



Metropolitan Water Reclamation District of Greater Chicago

**WELCOME
TO THE JULY EDITION
OF THE 2018
M&R SEMINAR SERIES**

BEFORE WE BEGIN

- **SAFETY PRECAUTIONS**
 - PLEASE FOLLOW EXIT SIGNS IN CASE OF EMERGENCY
 - AUTOMATED EXTERNAL DEFIBRILLATOR (AED) LOCATED OUTSIDE
- **PLEASE SILENCE CELL PHONES OR SMART PHONES**
- **A QUESTION AND ANSWER SESSION WILL FOLLOW PRESENTATION**
- **PLEASE FILL OUT THE EVALUATION FORM**
- **SEMINAR SLIDES WILL BE POSTED ON THE MWRD WEBSITE**
([www. MWRD.org](http://www.MWRD.org): Home Page ⇒ Reports ⇒ M&R Data and Reports ⇒ M&R Seminar Series ⇒ 2018 Seminar Series)
- **VIDEO STREAM OF THE PRESENTATION WILL BE AVAILABLE ON MWRD WEBSITE** (www.MWRD.org: Home Page ⇒ MWRDGC RSS Feeds)

Alan Cohn

- Alan Cohn is Managing Director of the Integrated Water Management group at the New York City Department of Environmental Protection. The Integrated Water Management team spearheads innovative partnerships and programs to reduce system demand, protect critical infrastructure, and promote awareness and sustainable water measures in the built environment. He has contributed to several sustainability and resiliency initiatives including New York City's Green Infrastructure Plan in 2010 and New York City's 2013 water and wastewater resiliency initiatives following Superstorm Sandy. More recently, he managed the development of New York City's 2018 Water Demand Management Plan to reduce water use by 10 million gallons over five years, and a Cloudburst Resiliency study and pilot projects to manage extreme rain events. Alan represents New York City on the Water Utility Climate Alliance, which provides leadership and collaboration on climate change issues affecting the country's water agencies.
- M.S. in Atmospheric & Oceanic Science, University of Maryland, College Park, MD
B.S. in Atmospheric Science, College of Engineering, Cornell University, Ithaca, NY



Climate-Resilient Water Management in New York City

July 27, 2018

Alan Cohn, Managing Director, Integrated Water Management
NYC Department of Environmental Protection

1. Introduction

- Water Supply System
- Sewer & Wastewater System

2. Extreme Events

- Climate Trends and Overview of Extremes
- Hurricane Sandy Impacts

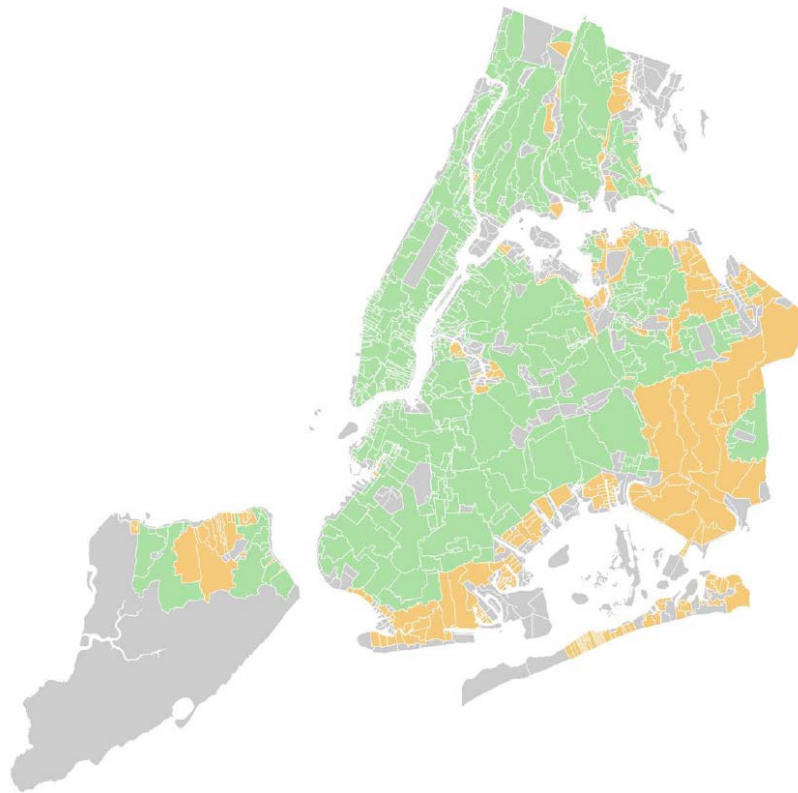
3. Preparing for the Future

- Coastal Resiliency & Protecting Wastewater Assets
- Extreme Rain Events & Green Infrastructure

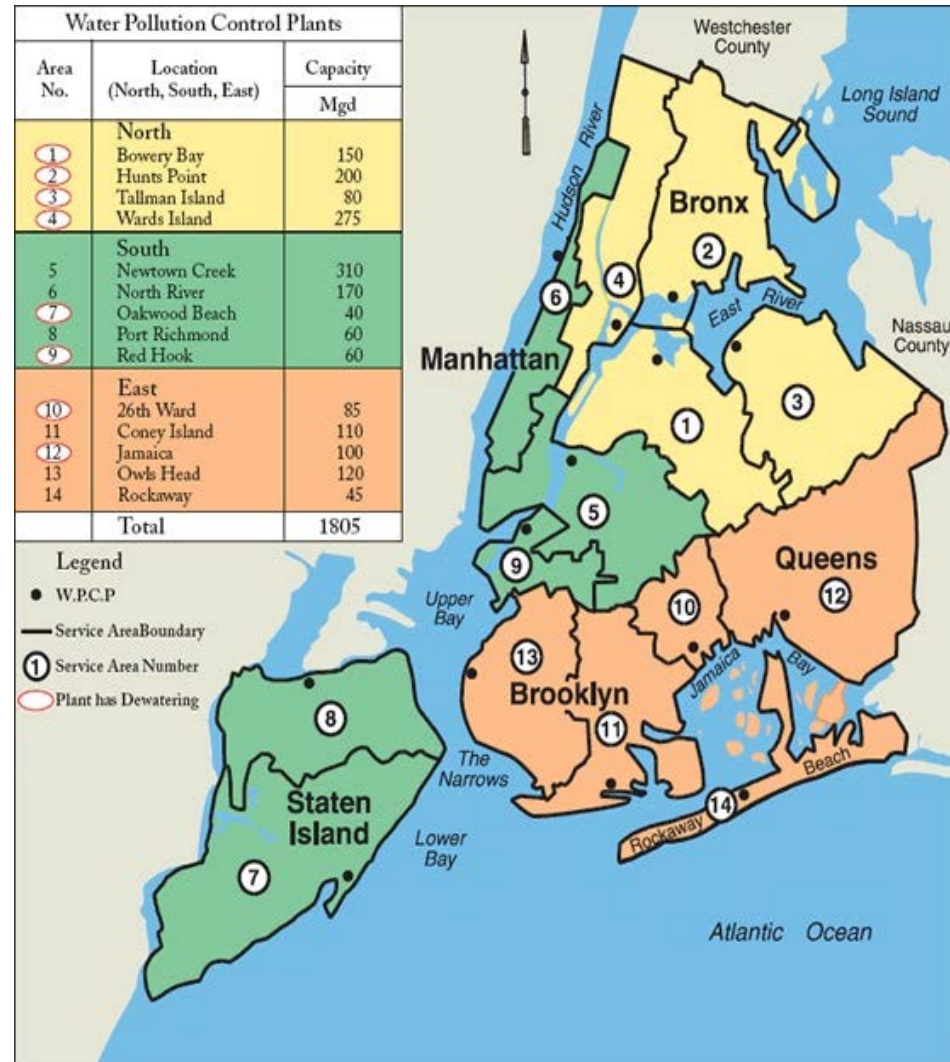
4. Q & A

Introduction: NYC's Sewer & Wastewater System

Sewage is conveyed to 14 wastewater treatment plants, located along the Harbor. Combined sewers serve Manhattan and large areas of Brooklyn, Bronx, & Queens.

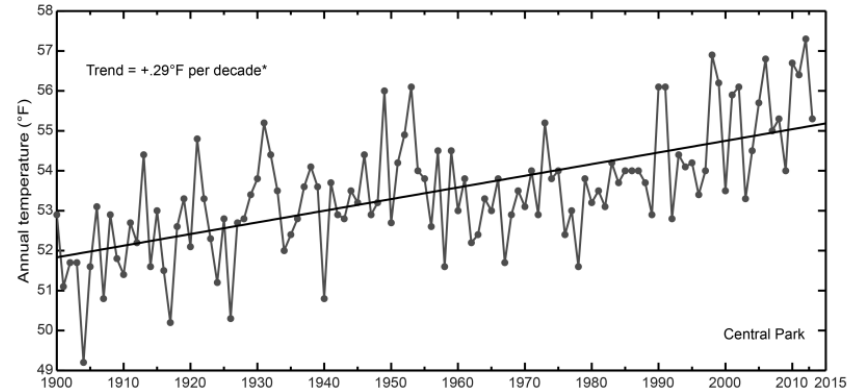


- COMBINED
- SEPARATE
- OTHER (Direct Drainage, Surface Drainage, Blue Belts, etc.)

