Hazard Profile –Severe Storm

Description

The severe storm hazard includes Coastal Storms, Hailstorms, Hurricanes, Tornados and Windstorms, each of which is defined in the table below.

Severe Storm Hazard Definitions

Table 5-25 Severe Storm Hazard Definitions

Hazard Type	Definition
Natural Hazards	
Coastal Storm	Any type of storm which develops over the ocean and ultimately impacts land areas.
Hailstorm	Showery precipitation in the form of irregular pellets or balls of ice more than 5 mm in diameter, falling from a cumulonimbus cloud.
Hurricane	Tropical cyclones, formed in the atmosphere over warm ocean areas, in which wind speeds reach 74 miles per hour or more and blow in a large spiral around a relatively calm center or "eye". Circulation is counterclockwise in the Northern Hemisphere.
Tornado	A local atmospheric storm, generally of short duration, formed by winds rotating at very high speeds, usually in a counterclockwise direction. The vortex, up to several hundred yards wide, is visible to the observer as a whirlpool-like column of winds rotating about a hollow cavity or funnel. Winds have been estimated to be in excess of 300 miles per hour.
Windstorm	Wind is air moving from high to low pressure. Windstorm events are associated with cyclonic storms, thunderstorms and tornados.

Source: New York State Hazard Mitigation Plan

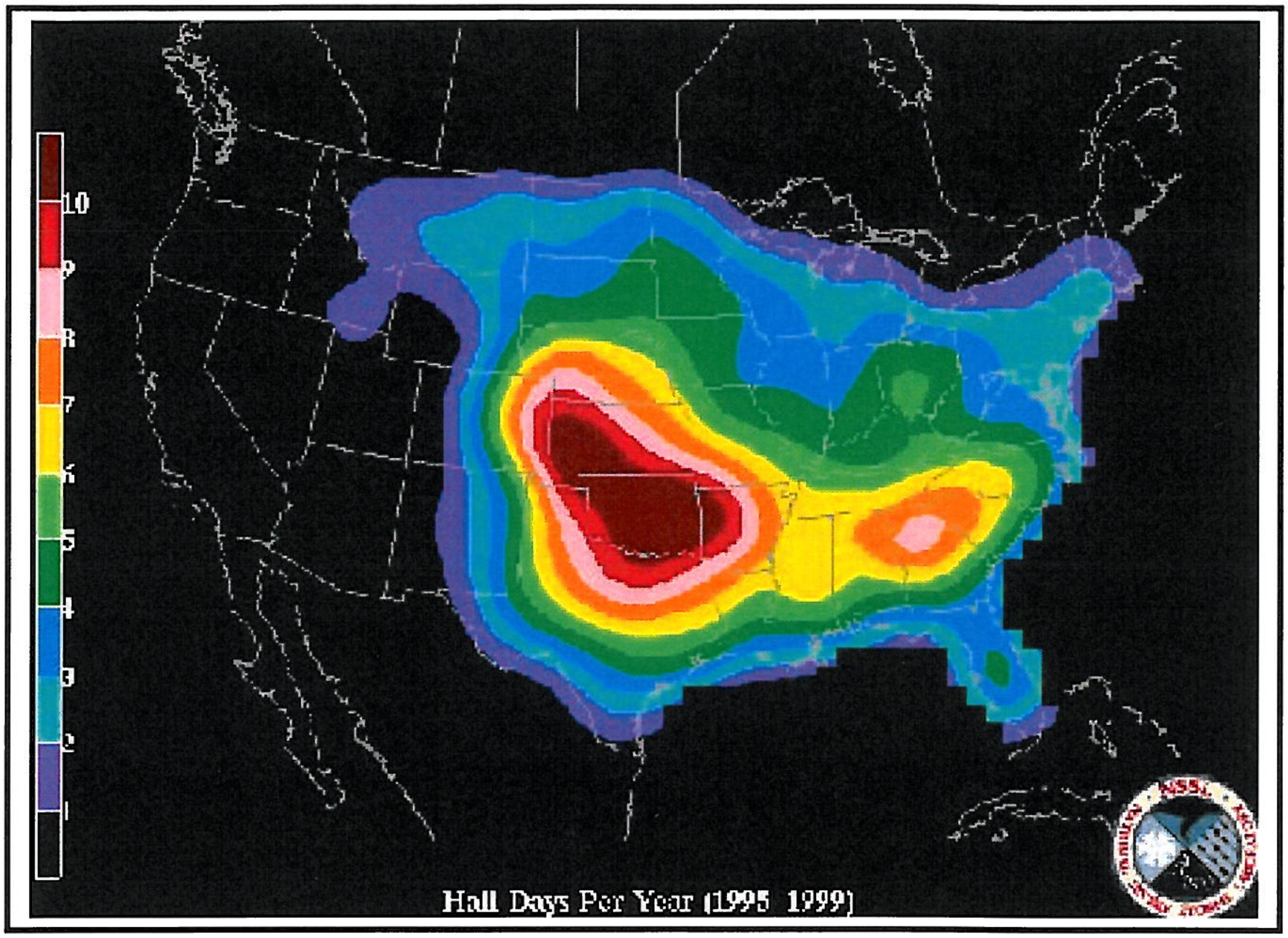
Location and Extent

Severe storms may impact the entire study area and have the ability to cause widespread damage. Although a minimum amount of locally documented information is available, certain areas as well as the Town /Village as a whole have been impacted by severe storm events in the past.

Hailstorms

The figure below indicates that the study area receives 2-3 days of hail annually. There are no records available locally which indicate any amount or the severity of damage from these type events. Hail is most common in areas of the Midwest where such storms can cause significant damage to crops. Locally, hail has been known to break the occasional window or dent a vehicles body.

