Assessing and Managing Climate Change Risk to New York City's Water Supply and Wastewater Treatment Systems

Committee Meeting of the
Water Supply Citizens Advisory Committee to the
Massachusetts Water Resources Authority
December 5, 2008

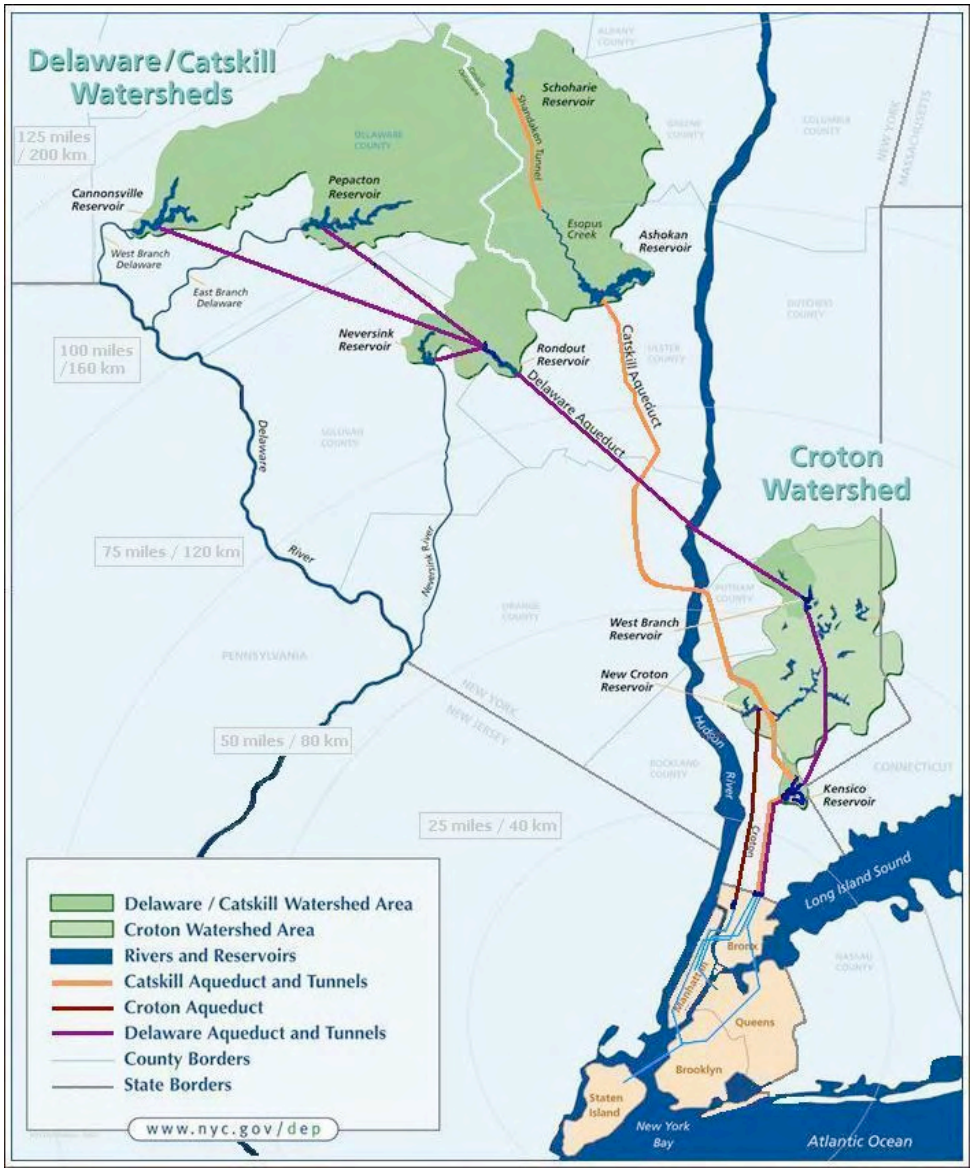
Gary Heath, Director of Operations
Bureau of Environmental Planning and Analysis




Agenda

- New York City's Water Supply & Wastewater Systems
- DEP's and New York City's Respond to Climate Change
- Observations and Projections
- DEP Climate Change Program
- Climate Change Impacts and Adaptations
- Greenhouse Gas Mitigation
- Key Observations

- 19 reservoirs and 3 aqueducts supply 1.1 billion gallons of water to 9.2 million people daily
- 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)



- 14 water pollution control plants process 1.5 billion gallons of wastewater daily

Randall's Island water pollution control plant

Responding to Climate Change

2000 US Global Change Research Program's Metro East Coast assessment indicates that water infrastructure is at risk for climate change impacts

2003 DEP commissions Columbia University's Center for Climate Systems Research (CCSR) and NASA's Goddard Institute for Space Studies (GISS) to develop climate projections for watershed region

…provides funding for Stony Brook University's regional storm surge barrier feasibility study

…signs-on as sole US participant in European Union's CLIME project, which studies effects of climate change on lake environments

2004 DEP institutes agency-wide Climate Change Task Force

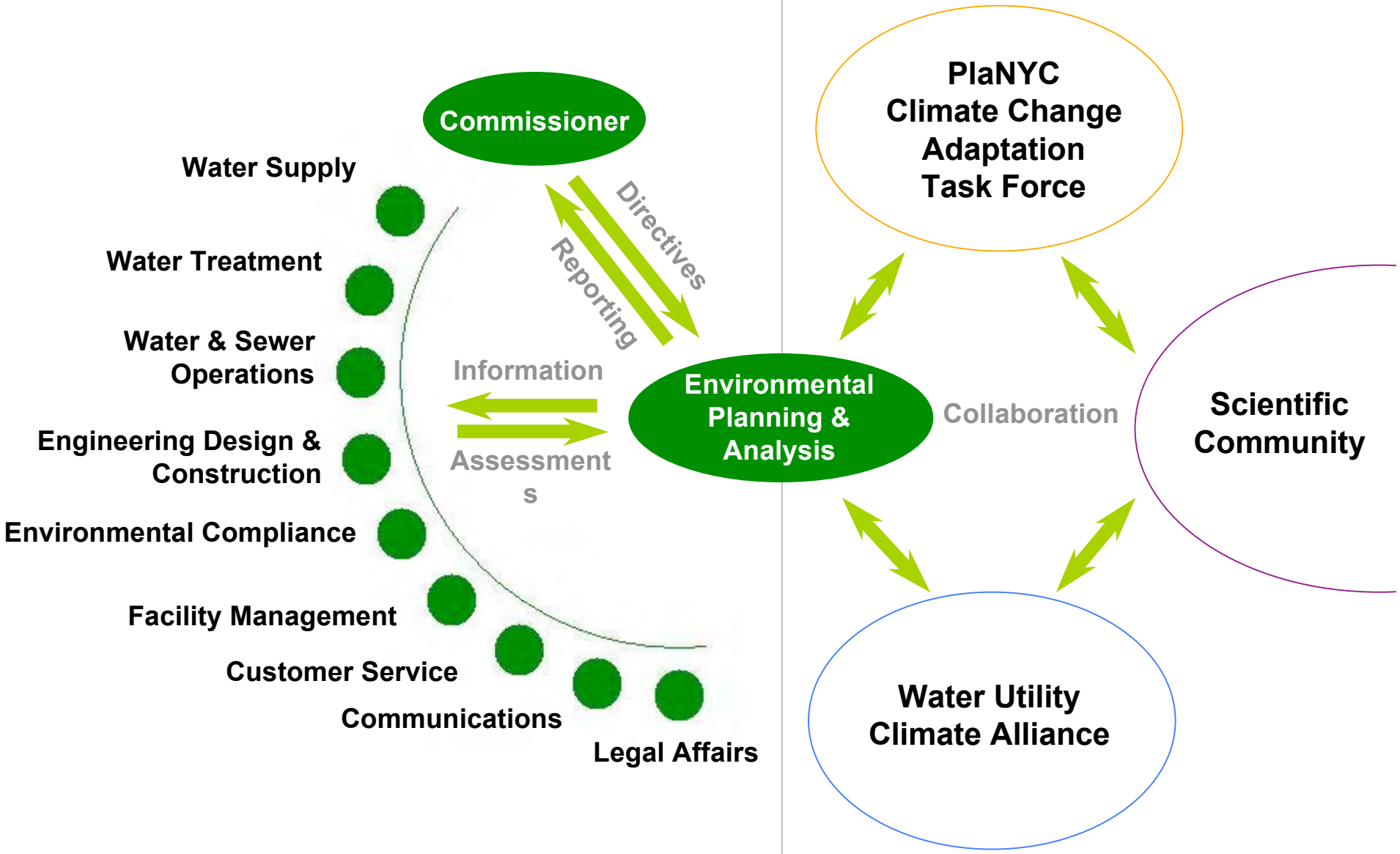
2006 Bureau of Environmental Planning & Analysis designated as coordinating body for ongoing climate change initiatives

2007 DEP commissions greenhouse gas mitigation feasibility study

2008 DEP releases Climate Change Assessment and Action Plan, Report 1

- Develop interdisciplinary awareness of climate change impacts
- Identify system vulnerabilities
- Integrate climate change risk assessment into department's strategic and capital planning

DEP Climate Change Task Force



PlaNYC Climate Change Adaptation Task Force

Policy

- Dept of Buildings
- Dept of City Planning
- Dept of Design & Construction
- Dept of Environmental Conservation
- Dept of Health
- Dept of Law
- Economic Development Corp
- Office of Emergency Management
- NYS Emergency Management Office
- Office of Management & Budget

Energy

- NY Power Authority
- NY Independent System Operator
- NYS Public Service Commission
- Astoria Energy LLC
- Con Edison
- National Grid
- NRG Energy
- TransCanada Corporation
- USPowerGen

Communications

- AT&T
- Cablevision
- Sprint Nextel
- T-Mobile
- Time Warner Cable
- Verizon

Water & Wastewater

- Dept of Environmental Protection
- Dept of Parks & Recreation
- Dept of Sanitation
- Economic Development Corp

Transportation

- Dept of Transportation
- NYS Dept of Transportation
- Metropolitan Transportation Authority
- NJ Transit
- Port Authority of New York & New Jersey
- Amtrak
- CSX

Seattle Public Utilities

Portland Water Bureau

San Francisco Public Utilities Commission

Metropolitan Water District of Southern California

San Diego County Water Authority

Denver Water

Southern Nevada Water Authority

New York City Department of Environmental Protection

WUCA is a consortium of water providers serving eight of the country's large metropolitan regions, working together "to improve research into the impacts of climate change on water utilities, develop strategies for adapting to climate change, and implement tactics to reduce greenhouse gas emissions."

DEP Used three Intergovernmental Panel on Climate Change (IPCC) Greenhouse Gas (GHG) Emissions Scenarios and five Global Climate Models (GCMs) to examine a global issue on a regional level.

