NYCDEP & Climate Change

"Seeking Local Solutions to a Global Problem."

NYCDEP Climate Change Task Force
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The Future of Engineering & Water Quality into the Next Century
October 20, 2005
National Museum of the American Indian, New York City

The Earth Institute at Columbia University

NYCDEP Climate Change Program

Mission Statement

To insure that NYCDEP's strategic and capital planning efficiently take into account the potential effects of climate change—sea level rise, higher temperature, increase in extreme events, and changing precipitation patterns—on the City's water supply and wastewater treatment systems.

Why Should NYCDEP Study & Address Climate Change?

- NYCDEP is responsible for providing a sufficient quantity of high quality drinking water to ~9 million New Yorkers (8 million in the City, 1 million upstate).
- NYCDEP is responsible for maintaining the chemical and physical integrity of New York Harbor and other local water bodies. Raw sewage discharge (from CSO events and system failures) can wreak havoc on the harbor and local estuaries.
- The NY metropolitan area is of great global significance; it's a major center for commerce, finance and industry, and there is a very dense urban population.
- All 14 of the City's water pollution control plants are located on waterfront property.
- Responsible capital and strategic planning requires consideration of potential impacts of climate change on the City's water systems.

Source: NYCDEP

System Impacts

Recent storms have highlighted adverse ways climate change could affect the City's water supply and impact DEP facilities.

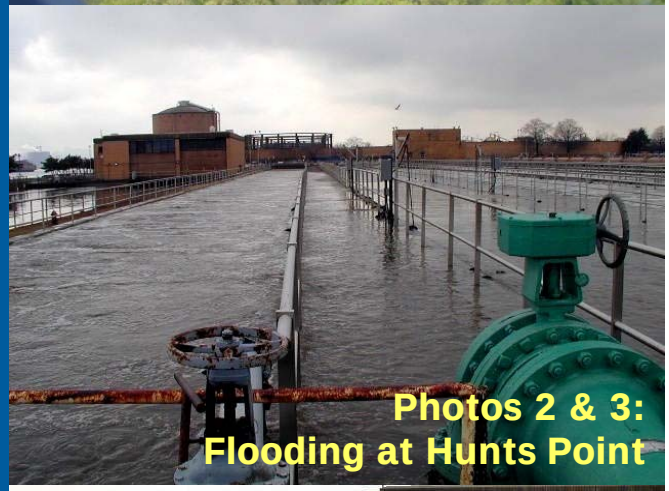
April & October 2005 Upstate Storm Events

Extremely turbid runoff from intense rainstorms required treating water from Catskill Aqueduct with aluminum sulfate (alum) under emergency permits from NYSDEC. Alum must now be dredged from the Kensico Reservoir.

March 2001 Coastal Storm Event

Coastal storm pushed ocean water into the East River, causing tides to be significantly above normal. Unable to overcome the hydraulic head of the tidal elevations, the Hunts Point Treatment plant could not discharge treated sewage into the East River & wastewater flowed back into plant.

