



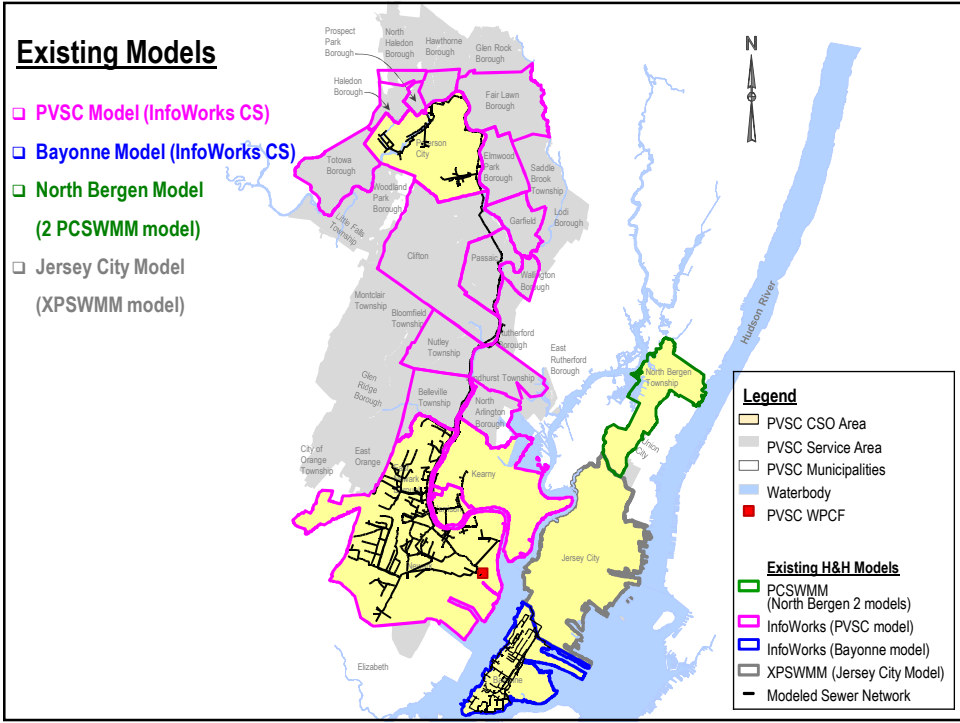
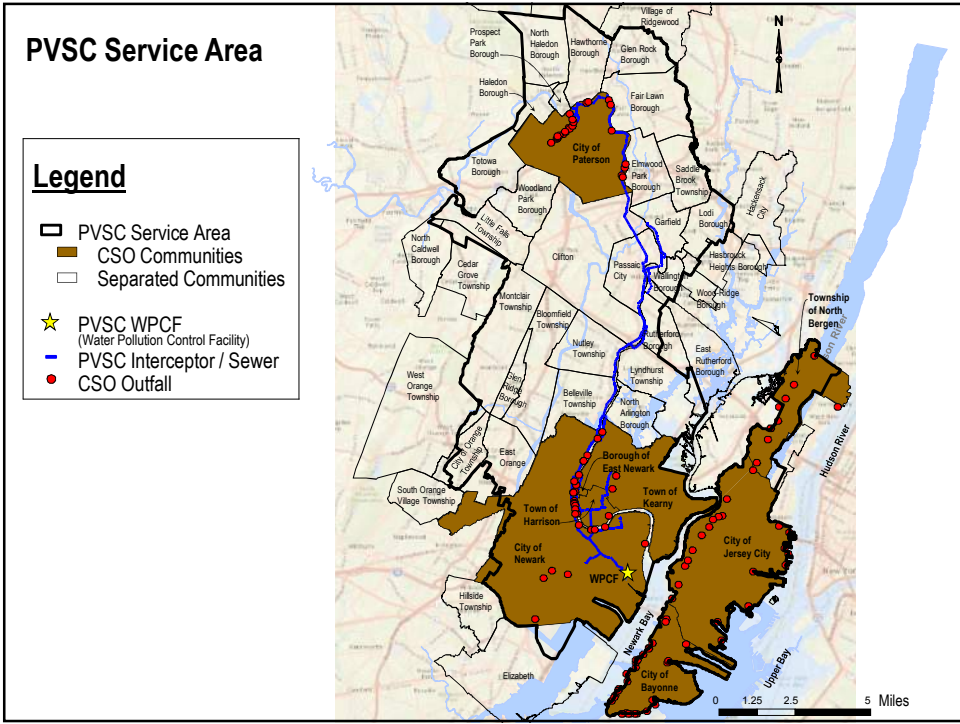
**PVSC – Long Term Control Plan
Modeling Evaluation Group – Session 2
*Hydrologic and Hydraulic Model***

**Greeley and Hansen LLC
March 17, 2017**

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Outline

- **Hydrologic and Hydraulic (H&H) Model Update**
 - Model Integration
 - Regulator Update
 - Paterson Re-delineation
 - Separated Service Area
 - Wet Weather Operating Rules
- **Next Step**



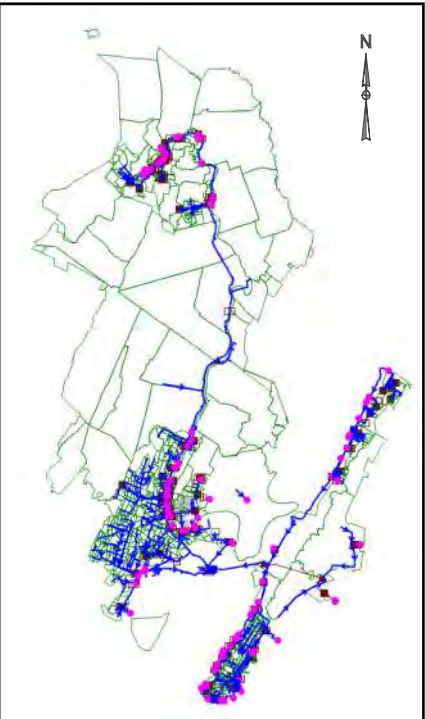
A Snapshot of Integrated Model...

- ❑ 48 PVSC communities
- ❑ 8 CSO communities
 - ✓ Paterson
 - ✓ Newark
 - ✓ East Newark
 - ✓ Harrison
 - ✓ Kearny

(Above 5 discharge to interceptor by gravity to WPCF)

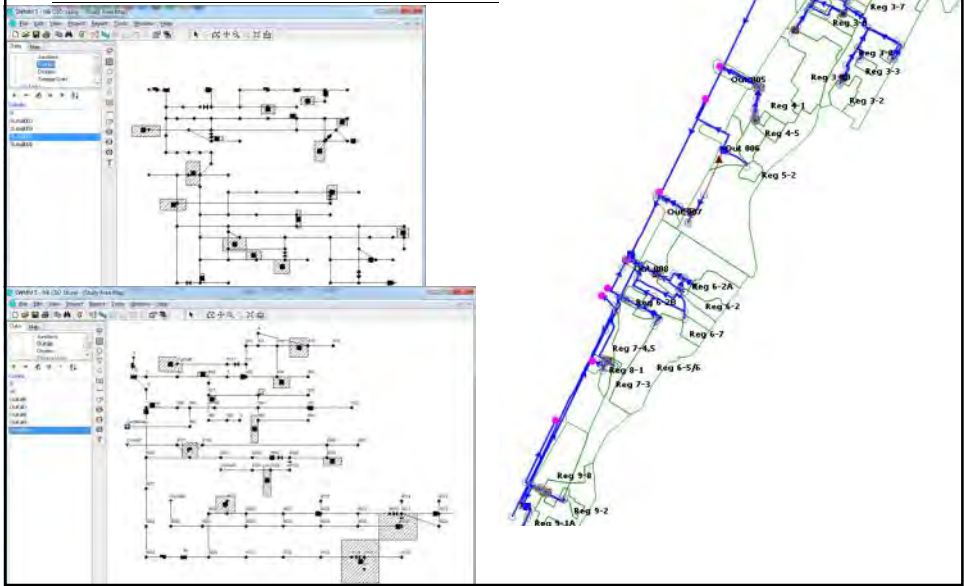
 - ✓ Bayonne
 - ✓ Jersey City
 - ✓ North Bergen

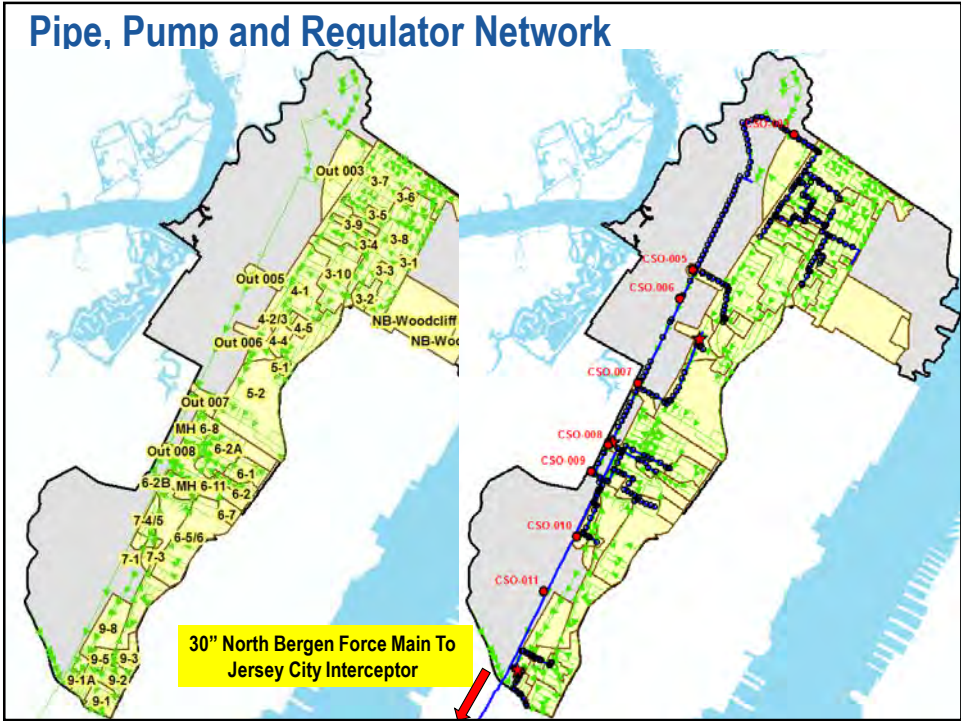
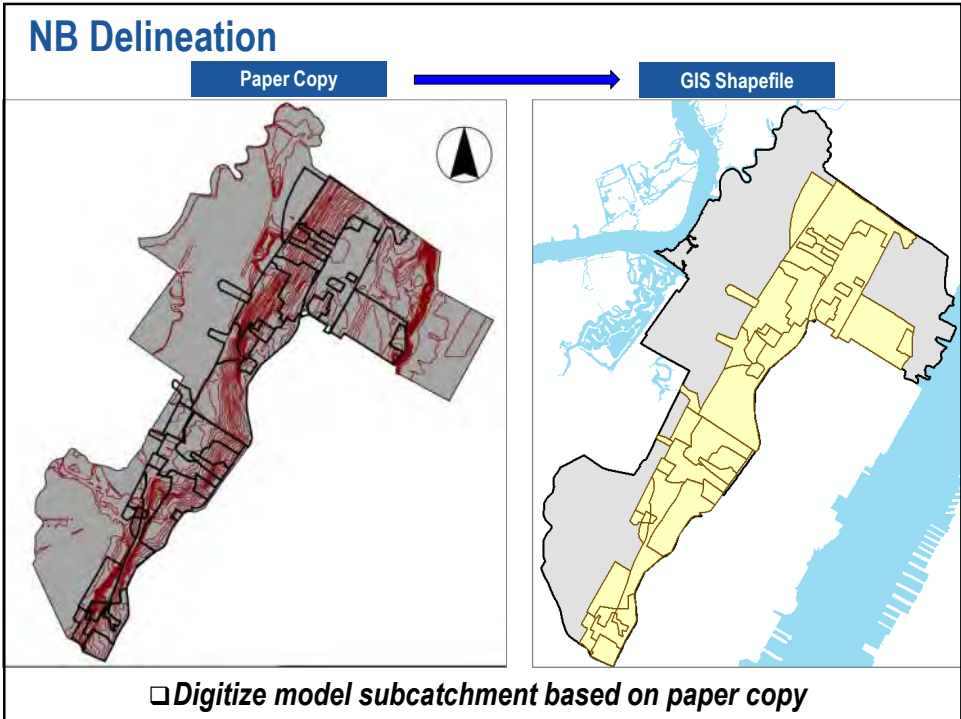
(Above 3 discharge to Hudson County Forcemain to WPCF)

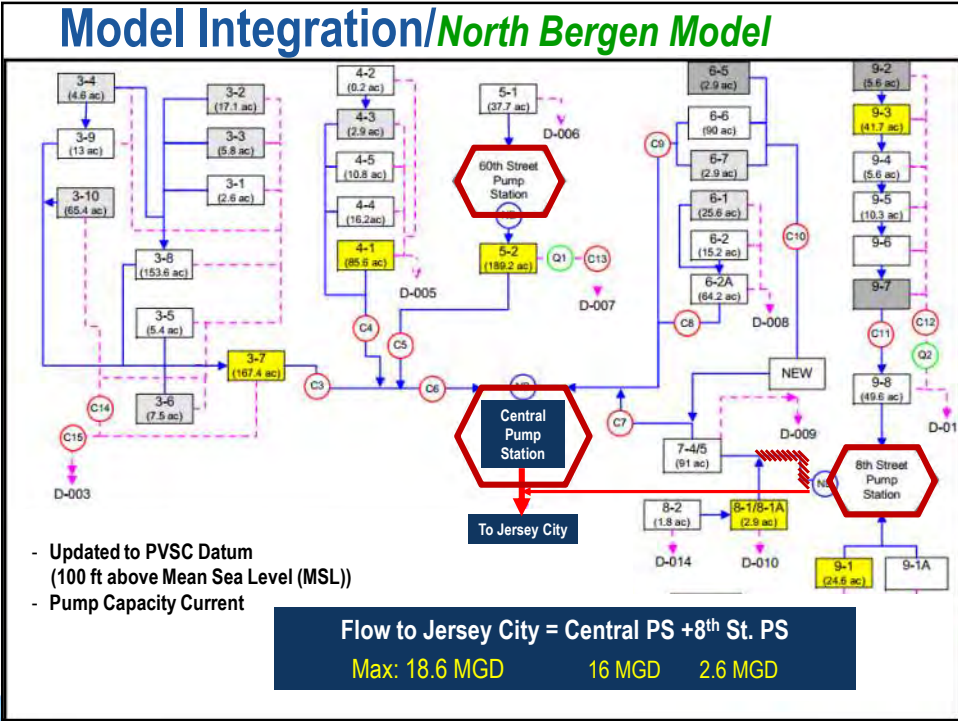
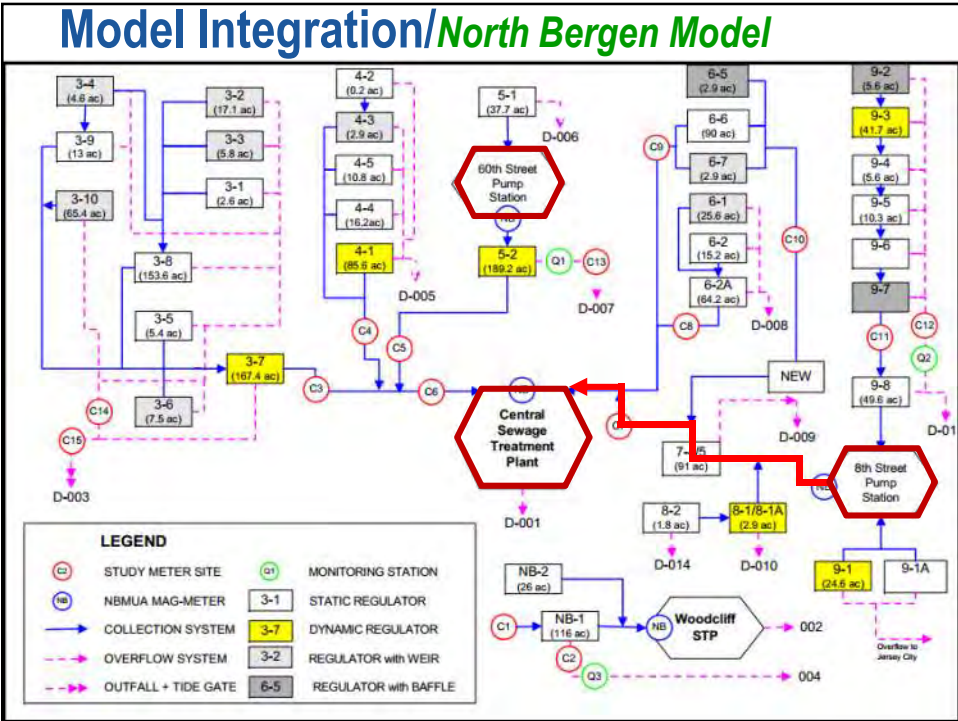


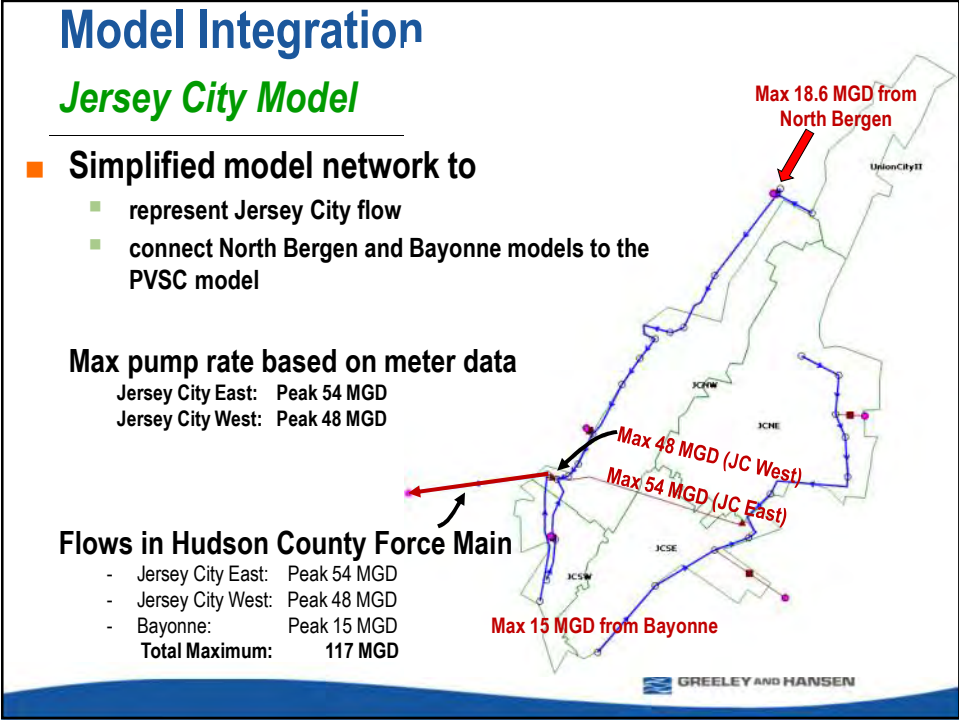
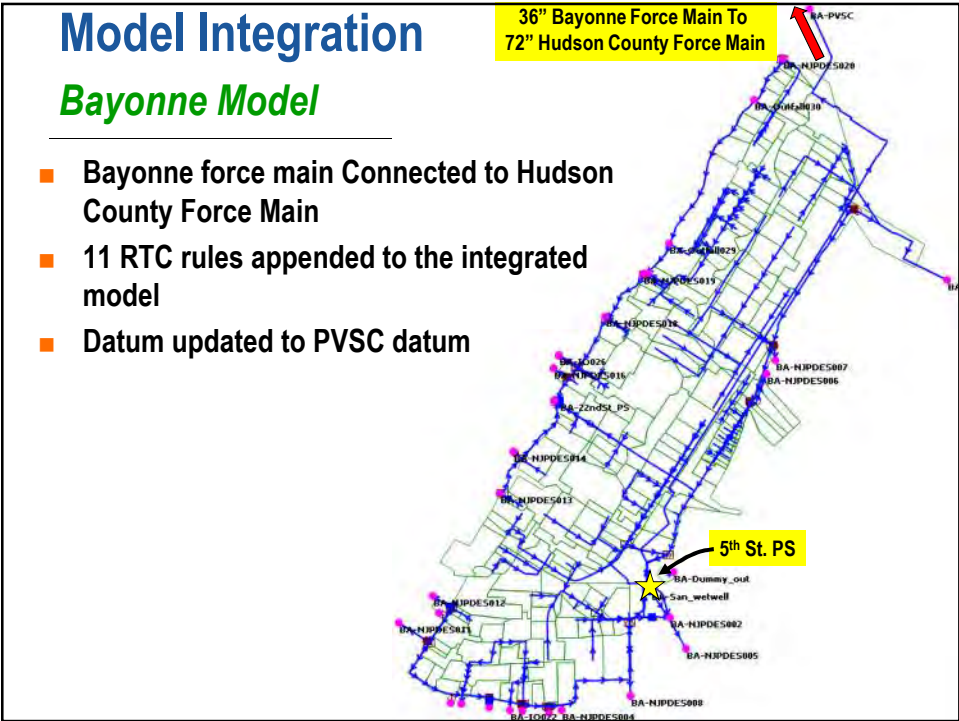
Model Integration

Recreate North Bergen Model from PCSWMM









Model Integration

Force Mains

- Hudson County Force Main was extended to the PVSC WPCF based on drawing
- South Kearny PS 30" force main was created and tied into the Hudson County Force Main



South Kearny Pump Station Service Area

- Kearny Meadowlands District
- South Kearny District
- Both Separated

South Kearny Pump Station

- Capacity: 17.5 MGD
- DWF: 1.6 MGD



Source: Mott MacDonald



Regulator Modification										
Regulator	Overflow Weir				Regulating Sluice Gate / Orifice					
	Drawing		Original Model		Drawing			Original Model		
	Crest	Width	Crest	Width	Invert	Width	Height	Invert	Width	Height
P_015A (S.U.M. Park)	152.9	2.5	152.9	2.5	151.87	1.25		151.87	1.25	
P-001A (Curtis Pl.)	146.9	3.83	146.9	3.83	143.94	3	1	143.94	2.25	
P-003A (West Broadway)	139.5	4	139.5	4	137.4	1.25		137.4	1.25	
P-005A (Bridge St.)	133.4	5	136.71	5	131.7	0.833	1.667	131.7	1.25	
P-006A (Montgomery St.)	134.2	8.0	135.25	8	129.53	2		129.53	2	
P-007A (Straight St.)	133.8	6	133.8	5	130.1	1.83	3	130.1	1.25	
P-009A (Keen St.)	135.4	4	135.4	4	133.44	1.67	0.83	133.44	1.25	
P-010A (Warren St.)	133.85	4	135.21	3						
P-016A (Northwest St., modified)	138.8	8	140.94	8.5	136.25	2.5		136.25	2.5	
P-017A (Arch St.)	135.7	4.5	135.69	3.67	132.6	1		132.6	1	
P-032A (Hudson St.)	135.2	4	135.2	4						
P-022A (Short St.)	132.6	4.5	132.6	4.5	130.63	2		130.63	2	
P-021A (Bergen St.)	132.7	4.5	132.7	4.5	130.75	1		130.75	1	
P-013A (East Eleventh St.)	133.4	4.83	133.4	4.83	131.7	1.67	0.83	131.7	1.25	
P-014A (Fourth Ave.)	140.9	4.5	140.9	3	137.76	1.67	0.83	137.76	1.25	
P-023A (Second Ave.)	129.8	5	130.56	5	127.4	Not available	Not available	127.4	1.25	
P-024A (Third Ave.)	130.3	4.5	130.3	5	128.2	1.67	0.83	128.2	1.25	
P-025A (East 33 rd Ave.)	128.9	8.58	129.87	8.58	127.07	3	1	127.07	2	
P-026A (East 20 th Ave.)	129.2	5.5	128.92	5.5	126.95	1.67	0.83	126.95	1.66	0.83
P-027A (Market St.)	131.1	7.11	131.1	4.0	129.6	3.5	1.167	129.6	3.5	2.0
					129.6	3.5	1.167	129.6	3.5	0.0

Regulator Modification

Regulator	Overflow Weir				Regulating Sluice Gate / Orifice					
	Drawing		Original Model		Drawing			Original Model		
	Crest	Width	Crest	Width	Invert	Width	Height	Invert	Width	Height
N-002A (modified, Verona)	110.43	41	103	6	102.65	2.5	2.5	99.33	2	2
N-004A/005A (modified, Herbert Pl.)	114.34	41	105.55	6.667	107.06	2	2	103.6	1.5	1.5
N-008A (4th Ave.)	103.5	6	103.5	6	100.7	1.5	1.5	100.7	1.5	1.5
N-009A (Passaic St.)	103.24	4	103.24	4	102.4	1.66	0.83	102.4	1.66	0.83
N-010A (Clay St.)	105.12	8.42	105.12	8.42	101.24	6	3	101.24	6	3
	105.12	8.42	105.12	8.42	101.24	6	3	101.24	6	3
	105.12	8.42	105.12	8.42						
N-014A (Rector St., modified)	102.56	5.5	103.66	5.5	99.97	1.5	1.5	101.07	1.5	1.5
N-014A (Saybrook Pl., modified)	102.33	7	103.43	7	99.02	2	2	100.12	2	2
N-015A (City Dock, modified)	98.67	14	98.67	14	95.67	3.5	2.5	95.67	3.5	2.5
N-016A (Jackson St.)	97.62	7	97.62	4.5	96	1.5	1.5	96	1.33	1.33
N-017A (Polk St.)	97.8	8	97.8	7	95.2	1.5	1.5	95.35	1.33	1.33
N-018A (Freeman St.)	100.26	4	100.26	4	99	2	2	99	2	2
N-022A (Roanoke Ave.)	98.93	6	98.93	6						
N-027A/029A	102	4.5	102	4.5	96.4	4	2.33	96.4	4	2.33
N-025A (Peddie St.)	98.6	8	98.6	8	93	4	2.33	93	4	2.33
	98.6	8	98.6	8						
	98.6	8	98.6	8						
	98.6	8	98.6	8						
N-030A	102.32	10	102.32	10	99.04	4	3	99.04	4	3
N-023A	98.54	7	98.54	7						



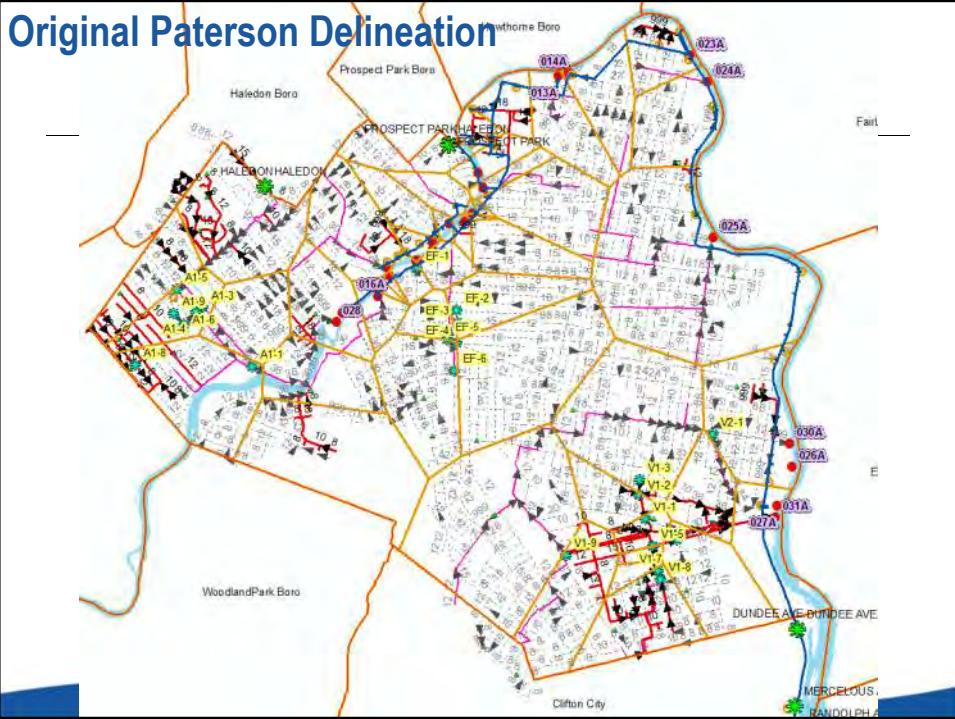
Regulator Modification

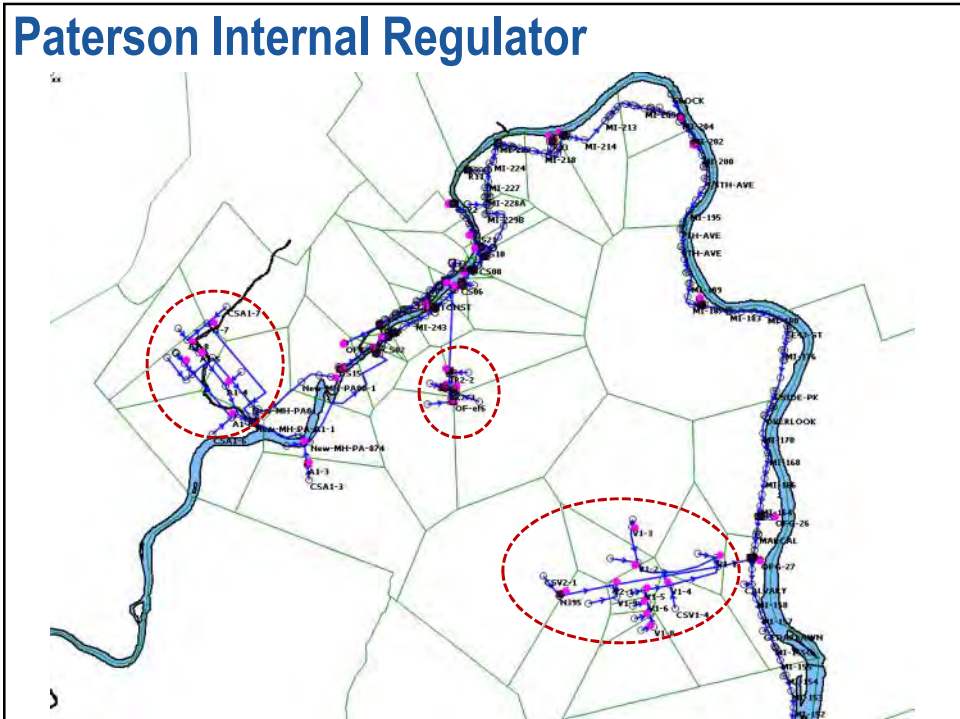
Regulator	Overflow Weir				Regulating Sluice Gate / Orifice					
	Drawing		Original Model		Drawing			Original Model		
	Crest	Width	Crest	Width	Invert	Width	Height	Invert	Width	Height
K-001A (Stewart Ave.)	120.85	4.5	120.27	1.5	119.07	1		119	1	
K-004A	107.9	1.5	108	1.5	106.9	1		107	1	
K-006A (Johnston Ave.)	99.9	5	100.9	10	98.7	1.5		98.2	1.5	
	99.9	5								
K-007A	103	9	103	9	100.2	3	1	100.2	3	1
K-010A (Duke St.)	102.5	4	102.5	4.5	98.84	1	1	100.45	1	
E-001A	101.6	4	101.6	4	99.2	1.25		99.2	1.25	
H-001A	101.2	4	101.2	4	99.8	1.25		99.8	1	
H-002A	102.2	4	102.2	4	101	1		101.2	1	
H-003A	103.9	4	103.9	4	101.4	1.25		101.4	1.25	
H-004A (Dey St.)	102.2	4	102.2	3.5	100.58	1		100.58	1	
H-005A	100.8	3.5	100.8	3.5	99.1	1		99.1	1	
H-006A	99.9	4	99.9	4	97.9	1		97.9	1	
H-007A	102.4	4.5	102.4	4.5	101.2	1		101.2	1	





