RISK ASSESSMENT: HAZARD PROFILES

Coastal Erosion

Description - Coastal Erosion

Erosion is defined as the group of natural processes by which material is worn away from the earth's surface. According to the U.S. Geological Survey, high waves and strong ocean currents work to erode coastlines. Waves work to suspend smaller particles, and dislodge larger particles. These particles then work with the waves to mechanically wear down other surfaces. Note that while wave action is a cause of erosion, it is also a unique hazard, addressed separately in this plan.

Coastal erosion processes are expedited during storm periods, when wave action is high and water levels and coastal currents tend to increase rapidly. Over time, erosive forces acting upon coastal shorelines may result in a landward retreat of the shoreline.

Erosion is only one factor contributing to net shoreline change over time. At the same time that erosion is working to wear away a shoreline, the process of accretion (the deposition of sediments) works to build it back up. When erosion rates exceed accretion rates, a horizontal retreat of the shoreline is observed. The converse is also true. And, when erosion rates and accretion rates are equal, the shoreline is said to be 'stable.'

Erosion rates vary over time. When considering erosion hazards at any location, it is important to note that any year's observed erosion rate could be reflective of a high occurrence of severe storms in that particular year. A beach that may have been eroding one year could accrete the next. For a more accurate representation of whether the overall trend in shoreline change at any location is eroding, accreting, or is stable, it is important to expand the period of observation and consider long-term rates.

Location – Coastal Erosion

Coastal erosion is an ongoing process for any community with coastal frontage. There are 188 miles of coastline in Nassau County.

Nassau County's entire northern shoreline is exposed to coastal erosion from the Long Island Sound. The north shore is characterized by an irregular shoreline and includes high bluffs, inlets, bays and harbors.

The County's south shore is exposed to the effects of coastal erosion from the Atlantic Ocean and the waters of its many back bays. Most of Nassau County's south shore is offered some degree of protection by its barrier beaches and tidal wetlands in the back bay areas; however, erosion has still been a historic problem in some back bay areas along the south shore.

The New York State Department of Environmental Conservation Coastal Erosion Management Unit administers the state's Coastal Erosion Hazard Area (CEHA) management and regulatory programs. According to the New York State Hazard Mitigation Plan (2005), DEC has estimated that a significant portion of Long Island's coastline is in high erosion hazard areas. Due to the erosion-prone nature of parts of the New York coastline, the Coastal Erosion Hazard Areas Act (CEHA) (Article 34 of the Environmental Conservation Law) regulates construction in areas where buildings and structures could be damaged by erosion and flooding. NYCRR Part 505 provides procedural requirements for development, new construction, and erosion protection structures.

The responsibilities for NYSDEC regarding towns, counties, and regulation of coastal erosion hazard areas are defined by these regulations. Towns within an area determined by NYSDEC are required to submit erosion hazard area ordinances for approval and public review. Counties can submit erosion hazard area regulations upon failure of a town to do so. NYSDEC enforces the regulations if the city and county do not provide CEHA regulations. The standards and criteria for erosion protection structures are based on a 30-year life of the structure or system. The Commissioner of NYSDEC is required to review the CEHA maps every 10 years and after the occurrence of major events, both human and natural, including coastal storms. If the CEHA boundary changes by 25 feet or more, the maps must be revised. In addition, NYSDEC has the authority to revoke certification of local CEHA management programs, if local administration is not consistent with statewide minimum standards, and to assert regulatory jurisdiction over these areas.

There are two categories of areas regulated by the CEHA: Natural Protective Features (NPFs) and Structural Hazard Areas (SHAs).

- NPFs include: the nearshore, beaches, bluffs, primary dunes, and secondary dunes.
- SHAs include: areas landward of the NPFs and are found on shorelines which have a demonstrated long-term average annual recession rate of one foot per year or greater. The SHA is determined by multiplying the recession rate times 40 and is measured from the landward limit of the NPF. If the recession rate is less than one foot per year or cannot be accurately established, then there is no SHA. The NYSDEC Permit Profile for CEHAs specifically notes the absence of accurately established recession rates for the barrier islands of Long Island's south shore.

Both regulated areas are depicted on CEHA maps, which depict the landward limit of the NPFs and SHAs and indicate the recession rate in feet per year, where applicable.

CEHA maps for Nassau County were obtained from Robert McDonough of the New York State Department of Environmental Conservation, Division of Water, Coastal Erosion Management Unit on November 22, 2005. The maps are dated 1988. CEHA maps were available only in hard copy format. For the purposes of this hazard mitigation planning project, an attempt was made to translate the approximate location of the CEHA from the hard copy maps into the County's GIS 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, and the resulting shape file should be considered for analysis purposes only. It does not serve as official digital representation of the CEHA boundary in Nassau County. For Nassau County, the CEHA boundary was drawn at the location of NPFs; CEHA maps did not included any mapped SHAs (areas with demonstrated long-term average annual recession rates of one foot per year or greater).

Figure 2 illustrates the location of mapped Coastal Erosion Hazard Areas in Nassau County.

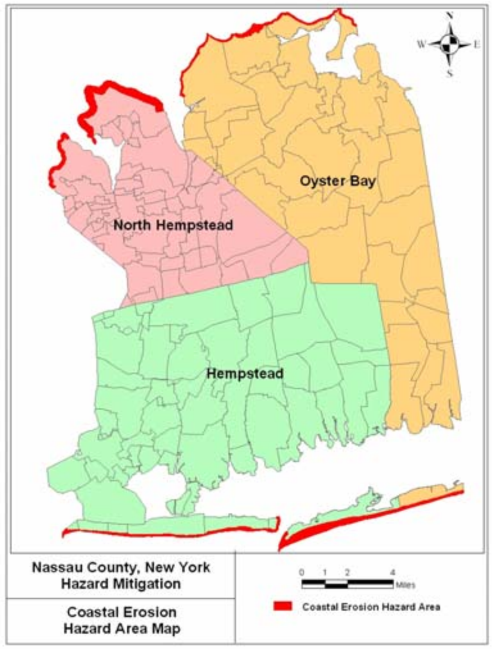


Figure 2 - NYSDEC Coastal Erosion Hazard Areas in Nassau County

North shore communities with mapped CEHA zones are:

Bayville (Oyster Bay Area)
Centre Island (Oyster Bay Area)
Glen Cove (Oyster Bay Area)
Kings Point (North Hempstead Area)
Lattingtown (Oyster Bay Area)
Locust Valley (Oyster Bay Area)
Sands Point (North Hempstead Area)

South shore barrier island communities with mapped CEHA zones are:

Atlantic Beach (Hempstead Area)
Atlantic Beach West (Hempstead Area)
East Atlantic Beach (Hempstead Area)
Jones Beach (Hempstead Area)
Lido Beach (Hempstead Area)
Long Beach (Hempstead Area)
Point Lookout (Hempstead Area)
Tobay Beach Park (Oyster Bay Area)

There are no south shore mainland communities with mapped CEHA zones.

In December of 2005, NYSDEC Region 1, Coastal Erosion and Flood Protection Section, indicated during a telephone conversation that the State administers the CEHA in the City of Long Beach, Town of Oyster Bay, and Village of Center Island while local jurisdictions administer the CEHA in Glen Cove, Town of Hempstead, Village of Atlantic Beach, Village of Bayville, Kings Point, Lattingtown, and Sands Point.

Extent – Coastal Erosion

Generally speaking, coastal erosion is most severe for north shore and south shore barrier island communities. It is less severe for south shore mainland communities because of the protective effects of the barrier island.

Nassau County's northern shoreline is exposed to coastal erosion and wave action from the Long Island Sound. The north shore is characterized by an irregular shoreline, with many inlets, bays and harbors. Generally sandy beaches are typically backed by high bluffs. The US Army Corps of Engineers New York District "North Shore of Long Island, New York, Storm Damage Protection and Beach Erosion Control reconnaissance Study" (September 1995) notes that historic erosion on the north shore has caused the loss of protective coastal structures, erosion of beaches and bluffs, and associated damages to buildings and roads. The Corps also notes that erosion is dominant along the north shore, with average rates of roughly 1 to 2 feet per year, and only isolated pockets of accretion. It is also explained in this same report that most shoreline recession, particularly bluff erosion, tends to be associated with storms.

The County's south shore is exposed to the effects of coastal erosion and wave action from the Atlantic Ocean and the waters of its many back bays. While much of Nassau County's south shore is offered some degree of protection by its barrier beaches and tidal wetlands in the back bay areas, erosion and wave action have still been a historic problem on the south shore. In addition to natural affects such as offshore topography, erosion on the south shore is affected by various jetties and groins. Information on the New York Sea Grant web site notes that over the past one hundred years, the average erosion rate along much of Long Island's south shore has been on the order of one to two feet per year (however, this average can have a degree of error of anywhere from -6 feet to + 10 feet) while some of the highest erosion rates, which can exceed 20 feet a year, have been observed near stabilized inlets or stone groins.

Acreage and number of affected parcels was determined by using GIS to overlay a best-estimate line representing the mapped CEHA with the County parcel data. For the purposes of this hazard mitigation planning project, an attempt was made to translate the approximate location of the CEHA from the hard copy maps into the County's GIS for more efficient viewing, sharing, and estimation of assets within the CEHA. This data is a best-estimate, but is strictly an estimate using this rudimentary methodology. Results are presented in Table 7.

Table 7
Number and Acreage of Parcels in the NYSDEC Mapped CEHA

Community	Estimated Number of CEHA-affected Parcels	Estimated Acreage of CEHA-affected Parcel
Atlantic Beach	4	96
Atlantic Beach West	1	32
Bayville	5	183
Bayville Unincorporated	3	38
Centre Island	2	28
East Atlantic Beach	2	46
Glen Cove	6	73
Jones Beach	1	750
Kings Point	7	194
Lattingtown	4	166
Lido Beach	2	307
Locust Valley	1	121
Long Beach	3	271
Point Lookout	1	154
Sands Point	9	1,185
Tobay Beach	2	860

Coastal erosion becomes most severe during storm periods, when water levels, wave action, and coastal currents tend to increase rapidly. The degree of severity can be marked, but will vary based upon several factors, including: soil properties, orientation of the shoreline, distance from the storm center, storm-surge heights, wave characteristics, direction of storm movement, angle of wave approach, forward speed and duration of the storm, and tidal stage during storm landfall. The New York State Hazard Mitigation Plan (2005) notes that the coastal erosion hazard on Long Island is especially severe due to its composition of a loose mixture of sand and grave and its location facing the ocean in direct opposition to the prevailing wind and water currents moving up the Atlantic Coast.

Generally speaking, sand is transported from the eastern end of Long Island to its western end; this is called "long shore transport". Long shore transport is interrupted at inlets. Coastal erosion rates tend to be most severe near inlets and in areas immediately down gradient of protective features extending perpendicularly from the shoreline, such as jetties and groins.

According to the USACE NYD's Draft Feasibility Report for Long Beach Island (September 1994), alternating erosive and accretive zones exist on Long Beach Island, with overall transport of sand being net westerly and an overall erosive trend. They note that slight accretion at the western end can be attributed in part to impoundment of sand by the East Rockaway jetty. The most erosive zone is located adjacent to Jones Inlet.

According to the "North Shore of Long Island, New York, Storm Damage Protection and Beach Erosion Control Reconnaissance Study" (USACE NYD, September 1995), erosion is most severe on the north shore of Nassau County in the Town of Oyster Bay, although isolated areas where the hazard is severe in North Hempstead include Sands Point and Kings Point. The erosion hazard is reportedly moderate in the areas of Glenwood Landing, City of Glen Cove, Villages of Sea Cliff and Lattingtown; severe in the areas of Bayville, Mill Neck, and Centre Island; and minor in the areas of Oyster Bay and Villages of Oyster Bay, Cove Neck, Oyster Bay Cove, and Laurel Hollow as the area lies within the relatively protected area of Cold Spring and Oyster Bay Harbors.

Over time, erosive forces acting upon coastal shorelines can result in a landward retreat of the shoreline. In addition, continued short and long term erosion can erode protective beaches and damage structures built to offer protection from these hazards; severity is increased as damages are incurred to protective features, if not repaired.

Coastal erosion and wave action have historically been the most severe on south shore barrier island communities of Long Beach, Atlantic Beach, Lido Beach, and Point Lookout, and in Jones Beach State Park. In back-bay communities, wave action and coastal erosion are subsided by barrier beaches and tidal marshes and is a relatively minor problem. In September 1995, the USACE NYD published a report entitled, "North Shore of Long Island, New York, Storm Damage Protection and Beach Erosion Control Reconnaissance Study." This report indicated that coastal erosion and wave action have historically been the most severe in the following areas on the north shore: Sands Point, Kings Point, Oak Neck Point, Bayville, Asharoken, and Centre Island.

Through the years, communities along Nassau County's shorelines have constructed coastal structures such as bulkheads, revetments, seawalls, breakwaters, groins, jetties, and gabions/rip rap protection. Soft structures include beach and dune nourishment projects, planting dune grasses, and erecting sand fencing, in an attempt to provide some degree of protection from coastal erosion and wave action.

Previous Occurrences - Coastal Erosion

While coastal erosion is an ongoing process, its affects are exacerbated during storm events. The history of previous occurrences of coastal erosion in Nassau County communities is extensive; one might expect that a separate report could be written dedicated solely to summarizing these types of events in Nassau County. The subset of events below represents only sampling, but is characteristic of what has happened in the past and the types of damages that can be expected to occur in the future. The history has been divided into three sections: North Shore, South Shore - Barrier, and South Shore - Mainland Back Bays.

Note to the reader: For much of the erosion hazard history, reports of damage did not distinguish between damages caused specifically by erosion versus those resulting from wave action or flooding alone. As this is the best available data, all reported events are presented here in their entirety for cases where the specific cause of damage was unclear. Future sections of the report dealing with wave action and flooding summarize many of these same events.

North Shore

The following paragraph is an excerpt from the Federal Register on January 16, 2002. It is reproduced here, as it provides a concise overview of recent historic coastal erosion events on the north shore.

> *"…the northern shoreline has historically experienced coastal erosion and related storm damage, most recently from the two storms of September 1996 and October 1996, and also from previous storms including the Christmas Eve 1994 storm, the March 1993 Blizzard of the Century, the December 1992 northeaster, Hurricane Danielle of September 1992 and the Halloween Storm of 1991. These storms caused evacuations in several north shore communities as well as damage from flooding and loss of structures from erosion. The December 1992 storm alone inundated hundreds of residential and business properties and caused damages estimated at $12,000,000. Approximately 300 families were evacuated and several sections of Bayville Avenue were impassable for days. The loss of beachfront in some areas now leaves the site increasingly vulnerable to severe damages even from moderate storms."*

The Village of Bayville is one north shore community in particular which has incurred significant damages over the years due to coastal erosion. A state sponsored beach nourishment project was completed in Bayville in 1947. During the Northeaster of December 1992, many of Bayville's seawalls, bulkheads, and gabions that had been installed as a means of protection against coastal erosion and wave action were damaged or destroyed (source: US Army Corps of Engineers New York District "North Shore of Long Island, New York, Storm Damage Protection and Beach Erosion Control reconnaissance Study", September 1995).

During the Hurricane of September 1938, bluff erosion was extensive in communities along the north shore. For the entire length of the north shore it was estimated that damage to private structure, utilities, and government facilities totaled $730,000 (1938 dollars); a breakdown between Nassau and Suffolk was not available (source: Governor's Coastal Erosion Task Force, Final Report, Volume Two, Long-Term Strategy, September 1994).

During the Hurricane of September 1944, it was reported that that bluffs along the north shore were eroded at their base, and summer cottages and houses were undermined. The USACE estimated that the north shore incurred $733,000 in damages (1944 dollars); a breakdown between Nassau and Suffolk was not available (source: Governor's Coastal Erosion Task Force, Final Report, Volume Two, Long-Term Strategy, September 1994).

Wave action, erosion, and inundation during the extratropical storm of November 1950 damaged bulkheads, docks, Coast Guard facilities, low-lying roads, beaches, and bluff (source: Governor's Coastal Erosion Task Force, Final Report, Volume Two, Long-Term Strategy, September 1994).

Hurricane Donna, of September 12, 1960, caused considerable erosion at the base of bluffs (source: Governor's Coastal Erosion Task Force, Final Report, Volume Two, Long-Term Strategy, September 1994).

Hurricane Doria (September 1971) damaged piers, docks or other boating facilities at Bayville (source: USACE NYD "The Floods of August and September 1971 (Hurricane Doria)", March 1975).

During the extratropical storm of March 1984, severe erosion was incurred (source: Governor's Coastal Erosion Task Force, Final Report, Volume Two, Long-Term Strategy, September 1994). In Saddle Rock, high tides undermined portions of the foundation and several walls of the Grist Mill historic site. At Sands Point, roads were undermined and pavement on roadway surfaces and shoulders was lost; the estimate of beach loss was about 14,000 cubic yards. At Roslyn, high water undermined pavement on Skillman Street by the neck of Hempstead Harbor. In Sea Cliff, high water and wave action eroded the shoreline along Prospect Avenue at Sitting Park. In Glen Cove, East Beach Road was washed out at the north terminus by Long Island Sound. It was estimated that about 13,000 cubic yards of sand were lost in Glen Cove, predominantly at the beach at the north end of the city. In Bayville, a section of the toe of a boat launch at West Harbor Beach on Oyster Bay Harbor washed out; portions of the concrete end sections of the recreational pier were destroyed at West Harbor Beach; and pilings and bracing were damaged at the boat dock at Creek Road Beach, located on the south shore at Mill Neck Creek (source: "Post Storm Evaluation of the March 29, 1984 Northeaster", URS, March 1986).

During the December 1992 northeaster, erosion undermined a 200 foot section of Lighthouse Road in Kings Point (source: US Army Corps of Engineers New York District "North Shore of Long Island, New York, Storm Damage Protection and Beach Erosion Control Reconnaissance Study", September 1995).

The Village of Oak Neck Point's high ground elevations preclude flooding, but historic bluff erosion has been severe. Several residents have built massive concrete retaining walls to protect against erosion (source: US Army Corps of Engineers New York District "North Shore of Long Island, New York, Storm Damage Protection and Beach Erosion Control Reconnaissance Study", September 1995).

Historically, erosion damages have occurred in the Town of Oyster Bay at the Theodore Roosevelt Memorial Park, and the Ransom and Stehli Beach areas. At one point, a section of the Long Island Railroad's tracks were undermined (date of event not noted; source: US Army Corps of Engineers New York District "North Shore of Long Island, New York, Storm Damage Protection and Beach Erosion Control Reconnaissance Study", September 1995).

The Village of Mill Neck has installed a bulkhead seawall along its north coast and most of its east coast in response to past flooding and erosion damages (source: FEMA Flood Insurance Study for Nassau County, April 1997).

South Shore – Barrier

During the Hurricane of September 1938, waves piled sand onto roads adjacent to the coastline, and many structures were damaged or destroyed from coastal erosion, wave action, and flooding (source: USACE NYD Long Beach Island, New York, Draft Feasibility Report, September 1994).

The Extratropical Storm of November 1950 resulted in severe erosion of the beaches on Long Beach Island and light stone groins were damaged. Residential structures were also damaged, but primarily due to flooding as opposed to coastal erosion or wave action (source: USACE NYD Long Beach Island, New York, Draft Feasibility Report, September 1994). Waves approximately 20 feet in height were recorded at Jones Inlet. Principal losses were identified as the result of erosion of developed beaches, breakthroughs of protecting dunes, battering of shore protection structures, and flooding and destruction of structures and infrastructure (source: Governor's Coastal Erosion Task Force, Final Report, Volume Two, Long-Term Strategy, September 1994).

During the Extratropical Storm of November 1953, Atlantic Beach and Long Beach were inundated with approximately 12 inches of water. The barrier island was breached and ocean waters met the back bays. Damages from flooding, erosion, and wave action were incurred (source: USACE NYD Long Beach Island, New York, Draft Feasibility Report, September 1994). Roads leading to an on Long Beach Island were severely flooded, and a major overwash occurred at Atlantic Beach. Along Jones Beach erosion extended to within 50 feet of Ocean Parkway (source: Governor's Coastal Erosion Task Force, Final Report, Volume Two, Long-Term Strategy, September 1994).

Hurricane Donne (September 1960) resulted in water depths of 3 to 4 feet deep in some places on Long Beach Island. Damages from flooding, erosion, and wave action were incurred. In particular, erosion at Jones Inlet was severe (source: USACE NYD Long Beach Island, New York, Draft Feasibility Report, September 1994).

During the Extratropical storm of March 1962 (often called "Five High" because of its duration over five successive astronomical high tides, severe erosion and wave action were incurred on Long Beach Island, when the ocean met the bay in at least one location. The storm's long duration was reported to have caused unprecedented destruction of beaches and dunes. Boardwalks, seawalls, bulkheads, groins and jetties and numerous homes were destroyed. This storm (including the effects of inundation) was reported to have caused approximately $20 million in damages (based on October 1992 price levels) (source: USACE NYD Long Beach Island, New York, Draft Feasibility Report, September 1994). Severe beach and dune erosion occurred along the shorefronts of Atlantic Beach, Long Beach, Lido Beach, Jones Beach, and Gilgo Beach. Foundations o the boardwalks at Atlantic Beach and Long Beach were undermined and a number of access ramps were damaged. Groins between Atlantic Beach and Long Beach were damaged. In Long Beach heavy depositions of sand occurred on all streets abutting the beachfront (source: USACE Report on Operation Five High, March 1962 Storm, August 1963). It was estimated that 60,000 cubic yards of fill were used to repair lost beachfront, over a length of 4,500 feet, between Long Beach and Lido Beach (source: USACE NYD "Report on Storm of 6-8 March 1962", Volume I, February 1963).

Hurricane Doria (September 1971) damaged jetties at Atlantic Beach and Long Beach; piers, docks or other boating facilities at Hempstead, Island Park, and Lawrence; and beaches were eroded at Massapequa and Island Park (source: USACE NYD "The Floods of August and September 1971 (Hurricane Doria)", March 1975).

During the extratropical storm of March 1984, significant wave action and severe erosion was incurred. Wave heights were estimated at 20 feet. Beaches and dunes suffered severe erosion and numerous shoreline protection structures were damaged, as were public recreational facilities (source: Governor's Coastal Erosion Task Force, Final Report, Volume Two, Long-Term Strategy, September 1994). In Atlantic Beach, coastal erosion and wave action damaged the boardwalk and seawall, and to the bulkhead on Reynold's Channel on the bay side. At Long Beach, beach sand was lost, uncovering timber groins and piles at several locations. On the bay side, Hagen Canal overtopped the bulkhead at the Clark Street playground, washing out the fill behind the bulkhead and undermining the pavement. At Lido Beach, docks and pilings were lifted by waves with some destroyed sections and piers were torn from bulkheads; beach loss on the ocean side was almost 15 feet wide by the Lido Towers, and waves from Reynold's Channel caused the failure of a two-foot high concrete wall at the Lido Beach Golf Course and scoured the concrete riprap behind the wall. In Hempstead Park, beach fencing for almost one mile was lost and approximately 80,000 cubic yards of sand were washed away. At Point Lookout, 160 feet of concrete walkway was undermined and destroyed on the Sound at Town Park. At Jones Beach, high tides and wave action damaged the substructure of the concrete patio slab of the bathhouse a, damaged two fishing piers, and resulted in lost sand and drops in berm heights. At Tobay Beach, high tides and wave action overtopped bulkheads at the picnic area, and shifted sand to the boat slips (source: "Post Storm Evaluation of the March 29, 1984 Northeaster", URS, March 1986).

During the Halloween Storm of 1991, the Town of Hempstead Town Park lost significant quantities of its beach due to erosion. The beach reportedly continued to erode causing subsequent damage to Town of Hempstead structures until placement of additional sand following the dredging of Jones Inlet in March of 1994. Point Lookout, the Town of Hempstead Beach, and Lido Beach experienced scarping. Three groins at Point Lookout were damage, and water and debris washed into the streets of central Long Beach (source: USACE NYD Long Beach Island, New York, Draft Feasibility Report, September 1994).

During the December 1992 Northeaster, the Town of Hempstead Town Park observed the collapse of the concrete sidewalk in front of the lifeguard stations on the east end of Long Beach Island. The lifeguard stations were subsequently undermined. The Town has consistently refilled the area with stone and concrete rubble to protect these facilities from further damage (source: USACE NYD Long Beach Island, New York, Draft Feasibility Report, September 1994).

Long Beach Island is a Nassau County south shore barrier island plagued by the affects of coastal erosion and wave action. On it lie the Village of Atlantic Beach, the City of Long Beach, and the unincorporated areas of Lido Beach and Point Lookout. The island itself offers protection from wave action and erosion in back bay mainland communities. The US Army Corps of Engineers is conducting a study of the area at this time, and notes that continued erosion has resulted in a reduction in the height and width of the protective beach front, which has increased the potential for storm damages. Erosion damages have been incurred during damaging storms in 1938, 1950, 1953, 1960, 1962, 1984, 1991, and 1992 (source: US Army Corps of Engineers New York District "Atlantic Coast of New York Jones Inlet to East Rockaway Inlet Long Beach Island, New York, Storm Damage Reduction Project – Fact Sheet).

South Shore – Mainland Back Bays

The barrier islands south of the Nassau County mainland offer protection from wave action and erosion in back bay mainland communities. Mainland back bay areas tend to experience flooding from three main sources: (1) back bays and canals; (2) tidal creeks; and (3) isolated flooding from heavy rainfall due to poor drainage. Flooding tends to be most severe under storm conditions (i.e., hurricanes and northeasters), when water entering the inlet at high tide cannot recede because of elevated ocean water levels. However, damages tend to be the result of inundation, as opposed to wave action or coastal erosion.

In Island Park, during the Northeaster of March 1984, sand loss at Big Beach, near Waterford Road, was estimated at 3000 cubic yards. Sand loss at Small Beach, near Pershing Place, was estimated at 1000 cubic yards. In Freeport, timber decking was torn up at the East Marina and Laboratory at the Village Basin. In Lawrence, erosion damage was reported to the asphalt walkway at the Lawrence Yacht Basin Park (source: "Post Storm Evaluation of the March 29, 1984 Northeaster", URS, March 1986).

The Village of Massapequa Park has placed riprap along the shore of the Great South Bay to provide erosion protection at the park owned by the Village; residents have installed bulkheading along the canal (source: FEMA Flood Insurance Study for Nassau County, April 1997).

Probability of Occurrence – Coastal Erosion

Probability of occurrence of specific short and long term coastal erosion rates for each community was not readily available at the time of this report. Erosion rates vary greatly over even short distances. Long-term erosion rates and short-term (or storm) erosion rates can differ greatly. **There are no known, systematic attempts to monitor erosion rates along New York's marine shoreline, including Nassau County, except for the incorporation of accepted rates greater than one foot per year into the CEHA mapping.** Much of the information available is presented in reports from multiple sources over many years, and tends to be presented for a small area as opposed to a comprehensive set of results along the County's coastal shorelines. Some of the data has been superceded by current or ongoing studies. Some information is available for particular regions, and this best readily available information on probabilities, as near to the jurisdictional level as possible at this time, are presented below. **This information will be updated during future maintenance cycles of the plan as better information becomes available.**

<u>Long-term Erosion:</u>

Long-term erosion is "ongoing", and is therefore 100% probable, for the general locations and average rates shown in Table 8. ** Note that these data are more recent than, and differ from, the current CEHA maps (circa 1988) which show no "demonstrated long-term average annual recession rates of one foot per year or greater". The CEHA is what is currently regulated, regardless of the information shown in Table 8.*

Table 8
Long-Term Erosion Probabilities

Location	Long-Term Erosion Probability	Long Term Erosion Rate for Given Probability *	Source
South Shore Barrier: Atlantic Ocean Shoreline of Long Beach Island, from East Rockaway Inlet to Jones Inlet	Ongoing, therefore 100% probable	2 to 4 feet per year	Rate is average, as per USACE's *Long Beach Island, New York, Hurricane and Storm Damage Reduction Limited Reevaluation Report*, Draft, February 2006).
South Shore Barrier: Atlantic Ocean Shoreline, Jones Beach, from Jones Inlet east to the Nassau/Suffolk border	Ongoing, therefore 100% probable	Unknown	The USACE is monitoring erosion rates from Jones Inlet east to the Nassau/Suffolk border as part of the ongoing Atlantic Coast of New York Monitoring Program, initiated in 1995. Study efforts were suspended in 1998 because the original authority expired. The Water Resources Development Act of 1999 reauthorized the study, but no additional funds were available. In 2001, Congress added an additional $1 million. No additional funds have been authorized since that time for completion of the project, and specific data is not available at this time.
South Shore- Mainland Back Bay (areas of mapped CEHA)	N/A	N/A	USACE studies and NYS CEHA mapping do not indicate erosion occurring in mainland back bay areas.
North Shore (areas of mapped CEHA)	Ongoing, therefore 100% probable	1-2 feet per year	The USACE has reported erosion is dominant along the north shore, with average rates of roughly 1 to 2 feet per year, and only isolated pockets of accretion. It is also explained in this same report that most shoreline recession, particularly bluff erosion, tends to be associated with storms.

* Note: According to current NYS CEHA mapping (circa 1988) demonstrated long-term average annual recession rates of one foot per year or greater do not exist.

Short-term Erosion

Severe storms can erode large quantities of sand in a relatively short amount of time. However, severe storms do not necessarily cause all beaches to erode. Some beaches will erode, and others will have sand deposited on them. Detailed short-term storm erosion rates for specific communities are not available at this time. The general information presented in Table 9 was taken from the *Hurricane Damage Mitigation Plan for the South Shore, Nassau and Suffolk Counties, NY* (LIRPB, 1984).