- Using various methods to assess climate impacts on NYC region, including:
  - Interpolation from GCM grids
  - Regional Climate Models (RCMs)

Using GCM and RCM output to forecast local/regional impacts on:

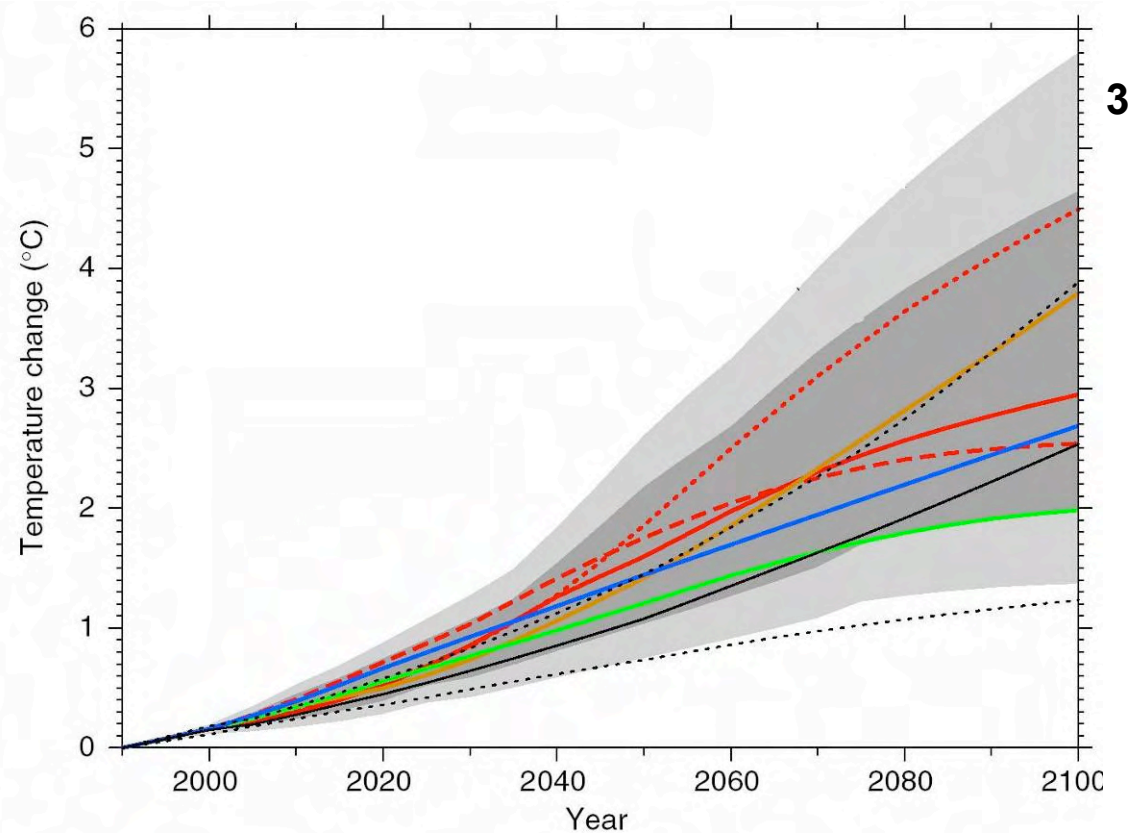
- Temperature
- Precipitation
- Sea Level Rise
- Storm Surges
- Watershed and Water Supply

Staying aware of High Impact Climate Scenarios including:

- Melting of the West Antarctic & Greenland Ice Sheets
- Reversal of Ocean Circulation 'Conveyor Belt'
- Global increases of GHG

Model Projections of Global Temperature

An Upward Trend for All Scenarios

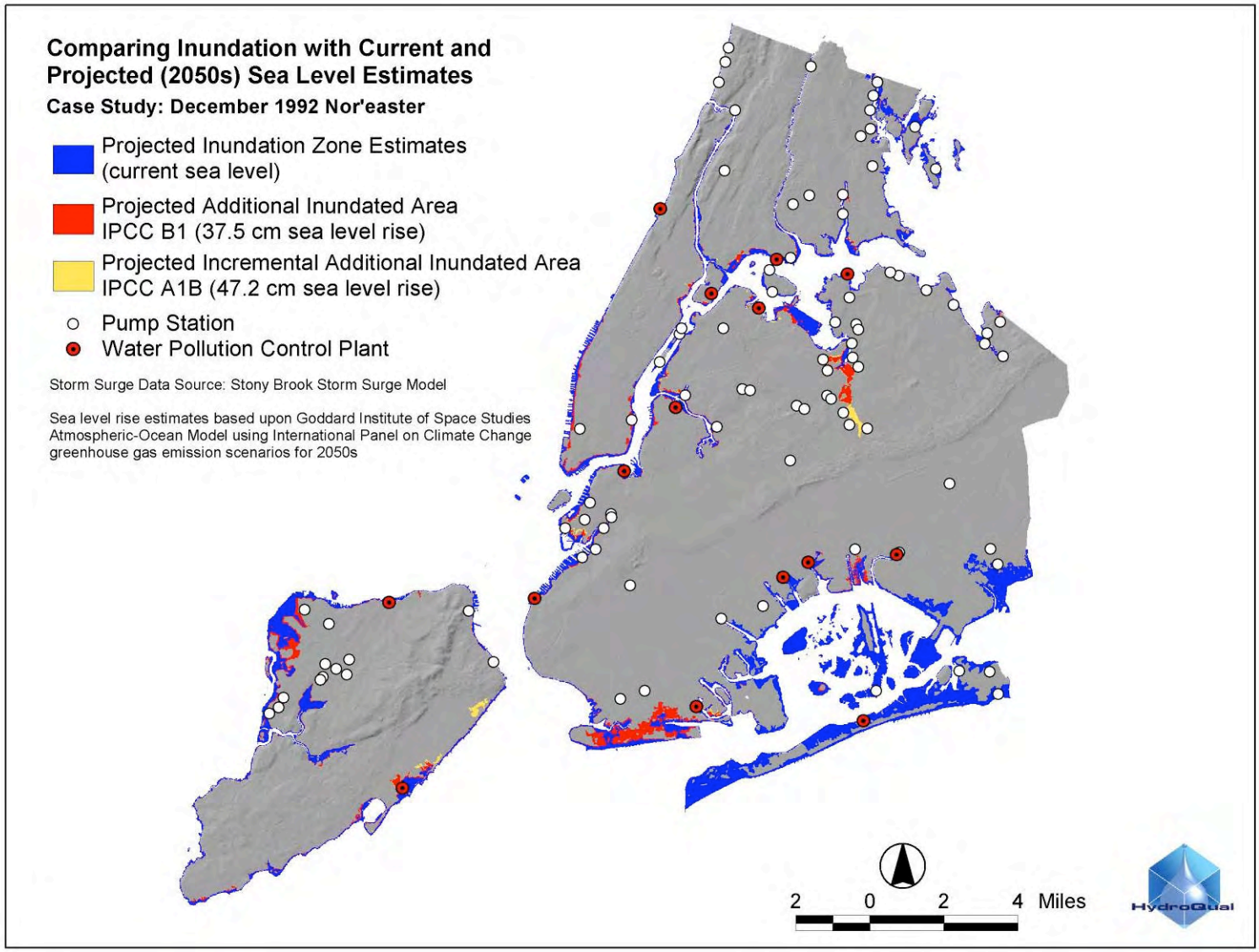


3 GHG Scenarios

A2

A1B

B1


Comparing Inundation with Current and Projected (2050s) Sea Level Estimates
Case Study: December 1992 Nor'easter
Projected Inundation Zone Estimates (current sea level)
Projected Additional Inundated Area IPCC B1 (37.5 cm sea level rise)
Projected Incremental Additional Inundated Area IPCC A1B (47.2 cm sea level rise)
Pump Station
Water Pollution Control Plant
Storm Surge Data Source: Stony Brook Storm Surge Model
Sea level rise estimates based upon Goddard Institute of Space Studies Atmospheric-Ocean Model using International Panel on Climate Change greenhouse gas emission scenarios for 2050s
2 0 2 4 Miles
HydroQual

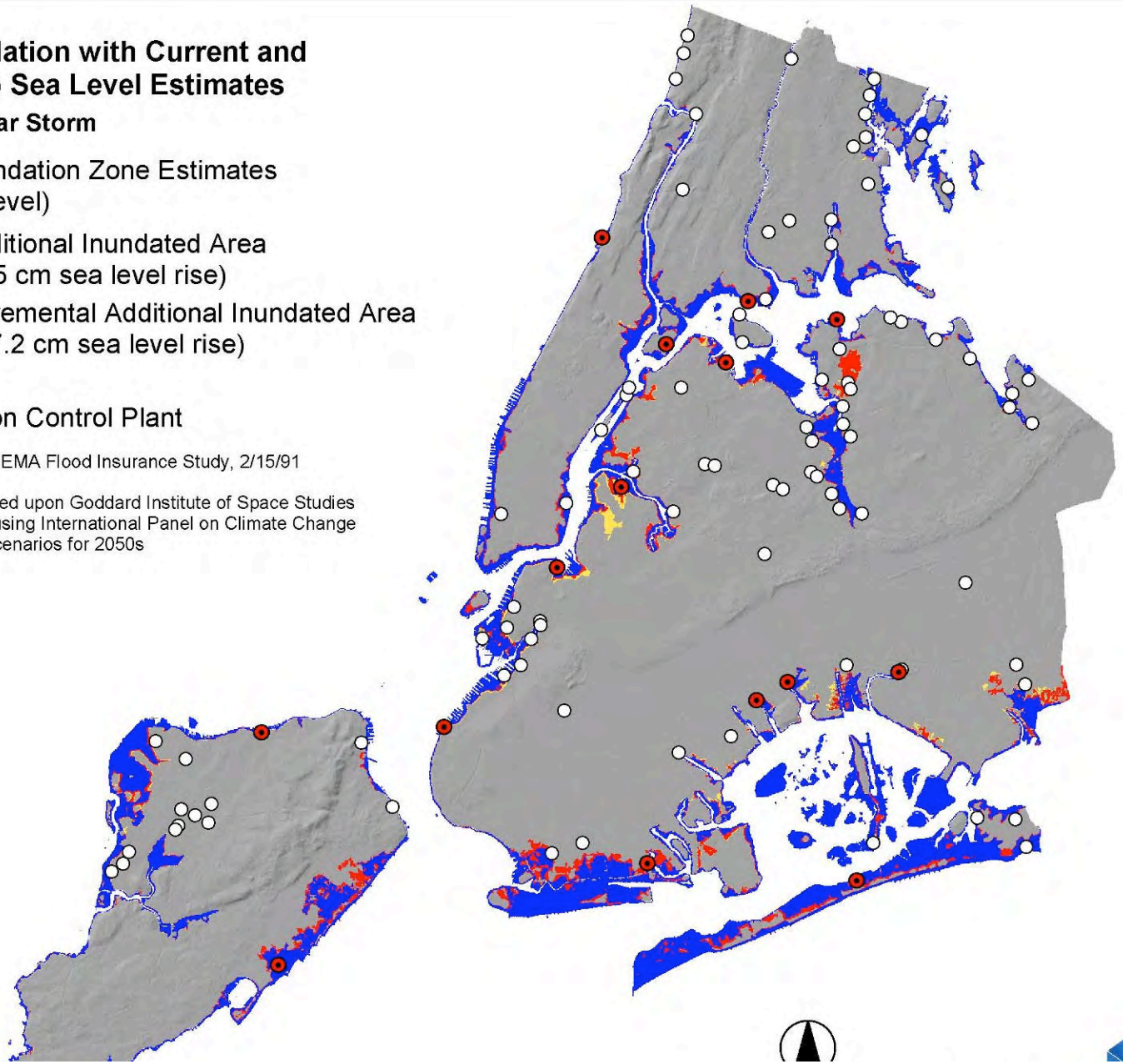
Comparing Inundation with Current and Projected (2050s) Sea Level Estimates

Case Study: 100-Year Storm

- Projected Inundation Zone Estimates (current sea level)
- Projected Additional Inundated Area IPCC B1 (37.5 cm sea level rise)
- Projected Incremental Additional Inundated Area IPCC A1B (47.2 cm sea level rise)
- Pump Station
- Water Pollution Control Plant

