



Climate-Resilient Water Resource Planning in New York City

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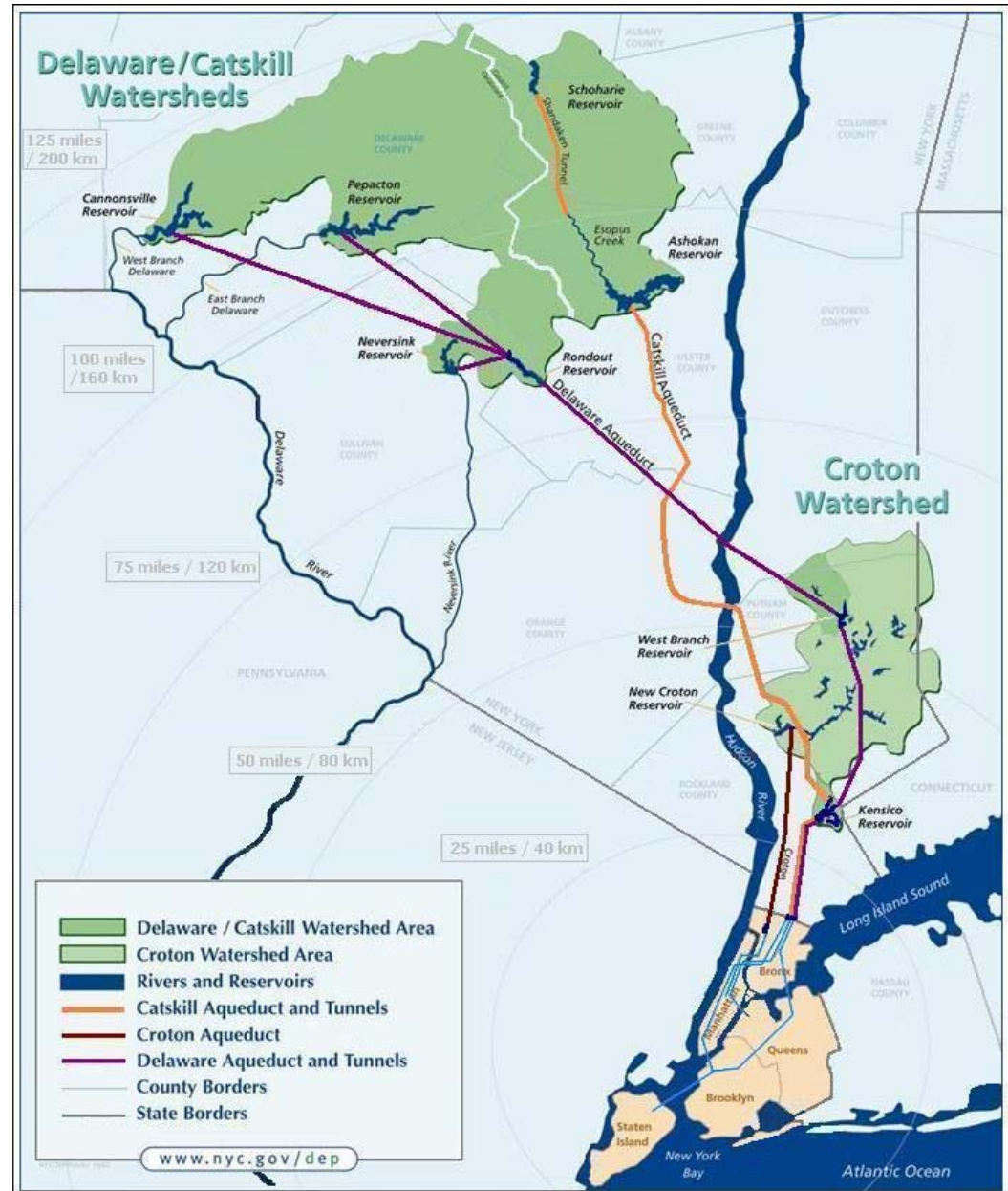
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A Brief Introduction to DEP

- NYC watershed extends more than 125 miles (200 km) from the city, and comprises 19 reservoirs, and 3 aqueducts
- Supply more than 1 billion gallons of water/day for 9 million residents
- NYC remains one of only five large cities in the United States that is not required to filter its drinking water



A Brief Introduction to DEP

- Treat 1.3 billion gallons of wastewater per day
 - ~7,400 miles of sewer lines take wastewater to 14 treatment plants
- Manage stormwater throughout the City



First Came Irene and Lee...