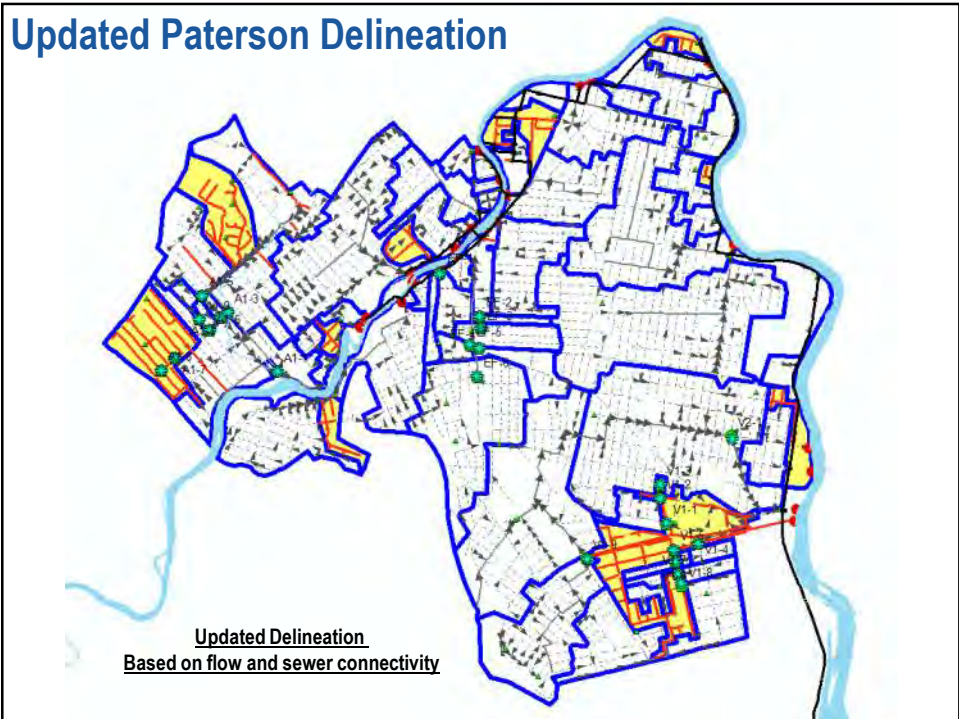
Paterson Update





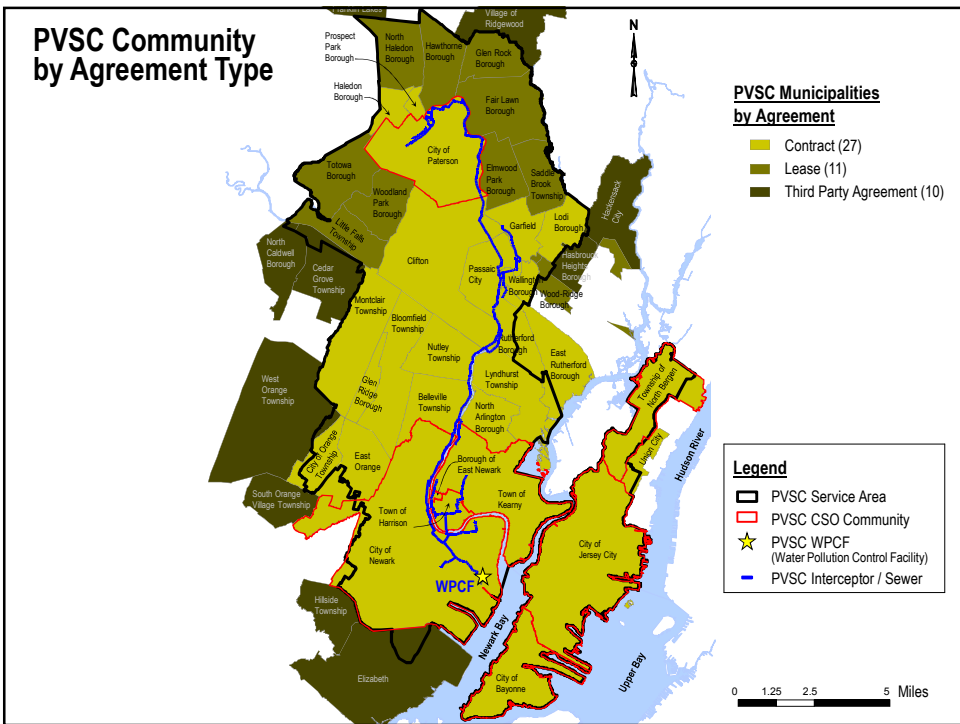
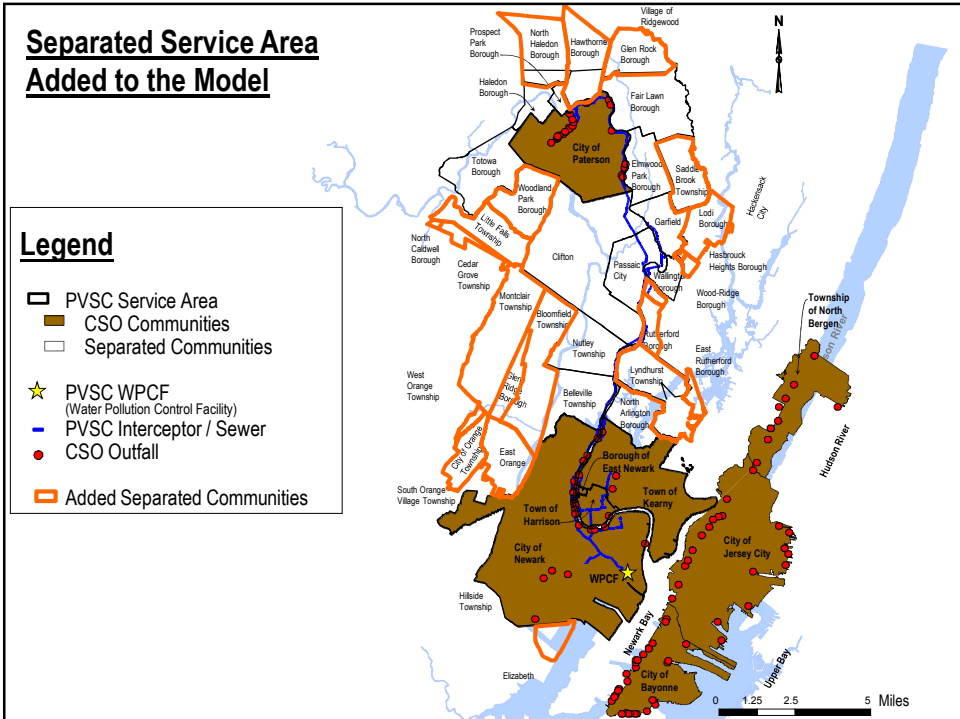
Paterson Internal Regulator Connectivity

Regulator #	Normal Flow Connection	Overflow Connection
A1-1 to A1-9 (8)	P_001A Regulator	P_028A
EF-2 to EF-6 (5)	P_006A Regulator	P_029A
V2-1	P_027A Regulator	P_030A
V1-1 to V1-9 (9)	P_027A Regulator	P_031A
EF-1	PVSC Interceptor MH 243	P_033A



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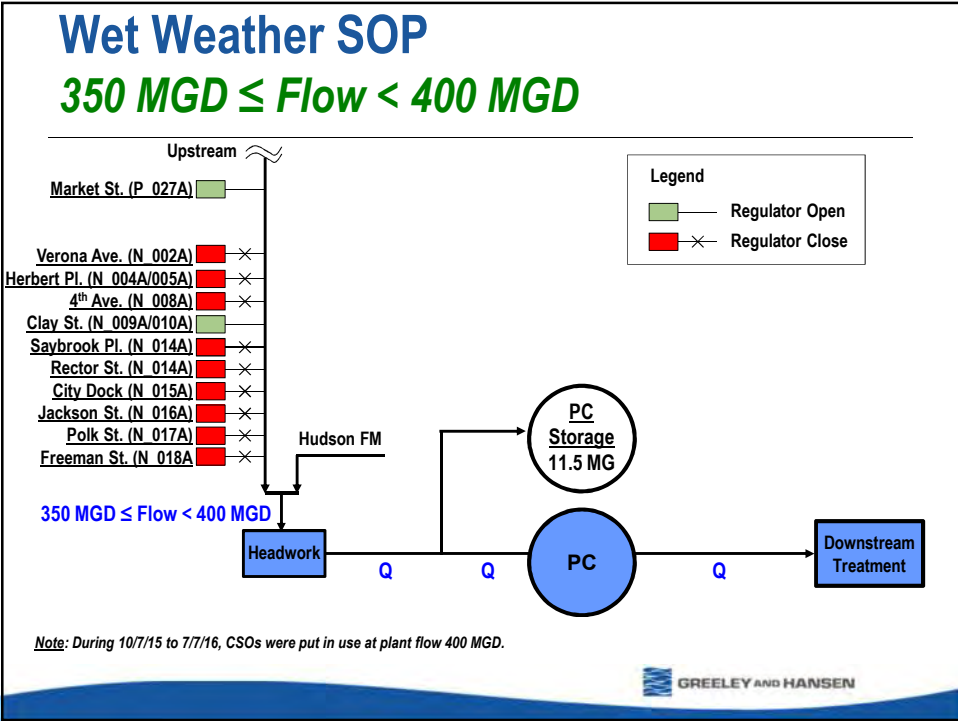
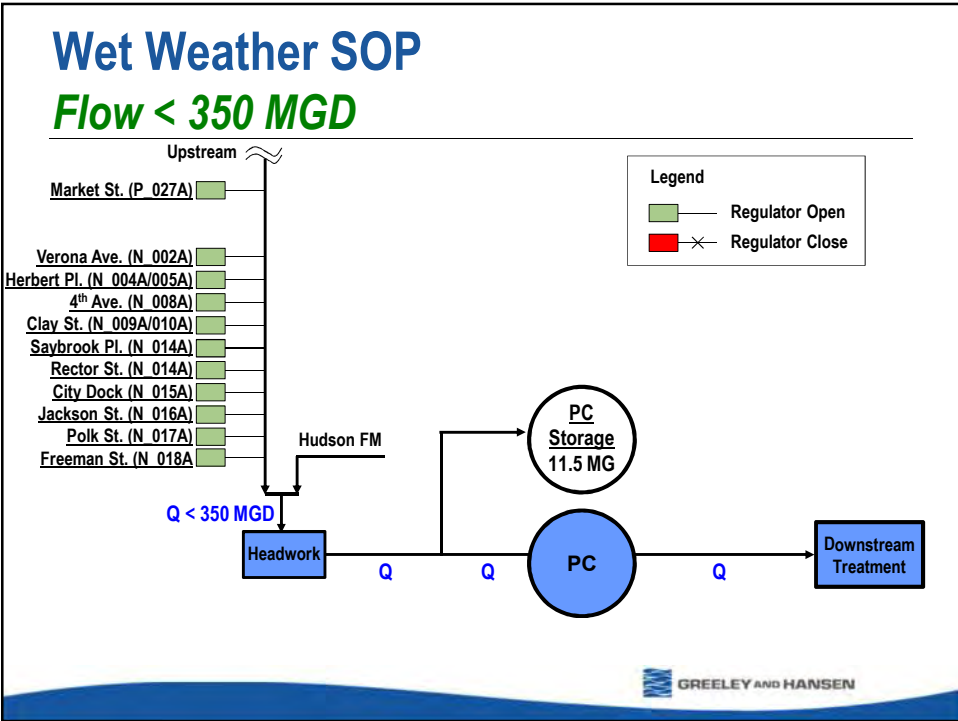
Separated Service Area

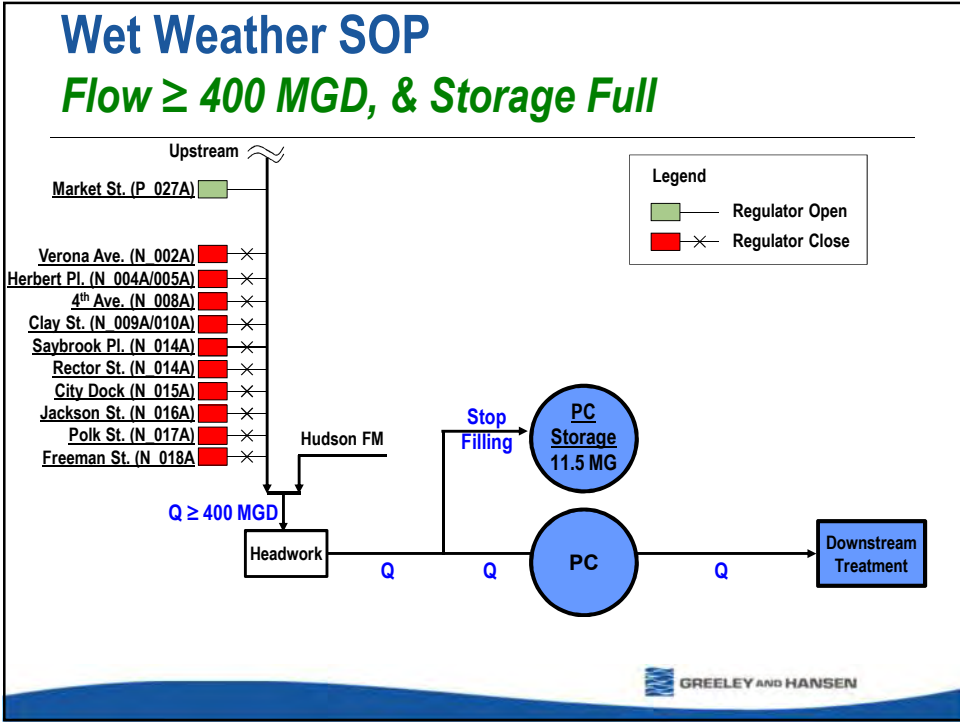
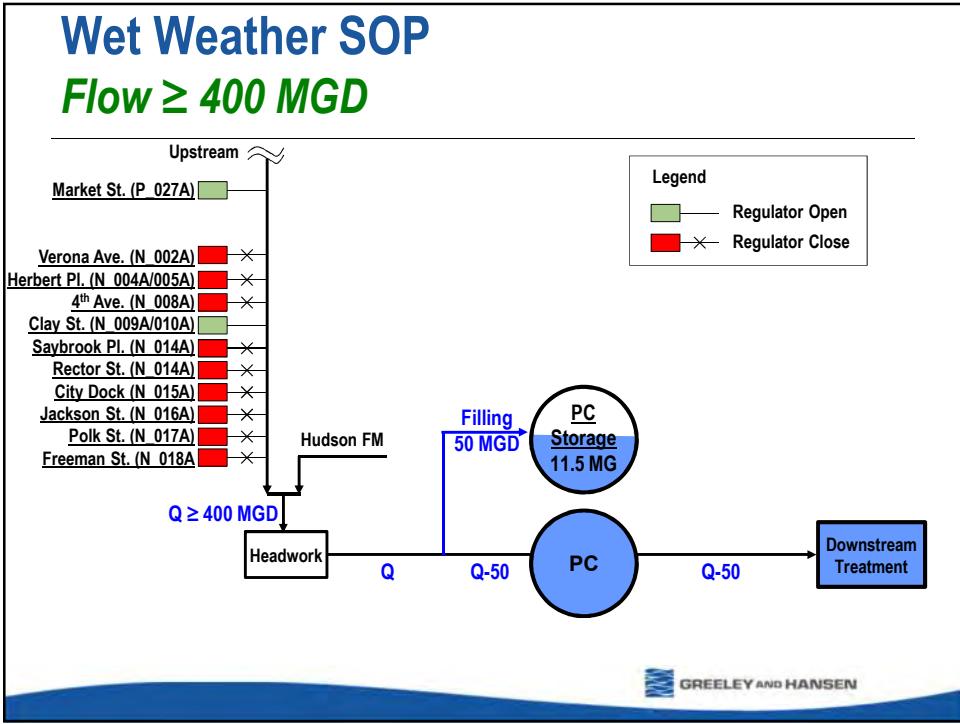


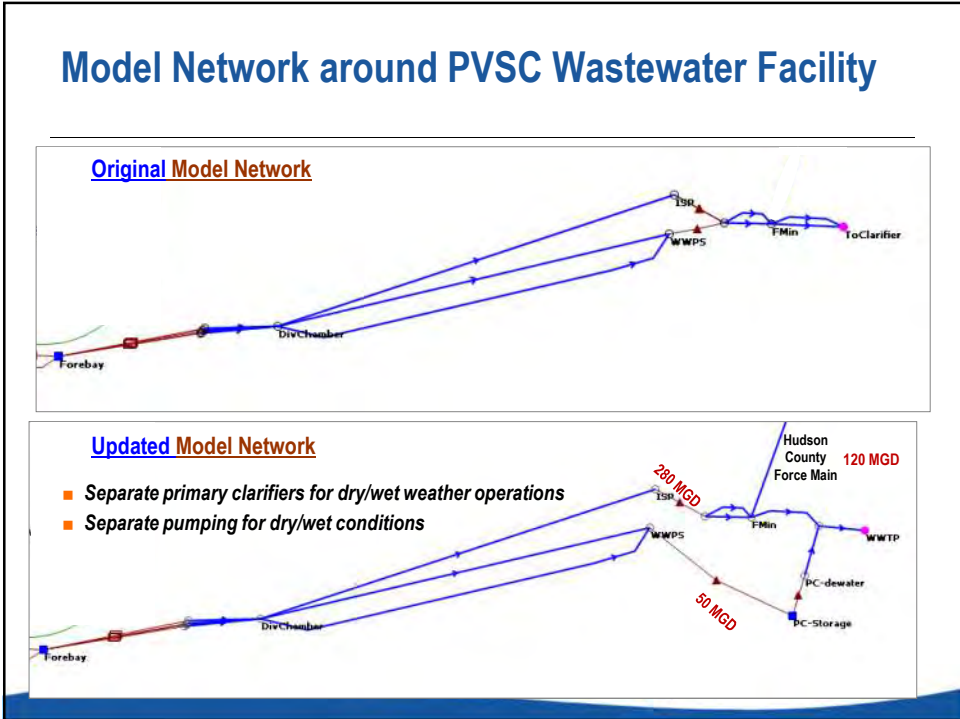
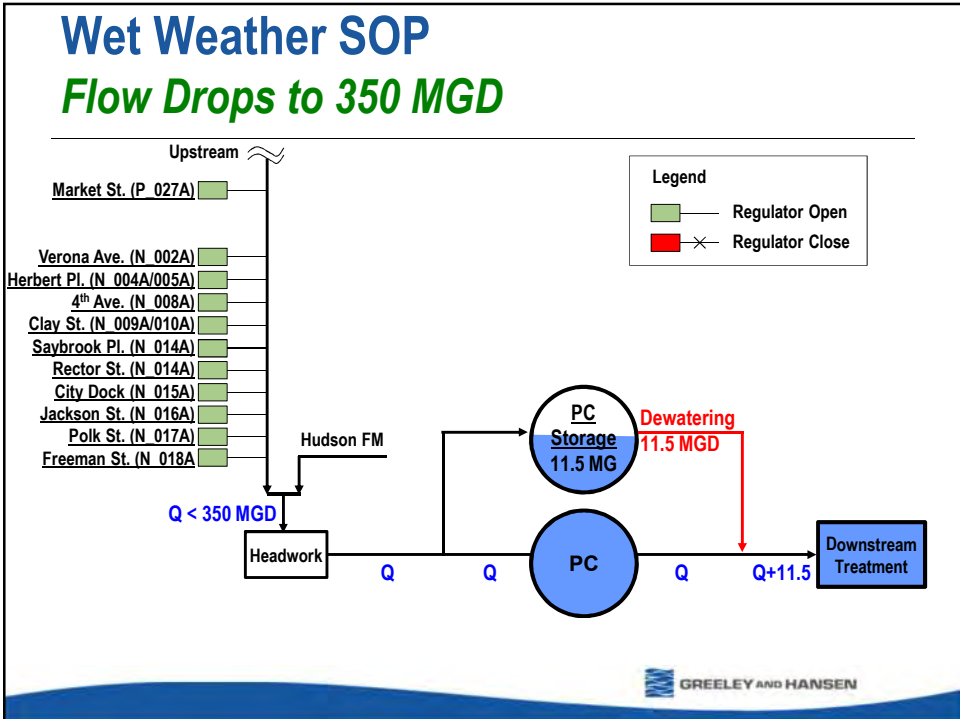
Municipality	Type of Agreement	Lease/Contract Date	Agreed Average Daily Flow (MGD)	Agreed Max Rate of Flow (MGD)	Comments
Passaic County					
Township of Little Falls	Lease	9/29/1986	2.2		
Borough of Woodland Park	Lease	4/25/1984	2	2	
Borough of Totowa	Lease	1/7/1986	2.4	2.4	
Borough of North Haledon	Lease	8/13/1980	1	1.8	
Borough of Hawthorne	Lease	3/23/1944	2	3	
Bergen County					
Township of South Hackensack	Lease	4/5/2010	0.05	0.1	
Borough of Hasbrouck Heights	Third Party Agreement				Via Lodi
City of Garfield	Contract	1/1/1965	16.11	16.11	
Borough of Lodi	Contract	8/8/1960	4.5	4.5	
City of Hackensack	Third Party Agreement				Via Lodi
Township of Saddle Brook	Lease	11/10/1960	2	2	
Borough of Elmwood Park	Lease	10/20/1943	1	1.5 (max day)	
Borough of Wood-Ridge	Lease	11/15/2006	0.25		Lodi & Wood Ridge
Village of Ridgewood	Third Party Agreement				Via Glen Rock & Hawthorne
Borough of Franklin Lakes	Third Party Agreement				Via North Haledon
Borough of Fair Lawn	Lease	1/3/1945	2.25	2.5 (max day)	
Borough of Glen Rock	Lease	10/23/1944	1	1.5 (max day)	
Essex County					
Township of Cedar Grove	Third Party Agreement				Via Little Falls and Montclair
Borough of North Caldwell	Third Party Agreement				Via Little Falls
Township of West Orange	Third Party Agreement				Via Orange
Township of South Orange Village	Third Party Agreement				Via Orange
Hudson County					
City of Bayonne	Contract	11/25/1986	11	17.6	
Township of North Bergen	Contract	3/9/2006	10	16	
City of Union City	Contract	9/25/1985	1.5	2.4	
City of Jersey City	Contract	9/24/1985	50	80	
Union County					
City of Elizabeth	Third Party Agreement				Via Airport / Port Newark to South Side Interceptor @ Waverly
Township of Hillside	Third Party Agreement				Via Newark South Side Interceptor



Wet Weather Operating Rules









Next Step

Model Calibration/Validation Approach

- **Dry Weather Flow Calibration**
 - DWF distribution based on metershed
 - Weekday/Weekend Diurnal
- **Wet Weather Flow Calibration**
 - 2-3 storm events
 - CSO area runoff
 - Separated area RDII (RTK)
 - Wet weather flow peak and volume







PVSC – Long Term Control Plan Modeling Evaluation Group – Session 2 *Flow Metering Data*

Greeley and Hansen LLC
March 17, 2017

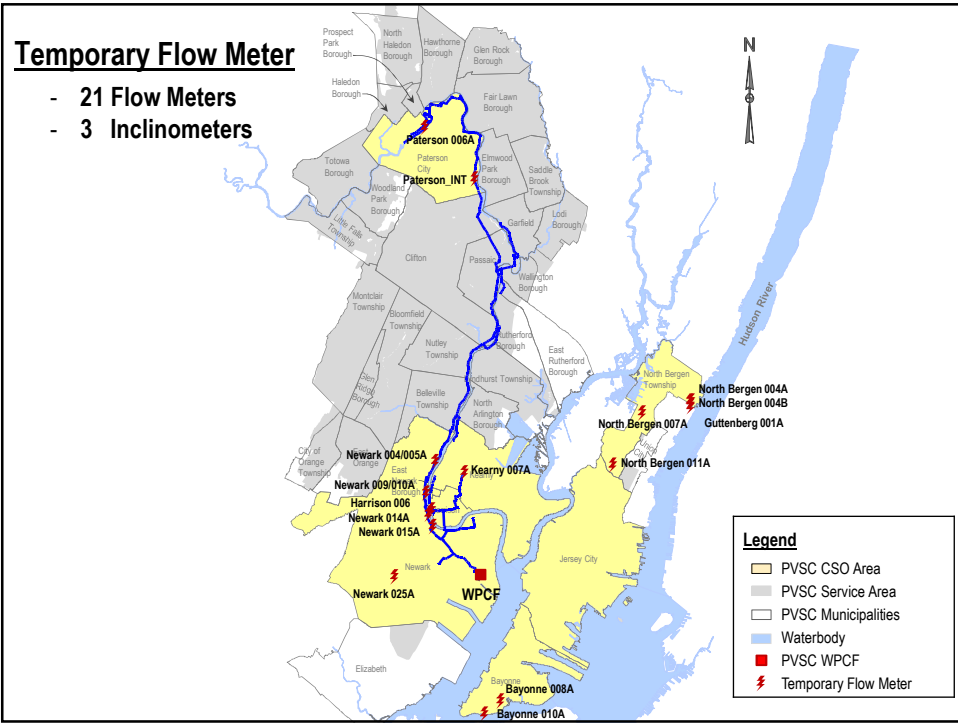
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Outline

- **Flow Monitoring Data**
 - Temporary Flow Meter
 - Permanent Meter Data
- **Rainfall Data**
 - Rainfall Stations
 - Rainfall Data Analysis
- **Calibration Event**



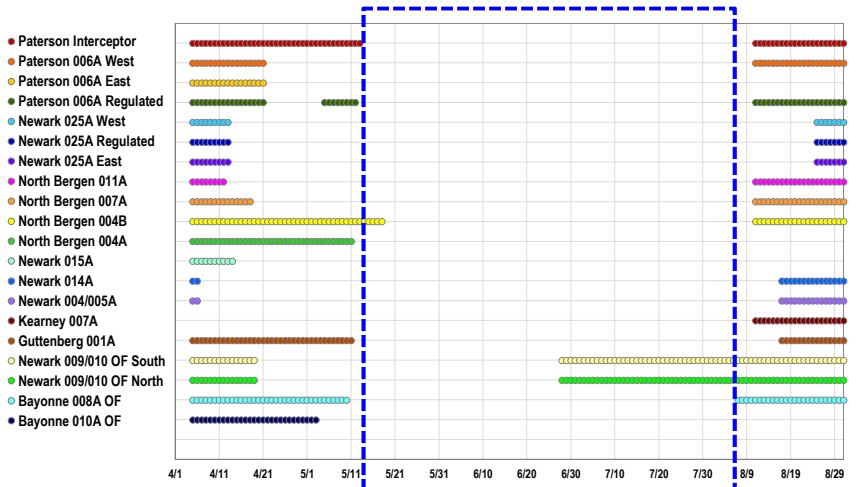
Temporary Flow Meter



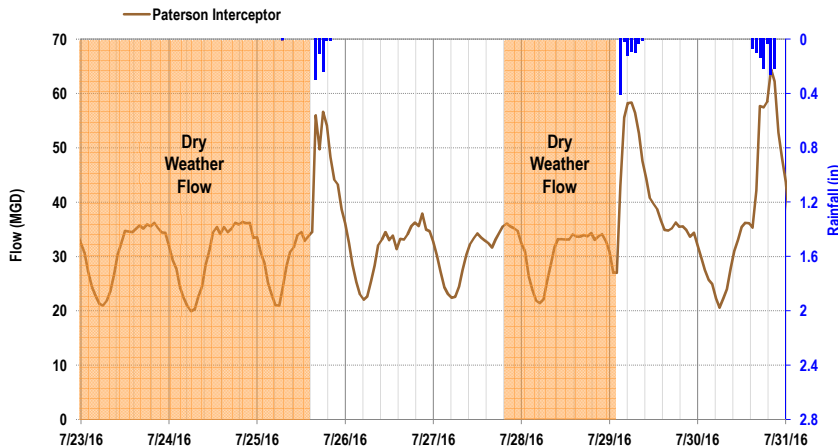
Meter Summary Table

Meter ID	Municipality	Location	Category
Bayonne 008A OF	Bayonne	East 5th and Ingham Ave	Outfall
Bayonne 010A OF	Bayonne	W 1st and Avenue C	Outfall
Guttenberg 001A	Guttenberg	70th and JFK Blvd	Outfall
Harrison 006 Influent	Harrison	Bergen and Dey	Regulator Influent
Kearny 007A	Kearny	King and Ivy Street	Outfall
Newark 004/005A	Newark	Herbert Place under elevated Hwy	Outfall
Newark 009/010 OF North	Newark	Clay Street - inside facility	Outfall
Newark 009/010 OF South	Newark	Clay Street - inside facility	Outfall
Newark 015A	Newark	City Dock	Outfall
Newark 014A	Newark	Saybrook in pull off	Outfall
Newark 025A East	Newark	Peddie - access through parking, near railroad	Regulator Influent
Newark 025A West	Newark	Peddie - access through parking, near railroad	Regulator Influent
Newark 025A Regulated	Newark	Peddie - access through parking, near railroad	Regulator Effluent
North Bergen 004A	North Bergen	73rd and Hudson County 693	Outfall
North Bergen 004B	North Bergen	Near 74th and Hudson County in grassy lot	Outfall
North Bergen 007A	North Bergen	53rd and Tonnelle Ave in Concrete Plant driveway	Outfall
North Bergen 011A	North Bergen	1101 Tonnelle Ave	Outfall
Paterson 006A East	Paterson	Montgomery and River St	Regulator Influent
Paterson 006A West	Paterson	Montgomery and River St	Regulator Influent
Paterson 006A Regulated	Paterson	Montgomery and River St	Regulator Effluent
Paterson_INT	Paterson	McLean Boulevard at Cemetary entrance	Interceptor

Missing Data Period for Each Flow Meter

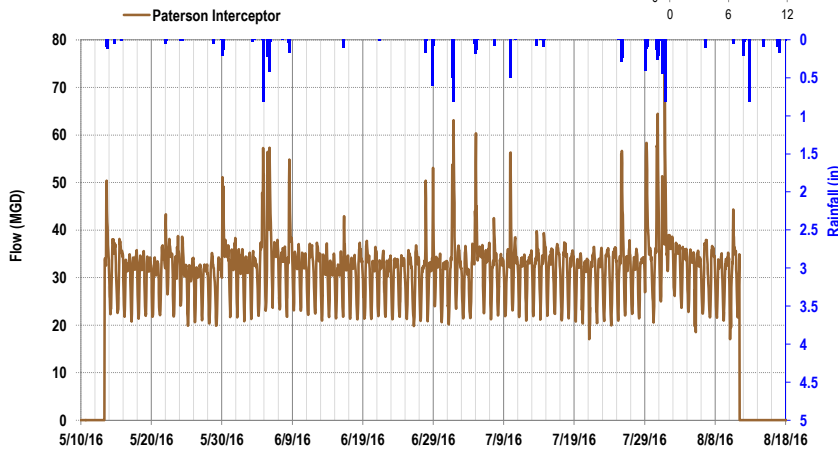


Dry Weather Flow Analysis

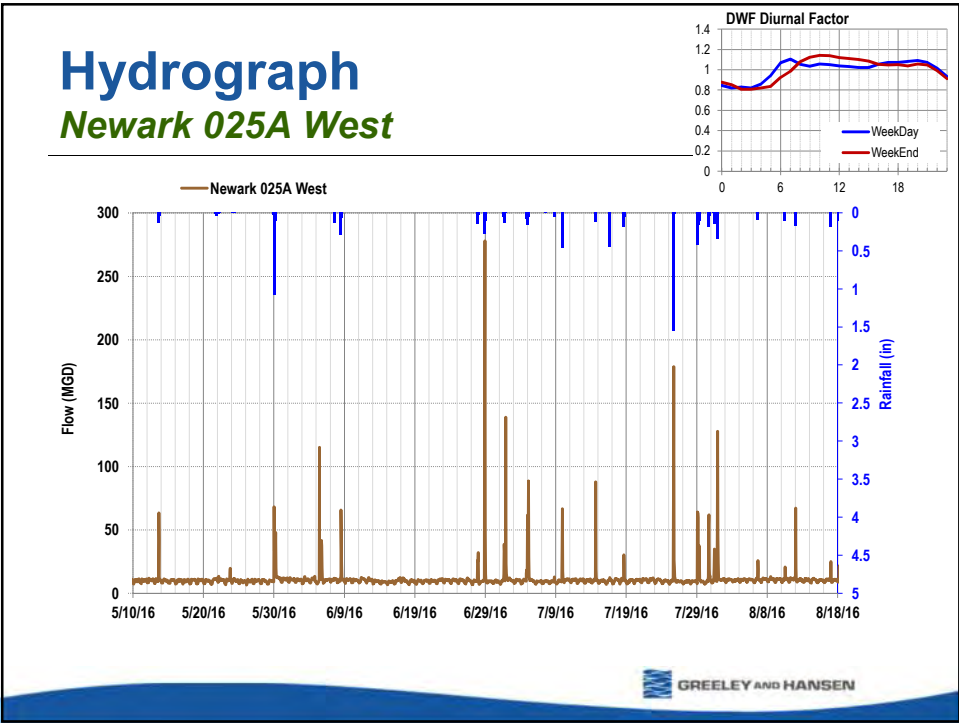
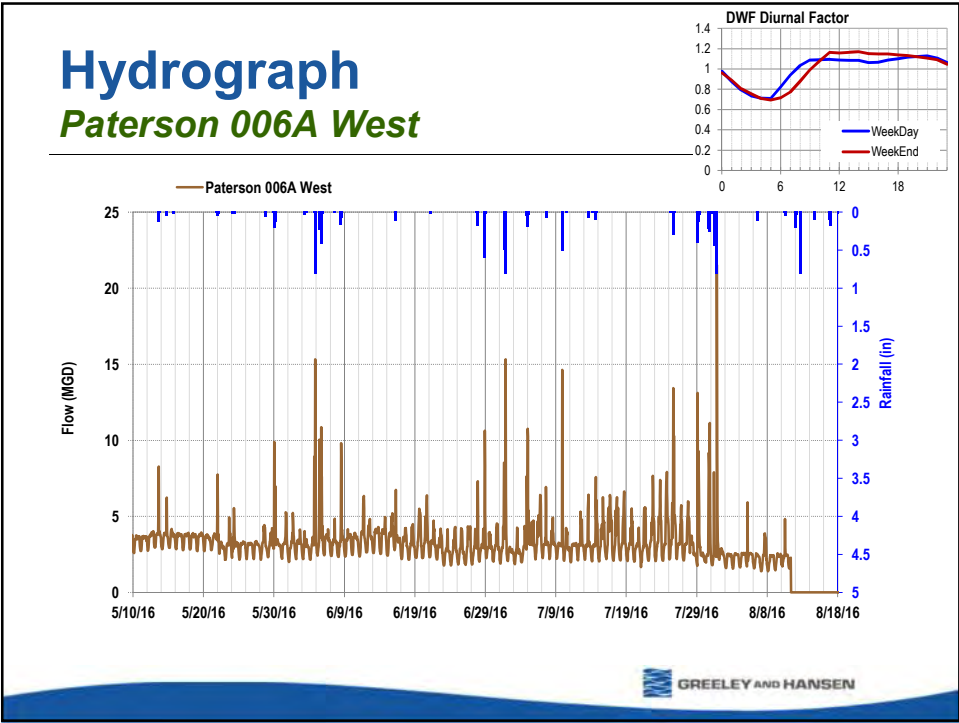


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Hydrograph Paterson Interceptor

