Section 4 2011 Plan Redo

Risk Assessment

What's new (summary of updated information) …

- Hazards have been identified with specific page number reverences.
- Hail has been added as a hazard impacting the State and Avalanche and Volcano have been excluded.
- Recent information, including census, flood insurance claims, public assistance has not been included because up-to-date information was not available.
- A comprehensive discussion of Wildfire Hazard is included.
- A discussion on other non-natural hazards has been intitatiated.
- Reference to State-wide critical facilities is incorporated and maps are included in the appendix.

Section 4.1 Final Rule Requirements for Risk Assessments

The Interim Final Rule (IFR) Subsection (201.4 (c) (2)) requires that a State Hazard Mitigation Plan include:

> "Risk Assessments that provide the factual basis for activities proposed in the strategy portion of the mitigation plan. Statewide risk assessments must characterize and analyze natural hazards and risks to provide a statewide overview. This overview will allow the State to compare potential losses throughout the State and to determine their priorities for implementing mitigation measures under the strategy, and to prioritize jurisdictions for receiving technical and financial support in developing more detailed local risk and vulnerability assessments. The risk assessment shall include the following:
>
> [i] An overview of the type and location of all natural hazards that can affect the State, including information on previous occurrences of hazard events, as well as the probability of future hazard events, using maps where appropriate.
>
> [ii] An overview and analysis of the State's vulnerability to the hazards described in paragraph (c) (2), based on estimates provided in local risk assessments as well as the State risk assessment. The State shall describe vulnerability in terms of jurisdictions most threatened by the identified hazards, and most vulnerable to damage and loss associated with hazard events. State owned critical or operated facilities located in the identified hazard areas shall also be addressed.
>
> [iii] An overview and analysis of potential losses to the identified vulnerable structures, based on estimates provided in local risk assessments as well as the State risk assessment. The State shall estimate the potential dollar losses to State owned or operated buildings, infrastructure and critical facilities located in the identified hazard areas."

The IFR Subsection (201.4 (d)) states: "Review and Updates. Plan must be reviewed and revised to reflect changes in development…"

Section 4.2 Background and General Discussion of Risk Assessment

Prior to reading the following sections about statewide risk, it is important to understand the meanings of several terms that appear in both the Federal hazard mitigation planning rules and throughout this plan. The terms *risk* and *vulnerability* appear many times in both places, and the terms are defined below and given some context in terms of this plan.

In the context of hazard mitigation planning "risk" is defined as the expected future losses to a community, business or State from the effects of natural events combining the probability, severity, and vulnerability. Risk is often expressed in terms of future monetary losses because this provides a common measure that can be used to compare the effects of different hazards. It is important to note that risk is cumulative. This means that although natural hazards may not affect a place in any particular year, the probability of one or more events (in some places multiple events) occurring "adds up" over time. Risk calculations incorporate possible future events over a specific period. Capturing a long period allows repetitive events to be included in the risk calculation. In many cases data is *annualized* to express the chance of a hazard occurring each year.

Probability: Probability is the likelihood that a hazard will impact a particular place. The ability of scientists and engineers to calculate probability varies considerably depending on the hazard in question. In many areas of the country, flood studies provide reasonably accurate estimates of how often water will reach particular places and elevations. On the other hand, tornados and earthquakes are nearly impossible to predict, except over very long periods of time and large areas.

Severity: Severity is the measure of "how bad" a hazard event is. Severity is measured in various ways, depending on the hazard. For example, floods are measured in terms of depth, velocity, duration, contamination potential, debris flow, and so forth. Tornados are measured primarily in terms of wind speed, although their duration on the ground can also be an important factor in their destructiveness.

Vulnerability: Vulnerability is the degree to which something is damaged by a hazard. These are based on studies of how buildings perform when they are exposed to hazards. Similar functions are available for infrastructure and other physical assets. Injury and mortality functions (how many people are injured or die during events) are also sometimes used as indicators of vulnerability, but these are generally not as reliable as functions for physical assets because there are many more variables.

Value: Value is how much it would cost to replace an asset that may be damaged or lost due to the impact of a natural hazard. Damage refers to physical destruction measured by physical indicators such as the number of deaths and injuries or the portions of buildings destroyed, or altered so that repair is needed. When valued in monetary terms, damages become direct losses There are many sources of this information, including standard cost-estimating guides (such as R.S. Means, which was used as the basis for the hurricane wind risk assessment), experience of local officials, the FEMA HAZUS (Hazards U.S.) software.

Risk Assessment is the estimated (and/or calculated) dollar value of future losses based on probability, severity and vulnerability. Monetary values are used as the basis of risk assessment so that different kinds of losses can be readily compared. For example, without a common basis for comparison, it would be virtually impossible to determine if the risk of injury from potential earthquakes is greater than damage to vehicles in potential floods. When the expected losses are expressed in dollars, damages can be compared and prioritized (and used in benefit-cost analysis to determine the cost effectiveness of projects that reduce the risk). In combination with the concepts discussed above, almost any kind of hazard can be quantified, although with varying accuracy. The exceptions to this idea are *infrequent* or *highly unpredictable* events such as meteors impacting the earth, or manmade hazards such as terrorism. In these cases, the element of probability is virtually impossible to characterize, so any risk calculus has considerable uncertainty.

Risk calculations often start with an annualized (yearly) loss figure, which is then projected into the future for some pre-determined period (sometimes called the *planning horizon*), then *discounted* to today's value using a discount rate. Discounting is a standard economic methodology that is required by the Federal government for analyses of many of its programs, including FEMA's mitigation initiatives. It is used to account for the decreasing monetary value of events that occur far in the future, such as natural hazards. Those who are interested can read more about the required methodology as described in Office of Management and Budget (OMB) Circular No. A-94.

The risk calculation techniques that were used as the basis for this plan are carefully described in the sections that follow, and conform to standard methodologies used by FEMA and other Federal agencies. As required by OMB, a discount rate of 7 percent is used in all calculations unless otherwise specified.

Section 4.3 Methodology for Identifying Statewide Hazards of Concern

In accordance with the requirements of the Interim Final Rule (Specific reference in 4.1.1 and full copy included in Appendix B) requires that all hazards with the potential to affect New Jersey are profiled in this section of the Plan. However, because this is a State-level hazard mitigation plan it is useful to identify the hazards that are of the most concern Statewide, so these can be the focus of more detailed assessment. It is important to note, however, that many hazards and risks are very site-specific, so as regional and local jurisdictions develop mitigation plans they should recognize that this process and the resulting table should be used only as a guide, and that more detailed and localized vulnerability and risk assessments are required for local mitigation plans.

Section 4.4 Statewide Hazard Profiles

Table 4.4-1
State of New Jersey Natural Hazards

Section Page	Hazard	Rationale	Sources
Section 4.4.1 Page 5	Flooding (Riverine, Coastal Flood, Storm Surge, Tsunami)	Widespread impacts, long history of occurrences in the State, significant annual damages	FEMA Flood Insurance Studies, numerous other studies for nearly all major flood sources, FEMA Flood Insurance Rate Maps, US Army Corps of Engineers, and National Oceanographic and Atmospheric Administration (NOAA), studies and records.
Section 4.4.2 Page 15	Hurricanes and Tropical Storms	Relatively low historic probability; potential for widespread impacts.	NOAA and National Climatic Data Center (NCDC) records, various studies of hurricane strike probability
Section 4.4.3 Page 25	Nor'easters	Moderate probability of more extreme events, potential for moderately widespread impacts.	National Weather Service (NWS), NOAA, NCDC, New Jersey State Climatologist.
Section 4.4.4 Page 29	Winter Storms (Snow, Ice storms, Cold waves and cold chills)	High annual probability, widespread impacts, but losses generally limited except in most extreme events.	National Weather Service (NWS), NOAA, NCDC, New Jersey State Climatologist.
Section 4.4.5 Page 37	Tornadoes, High Winds and Thunderstorms	High annual probability, widespread impacts, but losses generally limited except in most extreme events.	National Weather Service (NWS), NOAA, NCDC, New Jersey State Climatologist., ASCE and USACE wind maps.
Section 4.4.6 Page 43	Earthquakes	Relatively low annual probability, but potential for significant consequences	United States Geologic Survey (USGS), New Jersey Geologic Survey (NJGS).
Section 4.4.7 Page 55	Drought	High annual probability, but impacts generally limited	National Weather Service (NWS), NOAA, NCDC, New Jersey State Climatologist, New Jersey Department of Agriculture.

Section Page	Hazard	Rationale	Sources
Section 4.4.8 Page 61	Wildfire	High annual probability of site-specific events, but impacts generally limited	New Jersey Fire Service, New Jersey State Climatologist.
Section 4.4.9 Page 73	Geological Hazards (Landslide, Subsidence, Sinkholes)	High annual probability when all hazards are included in this grouping, impacts generally limited to northern part of the State, but potential for high level of damages under some scenarios.	United States Geologic Survey (USGS), New Jersey Geologic Survey (NJGS).
Section 4.4.10 Page 83	Hail	High annual probability but impacts are limited in severity and area	National Weather Service (NWS), NOAA, NCDC, New Jersey State Climatologist.
Section 4.4.11 Page 87	Extreme Heat	Relatively high annual probability, but impacts are limited.	National Weather Service (NWS), NOAA, NCDC, New Jersey State Climatologist.
Section 4.4.12 Page 89	Coastal Erosion	Relatively high annual probability, but impacts are limited to coastal areas.	NOAA, USACE

Note that for the 2008 and for this 2011 update, hurricane hazards were divided into wind and flooding, and merged into those categories in the risk assessment. For simplicity, hurricanes remain as a discreet hazard in this table, but they are treated as wind and flood hazards in other sections of the plan. The data in this table is intended only to give a general sense of the significance of hazards in the State, relative to each other.

The natural hazards of avalanche and volcano have been identified, profiled, and eliminated as a concern in this Hazard Mitigation Plan.

Earthquake and geologic hazards were updated by the New Jersey Bureau of Geology and Topography in July/August 2010. Climatic hazards have been updated by the State Climatologist in August 2010. Wildfire information was updated by the Forest Fire Service in June 2010. Flood information including repetitive and severe repetitive loss statistics were updated by the DEP Bureau of Dam Safety and Flood Control.

4.4.1 Floods

4.4.1.1 Nature of the Flood Hazard

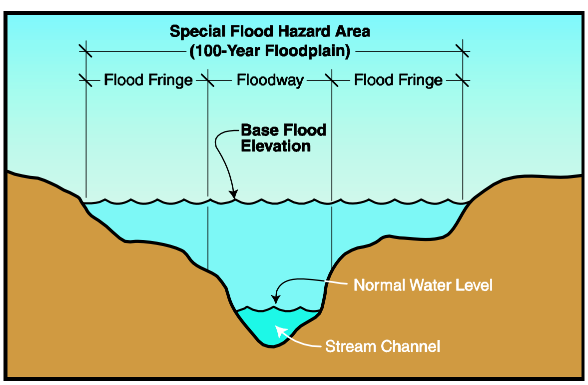
Riverine flooding is the accumulation of water within a water body (e.g., stream, river, lake, or reservoir) and the overflow of excess water onto adjacent floodplains. As illustrated in Figure 4.4-1-1 below, floodplains are usually lowlands adjacent to water bodies that are subject to recurring floods. Floods are natural events that are considered hazards only when people and property are affected. Nationwide, hundreds of floods occur each year, making them one of the most common hazards in the U.S. (FEMA, 1997). Floods have been and continue to be the most frequent, destructive, and costly natural hazard facing the State of New Jersey. The large majority of the State's damage reported for major disasters is associated with floods. There are a number of categories of floods in the U.S., including the following:

- Riverine flooding, including overflow from a river channel, flash, alluvial fan, ice-jam, and dam breaks
- Local drainage or high groundwater levels
- Fluctuating lake levels
- Coastal flooding, including storm surges
- Debris flows

Human activity has profound impacts on flooding. The two major activities, which impact flooding, are land use change and the building of flood control structures. The transportation network associated with land use change it creates the increased potential for flooding . In addition to the impacts of impervious paved surfaces, bridges and culverts usually constrict stream channels and flood plains. This aggravates upstream flooding, especially when the constrictions become clogged with ice or debris.

There are two major types of flooding that occur in New Jersey: riverine flooding and coastal flooding Riverine flooding is when the rate of rainfall or snowmelt exceeds the rate of infiltration to the ground, the excess water, called runoff, moves across the ground surface toward the lowest section of the watershed. As the surface runoff enters stream channels, stream levels increase. If the rate of runoff is high enough, water in the stream overflows the banks and flooding occurs.

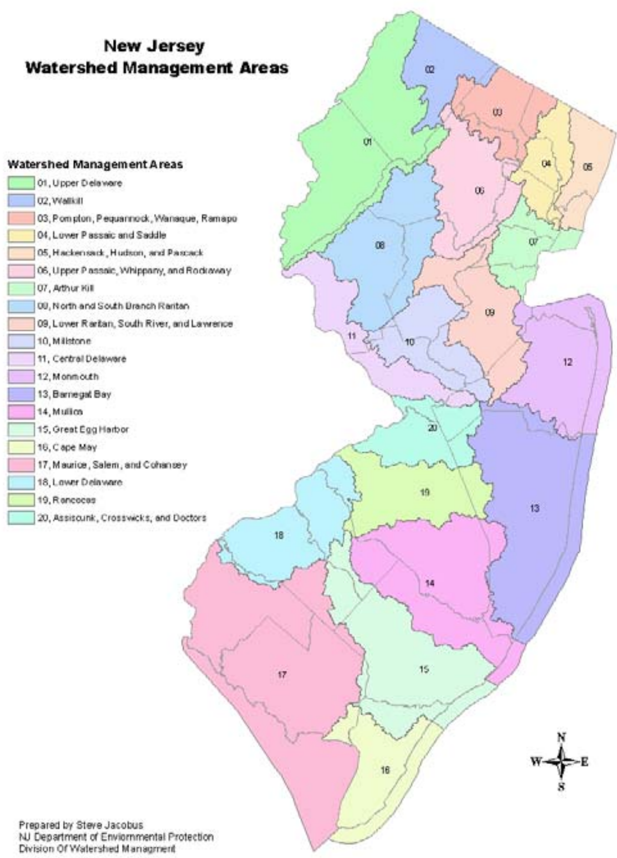
Figure 4.4-1-1
Floodplain Definition (Source: FEMA, August 2001)



Riverine flooding occurs to some extent almost every year and is considered New Jersey's number one hazard. Flooding occurs most frequently between November and April, with a peak from February through April. Flooding occurs in both natural and developed watersheds.

Floods can happen almost anywhere in New Jersey, although they do tend to occur in and around areas near existing bodies of water, such as rivers, streams, and the Atlantic Ocean. FEMA Flood Insurance Studies and Flood Insurance Rate Maps, as a rule, identify that the most damaging floods affecting developed areas in New Jersey occur in the northern half of the State. This is a function of a number of physiographic and physical features of the landscape. Greater geographic relief of the northern half of the State results in flowing water moving down steeper gradients, naturally or artificially channelized through valleys and gullies. Development patterns have resulted in denser development in North Jersey, and proximity to New York City boosts property values and thus damage dollar totals. Extensive development also leaves less natural surface available to absorb rainwater, forcing water directly into streams and rivers, swelling them more than when more natural surface existed. Since the Delaware, Raritan and Passaic rivers drain more than 90 percent of the northern counties in the State, these rivers and their tributaries are common locations for flooding. Source: http://www.capitalcentury.com/1955.html).

Figure 4.4-1-2
New Jersey Watershed Management Areas (NJDEP)



Based on history, NFIP records, and analysis engineering data about floodplains (FEMA FIRM, DFIRM and Q3 data, primarily) it is clear that New Jersey is one of the more floodprone States in the nation. The NOAA/NCDC database reports 1169 flood events just since 1996. The data reporting truncates the list at that year because of its length. The total

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reported losses related to flooding are $1.82 billion, according to NOAA. Because the definition of flooding is relatively broad, and because flooding can happen virtually anywhere, it is the most prevalent natural hazard almost everywhere in the U.S., including New Jersey. New Jersey has a significant coastline, and many rivers and streams, meaning that floods occur very frequently, although most are relatively minor.

4.4.1.2 Previous Flood Occurrences

- The Passaic River Basin is one of the most flood-prone river basins in the country. The April 1984 flood in the Passaic Basin claimed three lives, caused $335 million in damages, and forced about 9,400 people from their homes. (USGS October, 2007)
- From 1993 until April 2010 there have been 1241 floods in New Jersey according to the NCDC. These floods have caused over one and a quarter billion dollars in property damages and are responsible for 14 deaths and 197 injuries. Some of the most devastating floods causing over $10 million in damages are described below.
- January 19th thru the 26th 1996. Flash flooding on the afternoon and early evening of the 19th led to larger river flooding through the 21st, particularly along the Delaware and Raritan rivers.
- October 19, 1996. Heavy rain caused widespread and severe flooding throughout northern NJ, particularly along the Raritan and its tributaries, as well as the Rahway River and the Passaic River.
- August 20, 1997. Torrential rain fell across southeast New Jersey as a low pressure system developed over the Delmarva Peninsula and slowly moved northeast across southern New Jersey. Atlantic County bore the brunt of the storm, with storm totals in excess of 8 inches from Estell Manor through Galloway Township (and 13.52" at the Atlantic City Airport), resulting in severe flash flooding with several major roadways washing out and bridges collapsing.
- September 16, 1999. Hurricane Floyd caused the largest flood on record along the Raritan River. Extensive flooding occurred throughout central and northern NJ. Rainfall totals exceeded 12 inches in several locations. 8 to 10 inch totals were widespread.
- August 12, 2000. A nearly unprecedented torrential downpour (an approximately one in a thousand year event) remained nearly stationary for about six hours in eastern Sussex County, resulting in considerable flooding in southeastern Sussex and western Morris counties. The largest rainfall totals exceed 12 inches.
- July 12, 2004. Flash Flood occurred during the late afternoon and evening of the 12th, as thunderstorms with torrential downpours kept on redeveloping along the Interstate 295 corridor in southern Burlington County. This continued for several hours and resulted in widespread storm totals exceeding 6 inches across most of the Rancocas Creek Basin. A storm total of 13.20 inches was reported in Tabernacle within a 12 hour period and represented a once in a thousand year storm. The excessive rain caused record breaking flash flooding along nearly every stream in the Rancocas Basin and led to the failure or damage of 51 dams in Burlington County. Widespread poor drainage flooding also occurred.
- September 18, 2004. The remnants of Hurricane Ivan interacting with a slowly moving cold front caused widespread very heavy rain to fall during the first half of the day on the 18th in Warren, Sussex, and Morris counties, where storm totals averaged 3-6 inches. This, in combination with even heavier rain in eastern Pennsylvania and southeastern New York state, resulted in the worst flooding along the Delaware River since 1955.
- March 2005. Following a major rainstorm in the last days of March 2005 and another between Friday, April 1 and Sunday, April 3, 2005, the Delaware River overflowed its banks, flooding an estimated 3,500 homes and forcing the evacuation of more than 5,500 people.

- July 17, 2005. Thunderstorms with torrential downpours caused flash flooding in the Manalapan Brook basin in southeastern Middlesex County.
- June 27, 2006. Several days of heavy rain throughout the Delaware River Basin culminated with major flooding along the Delaware River from the 28th through the 30th.
- April 15-16, 2007. Spring Nor'easter dropped 4 to 8 inches of rain over most of NJ, resulting in major flooding along the Raritan, Passaic, Millstone, Hackensack, and Great Egg Harbor rivers (among others).
- An unusual late-winter heavy rain event on March 12-13, 2010, dropped between 4 and 8 inches of rain on much of northern and central NJ, causing significant flooding along the Raritan and Passaic rivers.

As noted in Subsection 4.5.3.3, which describes Statewide hazard vulnerabilities, flooding has been responsible for the most significant recent Presidentially-declared disasters in New Jersey, as shown in the table below.

Table 4.4.1.2-1
Summary of Recent Presidential Declared Riverine Flooding Disasters in New Jersey

FEMA Disaster #	Disaster Date	Counties	Type of Disaster
DR-1295	09/18/1999	Essex, Hunterdon, Middlesex, Morris, Passaic, Somerset	Hurricane Floyd
DR-1337	08/17/2000	Sussex, Morris	Severe storms, flooding and mudslides
DR-1530	07/16/2004	Burlington, Camden	Severe storms and flooding
DR-1563	10/01/2004	Hunterdon, Mercer, Warren, Sussex	Tropical Depression Ivan
DR-1588	04/2005	Bergen, Essex, Gloucester, Hunterdon, Mercer, Morris, Passaic, Sussex, Warren	Severe storms and flooding
DR-1653	07/07/2006	Hunterdon, Mercer, Sussex, Warren	Severe storms and flooding
DR-1694	04/26/2007	Atlantic, Bergen, Burlington, Camden, Essex, Gloucester,, Hudson, Mercer, Middlesex, Morris, Passaic, Somerset, Union, Warren, Sussex	Severe storms and flooding
DR-1873	02/2010	Atlantic, Burlington, Camden, Cumberland, Gloucester, Ocean, Salem (Both Riverine and Coastal Flooding)	Snow storm
DR-1889	03/2010	Atlantic, Burlington, Camden, Cape May, Cumberland, , Gloucester, Salem (Both Riverine and Coastal Flooding)	Severe winter storm, and snow storm.
DR-1897	04/2010	Atlantic, Bergen, Burlington, Cumberland, Cape May, Essex, oucester, Mercer, Hunterdon, Ocean, Middlesex, Monmouth, Morris, Passaic, Somerset, Union (Both Riverine and Coastal Flooding)	Severe storms and flooding

4.4.1.3 Coastal Flood and Storm Surge Occurrences in New Jersey

A storm surge is the rise of water levels during a storm measured by the difference between actual measured water levels and predicted astronomic tide levels. NOAA's National Climatic Data Center database indicates that since 1996 there have been 1169 floods, of which 141 were categorized as coastal. New Jersey's has 210-miles of coastline stretching from Raritan Bay in the north, along the Atlantic Coast to Delaware Bay in the south and includes the counties of Atlantic, Cape May, Ocean, and Monmouth. Though not as costly as other flood events, coastal flooding has caused beach erosion, damage to dunes and shore protection structures as well as tidal flooding impacts. There is an increased risk of flooding when the onset of coastal storms and storm surges occur at high tides. Slow moving storms can last through many high tides causing a great deal of damage.

