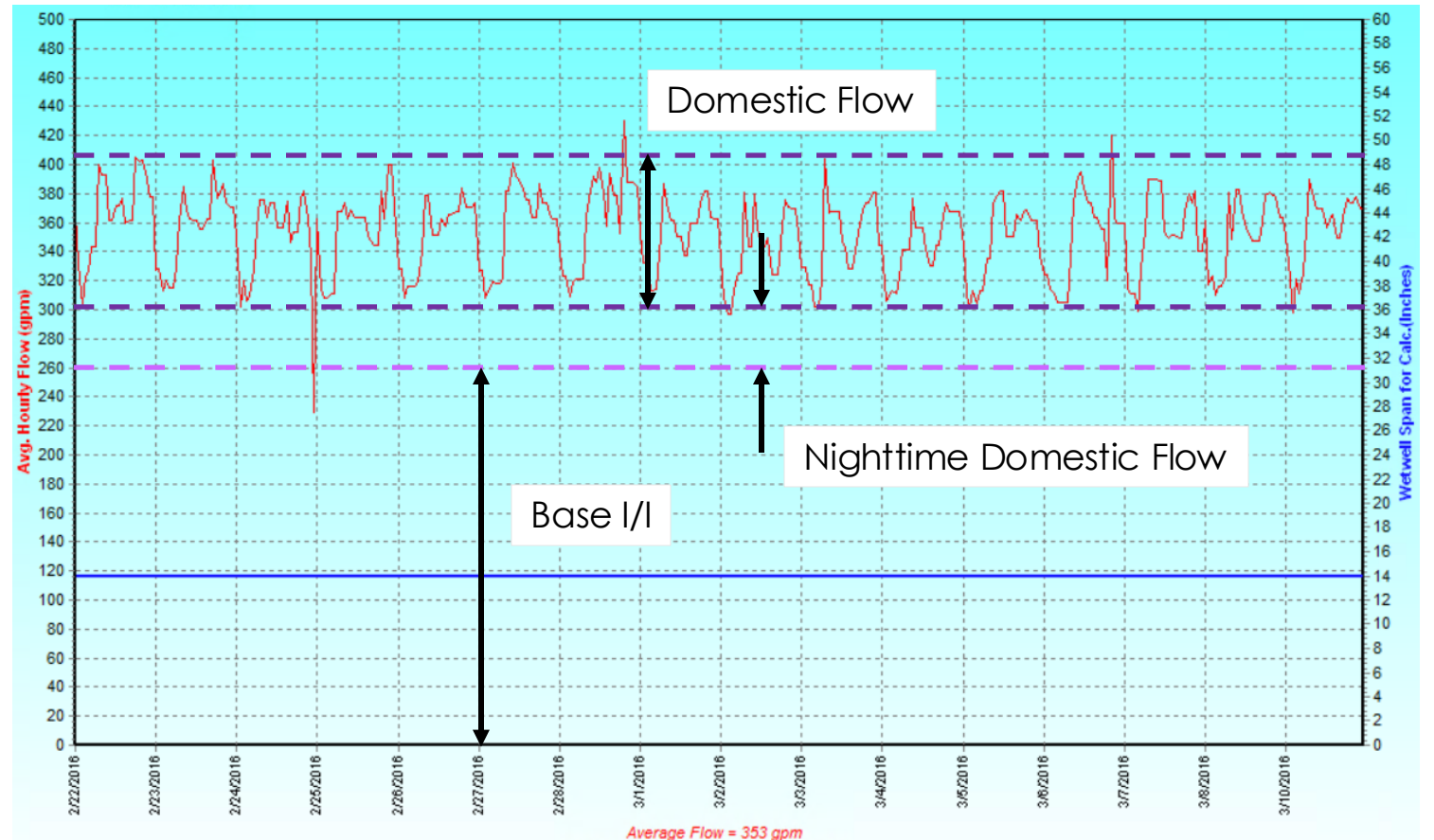
“The Suspects”

I/I OVERVIEW – BASE I/I

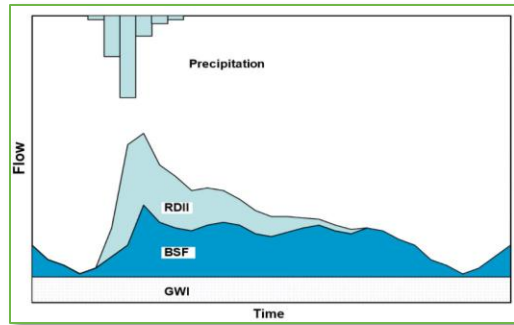


Base I/I

Steady 24-hour flow that does not significantly vary between dry season and wet season

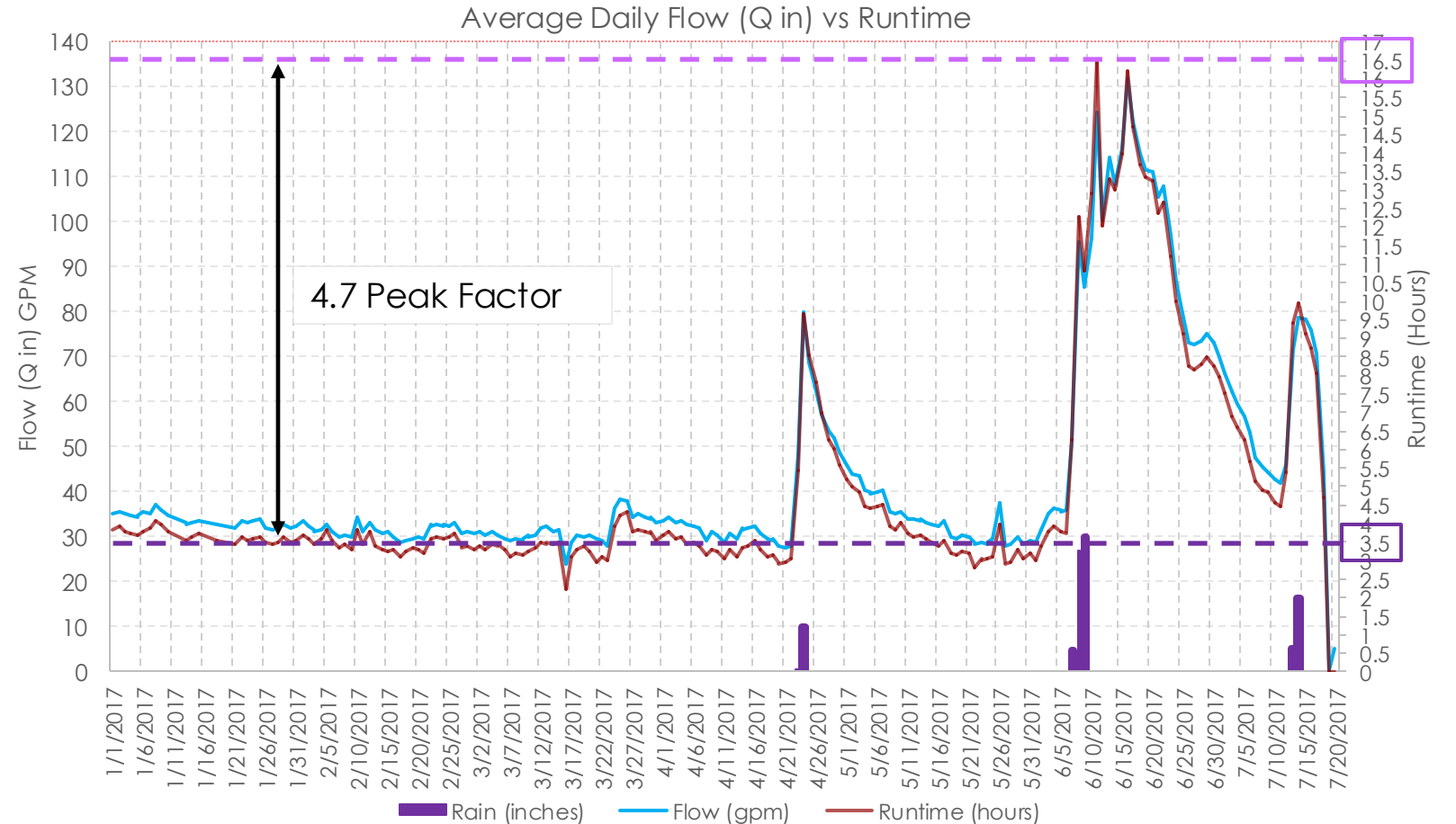


I/I OVERVIEW – RDI/I

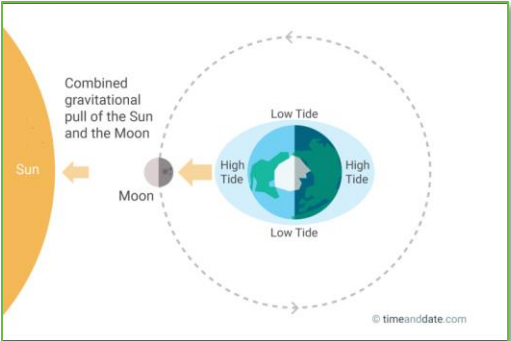


Rain Dependent I/I

Steady 24-hour flow that does not significantly vary between dry season and wet season

