

Brookville Sewer System Evaluation Monitoring, Modeling & Corrective Action

PennTec Conference
June 1, 2015

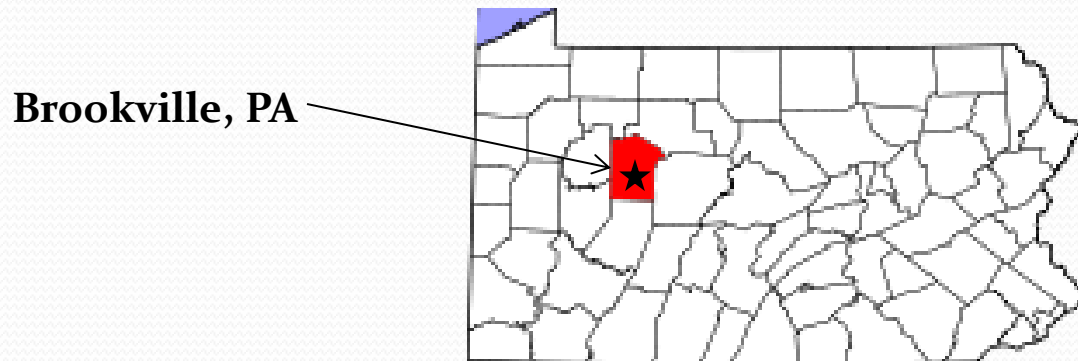
Presented By:
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Gwin, Dobson & Foreman, Inc.

Outline

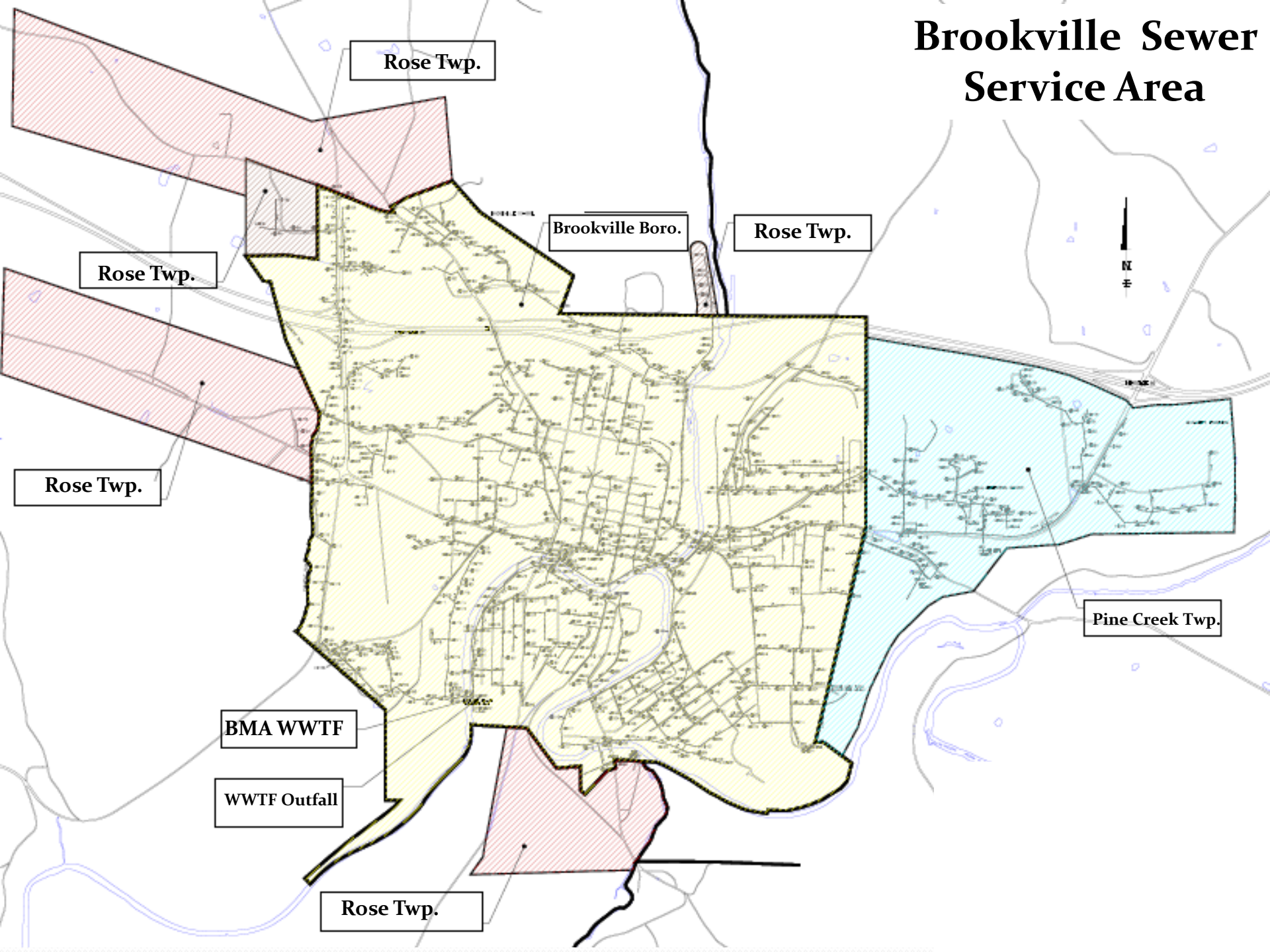
- Brookville Sewer System Evaluation
 - System Overview
 - Overflow Regulatory Problems
 - Flow Monitoring
 - Diagnostic Evaluation
 - Hydraulic Modeling
 - Analysis
- Compliance Projects
- Questions