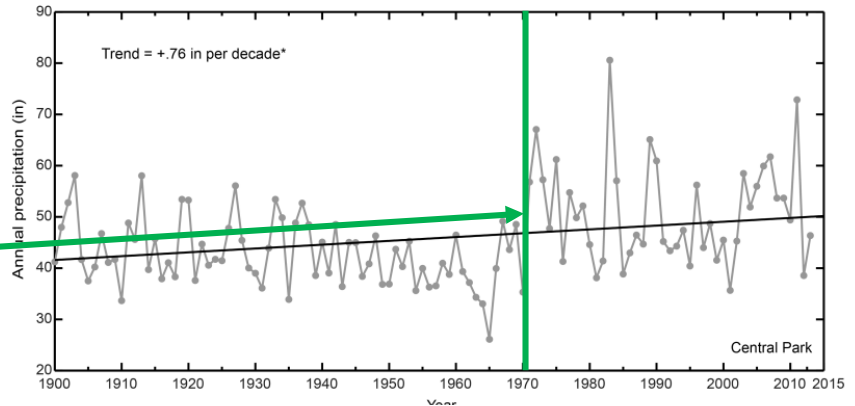


Extreme Events: NYC Climate Trends

Mean annual **temperature** has increased at a rate of 0.3°F per decade (total of 3.4°F).

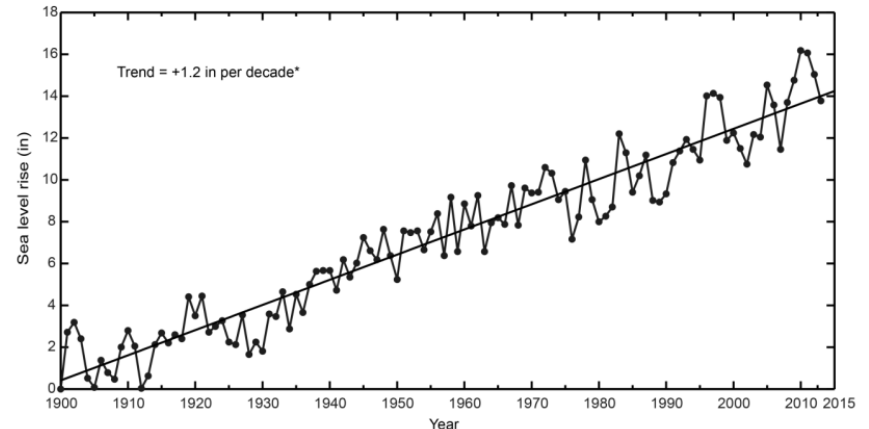


Mean annual **precipitation** has increased ~ 0.8 inches per decade (total of 8 inches).



Year-to-year variability has become more pronounced, especially since the 1970s.

Sea level rise has averaged 1.2 inches per decade (total of 1.1 feet), nearly twice the observed global rate.



Extreme Events: Drought



December 2001: Drought conditions at the Cannonsville Reservoir, Delaware County, NY

Extreme Events: Heavy Rain



August 2011: Water spills over the Gilboa Dam following Tropical Storm Irene, Gilboa, NY

Extreme Events: Heavy Rain



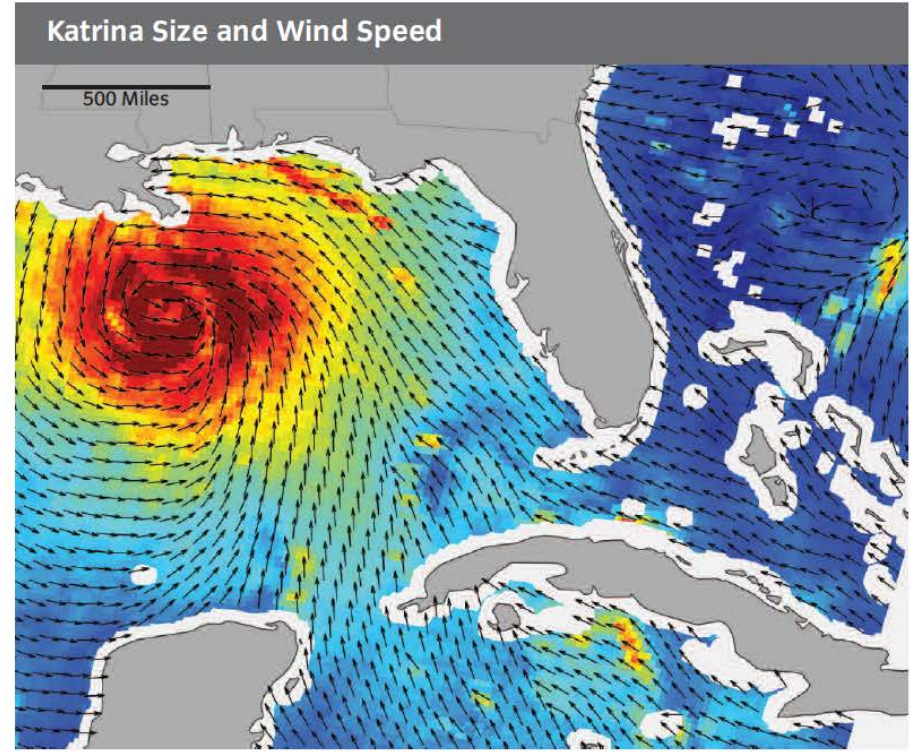
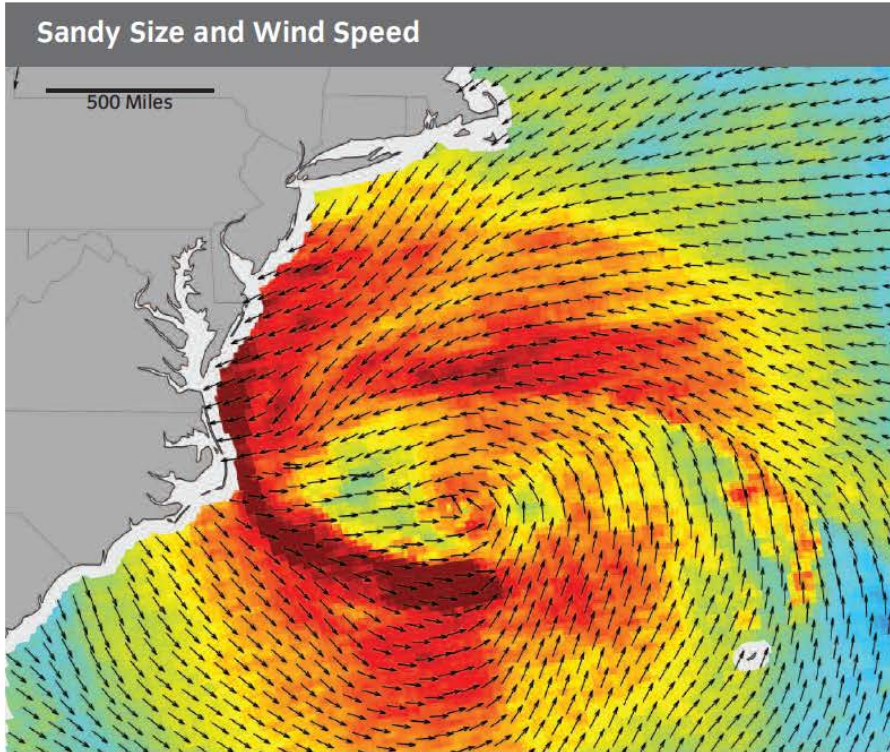
September 2004: Flooding after a downpour on 9th Street, Brooklyn, NY (Credit: Seth Wenig/The New York Times)

Extreme Events: Coastal Flooding



October 2012: A boat washed onto the premises of the Coney Island WWTP after Superstorm Sandy, Brooklyn, NY