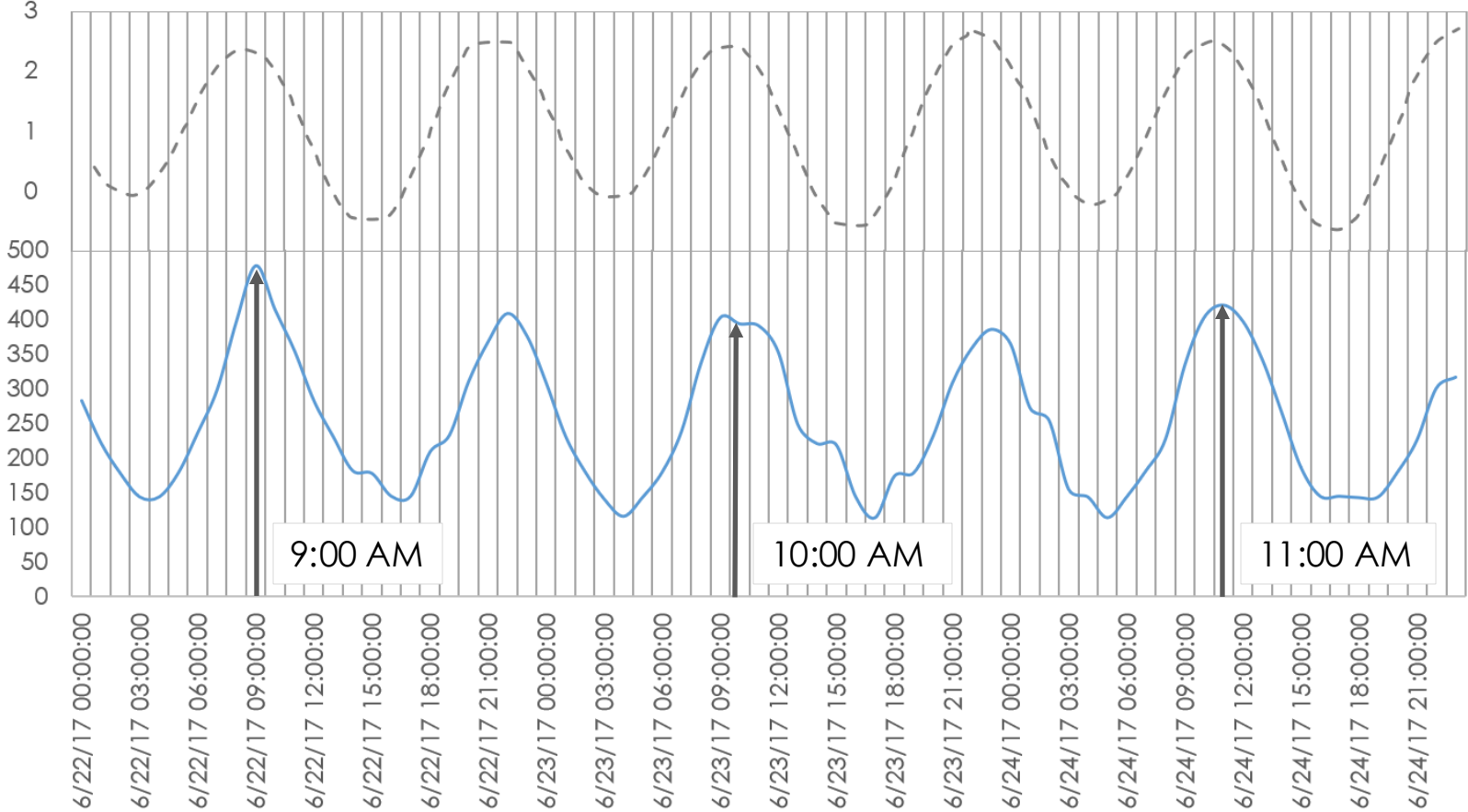


I/I OVERVIEW – TIDAL I/I



Tidal I/I

Increase in I/I which occurs when the groundwater table is temporarily elevated due to the impact of high tide



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Data Collection and Analysis

“The Forensics”

DATA SOURCES AND ANALYSIS

Data Sources

Analysis Results

WWTP Flow data
Potable water demand data



Identification of Citywide I&I levels
Targeted I&I reduction

Pump station SCADA data
O&M reports
Historical SSO data
Rainfall/groundwater data



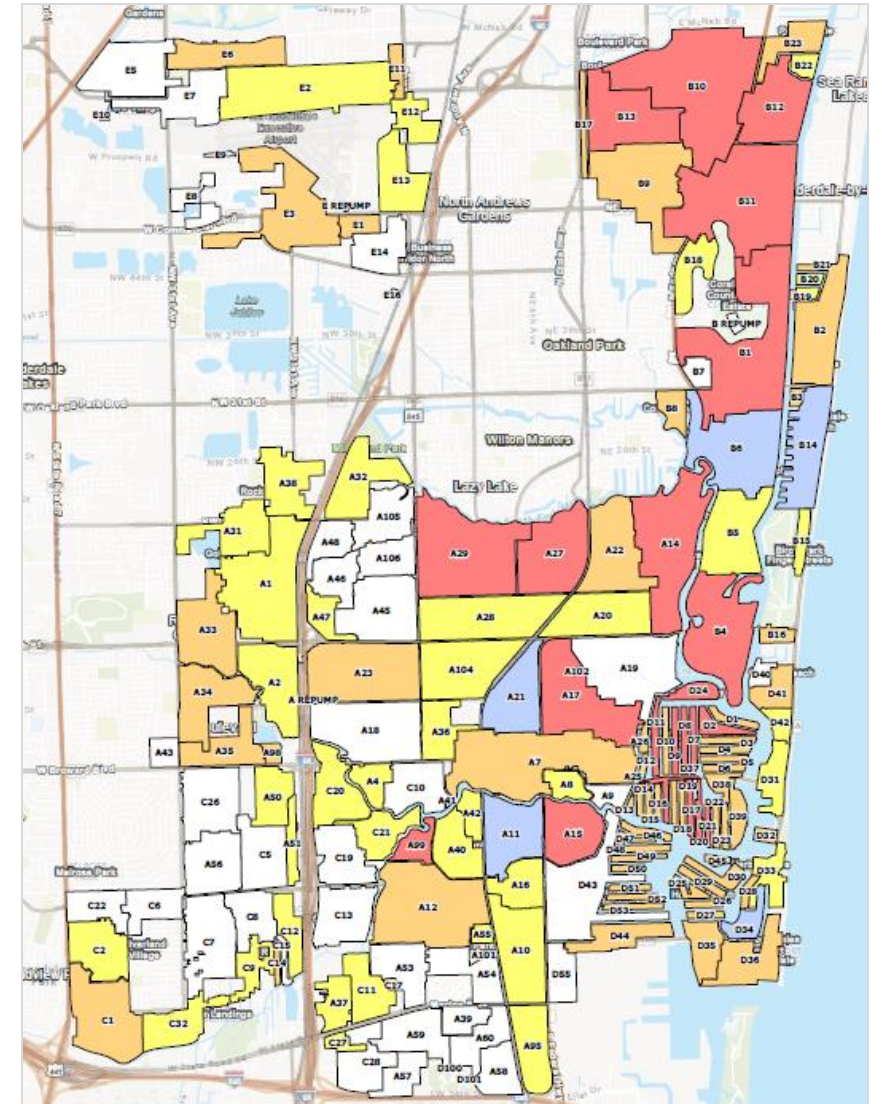
SSES Prioritization
Identification of individual basin I&I
quantity estimates
Identification of I&I sources

PHASING & PRIORITIZATION

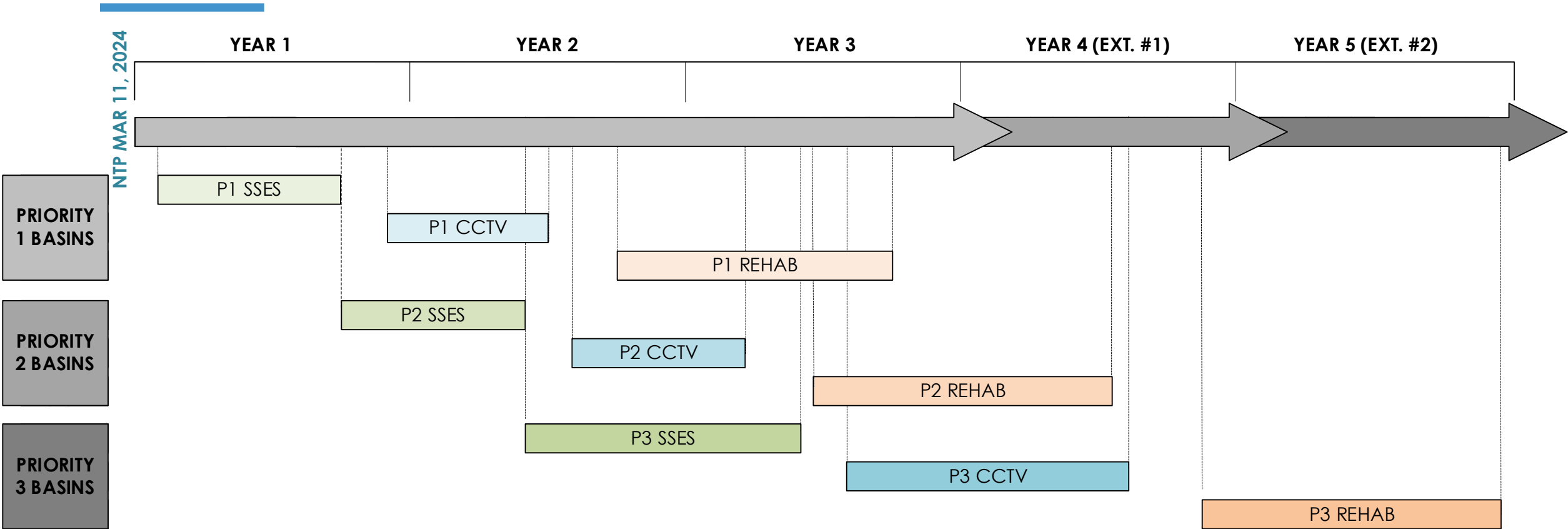
GTL Plant Capacity (MGD)	Estimated System-wide I/I (MGD)	Min. Target I/I Reduction (MGD)
55.7	20 - 40	6 - 12

