Environmental Protection

NYC Long-Term Control Planning

City-wide Modeling Workshop

February 28, 2013

Overview of Combined Sewer Overflow (CSO) Long Term Control Plan Process

Linda Allen
New York State DEC

NYC CSO Long Term Control Plans (LTCPs)

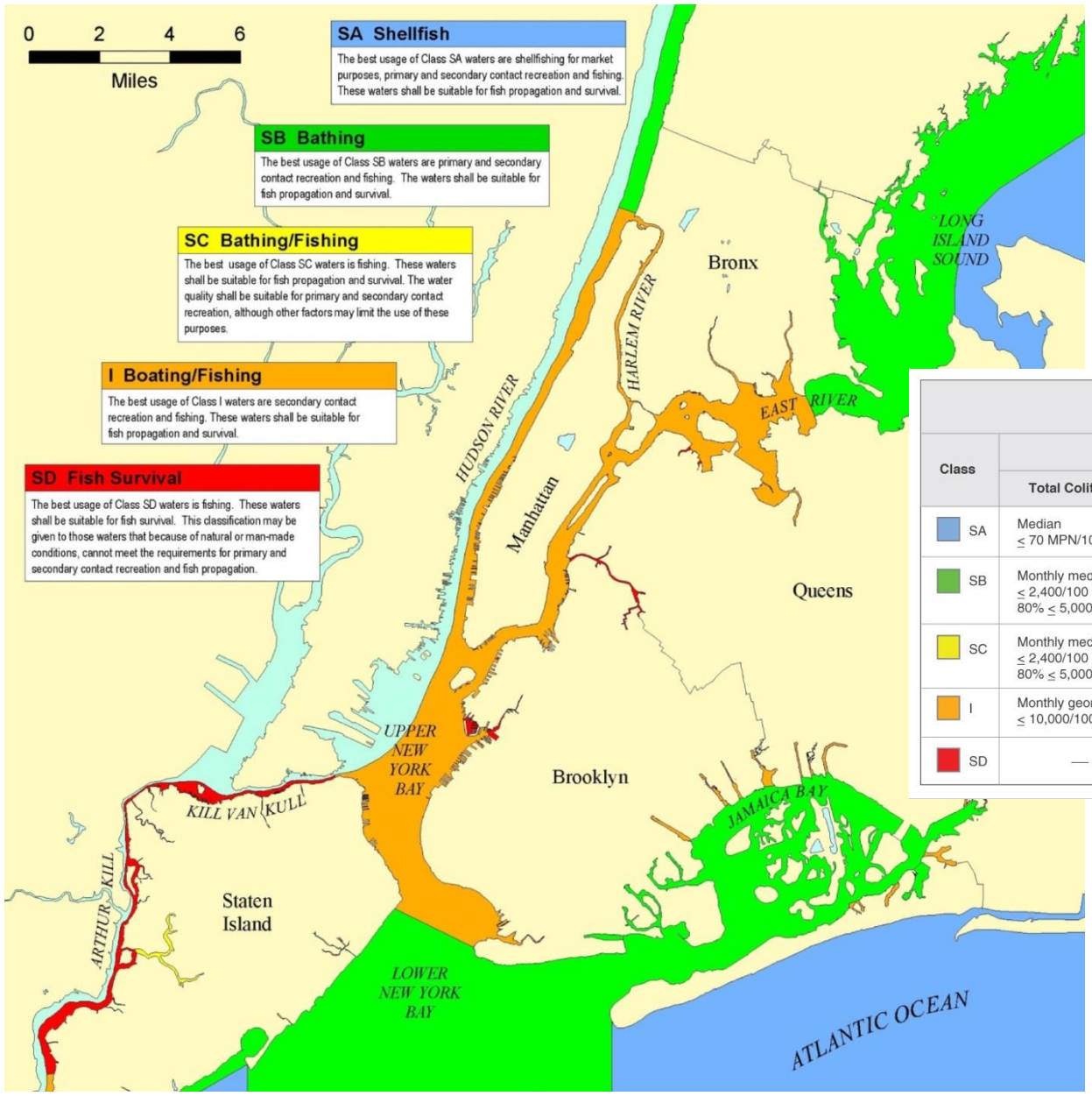
What is an LTCP?

- A plan required under NYC SPDES permits pursuant to the Clean Water Act (CWA) and Federal CSO Control Policy; CSO Order establishes time frames for submittal.
- Comprehensive evaluation of long term solutions, to reduce CSOs and improve water quality in NYC's waterbodies and waterways.
- The goal of each LTCP is to identify appropriate CSO controls necessary to achieve waterbody-specific water quality standards, consistent with the Federal CSO Policy and water quality goals of the CWA.

The LTCP process:

- Assesses feasibility of attaining current water quality standards, next highest standards and fishable/swimmable standards;
- Builds off Waterbody/Watershed Facility Plans completed under the first phase of the planning process;
- Requires robust, targeted public process; and
- Identifies grey-green infrastructure balance for different watersheds.

Current Water Quality Standards



New York State
Saline Surface Water Quality Standards

Class	Bacteria (when disinfection is practiced)			Dissolved Oxygen
	Total Coliform	Fecal Coliform	Enterococci	
SA	Median ≤ 70 MPN/10 mL	—	Geometric mean ≤ 35/100 mL	> 4.8 mg/l (daily avg) ≥ 3.0 mg/l
SB	Monthly median ≤ 2,400/100 mL 80% ≤ 5,000/100 mL	Monthly geometric mean ≤ 200/100 mL	Geometric mean ≤ 35/100 mL	> 4.8 mg/l (daily avg) ≥ 3.0 mg/l
SC	Monthly median ≤ 2,400/100 mL 80% ≤ 5,000/100 mL	Monthly geometric mean ≤ 200/100 mL	Geometric mean ≤ 35/100 mL	> 4.8 mg/l (daily avg) ≥ 3.0 mg/l
I	Monthly geometric mean ≤ 10,000/100 mL	Monthly geometric mean ≤ 2,000/100 mL	—	≥ 4.0 mg/l
SD	—	—	—	≥ 3.0 mg/l

USEPA CSO LTCP Guidance

- According to 1994 Guidance, CSO Long Term Control Plans must include the following 9 elements:
  1. Characterization, Monitoring, Modeling
  2. Public Participation
  3. Sensitive Areas
  4. Evaluation of Alternatives
  5. Cost Performance Considerations
  6. Operational Plan
  7. Maximization of Treatment at Existing Publicly Owned Treatment Plants
  8. Implementation Schedule
  9. Post-construction Monitoring Plan
- 2001 Guidance for Coordinating CSO Long Term Control Planning with Water Quality Standards Review

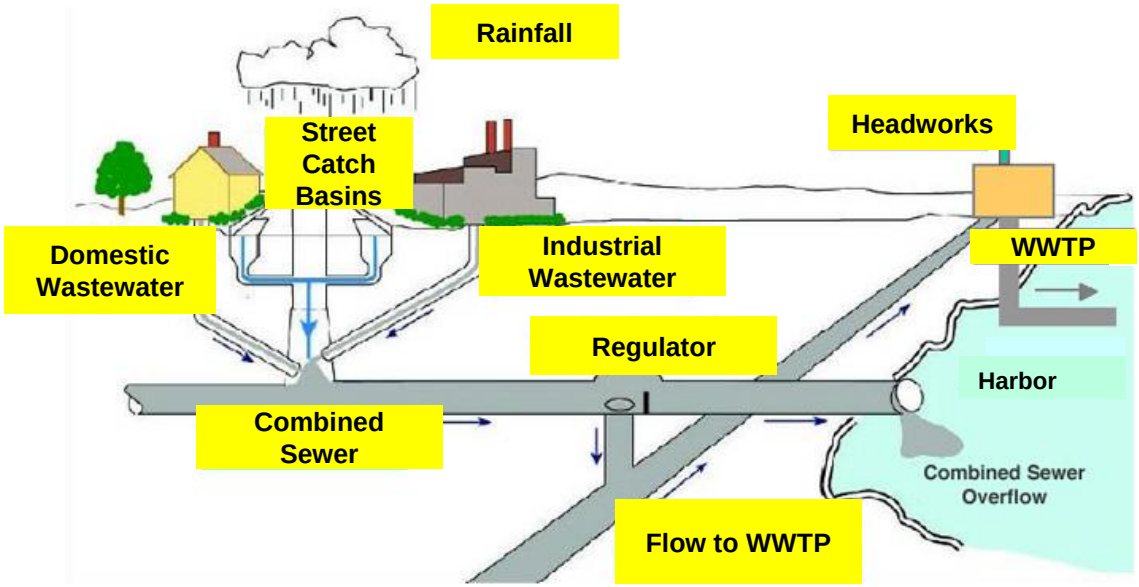
Water Quality Goals of the CSO LTCPs

- LTCPs to provide for continuing attainment of existing water quality standards and compliance with other CWA requirements.
- Where existing water quality standards do not meet the Fishable/Swimmable (F/S) goals of the Clean Water Act, or where the proposed alternative set forth in the LTCP will not achieve existing water quality standards or the F/S goals, the LTCP will include a Use Attainability Analysis (UAA).
- The UAA will identify appropriate alternative water quality outcomes and assess to the State the waterbody's "highest attainable use", which the State will consider in adjusting water quality standards, classifications, or criteria and developing waterbody-specific criteria. Any alternative selected by a LTCP and UAA will be developed with robust community engagement.

Mathematical Modeling to Support CSO/Water Quality Characterization and Evaluation of Alternatives for LTCPs

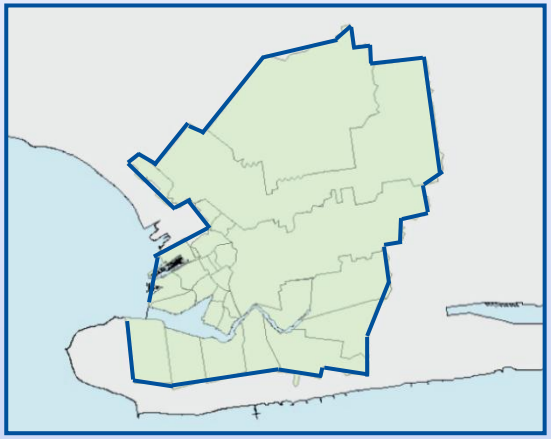
Sri Rangarajan, NYC DEP

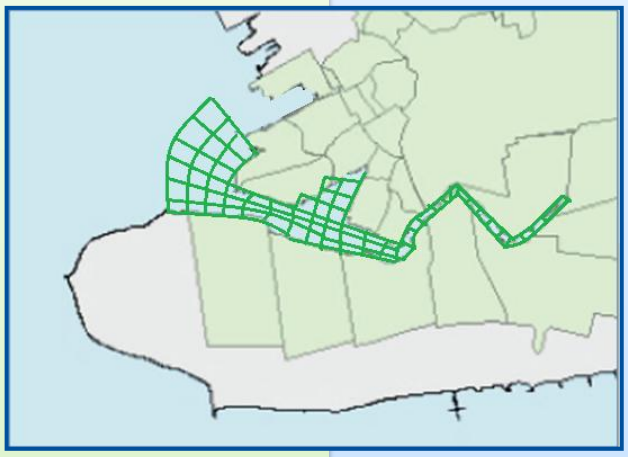
Mathematical Models



- Representation of physical/chemical/biological processes using equations
- USEPA endorsed methodology for LTCP Studies
- Constructed and calibrated to represent system performance as realistically as possible
- Sensitivity analysis to understand system performance under varying climate or operational conditions
- Evaluation of a range of CSO control measures to aid decision-making and select capital projects that can yield maximum return on investment on water quality