Figure 5-15 Hail Days per Year 1995-1999

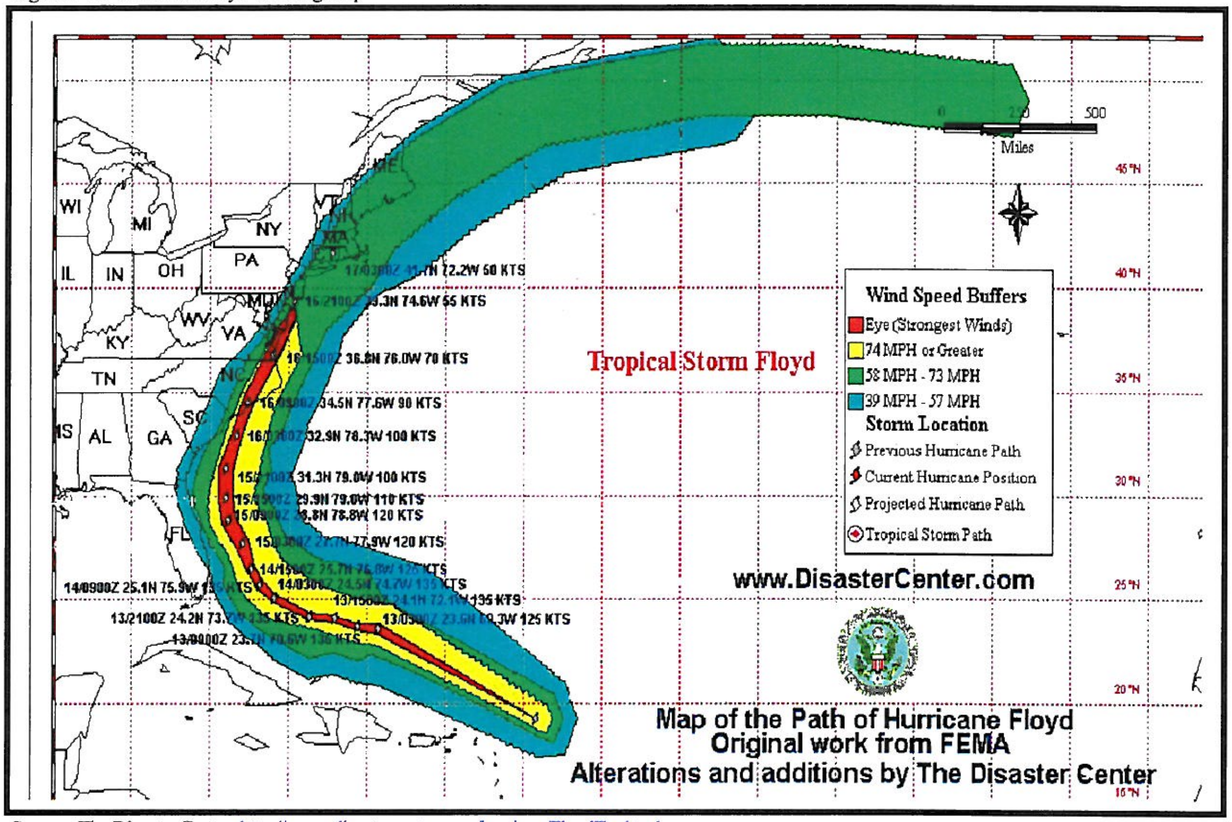


Source: NYS Hazard Mitigation Plan 2008

Hurricanes

A number of hurricanes form annually in the Atlantic Ocean typically starting in early June and ending in late November of each year. These hurricanes make their way west and for the most part impact the southern United States extending as far west as Texas. From time to time, hurricanes will turn north and impact the east coast of the United States from Florida to Maine. The last major hurricane to strike the study area was Floyd in 1999 and which gave only a glancing blow to the Town / Village of Harrison.

Figure 5-16 Hurricane Floyd Tracking Map



Source: The Disaster Center http://www.disastercenter.com/hurrican/FloydTre.html

The magnitude or severity of a severe storm consists of several factors including duration and sustained wind speed. Hurricanes are categorized utilizing a formula known as the Saffir – Simpson scale. This scale rates hurricanes from 1 to 5 based on intensity. The Saffir – Simpson scale, which provides a broad based estimate for potential property damage and anticipated flooding when a hurricane makes landfall is as follows:

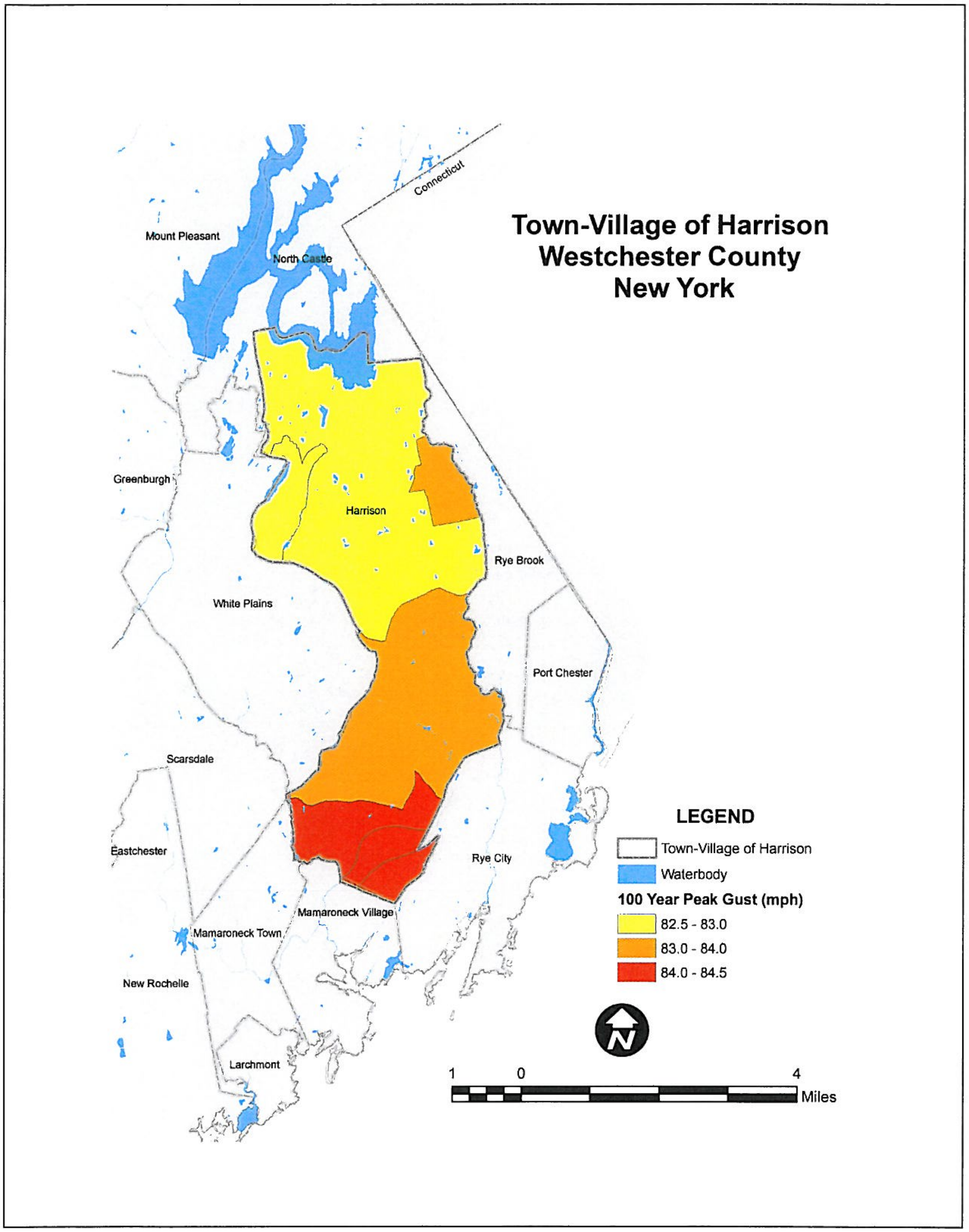
Saffir – Simpson Scale

Table: 5-26 Saffir – Simpson Scale

Hurricane Category	Wind Speed MPH	Typical Damage
Tropical Depression	Less than 39	
Subtropical Storm	39-73	
1	74-95	No real damage to buildings. Damage to unanchored mobile homes. Some damage to poorly constructed signs. Some coastal flooding and minor pier damage Examples: Irene 1999 and Allison 1995
2	96-110	Some damage to building roofs, doors and windows. Considerable damage to mobile homes. Flooding damages piers and small craft in unprotected moorings may break their moorings. Some trees blown down Examples: Bonnie 1998, Georges (Fl. & La. 1995)
3	111-130	Some structural damage to small residences and utility buildings. Large trees blown down. Mobile homes and poorly built signs destroyed. Flooding near the coast destroys smaller structures and larger structures damaged by floating debris. Terrain may be flooded well inland. Examples: Keith 2000, Fran 1996, Opal 1995
4	131-155	More extensive curtainwall failures with some complete roof structure failure on small residences. Major erosion on beach areas. Terrain may be flooded well inland Examples: Hugo 1989 and Donna 1960
5	156 and up	Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. Flooding causes major damage to lower floors of all structures near the shoreline. Massive evacuation of residential areas may be required. Examples: Andrew 1992, Camille 1969