	No. of Basins	Total Length of Gravity Mains (LF)	Total No. of Manholes	Estimated Length of Sewer Laterals (LF)	Estimated I/I Removal (MGD)
Ongoing I/I Basins (in progress)	5	139,337	597	51,325	0.5 - 1
Priority 1	22	557,320	1,958	269,875	1.8 - 3.6
Priority 2	62	596,957	2,409	283,425	2.4 - 4.8
Priority 3	41	624,192	2,380	265,650	1.3 - 2.6
					6.0 - 12.0

*MGD = Million Gallons per Day



PROGRAM TIMELINE





Sanitary Sewer Evaluation Survey (SSES)

“The Investigation”

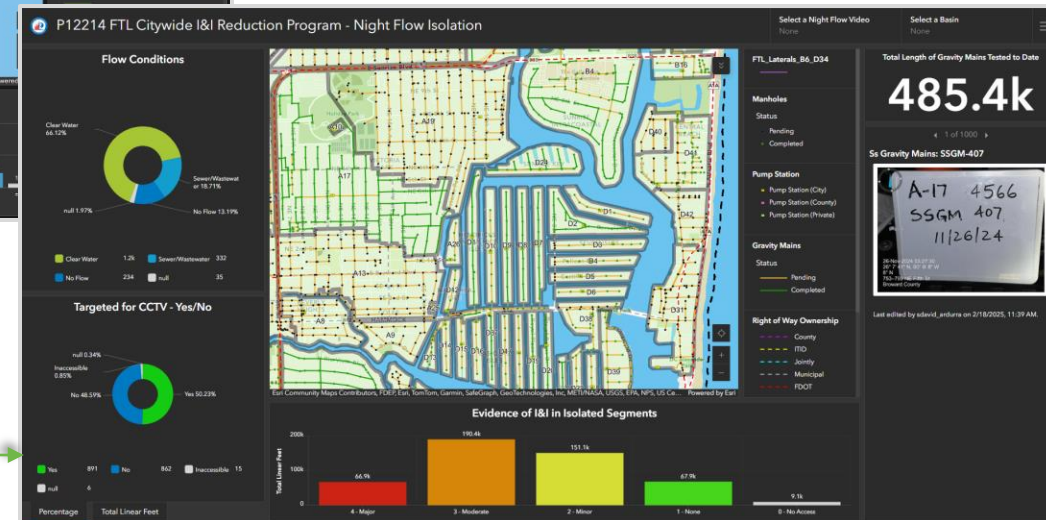
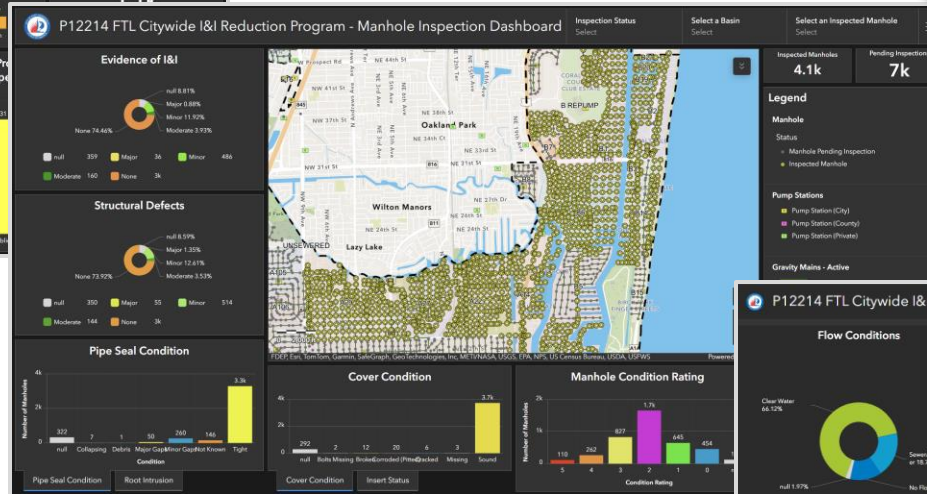
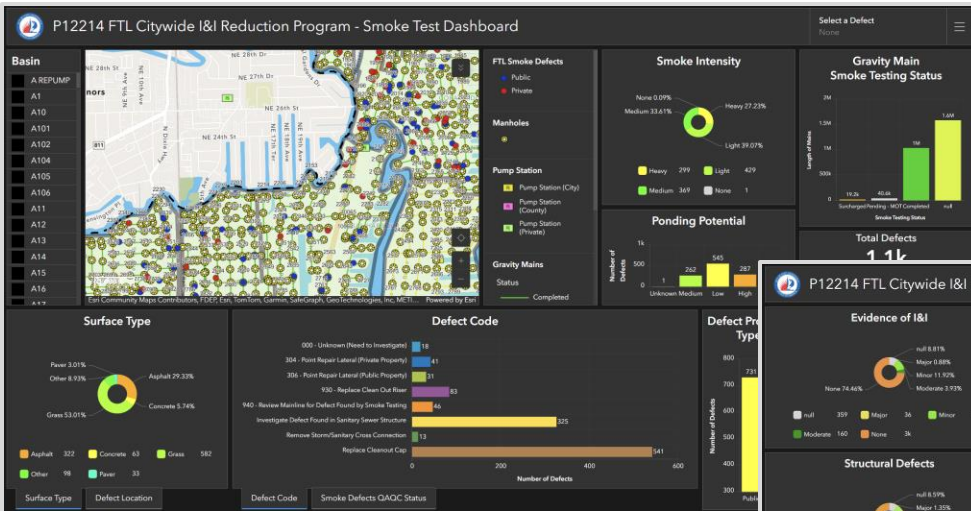
COST EFFECTIVE / DATA-CENTRIC SSES

Smoke Testing



Manhole Inspections

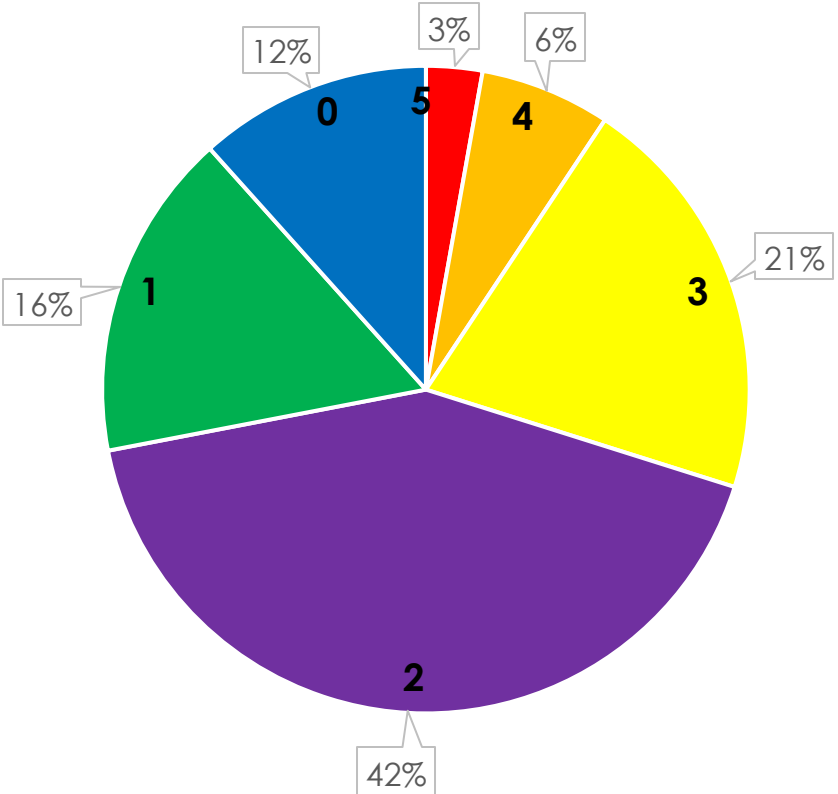
Night-flow Isolation



\$24.5M in savings

MANHOLE INSPECTION RESULTS

4,700 Manholes Inspected



Level I Inspection:
Visual evaluation of sanitary sewer system manholes



Identify and record GPS location (lat/long) of assets. Update City's GIS



Visual photo & video inventory to show overall condition

Grade	Condition	Condition Definition	Estimated time to failure
5	Extremely Poor	Most Significant Defect	May fail within the next 5 years
4	Poor	Significant Defect	5 to 10 years
3	Fair	Moderate Defect	10 to 20 years
2	Good	Minor to Moderate Defect	20 years or more
1	Excellent	Minor Defect	Unlikely in the foreseeable future

* Based on NASSCO Condition Grades

Grade	Condition Definition	Explanation/Reasoning
0	Cannot be Rated	Surcharged Manhole - Requires Vector Truck and/or further coordination with the City for Flow Control to complete manhole assessment
		Inaccessible
		Depicted on the City's Sewer GIS as a Sewer Manhole but determined in the field that the point is not a sewer manhole (i.e stormwater manhole, grease trap, etc.)