System Overview

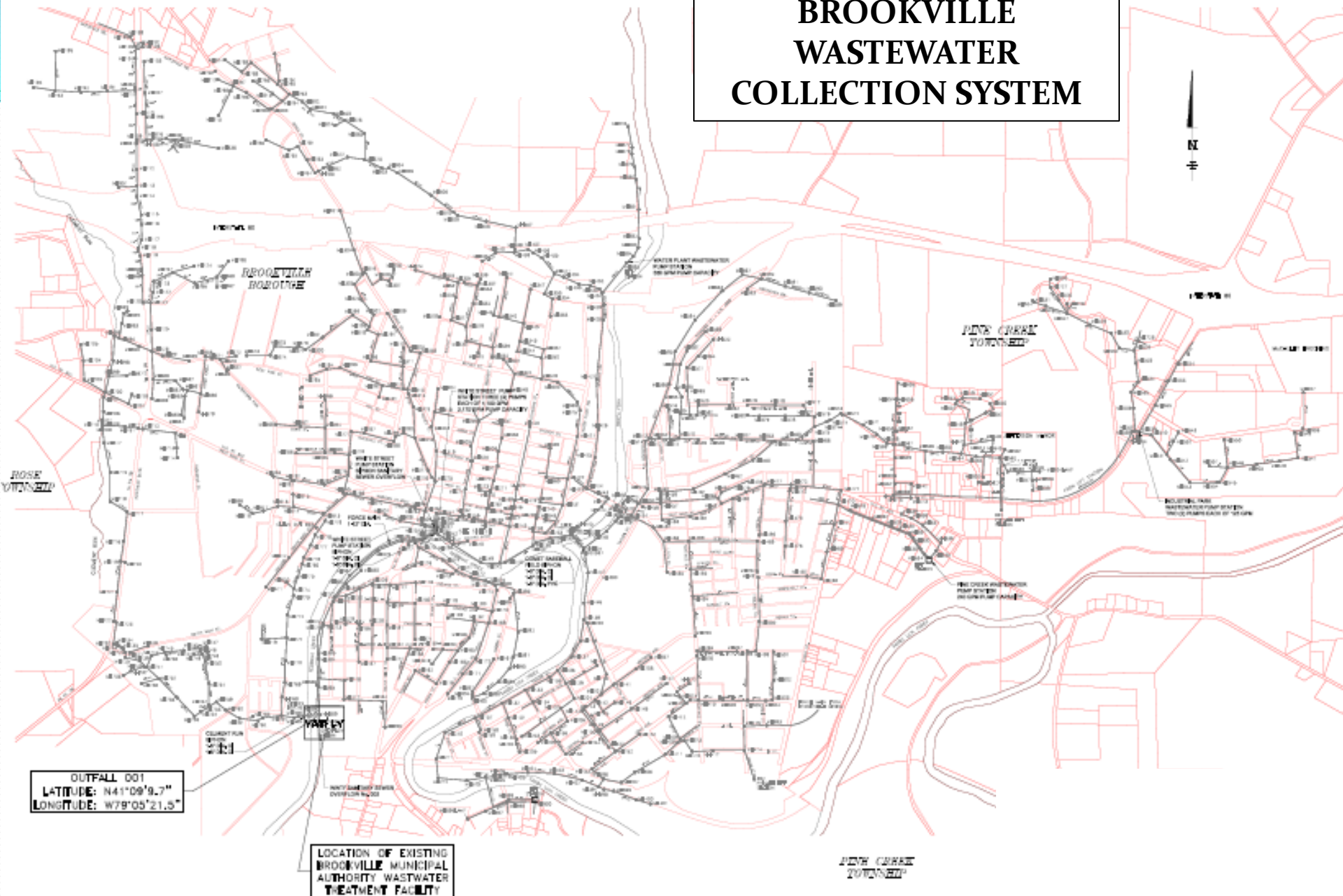
- Brookville Municipal Authority (BMA) Wastewater System
 - Service Area – 2,500 customers in Brookville Borough & Pine Creek, Rose and Knox Townships
 - Authority owns 42 miles of interceptor and collection sewers, 5 sewage lift stations and a regional wastewater treatment plant
 - Separate sewer system with sanitary sewer overflows (SSO's)
 - BMA under Consent Order & Agreement to eliminate overflows
 - Fined per overflow event



Brookville Sewer Service Area



BROOKVILLE WASTEWATER COLLECTION SYSTEM



System Description

- Sewer system – 220,000 LF of 6”-18” pipe
- 1 main pump station and 4 small lift stations
- Sewage collection system is 75-100 years old
- Interceptor sewer system and original treatment plant (primary treatment) were constructed in 1959
- Plant upgraded to secondary treatment (RBC's) and White Street pump station and new force main/interceptor sewer were installed in 1984

Sanitary Sewer Overflows (SSO's)

- System originally had 5 overflows; 3 SSO's were closed
- Two (2) active SSO's to alleviate hydraulic surcharging during wet weather events
- White Street Pump Station SSO
- Plant Bypass SSO
- SSO's discharge to Redbank Creek

White Street Pump Station SSO



- Station capacity – 4.85 MGD
- Located 1 mile above plant

Plant Bypass SSO



- Automatic Valve Controls Flow into Treatment Plant (4 MGD, max.)
- Bypass Chamber has a Manual Sluice Gate that Controls Flow to 18" Bypass Line; Ultrasonic Level Probe Records Overflow



Chapter 94 Overflow Summary (2008-2014)

Year	Annual Rainfall (inches)	WWTF ADF (MGD)	Annual SSO Volume (Gal)	Max. Event SSO Flow (GPD)	No. of SSO Events at WWTF	No. of SSO Events at White Street
2008	43.55	0.821	4,059,000	945,000	15	Unknown
2009	47.87	0.836	1,706,000	667,000	9	Unknown
2010	37.23	0.737	4,807,000	2,292,000	4	Unknown
2011	51.17	0.919	4,898,000	3,133,000	20	Unknown
2012	48.09	0.740	722,000	173,000	6	Unknown
2013	47.78	0.794	9,381,000	4,170,000	10	6
2014 *	25.62	0.887	2,264,000	662,000	11	9

*2014 Data Inclusive of up to and including July 2014.

