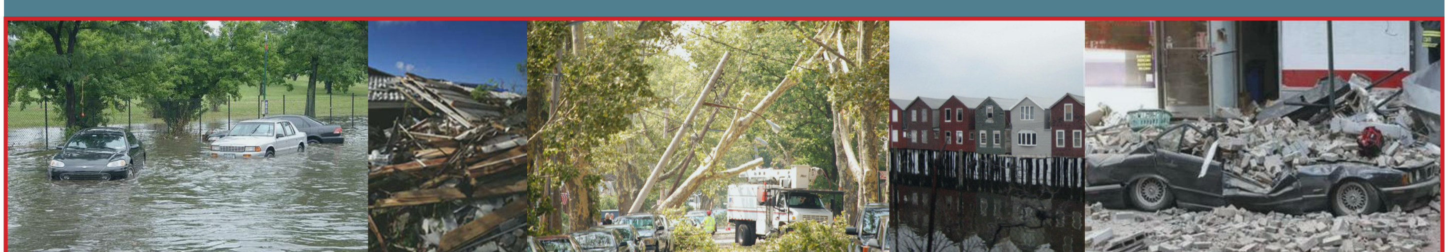
THE CITY OF NEW YORK

NATURAL HAZARD MITIGATION PLAN

MARCH 2009



MICHAEL BLOOMBERG, MAYOR
JOSEPH BRUNO, COMMISSIONER OF THE NEW YORK CITY OFFICE OF EMERGENCY MANAGEMENT

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THE PLAN

APPENDICES

Section I: Introduction

1) Overview

Hazard mitigation planning is the first of the four "phases of emergency management," followed by preparedness, response, and recovery. This prevention-related concept of emergency management often gets the least attention, yet it is one of the most important steps in creating a disaster-resistant community.

Figure 1: Phases of Emergency Management

Hazard mitigation is any action that reduces the effects of future disasters. It has been demonstrated time after time that hazard mitigation is most effective when based on an inclusive, comprehensive, long-term plan that is developed before a disaster actually occurs. It is impossible to predict exactly when and where disasters will occur or the extent to which they will impact New York City. However, with careful planning and collaboration among public agencies, stakeholders, and citizens, it is possible to minimize losses that can occur from disasters.

The New York City Office of Emergency Management (OEM) led the development of the 2009 New York City Natural Hazard Mitigation Plan (HMP) in an effort to assess natural hazard vulnerabilities, identify mitigation opportunities, and secure funding for the benefit of the City. This document is the culmination of a cooperative partnership between more than 30 city, state, and federal government agencies, authorities, and organizations, with input from the private sector, academic institutions, community organizations, and citizens. This plan meets all requirements for hazard mitigation plans under the Stafford Act. It is a living document and will be refined and updated every five years.

a) Disaster Mitigation Act of 2000

The Disaster Mitigation Act of 2000 (DMA 2000) amended the Stafford Act to reinforce the importance of mitigation planning and emphasize planning for disasters before they occur. As such, DMA 2000 established a pre-disaster hazard mitigation program and modified the requirements for the national post-disaster Hazard Mitigation Grant Program (HMGP). States and communities must have an approved mitigation plan to be eligible to apply for and receive hazard mitigation funds. Mitigation plans must demonstrate the proposed mitigation actions are based on a sound planning process that accounts for the risk to and the capabilities of the community. To facilitate the plan development, the Federal Emergency Management Agency (FEMA) has issued guidelines for HMPs under DMA 2000 regulations. As the State representative for the Hazard Mitigation Program, the New York State Emergency Management Office (NYSEMO) supports development of HMPs for jurisdictions within the state through various planning initiatives.

b) Benefits of Mitigation Planning

Natural hazard mitigation plans help communities reduce their risk from natural hazards by identifying vulnerabilities and developing strategies to lessen and sometimes even eliminate the effects of the hazard. Some of the benefits of mitigation planning to New York City agencies and other stakeholders are as follows:

- **Leads to judicious selection of risk reduction actions.** Hazard mitigation planning is a systematic process of learning about the hazards that can affect New York City; setting clear goals; and identifying and implementing policies, programs, and actions that reduce losses from disasters.

- **Builds partnerships.** Hazard mitigation planning enhances collaboration among a broad range of stakeholders to achieve a common vision for the City. Increased collaboration also reduces duplication of efforts among organizations with similar or overlapping goals.

- **Creates a more sustainable and disaster-resistant city.** There is an intrinsic link between the concept of sustainability and natural hazard risk reduction. An essential characteristic of a sustainable city is its resilience to disasters.

- **Establishes funding priorities.** A mitigation plan allows New York City to better identify and articulate its needs to state and federal officials when funding becomes available, particularly after a disaster. With its HMP in place, New York City can propose projects as an integral part of an overall, agreed-upon strategy, rather than as projects that exist in isolation. Mitigation planning coordinates existing and potential mitigation actions into a unified mitigation strategy. Only those states and communities with approved plans that meet the DMA 2000 criteria are eligible to receive HMGP funds for mitigation projects.

- **Increases public awareness of natural hazards.** Mitigation planning serves to help residents better understand the threat to public health, safety, and welfare, economic vitality, and the operational capability of critical infrastructure.

c) Planning Phases

New York City engaged in a four-phase planning process, as recommended by FEMA guidance.

Phase 1 – Organize Resources: The first phase included coordinating with agencies and organizations, integrating hazard mitigation with other planning efforts, and involving community groups and other stakeholders in the planning process.

Phase 2 – Assess Risks: The second phase included identifying and profiling hazards, assessing vulnerability, and estimating potential losses. This phase helped establish the scientific and technical foundations for the mitigation strategy.

Phase 3 – Develop the Plan: The third phase included developing hazard mitigation goals and objectives, conducting a capability assessment, working with planning participants to identify and analyze mitigation actions, and documenting the planning process.

Phase 4 – Implement and Monitor Progress: New York City is currently in the fourth phase of mitigation planning. This phase involves adopting, implementing, monitoring, and reviewing the HMP to ensure the plan's goals and objectives are met.

2) Plan Organization

The New York City HMP represents the City's approach to mitigating the adverse impacts of natural disasters. The HMP is organized into the following sections:

Section I: Introduction
The Introduction provides a brief overview of the HMP's background and purpose.

Section II: Planning Process
The Planning Process section outlines the manner in which New York city created the Plan. It identifies which agencies and organizations were involved in the process, how they were involved, and the methods of public participation that were employed. It also provides a detailed description of the decision-making and prioritization processes.

Section III: Risk Assessment
The Risk Assessment section includes an analysis of the hazards and risks facing New York City. It contains detailed hazard profiles and loss estimates. The Risk Assessment section provides a scientific and technical basis to guide the Mitigation Strategy.

Section IV: Mitigation Strategy
The Mitigation Strategy section describes how New York City intends to reduce losses identified in the Risk Assessment. It includes goals and objectives to guide the selection of activities to mitigate and reduce potential losses. The section contains a prioritized list of cost-effective, environmentally sound, and technically feasible mitigation actions. It identifies current and potential sources of funding and other resources needed to implement the mitigation actions. Finally, it includes a discussion of New York City's policies and programs that will serve to help administer many of the identified actions.

Section V: Plan Adoption
The Plan Adoption section establishes that New York City will formally adopt the Plan by Executive Order. This ensures comprehensive mitigation planning citywide, strong program management, and a Citywide commitment to mitigation planning.

Section VI: Plan Maintenance
The Plan Maintenance section describes how New York City will monitor, evaluate, and update its mitigation plan. It establishes review process and method for measuring progress. FEMA requires mitigation plan updates every five years.

3) Plan Status and Contact

The Planning Team incorporated comments submitted by the Hazard Mitigation Planning Team, Mitigation Planning Council, the public, and other stakeholders during the 30-public comment period as well as comments from NYSEMO, FEMA during the formal review process. The City formally adopted the final plan by an Executive Order in March 2009.

If you have any questions or comments on the New York City HMP or require additional information, please contact:

Hazard Mitigation Coordinator
New York City Office of Emergency Management
165 Cadman Plaza East
Brooklyn, NY 11201
Email: mitigation@oem.nyc.gov

3) List of Figures

Section II: Planning Process

1) Introduction

Effective planning efforts result in high quality and useful plans, but written plans are only one element in the process. The planning process is as important as the plan itself. A successful planning process forges partnerships and brings together a cross-section of government agencies, the public, and other stakeholders to reach consensus on how to achieve a desired outcome or resolve a community issue. Applying an inclusive and transparent process adds validity to the plan. Those involved gain a better understanding of the problem or issue and how solutions and actions were devised. The result is a common set of community values and widespread support for directing financial, technical, and human resources to an agreed upon action. The planning process was an integral part of the New York City Hazard Mitigation Plan (HMP). This section describes New York City's planning process and how the HMP evolved over the course of one year.

a) Planning Process Approach

This section serves as a permanent record of the New York City mitigation planning process and describes the following:

- Identification of planning participants
- Coordination with government agencies and other stakeholders
- Development of the plan document
- Purpose and outcome of planning activities and meetings
- Community involvement

b) FEMA Requirements Addressed in this Section

The New York City Hazard Mitigation Planning Team (Planning Team) devised a planning process consistent with the steps presented in the Federal Emergency Management Agency's (FEMA) How-To-Guide: Building Support for Mitigation Planning (FEMA 386-1). The following FEMA requirements are addressed in this section:

- **Requirement §201.6(b):** The planning process ***shall*** include:
  (1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;
  (2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and
  (3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.

- **Requirement §201.6(c)(1):** [The plan ***shall*** document] the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.

2) Mitigation Planning Council

The Mitigation Planning Council (MPC) is composed of representatives from 39 essential governmental and non-governmental stakeholders that have an interest in reducing the impact of natural hazards throughout New York City. Representatives from these agencies have a comprehensive knowledge of policies, plans, and projects that relate to hazard mitigation in New York City. The MPC played an essential role in the development of the Plan. MPC members contributed and reviewed information concerning New York City's risk and vulnerability to natural hazards. They also developed a comprehensive list of existing and potential mitigation actions that reduce or eliminate the impact of natural hazards.

a) Purpose

The MPC's purpose is as follows:

- Develop, review, revise, and maintain an HMP for New York City that is consistent with the Disaster Mitigation Act of 2000 (DMA 2000) and related Acts.
- Implement actions that reduce the potential for loss of life, property damage, and environmental degradation from natural disasters.
- Provide a forum for mitigation issues, programs, policies, and projects that will provide information and skills needed to assist in the implementation of the HMP.
- Develop and foster natural hazard mitigation partnerships.

b) Organizational Structure

The New York City Office of Emergency Management (OEM) organized the MPC structure to help guide the mitigation planning process. To make the MPC more focused and effective, the group has three components: the Planning Team, the MPC Steering Committee (Steering Committee), and the MPC General Body (MPC).

i) Planning Team

OEM served as the coordinating agency for the development of the HMP. The Planning Team was comprised of four planners from the OEM Planning and Preparedness Division and one Hazard Impact Modeler from the Geographic Information Systems (GIS) Unit. OEM planners facilitated the overall plan development to ensure the HMP met the requirements of DMA 2000, while OEM's Hazard Impact Modeler worked with GIS specialists to customize and execute hazard models, and create maps and data tables in support of the Plan.

(1) Responsibilities

As the HMP coordinator, the Planning Team had many responsibilities including administration, content organization, and text development. The following list summarizes the Planning Team's responsibilities.

- Organize and guide all meetings with the Steering Committee and MPC members.
- Develop and implement the community involvement process.
- Guide the plan development to adhere to DMA 2000 requirements.

- Manage identification, collection, and analysis of mitigation actions submitted by the MPC.
- Facilitate responsibilities and provide support for all participants in the hazard mitigation planning process.
- Coordinate with MPC members to identify relevant material for the HMP.

(2) Participants and Agency Descriptions

Planning Team participants and a brief description of the lead agency:

Hazard Mitigation Planning Team Participants		
Agency	**Description**	**Members**
OEM	The **New York City Office of Emergency Management (OEM)** plans and prepares for emergencies, educates the public about preparedness, coordinates emergency response and recovery, and collects and disseminates emergency information. To accomplish this mission, OEM maintains a disciplined unit of emergency management personnel, including responders, planners, watch commanders, and administrative and support staff, to identify and respond to various hazards.	Rexford Asiedu, Planner
		David Blitzer, Planner
		Joshua Friedman, Hazard Impact Modeler
		Heather Roiter, Planner
		Amy Schultz, Project Manager

Table 1: Planning Team Participants

ii) Mitigation Planning Council Steering Committee

The Steering Committee is a core group of eight agencies and organizations that own or manage some of the City's largest infrastructure networks and/or engage in planning for or regulating these systems. The Steering Committee provides subject-matter expertise in the following areas: emergency management, land use planning, building codes, transportation, infrastructure protection, climate change, regional planning, and natural resource protection. This team combines skills, expertise, and experience to achieve a common goal of natural hazard mitigation for New York City.

The Steering Committee helps develop, manage, and implement the City's HMP. On January 18, 2008, OEM held the first Steering Committee meeting. Following the first meeting, Steering Committee members participated in monthly meetings throughout the planning process to facilitate the development of the Plan. During these meetings, Steering Committee focused on providing information for and reviewing the Risk Assessment section, evaluating mitigation actions, and assisting with the community involvement process. Beyond the monthly meetings, OEM conducted individual meetings with Steering Committee members and maintained regular phone and email contact to develop specific ideas and identify additional resources related to the plan development.

(1) Responsibilities

The following list summarizes the Steering Committee's responsibilities.

- Support plan development.

- Attend monthly meetings through September 2008.
- Develop HMP mission statement, goals, and objectives.
- Provide subject matter expertise.
- Assist in evaluating and prioritizing mitigation actions.
- Assist in community involvement process.
- Review and comment on draft HMP sections provided by the Planning Team.
- Assist with plan maintenance.

(2) Participants and Agency Descriptions

Steering Committee participants and a brief description of each agency:

Participants in the Steering Committee		
Agency	**Description**	**Participant(s)**
	New York City Department of Buildings (**DOB**) ensures the safe and lawful use of more than 950,000 buildings and properties through enforcing the City's Building Code, Electrical Code, Zoning Resolution, New York State Labor Law, and New York State Multiple Dwelling Law. DOB's main activities include performing plan examinations, issuing construction permits, inspecting properties, and the maintenance of construction codes and licensing trades.	David Nussbaum Charles Shelhamer
	New York City Department of City Planning (DCP) is responsible for the City's physical and socioeconomic planning, including land-use and environmental review; preparation of plans and policies; providing technical assistance and planning information to government agencies, public officials, and community boards. The commissioner of the agency serves as the chair of the City Planning Commission.	Carolyn Grossman
	New York City Department of Environmental Protection (DEP) delivers drinking water from upstate reservoirs to over nine million state residents – more than 1.1 billion gallons a day. Within New York City, the department operates over 13,000 miles of water mains and sewers. To protect the environment of the surrounding waterways, the DEP operates 14 treatment plants capable of processing over 1.3 billion gallons of wastewater a day. In addition, the DEP enforces the City's Noise, Air, and Hazardous Materials Code.	Kathryn Garcia Constance Vavilis

Participants in the Steering Committee		
Agency	**Description**	**Participant(s)**
City of New York Parks & Recreation	**New York City Department of Parks & Recreation (Parks)** is responsible for maintaining the City's parks system, preserving and maintaining the ecological diversity of the City's natural areas, and furnishing recreational opportunities for City residents. The department maintains more than 1,700 parks, playgrounds, and recreation facilities across the five boroughs. It is responsible for more than 950 playgrounds, 700 playing fields, 550 tennis courts, 35 major recreation centers, 30 outdoor pools, 14 miles (23 km) of beaches, and 13 golf courses, as well as seven nature centers, six ice skating rinks, four zoos, four botanical gardens, and four major stadia. Parks also cares for park flora and fauna, community gardens, historic houses, statues and monuments, and more than 2.5 million trees.	Jon Ells Keith Kerman
NEW YORK CITY DOT	**New York City Department of Transportation (DOT)** is responsible for providing safe, efficient, and environmentally responsible movement of people and goods throughout New York City. The agency's responsibilities include day-to-day maintenance of the City's 5,800 miles of streets, highways, and sidewalks. The agency's responsibilities also include the management of 789 bridge structures, six tunnels, and the operation of the Staten Island Ferry service, along with other ferry operations on City-owned piers. DOT staff installs and maintains more than 1.3 million street signs, traffic signals at more than 11,900 signalized intersections, over 300,000 streetlights, 69 million linear feet of markings, and approximately 63,000 parking meters.	Nelson Castillo Ted Oberman
MTA	**Metropolitan Transportation Authority (MTA)** is a public benefit corporation responsible for North America's largest transportation network. This network services a population of 14.6 million people in the 5,000-square-mile area fanning out from New York City through Long Island, southeastern New York State, and Connecticut. The MTA is divided into seven subsidiary agencies: New York City Transit (NYCT), which is the busiest and largest transit system in North America; Long Island Rail Road (LIRR), the largest and oldest commuter railroad; Long Island Bus, a unified transportation system of 10 private bus companies that serve Long Island; Metro-North Railroad, the second largest commuter	Fredericka Cuenca, MTA Headquarters Ben Hellwege, MTA Headquarters Judy Walker, MTA Headquarters Detective Keyla Hammam, MTAPD

Participants in the Steering Committee		
Agency	**Description**	**Participant(s)**
	railroad in the nation; Bridges and Tunnels, which operates seven bridges and two tunnels; Capital Construction, which serves as the construction management for MTA projects; and MTA Bus Company, which is responsible for local and express bus operations of seven former bus franchises.	Lillian Fernandez, MTAPD Inspector Sean Montgomery, MTAPD
	Mayor's Office of Long Term Planning and Sustainability (OLTPS) coordinates and oversees efforts to develop and implement a strategic vision for the City's future, working closely with City agencies and the Mayor's Advisory Board for Sustainability. OLTPS manages the implementation of *PlaNYC: A Greener, Greater New York*, released by Mayor Bloomberg in 2007. This plan proposes 127 initiatives that address New York City's growing population, aging infrastructure, and increasing environmental risk from climate change using a timeframe of 2030.	Jon Dickinson Adam Freed
	Regional Plan Association (RPA) is an independent, not-for-profit regional planning organization that focuses on recommendations to improve the quality of life and the economic competitiveness of the 31-county New York-New Jersey-Connecticut region through research, planning, and advocacy. RPA's mission is to help shape transportation systems, protect open spaces, and promote better community design for the region's continued growth. RPA addresses future challenges to the region and works to mobilize the region's civic, business, and government sectors to take action.	Rich Barone

Table 2: Steering Committee Participants

iii) MPC General Body

The General Body of the MPC is composed of representatives from 39 essential governmental and non-governmental stakeholders who provided information on existing and/or potential projects that mitigate the effects of a natural hazard within New York City. The MPC members participated in a large-group meeting during the planning process on February 8, 2008. The Planning Team used this meeting to introduce participants to hazard mitigation, request a list of mitigation actions from each participant, discuss hazard mitigation funding and eligible projects, and finalize a schedule for the plan maintenance process. The General Body played an integral role identifying existing and potential mitigation actions that will make New York City more resilient to natural disasters.

In addition to the large-group meeting, the Planning Team met with each MPC-member agency or organization individually to provide additional hazard and risk information and discuss specific mitigation actions the agency might contribute to the Mitigation Strategy.

(1) Responsibilities

The following list summarizes the MPC's responsibilities.

- Attend MPC meetings.
- Identify, develop, and submit alternative mitigation actions for inclusion in the Mitigation Strategy section.
- Review and comment on the draft HMP.
- Provide ongoing monitoring of hazard mitigation efforts between plan maintenance-periods.

(2) Participants

OEM coordinated with a variety of government organizations, public authorities, and private utility providers that have a stake or interest in natural hazard mitigation. The following agencies participated in the MPC.

MPC Participating Agencies	
Agency	**Participant(s)**
New York City Agencies	
Department for the Aging (DFTA)	Linda Whitaker
	Joy Wang
Department of Buildings (DOB)*	Charles Shelhamer
	David Nussbaum
Department of City Planning (DCP)*	Carolyn Grossman
Department of Citywide Administrative Services (DCAS)	Mike Sicilano
Department of Corrections (DOC)	Office of Emergency Preparedness
Department of Design and Construction (DDC)	William Svilar
Department of Education (DOE)	Angelo Lisa
	John Rodriguez
Department of Environmental Protection (DEP)*	Kathryn Garcia
	Constance Vavilis
Department of Health and Mental Hygiene (DOHMH)	Nancy Clark
	David Grass
	Erich Giebelhaus
Department of Homeless Services (DHS)	Sarah Friedenthal-Greene
Department of Information Technology and Telecommunications (DoITT)	Joseph Gallagher
Department of Parks and Recreation (Parks)*	Jon Ells
	Keith Kerman
Department of Sanitation (DSNY)	Charlie Herbst
Department of Transportation (DOT)*	Nelson Castillo
	Ted Oberman
Economic Development Corporation (EDC)	Jawad Assaf
	Brian Larsen
	Jack Powers

MPC Participating Agencies	
Agency	**Participant(s)**
Fire Department of New York (FDNY)	Robert J Strong
	Fred Villani
Health and Hospitals Corporation (HHC)	Susan Meehan
	Karen Mattera
Housing and Preservation Development (HPD)	Vito Mustaciado
	Eugene Mc Ardle
Human Resources Administration (HRA)	Antonio Linares
Landmarks Preservation Commission (LPC)	Jared Knowles
New York Police Department (NYPD)	Anthony Tria
Office of Emergency Management (OEM)*	Rexford Asiedu
	David Blitzer
	Joshua Friedman
	Heather Roiter
	Amy Schultz
Office of Long-Term Planning and Sustainability (OLTPS)*	Adam Freed
	Jon Dickinson
Small Business Services (SBS)	Bernadette Nation
Other New York City Mitigation Stakeholders	
Amtrak	Emma Cattafi
Con Edison (Con Ed)	Dennis Connelly
MTA Bridges and Tunnels (B&T)	Donald Knapp
	Barry Silberfarb
MTA Buses	Josephine Brown
	William Keenan
MTA Headquarters*	Ben Hellwege
	Fredericka Cuenca
	Judy Walker
MTA Long Island Rail Road (LIRR)	Bret Becker
	Ken Sundberg
MTA Metro-North Railroad (MNR)	Joseph P. Streany
MTA New York City Transit (NYCT)	Mohammed Baalbalki
	Shoshana Cooper
MTA Police Department	Detective Keyla Hammam
	Lillian Fernandez
	Inspector Sean Montgomery
National Weather Service (NWS)	John Koch
New York City Housing Authority (NYCHA)	Barry Jennings
Port Authority of New York and New Jersey (PANYNJ)	Dave Dlugolenski
Regional Planning Association (RPA)*	Rich Barone
United States Army Corps of Engineers (USACE)	Russell Smith
Verizon	Debbie Cowart
	JJ Finn

*Also member of the Steering Committee

Table 3: MPC Participating Agencies

3) Hazard Mitigation Plan Development

a) Review and Incorporation of Existing Plans and Studies

The Planning Team members reviewed various plans, studies, and guides to begin developing the HMP. These plans included hazard mitigation plans from surrounding jurisdictions and other cities, FEMA guidance documents, emergency-services documents, contingency plans, community plans, federal, local, and state regulations and ordinances, and other similar documents. Table 4 lists the plans and other documents the Planning Team used to guide the HMP's development.

Existing Plans and Studies	
Plans/Studies/Guides	**Author**
Broome County Multi-Jurisdictional Hazard Mitigation Plan	Broome County, New York
Citywide Interagency Management System (CIMS) Protocol	OEM
Earthquake Hazard Program	United States Geological Survey
FEMA's How-to-Guide (Series 386–1, 2, 3, 4, and 5)	FEMA
Flood Insurance Study for New York City	FEMA
Flood Mitigation Taskforce Stormwater Mitigation Study Area Report	New York City Mayor's Office
Hazard Mitigation Planning	FEMA
Historical Hurricane Track	National Oceanic Atmospheric Administration Coastal Services Center
History of New York City Water Supply System	DEP
Improving Drought Management in the West	University of Nebraska Drought Mitigation Center
Landfalling Hurricane Probability Project	Willam Gray and P. Klotzbach
Nassau County Hazard Mitigation Plan	Nassau County, New York
National Flood Insurance Program	FEMA
Nature's Most Violent Storms	National Severe Storms Laboratory
New York City Construction Code	DOB
New York City Coastal Storm Plan	OEM
New York City Drought Management Plan	DEP
New York City Flash Flood Emergency Plan	OEM
New York City Heat Emergency Plan	OEM
New York City Local Waterfront Revitalization Plan	DCP

Existing Plans and Studies	
Plans/Studies/Guides	**Author**
New York City Winter Weather Emergency Plan	OEM
New York City Zoning Resolution	DCP
New York State Coastal Erosion Act	NYSDEC
New York State Coastal Erosion Map	NYSDEC
New York State Hazard Mitigation Plan	New York State Disaster Preparedness Commission
NFIP Community Rating System	FEMA
Northeastern U.S. Going through Dry Spell	USACE
Planning Population: Projecting the Future	DCP
PlaNYC	OLTPS
Protection from Extreme Wind	Texas Tech University Wind Science and Engineering Research Center
Seattle All-Hazards Mitigation Plan	City of Seattle, Washington
Suffolk County Hazard Mitigation Plan	Suffolk County, New York
2000 Census	U.S. Census Bureau
Vital Signs: Deaths Associated with Heat Waves in 2006	DOHMH

Table 4: Existing Plans and Studies Relevant to Natural Hazard Mitigation in New York City

b) Risk Assessment

The following section details the process the Planning Team used to develop the Risk Assessment section.

i) Identifying Hazards

To determine which hazards to profile in the HMP, the Planning Team examined the list of hazards profiled in the 2008 New York State Standard Multi-Hazard Mitigation Plan (NYS HMP). Based on this preliminary review, the Planning Team researched numerous natural hazard resources to determine the hazards that have the potential to occur in New York City. The Planning Team distributed a hazard selection worksheet to the Steering Committee members to determine which hazards may affect their facilities or operations and gain consensus on the list of hazards. The Planning Team eliminated some hazards addressed in the NYS HMP because they were either outside of the scope of the Plan or did not impact New York City. The final list of hazards included in the New York City HMP are coastal erosion, coastal storms, drought, earthquakes, extreme temperatures, floods, windstorms/tornadoes, and winter storms.

ii) Profiling Hazards

The hazard profiles provide a general description, as well as an analysis of the severity, probability of occurrence, location, and historical occurrences of the hazard. To ensure the Risk Assessment section contains the most accurate information, the Planning Team reviewed local and state hazard mitigation plans and natural hazard-related publications, attended conferences, and consulted with hazard-specific subject matter experts. Based on this research, the Planning Team drafted the section and the Steering Committee conducted a review and provided comments. The Planning Team used the most up-to-date and readily available research and information for the Plan.

iii) Estimating Potential Losses

OEM's Hazard Impact Modeler used HAZUS-MH and GIS technology to determine potential loss estimates for New York City. Initially, OEM determined the default HAZUS-MH data did not accurately reflect New York City's built environment. OEM GIS specialists worked with Applied Research Associates, Inc. to replace the general building stock data with New York City-specific data. OEM's Hazard Impact Modeler used the new data to generate loss estimates for the Risk Assessment section.

HAZUS-MH can generate potential loss estimates for earthquakes, coastal storms, and floods. OEM GIS specialists and the Planning Team employed a variety of methods to generate loss estimates for the remaining hazards, like estimating exposure, identifying vulnerable populations, and mapping infrastructure. The Risk Assessment section details the methodology and potential loss estimates for the hazards.

c) Mitigation Strategy

The Steering Committee followed a systematic planning process to develop the Mitigation Strategy section for the HMP. The following steps detail the planning process.

i) Establishing Goals and Objectives

Using information garnered from the NYS HMP, hazard profiles, vulnerability assessments, and community meetings, the Planning Team drafted a set of goals and objectives that represent New York City's long-term vision for reducing the impact of natural hazards on the built environment and the City's population. The Planning Team distributed the draft goals and objectives to the Steering Committee for review and comments. Mitigation goals were also presented at community involvement meetings. Based on these meeting discussions and comments, the Planning Team produced a final set of five goals and 23 objectives for the HMP as outlined in the Mitigation Strategy section.

ii) Indentifying Preliminary Mitigation Actions

The MPC was the designated entity for identifying preliminary mitigation actions. To provide the MPC members with information on hazard mitigation and the planning process, the Planning Team coordinated a kick-off meeting. The MPC kick-off meeting included opening remarks by OEM Commissioner Joseph Bruno, expressing the importance of mitigation planning and support of this effort. It also included presentations by FEMA Region II and the Planning Team regarding hazard mitigation and mitigation actions. At the conclusion of the kick-off meeting, the Planning Team asked the MPC to identify existing and potential mitigation actions within their respective agencies. The Planning Team recommended the MPC use the following criteria to identify mitigation actions: mitigates against one or more of the eight natural hazards profiled in the HMP, falls under one of the six FEMA mitigation categories (prevention, property protection, public education and awareness, natural resource protection, emergency services, and structural projects), and meets at least one of the five mitigation goals.

Participating MPC agencies completed mitigation action worksheets, attached as appendices to this Plan, that established criteria for implementation for each action. For each mitigation action, agencies identified the following information: lead agency, supporting agencies, relevant hazard(s), projected timeframe, estimated project cost, and possible funding sources. These criteria serve as a guide for implementing each action.

iii) Agency One-on-One Meetings

After receiving the mitigation actions worksheets from the MPC agencies, the Planning Team scheduled one-on-one meetings with each agency to review the actions. During each meeting, the participants determined what, if any, modifications were necessary to the text and/or content of the worksheet and if there were additional mitigation actions the agency could undertake in future. These meetings were a valuable opportunity for each agency to ask specific questions and gain a better understanding of how their operations relate to hazard mitigation. The Planning Team also gained a better understanding of the mitigation actions proposed by the agencies. Following the meetings, agencies reviewed their submissions, made appropriate corrections and additions, and resubmitted a revised list of mitigation actions for incorporation into the HMP. In total, the Planning Team conducted 26 one-on-one meetings.

iv) Finalizing Mitigation Actions

Upon receiving the revised mitigation action worksheets from the MPC agencies, the Planning Team reviewed and evaluated the compiled list of 493 mitigation actions based on consistency with mitigation funding guidelines and relevancy to natural hazard mitigation. This review resulted in 306 final mitigation actions for the HMP.

v) Evaluating Mitigation Actions

The Planning Team and Steering Committee performed a qualitative analysis of the final 306 mitigation actions. The Planning Team and Steering Committee used FEMA's Social, Technical, Administrative, Political, Legal, Economic, and Environmental (STAPLEE) analysis to understand the opportunities and constraints for implementing the potential mitigation actions. See the Mitigation Strategy section for the full results of the STAPLEE analysis.

vi) Prioritizing Mitigation Actions

In accordance with the FEMA requirements, the Planning Team prioritized the mitigation actions with an emphasis on maximizing benefits with consideration for the potential project's associated costs. The Planning Team devised a prioritization methodology using the seven STAPLEE criteria as well as the number of objectives each action addressed, project cost, and project timeframe. Based on these criteria, the potential mitigation actions received a numerical ranking that translated to a high, medium, or low priority.

See the Mitigation Strategy section for a detailed explanation of the prioritization process. The prioritization rankings generated by the methodology are dynamic and can change because of funding availability, revisions to the mitigation actions, or changing city conditions. The Steering Committee will work closely with New York State Emergency Management Office (NYSEMO) and FEMA to secure funding for all mitigation actions that are in accordance with the goals and objectives of this Plan.

d) Community Involvement

To engage the community in the hazard mitigation planning process, the Planning Team developed a comprehensive community involvement strategy. The Planning Team first held a series of meetings designed to garner support and comments from a range of stakeholder organizations. The draft HMP was available on the OEM website for a 30-day public comment period (November 1–30, 2008) and hard copies were available at nine public libraries throughout the City. To publicize the plan and garner additional support, OEM sent email notifications to members of New York City's Community Emergency Response Teams (CERT), Citizen Corps Council, elected officials, private sector, academics, and non-profit organizations, requesting feedback. The strategy the Planning Team employed to engage the public in the planning process is outlined in detail below.

i) Community Involvement Meetings

To engage private sector and community-based stakeholders, the Planning Team held three meetings designed to inform the participants about hazard mitigation, generate discussion, and receive feedback on the HMP. The meetings targeted New York City academic institutions, professional organizations, the private sector, community-based organizations, and neighboring jurisdictions.

(1) Academic Institutions Meeting

The Planning Team held its first community involvement meeting on July 22, 2008. Representatives from a variety of New York City academic institutions engaged in the fields of hazard mitigation, climate change, urban planning, architecture, and engineering participated in this discussion. The Planning Team first presented a brief overview of the HMP, which included a discussion of the hazards and highlighted some of the mitigation actions the MPC had submitted. The Planning Team then asked the participants for feedback as well as suggestions for additional research and potential mitigation actions. Throughout the meeting, participants had the opportunity to ask questions and participate in a planning discussion. One major theme of the discussion was the need to recognize the importance of climate change as it relates to hazard mitigation. The Planning Team addressed this by coordinating with OLTPS and other agencies to include a number of climate change-based mitigation actions in the Plan. Another key point made during the discussion was how the lack of viable infrastructure-based hazard models is especially problematic for New York City. The Planning Team addressed this by adding a mitigation action that proposes developing such models. To solicit additional comments and suggestions, all meeting invitees were notified when the draft HMP was available for review online. The full invitee list is included in Appendix C. Table 5 lists the meeting attendees.

Academic Institutions Meeting Attendees	
Affiliation	**Name**
Columbia University–Graduate School of Architecture, Planning, and Preservation	Sigurd Grava
Columbia University–Lamont Doherty Earth Observatory	Arthur Lerner-Lam
	Klaus Jacob
Columbia University–Mailman School of Public Health	Joyce Rosenthal
	Patrick L. Kinney
Hunter College–Graduate Center of Geography	Lesley Patrick
NASA Goddard Institute for Space Studies	Megan O'Grady
New York University–Center for Atmosphere Ocean Science	David Holland
New York University–Center for Catastrophe Preparedness and Response	David Berman
	Ian Portelli
New York University–Wagner Graduate School of Public Service	Rae Zimmerman
State University of New York at Stony Brook–Department of Marine Sciences	Douglas Hill
Steering Committee and Planning Team Attendees	
Charles Shelhamer (DOB), David Nussbaum (DOB), Nelson Castillo (DOT), Adam Freed (OLTPS), Jon Dickinson (OLTPS), Amy Schultz (OEM), Dave Blitzer (OEM), Elizabeth Rothstein (OEM), Heather Roiter (OEM), Josh Friedman (OEM) Lynn Seirup (OEM), Rexford Asiedu (OEM)	

Table 5: Academic Institutions Meeting Attendees

(2) Private Sector and Professional Organizations Meeting

On August 8, 2008, the Planning Team held the second community involvement meeting with representatives from New York City's private sector and professional organizations. The Planning Team presented a brief overview of the HMP, which included a discussion of the hazards and some of the mitigation actions the MPC had identified. The participants were asked for feedback on the work presented as well as suggestions about how the Planning Team can help participants educate their members about hazard mitigation. Throughout the meeting, participants were given the opportunity to ask questions and provide input. Several participants expressed a desire to continue to work with the Planning Team and provide a forum and audience for hazard mitigation. The Planning Team will work with the interested parties to help promote hazard mitigation through future working groups or mitigation discussions. Table 6 lists the meeting attendees. The full invitee list is included in Appendix C. All meeting invitees were notified when the draft HMP was available for review online.

Private Sector and Professional Organizations Meeting Attendees	
Affiliation	**Name**
American Institute of Architects–NY Chapter	Rick Bell
Building Owners & Management Assoc./LFG., Inc.	Sylvester A. Giustino
Food Industry Alliance of New York State	Pat Brodhagen
Small Business Services	Eric Parker
Partnership for New York City	Merrill Pond

Private Sector and Professional Organizations Meeting Attendees	
Affiliation	**Name**
Structural Engineers Association of New York	Savita Goel
Steering Committee and Planning Team Attendees	
Judy Walker (MTA), Nelson Castillo (DOT), Sharita Hunter (DOT), Jon Dickinson (OLTPS), Amy Schultz (OEM), Dave Blitzer (OEM), Elizabeth Rothstein (OEM), Heather Roiter (OEM), Ira Tannenbaum (OEM), Josh Friedman (OEM), Rexford Asiedu (OEM), Seth Cummins (OEM)	

Table 6: Private Sector and Professional Organizations Meeting Attendees

(3) Community-Based Groups and Neighboring Jurisdictions Meeting

The final community involvement meeting occurred on August 20, 2008 with representatives from a variety of New York City community-based organizations and neighboring jurisdictions. At the meeting, the Planning Team presented a brief overview of the HMP, which included a discussion of the hazards and some of the mitigation actions identified by the MPC. The participants were asked for feedback as well as suggestions to improve the Plan. The community-based organizations are a resource to educate the public about hazard mitigation and actions the community can engage in to make New York City more disaster resilient. Neighboring jurisdictions were given the opportunity to attend the meeting to provide insight, comments, and coordinate resources for Plan revisions. Throughout the meeting, participants were given the opportunity to ask questions. One important discussion point was whether pandemic influenza and other health hazards should be included in a hazard mitigation plan. This is something the Planning Team will research further, discuss with FEMA, and consider for possible inclusion in the next HMP submission. Table 7 lists the meeting attendees. The full invitee list is included in Appendix C. All meeting invitees were notified when the draft HMP was available for review online.

Community Groups and Neighboring Jurisdictions Meeting Attendees	
Affiliation	**Name**
American Red Cross in Greater New York	Diane Reiners, Jeanine Pekkarinen, Seth Golbey
Animal Care and Control	Michael Pastore
Coler Goldwater Specialty Hospital and Nursing Facility	Karen Miller
The Salvation Army	Diana C. Lopez, Ian Anderson, Zachery Hodgson
Tzu Chi	David Chao, John Hung, Yuru Chou
World Vision	Tim Bomgardner
Neighboring and Upstate Counties	
Bergen County, NJ	Barry Leventhal
Bergen County, NJ (NJ Meadowlands Commission)	Larry Scorzelli, Nicholas Agnoli, Ralph Venturini
NYSEMO Region I	David Zatlin
Steering Committee Attendees	
Judy Walker (MTA), Kathryn Garcia (DEP), Nelson Castillo (DOT), Sharita Hunter (DOT), Amy Schultz (OEM), Dave Blitzer (OEM), Elizabeth Rothstein (OEM), Heather Roiter (OEM), Josh Friedman (OEM), Rexford Asiedu (OEM)	

Table 7: Community Groups and Neighboring Jurisdictions Meeting Attendees

ii) Public Review

To engage the public in the planning and development of the HMP, the Planning Team posted the draft Plan on the OEM website for a 30-day comment period beginning November 1 and concluding November 30, 2008. The website provided an on-line comment form and a Frequently Asked Questions sheet to assist those who reviewed the Plan and/or provided comments. The Plan was also available at the following public libraries for review and comment:

Draft Hazard Mitigation Plan Hard Copy Locations	
Library	**Address**
Bronx	
Bronx Library Center	310 East Kingsbridge Road Bronx, NY 10458
Grand Concourse Library	155 East 173rd Street Bronx, NY 10457
Parkchester Library	1985 Westchester Avenue Bronx, NY 10462
Brooklyn	
Central Library	Grand Army Plaza Brooklyn, NY 11238
Manhattan	
Countee Cullen Library	104 West 136th Street New York, NY 10030
Seward Park Library	192 East Broadway New York, NY 10002
Queens	
Central Library	89-11 Merrick Boulevard Jamaica NY 11432
Flushing Library	41-17 Main Street Flushing NY 11355
Staten Island	
St. George Library Center	5 Central Avenue Staten Island, NY 10301

Table 8: List of Libraries with Hard Copies of Draft HMP

The Planning Team documented and reviewed comments received during the official comment period for inclusion in the 2009 HMP. Comments received after the 30-day period will be discussed at annual mitigation planning meetings and considered for inclusion in the Plan revision.

The Planning Team coordinated with the New York City Citizens Corps Council to help publicize the Plan and solicit feedback. The Citizen Corps Council is part of the national initiative to bring together local leaders from community organizations, government agencies, the private sector, and volunteer programs to promote community preparedness and volunteerism. The HMP was noted in the Citizen Corps newsletter and an email notification introducing the Plan and requesting comments was sent to Citizen Corps members. The Planning Team also notified local elected officials, including City Council members and Borough President's offices, when the plan was available for comment.

4) Plan Development Meetings

The Planning Team initiated the 2009 New York City HMP development in October 2007 and concluded the process in October 2008. During this timeframe, the Planning Team coordinated and participated in plan development meetings and discussions with agencies and public stakeholders, orchestrated one-on-one meetings with nearly all MPC members, devised and implemented a community involvement strategy, and drafted the sections of the HMP. The Planning Team had a standing weekly meeting, but met numerous other times for specific planning issues.

5) Meeting Documentation

The table below documents the meetings that took place during the planning process of the HMP. The HMP meeting tracker outlines the date meeting occurred, the purpose for holding the meeting, the participants, any outcomes generated from the meeting, and the appropriate section to which the meeting relates. Note weekly plan development meetings are not included in the meeting tracker.

Hazard Mitigation Plan Meeting Tracker					
Meeting #	**Date**	**Meeting Purpose**	**Participants**	**Notes**	**Relevant Plan Section(s)**
1	10/3/2007	Discuss strategy to complete HMP	Planning Team	• Created a draft work plan	All
2	10/17/2007	Discuss strategy for HMP development and approval	FEMA, NYSEMO, OEM	• Discussed development of New York City HMP and expectations of OEM and FEMA	All
3	10/22/2007	Review HMP Toolkit	FEMA, Planning Team	• FEMA furnished OEM with digital and hard copies of the HMP Toolkit	All
4	10/23/2007	Discuss link between the OLTPS and OEM for PlaNYC and HMP	OLTPS, Planning Team	• Initial discussion of potential overlap between HMP and PlaNYC goals • Discussed Critical Infrastructure Task Force	All
5	11/2/2007	Kick-off meeting	FEMA, NYSEMO, Planning Team	• Planning Team presented outline of MPC and work plan	All
6	11/16/2007	Discuss link between OLTPS and OEM for PlaNYC and HMP	OLTPS, Planning Team	• Discussed goals of HMP and MPC • Discussed overlap between OLTPS goals and HMP goals	Planning Process
7	11/20/2007	HAZUS-MH	OEM–GIS, Planning Team	• Demonstration of HAZUS-MH capabilities and current resources dedicated to HAZUS-MH • Commenced earthquake, flood, and hurricane modeling details	Risk Assessment
8	11/26/2007	HAZUS-MH for coastal storms	OEM–GIS, Planning Team	• Reviewed HAZUS-MH capabilities for coastal storms • Determined methodology for HAZUS-MH modeling • Decided on a probabilistic approach for earthquakes and coastal storms	Risk Assessment

Hazard Mitigation Plan Meeting Tracker					
Meeting #	**Date**	**Meeting Purpose**	**Participants**	**Notes**	**Relevant Plan Section(s)**
9	11/30/2007	HAZUS-MH for floods	OEM–GIS, Planning Team	• Reviewed HAZUS-MH capabilities for floods • GIS will load DFIRMS into HAZUS-MH • GIS will initially run HAZUS-MH with just DFIRM flood boundaries • GIS may incorporate urban flash flooding boundaries based on DEP data for future runs	Risk Assessment
10	12/18/2007	Relationship between OLTPS and OEM for PlaNYC and HMP	OLTPS, Planning Team	• Discussed PlaNYC's climate change initiatives • Brainstormed overlapping tasks between Critical Infrastructure Task Force and MPC	Planning Process, Mitigation Strategy
11	12/18/2007	HAZUS-MH	OEM–GIS, Planning Team	• OEM GIS reviewed their HAZUS-MH training • Participants decided on potential models for earthquakes, floods, and earthquakes	Risk Assessment
12	1/3/2008	Coordination between MPC and OLTPS	OLTPS, Planning Team	• Discussed overlap Critical Infrastructure Task Force and MPC • Agreed to modify invitations to address other group since they will overlap in certain initiatives and invitees	Planning Process
13	1/7/2008	Review NYC Sea, Lake, and Overland Surges from Hurricanes (SLOSH) study and technical information	OEM–Technology, Planning Team	• Discussed 2003 SLOSH model and technical details with OEM Project Manager	Risk Assessment

Hazard Mitigation Plan Meeting Tracker					
Meeting #	**Date**	**Meeting Purpose**	**Participants**	**Notes**	**Relevant Plan Section(s)**
14	1/18/2008	Steering Committee Kick-Off Meeting	DCP, DEP, DOB, DOT, MTA, OLTPS, Parks, RPA, Planning Team	• Kick-off meeting for the Steering Committee • Agenda items included: Commissioner and Deputy Commissioner introductions, NYSEMO presentation on HMP overview and funding opportunities, current work plan and expectations of the Steering Committee, next steps, and assigned tasks • Tasks included: 1) complete hazard selection worksheet by identifying which natural hazards have impacted agency and; 2) Local capabilities assessment worksheet	All
15	1/31/2008	Mapping critical infrastructure	OEM-GIS, Planning Team	• Discussed mapping critical infrastructure and facilities for Risk Assessment section • Discussed mapping citywide structural information	Risk Assessment
16	2/5/2008	Mapping thermal imagery and vulnerable populations	OEM-GIS, Planning Team	• Discussed methods for mapping extreme temperatures vulnerable population • OEM-GIS will obtain thermal imagery of NYC as well as vegetative land-cover data	Risk Assessment

Hazard Mitigation Plan Meeting Tracker					
Meeting #	**Date**	**Meeting Purpose**	**Participants**	**Notes**	**Relevant Plan Section(s)**
17	2/8/2008	MPC Kick-Off Meeting	Amtrak, ConEd, DCAS, DCP,DDC, DEP, DFTA, DHS, DOB, DOC, DOE, DOHMH, DoITT, DSNY, EDC, FEMA, FDNY, HHC, HPD, LPC, MTA–HQ, MTA–MNR, MTA–NYCT, MTA–Police, MTA–B&T, NYCHA, NYPD, OLTPS, PANYNJ, Parks, SBS, USACE, Verizon, Planning Team	• Kick-off meeting for MPC included: Commissioner and Deputy Commissioner greetings, OEM presentation on HMP and mitigation actions, FEMA presentation on funding, and example mitigation projects • Goal of meeting was for agencies to identify existing and potential mitigation projects within their agency and complete a worksheet • The Planning Team will follow-up with each agency to review their identified mitigation actions	Planning Process, Mitigation Strategy
18	2/14/2008	Plan requirement discussion	DHS, Planning Team	• OEM met with DHS to discuss the MPC and mitigation actions worksheet • Reviewed the type of projects that qualify for mitigation funding • Brainstormed more potential mitigation actions for DHS	Planning Process, Mitigation Strategy
19	2/20/2008	Earthquake hazards in New York City	Columbia University-Lamont Doherty Earth Observatory, OEM–GIS, Planning Team	• Columbia staff presented earthquake risks to New York City • Explained scientific studies taking place to understand hazards better across the region • Demonstrated the application tools that assist with identifying, locating, and understanding earthquakes	Planning Process, Risk Assessment

Hazard Mitigation Plan Meeting Tracker					
Meeting #	**Date**	**Meeting Purpose**	**Participants**	**Notes**	**Relevant Plan Section(s)**
20	3/3/2008	Agency one-on-one	NYPD, Planning Team	• Reviewed HMP and MPC • Discussed Mitigation Actions Worksheet and potential hazard mitigation actions for NYPD	Mitigation Strategy
21	3/5/2008	Understanding grant-eligible mitigation actions	FEMA–Mitigation Grants, Planning Team	• Mike Foley met with the Planning Team to review projects that are eligible and ineligible for mitigation findings • Focused on submitted mitigation actions from the MPC • Discussed other applicable FEMA grants that relate to the mitigation actions	Mitigation Strategy
22	3/10/2008	Agency one-on-one	Parks, Planning Team	• Reviewed Mitigation Actions Worksheet submitted by Parks • Discussed potential modifications	Mitigation Strategy
23	3/10/2008	Agency one-on-one	DOB, Planning Team	• Reviewed Mitigation Actions Worksheet submitted by DOB • Discussed potential modifications	Mitigation Strategy
24	3/12/2008	Identifying overlap between Continuity of Operations (COOP) and hazard mitigation	OEM–COOP, Planning Team	• Reviewed the COOP strategy and HMP strategy • Exchanged information to determine if there are overlapping contacts or initiatives within the two projects	Mitigation Strategy
25	3/12/2008	Agency one-on-one	DOC, Planning Team	• Reviewed Mitigation Actions Worksheet submitted by DOC • Discussed potential modifications	Mitigation Strategy
26	3/13/2008	Agency one-on-one	MTA B&T, Planning Team	• Reviewed Mitigation Actions Worksheet submitted by MTA B&T • Discussed potential modifications	Mitigation Strategy

Hazard Mitigation Plan Meeting Tracker					
Meeting #	**Date**	**Meeting Purpose**	**Participants**	**Notes**	**Relevant Plan Section(s)**
27	3/13/2008	Agency one-on-one	MTA (NYCT–Subways), Planning Team	• Reviewed Mitigation Actions Worksheet submitted by MTA (NYCT – Subways) • Discussed potential modifications	Mitigation Strategy
28	3/13/2008	Agency one-on-one	MTA (NYCT–Buses), (Bus Co.), Planning Team	• Reviewed Mitigation Actions Worksheet submitted by MTA (NYCT – Buses) and (Bus Co.) • Discussed potential modifications	Mitigation Strategy
29	3/14/2008	Agency one-on-one	DSNY, Planning Team	• Reviewed Mitigation Actions Worksheet submitted by DSNY • Discussed potential modifications	Mitigation Strategy
30	3/14/2008	Agency one-on-one	HPD, Planning Team	• Reviewed Mitigation Actions Worksheet submitted by HPD • Discussed potential modifications	Mitigation Strategy
31	3/17/2008	Agency one-on-one	Verizon, Planning Team	• Reviewed Mitigation Actions Worksheet submitted by Verizon • Discussed potential modifications	Mitigation Strategy
32	3/17/2008	Agency one-on-one	EDC, Planning Team	• Reviewed Mitigation Actions Worksheet submitted by EDC • Discussed potential modifications	Mitigation Strategy
33	3/17/2008	Agency one-on-one	DCP, Planning Team	• Reviewed Mitigation Actions Worksheet submitted by DCP • Discussed potential modifications	Mitigation Strategy
34	3/18/2008	Agency one-on-one	SBS, Planning Team	• Reviewed Mitigation Actions Worksheet submitted by SBS • Discussed potential modifications	Mitigation Strategy
35	3/18/2008	Agency one-on-one	Amtrak, Planning Team	• Reviewed Mitigation Actions Worksheet submitted by Amtrak • Discussed potential modifications	Mitigation Strategy

Hazard Mitigation Plan Meeting Tracker					
Meeting #	**Date**	**Meeting Purpose**	**Participants**	**Notes**	**Relevant Plan Section(s)**
36	3/19/2008	Agency one-on-one	DEP, Planning Team	• Reviewed Mitigation Actions Worksheet submitted by DEP • Discussed potential modifications	Mitigation Strategy
37	3/19/2008	Agency one-on-one	DFTA, Planning Team	• Reviewed Mitigation Actions Worksheet submitted by DFTA • Discussed potential modifications	Mitigation Strategy
38	3/20/2008	Agency one-on-one	DCAS, Planning Team	• Reviewed Mitigation Actions Worksheet submitted by DCAS • Discussed potential modifications	Mitigation Strategy
39	3/20/2008	Agency one-on-one	DHS, Planning Team	• Reviewed Mitigation Actions Worksheet submitted by DHS • Discussed potential modifications	Mitigation Strategy
40	3/21/2008	Agency one-on-one	NYCHA, Planning Team	• Reviewed Mitigation Actions Worksheet submitted by NYCHA • Discussed potential modifications	Mitigation Strategy
41	3/24/2008	Agency one-on-one	HRA, Planning Team	• Reviewed Mitigation Actions Worksheet submitted by HRA • Discussed potential modifications	Mitigation Strategy
42	3/25/2008	Agency one-on-one	DOT, Planning Team	• Reviewed Mitigation Actions Worksheet submitted by DOT • Discussed potential modifications	Mitigation Strategy
43	3/26/2008	Update on HAZUS-MH and incorporation into Mitigation Strategy	OEM-GIS, Planning Team	• Discussed current HAZUS-MH capabilities and updates to running earthquake models • Reviewed critical facilities selection and potential for adding critical facilities to HAZUS-MH • Discussed potential mitigation actions to model in HAZUS-MH	Risk Assessment and Mitigation Strategy

Hazard Mitigation Plan Meeting Tracker					
Meeting #	**Date**	**Meeting Purpose**	**Participants**	**Notes**	**Relevant Plan Section(s)**
44	3/27/2008	Agency one-on-one	DOHMH, Planning Team	• Reviewed Mitigation Actions Worksheet submitted by DOHMH • Discussed potential modifications	Mitigation Strategy
45	3/28/2008	Steering Committee Meeting #3	DCP, DEP, DOB, DOT, MTA-HQ, MTA-Police, OLTPS, Parks, RPA, Planning Team	• Reviewed status of Risk Assessment and Mitigation Strategy Sections • Reviewed critical facilities maps and asked for input • Introduced HAZUS-MH and potential for future modeling of mitigation strategies • Assigned Agency Capability Assessment Form	Planning Process and Mitigation Strategy
46	3/31/2008	Agency one-on-one	PANYNJ, Planning Team	• Reviewed Mitigation Actions Worksheet submitted by PANYNJ • Discussed potential modifications	Mitigation Strategy
47	3/31/2008	Agency one-on-one	DOE, Planning Team	• Reviewed Mitigation Actions Worksheet submitted by DOE • Discussed potential modification	Mitigation Strategy
48	4/14/2008	Agency one-on-one	HHC, Planning Team	• Reviewed Mitigation Actions Worksheet submitted by HHC • Discussed potential modification	Mitigation Strategy
49	5/8/2008	Update on HAZUS-MH and incorporation into Mitigation Strategy	OEM-GIS, Planning Team	• Discussed potential mitigation strategies to model in HAZUS-MH	Mitigation Strategy
50	5/16/2008	Steering Committee Meeting #4	DCP, DEP, DOB, DOT, MTA-HQ, MTA-Police, OLTPS, Parks, RPA, Planning Team	• Reviewed status of Risk Assessment and Mitigation Strategy sections • Discussed potential mitigation actions to model in HAZUS-MH as a case study • Performed STAPLEE and reviewed STAPLEE	Mitigation Strategy

Hazard Mitigation Plan Meeting Tracker					
Meeting #	**Date**	**Meeting Purpose**	**Participants**	**Notes**	**Relevant Plan Section(s)**
51	6/4/2008	Modeling DEP mitigation actions in HAZUS-MH	DEP, Planning Team	• Reviewed potential mitigation actions to model in HAZUS-MH	Mitigation Strategy
52	6/20/2008	Modeling Parks mitigation actions in HAZUS-MH	Parks, Planning Team	• Reviewed potential mitigation actions to model in HAZUS-MH	Mitigation Strategy
53	6/26/2008	Modeling DOB mitigation actions in HAZUS-MH	DOB, Planning Team	• Reviewed potential mitigation actions to model in HAZUS-MH	Mitigation Strategy
54	7/14/2008	HAZUS-MH update	OEM-GIS, Planning Team	• Reviewed HAZUS-MH outputs and case studies of mitigation actions	Mitigation Strategy
55	7/17/2008	Identify OEM-GIS mitigation actions	OEM-GIS, Planning Team	• Discussed potential mitigation actions for OEM-GIS to submit to the OEM mitigation actions list	Mitigation Strategy
56	7/18/2008	HAZUS-MH update	OEM-GIS, Planning Team	• Reviewed HAZUS-MH outputs and case studies of mitigation actions	Mitigation Strategy
57	7/18/2008	Update on HMP FEMA requirements	NYSEMO, Planning Team	• Discussed preliminary review by NYSEMO of Risk Assessment section • Reviewed October 2008 HMP requirements	All
58	7/22/2008	Academic Sector Meeting	Columbia University, NYU, SUNY Stonybrook, Hunter College, NASA Goddard Institute for Space Studies, DOB, MTA, DOT, OLTPS, Planning Team	• The Planning Team presented the HMP and the work accomplished thus far • Attendees received a draft copy of the Steering Committee mitigation actions to use as examples in hope that they will submit additional mitigation actions or research related to the Plan • Discussed future hazard mitigation partnerships between the City and the academic sector	All

Hazard Mitigation Plan Meeting Tracker					
Meeting #	**Date**	**Meeting Purpose**	**Participants**	**Notes**	**Relevant Plan Section(s)**
59	7/24/2008	Finalize OEM mitigation actions	OEM–External Affairs, Planning Team	• Reviewed all Ready New York and CERT mitigation actions to include in the HMP	Mitigation Strategy
60	7/28/2008	Finalize OEM mitigation actions	OEM–Public/Private, Planning Team	• Reviewed all Public/Private Partnership programs at OEM that will be part of the mitigation actions list in the HMP	Mitigation Strategy
61	7/29/2008	HMP planning process	Boston Consulting Group, OLTPS, Planning Team	• The Planning Team met with OLTPS and their consultant, to discuss the HMP planning process • OEM provided guidance and advice for PlaNYC's Climate Change Adaptation Task Force • Identified overlap between the two planning groups	All
62	8/6/2008	Private Sector and Professional Organizations Meeting	AIA–NY Chapter, NYS Banking Department, BOMA, Partnership for New York City, FIA, SBS, SEAoNY, Time Warner Cable, DOT, MTA, OLTPS, Planning Team	• The Planning Team presented the HMP to the private sector and professional organizations • Overview of the components of the HMP • Explained how attendees can become involved with the planning process • Attendees encouraged to review the draft version of the Plan and use its content for operations decisions within their organization	All

Hazard Mitigation Plan Meeting Tracker					
Meeting #	**Date**	**Meeting Purpose**	**Participants**	**Notes**	**Relevant Plan Section(s)**
63	8/20/2008	Community-Based Groups and Neighboring Jurisdictions Meeting	Animal Care and Control, ARCGNY, Bergen County, NJ Meadowlands Commission, Catholic Charities, Coler Goldwater Specialty Hospital and Nursing Facility, Salvation Army, NYSEMO, Tzu Chi, World Vision, DEP, DOT, MTA, Planning Team	• The Planning Team presented the HMP to neighboring jurisdictions and community groups • Overview of the components of the Plan and explained how attendees can become involved with the planning process • Attendees encouraged to review the draft version of the Plan and use its content for operations decisions within their organization	All
64	8/21/2008	HAZUS-MH update	OEM–GIS, Planning Team	• Reviewed HAZUS-MH outputs and case studies of mitigation actions • Reviewed map modifications for the Risk Assessment section	Risk Assessment, Mitigation Strategy
65	8/21/2008	Hazard mitigation and COOP	OEM–COOP, Planning Team	• Reviewed the overlap between the HMP and COOP with new staff • Explained how COOP can reference hazard mitigation with their partner agencies • COOP planners are encouraged to mention hazard mitigation when agencies do a hazard vulnerability assessment of their critical facilities	All
66	2009	MPC	MPC, Planning Team	TBD	All

Table 9: Meeting Tracker

6) List of Tables

Section III: Natural Hazard Risk Assessment

1) Introduction

Risk assessment is the process of evaluating the vulnerability of people, buildings, and infrastructure to estimate the potential loss of life, personal injury, economic injury, and property damage resulting from natural hazards. The Risk Assessment section answers the fundamental question that fuels the natural hazard mitigation planning process: *What would happen if a natural hazard event occurred in New York City?*

a) Risk Assessment Approach

- Determine which natural hazards pose a serious risk to New York City.
- Describe what these hazards can do to physical, social, and economic assets of New York City.
- Identify which areas of New York City are most vulnerable to damage from these hazards.
- Determine damages that may result from the identified natural hazards.
- Use the Risk Assessment section to identify mitigation actions and set priorities for implementation.

b) FEMA Requirements Addressed in this Section

The Office of Emergency Management (OEM) Hazard Mitigation Planning Team (Planning Team) used a risk assessment process consistent with the procedures and steps presented in the Federal Emergency Management Agency's (FEMA) How-To-Guide "Understanding Your Risks: Identifying Hazards and Estimating Losses." The Planning Team used the four-step risk assessment process shown in Figure 1.

RISK ASSESSMENT PROCESS

STEP 1: IDENTIFY HAZARDS

↓

STEP 2: PROFILE HAZARD EVENTS

↓

STEP 3: INVENTORY ASSETS

↓

STEP 4: ESTIMATE LOSSES

↓

USE RISK ASSESSMENT OUTPUTS TO PREPARE A HAZARD MITIGATION PLAN

Figure 1: Risk Assessment Process

The following FEMA requirements are addressed in this section:

- **Requirement §201.6(c)(2)(i):** [The risk assessment ***shall*** include a] description of the type… of all natural hazards that can affect the jurisdiction.

  [The risk assessment shall include a] description of the … location and extent of all natural hazards that can affect the jurisdiction. The plan ***shall*** include information on previous occurrences of hazard events and the probability of future hazard events.

- **Requirement §201.6(c)(2)(ii):** [The risk assessment ***shall*** include a] description of the jurisdictions vulnerability to the hazards described in paragraph §201.6(c)(2)(i). This description ***shall*** include an overall summary of each hazard and its impact on the community.

  [The risk assessment] ***must*** also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged by floods.

- **Requirement §201.6(c)(2)(ii)(A**): [The plan ***should*** describe vulnerability in terms of types and numbers of] existing and future buildings, infrastructure, and critical facilities located in the identified hazard area….

- **Requirement §201.6(c)(2)(ii)(B):** [The plan ***should*** describe vulnerability in terms of types and numbers of an] estimate of the potential dollar losses to vulnerable structures identified in §201.6(c)(2)(ii)(A) of this description the methodology used to prepare the estimate….

- **Requirement §201.6(c)(2)(ii)(C**): [The plan ***should*** describe vulnerability in terms of types and numbers of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

2) Hazard Identification

The first step in the risk assessment process is to determine which hazards to include in the plan. To initiate this process, the Planning Team, with input from the Mitigation Planning Council Steering Committee (Steering Committee), identified an initial list of hazards that might affect the City and then selected the priority hazards of concern for further profiling and analysis.

a) Hazards in New York State

To begin the hazard identification process, the Planning Team took the full range of hazards identified in the New York State Multi-Hazard Mitigation Plan (NYS HMP) and made a few minor alterations, which included wording and organization, to produce a comprehensive natural hazard list. Figure 2 lists the full range of New York State hazards the Planning Team considered for inclusion in the New York City Hazard Mitigation Plan (HMP).

Hazards in New York State	
Hazard	**Description**
Coastal Erosion	Loss or displacement of land along the coastline due to the action of wind, waves, currents, tides, wind-driven water, waterborne ice, runoff of surface waters, or groundwater seepage.
Coastal Storms/Hurricanes	Tropical cyclones formed in the atmosphere over warm ocean areas. Wind speeds reach 74 miles per hour or more and blow in a large spiral around a relatively calm center or "eye. Circulation is counterclockwise in the Northern Hemisphere.
Dam Failure	An uncontrolled release of impounded water resulting in downstream flooding.
Drought	A prolonged period with no rain. Limited winter precipitation accompanied by moderately dry periods during the spring and summer months can also lead to drought conditions.
Earthquakes	The sudden motion or trembling of the ground produced by abrupt displacement of rock masses, usually within the upper 10–20 miles of the earth's surface.
Extreme Temperatures	*Extreme Cold:* temperatures that drop well below normal in an area. Whenever temperatures drop well below normal and wind speed increases, heat can leave your body more rapidly (known as the wind-chill effect). *Extreme Heat:* temperatures that hover 10° F or more above the average high temperature for the region and last for several weeks. Humid or muggy conditions, which add to the discomfort of high temperatures, occur when a "dome" of high atmospheric pressure traps hazy, damp air near the ground.
Floods	A general and temporary condition of partial or complete inundation on normally dry land. Flooding can be categorized as coastal, riverine, or flash.
Hailstorms	Shower-like precipitation in the form of irregular pellets, or balls of ice more than five millimeters in diameter, falling from a cumulonimbus cloud.

Hazards in New York State	
Hazard	**Description**
Landslides	The downward and outward movement of slope-forming materials reacting to the force of gravity. Slide materials may be composed of natural rock, soil, artificial fill, or combinations of these materials. The term landslide includes rock falls, rockslides, block glide, debris slide, earth flow, mudflow, slump, and other such terms.
Subsidence	Depressions, cracks, and sinkholes in the earth's surface, which can threaten people and property. Subsidence depressions, which normally occur over many days to a few years, may damage structures with low strain tolerances such as dams, factories, nuclear reactors, and utility lines.
Tornadoes/Windstorms	A local atmospheric storm, generally of short duration, formed by winds rotating at very high speeds, usually in a counterclockwise direction. The vortex, up to several hundred yards wide, is visible to the observer as a whirlpool-like column of winds rotating about a hollow cavity or funnel.
Wildfires	Any instance of uncontrolled burning in grasslands, brush, or woodlands.
Winter Storms	Includes ice storms and blizzards. Extreme cold often accompanies winter storms. The National Weather Service (NWS) characterizes blizzards as being combinations of winds in excess of 35 mph with considerable falling or blowing snow, which frequently reduces visibility.

Figure 2: Natural Hazard Definitions

b) Hazard Selection Process

i) Existing Plans and Procedures

When considering which natural hazards to include in the HMP, the Planning Team identified the City's existing emergency plans and procedures that address natural hazards. The New York City Office of Emergency Management (OEM) and other City agencies have plans and procedures in place for many natural hazards, including coastal storms, drought, extreme temperatures, floods, tornadoes/windstorms, and winter storms. Therefore, it was evident these hazards significantly affect New York City and should be included in the HMP.

ii) Hazard Selection Worksheet

The Steering Committee supported the hazard identification process by completing a hazard selection worksheet. The hazard selection worksheet asked members of the Steering Committee to indicate which natural hazards would affect their agencies' operations, policies, and/or physical infrastructure. The worksheet also asked for an example or explanation for each hazard checked. Table 1 summarizes the results of the worksheets.

New York City Hazard Selection Worksheet Results								
Hazard	**Agency**							
	DCP	**DOB**	**DEP**	**Parks**	**OLTPS**	**DOT**	**MTA**	**OEM**
Coastal Erosion	✓	✓	✓	✓	✓	✓		✓
Coastal Storms/ Hurricanes	✓	✓	✓	✓	✓	✓	✓	✓
Dam Failure			✓		✓			
Drought		✓	✓	✓	✓			✓
Earthquakes		✓	✓				✓	✓
Extreme Temperatures		✓	✓	✓	✓	✓		✓
Floods	✓	✓	✓	✓	✓	✓	✓	✓
Hailstorms					✓		✓	
Landslides		✓		✓		✓		
Subsidence		✓	✓		✓	✓		
Windstorms/ Tornadoes		✓	✓	✓	✓	✓	✓	✓
Wildfires			✓	✓				
Winter Storms		✓	✓	✓	✓	✓	✓	✓

Table 1: New York City Hazard Selection Worksheet Results

A majority of Steering Committee members checked the following hazards: coastal erosion, coastal storms, drought, extreme temperatures, floods, tornadoes, and winter storms. The other hazards listed required additional research to determine whether they should be in the Plan. The Planning Team collected and analyzed additional data on dam failure, hailstorms, landslides, subsidence, and wildfires from newspapers, City records, and the National Oceanic and Atmospheric Administration (NOAA), NWS, and FEMA databases.

c) Eliminated Hazards

After conducting additional research, the Planning Team eliminated dam failure, hailstorms, landslides, subsidence, and wildfires from the HMP. Given the scope of this plan, the Planning Team chose to address only prevalent natural hazards for this submission. The Planning Team concluded dam failure in New York City is a technological hazard and therefore outside this Plan’s scope. Dam failure can occur as a secondary effect from a natural hazard and in that context, it is addressed in the Mitigation Strategy section. Further research into landslides in New York City revealed this phenomenon is generally related to human activity and most often occurs as the result of a failed retaining structure. Based on consultation with the New York State

Geological Survey (NYSGS) and a review of the NYS HMP, the Planning Team determined subsidence is highly unlikely due to New York City's hard soils. Although hailstorms are possible in New York City, there is little risk to agriculture here, and City property damage from this particular hazard is minimal. Finally, the City is too urbanized for large wildfires and while brushfires are possible in some areas, historic records and a review of OEM Watch Command notifications showed property damage from such fires is rare. Consequently, because of their limited impacts, hailstorms and wildfires are not included in the final list of hazards.

d) Final List of New York City Hazards

At the end of the hazard identification process, the Planning Team retained eight natural hazards for profiling and analysis in the HMP.

(1) Coastal Erosion
(2) Coastal Storms
(3) Drought
(4) Earthquakes
(5) Extreme Temperatures
(6) Flooding
(7) Windstorms and Tornadoes
(8) Winter Storms

3) New York City's Hazard Environment

With more than 8.2 million people, New York City is the most populous city in the United States and ranks among the largest urban areas in the world. It is also one of the most densely populated cities in the United States with an area of just 305 square miles. For more than a century, New York City has been a global center for commerce, finance, politics, foreign affairs, media, and the arts. Many of the City's neighborhoods and landmarks are known around the world. To accommodate its dense population and maintain its international prominence, New York City has developed a complex and interconnected network of transportation and infrastructure systems. However, New York City's defining characteristics – its dense population, international stature, and complex infrastructure – also increase the potential significance of hazards, making it more susceptible to their effects than many other cities.

a) The Natural Environment

New York City's geographic location, climate, and topography have influenced its growth and prominence in the United States. However, the City's natural features also increase its vulnerability to certain natural hazards.

i) Geography

New York City is located in the southeastern part of New York State, at the confluence of the Hudson River and the Atlantic Ocean. Much of New York City is built on the three islands of Manhattan, Staten Island, and western Long Island. The City contains numerous bays, rivers, and tidal straights including the Hudson River, New York Harbor, Long Island Sound, East River, Jamaica Bay, and Harlem River. Parts of the City border the Atlantic Ocean.

The City comprises five boroughs, each of which is a county. If the boroughs were each independent cities, four of the boroughs (the Bronx, Brooklyn, Manhattan, and Queens) would be among the ten most populous cities in the United States.

- The Bronx (Bronx County, 2006 population 1,371,353) is the City's northernmost borough and is the only borough attached to the U.S. mainland.
- Brooklyn (Kings County, 2006 population 2,523,047) is situated on the southwestern part of the Long Island landmass and is bounded by Queens to the east and north. Brooklyn is the City's most populous borough.
- Manhattan (New York County, 2006 population 1,611,581) is an island southwest of the Bronx, bordered on the west by the Hudson River and on the east by the East River. Manhattan is the City's most densely populated borough.
- Queens (Queens County, 2006 population 2,264,661) is geographically the largest borough in New York City. Also part of the Long Island landmass, it shares a border with Brooklyn.
- Staten Island (Richmond County, 2006 population 478,876) is an island southwest of Manhattan. It is connected by bridges to both Brooklyn and New Jersey and is accessible to Manhattan by ferry.

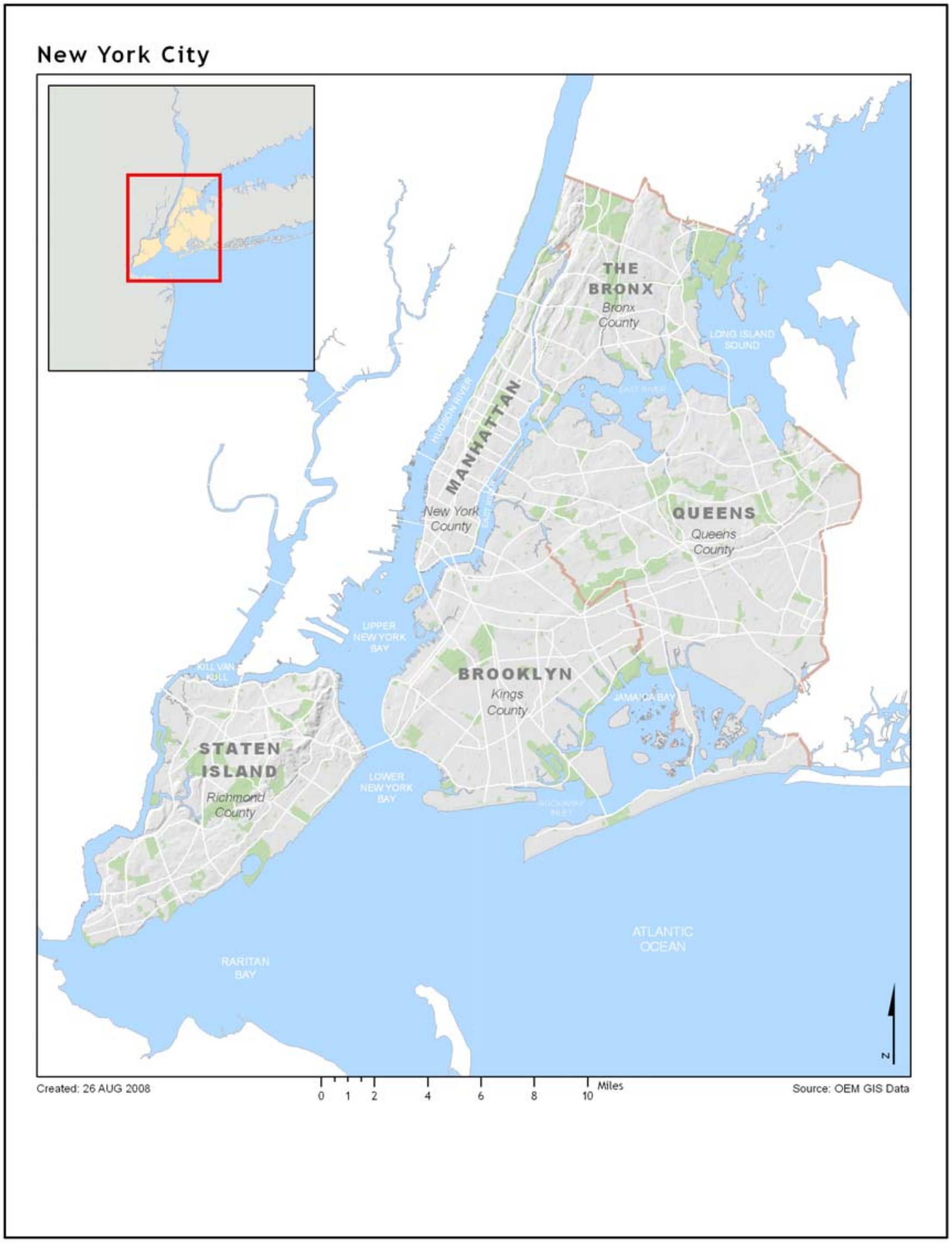


Figure 3: New York City

ii) Climate

New York City has a humid, continental climate with cold winters and hot, moist summers. The temperature has ranged from -15° F on February 9, 1934 to 106° F on July 9, 1936. The average annual temperature is 55° F. January's average temperature is 32° F, and July's is 77° F. The City's average annual precipitation, which is spread throughout the year, is 47 inches. Its average annual snowfall is 22 inches.

The New York City region encounters most storms and fronts from the west as they move across the North American continent. The result is hotter summers and colder winters than most continental coastal areas that share similar latitudes. The frequent weather systems passing through the region diminish warm and cold periods.

The ocean affects New York City's climate to a lesser degree. Wind coming off the sea often moderates afternoon heat, though less so inland because of the concentration of buildings and pavement and the resulting urban heat island effect. In winter, the relative warmth of the ocean compared to the land keeps the central City slightly warmer than inland suburbs. Additionally, the lag in water temperature delays winter snows and keeps spring temperatures cooler, longer.

iii) Topography

Elevation ranges from less than 50 feet for most of Manhattan, Brooklyn, and Queens to nearly 300 feet in northern Manhattan and the Bronx. The highest point in New York City is Todt Hill on Staten Island at 412 feet above sea level. Figure 4 shows New York City's topography and the highest point for each borough.

Human intervention and land reclamation along the waterfronts has altered the City's land considerably. Reclamation is most notable in Lower Manhattan, with developments such as Battery Park City built entirely on fill. Human intervention has also evened out some of the natural variations in topography, particularly in Manhattan.

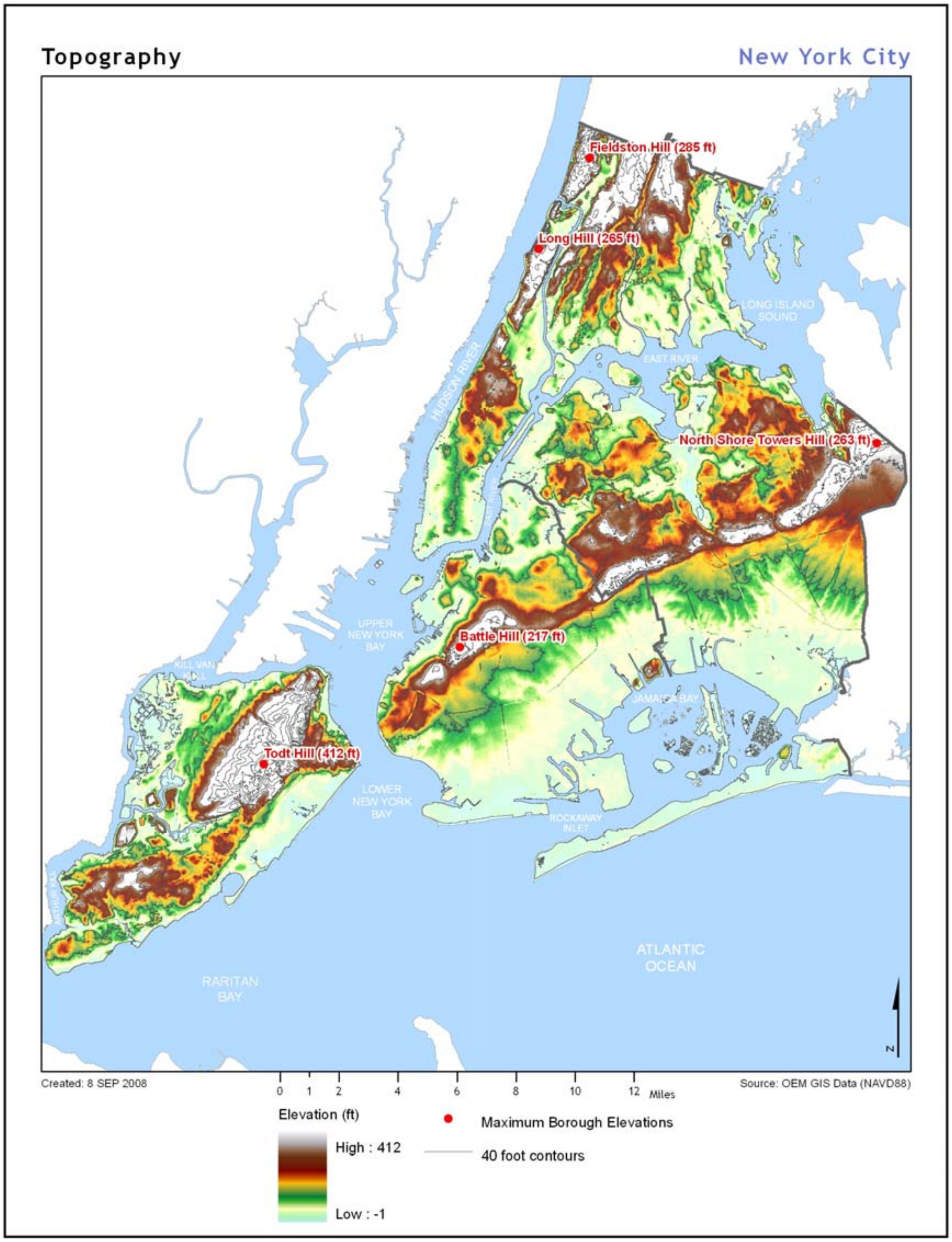


Figure 4: New York City Topography

b) The Social Environment

New York City's social environment – its history, demographics, and economy – influences how New Yorkers plan for and respond to disasters.

i) Demographics

Population Density: 8.2 million people live in the 305 square miles of New York City. Manhattan is the most densely populated borough with more than 67,000 people per square mile. Staten Island is the least densely populated borough with approximately 4,000 people per square mile.

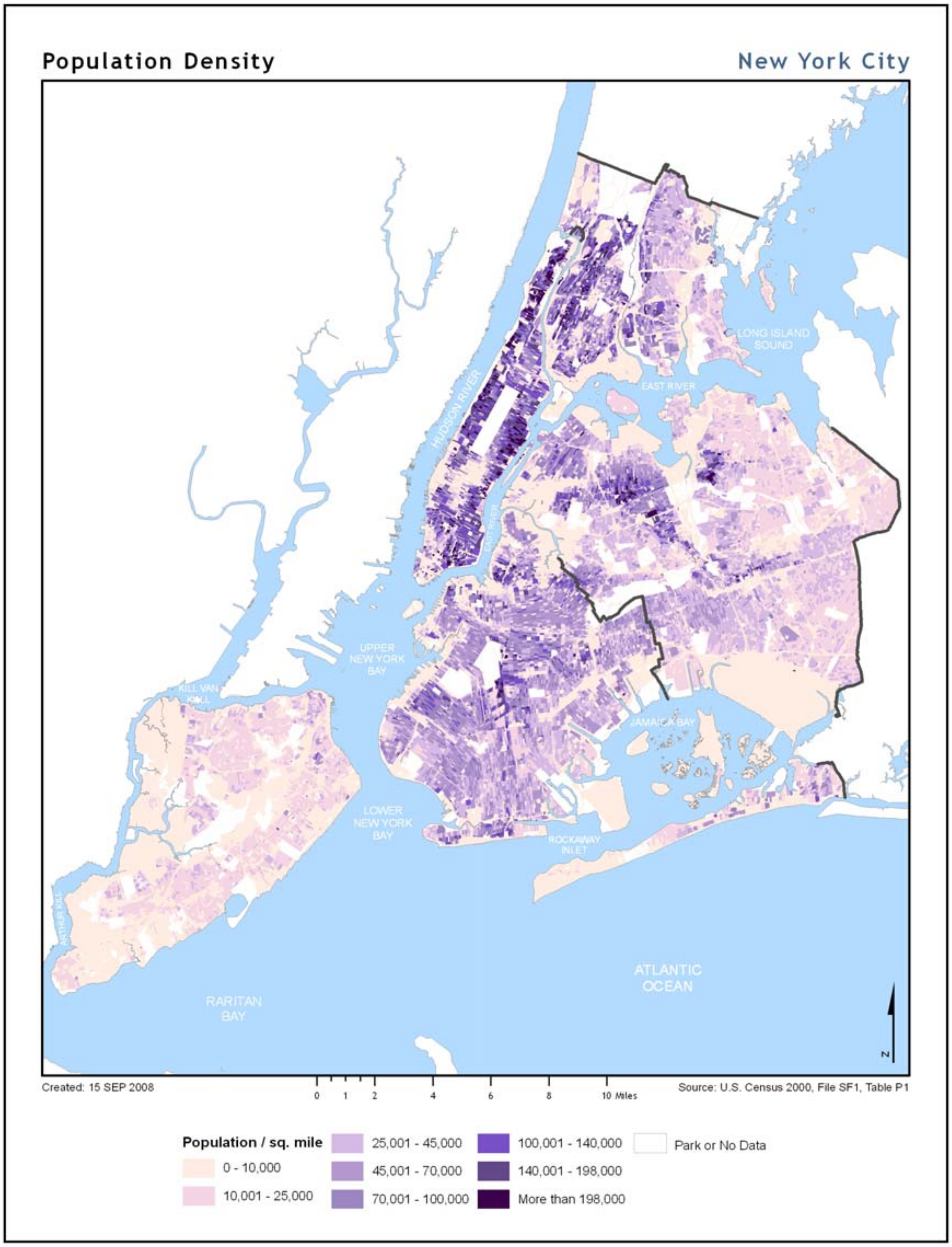


Figure 5: Population Density for New York City in 2000

Age: Approximately 937,000 seniors (people age 65 and older) live in New York City.

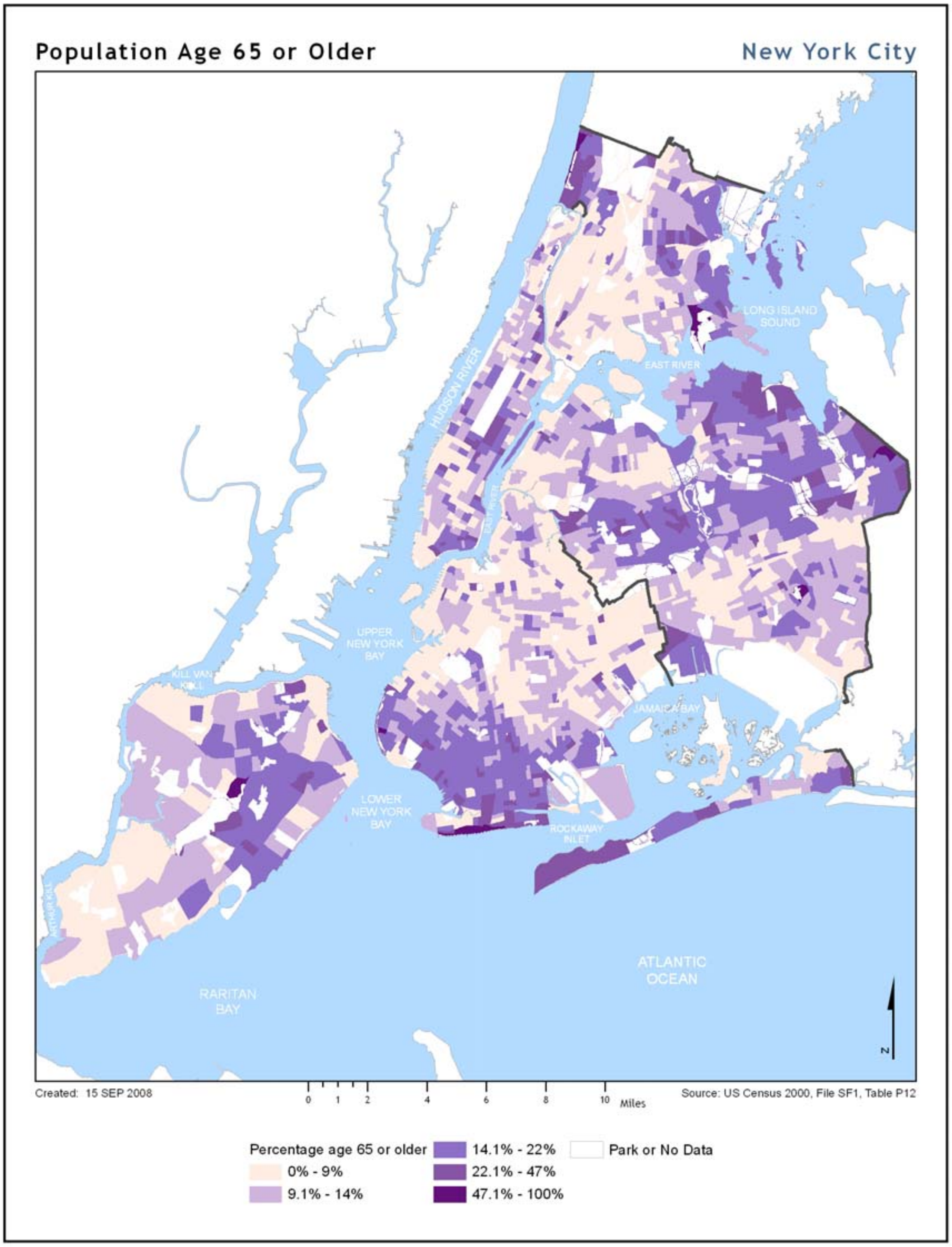


Figure 6: Population 65 and Older in New York City in 2000

Approximately 541,000 children under the age of five live in New York City.

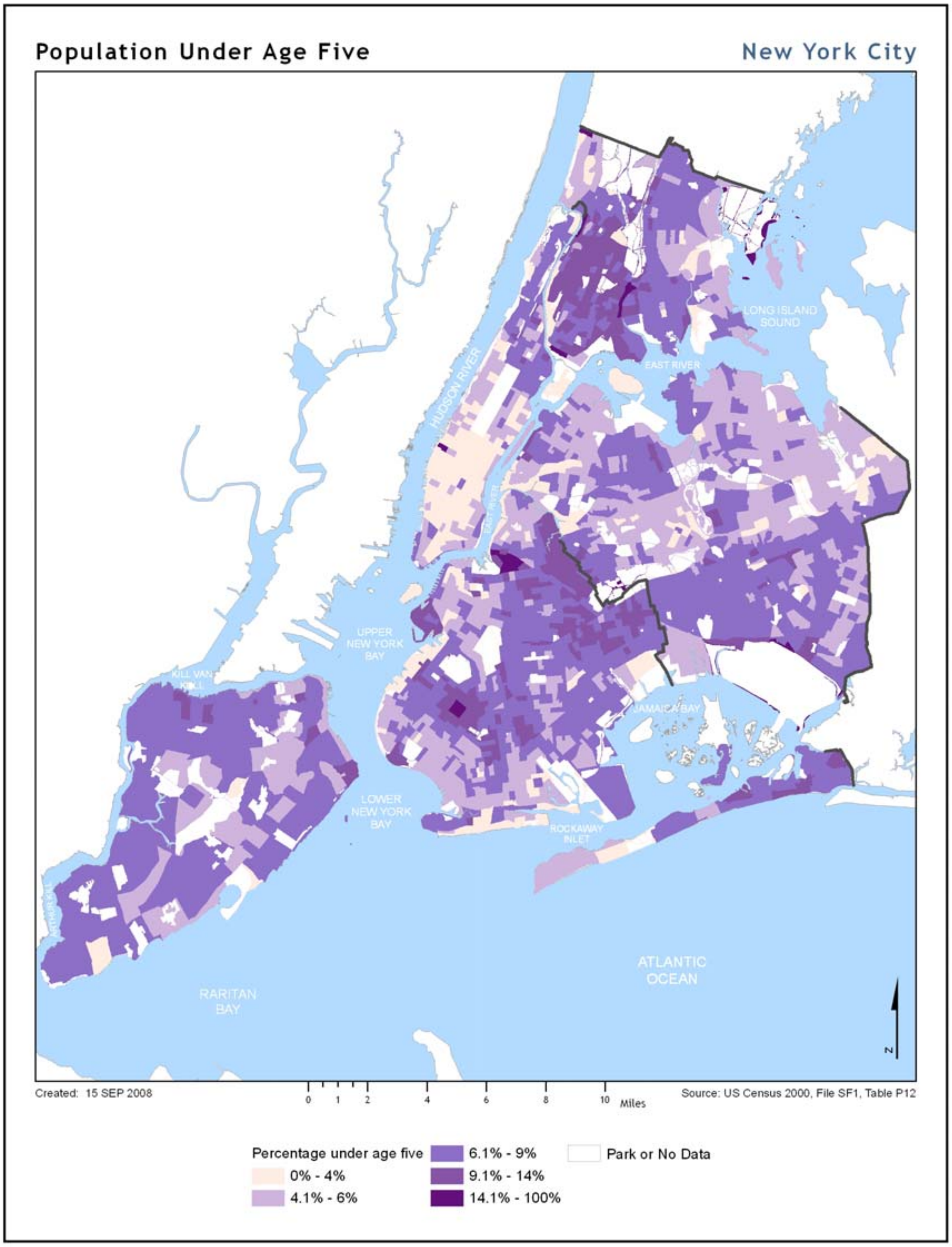


Figure 7: Population Under Five Years Old in New York City in 2000

Poverty: Census data from 2000 found approximately 20% of New York City residents live below the federal poverty line.