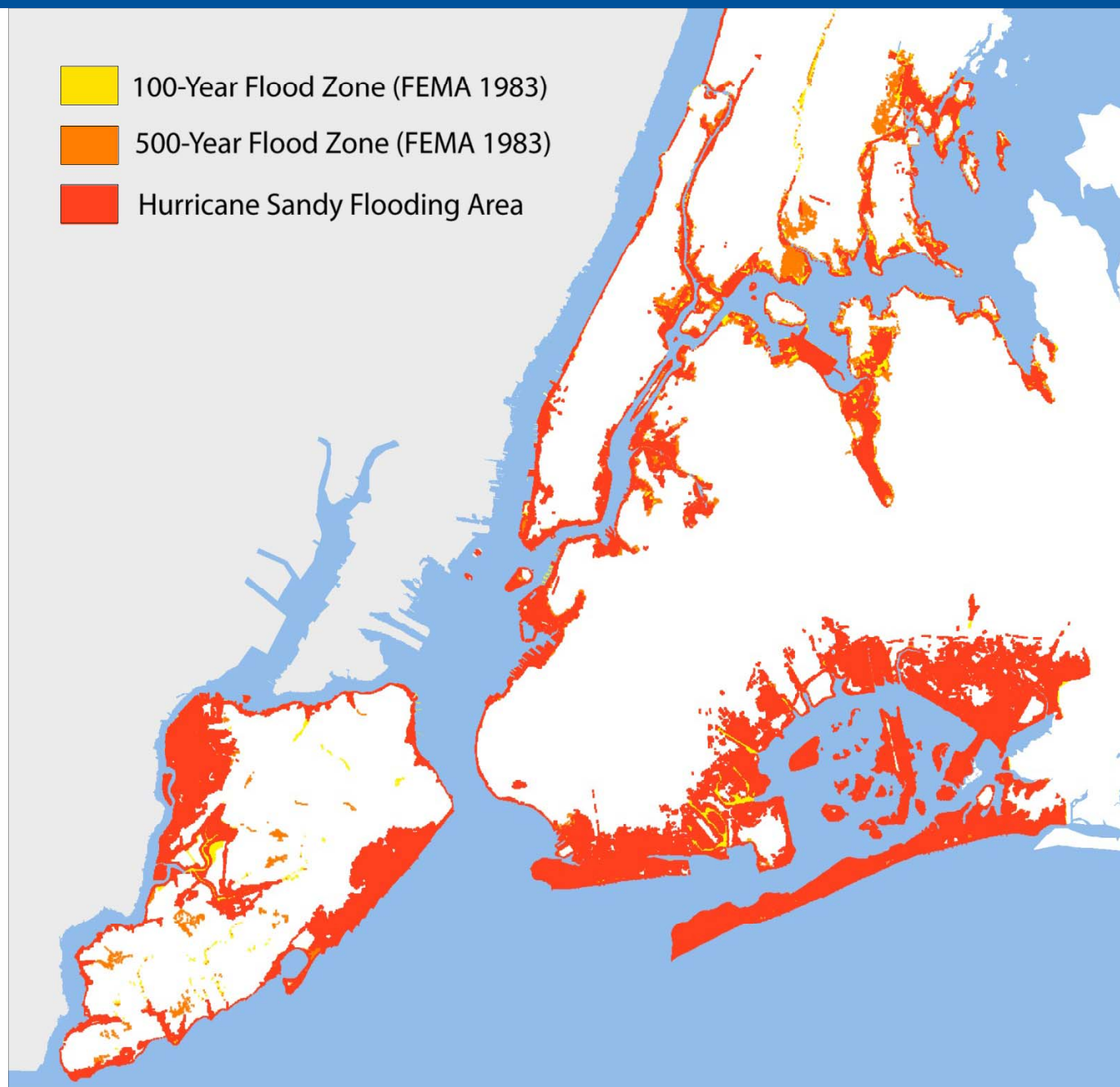
- In 2011, all-time rainfall records were broken
 - Tropical Storm Irene: 16 inches of rain < 24 hours.
 - Tropical Storm Lee - 2 weeks later the Catskill watershed received another 8 inches of intense rain
- Millions of dollars in reconstruction, repairs and debris removal, with millions of dollars committed to future studies



Water spills over the Gilboa Dam in Gilboa, NY. Aug. 29, 2011.

... And Now Sandy

- Record high water level- 13.88 feet at the Battery
- Wind gusts up to 90 mph
- Extensive flooding, beyond the boundaries of the 500-year floodplain



