3.5 – Hurricane Hazard Profile

The Mitigation Plan Development Team researched the Wind Event hazard and its effects on New York State. Contents of this section resulted from research and outreach including but not limited to the following sources:

- The Federal Emergency Management Agency (FEMA), www.fema.gov
- The National Hurricane Center (NHC), www.nhc.noaa.gov
- The National Climatic Data Center (NCDC), www.ncdc.noaa.gov
- The Public Entity Risk Institute (PERI), http://peripresdecusa.org/mainframe.htm

The following chart provides a few terms to know regarding a hurricane or tropical storm event

Term	Definition
Tropical Storm	An organized system of strong thunderstorms with a defined surface circulation and maximum sustained winds of 39-73 MPH
Hurricane	Tropical cyclones, formed in the atmosphere over warm ocean areas, in which wind speeds reach 74 mph or more and blow in a large spiral around a relatively calm center or "eye". Circulation is counterclockwise in the Northern Hemisphere.
Storm Surge	A dome of water pushed onshore by hurricane and tropical storm winds. Storm surges can reach 25 feet high and be 50-100 miles wide
Storm Watch	Hurricane/Tropical Storm conditions are possible in the specified area, usually within 36 hours.
Storm Warning	Hurricane/Tropical Storm conditions are expected in the specified area, usually within 24 hours.

Hurricane classification is determined by the Saffir-Simpson Scale. The National Hurricane Center defines the Saffir-Simpson Hurricane Scale as a 1-5 rating based on a hurricane's present intensity. This is used to give an estimate of the potential property damage and flooding expected along the coast from a hurricane landfall. Wind speed is the determining factor in the scale, as storm surge values are highly dependent on the slope of the continental shelf and the shape of the coastline, in the landfall region.

Table 3-21
Saffir-Simpson Hurricane Scale

Scale Number (Category)	Sustained Winds (MPH)	Damage	Storm Surge
1	74-95	Minimal: Unanchored mobile homes, vegetation and signs.	4-5 feet
2	96-110	Moderate: All mobile homes, roofs, small crafts, flooding.	6-8 feet
3	111-130	Extensive: Small buildings, low-lying roads cut off.	9-12 feet
4	131-155	Extreme: Roofs destroyed, trees down, roads cut off, mobile homes destroyed. Beach homes flooded.	13-18 feet
5	More than 155	Catastrophic: Most buildings destroyed. Vegetation destroyed. Major roads cut off. Homes flooded.	Greater than 18 feet

FEMA

Two major types of storm events generally impact the State's marine coastline and adjacent inland areas, hurricanes, and tropical storms. These storms can impact New York from June to November, which is the official eastern United States Hurricane season. However, late July to early October is the period that a hurricane or tropical storm is most likely to impact New York State, mainly due to the cooling of the North Atlantic Ocean waters during the earlier months of the season. According to the National Hurricane Center we are currently in a period of heightened hurricane activity that started around 1995 and could last at least another decade.

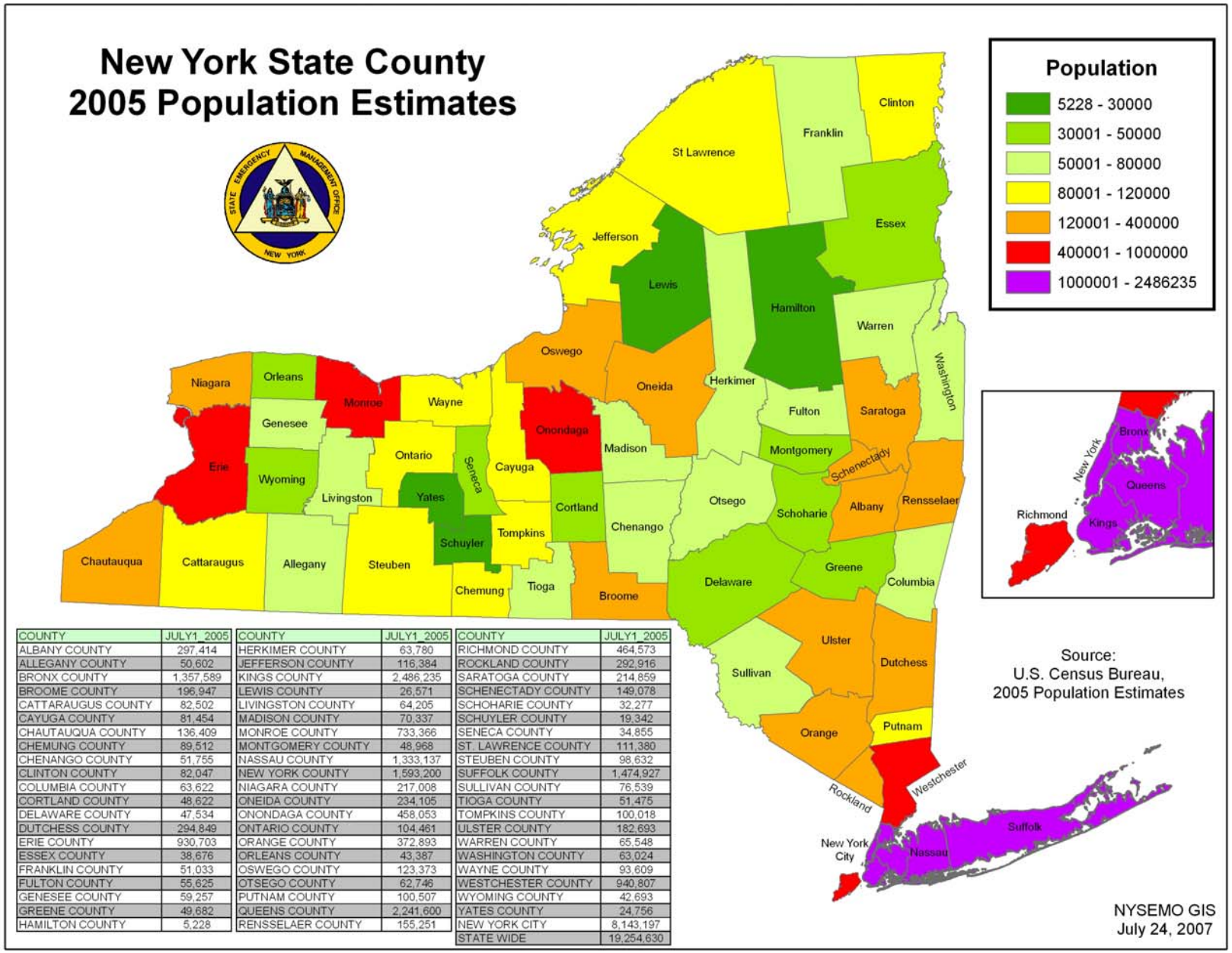
An extra-tropical storm (Nor'easters) typically occur during winter months. These storms are less intense, but can have localized wind velocities that generally reach hurricane strength. These winter storms are discussed later under the Winter Storms and Blizzards Hazard Profile.

Hurricanes and tropical storms have played an important role in the shaping of the present-day shoreline in New York State; their ability to erode coastlines and remove protective sand has dramatically altered the profile of the shores. The Department of Environmental Conservation (DEC) and the US Army Corps of Engineers have completed many coastal management projects to reduce the effects that Hurricanes and Tropical Storms have had and will have on New York, especially Long Island’s coastline and water ways. Some of these projects include Coastal Storm Damage Reduction, Inlet Dredging (Navigation), and Flood Damage Reduction. To reference a particular project please visit the US Army Corps of Engineers New York District web site at www.nan.usace.army.mil/.

Population Increase

The national trend that sees ever increasing numbers of substantial development along the coastline has also been evident in New York State. Accordingly, thousands of New Yorkers and the businesses now exist in areas that are vulnerable to hurricanes and tropical storms. See **Figure 3-86, Figure 1-1** in **Section 1,** and **Table 3-22**, which presents population density and growth across New York State.

Figure 3-86
NYS County 2005 Population Estimates



COUNTY	JULY1_2005
ALBANY COUNTY	297,414
ALLEGANY COUNTY	50,602
BRONX COUNTY	1,357,589
BROOME COUNTY	196,947
CATTARAUGUS COUNTY	82,502
CAYUGA COUNTY	81,454
CHAUTAUQUA COUNTY	136,409
CHEMUNG COUNTY	89,512
CHENANGO COUNTY	51,755
CLINTON COUNTY	82,047
COLUMBIA COUNTY	63,622
CORTLAND COUNTY	48,622
DELAWARE COUNTY	47,534
DUTCHESS COUNTY	294,849
ERIE COUNTY	930,703
ESSEX COUNTY	38,676
FRANKLIN COUNTY	51,033
FULTON COUNTY	55,625
GENESEE COUNTY	59,257
GREENE COUNTY	49,682
HAMILTON COUNTY	5,228

COUNTY	JULY1_2005
HERKIMER COUNTY	63,780
JEFFERSON COUNTY	116,384
KINGS COUNTY	2,486,235
LEWIS COUNTY	26,571
LIVINGSTON COUNTY	64,205
MADISON COUNTY	70,337
MONROE COUNTY	733,366
MONTGOMERY COUNTY	48,968
NASSAU COUNTY	1,333,137
NEW YORK COUNTY	1,593,200
NIAGARA COUNTY	217,008
ONEIDA COUNTY	234,105
ONONDAGA COUNTY	458,053
ONTARIO COUNTY	104,461
ORANGE COUNTY	372,893
ORLEANS COUNTY	43,387
OSWEGO COUNTY	123,373
OTSEGO COUNTY	62,746
PUTNAM COUNTY	100,507
QUEENS COUNTY	2,241,600
RENSSELAER COUNTY	155,251

COUNTY	JULY1_2005
RICHMOND COUNTY	464,573
ROCKLAND COUNTY	292,916
SARATOGA COUNTY	214,859
SCHENECTADY COUNTY	149,078
SCHOHARIE COUNTY	32,277
SCHUYLER COUNTY	19,342
SENECA COUNTY	34,855
ST. LAWRENCE COUNTY	111,380
STEUBEN COUNTY	98,632
SUFFOLK COUNTY	1,474,927
SULLIVAN COUNTY	76,539
TIOGA COUNTY	51,475
TOMPKINS COUNTY	100,018
ULSTER COUNTY	182,693
WARREN COUNTY	65,548
WASHINGTON COUNTY	63,024
WAYNE COUNTY	93,609
WESTCHESTER COUNTY	940,807
WYOMING COUNTY	42,693
YATES COUNTY	24,756
NEW YORK CITY	8,143,197
STATE WIDE	19,254,630

Table 3-22 shows estimated population growth within the Counties that are susceptible to Hurricane and Tropical storm damage. These estimates were made by the most recent data available from the US Census Data. Actual population figures will not be available until the 2010 Census.

Table 3-22

Estimated Population Growth For Counties Susceptible to Hurricane and/or Tropical Storm Damage

County	Census 2000 Data	Estimated Population Change Per Year						Total Estimated
	Apr-00	Jul-01	Jul-02	Jul-03	Jul-04	Jul-05	Jul-06	Population Change*
Suffolk	1,419,369	1,441,852	1,455,208	1,467,065	1,473,391	1,472,086	1,469,715	50,346
Nassau	1,334,544	1,337,069	1,339,514	1,338,864	1,336,843	1,331,620	1,325,662	(8,882)
Queens	2,229,379	2,236,424	2,234,000	2,224,238	2,250,718	2,256,576	2,255,175	25,796
Kings	2,465,326	2,475,837	2,481,122	2,483,164	2,497,859	2,511,408	2,508,820	43,494
Richmond	443,728	453,197	460,294	466,647	471,184	475,014	477,377	33,649
Bronx	1,332,650	1,348,418	1,361,973	1,367,244	1,367,529	1,364,566	1,361,473	28,823
New York	1,537,195	1,562,498	1,569,487	1,582,705	1,590,911	1,606,275	1,611,581	74,386
Westchester	923,459	935,095	941,254	943,772	946,577	947,719	949,355	25,896

Source: US Census/Population Estimate 7/07 ***Comparing 4/00-7/06**

Figure 3-87 and 3-88 show the FEMA designated wind zones that impact the State; these wind zones portray the frequency and strength of extreme windstorms. The generation of this map is based on 40 years of tornado history and over 100 years of hurricane history. **(NOTE: These Wind Zones are generated using past windstorm events and are not indicative of average/general wind speeds across the State)** Also indicated in **Figure 3-88** are the paths of tornadoes that have touched down in the State. Downed trees and the resulting debris as well as power failure caused by trees falling on power lines usually occur during these severe wind events. Power outages are detailed more in the **Power Failure Section** of this plan.