Regulatory Action

- PADEP regulatory action (Consent Order) forced the community to initiate corrective action to eliminate SSO's
- Act 537 Plan Update was deemed a necessity by DEP since last update was done 35 years ago
- Authority faced with either removing I/I; expanding sewer system & treatment plant; or both to abate SSO's
- Physical condition of system was an additional factor:
 - Treatment plant - many aging and deteriorated components
 - Process - often not functional with very high maintenance costs
 - Interceptor sewers – under capacity and deteriorated

Consent Order - Corrective Action

Compliance Plan

- Flow Monitoring
- Manhole Inspections
- Dye and Smoke Testing
- Sewer Cleaning & Televising
- Inflow and Infiltration Analysis
- Sewer System Evaluation
- Compliance Projects
- Compliance Schedule
- Update & Submit Act 537 Plan

Conveyance System Flow Monitoring

- Initial program monitored flows at 10 strategic locations in the main conveyance system and SSOs
- 13 flow monitoring locations from 2013 to 2015
- Combination of area-velocity, flow tube & ultrasonic level probe meters
- Authority maintained & serviced meters

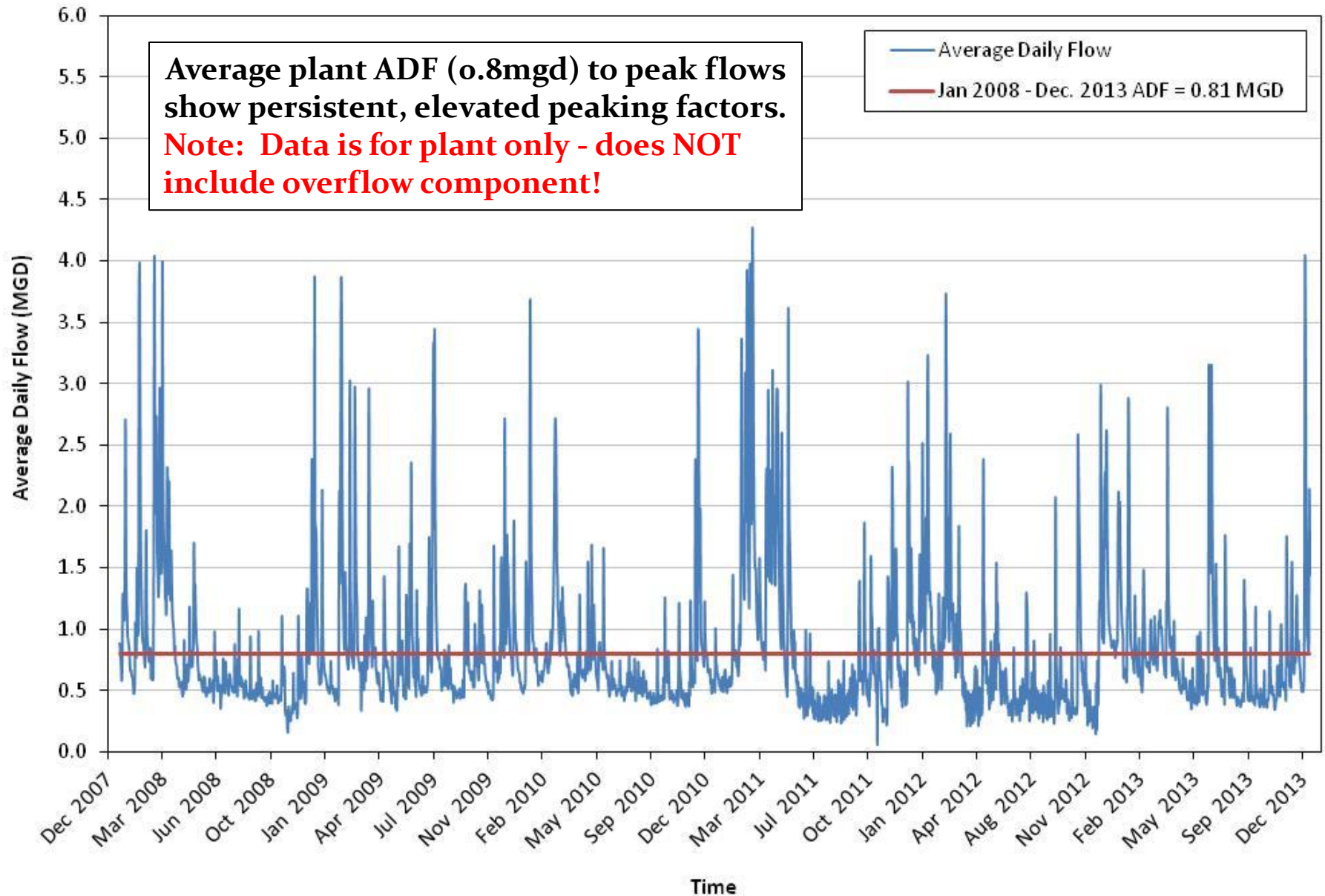


Flow Monitoring Devices

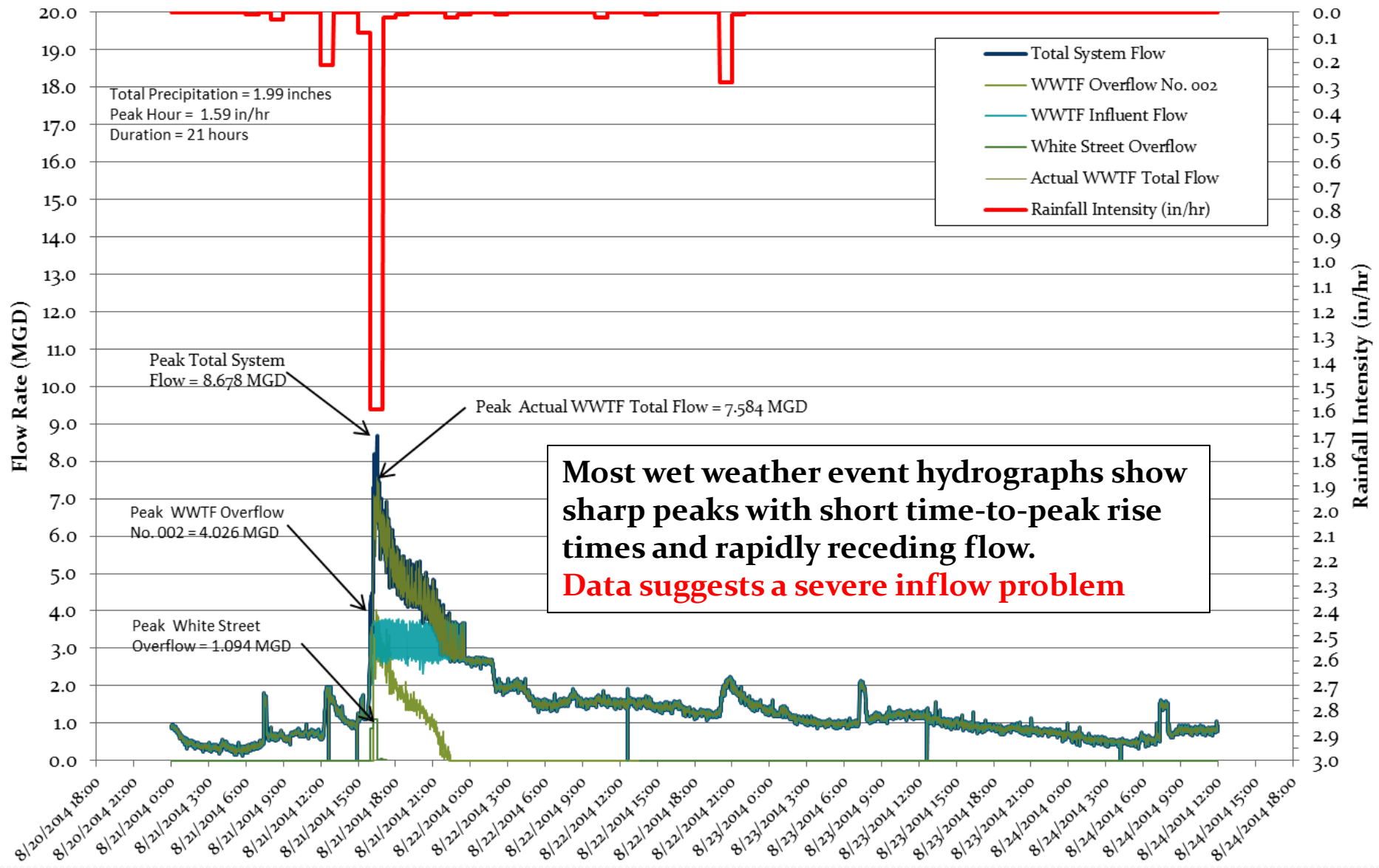
- Area-Velocity Meters (Sewer System)