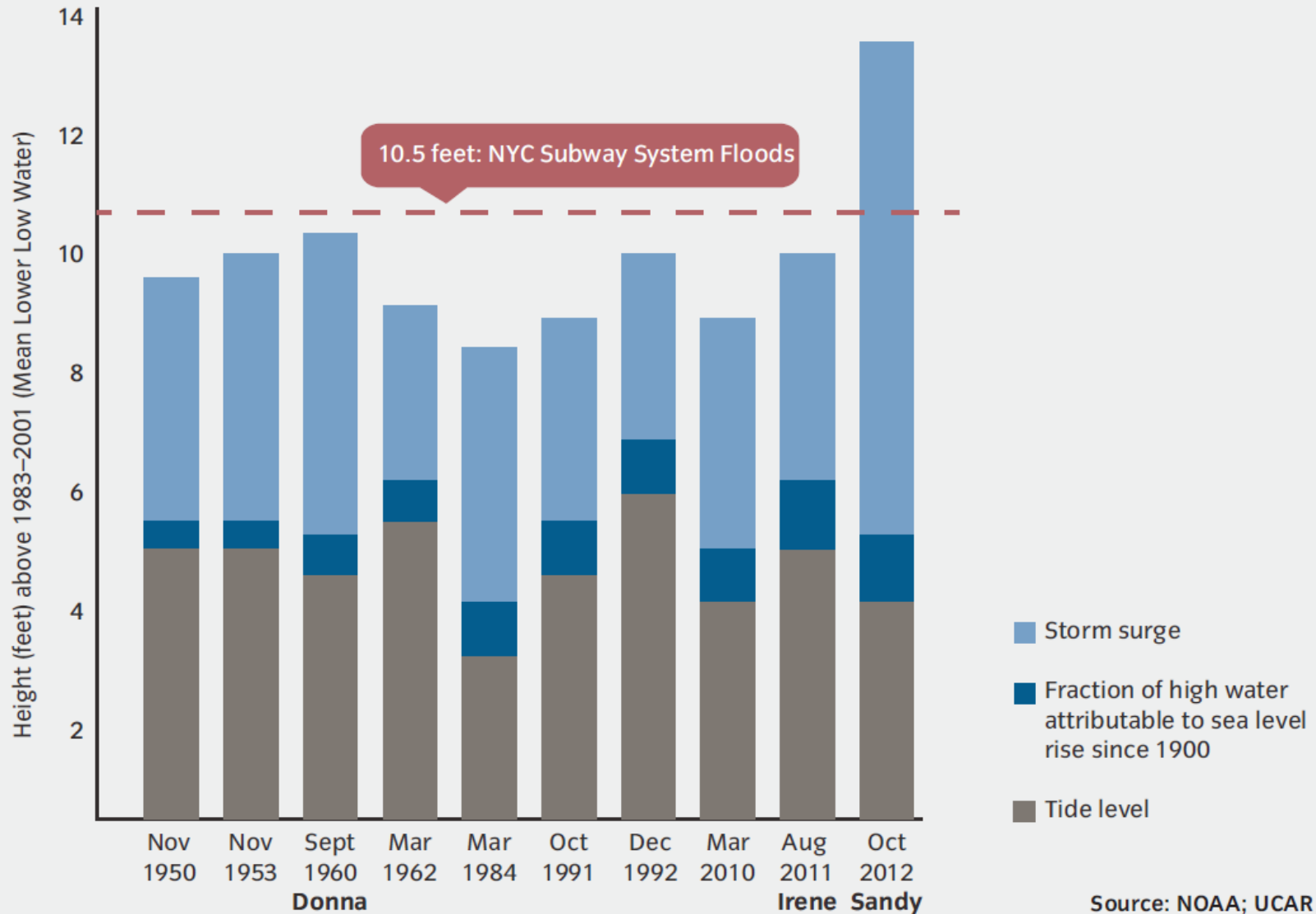
Extreme Events: Hurricane Sandy



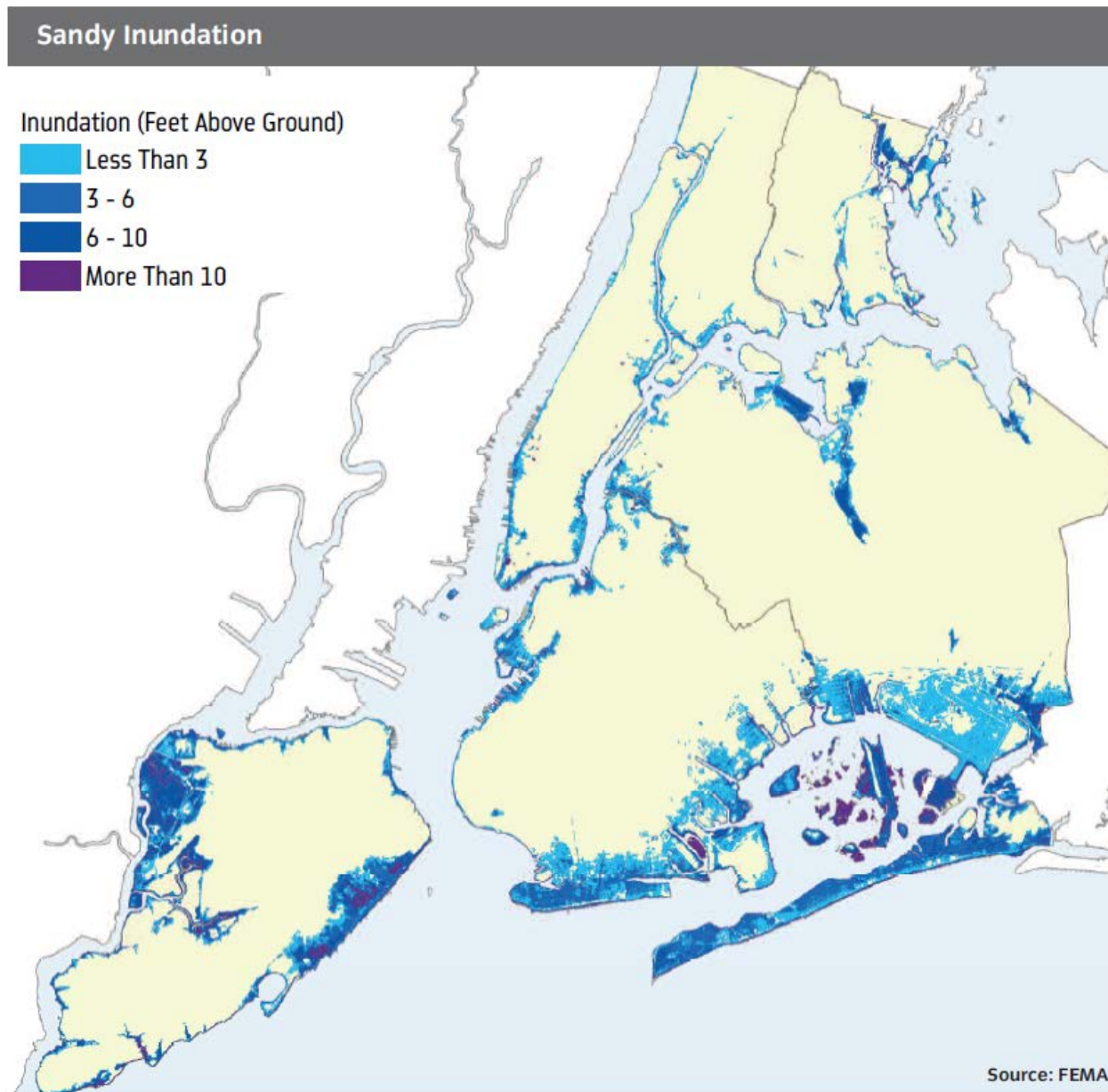
Source: NASA

Extreme Events: Hurricane Sandy

High-Water Events in Lower Manhattan



Extreme Events: Hurricane Sandy



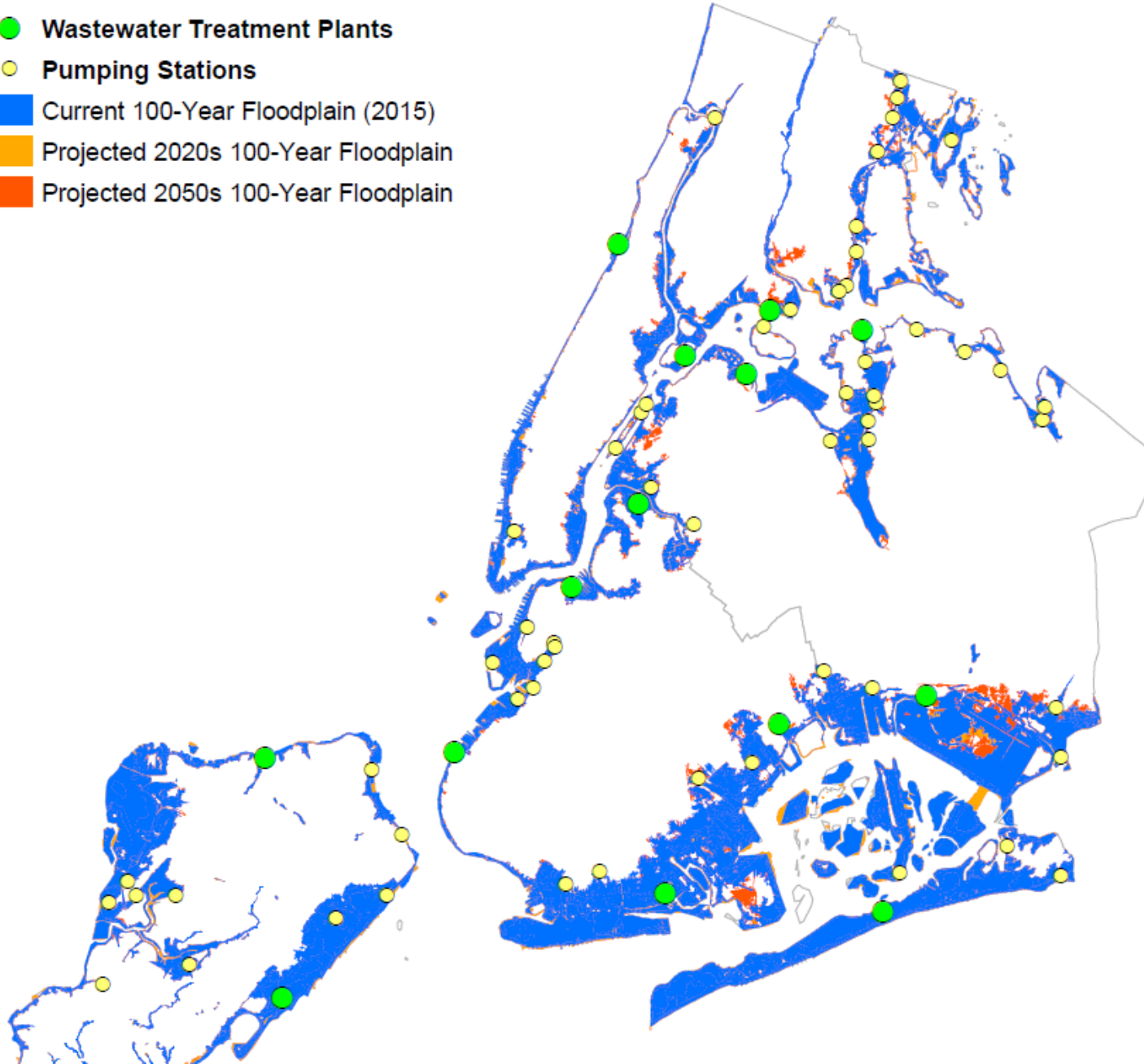
Extreme Events: Hurricane Sandy

Floodplain Comparison of Major American Cities				
City	Population in the 100-Year Floodplain	Share of Total Population	Land Area of 100-Year Floodplain (Square Miles)	Population Density of 100-Year Floodplain (People per Square Mile)
New York	398,100	5%	48	8,300
Houston	296,400	14%	107	2,800
New Orleans	240,200	70%	183	1,300
Miami	144,500	36%	18	8,000
Fort Lauderdale	83,200	50%	21	4,000
San Francisco	9,600	1%	3	3,200