Figure 3-87

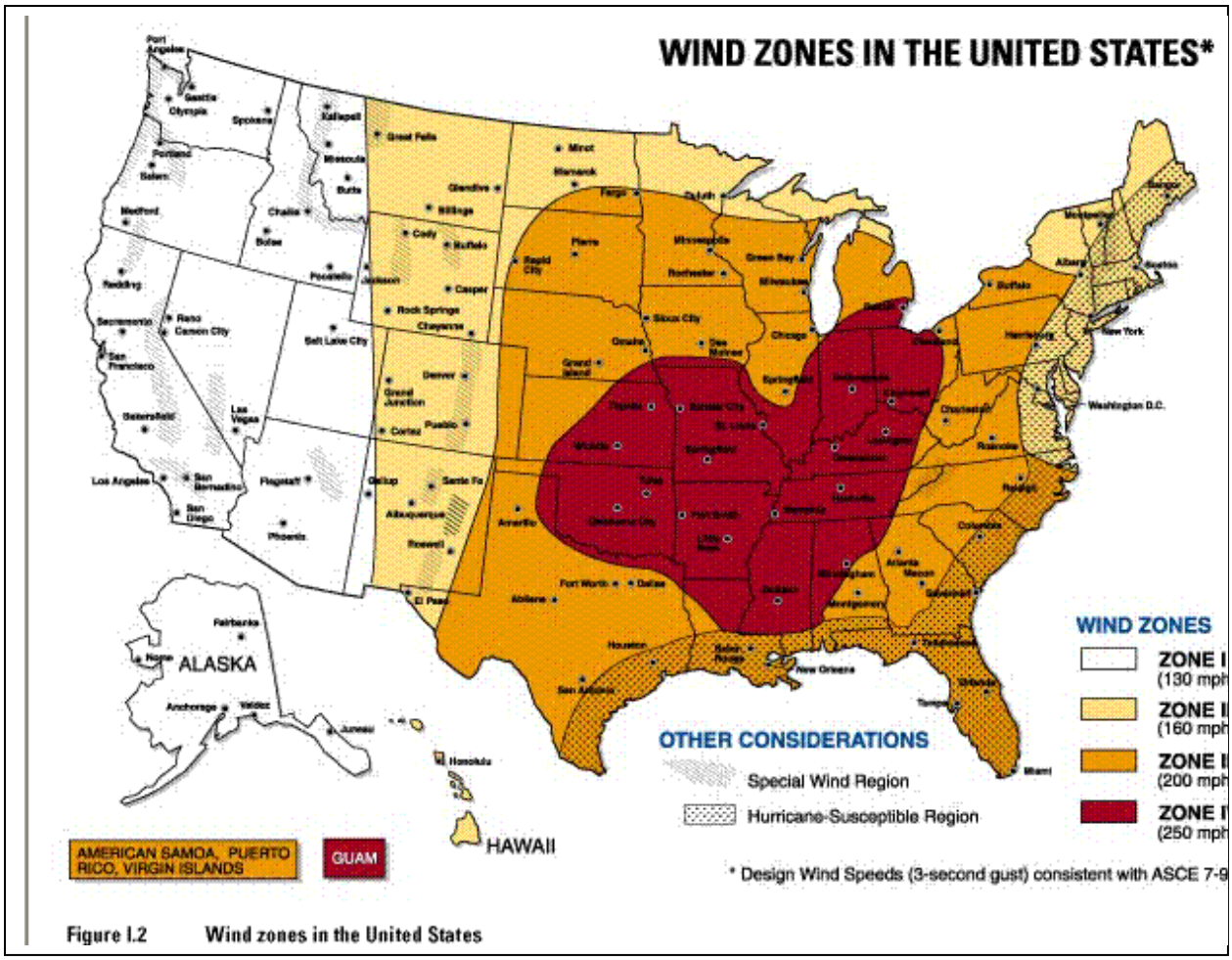
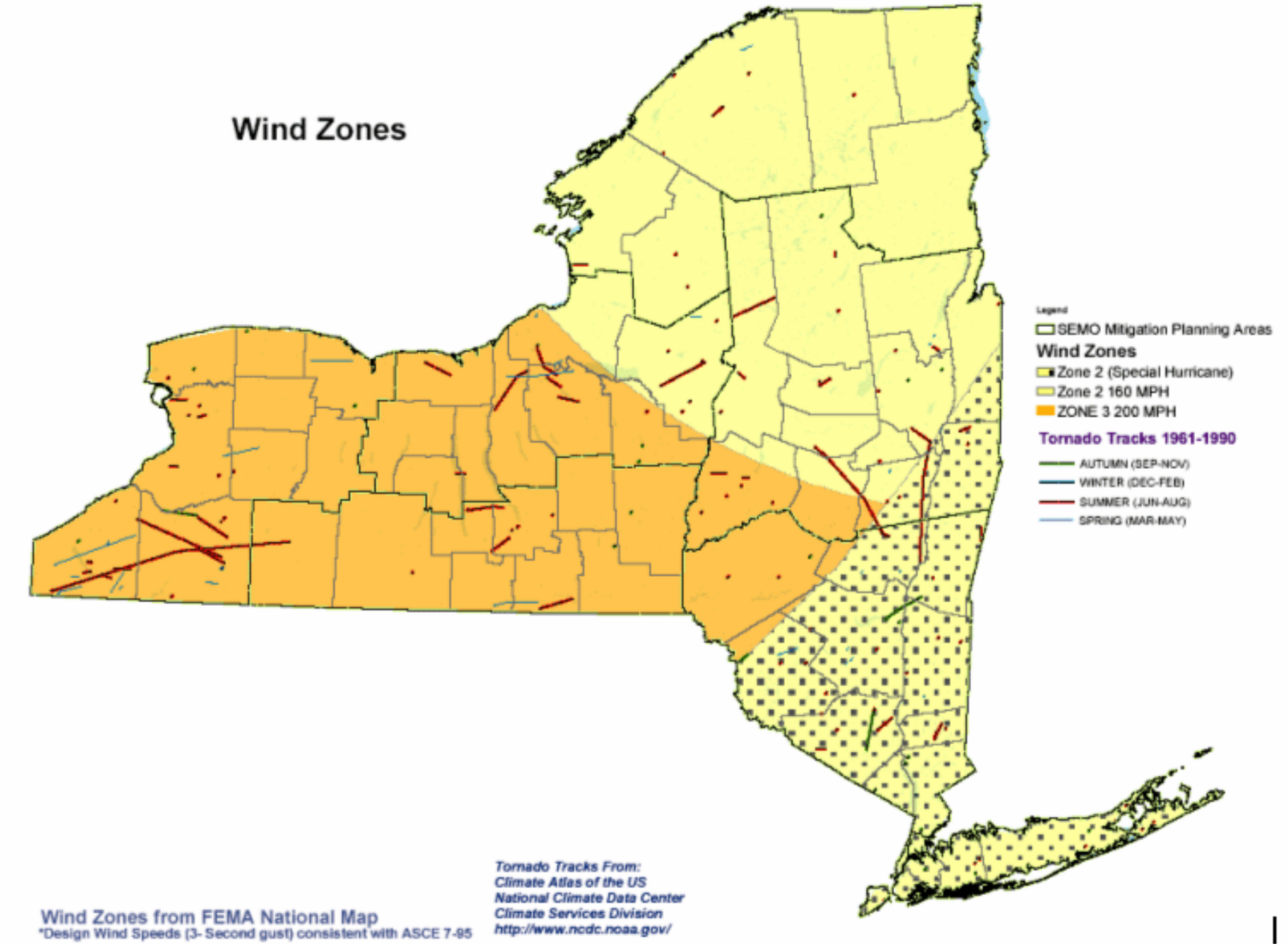

WIND ZONES IN THE UNITED STATES*
WIND ZONES
ZONE I
(130 mph
ZONE I
(160 mph
ZONE I
(200 mph
ZONE I
(250 mph
OTHER CONSIDERATIONS
Special Wind Region
Hurricane-Susceptible Region
ALASKA
HAWAII
AMERICAN SAMOA, PUERTO RICO, VIRGIN ISLANDS
GUAM
* Design Wind Speeds (3-second gust) consistent with ASCE 7-9
Figure I.2 Wind zones in the United States

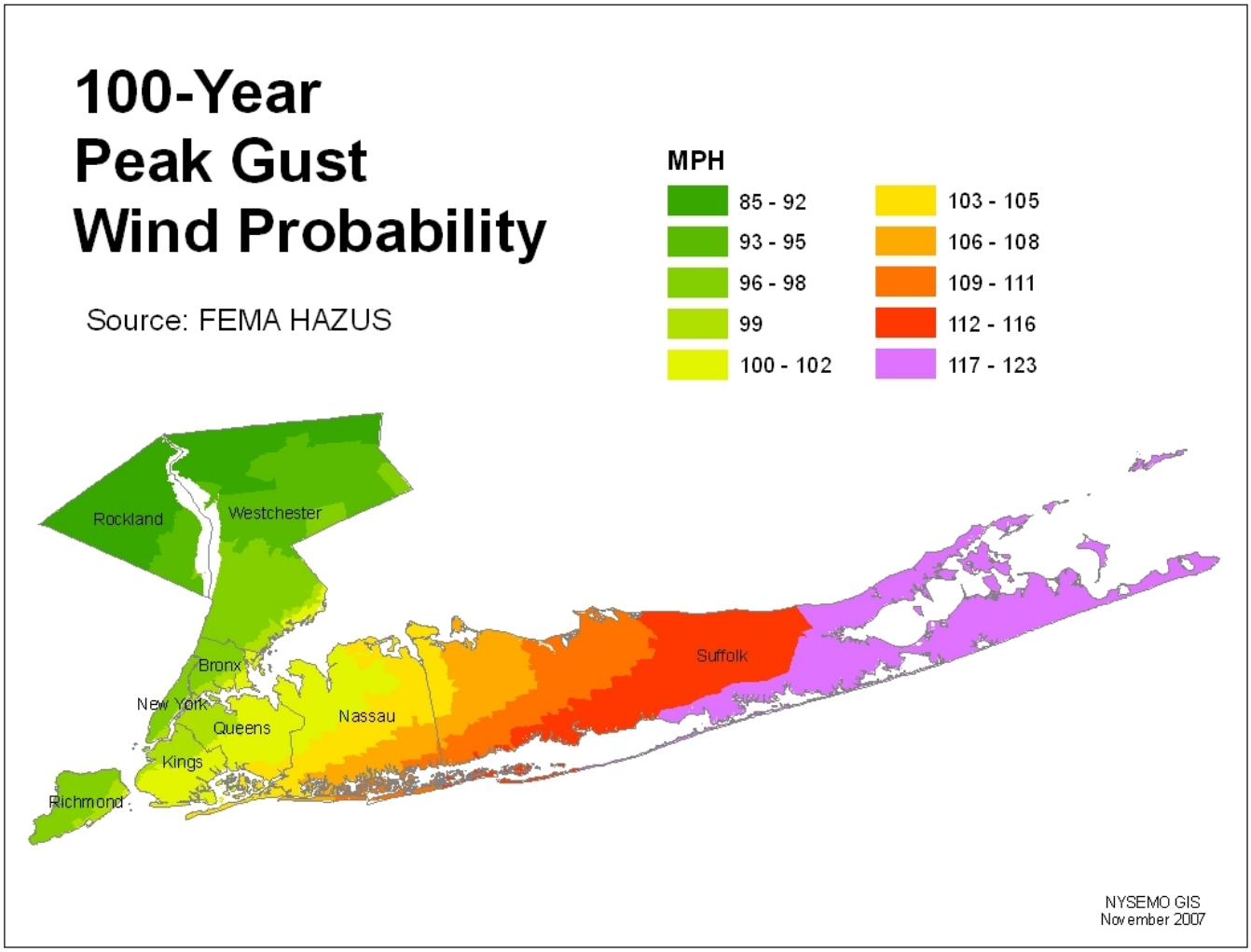
Figure 3-88


Wind Zones
Legend
SEMO Mitigation Planning Areas
Wind Zones
Zone 2 (Special Hurricane)
Zone 2 160 MPH
ZONE 3 200 MPH
Tornado Tracks 1961-1990
AUTUMN (SEP-NOV)
WINTER (DEC-FEB)
SUMMER (JUN-AUG)
SPRING (MAR-MAY)
Tornado Tracks From:
Climate Atlas of the US
National Climate Data Center
Climate Services Division
http://www.ncdc.noaa.gov/
Wind Zones from FEMA National Map
*Design Wind Speeds (3- Second gust) consistent with ASCE 7-95

Future Wind Probability Mapping for Coastal Hurricane Events

Through advancements in technology the ability to map probable wind areas/zones for Coastal Hurricane events has been greatly developed. The following map portrays the 100yr wind zone probabilities in MPH for a southern NYS hurricane event. This depiction gives greater insight into what type of high winds each jurisdiction is susceptible to and may have to deal with during a particular hurricane event.