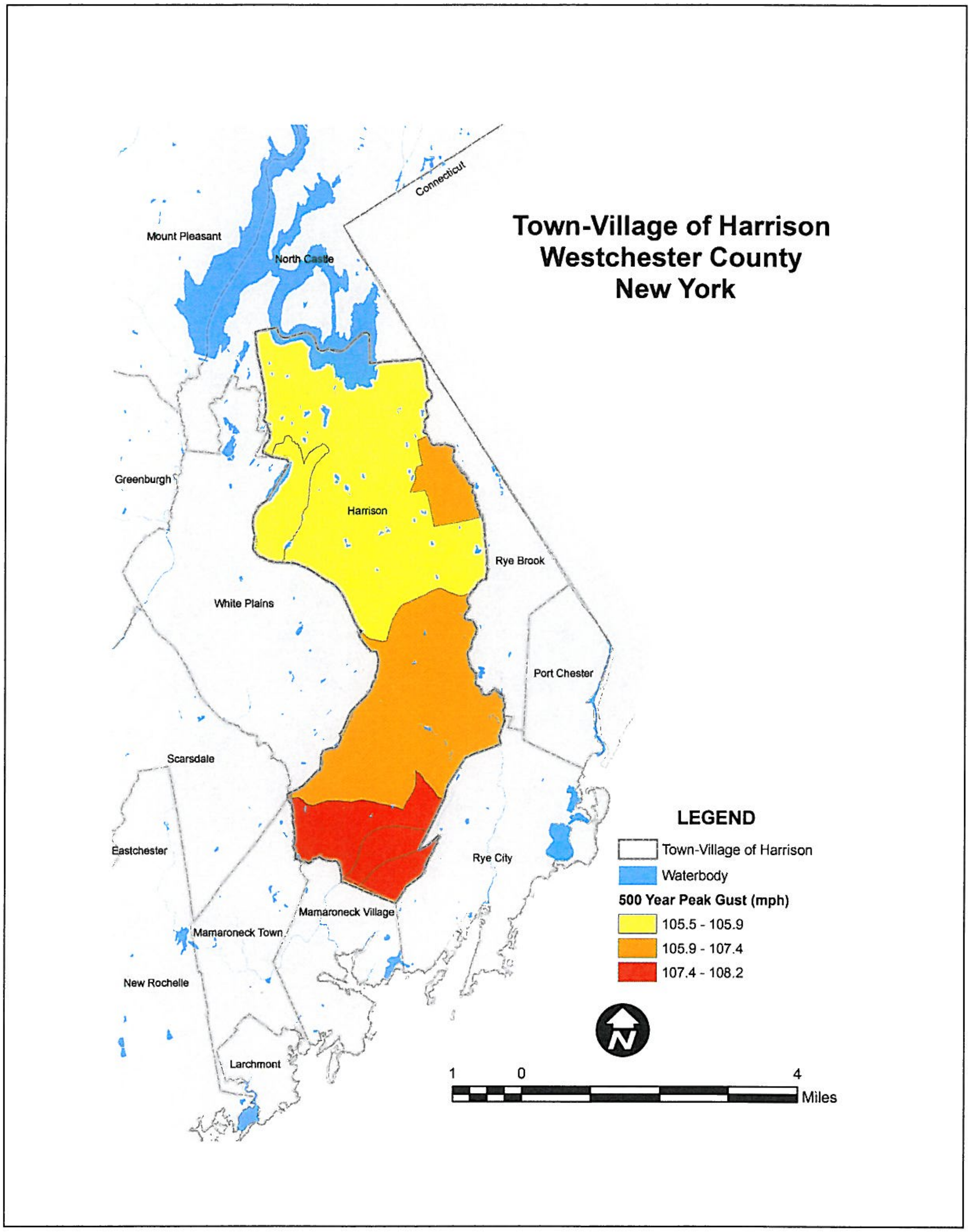
Source: http://www.nhc.noaa.gov/HAW2/english/basics/saffir_simpson.shtml

Figure 5-17 Peak Wind Speeds for 100 year Hurricane Severe Storm Event



Source: HAZUS-MH

Figure: 5-18 Peak Wind Speeds 500 year Hurricane Severe Storm Event

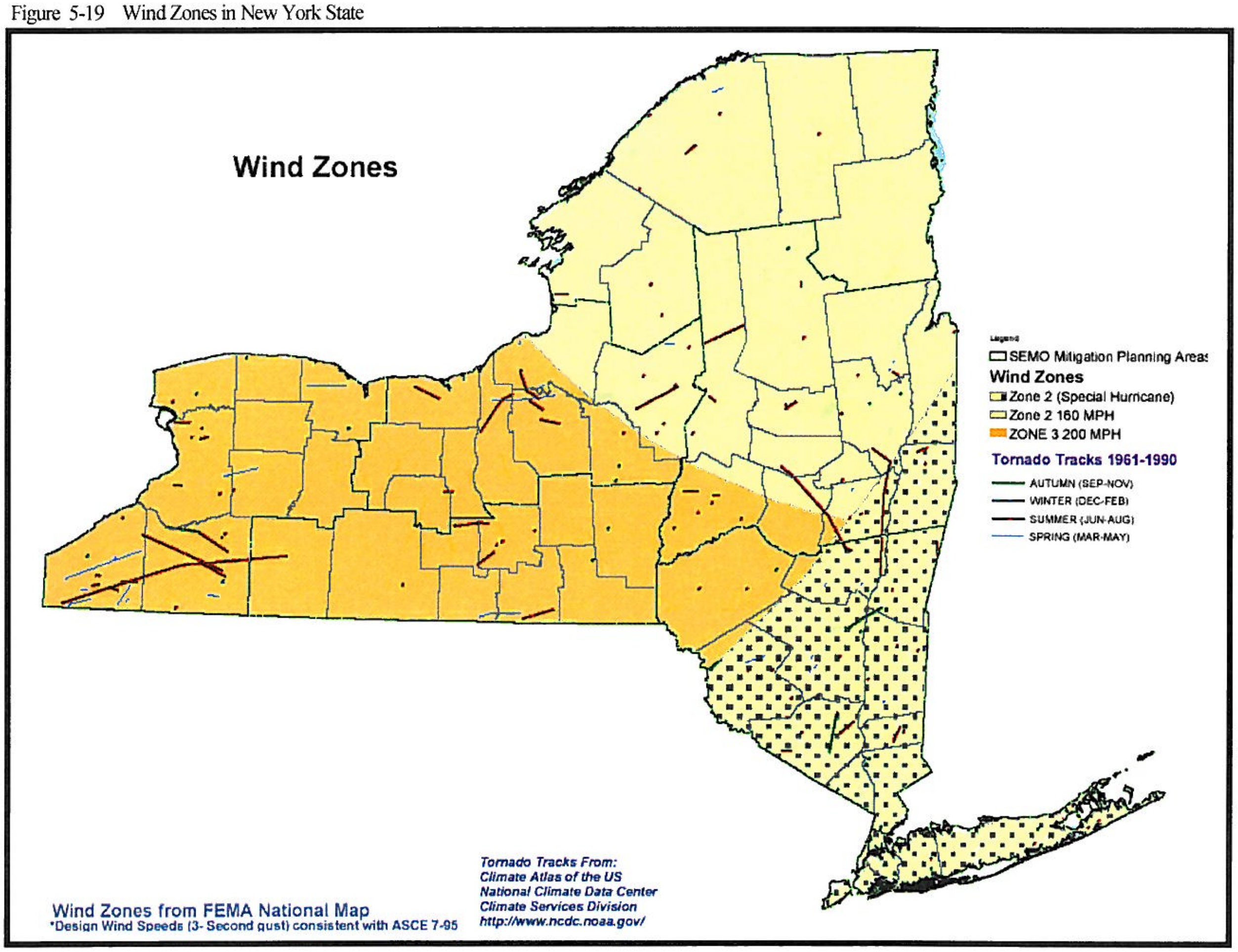


Source: HAZUS-MH

Tornados

Tornados are rotating columns of air marked by a funnel shaped downward extension of a cloud whirling at destructive speeds of up to 300 MPH. They may have the same pressure differential that fuels a 300 mile wide hurricane across a path only 300 yards wide. They can cause damage to property and loss of life. While most tornado damage is caused by violent winds, most injures and deaths result from flying debris. Property damage can include damage to buildings, fallen trees, power lines, broken gas lines, broken sewer and water mains and the outbreak of fires. Damage from winds and debris can be extensive and occurs in a relatively short period of time. Debris from tornados can cause extensive delays in the response of emergency workers, hamper rescue efforts and disrupt the everyday operations of municipal entities for days or weeks. The Fujita Scale shown in Table 5-27 shows the scale used to measure tornado winds and examples of damages associated with that scale.