Table 9
Short Term Erosion Volumes for Given Recurrence Interval Storms

Storm Event	Recurrence Interval *(1885-1962)*	Typical Erosion Damages *(Average volume of sand eroded above mean sea level from beaches more than five miles long as a result of storm occurrence)*
Unusually Severe/Rare Tropical Cyclones and Northeasters	38.5	20-50 cubic yards per foot
Severe/Extreme Tropical Cyclones and Northeasters	8.5	10-20 cubic yards per foot
Moderate Tropical Cyclones and Northeasters	1.2	4-10 cubic yards per foot

Wave Action

Description - Wave Action

Wave action can be defined as the situation that occurs when structures in certain areas of coastal communities nearest to the shoreline are directly impacted by high velocity waves. Wave action often causes significantly more damage to structures than still water flooding at similar depths. Wave action also increases erosion rates (see "Coastal Erosion" discussion beginning on Page 30).

Location - Wave Action

Nassau County's northern shoreline is exposed to wave action from the Long Island Sound. The County's south shore is exposed to wave action from the Atlantic Ocean and the waters of its many back bays.

Wave zones are the regions in which a breaking wave of at least 3 feet can be expected. A 3-foot wave is generally accepted as the minimum wave that would cause damage to typical structures. FEMA refers to theses areas as "Velocity Zones" (V-zones), or coastal high hazard areas. They are 100-year coastal floodplains where, generally speaking, high-energy waves can be expected inland to the point where the 100-year flood depth is insufficient to support a 3-foot breaking wave.

V-zones are evident in north and south shore communities. Mapped V-zones are extensive in south shore barrier island coastal areas fronting the Atlantic, as well as north shore coastlines facing north and east, but are not particularly widespread in south shore back-bay communities. Figure 3 illustrates mapped V-zones (coastal high hazard areas) in Nassau County (as per FEMA Q3 Flood Data).

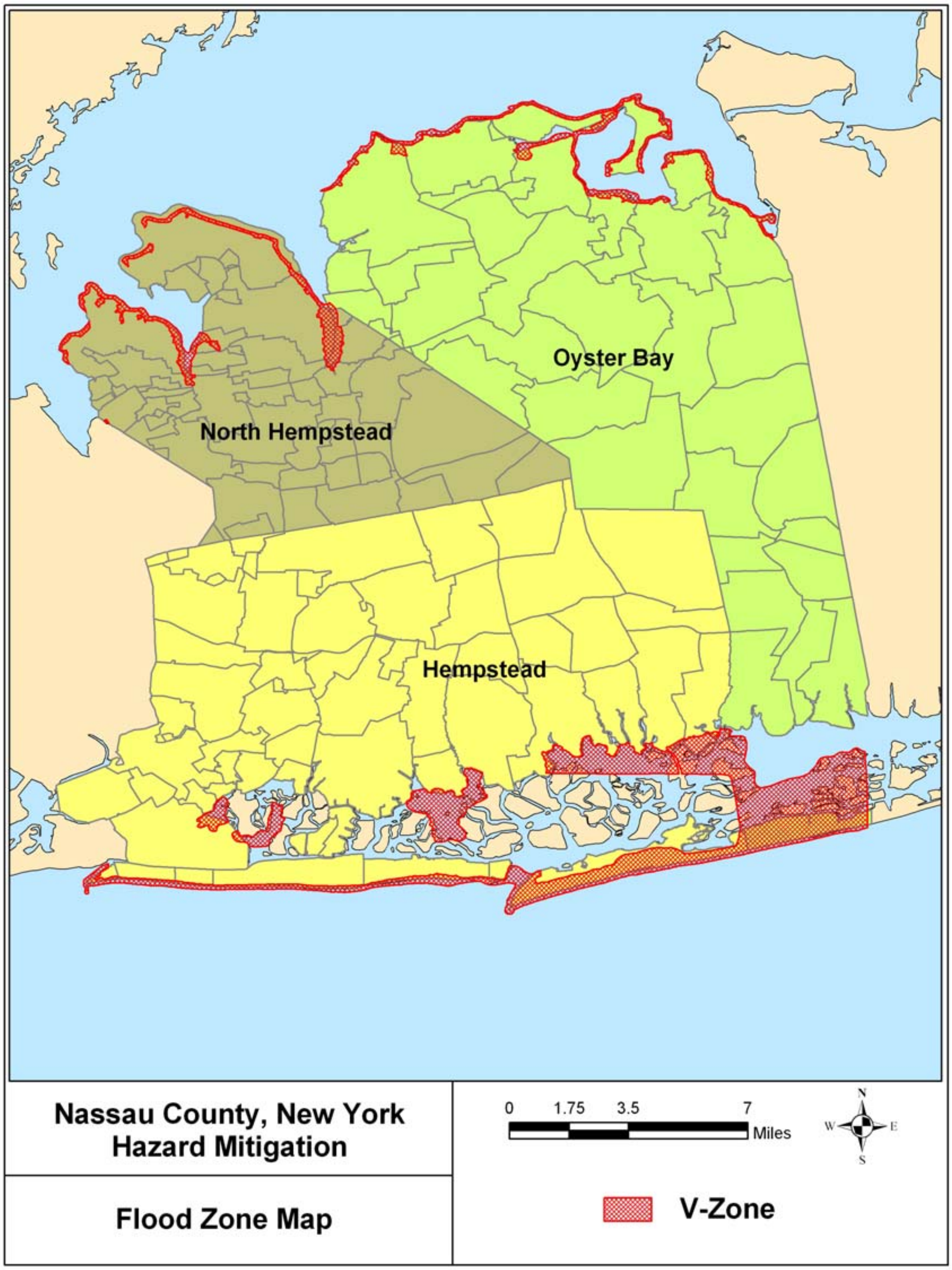


Figure 3 – FEMA Wave Action Hazard Areas in Nassau County

North shore communities with mapped V-zones are:

Nassau County North Shore	
Town	**Community**
North Hempstead	Flower Hill
North Hempstead	Glenwood Landing
North Hempstead	Great Neck
North Hempstead	Great Neck Estates
North Hempstead	Kings Point
North Hempstead	Manhasset
North Hempstead	Plandome
North Hempstead	Plandome Heights
North Hempstead	Plandome Manor
North Hempstead	Port Washington
North Hempstead	Roslyn
North Hempstead	Roslyn Harbor
North Hempstead	Sands Point
Oyster Bay	Bayville
Oyster Bay	Bayville Unincorporated
Oyster Bay	Centre Island
Oyster Bay	Cove Neck
Oyster Bay	Glen Cove
Oyster Bay	Glenwood Landing
Oyster Bay	Lattingtown
Oyster Bay	Laurel Hollow
Oyster Bay	Locust Valley
Oyster Bay	Mill Neck
Oyster Bay	Oyster Bay
Oyster Bay	Oyster Bay Cove

South shore mainland communities with mapped V-zones are:

Nassau County South Shore	
Town	**Community**
Hempstead	Baldwin Harbor
Hempstead	Bellmore
Hempstead	Freeport
Hempstead	Hewlett Neck
Hempstead	Lawrence
Hempstead	Merrick
Hempstead	Oceanside
Hempstead	Seaford
Hempstead	Wantagh
Hempstead	Woodsburgh

South shore Barrier Island communities with mapped V-zones are:

Nassau County South Shore Barrier Island	
Town	**Community**
Hempstead	Atlantic Beach
Hempstead	Atlantic Beach West
Hempstead	East Atlantic Beach
Hempstead	Jones Beach
Hempstead	Lido Beach
Hempstead	Long Beach
Hempstead	Point Lookout
Oyster Bay	Tobay Beach Park

Extent - Wave Action

Wave action is an ongoing process for any community with coastal frontage. However, the affects of wave action are exacerbated during storm events when water levels, wind driven waves, and coastal currents tend to increase rapidly.

Wave action exerts strong hydrodymanic forces on any objects obstructing the flow of water. The affects of wave action can be quite severe. Wave action can induce erosion of beaches and dunes in some locations, while other locations experience the deposition of large quantities of sand. Wave action can damage or destroy boardwalks, seawalls, bulkheads, groins and jetties, residences and business, roadways and parking areas.

Town of Hempstead Communities with V-zone	
Municipality Name	**Total Area (Acres)**
Atlantic Beach	26.9
Atlantic Beach West	38.9
Baldwin Harbor	37.1
Bellmore	4.3
East Atlantic Beach	19.8
Freeport	3.9
Hewlett Neck	2.4
Jones Beach	1,353.1
Lawrence	156.7
Lido Beach	124.9
Long Beach	113.4
Merrick	80.9
Oceanside	8.0
Point Lookout	17.5
Seaford	20.0
Wantagh	31.9
Woodsburgh	0.5
Total	**2,040.4**

Town of North Hempstead Communities with V-zone	
Municipality Name	**Total Area (Acres)**
Flower Hill	3.3
Great Neck	34.6
Great Neck Estates	2.1
Kings Point	426.4
Manhasset	5.2
Plandome	0.0
Plandome Heights	3.9
Plandome Manor	61.5
Port Washington	318.7
Roslyn	10.1
Roslyn Harbor	3.1
Sands Point	285.6
Total	**1,154.5**

Town of Oyster Bay Communities with V-zone	
Municipality Name	**Total Area (Acres)**
Bayville	43.9
Bayville Unincorporated	63.0
Centre Island	94.3
Cove Neck	113.4
Glen Cove	32.2
Glenwood Landing	209.4
Lattingtown	32.6
Laurel Hollow	90.1
Locust Valley	0.5
Mill Neck	105.8
Oyster Bay	69.9
Oyster Bay Cove	21.9
Sea Cliff	7.6
Sea Cliff	7.6
Tobay Beach Park	1,013.1
Total	**1,905.2**

The magnitude and/or severity of wave damage depends on the height and velocity of the waves, how far inland they travel, and the conditions of the buildings or other structures they come into contact with. Other factors affecting the magnitude and/or severity of wave damage include: soil properties, orientation of the shoreline, distance from the storm center, storm-surge heights, wave characteristics, direction of storm movement, angle of wave approach, forward speed and duration of the storm, and tidal stage during storm landfall. Where obstructions exist, wave affects inland of the obstruction are reduced. Older, pre-FIRM buildings would be more susceptible to wave damage because they were built before ordinances were adopted requiring more stringent design requirements. Large masonry buildings (i.e. high rise condominiums, hotels, etc.) are not likely to experience failure by wave action.

Wave action is most severe in areas not protected by barrier island features, and in areas perpendicular to prevailing wind and water currents. Generally speaking, wave action is most severe for north shore communities and south shore barrier island communities. It is less severe for south shore mainland back-bay communities because of the protective effects of the barrier island.

- In ***communities along the north shore*** of Nassau County, wave action has historically been the most severe in the following areas: Sands Point, Kings Point, Oak Neck Point, Bayville, Asharoken, and Centre Island (September 1995, the USACE NYD published a report entitled, "North Shore of Long Island, New York, Storm Damage Protection and Beach Erosion Control Reconnaissance Study.")
- Wave action has historically been the most severe on ***south shore barrier island communities*** of Long Beach, Atlantic Beach, Lido Beach, and Point Lookout, and in Jones Beach State Park.
- In ***south shore mainland back-bay communities***, wave action is subsided by barrier beaches and tidal marshes and its magnitude and degree of severity are low.

Wave heights in Nassau County communities can be quite significant. For example, during the Extratropical Storm of November 1950 waves approximately 20 feet in height were recorded at Jones Inlet. During Hurricane Carol (August 1954), waves along the south shore were estimated at 14 feet in some locations. During the Extratropical Storm of 1984, waves along the south shore were estimated at 20 feet in some locations.

Previous Occurrences - Wave Action

While wave action is an ongoing process, its affects are exacerbated during storm events. The history of previous occurrences of wave action in Nassau County communities is extensive; one might expect that a separate report could be written dedicated solely to summarizing these types of events in Nassau County. The subset of events below represents only sampling, but is characteristic of what has happened in the past and the types of damages that can be expected to occur in the future. The history has been divided into three sections: North Shore, South Shore - Barrier, and South Shore - Mainland Back Bays.

Note to the reader: For much of the wave action hazard history, reports of damage did not distinguish between damages caused specifically by wave action versus those resulting from coastal erosion or flooding alone. As this is the best available data, all reported events are *presented here in their entirety for cases where the specific cause of damage was unclear. Future sections of the report dealing with wave action and flooding summarize many of these same events.*

North Shore

The following paragraph is an excerpt from the Federal Register on January 16, 2002. It is reproduced here, as it provides a concise overview of recent historic coastal events (and associated wave action) on the north shore.

> *"…the northern shoreline has historically experienced coastal erosion and related storm damage, most recently from the two storms of September 1996 and October 1996, and also from previous storms including the Christmas Eve 1994 storm, the March 1993 Blizzard of the Century, the December 1992 northeaster, Hurricane Danielle of September 1992 and the Halloween Storm of 1991. These storms caused evacuations in several north shore communities as well as damage from flooding and loss of structures from erosion. The December 1992 storm alone inundated hundreds of residential and business properties and caused damages estimated at $12,000,000. Approximately 300 families were evacuated and several sections of Bayville Avenue were impassable for days. The loss of beachfront in some areas now leaves the site increasingly vulnerable to severe damages even from moderate storms."*

The Village of Bayville is one north shore community in particular which has incurred significant damages over the years due to coastal erosion and wave action. A state sponsored beach nourishment project was completed in Bayville in 1947. During the Northeaster of December 1992, many of Bayville's seawalls, bulkheads, and gabions that had been installed as a means of protection against coastal erosion and wave action were damaged or destroyed (source: US Army Corps of Engineers New York District "North Shore of Long Island, New York, Storm Damage Protection and Beach Erosion Control reconnaissance Study", September 1995).

During the Hurricane of September 1938, waves caused extensive bluff erosion in communities along the north shore. For the entire length of the north shore it was estimated that damage to private structure, utilities, and government facilities totaled $730,000 (1938 dollars); a breakdown between Nassau and Suffolk was not available (source: Governor's Coastal Erosion Task Force, Final Report, Volume Two, Long-Term Strategy, September 1994).

During the Hurricane of September 1944, it was reported that waves eroded bluffs along the north shore at their base, and summer cottages and houses were undermined. The USACE estimated that the north shore incurred $733,000 in damages (1944 dollars); a breakdown between Nassau and Suffolk was not available (source: Governor's Coastal Erosion Task Force, Final Report, Volume Two, Long-Term Strategy, September 1994).

Wave action, erosion, and inundation during the extratropical storm of November 1950 damaged bulkheads, docks, Coast Guard facilities, low-lying roads, beaches, and bluff (source: Governor's Coastal Erosion Task Force, Final Report, Volume Two, Long-Term Strategy, September 1994).

Waves impacting the shoreline during Hurricane Donna, of September 12, 1960, caused considerable erosion at the base of bluffs (source: Governor's Coastal Erosion Task Force, Final Report, Volume Two, Long-Term Strategy, September 1994).

Wave action during Hurricane Doria (September 1971) damaged piers, docks or other boating facilities at Bayville (source: USACE NYD "The Floods of August and September 1971 (Hurricane Doria)", March 1975).

During the extratropical storm of March 1984, significant wave action and resulting severe erosion was incurred (source: Governor's Coastal Erosion Task Force, Final Report, Volume Two, Long-Term Strategy, September 1994). In Saddle Rock, high tides undermined portions of the foundation and several walls of the Grist Mill historic site. At Sands Point, roads were undermined and pavement on roadway surfaces and shoulders was lost; the estimate of beach loss was about 14,000 cubic yards. At Roslyn, high water undermined pavement on Skillman Street by the neck of Hempstead Harbor. In Sea Cliff, high water and wave action eroded the shoreline along Prospect Avenue at Sitting Park. In Glen Cove, East Beach Road was washed out at the north terminus by Long Island Sound; the culvert at East Beach Road was damaged by wave action; waves also damaged the Prybil Beach Fishing Pier and the East Island Tide Gate. At Hempstead Bay in Glen Cove the seawall was damaged by wave action at Morgan Park. It was estimated that about 13,000 cubic yards of sand were lost in Glen Cove, predominantly at the beach at the north end of the city. In Bayville, high water and wave action washed out a section of the toe of a boat launch at West Harbor Beach on Oyster Bay Harbor; portions of the concrete end sections of the recreational pier were destroyed at West Harbor Beach; and pilings and bracing were damaged at the boat dock at Creek Road Beach, located on the south shore at Mill Neck Creek. Wave action topped the seawall at the public beach at East Beach Road in Lattingtown. In Mill Neck, wave action from Oyster Bay Harbor damaged the seawall in several locations along West Shore Road connecting the villages of Oyster Bay to Bayville. (source: "Post Storm Evaluation of the March 29, 1984 Northeaster", URS, March 1986).

During the December 1992 northeaster, wave action induced erosion undermined a 200 foot section of Lighthouse Road in Kings Point (source: US Army Corps of Engineers New York District "North Shore of Long Island, New York, Storm Damage Protection and Beach Erosion Control Reconnaissance Study", September 1995).

The Village of Oak Neck Point's high ground elevations preclude flooding, but historic bluff erosion has been severe. Several residents have built massive concrete retaining walls to protect against erosion (source: US Army Corps of Engineers New York District "North Shore of Long Island, New York, Storm Damage Protection and Beach Erosion Control Reconnaissance Study", September 1995).

In the Villages of Oyster Bay, Cove Neck, Oyster Bay Cove and Laurel Hollow, erosion is a relatively minor concern as the area lies within the relatively protected area of Cold Spring and Oyster Bay Harbors.

Historically, erosion damages have occurred in the Town of Oyster Bay at the Theodore Roosevelt Memorial Park, and the Ransom and Stehli Beach areas. At one point, a section of the Long Island Railroad's tracks were undermined (date of event not noted; source: US Army Corps of Engineers New York District "North Shore of Long Island, New York, Storm Damage Protection and Beach Erosion Control Reconnaissance Study", September 1995).

The Village of Mill Neck has installed a bulkhead seawall along its north coast and most of its east coast in response to past flooding and erosion damages. The seawall has suffered extensive damage from wave action in the past (source: FEMA Flood Insurance Study for Nassau County, April 1997).

South Shore – Barrier

During the Hurricane of September 1938, waves damaged a 50-foot section of the jetty at East Rockaway Inlet, and 15 stone and timber groins along the Long Beach oceanfront. Waves piled sand onto roads adjacent to the coastline, and many structures were damaged or destroyed from coastal erosion, wave action, and flooding (source: USACE NYD Long Beach Island, New York, Draft Feasibility Report, September 1994).

The Extratropical Storm of November 1950 wave action resulted in severe erosion of the beaches on Long Beach Island and light stone groins were damaged. Residential structures were also damaged, but primarily due to flooding as opposed to coastal erosion or wave action (source: USACE NYD Long Beach Island, New York, Draft Feasibility Report, September 1994). Waves approximately 20 feet in height were recorded at Jones Inlet. Principal losses were identified as the result of erosion of developed beaches, breakthroughs of protecting dunes, battering of shore protection structures, and flooding and destruction of structures and infrastructure (source: Governor's Coastal Erosion Task Force, Final Report, Volume Two, Long-Term Strategy, September 1994).

During the Extratropical Storm of November 1953, Atlantic Beach and Long Beach were inundated with approximately 12 inches of water. The barrier island was breached and ocean waters met the back bays. Damages from flooding, erosion, and wave action were incurred (source: USACE NYD Long Beach Island, New York, Draft Feasibility Report, September 1994). Roads leading to an on Long Beach Island were severely flooded, and a major overwash occurred at Atlantic Beach. Along Jones Beach erosion extended to within 50 feet of Ocean Parkway (source: Governor's Coastal Erosion Task Force, Final Report, Volume Two, Long-Term Strategy, September 1994).

During Hurricane Carol (August 1954), waves along the south shore were estimated at 14 feet in some locations (source: Governor's Coastal Erosion Task Force, Final Report, Volume Two, Long-Term Strategy, September 1994).

Hurricane Donne (September 1960) resulted in water depths of 3 to 4 feet deep in some places on Long Beach Island. Damages from flooding, erosion, and wave action were incurred. In particular, erosion at Jones Inlet was severe (source: USACE NYD Long Beach Island, New York, Draft Feasibility Report, September 1994).

During the Extratropical storm of March 1962 (often called "Five High" because of its duration over five successive astronomical high tides, severe erosion and wave action were incurred on Long Beach Island, when the ocean met the bay in at least one location. The storm's long duration was reported to have caused unprecedented destruction of beaches and dunes. Boardwalks, seawalls, bulkheads, groins and jetties and numerous homes were destroyed. This storm (including the effects of inundation) was reported to have caused approximately $20 million in damages (based on October 1992 price levels) (source: USACE NYD Long Beach Island, New York, Draft Feasibility Report, September 1994). Severe beach and dune erosion occurred along the shorefronts of Atlantic Beach, Long Beach, Lido Beach, Jones Beach, and Gilgo Beach. Foundations o the boardwalks at Atlantic Beach and Long Beach were undermined and a number of access ramps were damaged. Groins between Atlantic Beach and Long Beach were damaged. In Long Beach heavy depositions of sand occurred on all streets abutting the beachfront (source: USACE Report on Operation Five High, March 1962 Storm, August 1963). It was estimated that 60,000 cubic yards of fill were used to repair lost beachfront, over a length of 4,500 feet, between Long Beach and Lido Beach (source: USACE NYD "Report on Storm of 6-8 March 1962", Volume I, February 1963).

Hurricane Doria (September 1971) damaged jetties at Atlantic Beach and Long Beach; piers, docks or other boating facilities at Hempstead, Island Park, and Lawrence; and beaches were eroded at Massapequa and Island Park (source: USACE NYD "The Floods of August and September 1971 (Hurricane Doria)", March 1975).

During the extratropical storm of March 1984, significant wave action and sever erosion was incurred. Wave heights were estimated at 20 feet. Beaches and dunes suffered severe erosion and numerous shoreline protection structures were damaged, as were public recreational facilities (source: Governor's Coastal Erosion Task Force, Final Report, Volume Two, Long-Term Strategy, September 1994). In Atlantic Beach, coastal erosion and wave action damaged the boardwalk and seawall, and to the bulkhead on Reynold's Channel on the bay side. At Long Beach, beach sand was lost, uncovering timber groins and piles at several locations. Entrances to four comfort stations along the beach were damaged by high tides and wave action. On the bay side, Hagen Canal overtopped the bulkhead at the Clark Street playground, washing out the fill behind the bulkhead and undermining the pavement. At Lido Beach, docks and pilings were lifted by waves with some destroyed sections and piers were torn from bulkheads; beach loss on the ocean side was almost 15 feet wide by the Lido Towers, and waves from Reynold's Channel caused the failure of a two-foot high concrete wall at the Lido Beach Golf Course and scoured the concrete riprap behind the wall. In Hempstead Park, beach fencing for almost one mile was lost and approximately 80,000 cubic yards of sand were washed away. At Point Lookout, 160 feet of concrete walkway was undermined and destroyed on the Sound at Town Park. At Jones Beach, high tides and wave action damaged the substructure of the concrete patio slab of the bathhouse a, damaged two fishing piers, and resulted in lost sand and drops in berm heights. At Tobay Beach, high tides and wave action overtopped bulkheads at the picnic area, and shifted sand to the boat slips (source: "Post Storm Evaluation of the March 29, 1984 Northeaster", URS, March 1986).

During the Halloween Storm of 1991, the Town of Hempstead Town Park lost significant quantities of its beach due to erosion. The beach reportedly continued to erode causing subsequent damage to Town of Hempstead structures until placement of additional sand following the dredging of Jones Inlet in March of 1994. Point Lookout, the Town of Hempstead Beach, and Lido Beach experienced scarping. Three groins at Point Lookout were damage, and water and debris washed into the streets of central Long Beach (source: USACE NYD Long Beach Island, New York, Draft Feasibility Report, September 1994).

During the December 1992 Northeaster, the Town of Hempstead Town Park observed the collapse of the concrete sidewalk in front of the lifeguard stations on the east end of Long Beach Island. The lifeguard stations were subsequently undermined. The Town has consistently refilled the area with stone and concrete rubble to protect these facilities from further damage (source: USACE NYD Long Beach Island, New York, Draft Feasibility Report, September 1994).

Long Beach Island is a Nassau County south shore barrier island plagued by the affects of coastal erosion and wave action. On it lie the Village of Atlantic Beach, the City of Long Beach, and the unincorporated areas of Lido Beach and Point Lookout. The island itself offers protection from wave action and erosion in back bay mainland communities. The US Army Corps of Engineers is conducting a study of the area at this time, and notes that continued erosion has resulted in a reduction in the height and width of the protective beach front, which has increased the potential for storm damages. Erosion damages have been incurred during damaging storms in 1938, 1950, 1953, 1960, 1962, 1984, 1991, and 1992 (source: US Army Corps of Engineers New York

District "Atlantic Coast of New York Jones Inlet to East Rockaway Inlet Long Beach Island, New York, Storm Damage Reduction Project – Fact Sheet).

South Shore – Mainland Back Bays

The barrier islands south of the Nassau County mainland offer protection from wave action and erosion in back bay mainland communities. Mainland back bay areas tend to experience flooding from three main sources: (1) back bays and canals; (2) tidal creeks; and (3) isolated flooding from heavy rainfall due to poor drainage. Flooding tends to be most severe under storm conditions (i.e., hurricanes and northeasters), when water entering the inlet at high tide cannot recede because of elevated ocean water levels. However, damages tend to be the result of inundation, as opposed to wave action or coastal erosion.

During the Northeaster of March 1984, waves uplifted 36 feet of decking, cross bracing, and stringers at the Recreation Pier. Sand loss at Big Beach, near Waterford Road, was estimated at 3000 cubic yards. Sand loss at Small Beach, near Pershing Place, was estimated at 1000 cubic yards. In Freeport, timber decking was torn up at the East Marina and Laboratory at the Village Basin (source: "Post Storm Evaluation of the March 29, 1984 Northeaster", URS, March 1986).

The Village of Massapequa Park has placed riprap along the shore of the Great South Bay to provide erosion protection at the park owned by the Village; residents have installed bulkheading along the canal (source: FEMA Flood Insurance Study for Nassau County, April 1997).

Probability of Occurrence - Wave Action

There is a 1% chance per year of 3-foot breaking waves inundating Nassau County communities to the extent shown on the FEMA-mapped V-zones. This area is mapped in Figure 3 (see Page 42). The distance landward of the shoreline and the depth of water differs by location.

Earthquakes

Description – Earthquakes

FEMA defines the term "earthquake" as a sudden, rapid shaking of the Earth caused by the breaking and shifting of rock beneath the Earth's surface. This movement forces the gradual buildup and accumulation of energy. Eventually, strain becomes so great that the energy is abruptly released, causing the shaking at the earth's surface which we know as an earthquake.

According to the USGS Earthquake Hazards Program, most earthquakes occur at the boundaries where the plates meet (roughly 90%), although it is possible for earthquakes to occur entirely within plates. New York State, and Nassau County, are both far from any plate boundaries. In, "Do Earthquakes Occur in New York State?" by Isachson, Y. W., E. Landing, J. M. Lauber, et al., eds., (posted on the MCEER web site), scientists to not yet know what causes earthquakes in regions far from plate margins. Regardless of where they are centered, earthquakes can impact locations at – and beyond – their point of origin. They are often accompanied by "aftershocks" – secondary quakes in the earthquake sequence. Aftershocks are typically smaller than the main shock, and can continue over a period of weeks, months, or years from the main shock.

In addition to the effects of ground shaking, 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 sometimes trigger fires.

Location – Earthquakes

Earthquakes are possible within any of Nassau County's communities. Figure 4 is an earthquake hazard map for New York State prepared by NYSEMO (available on line at http://www.nysemo.state.ny.us/MITIGATION/earthquakes.htm).

As the figure shows, Nassau County is located within one of three main regions in New York State that have a seismic risk that tends to be higher than in the rest of the state. For Nassau County and its participating jurisdictions, the earthquake hazard is uniform across Nassau County and its communities.

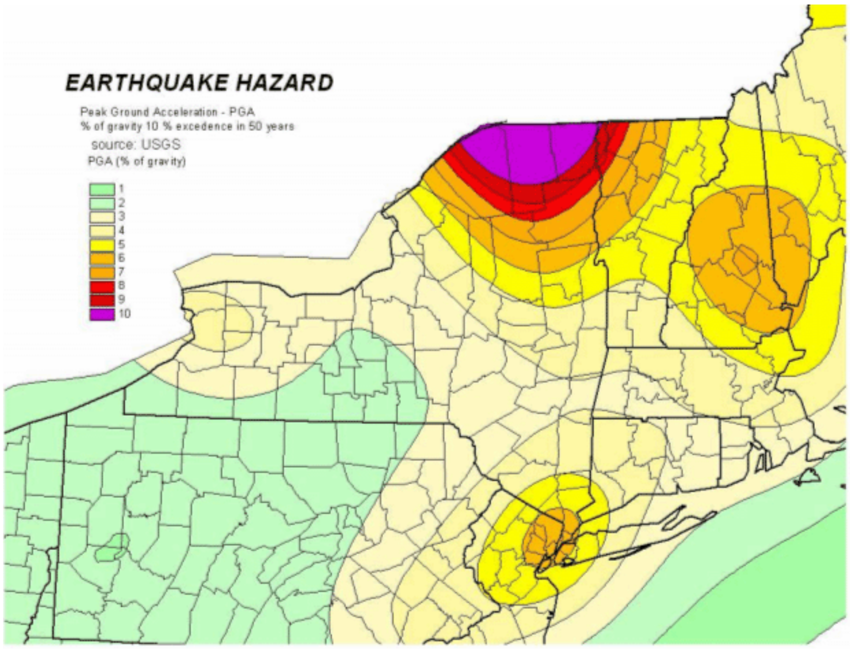


Figure 4 - Earthquake Hazard Map of New York State

Extent – Earthquakes

The severity of an earthquake at a given location depends on the amount of energy released at the epicenter, and the location's distance from the epicenter. The terms "magnitude" and "intensity" are two terms used to describe the severity of an earthquake. An earthquake's "magnitude" is a measurement of the total amount of energy released while its "intensity" is a measure of the effects of an earthquake at a particular place. Another way to express an earthquake's severity is to compare its acceleration to the normal acceleration due to gravity. 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/sec^2). Figure 4 shows that, for Nassau County and its participating jurisdictions, a PGA value of 5%g has a 10 percent chance of being exceeded over 50 years.