Figure 3-89



Events

Figure 3-91 shows the path of twenty four (24) hurricanes that crossed over New York State from 1903 to 1989. The vast majority have been over the eastern part of the State, specifically the southeastern corner. This area includes the New York City metropolitan area and mid and lower Hudson Valley areas. These areas comprise roughly **61%** of the State's population. During this same period and since, tropical storms have also impacted the State.

Other severe storms, such as micro-bursts, straight line winds, and high winds that are usually associated with thunderstorms have caused impacts at various times throughout the State. One such storm, the 1995 Adirondack Windstorm is detailed in the Wildfire section of this plan.

Described and Depicted in **Table 3-23** and **Figure 3-90** are several hurricanes, tropical storms, and other severe wind events that have occurred in New York State between 1985 and 2007.

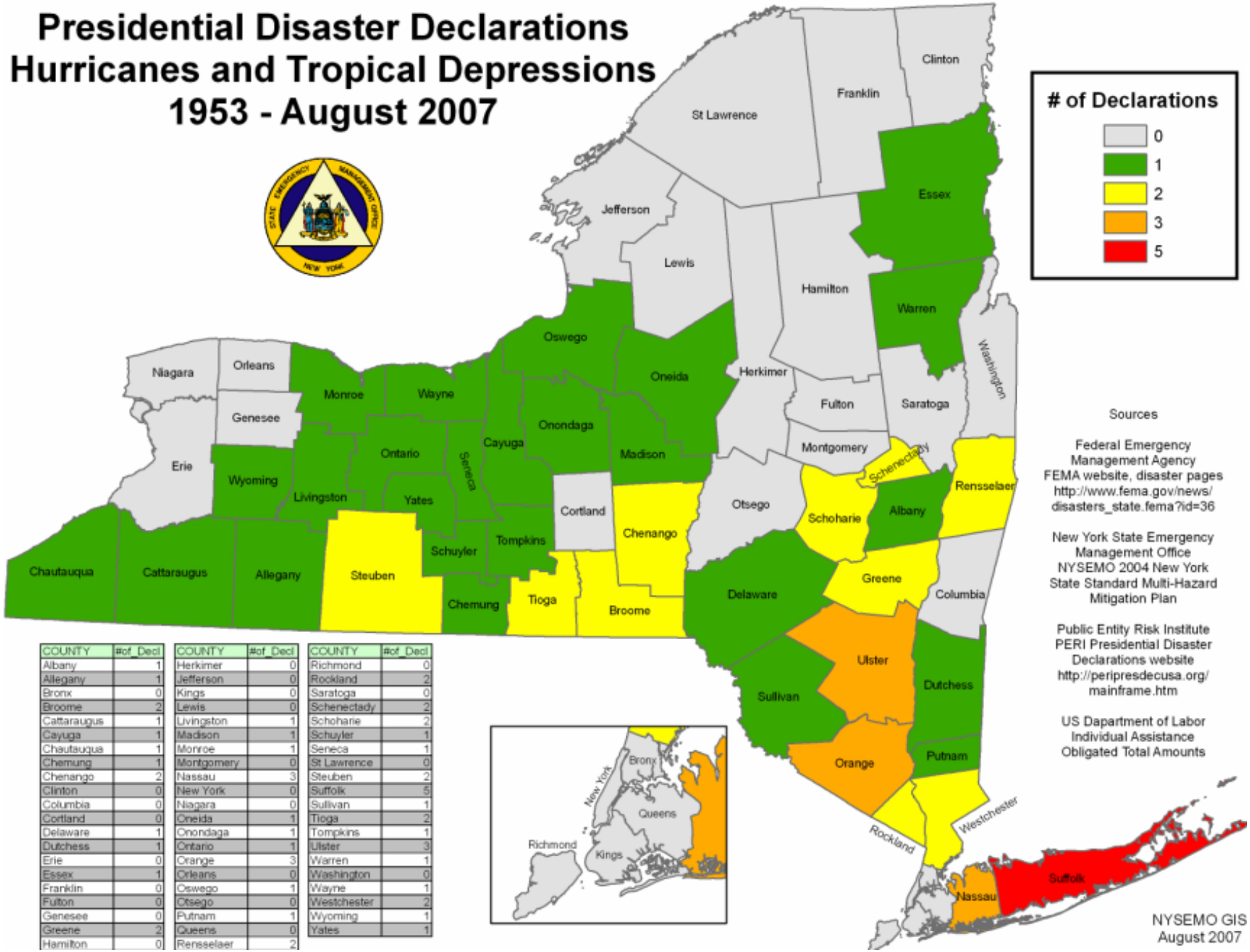
The resulting damages were of such severity that they were declared Major Disaster events. The types of damages ranged from coastal to riverine flooding and wind damage, primarily to trees and electric power lines. **Table 3-24** lists other severe wind events which resulted in damages of such a magnitude that the State requested a Federal disaster declaration. It will be noted that some Federal disaster declaration requests were denied for several of these events; one was withdrawn and one received an SBA/USDA disaster declaration.

TABLE 3-23
Historical Major Disaster Declarations

Disaster # & Date	Type of Event	Location Affected	Types and Extent of Impact
FEMA-750-DR-NY 10/18/85	Hurricane Gloria	Long Island	Flooding and coastal erosion, debris, damage to residential and commercial structures, utility lines, roads and other infrastructure
FEMA 974-DR-NY 12/21/92	Nor'easter	Nassau, New York City, Rockland, Suffolk, Westchester	Flooding and coastal erosion, debris, damage to residential and commercial structures, utility lines, roads and other infrastructure
FEMA 918-DR-NY 9/16/91	Hurricane Bob	Suffolk County	Flooding and coastal erosion, debris, damage to residential and commercial structures, utility lines, roads and other infrastructure
FEMA 1244-DR-NY 9/22/99	Severe Storm (Labor Day Storm)	Central New York	Flooding and severe wind damage to residential, governmental and utility facilities
FEMA 1296-DR-NY 9/16/99	Tropical Strom Floyd	Orange, Rockland, Ulster, Westchester,	Severe flooding to residential and commercial facilities, damage to roads, bridges and other infrastructure
FEMA 1335-DR-NY 7/21/2000	Severe Storms	Albany, Allegany. Cattaraugus, Chenango, Columbia, Dutchess, Erie, Essex, Greene, Herkimer, Lewis, Livingston, Maidison, Montgomery, Niagra, Oneida, Onodoga , Orleans, Ostego, Rensselaer, Schenectady, Schoharie, Streuben, Sullivan, Tioga, Tompkins, Ulster, & Yates	Flooding and severe wind damage to residential, governmental and utility facilities
FEMA 1486-DR-NY 8/29/2003	Severe Storms, Flooding, and Tornadoes	Allegany, Cattaraugus, Chemung, Columbia, Delaware, Fulton, Greene, Livingston, Madison, Montgomery, Ontario, Rensselaer, Schuyler, Steuben, Sullivan, Wyoming, & Yates	Flooding and severe wind damage to residential, governmental and utility facilities
FEMA 1565-DR-NY 10/01/2004	Tropical Depression Ivan	Broome, Chenango, Delaware, Orange, Schoharie, Steuben, Sullivan, Tioga, & Ulster	Flooding and coastal erosion, debris, damage to residential and commercial structures, utility lines, roads and other infrastructure
FEMA 1692-DR-NY 4/24/2007	Severe Storms and Inland and Coastal Flooding	Albany, Columbia, Dutchess, Essex, Greene, Montgomery, Orange, Putnam, Rockland, Schoharie, Suffolk, Ulster, & Westchester	Flooding and coastal erosion, debris, damage to residential and commercial structures, utility lines, roads and other infrastructure

Source: SEMO

Figure 3-90



COUNTY	#of_Decl
Albany	1
Allegany	1
Bronx	0
Broome	2
Cattaraugus	1
Cayuga	1
Chautauqua	1
Chemung	1
Chenango	2
Clinton	0
Columbia	0
Cortland	0
Delaware	1
Dutchess	1
Erie	0
Essex	1
Franklin	0
Fulton	0
Genesee	0
Greene	2
Hamilton	0

COUNTY	#of_Decl
Herkimer	0
Jefferson	0
Kings	0
Lewis	0
Livingston	1
Madison	1
Monroe	1
Montgomery	0
Nassau	3
New York	0
Niagara	0
Oneida	1
Onondaga	1
Ontario	1
Orange	3
Orleans	0
Oswego	1
Otsego	0
Putnam	1
Queens	0
Rensselaer	2

COUNTY	#of_Decl
Richmond	0
Rockland	2
Saratoga	0
Schenectady	2
Schoharie	2
Schuyler	1
Seneca	1
St Lawrence	0
Steuben	2
Suffolk	5
Sullivan	1
Tioga	2
Tompkins	1
Ulster	3
Warren	1
Washington	0
Wayne	1
Westchester	2
Wyoming	1
Yates	1

Table 3-24 lists previous disasters that affected New York State but were not declared a disaster by FEMA and thereby were not eligible to receive Federal Aid.

Table 3-24 FEDERAL DISASTER and EMERGENCY REQUEST TURNDOWNS IN NEW YORK STATE 1958 – 2001

Type of Request	Description	Dec. Date	Estimated Damage $ Mill	Action
Major Disaster	Hurricane	12/31/58	Unknown	Withdrawn
Major Disaster	Severe High Winds	07/10/73		Turned Down
Major Disaster	Severe Storms/Tornadoes	08/09/83		Turned Down
Major Disaster	Severe Storms and Flooding	07/21/76		Turned Down
Major Disaster	Severe Storms and Flooding	05/00/93		SBA/USDA
Major Disaster	Severe Storms and Flooding	05/31/80		Turned Down
Major Disaster	Coastal Storm	12/10/91	34.6	Turned Down
Major Disaster	Severe Storms/High Winds	09/21/95		Turned Down
Major Disaster	Severe Storms and Flooding	08/02/99		Turned Down
Major Disaster	Thunderstorm/Flooding	08/02/99		Turned Down
Major Disaster	Heavy Rains/Thunderstorm	10/19/00		Turned Down
Major Disaster	Rain	04/03/01		Turned Down

Source: State Emergency Management Office

In 1993, there were at least two well documented severe storm events; they occurred in the south eastern and central parts of the State causing severe erosion, debris, and power failure. The event that occurred in January 1993, impacted Westchester and Suffolk County and caused erosion damage that was estimated to cost close to $4 million. The Central New York event resulted with a less severe financial impact, almost $300,000, but given the rural nature of the area, the event was considered severe.

Table 3-25 lists, and **Figures 3-91 and 3-92** presents spatially, those hurricane storms that have tracked through New York State. It is important to mention that this data does not indicate that the storm event had a hurricane classification or category during its track through New York State.