Photo 1:
Alum treated water entering Kensico at Catskilll Influent

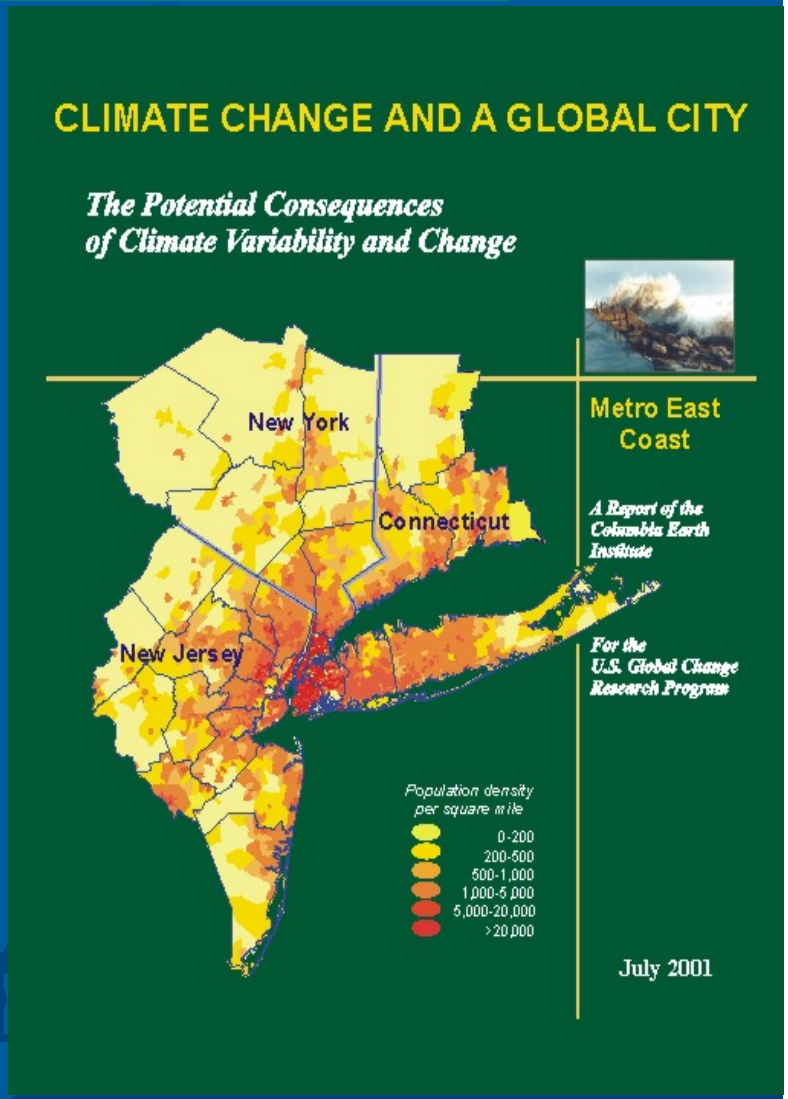


Photos 2 & 3:
Flooding at Hunts Point

Photo Sources: NYCDEP

Background

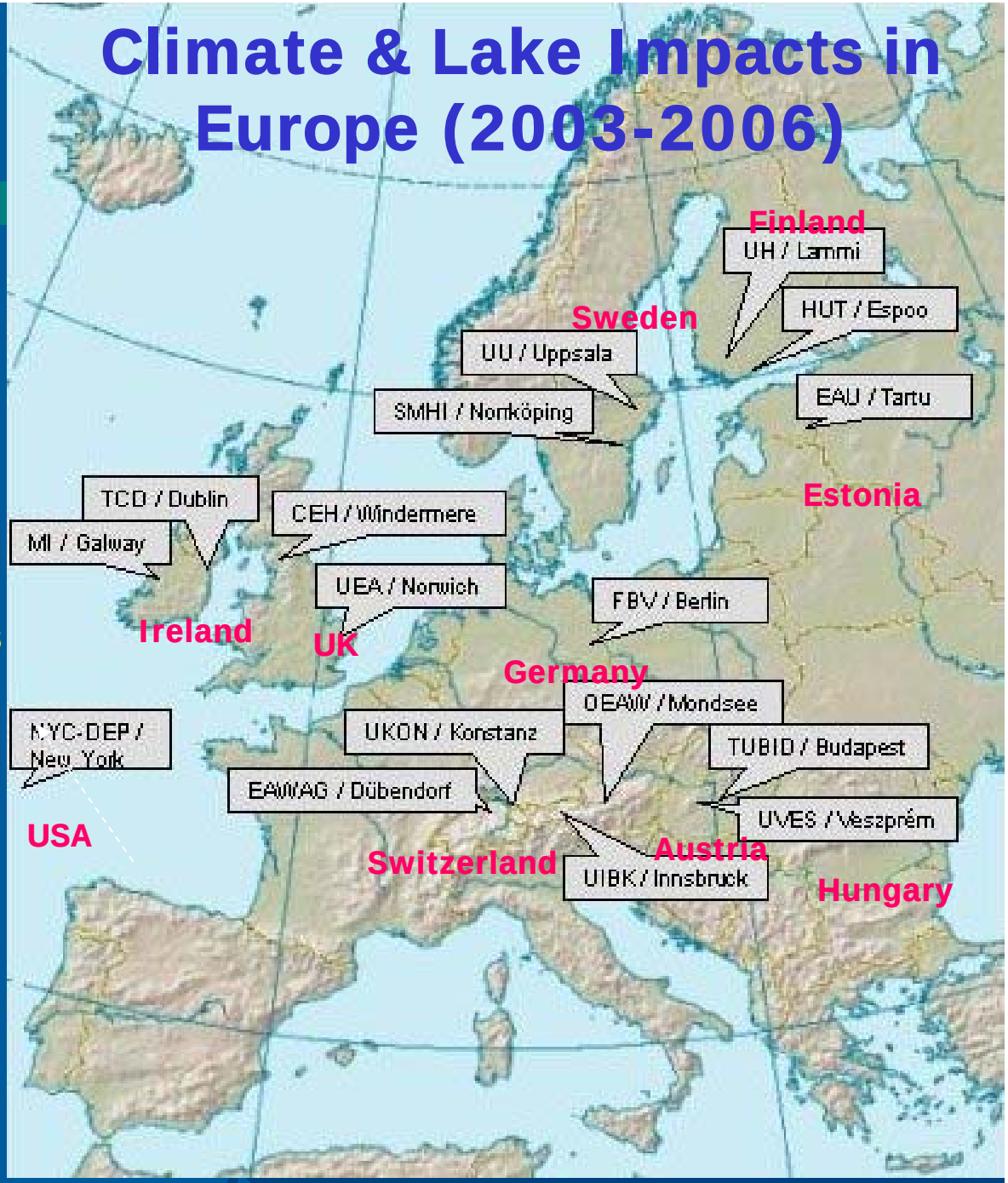
- Climate Change and a Global City. Metro East Coast (MEC) Assessment. July 2001. Columbia University.
- Climate Change 2001: Impacts, Adaptation and Vulnerability. Third Assessment Report. International Panel on Climate Change.
- Watershed and Water Quality Modeling – CLIME. "Development of a Regional-Scale Future Climate Scenario for New York City Drinking Water Quality Modeling". Columbia Center for Climate Systems Research. June 2005.
- "Increasing Destructiveness of Tropical Cyclones over the Past 30 Years". Nature. August 2005. Kerry Emanuel, MIT.