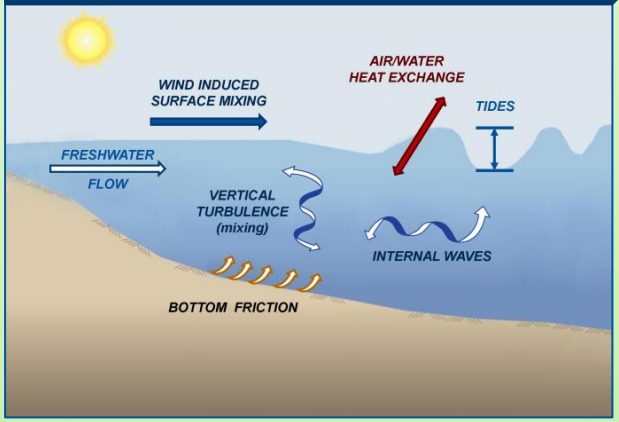
Integrated Modeling Framework



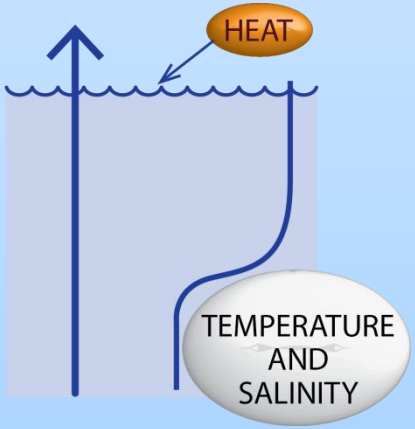


FRESHWATER INFLOW & POLLUTANT LOADS

CIRCULATION &TRANSPORT



CHEMICAL & BIOLOGICAL REACTIONS



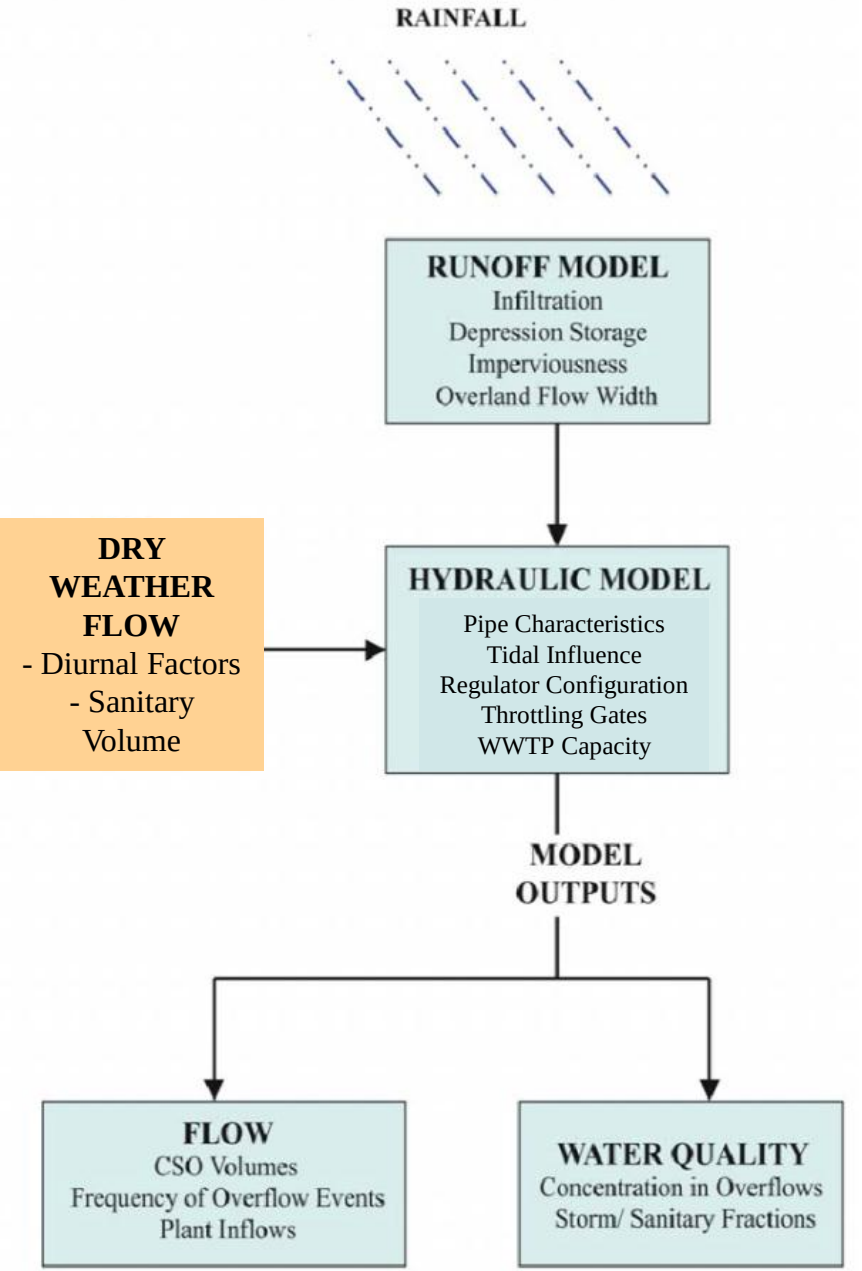
WATERSHED MODEL

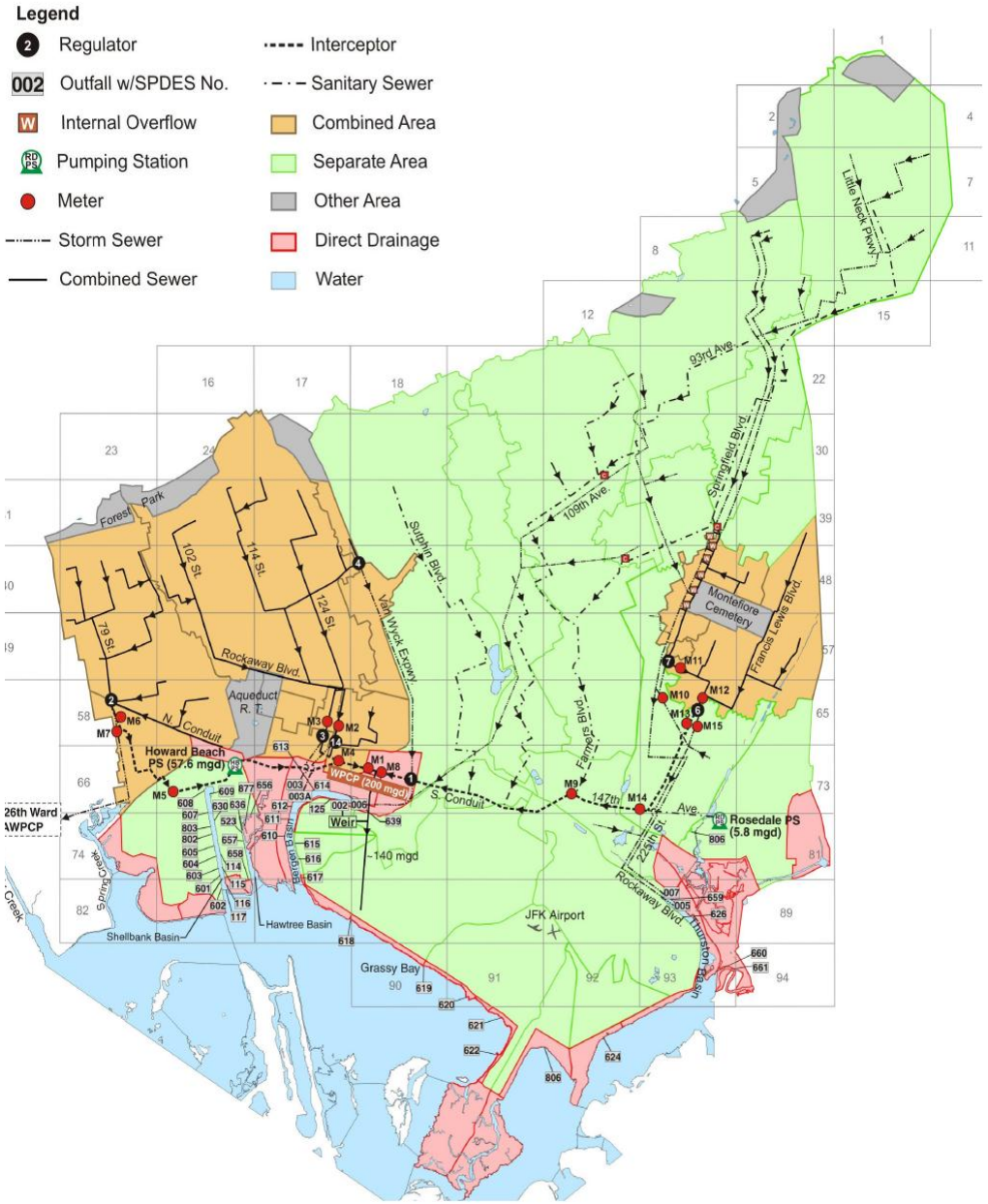
HYDRODYNAMIC MODEL

WATER QUALITY MODEL

Watershed Model Description

InfoWorks Watershed Model Components





Status of Models to Support LTCP

- Constructed and updated using physical data from several sources/field inspections, over the last 10+ years
- Calibrated using continuous WWTP inflows and temporary targeted flow metering data in sewer system
- Suitable for CSO facility planning using typical year(s) climatic/other system inputs
  - Waterbody/Watershed Facility Plans (WWFPs): Grey elements – retention tanks, bending weirs, pump station upgrades, new interceptors, etc.
  - Green Infrastructure – 2010 GI Plan

Peer Review

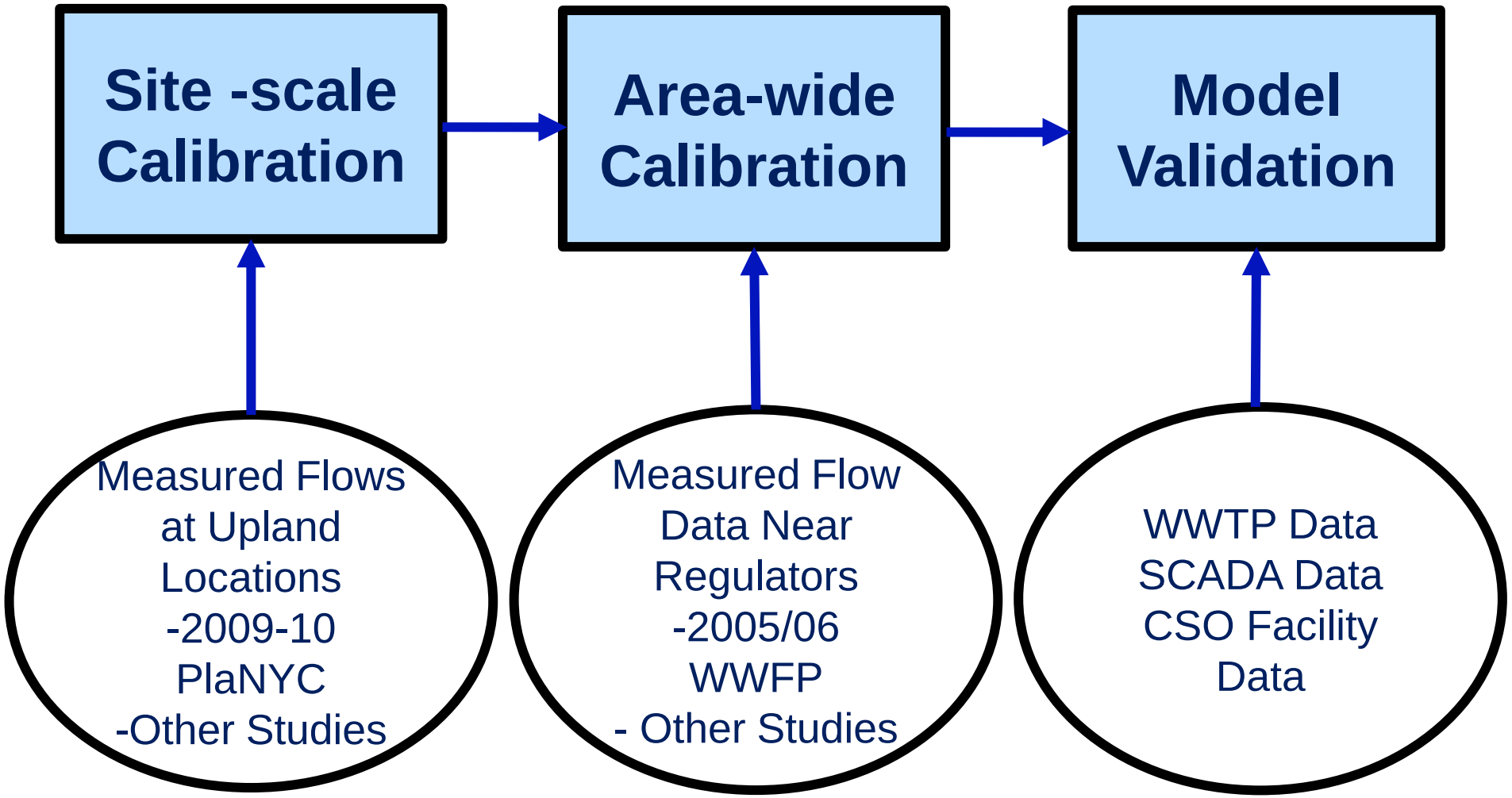
Models were peer reviewed by academics/practitioners and DEP already implemented the key recommendations in the recalibration efforts

- Improved method of estimating imperviousness from satellite imagery
- Improved calibration for hydrology by placing meters in upland areas instead of near regulators/outfalls
- Adoption of standardized criteria/approach for assessing the adequacy of calibration
- Sensitivity analyses of radar and gage rainfall data to gain further confidence on modeling

Characteristics of 13 InfoWorks Models

WWTP	Combined Area (Ac)	Storm Drainage Area (Ac)	Direct Drainage Area (Ac)	Subcatchments	Manholes	Pipes
26	4,358	320	1,109	111	243	246
BB	12,446	4	1,782	263	759	624
HP	11,546	2,638	8,359	529	988	894
JA	5,451	15,099	5,871	367	731	722
NC	13,562	536	1,005	314	1,031	760
NR	4,448	42	1,082	107	497	338
OH	9,448	483	147	129	406	367
CI	6,070	709	0	130	187	186
PR	3,575	7,966	0	97	522	409
RH	2,991	98	649	152	424	319
RO	0	2,153	3,557	599	465	353
TI	8,721	6,733	2,860	419	1,054	945
WI	12,822	1,212	1,765	349	906	657
Totals	**95,438**	**37,993**	**28,186**	**3,566**	**8,213**	**6,820**