 - Continuous wave Doppler technology measures average velocity
 - Primarily used in areas not prone to surcharge conditions
- Flow-Tube Meters (Sewer System)
 - Transducers estimate flow through pressure differential in the upstream and downstream sections of the meter
 - Installed in surcharge areas (pressure pipe flow) and in submerged overflow pipes with the potential for reverse flow
- Ultrasonic Level Probe Meters (Plant Bypass)
- Rain Gage
 - Tipping Bucket recorded hourly precipitation to develop flow-rainfall relationships

Brookville Wastewater Treatment Facility

Average Daily Flow (2008 - 2013)



BMA Wastewater System Hydrograph August 21 - 22, 2014 Event



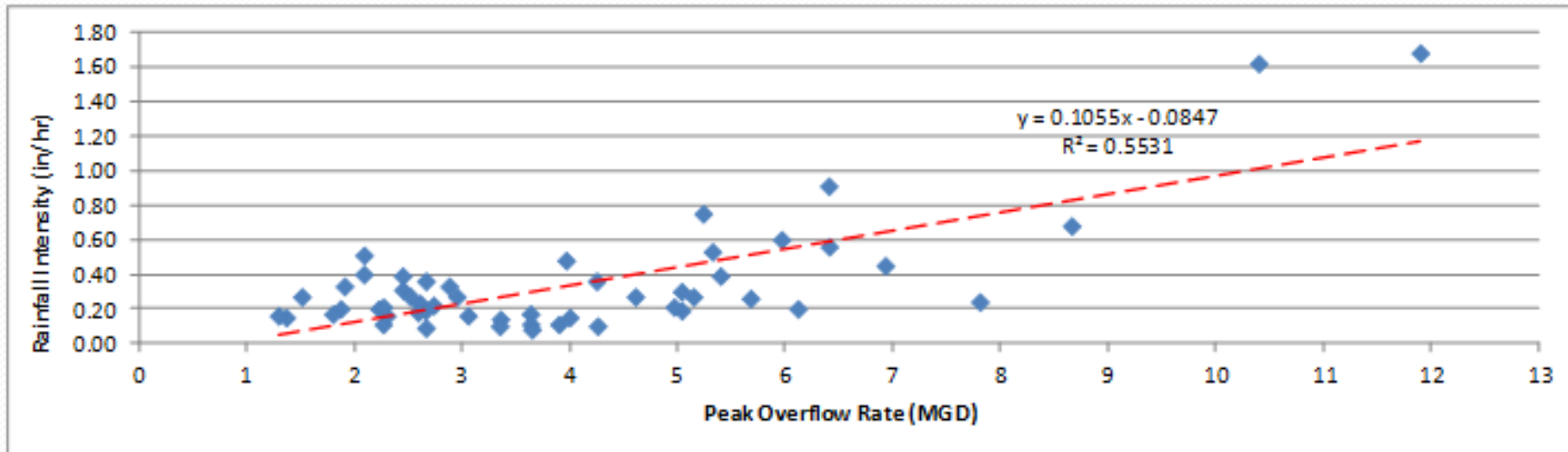
Typical Wet Weather Hydrograph Composite

Flow Monitoring Results

Study Period from April 2013 to April 2015

- One-third of significant rainfall events (22 of 65) caused overflows
- Plant Capacity: 1.25 MGD, Peak Capacity: 4.0 MGD
- Average Peak Wet Weather Overflow Event: 6.5 MGD
- Peak SSO Discharge Volume: 4.5 Million Gallons
- Peak SSO Discharge Rate: 6.4 MGD
- Peak Hourly Total Flow: 10-15 MGD
- Peak Rainfall Event: 3.44 inches in 14 hours
- Maximum Rainfall Intensity: 1.62 inches/hour
- 21 Events with Peak Hourly Flow 4 MGD or Greater
- 2 events with Peak Hourly Flow 10 MGD or Greater