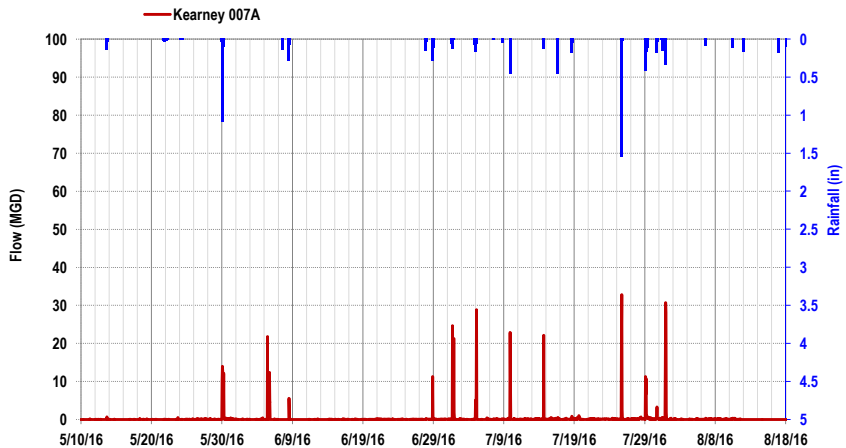


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Hydrograph

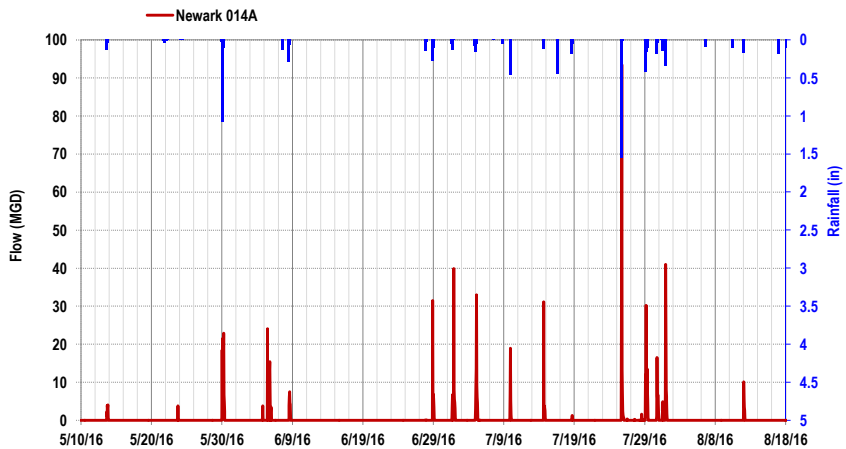
Kearney 007A Overflow



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Hydrograph

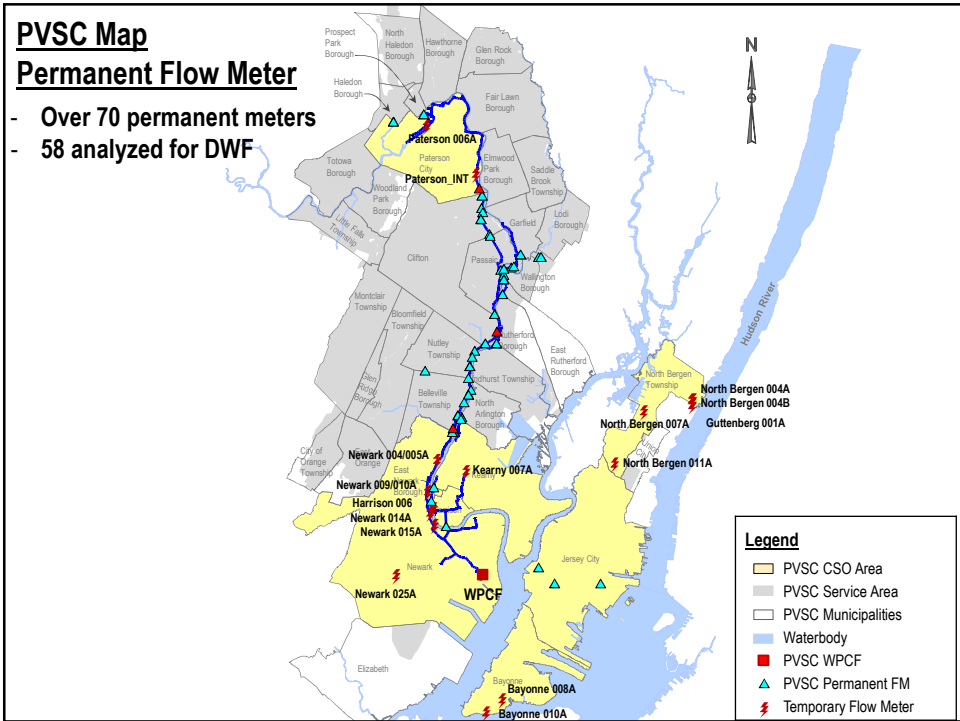
Newark 014A Overflow

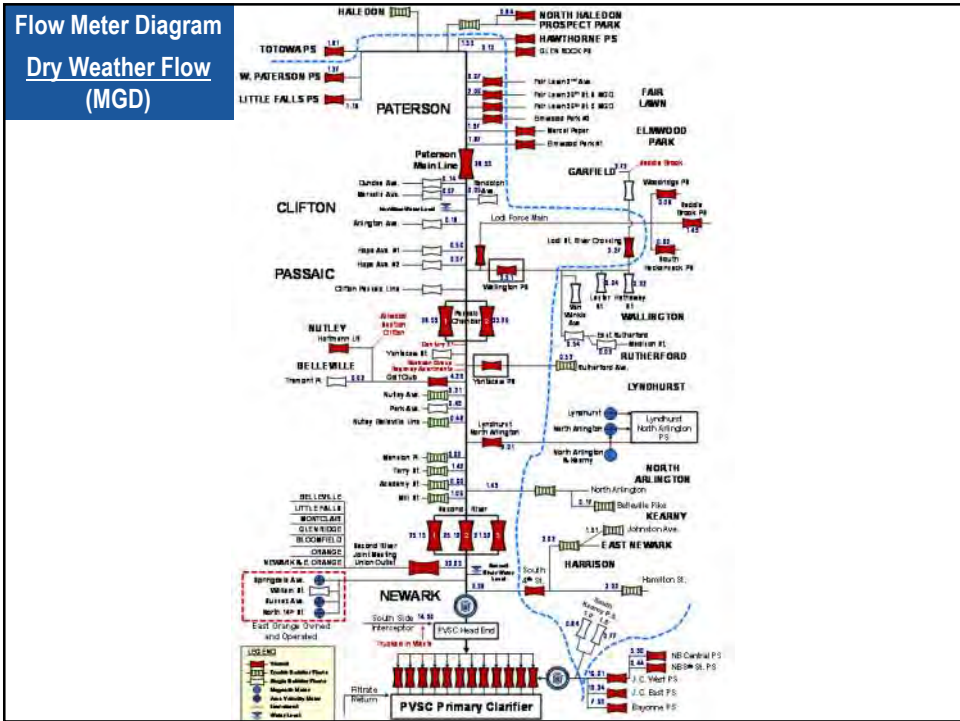
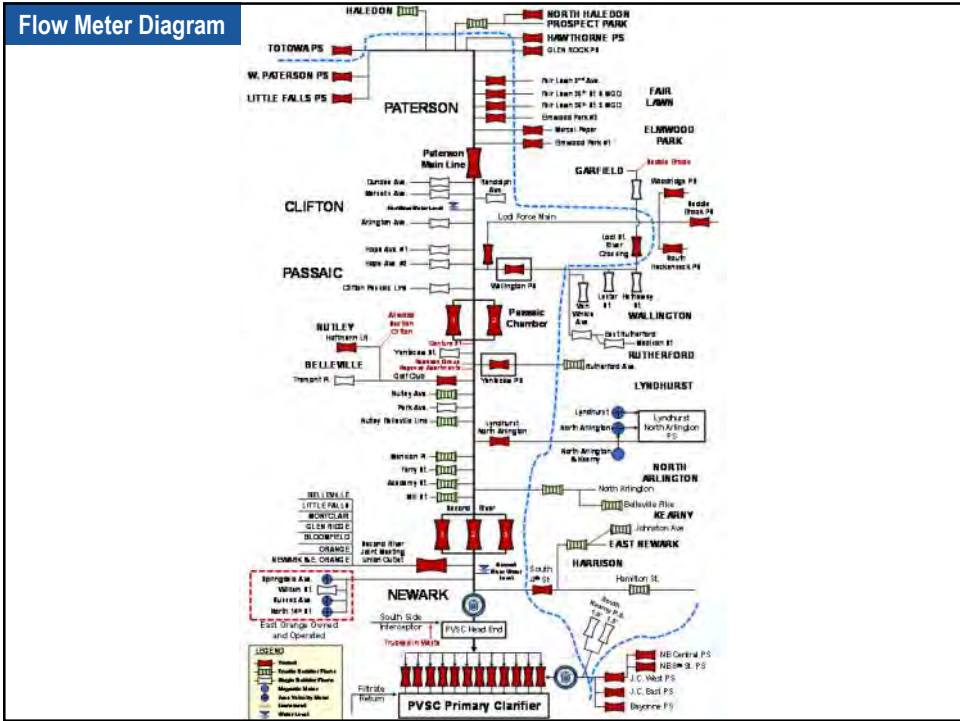


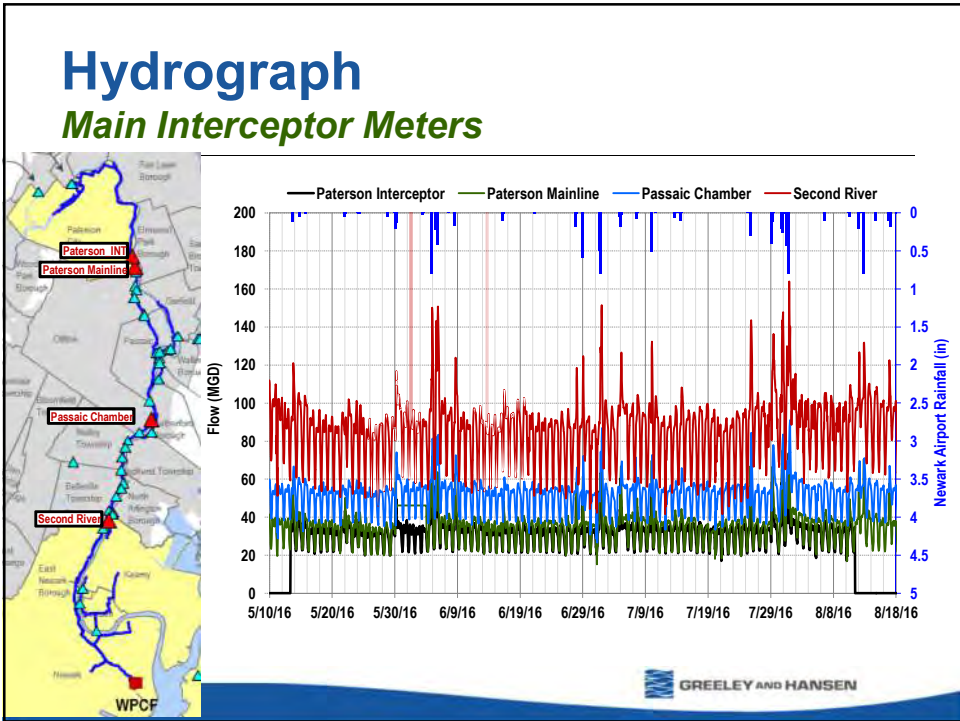
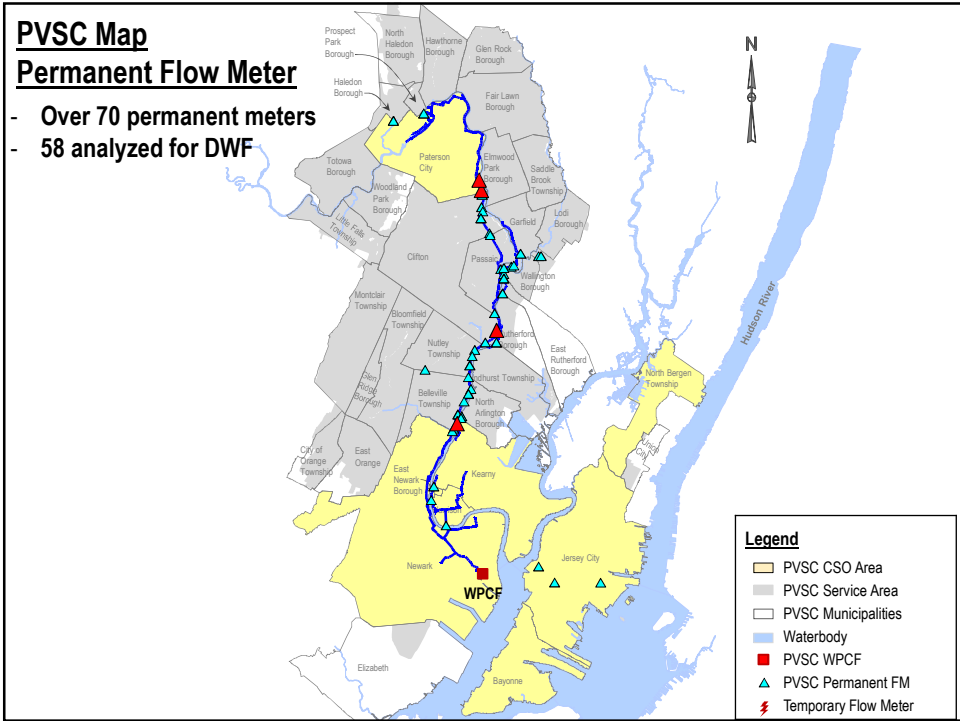
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Permanent Flow Meters

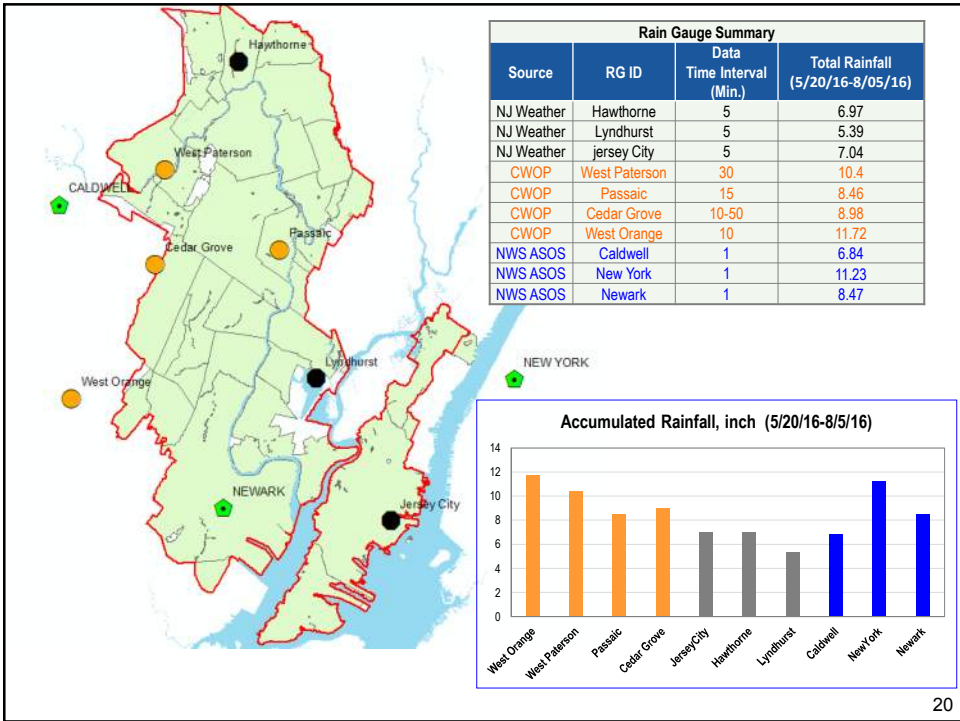


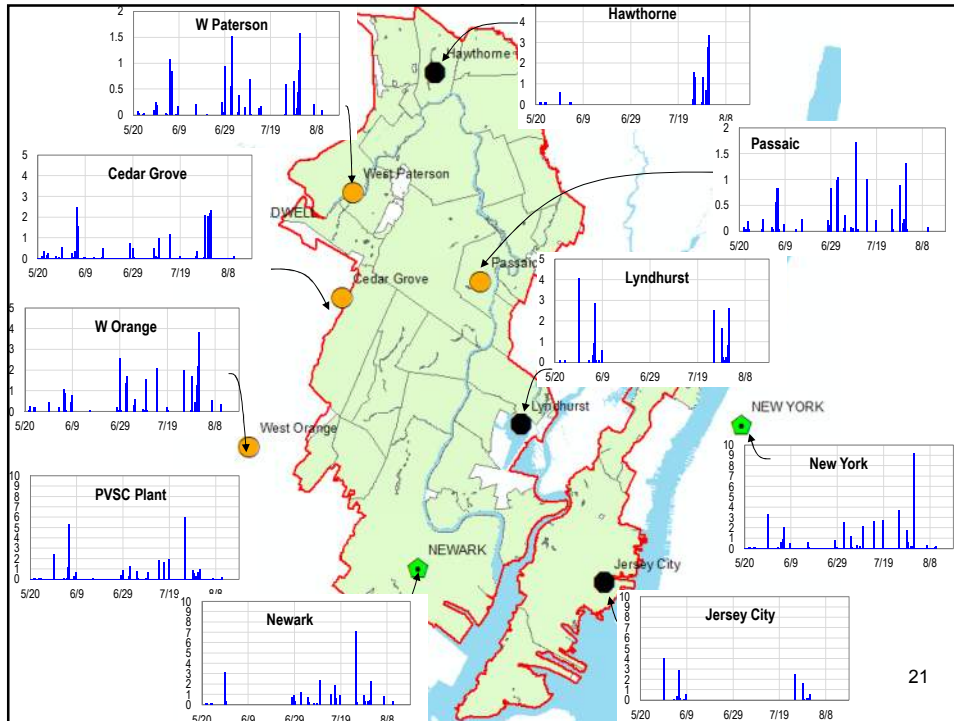






Rainfall Data Analysis





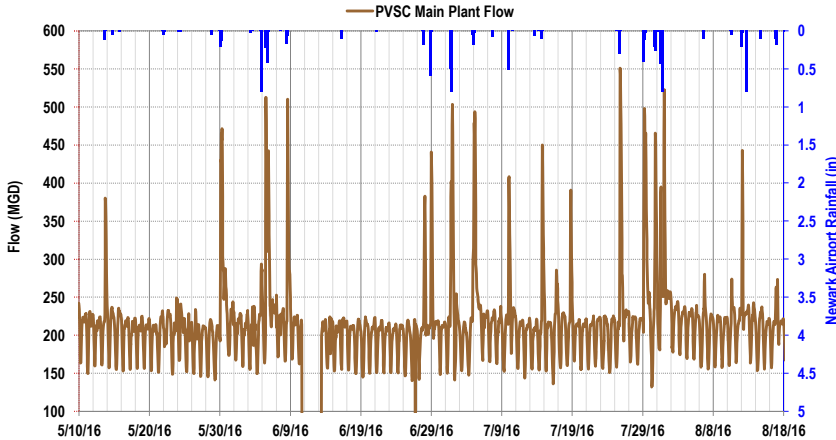
Candidate Storm Events for Calibration

Rain Start	Rain End	Duration (hr)	Depth (in)	Max Intensity (in/hr)	Average Intensity (in/hr)
7/25/16 16:05	7/25/16 18:50	2.75	1.81	1.68	0.66
5/29/16 23:50	5/30/16 5:20	5.50	1.6	1.09	0.29
7/29/16 0:20	7/29/16 8:35	8.25	0.85	0.42	0.10
5/2/16 22:40	5/3/16 9:50	11.17	0.7	0.17	0.06
7/31/16 8:35	7/31/16 22:35	14.00	0.69	0.49	0.05
7/4/16 19:20	7/5/16 2:50	7.50	0.63	0.23	0.08
5/6/16 2:30	5/6/16 12:25	9.92	0.6	0.19	0.06
7/16/16 14:50	7/16/16 15:35	0.75	0.56	0.75	0.75
6/8/16 11:25	6/8/16 14:10	2.75	0.49	0.3	0.18
7/9/16 21:30	7/9/16 22:05	0.58	0.48	0.82	0.82
4/4/16 7:45	4/4/16 17:00	9.25	0.43	0.12	0.05



Discussion

Hydrograph *PVSC Main Plant Flow*





PVSC – Long Term Control Plan Modeling Evaluation Group – Session 3

Hydrologic and Hydraulic Model Update and Calibration

Greeley and Hansen LLC
September 15, 2017

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Agenda

- **Background: PVSC Sewer System**
- **PVSC Hydrologic and Hydraulic (H&H) Model Snapshot**
- **H&H Model Update**
- **H&H Model Calibration and Validation**
- **Summary & Next Step**

Background

3

Sewer Systems

- **Passaic Valley Sewerage Commission**
 - 48 municipalities
 - 8 CSO municipalities (0.9 million residents)
 - 1.5 million residents
 - 147 mi² service area
 - 22 mile interceptor sewer
 - 330 mgd WPCF

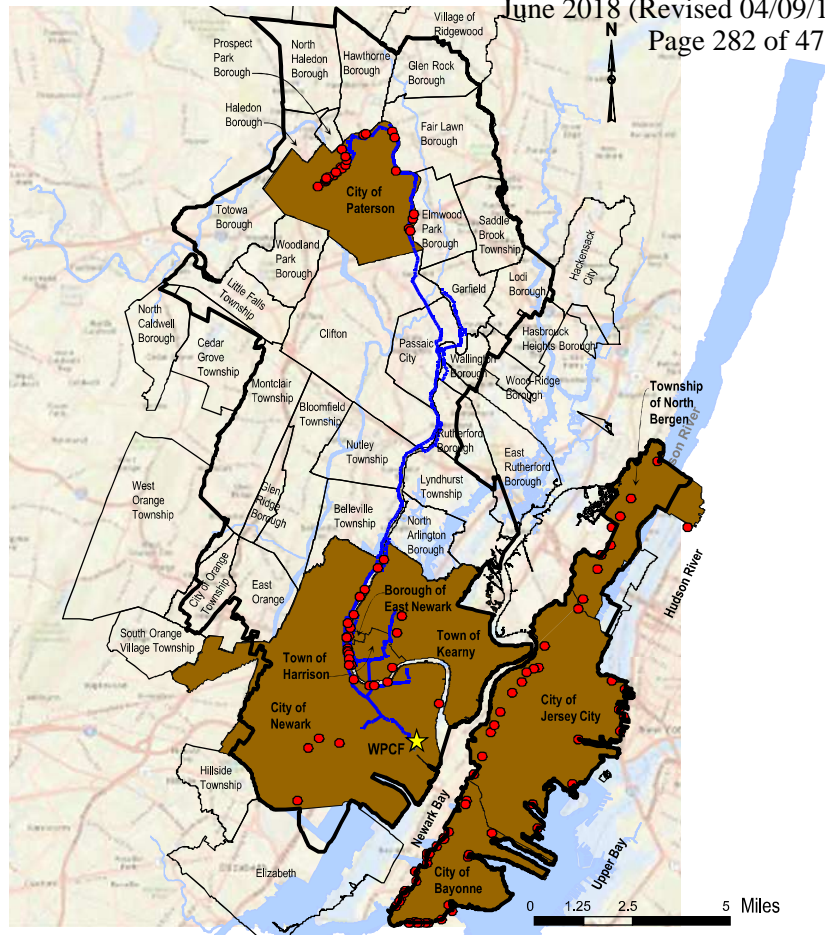
- **NBMUA Woodcliff WWTP**
 - 2 CSO municipalities
 - 3 mgd Woodcliff WWTP
 - 477 acres (368 acres in North Bergen)



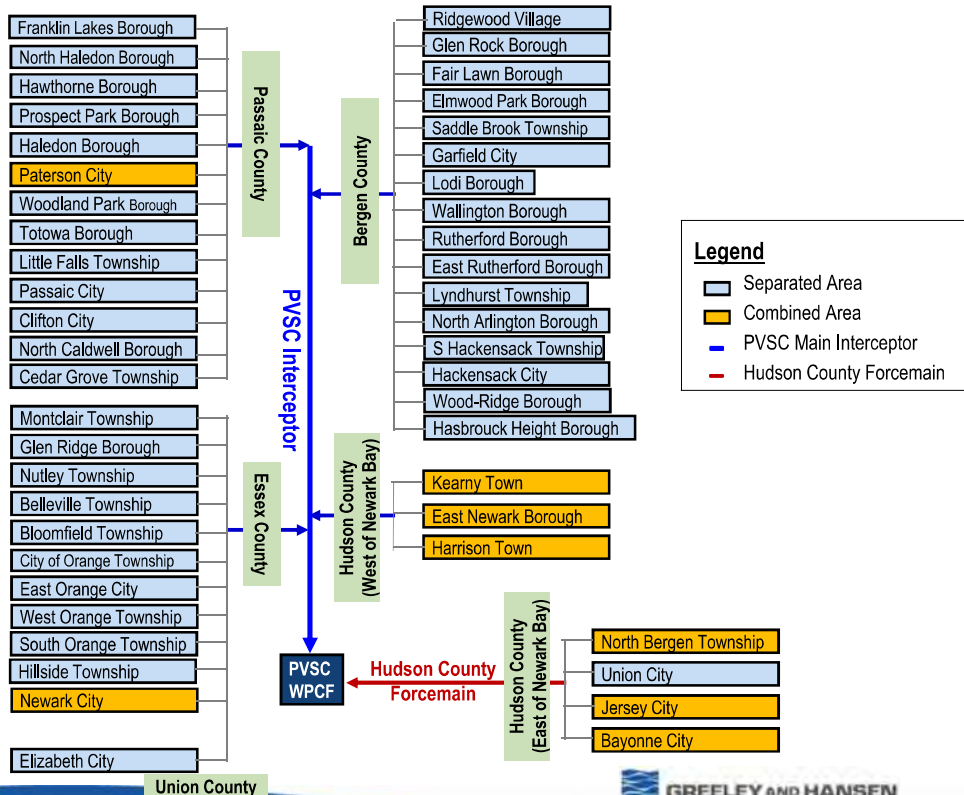
PVSC Service Area

Legend

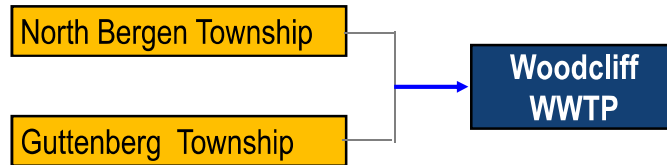
- PVSC Service Area
- CSO Communities
- Separated Communities
- ★ PVSC WPCF (Water Pollution Control Facility)
- PVSC Interceptor / Sewer
- CSO Outfall



PVSC WPCF Schematic



NBMUA Woodcliff WWTP Schematic



CSO Communities

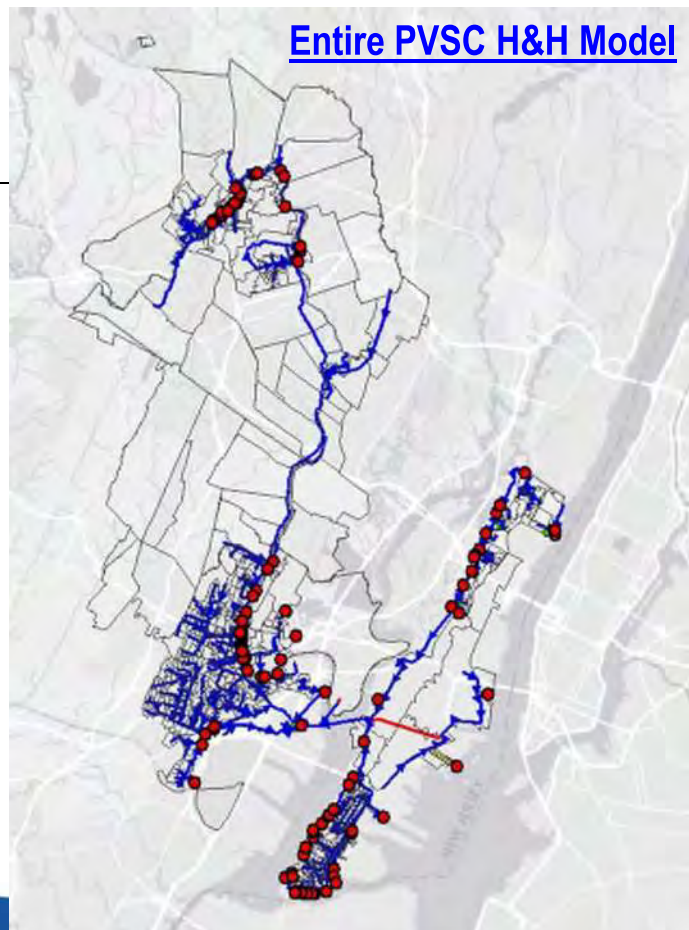
Municipality	WWTP	Population	Area (mi ²)	Sewerage (miles)	CSOs
Bayonne	PVSC	63,000	5.8	94	30
East Newark		2,400	0.1	2	1
Harrison		13,600	1.3	18	7
Jersey City		247,600	14.8	230	21
Kearny		40,700	6.5	52	5
Newark		277,100	22.3	579	18
North Bergen		52,600	4.5	59	7
Paterson		146,200	8.7	164	23
Guttenberg	NBMUA	11,200	0.2	5	1
North Bergen		8,200	0.7	8	1
Total		862,600	84	1,211	114

Current H&H Model Snapshots

9

Entire PVSC H&H Model

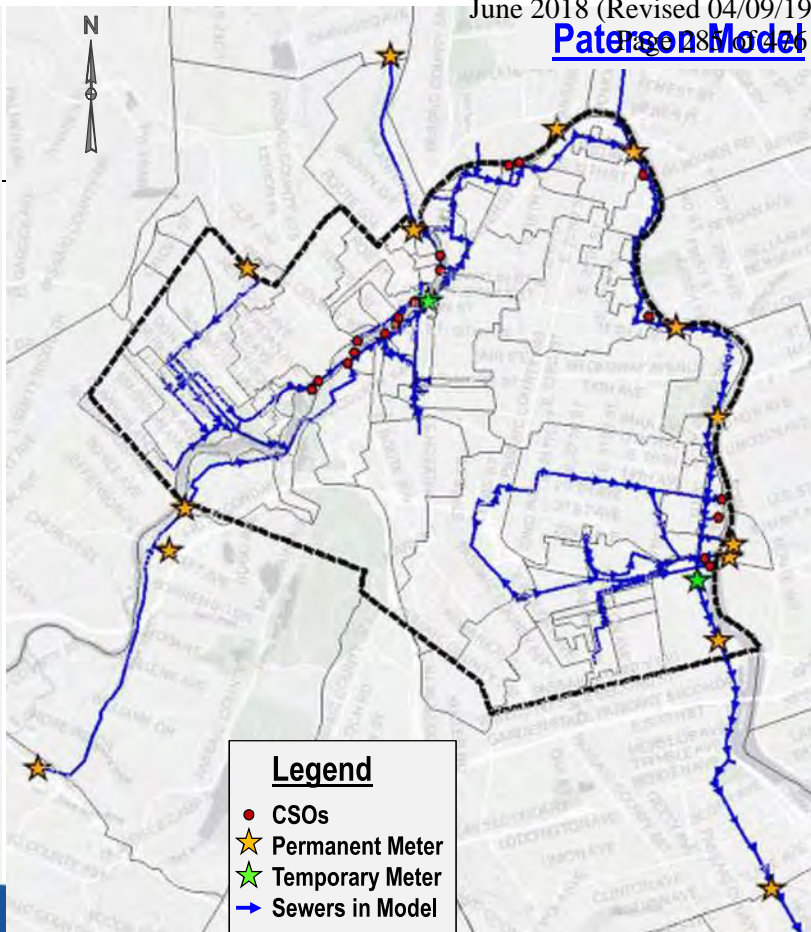
- Subcatchment: 732
- Nodes (2735)
 - Manhole: 2621
 - Outfall: 103
 - Storage: 11
- Link (2873)
 - Conduit: 2567
 - Flap Valve: 82
 - Orifice: 33
 - Pump: 14
 - Sluice: 74 (30 variable)
 - Weir: 103



10

Paterson Model

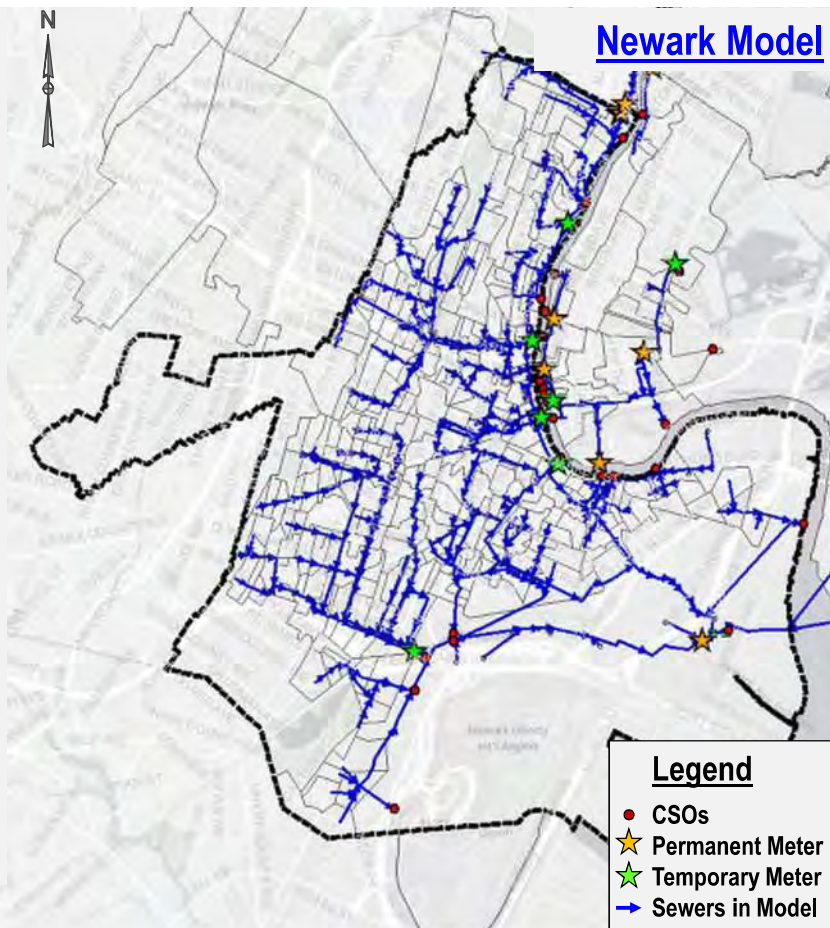
- Subcatchment: 67
- Nodes (585)
 - Manhole: 562
 - Outfall: 23
 - Storage: 0
- Link (657)
 - Conduit: 503
 - Flap Valve: 82
 - Orifice: 14
 - Pump: 0
 - Sluice: 16 (2 variable)
 - Weir: 42