Hurricane Sandy's Impact on the City



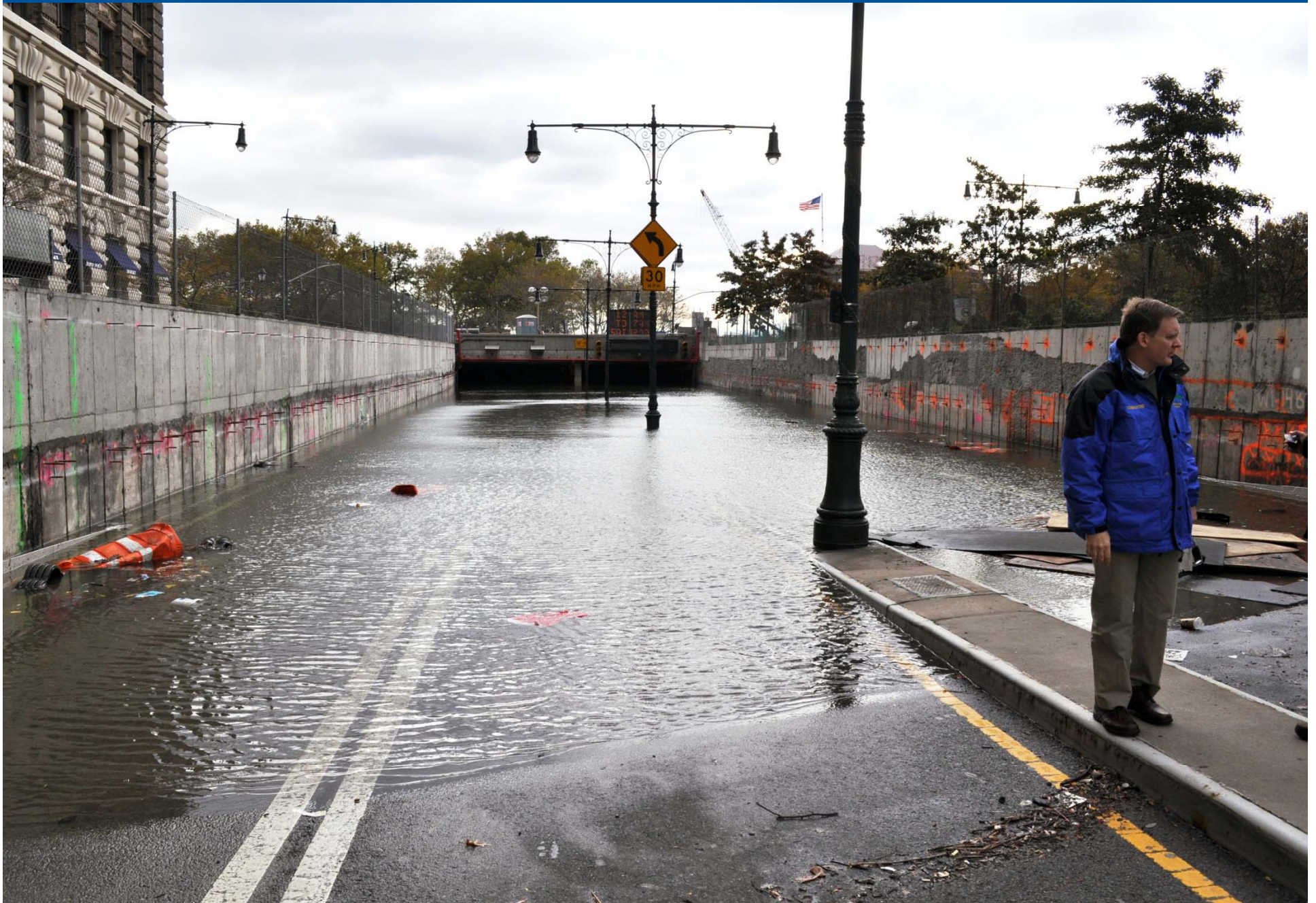
Widespread Flooding – Red Hook



Subway System Inundation



Battery Tunnel Underpass



High Water Mark, Newtown Creek WWTP



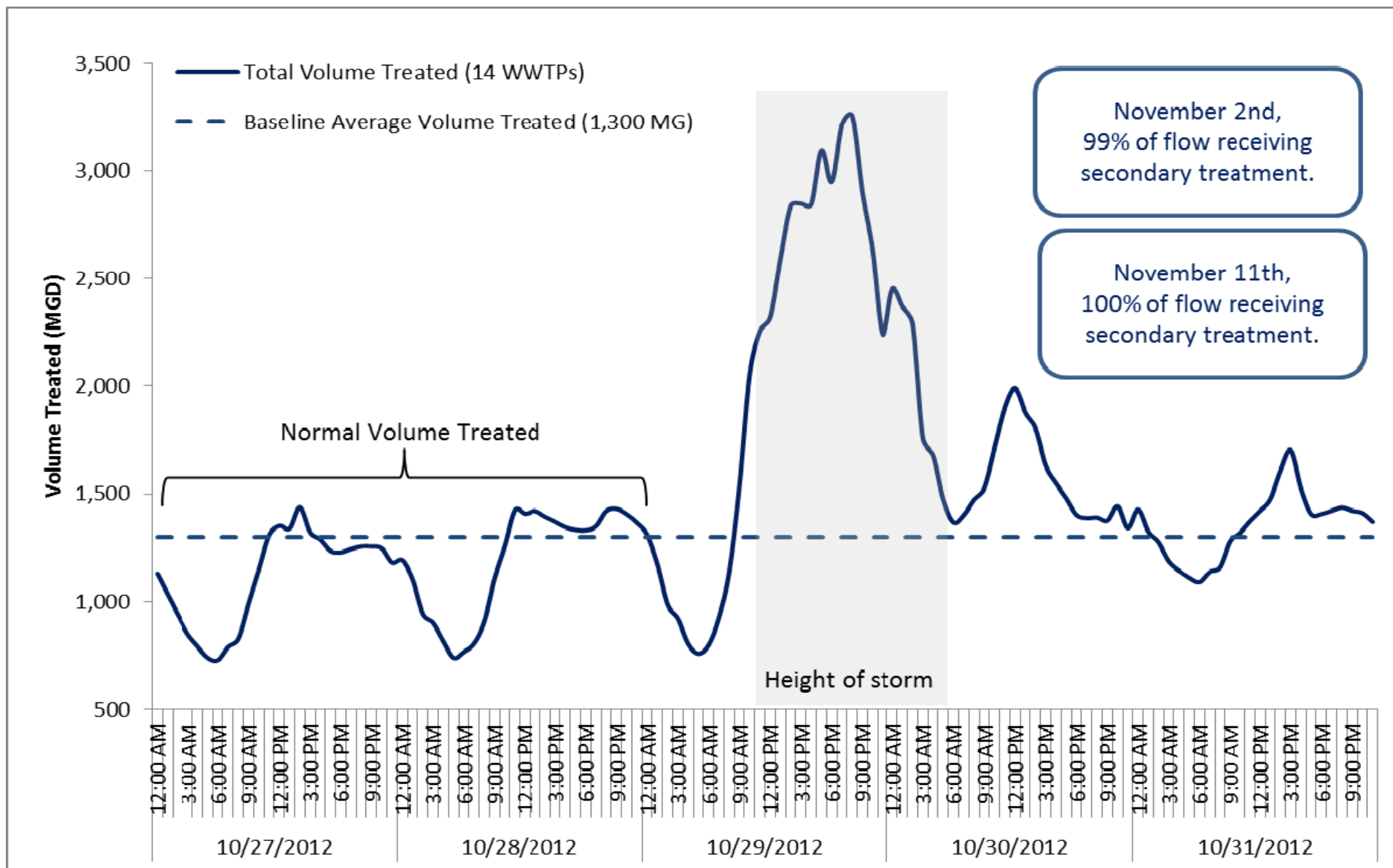
Wastewater Impacts



- Three plants lose ability to treat wastewater for some duration
- 10 of 14 plants experience some flooding or process issues
- 42 of 96 pump stations flooded or without utility power
- Damage to tide gates and interceptors
- Debris and sand pushed into catch basins and sewers