2012 Model Refinement



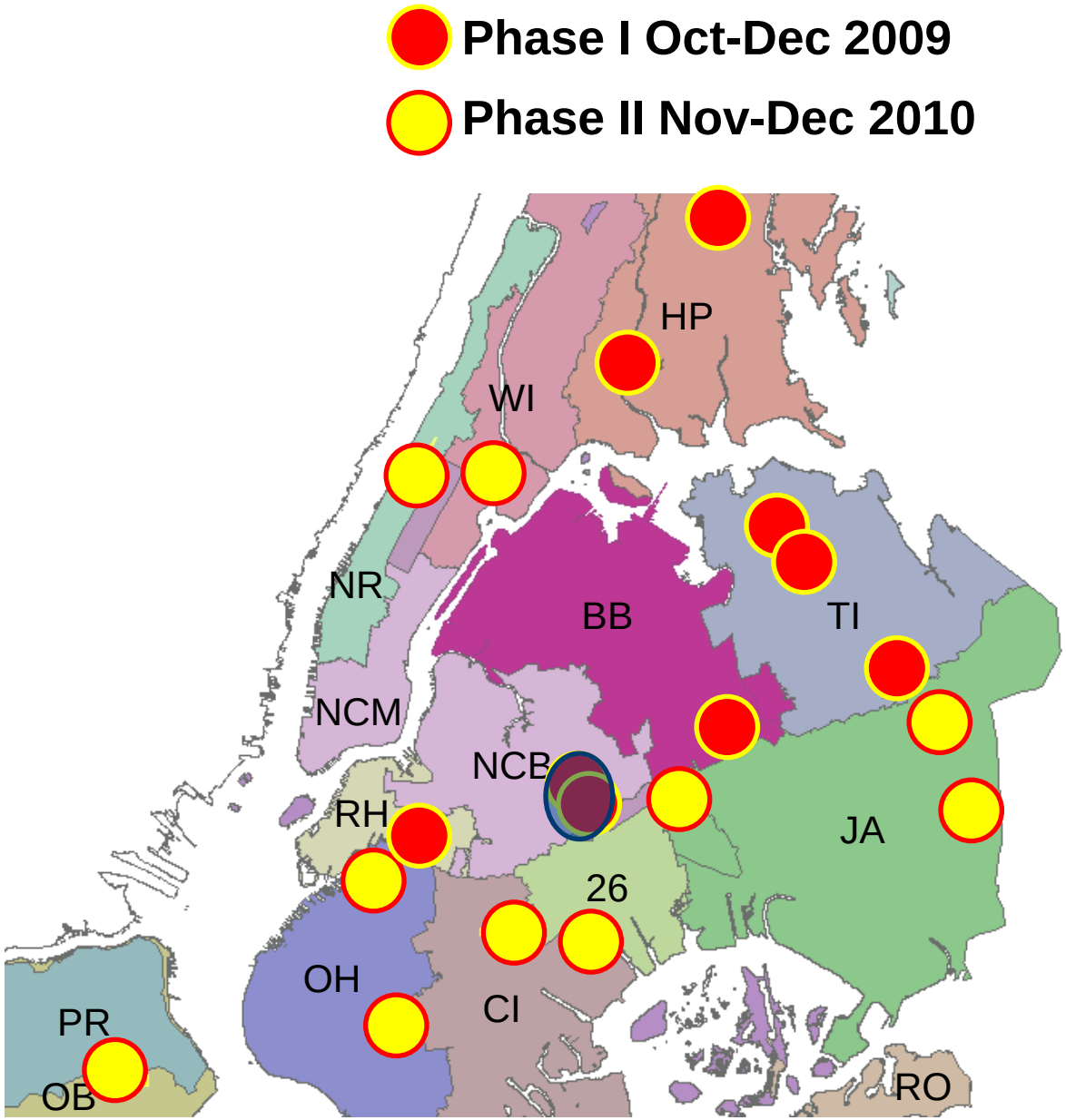
Imperviousness – Updated Model

- City-wide infrared satellite imagery
- Spectral Mixing Analysis
  - Map bare soil and fractional vegetation cover as proxies for pervious surface area
- Directly Connected Impervious Areas
  - Fraction that contributes runoff directly to sewers

Source: Christopher Small, Columbia University

Upland Flow Monitoring

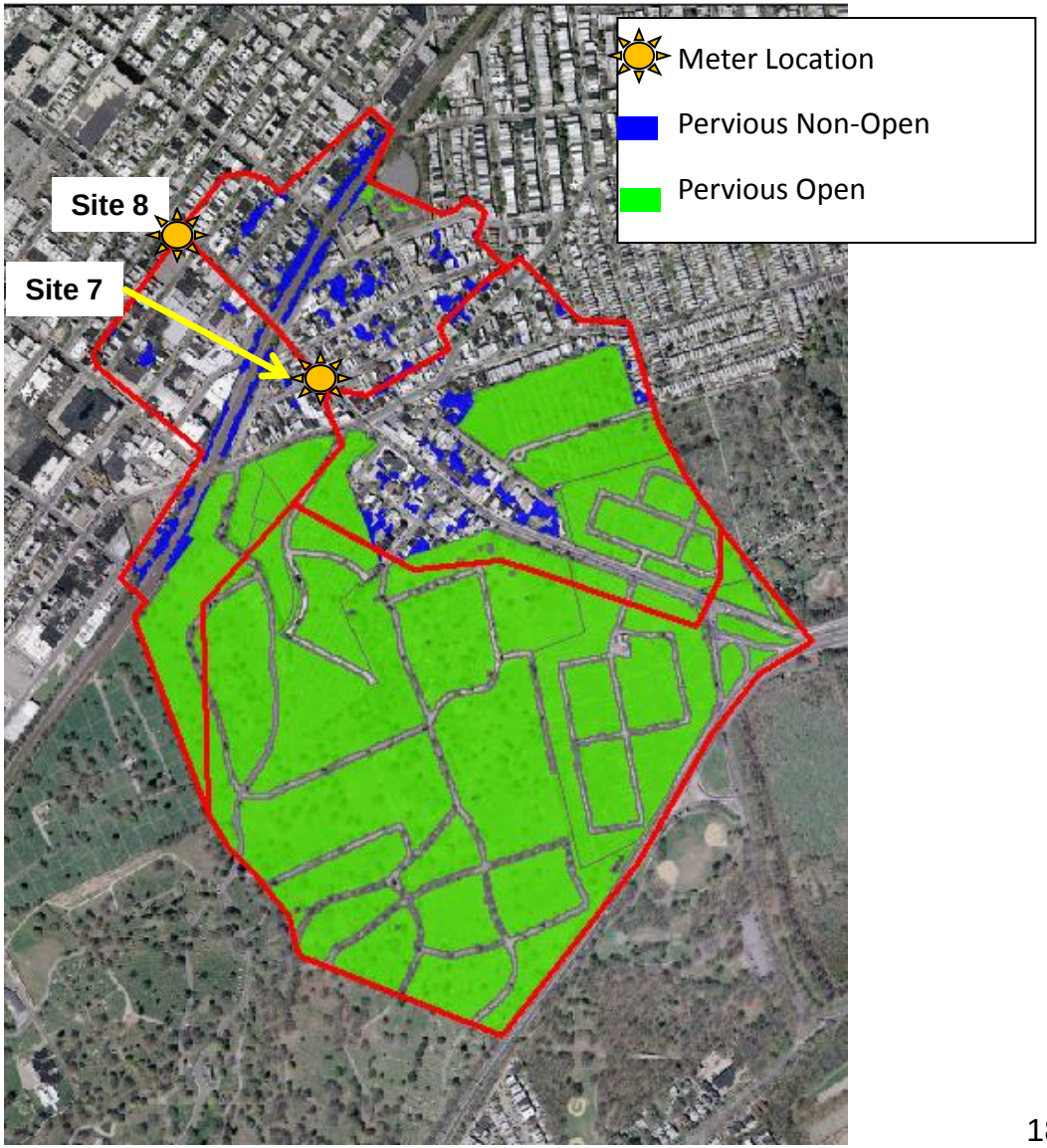
- 20 Sites in Total
- Distributed throughout five boroughs
- Diverse land uses to develop representative hydrology model parameters
- **Goal:** Achieve overall best correlation so the hydrology parameters can be applied for unmonitored areas



Runoff Surfaces in Sites 7 and 8

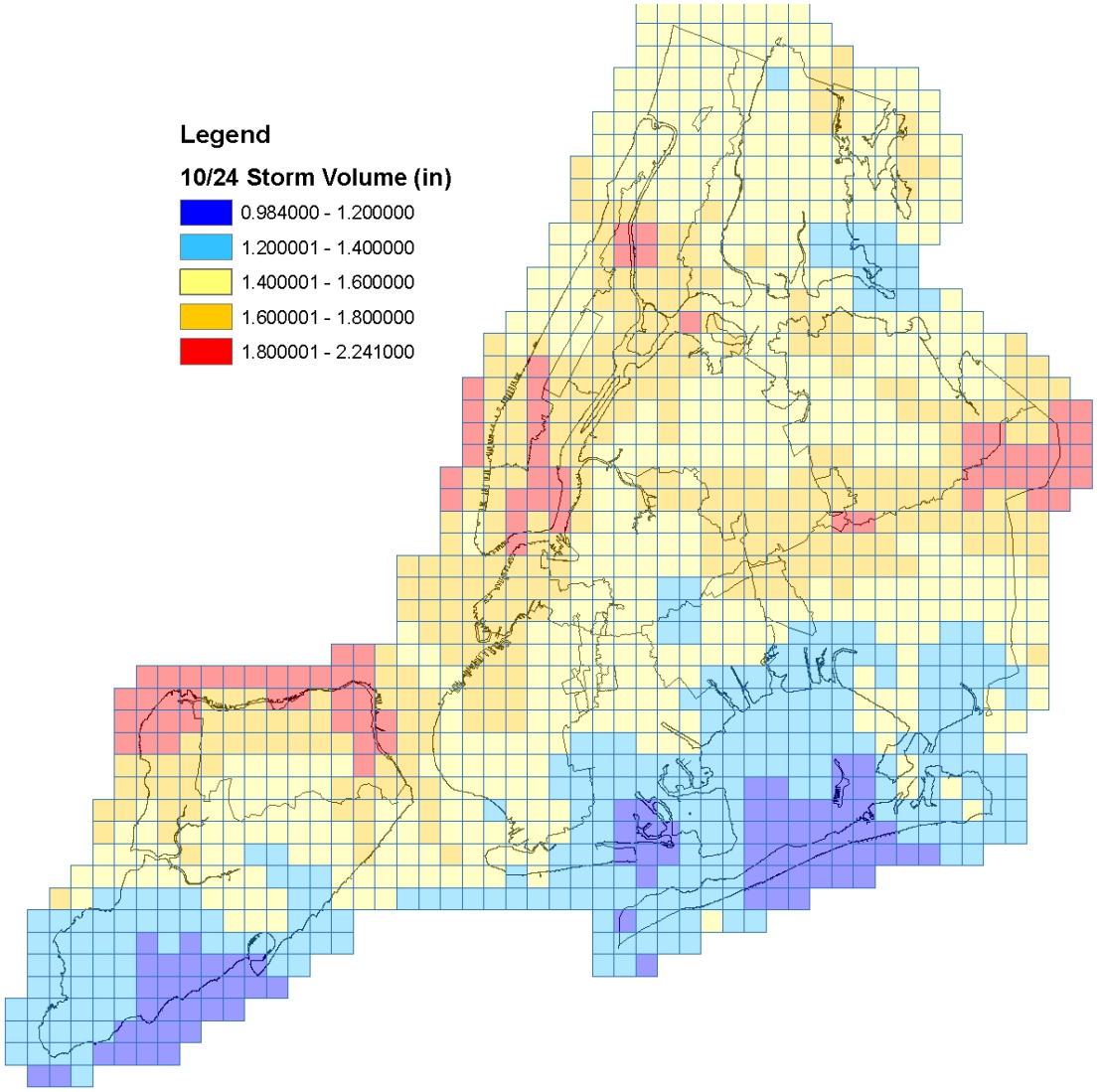
Three surfaces

- Impervious
  - Public right of way, roofs, parking lots, driveways, etc.
- Pervious
  - Open (parks, cemeteries)
  - Non-open (other pervious areas)



Radar Rainfall

- 1km x 1km grids
- 5-minute data
- Calibrated based on point gage data
- Phase I
  - Six calibration and seven validation events
- Phase II
  - Three calibration and two validation events



Calibration Assessment

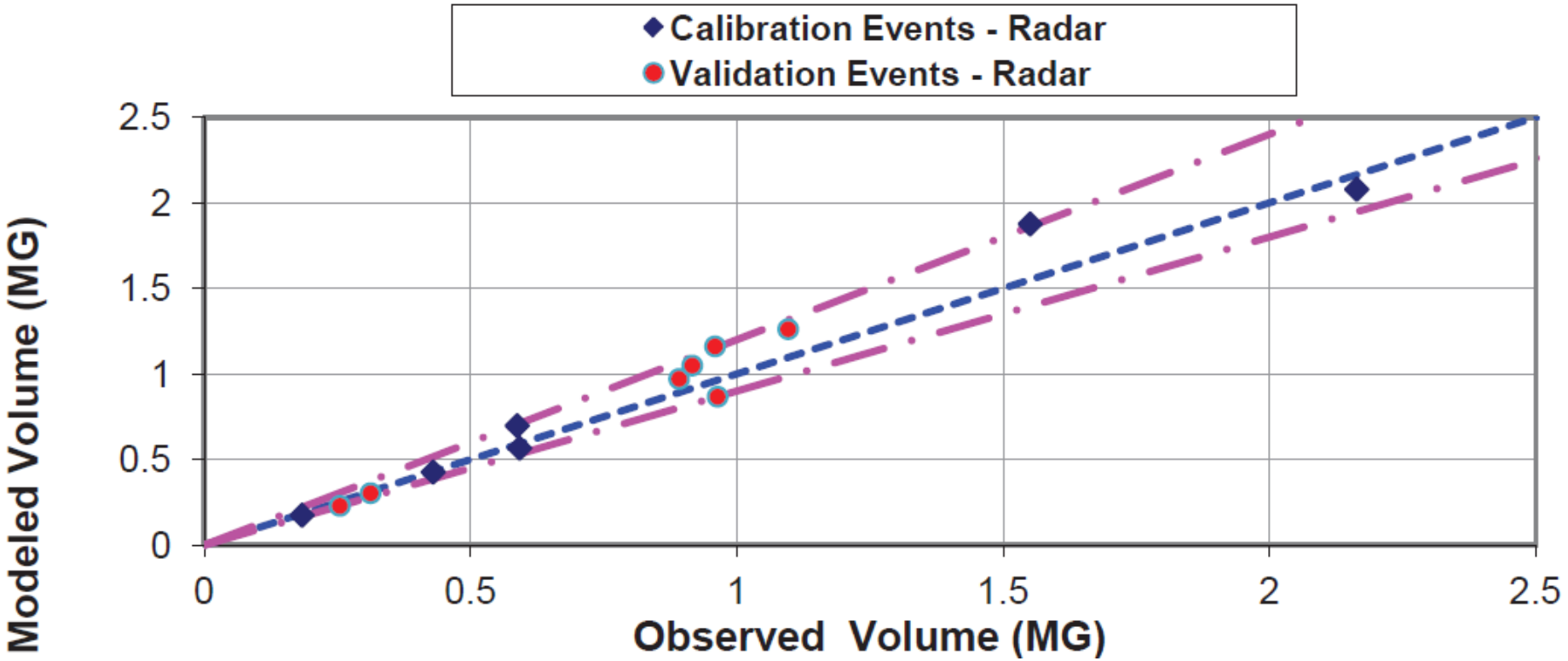
Weight of Evidence (WOE) Approach

- Involves quantitative and qualitative metrics to assess the adequacy of calibration
- Requires model validation at different spatial scales
- Accounts for uncertainty in model inputs such as rainfall