Table 4.4.1.3-1
Summary of Recent Presidential Declared Coastal Flooding Disasters in New Jersey

FEMA Disaster #	Disaster Date	Counties	Type of Disaster
DR-1867	12/2009	Atlantic, Cape May, Ocean	Tropical Storm Ida and a nor'easter

DR-1873	02/2010	Atlantic, Burlington, Camden, Cumberland, Gloucester, Ocean, Salem (Both Riverine and Coastal Flooding)	Snow storm
DR-1889	03/2010	Atlantic, Burlington, Camden, Cape May, Cumberland, , Gloucester, Salem (Both Riverine and Coastal Flooding)	Severe winter storm, and snow storm.
DR-1897	04/2010	Atlantic, Bergen, Burlington, Cumberland, Cape May, Essex, Gloucester, Mercer, Hunterdon, Ocean, Middlesex, Monmouth, Morris, Passaic, Somerset, Union (Both Riverine and Coastal Flooding)	Severe storms and flooding

4.4.1.4 Tsunami-Related Flood Occurrences in New Jersey

While the probability of a large tsunami impacting the coast of New Jersey is very small due to the position of New Jersey on the trailing edge of the North Atlantic Plate, the mid-Atlantic region has been subjected to minor tsunami action over the past 250 years and perhaps significant tsunami action over the last geologic period.

Lockridge, et al., (2002) analyzed tsunami and tsunami-like waves that have impacted the east coast of the United States and the National Geophysical Data Center of NOAA compiled a listing of all tsunamis and tsunami-like waves of the eastern United States and Canada. Forty-three potential tsunami events have been identified as possibly impacting the east coast of the United States between 1668 and 1992. Of these events, 15 are categorized as definite or probable tsunamis. Nine of the fifteen events generated either observed or possible impacts along the New Jersey. Three of the events were generated remotely and four were generated locally.

4.4.1.5 Probability of Flood Occurrences

Floods are virtually certain to occur somewhere in New Jersey every year, so the Statewide probability is very high. When considering specific sites in the State, however, probability must be estimated using engineering studies or flood insurance statistics. FEMA flood maps and flood insurance studies offer the best available information about where floods are likely to occur, and how often. There is virtually a 100 percent chance of floods occurring somewhere in New Jersey every year. Appendix I of the 2008 plan update includes Q3 and DFIRMs for every County in the State. Flood Insurance Studies can be obtained from the FEMA map service center.

4.4.1.6 Flood Loss Estimation

The sections immediately below comprise the State loss estimation (risk assessment) for the flood hazard. Although the results of these methodologies provide reasonable loss estimates on a Statewide level, they should be used only as a way to identify areas where relative risk is higher, with the purpose of further assessment as the State or local jurisdictions develop and prioritize potential mitigation efforts.

Because flooding is clearly the most significant natural hazard risk in New Jersey and there is a large amount of data available about flood losses, the present hazard identification section includes a more detailed calculation of future losses (risk) than is afforded the other hazards. The following subsections estimate future losses based on several related methodologies. Note that Appendix G of this plan (Severe Repetitive Loss Mitigation Strategy) includes more detailed flood loss estimations for Repetitive Loss and Severe Repetitive Loss properties in New Jersey, based on the most current NFIP data available.

4.4.1.6.1 Flood Loss Estimation Method 1 - Extrapolation of NFIP Flood Claims Data

An accurate way to estimate future flood losses is to utilize historical data as the basis for calculating future losses. In the case of New Jersey, there is an extensive history of flood claims, which indicates more than 82,000 claims since the inception of the NFIP in the late 1970s. The State has one of the highest number of claims of any in the country, and is also among the highest in repetitive flood claims (as defined by FEMA/NFIP, see related discussion elsewhere in this section). Although this is clearly not a positive statistic for the State, it does mean that there is a rich data set on which to base estimations of additional losses. The most reliable methodology for doing so is to annualize the losses, then calculate future losses using a present value coefficient that expresses combinations of time horizons and discount rate. This is a standard statistical methodology, and is used by FEMA in its various benefit-cost analysis software programs. The Office of Management and Budget requires most federal agencies to use a 7% discount rate in assessing benefits of their activities and programs, and that is used in the present calculation. The results of the calculations are displayed in Table 4.4.1.6-1 and a map of New Jersey broken into counties for clarification can be found in Figure 4.5-1-4.

Table 4.4.1.6.1-1
Annualized NFIP Flood Insurance Claims and Projected 50- and 100-year Losses (Risk), by Annual Claims Value

County	Annual NFIP Claims	Losses Estimated	
		Risk (50 year)	Risk (100-year)
Cape May	$3,316,044	$45,761,411	$47,319,952
Passaic	$3,090,582	$42,650,038	$44,102,612
Ocean	$2,967,862	$40,956,499	$42,351,394
Bergen	$2,856,276	$39,416,614	$40,759,064
Somerset	$2,537,978	$35,024,092	$36,216,941
Monmouth	$2,416,104	$33,342,229	$34,477,798
Atlantic	$1,837,057	$25,351,391	$26,214,808
Morris	$1,469,694	$20,281,779	$20,972,535
Warren	$936,357	$12,921,731	$13,361,819
Union	$908,803	$12,541,486	$12,968,623
Essex	$799,171	$11,028,564	$11,404,174
Mercer	$618,947	$8,541,466	$8,832,371
Middlesex	$612,696	$8,455,205	$8,743,172
Hunterdon	$581,335	$8,022,423	$8,295,650
Hudson	$414,129	$5,714,983	$5,909,624
Burlington	$378,543	$5,223,900	$5,401,815
Cumberland	$155,416	$2,144,738	$2,217,784
Camden	$105,418	$1,454,770	$1,504,316
Salem	$34,766	$479,769	$496,109
Gloucester	$30,292	$418,030	$432,268
Sussex	$17,744	$244,865	$253,204
Total	$26,085,216	$359,975,982	$372,236,034

Table 4.4.1.6.1-2
FEMA NFIP Actuarial Calculation of Potential Maximum Benefits for Mitigating SRL Properties, by County

County	Num. of SRL Properties	Number of Claims	Total $ Claims	% of Claims	Losses Estimated			
					30-year Risk/County	30-year Risk/Property	100-year Risk/County	100-year Risk/Property
Atlantic	33	234	$3,883,453	4.16%	$1,886,369	$57,163	$2,169,150	$65,732
Bergen	27	144	$4,518,894	4.84%	$2,670,403	$98,904	$3,070,717	$113,730
Camden	3	18	$236,843	0.25%	$180,069	$60,023	$207,063	$69,021
Cape May	141	837	$17,631,173	18.89%	$9,376,381	$66,499	$10,781,971	$76,468
Cumberland	1	13	$280,261	0.30%	$121,919	$121,919	$140,196	$140,196
Essex	6	51	$1,059,508	1.13%	$465,346	$77,558	$535,105	$89,184
Gloucester	1	13	$102,804	0.11%	$74,308	$74,308	$85,447	$85,447
Hudson	2	8	$153,549	0.16%	$197,304	$98,652	$226,881	$113,441
Hunterdon	10	33	$3,050,297	3.27%	$2,737,566	$273,757	$3,147,948	$314,795
Mercer	3	16	$284,018	0.30%	$189,456	$63,152	$217,856	$72,619
Middlesex	6	33	$481,237	0.52%	$309,908	$51,651	$356,366	$59,394

Monmouth	11	51	$2,010,354	2.15%	$1,213,278	$110,298	$1,395,158	$126,833
Morris	66	456	$10,520,713	11.27%	$4,956,735	$75,102	$5,699,788	$86,360
Ocean	30	179	$3,475,353	3.72%	$2,268,795	$75,626	$2,608,904	$86,963
Passaic	199	1,278	$33,367,945	35.74%	$15,920,245	$80,001	$18,306,811	$91,994
Somerset	13	58	$3,179,228	3.41%	$1,925,061	$148,082	$2,213,643	$170,280
Union	2	10	$222,367	0.24%	$142,397	$71,198	$163,743	$81,871
Warren	40	152	$8,898,507	9.53%	$6,908,711	$172,718	$7,944,379	$198,609
Total	**594**	**3,584**	**$93,356,504**	**100.00%**	**$51,544,251**	**$86,775**	**$59,271,126**	**$99,783**

Table above shows various data and calculations for Severe Repetitive Loss properties in New Jersey, as provided by FEMA and the National Flood Insurance Program. The data in the "risk" columns shows the actuarial calculation of the potential maximum flood losses over 30- and 100-year planning horizons. These horizons are used because they correspond to the standard mitigation project life figures that FEMA uses in benefit-cost analysis for elevations and acquisition/demolitions, respectively.

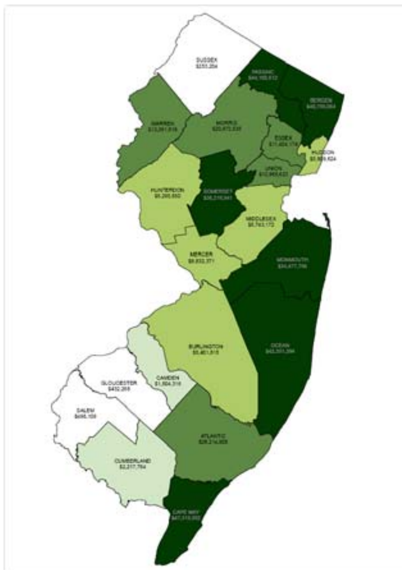


Figure four..4.1.6.1-1
State of New Jersey Annualized NFIP Flood Insurance Claims and projected Losses (Risk) for 100 year Horizon

4.4.1.6.2 Flood Loss Estimation Method 2 - Extrapolation of NFIP Repetitive Loss Claims Data

This risk loss estimation methodology uses historical repetitive flood loss insurance claims data as the basis for estimating future losses. The methodology is based on annualizing losses by dividing the total losses by the number of years since the inception of the NFIP, then projecting future losses using a standard present value coefficient (which integrates the required 7% discount rate with planning horizons of 50 and 100 years, respectively). This type of analysis is reasonably accurate on a large scale such as a State, but County-level data should be reviewed carefully prior to use in local or regional planning exercises. Note that the columns entitled "50-year risk" and "100-year risk" are projections of annual losses for whole Counties. The columns at the far right of the table show projected future losses (risk) on a per-policy basis. The secondary (shaded) rows for each County show the same data for only those policies that have made four or more claims against the NFIP. The data can be used by the State and regions to identify patterns indicating where the most significant claims history has been. Note to local and regional planning entities: this data can be obtained in a spreadsheet form, and extends to the level of individual claims.

Note that Appendix G of this Plan includes additional data related to Repetitive Loss and Severe Repetitive Loss properties, including the FEMA/NFIP actuarial calculation of the maximum potential benefits (risk) to SRL properties for 30- and 100-year planning horizons.

Table 4.4.1.6.2-1
Estimated Future Flood Losses to FEMA Repetitive Loss Properties, based on NFIP claims records, With 50- and 100-year Loss Projections on Countywide and Individual Policy Basis

County	Group	Total Building Payments	Total Contents Payments	Number of Losses	Total Payments	Average Annual Payment	50-year risk	100-year risk	# Properties/ Policies	Average annual loss/ policies	50-year risk/ policy	100-year risk/ policy
Atlantic	All RL	$21,405,715	$6,432,788	2,414	$27,838,503	$927,950	$12,805,711	$13,241,848	787	$1,179	$16,272	$16,826
	4+ claims	$9,958,362	$3,424,743	1,062	$13,383,105	$446,104	$6,156,228	$6,365,897	197	$2,264	$31,250	$32,314
Bergen	All RL	$37,739,514	$16,617,348	2,023	$54,356,861	$1,811,895	$25,004,156	$25,855,747	776	$2,335	$32,222	$33,319
	4+ claims	$8,380,271	$8,935,986	542	$17,316,257	$577,209	$7,965,478	$8,236,766	94	$6,141	$84,739	$87,625
Burlington	All RL	$5,129,719	$1,233,023	228	$6,362,742	$212,091	$2,926,861	$3,026,544	91	$2,331	$32,163	$33,259
	4+ claims	$470,977	$107,361	53	$578,338	$19,278	$266,036	$275,096	10	$1,928	$26,604	$27,510
Camden	All RL	$862,874	$184,812	126	$1,047,686	$34,923	$481,936	$498,349	50	$698	$9,639	$9,967
	4+ claims	$140,036	$50,749	22	$190,785	$6,359	$87,761	$90,750	4	$1,590	$21,940	$22,688
Cape May	All RL	$48,994,017	$20,436,970	6,192	$69,430,988	$2,314,366	$31,938,254	$33,026,006	1,904	$1,216	$16,774	$17,346
	4+ claims	$27,644,345	$13,598,895	3,138	$41,243,240	$1,374,775	$18,971,890	$19,618,034	591	$2,326	$32,101	$33,195
Cumberland	All RL	$1,053,029	$225,418	113	$1,278,448	$42,615	$588,086	$608,115	45	$947	$13,069	$13,514
	4+ claims	$251,974	$100,381	24	$352,355	$11,745	$162,083	$167,604	3	$3,915	$54,028	$55,868
Essex	All RL	$7,400,252	$5,077,233	624	$12,477,486	$415,916	$5,739,643	$5,935,124	768	$542	$7,473	$7,728
	4+ claims	$2,477,553	$2,705,115	238	$5,182,668	$172,756	$2,384,027	$2,465,223	41	$4,214	$58,147	$60,127
Gloucester	All RL	$322,879	$78,160	41	$401,039	$13,368	$184,478	$190,761	228	$59	$809	$837
	4+ claims	$52,483	$22,858	7	$75,341	$2,511	$34,657	$35,837	1	$2,511	$34,657	$35,837
Hudson	All RL	$2,051,762	$8,349,624	269	$10,401,386	$346,713	$4,784,638	$4,947,593	84	$4,128	$56,960	$58,900
	4+ claims	$941,930	$7,953,679	111	$8,895,608	$296,520	$4,091,980	$4,231,344	16	$18,533	$255,749	$264,459
Hunterdon	All RL	$13,383,447	$1,154,686	493	$14,538,133	$484,604	$6,687,541	$6,915,305	184	$2,634	$36,345	$37,583
	4+ claims	$2,734,058	$387,876	85	$3,121,934	$104,064	$1,436,090	$1,485,000	21	$4,955	$68,385	$70,714
Mercer	All RL	$8,721,701	$7,342,029	726	$16,063,731	$535,458	$7,389,316	$7,640,981	255	$2,100	$28,978	$29,965
	4+ claims	$2,200,673	$4,507,309	141	$6,707,982	$223,599	$3,085,672	$3,190,763	22	$10,164	$140,258	$145,035
Middlesex	All RL	$8,142,815	$1,204,283	488	$9,347,098	$311,570	$4,299,665	$4,446,103	195	$1,598	$22,050	$22,801
	4+ claims	$1,452,794	$297,254	69	$1,750,048	$58,335	$805,022	$832,440	14	$4,167	$57,502	$59,460
Monmouth	All RL	$23,719,726	$6,374,456	1,553	$30,094,182	$1,003,139	$13,843,324	$14,314,799	603	$1,664	$22,957	$23,739
	4+ claims	$6,913,408	$1,912,745	373	$8,826,153	$294,205	$4,060,031	$4,198,307	76	$3,871	$53,421	$55,241
Morris	All RL	$23,139,762	$7,851,699	1,998	$30,991,461	$1,033,049	$14,256,072	$14,741,605	539	$1,917	$26,449	$27,350
	4+ claims	$13,999,273	$4,825,505	1,198	$18,824,777	$627,493	$8,659,398	$8,954,319	209	$3,002	$41,433	$42,844
Ocean	All RL	$19,505,518	$5,177,768	1,914	$24,683,286	$822,776	$11,354,311	$11,741,016	735	$1,119	$15,448	$15,974

County	Group	Total Building Payments	Total Contents Payments	Number of Losses	Total Payments	Average Annual Payment	50-year risk	100-year risk	# Properties/ Policies	Average annual loss/ policies	50-year risk/ policy	100-year risk/ policy
	4+ claims	$5,313,412	$1,780,379	543	$7,093,792	$236,460	$3,263,144	$3,374,280	111	$2,130	$29,398	$30,399
Passaic	All RL	$49,504,524	$21,908,406	4,072	$71,412,930	$2,380,431	$32,849,948	$33,968,750	1,047	$2,274	$31,375	$32,444
	4+ claims	$28,756,766	$13,040,087	2,521	$41,796,853	$1,393,228	$19,226,552	$19,881,370	425	$3,278	$45,239	$46,780
Salem	All RL	$228,115	$25,033	35	$253,148	$8,438	$116,448	$120,414	13	$649	$8,958	$9,263
	4+ claims	$50,476	$12,447	9	$62,923	$2,097	$28,945	$29,930	2	$1,049	$14,472	$14,965
Somerset	All RL	$42,536,555	$9,072,149	1,503	$51,608,704	$1,720,290	$23,740,004	$24,548,540	607	$2,834	$39,110	$40,442
	4+ claims	$5,702,805	$1,448,639	195	$7,151,445	$238,381	$3,289,665	$3,401,704	43	$5,544	$76,504	$79,109
Sussex	All RL	$238,087	$4,953	11	$243,040	$8,101	$111,798	$115,606	5	$1,620	$22,360	$23,121
	4+ claims	$0	$0	0	$0	$0	$0	$0	0	$0	$0	$0
Union	All RL	$12,496,582	$7,939,667	1,060	$20,436,249	$681,208	$9,400,675	$9,720,843	431	$1,581	$21,811	$22,554
	4+ claims	$1,209,345	$6,421,813	166	$7,631,158	$254,372	$3,510,333	$3,629,888	24	$10,599	$146,264	$151,245
Warren	All RL	$21,707,307	$3,708,588	660	$25,415,895	$847,197	$11,691,312	$12,089,494	239	$3,545	$48,918	$50,584
	4+ claims	$6,774,011	$1,601,618	179	$8,375,629	$279,188	$3,852,789	$3,984,007	43	$6,493	$89,600	$92,651

4.4.1.6.3 Flood Loss Estimation Method 3 - Estimated Annual Damages for 1% (100-year) Probability Floods

This flood risk assessment methodology is completed by using the HAZUS estimates of total exposure for all land use categories, combined with the results of the GIS-based analysis of DFIRM and Q3 data. The latter were used to estimate the percentage of land area in A zones (assumed to be 100-year floodplain) for each County in the State. The fourth column (A Zone Exposure) shows the total value of assets in each County that is potentially exposed to a one percent annual chance of flooding. This methodology is constrained by the uncertainty of the value of assets that are actually in the 100-year floodplain, but offers a perspective on the potential annual damages in each County, and Statewide. Potential damages are directly correlated to the value of assets in the Counties, but the coefficient floodplain percentage also has a significant effect on the outcome.

Table 4.4.1.6.3-1
Estimated Annual Damages in New Jersey Counties for 1% Floods, sorted by Total Potential Damages
[Ref: NJ sf in floodplain all counties (begin row 177)]

County	Total Exposure	% A zone	A Zone Exposure*	Potential Ann Damages
Bergen	$100,653,325,000	20.32%	$20,454,933,398	**$204,549,334**
Hudson	$53,814,871,000	35.59%	$19,153,803,429	**$191,538,034**
Ocean	$50,946,874,000	25.89%	$13,187,896,960	**$131,878,970**
Essex	$79,240,485,000	15.89%	$12,591,376,804	**$125,913,768**
Middlesex	$78,836,283,000	13.92%	$10,977,399,938	**$109,773,999**
Burlington	$51,757,042,000	18.77%	$9,714,949,727	**$97,149,497**
Atlantic	$27,652,015,000	32.46%	$8,976,933,482	**$89,769,335**
Morris	$64,432,550,000	13.61%	$8,768,564,566	**$87,685,646**
Cape May	$18,311,425,000	46.43%	$8,501,530,083	**$85,015,301**
Monmouth	$67,233,273,000	8.52%	$5,731,103,444	**$57,311,034**
Passaic	$45,121,076,000	12.55%	$5,664,673,952	**$56,646,740**
Mercer	$40,721,537,000	10.65%	$4,336,537,938	**$43,365,379**
Gloucester	$24,721,631,000	16.43%	$4,061,302,346	**$40,613,023**
Cumberland	$12,235,912,000	31.56%	$3,861,595,910	**$38,615,959**
Somerset	$35,656,884,000	10.26%	$3,660,096,390	**$36,600,964**
Union	$50,021,816,000	6.76%	$3,383,045,455	**$33,830,455**
Camden	$46,731,673,000	6.80%	$3,177,894,007	**$31,778,940**
Salem	$6,080,176,000	33.18%	$2,017,293,129	**$20,172,931**
Sussex	$14,692,482,000	7.38%	$1,083,767,464	**$10,837,675**
Hunterdon	$15,132,181,000	5.19%	$784,753,392	**$7,847,534**
Warren	$10,381,209,000	5.69%	$590,394,133	**$5,903,941**
Total	**$894,374,720,000**		**$150,679,845,946**	**$1,506,798,459**

4.4-2 Hurricanes and Tropical Storms

4.4.2.1 Nature of the Hurricane and Tropical Storm Hazards

A hurricane is a tropical storm that attains hurricane status when its wind speed reaches 74 or more miles an hour. Tropical systems may develop in the Atlantic between the Lesser Antilles and the African coast, or may develop in the warm tropical waters of the Caribbean and Gulf of Mexico. These storms may move up the Atlantic coast of the United States and impact the Eastern seaboard, or move into the U.S. through the states along the Gulf Coast, bringing wind and rain as far north as New England before moving off shore and heading east.

Because of its northern location on the Atlantic coastline, direct hits by storms of hurricane strength have a relatively low probability of impacting New Jersey, compared to the Southern coastal and Gulf States. It is possible for the entire State to be impacted by hurricanes, although wind and surge effects tend to be concentrated in coastal areas, as well as specific riverine regions that may experience storm surge backwater effects.

The cooler waters off the coast of New Jersey can serve to diminish the energy of storms that have traveled up the eastern seaboard in the Gulf Stream current. However, historical data shows that a number of hurricanes/tropical storms have impacted New Jersey, often as the remnants of a large storm hitting the Gulf or Atlantic coast hundreds of miles south of New Jersey, but maintaining sufficient wind and precipitation to cause substantial damage to the State.

The following paragraphs summarize the nature of these storms as they intensify from tropical depressions into storms and Hurricanes:

- *A Tropical depression* is an organized system of clouds and thunderstorms with a defined surface circulation and maximum sustained winds of less than 38 miles per hour. Although a low pressure system is present, there is no eye and typically does not have the organization or spiral shape of more powerful storms. It has a low pressure system.

- A *tropical storm* is an organized system of strong thunderstorms with a defined surface circulation and maximum sustained winds between 39 and 73 miles per hour. At this point the distinctive cyclonic shape starts to develop, although an eye is not usually present. The National Oceanic and Atmospheric Administration assign storm names to systems that reach this level of intensity.

- A *hurricane* is a storm system with sustained winds of greater than 74 miles per hour. Storms of this intensity develop a central eye that is an area of relative calm and the lowest atmospheric pressure. Surrounding the eye is a circulating eye wall and the strongest thunderstorms and winds.