Storm Surge Data Source: FEMA Flood Insurance Study, 2/15/91

Sea level rise estimates based upon Goddard Institute of Space Studies Atmospheric-Ocean Model using International Panel on Climate Change greenhouse gas emission scenarios for 2050s



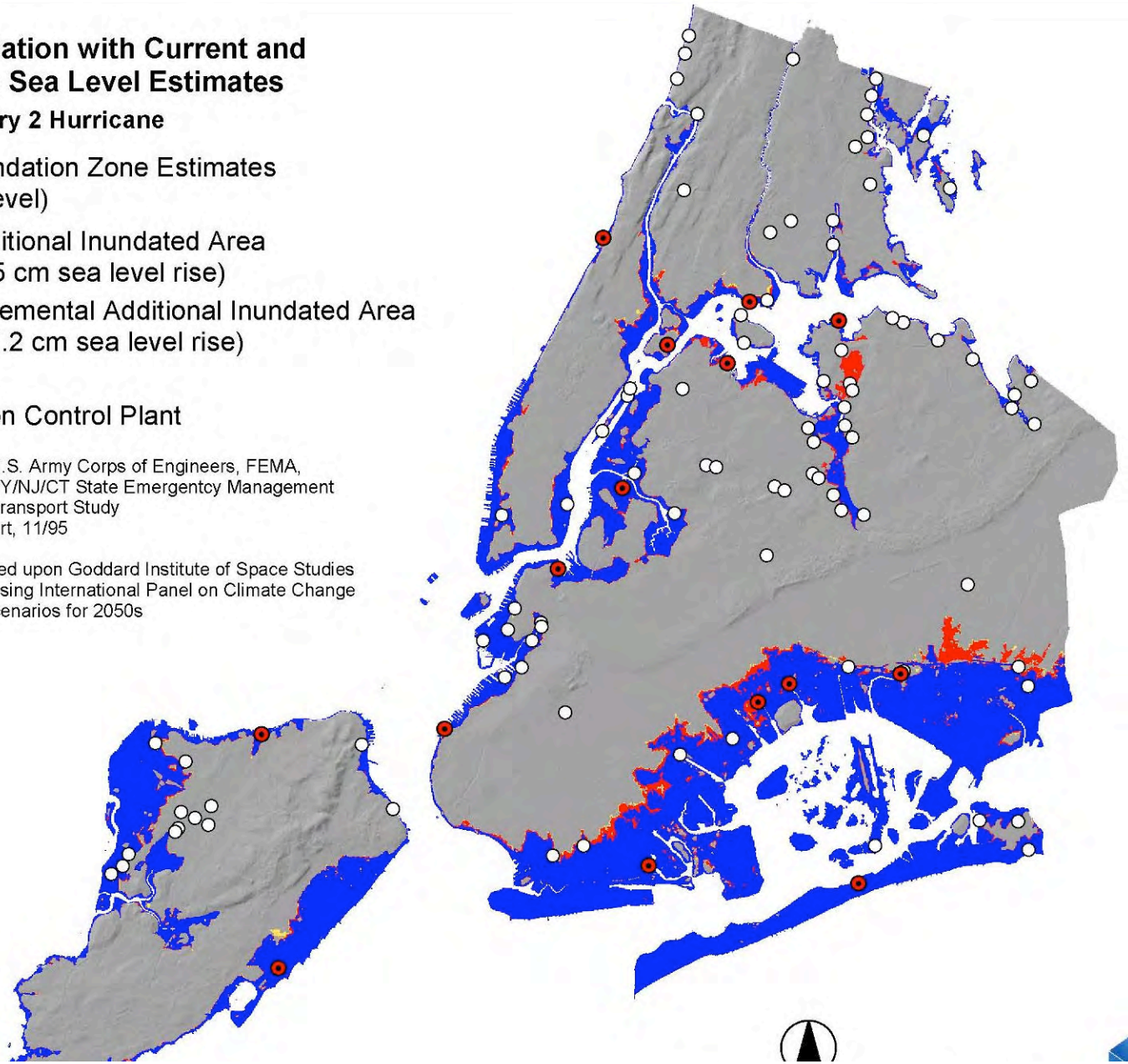
Comparing Inundation with Current and Projected (2050s) Sea Level Estimates

Case Study: Category 2 Hurricane

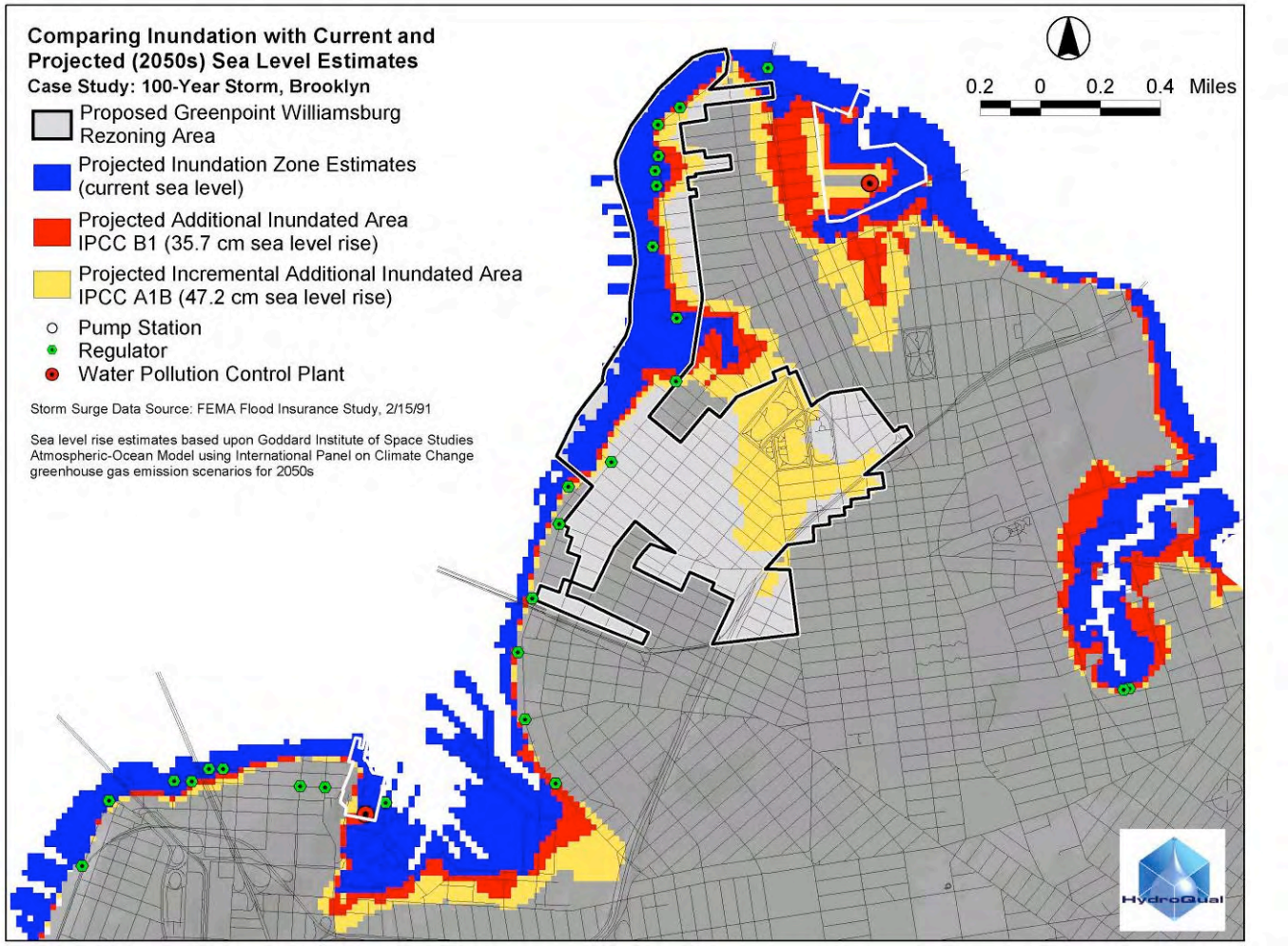
- Projected Inundation Zone Estimates (current sea level)
- Projected Additional Inundated Area IPCC B1 (37.5 cm sea level rise)
- Projected Incremental Additional Inundated Area IPCC A1B (47.2 cm sea level rise)
- Pump Station
- Water Pollution Control Plant

Storm Surge Data Source: U.S. Army Corps of Engineers, FEMA, National Weather Service, NY/NJ/CT State Emergentcy Management Metro New York Hurricane Transport Study Interim Technical Data Report, 11/95

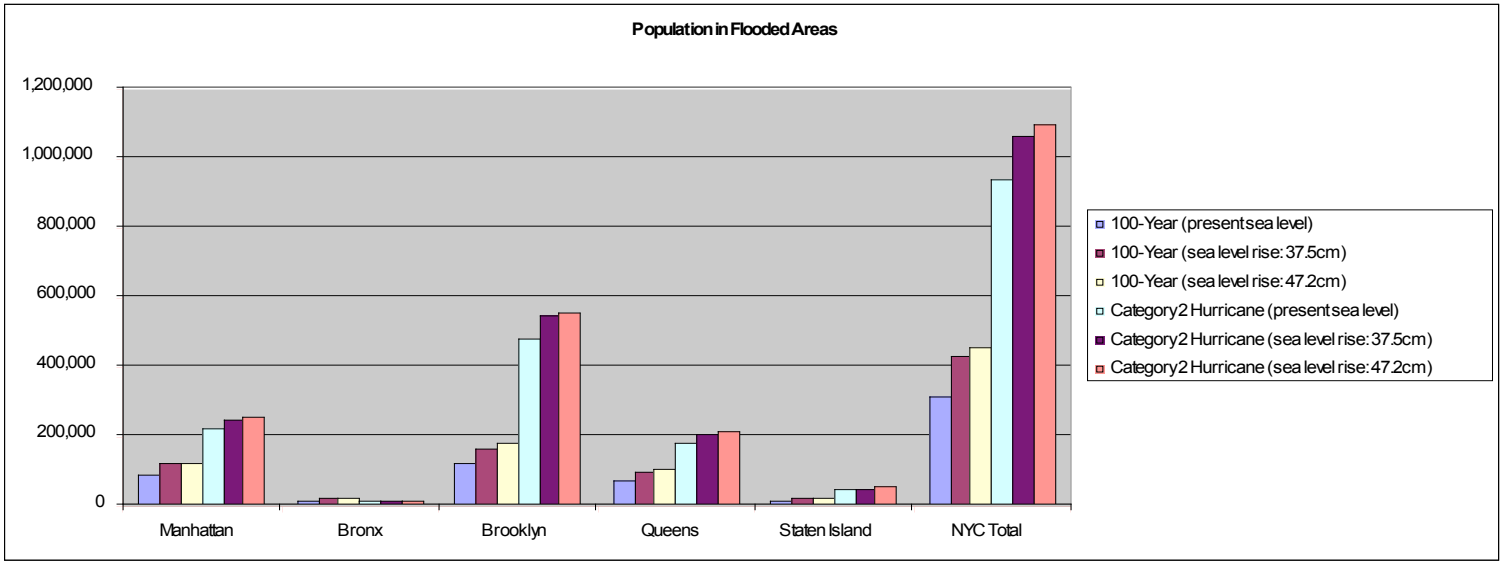
Sea level rise estimates based upon Goddard Institute of Space Studies Atmospheric-Ocean Model using International Panel on Climate Change greenhouse gas emission scenarios for 2050s