Source: NOAA's Spatial Trends in Coastal Socioeconomics, Demographic Trends (1970-2011); 2010 US Census Tiger Files, and population data; floodplain census data gathered from Miami's Chief of Community Planning, Houston's City Engineer, and Fort Lauderdale's Planning Department; New York population data was obtained from the Department of City Planning Population Division.

Preparing for the Future: Infrastructure At Risk

- Wastewater Treatment Plants
- Pumping Stations
- Current 100-Year Floodplain (2015)
- Projected 2020s 100-Year Floodplain
- Projected 2050s 100-Year Floodplain

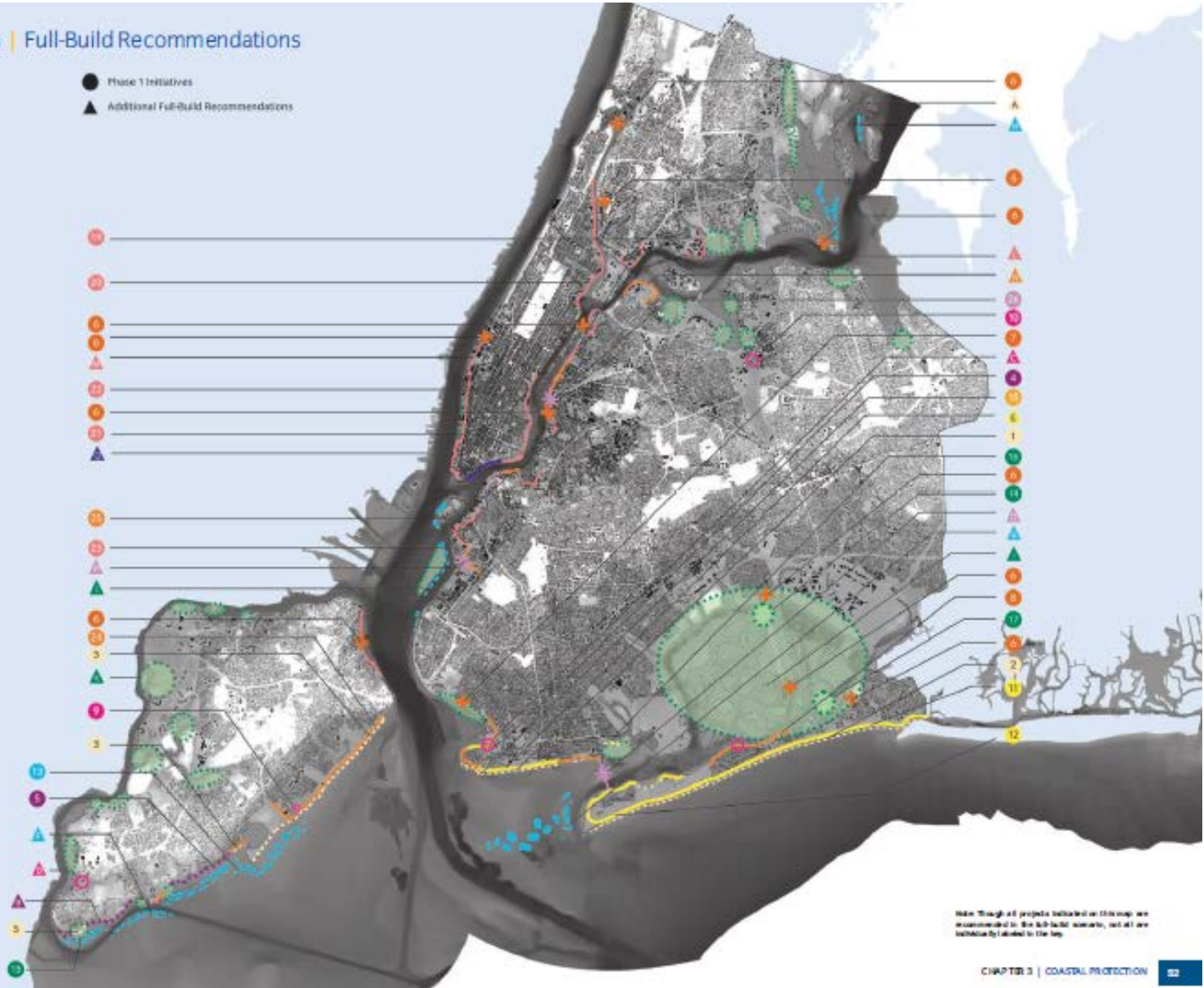


Preparing for the Future: Coastal Resiliency

Comprehensive Coastal Protection Plan | Full-Build Recommendations

- Increase Coastal Edge Elevations**
- Beach Nourishment**
 - Coney Island, Brooklyn
 - Rockaway Peninsula, Queens
 - East and South Shores, Staten Island
 - △ Orchard Beach, Bronx
- Armor Stone (Revetments)**
 - Coney Island Creek, Brooklyn
 - Amadile, Staten Island
 - South Shore, Staten Island
- Bulkheads**
 - Citywide Program
 - Bell Park way Brooklyn
 - Beach Channel Drive, Queens
- Tide Gates / Drainage Devices**
 - Oakwood Beach, Staten Island
 - Flushing Meadows, Queens
 - Coney Island Creek, Brooklyn
 - Mill Creek, Staten Island
- Minimize Upland Wave Zones**
- Dunes**
 - Rockaway Peninsula, Queens
 - Janszwy Point, Queens
 - Coney Island, Brooklyn
- Offshore Breakwaters**
 - Great Kills Harbor, Staten Island
 - South Shore, Staten Island
 - Rockaway Extension
 - City Island, Bronx
- Wetlands, Living Shorelines and Reefs**
 - Howard Beach, Queens
 - Totterville, Staten Island
 - Flumb Beach, Brooklyn
 - Snarl Point, Queens
 - Jamaica Bay
 - Bay Ridge Flats
 - Saw Mill Creek, Staten Island
- Groins**
 - Sea Gate, Brooklyn
- Protect Against Storm Surge**
- Integrated Flood Protection System**
 - Hunts Point, Bronx
 - East Harlem, Manhattan
 - Lower Manhattan / Lower East Side
 - Hospital Row, Manhattan
 - Red Hook, Brooklyn
 - Brooklyn-Queens Waterfront
 - West Midtown, Manhattan
- Roadwalls / Levees**
 - East Shore, Staten Island
 - Farnegut Substation, Brooklyn
 - Astoria Generating Station, Queens
- Local Storm Surge Barrier**
 - Newtown Creek
 - Rockaway Inlet
 - Gowanus Canal, Brooklyn
- Multipurpose Levee**
 - Lower Manhattan

- Phase 1 Initiatives
- ▲ Additional Full-Build Recommendations



Note: Though all projects indicated on this map are recommended in the full-build scenario, not all are technically feasible in the long term.