Newark Model

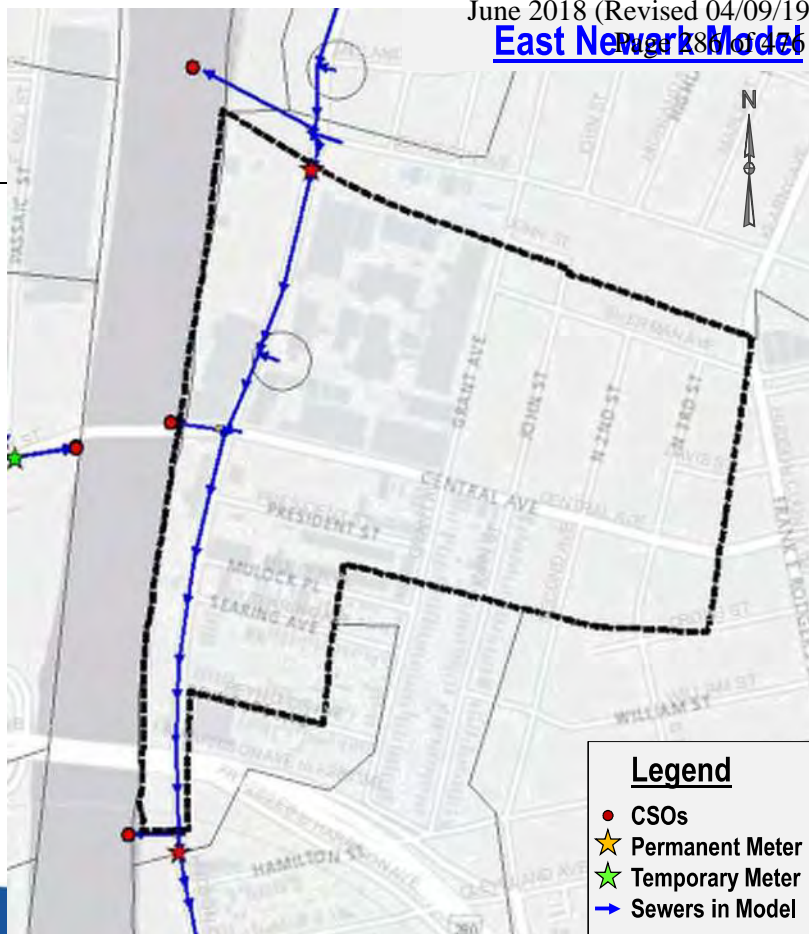
Newark Model

- Subcatchment: 310
- Nodes (758)
 - Manhole: 738
 - Outfall: 18
 - Storage: 2
- Link (819)
 - Conduit: 746
 - Flap Valve: 17
 - Orifice: 3
 - Pump: 3
 - Sluice: 27 (17 variable)
 - Weir: 23



East Newark Model

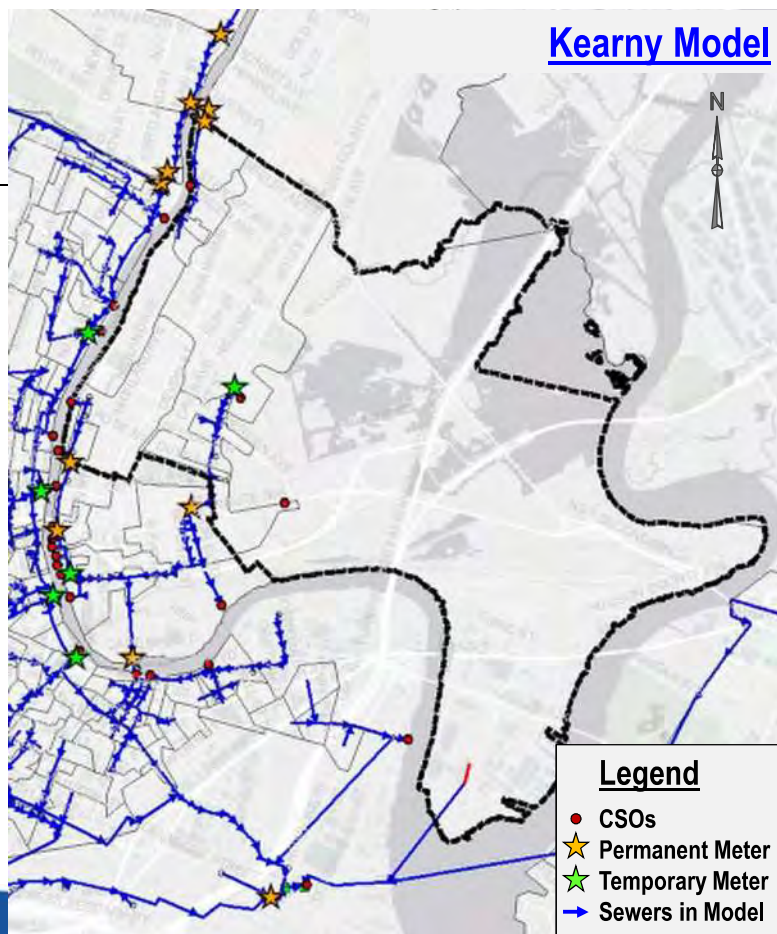
- Subcatchment: 1
- Nodes (22)
 - Manhole: 21
 - Outfall: 1
 - Storage: 20
- Link (22)
 - Conduit: 19
 - Flap Valve: 1
 - Orifice: 1
 - Pump: 0
 - Sluice: 0
 - Weir: 1



Kearny Model

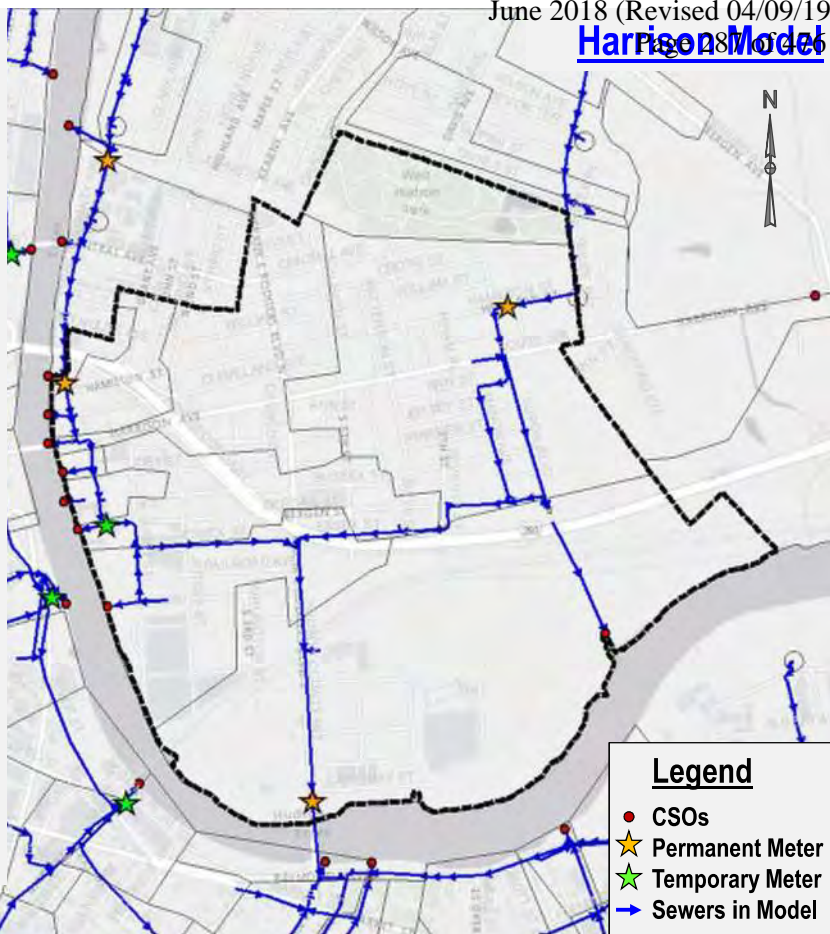
Kearny Model

- Subcatchment: 16
- Nodes (97)
 - Manhole: 91
 - Outfall: 5
 - Storage: 1
- Link (97)
 - Conduit: 78
 - Flap Valve: 5
 - Orifice: 7
 - Pump: 1
 - Sluice: 1
 - Weir: 5



Harrison Model

- Subcatchment: 16
- Nodes (117)
 - Manhole: 110
 - Outfall: 7
 - Storage: 0
- Link (118)
 - Conduit: 97
 - Flap Valve: 7
 - Orifice: 7
 - Pump: 0
 - Sluice: 0
 - Weir: 7



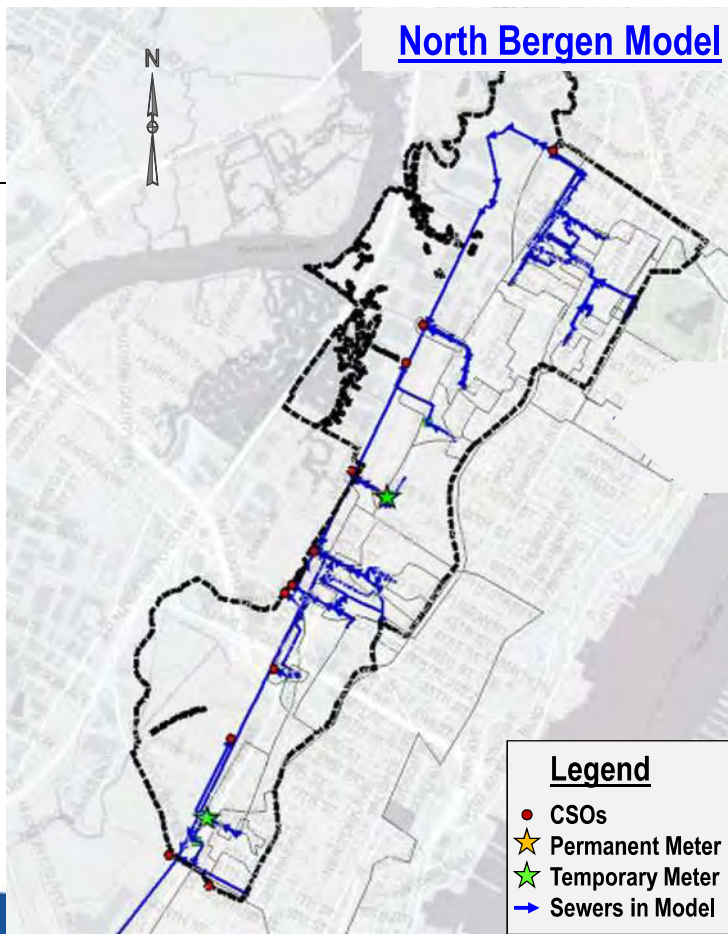
Legend

- CSOs
- ★ Permanent Meter
- ★ Temporary Meter
- Sewers in Model

North Bergen Model

North Bergen Model

- Subcatchment: 41
- Nodes (178)
 - Manhole: 166
 - Outfall: 9
 - Storage: 3
- Link (199)
 - Conduit: 183
 - Flap Valve: 0
 - Orifice: 0
 - Pump: 3
 - Sluice: 5
 - Weir: 8

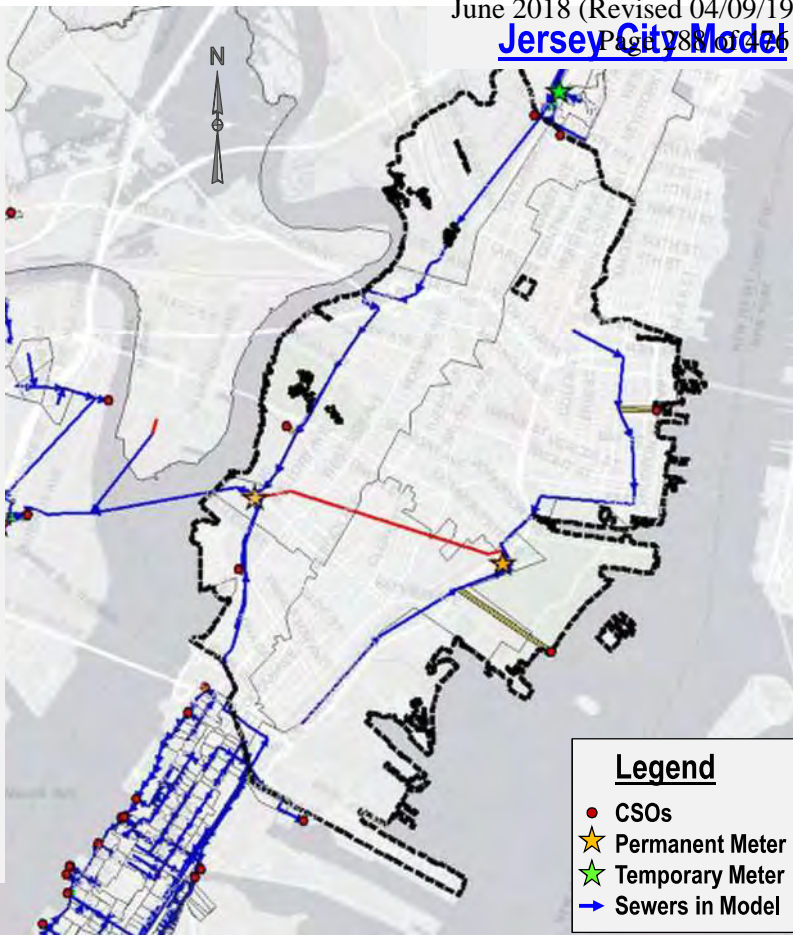


Legend

- CSOs
- ★ Permanent Meter
- ★ Temporary Meter
- Sewers in Model

Jersey City Model

- Subcatchment: 5
- Nodes (34)
 - Manhole: 29
 - Outfall: 5
 - Storage: 0
- Link (36)
 - Conduit: 24
 - Flap Valve: 5
 - Orifice: 0
 - Pump: 2
 - Sluice: 5
 - Weir: 0

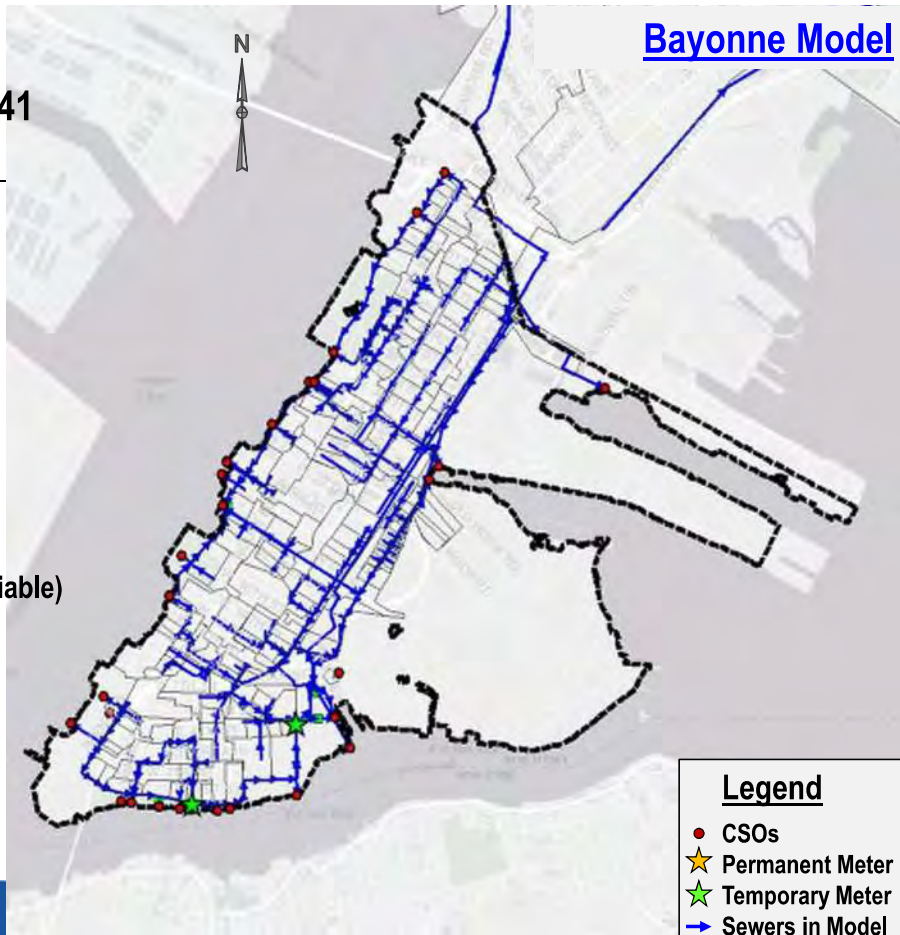


Legend

- CSOs
- ★ Permanent Meter
- ★ Temporary Meter
- Sewers in Model

Bayonne Model

- Subcatchment: 41
- Nodes (685)
 - Manhole: 651
 - Outfall: 29
 - Storage: 5
- Link (712)
 - Conduit: 648
 - Flap Valve: 27
 - Orifice: 0
 - Pump: 5
 - Sluice: 20 (11 variable)
 - Weir: 12



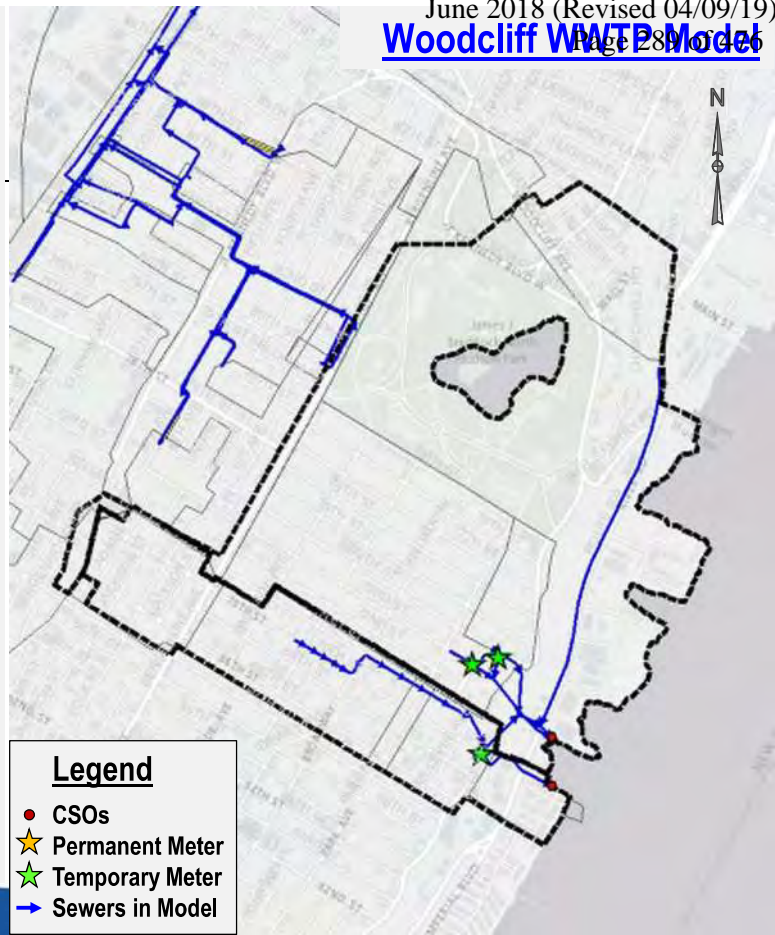
Bayonne Model

Legend

- CSOs
- ★ Permanent Meter
- ★ Temporary Meter
- Sewers in Model

Woodcliff WWTP Model

- Subcatchment: 5
- Nodes (38)
 - Manhole: 35
 - Outfall: 2
 - Storage: 1
- Link (39)
 - Conduit: 37
 - Flap Valve: 0
 - Orifice: 0
 - Pump: 0
 - Sluice: 1
 - Weir: 1



Model Update

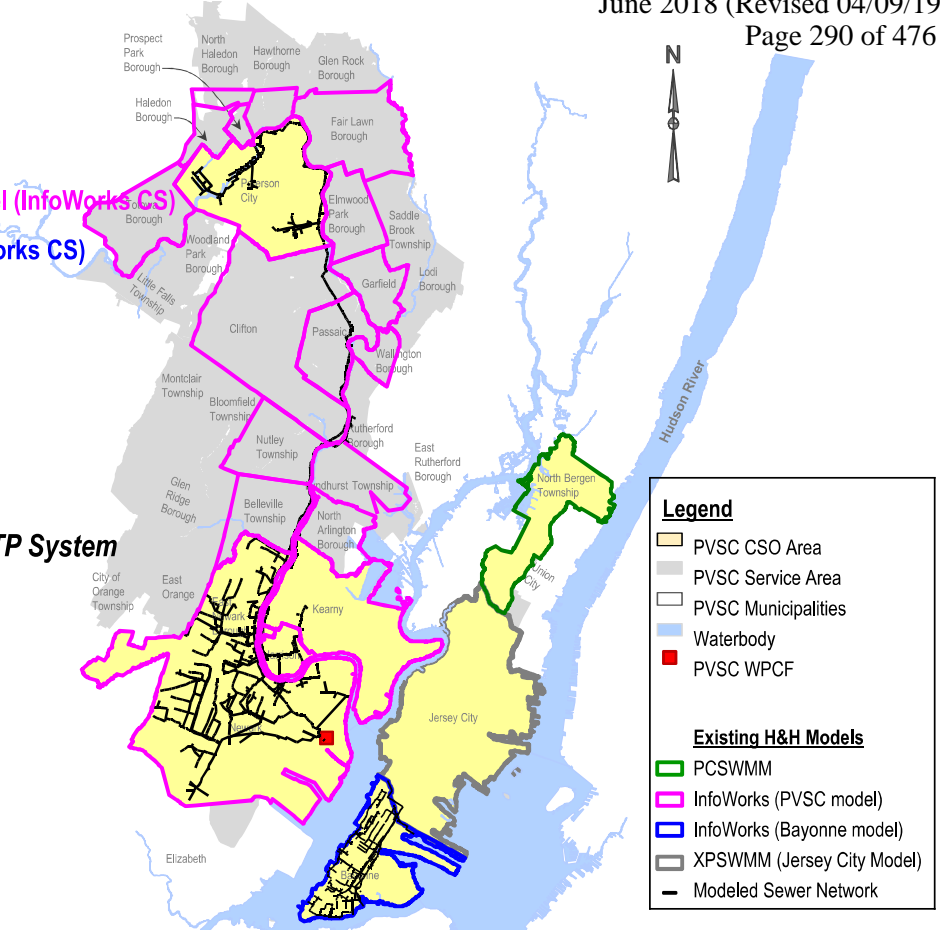
Existing Models

PVSC WPCF System

- PVSC Interceptor Model (InfoWorks CS)
- Bayonne Model (InfoWorks CS)
- North Bergen Model (2 PCSWMM model)
- Jersey City Model (XPSWMM model)

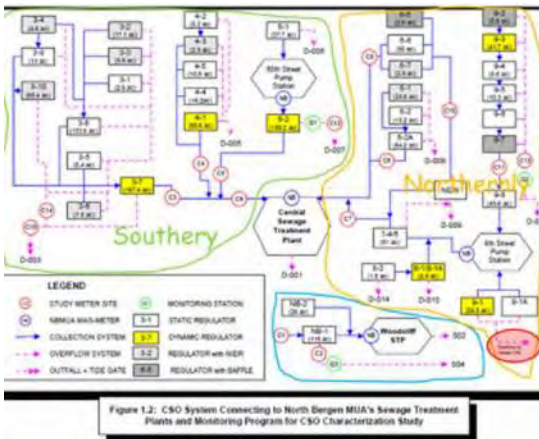
NBMUA Woodcliff WWTP System

- North Bergen Model (1 PCSWMM model)
- Guttenberg Model (1 PCSWMM model)



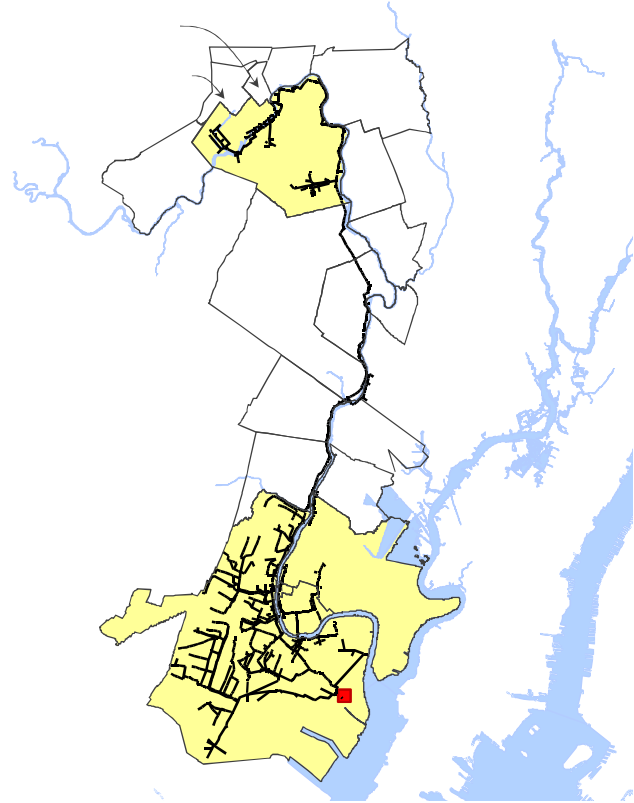
North Bergen Models

- North Bergen
 - Najarian Associates
 - 3 PCSWMM Models
 - LTCP Team has model
 - Converted to EPA SWMM for CSO Alert System



PVSC Main Interceptor Model

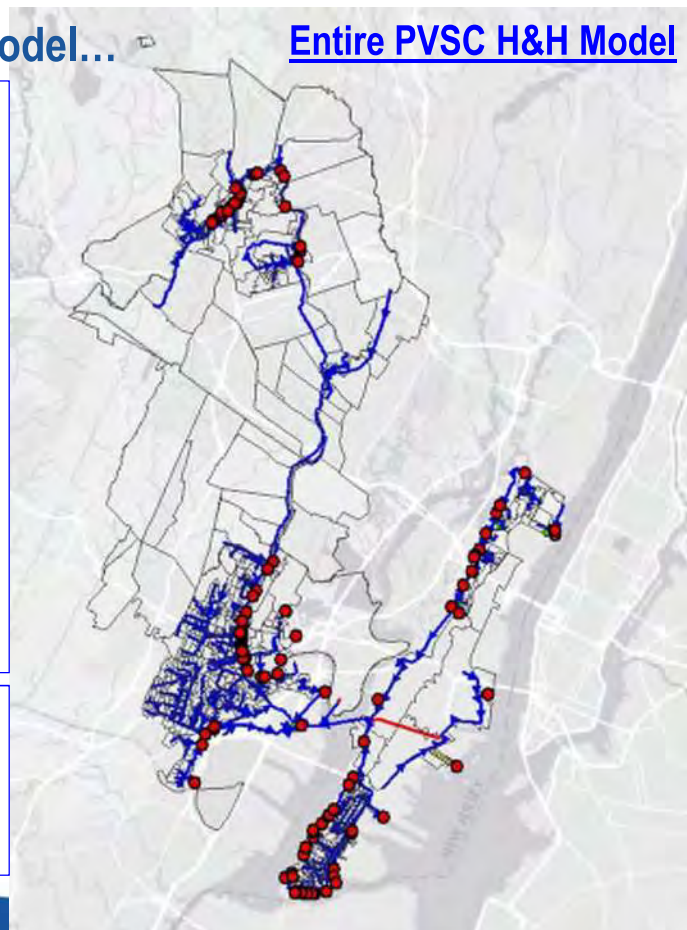
- **Large, Complex System**
 - Main interceptor
 - Seven branch interceptors
 - Combined and separate sewers
 - Regulators
 - RTC
 - Pump stations
 - River crossings
 - Treatment plant



A Snapshot of Integrated Model...

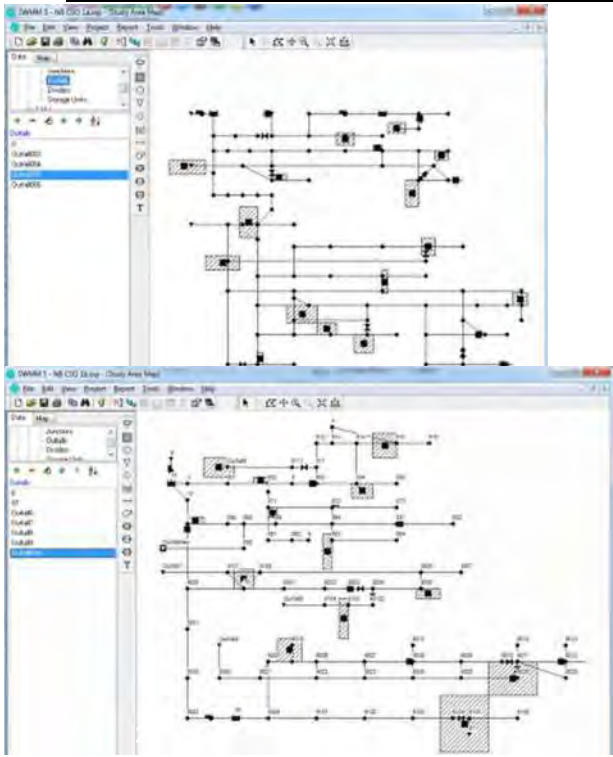
Entire PVSC H&H Model

- 48 PVSC communities
- 8 CSO communities
 - ✓ Paterson
 - ✓ Newark
 - ✓ East Newark
 - ✓ Harrison
 - ✓ Kearny
 - (Above 5 discharge to interceptor by gravity to WPCF)*
 - ✓ Bayonne
 - ✓ Jersey City
 - ✓ North Bergen
 - (Above 3 discharge to Hudson County Forcemain to WPCF)*
- 2 NBMUA Woodcliff WWTP CSO communities
 - ✓ North Bergen
 - ✓ Guttenberg