An approximated relationship between PGA, magnitude, and intensity is shown in Table 10. Using Table 10, one can approximate that, for an earthquake of expected severity for Nassau County and its participating jurisdictions (PGA value of 5%g), perceived shaking would be light to moderate (depending upon the distance from the epicenter) and potential damage could range from none to very light (also depending upon the distance from the epicenter).

Table 10
Earthquake Magnitude/Intensity Comparison

PGA	Magnitude	Intensity	Perceived Shaking	Potential Damage
< 0.17	1.0-3.0	I	Not Felt	None
0.17 – 1.4	3.0 – 3.9	II - III	Weak	None
1.4 – 9.2	4.0 – 4.9	IV – V	IV. Light V. Moderate	IV. None V. Very Light
9.2 - 34	5.0 – 5.9	VI – VII	VI. Strong VII. Very Strong	VI. Light VII. Moderate
34 - 124	6.0 – 6.9	VIII - IX	VIII. IX.	VIII. IX.
> 124	7.0 and higher	X and higher	Extreme	Very Heavy

Sources: (1) FEMA Mitigation Planning "How-To" Guide 386-2 (as reported in the New York State Hazard Mitigation Plan 2005; (2) Wald, D., et al., 1999, Relationship between Peak Ground Acceleration, Peak Ground Motion, and Modified Mercalli Intensity in California", Earthquake Spectra, V. 15, p. 557-564; (3) Community Internet Intensity, USGS Modified Mercalli Intensity, and Instrumental Intensity. 1999. http://www-socal.wr.usgs.gov/ciim/pubs/ciim/node5.html (July 27, 2003).

An earthquake with a 10 percent chance of exceedance over 50 years in Nassau County would have a PGA of 5%g and an intensity ranging from only IV to V, which would result in light to moderate perceived shaking and damages ranging from none to very light. For comparison purposes, as noted on the MCEER web site in an article entitled, "Have there been earthquakes in Western New York?" by Jerold C. Bastedo, an earthquake of intensity I on the Modified Mercalli Scale would most likely go unnoticed; a tremor of about intensity VI would probably be felt by everyone and cause slight damage; whereas, a quake of intensity XII would result in almost total destruction of buildings, objects thrown into the air and waves seen on the earth's surface

As noted in the New York State Hazard Mitigation Plan, soil type can have an impact on the severity of an earthquake at a given location. For example, soft soils (i.e., fill, sand) are more likely to amplify ground motion during an earthquake. Liquefaction is also more likely to occur in areas of soft soils. In contrast, harder soils (i.e., granite) tend to reduce ground motion during an earthquake. The State Plan includes a map prepared by the New York State Geological Survey showing five soil classifications in New York State, as shown in Figure 5.

Nassau County contains soil classifications B through E. Class B soils are found in a band running generally along the northern third of the County. Class B soils are primarily rock or firm ground, and have a moderately low likelihood of amplifying the affects of an earthquake. A thin band of Class C soils is found south of the Class B band. Class C soils are primarily stiff clays, which have a moderate likelihood of amplifying the affects of an earthquake. The southern two thirds of Nassau County consists of Class D soils (soft to medium clays or sands), which have a moderate likelihood of amplifying the affects of an earthquake. Areas of Class E soils (soft soil, including fill, loose sand, waterfront, or lake bed clays), the type most likely to amplify the effects of an earthquake, are visible in the back bay areas in southern Nassau County in the Town of Hempstead, roughly in the vicinity of the Villages of Atlantic Beach and Long Beach.

Hempstead Soil Class (Area in Acres)						
Municipality Name	**Total Area**	**B**	**C**	**D**	**E**	**None**
Atlantic Beach	379.5			279.7		99.8
Atlantic Beach West	118.7			115.9		2.8
Baldwin	1,906.5			1,906.5		
Baldwin Harbor	756.5			734.5		22.0
Barnum Island	407.1		0.4	394.1		12.6
Bay Park	322.6			320.0	0.0	2.6
Bellerose	78.3			78.3		
Bellerose Terrace	86.9			86.9		
Bellmore	1,473.5		0.1	1,470.6		2.8
Cedarhurst	444.1			444.1		
East Atlantic Beach	257.9			195.5		62.4
East Garden City	1,941.8			1,941.8		
East Meadow	3,211.0			3,211.0		
East Rockaway	676.6			676.6		
Elmont	2,213.9			2,213.9		
Floral Park	916.2			916.2		
Franklin Square	1,836.2			1,836.2		
Freeport	3,108.1			3,061.5		46.6
Garden City	3,421.2			3,421.2		
Garden City South	257.6			257.6		
Harbor Isle	114.9			114.0		1.0
Hempstead	2,358.1			2,358.1		
Hewlett	569.1			569.1		
Hewlett Bay Park	245.3			245.3		
Hewlett Harbor	528.3			491.7	0.0	36.6
Hewlett Neck	137.7			137.3		0.4
Inwood	1,377.9			1,034.4		343.5
Island Park	252.7			250.3		2.4
Jones Beach	2,247.8			1,912.0		335.8
Lakeview	751.4			713.3	38.2	
Lawrence	2,973.0		3.0	1,397.6	1,075.2	497.2
Levittown	4,364.7			4,364.7		
Lido Beach	1,112.4			1,075.8		36.7
Long Beach	1,648.8			1,377.1	26.8	244.9
Lynbrook	1,289.9			1,289.9		
Malverne	681.2			681.2		
Malverne Park - Oaks	71.3			71.3		
Merrick	2,682.7		0.0	2,668.3		14.4
New Hyde Park	545.2			545.2		
North Bellmore	1,683.7			1,683.7		
North Lynbrook	53.2			53.2		
North Merrick	1,089.3			1,089.3		
North Valley Stream	1,198.8			1,198.8		
North Wantagh	1,201.0			1,201.0		
Oceanside	3,233.4		0.8	3,227.1		5.5
Point Lookout	146.5			145.6		0.9
Rockville Centre	2,124.3			2,124.3		
Roosevelt	1,168.8			1,168.8		
Salisbury	1,979.1			1,979.1		
Seaford	1,631.5		1.4	1,629.9		0.3
South Floral Park	65.0			65.0		
South Hempstead	373.8			373.8		
South Valley Stream	550.5			550.5		
Steward Manor	128.3			128.3		
Uniondale	1,721.1			1,721.1		
Valley Stream	2,267.0			2,267.0		
Wantagh	2,459.1		1.5	2,456.8		0.9
West Hempstead	1,777.4			1,684.1	93.3	
Woodmere	1,768.3			1,756.9		11.3
Woodsburgh	265.9			265.4		0.6
Total	**74,652.8**	**0.0**	**7.2**	**71,628.4**	**1,233.4**	**1,783.7**

Oyster Bay Soil Class (Area in Acres)						
Municipality Name	Total Area	B	C	D	E	None
Bayville	899.3	640.8	0.0	230.6		28.0
Bayville Unincorporated	99.0	23.5		71.6		3.8
Bethpage	2,349.3			2,349.3		
Brookville	2,564.8	394.9	1,603.7	566.2		
Centre Island	695.3	688.2				7.1
Cove Neck	888.2	817.6				70.6
East Massapequa	2,198.2			2,186.7		11.5
East Norwich	667.6	417.3	250.4			
Farmingdale	700.9			700.9		
Glen Cove	4,372.8	4,368.5				4.3
Glen Head	1,049.8	1,049.8				
Glenwood Landing	905.7	663.5	0.9	2.2		239.2
Hicksville	4,338.6			4,338.6		
Jericho	2,823.9		284.0	2,539.9		
Lattingtown	2,428.3	2,426.1	0.6			1.6
Laurel Hollow	1,912.4	630.6	919.7	317.1		45.0
Locust Valley	651.3	651.2				0.1
Massapequa	2,348.1			2,337.0		11.1
Massapequa Park	1,410.5			1,396.3		14.3
Matinecock	1,700.2	1,700.2				
Mill Neck	1,784.6	1,724.4				60.2
Muttontown	3,889.3	613.4	1,930.2	1,345.6		
North Massapequa	1,930.0			1,930.0		
Old Bethpage	2,608.6			2,608.6		
Old Brookville	2,537.6	2,521.3	16.3			
Oyster Bay	814.2	811.3				2.8
Oyster Bay Cove	2,683.7	1,502.2	1,083.1	78.0		20.5
Plainedge	909.9			909.9		
Plainview	3,654.7		108.6	3,546.1		
Sea Cliff	699.5	698.4				1.1
Sea Cliff	699.5	698.4				1.1
South Farmingdale	1,412.7			1,412.7		
Syosset	3,202.9		492.1	2,710.7		
Tobay Beach Park	1,046.8		6.9	1,025.1		14.8
Upper Brookville	2,753.4	2,669.9	83.6			
Woodbury	3,242.9		1,291.8	1,951.0		
Total	**68,874.6**	**25,711.5**	**8,071.8**	**34,554.2**	**0.0**	**537.1**

North Hempstead Soil Class (Area in Acres)						
Municipality Name	Total Area	B	C	D	E	None
Albertson	436.7		54.2	382.5		
Baxter Estates	106.9	86.5	20.4			0.0
Carle Place	621.8			621.8		
East Hills	1,436.4	0.9	857.7	577.7		
East Williston	363.8			363.8		
Flower Hill	1,051.8	1,051.5		0.2		0.1
Garden City Park	637.3			637.3		
Great Neck	871.7	852.8				18.9
Great Neck Estates	513.6	484.5				29.1
Great Neck Gardens	141.4	141.4				
Great Neck Gardens	141.4	141.4				
Great Neck Plaza	196.4	196.4				
Greenvale	170.7	59.9	110.9			
Harbor Hills	78.3	77.1				1.2
Herricks	370.9			370.9		
Kensington	146.9	146.1				0.8
Kings Point	2,587.6	2,161.9				425.7
Lake Success	1,206.0	135.6	872.1	198.2		
Manhasset	1,544.9	851.5	679.0			14.4
Manhasset Hills	380.7		91.1	289.5		
Manorhaven	404.1	53.3	253.7			97.0
Mineola	1,196.6			1,196.6		
Munsey Park	321.3	321.3				
New Cassel	938.4			938.4		
North Hills	1,773.3	46.0	1,727.3	0.0		
North New Hyde Park	1,287.8			1,287.8		
Old Westbury	5,442.1	27.8	2,074.0	3,340.3		
Plandome	319.2	316.0				3.2
Plandome Heights	118.7	112.8				6.0
Plandome Manor	396.5	358.1				38.5
Port Washington	2,997.1	1,725.6	153.3	842.7		275.6
Port Washington North	323.4	13.6	297.9			11.9
Roslyn	429.3	128.0	301.1			0.2
Roslyn Estates	269.2	57.5	211.7			
Roslyn Harbor	707.9	704.2	1.1			2.6
Roslyn Heights	939.2		413.1	526.1		
Russell Gardens	112.3	112.3				
Saddle Rock	184.2	175.2				9.0
Saddle Rock Estates	48.5	48.5				
Sands Point	3,711.2	2,588.7	98.5			1,024.1
Searingtown	600.4		298.1	302.3		
Thomaston	262.5	262.5				
University Gardens	362.6	307.7	54.9			
Westbury	1,490.8			1,490.8		
Williston Park	392.6			392.6		
Total	**38,034.3**	**13,746.4**	**8,570.1**	**13,759.6**	**0.0**	**1,958.2**

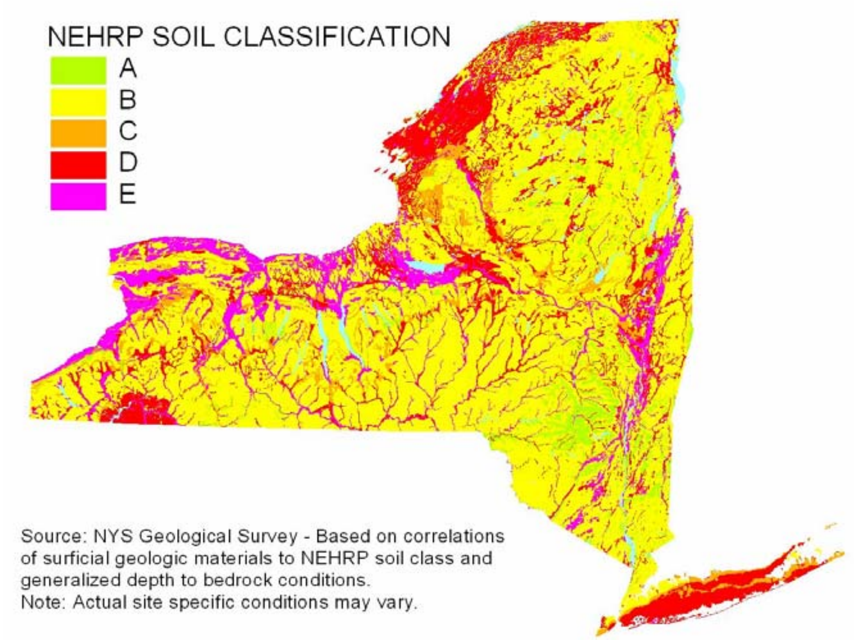


Figure 5 - NEHRP Soil Classifications in New York State

Previous Occurrences - Earthquakes

Despite the fact that it is far from any plate margins, earthquakes have occurred in and around the State of New York in the past. Figure 6 illustrates past earthquake epicenters in and around New York State. This figure was obtained by performing an on-line search of the US Geological Survey National Earthquake Information Center Earthquake Database (online at http://wwwneic.cr.usgs.gov/neis/epic/epic_rect.html) for earthquakes that occurred between 1534 and 1986 in the rectangular area with a latitude range of 40 to 45 degrees and a longitude range of -80 to -72 degrees, which includes but is not limited to New York State (and Long Island). The search resulted in 729 earthquakes of at least magnitude 0.9, all of which occurred at depths of between zero and 33 kilometers below the surface.

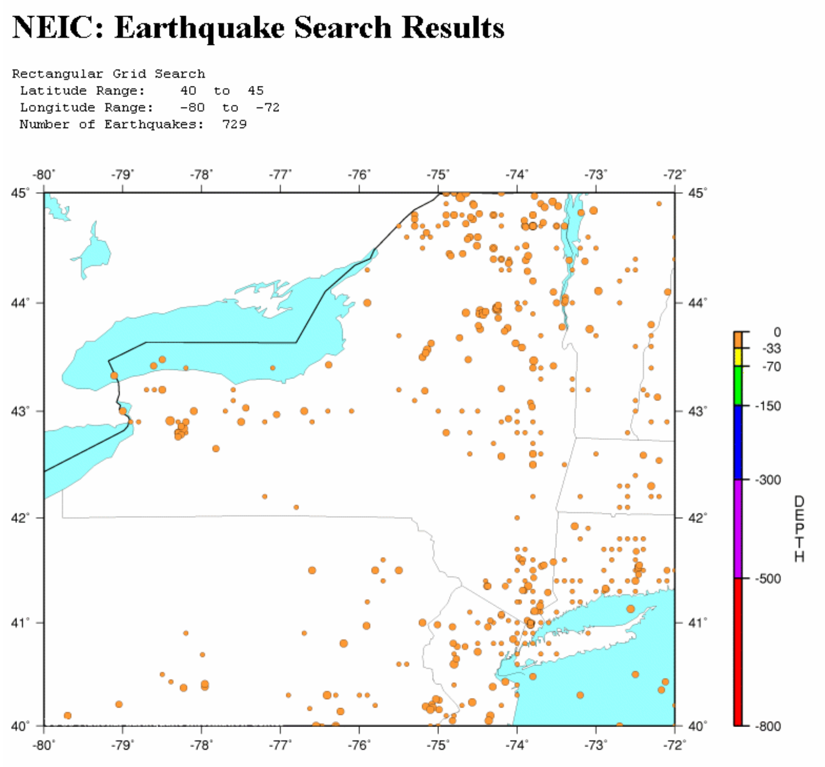


Figure 6 - Earthquake Epicenters in and near New York State (1534-1986)

According to the US Geological Survey National Earthquake Information Center, the largest earthquake in New York State occurred in Massena on September 5, 1944. Massena is located in northern St. Lawrence County, not far from the Canadian border and the St. Lawrence River (approximately 400 miles north of Nassau County). The USGS reports that this quake (with a recorded magnitude of 5.8 and intensity of VIII) was felt from Canada south to Maryland and from Maine west to Indiana. It caused an estimated $2 million in damages in Massena and nearby Cornwall. In Massena, 90 percent of the chimneys were reportedly destroyed or damaged and house foundations, plumbing, and masonry were damaged severely. Effects were similar in Cornwall. In Hogansburg, cracks formed in the ground were reported, along with damage to brick-masonry and concrete structures. County-wide, many residents reported that water wells went dry and chimneys were downed in several towns in New York, including Fort Covington, Keeseville, Malone, Norfolk, Ogdensburg, and Waddington.

A review of information posted on the University of Buffalo Multidisciplinary Center for Earthquake Engineering Research (MCEER) web site (specifically, "Earthquake Data for New York State" by Carl W. Stover and Jerry Coffman) indicates that only 24 damaging earthquakes (intensities of VI or better) have been centered in New York State from the year 1568 to 1989. While none were centered in Nassau County, one was centered in nearby Queens County in 1878 and two others were centered in the New York City area (in 1737 and again in 1884). Reviewing Stover and Coffman's data in combination with other historical information, including NYSEMO's *Emergency Management Times* (Summer 2002 issue) and the NYS Hazard Mitigation Plan, it was found that no specific damage in Nassau County has been reported from any nearby events; however, on occasion, some residents of the County have reported feeling the shaking.

Probability of Occurrence – Earthquakes

Earthquakes cannot be predicted. They strike without warning, at any time of the year, and at any time of the day or night. Earthquake hazard maps – sometimes referred to as "PGA maps" – are used as a tool to project the likelihood of a various intensity quake being exceed at a certain location over a given period of time. They depict the Peak Ground Acceleration (PGA), expressed as a percentage of the force of gravity that can be expected to be exceeded at a given location for a particular probability of exceedance over a specific time frame. Figure 4 (see Page 51) is an example of an earthquake hazard map for New York State prepared by NYSEMO (available on line at http://www.nysemo.state.ny.us/MITIGATION/earthquakes.htm). It shows PGA values for New York State that have a 10 percent chance of being exceeded over 50 years.

As Figure 4 shows, Nassau County is located within one of three main regions in New York State that have a seismic risk that tends to be higher than in the rest of the state. For Nassau County and its participating jurisdictions, a PGA value of 5%g has a 10 percent chance of being exceeded over 50 years.

The USGS has estimated that, over the next 100 years, the probability of a damaging earthquake of at least magnitude 5.0 and centered within 50 km of the county seat in East Meadow is only between 0.12 and 0.15. At this level, perceived shaking would be strong to very strong and damage would be light to moderate.

The New York State Hazard Mitigation Plan states that New York State can expect damaging earthquake events on the order of once every 22 years, and that these events are more likely to occur within one of the three regional areas identified previously. Nassau County and its participating jurisdictions are included in the southernmost of these three regions. The State Plan goes on to reference 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 3 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.*"

As stated previously, according to the Earthquake Hazard Map of New York State, there is a 10 percent chance over 50 years that an earthquake with a PGA of greater than 5%g will be centered within Nassau County and/or its participating jurisdictions. This earthquake, if it did occur, would likely have associated with it light to moderate perceived shaking and little to no damage.

Floods

Description – Floods

The New York State Hazard Mitigation Plan defines flooding as the accumulation of water within a water body which results in the overflow of excess water onto adjacent lands, usually floodplains. The floodplain is the land adjoining the channel of a river, stream, ocean, lake, or other watercourse or water body that is susceptible to flooding. According to FEMA's *NFIP Floodplain Management Requirements: a Study Guide and Desk Reference for Local Officials* (FEMA-480), most floods fall into the following three categories:

- **Riverine Flooding – Flooding that occurs along a channel** (where a "channel" is defined as a feature on the ground that carries water through and out of a watershed, whether natural channels such as rivers and streams, or man-made channels such as drainage ditches).
    - Overbank flooding occurs along a channel as excess flows overflow channel banks. Overbank flooding occurs when downstream channels receive more rain or snowmelt from their watershed than normal, or a channel is blocked by an ice jam or debris.
    - Flash floods are a type of riverine flooding typically caused when a significant amount of rainfall occurs in a very short duration. Flash flooding is characterized by a rapid rise in water level and high velocity flows. Flash floods can also be caused by ice jams (ice jam flooding, which can be upstream of an intact jam or downstream of a jam that has broken downstream) or dam breaks. ** Note: Dam break flooding is not a natural hazard and thus is not specifically addressed in this mitigation plan. Nassau County has six dams listed in the National Inventory of Dams: Hempstead Lake Dam and South Pond Dam in Rockville Centre; Mill Pond Dam in Oyster Bay; Leeds Pond Dam in Plandome Manor; and Massapequa Lake Dam and Upper Massapequa Lake Dam in Massapequa. All are regulated by the NYSDEC and none are listed as high hazard dams. Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.*
- **Coastal Flooding – Flooding that occurs along the coasts of oceans, the Gulf of Mexico, and large lakes** (i.e., the Great Lakes). Hurricanes and severe storms cause most coastal flooding, including "Nor'easters" which are severe storms that occur in the Atlantic basin that are extratropical in nature with winds out of the northeast.
    - Storm surge is one characteristic of coastal flooding caused as persistent high winds and changes in air pressure work to push water on shore, often on the order of several feet.
- **Shallow Flooding – Flooding that occurs in flat areas where a lack of channels means water cannot drain away easily.**
    - Sheet flow occurs when there are inadequate or no defined channels, and floodwaters spread out over a large area at a somewhat uniform depth. Sheet flow occurs after intense or prolonged rainfalls during which rain cannot soak into the ground.
    - Ponding occurs when runoff collects in a depression and cannot drain out. Ponding floodwaters do not move or flow away; they will remain until the water infiltrates into the soil, evaporates, or is pumped away.
    - Urban drainage flooding occurs when the capacity of an urban drainage system is exceeded. An urban drainage system comprises the ditches, storm sewers, retention ponds and other facilities constructed to store runoff or carry it to a receiving stream, lake or the ocean. Urban drainage flooding can also occur in areas protected by levees, as water collects on the protected side of the levee when pump capacities are exceeded during severe storms.

Floods are considered hazards when people and property are affected. Historically, development in floodplains was often a necessity, as water bodies provided a means of transportation, electricity, water supply, and often supported the livelihood of local residents (i.e., fishing, farming, etc.). Today, development in floodplains is more often spurred by the aesthetic and recreational value of the floodplain.

The **National Flood Insurance Program (NFIP)** was established by Congress with the passage of the National Flood Insurance Reform Act of 1968. Through this program, Federally-backed flood insurance is made available to homeowners, renters, and businesses in a community if that community adopts and enforces a floodplain management ordinance to reduce future flood damages within its floodplains. This includes not only preventative measures for new development, but also corrective measures for existing development. In addition to providing flood insurance, the NFIP also studies and maps the nation's floodplains, preparing its findings in Flood Insurance Rate Maps (FIRMs) and Flood Insurance Studies (FISs). FEMA also prepares digital Q3 Flood Data files, which contain digital flood hazard mapping. Using GIS, these digital maps can be overlaid upon a community's existing GIS base map. FEMA Q3 Flood Data and the Nassau County GIS formed the basis of our analysis of the flood hazard.

Location – Floods

Flooding in Nassau County and its jurisdictions includes all types of flooding, from coastal and riverine flooding to shallow flooding resulting from urban drainage issues. When FEMA prepared the Nassau County Flood Insurance Study (FIS) and Flood Insurance Rate Maps (FIRMs), the following flooding sources were studies by detailed methods:

Coastal/Tidal		
• Atlantic Ocean	• Baldwin Bay	• Broad Channel
• Brosewere Bay	• Cold Spring Harbor	• East Bay
• Head of Bay	• Hempstead Harbor	• Jones Inlet
• Little Neck Bay	• Long Island Sound	• Manhassett Bay
• Middle Bay	• Reynolds Channel	• Sloop Channel
• South Oyster Bay	• Hewlett Bay *(including Mill River, Powell Creek, and Rockaway Creek)*	• Oyster Bay Harbor *(including Beaver Brook, Beaver Lake, Mill Neck Creek, and Oak Neck Creek)*
Riverine		
• Massapequa Creek	• Massapequa Creek Tributary No. 1	• Massapequa Creek Tributary No. 2
• Motts Creek	• Russells Creek	• Valley Stream

FEMA studied the following flood sources (all, or portions of) by approximate methods:

• Roslyn Pond	• Smith Pond	• East Meadow Brook
• Several unnamed tributaries and streams	• Areas having a low development potential	• Areas having minimal flood hazards

FEMA's Q3 Flood Data was used to identify the location of flood hazard areas in Nassau County. Mapped flood zones exist in most, but not all, Nassau County communities. Most mapped flood hazard areas are located along the south shore and barrier island communities along the Atlantic Ocean and various back bays along the north shore of the County along the Long Island Sound.

According to the FEMA FIS for Nassau County and information posted on the FEMA web site, the following 22 jurisdictions are **not** flood prone:

• Bellerose	• East Hills	• East Williston
• Farmingdale	• Floral Park	• Garden City
• Lake Success	• Lynbrook	• Matinecock
• Mineola	• Munsey Park	• Muttontown
• New Hyde Park	• North Hills	• Old Brookville
• Old Westbury	• Roslyn Estates	• South Floral Park
• Steward Manor	• Upper Brookville	• Westbury
• Williston Park		

Figure 7 illustrates the location of FEMA mapped flood hazard areas in Nassau County. The mapped Q3 flood data is not exact, and in many cases flood hazard area boundaries do not match landform boundaries, particularly along the north shore. However, this represents best readily available GIS data at the time of the study and was deemed suitable for planning purposes. Updates should be made in the future if better data becomes available.

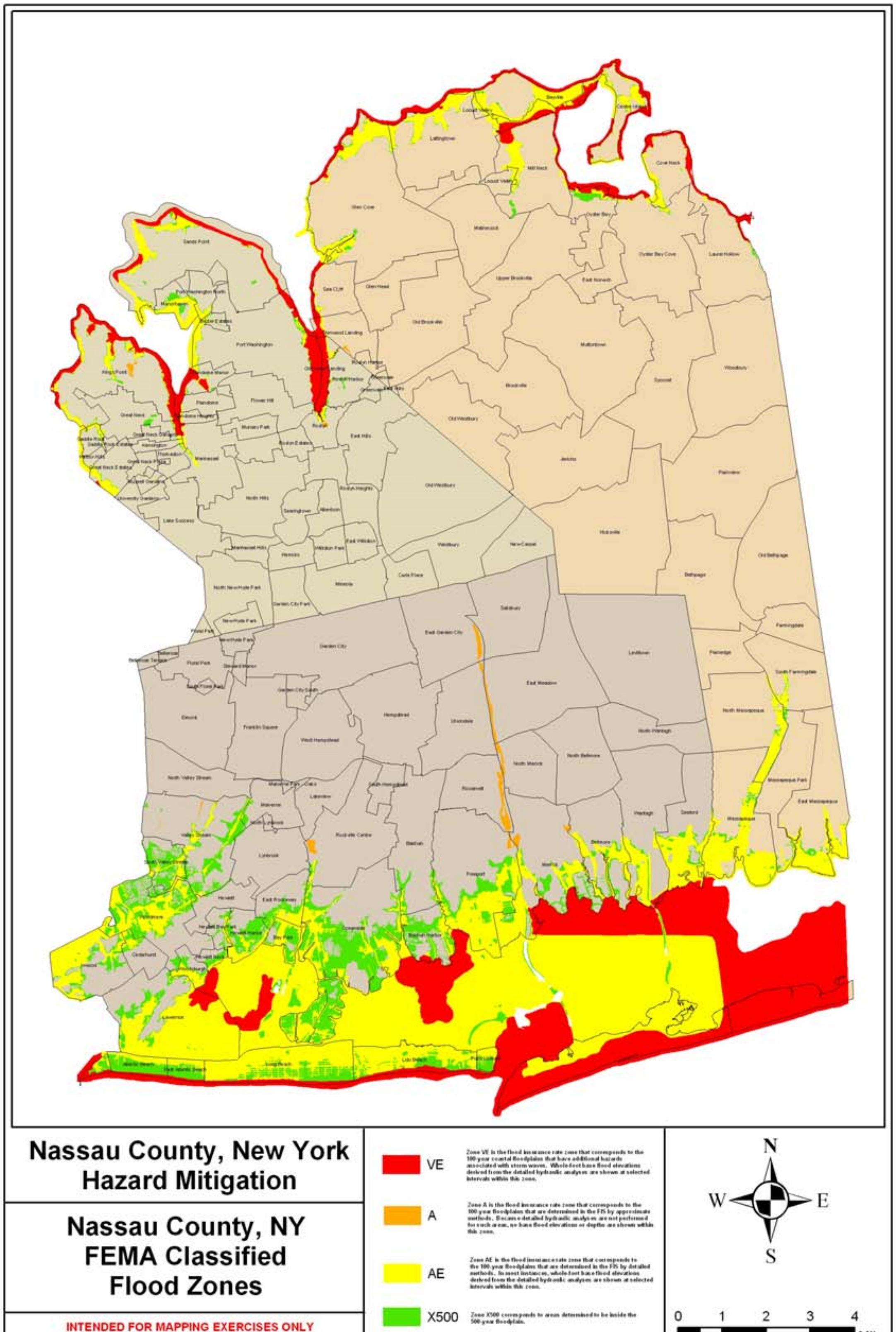


Figure 7 – FEMA Flood Hazard Areas in Nassau County

Storm surge is another type of flooding that can be experienced in Nassau County communities. Because storm surge can extend well beyond mapped flood hazard areas, storm surge zones have been mapped separately in the New York State Hurricane Evaluation Study 1993. This study was conducted jointly by the New York State Emergency Management Office (NYSEMO), the Federal Emergency Management Agency (FEMA), and the US Army Corps of Engineers (USACE). As part of the study, maps were prepared noting areas inundated during different categories of hurricanes. The original source inundation maps developed by the Army Corps were based on surge height projections as calculated by the National Weather Service's "Sea - Lake Overland Surge from Hurricanes - SLOSH Model. Using SLOSH, surge heights were calculated for set locations throughout the region for a number of category 1 - 4 hurricanes, varying in forward speed, landfall location and track. The maximum values obtained for all hurricanes of a particular category were then transferred to a 1:24,000 base map (contour interval 10 feet) to delineate surge zones. The SLOSH Feature Class is a part of the Emergency Management Feature DataSet. It is important that users of this mapping fully understand limitations. The process of creating the digital coverage required a significant amount of interactive manipulation. Additionally, the hurricane inundation zones are based on the SLOSH model projections and may be subject to error. It should also be noted, that this data set does not include information for Fisher's Island. However, this area is clearly subject to inundation by hurricane. Metadata for the GIS mapping files strongly recommends that NYSEMO be consulted with any questions regarding the appropriate use of this data set.