MEC 2001.

Climate & Lake Impacts in Europe (2003-2006)

- Funded by European Commission.
- Participants represent 17 partner institutions in 10 countries.
- Aim is to develop a suite of methods & models (GCMs, RCMs, terrestrial models, reservoir models) that can be used to manage lakes and catchments under current and future climatic conditions.
- DEP staff learn from model runs in other regions.
- NYC reservoir watersheds used as a test area for CLIME model development. NYC system provides flexible management opportunities (unique in the CLIME project).

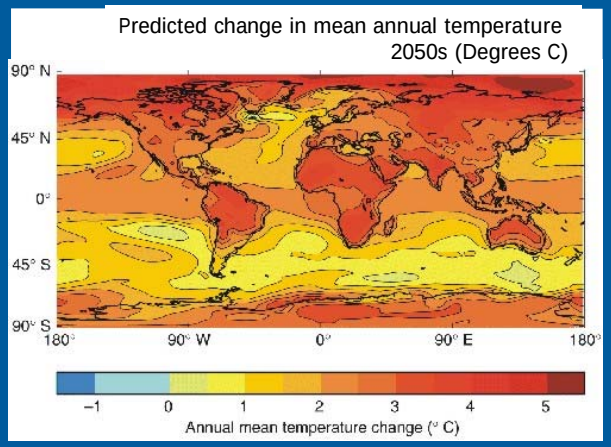


Source: CLIME

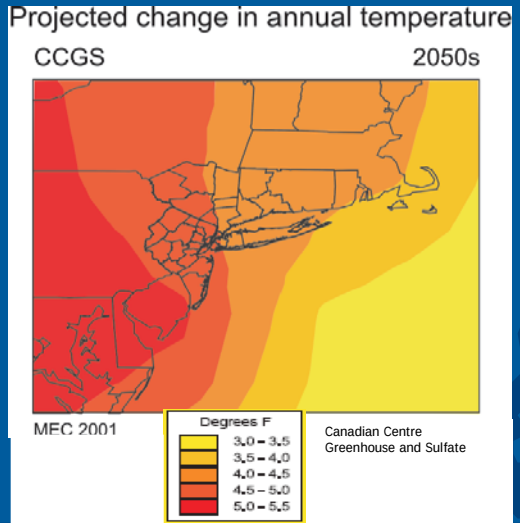
Climate Change may be accelerated by anthropogenic emissions of greenhouse gases, mainly from the energy, industrial, and transportation sector, and from change in land use, such as deforestation.

