NYC Wastewater Infrastructure: Response and Recovery from Sandy

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Overview

- Overview of DEP Infrastructure
- Hurricane Sandy Impacts
  - Storm Preparations
  - Major Storm and Storm Surge impacts
  - DEP Response Actions
  - Lessons Learned
- DEP's Approach to Climate Change and Long-term Adaptation Strategies
  - What's different?
  - Storm water management
  - DEP Infrastructure Assessment
  - Moving Forward

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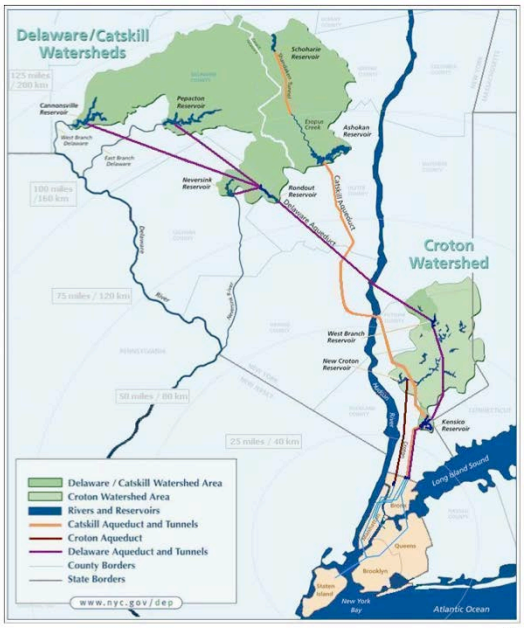
A Brief Introduction to DEP

- NYC watershed extends more than 125 miles (200 km) from the city, and is comprised of 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



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Catskill and Delaware watersheds currently supply **100%** of demand. Croton watershed has potential to meet up to **30%** of demand.

System is gravity driven

90 % of water supply sourced from Catskill and Delaware watersheds, requires no filtration New filtration plant filters water sourced from Croton watershed (10 % of supply)

System of 19 reservoirs and 3 aqueducts serving 9.3 million people

Reservoir capacity sufficient to meet 1 year demand without replenishment

95 miles of aqueduct and tunnels

1 billion gallons delivered daily

7,000 miles of water mains

A Brief Introduction to DEP (cont.)

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

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14 treatment plants spread throughout the 5 boroughs

2 Staten island

2 Bronx

1 Manhattan

4 Brooklyn

5 Queens

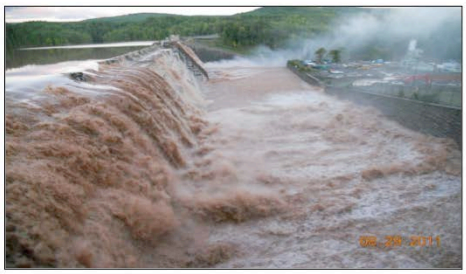
1.3 Billion gallons treated per day

7,400 miles of sewer lines

All in close proximity to waterways and discharge into local receiving bodies

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.
- Significant impact to the DEP's upstate watershed infrastructure



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

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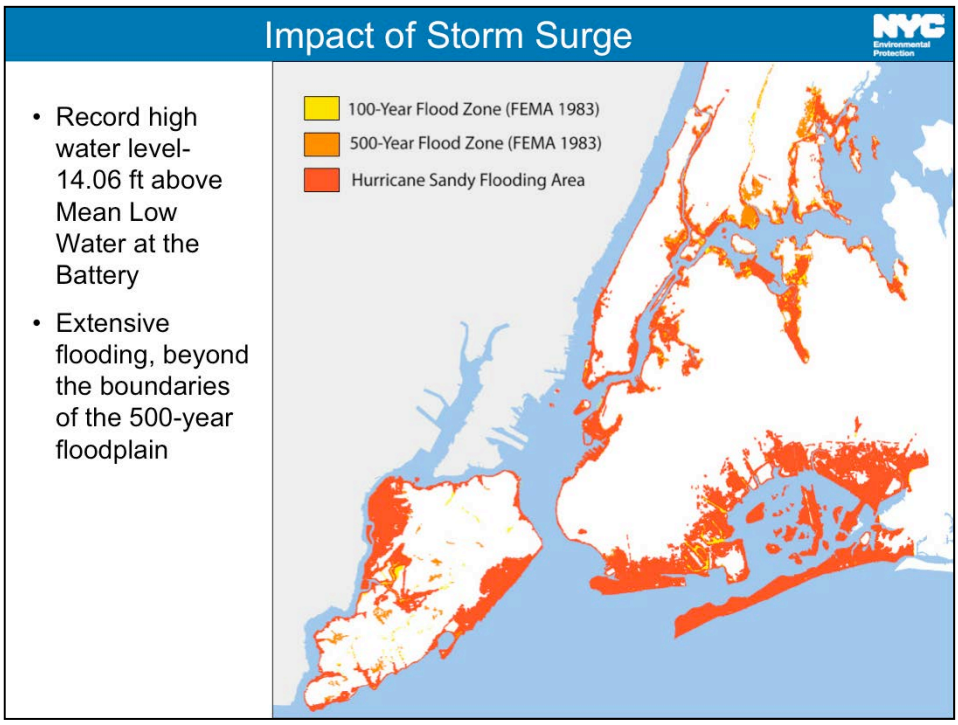
Initially, Sandy was not anticipated to have major impacts.

As the storm moved closer, forecast changed to “Frankenstorm” that would hit the East Coast roughly somewhere between Cape May, NJ, and New York City.

Rainfall impacts predicted to be less severe than Hurricane Irene, with 2-3 inches forecast in the watershed and 3-4 inches forecast in-city. No major rain-related flooding predicted in the watershed.

Sustained wind speeds of greater than 50 mph were forecast for Monday, October 29, with gusts over 90 mph possible.



The combination of slow moving storm hitting landfall at high tide with a full moon caused water levels at the battery to reach an unprecedented 14 feet above sea level. FEMA estimated that there was less than a 0.1% chance of that happening. (1000 year storm).