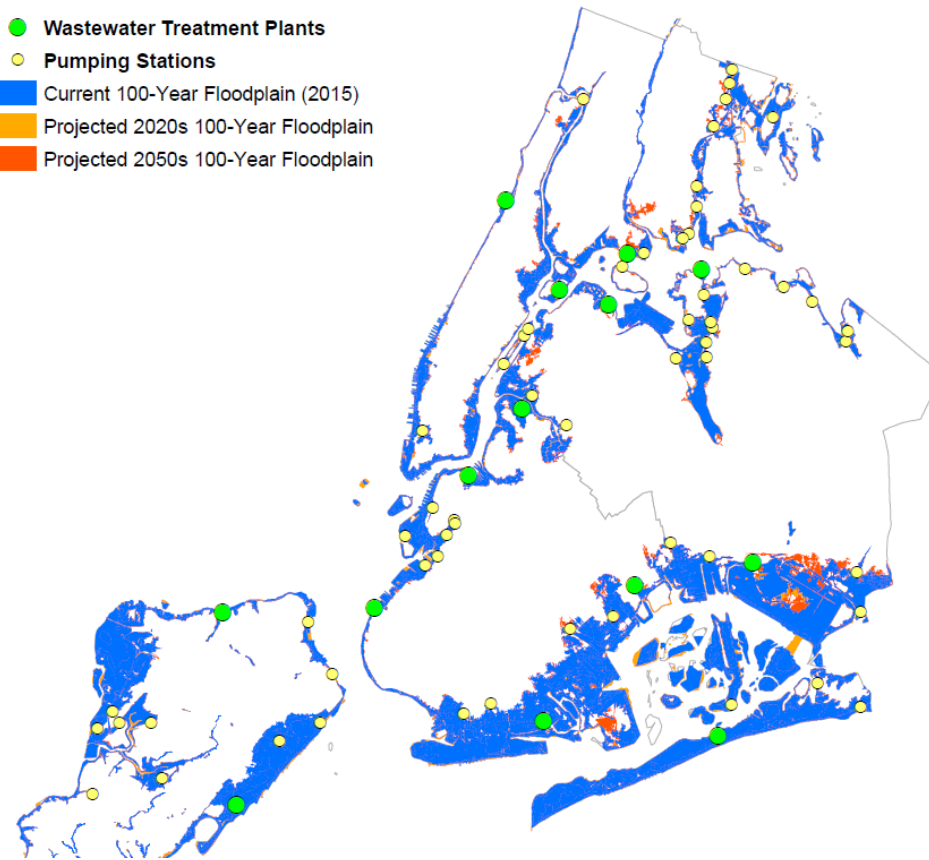
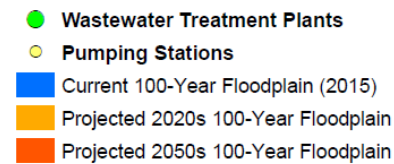
1 Create and apply resiliency design standards

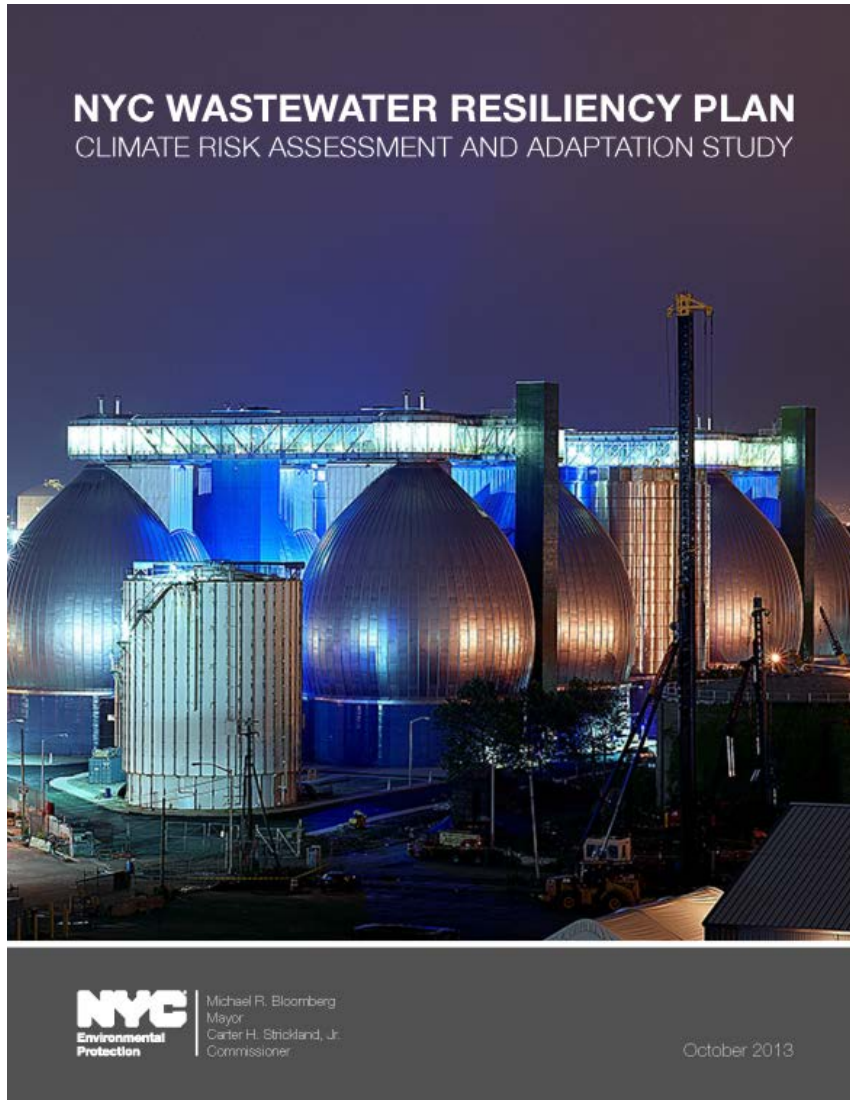
2 Incorporate resiliency into existing projects where possible

3 Develop an inventory of projects requiring flood protection

4 Identify and secure funding for implementation

- 2013: “Design Guideline for Crucial Equipment” adopted
- Protects to 100-year Base Flood Elevation (BFE) plus 30 inches (90th percentile sea level rise projection for 2050s)
- 2017: “Preliminary Climate Resiliency Design Guidelines” recommends protection to 100-year BFE plus 40 inches





1) Climate Analysis:

- What future climate and storm surge conditions should NYC prepare for?














2) Risk Analysis:

- What are the critical flood pathways ?
- What buildings and assets are at risk?
- What is the value of assets at risk?

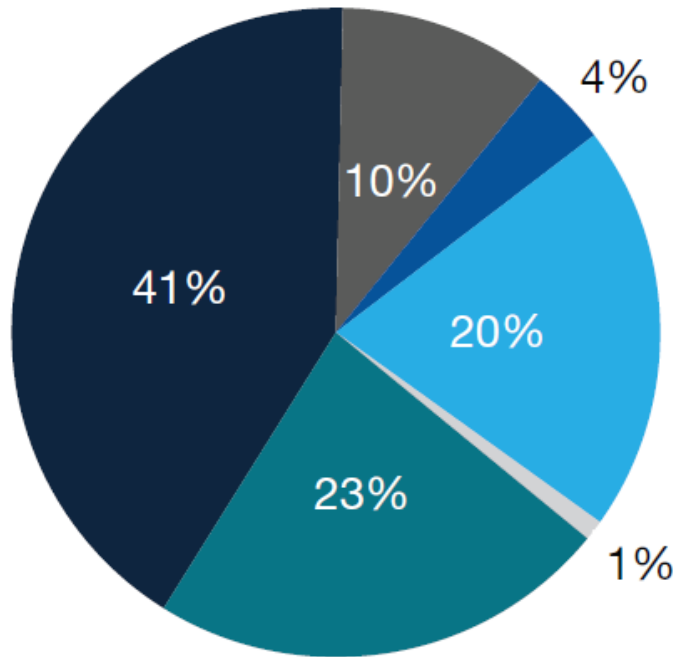


3) Adaptation Analysis:

- What protective measures should be implemented to reduce risk while balancing resiliency and cost?

Adaptation Strategy		Resiliency/Effectiveness	Cost
	<p>Elevate Equipment on pads or platforms, to a higher floor, to the roof, or to a new elevated building.</p>		<p>\$\$\$\$</p>
	<p>Flood-Proof Equipment by replacing pumps with submersible pumps and installing watertight boxes around electrical equipment.</p>		<p>\$\$\$</p>
	<p>Install Static Barrier across critical flood pathways or around critical areas.</p>		<p>\$\$\$</p>
	<p>Seal Building with water-tight doors and windows, elevating vents and secondary entrances for access during a flood event.</p>		<p>\$\$</p>
	<p>Sandbag Temporarily around doorways, vents, and windows before a surge event.</p>		<p>\$</p>
	<p>Install Backup Power via generators nearby or a plug for a portable generator.</p>	<p><i>Does not protect equipment but facilitates rapid service recovery.</i></p>	<p>\$\$\$</p>