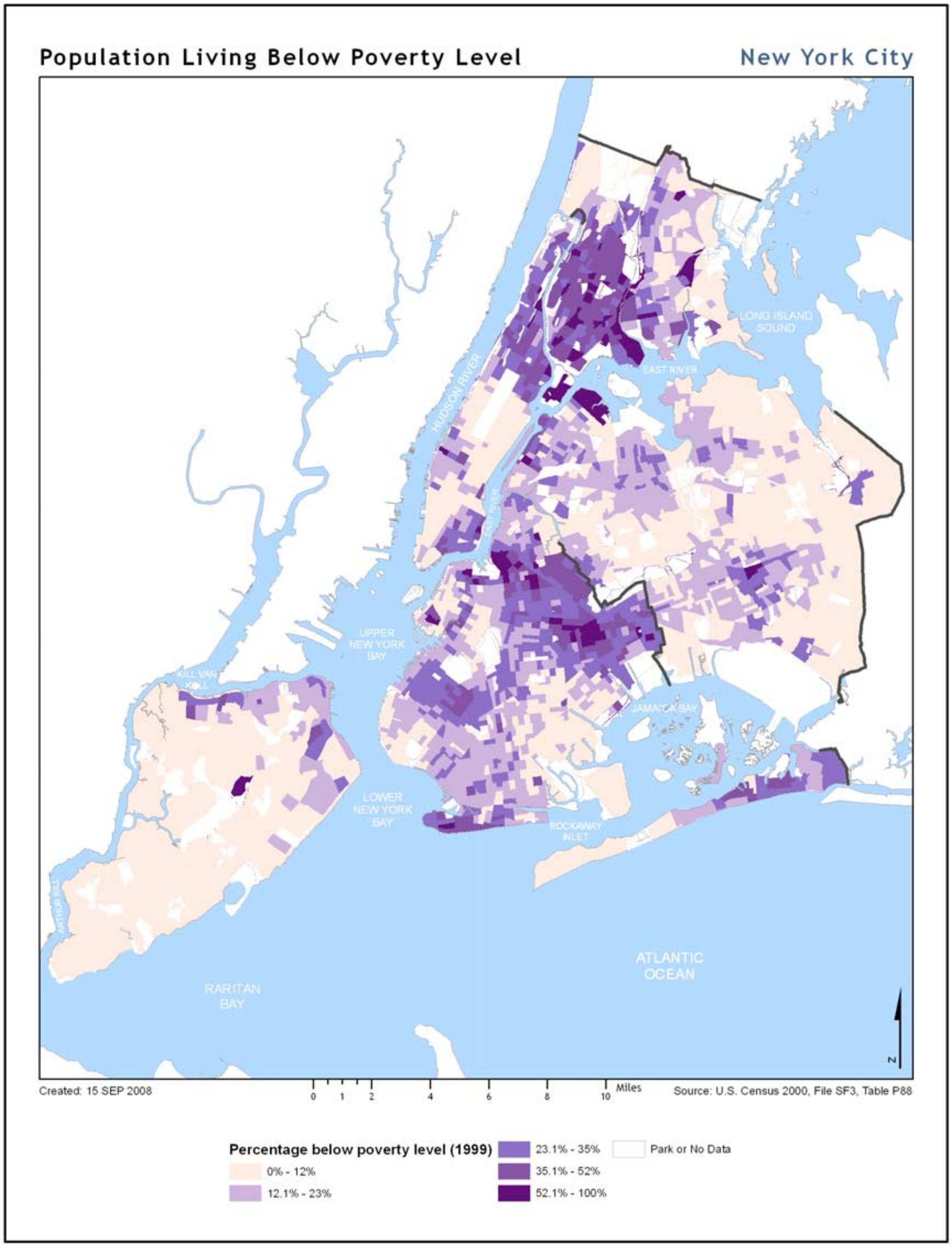


Figure 8: Population Living Below the Poverty Level in New York City in 2000

Linguistically Isolated: New York City is exceptionally diverse and has been a major point of entry for immigrants throughout its history. Today, 38% of the City's population is foreign-born and New Yorkers speak about 200 different languages and dialects. People who do not speak English very well are of special concern during a natural hazard event. An estimated 440,000 households, or 15% of the City's total households, are linguistically isolated.

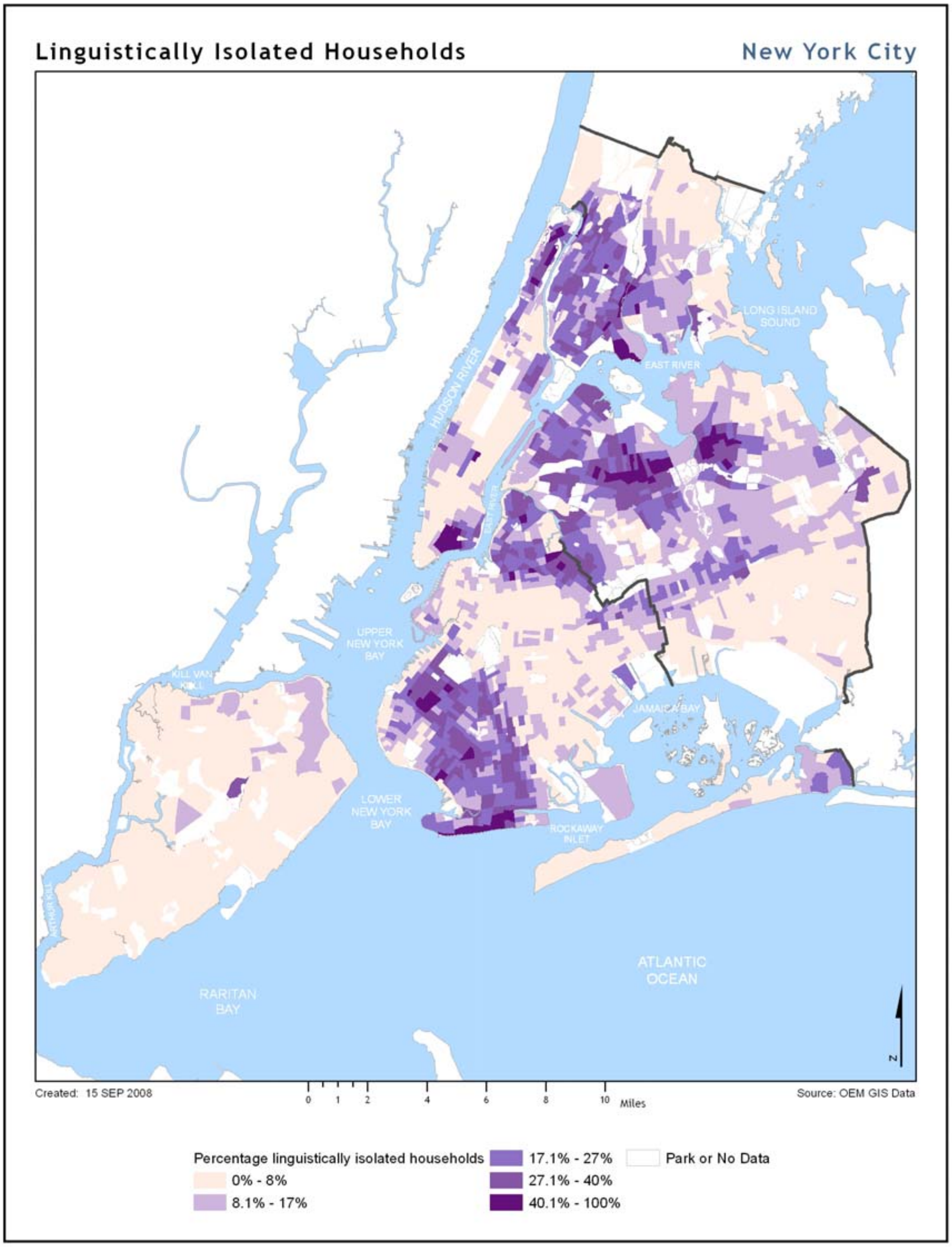


Figure 9: Population of Linguistically Isolated Households in New York City in 2000

People with Disabilities: There are four major categories of disabilities. Sensory disabilities include blindness, deafness, or a severe vision or hearing impairment. Physical disabilities are long-lasting conditions that substantially limit one or more basic physical activities, such as walking, climbing stairs, reaching, lifting, or carrying. Self-care disabilities are conditions lasting six or more months that make dressing, bathing, or getting around inside the home difficult. Go-outside-the-home disabilities are conditions lasting six or more months that make going outside the home alone to shop or visit a doctor's office difficult. The Census Bureau believes some disability numbers were overstated in 2000 because of problems with its questionnaire, the details of which are beyond the scope of this plan. For New York City, the 2005 American Community Survey found a 56% decrease in the numbers of people with a go-outside-the-home disability. Therefore, disability rates may not be as high as shown in Table 2 and Figure 10.

People with Disabilities in New York City		
Disability	**Total # of Disabilities in People Age 16 & Older**	**% of Total Population Age 16 & Older**
Sensory Disability	222,037	3.5%
Go-Outside-the-Home Disability	893,864	14.2%
Physical Disability	588,684	9.4%
Self-Care Disability	229,562	3.7%

Table 2: People with Disabilities in New York City in 2000 (Source: U.S. Census, 2000)

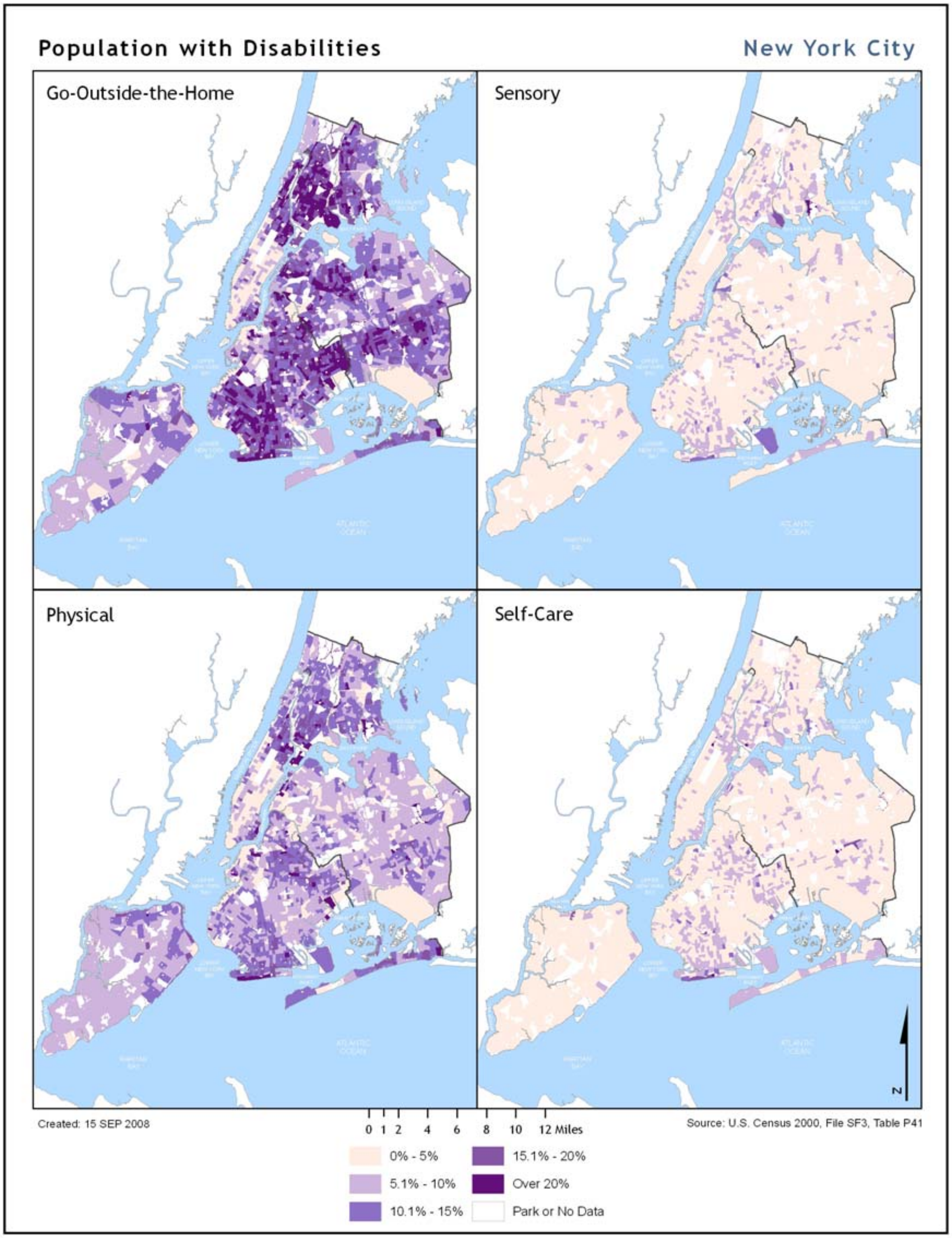


Figure 10: People with Disabilities in New York City in 2000 (Source: U.S. Census, 2000)

ii) Neighborhoods

New York City encompasses five boroughs, 59 community districts (CD), and hundreds of neighborhoods. Each neighborhood has unique physical and social characteristics. The geographical boundaries and names of neighborhoods constantly change as populations move and development occurs.

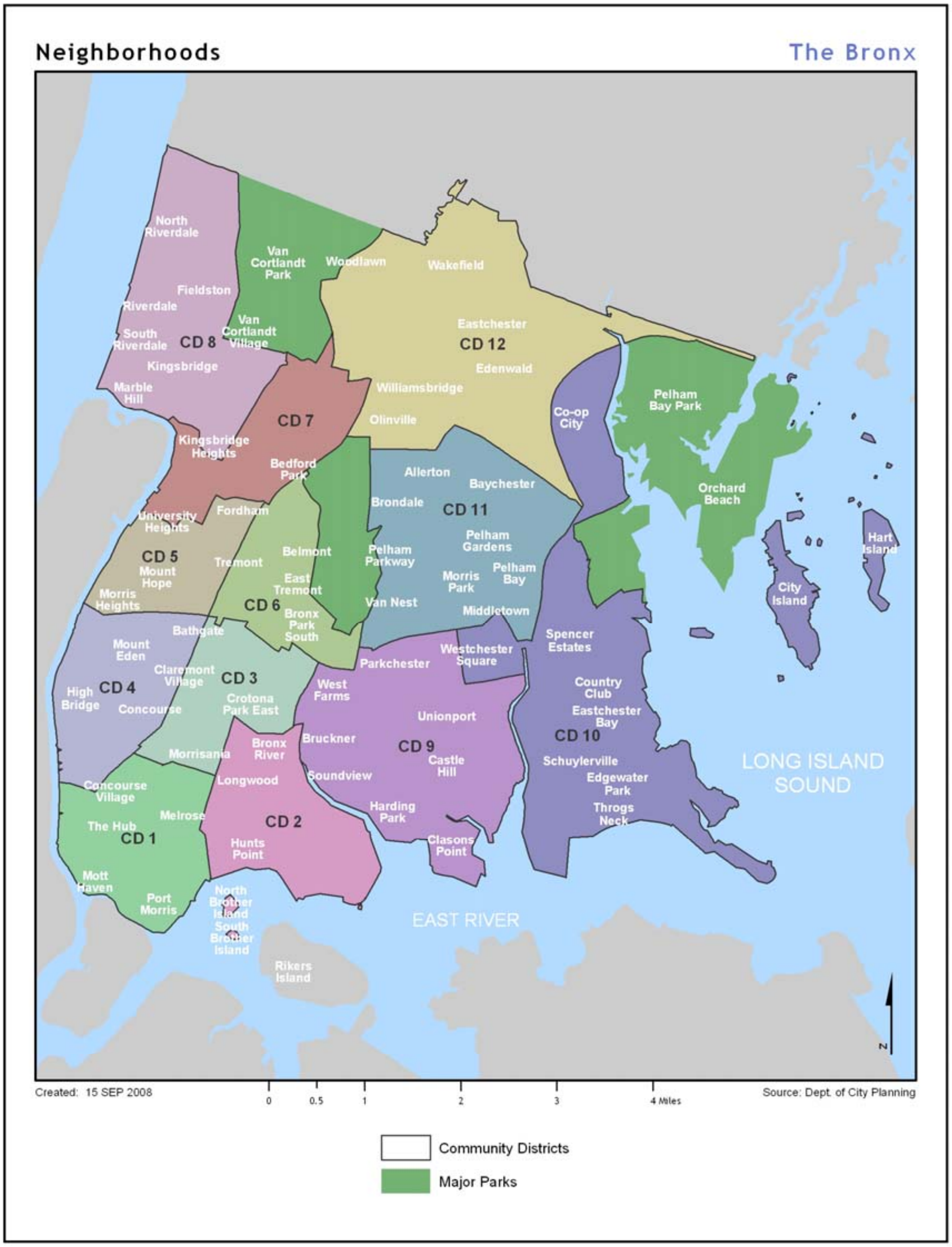


Figure 11: Bronx Neighborhoods

Figure 12: Brooklyn Neighborhoods

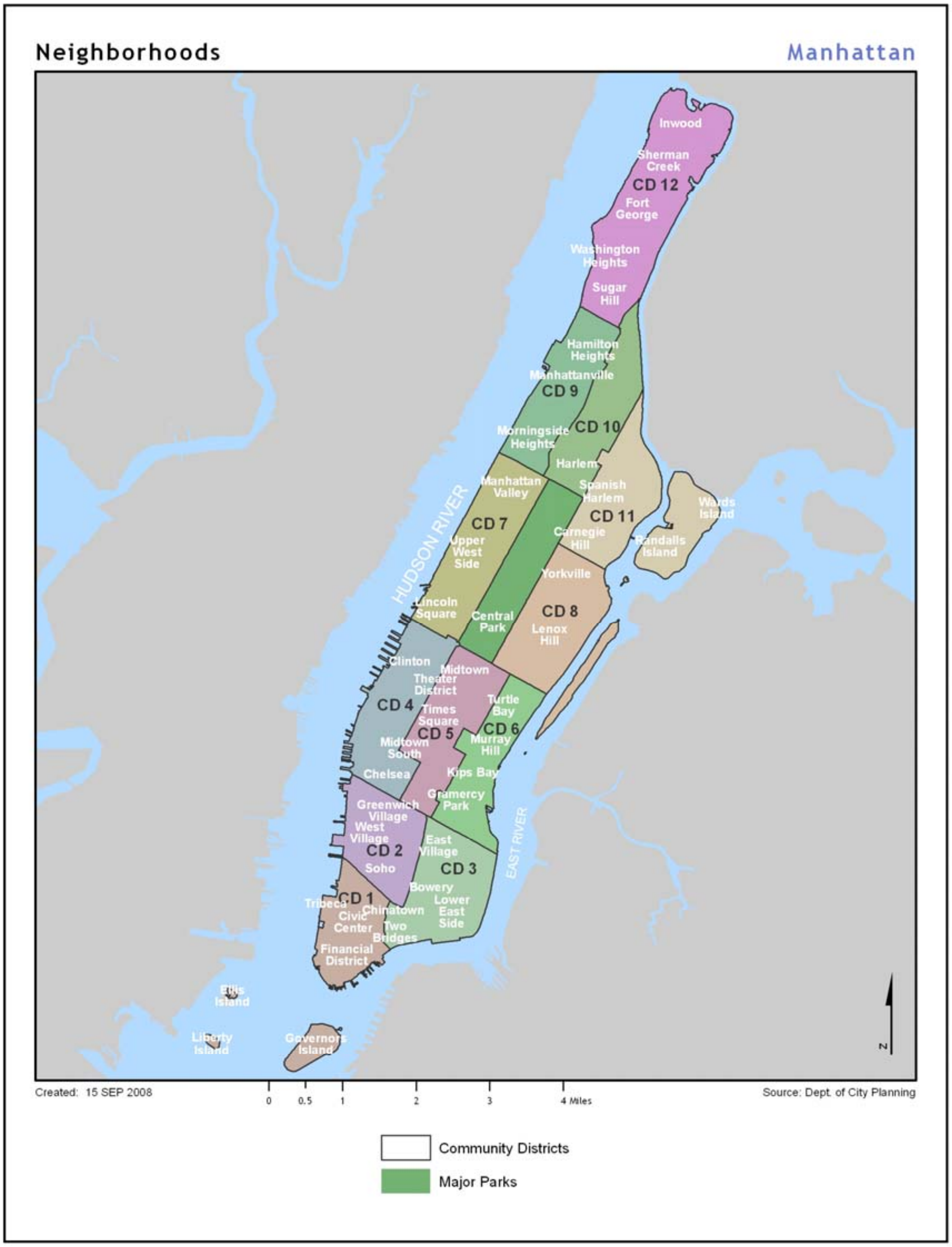


Figure 13: Manhattan Neighborhoods

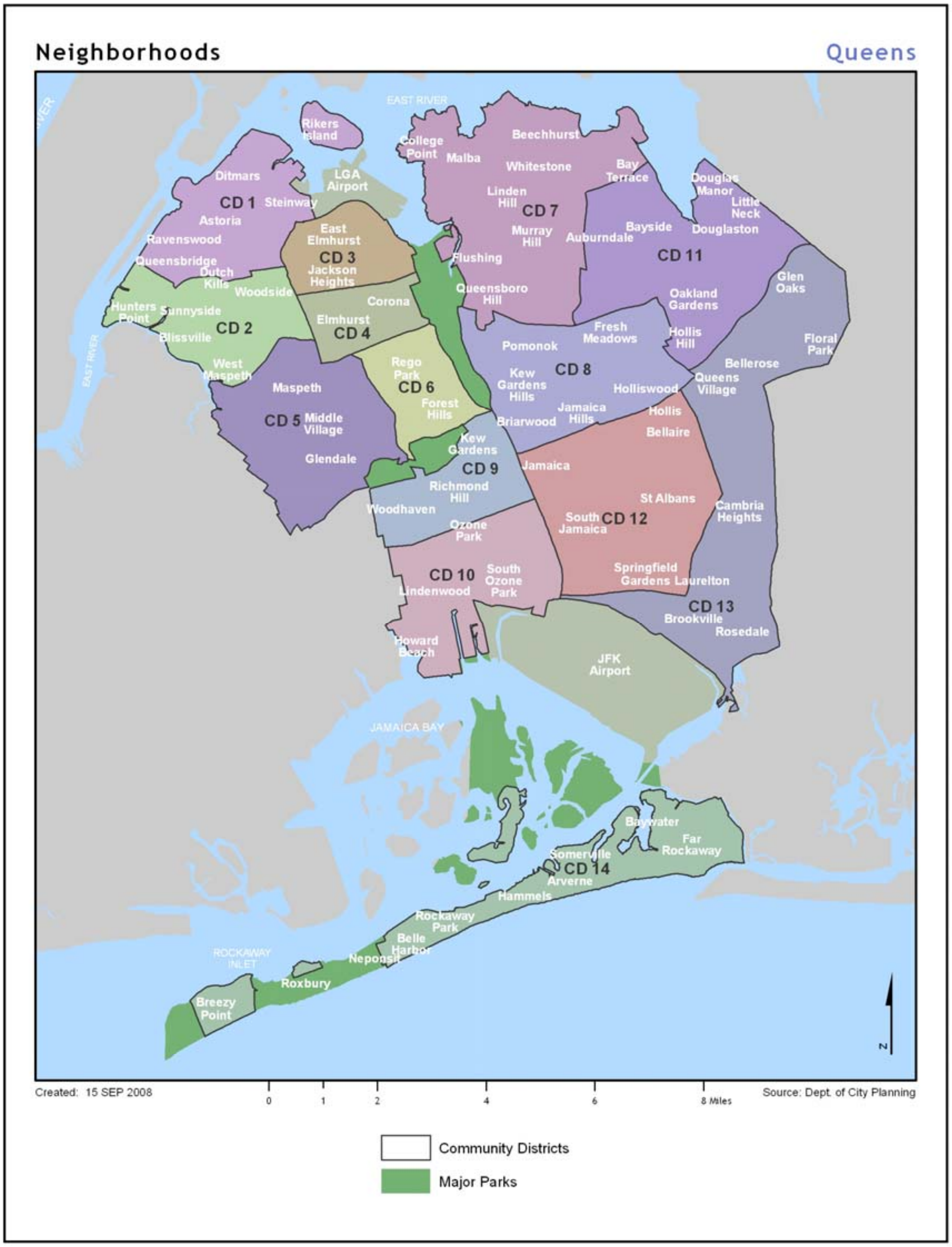


Figure 14: Queens Neighborhoods

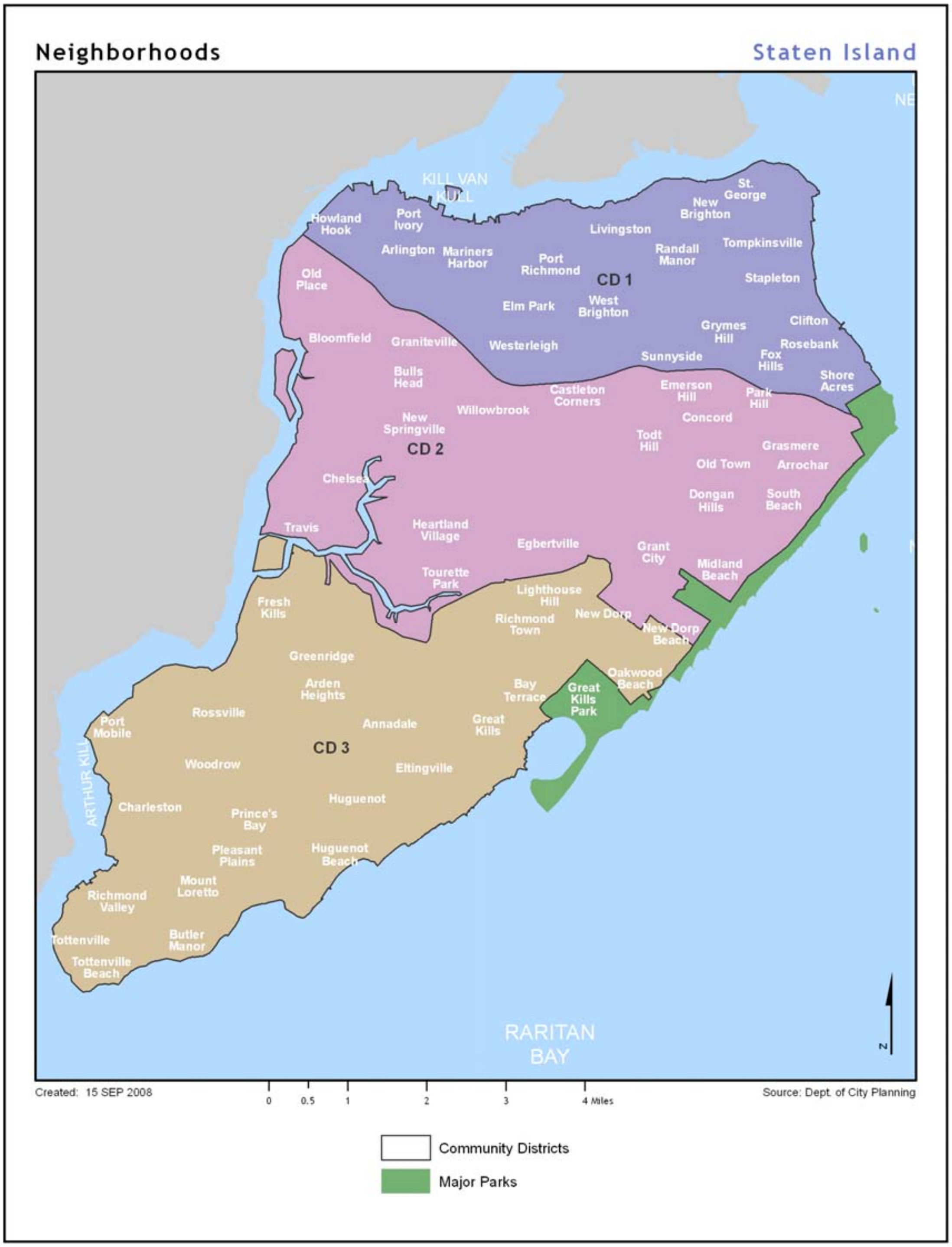


Figure 15: Staten Island Neighborhoods

iii) Economy

New York City a headquarters location for many global financial services companies. At the time the HMP was written, the financial services and insurance industries employed more than 342,000 people in New York City, totaling almost 11% of the City's private sector employment and 5.5% of financial services employment nationwide. More Fortune 500 financial services companies have their headquarters in New York City than in any other U.S. city.

Fortune 500 Companies in New York City		
Citigroup	News Corp.	CIT Group
J.P. Morgan Chase & Co.	TIAA-CREF	Assurant
American Intl. Group	Bristol-Meyers Squibb	Virgin Media
Verizon Communications	Loews	Dover
Goldman Sachs	Bear Sterns	Estee Lauder
Morgan Stanley	Bank of New York Mellon Corp	McGraw-Hill
Merrill Lynch	CBS	IAC/InterActiveCorp
Lehman Brothers Holdings	L-3 Communications	Interpublic Group
MetLife	Colgate-Palmolive	Asbury Motor Group
Pfizer	Viacom	Foot Locker
Time Warner	Consolidated Edison	Barnes and Noble
American Express	Omnicom Group	BlackRock
Hess	Marsh & McLennan	Liz Claiborne
Alcoa	Guardian Life Ins. Co.	
New York Life Insurance	Avon Products	

Table 3: Fortune 500 Companies in New York City (Source: *Fortune Magazine*, May 5, 2008)

New York City is a center of international financial services: 119 financial services firms from 31 countries worldwide have their offices in New York City. The City is also home to six major stock, commodities, and futures exchanges:

- American Stock Exchange
- International Securities Exchange
- NASDAQ Stock Market
- New York Stock Exchange
- New York Mercantile Exchange
- New York Board of Trade

Although known for its financial services industry, New York City is also home to a variety of other industries and trades.

Number of Employees by Industry in New York City	
Industry	**Number of Employees**
Finance / Insurance / Real Estate	**466,000**
Finance and Insurance	342,000
Real Estate	124,000
Services	**1,941,000**
Information	170,000
Professional and Business	594,000
Educational	155,000
Health and Social Assistance	559,000
Arts and Entertainment	65,000
Accommodation and Food	238,000
Other	159,000
Trade	**453,000**
Retail	303,000
Wholesale	150,000
Manufacturing	**93,000**
Transportation and Utility	**128,000**
Construction	**130,000**
Total Private	*3,210,000*
Government	560,000
Total (Private + Government)	***3,770,000***

Table 4: Industry Diversity in New York City (Source: EDC, June 2008)

Business Districts:
Figure 16 displays the locations of industrial, borough, and central business districts in New York City. The largest concentrations of business activity within the City are in Downtown Brooklyn, the Financial District, Midtown Manhattan, and Long Island City, as seen in red. While manufacturing and industrial activity have declined in New York City, there are still many industrial areas located across the five boroughs, as seen in blue.

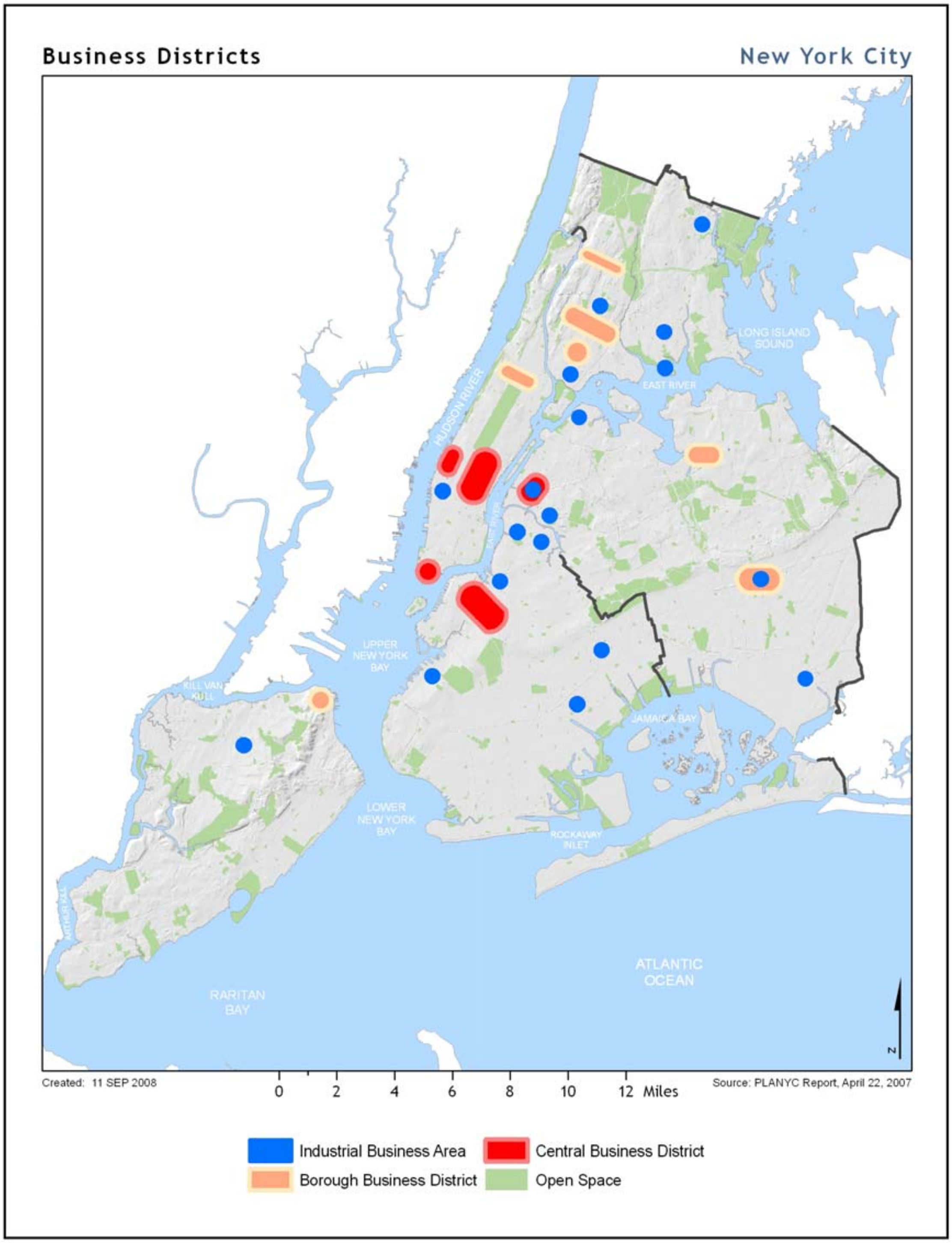


Figure 16: New York City Business Districts (Source: PlaNYC, 2007)

c) The Built Environment

No other American city can match the diversity of New York's built environment. From the skyscrapers and vast network of underground infrastructure in Manhattan, to the brownstones and houses of Brooklyn and Queens, to the expanses of parkland and beaches in the Bronx and Staten Island, New York is one of the most complex cities in the world. It has 578 miles of waterfront, more than 6,000 miles of streets and highways, over 800 miles of subway track, more than 2,000 bridges, and four major tunnels. There are over 800,000 buildings in the City, more than 2,200 schools, 66 hospitals, four major stadiums, and two major airports.

While millions of physical assets exist throughout the City, certain assets are vital to the City's security, public health and safety, economy, and way of life. In the event of a major natural disaster, the City will need these critical assets to continue operating and sustain daily activities for its residents.

i) Rail Transportation

Millions of people commute into and within New York City each day on rail public transit. The Metropolitan Transportation Authority (MTA) is the largest transit authority in the nation and operates three main rail systems: New York City Transit (NYCT), Long Island Rail Road (LIRR) and Metro-North Railroad (MNR). In addition, the Port Authority of New York and New Jersey (PANYNJ) provides commuter rail service between New Jersey and New York City on the Port Authority Trans-Hudson (PATH) train.

2007 New York City Rail Ridership		
Operator	**Daily Ridership**	**Annual Ridership**
MTA NYCT Subway	5,042,300	1,563,000,000
MTA LIRR	301,763	86,100,000
MTA MNR	276,555	80,100,000
NJ Transit-Penn Station	76,471	N/A
PATH	242,000	71,600,000
Total	***5,939,089***	***1,800,800,000***

Table 5: New York City Rail Ridership

Figure 17 displays rail lines as well as major transportation hubs in the City.

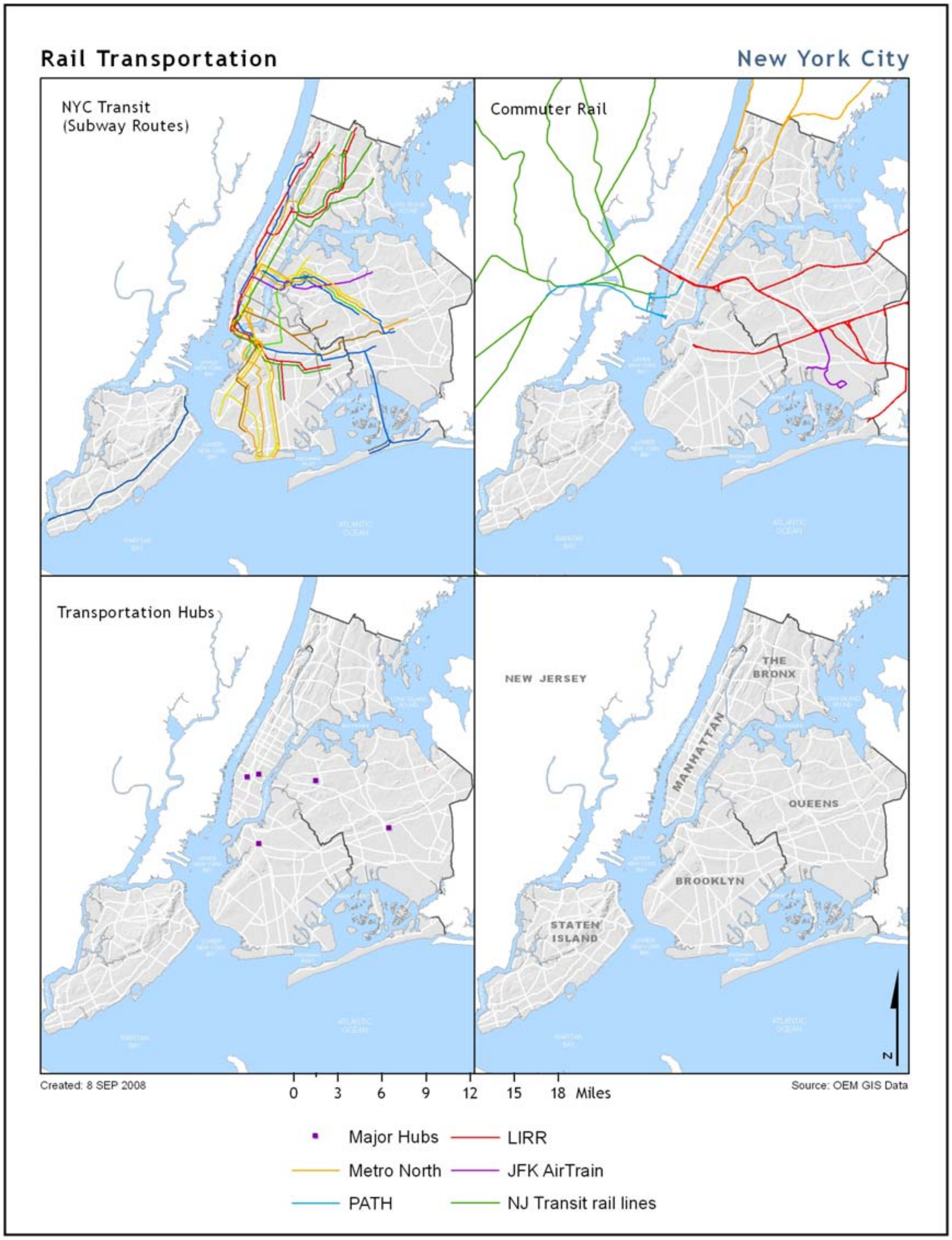


Figure 17: New York City Rail Transportation

ii) Roadway Transportation

The New York City Department of Transportation (DOT), New York State Department of Transportation (NYS DOT), MTA, and PANYNJ manage roadway travel in New York City. Bridges and tunnels are vital, providing inter-borough transit for vehicles and public transit as well as access into and out of the City. In total, New York City has 2,027 bridges. DOT manages 789 bridge structures including six tunnels. DOT also maintains approximately 5,800 miles of streets, sidewalks, and highways. The MTA operates 324 bus routes throughout the City and oversees seven bridges and two tunnels that service more than 300 million vehicles each year. PANYNJ manages most of the transportation between New York and New Jersey including four bridges, two tunnels, and two bus terminals. Figure 18 represents the major roads, highways, bridges, tunnels, and bus stations in New York City.

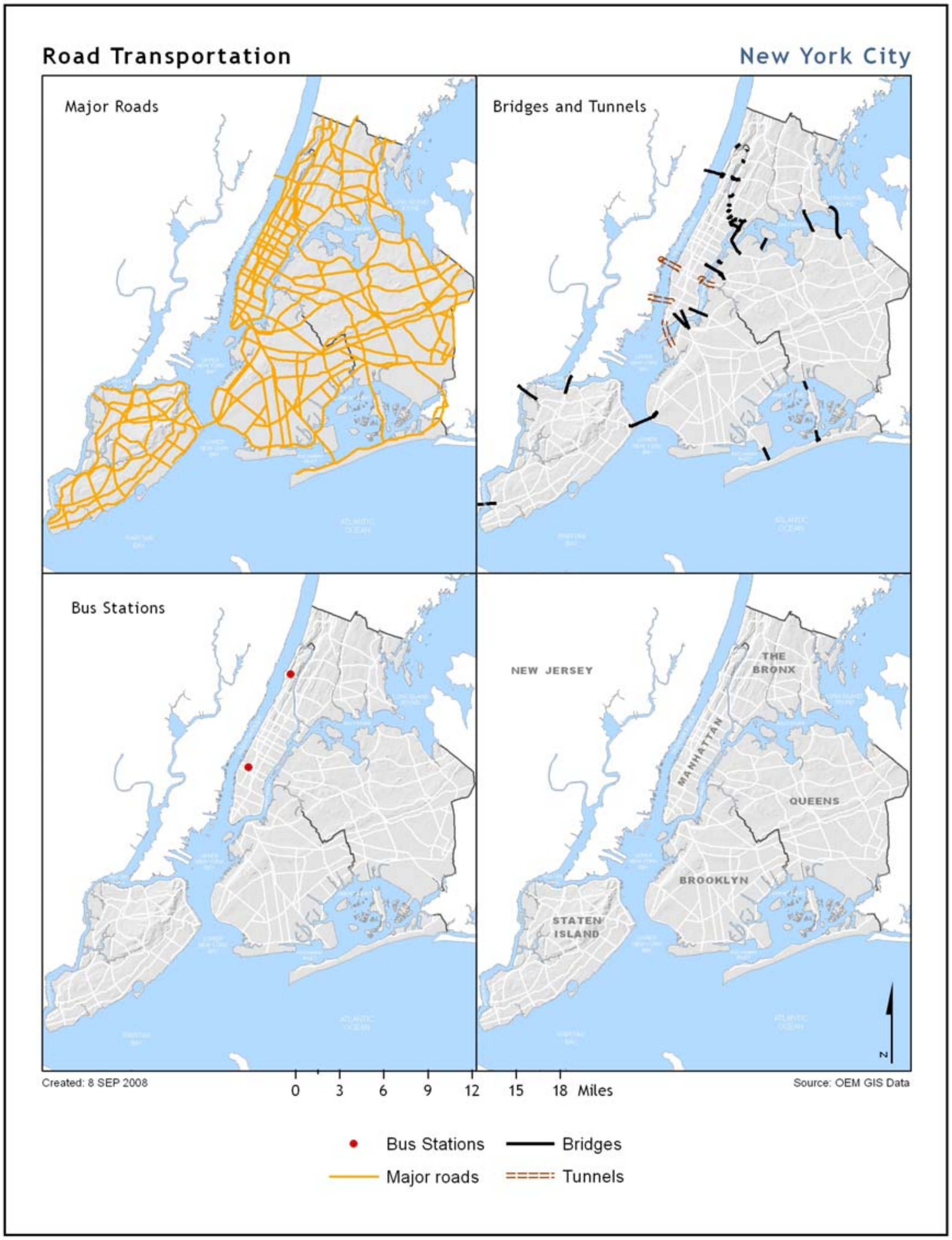


Figure 18: New York City Road Transportation

iii) Air and Water Transportation

Ferry landings, piers, and airports are located throughout the New York City region. New York City has two major airports, LaGuardia Airport and John F. Kennedy International Airport, both located in Queens. In 2006, more than 67 million passengers traveled through the two airports. Newark Liberty Airport, located in New Jersey, is also accessible to New York City. PANYNJ operates all three airports in the area.

The Port of New York and New Jersey, managed by PANYNJ and used by private operators, is the largest port complex on the East Coast. In 2006, more than 30 million tons of ocean-borne general cargo with an estimated value of $149 billion moved through the port. There are three passenger cruise terminals in the port, two in New York, and one in New Jersey. Public and private ferry service is a regular mode of transit for many commuters. The largest commuter ferry is the Staten Island Ferry, which is operated by DOT. It carries more than 19 million passengers each year on a 5.2-mile route between Staten Island and Lower Manhattan. In total, there are 22 active ferry landings providing services for the City and region.

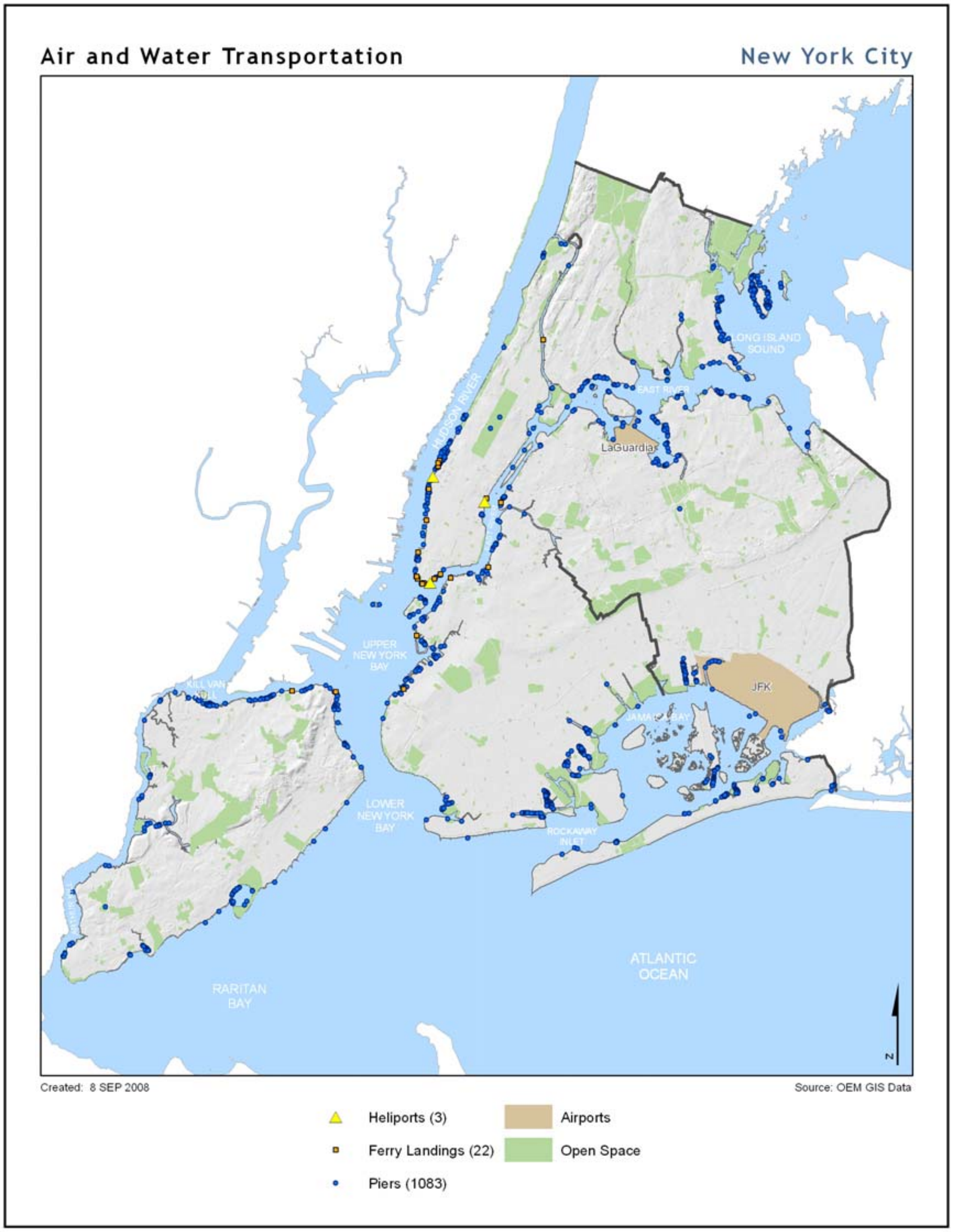


Figure 19: New York City Air and Water Transportation

iv) Emergency Services

New York City's emergency services include the Police Department (NYPD), Fire Department (FDNY), Fire Department Emergency Medical Services (FDNY-EMS), and OEM. A number of other City agencies, including the Department of Health and Mental Hygiene (DOHMH), Department of Environmental Protection (DEP), and Department of Buildings (DOB) also have emergency response functions. Emergency services are generally well dispersed across the City and correlate to population density. Figure 20 shows the locations of police and fire stations as well as OEM's headquarters.

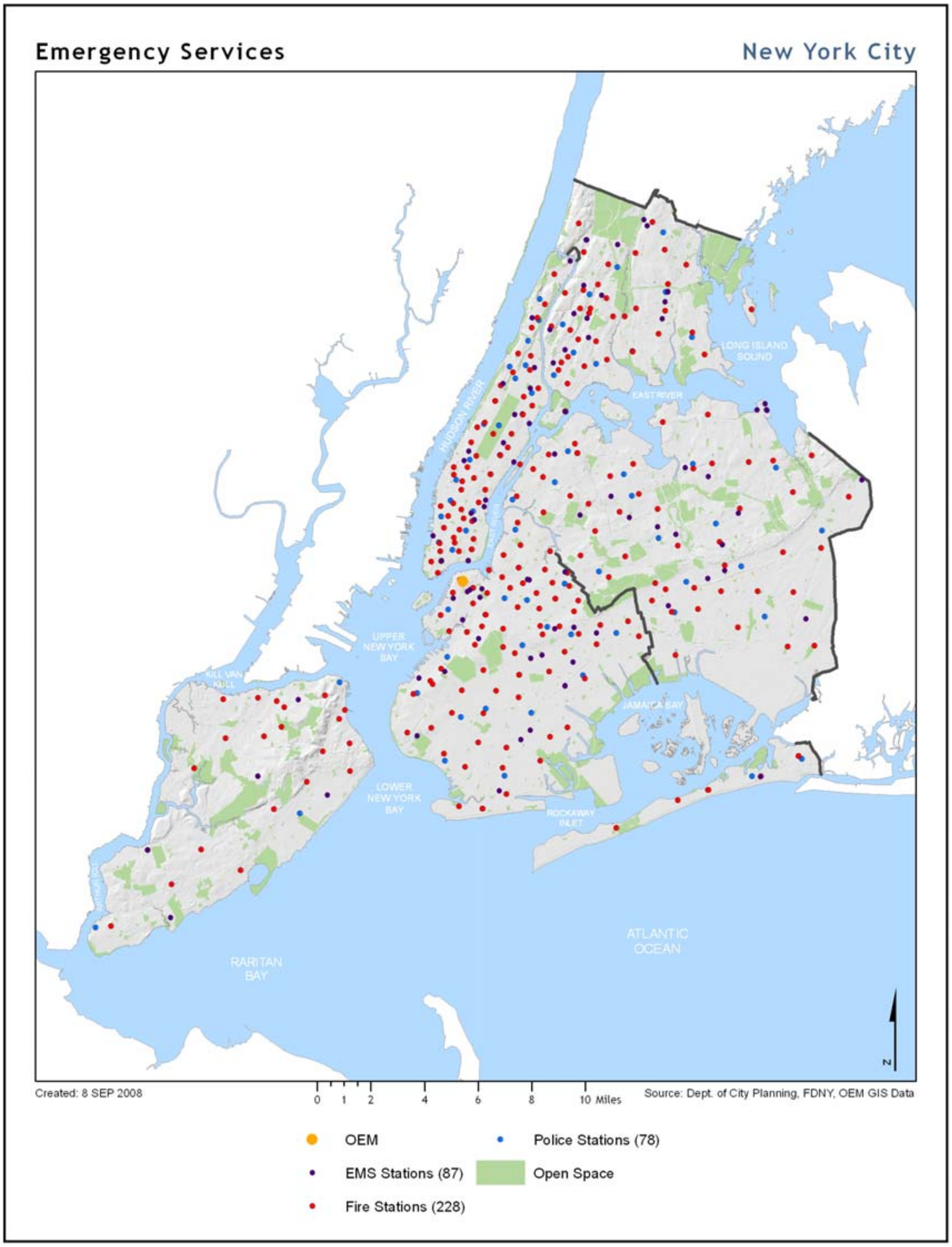


Figure 20: New York City Emergency Services

v) Hospitals and Healthcare

New York City has the greatest concentration of healthcare facilities in the world. Figure 21 displays the 66 hospitals and 182 nursing homes within the City.

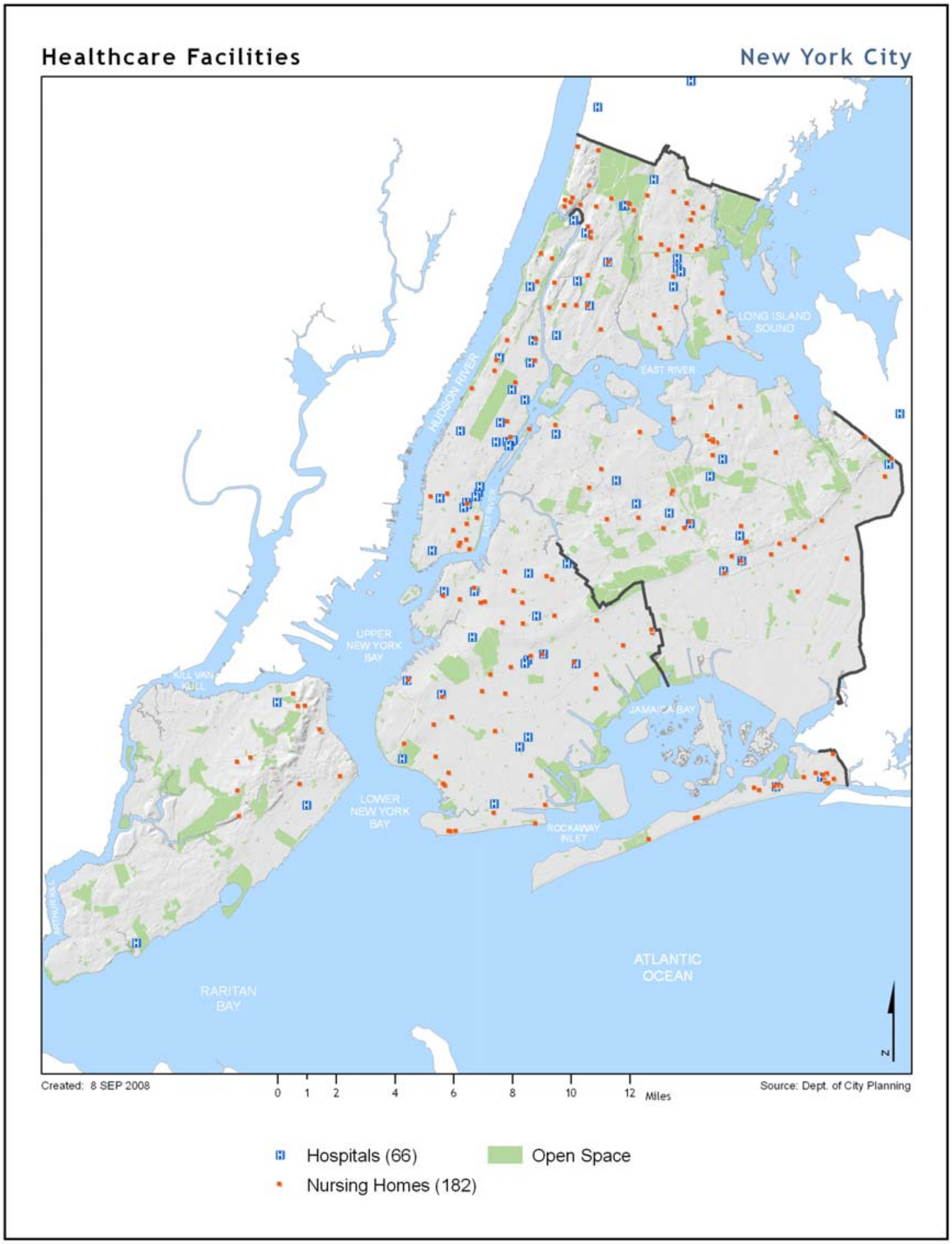


Figure 21: New York City Healthcare Facilities

vi) Education

Nearly 1.4 million school-aged children ages 5 to 17, live in New York City. There are 2,255 educational facilities located in the City. In New York City, public school facilities may also serve as emergency shelters.

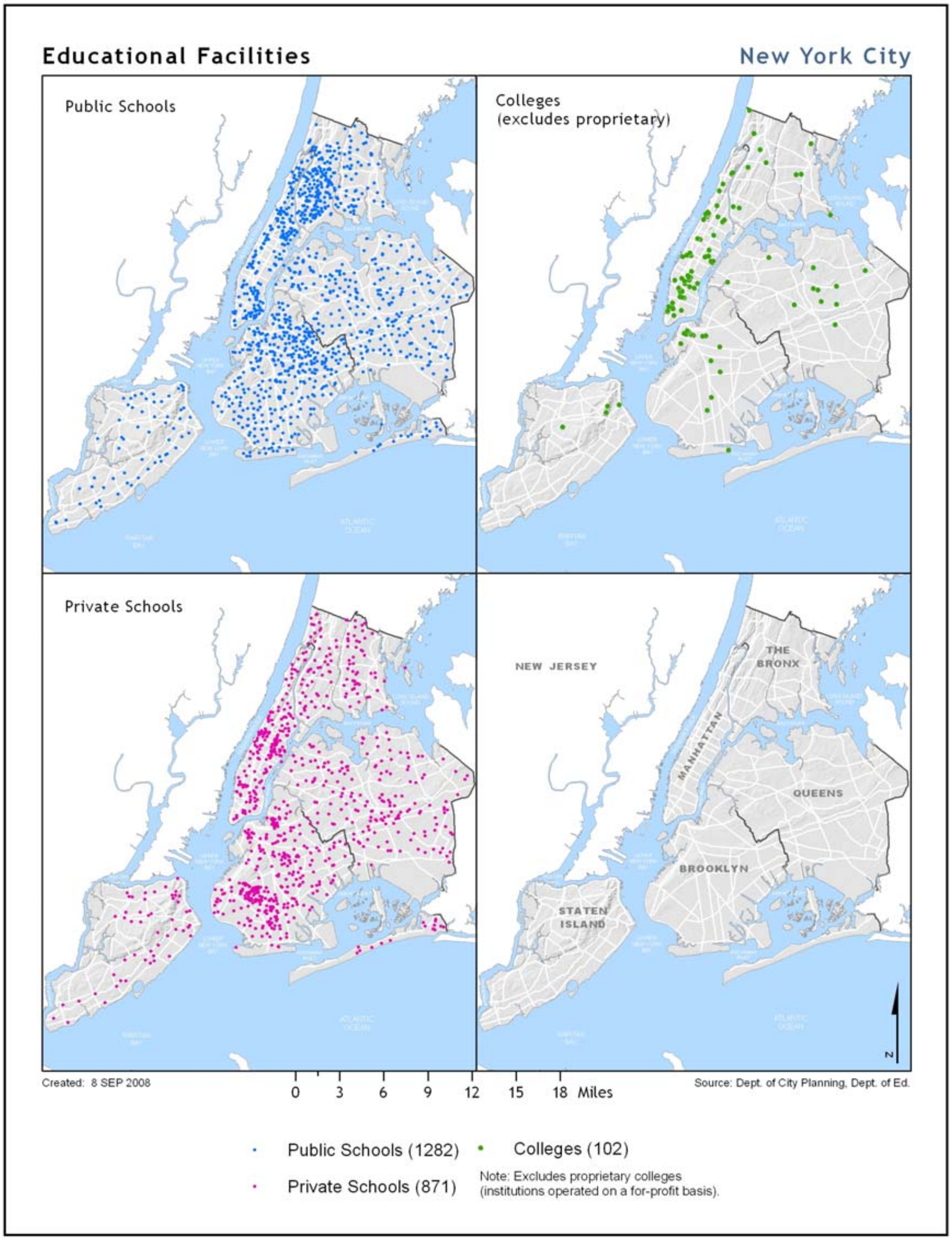


Figure 22: New York City Educational Facilities

vii) Cultural Facilities

New York City has one of the greatest concentrations of cultural institutions in the world. Table 6 and Figure 23 display some of New York City's most visited museums, zoos, stadiums, iconic buildings, theaters, and concert halls.

Cultural Facilities	
Iconic Buildings	**Stadiums**
American Stock Exchange	Arthur Ashe Stadium
Chrysler Building	Brooklyn Cyclones
Ellis Island	Madison Square Garden
Empire State Building	Shea Stadium
Grand Central Station	Staten Island Yankees
Jacob K. Javits Convention Center	Yankee Stadium
New York Stock Exchange	**Theaters/Concert Halls**
Rockefeller Center	Carnegie Hall
St. Patrick's Cathedral	Lincoln Center
Statue of Liberty	Radio City Music Hall
Times Square	**Zoos**
United Nations Headquarters	Bronx Zoo
Museums	Central Park Zoo
American Museum of Natural History	New York Aquarium
Bronx Museum of Art	Prospect Park Wildlife Center
Brooklyn Museum of Art	Queens Wildlife Center
Cloisters	Staten Island Zoo
Guggenheim Museum	
Intrepid Museum	
Metropolitan Museum of Art	
Museum of Modern Art	
Queens Museum of Art	
Staten Island Museum	
Whitney Museum of American Art	

Table 6: Cultural Facilities in New York City

Figure 23: New York City Cultural Facilities

viii) Energy

In electrical terms, New York City is a load pocket, which means transmission lines cannot carry enough energy into the City to meet its peak load. Regulations require in-city generation to supply 80% of the forecasted demand. Transmission lines connecting the City to upstate New York, Long Island, and New Jersey import the balance. New York City's transmission and distribution system is unique in that approximately 70% of the 130,000 miles is underground.

The following parties own almost all of the in-city generation:

- US Power Generating Company
- NRG Energy
- TransCanada
- New York Power Authority
- Astoria Energy

The following parties own and operate New York City's electric transmission and distribution system:

- Con Edison (majority of New York City electric customers)
- Long Island Power Authority/National Grid (Rockaway peninsula, Queens customers)

Three interstate pipeline companies and five interconnections serve New York City with natural gas. Con Edison and National Grid operate gas systems within New York City. Each company has its own distribution system that carries gas from delivery points in the City, and to interconnections between the companies. New Yorkers rely on natural gas for heat, hot water, and cooking.

Con Edison operates the largest district steam system in the United States. The system contains 105 miles of mains and service pipes, providing steam for heating, hot water, and air conditioning to approximately 1,800 customers in Manhattan.

ix) Telecommunications

New York City's telecommunications networks are vitally important components of its basic infrastructure and essential to public safety. Multiple companies provide voice, data, and video services using a variety of technologies. Although New York City's telecommunications systems are generally very reliable, a large volume of traffic is routed through a small number of collocation facilities in Lower Manhattan. This centralization may increase the network's vulnerability.

The primary fixed-line telephone provider in New York City is Verizon, although there are a number of other companies that provide this service to residential and business customers.

Major wireless carriers that serve New York City include:

- AT&T

- Sprint/Nextel
- T-Mobile
- Verizon Wireless

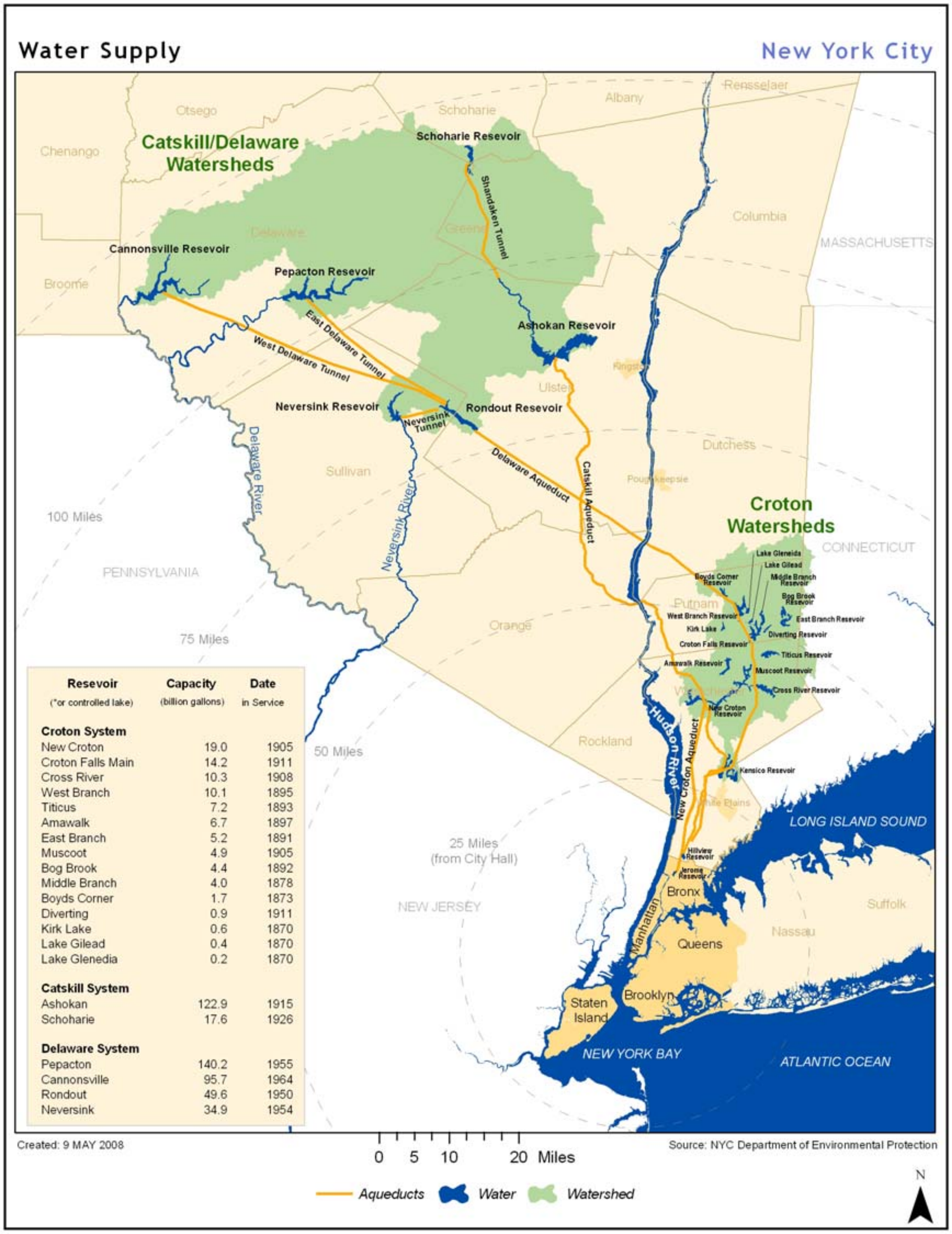
Cable and open video service providers in New York City include:
- Cablevision
- RCN Telecom Services of New York
- Staten Island Cable
- Time Warner Cable

x) Water Supply and Wastewater Treatment

DEP maintains and operates the City's surface water supply system. It provides approximately 1.1 billion gallons of drinking water daily to more than eight million residents of New York City; approximately one million people living in Westchester, Putnam, Ulster, and Orange counties; as well as the millions of tourists and commuters who visit the City throughout the year. In addition to the surface water supplies, fewer than 100,000 people in southeastern Queens may receive groundwater or a blend of groundwater and surface water. In all, the City system supplies nearly half the population of New York State with water.

Three upstate reservoir systems, including 19 reservoirs and three controlled lakes with a total storage capacity of approximately 580 billion gallons, impound water for the system. The City designed and built the three water collection systems with various interconnections to increase flexibility by permitting exchange of water from one to another.

New York City's water distribution system is almost entirely dependent on gravity alone. Water travels from the reservoirs with sufficient pressure to reach up to the sixth floor of most buildings. High-rise buildings rely on rooftop water towers or pump systems to provide water to upper floors.



Resevoir (*or controlled lake)	Capacity (billion gallons)	Date in Service
Croton System		
New Croton	19.0	1905
Croton Falls Main	14.2	1911
Cross River	10.3	1908
West Branch	10.1	1895
Titicus	7.2	1893
Amawalk	6.7	1897
East Branch	5.2	1891
Muscoot	4.9	1905
Bog Brook	4.4	1892
Middle Branch	4.0	1878
Boyds Corner	1.7	1873
Diverting	0.9	1911
Kirk Lake	0.6	1870
Lake Gilead	0.4	1870
Lake Glenedia	0.2	1870
Catskill System		
Ashokan	122.9	1915
Schoharie	17.6	1926
Delaware System		
Pepacton	140.2	1955
Cannonsville	95.7	1964
Rondout	49.6	1950
Neversink	34.9	1954

Figure 24: New York City's Water Supply System (Source: DEP, 2008)

Every day, wastewater goes down toilets and drains in homes, schools, businesses, and factories and then flows into New York City's sewer system. Runoff from rain and melting snow, street and sidewalk washing, and other outdoor activities flows into catch basins in the streets and from there into the sewers. In some New York City neighborhoods, separate storm sewers carry runoff from the streets directly to local streams, rivers, and bays. In most areas of the City, a combined sewer system collects both sanitary and industrial wastewater, rainwater, and street runoff and conveys all of it to the City's treatment plants. Sometimes, during heavy rains or snow, combined sewers fill to capacity and are unable to carry the combined sanitary and storm sewage to the plants. When this occurs, the mix of excess storm water and untreated sewage flows directly into the City's waterways. This is called combined sewer overflow. Approximately 70% of the City sewers are combined.

New York City’s 14 wastewater treatment plants remove most pollutants from wastewater before releasing it to local waterways. At the plants, physical and biological processes closely duplicate how wetlands, rivers, streams, and lakes naturally purify water. Treatment at these plants is quick, taking only about seven hours to remove most of the pollutants from the wastewater. In the natural environment, this process could take many weeks and nature alone cannot handle the volume of wastewater New York City produces.

Figure 25: New York City Wastewater Treatment Facilities

xi) New York City's Building Stock

In 2006, there were 801,815 buildings in New York City. Queens had the most with 38% of the City's buildings, while Manhattan had the least with only 5.2%. This data is not representative of the size or height of these buildings. Some boroughs have more building space and fewer building units.

New York City Building Summary Data						
Borough	**Bronx**	**Brooklyn**	**Manhattan**	**Queens**	**Staten Island**	**Total**
Number of Buildings	81,603	262,702	42,073	307,970	107,467	***801,815***
Construction Type (known)						
Masonry	54,434	178,920	28,762	115,062	8,870	386,048
Steel	377	2,367	10,808	1,992	443	15,987
Manufactured Housing	107	55	66	533	922	1,683
Concrete	1,334	676	1,904	65	271	4,250
Wood	24,681	79,239	206	189,050	96,508	389,684
Total	***80,933***	***261,257***	***41,746***	***306,702***	***107,014***	***797,652***
Occupation Type (known)						
Residential	70,780	235,963	30,375	284,904	101,786	723,808
Commercial	8,595	20,041	8,796	18,080	4,691	60,203
Industrial	984	3,828	1,241	3,011	521	9,585
Religion	699	1,735	822	1,178	193	4,627
Government	117	218	224	187	96	842
Education	425	888	615	602	180	2,710
Total	***81,600***	***262,673***	***42,073***	***307,962***	***107,467***	***801,775***
Value ($)						
Total Building Value	110,218,680,000	212,351,035,000	283,586,028,000	178,547,138,000	41,609,258,000	826,312,139,000
Total Building Content Value	70,120,000,000	141,230,000,000	209,920,000,000	115,910,000,000	25,830,000,000	563,010,000,000
Total	***180,338,680,000***	***353,581,035,000***	***493,506,028,000***	***294,457,138,000***	***67,439,258,000***	***1,389,322,139,000***

Table 7: Building Summary Information for New York City (Source: DCP MapPLUTO, 2007 and DOF Mass Appraisal System, 2004)

(1) Building Age

A building's age may increase its susceptibility to certain natural hazards. Some buildings in New York City date back to the 18th century.

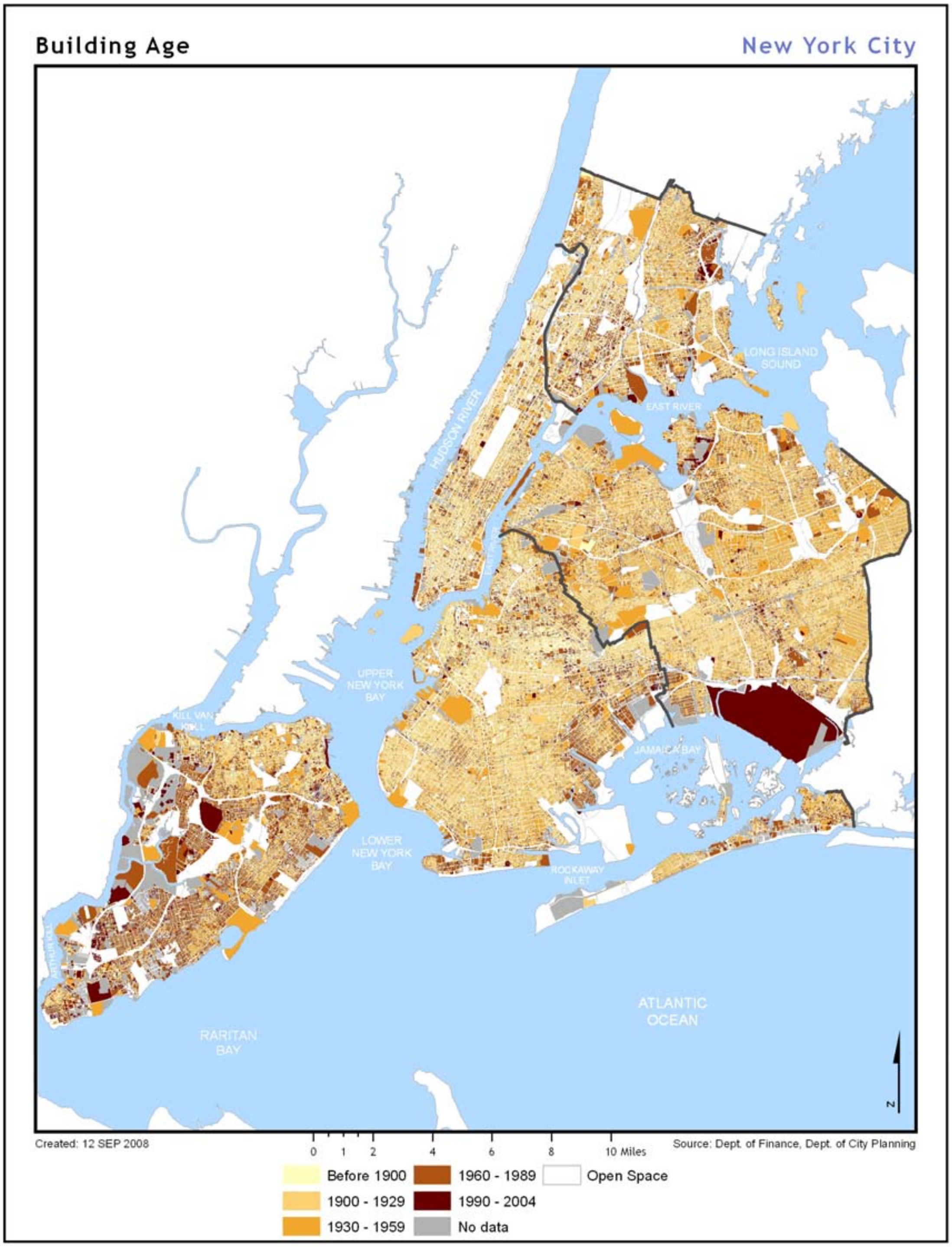


Figure 26: Age of Buildings in New York City
(Source: DCP MapPLUTO, 2007 and DOF Mass Appraisal System, 2004)

(2) Building Value

Hazards U.S. Multi-Hazard (HAZUS-MH) estimates New York City's total building value at $826 billion and the content value within these buildings at $563 billion. Manhattan accounts for the largest proportion with 35% of the City's building value and 34% of its contents value. However, the physical value of a building and its contents are not representative of the overall value. The businesses and industries housed in many of these buildings, especially in Manhattan's financial district and midtown, are sometimes worth billions more.

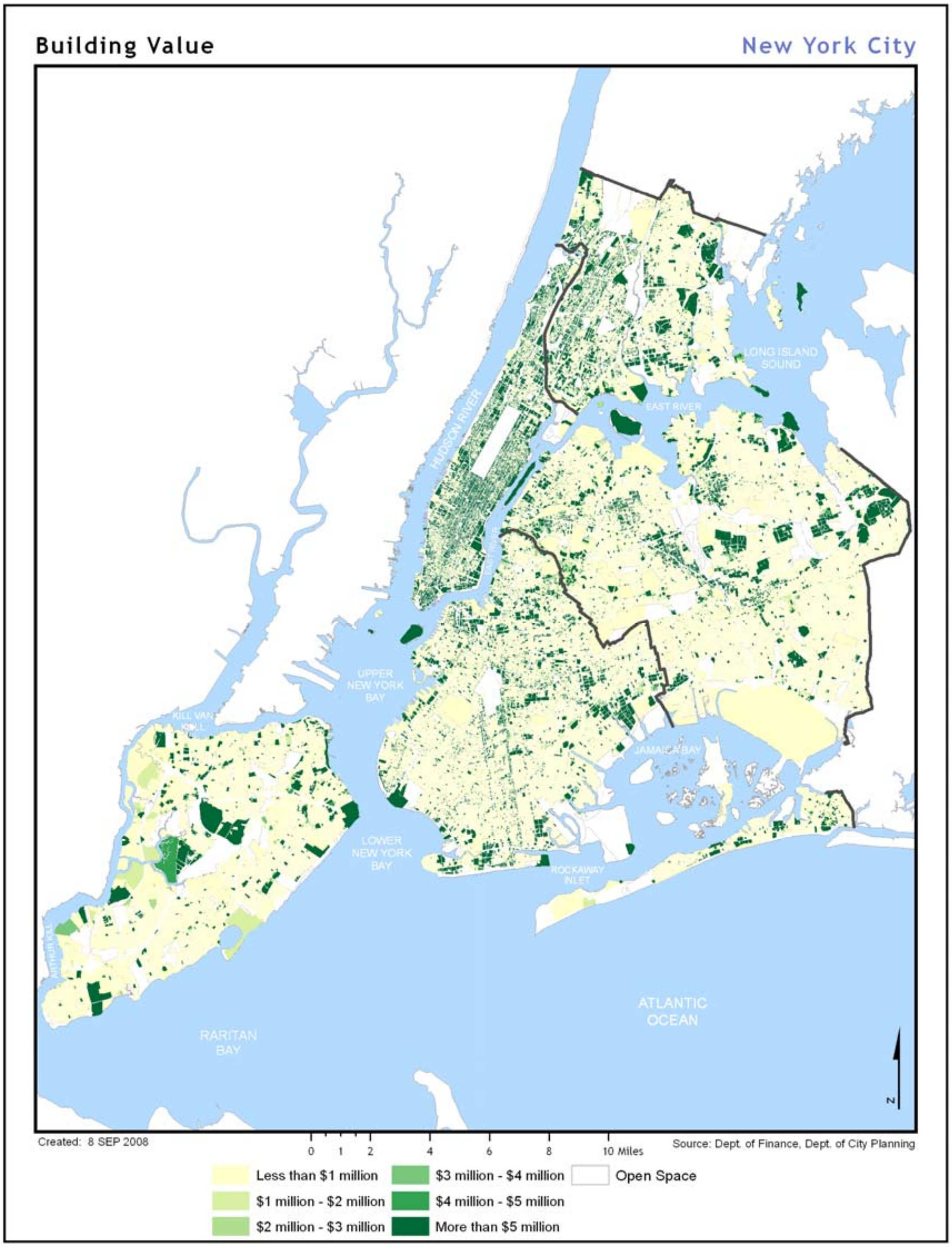


Figure 27: Value of Buildings in New York City
(Source: DCP MapPLUTO, 2007 and DOF Mass Appraisal System, 2004)

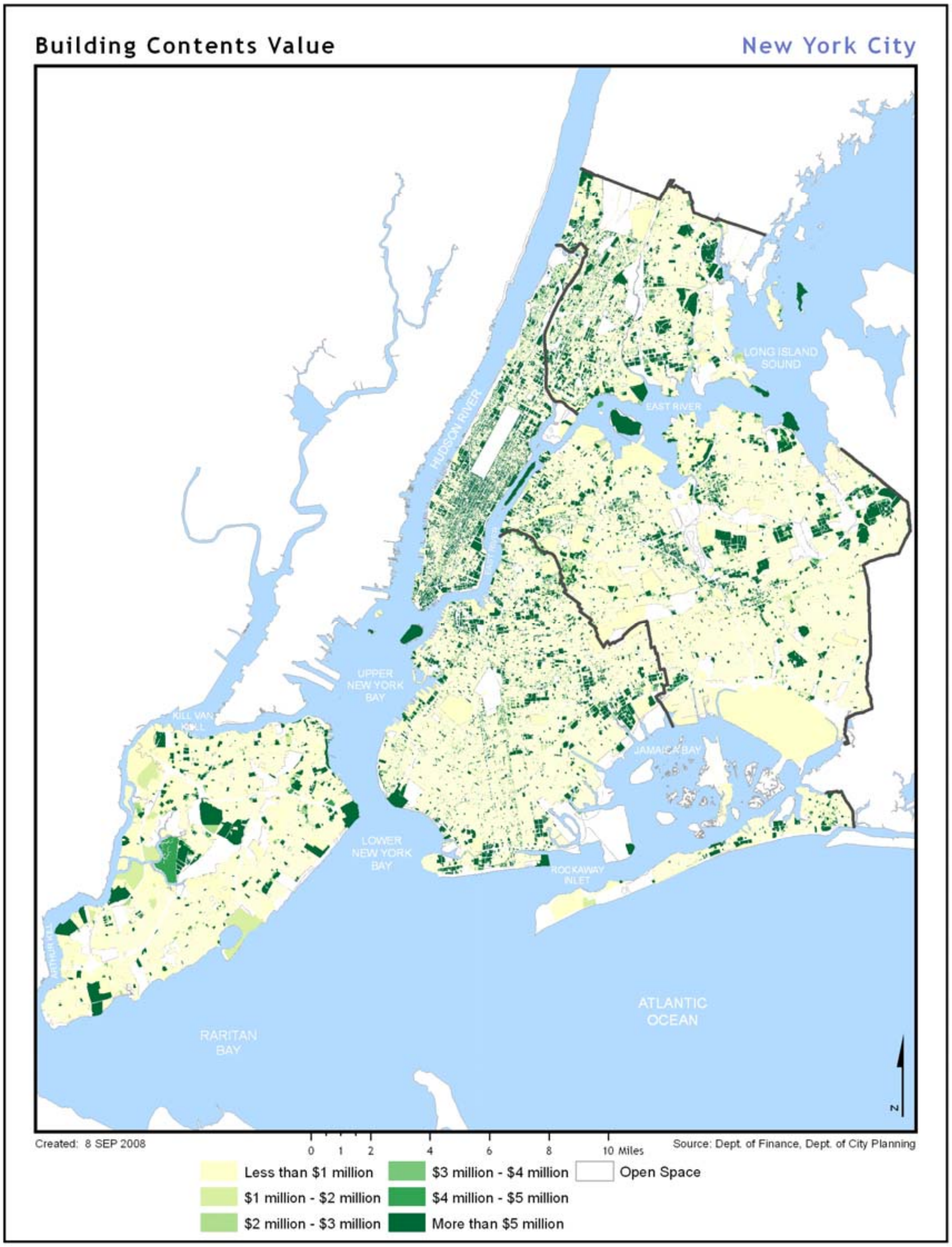


Figure 28: Value of Building Contents in New York City
(Source: DCP MapPLUTO, 2007 and DOF Mass Appraisal System, 2004)

(3) Construction Type

Construction type is extremely important in the context of structural vulnerability. Unreinforced masonry buildings are especially vulnerable to shaking ground, high winds, and surface degradation. Wood buildings, which account for more than half of the City's buildings, are at risk to hazards such high winds, floods, and coastal storms. The majority of buildings within New York City are either masonry or wood. Of the 797,652 buildings with a known construction type, 48% are masonry and 49% are wood. Manhattan is the only borough that commonly sees a third construction type; steel, which comprises 26% of the total buildings in the borough. Manhattan has very few wood structures, only 0.5% of the total 41,746 buildings whereas 69% of the structures are masonry. Staten Island is the inverse with 90% of the structures made from wood, a common construction type for single-family residential buildings.

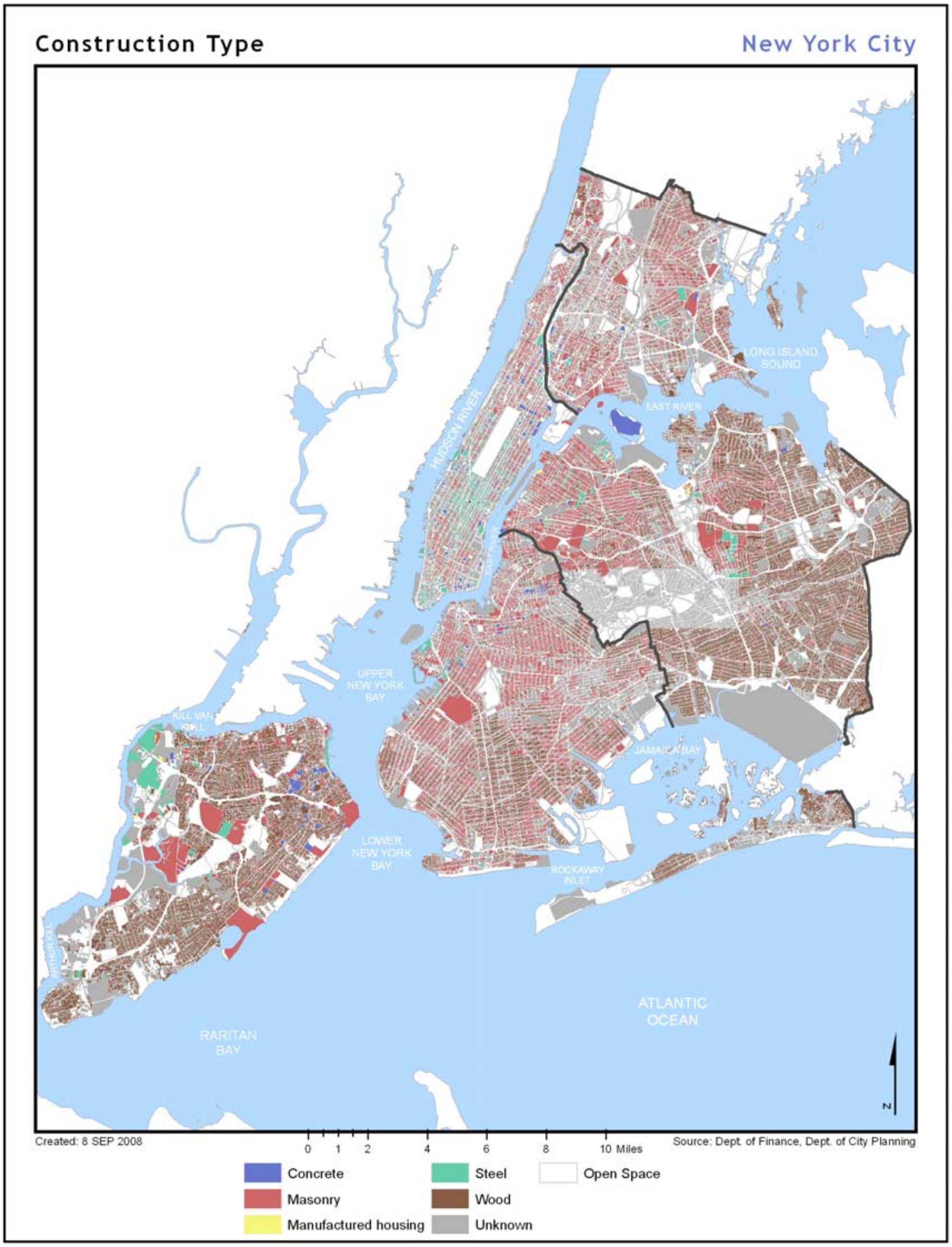


Figure 29: Building Construction Type in New York City
(Source: DCP MapPLUTO, 2007 and DOF Mass Appraisal System, 2004)

xii) Structural Vulnerability to Natural Hazards

New York City's physical assets are vulnerable to a variety of hazards. For example, buildings and infrastructure located within the floodplain or storm surge zone are susceptible to flooding and/or coastal storms. Buildings along the coastline are also vulnerable to the results of long-term coastal erosion. Unreinforced masonry buildings are at a higher risk to earthquake damage than buildings made from sturdier materials, or buildings that are reinforced. Extreme temperatures can cause pavement to buckle and damage overhead electric and telephone lines. Windstorms can cause trees and power lines to fall and debris to fly in the air. High-wind events, such as coastal storms or tornadoes, can cause less robustly built structures to suffer roof failures and building collapses. Winter weather can cause surface degradation to buildings and roadways, and disrupt movement on the roadway. Overall, a structure's geographic and physical attributes generally affect its susceptibility to certain hazards.

xiii) New York City Construction Code

Enacted in 1968, the New York City Building Code was one of the country's most stringent building codes. However, decades of piecemeal modifications produced a long, cumbersome code that was difficult to interpret. In 2002, Mayor Bloomberg assembled an advisory committee to study the possibility of adopting a Model Code. The committee, led by DOB, concluded adopting the International Building Code (IBC) format would ensure an up-to-date and comprehensive building code to meet the present and future challenges of New York City's dense urban environment. Using the ICB, the Committee developed a new code for the City. The revised New York City Construction Code (Construction Code) became effective on July 1, 2008 and applies to all new construction within the City. Many of the new code provisions address natural hazard mitigation, including new standards to protect buildings from drought, earthquakes, extreme temperatures, flooding, wind, and winter weather.

(1) Drought

The Construction Code addresses water conservation by providing rebates to encourage the use of products and engineering that reduce consumption, such as waterless urinals and rain/wastewater recycling for non-potable uses in the construction of new and sustainable buildings.

(2) Earthquakes

The Construction Code updates the seismic engineering requirements to current national standards. In addition, the Construction Code takes soil and foundation underpinning into account during construction for the first time. It requires seismic detailing and inspections to ensure compliance with new construction standards.

(3) Extreme Temperatures

The Construction Code adopts sustainable elements in the design of new and old buildings. It allows the construction of green roofs as a right, whereas the previous code required special permission before a green roof could be constructed. The Construction Code also requires heat-reflective coverings on roofs or setbacks with a slope less than

25%. These two provisions will help New York City reduce the urban heat island effect and mitigate extreme heat.

(4) Flooding

The Construction Code requires the installation of overflow drains to protect the roof should the primary drains fail. The new requirement for secondary drainage systems also requires the structural members of roofs must support the load of the accumulated rainwater. For construction in flood zones, the Construction Code clarifies current flood regulations and adopts the latest national standards, meeting or exceeding state and federal flood regulations. In addition, the Construction Code requires critical facilities located in flood zones, such as fire stations and hospitals, be elevated to protect the structures.

(5) Wind

The Construction Code updates wind load requirements and brings them in line with current wind-design practices used throughout the United States. It also establishes wind exposure categories that take into account the influence of surrounding ground surface irregularities and building heights in wind design.

(6) Winter Storms

The Construction Code updates snow-load requirements to incorporate thermal factors for heated and unheated buildings, as well as provisions for snowdrifts caused by parapets and adjacent buildings.