The storm lingered over the area for two tidal cycles - exacerbating flooding beyond the 500 year flood plain

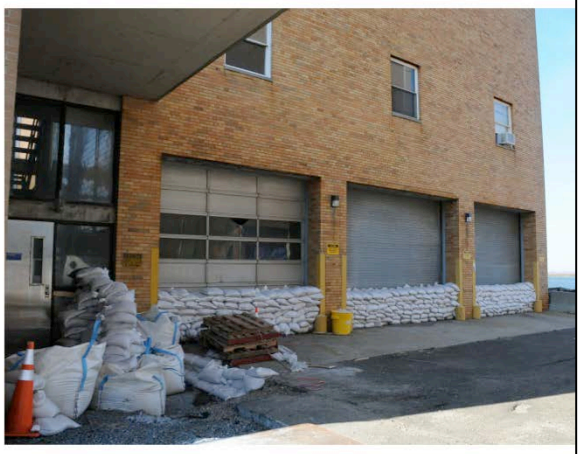
Broke the oldest official record of 10.02 feet set by Hurricane Donna in 1960

We are all familiar with the devastating impacts of the storm, which brought surprisingly little rain but fierce winds and an unprecedented tidal storm surge. At its peak of more than 14 feet at the Battery, the surge was three feet higher than the previous record.

Most of the damage was to the electrical systems, including substations, motors, control panels, junction boxes, and instrumentation. In addition, due to Consolidated Edison and Long Island Power Authority power outages, many DEP facilities had to operate on their emergency generators for upwards of two

Preparations

- Hardening of critical infrastructure
- Topped off chemical and fuel supplies
- Ran plant shutdown drills
- Moved water out of reservoirs
- Activated Several Incident Command Centers



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DEP began to prepare a week before the storm.

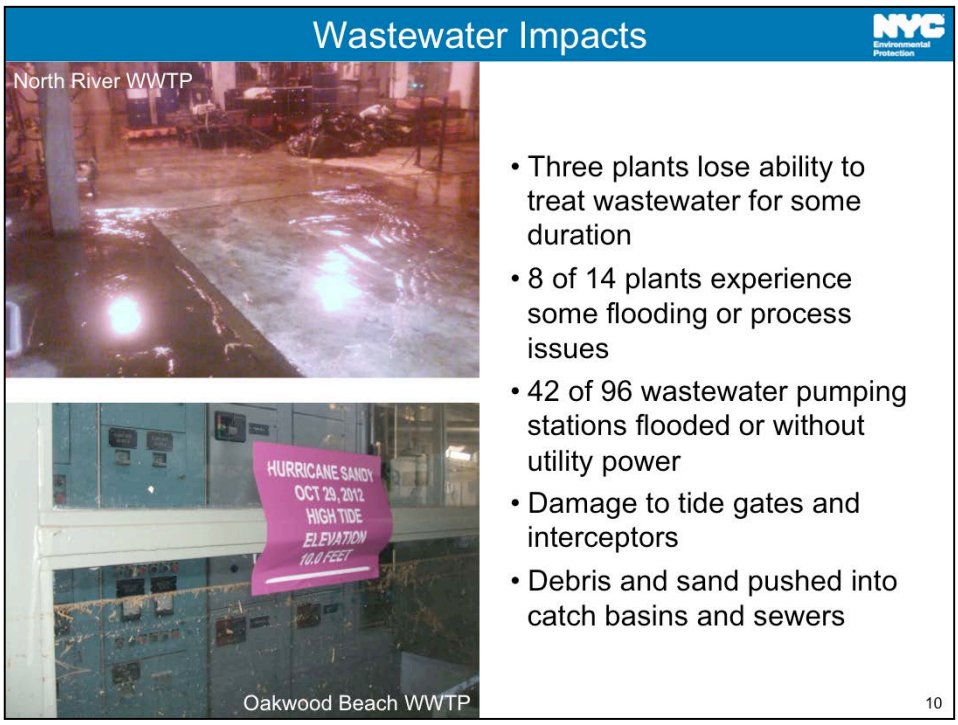
- Hardened critical infrastructure including pump stations, wastewater treatment plants, and maintenance yards with sand bags
- Worked with suppliers to top off critical chemical and fuel supplies
- Ran plant emergency shutdown drills and reviewed Emergency Action Plans
- In the watershed, we lowered the height of reservoirs to absorb potential runoff
- Activated DEP Incident Command Center at Lefrak with remote centers throughout the 5 boroughs
- Moved Emergency Communications Center our of Lower Manhattan in anticipation of flooding and communication network failure.

Fire in Breezy Point – more than 100 homes completely destroyed. Flooding limited firefighter access; damage to private water main network forced firefighters to pump seawater to fight fire.

Major street and home flooding – 760 red tagged buildings (uninhabitable, structurally unsound); 6700 yellow tagged buildings (require major reconstruction)

Transit system – Commuter rail and subway flooding and severe damage. Subways closed for two days after the storm, no subways in Lower Manhattan for five days.

All bridges/tunnels were immediately closed. All Tunnels except the Lincoln Tunnel were flooded and closed for upwards of 2 weeks.



Three WWTP inundated by floodwater and forced to shut down: Rockaway, North River, Coney Island

The Rockaway WWTP was completely underwater as the ocean met the bay.

The North River WWTP had its primary flood protection breached and its Main Sewage Pumping drywell was completely flooded.

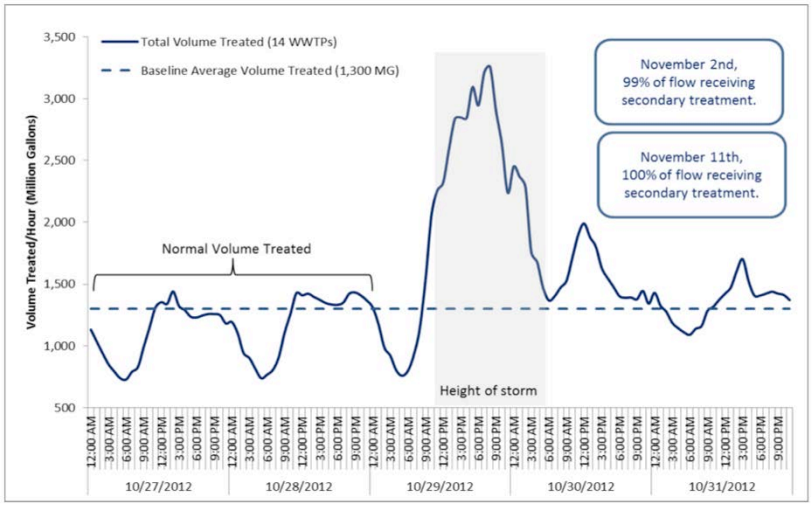
At Coney island the plant was shutdown for 2 hours due to loss of power

Oakwood Beach WWTP was completely surrounded by water,…….. an island within Staten Island.