Table 3-25
Historic Hurricane Tracking Through NYS

Hurricane Name	Date	*Saffir-Simpson Category
No Name	8/14/1888	N/A
No Name	8/15/1893	N/A
No Name	9/25/1893	N/A
No Name	10/1/1894	N/A
No Name	10/23/1899	1
No Name	9/12/1903	1
No Name	9/6/1928	4
No Name	9/22/1929	3
No Name	8/17/1933	2
No Name	6/4/1934	3
No Name	9/10/1938	3
No Name	8/7/1939	1
No Name	9/9/1944	3
No Name	9/12/1945	3
No Name	8/23/1949	3
Able	8/18/1952	1
Carol	8/25/1954	3
Hazel	10/5/1954	4
Connie	8/3/1955	3
Diane	8/7/1955	1
Audrey	6/25/1957	4
Gracie	9/20/1959	3
Donna	8/29/1960	4
Agnes	6/14/1972	1
Belle	8/6/1976	1
David	8/25/1979	2
Frederic	8/29/1979	3
Gloria	9/16/1985	3
Hugo	9/10/1989	4
Bob	9/16/1991	2
Floyd	9/19/1999	4
Katrina	9/30/2005	5

***Not indicative of Category during track through NYS**

Figure 3-91

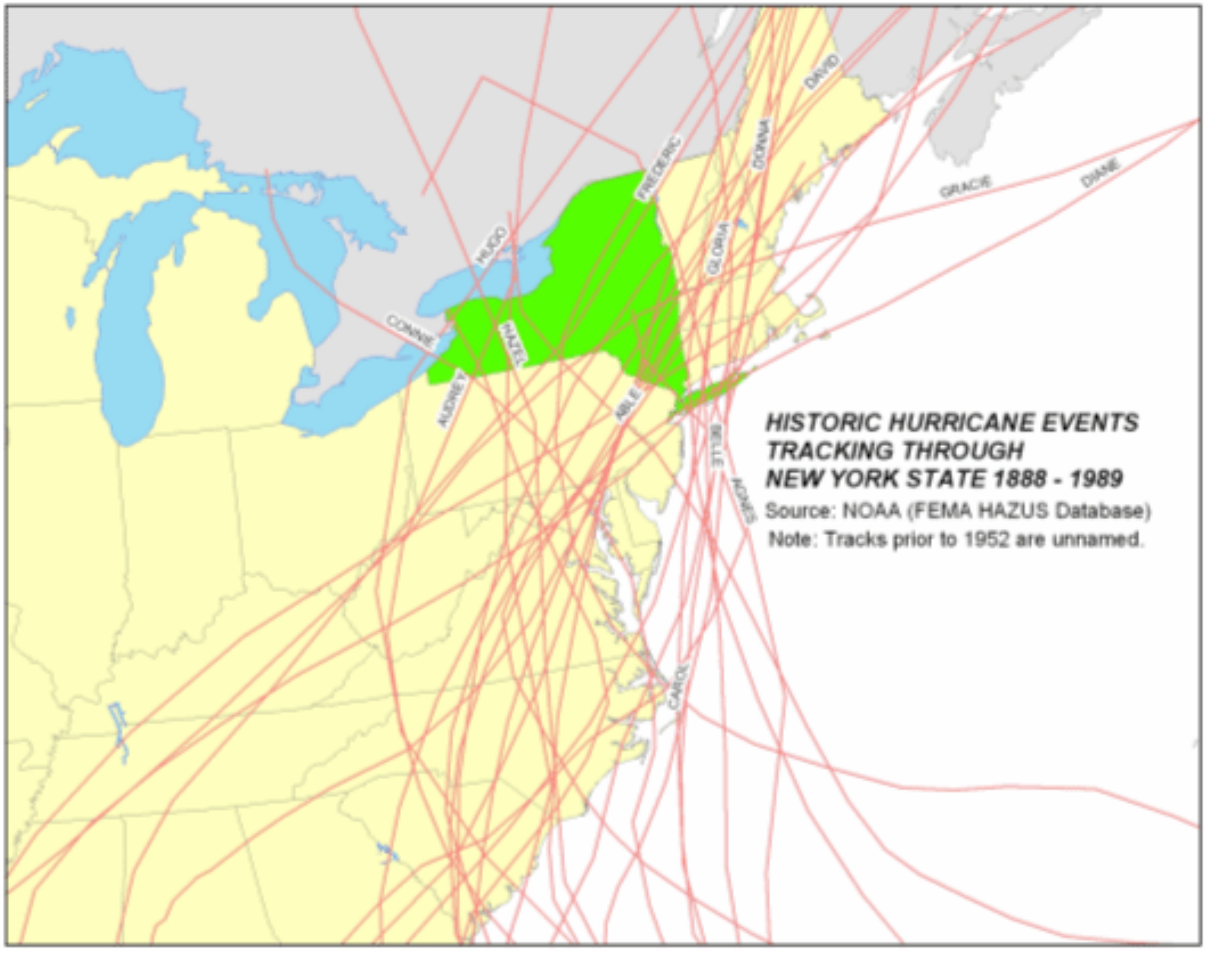
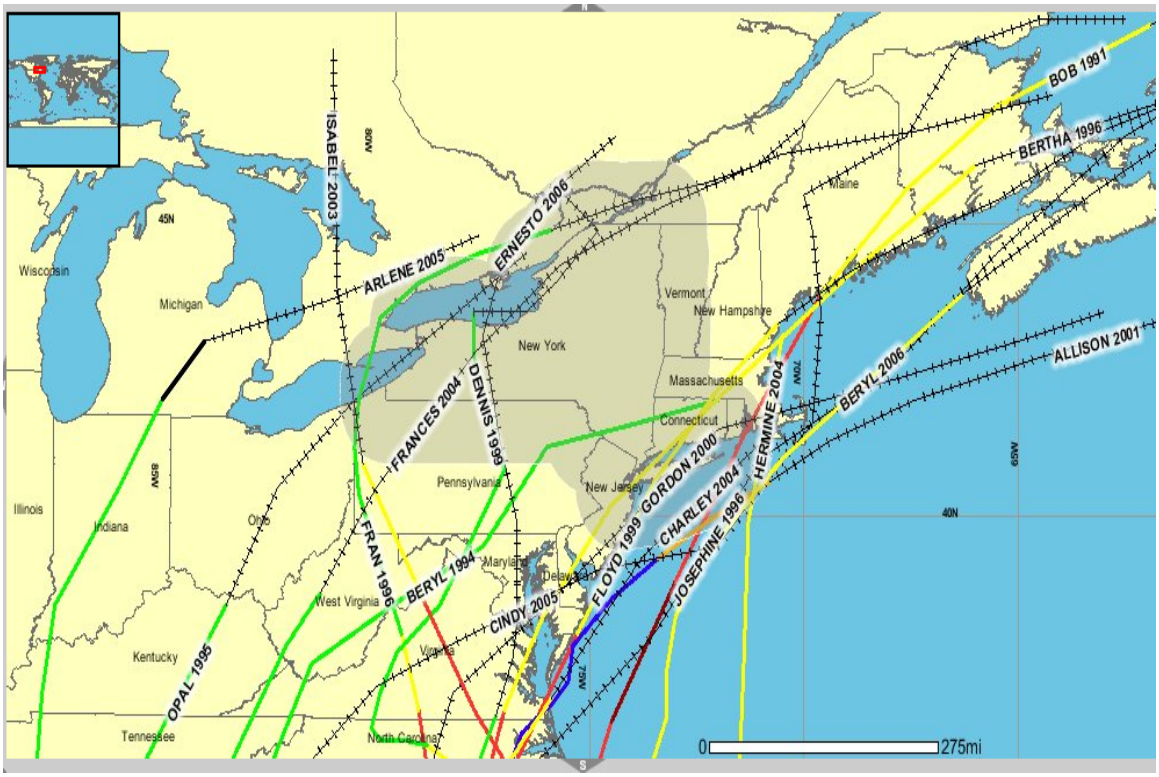

HISTORIC HURRICANE EVENTS
TRACKING THROUGH
NEW YORK STATE 1888 - 1989
Source: NOAA (FEMA HAZUS Database)
Note: Tracks prior to 1952 are unnamed.
DAVID
DONNA
FREDERIC
GLORIA
GRACIE
DIANE
HUGO
CONNIE
HAZEL
AUDREY
ABLE
BELLE
CAROL

Figure 3-92
1990-2006 Hurricane Tracks



Source: NOAA Coastal Services Center

State Facilities – Assessing Vulnerability and Estimating Loss for Wind Hazard:

Table 3-26 presents the result of the wind hazard vulnerability assessment and loss analysis for State facilities. The results present a gross estimate of potential wind losses to those identified vulnerable State facilities in terms of dollar value of exposed property. The wind hazard vulnerability analysis and loss estimation methodology was supported by GIS technology and involved collaboration with key State agencies. Collaboration resulted in the identification of two State databases that provided key facility information. The NYS Offices of General Services (OGS) fixed asset database and Cyber Security Critical Infrastructure Coordination (CSCIC) database included fields that provide coordinate location information and building replacement value in dollars. The analysis process involved creation of a GIS mapping layer showing facility location using the coordinate information and overlaid on a wind hazard layer developed using the FEMA Wind-Zone map data. The Mitigation Planning Committee acknowledges its applicability may not be appropriate beyond a general indication. The analysis results may be best used as a guide to help target those facilities that might benefit from further analysis. The Mitigation Planning Committee has established activities in our mitigation strategy that will advance the accuracy of the wind risk assessment through further analysis. Future analysis may include expressing potential loss based on historical wind loss events; continued application of GIS technology, use of HAZUS MH wind loss estimation software created by FEMA, and continue collaboration with state agency representatives in order to collect site and facility specific information that may improve the integrity of the wind vulnerability analysis.

Table 3-26
Wind Hazard Exposure (FEMA wind zone Hurricane-Susceptible Region)
New York State Agency Facilities

NY State Agency	Total Facilities	Total number # and percent % in Hurricane-susceptible region	Critical facilities total number # and percent % in Hurricane-susceptible region
Department of Environmental Conservation	1880	1516 (80.6%)	0
	$104,611,361	$81,275,100 (77.7%)	0
Department of Transportation	908	302 (33.3%)	0*
	$232,514,852	107,517,200 (46.2%)	0*
Office of General Services	130	101 (77.7%)	101 (77.7%)
	$2,133,659,048	$2,044,276,795 (95.8%)	$2,044,276,795 (95.8%)
State Emergency Management Office	4	1 (25%)	1 (25%)
	$3,365,434	$940,816 (28 %)	$940,816 (28 %)
Number of facilities Total	**2922**	**1920 (65.7%)**	**102 (3.5%)**
Approximate Replacement Value of Structure ($)	**$2,472,819,244**	**$2,234,009,911 (90.3%)**	**$2,045,217,611 (82.7%)**

Source: NYS Fixed Asset information -Offices of General Services and Cyber Security Critical Infrastructure Coordination data bases and FEMA wind zone map information. Analysis supported by GIS technology. * DOT facility determined critical is included in the OGS listing.

Table 3-26
Wind Hazard Exposure - FEMA Wind Zone 2 (up to 160mph)
New York State Agency Facilities

NY State Agency	Total Facilities	Total number and percent in Zone 2 up to 160mph	Critical facilities total number and percent in Zone 2 up to 160mph
Department of Environmental Conservation	1880	0	0
	$104,611,361	0	0
Department of Transportation	908	224 (24.7%)	0*
	$232,514,852	$38,674,128 (16.6%)	0*
Office of General Services	130	4 (3.1 %)	4 (3.1 %)
	$2,133,659,048	$29,478,919 (1.4%)	$29,478,919 (1.4%)
State Emergency Management Office	4	2 (50%)	2 (50%)
	$3,365,434	$1,002,095 (30 %)	$1,002,095 (30 %)
Number of facilities Total	**2922**	**230 (7.9%)**	**6 (.2%)**
Approximate Replacement Value of Structures ($)	**$2,472,819,244**	**$69,155,142 (2.8%)**	**$30,481,014 (1.2%)**

Source: NYS Fixed Asset information -Offices of General Services and Cyber Security Critical Infrastructure Coordination data bases and FEMA wind zone map information.* DOT facility determined critical is included in the OGS listing

Table 3-26
Wind Hazard Exposure - FEMA wind Zone 3 (up to 200mph)
New York State Agency Facilities

NY State Agency	Total Facilities	Total number and percent in Zone 3 up to 200mph	Critical facilities total number and percent in Zone 3 up to 200mph
Department of Environmental Conservation	1880	364 (19.4%)	0
	$104,611,361	$23,336,261 (22.3%)	0
Department of Transportation	908	382 (42.1%)	0*
	$232,514,852	$86,323,524 (37.1%)	0*
Office of General Services	130	25 (19.2 %)	25 (19.2 %)
	$2,133,659,048	$59,903,334 (2.8%)	$59,903,334 (2.8%)
State Emergency Management Office	4	1 (25%)	1 (25%)
	$3,365,434	$91,072 (2.7%)	$91,072 (2.7%)
Number of facilities Total	**2922**	**772 (26.4%)**	**26 (.9%)**
Approximate Replacement Value of Structures ($)	**$2,472,819,244**	**$169,654,191 (6.9%)**	**$59,994,406 (2.4%)**

Source: NYS Fixed Asset information -Offices of General Services and Cyber Security Critical Infrastructure Coordination data bases and FEMA wind zone map information. * DOT facility determined critical is included in the OGS listing

Estimating Potential Loss for Wind Hazard by Jurisdiction

Table 3-27 presents the results of our vulnerability assessment; it identifies the Counties most vulnerable to wind hazard as determined by a final rating score. Each County accumulates points based on the value of each vulnerability indicator, the higher the indication for wind exposure the more points assigned resulting in a final rating score. The results of our wind vulnerability assessment present a gross indication of Counties most threatened by and vulnerable to wind hazard using readily available information. We believe our analysis methodology is sound in that it provides a reasonable assessment of vulnerability using key available indicators. We acknowledge its limitations for complete accuracy and recognize some of the reasons why. Many vulnerability indicators for wind are not readily available, and are not comprehensive and standardized enough to be easily included into our analysis at this time. Gaps include building attributes and associated level of vulnerability, local or site specific conditions, and building positional accuracy. Furthermore, we recognize that the applicability of this vulnerability assessment may not be appropriate beyond a general indication, especially at the Local level. Instead, the analysis results may be best used as a guide to help target communities that would benefit from further wind hazard and vulnerability analysis. We have established activities in our mitigation strategy that will advance the accuracy of multi-hazard risk assessment through future more detailed analysis using Local risk assessment information, better data as it becomes available, and continued application of GIS technology. Our methodology includes the FEMA promoted "wind-zone" map created by the American Society of Civil Engineers (ASCE) as a key indicator of wind hazard. This map was recreated (see **figure 3-88**) as a GIS layer to run the wind hazard analysis. The map shows suggested design speed zones according to the maximum wind expected. In general, and according to the wind-zone map Jurisdictions most threatened by and vulnerable to extreme wind hazard include built environment of those in most of the western half and southeastern one-third of New York State. The western half of the State is in Wind Zone 3 (up to 200 mph) mostly representing the increased chance for tornados. The southeastern one-third of the State is primarily due to the higher risk for hurricanes. The following table identifies Jurisdictions by County most vulnerable to extreme wind hazard as determined by several available data variables in addition to the Wind-Zone map indications.