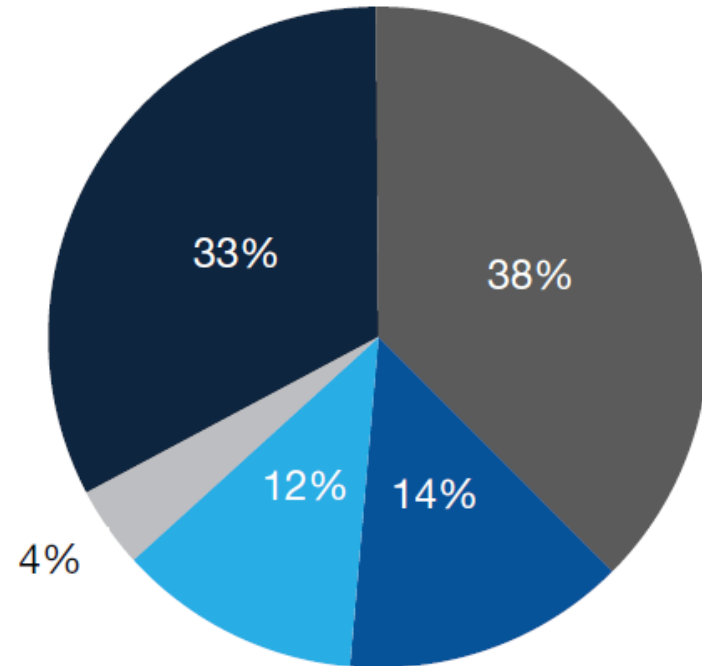
Pumping Stations



- Elevate Equipment
- Flood-Proof Equipment
- Seal Building

Wastewater Treatment Plants

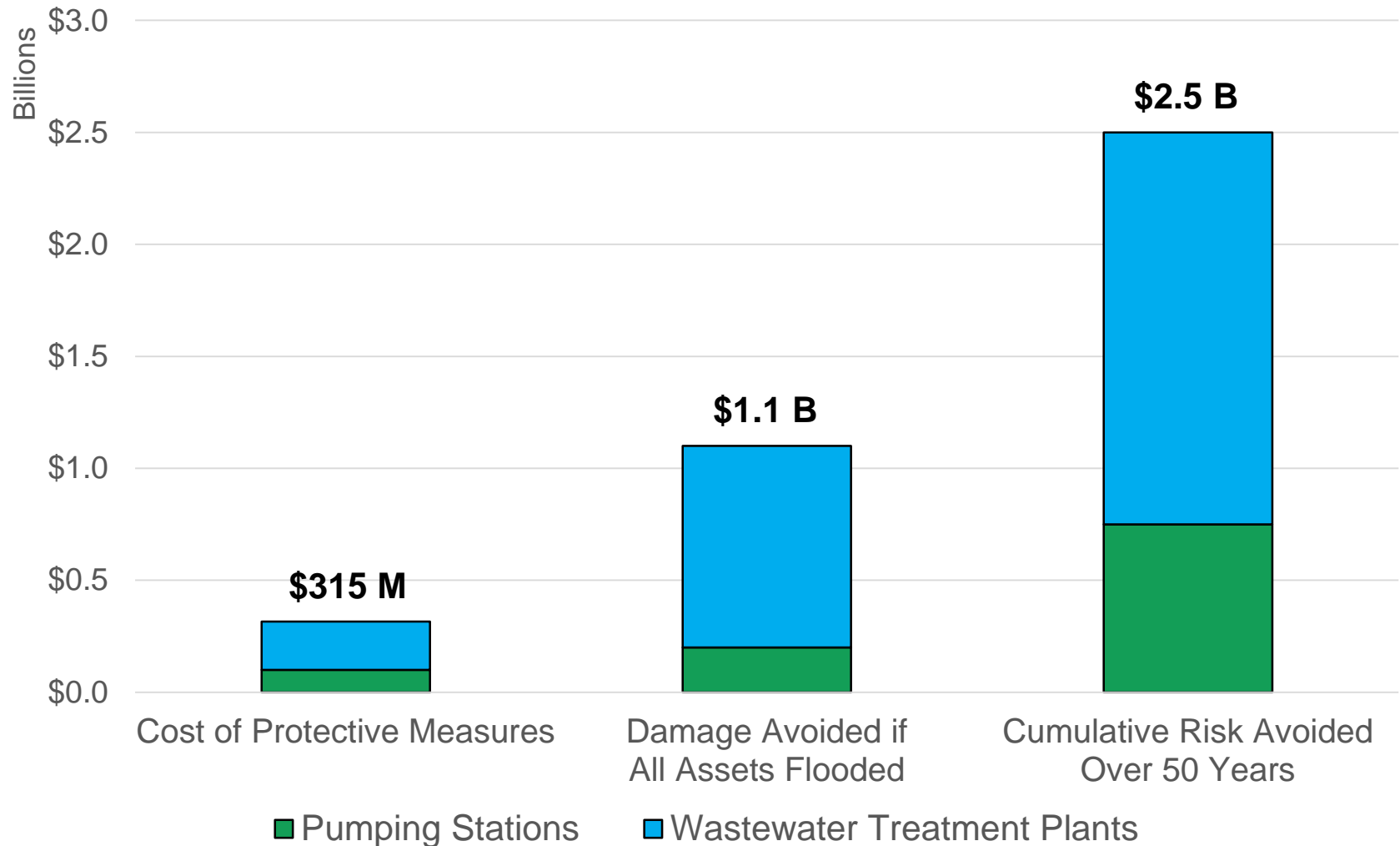
Note: All facilities are already equipped with backup power generators



- Construct Barrier
- Sandbag Temporarily
- Install Backup Power

Preparing for the Future: Wastewater Retrofits

*Investing **\$315 million** in strategic flood protection measures could save the City **\$2.5 billion** in emergency response costs over the next 50 years.*



Preparing for the Future: Extreme Rain



July 2011: Cloudburst event in Copenhagen, Denmark

Preparing for the Future: Extreme Rain



September 2015: Cloudburst event in Copenhagen, Denmark

Preparing for the Future: Extreme Rain



Rotterdam's "Water Square"

Preparing for the Future: Green Infrastructure



City Sidewalks



City Streets



Grant Program for Private Property Owners



Public Property Retrofits

Preparing for the Future: Green Infrastructure



Before

Preparing for the Future: Green Infrastructure



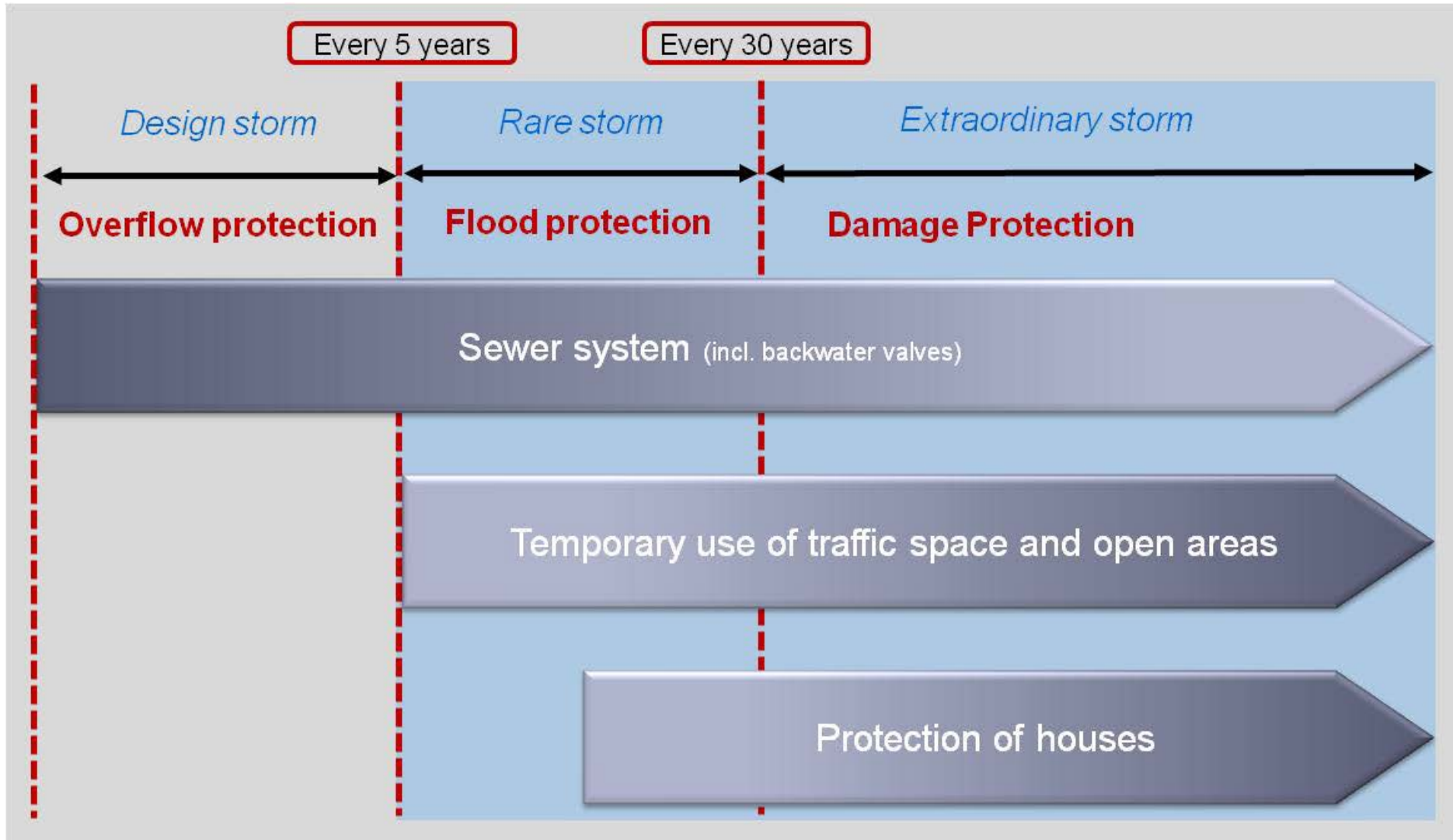
After

Preparing for the Future: Cloudburst Management



Preparing for the Future: Cloudburst Management

						Return periods			
CITY	ADAPTATION PLANNING START	EXTREME RAIN TERMINOLOGY		SERVICE LEVEL		EXTREME RAIN			
COPENHAGEN	2009	Cloudburst		5		100			
LONDON	2011	Heavy rain // extreme rain		30		30-100			
NEW ORLEANS	2009	Heavy rainfall // rainfall storm				10			
CHICAGO	2003	Heavy rain // extreme rain events		5		100			
ROTTERDAM	2008	Extreme rainfall // heavy downpours		2		100			
MELBOURNE	2009	Overland flows // flash floods // storms		5		100			
NYC	2007	?		5		?			