Generally speaking, surge would be contained relatively close to the shoreline in most communities along the north shore. This is due to shoreline bluffs and generally high ground elevations. However, on the south shore, where low-lying areas are predominant, the case would be quite different. A Category 4 storm surge could inundate nearly everything seaward of a general line halfway between the Southern State Parkway and Sunrise Highway. A Category 2-3 storm surge could inundate to approximately Sunrise Highway in many locations; and a Category 1 storm surge could inundate approximately halfway to Sunrise Highway in many locations. Figure 8 illustrates areas potentially inundated by various categories storm surge in the Town of Hempstead; Figure 9 illustrates areas potentially inundated by various categories storm surge in the Town of North Hempstead; and Figure 10 illustrates areas potentially inundated by various categories storm surge in the Town of Oyster Bay. These maps have also been posted (even before the hazard mitigation planning project began) on the Nassau County web site to ensure that the public and other stakeholders are aware of the potential risks of storm surge.

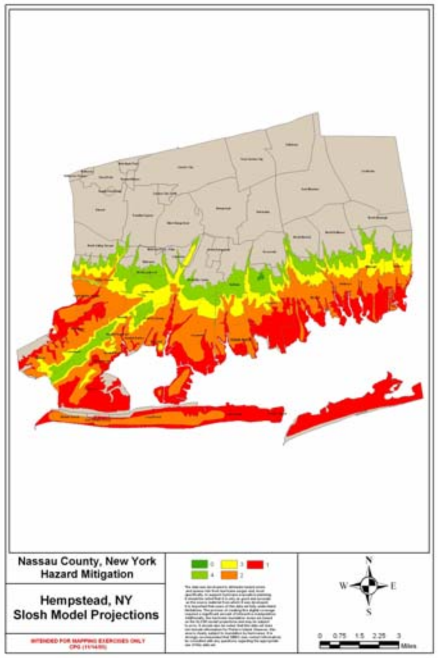


Figure 8 – SLOSH Mapping, Town of Hempstead

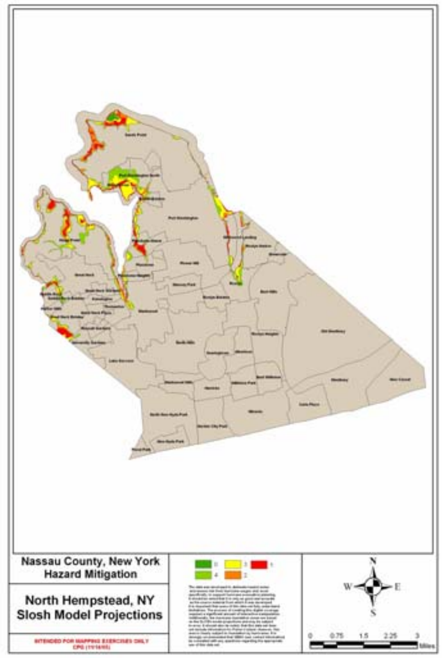


Figure 9 – SLOSH Mapping, Town of North Hempstead

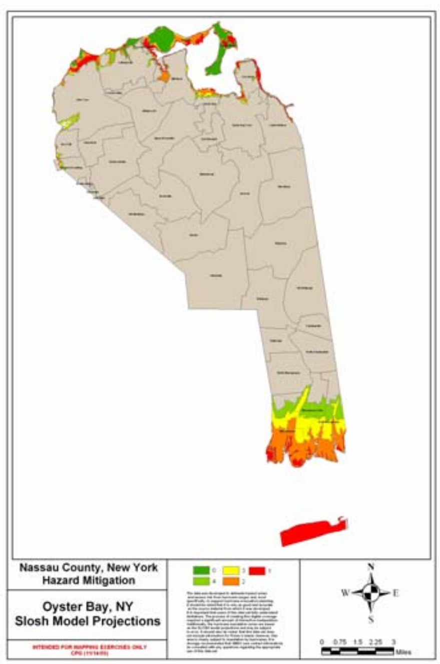


Figure 10 – SLOSH Mapping, Town of Oyster Bay

Extent – Floods

The extent of flooding associated with a 1% probability of occurrence – the "100-year flood" or "base flood" – is used as regulatory boundaries by a number of federal, state and local agencies. Also referred to as the "special flood hazard area", this boundary is a convenient tool for assessing vulnerability and risk in flood prone communities since many communities in Nassau County have maps that show the extent of the base flood and the likely depths that will be experienced.

FEMA considers:

High Risk Coastal Areas	100-year floodplain with wave affects (V-Zones)
High Risk Areas	100-year floodplain without wave affects (A-Zones)
Moderate Risk Areas	Areas between the 100-year and 500-year floodplains
Low Risk Areas	Areas outside of the 500-year floodplain

FEMA's Q3 flood mapping was overlaid upon the Nassau County GIS Base Map to summarizes the Q3 flood mapping and flood risk areas for various communities (incorporated and unincorporated), as shown in Table 11. Acres and percentages are rounded to the nearest whole number; totals may not match due to rounding.

Table 11
Summary of FEMA Q3 Flood Data by Community

Municipality Name	Total Acres	Acres High Coastal Flood Risk	Acres High Flood Risk	Acres Moderate Flood Risk	Acres Little to No Flood Risk	Percent of Land in High or Moderate Flood Risk
HEMPSTEAD AREA						
Lido Beach	1,112	125	768	220	1	100%
East Atlantic Beach	258	20	101	137	1	100%
Harbor Isle	115		53	62	1	100%
Jones Beach	2,248	1,353	895		1	100%
Point Lookout	146	18	66	63	1	100%
Long Beach	1,649	113	1,162	373	1	100%
Island Park	253		128	124	1	100%
Atlantic Beach West	119	39	32	47	1	99%
Atlantic Beach	380	27	116	231	6	98%
Barnum Island	407		118	265	24	94%
Bay Park	323		141	128	53	83%
Lawrence	2,973	157	1,791	234	791	73%
Hewlett Harbor	528		118	223	188	65%
Woodmere	1,768		581	513	674	62%
South Valley Stream	550		77	260	213	61%
Baldwin Harbor	756	37	122	271	326	57%
Inwood	1,378		615	166	597	57%
Woodsburgh	266	1	106	42	118	56%
Oceanside	3,233	8	634	1,047	1,544	52%
Hewlett Neck	138	2	21	43	71	48%
Freeport	3,108	4	927	376	1,801	42%
Seaford	1,632	20	539	64	1,008	38%

Table 11 Summary of FEMA Q3 Flood Data by Community						
Municipality Name	**Total Acres**	**Acres High Coastal Flood Risk**	**Acres High Flood Risk**	**Acres Moderate Flood Risk**	**Acres Little to No Flood Risk**	**Percent of Land in High or Moderate Flood Risk**
East Rockaway	677		113	124	440	35%
Merrick	2,683	81	603	216	1,783	34%
Hewlett Bay Park	245		30	40	176	29%
Valley Stream	2,267		162	358	1,746	23%
Bellmore	1,473	4	260	72	1,136	23%
Cedarhurst	444		50	43	352	21%
Wantagh	2,459	32	314	40	2,073	16%
Roosevelt	1,169		94		1,075	8%
Baldwin	1,906		37	78	1,792	6%
Malverne	681		2	24	655	4%
Rockville Centre	2,124		49	12	2,064	3%
Hewlett	569		5	11	553	3%
North Merrick	1,089		26		1,064	2%
East Garden City	1,942		42		1,900	2%
Uniondale	1,721		22		1,699	1%
East Meadow	3,211		35		3,176	1%
Lynbrook	1,290		1	10	1,280	1%
North Valley Stream	1,199		1		1,199	0%
Bellerose	78				78	0%
Bellerose Terrace	87				87	0%
Elmont	2,214				2,214	0%
Floral Park	916				916	0%
Franklin Square	1,836				1,836	0%
Garden City	3,421				3,421	0%
Garden City South	258				258	0%
Hempstead	2,358				2,358	0%
Lakeview	751				751	0%
Levittown	4,365				4,365	0%
Malverne Park - Oaks	71				71	0%
New Hyde Park	545				545	0%
North Bellmore	1,684				1,684	0%
North Lynbrook	53				53	0%
North Wantagh	1,201				1,201	0%
Salisbury	1,979				1,979	0%
South Floral Park	65				65	0%
South Hempstead	374				374	0%
Steward Manor	128				128	0%
West Hempstead	1,777				1,777	0%
SUBTOTAL, HEMPSTEAD AREA	***74,653***	***2,040***	***10,956***	***5,916***	***55,740***	***25%***
NORTH HEMPSTEAD AREA						
Manorhaven	404		178	47	179	56%
Kings Point	2,588	426	229	47	1,885	27%
Plandome Manor	397	62	22	10	303	24%
Saddle Rock	184		36	6	142	23%
Sands Point	3,711	286	325	47	3,053	18%
Great Neck Estates	514	2	79	6	426	17%
Port Washington	2,997	319	106	29	2,543	15%
Port Washington North	323		32	7	284	12%
Roslyn	429	10	32	6	382	11%
Baxter Estates	107		5	6	96	10%
Plandome Heights	119	4	7		108	9%
Great Neck	872	35	13	21	803	8%
Kensington	147		8	1	138	6%
Harbor Hills	78		3	1	74	5%
Thomaston	263		9	3	251	5%

Table 11
Summary of FEMA Q3 Flood Data by Community

Municipality Name	Total Acres	Acres High Coastal Flood Risk	Acres High Flood Risk	Acres Moderate Flood Risk	Acres Little to No Flood Risk	Percent of Land in High or Moderate Flood Risk
Roslyn Harbor	708	3	11	18	676	5%
Great Neck Gardens	141			4	137	3%
Great Neck Gardens	141			4	137	3%
Russell Gardens	112		3		109	3%
Manhasset	1,545	5	27	4	1,508	2%
Plandome	319	1	3	1	316	2%
Great Neck Plaza	196		1		196	1%
Flower Hill	1,052	3	1		1,047	0%
Albertson	437				437	0%
Carle Place	622				622	0%
East Hills	1,436				1,436	0%
East Williston	364				364	0%
Garden City Park	637				637	0%
Greenvale	171				171	0%
Herricks	371				371	0%
Lake Success	1,206				1,206	0%
Manhasset Hills	381				381	0%
Mineola	1,197				1,197	0%
Munsey Park	321				321	0%
New Cassel	938				938	0%
North Hills	1,773				1,773	0%
North New Hyde Park	1,288				1,288	0%
Old Westbury	5,442				5,442	0%
Roslyn Estates	269				269	0%
Roslyn Heights	939				939	0%
Saddle Rock Estates	49				49	0%
Searingtown	600				600	0%
University Gardens	363				363	0%
Westbury	1,491				1,491	0%
Williston Park	393				393	0%
SUBTOTAL, NORTH HEMPSTEAD AREA	***38,034***	***1,154***	***1,131***	***267***	***35,482***	***7%***
OYSTER BAY AREA						
TB	1,047	1,013			34	97%
Bayville U	99	63	30	2	4	96%
Bayville	899	44	337	16	503	44%
Massapequa	2,348		886	67	1,395	41%
Centre Island	695	94	142	20	439	37%
Glenwood Landing	906	209	50	1	646	29%
Cove Neck	888	113	75	8	691	22%
East Massapequa	2,198		429	32	1,737	21%
Oyster Bay	814	70	30	61	652	20%
Mill Neck	1,785	106	172	29	1,478	17%
Lattingtown	2,428	33	349	21	2,025	17%
North Massapequa	1,930		252	21	1,657	14%
Locust Valley	651	1	68	4	579	11%
Glen Cove	4,373	32	405	45	3,891	11%
Laurel Hollow	1,912	90	13	10	1,799	6%
Massapequa Park	1,411		51	22	1,337	5%
South Farmingdale	1,413		54	11	1,347	5%
Sea Cliff	699	8	19	4	669	4%
Sea Cliff	699	8	19	4	669	4%
Oyster Bay Cove	2,684	22	31	7	2,624	2%
Matinecock	1,700			1	1,700	0%
Bethpage	2,349				2,349	0%
Brookville	2,565				2,565	0%

Table 11
Summary of FEMA Q3 Flood Data by Community

Municipality Name	Total Acres	Acres High Coastal Flood Risk	Acres High Flood Risk	Acres Moderate Flood Risk	Acres Little to No Flood Risk	Percent of Land in High or Moderate Flood Risk
East Norwich	668				668	0%
Farmingdale	701				701	0%
Glen Head	1,050				1,050	0%
Hicksville	4,339				4,339	0%
Jericho	2,824				2,824	0%
Muttontown	3,889				3,889	0%
Old Bethpage	2,609				2,609	0%
Old Brookville	2,538				2,538	0%
Plainedge	910				910	0%
Plainview	3,655				3,655	0%
Syosset	3,203				3,203	0%
Upper Brookville	2,753				2,753	0%
Woodbury	3,243				3,243	0%
SUBTOTAL, OYSTER BAY AREA	***68,874***	***1,905***	***3,415***	***383***	***63,171***	***8%***
TOTAL, NASSAU COUNTY	**181,561**	**5,100**	**15,501**	**6,567**	**154,393**	**15%**

Several factors determine the magnitude or severity of floods, as discussed below:

- Velocity of Water and Terrain: High velocity floodwaters are more damaging than lower velocity floodwaters. Floodwaters flow more quickly in areas of steep topography.

- Size of a Watershed: In large watersheds, it is often possible to predict flooding hours or even days in advance as conditions are observed building over time. In small watersheds in areas of steep terrain, flooding may come with little or no advance warning because of the speed of the water.

- Volume of Water: As rainfall volume and intensity increase, so does the likelihood for flooding as the capacity of natural and man-made conveyances is exceeded. This is also true for higher volumes and rates of snowmelt.

- Ground Cover: According to the Nassau County Flood Insurance Study, Nassau County soils have a low runoff potential, which means more rainwater and/or snowmelt is likely to infiltrate the soils. However, developed areas with higher proportions of impervious surfaces (paved areas, buildings, etc.) would have a much higher runoff potential. The highest percentages of impervious area exist in communities within the boundary of the Town of Hempstead, followed next by communities in the Town of North Hempstead and finally by communities in the Town of Oyster Bay.

- Topography: Runoff will reach natural and man-made conveyance channels more rapidly in areas of steeper terrain.

- Tides: The timing of storms as they relate to the tidal cycle often has a drastic effect on the severity of flooding in coastal areas. The level of coastal waters and tidally affected water courses increases at the time of high tide. The coincidence of a severe storm at the time of a high tide can exacerbate the effects of flooding. These effects can be combined with high intensity rainfall and urban runoff as storm sewer outlets become blocked by high tidal waters and runoff backs up through the system onto roadways.

Storm Surge Extent

Hurricanes are addressed separately in this report, beginning on Page ___. Impacts of storms surge could be devastating in Nassau County. Generally speaking, based upon USACE mapping of storm surge under worst case conditions as part of the 1993 Hurricane Evacuation Study, surge would not come very far inland in most communities on the north shore due to the local topography characterized in many locations by steep bluffs near the shoreline. On the south shore, because the topography is generally flat and closer to sea level, a Category 4 storm surge could inundate nearly everything seaward of a general point halfway between the Southern State Parkway and Sunrise Highway. A Category 2-3 storm surge could inundate to approximately Sunrise Highway in many locations; and a Category 1 storm surge could inundate approximately halfway to Sunrise Highway in many locations. Previous Figures 8, 9 and 10 show SLOSH mapping for the Town of Hempstead, North Hempstead, and Oyster Bay, respectively (Page 63). Table 12 illustrates areas inundated for each scenario, for each community in Nassau County.

Table 12
Summary of Potential Surge Inundation Areas by Community

Municipality Name	Total Acres	% in CAT1 Surge Zone	% in CAT2 Surge Zone	% in CAT3 Surge Zone	% in CAT4 Surge Zone
HEMPSTEAD AREA					
Atlantic Beach West	119	100%	100%	100%	100%
Jones Beach	2,248	100%	100%	100%	100%
Point Lookout	146	100%	100%	100%	100%
Lido Beach	1,112	98%	100%	100%	100%
Barnum Island	407	97%	100%	100%	100%
Harbor Isle	115	90%	100%	100%	100%
Bay Park	323	81%	100%	100%	100%
Lawrence	2,973	72%	90%	93%	100%
Long Beach	1,649	72%	100%	100%	100%
East Atlantic Beach	258	60%	100%	100%	100%
Freeport	3,108	56%	71%	83%	97%
Inwood	1,378	55%	83%	95%	100%
Woodsburgh	266	54%	96%	100%	100%
Island Park	253	53%	100%	100%	100%
Hewlett Harbor	528	46%	90%	99%	100%
Baldwin Harbor	756	45%	100%	100%	100%
Woodmere	1,768	45%	84%	93%	100%
Merrick	2,683	42%	71%	85%	99%
South Valley Stream	550	39%	100%	100%	100%
Bellmore	1,473	37%	69%	86%	100%

Table 12 Summary of Potential Surge Inundation Areas by Community					
Municipality Name	**Total Acres**	**% in CAT1 Surge Zone**	**% in CAT2 Surge Zone**	**% in CAT3 Surge Zone**	**% in CAT4 Surge Zone**
Oceanside	3,233	36%	92%	98%	100%
Seaford	1,632	30%	55%	73%	86%
Hewlett Neck	138	28%	77%	100%	100%
Atlantic Beach	380	26%	100%	100%	100%
Wantagh	2,459	25%	41%	64%	80%
Cedarhurst	444	22%	44%	67%	100%
East Rockaway	677	13%	75%	91%	100%
Hewlett Bay Park	245	13%	80%	94%	100%
Valley Stream	2,267	4%	47%	70%	88%
Baldwin	1,906	3%	20%	37%	60%
Rockville Centre	2,124	2%	11%	39%	63%
Hewlett	569	1%	33%	82%	100%
Lynbrook	1,290	0%	9%	67%	100%
Roosevelt	1,169	0%	1%	3%	10%
Lakeview	751	0%	0%	66%	81%
Malverne	681	0%	0%	12%	47%
North Bellmore	1,684	0%	0%	3%	12%
North Valley Stream	1,199	0%	0%	1%	9%
North Merrick	1,089	0%	0%	0%	12%
North Lynbrook	53	0%	0%	0%	92%
Franklin Square	1,836	0%	0%	0%	2%
North Wantagh	1,201	0%	0%	0%	1%
Elmont	2,214	0%	0%	0%	0%
Bellerose	78	0%	0%	0%	0%
Bellerose Terrace	87	0%	0%	0%	0%
East Garden City	1,942	0%	0%	0%	0%
East Meadow	3,211	0%	0%	0%	0%
Floral Park	916	0%	0%	0%	0%
Garden City	3,421	0%	0%	0%	0%
Garden City South	258	0%	0%	0%	0%
Hempstead	2,358	0%	0%	0%	0%
Levittown	4,365	0%	0%	0%	0%
Malverne Park - Oaks	71	0%	0%	0%	0%
New Hyde Park	545	0%	0%	0%	0%
Salisbury	1,979	0%	0%	0%	0%
South Floral Park	65	0%	0%	0%	0%
South Hempstead	374	0%	0%	0%	0%
Steward Manor	128	0%	0%	0%	0%
Uniondale	1,721	0%	0%	0%	0%

Table 12
Summary of Potential Surge Inundation Areas by Community

Municipality Name	Total Acres	% in CAT1 Surge Zone	% in CAT2 Surge Zone	% in CAT3 Surge Zone	% in CAT4 Surge Zone
West Hempstead	1,777	0%	0%	0%	0%
SUBTOTAL, HEMPSTEAD AREA	***74,653***	***26%***	***40%***	***47%***	***53%***
NORTH HEMPSTEAD AREA					
Manorhaven	404	58%	59%	77%	93%
Plandome Manor	397	31%	38%	45%	49%
Kings Point	2,588	27%	30%	35%	51%
University Gardens	363	18%	18%	18%	26%
Sands Point	3,711	16%	39%	42%	43%
Plandome Heights	119	14%	16%	21%	23%
Saddle Rock	184	13%	20%	28%	39%
Roslyn	429	10%	10%	15%	22%
Plandome	319	9%	11%	19%	22%
Harbor Hills	78	8%	8%	14%	15%
Roslyn Harbor	708	7%	11%	12%	12%
Great Neck Estates	514	7%	8%	10%	12%
Port Washington	2,997	3%	4%	22%	33%
Thomaston	263	2%	7%	7%	8%
Manhasset	1,545	2%	4%	9%	9%
Port Washington North	323	2%	15%	29%	50%
Great Neck	872	1%	2%	4%	9%
Baxter Estates	107	0%	4%	12%	23%
Saddle Rock Estates	49	0%	4%	10%	30%
Kensington	147	0%	2%	2%	2%
Flower Hill	1,052	0%	0%	0%	0%
Albertson	437	0%	0%	0%	0%
Carle Place	622	0%	0%	0%	0%
East Hills	1,436	0%	0%	0%	0%
East Williston	364	0%	0%	0%	0%
Garden City Park	637	0%	0%	0%	0%
Great Neck Gardens	141	0%	0%	0%	0%
Great Neck Gardens	141	0%	0%	0%	0%
Great Neck Plaza	196	0%	0%	0%	0%
Greenvale	171	0%	0%	0%	0%
Herricks	371	0%	0%	0%	0%
Lake Success	1,206	0%	0%	0%	0%
Manhasset Hills	381	0%	0%	0%	0%
Mineola	1,197	0%	0%	0%	0%
Munsey Park	321	0%	0%	0%	0%
New Cassel	938	0%	0%	0%	0%

Table 12 Summary of Potential Surge Inundation Areas by Community					
Municipality Name	**Total Acres**	**% in CAT1 Surge Zone**	**% in CAT2 Surge Zone**	**% in CAT3 Surge Zone**	**% in CAT4 Surge Zone**
North Hills	1,773	0%	0%	0%	0%
North New Hyde Park	1,288	0%	0%	0%	0%
Old Westbury	5,442	0%	0%	0%	0%
Roslyn Estates	269	0%	0%	0%	0%
Roslyn Heights	939	0%	0%	0%	0%
Russell Gardens	112	0%	0%	0%	0%
Searingtown	600	0%	0%	0%	0%
Westbury	1,491	0%	0%	0%	0%
Williston Park	393	0%	0%	0%	0%
SUBTOTAL, NORTH HEMPSTEAD AREA	***38,034***	***3%***	***5%***	***6%***	***8%***
OYSTER BAY AREA					
Bayville U	99	100%	100%	100%	100%
TB	1,047	100%	100%	100%	100%
Centre Island	695	59%	75%	83%	85%
Cove Neck	888	51%	61%	64%	67%
Sea Cliff	699	35%	100%	100%	100%
Massapequa	2,348	25%	61%	76%	88%
Glen Cove	4,373	21%	22%	24%	28%
Bayville	899	20%	41%	47%	53%
Lattingtown	2,428	19%	30%	33%	39%
Mill Neck	1,785	13%	24%	28%	30%
Laurel Hollow	1,912	13%	14%	14%	14%
Oyster Bay	814	9%	14%	17%	24%
Massapequa Park	1,411	8%	22%	40%	68%
East Massapequa	2,198	6%	26%	45%	53%
Glenwood Landing	906	6%	18%	35%	36%
Locust Valley	651	5%	6%	7%	8%
Oyster Bay Cove	2,684	1%	3%	4%	5%
Sea Cliff	699	1%	3%	4%	6%
North Massapequa	1,930	0%	0%	11%	26%
Bethpage	2,349	0%	0%	0%	0%
Brookville	2,565	0%	0%	0%	0%
East Norwich	668	0%	0%	0%	0%
Farmingdale	701	0%	0%	0%	0%
Glen Head	1,050	0%	0%	0%	0%
Hicksville	4,339	0%	0%	0%	0%
Jericho	2,824	0%	0%	0%	0%
Matinecock	1,700	0%	0%	0%	0%
Muttontown	3,889	0%	0%	0%	0%

Table 12 Summary of Potential Surge Inundation Areas by Community					
Municipality Name	**Total Acres**	**% in CAT1 Surge Zone**	**% in CAT2 Surge Zone**	**% in CAT3 Surge Zone**	**% in CAT4 Surge Zone**
Old Bethpage	2,609	0%	0%	0%	0%
Old Brookville	2,538	0%	0%	0%	0%
Plainedge	910	0%	0%	0%	0%
Plainview	3,655	0%	0%	0%	0%
South Farmingdale	1,413	0%	0%	0%	0%
Syosset	3,203	0%	0%	0%	0%
Upper Brookville	2,753	0%	0%	0%	0%
Woodbury	3,243	0%	0%	0%	0%
SUBTOTAL, OYSTER BAY AREA	***68,874***	***5%***	***8%***	***10%***	***11%***
TOTAL, NASSAU COUNTY	**181,561**	**12%**	**18%**	**22%**	**25%**

Previous Occurrences – Floods

Floods have occurred in Nassau County's communities in the past, and will continue to do so in the future. Nassau County and its communities have been impacted by all three types of flooding: coastal, riverine, and shallow.

The following table represents incidents of flooding in Nassau County, along with the source of data. This table is not intended to be all-inclusive. In addition, information presented is as reported by the data source and often presents a summary of damages to the entire state. In some cases, "Long Island" location is not specific to which county. Data reported from the New York State Hazard Mitigation Plan is listed as "NYSHMP". Data reported from NOAA's National Climatic Data Center is listed as "NOAA's NCDC". NOAA's data set was searched for events from 1950 through the present. The earliest records listed were recorded in 1993, with a total of 53 events from 1993 through December 2005 (some of these were found to be duplicates or entered in the wrong county). It is clear that many similar flood events probably occurred prior to 1993 but are not recorded in the NCDC database.