4) Population and Development Trends

Virtually every part of New York City is growing. In the coming decades, population, business, and industry are all projected to increase. To accommodate this growth, construction is at record levels. From the reconstruction of the World Trade Center site in Lower Manhattan, to a comprehensive re-zoning of Coney Island, to growth management in Staten Island, it is nearly impossible to capture all the changes taking place in the City every day. As the City faces unprecedented levels of growth and development, the effects on vulnerability must also be considered.

a) Population Trends

New York City's population is projected to grow from more than eight million in 2000 to over 9.1 million in 2030, an increase of 1.1 million or 14%. Between 2000 and 2010, New York City's population is projected to increase by 4.9%. Growth is expected to slow to 3.5% in the following decade, with the population reaching about 8,693,000 by 2020. Between 2020 and 2030, however, the growth rate will climb back up to 5.1%, and by 2030, the population should reach nearly 9,132,000. In all boroughs, except for Queens, the highest level of growth will be in the 2000–2010 period. Although the City's overall projected 2030 population will be a new high, only two boroughs, Queens and Staten Island, will reach a new population peak in 2030. Manhattan's 2030 projected population will be below its 1910 peak population, while the 2030 populations in the Bronx and Brooklyn will be slightly lower than their population highs attained in 1970 and 1950, respectively.

New York City Population 1910-2030						
Year	Bronx	Brooklyn	Manhattan	Queens	Staten Island	Total
1910	430,980	1,634,351	2,331,542	284,041	85,969	***4,766,883***
1920	732,016	2,018,356	2,284,103	469,042	116,531	***5,620,048***
1930	1,265,258	2,560,401	1,867,312	1,079,129	158,346	***6,930,446***
1940	1,394,711	2,698,285	1,889,924	1,297,634	174,441	***7,454,995***
1950	1,451,277	2,738,175	1,960,101	1,550,849	191,555	***7,891,957***
1960	1,424,815	2,627,319	1,698,281	1,809,578	221,991	***7,781,984***
1970	1,471,701	2,602,012	1,539,233	1,986,473	295,443	***7,894,862***
1980	1,168,972	2,230,936	1,428,285	1,891,325	352,121	***7,071,639***
1990	1,203,789	2,300,664	1,487,536	1,951,598	378,977	***7,322,564***
2000	1,332,650	2,465,326	1,537,195	2,229,379	443,728	***8,008,278***
*2006	1,371,353	2,523,047	1,612,630	2,264,661	478,876	***8,250,567***
**2010	1,401,194	2,566,836	1,662,701	2,279,674	491,808	***8,402,213***
**2020	1,420,277	2,628,211	1,729,530	2,396,949	517,597	***8,692,564***
**2030	1,460,000	2,720,000	1,830,000	2,570,000	551,906	***9,131,906***

Table 8: New York City Population 1910-2030 (Source: U.S. Census, 2000; *2006 American Community Survey; **DCP population projections)

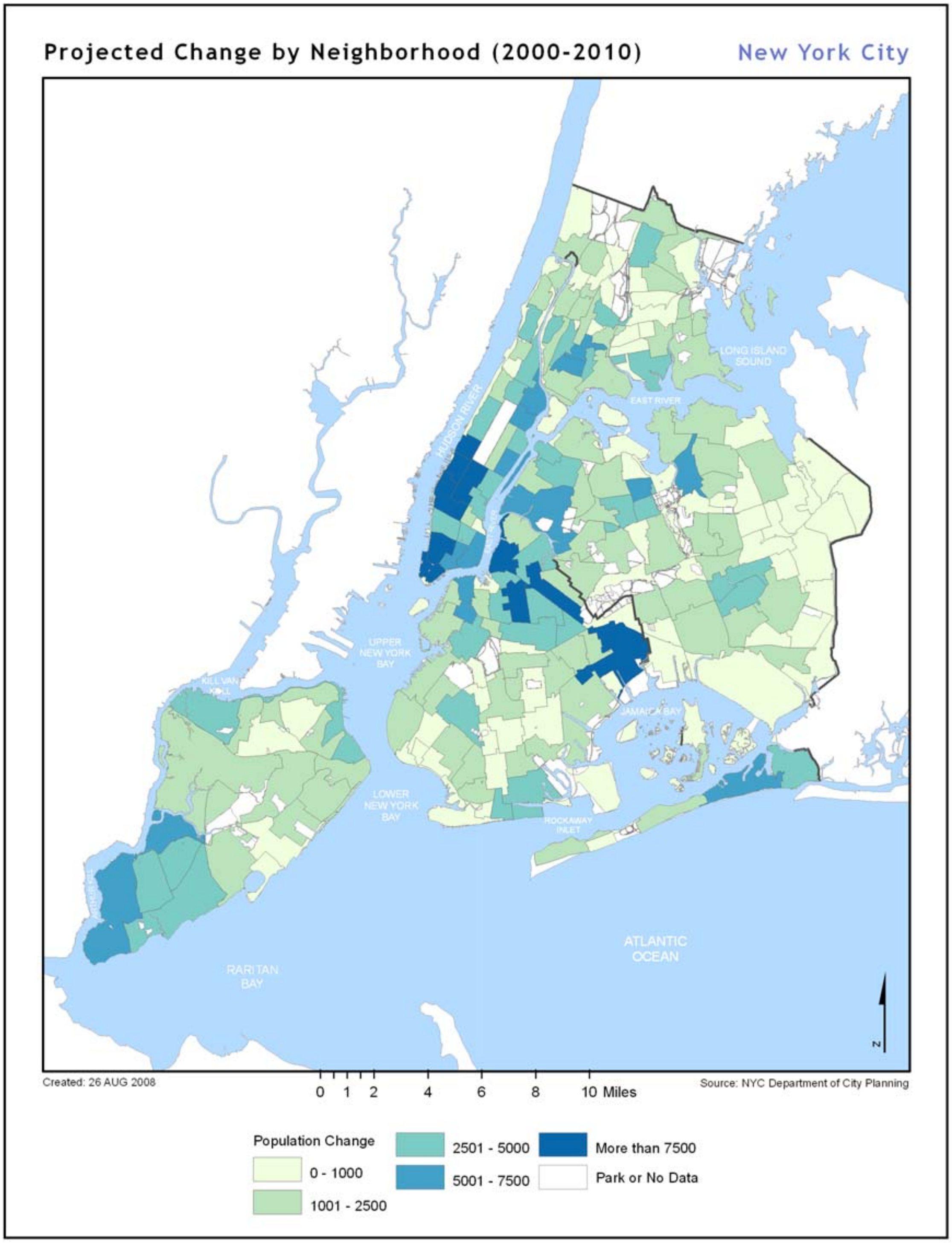


Figure 30: New York City 2000-2010 Projected Population Change by Neighborhood (Source: PlaNYC, 2007)

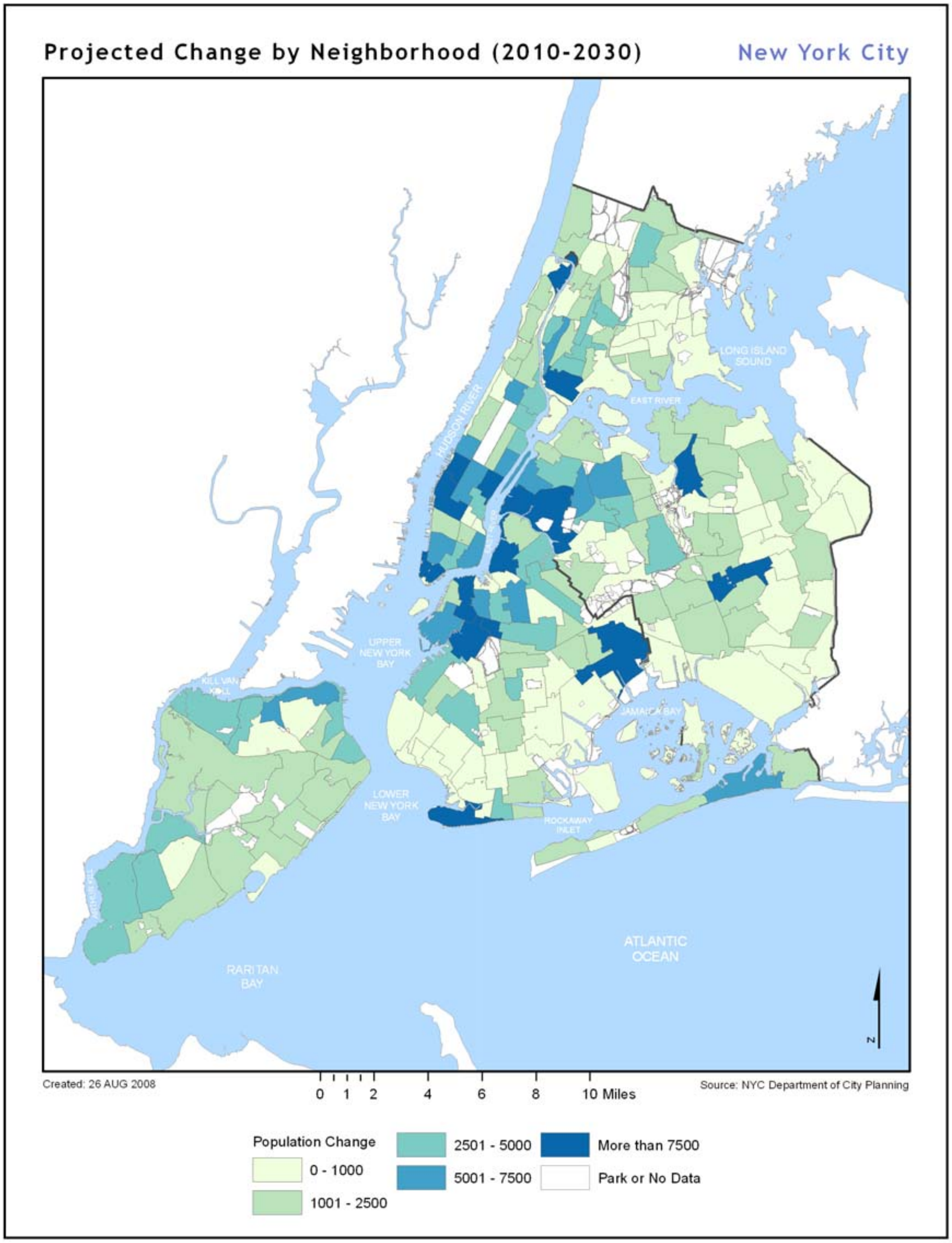


Figure 31: New York City 2010-2030 Projected Population Change by Neighborhood (Source: PlaNYC, 2007)

i) Age Trends

In the coming decades, New York City will see substantial increases in its senior population. The number of people age 65 and older is projected to increase 44.2%, from 938,000 in 2000, to 1.35 million in 2030. Seniors comprising a more substantial share of the City's population combined with the increasing longevity of the population indicates a new demographic era in the City's history.

New York City Senior Population 2000–2030				
	2000	2010	2020	2030
Bronx	133,948	132,716	139.589	172,653
Brooklyn	282.658	281,517	323,192	409,769
Manhattan	186,776	203,101	234,478	294,919
Queens	283,042	253,522	281,536	372,068
Staten Island	51,433	60,794	77,155	102,966
New York City	***937,857***	***931,650***	***1,055,950***	***1,352,375***

Table 9: Historical and Projected Senior Population for New York City

b) Land Use and Development Trends

New York City's land area covers approximately 305 square miles (approximately 195,000 acres or 8.5 billion square feet). Excluding streets and major bodies of water, approximately 153,000 acres (about 6.7 billion square feet) of land, or lot area, is available for use. The citywide and borough distributions of major categories of land use are presented in Table 10 and Figure 32 through Figure 36.

Summary of New York City Land Use						
Land Use	Lots		Total Lot Area		Total Building Area	
	#	%	Sq. Feet	%	Sq. Feet	%
Residential	697,125	82%	2,630,145,960	40%	2,884,315,336	56%
Mixed Use	46,359	5%	179,175,767	3%	617,337,223	12%
Commercial	24,318	3%	256,215,948	4%	704,296,146	14%
Industrial	12,732	2%	249,652,933	4%	286,002,105	6%
Transportation/Utility	6,573	1%	502,055,893	8%	78,566,463	2%
Public Facilities	11,616	1%	489,396,459	7%	536,735,808	10%
Open Space	3,157	0%	1,691,291,627	26%	34,504,954	1%
Parking	13,111	2%	92,863,802	1%	37,481,782	1%
Vacant Land	33,674	4%	456,949,235	7%	3,804,702	0%
Total	***848,665***	***100%***	***6,547,747,624***	***100%***	***5,183,044,519***	***100%***

Table 10: Summary of New York City Land Use

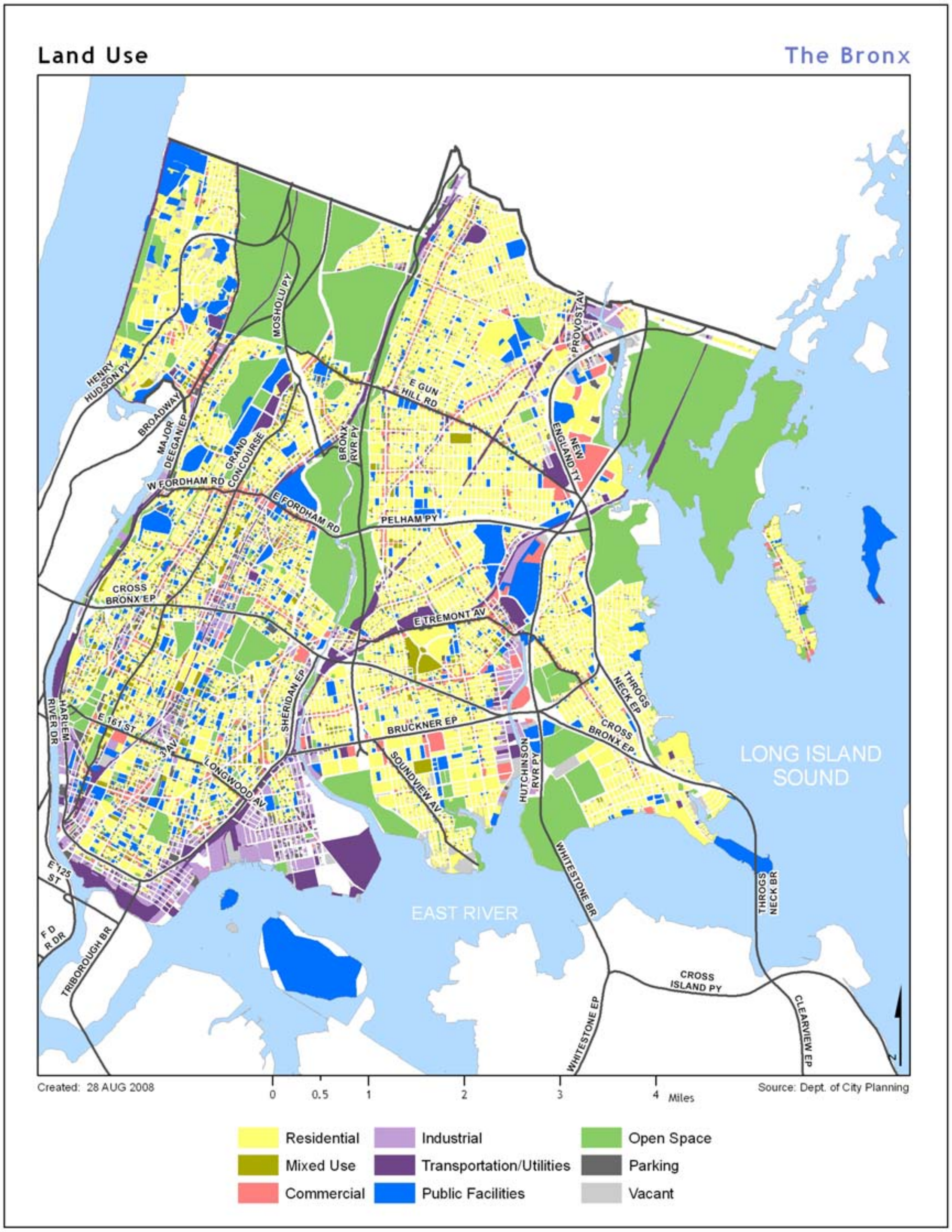


Figure 32: 2006 Bronx Land Use

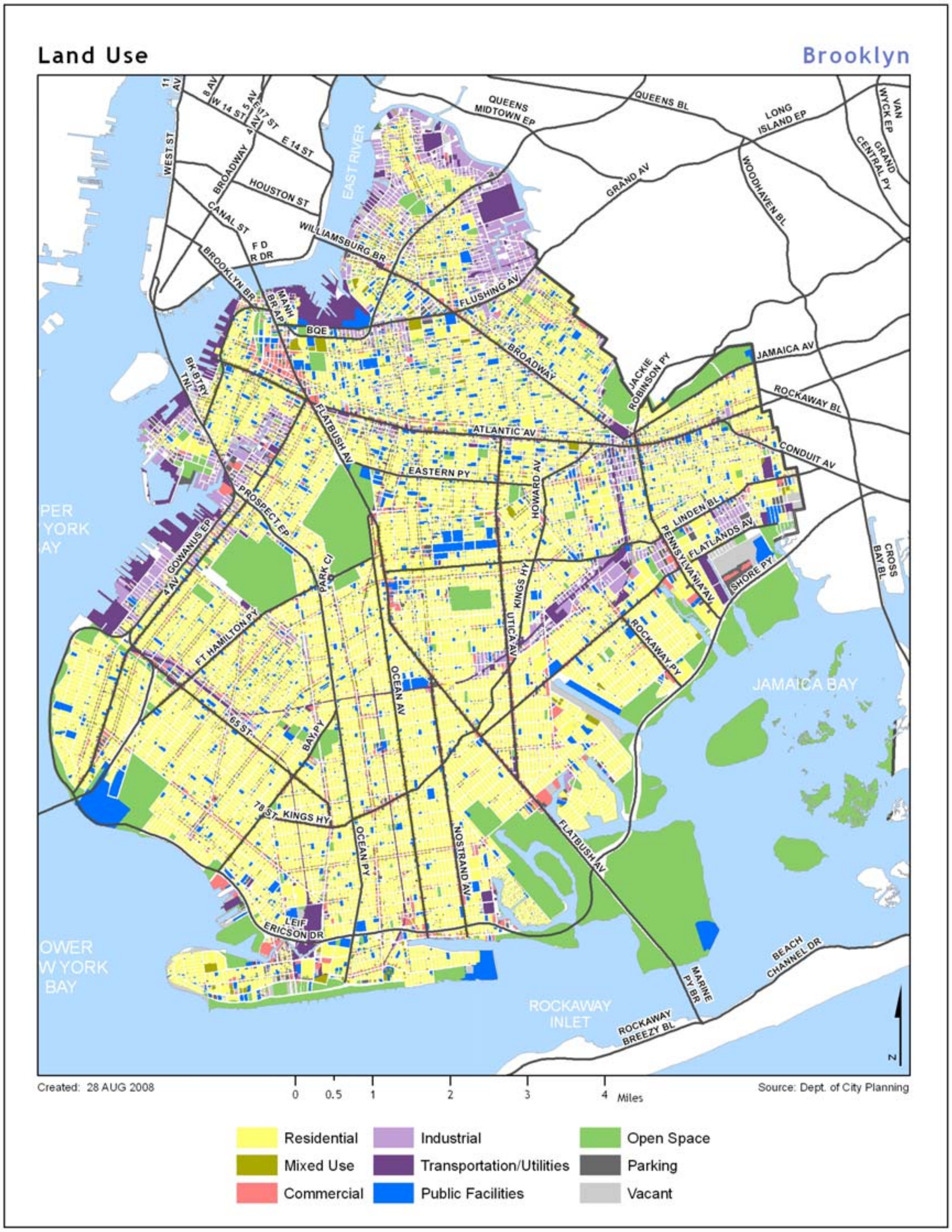


Figure 33: 2006 Brooklyn Land Use

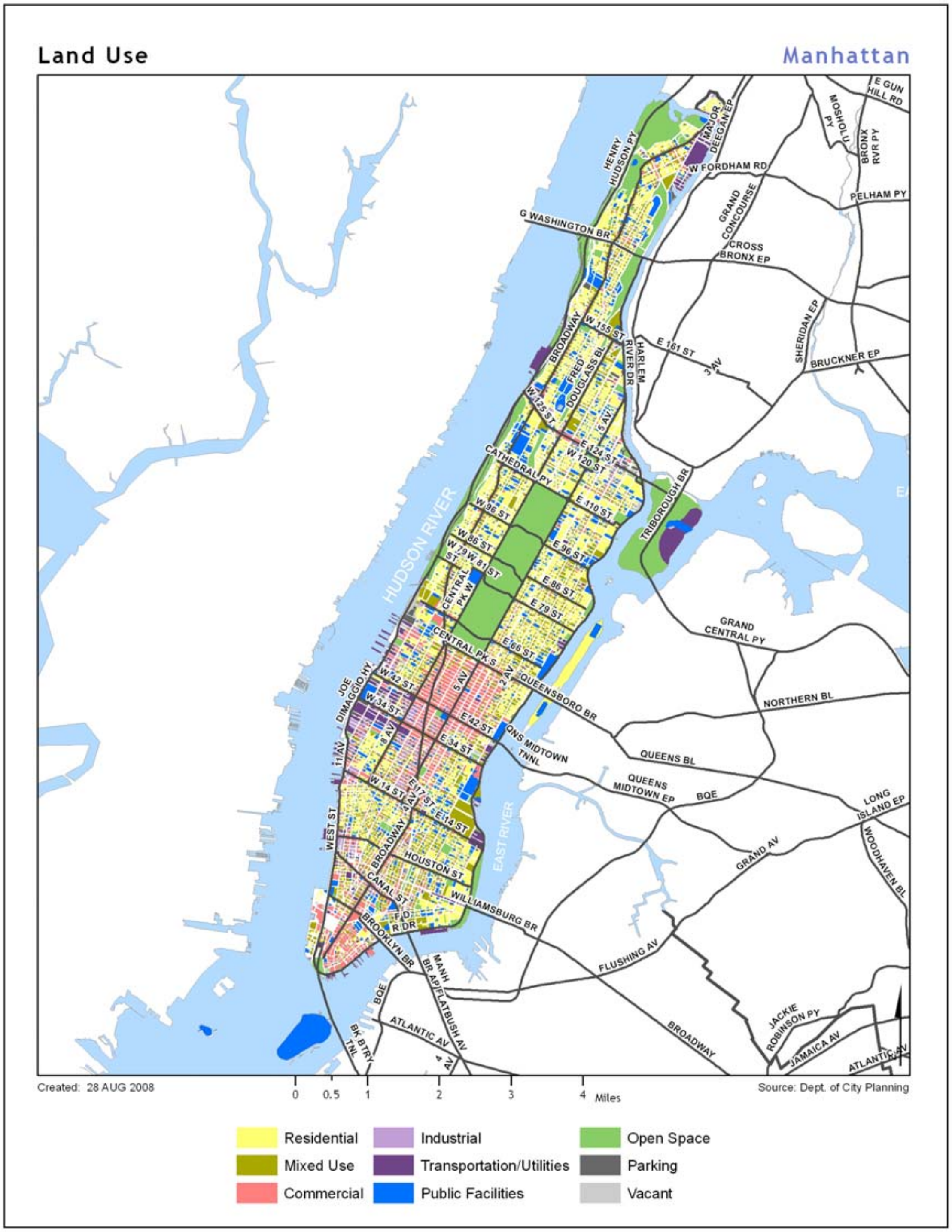


Figure 34: 2006 Manhattan Land Use

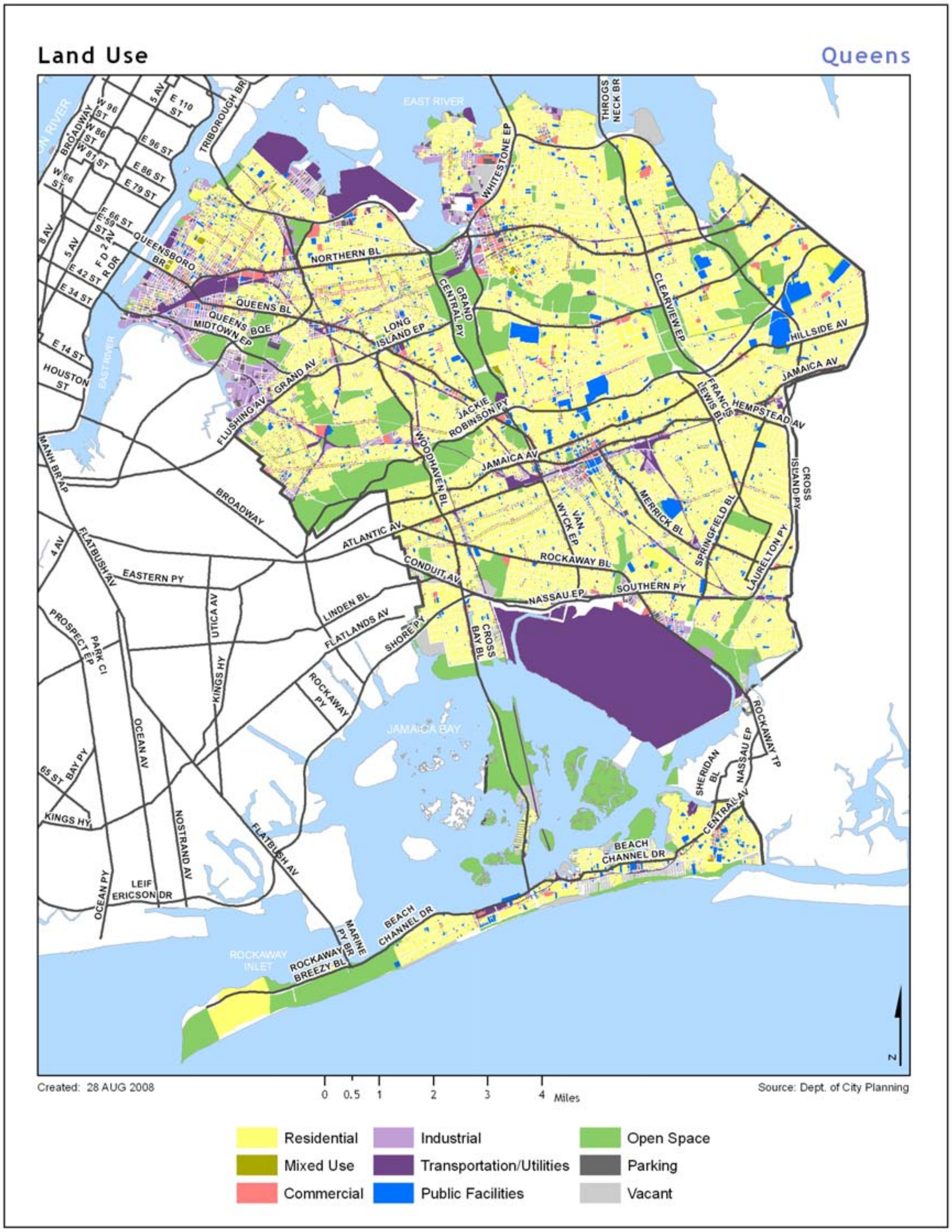


Figure 35: 2006 Queens Land Use

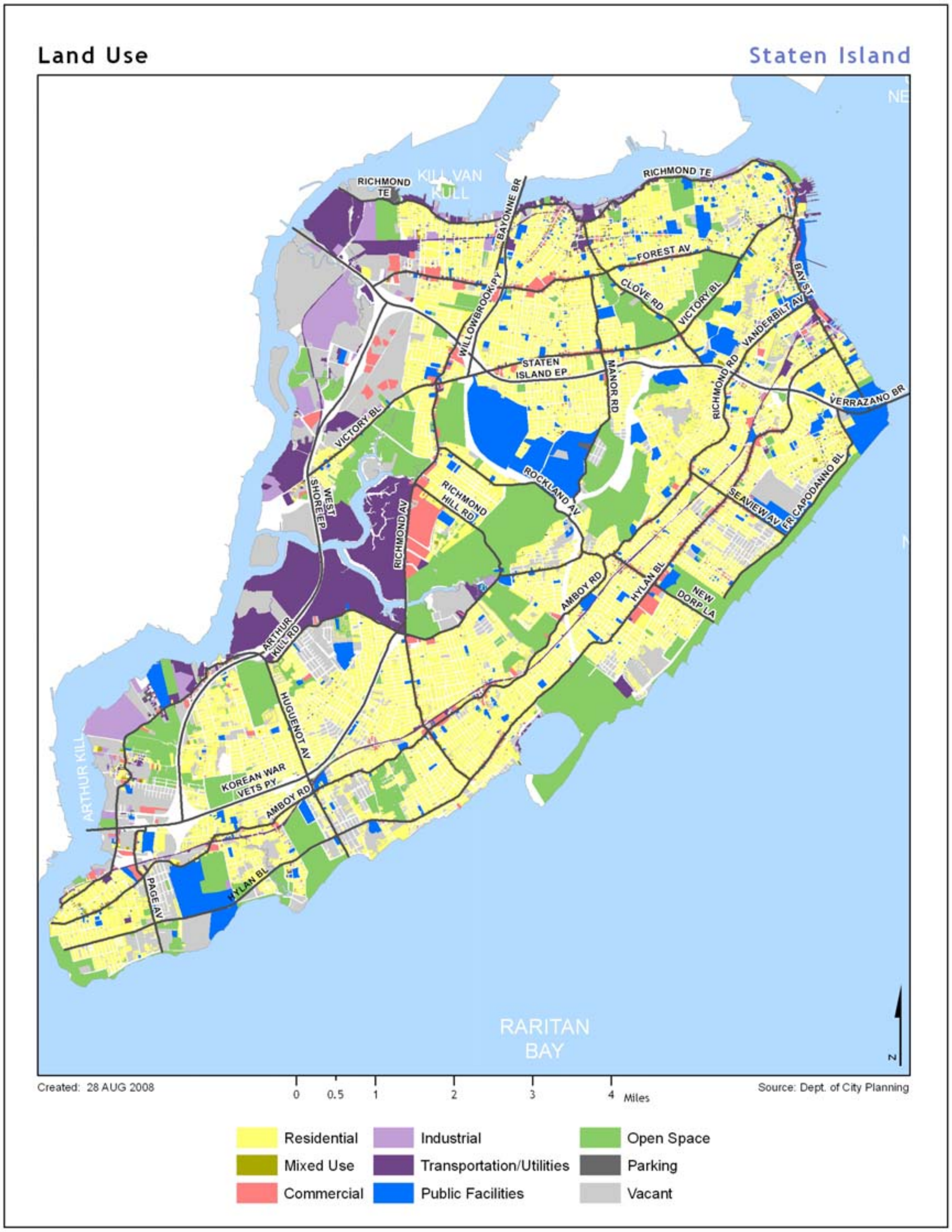


Figure 36: 2006 Staten Island Land Use

With new construction, New York City's land use patterns will continue to change in the coming decades. To accommodate population growth, the City will reclaim underused waterfronts, adapt old buildings to new uses, and increase density. This is also an opportunity to consider how these changes might increase New Yorkers' vulnerability to hazards and what particular mitigation actions would lessen these impacts. The HMP will play an important role in advocating for hazard mitigation as an important consideration when planning for the City's future.

i) PlaNYC

New York City's growth and redevelopment is not haphazard, but guided by a number of plans. One of the most prominent plans is "PlaNYC: A Greener, Greater New York" (PlaNYC). PlaNYC outlines a detailed strategy for how the City will address the challenges of population growth, aging infrastructure, and climate change. PlaNYC contains 127 initiatives designed to achieve sustainability goals for land, water, transportation, energy, air quality, and climate change. The Mayor's Office of Long-Term Planning and Sustainability (OLTPS) administer the efforts to implement the 127 initiatives. In turn, OLTPS assigns many of the initiatives to the appropriate City agency.

Many of PlaNYC's sustainability initiatives also serve to mitigate natural hazards. For example, DCP modified zoning regulations to promote the "greening" of parking lots. The new regulations require all off-street parking areas with more than 18 spaces or 6,000 square feet to include landscaping, perimeter screening, and tree planting. This initiative mitigates flooding and sewer capacity issues by reducing storm water runoff. It also helps reduce the urban heat island effect. PlaNYC reinforces New York City's commitment to addressing issues brought on by population growth, climate change, and natural hazards. Many more PlaNYC initiatives that serve both hazard mitigation and sustainability purposes are outlined in the Mitigation Strategy section of this plan.

ii) Large-scale Planning Initiatives

DCP identified large-scale planning initiatives in its Agency Strategic Plan for 2002 through 2008. During these six years, more than two-dozen projects were initiated that affected the cityscape. These projects include redeveloping Lower Manhattan, facilitating housing production, fostering mixed-use development, protecting neighborhood character, revitalizing the waterfront, and encouraging sustainability. Each project is tailored to meet the needs and interests of the community and the developer(s). Figure 37 displays the location of DCP initiatives, many of which are ongoing. In addition to these initiatives, hundreds of small-scale development projects take place in New York City every day.

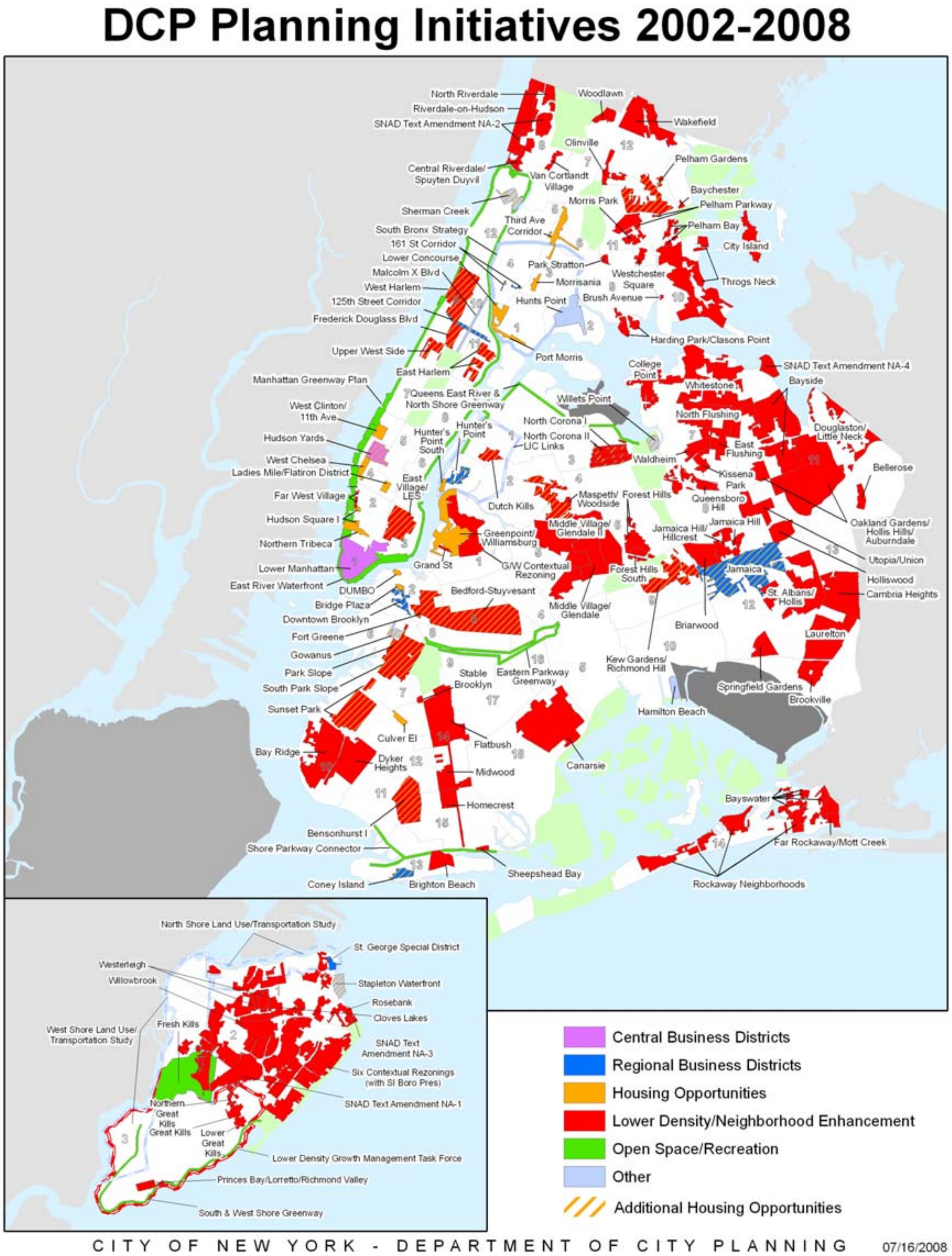


Figure 37: New York City Planning Initiatives from 2002-2008 (Source: NYC DCP, 2008)

5) Vulnerability Assessment Methodology

To address the requirements of the Disaster Mitigation Act of 2000 and better understand the potential vulnerability and losses associated with hazards of concern, New York City used standardized tools including the HAZUS-MH modeling software, combined with local, state, and federal data to conduct the vulnerability assessment.

a) HAZUS-MH Methodology

HAZUS-MH is a nationally applicable standardized methodology and software program, developed by FEMA, which is under contract with the National Institute of Building Sciences. The program estimates potential losses from earthquakes, hurricane winds, and floods. In HAZUS-MH, current scientific and engineering knowledge is coupled with Geographic Information Systems (GIS) technology to produce estimates of hazard-related damage before, or after, a disaster occurs.

Potential loss estimates analyzed in HAZUS-MH include:

- **Physical damage** to residential and commercial buildings, schools, critical facilities, and infrastructure.
- **Economic loss**, including lost jobs, business interruptions, repair and reconstruction costs.

HAZUS-MH is designed to generate estimates of hazard-related damage to a city or a region for a specific "hazard event" (that is, an earthquake, hurricane, or flood of a given severity and location, also known as a deterministic event) or it can model the effects of probabilistic events. Probabilistic events are modeled by looking at the damage caused by an event that is likely to occur over a given period of time, known as a return period. For example, HAZUS-MH can estimate the damage caused by an earthquake that is likely to occur once every 500 years (which has a 1 in 500 or 0.2% chance of occurring in a given year).

HAZUS-MH uses demographic and general building stock (GBS) data, which is used to estimate hazard-related damage. New York City supplemented this default data with a refined set of GBS data because an initial review found that for the City as a whole, the default GBS data provided with HAZUS-MH did not adequately reflect actual conditions. In order to refine the default GBS dataset, OEM provided an updated set of building data to Applied Research Associates, Inc. (ARA). ARA converted this dataset to a format that was usable by HAZUS-MH, classifying all structures according to the building type and occupancy classes required by the software. The resulting census block-based dataset provided a much more accurate starting point for subsequent analyses.

i) HAZUS-MH for Earthquakes

A probabilistic earthquake model incorporating a locally refined version of the National Earthquake Hazards Reduction Program's (NEHRP) soil data was used to estimate building damage from earthquakes over the 100, 250, 500, 1,000, and 2,500-year return periods. Additionally, HAZUS-MH generated an estimate of annualized capital-stock losses due to earthquakes.

ii) HAZUS-MH for Hurricane Winds (Coastal Storms)

A probabilistic hurricane wind-model was used to estimate building damage resulting from 10, 20, 50, 100, 200, 500, and 1,000-year return period storms. Additionally, HAZUS-MH generated an estimate of annualized capital-stock losses due to hurricane winds.

iii) HAZUS-MH for Floods

A scenario-based, or deterministic, flood model was used to estimate capital-stock losses (including building damage, contents damage, and inventory) from a 100-year flood. A 100-year flood is calculated to be the level of floodwater expected to be equaled or exceeded every 100 years on average. The extent of a 100-year flood was delineated horizontally using FEMA Digital Flood Insurance Rate Map boundaries and vertically using a New York City digital elevation model.

iv) HAZUS-MH for Coastal Erosion

Although coastal erosion is not one of the hazards directly modeled by HAZUS-MH, HAZUS-MH data was used to estimate loss. The extent of the coastal erosion loss area was delineated horizontally using New York State Department of Environmental Conservation (NYSDEC) Coastal Erosion Hazard Area (CEHA) boundaries. Because HAZUS-MH estimates loss on the census block level, the value of all buildings within the CEHA were calculated manually and then reduced based on the percentage of building footprints within the CEHA.

v) Data Limitations

While the results of the HAZUS-MH analysis provide a good starting point for loss and damage estimation, the results are approximate predictions. There is uncertainty inherent in any predictive model and HAZUS-MH is no exception. For example, the use of general-engineering data supplied with the software combined with building-stock data that has been compiled to the census-block level means that, as a rule, site-specific damage analysis is not practical. However, the use of HAZUS-MH as a tool for more macro-level citywide analysis can provide a good overall view of potential exposure to various hazards based on the best available local data.

vi) Role of HAZUS-MH in Future Hazard Mitigation Planning

OEM is considering the following options for HAZUS-MH in the future:

- Refine and update data sets for GBS, essential facilities, vegetation, vehicle distribution, and population, and update the earthquake, hurricane wind (coastal storm), and flood models.

- Pilot the use of HAZUS-MH with inputs from actual events, as they are about to occur, to affect pre-event mitigation and preparedness. Work with planning, preparedness, and operations personnel to design useful HAZUS-MH outputs for these events.

b) Methodology for Assessing Hazards Not Covered by HAZUS-MH

i) Approach

Non-HAZUS-MH hazards include drought, extreme temperatures, winter storms, and windstorms/tornadoes. Vulnerable populations and infrastructure were mapped and evaluated using the best available data to assess vulnerability to these natural hazards and to help identify appropriate mitigation efforts.

ii) Limitations

While this risk assessment relies on the best available data and methodologies, uncertainties are inherent in any loss-estimation methodology and arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from the following:

- Incomplete or dated inventory, demographic, or economic parameter data
- The unique nature, geographic extent, and severity of each hazard

These factors can result in a range of uncertainties in loss estimates. Therefore, potential exposure and loss estimates are approximate.

Hazard Analysis

6) Coastal Erosion Hazard Analysis for New York City

a) Hazard Profile

i) Hazard Description

Coastal erosion results from beach-ocean interaction coupled with human activity. In its natural state, the beach system is in dynamic equilibrium. Sand is moved from one location to another but it does not leave the system. For example, winter storms may remove significant amounts of sand, creating steep, narrow beaches. In the summer, gentle waves return the sand, widening beaches and creating gentle slopes. Because there are so many factors involved in coastal erosion, including human activity, sea-level rise, seasonal fluctuations, and climate change, sand movement will not be consistent year after year in the same location.

Wind, waves, and long shore currents are the driving forces behind coastal erosion. This removal and deposition of sand permanently changes beach shape and structure. Sand may be transported to landside dunes, deep ocean trenches, other beaches, and deep ocean bottoms. Coastal erosion poses many problems to coastal communities when valuable property is lost to this dynamic beach-ocean system. Additionally, human activity may worsen the process of coastal erosion through poor land use methods. Thus, issues of beach restoration and erosion control are at the forefront in coastal communities.

ii) Severity

Geologists measure erosion as a rate of either linear retreat (feet of shoreline recession per year), or volumetric loss (cubic yards of eroded sediment per linear foot of shoreline frontage per year). According to the Evaluation of Erosion Hazards study conducted by the Heinz Center, the average annual erosion rate on the Atlantic coast is roughly two to three feet per year. States bordering the Gulf of Mexico have the nation's highest average annual erosion rates of six feet per year.

iii) Probability

Long-term coastal erosion is a continuous process and therefore 100% probable for the locations below.

iv) Location

NYSDEC has identified three distinct CEHAs for New York City:

- Coney Island, Brooklyn
- The Rockaways, Queens
- South Shore, Staten Island

Within the CEHAs, NYSDEC manages and regulates the following:

- Natural Protective Features (NPF), such as the near shore, beaches, bluffs, primary dunes, and secondary dunes

- Structural Hazard Areas (SHA), which include areas landward of the NPFs that have demonstrated a long-term average annual recession rate of one foot per year or greater

CEHA maps depict both regulated areas, including the landward limit of the NPFs and SHAs, and indicate the recession rate in feet per year, where applicable.

CEHA maps for New York City were obtained from the NYSDEC, Division of Water, Coastal Erosion Management Unit on January 14, 2008. The maps are dated 1988, with legend updates in 1991. CEHA maps were available only in hard-copy format. For the purposes of this plan, CEHAs were translated from the hard-copy maps into GIS format for more efficient viewing, sharing, and estimation of assets within the CEHA. This was not a formal translation of the hard-copy data into GIS format. The resulting image is for analysis purposes only and does not serve as official digital representation of the CEHA boundary in New York City. For New York City, the CEHA boundary was drawn at the location of NPFs; CEHA maps did not designate SHAs.

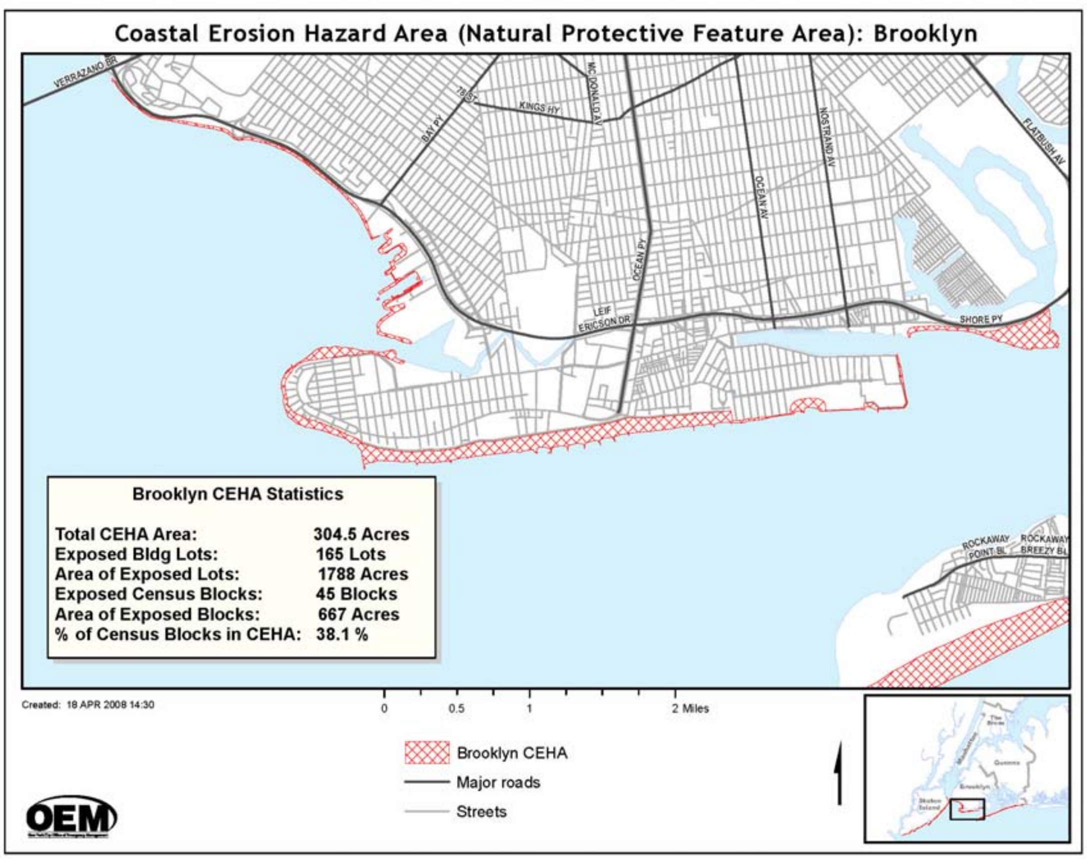


Figure 38: Brooklyn CEHA Areas

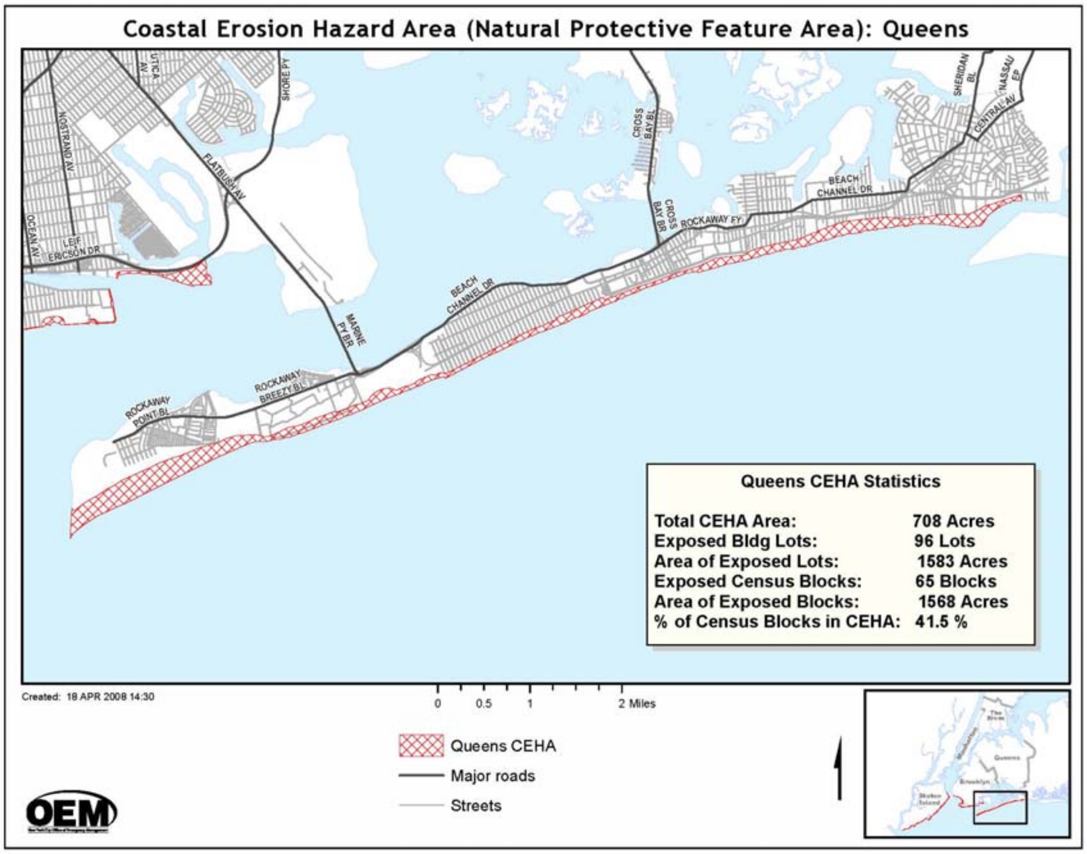


Figure 39: Queens CEHA Areas

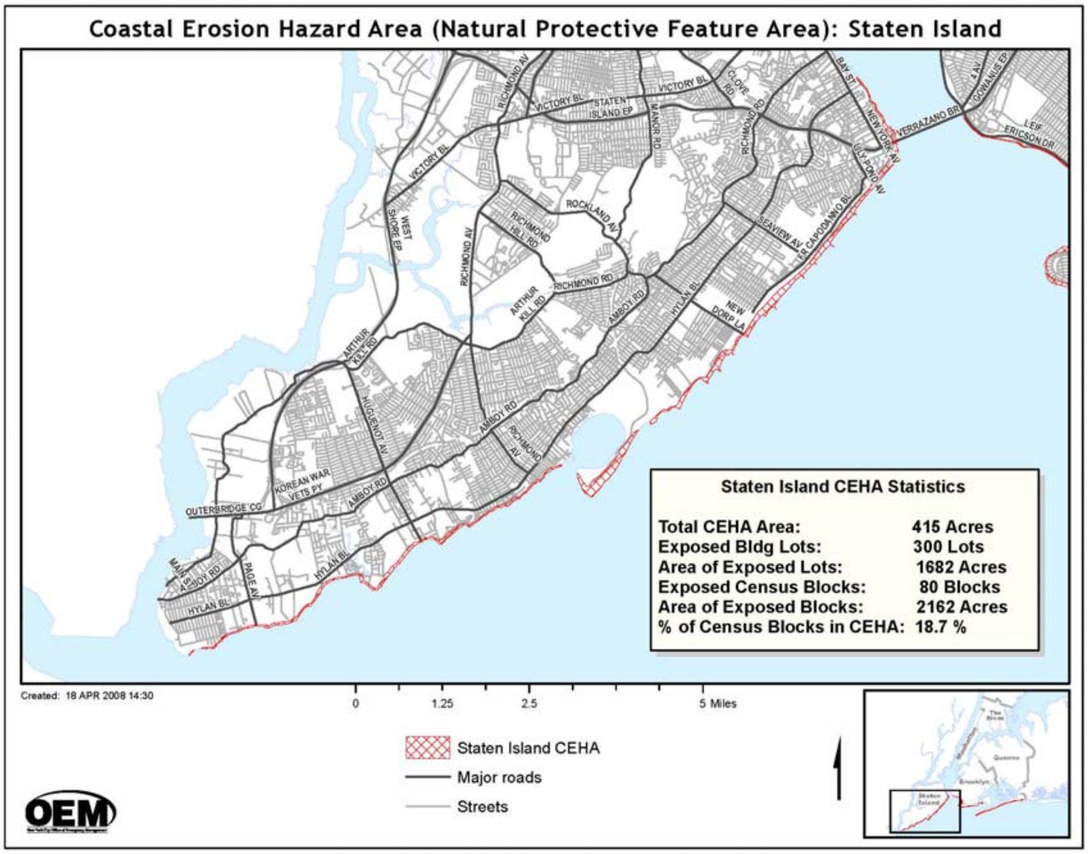


Figure 40: Staten Island CEHA Areas

v) Historic Occurrences

Coastal erosion is an ongoing natural process frequently exacerbated by human activity. Specific occurrences of coastal erosion are usually associated with a significant coastal storm, such as a nor'easter or hurricane. According to the National Climatic Data Center, 16 significant coastal storms have affected New York City since 1821. See the Coastal Storms Historical Occurrences section in this plan for more information.

b) Vulnerability Assessment

i) Impact to New York City

Coastal erosion causes extensive damage to public and private property and coastal natural resources. It may also endanger human lives. Human activities often contribute to coastal erosion problems by damaging or destroying natural protective features such as dunes, beaches, and barrier bars. Building without considering the impact of erosion, including building ill-conceived coastal erosion control structures, may increase erosion or shift it to adjacent area.

The City's south shore is exposed to the effects of coastal erosion and wave action from the Atlantic Ocean as well as from the waters of its bays including Lower New York, Gravesend, and Jamaica Bay. Over the past 100 years, the average erosion rate along much of Long Island's south shore, including parts of New York City's CEHAs, was at a rate of one to two feet per year. Some of the highest erosion rates, which can exceed 20 feet a year, have been observed near stabilized inlets or stone groins.

ii) Structural Vulnerability

Eroding coastlines essentially bring structures closer to the water's edge. Consequently, if not mitigated, the structures will become inundated with water causing damage or destruction. As water begins to affect the structure, the forces are similar to that of flooding, which tends to affect the contents, foundation, and utilities associated with the structure. Shoreline protection is a key part of withstanding the forces produced by coastal erosion. Engineering structures such as sea walls, riprap, armoring, and bulkheads are used to control erosion in New York City.

Approximately 1,427 acres or 0.7% of New York City's land area is located within a CEHA. The following table presents a summary of building lots, acreage, and buildings that lie within a CEHA.

Number and Acreage of Exposed Lots within the CEHA			
Coastal Erosion Hazard Area (CEHA)	**Lots Exposed**	**Acreage Exposed**	**Buildings Exposed**
Coney Island, Brooklyn	165	304.5	37
The Rockaways, Queens	96	708	24
South Shore, Staten Island	300	415	146
Total	***561***	***1,427.5***	***207***

Table 11: Number and Acreage of Lots within NYSDEC Mapped CEHA

There are three critical roadways located within New York City CEHAs:
- Verrazano Narrows Bridge
- I-278 (Highway)
- Shore Parkway

iii) Potential Loss Estimate

HAZUS-MH does not have a direct way to estimate loss due to coastal erosion. The total value of all buildings located in a CEHA was calculated using a modified HAZUS-MH flood model, which assumed a total loss of all CEHA from the current shoreline to the NPF line.

HAZUS-MH uses census blocks to calculate these values. If any part of a census block is located in a CEHA, the value of the whole block is counted, which tends to overestimate the total building value located in a CEHA. Furthermore, it does not take into account building locations within the lots. A more accurate building value can be derived by examining the census blocks, determining the number of buildings within a CEHA, and reducing the building value by that factor. Table 12 presents the approximate adjusted building values within New York City CEHAs.

Adjusted Building Value in CEHA					
CEHA Zone	**Exposed Census Blocks**	**Buildings in Exposed Census Blocks**	**Building Value of Exposed Census Blocks**	**Number of Buildings in Exposed Census Blocks that Lie within CEHA**	**Adjusted* Building Value (Estimated)**
Brooklyn	45	378	$245 million	37 of 378 (9.8%)	$24 million
Queens	65	1,203	$2,400 million	24 of 1,203 (2%)	$49 million
Staten Island	80	1,242	$551 million	146 of 1,242 (11.8%)	$65 million
Total	***190***	***2,823***	***$3.2 billion***	***207 of 2,823 (7.3%)***	***$138 million***

Table 12: Adjusted Building Values (Approximate) within New York City CEHAs

* Adjusted building value was calculated by valuing all buildings equally within a census block, and counting the number of buildings that lie within a CEHA. This approach introduces a level of inaccuracy; however, it demonstrates the actual building value at risk may be at least an order of magnitude lower than building value estimation calculated by HAZUS-MH.

7) Coastal Storms: Multi-Hazard Analysis for New York City

a) Hazard Profile

i) Hazard Description

Coastal storms, including nor'easters, tropical storms, and hurricanes, can and do affect New York City. New York's densely populated and highly developed coastline makes the City among the most vulnerable to hurricane-related damage.

Tropical Storms and Hurricanes

A hurricane is a type of tropical cyclone, which is a generic term for a low-pressure system that generally forms in the tropics. Thunderstorms and, in the Northern Hemisphere, a counterclockwise circulation of winds near the earth's surface accompany the cyclone. Tropical cyclones are classified as follows:

- A tropical depression is an organized system of clouds and thunderstorms, with a defined surface circulation, and maximum sustained winds of 38 miles per hour or less.
- A tropical storm is an organized system of strong thunderstorms, with a defined surface circulation, and maximum sustained winds of 39 to 73 miles per hour.
- A hurricane is an intense tropical weather system of strong thunderstorms, with a well-defined surface circulation, and maximum sustained winds of 74 miles per hour or higher.

Atlantic hurricanes form off the coast of Africa or in the southern Atlantic Ocean, Caribbean Sea, or Gulf of Mexico. Hurricanes require warm tropical oceans, moisture, and light winds above them to form. A hurricane can produce violent winds, tornadoes (primarily on the leading and trailing edges of the hurricane), powerful waves and storm surge, and torrential rains and floods.

Atlantic hurricane season lasts from June to November, averaging 11 tropical storms each year, six of which turn into hurricanes. New York City is at highest risk between August and October because water temperatures in the Northern Atlantic are most likely to reach a temperature warm enough to develop and sustain a hurricane. According to the National Hurricane Center, the Atlantic hurricane season is currently in a period of heightened activity that started around 1995 and could last at least another decade.

Heavy rain, coastal flooding, and powerful winds are commonly associated with hurricanes. Storm surge is often the greatest hurricane-related hazard.[1] Storm surge is water that is pushed toward the shore by the force of the winds swirling around the storm. This advancing surge combines with the normal tides to create the hurricane storm tide, which can increase the mean water level 15 feet or more. In addition, wind driven waves are superimposed on the storm tide. This rise in water level can cause severe inundation in coastal areas, particularly when the storm tide coincides with the normal high tides.

[1] Storm surge is measured as the difference between tide levels and observed storm water levels.

New York City is particularly vulnerable to storm surge because of a geographic characteristic called the New York Bight. A bight is a curve in the shoreline of an open coast that funnels and increases the speed and intensity of storm surge. The New York Bight is located at the point where New York and New Jersey meet, creating a right angle in the coastline.

Figure 41: New York Bight

Nor'easters

A nor'easter is a strong low-pressure system that affects the Mid-Atlantic and New England states. It can form over land or coastal waters. These typically winter events are notorious for producing heavy snow, rain, and tremendous waves that crash onto Atlantic beaches, often causing beach erosion and structural damage. Wind gusts associated with these storms can exceed hurricane force in intensity. A nor'easter gets its name from the continuously strong northeasterly winds blowing in from the ocean ahead of the storm and over the coastal areas.

Nor'easters may occur at any time of the year but are most common from September through April. If a wintertime nor'easter moves up the coast, following a track west of New York City, wintry precipitation will often change to rain. However, if the storm maintains a track just off the eastern coast of the City, snow, or mixed precipitation is likely to occur, assuming there is enough moisture and cold air.

ii) Severity

The NWS uses the Saffir-Simpson Scale to classify hurricane severity. The scale categorizes a hurricane's present intensity on a one to five rating and provides an estimate of property damage and coastal flooding upon landfall. Wind speed determines a hurricane's Saffir-Simpson Scale rating since storm surge is greatly dependent on the coastline shape and slope of the continental shelf.

Saffir-Simpson Hurricane Scale				
Category	**Storm Surge (ft)**	**Winds (mph)**	**Damage**	**Damage Description**
1	6.1–10.5	74–95	Moderate	• Damage primarily to trees and unanchored homes • Some damage to poorly constructed signs • Coastal road flooding
2	13.0–16.6	96–110	Moderate-Severe	• Some roofing material, door, and window damage to buildings • Considerable damage to shrubbery and trees • Flooding of low-lying areas
3	14.8–25	111–130	Extensive	• Some structural damage to residences and utility buildings • Foliage blown off trees and large trees blown down • Structures close to the coast will have structural damage by floating debris
4	24.6–31.3	131–155	Extreme	• Curtainwall failures with utilities and roof structures on residential buildings • Shrubs, trees, and signs all blown down • Extensive damage to doors and windows • Major damage to lower floors of structures near the shore
5	Not predicted	>155	Catastrophic	• Complete roof failure on many residences and industrial buildings • Some complete building and utility failures • Severe, extensive window and door damage • Major damage to lower floors of all structures close to shore

Table 13: Saffir-Simpson Hurricane Scale

iii) Probability

According to hurricane probability models, there is a 2.6% chance a hurricane will impact the New York City area (New York City, Westchester, and Long Island) during any given hurricane season. During a 50-year period there is a 13.6% chance a hurricane will impact the New York City area and a 3.3% chance an intense hurricane (Category 3 or higher) will affect the City.

iv) Location

OEM uses a computer model called SLOSH (Sea, Lake, and Overland Surges from Hurricanes) to predict the effects of storm surge and help guide the City's planning efforts for coastal storms. The SLOSH model calculates surge based on storms moving in different directions and with varying strengths. The SLOSH model analyzes storms moving northeast, northwest (the direction that will have the greatest impact), and varying in strength from Category 1 to Category 4.

The SLOSH calculations are based on the storm surge above the mean tide and the strongest potential winds for each category storm. The error is +/- three feet. Additionally, the SLOSH model calculates inundation levels for each location as if the hurricane hit that particular location head-on. The culmination of these factors results in a "worst-case" scenario for storm surge in the SLOSH model.

The SLOSH[2] map in Figure 42 shows the areas of the City that would experience inundation from storm surge based on hurricane category. The following four maps display the estimated storm surge levels for different neighborhoods throughout New York City. These maps provide a visual representation of New York City's physical vulnerability. A Category 2 storm would completely inundate the Rockaway Peninsula and a Category 3 storm could put Coney Island under 21 feet of water. With more than 21 square miles of land within a Category 4 surge zone, a significant hurricane would affect millions of New Yorkers and compromise the City's aging infrastructure.

[2] The SLOSH map represents locations that may experience flooding from hurricane storm surge. In contrast, the floodplain map represents locations that experience natural coastal flooding, which may be unrelated to hurricanes, and are within the FEMA-defined 100-year floodplain. Hurricane storm surge areas overlap many areas that are designated as the 100-year floodplain, but the hurricane storm surge areas are considerably larger and represent a different hazard.

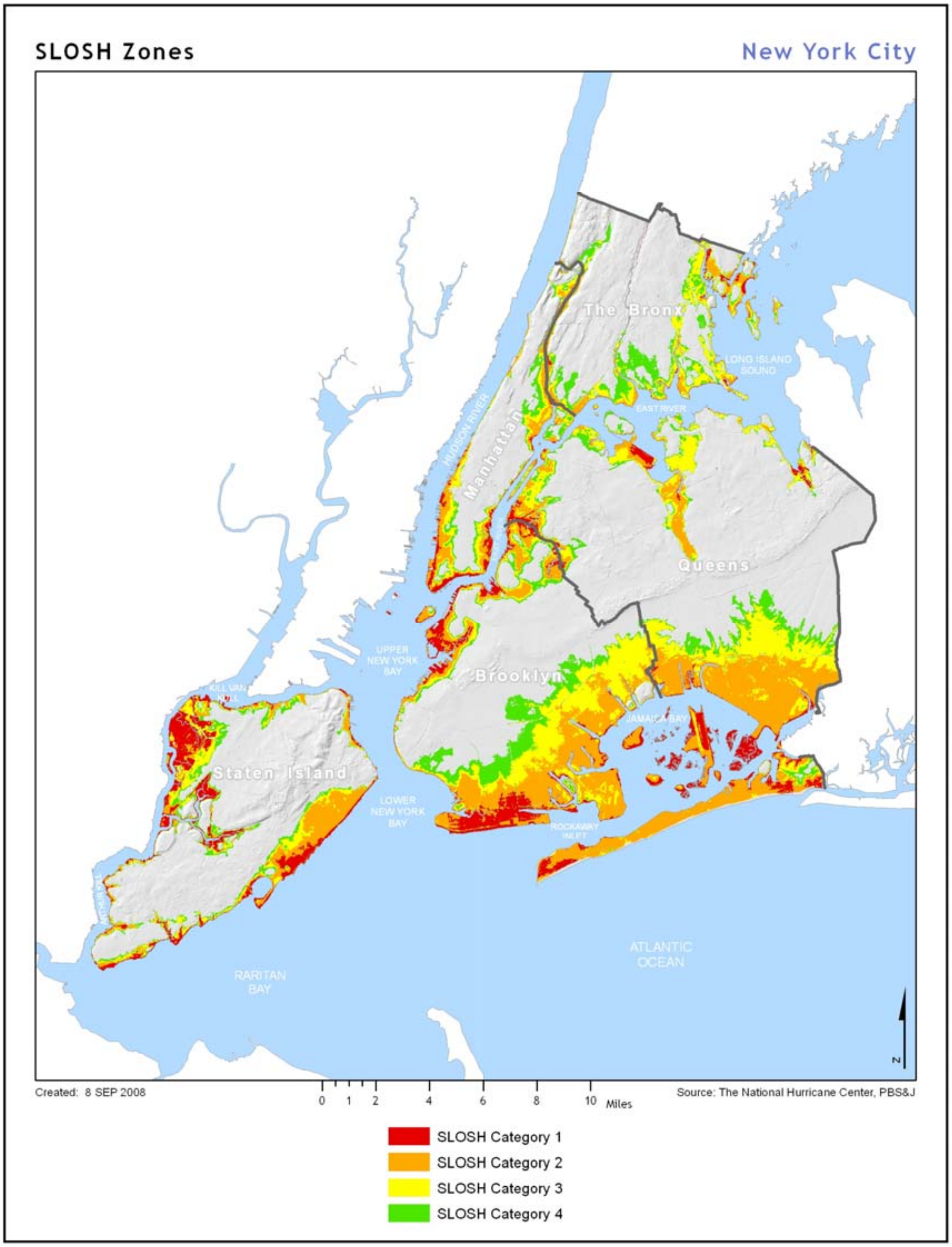


Figure 42: New York City SLOSH Model

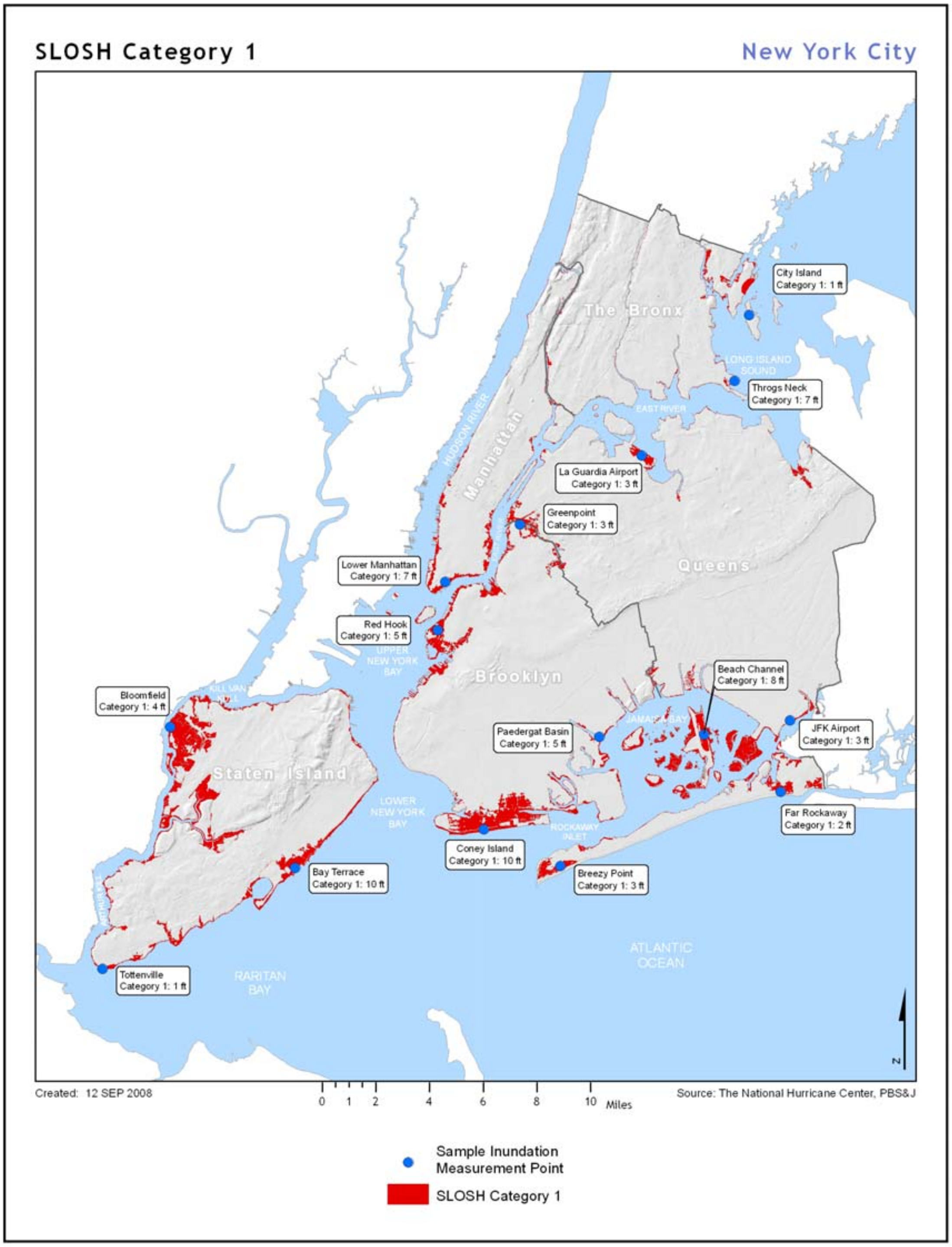


Figure 43: New York City Storm Surge for a Category 1 Hurricane

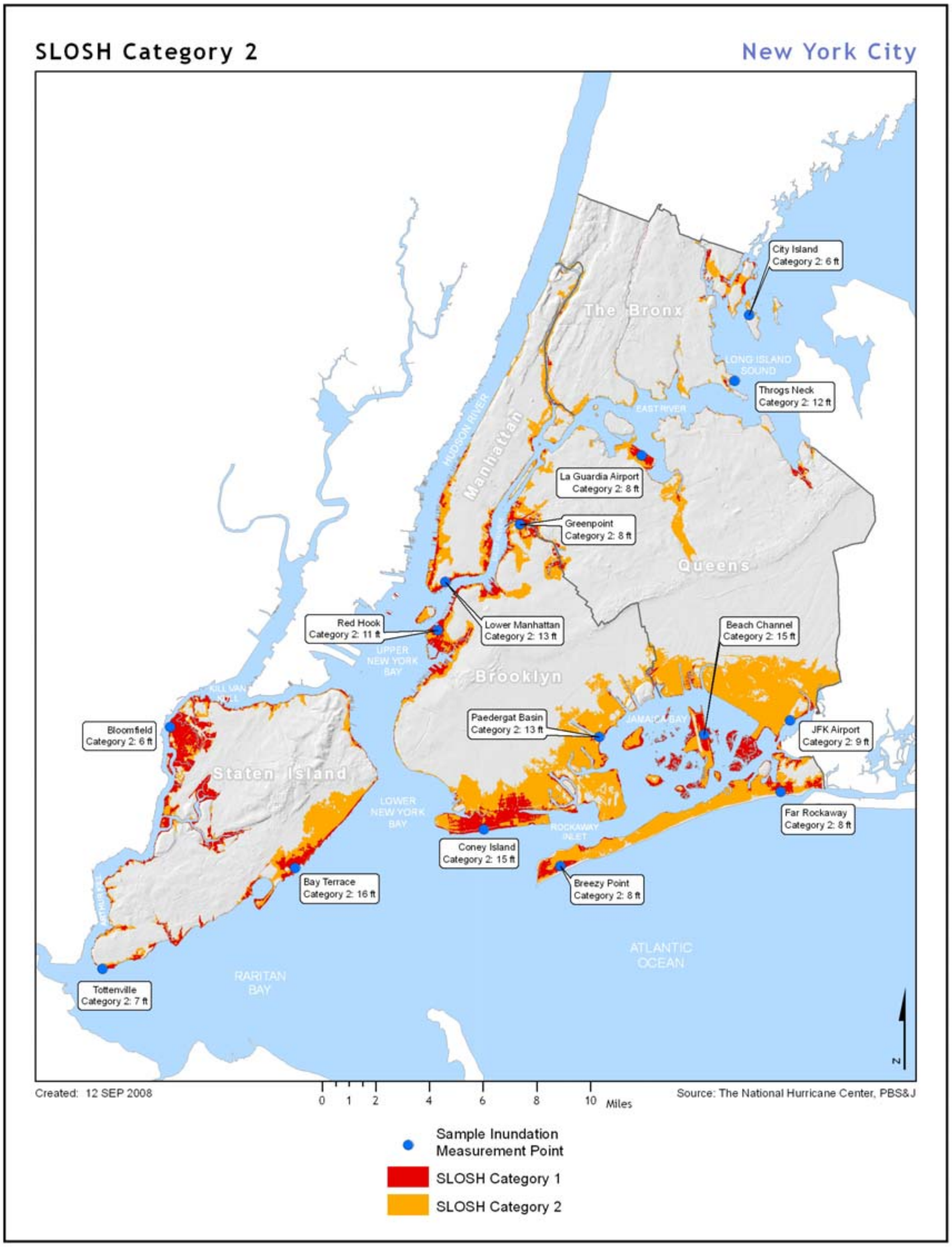


Figure 44: New York City Storm Surge for a Category 2 Hurricane

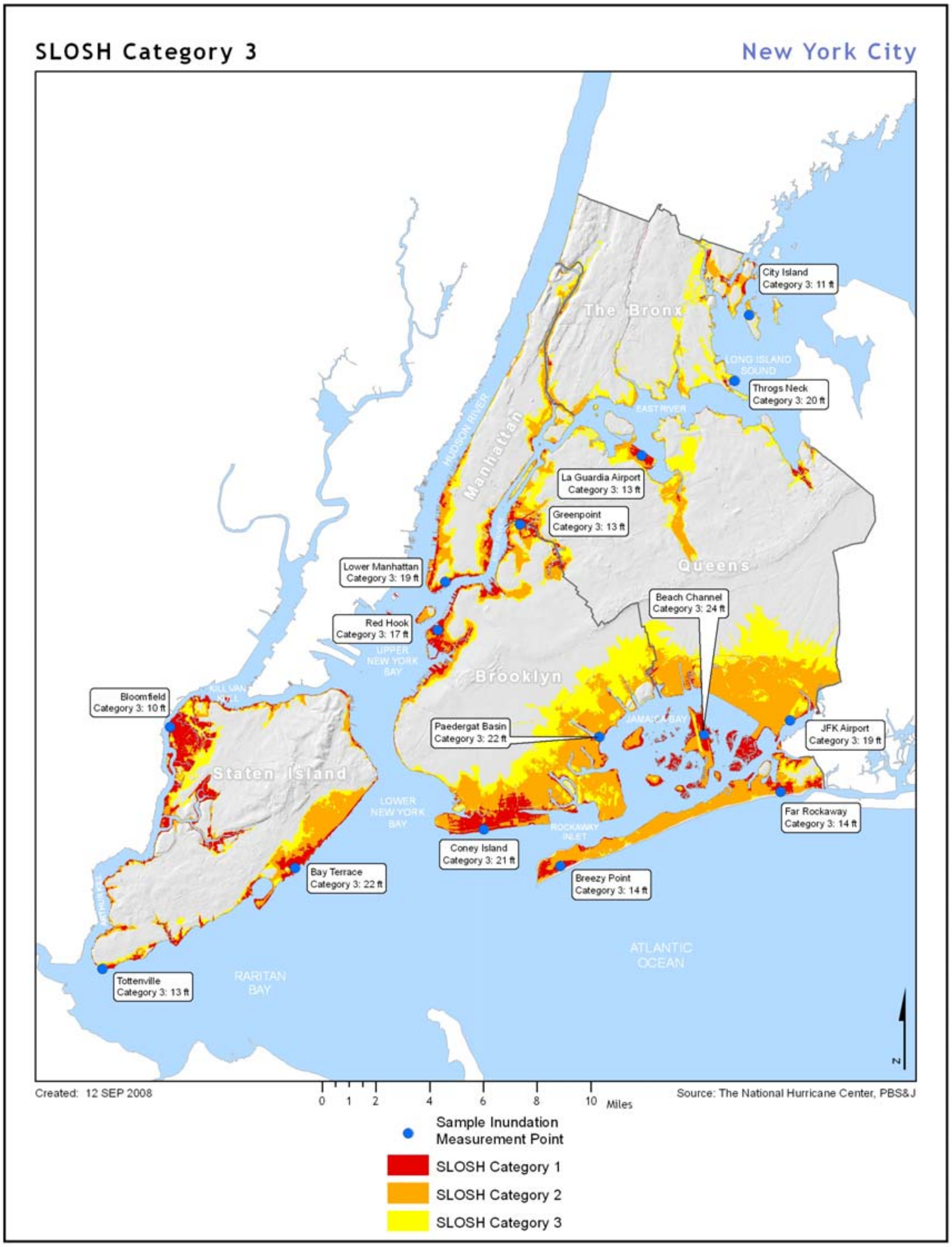


Figure 45: New York City Storm Surge for a Category 3 Hurricane

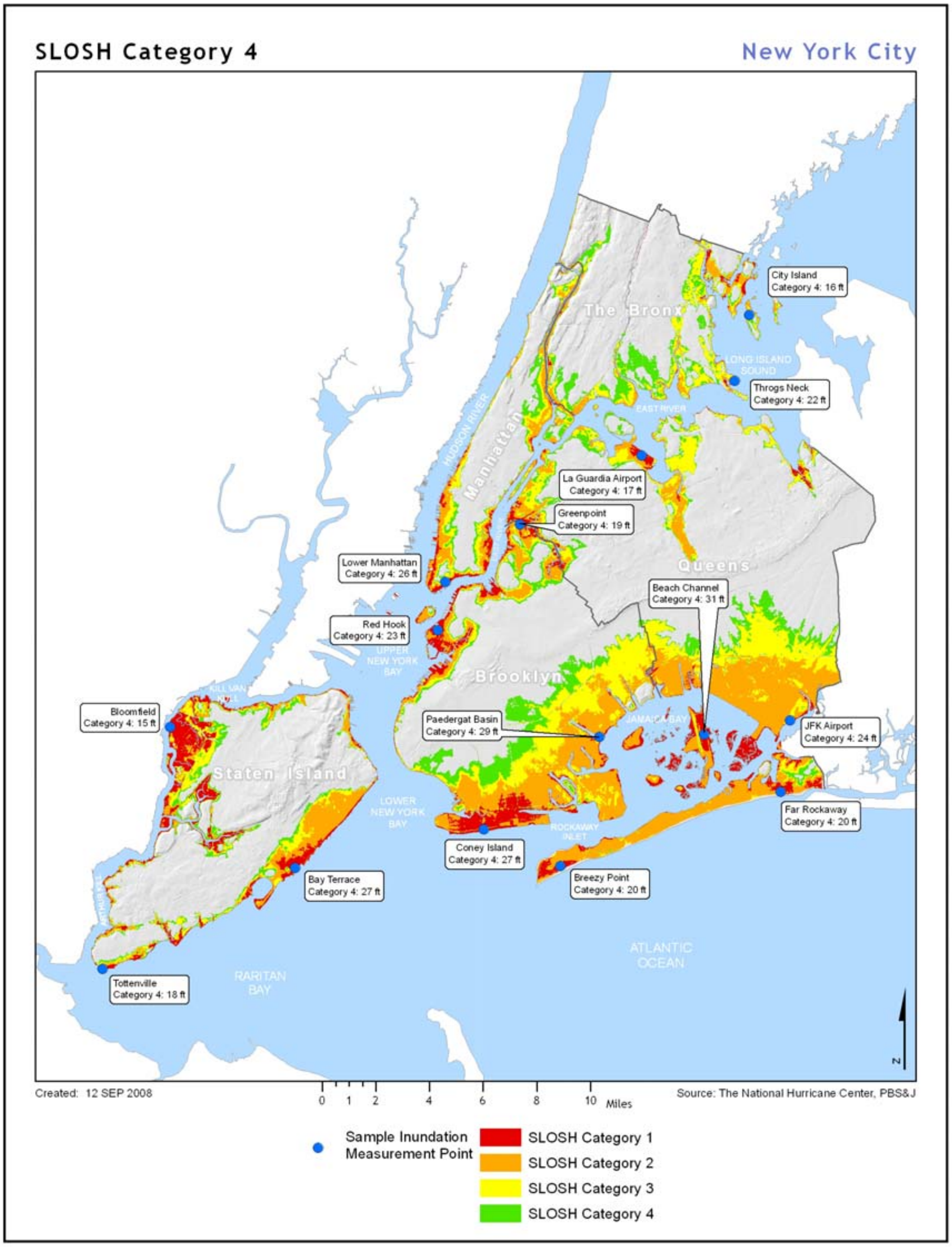


Figure 46: New York City Storm Surge for a Category 4 Hurricane

v) Historic Occurrences

Historic Occurrences of Coastal Storms in New York City			
Date	**Event**	**Location(s)**	**Description**
Sept. 3, 1821	Hurricane	Citywide	• Believed to pass directly over parts of New York City • Tides rose 13 feet in one hour and caused the East River to converge into the Hudson River across lower Manhattan along Canal Street • No deaths reported
Aug. 24, 1893	Hurricane	Citywide	• Category 1 • Destroyed Hog Island
Oct. 10, 1894	Hurricane	Citywide	• Category 1
Sept. 21, 1938	Hurricane	Citywide	• Category 3 • Most powerful hurricane to make landfall near New York City • Eye crossed over Long Island giving it its name, the Long Island Express • Killed nearly 200 people total; 10 in New York City • Electricity knocked out north of 59th Street in Manhattan • 100 large trees in Central Park were destroyed
Aug. 30, 1954	Hurricane Carol	Citywide	• Made landfall in eastern Long Island and SE Connecticut • Sustained winds more than 100 mph and gusts 115 to 125 mph • Most destructive hurricane to hit the northeast coast since the 1938 hurricane • Major flooding throughout the City
Aug. 19, 1955	Hurricanes Diane and Connie	Citywide	• Leftover rains from hurricanes dropped nearly 12 inches of rain at LaGuardia Airport • In just over one week, the remnants of 2 hurricanes passed over the City.
Sept. 12, 1960	Hurricane Donna	Citywide	• Created an 11-foot storm tide in New York Harbor and caused extensive pier damage

Historic Occurrences of Coastal Storms in New York City			
Date	**Event**	**Location(s)**	**Description**
June 22, 1972	Tropical Storm Agnes	Citywide	• Agnes fused with another storm system in the northeastern U.S., flooding areas from North Carolina to New York State • Caused 122 deaths • More than $6 billion in damage (when adjusted for inflation)
Sept. 27, 1985	Hurricane Gloria	Citywide	• Category 3 • Made landfall on Long Island at 80 mph • Produced a modest storm surge of 4-7 feet above normal across the Atlantic • Could have produced a much stronger and intense storm surge if it happened during high tide • Caused the largest single power loss in U.S. history at the time • Total damage estimated at $900 million in 1986
Dec. 21, 1992	Nor'easter	Citywide	• Flooding and coastal erosion, debris • Damage to residential and commercial structures, utility lines, roads and other infrastructure
June 17, 1995	Hurricane Felix	Citywide	• Hurricane Felix lingered off the East Coast for nearly a week, menacing the northeastern U.S. before it finally drifted out to sea
June 18, 1996	Tropical Storm Bertha	Citywide	• Weakening storm brought heavy rain to the City
Jan. 3, 1999	Nor'easter	Citywide	• 2.42 inches of rain • 50-vehicle accident in Queens
Sept. 16, 1999	Tropical Storm Floyd	Citywide	• Flooded subway tunnels across the City causing service disruptions • Dropped 10-15 inches of rain in a 24-hour period • Public schools closed for the day
Sept. 18, 2003	Tropical Storm Isabel	Brooklyn, Bronx, Queens, Staten Island	• One fatality in the NY area – a man drowned while bodysurfing off Long Beach, Long Island • A fallen tree branch in the Bronx seriously injured a man • 640 trees and 801 tree limbs were downed across the City • Total damage exceeded $1 billion along the East Coast

Historic Occurrences of Coastal Storms in New York City			
Date	**Event**	**Location(s)**	**Description**
Apr. 15, 2007	Nor'easter	Citywide	• More than 7.5 inches of rain in Central Park • More than 500 flights cancelled • Disrupted power to 18,500 customers in three states

Table 14: Historic Occurrences of Coastal Storms in New York City

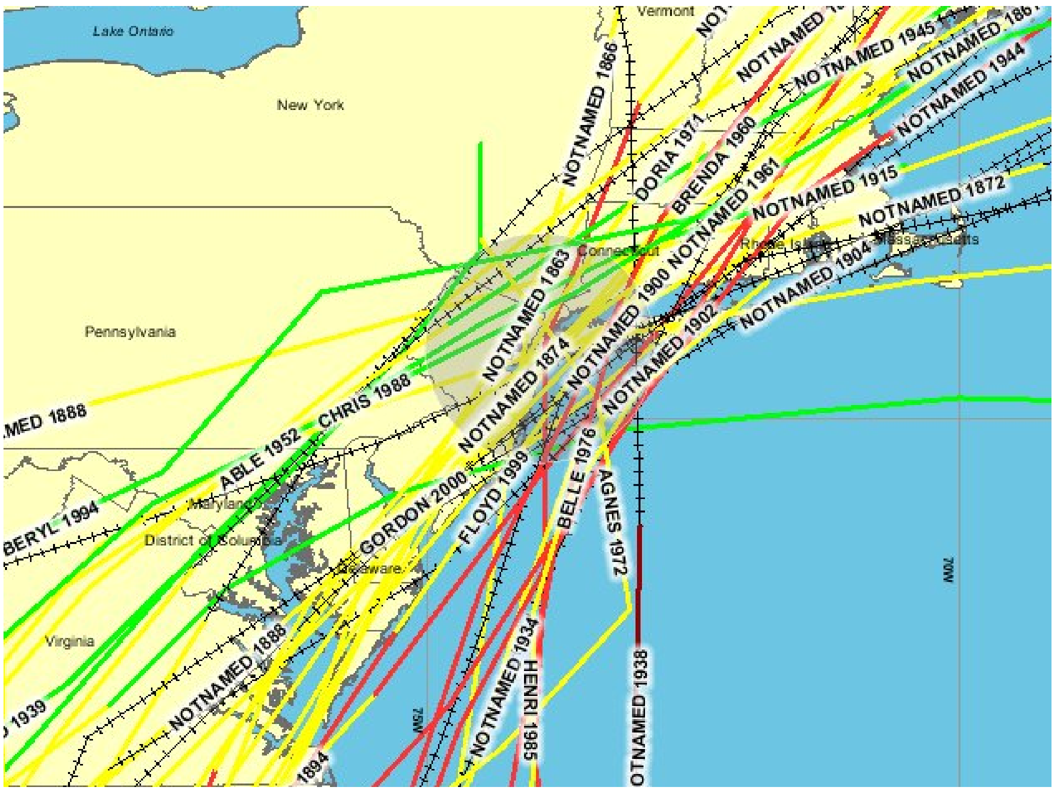


Figure 47: History of Coastal and Tropical Storms Tracks

b) Vulnerability Assessment

i) Impact to New York City

A Category 1 hurricane can cause storm surge of up to 10 feet and 95 mile per hour winds causing moderate damage to the City's foliage and unstable buildings along the coast. A Category 4 hurricane would devastate New York City with surge levels surpassing 30 feet in some areas, causing large-scale utility disruptions and damage to buildings and infrastructure. Due to the geography and climate characteristics of New York City, scientists do not predict a Category 5 hurricane would reach as far north as New York City and although possible, a Category 4 hurricane is unlikely.

The New York City Coastal Storm Plan (CSP) uses the SLOSH zones to define the areas that may be required to evacuate, called evacuation zones, based on different categories of storms. Zone A would evacuate prior to a Category 1 hurricane, Zone B prior to a Category 2 hurricane, and Zone C prior to a Category 3 or 4 hurricane.

Depending on the severity of the hurricane, OEM estimates that between 272,000 and three million New Yorkers may have to evacuate. Most evacuees will stay with friends or family within or outside of the City. Some evacuees will go to City-provided shelters located outside the SLOSH zones. Table 15 is an estimate of total evacuees in New York City based on the evacuation zones. These numbers derive from population data, behavioral assumptions, tourist occupancy, and vehicle accessibility. “Other evacuees” refers to the shadow population that will evacuate even though they do not live in the evacuation zone.

CSP Evacuees by Zone	
Order Scope	**Evacuees**
Zone A (Category 1)	272,331
Zone B (Category 2)	677,940
Zone C (Categories 3 and 4)	1,380,388
Subtotal Zone Evacuees	2,330,659
Other Evacuees*	714,162
Total Potential Evacuees	***3,044,821***

*Other evacuees are people who will evacuate from non-flood zones

Table 15: CSP Evacuees

Density is a major concern for New York City in the context of a hurricane. More than eight million people live within 305 square miles across the five boroughs. New York City’s three islands and the main land create 578 miles of coastline. Close to two million people in 743,000 households live within a SLOSH zone and as much as 38% of the City’s land may experience inundation by storm surge in a coastal storm.

ii) Structural Vulnerability

The Planning Team used HAZUS-MH to estimate potential losses from hurricanes in New York City based on a probabilistic model, in which the probability is expressed as a percent chance that a hurricane of a specific magnitude will occur in any given year. For example, a hurricane with a 50-year return period, or occurrence rate, has a 2% chance of occurring in any one year.

Probabilistic Modeling	
Return Period (Years)	**Chance of Occurrence in Any Given Year (%)**
10	10
20	5
50	2

Probabilistic Modeling	
Return Period (Years)	Chance of Occurrence in Any Given Year (%)
100	1
200	0.5
250	0.4
500	0.2
1,000	0.1

Table 16: Return Periods for Probabilistic Modeling

HAZUS-MH runs were conducted for 10, 20, 50, 100, 200, 500, and 1,000-year return periods. Using a 10-year return period, HAZUS-MH predicts no buildings would experience any form of damage. At the 100-year return period, HAZUS-MH estimates three buildings would experience complete destruction from a hurricane. The 1,000-year return period estimates 407,000 structures, or more than half of the City's current building stock, would experience some type of damage.