Peak Overflow Rates & Rainfall Intensity Relationship

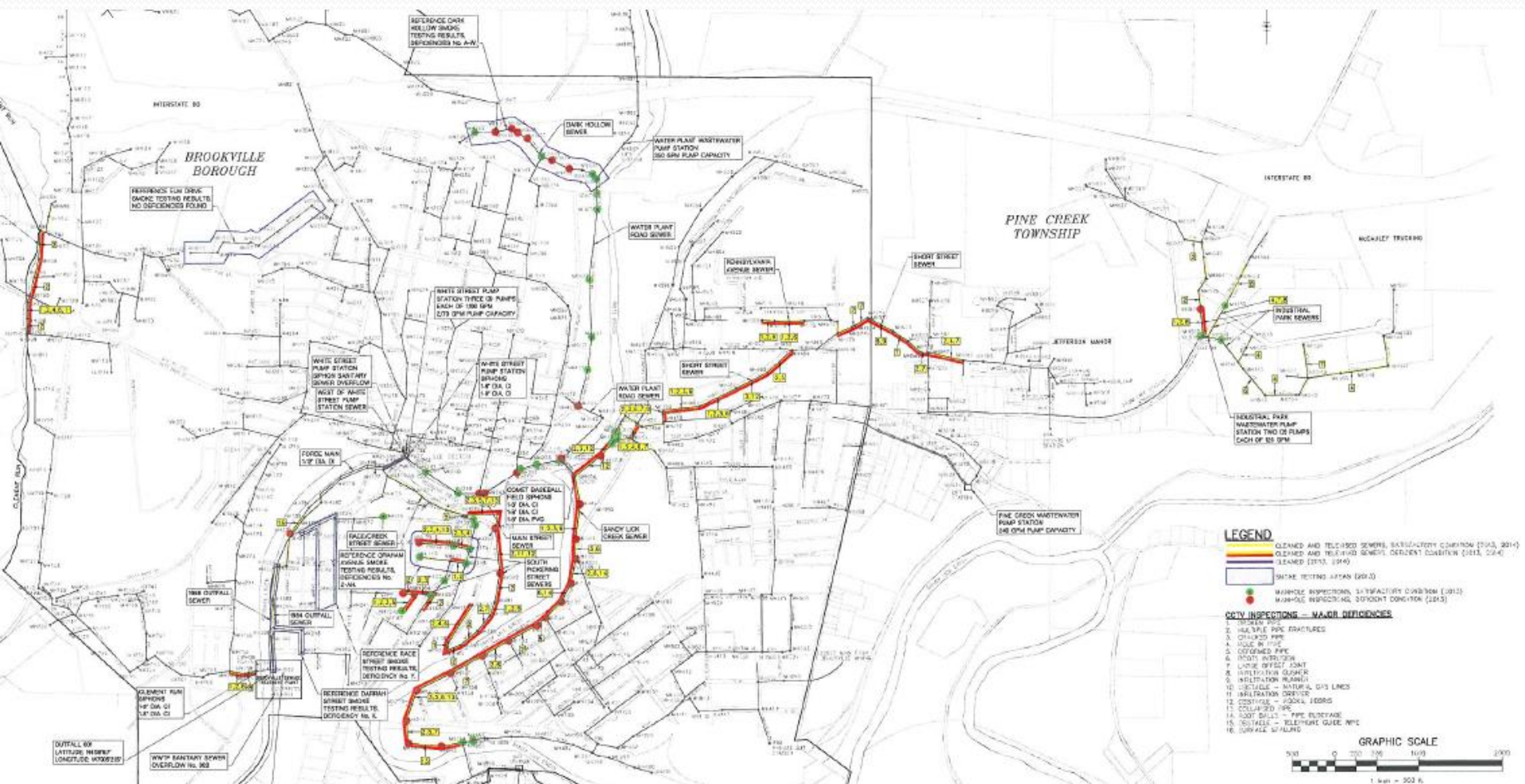


- 1 inch per hour rainfall will produce ≈ 10 MGD system flow
- 0.5 inch per hour rainfall will produce ≈ 5 MGD system flow
- Most wet weather event hydrographs show sharp peaks with short time-to-peak rise times and rapidly receding flow
- **Data suggests a severe inflow problem**

Diagnostic Work

- Manhole Inspections - Interceptor Sewer
- Cleaning & Televising of Conveyance System
- Smoke Testing (Selective High Inflow Areas)
- Dye Testing of Suspected Direct Cross Connections

Location of Conveyance System Diagnostic Work



Manhole Inspections



Brick Manhole Subject to Infiltration



Manhole Subject to Inflow

Sewer Cleaning Televising Work

- Brookville cleaned and televised all major interceptor lines for condition and available capacity in 2013 & 2014
- Contracted with private firm to perform work
- TV inspection work totaled 26,613 feet (5 miles)



Main Interceptor Infiltration



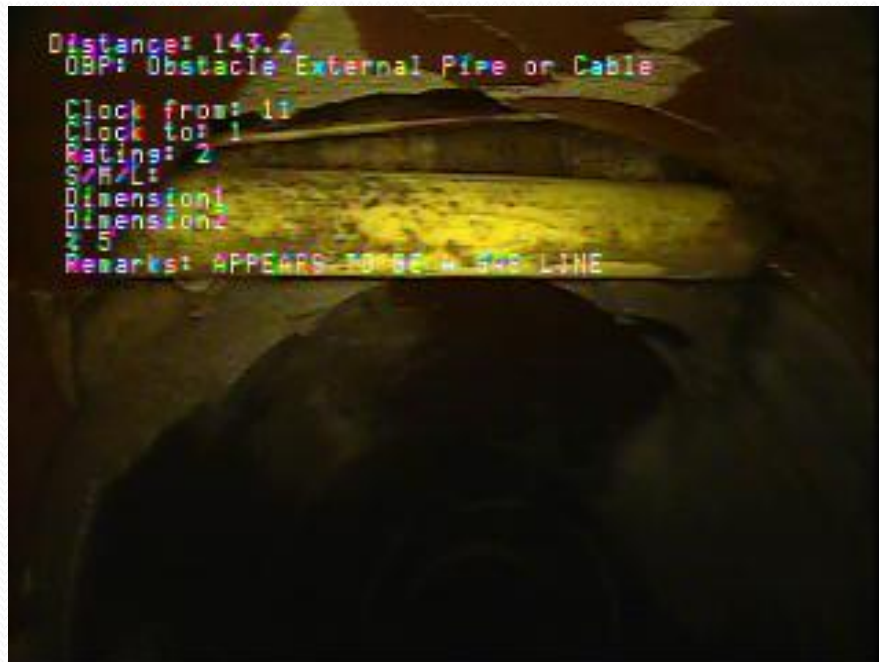
Root Intrusion (60% Blockage)