Table 13 Incidents of Flooding in Nassau County		
Date	**Location and Description**	**Data Source**
August 1635	Long Island, first recorded hurricane in NY. Storm surge 14' above high tide.	NYSHMP
September 1815	Long Island, "Great September Gale of 1815". Many structures damaged.	NYSHMP
September 1821	Long Island, tropical storm. 21 deaths.	NYSHMP
September 1944	Long Island, tropical storm related. Damages in excess of $800,000.	NYSHMP
August 1954	Hurricane Carol, Long Island (DR-26). Property damage, road closures. Damages approximately $3 million.	NYSHMP
September 1960	Long Island, Hurricane Donna, $1.9 million in damages.	NYSHMP
June 1972	Statewide, Hurricane Storm Agnes. (DR -338) Statewide, 5000 homes destroyed or badly damaged, 24 deaths, damages $703 million.	NYSHMP
August 1976	Flooding in New York City, Nassau, and Suffolk Counties	NYSHMP
October 1985	Hurricane Gloria (DR-750), Long Island. Flooding, property damage, total damages $48.5 million.	NYSHMP

Table 13
Incidents of Flooding in Nassau County

Date	Location and Description	Data Source
August 1991	Hurricane Bob (DR-918), Long Island. Flooding, property damage, total damages $11.7 million.	NYSHMP
December 1992	Coastal Storm, Nor'Easter, (DR-974) statewide damages $31.2 million.	NYSHMP
August 9, 1993	A rather violent rainstorm struck the village of Oyster Bay. A couple of inches of rain falling in a very short time lead to significant street flooding.	NOAA's NCDC
December 14, 1993	Countywide-coastal. A low pressure center generated tides about two feet above normal and very rough seas. Coastal flooding occurred during the morning set of high tides although it was relatively minor.	NOAA's NCDC
January 4, 1994	Countywide-coastal. A persistent onshore flow caused water to pile-up along the coast. Tides rose between three and five feet above normal and this lead to significant coastal flooding and serious beach erosion.	NOAA's NCDC
January 28, 1994	A combination of warm temperatures melting snow and the arrival of heavy rains caused significant and widespread urban flooding across the area. Many roads were closed for hours during this event. Numerous cars stalled out attempting to cross some of these flooded roads. Several of these motorists had to be rescued from their vehicles.	NOAA's NCDC
March 2, 1994	Countywide-coastal. Further information unavailable from NOAA NCDC.	NOAA's NCDC
August 22, 1994	Countywide urban flooding. Further information unavailable from NOAA NCDC.	NOAA's NCDC
February 4, 1995	Countywide-coastal. In advance of a winter storm, onshore winds began to increase and pile water up along coastal sections during the early morning hours. By late morning with the coming of high tides, some minor to moderate coastal flooding was observed along with minor to moderate beach erosion.	NOAA's NCDC
June 22, 1995	Torrential rain caused extensive urban flooding. Rainfall amounts generally ranged between three and four inches however isolated amounts of six inches occurred overnight.	NOAA's NCDC
July 23, 1995	Plainview flooding. Further information unavailable from NOAA NCDC.	NOAA's NCDC
November 14, 1995	Countywide-coastal. Further information unavailable from NOAA NCDC.	NOAA's NCDC
December 20, 1995	Tides rising to about two feet above normal in response to a coastal storm, caused minor flooding along the coast during the early morning high tides.	NOAA's NCDC
January 1996	Severe flooding (DR-1095), statewide. Road closures, property damages, closed businesses, and 10 deaths, statewide damages at $160 million	NYSHMP
July 3, 1996	Strong thunderstorms during late morning and again from late afternoon through early evening produced torrential rain that caused widespread flash flooding of low lying and poor drainage areas, small streams, and rivers. Cars were trapped in flooding on the Long Island Expressway in Queens and the Northern State Parkway in Nassau Counties.	NOAA's NCDC
July 13, 1996	As Tropical Storm Bertha moved northeast, passing east of Atlantic City, NJ around 11 am and over Long Island during the afternoon, it produced torrential rain and strong gusty winds. Torrential rain caused flooding of low lying and poor drainage areas, streams, and rivers across the area. Serious widespread flooding was reported along the Long Island Expressway in Nassau County. Rainfall totals of 1.80 inches were measured at Lynbrook and 1.82 inches at Levittown.	NOAA's NCDC
July 31, 1996	Thunderstorms produced torrential rains. From 2 to 5 inches of rain fell in 3-hour period. Serious widespread flash flooding of roads occurred and numerous basements were flooded. In Nassau County, the same events occurred. Water was up to 2 feet deep in several streets at Long Beach, where several basements flooded. The Wantagh and Meadowbrook State Parkways were closed near East Meadow as well as Bellmore Ave. Widespread street flooding was also reported in Wantagh.	NOAA's NCDC
August 29, 1996	Fringe effects from Hurricane Edouard. No significant rainfall, but minor to moderate coastal flooding, particularly during high tide. Along the south shore of Long Island, sections of Jones Beach, Robert Moses State Park and Hither Hills State Park were flooded during times of high tide from Friday through Monday.	NOAA's NCDC

Table 13
Incidents of Flooding in Nassau County

Date	Location and Description	Data Source
October 19, 1996	Severe coastal storm, flooding, and wind (DR-1146), statewide damages $16.1 million (per NYSHMP). Widespread minor to major coastal flooding and beach erosion resulted during Saturday afternoon and evening high tides. Bayville of Nassau County, up to 3 feet of water covered many streets. More than 100 homes were damaged and dozens of cars were totally damaged in flood waters. The hardest hit areas in East Bayville were on and around 5th, 6th, 7th, 1st, and 2nd Streets. Water flooded the causeway to Centre Island, where major flooding also occurred. The streets of many south shore communities like the village of Freeport were under up to 3 feet of water and over 1400 homes suffered damage. Flooding was reported along parts of the LIE. Nassau County rainfall totals reported ranged from 1.66 inches at Levittown to 4.90 inches at Lynbrook.	NYSHMP and NOAA's NCDC
December 13, 1996	Severe flooding (DR-1148), statewide damages $25.6 million. Low pressure system with winds averaging 20 to 30 MPH combined with high astronomical tides and tide anomalies of 1 1/2 to 2 1/2 feet above normal caused minor to locally moderate coastal flooding along parts of the coastline. Tidal flooding was reported in Freeport in Nassau County and also in both Babylon and Lindenhurst in Suffolk County. It inundated parts of streets in the aforementioned and other areas.	NYSHMP and NOAA's NCDC
January 10, 1997	Low pressure system - high astronomical tides combined with brief easterly gales caused water to pile-up along sections of the coast during morning high tide. Tidal flooding submerged cars under 2 feet of water along Rockaway Blvd. in Brookville. Moderate tidal flooding occurred in Freeport.	NOAA's NCDC
August 20, 1997	Coastal flooding in Freeport; no further information available.	NOAA's NCDC
November 14, 1997	Coastal flooding; no further information available.	NOAA's NCDC
January 29, 1998	Low pressure system produced strong gusty northeast winds, high seas, large sea swells, heavy surf, and minor to moderate beach erosion and coastal flooding. Local emergency managers from Freeport reported moderate coastal flooding during the morning high tide. Some cars were towed to minimize damage.	NOAA's NCDC
February 5, 1998	Nor'Easter caused strong gusty northeast winds, high seas, heavy surf, moderate beach erosion, and minor to moderate coastal flooding for three successive high tides starting with the early morning high tides on February 5th. During the first high tides, water inundated streets in Freeport and Massapequa. Up to 1 foot of water inundated Woodcleft Ave. in Freeport.	NOAA's NCDC
February 24, 1998	Nor'Easter produced strong gusty northeast winds, high seas, heavy rain, moderate beach erosion, and minor to moderate coastal flooding mainly across the inland bays where water piled-up and remained trapped. Across Nassau County, streets and basements were flooded. Long Beach Police Department reported that flooding forced the closure of West Park Ave. from New York Ave. all through the West End from 6 am to 8 am (during high tide). Streets were also flooded in Freeport (Woodcleft Ave.) and Island Park (Brighton Road). People in Point Lookout were pumping out their basements.	NOAA's NCDC
June 12, 1998	Thunderstorms produced torrential flash flooding rains and frequent lightning. Torrential rains resulted in widespread serious flooding of streets, poor drainage and low-lying areas, home basements, and small streams. Lightning struck many homes and ignited fires that damaged them.	NOAA's NCDC
January 3, 1999	Rain fell on a frozen ground surface at rates as high as 3 inches per hour. This resulted in rapid runoff that caused widespread serious flooding of low-lying and poor drainage areas. Many locations throughout Long Island along the Belt and Southern State Parkways, the Long Island Expressway, and Northern State Parkway were closed due to serious flooding. Rainfall amounts across the County ranged from 3.69 inches at Sea Cliff to 5.02 inches at Merrick.	NOAA's NCDC
January 15, 1999	Heavy rain fell on a frozen ground surface with partially clogged storm	NOAA's NCDC

Table 13
Incidents of Flooding in Nassau County

Date	Location and Description	Data Source
	drains, widespread flash flooding of low-lying and poor drainage areas occurred across the region. A portion of Valley Stream Blvd. north of Village Green was washed away. Rainfall amounts of 1.74 inches were reported at Farmingdale.	
September 1999	Remnants of Hurricane Floyd, property damages and debris accumulation, statewide damages $62.2 million. Serious widespread flooding of low-lying and poor drainage areas resulted in the closure of many roads and basement flooding across the entire region. Downed trees and power lines Rainfall amounts ranged from 3.67 inches at Wantagh to 4.12 inches at Mineola.	NYSHMP and NOAA's NCDC
April 21, 2000	Thunderstorms were accompanied by torrential rainfall that produced widespread severe flooding of low-lying and poor drainage areas and frequent and intense lightning strikes. Rainfall amounts ranged from around 3 to 7 inches. Significant and widespread ponding of water caused the closure of several stretches of road. Severe urban flooding also occurred in the westbound lanes of Hempstead Turnpike near the Nassau Medical Center in East Meadow. Frequent and intense lightning strikes ignited fires and caused damage to many houses throughout Nassau and Suffolk Counties.	NOAA's NCDC
August 12, 2000	thunderstorms produced rainfall rates estimated at around 2 inches per hour, which caused significant flooding of low-lying and poor drainage areas. In Bayville, water quickly ponded and rose up to 3 feet, which caused a road closure near the Tide Motel. Nassau County Police reported severe flooding near the town beach. 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.	NOAA's NCDC
August 28, 2000	Heavy rain along with embedded thunderstorms drifted very slowly north across Northeastern Queens and Northwestern Nassau Counties. National Weather Service radar estimated rainfall rates from 1.5 to 2 inches per hour with a Storm Total Precipitation amount from 3.5 to 4 inches across this area. Emergency managers reported numerous roads and stores flooded in Great Neck.	NOAA's NCDC
September 3, 2000	Nearly stationary thunderstorms produced torrential rain that caused significant flash flooding of low-lying and poor drainage areas across parts of the county, with roughly 3 inches of rain.	NOAA's NCDC
June 17, 2001	Remnants of Tropical Storm Allison. Rainfall rates of up to 3 inches per hour produced widespread street and highway flooding, in addition to some flash flooding of small streams. Some rivers approached or even slightly exceeded flood stage during this heavy rain event. Reports of street and highway flooding, which led to several major road and highway closings. Rainfall totals for the event were 2.51 inches at Wantagh and 5 inches at Lido Beach.	NOAA's NCDC
May 31, 2002	Thunderstorms produced rainfall rates between 1 and 2 inches per hour, which resulted in widespread flooding of streets and poor drainage areas in the Glen Cove and Farmingdale areas.	NOAA's NCDC
August 16, 2002	Torrential rain caused significant urban flooding from Valley Stream to Rockville Center. In Valley Stream, water ponded up to 2 1/2 feet deep in low lying areas.	NOAA's NCDC
August 29, 2002	Wet antecedent conditions followed by periods of torrential rain resulted in widespread and significant flooding of low lying and poor drainage areas. Many spotters reported street flooding with road closures throughout these areas. In Nassau County, street flooding was reported in Lido Beach, Merrick, and Hicksville. High waters closed the Northern State Parkway at Routes 106 and 107. Storm total rainfall ranged from 3.05 inches in Hicksville to 5.15 inches in South Massapequa. In Wantagh, flooding was reported on Old Mill Road.	NOAA's NCDC
October 16, 2002	Strong east to northeast winds reached a peak just below storm force (48 knots) around noon. These strong winds resulted in tides of 2 to 3 feet above normal around the times of high tide between 5:30 pm and 7:30pm. In	NOAA's NCDC

Table 13 Incidents of Flooding in Nassau County		
Date	**Location and Description**	**Data Source**
	Nassau County, moderate tidal flooding was reported in Freeport on Woodcleft Avenue adjacent to a canal. The Nassau County Office of Emergency Management reported that water rose into several area restaurants.	
July 22, 2003	The Nassau County Office of Emergency Management reported flooding near Oyster Bay High School.	NOAA's NCDC
June 17, 2004	Thunderstorms developed and moved at a slow rate of speed. These storms passed over portions of New York City and Long Island and produced torrential downpours. This caused flash flooding at several locations. Several roadways in Roslyn experienced significant street flooding. Torrential rains resulted in flash flooding of several streets in Baldwin.	NOAA's NCDC
September 8, 2004	The remnants of Hurricane Frances produced torrential rainfall. Rainfall amounts ranging from an inch to up to 6 inches were common across the area, causing extensive flash flooding and resulting in rescues of people from homes and cars. Flash flooding was reported on the Long Island Expressway, causing lane closures.	NOAA's NCDC
September 18, 2004	The remnants of Hurricane Ivan produced torrential rains with storm total rainfall reports added up to over 5 inches in some areas. This caused extensive flash flooding of roads and highways across the region. Torrential rains flooded the Sunrise Highway, resulting in closure.	NOAA's NCDC
July 18, 2005	Thunderstorm rainfall rates of as high as 3 inches per hour. Flash flooding of streets reported in Oyster Bay.	NOAA's NCDC
September 15, 2005	Thunderstorms with torrential downpours caused by interaction of offshore Tropical Storm Ophelia and a cold front to the west of New York City. Torrential rains caused flash flooding of streets in Westbury.	NOAA's NCDC
October 2005	Heavy rains over a one week period caused shallow flooding in urban areas, riverine flooding, flooded basements, toppled trees, downed power lines, and caused coastal flooding as winds of 40-50 mph piled water up in the bays during high tide. Heavy rain resulted in significant flooding on some rivers, most small brooks and streams, and throughout urban areas in low lying and poor drainage areas Trained spotters reported up to 6 feet of water in basements throughout Massapequa. Property damages for this event were estimated at $11 million for Nassau County. This storm system resulted in record setting monthly and daily rainfall, and set a record for 24-hour rainfall with 9 inches on October 14th at Brookhaven National Laboratory in nearby Suffolk County.	*The Bulletin,* Volume 59 Number 37, published by Brookhaven National Laboratory and NOAA's NCDC

Flood events in Nassau County have caused significant damages. In Nassau County, 47 communities participate in FEMA's National Flood Insurance Program. Table 14 summarizes NFIP policy and claims data for participating communities as of February 28, 2006. Participating communities were taken from the current Nassau County Flood Insurance Study (April 2, 1997). This shows that Nassau County NFIP insured flood losses have totaled more than $81 million. Actual flood losses community wide are likely much higher, as this value only includes NFIP payouts and does not include losses incurred by non-policy holders, losses for which a claim was not submitted, or losses for which payment on a claim was denied.

Table 14
FEMA NFIP Policy and Claim Information for Nassau County Jurisdictions
(Claims from January 1, 1978 as of February 28, 2006)
(Policy Data In Effect As Of February 28, 2006)
Source: www.fema.gov through www.bsa.nfipstat.com

NFIP Participating Communities in Nassau County, NY	Community Number	Policies in Force	Insurance in Force ($)	Number of Losses	Total Payments ($)
Total, Nassau County	**--**	**25,404**	**$5,504,917,500**	**12,784**	**$81,167,143**
Hempstead, Town of	360467	9,315	$2,176,154,700	4,613	$23,473,202
Oyster Bay, Town of	360483	2,899	658,143,700	1,677	$13,479,136
Freeport, Village of	360464	2,756	$553,055,800	1,965	$10,488,098
Long Beach, City of	365338	6,246	$1,159,793,300	1,530	$8,316,199
Bayville, Village of	360988	837	$160,274,800	728	$7,972,489
Island Park, Village of	360471	648	$133,516,900	566	$5,020,124
Manorhaven, Village of	360479	90	$20,758,000	55	$260,6758
Massapequa Park, Village of	360480	443	$107,595,700	308	$1,632,351
East Rockaway, Village of	360463	391	$79,263,500	254	$1,245,271
Valley Stream, Village of	360495	270	$49,857,300	109	$1,128,434
Glen Cove, City of	360465	119	$31,887,100	107	$1,022,008
Sands Point, Village of	360492	70	$22,957,100	64	$672,622
Great Neck, Village of	361519	35	$9,213,500	98	$567,641
North Hempstead, Town of	360482	152	$44,800,100	116	$525,793
Kings Point, Village of	360473	98	$29,320,600	78	$448,947
Lawrence, Village of	360476	227	$67,999,600	99	$427,387
Hewlett Harbor, Village of	360469	94	$27,782,700	36	$322,788
Great Neck Estates, Village of	360466	16	$3,969,100	25	$299,491
Cedarhurst, Village of	360460	121	$27,440,200	73	$271,100
Lake Success, Village of	361582	3	$720,000	5	$183,354
Port Washington North, Village of	361562	89	$21,748,600	20	$159,240
Lattingtown, Village of	360474	35	$9,852,200	11	$148,063
Hewlett Bay Park, Village of	360468	21	$6,363,100	12	$114,192
Centre Island, Village of	360461	25	$5,274,000	22	$100,988
Plandome Manor, Village of	360486	23	$6,489,800	10	$87,873
Roslyn, Village of	360489	29	$8,109,200	32	$64,623
Roslyn Harbor, Village of	361035	11	$3,587,500	14	$57,504
Saddle Rock, Village of	360491	17	$4,441,800	15	$57,471
Woodsburgh, Village of	360496	30	$9,438,400	11	$45,221
Rockville Centre, Village of	360488	105	$11,519,400	27	$41,482
Sea Cliff, Village of	360493	18	$4,738,200	16	$40,967
Oyster Bay Cove, Village of	361486	11	$3,132,200	12	$25,976
Atlantic Beach, Village of	360458	30	$9,201,000	3	$24,575
North Hills, Village of	361600	19	$6,036,700	9	$24,351
Plandome, Village of	360484	8	$1,767,300	13	$17,598
Hewlett Neck, Village of	360470	37	$10,182,500	19	$16,736
Thomaston, Village of	360494	4	$1,550,000	7	$8,725
Plandome Heights, Village of	360485	3	$850,000	7	$8,482

Table 14
FEMA NFIP Policy and Claim Information for Nassau County Jurisdictions
(Claims from January 1, 1978 as of February 28, 2006)
(Policy Data In Effect As Of February 28, 2006)
Source: www.fema.gov through www.bsa.nfipstat.com

NFIP Participating Communities in Nassau County, NY	Community Number	Policies in Force	Insurance in Force ($)	Number of Losses	Total Payments ($)
Mill Neck, Village of	360481	12	$3,745,600	5	$8,477
Cove Neck, Village of	360462	10	$2,859,000	4	$7,637
Russell Gardens, Village of	361583	2	$700,000	2	$1,555
Kensington, Village of	360472	5	$1,232,000	2	$1,302
Baxter Estates, Village of	360459	10	$2,433,400	2	$912
Laurel Hollow, Village of	360475	6	$1,737,600	3	$0
Flower Hill, Village of	361604	Not Available			
Hempstead, Village of	361647	Not available			
Malverne, Village of	361633	14	$3,424,300	Not Available	

Repetitive Loss Property Information for Nassau County Jurisdictions

Some communities in Nassau County have high number of properties which have recurrent losses (that is, "repetitive loss properties" – those properties which have incurred at least two NFIP insured flood losses of greater than $1,000 each in any rolling ten-year period since 1978. FEMA's NFIP terms these communities "Repetitive Loss Communities". Nassau County has 35 Repetitive Loss Communities. Together, these communities contain a total of 1,312 Repetitive Loss Properties. Of the total of approximately $81 million in total claims paid through the NFIP, approximately $42 million represent losses to Repetitive Loss Properties. The Repetitive Loss Data shows that historically, roughly 75% of losses represent building damages and 25% of losses represent damages to contents. Information is summarized in Table 15.

Table 15
FEMA NFIP Repetitive Loss Property Information for Nassau County Jurisdictions
(provided by FEMA Region 2 in)

Repetitive Loss Communities in Nassau County, NY	Community Number	Number of Repetitive Loss Properties	Number of Losses	Building Payments	Contents Payments	Total Payments
Hempstead, Town of	360467	414	1,109	$9,273,327	$2,809,726	$12,083,053
Oyster Bay, Town of	360483	214	588	$6,596,183	$2,433,997	$9,030,180
Freeport, Village of	360464	287	854	$5,712,633	$1,952,428	$7,665,061
Bayville, Village of	360988	97	221	$2,886,843	$631,753	$3,518,596
Long Beach, City of	365338	104	261	$2,241,659	$626,498	$2,868,157
Island Park, Village of	360471	71	212	$2,137,156	$521,602	$2,658,757
Atlantic Beach, Village of	360458	23	48	$1,042,657	$111,923	$1,154,580
Glen Cove, City of	360465	15	38	$639,863	$245,380	$885,243
Sands Point, Village of	360492	7	14	$375,267	$58,136	$433,403
East Rockaway, Village of	360463	9	28	$273,966	$97,769	$371,735
Great Neck, Village of	361519	7	28	$156,180	$69,529	$225,708
Massapequa Park, Village of	360480	5	16	$145,292	$38,261	$183,552
Hewlett Harbor, Village of	360469	5	12	$94,260	$86,158	$180,417
North Hempstead, Town of	360482	11	25	$57,578	$71,482	$129,060

Table 15 FEMA NFIP Repetitive Loss Property Information for Nassau County Jurisdictions (provided by FEMA Region 2 in)						
Repetitive Loss Communities in Nassau County, NY	Community Number	Number of Repetitive Loss Properties	Number of Losses	Building Payments	Contents Payments	Total Payments
Great Neck Estates, Village of	360466	3	6	$63,984	$61,300	$125,284
Lawrence, Village of	360476	9	21	$53,082	$54,816	$107,898
Kings Point, Village of	360473	4	12	$62,739	$44,267	$107,006
Cedarhurst, Village of	360460	4	9	$36,222	$27,281	$63,503
Hempstead, Village of	361647	2	5	$39,032	$17,782	$56,814
Brookville, Village of	361626	1	2	$10,000	$17,500	$27,500
Plandome Manor, Village of	360486	2	4	$23,625	$0	$23,625
Port Washington North, Vill. of	361562	2	4	$6,418	$13,574	$19,992
Old Westbury, Village of	361639	1	4	$10,400	$9,433	$19,832
Muttontown, Village of	361637	1	2	$10,218	$8,774	$18,992
Old Brookville, Village of	361646	1	2	$12,761	$3,738	$16,499
Valley Stream, Village of	360495	1	3	$14,228	$550	$14,778
Oyster Bay Cove, Village of	361486	2	5	$5,457	$6,747	$12,204
Manorhaven, Village of	360479	1	2	$12,118	$0	$12,118
Sea Cliff, Village of	360493	2	5	$4,642	$7,025	$11,667
Thomaston, Village of	360494	2	4	$5,249	$3,464	$8,714
Saddle Rock, Village of	360491	1	2	$1,024	$5,005	$6,029
Roslyn Harbor, Village of	361035	1	2	$3,421	$2,250	$5,671
Flower Hill, Village of	361604	1	2	$3,486	$2,000	$5,486
Matinecock, Village of	361634	1	2	$3,617	$200	$3,817
Hewlett Neck, Village of	360470	1	2	$1,454	$1,859	$3,313
Nassau County Total		**1,312**	**3,554**	**$32,016,038**	**$10,042,205**	**$42,058,243**

Nassau County Jurisdictions' Participation in the NFIP's Community Rating System

The NFIP's Community Rating System (CRS), first implemented nationwide in 1990, provides discounts on flood insurance premiums in those communities that establish floodplain management programs that go beyond NFIP minimum requirements. Communities participating in the CRS program receive 'points' for various activities and initiatives they undertake. As more points are accrued, the community's CRS Class increases. There are 10 CRS classes: Class 1 requires the most credit points and gives the largest premium reduction, while Class 10 requires not credit points and gives no premium reduction. CRS premium discounts on flood insurance range from 5 percent for Class 9 communities up to 45 percent for Class 1 communities. Nationwide, there are over 900 communities receiving flood insurance premium reductions due to their participation in the CRS program.

As of May 2006, FEMA reports that four communities in Nassau County participate in the CRS, achieving benefits in the form of premium discounts for their efforts to exceed the minimum requirements of the NFIP (see Table 16).

Table 16 CRS Communities in Nassau County *(current as of May 2006)*						
Community Name	Community Number	CRS Entry Date	Current Effective Date	Current Class	% Discount for Special Flood Hazard Area	Status
East Rockaway, Village of	360463	10/01/92	10/01/92	9	5	Current
Freeport, Village of	360464	10/01/92	10/01/92	8	10	Current
Lawrence, Village of	360476	10/01/92	10/01/03	8	10	Current
Bayville, Village of	360988	10/01/92	10/01/03	8	10	Current

Probability of Occurrence – Floods

The probability of occurrence of a flood at a given location (the odds of being flooded) is expressed in percentages as the chance of a flood of a specific magnitude occurring in any given year. The "100-year flood" has a 1% chance of occurring in any given year. The 100-year flood is often also referred to as the "base flood". This probability of occurrence might imply that a 100-year flood would reoccur only once every 100 years; in reality, this is not the case. A 100-year flood can happen multiple times in a single year, or not at all for more than 100 years. Properties located in FEMA-mapped A and V Zones are within the footprint of the 100-year floodplain. FEMA A-Zones represent the 100-year floodplain. FEMA V-Zones represent that portion of the 100-year floodplain inland as far as a 3-foot breaking wave would propagate (the 3-foot breaking wave represents the minimum size wave capable of causing major damage to conventional wood frame or brick veneer structures).

For all floodplains, there is an associated water surface elevation. This elevation is unique to any given location on the map (in other words, 100-year flood levels vary from one community to the next throughout Nassau County, and also within individual communities).

Within the 100-year floodplain, flooding can occur at less than 100-year flood level, and also more than the 100-year flood level. The 100-year flood represents a flood of high magnitude – it is a deep and widespread event. The 500-year flood is of a greater magnitude, and would be deeper and more widespread than a 100-year event. However, it is not as likely to occur. Smaller floods, with magnitudes of 10-years or 50-years for example, are also possible within the 100-year floodplain. These are not as deep or as widespread as a 100-year flood would be, however, they are much more likely to occur.

The term "100-year flood" can often be confusing to someone not intimately familiar with flooding or statistics. FEMA's *NFIP Floodplain Management Requirements: a Study Guide and Desk Reference for Local Officials* (FEMA-480), suggests that another way to look at flood risk is to think of the odds that a 100-year flood will happen some time during the life of a 30-year mortgage of a home in the floodplain. Figure 11 illustrates these odds, over various time periods for different size floods. In any given year, a property in the 100-year floodplain has a 10 percent chance of being flooded by a 10-year flood, and a 1 percent chance of being flooded by a 100-year flood. This may not sound terribly risky at first glance. However, over a 30 –year period, that same location has a 96% chance of being flooded by a 10-year flood and a 26% chance of being flooded by a 100-year flood.

WHAT ARE THE ODDS OF BEING FLOODED?

The term "100-year flood" has caused much confusion for people not familiar with statistics. Another way to look at flood risk is to think of the odds that a 100-year flood will happen sometime during the life of a 30-year mortgage—a 26% chance for a structure located in the SFHA.

Chance of Flooding over a Period of Years

Time Period	Flood Size 10-year	25-year	50-year	100-year
1 year	10%	4%	2%	1%
10 years	65%	34%	18%	10%
20 years	88%	56%	33%	18%
30 years	96%	71%	45%	26%
50 years	99%	87%	64%	39%

Even these numbers do not convey the true flood risk because they focus on the larger, less frequent, floods. If a house is low enough, it may be subject to the 10- or 25-year flood. During a 30-year mortgage, it may have a 26% chance of being hit by the 100-year flood, but the odds are 96% (nearly guaranteed) that it will be hit by a 10-year flood. Compare those odds to the only 1-2% chance that the house will catch fire during the same 30-year mortgage.

Figure 11

According to the National Weather Service Eastern Region Headquarters, the 100-year rainfall in Nassau County over a 24-hour period is 8 inches.

Landslides

Description - Landslides

According to the USGS National Landslide Information Center (NLIC), the term "landslide" is defined as the movement of a mass of rock, debris, or earth down a slope. The force of gravity acting upon a steep (or sometimes, even a moderately steep) slope is the primary cause of a landslide. Slope failure occurs when the force of gravity pulling the slope downward exceeds the strength of the earth materials that comprise the slope to hold it in place. In addition to the force of gravity, other contributing factors to landslides can include rainfall and/or rapid snowmelt, earthquakes, volcanic activity, changes in groundwater, and human-induced modifications to existing slopes.

The potential for a landslide to occur exists in every state in the country wherever very weak or fractured materials are resting on a moderate to steep slope (typically, a slope steep enough to make walking difficult). However, not all moderate to steep slopes are prone to landslides. As slope stability increases, the susceptibility to landslides decreases. Key factors in slope stability are:

- Soil Type. Certain types of soil are more stable on slopes than others. For example, as noted in the New York State Hazard Mitigation Plan, glacial till is one type of soil that tends to stand up well to the landslide tendency while glacial lake clay soils tend to have a higher risk for landslides.
- Terrain. The degree of the slope and the height from top of the slope to its toe also affect slope stability. The New York State Hazard Mitigation Plan indicates that the steeper the slope the higher the risk for landslides to occur (all other things being equal). They note that minor landslides called "slumps" can occur with very minor slopes, and that landslides are most likely on slopes greater than or equal to 10 degrees. In terms of the height of the slope, the State Plan notes that relief greater than 40 feet is generally accepted to be the threshold where the potential becomes more significant.
- Vegetative Cover. Slopes with little or no vegetative cover are more prone to landslides than other more vegetated slopes.
- Soil Water Content. As soil water content increases, slope stability decreases. Periods of sustained above-average precipitation, short duration rainfall events with significant precipitation, and snowmelt events can all add to soil water content and increase susceptibility to landslides.

Landslides can be triggered by natural events or by humans. Natural events include erosion, decreases in vegetative cover to do natural causes and/or seasonal changes, and ground shaking from earthquakes. Human caused triggers include altering the slope gradient, increasing the soil water content, and removal of vegetative cover.