GLOBAL

REGIONAL



The Hadley Centre for Climate Prediction & Research, 2001



Canadian Centre
Greenhouse and Sulfate

IMPACTS

Source: Columbia Center for Climate Systems Research (CCSR)

Climate Data, Scenarios, & Models

Climate Change Variables Important To NYCDEP

Surface Air Temperature (min, max, mean)	Precipitation	Droughts / Floods	Sea Level Rise

Center for Climate Systems Research (CCSR) partnership:

Model Forecasts

- Global Climate Models (GCMs) – resolution ~300 km
- Regional Climate Models (RCMs) – resolution currently ~36 km
- International Panel on Climate Change (IPCC) Greenhouse Gas Emission Scenarios
- Sea Level Rise & Storm Surge
- Watershed & Terrestrial Models
- Drought & Flood Indices

Coordinated Science Example

- Multi-institutional science project on coastal flooding
  - Uses sea level rise forecasts with storm surge & elevation models to analyze impact on NYCDEP coastal facilities

Sea Level Rise

Global sea level is rising at a rate of ~.17 cm/year, while the NY Metro Region rate ranges from .24-.39 cm/year due to local subsidence & thermal expansion.

Sea Level Rise Projections -- New York Metropolitan Region, cm

Time Period	Current Trend	Low-Level GHG Emission Scenario	Mid-Level GHG Emission Scenario
	(cm)	(cm)	(cm)
2020s	8.3	17.6	11.2
2050s	16.6	35.7	47.2
2080s	27.7	79.3	97.7

IPCC GHG Emission Scenarios (Low-Level Scenario = B1 & Mid-Level Scenario = A1B

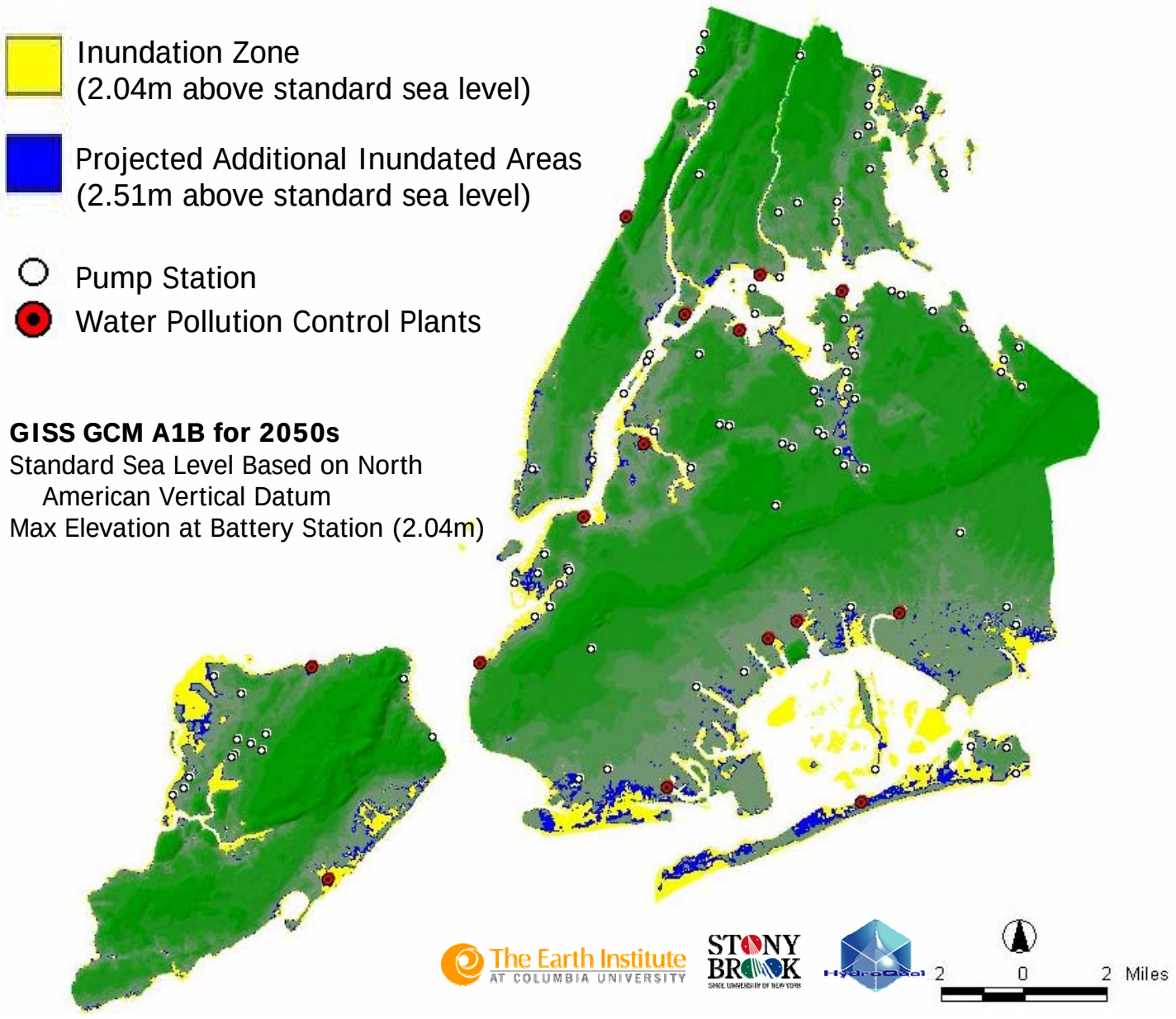
Goddard Institute of Space Studies GCM
Source: CCSR