Figure 5-19 Wind Zones in New York State



Source: New York State Hazard Mitigation Plan, 2005

Enhanced Fujita Scale

Table: 5-27 Enhanced Fujita Scale

Scale	Wind Estimate*** MPH	Typical Damage Extreme
F0	65-85	Some damage to chimneys; branches broken off trees; shallow – rooted trees pushed over; sign boards damaged.
F1	86-110	Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads.
F2	111-135	Roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
F3	136-165	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	166-200	Well-constructed houses leveled; structures with weak foundations blown away some distance; cars thrown and large missiles generated.
F5	Over 200	Strong frame houses leveled off foundations and swept away; automobile size missles fly through the air in excess of 109 yards; trees debarked; incredible phenomena will occur.

Source: http://www.spc.noaa.gov/faq/tornado/ef-scale.html

*** Important note about F scale winds: Do not use F-scale winds literally. These precise wind speed numbers are actually guesses and have never been scientifically verified. Different wind speeds may cause similar-looking damage from place to place—even from building to building.

Previous Occurrences and Losses

Severe storms are a frequent occurrence. Since 1992, there have been three Presidential Declarations associated with Severe Storms in Westchester County, the details of which are shown in Table 5-28

Table 5-28 Presidential Declaration

Type Event	Date	Declaration Number	Approximate Dollar Value of Losses TVH
Nor'easter	**October 1996**	**1146**	
Hurricane Floyd	**September 1999**	**1296**	
Inland/Coastal Flooding	**April 2007**	**1692**	

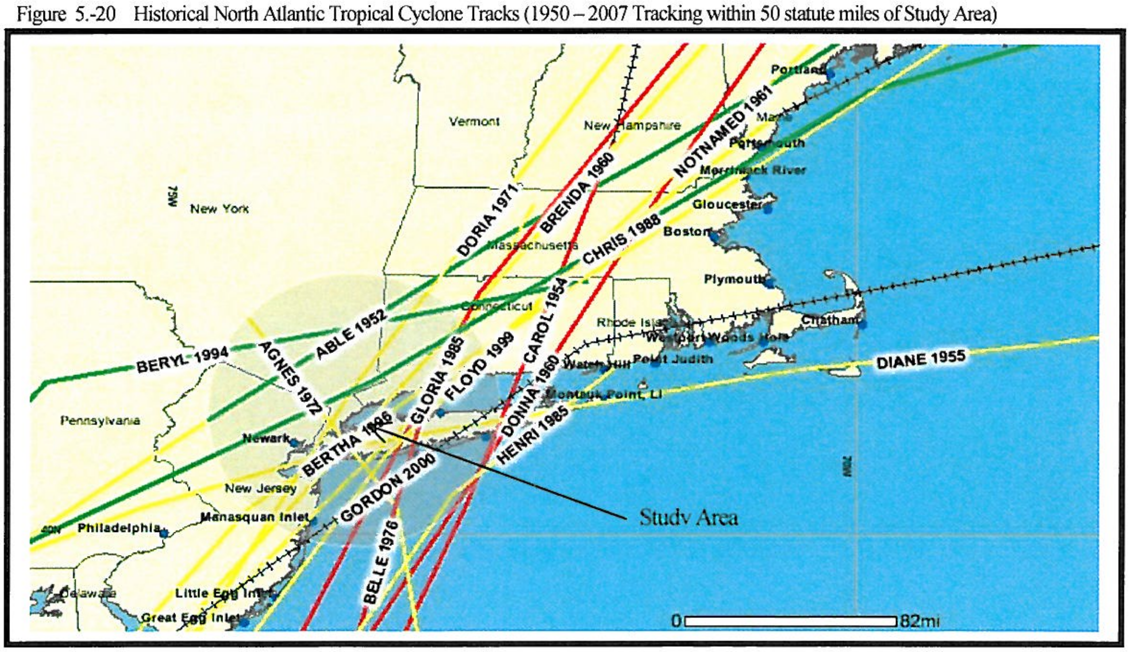
Table 5-29lists hurricane type events tracking within 50 statute miles of the Town / Village of Harrison from 1950 through 2007

Table 5-29 Hurricanes with 50 statute miles of study area 1950 - 2007

Name of Hurricane Type Event	Date	Category	Wind Speed (Kts)	Dollar Valve of Losses where available
Able	September 1, 1052	Tropical Storm	35	
Carol	August 31, 1954	H2	85	
Diane	August 19, 1955	Tropical Storm	40	
Brenda	July 30, 1960	Tropical Storm	45	
Donna	September 30, 1960	H2	90	
Not Named	September 15, 1961	Tropical Storm	35	
Doria	August 28, 1971	Tropical Storm	50	
Agnes	June 22, 1972	Tropical Storm	60	
Belle	August 10, 1976	H1	80	
Henri	September 25, 1985	Tropical Storm	35	
Gloria	September 27, 1985	H2	85	
Chris	August 29, 1988	Tropical Depression	20	
Beryl	August 18, 1994	Tropical Depression	15	
Bertha	July 13, 1996	Tropical Storm	60	
Floyd	September 16, 1996	Tropical Storm	60	
Gordon	September 19, 2000	Extratropical	25	

Source: NOAA Coastal Services Center

Figure 5.-20 Historical North Atlantic Tropical Cyclone Tracks (1950 – 2007 Tracking within 50 statute miles of Study Area)



Sorcee: NOAA, Tropical Prediction Center / National Hurricane Center 2008

Tornados

Since 1971, Westchester County has experienced 8 recorded Tornados ranging in intensity from F0 to F2. Records do not indicate any having directly impacted the Town / Village of Harrison. The most recent tornado (as reported in The Journal News on July 13, 2006) to strike within close proximity of the Town / Village of Harrison occurred on July 12, 2006 and had a magnitude of F2, injured 6 people and caused $10,100,000 in property damage. This tornado touched down just south of the Tappan Zee Bridge in Rockland County and traveled in a generally northeast direction through the Town of Mount Pleasant, into the Town of North Castle (immediately north of the Town / Village of Harrison) and on into Fairfield County Connecticut.

Table: 5-30 Tornados impacting Westchester County 1971 - 2007

Location by County	Date	Time (24 hr. clock)	Magnitude	Deaths	Injuries	Property Damage
Westchester	08/11/1971	10:30	F1	0	0	$25,000
Westchester	09/01/1974	23:50	F1	0	0	$250,000
Westchester	09/26/1977	15:15	F	0	0	$25,000
Westchester	11/16/1989	10:15	F0	0	0	$0
Westchester	06/12/1991	14:10	F0	1	0	$25,000
Westchester	09/03/1992	16:10	F0	0	0	$0
Peekskill	06/02/2000	18:05	F1	0	2	$0
Tarrytown	07/12/2006	14:37	F2	0	6	$10,100,000

Source: NOAA Satellite and Information Service (http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dl1?wwevents~storms)

Probability of Future Events

Because natural hazards are only broadly predictable, the incidence of future events can only be expressed as probabilities. This presents a problem because what may be perfectly rational and useful to a mathematician may be confusing or even counterproductive to the public and their decision-makers. The probability of occurrence of earthquakes, floods, and high winds is commonly expressed by use of the term "return period" or "mean recurrence interval." This is defined as the average or mean time in years between the expected occurrence of an event of specified intensity.

Values for high winds are commonly expressed in codes as a 50-year return period, much shorter than earthquakes because their incidence is much more frequent. Floods are expressed as a 100-year return period (i.e., the "100-year flood"). To the public, these return periods seem very long (i.e., why would a business owner confronting small crises every day and large ones every month be worried about an event that might not occur for 500 years. The problem is that these figures represent mean or average return periods over a very long period of time, with the result that the return period is often quite inaccurate in relation to the shorter time periods in which most of us are interested (i.e., the next year or the next 10 years). Because high winds are relatively frequent, the discrepancy between the actual return period and the mean return period used in tables is much more noticeable than the corresponding probabilities for earthquakes.