Number of Buildings Damaged from a Hurricane					
Return Period (Years)	Minor	Moderate	Severe	Destruction	Total
10	0	0	0	0	***0***
20	2,546	84	3	0	***2,633***
50	12,473	1,729	41	0	***14,242***
100	39,111	11,119	183	3	***50,416***
200	80,043	34,514	623	52	***115,233***
500	175,907	110,079	4,966	1,672	***292,623***
1,000	219,682	170,640	12,067	5,090	***407,480***

Table 17: HAZUS-MH Calculation of Number of Buildings Damaged from a Hurricane by Return Period

Table 18 displays the total number of critical facilities and key assets located within the Category 4 SLOSH zone. These facilities and assets are at risk to storm surge and severe damage in a Category 4 hurricane.

Critical Assets Located within SLOSH Zones	
Critical Asset	#
Subway Stations	119
Rail Stations	30
Bridges and Tunnels	31
Major Roads (miles)	461
Airports	2
Ferry Landings	25
Emergency Services – Police Stations	22
Emergency Services – Fire Stations	56

Critical Assets Located within SLOSH Zones	
Critical Asset	**#**
Emergency Services – EMS Stations	10
Educational – Colleges	19
Educational – Public Schools	343
Educational – Private Schools	215
Healthcare – Hospitals	23
Healthcare – Nursing Homes	57
Cultural Facilities	11
Infrastructure – Power Plants	17
Infrastructure – Wastewater Treatment Plants	13

Table 18: Critical Assets within SLOSH Zones

iii) Potential Loss Estimate

Table 18 and Figure 48 highlight the key findings from the HAZUS-MH probabilistic run. In total, the City has $826 billion of buildings exposed to hurricanes of any or all categories. Residential buildings account for $583 billion, or 70%, of this total. The annualized loss, or long-term average losses in a given year, is $276 million for total building structures. More than 80% of the annualized capital loss results from damage to buildings, while less than 0.5% is derived from inventory loss.

Annualized Capital Stock Loss for Hurricanes ($1,000s)				
County	**Building Damage**	**Contents Damage**	**Inventory Loss**	**Total**
Brooklyn	58,862	12,143	439	***71,444***
Bronx	32,284	6,940	199	***39,423***
Manhattan	70,276	14,476	125	***84,877***
Queens	53,880	12,217	315	***66,412***
Staten Island	10,914	3,148	30	***14,092***
Total	***226,216***	***48,924***	***1,108***	***276,248***

Table 19: HAZUS-MH Results for Hurricanes

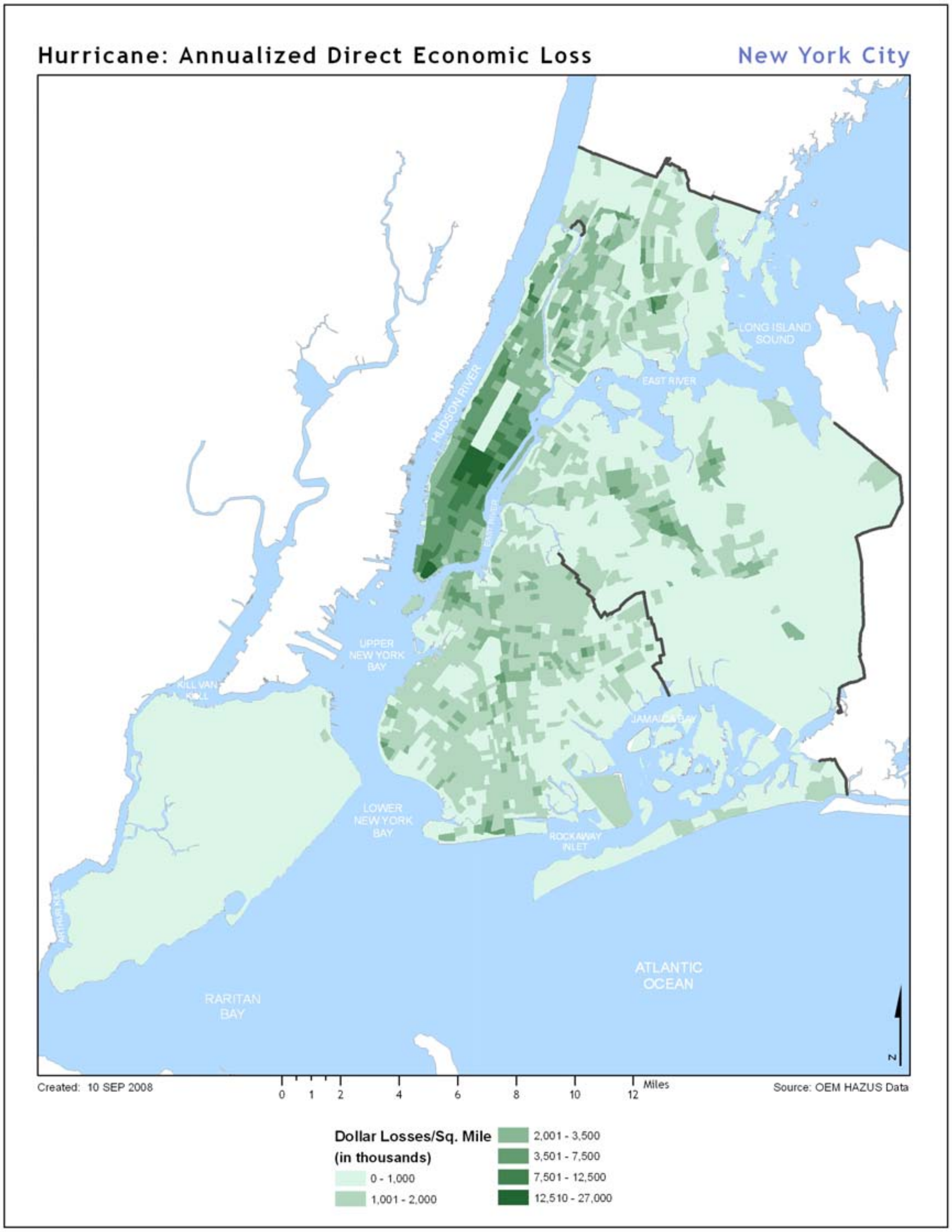


Figure 48: HAZUS-MH Results for Annualized Losses from a Hurricane

8) Drought Hazard Analysis for New York City

a) Hazard Profile

i) Hazard Description

The NWS describes four types of drought: meteorological, agricultural, hydrological, and socioeconomic.

Meteorological/climatological drought is defined in terms of the departure from a normal precipitation pattern and the duration of the drought hazard.
Meteorological/climatological drought has a slow-onset that usually takes at least three months to develop and may last for several seasons or years.

Agricultural droughts link the various characteristics of meteorological drought to agricultural impacts. The focus is on precipitation shortages and soil-water deficits. A plant's demand for water is dependent on prevailing weather conditions, biological characteristics of the specific plant, its stage of growth, and the physical and biological properties of the soil. This kind of drought has minimal direct impact to New York City because there is no significant agriculture activity within the City's boundaries.

Hydrological droughts refer to deficiencies in surface water and sub-surface water supplies. The frequency and severity of hydrological drought is often defined on a watershed basin scale. Although climate is a primary contributor, other factors such as changes in land use, land degradation, and the construction of dams all affect the hydrological characteristics of the basin. Hydrological droughts often lag behind meteorological and agricultural droughts.

Socioeconomic droughts occur when physical water shortage begins to affect the population, individually and collectively. Most socioeconomic definitions of drought associate it with supply, demand, and economic good.

Drought differs from other hazards in many ways. First, the effects of drought take a considerable amount of time to accumulate and the extent of the hazard can linger for prolonged periods after the drought itself has ceased. Second, the absence of a definitive and universally accepted definition of drought complicates the determination of whether a drought is occurring and the level of its severity. Third, compared to other natural hazards, the geographical area, impacts, and duration of drought are difficult to quantify. This is especially true in New York City because its water comes from three upstate sources.

ii) Severity

DEP has developed the New York City Drought Management Plan to guide the City's response to a drought. The Drought Management Plan has three phases: drought watch, drought warning, and drought emergency. Drought emergency is further subdivided into four stages, each with increasingly severe mandated use restrictions. The Drought Management Plan establishes guidelines for declaring a watch, warning, or emergency and the appropriate response for each phase. Factors such as prevailing hydrological and meteorological conditions, as well as certain operational considerations inform the guidelines.

DEP declares a *drought watch* when there is less than a 50% probability that either of the two largest reservoir systems, the Delaware (Cannonsville, Neversink, Pepacton, and Rondout reservoirs) or the Catskill (Ashokan and Schoharie reservoirs), will fill by the following June 1, the start of the water-year.

DEP declares a *drought warning* when there is less than a 33% probability that either the Delaware or Catskill Systems will fill by the next June 1.

DEP declares a *drought emergency* when there is a reasonable probability that, without the implementation of stringent measures to reduce consumption, a protracted dry period would drain the City's reservoirs. DEP estimates this probability during dry periods in consultation with the New York State Drought Management Task Force and the New York State Disaster Preparedness Commission. Analyses of the historical record, the pattern of the dry period months, water quality, sub-system storage balances, delivery system status, system construction, maintenance operations, snow cover, precipitation patterns, use forecasts, and other factors inform the estimation.

iii) Probability

Occasional drought is a normal, recurrent feature of virtually every climate in the United States. New York's average annual precipitation that ranges from 60 inches in the Catskills to 28 inches in the Lake Champlain Valley feeds the state of New York's streams, lakes, and coasts. However, even with a temperate moist climate, normal fluctuations in regional weather patterns can lead to periods of dry weather. The last severe droughts in New York State occurred in the mid 1960s and again in the early and mid 1980s. According to the National Drought Atlas, a guide to the severity, frequency, and duration of droughts for the continental United States measured in terms of precipitation and stream flow, weather that brings 62% of normal precipitation or less occurs only one year out of 50 in New York City.

iv) Location

Droughts can occur within any region of New York State. The major components of the New York City water system are shown in Figure 24 of this Plan, however, the location of the City's water supply system upstate makes it vulnerable to weather conditions outside its borders. As part of the New York State Drought Response Plan, NYSDEC subdivided New York State into different drought management regions. New York City is located in Drought Region IIA; however most of its watershed lies to the north in Region II.

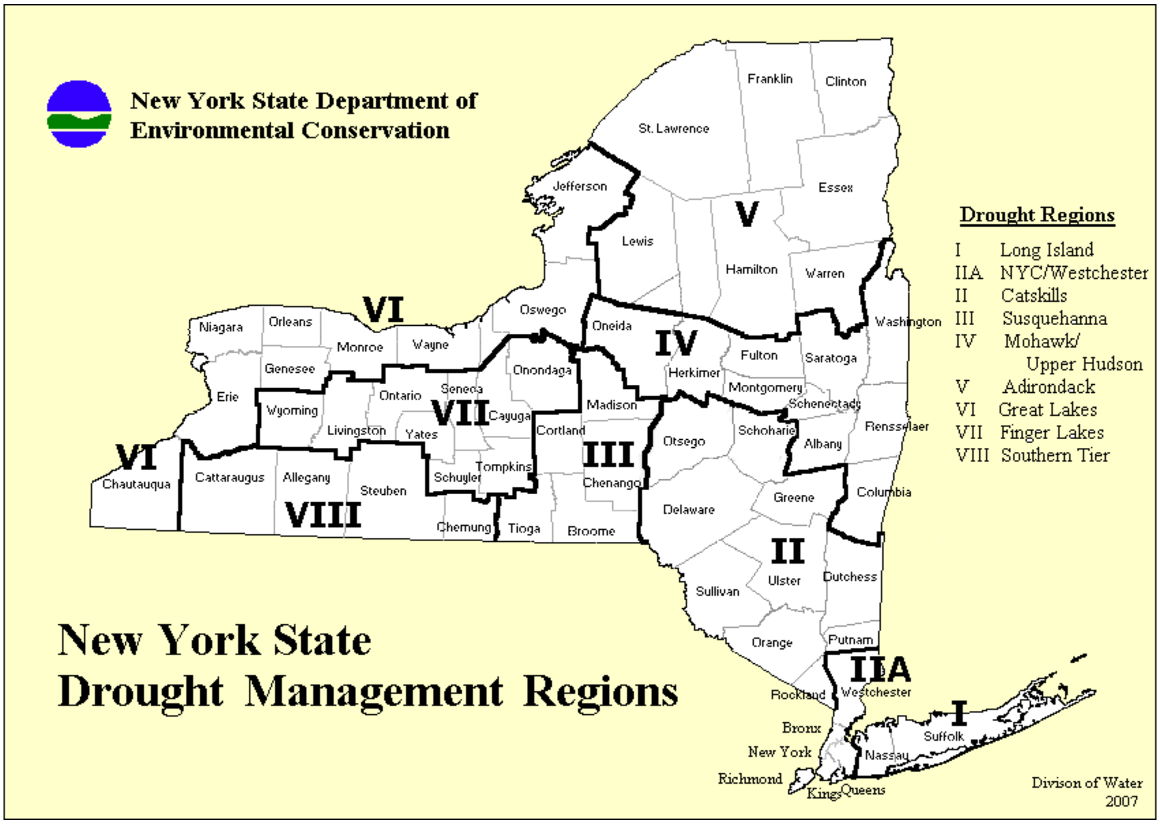


Figure 49: Drought Management Regions Map (Source: NYSDEC, 2007)

v) Historic Occurrences

Historic Occurrences of Drought in New York City			
Date	**Event**	**Location**	**Description**
1963–1965	Drought Emergency	Citywide	• Intense water conservation campaign Nov. 1963 until May 1964 • Aug. 18, 1965, federal government declared a water shortage disaster for New York City • New York State's only federal disaster declaration for a drought • No damages recorded for this event

Historic Occurrences of Drought in New York City			
Date	**Event**	**Location**	**Description**
1980–1982	Drought Emergency	Citywide	• Drought watch was issued in Oct. • Drought warning issued in Nov. • Drought emergency put into effect when water storage levels reached 33% on Jan. 1, 1981 • Downgraded to warning Jan. 18, 1982 and to watch on Nov. 11, 1982 • No damages recorded for this event
1985–1986	Drought Emergency	Citywide	• Drought watch issued Feb. 25, 1985 when water storage levels reached 50% • In span of two months, drought conditions upgraded from drought watch, to drought warning, to drought emergency • Downgraded to warning Nov. 1985 • Conditions restored to normal on Feb. 25, 1986 • No damages recorded for this event • New York State Drought Management Plan revised based on lessons learned from this and the previous 1980 drought occurrences
1989	Drought Emergency	Citywide	• Drought watch issued Jan. 17, 1989 when water-storage facilities were at 58% • Drought conditions were upgraded to drought emergency (Stage II) on Mar. 22, 1989 • Drought conditions downgraded to normal on May 15, 1989 • No damages recorded for this event
1991	Drought Warning	Citywide	• Drought watch issued Sept. 25, 1991 when water-storage facilities were at 53% • DEP subsequently issued drought warning • No damages recorded for this event

Historic Occurrences of Drought in New York City			
Date	**Event**	**Location**	**Description**
1995	Drought Warning	Citywide	• Drought watch issued July 5, 1995 when water-storage capacities fell to 84% • DEP issued drought warning on Sept. 13, 1995 • Conditions restored to normal Nov. 14, 1995 • No damages reported for this event
2001–2003	Drought Emergency	Citywide	• Drought watch issued Dec. 23, 2001 with water-storage capacity levels at 44% • One month later DEP issued drought warning • Drought emergency issued Apr. 1, 2002 • Over the next eight months, increased precipitation and reduced water consumption alleviated drought conditions • Conditions restored to normal Jan. 2, 2003 • No damages reported for this event

Table 20: Historic Occurrences of Drought in New York City

b) Vulnerability Assessment

i) Impact to New York City

Each drought produces a unique set of impacts, depending not only on its severity, duration, and spatial extent but also on ever-changing social conditions. A wide-range of factors, both physical and social, determine society's vulnerability to drought.

Understanding both direct and indirect impacts is one of the most significant challenges in preparing for drought. The direct impacts include loss of revenue from businesses reliant on water, such as car washes, landscapers, and manufacturers. In a drought, water use restrictions may force businesses to suspend all or a portion of their activities. The indirect impacts associated with drought may be far-reaching. The more removed the impact from the cause, the more complex the link to the cause. Indirect impacts are diffuse, making it very difficult to determine financial estimates of damages.

The following is a list of impacts associated with drought. Each one can directly or indirectly impact New York City's economy, environment, and people.

<table>
<tr><th colspan="3">Drought Impacts</th></tr>
<tr><th>Economy</th><th>Environment</th><th>People</th></tr>
<tr><td>• Damage to crops
• Increase in food prices
• Increased transportation costs for food
• Reduced dairy and livestock production
• Increased fire hazard
• Loss to recreational and tourism industry
• Revenue loss to water-reliant businesses
• Loss of hydro-electric power
• Loss of navigability of rivers and canals
• Reduction of economic development</td><td>• Reduction and degradation of fish and wildlife habitat
• Wind and water erosion of soils
• Loss of wetlands
• Increased number and severity of fires
• Air quality effects
• Damage to plant species, loss of biodiversity
• Lower water levels in reservoirs, lakes, and ponds
• Water quality effects (e.g., salt concentration, increased water temperature, pH, dissolved oxygen, turbidity)</td><td>• Food shortages
• Public dissatisfaction with government
• Loss of aesthetic values
• Reduction or modification of recreational activities
• Health issues related to use restrictions
• Increased fire hazard
• Mental and physical stress
• Decrease in quality of life
• Increased poverty
• Population migrations</td></tr>
</table>

Figure 50: Drought Impacts

ii) Structural Vulnerability

In general, drought does not cause structural damage and does not affect infrastructure such as highways, bridges, and electric conveyance systems. A rare exception is severe soil shrinkage. When it occurs, severe soil shrinkage compromises the foundation upon which the infrastructure stands. Soil shrinkage requires expansive soil, types of soil that shrink or swell as the moisture content decreases or increases, to cause any real damage. According to the U.S. Geological Survey (USGS), New York City soils do not have high swelling potential, therefore, there is a very low risk of structural damage associated with drought.

iii) Potential Loss Estimate

Although potential direct and indirect impacts are detailed above, accurate loss estimates for drought are not available. Reduced water levels and subsequent curtailment of water usage will have a direct economic impact on businesses and industries that are water-dependent. The indirect impacts associated with drought are far-reaching but so diffuse that financial estimates of potential damages are not feasible.

9) Earthquakes Hazard Analysis for New York City

a) Hazard Profile

i) Hazard Description

An earthquake is a sudden, rapid shaking of the earth caused by the breaking and shifting of rock beneath the earth's surface. Most earthquakes originate from faults, or a break in the rocks that make up the earth's crust, along which rocks on either side that have moved past each other. As the rocks move past each other, they occasionally stick, causing a gradual buildup of energy or strain. Eventually, this accumulated energy becomes so great that it is abruptly released in the form of seismic waves, which travel away from the earthquake's source (or focus) deep underground, causing the shaking (ground acceleration) at the earth's surface is known as an earthquake. The point on the earth's surface that is directly above the focus is the epicenter.

Ground acceleration caused by earthquakes has the potential to destroy buildings and infrastructure and cause loss of life. Aftershocks are typically smaller than the main shock, and can continue over a period of weeks, months, or years after the initial earthquake is felt. In addition to the effects of ground acceleration, earthquakes can also cause landslides and liquefaction under certain conditions. Liquefaction occurs when unconsolidated, saturated soils exhibit fluid-like properties due to intense shaking and vibrations experienced during an earthquake. Together, ground shaking, landslides, and liquefaction can damage or destroy buildings, disrupt utilities (i.e., gas, electric, phone, water), and trigger fires.

According to the USGS Earthquake Hazards Program, most earthquakes (roughly 90%) occur at the boundaries where the earth's tectonic plates meet, although it is possible for earthquakes to occur entirely within plates. New York City is located well within the North American plate, far from the plate boundary located approximately 2,000 miles east in the Atlantic Ocean. Seismic research is ongoing with regard to causes of earthquakes in regions far from plate margins. Regardless of where they are centered, earthquakes can affect locations beyond their point of origin.

ii) Severity

The terms magnitude and intensity are used to describe the overall severity of an earthquake. The severity of an earthquake depends on the amount of energy released at the epicenter, the distance from the epicenter, and the underlying soil type. All these factors affect how much the ground shakes, known as Peak Ground Acceleration (PGA) and what a building experiences, known as Spectral Acceleration (SA) during an earthquake.

An earthquake's magnitude is a measurement of the total amount of energy and is expressed in terms of the Richter scale. Intensity measures the effects of an earthquake at a particular place and is expressed in terms of the Modified Mercalli scale. Table 21 shows the approximate comparison between Richter scale magnitude and Modified Mercalli Intensity (MMI).

Magnitude and Intensity Comparison	
Richter Magnitude Scale	Typical Maximum MMI
1.0 to 3.0	I
3.0 to 3.9	II to III
4.0 to 4.9	IV to V
5.0 to 5.9	VI to VII
6.0 to 6.9	VII to IX
7.0 and Higher	VIII or Higher

Table 21: Magnitude and Intensity Comparison

Table 22 describes the effects of the various intensity ratings. According to the National Climatic Data Center, the strongest earthquake near New York City, which occurred on August 10, 1884 with a magnitude of 5.2 on the Richter scale, would have an intensity of VI to VII on the MMI scale.

MMI Scale Rating	
MMI	Damage/Perception
I	• Not felt except by a very few under especially favorable conditions
II	• Felt only by a few people at rest, especially on upper floors of buildings
III	• Felt quite noticeably by people indoors, especially on upper floors of buildings • Many people do not recognize it as an earthquake • Standing motor cars may rock slightly • Vibrations similar to the passing of a truck
IV	• Felt indoors by many, outdoors by few during the day • At night, some awakened • Dishes, windows, doors, disturbed; walls make cracking sound • Sensation like heavy truck striking building • Standing motor cars rocked noticeably
V	• Felt by nearly everyone; many awakened • Some dishes, windows broken • Unstable objects overturned • Pendulum clocks may stop
VI	• Felt by all; many frightened • Some heavy furniture moved • Few instances of fallen plaster • Damage slight
VII	• Damage negligible in buildings of good design and construction • Slight to moderate damage in well-built ordinary structures • Considerable damage in poorly built or badly designed structures • Some chimneys broken
VIII	• Damage slight in specially designed structures • Considerable damage in ordinary substantial buildings with partial collapse • Damage great in poorly built structures • Fall of chimneys, factory stacks, columns, monuments, walls

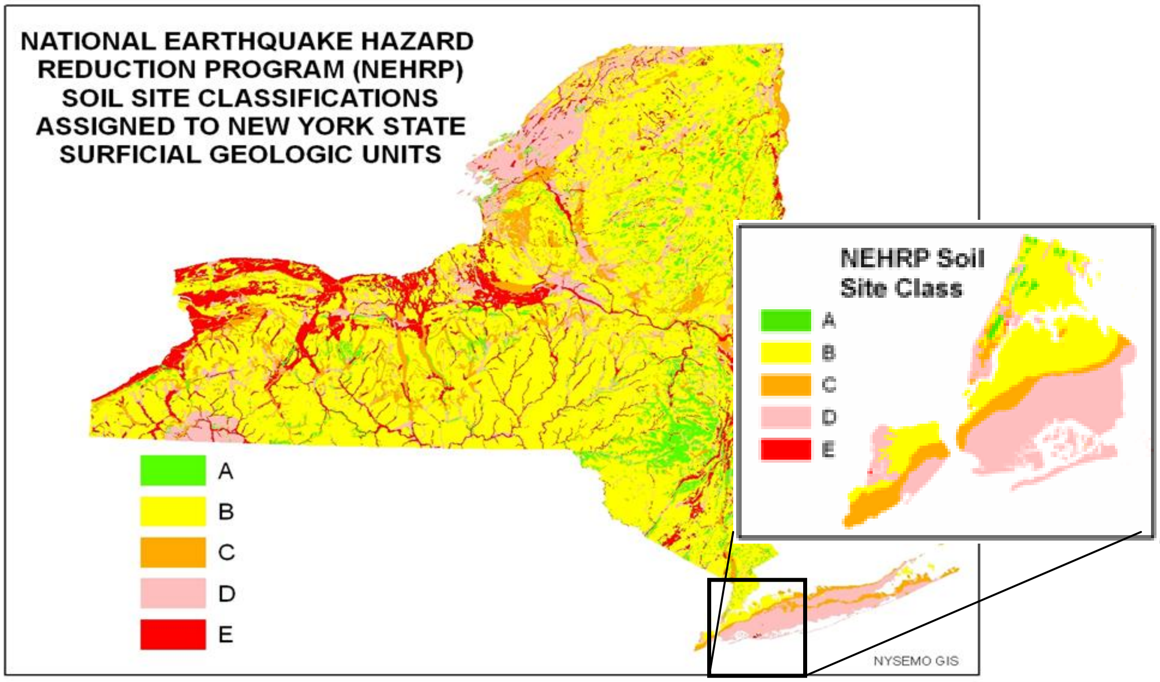
MMI Scale Rating	
MMI	**Damage/Perception**
	• Heavy furniture overturned
IX	• Damage considerable in specially designed structures • Well-designed frame structures thrown out of plumb • Damage great in substantial buildings, with partial collapse • Buildings shifted off foundations
X	• Some well-built wooden structures destroyed • Most masonry and frame structures destroyed with foundations • Rails bent
XI	• Few, if any masonry or frame structures remain standing • Bridges destroyed • Rails bent greatly
XII	• Total damage • Lines of sight and level are distorted • Objects thrown into the air

Table 22: MMI Scale

Soil type can have an impact on the severity of an earthquake at a given location. Seismic waves propagate out from the earthquake epicenter and travel outward through the bedrock up into the soil layers. As the waves move into the soils, how stiff or soft the soil is affects the wave speed and velocity. Generally, in a stiff or hard soil, the wave will travel at a higher velocity. With soft soils, the wave will slow, traveling at lower velocities. With slower waves, the seismic energy is modified, resulting in waves with greater amplitude. This amplification results in greater earthquake damage.

The NEHRP soil-classification system describes how soils affect seismic waves. Class A soils (shown in green) tend to reduce ground motions, whereas Class E soils (shown in red) tend to further amplify and magnify seismic waves.

As shown in Figure 51, New York City has a variety of NEHRP soil site classes ranging from hard rock to soft soil. Most of New York City is classified as Class B (rock) and Class D (soft to medium clays or sands).



Reduces Ground Motion	
A	Very hard rock (e.g., granite, gneisses; and most of the Adirondack Mountains)
B	Rock (sedimentary) or firm ground
C	Stiff Clay
D	Soft to medium clays or sands
E	Soft soil (including fill, loose sand, waterfront, lake bed clays)
Amplifies Ground Motion	

Figure 51: New York Soil Classifications (Source: NYSEMO, 2008)

PGA measures the rate of change in motion of the earth's surface and expresses it as a percent of the established rate of acceleration due to gravity (9.8 m/sec²). Figure 52 shows that PGA values of 3% to 4% of gravity have the potential to occur within New York City.

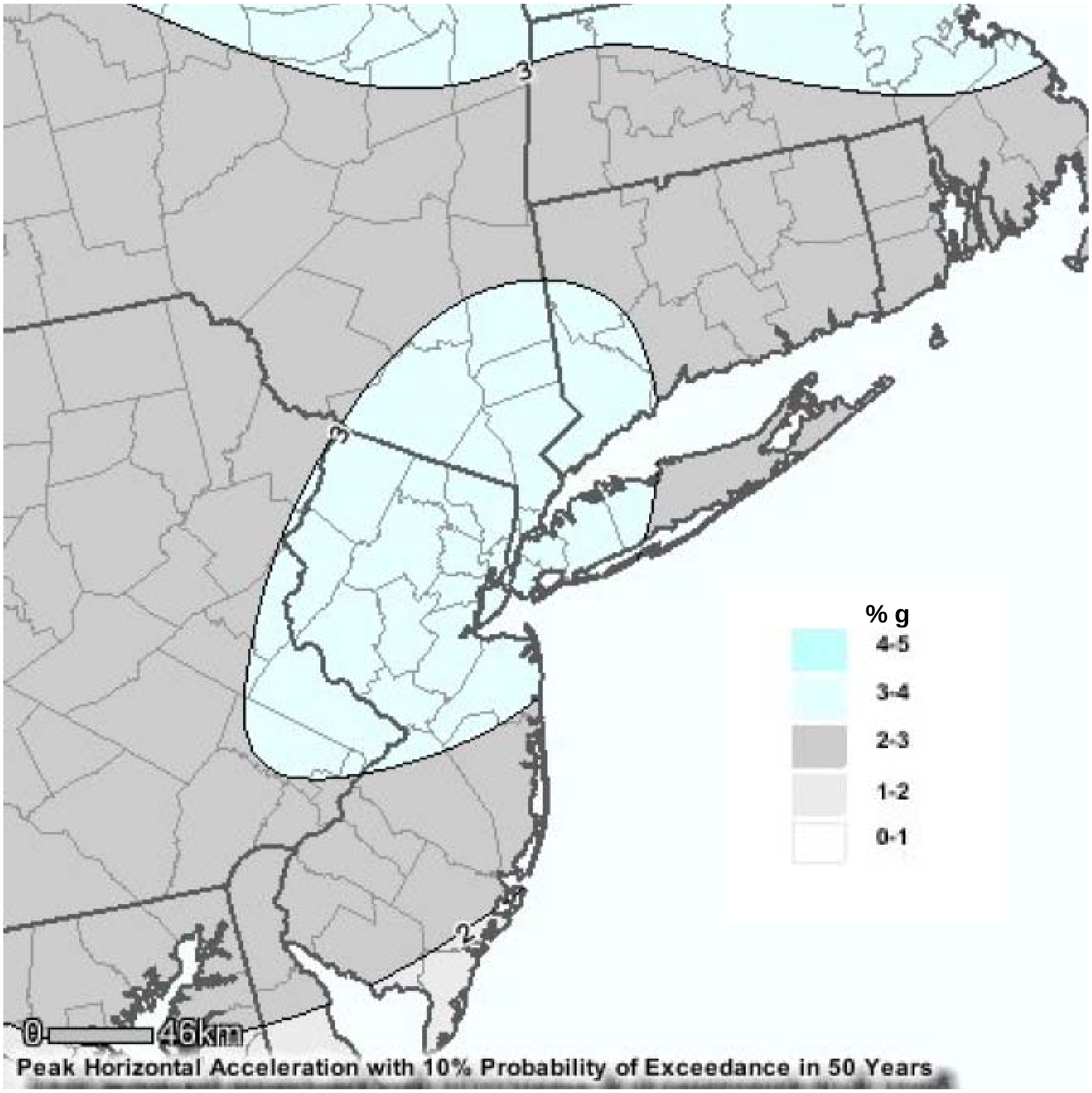


Figure 52: PGA in New York City (Source: National Seismic Hazards Maps, 2008)

An approximated relationship between MMI and PGA is shown in Table 23. The 3% to 4% PGA predicted above would result in an MMI intensity of IV (light perceived shaking and no damage).

Approximate Relationship between MMI and PGA			
MMI	Acceleration (%g) (PGA)	Perceived Shaking	Potential Damage
I	< .17	Not Felt	None
II	.17–1.4	Weak	None
III	.17–1.4	Weak	None
IV	1.4–3.9	Light	None
V	3.9–9.2	Moderate	Very Light
VI	9.2-18	Strong	Light
VII	18–34	Very Strong	Moderate
VIII	34–65	Severe	Moderate to Heavy
IX	65–124	Violent	Heavy
X	> 124	Extreme	Very Heavy
XI	> 124	Extreme	Very Heavy
XII	> 124	Extreme	Very Heavy

Table 23: Approximate Relationship between MMI and PGA

SA is approximately what is experienced by a building during an earthquake, as modeled by a particle mass on a mass-less vertical rod having the same natural period of vibration as the building. SA can be used as a better indicator of damage to specific buildings types and heights

The New York State Emergency Management Office (NYSEMO) created county-specific seismic hazard maps that reflect the soil's ability to affect seismic waves and the resulting SA experienced by a building. The maps are based on NYSGS shear-wave tests of the surficial soils. These maps facilitate a better understanding of local, seismic hazards by identifying areas of higher vulnerability within the City. This figure shows SA values of 25% to 75% of gravity have the potential to occur within New York City.
Figure 53 presents the adjusted USGS 0.2 sec SA with a 2% probability of exceedance within 50 years.

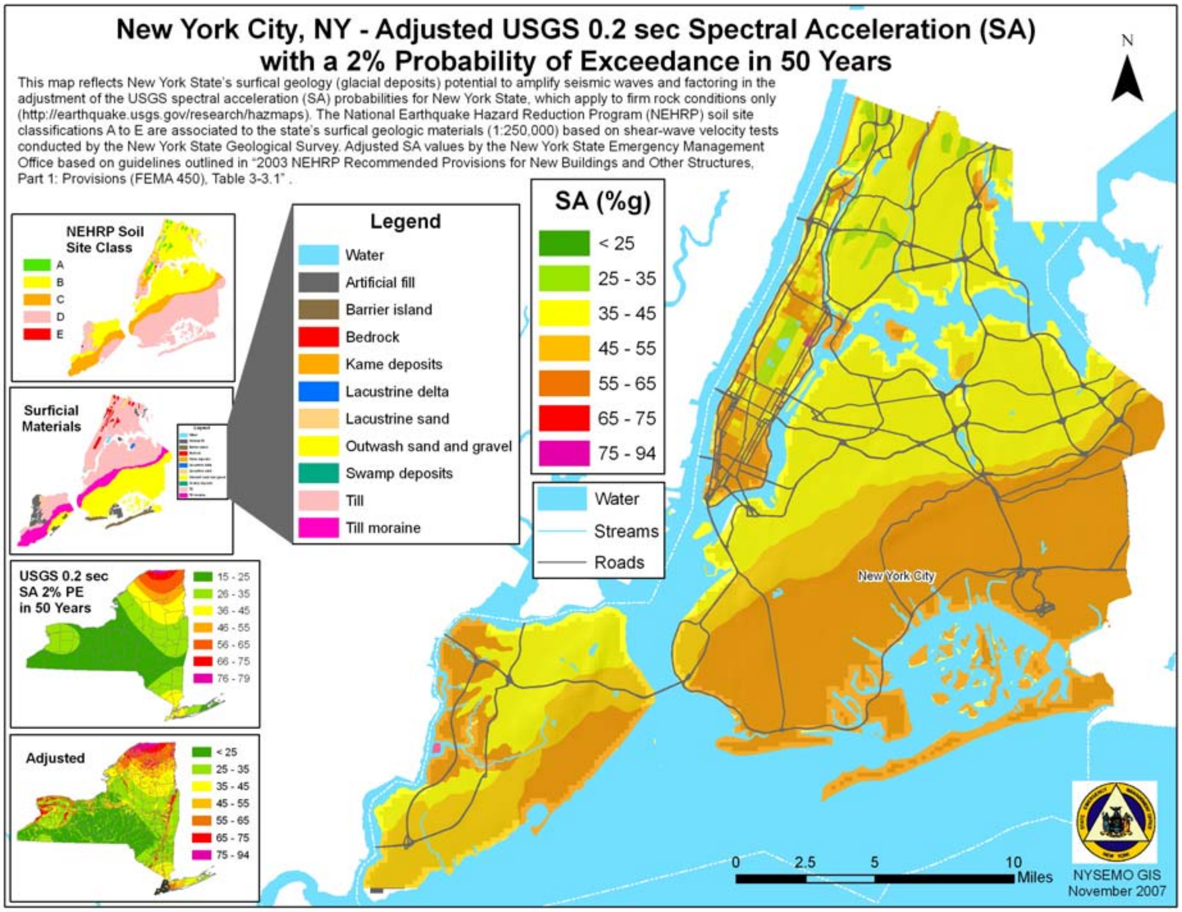


Figure 53: Adjusted USGS 0.2 Sec SA for New York City (Source: NYSEMO, 2008)

iii) Probability

Seismic hazard maps, or PGA maps, project the likelihood of an earthquake at a certain location over a given period.
Figure 53 is a USGS seismic hazard map for New York City. For New York City, a PGA value of 3% to 4% has a 10% chance of being exceeded over 50 years. This earthquake, if it did occur, would likely produce light to moderate perceived shaking and little to no physical damage.

The NYS HMP states New York State can expect a damaging earthquake about once every 22 years, and these events are more likely to occur within one of the three regional areas identified previously. New York City is included in the southernmost of these three regions. The State Plan references a NYSGS study by W. Mitrovonas, entitled, "Earthquake Hazard in New York State," which states, "…at present an earthquake of magnitude 3.5 to 4 occurs, on the average every three years somewhere in the State. Such earthquakes do not cause any appreciable damage (except for cracks in plaster, perhaps) but are large enough to be felt strongly by many people near the epicenter."

Although New York City is a region with low seismic hazard (infrequent damaging earthquakes), seismic risk is higher because of its tremendous assets, concentration of buildings, and the fragility of its structures, most of which have not been seismically designed.

iv) Location

Earthquakes are possible within any of New York City's counties. The earthquake hazard is not uniformly distributed throughout the City, as evidenced by higher SA values in certain parts of the City. These areas would likely experience more damage depending on their proximity to an earthquake's epicenter. Figure 54 shows the distribution of historical earthquake epicenters throughout New York City and the northeast region.

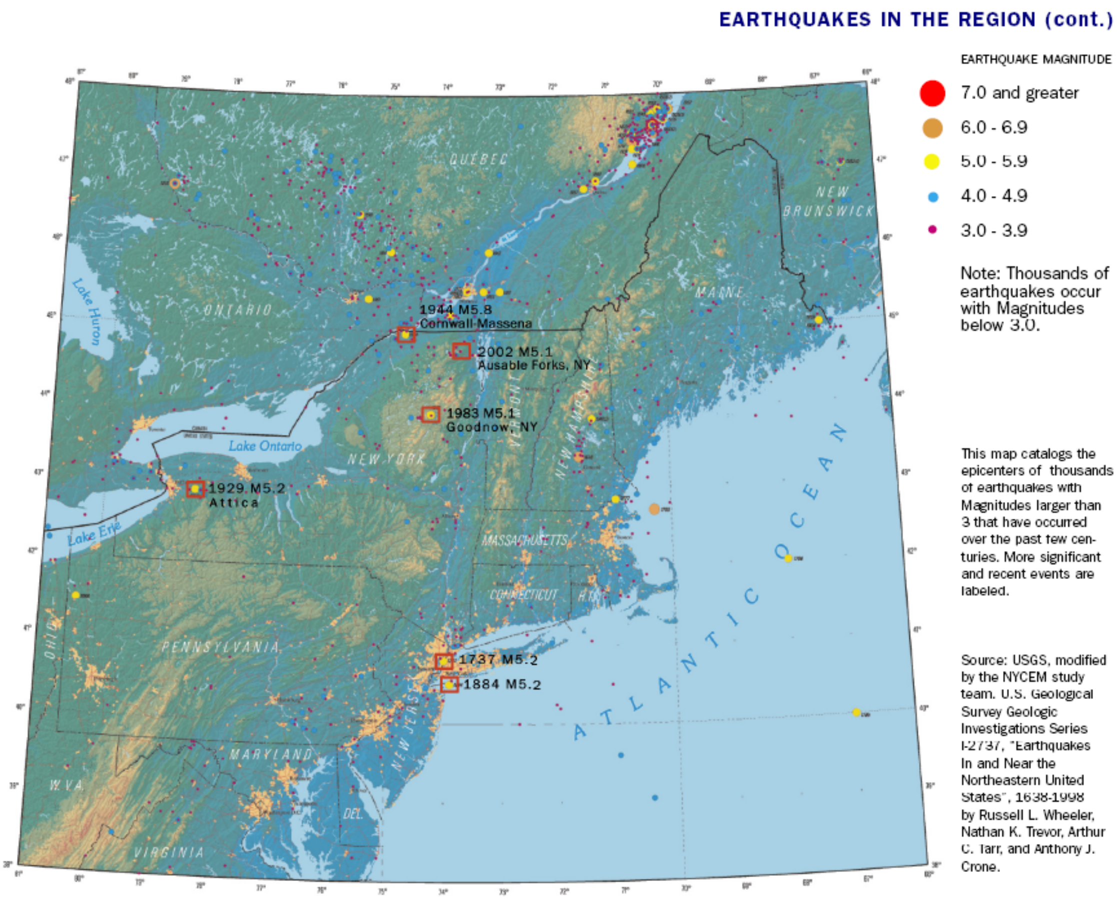


Figure 54: Epicenter of Earthquakes in the Northeast (Source: NYCEM, 2003)

v) Historic Occurrences

More than 400 earthquakes with Richter magnitude greater than 2.0 are on record in New York State between 1700 and 1986, but many more have occurred unrecorded. Table 24 shows a timeline of four historical earthquakes in New York City. It includes magnitude values from the Richter scale.

Historic Occurrences of Earthquakes in New York City			
Date	**Location**	**Richter Magnitude**	**Description**
Dec. 18, 1737	Citywide	5.2	Bells rang, several chimneys fell
Sept. 2, 1847	Citywide (offshore)	3.5	No reference and/or no damage reported
Aug. 10, 1884	Citywide	5.2	Chimneys and bricks fell, walls cracked
July 9, 1937	Brooklyn	3.5	No reference and/or no damage reported

Table 24: Historic Occurrences of Earthquakes in New York City

b) Vulnerability Assessment

i) Impact to New York City

The infrequency of major earthquakes, coupled with relatively low magnitude events in the past, has led the public to perceive New York City is not vulnerable to a damaging earthquake. This perception has allowed New York City to develop largely without regard for earthquake safety. While the City does not sit on a major fault system, like the San Andreas in California, it is susceptible to earthquakes that originate in or near the City.

A high-magnitude earthquake could cause significant financial losses, casualties, and disruptions in critical facilities and services. New York City's unreinforced masonry buildings and underground infrastructure are especially vulnerable to ground acceleration caused by earthquakes. Upstate dams and aqueducts are also a concern and could incur serious damage from an earthquake, affecting the water supply to New York City.

Table 25 and Table 26 describe the potential impact of a variety of earthquake scenarios in and around New York City as modeled in the New York City Area Consortium for Earthquake Loss Mitigation (NYCEM) Study published in 2003.

Deterministic Results of the NYCEM Study (Summary)								
Richter Scale	Building Damage (billion)	Income Loss (billion)	Total (billion)	Hospitalization (people)	Shelter Required (people)	Fires	Buildings Completely Damaged	Debris (million tons)
5	$4.4	$0.4	**$4.8**	24	2800	500	45	1.6
6	$28.5	$10.8	**$39.3**	2,296	197,705	900	2,600	31.9
7	$139.8	$57.1	**$196.8**	13,171	766,746	1,200	12,800	132.1

Note: Epicenter located at historic August 10, 1884 location

Table 25: Summary of Deterministic Results of the NYCEM Study (Source: NYCEM, 2003)

Probabilistic Results of the NYCEM Study (Summary)								
Return Period	Building Damage (billion)	Income Loss (billion)	Total (billion)	Hospitalization (people)	Shelter Required (people)	Fires	Buildings Completely Damaged	Debris (million tons)
100-year	$0.1	$0.1	**$0.2**	0	0	0	0	0.2
500-year	$6.1	$2.0	**$8.1**	28	575	50	100	3.1
2,500-year	$64.3	$20.4	**$84.8**	1,430	84,626	900	2,200	34.0
Annualized Losses	$0.1	$0.1	**$0.2**	N/A	N/A	N/A	N/A	N/A

Table 26: Summary of Probabilistic Results of the NYCEM Study (Source: NYCEM, 2003)

ii) Structural Vulnerability

A building's construction is a key factor in how well it can withstand the forces produced by earthquakes. Unreinforced masonry buildings are most at risk in an earthquake because the walls are prone to collapse outward. Steel and wood buildings have more ability to absorb the energy from an earthquake. Wood buildings with proper foundation ties have rarely collapsed in earthquakes.

The greatest concentration of masonry buildings are found in Brooklyn (178,920) followed by Queens (115,062), the Bronx (54,434), Manhattan (28,762) and Staten Island (8,870). Masonry buildings make up roughly 48% of the buildings in all of New York City. It is likely Brooklyn, the Bronx, and Queens would sustain the highest amounts of building damage during an earthquake. This estimation is refined further in the HAZUS-MH analysis presented below.

DOB has addressed structural vulnerability for earthquakes in the revised Construction Code. The current code contains seismic provisions that, in effect, require a building to be "stronger" by requiring designers to increase the load the building can withstand. The newly enacted code not only makes buildings "stronger," but also "flexible." For example, the type of soil and foundation underpinning of the building will be taken into account, and seismic detailing is required to ensure the joints and connections of a building hold up during an earthquake. Inspections are also required during construction to ensure seismic features are built correctly. Furthermore, as they are in the old code, critical facilities—such as firehouses and hospitals will be designed under the revised code to not only survive an earthquake, but also remain open and functional afterwards. For more information on the New York City Construction Code, see page 57.

The Planning Team used HAZUS-MH to estimate losses and structural vulnerability for earthquakes in New York City. The Planning Team used a probabilistic model for earthquakes. The probability is expressed as a percent chance that an earthquake of a specific magnitude will occur in any given year. For example, an earthquake with a 100-year return period, or occurrence rate, has a 1% chance of occurring in any one year. This is also called a 100-year return period.

Probabilistic Modeling	
Return Period (Years)	**Chance of Occurrence in Any Given Year (%)**
100	1
200	0.5
250	0.4
500	0.2
1,000	0.1
2,500	0.04

Table 27: Return Periods for Probabilistic Modeling for Earthquakes

The Planning Team ran HAZUS-MH for 100, 250, 500, 1,000, and 2,500-year return periods. The return period is the expected probability an earthquake will occur during that time. At the 100-year return period, HAZUS-MH estimates 96 buildings will experience damage, but no buildings will experience complete destruction. The 2,500-year return-period estimates 257,661 structures, or nearly one third of the City's current building stock, will experience damage.

Earthquake Building Damage by Return Period					
Return Period (Years)	**Slight**	**Moderate**	**Extensive**	**Complete Destruction**	**Total**
100	74	20	2	0	***96***
250	42,639	4,116	515	44	***47,314***
500	35,147	13,284	2,193	232	***50,856***
1,000	71,248	31,502	6,683	890	***110,323***
2,500	139,814	84,067	27,287	6,493	***257,661***

Table 28: Calculation of Number of Buildings Damaged from an Earthquake by Return Period

Earthquakes are a citywide hazard; therefore, all buildings are vulnerable to an earthquake. Depending on the epicenter, depth and magnitude of the earthquake, certain structures will experience more damage than others will.

iii) Potential Loss Estimate

The Planning Team used HAZUS-MH to calculate building damage from an earthquake at the county level. Table 29 and Figure 55 display HAZUS-MH estimates of annualized capital stock losses. Annualized losses are an estimated long-term value of earthquake losses to the general building stock in any single year for New York City. Overall, New York City has a total annualized loss of $45.2 million from earthquakes. More than half of this cost is from non-structural damage or damage done to architectural, mechanical, and/or electric components of the building. Manhattan and Brooklyn have the highest annualized losses of the five boroughs with 67% of the citywide losses.

Annualized Capital Stock Losses for Earthquakes ($1,000s)				
Borough	**Structural Damage**	**Non-Structural Damage**	**Contents Damage**	**Total**
Brooklyn	2,883	9,002	2,932	***14,817***
Bronx	825	2,594	851	***4,270***
Manhattan	3,056	9,893	3,593	***16,542***
Queens	1,542	4,881	1,776	***8,200***
Staten Island	217	837	363	***1,417***
Total	***8,524***	***27,207***	***9,516***	***45,247***

Table 29: HAZUS-MH Calculation of Annualized Capital Stock Losses for Earthquakes

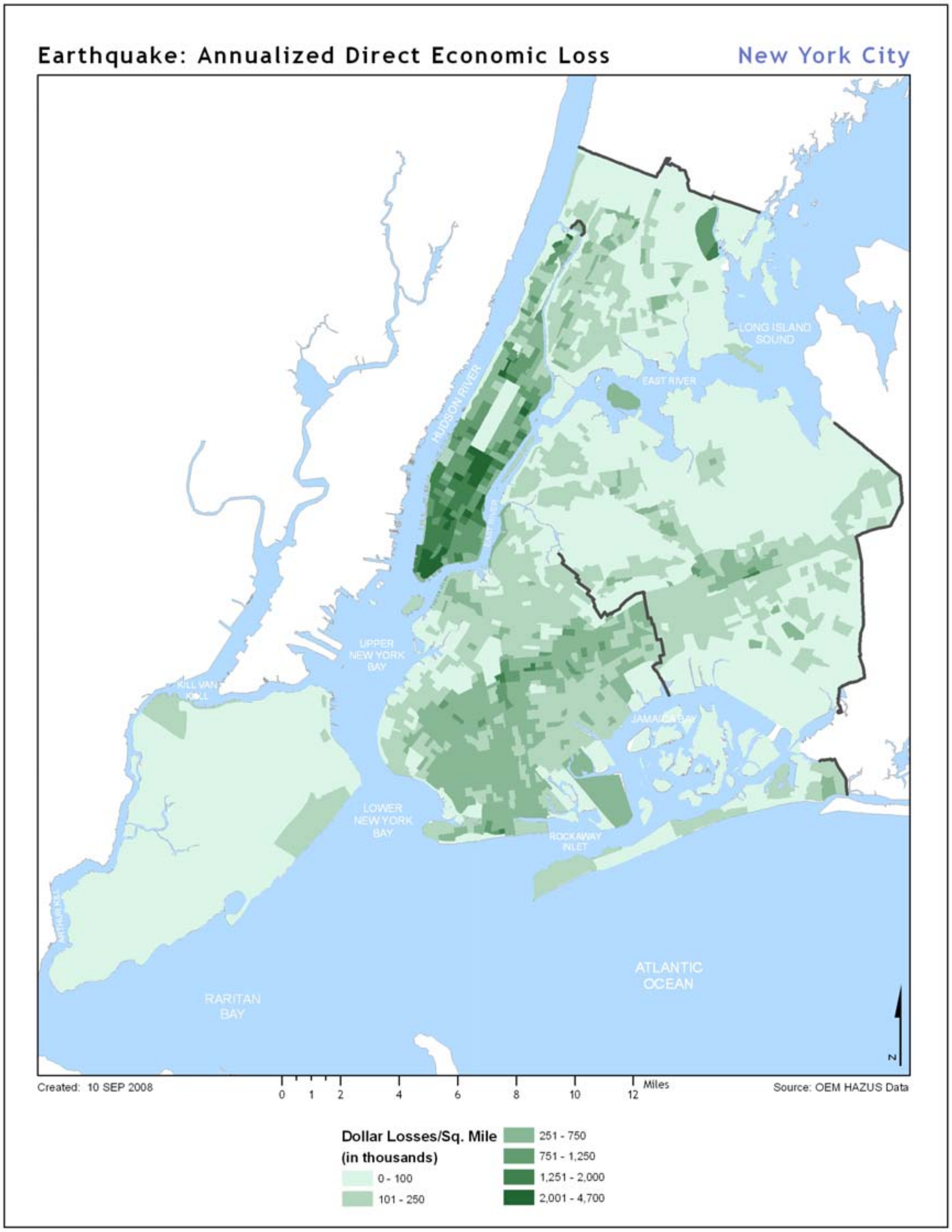


Figure 55: HAZUS-MH Results for Annualized Losses from an Earthquake

10) Extreme Temperatures Hazard Analysis for New York City

a) Hazard Profile

i) Hazard Description

Extreme temperatures, both cold and hot, have a significant effect on human health and/or infrastructure. Weather conditions that represent extreme cold or heat vary across the different areas of the country because people experience a range of average temperatures based on their particular region.

Extreme Heat
Temperatures that hover 10 degrees or more above the average high temperature for a region, and last for several weeks, constitute an extreme heat event. During summer months, high atmospheric pressure traps hazy and damp air near the ground, creating a humid and muggy dome throughout New York City. Prolonged exposure to extreme heat may lead to serious health problems, including heat stroke, heat exhaustion, or sunburn. Seniors, young children, and those who are sick or overweight are more likely to succumb to extreme heat. New York City receives advisories from the NWS when the predicted heat index is greater than 100° F for one or more days, or the predicted heat index is 95° F or greater for two or more days. These advisories are based on historical weather analysis and mortality data analysis conducted by DOHMH. Based on these advisories and consultation with the NWS, the City activates its Heat Emergency Plan.

Extreme Cold
Extreme cold events are days where the mean daily temperature (average of the high and low recorded temperatures over a 24-hour period) falls below 32° F. Prolonged exposure to extreme cold temperatures will lead to serious health problems such as hypothermia, cold stress, frostbite, or freezing of the exposed extremities such as fingers, toes, nose and earlobes. Infants, seniors, people who are homeless, and those living in a home without adequate heat are most susceptible to such conditions. As the temperature drops and wind speed increases heat can leave the body more rapidly. This phenomenon is known as the wind-chill effect, which can exacerbate an extreme cold event.

Compared to other natural hazards, fatalities caused by extreme temperatures ranks the highest in the United States, with 188 deaths every year. Between 1994 and 2007, there were 89 heat-related fatalities in New York City. This total does not account for deaths that were accelerated because of extreme heat conditions. New York City's Office of the Chief Medical Examiner classifies a death as heat-related if two of the following three criteria exist: 1) pathologically elevated core-body temperature of the decedent, usually greater than 105° F at the time of or immediately after death; 2) substantial environmental or circumstantial evidence of heat as a contributor to death; and/or 3) decedent in a decomposed condition without evidence of other cause of death. Based on these criteria, the numbers of heat-related deaths can be substantially lower from what other cities report.

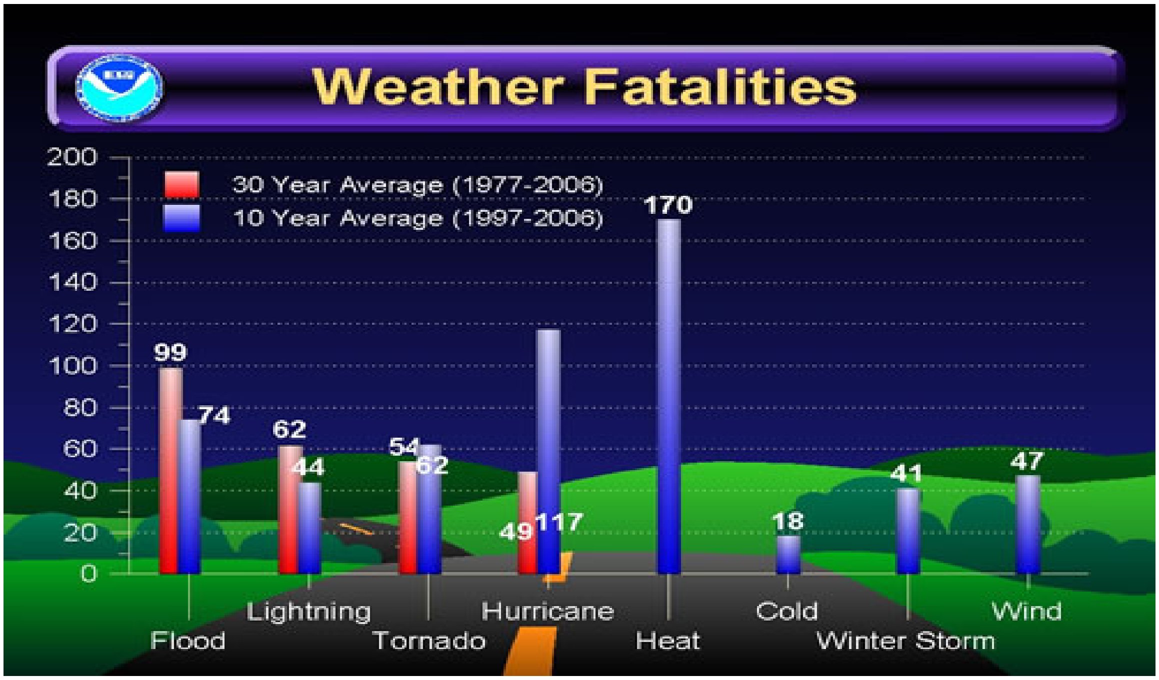


Figure 56: National Weather Fatalities (Source: NOAA, 2006)

ii) Severity

Extreme heat

The NWS heat index is a chart that measures the apparent temperature of the air as it increases with relative humidity. The NWS uses the heat index to determine what effects the temperature and humidity will have on the population. The heat index table describes the adverse effects that prolonged exposure can have on individuals. The NWS devised heat index values for shady, light wind conditions. Exposure to full sunshine can increase heat index values by up to 15 degrees. In addition, strong winds, particularly with very hot, dry air are extremely hazardous to individuals.

To aid in the prediction of and response to an extreme heat event, the NWS provides alerts to New York City when heat indices approach hazardous levels. Table 30 provides the alert procedures for the NWS. Upon issuing an extreme heat advisory, the NWS does the following:

- Includes heat index values and City forecasts
- Issues special weather statements including who is most at risk, safety rules for reducing risk, and the extent of the hazard and heat index values
- Assists state/local health officials in preparing civil emergency messages for the severe heat wave

NWS Heat Index Scale

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution   Extreme Caution   Danger   Extreme Danger

Table 30: NWS Apparent Temperature Product (Source: NWS, 2008)

Health Hazards Associated with Heat Index Values		
Category	**Heat Index**	**Health Hazards**
Extreme Danger	**130°F-Higher**	**Heat Stroke/Sunstroke is likely with continued exposure**
Danger	**105°F-129°F**	**Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity**
Extreme Caution	**90°F-105°F**	**Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity**
Caution	**80°F-90°F**	**Fatigue possible with prolonged exposure and/or physical activity**

Table 31: Adverse Conditions Associated with the Heat Index

When conditions warrant, the NWS issues heat-related weather products for New York City. Table 32 describes criteria for these products.

NWS Heat Products	
Product	**Criteria**
Heat Advisory (New York City)	Issued within 24 hours prior to onset of any of the following conditions: • Heat index of at least 100° F but less than 105° F for any period of time • Maximum heat index of 95°F or greater for two consecutive days • Nighttime lows above 80° F for any period of time
Excessive Heat Watch	Issued within 48 hours prior to onset of the following conditions: • Heat index of at least 105° F for more than 3 hours per day for 2 consecutive days • Heat index of at least 115° F for any time of 95° F or higher for two consecutive days
Excessive Heat Warning	Issued within 24 hours of onset of the following conditions: • Heat index of at least 105° F for more than 3 hours per day for 2 consecutive days • Heat index of more than 115° F for any time period

Table 32: NWS Extreme Heat Weather Products

Extreme Cold

The NWS created a wind chill chart that measures apparent temperature felt on exposed skin due to the combination of air temperature and wind speed.

NWS Windchill Chart

Temperature (°F)

Wind (mph) / Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Table 33: NWS Windchill Chart (Source: NWS, 2008)

When conditions warrant, the NWS issues wind chill products for New York City. Table 34 describes criteria for these weather products.

NWS Wind Chill Products	
Product	**Description**
Wind Chill Watch	Issued by the NWS when there is a chance that wind chill temperatures will decrease to at least 24º F below zero during the next 24 to 48 hours
Wind Chill Advisory	Issued when the wind chill could be life threatening if action is not taken. The criteria for this advisory are expected wind chill readings of 15º F to 24º F degrees below zero
Wind Chill Warning	Issued when wind chill readings are life threatening. Wind chill readings of 25º F below zero or lower are expected

Table 34: NWS Wind Chill Products

iii) Probability

Based on data from DOHMH, New York City residents can expect approximately four extreme heat events per year (totaling nine days) where the heat index is 100° F or greater for one or more days, or a heat index of 95° F or greater for two or more days. Scientists predict the effects of global warming will cause this number to increase.

According to NWS data, New York City residents can expect approximately 25 days per year where the mean daily temperature falls below 32° F.

iv) Location

Extreme temperatures affect all of New York City. However, an urban environment can exacerbate an extreme heat event. This is known as the urban heat island effect. Figure 57 a thermal image of New York City, taken on July 22, 2002, one of the hottest days of that year. The second map displays the City's vegetative cover. Based on a comparison of the two images, hotspots generally correlate to areas that lack vegetation. These areas within the City are of greatest vulnerability during extreme heat events. For both extreme heat and cold, there are geographic variations in vulnerability due to demographic features, such as concentrations of seniors, young children, and individuals living below the poverty line (who are less likely to have adequate heat and air conditioning). See the Demographics section on page 16.

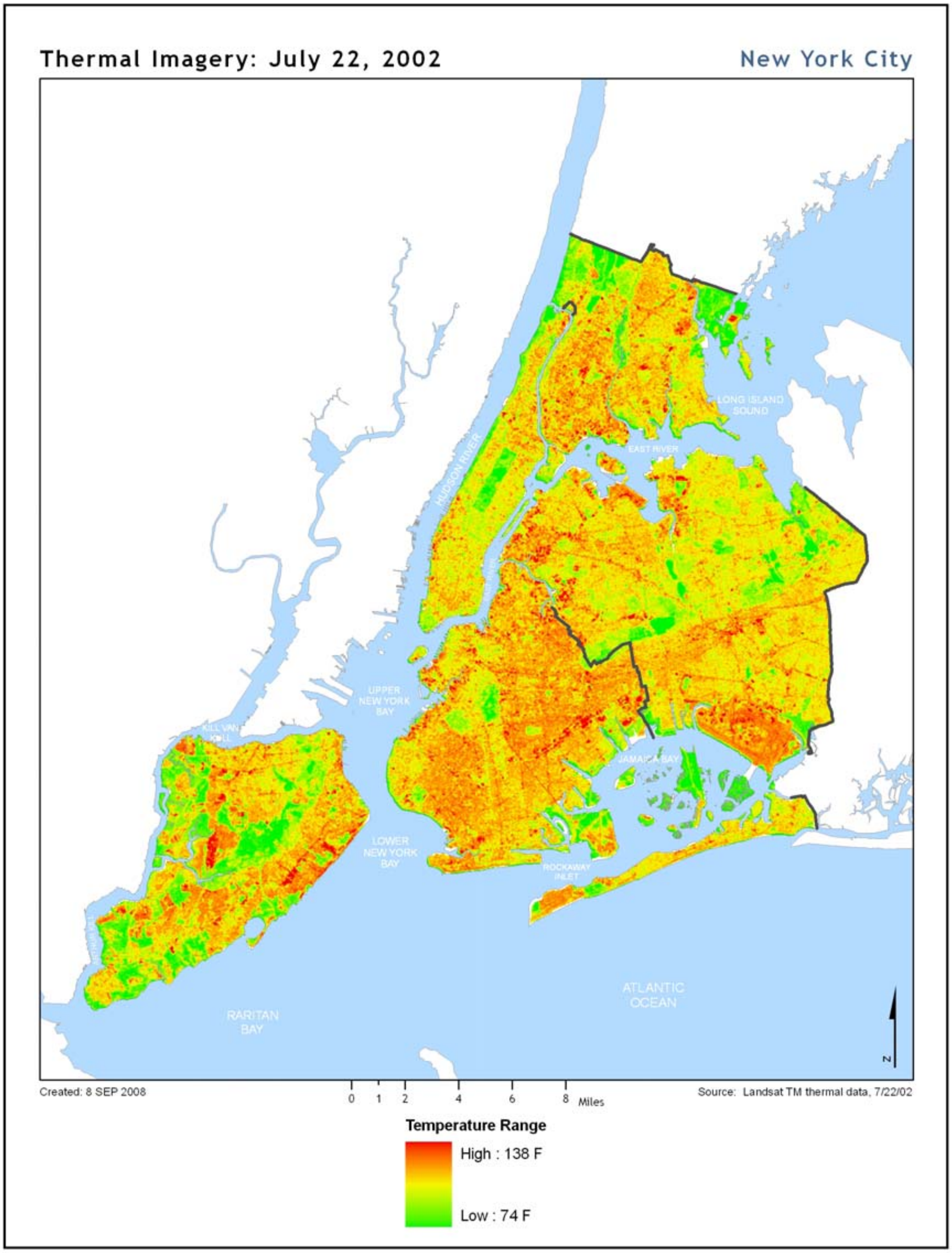


Figure 57: New York City Thermal Imagery Taken on July 22, 2002

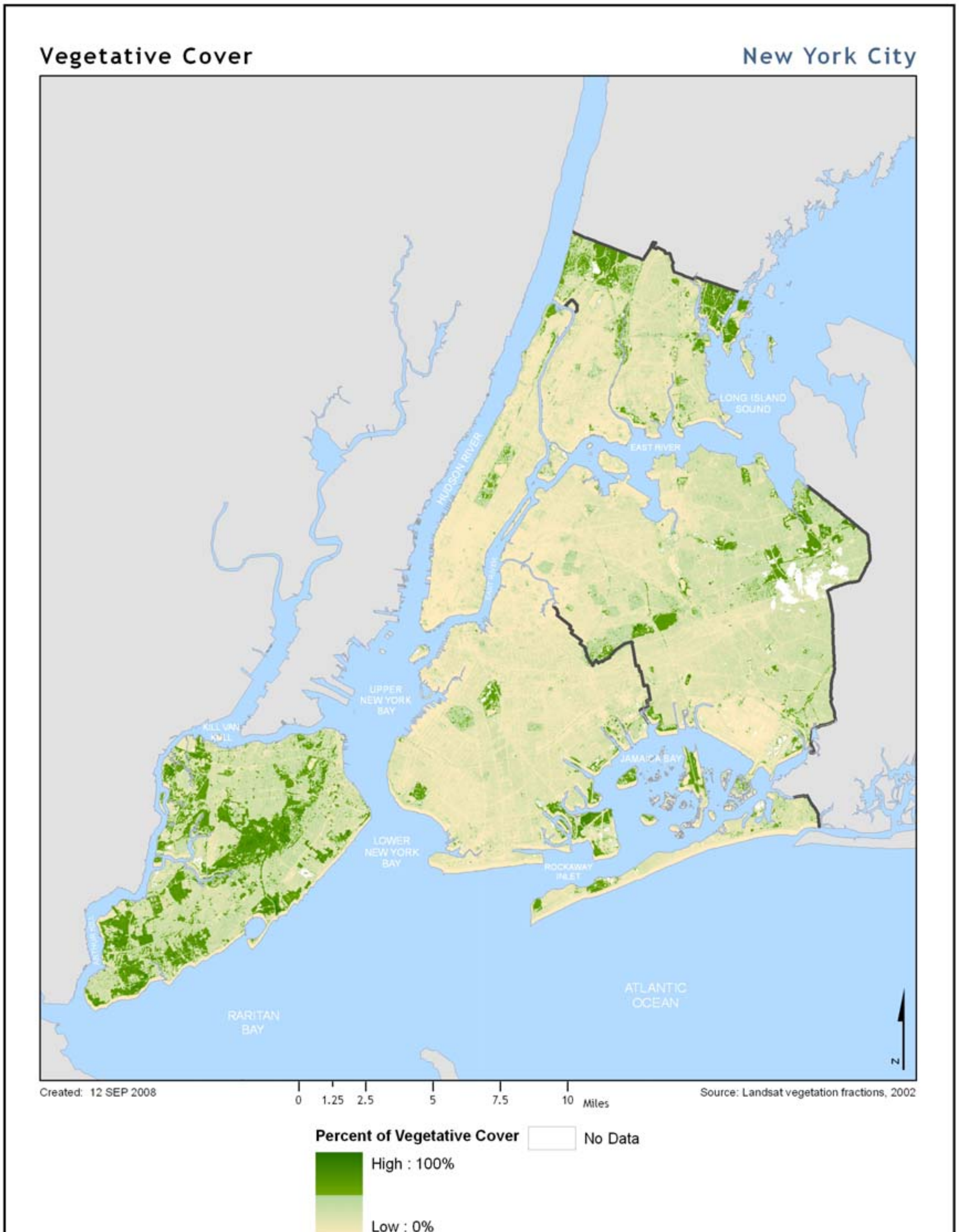


Figure 58: New York City Vegetative Cover

v) Historic Occurrences

Historic Occurrences of Extreme Temperatures in New York City			
Date	**Event**	**Location**	**Description**
Jul. 13, 1995	Extreme Heat	Citywide	• Temperatures rose to a record high of 102° F in Central Park • Responsible for 7 deaths in New York City • Hundreds treated for heat-related illness
Jul. 4–6, 1999	Extreme Heat	Citywide	• Extremely hot and humid air mass covered the region July 4–6 • July 4, temperatures soared into the mid and upper 90s • Heat indices from 100 to 105° F • Widespread blackouts observed throughout the region • Responsible for 31 deaths in New York City.
Jan. 17–18, 2000	Extreme Cold	Citywide	• Arctic cold front swept across the region Jan. 16 • Strong and gusty northwest winds combined with well below normal temperatures • Extremely low windchill values • Responsible for 3 deaths: 2 homeless men, and a hospital patient who wandered outdoors
Jan. 21, 2000	Extreme Cold	Citywide	• Northwest winds averaged 52 mph at LaGuardia Airport from around 2 PM to 8 PM • Temperatures fell to around 10° F; windchill values plummeted to –30° F along the coast and –35° F inland • No deaths reported for this event
Jan. 27–28, 2000	Extreme Cold	Citywide	• Extremely low windchill values • JFK Airport: windchill of –30° F around 8 AM on the 28th when the temperature was 9° F and the wind speed was 24 mph • LaGuardia Airport: windchill of –28° F • No deaths reported for this event.

Historic Occurrences of Extreme Temperatures in New York City			
Date	**Event**	**Location**	**Description**
Aug. 8–10, 2001	Extreme Heat	Citywide	• Bermuda high-pressure system "pumped" hot temperatures and high humidity across the region • 6-day heat wave began on Sunday, August 5, when temperatures first reached 90° F at Central Park • High temperatures at Central Park reached 103° F on the 9th and 99° F on the 7th and 8th • Heat indices ranged between 105 and 110° F • OEM opened cooling centers throughout the City • Responsible for four deaths
July 2–4, 2002	Extreme Heat	Citywide	• Temperatures rose into the mid and upper 90s across the region • Overnight low temperatures remained in the lower 80s • Temperatures averaged 10 to 15° F above normal • July 4, the temperature reached 98° F at LaGuardia Airport, which set a new record • Heat indices from 100 to 105° F • Cooling centers opened across the City • No deaths reported for this event
July 29–Aug. 5, 2004	Extreme Heat	Citywide	• 8-day heat wave began on July 29 and extended through Aug. 5 • High temperatures mid and upper 90s • Heat indices 100 to 105° F on July 29; 95 to 100° F on July 30 and 31 • No deaths reported for this event
Aug. 1–3, 2006	Extreme Heat	Citywide	• 3 consecutive days of excessive heat • Temperatures in the 90s to 100° F • Heat indices ranged from 105 to 115° F • Responsible for 40 deaths in New York City • Scattered power outages • OEM opened 383 cooling centers. Record temperatures set throughout the region
Feb. 4–8, 2007	Extreme Cold	Citywide	• Arctic air mass produced subfreezing temperatures • Daily mean temperature averaged 15° F below normal for 5 consecutive days • 11 fatalities reported due to hypothermia

Historic Occurrences of Extreme Temperatures in New York City			
Date	**Event**	**Location**	**Description**
Mar. 6–9, 2007	Extreme Cold	Citywide	• Arctic air mass produced temperatures 19° F below normal for 3 consecutive days • One fatality reported

Table 35: Historic Occurrences of Extreme Temperatures in New York City

b) Vulnerability Assessment

i) Impact to New York City

New York City's urban environment exacerbates hazardous conditions resulting from extreme heat. Conditions that induce heat-related illnesses include stagnant atmospheric conditions and poor air quality. Consequently, people living in New York City are at greater risk from the effects of a heat wave than those living in less urbanized areas. New York City also has a large number of individuals who may be susceptible to extreme heat conditions, such as seniors and those living below the poverty line.

The built environment of New York City greatly contributes to the phenomenon of the urban heat-island effect. Heat islands develop when built surfaces replace a large portion of natural land. Incoming solar radiation is trapped during the day and is then re-radiated at night. This slows the cooling process, keeping nighttime air temperatures high, relative to temperatures in less urbanized areas. According to meteorologists, a heat island is a well-defined area where temperatures are higher than the surrounding region, sometimes as much as 15º F higher. In infrared satellite photographs of New York City, particularly at night, the City appears as a distinct "heat island," as much as 20º F warmer than the surrounding suburbs.

Concrete, asphalt, and metal absorb the sun's heat during the day before radiating it out into the environment at night. These materials trap solar radiation faster than wooded parks and suburban lawns and fields, and hence cool more slowly, radiating a furnace-like heat. Other by-products of the City's activities, such as exhaust fumes, burning furnaces, heating units, smokestacks, and even New York City's dense population, contribute to this phenomenon. In addition, the City's numerous tall buildings block the path of cooling winds from the Atlantic Ocean. Generally, wind speeds greater than 15 to 20 miles per hour can substantially dissipate heat and reduce the heat island effect.

A link exists between extreme heat and power disruptions. During the summer months, when temperatures rise above 90° F, demand for electricity also rises to operate air conditioners, fans, and other devices. This increase in demand stresses the electrical generation, transmission, and distribution infrastructure, which in turn increases the likelihood that sections or components of the electrical system will fail, causing power outages.

During hot weather, some people illegally open fire hydrants for use as sprinklers. The resulting drop in system water pressure can reduce firefighting capabilities and create potentially life-threatening situations for the public. Hydrant spray caps reduce the discharge of open hydrants from approximately 1,000 gallons per minute to 25 gallons per minute. FDNY distributes hydrant spray caps to the public to prevent this waste.

During periods of extreme cold and hot temperatures, inadequate protection from harsh elements is especially dangerous. Consequently, during extreme temperature conditions, New York City's homeless population is especially vulnerable. Both the New York City Heat and Winter Weather Emergency Plans include strategies for outreach to these populations.

ii) Structural Vulnerability

A large portion of New York City's utility infrastructure is susceptible to cracks and breaks from extreme temperatures. During the winter periods, frozen pipes are a routine occurrence. This can create service interruptions in water, drainage, and gas supply. To limit these effects, utility providers monitor conditions, perform routine maintenance, and address problems as they arise. Although buildings in New York City are generally not susceptible to extreme temperatures, some provisions in the building code aim to reduce the effects of extreme heat or cold. Movable bridges within New York City are susceptible to damage from extreme heat conditions. Aging utility infrastructure is also of particular concern.

iii) Potential Loss Estimate

Unlike other natural hazards that affect New York City, extreme temperatures have limited physical destructive force. The primary concern associated with extreme temperatures is public health and safety and the effect on vulnerable populations. Situational, social, and physical characteristics help to identify vulnerable populations. The following groups are vulnerable or at greater risk to extreme temperatures:

- People who are homeless
- Infants and small children under age five (see Demographics section on page 16 for map)
- People age 65 or older (see Demographics section on page 16 for map)
- People who are obese
- People with medical conditions
- People who work outdoors
- Women who are pregnant
- People who are poor

11) Flooding Hazard Analysis for New York City

a) Hazard Profile

i) Hazard Description

A flood is a general and temporary condition of partial or complete inundation of normally dry land areas. Three distinct types of flooding affect New York City: coastal flooding, river flooding, and flash flooding.

Coastal Flooding
Long and short wave surges that affect the shores of the open ocean, bays, and tidally influenced rivers, streams, and inlets cause coastal flooding. The astronomic tide and meteorological forces such as nor'easters and hurricanes influence the movement of coastal waters.

River Flooding
River flooding is caused when rivers and streams overflow their banks. Flooding from large rivers usually results from large-scale weather systems that generate prolonged rainfall over wide areas. These same weather systems may cause flooding of smaller basins that drain to major rivers. Small rivers and streams are susceptible to flooding from more localized weather systems that cause intense rainfall over small areas. According to the New York City Flood Insurance Study, while overbank flooding of rivers and streams is the most common type of flood event in New York State, this type of flooding is less frequent and severe in New York City than other types of flooding.

Flash Flooding
Short-term, high-intensity rainfall that occurs in inland areas with poor drainage often produces urban flash floods. Densely populated areas have a high risk for flash floods. The construction of buildings, highways, driveways, and parking lots increases runoff by reducing the amount of rain absorbed by the ground. During periods of heavy rainfall, storm drains may become overwhelmed and flood roads and buildings. Low spots, such as underpasses, underground parking garages, and basements are especially vulnerable to flash floods. Subway stations and rail lines are also vulnerable to flash floods.

ii) Severity

The NWS categorizes flooding as major, moderate, and minor.

NWS Flood Categories	
Category	**Description**
Major	• Extensive inundation and property damage • Often involves the evacuation of people and the closure of both primary and secondary roads
Moderate	• Inundation of secondary roads • Transfer to higher elevation necessary to save property • Some evacuation may be required
Minor	• Minimal or no property damage • Possibly some public inconvenience

Figure 59: NWS Flood Categories

iii) Probability

Coastal and River Flooding

FEMA Flood Insurance Rate Maps delineate special flood-hazard areas and the risk-premium zones in a community. These special flood-hazard areas identify locations that have a chance of experiencing coastal or river flooding in any given year. The 100-year flood designation means the area has a 1% chance of flooding in any given year.

Flash Flooding

Intense rainfall, producing several inches of rain in a short period, is most likely to cause flash flooding and other problems, such as sewer back-ups into residences. These floods are unrelated to the 100-year floodplain designation. According to DEP's rain gauges, the July 18, 2007 storm produced 1.93 inches of rain in one hour in northern Queens. The August 8, 2007 storm, which resulted in levels of flooding throughout the City not seen for decades, produced more than three inches of rain in a two-hour period. Based on historic probability, that level of rainfall has a chance of occurring about once every 25 years. Over the last several years, storms of intense magnitude have been occurring somewhat more frequently than expected, and climatologists warn that the trend may continue as the effects of climate change are felt.

Given the history of flooding in New York City, it is certain future floods will occur. Based on analysis of records from the National Climatic Data Center of NOAA, New York City has experienced flooding 60 times during the 15-year period between 1993 and 2007. Using simple historic frequency to indicate the future flooding potential, New York City will likely experience an average of four floods per year.

iv) Location

As shown in Figure 60 through Figure 64[3], all five boroughs have 100-year flood designations. There are also many low-lying and poor drainage areas susceptible to flash flooding.

Coastal Flooding

Direct ocean surges and waves affect sections of Queens, Brooklyn, and Staten Island. Coney Island and the Rockaway Peninsula are particularly vulnerable to wave damage. On Rockaway Peninsula and Jamaica Bay, the shoreline configuration has changed considerably over the past 50 years because of dredging and filling. These changes affect wave propagation, particularly in areas such as Rockaway Point and Rockaway Inlet, where the configuration of the point controls the direction of incoming waves. Inundation of low-lying coastal areas in the City is primarily the result of storm surges, wave setup, and wave run-up, which occur during hurricanes and nor'easters. For more information on the combined effects of wind and storm surge and its impact to New York City, see the Coastal Storm Hazard Analysis.

River Flooding

The Flood Insurance Study conducted for New York City found river flooding was not a major cause of flood damage in the City: Ocean tides influence most of the rivers within New York City. This means the tidal conditions at the mouth of the river control the water levels in the rivers, with little or no influence from the flow in the stream. Therefore, river flooding affects only a small portion of flood-prone areas in New York City, primarily in the Bronx and Staten Island. Flooding from the Bronx and Hutchinson Rivers may potentially cause overbank flooding in the northern portion of the City.

Flash Flooding

There have long been flash flood-prone areas of the City because of its dense population and abundance of impervious surfaces. In recent years, flash floods have affected a much broader range of communities. Much of New York City's infrastructure, particularly low-lying and poor drainage areas, cannot cope with rainfall of more than one inch per hour. New York City's drainage and sewer system consists of more than 6,600 miles of pipes, the majority of which were laid before 1960. Prior to 1960, sewers were designed to handle up to 1.5 inches of rain per hour. Since 1960, the City built sewers to handle up to 1.75 inches of rain per hour. (1.75 is the national standard.) Adding to the impact of overflows, 70% of the sewer system is combined, which means both storm water runoff and sanitary sewage travel through the same pipes.

An important factor exacerbating the effects of extreme rainfall is the pattern of residential and commercial development. Runoff from low-density developments like single- and two-family homes has increased 50% since 1950 as residents pave over their

[3] The floodplain map represents locations that experience natural coastal flooding, unrelated to hurricanes, and are within the FEMA-defined 100-year floodplain In contrast, the SLOSH map represents locations that may experience flooding from a hurricane storm surge. Hurricane storm surge areas overlap many areas that are designated as the 100-year floodplain, but the hurricane storm surge areas are considerably larger and represent a different hazard.

yards in an effort to secure more parking or living spaces. Widespread use of basements and below-grade areas as dwelling units has also contributed to the increased costs and impacts of extreme rain events.

In New York City, flash-flooding locations, often the result of urban drainage issues, are frequently not located in the FEMA-designated floodplain. In 2008, the City developed the New York City Flash Flood Emergency Plan addressing street level cleaning and maintenance, targeted monitoring of reoccurring flood locations, coordinated response, and recovery assistance.

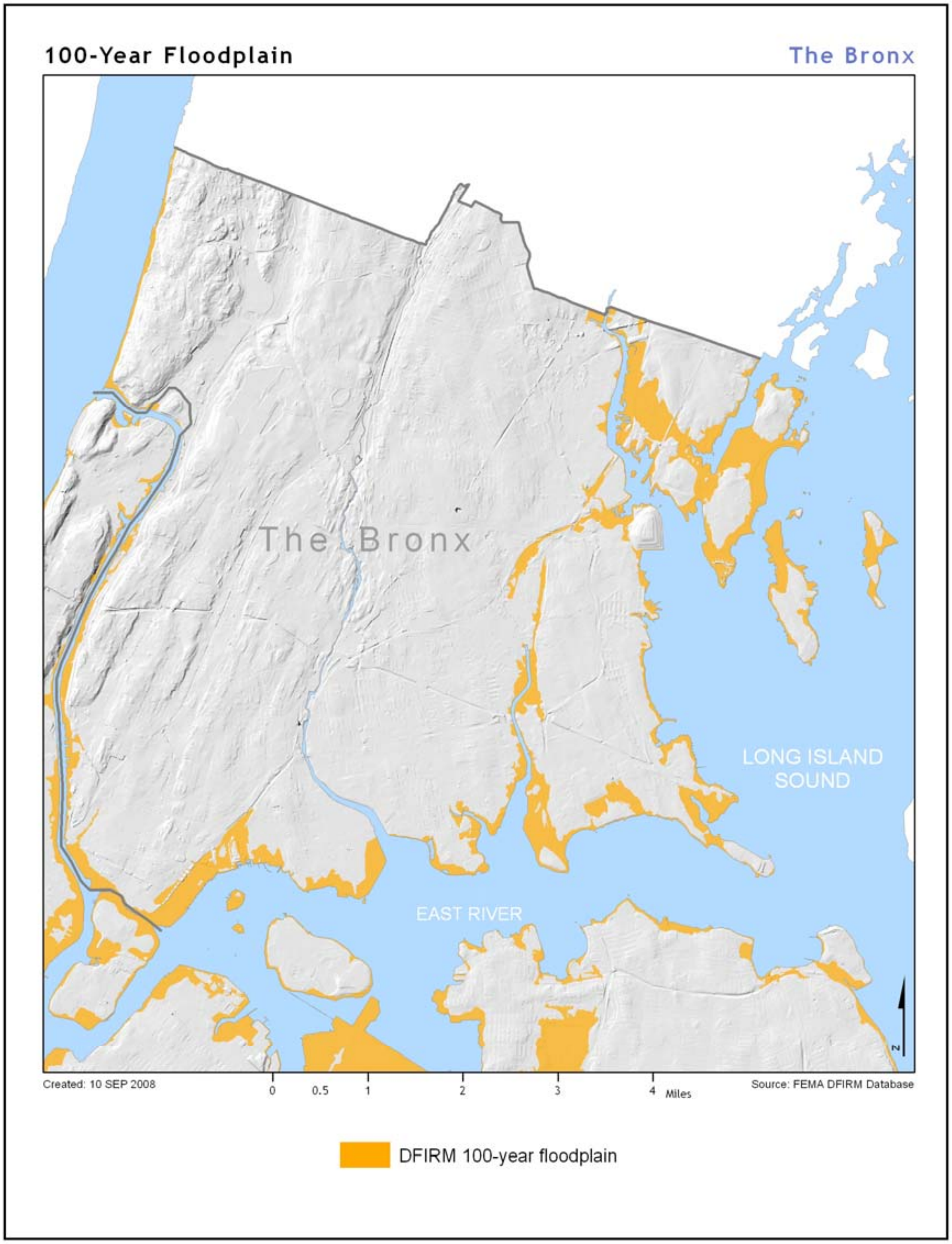


Figure 60: Bronx 100-Year Floodplain

Figure 61: Brooklyn 100-Year Floodplain

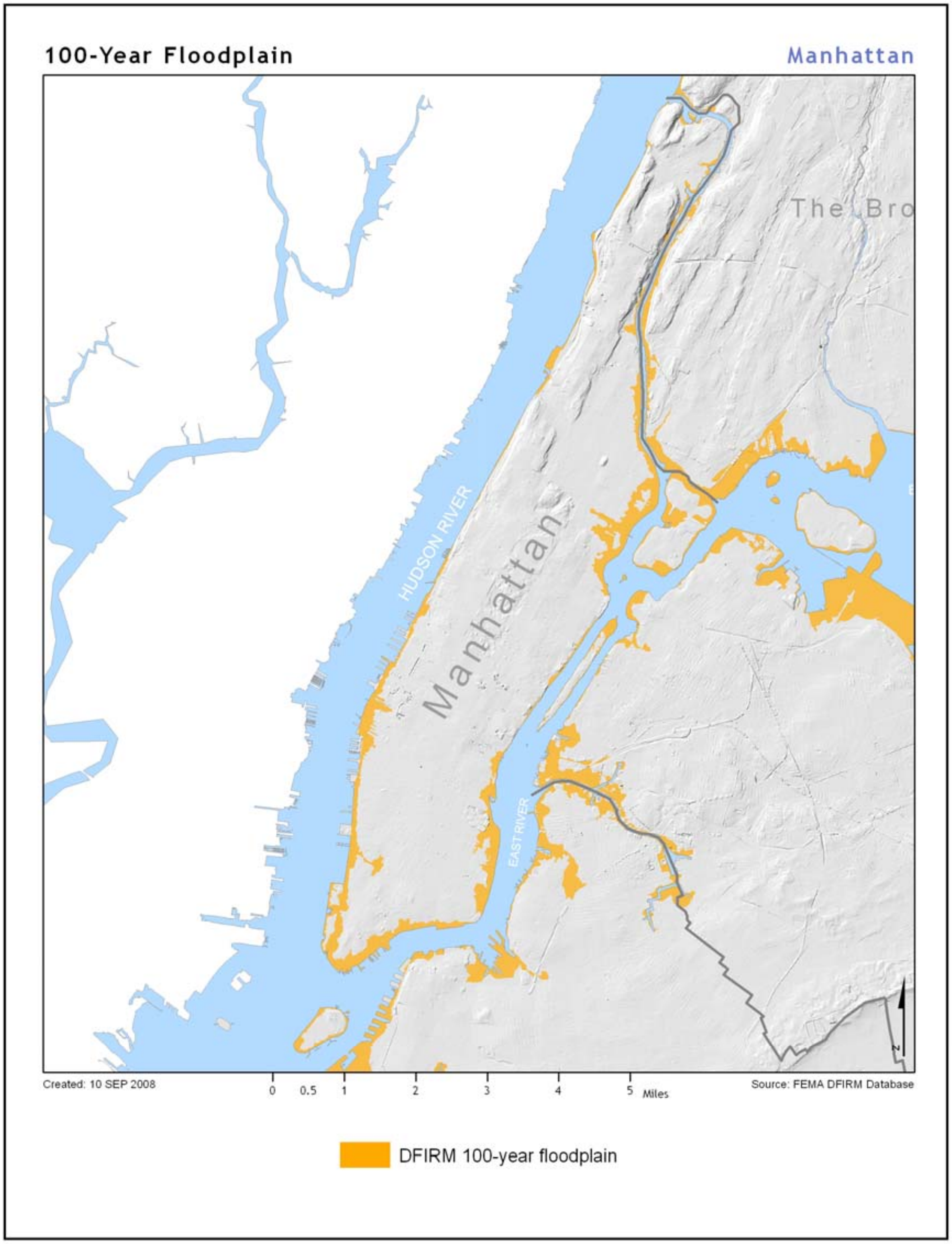


Figure 62: Manhattan 100-Year Floodplain

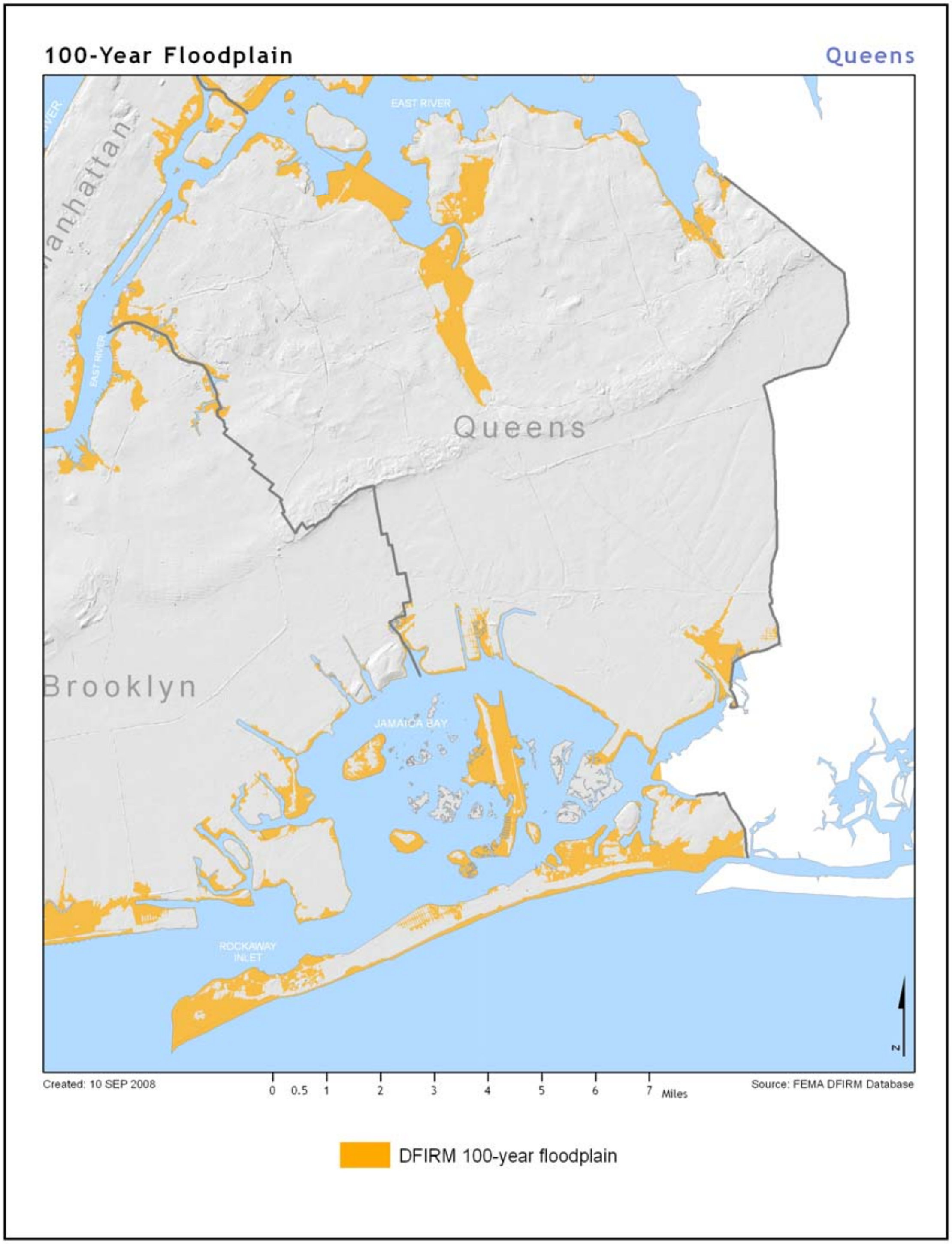


Figure 63: Queens 100-Year Floodplain

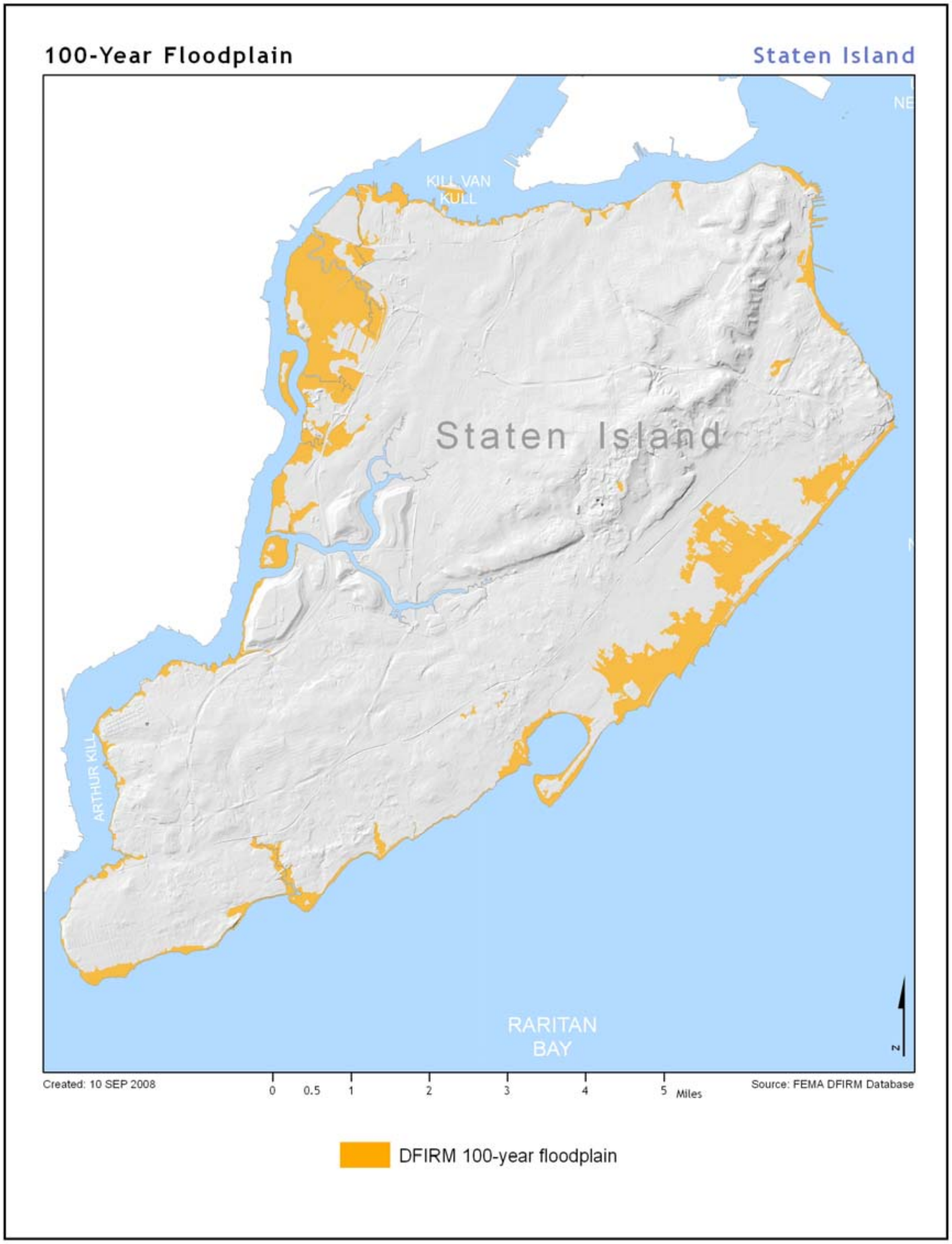


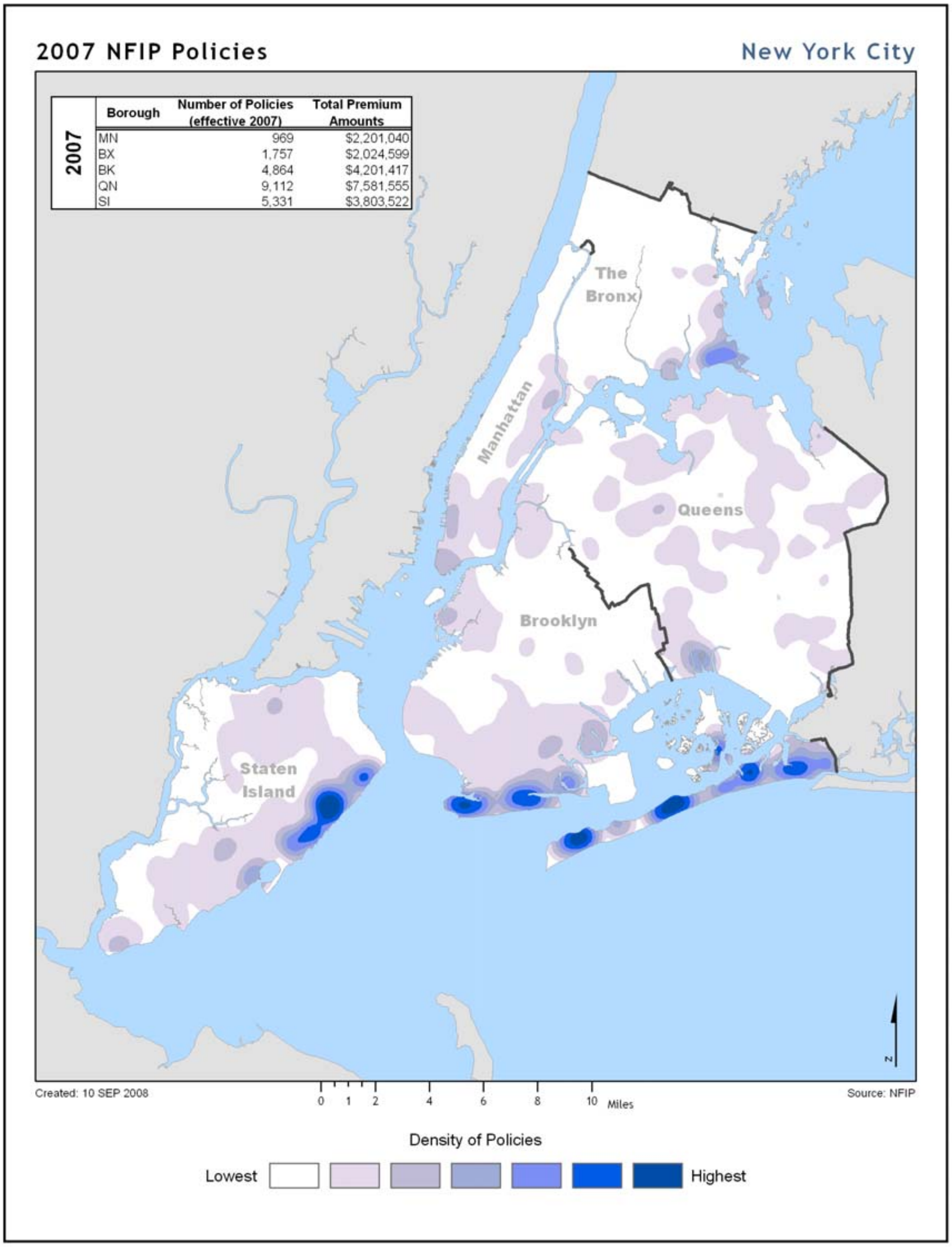
Figure 64: Staten Island 100-Year Floodplain

National Flood Insurance Program

New York City is a participant of the National Flood Insurance Program (NFIP). The NFIP Administrator, or manager of the NFIP for New York City, collects and stores a vast quantity of information on insured structures, including the number and location of flood insurance policies, number of claims per insured property, dollar value of each claim and repetitive loss claims. In New York City, DOB is the NFIP Administrator.