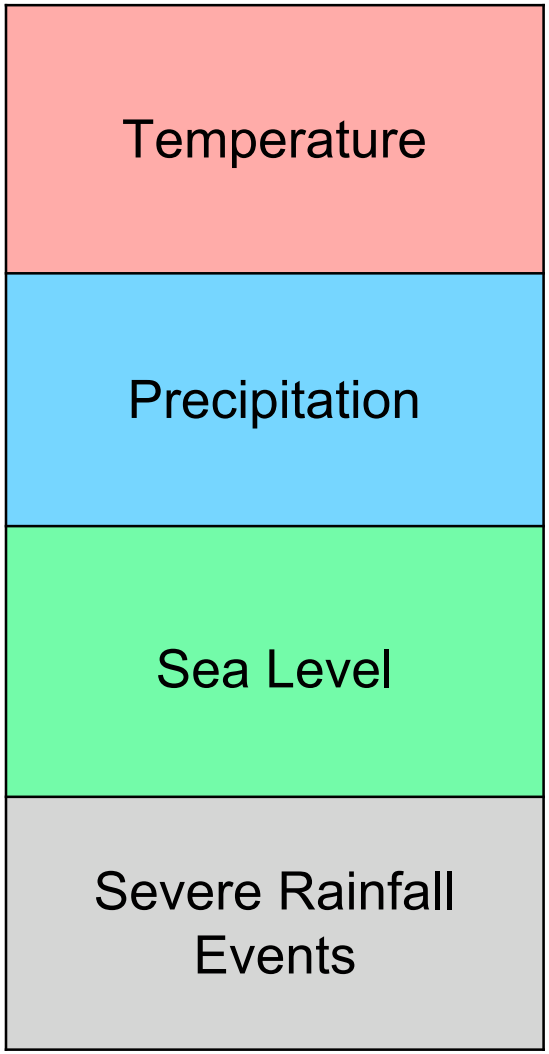


Observations and Projections



Comparing Population in Flooded Areas with Current and Projected (2050s) Sea Level Estimates - Case Study: 100-Year Storm and Category 2 Hurricane





From 1900 to 2005, New York's City's annual mean temperature increased by **1.9 °F**

Annual mean precipitation also increased by **4.2 in**

In the same period, mean sea level at Battery Park rose by **1 ft**

More frequent and more severe rain events threaten our infrastructure, cause major flooding and affect the quality of our water supply

Projected Climate Change Impacts

	Temperature increase	Precipitation increase	Sea level rise	High end estimates
2020s	1.5 – 3.0 °F	0 – 5 %	4 – 7 in	--
2050s	3.0 – 5.0 °F	0 – 10 %	9 – 14 in	24 in
2080s	4.0 – 7.5 °F	5 – 10 %	16 – 25 in	36 in

Increases relative to the 1971-2000 base period using seventeen Global Climate Models

High end sea level rise estimates based on recent icemelt observations in Greenland and West Antarctica as well as on paleoclimate studies

Data provided by **New York City Panel on Climate Change** (NPCC)

Climate Change Implications

Impact	Implications
Temperature Increases	**Rising temperatures will lead to...** • Increased water demand straining water supply systems • Extended growing seasons; early leaf out and increased water demand • A strain on materials leading to increased maintenance and equipment replacement cycles • Browning of lawns and other vegetation • More demand for beaches and recreational facilities, stressing existing operations and infrastructure • More water needed for cooling • Increased heat level of playground equipment • Potential for increased odor from waste transfer facilities, affecting surrounding communities
Precipitation Increases	**Heavier more frequent rainfall will lead to...** • More turbidity in reservoirs affecting water quality • Increased flooding leading to more infrastructure damage • Overwhelmed drainage systems, leading to sewer back ups and combined sewer overflow events • More frequent beach closures • Increased sediment requiring more frequent dredging
Sea Level Rise	**Rising sea levels will lead to increased storm surges and more flood occurrences, causing...** • Salt front encroachment • Damage from saltwater to water front infrastructure/assets (e.g., piles for piers) • More frequent or permanent inundation of low lying areas (e.g., coastal parks, wetlands) • More frequent or permanent flooding of piers and marine transfer stations • Erosion of beaches
Severe Rainfall Events	**Severe Rainfall Events** • More downed trees and forestry emergencies • Changes in water levels in reservoirs and lake flooding • Street and infrastructure flooding

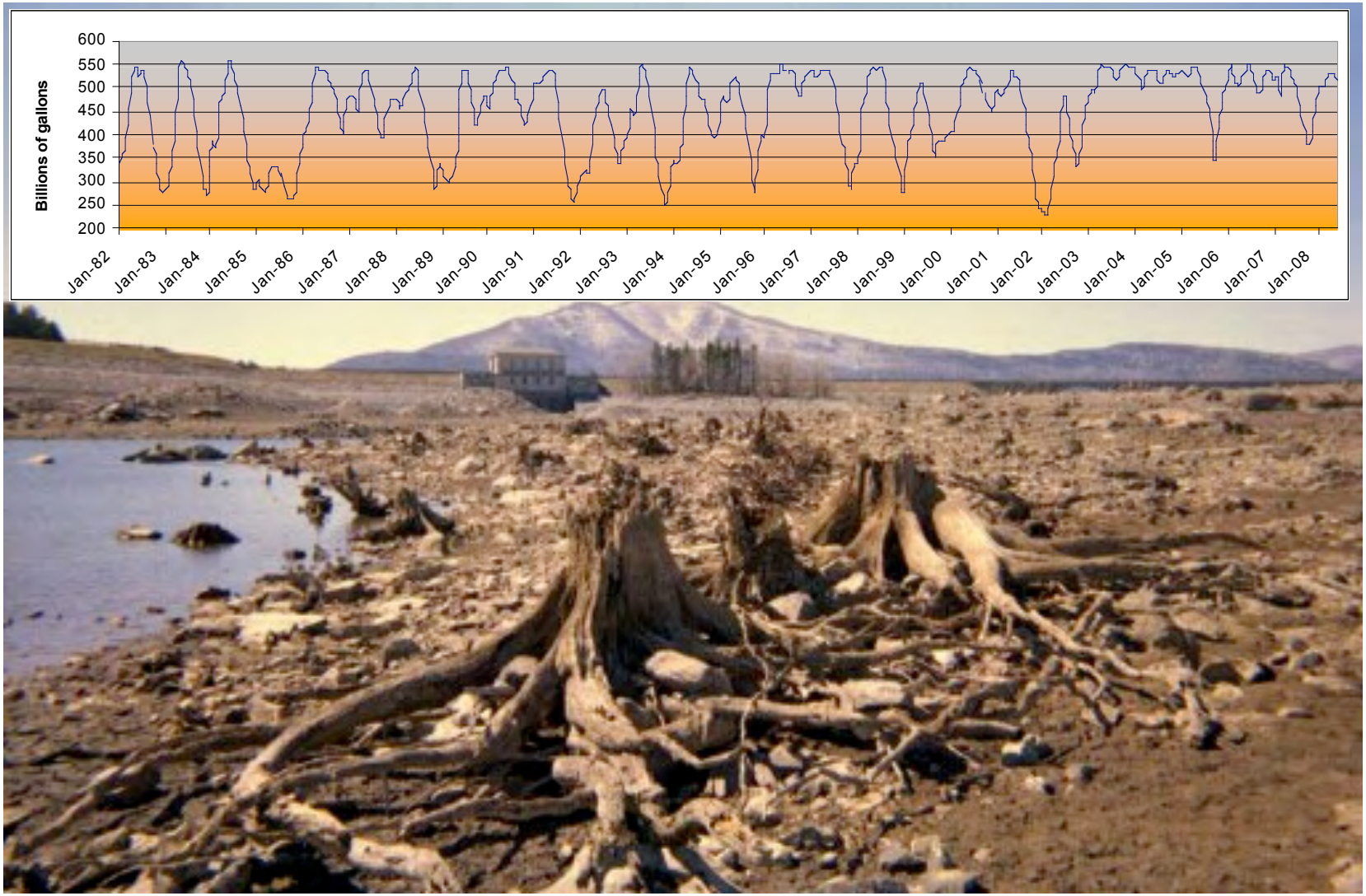
Recent Severe Rainfall Events

September 23, 2004	2.5” of rain recorded in 1 hour at Central Park
October 2005	13” accumulation over 8 day period
April 15, 2007	7” of rain recorded in upper Manhattan, the largest daily accumulation since 1882
July 18, 2007	between 3” and 5” of rain recorded at locations across the region within a 4 hour period (in some areas, 3” fall in 1 hour)
August 8, 2007	1.4”–3.5” of rain recorded within a 2 hour period; DEP measures 4.2” daily accumulation at Owl’s Head Water Pollution Control Plant

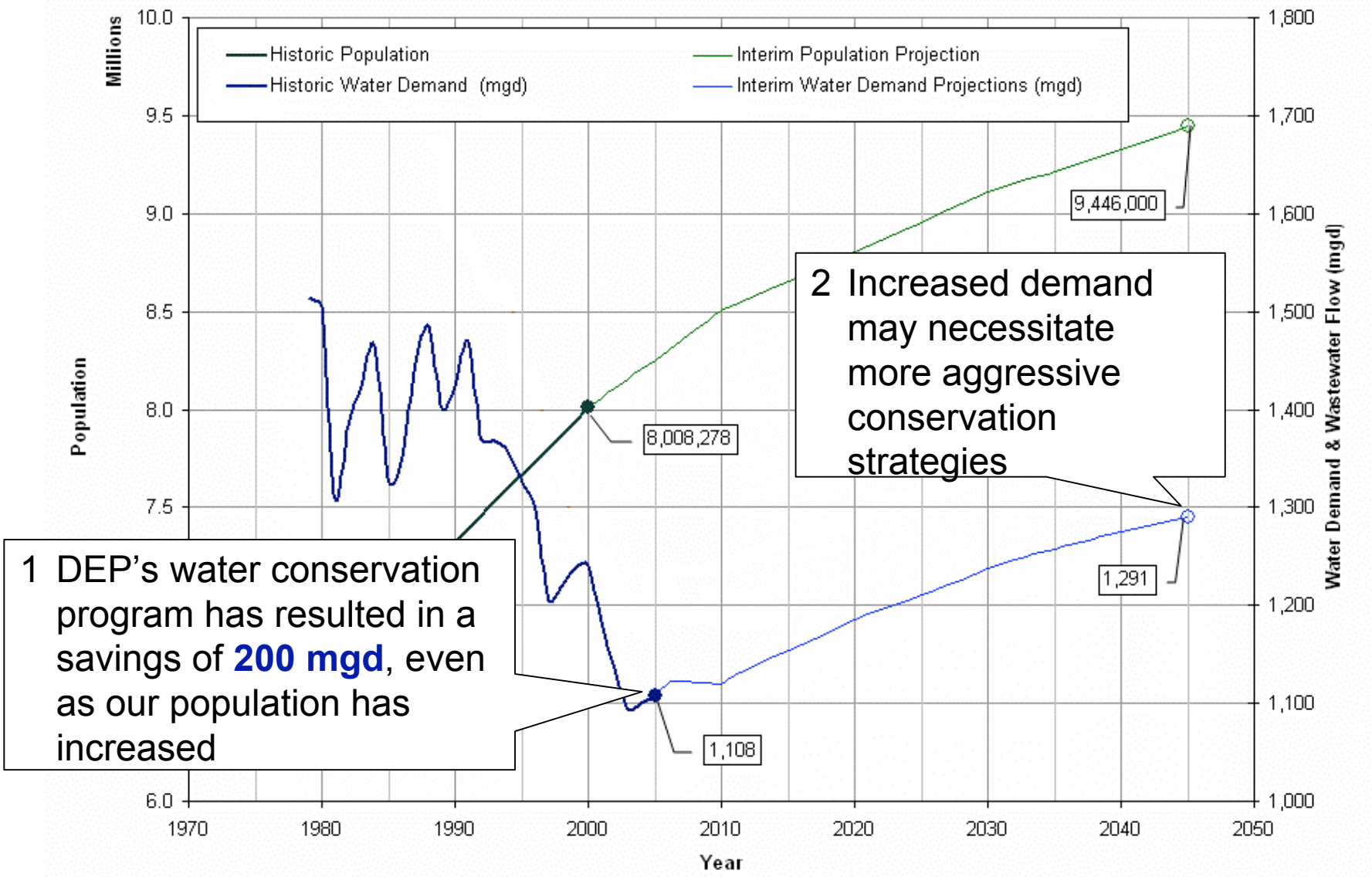
Water Supply System Impacts and Adaptation