8 WWTP's experience some flood damage. Total wastewater bypass estimated at 580 million gallons. This is less than half of the total volume on a dry day. This is attributed to most people being evacuated and the sewers being full of seawater.

Wastewater Impacts

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



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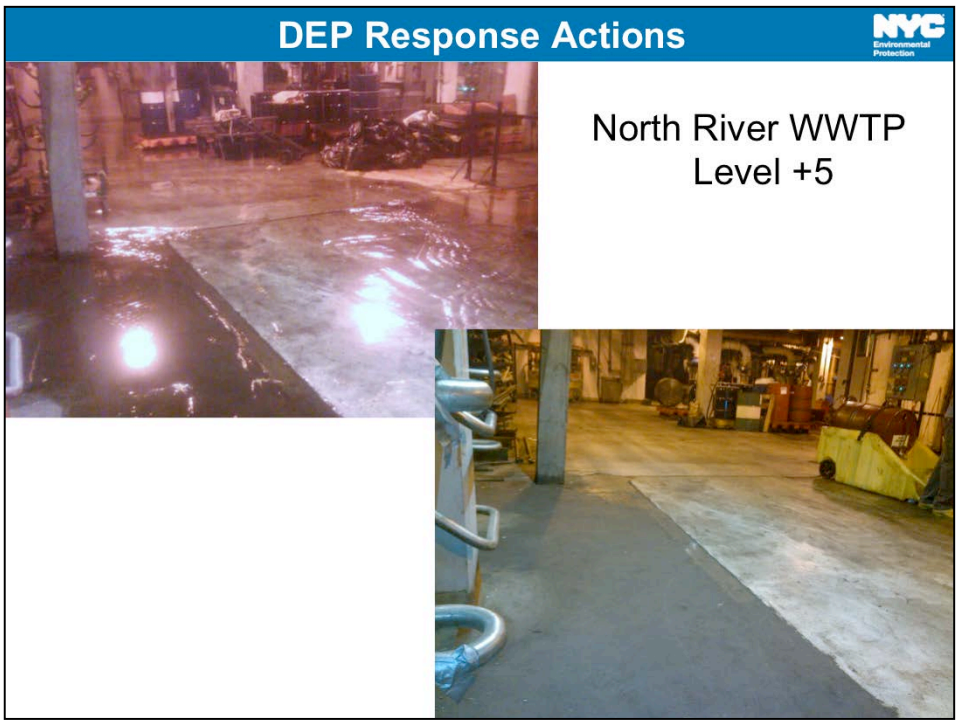
At the peak of the storm, due to combined sewers our wastewater treatment plants were treating over 3.3 billion gallons per day, 2.5 times average daily flow.

As the chart shows – flows into the plants stayed high for the next few days attributable to the flooded city.



NR WWTP is a 28 acre site and is built out on the Hudson River on 7500 caissons.

During the storm surge the pressure cover on a regulator chamber within the plant perimeter failed and over 1000 linear ft of expansion joint failed due to the high head

Sea water ran throughout the 28 acre site and filled the dry well with more than 50’ of water

We had our own CSO facility within the plant

Roughly $1 M worth of damage

Wastewater Response

Rockaway WWTP

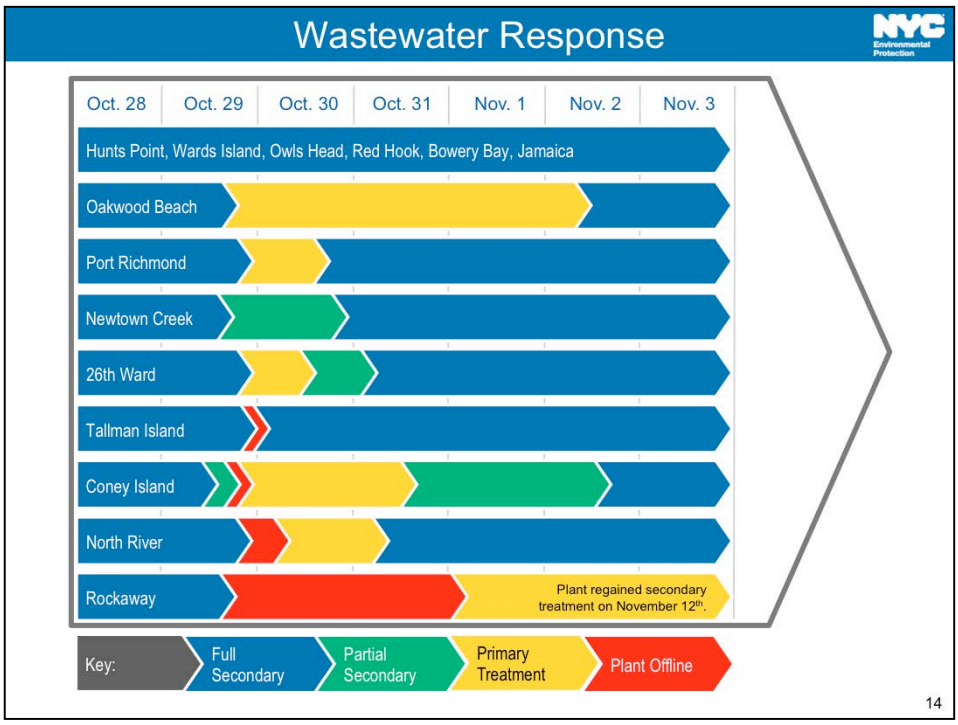
Rockaway WWTP is a typical DEP WWTP with numerous below grade structures with connecting pipe galleries

During the storm surge everything below grade to 3’ above the ground level was underwater for a day

Sandy caused an estimated $19 million in damage at New York City’s smallest wastewater treatment facility.