Location - Landslides

Areas that are commonly considered to be safe from landslides include areas that have not experienced landslides in the past, areas of minimal slope, and areas set back from the tops of slopes. Conversely, areas that are commonly considered to be more prone to landslides tend to be areas where a landslide has occurred in the past, bases of steep slopes or drainage channels, and developed hillsides where leach field septic systems are used.

The USGS has published a landslide overview map of the conterminous United States. Prepared in hard copy format in 1982 by Dorothy H. Radbruch-Hall, Roger B. Colton, William E. Davies, Ivo Lucchitta, Betty A. Skipp, and David J. Varnes (Geologic Survey Professional Paper 1183), the map was later compiled digitally by Jonathan W. Godt (USGS Open-File Report 97-289). Data from this map is available on NationalAtlas.gov. Figure 12 illustrates this data for Nassau County. It shows that roughly the northern 30 percent of the County that falls within a mapped area of high susceptibility and low incidence, rather than in areas further south (roughly the remaining 70 percent that falls within a mapped area of low susceptibility and low incidence). This coincides generally with the topography of the County, with areas along the southern portion being relatively flat and areas along the northernmost areas exhibiting a certain degree of relief.

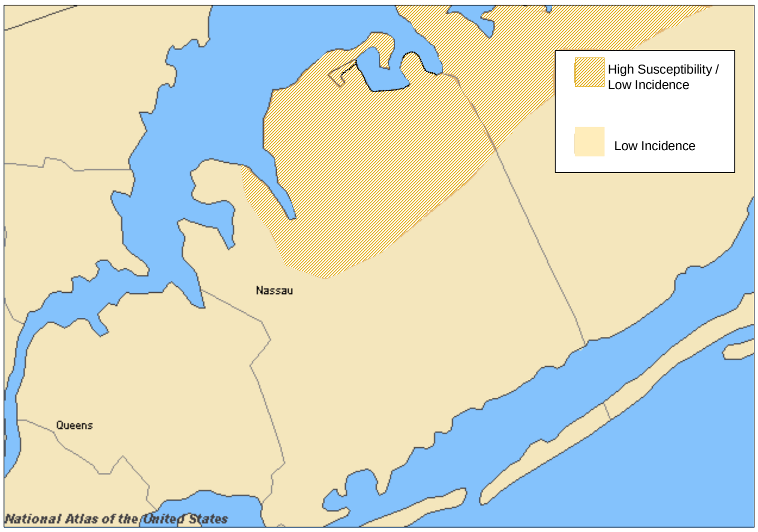


Figure 12 - USGS Landslide Hazard Susceptibility in Nassau County

As per the New York State Hazard Mitigation Plan, the USGS provides the following supporting narrative for the landslide hazard classifications:

> *"Susceptibility not indicated where same or lower than incidence. Susceptibility to land sliding was defined as the probably degree of response of [the areal] rocks and soils to natural or artificial cutting or loading of slopes, or to anomalously high precipitation. High, moderate, and low susceptibility are delimited by the same percentages used in classifying the incidence of land sliding. Some generalization was necessary at this scale, and several small areas of high incidence and susceptibility were slightly exaggerated."*

Extent – Landslides

The severity of a landslide depends in large part on the degree of development in the area in which it occurs and the geographic area of slide itself. Generally speaking, landslides often result in devastating consequences, but in very localized areas. A landslide occurring in an undeveloped are would be less severe because lives and property would not be affected; the only impacts would be to land, vegetation, and possibly some wildlife. On the contrary, a landslide occurring in a developed area could have devastating affects, ranging from structure and infrastructure damage to injury and/or loss of life. Structures or infrastructure built on susceptible land would likely collapse as their footings slide downhill, while those below the land failure would likely be crushed. Landslides in the area of roadways could have the potential to fall and damage or destroy vehicles, and force other drivers to have accidents.

Town of Hempstead Land Slide Susceptibility

Municipality Name	Total Area (acres)	Percent with High Susceptibility Low Incidence
Atlantic Beach	379.5	0%
Atlantic Beach West	118.7	0%
Baldwin	1,906.5	0%
Baldwin Harbor	756.5	0%
Barnum Island	407.1	0%
Bay Park	322.6	0%
Bellerose	78.3	0%
Bellerose Terrace	86.9	0%
Bellmore	1,473.5	0%
Cedarhurst	444.1	0%
East Atlantic Beach	257.9	0%
East Garden City	1,941.8	0%
East Meadow	3,211.0	0%
East Rockaway	676.6	0%
Elmont	2,213.9	0%
Floral Park	916.2	0%
Franklin Square	1,836.2	0%
Freeport	3,108.1	0%
Garden City	3,421.2	0%
Garden City South	257.6	0%
Harbor Isle	114.9	0%
Hempstead	2,358.1	0%
Hewlett	569.1	0%
Hewlett Bay Park	245.3	0%
Hewlett Harbor	528.3	0%
Hewlett Neck	137.7	0%
Inwood	1,377.9	0%
Island Park	252.7	0%
Jones Beach	2,247.8	0%
Lakeview	751.4	0%
Lawrence	2,973.0	0%
Levittown	4,364.7	0%
Lido Beach	1,112.4	0%
Long Beach	1,648.8	0%
Lynbrook	1,289.9	0%
Malverne	681.2	0%
Malverne Park - Oaks	71.3	0%
Merrick	2,682.7	0%
New Hyde Park	545.2	0%
North Bellmore	1,683.7	0%
North Lynbrook	53.2	0%
North Merrick	1,089.3	0%
North Valley Stream	1,198.8	0%
North Wantagh	1,201.0	0%
Oceanside	3,233.4	0%
Point Lookout	146.5	0%
Rockville Centre	2,124.3	0%
Roosevelt	1,168.8	0%
Salisbury	1,979.1	0%
Seaford	1,631.5	0%
South Floral Park	65.0	0%
South Hempstead	373.8	0%
South Valley Stream	550.5	0%
Steward Manor	128.3	0%
Uniondale	1,721.1	0%
Valley Stream	2,267.0	0%
Wantagh	2,459.1	0%
West Hempstead	1,777.4	0%
Woodmere	1,768.3	0%
Woodsburgh	265.9	0%
Total	**74,652.8**	**0%**

Town of North Hempstead Land Slide Susceptibility

Municipality Name	Total Area (acres)	Percent with High Susceptibility Low Incidence
Albertson	436.7	60%
Baxter Estates	106.9	0%
Carle Place	621.8	0%
East Hills	1,436.4	100%
East Williston	363.8	24%
Flower Hill	1,051.8	44%
Garden City Park	637.3	0%
Great Neck	871.7	0%
Great Neck Estates	513.6	0%
Great Neck Gardens	141.4	0%
Great Neck Gardens	141.4	0%
Great Neck Plaza	196.4	0%
Greenvale	170.7	100%
Harbor Hills	78.3	0%
Herricks	370.9	0%
Kensington	146.9	0%
Kings Point	2,587.6	0%
Lake Success	1,206.0	0%
Manhasset	1,544.9	2%
Manhasset Hills	380.7	0%
Manorhaven	404.1	0%
Mineola	1,196.6	0%
Munsey Park	321.3	9%
New Cassel	938.4	0%
North Hills	1,773.3	17%
North New Hyde Park	1,287.8	0%
Old Westbury	5,442.1	93%
Plandome	319.2	0%
Plandome Heights	118.7	0%
Plandome Manor	396.5	0%
Port Washington	2,997.1	52%
Port Washington North	323.4	0%
Roslyn	429.3	100%
Roslyn Estates	269.2	100%
Roslyn Harbor	707.9	100%
Roslyn Heights	939.2	98%
Russell Gardens	112.3	0%
Saddle Rock	184.2	0%
Saddle Rock Estates	48.5	0%
Sands Point	3,711.2	14%
Searingtown	600.4	21%
Thomaston	262.5	0%
University Gardens	362.6	0%
Westbury	1,490.8	6%
Williston Park	392.6	1%
Total	**38,034.3**	**33%**

Town of Oyster Bay Land Slide Susceptibility		
Municipality Name	Total Area (acres)	Percent with High Susceptibility Low Incidence
Bayville	899.3	100%
Bayville Unincorporated	99.0	100%
Bethpage	2,349.3	0%
Brookville	2,564.8	100%
Centre Island	695.3	100%
Cove Neck	888.2	100%
East Massapequa	2,198.2	0%
East Norwich	667.6	100%
Farmingdale	700.9	0%
Glen Cove	4,372.8	100%
Glen Head	1,049.8	100%
Glenwood Landing	905.7	100%
Hicksville	4,338.6	3%
Jericho	2,823.9	88%
Lattingtown	2,428.3	100%
Laurel Hollow	1,912.4	100%
Locust Valley	651.3	100%
Massapequa	2,348.1	0%
Massapequa Park	1,410.5	0%
Matinecock	1,700.2	100%
Mill Neck	1,784.6	100%
Muttontown	3,889.3	100%
North Massapequa	1,930.0	0%
Old Bethpage	2,608.6	0%
Old Brookville	2,537.6	100%
Oyster Bay	814.2	100%
Oyster Bay Cove	2,683.7	100%
Plainedge	909.9	0%
Plainview	3,654.7	0%
Sea Cliff	699.5	100%
South Farmingdale	1,412.7	50%
Syosset	3,202.9	98%
Tobay Beach Park	1,046.8	0%
Upper Brookville	2,753.4	100%
Woodbury	3,242.9	96%
Total	**68,175.1**	**61%**

Previous Occurrences - Landslides

The New York State Hazard Mitigation Plan was evaluated to identify historic landslide events in Nassau County and its participating jurisdictions. The State Plan indicates that 11 landslides occurred in Nassau County between the years of 1837 and 1988. Figure 13 was obtained from the State Plan; it illustrates the locations of these events. According to the State Plan, data was produced by the New York State Geological Survey (NYSGS) in cooperation with the USGS, with mapping prepared by NYSEMO. The State Plan notes that the number of events is based on the NYSGS Landslide Inventory Map of New York, published in 1989. It indicates that data is approximate and that it could include mud slides, rock slides, and landslides. According to the State Plan, no fatalities were associated with these events. The State Plan also includes a summary of known non-fatal landslides in New York State for the period 1963 to 2003; none were listed in Nassau County for this time period.

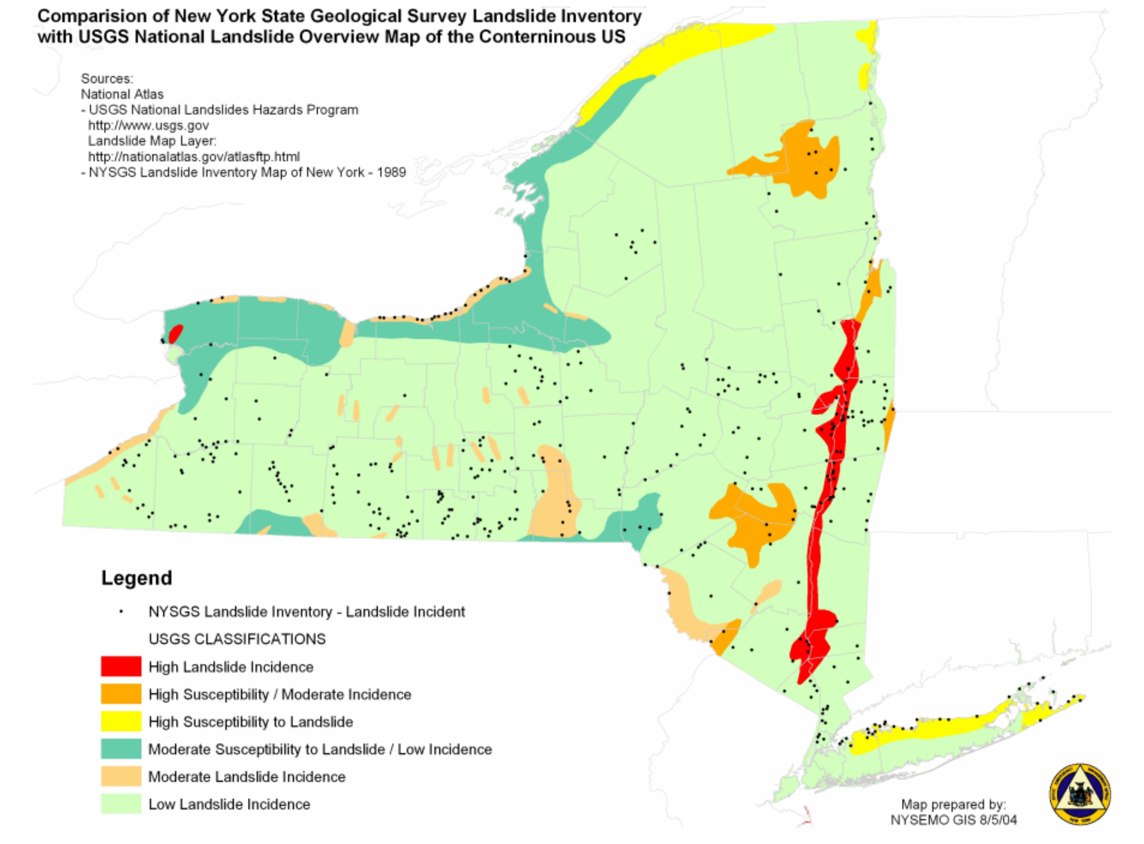


Figure 13 - New York State Geological Survey Landslide Inventory
(overlain upon USGS national Landslide Overview Map of the Conterminous US)

Figure 14 illustrates Figure 13 (above), but solely for Nassau County. At this larger scale, one can see that the figure presented in the State Plan appears to show only eight events in Nassau County while the text refers to 11. Information on the other three events is unknown. It is possible that more than one event occurred at three location, or that, at this scale, different locations appear to be mapped at a single point. The third possibility is that the location of the remaining three is not shown.

Figure 14 - New York State Geological Survey Landslide Inventory for Nassau County
(overlain upon USGS national Landslide Overview Map of the Conterminous US)

The Planning Group consulted the North Hempstead, Hempstead, and Oyster Bay Area Assessment Teams to see if additional information was available at the local level on any of the 11 landslide events recorded through 1988, or possibly any additional events that may have occurred since that time. Further details on landslide events were not known by team members. The most recent landslide event that the Planning Group was aware of occurred as a result of severe rains in October of 2005, when a landslide occurred behind the Roslyn Village Hall and covered public works equipment to depths of between three and five feet.

NationalAtlas.gov was consulted as well. On this web site, one can query “Landslides – Costly Events” and “Landslides – Costly Regional Events”. No events in Nassau County were noted on this site. The source of data is reported to be the USGS National Landslides Hazard Program.

Probability of Occurrence – Landslides

Landslides have occurred in Nassau County’s past, and are highly probable to occur there in the future. Using documented historical occurrences to estimate the probability of future landslides in Nassau County and its jurisdictions, best available data indicates that the County has a whole can expect on average approximately one landslide every 14 years. Based on the location of historic landslides and the local landslide susceptibility map for Nassau County, it is more likely that future landslides will occur generally north of the Long Island Expressway in the Town of North Hempstead or the Town of Oyster Bay (that is, roughly the northern 30 percent of the County that falls within a mapped area of high susceptibility and low incidence).

Drought

Description – Drought

The general term “drought” is defined by the US Geological Survey (USGS) as, “a prolonged period of less-than-normal precipitation such that the lack of water causes a serious hydrologic imbalance.” As stated in FEMA’s, “Multi-Hazard Identification and Risk Assessment “ (1997), drought is the consequence of a natural reduction in the amount of precipitation expected over an extended period of time, usually a season or more in length.

According to the National Oceanic and Atmospheric Administration’s (NOAA’s) Drought Information Center, there are four types of drought:

- Meteorological Drought – A measure of precipitation departure from normal.
- Agricultural Drought – When the amount of moisture in soil does not meet the needs of a particular crop.
- Hydrological Drought – When both surface and subsurface water supplies are below normal.
- Socioeconomic Drought - When a water shortage begins to affect people. *(The New York State Hazard Mitigation Plan expands upon NOAA's definition of Socioeconomic Drought by explaining that socioeconomic drought occurs when the demand for an economic good exceeds supply as a result of a weather-related shortfall in water supply.)*

Groundwater is the primary source of water supply on Long Island. According to the USGS Hydrologic Atlas 730-M for Segment 12 (which includes New York State, in addition to the states of Maine, Vermont, New Hampshire, Massachusetts, Connecticut and Rhode Island), published by Perry G. Olcott in 1995, precipitation is the source of all freshwater in New York State. Most of the precipitation that is not evapotranspired runs directly off the land surface to streams or reaches streams after temporary storage in lakes, reservoirs, wetlands, and soils. A small part of precipitation infiltrates the land surface and percolates downward to recharge aquifers. On Long Island, the aquifer is known as the Northern Atlantic Coastal Plain Aquifer System. Nassau County obtains its water supply from this aquifer system. The system consists of the Magothy aquifer and its underlying Lloyd aquifer. The aquifers are separated by a leaky confining unit of clays of the Raritan Formation. The Magothy aquifer provides most of the public water supply in Queens, Nassau, and western Suffolk Counties. The Lloyd aquifer provides most of the water for public supply for the northwest shore area of Long Island. In the report notes that in 1985, withdrawals of the Magothy and Lloyd aquifers of the Northern Atlantic Coastal Plain underlying Long Island were about 469 million gallons per day. For this same year (for all of Long Island) the report notes that nearly 71 percent of water withdrawals were for public supply. Withdrawals for industrial, mining, and thermoelectric power were estimated to be about 15 percent; while combined domestic, commercial, and agricultural uses accounted for the remaining 14 percent of total withdrawals.

Location – Drought

Droughts can occur in any part of the country, at any time of the year, depending upon temperature and precipitation over time. The footprint of the drought hazard area would encompass the full planning area for this document (Nassau County and each of its jurisdictions), with equal susceptibility; thus, a drought hazard area map has not been prepared.

Extent – Drought

Drought has the potential to affect nearly all sectors of the economy, environment, and government. Impacts of drought typically evolve gradually, and regions of maximum intensity change with time. Impacts of drought can be categorized as economic, environmental, or social. The New York State Hazard Mitigation Plan contains a comprehensive summary of drought impacts on Pages 3-101 to 3-106. In general, impacts of drought can include significant adverse consequences to:

- Public water supplies for human consumption
- Rural water supplies for livestock consumption and agricultural operations
- Water quality
- Natural soil water or irrigation water for agriculture

- Water for forests and for fighting forest fires
- Water for navigation and recreation.

The severity of these impacts depends not only on the duration, intensity, and geographic extent of a specific drought event, but also on the demands made by human activities and vegetation on regional water supplies. New York State's Drought Plan (as developed in 1982 and last revised in 1988) includes: (1) a state drought preparedness plan which focuses on monitoring and evaluating conditions and options to minimize drought impacts, and (2) a drought response plan that defines specific actions to be taken during various stages of drought. Drought severity is measured by the state using the Palmer Drought Index and the State Drought Index. Conditions monitored include climatological data, reservoir/lake storage, stream flow, and groundwater levels. The five stages of drought severity in New York State are Normal, Drought Alert, Drought Warning, Drought Emergency, and Drought Disaster.

According to the Nassau County Comprehensive Plan, the County contains 47 water districts which provide water service to over 90 percent of the County's residents. Approximately 3,550 residents of the less densely populated northern sections of the County draw their water from private wells. Nassau County has four aquifers which provide fresh water and are continuously being recharged by precipitation. Natural recharge to aquifers each day is reported to exceed average withdrawals from Long Island aquifers by 153 million gallons.

In summary, the magnitude and severity of drought in Nassau County is expected to be low, for the following reasons:

- Crop failure is one common affect of drought. According to the 2002 Agriculture Census for Nassau County, only 495 acres in Nassau County represents cropland (0.77 square miles). Of this, 483 acres (0.75 square miles) are used for harvesting crops and 12 acres (0.02 square miles) are used for pastureland or grazing. Losses to crops in Nassau County would be minimal.

- Water supply shortages are a second affect of drought. Nassau County gets most of its water from underground aquifers. Because underground aquifers are fairly resistant to the impacts of short-term droughts (the most likely type of drought to occur in Nassau County), the expected likelihood of future losses associated with reductions in water supply would be low.

- A third common affect of drought is fish and wildlife mortality. Because so much of the land area in Nassau County is developed, fish and wildlife habitat is fairly low and therefore losses to fish and wildlife would likely be low.

- A fourth common affect of drought is wildfires. Wildfires are not likely to occur in Nassau County. Small brushfires are possible, however. The expected likelihood of future losses during a drought as a result of brushfires is relatively low on a county or community level. However, losses in the particular location of the fire could be quite severe, particularly in areas where transportation or utilities are located.

Previous Occurrences – Drought

The New York State Hazard Mitigation Plan contains a summary of a total of six past occurrences of drought in New York State (presented in Table 3-45, Page 3-107). The earliest event recorded in the State Plan is the drought of August-December 1993. The most recent event recorded in the State Plan is the drought of April-October 2002. Long Island was included in three of the six reported declarations. The drought events for which Long Island (and, therefore, Nassau County) was included in the State Plan table are reproduced here in Table 17 below.

Table 17
Past Occurrences of Drought on Long Island

Date	Area Affected	Types of Damages	Dollar Amount of Damages
October 1994	Statewide	October 1994 tied for the 7th driest month on record at Albany.	Unknown
November 2001-January 2002	Orange, Putnam, Rockland, and Westchester Counties; New York City; and Long Island	The combined storage in the New York City water supply reservoir system was 41% of capacity (normal for this time is 71%).	Unknown
April 2002 – October 2002	New York City; Long Island; and Westchester, Orange, Putnam, and Rockland Counties	Groundwater and water storage facilities were below normal. The New York City reservoir system reached a low of 64.5%, which was 34% below normal.	Unknown

Source: New York State Hazard Mitigation Plan, Table 3-45 (Page 3-107)

Probability of Occurrence – Drought

Nassau County has averaged three droughts during the nine year period of record (1993-2002) reported in the New York State Hazard Mitigation Plan, or an average of 0.33 droughts per year.

Past drought occurrences are expected to be a sound indicator of the probability of future drought occurrences for Nassau County. Certain parts of the country are more susceptible to being impacted by a drought than others are. Arid parts of the country tend to be at greater risk of experiencing long-term droughts, while more humid parts of the country tend to be more susceptible to short-term droughts. According to the USGS Division of water Resources, Nassau County and its jurisdictions fall within what is described as a "humid region" and is more likely to experience a short-term drought.

Extreme Winds

Description – Extreme Winds

Wind, as defined by the American Meteorological Society, is air that is in constant motion relative to the surface of the earth. Since vertical components of atmospheric motion are relatively small, especially near the surface of the earth, meteorologists use the term "wind" to denote almost exclusively the horizontal component. Vertical winds are usually identified as such. Extreme winds are most often associated with tornadoes, hurricanes, tropical cyclones, destructive wind, and thunderstorms.

Extreme wind events can occur suddenly without warning. They can occur at any time of the day or night, at any location within Nassau County. Extreme winds pose a significant threat to lives, property, and vital utilities due to flying debris, such as rocks, lumber, fuel drums, sheet metal and loose gear of any type that can be picked up by the wind and hurled with great force.

Extreme winds also down trees and power lines, often resulting in power outages across an affected area. Extreme winds are most commonly the result of tornadoes, hurricanes, tropical cyclones, extratropical cyclones (northeasters), destructive wind, and thunderstorms, but can also occur in their absence as mere "windstorms."

(1) Tornadoes: Tornadoes are the most commonly known type of windstorm causing the most damage to property and life and all is due to severe winds. As researched by FEMA, there are, on average, 10 severe windstorms, classified as tornadoes, in the United States defined as F4 or F5 on the Fujita scale. (The Fujita scale reflects how much wind damage results from a tornado expressed in wind speeds. For example, wind speeds can vary between 50 and 250 mph in a typical F5 tornado.)

(2) Hurricanes: A hurricane is a tropical storm with winds that have reached a constant speed of 74 mph or more. Hurricane winds blow in a large spiral around a relative calm center known as the "eye." The "eye" is generally 20 to 30 miles wide.

(3) Coastal Storms: Coastal storms include both tropical cyclones and extratropical cyclones. The National Weather Service defines these terms as follows:

- Cyclone: An area of low pressure around which winds blow counterclockwise in the Northern Hemisphere. Also the term used for a hurricane in the Indian Ocean and in the Western Pacific Ocean.

- Tropical Cyclone: A cyclone that forms over tropical or sub-tropical waters around centers of low barometric pressure. Tropical cyclones derive their energy from the ocean. Tropical cyclones can be further broken down according to maximum sustained winds, as follows:

Tropical Depression:	Winds < 39mph
Tropical Storm:	39 mph $\leq$ Winds < 74 mph
Hurricane: *	Winds $\geq$ 74 mph

*** Note that "hurricanes" are tropical cyclones that develop over the Atlantic Ocean, northeast Pacific Ocean, or south Pacific Ocean. Similar storms that develop over the western North Pacific Basin are referred to as "typhoons" (or, if maximum sustained winds are at least 150 mph, "super typhoons").*

- Extratropical Cyclone: A non-tropical cyclone that forms around a center of low barometric pressure and derives its energy from the atmosphere. Extratropical cyclones are more commonly referred to as "winter storms." Extratropical storms can be experienced on both the East and West Coasts of the United States. On the East Coast, extratropical cyclones are often called "Nor'easters" due to the direction of the storm winds.

(4) Destructive Wind: Destructive wind is a windstorm that poses a significant threat to life and property and destroying everything in its path. Destructive wind can also

cause damage by flying debris, such as rocks, lumber, fuel drums, sheet metal and loose gear of any type which can be picked up by the wind and hurled with great force.

(5) Thunderstorms: A thunderstorm is a combination of moisture, rapidly rising warm air and forceful winds capable of lifting air that's either warm or cold. They also contain lightning and thunder.

Location – Extreme Winds

A useful tool for determining the location of the extreme wind hazard area in a jurisdiction is depicted in Figure 15 - Wind Zones in the United States. This map of design wind speeds was developed by the American Society of Civil Engineers and identifies wind speeds that are likely to occur in different parts of the country to be used as the basis for design and evaluation of the structural integrity of buildings and other facilities (i.e., utility transmission towers).

Similarly, Figure 16 is an excerpt from the New York State Hazard Mitigation Plan (2005). This figure was adapted by NYSEMO to focus solely upon New York State. The figure shows that a single wind speed zone covers Nassau County and its jurisdictions; Zone II – Hurricane Susceptible, with a design wind speed of 160 miles per hour.

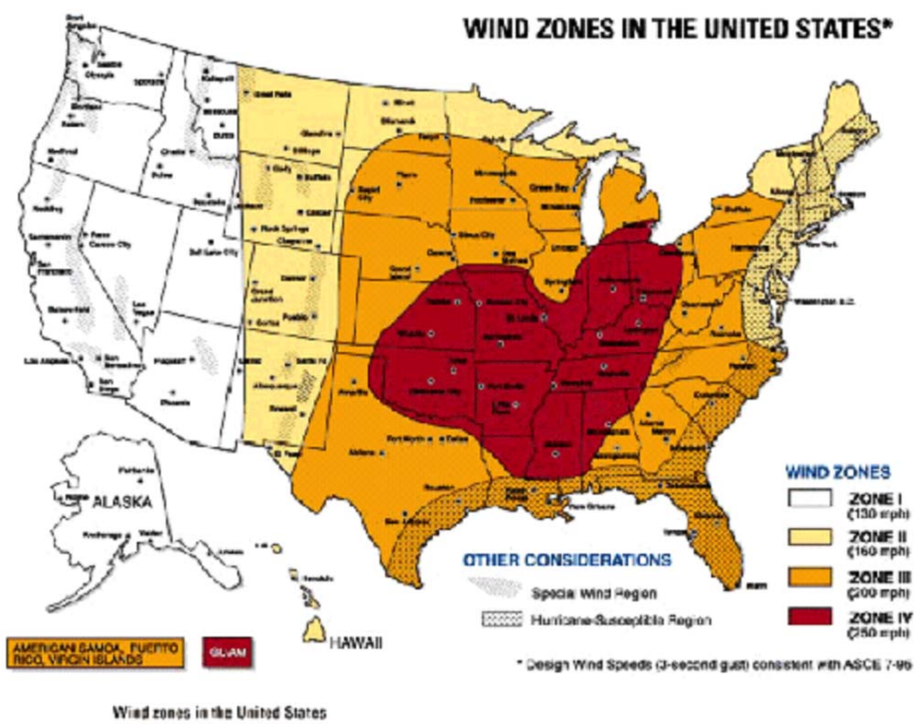


Figure 15 - Wind Zones in the United States

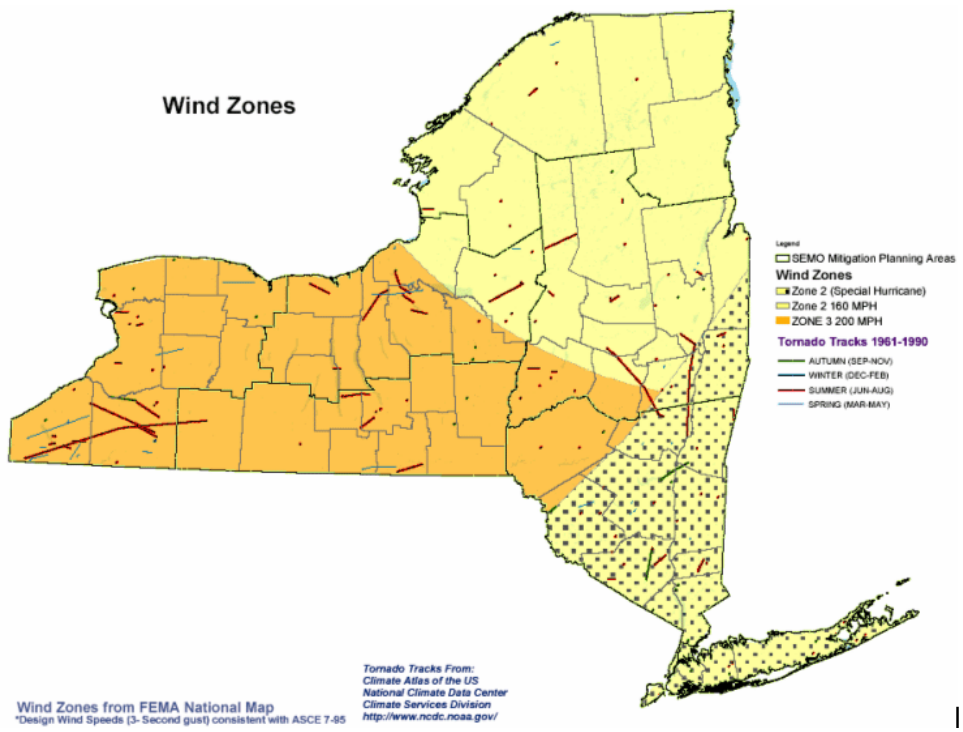


Figure 16 - Wind Zones in New York State

Extent – Extreme Winds

The severity of a severe wind event depends upon the maximum sustained winds experienced in any given area. For Nassau County, the 100-year wind speed ranges from 101 mph on the south shore to 99 mph on the north shore. Wind speeds in excess of this amount are highly unlikely, though not impossible, in Nassau County. Damages associated with winds up to 101 mph range from minimal to moderate. The damages associated with an extreme wind event in Nassau County would be high, however, because the County is highly developed and has a high population, so more people, buildings, and infrastructure could potentially be exposed than in, for example, a similar area of lesser development. Table 18 illustrates the severity and typical effects of various wind speeds, as obtained from the NOAA NCDC web site.