Wastewater Impacts

During the height of the storm 10 of the 14 WWTPs were treating 2xDDWF



City-wide Recovery

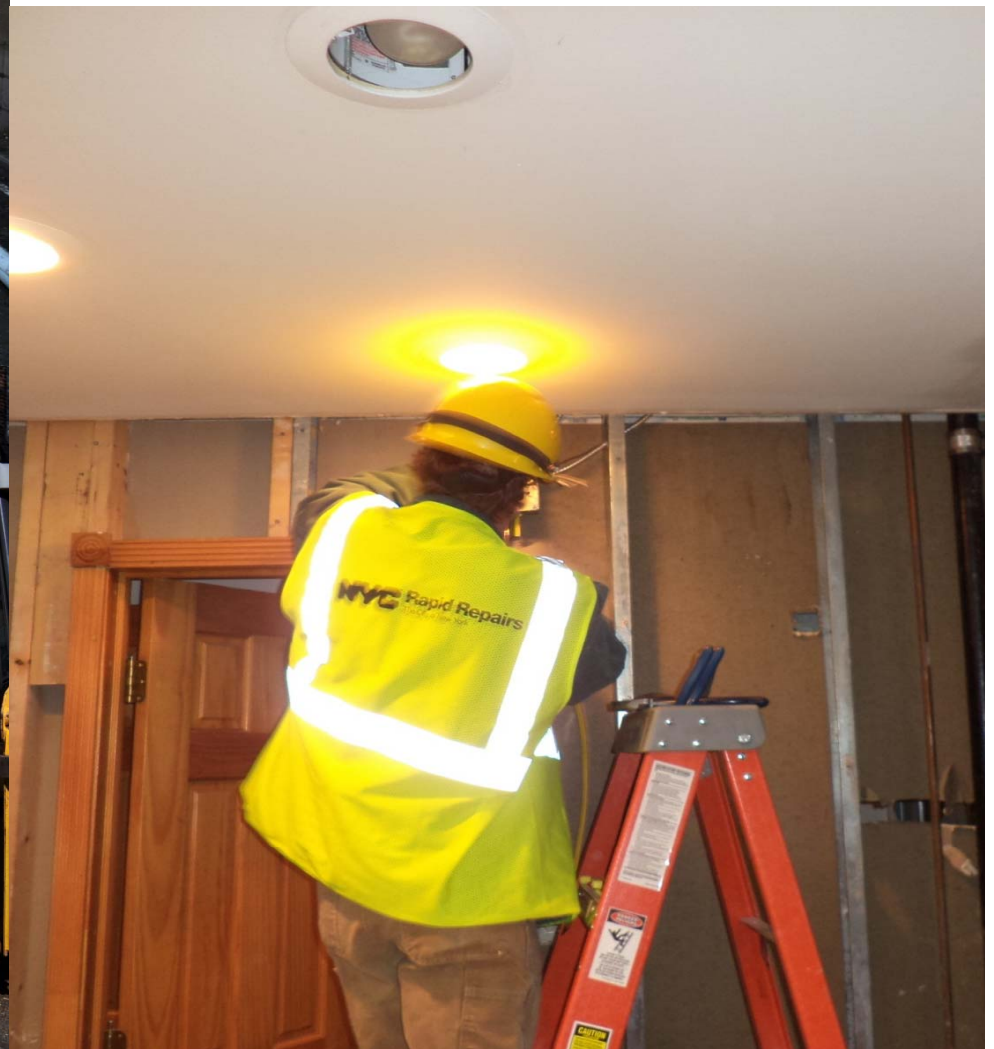


Dewatering

NYC Rapid Repairs
The City of New York

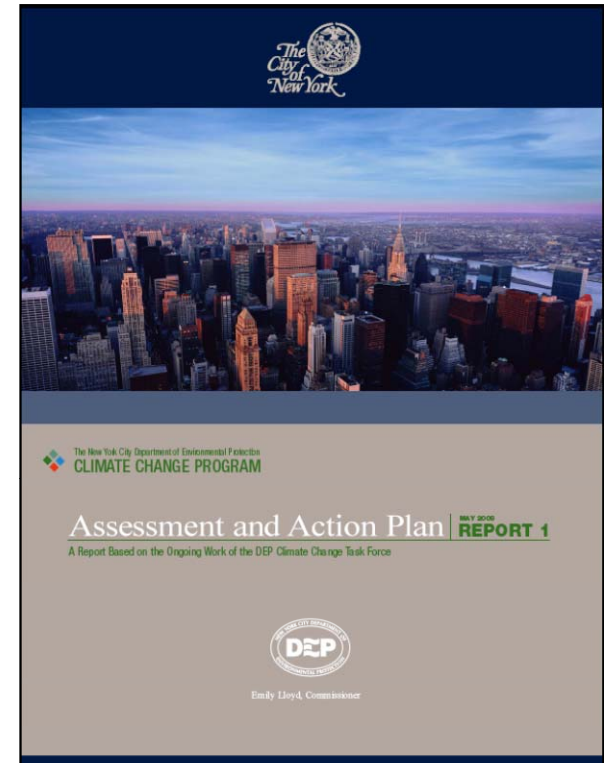


Tree Cleaning



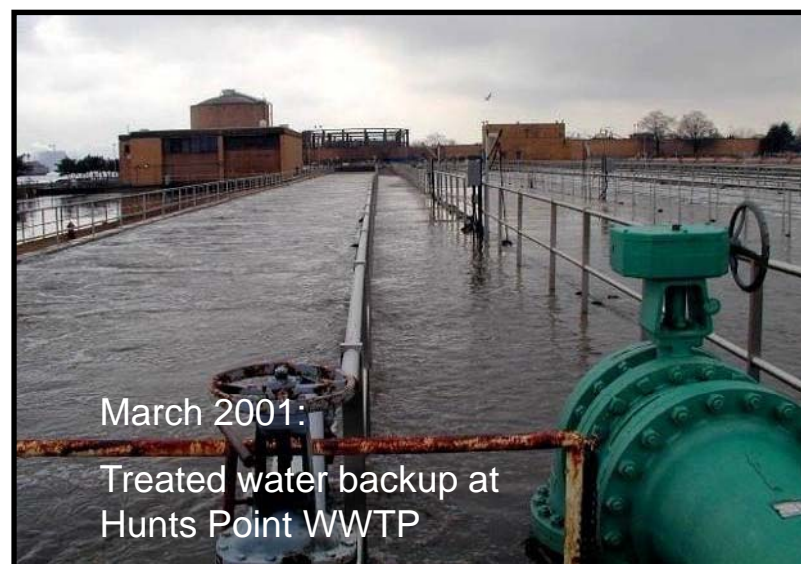
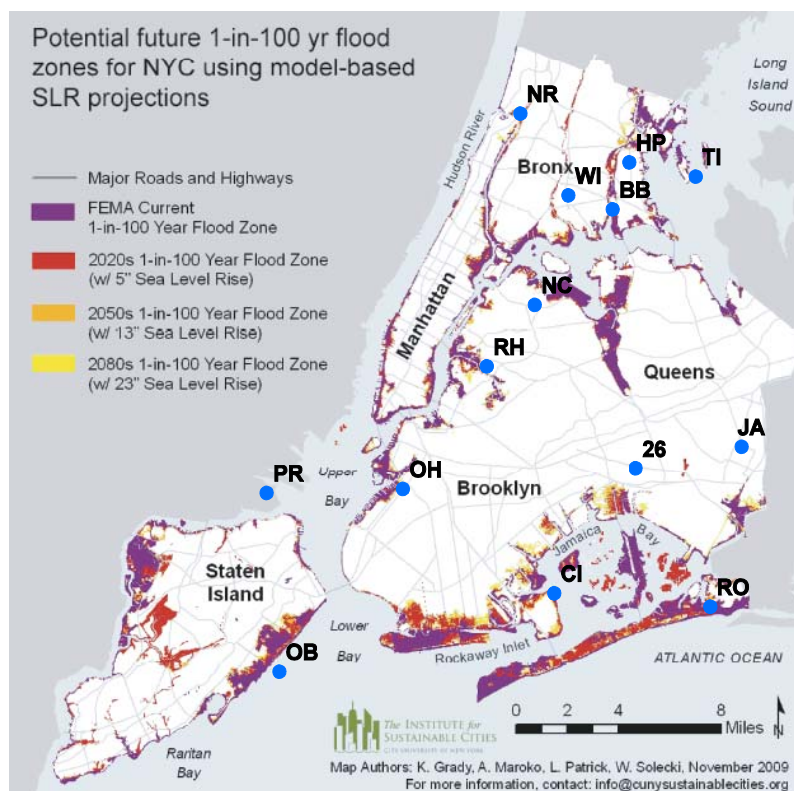
Climate Change Planning at DEP