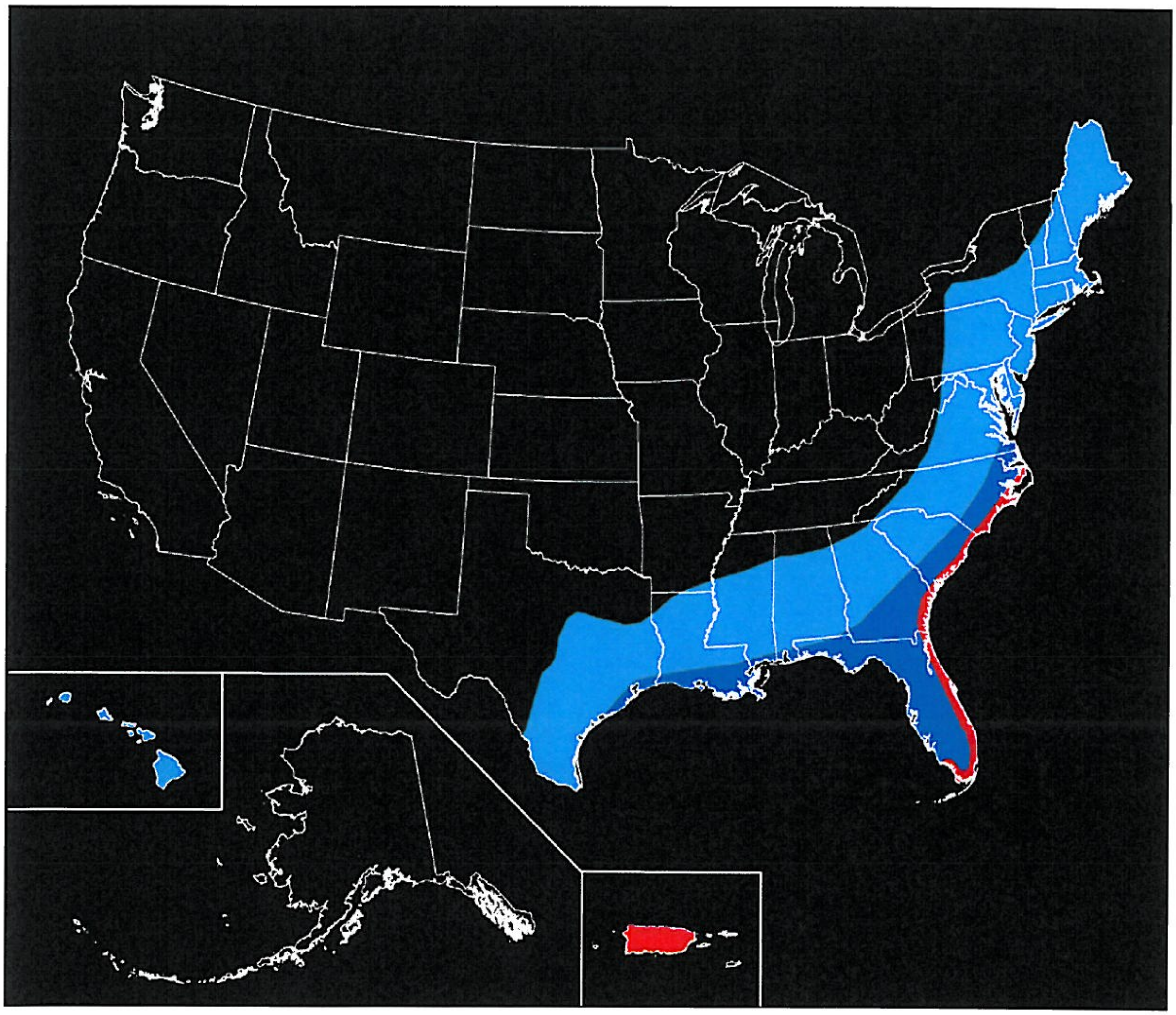
Currently, these statements of probability are the best available. Because they express mean values over long periods of time, they tell little about what will really happen this year or next year, but they may give a hint as to what will happen in our lifetime. For purposes of this report, we must assume that disastrous hazards may occur at any time.

Table: 5-31 Return Period in Years for Hurricane by Category for Westchester County

Category	Wind Speed (in MPH)	Return Period
1	74-95	17
2	96-110	39
3	111-130	68
4	131-155	150
5	>155	370

Source: NOAA NHC (http://www.nhc.noaa.gov/HAW2/english/basics/return.shtml)

Figure: 5-21 Number of Hurricanes for a 100 year return period



Source: USGS http://www.usgs.gov/hazards/hurricanes/

Previously, hazards for the Town/Village of Harrison were ranked similar to what had been done for hazards that affect the entire State of New York. The likelihood of a particular type hazardous event occurring is one parameter used in ranking. Based on historical data found in Federal, State and Local records, as well as input from the HMPC, the likelihood of a severe storm occurring is frequent (more than once every 5 years, see Table 5.2). In all likelihood, the Town/Village of Harrison will continue to experience severe storms. The USGS figure above indicates that the Town/Village of Harrison would be susceptible to 20-40 hurricanes in a 100 year period.

Vulnerability Assessment

A vulnerability assessment is defined as assessing the vulnerability of people and the built environment to a given level of hazard. After identifying types of risk, a vulnerability analysis can help to determine the weak points in the community. This assessment examines the vulnerability of the existing and future built environment, such as structures, utilities, roads and bridges, as well as environmental vulnerability, such as open space that can suffer from erosion. Once the geographic areas of risk are identified in the Town / Village, vulnerability can be assessed for the population, property and resources at risk in those areas. Vulnerability indicates what is likely to be damaged by the identified hazards and how sever the damage may be. For example, if an area is determined to be at risk of flooding, vulnerability estimates for that area could include residential property losses, impacts to the tax base and damages to public infrastructure. Severe storm events can impact the entire Town/Village of Harrison. All assets including population, structures, critical facilities and utilities are vulnerable. The following sections evaluate and estimate the potential impact of severe storms:

- Overview of vulnerability
- Data and methodology used in the evaluation
- Impact on life, safety and health
- Identifying structures including general building stock, critical facilities and critical infrastructure
- Economic impact
- Addressing Repetitive Loss Properties (NFIP data for floods, other hazards as available)
- Estimating Potential Losses
- Analyzing Development Trends (new buildings, critical facilities and Infrastructure)
- Additional Data and Next Steps
- Overall vulnerability conclusion
- Multi-jurisdictional Risk Assessment

Overview of Vulnerability

The most hazardous element of all severe storms is wind. High winds typically generate damage to both the natural and physical environments. When such events occurs, lives may be placed at risk when individuals are not properly sheltered Damage to structures, infrastructure and trees and disruption of electrical service and can generate millions of dollars in damages. The debris generated by wind damage restricts the free and unimpeded access to places of work, hinders the ability to transport goods and provide services, and typically disrupts the ability to carry out routine municipal service functions over several days or longer.

Until recently, hurricanes with accompanying wind and rain were considered the most severe threat to the Town / Village of Harrison. Similar severe storms such as Nor'easters and sustained thunderstorms have caused extensive damage to areas of the community in recent years. These events have caused isolated flooding events throughout the community. The flood hazard is discussed elsewhere in the plan.

The entire municipality is susceptible to damage from severe storm events. Specific areas such as floodways are more vulnerable due to flooding and debris carried by floodwaters.

Various types of constructed facilities can have direct exposure to high winds while others are sheltered behind low lying hills and other structures.

Developing data for losses associated with high winds was based on 100 year and 500 year hurricane events and utilized the HAZUS-HM software.