The impacts of Hurricanes can cross several categories:

1. Rainfall. Hurricanes can produce significant amounts of precipitation that can last for days and cause major inland flooding.

2. Winds. Strong winds related to hurricanes can cause significant damage to buildings, with strong storms creating extremely hazardous flying debris. Included in the wind hazard is the potential for the creation of tornadoes.

3. Storm surge and wave action. A fast rise in sea level can occur as a storm approaches a coastline. This surge in water can damage buildings and infrastructure with water inundation and high velocity waves, often reshaping the coastline through erosion.

The following table outlines the definition of the intensity of hurricanes (known as the Saffir/Simpson Hurricane Scale). The table also highlights the type of damage that typically occurs in each category of intensity.

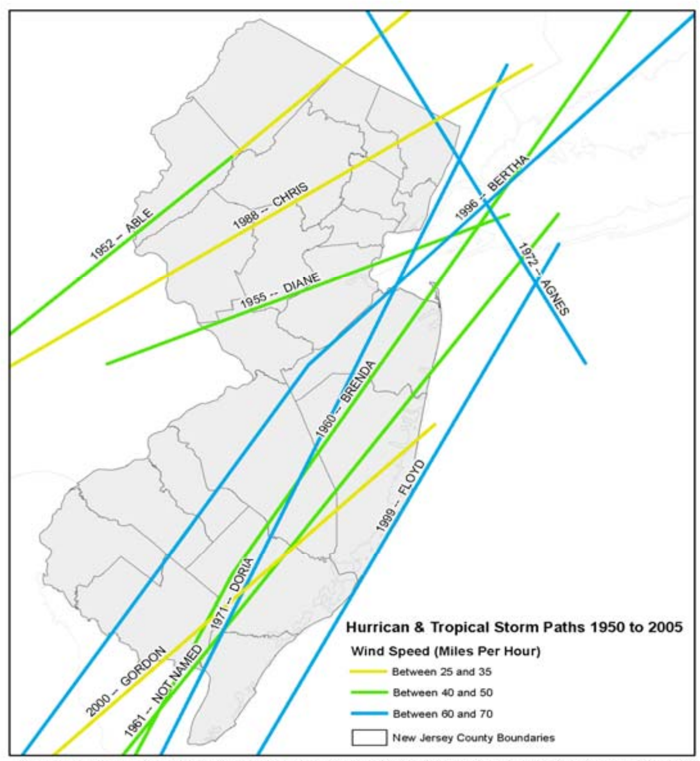
Table 4.4.2.1-1
Saffir/Simpson Hurricane Intensity Categories

Category	Central pressure mbar	Max wind m.p.h.	Surge ft	Damage
1 weak	≥ 980	75 to 95	4 to 5	Mostly to trees and loose objects; no real damage to building structures
2 moderate	965 to 979	96 to 110	6 to 8	Flimsy structures damaged, trees down, some damage to roofing, windows, and doors
3 strong	945 to 964	111 to 130	9 to 12	Mobile homes, etc., and signs destroyed, some structural damage to small buildings
4 very strong	920 to 944	131 to 155	13 to 18	Extensive roof, window, and door failures, some structural damage to better buildings
5 devastating	<920	>155	>18	Very extensive roof and glass failure; some buildings blown down, over or away

As illustrated in Figure 4.4-2-1, a number of major hurricanes and tropical storms have impacted New Jersey in the last half century.

Figure 4.4-2.1-1

Hurricanes and Tropical Storms that have Crossed New Jersey 1950-2007



Prepared for the New Jersey Office of Emergency Managment January 2007. Source: National Oceanic and Atmospheric Administraton, Tropical Prediction Center/National Hurricane Center, September 2005. Original map layer distributed by the National Atlas of the United States. Contact address: NOAA Coastal Services Center, 2234 South Hobson Ave., Charleston, SC 29405-2413. Phone: 843-740-1200

The hurricane hazard can be detailed in the following categories as the impacts relate to New Jersey:

- Flooding. Flooding causes severe damage in New Jersey during hurricanes. Flooding and flash floods brought by the torrential rains of a hurricane are dangerous killers. Rain delivered by tropical storm can amount to almost nothing to as much as 15 inches in two to three days. Hurricane Diane (1955) caused little damage as it moved into the continent, but long after its winds subsided, it brought floods to Pennsylvania, New York and New England that killed 200 persons and cost an estimated 700 million dollars in damage. In 1972, Agnes fused with another storm system, flooding stream, and river basins in the Northeast with more than a foot of rain in less than 12 hours, killing 117 people and causing almost three billion dollars of damage.
- Storm Surge. It is estimated that 90 percent of deaths and most property damage near the coast during hurricanes are caused by storm surge. Storm surge occurs when coastal waters are pushed toward shore and held above mean sea level. Depending on storm size, characteristics and distance from the shoreline, the storm can raise the sea level of along 50 or more miles of coastline by 20 or more feet. The higher sea level, along with the wind-enhanced hammering of waves, act as a giant bulldozer sweeping everything in its path. In fact, during at least two hurricanes this century, New Jersey's barrier islands Island Beach and Long Beach Island experienced a complete over wash as a result of the storm surge, with waves completely washing over the islands taking with them homes and other infrastructure.

  The damage does not end with destruction from wave action effects. Still-water damage from inundated structures and facilities is exacerbated by the harmful effects of saltwater. Structures, once salted, will remain more susceptible to moisture, leading to mildewing and corrosion of the structure and all contents that came in contact with the saltwater.
- Wind. High wind speeds occur in a narrow ring usually extending 20 to 30 miles from the wall of the eye of a hurricane. Minor damage begins at approximately 50 MPH and includes broken branches. Moderate damage, such as broken window and loosed shingles begins around 80 MPH, and major structural damage and destruction begins at 100 MPH. For some structures, wind force alone is sufficient to cause total destruction. Mobile homes with their lack of foundation, light weight, and minimal anchoring make them particularly vulnerable to hurricane winds. Some hurricanes spawn tornadoes that contribute to the damage delivered by hurricanes. Tornadoes are discussed in the thunderstorms & tornadoes section of this report. Winds to the right of the storm track typically cause more damage because wind speed is added to track speed. New Jersey, typically to the left of the storm track, tends to suffer less damage than Long Island.

4.4.2.2 Previous Hurricane Occurrences in New Jersey

The table below (with data provided from the National Climatic Data Center) shows that a relatively small number of Hurricane/Tropical Storm events have impacted New Jersey since 1950.

Table 4.4.2.2-1
Hurricanes and Tropical Storms affecting New Jersey from 1950 to 2007

5 HURRICANE & TROPICAL STORMS event(s) were reported in **New Jersey** between **01/01/1950** and **08/31/2007**.

*Click on **Location or County** to display Details.*

Mag: Magnitude
Dth: Deaths
Inj: Injuries
PrD: Property Damage
CrD: Crop Damage

New Jersey

Location or County	Date	Time	Type	Mag	Dth	Inj	PrD	CrD
1 NJZ013>014 - 020>026	07/13/1996	04:00 AM	Tropical Storm	N/A	1	2	0	0
2 NJZ024>026	09/16/1999	02:00 AM	Hurricane	N/A	0	0	1.2M	0
3 NJZ014 - 024>026	09/16/1999	04:00 PM	Tropical Storm	N/A	0	0	500K	0
4 NJZ005>006 - 011	09/18/2003	04:00 PM	Tropical Storm	N/A	0	0	0	0
5 NJZ014 - 021 - 023>026	09/18/2003	04:00 PM	Tropical Storm	N/A	0	0	2.1M	0
				TOTALS:	1	2	3.750M	0

http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms

Although NCDC records are generally reliable, Table 4.4.2.2-1 above somewhat disagrees with the NOAA Storm Prediction Center data that is displayed above. This is likely the result of differences in data that the agencies use, or in the nature of their reporting (i.e., the definition of "affecting"). Note that Section 5 of this Plan includes descriptions of recent Presidentially-declared disasters, including some of those shown in the table above. According to FEMA records, the following disaster declarations are the only ones made in New Jersey related to Hurricanes:

Table 4.4.2.2-1

Hurricane-related Presidential Disaster Declarations in New Jersey

Date	Name	FEMA Disaster Number
August 1955	Diane	41
October 1985	Gloria	749
September 1999	Floyd	1295

Table 4.4.2.2-2 provides a more in-depth analysis of Hurricane and tropical storm events that have impacted New Jersey between 2001 and 2008, including the nature of the impact of these events.

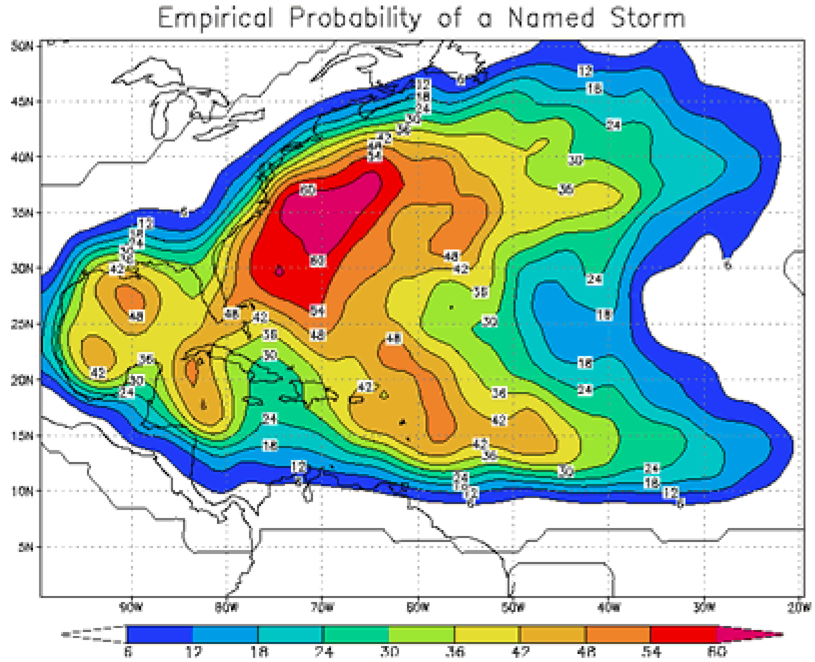
Table 4.4.2.2-2
Hurricanes and Tropical Storms affecting New Jersey from 2001 to 2008

Date	Name	Description
June 17, 2001	Tropical Storm Allison	Passed just east of the state as a subtropical depression, causing gusty winds and up to 4.86 inches (12.34 cm) of rain.
September 13, 2003	Tropical Storm Henri	Caused up to 3 inches (8 cm) of rain across the state.
September 19, 2003	Hurricane Isabel	Passed well to the southwest of the state, though because of the hurricane's large windfield, Isabel caused strong storm surges of up to 10.6 feet (3.2 m) in Burlington. Persistent strong waves severely erode beaches along the coast.
August 31, 2004	Tropical Storm Gaston	Passed to the east of the state, causing up to 3 inches (8 cm) of rainfall across the state.
September 8, 2004	Hurricane Frances	Extratropical storm dropped around 3 inches (8 cm) of rain in North Jersey.
September 17, 2004:	Hurricane Ivan	Dropped 5.5 inches (14.0 cm) of rain in Maplewood.
September 28, 2004:	Hurricane Jeanne	Passed to the south of the state as an extratropical storm, causing up to 5 inches (13 cm) of rainfall across New Jersey.
August 11-August 16, 2005:	Hurricane Irene	Passed to the southeast of the state, causing rip currents and strong waves. In Point Pleasant Beach, New Jersey, lifeguards made 150 rescues in a three day period. Many beaches banned swimming due to the threat.
September 7-September 8, 2005:	Hurricane Maria and Hurricane Nate	Rip currents from storms killed one and seriously injured another.
September 3, 2006:	Tropical Storm Ernesto	The interaction between the remnants of the storm and a strong high pressure system produced intense wind gusts of up to 81 mph in Strathmere. The storm also dropped heavy rainfall, totaling to a maximum of 4.92 inches in Margate. The winds and rain down trees and power lines, resulting in power outages.
September 6. 2008:	Tropical Storm Hanna	Traveled northeast across the southern half of the state, resulting in modest wind gusts along the coast (40-45 mph), widespread rain totals of 2 to 5 inches, and a rip current-related drowning death in Spring Lake.

4.4.2.3 Probability of Hurricanes and Tropical Storms

Because they are relatively infrequent in the Northeastern U.S., it is impossible to assign accurate probabilities to hurricanes and tropical storms in the region, except on a very long-term basis. As noted, such storms that do impact the region are often remnants of hurricanes rather than named events, so their effects often appear as floods or (to a lesser extent) as windstorms, rather than hurricanes or tropical storms. Because the reporting period is relatively long, it is reasonable to assume that the probabilities of these events will remain about the same in the future, with the region experiencing the effects of a hurricane every 15 or 20 years, and tropical storms perhaps every five years.

Figure 4.4-2.3-1
What is my chance of being struck by a tropical storm or hurricane?



The figure above shows for any particular location what the chance is that a tropical storm or hurricane will affect the area sometime during the whole June to November hurricane season. We utilized the years 1944 to 1999 in the analysis and counted hits when a storm or hurricane was within about 100 miles (165 km). This figure is created by Todd Kimberlain.

For example, people living in New Orleans, Louisiana have about a 40% chance (the green-orange color) per year of experiencing a strike by a tropical storm or hurricane. For the U.S., the locations that have the highest chances are the following: Miami, Florida - 48% chance; Cape Hatteras, North Carolina - 48% chance; and San Juan, Puerto Rico - 42% chance.

Source: The Atlantic Oceanographic and Meteorological Laboratory (AOML), Frequently Asked Questions, G#12. www.aoml.noaa.gov/hrd/tcfaq/tcfaqG.html#G12

4.4.2.4 Hurricane Wind Loss Estimation

This subsection includes a detailed calculation of hurricane wind risk in New Jersey. The present analysis uses information extracted from the FEMA HAZUS software (estimated square footages of various land uses, including residential, industrial, commercial, agricultural, educational, and religious) in combination with FEMA software and methodologies to estimate future wind losses. The methodology is based on the following steps.

1. Compile data about land uses by County, including estimated square footage of each use category.
2. Assign specific typical building types to each category, using the R.S. Means standard list (see note).
3. Determine replacement values for all building types using the R.S. Means on-line calculator (see note).
4. Estimate contents values using USACE contents-to-structure value ratios and other methods.
5. Divide Counties into three groups based on proximity to the coast.
6. Assign a ZIP code to each group of Counties.
7. Determine damage functions using FEMA Wind Damage Function software.
8. Determine wind hazard profiles using FEMA Wind Damage Function software.
9. Perform risk calculations using FEMA Full-Data Hurricane Wind benefit-cost analysis software.

Note: R.S. Means is a national-standard reference guide that is used by engineers, architects and planners to estimate the cost to construct a range of different types of buildings, based on size, type and location.

The 21 Counties in the State were divided into three groups, based on proximity to the Atlantic Coast, and a central ZIP code was assigned to each group. Then the FEMA Wind Damage Function database was queried to determine the general wind speed profiles for the Counties in each sample. The series of three figures below shows the wind profiles for selected areas of New Jersey. Note the differences in the wind profiles, particularly for the higher category events, between the inland areas and Counties near the Atlantic Coast.

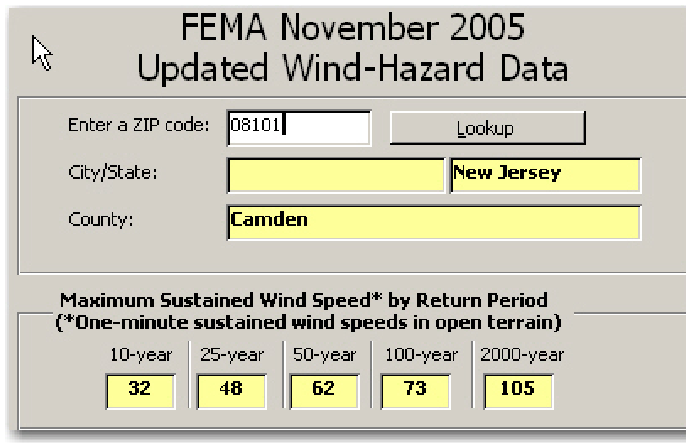


Figure 4.4.2.4-1
Wind Hazard Profile for Southern Inland New Jersey Counties

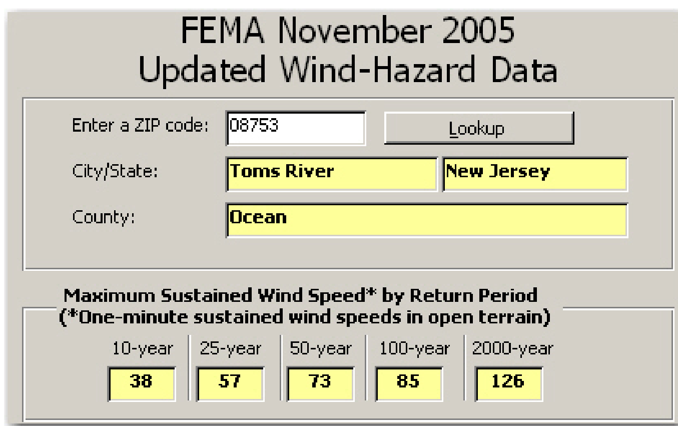


Figure 4.4.2.4-2
Wind Hazard Profile for Coastal New Jersey Counties

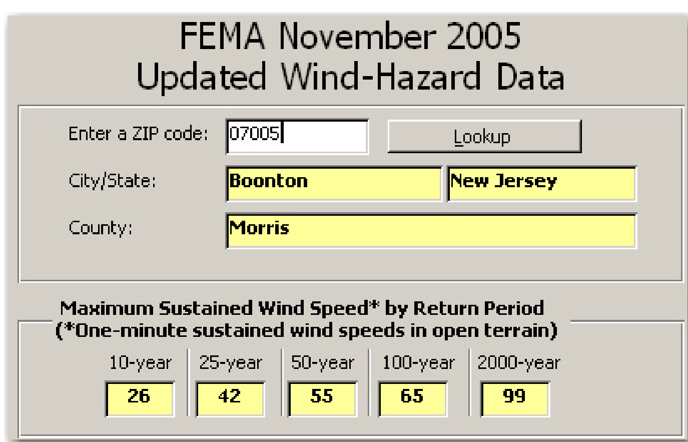


Figure 4.4.2.4-3
Wind Hazard Profile for Northern Inland New Jersey Counties

The results of the risk calculation are displayed in the series of tables below. The dollar figures in the tables represent the expected future losses (risk) over a 100-year planning horizon. This assessment should be used for comparative purposes only – in order to accurately characterize risk to individual structures or operations it is necessary to gather much more detailed information. However, the results of this assessment can be used to show relative risk across the State from hurricane winds.

Table 4.4.2.4-1
Hurricane Wind Risk for Coastal New Jersey Counties

County	Residential	Commerce	Industrial	Agri	Education	Govt.	Religious	Total
Atlantic	$336,385,398	$3,163,510	$483,219	$674	$57,594	$14,461	$12,964	**$340,117,818**
Cape May	$344,322,734	$2,237,484	$640,448	$422	$18,055	$5,217	$12,173	**$347,236,533**
Middlesex	$828,319,087	$11,181,596	$3,709,021	$2,159	$82,840	$11,509	$29,620	**$843,335,832**
Monmouth	$761,583,109	$7,567,886	$1,419,557	$3,305	$61,892	$18,744	$24,268	**$770,678,760**
Ocean	$748,459,178	$4,548,184	$849,393	$937	$31,733	$6,721	$20,024	**$753,916,171**
Total	**$3,019,069,506**	**$28,698,660**	**$7,101,638**	**$7,497**	**$252,114**	**$56,652**	**$99,049**	**$3,055,285,115**

Table 4.4.2.4-2
Hurricane Wind Risk for Northern Inland New Jersey Counties

County	Residential	Commerce	Industrial	Agri	Education	Govt.	Religious	Total
Bergen	$253,038,075	$4,877,740	$1,881,658	$251	$52,880	$7,655	$14,288	**$259,872,547**
Essex	$195,648,649	$3,411,984	$1,330,693	$101	$59,529	$8,193	$18,230	**$200,477,379**
Hudson	$138,318,264	$3,468,319	$701,324	$27	$27,046	$1,734	$10,967	**$142,527,681**
Hunterdon	$37,798,125	$549,028	$256,781	$176	$7,703	$1,167	$2,986	**$38,615,967**
Morris	$139,780,278	$2,662,741	$1,143,951	$294	$26,101	$3,058	$10,274	**$143,626,697**
Passaic	$120,517,938	$1,990,821	$960,440	$98	$14,915	$4,631	$9,036	**$123,497,878**
Somerset	$89,061,719	$1,450,685	$513,989	$135	$20,454	$2,505	$5,328	**$91,054,817**
Sussex	$43,945,406	$441,127	$130,703	$80	$8,157	$496	$2,451	**$44,528,420**
Union	$139,119,111	$2,259,025	$950,829	$159	$13,745	$2,727	$9,877	**$142,355,472**
Warren	$30,249,943	$352,945	$114,963	$82	$7,829	$502	$1,779	**$30,728,043**
Total	**$1,187,477,508**	**$21,464,416**	**$7,985,330**	**$1,403**	**$238,360**	**$32,668**	**$85,216**	**$1,217,284,902**

Table 4.4.2.4-3
Hurricane Wind Risk for Southern Inland New Jersey Counties

County	Residential	Commerce	Industrial	Agri	Education	Govt.	Religious	Total
Burlington	$79,910,340	$2,719,713	$215,751	$9,730	$22,109	$12,720	$3,486	**$82,893,850**
Camden	$92,936,981	$1,235,328	$209,883	$403	$37,000	$12,180	$4,352	**$94,436,126**
Cumberland	$11,783,231	$97,672	$13,895	$344	$2,637	$3,149	$761	**$11,901,691**
Gloucester	$46,553,313	$562,937	$234,676	$692	$17,409	$6,381	$2,231	**$47,377,639**
Mercer	$66,001,998	$984,346	$141,234	$431	$172,365	$48,715	$4,661	**$67,353,749**
Salem	$12,247,401	$133,435	$30,829	$241	$4,328	$3,029	$1,038	**$12,420,301**
Total	**$309,433,264**	**$5,733,430**	**$846,270**	**$11,841**	**$255,848**	**$86,174**	**$16,529**	**$316,383,356**

Table 4.4.2.2-4 shows the Statewide wind risk calculation ordered by County total wind risk. The calculation uses a 100-year planning horizon.