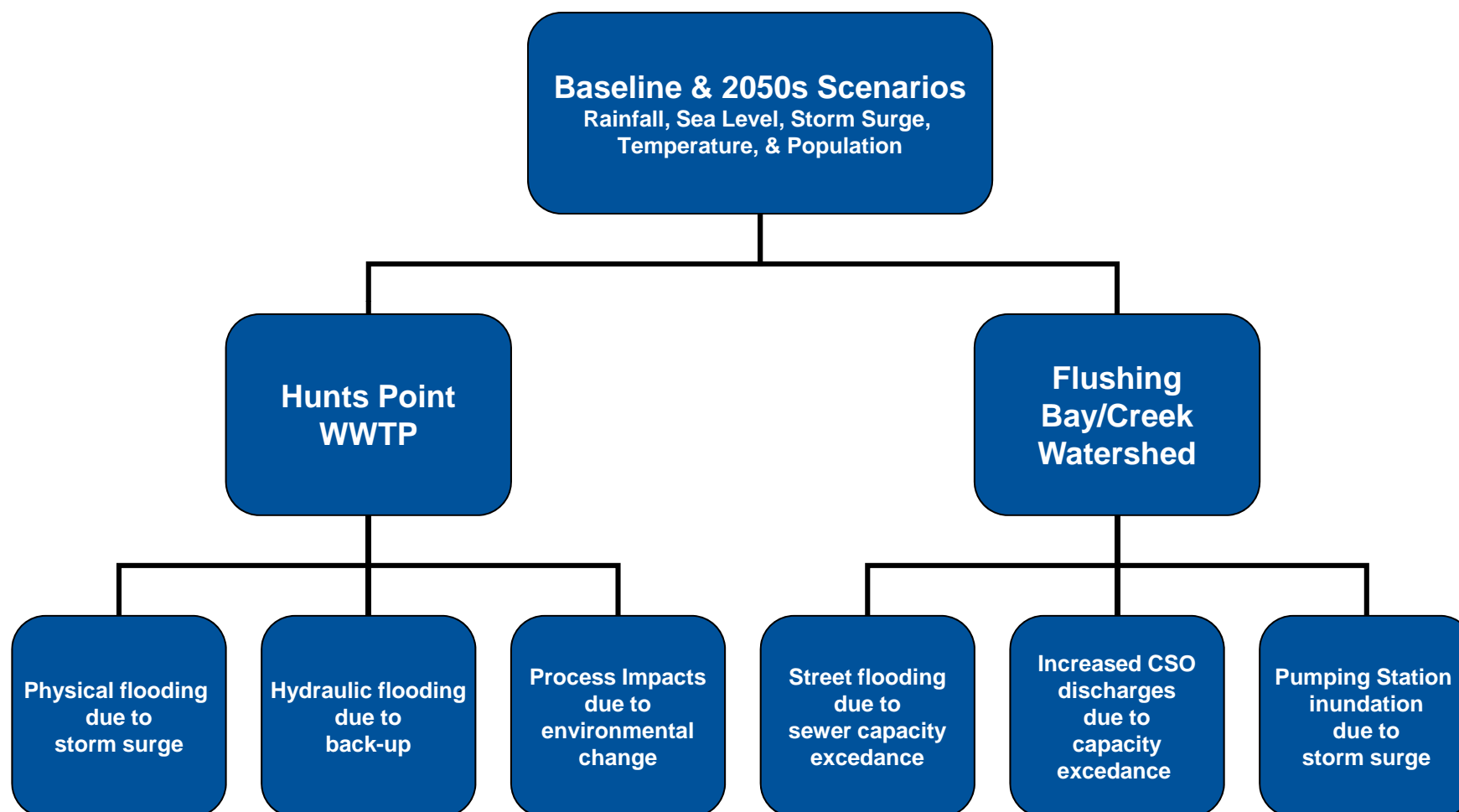
- 2003 Columbia University/NASA GISS commissioned to develop forecast scenarios for watershed region
- 2004 DEP initiates Climate Change Task Force
- 2008 Founding of Water Utility Climate Alliance (WUCA)
Climate Change Assessment and Action Plan released.
NYC Mayor's Office kicks off citywide Climate Change Adaptation Task Force
- 2009 DEP initiates Climate Change Integrated Modeling Project to quantify potential impacts of climate change on drinking water supply and quality
- 2011 DEP initiates 2 year study of Climate Change and Population Growth Effects on NYC Sewer and Wastewater Systems