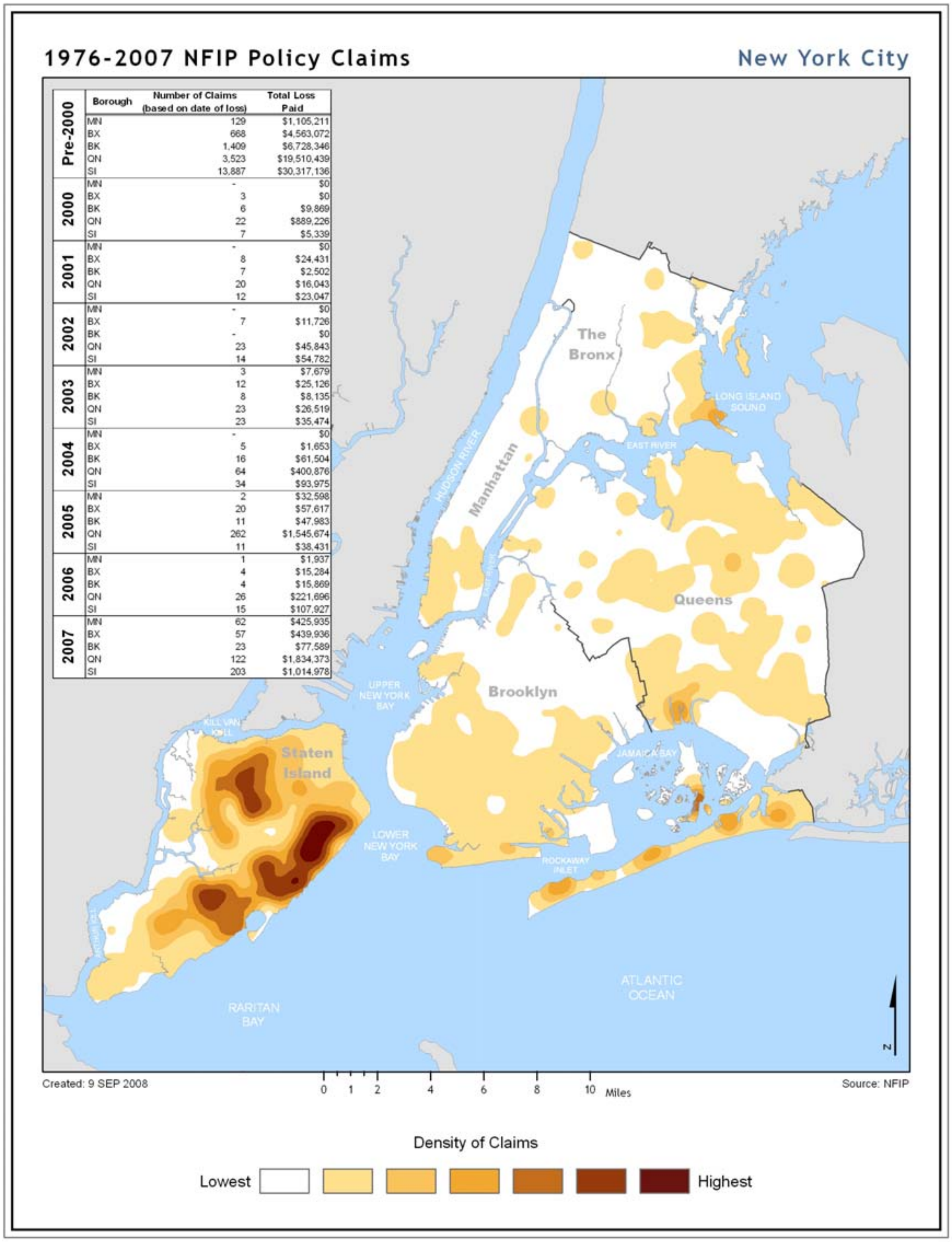
NFIP data helps indicate the location of potential flood events. The maps on pages 137 through 139 spatially present several types of NFIP insurance data for each borough of New York City. In 2007, the City had 22,033 NFIP policies amounting to $19.8 million in premiums.

New York City has recorded 2,322 repetitive loss policies amounting to $33.6 million in payouts. Repetitive loss properties are a high priority for flood mitigation. The Mitigation Strategy section provides actions that aim to reduce the impact of flooding to these properties.



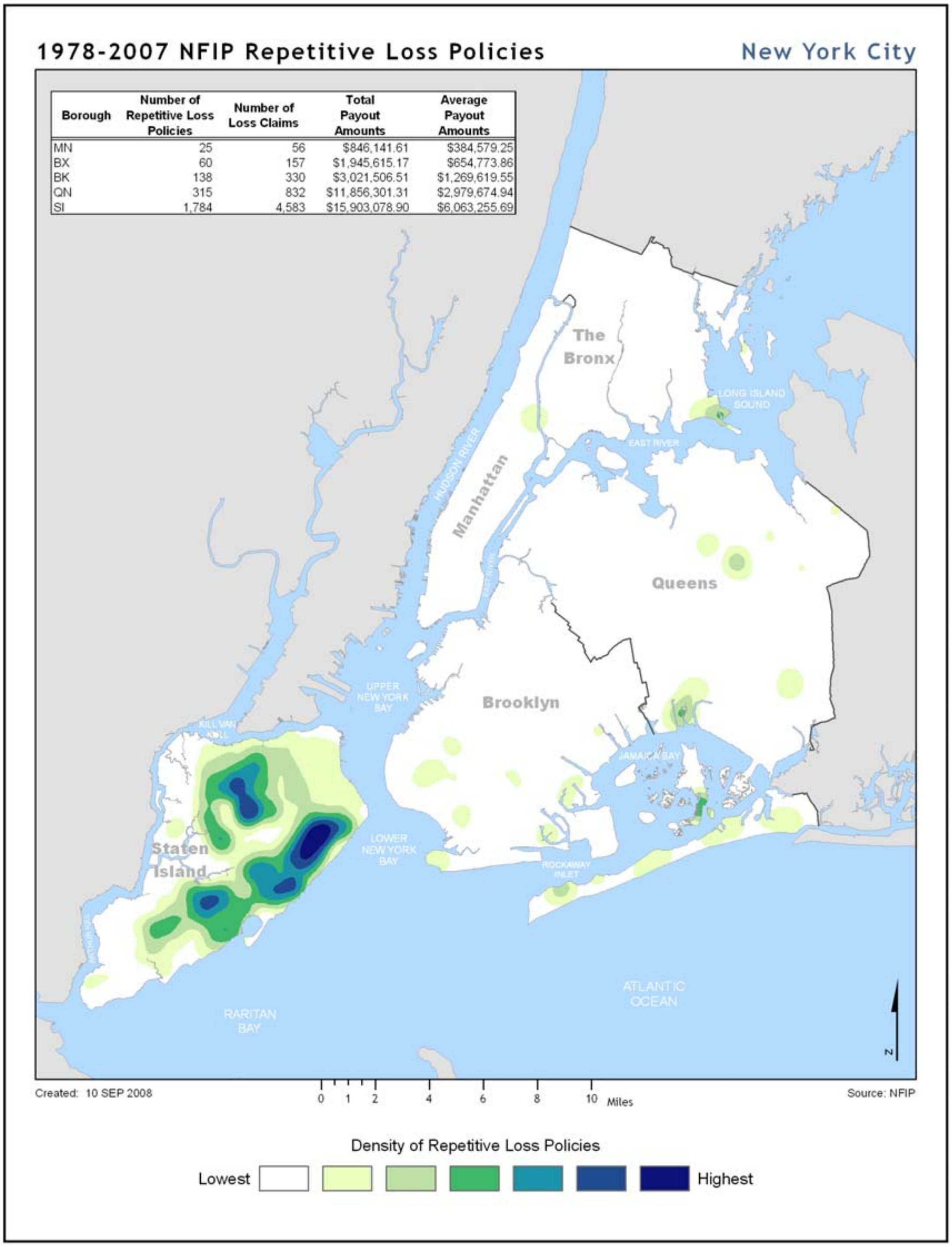
2007	Borough	Number of Policies (effective 2007)	Total Premium Amounts
	MN	969	$2,201,040
	BX	1,757	$2,024,599
	BK	4,864	$4,201,417
	QN	9,112	$7,581,555
	SI	5,331	$3,803,522

Figure 65: NFIP Policies by Borough



	Borough	Number of Claims (based on date of loss)	Total Loss Paid
Pre-2000	MN	129	$1,105,211
	BX	668	$4,563,072
	BK	1,409	$6,728,346
	QN	3,523	$19,510,439
	SI	13,887	$30,317,136
2000	MN	-	$0
	BX	3	$0
	BK	6	$9,869
	QN	22	$889,226
	SI	7	$5,339
2001	MN	-	$0
	BX	8	$24,431
	BK	7	$2,502
	QN	20	$16,043
	SI	12	$23,047
2002	MN	-	$0
	BX	7	$11,726
	BK	-	$0
	QN	23	$45,843
	SI	14	$54,782
2003	MN	3	$7,679
	BX	12	$25,126
	BK	8	$8,135
	QN	23	$26,519
	SI	23	$35,474
2004	MN	-	$0
	BX	5	$1,653
	BK	16	$61,504
	QN	64	$400,876
	SI	34	$93,975
2005	MN	2	$32,598
	BX	20	$57,617
	BK	11	$47,983
	QN	262	$1,545,674
	SI	11	$38,431
2006	MN	1	$1,937
	BX	4	$15,284
	BK	4	$15,869
	QN	26	$221,696
	SI	15	$107,927
2007	MN	62	$425,935
	BX	57	$439,936
	BK	23	$77,589
	QN	122	$1,834,373
	SI	203	$1,014,978

Figure 66: NFIP Claims by Borough



Borough	Number of Repetitive Loss Policies	Number of Loss Claims	Total Payout Amounts	Average Payout Amounts
MN	25	56	$846,141.61	$384,579.25
BX	60	157	$1,945,615.17	$654,773.86
BK	138	330	$3,021,506.51	$1,269,619.55
QN	315	832	$11,856,301.31	$2,979,674.94
SI	1,784	4,583	$15,903,078.90	$6,063,255.69

Figure 67: NFIP Repetitive Loss Properties

v) Historic Occurrences

Historic Occurrences of Flooding in New York City			
Date	**Event**	**Location(s)**	**Description**
Aug. 16, 1993	Flash Flood	Manhattan	• Widespread rain embedded with thunderstorms • Floodwaters partially covered cars, stranding several people on their roofs
June 29, 1994	Flood/Flash Flood	Citywide	• Torrential rains of nearly 2.5 inches produced substantial road and highway flooding • Many basements flooded
June 22, 1995	Flash Flood	Brooklyn, Queens	• No information available
July 1, 1995	Flash Flood	Staten Island	• Several homes damaged • 3 people injured at a movie theater when ceiling tiles fell because of standing water on the roof
July 17, 1995	Flash Flood	Bronx, Manhattan, Queens	• Rainfall between 2 and 4 inches • Many roadways closed
July 23, 1995	Flash Flood	Bronx, Queens	• No information available
Oct. 21, 1995	Urban Flood	Manhattan, Queens	• No information available
Nov. 14, 1995	Coastal Flood	Queens	• No information available
Jan. 12, 1996	Urban Flood	Citywide	• No information available
Jan. 27, 1996	Urban Flood	Queens	• No information available
Apr.16, 1996	Urban Flood	Citywide	• No information available
June 3, 1996	Urban Flood	Citywide	• No information available
July 3, 1996	Flash Flood	Queens, Staten Island	• Cars trapped in flooding on the Long Island Expressway • Serious road flooding reported along Richmond Parkway
July 8, 1996	Flash Flood	Manhattan	• High winds, large hail, and torrential rain
July 13, 1996	Flood	Brooklyn	• Tropical Storm Bertha • Serious widespread flooding was reported along the Brooklyn-Queens Expressway
July 31, 1996	Flash Flood	Brooklyn, Queens, Staten Island	• 2 to 5 inches of rain in 3 hours • Several houses damaged in mudslides at Richmondtown • Serious widespread flash flooding of roads and numerous basements flooded across Brooklyn and Queens

Historic Occurrences of Flooding in New York City			
Date	**Event**	**Location(s)**	**Description**
Sept. 8, 1996	Flash Flood	Bronx, Brooklyn Staten Island	• Thunderstorms produced torrential rain • Significant flash flooding of low lying and poor drainage areas, including many streets
Oct. 19, 1996	Flood	Citywide	• Heavy flood producing rains and minor coastal flooding • 3 to 5 inches with isolated higher amounts • Serious flooding of basements and first floors caused damage to 226 homes in Flushing and 70 homes in Springfield Gardens • Numerous cars were damaged in floodwaters
Jan. 10, 1997	Coastal Flood	Queens	• Tidal flooding submerged cars under 2 feet of water along Rockaway Blvd. in Brookville • Moderate tidal flooding reported at Howard Beach
Nov. 2, 1997	Flash Flood	Staten Island	• Police scuba divers used rubber raft to rescue people from submerged car on Arthur Kill Road in Greenridge
Jan. 23, 1998	Urban Flood	Citywide	• Heavy rainfall from 2 to just more than 4 inches
Mar. 9, 1998	Urban Flood	Citywide	• Widespread heavy rainfall including thunderstorms • Many low-lying and poor drainage areas, including streets were flooded throughout the area
Aug. 17, 1998	Flood	Bronx, Manhattan Queens, Staten Island	• Rainfall rates up to 2 inches per hour • LaGuardia Airport, 3.54 inches of rain
Jan. 3, 1999	Urban Flood	Citywide	• People required rescue from their flooded basement apartments in Springfield Gardens, Queens • Water rose within 6 inches of ceilings in several apartments
Jan. 15, 1999	Flood	Staten Island	• Heavy rain fell on frozen ground with partially clogged storm drains • Up to 2 feet of water collected in many streets in South Beach

Historic Occurrences of Flooding in New York City			
Date	**Event**	**Location(s)**	**Description**
Aug. 26, 1999	Flood	Bronx, Manhattan, Queens	• Flash flooding crippled public transit during the morning rush hour • Subway service was severely disrupted as 3 to 5 feet of water collected at subway station locations • Fifty-two inches of water measured at the #6 station at Cypress Ave. • A 10 to 20 foot section of the northbound platform on the 6 line at 28th Street crumbled and washed away • Metro-North Railroad forced to close in Mott Haven, South Bronx
Sept. 16, 1999	Flood	Citywide	• Remnants of Hurricane Floyd • Maximum rainfall rates from 1 to around 2 inches per hour lasted for at least 3 consecutive hours • 5.02 inches at Central Park
July 3, 2000	Flash Flood	Brooklyn, Queens, Staten Island	• Rainfall rates estimated up to 4 inches per hour for less than 1 hour • Significant ponding of water trapped people in two cars near the Verrazano Bridge • Significant low-lying and poor drainage flooding on Cross Island Parkway near Whitestone Bridge
Aug. 11, 2000	Flash Flood	Bronx, Queens	• Slow moving thunderstorms produced rainfall rates estimated at around 2 inches per hour, which caused significant flooding of low-lying and poor drainage areas. • In the Bronx, cars were submerged in rising water and many people were trapped. • NWS radar estimated a 2 to 3 inch rainfall from 2:30 AM to 3:30 AM, with up to 5 inches during the preceding 24 hours.

Historic Occurrences of Flooding in New York City			
Date	**Event**	**Location(s)**	**Description**
Aug. 27, 2000	Flash Flood	Staten Island	• Heavy showers moved very slowly east across Northern Staten Island. • NWS radar estimated rainfall rates of 1.5 to 2 inches per hour for at least 2 consecutive hours. • Estimated rainfall amounts of 3.5 to 4 inches resulted in serious widespread flooding of low lying and poor drainage areas
Aug. 28, 2000	Flash Flood	Queens	• NWS radar estimated rainfall rates from 1.5 to 2.0 inches per hour • Total precipitation amount from 3.5 to 4 inches • Serious widespread flooding on Cross Island Parkway in Whitestone • Up to 5 feet of water ponded on streets in Bay Terrace
Sept. 3, 2000	Flash Flood	Queens	• Nearly stationary thunderstorms produced torrential rain • People had to be rescued from submerged cars on Northern Blvd. • Several residential basements in poor drainage areas were flooded
June 17, 2001	Flash Flood	Bronx, Brooklyn, Manhattan, Queens	• Remnants of Tropical Storm Allison • Rainfall rates up to 3 inches per hour • Numerous reports of street and highway flooding
June 23, 2001	Urban Flood	Manhattan, Staten Island	• Several people required rescue from their cars in Staten Island. • Large segment of West Side Highway between 100th and 120th Streets closed
Aug. 13, 2001	Flash Flood	Brooklyn, Manhattan, Queens	• Rainfall rates in excess of 2 inches per hour in portions of northern Queens • Highly localized rainfall amounts of 5 inches or more • Several health care facilities flooded, including one area hospital and seven area nursing homes
June 26, 2002	Flood, Thunderstorm	Bronx	• Widespread flash floods in the Bronx

Historic Occurrences of Flooding in New York City			
Date	**Event**	**Location(s)**	**Description**
Aug. 16, 2002	Flood	Bronx, Manhattan, Queens	• 3 feet of water on Major Deegan Expressway at Cross Bronx Expressway interchange which required police rescues • Shutdown of the Henry Hudson Parkway from 96th Street to 125th Street • Significant urban flooding in Far Rockaway
Sept. 2, 2002	Flash Flood	Brooklyn, Queens	• Significant street flooding in Greenpoint and on Brooklyn-Queens Expressway • Significant widespread street flooding in Woodside
July 22, 2003	Flash Flood	Queens, Staten Island	• Significant street flooding in Bayside Hills and Ridgewood. • Con Ed reported significant flooding that resulted in street closings near Richmond Avenue and Victory Boulevard
Aug. 4, 2003	Flash Flood	Brooklyn, Manhattan, Queens, Staten Island	• Rainfall rates were between 2 and 3 inches per hour • N and R subway tunnels flooded • Flooded basements in Brooklyn • Sewers and septics backed up onto streets in Annadale
Aug. 17, 2003	Flash Flood	Brooklyn	• Isolated locations received as much as 3 to 4 inches of rain in as little as 2 hours. • NYC OEM reported water levels up to car doors on the Belt Parkway near Pennsylvania Avenue in Brooklyn
Sept. 23, 2003	Flash Flood	Bronx, Brooklyn, Manhattan, Queens	• Several lanes closed on the FDR and Harlem River Drives in Manhattan, the Van Wyck Expressway in Queens, Ocean Parkway in Brooklyn and several local streets in Riverdale in the Bronx
June 17, 2004	Flash Flood	Bronx, Brooklyn Manhattan, Queens	• Significant flash flooding on the roadways resulted in people needing to be rescued from their cars
June 25, 2004	Flash Flood	Queens, Staten Island	• Several cars trapped in floodwaters in Queens and Staten Island

Historic Occurrences of Flooding in New York City			
Date	**Event**	**Location(s)**	**Description**
July 2, 2004	Flash Flood	Bronx, Queens	• 179th Street and Major Deegan in the Bronx flooded • Bell Boulevard and 208 Place intersection in Queens flooded with 2 people having to be rescued from cars
Sept. 8, 2004	Flash Flood	Bronx, Brooklyn, Manhattan, Queens	• Remnants of Hurricane Frances • Rainfall amounts up to 6 inches • Extensive flash flooding across the region, resulting in rescues of people from homes and cars
Sept. 18, 2004	Flash Flood	Citywide	• Remnants of Hurricane Ivan • Torrential rains up to 5 inches in some areas
Sept. 28, 2004	Flash Flood	Citywide	• Remnants of Hurricane Jeane dropped between 3 and 6 inches across Southeastern New York State • Numerous roads and highways closed
July 6, 2005	Flash Flood	Brooklyn	• Slow moving thunderstorms containing hourly rainfall rates of around 2 inches per hour caused flash flooding of streets
Oct. 14, 2005	Flash Flood	Brooklyn, Queens	• Flooding along Ocean Parkway and the Grand Central Parkway • Several trees and power poles were leaning from soggy ground
June 1, 2006	Flash Flood	Staten Island	• Flash flooding on the West Shore Expressway
June 2, 2006	Flash Flood	Manhattan, Queens, Staten Island	• Flash flooding on FDR • Flash flooding of roads submerged vehicles and a few houses were surrounded by 5 feet of water in Staten Island
July 12, 2006	Flash Flood, Thunderstorm	Citywide	• Flash flooding of the FDR service road at 34th Street • Wall collapse in Washington Heights
July 21, 2006	Flash Flood, Thunderstorm	Citywide	• Partial road closures on the Staten Island Expressway., the Belt Parkway, the Brooklyn-Queens Expressway., the Grand Central Parkway and Van Wyck Expressway • Subway service suspended in both directions on the R and W lines between Whitehall Street in Manhattan and Ditmars Boulevard in Queens

Historic Occurrences of Flooding in New York City			
Date	**Event**	**Location(s)**	**Description**
Aug. 10, 2006	Flash Flood	Manhattan, Queens	• Flash flooding forced closure of subway lines 1, 2, 3, and 6.
Aug. 25, 2006	Flash Flood	Bronx, Queens	• Flash flooding along many major roads, which resulted in road closures • Most significant flooding along the Deegan and Cross Bronx Expressways
Oct. 28, 2006	Flash Flood	Bronx	• Flash flooding along portions of the Bronx River Parkway and Bruckner Expressway
Nov. 8, 2006	Flash Flood	Staten Island	• Heavy rain flooded multiple basements and closed numerous streets • Staten Island Railroad service was suspended because of flash flooding across tracks
Apr. 15, 2007	Flood	Brooklyn, Manhattan, Queens	• Nor'easter brought heavy rain and high winds. • 8.41 inches at Central Park • Street flooding along the Belt Parkway and FDR Drive
Apr. 27, 2007	Flash Flood	Bronx, Manhattan, Queens	• Rainfall amounts from 2–3 inches • Flash flooding of the Jackie Robinson Parkway and West Side Highway

Table 36: Historic Occurrences of Flooding in New York City

August 8, 2007 Storms

On August 8, 2007, severe storms disrupted transit service throughout much of the New York City area and a rare tornado touched down in Brooklyn. An estimated three inches of rain fell in about an hour, flooding major roads, causing power outages, and disrupting train service. MTA subways, buses, and commuter railroads were overcome by flooding. The flooding affected more than 2.5 million transit customers by mid-morning. The President issued a major disaster declaration on August 31, 2007, which authorized individual assistance for Queens residents who had flood-related losses. Approximately 3,700 households and business owners registered for assistance. Total disaster assistance grants topped $7.2 million.

b) Vulnerability Assessment

i) Impact on New York City

In 2000, more than 200,000 people in approximately 77,700 households live within the 100-year floodplain. Nearly 10% of the City could experience flooding in a 100-year flood event.

Population and Households in 100-Year Floodplain		
Borough	**Population**	**Households**
Bronx	11,023	4,188
Brooklyn	63,654	24,477
Manhattan	63,576	24,562
Queens	46,674	18,070
Staten Island	18,108	6,487
Total	***203,035***	***77,784***

Table 37: Population and Households in 100-Year Floodplain (Source: 2000 U.S. Census)

ii) Structural Vulnerability

The Planning Team used HAZUS-MH to determine property exposure to flooding. Overall, 13,341 buildings are at risk to damage from a 100-year flood. More than half of these buildings are not predicted to have damage based on the HAZUS-MH output. 2.5% of these buildings are predicted to have significant damage to more than 50% of the structure.

100-Year Flood Building Damage								
Borough	**Percentage of Building Damage**							
	None	**1–10%**	**11–20%**	**21–30%**	**31–40%**	**41–50%**	**>50%**	**Total**
Bronx	529	34	295	316	74	*90*	24	***1,362***
Brooklyn	2,280	271	450	271	44	*46*	11	***3,373***
Manhattan	211	70	70	111	10	1	4	***477***
Queens	2,512	346	594	655	181	130	89	***4,507***
Staten Island	1,961	78	478	497	250	148	210	**3,622**
Total	***7,493***	***799***	***1,887***	***1,850***	***559***	***415***	***338***	***13,341***

Table 38: HAZUS-MH Calculations for Building Damage from a 100-Year Flood

Table 39 displays the number of critical assets located within the 100-year floodplain. These assets have a 1% chance of being flooded in any given year.

Critical Assets Located in the 100-Year Floodplain	
Critical Asset	**#**
Subway Stations	14
Rail Stations	18
Bridges and Tunnels	31
Major Roads (miles)	105
Airports	2
Ferry Landings	25
Emergency Services—Police Stations	1
Emergency Services—Fire Stations	8
Emergency Services—EMS Stations	2
Educational—Colleges	4
Educational—Public Schools	45
Educational—Private Schools	18
Healthcare—Hospitals	1
Healthcare—Nursing Homes	10
Cultural Facilities	6
Infrastructure—Power Plants	10
Infrastructure—Wastewater Treatment Plants	1

Table 39: Critical Assets in the 100-Year Floodplain

iii) Potential Loss Estimate

The Planning Team used a deterministic model based on the 100-year flood to estimate potential economic losses. Table 40 and Figure 68 through Figure 72 highlight the key findings from the HAZUS-MH run of a 100-year flood in New York City. A 100-year flood affecting all five boroughs could cause more than $12 billion in damage. More than 60% of the total damage would be to contents such as furniture, supplies, and other possessions.

Capital Stock Losses for a 100-Year Flood ($1,000s)				
Borough	**Building Damage**	**Contents Damage**	**Inventory**	**Total**
Bronx	302,256	439,998	21,455	***763,709***
Brooklyn	903,775	2,025,808	148,686	***3,078,269***
Manhattan	1,737,769	2,639,381	49,764	***4,426,914***
Queens	1,053,671	2,323,539	72,530	***3,449,740***
Staten Island	224,797	268,275	10,232	***503,304***
Total	***4,222,268***	***7,697,001***	***302,667***	***12,221,936***

Table 40: HAZUS-MH Calculations for Capital Stock Losses for a 100-Year Flood

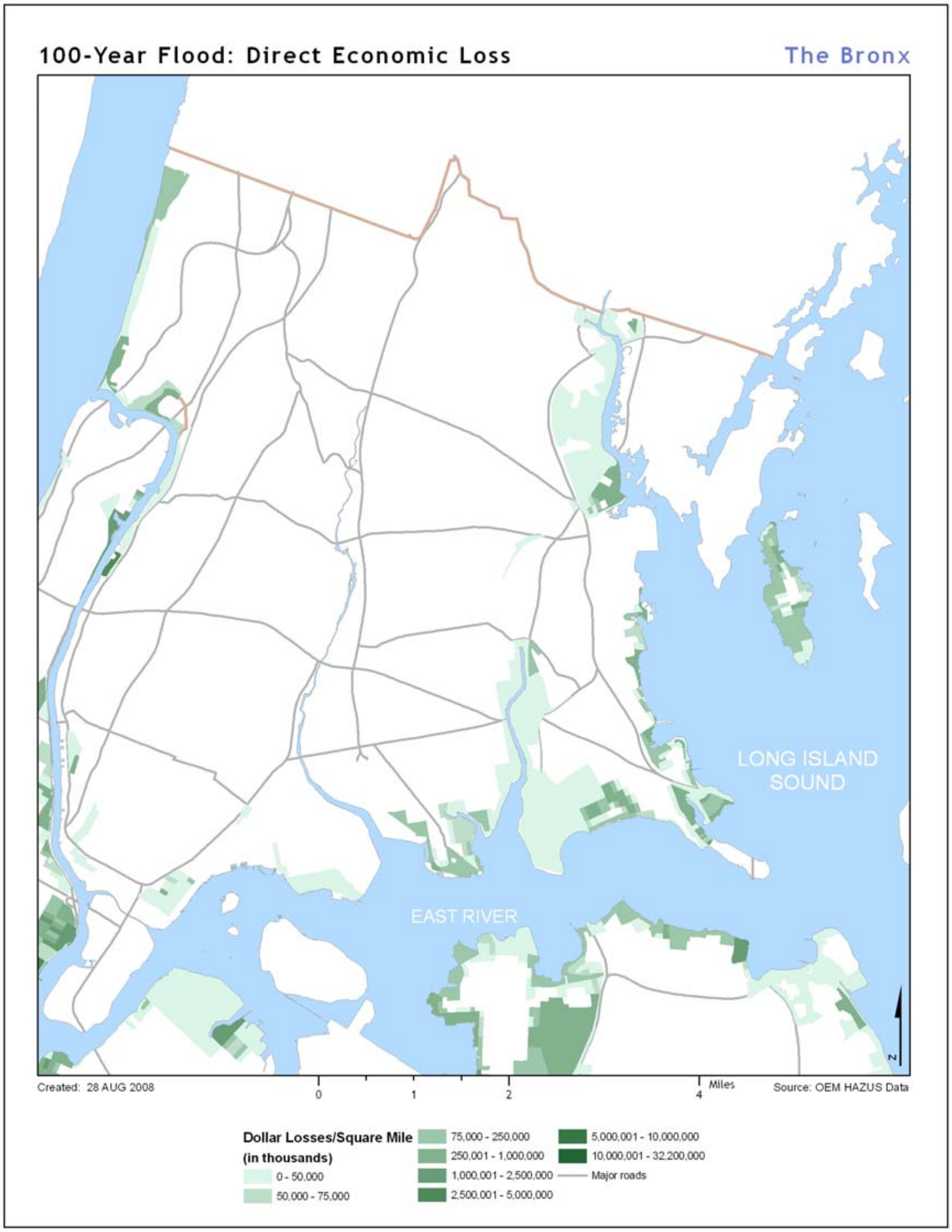


Figure 68: HAZUS-MH Results for Economic Losses from a 100-Year Flood in the Bronx

Figure 69: HAZUS-MH Results for Economic Losses from a 100-Year Flood in Brooklyn

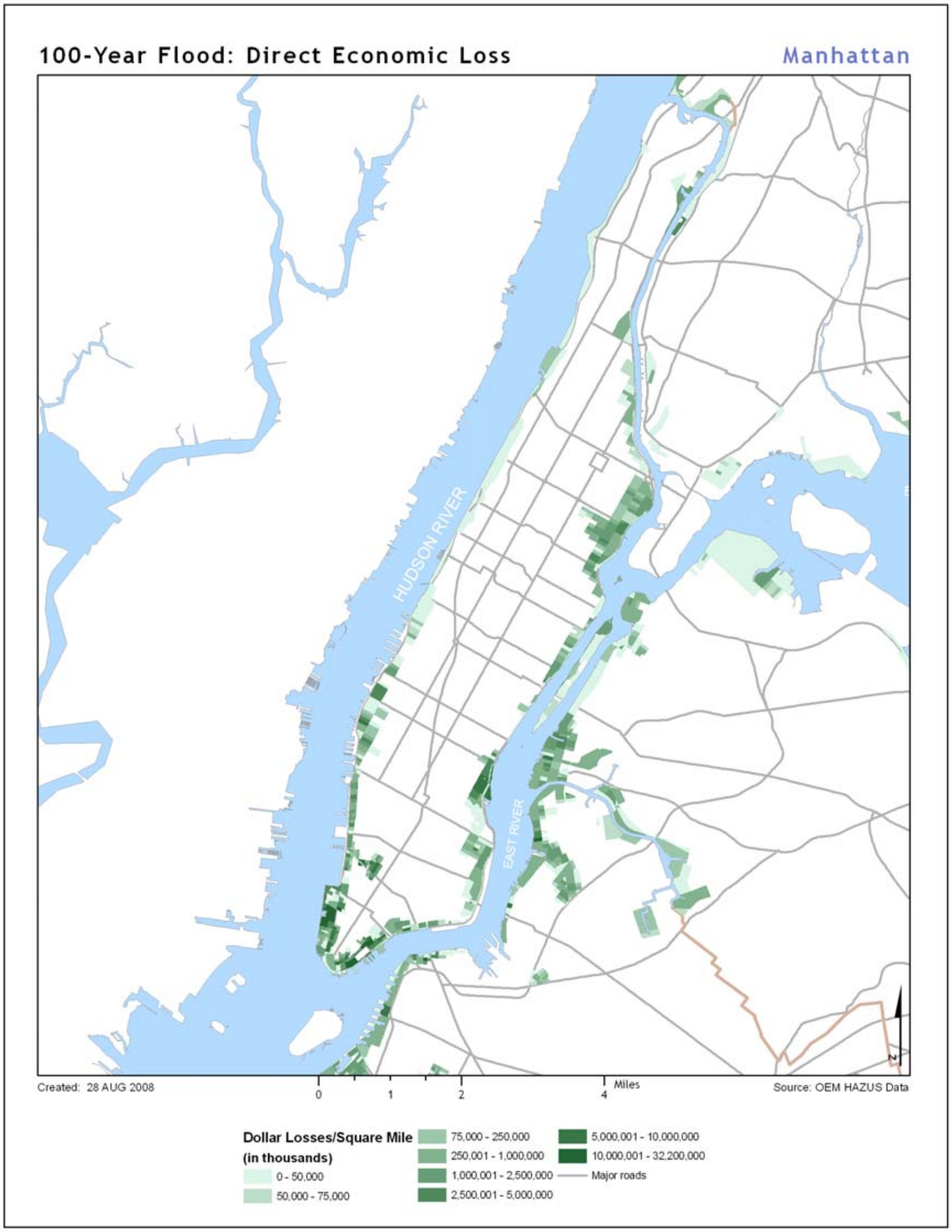


Figure 70: HAZUS-MH Results for Economic Losses from a 100-Year Flood in Manhattan

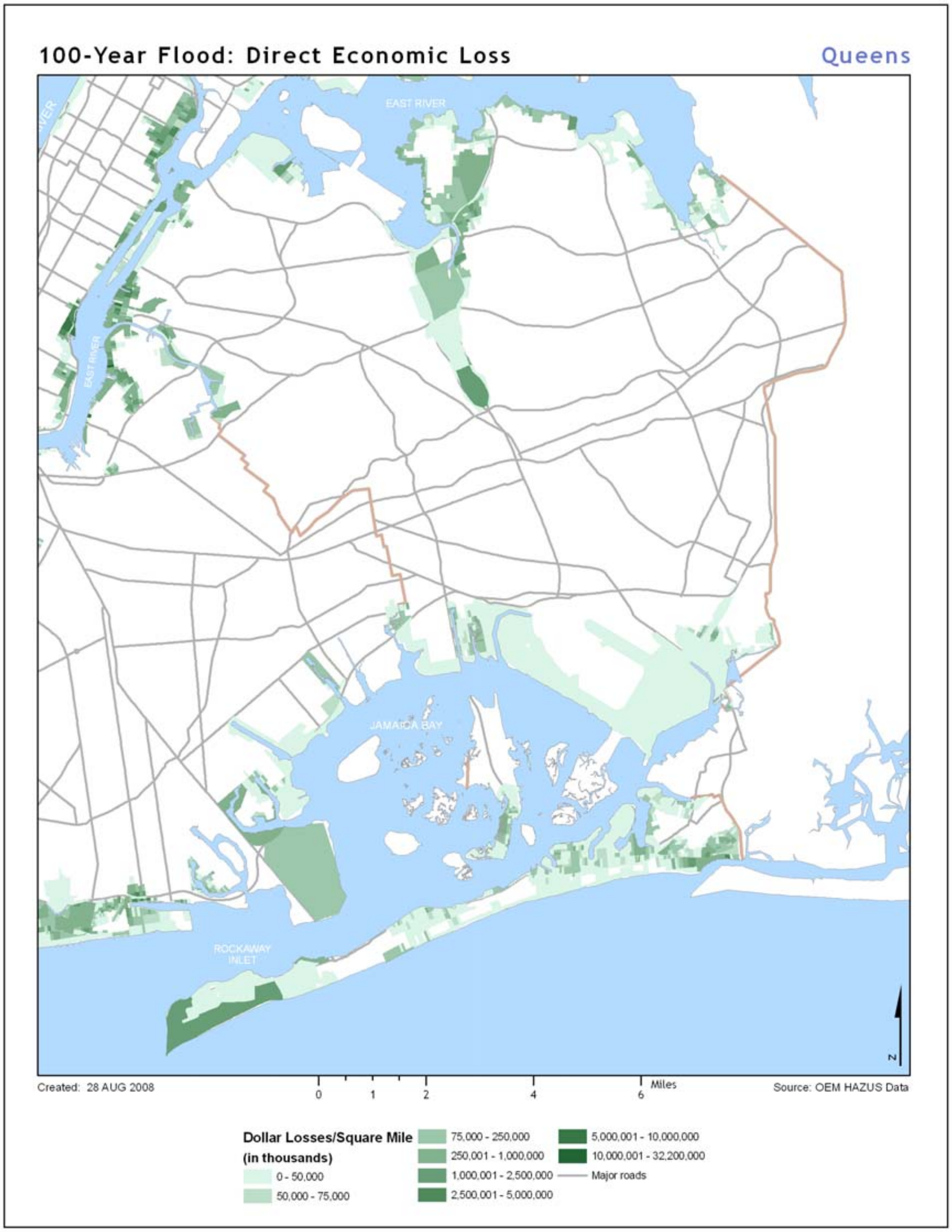


Figure 71: HAZUS-MH Results for Economic Losses from a 100-Year Flood in Queens

Figure 72: HAZUS-MH Results for Economic Losses from a 100-Year Flood in Staten Island

12) Windstorms and Tornadoes Hazard Analysis for New York City

a) Hazard Profile

i) Hazard Description

Windstorms are often associated with other storms, such as hurricanes or nor'easters, but may occur independently. High winds can cause downed trees and power lines, flying debris, and building collapses, all of which may lead to power outages, transportation disruptions, damage to buildings and vehicles, and injury or death. Flying debris is the primary cause of damage during a windstorm. While a building may be generally structurally sound, broken glass from windows can cause injuries inside and outside the building and extensive damage to building content.

A tornado is a violent storm with winds up to 300 miles per hour. It appears as a rotating funnel-shaped cloud, gray to black in color, extending toward the ground from the base of a thundercloud. The average tornado moves southwest to northeast at a forward speed of 30 miles per hour, but tornadoes can move in any direction and may vary from stationary to 70 miles per hour. Tornadoes are most frequent east of the Rocky Mountains during spring and summer months between the hours of 3 PM and 9 PM. Tornadoes may also accompany hurricanes. Tornadoes can uproot trees and buildings and turn harmless objects into deadly missiles in a matter of seconds. Tornadoes are especially dangerous because they appear transparent until they begin to pick up debris and dust. These short-lived storms are the most violent of all atmospheric phenomena and, over a small area, are the most destructive. Approximately 800 tornadoes occur across the nation each year, resulting in nearly 80 deaths and 1,500 injuries. Damage paths can exceed one mile wide and 50 miles long.

ii) Severity

The Beaufort Wind Scale is a simplified scale to aid in the estimation of wind speed and corresponding typical effects.

Beaufort Wind Scale		
Wind Speed (mph)	Name	Damage
25–31	Strong Breeze	Large branches in motion; whistling in telephone wires; umbrellas used with difficulty
32–38	Near Gale	Whole trees in motion; resistance felt while walking against the wind
39–46	Gale	Twigs break off of trees; wind impedes walking
47–54	Strong Gale	Slight structural damage to chimneys and slate roofs
55–63	Storm	Seldom felt inland; trees uprooted; considerable structural damage

Beaufort Wind Scale		
Wind Speed (mph)	**Name**	**Damage**
64–72	Violent Storm	Very rarely experienced; widespread structural damage; roofing peels off buildings; windows broken; mobile homes overturned
73+	Hurricane	Widespread structural damage; roofs torn off homes; weak buildings and mobile homes destroyed; large trees uprooted

Table 41: Beaufort Wind Scale

The Fujita Scale (F-Scale) is the standard measurement for rating the strength of a tornado. The NWS bases this scale on an analysis of damage after a tornado to infer wind speeds. On February 1, 2007, the NWS transitioned from the F-Scale to the Enhanced Fujita Scale (EF-Scale). The EF-Scale is considerably more complex and enables surveyors to assess tornado severity with greater precision. Table 42 details both scales.

F-SCALE and EF-SCALE				
F-Scale	**3-sec. gust speed (mph)**	**EF-Scale**	**3-sec. gust speed (mph)**	**TYPICAL DAMAGE**
F0	45–78	**EF0**	65–85	Light damage. Some damage to chimneys. Branches broken off trees. Shallow-rooted trees pushed over; signboards damaged.
F1	79–117	**EF1**	86–109	Moderate damage. Peels surface off roofs. Mobile homes pushed off foundations or overturned. Moving autos blown off roads.
F2	118–161	**EF2**	110–137	Considerable damage. Roofs torn off frame houses. Mobile homes demolished. Boxcars overturned. Large trees snapped or uprooted. Light-object missiles generated. Cars lifted off ground.
F3	162–209	**EF3**	138–167	Severe damage. Roofs and some walls torn off well-constructed houses. Trains overturned. Most trees in forest uprooted. Heavy cars lifted off the ground and thrown.
F4	210–261	**EF4**	168–199	Devastating damage. Well-constructed houses leveled. Structures with weak foundations blown away some distance. Cars thrown and large missiles generated.
F5	262–317	**EF5**	200–234	Incredible damage. Strong frame houses leveled off foundations and swept away. Automobile-sized missiles fly through the air in excess of 100 meters (109 yards). Trees debarked. Incredible phenomena will occur

Table 42: Fujita and Enhanced Fujita Scale

iii) Probability

Windstorms are a common occurrence in New York City, making them a highly probable hazard. Based on the historic occurrences, New York City experiences a high-wind event at least once a year.

Though infrequent, tornadoes in New York City are not unprecedented. Over the past 22 years, six tornadoes have hit New York City, five of which were scaled F0 or F1. Based on historic frequency, an estimated 27 tornadoes will hit the City every 100 years.

iv) Location

Windstorms occur in all five boroughs of New York City. Figure 73 and Figure 74 display wind zones throughout the United States and New York State. These wind zones portray the frequency and strength of extreme windstorms.

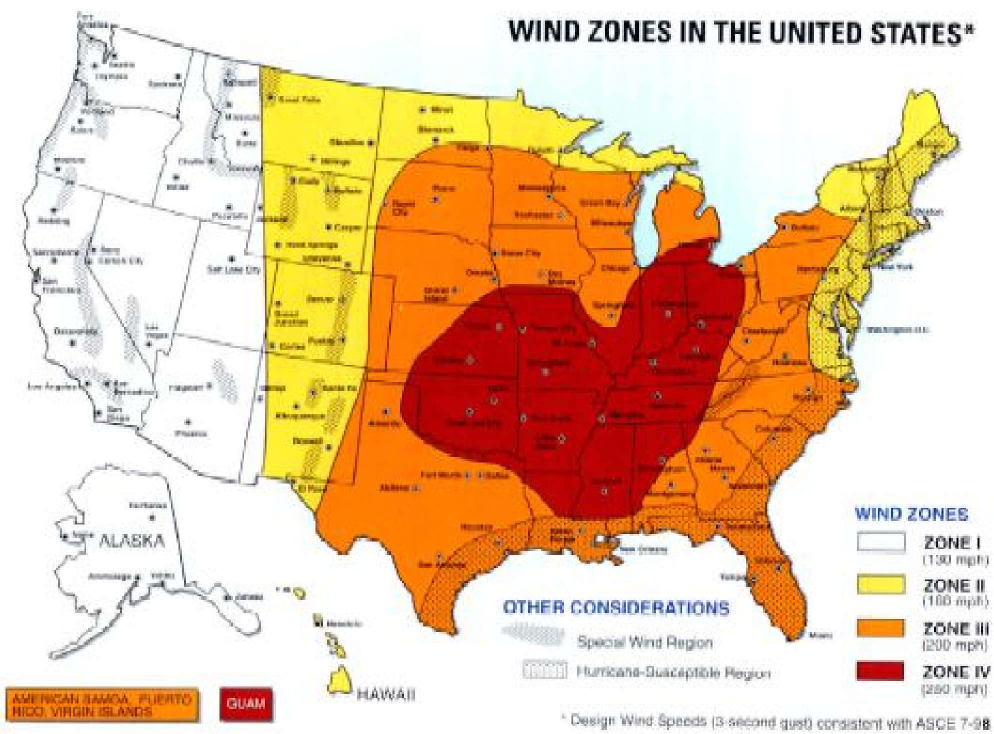


Figure 73: Wind Zones in the United States (Source: FEMA, 2008)

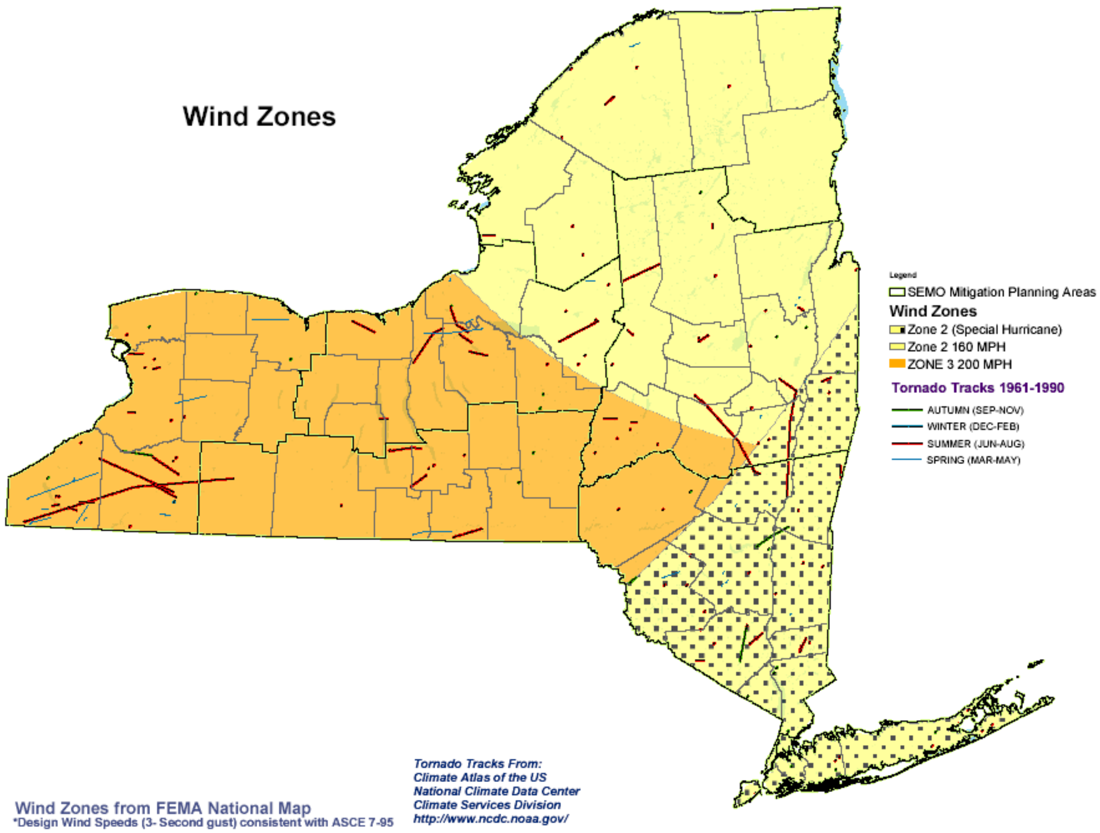


Figure 74: Wind Zones in NY State (Source: FEMA, 2008)

Of the six tornadoes that have affected the City, three were in Staten Island, while Manhattan, Brooklyn, and Queens each experienced one. However, scientists caution that though rare, a tornado is possible anywhere in the City.

v) Historic Occurrences

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Historic Occurrences of Windstorms and Tornadoes in New York City			
Date	**Event**	**Location(s)**	**Description**
Oct. 5, 1985	Tornado	Queens	• F1 tornado • Ran for 2 miles; width of 50 yards • No fatalities; 6 injuries
Aug. 10, 1990	Tornado	Staten Island	• F0 tornado • Ran for 2 miles; width of 17 yards • No fatalities; 3 injuries
Mar. 2, 1994	High Wind	Citywide	• High winds of 53 knots
Aug. 31, 1995	Tornado	Manhattan	• F1 tornado • Ran for 0 miles; width of 10 yards • No fatalities; 1 injury • Property damages totaled $30,000

Historic Occurrences of Windstorms and Tornadoes in New York City			
Date	**Event**	**Location(s)**	**Description**
Oct. 28, 1995	Tornado	Staten Island	• F1 tornado • No fatalities or injuries • Estimated damage $500,000
Feb. 25, 1996	High Wind	Citywide	• Intensity unknown • 1 fatality in Brooklyn due to a fallen tree • 1 reported injury
Mar. 19, 1996	High Wind	Citywide	• High winds of 69 knots • No fatalities or injuries
Oct. 19, 1996	High Wind	Citywide	• High winds of 80 knots • Fallen trees caused 3 fatalities; no additional injuries • Power lines and downed trees closed Bayonne Bridge • Reported roof ripped off a Bronx building
Nov. 2, 1997	Wind	Citywide	• Reported wind gusts 35-40 knots • 1 fatality; 1 injury
Nov. 27, 1997	Wind	Manhattan	• Winds averaged 25 to 35 mph; gusts around 50 mph • Balloon handlers lost control of Cat in the Hat balloon at Macy's Thanksgiving Day Parade; caused top of light pole to fall on 4 spectators • 1 serious and 3 less-serious injuries
Feb. 4, 1998	High Wind	Manhattan	• High winds of 50 knots • No fatalities; 1 injury reported
Mar. 18, 1999	Wind	Manhattan	• High winds 40-47 mph • 15-foot metal rod to tumbled 22 stories from top of 1 Times Square; injured 3 women
Dec. 12, 2000	High Wind	Citywide	• High winds 56 knots • Nor'easter • 1 fatality; 6 injuries
Sept. 11, 2002	High Wind	Citywide	• Strongest winds measured 66 mph in Queens • Winds lasted at least 6 hours • 1 fatality; 4 injuries • Widespread power outages • Construction debris caused injuries
Sept. 19, 2003	Strong Wind	Bronx	• Strong winds up to 40 knots • Hurricane Isabel • No fatalities; 1 injury • Downed trees and power lines
Oct. 15, 2003	High Wind	Queens	• High winds of 39 knots • No fatalities or injuries reported • Downed trees and power lines

Historic Occurrences of Windstorms and Tornadoes in New York City			
Date	**Event**	**Location(s)**	**Description**
			reported • Property damage estimated at a least $100,000
Oct. 27, 2003	Tornado	Staten Island	• F0 tornado • No fatalities or injuries
Nov. 13, 2003	High Wind	Citywide	• High winds of 56 knots • 1 fatality; no injuries reported
Dec. 1, 2004	High Wind	Brooklyn	• High winds of 61 knots • No fatalities or injuries reported
Dec. 23, 2004	Strong Wind	Queens	• High winds of 47 mph • 1 fatality caused by tree crushing traveling car; no injuries
Mar. 8, 2005	High Wind	Queens	• High winds of 50 knots • No fatalities; no injuries reported
Apr. 2, 2005	High Wind	Queens	• High winds of 50 knots • No fatalities and no injuries reported
Oct. 16, 2005	Strong Wind	Citywide	• High winds of 31 knots • No fatalities or injuries reported • Trees downed • Windows in a high-rise office building in Manhattan blew out • $17,000 in property damage reported
Oct. 25, 2005	High Wind	Citywide	• High winds of 42 knots • No fatalities or injuries reported • Downed trees City reported • Property damaged reported $35,000
Nov. 24, 2005	Strong Wind	Citywide	• High winds of 35 knots • No fatalities and 2 injuries resulting from a Macy's Thanksgiving Day parade balloon hitting a lamppost and causing a 30-pound light to fall into the crowd • No cost in damages reported
Jan. 15, 2006	High Wind	Queens	• High winds of 55 knots • No fatalities and 1 injury reported
Jan. 18, 2006	High Wind	Bronx, Manhattan, Staten Island, Queens	• High winds of 59 knots • No fatalities or injuries reported
Feb. 17, 2006	High Wind	Brooklyn, Queens, Staten Island	• High winds of 53 knots • No fatalities or injuries reported
Oct. 20, 2006	High Wind	Staten Island	• High winds of 50 knots • No fatalities or injuries reported

Historic Occurrences of Windstorms and Tornadoes in New York City			
Date	**Event**	**Location(s)**	**Description**
Jan. 20, 2007	Strong Wind	Citywide	• High winds of 41 knots • Flying construction resulted in no fatalities and 1 injury from debris
Aug. 8, 2007	Tornado	Brooklyn	• EF2 tornado • Discontinuous path • 16 homes had moderate to severe roof damage • Tornado tore the roof off a car dealership • Downed trees reported • Event accompanied by severe flooding • Federally declared disaster with more than $7.2 million given in IHP funding from FEMA • More than 3,700 residents filed claims at Disaster Assistance Service Centers

Table 43: Historic Occurrences of Windstorms and Tornadoes in New York City

b) Vulnerability Assessment

i) Impact to New York City

High-wind events can pose a serious threat to people and infrastructure. New York City's dense urban environment provides numerous objects that can become flying debris and severely injure people and damage structures. Areas with tall buildings such as Midtown Manhattan, the Financial District, and Downtown Brooklyn are at a greater risk because of increased wind pressures at greater heights. While these structures can withstand strong winds, glass windows pose a fatal threat if broken. Construction sites are also especially vulnerable to high winds. Loose tools and construction materials, cranes, scaffolding, and other building appurtenances may become loose from exposure to high winds.

ii) Structural Vulnerability

Structural vulnerability to wind is related to the building's construction type. Wood structures and manufactured homes are more susceptible to wind damage, while steel and concrete buildings are more resistant. Less than 0.1% of the City's buildings are manufactured housing and 54% are wooden structures. Staten Island has the highest percentage of structure vulnerable to windstorms and tornadoes with 93% of the borough's structures made of wood.

The New York City Construction Code addresses high winds in a dense, high-rise environment. The Construction Code establishes wind-exposure categories to set design requirements for new buildings. These requirements account for location, surroundings, and occupancy to ensure buildings can withstand extreme wind. For example, buildings along the coastline are subject to higher wind loads, as are buildings more than 300 feet.

iii) Potential Loss Estimate

It is difficult to estimate potential losses to specific structures because wind is a citywide hazard. More information regarding New York City's physical and structural vulnerability is located in section 3 on page 12.

13) Winter Storms Hazard Analysis for New York City

a) Hazard Profile

i) Hazard Description

New York City winters often usher in heavy snow, and ice. Heavy snow generally means snowfall accumulating to four inches or more in depth in 12 hours or less, or snowfall accumulating to six inches or more in depth in 24 hours or less. A blizzard has winds of 35 miles per hour or more with snow and blowing snow, reducing visibility to less than 1/4 mile for at least three hours.

Ice storms occur when damaging accumulations of ice accompany freezing rain. Significant accumulations of ice pull down trees and utility lines resulting in loss of power and communication. These accumulations of ice make walking and driving extremely dangerous. Significant ice accumulations are usually 1/4 inch or greater.

The winter months can also bring frigid temperatures that pose a hazard to public health and safety, especially for people who work outdoors, people who are homeless, and at-risk populations, such as seniors and children. See Extreme Temperatures Hazard Analysis on page 116 for more information.

ii) Severity

The severity of a winter storm depends on several factors including temperature, wind speed, type of precipitation, rate of deposition, and time of day and/or year the storm occurs.

The severity of a winter storm can be classified by meteorological measurements and by evaluating societal impacts. The Northeast Snowfall Impact Scale (NESIS) characterizes and ranks high-impact northeast snowstorms. These storms have large areas of 10-inch snowfall accumulations and greater. NESIS has five categories: extreme, crippling, major, significant, and notable. The index differs from other meteorological indices in that it uses population information in addition to meteorological measurements. Thus, NESIS gives an indication of a storm’s societal impact. This scale was developed because of the transportation and economic impacts northeast snowstorms can have on the rest of the country.

NESIS scores are a function of the area affected by the snowstorm, the amount of snow, and the number of people living in the path of the storm. The distribution of snowfall and population information are combined in an equation that calculates a NESIS score, which varies from around one for smaller storms to over 10 for extreme storms. The raw score is then converted into one of the five NESIS categories. The largest NESIS values result from storms producing heavy snowfall over large areas that include major metropolitan centers.

Since 1798, New York City has experienced 23 snowstorms with 16 inch or greater snowfall totals. According to NESIS, of these 23 storms, one was extreme, five were crippling, three were major, and three were significant. The remaining 11 historical snowstorms did not qualify for a NESIS rank. See Historic Occurrences in Table 44.

iii) Probability

Snowstorms and severe winter weather are frequent occurrences in New York City. Based on historical frequency, New York City can expect a major snowstorm of 16 inches or more approximately once every nine years.

iv) Location

All areas of New York City are susceptible to winter storms. Roads and bridges are especially vulnerable because of transportation accidents and disruptions related to severe winter storms.

v) Historic Occurrences

According to NWS, the three biggest snowstorms in New York City were:

(1) 26.9 inches on February 11–12, 2006
(2) 26.4 inches on December 26–27, 1947
(3) 21.0 inches on March 12–14, 1888

Historic Occurrences of Winter Storms in New York City				
Date	**Name**	**Total**	**NESIS**	**Comments**
Nov. 19–21, 1798	The Long Storm	~18"	N/A	• Snow from Maryland to Maine
Jan. 26–28, 1805	N/A	~24"	N/A	• 48 hours of continuous snow
Jan. 14–16, 1831	The Great Snowstorm	~15"	N/A	• Rivaled Superstorm of 1993 for expansiveness of coverage
Jan. 26–28, 1836	The Big Snow	~15"	N/A	• Interior sections saw widespread 30-40 inch tallies
Mar. 12–14, 1888	The Blizzard of '88	21.0"	4	• Extreme blizzard conditions left behind more than 50 inches of snow in some areas of Connecticut and the Hudson Valley
Mar. 16–18, 1892	St. Patrick's Day Snowstorm	15.4"	N/A	• Largest snowstorm on record for many areas of the South
Feb. 17–18, 1893	N/A	17.8"	N/A	• Followed a warm spell when temperatures reached as high as 54° F
Feb. 25–27, 1894	N/A	15.2"	N/A	• Before the storm, temperatures started out around 0°F, before rising to just above freezing
Feb. 12–13, 1899	The Blizzard of 1899	16.0"	4	• Temperatures in the single digits for most of the storm
Feb. 4–7, 1920	N/A	17.5"	N/A	• Parts of Westchester received more than 20 inches of snow
Jan. 22–24, 1935	N/A	17.5"	N/A	• Snow from Gulf Coast to Maine

Historic Occurrences of Winter Storms in New York City				
Date	**Name**	**Total**	**NESIS**	**Comments**
Mar. 7–8, 1941	N/A	18.1"	N/A	• Quick drop-off toward the coast as parts of New Jersey and Eastern Suffolk reported less than 10 inches of snow
Dec. 26–27, 1947	Big Snow	26.4"	2	• Worst blizzard since 1888 and record holder until 2006
Dec. 19–20, 1948	N/A	16.0"	N/A	• 20 hour duration • Widespread totals of 12-18 inches across the Metropolitan Area
Dec. 11–12, 1960	N/A	15.2"	3	• 20.4 inches recorded at Newark • 17.0 inches at The Battery
Feb. 3–4, 1961	N/A	17.4"	4	• Storm followed prolonged cold period (16 days of tens and 20s) • JFK Airport recorded 24.0 inches
Feb. 6–7, 1967	N/A	15.2"	2	• Blizzard conditions produced totals of more than 20 inches in parts of New Jersey
Feb. 9–10, 1969	Lindsay Storm	15.3"	2	• Mayor John Lindsay received criticism after sections of New York City remained unplowed for a week
Feb. 5–7, 1978	Blizzard of '78	17.7"	3	• Long Island and New England hardest hit • Near hurricane-strength winds, • Rare thundersnow reported • 36-hour storm duration
Feb. 11–12, 1983	Megalopolitan Snowstorm	17.6"	4	• Occurred during one of the strongest El Niños of the 20th Century
Jan. 7–8, 1996	Blizzard of 1996	20.2"	5	• Areas of more than 30 inches across portions of New Jersey • New York City schools closed, first time since Blizzard of '78
Feb. 16–17, 2003	Presidents' Day Snowstorm II	19.8"	4	• 25.6 inches of snow recorded at JFK Airport • "Presidents' Day Snowstorm I" brought 12.7 inches on Feb. 19, 1979
Feb. 11–12, 2006	Blizzard of 2006	26.9"	3	• Largest snowstorm in New York City history, surpassing Dec. 26–27, 1947 (26.4 inches) • Rare thundersnow reported

Table 44: Historic Occurrences of Winter Storms in New York City (Source: Weather 2000, 2007)

Between 1953 and 2007, there have been two presidential disaster declarations for winter snowstorms and blizzards in New York City. DR-1083 was declared on January 12, 1996. There were $21.3 million in eligible damages for all counties. EM-3184 was declared on March 3, 2003 for the incident period February 17–18, 2003. New York City has not had any presidential disaster declarations for ice storms.

b) Vulnerability Assessment

i) Impact on New York City

Heavy snow can paralyze the City, stranding commuters, closing airports, stopping the flow of supplies, and disrupting emergency and medical services. Accumulations of snow can cause roofs to collapse and knock down trees and power lines. The cost of snow removal, repairing damages, and the loss of business can have a severe economic impact on New York City.

Ice storms can also have a significant impact on New York City. Heavy accumulations of ice can bring down trees and topple utility poles and communication towers. Ice can disrupt communication and power for days while utility companies repair extensive damage. Even small accumulations of ice can be extremely dangerous to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces. In addition, ice accumulations affect rail beds and the public transit switch system.

The greatest danger during winter storms in New York City is the risk of automobile accidents. Snow and ice also have the potential to interfere with the public transit system if rail signals, switches, and tracks are affected. Commercial and financial business may see some revenue and productivity losses, although this is usually short-term. Government services may also be affected. A large snowstorm will significantly increase costs to City agencies. The Department of Sanitation, Department of Transportation, and Department of Parks and Recreation will incur additional costs related to snow and ice removal and pothole repair.

ii) Structural Vulnerability

Structural damage or building collapses because of snow are very rare in New York City. However, when snow accumulates on flat rooftops, it can cause damage, even to the point of jeopardizing the building’s structural soundness. As the snow melts, it can collect in depressed or recessed areas, a condition commonly called ponding. This additional weight or load can lead to roof damage or even collapse.

Chapter 16 of the New York City Construction Code governs the structural design of buildings and provides minimum design loads, load combinations, and procedures for determining snow loads, among others. DOB bases snow loads on New York City regional climate value for ground snow load and incorporates thermal factors for heated and unheated buildings. There are also provisions for snowdrifts caused by parapets and adjacent buildings.

iii) Potential Loss Estimate

Unlike flood or earthquake hazards, there are no standard loss estimation models or methodologies for the winter storms hazard. Potential losses from winter storms are, in most cases, indirect and therefore difficult to quantify. In May of 1994, the New York City Office of the Comptroller conducted a study of the fiscal and economic impact of the winter of 1993-94. The study revealed the unseasonably cold and snowy weather of the 1993-94 winter cost the City about $50 million more than a normal winter ($76 million when adjusted for inflation to 2008 dollars). Of this, $35.7 million was from additional costs to City agencies (the Departments of Sanitation, Transportation, and Parks and Recreation) and snow-related claims against the City. The other $14.7 million was from lost City revenues, such as parking meters and towing fees, and lost savings from the City's energy plan. In addition to costs to City government, a major winter storm impacts the daily routine of more than eight million New Yorkers and causes significant economic losses for many of the City's businesses.

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Section IV: Mitigation Strategy

1) Introduction

The Mitigation Strategy section describes how New York City will reduce or eliminate potential losses from hazards identified in the Natural Hazard Risk Assessment section. The strategy focuses on existing and potential mitigation actions that will mitigate the effects of a natural hazard event on New York City's population, economy, and property. The Mitigation Strategy is a coordinated effort by 39 New York City agencies and partners to develop and implement a comprehensive range of inventive and effective natural hazard mitigation actions.

a) Mitigation Strategy Approach

- Establish mitigation goals and objectives that aim to reduce or eliminate New York City's long-term vulnerability to natural-hazard events.
- Identify and analyze a comprehensive range of hazard-specific mitigation actions that aim to achieve the goals and objectives of the Mitigation Strategy.
- Describe how New York City will prioritize, implement, and administer mitigation actions.

b) FEMA Requirements Addressed in this Section

The OEM Hazard Mitigation Planning Team (Planning Team) developed the mitigation strategy consistent with the process and steps presented in the Federal Emergency Management Agency's (FEMA) How-To-Guide: Developing the Mitigation Plan (FEMA 386-3). This section satisfies the following requirements:

- **Requirement §201.6(c)(3)(i):** [The hazard mitigation strategy ***shall*** include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

- **Requirement §201.6(c)(3)(ii):** [The mitigation strategy ***shall*** include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure. [The mitigation strategy] must also address the jurisdiction's participation in the National Flood Insurance Program (NFIP), and continued compliance with NFIP requirements, as appropriate.

- **Requirement: §201.6(c)(3)(iii):** [The mitigation strategy section ***shall*** include] an action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization ***shall*** include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.

2) Developing Goals and Objectives

The first step in developing a hazard mitigation strategy is to establish goals and objectives that aim to reduce or eliminate New York City's long-term vulnerability to natural hazard events. Mitigation goals are general guidelines explaining what New York City wants to achieve in terms of hazard and loss prevention. Objectives are specific, measurable strategies or implementation steps used to achieve the identified goals. Developing clear goals and objectives helped reinforce New York City's overall purpose and mission for undertaking a mitigation planning process.

The Planning Team developed a preliminary set of hazard mitigation goals and objectives based on the findings of the Natural Hazard Risk Assessment and the New York State Multi-Hazard Mitigation Plan and presented these to the Steering Committee. The Planning Team also presented the goals at each of the community involvement meetings. Based on input and suggestions from the Steering Committee, the Planning Team revised and refined the goals and objectives into the final list below.

The goals and objectives set forth below provide the necessary framework to develop a mitigation strategy. New York City will re-evaluate its hazard mitigation goals and objectives each plan maintenance cycle to ensure they continue to represent New York City's hazard mitigation priorities.

Hazard Mitigation Goals and Objectives	
Goal 1: Protect public health and safety	
Objective 1.1	Improve systems that provide warning and emergency communications.
Objective 1.2	Reduce the impacts of hazards on vulnerable populations.
Objective 1.3	Strengthen state and local building code enforcement.
Objective 1.4	Train emergency responders.
Goal 2: Protect property	
Objective 2.1	Implement mitigation programs that protect critical facilities and services and promote reliability of lifeline systems to minimize impacts from hazards, maintain operations, and expedite recovery in an emergency.
Objective 2.2	Consider known hazards when identifying a site for new facilities and systems.
Objective 2.3	Create redundancies for critical networks such as water, sewer, digital data, power, and communications.
Objective 2.4	Adopt and enforce public policies to minimize hazard impacts on buildings, infrastructure, and neighborhoods and enhance safe construction in high hazard areas.
Objective 2.5	Integrate new hazard and risk information into building codes and land use planning mechanisms.
Objective 2.6	Educate public officials, developers, realtors, contractors, building owners, and the public about hazard risks and building requirements.

Hazard Mitigation Goals and Objectives	
Objective 2.7	Promote appropriate mitigation actions for all public and privately owned property within the City's jurisdiction including, but not limited to, residential units, commercial structures, educational institutions, healthcare facilities, cultural facilities, and infrastructure systems.
Objective 2.8	Incorporate effective mitigation strategies into New York City's capital improvement projects.
Objective 2.9	Promote post-disaster mitigation as part of restoration and recovery.
Goal 3: Promote a sustainable economy	
Objective 3.1	Form partnerships to leverage and share resources.
Objective 3.2	Continue critical business operations.
Objective 3.3	Partner with private sector, including small businesses, to promote structural and non-structural hazard mitigation as part of standard business practice.
Objective 3.4	Educate businesses about citywide contingency planning, targeting small businesses and those businesses located in high-risk areas.
Objective 3.5	Partner with private sector to promote employee/employer education about disaster preparedness while at work and at home.
Goal 4: Protect the environment	
Objective 4.1	Develop hazard mitigation policies that protect the environment.
Objective 4.2	Promote climate change adaptation strategies that mitigate the long-term effects of natural hazards on the environment.
Goal 5: Increase public preparedness for disasters	
Objective 5.1	Enhance understanding of natural hazards and the risks they pose.
Objective 5.2	Improve hazard information, including databases and maps.
Objective 5.3	Improve public knowledge of hazards and protective measures allowing individuals to appropriately prepare for and respond to hazard events.

Table 1: Hazard Mitigation Goals and Objectives

3) Identification and Analysis of Mitigation Actions

Mitigation actions include programs, plans, projects, or policies that help reduce or eliminate the long-term risk to human life and property from natural hazards. The Planning Team, with the assistance of the Steering Committee, identified and analyzed a comprehensive range of hazard-specific mitigation actions with particular emphasis on actions that affect new and existing buildings and infrastructure within New York City.

a) Identification

Mitigation Planning Council (MPC) members identified both existing and potential mitigation actions within their respective agencies that have the following criteria:

- Reduce or eliminate the long-term risk to human life and property from at least one of the eight natural hazards identified in the Risk Assessment Section
- Fall under one or more of the six FEMA mitigation action categories
- Achieve one or more of the five hazard mitigation goals and 23 objectives

Thirty-nine MPC agencies submitted 493 preliminary mitigation actions for inclusion in this mitigation strategy. The Planning Team worked with MPC members on a one-on-one basis to revise their agencies' mitigation actions. The final submittal resulted in 306 mitigation actions (145 existing and 161 potential) that meet the criterion above.

i) Mitigation Action Categories

FEMA organizes mitigation actions into six broad categories. These categories allow similar types of mitigation actions to be compared, and provides a standardized method for eliminating unsuitable actions. All mitigation actions identified in this strategy fall within one of the FEMA mitigation action categories below:

1. **Prevention**: Government administrative or regulatory actions or processes that influence the way land and buildings are developed and built. These actions also include public activities that reduce hazard losses. Examples from this strategy include building and construction code revisions, zoning regulation changes, and computer-hazard modeling.

2. **Property Protection**: Actions that involve the modification of existing buildings or structures to protect them from a hazard, or removal from the hazard area. Examples from this strategy include seismic retrofits, roadway elevations, and floodproofing.

3. **Public Education and Awareness**: Actions to inform and educate citizens, elected officials, and property owners about the hazards and potential ways to mitigate them. Examples from this strategy include programs that target severe repetitive loss properties and vulnerable populations.

4. **Natural Resource Protection**: Actions that, in addition to minimizing hazard losses, also preserve or restore the functions of natural systems. Examples from this strategy include projects create open space, greenbelts, bluebelts, or wetlands.

5. **Emergency Services**: Actions that protect people and property during and immediately after a disaster or hazard event. Examples from this strategy include enhancements that provide advanced warning and redundant communications.

6. **Structural Projects**: Actions that involve the construction of structures to reduce the impact of a hazard. Examples from this strategy include projects that control floodwater, reconstruct dams and seawalls, and construct green roofs.

ii) Planning Team

The final list of mitigation actions includes many structural projects that apply to both new and existing buildings and infrastructure. Many of the actions protect public health and safety, promote a sustainable economy, protect the environment, and increase public preparedness for disasters. The following table summarizes New York City's mitigation actions by hazard, mitigation action category, and goal/objective addressed. All actions described in this Plan reflect an April 2008 submission.

Summary of Mitigation Actions			
Category	**Existing**	**Potential**	**Total**
Number of Mitigation Actions	145	161	***306***
Mitigation Actions by Hazard Addressed			
Coastal Erosion	0	2	2
Coastal Storms	0	9	9
Drought	6	7	13
Earthquakes	8	12	20
Extreme Temperatures	9	9	18
Flood	52	39	91
Windstorms/Tornadoes	1	4	5
Winter Storms	3	1	4
Multi-Hazard	66	78	144
Total	***145***	***161***	***306***
Mitigation Actions by Category			
Prevention	53	15	68
Property Protection	32	56	88
Public Education and Awareness	11	19	30
Natural Resource Protection	16	6	22
Emergency Services	20	34	54
Structural Projects	13	31	44
Total	***145***	***161***	***306***
Mitigation Actions by Goal/Objective Addressed*			
1.1	12	6	18
1.2	3	11	14
1.3	11	1	12
1.4	1	0	1
2.1	71	79	150
2.2	15	3	18
2.3	14	15	29
2.4	25	5	30

Summary of Mitigation Actions			
Category	**Existing**	**Potential**	**Total**
2.5	23	12	35
2.6	7	9	16
2.7	88	104	192
2.8	21	52	73
2.9	2	4	6
3.1	5	4	9
3.2	1	1	2
3.3	10	6	16
3.4	5	6	11
3.5	3	4	7
4.1	28	26	54
4.2	13	8	21
5.1	16	30	46
5.2	12	20	32
5.3	9	13	22
Total	***395***	***419***	***814***

*Many mitigation actions address more than one goal and/or objective

Table 2: Mitigation Actions Summary Table

iii) Existing Mitigation Actions

Existing mitigation actions are New York City's programs, plans, projects, and policies currently underway that mitigate hazards. By assessing what the City is currently doing to mitigate natural hazards, the Planning Team was able to determine how the City might expand or improve upon these programs. Identifying New York City's existing mitigation actions also allowed the Planning Team to determine which hazards the City needs to address. The MPC identified 145 existing mitigation actions that have taken place or are in progress in the City.

For further details on the fields displayed in this table, see Table 13 on page 153. Each mitigation action is assigned an index value to indicate the hazard addressed, whether it is an existing or potential action, and its alphabetized placement in the list. For example, the mitigation action with the index EQ.E.9 is the ninth existing mitigation action that addresses earthquakes.