Data and Methodology

Recent changes in Hazard Mitigation Plan development by FEMA Region II, requires the utilization of the FEMA HAZUS-MH software and associated guidance in the study a hurricanes potential for damage and losses in a municipality. In addition to the use of HAZUS-MH, other federal agency data bases including but not limited to (NOAA, USGS), New York State databases, local archives and the knowledge of individuals on the HMPC as well as input from the general public were used in developing the analysis.

The majority of information provided by HAZUS –MH is historical in nature based on records maintained by a variety of Federal agencies. Naturally occurring terrain and tree coverage features are also available for analyzing wind over various types of terrain. Hurricane and constructed features data are available in HAZUS – MH and were utilized to evaluate losses from 100 and 500 year event return periods. Locally available inventory data were reviewed and included as part of the analysis where appropriate. Residential and commercial classes of facilities were combined to make the data more manageable and are identified in the Building Stock Tables later in this section. Critical facilities were evaluated separately from other Building Stock.

Impact on Life, Health and Safety

The impact of severe storms on life, health and safety is a function of storm intensity and duration. Temporary and long-term sheltering / displacement can create conditions of severe stress and anxiety on anyone, particularly the elderly. The 2,000 Census for the Town / Village of Harrison indicates that 14.6% of the population is over 65 year of age. Severe Storm events not requiring the displacement of individuals or families are no less severe. High winds, loss of power, damage to homes, downed trees and the inability to travel and move about freely all have the potential for causing injury and in extreme cases, loss of life. The Tables below are associated with Hurricane Severe Storm Events

Table 5-32 Sheltering Requirements (Hurricane Event)

Category	100 Year Event	500 Year Event
Households Displaced	0	33
Persons Seeking Temporary Shelter	0	6

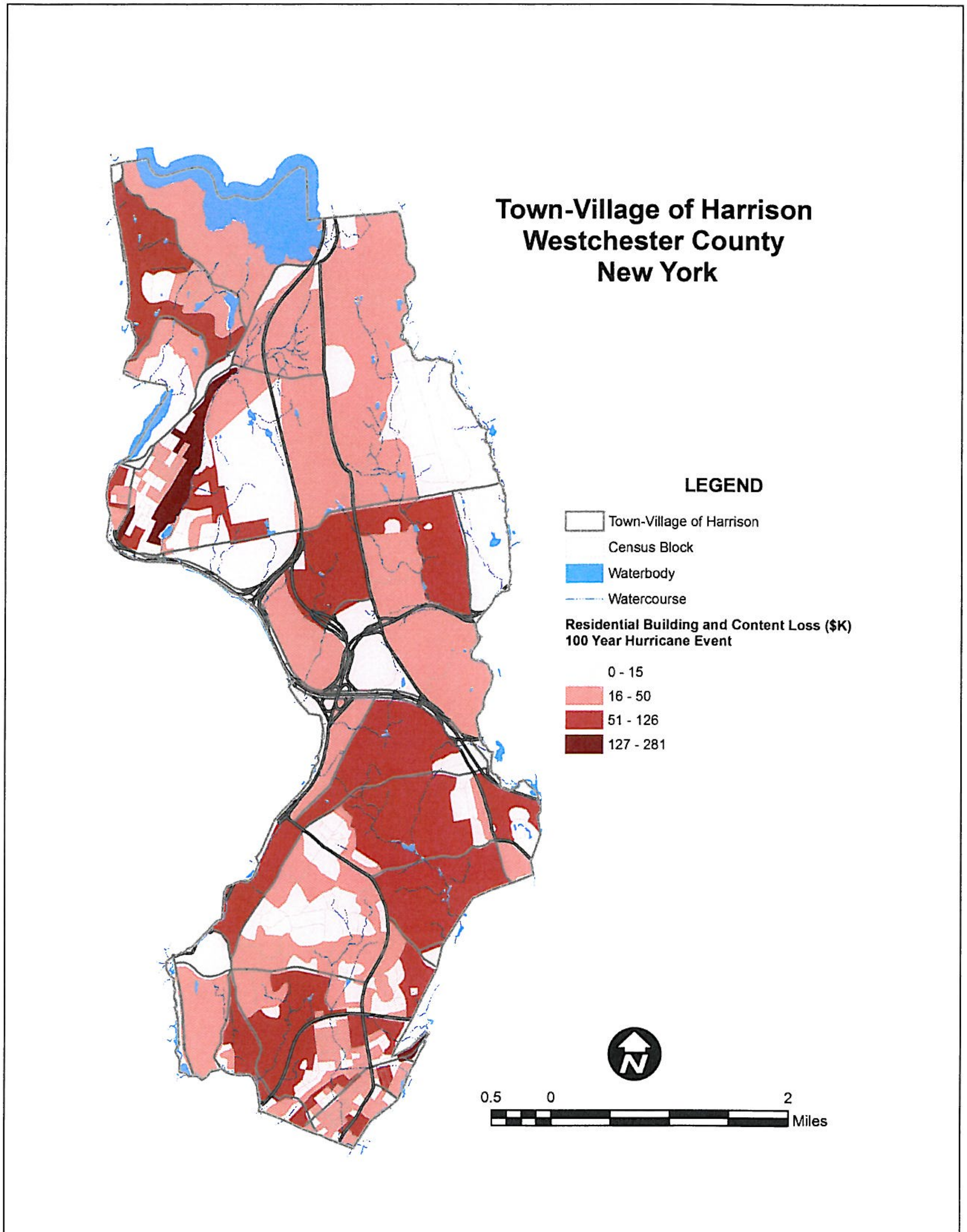
The 100 and 500 year mean return period is utilized for evaluating damage and the associated value of general building stock. The following Tables and Figures summarize building occupancy by class in the study area.

Table 5-33 Building Occupancy by Class

Building Occupancy Class	Number of Buildings	Exposure Value ($1,000)	Percent of Total Exposure Value
Agriculture	57	9,704	.3%
Commercial	673	669,177	23.6%
Education	27	52,876	1.9%
Government	16	18,789	.7%
Industrial	190	180,212	6.3%
Residential	6,618	1,865,990	65.8%
Religion	43	41,243	1.5%
Total	**7,624**	2,837,991	100%