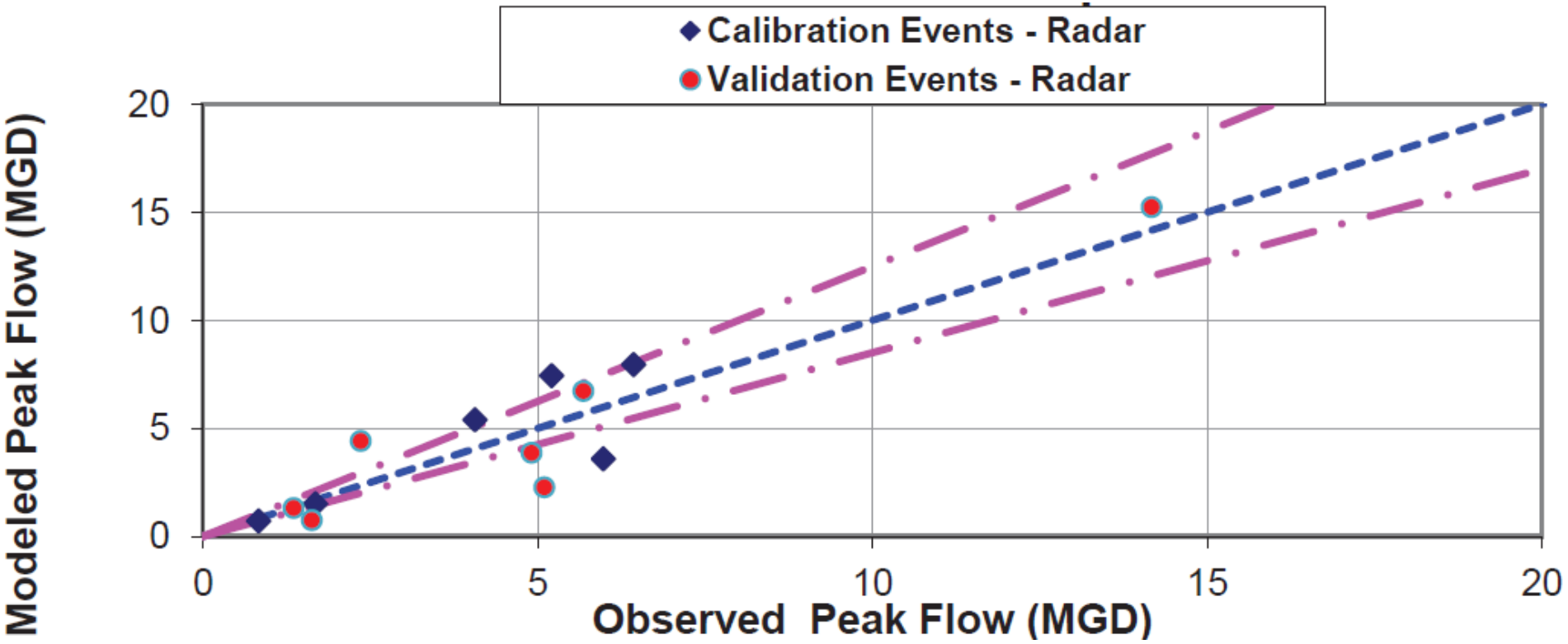
Metrics included:

- Scatterplots for monitored vs. modeled volume, peak flow and water depth
- Time-series comparisons of monitored and modeled flows/depths
- Comparative analysis with different rainfall inputs

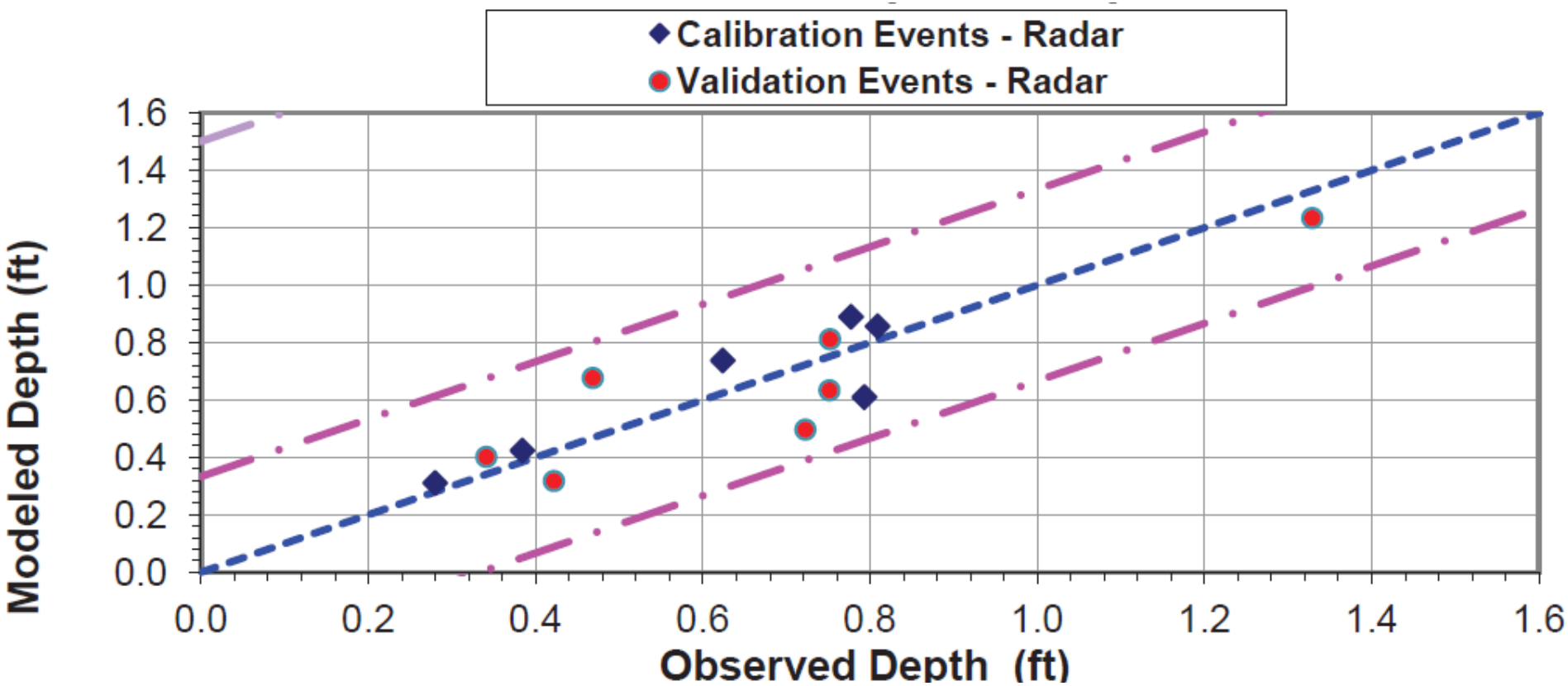
Event Volume Comparison



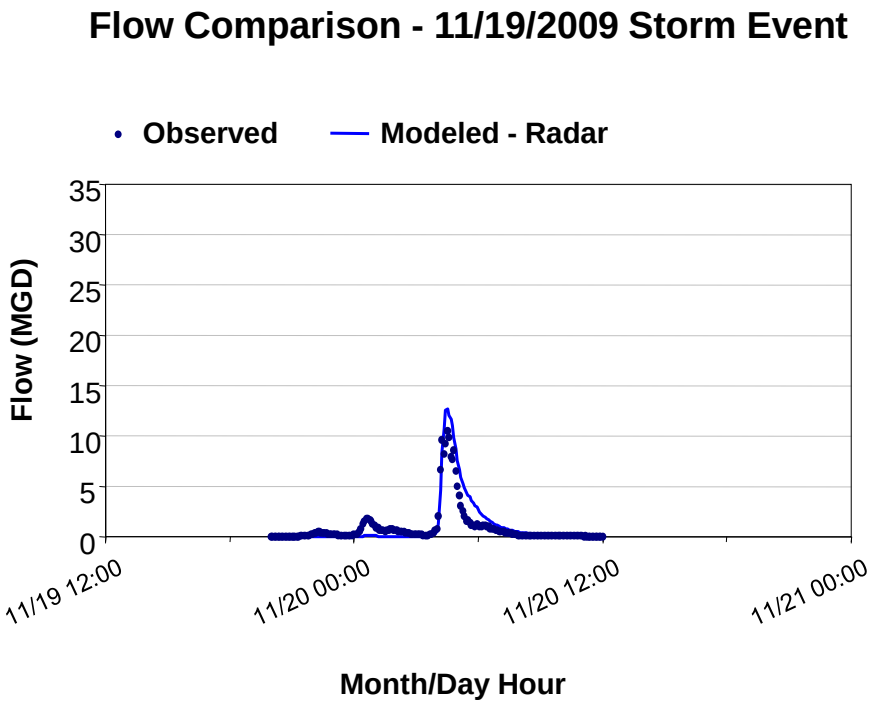
Peak Flow Comparison

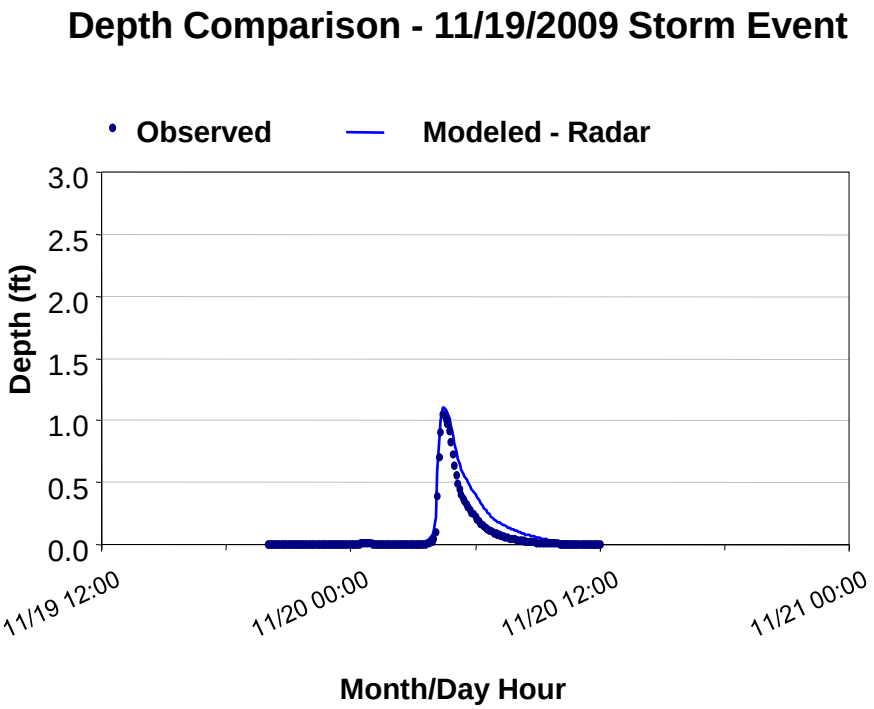


Water Depth Comparison



Time-series


Flow Comparison - 11/19/2009 Storm Event
Observed
Modeled - Radar
Flow (MGD)
35
30
25
20
15
10
5
0
11/19 12:00
11/20 00:00
11/20 12:00
11/21 00:00
Month/Day Hour


Depth Comparison - 11/19/2009 Storm Event
Observed
Modeled - Radar
Depth (ft)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
11/19 12:00
11/20 00:00
11/20 12:00
11/21 00:00
Month/Day Hour