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
Drought								
D.E.1	**179th Street Pumping Station Rehabilitation:** Provide additional redundancy for water supply operations by allowing DEP to move water between the Croton and Catskill/Delaware systems to supplement the local distribution system.	DEP	NYPA	TBD	$16,000,000	Capital Budget	Structural Projects	2.1, 2.3, 2.7, 2.8
D.E.2	**Water Quality Protection:** Construct a water filtration plant to protect the Croton supply.	DEP	USGS, NYSDEC	5 Years	TBD	TBD	Structural Projects	2.1, 2.7, 2.8
D.E.3	**Water Quality:** Remove sediment from the Schoharie Reservoir Intake Channel to allow proper water flow and potentially lower turbidity levels. Extreme weather events introduce significantly turbid run-off into the reservoir. Schoharie Reservoir provides 10% of the City's water supply.	DEP	N/A	1 Year	$6,699,000	Capital Budget	Natural Resource Protection	2.1, 2.7

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
D.E.4	**Construction Code Revision:** Allow the use of waterless urinals as part of an approved water conservation plan.	DOB	N/A	Revision complete; Will be phased in by July 1, 2009	TBD	Staff Time	Prevention	2.5, 2.7, 4.1
D.E.5	**Water Conservation:** Replace existing water fixtures with new code-compliant low water use fixtures at the Gouverneur Healthcare Services facility.	HHC	DASNY	4 Years	$680,000	General Obligation Bonds	Prevention	2.1, 2.7, 4.1
D.E.6	**Water Conservation:** Reduce fleet-washing activities upon notification of drought conditions. Evaluate water usage at facilities, particularly concerning fleet cleaning. Use study results to develop a potential system-wide water conservation standard to reduce the impact of drought.	MTA	N/A	TBD	TBD	TBD	Prevention	2.1, 4.1

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
Earthquake								
EQ.E.1	**Facility Protection:** Install a seismically-resistant fire standpipe, air monitoring, and automatic valve system in all New York City tunnels to provide a fully automated and monitored fire suppression system.	Amtrak	FDNY, MTA	5 Years	$85,000,000	FRA, General Capital Funding, LIRR	Emergency Services	2.1, 2.3
EQ.E.2	**Hudson County Portal Bridge Replacement:** Replace portal bridge in Hudson County, NJ with new bridge designed to withstand seismic activity.	Amtrak	NJT, PANYNJ	10 Years	$1,200,000,000	FRA, Amtrak, NJT, PANYNJ	Structural Projects	2.1, 2.8
EQ.E.3	**Construct City Tunnel 3**: Construct a seismically resistant and redundant third water tunnel. City Tunnels 1 and 2 currently distribute water to all five boroughs of New York City. These tunnels are nearly 90 and 70 years old respectively, and have never been taken out of service.	DEP	N/A	TBD	$561,000,000	Capital Budget	Structural Projects	2.1, 2.3, 2.7, 2.8

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
EQ.E.4	**Construction Code Revision:** Require new critical facilities, such as fire stations and hospitals, to be designed with redundant structural systems. The previous code had no such requirement.	DOB	N/A	Revision complete; Will be phased in by July 1, 2009	TBD	Staff Time	Prevention	2.1, 2.3, 2.5, 2.7
EQ.E.5	**Construction Code Revision:** Update seismic engineering requirements to current national standards. Take into account soil and foundation underpinning. Require seismic detailing and inspections to ensure compliance. This will make new buildings both stronger and more flexible in an earthquake.	DOB	N/A	Revision complete; Will be phased in by July 1, 2009	TBD	Staff Time	Prevention	2.5, 2.7
EQ.E.6	**Building Upgrade:** Design Gouverneur Healthcare Services building to meet new seismic codes.	HHC	DASNY	4 Years	$184,000	General Obligation Bonds	Property Protection	2.1, 2.7
EQ.E.7	**Building Upgrade:** Design Harlem Hospital superstructure to meet new seismic codes.	HHC	DASNY	12 Months	$12,986,500	General Obligation Bonds	Property Protection	2.1, 2.7

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
EQ.E.8	**Ground Stabilization:** Densify soil beneath the new Patient Pavilion building at Harlem Hospital to reduce the impact of seismic activity.	HHC	DASNY	4 Months	$8,500,000	General Obligation Bonds	Property Protection	2.1, 2.4, 2.7
Extreme Temperatures								
ET.E.1	**Peak Load Management Program:** Conserve power during summer peak demand hours, usually noon to 6 PM, on days designated by NYPA. Conservation measures include: pre-cooling buildings before the peak demand hours, raising chill water temperatures and thermostats, turning off selected lighting and office equipment, and shutting down 10% to 15% of elevators.	DCAS	DCAS-DFMC	5 Years FY 2009–2014	TBD	Expense Budget	Prevention	2.1, 2.7, 4.1

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
ET.E.2	**Code Blue and Extended Outreach:** Coordinate personnel to increase efforts to keep New York City's street homeless population safe during extreme cold events.	DHS	DOHMH	Ongoing	$120,000	City Tax Levy	Public Education and Awareness	1.2, 5.3
ET.E.3	**Construction Code Revision:** Require roof coverings or setbacks with a slope less than a 25% (3 units vertical in 12 units horizontal) to be white or a color rated by EnergyStar as highly reflective. This color shall cover at least 75% of the area of the roof or setback surface to better reflect heat.	DOB	N/A	Revision complete; Will be phased in by July 1, 2009	TBD	Staff Time	Prevention	2.4, 2.5, 2.7, 4.1, 4.2

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
ET.E.4	**Public Health Information for Healthcare Providers:** Provide timely and accurate extreme heat health alerts, advisories, and updates to healthcare providers through the Health Alert Network, Dialogic NXT Communications System, and blast fax.	DOHMH	OEM	Ongoing	TBD	TBD	Public Education and Awareness	1.1, 1.2
ET.E.5	**Public Health Risk Communication for the General Public:** Raise public awareness on how to reduce or prevent heat illness and heat mortality through 311, www.NYC.gov, printed materials, and media.	DOHMH	OEM	Ongoing	TBD	TBD	Public Education and Awareness	1.2, 5.1, 5.3
ET.E.6	**Syndromic Surveillance Systems:** Monitor health impacts of heat wave using syndromic surveillance of heat-related calls to EMS and chief complaints in hospital emergency departments to trigger appropriate interventions and predict future trends.	DOHMH	N/A	Ongoing	TBD	TBD	Public Education and Awareness	5.1, 5.2

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
ET.E.7	**Summer Operations Manual:** Perform pre-trip bus inspections to confirm windows and hatches are closed and the air conditioning system is working properly. Provide bus operators with summer uniforms and information about heat stress.	MTA (Buses)	OEM	TBD	TBD	Agency Operating Budget	Prevention	2.1, 5.1, 5.3
ET.E.8	**Protect System from Heat-Related Damage:** Protect engines, increase pantograph inspections, and prepare for response to heat-related incidents including increased switch, bridge, signal, catenary, and track circuit failures, as well as heat kinks.	MTA (LIRR/MNR)	N/A	TBD	TBD	Agency Operating Budget	Property Protection	2.1

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
ET.E.9	**Infrastructure Protection:** Advocate for Con Ed to implement recommendations from the City's report on the northwest Queens power outages. Power outages of this magnitude are often caused by extreme-heat events.	OLTPS	Con Ed, NYSPSC	8 Years	TBD	TBD	Prevention	2.1, 2.7
Flood								
F.E.1	**Culvert Improvement:** Increase culvert diameter from 18" to 24" to improve drainage along Pelham Bay.	Amtrak	N/A	1 Year	$50,000	Amtrak	Structural Projects	2.1, 2.7
F.E.2	**Floodgates:** Upgrade floodgate hardware and mechanisms to control rise rate of water into Penn Station tunnels.	Amtrak	MTA, NJT	2 Years	$3,000,000	General Capital Funding, MTA, NJT	Structural Projects	2.1, 2.7
F.E.3	**Tunnel Radio/Communication Improvement:** Add resiliency to facility communication technology by using fiber optics.	Amtrak	MTA	5 Years	$100,000	FRA	Emergency Services	1.1, 2.3

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
F.E.4	**Upgrade Mid-River Pumps:** Upgrade East River pumps to handle flooding conditions in tunnels under the river.	Amtrak	MTA, NJT	2 Years	$150,000	MTA, NJT	Property Protection	2.1, 2.7
F.E.5	**Mapping Improvements:** Improve/enhance flood vulnerability data. Enhance planning by using surveys to more accurately define flood vulnerability of electric supplies.	Con Ed	N/A	3 Years	$100,000	Agency Operating Budget	Prevention	3.3, 5.1, 5.2

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
F.E.6	**Combined Sewer Overflow (CSO) Storage Tanks:** CSO storage tank projects at Paerdegat Basin, Spring Creek, Flushing Bay, and Alley Creek. These tanks will capture and store millions of gallons of combined sanitary and stormwater during extreme weather to reduce CSO into surrounding water bodies. The collected combined sewage is later conveyed to a wastewater treatment plant after the sewer system returns to normal to be fully treated before discharged into surrounding water bodies.	DEP	N/A	Flushing Bay and Spring Creek—Complete; Paerdegat Basin—September 2009; Alley Creek—June 2009	$764,860,000	Capital Budget	Structural Projects	2.1, 4.1, 2.8

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
F.E.7	**Dam Inspection Program**: Implement New York City dam-inspection program on both monthly and yearly cycles to facilitate appropriate maintenance and attain state of good repair.	DEP	N/A	Ongoing Beginning Fall 2008	$100,000	Agency Operating Budget	Prevention	2.1, 2.8
F.E.8	**Infrastructure Enhancement:** Construct high-level storm sewers in the following combined sewer areas: Laurelton, Throgs Neck, and Gowanus. This will reduce the impact of flooding by draining more stormwater from these areas.	DEP	DDC	25 Years	$750,000,000	Capital Budget, Federal Funding	Structural Projects	2.1, 2.7, 2.8
F.E.9	**Infrastructure Improvement:** Install additional storm sewers in the following flood-prone areas: southeast Queens, Rockaways, Coney Island, and Flushing.	DEP	DDC	50 Years	$6,000,000,000	Capital Budget, Federal Funding	Structural Projects	2.1, 2.7, 2.8

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
F.E.10	**Natural Resource Enhancement:** Construct bluebelts in the following areas: Springfield Lake, Baisley Pond, Udall's Cove, Brookville Triangle, Meadow Lake, and Van Cortlandt Park.	DEP	DDC, Parks, NYSDEC	15 Years	$100,000,000	Capital Budget	Natural Resource Protection	2.2, 2.4, 2.7, 4.1
F.E.11	**Natural Resource Enhancement:** Construct bluebelts on Staten Island's South Shore, Mid Island, and Snug Harbor.	DEP	DCP, DDC, Parks, NYSDEC	25 Years	$300,000,000	Capital Budget	Natural Resource Protection	2.2, 2.4, 2.7, 4.1
F.E.12	**Property and Infrastructure Protection:** Prepare large area drainage plans for the following flood prone areas: southeast Queens, Rockaways, Coney Island, and Whitestone. These plans will examine and optimize how storm and floodwater is managed in these areas.	DEP	DOH, DCP	3 Years	$7,000,000	Capital Budget	Prevention	2.1, 2.7, 2.8

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
F.E.13	**Stormwater/Flooding Public Outreach and Education Program:** Develop school curricula and public outreach materials to educate the public about flooding and stormwater.	DEP	N/A	TBD	TBD	Operating Budget	Public Education and Awareness	2.6, 5.1, 5.2, 5.3
F.E.14	**Water Quality Protection:** Integrate high-level storm sewers into major new developments, as appropriate. This will alleviate street flooding in problematic areas.	DEP	DOT, DOB	8 Years	TBD	TBD	Structural Projects	2.7, 2.8
F.E.15	**Water Quality Protection:** Pilot one swale to collect rainwater from roadways to reduce flooding during storms.	DEP	DOT, OLTPS	8 Years	TBD	TBD	Structural Projects	2.7, 2.8, 5.1
F.E.16	**Natural Resource Protection:** Purchase (anticipated) 126 acres on Staten Island to construct and recreate wetlands, which will help mitigate the impact of flooding.	DEP	Law Department, Parks, NYSDEC	10 Years	$200,000,000	Capital Budget	Natural Resource Protection	2.2, 2.4, 2.7, 4.1

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
F.E.17	**Construction Code Revision:** Clarify current flood regulations and adopt the latest national standards.	DOB	N/A	Revision complete; Will be phased in by July 1, 2009	TBD	Staff Time	Prevention	2.4, 2.5, 2.7
F.E.18	**Construction Code Revision:** Require new critical facilities located in flood zones to be raised above the base flood elevation.	DOB	N/A	Revision complete; Will be phased in by July 1, 2009	TBD	Staff Time	Prevention	2.1, 2.2, 2.4, 2.5, 2.7
F.E.19	**Facility Protection:** Execute flood elimination capital projects at 20 sites that need long-term solutions for reoccurring flood damage due to groundwater infiltration.	DOE	DOE-SCA	1 Year	TBD	FEMA	Property Protection	2.1, 2.7, 2.8
F.E.20	**Natural Resource Restoration:** Include wetlands restoration as part of waterfront development projects to comply with aesthetic permitting or stormwater management requirements.	EDC	NYSDEC	TBD	TBD	NYSDEC, City Capital	Natural Resource Protection	2.2, 2.4, 2.7, 4.1
F.E.21	**Wetland Restoration:** Implement Flushing Airport Wetlands Mitigation Project in College Point, Queens.	EDC	NYSDEC	TBD	$9,000,000	NYSDEC, City Capital	Natural Resource Protection	2.4, 2.7, 4.1

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
F.E.22	**Facility Protection:** Install special waterproofing membrane in the basement of the Gouverneur Healthcare facility to prevent groundwater from entering the building's basement.	HHC	DASNY	4 Years	$225,000	General Obligation Bonds	Property Protection	2.1, 2.7
F.E.23	**Track Drainage Study:** Perform track drainage study on the Harlem Line at the Mott Haven Interlocking located near 149th and 159th streets in the Bronx. Depending on the recommendations of this study and support by the City, initiate capital project to improve drainage and reduce impact of flooding in this area.	MTA (MNR)	DEP, DOT, MTA, DOE-SCA	2 Years	$3,000,000 – $5,000,000	MTA Capital Budget	Emergency Services	2.1, 2.7, 2.8

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
F.E.24	**Baisley Park Depot Drainage Improvement:** Implement corrective actions to mitigate repetitive flooding caused by moderate to heavy rain. This flooding interferes with bus service. The drainage deficiencies that cause this flooding were identified by a recent study.	MTA (NYCT-Bus)	DEP, FTA, NYSDEC	2 Years	TBD	Capital Budget	Property Protection	2.1, 2.7
F.E.25	**Flood Control:** Dewater oil-water separators at East New York, Castleton, Michael J. Quill, and Grand Avenue depots to provide additional capacity for incoming rainwater. Drain 200,000 gallon stormwater retention tank to accept incoming rainwater. This tank is normally full and used for bus washing.	MTA (NYCT-Bus)	N/A	Ongoing	TBD	TBD	Property Protection	2.1, 2.7

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
F.E.26	**JFK Depot Drainage Improvement:** Include on-site stormwater management improvements at new parking facilities to decrease flow to DEP treatment facilities during high-volume precipitation events.	MTA (NYCT-Bus)	DEP, FTA, NYSDEC	2 Years	$3,234,000	Capital Budget	Structural Projects	2.2, 2.7
F.E.27	**Draft NYCT Flood Plan:** Perform pre-storm flood mitigation actions in pre-identified flood prone areas. Actions include checking drains, vents, and installed-pumps as well as deploying tarps and sand bags to pre-identified sites to cover vents and protect subway entrances.	MTA (NYCT-Subway)	NJT, PANYNJ (PATH)	Ongoing	TBD	TBD	Emergency Services	2.1, 2.7
F.E.28	**Drainage Improvement Plan:** Finalize Flood Plan, including mapping of critical areas, mitigation plan, and contingency plan.	MTA (NYCT-Subway)	DEP	Ongoing	TBD	Agency Operating Budget	Emergency Services	2.1, 5.1, 5.2

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
F.E.29	**Drainage Improvement:** Implement joint DEP/NYCT station inspection and cleaning program. This program will feature cleaning of catch basins, sewers, and siphons at flood-prone areas.	MTA (NYCT-Subway)	N/A	Ongoing	TBD	Agency Operating Budget	Property Protection	2.1, 2.7
F.E.30	**Facility and Infrastructure Protection Plan:** Conduct system-wide flood study to determine locations and impacts of storm-related water infiltration into the NYCT system.	MTA (NYCT-Subway)	N/A	2 Years	$3,000,000	MTA	Emergency Services	2.1, 2.7
F.E.31	**Facility Protection:** Raise identified street entrances above 100-year flood plain, avoid street gratings, and install large sump system.	MTA (NYCT-Subway)	N/A	7 Years (Phase 1)	TBD	FTA, Capital Budget	Property Protection	2.1, 2.7

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
F.E.32	**Stormwater Drainage Improvement**: Install 34 check valves at all direct connections to the City's combined sewer/storm drainage system to prevent backflow into the NYCT drainage system.	MTA (NYCT-Subway)	DEP	3 Years	TBD	NYCT, Capital Budget	Structural Projects	2.1, 2.7, 2.8
F.E.33	**Stormwater Drainage Improvement:** Raise vent grating and subway entrances at five locations: (1) Broadway-7th Avenue Line: 77th to 96th Street; (2) Broadway-7th Avenue Line: Chambers Street; (3) 8th Avenue Line: 34th Street; (4) Hill Avenue Line; and (5) Broadway Line.	MTA (NYCT-Subway)	DEP	Ongoing	TBD	NYCT, Capital Budget	Property Protection	2.1, 2.7, 2.8
F.E.34	**Critical Facility Relocation:** Relocate OEM supply warehouse to higher elevation, out of the 100-year floodplain and coastal storm-surge zone.	OEM	N/A	1 Month	$20,000	Agency Operating Expenses	Property Protection	2.1, 2.2, 2.7

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F.E.35	**Resiliency Improvement:** Update FEMA 100-year floodplain maps for New York City to reflect current weather conditions and topography/bathymetry.	OLTPS	DOB, DCP, EDC, OEM	8 Years	TBD	TBD	Prevention	2.4, 2.5, 5.2
F.E.36	**Water Quality Protection:** Form interagency Best-Management Practices (BMP) task force. Encourage addition of stormwater BMPs to New York City projects. Currently, stormwater BMPs are included to the extent allowed by the project's budget. Additionally, task force will pilot innovative stormwater BMPs.	OLTPS	DEP, DOB, DOT, Parks, EDC	8 Years	TBD	TBD	Emergency Services	2.5, 3.1, 5.1, 5.2, 5.3

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F.E.37	**Backflow Preventers:** Install backflow prevention devices and water meter upgrades to Port Authority-controlled buildings at JFK airport in accordance with the New York State Sanitary Code and City regulations. Perform water-meter upgrades as required.	PANYNJ (Aviation)	NYC, NYS	6 Years	$19,203,000	Capital Budget	Property Protection	2.1, 2.7
F.E.38	**Drainage Improvement:** Install synthetic material at two locations at the intersection of Runways 4L and 31L to increase permeable surfaces and enhance stormwater runoff capacity at JFK airport.	PANYNJ (Aviation)	FAA	13 Years	$29,998,000	Capital Budget	Property Protection	2.1, 2.7
F.E.39	**Drainage Improvement:** Retrofit and/or rebuild stormwater outfalls, including replacing terminating section of concrete triple box culvert, to enhance drainage capacity at JFK airport.	PANYNJ (Aviation)	DEP, NYSDEC	8 Years	$8,434,000	Capital Budget	Property Protection	2.1, 2.7,

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F.E.40	**Facility Upgrade:** Redesign and retrofit runways 13R-31L at JFK airport, including raising existing grade, modifying existing drainage, and installing new lighting and concrete pavement.	PANYNJ (Aviation)	FAA	4 Years	$218,063,000	Capital Budget	Property Protection	2.1, 2.7
F.E.41	**Storm Drainage Rehabilitation—Phase III:** Upgrade existing storm drainage pipe system by replacing pipe or installing an inner-lining system to eliminate leaks in the stormwater pipe system at LGA airport.	PANYNJ (Aviation)	PANYNJ	15 Years	$12,000,000	2007–2016 Capital Plan	Property Protection	2.1, 2.7
F.E.42	**Facility Improvement:** Retrofit and floodproof eastbound and westbound platforms.	PANYNJ (PATH)	N/A	6 Years	$73,000,000	2007–2016 Capital Plan	Property Protection	2.1, 2.7
F.E.43	**Facility Upgrade:** Redesign and floodproof eastbound and westbound station head houses at Harrison Station.	PANYNJ (PATH)	N/A	6 Years	$95,000,000	2007–2016 Capital Plan	Property Protection	2.1, 2.7

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F.E.44	**Facility Upgrade:** Redesign, floodproof, and strengthen existing PATH car running repair shop.	PANYNJ (PATH)	N/A	4 Years	$16,000,000	2007–2016 Capital Plan	Property Protection	2.1, 2.7
F.E.45	**Facility Upgrade:** Redesign, floodproof, and strengthen Grove Street Station from street level to mezzanine and mezzanine to platform.	PANYNJ (PATH)	N/A	5 Years	$100,000,000	2007–2016 Capital Plan	Property Protection	2.1, 2.7
F.E.46	**Facility Upgrade:** Redesign, floodproof, and strengthen substations 7, 8, and 9.	PANYNJ (PATH)	N/A	8 Years	$71,000,000	2007–2016 Capital Plan	Property Protection	2.1, 2.7
F.E.47	**Drainage Improvement:** Enhance drainage capacity in caisson #1 to prevent water intrusion into PATH emergency exit shaft.	PANYNJ (PATH)	N/A	1 Year	$40,000	2007–2008 Operating Major Works Project Budget	Property Protection	2.1, 2.7
F.E.48	**Facility Protection:** Provide means of preventing or diverting stormwater infiltration into the Hudson Corridor during a severe flooding event.	PANYNJ (PATH)	N/A	3–4 Years	$5,000,000	2007–2016 Capital Plan	Property Protection	2.1, 2.7
F.E.49	**Facility Upgrade:** Retrofit and waterproof entire west end of Pavonia Station.	PANYNJ (PATH)	N/A	5–8 Years	$35,000,000	2007–2016 Capital Plan	Property Protection	2.1, 2.7

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F.E.50	**Wetland or Upland Habitat Restoration:** Improve ability of land to absorb and retain water. Prevent flooding and release of silt and dirt into sewers and habitat. Parks' Natural Resources Group oversees upland and wetland restoration.	Parks	N/A	5 Years	$10,000 – $50,000 per acre	HMGP, Other Grants	Natural Resource Protection	2.4, 2.7, 2.8, 4.1
F.E.51	**Water and Air Quality Protection:** Assess vulnerability of existing wetlands and identify additional policies to protect them.	Parks, DEP, OLTPS	EDC, DCP, USEPA, USNPS	8 Years	TBD	TBD	Emergency Services	2.4, 2.7, 4.1
F.E.52	**Facility Protection:** Perform pre-storm inspection, testing, and maintenance of central office cable vault sump pumps and battery backups. Sump pumps activate automatically when certain water levels are reached.	Verizon	N/A	Ongoing	TBD	Expense and Capital Budget	Property Protection	2.1, 2.7

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Windstorms/Tornadoes								
WT.E.1	**Advance Warning:** Monitor forecasts of wind speed to issue speed restrictions or ensure suspension of service prior to major wind impact (all elevated structures).	MTA	NWS	Ongoing	TBD	Agency Operating Budget	Emergency Services	1.1
Winter Storms								
WS.E.1	**Construction Code Revision:** Apply the latest national standards for the determination of snow load, snowdrift loads, and sliding snow loads.	DOB	N/A	Revision complete; Will be phased in by July 1, 2009	TBD	Staff Time	Prevention	2.2, 2.4, 2.5, 2.7
WS.E.2	**Advanced Warning and Equipment Protection:** Disseminate protocols in the Winter Standard Operating Procedures for declaring advisories and alerts, adjusting or reducing service, and protecting rolling stock prior to and during winter weather emergencies.	MTA	N/A	TBD	TBD	Agency Operating Budget, HMGP	Emergency Services	1.1, 2.1

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WS.E.3	**Infrastructure and Equipment Protection:** Store trains underground when forecast calls for temperatures -10° F, ice storms, icing conditions, or > 5 inches of snow.	MTA (NYCT-Subway)	N/A	Ongoing	$220,000/per year	Agency Operating Budget	Property Protection	2.1
Multi-Hazard								
MH.E.1	**1st Avenue Ventilation System Rehabilitation:** Upgrade tunnel sump pumps to control flooding and seismically harden the evacuation/response staircase with a reinforced concrete staircase. The existing stairs were built in 1909.	Amtrak	FDNY, MTA	7 Years	$200,000,000	FRA, General Capital Funding, MTA	Property Protection	2.1, 2.7
MH.E.2	**Emergency Power System:** Provide redundancy to lighting, ventilation, and pumps in Penn Station and in the tunnel system.	Amtrak	MTA	5 Years	$1,500,000	General Capital Funding, NJT	Emergency Services	2.1, 2.3

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MH.E.3	**Long Island City Ventilation System Rehabilitation:** Upgrade tunnel sump pumps to control flooding and seismically harden the evacuation/response staircase with a reinforced concrete staircase. The existing stairs were built in 1909.	Amtrak	FDNY, MTA	6 Years	$110,000,000	FRA, General Capital Funding, MTA	Property Protection	2.1, 2.7
MH.E.4	**Improved Weather Forecasting:** Develop a multi-party team to apply IBM's Deep Thunder technology to forecast weather-caused damage at a micro-geographic level. IBM's Deep Thunder can predict rain, wind speed and direction, and temperature to assist in advance warning capabilities.	Con Ed	N/A	2 Years	$400,000	Agency Research and Development Budget	Emergency Services	1.1, 3.3

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MH.E.5	**Vegetation Management Program:** Perform vegetation management to ensure infrastructure, as well as the public, is secure during and after a natural hazard event. Proper pruning and thinning of the tree canopy is important to minimize damage during hurricanes and wind events. Improperly maintained trees damage utilities and require extensive clean-up after storms.	Con Ed	N/A	Ongoing	$4,000,000	Agency Operating Budget	Prevention	2.1, 2.7, 3.3, 4.1

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MH.E.6	**Green Zoning Regulations:** Promote the greening of new and expanded commercial parking lots of more than 18 spaces or 6,000 square feet by requiring landscaping, perimeter screening, tree planting, and maneuverability standards based on the lot size. In keeping with the Mayor's PlaNYC: A Greener, Greater New York (PlaNYC) sustainability goals, the new regulations, approved in 2007, will assist in effectively managing stormwater runoff, cooling the air, improving vehicular circulation, and enhancing the City's public realm by visually improving unsightly expanses of pavement.	DCP	DOB, OLTPS	Ongoing	TBD	TBD	Prevention	2.4, 2.5, 4.1, 4.2

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MH.E.7	**Hazard Mitigation Planning and Zoning:** Examine ways to incorporate hazard mitigation goals into future City-sponsored rezoning initiatives. A number of re-zonings with waterfront and floodplain components have recently been initiated by the City, including: Hunter's Point, Flushing, City Island, Throgs Neck, and Greenpoint/Williamsburg. Future/in progress zoning initiatives include Coney Island, the Rockaways, Sherman Creek, and the Lower Concourse. These re-zonings incorporate goals established in the Waterfront Revitalization Program (WRP) and pave the way for the predictable development of open space along the waterfront.	DCP	DOB, EDC, Parks	Ongoing	TBD	TBD	Prevention	2.2, 2.4, 2.5, 2.7

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MH.E.8	**Open Space:** Promote the preservation and development of waterfront open space. Pursuant to Policy 8 of the WRP, the development of public open space along the waterfront is promoted through public and private initiatives.	DCP	DOB, Parks	Ongoing	TBD	TBD	Natural Resource Protection	2.2, 2.4, 3.3 2.5, 4.1
MH.E.9	**Planning and Zoning:** Review discretionary projects for consistency with WRP. Policy 6 of the City's WRP establishes a goal of ”minimizing loss of life, structures and natural resources caused by flooding and [coastal] erosion," and impacts decisions regarding all discretionary review of development on the waterfront and in the 100-year floodplain.	DCP	N/A	Ongoing	TBD	TBD	Prevention	2.2, 2.4, 2.5

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MH.E.10	**Stormwater Management Regulations:** Prevent excessive paving of front yards. Require a minimum percentage of all front yards be landscaped, prohibit steeply pitched driveways in front yards, and encourage rear-yard garages to maximize planting area in the front yard. This package of regulations mitigates stormwater runoff, reduces surrounding temperatures, and enhances the attractiveness of neighborhood streets while furthering the Mayor's PlaNYC sustainability goals.	DCP	DOB, OLTPS	Adopted April 30, 2008	TBD	Staff Time	Prevention	2.4, 2.5, 5.2

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MH.E.11	**Street Tree Requirements:** Require planting of one street tree for every 25 feet of street frontage of the zoning lot for virtually all new developments, major enlargements, and certain use conversions. Each lot is subject to a minimum of one street tree. This zoning resolution establishes requirements for sidewalk planting strips in lower density residential districts. These zoning regulations support the Mayor's PlaNYC goals for increased street-tree canopy, air-quality improvement, and stormwater management.	DCP	DOB, Parks, OLTPS	Adopted April 30, 2008	TBD	TBD	Natural Resource Protection	2.5, 4.1, 4.2

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MH.E.12	**Waterfront Planning and Zoning:** Prepare comprehensive waterfront plan to establish citywide and site-specific guidelines for regulating development at the water's edge (See New York City Comprehensive Waterfront Plan: Reclaiming the City's Edge, 1992 and New Waterfront).	DCP	N/A	Ongoing	TBD	TBD	Prevention	2.2, 2.4, 2.5
MH.E.13	**Water and Air Quality Protection:** Design five expanded tree pits with below-grade water catchments to increase stormwater infiltration and monitor impacts.	DEP	Parks	8 Years	TBD	TBD	Structural Projects	2.7, 4.1

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MH.E.14	**Advanced Warning System:** Provide advanced warning of wind and other weather hazards to registered construction superintendents, site safety managers, and the media. This system allows construction sites to take mitigating steps prior to the onset of hazardous weather.	DOB	N/A	Completed	TBD	Staff Time	Emergency Services	1.1
MH.E.15	**Construction Code Revision:** Enhance connectivity requirements for structural components. These changes increase the structural integrity of new buildings, allowing them to better withstand an unanticipated event.	DOB	N/A	Revision complete; Will be phased in by July 1, 2009	TBD	Staff Time	Prevention	2.2, 2.4, 2.5, 2.7

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MH.E.16	**Construction Code Revision:** Introduce importance factors into the design of new critical facilities, power generating facilities, water-treatment plants, and buildings where 300 people or more congregate in one area. Importance factors increase the design seismic, snow, and wind loads of a structure to prevent catastrophic collapse.	DOB	N/A	Revision complete; Will be phased in by July 1, 2009	TBD	Staff Time	Prevention	2.1, 2.2, 2.4, 2.5, 2.7
MH.E.17	**Construction Code Revision:** Provide fee rebates to encourage construction of sustainable buildings.	DOB	N/A	Revision complete; Will be phased in by July 1, 2009	TBD	Staff Time	Prevention	2.5, 4.1, 4.2
MH.E.18	**Construction Code Revision:** Require overflow drains to protect roof structures if primary roof drains fail. The structural load of accumulated rainwater will be accounted for in roof design.	DOB	N/A	Revision complete; Will be phased in by July 1, 2009	TBD	Staff Time	Prevention	2.4, 2.5, 2.7

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MH.E.19	**Existing Building Code Revision:** Develop a building code that will promote the inclusion of natural hazard mitigation measures into existing building design and retrofit projects.	DOB	N/A	TBD	$475,000	Agency Operating Budget	Prevention	2.2, 2.4, 2.5, 2.7
MH.E.20	**Interagency Coordination:** Participate in regular interdepartmental coordination with OEM to discuss natural hazard mitigation.	DOB	OEM	Ongoing	Staff Time	Agency Operating Budget	Prevention	3.1, 5.1, 5.2
MH.E.21	**Staff Development:** Participate in natural hazard mitigation code and standards development by sending staff to national events and training sessions that focus on seismic, wind, and flood codes.	DOB	N/A	Ongoing	$25,000	Agency Operating Budget	Public Education and Awareness	2.5, 2.6, 5.1
MH.E.22	**Training:** Send staff to national training sessions and seminars on hazards and mitigation practices.	DOB	N/A	Ongoing	$25,000	Agency Operating Budget	Public Education and Awareness	2.6, 5.1

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MH.E.23	**Cogeneration Plant:** Install cogeneration plant to reduce reliance on Con Ed power while complying with Mayor Bloomberg's GreeNYC Plan for the Department.	DOC	DCAS, DMJM HARRIS, NYPA	3 Years	$57,000,000	NYPA	Emergency Services	2.3, 4.1, 4.2
MH.E.24	**Redundant Communications:** Establish a redundant emergency communications system.	DOE	OEM	2 Years	$5,000,000	FEMA	Emergency Services	1.1, 2.3
MH.E.25	**Emergency Planning for Employers Workshop:** Host annual conference to provide mitigation and emergency preparedness resources to New York City employers and building managers. Conference targets small businesses and addresses earthquake-related building code changes, evacuation plans, fire safety, and business continuity.	DOHMH	OEM	Annual	$50,000 per annum	USCDC Public Health Emergency Preparedness Grant	Public Education and Awareness	2.6, 3.1, 3.3, 3.4, 3.5, 5.1, 5.2

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MH.E.26	**Environmental Data Exchange Network:** Facilitate environmental data exchange among government agencies using web-based data system. Interagency data exchange supports timely identification and characterization of potential hazards and provides a means to mitigate impacts of natural disasters.	DOHMH	Various	Ongoing	$2,400,000	USCDC Public Health Emergency Preparedness Grant, USDHS UASI Grant	Public Education and Awareness	5.1, 5.2
MH.E.27	**Interagency Environmental Data Workshop:** Host annual conference to improve interagency coordination, promote best practices, and introduce emerging tools for data sharing, risk analysis, and vulnerability assessment.	DOHMH	OEM	Annual	$50,000 per annum	USCDC Public Health Emergency Preparedness Grant	Public Education and Awareness	3.1, 5.1, 5.2
MH.E.28	**Health Code Revisions:** Examine the New York City Health Code to identify what elements can be revised to bolster natural hazard mitigation.	DOHMH	N/A	Ongoing	TBD	TBD	Prevention	2.4

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MH.E.29	**Advance Warning/Infrastructure Protection:** Implement electronic chart display and information system for DOT vessels. This advance notification system, designed to prevent loss of life and property, provides real-time updates of impending severe weather conditions (including wind and current), chart information, email, and navigational information from shore.	DOT	N/A	2 Years	$2,400,000	Agency Operating Budget, HMGP	Emergency Services	1.1, 2.1
MH.E.30	**Critical Facility Protection:** Protect existing and future critical facilities from natural hazards. Facilities considered under this action include the Traffic Management Center, Signs and Markings-Maspeth Shop, Signals and Street Lighting Facility, and Division of Parking.	DOT	EMS, FDNY, OEM	TBD	TBD	Expense and Capital Budget	Property Protection	2.1, 2.7, 2.8

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MH.E.31	**East River Bridges Retrofit (Design):** Perform study to identify potential seismic retrofit and structural hardening projects for the Brooklyn, Manhattan, and Queensboro Bridges.	DOT	FDNY, FEMA, NYPD, USCG	1 Year	$34,079,247	Capital Improvement Budget, FEMA, Grants	Prevention	2.1, 2.7, 2.8
MH.E.32	**Emergency Training:** Provide electronic chart display and information system and radar training.	DOT	GMATS	2 Years	$750,000	USDHS Grants, Agency Operating Budget, HMGP	Emergency Services	1.4
MH.E.33	**Infrastructure Protection:** Determine if protective film and blast curtains are necessary for the large glass areas in Whitehall Terminal, St. George Terminal, and Pier 79. Study is being performed by the U.S. Army Corps of Engineers.	DOT	USACE	TBD	$3,300,000	USDHS Grants	Property Protection	2.1, 2.7

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MH.E.34	**Power Redundancy:** Provide five large and 60 small emergency power generators to facilities during a natural hazard event.	DSNY	N/A	Completed	$1,021,500	Agency Operating Budget, Other-Than-Personnel-Services	Emergency Services	2.1, 2.3
MH.E.35	**Infrastructure Upgrade:** Provide technical assistance to inform the design and installation of passenger ferry landings. EDC has experience with regard to the mooring, anchoring, and stabilization mechanisms available for ferry landings that are able to withstand the effects of various natural hazard events.	EDC	DOT	TBD	TBD	EDC, DOT	Public Education and Awareness	2.1, 2.7
MH.E.36	**Infrastructure Upgrade:** Upgrade Arthur Kill lift bridge including possible construction of new bulkheads/pier.	EDC	N/A	TBD	TBD	EDC	Property Protection	2.1, 2.7
MH.E.37	**Power Redundancy:** Provide emergency power generators to facilities during a natural hazard event.	EDC	NA	Ongoing	TBD	EDC, OEM	Emergency Services	2.3

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MH.E.38	**Power Redundancy:** Install back-up electrical power generators in firehouses.	FDNY	OEM	TBD	TBD	Capital Budget	Emergency Services	2.1, 2.3
MH.E.39	**Property Protection/Water Supply Redundancy:** Increase water drafting capabilities citywide. Drafting water refers to the use of suction to move water from a body of water to a fire apparatus. Drafting can decrease the demand on the water supply system and provides redundant fire suppression water in the event of a drought or earthquake induced water supply disruption.	FDNY	DEP, USEPA	TBD	TBD	Grants	Emergency Services	2.1, 2.3
MH.E.40	**Power Redundancy:** Install redundant emergency generators for Group 1 Trauma Centers.	HHC	DASNY	5 Years	$102,000,000	General Obligation Bonds	Emergency Services	2.1, 2.3

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MH.E.41	**Communications Redundant System:** Communications system is with surge protection to allow uninterrupted operation during potential power surges due to rolling black-outs or electrical storms. Additional system include steam generator back-up and "failsoft" computer-based protection.	MTA (Buses)	N/A	TBD	TBD	TBD	Emergency Services	1.1, 2.3
MH.E.42	**Tree Pruning:** Reduce probability of downed trees or limbs due to tornadoes, windstorms, and coastal storms along active rail lines by engaging in preventive tree pruning measures.	MTA (LIRR)	N/A	TBD	TBD	Agency Operating Budget, HMGP	Natural Resource Protection	2.1, 2.7
MH.E.43	**Warning System:** Improve communications link to Doppler Radar located at JFK and Newark airports to improve severe weather detection and warning.	NWS	N/A	1 Year	TBD	TBD	Emergency Services	1.1

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Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
MH.E.44	**Facility Protection:** Install new flashing and four-ply torch applied modified bitumen roofing with high reflective coating over polyisocyanurate tapered insulation in 46 developments (524 buildings) citywide. This project will involve removal of existing roofing and insulation and asbestos abatement. These improvements will increase storm resiliency and reduce the impacts of extreme heat events.	NYCHA	DOE-SCA	1 Year Beginning FY 2008	$126,184,945	Capital Improvement Budget	Property Protection	2.7, 2.8
MH.E.45	**Facility Protection:** Install new shatter resistant operable windows and frames, and repair lintels and sills in nine developments (62 buildings) citywide. Remove existing windows and conduct asbestos abatement.	NYCHA	DOE-SCA	2 Years Beginning FY 2008	$14,388,787	Capital Improvement Budget	Property Protection	2.7, 2.8

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
MH.E.46	**Facility Protection:** Remove all loose and damaged brick, stucco, and copping to reduce the amount of flying debris during wind storms, coastal storms, and tornadoes. Install new brick and copping in 34 developments (313 buildings) citywide.	NYCHA	N/A	2 Years Beginning FY 2008	$237,141,686	Capital Improvement Budget	Property Protection	2.7, 2.8
MH.E.47	**Continuity of Operations (COOP):** Ensure City agencies can provide essential services to the public during emergencies, while maintaining internal critical functions. Agencies are developing plans that build contingencies around essential services, mitigate the impact of disruptions to services, and enhance the ability to provide Citywide Incident Management System (CIMS) operations, social services, and government operations.	OEM	DoITT	4 Months	$3,100,000	USDHS–UASI Grant	Emergency Services	2.1, 3.2

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
MH.E.48	**Incident-Based Distribution Project:** Implement program to track and study areas impacted by natural disasters using OEM Watch Command data and Geographic Information Systems technology. Target affected areas for post-disaster outreach and Ready New York materials. Encourage property owners to incorporate mitigation measures during recovery.	OEM	N/A	Ongoing	$25,000	USDHS–UASI Grant	Emergency Services	2.9, 5.1, 5.2, 5.3
MH.E.49	**Insurance Working Group:** Use the insurance industry and regulators to partner with the private sector and provide educational opportunities on insurance related mitigation measures.	OEM	NYS Insurance Department	TBD	TBD	TBD	Prevention	3.1, 3.3, 3.4, 3.5

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
MH.E.50	**Public Education:** Promote Ready New York guides as a tool to educate New Yorkers about natural hazards. This program offers all-hazards guides, as well as hazard-specific guides for hurricanes, floods, and heat. There are also guides geared specifically for seniors and people with disabilities, children, and businesses. Guides contain information on how to mitigate, prepare for, and respond to an emergency. Brochures are offered in up to 14 languages as well as audiotapes and Braille. In 2006 and 2007, OEM mailed over 1.6 million hurricane guides to households within the City's hurricane evacuation zones.	OEM	DOE, DEP, Mayor's Office, SBS, DFTA, MOPD	Ongoing	$1,060,000	USDHS–UASI Grant	Public Education and Awareness	2.6, 3.4, 5.3

New York City Existing Hazard Mitigation Actions								
Index	Mitigation Action and Description	Lead Agency	Supporting Agency(s)	Project Timeframe/Duration	Estimated Project Cost	Possible Funding Source(s)	FEMA Category	Goals and Objectives
MH.E.51	**Public Outreach:** The Ready New York program provides public outreach throughout the City by presenting and tabling at community and private sector events. This program encourages communities to understand the impact of natural hazards so they may better mitigate, prepare, and respond to these hazards.	OEM	N/A	Ongoing	$50,000	USDHS–UASI Grant	Public Education and Awareness	2.6, 3.4, 5.3
MH.E.52	**Green Roof Installation:** Encourage the installation of green roofs through a new incentive program. Green roofs can reduce the volume of stormwater runoff by absorbing or storing water and help reduce the impact of the urban heat island effect.	OLTPS	DOB, DOF	8 Years	TBD	TBD	Structural Projects	2.7, 3.3, 4.1, 4.2

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
MH.E.53	**Public Education:** Create a community planning process and "tool kit" to engage all stakeholders in community-specific climate adaptation and flood-mitigation strategies.	OLTPS	OEM	2 Years	TBD	TBD	Public Education and Awareness	2.6, 4.2, 5.1, 5.3
MH.E.54	**Resiliency Improvement:** Amend the building code to address the impacts of climate change.	OLTPS	DOB	8 Years	TBD	TBD	Prevention	2.5, 4.2
MH.E.55	**Emergency Notification System:** Install advanced automated early warning and emergency notification system in the green and blue quadrants of JFK airport's central terminal area. System includes variable message signs along main access roads.	PANYNJ (Aviation)	DOT	8 Years	$18,033,000	Capital Budget	Emergency Services	1.1

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
MH.E.56	**Engineered Material Arresting System (EMAS):** Design and build EMAS to prevent aircraft from overrunning the runway during severe weather at JFK airport.	PANYNJ (Aviation)	FAA	3 Years	$19,637,000	Capital Budget	Structural Projects	2.7
MH.E.57	**Drainage and Air Quality Improvement:** Expand Green Streets program to transform unused road space into open (green) space. Green space can reduce the volume of stormwater runoff by absorbing or storing water. It may also help reduce the impact of extreme heat events. The goal of this project is to add 40 Green Streets totaling 75 acres of open space with a storage capacity of four million gallons of stormwater.	Parks	DOT	8 Years	$15,000,000	Private Donors	Prevention	2.7, 4.1, 4.2

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
MH.E.58	**Drainage and Air Quality Improvement:** Fill every available street tree opportunity in New York City. This will improve drainage across the City and reduce the effects of extreme temperatures. The goal is to raise the street stocking level from 74% to 100%.	Parks	DOT, DOB	8 Years	$246,900,000	TBD	Natural Resource Protection	2.7, 4.1, 4.2
MH.E.59	**Drainage Improvement:** Convert 24 asphalt fields to either natural or synthetic turf fields with new drainage systems. Either would result in improved drainage and possible reduction of the urban heat island effect in large park areas.	Parks	HHC, DOH	8 Years	$42,100,000	TBD	Property Protection	2.7, 4.1, 4.2
MH.E.60	**Environmental Protection:** Reforest 2,000 acres of parkland.	Parks	USNPS	10 Years	$118,000,000	TBD	Natural Resource Protection	2.7, 4.1, 4.2

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
MH.E.61	**Tree Pruning:** Implement program to prune or remove old and overgrown trees. This program is designed to reduce the impact of severe weather including tornadoes, windstorms, and coastal storms.	Parks	N/A	5 Years	TBD	PlaNYC	Natural Resource Protection	2.7
MH.E.62	**Water and Air Quality Protection:** Assess the vulnerability of existing wetlands and identify additional policies to protect them.	Parks, DEP, OLTPS	EDC, DCP, USEPA, USNPS	8 Years	TBD	TBD	Natural Resource Protection	2.4, 2.7, 4.1
MH.E.63	**Drainage and Air Quality Improvement:** Partner with stakeholders to help plant one million trees by 2017. Trees reduce temperature, absorb additional stormwater, and decrease flooding.	Parks, OLTPS	DOT, DOB, USNPS	9 Years	TBD	TBD	Natural Resource Protection	2.7, 4.1, 4.2

New York City Existing Hazard Mitigation Actions								
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**
MH.E.64	**Emergency Response Unit:** Support team of business counselors that assist businesses in recovering and reopening in the wake of a disaster or emergency. Team can provide information on mitigation business practices.	SBS	OEM, Other City, State, and Federal Partners as Necessary	Ongoing	TBD	Agency Operating Budget	Public Education and Awareness	2.9, 3.3, 3.4, 3.5
MH.E.65	**Infrastructure Protection:** Implement tree-pruning program near overhead aerial cables to prevent damage from windstorms, tornadoes, and coastal storms.	Verizon	N/A	Ongoing	TBD	Expense and Capital Budget	Natural Resource Protection	2.7, 3.3, 4.1
MH.E.66	**Warning System:** Implement enhanced proactive network surveillance of facilities to reduce and/or minimize outage durations.	Verizon	N/A	Ongoing	TBD	Expense and Capital Budget	Emergency Services	1.1, 2.7, 3.3

Table 3: New York City Hazard Mitigation Action Table (Existing)

iv) Potential Mitigation Actions

Potential mitigation actions are programs, plans, projects, or policies New York City may implement to help reduce or eliminate the long-term risk to human life and property from natural hazards. The Planning Team and MPC identified, analyzed, and prioritized all potential actions. *Note some mitigation actions identified may not ultimately be implemented due to prohibitive costs, scale, low benefit/cost analysis ratios, or other concerns.*

For further details on the fields displayed in this table, see Table 13 on page 153. Each mitigation action is assigned an index value to indicate the hazard addressed, whether it is an existing or potential action, and its alphabetized placement in the list. For example, the mitigation action with the index EQ.P.9 is the ninth potential mitigation action that addresses earthquakes.

New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
Coastal Erosion									
CE.P.1	**Rikers Island Shoreline Protection:** Install various shoreline protection structures to mitigate coastal erosion.	DOC	USACE	TBD	$8,000,000	FEMA	Property Protection	2.1, 2.7	Low
CE.P.2	**Beach Renourishment:** Renourish Orchard Beach in the Bronx. Beach facilities periodically require renourishment with sand to prevent greater erosion and protect infrastructure.	USACE	Parks	5 Years	$7,000,000	USACE, HMGP	Natural Resource Protection	2.1, 2.7, 4.1	Medium
Coastal Storms									
CS.P.1	**Facility Protection:** Elevate electrical substations, switchgear, feeders, and main sewage pump motors above Category 3 storm surge level to ensure treatment is not interrupted.	DEP	Con Ed, LIPA, NYPA, NYSDEC	>10 Years	$5,600,000,000	Capital Program	Property Protection	2.1, 2.7, 2.8	High

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New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
CS.P.2	**Hillview Reservoir Cover:** Construct a cover to protect Hillview Reservoir from debris and degradation of water quality due to exposure resulting from extreme-weather events, including coastal storms. Hillview Reservoir is the final balancing reservoir for 90% of the City's water supply and is the water's last point of exposure to the elements prior to passing into the City's distribution tunnels.	DEP	N/A	5 Years	$1,607,450,000	Capital Budget	Structural Projects	2.8, 4.1	Medium

Note some mitigation actions identified may not ultimately be implemented due to prohibitive costs, scale, low benefit/cost analysis ratios, or other concerns.

New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
CS.P.3	**Kensico Reservoir Turbidity Curtain:** Repair existing and install back-up turbidity curtain. These curtains will catch floatables and allow more time for particulate matter to settle out of the water prior to being conveyed to the City. Floatables and particulate matter affect water quality and are introduced to the reservoir from overland runoff during extreme weather events including coastal storms. At least 90% of the City's water supply passes through Kensico Reservoir.	DEP	N/A	2 Years	$1,000,000	Capital Budget	Structural Projects	2.8, 4.1	Medium
CS.P.4	**Natural Resource Protection:** Dredge the Fresh, Hendrix, Flushing, and Newtown Creeks, Flushing Bay, and the Bergen and Thurston Basins to provide better flow, and channel area for water exiting sewer system tide-gates during significant storm events. This action will also reduce the impacts of flooding in low-lying areas.	DEP	N/A	TBD	$296,800,000	Capital Budget	Natural Resource Protection	2.1, 2.7	Low

Note some mitigation actions identified may not ultimately be implemented due to prohibitive costs, scale, low benefit/cost analysis ratios, or other concerns.

New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
CS.P.5	**Computer Modeling:** Determine engineering effectiveness and cost-benefit of various coastal storm/hurricane mitigation measures using computer modeling. DOB will evaluate various coastal storm/hurricane design enhancements using prototypical New York City building types.	DOB	N/A	1 Year	$2,250,000	Grants	Emergency Services	5.1, 5.2	High
CS.P.6	**Protective Measures for Critical Facilities:** Install coastal storm control measures around facilities in hurricane Sea, Lake, and Overland Surges from Hurricanes (SLOSH) zones.	DOC	N/A	TBD	TBD	TBD	Property Protection	2.1, 2.7	Medium
CS.P.7	**Infrastructure Improvements and Study:** Design and install flood gates and barriers at Brooklyn-Battery Tunnel and Queens-Manhattan Tunnel. Determine the coastal storm vulnerability of the Triborough Bridge.	MTA (Bridges and Tunnels)	MTA	2 Years	$35,000,000	Capital Improvement Budget	Structural Projects	2.1, 2.7, 2.8	High
CS.P.8	**Facility Protection:** Retrofit hurricane shelter windows to withstand winds associated with coastal storm events.	OEM	DOE, FEMA, NYSEMO	TBD	TBD	HMGP, PDM-C	Property Protection	2.1, 2.7	Medium

Note some mitigation actions identified may not ultimately be implemented due to prohibitive costs, scale, low benefit/cost analysis ratios, or other concerns.

New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
CS.P.9	**Hazards U.S. Multi-Hazard (HAZUS-MH) Modeling:** Determine losses generated by a coastal storm/hurricane and engineering effectiveness and cost-benefit of various coastal storm mitigation measures using HAZUS-MH computer modeling. Evaluate various flood and wind design enhancements using prototypical New York City building types.	OEM	DOB	3 Months	TBD	Agency Operating Budget	Emergency Services	2.5, 5.1, 5.2	High
Drought									
D.P.1	**Water Conservation:** Install hands-free sensors in restroom sinks during renovations to 53 City-owned buildings.	DCAS	DCAS-DFMC	Ongoing	$2,000,000	Capital Budget	Prevention	2.1, 2.7, 4.1	High
D.P.2	**Water Conservation:** Install low-water use toilets and flush sensors during renovations to 53 City-owned buildings.	DCAS	DCAS-DFMC	Ongoing	$2,000,000	Capital Budget	Prevention	2.1, 2.7, 4.1	High

Note some mitigation actions identified may not ultimately be implemented due to prohibitive costs, scale, low benefit/cost analysis ratios, or other concerns.

New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
D.P.3	**Aquifer Storage and Recovery:** Store drinking water, supplied from upstate reservoirs below ground, within the City for future use. This action reduces drought impact and provides a redundant source of water.	DEP	N/A	TBD	$20,000,000	Capital Budget	Structural Projects	2.1, 2.3	Medium
D.P.4	**Croton Falls and Cross River Pump Station Rehabilitation:** Provide additional redundancy for water supply operations by allowing DEP to move water between the Croton and Catskill/Delaware systems to supplement the local distribution system. Upgrade pump stations to provide 87 million additional gallons per day into distribution if there is an emergency service disruption in the Catskill or Delaware system.	DEP	N/A	TBD	$109,530,000	Capital Budget	Structural Projects	2.1, 2.3, 2.7, 2.8	Medium

Note some mitigation actions identified may not ultimately be implemented due to prohibitive costs, scale, low benefit/cost analysis ratios, or other concerns.

New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
D.P.5	**Delaware-Rondout Parallel Tunnel:** Create redundant parallel tunnel to maintain adequate water supply. Existing tunnel crosses a faulted fractured rock formation and has cracks that are leaking up to 30 million gallons per day. Parallel tunnel will provide alternate means of conveyance to allow for repair of existing tunnel, and redundancy in case of emergency. Delaware system accounts for 50% of City water supply.	DEP	N/A	TBD	$20,525,000,000	Capital Budget	Structural Projects	2.1, 2.3, 2.7, 2.8	Medium
D.P.6	**Hydrant Locking Program:** Fit critical fire hydrants in the City with locks to limit water usage during a drought. Conduct a pre-installation study to identify the best available hydrant-locking technology.	DEP	N/A	TBD	TBD	Capital Budget	Prevention	2.1, 2.7	Medium

Note some mitigation actions identified may not ultimately be implemented due to prohibitive costs, scale, low benefit/cost analysis ratios, or other concerns.

New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
D.P.7	**Increase Catskill Aqueduct Capacity:** Increase capacity to allow movement of water out of the Catskill systems, thereby providing up to 60 million gallons per day of additional flow from the Catskill Watershed in the event of a localized drought or loss of access to the Croton and Delaware systems.	DEP	N/A	TBD	$1,254,000,000	Capital Budget	Structural Projects	2.1, 2.7, 2.8	Low
Earthquake									
EQ.P.1	**Mechanical Equipment Seismic Upgrade:** Install new mechanical equipment to resist seismic forces in 53 City-owned buildings.	DCAS	DCAS-DFMC	Ongoing	$500,000	Capital Budget, NYPA	Property Protection	2.4, 2.7, 2.8	High

Note some mitigation actions identified may not ultimately be implemented due to prohibitive costs, scale, low benefit/cost analysis ratios, or other concerns.

New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
EQ.P.2	**Construct Redundant Kensico City Aqueduct:** Construct a seismically resistant and redundant third aqueduct between Kensico and Hillview Reservoirs. At present, two aqueducts carry 90% of the City's water supply from Kensico Reservoir to Hillview Reservoir. Neither of these aqueducts can be taken out of service without jeopardizing sufficient supply of water into the City. A third means of conveyance is necessary to ensure continuity of service in case of seismic disruption or planned shutdown to either of the existing aqueducts.	DEP	N/A	TBD	$5,520,000,000	Capital Budget	Structural Projects	2.1, 2.3, 2.7, 2.8	Medium
EQ.P.3	**Hunt's Point Wastewater Treatment Plant Facility Seismic Retrofit:** Retrofit wastewater treatment facility and methane gas storage system to withstand seismic activity. Design facility to exceed current building codes.	DEP	TBD	TBD	$25,000,000	Capital Budget	Property Protection	2.1, 2.7, 2.8	High

Note some mitigation actions identified may not ultimately be implemented due to prohibitive costs, scale, low benefit/cost analysis ratios, or other concerns.

New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
EQ.P.4	**Rondout West Branch Tunnel Repair:** Repair cracks and leaks in tunnel to reduce impact of seismic activity. This deep-bored tunnel crosses a faulted fractured rock formation, which makes it more vulnerable to seismic activity. This tunnel carries 50% of the City's water supply from the Delaware system across the Hudson River and is currently losing 30 million gallons of water per day. DEP intends to repair the tunnel once alternate sources or means of conveyance ensure a sufficient supply of water into the City.	DEP	N/A	TBD	$425,000,000	Capital Budget	Property Protection	2.1	Low
EQ.P.5	**Seismic Infrastructure Protection:** Inspect and repair structural deficiencies in intercepting sewers to reduce the impact of seismic activity.	DEP	DOHMH, FEMA	>10 Years	$80,000,000	Capital Program	Property Protection	2.1, 2.7, 2.8	High

Note some mitigation actions identified may not ultimately be implemented due to prohibitive costs, scale, low benefit/cost analysis ratios, or other concerns.

New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
EQ.P.6	**Seismic Inspection and Retrofit Program:** Conduct study to determine seismic design standards and seismic resiliency of drinking water distribution system (tunnels, piping, clean water pump stations, dams, shafts, and tanks). Use study results to prioritize and retrofit distribution infrastructure to appropriate seismic standards as needed.	DEP	N/A	TBD	TBD	Capital Budget, Grants	Property Protection	2.1, 2.7, 2.8	Medium
EQ.P.7	**Computer Modeling:** Determine engineering effectiveness and cost-benefit of various earthquake mitigation measures using computer modeling. Evaluate various seismic design enhancements using prototypical New York City building types.	DOB	N/A	1 Year	$2,250,000	Grants	Emergency Services	2.5, 5.1, 5.2	High
EQ.P.8	**Facility Retrofit:** Perform seismic study of existing tall buildings. Retrofit buildings to exceed new building code seismic provisions.	DOE	DOE-SCA, DOB	10 Years	TBD	FEMA	Property Protection	1.2, 2.1, 2.7	Medium

Note some mitigation actions identified may not ultimately be implemented due to prohibitive costs, scale, low benefit/cost analysis ratios, or other concerns.

New York City Potential Hazard Mitigation Actions									
Index	Mitigation Action and Description	Lead Agency	Supporting Agency(s)	Project Timeframe/ Duration	Estimated Project Cost	Possible Funding Source(s)	FEMA Category	Goals and Objectives	Prioritization
EQ.P.9	**Rikers Island Bridge Seismic Retrofit:** Retrofit all bridges to withstand a magnitude 8 earthquake.	DOT	DOC	TBD	TBD	HMGP, PDM-C	Property Protection	2.1, 2.7, 2.8	Medium
EQ.P.10	**Facility Improvement:** Retrofit HPD site offices to withstand a magnitude 8 earthquake.	HPD	DCAS	2 Years	$10,000,000	Grants	Property Protection	2.7	Medium
EQ.P.11	**Seismic Studies and Retrofit:** Identify and incorporate seismic requirements in bridge and tunnel restoration projects.	MTA (Bridges and Tunnels)	MTA-HQ	Beginning 2010	$154,000,000	Capital Improvement Budget	Property Protection	2.1, 2.7, 2.8	Medium
EQ.P.12	**HAZUS-MH Modeling:** Evaluate various seismic building design enhancements using HAZUS-MH to identify enhancements that reduce losses generated by earthquakes.	OEM	DOB	3 Months	TBD	Agency Operating Budget	Emergency Services	2.5, 5.1, 5.2	High
Extreme Temperatures									
ET.P.1	**Power Conservation:** Install energy saving light fixtures in 53 City-owned buildings.	DCAS	DCAS-DFMC	5 Years FY 2009–2014	$10,000,000	Capital Budget, PlaNYC	Prevention	2.1, 2.7, 4.1	High

Note some mitigation actions identified may not ultimately be implemented due to prohibitive costs, scale, low benefit/cost analysis ratios, or other concerns.

New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
ET.P.2	**Power Redundancy:** Install generators in select buildings to provide power during blackouts and emergency operations. Determine locations from the 53 City-owned buildings.	DCAS	DCAS-DFMC	5 Years FY 2009–2014	$10,000,000	Capital Budget	Emergency Services	2.1, 2.3	Medium
ET.P.3	**Equipment Upgrade:** Increase blower output and diffuser density to wastewater treatment tanks. During periods of extreme heat, increased levels of dissolved oxygen are necessary to achieve safe and balanced wastewater treatment. The blower sends dissolved oxygen to the tank where the diffuser distributes it throughout the tank.	DEP	NYSDEC	>10 Years	$140,000,000	Capital Program	Emergency Services	2.1, 2.7, 2.8, 4.1	High
ET.P.4	**Facility Upgrade:** Continue to review status of air conditioning systems and requirements for upgrading systems in senior centers with window air conditioners to help mitigate the effects of extreme heat.	DFTA	NYCHA	2 Years	TBD	TBD	Emergency Services	1.2, 2.7	Medium

Note some mitigation actions identified may not ultimately be implemented due to prohibitive costs, scale, low benefit/cost analysis ratios, or other concerns.

New York City Potential Hazard Mitigation Actions									
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ET.P.5	**Facility Upgrade:** Provide ducted central air conditioning system at BRC Senior Center located at 411 Delancey St. in Manhattan.	DFTA	Parks	1 Year	$150,000	TBD	Emergency Services	1.2, 2.7	Medium
ET.P.6	**Property Protection:** Advocate to expand Weatherization, Referral, and Packaging Program to help low-income seniors and people with disabilities weatherize their homes against extreme cold and heat events**.**	DFTA	HRA, MOPD	2 Years	TBD	TBD	Public Education and Awareness	1.2, 2.6, 5.1	High
ET.P.7	**Public Outreach:** Advocate to expand Home Emergency Assistance Program to include financial assistance to low-income seniors and people with disabilities who require help paying electric bills for air conditioning during extreme heat events.	DFTA	HRA, MOPD	2 Years	TBD	TBD	Public Education and Awareness	1.2, 5.1, 5.3	Medium
ET.P.8	**Public Outreach:** Secure funding to make air conditioners available to qualified seniors and people with disabilities.	DFTA	DOHMH, HRA, NYSDHCR, NYSOTDA	2 Years	TBD	NYSDHCR	Public Education and Awareness	1.2, 3.1, 5.3	High

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New York City Potential Hazard Mitigation Actions									
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ET.P.9	**Health Education and Outreach:** Conduct "Extreme Heat—Extreme Care" workshops with community-based organizations that provide services to vulnerable populations (children, seniors, inmates, the homeless, and mentally ill). Workshops provide targeted instruction on how to reduce the risk of heat-related illness and mortality among affected populations.	DOHMH	DEP, DFTA, HRA, OEM	TBD	TBD	TBD	Public Education and Awareness	1.2, 2.6, 5.1, 5.3	Medium
Flood									
F.P.1	**Drainage Improvement:** Improve drainage along the Empire Line Corridor.	Amtrak	N/A	3–5 Years	$250,000	General Capital Funding	Structural Projects	2.1, 2.7	High
F.P.2	**Scour Protection:** Replace rip-rap for bridges on Northeast Corridor to prevent scour during a flood event.	Amtrak	NJT	10 Years	$2,000,000	FRA, General Capital Funding, NJT	Property Protection	2.1, 2.7	High
F.P.3	**Tunnel Structure Rehabilitation:** Enhance tunnel protection from water infiltration, flooding, and potential structure breach.	Amtrak	TBD	TBD	TBD	Amtrak, FRA	Property Protection	2.1, 2.7	Medium

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F.P.4	**Facility Damage Prevention:** Avoid occupying any space near or in designated SLOSH zones A and B, even if the HRA-General Support Services program can accept the space from DCAS.	DCAS	HRA	TBD	TBD	Agency Lease Budget	Prevention	2.2	Medium
F.P.5	**Infrastructure Protection:** Create spill vaults to minimize damage from flooding in below-grade fuel-storage containers.	DCAS	DOE	TBD	TBD	FEMA	Property Protection	2.7, 4.1	Medium
F.P.6	**Check Valve Installation/ Plumbing Improvement Subsidies:** Seek federal subsidies for check valve or ejector pump system installations in flood prone areas to mitigate sewer back-ups.	DEP	DOB	TBD	TBD	Federal Grants	Property Protection	2.7	Low
F.P.7	**Drainage Improvement Plan and Design:** Identify flash flood and coastal flood prone areas and determine appropriate improvements to drainage services and levels of flood protection.	DEP	DCP, DOB, DOT, Parks	20–50 Years	$25,000,000 – $50,000,000	Capital Budget, Federal Grants	Property Protection	2.7, 2.8, 5.1	Medium

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F.P.8	**Drainage Improvement:** Promote and expand bluebelts and other projects that absorb water that would otherwise be sent to the stormwater system. Parks has also installed two gray water systems that re-use water to irrigate horticulture.	DEP	Parks	5 Years	TBD	Capital Improvement Budget, HMGP, PlaNYC	Natural Resource Protection	2.4, 2.7, 4.1	High
F.P.9	**Facility Protection:** Construct tide gates on outfalls to reduce sea surge into the system citywide.	DEP	USACE	10 Years	$20,000,000	Capital Budget, Federal Funding	Structural Projects	2.1, 2.7, 2.8	Medium
F.P.10	**Facility Redesign:** Reconstruct wastewater pumping stations so electrical equipment is above the flood plain to ensure sewer service for the tributary community.	DEP	DOHMH, FEMA, NYSDEC	>10 Years	$470,000,000	Capital Program	Property Protection	2.1, 2.7, 2.8	High
F.P.11	**Infrastructure Protection:** Rebuild seawalls at wastewater treatment plants to prevent flooding of equipment.	DEP	DOHMH, NYSDEC	>10 Years	$112,000,000	Capital Program	Structural Projects	2.1, 2.7, 2.8	Medium

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F.P.12	**Infrastructure Upgrade:** Perform regulator improvements for sewer outfalls around East River, Westchester Creek, Hutchinson Creek, Flushing Bay, and Newtown Creek. Improved regulators will control releases from the sewer system during storms, reduce street flooding, and prevent sewer backups.	DEP	N/A	TBD	$134,060,000	Capital Budget	Structural Projects	2.1, 2.7, 2.8, 4.1	Medium
F.P.13	**Infrastructure Upgrade:** Reconfigure and expand sewer system capacity in Bergen Basin and Tallman Island Wastewater Treatment Plant drainage areas to capture more stormwater, reduce combined sewer overflow into surrounding water bodies, and prevent sewer back-ups and street flooding.	DEP	N/A	TBD	$80,495,000	Capital Budget	Structural Projects	2.1, 2.7, 2.8, 4.1	High
F.P.14	**Infrastructure Upgrade:** Replace main sewage pumps with higher-head units to overcome hydraulic resistance created by a flooding event.	DEP	NYSDEC, Con Ed, LIPA, NYPA	>10 Years	$350,000,000	Capital Program	Structural Projects	2.1, 2.7, 2.8	Medium

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F.P.15	**Natural Resource Protection:** Perform pre-storm and preventive maintenance of bluebelt structures.	DEP	Parks, NYSDEC	50 Years	$5,000,000	Operating Budget	Natural Resource Protection	2.4, 2.7, 4.1	Medium
F.P.16	**Facility Improvement:** Perform floodproofing at senior centers.	DFTA	Aging Network, DFTA, NYCHA, OEM	5 Years	TBD	TBD	Property Protection	1.2, 2.1, 2.7	Medium
F.P.17	**Facility Improvements:** Relocate electrical closets from the lower floors/basements to higher levels at the 29 DHS sites.	DHS	N/A	Ongoing	$13,500,000	TBD	Property Protection	2.1, 2.7	Medium
F.P.18	**Computer Modeling:** Determine the engineering effectiveness and cost-benefit of various flood mitigation measures using computer modeling. Evaluate various flood design enhancements using prototypical New York City building types.	DOB	N/A	1 Year	$2,250,000	Grants	Emergency Services	2.5, 5.1, 5.2	High
F.P.19	**Roadway Elevation and Regrade:** Redesign and regrade roadways on Rikers Island to alleviate flooding conditions.	DOC	N/A	TBD	TBD	FMA, HMGP, PDM-C, SRL, RFC	Property Protection	2.1, 2.7	Medium

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F.P.20	**Wet/Dry Floodproofing:** Install flood proof measures at all DOC facilities to ensure flood waters do not affect operations.	DOC	N/A	TBD	TBD	FMA, HMGP, PDM-C, SRL, RFC	Property Protection	2.1, 2.7	Medium
F.P.21	**Curb Repair and Installation:** Remediate low-level curbs in potential flooding areas with higher ones to prevent excess flooding into basements and other structures. Higher curbs ensure excess stormwater runoff is discharged into catch basins or open channels.	DOT	N/A	Ongoing	$6,000,000	CHIP	Structural Projects	2.7, 2.8	High
F.P.22	**Drainage Improvement:** Expand use of pedestrian plazas and refuge islands that incorporate street and open space trees to capture and hold stormwater.	DOT	DEP	4 Years	TBD	Capital Improvement Budget, CHIP	Property Protection	2.7, 2.8, 4.1	High
F.P.23	**Building Upgrade:** Install flood proofing in Coney Island Hospital basement as part of the phase II modernization.	HHC	TBD	7 Years	$13,293,000	General Obligation Bonds	Property Protection	2.1, 2.7, 2.8	High

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F.P.24	**Marine Parkway Bridge Protection:** Perform substructure and underwater work to prevent damage from flooding, including scour.	MTA (Bridges and Tunnels)	MTA	2 Years	$11,591,562	Capital Improvement Budget	Property Protection	2.1, 2.7	Medium
F.P.25	**Drainage Mitigation:** Design and install storm-water pump stations to relieve major flood problem areas in LIRR track system.	MTA (LIRR)	N/A	TBD	TBD	Agency Operating Budget, HMGP	Structural Projects	2.1, 2.7	Medium
F.P.26	**Drainage Improvement:** Study flood-prone areas to determine ways to prevent water from entering system. This water-balance study will involve analyzing inflow and outflow capacity, storage, etc. Identify funding and implement Drainage Master Plan, if recommended by study.	MTA (NYCT-Subway)	DEP	5 Years (study) 20 Years (improvements)	TBD	FEMA, NYCT	Emergency Services	2.1, 2.7	Medium
F.P.27	**Basement/Cellar Equipment Safeguard**: Install duplex sump pumps for dewatering, additional floor drains, and elevated platforms for vital equipment. Avoid using cellars for public use (i.e. meeting rooms, centers, etc.).	NYCHA	N/A	Fiscal Year 2010	$7,700,000	Capital Improvement Budget	Property Protection	2.7, 2.8	High

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F.P.28	**Critical Infrastructure Protection:** Implement flood mitigation measures for New York City's back-up Emergency Operations Center, including sump-pumps, wet flood proofing, and drainage improvements.	OEM	DCAS, DDC, NYPD	2–3 Years	$10,000,000	HMGP, PDM-C, SRL, RFC	Property Protection	2.1, 2.7	Medium
F.P.29	**HAZUS-MH Modeling:** Evaluate various building design enhancements using HAZUS-MH to identify opportunities to reduce flooding.	OEM	DOB	3 Months	Staff Time	Agency Operating Budget	Emergency Services	2.5, 5.1, 5.2	High
F.P.30	**Property Protection:** Enroll in NFIP Community Rating System. By implementing floodplain management initiatives and reducing the City's flood risk, residents can receive discounted flood insurance.	OEM	DCP, DOB	5 Years	TBD	Agency Operating Budget	Prevention	2.4, 2.7	Medium
F.P.31	**Public Information and Guidance:** Disseminate mitigation information and help provide technical assistance to property owners affected by flood events.	OEM	DEP, FEMA, NYSEMO	TBD	TBD	HMGP, PDM-C, SRL, RFC	Public Education and Awareness	2.6, 5.1, 5.2, 5.3	High

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F.P.32	**Severe Repetitive Loss Outreach and Education:** Compile and map SRL properties throughout the city. Determine SRL funding eligibility and target these properties for outreach.	OEM	DEP, FEMA, NYSEMO	TBD	TBD	HMGP, PDM-C, SRL, RFC	Public Education and Awareness	2.9, 5.1, 5.2, 5.3	High
F.P.33	**Drainage Improvement:** Upgrade pumps and electrical power supply, and modify structural walks and platform decks in Pump House #4 and #6 at LGA airport.	PANYNJ (Aviation)	PANYNJ	6 Years	$7,500,000	2007–2016 Capital Plan	Property Protection	2.1, 2.7	Medium
F.P.34	**Facility Protection:** Redesign “moat” system that surrounds each fuel farm tank as a protection against flooding at JFK airport.	PANYNJ (Aviation)	NYC, NYS	4 Years	$7,000,000	Capital Budget	Structural Projects	2.1, 2.7, 4.1	High
F.P.35	**Facility Protection:** Reinforce dike wall along Bowery Bay and Runways 13–31 at LGA airport.	PANYNJ (Aviation)	NYSDEC	4 Years	$5,000,000	2007–2016 Capital Plan	Structural Projects	2.1, 2.7	Medium
F.P.36	**Facility Upgrade:** Redesign and upgrade existing sanitary lift station at JFK airport in Central Terminal area to prevent flooding in the facility.	PANYNJ (Aviation)	NYC, NYS	5 Years	$8,000,000	Capital Budget	Property Protection	2.1, 2.7	High

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F.P.37	**Facility Upgrade:** Redesign and retrofit of runways 4R and 22L including raising the existing grade, modifications to existing drainage, new lighting and concrete pavement at JFK airport.	PANYNJ (Aviation)	FAA	4 Years	$40,000,000	Capital Budget	Property Protection	2.1, 2.7	Medium
F.P.38	**Facility Upgrade:** Redesign and retrofit runways 4L and 22R including raising the existing grade, modifications to existing drainage, new lighting and concrete pavement at JFK airport.	PANYNJ (Aviation)	FAA	4 Years	$47,997,000	Capital Budget	Property Protection	2.1, 2.7	Medium
F.P.39	**Floodproofing at Olmsted Site:** Implement flood proofing actions including possible elevation and creation of additional drainage capacity. The Olmsted Center, Parks' capital division headquarters, suffers repetitive flooding.	Parks	N/A	5 Years	$20,000,000	TBD	Property Protection	2.1, 2.7	Medium

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Windstorms/Tornadoes									
WT.P.1	**Infrastructure Protection:** Develop enhanced inspection program of all street, parking, and life-protecting signs throughout the City to ensure these do not become potentially hazardous debris during high wind events.	DOT	N/A	3 Years	$3,250,000	CHIP	Emergency Services	2.7	High
WT.P.2	**Building Retrofit:** Replace windows at Coney Island Hospital to withstand a high-wind event.	HHC	TBD	2 Years	$2,000,000	TBD	Property Protection	2.1, 2.7	High
WT.P.3	**Facility Protection:** Secure rooftop equipment to withstand high-wind events at HRA facilities.	HRA	OEM, DEP, DDC, DCAS, FEMA	5 Years	$5,000,000	Agency Capital Budget	Property Protection	2.7	Medium
WT.P.4	**Infrastructure Reinforcement:** Study and design to construct bridge features that mitigate against the effects of severe windstorm events.	MTA (Bridges and Tunnels)	N/A	TBD	$64,800,000	Capital Improvement Budget	Structural Projects	2.1, 2.7, 2.8	Medium
Winter Storms									
WS.P.1	**Public Outreach:** Partner with DOB to educate property owners about the impacts of snow load, snow drift loads, and sliding snow loads.	OEM	DOB	1 Year	TBD	Agency Operating Budget	Public Education and Awareness	2.6, 3.4, 5.3	High

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Multi-Hazard									
MH.P.1	**Danger Tree Program:** Identify and eliminate right-of-way tree and dead vegetation hazards.	Con Ed	N/A	TBD	$600,000	Agency Operating Budget	Prevention	2.7, 3.3	Medium
MH.P.2	**Building Retrofit:** Perform window replacement upgrades at 100 Centre Street, 1 Centre Street, 22 Lafayette Street, 125 Worth Street, and 80 Centre Street.	DCAS	DCAS-DFMC	10 Years	$15,000,000	Capital Budget	Property Protection	2.1, 2.7, 2.8	Medium
MH.P.3	**Green Roof Installation:** Install two green roofs a year on City-owned buildings. Green roofs can reduce the volume of stormwater runoff by absorbing or storing water and help reduce the urban heat island effect.	DCAS	DCAS-DFMC	5 Years	$12,000,000	Capital Budget, PlaNYC	Structural Projects	2.7, 2.8, 4.1, 4.2	High
MH.P.4	**Bridge Reconstruction and Stabilization:** Reconstruct and stabilize DEP-owned bridges and culverts located in the Croton, Catskill, and Delaware watersheds. Adhere to NYSDOT bridge	DEP	N/A	TBD	Active Contracts– $77,823,000	Capital Budget	Property Protection	2.1, 2.7, 2.8	Medium

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	safety standards to meet 50-year storm event design standards and withstand seismic loading. Thirty-one bridges and culverts are under construction or were recently upgraded. Another 23 are currently planned for reconstruction.				Future Contracts–$322,700,000				
MH.P.5	**CSO Storage:** Install tunnels, relief sewers, and inline sewer storage for Flushing Bay and Newtown Creek areas to capture and store combined sanitary and stormwater during extreme weather. These facilities will reduce CSOs into surrounding water bodies. The inline sewer-storage installation is underway and is anticipated for completion in July 2009. The remaining projects will be initiated at a later date.	DEP	N/A	TBD	$5,182,925,000	Capital Budget	Structural Projects	2.1, 2.7, 2.8, 4.1	Medium

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MH.P.6	**Critical Facility Protection:** Implement programmatic inspection and upgrade program to ensure all critical DEP facilities maintain continuity of operations during flood, hurricane, or earthquake events. This program will include floodproofing and structural retrofits of DEP offices, field locations, and other critical facilities.	DEP	N/A	10–20 Years	TBD	Capital Budget, Federal Grants	Property Protection	2.1, 2.7, 2.8	Medium

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MH.P.7	**Dam Reconstruction Program:** Reconstruct seven high-hazard dams to safely pass the probable maximum flood criteria in accordance with NYS Dam Safety Guidelines and withstand seismic loading based on NYSDEC seismic guidance. This program will mitigate the impact of flooding and storm surge by capturing stormwater and runoff. The following dams are being reconstructed: Gilboa Dam (impounding Schoharie Reservoir), Olivebridge Dam (impounding Ashokan Reservoir), New Croton Dam (impounding New Croton Reservoir), Cannonsville Dam (impounding Cannonsville Reservoir), Merriman Dam (impounding Rondout Reservoir), Downsville Dam (impounding Pepacton Reservoir) and Neversink Dam (impounding Neversink Reservoir).	DEP	N/A	TBD	$1,011,000,000	Capital Budget	Structural Projects	2.1, 2.7, 2.8	Medium

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MH.P.8	**Drainage Improvement:** Develop a drainage improvement plan that will use enhanced conveyance capacity and redundant sewers to enhance drainage citywide. This plan will include sewer design and construction, maximize the use of the City right of way and City-owned parcels for stormwater management, consider potential for climate change, and integrate with DEP's capital planning process.	DEP	DOB, DCP, DOT, Parks	20–50+ Years	TBD	Capital Budget, Federal Grants	Structural Projects	2.1, 2.3, 2.7, 2.8, 5.2	High
MH.P.9	**Facility and Infrastructure Protection:** Reconstruct and harden sludge-vessel docks and piping to ensure continuity of treatment and protection of marine fleet assets.	DEP	NYSDEC, USCG	>10 Years	$70,000,000	Capital Program	Property Protection	2.1, 2.7	High

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MH.P.10	**Groundwater Development:** Construct treatment facilities throughout the southeast Queens groundwater system to provide up to 55 million gallons per day of additional water. Removal and treatment of groundwater lowers the water table, which can mitigate flooding impacts. This water will be treated to meet EPA Safe Drinking Water Act standards.	DEP	N/A	TBD	$3,225,930,000	Capital Budget	Structural Projects	2.1, 2.3, 2.7, 2.8	Medium
MH.P.11	**Groundwater Treatment Plant:** Construct a treatment facility in southeast Queens for four existing groundwater wells to provide an additional 12 million gallons of water supply for the City. Removal and treatment of groundwater lowers the water table, which can mitigate flooding impacts. This water will be treated to meet EPA Safe Drinking Water Act standards.	DEP	N/A	TBD	$253,900,000	Capital Budget	Structural Projects	2.1, 2.3, 2.7, 2.8	Medium

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MH.P.12	**Mapping and Analysis Enhancement:** Develop flood and storm surge impact model for sewer system. This model will allow the system to be tested under various conditions to appropriately target and prioritize mitigation actions. This effort includes securing more accurate topographical/grade information for the entire City and coupling this information with the actual built condition of the sewer system. Model could help proactively identify areas that are prone to repetitive losses due to street flooding and sewer backups.	DEP	OEM	>10 Years	$10,000,000	Capital Budget	Emergency Services	5.1, 5.2	High
MH.P.13	**Wetlands Restoration:** Restore wetlands in Alley Creek, Paerdegat Basin, and Oakland Ravine to improve natural drainage of stormwater to reduce flooding, improve harbor water quality, and prevent coastal erosion.	DEP	N/A	TBD	$38,000,000	Capital Budget	Natural Resource Protection	2.7, 4.1	High

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MH.P.14	**Public Education:** Develop and conduct educational forums or seminars addressing emergency preparedness and hazard-mitigation actions.	DFTA	OEM, ARC	2 Years	TBD	TBD	Public Education and Awareness	2.6, 3.3, 3.4, 5.3	Medium
MH.P.15	**Public Outreach:** Increase enrollment in Carrier Alert and Safe Return programs to prepare seniors to meet the challenges of disasters.	DFTA	Alzheimer's Foundation, HRA, MOPD, NYPD, USPS	2 Years	TBD	Agency Operating Budget	Public Education and Awareness	1.2, 5.3	High
MH.P.16	**Building Upgrade:** Add exterior reinforcements and energy performance enhancements to 29 DHS-owned buildings. These improvements will exceed the requirements of New York City building codes.	DHS	N/A	Ongoing	TBD	TBD	Property Protection	2.1, 2.7, 2.8	Medium
MH.P.17	**Communications Equipment:** Purchase 600 radios to provide redundant 800 MHz communications. Develop pre-event radio operations training program.	DHS	OEM, HHC, DOHMH,	Ongoing	$600,000	TBD	Emergency Services	1.1, 2.3	Medium

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MH.P.18	**Facility Improvements:** Add ballast to roofs (flat roofs only) of 21 DHS-owned facilities to protect against elements such as high winds, heavy rain, and flying debris. These improvements will exceed the requirements of the City's building codes.	DHS	N/A	Ongoing	$2,000,000	TBD	Property Protection	2.1, 2.7, 2.8	High
MH.P.19	**Facility Retrofit:** Retrofit existing windows in 29 DHS-owned facilities by glazing to withstand effects of a coastal storm, windstorms, and tornadoes. These improvements will exceed the requirements of the City's building codes.	DHS	N/A	Ongoing	$18,000,000	TBD	Property Protection	2.1, 2.7, 2.8	Medium
MH.P.20	**Power Redundancy:** Install redundant power supply for eight special medical needs shelters, the maximum number the City will need to support its special needs population during a disaster.	DHS	CUNY, DOE, DOHMH, OEM,	Ongoing	$400,000 (8 x $50000)	TBD	Emergency Services	1.2, 2.3	Medium

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MH.P.21	**Power Redundancy:** Purchase five large capacity (50kw) emergency generators to provide redundant power supplies for critical operations at the Bedford/Atlantic, Jamaica, Franklin, and Fort Washington Armories as well as the PATH facility.	DHS	N/A	Ongoing	$250,000 (5 x $50,000)	TBD	Emergency Services	2.1, 2.3	Low
MH.P.22	**Property Protection:** Obtain restrictive covenants on six DHS shelters to replace with non-residential structures in areas within the flood and SLOSH zone.	DHS	N/A	Ongoing	TBD	TBD	Prevention	2.2, 2.7	Medium

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New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
MH.P.23	**Construction Code Revision:** Develop construction code amendments to reduce both energy demand and reliance on fossil fuels as part of the Mayor's PlaNYC for 2030. These amendments will apply to both existing and new buildings and in some cases may result in energy reductions beyond the requirements of the Energy Conservation Construction Code of New York State. Review existing literature on how climate change will impact New York City, and review provisions developed by other jurisdictions to mitigate against the anticipated effects of climate change.	DOB	OLTPS	2 Years	$5,800,000	Agency Operating Budget	Prevention	2.5, 4.1, 4.2, 5.1	High
MH.P.24	**Information Gathering:** Conduct a review and assessment of how other jurisdictions have incorporated mitigation measures into their construction codes.	DOB	N/A	3 Months	Staff Time	Agency Operating Budget	Prevention	2.5, 5.1	Medium

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New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
MH.P.25	**Information Gathering:** Conduct an environmental review of the proposed building code for existing buildings.	DOB	N/A	1 Year	$250,000 (budgeted)	Agency Operating Budget	Prevention	2.5, 4.1, 5.1	Medium
MH.P.26	**Information Gathering:** Conduct study on the effect of introducing mitigation measures into building codes on insurance rates and losses following a disaster.	DOB	N/A	3 Months	Staff Time	Agency Operating Budget	Prevention	2.5, 5.1	Medium
MH.P.27	**Stormwater Management:** Upgrade steam tunnel pumps to remove water that may enter during a coastal storm or a flooding event.	DOC	N/A	TBD	TBD	FEMA	Structural Projects	2.1, 2.7	Medium
MH.P.28	**Critical Equipment Redundancy:** Acquire portable generators, pumping station, lighting systems, radios, and other essential equipment to create redundancy for critical networks.	DOE	DOE	TBD	$1,000,000	FEMA	Emergency Services	2.3	Medium

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New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
MH.P.29	**Facility Protection:** Implement program to prune or remove old and overgrown trees near DOE facilities. This program is designed to prevent damage to the electrical distribution grid and nearby structures during tornadoes, windstorms, and coastal storms.	DOE	DOE-SCA	TBD	TBD	TBD	Property Protection	2.1, 2.7	Medium
MH.P.30	**Green Roof Installation:** Install updated building management systems that include green roof structures for DOE facilities. Green roofs can reduce the volume of stormwater runoff by absorbing or storing water and help reduce the urban-heat island effect.	DOE	DOE-SCA	TBD	TBD	TBD	Property Protection	2.7, 4.1, 4.2	Medium
MH.P.31	**Infrastructure Protection:** Install surge suppression protection for critical electrical systems to minimize impacts from severe weather.	DOE	DOE-SCA	TBD	TBD	TBD	Emergency Services	2.1, 2.7	Medium
MH.P.32	**Power Redundancy:** Install emergency power generation systems at existing DOE facilities.	DOE	DOE-SCA	TBD	$1,250,000	FEMA	Emergency Services	2.3	Low

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New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
MH.P.33	**Early Warning System:** Develop an enhanced notification system for contacting City employees using a variety of communication media to simultaneously notify, alert, and/or instruct City employees prior to and during an emergency.	DoITT	N/A	TBD	TBD	TBD	Emergency Services	1.1	Medium
MH.P.34	**Bridge Inspections:** Implement inspection program to identify bridges susceptible to natural hazards. Use results to develop structural mitigation actions designed to prevent collapse or failure of structure.	DOT	NYSDOT	2 Years	$2,000,000	Federal, State, City	Prevention	2.1, 2.7, 2.8	High
MH.P.35	**Critical Facility Loss Estimation:** Conduct a detailed natural hazard loss estimation on critical facilities using increased positional accuracy-building attribute databases and available hazard maps.	DOT	DOB, OEM	TBD	$50,000	Expense	Emergency Services	5.1, 5.2	High

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New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
MH.P.36	**Curb Repair and Installation:** Remediate low-level curbs in flood prone areas to prevent excess flooding into basements and other structures. Higher curbs ensure that excess stormwater runoff is channeled and discharged into catch basins or open channels.	DOT	N/A	Ongoing	$6,000,000	CHIP	Structural Projects	2.7, 2.8	Medium
MH.P.37	**Drainage and Surface Improvement:** Incorporate use of porous and albedo concrete into street reconstruction projects to reduce the amount of stormwater that enters the sewer system and the urban heat island effect. DOT will make this a standard specification for all street reconstruction projects.	DOT	DEP	Ongoing	TBD	Capital Improvement Budget, CHIP	Structural Projects	2.1, 2.7, 2.8, 4.2	High
MH.P.38	**East River Bridges Retrofit (Construction):** Implement seismic retrofit and structural hardening of Brooklyn, Manhattan, and Queensboro Bridges.	DOT	FDNY, FEMA, NYPD, USCG	2 Years	$473,391,280	Capital Improvement Budget, FEMA, Grants	Property Protection	2.1, 2.7, 2.8	Medium

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New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
MH.P.39	**Information Update:** Track formalized response to natural hazard-based incidents to identify repetitive loss locations or hazards. Use this information to inform the creation and implementation of future mitigation actions.	DOT	OEM	2 Years	$150,000	Expense and Capital Budget	Emergency Services	5.1, 5.2	High
MH.P.40	**Infrastructure Protection:** Inspect and retrofit all moveable bridges to ensure they can withstand natural hazards.	DOT	FDNY, FEMA, NYPD, USCG	2 Years	TBD	Capital Improvement Budget, FEMA, Grants	Property Protection	2.1, 2.7, 2.8	High
MH.P.41	**Critical Infrastructure Relocation:** Relocate passenger ferry barge at World Financial Center to Hunters Point. Provide for stable landing at Hunters Point, allowing for transportation system redundancy.	EDC	DOT	TBD	$300,000	EDC	Property Protection	2.1, 2.7	High
MH.P.42	**Green Roof Installation:** Install green roofs on facilities, where appropriate. Green roofs can reduce the volume of stormwater runoff by absorbing or storing water. They can also help reduce the urban-heat island effect.	EDC	DEP	TBD	TBD	TBD	Property Protection	2.7, 2.8, 4.1, 4.2	Medium

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New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
MH.P.43	**Backup Water Main System:** Develop system to transmit fire suppression water throughout the City if existing infrastructure is disrupted due to a drought or earthquake.	FDNY	N/A	TBD	TBD	TBD	Emergency Services	2.1, 2.3	Medium
MH.P.44	**Public Awareness:** Develop hazard- mitigation and emergency preparedness program for homeowners.	HPD	N/A	2 Years	$5,000,000	Grants	Public Education and Awareness	2.6, 5.3	High
MH.P.45	**Critical Facility Protection:** Evaluate flood-protection measures in long-term leased buildings in or near flood zones and coastal storm evacuation zones A and B. Make recommendations to building owners.	HRA	OEM, DCAS, DEP, DOT	5 Years	TBD	Lease Budget, Other-Than-Personnel-Services Budget	Public Education and Awareness	2.7, 5.1	High
MH.P.46	**Explore Loss Reduction Actions:** Assist potentially affected historic or landmarked properties with appropriate protection and/or retrofit options.	LPC	DOB	TBD	TBD	Agency Operating Budget, Grants	Public Education and Awareness	2.6, 2.9	High

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New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
MH.P.47	**Public Education and Outreach:** Provide information on site and building preservation in severe repetitive loss and high hazard areas.	LPC	DOB, CPC, DOT, DCAS	TBD	TBD	Agency Operating Budget, Grants	Public Education and Awareness	2.6, 2.9, 5.1, 5.3	High
MH.P.48	**Technical Assistance:** Provide technical assistance to owners of historic or landmarked structures that are subject to severe repetitive loss.	LPC	DOB, CPC, DOT, DCAS	TBD	TBD	Agency Operating Budget, Grants	Public Education and Awareness	2.6, 2.9	High
MH.P.49	**Far Rockaway Depot Green Roof:** Design and install green roof. Green roofs can reduce the volume of stormwater runoff by absorbing or storing water and help reduce the urban-heat island effect.	MTA (Bus)	DEP, NYSDEC, FTA	2 Years	$4,703,730	Capital Improvement Budget	Structural Projects	2.7, 4.1, 4.2	High
MH.P.50	**Advanced Warning:** Improve NWS ability to communicate forecast in non-text formats.	NWS	N/A	2 Years	TBD	TBD	Emergency Services	1.1	Medium
MH.P.51	**Doppler Radar Upgrade:** Upgrade software and hardware to improve precipitation-type detection and rainfall estimation.	NWS	N/A	4 Years	TBD	TBD	Emergency Services	1.1	Medium

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New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
MH.P.52	**Grounds, Pavements, and Drainage:** Install planting for soil stabilization and to create buffer zones. Increase strength of anchorage/footings for play equipment and pole lighting in nine developments (91 buildings) citywide.	NYCHA	N/A	FY 2010	$9,390,708	Capital Improvement Budget	Property Protection	2.7, 2.8	High
MH.P.53	**Facility Protection:** Enhance facility design of the 40th, 66th, 70th, 110th, 120th, 121st, and Central Park Precincts to endure severe wind, rain, and flooding events.	NYPD	N/A	TBD	TBD	TBD	Property Protection	2.1, 2.7, 2.8	High
MH.P.54	**Facility Protection:** Enhance facility design of the Public Safety Answering Center I, Public Safety Answering Center II, and Joint Operations Center to endure severe wind, rain, and flooding events.	NYPD	N/A	TBD	TBD	TBD	Property Protection	2.1, 2.7, 2.8	Medium
MH.P.55	**Facility Protection:** Promote hardening of existing and future critical facilities from the primary and secondary effects of natural hazards.	NYPD	N/A	TBD	TBD	TBD	Property Protection	2.1, 2.7, 2.8	High

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New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
MH.P.56	**Advance Warning System Integration:** Integrate Notify NYC and NY-ALERT advance warning and emergency capabilities. When fully operable, this system will provide advance warning to New York City residents prior to natural hazard events.	OEM	DoITT, FEMA, NYSEMO	TBD	TBD	HMGP	Emergency Services	1.1	Low
MH.P.57	**Critical Facility Protection**: Conduct or update natural hazard vulnerability assessments for critical facilities throughout the City.	OEM	MPC	5 Years	TBD	TBD	Emergency Services	2.7, 5.1	Medium
MH.P.58	**Educational Outreach:** Coordinate and provide educational outreach on mitigation strategies the private sector can take to reduce or eliminate the impact of hazards on their services and infrastructure. Opportunities to educate OEMs private sector partners include conferences, OEMs website, and presentations.	OEM	N/A	TBD	TBD	TBD	Public Education and Awareness	3.1, 3.3, 3.4, 3.5	High

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New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
MH.P.59	**Facility Protection:** Conduct or update natural-hazard vulnerability assessments for all OEM facilities. Harden facilities to damage from natural hazard events.	OEM	DCAS, FEMA, NYSEMO	TBD	TBD	HMGP, PDM-C	Property Protection	2.1, 2.7, 2.8	Medium
MH.P.60	**Facility Protection:** Install storm shutters at OEM headquarters designed to protect windows from flying debris.	OEM	N/A	3–5 Years	$800,000	HMGP, PDM-C	Property Protection	2.1, 2.7	High
MH.P.61	**HAZUS-MH Update:** Optimize use of HAZUS-MH software for New York City's unique urban environment. The software update will allow New York City to generate more accurate loss estimates for various hazards.	OEM	FEMA, NYSEMO	1 Year	TBD	HMGP, PDM-C	Emergency Services	2.5, 5.1, 5.2	High

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New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
MH.P.62	**Incorporate Hazard Mitigation into Community Emergency Response Team (CERT) Curriculum:** Adapt CERT curriculum to educate teams members on strategies that will mitigate the impact of natural hazards to the City. This can include education on protecting utility services, redundant communication, continuity of business services (for corporate CERTs), and property protection.	OEM	NYPD, FDNY	Ongoing	$200,000	USDHS–UASI, Grants	Public Education and Awareness	3.2, 3.4, 3.5, 5.3	High
MH.P.63	**Infrastructure Systems Modeling:** Coordinate the development of a multi-hazard infrastructure vulnerability model, including storm surge barriers.	OEM	FEMA, NYSEMO, Academic Institutions	3 Years	TBD	HMGP	Emergency Services	5.1, 5.2	High
MH.P.64	**Loss Estimation Assistance**: Assist agencies in determining loss estimates using HAZUS-MH.	OEM	MPC	5 Years	TBD	HMGP, PDM-C, FMA	Emergency Services	5.1, 5.2	Medium

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New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
MH.P.65	**Natural Hazard Event Database:** Create a natural hazard event database to capture description, severity, location, impact, and potential loss/damage estimate from an event. This data will be used to update the hazard analysis and mitigation actions for New York City.	OEM	FEMA, NYSEMO	5 Years	TBD	Agency Operating Budget	Emergency Services	5.1, 5.2	Medium
MH.P.66	**Partner with Community Groups:** Partner the CERT program with local community organizations, including civic, faith-based, and tenant associations, to promote mitigation strategies.	OEM	NYPD, FDNY	Ongoing	$200,000	USDHS–UASI, Grants	Public Education and Awareness	3.1, 3.3, 3.4, 3.5, 5.3	High
MH.P.67	**Public Outreach:** Update and expand Ready New York for seniors and people with disabilities.	OEM	DFTA, MOPD	1 Year	TBD	OEM	Public Education and Awareness	1.2, 5.3	High

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New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
MH.P.68	**Public/Private Mitigation Initiatives:** Support the resiliency of the City's private sector through information sharing, partnership building, training and education on mitigation principles and the City's Hazard Mitigation Plan.	OEM	N/A	Ongoing	TBD	TBD	Public Education and Awareness	3.1, 3.3, 3.4, 3.5	High
MH.P.69	**Regional Critical Infrastructure Mapping:** Map critical infrastructure for the New York City region to better understand the interrelationships among the various components of the region's infrastructure. This information will also support the Hazard Mitigation Plan's Risk Assessment Section.	OEM	DHS, NYSOHS, PANYNJ	12 Months	TBD	TBD	Emergency Services	5.1, 5.2	Medium
MH.P.70	**Subway Depths Mapping:** Collaborate with NYCT to assign depth below-street level and absolute depth below sea level elevations for subway stations and tunnels. This effort will support planning for flooding and secondary impacts from other natural hazards.	OEM	NYCT	12 Months	TBD	TBD	Emergency Services	5.1, 5.2	Medium

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New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
MH.P.71	**Vegetation Data:** Develop vegetation data for New York City for use in HAZUS-MH and other hazard-impact models This will allow for better debris estimates and will identify areas more susceptible to the urban-heat island effect.	OEM	Parks	6 Months	TBD	TBD	Prevention	5.1, 5.2	Medium
MH.P.72	**Zoning for Hazard-Prone Areas:** Correlate natural hazard vulnerable areas with existing zoning districts to identify areas where mitigation actions would be necessary to maintain the responsible and sustainable development of these areas.	OEM	DCP	12 Months	TBD	TBD	Prevention	2.4, 2.5, 5.1, 5.2	Medium
MH.P.73	**Warning System/Environmental Protection:** Implement advance-warning system for emergency fuel shut off during a natural disaster event.	PANYNJ (Aviation)	NYC, NYS	3 Years	$500,000	Capital Budget	Emergency Services	1.1, 4.1	High

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New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
MH.P.74	**Green Roof Installation:** Install green roofs on select Parks facilities. Green roofs can reduce the volume of stormwater runoff by absorbing or storing water and help reduce the urban heat island effect. Estimated cost is approximately $25 per square foot**.**	Parks	DOE-SCA	2 Years	$30,000 – $50,000 per site	HMGP, Other Grants	Property Protection	2.7, 2.8, 4.1, 4.2	High
MH.P.75	**Green Streets:** Transform selected traffic medians from concrete to areas densely planted with trees and horticulture. Green streets can reduce the volume of stormwater runoff by absorbing or storing water and help reduce the urban-heat island effect.	Parks	DOT	2 Years	$50,000 per site	HMGP, Other Grants	Natural Resource Protection	2.7, 2.8, 4.1, 4.2	High
MH.P.76	**Land Acquisition:** Leave purchased or donated land and wetlands in a natural state to absorb floodwaters, mitigate storm surge impacts, reduce heat impacts, and prevent construction in flood zones.	Parks	N/A	5 Years	$1,000,000 per acre	HMGP	Property Protection	2.2, 2.5, 2.7, 4.1	Medium

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New York City Potential Hazard Mitigation Actions									
Index	**Mitigation Action and Description**	**Lead Agency**	**Supporting Agency(s)**	**Project Timeframe/ Duration**	**Estimated Project Cost**	**Possible Funding Source(s)**	**FEMA Category**	**Goals and Objectives**	**Prioritization**
MH.P.77	**Seawall, Pier, and Marina Structural Repairs:** Restore docks and other seawall structures at the 79th Street Boat Basin in Manhattan. Emergency repair to Shore Road seawall in Brooklyn (completed). Parks has jurisdiction over miles of seawall, including much of Manhattan's frontage on the East River. Seawalls help mitigate erosion and prevent flooding.	Parks	N/A	5 Years	TBD for Seawall, $1,000,000 for 79th Street Boat Basin	HMGP	Structural Projects	2.7	Medium
MH.P.78	**Infrastructure Upgrade:** Construct diverse redundant air- pressure system to maintain pressure on underground telephone cables during flooding from major storms/hurricanes.	Verizon	N/A	1 Year	$1,140,000	Capital improvement budget	Structural Projects	2.1, 2.3, 3.3	Medium

Table 4: New York City Hazard Mitigation Action (Potential)/Implementation Table

Note some mitigation actions identified may not ultimately be implemented due to prohibitive costs, scale, low benefit/cost analysis ratios, or other concerns.

b) Analysis

The Planning Team and Steering Committee analyzed potential mitigation actions using the FEMA STAPLEE method and HAZUS-MH. This analysis helped determine whether actions achieved one or more of the five hazard mitigation goals and 23 objectives. The analysis also established the opportunities and constraints of implementing each potential mitigation action.

i) STAPLEE Analysis

The Planning Team and Steering Committee conducted a qualitative evaluation of potential mitigation actions using the STAPLEE (social, technical, administrative, political, legal, economic, and environmental) review method. STAPLEE is an evaluation process developed by FEMA that is a systematic method to help identify the benefits and constraints of a particular mitigation action. The table below provides a summary of the STAPLEE criteria.

STAPLEE Summary Table	
Criteria	**Description**
S	**Social criteria:** The social aspects of the proposed mitigation action are considered including: • Community acceptance • Effect on segment of population
T	**Technical criteria**: The technical aspects of the proposed mitigation action are considered including: • Technical feasibility • Long-term solution • Secondary impacts
A	**Administrative criteria**: The administrative aspects of each proposed mitigation action are considered including: • Staffing • Funding allocation • Maintenance/operations
P	**Political criteria**: The political aspects of the proposed mitigation action are considered including: • Political support • Public support
L	**Legal criteria**: The legal authority to implement proposed mitigation action is considered including: • State authority • Existing local authority • Potential legal challenges
E	**Economic criteria:** The economic aspects of the proposed mitigation action are considered including: • Benefit of action • Cost of action • Outside funding requirements
E	**Environmental criteria:** Environmental impacts of the proposed mitigation action are considered including: • Effect on land/water • Consistent with community environmental goals

Table 5: STAPLEE Summary Table

The table below summarizes the STAPLEE evaluation of potential mitigation actions organized by hazard. The seven STAPLEE evaluation criteria were assigned a plus (+), if the proposed action is favorable; a minus (-), if the action is unfavorable; or a Not Applicable (N) if the evaluation criteria does not apply to the mitigation action.