MANHOLE INSPECTION PROGRESS

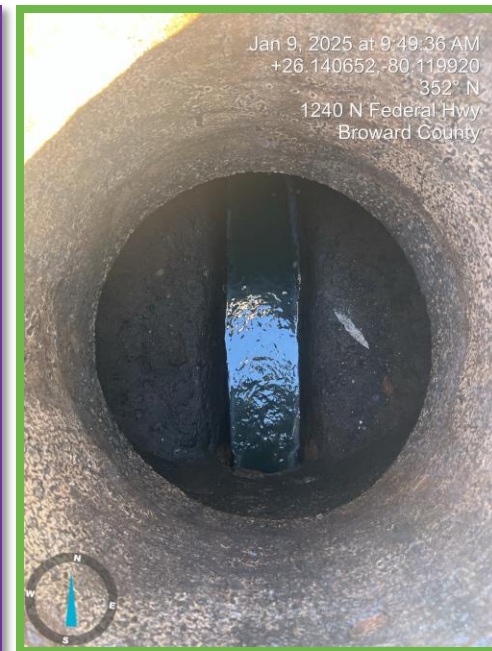
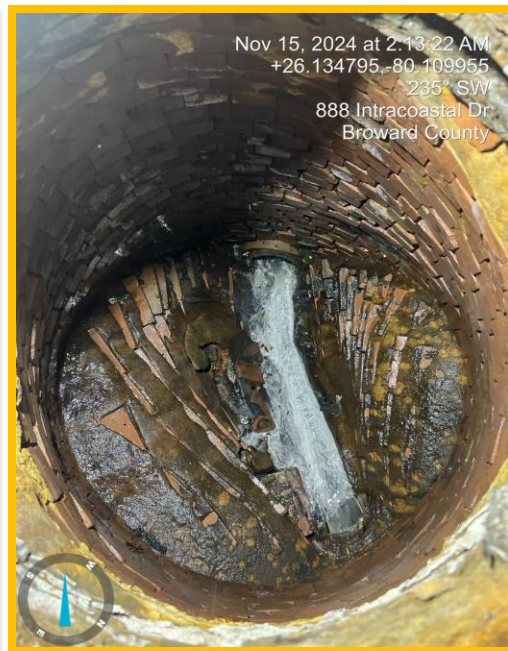
Grade 5

Grade 4

Grade 3

Grade 2

Grade 1





P12214 FTL Citywide I&I Reduction Program - Manhole Inspection Dashboard

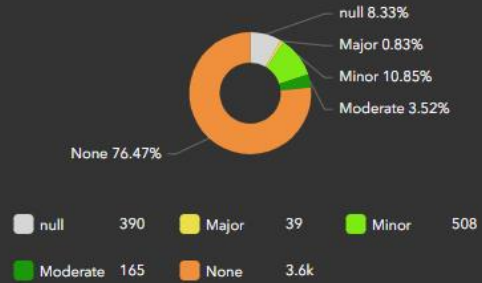
Inspection Status
Select

Select a Basin
Select

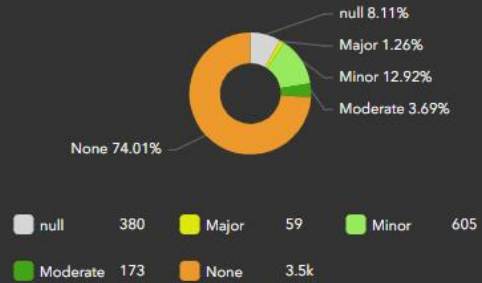
Select an Inspected Manhole
Select



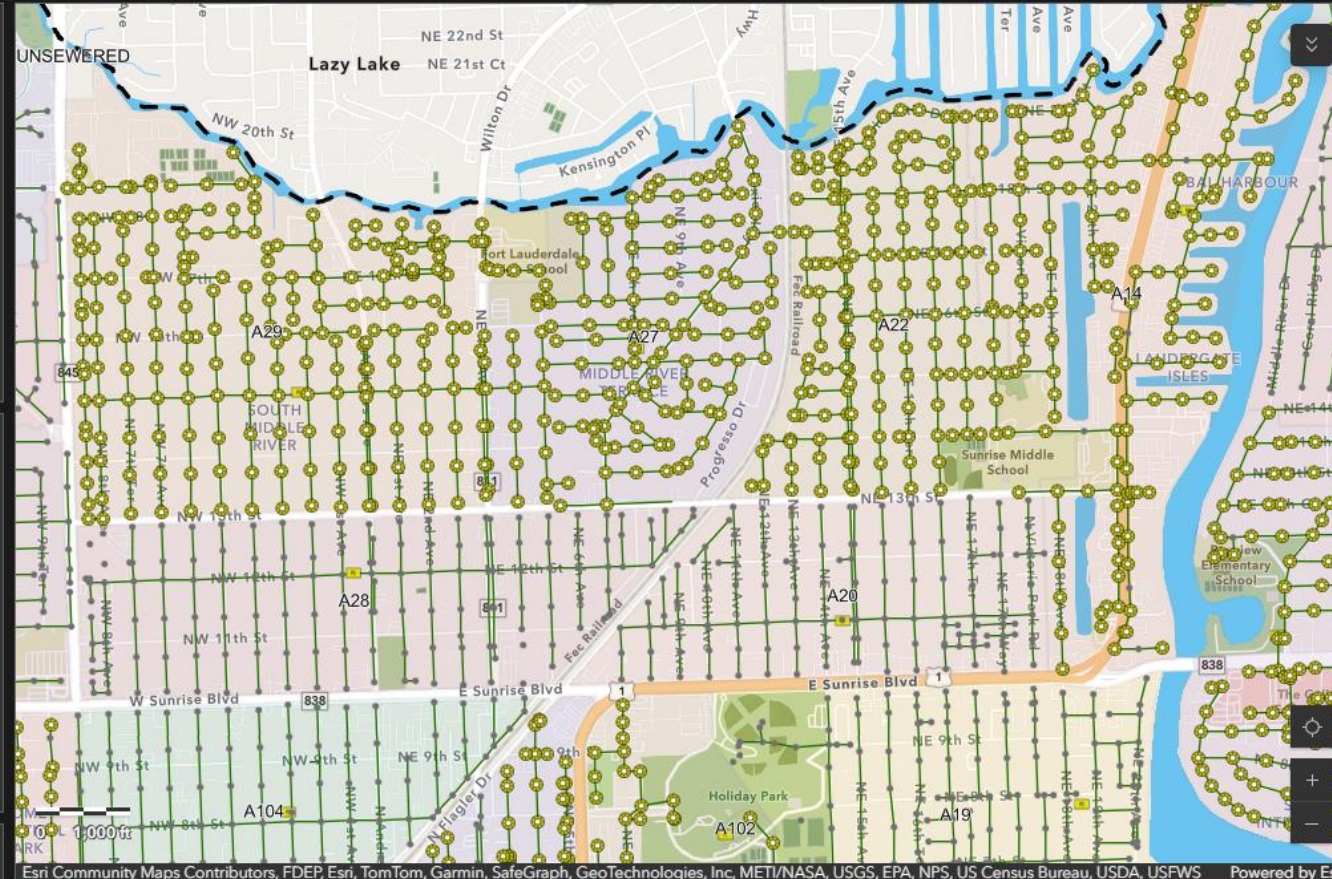
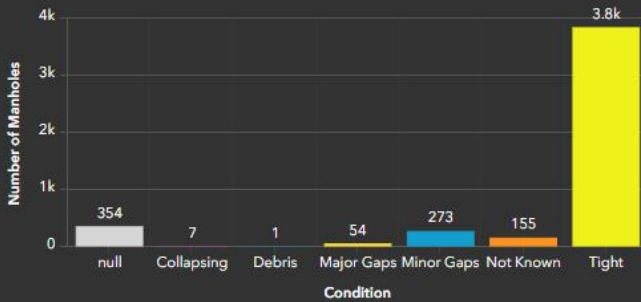
Evidence of I&I



Structural Defects



Pipe Seal Condition



Inspected Manholes
4.7k

Pending Inspections
6.4k

Legend

Manhole

Status

- Manhole Pending Inspection
- Inspected Manhole

Pump Stations

- Pump Station (City)
- Pump Station (County)
- Pump Station (Private)