Model Integration

Recreate North Bergen Model from PCSWMM

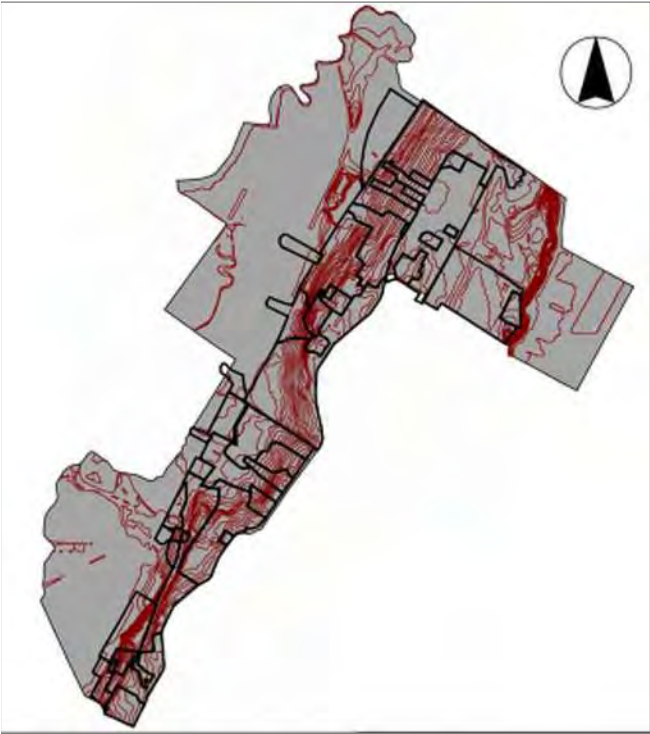


NB Delineation

Paper Copy

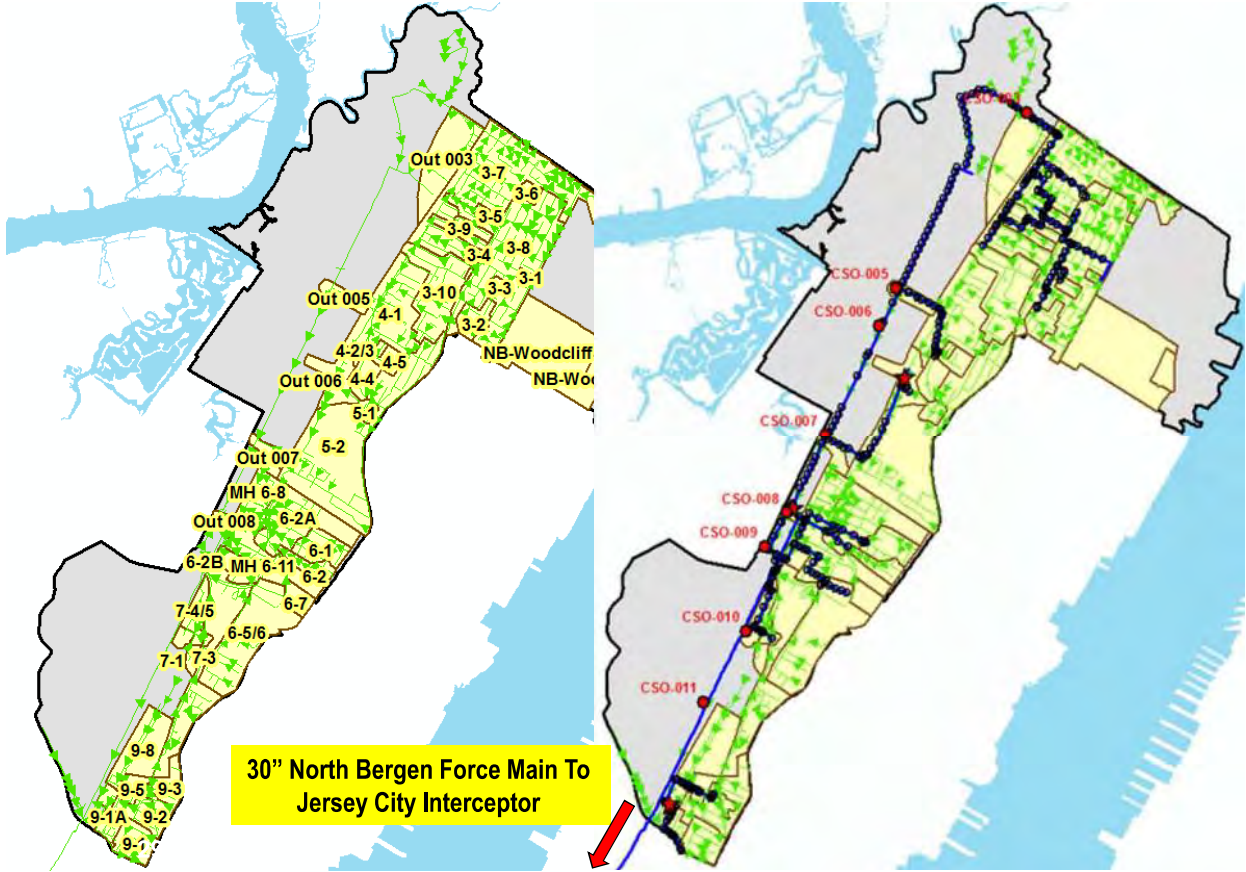


GIS Shapefile

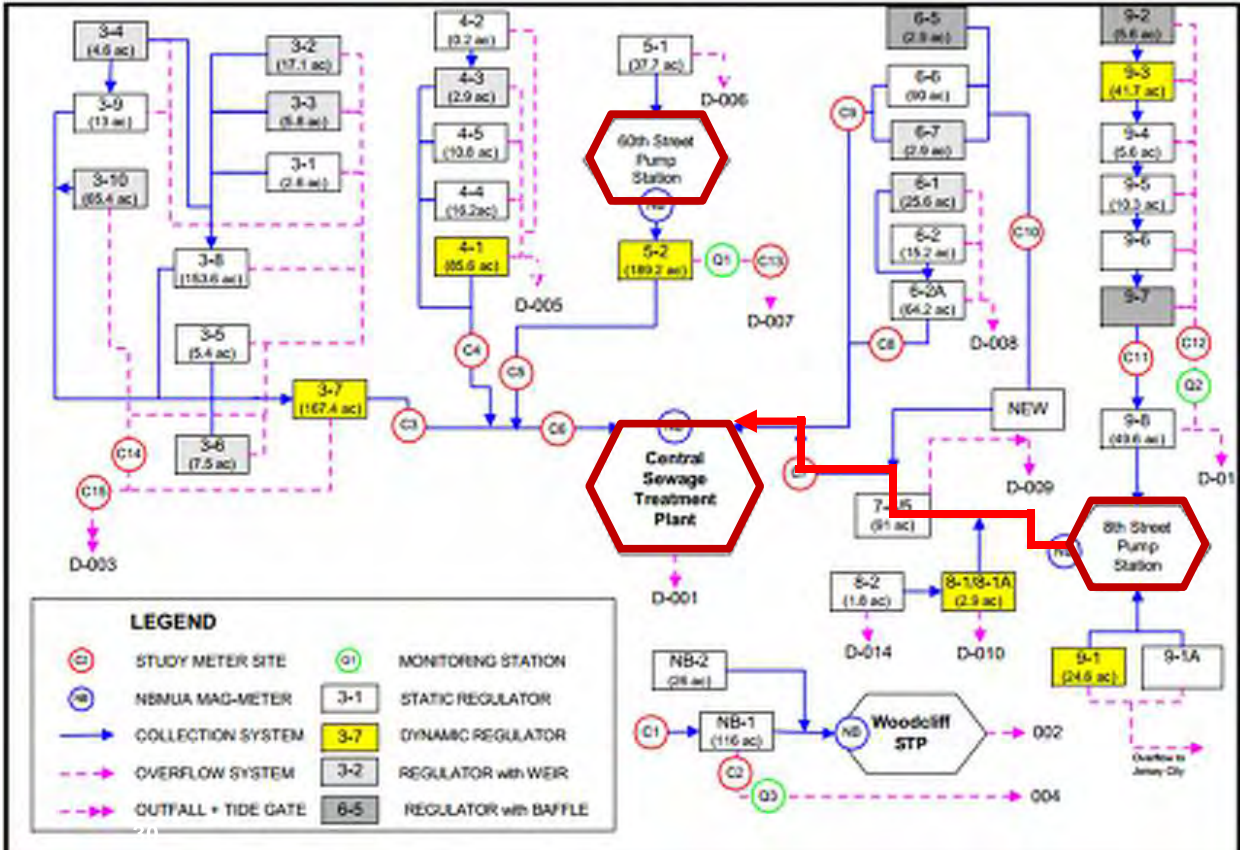


Digitize model subcatchment based on paper copy

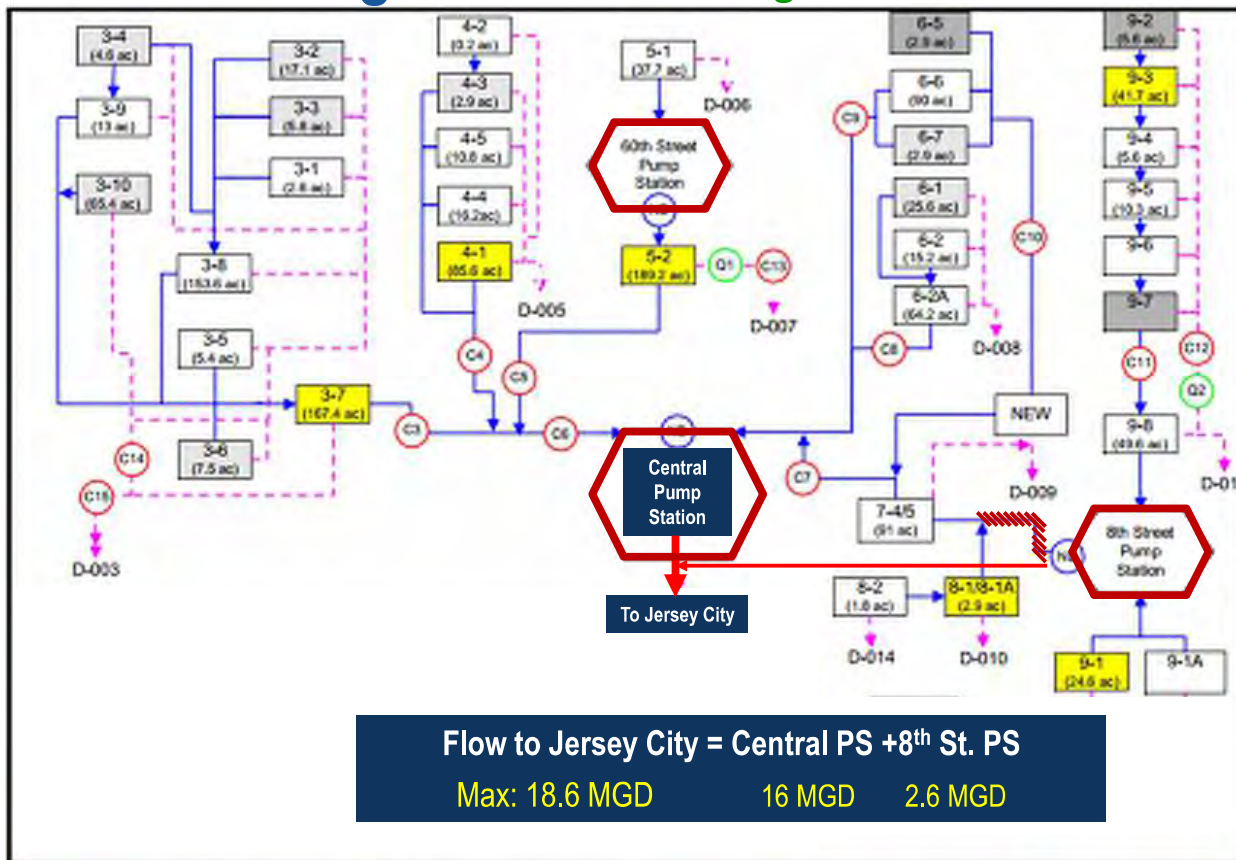
Sewer Network



Model Integration/North Bergen Model



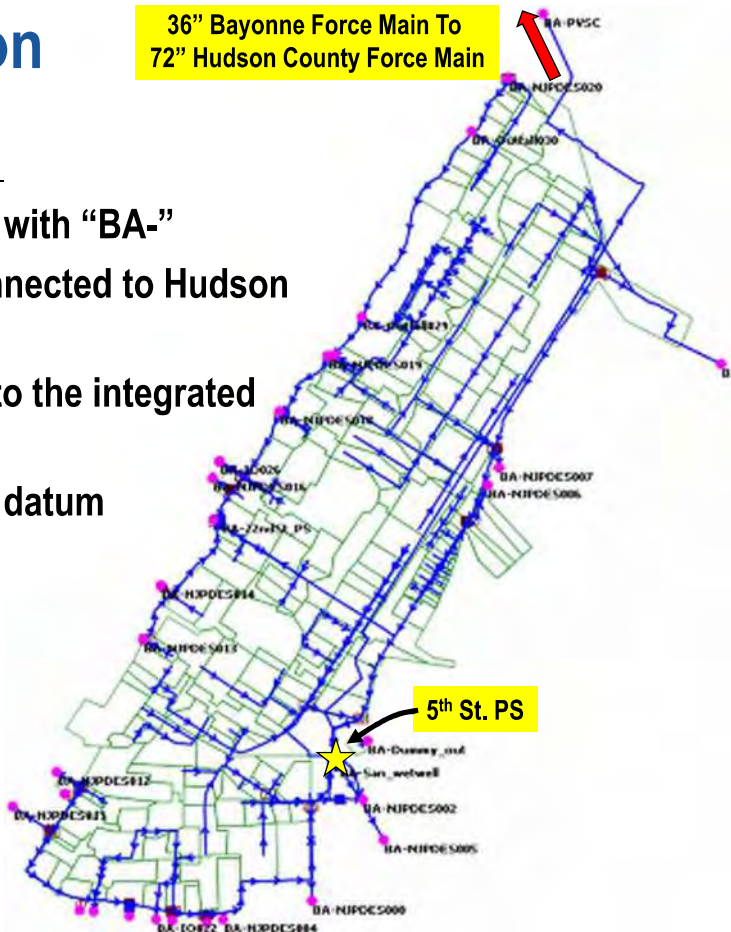
Model Integration/*North Bergen Model*



Model Integration

Bayonne Model

- With unique IDs starting with "BA-"
- Bayonne force main Connected to Hudson County Force Main
- 11 RTC rules appended to the integrated model
- Datum updated to PVSC datum



South Kearny Pump Station Service Area

- Kearny Meadowlands District
- South Kearny District
- Both Separated

South Kearny Pump Station

- Capacity: 17.5 MGD
- DWF: 1.6 MGD



Source: Mott MacDonald



Regulator Update

Regulator Modification

Regulator	Overflow Weir				Regulating Sluice Gate / Orifice					
	Drawing		Original Model		Drawing			Original Model		
	Crest	Width	Crest	Width	Invert	Width	Height	Invert	Width	Height
P_015A	152.9	2.5	152.9	2.5	151.87	1.25		151.87	1.25	
P-001A	146.9	3.83	146.9	3.83	143.94	3	1	143.94	2.25	
P-003A	139.5	4	139.5	4	137.4	1.25		137.4	1.25	
P-005A	133.4	5	136.71	5	131.7	0.833	1.667	131.7	1.25	
P-006A	134.2	8.0	135.25	8	129.53	2		129.53	2	
P-007A	133.8	6	133.8	5	130.1	1.83	3	130.1	1.25	
P-010A	135.4	4	135.4	4	133.44	1.67	0.83	133.44	1.25	
P-010A	133.85	4	135.21	3						
P-016A (modified)	138.8	8	140.94	8.5	136.25	2.5		136.25	2.5	
P-017A	135.7	4.5	135.69	3.67	132.6	1		132.6	1	
P-032A	135.2	4	135.2	4						
P-022A	132.6	4.5	132.6	4.5	130.63	2		130.63	2	
P-021A	132.7	4.5	132.7	4.5	130.75	1		130.75	1	
P-013A	133.4	4.83	133.4	4.83	131.7	1.67	0.83	131.7	1.25	
P-014A	140.9	4.5	140.9	3	137.76	1.67	0.83	137.76	1.25	
P-023A	129.8	4.5	130.56	5	127.4	Not available	Not available	127.4	1.25	
P-024A	130.3	4.5	130.3	5	128.2	1.67	0.83	128.2	1.25	
P-025A	128.9	8.58	129.87	8.58	127.07	3	1	127.07	2	
P-026A	129.2	5.5	128.92	5.5	126.95	1.67	0.83	126.95	1.66	0.83
P-027A	131.1	7.11	131.1	4.0	129.6	3.5	1.167	129.6	3.5	2.0
					129.6	3.5	1.167	129.6	3.5	0.0

Regulator Modification

Regulator	Overflow Weir				Regulating Sluice Gate / Orifice					
	Drawing		Original Model		Drawing			Original Model		
	Crest	Width	Crest	Width	Invert	Width	Height	Invert	Width	Height
N-002A (modified, Verona)	110.43	41	103	6	102.65	2.5	2.5	99.33	2	2
N-004A/005A (modified, Herbert PL)	114.34	41	105.55	6.667	107.06	2	2	103.6	1.5	1.5
N-008A	103.5	6	103.5	6	100.7	1.5	1.5	100.7	1.5	1.5
N-009A	103.24	4	103.24	4	102.4	1.66	0.83	102.4	1.66	0.83
N-010A	105.12	8.42	105.12	8.42	101.24	6	3	101.24	6	3
	105.12	8.42	105.12	8.42	101.24	6	3	101.24	6	3
	105.12	8.42	105.12	8.42						
N-014A (modified, Rector)	102.56	5.5	103.66	5.5	99.97	1.5	1.5	101.07	1.5	1.5
N-014A (modified, Saybrook)	102.33	7	103.43	7	99.02	2	2	100.12	2	2
N-015A (modified)	98.67	14	98.67	14	95.67	3.5	2.5	95.67	3.5	2.5
N-016A	97.62	7	97.62	4.5	96	1.5	1.5	96	1.33	1.33
N-017A	97.8	8	97.8	7	95.2	1.5	1.5	95.35	1.33	1.33
N-018A	100.26	4	100.26	4	99	2	2	99	2	2
N-022A	98.93	6	98.93	6						
N-027A/029A	102	4.5	102	4.5	96.4	4	2.33	96.4	4	2.33
N-025A	98.6+	6	98.6	8	93	4	2.33	93	4	2.33
	98.6+	8	98.6	8						
	105.85	5	98.6	8						
	105.85	5	98.6	8						
N-030A	102.32	10	102.32	10	99.04	4	3	99.04	4	3
N-023A	98.54	7	98.54	7						

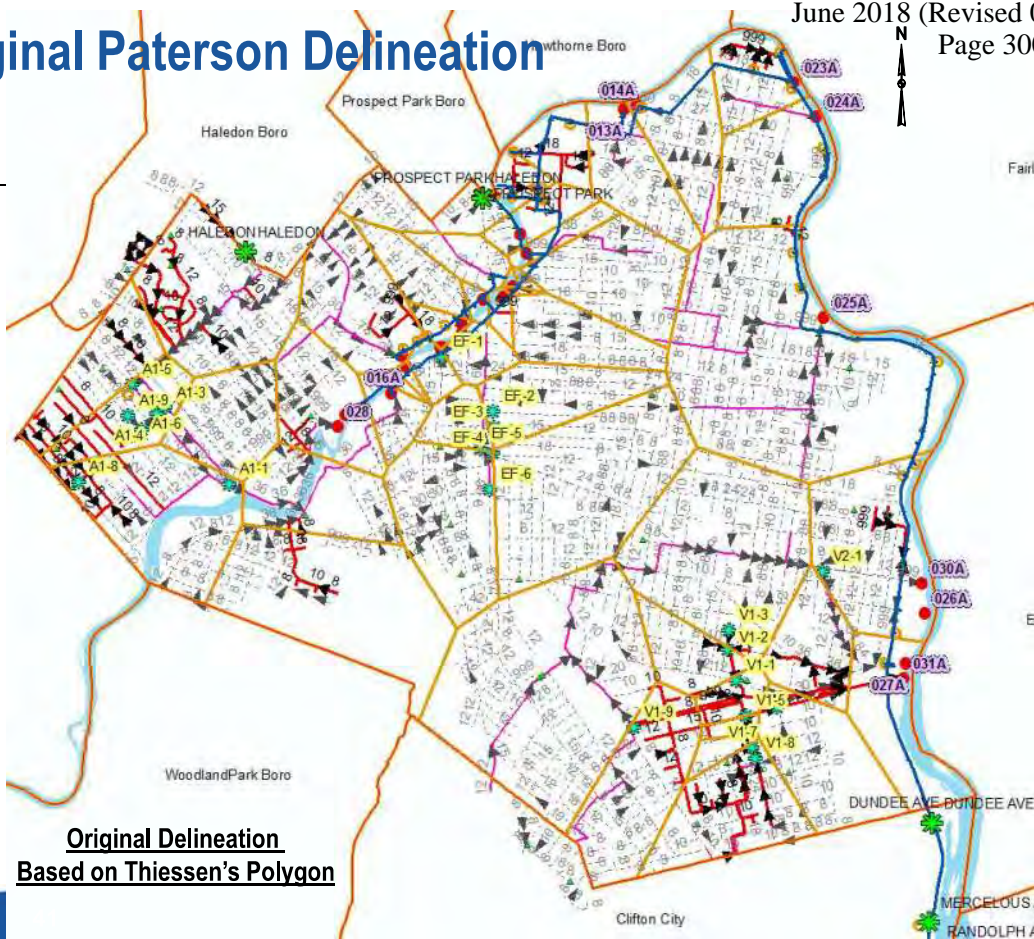
Regulator Modification

Regulator	Overflow Weir				Regulating Sluice Gate / Orifice					
	Drawing		Original Model		Drawing			Original Model		
	Crest	Width	Crest	Width	Invert	Width	Height	Invert	Width	Height
K-001A	120.85	4.5	120.27	1.5	119.07	1		119	1	
K-004A	107.9	1.5	108	1.5	106.9	1		107	1	
K-006A	99.9	5	100.9	10	98.7	1.5		98.2	1.5	
	100.1	5								
K-007A	103	9	103	9	100.2	3	1	100.2	3	1
K-010A	102.5	4	102.5	4.5	98.84	1	1	100.45	1	
E-001A	101.6	4	101.6	4	99.2	1.25		99.2	1.25	
H-001A	101.2	4	101.2	4	99.8	1.25		99.8	1	
H-002A	102.2	4	102.2	4	101	1		101.2	1	
H-003A	103.9	4	103.9	4	101.4	1.25		101.4	1.25	
H-004A	102.2	4	102.2	3.5	100.58	1		100.58	1	
H-005A	100.8	3.5	100.8	3.5	99.1	1		99.1	1	
H-006A	99.9	4	99.9	4	97.9	1		97.9	1	
H-007A	102.4	4.5	102.4	4.5	101.2	1		101.2	1	



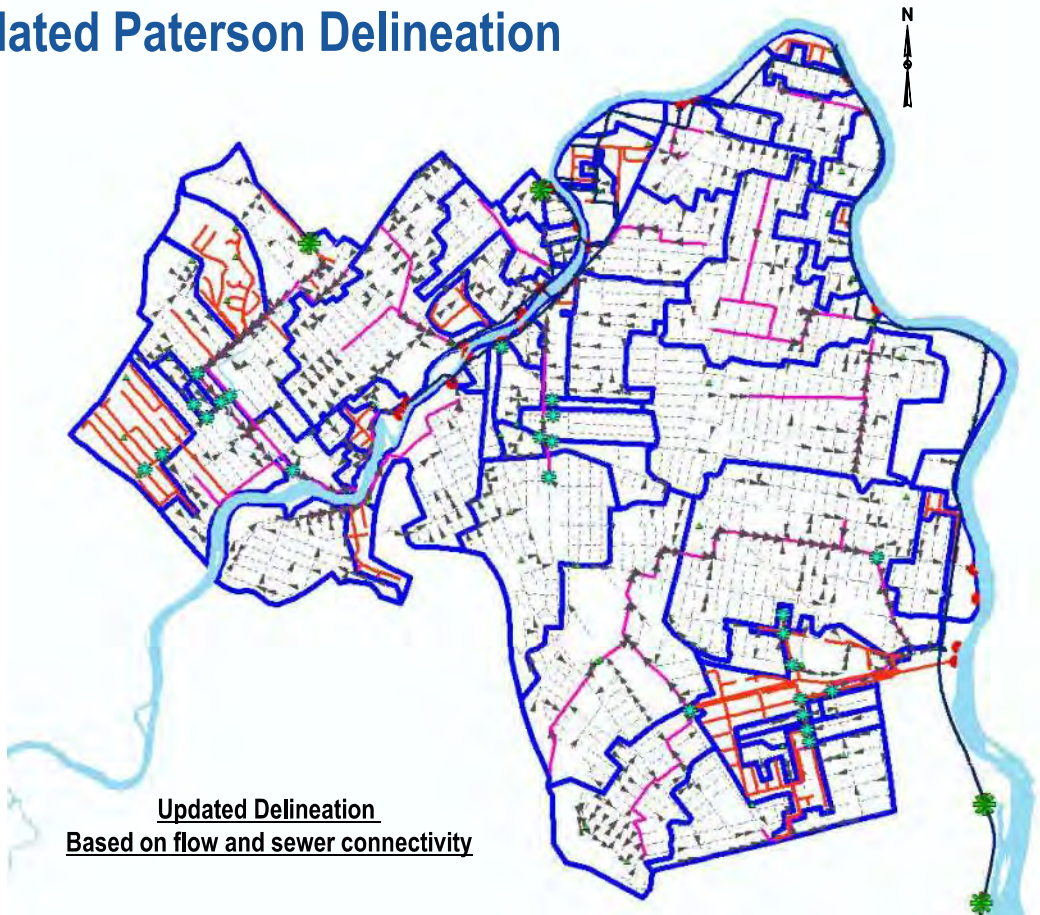
Paterson Update

Original Paterson Delineation



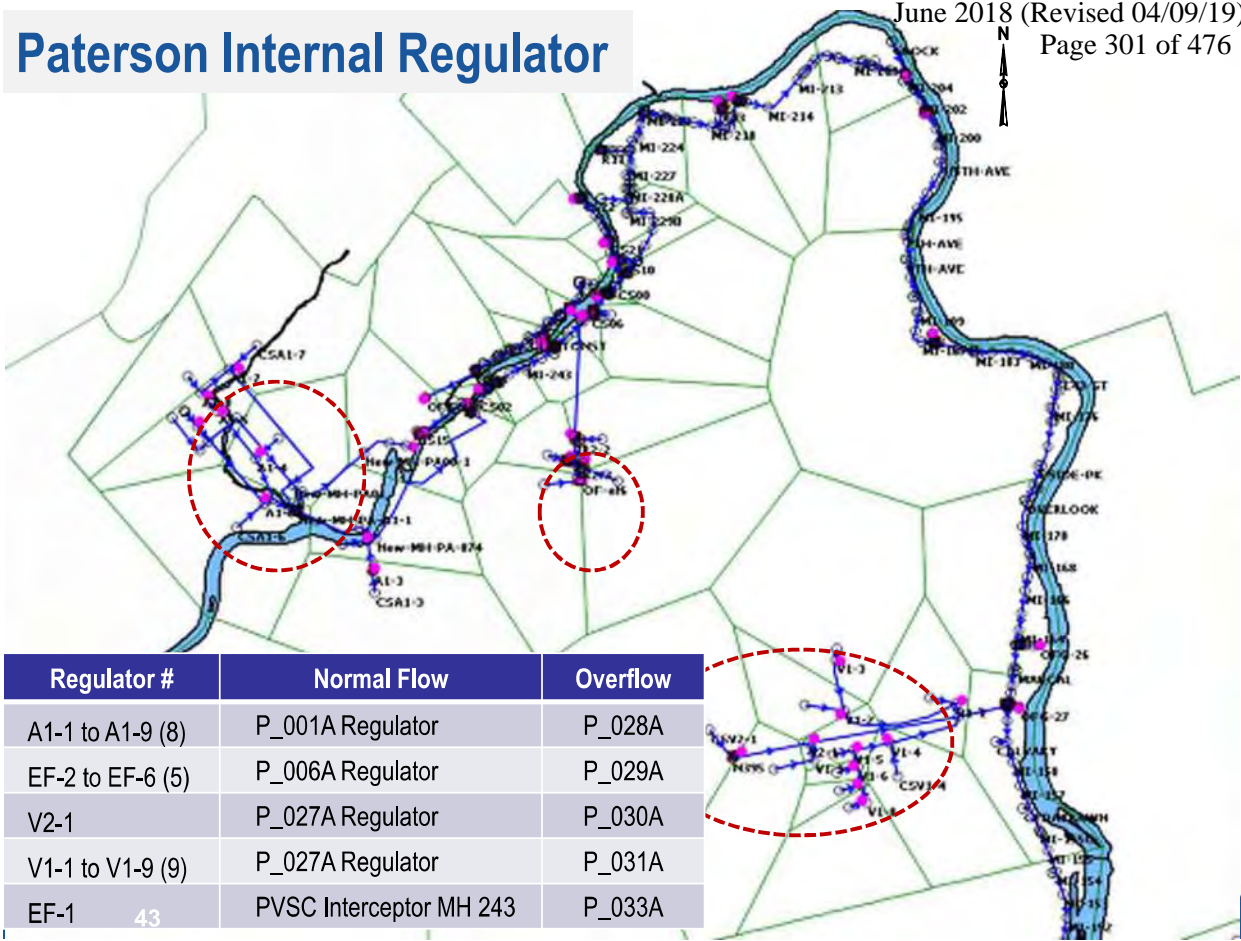
Original Delineation
Based on Thiessen's Polygon

Updated Paterson Delineation

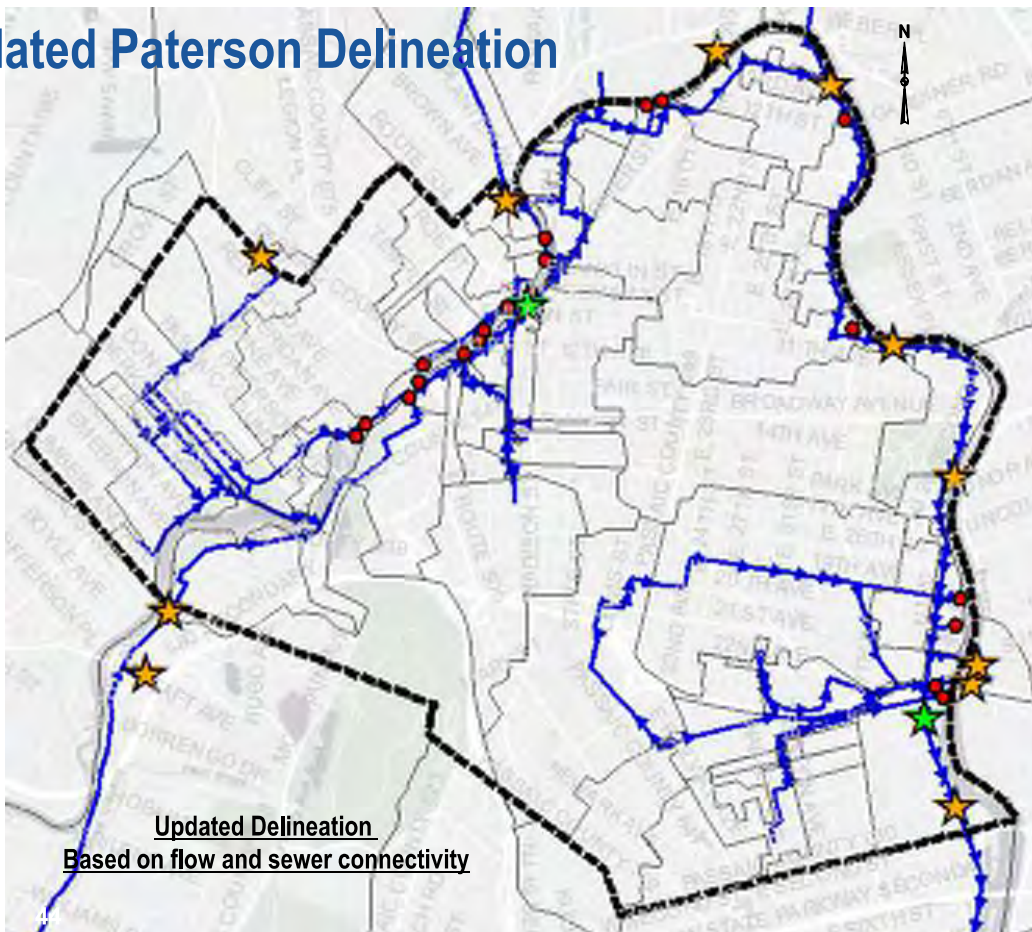


Updated Delineation
Based on flow and sewer connectivity

Paterson Internal Regulator



Updated Paterson Delineation



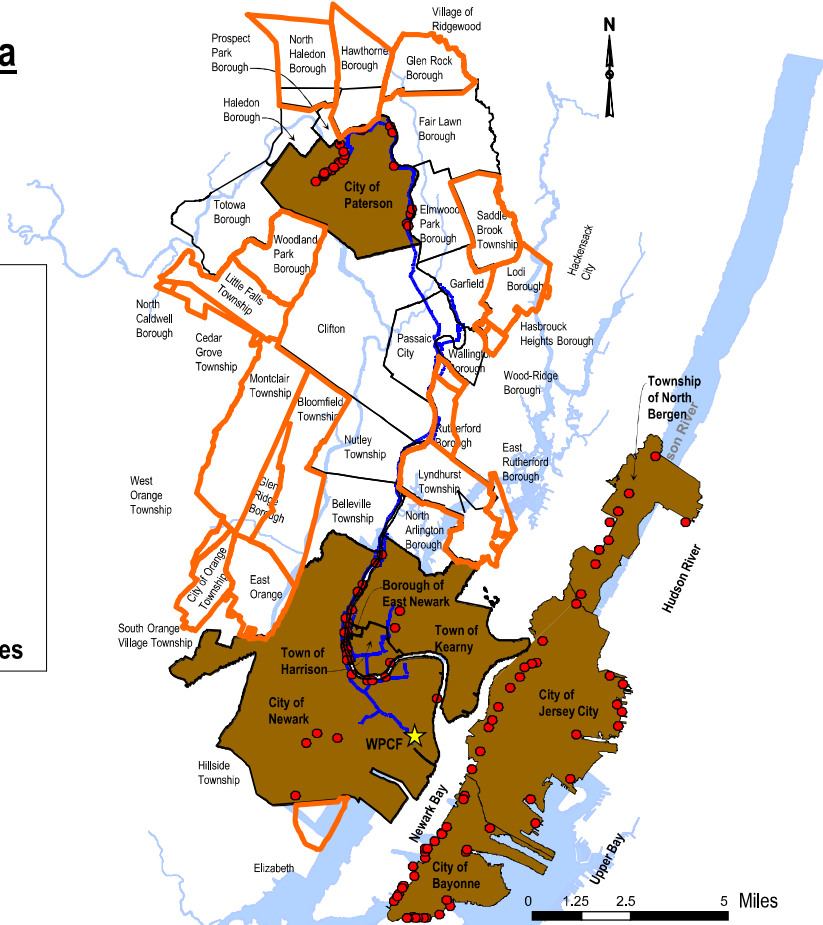


Separated Service Area

Separated Service Area Added to the Model

Legend

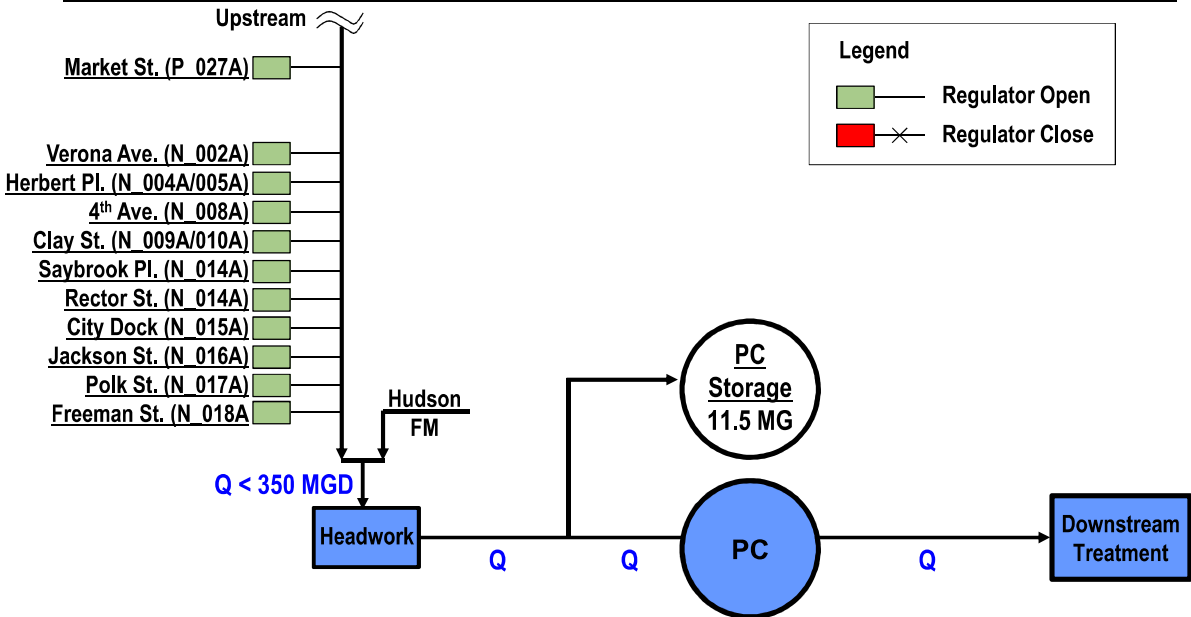
-  PVSC Service Area
-  CSO Communities
-  Separated Communities
-  PVSC WPCF (Water Pollution Control Facility)
-  PVSC Interceptor / Sewer
-  CSO Outfall
-  Added Separated Communities





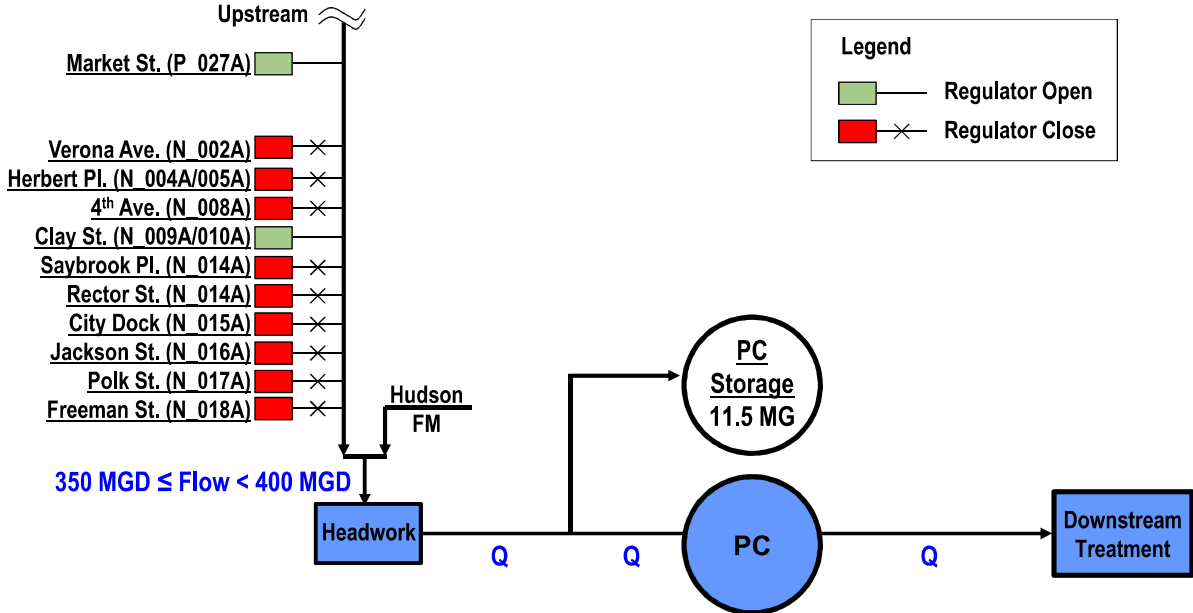
Wet Weather Operating Rules

Wet Weather SOP Flow < 350 MGD



Wet Weather SOP

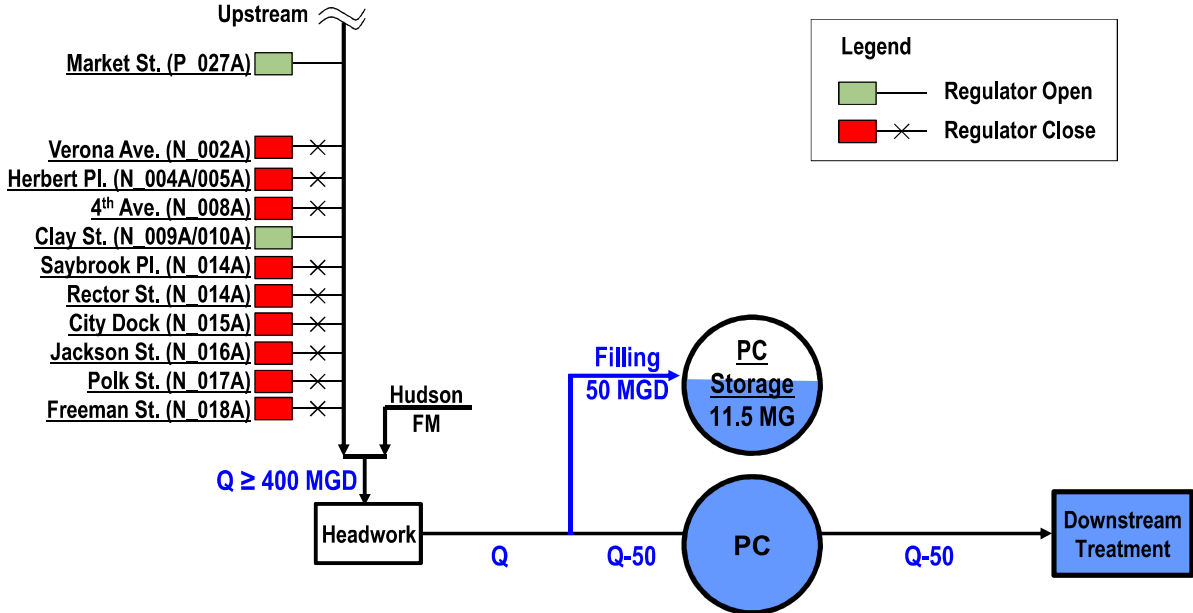
350 MGD ≤ Flow < 400 MGD



Note: During 10/7/15 to 7/7/16, CSOs were put in use at plant flow 400 MGD.