Elements of flood protection of municipal drainage systems (Reference: DWA, 2008)

A. LITERATURE REVIEW

COPENHAGEN

LONDON

NEW ORLEANS

CHICAGO

ROTTERDAM

MELBOURNE

NEW YORK

B. CLOUDBURST MASTERPLAN



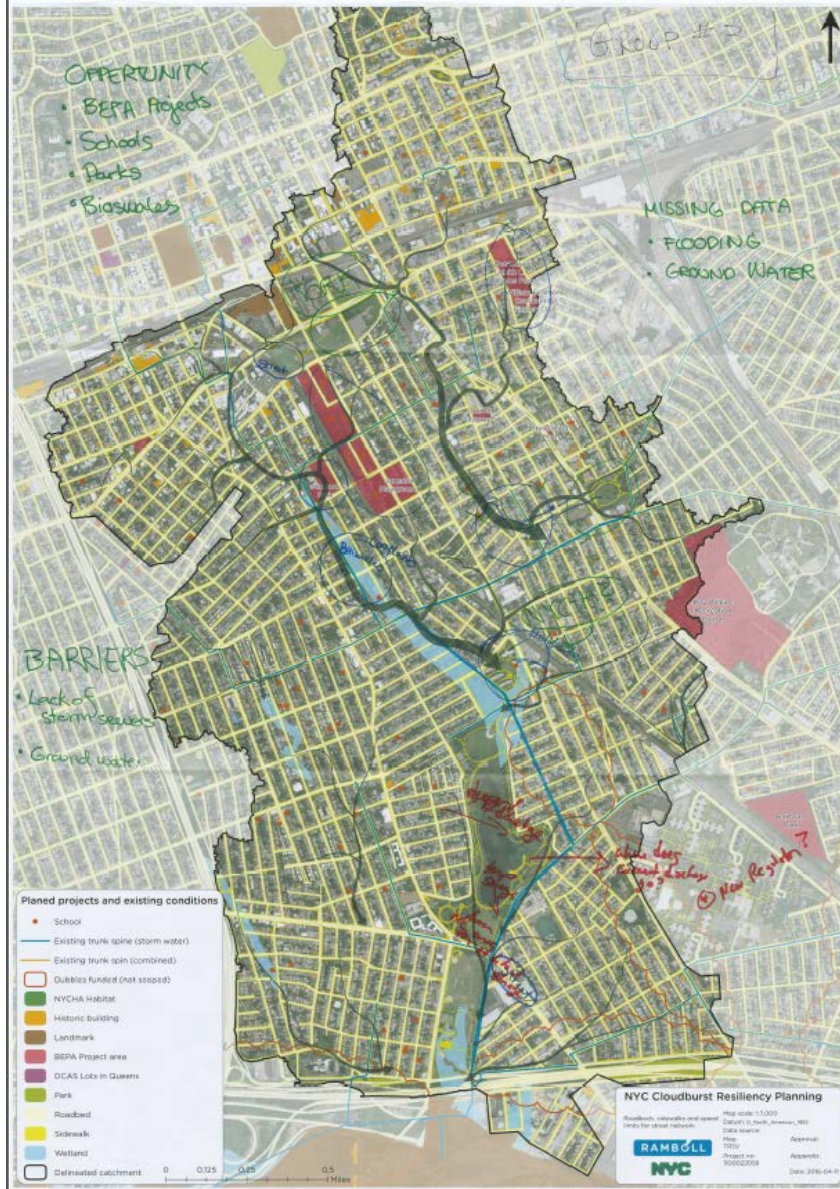
**Southeast Queens
Study Area**

C. PILOT PROJECT



**South Jamaica
Houses**

Preparing for the Future: Cloudburst Management



Historic waterways and areas



Social infrastructure



Elevation map



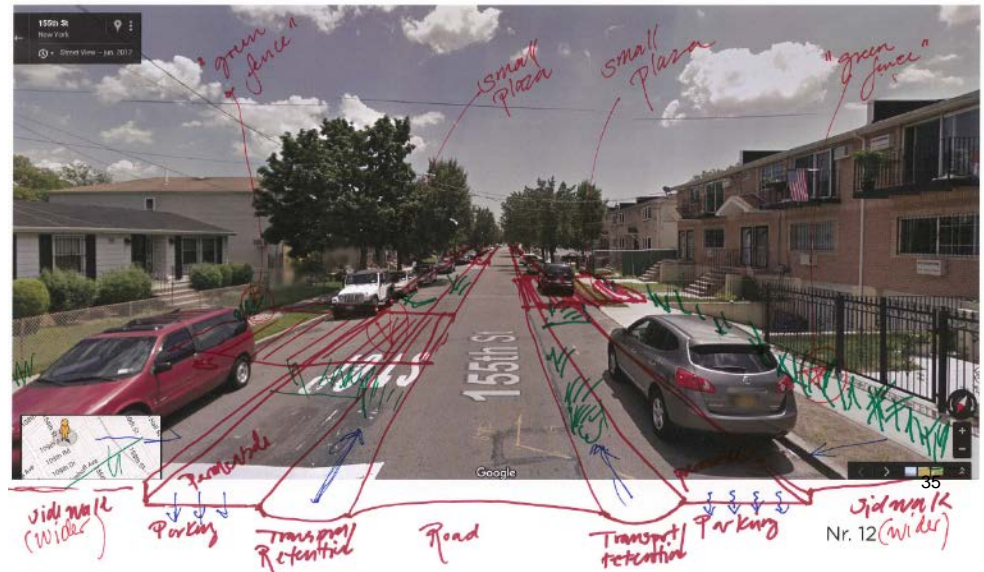
Transport infrastructure



Terrainbased flowlines

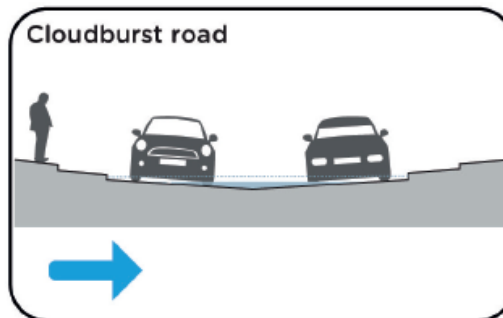


Green connections

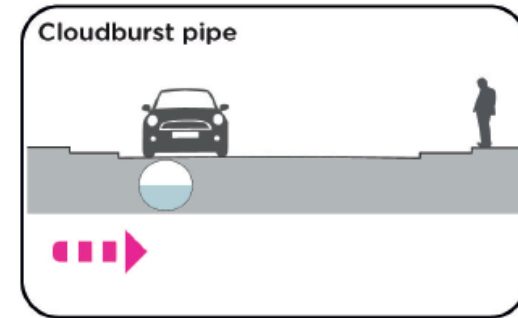


MASTERPLANNING

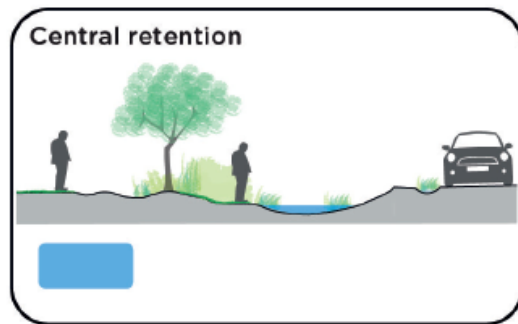
- RISK** Where does water come from?
Where are the risks?
- POTENTIAL** Where can water be stored?
- TERRAIN** Where does the water flow?
Where should it flow?
- FRAMES** What can we (not) accept?
- SYNERGY** Where can we improve urban connectivity?



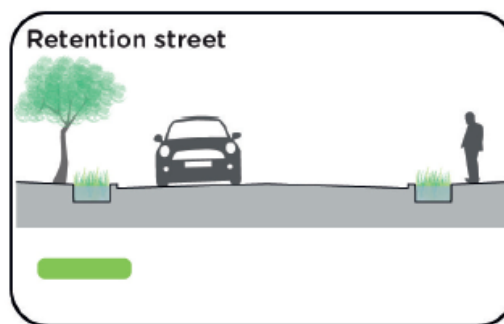
Used to convey water where the terrain is favourable



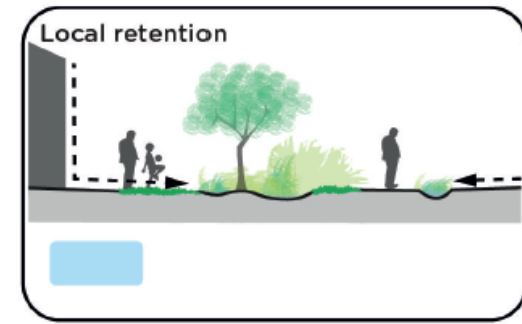
Used to convey water where the terrain does not permit BGI projects