Table 3-27
Jurisdiction Most Threatened by Extreme Wind and Vulnerable to Extreme Wind Loss

County	Rating Score	Wind Zone (h-hurricane susceptible)	# of Tornados	Population Density (per square mile)	Total # of Structures (HAZUS)
Suffolk	19	h	20	1542.8	461456
Nassau	18	h	8	4642.1	395748
Albany	17	h	7	552.8	83117
Dutchess	18	h	11	339.8	79721
Erie	17	3	17	906.3	277470
Orange	17	h	8	407.5	92068
Richmond(Staten Is)	17	h	3	7633.8	111561
Westchester	17	h	8	1951.4	211689
Bronx	16	h	1	31412.5	89896
Kings(Brooklyn)	16	h	1	34951.2	258603
Queens	16	h	1	20442.3	343289
Rensselaer	16	h	9	229.4	44593
Ulster	16	h	11	153.2	58343
Chautauqua	15	3	24	128.5	45310

Table 3-27
Jurisdiction Most Threatened by Extreme Wind and Vulnerable to Extreme Wind Loss

County	Rating Score	Wind Zone (h-hurricane susceptible)	# of Tornados	Population Density (per square mile)	Total # of Structures (HAZUS)
New York(Manhattan)	15	h	1	65309.3	56385
Onondaga	15	3	8	569.3	132013
Columbia	14	h	13	97.4	23405
Putnam	14	h	4	389.2	32303
Rockland	14	h	2	1438.7	73767
Sullivan	14	h	9	74.3	33201
Broome	13	3	7	280.4	60079
Monroe	13	3	2	1108.7	210552
Cattaraugus	12	3	10	63.4	29499
Greene	12	h	8	73.3	19884
Oneida	12	2	13	187.4	69590
Tompkins	12	3	7	196.4	24171
Cayuga	11	3	4	111.7	26291
Chenango	11	3	11	57.2	18194
Oswego	11	2	9	120.7	40083
Otsego	11	3	11	60.8	21815
Saratoga	11	2	8	699.5	66122
St. Lawrence	11	2	9	237.8	36213
Washington	11	h	4	72.6	20361
Chemung	10	3	1	221.6	26831
Niagara	10	2	4	416.7	66394
Tioga	10	3	6	99.1	17232
Wayne	10	3	2	154.7	30592
Delaware	9	3	8	32.8	21904
Genesee	9	3	1	121.8	17646
Livingston	9	3	2	100.4	18476
Madison	9	3	2	105.1	21705
Schuyler	9	3	4	85.4	7378
Steuben	9	3	3	70.3	34710
Allegany	9	3	6	48.2	18096
Cortland	8	3	3	97.0	13599
Fulton	8	2	8	103.4	20226
Wyoming	8	3	3	72.8	12844
Yates	8	3	4	65.5	9542
Jefferson	7	2	4	86.8	37938
Ontario	7	2	2	151.2	32618
Schenectady	7	2	2	50.5	44729
Schoharie	7	3	2	56.1	12026
Montgomery	6	2	4	121.2	14829
Warren	6	2	2	68.0	26234
Clinton	6	2	1	75.8	24229
Essex	5	2	3	21.2	17157
Herkimer	5	2	5	44.2	22928
Orleans	5	2	1	112.3	13110
Seneca	5	3	0	40.6	11423
Franklin	4	2	2	30.2	17453
Hamilton	4	2	4	3.0	6252
Lewis	3	2	4	20.9	11475

Source: FEMA wind-zone map, NCDC database, HAZUS. Analysis supported by GIS technology.

Table 3-27
Jurisdiction Most Threatened by Extreme Wind and Vulnerable to Extreme Wind Loss

	Rating Score	Wind Zone	# of Tornados	Population Density (per square mile)	Total # of Structures
Rating Score - Variables Distributions and Point Values	score value 1	[redacted]	1-5	1 - 49	1-17K
	score value 2		6-10	50 - 99	18-24K
	score value 3	Wind zone 3	11-15	100 – 299	25-40K
	score value 4	[redacted]	16-20	300 - 1999	41-80K
	score value 5	Hurricane zone	21 +	2000 - 67,000	81-462K

Hurricane Storm Surge and Wind Studies

The south shore of Long Island and New York City has been impacted by a number of major storms in recent years. These storms have caused serious coastal flooding, wind damage, and erosion in many communities. When referring to the flooding aspect of a Hurricane event, Storm Surge is typically the most dangerous part of a hurricane. These surges can reach 25 feet high and be 50-100 miles wide. Typically in a hurricane or tropical storm event, storm surge is the number one cause of death. One of the current projects being used to address these issues is storm surge modeling. Following the prior State Hazard Mitigation Plan the Storm Surge GIS Layers for all coastal Counties have been generated and are available with unrestricted access on the New York State GIS Clearinghouse. As well many Inventory (facility location) maps and SLOSH models (Sea, Lake, and Overland Surges from Hurricanes) have been computerized and run by SEMO, as well as other organizations, to estimate storm surge heights and winds resulting from historical, hypothetical, or predicted hurricanes by taking into account pressure, size, forward speed, track, and winds.

In conjunction with the following entities SLOSH models and maps have been generated and the data sets are available through the New York State GIS Clearinghouse. Some information may require clearance before being able to be accessed.

Table 3-28

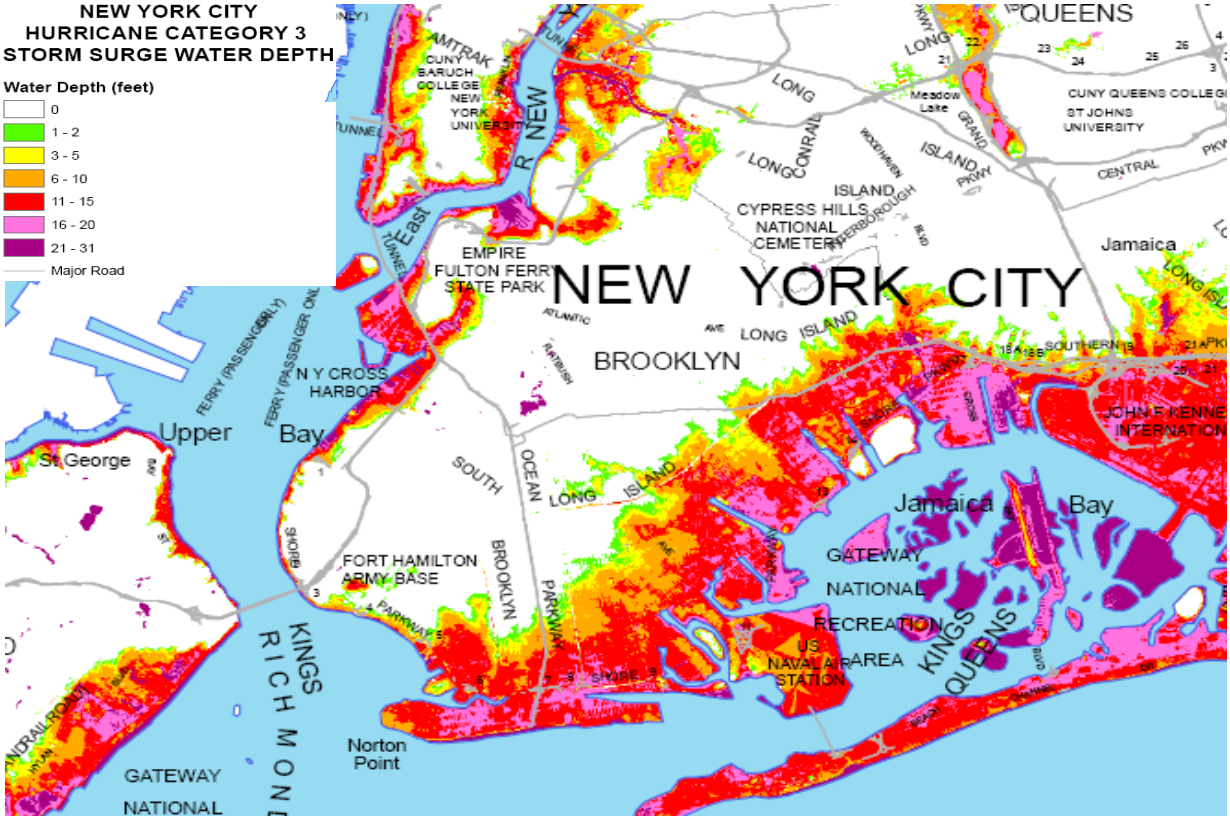
NYS Public & Private Mapping and Modeling	
Entity	**Mapping/Modeling**
NYS Education Dept	SLOSH Modeling of Public Schools
American Red Cross	SLOSH Modeling of Shelters
Hospitals	SLOSH Modeling of Hospitals
Power Authorities	Sub Station Mapping
MTA	Facility Inventory With Relation to Exposure/Accessibility
Coast Guard	Facility Inventory With Relation to Exposure/Accessibility
Armories	Facility Inventory With Relation to Exposure/Accessibility
Wal-Mart	Facility Inventory With Relation to Exposure/Accessibility
Home Depot	Facility Inventory With Relation to Exposure/Accessibility

NOTE: (This table is not meant to be all inclusive, there may in fact be other available data regarding other entities)

Figure 3-93 was generated as part of the hurricane re-study and GIS mapping that took place in order to generate new and up to date information for the updated plan. This map portrays the storm surge inundation levels that a Category 3 hurricane would have on an area in New York City.

This type of modeling of coastal counties can make fairly accurate predictions of the affects of a particular hurricanes storm surge. This detailed mapping can allow the State and Counties to get down to a street level representation of how a storm surge would move over land, allowing for extremely detailed and accurate preparedness plans to be developed. For example Nassau County's Mitigation plan references storm surge and their susceptibility, they have determined that due to topography and surge heights the north shore is not highly vulnerable, but the south shore with its low lying topography is very susceptible to a devastating storm surge.

Figure 3-93
Location Scenario of NYC Storm Surge Susceptibility



Source: SEMO GIS

Table 3-29 portrays the estimated population living within a hurricane storm surge area and the effect a particular category hurricane would have on that population.