Table 4.4.2.4-4
100-year New Jersey Wind Risk, Ordered by County

County	100-year Wind Risk	% of State Risk
Middlesex	$843,335,832	**18.38%**
Monmouth	$770,678,760	**16.79%**
Ocean	$753,916,171	**16.43%**
Cape May	$347,236,533	**7.57%**
Atlantic	$340,117,818	**7.41%**
Bergen	$259,872,547	**5.66%**
Essex	$200,477,379	**4.37%**
Morris	$143,626,697	**3.13%**
Hudson	$142,527,681	**3.11%**
Union	$142,355,472	**3.10%**
Passaic	$123,497,878	**2.69%**
Camden	$94,436,126	**2.06%**
Somerset	$91,054,817	**1.98%**
Burlington	$82,893,850	**1.81%**
Mercer	$67,353,749	**1.47%**
Gloucester	$47,377,639	**1.03%**
Sussex	$44,528,420	**0.97%**
Hunterdon	$38,615,967	**0.84%**
Warren	$30,728,043	**0.67%**
Salem	$12,420,301	**0.27%**
Cumberland	$11,901,691	**0.26%**
Total	**$4,588,953,373**	**100.00%**

As noted earlier, the wind risk calculation has several components that influence the outcome of the assessment. These include proximity to the coast, building types in the sample area, and the gross square footage of assets in the sample area

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4.4.3 Nor'easters

4.4.3.1 Nature of the Nor'easter Hazard

A nor'easter is a macro-scale storm whose winds come from the northeast, especially in the coastal areas of the Northeastern United States and Atlantic Canada. More specifically, it describes a low pressure area whose center of rotation is just off the coast and whose leading winds in the left forward quadrant rotate onto land from the northeast. The precipitation pattern is similar to other extra-tropical storms. They also can cause coastal flooding, coastal erosion and gale force winds. As with hurricanes, coastal areas of the State tend to be affected most by Nor'easters because of their proximity to the ocean, but all parts of New Jersey have some exposure to the hazard, and past effects have been widespread.

Nor'easters are usually formed by an area of vorticity associated with an upper level disturbance or from a kink in a frontal surface that causes a surface low pressure area to develop. Such storms often move slowly in their latter, frequently intense, mature stage. Until the nor'easter passes, thick dark clouds often block out the sun. During a single storm, the precipitation can range from a torrential downpour to a fine mist. Low temperatures and wind gusts of up to 90 miles per hour are also associated with nor'easters. Figure 4.4-3-1 below describes the different intensities of Nor'easter storms.

Figure 4.4.3.1-1
The Dolan-Davis Nor'easter Intensity Scale

Storm Class	Beach Erosion	Dune Erosion	Overwash	Property Damage
1 (*Weak*)	Minor Changes	None	No	No
2 (*Moderate*)	Modest; mostly to lower beach	Minor	No	Modest
3 (*Significant*)	Erosion extends across the beach	Can be significant	No	Loss of many structures at local level
4 (*Severe*)	Severe beach erosion and recession	Severe dune erosion or destruction	On low beaches	Loss of structures at community level
5 (*Extreme*)	Extreme beach erosion	Dunes destroyed over extensive areas	Massive in sheets and channels	Extensive at regional-scale; millions of dollars

The Atlantic coast, from northern Georgia northward up the coast, can suffer high winds, pounding surf and extremely heavy rains during these storms. Nor'easters cause a significant amount of severe beach erosion in these areas, as well as flooding in low-lying areas. Beach residents in these areas may actually fear the repeated depredations of nor'easters over those of hurricanes, because they happen more frequently, and cause substantial damage to beach-front property and their dunes. The northeastern United States, from New Jersey to the New England coast, Quebec and Atlantic Canada see nor'easters each year, most often in the winter and early spring, but also sometimes during the autumn. These storms can leave inches of rain or several feet of snow on the region, and sometimes last for several days.

4.4.3.2 Previous Nor'easter Occurrences

Nor'easter storms can wreak significant damage for New Jersey. Four of the past six nor'easters have been severe enough to result in Presidential disaster declarations. Table 4.4.3.2-1 describes these events.

Table 4.4.3.2-1
New Jersey Presidential Disaster Declarations for Nor'easter Storms

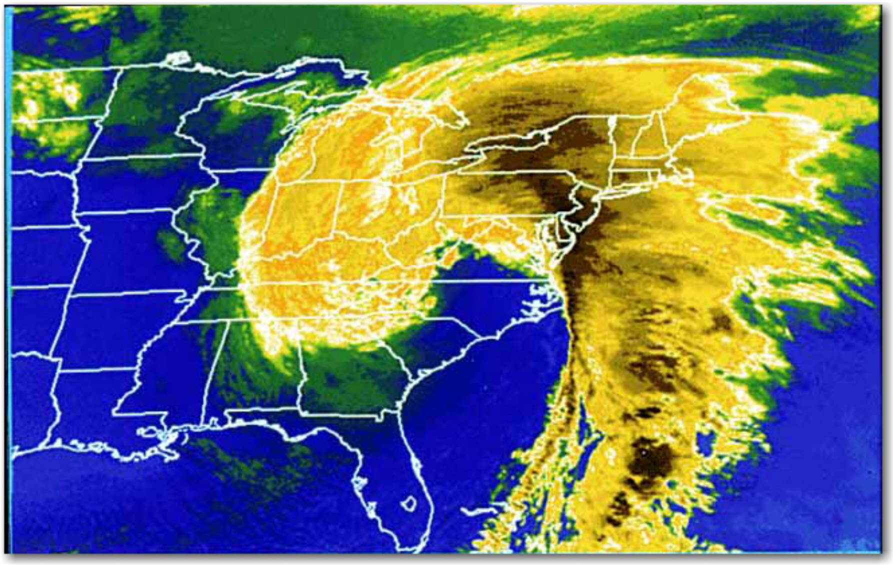
Date(s)	Description
March 6-8, 1962	FEMA Disaster # 124: The most damaging northeast storm since the 1888 Blizzard struck New Jersey. Although this storm did not produce record surge levels, it inflicted substantially greater overall damages and loss of life than any other storm. This was primarily due to the prolonged duration of the storm that caused damaging over wash and flooding through five successive high tides. Increased development along the coast since the 1944 hurricane also accounted for increased damages. This storm was also responsible for the loss of 22 lives, completely destroyed 1,853 homes and caused major damage to approximately 2,000 additional homes. The total damage caused by this storm to public and private property was about $85 million (1962 dollars).
December 18, 1992	FEMA Disaster #973: This storm impacted Ocean, Monmouth, Atlantic, Cape May, Cumberland, Bergen, Salem, Middlesex, Somerset, Union, Essex, Hudson counties. Public Assistance, Individual Assistance, Hazard Mitigation Programs were granted with the total eligible amount of $51.0 million Public Assistance (25% state share $12.5 million) $10.5 million Individual Assistance (25% state share $1.32 million) $ 2.2 million Hazard Mitigation. In addition 238 municipalities were eligible for Public Assistance.
March 3, 1998	FEMA Disaster # 1206: A severe Nor'easter in February impacted Atlantic, Cape May, and Ocean counties. Various programs were activated for Public Assistance, Individual Assistance, and Hazard Mitigation. The dollar amounts awarded were: Public Assistance $2.2 million (12.5% state share, 12.5% local share) Disaster Housing Program $1.1 million Individual/Family Grant Program $88,184 million ($28,000 state share) Hazard Mitigation $477,000.
April 26, 2007	FEMA Disaster # 1694: This was one of the worst Nor'easter storms to hit New Jersey in several decades. While filing for federal disaster relief, acting Governor Codey of New Jersey indicated that the storm caused $180 million in property damage in New Jersey, making it the second-worst rain storm in its history, after Hurricane Floyd. Individual and Public Assistance programs were issued for Bergen, Burlington, Essex, Passaic, Somerset, Camden, Mercer, and Union Counties. Public Assistance was issued for Atlantic, Hudson, Middlesex, Sussex and Warren Counties. Gloucester County for Individual Assistance.

Two other significant storms caused severe damage to parts of the State in 1994 and 1996, but were not declared Presidential disasters. A storm occurred on December 22, 1994 and dissipated on December 26. This storm caused $17 million in damages. The long duration of north winds pushed New Jersey tides 2.5 feet above normal, leading to significant coastal erosion and flooding.

Another storm moved into New Jersey on October 18, 1996 and due to climactic conditions became stationary, raining on New Jersey through October 23rd. Record rainfall, flooding, and high winds affected New Jersey from Morris County to Middlesex County to Hunterdon County. Hundred-year floods were reached on various streams in Morris, Somerset, and Union Counties. Thousands of electrical customers lost power.

The Storm of March 1993 (Figure 4.4-3-2) was considered a Super Storm and is often referred to as "the Perfect Storm". New Jersey did not receive a Presidential Declaration for this event.

Figure 4.4.3.2-1
The "Super Storm" of March, 1993 (NOAA)



4.4.3.3 Probability of Nor'easters

As with any weather phenomenon, it is nearly impossible to assign probabilities to Nor'easters, except over the long-term. New Jersey experiences one or two storms every year that could potentially be classified as Nor'easters, but not all of these are severe enough to cause significant damages or result in disaster declarations.

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4.4.4 Winter Storms

4.4.4.1 Nature of the Winter Storm Hazard

Heavy snowfall and extreme cold can immobilize an entire region. Even areas that normally experience mild winters can be hit with a major snowstorm or extreme cold. Winter storms can result in flooding, storm surge, closed highways, blocked roads, downed power lines and hypothermia. The following descriptions provide the commonly used definitions of winter storms:

- Winter storm. A storm with significant snowfall, ice, and/or freezing rain; the quantity of precipitation varies by elevation.
  - Non-mountainous areas - heavy snowfall is 4 inches or more in a 12-hour period, or 6 or more inches in a 24-hour period
  - Mountainous areas - 12 inches or more in a 12-hour period or 18 inches or more in a 24-hour period
- Blizzard. A storm with considerable falling and/or blowing snow combined with sustained winds or frequent gusts of 35 mph or greater that frequently reduces visibility to less than one-quarter mile.

These storms derive their energy from the clash of two air masses of substantially different temperatures and moisture levels. An *air mass* is a large region above the Earth, usually about 1,000-5,000 km in diameter, with a fairly uniform temperature and moisture level. In North America, winter storms usually form when an air mass of cold, dry, Canadian air moves south and interacts with a warm, moist air mass moving north from the Gulf of Mexico. The point where these two air masses meet is called a *front*. If cold air advances and pushes away the warm air, it forms a *cold front*. When warm air advances, it rides up over the denser, cold air mass to form a *warm front*. If neither air mass advances, it forms a *stationary front*.

(http://teacher.scholastic.com/activities/wwatch/winter_storms/).

Winter storms affect the entire State of New Jersey about equally, and are responsible for many deaths each year. Of reported deaths, more than 33 percent were attributed to automobile and other accidents; about 30 percent to overexertion, exhaustion, and consequent heart attack; about 13 percent to exposure and freezing; and the rest to combustion heater fires, carbon monoxide poisoning in stalled cars, falls on slippery walks, electrocution from downed wires, and building collapse. Communications systems and medical care delivery can be disrupted during winter hazard conditions, exacerbating hazards already part of the winter experience. Some of these deaths may be eliminated through the application of better forecasting and mitigation measures.

Older people are particularly sensitive to overexposure because of their economic and physical condition. Often senior citizens do not feel they have the income to heat their homes properly and they leave their homes far less heated than they should. In addition, senior citizen's changing sensitivities to heat and cold often result in their not realizing the temperatures they are experiencing are dangerously low. This leads to increased stresses on the body, especially when exerting themselves outside.

4.4.4.2 Snow

Heavy snow accumulations can immobilize a region and paralyze a city, stranding commuters, stopping the flow of supplies, and disrupting emergency and medical services. Ice storms can be accompanied by high winds, and they have similar impacts, especially to trees, power lines, and residential utility services. New Jersey, because of its unique location at a climactic crossroads and distinctive geography, experiences the full effect of all four seasons, and winter is no exception. Snowstorms are the most obvious manifestation of intense winter weather.

The most common conditions for snowstorm formation begin with the formation of a storm-system somewhere in a crescent-shaped zone running from Texas through the northern Gulf of Mexico to the Atlantic Ocean waters off Georgia and the Carolinas. Storm centers moving northeast pass near Cape Hatteras and continue over the Ocean toward Cape Cod and Nantucket. If this mass of air meets a northeast already cooled by cold arctic air, a snowstorm can form. Snow begins in cooling clouds as water droplets freezing around an ice-covered particle of matter. Once the ice crystal grows large enough to leave the cloud, it falls as a snowflake. If the air into which the snow is falling through has not cooled sufficiently, the snow will ultimately fall as rain.

The trajectory of the storm center, whether it passes close to the New Jersey coast or at a distance, largely determines both the intensity and the duration of the snowfall over the State. The zone of heaviest snowfall across New Jersey usually occurs in the southwest-to-northeast strip about 150 miles wide, approximately parallel to the path of the storm center, and about 125 and 175 miles northwest of it. (Figure 4.4-4-1 Average Yearly Snowfall) If the center passes well offshore, only South Jersey receives substantial snowfall. When the track passes close to shore, warm air from the Ocean is drawn into the surface circulation, resulting in rain falling over South Jersey and snow over the rest of the State. Often, a passing storm center brings rain to the South, mixed precipitation to central sections and snow to the north.

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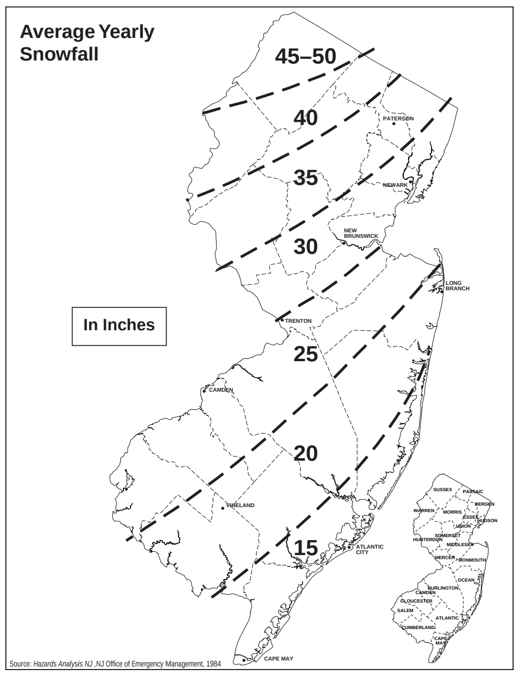
Figure 4.4-4.2-1

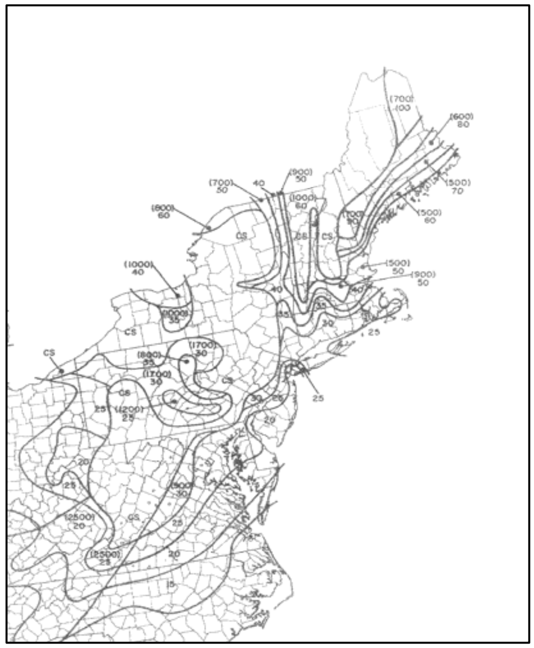
Average Annual Snowfall

in New Jersey



Seasonal snowfall in New Jersey varies from an average of about 15 inches at Atlantic City to about 50 inches in Sussex County. There is, however, great variability from year to year. In addition, February is the month when maximum accumulations on the ground are usually reached. After three major snows in February 1961, total accumulations reached 30 to 50 inches from Trenton to the Highlands

Figure 4.4.4.2-2
Ground Snow Loads (pounds per square foot) for the Northeastern United States



Source: Ground snow loads in pounds per square foot with a 2% probability of being exceeded. Based on American Society of Engineers Standards ASCE 7-98, Minimum Design Loads for Buildings and Other Structure, and referenced in FEMA 55CD, Coastal Construction Manual, 3rd Edition.

Most extreme snowfall events occur as the result of strong low pressure systems moving to the north, northeast off of the coast of New Jersey from early winter through mid-spring. If the conditions are right, these coastal lows transport Atlantic moisture over a cold layer of air over New Jersey resulting in extremely high snowfall rates and occasionally blizzard conditions. Between 1926 –2010 significant snowfalls have occurred in 1933, 1947, 1958, 1961, 1978, 1996, 2001, 2003, and 2010, with the greatest single day snowfall of 28.4 inches occurring along the coast in Long Branch, NJ on December 26, 1947

www.ncdc.noaa.gov/servlets/SCoptions?state=1111&short=28).

Beyond disruption to transportation, the main hazard associated with snow is the weight of the frozen liquid on buildings and utilities. The ground snow load in pounds per square foot varies with the amount of water content in the ice crystals that make up the snow. Large snowfalls with low water content can generate the same snow load as a light snowfall with high water content. Ground snow loads in pounds per square foot with a 2% probability of being exceeded have been tabulated by the American Society of Engineers Standard ASCE 7-98, Minimum Design Loads for Buildings and Other Structures. Snow loads with a 1 in 50 chance of occurring over 100 years range from 20 lb/sq. ft. south of the Atlantic City Expressway and along the Atlantic Ocean coast to over 35 lb/sq.ft. in Northwester New Jersey. Extreme variations in snow loads within the Highlands section of New Jersey require the use of specific engineering case studies to determine appropriate ground snow loads.

4.4.4.3 Ice Storms

Although snow is the weather phenomenon most commonly associated with winter, ice storms are a much greater winter menace. The freezing rain that coats all objects in a sheath of ice can cause power outages, structural damage, and damaging tree falls. Ice storms occur when rain droplets fall through freezing air and but do not freeze until they touch objects such as trees, roads, or structures. A clear icy sheath, known as a glaze, forms around branches, structures and wires and has been known to bring down high-tension utility, radio, and television transmission towers.

All regions of New Jersey have been and continue to be subject to ice storms. Besides temperature, their occurrence depends on the regional distribution of the pressure systems, as well as local weather conditions. The distribution of ice storms often coincides with general distribution of snow within several zones in the State. A cold rain may be falling over the southern portion of the State, freezing rain over the central region, and snow over the northern counties as a coastal storm moves northeastward offshore. A locality's distance to the passing storm center is often the crucial factor in determining the temperature and type of precipitation during a winter storm.

Normally experiencing lower temperatures on most winter days, the north has a greater chance of all types of winter storms occurring. Elevation can play a role in lowering the temperature to cause ice and snow to form on hilltops while valley locations remain above freezing, receiving only rain or freezing rain. Often a difference of only one or two hundred feet can make a difference between liquid rain, adhering ice, and snow. Essex County's Orange Mountains, with an elevation of only two hundred feet above the valley, have on occasion been locked in an icy sheath while valley residents have experienced only rain. Conversely, ice storms may occur in valleys and not on hilltops if cold air gets trapped in the valleys of regions with greater relief.

4.4.4.4 Cold Waves and Wind Chill

Two dangers of winter do not even involve precipitation. A cold wave, as used in the U.S. National Weather Service, a rapid fall in temperature within 24 hours to temperatures requiring substantially increased protection to agriculture, industry, commerce, and social activities and involves both the rate of temperature fall and the minimum to which it falls. A cold wave is classified as a rapid drop of 20 degrees, to below between 28 and 10 degrees, depending on the time of year and whether the drop occurs in the southern or northern half of the State.

The extreme northwest corner of New Jersey can expect temperatures as low as zero degrees almost every year, and the State's entire northwest quarter about once every two years. In this section of New Jersey, the combined effects of latitude, topography, and elevation create favorable radiational cooling conditions at night, with low temperatures resulting. A second area of lower temperatures is found in the Pine Barrens, where the flat terrain and strong radiational quality of the sandy soil produce low temperatures. The central part of Burlington County, the center of the Pine Barrens, can expect a zero reading once every two years.

The central and south coasts are the least susceptible to zero temperatures, with a zero reading occurring less than once every ten years. Urban complexes, such as Newark and Trenton, can expect a zero reading only once or twice in ten years, because of the heat-island effect resulting from the retention of heat by buildings and pavements, the reduction of nocturnal radiation by pollution-laden atmosphere, input of heat into the atmosphere from fossil fuel combustion, and emanation of waste heat from heated and cooled buildings.

Wind chills can make winter a more dangerous. Very strong winds combined with temperatures slightly below freezing can have the same chilling effect as a temperature nearly 50 degrees F lower in a calm atmosphere. Arctic explorers and military experts have developed what is called the "wind-chill factor", which calculates an equivalent calm-air temperature for the combined effects of wind and temperature. In effect, the index describes the cooling power of air on exposed flesh and to a lesser extent a clothed person. Wind-chill temperatures throughout New Jersey annually fall below zero a number of times each winter, with wind chills in Northwestern New Jersey occasionally reaching 30 degrees F below zero.

4.4.4.5 Winter Storm Occurrences

New Jersey's middle latitude location results in snow falling in all portions of the state each winter. There have been several unusual winters in the past century when measurable snow (greater than or equal to 0.1") has failed to fall or been almost absent over southern portions of the state, but these are rare exceptions. On average, seasonal snowfall totals 10"-20" in the southern third of the state, 20"-30" in the central third and 30"-40" in the lower elevations of the northern third. The higher northern locations receive 40"-60". These averages are not particularly meaningful, as inter-annual variations may be on the order of feet. Two winters within the past decade exemplify the variability. Statewide, the winter of 1997/98 was one of the least snowy on record (1972-73 had the least snow). Less than 5" fell in most of southern and central NJ, with only the northwest corner of the state having close to half of their annual average. Conversely, the winter of 1995/96 was the snowiest on record in NJ. As much as 110" fell at High Point, with record breaking amounts, as much as 20" over former records, in northeast and central NJ. Less snow fell to the south, however totals still were commonly twice or more the annual average.

At the New Jersey State Climatologist internet link extreme long-term averages for daily temperatures, precipitation totals and snowfall totals at forty stations in New Jersey can be found:
http://climate.rutgers.edu/stateclimate

New Jersey has had its share of wintry weather. Since 1950 there have been 641 winter weather events (snow, ice, and freezing rain) recorded for the State of New Jersey. These events caused $69.7 million in property damages and are responsible for eight deaths and 47 related injuries. Table-4-1 below summarizes significant winter storm events by county.