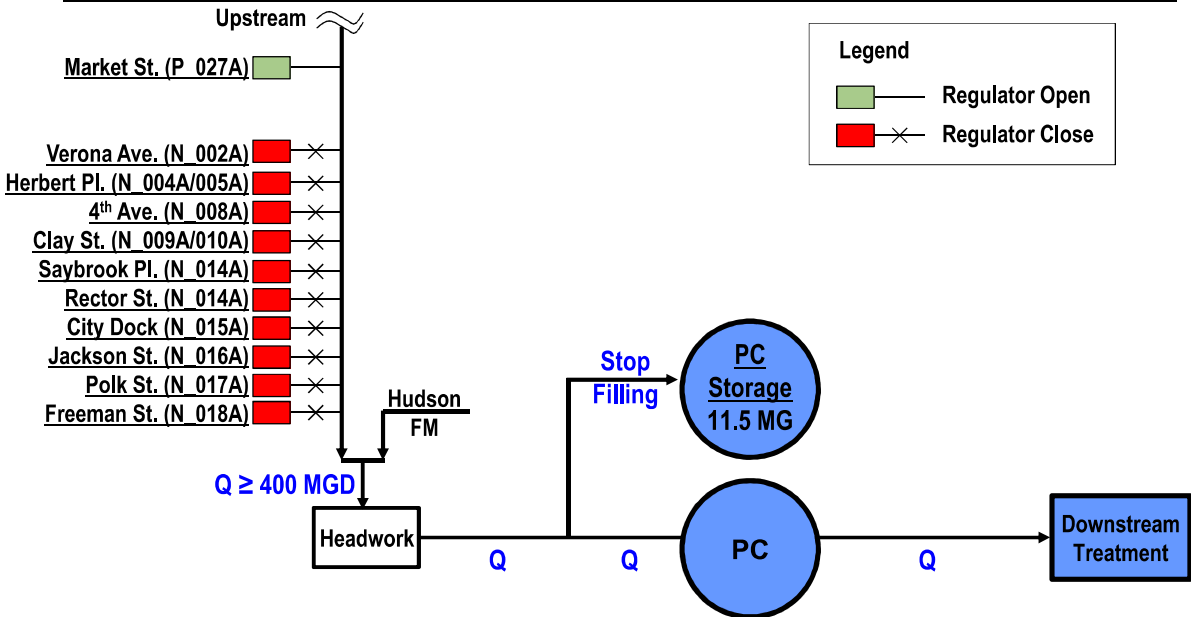
Wet Weather SOP

Flow ≥ 400 MGD



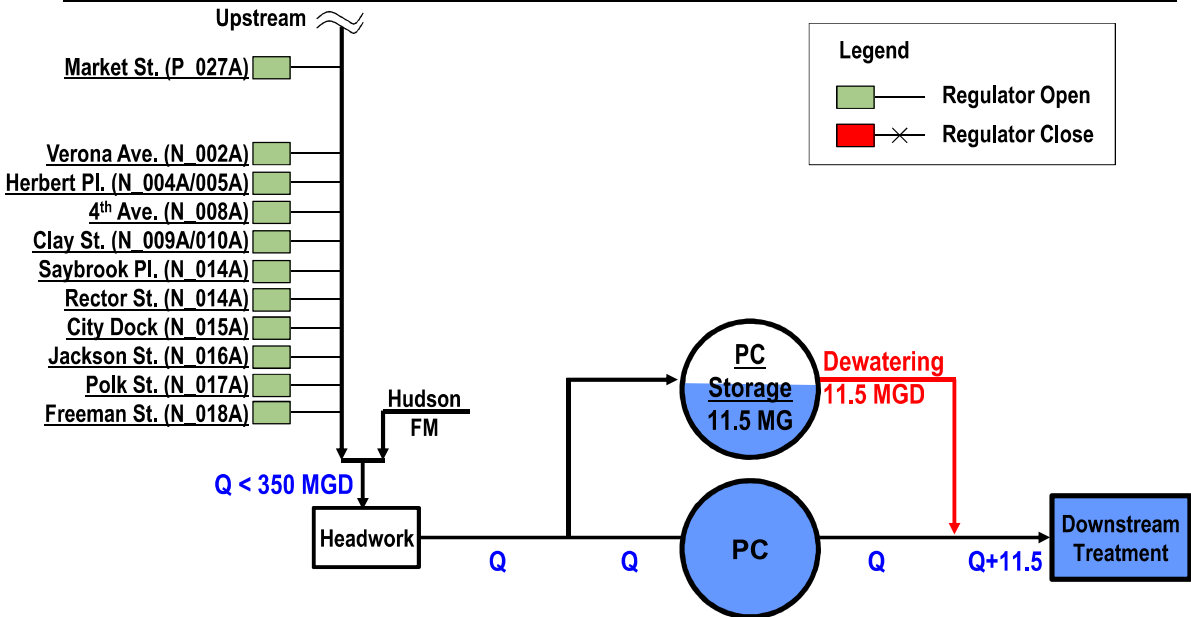
Wet Weather SOP

Flow ≥ 400 MGD, & Storage Full



Wet Weather SOP

Flow Drops to 350 MGD



Bayonne Real Time Control Rule Update

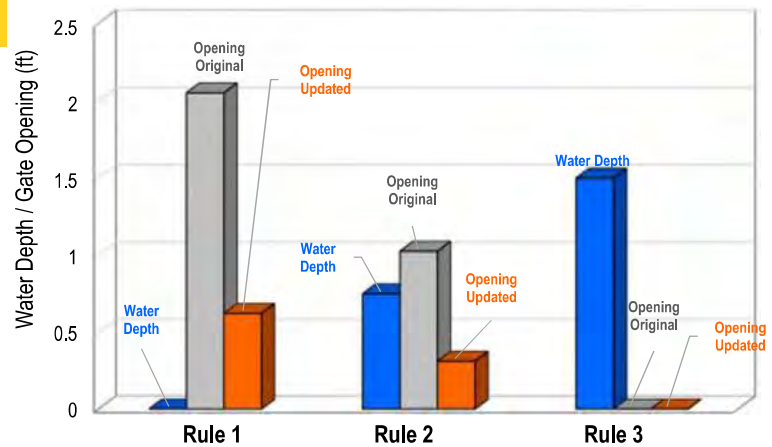
एक फुट = 0.3048 मीटर
एक मीटर = 3.28 फुट

Original RTC Closing Table		
	Input ft	Output
Rule 1	0	0.625
Rule 2	0.751	0.313
Rule 3	1.499	0



Updated RTC Closing Table		
	Input ft	Output
Rule 1	0	0.190
Rule 2	0.751	0.095
Rule 3	1.499	0

Comparison of Original and Updated Sluice Gate Opening

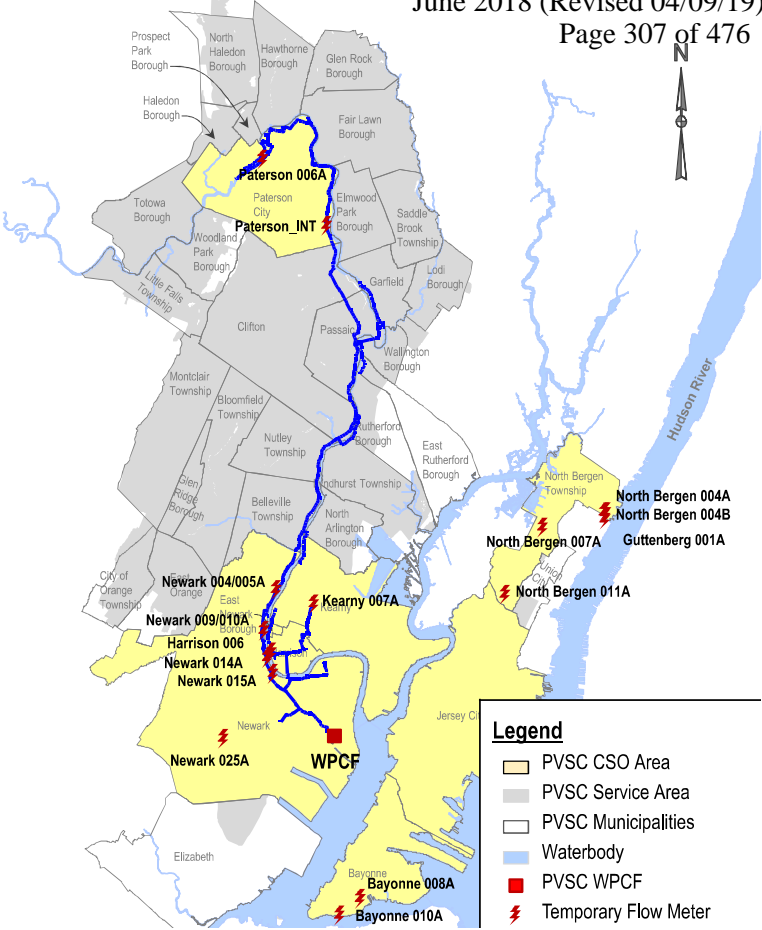


PVSC H&H Model Calibration and Validation

Temporary Flow Meter

21 Flow Meters

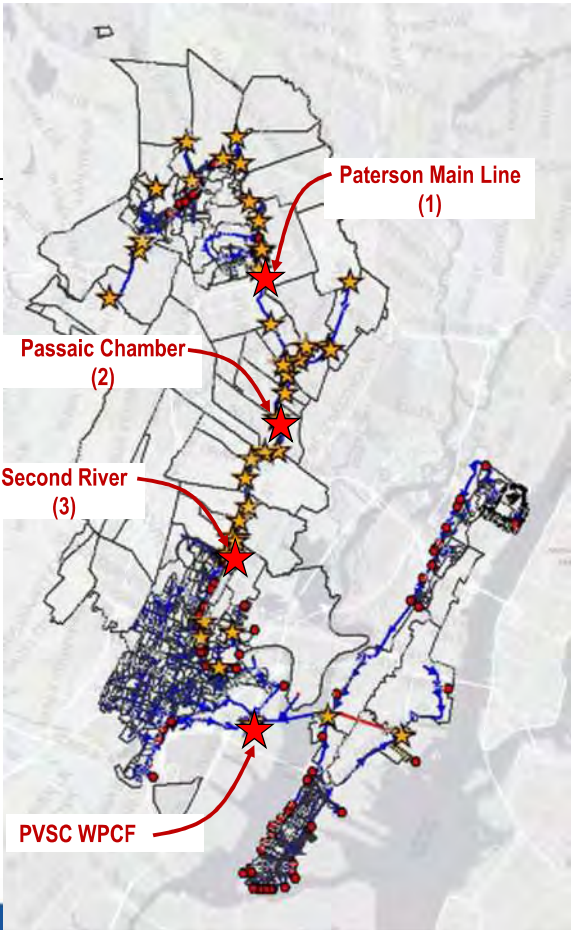
- 13 outfall pipe
- 5 regulator influent
- 2 regulator effluent
- 1 interceptor



PVSC Permanent Flow Meters

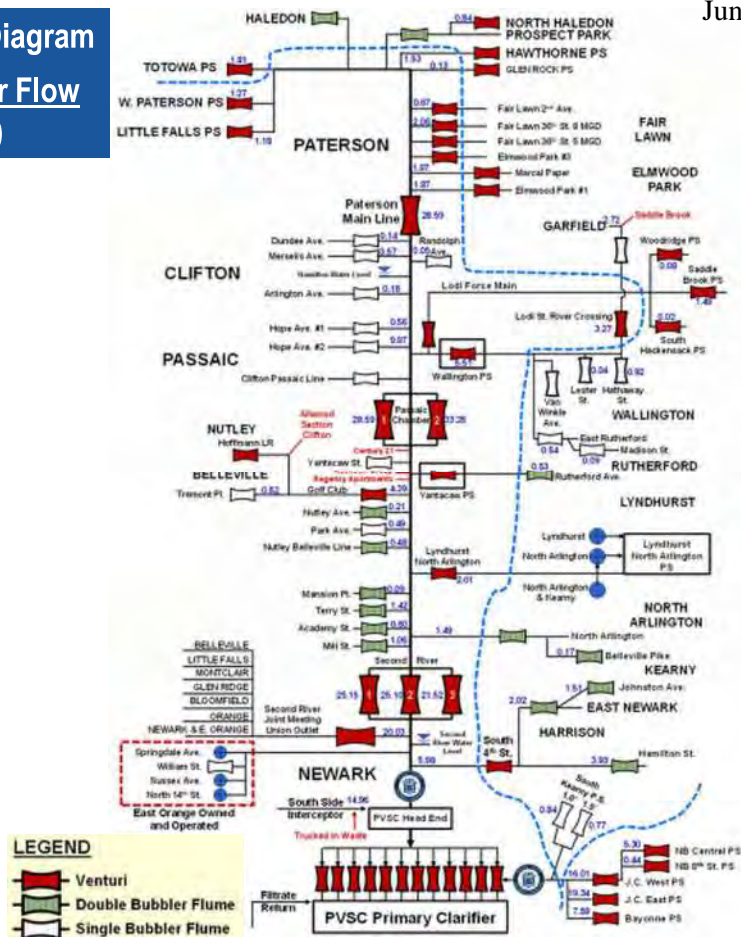
Over 70 Flow Meters, 55 was analyzed for DWF and model calibration

- PVSC Interceptor: 6
- Pump Station: 6
- Combined area: 5
- Separated Area: 38

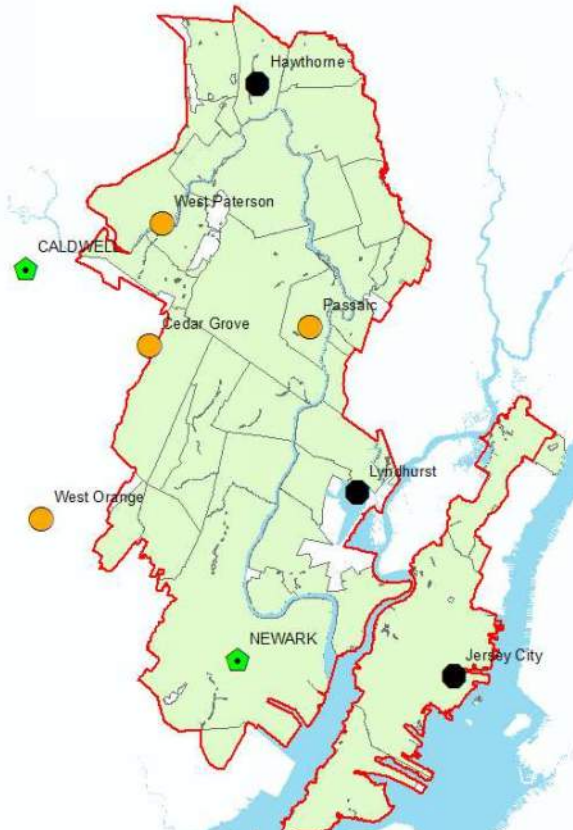


Flow Meter Diagram

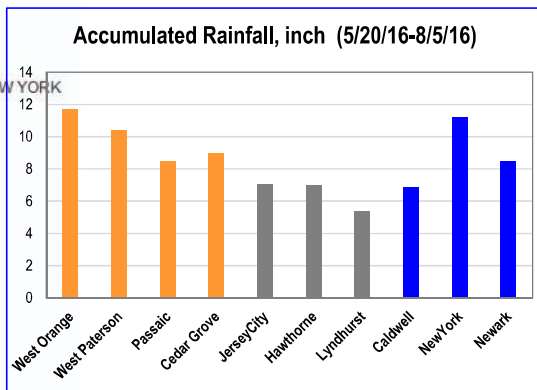
Dry Weather Flow (MGD)



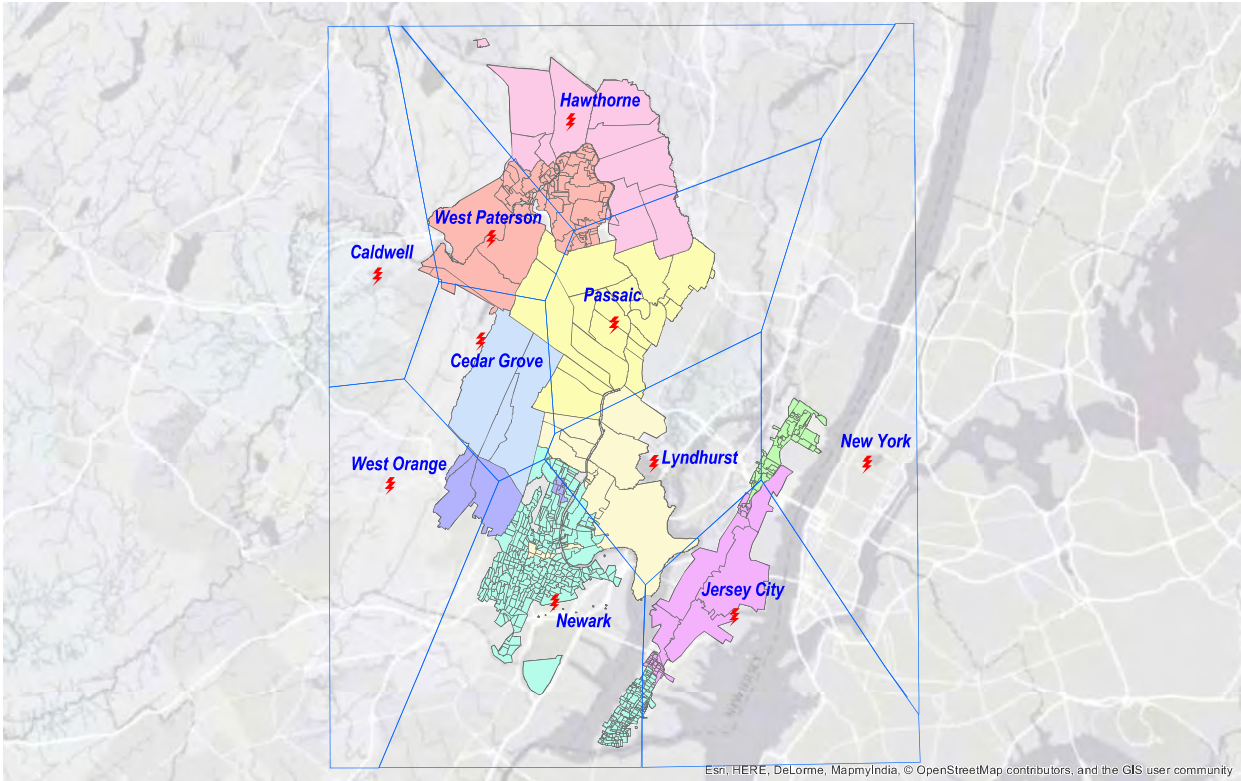
Rainfall Stations



Rain Gauge Summary			
Source	RG ID	Data Time Interval (Min.)	Total Rainfall (5/20/16-8/05/16)
NJ Weather	Hawthorne	5	6.97
NJ Weather	Lyndhurst	5	5.39
NJ Weather	jersey City	5	7.04
CWOP	West Paterson	30	10.4
CWOP	Passaic	15	8.46
CWOP	Cedar Grove	10-50	8.98
CWOP	West Orange	10	11.72
NWS ASOS	Caldwell	1	6.84
NWS ASOS	New York	1	11.23
NWS ASOS	Newark	1	8.47



Rainfall Station Assignment



Candidate Storm Events for Calibration
Rainfall Based on Newark

Rain Start	Rain End	Duration (hr)	Depth (in)	Max Intensity (in/hr)	Average Intensity (in/hr)
7/25/16 16:05	7/25/16 18:50	2.75	1.81	1.68	0.66
5/29/16 23:50	5/30/16 5:20	5.50	1.6	1.09	0.29
7/29/16 0:20	7/29/16 8:35	8.25	0.85	0.42	0.10
5/2/16 22:40	5/3/16 9:50	11.17	0.7	0.17	0.06
7/31/16 8:35	7/31/16 22:35	14.00	0.69	0.49	0.05
7/4/16 19:20	7/5/16 2:50	7.50	0.63	0.23	0.08
5/6/16 2:30	5/6/16 12:25	9.92	0.6	0.19	0.06
7/16/16 14:50	7/16/16 15:35	0.75	0.56	0.75	0.75
6/8/16 11:25	6/8/16 14:10	2.75	0.49	0.3	0.18
7/9/16 21:30	7/9/16 22:05	0.58	0.48	0.82	0.82
4/4/16 7:45	4/4/16 17:00	9.25	0.43	0.12	0.05