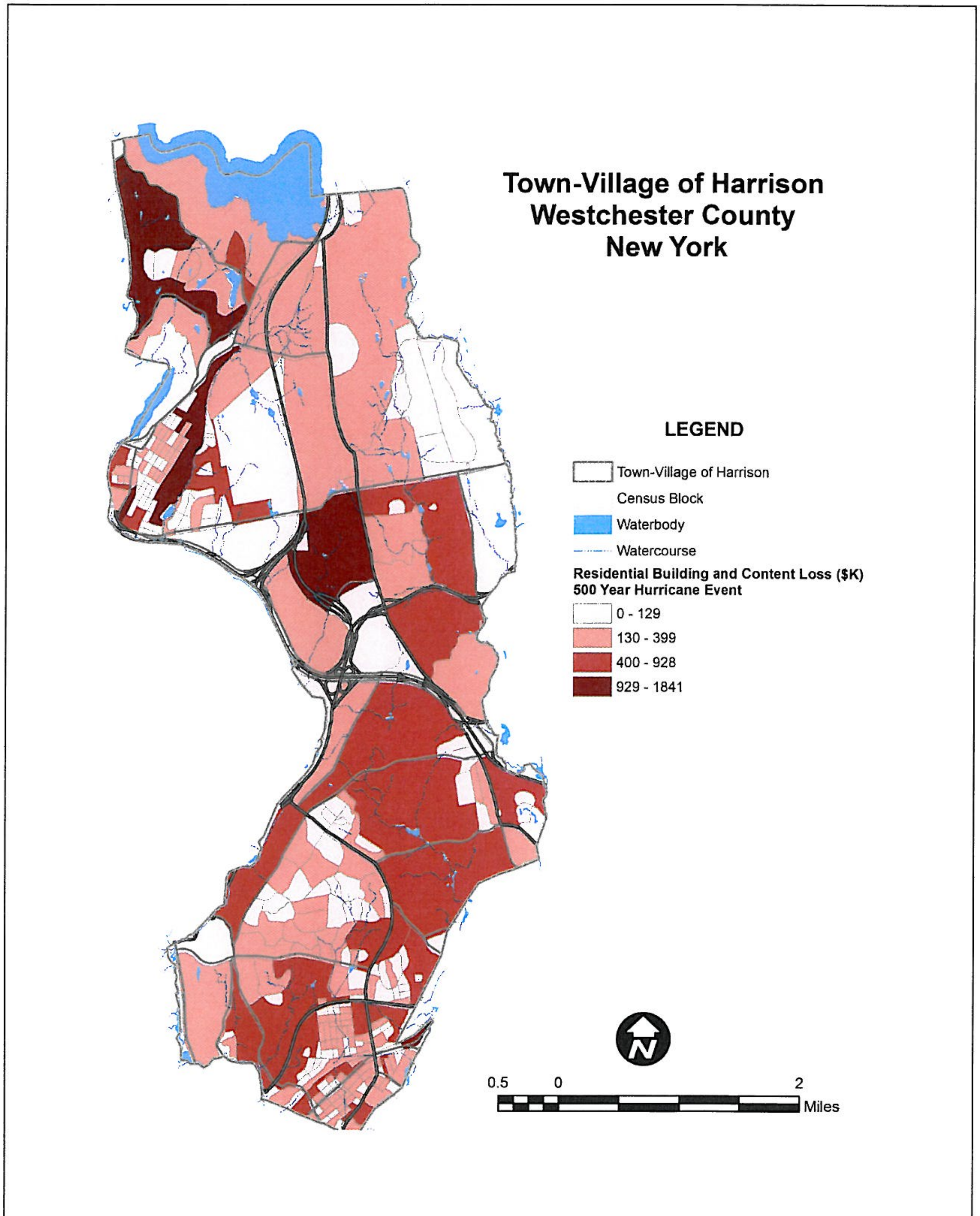
Source: HAZUS-MH

Figure 5-22 Density of Losses for Residential Structures (Structure and Content) for the 100 year MRP Hurricane Wind



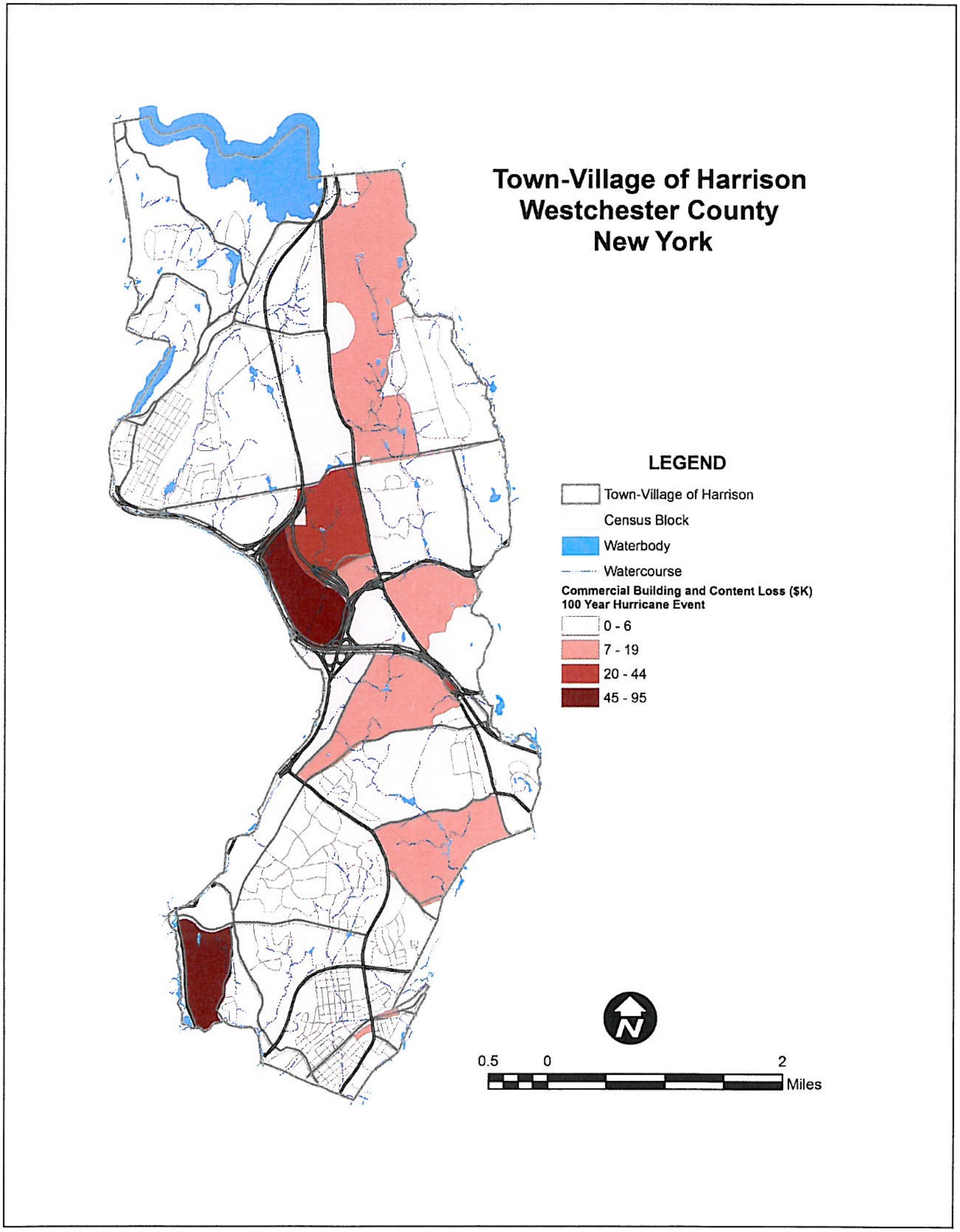
Source: HAZUS MH Municipal Boundary is the study area generated in HAZUS-MH based on Census blocks and tracts

Figure 5-23 Density of Losses for Residential Structures (Structure and Content) for the 500 year MRP Hurricane Wind