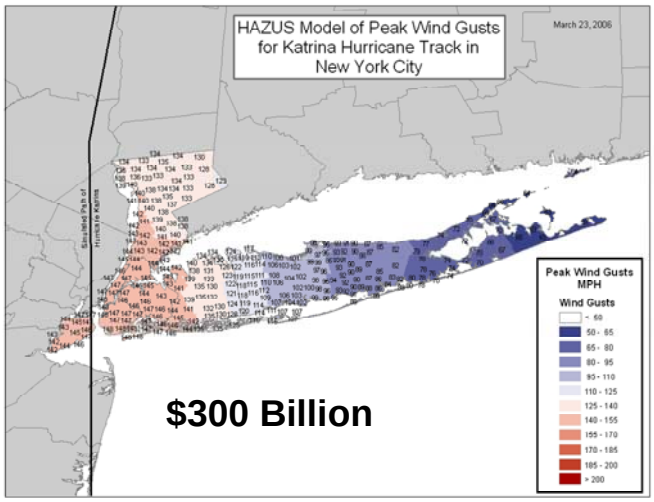
Table 3-29 ESTIMATED POPULATION RESIDING WITHIN HURRICANE STORM SURGE ZONES

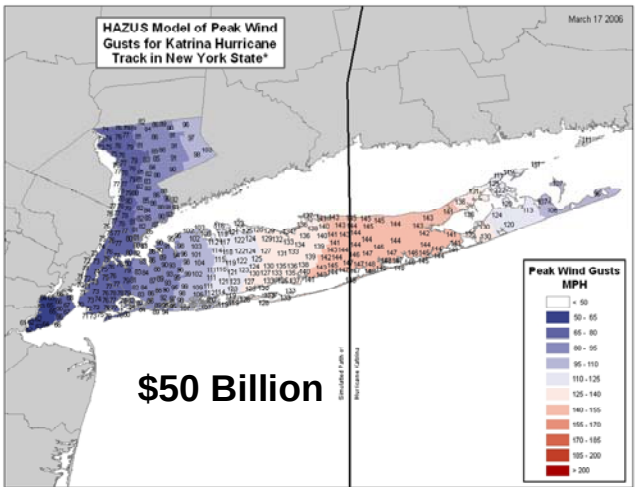
County	Total Population	Cat 1 Vulnerable Population	Cat 2 Vulnerable Population	Cat 3 Vulnerable Population	Cat 4 Vulnerable Population	Total Vulnerable Population	% of Population Vulnerable
NEW YORK CITY	8,008,278	305,908	976,071	1,561,391	2,181,656	**2,181,656**	**27.24**
Brooklyn (Kings)	2,465,326	128,411	492,589	720,083	996,110	**996,110**	**40.40**
Bronx (Bronx)	1,332,650	7,694	31,028	99,273	181,736	**181,736**	**13.64**
Manhattan (New York)	1,537,195	66,947	216,191	348,451	493,783	**493,783**	**32.12**
Queens (Queens)	2,229,379	85,408	197,657	333,016	429,098	**429,098**	**19.25**
Staten Island (Richmond)	443,728	17,448	38,606	60,568	80,929	**80,929**	**18.24**
NASSAU COUNTY	1,334,544	108,139	236,603	334,397	406,038	**406,038**	**30.43**
SUFFOLK COUNTY	1,419,369	28,849	93,485	165,591	225,477	**225,477**	**15.89**
WESTCHESTER COUNTY	923,459	4,879	10,150	16,042	25,235	**25,235**	**2.73**
HES Coverage Area Totals	**11,685,650**	**447,775**	**1,316,309**	**2,077,421**	**2,838,406**	**2,838,406**	**24.29**

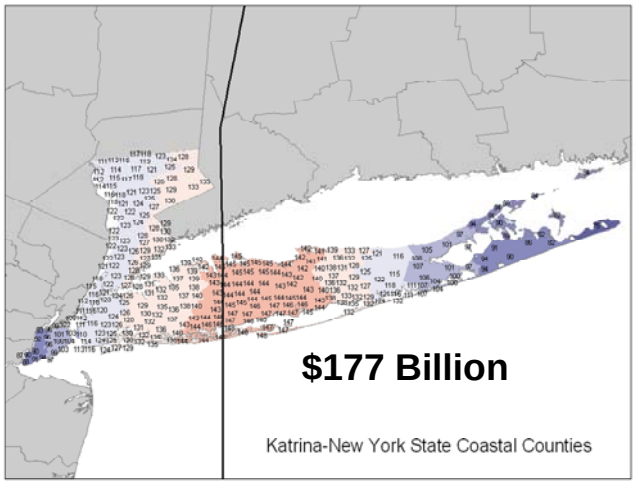
Hurricane Katrina Scenario Tracking Through NYS

The following three figures represent the total building related loss based off of wind loss estimates generated through HAZUS if Hurricane Katrina tracked through New York State. These maps were created by SEMO for use as a case study.

Figure 3-94







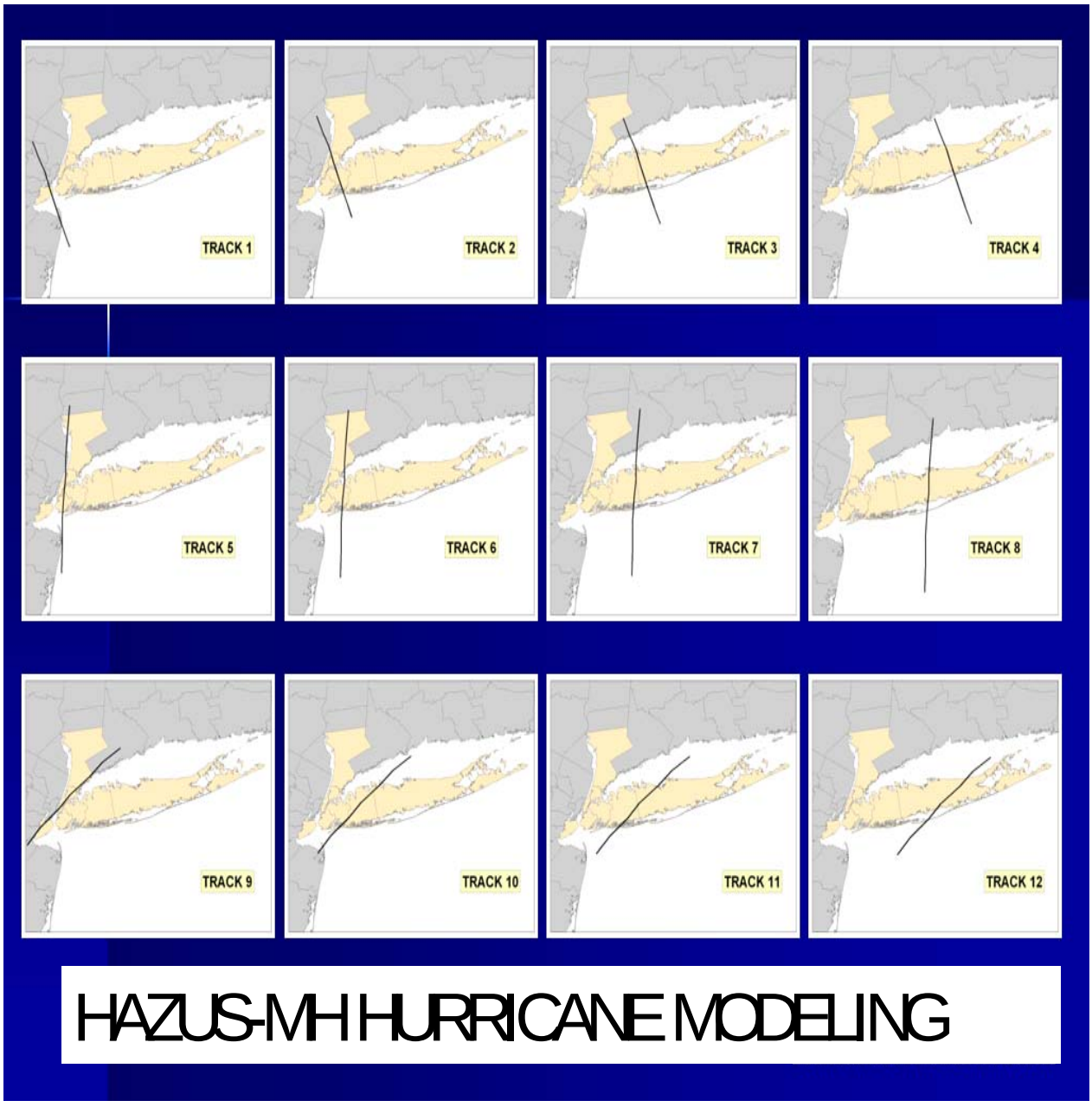
HAZUS-MH ESTIMATED BUILDING RELATED LOSS (NEW YORK STATE COASTAL COUNTIES ONLY) IF HURRICANE KATRINA TRACKED THROUGH NYS

***Model reflects only losses associated to wind**

HAZUS Wind Study

Figure 3-95 demonstrates using HAZUS the potential Hurricane tracks/paths that could pass through New York State.

Figure 3-95 Hurricane storm modeling tracks



The following **Figures 3-96** through **3-99** are indicative of the results of a particular category hurricane relative to a specific hurricane track and speed. These Figures were created using a cumulative numbers generated from HAZUS runs. Each Figure compliments **Figure 3-95 (Storm Track Models)**. **(NOTE: These estimates are based off of wind damage)**

Figure 3-96 portrays the total economic loss that would occur based on the category level of a hurricane traveling through a certain track at a speed of slow, moderate, or fast. For example, according to the information, if a Track 1(refer to **Figure 3-95**), category 3 hurricane traveling at a slow speed, hit, the estimated economic loss for the affected coastal county areas would be roughly 350 billion dollars. This loss estimation does not account for areas outside of the coastal counties that are located in New York State and is for wind damage only. This test run accounts for the coastal counties of Nassau, Suffolk, Westchester, and those of the New York City area.

Figure 3-96 Indicating Total Economic Loss Per Category, Track, and Speed

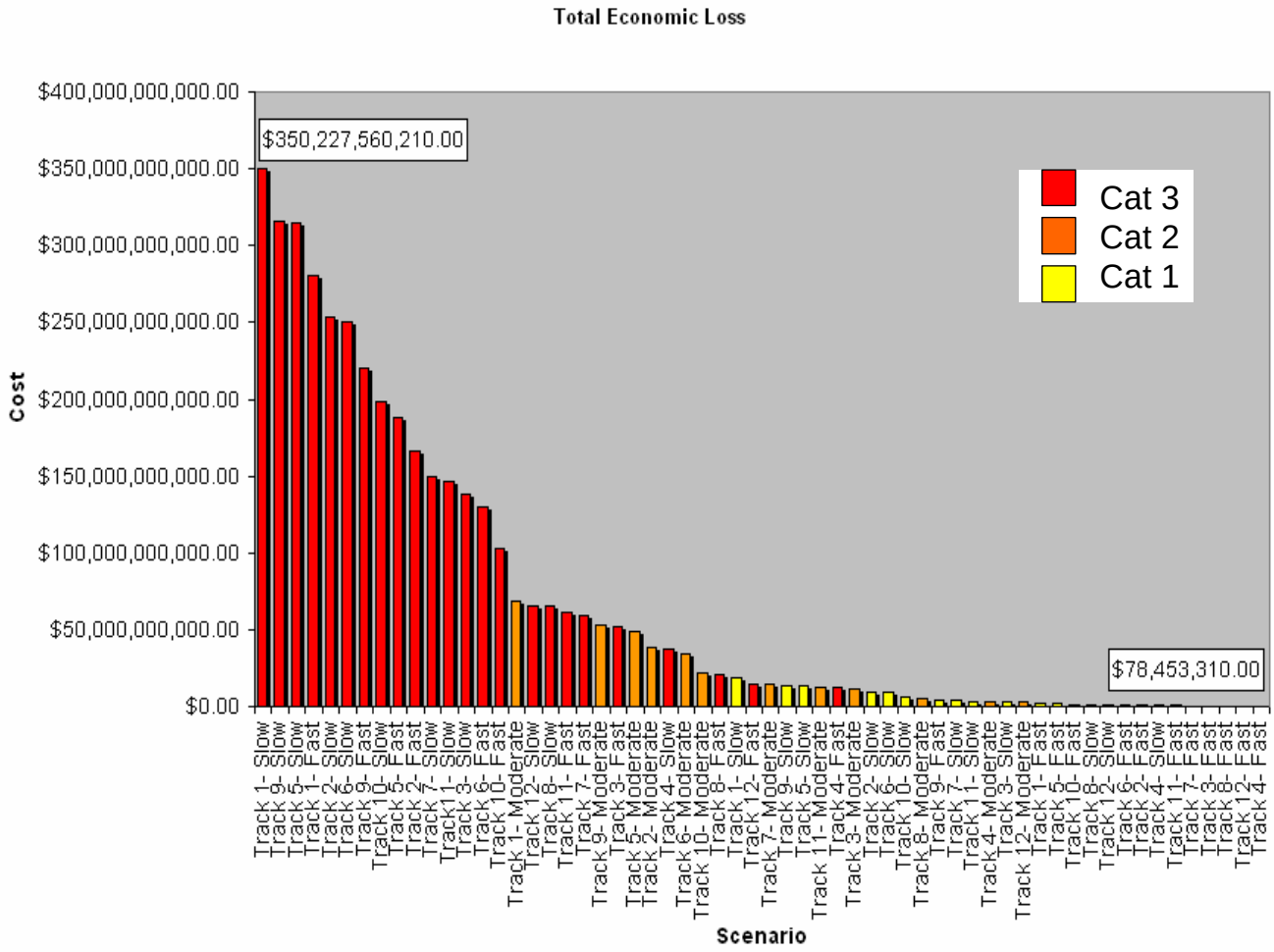
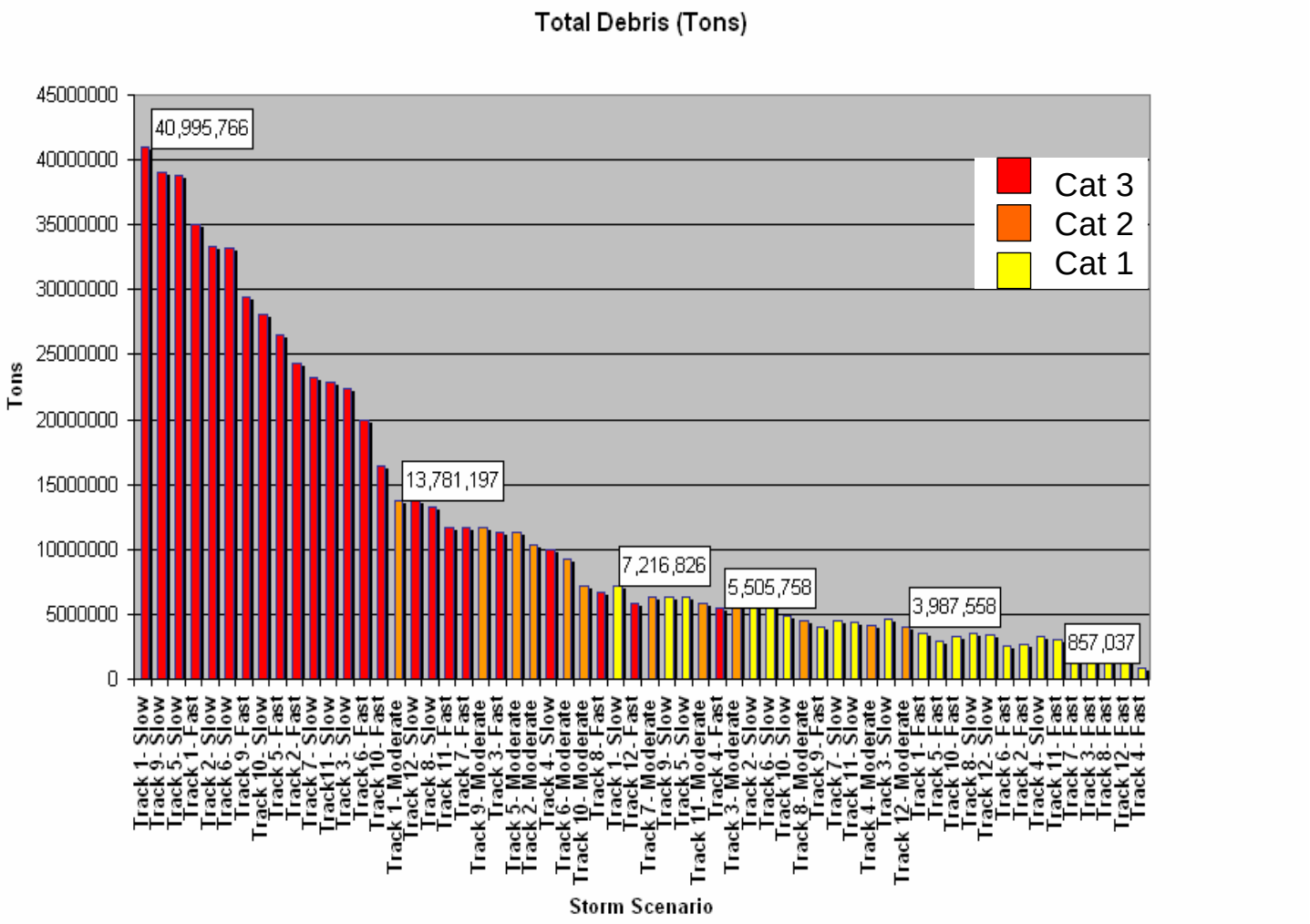