– NYC sea-level rise from 1990s decadal mean to indicated years.

– 2050s range is **16.6 to 47.2 cm** (6.1 to 18.8 in) increase from 2005.

Comparison of Inundation Estimates

December 1992 Nor'easter as Case Study
Current and Projected (2050s) Sea Level Elevations



Range of Potential Adaptations

Adaptation Assessment Includes:

- **Characterizing options:** management, infrastructure, policy
- **Conducting initial screening:** engineering, institutional, regulatory feasibility
- **Applying future climate scenarios:** determine climate change impacts for which adaptation is needed
- **Linking to capital cycle**
- **Evaluating options:** costs/benefits
- **Creating implementation plans:** time scales - short, medium, long-term
- **Monitoring and Reassessing:** use of indicators, refining science

Adaptation Examples

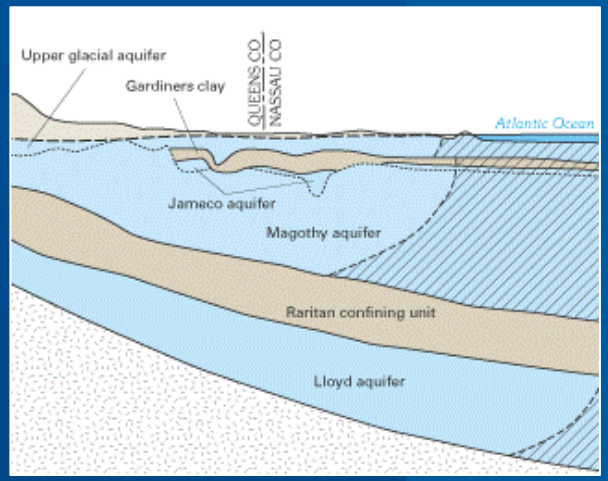
Management:

Integrated operation of NYCDEP and other water agency facilities

F.E. Walter Reservoir – storage reallocation

Lake Wallenpaupack– drought operating plan

F.E. Walter Reservoir
Source: Army Corp of Engineers



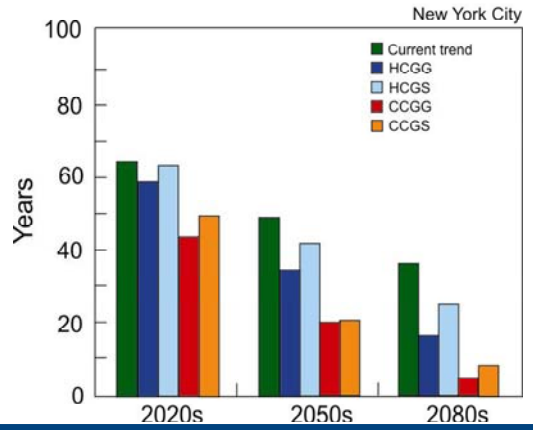
Source: USGS, modified from Buxton and Shernoff (1999)