Table 4.4.4.5-1
New Jersey Snow and Ice Storm Events by County, 1950-2010
(Source: NOAA National Climatic Data Center)

County	Number of Events	Deaths	Injuries	Property Damage
Atlantic	93	2	2	30.1M
Bergen	43	0	0	0
Burlington	122	1	27	27.7M
Camden	106	1	10	27.7M
Cape May	68	1	10	13.9M
Cumberland	93	1	10	30.1M
Essex	45	0	0	0
Gloucester	107	0	10	27.7M
Hudson	36	0	0	0
Hunterdon	141	1	33	8M
Mercer	120	1	33	19M
Middlesex	116	2	33	19M
Monmouth	105	2	8	19.1M
Morris	169	1	33	19M
Ocean	104	0	10	27.7M
Passaic	63	0	0	0
Salem	102	0	10	28.2M
Somerset	123	1	33	19M
Sussex	244	1	37	20.2M
Union	36	0	0	0
Warren	180	1	33	19M
	Total 2216			

Table 4.4.4.5-2
Summary of Notable Winter Storm Events in New Jersey

Date(s)	Storm Type	Description
February 7, 1978	Blizzard	This blizzard caused an estimated $24 million in damage, primarily to dunes, beaches, and public facilities along the beachfront.
January 7, 1996	Blizzard	A State of Emergency was declared for the blizzard that hit the State. Snowfall amounts ranged from 30 inches in southern interior sections to 14 inches in coastal areas. Road conditions were dangerous due to the high winds and drifts. Because of these road conditions, a non-essential travel ban was issued and mass transit operations were suspended. Both government and contract snow plowing operations were running at a maximum. Local roads were impassable. This blizzard also brought on coastal flooding with the high tides of Sunday evening and Monday morning, and there were reports of damage to dunes and beaches from the heavy wave activity. Evacuations were instituted in Cape May, Ocean and Monmouth counties. A total of nine Red Cross Shelters were opened, and provided equipment for two community shelters. More than 400 National Guard personnel were activated for transport assistance, primarily for medic missions.
February 16, 2003	Snow Storm	The combination of the very cold temperatures and the approach of a strong storm system caused widespread snow to break out, starting before sunrise on Sunday, February 16th. Snow continued during the day Sunday, heavy at times, and continued into Sunday night before mixing with and changing to sleet and rain in the southeastern part of the state later Sunday night. Precipitation continued on Monday, before finally coming to an end on Tuesday. When all was said and done, a significant snowfall occurred across the entire state of New Jersey. Total snowfall across New Jersey ranged from 12 to 24 inches. The President's Day snowstorm tied or set records in all 21 New Jersey counties, and all municipalities were involved in states of emergency. New Jersey requested and was granted a Snow Emergency Declaration.
February 5-6 and 9-10, 2010	Snow Storm	A strong Nor'easter impacted the state from Friday evening February 5th through Saturday the 6th. The highest accumulations occurred in the southern half of the state, with snow totals of 20-30 inches common from Camden and Atlantic counties southward. Winds up to 50 mph produced blizzard conditions in the southeastern part of the state during the morning of the 6th. Cape May County was particularly hard hit, with 70,000 homes and business losing power. A second storm occurred within the same week on the 9th and 10th. However, storm totals were not as much as the 5th-6th event, snowfall was still significant and averaged 7 to 15 inches across northwest New Jersey, 12 to 20 inches across central New Jersey and 6 to 12 inches across the southern third of New Jersey. Though snowfall totals were lighter in southern NJ, the weight of additional rain and snow on top of the previous storm's heavy snowpack led to several roof collapses, tree damage, and about 100,000 new power outages.

4.4.6 . Probability of Winter Storms

As shown above in Table 4.4.4.5-1, the NCDC reports 2,216 ice and snow events in New Jersey between 1950 and 2010. This translates to 7.7 events per year (note that only those reported to NCDC are included in the total and average). The period of time over which this data is provided suggests that probability of winter storms will be about the same in the future, with year-to-year variations.

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4.4.5 Tornadoes and High Winds

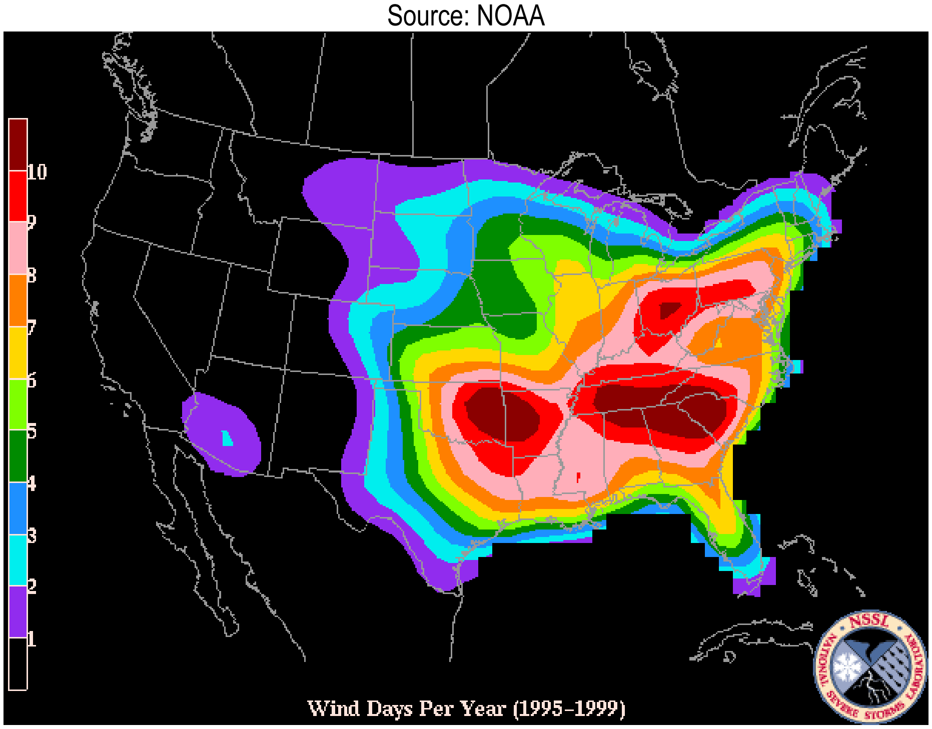
Note: Future editions of the NJ State Hazard Mitigation Plan will include updated information on Wind and Tornado

4.4.5.1 Nature of the Tornado and High Wind Hazard

The State of New Jersey is susceptible to high winds from several sources – most notably thunderstorms and hurricanes/tropical storms, which can all spawn tornadoes and straight line winds. High straight-line winds related to thunderstorms affect nearly all areas of the State equally, although tornadoes are relatively uncommon in the northeast part of the U.S. compared to the central and south-central States. The potential for a tornado strike is about equal across New Jersey, except in the northern parts of the State, which generally have steeper terrain, are less likely to experience tornadoes.

Included below as Figure 4.4.5.1-1 is NOAA's national probability map for thunderstorm winds. For New Jersey it shows a moderate probability of 6-8 wind days per year (yellow and orange color).

Figure 4.4.5.1-1
Wind Days per Year (1995-1999)
Source: NOAA



4.5.5.2 Tornadoes

These are nature's most violent storms and can cause fatalities and devastate a neighborhood in seconds. A tornado appears as a rotating, funnel-shaped cloud that extends from a thunderstorm to the ground with whirling winds that can reach 250 miles per hour. Damage paths can be in excess of one mile wide and 50 miles long. Before a tornado hits, the wind may die down and the air may become very still. A cloud of debris can mark the location of a tornado even if a funnel is not visible. Tornadoes generally occur near the trailing edge of a thunderstorm. It is not uncommon to see clear, sunlit skies behind a tornado. Tornadoes are typically developed from either a severe thunderstorm or hurricane as cool air rapidly over-rides a layer of warm air. This causes the warm air to rise rapidly as a funnel shaped cloud.

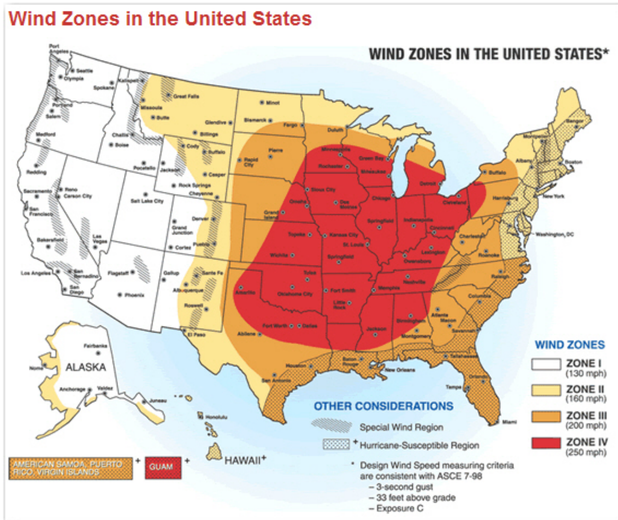
The most violent tornadoes are capable of tremendous destruction with wind speeds of 250 mph or more. The severity of tornadoes is measured by the Fujita Scale and illustrated in Table 4.4-5.2-1 below. This table provides the level of destruction which may occur with each level of intensity.

Table 4.4.5.2-1
Enhanced Fujita Tornado Intensity Scale
(Source: National Weather Service)

Enhanced F-Scale Number	Intensity Phrase	Second Gust (MPH)	Type of Damage Done
F0	Gale	65–85	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages to sign boards.
F1	Moderate	86–110	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Significant	111–135	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe	136–165	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted.
F4	Devastating	166–200	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	Incredible	Over 200	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel re-enforced concrete structures badly damaged.

Tornado season in New Jersey is generally March through August, though tornadoes can occur at any time of year. Over 80 percent of all tornadoes strike between noon and midnight. Approximately five tornadoes occur each year within the State, and in general, they tend to be weak. Figure 4..4.5.4-1 is from ASCE 7-98, and depicts design wind speeds for the United States. New Jersey is in Zone II, but the entire State is also in a hurricane-susceptible region. See Subsection 4.4-2 (hurricane hazard profile) for more information about the potential for hurricane winds to impact the State.

Figure 4.4.5.2-1
United States Wind Zones (ASCE 7-98, 3-second gust, 3 meters above grade)



4.4.5.3 Thunderstorms

Along with high winds, thunderstorms can bring other hazards including lightning and flash flooding. In the United States, an average of 300 people is injured and 80 people are killed each year by lightning. Dry thunderstorms that do not produce rain that reaches the ground are most prevalent in the western United States. Falling raindrops evaporate, but lightning can still reach the ground and can start wildfires. Thunderstorms affect relatively small areas when compared with hurricanes and winter storms. The typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Despite their small size, thunderstorms are dangerous. Of the estimated 100,000 thunderstorms that occur each year in the United States, about 10 percent are classified as severe. (FEMA.gov)

During the warm season, thunderstorms are responsible for most of the rainfall. Cyclones and frontal passages are less frequent during this time. Thunderstorms spawned in Pennsylvania and New York State often moves into Northern New Jersey, where they often reach maximum development in the evening. This region has about twice as many thunderstorms as the coastal zone, where the nearby ocean helps stabilize the atmosphere. (http://climate.rutgers.edu/stateclim_v1/njclimoverview.html). The conditions most favorable to thunderstorm development occur between June and August, with July being the peak month for all weather stations in New Jersey.

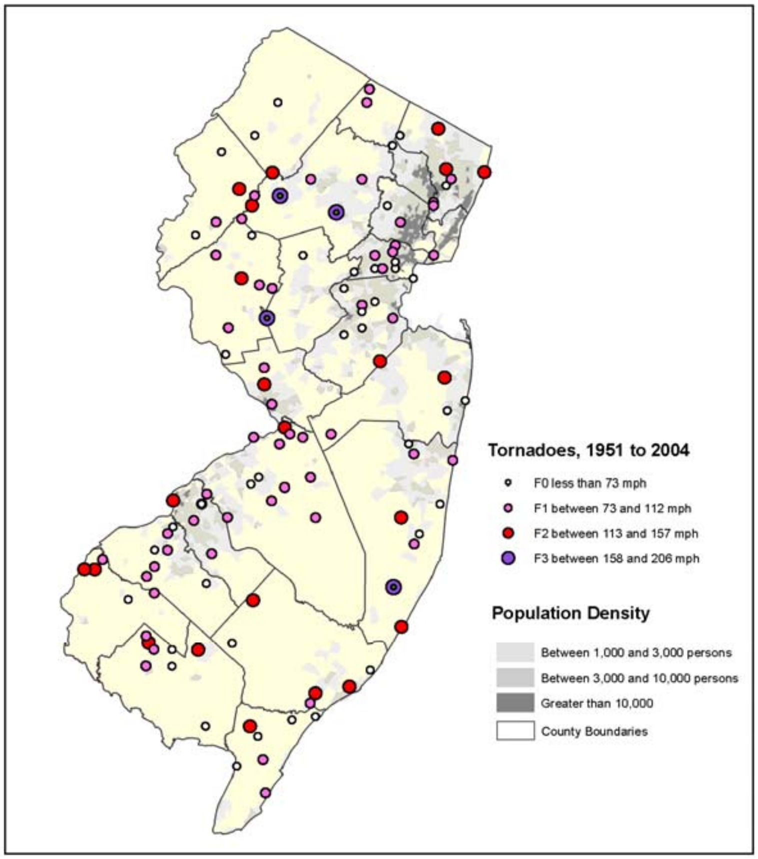
Straight line winds and microbursts, though not contained in tornadoes, can still reach very high speeds and are in fact for a much greater volume of injuries and damage. Quite often, straight-line winds are associated with thunderstorms and their intense downbursts; however, any frontal passage, storm, or significant gradient between high and low pressure zones in the region can be result in damaging winds. These winds have been known to cause tornado like damage and even be mistaken for tornadoes to the untrained observer. Straight-line winds occur more often in areas with large expanses unbroken by buildings or geographic relief and as with tornadoes are associated with thunderstorms. They often cause extensive crop damage

4.4.5.4 Previous Tornado and High Wind Occurrences

In an analysis of tornado occurrence per square mile, New Jersey ranks number 20 in the United States for the frequency of tornadoes, number 30 for injuries per area, and number 23 for costs per area.

Figure 4.4.5.4-1 shows the historic distribution of tornadoes in the State, including an indicator of intensity.

Figure 4.4.5.4-1
Historic Tornado Distribution and Intensity in the State of New Jersey



Map prepared by New Jersey Office of Emergency Management January 2007. Source: Population density statistics originated from the United States Bureau of Census 2000. Tornado touchdown points and wind speeds originated from the National Weather Service, Storm Prediction Center, September 2005. Contact address: NOAA Storm Prediction Center, SPC Warning Coordination Meteorologist, 1313 Halley Circle, Norman, OK 73069.

Table 4.4.5.4-1 summarizes the number of tornadoes that have impacted New Jersey during the 59 year period between 1950 and 2009.

Table 4.4.5.4-1
Tornadoes affecting New Jersey from 1950 to 2009
(Source NOAA, National Climatic Data Center)

Tornado Magnitude	Total Occurrences Within New Jersey 1951 to 2009
F-0	47
F-1	63
F-2	27
F-3	4

- The most costly tornado in New Jersey history occurred on July 13, 1975 and caused $25 million in property damage.

- The most recent tornado occurred on July 29, 2009. An F-2 tornado touched down in Wantage Township in Sussex County at about 248 p.m. EDT. It was the first confirmed tornado in Sussex County since August of 1990, the first tornado of F2 strength ever in the county since records started in 1950 and the first tornado to reach F2 or F2 strength in New Jersey since the Manalapan tornado of May 27, 2001. The tornado remained on the ground for 6.6 miles before it crossed the border into New York State. Its maximum width was about 100 yards and its highest estimated wind speed was 120 mph. The tornado damaged thousands of trees, decimated acres of farmland and some rural property. Total property damage from this event was $800,000.

Table 4.4.5.4-2 - Annual Tornado Summary, State of New Jersey, 1950-2010

Year	Tornadoes	Deaths	Injuries	Total Damages
1951	1	0	2	**$ 25,000**
1952	4	0	0	**$ 78,000**
1955	1	0	0	**$0**
1956	4	0	8	**$ 50,000**
1957	1	0	0	**$ 250,000**
1958	4	0	1	**$ 528,000**
1960	6	0	6	**$ 303,000**
1962	3	0	1	**$ 500,000**
1964	6	0	10	**$ 1,275,000**
1967	1	0	0	**$ 25,000**
1970	2	0	0	**$ 275,000**
1971	3	0	0	**$ 750,000**
1973	8	0	12	**$ 536,000**
1974	2	0	0	**$ 0**
1975	3	0	0	**$ 25,275,000**
1976	1	0	0	**$ 250,000**
1977	2	0	1	**$ 250,000**
1979	2	0	1	**$ 253,000**
1980	1	0	0	**$25,000**
1981	3	0	0	**$ 250,000**
1982	1	0	0	**$ 2,500,000**
1983	1	0	0	**$ 2,500,000**
1985	3	0	8	**$ 0**
1986	1	0	0	**$ 250,000**
1987	9	0	3	**$ 259,000**
1988	6	0	1	**$ 3,253,000**
1989	17	0	2	**$ 8,828,000**
1990	8	0	11	**$ 6,000,000**
1991	1	0	0	**$ 3,000**
1992	4	0	0	**$ 500,000**
1993	2	0	0	**$ 503,000**
1994	7	0	0	**$ 10,575,000**
1995	5	0	0	**$ 0**
1996	2	0	0	**$ 10,000**
1997	2	0	0	**$ 103,000**
1998	3	0	0	**$ 3,050,000**
1999	2	0	1	**$ 4300,000**
2001	2	0	0	**$ 1,015,000**
2003	7	1	0	**$ 2,100,000**
2004	2	0	2	**$ 600,000**
2006	1	0	0	**$ 100,000**
2009	1	0	0	**$1,000,000**
Total	**145**	**1**	**70**	**$ 78,347,000**

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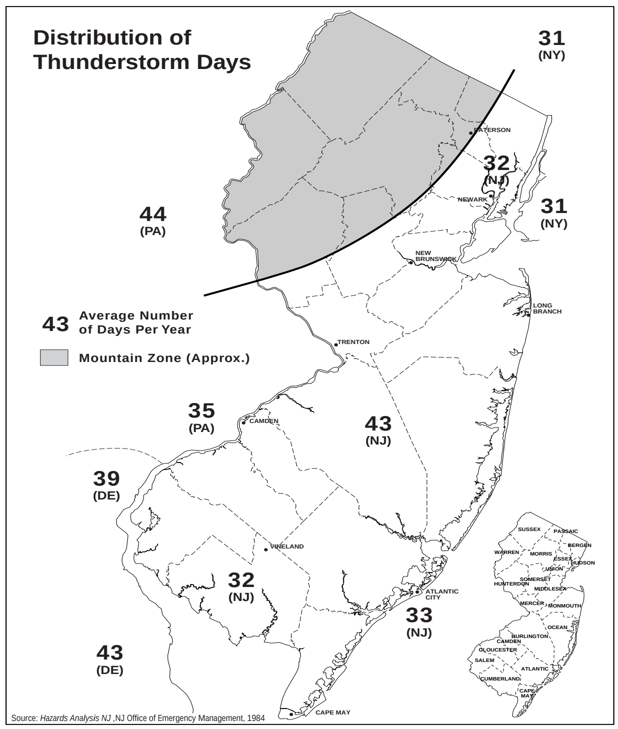
Year	Tornadoes	Deaths	Injuries	Total Damages
Average	**2.5**	**.02**	**1.19**	**$1,327,915**

Source: National Climatic Data Center

For the State, an average of thirty thunderstorms a year occurs for each locality, with more storms occurring in the northwestern portion of the state than the eastern portion (Figure 4.4.5.4-2 Distribution of Thunderstorm Days). This is because the passage of air masses most commonly associated with storms and other weather phenomenon, known as frontal passages, is in a generally west to east direction. Thus, thunderstorms created in New York State and Pennsylvania are carried into New Jersey. Geologic relief in Pennsylvania, New York and northern New Jersey enhance the intensity and frequency of thunderstorm development, which is why there are more thunderstorms in the northern portion of the State. As a result, Sussex County experiences twice as many thunderstorms as Cape May County.

Figure 4.4.5.4-2 Distribution of Thunderstorm Days in New Jersey

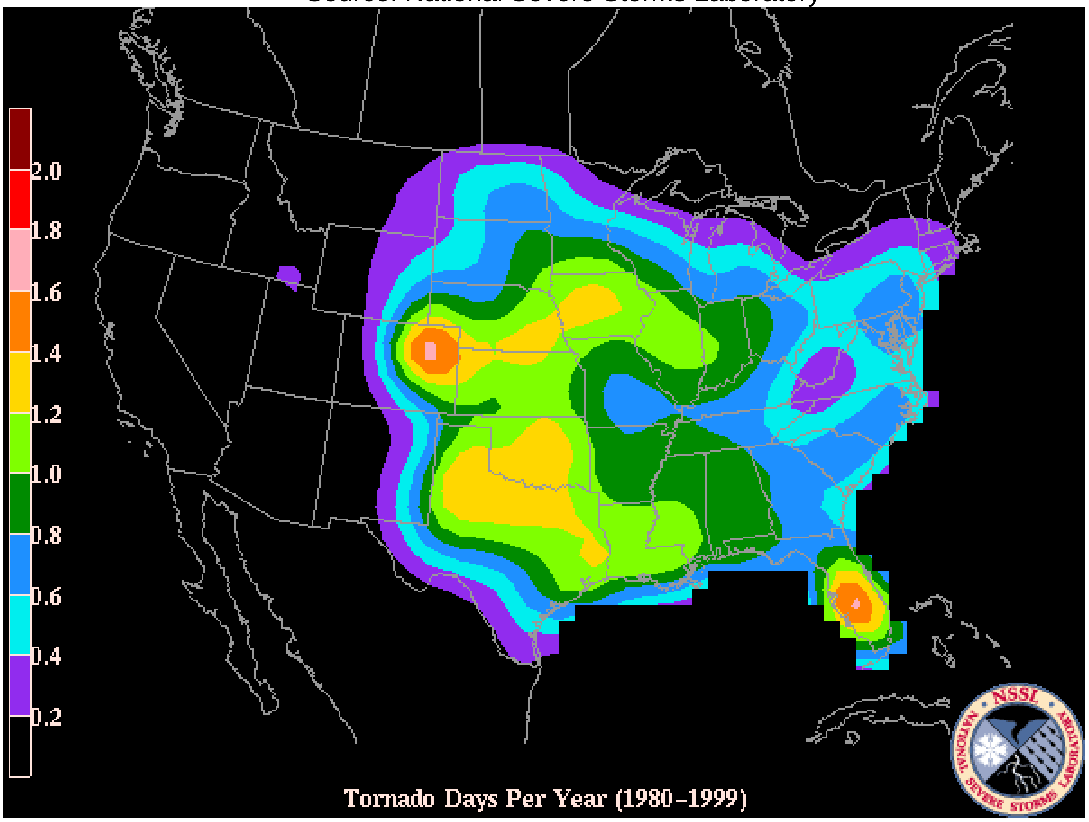


4.4.5.5 Probability of Future Occurrences

Tornado distribution throughout the State is uncertain and does not exhibit readily identifiable patterns. Therefore, the areas selected for the vulnerability analysis at highest risk are those of highest urbanization. Recent advances in technology and prediction methodologies have enabled the Storm Prediction Center of the National Weather Service to provide the public with up to a 15-minute warning of an approaching tornado compared to only three minutes in 1978. This advance warning will definitely reduce deaths and injuries associated with tornadoes, and may also reduce property damage, at least at the fringes of the path, by allowing loose objects to be better sheltered or secured.