Used to retain water in a larger area connected to other BGI projects



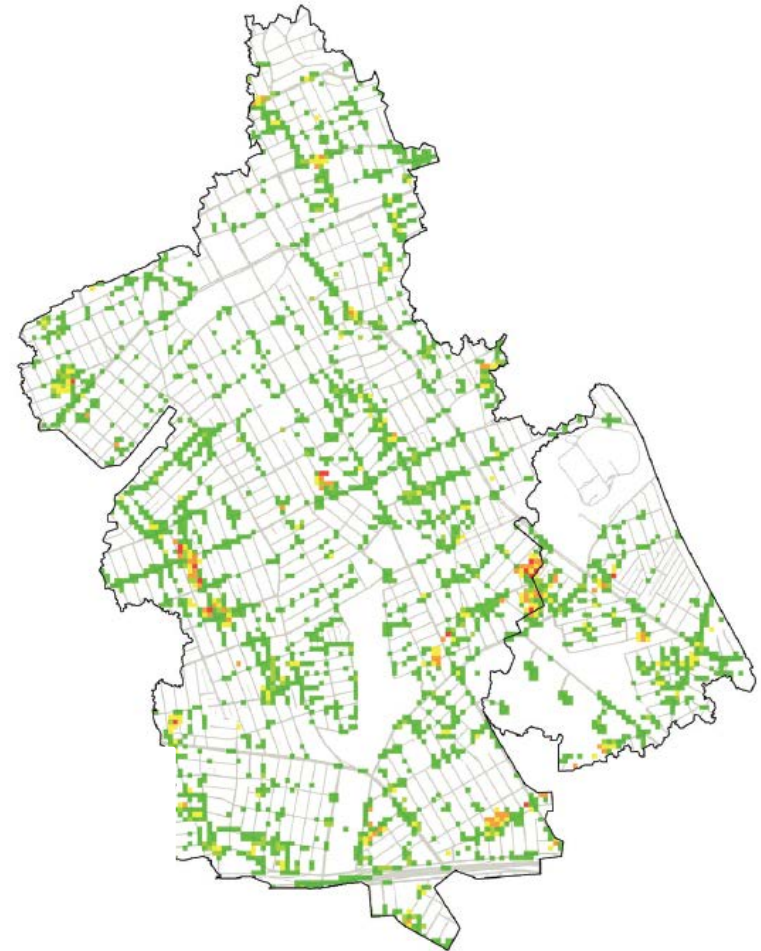
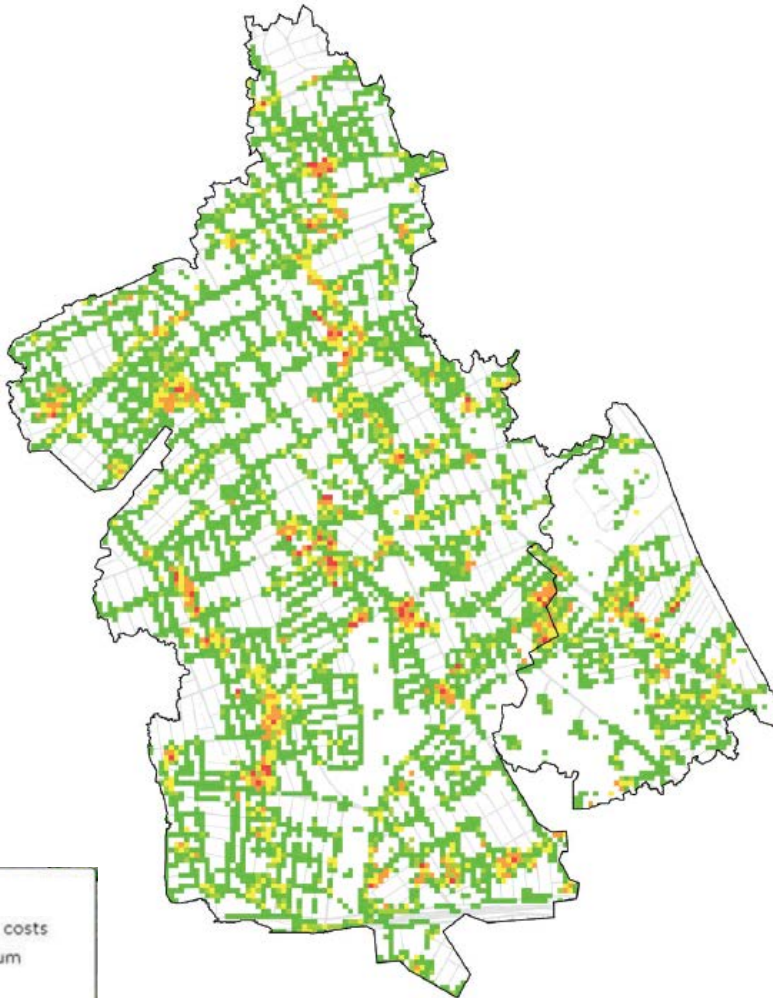
Used to retain water where the terrain is favourable

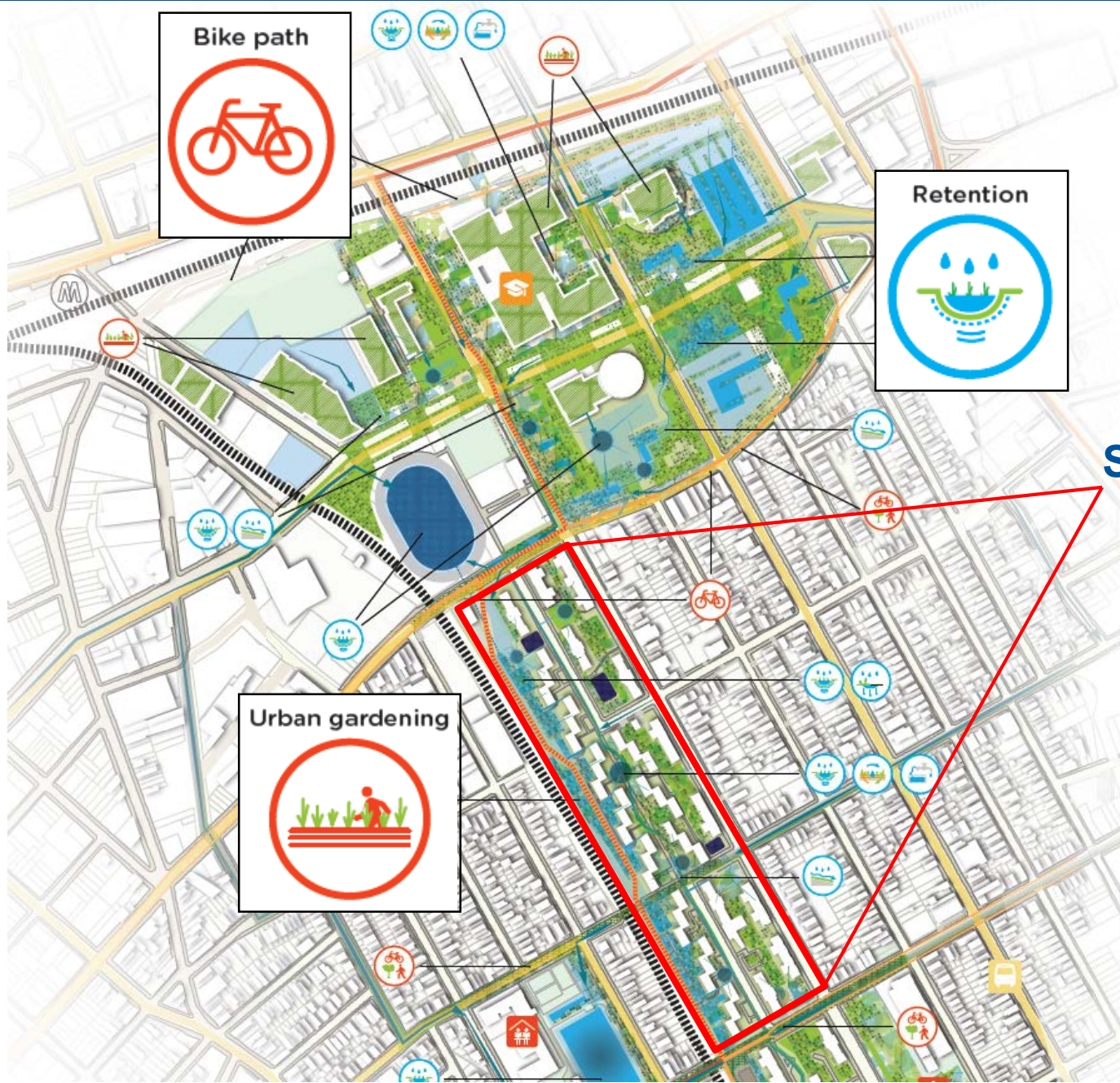


Used to retain water in larger areas from roofs and local surroundings

Before Implementation

After Implementation





**South Jamaica
Houses**

South Jamaica Houses – Today



South Jamaica Houses – Future Concept



South Jamaica Houses – Future Concept



1. NYC water, wastewater, and stormwater systems are robust
2. Coastal flooding and rainfall extremes are primary risks
3. DEP's responses include:
 - Wastewater Treatment:
 - Design standard for storm surges and sea level rise
 - Resiliency implementation through capital projects
 - Stormwater Management:
 - Leveraging existing programs and partnerships
 - Integrated planning to manage inland flooding



- The impacts of climate change are happening here and now



- Know your system and explore its vulnerabilities



- Plan for multiple futures



- Capacity building and assessment are part of the adaptation equation

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nyc.gov/dep/climatechange