Due to its location, the smallest plant has at the biggest risk to this type of event.

Overall the impact to DEP’s wastewater infrastructure is estimated at greater than $90 Million.



Eight plants experienced process disruptions due to flooding or power failure.

Total raw sewage bypass mixed with CSO: 580 million gallons

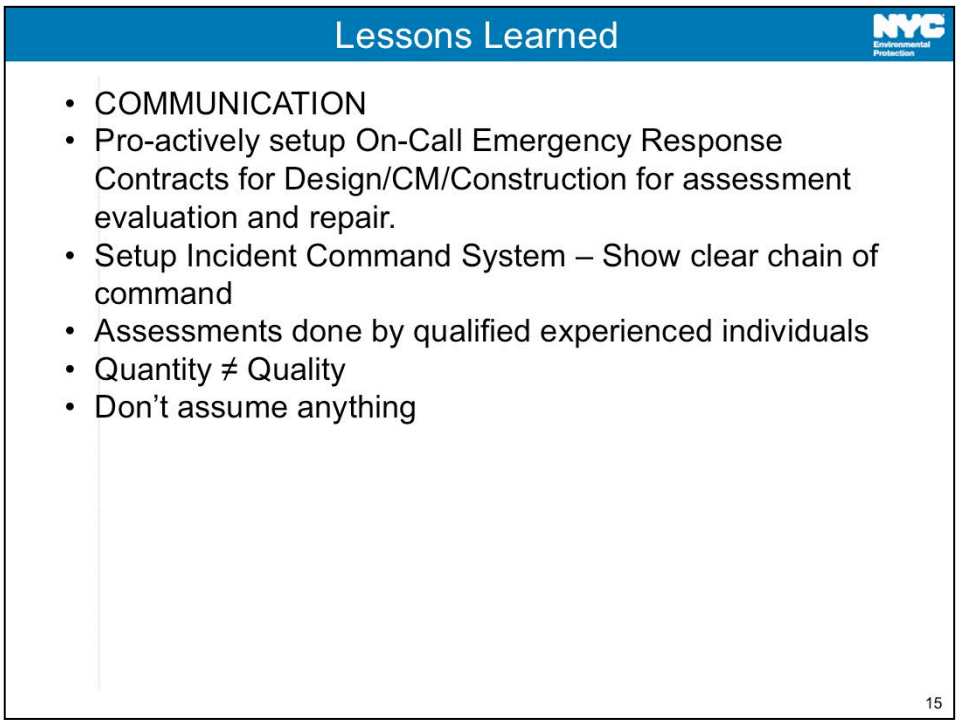
Total secondary treatment reduction: 805 million gallons

$3 million spent on overtime and $38 million spent on contractual services during initial recovery. 55 contractors contributed to response and recovery effort.

Identified $50.8 million in long term capital projects to repair facilities and, in some cases, make improvements to reduce the impact of future storm surge.

Total DEP cost for Sandy is estimated at more than $90 million.

DEP also sent out vessels to begin sampling in the harbor. All samples came back with in normal parameters except for in Raritan Bay which was also impacted by PVSC.



Communication is always keys - Enables a coordinated response among the various stakeholders.

Pro actively setup contracts so when you arrive, everyone knows what their role is, scope, manpower needed, contractual terms, etc.…no questions asked after the fact

Establish an emergency response unit comprised of individuals able to quickly initiate an Incident Command

System and execute a response plan.

Assessments need to be done by qualified experienced individuals…this will save you time and Money

More people doesn't means higher quality. Select key qualified individuals who are able to work under pressure. Pressure either burst pipes or makes diamonds.

Example – Gas shortage. We never thought of the gas situation for workers only

Climate Change Planning at DEP

- Of all Infrastructure types, water is the most fundamental to life.
- Proactive planning for climate change
- Mayor's Climate Change Adaptation Task Force and the New York City Panel on Climate Change, formed in 2008.

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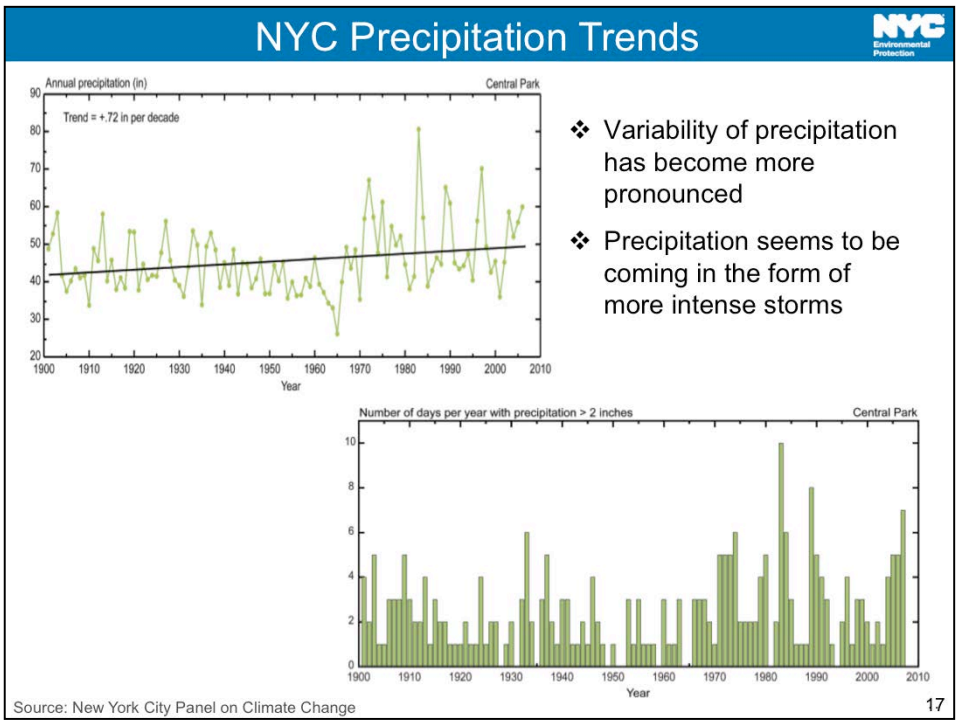
Of all infrastructure types, water is the most fundamental to life and is irreplaceable for drinking, cooking, and bathing. Farms, offices, hospitals, restaurants, etc…all cannot operate without clean water.