Figure 3-97 portrays the total debris in tons that would have to be addressed after a particular hurricane event. For this graph debris is broken up into 3 categories, 1) Brick/Wood, 2) Reinforced Concrete/Steel, and 3) Trees. For the same before mentioned example, if a track 1, category 3 hurricane moving slowly, hit, the estimated amount of debris that would need to be addressed would be roughly 41 million tons from one storm. When looking at the estimate of 41 million tons of debris from one storm the need for debris removal plans are pertinent to recovery efforts. That is why the DEC as well as many local jurisdictions have emergency debris management plans in place. As well, FEMA offers Debris Removal Workshops for Local Governments.

Figure 3-97 Indicating Total Debris in Tons Per Category, Track, and Speed



Figures 3-98 and **3-99** portray the need for shelters and personal assistance among other things.

Figure 3-98 portrays the amount of displaced households relative to a particular hurricane event. To reference the previously used example if a track 1, category 3 hurricane, moving slowly, hit, an estimated 1.8 million households would be displaced.

Figure 3-98 Indicating Total Displaced Households Per Category, Track, and Speed

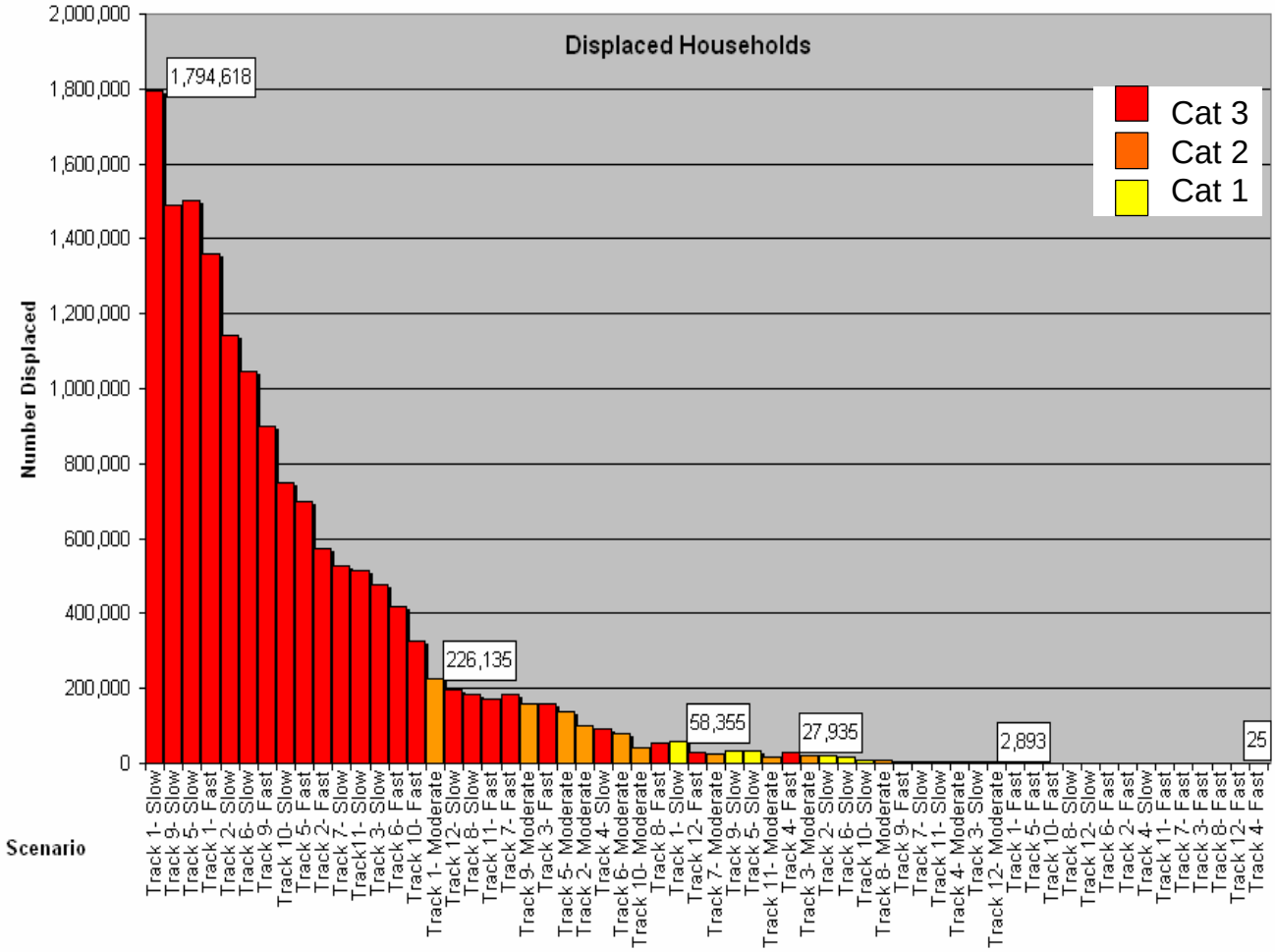


Figure 3-99 portrays the short-term shelter needs for the affected areas. Again, to reference the previous example, if a track 1, category 3, slow moving, hurricane hit, the immediate short-term shelter needs would be that of roughly 500,000 people.

Figure 3-99 indicating Total Short-Term Shelter Needs per Category, Track, and Speed

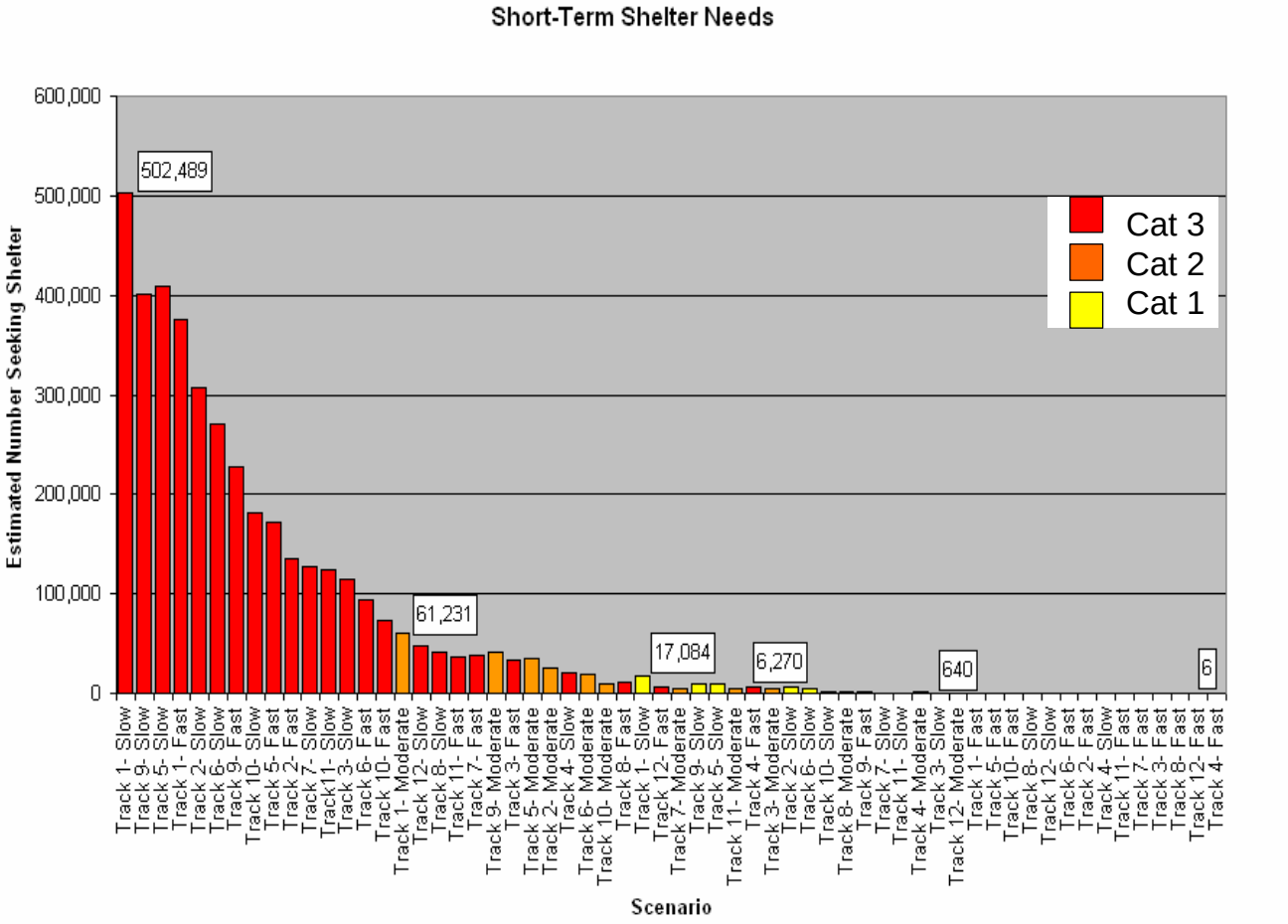


Figure 3-100 Portrays the population that lie in a track 1 storm surge inundation area broken up by jurisdiction. The total estimated population is 317,850 people spread throughout 9 coastal jurisdictions.