A recent study from NOAA's National Severe Storms Laboratory provided highly accurate and accessible estimates of the long-term threat from tornadoes. Using historical data, the NSSL estimated the daily probability of a tornado occurring near any location in the U.S for any tornado no matter how strong or weak (i.e., no matter what its magnitude). The NSSL map below (Figure 4.4.5.5-1) can be used to obtain these estimates. For example, the NSSL estimates a probability for any tornado of "0.6 to 0.8 days per year in New Jersey.

Figure 4.4.5.5-1
Tornado Days Per Year (1980-1999)
Source: National Severe Storms Laboratory



Although exact tornado probability is impossible to determine, given the relatively long reporting period, it is reasonable to assume that the average annual statewide figure will remain relatively constant in the future. Note however, the numbers of deaths, injuries, and dollar amount of damages can fluctuate drastically depending on the severity of the tornados and the locations that they impact.

Thunderstorms and associated high winds are a fairly regular occurrence in the State, and it is reasonable to expect that the frequency of such events will remain about the same as it has been in the past.

4.4-6 Earthquakes

Note: This unit will be updated with additional information in future editions of the NJ State Hazard Mitigation Plan.

4.4.6.1 Nature of the Earthquake Hazard

In the popular press, earthquakes are often described by their Richter Magnitude (M). Magnitude is a measure of the total energy released by an earthquake. In addition to Richter magnitude, there are several other measures of earthquake magnitude used by seismologists, but such technical details are beyond the scope of this discussion. It is important to recognize that the Richter scale is not linear, but rather logarithmic. A Magnitude (M) 8 earthquake is not twice as powerful as an M4, but rather thousands of times more powerful. An M7 earthquake releases about 30 times more energy than an M6, while an M8 releases about 30 times more energy than an M7, and so on. Thus, great M8 earthquakes may release hundreds or thousands of times as much energy as do moderate earthquakes in the M5 or M6 range.

It is often assumed that the larger the magnitude of an earthquake the "worse" the earthquake. Thus, the "big one" is the M8 earthquake and smaller earthquakes (M6 or M7) are not the "big one". However, this is true only in very general terms. Larger magnitude earthquakes affect larger geographic areas, with much more widespread damage than smaller magnitude earthquakes. However, for a given site, the magnitude of an earthquake is not a good measure of the severity of the earthquake at that site. Rather, the intensity of ground shaking at the site depends on the magnitude of the earthquake and on the distance from the site to the earthquake.

An earthquake is located by its epicenter - the location on the earth's surface directly above the point of origin of the earthquake. Earthquake ground shaking diminishes (attenuates) with distance from the epicenter. Thus, any given earthquake will produce the strongest ground motions near the epicenter with the intensity of ground motions diminishing with increasing distance from the epicenter. Thus, for a given site, a moderate earthquake (such as an M5.5 or M6.0) which is very close to the site could cause greater damage than a much larger earthquake (such as an M7.0 or M8.0) which is quite far away from the particular site. However, earthquakes at or below M5 are not likely to cause significant damage, even locally very near the epicenter. Earthquakes between about M5 and M6 will cause damage near the epicenter. Earthquakes of about M6.5 or greater will cause major damage, with larger earthquakes resulting in greater damage over increasingly large areas.

The intensity of ground shaking from an earthquake, and the resulting damage, varies not only as a function of M and distance, but also depends on soil types. Soft soils may amplify ground motions and increase the level of damage. Thus, for any given earthquake there will be contours of varying intensity of ground shaking. The intensity will generally decrease with distance from the earthquake, but often in an irregular pattern, reflecting soil conditions (amplification) and possible directionality in the dispersion of earthquake energy.

There are many measures of the severity or intensity of earthquake ground motions. A very old scale, but still commonly used, is the Modified Mercalli Intensity scale (MMI), which is a descriptive scale that relates severity to the types of damage experienced. MMIs range from I to XII. For reference, the MMI intensity scale is shown below. However, it is important to note that these descriptions are not particularly applicable to modern buildings and that for any level of ground shaking, damage patterns for specific buildings or infrastructure will vary markedly depending on the specific vulnerabilities of each facility.

Table 4.4.6.1-1

Modified Mercalli Intensity Scale of 1931[1]

Mercalli Intensity	Equivalent Magnitude[2]	Effects
I	1.9	Not felt except by a very few under especially favorable circumstances.
II	2.5	Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended object may swing.
III	3.1	Felt quite noticeably indoors, especially on upper floors of building but many people do not recognize it as an earthquake. Standing motorcars may rock slightly. Vibration like passing of truck. Duration estimated.
IV	3.7	During the day, felt indoors by many, outdoors by few. At night, some awakened. Dishes, windows, doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing motorcars rocked noticeably.
V	4.3	Felt by nearly everyone, many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop.
VI	4.9	Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.
VII	5.5	Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well--built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motorcars.
VIII	6.1	Damage slight in specially designed structures; considerable in ordinary substantial buildings, with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motorcars disturbed.
IX	6.7	Damage considerable in specially designed structures; well designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.
X	7.3	Some well--built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from riverbanks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.
XI	7.9	Few, if any, (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.
XII	8.5	Damage total. Waves seen on ground surfaces. Lines of sight and level distorted. Objects thrown upward into air.

1 Abridged (Wood and Neumann, 1931). Wording is that of Wood and Neumann. Effects on cars, trucks and buildings built according to modern standards may be different.

2 Magnitude values were estimated using the formula: magnitude = 1.3 + (0.6 maximum intensity).

Source: Wood and Neumann (1931), Bulletin of Seismological Society of America, Volume 21.

More useful, modern intensity scales use terms that can be physically measured with seismometers, such as the acceleration, velocity, or displacement (movement) of the ground. The most common physical measure, and the one used in this mitigation plan, is Peak Ground Acceleration, or PGA. PGA is a measure of the intensity of shaking, relative to the acceleration of gravity (g). For example, 1.0 G PGA in an earthquake (an extremely strong ground motion) means that objects accelerate sideways at the same rate as if they had been dropped from the ceiling. 10% G PGA means that the ground acceleration is 10% that of gravity, and so forth.

Damage levels experienced in an earthquake vary with the intensity of ground shaking and with the seismic capacity of structures as can be seen in table below.

Table 4.4.6.1-2
Damage Levels Experienced in Earthquakes (relative to acceleration of gravity)

Ground Motion Percentage	Explanation of Damages
1-2% G	Motions are widely felt by people; hanging plants and lamps swing strongly, but damage levels, if any, are usually very low.
Below 10% G	Usually cause only slight damage, except in unusually vulnerable facilities.
10-20% G	May cause minor to moderate damage in well-designed buildings, with higher levels of damage in poorly designed buildings. At this level of ground shaking, only unusually poor buildings would be subject to potential collapse.
20-50% G	May cause significant damage in some modern buildings and very high levels of damage (including collapse) in poorly designed buildings.
50% + G	May causes higher levels of damage in many buildings, even those designed to resist seismic forces.

The level of seismic hazard – the frequency and severity of earthquakes – is substantially lower in New Jersey than in more seismically active States such as California or Alaska. However, the level of seismic risk – the threat to buildings, infrastructure, and people – is significant in New Jersey, especially in the northern part of the State. The level of seismic *risk* (i.e. potential damages) in New Jersey is higher than might be expected because the vast majority of the buildings and infrastructure in New Jersey have been built with minimal or no consideration of earthquakes. Thus, the inventory of buildings and infrastructure in New Jersey is much more vulnerable to earthquake damage than the buildings and infrastructure in more seismically active States where much of the inventory has been built with consideration of earthquakes.

In New Jersey, earthquakes are most likely to occur in the northern parts of the State, where significant faults are concentrated. However, low-magnitude events can and do occur in many areas of the State. The New Jersey Geological Survey and the U.S. Geological Survey have compiled considerable bodies of information about earthquake hazards across the State, as discussed below. It is important to recognize that earthquake risk (the potential for damage) is determined by factors other than proximity to faults. As discussed in this section, the nature of soils and the vulnerability of the built environment are also significant determinants of risk.

For New Jersey, major damaging earthquakes are low probability events. However, when they do occur they may have very high consequences because of the nature of the built environment in the State, much of which (particularly older structures) was not designed to withstand the stresses induced by shaking forces. Generally speaking, the effects of high-severity (and hence relatively lower probability) hazards are more difficult and expensive to mitigate than are hazards with higher probabilities and lower consequences.

4.4.6.2 Previous Earthquake Occurrences in New Jersey

The New Jersey Geological Survey has compiled records of over 150 earthquakes in New Jersey, with most of these in the northern part of the State. However, nearly every County in New Jersey has experienced at least one earthquake. Most of these earthquakes have been too small to cause damage. Figure 4.4.6.2-1 shows the locations of these earthquakes, along with their magnitudes.

Historically, there have been four earthquakes noted that caused damage in the State:

1. New York City, 1737
2. West of New York City, 1783
3. New York City, 1884
4. New Jersey Coast near Asbury, 1927

The magnitudes of these earthquakes, based on reported damage patterns, were probably approximately M5.0 to M5.5 (Richter). Damage in New Jersey from these earthquakes was relatively minor, and included building damage such as chimney collapse and objects falling from shelves.

Historically New Jersey also felt several large earthquakes which caused major damage near their epicenters: Cape Ann, Massachusetts in 1755, Charleston, South Carolina in 1886, and three large earthquakes near New Madrid, Missouri in 1811 and 1812.

Figure 4.4.6.2-1

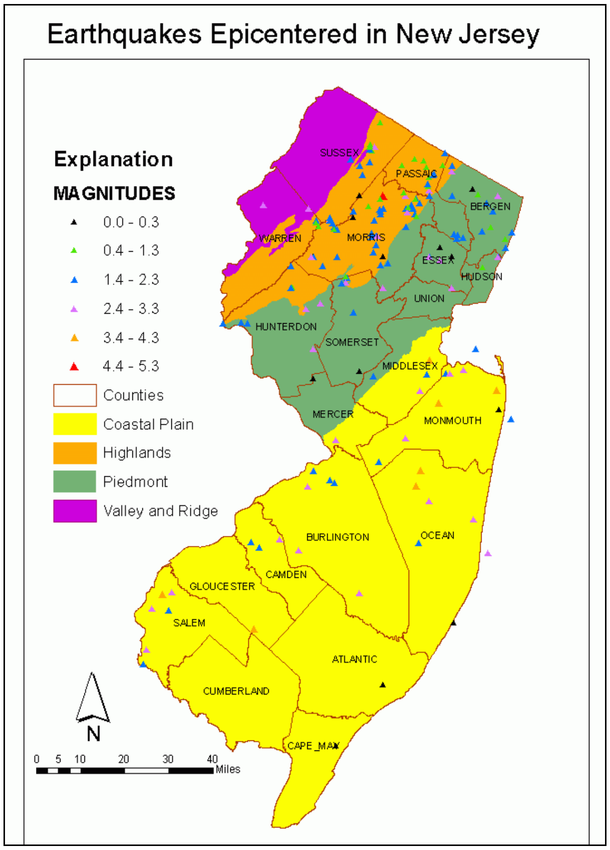


Figure 4.4.6.2-3 below (provided by NJGS) presents historical earthquake epicenters spatially across the Northeast, illustrating and indicating, through areas of historical earthquake groupings, a generally higher incidence and magnitude of earthquakes. Figure 4.4.6.2-2 was prepared by the GIS section of NY SEMO using NYS Geological Survey; National Institute of Building Sciences data.

Figure 4.4.6.2-2
Reserved

The level of seismic hazard in New Jersey – the probability and severity of earthquakes – varies markedly with location with the State. It is not possible to predict exactly when and where future earthquakes will occur. Thus, seismic hazard is expressed in probabilistic terms. The following figures show the levels of ground shaking (PGA, peak ground acceleration, in percent of G, the acceleration of gravity) with 10% and 2% probabilities of being exceeded in any 50-year time period. These maps are national consensus, United States Geological Survey estimates, which are used in building codes (along with other maps showing spectral acceleration values) and for seismic risk assessments.

The 10% in 50-year and 2% in 50-year contour maps shown below represent probabilistic ground motions that are expected to occur, on average, about once every 500 years and about once every 2500 years, respectively. However, earthquakes with these levels of ground motions could occur anytime time. For example, over the next 10 years, there is about a 2% chance of experiencing the 10% in 50-year ground motions and about a 0.4% chance of experiencing the 2% in 50-year ground motions at any location in New Jersey.

As shown by the seismic hazard maps below, the level of seismic hazard is highest in northern New Jersey, especially in the northeast corner of the State. Within this area, the level of seismic hazard is especially high in locations underlain by soft soils because soft soil sites amplify earthquake ground motions resulting in much higher levels of shaking (and damage) than on nearby firm soil or rock sites. The following geologic map for the seven counties in northeastern New Jersey with the highest level of seismic hazard shows areas of soft soils where the level of seismic hazard and risk is especially high.

Figure 4.4.6.2-3
USGS 10% in 50-Year Earthquake Ground Motions for Northeast U.S.

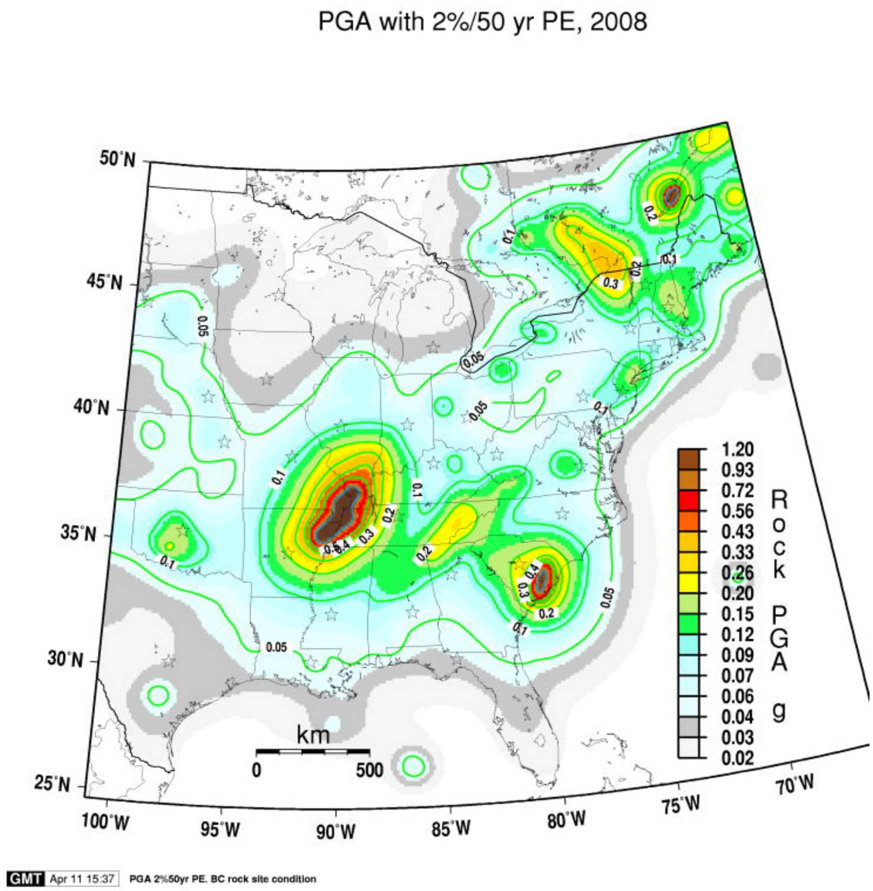
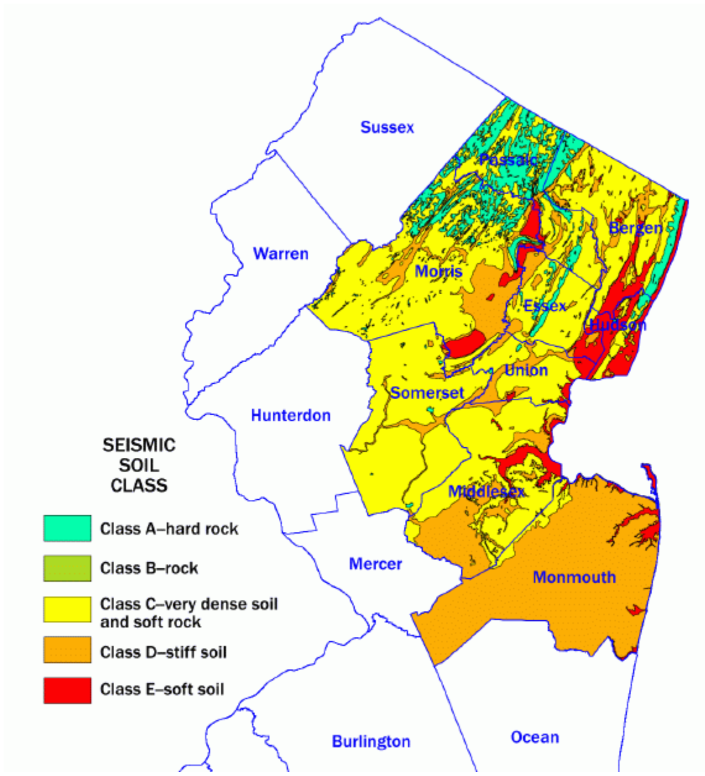


Figure 4.4.6.2-4
Rock-Soil Class Map for Northeastern New Jersey



Source: New Jersey Geological Survey, Earthquake Loss Estimation Study for New Jersey (www.State.nj.us/dep/njgs)

4.4.6.3 Probability of Earthquakes

In any given year, the probability of damaging earthquakes affecting New Jersey is low. Nevertheless, current understanding of the seismicity in the northeastern United States, as reflected in the USGS seismic hazard maps shown above is conclusive: there is a definite threat of major earthquakes which could cause widespread damages and casualties in New Jersey. Major damaging earthquakes are infrequent in New Jersey and may occur only once every few hundred years or longer, but the consequences of major earthquakes would be very high.

As shown in the figures above, the 10% in 50-year ground motions are about 6% g shaking in northeastern New Jersey, 4% to 6% in much of northern New Jersey and below 4% in southern New Jersey. At these levels of shaking, the potential for damage to buildings or infrastructure is very low, with only very minimal damage expected, even for rather vulnerable facilities.

As shown in Figure 4.4.6.2-4, the 2% in 50-year ground motions are much higher than the 10% in 50-year ground motions. The ground motions are above 20% G in northeastern New Jersey, above 16% G for all of northern New Jersey, and 8% to 16% G for southern New Jersey. At these levels of shaking, there would be substantial damages to vulnerable buildings and infrastructure, especially in northern New Jersey.

However, a very important aspect of seismic hazards in New Jersey is that the expected levels of ground shaking from future earthquakes depends only on location within the State, but also on soil conditions at specific locations. The levels of ground shaking shown on the figures above are for rock sites. Locations underlain by firm soils, and especially locations underlain by soft soils, will experience significantly higher levels of ground shaking than nearby locations on rock sites. For firm soil sites, ground motions are likely to be as much as 40% to 60% higher than shown above. For very soft soil locations, ground motions are likely to be from 70% to as much as 250% higher than shown above.

For the 10% in 50- ground motions, the levels of shaking, for firm soil sites are expected to be below 10% G. At such levels of shaking, the potential for damage to buildings and infrastructure is generally low, with low levels of damage for most structures, even vulnerable structures, with only extremely vulnerable structures perhaps experiencing major damage. However, for the 10% in 50-year ground motions, the levels of shaking for soft soil sites in northern New Jersey would be in the 10% to 15% G range. At this level of shaking, many vulnerable structures may have low to moderate levels of damage, with highly vulnerable structures experiencing major damage.

For the 2% in 50-year ground motions, levels of shaking on firm soil sites would be in the 15% to 25% G range for much of the State. At such levels of shaking, widespread damage to vulnerable structures is expected. For soft soil sites, levels of shaking would be above 20% G for much of the State and above 30% G in northeastern New Jersey. At such levels of shaking very widespread damage is expected, with heavy damage to many vulnerable structures, and possible collapse of some highly vulnerable structures.

A very important characteristic of earthquake risk is that it is not uniform. Rather, earthquake damage is always concentrated in the most vulnerable buildings and infrastructure. The building types most vulnerable to earthquake damage include: un-reinforced masonry, pre-cast concrete buildings, tilt-up buildings, and some concrete frame buildings. Buildings of the above structural systems may be especially vulnerable if they have soft first stories and very irregular configurations.

Most wood frame buildings perform relatively well in earthquakes, with two exceptions. Buildings with cripple wall foundations and buildings with sill plates not bolted to the foundation are very vulnerable to earthquake damage. Cripple wall foundations are short stud walls which raise the first floor two or three feet above grade; these walls are subject to collapse in earthquakes if not adequately braced.

Infrastructure that may be especially vulnerable includes some types of older bridges, especially multispan bridges, and high voltage (220 kV or higher) electric substations with unanchored transformers and non-seismically rated equipment.

The level of risk – the threat to buildings, infrastructure and people – from earthquakes in New Jersey is addressed in the following section, which includes quantitative earthquake loss estimates.

4.4.6.4 HAZUS Earthquake Loss Estimates for Seven Northeastern New Jersey Counties

The New Jersey Geological Survey used FEMA's HAZUS Loss Estimation software to make quantitative loss estimates for several scenario earthquakes. The scenario was run in seven counties in northeastern New Jersey: Bergen, Essex, Hudson, Middlesex, Morris, Passaic, and Union. Summary results are given in Table 4.4.6.4-1 below.

For each County, five scenario earthquakes were considered: M5.0, M5.5, M6.0, M6.5, and M7.0 with an epicenter at the centroid of the County and a depth of 10 kilometers. Two sets of geologic rock/soil data were evaluated: a) the default rock-soil data in HAZUS and b) updated New Jersey-specific rock/soil data compiled by the New Jersey Geological Survey. The New Jersey-specific data are more accurate. Thus, the results summarized below all reflect the HAZUS runs using the New Jersey-specific rock/soil data. The New Jersey-specific rock/soil resulted in somewhat lower damage estimates than the default HAZUS results in areas of rock or very firm dense soils and higher damage estimates in areas of soft, liquefiable soils.