- Increased demand, both within New York City and in watershed supply areas

- Increased variability in reservoir storage levels



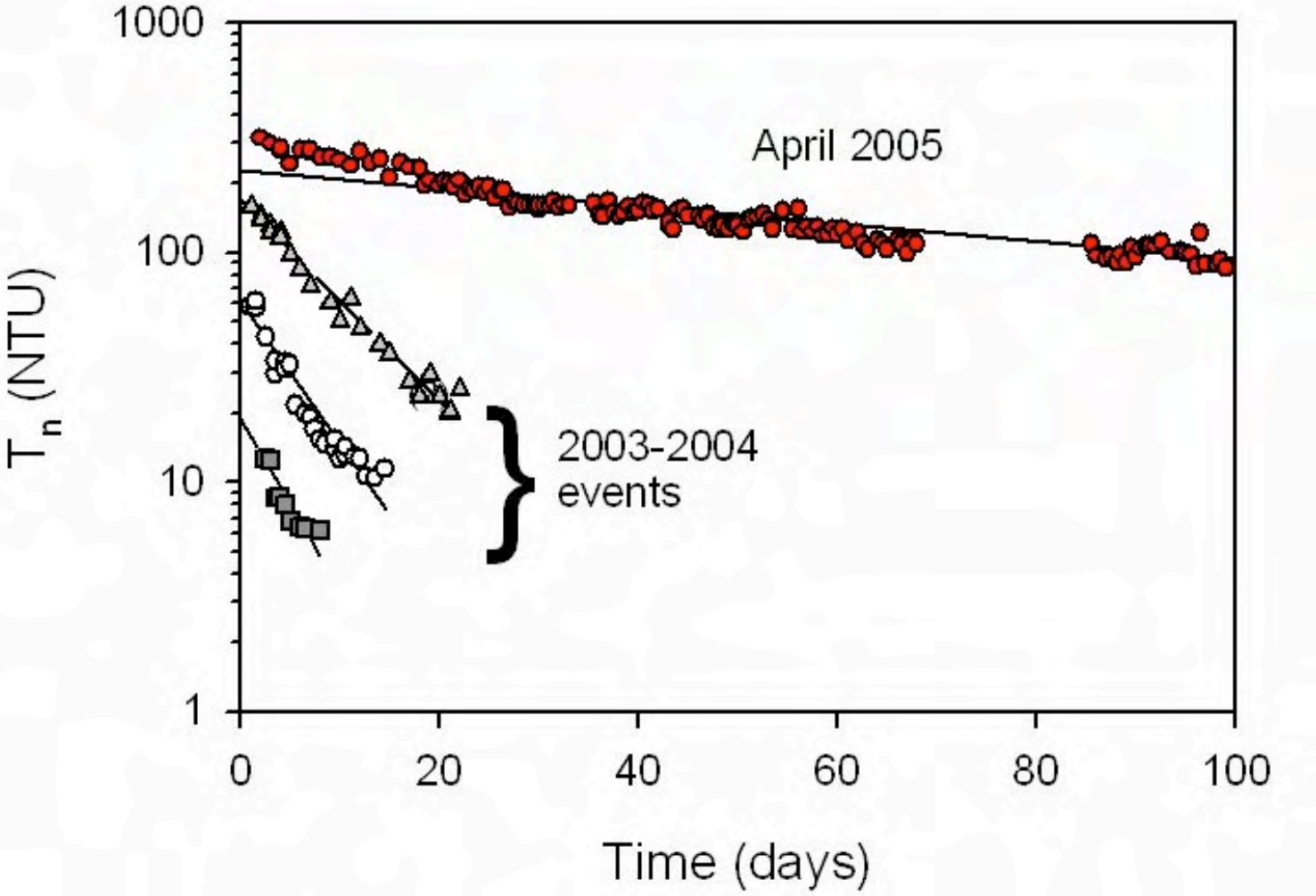
Adaptation: Expand Existing Water Conservation Program



- Increased precipitation intensity, leading to an increase in reservoir turbidity

Sept 1999: turbidity in Ashokan reservoir following Hurricane Floyd

Recent turbidity events in Schoharie Reservoir



Adaptation: Mitigate Turbidity Increases

Challenge — **Ensure continued viability of unfiltered water supply**

Impact Assessment — **Quantify turbidity increases for range of climate scenarios**

- Consultant contract currently in progress
- Project to commence early 2009

Adaptation Strategy

Near term: accelerate existing land acquisition program

Mid-term: begin implementing targeted stream, forest and snow pack management programs attenuating storm flows and reducing soil erosion

Long-term: consider aqueduct interconnections between turbidity-prone Catskill system and turbidity-resistant Delaware system

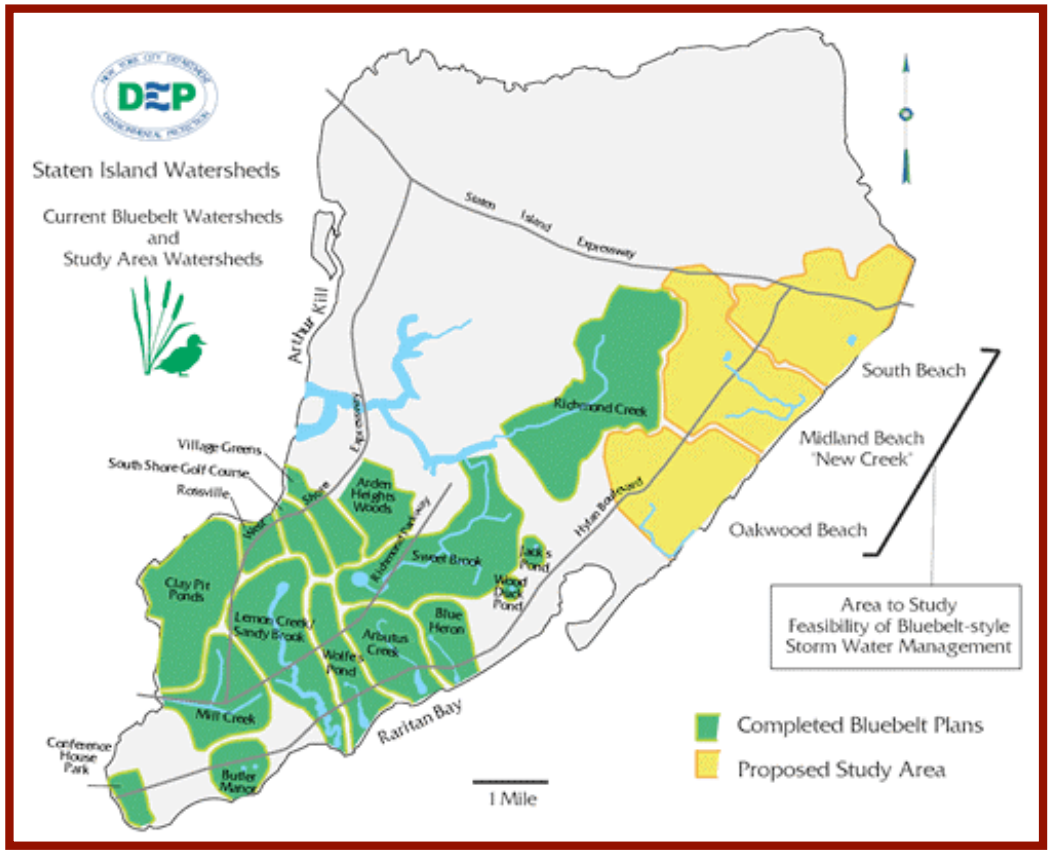


Wastewater System Impacts & Adaptation

- Increased intensity of rain events, leading to extensive flooding of streets and private property

Adaptation: Implement Stormwater Best Management Practices

Rain barrels, 'blue' roofs, and integrated stormwater management practices serve to capture stormwater, attenuating burden of high-intensity rain events on conveyance and treatment infrastructure.



Network of preserved and restored wetlands serves as natural alternative to hardened stormwater conveyance system

Completed network now drains **14,000 acres**

- Sea level rise compounding seasonal storm events to overwhelm water pollution control plants