The DEP understands climate change is a problem and the New York City Panel on Climate Change (NPCC) was created to advise the City on Climate Change and climate change projections. As a result the DEP has committed to two tiers of study, one focused on water supply and another focused on drainage and wastewater treatment, to identify what is working today and implement adjustments and adaptations to DEP programs and operations. The remaining portion of thepresentation will focus of Drainage and wastewater treatment infrastructure.



- Inter-annual variability of precipitation has become more pronounced, with a notable shift around 1970 shown in the figure in the top left.

- This precipitation also seems to be coming in the form of more intense storms. The figure on the bottom right shows the number of days each year with more than 2 inches of rain, with a notable cluster of large events in the last three decades.

- In 2011, all-time rainfall records were broken.

- DEP is very vulnerable to intense rain storms due to its infrastructure.

NYC Climate Change Projections

	BASELINE 1971-2000	2020s	2050s	2080s
Air Temperature[2]	55°F	+ 1.5 to 3°F	+ 3 to 5°F	+ 4 to 7.5°F
Precipitation[2]	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 Rise[4]	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 Average[5]	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.

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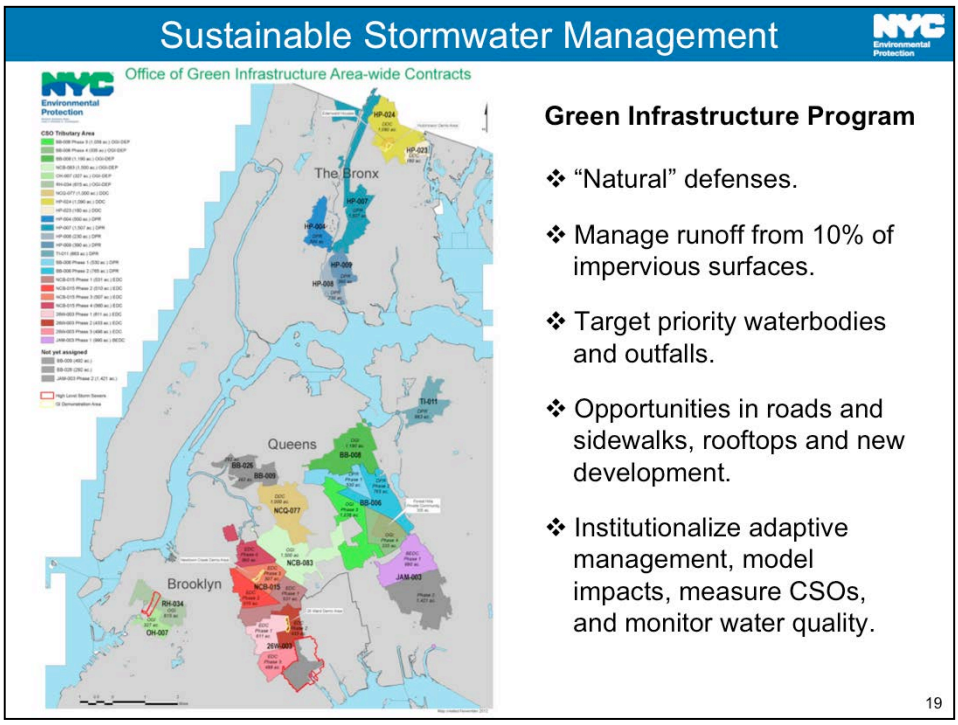
•In 2009 the Panel on Climate change updated their 2006 study which was commissioned by the DEP.

•The Projections have been adopted by the DEP and used by other agencies for consistency.

Please note that these sea level rise projections need to be updated based on the new FEMA numbers from Hurricane Sandy, but the message essentially stays the same: Coastal restoration will require an adaptive approach to protect coastal ecosystems and the upland communities for which they act as a buffer from the ocean



A solution to pollution by dilution is no longer the way to get away from storm water and its pollutants.

City will invest an estimated $187 million in green infrastructure projects by 2015, part of a planned $2.4 billion public and private investment over the next 20 years.

The city will also complete work on approximately $1.6 billion in gray infrastructure projects.

What happens if we don't invest?

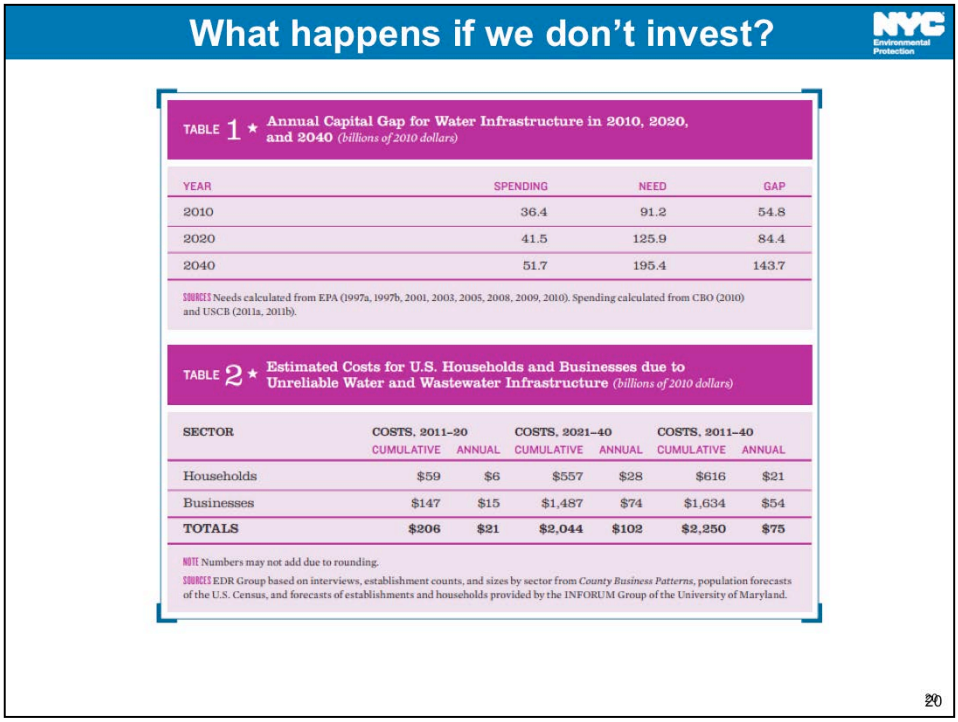


TABLE 1 ★ Annual Capital Gap for Water Infrastructure in 2010, 2020, and 2040 *(billions of 2010 dollars)*