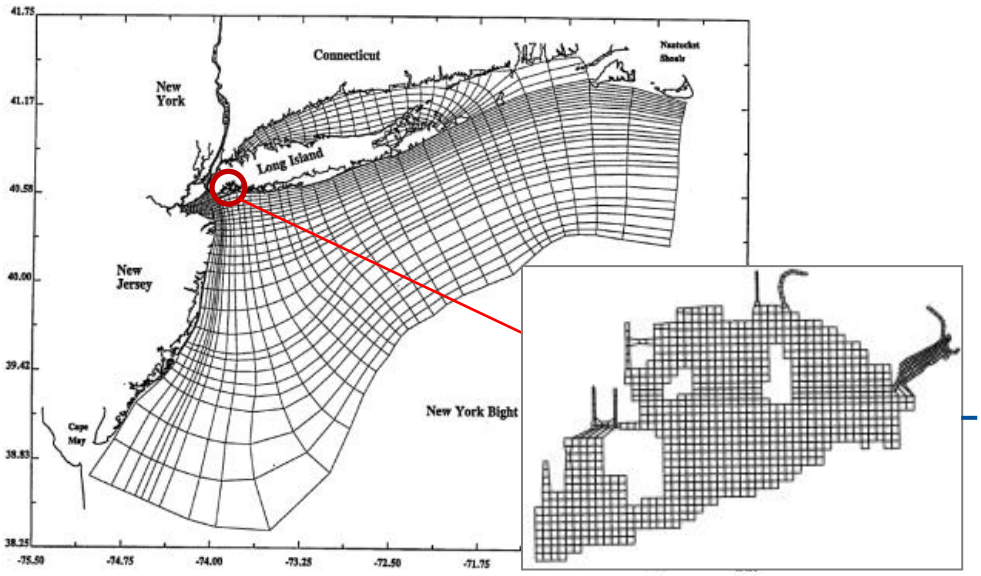
Water Quality (WQ) Model Description

Thomas Newman, HDR

Timeline of WQ Model Development

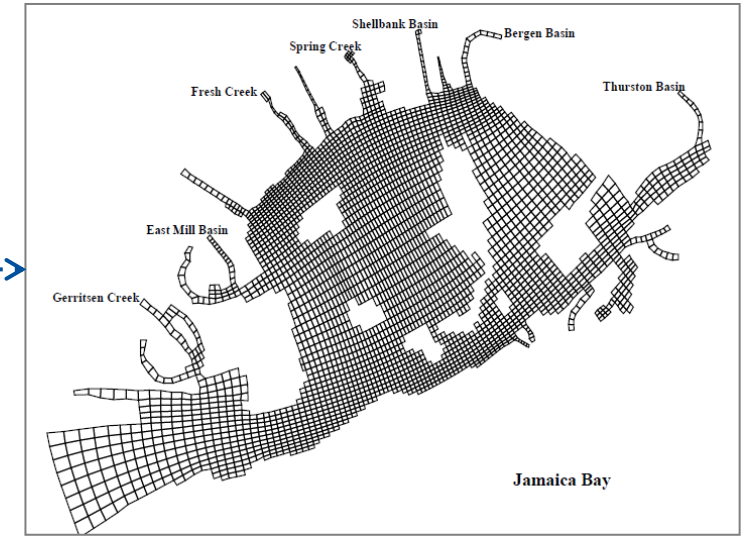
Year	Model	Systems	Benefits & Applications
1990s	System Wide Eutrophication Model (SWEM)	Sal, Temp, DO, N & P Series, Diss. & Part. Org. C, Silica, Tot. & Fecal Coli, Entero, Algal Groups	*TMDL Development (LI Sound Nitrogen; Harbor Pathogens/Nutrients/Toxics) *Facilities Planning (Newtown Creek WPCP Upgrade, East River Facility Planning)
2002	Jamaica Bay Eutrophication Model (JEM)	Adds sediment nutrient flux	*Comprehensive BNR Action Plan for Nitrogen for four WWTPs *Jamaica Tributary CSO Studies (Nested Models) *Outfall Relocation Impacts on Offshore Water Quality *Post Construction Monitoring Assessments
2007	East River Tributaries Model (ERTM)	Same systems as JEM. Higher-resolution model grid than SWEM.	*Waterbody/Watershed Facility Plan Development for Several Tributary CSO Studies (Bronx River, Hutchinson River, Westchester Ck, Alley Ck /Little Neck Bay, Flushing Ck, Flushing Bay) *Post Construction Monitoring Assessments
2010	Refined JEM (JEM-LT)	Adds larval transport. High resolution grid.	*Assess Larval Transport (sustainability of artificial reefs to support water quality) *Tributary CSO Studies *Post Construction Monitoring Assessments

1990's



2010

Example of Higher Resolution Grid



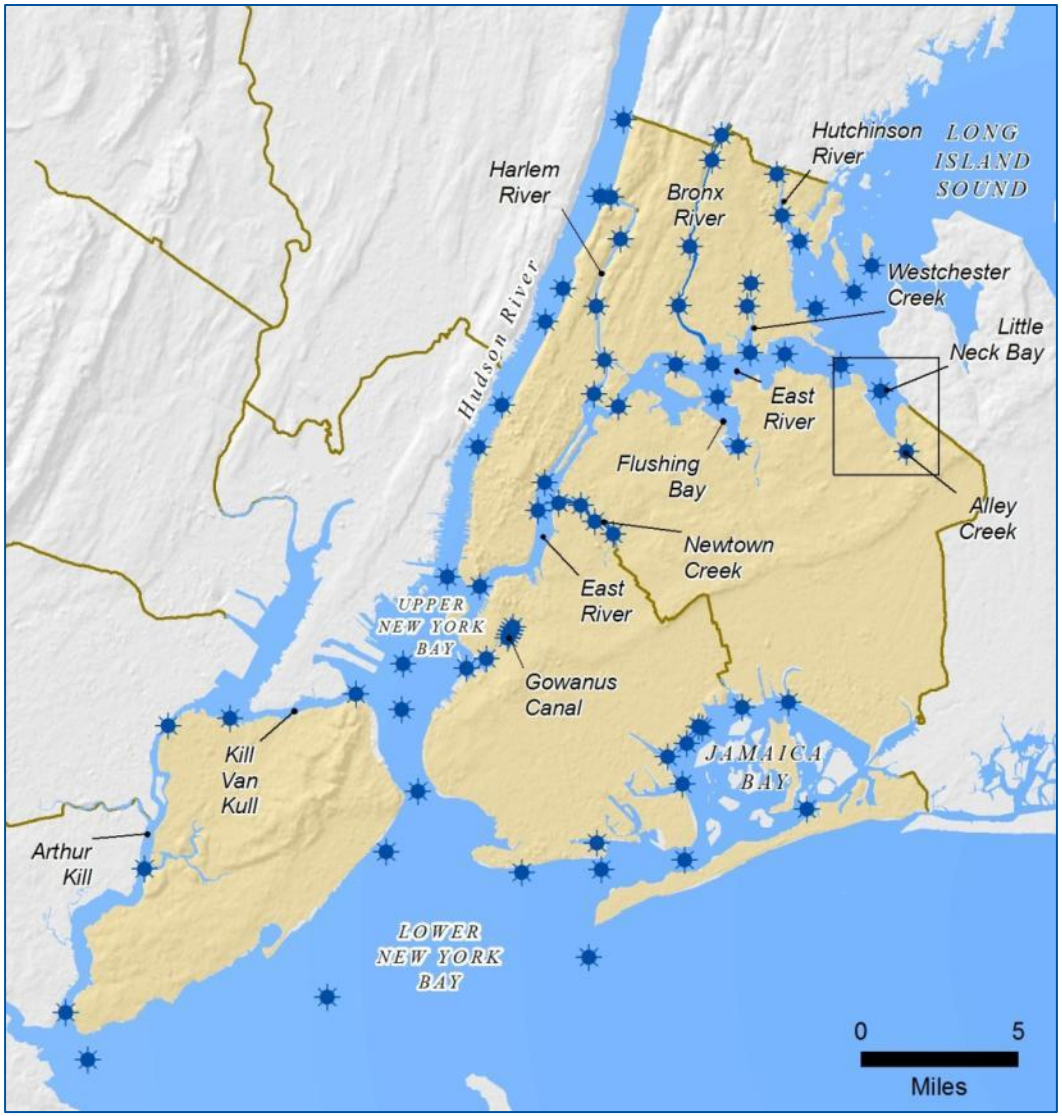
2012 Model Refinement

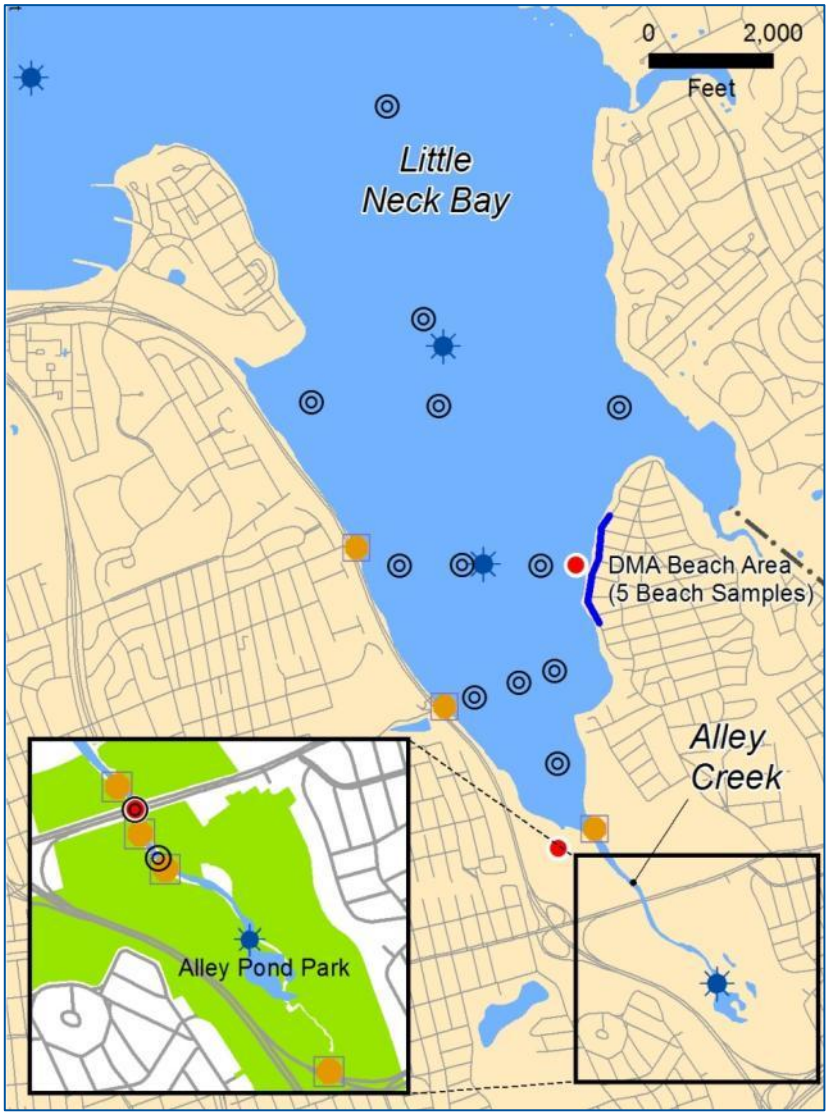
Little Neck Bay / Alley Creek

WWFP (2008)