Main Conveyance Sewer - Deformed & Collapsed Pipe



Multiple Pipe Fractures and Deformed Pipe



Gas Lines Through Sewer Pipe



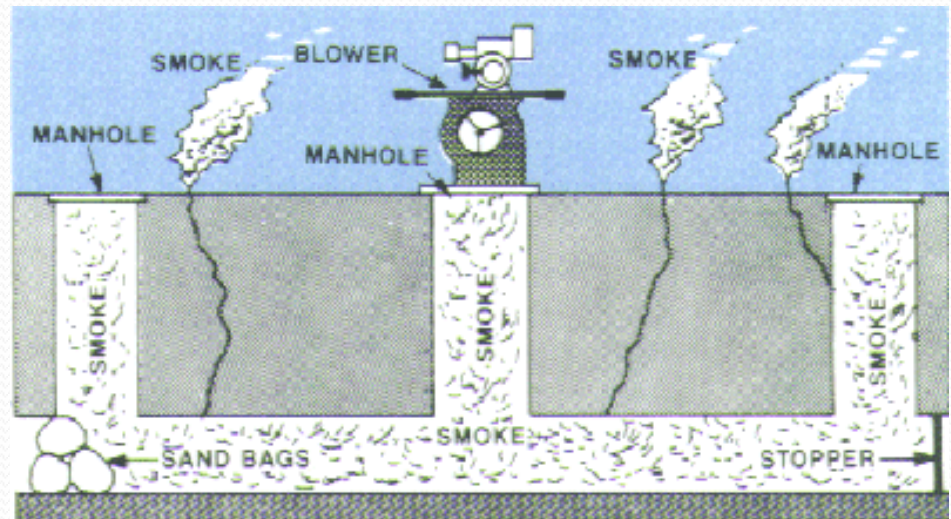
Volunteer Sewer Inspector

Summary of Sewer Televising Deficiencies

Industrial Park	Pennsylvania Avenue	Short Street	Mabon Street	Race Street	Graham Avenue	Kline Street	Hiram Street	Clement Run	Darrah Street	Sandy Lick Int.	Deficiency	Totals
2	0	4	4	0	0	0	0	3	0	0	Infiltration	13
1	4	10	0	0	0	1	0	3	0	24	Root Intrusion	43
0	0	0	0	0	0	0	0	0	0	2	Collapsed Pipe	2
20	0	48	12	14	0	0	0	37	4	23	Sag in Pipe	158
0	0	0	1	5	0	0	0	0	0	3	Deformed Pipe	9
8	2	5	3	0	2	1	1	2	0	1	Hole/Broken Pipe	25
19	1	57	18	8	10	2	3	11	7	19	Other	155
11	8	35	46	6	23	12	13	16	0	21	Fractures/Cracks	191

Selective Smoke & Dye Testing

- Goal is to identify possible cross connections and inflow to the sewer system
- Introduction of non-toxic smoke into sewer system for interconnection of:
 - Roof leaders
 - Area drains
 - Broken main lines
 - Leaking manholes
 - Storm sewer cross connections
- Follow-up dye testing
- BMA enforcement of illegal connections removal





Defective Brick Manhole



Building Lateral Defects



Illegal Roof Leader

Analysis Tools - Hydraulic Modeling

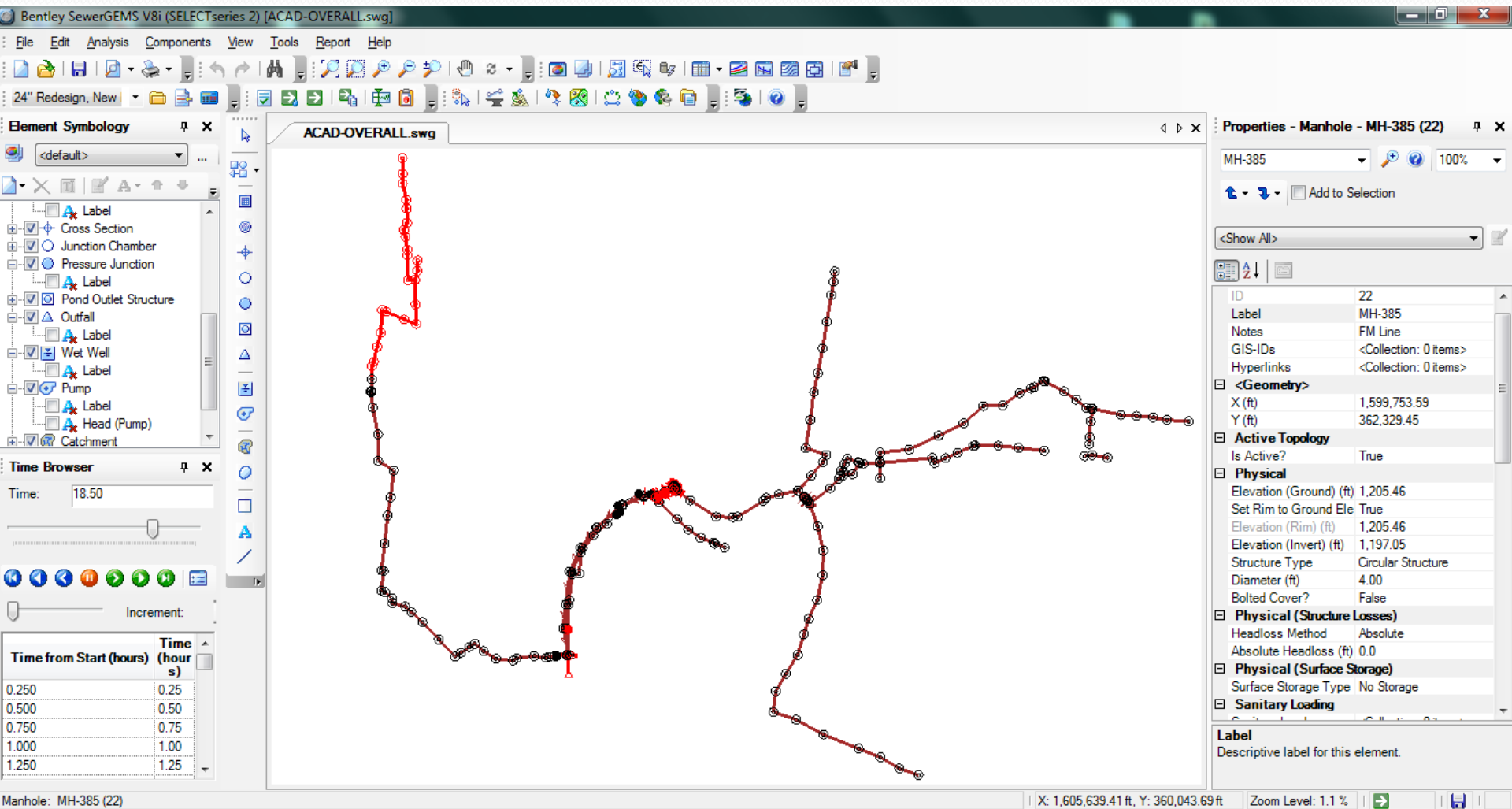
- Interceptor System modeled using Bentley SewerGEMS V8i software for capacity analysis
- System Model
 - Gravity interceptors
 - Submerged outfalls
 - Pump stations
 - Force mains
 - Overflows
 - Inverted siphons