Infrastructure:

Aquifer Storage Recovery

Potential increased frequency of droughts

Change in 100-yr Coastal Flood



Source: CCSR

Policy:

Modify design criteria to reflect changing hydrologic processes

Redefine the 100-year flood

Looking Forward

NYCDEP Climate Change Task Force to Finalize Report

- ***Responding to Climate Change: Draft Guidelines for NYCDEP***
  (draft December 2005, final June 2006)

Executive Policy Decisions

- **Commissioner Lloyd and executive staff to decide which recommendations to further study and/or implement**

Continue Refinement of Science

- **Continue collaboration with research institutions and coordinated science projects research, GCM/RCM refinement**
- **Develop science-engineering coordination team**

Looking Forward

Engagement & Outreach

- Imbed consideration of climate change within DEP (already briefed ~100 DEP staff at education workshops)
- Integrate climate work with that of the Dependability Study
- Investigate a GHG management program for DEP
- Develop institutional links with other agencies and systems (e.g. OEM, EDC, DCP, DOH, ACOE, DRBC)

Leadership

- Share methods and efforts with regional agencies and beyond
- Provide lessons learned (DEP work is potential case study for the IPCC Fourth Assessment (report due in 2007))
- Participate in conferences/workshops (11/05 Commissioner Lloyd is speaking at Climate Change Science Program workshop in D.C.)

New York City DEP Water Demand and Wastewater Flow Projections

Agenda

- Introduction
- Types of Water Demand Models
- Past NYCDEP Water Demand Modeling Efforts
- Modeling Challenges
- Population Projection
- Model Applicability
- Summary

Introduction

A Good Demand Model Should……

- Be simple - containing only those variables that affect demand
- Be explanatory - it should make sense, containing variables that can be quantified and measured
- Forecast well - tested by backcasting

Types of Water Demand Models

- Aggregate Water Use Models
  - Household Size
  - Price
  - Home Value
- End Use Water Demand Models - project the “end uses” of water at all places where water is used:
  - # of faucets per unit
  - # of toilets per unit
- Macro-Level Water Demand Models
  - Economic activity, Fixture efficiencies, Meter Conservation
  - Temperature
  - Rainfall
  - Price
  - Unaccounted for water - leakage, theft etc.

Past NYCDEP Water Demand Modeling Efforts

Past NYC Water Demand Modeling Efforts

- 1989 DEP Demand Model
  - Believed to be Overestimating
  - Flat Line Projection
- IWR-Main Model
  - Developed for Suburban Areas (Not Urban Areas)
- 1998 DEP Demand Model
  - High End Model – Based on IWR-Main Model
  - Low End Model – Based on gpcd

Modeling Challenges

Modeling Challenges

- Questions regarding undercounts in prior census
- As a tourist destination and economic center, NYC may be more affected by economics than other cities
- The number of metered accounts is a high % of the total, but many large residential accounts are un-metered
- Percentage of estimated reads for metered accounts is high
- Meter slippage
- Usage at Bronx Zoo, Central Park Lake, the Botanical Garden, etc. are not metered