Adaptation: Relocating Critical Equipment at Rockaway WPCP

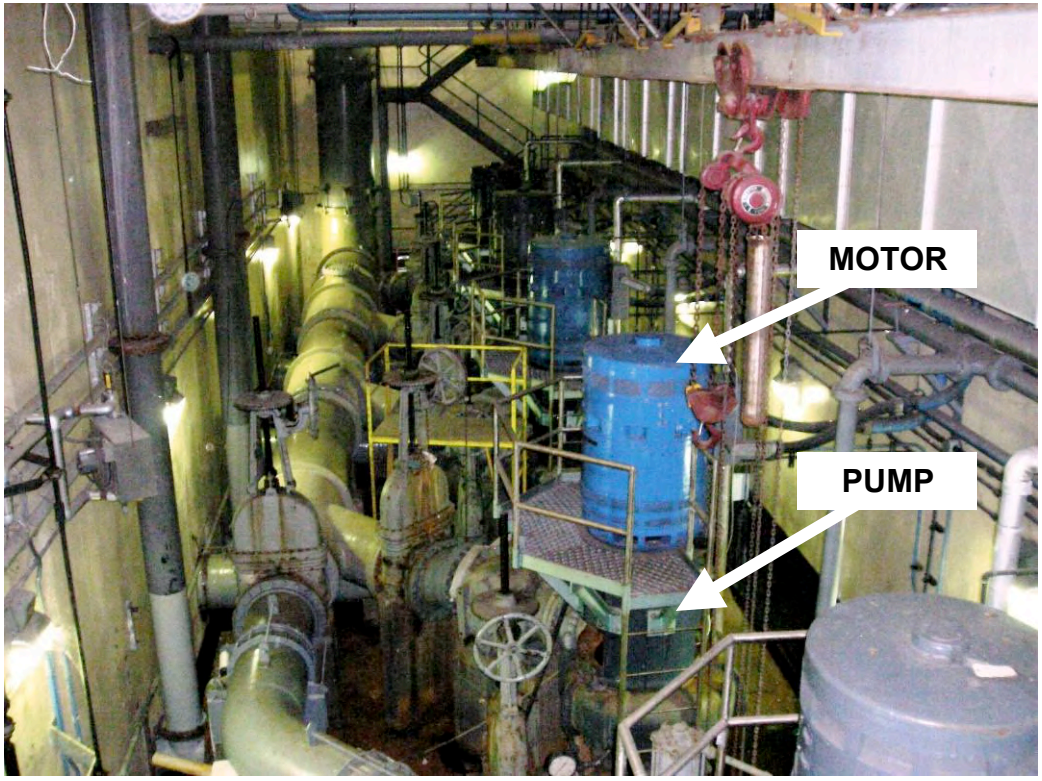
Rockaway WPCP

Data Sources
Orthophotos: 2004 DOITT

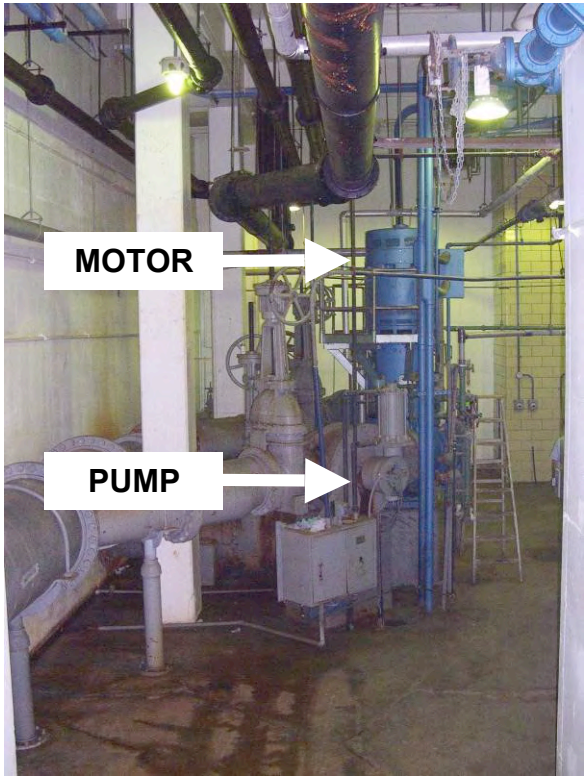
NYC Department of
Environmental Protection
Bureau of Environmental
Planning and Analysis

AUGUST 2007

Adaptation: Relocating Critical Equipment at Rockaway WPCP

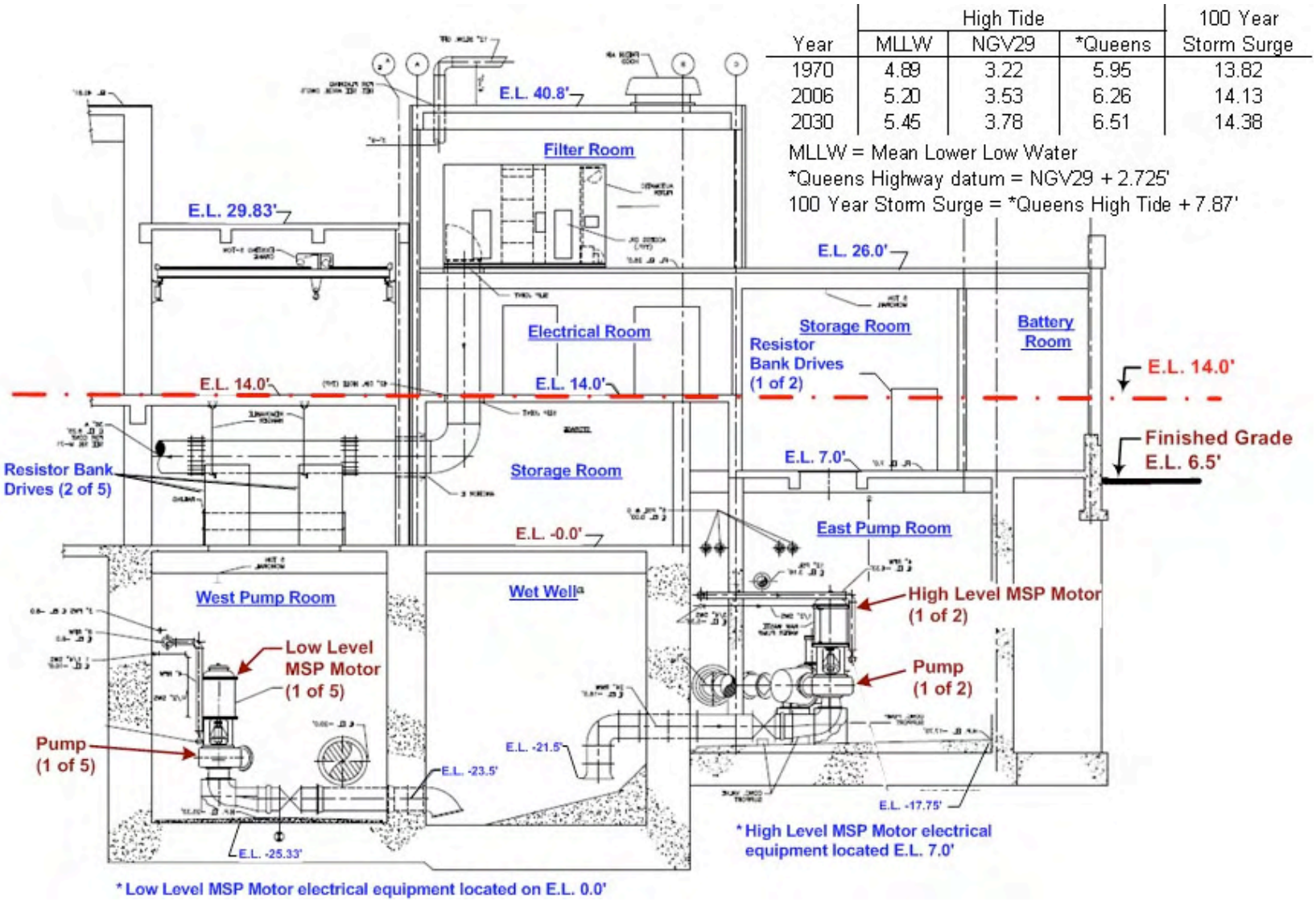


West pump room: 25.33’ below sea level



East pump room: 17.75’ below sea level

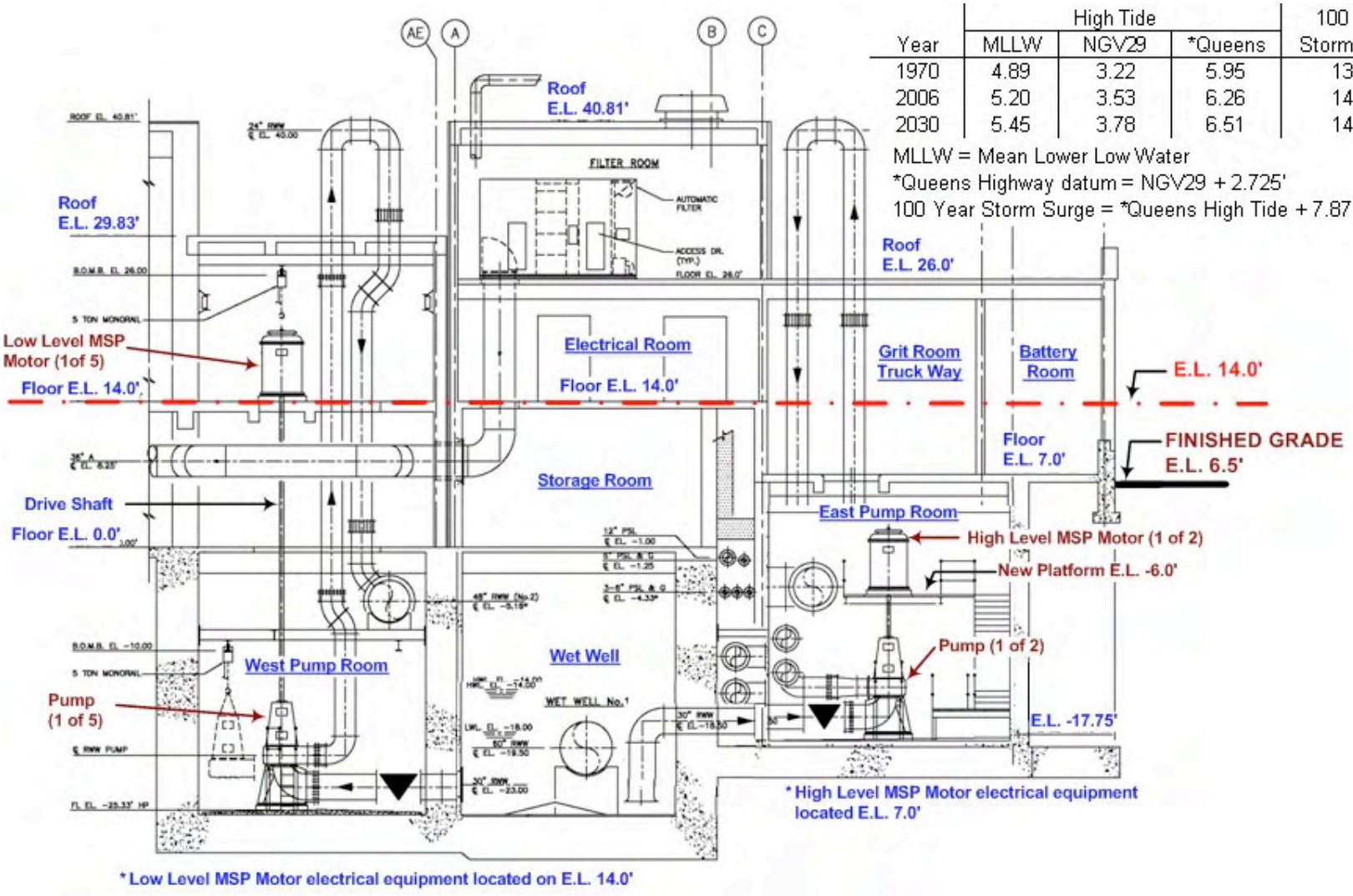
Existing Equipment Locations



Year	High Tide MLLW	High Tide NGV29	High Tide *Queens	100 Year Storm Surge
1970	4.89	3.22	5.95	13.82
2006	5.20	3.53	6.26	14.13
2030	5.45	3.78	6.51	14.38

MLLW = Mean Lower Low Water
*Queens Highway datum = NGV29 + 2.725'
100 Year Storm Surge = *Queens High Tide + 7.87'

Proposed Equipment Locations



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100 Year Storm Surge = *Queens High Tide + 7.87'

Adaptation: Installing Flood Gates at Facility Entryways

Flood Gate at Tallman Island WPCP

Greenhouse Gas Mitigation

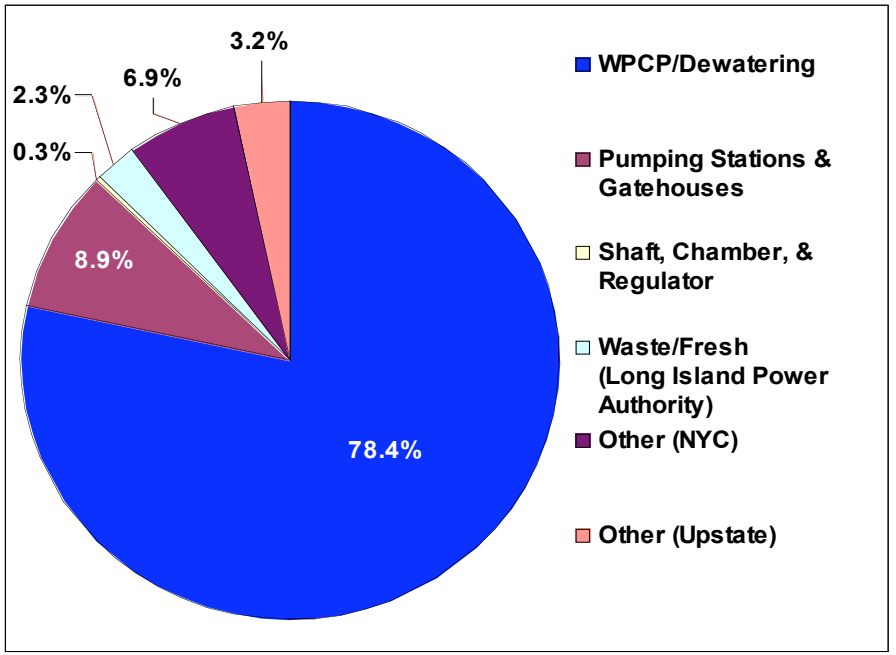
- DEP facilities emit ~10 percent of NYC government GHG emissions
largest source is the WPCP facilities