2013 REVISION - DRAFT

Water Quality Model Calibration

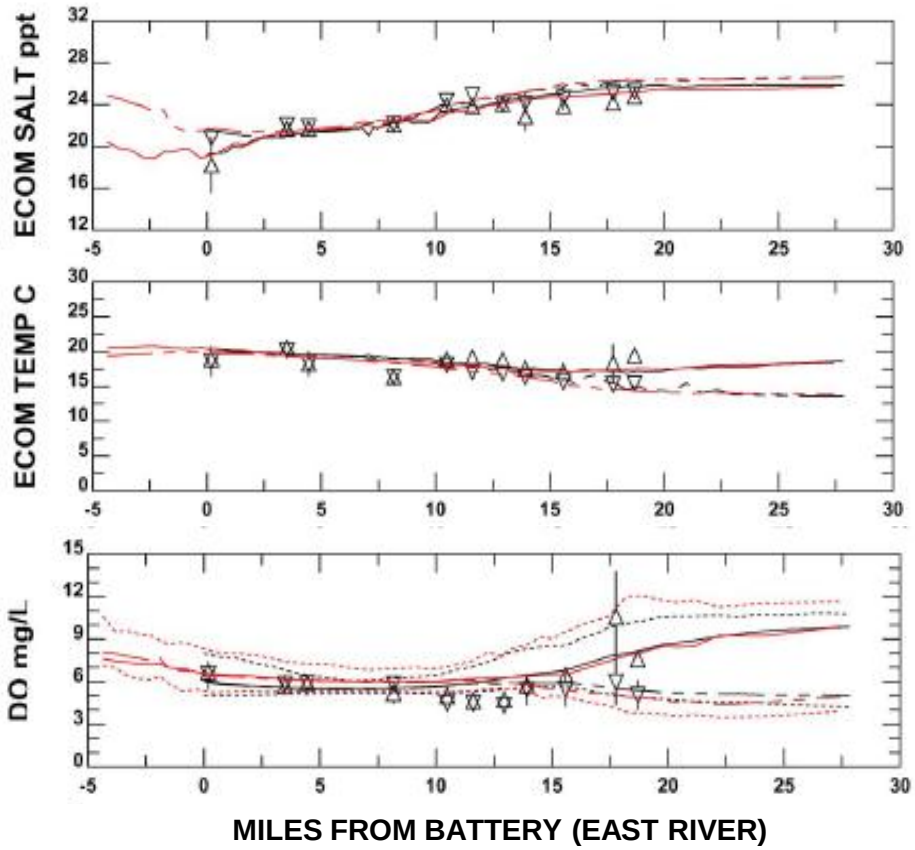




Harbor Survey Open Water Sample
Outfall Station

Water Quality Model Calibration

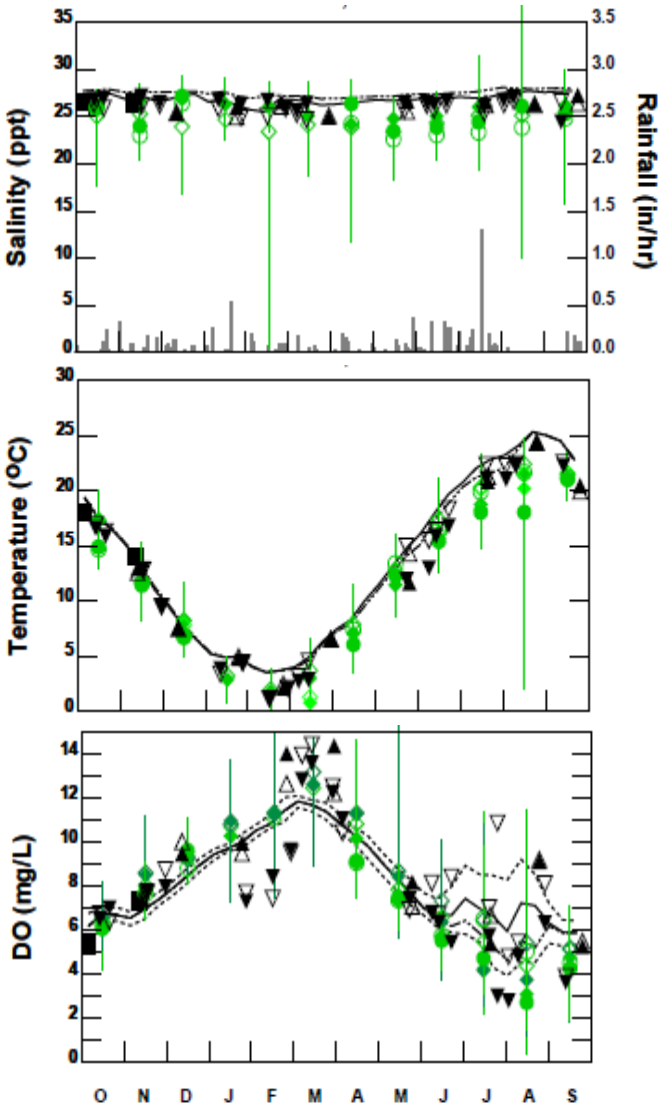
Spatial Calibration



Symbols = measured data
Lines = model calculations

Annual Calibration

Location: East River at Little Neck Bay



A Long History of Peer Reviews and Value-Engineering Reviews

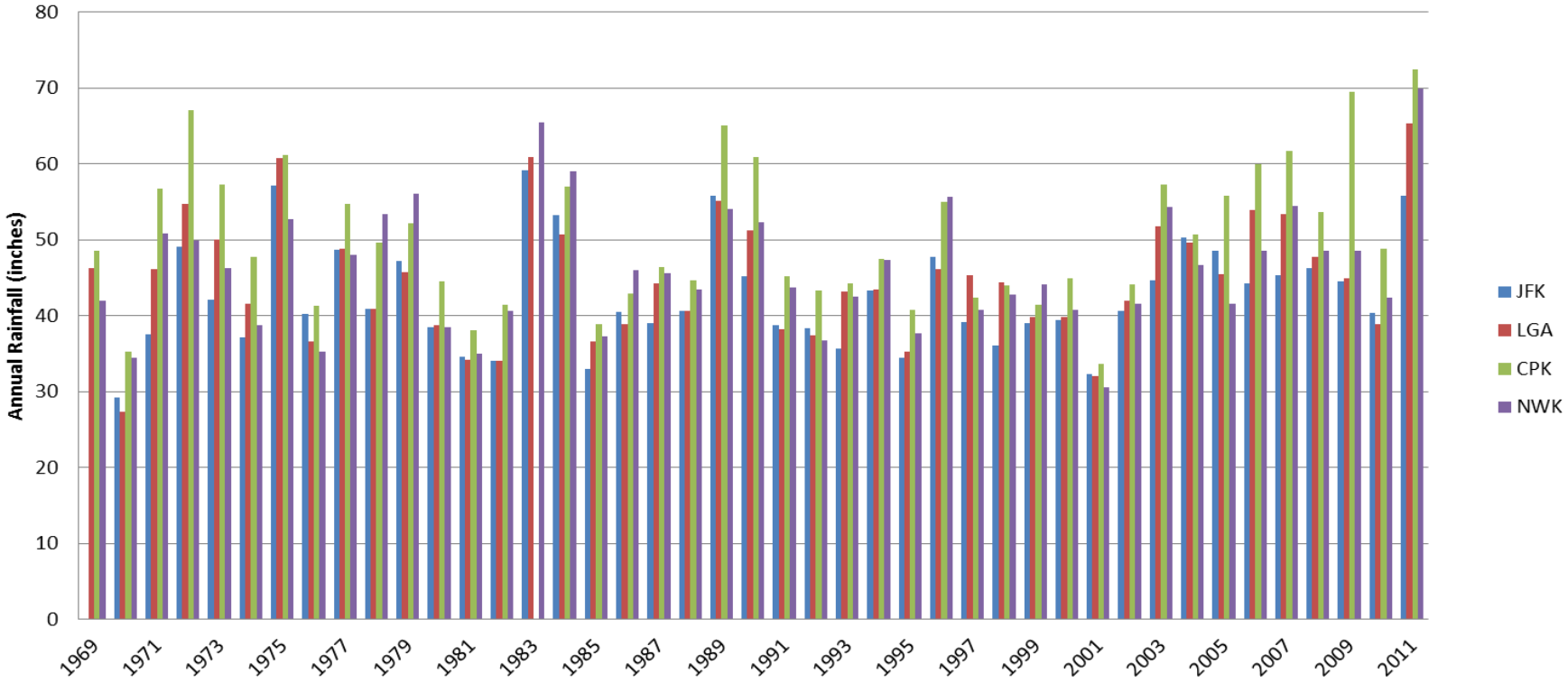
- **SWEM (System Wide Eutrophication Model)**
  Three Model Evaluation Groups (MEGs) over a 5-year period
- **PATH (Harbor Estuary Program Pathogens Model)**
  MEG reviews (2005)
- **JEM (Jamaica Bay Eutrophication Model)**
  MEG reviews (2002-2003)
- **CARP (Contaminant Assessment & Reduction Program)**
  MEG reviews (2002-2007)

ASCE Award - Blumberg, Khan, St. John (1999). Three-Dimensional Hydrodynamic Model of NY Harbor Region. J. Hydraulic Eng.

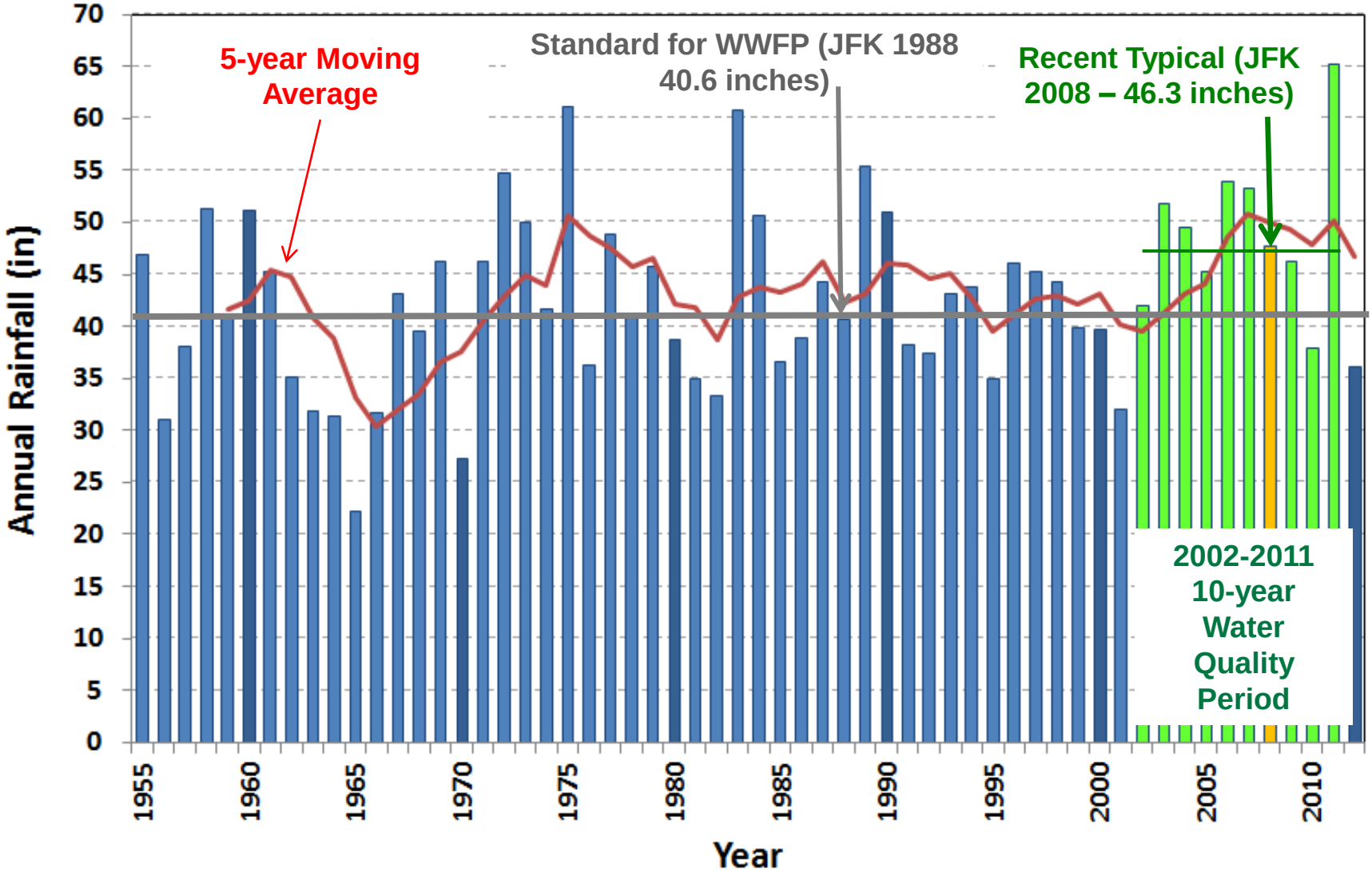
Assumptions Used for LTCP Baseline Conditions in 2040

Rainfall Conditions

- Reevaluate rainfall conditions to incorporate more recent wet weather events and patterns
- Account for climate variability through sensitivity analysis



Annual Rainfall History

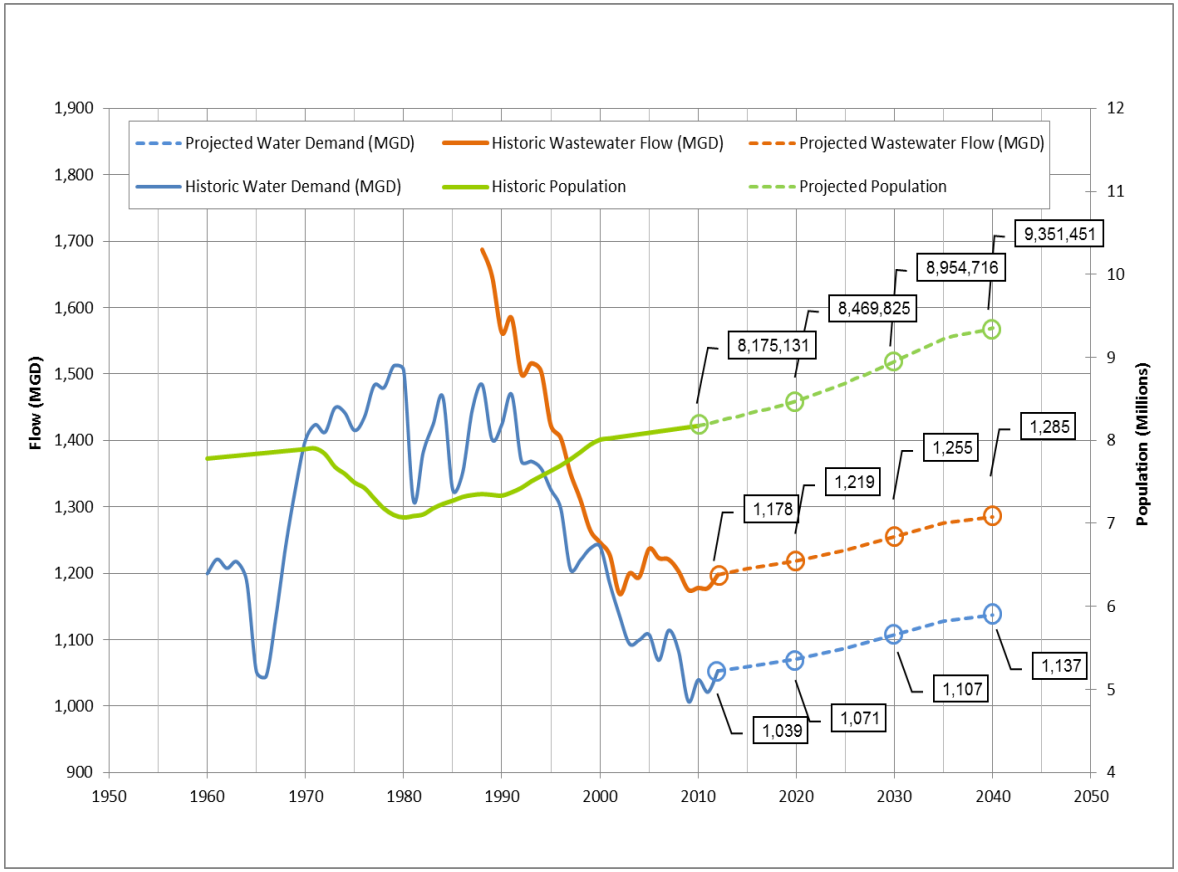


Varying Rainfall for Baseline Assessments

- CY2008 JFK, as typical year, for screening and selection of alternatives
- CY2008 JFK to project attainment of DO water quality standards (WQS), because eutrophication modeling requires significant computational effort
- 10 years of recent rainfall data (2002-2011) to assess attainment with Pathogen WQS