Understanding Wastewater Impacts

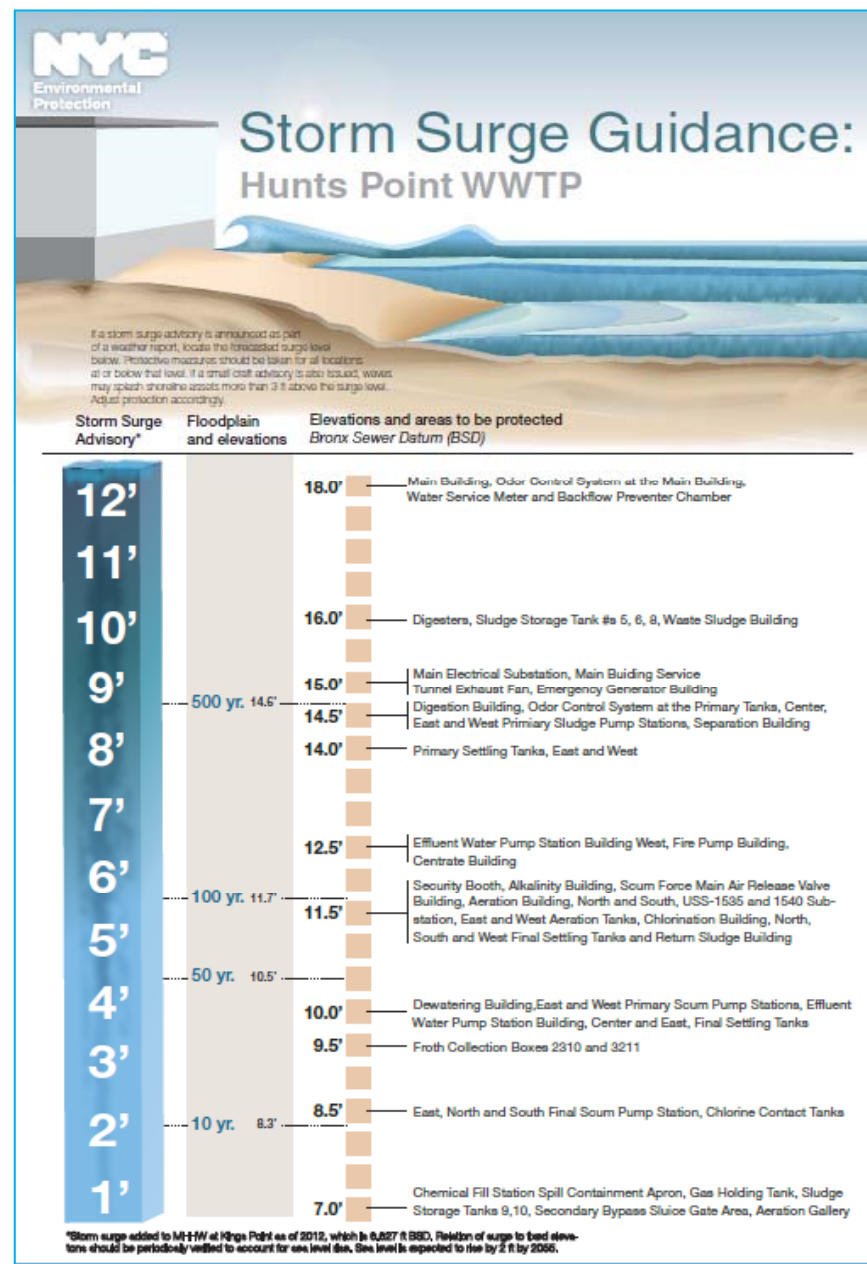
- Initiated a comprehensive framework to quantify the potential impacts of climate change-induced sea level rise, coastal flooding and precipitation changes in City wastewater infrastructure and harbor water quality





Hunt Point WWTP Storm Surge Analysis

- Almost 2,000 assets reviewed for Hunts Point WWTP
- Number of vulnerable, critical assets increases with sea level rise
 - 586 critical assets are in existing 100-year floodplain
 - With 24" of sea level rise, an additional 212 assets are at risk
 - With 29" of sea level rise, ~150 additional assets at risk



WWTP Adaptation Strategy Evaluation

Strategy	Relative Cost	Time to Implement
Empty sludge storage tanks in advance of a storm	\$	Immediate
Install water-tight doors and windows	\$	5-10 years
Sandbag critical pathways	\$	Immediate
Build static barriers	\$\$	5-10 years
Elevate key infrastructure	\$\$	10-15 years
Install flood-proof equipment	\$\$	10-15 years
Provide portable generators, pumps and other emergency equipment on-site or nearby for flood control	\$\$	Immediate
Use effluent pumping to overcome reductions in outfall capacity	\$\$\$	>15 years
Increase redundancy: Install more resilient redundant infrastructure to hedge against infrastructure losses and disruptions	\$\$\$	10-15 years

In-City Infrastructure Assessment: Phase II

- Expand the study area to locations affected by Hurricane Sandy and citywide and develop database with DEP infrastructure elevations and critical flood pathways
- Conduct risk analysis of citywide infrastructure
- Assess sensitivity of communities and sensitive areas affected by DEP infrastructure
- Recommendations for projects currently in facility planning or early design
- Recommend long term and near-term targeted strategies to protect citywide infrastructure



Understanding Water Quality Impacts

- Completed an integrated modeling project: climate change impacts on drinking water quality, supply, and demand



Sept 1999: turbid water overwhelms Ashokan dividing weir following Hurricane Floyd



➤ Continue maintaining DEP's Filtration Avoidance Determination:

- Land Acquisition
- Land Management
- Partnership Programs
- Streams, Farms and Forestry Programs
- Flexible Flow Management Program