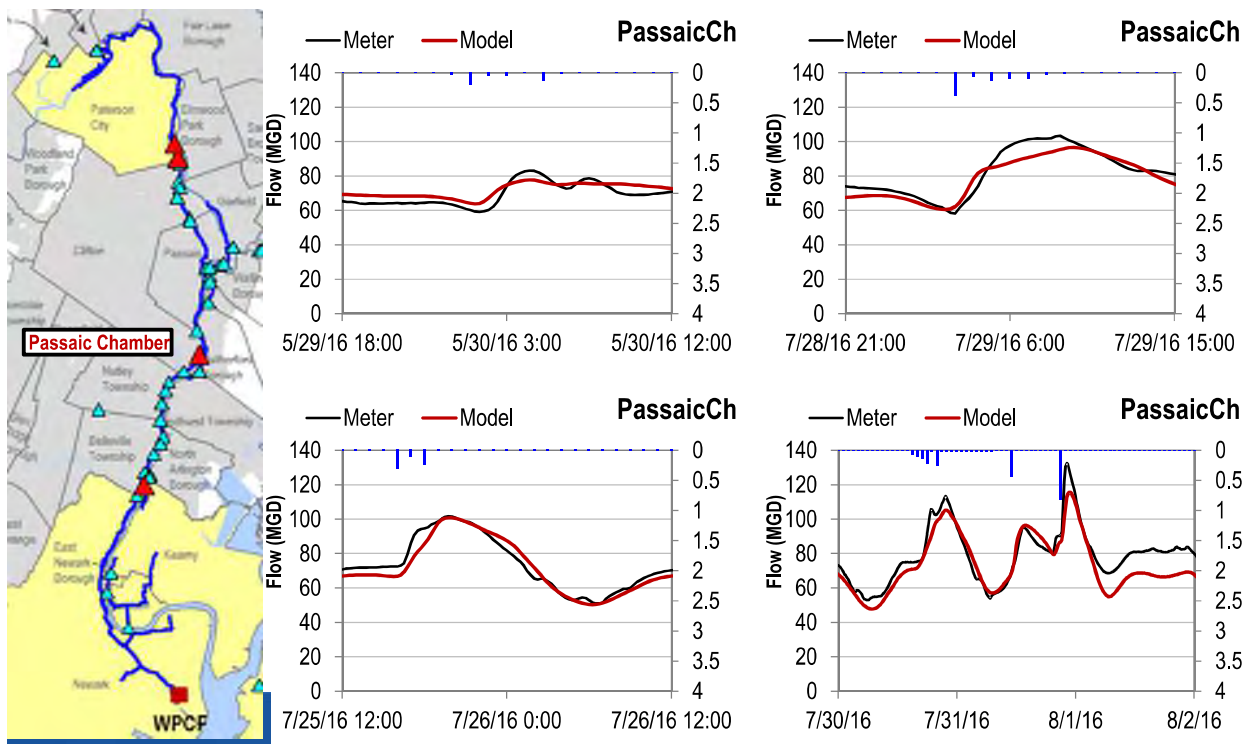
Model Calibration and Validation Goals

- **Visual match**
- **+/- 20% volume and**
- **+25%/-15% peak**

Major Interceptor

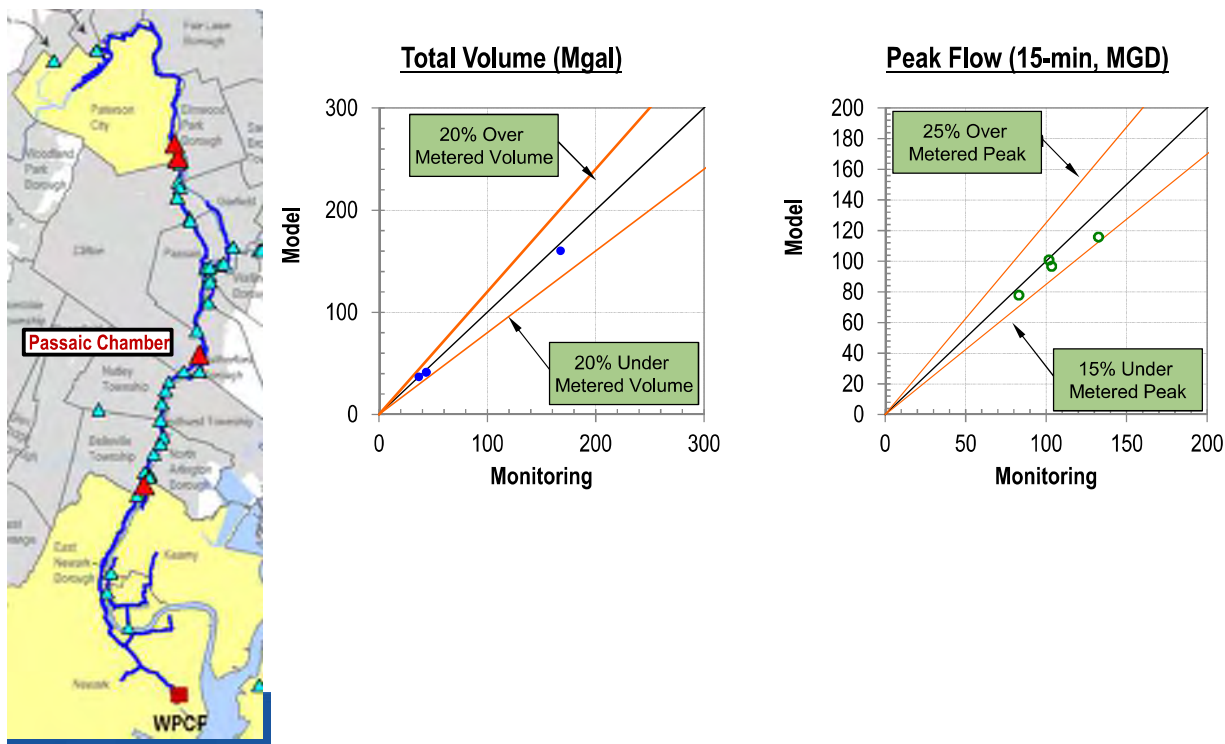
Calibration Results – Main Interceptor

Passaic Chamber



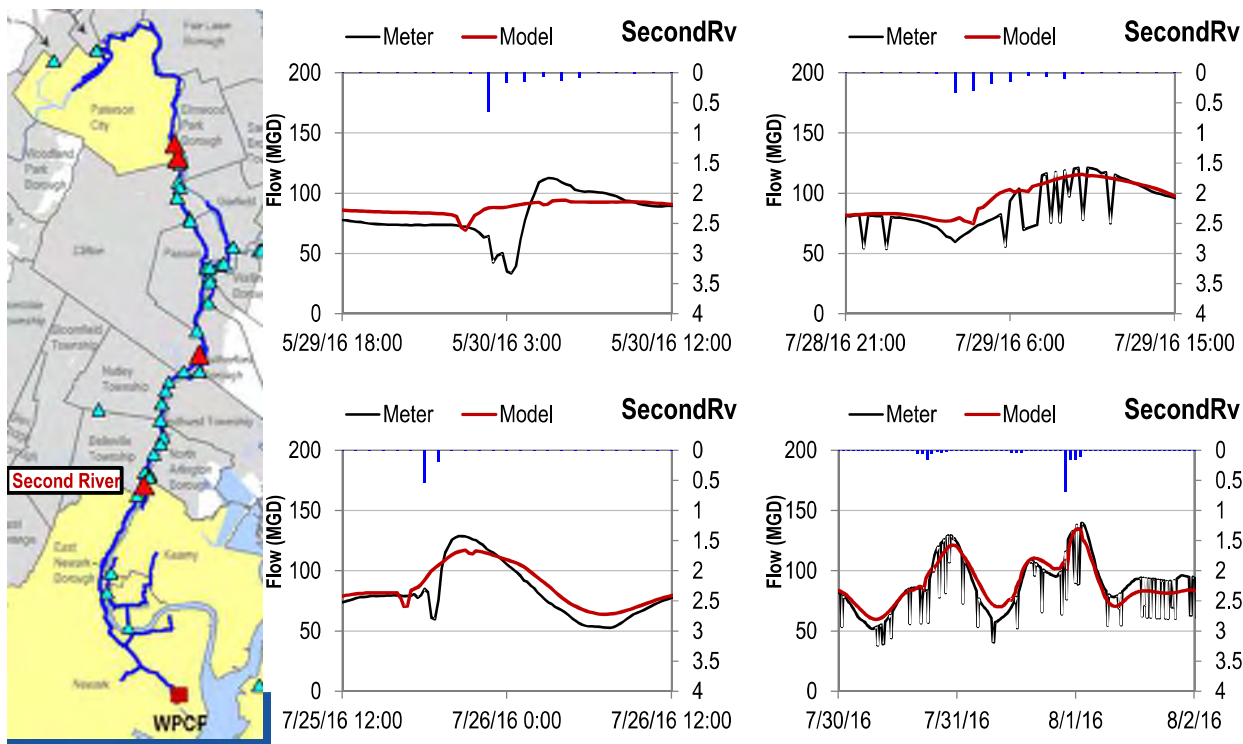
Calibration Results – Main Interceptor

Passaic Chamber: Goodness-of-Fit



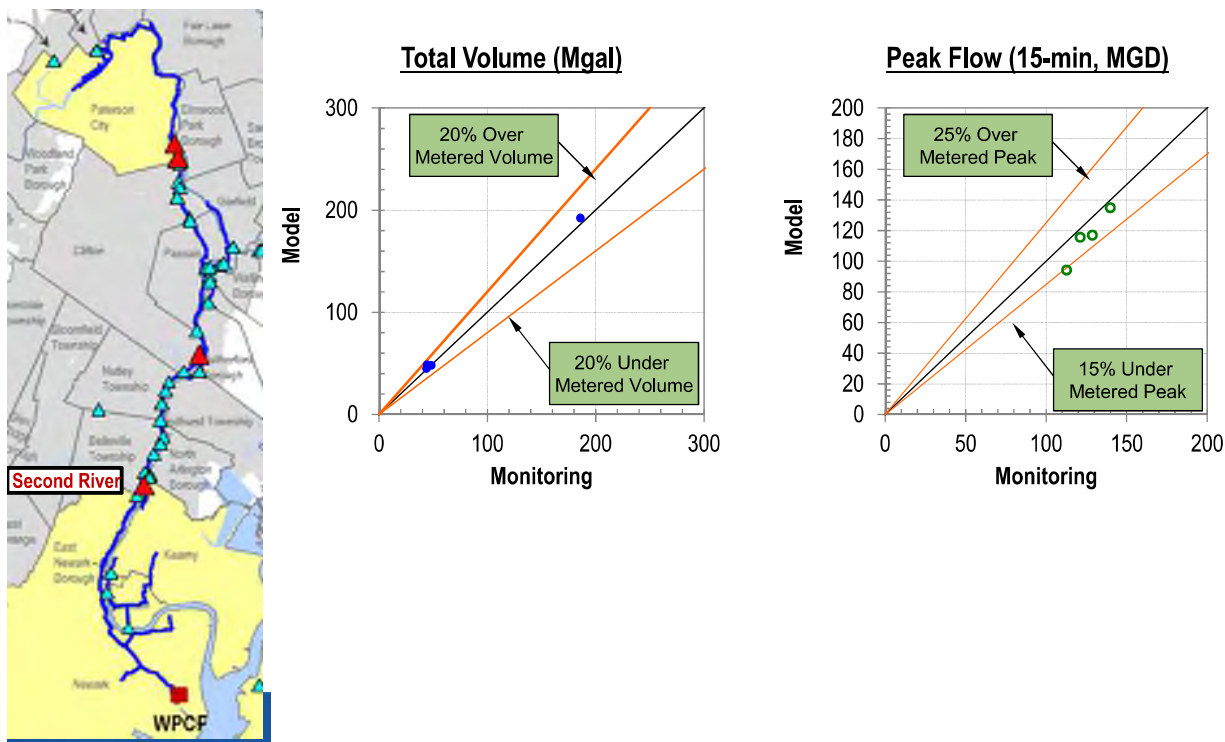
Calibration Results – Main Interceptor

Second River Crossing



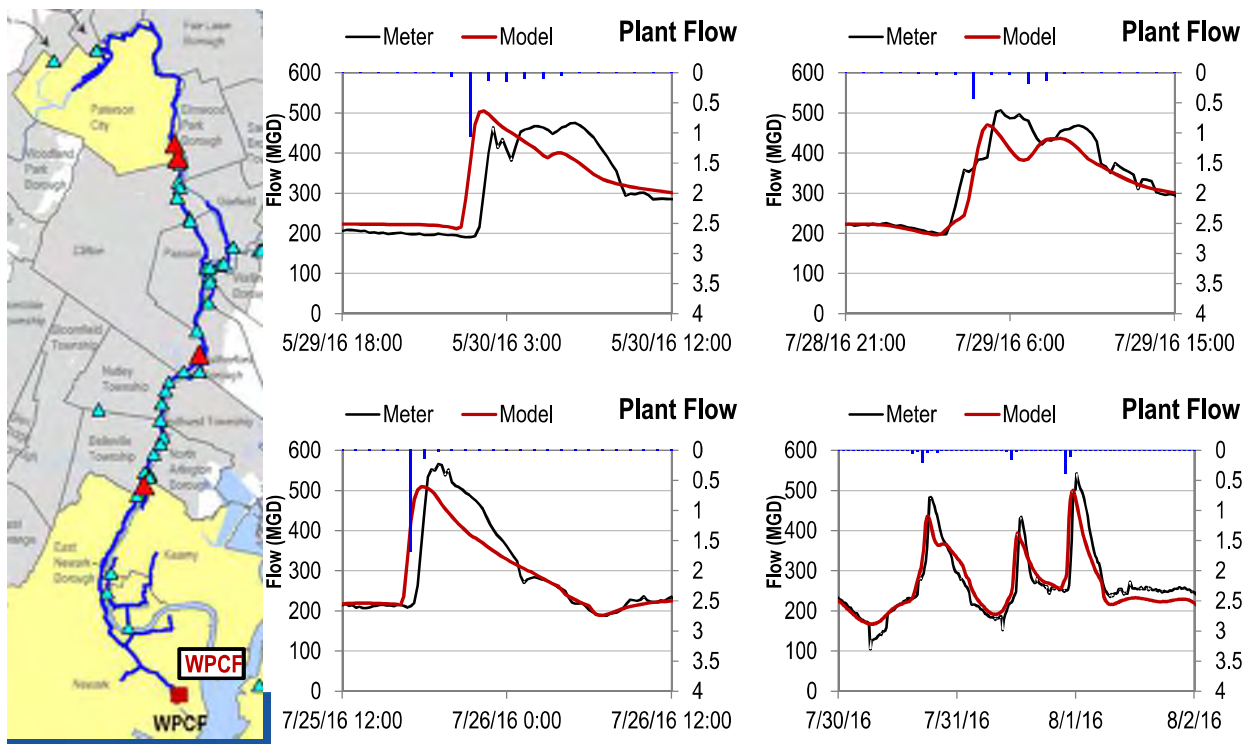
Calibration Results – Main Interceptor

Second River Crossing: Goodness-of-Fit



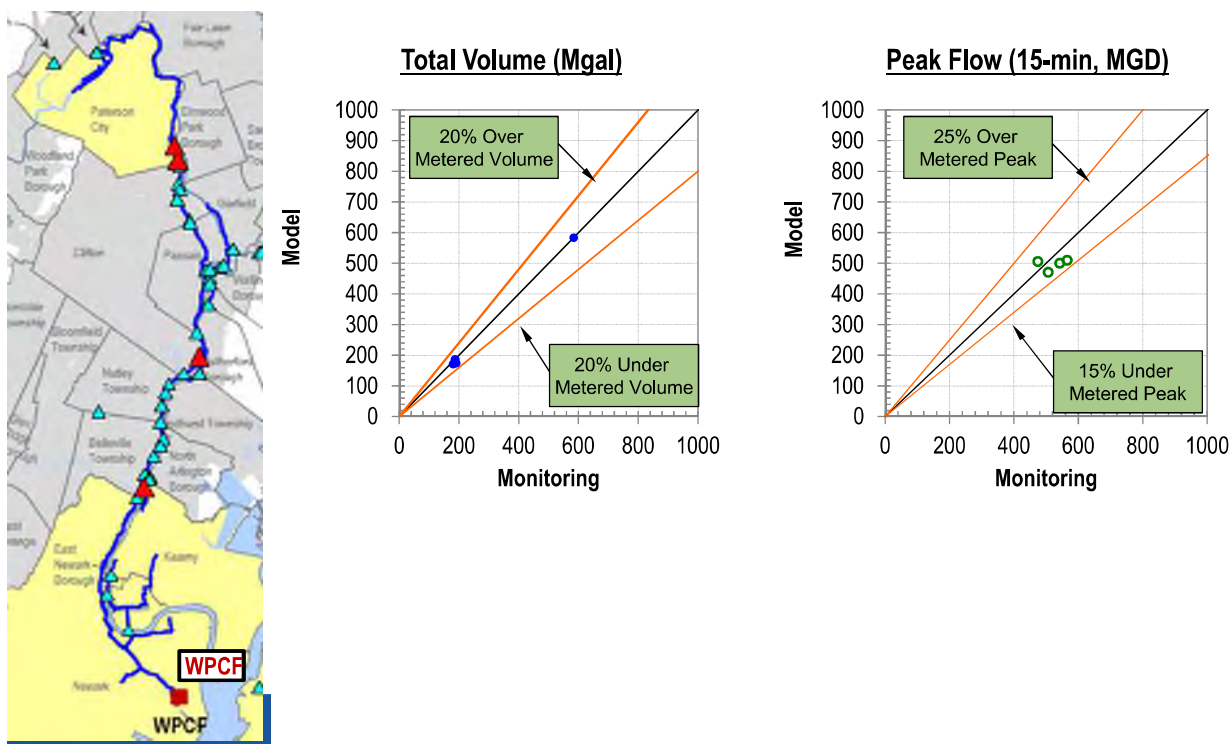
Calibration Results – Main Interceptor

PVSC WPCF



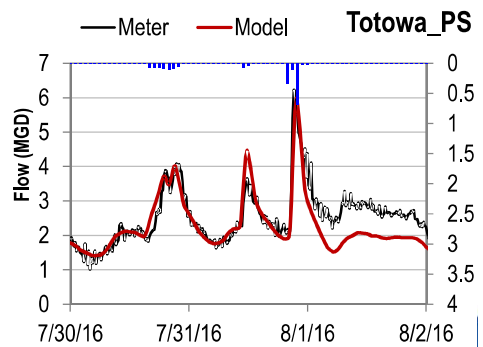
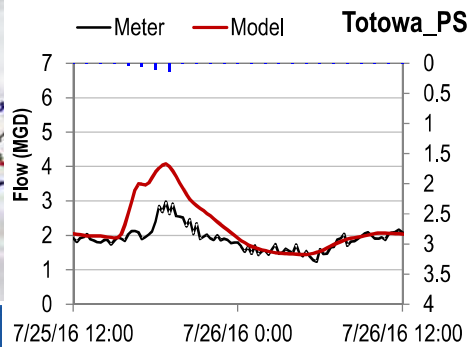
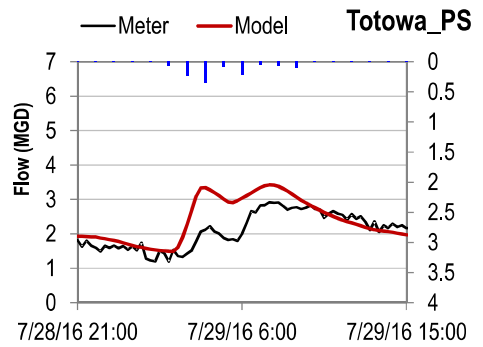
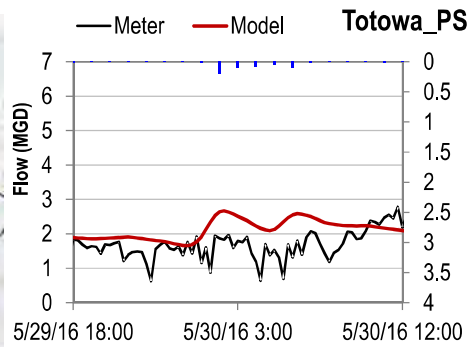
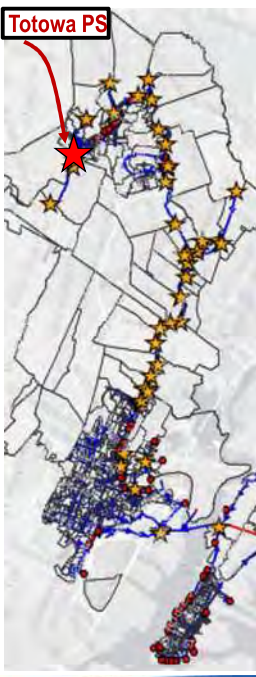
Calibration Results – Main Interceptor

PVSC WPCF: Goodness-of-Fit



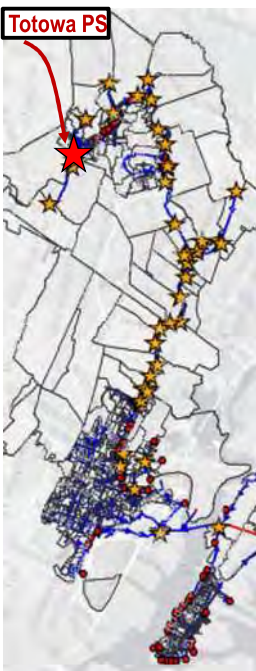
Separated Area

Calibration Results – Separated Area *Totowa PS*



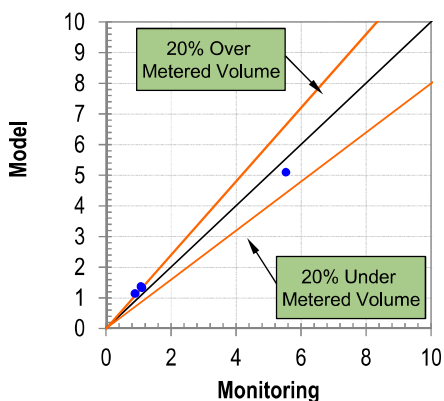
Calibration Results – Separated Area

Totowa PS: Goodness-of-Fit

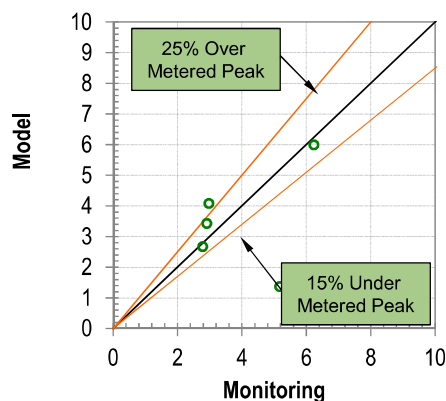


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Total Volume (Mgal)

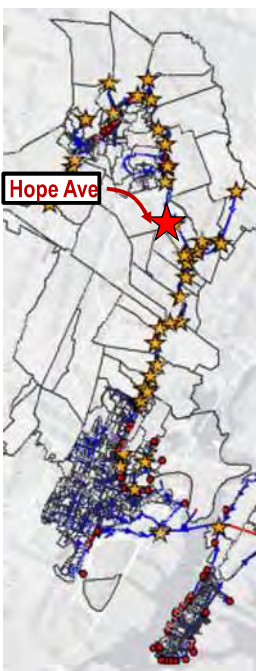


Peak Flow (15-min, MGD)

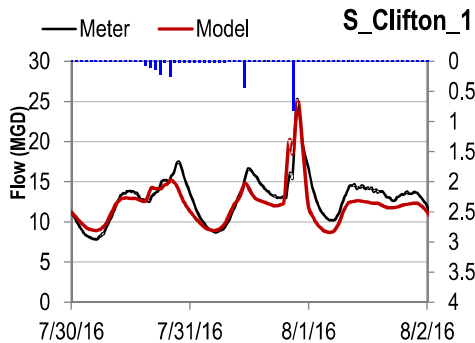
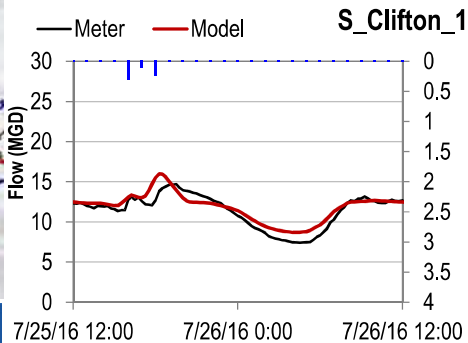
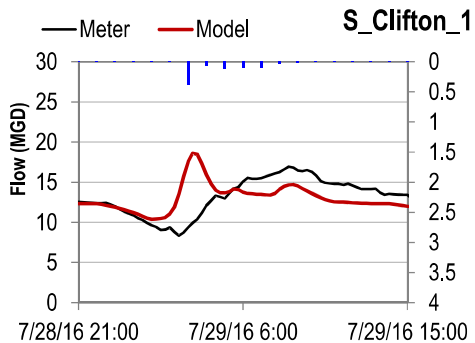
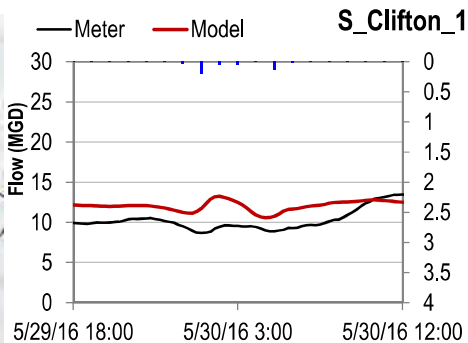


Calibration Results – Separated Area

Hope Ave

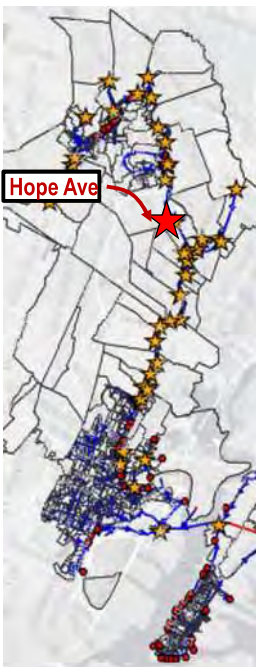


74

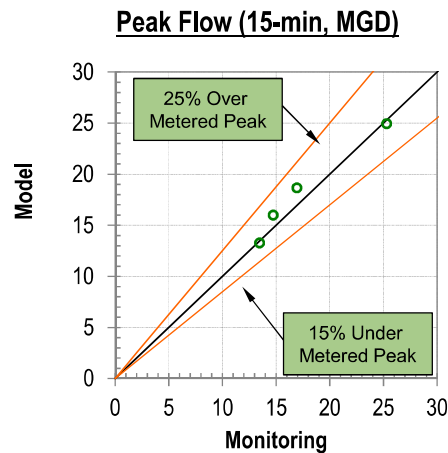
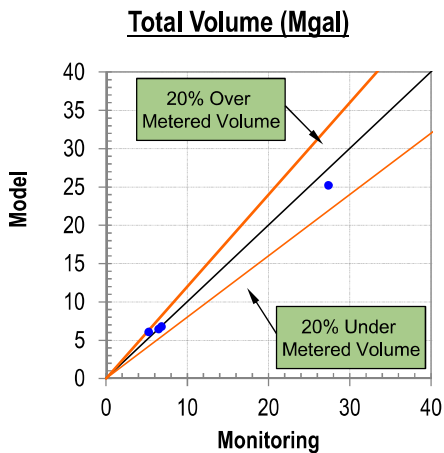


Calibration Results – Separated Area

Hope Ave: Goodness-of-Fit

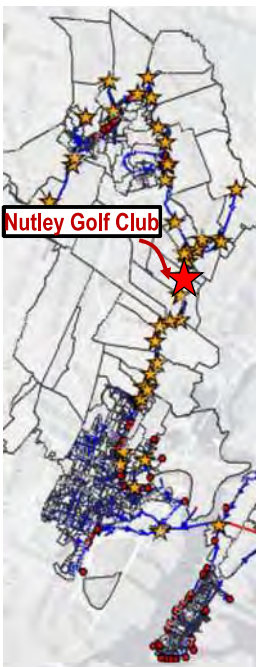


75

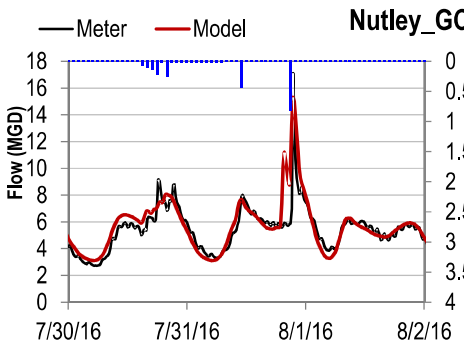
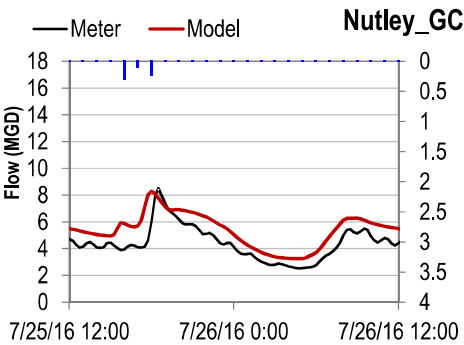
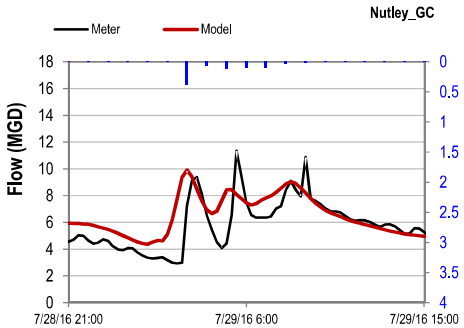
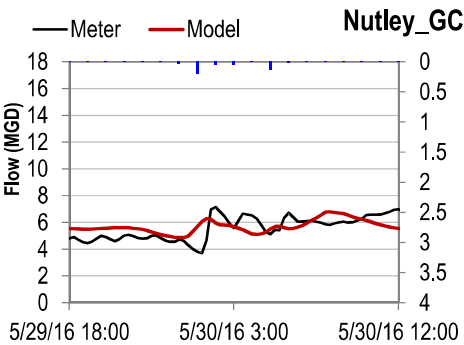


Calibration Results – Separated Area

Nutley Golf Club

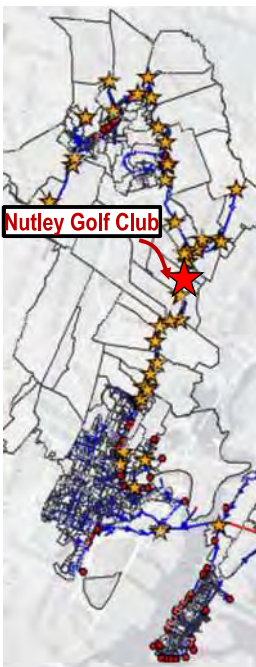


76



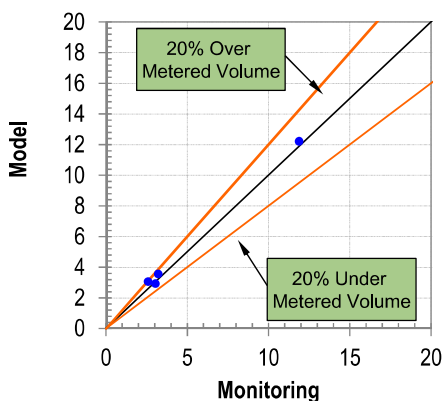
Calibration Results – Separated Area

Nutley Golf Club: Goodness-of-Fit

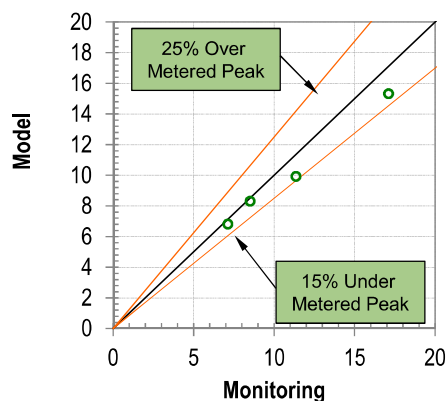


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Total Volume (Mgal)

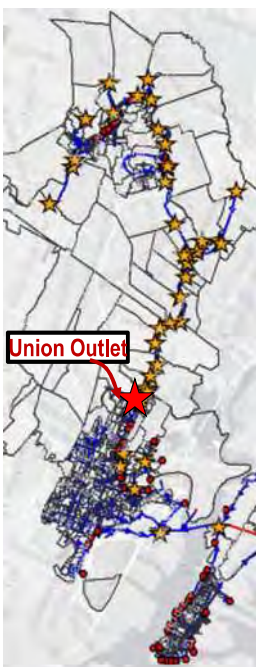


Peak Flow (15-min, MGD)

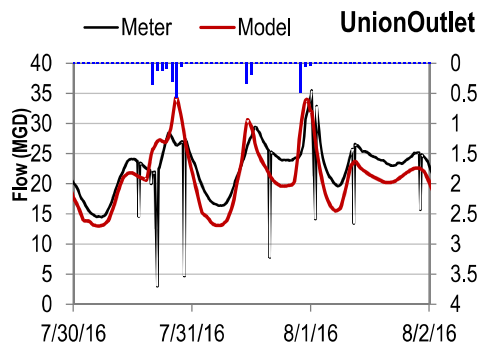
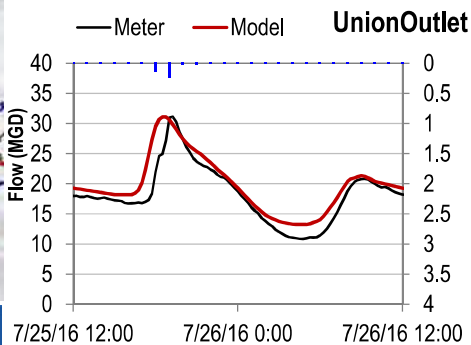
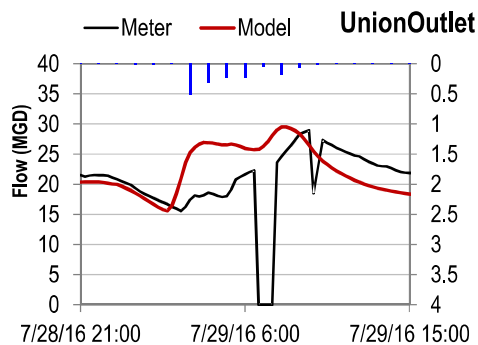
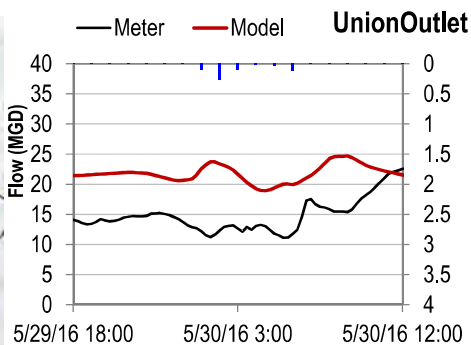


Calibration Results – Separated Area

Union Outlet

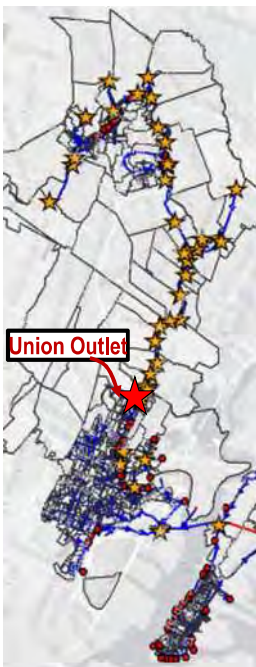


78



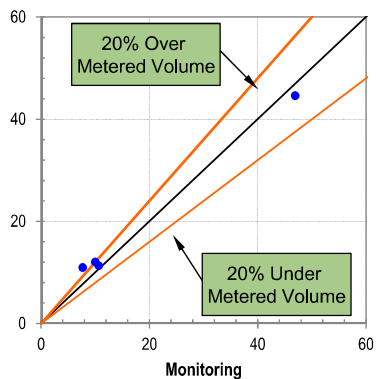
Calibration Results – Separated Area

Union Outlet

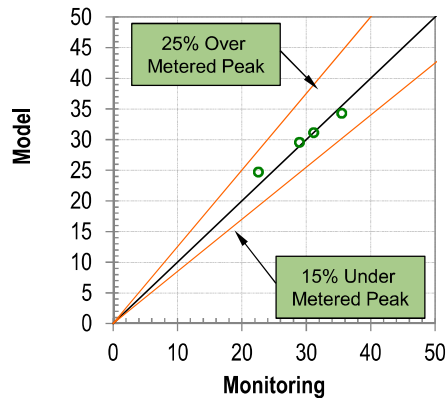


79

Total Volume (Mgal)



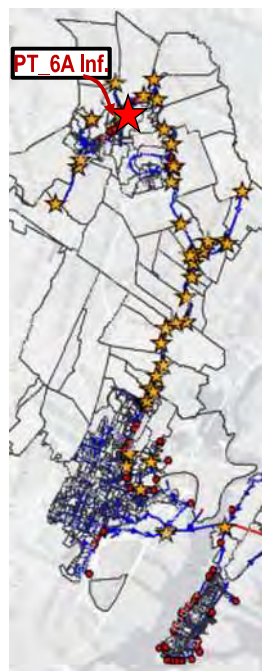
Peak Flow (15-min, MGD)



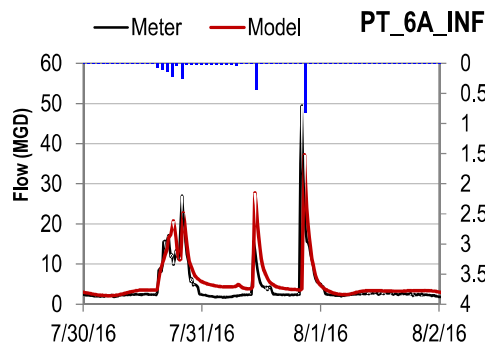
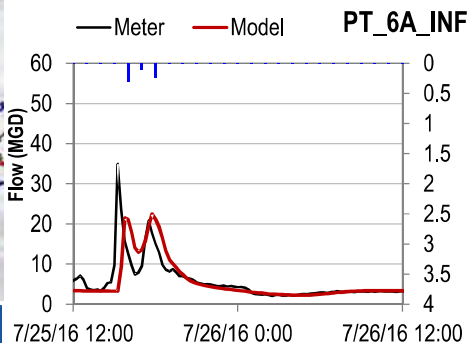
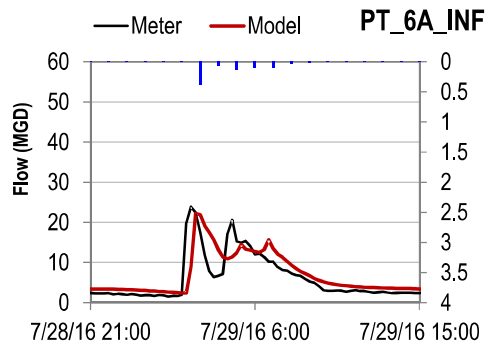
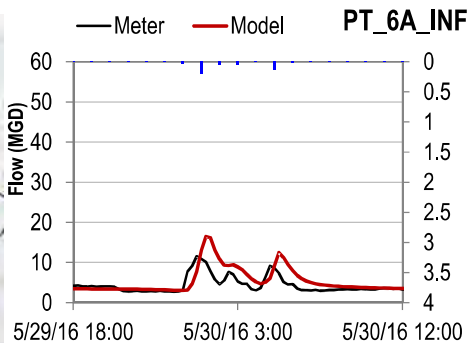
Combined Area

Calibration Results – Combined Area

Paterson 6A Influent



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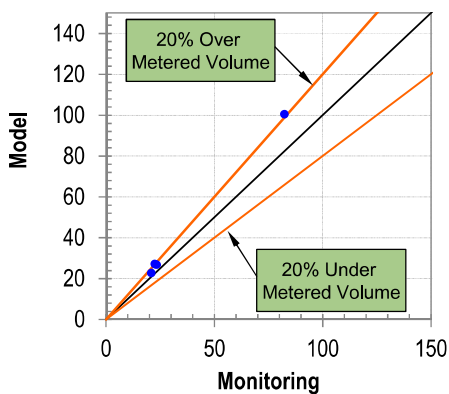
Calibration Results – Combined Area

Paterson 6A Influent

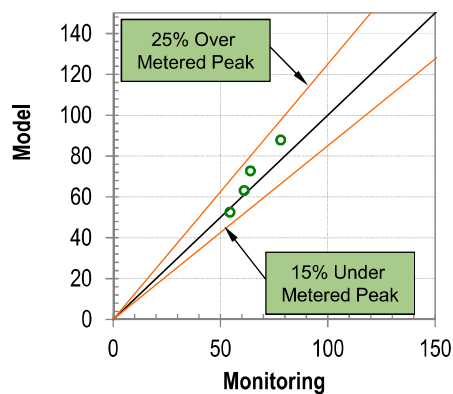


82

Total Volume (Mgal)

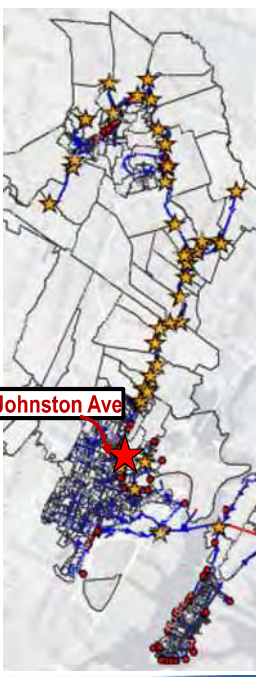


Peak Flow (15-min, MGD)

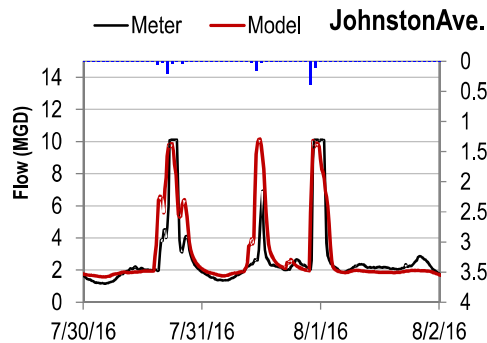
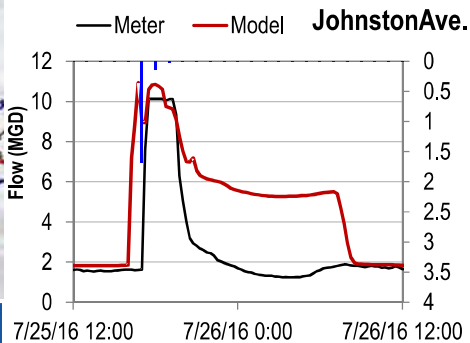
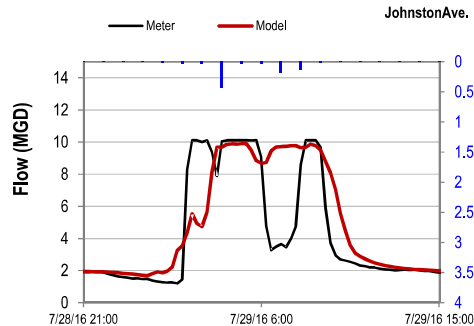
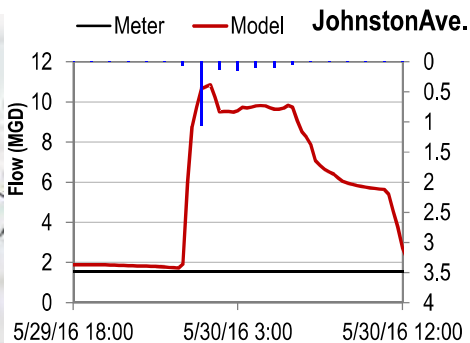


Calibration Results – Combined Area

Johnston Ave.