YEAR	SPENDING	NEED	GAP
2010	36.4	91.2	54.8
2020	41.5	125.9	84.4
2040	51.7	195.4	143.7

SOURCES Needs calculated from EPA (1997a, 1997b, 2001, 2003, 2005, 2008, 2009, 2010). Spending calculated from CBO (2010) and USCB (2011a, 2011b).

TABLE 2 ★ Estimated Costs for U.S. Households and Businesses due to Unreliable Water and Wastewater Infrastructure *(billions of 2010 dollars)*

SECTOR	COSTS, 2011–20		COSTS, 2021–40		COSTS, 2011–40	
	CUMULATIVE	ANNUAL	CUMULATIVE	ANNUAL	CUMULATIVE	ANNUAL
Households	$59	$6	$557	$28	$616	$21
Businesses	$147	$15	$1,487	$74	$1,634	$54
TOTALS	**$206**	**$21**	**$2,044**	**$102**	**$2,250**	**$75**

NOTE Numbers may not add due to rounding.

SOURCES EDR Group based on interviews, establishment counts, and sizes by sector from *County Business Patterns*, population forecasts of the U.S. Census, and forecasts of establishments and households provided by the INFORUM Group of the University of Maryland.

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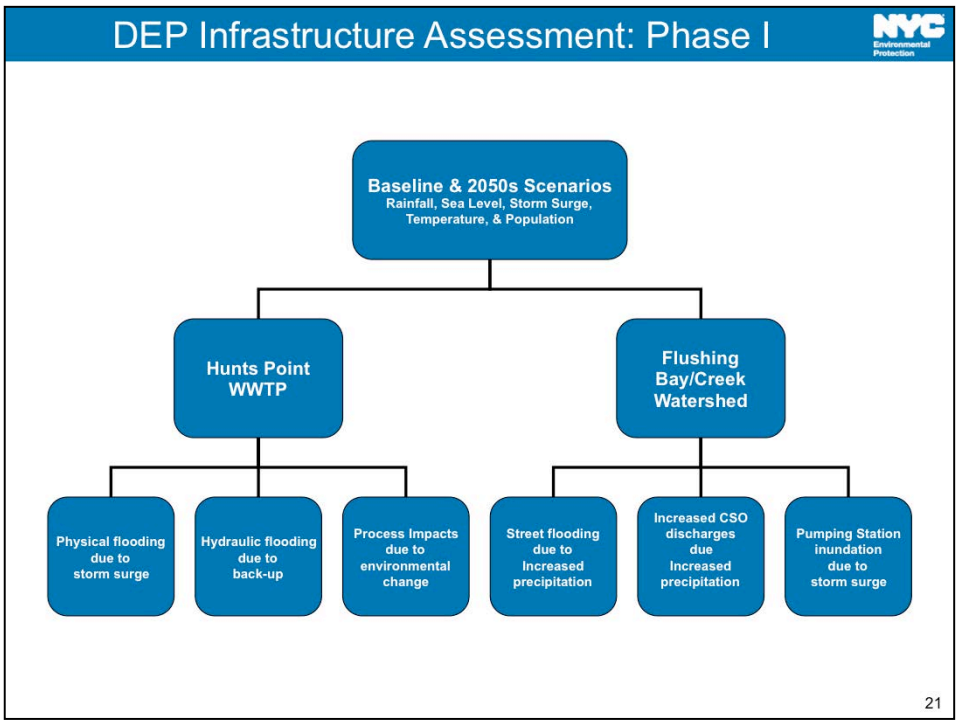
This table comes from a report from issued by the American Society of Civil Engineers titled "Failure to Act: The Impact of Current Infrastructure Investment on America's Economic Future"

Not only will our fiscal gap become larger but everyone will see their wallets shrink.

With failing infrastructure, eventually it will be more cost effective for people to "self-supply".

Increases in water-borne illnesses due to unreliable delivery and wastewater services will occur.

The list goes on an on.