- Mayor Bloomberg has announced a goal of a City-wide 30% reduction of GHG emissions by 2030

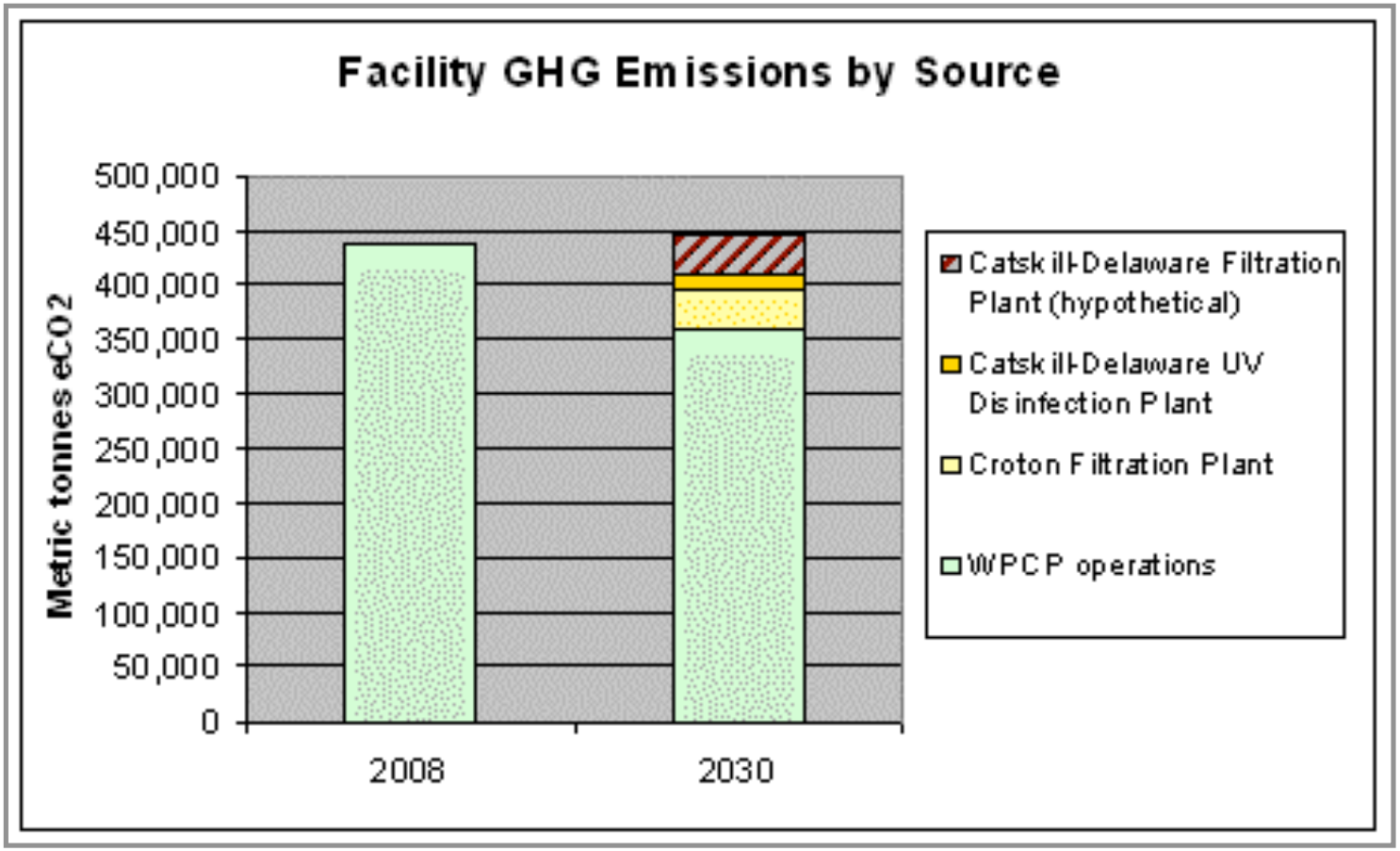
- City Agencies are required to reduce there GHG emissions by 30% by 2017

- DEP conducting a GHG inventory of operations & will be developing GHG management plans

- Most aggressive GHG emissions control must be factored into design
  - New equipment must be clean
  - Old must be retrofitted and controlled



Impact of Hypothetical Catskill-Delaware Filtration Plant



Moving Forward

- We will continue collaborating with the New York City Climate Change Adaptation Task Force as it develops a city-wide adaptation strategy

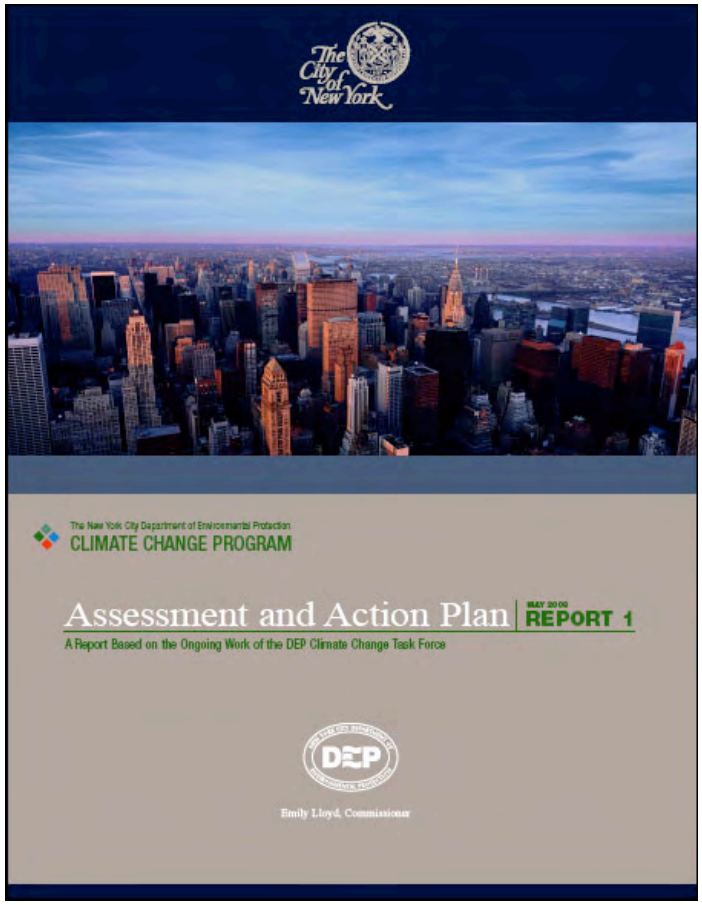
- We will also be seeking to actively engage other New York City agencies to identify and implement integrated adaptation strategies

- We will continue collaborating with our WUCA partners to advance the frontier of decisionmaking methodology and climate science research