➤ System interconnections

➤ Gravity Fed



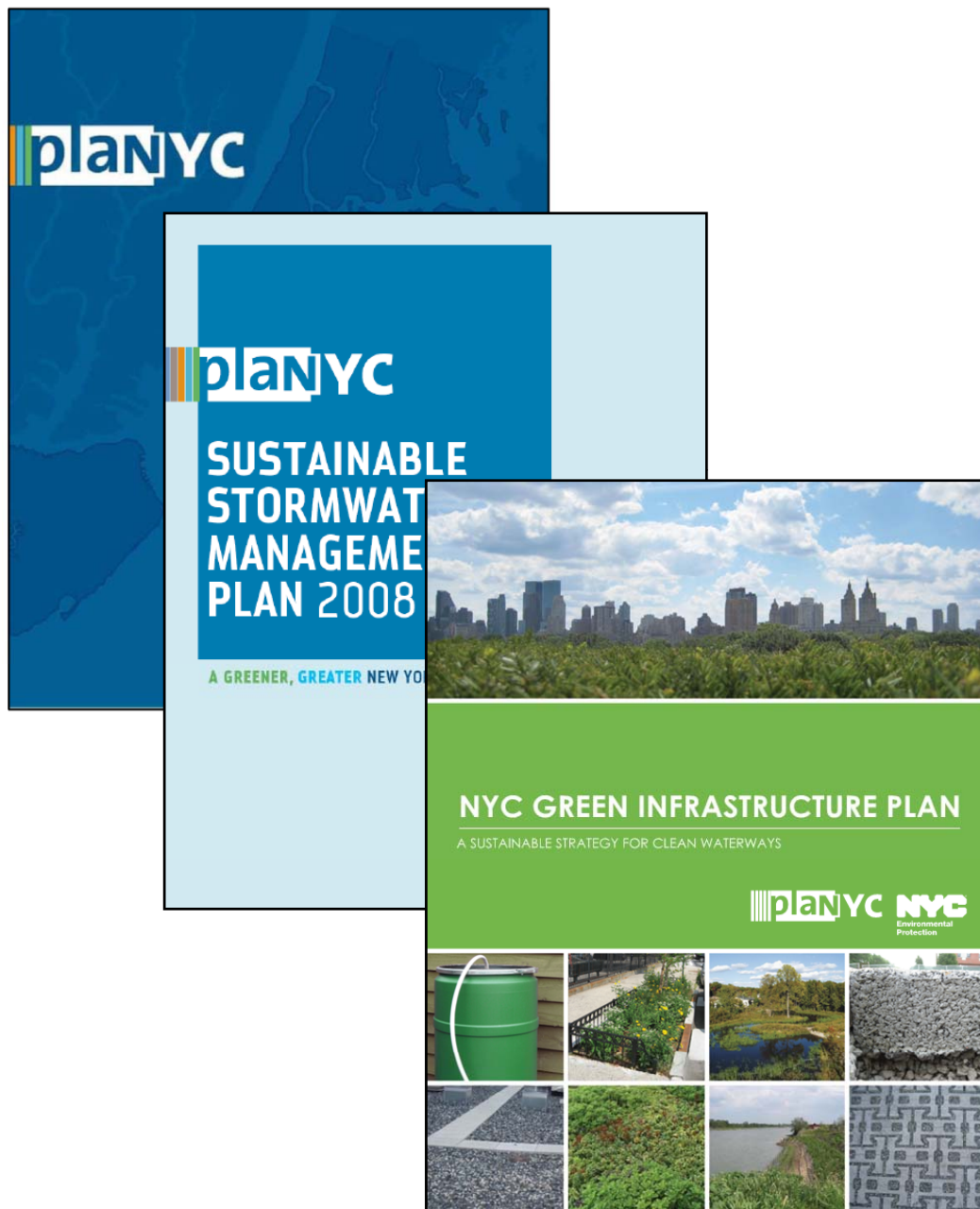
Sustainable Drinking Water Management

Distribution Management:

- Automated meter reading
- Enhanced water conservation
- Leak Detection



Sustainable Stormwater Management



- Build cost-effective grey infrastructure
- Optimize the existing wastewater system
- Control runoff from 10% of impervious surfaces through green infrastructure and other source controls
- Institutionalize adaptive management, model impacts, measure CSOs, and monitor water quality
- Sustain stakeholder engagement