Gravity Mains - Active

Fort Lauderdale Basins

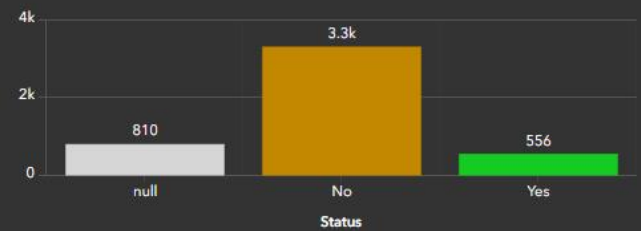
- UNSEWERED

19 of 4683

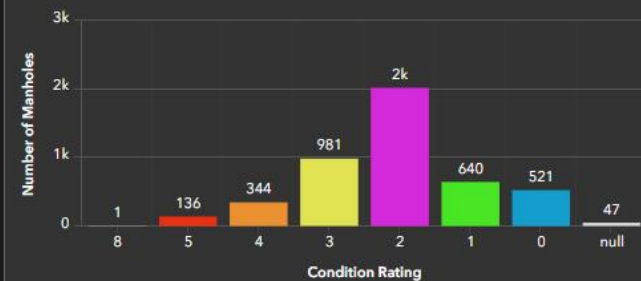
Manhole Photos



Manhole Insert Status



Manhole Condition Rating



Pipe Seal Condition

Root Intrusion

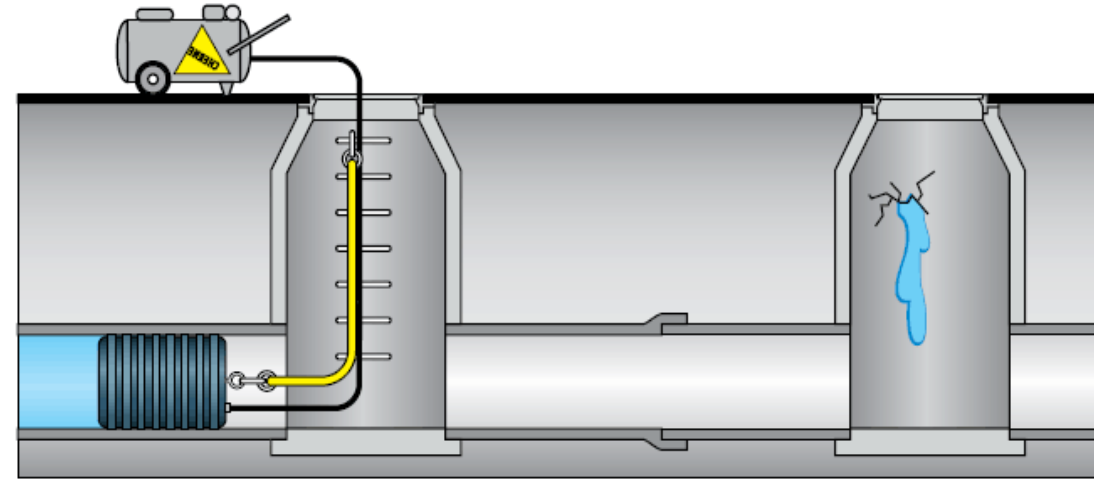
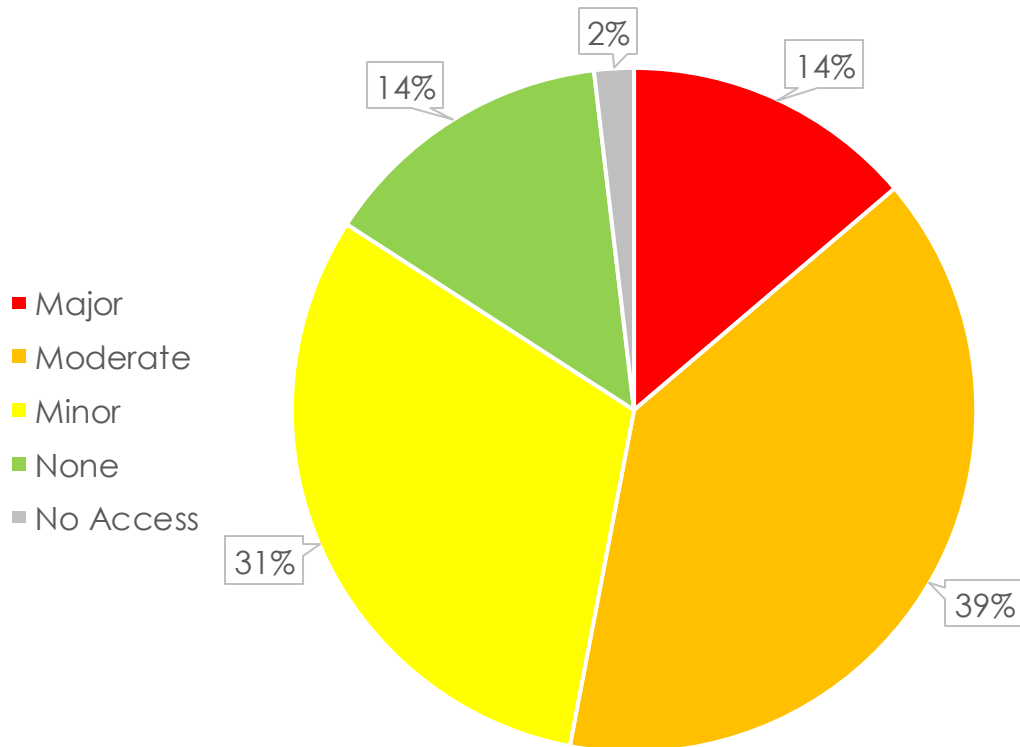
Cover Condition

Insert Status

Condition Rating

NIGHT FLOW ISOLATION RESULTS

485,400 Linear feet of Gravity Main tested



Flow Severity	Estimated Depth of Flow (in)
None	0 - 0.5
Minor	0.5 - 1.5
Moderate	1.5 - 4.0
Major	4.0+

Selected for CCTV → Moderate
Selected for CCTV → Major

NIGHT FLOW ISOLATION PROGRESS

Mains Selected for CCTV

Major
(Basin D7)



Moderate
(Basin A99)



NIGHT FLOW ISOLATION PROGRESS

Mains Not Selected for CCTV

Minor
(Basin B-10)



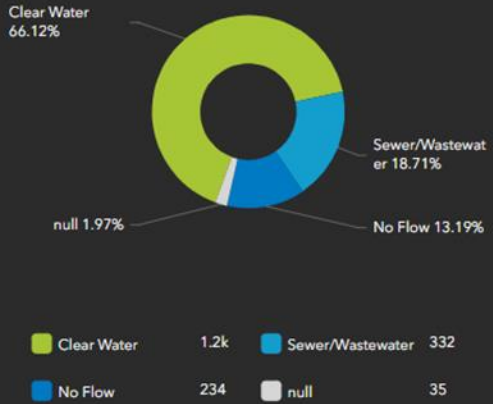
None
(Basin A-27)



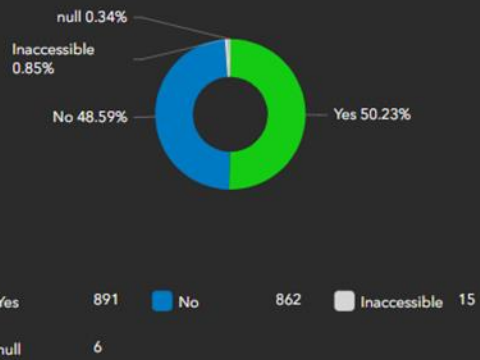
Select a Night Flow Video
None

Select a Basin
None

Flow Conditions



Targeted for CCTV - Yes/No



Percentage | Total Linear Feet



Esri Community Maps Contributors, FDEP, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Ce... Powered by Esri

FTL_Laterals_B6_D34

Manholes

- Status
- Pending
 - Completed

Pump Station

- Pump Station (City)
- Pump Station (County)
- Pump Station (Private)

Gravity Mains

- Status
- Pending
 - Completed

Right of Way Ownership

- County
- ITID
- Jointly
- Municipal
- FDOT

Total Length of Gravity Mains Tested to Date

485.4k

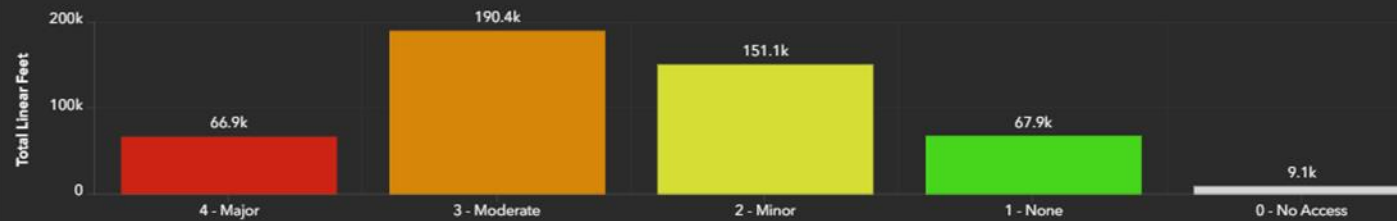
1 of 1000

Ss Gravity Mains: SSGM-407



Last edited by sdauid_ardurra on 2/18/2025, 11:39 AM.