Model Input

- Model created from data on as-built sewer drawings and field instrument surveys
- Physical Data
 - Pipe materials, lengths, diameters
 - Manhole diameters, invert and rim elevations, locations
 - Pump stations
 - Inverted siphons
 - Overflow configurations

Model Input



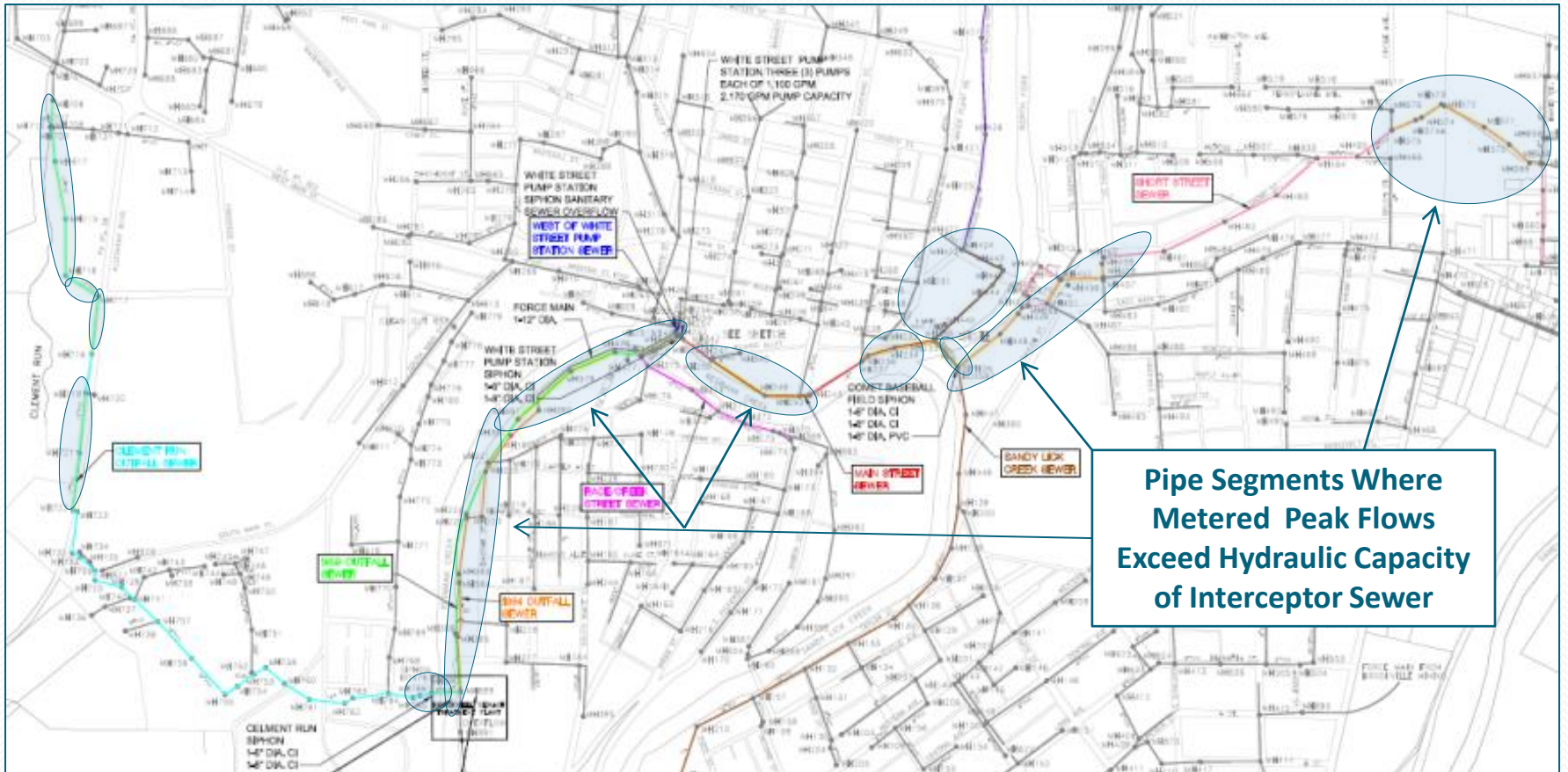
Model Calibration

- Model calibrated with flow monitoring data during baseline conditions and wet weather events
- Model output of Hydraulic Grade Line elevations were compared to monitoring data at key locations in the sewer system
- Model calibrated to achieve an allowable tolerance (3 inches) for the Hydraulic Grade Line

Modeling Results – Existing System

- Majority of main interceptor sewer system has insufficient capacity to convey peak flows without surcharging
- Without bypassing, surcharging of main lines will result in sewer backups on private property
- Verification of SSO overflow rates

System Map of Hydraulically Overloaded Sections Based on Hydraulic Modeling



Modeling & Design of Future Conveyance System

- Modeling found that a conveyance capacity of 10 MGD is sufficient for the peak flows generated in sewer system
- Model was used to design new interceptors sewers based on physical restrictions of system
 - River crossings
 - Collection system interconnections
 - Available slope
- Modeling provided design parameters for new White Street pump station
- Conveyance system upgrades will convey all flow to the treatment plant without surcharging or bypassing