Sustainable Stormwater Management



Paerdegat Detention Facility



Staten Island Bluebelt

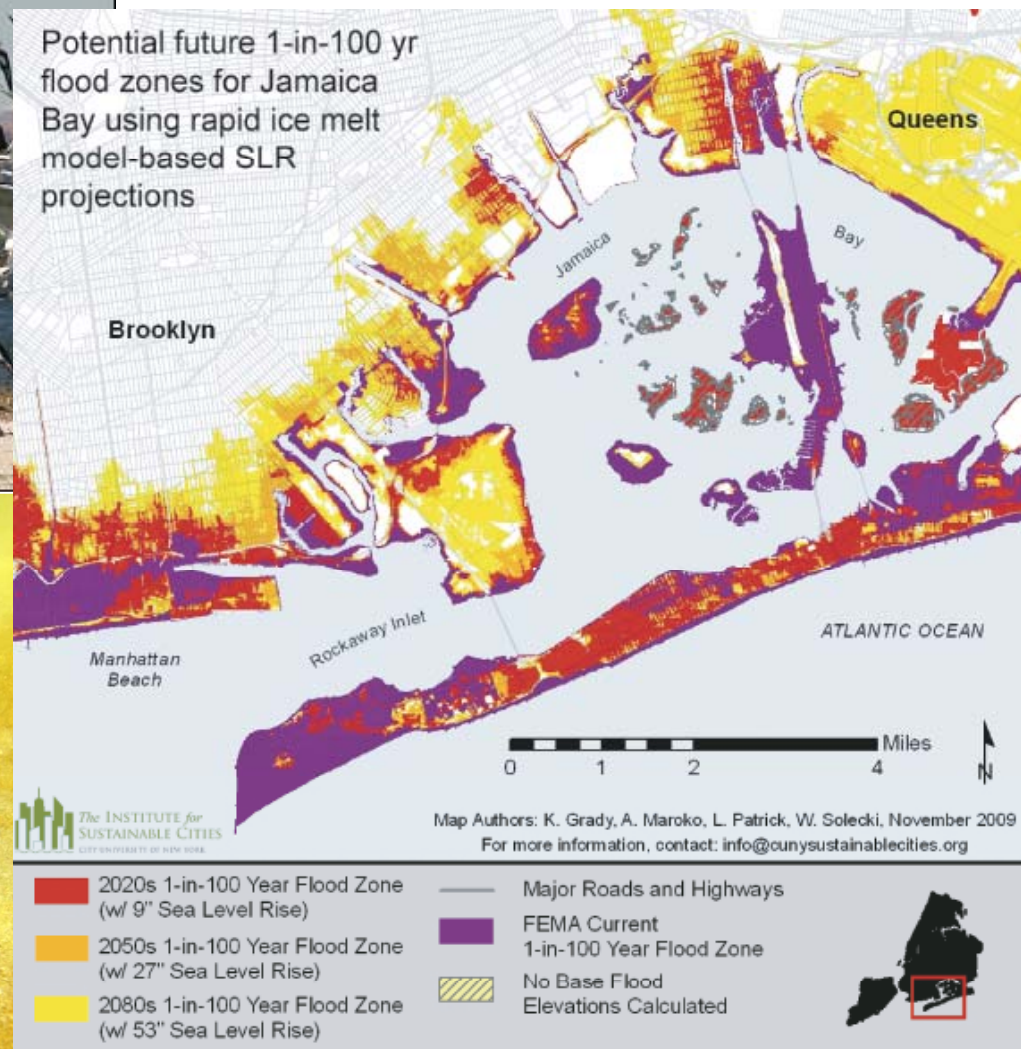


Catch Basins



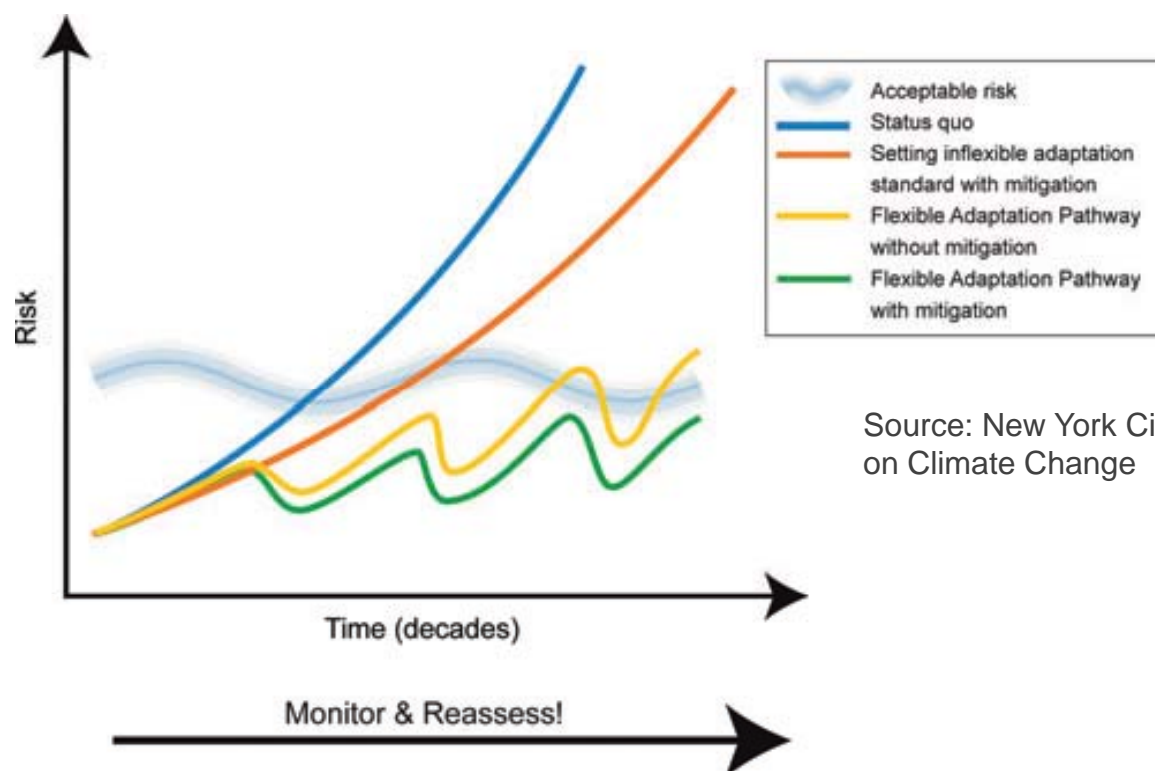
Bioswales

Restoring New York Harbor



Climate Resilience Summary

- Adaptation can come in many forms:
- adjustments in **operations and management**
 - **capital investments** in infrastructure
 - policies that **promote flexibility**
 - recalibrating **design standards**
 - leveraging **co-benefits** and pursuing **no-regrets** strategies



Source: New York City Panel
on Climate Change

Thank You!



<http://www.nyc.gov/dep>

Climate Change Projections

	BASELINE 1971-2000	2020s	2050s	2080s
Air Temperature²	55°F	+ 1.5 to 3°F	+ 3 to 5°F	+ 4 to 7.5°F
Precipitation²	46.5 in	+ 0 to 5%	+ 0 to 10%	+ 5 to 10%
Sea Level Rise^{2,3}	NA	+ 2 to 5 in	+ 7 to 12 in	+ 12 to 23 in
Rapid Ice-Melt Sea Level Rise⁴	NA	+ 5 to 10 in	+ 19 to 29 in	+ 41 to 55 in
Number of Days Per Year With Temperature Over 90°F	14	23 to 29	29 to 45	37 to 64
1-in-100 Year Flood to Reoccur, On Average⁵	once every 100 years	once every 65 to 85 years	once every 35 to 55 years	once every 15 to 35 years

New York City Panel on Climate Change. *Climate Risk Information*. February 2009.