Evidence of I&I in Isolated Segments

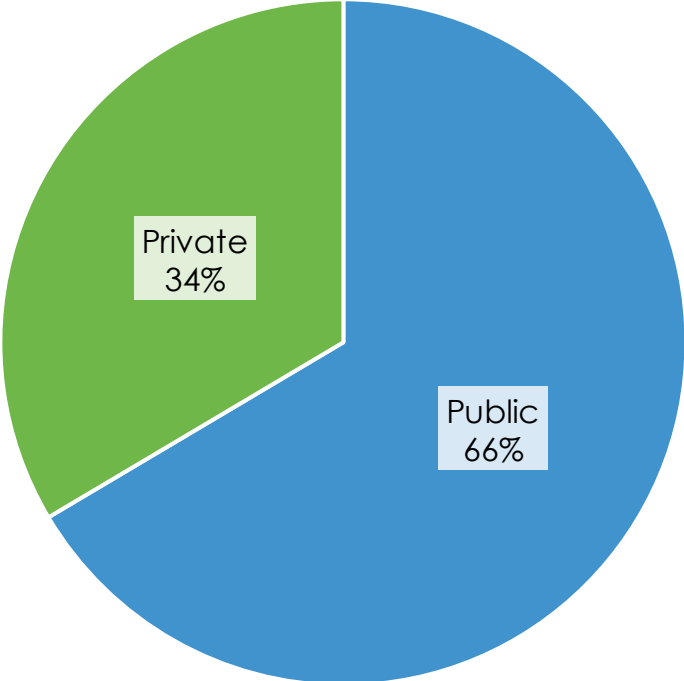


SMOKE TESTING RESULTS

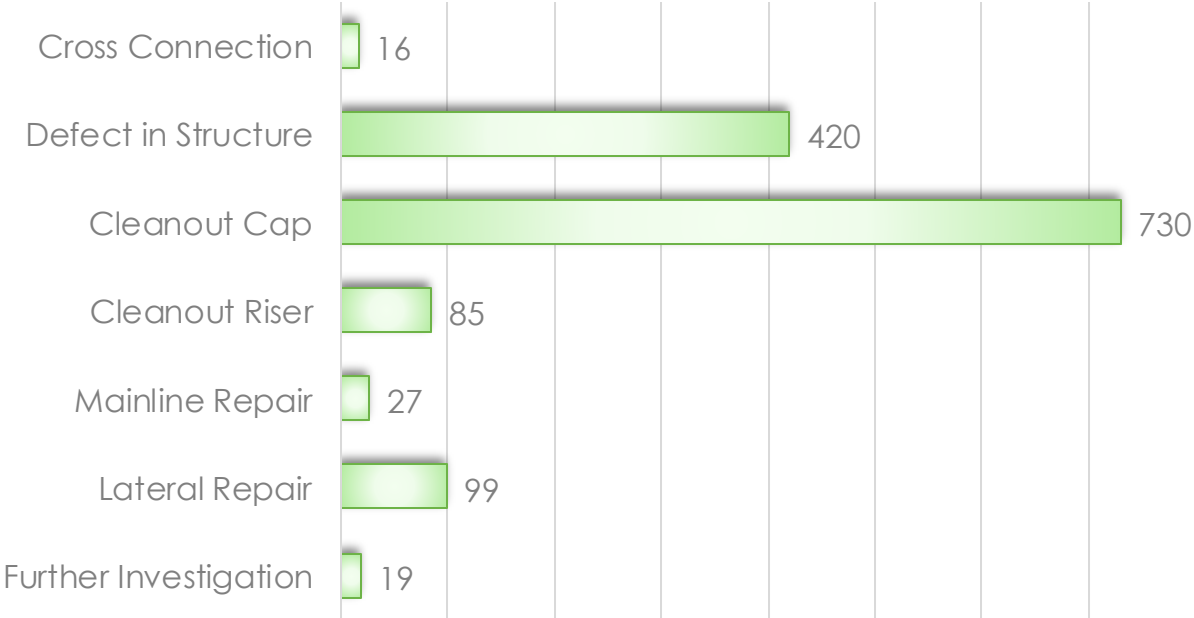


1.3 M Linear feet of mains smoke tested to date

1,400 Defects Identified



Defects Identified by Type



SMOKE TESTING RESULTS

Defects Identified - Cleanouts

Cleanout Cap Replacement



Cleanout Riser Replacement



SMOKE TESTING RESULTS

Defects Identified – Pipeline Defects

Further Investigation
of Mains or Laterals



SMOKE TESTING RESULTS

Defects Identified – Structure Defects



Manhole Defects



Pump Station Defects



Stormwater Cross Connections



SSES – TARGETED CCTV SURVEY

Objectives:

- Confirm source of I/I observed in other SSES activities
- Identify suspect service laterals for further inspection
- Identify specific defects in suspect mains and laterals

Methodology:

- Preliminarily clean mains and laterals
- Use of CCTV cameras to inspect gravity sewer mains and laterals
- Identify and categorize defect types
- Estimate I&I quantity where applicable
- Delivery of reports detailing the condition of the subject asset



TARGETED CCTV SURVEY RESULTS

Identification of I&I Sources



IGJ (Infiltration Gusher Joint) – separated joint



IRC (infiltration runner connection) due to a defective connection/tap

TARGETED CCTV SURVEY RESULTS

Identification of Major Pipe Defects



A decorative graphic on the left side of the slide. It features a large green hexagon in the center containing a white line-art icon of handcuffs. Surrounding this central hexagon are four other hexagons: a blue one at the top, a white outline one on the left, and a smaller green one at the bottom.

Corrective Actions & Rehabilitation

“Sentencing”

COST EFFECTIVE CORRECTIVE ACTION PLAN



Critical & High I/I

**Peaking Factors
Reduce RDI/I**



**Tidal I/I &
King Tides**

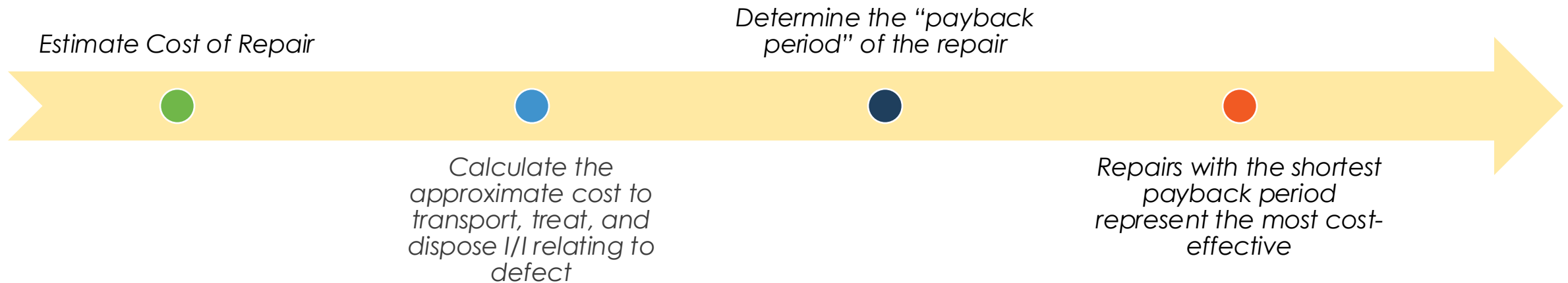
**Reduce Potential
Sewer Overflows
(SSOs)**



COST EFFECTIVE CORRECTIVE ACTION PLAN

I/I Reduction is not a one size fits all approach

- **Targeted work plan** based on basin assessment and prioritization
- **Case-by-base analysis** to choose appropriate improvements for each individual basin
- Focused on prioritizing repairs that will have the **greatest impact & cost savings**

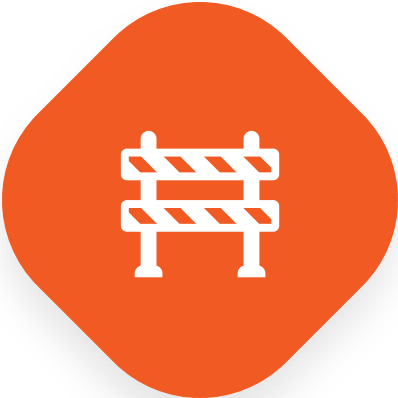


- Consider Non-quantitative Issues: Criticality, Consequence of Failure, Health Hazards, System Hydraulics and Operations and Maintenance
- Rank and Schedule Repairs

CRITERIA FOR REPAIR APPLICATIONS



● Feasibility



● Type of Failure



● Cost

- Cured-in-Place Pipe
- Dig and Replace
- Manhole Repair
- Lateral Liners
- Chemical Grouting
- Sectional Lining
- Point Repairs
- Pipe Bursting