Population Projection

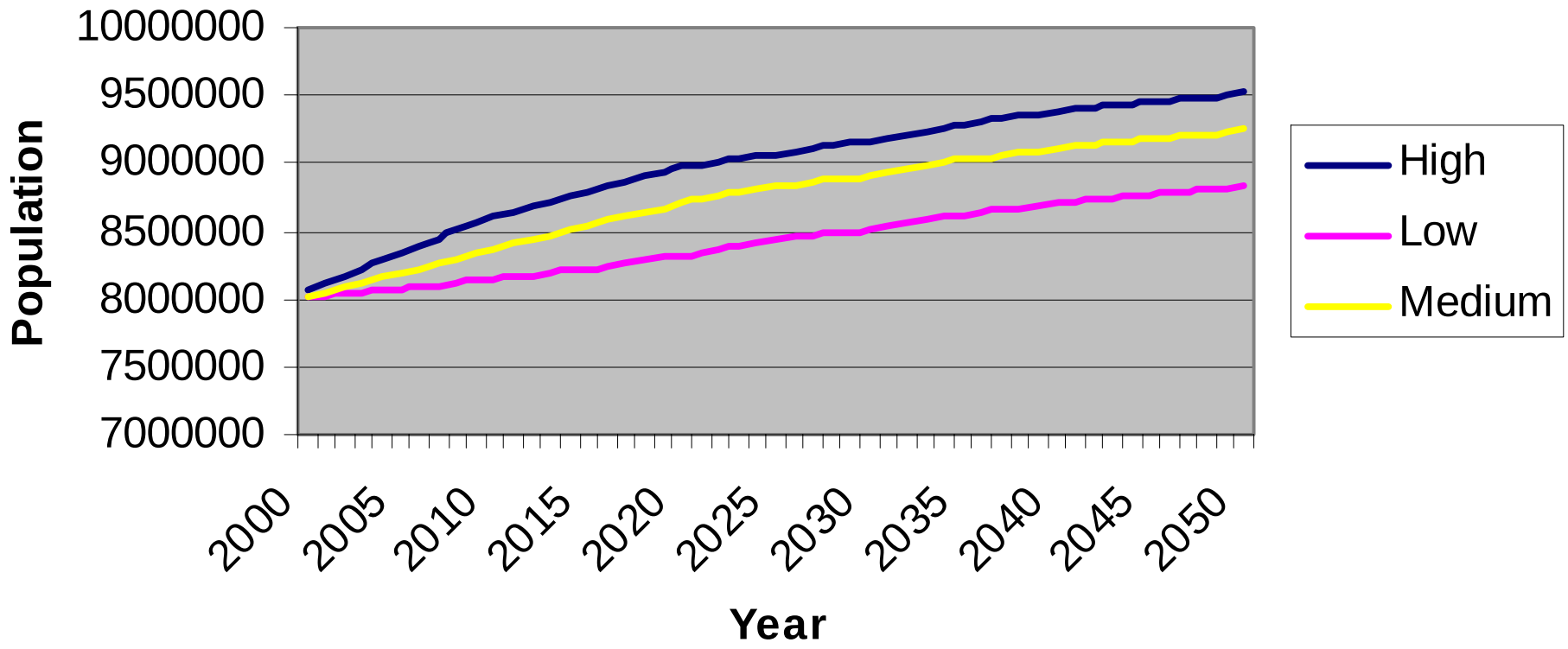
Population & Employment Forecasts - Overview

- Five-Year Interval Projection Through 2050
  - Population
  - Employment
- Direction / Coordination
  - NYC Department of City Planning's Population Division
- Alternatives
  - High
  - Mid
  - Low

Forecast Methodology

- Developed Projections At City/Borough/Community District Level
- Distributed Spatially to WPCP Drainage Areas With Revisions For:
  - Proposed Major Development Areas
  - Zoning Initiatives
  - Recent Building Permit Trends
- Results Consistent With DCP's Community District Projections
- Employment Forecast
  - Regression-based Models

Projected NYC Population 2000-2050 by Alternative



Review of Water Demand Model Principles

Factors Affecting Water Demand

- Population
- Income
  - Reverse wealth effect
  - High percentage of apartment dwellings
- Economic activity
  - Higher tourism activity & industrial uses
- Employment
- Fixture efficiencies/ Meter Conservation/Toilet Rebate
  - ULF Toilet Program, Fixture Turnover; Leak Fixing
- Temperature
  - Good proxy for outdoor use
- Rainfall
  - Relevant where irrigation is a major factor
- Price
  - Large apartment buildings
  - Not individually billing tenants
  - Consumer generally not aware of price or price hike
- Unaccounted for water
  - Leakage, theft, etc.

Model Applicability

Model Applicability

- Provides a planning tool
- Range of values permits consideration of modular approach to facility planning
- Method of evaluating impacts of additional conservation programs
- Benefit to ongoing City efforts such as Dependability Study
- Update 1998 Report
- Provides tool for exploring what/if scenarios

Summary

Summary

- Conventional demand models not applicable to NYC
- DEP is currently resolving past meter data challenges
- Water Demand in NYC shows a downward trend over the past 10-years
- Population Growth is a major driver for water demand
- Other factors (economy, employment, temperature) adjust demand from year to year
- Meter-related/fixture-efficiency conservation has reduced demand
- Future elasticity in water demand is important to DEP