Potential Mitigation Actions STAPLEE Analysis Table

Index	Mitigation Action	Lead Agency	Social		Technical			Administrative			Political		Legal			Economic			Environment	
			Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Staffing	Funding Allocation	Maintenance/Operations	Political Support	Public Support	State Authority	Existing Local Authority	Potential Legal Challenge	Benefit of Action	Cost of Action	Outside Funding Required	Effect on Land/ Water	Consistent with Community Environmental Goals
Coastal Erosion																				
CE.P.1	Rikers Island Shoreline Protection	DOC	-	+	+	+	-	-	-	+	+	+	-	-	+	+	+	-	-	-
CE.P.2	Beach Renourishment	USACE	+	+	+	+	-	+	-	-	+	+	+	-	+	+	-	-	-	+
Coastal Storms																				
CS.P.1	Facility Protection	DEP	+	+	+	+	N	+	+	+	+	+	N	+	+	+	-	+	N	+
CS.P.2	Hillview Reservoir Cover	DEP	+	+	+	+	-	+	+	-	+	+	-	-	+	+	-	+	-	+
CS.P.3	Kensico Reservoir Turbidity Curtain	DEP	+	+	+	+	-	+	+	-	+	+	-	-	+	+	+	+	-	-
CS.P.4	Property Protection	DEP	-	-	+	+	-	+	+	-	+	-	-	-	-	+	-	+	-	-
CS.P.5	Computer Modeling	DOB	+	N	+	+	N	+	-	+	+	+	+	+	+	+	+	N	N	N
CS.P.6	Protective Measures for Critical Facilities	DOC	N	+	+	+	+	-	-	-	+	+	N	+	+	+	N	-	+	N
CS.P.7	Infrastructure Improvements and Study	MTA (Bridges and Tunnels)	+	+	+	+	N	+	+	-	+	+	-	-	+	+	+	+	N	+
CS.P.8	Facility Protection	OEM	+	+	+	+	N	-	-	+	+	+	N	+	+	+	N	-	N	N

Potential Mitigation Actions STAPLEE Analysis Table																				
			Social		Technical			Administrative			Political		Legal			Economic			Environment	
Index	Mitigation Action	Lead Agency	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Staffing	Funding Allocation	Maintenance/Operations	Political Support	Public Support	State Authority	Existing Local Authority	Potential Legal Challenge	Benefit of Action	Cost of Action	Outside Funding Required	Effect on Land/ Water	Consistent with Community Environmental Goals
CS.P.9	HAZUS-MH Modeling	OEM	N	+	+	+	N	+	+	+	+	+	N	N	+	+	+	+	N	N
Drought																				
D.P.1	Water Conservation	DCAS	+	+	+	+	+	-	+	+	+	+	N	+	+	+	+	+	+	+
D.P.2	Water Conservation	DCAS	+	+	+	+	+	-	+	+	+	+	N	+	+	+	+	+	+	+
D.P.3	Aquifer Storage and Recovery	DEP	+	+	+	+	-	+	+	-	+	+	-	-	+	+	-	+	-	-
D.P.4	Croton Falls and Cross River Pump Station Rehabilitation	DEP	+	+	+	+	-	+	+	-	+	+	-	-	+	+	-	+	-	+
D.P.5	Delaware-Rondout Parallel Tunnel	DEP	+	+	+	+	-	+	+	-	+	+	-	-	+	+	-	+	-	-
D.P.6	Hydrant Locking Program	DEP	-	+	+	+	+	+	-	-	+	+	N	+	+	+	N	+	+	+
D.P.7	Increase Catskill Aqueduct Capacity	DEP	-	-	+	+	-	+	+	-	+	-	-	-	-	+	-	+	-	-
Earthquake																				
EQ.P.1	Mechanical Equipment Seismic Upgrade	DCAS	N	N	+	+	N	+	+	+	+	+	N	+	+	+	+	+	N	N

Potential Mitigation Actions STAPLEE Analysis Table

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EQ.P.2	Construct Redundant Kensico City Aqueduct	DEP	+	+	+	+	-	+	+	-	+	+	-	-	+	+	-	+	-	-
EQ.P.3	Hunt's Point Wastewater Treatment Plant Facility Seismic Retrofit	DEP	+	+	+	+	+	+	+	-	+	+	N	+	+	+	-	+	+	+
EQ.P.4	Rondout West Branch Tunnel Repair	DEP	+	+	+	+	-	+	+	-	-	-	-	-	+	-	-	+	-	N
EQ.P.5	Seismic Infrastructure Protection	DEP	-	+	+	+	-	+	+	+	+	+	N	+	+	+	-	+	+	+
EQ.P.6	Seismic Inspection and Retrofit Program	DEP	+	+	+	+	+	-	-	N	+	+	+	+	N	+	N	N	N	+
EQ.P.7	Computer Modeling	DOB	N	+	+	+	N	+	-	+	+	+	N	N	+	+	-	+	N	N
EQ.P.8	Facility Retrofit	DOE	N	N	+	+	-	-	-	+	+	+	+	-	+	+	N	-	+	N
EQ.P.9	Rikers Island Bridge Seismic Retrofit	DOT	+	+	+	+	N	-	-	+	+	+	N	+	+	+	N	-	N	N
EQ.P.10	Facility Improvement	HPD	N	N	+	+	+	-	-	+	+	+	N	+	+	-	-	-	+	N
EQ.P.11	Seismic Studies and Retrofit	MTA (Bridges	+	+	+	+	-	+	+	+	+	+	-	-	+	+	-	+	-	+

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		and Tunnels)																		
EQ.P.12	HAZUS-MH Modeling	OEM	N	+	+	+	N	+	-	+	+	+	N	N	+	+	-	+	N	N
Extreme Temperatures																				
ET.P.1	Power Conservation	DCAS	N	+	+	+	+	+	+	-	+	+	N	+	+	+	+	+	+	+
ET.P.2	Power Redundancy	DCAS	N	N	+	-	N	+	-	-	+	+	N	+	+	+	-	-	N	N
ET.P.3	Equipment Upgrade	DEP	+	+	+	+	+	+	+	-	+	+	N	+	+	+	-	+	+	+
ET.P.4	Facility Upgrade	DFTA	+	+	+	+	N	+	-	-	+	+	N	+	+	+	N	-	N	N
ET.P.5	Facility Upgrade	DFTA	+	+	+	+	N	+	-	-	+	+	N	+	+	+	N	-	N	N
ET.P.6	Property Protection	DFTA	+	+	+	+	+	+	-	+	+	+	N	+	+	+	N	-	+	+
ET.P.7	Public Outreach	DFTA	+	+	+	+	N	+	-	+	+	+	N	+	+	+	N	-	N	-
ET.P.8	Public Outreach	DFTA	+	+	+	-	N	+	+	-	+	+	N	+	+	+	N	+	N	+
ET.P.9	Health Education and Outreach	DOHMH	+	+	+	-	N	+	-	+	+	+	N	+	+	+	N	-	N	N
Flood																				
F.P.1	Drainage Improvement	Amtrak	+	+	+	+	-	+	+	+	+	+	-	-	+	+	+	+	+	+
F.P.2	Scour Protection	Amtrak	-	+	+	+	N	+	+	-	+	+	+	-	+	+	+	+	N	+

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F.P.3	Tunnel Structure Rehabilitation	Amtrak	-	+	+	+	+	-	-	+	+	+	+	-	N	+	N	-	+	+
F.P.4	Facility Damage Prevention	DCAS	N	N	+	+	N	-	+	N	+	+	N	+	+	-	N	+	N	N
F.P.5	Infrastructure Protection	DCAS	+	+	+	+	+	+	-	+	N	N	+	-	+	+	N	-	+	-
F.P.6	Check Valve Installation/Plumbing Improvement Subsidies	DEP	+	+	+	+	+	+	-	-	+	+	-	-	+	-	N	-	+	-
F.P.7	Drainage Improvement	DEP	+	+	+	+	+	-	-	N	+	+	+	+	+	+	N	-	+	+
F.P.8	Drainage Improvement Plan and Design	DEP	+	+	+	+	N	+	+	N	+	+	N	+	+	+	+	+	N	N
F.P.9	Facility Protection	DEP	+	+	+	+	+	+	+	-	+	+	-	-	-	+	+	+	-	-
F.P.10	Facility Redesign	DEP	+	+	N	+	+	+	+	+	+	+	+	-	+	+	-	+	+	+
F.P.11	Infrastructure Protection	DEP	+	+	+	-	+	+	+	-	+	+	+	-	N	+	-	+	+	-
F.P.12	Infrastructure Upgrade	DEP	+	+	+	+	-	+	+	-	+	+	-	-	+	+	-	+	-	+
F.P.13	Infrastructure Upgrade	DEP	+	+	+	+	-	+	+	+	+	+	N	+	+	+	-	+	+	+
F.P.14	Infrastructure Upgrade	DEP	+	+	+	+	+	+	+	-	+	+	-	-	+	+	-	+	+	+

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F.P.15	Natural Resource Protection	DEP	+	+	+	+	+	+	+	-	+	+	-	-	N	+	+	+	+	+
F.P.16	Facility Improvement	DFTA	+	+	+	+	+	-	-	+	+	+	N	+	+	+	N	-	+	N
F.P.17	Facility Improvements	DHS	+	+	+	+	N	-	-	+	+	+	N	+	+	+	+	-	N	N
F.P.18	Computer Modeling	DOB	N	+	+	+	N	+	-	N	+	+	N	N	+	+	+	-	N	N
F.P.19	Roadway Elevation and Regrade	DOC	-	+	+	+	+	-	-	+	N	N	N	+	+	+	N	-	+	+
F.P.20	Wet/Dry Flood proofing	DOC	-	+	+	+	N	-	-	+	N	N	N	+	+	+	N	-	N	N
F.P.21	Curb Repair and Installation	DOT	+	+	+	+	+	+	+	+	+	+	-	-	+	+	-	+	+	+
F.P.22	Drainage Improvement	DOT	+	+	+	+	+	+	+	+	+	+	-	-	+	+	N	+	+	+
F.P.23	Building Upgrade	HHC	+	+	+	+	+	-	+	+	+	+	N	+	+	+	+	+	+	N
F.P.24	Marine Parkway Bridge Protection	MTA (Bridges and Tunnels)	N	N	+	+	N	+	+	-	N	N	N	N	+	+	-	+	N	-
F.P.25	Drainage Mitigation	MTA (LIRR)	+	+	+	+	+	+	-	-	+	+	-	-	+	+	N	+	+	+

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F.P.26	Drainage Improvement	MTA (NYCT-Subway)	+	+	+	N	N	+	-	N	+	+	N	+	+	+	N	-	N	N
F.P.27	Basement/Cellar Equipment Safeguard	NYCHA	+	+	+	+	+	+	+	-	+	+	-	-	+	+	+	+	+	+
F.P.28	Critical Infrastructure Protection	OEM	N	N	+	+	+	+	-	-	+	+	N	+	+	+	+	-	+	N
F.P.29	HAZUS-MH Modeling	OEM	+	+	+	+	+	+	+	+	+	+	N	+	+	+	+	+	+	N
F.P.30	Property Protection	OEM	+	+	+	+	+	+	+	+	+	+	-	-	+	+	+	+	+	N
F.P.31	Public Information and Guidance	OEM	+	+	+	+	+	+	-	+	+	+	N	+	+	+	+	-	+	N
F.P.32	Severe Repetitive Loss Outreach and Education	OEM	+	+	+	+	+	+	-	+	+	+	N	+	+	+	+	-	+	N
F.P.33	Drainage Improvement	PANYNJ (Aviation)	N	N	+	+	+	N	+	-	+	+	N	+	N	+	+	+	N	N
F.P.34	Facility Protection	PANYNJ (Aviation)	-	+	+	+	+	N	+	+	+	+	+	-	+	+	+	+	N	-

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F.P.35	Facility Protection	PANYNJ (Aviation)	-	N	+	+	+	N	+	-	+	+	+	-	+	+	+	+	N	N
F.P.36	Facility Upgrade	PANYNJ (Aviation)	N	+	+	+	+	N	+	+	+	+	N	+	+	+	-	+	N	N
F.P.37	Facility Upgrade	PANYNJ (Aviation)	-	+	+	+	+	N	+	+	N	N	N	+	+	+	-	+	N	N
F.P.38	Facility Upgrade	PANYNJ (Aviation)	-	+	+	+	+	N	+	+	N	N	-	-	+	+	-	+	N	N
F.P.39	Flood Proofing at Olmsted Site	Parks	+	+	+	+	+	+	-	+	+	+	N	+	+	+	-	-	+	N
Windstorms/Tornadoes																				
WT.P.1	Infrastructure Protection	DOT	+	+	+	+	+	+	+	-	N	+	-	-	+	-	+	+	+	+
WT.P.2	Building Retrofit	HHC	N	N	+	+	N	+	-	+	+	+	N	+	+	+	+	-	N	N
WT.P.3	Facility Protection	HRA	N	N	+	+	N	+	+	+	N	N	-	-	+	-	+	+	N	N
WT.P.4	Infrastructure Reinforcement	MTA (Bridges and Tunnels)	+	+	+	+	N	N	+	-	+	+	-	-	+	+	-	+	N	N

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Winter Storms																				
WS.P.1	Public Outreach	OEM	+	+	+	+	+	+	+	+	+	+	N	N	+	+	+	+	+	+
Multi-Hazard																				
MH.P.1	Danger Tree Program	Con Ed	+	+	+	+	-	+	+	-	+	+	+	-	-	+	+	+	-	-
MH.P.2	Building Retrofit	DCAS	-	+	+	+	+	+	+	+	+	+	N	+	+	+	-	+	+	N
MH.P.3	Green Roof Installation	DCAS	N	+	+	+	+	N	+	-	+	+	N	+	+	+	-	+	+	+
MH.P.4	Bridge Reconstruction and Stabilization	DEP	+	+	+	+	-	+	+	-	+	+	-	-	+	+	-	+	+	+
MH.P.5	Combined Sewer Overflow Storage	DEP	+	+	+	+	-	+	-	-	+	+	-	-	+	+	-	-	+	+
MH.P.6	Critical Facility Protection	DEP	+	+	+	+	+	+	-	+	N	N	N	+	+	+	N	-	+	+
MH.P.7	Dam Reconstruction Program	DEP	+	+	+	+	+	+	+	-	+	+	-	-	+	+	-	+	+	+
MH.P.8	Drainage Improvement	DEP	+	+	+	+	+	+	N	+	+	+	N	+	+	+	N	-	+	+
MH.P.9	Facility and Infrastructure Protection	DEP	N	+	+	+	+	+	+	-	+	+	+	-	+	+	-	+	+	N
MH.P.10	Groundwater	DEP	+	+	+	+	-	+	+	-	+	+	-	-	+	+	-	+	+	+

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	Development																			
MH.P.11	Groundwater Treatment Plant	DEP	+	+	+	+	+	+	+	-	+	+	-	-	+	+	-	+	+	+
MH.P.12	Mapping and Analysis Enhancement	DEP	+	+	+	-	+	+	+	+	+	+	+	-	+	+	+	+	+	+
MH.P.13	Wetlands Restoration	DEP	+	+	+	+	+	+	+	-	+	+	N	+	+	+	M	+	+	+
MH.P.14	Public Education	DFTA	+	+	+	+	N	+	-	-	+	+	N	+	+	+	N	-	N	N
MH.P.15	Public Outreach	DFTA	+	+	+	+	N	+	+	-	+	+	N	+	+	+	N	+	N	N
MH.P.16	Building Upgrade	DHS	-	+	+	+	+	-	-	+	+	+	N	+	+	+	N	-	+	N
MH.P.17	Communications Equipment	DHS	-	+	+	-	N	-	-	-	+	+	N	N	N	+	+	-	N	N
MH.P.18	Facility Improvements	DHS	N	N	+	+	+	N	-	+	+	+	N	+	+	+	+	-	+	+
MH.P.19	Facility Retrofit	DHS	N	+	+	+	+	-	-	+	+	+	N	+	-	+	+	-	+	N
MH.P.20	Power Redundancy	DHS	N	N	+	-	N	+	-	-	+	+	N	+	+	+	-	-	N	N
MH.P.21	Power Redundancy	DHS	N	N	+	-	N	+	-	-	+	+	N	+	+	+	-	-	N	N
MH.P.22	Property Protection	DHS	N	N	+	+	+	+	-	+	+	+	N	+	+	+	N	-	+	N
MH.P.23	Construction Code Revision	DOB	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+

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MH.P.24	Information Gathering	DOB	-	N	+	-	N	+	+	+	+	+	N	+	+	+	+	+	N	N
MH.P.25	Information Gathering	DOB	-	N	+	-	N	+	+	+	+	+	N	+	+	+	+	+	N	N
MH.P.26	Information Gathering	DOB	-	N	+	-	N	+	+	+	+	+	N	+	+	+	+	+	N	N
MH.P.27	Stormwater Management	DOC	+	+	+	+	N	+	-	+	+	+	N	+	+	+	N	-	N	N
MH.P.28	Critical Equipment Redundancy	DOE	+	+	+	-	+	+	+	-	+	+	N	+	+	-	+	-	+	+
MH.P.29	Facility Protection	DOE	+	+	+	+	-	+	+	-	+	+	N	+	+	+	N	-	-	+
MH.P.30	Green Roof Installation	DOE	+	+	+	+	+	+	-	-	+	+	+	-	+	+	N	-	+	+
MH.P.31	Infrastructure Protection	DOE	+	N	+	+	N	+	-	+	+	+	+	-	+	+	N	-	N	N
MH.P.32	Power Redundancy	DOE	N	N	+	-	N	+	-	-	+	+	N	+	+	+	-	-	N	N
MH.P.33	Early Warning System	DoITT	+	+	+	+	+	+	-	+	+	+	N	+	+	-	N	-	+	+
MH.P.34	Bridge Inspections	DOT	+	+	+	+	+	+	+	+	+	+	N	+	+	+	+	+	+	+
MH.P.35	Critical Facility Loss Estimation	DOT	+	+	+	+	+	+	+	+	+	+	N	N	+	+	+	+	+	N
MH.P.36	Curb Repair and Installation	DOT	+	-	+	+	+	+	+	-	+	+	-	-	-	+	-	+	+	+
MH.P.37	Drainage and Surface	DOT	+	+	+	+	+	+	+	-	+	+	-	-	+	+	N	+	+	+

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	Improvement																			
MH.P.38	East River Bridges Retrofit (Construction)	DOT	+	+	+	+	+	+	+	+	+	+	N	-	-	+	-	-	-	+
MH.P.39	Information Update	DOT	+	-	+	+	+	+	-	+	+	+	N	+	+	+	+	-	-	N
MH.P.40	Infrastructure Protection	DOT	+	+	+	+	N	+	+	+	+	+	N	+	+	+	N	+	N	N
MH.P.41	Critical Infrastructure Relocation	EDC	+	+	+	+	+	+	+	+	+	+	N	+	N	+	+	+	+	N
MH.P.42	Green Roof Installation	EDC	+	+	+	+	+	+	-	-	+	+	N	+	+	+	N	-	+	+
MH.P.43	Back up Water Main System	FDNY	+	+	+	+	+	-	-	-	+	+	N	+	+	+	N	-	+	+
MH.P.44	Public Awareness	HPD	+	+	+	+	+	+	-	-	+	+	N	+	+	+	+	-	+	+
MH.P.45	Critical Facility Protection	HRA	+	+	+	+	+	-	+	+	+	+	N	+	N	+	N	+	+	N
MH.P.46	Explore Loss Reduction Actions	LPC	+	+	+	+	+	+	+	+	+	+	N	+	+	+	N	+	+	N
MH.P.47	Public Education and Outreach	LPC	+	+	+	+	N	+	+	-	+	+	N	+	+	+	N	+	N	N
MH.P.48	Technical Assistance	LPC	+	N	+	+	+	+	+	-	+	+	N	+	+	+	N	+	+	N

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MH.P.49	Far Rockaway Depot Green Roof	MTA (Bus)	+	+	+	+	+	+	+	-	+	+	N	+	+	+	+	+	+	+
MH.P.50	Advanced Warning	NWS	+	+	+	+	+	+	-	+	+	+	-	-	N	-	N	-	+	+
MH.P.51	Dopler Radar Upgrade	NWS	+	+	+	+	+	+	-	-	+	+	N	+	+	-	N	-	+	+
MH.P.52	Grounds, Pavements, and Drainage	NYCHA	+	+	+	+	+	+	+	+	+	+	-	-	+	+	+	+	+	N
MH.P.53	Facility Protection	NYPD	+	N	+	+	+	+	-	+	+	+	N	+	+	+	N	-	+	N
MH.P.54	Facility Protection	NYPD	+	+	+	+	N	+	-	+	+	+	N	+	+	+	N	-	N	N
MH.P.55	Facility Protection	NYPD	+	+	+	+	+	+	-	+	+	+	N	+	+	+	N	-	+	N
MH.P.56	Advance Warning System Integration	OEM	+	+	+	+	+	+	-	-	+	+	-	-	N	-	+	-	+	N
MH.P.57	Critical Facility Protection	OEM	+	+	+	+	+	+	-	+	N	N	N	+	+	+	N	-	+	N
MH.P.58	Educational Outreach	OEM	+	+	+	+	+	+	-	+	+	+	N	+	N	+	N	-	+	N
MH.P.59	Facility Protection	OEM	+	N	+	+	+	+	-	-	+	+	N	+	+	+	N	-	+	N
MH.P.60	Facility Protection	OEM	+	+	+	+	N	+	-	-	+	+	N	+	+	+	+	-	N	+
MH.P.61	HAZUS-MH Update	OEM	N	N	+	+	+	+	+	+	+	+	N	+	+	+	N	+	+	N

Potential Mitigation Actions STAPLEE Analysis Table

Index	Mitigation Action	Lead Agency	Social		Technical			Administrative			Political		Legal			Economic			Environment	
			Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Staffing	Funding Allocation	Maintenance/Operations	Political Support	Public Support	State Authority	Existing Local Authority	Potential Legal Challenge	Benefit of Action	Cost of Action	Outside Funding Required	Effect on Land/ Water	Consistent with Community Environmental Goals
MH.P.62	Incorporate Hazard Mitigation into CERT Curriculum	OEM	+	+	+	+	N	+	+	-	+	+	N	+	+	+	+	+	N	N
MH.P.63	Infrastructure Systems Modeling	OEM	+	+	+	+	-	+	+	+	+	+	+	+	-	+	N	-	-	+
MH.P.64	Loss Estimation Assistance	OEM	-	N	+	-	N	+	-	+	+	+	N	+	+	+	N	-	N	N
MH.P.65	Natural Hazard Event Database	OEM	-	N	+	-	N	+	+	+	+	+	N	+	+	+	N	+	N	N
MH.P.66	Partner with Community Groups	OEM	+	-	+	+	N	+	+	+	+	+	N	+	+	+	+	+	N	N
MH.P.67	Public Outreach	OEM	+	+	+	+	N	+	+	+	+	+	N	+	+	+	N	``	N	N
MH.P.68	Public/Private Mitigation Initiatives	OEM	+	+	+	+	N	+	-	+	+	+	N	+	+	+	N	-	N	N
MH.P.69	Regional Critical Infrastructure Mapping	OEM	-	N	+	-	N	+	-	-	+	+	N	+	+	+	N	-	N	N
MH.P.70	Subway Depths Mapping other natural hazards	OEM	-	N	+	-	N	+	-	+	+	+	N	+	+	+	N	-	N	N
MH.P.71	Vegetation Data	OEM	-	N	+	-	N	+	-	+	+	+	N	+	-	+	N	-	N	N

Potential Mitigation Actions STAPLEE Analysis Table																				
			Social		Technical			Administrative			Political		Legal			Economic			Environment	
Index	Mitigation Action	Lead Agency	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Staffing	Funding Allocation	Maintenance/Operations	Political Support	Public Support	State Authority	Existing Local Authority	Potential Legal Challenge	Benefit of Action	Cost of Action	Outside Funding Required	Effect on Land/ Water	Consistent with Community Environmental Goals
MH.P.72	Zoning for Hazard-Prone Areas	OEM	+	+	+	+	+	+	-	-	+	+	N	+	-	+	N	-	+	+
MH.P.73	Warning System/Environmental Protection	PANYNJ (Aviation)	+	N	+	+	N	N	+	-	+	+	N	+	+	+	+	+	N	N
MH.P.74	Green Roof Installation	Parks	+	+	+	+	+	+	-	-	+	+	N	+	+	+	+	-	+	+
MH.P.75	Green Streets	Parks	+	+	+	+	+	+	+	-	+	+	N	+	+	+	+	+	+	+
MH.P.76	Land Acquisition	Parks	+	+	+	+	+	+	-	-	+	+	N	N	-	+	-	-	+	+
MH.P.77	Seawall, Pier, and Marina Structural Repairs	Parks	+	+	+	+	+	+	+	-	+	+	N	+	+	-	+	-	+	+
MH.P.78	Infrastructure Upgrade	Verizon	+	+	+	+	-	+	+	-	N	N	-	-	+	+	+	+	-	N

Table 6: Mitigation Action STAPLEE Analysis Table

ii) HAZUS Case Studies

To explore further how HAZUS-MH can be applied to mitigation planning, the Planning Team chose to model two case studies. Each of the case studies explored mitigation actions identified in the table above and focused on mitigating against a 100-year flood. The goal was to demonstrate HAZUS-MH capabilities as a tool for mitigation planning efforts, as well as establish and quantify the effectiveness of these actions. Although both case studies are generalized due to data and technology constraints, they serve to demonstrate the cost effectiveness of a mitigation action.

(1) Case Study 1: Raising Critical Facilities in the 100-Year Floodplain

Case Study 1 is based on mitigation action F.E.18, a 2008 Construction Code revision that requires raising critical facilities above the base flood elevation (BFE) if the facility is built on or after July 1, 2008 and is located in a flood hazard area, or the A-Zones or V-Zones of the FEMA flood insurance rate map (FIRM). Specifically, Appendix G of the Construction Code requires raising the first floor of type III critical facilities, such as grade K-12 schools, one foot above BFE and type IV critical facilities, such as fire stations, two feet above BFE. This mitigation action will protect critical facilities from losing their ability to maintain operations and prevent building damage during a flood event.

To demonstrate the effectiveness of these new requirements, Case Study 1 estimates economic losses caused by a 100-year flood event to existing schools and fire stations located in the flood hazard area of Queens and Brooklyn. OEM's Hazard Impact Modeler ran a 100-year flood simulation for the two boroughs to determine the change in economic losses between the current BFE requirements and the new BFE requirements. These facilities are displayed in Figure 1. The mitigation action is used as a guideline for modeling and the case study does not fully capture the monetary benefit of implementing mitigation action F.E.18 for new facilities.

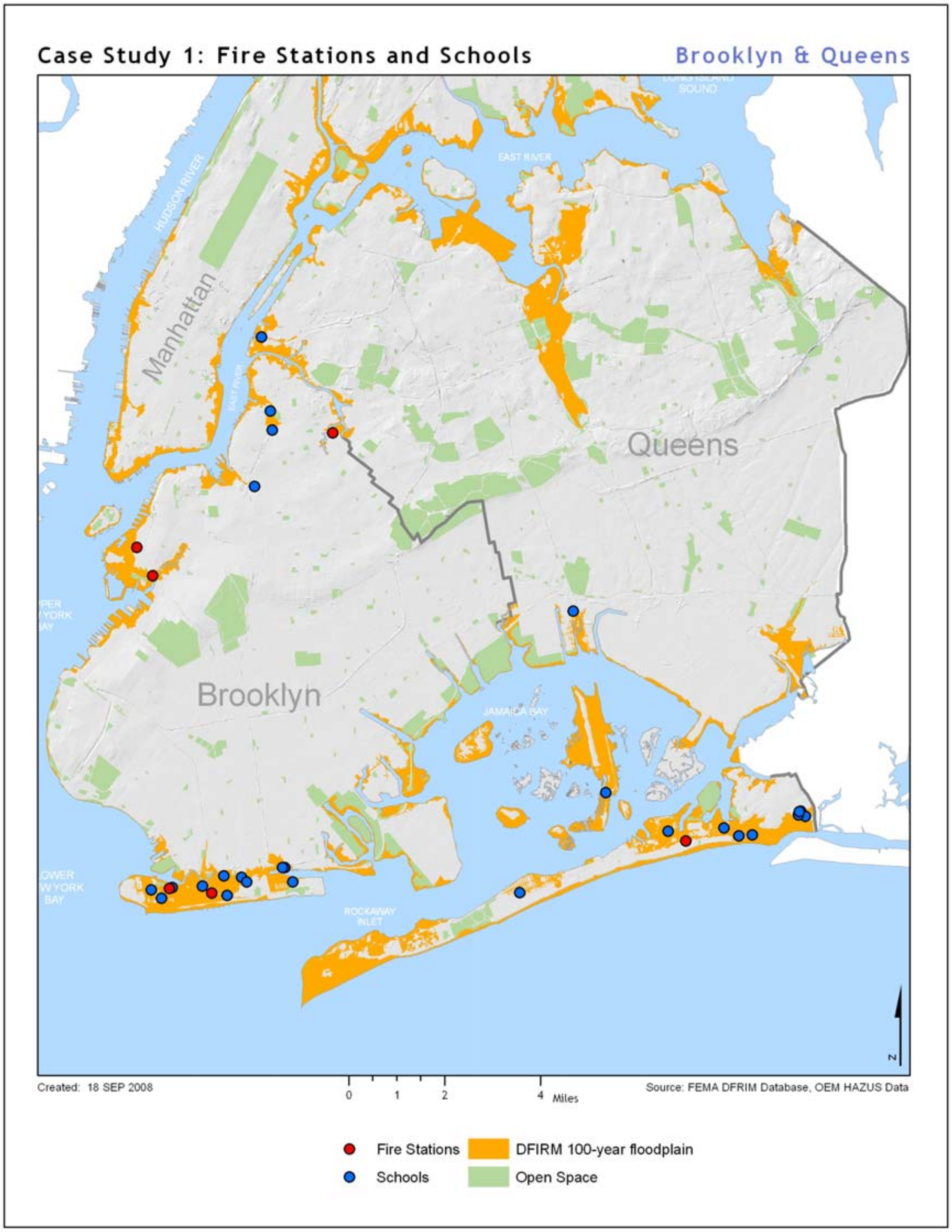

Figure 1: Fire Stations and Schools in Brooklyn and Queen's 100-Year Floodplain

OEM's Hazard Impact Modeler ran two HAZUS-MH models: a 100-year flood event in Brooklyn and Queens using *existing building data* and a 100-year flood event in

Brooklyn and Queens using *modified building data* where schools and fire stations were raised one foot and two feet, respectively. The results are in Table 7 below.

Case Study 1 HAZUS-MH Results for 100-Year Flood					
Borough	**Facility Information**		**Total Building Damage ($)**		
	Type	**Count**	**Existing Building Data**	**Modified Building Data**	**% Change**
Brooklyn	Schools	15	9,392,000	6,925,000	-26.3%
	Fire Stations	5	347,000	135,000	-61.1%
Queens	Schools	11	3,221,370	1,343,040	-58.3%
	Fire Stations	1	50,000	0	-100.0%
Total		***32***	***13,010,370***	***8,403,040***	***-35.4%***

Table 7: Case Study 1 HAZUS-MH Results

Overall, 32 schools and fire stations lie within the Brooklyn and Queens 100-year floodplain. The existing building data identifies these facilities as having a zero foot BFE. Under this condition, HAZUS-MH estimates $13 million in damage from a 100-year flood event. Taking mitigation action F.E.18 into account, HAZUS-MH estimates only $8.4 million in damages will occur from the same event, a 35% reduction in total building damage.

There is a clear economic benefit by implementing this mitigation action. The presumably small cost of raising a new facility one to two feet during construction could reduce 26% or more the cost of building damages from a 100-year flood event. While this case study does not model the exact mitigation action, the results strongly suggest this is a cost-effective mitigation action for protecting critical facilities in New York City.

(2) Case Study 2: Open Space Initiatives

There are various programs in the City that aim to increase open space, public space and protect the natural environment that also mitigate the affects of natural hazards. This case study aims to model the economic benefit of increasing open space and consequentially restricting development of homes and commercial space in Staten Island’s 100-year floodplain. While not a specific mitigation action, this case study models multiple actions related to NYC Department of Environmental Protection’s (DEP) Bluebelt program. (See F.E.10, F.E.11, and F.P.8 mitigation actions)

The Staten Island Bluebelt program began in 1991 and is an award winning, ecologically sound, and cost-effective storm water management program that preserves natural drainage corridors over one third of Staten Island. Preserving these natural corridors, or Bluebelts, allows them to perform their function of conveying, storing, and filtering storm water from normal rain events and extreme rain events such a coastal flood or a coastal storm. As of September 2008, the Bluebelt program has acquired 333 acres of property and has proposed acquiring an additional 141 acres.

Existing or proposed Bluebelt projects provide an opportunity to examine the benefits to natural hazard mitigation of retaining open space, especially in at-risk areas. While the mitigation actions undertaken by DEP focus on drainage and storm water, this analysis attempts to quantify the savings in property damage that result from leaving these areas as open space. For this study, the Planning Team looked at the 316 acres of South Beach, Oakwood Beach, and New Creek Bluebelts. Figure 2 displays where these Bluebelts are located on Staten Island.

Figure 2: Staten Island Bluebelts

The analysis simply compares the estimated damages from a 100-year flood event in Staten Island with the three Bluebelts and without the Bluebelts, treating the area as a residentially developed neighborhood. In order to model this analysis in HAZUS-MH, OEM's Hazard Impact Modeler ran a 100-year flood model to identify damage estimates for Staten Island using *existing building data,* or data presented in the Flood Vulnerability Assessment section. Next, the Modeler examined the General Building Stock data used in HAZUS-MH to determine what the built environment (building types, uses, and sizes) looks like in the developed areas surrounding these Bluebelts. The Modeler applied similar building data to the currently empty census blocks within the three Bluebelts. This allowed HAZUS-MH to simulate what the area might look like if the Bluebelt program did not exist and the areas were instead built out in a manner similar to the surrounding areas. Using this *modified building data* for the Bluebelt areas, the 100-year flood model was rerun to produce new, comparative damage estimates.

Table 8 displays the results of these two model runs. HAZUS-MH estimates more than $493 million in building and contents damages to the 107,467 existing buildings in all of Staten Island. By mimicking development in the 316 acres of current Bluebelts, 111,197 buildings are estimated to experience $661 million in damages, a $168 million increase. A noticeable and important benefit of this model is that adding only 3.5% to the total buildings in Staten Island, increasing the building stock value by 1.5%, results in nearly a 34% increase in estimated damage.

Case Study 2 HAZUS-MH Results for 100-Year Flood ($1,000s)					
Scenario	**Total Buildings in Staten Island**		**Damage Estimates**		
	Value	**Count (#)**	**Building**	**Contents**	**Total**
Existing Building Data	41,609,000	107,467	224,797	268,275	493,072
Modified Building Data	42,240,000	111,197	327,476	333,525	661,001
% Difference	*1.5%*	*3.5%*	*45.7%*	*24.3%*	*34.1%*

Table 8: Case Study 2 HAZUS-MH Results

This case study reinforces the concept that structural development in the 100-year floodplain can result in a disproportionally higher amount of damage from a flood. By restricting development in small, but vulnerable areas, a significant and costly amount of damage is prevented. Open space programs and related projects across the City, such as the Bluebelt program in Staten Island, provide benefits beyond their intended purposes. They provide an added mitigation component of protecting people and property from costly flood damage.

4) Prioritization

The Planning Team developed a methodology for prioritizing the mitigation actions using the STAPLEE criteria and implementation categories as presented above. By assigning a numerical value to each action based on a set of 10 criteria, the Planning Team was able to prioritize the 161 actions into a high, medium, and low ranking. Note the Planning Team did not prioritize existing mitigation actions because they have already secured funding and have been scheduled for implementation.

a) Methodology

The Planning Team established 10 criteria: the first seven based on the STAPLEE analysis and the remaining three based on (1) number of objectives the action meets, (2) projected costs, and (3) projected timeline. Each criterion was assigned a value of -1, 0, or 1. These values represent whether the criterion is unfavorable or negative (-1), neutral, not applicable, or moderate (0), or favorable or positive (1).

i) STAPLEE Criteria

To determine the value of the seven STAPLEE criteria, the Planning Team assessed each of the 18 measures addressed in the STAPLEE analysis. For each criteria (social, technological, administrative, political, legal, economic, and environmental), two to three measures are taken into consideration. The Planning Team used the matrix shown in Table 9 to determine the criteria's overall value based off the number of –, +, or N assigned to the measures. For example, the administrative criterion has three measures: staffing, funding allocation, and maintenance/operations. If these three measure are given a value of +, +, and -, the administrative criterion's overall value is a +. After each STAPLEE criteria received a new, overall, value of -, N, or +, the Planning Team assigned a prioritization value of -1, 0, or 1, respectively.

Applying STAPLEE Criteria to Prioritization					
	Number of measures with a "-"				
Number of measures with a "+"		0	1	2	3
	0			-	-
	1		N	-	
	2	+	+		
	3	+			

Table 9: Applying STAPLEE Criteria to Prioritization

ii) Implementation Criteria

For the three remaining criteria (number of objectives met, projected cost, and projected timeframe), the Planning Team evaluated the distribution of each criteria's values. Using this information, the Planning Team established quantifiable ranges for each criterion that met the parameters of the -1, 0, or 1 values. Table 10 presents the how the 10 criteria's values were assigned a value of -1, 0, or 1.

	Criteria									
Value	S	T	A	P	L	Ec	Ev	# of Objectives	Project Cost	Project Timeframe
-1	-	-	-	-	-	-	-	1 objective	≥ $100 million	≥ 10 years
0	N	N	N	N	N	N	N	2-3 objectives	TBD, ≥ $10 million to <$100 million	TBD, ongoing, ≥ 5 years to <10 years
1	+	+	+	+	+	+	+	4+ objectives	< $10 million	≤ 5 years

Table 10: Values Assigned to 10 Criteria in Mitigation Action Prioritization

Summing the values of the 10 criteria was the next step in prioritizing the mitigation actions. The 161 potential mitigation actions received a cumulative value ranging from –10 to 10. These values were sorted in ascending order. Based on the overall value distribution, the Planning Team assigned a final prioritization value of "low" to actions with a final score of zero or lower because these actions have more or an equal amount of negative attributes than positive attributes. Actions with a final score of 1–5 were prioritized as "medium" while actions with a final score of 6–10 received a prioritization value of "high" because they have many positive attributes and few, if any, negative attributes.

Table 11 presents the distribution of action by final prioritization value. These final prioritization values are determined from very general criteria and additional information or data not included in this analysis could affect the prioritization results.

Summary Prioritization Table				
	Priority Ranking			
Hazard	Low	Medium	High	Total
Coastal Erosion	1	1	0	***2***
Coastal Storms	1	4	4	***9***
Drought	1	4	2	***7***
Earthquakes	1	6	5	***12***
Extreme Temperatures	0	5	4	***9***
Flood	1	23	15	***39***
Windstorms/Tornadoes	0	2	2	***4***
Winter Storms	0	0	1	***1***
Multi-Hazards	3	41	34	***78***
Total	***8***	***86***	***67***	***161***

Table 11: Summary of Mitigation Action Prioritization

b) Benefit-Cost Analysis for Specific Projects

A Benefit-Cost Analysis (BCA) is a method for determining the potential positive effects of a specific mitigation action and comparing them to the cost of the action. To assess and demonstrate the cost-effectiveness of mitigation actions, FEMA has developed a suite of BCA software, including hazard-specific modules. Agencies seeking funding under one of FEMA's mitigation grant programs will perform a detailed BCA using this software prior to the submission the grant application. OEM and the Planning Team will assist agencies with this effort.

Potential Mitigation Action Prioritization Table															
					Criteria										
Index	Mitigation Action & Description	Lead Agency	Prioritization	Total	S	T	A	P	L	Ec	Ev	# of Objectives	Project Cost	Project Timeframe
Coastal Erosion														
CE.P.1	Rikers Island Shoreline Protection	DOC	Low	1	0	1	-1	1	-1	1	-1	0	1	0
CE.P.2	Beach Renourishment	USACE	Medium	3	1	1	-1	1	1	-1	0	0	1	0
Coastal Storms														
CS.P.1	Facility Protection	DEP	High	6	1	1	1	1	1	1	1	0	-1	0
CS.P.2	Hillview Reservoir Cover	DEP	Medium	3	1	1	1	1	-1	1	0	0	-1	0
CS.P.3	Kensico Reservoir Turbidity Curtain	DEP	Medium	5	1	1	1	1	-1	1	-1	0	1	1
CS.P.4	Property Protection	DEP	Low	-1	-1	1	1	0	-1	1	-1	0	-1	0
CS.P.5	Computer Modeling	DOB	High	8	1	1	1	1	1	1	0	0	1	1
CS.P.6	Protective Measures for Critical Facilities	DOC	Medium	4	1	1	-1	1	1	0	1	0	0	0
CS.P.7	Infrastructure Improvements and Study	MTA (Bridges & Tunnels)	High	6	1	1	1	1	-1	1	1	0	0	1
CS.P.8	Facility Protection	OEM	Medium	3	1	1	-1	1	1	0	0	0	0	0
CS.P.9	HAZUS-MH Modeling	OEM	High	7	1	1	1	1	1	1	0	0	0	1
Drought														
D.P.1	Water Conservation	DCAS	High	8	1	1	1	1	1	1	1	0	1	0
D.P.2	Water Conservation	DCAS	High	8	1	1	1	1	1	1	1	0	1	0
D.P.3	Aquifer Storage and Recovery	DEP	Medium	3	1	1	1	1	-1	1	-1	0	0	0
D.P.4	Croton Falls and Cross River Pump Station Rehabilitation	DEP	Medium	4	1	1	1	1	-1	1	0	1	-1	0
D.P.5	Delaware-Rondout Parallel Tunnel	DEP	Medium	3	1	1	1	1	-1	1	-1	1	-1	0
D.P.6	Hydrant Locking Program	DEP	Medium	4	0	1	-1	1	1	1	1	0	0	0
D.P.7	Increase Catskill Aqueduct	DEP	Low	-1	-1	1	1	0	-1	1	-1	0	-1	0

Potential Mitigation Action Prioritization Table															
					Criteria										
Index	Mitigation Action & Description	Lead Agency	Prioritization	Total	S	T	A	P	L	Ec	Ev	# of Objectives	Project Cost	Project Timeframe
	Capacity													
Earthquake														
EQ.P.1	Mechanical Equipment Seismic Upgrade	DCAS	High	6	0	1	1	1	1	1	0	0	1	0
EQ.P.2	Construct Redundant Kensico City Aqueduct	DEP	Medium	3	1	1	1	1	-1	1	-1	1	-1	0
EQ.P.3	Hunt's Point Wastewater Treatment Plant Facility Seismic Retrofit	DEP	High	7	1	1	1	1	1	1	1	0	0	0
EQ.P.4	Rondout West Branch Tunnel Repair	DEP	Low	-3	1	1	1	-1	-1	-1	-1	-1	-1	0
EQ.P.5	Seismic Infrastructure Protection	DEP	High	7	0	1	1	1	1	1	1	0	0	1
EQ.P.6	Seismic Inspection and Retrofit Program	DEP	Medium	5	1	1	-1	1	1	1	1	0	0	0
EQ.P.7	Computer Modeling	DOB	High	8	1	1	1	1	1	1	0	0	1	1
EQ.P.8	Facility Retrofit	DOE	Medium	3	0	1	-1	1	1	1	1	0	0	-1
EQ.P.9	Rikers Island Bridge Seismic Retrofit	DOT	Medium	5	1	1	1	1	1	0	0	0	0	0
EQ.P.10	Facility Improvement	HPD	Medium	2	0	1	-1	1	1	-1	1	-1	0	1
EQ.P.11	Seismic Studies and Retrofit	MTA (Bridges & Tunnels)	Medium	4	1	1	1	1	-1	1	0	0	-1	1
EQ.P.12	HAZUS-MH Modeling	OEM	High	7	1	1	1	1	1	1	0	0	0	1
Extreme Temperatures														
ET.P.1	Power Conservation	DCAS	High	8	1	1	1	1	1	1	1	0	0	1
ET.P.2	Power Redundancy	DCAS	Medium	1	0	0	-1	1	1	-1	0	0	0	1
ET.P.3	Equipment Upgrade	DEP	High	9	1	1	1	1	1	1	1	1	1	0
ET.P.4	Facility Upgrade	DFTA	Medium	4	1	1	-1	1	1	0	0	0	0	1

Potential Mitigation Action Prioritization Table															
					Criteria										
Index	Mitigation Action & Description	Lead Agency	Prioritization	Total	S	T	A	P	L	Ec	Ev	# of Objectives	Project Cost	Project Timeframe
ET.P.5	Facility Upgrade	DFTA	Medium	5	1	1	-1	1	1	0	0	0	1	1
ET.P.6	Property Protection	DFTA	High	7	1	1	1	1	1	0	1	0	0	1
ET.P.7	Public Outreach	DFTA	Medium	5	1	1	1	1	1	0	-1	0	0	1
ET.P.8	Public Outreach	DFTA	High	7	1	0	1	1	1	1	1	0	0	1
ET.P.9	Health Education and Outreach	DOHMH	Medium	5	1	0	1	1	1	0	0	1	0	0
Flood														
F.P.1	Drainage Improvement	Amtrak	High	7	1	1	1	1	-1	1	1	0	1	1
F.P.2	Scour Protection	Amtrak	High	6	0	1	1	1	1	1	1	0	1	-1
F.P.3	Tunnel Structure Rehabilitation	Amtrak	Medium	2	0	1	-1	1	0	0	1	0	0	0
F.P.4	Facility Damage Prevention	DCAS	Medium	2	0	1	0	1	1	0	0	-1	0	0
F.P.5	Infrastructure Protection	DCAS	Medium	4	1	1	1	0	1	0	0	0	0	0
F.P.6	Check Valve Installation/ Plumbing Improvement Subsidies	DEP	Low	-1	1	1	-1	1	-1	-1	0	-1	0	0
F.P.7	Drainage Improvement	DEP	Medium	3	1	1	-1	1	1	0	1	0	0	-1
F.P.8	Drainage Improvement Plan and Design	DEP	High	6	1	1	1	1	1	1	0	0	0	0
F.P.9	Facility Protection	DEP	Medium	2	1	1	1	1	-1	1	-1	0	0	-1
F.P.10	Facility Redesign	DEP	High	6	1	1	1	1	1	1	1	0	-1	0
F.P.11	Infrastructure Protection	DEP	Medium	4	1	1	1	1	0	1	0	0	-1	0
F.P.12	Infrastructure Upgrade	DEP	Medium	4	1	1	1	1	-1	1	0	1	-1	0
F.P.13	Infrastructure Upgrade	DEP	High	8	1	1	1	1	1	1	1	1	0	0
F.P.14	Infrastructure Upgrade	DEP	Medium	4	1	1	1	1	-1	1	1	0	-1	0
F.P.15	Natural Resource Protection	DEP	Medium	5	1	1	1	1	-1	1	1	0	1	-1
F.P.16	Facility Improvement	DFTA	Medium	4	1	1	-1	1	1	0	1	0	0	0

Potential Mitigation Action Prioritization Table															
					Criteria										
Index	Mitigation Action & Description	Lead Agency	Prioritization	Total	S	T	A	P	L	Ec	Ev	# of Objectives	Project Cost	Project Timeframe
F.P.17	Facility Improvements	DHS	Medium	4	1	1	-1	1	1	1	0	0	0	0
F.P.18	Computer Modeling	DOB	High	7	1	1	0	1	1	1	0	0	1	1
F.P.19	Roadway Elevation and Regrade	DOC	Medium	2	0	1	-1	0	1	0	1	0	0	0
F.P.20	Wet/Dry Flood proofing	DOC	Medium	1	0	1	-1	0	1	0	0	0	0	0
F.P.21	Curb Repair and Installation	DOT	High	6	1	1	1	1	-1	1	1	0	1	0
F.P.22	Drainage Improvement	DOT	High	6	1	1	1	1	-1	1	1	0	0	1
F.P.23	Building Upgrade	HHC	High	7	1	1	1	1	1	1	1	0	0	0
F.P.24	Marine Parkway Bridge Protection	MTA (Bridges & Tunnels)	Medium	4	0	1	1	0	1	1	-1	0	0	1
F.P.25	Drainage Mitigation	MTA (LIRR)	Medium	3	1	1	-1	1	-1	1	1	0	0	0
F.P.26	Drainage Improvement	MTA (NYCT-Subway)	Medium	4	1	1	0	1	1	0	0	0	0	0
F.P.27	Basement/Cellar Equipment Safeguard	NYCHA	High	7	1	1	1	1	-1	1	1	0	1	1
F.P.28	Critical Infrastructure Protection	OEM	Medium	5	0	1	-1	1	1	1	1	0	0	1
F.P.29	HAZUS-MH Modeling	OEM	High	9	1	1	1	1	1	1	1	0	1	1
F.P.30	Property Protection	OEM	Medium	5	1	1	1	1	-1	1	1	0	0	0
F.P.31	Public Information and Guidance	OEM	High	8	1	1	1	1	1	1	1	1	0	0
F.P.32	Severe Repetitive Loss Outreach and Education	OEM	High	8	1	1	1	1	1	1	1	1	0	0
F.P.33	Drainage Improvement	PANYNJ (Aviation)	Medium	5	0	1	0	1	1	1	0	0	1	0

Potential Mitigation Action Prioritization Table														
					Criteria									
Index	**Mitigation Action & Description**	**Lead Agency**	**Prioritization**	**Total**	**S**	**T**	**A**	**P**	**L**	**Ec**	**Ev**	**# of Objectives**	**Project Cost**	**Project Timeframe**
F.P.34	Facility Protection	PANYNJ (Aviation)	High	6	0	1	1	1	1	1	-1	0	1	1
F.P.35	Facility Protection	PANYNJ (Aviation)	Medium	5	-1	1	0	1	1	1	0	0	1	1
F.P.36	Facility Upgrade	PANYNJ (Aviation)	High	7	1	1	1	1	1	1	0	0	1	0
F.P.37	Facility Upgrade	PANYNJ (Aviation)	Medium	5	0	1	1	0	1	1	0	0	0	1
F.P.38	Facility Upgrade	PANYNJ (Aviation)	Medium	3	0	1	1	0	-1	1	0	0	0	1
F.P.39	Flood Proofing at Olmsted Site	Parks	Medium	5	1	1	1	1	1	-1	1	0	0	0
Windstorms / Tornadoes														
WT.P.1	Infrastructure Protection	DOT	High	6	1	1	1	1	-1	1	1	-1	1	1
WT.P.2	Building Retrofit	HHC	High	7	0	1	1	1	1	1	0	0	1	1
WT.P.3	Facility Protection	HRA	Medium	2	0	1	1	0	-1	1	0	-1	1	0
WT.P.4	Infrastructure Reinforcement	MTA (Bridges & Tunnels)	Medium	3	1	1	0	1	-1	1	0	0	0	0
Winter Storms														
WS.P.1	Public Outreach	OEM	High	8	1	1	1	1	1	1	1	0	0	1
Multi-Hazard														
MH.P.1	Danger Tree Program	Con Ed	Medium	4	1	1	1	1	-1	1	-1	0	1	0
MH.P.2	Building Retrofit	DCAS	Medium	5	0	1	1	1	1	1	1	0	0	-1
MH.P.3	Green Roof Installation	DCAS	High	7	1	1	0	1	1	1	1	1	0	0
MH.P.4	Bridge Reconstruction and Stabilization	DEP	Medium	4	1	1	1	1	-1	1	1	0	-1	0
MH.P.5	Combined Sewer Overflow Storage	DEP	Medium	1	1	1	-1	1	-1	-1	1	1	-1	0

Potential Mitigation Action Prioritization Table														
					Criteria									
Index	**Mitigation Action & Description**	**Lead Agency**	**Prioritization**	**Total**	**S**	**T**	**A**	**P**	**L**	**Ec**	**Ev**	**# of Objectives**	**Project Cost**	**Project Timeframe**
MH.P.6	Critical Facility Protection	DEP	Medium	4	1	1	1	0	1	0	1	0	0	-1
MH.P.7	Dam Reconstruction Program	DEP	Medium	5	1	1	1	1	-1	1	1	0	0	0
MH.P.8	Drainage Improvement	DEP	High	6	1	1	1	1	1	0	1	1	0	-1
MH.P.9	Facility and Infrastructure Protection	DEP	High	7	1	1	1	1	1	1	1	0	0	0
MH.P.10	Groundwater Development	DEP	Medium	5	1	1	1	1	-1	1	1	1	-1	0
MH.P.11	Groundwater Treatment Plant	DEP	Medium	5	1	1	1	1	-1	1	1	1	-1	0
MH.P.12	Mapping and Analysis Enhancement	DEP	High	7	1	1	1	1	1	1	1	0	0	0
MH.P.13	Wetlands Restoration	DEP	High	7	1	1	1	1	1	1	1	0	0	0
MH.P.14	Public Education	DFTA	Medium	5	1	1	-1	1	1	0	0	1	0	1
MH.P.15	Public Outreach	DFTA	High	7	1	1	1	1	1	1	0	0	0	1
MH.P.16	Building Upgrade	DHS	Medium	3	0	1	-1	1	1	0	1	0	0	0
MH.P.17	Communications Equipment	DHS	Medium	2	0	0	-1	1	0	1	0	0	1	0
MH.P.18	Facility Improvements	DHS	High	6	0	1	0	1	1	1	1	0	1	0
MH.P.19	Facility Retrofit	DHS	Medium	4	1	1	-1	1	0	1	1	0	0	0
MH.P.20	Power Redundancy	DHS	Medium	1	0	0	-1	1	1	-1	0	0	1	0
MH.P.21	Power Redundancy	DHS	Low	0	0	0	-1	1	1	-1	0	-1	1	0
MH.P.22	Property Protection	DHS	Medium	5	0	1	1	1	1	0	1	0	0	0
MH.P.23	Construction Code Revision	DOB	High	10	1	1	1	1	1	1	1	1	1	1
MH.P.24	Information Gathering	DOB	Medium	5	-1	0	1	1	1	1	0	0	1	1
MH.P.25	Information Gathering	DOB	Medium	5	-1	0	1	1	1	1	0	0	1	1
MH.P.26	Information Gathering	DOB	Medium	5	-1	0	1	1	1	1	0	0	1	1
MH.P.27	Stormwater Management	DOC	Medium	5	1	1	1	1	1	0	0	0	0	0
MH.P.28	Critical Equipment Redundancy	DOE	Medium	5	1	1	1	1	1	-1	1	-1	1	0

Potential Mitigation Action Prioritization Table															
					Criteria										
Index	Mitigation Action & Description	Lead Agency	Prioritization	Total	S	T	A	P	L	Ec	Ev	# of Objectives	Project Cost	Project Timeframe
MH.P.29	Facility Protection	DOE	Medium	5	1	1	1	1	1	0	0	0	0	0
MH.P.30	Green Roof Installation	DOE	Medium	4	1	1	-1	1	1	0	1	0	0	0
MH.P.31	Infrastructure Protection	DOE	Medium	5	1	1	1	1	1	0	0	0	0	0
MH.P.32	Power Redundancy	DOE	Low	0	0	0	-1	1	1	-1	0	-1	1	0
MH.P.33	Early Warning System	DoITT	Medium	4	1	1	1	1	1	-1	1	-1	0	0
MH.P.34	Bridge Inspections	DOT	High	9	1	1	1	1	1	1	1	0	1	1
MH.P.35	Critical Facility Loss Estimation	DOT	High	8	1	1	1	1	1	1	1	0	1	0
MH.P.36	Curb Repair and Installation	DOT	Medium	5	0	1	1	1	-1	1	1	0	1	0
MH.P.37	Drainage and Surface Improvement	DOT	High	6	1	1	1	1	-1	1	1	1	0	0
MH.P.38	East River Bridges Retrofit (Construction)	DOT	Medium	2	1	1	1	1	-1	-1	0	0	-1	1
MH.P.39	Information Update	DOT	High	6	0	1	1	1	1	1	-1	0	1	1
MH.P.40	Infrastructure Protection	DOT	High	7	1	1	1	1	1	1	0	0	0	1
MH.P.41	Critical Infrastructure Relocation	EDC	High	8	1	1	1	1	1	1	1	0	1	0
MH.P.42	Green Roof Installation	EDC	Medium	5	1	1	-1	1	1	0	1	1	0	0
MH.P.43	Back up Water Main System	FDNY	Medium	4	1	1	-1	1	1	0	1	0	0	0
MH.P.44	Public Awareness	HPD	High	7	1	1	-1	1	1	1	1	0	1	1
MH.P.45	Critical Facility Protection	HRA	High	7	1	1	1	1	1	1	1	0	0	0
MH.P.46	Explore Loss Reduction Actions	LPC	High	7	1	1	1	1	1	1	1	0	0	0
MH.P.47	Public Education and Outreach	LPC	High	7	1	1	1	1	1	1	0	1	0	0
MH.P.48	Technical Assistance	LPC	High	7	1	1	1	1	1	1	1	0	0	0
MH.P.49	Far Rockaway Depot Green Roof	MTA (Bus)	High	9	1	1	1	1	1	1	1	0	1	1

Potential Mitigation Action Prioritization Table														
					Criteria									
Index	**Mitigation Action & Description**	**Lead Agency**	**Prioritization**	**Total**	**S**	**T**	**A**	**P**	**L**	**Ec**	**Ev**	**# of Objectives**	**Project Cost**	**Project Timeframe**
MH.P.50	Advanced Warning	NWS	Medium	3	1	1	1	1	-1	-1	1	-1	0	1
MH.P.51	Dopler Radar Upgrade	NWS	Medium	3	1	1	-1	1	1	-1	1	-1	0	1
MH.P.52	Grounds, Pavements, and Drainage	NYCHA	High	7	1	1	1	1	-1	1	1	0	1	1
MH.P.53	Facility Protection	NYPD	High	6	1	1	1	1	1	0	1	0	0	0
MH.P.54	Facility Protection	NYPD	Medium	5	1	1	1	1	1	0	0	0	0	0
MH.P.55	Facility Protection	NYPD	High	6	1	1	1	1	1	0	1	0	0	0
MH.P.56	Advance Warning System Integration	OEM	Low	0	1	1	-1	1	-1	-1	1	-1	0	0
MH.P.57	Critical Facility Protection	OEM	Medium	5	1	1	1	0	1	0	1	0	0	0
MH.P.58	Educational Outreach	OEM	High	7	1	1	1	1	1	0	1	1	0	0
MH.P.59	Facility Protection	OEM	Medium	4	1	1	-1	1	1	0	1	0	0	0
MH.P.60	Facility Protection	OEM	High	7	1	1	-1	1	1	1	1	0	1	1
MH.P.61	HAZUS-MH Update	OEM	High	7	0	1	1	1	1	1	1	0	0	1
MH.P.62	Incorporate Hazard Mitigation into CERT curriculum	OEM	High	8	1	1	1	1	1	1	0	1	1	0
MH.P.63	Infrastructure Systems Modeling	OEM	High	6	1	1	1	1	1	0	0	0	0	1
MH.P.64	Loss Estimation Assistance	OEM	Medium	2	-1	0	1	1	1	0	0	0	0	0
MH.P.65	Natural Hazard Event Database	OEM	Medium	3	-1	0	1	1	1	1	0	0	0	0
MH.P.66	Partner with Community Groups	OEM	High	7	0	1	1	1	1	1	0	1	1	0
MH.P.67	Public Outreach	OEM	High	6	1	1	1	1	1	0	0	0	0	1
MH.P.68	Public/Private Mitigation Initiatives	OEM	High	6	1	1	1	1	1	0	0	1	0	0
MH.P.69	Regional Critical Infrastructure Mapping	OEM	Medium	1	-1	0	-1	1	1	0	0	0	0	1

Potential Mitigation Action Prioritization Table															
					Criteria										
Index	Mitigation Action & Description	Lead Agency	Prioritization	Total	S	T	A	P	L	Ec	Ev	# of Objectives	Project Cost	Project Timeframe
MH.P.70	Subway Depths Mapping other natural hazards	OEM	Medium	3	-1	0	1	1	1	0	0	0	0	1
MH.P.71	Vegetation Data	OEM	Medium	2	-1	0	1	1	0	0	0	0	0	1
MH.P.72	Zoning for Hazard-Prone Areas	OEM	Medium	5	1	1	-1	1	0	0	1	1	0	1
MH.P.73	Warning System/Environmental Protection	PANYNJ (Aviation)	High	7	1	1	0	1	1	1	0	0	1	1
MH.P.74	Green Roof Installation	Parks	High	8	1	1	-1	1	1	1	1	1	1	1
MH.P.75	Green Streets	Parks	High	10	1	1	1	1	1	1	1	1	1	1
MH.P.76	Land Acquisition	Parks	Medium	3	1	1	-1	1	-1	-1	1	1	1	0
MH.P.77	Seawall, Pier, and Marina Structural Repairs	Parks	Medium	5	1	1	1	1	1	-1	1	-1	1	0
MH.P.78	Infrastructure Upgrade	Verizon	Medium	4	1	1	1	0	-1	1	-1	0	1	1

Table 12: Mitigation Action Prioritization Worksheet

5) Implementation and Administration

The mitigation action table identifies the following categories of information for each action that will guide New York City in the implementation and administration of the actions: description, lead and supporting agencies, timeframe, cost, funding source, and priority. It also serves to coordinate the various agencies involved to avoid duplicating or conflicting efforts. The mitigation strategy tables contain a wide variety of prioritized actions that mitigate the effects of natural hazards on the population, economy, and property of New York City. Implementation of certain mitigation actions in this strategy can take as little as three months while some may take more than 50 years. Actions range from a $25,000 training program to a $20.5 billion tunnel project. The implementation strategy for existing and potential actions is located in Table 4 and Table 5, respectively. The table below explains the columns in the Implementation Strategy Table.

Implementation Key	
Column Header	**Description**
Mitigation Action & Description	Contains the title and description of the action.
Lead Agency	Lists the agency that has primary jurisdiction over the mitigation action. The listed agency will be the primary point of contact for the mitigation action.
Supporting Agency	Lists supporting entities that will assist in the implementation, funding, or maintenance of the mitigation action.
Project Timeframe/Duration	Estimates when the project will begin and approximately how long it will take to complete. "Ongoing" refers to actions that are either underway or have no definitive end date.
Estimated Project Cost	Estimates costs associated with implementing each mitigation action.
Possible Funding Source(s)	Identifies possible sources of funding including capital funding, grants, bonds, and other types of funding.
FEMA Category	Identifies the associated FEMA mitigation action category (Prevention, Property Protection, Public Education and Awareness, Natural Resource Protection, Emergency Services, and Structural Projects).
Goals and Objectives	Identifies the hazard mitigation goals and objectives addressed by the mitigation action.
Priority	Lists the results of the mitigation action prioritization.

Table 13: Implementation Key

a) Capability Assessment

New York City, through its various agencies and departments, has local policies, regulations, funding, and practices currently in place that will help facilitate this natural hazard mitigation strategy. These mechanisms include:

- Building and construction codes
- Floodplain management plans
- Land use plans
- Local laws and ordinances
- Master and comprehensive plans
- Zoning and land use regulations

The Steering Committee and Planning Team developed the following table to assess New York City current capabilities to implement mitigation actions. It contains the classification, agency responsible, and a description for each initiative or capability. In addition to OEM's hazard mitigation planning program, as outlined in the Plan Maintenance section of this plan, the following planning mechanisms will serve to implement many of the actions described in this section.

New York City Capability Assessment		
Capability	**Agency**	**Description**
Planning Mechanisms		
Capital Improvement or Development Plan – *Drainage Plan for Areas Lacking Sewers*	DEP	The Bureau of Water and Sewer Operations (BWSO) drainage plans are developed to provide adequate storm and sanitary infrastructure for areas of the City lacking a fully built-out sewer system. Build out is concentrated in populated areas lacking existing infrastructure and where improvements or a need is identified.
Capital Improvement or Development Plan – *Trunk Water Main Master Plans*	DEP	BWSO creates plans depicting water mains that will provide adequate water supply and fire protection for existing and future development.
Capital Improvement or Development Plan – *Agency Capital Budget*	DEP	DEP currently has a $19.7B capital improvement plan to upgrade and bring the water and wastewater infrastructure into a state of good repair.
Capital Improvement or Development Plan – *Capital Projects*	DEP	The Bureau of Water Supply (BWS) maintains a 600+ line master list spreadsheet of capital and filtration avoidance determination projects; works with the BWS Directorates to develop project scope and cost estimates, obtain funding and registration; and works with IDC and Bureau of Engineering Design and Construction to commence design and construction work effort.
Capital Improvement or Development Plan – *Parks Department Capital Improvement Plan*	Parks	The Capital Projects division is responsible for capital improvements and reconstruction of playgrounds, structures, and parkland. The division currently has over $1 billion in active restoration contracts underway. The Operations division assists with drafting of maintenance and operational agreements for new park developments such as the Highline.

New York City Capability Assessment		
Capability	**Agency**	**Description**
Land Use Plan – *DCP-Initiated Rezoning*	DCP	DCP is responsible for zoning amendments that change the applicable use, bulk, and density regulations for a location or area. Since 2002, DCP has sponsored 80 individual area-wide rezoning projects that are adopted into law, covering approximately 1/6 of the City. All re-zonings are required to pass through City Environmental Quality Review (CEQR) environmental review. Many of the re-zonings incorporate additional provisions for waterfront access and green space.
Land Use Plan – *Parks Department Parkland Plan*	Parks	The Planning Division coordinates specific plans for new uses of parkland and for remediation of environmental damage.
Local Waterfront Revitalization Plans – *Consistency Review*	DCP	Local discretionary actions, including those subject to land use (ULURP), environmental (CEQR) and Board of Standards and Appeals (BSA) review procedures, are reviewed for consistency with the New York City Waterfront Revitalization Program policies.
Local Waterfront Revitalization Plans – *Waterfront Parking and Recreational Areas*	Parks	The Planning Division coordinates new uses of waterfront areas and remediation of past environmental damage. The Operations Unit assists with the drafting of operational agreements and oversees municipal marinas such as the 79th Street Boat Basin and World's Fair Marina.
Local Emergency Plans – *Drought Operations Plan*	DEP	During drought, the BWSO procedures are modified to maximize different water sources, prioritize leak detection programs that minimize water losses, and review hydrant-locking procedures to ensure areas with illegal hydrant use are compliant with the water-use restrictions.
Master/Comprehensive Plan – *PlaNYC*	OLTPS	PlaNYC is the city's long-term, comprehensive sustainability plan that focuses on improving the city's environment while accommodating an increase in population of almost one million people by 2030.

New York City Capability Assessment		
Capability	**Agency**	**Description**
Other Hazard Mitigation Plan – *Downstream Flooding Reduction Program*	DEP	BWS provides for the reduction of downstream flooding through attenuation of runoff by lowering reservoir elevation at a controlled rate in anticipation of forecasted storms and snow pack melting.
Other Hazard Mitigation Plan – *Reservoir Release Notification Plan*	DEP	BWS provides notification of reservoir releases/spilling rates at predefined levels to all downstream counties' emergency management officials.
Other Hazard Mitigation Plan – *Coastal Storm Plan*	OEM	The Coastal Storm Plan describes the citywide efforts before, during, and after a coastal storm event, particularly a hurricane. The plan contains components relating to decisions-making, sheltering, advance warning systems, logistics, public information, debris management, and post-disaster reconstruction.
Other Hazard Mitigation Plan – *Flash Flood Plan*	OEM	The Flash Flood Plan contains detailed procedures to mitigate the effects of a flash flood event on people and property and guides agency stakeholders through the decisions and actions that will be required before, during, and after such an event.
Other Hazard Mitigation Plan – *Heat Emergency Plan*	OEM	The Heat Plan contains detailed procedures to mitigate the effects of extreme heat conditions on critical infrastructure, at-risk populations, and New York City operations. The contents of the plan guide New York City stakeholders (including city and state agencies, the private sector, non-profits and volunteer organizations) through the complex decisions that may be necessary during a heat emergency.
Policies/Ordinances/Regulations		
Codes Building Site/Design – *PlaNYC Green Building Task Force*	OLTPS	OLTPS will lead a task force that will develop amendments to the City's building code to incorporate climate change impacts.
Codes Building Site/Design Policies/Ordinances – *New York City Construction Codes*	DOB	The New York City Construction Codes enhances safety and encourages efficiency, cost savings and sustainable building. The Construction Codes enhance fire protection, construction safety and structural integrity in new buildings.
Land Use Regulations – *Recreational Land Use Regulations*	DEP	BWS maintains regulations for the public recreational use of New York City-owned lands and waters.

New York City Capability Assessment		
Capability	**Agency**	**Description**
Land Use – *City Environmental Quality Review*	Office of Environmental Coordination	CEQR identifies any potential adverse environmental effects of proposed actions, assesses their significance, and proposes measures to eliminate or mitigate significant impacts. Only certain minor actions identified by the state, known as Type II actions, are exempt from environmental review.
Property Set-Back Ordinance – *Wildland-Urban Interface*	DEP	BWSO enforces a 25-foot setback around vegetated areas where possible to help mitigate potential for wildfire in the Staten Island Bluebelt.
Site Plan Review Requirements – *Site Connection Applications for New Developments*	DEP	BWS issues certifications indicating the ability of existing sewers to accommodate increase usage to all new development projects. Certification is needed before a construction permit is issued.
Site Plan Review Requirements – *City Planning Commission Discretionary Review*	DCP	In cases where discretionary action by the City Planning Commission is necessary, various Borough and Technical staff reviews site plan applications for consistency with sound planning policy, environmental reviews consistent with CEQR guidelines, and any other relevant findings as applicable.
Site Plan Review Requirements – *Parks Department Site Plan Review*	Parks	The Forestry Division reviews site plans for capital work and ensures that all trees and horticulture are protected. Parks also reviews any work that might affect street trees and governs the removal or planting of any public tree in New York City.
Site Plan Review Requirements – *Site Plan Review*	DOB	DOB possesses an extensive plan review system to ensure lawful compliance with the City's Building Code, Electrical Code, Zoning Resolution, New York State Labor Law, and New York State Multiple Dwelling Law. Any person seeking a permit must meet with a plan examiner.
Steep Slope Ordinances – *Hillsides Preservation Districts; Special Natural Area Districts*	DCP	The City Planning Commission reviews site plans to maximize protection of natural areas, including the goals of "reducing hillside erosion, landslides and excessive storm water runoff associated with development. This is accomplished through conserving vegetation and protecting natural terrain.

New York City Capability Assessment		
Capability	**Agency**	**Description**
Storm Water Ordinances – *New York City Storm Water Regulations*	DEP	DEP is responsible for providing adequate draining services to the City. DEP also governs the construction of private sewers and drains to ensure compliance and adequate drainage capabilities.
Watershed Ordinance – *Watershed Rules and Regulations*	DEP	DEP enforces and develops regulations to protect New York City's reservoirs from contamination from human activity and storm water.
Zoning/Land Use Restrictions – *Zoning Resolution*	DCP	The Zoning Resolution sets forth the regulations governing land use and development. Articles I through VII contain the use, bulk, parking, and other applicable regulations for each zoning district.
Programs		
Anticipate Future Vulnerabilities and Needs – *DEP Long-term and Strategic Planning*	DEP	The Long-term and Strategic Plan assess and communicates DEP's long term and strategic goals, vulnerabilities and opportunities for management of the water supply system for optimal dependability/reliability.
Capital Improvement Program – *Sewer Construction*	DEP	DEP maps and studies flood prone areas to create a comprehensive plan for sewer upgrades.
Floodplain Maps/Flood Insurance Studies – *NFIP Compliance*	DOB	As part of the NFIP, New York City has adopted floodplain maps developed by FEMA.
Hazard Awareness Program – *Annual Right to Know and Hazardous Communication*	DEP	DEP conducts annual Right to Know and Hazard Awareness Communications with its employees and submits SARA III reports which informs the public of any hazardous and toxic chemicals at DEP facilities.
Hazard Awareness Program – *Ready New York*	OEM	OEM collaborates with City agencies to distribute Ready New York brochures at numerous occasions throughout the City.

New York City Capability Assessment		
Capability	**Agency**	**Description**
Local Waterfront Revitalization – *New York City Waterfront Revitalization Program*	DCP	The New York City Waterfront Revitalization Program is the city's principal coastal zone management tool. It establishes the City's policies for development and use of the waterfront and provides the framework for evaluating the consistency of all discretionary actions in the coastal zone with those policies.
NFIP – *Participation and Enforcement*	DOB	To maintain compliance with the program, flood zone building requirements are incorporated into the building code. DOB enforces these requirements to ensure that all new construction and significant alterations within flood zones are built in accordance with the flood zone design regulations.
Planning/Zoning Boards – *New York City Planning Commission*	DCP	The City Planning Commission is responsible for the conduct of planning relating to the orderly growth and development of the City, including adequate and appropriate resources for the housing, business, industry, transportation, distribution, recreation, culture, comfort, convenience, health and welfare of its population. The Commission meets regularly to hold hearings and vote on applications concerning the use, development and improvement of real property subject to City regulation.
Planning Programs Department – *Citywide Planning*	DCP	DCP serves as the lead agency on citywide planning initiatives.
Property Acquisition Programs – *Wetland Acquisition*	DEP	The Bureau of Water and Sewer Operations oversees Bluebelt property acquisition in Staten Island.
Property Acquisition Programs – *Parkland Conversion*	Parks	The Parklands division works with DCAS' real estate division to acquire a limited number of properties in the city for conversion to parkland.

New York City Capability Assessment		
Capability	**Agency**	**Description**
Public Education/Awareness Programs – *Recreation and Education Programming*	Parks	The Recreation Division runs 34 recreation centers and provides extensive recreation and education programming. The Urban Park Rangers provide classroom and on-site environmental programming and operate ten Nature Centers. The Operations division runs educational programs promoting the use of marinas and waterfront. Parks is also associated with non-profit partners such as the City Parks Foundation and Historic House Trust. These partners augment Parks' educational and cultural offerings.
Site Plan Review Program – *Discretionary Review of Jamaica Rezoning*	DEP	DEP reviews all site plans in the Downtown Jamaica Rezoning Area before a building permit is issued from DOB. DEP's review ensures that the existing sewer surcharge conditions are not exacerbated by the proposed project.
Site Plan Review Program – *City Planning Commission Discretionary Review*	DCP	The borough offices and technical staff review site plan applications for consistency with sound planning policy, environmental reviews consistent with CEQR guidelines, in cases where discretionary action by the City Planning Commission is necessary.
Site Plan Review Program – *Tree and Horticulture Protection*	Parks	The Forestry division reviews site plans citywide for capital work and ensures that all trees and horticulture are protected. The Capital division reviews plans for projects in parks to ensure the protection of trees and horticulture.
Storm Drainage Systems Maintenance Program – *Sanitary, Storm, and Combined Sewer Maintenance and Programmatic Catch Basin Inspection and Cleaning*	DEP	DEP's Bureau of Water & Sewer Operations is responsible for the maintenance of sanitary, storm and combined sewers. DEP inspects and cleans the city's 140,000 catch basins on a three-year cycle. The agency makes repairs to the sewer system as needed.
Storm Drainage Systems Maintenance Program – *City Park Drainage Maintenance*	Parks	The Central Technical Services Division and Borough Shops maintain catch basins and storm drains in all the city parks.
Stream Maintenance Program – *Bronx River Natural Resources Group*	Parks	The Natural Resources Group in conjunction with the Bronx River Alliance, an associated non-profit maintains and cleans rivers, other wetlands, and riparian areas in the city.

New York City Capability Assessment		
Capability	**Agency**	**Description**
Stream Maintenance Program – *Bluebelt Watersheds Stream Maintenance*	DEP	DEP maintains stream-bank stabilization and removes obstructions from Streams and Wetlands in the Staten Island Bluebelt.
Stream Maintenance Program – *Stream Rehabilitation and Stabilization Program*	DEP	DEP rehabilitates and stabilizes stream banks to mitigate turbidity as part of its filtration avoidance determination obligations, in New York City watershed areas.
Vegetation Maintenance Program – *Tree Pruning Program*	Parks	The Central Forestry division oversees the block pruning and commitment-pruning program. Block pruning is done by contractors on a 7-8 year schedule and involves pruning of all street trees on a block. Commitment pruning addresses emergency issues, such as tree limbs obscuring traffic signals. Parks also performs in-park pruning of trees.
Studies/Reports		
Floodplain Maps/Flood Insurance Studies – *Revision*	OLTPS	OLTPS is leading an interagency effort to work with FEMA to revise the Flood Insurance Rate Maps.
Hydrological/Hydraulic Studies – *Reservoir Basin Hydrologic/Hydraulic Study*	DEP	DEP conducts H&H studies to confirm probable maximum precipitation and probable maximum flood for reservoir basins.
Hydrological/Hydraulic Studies – *High Hazard Dams*	DEP	BWS maintains studies of its high hazard dams and dikes.
Hydrological/Hydraulic Studies – *Hydraulic Analyses of Problem Areas*	DEP	DEP performs hydraulic analyses of sewer systems in areas experiencing sewer problems determine the need for and scope of future capital projects. These studies often occur before a drainage plan is developed and guide the determination of where improvements will be focused.
Hydrological/Hydraulic Studies – *SLOSH Study*	OEM	OEM performs SLOSH modeling for New York City to determine what areas would be inundated in a coastal storm. These models guide planning and evacuation operations as outlined in the Coastal Storm Plan.

Table 14: Existing Planning Mechanisms for Hazard Mitigation

6) Bibliography

Federal Emergency Management Agency, *State and Local Mitigation Planning How-to-Guide, Developing the Mitigation Plan: Identifying Mitigation Actions and Implementation Strategies,* FEMA 386-3 (2003).

Federal Emergency Management Agency, *State and Local Mitigation Planning How-to-Guide, Using Benefit-Cost Review in Mitigation Planning,* FEMA 386-5 (2007).

New York State Disaster Preparedness Commission, *New York State Standard Multi-Hazard Mitigation Plan, 2008,* http://www.semo.state.ny.us/programs/planning/hazmitplan.cf (last accessed Aug. 7, 2008).

7) List of Figures

8) List of Tables

Section V: Plan Maintenance

1) Introduction

The Plan Maintenance section of New York City's 2009 Hazard Mitigation Plan (HMP) describes the formal process that will ensure the Plan remains an effective and relevant document. This section establishes the method and schedule for monitoring, evaluating, and updating the HMP during a five-year plan-update cycle. It also establishes how New York City will maintain community involvement in the Plan.

a) Plan Maintenance Approach

- Incorporate hazard mitigation actions into existing planning mechanisms.
- Determine how mitigation projects and actions will be monitored.
- Establish indicators of effectiveness or success.
- Develop an evaluation and revision schedule to ensure the Plan is up-to-date at the end of the five-year cycle.
- Establish a process for public input and community involvement during the planning cycle.

b) FEMA Requirements Addressed in this Section

The New York City Office of Emergency Management Hazard Mitigation Planning Team (Planning Team) created the plan maintenance strategy consistent with the process and steps presented in the Federal Emergency Management Agency's (FEMA) How-To-Guide: Bringing the Plan to Life (FEMA 386-4). The following FEMA requirements are addressed in this section:

- **Requirement §201.6(c)(4)(i):** [The plan maintenance process ***shall*** include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.

- **Requirement §201.6(c)(4)(ii):** [The plan ***shall*** include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, where appropriate.

- **Requirement §201.6(c)(4)(iii):** [The plan maintenance process ***shall*** include a] discussion on how the community will continue public participation in the plan maintenance process.

2) Monitoring

As the lead agency for the 2009 New York City HMP, the New York City Office of Emergency Management (OEM) will monitor the implementation of mitigation actions identified in the Plan. To facilitate plan maintenance, OEM will appoint a staff member to serve as New York City's Hazard Mitigation Coordinator (HMC). This staff member will be the point of contact for hazard mitigation-related issues and serve as the lead coordinator on the plan update. OEM will also maintain adequate mitigation planning staff to support the HMC in monitoring and evaluating the Plan. During the five-year planning cycle, the HMC will undertake the following initiatives:

- Collect annual reports from the agencies involved in implementing mitigation projects or activities identified in the Mitigation Strategy section of this Plan.
- Maintain and update the mitigation action table.
- Conduct site visits and obtain reports of completed or initiated mitigation actions to incorporate in the plan revision as needed.
- Research and document new natural disaster information pertaining to New York City during the planning cycle and incorporate into a revised Risk Assessment section as needed.
- Organize annual meetings with the Mitigation Planning Council Steering Committee (Steering Committee) to discuss relevant hazard mitigation issues, provide status updates, and discuss available grant opportunities.
- Organize biannual meetings with Mitigation Planning Council (MPC) members to discuss relevant hazard mitigation issues, provide status updates, and discuss available grant opportunities.
- Coordinate, compile, and disseminate hazard mitigation funding information and applications.
- Convene a meeting of the Steering Committee following a natural disaster or when funding is announced to prioritize and submit potential mitigation actions for funding.

The above activities outline plan maintenance during the four years leading up to the fifth year of the planning cycle (2009–2013). Beginning in March 2013, the HMC will lead a more intensive planning effort and reconvene the Planning Team to ensure New York City has an updated HMP by the end of 2013. The HMC will be responsible for compiling, documenting, and incorporating all changes derived from the activities listed above into a revised plan document.

3) Evaluation

The New York City HMP will be evaluated annually to determine the effectiveness of its projects, programs, and policies. The HMC will be responsible for scheduling and organizing the MPC and Steering Committee meetings, collecting, analyzing and incorporating annual reports, and providing revised drafts to the MPC. Each year, the HMC and Steering Committee members will assess the current version of the Plan and determine the improvements necessary for the plan update. The HMC will evaluate the Steering Committee to determine if other agencies should be added.

A thorough examination of the Plan will take place during the fifth year of the process to ensure New York City has an updated HMP at the end of the planning cycle. The MPC will review the goals and action items to determine their relevance to changing situations in the City, as well as changes in state or federal policy, and to ensure they are addressing current and expected conditions. The Steering Committee will look at any changes in City resources that may influence the plan implementation (such as funding) and program changes to determine need for reassignment. The Steering Committee will review the all portions of the Plan to determine if this information should be updated or modified, given any new available data. The Steering Committee will evaluate the content of the Plan using the following criteria:

- Are the mitigation actions effective?
- Are there any changes in land development that affect mitigation priorities?
- Do the goals, objectives, and action items meet social, technical, administrative, political, legal, economic, and environmental criteria as defined in FEMA's STAPLEE analysis?
- Are the goals, objectives, and mitigation actions relevant given any changes in New York City?
- Are the goals, objectives, and mitigation actions relevant given any changes to state or federal regulations or policy?
- Is there any new data that affects the Risk Assessment portion of the Plan?

4) Update

The Planning Team will update the HMP every five years to reflect the results of the annual reports and on-going plan evaluation by the HMC. Throughout the planning cycle, the HMC will compile new information and incorporate it into the Plan. The HMC will also assess and incorporate recommended comments expressed by FEMA in the initial review into the plan revision. At the end of the planning cycle, the Planning Team will submit the updated Plan to the State Emergency Management Office (NYSEMO) and FEMA for review. After FEMA has approved New York City's 2014 HMP, the City will again formally adopt the Plan by Executive Order. The following table is an outline of how the Plan will be updated after the 2009 FEMA-approval:

Plan Update Schedule		
Timeframe	**Participants**	**Outcome**
First Quarter 2010	Steering Committee, HMC	• Reconvene Steering Committee to discuss mitigation action progress and possible plan improvements.
First quarter 2011	MPC, HMC	• Reconvene MPC to discuss progress on mitigation actions.
Second quarter 2011	OEM	• Apply for plan update grant funding.
First quarter 2012	Steering Committee, HMC	• Reconvene Steering Committee to discuss mitigation action progress and discuss possible plan improvements.
Second quarter 2013	Steering Committee, MPC, Planning Team	• Reconvene Planning Team and begin plan update. • Coordinate monthly meetings with Steering Committee. • Reconvene MPC and schedule one-on-ones as required.
Fourth quarter 2013	NYSEMO, Planning Team	• Submit draft plan update to NYSEMO for review and comments.
First quarter 2014	FEMA, Planning Team	• Submit plan to FEMA for final approval.
First quarter 2014	New York City	• Re-adopt the FEMA-approved HMP.

Table 1: Plan Update Schedule

5) Incorporation into Existing Planning Mechanisms

As part of the local capability assessment conducted during the planning process, the Planning Team and Steering Committee identified current plans, programs, policies/ordinances, and studies/reports that will augment or help support mitigation planning efforts. The Steering Committee, which will meet on an annual basis, will be the mechanism for ensuring the City integrates hazard mitigation into its future planning activities. The New York City capability assessment is located in the Mitigation Strategy Section. Following the HMP approval and adoption, the Steering Committee will work to incorporate, where applicable, the HMP into the planning mechanisms identified in Table 14 of Section 4: Mitigation Strategy.

Throughout the plan maintenance cycle, the Planning Team will work to integrate hazard mitigation goals and actions into the general operations of New York City agencies. The Planning Team will work with agencies to identify opportunities as outlined below:

- Update work plans, policies, or procedures to include hazard mitigation concepts.
- Establish mitigation funding within capital and operational budgets.
- Issue plans, policies, executive orders, regulations, or other directives to carry out mitigation actions.
- Add hazard mitigation elements to redevelopment plans.

6) Continued Public Involvement

New York City is dedicated to continued public involvement in the hazard mitigation planning and review process. During all phases of plan maintenance, the public will have the opportunity to provide feedback. The 2009 Plan will be maintained and available for review on the OEM website through 2013. Individuals will have an opportunity to submit comments for the Plan update at any time by email. The HMC will compile all comments and present them at the annual Steering Committee meetings where members will consider them for incorporation into the revision. To help publicize the revised plan, six months prior to the submission of the 2014 Plan update, OEM will post a notice on its website requesting feedback on an updated draft HMP. The Planning Team will hold community involvement meetings with representatives from academic institutions, the private sector, community groups, and neighboring jurisdictions. Finally, OEM will send a notice to Citizen Corps members, informing them of the Plan update. This will provide the public an opportunity to express their concerns, opinions, or ideas about any updates/changes that are proposed to the Plan.

7) List of Tables

Section VI: Plan Adoption

1) Overview

Formal plan adoption is a required part of the planning process and demonstrates New York City's commitment to fulfilling the mitigation goals and objectives outlined in the Plan. In addition to fulfilling the requirements of the Disaster Mitigation Act of 2000, the Mayoral adoption of the Hazard Mitigation Plan (HMP) establishes it as a policy for New York City that defines the actions agencies should take to comply with or implement the HMP.

a) Plan Adoption Process

- Obtain "Approval Pending Adoption" status from FEMA.
- Draft an adoption resolution to meet plan requirements and demonstrate New York City's commitment to protect its residents and built environment from the effects of natural hazards.
- Adopt HMP through Mayoral Executive Order.

b) FEMA Requirements Addressed in this Section

The OEM Hazard Mitigation Planning Team created a plan adoption strategy consistent with the process and steps presented in FEMA's How-To-Guide: Bringing the Plan to Life (FEMA 386-4). This section satisfies the following FEMA requirement:

- **Requirement §201.6(c)(5):** [The local hazard mitigation plan ***shall*** include] documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan.

2) Local Adoption Resolution

THE CITY OF NEW YORK
OFFICE OF THE MAYOR
NEW YORK, N.Y. 10007

EXECUTIVE ORDER No. 126

NEW YORK CITY HAZARD MITIGATION PLAN

March 4, 2009

WHEREAS, the Disaster Mitigation Act of 2000, Public Law 106-390, was enacted to establish a national disaster hazard mitigation program to reduce the loss of life and property, human suffering, economic disruption, and disaster assistance costs resulting from natural disasters, and to assist state, local and Indian tribal governments in implementing effective hazard mitigation measures designed to ensure the continuation of critical services and facilities after a natural disaster; and

WHEREAS, the Disaster Mitigation Act requires such governments to develop hazard mitigation plans to identify the natural hazards that could impact their jurisdictions, identify actions and activities to mitigate the effects of those hazards, and establish a coordinated process to implement such plans; and

WHEREAS, the City of New York (the "City") has been and continues to be committed to reducing the loss of life and property, alleviating human suffering and economic disruption, and controlling disaster assistance costs resulting from natural hazards and accelerating the City's recovery after the occurrence of any such hazard; and

WHEREAS, the New York City Office of Emergency Management ("OEM"), in coordination with governmental and non-governmental stakeholders having an interest in reducing the impact of natural hazards throughout the City and with input from the private sector and other members of the public, developed the Natural Hazard Mitigation Plan for the City of New York, which identifies natural hazards that have the potential to occur in the City and establishes mitigation strategies to address these hazards; and

WHEREAS, such Natural Hazard Mitigation Plan has been approved by the Federal Emergency Management Agency ("FEMA") subject to adoption by the City;

NOW, THEREFORE, by the power vested in me as the Mayor of the City of New York, it is hereby ordered:

Section 1. The Natural Hazard Mitigation Plan developed by OEM and approved by FEMA is hereby adopted as the City's hazard mitigation plan pursuant to the Disaster Mitigation Act.

§ 2. OEM shall be the agency responsible for monitoring, evaluating and updating the Natural Hazard Mitigation Plan in accordance with the Disaster Mitigation Act.

§ 3. All agencies shall provide such assistance and cooperation as may be necessary or appropriate to implement the provisions of the Natural Hazard Mitigation Plan and carry out the City's responsibilities under the Disaster Mitigation Act.

§ 4. This Order shall take effect immediately.

Michael R. Bloomberg
Mayor

3) NYSEMO Approval Letter

New York State Emergency Management Office
1220 Washington Avenue
Building 22, Suite 101
Albany, NY 12226-2251

David A. Paterson, Governor

John R. Gibb, Director

March 17th, 2009

Commissioner Joseph Bruno
NYC Office of Emergency Management
165 Cadman Plaza East
Brooklyn, NY 11201

Re: HMGP-1391
NYC Multi-Hazard Mitigation Plan Approval

Dear Commissioner Bruno:

The New York State Emergency Management Office (SEMO) is pleased to inform you that the Federal Emergency Management Agency (FEMA) has officially approved the New York City Multi-Hazard Mitigation Plan. FEMA has officially recognized the adoption and approval of the plan as March 12, 2009. This approval date starts the time clock for the five-year update which will be required by March 12, 2014. To summarize:

- Approved Pending Adoption: 1/16/09
- Final Approval of the Plan: 3/12/09
- Five-Year Update Required by: 3/12/14

Please use this timeframe to plan accordingly when taking into account any monitoring, evaluating, and updating of the Plan and planning process that the City has committed to. The returned "Planning Crosswalk" can be used as a reference document when monitoring and updating of the plan.

Approval of the plan ensures that the City of New York will be eligible for the next five years to apply for FEMA Hazard Mitigation Grants. These grant programs are Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation (PDM), Flood Mitigation Assistance (FMA), Repetitive Flood Claims (PFC), and Severe Repetitive Loss (SRL). We strongly encourage the City to consider applying for these grants as they become available.

Please contact Mr. John Fishbein at 518-292-2459 or me at 518-292-2370, respectively, if you or your staff have questions or need additional information. Congratulations to you and your team.

Sincerely,

Richard Lord

Richard M. Lord
Chief of Mitigation Programs
and Agency Preservation Officer

W/ Enclosures
cc: Deputy Commissioner Kelly McKinney
Director Amy Schultz

State Emergency
Coordination Center: (518) 292-2200 Fax: (518) 322-4978 Executive Offices: (518) 292-2222

4) FEMA Approval Letter

U.S. Department of Homeland Security
Region II
Jacob K. Javits Federal Office Building
26 Federal Plaza, Room 1311
New York, New York 10278-0002

FEMA

March 13, 2009

Mr. John R. Gibb
Executive Director
New York State Emergency Management Office
Building 22, Suite 101
1220 Washington Avenue
Albany, NY 12226-2251

Re: Approval of the City of New York, New York Local Hazard Mitigation Plan
FEMA Funding: HMGP 1391

Dear Mr. Gibb:

I am pleased to inform you that the Federal Emergency Management Agency (FEMA) formally approves the City of New York's Hazard Mitigation Plan. The plan was officially adopted by a resolution received by this office on March 12, 2009. FEMA's approval of the plan will be for a period of five years from this date (March 12, 2014).