DEVELOPMENT OF REHABILITATION PACKAGES

CORRECTIVE ACTION PLAN

Prioritization of proposed rehabilitation

CITY OF FORT LAUDERDALE
P12214 - CITY-WIDE I&I REDUCTION PROGRAM
BASIN B6 CORRECTIVE ACTION PLAN (CAP) TABLE

Repairs specified for each defect

CCTV & PIPELINE REHABILITATION

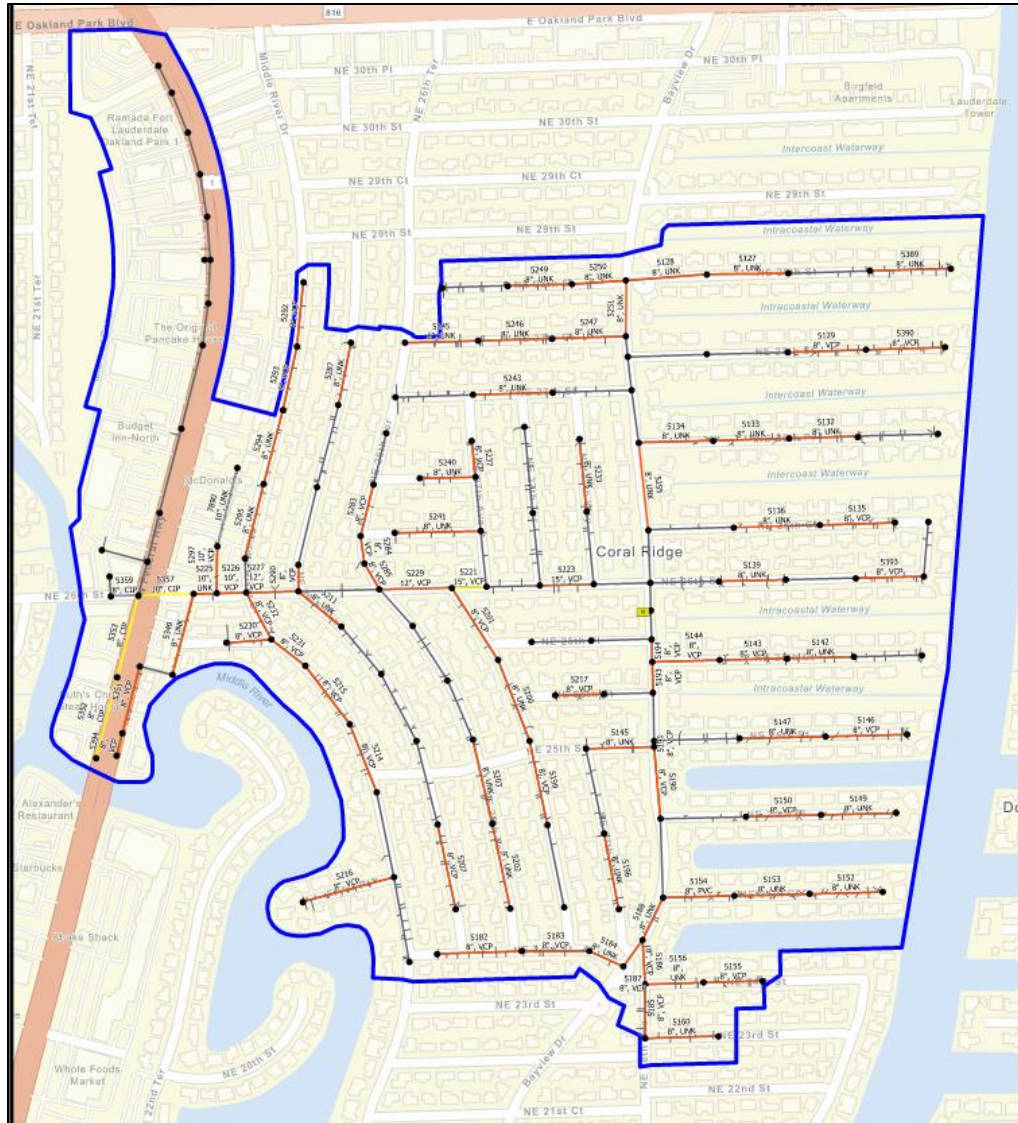
GENERAL INFORMATION								FINDINGS/STATUS/REPAIR INFORMATION										
ITEM ID N°	BASIN or SUB-BASIN NAME	ASSET TYPE	MAIN ID	LATERAL ASSET NAME / NUMBER	PIPE DIAMET (IN)	PIPE MATERIA	PIPE LENGT (LF)	CCTV DATE	PRIORITY	I&I QUANTIT (GPM)	DEFECT CODE / DESCRIPTION	ASSET SUMMARY / COMMENTS	DEFECT LOCATION (LF)	REPAIR TYPE	REPAIR QTY (LF)	REPAIR QTY (EA)	PENDING / COMPLETION DATE	REHABILITATION DOCUMENTATION
1.00	B6	MAIN	SSGM-5127		8	UNK	377.3	2/28/2024				DEFECT SUMMARY: CL - 77.3, CM - 47.7-147.6						
	B6	MAIN	SSGM-5127		8	UNK	377.3	2/28/2024	4	0			0	CIPP	377.3			
	B6	MAIN	SSGM-5127		8	UNK	377.3	2/28/2024	3	0	CL	Defect Location and code noted for reference as incidental to CIPP lining work	77.3					
	B6	MAIN	SSGM-5127		8	UNK	377.3	2/28/2024	4	0	CM	Defect Location and code noted for reference as incidental to CIPP lining work	47.7-147.6					
SUMMARY OF REHABILITATION:																		
MAINLINE REPAIRS:																		
CIPP: 377.3 LF																		
2.00	B6	MAIN	SSGM-5128		8	UNK	377	3/4/2024				DEFECT SUMMARY: LATERALS PENDING REHABILITATION: 1						
	B6	MAIN	SSGM-5128		8	UNK	377	3/4/2024	5	2		CIPP FOR MAIN LINE DUE TO LATERAL LINER	0	CIPP	377			
2.01	B6	LATERAL	SSGM-5128	B6-1905-212-T	6	N/A	N/A	3/4/2024				DEFECT SUMMARY: IRC - 0.1						
	B6	LATERAL	SSGM-5128	B6-1905-212-T	6	N/A	N/A	3/4/2024	5	2			0	Lateral Liner	15			
	B6	LATERAL	SSGM-5128	B6-1905-212-T	6	N/A	N/A	3/4/2024	5	2	IRC	Defect Location and code noted for reference as incidental to CIPP lining work	0.1					

SUMMARY OF REHABILITATION:	
MAINLINE REPAIRS:	
CIPP:	377 LF
LATERAL REPAIRS:	
Lateral Liner:	15 LF

Detailed summaries of proposed rehabilitation

REHABILITATION MAPS

CIPP LINING

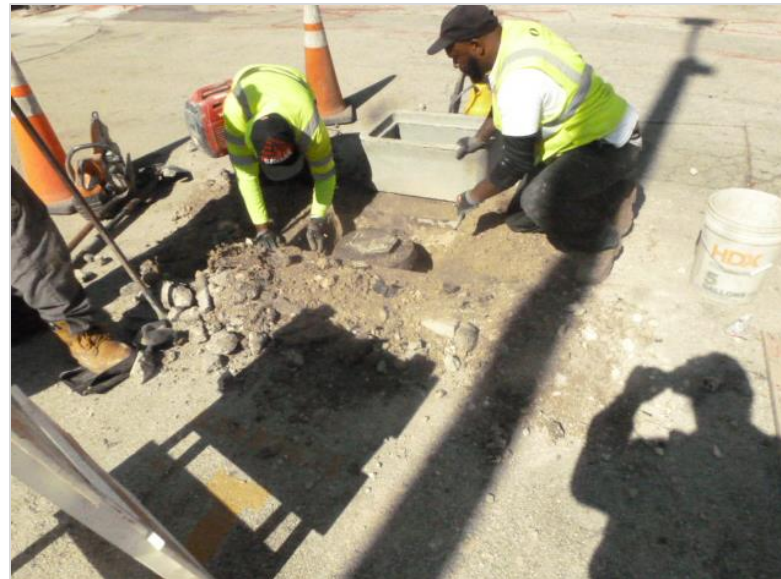


POINT REPAIRS



REHABILITATION/REPAIR & POST REHAB MONITORING

- Estimate & Track Rehab Costs
- Monitor Flow Reduction
- Evaluate Cost Savings
- Manage I/I Contracts & Contractors



A decorative graphic consisting of four hexagons: a large solid green one in the center, a smaller solid blue one above it, a smaller solid green one below it, and a white outline hexagon to the left of the large green one.

Success Stories

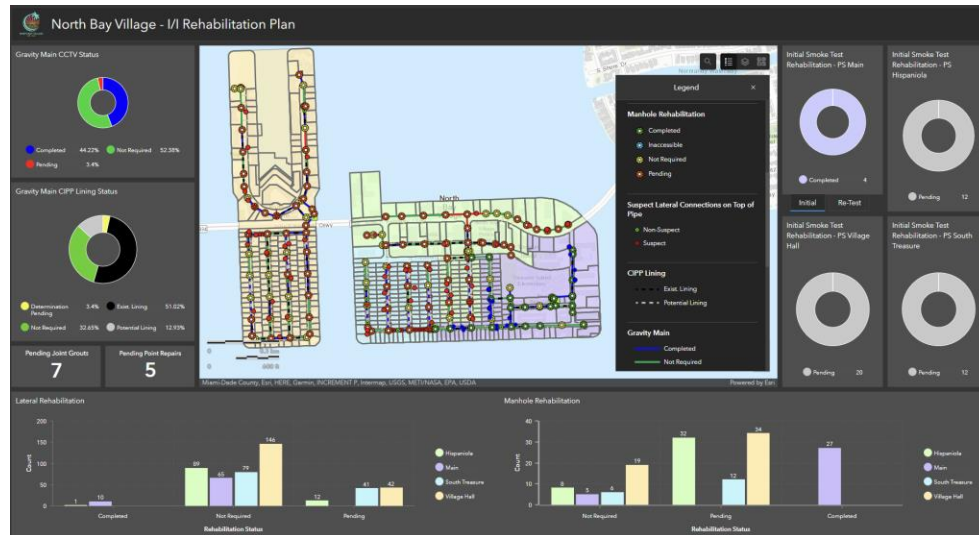
“Rehabilitated Suspects”

North Bay Village

**ROI:
Less
than 2
Years!**

PS Basin	Pre-Rehabilitation Measured I-I Flow (GPD)	Pre-Rehabilitation GPDIM	Post-Rehabilitation Measured I-I Flow (GPD)	Post-Rehabilitation GPDIM	I-I Flow Reduction (%)
Village Hall	684,864	25,711	54,693	2,053	92%
South Treasure	237,312	22,342	41,071	3,867	83%
Hispanola	28,608	1,650	N/A	N/A	N/A
Main	134,400	7,952	48,960	2,897	64%

Monthly Sewer Billing Savings	\$110,270
Yearly Sewer Billing Savings	\$1,323,250
Total I/I Rehab Cost	\$2,482,736
ROI (Years)	1.88



Well done team for your focus on this and success in achieving something that had been in process for years.