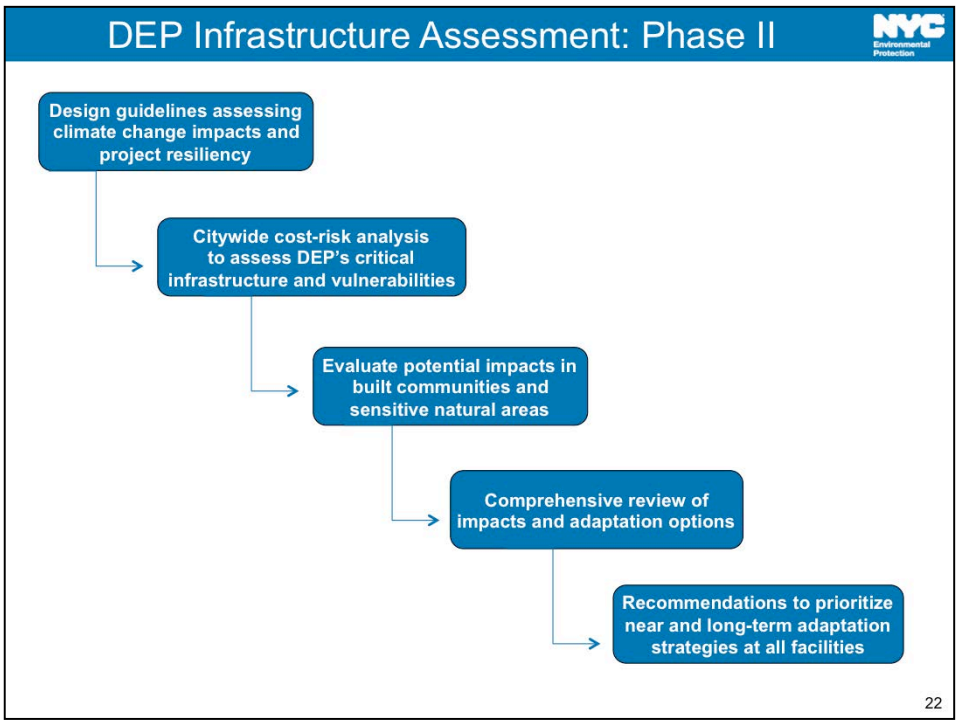


The DEP performed a vulnerability assessment for one wastewater treatment plant, 8 pumping stations and a 16,377 acre drainage area.

The DEP evaluated physical impacts of storm surge and impacts on operations of different changes in sea level, temperature, and precipitation

Considered critical assets for primary and secondary treatment and assigned corresponding critical elevations

The assessment provided a detailed evaluation of adaptation strategies and actionable recommendations for capital projects (i.e. sandbagging, infrastructure elevation, static barriers, flood-proof equipment, etc.)



Develop design guidelines that incorporate climate change considerations and assess resiliency of projects currently in design or construction.

- Develop a citywide risk-based framework to assess DEP's critical infrastructure and vulnerabilities at all facilities including assets.

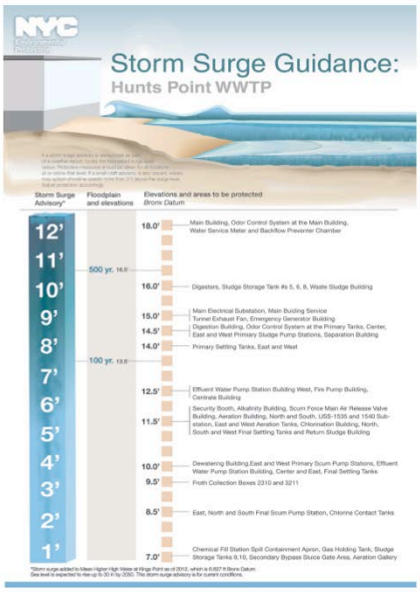
- Evaluate potential impacts in already built communities and sensitive natural areas.

- Comprehensive review of impacts and adaptation options and cost-risk analysis for project which are in design or construction

- Provide recommendations to prioritize near and long-term adaptation strategies employing a facility-level planning approach.

Hunt Point WWTP Vulnerability Analysis

- Almost 2,000 assets reviewed for Hunts Point WWTP
- Prioritization based on criticality of equipment, vulnerability to flooding, and cost of 'do nothing' scenario versus benefits and costs of protective measures
- Number of vulnerable, critical assets increases with sea level rise
- Final adaptation portfolio will likely a mix of emergency response, hardening assets and operational measures



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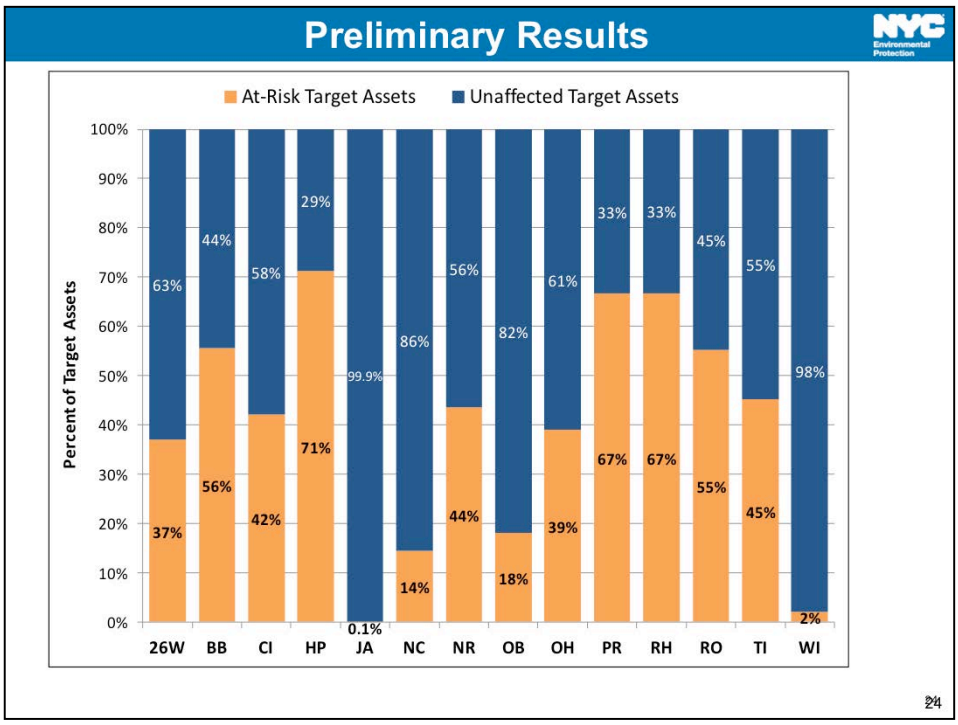
Number of vulnerable, critical assets increases with sea level rise

- 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
- 1000's of critical assets at risk

Given the likelihood of a 100-year flood event occurring, over 50 years the expected unmitigated risk is estimated at $19 million in net present value