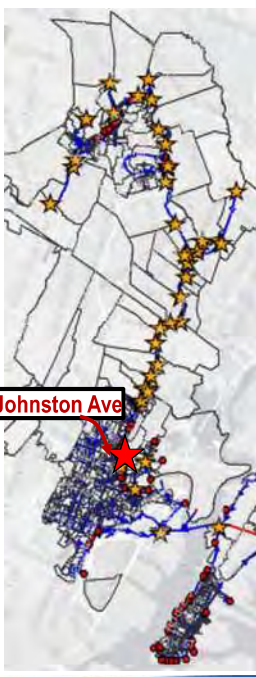


83

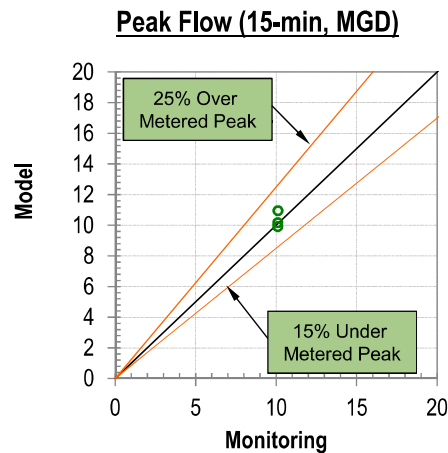
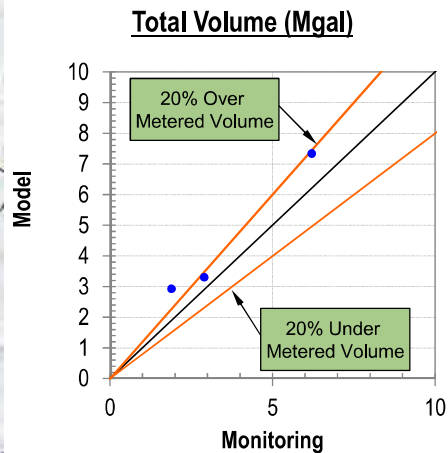


Calibration Results – Combined Area

Johnston Ave.

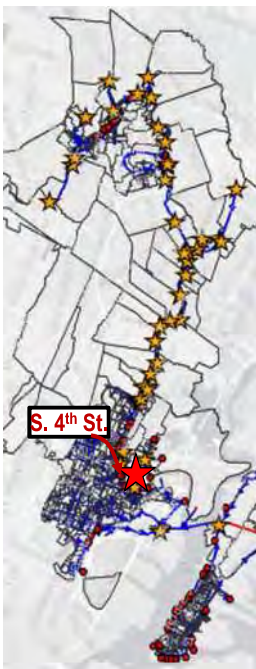


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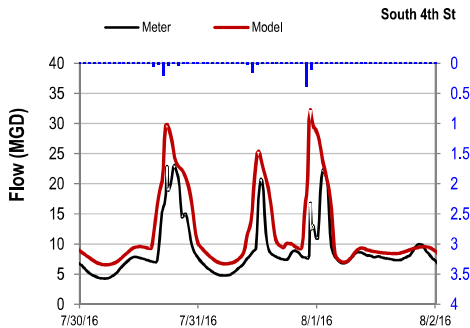
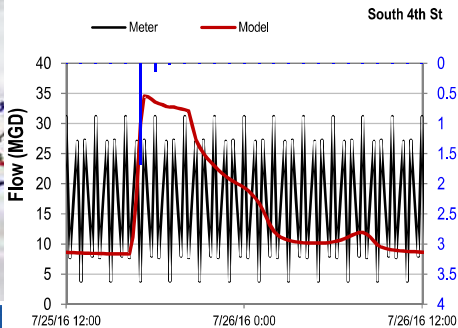
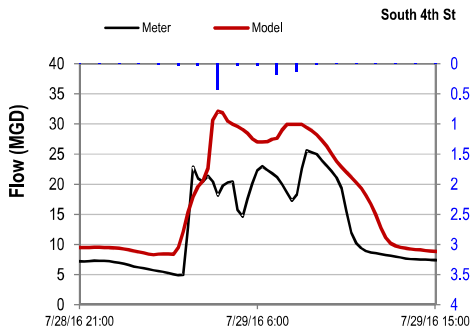
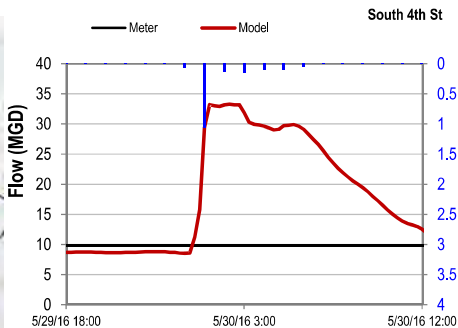


Calibration Results – Combined Area

South 4th St.

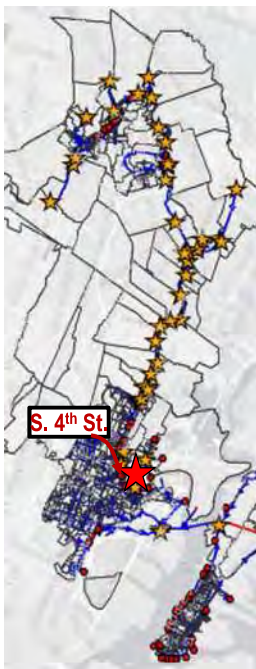


85

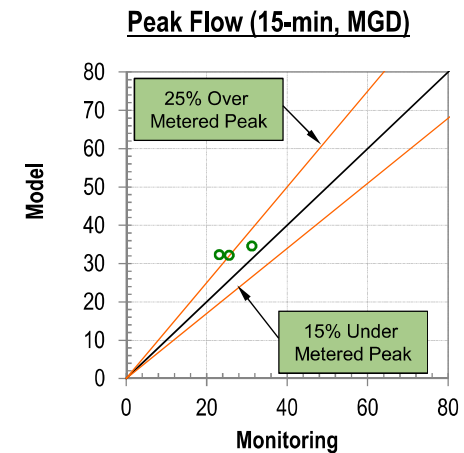
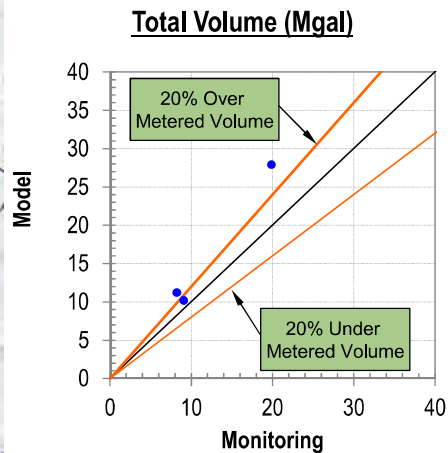


Calibration Results – Combined Area

South 4th St.

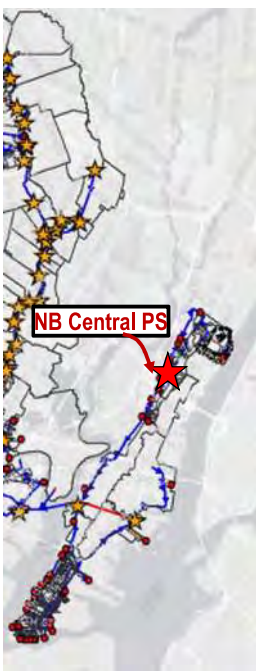


86

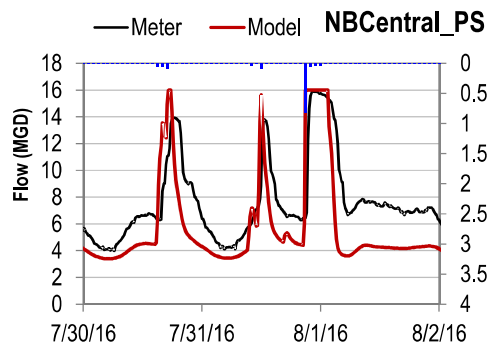
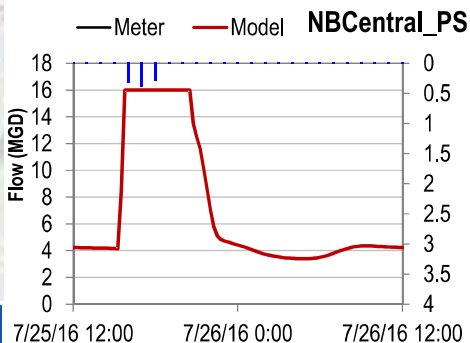
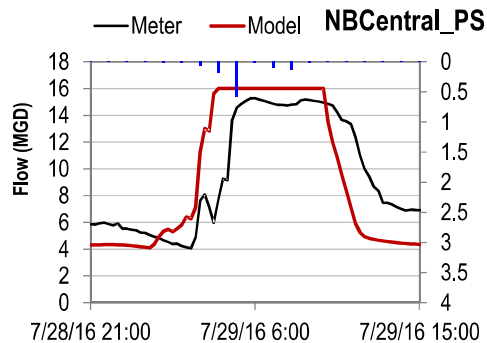
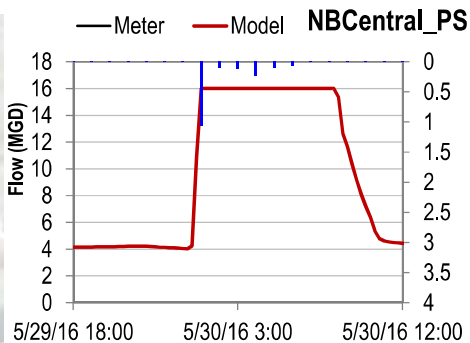


Calibration Results – Combined Area

NB Central PS.

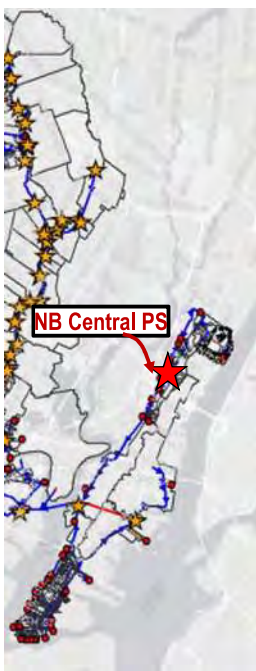


87

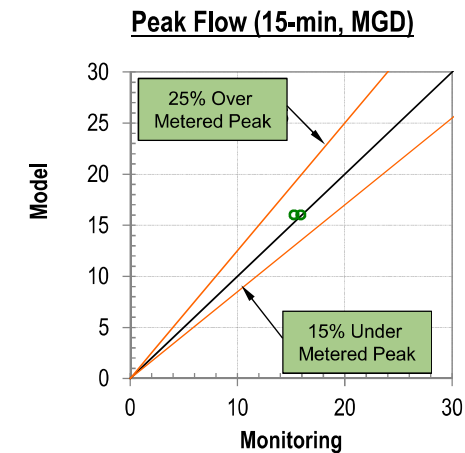
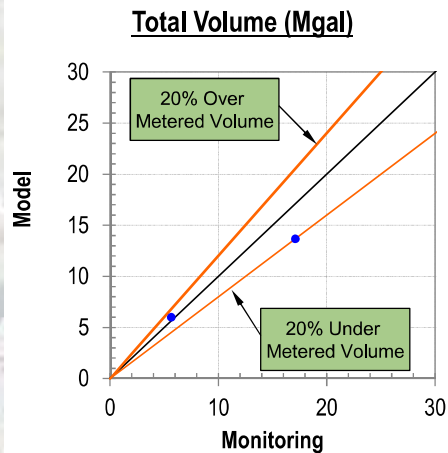


Calibration Results – Combined Area

NB Central PS.



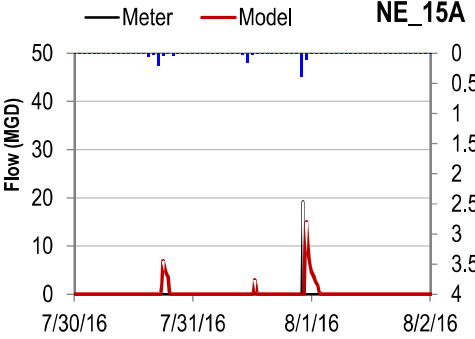
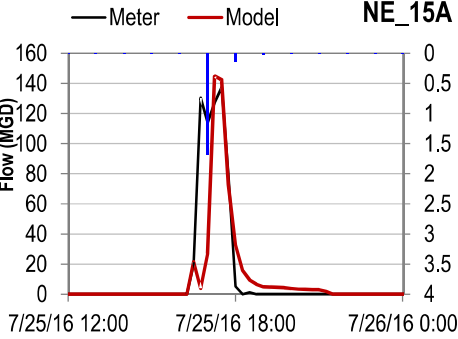
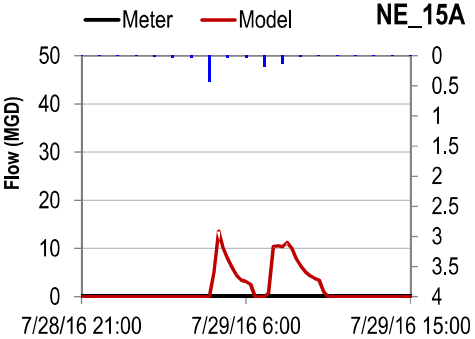
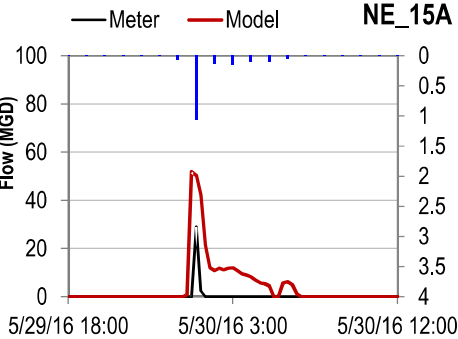
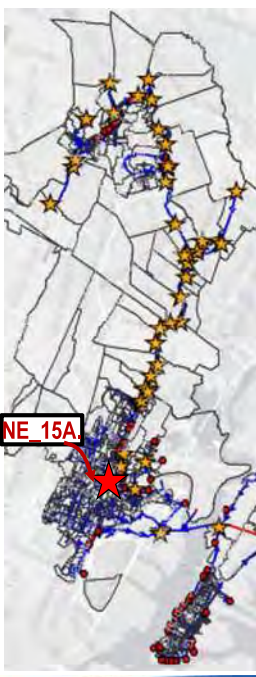
88





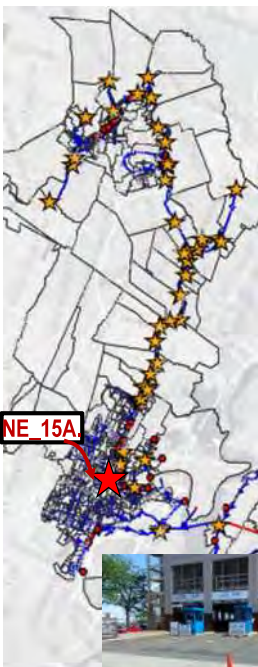
CSO Meters

Calibration Results – CSO Overflow *NE_15A*



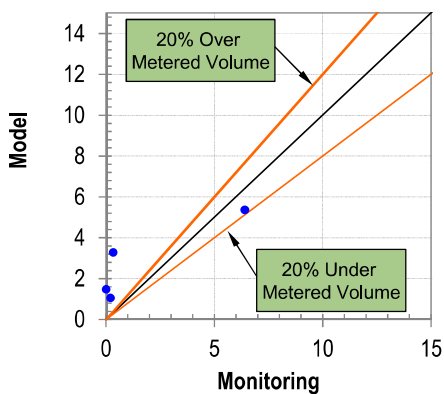
Calibration Results – CSO Overflow

NE_15A

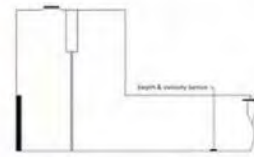
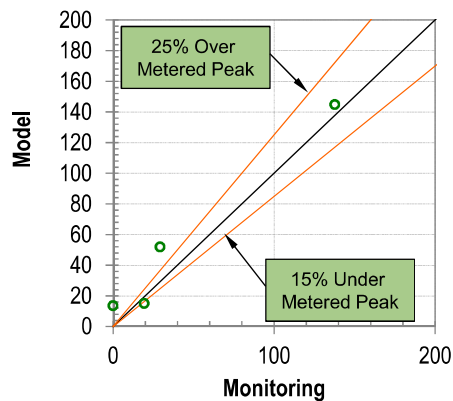


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Total Volume (Mgal)

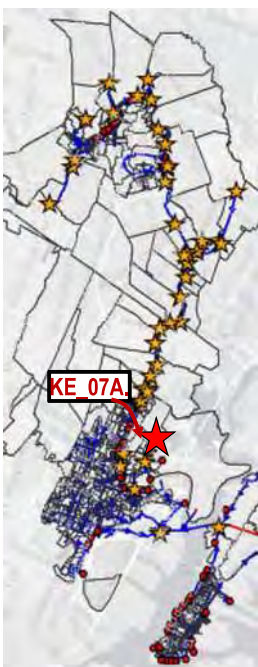


Peak Flow (15-min, MGD)

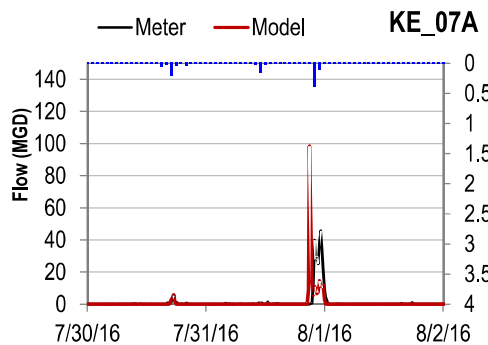
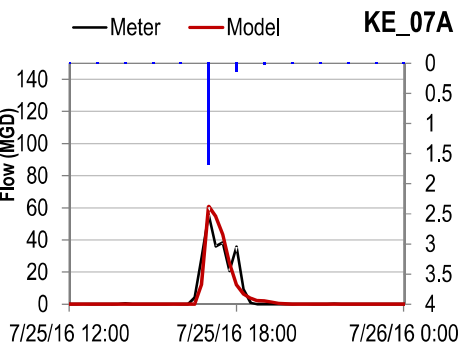
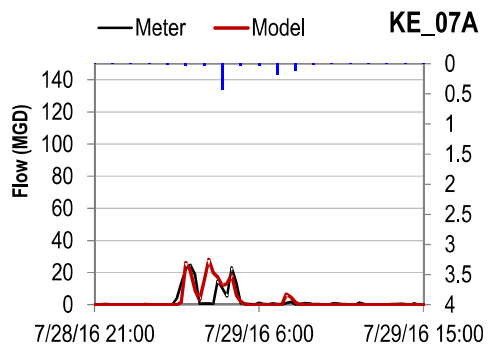
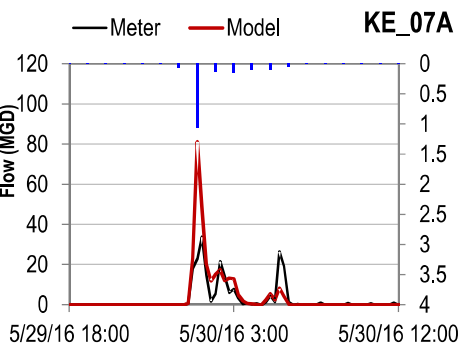


Calibration Results – CSO Overflow

KE_07A

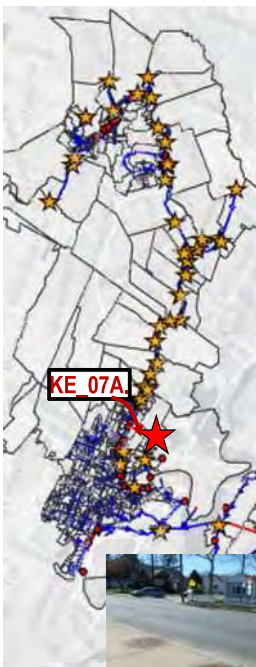


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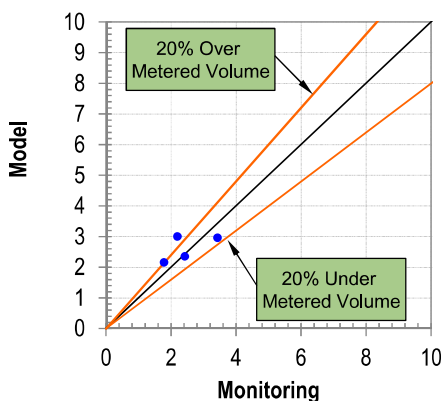
Calibration Results – CSO Overflow

KE_07A

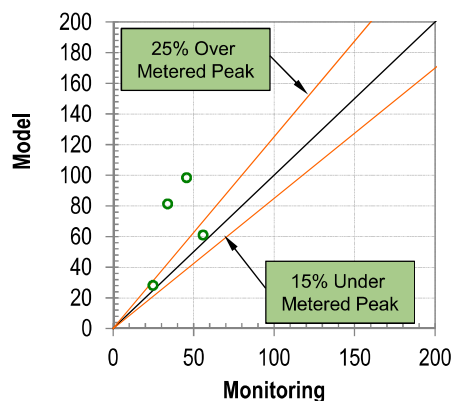


KE_07A

Total Volume (Mgal)



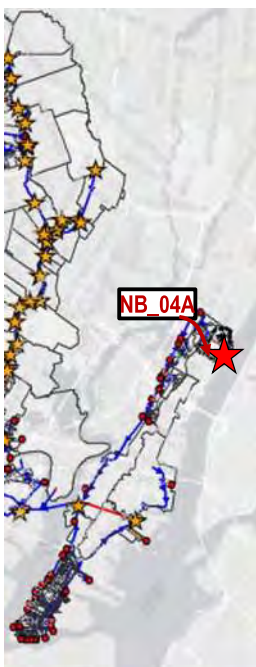
Peak Flow (15-min, MGD)



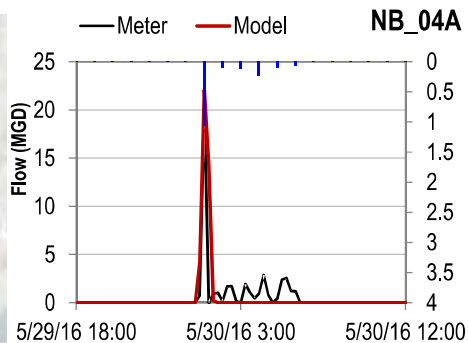
93

Calibration Results – CSO Overflow

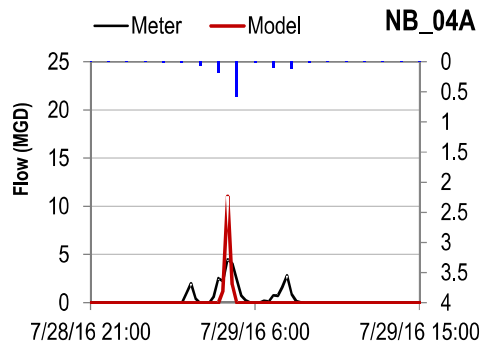
NB_04A



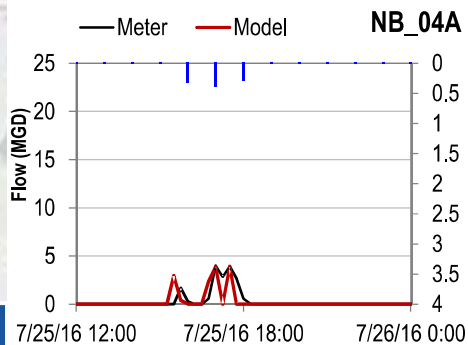
NB_04A



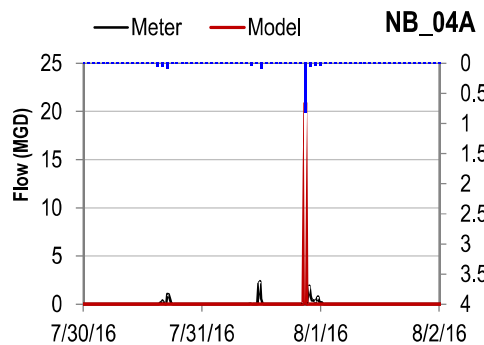
NB_04A



NB_04A



NB_04A

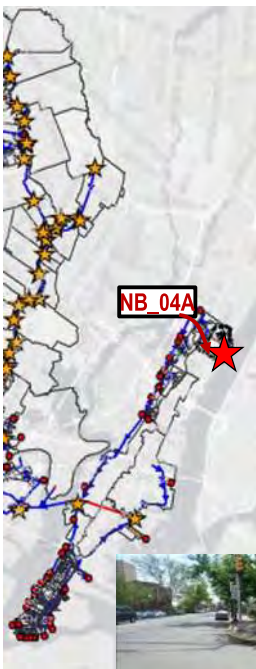


NB_04A

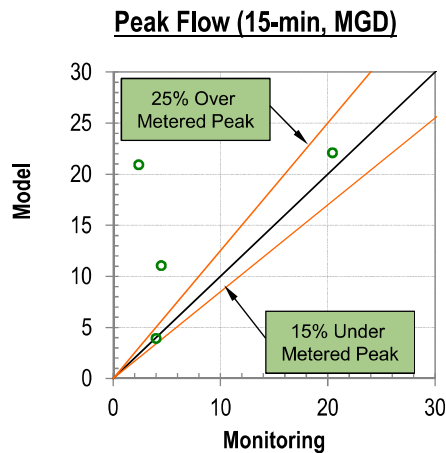
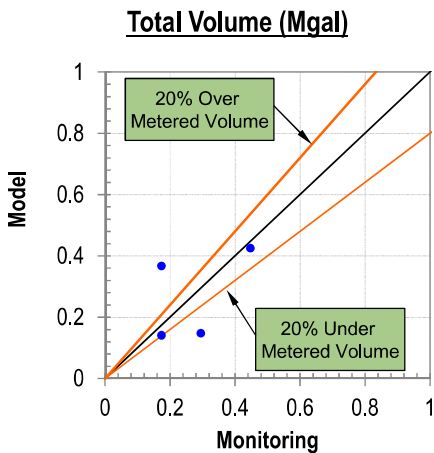
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Calibration Results – CSO Overflow

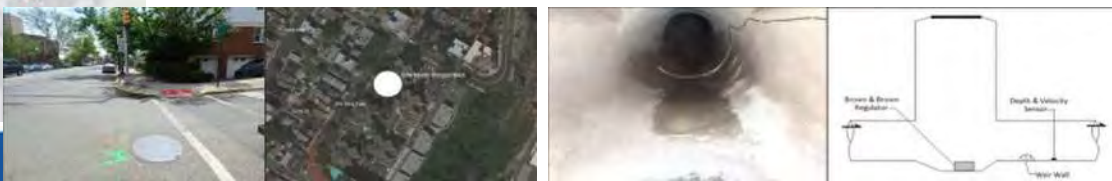
NB_04A



NB_04A

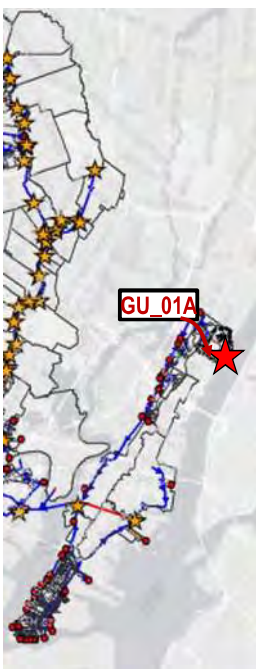


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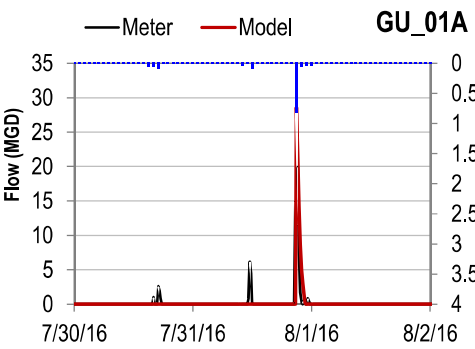
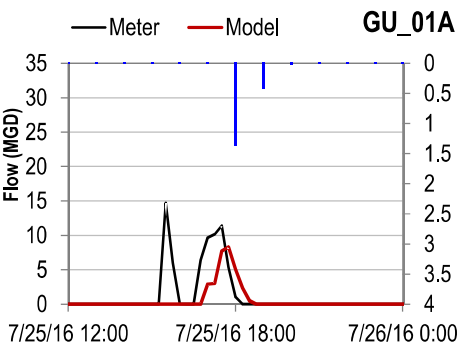
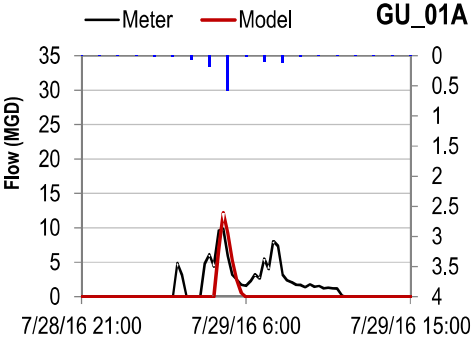
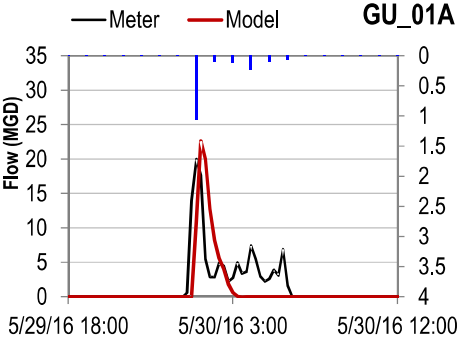


Calibration Results – CSO Overflow

GU_01A



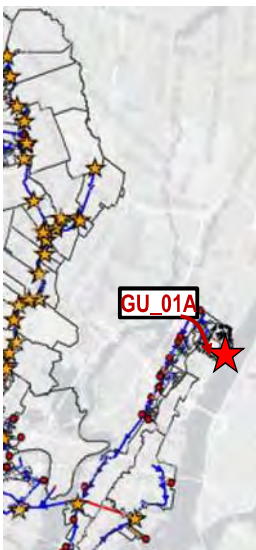
GU_01A



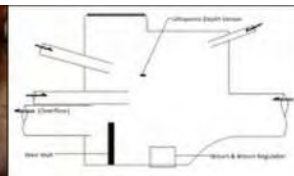
96

Calibration Results – CSO Overflow

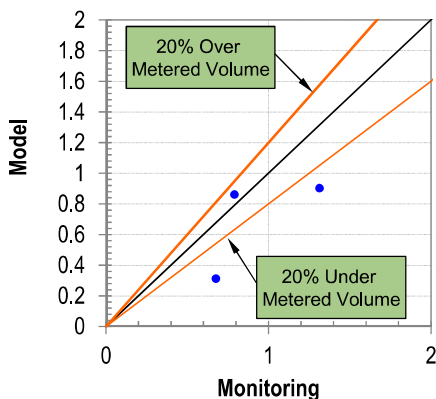
GU_01A



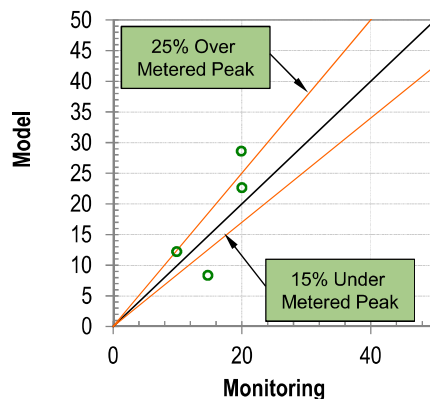
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Total Volume (Mgal)



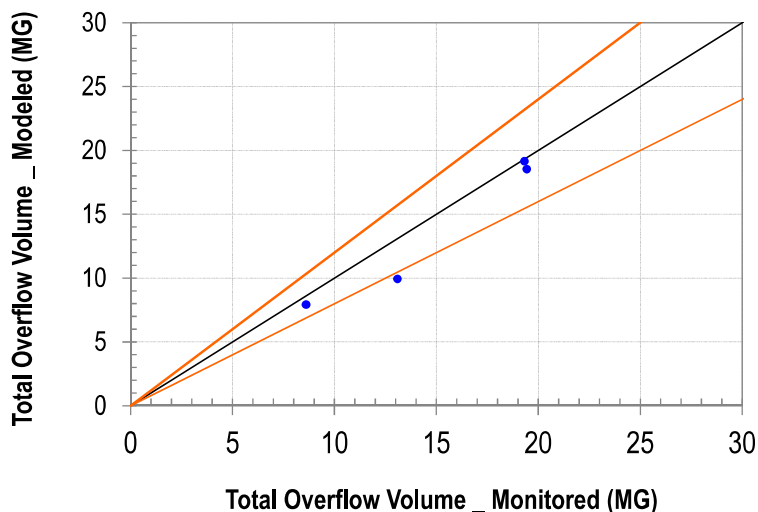
Peak Flow (15-min, MGD)



Total Overflow Volume

NE_04&05, NE_09&10, NE_14A, NE_15A, KE_07A, BA_08A, BA_10A, NB_11A, NB_07A, NB_04A, NB_04B, GU_01A

Total Overflow Volume from Sampling Locations



Summary & Next Step

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Summary

- **The updated PVSC H&H model includes**
 - 48 municipalities served by the PVSC WPCF
 - 2 municipalities served by the NBMUA Woodcliff WWTP
 - Dry weather flow based on 2016 flow monitoring data
 - Wet weather flow simulated as runoff from the combined areas and RDII from the separated areas
 - Current PVSC WPCF wet weather operating rules
- **The model is calibrated and validated to 2016 flow monitoring data**

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Next Step

- Finalize model
- Address comments received
- Generate CSO flows for WQ model
- Distribute model to CSO permittees

The End