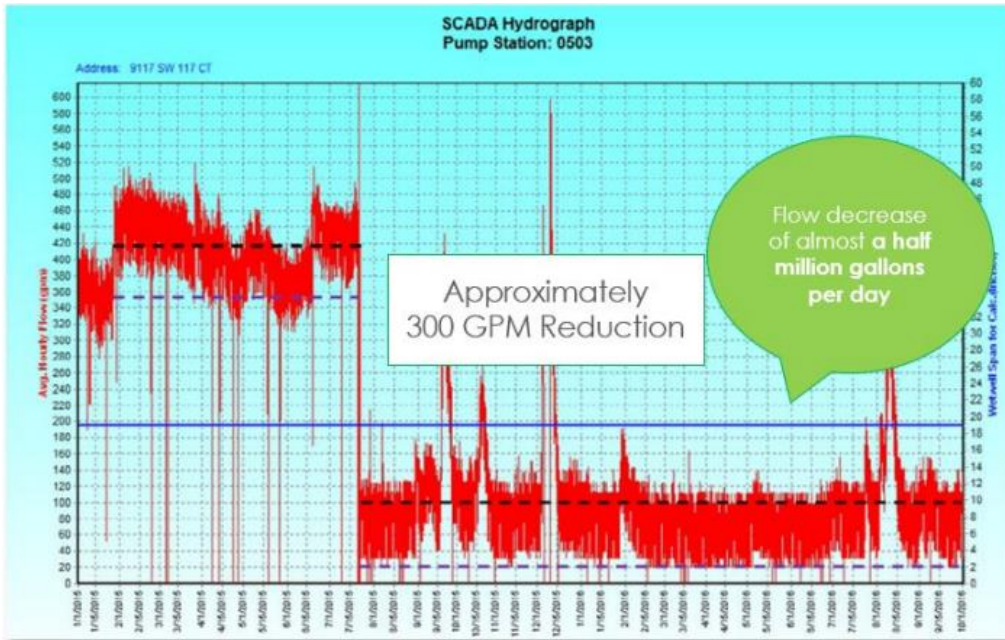
This was a heavy lift over the village for the better part of a decade. It shows why continuity is so important in a team and with the staff.

Let's get the rest of it finished. Can't underestimate how important this is.

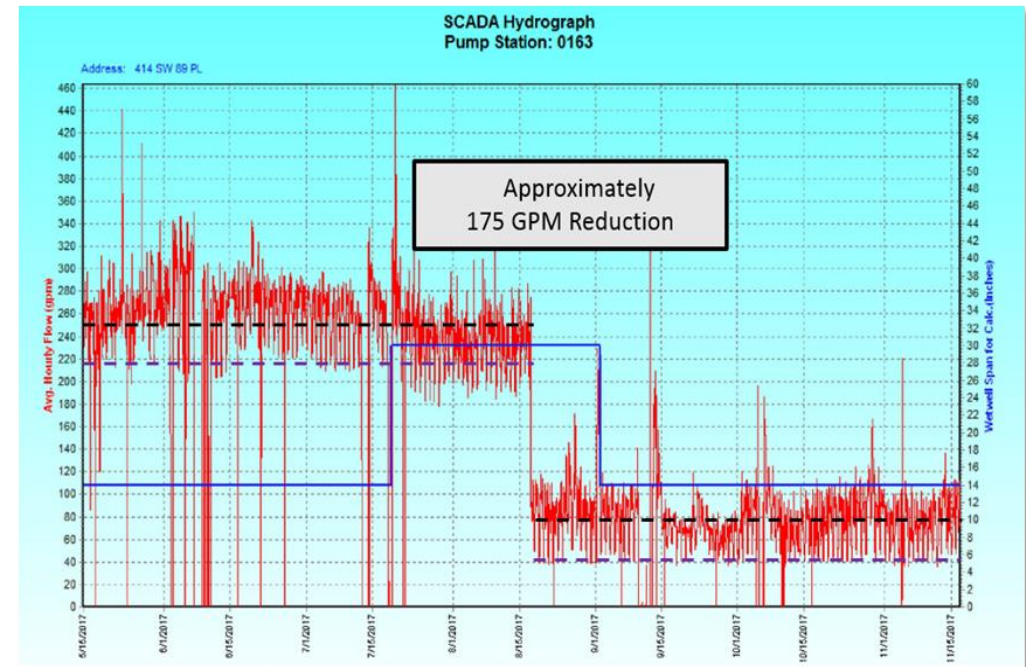
Mayor Brent Latham
North Bay Village

Miami Dade - PSIP

3.9 MGD of I/I reduction from 15 PSIP
Critical & High Priority Stations



Total Savings	\$7,196,464.03	Pump Station Runtime	
Cost per WASD	\$34,211.17	PRE I/I Repair	10.2 hr/day
ROI	21,035 %	POST I/I Repair	5.8 hr/day



Total Savings	\$10,480,365	Pump Station Runtime	
Cost per WASD	\$79,901.62	PRE I/I Repair	16 hr/day
ROI	13,117 %	POST I/I Repair	6.2 hr/day

CITY OF CORAL GABLES – SSES NIGHT FLOW STUDY & BASIN PRIORITIZATION

Night Flow Study & 10-Year SSES Report

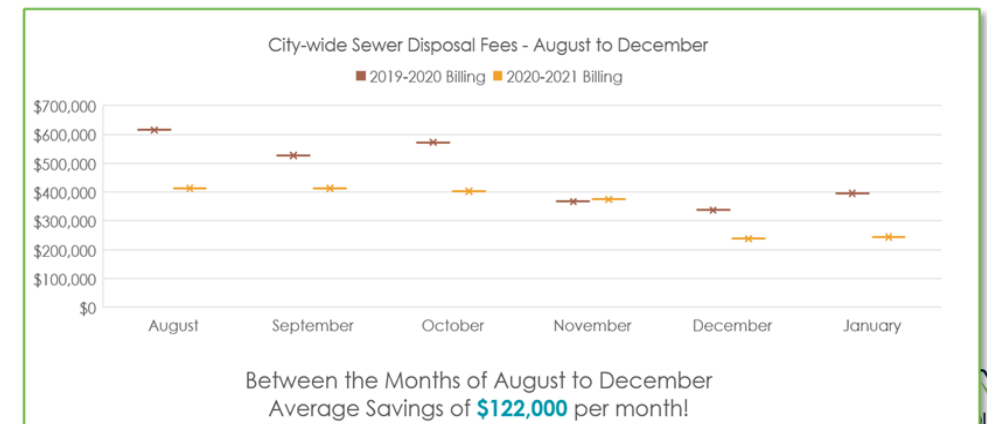
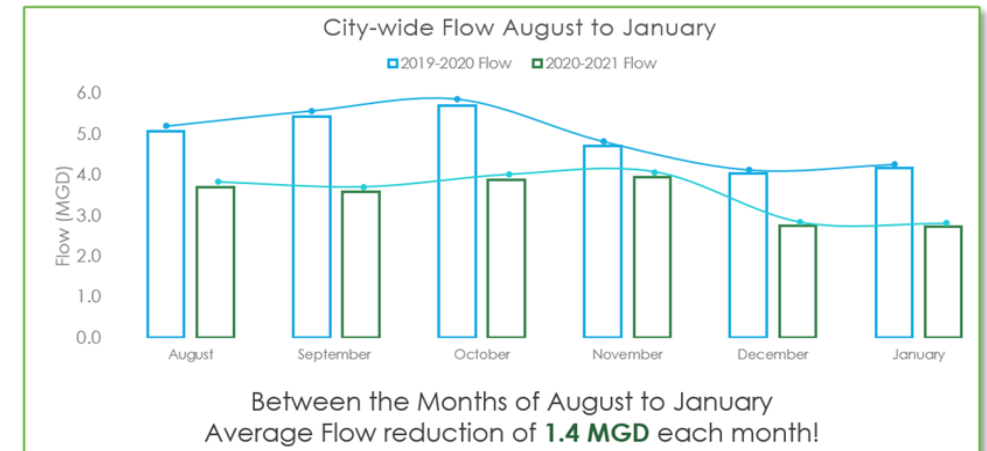
- Smoke Testing
- Manhole Inspections
- Regulatory Coordination & Reporting
- SCADA & Field Data Analysis

Basin Prioritization Plan

- Base I&I, RD-I&I, Tidal I&I, & King Tides Impact Evaluation
- Multi-year Cost-Effective Work Plan Creation

PROJECT SUCCESS:

- Substantial I&I Reduction
- \$122K Monthly Sewer Billing Savings & 1.4 MGD Flow reduction



Questions?