Table 18
Severity and Typical Effects of Various Speed Winds

Maximum Wind Speeds	Equivalent Saffir-Simpson Scale* (Hurricanes)	Equivalent Fujita Scale (Tornadoes)	Severity	Typical Effects
40-72 mph *(35-62 kt)*	Tropical Storm = 39-73 mph	F0	Minimal	Some damage to chimneys; breaks twigs and branches off tress; pushes over shallow-rooted trees; damages signboards; some windows broken; hurricane wind speed begins at 73 mph.
73-112 mph *(63-97 kt)*	Cat 1 = 74-95mph Cat 2 = 96-110 mph Cat 3 = 111-130 mph	F1	Moderate	Peels surfaces off roofs; mobile homes pushed off foundations or overturned; outbuildings demolished; moving autos pushed off the roads; trees snapped or broken.
113-157 mph *(98-136 kt)*	Cat 3 = 111-130 mph Cat 4 = 131-155 mph Cat 5 > 155 mph	F2	Considerable	Roofs torn off frame houses; mobile homes demolished; frame houses with weak foundations lifted and moved; boxcars pushed over; large trees snapped or uprooted; light-object missiles generated.
158-206 mph *(137-179 kt)*	Cat 5 > 155 mph	F3	Severe	Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forests uprooted; heavy cars lifted off the ground and thrown; weak pavement blown off roads.
207-260 mph *(180-226 kt)*	? Cat 5 > 155 mph	F4	Devastating	Well constructed homes leveled; structures with weak foundations blown off some distance; cars thrown and disintegrated; large missiles generated; trees in forest uprooted and carried some distance away. The maximum wind speeds of hurricanes are not likely to reach this level.
261-318 mph *(227-276 kt)*	N/A	F5	Incredible	Strong frame houses lifted off foundations and carried considerable distance to disintegrate; automobile-sized missiles fly through the air in excess of 300 ft (100 m); trees debarked; incredible phenomena will occur. The maximum wind speeds of hurricanes are not expected to reach this level.
Greater than 319 mph *(277 kt)*	N/A	F6	N/A	The maximum wind speeds of tornadoes are not expected to reach this level. The maximum wind speeds of hurricanes are not expected to reach this level.

** The Saffir-Simpson Scale is a five-category wind speed / storm surge classification scale used to classify Atlantic hurricane intensities. The Saffir-Simpson values range from Category 1 to Category 5. The strongest SUSTAINED hurricane wind speeds correspond to a strong F3 (Severe Tornado) or possibly a weak F4 (Devastating Tornado) value. Whereas the highest wind gusts in Category 5 hurricanes correspond to moderate F4 tornado values, F5 tornado wind speeds are not reached in hurricanes.*

Previous Occurrences – Extreme Winds

Nassau County has incurred damage from extreme winds in the past, and it will continue to do so in the future.

According to NOAA's National Climatic Data Center (NCDC), 88 thunderstorm and high wind events have been reported in Nassau County between January 1, 1950 and June 30, 2005, resulting in 14 deaths, 38 injuries, and $2.5 million in property damage. A detailed review of this data indicates that the death and injury totals include locations outside of Nassau County in southeastern New York State. For most events affecting Nassau County, downed trees and power lines were common affects of high winds, which ranged from 50 to 80 miles per hour and were often the result of severe thunderstorms or strong pressure systems moving through the area between the months of May and November. The first 28 events in the database (from May 1962 through March 1994) do not include descriptions. The majority of the remaining reported wind events included downed trees and power lines, and associated power outages. A sample of some of the more unique events are described below:

- July 7, 1994 - Thunderstorm winds downed trees and power lines across the County. At a festival in Oyster Bay a large tent, with about 70 people inside, was blown over.
- March 19, 1996 – A strong low pressure system generated wind gusts across southeastern New York from 50-60 mph. Maximum recorded gust of 79 mph at Fire Island. Many downed trees and power lines. The roof at the Cedarhurst Post Office was blown off.
- January 16, 1997 - A teenage boy was killed when a strong gust of wind blew him off the side of the roof of United Artists Plaza in East Meadow.
- August 16, 1997 - High winds overturned a boat in Oyster Bay. A man and woman fell overboard. The man was injured, but later rescued. Unfortunately, the woman was accidentally run over by a power boat and later died. A 58 mph wind gust was reported in North Massapequa. High winds downed numerous trees and power lines in Garden City.
- December 29, 1997 – A low pressure system developed off the Carolina Coast, while a high pressure system was northeast of the area. As the low moved north along the coast, it rapidly intensified. The pressure differential between these two system caused high winds throughout the area. Wind speeds were sustained from 30 to 40 mph. Wind gusts were measured at 68 mph at Long Beach.
- September 7, 1998 – Severe thunderstorms, high winds, large hail, and an isolated tornado downed many trees and power lines Labor Day afternoon. In Nassau County, the following peak wind gusts were reported: 75 mph in Farmingdale, 60 mph in Port Washington and Mineola and 58 mph at Farmingdale Republic Airport. High winds downed large tree limbs at Rockville Center, Baldwin, and Oceanside and downed trees in Long Beach, Massapequa, and Valley Stream. One-inch diameter hail dented cars and covered the ground in Farmingdale. $2.5 million in damages were reported.
- October 14, 1999 – A strong cold front moving through the area caused 40-50 mph wind gusts in Nassau County. Gusty winds downed a dead one and a half-foot wide, 70 foot tall oak tree. This tree fell on and crushed a car, including a 72 year old man who was sitting in the back seat. This occurred on Sagamore Hill Road in Cove Neck and resulted in the man's critical injury.
- December 12, 2000 - High winds associated with the passage of strong cold front caused a tree to fall on and injure one person in Great Neck. Property damage and power outages were also reported. Peak wind gusts in Farmingdale were measured at 53 mph.
- December 17, 2000 - _Pressure differential between two fronts produced strong winds which downed trees that fell onto and downed power lines at the corner of Muttontown's Mill Neck Road and Upper Brookville's Juniper Lane in Oyster Bay.
- September 19, 2003 – Tropical storm force winds as a result of Hurricane Isabel affected Nassau County. Tree limbs and power lines were downed. A large tree limb fell through the driver's side door and speared a man while driving through Great Neck Estates at the Intersection of Bayview Avenue and Glenview Drive; this resulted in a critical injury. In Nassau County, sustained wind speeds were measured at 10 pm EDT by an Automated Weather Station at 38 mph with a peak gust to 50 mph at Long Beach High School. The Long Island Power Authority reported 41,599 power outages across Nassau County.

In addition to high wind events associated with pressure systems and storms, tornadoes are a particular type of high wind event which have been recorded by NOAA's NCDC (and also reported in the New York State Hazard Mitigation Plan 2005) six times between January of 1950 and June of 2005. In total, the six tornadoes in Nassau County have reportedly caused $1.26

million in damages and six injuries. A summary of information available on all six events is presented in Table 19.

Table 19
Tornadoes Reported in Nassau County
(Source: NOAA's NCDC Storm Events Database for the period January 1, 1950 – June 30, 2005)

Date	Location	Town	Number of Deaths	Number of Injuries	Property Damage	Crop Damage	Magnitude	Length	Width
09/27/70	North Wantagh	Hempstead	0	0	$250,000	$0	F2	1 mile	77 yards
09/18/73	Seaford	Hempstead	0	0	$0	$0	F2	2 miles	167 yards
06/01/76	Bethpage	Oyster Bay	0	0	$3,000	$0	F0	Not Reported	Not Reported
08/12/78	Plainview	Oyster Bay	0	0	$3,000	$0	Not Reported	Not Reported	Not Reported
07/23/95	Not Reported	Not Reported	0	0	$0	$0	F1	<1 mile miles	130 yards
09/07/98	Village of Lynbrook	Hempstead	0	6	$1,000,000	$0	F2	<1 mile	200 yards
Total:			*0*	*6*	*$1,256,000*	*$0*			

Source: NOAA's National Climatic Data Center
Notes: Casualty and damage information are the total for the event, not necessarily the total for the county.
Magnitude refers to the Fujita Scale

The NCDC database only includes a description of the tornado that occurred on September 7, 1998, in Lynbrook. This F2 tornado caused $1 million in property damage and six injuries. The NWS confirmed that an F2 tornado was responsible for significant damage that occurred in Lynbrook. Most of the village received damage from straight line winds up to 80 mph which was associated with a severe squall line. Downed trees covered the village with some structural damage where the F2 tornado touched down. The major path of damage was from the northwest section of Lynbrook east-southeast to the southeast section of the village. Funnel clouds were observed from near the intersection of Marshall Ave. and Burtis Street and to the southeast. A tornado was first sighted by two eyewitnesses on Hampton Place. It rose and touched down several times: Second, near Winter Street and across Glover Circle; Third, along Peninsula Blvd. between Earle and Benton Avenues; and Fourth, as a weak F2 near the intersection of Rocklyn Ave. and Merrick Road. It moved across the Long Island Railroad Tracks and Sunrise Highway before it finally dissipated. More than three hundred trees were blown over, many on houses and cars. Six people received minor injuries. Four of these were in "The Fun Zone" on Rocklyn Avenue. One woman was slightly injured by a tree that fell on her car. One police officer was also injured. An intense line of severe thunderstorms oriented from north to south developed during Labor Day afternoon ahead of a strong approaching cold front. As the storms moved east at 40 to 50 mph, they produced high winds, large hail, and an isolated tornado. Wind gusts from 60 to 80 mph downed many trees and power lines throughout the area. The cost estimates of damage included above are preliminary figures submitted by the Nassau County Office of Emergency Management. In Nassau County, the following peak wind gusts were reported: 75 mph in Farmingdale, 60 mph in Port Washington and Mineola and 58 mph at Farmingdale Republic Airport. High winds downed large tree limbs at Rockville Center, Baldwin, and Oceanside and downed trees in Long Beach, Massapequa, and Valley Stream. One-inch diameter hail dented cars and covered the ground in Farmingdale.

Table 20 illustrates a summary of wind-related events in both New York State and Nassau County, and provides an associated average annual number of storms. This does not include hurricanes, tropical storms, or extratropical storms.

Table 20
Average Annual Number of Wind Events
(Source: NOAA's NCDC Storm Events Database for the period January 1, 1950 – June 30, 2005)

Event Type	Total Number of Events in New York State	Total Number of Events in Nassau County	Average Annual Number of Events in New York State	Average Annual Number of Events in Nassau County
Thunderstorm and High Wind	7,104	88	129.2	1.6
Tornadoes	346	6	6.3	0.1

Probability of Occurrence – Extreme Winds

Extreme winds are a probabilistic natural phenomenon: it is impossible to predict in what years windstorms will occur or how severe the winds will be. Wind hazards are often expressed in terms of wind frequencies or recurrence intervals, such as a 10-year wind or a 100-year wind. A "100-year wind" means that there is a 1 percent chance in any given year of a wind at the 100-year or higher wind speed. A 10-year wind means that there is a 10 percent chance in any given year of a wind at the 10-year or higher wind speed. Wind recurrence intervals don't mean that windstorms occur exactly at these intervals; rather, they express probabilities of winds. Thus, a given location may experience two 100-year windstorms in a short time period or go several decades without experiencing a 10-year windstorm.

Extreme winds can occur during tornadoes, hurricanes, tropical cyclones, extratropical cyclones (northeasters), destructive wind, and thunderstorms, but can also occur in their absence as mere "windstorms." Extreme winds have a history of occurrence throughout Nassau County, and are highly likely to occur in the future.

The degree of wind hazard risk at a particular site is characterized by the wind speeds expected at the site with recurrence intervals of 10-, 25-, 50-, 100-, and 2000- years. The FEMA Benefit-Cost Module for Wind Hazard Risk (Version 1.0, 01/20/95) provides winds speed data for various return periods at a series of mileposts located along US Gulf and Atlantic coastlines. The data is provided for locations at the coast and for locations 200 km (approximately 125 miles) inland. For the purposes of estimating wind data applicable for Nassau County, milepost 2550 was assumed to most closely resemble conditions in Nassau County. This milepost is located midway between milepost 2500 (located on the New Jersey shore) and milepost 2600 (located on the eastern end of Long Island). Table 21 illustrates Wind Speed Data for Nassau County. FEMA's Hurricane Benefit Cost Analysis module was used to obtain wind speeds at distances between the coast and 20 miles inland (where 20 miles is roughly the distance between Nassau County's north and south shorelines).

Table 21
Wind Speed Probabilities for Nassau County and Surrounding Area
(Milepost 2550, as per FEMA B-C Module – Wind, Version 1.0, January 20, 1995)

Recurrence Interval	Annual Probability of Occurrence (%)	Wind Speed At the Coast – South Shore (mph)	Wind Speed At 5 Miles Inland (mph)	Wind Speed At 10 Miles Inland (mph)	Wind Speed At 15 Miles Inland (mph)	Wind Speed At 20 Miles Inland – North Shore (mph)	Wind Speed At 125 Miles Inland (mph)
10	10	51	50	49	49	48	32
25	4	77	76	76	75	74	61
50	2	92	91	91	90	89	76
100	1	101	101	100	100	99	90
2000	0.05	138	138	137	137	137	130

Importing this data into FEMA's Hurricane Benefit Cost Analysis module allows the user to generate the estimated annual number of wind events that reach various strengths. These estimates are calculated from the wind recurrence interval data, wind speed data, and the number of miles inland the site is from the nearest milepost. "Expected annual number" of windstorms does not mean that this number of windstorms occurs every year, but rather "expected" indicates the long-term statistical average number of windstorms per year. Table 22 illustrates the expected annual number of wind events of various magnitudes at various distances from the coast for Nassau County and surrounding areas, while Table 23 illustrates the associated annual probability of occurrence.

Table 22
Expected Annual Number of Wind Events of Various Magnitudes
At Various Distances from the Coast
For Nassau County and Surrounding Areas
(Milepost 2550, as per FEMA B-C Module – Wind, Version 1.0, January 20, 1995)

Storm Class (Saffir-Simpson Scale)	Wind Speed (mph)	0.1 miles from the coast (mph)	5 miles from the coast (mph)	10 miles from the coast (mph)	15 miles from the coast (mph)	20 miles from the coast – north shore (mph)
0	60-73	0.0260	0.0250	0.0240	0.0231	0.0222
1	74-95	0.0291	0.0289	0.0286	0.0283	0.0280
2	96-110	0.0105	0.0101	0.0097	0.0093	0.0090
3	111-130	0.0032	0.0031	0.0030	0.0029	0.0028
4	131-155	0.0007	0.0006	0.0006	0.0006	0.0006
5	>155	0.0002	0.0002	0.0002	0.0002	0.0002

Table 23 Annual Probability of Wind Events of Various Magnitudes At Various Distances from the Coast For Nassau County and Surrounding Areas *(Milepost 2550, as per FEMA B-C Module – Wind, Version 1.0, January 20, 1995)*						
Storm Class (Saffir-Simpson Scale)	**Wind Speed (mph)**	**0.1 miles from the coast (south shore)**	**5 miles from the coast**	**10 miles from the coast**	**15 miles from the coast**	**20 miles from the coast (north shore)**
0	60-73	2.60%	2.50%	2.40%	2.31%	2.22%
1	74-95	2.91%	2.89%	2.86%	2.83%	2.80%
2	96-110	1.05%	1.01%	0.97%	0.93%	0.90%
3	111-130	0.32%	0.31%	0.30%	0.29%	0.28%
4	131-155	0.07%	0.06%	0.06%	0.06%	0.06%
5	>155	0.02%	0.02%	0.02%	0.02%	0.02%

According to NOAA's National Severe Storms Laboratory, the mean number of days per year with one or more tornado events in Nassau County is 0.5; the mean number of days per year with one or more severe wind events (winds of at least 57.5 miles per hour) in Nassau County is approximately 4. According to NOAA's National Climatic Data Center, the State of New York has an annual average of 6 tornadoes (based on data recorded between the years of 1950 and 1995).

Severe Weather Events: Hurricanes and Tropical Storms, Tornadoes, and Winter Storms/Ice Storms

A Distinction Between "Hazards" and "Events"

This section of the plan speaks to hurricanes and tropical storms, tornadoes, and winter storms/ice storms. These are severe weather events (not hazards themselves). Severe weather events have specific hazards associated with them. The unique hazards associated with the severe weather events discussed in this section are addressed specifically elsewhere in the plan; they are summarized briefly here. While HAZARDS are fully identified and profiled, with vulnerability assessments completed, EVENTS are merely summarized here for information only. EVENTS are not fully profiled and a vulnerability assessment has not been completed. The reader is, however, directed to the HAZARDS associated with these EVENTS (for profile/vulnerability assessment/etc.).

Hurricane and Tropical Storm Events

Hazards Associated with Hurricane and Tropical Storm Events

Hurricanes and tropical storms are particular types of events. The hazards associated with a hurricane or tropical storm event are: high winds, flooding (including storm surge), coastal erosion, and wave action. Each of the unique hazards associated with hurricane and tropical storm events are summarized briefly below, and addressed specifically elsewhere in the plan. Hurricane and tropical storm events are discussed in the remainder of this section.

- Winds. After making landfall, hurricane winds can remain at or above hurricane force well inland (sometimes more than 100 miles). In addition, hurricanes can also spawn tornadoes. Typically, the more intense a hurricane is, the greater the tornado threats. High winds are addressed separately in this document, beginning on Page 90.
- Flooding. Upon making landfall, a hurricane rainfall can be as high as 20 inches or more in a 24-hour period, with amounts in the 10 to 15 inch range being most common. If the storm is large and moving slowly, the rainfall amounts can be much higher. Heaviest rainfall tends to be along the coastline, but sometimes there is a secondary maximum further inland. Following a hurricane, inland streams and rivers can flood and trigger landslides. Flooding can also be caused when drainage system capacities are exceeded. Flooding is addressed separately in this document, beginning on Page 57.
- Storm Surge. Even more dangerous than the high winds of a hurricane is the storm surge, a dome of ocean water that is basically pushed ashore by the hurricane winds. Hurricane storm surge can be as much as 20 feet at its peak and 50 to 100 miles wide, depending on hurricane strength and depth of offshore waters. Generally, the stronger the hurricane and the shallower the offshore water depths, the higher the storm surge. Most hurricane fatalities and coastal damages are attributable to storm surge, as opposed to hurricane winds. Storm surge can cause the most damage when it occurs during high tides. Storm surge can come ashore as much as five hours in advance of the time that a hurricane makes landfall. Storm surge is addressed in the Flooding section of this document, beginning on Page 57.
- Coastal Erosion. The currents created by the tide and storm surge, combined with wave action, can severely erode coastlines. Many buildings withstand hurricane force winds until their foundations, undermined by erosion, are weakened and fail. Coastal erosion is addressed separately in this document, beginning on Page 30.
- Wave Action**.** Hurricanes and tropical storms are also associated with significant wave action, which can damage not only buildings but infrastructure and protective features. Wave action is addressed separately in this document, beginning on Page 41.

Description – Hurricane and Tropical Storm Events

A **hurricane** is a severe tropical cyclone with winds that have reached a constant speed of 74 miles per hour or more. Hurricane winds blow in a large spiral around a relative calm center known as the "eye." The "eye" is generally 20 to 30 miles wide, and the system can extend outward from the eye by up to 400 miles. In the Northern Hemisphere, circulation is in a counterclockwise motion around the eye. These storms are usually short in duration but are extremely powerful and cause the greater amount of damage due to significant storm surges and high winds. If these systems have wind speeds of between 39 and 73 miles per hour, they are classified as **tropical storms**.

In the Atlantic basin, hurricanes and tropical storms are most likely to occur between June 1st and November 30th, with the peak number of events typically occurring between mid-August and late October.

Location – Hurricane and Tropical Storm Events

No one jurisdiction within Nassau County is any more likely to have such a system make landfall within its borders than any other location. Because of the size of hurricane and tropical storm systems, areas within Nassau County can still be affected even when the eye makes landfall outside of Nassau County. The hazards associated with hurricane and tropical storm events (high winds, flooding, and coastal erosion) have distinct hazard area locations, discussed in other sections of this report.

Extent – Hurricane and Tropical Storm Events

The magnitude or severity of hurricanes is categorized by the Saffir-Simpson scale. The Saffir-Simpson Scale is a five-category wind speed / storm surge classification scale used to classify Atlantic hurricane intensities. The scale is used to give an estimate of the potential property damage and flooding that can be expected. The Saffir-Simpson values range from Category 1 to Category 5, as shown in Table 24. Wind speed is the determining factor in the scale, as storm surge values are highly dependent on the slope of the continental shelf in the landfall region.

Note that, for tropical storms (not represented on the scale), winds are between 39 and 73 miles per hour and typical effects include breakage of twigs and branches off tress, toppling of shallow-rooted trees, and some damage to signboards and windows.

Table 24
The Saffir-Simpson Hurricane Scale

Category	Wind Speed (miles per hour)	Storm Surge (feet above normal sea level)	Expected Damage
1	74-96 mph	4-5 ft	Minimal: Damage is done primarily to shrubbery and trees, unanchored mobile homes are damaged, some signs are damaged, no real damage is done to structures
2	96-110 mph	6-8 ft	Moderate: Some trees are toppled, some roof coverings are damaged, and major damage is done to mobile homes.
3	111-130 mph	9-12 ft	Extensive: Large trees are toppled, some structural damage is done to roofs, mobile homes are destroyed, structural damage is done to small homes and utility buildings.
4	131-155 mph	13-18 ft	Extreme: Extensive damage is done to roofs, windows, and doors; roof systems on small buildings completely fail; some curtain walls fail.
5	Greater than 155 mph	Greater than 18 ft	Catastrophic: Roof damage is considerable and widespread, window and door damage is severe, there are extensive glass failures, and entire buildings could fail.

** Source: FEMA's How-To #2, page 2-23*

The magnitude or severity of hurricane and tropical storm events will increase under the following conditions:

- as the storm category increases;
- as the diameter of the storm system increases;
- as the system's forward speed decreases;
- as rainfall amounts increase;
- as storm surge increases;

- as coastal erosion increases;
- as wave action increases; and
- as the quantity of people, structures and infrastructure in the affected areas increases.

In all likelihood, the magnitude and severity of damages would be the greatest within the geographical boundary of the Town of Hempstead, as this is where the county's population, structure, and infrastructure are greatest in number. In addition, this area includes the highly developed Long Beach Island barrier island communities.

Previous Occurrences – Hurricane and Tropical Storm Events

Hurricanes and tropical storms have impacted Nassau County and its participating jurisdictions in the past, and will continue to do so in the future.

Figure 17 was obtained from the NOAA web site. It shows seven hurricanes that have impacted Nassau County since 1900.

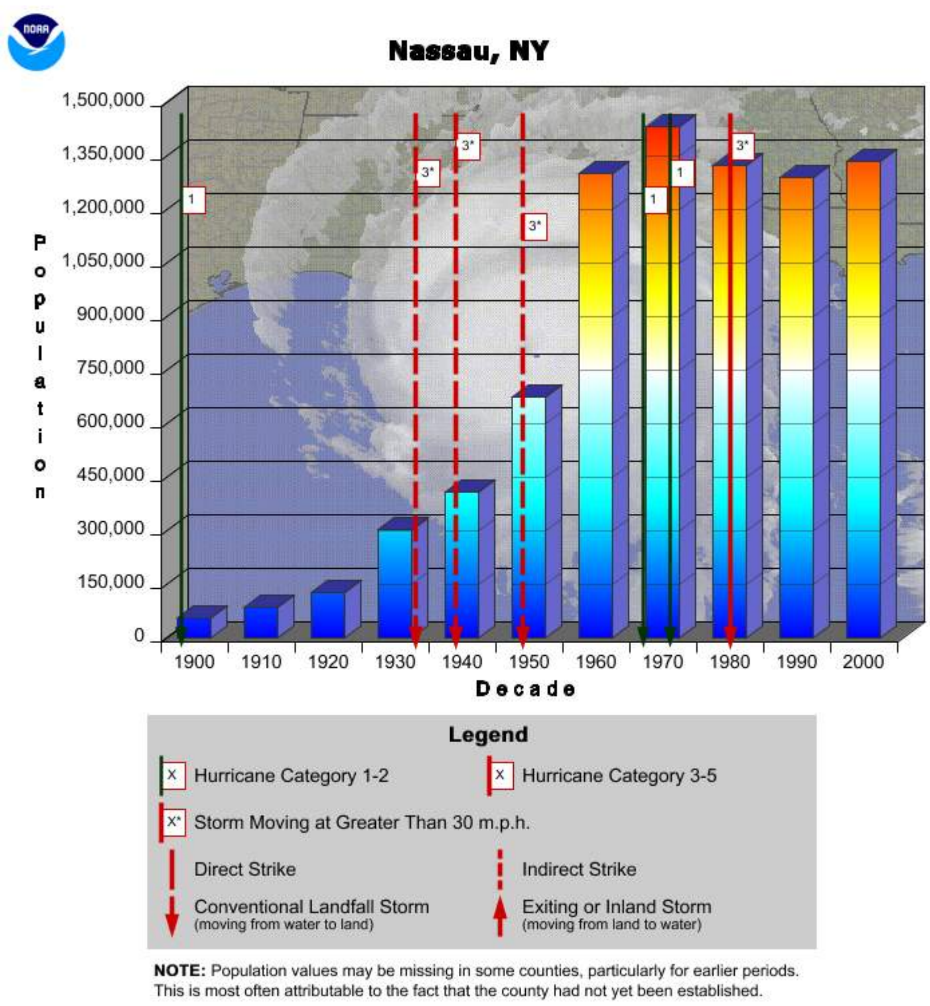


Figure 17 – Hurricanes Impacting Nassau County Since 1900

The following bullets describe historic hurricanes that have impacted Nassau County.

- **Hurricane of September 1904**. At the time that this hurricane crossed over Long Island, the County's population was a mere fraction of what it is today. On September 14-15, 1904 the Sag Harbor Express reported on a storm that passed over the western end of Long Island. The high winds downed trees blocking roads. At Bridgehampton, the forty-foot high steeple of the Presbyterian Church was blown down smashing a large hole in the roof. Fishing boats anchored in the bay were blown up on the shore.
- **The New England Hurricane (also known as the Long Island Express) hit Long Island on September 21, 1938** as a Category 3 (winds 111-130 mph) and devastated the coast of Long Island with storm surges of 10 to 12 feet and was responsible for, in total, 700 deaths, $308 million in damage, and 63,000 people homeless between Long Island and New England. The LI Express was so powerful that it created the Shinnecock Inlet and widened the Moriches Inlet in Suffolk County. Nassau County was not impacted as heavily. The team noted that rain fell steadily for 5 days during this event. Downed trees were a significant problem, blocking access routes in some cases. Flooding of coastal structures and basement flooding of other structures was widespread, as well as boat damage.
- **The Great Atlantic Hurricane of 1944** was a Category 3 (winds 111-130 mph) storm. The storm swept over eastern Long Island and Nassau County was spared the brunt of the damages. Most damages were in the form of downed trees and power lines, boat wreckage, flooding and other property damage. Upwards of 4 inches of rain fell and total damage for all of Long Island were estimated at $1,000,000. The storm could have caused significant more damage if it had instead struck at high tide.
- **Hurricanes Carol and Edna of 1954** were both Category 3 hurricanes when they hit Long Island and Connecticut. Nassau County did not receive the brunt of the damages. During Hurricane Carol high winds downed trees and power lines cutting off electric and phone services in many areas. High tides inundated local roadways, docks, beaches and cellars. The Plandome Bridge was completely covered, as was Shore Road and Manorhanven Boulevard. **For Hurricane Carol** (August 31, 1954) damages in Nassau and Suffolk County were estimated at $3,000,000. Personal injuries were minimal, one death, from a heart attack was attributed to the storm. Rainfall recorded during the storm on August 31 was 3.3 inches. The forward speed of the storm was 40 mph as the storm center crossed Long Island 25 miles east of Westhampton. The hurricane which brought 14 foot waves and wind up to 96 mph and sustained winds of 55 mph hit at the time of the predicted high tide. For Hurricane Edna (September 11, 1954), power and telephone outages lasted for several days following the storm. Rainfall between September 11 and September 12 was recorded at over 6 inches.
- **Hurricane Donna of 1960** started as a Category 4 and hit Nassau County as a Category 3 (winds 111-130 mph). According to the FEMA Flood Insurance Study, as this storm passed over Long Island, its eye became elongated and extended over the entire length of Long Island. Then it broke up into three eyes, causing variable wind patterns. Maximum tides in Nassau County were below 8.6 feet. At LaGuardia Airport, 70 mph winds from the northeast were recorded with gusts up to 97 miles per hour. Winds downed trees and power lines disrupting telephone and electric services. High tides and roadway flooding were widespread. Roof damage was widespread, ranging from shingle loss to loss of entire roofs. Hundreds of boats capsized and were destroyed. Manorhaven and Sands Point were hit especially hard with power outages.
- **Hurricane Belle.** On August 10, 1976, Hurricane Belle threatened Long Island. While Belle had been much stronger when it was off the coast of Florida and North Carolina.