Figure 3-100

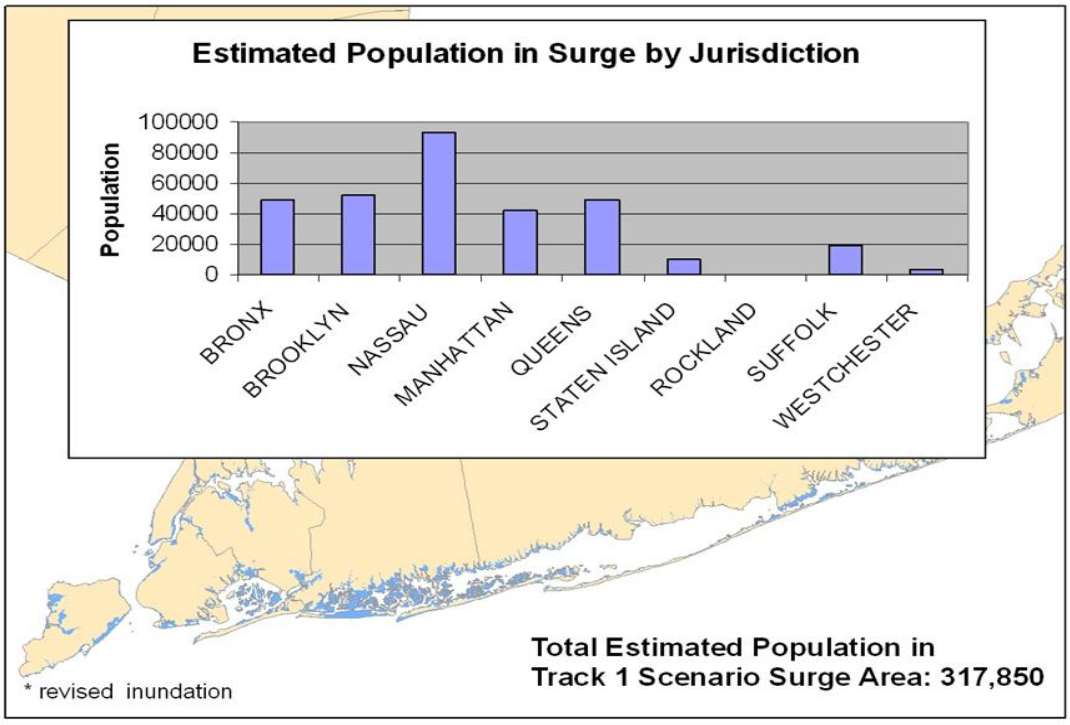
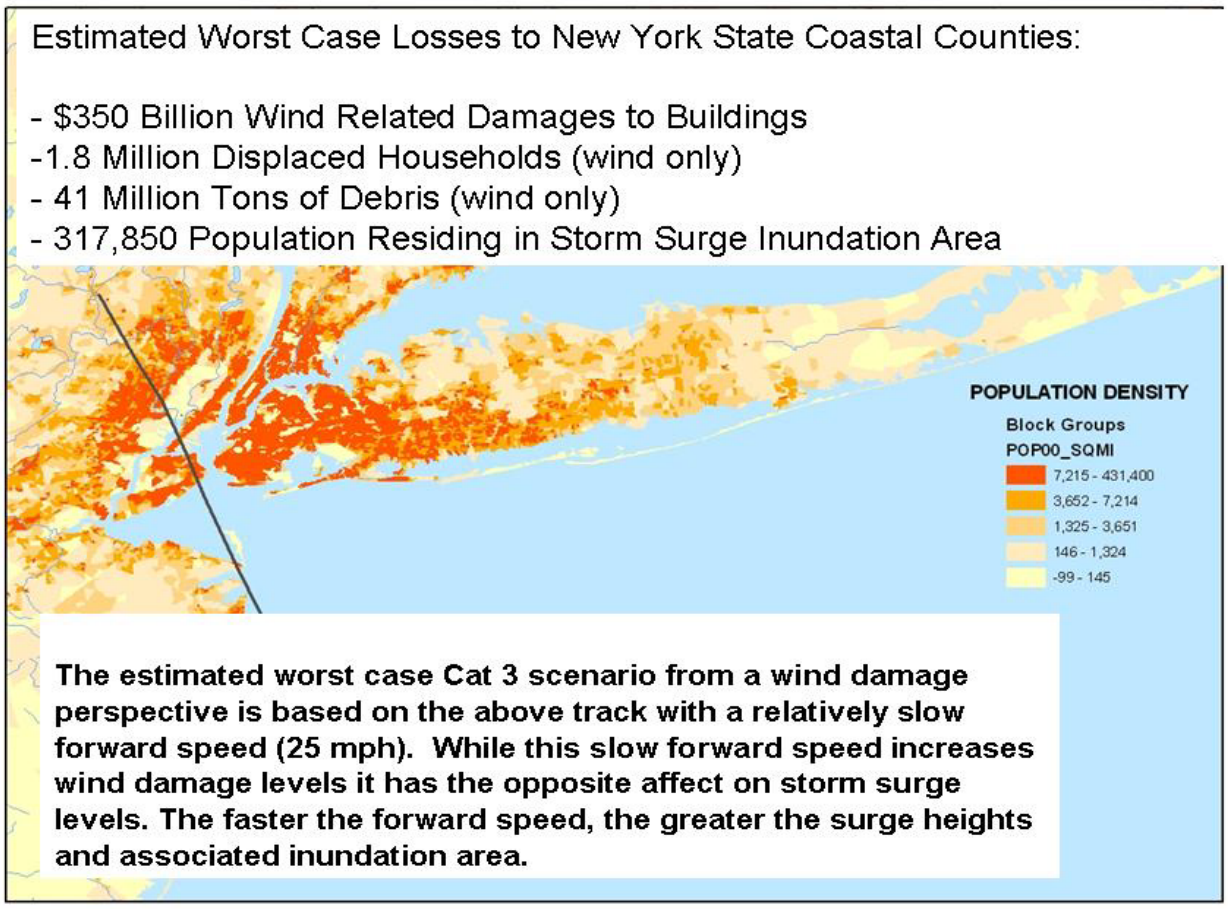


Figure 3-101 represents a culmination of all of the previously presented data



A combination of many aspects of predictive measures can be used in the future to determine the multiple needs of affected people during the course of a storm event. Through continuous research and data collection disaster preparedness can dramatically reduce the risk to New York State.

Local Jurisdiction Assessment

Many of the local jurisdictions have recognized their vulnerability when it comes to Hurricanes and/or Tropical storms. Suffolk County, Nassau County, the New York City area, and Westchester County have recognized that there is a high probability of such an event occurring and that its effects would be devastating. All of these jurisdictions have taken precautionary measures as well as developed some form of a Hurricane preparedness plan, all of which can be accessed via the internet. These plans can be used as examples for other communities that wish to develop hurricane preparedness plans. They offer before, during, and after the storm advice, as well as, evacuation route information and links to other useful websites.

- Suffolk- http://www.co.suffolk.ny.us/webtemp3.cfm?dept=48&id=2521
- Nassau- http://www.nassaucountyny.gov/agencies/OEM/
- NYC- http://www.nyc.gov/html/oem/html/home/home.shtml
- Westchester- http://www.westchestergov.com/emergserv/oemsevere.htm

Mitigation Actions

One of the crucial factors in prevention and mitigation requires that jurisdictions adhere to the building codes that NYS has adopted. New York State follows the International Building and Residential Codes and each jurisdiction within NYS is required to meet these standards. Local jurisdictions can have there own codes and variances as well, but the International Building and Residential Codes must be met. These codes have specific requirements for construction (typically new construction) that take into account wind load and seismic activity. For further information regarding New York State's building codes please visit the Department of States website at http://www.dos.state.ny.us/, as well please reference any local codes or variances that may apply to your specific area.

The following chart lists and describes Hazard Mitigation Projects that have been applied for and approved by FEMA from 1997 to 2005. This list is limited to the counties typically affected by hurricane and/or tropical storm events, but is not intended to represent these projects as specifically related to a hurricane and/or tropical storm event.

Table 3-30
Mitigation Actions

HMGP APPL	APPLICANT	PROJECT TYPE	FEMA APPROVAL DATE	DR #	STATUS	COUNTY
1056	VIL. OF BELMONT	RELOCATE WATER WELLS	8/19/1997	1095	CLOSED	SUFFOLK
1145	TOWN OF NEW YORK	NOT IN FILES	6/15/1997	1095	CLOSED	NEW YORK
2000	TOWN OF BABYLON	COASTAL EROSION CONTROL	3/30/1998	1146	CLOSED	SUFFOLK
2001	NASSAU CO. PUBLIC WORK	COASTAL EROSION CONTROL	5/22/1998	1146	W/DRAWN	NASSAU
2002	VIL. OF SALTAIRE	COASTAL EROSION CONTROL	3/30/1998	1146	CLOSED	SUFFOLK
2004	VIL. ROCKVILLE CENTRE	DRAINAGE IMPROVEMENT	5/22/1998	1146	CLOSED	NASSAU
2006	TOWN OF BROOKHAVEN	HURRICANE SHUTTERS	1/26/1998	1146	CLOSED	SUFFOLK
2007	TOWN OF N. HEMPSTEAD	DRAINAGE IMPROVEMENT	1/15/1998	1146	CLOSED	NASSAU
2008	VIL. OF BAYVILLE	DRAINAGE IMPROVEMENT	2/6/1998	1146	CLOSED	NASSAU
2009	NASSAU CO. POLICE	EMERGENCY SHELTER	2/20/1998	1146	CLOSED	NASSAU
2010	CITY OF NEW ROCHELLE	COASTAL EROSION CONTROL	1/10/1998	1146	CLOSED	WESTCHESTER
2011	CITY OF NEW ROCHELLE	COASTAL EROSION CONTROL	1/10/1998	1146	CLOSED	WESTCHESTER
2012	CITY OF NEW ROCHELLE	COASTAL EROSION CONTROL	1/10/1998	1146	CLOSED	WESTCHESTER
2018	VIL. OF ROCKAWAY	DRAINAGE IMPROVEMENT	1/10/1998	1146	CLOSED	NASSAU

2019	VIL. OF OCEAN BEACH	LOCAL CODE	3/18/1998	1146	CLOSED	SUFFOLK
4032	N/BELLMORE-F.D.-NASSAU	HURRICANE SHUTTERS	4/27/1999	1196	CLOSED	NASSAU
4063	VILLAGE OF FREEPORT	ROADWAY ELEVATION	4/24/1999	1196	CLOSED	NASSAU
5002	V. SOUTHHAMPTON	HURRICANE SHUTTERS	7/13/1999	1222	CLOSED	SUFFOLK
5011	C. OF GLEN COVE	DRAINAGE IMPROVEMENT	11/19/1999	1222	CLOSED	NASSAU
5027	NYC EDUCATION	FLOOD PREVENTION	7/1/1999	1222	CLOSED	NEW YORK
5042	SUFFOLK COUNTY	COASTAL EROSION CONTROL	6/19/2000	1244	OPEN	SUFFOLK
6014	T/ OYSTER BAY	ELEVATION (HOME)	11/7/2000	1296	CLOSED	NASSAU
6084	V/FREEPORT	ELEVATION (HOME)	10/19/2000	1296	CLOSED	NASSAU
6009	VILLAGE OF ASHAROKEN	ELEVATION (HOME)	2/22/2001	1296	CLOSED	SUFFOLK
6059	TOWN OF SOUTHAMPTON	ELEVATION (HOME)	4/2/2001	1296	TERMINATED	SUFFOLK
6105	VILL OF AMITYVILLE	ELEVATION (HOME)	12/21/2000	1296	CLOSED	SUFFOLK
6058	TOWN OF SOUTHAMPTON	ELEVATION (HOME)	7/5/2001	1296	CLOSED	SUFFOLK
6059	TOWN OF SOUTHAMPTON	CODES PROJECT	4/2/2001	1296	W/DRAWN	SUFFOLK
6060	TOWN OF SOUTHAMPTON	ELEVATION (HOME)	7/5/2001	1296	CLOSED	SUFFOLK
7004	FREEPORT	ROADWAY ELEVATION	11/1/2001	1335	CLOSED	NASSAU
6014	PATCHOGUE	ROADWAY ELEVATION	7/20/2004	1467	CLOSED	SUFFOLK
9068	T/GREENBURGH	ELEVATION (HOME)	12/30/2005	1564	OPEN	WESTCHESTER

SEMO Mitigation Database 7/07