Table 4.4.6.4-1 (3 units)
HAZUS Scenario Earthquake Loss Estimates for Seven New Jersey Counties
(conducted by the New Jersey Geological Survey)

M5.0 Scenario: Upgraded Geology

County	Damage or Loss Estimate ($millions)									Max PGA (g)
	Damaged Buildings[1]	Heavily Damaged Buildings[2]	Property Damage $millions	Business Interuption Loss $millions	Injuries[3]	Injuries[4]	Deaths[5]	Displaced Households	People Needing Shelter	
Bergen	12,800	400	$1,080	$80	80	11	1	240	150	0.37
Essex	8,800	200	$1,410	$90	92	11	1	270	230	0.36
Hudson	5,786	298	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Middlesex[6]	12,500	500	$1,160	$50	245	30	<20	320	190	0.37
Morris[6]	9,000	1,000	$1,350	$50	325	75	<20	1,300	315	n/a
Passaic[6]	5,000	500	$550	$50	315	100	30	1,300	315	n/a
Union[6]	11,000	<1000	$1,200	$50	190	30	<20	370	250	0.38

M6.0 Scenario: Upgraded Geology

County	Damage or Loss Estimate ($millions)									Max PGA (g)
	Damaged Buildings[1]	Damaged Buildings[2]	Property Damage $millions	Business Interuption Loss $millions	Injuries[3]	Injuries[4]	Deaths[5]	Displaced Households	People Needing Shelter	
Bergen	99,900	12,000	$5,670	$1,610	1,902	367	36	9,900	1,610	0.68
Essex	71,700	9,800	$6,970	$1,890	2,742	506	48	19,270	16,310	0.69
Hudson	27,445	5,546	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Middlesex[6]	110,000	12,500	$5,950	$1,250	4,300	1,075	250	12,000	7,500	0.68
Morris[6]	85,000	18,500	$6,350	$800	3,150	895	185	15,500	3,150	1.00
Passaic[6]	55,000	10,500	$3,700	$50	2,500	800	190	5,500	1,300	1.00
Union[6]	85,000	11,500	$5,650	$1,200	3,750	1,025	250	12,500	9,000	0.69

M7.0 Scenario: Upgraded Geology

County	Damage or Loss Estimate ($millions)									Max PGA (g)
	Damaged Buildings[1]	Damaged Buildings[2]	Property Damage $millions	Business Interuption Loss $millions	Injuries[3]	Injuries[4]	Deaths[5]	Displaced Households	People Needing Shelter	
Bergen	133,000	47,500	$15,160	$5,530	8,980	2,156	223	38,690	22,710	1.19
Essex	79,300	36,900	$66,180	$6,110	11,054	2,553	273	66,180	55,700	1.21
Hudson	25,293	22,363	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Middlesex[6]	130,000	50,000	$15,500	$3,650	17,500	5,750	1,300	42,500	27,000	1.20
Morris[6]	105,000	55,000	$17,900	$2,150	10,000	2,815	315	42,500	8,500	2.00
Passaic[6]	75,000	37,500	$10,450	$1,500	9,000	2,880	750	47,500	12,500	2.00
Union[6]	80,000	5,500	$16,650	$4,300	23,500	8,150	1,950	60,500	42,000	1.21

[1] Damaged buildings with slight or moderate damage.
[2] Damaged buildings with extensive or complete damage
[3] Injuries requiring medical treatment, but not hospitilization
[4] Injuries requiring hospitilization
[5] Death estimates in HAZUS are given for daytime and for nightime earthquakes. Nightime casualties are typically much lower than daytime casualties because most people are in wood frame residential buildings which are less vulnerable to collapse than commercial masonry or concrete buildings. Time of day is unspecified for the estimates shown above, per the published New Jersey HAZUS summaries.
[6] Values shown are midpoints of ranges given in the HAZUS Summary

4.4.6.5 Limitations of the HAZUS Results

The results displayed in the table above should be interpreted cautiously because they are more like worst-case scenarios than typical earthquakes for New Jersey. First, each scenario earthquake is assumed to be located at the centroid of a County. The historic record shows a clustering of earthquakes in northeastern New Jersey and adjacent New York. This observation is the reason why the contours of ground motion in New Jersey are highest at the extreme northeast corner of the state and systematically decrease to the west and south.

Second, for earthquakes within New Jersey or nearby, the most likely significant earthquakes are in the M5 to M5.5 magnitude range, with earthquakes of larger magnitude being possible but very unlikely. An M7.0 earthquake is probably the largest magnitude earthquake possible anywhere in the northeastern United States and adjacent parts of Canada. While such an earthquake is possible, it very unlikely to occur in or very near New Jersey.

In combination, the above two factors mean that the return periods for the scenario earthquakes modeled in the HAZUS runs are very long – somewhat above 2,500 years for the smaller M5.0 or M5.5 scenarios and well above 2,500 years for the M6.0 or larger scenarios. Thus, the levels of ground shaking and the corresponding levels of damage expected for more likely earthquakes affecting New Jersey will be substantially lower than any of the scenarios summarized and drastically lower than the M7.0 scenario results.

A further caveat on the scenario results presented below is that each earthquake scenario was evaluated only for damages within a single County. More realistically, these scenarios would also result in significant damages and casualties in adjacent and nearby counties. Thus, for example, building damages for the M7.0 scenario in Bergen County are shown as about $15 billion. For New Jersey overall, building damages could be several times the Bergen County estimate, with most of the damage in adjacent counties. In interpreting the loss estimates above, it is important to remember that all of these results are much more like worst case scenarios and not representative of the major damaging earthquakes most likely to affect New Jersey. The most likely damaging earthquakes for New Jersey would be moderate size earthquakes, roughly M5.0 to M5.5. Earthquakes on these faults would affect the counties nearest the epicenter most strongly, but would have effects in all of the northern New Jersey counties, with minor effects perhaps extending to mid- or southern New Jersey as well.

The above caveats notwithstanding, the scenario results for M5.0 and M5.5 earthquakes are reasonably representative of the damage expected from New Jersey earthquakes with these magnitudes, although the damages will not be limited to a single County. For earthquakes of similar magnitudes in New York, damage levels in New Jersey will be less, depending on the distance to the epicenter.

4.4.6.6 Statewide Earthquake Loss Estimates for New Jersey

As discussed above the most likely earthquakes affecting New Jersey are M5.0 or M5.5 earthquakes in northeastern New Jersey or adjacent New York. Loss estimates for individual counties for earthquakes representative of such earthquakes were shown above for the seven northeastern counties. Each of these scenario earthquakes was postulated to be at the centroid of a given County. For such earthquakes, the Statewide impacts can be estimated approximately. For such small to moderate earthquakes most of the damage will be near the epicenter, within the County in which the earthquake occurs. For a M5.0 earthquake in any of these seven counties, the Statewide loss estimates are likely to be approximately 50% to 100% more than the single County estimate, with total property damage in the $2 billion range, with perhaps several hundred injuries and possibly a few deaths. Such an event would be roughly a once in 150-year event.

It is important to note that Statewide estimates or seven-County estimates cannot be made simply by summing the results because each County loss estimate represents a different earthquake (at the centroid of each County). Thus, for example, the seven M5.0 loss estimates represent seven different earthquakes.

For larger earthquakes, such as M6.0 or M7.0, the most likely epicenters would also be in these seven northeastern Counties. For such larger earthquakes, damaging effects occur over wider geographic areas and thus the ratio of Statewide losses to the losses in the County where the earthquake occurred would be higher than for the M5.0 scenarios discussed above. For an M6.0 earthquake, statewide losses would likely be 2 or 3 times the single County losses. Total property damage might be in the $10 billion to $15 billion range, with perhaps 5,000 or 10,000 injuries and a few dozen to possibly a few hundred deaths. Such damage would be highly concentrated in the nearest County to the epicenter and in adjacent counties, with very limited damage in more distant counties.

For an M7.0 earthquake, which would represent the worst case scenario for New Jersey, with return periods in the many thousands of years, the Statewide losses would likely be 5 to 10 times higher than the single County estimates, with total property damages roughly in the $50 billion to $100 billion range, with tens of thousands of injuries and perhaps over 1,000 deaths. These damages would be concentrated in the nearest County to the epicenter and in adjacent counties, with some damage in further away counties. However, even a very large M7.0 earthquake in northeastern New Jersey would have only minor effects in central New Jersey and nearly negligible effects in southern New Jersey.

4.4.6.7 Extrapolation of HAZUS Loss Estimates to All Counties in New Jersey

As an alternative to the general estimates described in the paragraphs above, the HAZUS Total Economic Loss (TEL) figures for an M5.5 earthquake (for the seven Counties for which such estimates have been calculated) are used to extrapolate potential loss figures for the other Counties in the State. As estimated by HAZUS, TEL values for the seven studied Counties average 2.9% of the total exposure (i.e. total value of assets). For this table, a simple extrapolation as 2.9% of total exposure was used for all Counties in the State. This data should be regarded as useful for planning purposes only, as it does not account for variations in the numerous factors that influence earthquake losses.

Table 4.4.6.7-1
Potential Earthquake Losses to New Jersey Counties,
as extrapolated from M5.5 HAZUS scenario Loss Calculation

County	$ Exposure [1000s]	Earthquake [1000s]
Atlantic	$27,652,015	$801,908
Bergen	$100,653,325	$2,918,946
Burlington	$50,946,874	$1,477,459
Camden	$50,021,816	$1,450,633
Cape May	$18,311,425	$531,031
Cumberland	$12,235,912	$354,841
Essex	$78,836,283	$2,286,252
Gloucester	$24,721,631	$716,927
Hudson	$53,814,871	$1,560,631
Hunterdon	$14,692,482	$426,082
Mercer	$40,721,537	$1,180,925
Middlesex	$79,240,485	$2,297,974
Monmouth	$64,432,550	$1,868,544
Morris	$67,233,273	$1,949,765
Ocean	$46,731,673	$1,355,219
Passaic	$45,121,076	$1,308,511
Salem	$6,080,176	$176,325
Somerset	$35,656,884	$1,034,050
Sussex	$15,132,181	$438,833
Union	$51,757,042	$1,500,954
Warren	$10,381,209	$301,055
Total		**$4,588,953**

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4.4.7 Drought

4.4.7.1 Nature of the Drought Hazard in New Jersey

Drought is a period of drier-than-normal conditions that results in community water issues. Low precipitation may also dry out soils and threaten agriculture. When precipitation is less than normal for long enough, stream flows decrease, water levels in lakes and reservoirs fall and the depth to reach well water increases. Although below-normal rainfall does not automatically result in drought conditions, persistent dry weather and water-supply issues may evolve into a drought emergency. Because droughts are generally the results of meteorological patterns, the entire State of New Jersey is about equally subject to their effects. As shown in Table 4.4-7-1, nearly every County in the State has experienced at least one drought in the past ten years. Droughts are partly a function of antecedent conditions, so areas that are already experiencing dry conditions are likely to experience more problems when meteorological droughts occur.

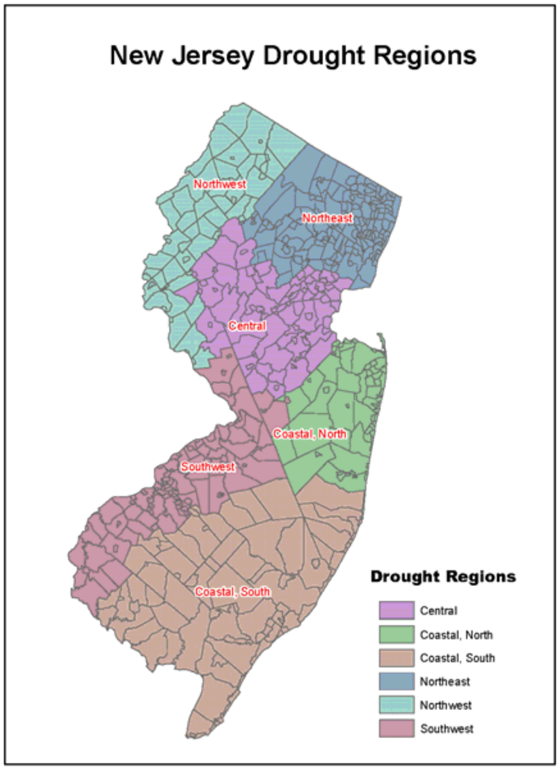
The first evidence of drought is usually recorded with below normal rainfall. Nevertheless, the impact of a drought on streams, river flows, and reservoir levels may not be evident for weeks or months. The water level in deep wells may take a year or more before showing drought impacts whereas shallow wells may be affected as quickly as streams are.

There are numerous nationally-used indices that measure average precipitation levels. Although none of the major indices are inherently superior in all circumstances, some indices are better suited than others for certain uses. The Palmer Index has been widely used by the U.S. Department of Agriculture to determine when to grant emergency drought assistance to states and municipalities. Although the Palmer Index is better suited for large areas of uniform topography it does not generally work well with areas that encompass differing regional environments. Palmer values generated typically lag emerging droughts by several months. Additionally, when conditions change from dry to normal or wet, the index indicates the drought termination without taking into account stream-flow, lake and reservoir levels and other longer term hydrologic impacts. The Palmer Index also neglects to measure the human impact on water balance such as irrigation.

During the New Jersey droughts that occurred during 1998 and 1999 the New Jersey Department of Environmental Protection had difficulty comparing the severity of drought throughout the state. To improve monitoring and measurement of drought severity from region to region, the New Jersey Department of Environmental Protection devised a unique set of indices specifically designed for the unique characteristics and needs of the state. These were implemented in January 2001. This new set of state-wide indicators supplements the Palmer Index with the measurement of regional precipitation, stream-flow, reservoir levels, and ground-water levels. New Jersey currently measures the status of each indicator as: near or above normal; moderately dry; severely dry; and extremely dry. The status is based on a statistical analysis of historical values with generally the driest 10% being classified as extremely dry, from 10%-30% as severely dry, and 30%-50% as moderately dry.

New Jersey is divided into six drought regions. The goal is to allow the State to respond to changing conditions without imposing restrictions on areas not experiencing water-supply shortages. As indicated in Figure 4.4.7.1-1 the regions are: Northeast, Central, Northwest, Southwest, Coastal North, and Coastal South. Each region is based on regional similarities in water-supply sources and rainfall patterns that correspond closely to natural watershed boundaries and municipal boundaries. These regions were developed based upon hydro geologic conditions, watershed boundaries, municipal boundaries, and water-supply characteristics. Drought region boundaries are contiguous with municipal boundaries because during a water emergency the primary enforcement mechanism for restrictions is municipal police forces.

Figure 4.4.7.1-1
New Jersey Drought Regions



As explained in the text that follows, when publicly monitoring and declaring the status of drought conditions, the State of New Jersey uses four condition levels: Drought Watch, Drought Warning, Water Emergency, and Drought Emergency Levels I through IV.

- *Drought Watch*: Indicates the New Jersey Department of Environmental Protection is closely monitoring drought indicators, including precipitation, stream flows, and reservoir and ground water levels and water demands. Under a drought watch, the public should begin voluntarily cutting back on water usage. The Commissioner of DEP is responsible for exercising non-emergency powers during a Drought Watch. Such non-emergency powers are used to develop alternative water supplies where necessary, rehabilitate and activate interconnections between water systems, and transfers water between different water systems.

- *Drought Warning*: A drought warning condition may be designated by the Commissioner of DEP as a non-emergency response to managing available water supplies. Under a designated drought warning, the DEP may order water purveyors to develop alternative sources of water and to transfer water around the State from areas with relatively more water those with less. The aim of this stage of a response to drought conditions is to avert a more serious water shortage that would necessitate declaration of a water emergency and the imposition of mandatory water use restrictions.

Table 4.4.7.1-1
Water Emergency Phases

Phases	Description of Emergency
Phase I	Restricts water use for non-commercial plants, cars, streets, hydrant flushing, etc.
Phase II-III	Water is allocated and rationed. These restrictions are enforced when there is substantial threat to public health.
Phase IV	Considered a disaster stage where public water service is interrupted. Public health and safety cannot be guaranteed and selective business and industrial closings are enforced.

- *Drought Emergency*: A drought emergency (also called a water supply emergency) can only be declared by the Governor. While drought warning actions focus on improving the supply of water, drought emergency actions focus on reducing water demands. During a water emergency that is imposed due to drought conditions, a phased approach to restricting water consumption may be initiated. Phase I of water use restrictions typically targets non-essential, outdoor residential water use. This includes water use for of non-commercial plants, cars, streets, hydrant flushing, etc.. While some indirect economic impacts may occur, the first phases of water use restrictions seek to avoid curtailment of water use by the agriculture and business sectors. Those who are uniquely impacted by the restrictions can apply for a hardship exemption. Phases II through IV restrictions may be instituted as drought conditions worsen and the need for more drastic measures become essential to preserve public health and safety. Phase II, and Phase III restrictions are enforced when there is substantial threat to public health and welfare. Water usage is allocated and rationed. Phase IV is considered a disaster stage where public water service is interrupted. Pubic health and safety cannot be guaranteed and selective business and industrial closings are enforced.

The New Jersey Department of Environmental Protection Commissioner has the authority to declare drought watches and warnings while only the State Governor declares or lifts drought/water emergencies.

4.4.7.2 Previous Drought Occurrences in New Jersey

Table 4.4.7.2-1
New Jersey Drought History and Location, 1995 to 2010 Source

Month of Drought Conditions	Counties of Impact	Brief Overview of Impact
March 1995	Camden, Cumberland, Atlantic, Cape May, Monmouth, Ocean, Gloucester, Hunterdon, Mercer, Middlesex, Morris, Burlington, Salem, Somerset	Precipitation 50% to 67% normal in northwest and southern NJ and as low as 40% normal in Cape May, Cumberland and Ocean Counties.

Month of Drought Conditions	Counties of Impact	Brief Overview of Impact
October 1997	Camden, Cumberland, Eastern Atlantic, Eastern Cape May, Eastern Monmouth, Eastern Ocean, Gloucester, Hunterdon, Mercer, Middlesex, Morris, Northwestern Burlington, Salem, Somerset, Sussex, Warren, Western Atlantic, Western Cape May, Western Monmouth, Western Ocean	New York City Reservoir fell below 40% below capacity. Salt line in Delaware River was located near Bridgeport, Gloucester County four miles farther north than normal.
December 1998	Camden, Cumberland, Eastern Atlantic, Eastern Cape May, Eastern Monmouth, Eastern Ocean, Gloucester, Hunterdon, Mercer, Middlesex, Morris, Northwestern Burlington, Salem, Somerset, Sussex, Warren, Western Atlantic, Western Cape May, Western Monmouth, Western Ocean	State forestry service extinguished 42 small wildfires the weekend of Dec. 5th and 6th. Grain farmers suffered serious losses of corn and late season crops. Reservoir levels fell. Saltwater line of Delaware River was at River Mile 85. This was 11 miles farther upstream than normal and increased corrosion control costs of industries.
January 1999	Camden, Cumberland, Eastern Atlantic, Eastern Cape May, Eastern Monmouth, Eastern Ocean, Gloucester, Hunterdon, Mercer, Middlesex, Morris, Northwestern Burlington, Salem, Somerset, Sussex, Warren, Western Atlantic, Western Cape May, Western Monmouth, Western Ocean	On January 5th, the Delaware River Basin Commission (DRBC) issued a conditional drought emergency. Heavy precipitation on the 3rd gave the area a temporary reprieve from going straight into a drought emergency.
July 1999	Camden, Cumberland, Eastern Atlantic, Eastern Cape May, Eastern Monmouth, Eastern Ocean, Gloucester, Hunterdon, Mercer, Middlesex, Morris, Northwestern Burlington, Salem, Somerset, Sussex, Warren, Western Atlantic, Western Cape May, Western Monmouth, Western Ocean	Through the 13th there were 44 forest fires in the state. Many shallow wells in northwest ran dry. Rivers and streams had 25 percent of normal flow. In an effort to maintain a flow of Delaware River, the Delaware River Basin Commission increased releases from the upstate New York reservoirs as well as Beltzville and Blue Marsh Lakes in Pennsylvania. Plant corrosion issues resulted from brackish water. Salt line along Delaware River was 12 miles farther north than usual. Livestock feed crops were at a near-total loss.
August/September 1999	Camden, Cumberland, Eastern Atlantic, Eastern Cape May, Eastern Monmouth, Eastern Ocean, Gloucester, Hunterdon, Mercer, Middlesex, Morris, Northwestern Burlington, Salem, Somerset, Sussex, Warren, Western Atlantic, Western Cape May, Western Monmouth, Western Ocean	Crops were decimated, especially grain and forage crops in the northern part of the state. Crop losses were estimated at $80 million dollars. Older wells failed in the northwest particularly Hunterdon and Sussex Counties. Field corn losses in the northern part of the state averaged between 75% to 10%. Many farms were close to total disaster. Livestock dealers auctioned off animals because they did not have enough food to feed them. The upstream advancing salt front along the lower Delaware River stressed fish and wildlife. Some groundwater supplies were also contaminated with the saltier water and had to be treated.