However, its intensity was reduced in the colder waters of the northern Atlantic. In addition, it hit several hours after high tide. Damages were relatively minor.

- **Hurricane Gloria of 1985** began as a Category 3 hurricane when it hit Cape Hatteras, North Carolina, but was considered a Category 1 (winds 74-95 mph) when it reached Nassau County. Gloria devastated the U.S., including serious damage to Nassau County. High tides caused roadway flooding. Downed trees and power lines were widespread. Basement flooding, roof damage, and window damage was also widespread, as well as damage to boats.

Probability of Occurrence – Hurricane and Tropical Storm Events

Internet resources on NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML) web site were researched and it was determined that Nassau County and its jurisdictions have roughly an 18 to 24 percent chance of being impacted by a named coastal storm in any given year. This is shown graphically in Figure 18.

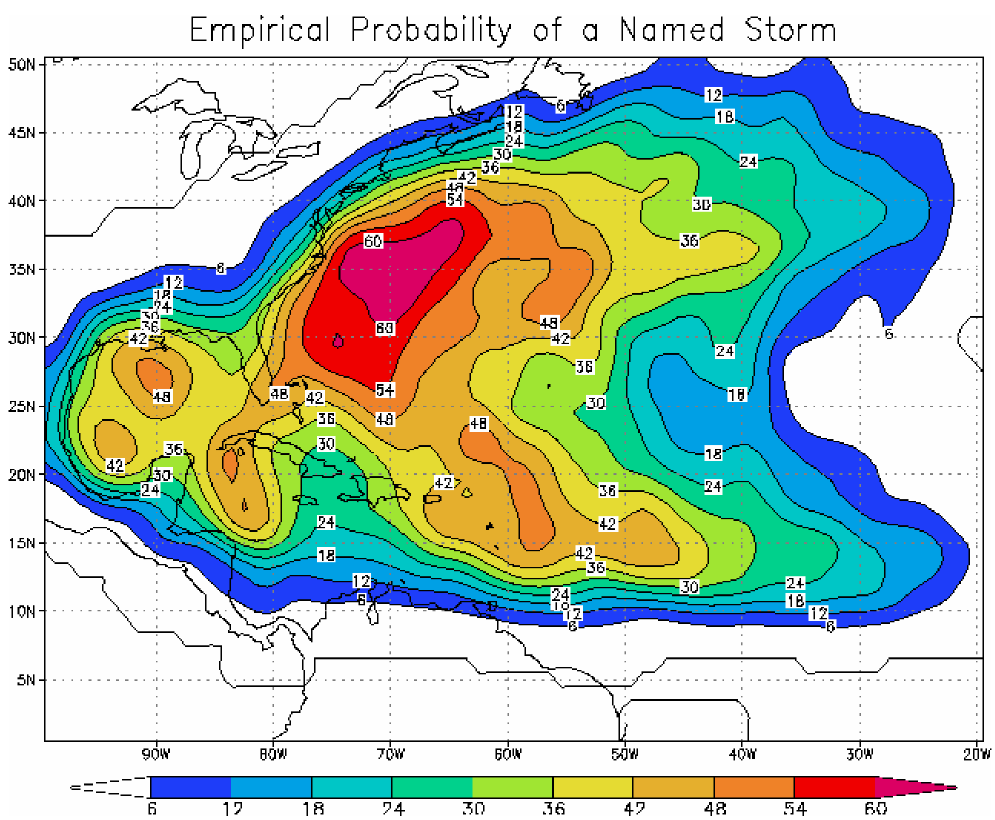


Figure 18 - Empirical Probability of a Named Storm (Atlantic Basin)

However, more specific information is available. NOAA's National Hurricane Center web site has posted return periods for various category hurricanes. Annual probabilities have been calculated from these return periods. For Nassau County and its participating jurisdictions, the estimate percent chance of occurrence of various category storms impacting the area in a given year is presented in the table below.

Table 25 Estimated Annual Percent Chance of Occurrence, Hurricanes (by Category)					
Category*	**Wind Speed (miles per hour) ***	**Storm Surge (feet above normal sea level)***	**Expected Damage***	**Return Period****	**Estimated Percent Chance of Occurrence in Any Given Year****
1	74-96 mph	4-5 ft	Minimal: Damage is done primarily to shrubbery and trees, unanchored mobile homes are damaged, some signs are damaged, no real damage is done to structures	17 years	5.9%
2	96-110 mph	6-8 ft	Moderate: Some trees are toppled, some roof coverings are damaged, and major damage is done to mobile homes.	39 years	2.6%
3	111-130 mph	9-12 ft	Extensive: Large trees are toppled, some structural damage is done to roofs, mobile homes are destroyed, structural damage is done to small homes and utility buildings.	68 years	1.5%
4	131-155 mph	13-18 ft	Extreme: Extensive damage is done to roofs, windows, and doors; roof systems on small buildings completely fail; some curtain walls fail.	150 years	0.7%
5	Greater than 155 mph	Greater than 18 ft	Catastrophic: Roof damage is considerable and widespread, window and door damage is severe, there are extensive glass failures, and entire buildings could fail.	370 years	0.3%

** Source: FEMA's How-To #2, page 2-23*
*** Source: NOAA's National Hurricane Center online at http://www.nhc.noaa.gov/HAW2/english/basics/return.shtml*

Tornado Events

Hazards Associated with Tornado Events

Tornadoes are particular types of events. The hazard associated with a tornado event is high winds. The high wind hazard is summarized briefly below, and addressed specifically elsewhere in the plan. Tornado events are discussed in the remainder of this section.

- Winds. After making landfall, hurricane winds can remain at or above hurricane force well inland (sometimes more than 100 miles). In addition, hurricanes can also spawn tornadoes. Typically, the more intense a hurricane is, the greater the tornado threats. High winds are addressed separately in this document, beginning on Page 90.

Description – Tornado Events

The American Meteorological Society, "Glossary of Meteorology" defines a tornado as violently rotating column of air that has contact with the ground and extends downward from a cumulonimbus cloud. Tornado wind speeds can range from as low as 40 mph to as high as 318 mph. Tornadoes often accompany thunderstorms and hurricanes. Tornadoes can occur at any time of the year but are more prevalent during the spring and summer months.

Location – Tornado Events

Tornadoes can occur anywhere in the US. They have struck in all 50 states, with the highest concentration on the central plains and in the southeastern states, such as Oklahoma, Texas, and Florida. No one jurisdiction within Nassau County is any more likely to have a tornado touch down within its borders than any other location. The hazard associated with tornado events (high winds) have distinct hazard area locations, discussed in other sections of this report.

Extent – Tornado Events

The magnitude or severity of a tornado is dependent upon wind speed and is categorized by the Fujita Scale, presented in Table 26. Tornadoes are typically considered to be "significant" for F2 or F3 on the Fujita Scale, and "violent" for F4 and F5.

Table 26
The Fujita Scale
(Source: NOAA)

Scale	Wind Estimate (mph)	Damage Type	Damage Description
F0	< 73	Light	Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged.
F1	73 - 112	Moderate	Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads.
F2	113 - 157	Considerable	Roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
F3	158 - 206	Severe	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	207 - 260	Devastating	Well-constructed houses leveled; structures with weak foundations blown away some distance; cars thrown and large missiles generated.
F5	261 - 318	Incredible	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.

Previous Occurrences – Tornado Events

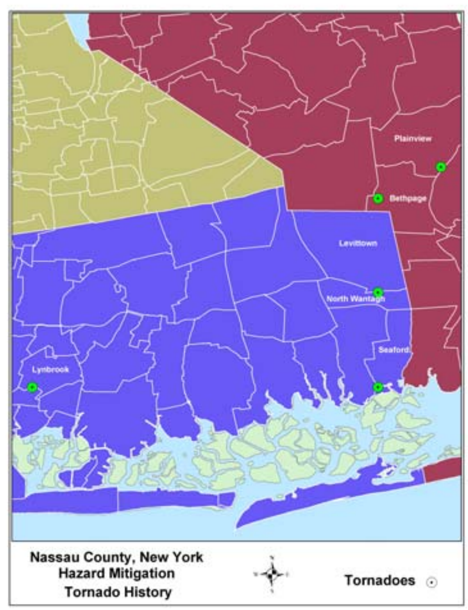
Tornadoes are a particular type of high wind event which have been recorded by NOAA's NCDC (and also reported in the New York State Hazard Mitigation Plan 2005) six times between January of 1950 and June of 2005. In total, the six tornadoes in Nassau County have reportedly caused $1.26 million in damages and six injuries. A summary of information available on all six events is presented in Table 27.

Table 27
Tornadoes Reported in Nassau County
(Source: NOAA's NCDC Storm Events Database for the period January 1, 1950 – June 30, 2005)

Date	Location	Town	Number of Deaths	Number of Injuries	Property Damage	Crop Damage	Magnitude	Length	Width
09/27/70	North Wantagh	Hempstead	0	0	$250,000	$0	F2	1 mile	77 yards
09/18/73	Seaford	Hempstead	0	0	$0	$0	F2	2 miles	167 yards
06/01/76	Bethpage	Oyster Bay	0	0	$3,000	$0	F0	Not Reported	Not Reported
08/12/78	Plainview	Oyster Bay	0	0	$3,000	$0	Not Reported	Not Reported	Not Reported
07/23/95	Not Reported	Not Reported	0	0	$0	$0	F1	<1 mile miles	130 yards
09/07/98	Village of Lynbrook	Hempstead	0	6	$1,000,000	$0	F2	<1 mile	200 yards
Total:			*0*	*6*	*$1,256,000*	*$0*			

Source: *NOAA's National Climatic Data Center*
Notes: *Casualty and damage information are the total for the event, not necessarily the total for the county.*
Magnitude refers to the Fujita Scale

The NCDC database only includes a description of the tornado that occurred on September 7, 1998, in Lynbrook. This F2 tornado caused $1 million in property damage and six injuries. The NWS confirmed that an F2 tornado was responsible for significant damage that occurred in Lynbrook. Most of the village received damage from straight line winds up to 80 mph, which was associated with a severe squall line. Downed trees covered the village with some structural damage where the F2 tornado touched down. The major path of damage was from the northwest section of Lynbrook east-southeast to the southeast section of the village. Funnel clouds were observed from near the intersection of Marshall Ave. and Burtis Street and to the southeast. A tornado was first sighted by two eyewitnesses on Hampton Place. It rose and touched down several times: Second, near Winter Street and across Glover Circle; Third, along Peninsula Blvd. between Earle and Benton Avenues; and Fourth, as a weak F2 near the intersection of Rocklyn Avenue and Merrick Road. It moved across the Long Island Railroad Tracks and Sunrise Highway before it finally dissipated. More than three hundred trees were blown over, many on houses and cars. Six people received minor injuries.



Four of these were in "The Fun Zone" on Rocklyn Avenue. One woman was slightly injured by a tree that fell on her car. One police officer was also injured. An intense line of severe thunderstorms oriented from north to south developed during Labor Day afternoon ahead of a strong approaching cold front. As the storms moved east at 40 to 50 mph, they produced high winds, large hail, and an isolated tornado. Wind gusts from 60 to 80 mph downed many trees and power lines throughout the area. The cost estimates of damage included above are preliminary figures submitted by the Nassau County Office of Emergency Management. In Nassau County, the following peak wind gusts were reported: 75 mph in Farmingdale, 60 mph in Port Washington and Mineola and 58 mph at Farmingdale Republic Airport. High winds downed large tree limbs at Rockville Center, Baldwin, and Oceanside and downed trees in Long Beach, Massapequa, and Valley Stream. One-inch diameter hail dented cars and covered the ground in Farmingdale.

Probability of Occurrence – Tornado Events

For tornado events, this plan indicates the probability of future occurrences in terms of frequency based on historical events. According to the NOAA National Climatic Data Center, Nassau County has experienced 6 tornadoes in the 55 year period between 1950 and 2005, or an average of 0.11 tornadoes per year. Table 28 illustrates a summary of tornado events in both New York State and Nassau County, and provides an associated average annual number of storms and probability of occurrence.

Table 28
Probability of Occurrence of Tornadoes
(Source: NOAA's NCDC Storm Events Database for the period January 1, 1950 – June 30, 2005)

Category	Total Number of Events	Probability of Occurrence (%)	Average Annual Number of Events
New York State			
F0	113	33.2 %	2.05
F1	136	40.0 %	2.47
F2	45	13.2 %	0.82
F3	24	7.1 %	0.44
F4	6	1.8 %	0.11
F5	0	0 %	0.00
Unable to Determine	16	4.7 %	0.29
Total	*340*		*6.18*
Nassau County			
F0	1	16.7 %	0.02
F1	1	16.7 %	0.02
F2	3	50 %	0.05
F3	0	0 %	0.00
F4	0	0 %	0.00
F5	0	0 %	0.00
Unable to Determine	1	16.7 %	0.02
Total	*6*		*0.11*

Winter Storms / Ice Storms

Hazards Associated with Winter Storms / Ice Storms

Severe winter storms are particular types of events. They are characterized by the hazards of high winds, extreme cold, heavy precipitation (in the form of snow and/or ice), and sometimes wave action, coastal erosion and flooding. Winter storm and ice storm events are discussed in general terms in this section of the document; their specific hazards are discussed elsewhere in the plan.

Description – Winter Storms / Ice Storms

Winter storms consist of cold temperatures and heavy snow or ice. Because winter storms are regular, annual occurrences in Nassau County, they are considered hazards only when they result in damage to specific structures and/or overwhelm local capabilities to handle disruptions to traffic, communications, and electric power.

Winter storms and ice storms can occur in New York State from late October until mid-April. Peak months for these events for Nassau County and its jurisdictions would be December through March.

Northeasters are one type of winter storm that is common in Nassau County. The New York State Hazard Mitigation Plan notes that these storms usually form off the US East Coast near the Carolinas then follow a track northward along the coast until they blow out to sea, hence the term "northeaster". Occasionally these storms are large enough to cover a majority of the state; however, they most often affect southern New York State and Long Island. Northeasters are most notable for snow accumulations in excess of nine inches accompanied by high winds (sometimes gale force) and storm surges.

New York State also experiences "Lake Effect" storms, from systems picking up moisture across the Great Lakes; however, Nassau County is too far south to be impacted by these types of events except under rare circumstances where the system is unusually large.

Statewide, average annual snowfall is about 65 inches. Many areas in extreme northern and western New York State see more than twice this amount on an annual basis. Extreme southern New York State and Long Island have some of the lowest annual snowfall averages in the state, with Nassau County at 22.1 inches.

Location – Winter Storms / Ice Storms

Severe winter storms and ice storms can occur anywhere in the County; no one jurisdiction within Nassau County is any more likely to be impacted by a severe winter storm or ice storm within its borders than any other location. The hazards associated with this event have distinct hazard area locations, discussed in other sections of this report.

Extent – Winter Storms / Ice Storms

A severe winter storm can adversely affect roadways, utilities, business activities and can cause loss of life, frostbite, or freezing. The most common effect of winter storms and ice storms is traffic accidents, interruptions in power supply and communications; and the failure of inadequately designed and/or maintained roofing systems. Power outages and temperatures below freezing for extended periods of time can cause pipes to freeze and burst. Heavily populated areas tend to be significantly impacted by losses of power and communications systems due to downed lines. Distribution lines can be downed by the weight of snow or ice, or heavy winds. When limbs and lines fall on roadways, transportation routes can be adversely affected and buildings, automobiles can be damaged. Heavy snow loads can cause roof collapse for residential, commercial, and industrial structures in cases of inadequate design and/or maintenance. Severe winter storms can also cause extensive coastal flooding, coastal erosion, and wave damage. If significant snowfall amounts melt quickly, inland flooding can occur as bankfull conditions are exceeded or in areas of poor roadway drainage.

The severity of the effects of winter storms and ice storms increases as the amount and rate of precipitation increase. In addition, storms with a low forward velocity are in an area for a longer duration and become more severe in their affects. Storms that are in full force during the morning or evening rush hours tend to have their affects magnified because more people are out on the roadways and directly exposed. Storms that arrive at high tide can also have exacerbated affects in coastal areas.

The magnitude of a severe winter storm or ice storm can be qualified into five main categories by event type, as shown below:

- Heavy Snowstorm: Accumulations of four inches or more of snow in a six-hour period, or six inches or more of snow in a twelve-hour period.
- Sleet Storm: Significant accumulations of solid pellets which form from the freezing of raindrops or partially melted snowflakes causing slippery surfaces posing hazards to pedestrians and motorists.
- Ice Storm: Significant accumulations of rain or drizzle freezing on objects (tress, power lines, roadways, etc.) as it strikes them, causing slippery surfaces and damage from the sheer weight of ice accumulation.
- Blizzard: Wind velocity of 35 miles per hour or more, temperatures below freezing, considerable blowing snow with visibility frequently below one-quarter mile prevailing over an extended period of time.
- Severe Blizzard: Wind velocity of 45 miles per hour, temperatures of 10 degrees Fahrenheit or lower, a high density of blowing snow with visibility frequently measured in feet prevailing over an extended period of time.

Previous Occurrences – Winter Storms / Ice Storms

In Nassau County, severe winter storms and ice storms are expected and normal. In Nassau County, severe snow events tend to occur more often than severe ice events.

A review of the New York State Hazard Mitigation Plan shows that, out of 11 FEMA snow and/or ice disaster and emergency declarations in New York State since 1977, Nassau County was declared only two times, both for snow related events. Nassau County was included in one emergency declaration (EM-3107) during the statewide blizzard of March 1993. Statewide damages for this event were reported in the State Plan as $8.4 million. Nassau County was also declared in the southern New York blizzard of January 1996, during which total damages statewide were estimated at $21.3 million.

In addition to information provided in the New York State plan on Federal declarations, a review of the NOAA National Climatic Data Center's database yielded 29 snow and ice events reported in Nassau County between February 1994 and March 2005, as summarized in Table 29.

Table 29
Snow/Ice Events Reported in Nassau County
(Source: NOAA's NCDC Storm Events Database)

Date	Type	Description
02/08/94	Snow/Ice	Snow sometimes at a rate of two or three inches an hour. After depositing between six and nine inches, the snow began to mix then change to sleet and freezing rain. This added a dangerous coating of ice which caused major transportation problems.
02/11/94	Snow/Ice	Snow accumulated between 6 and 14 inches before it mixed or changed to sleet and/or freezing rain in some locations. The wintry mix caused major transportation problems throughout the region.
02/23/94	Snow/Ice	Three and five inches of snow fell before a dangerous coating of ice was added as the snow changed to sleet and/or freezing rain. Major transportation problems developed as roadways became extremely hazardous.
03/03/94	Snow/Ice	Powerful Nor'easter. Strong northeasterly winds of between 35 and 40 mph prevailed for several hours along coastal sections. Several locations reported gust of around 60 mph. These winds brought down large branches and some relatively small trees. These in turn brought down numerous power lines which left thousands of residents without power. The winds also attributed directly to widespread, but relatively minor coastal flooding along with moderate beach erosion. One home was destroyed on Dune road on eastern Long Island. In addition, snow and ice accumulated between five and eight inches. This caused significant transportation problems for trains, planes, and motorist.
02/04/95	Heavy Snow	No details reported.
12/19/95	Heavy Snow	Snow accumulations from approximately 8 to 12 inches.
02/03/96	Heavy Snow	Snow accumulations ranged from 7 to 10 inches.
02/16/96	Heavy Snow	Snow accumulations ranged from 6 to 12 inches.
03/02/96	Heavy Snow	Snow accumulations from 6 to 7 inches.
04/09/96	Heavy Snow	Heavy wet snow downed numerous trees and power lines. For Nassau County snowfall ranged from 4.5 inches at Merrick and Manhasset to 9 inches in Syosset.
03/14/99	Heavy Snow	Snowfall amounts generally ranged from 6 to 11 inches. Heavy wet snow downed many tree limbs and power lines across the region. In Nassau County, amounts ranged from 6 inches at Oceanside, Lynbrook, Mineola, and Hicksville to 7 inches at Merrick and East Norwich.
01/25/00	Snow/Ice	Strong Nor'easter. Snowfall rates up to 2 inches per hour during peak of morning rush hour. White-out conditions caused massive traffic interruptions. Snow later changed to freezing rain and sleet. Around 1/4-inch thick ice coated trees, which caused limbs to snap off from Eastern Nassau County east across all of Suffolk County. Bands of heavy snow fell across the Lower Hudson Valley, New York City, and Western Nassau County during the evening. Snowfall amounts in Nassau County from 5.3 inches at Valley Stream to 6.8 inches at Merrick. Strong northeast wind gusts from 40 to 45 mph. In addition, minor tidal flooding occurred in Long Beach and Freeport around the times of high tides from 11 am to noon.
02/18/00	Snow/Ice	Snow fell at the rate of at least 1 inch per hour from around 10 am later changing freezing rain. Snowfall amounts ranged from 1 to 2 inches along the south shores of Long Island, to 3 to 4 inches across the north shores. This first round of heavy precipitation was followed by up to a 1/8th-inch thick ice coating, which caused serious and widespread traffic disruptions. A second low pressure system followed, producing roughly one quarter inch of freezing rain. Significant icing of roads occurred, which forced the closure of many metro roads overnight. Numerous traffic accidents occurred (including 1 death in Suffolk County).
12/30/00	Heavy Snow	Snowfall rates of one to two inches per hour were common. Numerous reports of thunder and lightning and high winds. Winds caused some blowing and drifting of snow, which reduced visibilities significantly, and created near blizzard conditions at times in some areas. Subfreezing temperatures and gusty winds lingered behind the storm system. Snowfall totals in Nassau County: 11 inches at Lynbrook, to 15.6 inches at Oceanside.

Table 29
Snow/Ice Events Reported in Nassau County
(Source: NOAA's NCDC Storm Events Database)

Date	Type	Description
01/20/01	Snow/Ice	Across Nassau County, a period of sleet and freezing rain occurred Saturday night, producing ice accumulations of up to 0.20 inches. This buildup of ice on major highways and bridges produced hazardous travel conditions Saturday night, and contributed to an airplane skidding off the runway at JFK Airport Sunday morning. The sleet and freezing rain changed to heavy snow early Sunday morning. This accretion of ice on tree limbs caused some tree branches to fall, and led to power outages. Here are some specific snowfall and ice amounts for: Nassau County: 0.20 inches of ice followed by 7 inches of snow at Bayville.
02/05/01	Heavy Snow	Rain and heavy wet snow. Due to the rapid rate at which the snow fell, hazardous travel resulted across much of the New York City area and Long Island for the Monday evening commute. Snowfall totals in Nassau County: 3 inches at Garden City, to 6 inches at Great Neck and Plainview.
02/22/01	Heavy Snow	Event was relatively brief in duration. Snowfall rates of one to two inches per hour were common creating hazardous traveling conditions for evening commute, resulting in numerous minor traffic accidents. Snowfall amounts for Nassau County: 3.9 inches at Hicksville, to 6 inches at West Hempstead.
03/05/01	Snow/Ice	Slow-moving coastal storm accompanied by a mixture of snow, sleet, freezing rain and rain through the early portion of the event, and mainly heavy snow for the remainder of the event (approximately 4 days). Gusty winds and minor to moderate coastal flooding and beach erosion also occurred along coastal portions of Long Island. The combination of very heavy wet snow and strong winds with this prolonged coastal storm produced scattered power outages across southeast New York, primarily across Suffolk County. In addition, many schools and businesses were closed for several days due to the hazardous nature of this storm. Total snowfall amounts for Nassau County: 4 inches at Sea Cliff, to 7.4 inches at Hicksville.
12/05/02	Heavy Snow	Moderate to heavy snow falling at times at rates over an inch per hour. Final snowfall accumulations ranged from 6 to 8 inches in New York City, Long Island and the nearby northern suburbs.
12/25/02	Snow/Ice	Wintry mix of light freezing rain, freezing drizzle, rain, sleet and snow changing to all snow. On Long Island, 6 to 12 inches fell in Nassau and Western Suffolk counties.
02/07/03	Heavy Snow	Heavy snow. Nassau County totals ranged from 5.0 inches at Baldwin to 7.5 inches at Wantagh.
02/17/03	Heavy Snow	Light snow and winds Sunday afternoon, February 16th. Snow widespread and heavy, falling at rates up to 2 to 3 inches per hour Sunday night and Monday, February 17th. Heavy snow blown by northeast winds 20 to 30 mph caused near blizzard conditions and record heavy snowfalls crippled mass transit. Local emergency declarations throughout the region. In New York City alone, the cost estimate for total snowfall operations was around 20 million dollars. Widespread moderate beach erosion and minor tidal flooding. Storm total snowfall amounts from 14.1 inches at Valley Stream to 23.5 inches at Farmingdale.
04/07/03	Heavy Snow	Late season snowstorm produced widespread snowfall amounts of 4 to 7 inches in New York City and Long Island. This included about a 4 hour period on the afternoon of April 7th during which heavy snow fell at rates of an inch or more per hour. Local impacts from the storm included over 300 cancelled flights at LaGuardia and Kennedy Airports, a crippled mass transit system, numerous traffic accidents on area roadways and downed tree limbs in the vicinity of Peter Cooper Village in Manhattan.
12/05/03	Heavy Snow	Significant and rapid accumulation of snow; major widespread impacts to mass transit operations during evening rush hours. Blizzard conditions with wind gusts of at least 35 mph combined with heavy falling snow created "white out" conditions and visibility less than 1/4 mile. Two-day event. Storm total snowfall amounts from 12.0 inches at Rockville Center to 16.6 inches at Bethpage.
01/15/04	Heavy Snow	Strong Alberta clipper produced heavy snow; storm total snowfall amounts ranged from 5.5 inches at Lynbrook to 7.0 inches at Farmingdale and West Hempstead.
01/28/04	Snow/Ice	Snow, sleet, and freezing rain. Ice on area roads made traveling extremely hazardous; many traffic accidents reported. Storm total snowfall amounts for Nassau County from 6.5 inches at Lynbrook to 11.5 inches at Bellmore.
01/22/05	Heavy Snow	Near blizzard conditions with heavy snow, strong and gusty winds, blowing snow, and drifting snow. Widespread moderate beach erosion and minor tidal flooding across Atlantic Ocean shores. Snow fell at a rate of at least 1 inch per hour at times. Hazardous driving and widespread impacts to mass transit. North winds of 20 to 30 mph with gusts between 35 and 50 mph caused blowing and drifting snow. Snowfall amounts ranged from 11.3 inches at Great Neck to 16.5 inches at Farmingdale. In Bayville, waves broke over barriers and encased lamp posts and wires in sheets of ice.
02/25/05	Heavy Snow	Storm total snowfall amounts in Nassau County - from 5.0 inches at Merrick and Lynbrook to 6.8 inches at Bellmore.

Table 29 Snow/Ice Events Reported in Nassau County *(Source: NOAA's NCDC Storm Events Database)*		
Date	**Type**	**Description**
03/08/05	Snow/Ice	Snow, with near blizzard conditions for a short time. Wind gusts between 40 and 55 mph. Storm total snowfalls ranged from around 2 to 4 inches. Wet and mild antecedent conditions followed by more than a 20 degree drop in temperature in 3 hours with strong gusty winds resulted in a "flash" freeze across roads that resulted in hundreds of vehicle accidents.

Probability of Occurrence – Winter Storms / Ice Storms

Using the same methodology as the New York State Hazard Mitigation Plan for winter storm and ice storm events, this plan indicates the probability of future occurrences in terms of frequency based on historical events. Using the historical data presented in Table 29, Nassau County and its participating jurisdictions have experienced 29 winter storms / ice storms between February 8, 1994 and June 30, 2005 – an average of 2.64 storms per year. Based on historic records, it is more likely that these events will be heavy snow (see Table 30 below).

Table 30 Probability of Occurrence of Winter Storms/Ice Storms, Nassau County *(Source: NOAA's NCDC Storm Events Database)*			
Type	**Total Number of Events**	**Probability of Occurrence (%)**	**Average Annual Number of Events**
Heavy Snow Events	18	62.1%	1.64
Snow/Ice Events	11	37.9%	1.00
All Winter Storm / Ice Storm Events	29	100%	2.64