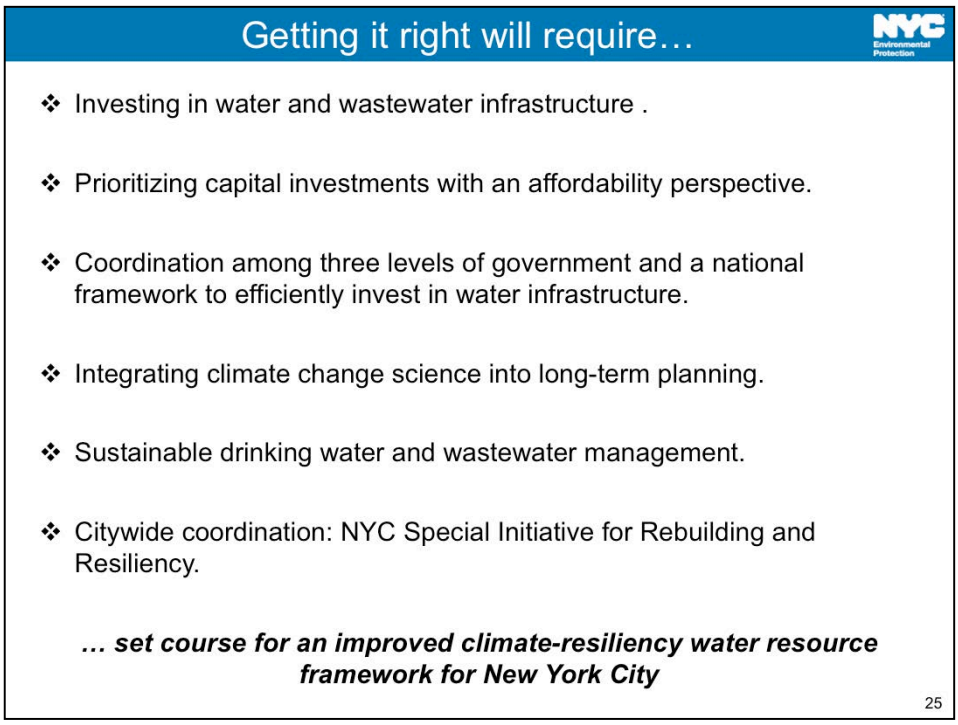
Targeted implementation of basic flood protection alone at net present cost of $5 million can reduce expected risk by $6 Million dollars for an $8 Million net savings

Flood-proofing equipment would have a net present cost of $18 million but would reduce expected risk by $17.5 million in net present value. This would result in a net increase of $0.5 Million



Bowery Bay, Hunts Point, Port Richmond, Red Hook and Rockaway WWTP potentially have more than 50% of target assets at risk under the forecast climate scenario.

You may wonder why Rockaway has a low percent of target assets considering it was the costliest plant to fix after the storm. This is because most of the critical equipment (MCC's, VFD's etc,…) are located above the flood plain.



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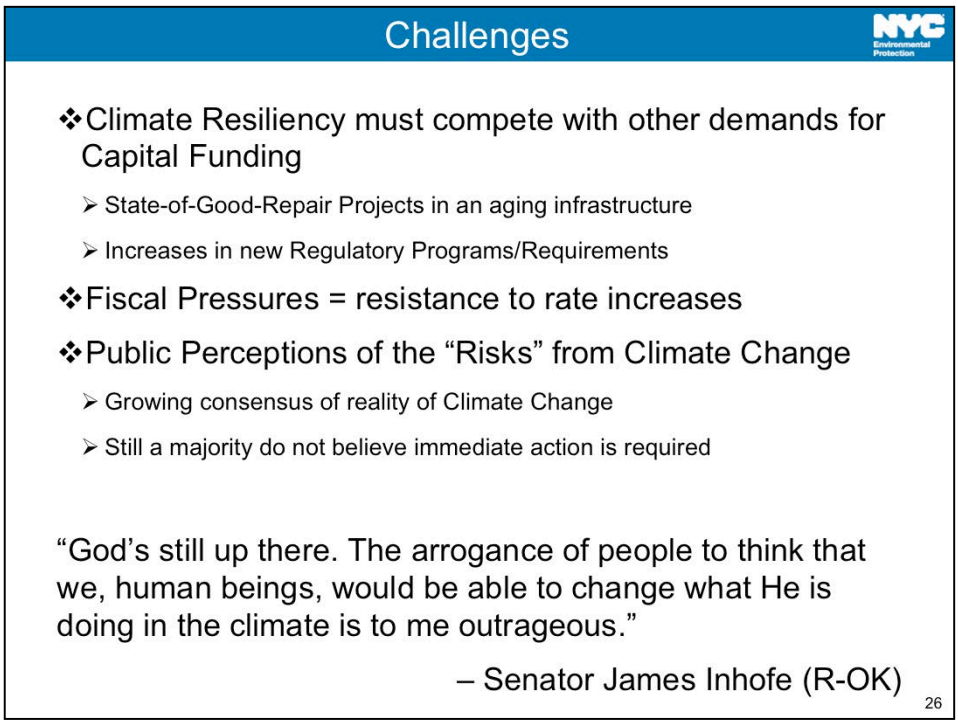

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For example – consent orders, agreements with other agencies, new building/ fire codes, EPA, TRC, BNR, etc

Special Thanks

Kathryn Garcia, NYC DEP Chief Operating Officer

Angela Licata, Deputy Commissioner, Bureau of Environmental Analysis and Planning

Kevin Donnelly, Assistant Commissioner, Bureau of Engineering Design and Construction

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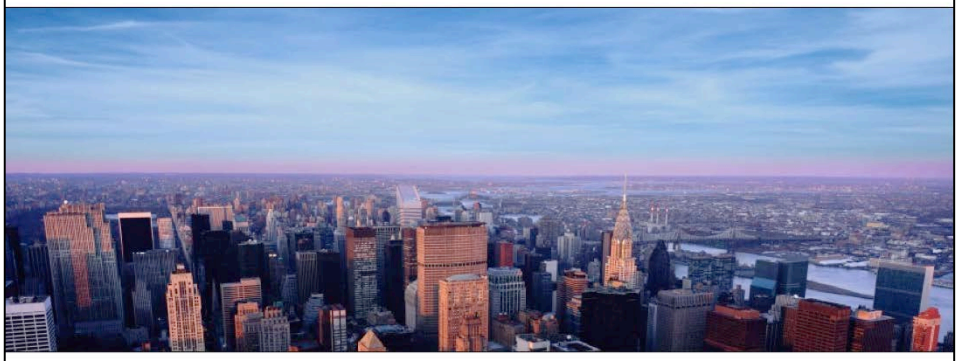
Thank You!



http://www.nyc.gov/dep

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