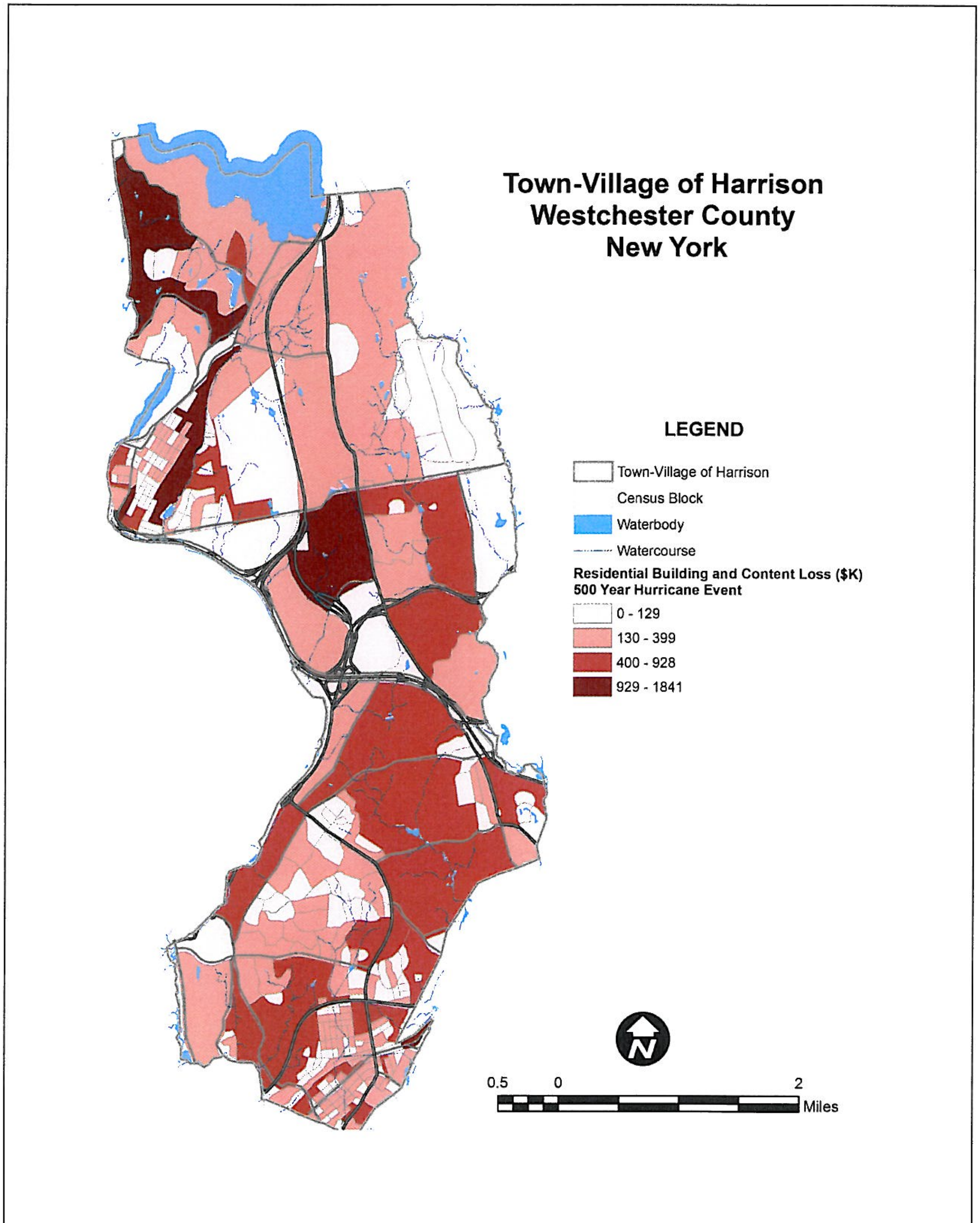
Source: HAZUS MH Municipal Boundary is the study area generated in HAZUS-MH based on Census blocks and tracts

Figure 5-24 Density of Losses for Commercial Structures (Structure and Content) for the 100 year MRP Hurricane Wind



Source: HAZUS MH Municipal Boundary is the study area generated in HAZUS-MH based on Census blocks and tracts

Figure 5-25 Density of Losses for Commercial Structures (Structure and Content) for the 500 year MRP Hurricane Wind



Source: HAZUS MH Municipal Boundary is the study area generated in HAZUS-MH based on Census blocks and tracts

Economic Impact

HAZUS-MH was utilized to estimate economic losses for buildings. Building related losses are broken into two categories: direct property damage losses and business interruption looses. The direct property damage losses are estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

Tables 5-34 and 5-35 shows the estimated building related economic loss estimates for 100 and 500 year hurricane events.

Table 5-34 Building Related Economic Loss Estimates 100 Year MRP Event (Thousands of Dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage	Building	6,825.37	516.85	136.32	73.54	7,552.09
	Content	231.02	66.87	132.98	6.46	437.33
	Inventory	0	1.14	13.84	.27	15.26
	Subtotal	*7,056.39*	*584.87*	*283.15*	*80.28*	*8,004.68*
Business Interruption Loss	Income	0	117.84	0	0	117.84
	Relocation	268.26	76.28	.93	.78	346.25
	Rental	277.75	53.320	0	0	331.07
	Wage	0	41.87	0	0	41.87
	Subtotal	*546.01*	*289.30*	*.93*	*.78*	*837.02*
Total	**Total**	7,602.40	874.17	284.08	81.06	8,841.71

Source: HAZUS-MH

Table 5-35 Building Related Economic Loss Estimates 500 Year MRP Event (Thousands of Dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage	Building	51,516.19	8,593.39	2,337.96	1,463.60	63,911.14
	Content	9,467.37	3,081.51	1,855.20	575.47	14,979.56
	Inventory	0	47.43	221.29	13.32	282.04
	Subtotal	*60,963.57*	*11,722.33*	*4,414.45*	*2,052.39*	*79,172.74*
Business Interruption Loss	Income	0	931.83	22.12	124.67	1,078.62
	Relocation	3,678.04	1,554.90	196.21	283.67	5,712.83
	Rental	2,496.62	844.18	24.12	19.96	3,384.88
	Wage	0	703.16	36.53	1,067.00	1,806.69
	Subtotal	*6,174.67*	*4,034.07*	*278.98*	*1,495.30*	*11,983.02*
Total	**Total**	67,158.24	15,756.40	4,693.43	3,547.69	91,155.76

Source: HAZUS-MH

Addressing Repetitive Loss Properties

The National Flood Insurance Program provides information on payments to homeowners resulting from losses due to flooding. Under the severe storm (hurricane) category, flooding may be a secondary or resulting event brought about by extended periods of rain and wind. Flooding events, repetitive loss properties and the associated analysis are discussed elsewhere in this report.

Estimating Potential Losses

The HAZUS –MH software program was utilized to determine loss information associated with hurricane wind damage.

Table 5-36 Expected Building Damage by Occupancy (100 Year Event)

	None	None	Minor	Minor	Moderate	Moderate	Severe	Severe	Destruction	Destruction
Occupancy	Count	%	Count	%	Count	%	Count	%	Count	%
Agriculture	55	97.05	1	2.54	0	.31	0	.09	0	0
Commercial	655	97.39	16	2.38	1	.21	0	.01	0	0
Education	26	97.69	1	2.24	0	.07	0	0	0	0
Government	16	97.66	0	2.28	0	.06	0	0	0	0
Industrial	185	97.56	4	2.33	0	.10	0	.01	0	0
Religion	42	97.71	1	2.21	0	.07	0	.01	0	0
Residential	6,409	96.85	193	2.91	15	.23	1	.01	0	0
Total	7,390		217		17		1		0	

Source: HAZUS-MH

Table 5-37 Expected Building Damage by Building Type (100 Year Event)

Building	None	None	Minor	Minor	Moderate	Moderate	Severe	Severe	Destruction	Destruction
Type	Count	%	Count	%	Count	%	Count	%	Count	%
Concrete	120	97.24	3	2.67	0	.09	0	0	0	0
Masonry	1,293	96.16	44	3.24	8	.57	0	.03	0	0
MH	0	0	0	0	0	0	0	0	0	0
Steel	429	97.50	10	2.31	1	.17	0	.01	0	0
Wood	5,287	97.17	147	2.70	6	.11	0	.01	0	0

Source: HAZUS-MH MH= Manufactured Housing

Table 5-38 Expected Damage to Essential Facilities (Number of Facilties) 100 Year Event

Classification	Total	Probability of at Least Moderate Damage >50%	Probability of Complete Damage >50%	Expected Loss of Use <1 Day
Fire Stations	3	0	0	3
Police Stations	1	0	0	1
Schools	10	0	0	10

Additional Data and Next Steps

Wind and associated airborne debris has been determined to be the most significant element of severe storm events to which the study area is exposed. High winds can topple and damage trees, causing secondary damage to homes and aboveground utilities. Part of any municipalities hazard mitigation plan is a strong educational effort informing residences and businesses as to how they can protect their property and that of their neighbor through proper maintenance of trees and securing of potential windblown objects. A more detailed analysis of damage following a significant wind associated events such as tornados will assist FEMA in expanding the modeling capabilities of HAZUS-MH.

Overall vulnerability conclusion

The severe storm hazard has been determined to be a significant event and has been ranked as a high risk for the Town /Village of Harrison.