Sewer System Options to Eliminate SSO's

- **Non-Structural Alternative: Full Inflow Removal**
 - Aggressive targeting & enforcement of private inflow removal
 - Borough to remove any storm sewer cross-connections
 - Lack of an adequate storm sewer system a major problem
 - Documented sewer deficiencies remain
- **Replace Entire Sewer System and No Inflow Removal**
 - Will reduce infiltration (analysis shows it is not a major problem)
 - Very costly and may not solve SSO problem without plant expansion
- **Replace Entire Sewer System with Inflow Removal**
 - Building lateral replacement must be included
 - Permanent, ongoing inspection and enforcement program a necessity
 - Major commitment of annual Authority personnel and resources
 - Very costly, may not solve long term inflow problem - the source of SSO's

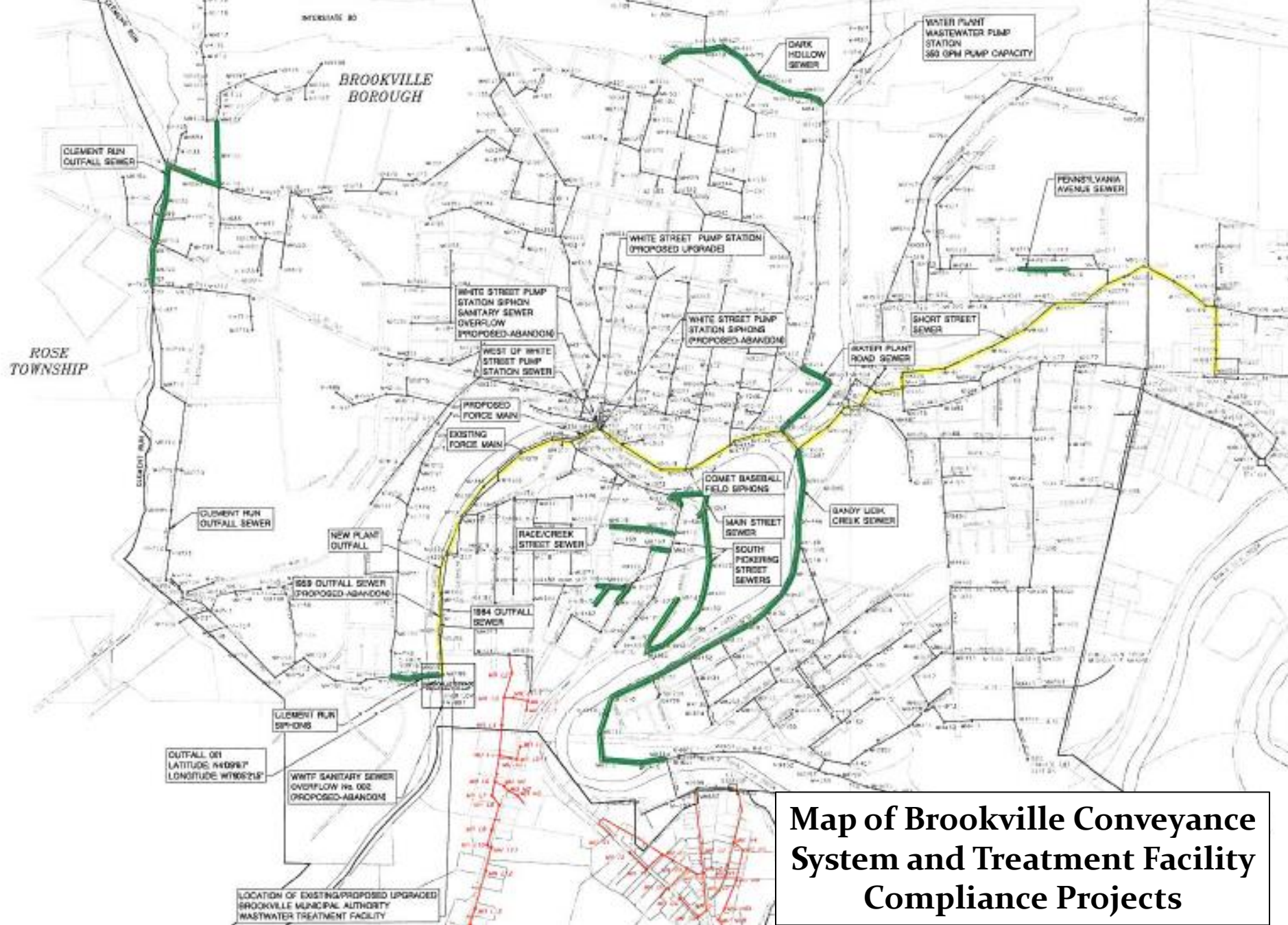
Wastewater Treatment Facility

- Existing plant is old and deteriorated
- Lack of process flexibility & adaptation for future upgrade
- Inadequate capacity for treating peak flows (10 mgd+)
- Maintenance intensive
- Upstream pump station and interceptors have low capacity
- Diagnostic work shows poor condition of interceptors
- **Condition of plant & sewer lines warrant major project regardless of capacity concerns!**



Final Compliance Plan

- Authority stated it has insufficient resources and personnel needed for an annual I/I removal, maintenance & enforcement program
- Lack of a storm sewer system complicates inflow removal due to Authority concerns of localized flooding, icing and property drainage
- Blended approach for SSO compliance was recommended
- Compliance Plan
 - Replace Interceptor Sewer System with Higher Capacity Lines
 - Replace White Street Pump Station with Larger Pumps
 - Upgrade and Expand Wastewater Treatment Plant
 - Perform Targeted Inflow Removal to Reduce System Peak Flow to 10 MGD



Compliance Projects and Goals

- Projects

- Interceptor Sewer Replacement (28,000 LF of 12-30" pipe) - \$6.5 million
- New White Street Pump Station (10 mgd capacity) - \$1.5 million
- Wastewater Treatment Plant: \$12 million
- Total Project Cost: \$20 million
- Funding: RUS Loan-\$9 million/RUS Grant-\$8.5 million/Pennworks Grant- \$2.5 million
- Targeted Inflow Reduction: BMA televising, smoke testing, inspection

- Anticipated Results

- Regulatory compliance for SSO removal
- Replacement of deficient and deteriorated system components
- Plant will have treatment capacity for all wet weather flow
- System will have capacity for future growth and development
- Plant has flexibility for achieving future nutrient removal
- Affordable project financing resulting in \$46/EDU monthly sewer rate

Questions