Projected Sanitary WWTP Inflows

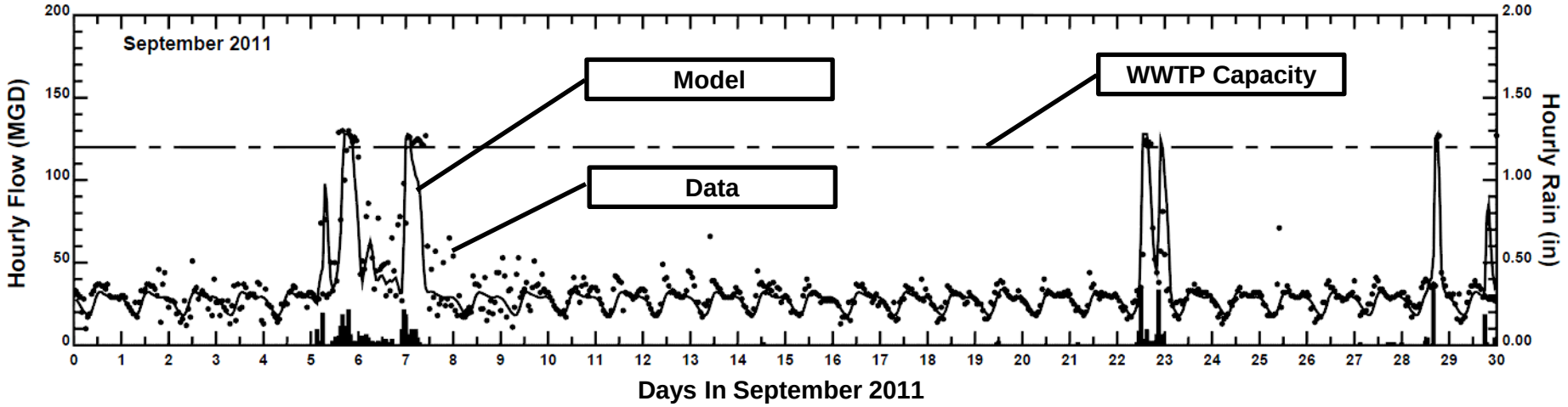
- DEP updated water consumption and DWF projections in 2012 based on 2010 census
- Flow projections are based on Transportation Analysis Zones from NY Metropolitan Transportation Council and City Planning

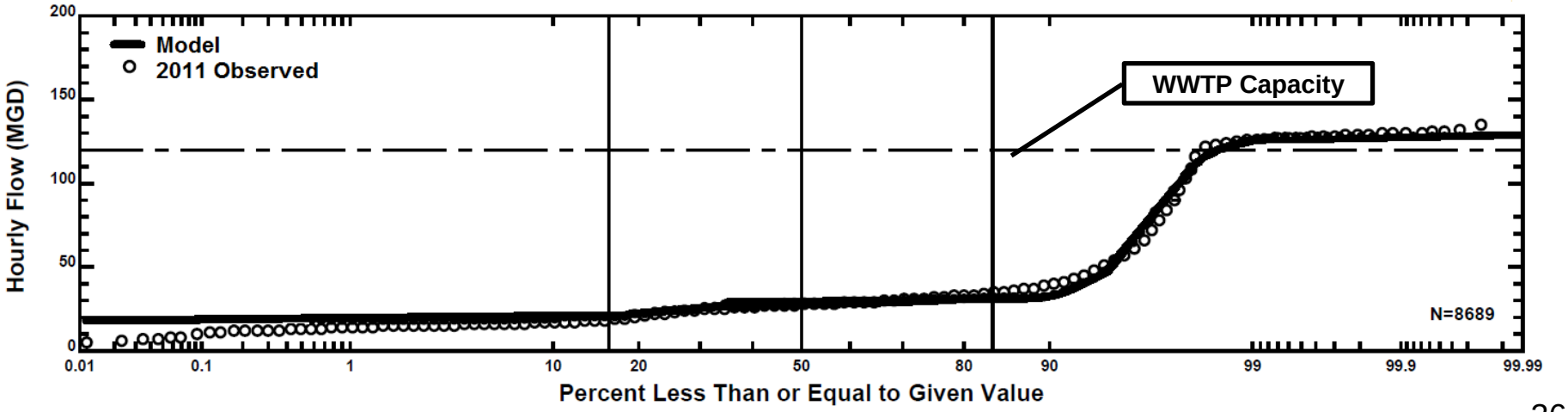


Year	26W	BB	CI	HP	JA	NC	NR	OB	OH	PR	RH	RK	TI	WI	Total
2040	48	114	85	122	84	234	125	32	93	29	30	23	60	208	1,285

Wet Weather Capacity at WWTPs

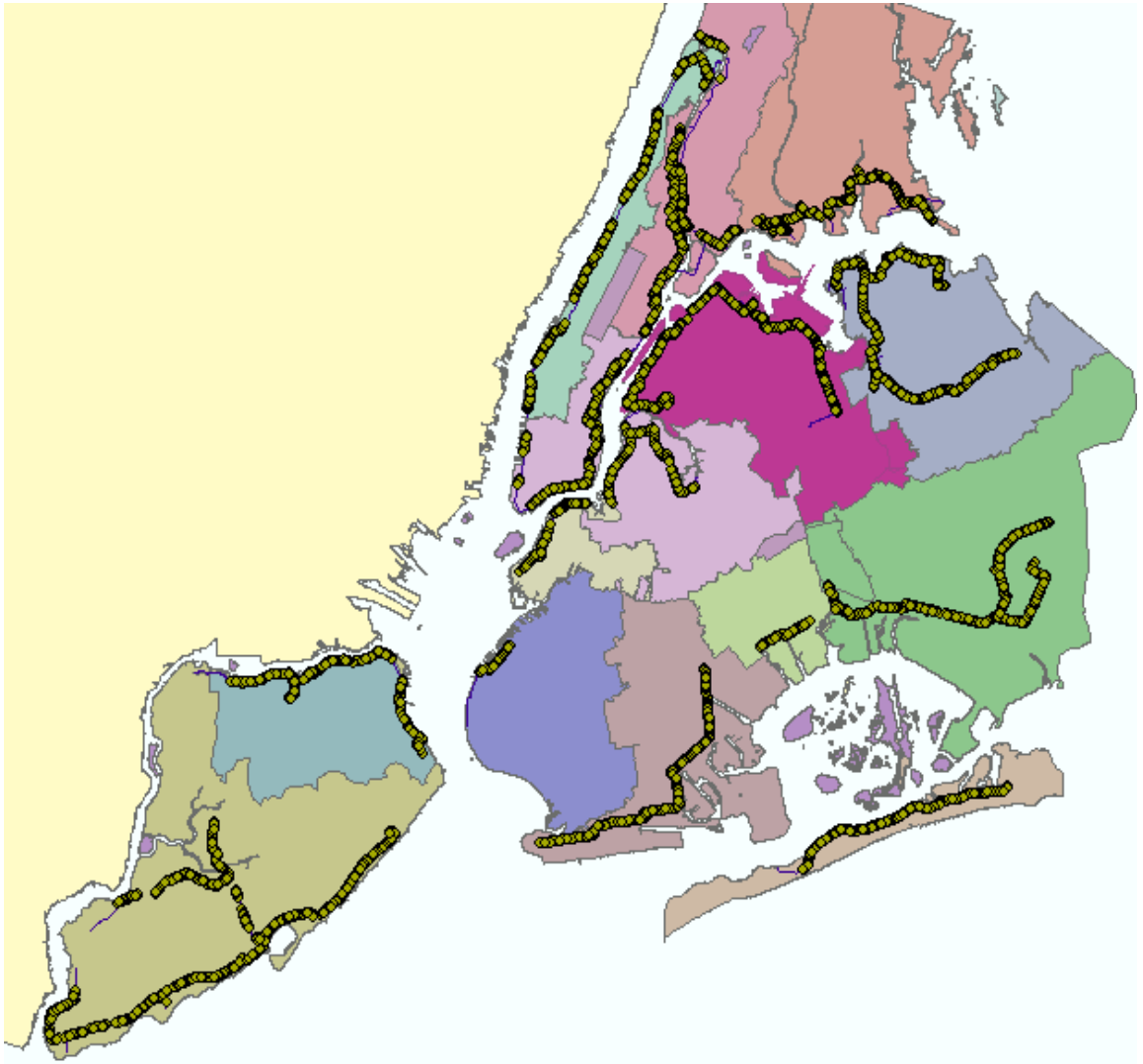
Assumption: Maximum WWTP Capacity is set at 2XDesign Dry Weather Flow Level





Sewer System Conditions

- Sediment inspections facilitated interceptor sewer cleaning
- Assumed post sewer-cleaning sediment conditions in interceptors
- Assumed no sedimentation in upstream combined sewers



Sonar Inspection Locations

Green Infrastructure (GI) Implementation

- Phased approach between 2010 and 2030
- Current phase focuses on specific tributary watersheds
- Future phase for East River, open waters, and tributaries with grey projects

Waterbodies/Watersheds	CSIA (Acres)	ROW Public		Onsite Public		Onsite Private		Total	
		Managed Acres	Percent of CSIA	Managed Acres	Percent of CSIA	Managed Acres	Percent of CSIA	Managed Acres	Percent of CSIA
Current Phase: Priority Drainage Areas									
Alley Creek	1,490		0%		0%	45	3.0%	**45**	**3.0%**
Bronx River	2,331	244	10%	13	0.6%	66	2.8%	**322**	**14%**
Coney Island Creek	694		0%		0%	7	1.0%	**7**	**1.0%**
Flushing Bay	4,049	401	10%	11	0.3%	110	2.7%	**522**	**13%**
Flushing Creek	5,923	314	5.3%		0%	165	2.8%	**479**	**8.1%**
Gowanus Canal	1,387	135	10%	5	0.4%	22	1.6%	**162**	**12%**
Hutchinson River	1,128	111	10%	15	1.3%	32	2.9%	**158**	**14%**
Jamaica Bay & CSO Tributaries	7,891	386	4.9%	23	0.3%	266	3.4%	**675**	**8.6%**
Newtown Creek	4,524	461	10%	14	0.3%	118	2.6%	**593**	**13%**
Westchester Creek	3,480	348	10%	17	0.5%	122	3.5%	**487**	**14%**
Future Phase: DEP will explore opportunities for remainder of 10% GI target									

Capital Grey Infrastructure Projects

Recently Completed Projects:

- Alley Creek CSO Facility
- Paerdegat Basin CSO Facility
- Avenue V Pump Station and Force Main
- Bronx River Floatables Control

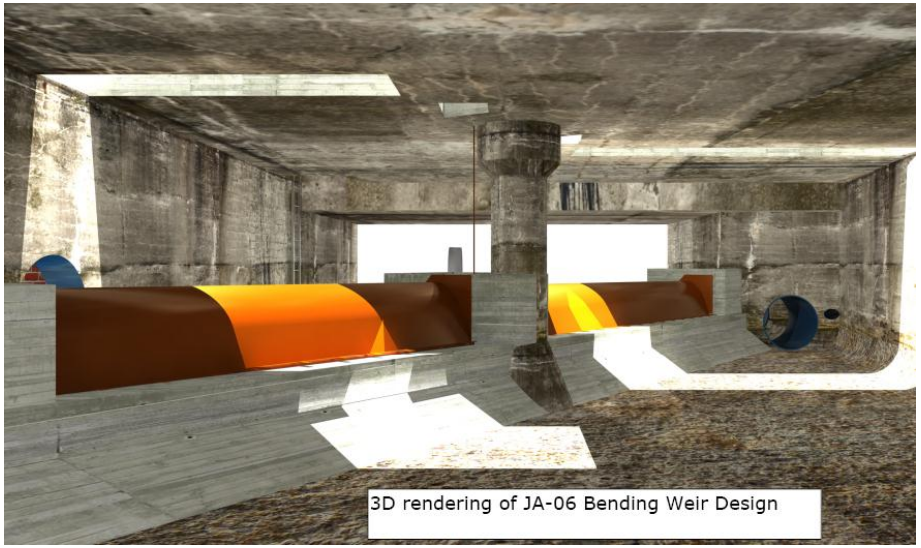
Active Construction Projects:

- Gowanus Pump Station & Flushing Tunnel
- Tallman Island Wet Weather Maximization

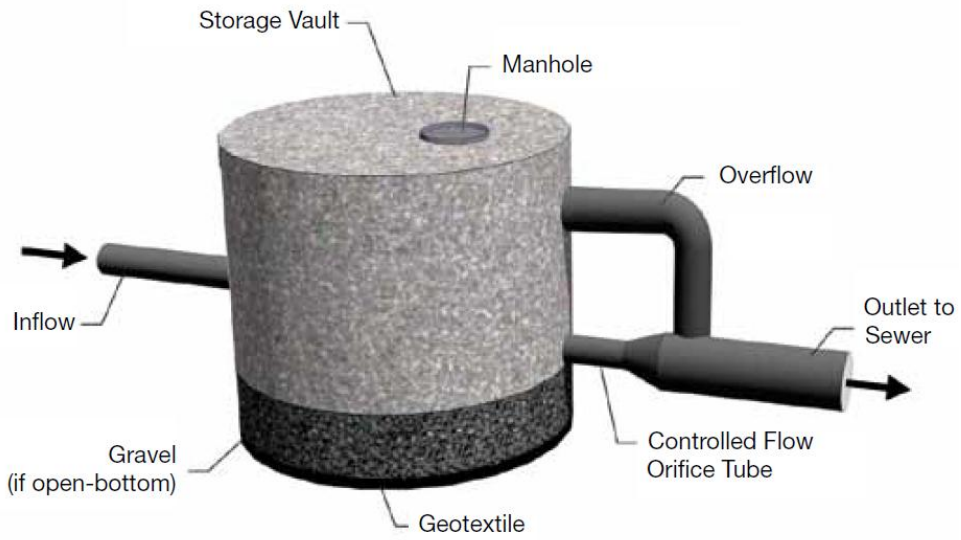
Upcoming Construction Projects:

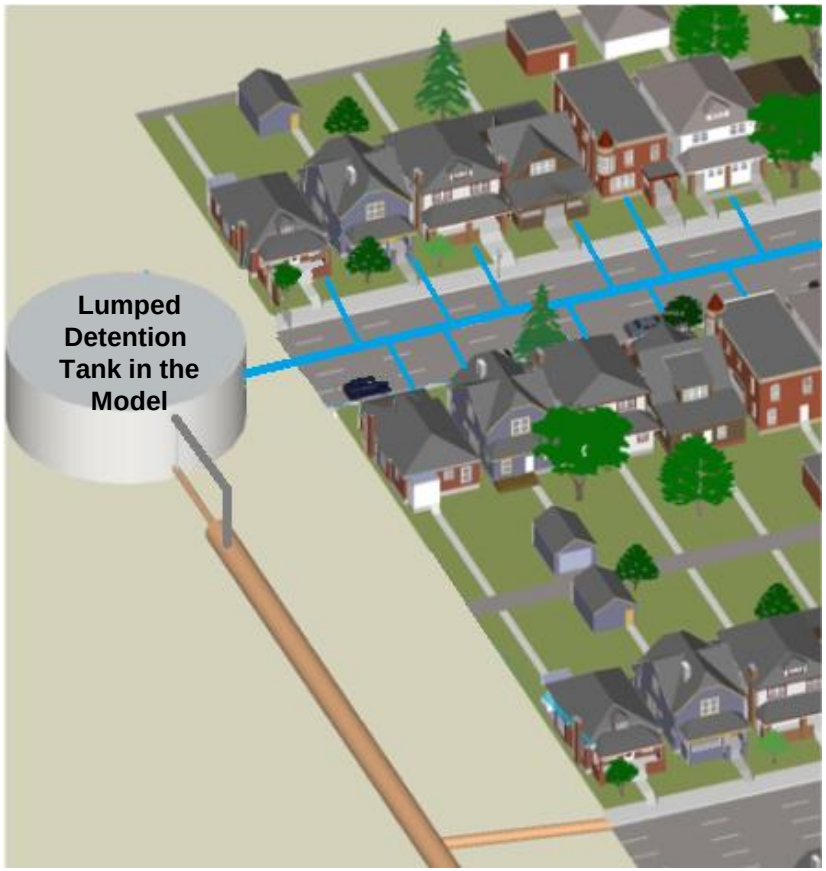
- Dredging (Flushing/ Paerdegat/ Gowanus)
- Newtown Creek Aeration
- Regulator Modifications (Newtown Creek, Flushing Bay, Jamaica Tributaries, and Westchester Creek)
- Sewer Work (Pugsley Creek, Fresh Creek HLSS, Belt Pkwy Crossing, & Flushing Bay Low Lying Sewers)
- 26th Ward Wet Weather Stabilization

Paerdegat Basin CSO Retention Facility



Modeling Methodology for On-site Detention

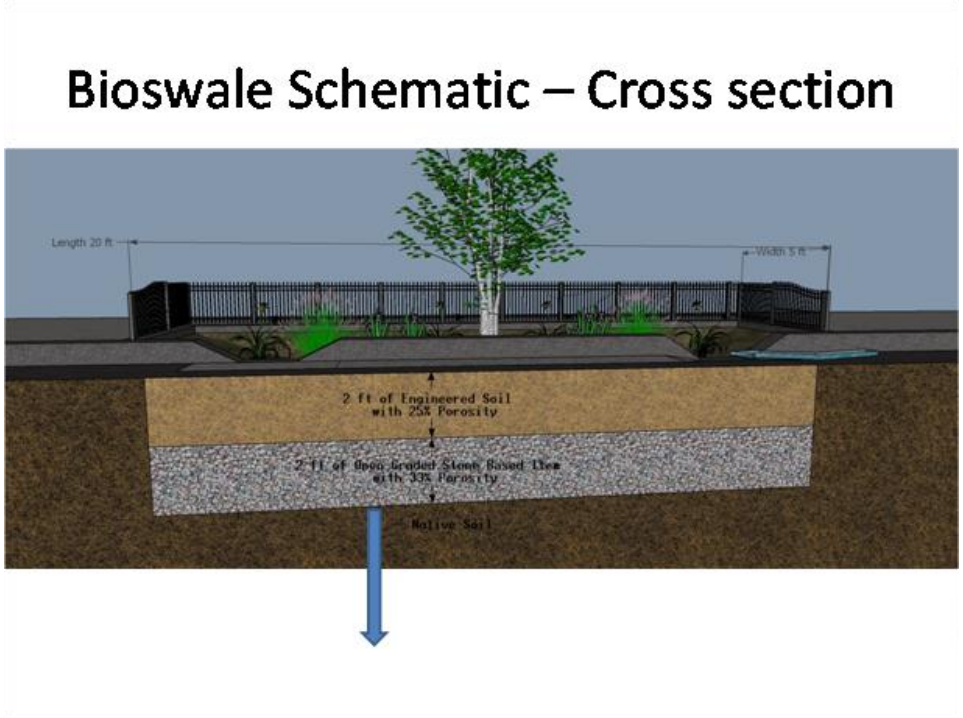




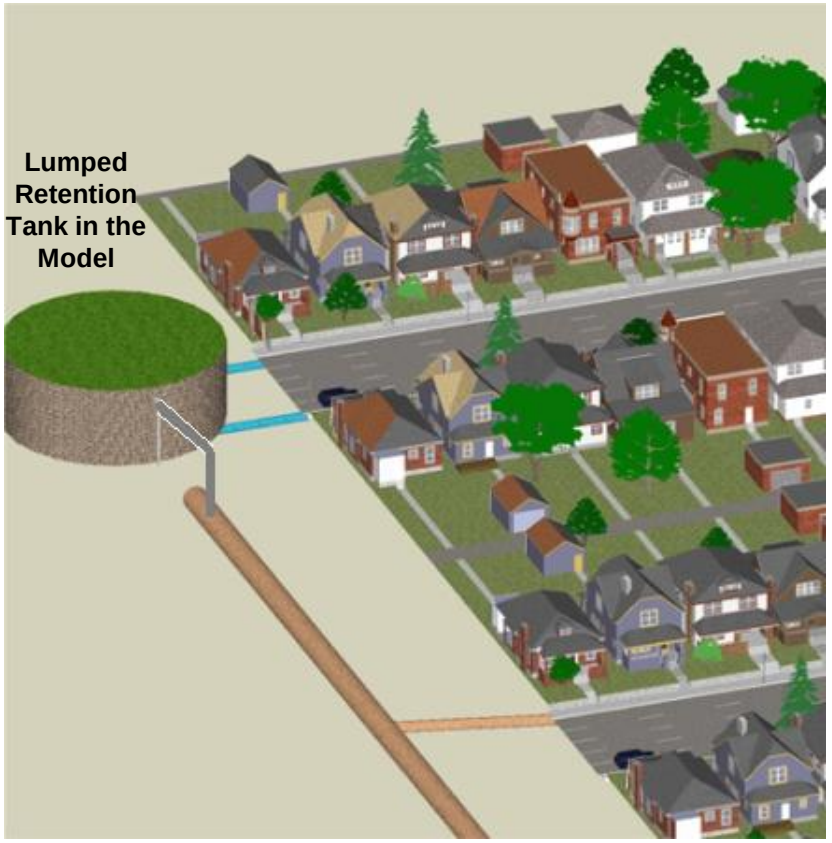
Site-scale

Sub-catchment Scale

Modeling Methodology for Retention



Site-scale



Sub-catchment Scale

Citywide Baseline Model Projections

WWTP-based Summary

WWTP Service Area	CSO Volume (MG/Yr)
26th Ward	435
Bowery Bay High Level	2,080
Bowery Bay Low Level	1,167
Coney Island	645
Hunts Point	2,766
Jamaica	1,533
Newtown Creek - Brooklyn	2,046
Newtown Creek - Manhattan	985
North River	517
Owls Head	2,635
Port Richmond	722
Red Hook	510
Tallman Island	1,676
Wards Island	2,868
Totals	**20,586**

Baseline inputs include:

- 2008 JFK Rainfall
- 2040 DWF
- Plants at 2XDDWF capacity
- Grey infrastructure from approved WWFPs (Appendix A of 2012 ACO)
- Current phase of GI implementation shown in Slide 38
- Post-cleaning sediment conditions in interceptors

Waterbody-based Summary

Waterbody	CSO Volume (MG/Yr)
Alley Creek and Little Neck Bay	131
Bronx River	565
Coney Island Creek	62
East River and Open Waters	12,225
Flushing Bay and Creek	2,442
Gowanus Canal	269
Hutchinson River	339
Jamaica Bay and CSO Tributaries	1,968
Newtown Creek	1,657
Paerdegat Basin	645
Westchester Creek	282
Total	**20,586**

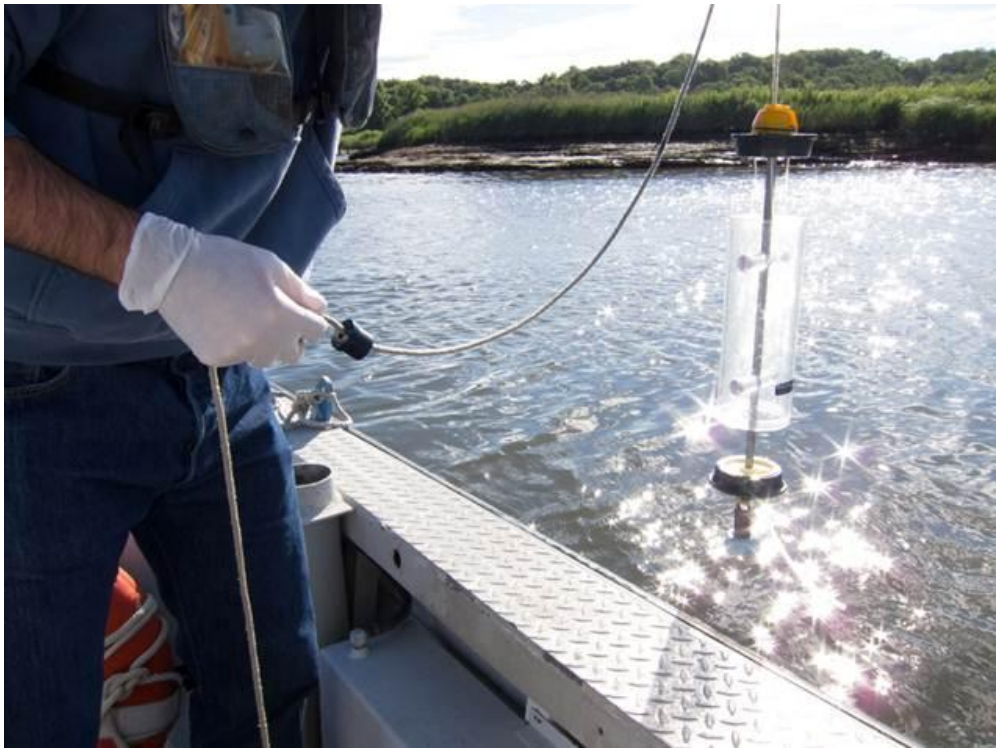
Next Steps

Future Watershed Model Refinements

- Ongoing monitoring to determine the success of the GI projects in managing one inch of stormwater from their catchment areas:
  - Continue to analyze water quantity data from 25 pilot projects
  - Complete in-sewer monitoring for three demonstration projects that include neighborhood-wide installations of ROW bioswales
  - Vary performance based on watersheds/boroughs, using the above data and additional information on underlying soil characteristics
- Additional targeted flow monitoring or post-construction monitoring in specific drainage areas
- InfoWorks watershed model parameters may be adjusted based on these monitoring efforts and updated to support waterbody-specific LTCP planning/facility designs

Post-Construction Monitoring (PCM)

- Provides measurements to verify that completed CSO controls are performing as designed and that the environmental benefits are as expected
- Also provides a way to validate and update modeling tools for continuing the assessment of WQ benefits from controls, subsequent to PCM completion



Questions and Discussions

Sensitivity Analysis for Climate Change

- **Rainfall –** JFK 2005 record to be used to reflect a Central Scenario in terms of increased event intensity/volumes
- **Sea Level Rise** – adjust 2005 tide data (hourly water levels from the Battery) by 0.8 feet to reflect a Central Scenario in terms of sea level rise

Applied Rainfall Statistics	WWFP JFK 1988	Average 1969-2010	Present Best Fit JFK 2008	Future Best Fit JFK 2005
Annual Rainfall (inches)	40.7	45.5	46.3	48.5
July Rainfall (inches)	6.7	4.3	3.3	5.2
November Rainfall (inches)	6.3	3.7	3.3	4.0
# Very Wet Days (> 2")	3.0	2.4	3.0	3.0
Avg Peak Storm Intensity (in/hr)	0.15	0.15	0.15	0.16