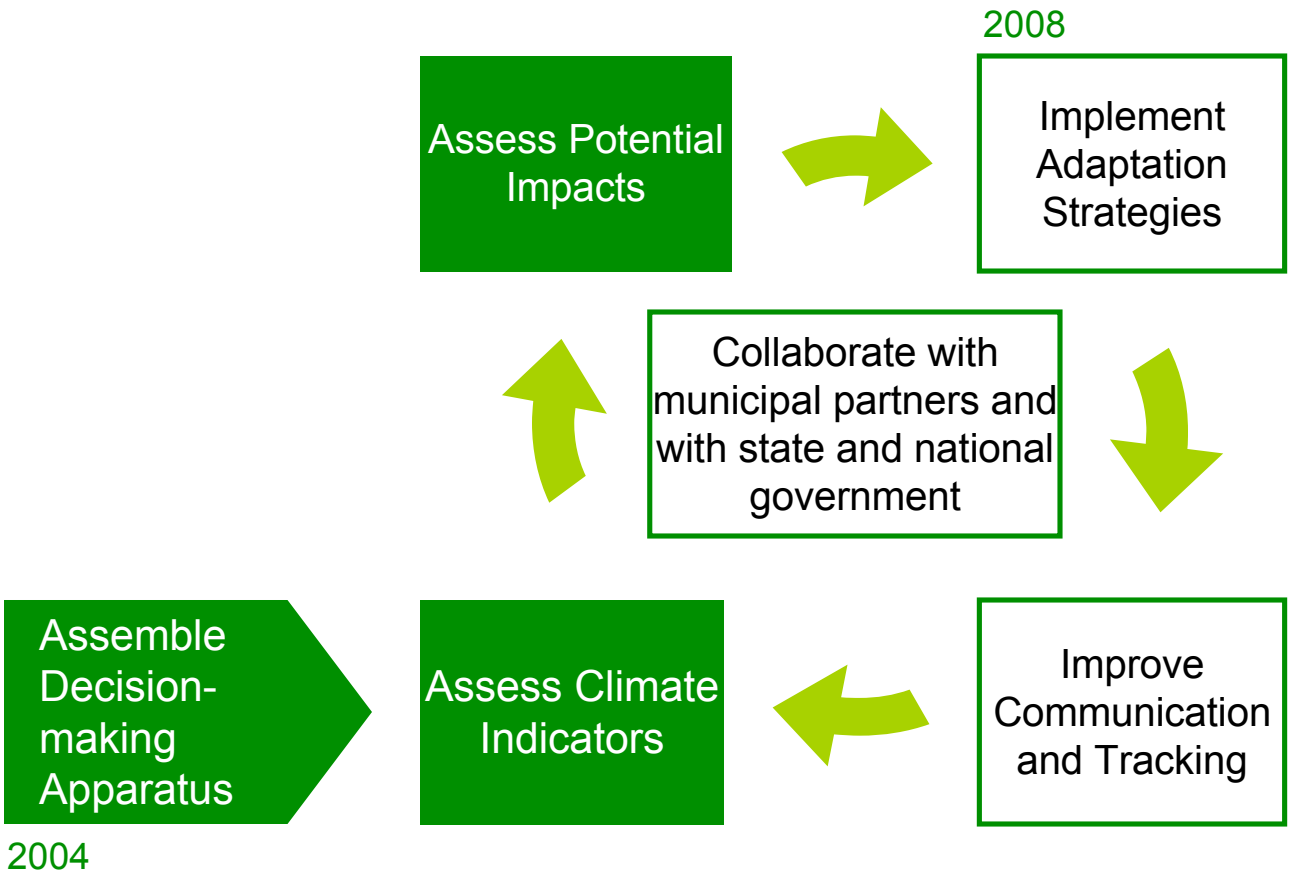
DEP Climate Change Program

Assessment and Action Plan, Report 1

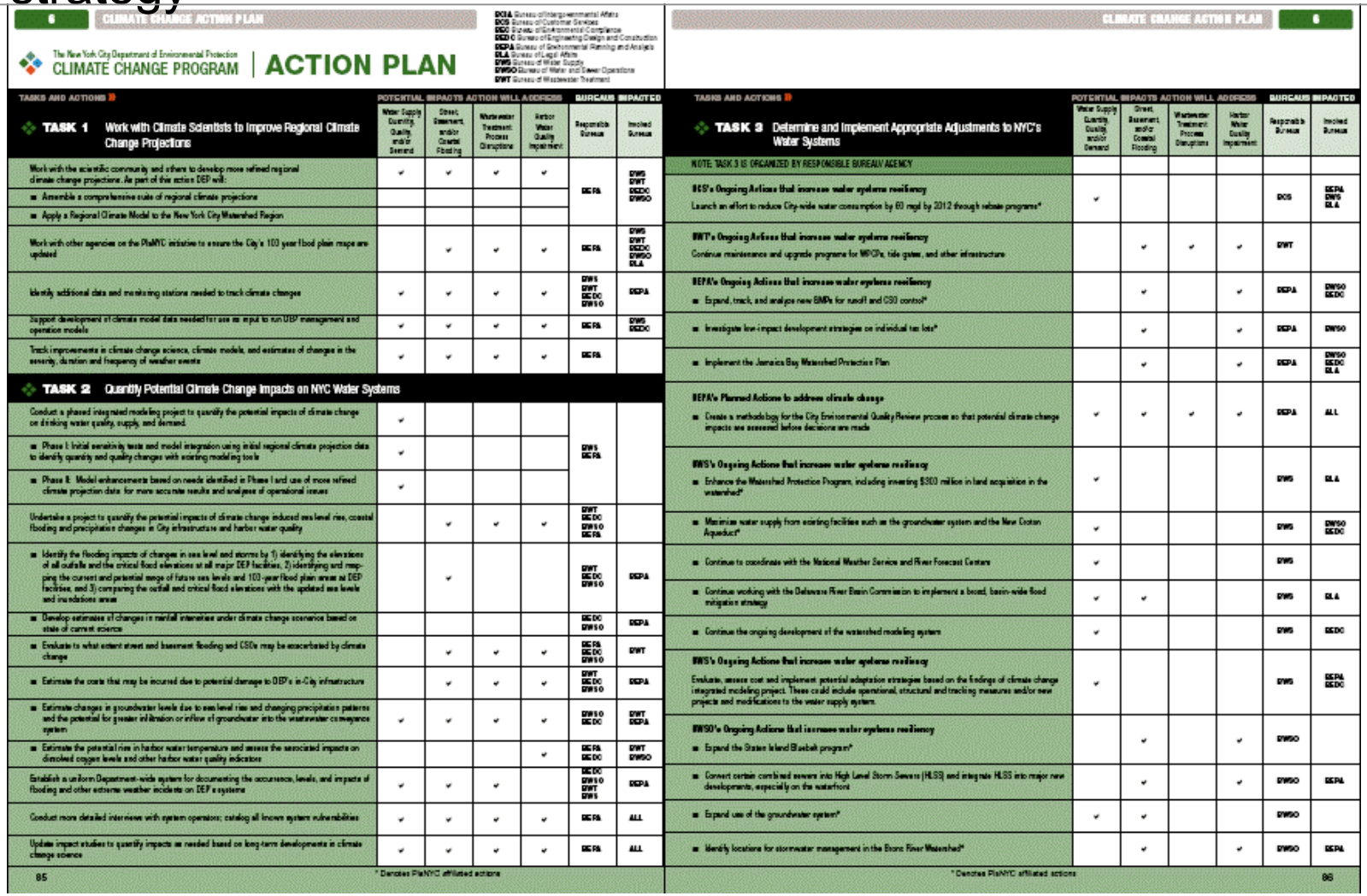
http://www.nyc.gov/dep



- Impact assessment and adaptation is by necessity iterative, requiring agile decision-making at each step



- Action plan defines Department-wide climate change adaptation strategy



6 CLIMATE CHANGE ACTION PLAN

The New York City Department of Environmental Protection
CLIMATE CHANGE PROGRAM | ACTION PLAN

BCIA Bureau of Intergovernmental Affairs
BCS Bureau of Customer Services
BEC Bureau of Environmental Compliance
BEDC Bureau of Engineering Design and Construction
BEPA Bureau of Environmental Planning and Analysis
BLA Bureau of Legal Affairs
BWS Bureau of Water Supply
BWSO Bureau of Water and Sewer Operations
BWT Bureau of Wastewater Treatment

TASKS AND ACTIONS	POTENTIAL IMPACTS ACTION WILL ADDRESS: Water Supply Quantity, Quality, and/or Demand	Street, Basement, and/or Coastal Flooding	Wastewater Treatment Process Disruptions	Harbor Water Quality Impairment	BUREAUS IMPACTED: Responsible Bureau	Involved Bureau
TASK 1 Work with Climate Scientists to Improve Regional Climate Change Projections						
Work with the scientific community and others to develop more refined regional climate change projections. As part of this action DEP will:	✔	✔	✔	✔	BEPA	BWS BWT BEDC BWSO
■ Assemble a comprehensive suite of regional climate projections						
■ Apply a Regional Climate Model to the New York City Watershed Region						
Work with other agencies on the PlaNYC initiative to ensure the City's 100 year flood plain maps are updated		✔	✔	✔	BEPA	BWS BWT BEDC BWSO BLA
Identify additional data and monitoring stations needed to track climate changes	✔	✔	✔	✔	BWS BWT BEDC BWSO	BEPA
Support development of climate model data needed for use as input to run DEP management and operation models	✔	✔	✔	✔	BEPA	BWS BEDC
Track improvements in climate change science, climate models, and estimates of changes in the severity, duration and frequency of weather events	✔	✔	✔	✔	BEPA	
TASK 2 Quantify Potential Climate Change Impacts on NYC Water Systems						
Conduct a phased integrated modeling project to quantify the potential impacts of climate change on drinking water quality, supply, and demand:	✔				BWS BEPA	
■ Phase I: Initial sensitivity tests and model integration using initial regional climate projection data to identify quantity and quality changes with existing modeling tools	✔					
■ Phase II: Model enhancements based on needs identified in Phase I and use of more refined climate projection data for more accurate results and analyses of operational issues	✔					
Undertake a project to quantify the potential impacts of climate change induced sea level rise, coastal flooding and precipitation changes in City infrastructure and harbor water quality		✔	✔	✔	BWT BEDC BWSO BEPA	
■ Identify the flooding impacts of changes in sea level and storms by 1) identifying the elevations of all outfalls and the critical flood elevations at all major DEP facilities, 2) identifying and mapping the current and potential range of future sea levels and 100-year flood plain areas at DEP facilities, and 3) comparing the outfall and critical flood elevations with the updated sea levels and inundations areas		✔			BWT BEDC BWSO	BEPA
■ Develop estimates of changes in rainfall intensities under climate change scenarios based on state of current science					BEDC BWSO	BEPA
■ Evaluate to what extent street and basement flooding and CSOs may be exacerbated by climate change		✔	✔	✔	BEPA BEDC BWSO	BWT
■ Estimate the costs that may be incurred due to potential damage to DEP's in-City infrastructure		✔	✔	✔	BWT BEDC BWSO	BEPA
■ Estimate changes in groundwater levels due to sea level rise and changing precipitation patterns and the potential for greater infiltration or inflow of groundwater into the wastewater conveyance system	✔	✔	✔	✔	BWSO BEDC	BWT BEPA
■ Estimate the potential rise in harbor water temperature and assess the associated impacts on dissolved oxygen levels and other harbor water quality indicators				✔	BEPA BEDC	BWT BWSO
Establish a uniform Department-wide system for documenting the occurrence, levels, and impacts of flooding and other extreme weather incidents on DEP systems	✔	✔	✔		BEDC BWSO BWT BWS	BEPA
Conduct more detailed interviews with system operators; catalog all known system vulnerabilities	✔	✔	✔	✔	BEPA	ALL
Update impact studies to quantify impacts as needed based on long-term developments in climate change science	✔	✔	✔	✔	BEPA	ALL

85

* Denotes PlaNYC affiliated actions

CLIMATE CHANGE ACTION PLAN 6

TASKS AND ACTIONS	POTENTIAL IMPACTS ACTION WILL ADDRESS: Water Supply Quantity, Quality, and/or Demand	Street, Basement, and/or Coastal Flooding	Wastewater Treatment Process Disruptions	Harbor Water Quality Impairment	BUREAUS IMPACTED: Responsible Bureau	Involved Bureau
TASK 3 Determine and Implement Appropriate Adjustments to NYC's Water Systems						
NOTE: TASK 3 IS ORGANIZED BY RESPONSIBLE BUREAU/AGENCY						
BCS's Ongoing Actions that increase water systems resiliency						
Launch an effort to reduce City-wide water consumption by 60 mgd by 2012 through rebate programs*	✔				BCS	BEPA BWS BLA
BWT's Ongoing Actions that increase water systems resiliency						
Continue maintenance and upgrade programs for WPCPs, tide gates, and other infrastructure		✔	✔	✔	BWT	
BEPA's Ongoing Actions that increase water systems resiliency						
■ Expand, track, and analyze new BMPs for runoff and CSO control*		✔		✔	BEPA	BWSO BEDC
■ Investigate low-impact development strategies on individual tax lots*		✔		✔	BEPA	BWSO
■ Implement the Jamaica Bay Watershed Protection Plan		✔		✔	BEPA	BWSO BEDC BLA
BEPA's Planned Actions to address climate change						
■ Create a methodology for the City Environmental Quality Review process so that potential climate change impacts are assessed before decisions are made	✔	✔	✔	✔	BEPA	ALL
BWS's Ongoing Actions that increase water systems resiliency						
■ Enhance the Watershed Protection Program, including investing $300 million in land acquisition in the watershed*	✔				BWS	BLA
■ Maximize water supply from existing facilities such as the groundwater system and the New Croton Aqueduct*	✔				BWS	BWSO BEDC
■ Continue to coordinate with the National Weather Service and River Forecast Centers	✔				BWS	
■ Continue working with the Delaware River Basin Commission to implement a broad, basin-wide flood mitigation strategy	✔	✔			BWS	BLA
■ Continue the ongoing development of the watershed modeling system	✔				BWS	BEDC
BWS's Ongoing Actions that increase water systems resiliency						
Evaluate, assess cost and implement potential adaptation strategies based on the findings of climate change integrated modeling project. These could include operational, structural and tracking measures and/or new projects and modifications to the water supply system.	✔				BWS	BEPA BEDC
BWSO's Ongoing Actions that increase water systems resiliency						
■ Expand the Staten Island Bluebelt program*		✔		✔	BWSO	
■ Convert certain combined sewers into High Level Storm Sewers (HLSS) and integrate HLSS into major new developments, especially on the waterfront		✔		✔	BWSO	BEPA
■ Expand use of the groundwater system*	✔	✔			BWSO	
■ Identify locations for stormwater management in the Bronx River Watershed*		✔		✔	BWSO	BEPA

* Denotes PlaNYC affiliated actions

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Key Observations

- Infrastructure planning has to this point been informed by historical climate data; these data can no longer be relied upon as accurate predictors of future conditions
- Climate change issues are complex and impacts remain indeterminate, but we cannot afford to wait for uncertainties to diminish; we must act now to keep pace with changes
- Many currently scheduled capital projects may already serve to advance climate change adaptation goals; others may require only minor modification
- It is essential to actively engage all of the organization's operating units in the assessment and adaptation process
- State and federal policymakers and regulators must be engaged


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