FEMA Region II concluded its review of the referenced plan in conformance with Title 44 Code of Federal Regulations (CFR) Part 201, *Mitigation Planning* and using FEMA's *Multi-Hazard Mitigation Planning Guidance,* the official guidance to develop and review new and updated mitigation plans to meet the requirements of 44 CFR 201. The Local Hazard Mitigation Plan Review Crosswalk (dated January 16, 2009) documents the Region's review.

The approval of this plan ensures the jurisdiction's eligibility for the next five years for project grants under FEMA's hazard mitigation assistance programs, including Hazard Mitigation Grant Program, Pre-Disaster Mitigation, Flood Mitigation Assistance and Severe Repetitive Loss grant programs. All requests for funding, however, will be evaluated individually according to the specific eligibility and other requirements of the particular program under which applications are submitted.

Please advise the jurisdiction of this approval. Note that we have already received a final electronic copy of the entire plan for our national electronic repository.

www.fema.gov • PH: (212) 680-3600

Mr. John R. Gibb
March 13, 2009
Page 2 of 2

Please refer to the referenced crosswalk for assistance in maintaining and updating this plan. If you have any questions, please contact Scott Duell, Risk Analysis Branch Chief, at (212) 680-3630.

Sincerely,

Scott V. Duell for

Michael J. Dabney, Director
Federal Insurance and Mitigation Division

Cc: Richard Lord, NY State Hazard Mitigation Officer,
NY State Emergency Management Office

www.fema.gov • PH: (212) 680-3600

Appendix A

Acronym List

Acronym List	
Acronym	**Definition**
ARA	Applied Research Associates
ARC	American Red Cross
B&T	Metropolitan Transportation Authority Bridges and Tunnels
BCA	Benefic-Cost Analysis
BFE	Base Flood Elevation
BMP	Best Management Practices
BSA	Board of Standards and Appeals
BWS	New York City Department of Environmental Protection-Bureau of Water Supply
BWSO	New York City Department of Environmental Protection-Bureau of Water and Sewer Operations
CAU	New York City Community Affairs Unit
CCC	New York City Citizen Corps Council
CD	Community Districts
CEHA	Coastal Erosion Hazard Area
CEQR	City Environmental Quality Review
CERT	Community Emergency Response Team
CHIP	Consolidated Highway Improvement Program
CIMS	Citywide Incident Management Systems
CITF	Critical Infrastructure Task Force
Con - Ed	Consolidated Edison
COOP	Continuity of Operations
CPC	New York City Planning Commission
CSO	Combined Sewage Overflow
CSP	Coastal Storm Plan
DASNY	Dormitory Authority of the State of New York
DCAS	New York City Department of Citywide Administrative Services
DCAS-DFMC	New York City Department of Citywide Administration-Division of Facilities and Management Construction (DCAS)
DCP	New York City Department of City Planning
DDC	New York City Department of Design and Construction
DEP	New York City Department of Environmental Protection
DFIRM	Digital Flood Insurance Rate Map
DFTA	New York City Department for the Aging
DHS	New York City Department of Homeless Services
DMA 2000	Disaster Mitigation Act of 2000
DMJM Harris	Daniel, Mann, Johnson, & Mendenhall Harris (Consultant)
DMP	Drainage Master Plan
DOB	New York City Department of Buildings
DOC	New York City Department of Corrections
DOE	New York City Department of Education
DOE-SCA	New York City Department of Education-School Construction Authority
DOF	New York City Department of Finance

Acronym List	
Acronym	**Definition**
DOHMH	Department of Health and Mental Hygiene
DOITT	New York City Department of Information Technology and Telecommunications
DOT	New York City Department of Transportation
DPR	New York City Department of Parks and Recreation
DR	Disaster Declaration Number
DSNY	The City of New York Department of Sanitation
EDC	New York City Economic Development Corporation
EF-Scale	Enhanced Fujita Scale
EM	Emergency Declaration Number
EMAS	Engineered Material Arresting System
EMS	Emergency Medical Services
EPA	United States Environmental Protection Agency
FAA	United States Federal Aviation Administration
FDNY	Fire Department of New York City
FEMA	United States Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FMA	Flood Mitigation Assistance
FRA	United States Federal Railroad Administration
F-Scale	Fujita Scale
ft	Feet
FTA	United States Federal Transit Administration
FY	Fiscal Year
GBS	General Building Stock
GCF	General Capital Funding
GIS	Geographic Information Systems
GMATS	Global Maritime and Transportation School
H&H	Hydrological/Hydraulic
HAZUS-MH	Hazards U.S. Multi-Hazard
HHC	New York City Health and Hospitals Corporation
HI	Heat Index
HMC	Hazard Mitigation Coordinator
HMGP	Hazard Mitigation Grant Program
HMP	New York City Hazard Mitigation Plan
HPD	New York City Housing and Preservation Development
HQ	Headquarters
HRA	New York City Human Resources Administration
IBM	International Business Machines
JFK	John Fitzgerald Kennedy Airport
LGA	Fiorello LaGuardia Airport
LIPA	Long Island Power Authority
LIRR	Metropolitan Transportation Authority Long Island Rail Road
LPC	New York City Landmarks Preservation Commission
MMI	Modified Mercalli Intensity
MNR	Metropolitan Transportation Authority Metro-North Railroad

Acronym List	
Acronym	**Definition**
MOPD	New York City Mayor's Office for People with Disabilities
MPC	Mitigation Planning Council
mph	Miles Per Hour
MTA	Metropolitan Transportation Authority
N/A	Not Applicable
NEHRP	National Earthquake Hazards Reduction Program
NESIS	Northeast Snowfall Impact Scale
NFIP	National Flood Insurance Program
NJT	New Jersey Transit
NOAA	United States National Oceanic and Atmospheric Administration
NPF	National Protective Features
NPS	National Park Service
NRE	Natural Resource Enhancement
NWS	National Weather Service
NYC	New York City
NYCEM	NYC Area Consortium for Earthquake Loss Mitigation
NYCHA	New York City Housing Authority
NYCT	Metropolitan Transportation Authority New York City Transit
NYPA	New York Power Authority
NYPD	New York Police Department
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDHCR	New York State Department of Housing and Community Renewal
NYSDOH	New York State Department of Health
NYSDOT	NYS Department of Transportation
NYSOHS	New York State Office of Homeland Security
NYSEMO	State Emergency Management Office
NYSGS	New York State Geological Survey
NYSHMP	New York State Hazard Mitigation Plan
NYSOTDA	New York State Department of Temporary and Disability Assistance
OEM	New York City Office of Emergency Management
OLTPS	New York City Office of Long-Term Planning and Sustainability
PANYNJ	Port Authority of New York and New Jersey
Parks	New York City Department of Parks & Recreation
PATH	Port Authority Trans-Hudson
PDM-C	Pre-Disaster Mitigation-Competitive
PGA	Peak Ground Acceleration
PlaNYC	PlaNYC: A Greener, Greater New York
PSC	New York State Public Service Commission
RFC	Repetitive Flood Claims
RPA	Regional Plan Association
SA	Spectral Acceleration
SBS	New York City Small Business Services
SHA	Structural Hazard Areas
SLOSH	Sea, Lake, and Overland Surges from Hurricanes

Acronym List	
Acronym	**Definition**
SRL	Severe Repetitive Loss
STAPLEE	Social, Technical, Administrative, Political, Legal, Economical , Environmental
TBD	To Be Determined
UASI	Urban Area Security Imitative
ULURP	Uniform Land Use Review Procedure
USACE	United States Army Corps of Engineers
USCDC	United States Center for Disease Control
USCG	United States Coast Guard
USDHS	United States Department of Homeland Security
USDOE	Department of Energy
USGS	United States Geological Survey
USPS	United States Postal Service
WRP	Waterfront Revitalization Program

Table 1: Acronym Table

Appendix B

Glossary

1) Glossary

Glossary	
Term	**Definition**
100-Year Flood	The term “100-year flood” can be misleading. The 100-year flood does not necessarily occur once every 100 years. Rather, it is the flood that has a 1 % chance of being equaled or exceeded in any given year. Thus, the 100-year flood could occur more than once in a relatively short period of time. The Federal Emergency Management Agency (FEMA) defines it as the 1 % annual chance flood, which is now the standard definition used by most federal and state agencies and by the National Flood Insurance Program (NFIP).
Agricultural Drought	Links the various characteristics of meteorological drought to agricultural impacts, while focusing on precipitation shortages and soil-water deficits.
Annualized Capital Stock Losses	Long-term average losses in a given year
Base Flood Elevation (BFE)	The water surface elevation of a 100-year flood event (a flood that has a 1 % chance of occurring in any given year as defined by the NFIP). The base flood is a statistical concept used to ensure that all properties subject to NFIP are protected to the same degree against flooding.
Beaufort Wind Scale	A simplified scale to aid in the estimation of wind speed and corresponding typical effects.
Benefit-Cost Analysis	A systematic, quantitative method of comparing projected benefits to projected costs of a project or policy. It is used as a measure of cost effectiveness.
Building Contents Value	Represents a predefined proportion of the building value.
Building Value	Value of the physical building.
Capability Assessment	Provides a description and analysis of a community’s current capacity to address threats associated with hazards. The assessment includes two components: an inventory of an agency’s mission, programs, and policies, and an analysis of its capacity to carry them out. A capability assessment is an integral part of the planning process in which a community’s actions to reduce losses are identified, reviewed, and analyzed, and the framework for implementation is identified.
Coastal Erosion	Loss or displacement of land along the coastline due to the action of wind, waves, currents, tides, wind-driven water, waterborne ice, runoff of surface waters, or groundwater seepage.
Coastal Erosion Hazard Area (CEHA)	An area of the coastline, which is a structural hazard area, or a natural protective feature area.
Coastal Flooding	Caused by long and short wave surges that affect the shores of the open ocean, bays, and tidally influenced rivers, streams, and inlets
Coastal Storms	Tropical cyclones formed in the atmosphere over warm ocean areas. Wind speeds reach 74 miles per hour or more and blow in a large spiral around a relatively calm center or "eye. Circulation is counterclockwise in the Northern Hemisphere.

Glossary	
Term	**Definition**
Community District	59 distinct geographical boundaries within New York City that have an important advisory role in dealing with land use and zoning matters, the City budget, municipal service delivery, and many other matters relating to their communities' welfare.
Community Rating System	A voluntary program under the NFIP that rewards participating communities (provides incentives) for exceeding the minimum requirements of the NFIP and completing activities that reduce flood hazard risk by providing flood insurance premium discounts.
Cultural Facilities	A critical facility is vital to the City's ability to provide essential services and protect life and property. Loss of a critical facility would result in a severe economic or catastrophic impact.
Dam Failure	An uncontrolled release of impounded water resulting in downstream flooding.
Debris	The scattered remains of assets broken or destroyed during the occurrence of a hazard. Debris caused by wind or water hazards can cause additional damage to other assets.
Disaster Mitigation Act of 2000 (DMA 2000)	The latest federal legislation enacted to encourage and promote proactive, pre-disaster planning as a condition of receiving financial assistance under the Robert T. Stafford Act. The DMA emphasizes planning for disasters before they occur. Under the DMA, a pre-disaster hazard mitigation program and new requirements for the national post-disaster hazard mitigation grant program (HMGP) were established.
Drought	A prolonged period with no rain. Limited winter precipitation accompanied by moderately dry periods during the spring and summer months can also lead to drought conditions.
Drought Emergency	Declared by the New York City Department of Environmental Protection when there is a reasonable probability that, without the implementation of stringent measures to reduce consumption, a protracted dry period would drain the City's reservoirs.
Drought Warning	Declared by the New York City Department of Environmental Protection when there is less than a 33% probability that either of the two largest reservoir systems, the Delaware or the Catskill, will fill by the following June 1, the start of the water-year.
Drought Watch	Declared by the New York City Department of Environmental Protection when there is less than a 50% probability that either of the two largest reservoir systems, the Delaware or the Catskill, will fill by the following June 1, the start of the water-year.
Earthquakes	The sudden motion or trembling of the ground produced by abrupt displacement of rock masses, usually within the upper 10–20 miles of the earth's surface.
Enhanced Fujita Scale	National Weather Service's revised Fujita-scale, which is a complex, systematic approach to measuring the strength of a tornado.
Excessive Heat Warning	Issued within 24 hours of onset of the following conditions: 1) Heat index of at least 105° F for more than three hours per day for two consecutive days 2) Heat index of more than 115° F for any time period

Glossary	
Term	**Definition**
Excessive Heat Watch	Issued within 48 hours prior to onset of the following conditions: 1) Heat index of at least 105° F for more than three hours per day for two consecutive days 2) Heat index of at least 115° F for any time of 95° F or higher for two consecutive days
Existing Mitigation Action	A project, plan, policy, or program the City has already taken or has begun to implement that addresses natural hazard mitigation.
Exposure	The number and dollar value of assets considered to be at risk during the occurrence of a specific hazard.
Extreme Cold	Temperatures that drop well below normal in an area. Whenever temperatures drop well below normal and wind speed increases, heat can leave your body more rapidly (known as the wind-chill effect).
Extreme Heat	Temperatures that hover 10° F or more above the average high temperature for the region and last for several weeks. Humid or muggy conditions, which add to the discomfort of high temperatures, occur when a "dome" of high atmospheric pressure traps hazy, damp air near the ground.
Federal Emergency Management Agency (FEMA)	An independent federal agency (now part of the Department of Homeland Security) created in 1978 to provide a single point of accountability for all federal activities related to disaster mitigation and emergency preparedness, response, and recovery.
Flash Flooding	Caused by short-term, high-intensity rainfall that occurs in inland areas with poor drainage
Flood Insurance Rate Map (FIRM)	The official map of a community for which FEMA has delineated the special flood hazard area (SFHA) and the risk premium zones applicable to the community.
Floodplain	Any land area that becomes inundated with water during a flood or from any other source. Floodplain can be defined in different ways but is commonly defined as the area that is also called the 100-year floodplain.
Floods	A general and temporary condition of partial or complete inundation on normally dry land. Flooding can be categorized as coastal, riverine, or flash.
Fujita Scale (F-Scale)	Standard measurement for rating the strength of a tornado.
Geographic Information Systems (GIS)	A computer software application that relates data regarding physical and other features on the earth to a database for mapping and analysis.
Goal	A general guideline that explains what is to be achieved. Goals are usually broad-based, long-term, policy-type statements and represent global visions. Goals help define the benefits that a plan is trying to achieve.
Go-Outside-the-Home Disability	Conditions lasting six or more months that make going outside the home alone to shop or visit a doctor’s office difficult.
Ground Acceleration	Shaking of the ground resulting from seismic waves caused by an earthquake.
Hailstorms	Shower-like precipitation in the form of irregular pellets, or balls of ice more than five millimeters in diameter, falling from a cumulonimbus cloud.

Glossary	
Term	**Definition**
Hazard	A source of potential danger or adverse condition that could harm people and/or cause property damage.
Hazard Mitigation	Reduction or alleviation of the loss of life, personal injury, and property damage that could result from a disaster through long- and short-term strategies. Hazard mitigation involves strategies such as planning, policy changes, programs, projects, and other activities that could mitigate the impacts of hazards.
Hazard Mitigation Grant Program (HMGP)	Authorized under Section 202 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, the HMGP is administered by FEMA and provides grants to states, tribes, and local governments to implement hazard mitigation actions after a major disaster declaration. The purpose of the program is to reduce the loss of life and property due to disasters and to enable mitigation activities to be implemented as a community recovers from a disaster.
Hazard Mitigation Plan (HMP)	A collaborative document that identifies hazards that could affect a community, assesses vulnerability to hazards, and represents consensus decisions reached on how to minimize or eliminate the effects of hazards.
Hazards U.S. Multi-Hazard (HAZUS-MH)	A nationally applicable standardized methodology and software program, developed by FEMA, which is under contract with the National Institute of Building Sciences. The program estimates potential losses from earthquakes, hurricane winds, and floods. In HAZUS-MH, current scientific and engineering knowledge is coupled with Geographic Information Systems (GIS) technology to produce estimates of hazard-related damage before, or after, a disaster occurs.
Heat Advisory	Issued within 24 hours prior to onset of any of the following conditions: 1) Heat index of at least 100° F but less than 105° F for any period of time 2) Maximum heat index of 95°F or greater for two consecutive days 3) Nighttime lows above 80° F for any period of time.
Heat Index	The temperature the body feels when heat and humidity are combined.
Hurricane	A tropical storm with winds that have reached a constant speed of 74 miles per hour or more.
Hydrological Drought	A drought caused by deficiencies in surface and subsurface water supplies.
Intensity (earthquakes)	Measures the effects of an earthquake at a particular place and is expressed in terms of the Modified Mercalli scale.
Landslides	The downward and outward movement of slope-forming materials reacting to the force of gravity. Slide materials may be composed of natural rock, soil, artificial fill, or combinations of these materials. The term landslide includes rock falls, rockslides, block glide, debris slide, earth flow, mudflow, slump, and other such terms.
Linguistically Isolated	Households where no one over age 14 speaks English very well, as reported in the 2000 US Census.

Glossary	
Term	**Definition**
Liquefaction	The complete failure of soils when soils lose shear strength and flow horizontally during earthquakes. Liquefaction is most likely to occur in fine-grained sands and silts with high water content. These materials behave like viscous fluids when liquefaction occurs. Liquefaction undermines the ground's ability to solidly support building structures. Foundations on liquefiable soils can lose their ability to support load and can experience settlement approximately several inches or more. This situation is extremely hazardous and generally results in extreme property damage and threats to life and safety. Differential settlement can cause significant damage to buildings, lifelines, and transportation structures with partial or total collapse.
Magnitude (earthquakes)	Measurement of the total amount of energy and is expressed in terms of the Richter scale
Mitigation Actions	Specific projects, plans, or policies that achieve goals and objectives that minimize the effects from a disaster and reduce the loss of life and property.
Mitigation Planning Council (MPC)	Composed of 39 essential governmental and non-governmental stakeholders that have an interest in reducing the impact of natural hazards throughout New York City.
Mitigation Planning Council Steering Committee (Steering Committee)	A core group of eight agencies and organizations that own or manage some of the City's largest infrastructure networks and/or engage in planning for or regulating these systems.
Mitigation Strategy	A systematic process for analyzing, prioritizing, and implementing the identified mitigation actions in the Hazard Mitigation Plan.
Modified Mercalli Intensity	A scale used for measuring the intensity of an earthquake. The scale quantifies the effects of an earthquake on the Earth's surface, humans, objects of nature, and man-made structures on a scale of I through XII, with I denoting a weak earthquake and XII one that causes almost complete destruction.
National Flood Insurance Program (NFIP)	The three components of the NFIP are flood insurance, floodplain management, and flood hazard mapping. Nearly 20,000 communities across the United States and its territories participate in the NFIP by adopting and enforcing floodplain management ordinances to reduce future flood damage. In exchange, the NFIP makes Federally backed flood insurance available to homeowners, renters, and business owners in these communities. Community participation in the NFIP is voluntary.
Natural Protective Feature Area	A land and/or water area containing natural protective features, the alteration of which might reduce or destroy the protection afforded other lands against erosion or high water or lower the reserve of sand or other natural materials available to replenish storm losses through natural processes.
New York Bight	A curve in the shoreline of an open coast that funnels and increases the speed and intensity of storm surge. The New York Bight is located at the point where New York and New Jersey meet, creating a right angle in the coastline.

Glossary	
Term	**Definition**
New York City Construction Code	The City's comprehensive building code managed by the New York City Department of Buildings and revised in 2008. The revised code became effective July 1, 2008 and applies to all new construction within the City.
New York City Office of Emergency Management (OEM)	OEM plans and prepares for emergencies, educates the public about preparedness, coordinates emergency response and recovery, and collects and disseminates emergency information. To accomplish this mission, OEM maintains a disciplined unit of emergency management personnel, including responders, planners, watch commanders, and administrative and support staff, to identify and respond to various hazards.
Nor'easter	A strong low-pressure system that affects the Mid-Atlantic and New England states. It can form over land or coastal waters. These typically winter events are notorious for producing heavy snow, rain, and tremendous waves that crash onto Atlantic beaches, often causing beach erosion and structural damage.
Objective	A short-term aim that, when combined with other objectives, forms a strategy or course of action to meet a goal. Unlike goals, objectives are specific and measurable.
Peak Ground Acceleration (PGA)	Measures the rate of change in motion of the earth's surface and expresses it as a percent of the established rate of acceleration due to gravity (9.8 m/sec2).
Physical Disability	Long-lasting conditions that substantially limit one or more basic physical activity, such as walking, climbing stairs, reaching, lifting, or carrying.
Planning Team	The coordinators for the HMP. The Planning Team was comprised of four planners from the OEM Planning and Preparedness Division and one Hazard Impact Modeler from the Geographic Information Systems (GIS) Unit whom facilitated the overall plan development to ensure the HMP met the requirements of DMA 2000 and executed hazard models to create maps and data tables that support the Plan.
PlaNYC	Outlines a detailed strategy for how the City will address the challenges of population growth, aging infrastructure, and climate change. PlaNYC contains 127 initiatives designed to achieve sustainability goals for land, water, transportation, energy, air quality, and climate change.
Potential Mitigation Action	A project, plan, policy or program that the City would like to take, but currently does not have the funds and/or resources to implement, that addresses natural hazard mitigation.
Preparedness	Actions that strengthen the capability of government, citizens, and communities to respond to disasters.
Presidential Disaster Declaration	Typically made for events that cause more damage than state and local governments and resources can handle without federal government assistance. Generally, no specific dollar loss threshold has been established for such declarations. A Presidential Disaster Declaration puts into motion long-term federal recovery programs, some of which are matched by state programs, designed to help disaster victims, businesses, and public entities.

Glossary	
Term	**Definition**
Probabilistic (for HAZUS-MH)	Events modeled by looking at the damage caused by an event that is likely to occur over a given period of time, known as a return period.
Recovery	Recovery refers to actions taken by an individual or community after a catastrophic event to restore order and community lifelines.
Repetitive Loss Property	Any NFIP-insured property that, since 1978 and regardless of any change(s) of ownership during that period, has experienced any of the following:1) Four or more paid flood losses exceeding $1,000 each 2) Two paid flood losses exceeding $1,000 each within any 10-year period since 1978 3)Three or more paid losses that equal or exceed the current value of the insured property
Return Period	Average period of time in years between occurrences of a particular hazard (equal to the inverse of the annual frequency of occurrence).
Richter Scale	A logarithmic scale used to express the total amount of energy released by an earthquake. Its values typically fall between 0 and 9, with each increase of 1 representing a 10-fold increase in energy.
Risk	The estimated impact that a hazard would have on people, services, facilities, and structures in a community. Risk measures the likelihood of a hazard occurring and resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate, or low hazard. Risk also can be expressed in terms of potential monetary losses associated with the intensity of likelihood of sustaining damage above a particular threshold due to occurrence of a specific type of the hazard.
Risk Assessment	The process of measuring potential loss of life, personal injury, economic injury, and property damage resulting from hazards. This process assesses the vulnerability of people, buildings, and infrastructure to hazards and focuses on 1) hazard description 2) severity 3) probability 4) location 5) historic occurrences 6) impact to NYC 7) structural vulnerability and 8) potential loss estimates.
River Flooding	Caused when rivers and streams overflow their banks.
Saffir-Simpson Scale	Use by the National Weather Service, this scale uses windspeed to determine the category strength of a hurricane on a scale of 1 to 5.
Sea, Lake, and Overland Surges from Hurricanes (SLOSH)	Calculates surge based on storms moving in different directions and with varying strengths.
Self-Care Disability	Conditions lasting six or more months that make dressing, bathing, or getting around inside the home difficult.
Sensory Disability	Blindness, deafness, or a severe vision or hearing impairment.
Socioeconomic Droughts	A socioeconomic drought impacts the health, well being, and quality of life or starts to have an adverse impact on a region.
Spectra Acceleration	Measures what is experienced by a building during an earthquake, by referencing a particle mass on a mass-less vertical rod having the same natural period of vibration as the building.

Glossary	
Term	**Definition**
STAPLEE	A set of criteria used to examine the Social, Technical, Administrative, Political, Legal, Economic, and Environmental (STAPLEE) opportunities and constraints of implementing a particular mitigation measure using a consistent framework.
New York State Emergency Management Agency (NYSEMO)	The mission of the New York State Emergency Management Office (SEMO) is to protect the lives and property of the citizens of New York State from threats posed by natural or man-made events. To fulfill this mission, SEMO coordinates emergency management services with other federal and State agencies to support county and local governments. SEMO routinely assists local government, volunteer organizations, and private industry through a variety of emergency management programs. These programs involve hazard identification, loss prevention, planning, training, operational response to emergencies, technical support, and disaster recovery assistance.
Storm Surge	An offshore rise of water associated with a low-pressure weather system, typically a tropical cyclone. Storm surge is caused primarily by high winds pushing on the ocean's surface. The wind causes the water to pile up higher than the ordinary sea level.
Structural Hazard Areas	Shore lands located landward of natural protective features and having shorelines receding at a long-term average recession rate of one foot or more per year. The inland boundary of a "structural hazard area" is calculated by starting at the landward limit of the fronting natural protective feature and measuring along a line perpendicular to the shoreline a horizontal distance landward which is 40 times the long-term average annual recession rate.
Subsidence	Depressions, cracks, and sinkholes in the earth's surface, which can threaten people and property. Subsidence depressions, which normally occur over many days to a few years, may damage structures with low strain tolerances such as dams, factories, nuclear reactors, and utility lines.
Tornadoes	A local atmospheric storm, generally of short duration, formed by winds rotating at very high speeds, usually in a counterclockwise direction. The vortex, up to several hundred yards wide, is visible to the observer as a whirlpool-like column of winds rotating about a hollow cavity or funnel.
Tropical Depression	An organized system of clouds and thunderstorms, with a defined surface circulation, and maximum sustained winds of 38 miles per hour or less.
Tropical Storms	An organized system of strong thunderstorms, with a defined surface circulation, and maximum sustained winds of 39 to 73 miles per hour.
Urban Heat Island Effect	Develop when built surfaces replace a large portion of natural land. Incoming solar radiation is trapped during the day and is then re-radiated at night. This slows the cooling process, keeping nighttime air temperatures high, relative to temperatures in less urbanized areas.
Wildfires	Any instance of uncontrolled burning in grasslands, brush, or woodlands.

Glossary	
Term	**Definition**
Windchill	Measures apparent temperature felt on exposed skin due to the combination of air temperature and wind speed.
Windstorms	Short-duration events involving straight-line winds or gusts exceeding 50 mph. These gusts can produce winds of sufficient strength to cause property damage. Windstorms are especially dangerous in areas with significant tree stands, exposed property, poorly constructed buildings, mobile homes (manufactured housing units), major infrastructure, and aboveground utility lines. A windstorm can topple trees and power lines; cause damage to residential, commercial, critical facilities; and leave tons of debris in its wake.
Winter Storms	Includes ice storms and blizzards. Extreme cold often accompanies winter storms. The National Weather Service (NWS) characterizes blizzards as being combinations of winds in excess of 35 mph with considerable falling or blowing snow, which frequently reduces visibility.

Table 1: Glossary

Appendix C

Meeting Invitees

1) List of Invitees for Mitigation Planning Council (MPC)

MPC Participating Agencies
New York City Agencies
Department for the Aging
Department of Buildings*
Department of City Planning*
Department of Citywide Administrative Services
Department of Corrections
Department of Design and Construction
Department of Education
Department of Environmental Protection*
Department of Health/Mental Health
Department of Homeless Services
Department of Information Technology and Telecommunications
Department of Parks and Recreation*
Department of Sanitation
Department of Transportation*
Economic Development Corporation
Fire Department of New York
Health and Hospitals Corporation
Housing and Preservation Development
Human Resources Administration
Landmarks Preservation Commission
New York Police Department
Office of Emergency Management*
Office of Long-Term Planning and Sustainability*
Small Business Services

MPC Participating Agencies
Other Stakeholders
Amtrak
Con Edison
MTA Bridges and Tunnels
MTA Buses
MTA Headquarters*
MTA Long Island Rail Road
MTA Metro-North Railroad
MTA New York City Transit
MTA Police*
National Weather Service
New York City Housing Authority
Port Authority of New York and New Jersey
Regional Planning Association*
United States Army Corps of Engineers
Verizon

* Mitigation Planning Council Steering Committee Invitees

Table 1: Mitigation Planning Council Invitees

2) List of Invitees to Community Involvement Meetings

a. Academic Institutions

Academic Institutions Meeting Invitees
Academic Affiliation
City University of New York-City College
City University of New York-Graduate School and University Center
City University of New York-Queens College Graduate School
Columbia University-Graduate School of Architecture, Planning and Preservation
Columbia University–Lamont Doherty Earth Observatory
Columbia University-Mailman School of Public Health
Hunter College–Graduate Center of Geography
Manhattan College-Bronx
NASA Goddard Institute for Space Studies
New York Institute Of Technology-Manhattan Campus New York
New York University–Center for Atmosphere Ocean Science
New York University-Center for Catastrophe Preparedness & Response
New York University–Wagner Graduate School of Public Service
Polytechnic University-Kings
Pratt Institute-Kings
State University of New York at Stony Brook–Department of Marine Sciences
State University of New York-Maritime College in the Bronx
The Cooper Union University
The New School University-Parsons
Steering Committee
Department of Buildings
Department of City Planning
Department of Environmental Protection
Department of Parks and Recreation
Department of Transportation
MTA Headquarters
MTA Police
Office of Emergency Management
Office of Long-Term Planning and Sustainability
Regional Planning Association

Table 2: Academic Institutions Invitees

b. Private Sector and Professional Organizations

Private Sector and Professional Organizations Meeting Invitees
Business Community
Association for a Better New York
Bronx Chamber of Commerce
Brooklyn Chamber of Commerce
Building Owners and Management Association
Consortium of Private Universities
Food Industry Alliance of New York State
Hotel Association of New York
Industrial Supply Working Group
Manhattan Chamber of Commerce
Municipal Art Society
New York City Economic Development Corporation
New York City Investment Fund
New York City Small Business Services
New York State Banking
New York State Insurance Department
Queens Chamber of Commerce
Real Estate Board of New York
Securities Industry and Financial Markets Association
Staten Island Chamber of Commerce
The Clearing House
Professional Affiliations
American Institute of Architects/NY Chapter
American Planning Association/NY Metro Chapter
Structural Engineers Association of New York
Steering Committee
Department of Buildings
Department of City Planning
Department of Environmental Protection
Department of Parks and Recreation
Department of Transportation
MTA Headquarters
MTA Police
Office of Emergency Management
Office of Long-Term Planning and Sustainability
Regional Planning Association

Table 3: Business Professional Community Invitees

c. Community Groups and Neighboring Jurisdictions Meeting

Community Groups and Neighboring Jurisdictions Meeting Invitees
Not-for-Profit Affiliation
American Red Cross in Greater New York
American Society for the Prevention of Cruelty to Animals
Animal Care and Control
Catholic Charities-Archdiocese of NY
Catholic Charities-Brooklyn Queens
City Harvest
Coler Goldwater Specialty Hospital and Nursing Facility
Community Emergency Response Teams
Consortium for Haitian Empowerment
Disaster Chaplaincy Services
Federation Employment and Guidance Services/Health and Human Services System
Neighborhood Housing Services
New York Cares
New York Disaster Interfaith Services
Nonprofit Coordinating Committee of New York
Safe Horizon
The New York Immigration Coalition
The Salvation Army
Tzu Chi
United Jewish Appeal Federation of New York
World Vision
Local Government
New York City Department of Homeless Services
Community Affairs Unit
Neighboring and Upstate Counties
Bergen County-NJ
Bergen County-NJ (NJ Meadowlands Commission)
Delaware County-NY
Dutchess County-NY
Greene County-NY
Hudson County-NJ
Middlesex County-NJ
Nassau County-NY
Orange County-NY
Putnam County-NY
Schoharie County-NY
Sullivan County-NY
Union County - NJ
Westchester County-NY
New York State Office of Emergency Management
NY SEMO Region I
NY SEMO Region II
Steering Committee

Community Groups and Neighboring Jurisdictions Meeting Invitees
Not-for-Profit Affiliation
Department of Buildings
Department of City Planning
Department of Environmental Protection
Department of Parks and Recreation
Department of Transportation
MTA Headquarters
MTA Police
Office of Emergency Management
Office of Long-Term Planning and Sustainability
Regional Planning Association

Table 4: Community Groups and Neighboring Jurisdictions Meeting Invitees

Appendix D

Planning Process Toolkit

Worksheets

1) Hazard Selection Worksheet

Name ______________________________

Agency ______________________________

Hazard Selection

The HMP will only address those hazards that pose a real threat to NYC and we would like the Steering Committee's input on hazard selection. Below is the complete list of SEMO identified hazards. Please review this list and check 'Yes' or 'No' if your agency has been affected by this hazard. Please consider if each hazard has influenced your agency's operations and/or policy and program development and/or physical structures and property.

SEMO Identified Hazards	Yes	No	If Yes, please explain or give example(s)
Coastal Erosion	☐	☐	
Coastal Storms/Hurricanes	☐	☐	
Dam Failure	☐	☐	
Drought	☐	☐	
Earthquakes	☐	☐	
Extreme Temperatures	☐	☐	
Floods	☐	☐	
Hailstorm	☐	☐	
Landslides	☐	☐	
Subsidence	☐	☐	
Tornadoes/Windstorms	☐	☐	

Wildfires	☐	☐	
Winter Storms (severe)	☐	☐	
Other	☐	☐	

Hazard Definitions	
Coastal Erosion	Coastal Erosion is the loss or displacement of land along the coastline due to the action of wind, waves, currents, tides, wind-driven water, waterborne ice, runoff of surface waters, other impact s of storms, or groundwater seepage.
Coastal Storms/Hurricanes	Tropical cyclones, formed in the atmosphere over warm ocean areas, in which wind speeds reach 74 miles per hour or more and blow in a large spiral around a relatively calm center or "eye". Circulation is counterclockwise in the Northern Hemisphere.
Dam Failure	An uncontrolled release of impounded water resulting in downstream flooding.
Drought	A prolonged period with no rain. Limited winter precipitation accompanied by moderately long periods during the Spring and Summer months can also lead to drought conditions.
Earthquakes	The sudden motion or trembling of the ground produced by abrupt displacement of rock masses, usually within the upper 10-20 miles of the earth's surface.
Extreme Temperatures	**Extreme Cold -** temperatures drop well below normal in an area. Whenever temperatures drop well below normal and wind speed increases, heat can leave your body more rapidly (known as the wind chill effect). **Extreme Heat -** temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks are defined as extreme heat. Humid or muggy conditions, which add to the discomfort of high temperatures, occur when a "dome" of high atmospheric pressure traps hazy, damp air near the ground.
Floods	A general and temporary condition of partial or complete inundation on normally dry land. Flooding can be categorized coastal, riverine, or flash/urban.
Hailstorms	Showery precipitation in the form of irregular pellets or balls of ice more than 5 mm in diameter, falling from a cumulonimbus cloud.
Landslides	The downward and outward movement of slope forming materials reacting to the force of gravity. Slide materials may be composed of natural rock, soil, artificial fill, or combinations of these materials. The term landslide is generalized and includes rockfalls, rockslides, block glide, debris slide, earth flow, mud flow, slump, and other such terms.

Subsidence	Depressions, cracks, and sinkholes in the earth's surface which can threaten people and property. Subsidence depressions, which normally occur over many days to a few years, may damage structures with low strain tolerances such as dams, factories, nuclear reactors, and utility lines. The sudden collapse of the ground surface to form sinkholes, many yards wide and deep within the span of a few minutes to a few hours poses immediate threat to life and property.
Tornadoes/Windstorms	A local atmospheric storm, generally of short duration, formed by winds rotating at very high speeds, usually in a counterclockwise direction. The vortex, up to several hundred yards wide, is visible to the observer as a whirlpool-like column of winds rotating about a hollow cavity or funnel.
Wildfires	Any instance of uncontrolled burning in grasslands, brush, or woodlands.
Winter Storms	Includes ice storms, blizzards and can be accompanied by extreme cold. The National Weather Service characterizes blizzards as being combinations of winds in excess of 35 miles per hour with considerable falling or blowing snow, which frequently reduces visibility.

2) Local Capability Assessment

Local Capability Assessment

The Local Capability Assessment examines the policies, programs, regulations, studies, and initiatives which are in place to reduce the risks NYC may face from natural hazards. This Capability Assessment also examines the shortfalls of any plans, programs, and regulations and devises ways to improve on them. For the purposes of next months meeting, please insert your agency's name by any of the plans or policies your agency undertakes. If there are other related plans, policies, programs, studies, or initiatives which are not listed and are related to hazard mitigation, please add them to the list. For the next meeting, we will be collecting this list and an organizational chart or list of divisions within your agency. This chart/ list will assist OEM in understanding your agencies responsibilities and how they may relate to NYC's Hazard Mitigation Plan.

Capabilities	**Responsible Agency(s)**
Planning mechanisms	
Local Emergency Plan	OEM
Local Emergency Disaster Recovery Plan	OEM
Flood Mitigation Assistance (FMA) Flood Mitigation Plan	
Floodplain Management Plan (CRS/NFIP)	
Other Hazard Mitigation Plan	
Capital Improvement or Development Plan	
Land-use Plans	
Local Waterfront Revitalization Plans (LWRP),	
Master/Comprehensive Plan	
Policies/Ordinance	
Steep slope ordinances	
Property set-back ordinance (water/wildfire/other hazard)	
Watershed Ordinance	
Storm Water Ordinance	
Zoning/land use restrictions	
Codes building site/design	

Capabilities	Responsible Agency(s)
Real Estate disclosure requirements	
Site plan review requirements	
Programs	
Zoning/land use restrictions	
Codes building site/design	
National Flood Insurance Program Participant (NFIP)	
National Flood Insurance Program Participant (NFIP) Community Rating System (CRS) Participating Community	
Hazard awareness program	
Planning Programs Department	
Planning/zoning boards	
Property Acquisition Programs	
Local Waterfront Revitalization Plans (LWRP), Program	
Comprehensive Development Program	
Capital Improvement or Development Program	
Land Use Program	
Public education/awareness programs	
Stream Maintenance Program	
Storm drainage systems maintenance Program	
Tree pruning program	
Site plan review program	
Studies/Reports	
Hazard analysis/risk assessment	OEM
Floodplain Maps/Flood Insurance Studies	
Hydrological/Hydraulic Studies	

3) Goal and Objectives

The Hazard Mitigation Plan must have established goals and objectives to direct the development and implementation of the mitigation strategy section. The goals and objectives represent a long-term vision for hazard reduction and enhancement of mitigation capabilities for NYC.

Goals are general guidelines that explain what the HMP wants to achieve. They are long-term and represent global visions.
Objectives define strategies or implementation steps to attain the identified goal. Objectives are specific and may be measurable.

Assignment: Below is a draft of generic goals and objectives used in Local Hazard Mitigation Plans. In an effort to focus the goals and objectives to NYC, please suggest 2 to 3 objectives you believe are specific to NYC and/or your agency while encompassing hazard mitigation.

Suggested Goal/Objective 1:

____

____

____

Suggested Goal/Objective 2:

____

____

Suggested Goal/Objective 3:

____

____

____

Goal 1: Protect public health and safety

Objective 1.1 – Improve systems that provide warning and emergency communications.
Objective 1.2 – Reduce the impacts of hazards on vulnerable populations.
Objective 1.3 – Strengthen state and local building code enforcement.
Objective 1.4 – Train emergency responders.

Goal 2: Protect property

Objective 2.1 – Implement mitigation programs that protect critical facilities and services and promote reliability of lifeline systems to minimize impacts from hazards, to maintain operations, and to expedite recovery in an emergency.
Objective 2.2 – Consider known hazards when identifying the site for new facilities and systems.
Objective 2.3 – Create redundancies for critical networks such as water, sewer, digital data, power, and communications.
Objective 2.4 – Adopt and enforce public policies to minimize impacts of development and enhance safe construction in high hazard areas.
Objective 2.5 – Integrate new hazard and risk information into building codes and land use planning mechanisms.
Objective 2.6 – Educate public officials, developers, realtors, contractors, building owners and the general public about hazard risks and building requirements.
Objective 2.7 – Promote appropriate mitigation of all public and privately-owned property within the city's jurisdiction including, but not limited to, residential units, commercial structures, educational institutions, health care facilities, stadiums, and infrastructure systems.
Objective 2.8 – Incorporate effective mitigation strategies into the city's Capital Improvement Projects.
Objective 2.9 – Promote post-disaster mitigation as part of repair and recovery.

Goal 3: Promote a sustainable economy

Objective 3.1 – Form partnerships to leverage and share resources.
Objective 3.2 – Continue critical business operations.

Objective 3.3 – Partner with private sector, including small businesses, to promote structural and non-structural hazard mitigation as part of standard business practice.
Objective 3.4 – Educate businesses about contingency planning citywide, targeting small businesses and those located in high risk areas.
Objective 3.5 – Partner with private sector to promote employee education about disaster preparedness while on the job and at home.

Goal 4: Protect the environment

Objective 4.1 – Develop hazard mitigation policies that protect the environment.
Objective 4.2 – Promote climate change adaptation strategies that protect the long term effects on the environment

Goal 5: Increase Public Preparedness for Disasters

Objective 5.1 – Enhance understanding of natural hazards and the risk they pose.
Objective 5.2 – Improve hazard information, including databases and maps.

Objective 5.3 – Improve public knowledge of hazards and protective measures so individuals appropriately respond during hazard events.

4) Mitigation Action Worksheet Packet

Directions: Please fill out the worksheet electronically with any natural hazard-related mitigation actions. Mitigation actions should be current or potential plans, projects, policies or programs. Please fill out this worksheet as completely as possible on behalf of your agency.

The mitigation actions should align with the five Mitigation Strategy Goals listed below. Page 3 of this packet contains a list of natural hazards and recommended projects/ initiatives related to that hazard..

Hazard Mitigation Goals

- Goal 1: Protect public health and safety
- Goal 2: Protect critical facilities and Infrastructure
- Goal 3: Protect public and private property
- Goal 4: Ensure economic stability
- Goal 5: Protect the environment

Mitigation Action & description – Provide a brief description of the project.

Hazard Addressed – List applicable hazard(s) addressed by each mitigation action.

Lead Agency – List the agency responsible for overseeing the planning, completion, implementation and monitoring of the potential or existing action.

Supporting Agency – List any agency or agencies that will assist in planning, implementing or monitoring of the potential or existing mitigation action.

Project timeline – Expected time of completion of potential or existing project. If the project is an ongoing initiative, please insert *ongoing* under the heading.

Estimated Project Cost – Estimated cost of the potential or existing project. If the costs can not be determined at this time, please insert TBD.

Possible funding sources –Source(s) which are or can be used to fund the mitigation action. For example: agency operating budget, grant, etc.

Existing or Potential – Indicate whether the action is existing or potential. An existing action is currently or underway. A potential action is a mitigation action your agency would like to implement in the future

Sample Hazard Mitigation Worksheet

Mitigation Action & Description	Hazard Addressed	Lead Agency	Supporting Agency(s)	Project Timeline	Estimated Project Cost	Possible funding Source(s)	Existing or Potential
Bridge Seismic Retrofit – Seismic retrofit all bridges to withstand a magnitude 8 earthquake	Earthquake	DOT	NYCOEM, FEMA, USACE,	6 years	$32,000,000	Agency operating budget, HMGP	Existing
Drainage Improvement- Increase capacity of NYC Transit stormwater pipes to withstand torrential downpours	Flood	MTA	NYCOEM, NYSDEC, NYCDEP	15 years	$50,000,000	Capital Improvement budget, HMGP	Potential

Sample Hazard Mitigation Actions

Potential Mitigation Actions by Hazard

*Please note this list is intended as a guide but is not all-inclusive.

Drought
- Public Awareness
- Retrofit/Upgrade Irrigation System
- Drought Resistant Vegetation
- Drought Preparedness/Planning
- Increase Water Conservation Standards

Earthquake
- Planning and Zoning
- Seismic Retrofit buildings and Infrastructure
- Improve/Upgrade/Enforce Building Codes

Flood
- Public Awareness of floodplains
- Planning and Zoning
- Stormwater Management
- Warning System
- Post Disaster Code Enforcement
- Major/Minor Structural Flood Control Projects
- Protective Measures for Critical Facilities
- Property Protection
- Protective Measures for Critical Facilities
- Wet/Dry Floodproofing

Coastal Storm / Hurricane
- Public Awareness
- Evacuation Plan
- Warning System
- Develop/Improve/Enforce Building Codes in Hazard Areas
- Structural Retrofit
- Wind Resistant Design and Construction

Winter Storm
- Structural Retrofit
- Redundant Utilities/Communications
- Tree Pruning
- Selective Planting around Utility Lines
- Public Awareness
- Develop/Improve/Enforce Building Codes in Hazard Areas
- Underground Wiring/Utilities

Wildfire

- Public Awareness
- Evacuation Plan
- Warning System
- Redundant Utilities/Communications
- Tree Pruning
- Selective Planting/Vegetative Setback around Structures

Tornado / Windstorm

- Public Awareness
- Redundant Utilities/Communications
- Tree Pruning
- Warning System
- Develop/Improve/Enforce Building Codes in Hazard Areas
- Retrofit Critical Structures
- Hazard Resistant Construction

Coastal Erosion

- Public Awareness
- Planning and Zoning
- Property Protection
- Coastal barriers
- Coastal replenishing
- Selective Planting/Vegetation
- Open space
- Residential property buyouts

Extreme Temperatures

- Public Awareness
- Extreme Temperature monitoring
- Street Trees
- Green-roofs
- Using cool materials for buildings and pavement

Subsidence

- Groundwater Use Restriction
- Public Awareness

5) Agency Capability Assessment Form

In January, you identified capabilities within your agency by completing the Local Capability Assessment worksheet. Based on your response, please expand this information by identifying and describing the specific plan, policy, program, regulation or study cited in the worksheet (See Page 3).

Below is the Agency Capability Assessment form. Please fill out the form electronically based on the answers your agency submitted.

Agency: Insert your agency's name, along with a brief description of the agency's mission/ function.

Initiatives: List the plan, policy, program, regulation, study, and/ or other initiative your agency acknowledged responsibility for in the Local Capability Assessment.

Division: Insert the division within your agency responsible for the described action. If the entire agency is responsible for the action, list your agency's name.

Description: Insert a brief description of the listed action, no longer than a paragraph.

Agency (Mission / Function)	Initiatives (Policies, Programs, Regulations, Studies, or other initiatives)	Division	Description
OEM The New York City Office of Emergency Management (OEM) plans and prepares for emergencies, educates the public about preparedness, coordinates emergency response and recovery, and collects and disseminates emergency information.	Flood Mitigation Plan	Transportation & Infrastructure	OEM developed a Flash Flood Emergency Plan as part of the larger Flood Mitigation Task Force headed by the Mayor's Office of Operations and DEP. The Plan outlines procedures for weather monitoring and plan activation triggers. Operations in the Plan include targeted catch basin cleaning and maintenance, improved flood monitoring and communication between agencies, and recovery.
	Hazard Analysis / risk assessment	Transportation & Infrastructure	OEM is serving as the lead agency on the Hazard Mitigation Plan. New York City's Hazard Mitigation Plan is developed to address all natural hazards which may affect the City as well as the vulnerability of NYC's built environment to these natural Hazards. The plan also devises mitigation actions which will lessen risk and vulnerability of the natural hazards on New York City's built environment.
	Local Emergency Plan	All	OEM coordinates the creation and implementation of Emergency Plans which address numerous emergencies ranging from Heat, Winter, Coastal Storms, and Power Outages, to name a few.

Agency (Mission / Function)	Initiatives (Policies, Programs, Regulations, Studies, or other initiatives)	Division	Description

Capabilities	Responsible Agency(s)
Planning mechanisms	
Local Emergency Plan	OEM, DOT
Local Emergency Disaster Recovery Plan	OEM, DOT
Flood Mitigation Assistance (FMA) Flood Mitigation Plan	DOT
Floodplain Management Plan (CRS/NFIP)	DOT
Other Hazard Mitigation Plan	DOT, DEP
Capital Improvement or Development Plan	DOT, DPR, DEP
Land-use Plans	DCP, DOT, DPR
Local Waterfront Revitalization Plans (LWRP),	DCP, DPR
Master/Comprehensive Plan	DCP
Policies/Ordinance	
Steep slope ordinances	DCP, DOT
Property set-back ordinance (water/wildfire/other hazard)	DOT
Watershed Ordinance	DEP,
Storm Water Ordinance	DEP
Zoning/land use restrictions	DCP, DEP
Codes building site/design	DOB, DEP
Real Estate disclosure requirements	
Site plan review requirements	DCP, DOB, DPR
Programs	
Zoning/land use restrictions	DCP
Codes building site/design	DOB
National Flood Insurance Program Participant (NFIP)	DOB
National Flood Insurance Program Participant (NFIP) Community Rating System (CRS) Participating Community	
Hazard awareness program	DOT
Planning Programs Department	DCP
Planning/zoning boards	DCP
Property Acquisition Programs	DOT, DPR, DEP
Local Waterfront Revitalization	DCP

Capabilities	Responsible Agency(s)
Plans (LWRP), Program	
Comprehensive Development Program	
Capital Improvement or Development Program	DOT, DEP
Land Use Program	DCP, DOT
Public education/awareness programs	DOT, DPR
Stream Maintenance Program	DPR, DEP
Storm drainage systems maintenance Program	DPR, DEP
Tree pruning program	DOT, DPR
Site plan review program	DCP, DOB, DPR
CEQR	DCP
Studies/Reports	
Hazard analysis/risk assessment	OEM, DOT
Floodplain Maps/Flood Insurance Studies	DOB
Hydrological/Hydraulic Studies	DOT, DEP

6) STAPLEE

Hello [Steering Committee Member(s)],

Before next week's meeting and in the effort of saving time, we are asking the MPC Steering Committee to perform the STAPLEE analysis on 3 selected mitigation actions your agency submitted. Discussed in the March 28th meeting, STAPLEE is a FEMA strategy for municipalities to review their actions based on 7 categories: **s**ocial, **t**echnological, **a**dministrative, **p**olitical, **l**egal, **e**conomic and **e**nvironmental. Each category has 2-4 criteria to determine if the action is favorable, unfavorable or not applicable. Attached is an excel document and PowerPoint presentation.

1. The first worksheet in the excel file (Mitigation Actions) contains the 3 mitigation actions and all the information submitted by your agency.
2. The second worksheet in the excel file (STAPLEE) contains a form your agency will populate.
3. The PowerPoint contains the slides on STAPLEE presented in March for additional guidance.

Instructions:
For mitigation actions that have positive implications or no foreseen negative implications associated with the corresponding STAPLEE criteria, use the drop-down menu to insert (+). For actions with negative implications, use the table drop-down menu to insert (-). For the STAPLEE criteria which do not apply or are not relevant to the mitigation action, use the drop-down menu to insert (N).

Please submit your STAPLEE analysis to Rexford by **COB Wednesday May 14th.** We will briefly review your STAPLEE analysis at the Steering Committee meeting.

Thank you,
The Hazard Mitigation Team

Instructions: Click on the cell and use the drop down menu to select whether the mitigation action is favorable (+), unfavorable (-) or not applicable (N) for the selected category.

Mitigation Action	Social		Technical			Administrative			Political		Legal			Economic				Environment		
	Community Acceptance	Effect on Segment of Population	Technically Feasible	Long-Term Solution	Secondary Impacts	Staffing	Funding Allocation	Maintenance/Operations	Political Support	Public Support	State Authority	Existing Local Authority	Potential Legal Challenge	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land/ Water	Consistent with Community Environmental Goals	Consistent with Federal Laws
Mitigation Action																				
Mitigation Action																				
Mitigation Action																				

Resources

7) Mitigation Action Funding Matrix

Program Element	Hazard Mitigation Grant Program (HMGP)	Flood Mitigation Assistance (FMA)	Pre-Disaster Mitigation-Competitive (PDM-C)	Repetitive Flood Claims (RFC)	Severe Repetitive Loss (SRL)
Description	Hazard mitigation Grant Program provides States, territories, Indian tribal governments, and communities funding to significantly reduce or permanently eliminate future risk to lives and property from natural disasters by funding cost-effective measures.	Used to implement cost-effective measures that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other sources insured under the National Flood Insurance Program.	A national competitive program used to fund state, territories, Indian Tribal governments, and communities for hazard mitigation planning and the implementation of cost-effective mitigation projects prior to a disaster event.	Funding to reduce or eliminate the long-term risk of flood damage to structures insured under the NFIP that have had one or more claim payment(s) for flood damages.	Grant funding to reduce or eliminate the long-term risk of flood damage to severe repetitive loss residential properties and the associated drain on the National Flood Insurance Fund.
Eligibility	In order to be eligible for HMGP funding, the following conditions must exist: The State must have a FEMA-approved and adopted State or Enhanced Hazard Mitigation Plan, which has been adopted by the jurisdiction; NYC must have a FEMA-approved local hazard mitigation plan, which has been adopted by the jurisdiction; and the proposed activity must be consistent with the Grantee's (NYS) state standard or enhanced hazard mitigation plan and the sub-grantee's (NYC) local hazard mitigation plan.	Prospective applicants for FMA grant funding must have a FEMA-approved Flood Mitigation Plan, and be a member in good standing with the National Flood Insurance Program. No state plan or local hazard mitigation plan is required to be eligible for funding; however, FEMA recommends that in-lieu of a Flood Mitigation Plan, municipalities undertake a all-hazard mitigation plan including flood hazard.	Funding is available to municipalities and States with approved hazard mitigation plans. PDM-C is a national competitive grant which is judged and distributed by FEMA.	The state which the sub-applicant is located must have an approved State Hazard Mitigation Plan. No local plan is necessary for jurisdictions to receive funding thorough this program. Applicants must be insured under the NFIP and the State and municipality must not be able to meet the FMA program requirements for either cost-share or capacity to manage the activities.	A FEMA-approved State or Enhanced hazard mitigation plan. To be eligible for funding from Severe Repetitive Loss, residential properties must meet the following criteria: • Have at least four NFIP claim payments over $5,000 each, when at least two such claims have occurred within any ten-year period, and the cumulative amount of such claims payments exceeds $20,000; or • For which at least two separate claims payments have been made with the cumulative amount of the building portion of such claims exceeding the value of the property, when two such claims have occurred within any ten-year period.
Application Process	The primary responsibility for processing and administering mitigation activity funding resides with SEMO. The State sets mitigation priorities and selects project applications in accordance with State planning and mitigation objectives. Potential sub-applicants for project	Applicants applying for funding must apply electronically through FEMA's e-grant application. Sub-applicants apply directly to the State (SEMO), who reviews and prioritizes sub-applications. The applicant (SEMO) submits the application to FEMA for review and approval.	*Same as FMA*	Applicants must apply using paper OMB and FEMA forms, including the e-Grants project sub-application. Sub-applicants process is the same as described in FMA	*Same as FMA*

Program Element	Hazard Mitigation Grant Program (HMGP)	Flood Mitigation Assistance (FMA)	Pre-Disaster Mitigation-Competitive (PDM-C)	Repetitive Flood Claims (RFC)	Severe Repetitive Loss (SRL)
	or planning grants must send a Letter Of Intent (LOI), followed by a completed project application. After SEMO has reviewed and prioritized potential mitigation projects, applications are forwarded to FEMA for final review and approval.				
Sample Eligible Projects	Acquiring and relocating structures from hazard-prone areas, Retrofitting structures to protect from natural hazards, and constructing certain types of minor and localized flood control projects. Grant monies can be used to fund both public and private projects, as long as the projects fit within State and local government mitigation strategy objectives and goals. Generally speaking, this is program provides the most funding for hazard mitigation project and planning grants .	Elevation of structures; Dry flood-proofing of non-residential structures; acquisitions; structure relocations w/ property deed restricted to open space; structure demolitions; and, minor flood control activities	Voluntary acquisitions of real property for open space conversion; relocation or elevating structures; structural & non-structural retrofitting to meet or exceed building codes. Hydrologic and Hydraulic studies/analyses, engineering studies, and drainage studies, which must be tied in with a proposed project; and, vegetation management for natural dune restoration	Acquisition, structure demolition, or structure relocation w/ property deed restrictions for open space. The RFC program has broadened the eligible project types to include Dry Flood proofing of non-residential structures; and Minor Localized Flood Control Projects (funding limited to $1M per project).	Same as FMA. Funds can also be used for mitigation reconstruction of damaged structures
Fiscal Year 2007 Funds	Funds from this program vary from year-to-year. Program funding is contingent upon the total Presidential declared disaster funding from Individual (IA) and Public Assistance (PA). Generally speaking, 15% of the total Public and Individual Assistance for a specific disaster is allocated towards this program. For this grant program, FEMA requires a 75% Federal share, minimum 25% non-Federal match	31 million has been allocated nationwide for this program. FEMA requires a 75% Federal share, minimum 25% non-Federal match. The FMA program is an annual program and funding is a state allocation of approximately $900,000 annually generated by a surcharge on flood insurance premiums, unlike the PDM or RFC program which is a state wide competitive program.	$100 million has been allocated nationwide for this program. FEMA requires a 75% Federal share, minimum 25% non-Federal match. Small impoverished communities may be eligible for up to 90% Federal cost-share.	10 million is allocated for this program nationwide. Up to 100% Federal funding is available (No non-Federal match requirement)	FEMA is combining $40 million from FY 2006 and $40 million from FY 2007 for a total of $80 million. $40 million has been allocated nationwide from FY 2005 – FY 2009. FEMA requires a 75% Federal share, minimum 25% non-Federal match.

8) Hazard Mitigation Fact Sheet for Mitigation Planning Council

What is Hazard Mitigation?
Hazard mitigation is any sustained action taken to reduce or eliminate the long-term risk to human life and property from natural hazards.

Why develop a Hazard Mitigation Plan?

- Break the continuous cycle of disasters
- Resiliency
- Proactive approach
- Funding

What is a Mitigation Action?
Mitigation Actions include programs, plans, projects or policies within your agency that help reduce or eliminate the long-term risk to human life and property from natural hazards. These actions fall under 6 major categories:

1) **Prevention**
Government administrative or regulatory actions or processes that influence the way land and buildings are developed and built. These actions also include public activities to reduce hazard losses. Examples include planning and zoning, building codes, capital improvement programs, open space preservation, and storm water management regulations.

2) **Property Protection**
Actions that involve the modification of existing buildings or structures to protect them from a hazard, or removal from the hazard area. Examples include acquisition, elevation, relocation, structural retrofits, storm shutters, and shatter-resistant glass.

3) **Public Education and Awareness**
Actions to inform and educate citizens, elected officials, and property owners about the hazards and potential ways to mitigate them. Such actions include outreach projects, real estate disclosure, hazard information centers, and school-age and adult education programs.

4) **Natural Resource Protection**
Actions that, in addition to minimizing hazard losses, also preserve or restore the functions of natural systems. These actions include sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.

5) **Emergency Services**
Actions that protect people and property during and immediately after a disaster or hazard event. Services include warning systems, emergency response services, and protection of critical facilities.

6) **Structural Projects**
Actions that involve the construction of structures to reduce the impact of a hazard. Such structures include dams, levees, floodwalls, seawalls, retaining walls, and safe rooms.

The MPC is representatives from approximately 40 agencies and organizations that may have an interest in reducing the impact of natural hazards. Members of the MPC will identify existing and potential projects within their agency that will mitigate natural hazards.

MPC Members

NYC		Other	
DCAS	EDC	Amtrak	MTA-NYCT
DCP	FDNY	Con Ed	MTA-TB&T
DDC	HHC	LIPA	National Grid
DEP	HPD	MTA-Buses	NWS
DFTA	HRA	MTA-Police	PANYNJ
DHS	LPC	MTA-HQ	RPA
DOB	NYCHA	MTA-LIRR	US ACE
DOC	NYPD	MTA-MNR	Verizon
DOE	OEM		
DOHMH	OMB		
DoITT	OLTPS		
DOT	Parks		
DSNY	SBS		

What are the goals of the MPC?

- Develop, review, revise and maintain the HMP
- Provide a forum for mitigation issues, programs, policies and projects
- Develop and foster mitigation partnerships

What is the New York City Mitigation Planning Council Steering Committee?
A subset of the Mitigation Planning Council, the MPC Steering Committee (MPCSC) will help OEM develop a Mitigation Strategy out of the project descriptions provided by the larger MPC.

MPCSC Members

NYC	Other
DOB	MTA
DCP	RPA
DEP	
DOT	
OEM	
OLTPS	
PARKS	

9) Sample Mitigation Actions for the Mitigation Planning Council

Mitigation Action*	Hazard(s)	Mitigation Action Description	Potential Agencies	Origin
All Agencies				
Acquisition of Land	All Hazards	Land acquisition resulting in open space or development restriction/prevention in a hazard area is a fundamental form of hazard mitigation.	All Agencies	NYS Hazard Mitigation Plan
Continuity of Operations	All Hazards	Continue to enhance and verify information in Agency COOP Plans. This includes mission critical personnel, facilities, systems, equipment, documentation, and files.	OEM, All Agencies	NYS Hazard Mitigation Plan
Promote hardening of NYC government facilities to increase resistance to natural hazards	All Hazards	Protect critical government facilities– prioritize structural and non-structural retrofits based on hazard vulnerability analysis.	All Agencies	NYS Hazard Mitigation Plan
Critical facility protection	All Hazards	Promote hardening of existing and future critical facilities from the effects of natural hazards	All Agencies	NYS Hazard Mitigation Plan
Facilities Hardening	Hurricane	Enhance facilities design to endure severe wind, rain and storm surge events.	All Agencies	Miami Hazard Mitigation Plan Hazard Mitigation Plan
Amtrak				
Bridge Seismic Retrofit	Earthquake	Seismically Retrofit Bridges	AMTRAK	Seattle Hazard Mitigation Plan
HRA				

Mitigation Action*	Hazard(s)	Mitigation Action Description	Potential Agencies	Origin
All Agencies				
Crisis Counseling	All Hazards	Training and certifying local crisis counselors through local agencies and/or FEMA Emergency Management Institute where they receive crisis counseling, program training and certification in crisis management	HRA	NYS Hazard Mitigation Plan
MTA				
Bridge Safety Assurance	Flood, Coastal Storm, Earthquake, Tornado	Develop a program to assess a bridge's relative vulnerability to the different modes of failure (scour, overloads, steel detail deficiencies, collision, concrete detail deficiencies & earthquakes).	MTA	NYS Hazard Mitigation Plan
Bridge Inspections	Flood, Coastal Storm, Earthquake, Tornado	Continue to inspect NYC bridges for faults and structural defects.	MTA	NYS Hazard Mitigation Plan
Seismically Retrofit Bridges	Earthquake	Strengthen bridges providing access to critical areas and services	MTA	Seattle Hazard Mitigation Plan
DOB				
Hazard Mitigation through Local Waterfront Revitalization Plans (LWRP)	Flood, Coastal Storm	Promote, provide technical assistance and the availability of funding sources for the development of Local Water Front Revitalization Plans including incorporation of flood mitigation considerations.	DOB	NYS Hazard Mitigation Plan
Advance Citywide Hazard Mitigation through Programmatic and Regulatory Initiatives	All Hazards	Continue NYC Disaster Preparedness efforts to guide and advance citywide hazard mitigation initiatives. Encourage city agencies to incorporate mitigation activities in day-to-day operations.	DOB	NYS Hazard Mitigation Plan
Public and Local Officials Education – Mitigation through Hazard Resistant Construction	Earthquake, Severe Windstorms, Flood, Winter Storm	Enhance efforts to educate NYC citizens and local officials regarding hazard resistant construction methods	DOB	NYS Hazard Mitigation Plan

Mitigation Action*	Hazard(s)	Mitigation Action Description	Potential Agencies	Origin
All Agencies				
Address and Explore Loss Reduction Options for Defined Repetitive Loss Properties	Flood, Coastal Storm	Assist communities to identify repetitive loss locations and support search for potential funding to mitigate future loss.	DOB	NYS Hazard Mitigation Plan
Repetitive Loss Properties	Flood, Coastal Storm	Identify & Mitigate Repetitive Loss Properties. Continue and enhance comprehensive loss reduction efforts to target repetitive loss properties for mitigation including acquisition and appropriate retrofit of structures.	DOB	NYS Hazard Mitigation Plan
Building Codes	All Hazards	Increase effectiveness to mitigation impacts of natural hazards through comprehensive training and certification. Enhance building code enforcement through training programs and promotion of the codes at all levels; in particular, the building and developers industry.	DOB	NYS Hazard Mitigation Plan
Seismic Upgrade of Standpipe	Earthquake	Ensure standpipes can withstand local seismic activity.	DOB	Seattle
Building Damage Assessment, Post disaster	All Hazards	Continue code enforcement disaster assistance to support response and recovery efforts. Promote the mitigation benefits of the disaster response team via agency training and local community awareness	DOB	NYS Hazard Mitigation Plan
Map Enhancement -- Flood Vulnerability	Flood/Coastal Storm	Improve/enhance flood vulnerability data including alternative analysis and Cost Benefit analysis. Enhance planning using surveys to more accurately define flood vulnerability.	DOB	Houston Hazard Mitigation Plan
DCP				

Mitigation Action*	Hazard(s)	Mitigation Action Description	Potential Agencies	Origin
All Agencies				
Promote the hazard mitigation potential of existing planning initiatives and mechanisms including Local Waterfront Revitalization Plans (LWRP)	Flood, Coastal Storm	Promote, provide technical assistance for the development of Local Water Front Revitalization Plans including incorporation of flood mitigation considerations.	DCP	NYS Hazard Mitigation Plan
Advance Citywide Hazard Mitigation through Programmatic and Regulatory Initiatives	All Hazards	Continue NYC Disaster Preparedness efforts to guide and advance citywide hazard mitigation initiatives. Encourage city agencies to incorporate mitigation activities in day-to-day operations.	DCP	NYS Hazard Mitigation Plan
Map Enhancement -- Flood Vulnerability	Flood/Coastal Storm	Improve/enhance flood vulnerability data including alternative analysis and Cost Benefit analysis. Enhance planning using surveys to more accurately define flood vulnerability.	DCP	Houston Hazard Mitigation Plan
Parks				
Rip Rap	Hurricane, Coastal Erosion	Mitigation for the City's shoreline rip rap areas.	Parks	Miami Hazard Mitigation Plan
NYC Dredging Projects	Hurricane	Identify new/existing dredging projects throughout the city. The benefits would include reduced damage to the communities from exacerbated flooding, and would also protect these areas from future events, and greatly mitigate potential damages.	Parks	Miami Hazard Mitigation Plan
Beach and Dune Restoration and Maintenance	Hurricane	Renourishment of coastal erudition areas	Parks	Miami Hazard Mitigation Plan

Mitigation Action*	Hazard(s)	Mitigation Action Description	Potential Agencies	Origin
All Agencies				
Promote the hazard mitigation potential of existing planning initiatives and mechanisms including Local Waterfront Revitalization Plans (LWRP)	Flood, Coastal Storm	Promote, provide technical assistance for the development of Local Water Front Revitalization Plans including incorporation of flood mitigation considerations.	Parks	NYS Hazard Mitigation Plan
Map Enhancement -- Flood Vulnerability	Flood/Coastal Storm	Improve/enhance flood vulnerability data including alternative analysis and Cost Benefit analysis. Enhance planning using surveys to more accurately define flood vulnerability.	Parks	Houston Hazard Mitigation Plan
Tree Pruning and Maintenance	Hurricane	Proper pruning and thinning of the tree canopy is important to minimize damage during hurricanes. Improperly maintained trees damage utilities, building structures and automobiles and require extensive clean up after storms.	Parks	Miami Hazard Mitigation Plan
Rebuild Seawall	Earthquake, Coastal Erosion	Prevent bank erosion and seismic upgrades	Parks	Seattle Hazard Mitigation Plan
DSNY				
Weather Emergency Communication -NOAA Weather Radio (NWR) Alert Receivers	All hazards	Continue and enhance efforts to promote awareness and use of the NOAA Weather Alert receivers and warning program by all citizens, government agencies, and emergency managers. Continue and enhance encouragement of weather warning alert receivers	DSNY	NYS Hazard Mitigation Plan
SBS				
Development of a Contingency Planning Toolkit for Small Businesses	All Hazards	Promote Business Awareness About Disaster Contingency Planning	SBS	Seattle Hazard Mitigation

Mitigation Action*	Hazard(s)	Mitigation Action Description	Potential Agencies	Origin
All Agencies				
				Plan
Promote Hazard Mitigation Activity to Maintain Continuity of Business	All Hazards	Collaborate with the business community to promote communication and coordination in preparedness and response activities.	SBS	NYS Hazard Mitigation Plan
DOT				
NYC Highway Infrastructure	All Hazards	Design, construct, and maintain City highway infrastructure according to agency standards. Continue to follow agency policies and procedures; regularly review and adopt appropriate changes; conduct training.	DOT	NYS Hazard Mitigation Plan
Advance Citywide Hazard Mitigation through Programmatic and Regulatory Initiatives	All Hazards	Continue NYC Disaster Preparedness efforts to guide and advance citywide hazard mitigation initiatives. Encourage city agencies to incorporate mitigation activities in day-to-day operations.	DOT	NYS Hazard Mitigation Plan
Hazard Mitigation Program--Areaways	Earthquake	Retrofit or Fill Areaways	DOT	Seattle Hazard Mitigation Plan
Bridge Safety Assurance	Flood, Coastal Storm, Earthquake, Tornado	Develop a program to assess a bridge's relative vulnerability to the different modes of failure (scour, overloads, steel detail deficiencies, collision, concrete detail deficiencies & earthquakes).	DOT	NYS Hazard Mitigation Plan
Bridge Inspections	Flood, Coastal Storm, Earthquake, Tornado	Continue to inspect NYC bridges per year for faults and identifying and notifying owners about structural defects.	DOT	NYS Hazard Mitigation Plan
Bridge Seismic Retrofit	Earthquake	Seismically Retrofit Bridges	DOT	Seattle Hazard Mitigation Plan

Mitigation Action*	Hazard(s)	Mitigation Action Description	Potential Agencies	Origin
All Agencies				
Seawall & Viaduct Study	Earthquake	Study options for retrofitting or replacing Viaduct Infrastructure	DOT	Seattle Hazard Mitigation Plan
Rebuild Seawall	Earthquake/Erosion	Prevent bank erosion and seismic upgrades	DOT	Seattle Hazard Mitigation Plan
Replacing Span Wire Signals with Mast Arm Signals	Hurricane	Traffic signals mounted on steel mast arms resisted hurricane winds much more efficiently than the traffic signals mounted on span wires. As a result, damaged mast arm signals could be repaired faster and with much less cost per signal, while repairs to span wire installations are costly, cumbersome and time consuming.	DOT	Miami Hazard Mitigation Plan
Tree Pruning and Maintenance	Hurricane	Proper pruning and thinning of the tree canopy is important to minimize damage during hurricanes. Improperly maintained trees damage utilities, building structures and automobiles and require extensive clean up after storms.	DOT	Miami Hazard Mitigation Plan
FDNY				
Search and rescue	All Hazards	Increase Urban Search & Rescue capabilities through additional urban search and rescue teams as well as an evaluation of local capabilities.	FDNY	NYS Hazard Mitigation Plan

Mitigation Action*	Hazard(s)	Mitigation Action Description	Potential Agencies	Origin
All Agencies				
Adding Redundancy to Security Operations Center	All Hazards	Alarm monitoring and first responder dispatch operations are critical to an effective emergency response strategy. The ability to maintain operational continuity through and after an event would enable the security of critical facilities to continue to be monitored from a remote location out of harms way.	FDNY	Miami Hazard Mitigation Plan
Fire Codes	All Hazards	Create a program to develop and update codes to ensure fire safety, prevention, and suppression systems can withstand the effects of natural hazards.	FDNY	NYS Hazard Mitigation Plan
Seismic Upgrade of Standpipe	Earthquake	Ensure standpipes can withstand local seismic activity.	FDNY	Seattle
Building Damage Assessment, Post disaster	All Hazards	Continue code enforcement disaster assistance to support response and recovery efforts. Promote the mitigation benefits of the disaster response team via agency training and local jurisdiction awareness	FDNY	NYS Hazard Mitigation Plan
NYCHA				
Acquire Emergency Equipment	All Hazards	Acquire the following items to enhance the efficiency of recovery from emergency or natural disaster situations: [portable generators, lighting systems, spot coolers, chippers, grinders, radios, and more!]	NYCHA	Miami Hazard Mitigation Plan
Harden Building and Improve Drainage	Hurricane	To install window protection, replacement of roofs and/or drainage improvements throughout the various NYCHA properties.	NYCHA	Miami Hazard Mitigation Plan
Landmarks				

Mitigation Action*	Hazard(s)	Mitigation Action Description	Potential Agencies	Origin
All Agencies				
Promote the hazard mitigation potential of existing planning initiatives and mechanisms including Local Waterfront Revitalization Plans (LWRP)	Flood, Coastal Storm	Promote, provide technical assistance and the availability of funding sources for the development of Local Water Front Revitalization Plans including incorporation of flood mitigation considerations.	Landmarks	NYS Hazard Mitigation Plan
Address and Explore Loss Reduction Options for Defined Repetitive Loss Properties	Flood, Coastal Storm	Assist communities to identify repetitive loss locations and support search for potential funding to mitigate future loss.	Landmarks	NYS Hazard Mitigation Plan
Repetitive Loss Properties	Flood, Coastal Storm	Identify & Mitigate Repetitive Loss Properties. Continue and enhance the comprehensive loss reduction efforts to target repetitive loss properties for mitigation including acquisition and appropriate retrofit of structures.	Landmarks	NYS Hazard Mitigation Plan
NYPD				
Search and rescue	All Hazards	Increase Urban Search & Rescue capabilities through additional urban search and rescue teams as well as an evaluation of local capabilities.	NYPD	NYS Hazard Mitigation Plan
Adding Redundancy to Security Operations Center	All Hazards	Alarm monitoring and first responder dispatch operations are critical to an effective emergency response strategy. The ability to maintain operational continuity through and after an event would enable the security of critical facilities to continue to be monitored from a remote location out of harms way.	NYPD	Miami Hazard Mitigation Plan
PANYNJ				
NYC Airport Flood Control	Flood	Identify and address flood problem areas in airport vicinity.	PANYNJ	Miami Hazard Mitigation Plan

Mitigation Action*	Hazard(s)	Mitigation Action Description	Potential Agencies	Origin
All Agencies				
Bridge Inspections	Flood, Coastal Storm, Earthquake, Tornado	Continue to inspect NYC bridges per year for faults and identifying and notifying owners about structural defects.	PANYNJ	NYS Hazard Mitigation Plan
Rip Rap	Hurricane, Coastal Erosion	Mitigation for shoreline rip rap areas.	PANYNJ	Miami Hazard Mitigation Plan
Bridge Seismic Retrofit	Earthquake	Seismically Retrofit Bridges	PANYNJ	Seattle Hazard Mitigation Plan
OEM				
Search and rescue	All Hazards	Increase Urban Search & Rescue capabilities through additional urban search and rescue teams as well as an evaluation of local capabilities.	OEM	NYS Hazard Mitigation Plan
Adding Redundancy to Security Operations Center	All Hazards	Alarm monitoring and first responder dispatch operations are critical to an effective emergency response strategy. The ability to maintain operational continuity through and after an event would enable the security of critical facilities to continue to be monitored from a remote location out of harms way.	OEM	Miami
Weather Emergency Communication -NOAA Weather Radio (NWR) Alert Receivers	All Hazards	Continue and enhance efforts to promote awareness and use of the NOAA Weather Alert receivers and warning program by all citizens, government agencies, and emergency managers. Continue and enhance encouragement of weather warning alert receivers	OEM	NYS Hazard Mitigation Plan

Mitigation Action*	Hazard(s)	Mitigation Action Description	Potential Agencies	Origin
All Agencies				
Emergency Alert System (EAS) (Radio and TV broadcast)	All Hazards	Support and enhance FCC EAS broadcast initiative by providing all NYC broadcasters with satellite distribution receivers.	OEM	NYS Hazard Mitigation Plan
Expand Disaster Aid & Response Teams Program (CERT)	All Hazards	Educate Public About Preparedness and Disaster Response	OEM	Seattle
Local Mitigation Collaboration	All Hazards	Build and establish mitigation relationships and increase mitigation awareness and training. Continue holding periodic NYC mitigation training to individual property owners, public education initiatives, conferences, builders and environmental groups. Identify areas of common interests, information sharing via websites, newsletters, etc. Develop an outreach program to local communities about mitigation planning, upgrading capabilities and technical resources.	OEM	NYS Hazard Mitigation Plan
Mitigation Planning and Project Resources	All Hazards	Increase mitigation planning and project activity by providing comprehensive assistance for agencies and organizations. Provide comprehensive technical assistance and training for mitigation including grant application and administration, plan development, and project identification.	OEM	NYS Hazard Mitigation Plan

Mitigation Action*	Hazard(s)	Mitigation Action Description	Potential Agencies	Origin
All Agencies				
Natural Hazard Analysis data and mapping	All Hazards	Enhance existing hazard analysis data and mapping and continue to improve efforts to make data accessible. Continue use of GIS mapping technology to develop and improve hazard mapping and vulnerability assessments. For instance, consider exploring use of real property data and overlay with landslide hazard characteristics (topographic and soils) data to identify vulnerable structures and to assist with hazard mitigation requirements, such as vulnerability assessment and loss estimation.	OEM	NYS Hazard Mitigation Plan
Notify-NYC	All Hazards	Encourage utilization of Notify-NYC.	OEM	NYS Hazard Mitigation Plan
Damage loss estimation for NYC government critical facilities	All Hazards	Analyze individual NYC critical facilities to determine potential loss from natural hazards. Conduct detailed loss assessment using databases and available hazard maps. Data sets should include other information such as building attributes, positional accuracy, natural hazard loss estimation which may be valuable to the hazard mitigation initiative.	OEM	NYS Hazard Mitigation Plan
Increase awareness of vulnerable NYC government facilities	All Hazards	Conduct hazard vulnerability awareness campaign to educate NYC government facility managers. Facilitate natural hazard awareness discussion during the annual NYC government facility manager conference.	OEM	NYS Hazard Mitigation Plan
Natural Hazard Events Database	All Hazards	Develop a natural hazard data base system to assist Local officials with risk assessment, mitigation, and other planning initiatives. Heighten awareness of natural hazard exposure by developing a comprehensive	OEM	NYS Hazard Mitigation Plan

Mitigation Action*	Hazard(s)	Mitigation Action Description	Potential Agencies	Origin
All Agencies				
		data base.		
Hazard Mitigation support via GIS mapping capabilities	All Hazards	Continue enhancement of GIS mapping capabilities to support current mitigation programs. Explore the possibilities and benefits of OEM or local agency GIS intranet program.	OEM	NYS
Complete Hazard Mitigation Risk Assessment	All Hazards	Assess Potential Risk	OEM	Seattle
Public Information Awareness	All Hazards	Update and provide public education programs\guide to community on natural hazards and actions to take to protect lives and property	OEM	Houston
Update Mitigation Activities and Track Results of Activities	All Hazards	Define and track Mitigation Initiatives to ensure proper implementation and development of future initiatives to ensure effective mitigation effects of future disasters.	OEM	Houston
Disaster Recovery Plan	Flood, Tropical Storms, Hurricane	This project will develop a GIS-based damage-tracking tool. Once this tool is complete, the City of New York will be capable of developing effective mitigation actions, measures, or strategies based on actual documented disaster data.	OEM	Houston

Mitigation Action*	Hazard(s)	Mitigation Action Description	Potential Agencies	Origin
All Agencies				
Planning Grant Critical Facilities - Prioritization and Development of Site Specific Criteria for Vulnerability of Critical Facilities	All Hazards	Identify critical facilities in the NYC that directly impact the safety, health, and welfare of residents. The list will be updated, and criteria for prioritization will be developed. The facilities will then be prioritized, using available vulnerability data and additional data gathered as necessary. This prioritized list will be used to target specific facilities for mitigation action.	OEM	Houston
Map Enhancement -- Flood Vulnerability	Flood/Coastal Storm	Improve/enhance flood vulnerability data including alternative analysis and Cost Benefit analysis. Enhance planning using surveys to more accurately define flood vulnerability.	OEM	Houston
DEP				
Promote land-use practices that will reduce risk from natural hazard	All Hazards	Continue promoting comprehensive and cost-effective recommendations for local land-use plans and ordinances that reduce loss from natural hazards. Provide technical assistance and training material for local officials to improve understanding of potential land-use policies and ordinances to mitigate hazards.	DEP	NYS Hazard Mitigation Plan
Promote the hazard mitigation potential of existing planning initiatives and mechanisms including Local Waterfront Revitalization Plans (LWRP)	Flood, Coastal Storm	Development of Local Water Front Revitalization Plans including incorporation of flood mitigation considerations.	DEP	NYS Hazard Mitigation Plan
Seismic Upgrade--Pipeline Backbone System	Earthquake	Strengthen critical infrastructure/networks	DEP	Seattle
Seismic Upgrade--Pump Station Buildings	Earthquake	Protect Water Supply	DEP	Seattle

Mitigation Action*	Hazard(s)	Mitigation Action Description	Potential Agencies	Origin
All Agencies				
Retrofit Storm Water Pump Station	Hurricane	Modify the storm-water pump station to protect it from wind borne debris, inland flooding from storm surge and wind driven rain. Retrofit must be designed and constructed in accordance with NYC Building Code.	DEP	Miami
Drainage Mitigation	Hurricane, Coastal Erosion	Install and/or upgrade drainage systems throughout the NYC coastline to eliminate flooding and to treat stormwater runoff.	DEP	Miami
Storm Sewer Improvements	Flood	Implement design measures to enable the storm sewer system to convey runoff flows to a discharge point. Analyze sheet flow to determine additional measures necessary for larger storms (e.g. 100-year).	DEP	Houston
Map Enhancement -- Storm Surge Vulnerability	Hurricane - Flood	Elevation data obtained by field survey, in addition to data collected from existing plans and records, would be compiled into a database and the most vulnerable facilities and transportation links may be identified for mitigation actions.	DEP	Houston
Seismic Upgrade - Bridge Tanks	Earthquake	Protect Water Supply	DEP	Seattle
Seismic Upgrade - Park Tanks	Earthquake	Protect Water Supply	DEP	Seattle
Rip Rap	Hurricane, Coastal Erosion	Mitigation for the City's shoreline rip rap areas.	DEP	Miami
NYC Dredging Projects	Hurricane	Identify new/existing dredging projects throughout the city. The benefits would include reduced damage to the communities from exacerbated flooding, and would also protect these areas from future events, and greatly mitigate potential damages.	DEP	Miami

Mitigation Action*	Hazard(s)	Mitigation Action Description	Potential Agencies	Origin
All Agencies				
Beach and Dune Restoration and Maintenance	Hurricane	Renourish coastal areas	DEP	Miami
Advance Citywide Hazard Mitigation through Programmatic and Regulatory Initiatives	All Hazards	Continue NYC Disaster Preparedness efforts to guide and advance citywide hazard mitigation initiatives. Encourage city agencies to incorporate mitigation activities in day-to-day operations.	DEP	NYS Hazard Mitigation Plan
Public and Local Officials Education – Mitigation through Hazard Resistant Construction	Earthquake, Severe Windstorms, Flood, Winter Storm	Enhance efforts to educate NYC citizens and local officials regarding hazard resistant construction methods	DEP	NYS Hazard Mitigation Plan
Address and Explore Loss Reduction Options for Defined Repetitive Loss Properties	Flood, Coastal Storm	Assist communities to identify repetitive loss locations and support search for potential funding to mitigate future loss.	DEP	NYS Hazard Mitigation Plan
Repetitive Loss Properties	Flood, Coastal Storm	Identify & Mitigate Repetitive Loss Properties. Continue and enhance the comprehensive loss reduction efforts to target repetitive loss properties for mitigation including acquisition and appropriate retrofit of structures.	DEP	NYS Hazard Mitigation Plan
Map Enhancement -- Flood Vulnerability	Flood/Coastal Storm	Improve/enhance flood vulnerability data including alternative analysis and Cost Benefit analysis. Enhance planning using surveys to more accurately define flood vulnerability.	DEP	Houston
DDC				
Storm Sewer Improvements	Flood	Implement design measures to enable the storm sewer system to convey runoff flows to a discharge point. Analyze sheet flow to determine additional measures necessary for larger storms (e.g. 100-year).	DDC	Houston

Mitigation Action*	Hazard(s)	Mitigation Action Description	Potential Agencies	Origin
All Agencies				
Public and Local Officials Education – Mitigation through Hazard Resistant Construction	Earthquake, Severe Windstorms, Flood, Winter Storm	Enhance efforts to educate NYC citizens and local officials regarding hazard resistant construction methods	DDC	NYS Hazard Mitigation Plan
Building Codes	All Hazards	Increase effectiveness to mitigation impacts of natural hazards through comprehensive training and certification. . Enhance building code enforcement through training programs and promotion of the codes at all levels; in particular, the building and developers industry.	DDC	NYS Hazard Mitigation Plan
Building Damage Assessment, Post disaster	All Hazards	Continue code enforcement disaster assistance to support response and recovery efforts. Promote the mitigation benefits of the disaster response team via agency training and local jurisdiction awareness	DDC	NYS Hazard Mitigation Plan
DOITT				
Upgrade Agency communication system	All Hazards	Ensure agency communication systems are operable, in the event of a natural disaster.	DoITT	
Promote hazard mitigation activity to protect city agency information technology infrastructure	All Hazards	Continue awareness and training activity to promote cyber security readiness and response.	DoITT	NYS Hazard Mitigation Plan
Development of a Contingency Planning Toolkit for Small Businesses	All Hazards	Promote Business Awareness About Disaster Contingency Planning	DoITT	Seattle

Note:
* - These mitigation action examples were taken from other jurisdiction's hazard mitigation plans.

10) Potential Mitigation Actions to Model in HAZUS-MH for the Steering Committee

DOB

1. The City of New York recently enacted a set of new construction codes, which will be phased in between July 1, 2008 and July 1, 2009. The new construction codes contain provisions that will enhance the structural integrity of new buildings. In addition, enhanced connectivity requirements for structural components have been included so that buildings will better withstand an unanticipated event.
   - Will need very detailed specifics to determine if this can be modeled.
2. The City of New York recently enacted a set of new construction codes, which will be phased in between July 1, 2008 and July 1, 2009. The new construction codes will require new critical facilities - such as fire stations and hospitals - be designed with redundant structural systems. The current code has no such requirement.
   - Will need very detailed specifics to determine if this can be modeled.
3. The City of New York recently enacted a set of new construction codes, which will be phased in between July 1, 2008 and July 1, 2009. The new construction codes clarify current flood regulations and adopt the latest national standards for construction in flood zones, meeting or exceeding state and federal flood regulations.
   - Will need very detailed specifics to determine if this can be modeled.
4. The City of New York recently enacted a set of new construction codes, which will be phased in between July 1, 2008 and July 1, 2009. The new construction codes mandate that new critical facilities located in flood zones be raised higher than currently required.
   - Will need exact height of raise

DCP

1. Waterfront revitalization program: establish a build and no build line along waterfront
   - Will need details on setback for building along waterfront.
2. Increasing open space by regulating green zoning for yards. Will need to model paved yards before and open space after. N
   - Will only be able to model if specific numbers of area and/or homes are identified for regulation. .

DEP

1. Purchase Land to Construct and Recreate Wetlands: DEP anticipates the purchase of 126 acres on Staten Island
   - Provide location and details on acquisition.
2. Wetlands Restoration in Alley Creek, Paerdegat Basin, and Oakland Ravine - Restoration of wetlands to improve natural drainage of storm water to reduce storm flooding, improve harbor water quality and prevent coastal erosion

   - Need details on physical modifications taking place. If changing open space to improved open space, this may not work.

DOT

1. Expand use of pedestrian plazas and refuge islands that will incorporate street and open space trees to capture and hold storm water in the event of a coastal storm.
   - Need details for location and scale of projects to determine if potential action.
2. Curb Repair and Installation: Based on potential flooding areas, implement program to remediate low-level curbs with higher ones to prevent excess flooding into basements and other structures. Higher curbs insure that excess storm water runoff is channeled and discharged into catch basins or open channel.
   - Will need detailed information on location, number of curbs and height of old and new curbs.

Parks

1. Green streets - These projects involve transforming traffic medians from concrete areas into areas densely planted with trees and horticulture. Through curb cuts, swales, and precipitation, green streets absorb water that would have run off into the sewer system or flooded roadways
   - Need additional information on location and scale of project.
2. Land Acquisition Parks purchases or receives donations of available land. This land can be left in a natural state to absorb floodwaters, reduce heat impacts, and prevent construction in flood zones. Wetland in particular mitigates storm surge impacts.
   - Need additional information on location and scale of acquisition.

OLTPS

1. Open Space Expansion: Fulfill the potential of at least one major undeveloped park site in every borough
   - Need additional information on location and scale of open space expansion.
2. Drainage Improvement: Convert asphalt into multi-use fields
   - Need additional information on location and scale.
3. Drainage and Air Quality Improvement: Expand Green streets program (if large enough impact)
   - Need additional information on location and scale. Work with Parks on this action.
4. Drainage and Air Quality Improvement: Reforest 2,000 acres of parkland
   - Need additional information on location, scale and existing use of land.

11) Public Involvement Process

Draft Public Involvement Process

Section 201.6(b) of the Disaster Mitigation Act of 2000 (DMA 2000) requires that there be an open public involvement process in the formation of a plan. This process shall provide an opportunity for the public to comment on the plan during its formation as well as an opportunity for any neighboring communities, businesses, and other interested parties to participate in the planning process.

The following Public Involvement Process components are proposed to the MPC-SC:

1) **Academic Sector Meeting – Week of June 23, 2008 (Tentative)**
   a. This meeting will include a selection of representatives from universities located in NYC and the MPC-SC. This group will be leveraged to discuss and document cutting edge research in the fields of Hazard Mitigation, Architecture, and Engineering as it relates to the Hazard Mitigation Plan.
      i. Columbia University / Lamont Doherty – New York
      ii. City University of New York - City College - New York
      iii. City University of New York - Graduate School and University Center - New York
      iv. Manhattan College - Bronx
      v. Polytechnic University - Kings
      vi. The Cooper Union - New York
      vii. State University of New York Maritime College – Bronx
      viii. Barnard College - New York
      ix. Parsons – The New School University - New York
      x. New York Institute Of Technology-Manhattan Campus New York
      xi. New York University-New York
      xii. Pratt Institute- Kings
   b. Purpose of this meeting
      i. Provide Brief Overview of the Hazard Mitigation Plan
      ii. Discuss Draft Mitigation Action Worksheet which will be provided to participants prior to meeting.

2) **Private Sector Meeting – Week of August 4, 2008 (Tentative)**
   a. This meeting will offer an opportunity for a selection of representatives from the NYC Private Sector to participate in the planning process. This meeting will be strengthened by the presence of select MPC-SC members
      i. OEM Public/Private Coordinator
      ii. The Building Owners and Managers Association (BOMA) New York Association
      iii. NYC Small Business Services (SBS)
      iv. Regional Plan Association (RPA)
      v. Chamber of Commerce (All 5 Boros)

vi. American Institute of Architects (AIA) – NY Chapter
vii. Real Estate Board of NY (REBNY)
viii. Structural Engineers Association of New York (SEAoNY)

b. Purpose of this meeting
   i. Provide Brief Overview of the Hazard Mitigation Plan
   ii. Provide the Draft Mitigation Action Worksheet For Review and Comment

3) Community Meeting – Friday August 29, 2008 (Tentative)

a. This meeting will present the plan to representatives of the NYC community and seek their comments.
   i. Community Groups
   ii. Not-For-Profit Groups
   iii. CERT
   iv. Religious Organizations
   v. Elected Officials
   vi. Neighboring Communities
      1. Nassau, Westchester, Bergen, Essex, Union, Middlesex, and Monmouth Counties
b. Purpose of this meeting
   i. Provide Brief Overview of the Hazard Mitigation Plan
   ii. Direct group to the Draft Hazard Mitigation Plan For Review and Comment (Online)
c. General Public will have an opportunity to view and comment on the plan online.