Month of Drought Conditions	Counties of Impact	Brief Overview of Impact
November 2001	Bergen, Eastern Passaic, Essex, Hudson, Union, Western Passaic	The combined storage in the 13 major water supply reservoirs serving northeast New Jersey was 35.3 billion gallons, which was 43.9% capacity. This storage was 4.7 billion gallons less than 1 month ago and 23.4 billion gallons less than 1 year ago.
November 2001	Camden, Cumberland, Eastern Atlantic, Eastern Cape May, Eastern Monmouth, Eastern Ocean, Gloucester, Hunterdon, Mercer, Middlesex, Morris, Northwestern Burlington, Salem, Somerset, Sussex, Warren, Western Atlantic, Western Cape May, Western Monmouth, Western Ocean	Sussex and Atlantic County shallow wells were drying up while permits for deeper wells were increasing. Twenty-five residents in Wawayanda (Sussex County) ran out of water. Winter crops such as rye and grasses were struggling. On a county weighted average, monthly precipitation totals ranged from 0.7 inches in Cape May County to 1.2 inches in Sussex and Warren Counties. All were less than 31% normal.
December 2001	Camden, Cumberland, Eastern Atlantic, Eastern Cape May, Eastern Monmouth, Eastern Ocean, Gloucester, Hunterdon, Mercer, Middlesex, Morris, Northwestern Burlington, Salem, Somerset, Sussex, Warren, Western Atlantic, Western Cape May, Western Monmouth, Western Ocean	Rainfall was below average for the last six consecutive months, which yielded an average deficit of 10.36 inches. The combined storage in the 13 major water supply reservoirs serving northeast New Jersey was 47.4% capacity, which was 30% below normal. Current levels stopped declining, comparable to the 1998-1999 drought levels. Capacities in the individual systems at the end of the month were: Newark Reservoirs 44.2% (percent capacity) Jersey City Reservoirs 53.1% North Jersey District 44.5% United Water of New Jersey 53.6%.
January 2002	Camden, Cumberland, Eastern Atlantic, Eastern Cape May, Eastern Monmouth, Eastern Ocean, Gloucester, Hunterdon, Mercer, Middlesex, Morris, Northwestern Burlington, Salem, Somerset, Sussex, Warren, Western Atlantic, Western Cape May, Western Monmouth, Western Ocean	Northern New Jersey reservoirs were at 42.9% of capacity rather than typical 80% capacity. Issues of salt water intrusion and corrosion became an issue for industries. Water treatment costs for municipalities that depend on the river for their water supply became an issue.
January 2002	Bergen, Eastern Passaic, Essex, Hudson, Union, Western Passaic	Precipitation was 50% of normal. The combined storage of 3 major reservoirs serving northeast New Jersey was 44% capacity, or 36% below normal.
February 2002	Camden, Cumberland, Eastern Atlantic, Eastern Cape May, Eastern Monmouth, Eastern Ocean, Gloucester, Hunterdon, Mercer, Middlesex, Morris, Northwestern Burlington, Salem, Somerset, Sussex, Warren, Western Atlantic, Western Cape May, Western Monmouth, Western Ocean	Continued dry weather, the drop in stream flow and groundwater levels reduced levels in the New York State reservoirs. This forced the New Jersey DEP to continue the drought warning for all New Jersey except Union, Middlesex and Somerset Counties. Unseasonably dry weather in February exacerbated the drought and forced several individual counties to declare water emergencies, especially in the northeast. Four northern New Jersey reservoirs remained 43% capacity or half normal level.

Month of Drought Conditions	Counties of Impact	Brief Overview of Impact
March/April/ May/June/July 2002	Camden, Cumberland, Eastern Atlantic, Eastern Cape May, Eastern Monmouth, Eastern Ocean, Gloucester, Hunterdon, Mercer, Middlesex, Morris, Northwestern Burlington, Salem, Somerset, Sussex, Warren, Western Atlantic, Western Cape May, Western Monmouth, Western Ocean	Northern reservoirs were at 40% capacity. Most surface streams were 25% normal. 500 wells throughout state needed replacement. Between Oct. and March the Forest Service responded to 1,116 wildfires. Many streams and ponds used to fight fires were dry. Incidences of salt water infiltrating wells occurred. Consequently many wells became brackish and unusable. The Governor estimated the drought cost farmers approximately $125 million. Crop revenue in some areas was reduced more than 50%.
August 2002	Bergen, Eastern Passaic, Essex, Hudson, Union, Western Passaic	The majority of the streams monitored had stream-flows in the 10 to 24 percentile, which was well below normal. The combined storage in the 13 major reservoirs serving Northeast New Jersey was 67.7% capacity, which was 10% to 15% below normal.
September 2002	Camden, Cumberland, Eastern Atlantic, Eastern Cape May, Eastern Monmouth, Eastern Ocean, Gloucester, Hunterdon, Mercer, Middlesex, Morris, Northwestern Burlington, Salem, Somerset, Southeastern Burlington, Sussex, Warren, Western Atlantic, Western Cape May, Western Monmouth, Western Ocean	Capacities of reservoirs on September 30th were: Newark Reservoirs 55.0% (percent capacity) Jersey City Reservoirs 62.5% North Jersey District 67.6% United Water of New Jersey 61.8%
October 2002	All 21 counties	Many New Jersey farmers suffered losses of 50% or more, notably in commodities such as corn and soybean. Combined farming losses approximately $125 million.
September 2005	Camden, Cumberland, Atlantic, Cape May, Monmouth, Ocean, Gloucester, Hunterdon, Mercer, Middlesex, Morris, Burlington, Salem, Somerset, Southeastern Burlington, Sussex, Warren, Western Atlantic	Lack of rain permitted rain to build on power lines. When rain occurred at end of month, 9,000 homes and businesses mainly in Atlantic and Cape May lost power. The heat scorched and damaged many agricultural plants. Entered drought watch on September 13, 2005 statewide. Rains in late September led to resuming normal conditions on October 14, 2005.
May to July 2006	All 21 counties	Entered drought watch May 8, 2006 statewide. Resumption of significant precipitation in June led to lifting of watch on July 3, 2006.

4.4.7.3 Probability of Drought

As shown in the table above, droughts of at least moderate severity occur at least every few years in New Jersey, and this pattern can reasonably be expected to continue going forward. This may be particularly true depending on the effects of global warming on the region.

4.4.8 Wildfires

4.4.8.1 Nature of the Wildfire Hazard in New Jersey

Wildfires represent a serious threat to life, property and natural resources. The Forest Fire Service was established in 1906 under N.J.S.A. Title 13, Chapter 9, "for the protection of forests, and property adjacent thereto, wherever the department shall determine the necessity therefore". The statute further states that, "The Legislature declares it to be the policy of the State to prevent, control, and manage wildfires on or threatening the forest or Wildland of New Jersey in order to preserve forests and other natural resources; to enhance the growth and maintenance of forests; to protect recreational, residential, wildlife, plant life, watershed, airshed, and other values; to promote the stability of forest using industries; and to prevent loss of life, bodily injury and damage to property from wildfire and conflagrations.

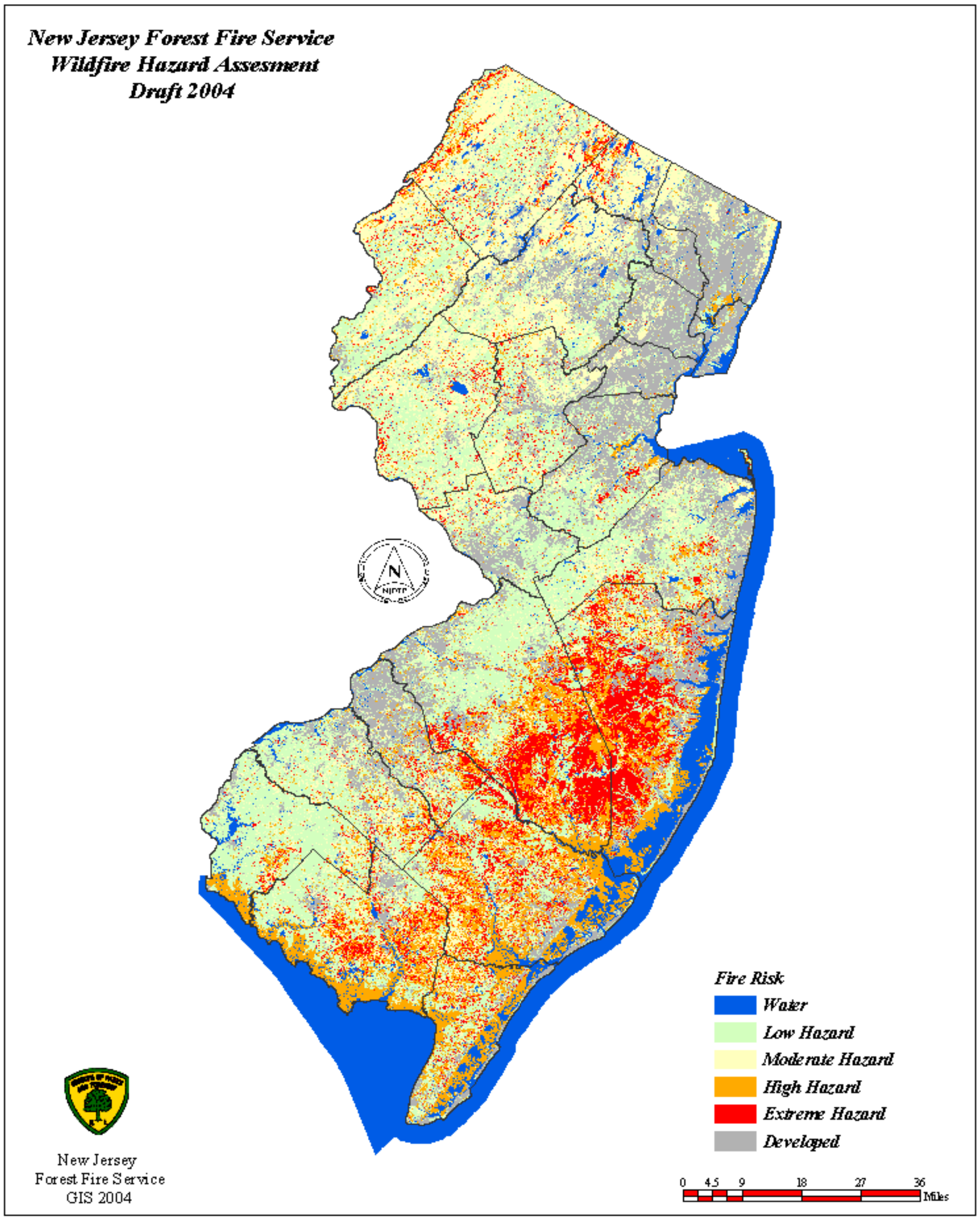
The New Jersey Pinelands is a fire adapted forest community that takes advantage of wildfire to reproduce. The Pinelands are classified as Fuel Model B of the National Fire Danger Rating System with California chaparral and a number of other high hazard types. Fuel loadings exceed twenty tons per acre in some locales. This has been equated to having an inch of gasoline covering all of south and central New Jersey. Pinelands fires burn extremely hot and spread rapidly. Crown fires are fairly common, spreading from treetop to treetop, as is long range spotting where flying embers start new fires in advance of the main fire.

From the hillside farms and oak forests of northern New Jersey, to the phragmites covered coastal areas along the Atlantic Ocean and the Delaware Bay; and from the state's core of urban development to the desolation within a sea of trees known as the Pinelands, these vast differences hint at the challenge and difficulties in protecting the state's citizens from the threat of wildfire.

New Jersey's high population density has created land use pressures in which more people are moving from urban areas to build homes in rural wildland areas. With more people living in, and enjoying the state's wildlands for various forms of recreation, the number of fires started and the seriousness of their consequences increases. A potentially explosive combination is created when the factors of hazardous wildland fuels, interface home development, and an increased risk of human caused ignition come together under extreme fire weather conditions. Although many plants in the Pine Barrens ecosystem rely on fire for a part of their reproductive cycle, the homes and property of the people who live there do not. Although Pinelands fires generally do not cause casualties, property loss can amount to thousands of dollars for each fire.

Although wildfires can occur during all months of the year, spring is the period when the most devastating incidents typically happen. With the coming of longer days, drying conditions, stronger winds, the weather provides excellent conditions for the rapid spread of fire. A second "season" develops in the northern part of the State during the fall when the abundance of freshly fallen leaves provide a bed of fuel for wildfire to race rapidly up the slopes. As shown in Figures 4.4.8.1-1, wildfire locations in the State tend to be in the less developed areas because they are more likely to have sources of fuel for fires, and because detection and suppression are somewhat less likely because there is lower population.

Figure 4.4.8.1-1
Wildfire Hazard Assessment



To manage wildfire danger and to protect communities within the State, the NJ Forest Fire Service has historically applied a series of prevention, preparedness, and suppression programs. These programs have been informally developed through practical experience over many years; however, it is now desired that they be planned, integrated and implemented on a landscape scale.

One of the most consistent and serious impacts of drought is the contribution to conditions conducive to forest fires. This applies particularly to the Pine Barrens, where drying conditions favor the combustion of forest fuels. Generally, a relative humidity of less than 40 percent, winds greater than 13 miles and hour, and precipitation of less than 0.01 inches during a month are ideal conditions for forest fires in the Pine Barrens. Given the proper conditions, stray cigarette butts, improperly extinguished campfires, and intentional matches can all start fires in the Pine Barrens. The season of greatest fire threat runs from March through May, though extensive fires have occurred in the summer and autumn months.

The New Jersey Pine Barrens is widely recognized as one of the most hazardous fuel types in the country. The Pinelands National Reserve is located in the south-central part of New Jersey and has similar wildfire behavior as the chaparral of California. Recognized for its globally unique fire-dependent ecosystem, the many threatened and endangered plant and animal communities located in the Pine Barrens are protected through the Pinelands Commission, an authority that regulates development within the Reserve. Within relatively vast areas of this hazardous fuels co-exist many homes in isolated developments that were developed prior to the Pinelands Commission, surrounded by nearly solid development on the perimeter of the Reserve. This development continues to challenge efforts to reduce the risk of devastating wildfires in New Jersey.

The NJ Forest Fire Service protects a primary response area of 3.25 million acres within the suburban and rural areas of the state. The goal of the Forest Fire Service is to limit the number of wildfires to less than 2,000 annually, and the acreage burned to less than one half of one percent (0.5%) of the area protected, or 15,750 acres. The Service accomplishes these goals by maintaining an aggressive fire management program that addresses the hazards and risks unique to each region of the state.

Fire has played a significant role in the development and distribution of the natural communities found within New Jersey. The New Jersey Pinelands is a fire adapted forest ecosystem that depends on wildfire for reproduction and the control of fuel buildup. This forest community is one of the most hazardous wildland fuel types in the nation. Additionally, the oak forests of the north, particularly those found on the slopes of the Appalachian Mountains within the state, produce rapid rates of spread and were once considered a greater threat due to slash piles and scattered debris left after logging for charcoal for furnaces in the late 1800’s. Phragmites, an invasive grass with its 10 foot height dominating over native species, became established and is a seasonal threat to homes along the “Jersey Shore”.

These, and other wildland fuels of New Jersey have been ranked to the hazard they pose and are presented in the “New Jersey Wildland Hazardous Fuels Map”. The 2007 statewide “Land Cover/Land Type” dataset maintained by the NJ Department of Environmental Protection was used as the base map, with each cover type ranked low to extreme. Where slope exceeds 30%, the rank was assigned the next higher step. With this image, a better understanding of the location of hazardous fuels can be found.

The frequency and severity of wildfires is dependent on weather and human activity. Nearly all wildfires in New Jersey are human-caused (99%) with arson, children and careless debris burning being the major causes of wildfires. When not promptly controlled, wildfires may grow into catastrophic events. Fire has been a major factor in New Jersey’s environment since prehistoric times. Natural fires and Native American burning played a major role in shaping the land and providing the vast expanses of forestland that greeted early settlers. These settlers soon realized that the Pinelands of New Jersey is one of the most hazardous fuel types in the nation.

4.4.8.2 Previous Wildfire Occurrences in New Jersey

There are a number of early accounts and newspaper stories of fires burning thousands of acres of New Jersey woodlands, causing extensive damage to improved property and untold loss of life. One such account from 1755 reported a fire 30 miles long between Barnegat and Little Egg Harbor. In 1895, John Gifford reported to the state geologist that 49 fires burned 60,000 acres in Burlington, Atlantic and Ocean counties. Other early surveys, including those of 1872 and 1885, indicate that as many as 100,000 to 130,000 acres burned annually in the Pine Barrens region alone. Figure 4.4-8-1 summarizes historic fires in the State.

New Jersey's unique geographical and economic position has made it an optimum place to work and live. The state has over 8.7 million residents in its 8,721 square mile area, making New Jersey the most densely populated state in the nation. Over 50 % of the state is currently forested with housing developments and individual residences increasingly expanding into forested regions.

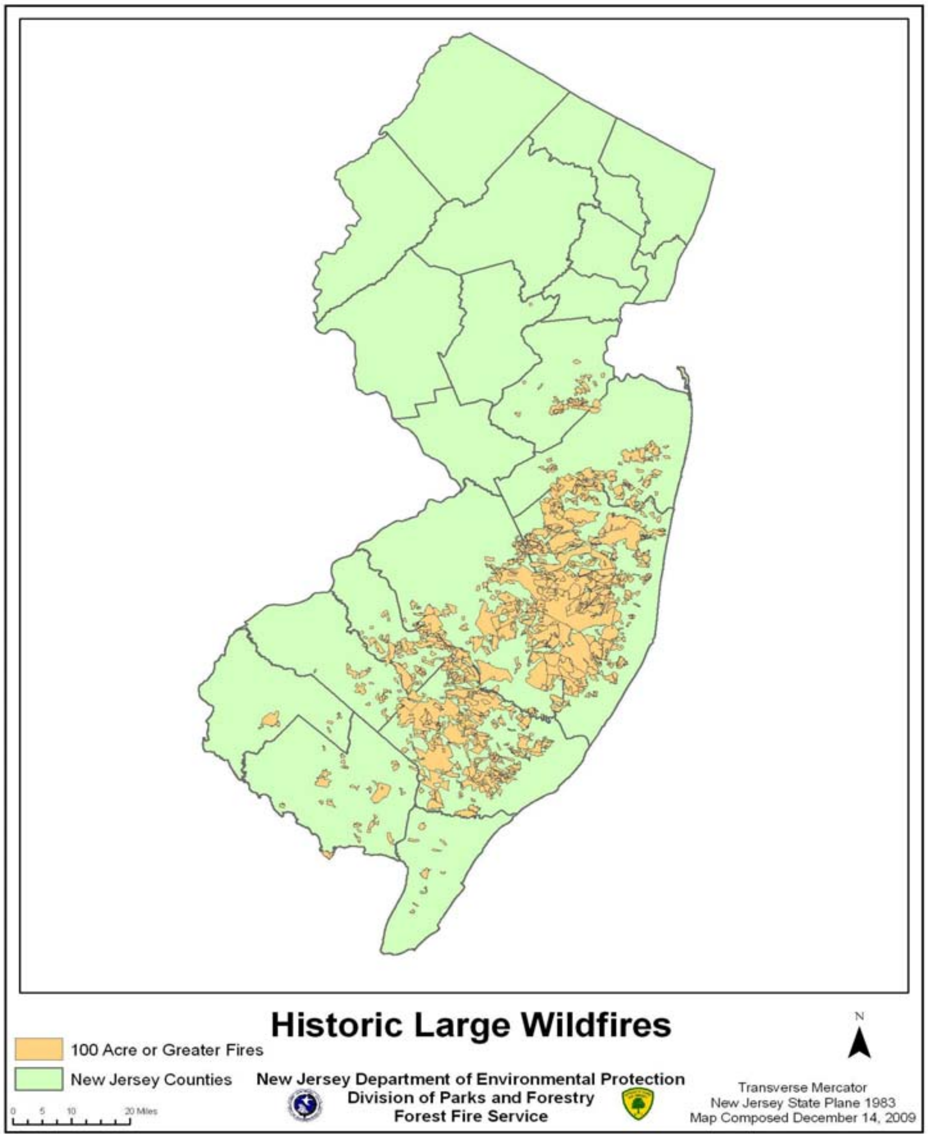
The spread of urbanization into forested regions is known as the wildland urban interface and is defined as the line, area or

zone where structures and other human development meet or intermingle with undeveloped wildlands or vegetative fuel. These resulting wildland urban interface areas pose significant challenges to the New Jersey Forest Fire Service in providing forest fire protection.

Most people across the United States equate wildland urban interface fires with the western portion of the nation, but the potential for significant wildfire activity that threatens human lives and improved property is a reality in New Jersey. Across New Jersey, any person who lives in a wildland urban interface area is at risk of being threatened or impacted by a wildfire. Some portions of New Jersey, such as the Pinelands National Reserve and surrounding Pine Barrens region, are more susceptible to serious wildfire occurrences than other areas based on their volatile forest fuels, topographic features, weather patterns and the prevalence of the wildland urban interface encountered there.

This combination of hazard and risk can lead to devastating results as illustrated by the photo above.

Figure 4.4.8.2-1.
Historic Large Fires



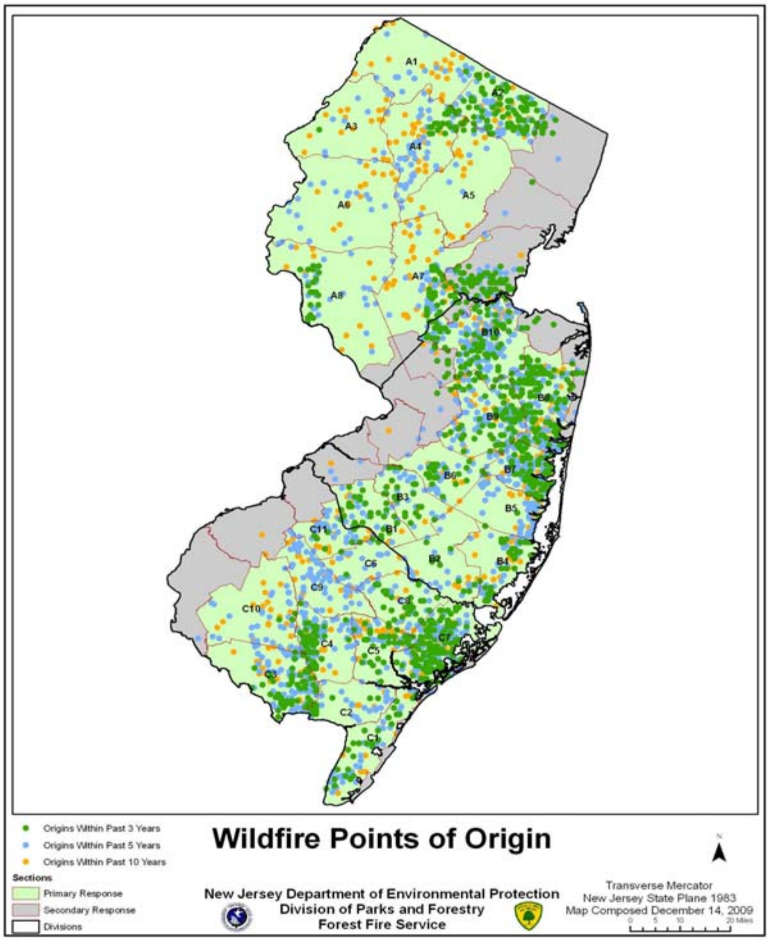
Large conflagrations have occurred several times, most recently in 2007. In 1995, one fire in Ocean County burned 19,225 acres of Pine Barrens forests and a 1997 wildfire burned 800 acres, damaged 52 homes and threatened over 300 homes in Berkeley Township, Ocean County. In 2001, the Jakes Branch wildfire burned over 1,277 acres, destroyed one home, damaged 35 homes and buildings and forced the extended closure of the Garden State Parkway impacting traffic throughout the tri state area on a summer Sunday afternoon. The most notable of New Jersey wildland urban interface wildfires was on the weekend of April 20 – 21, 1963, when a conflagration of wildfires consumed 190,000 acres of forestland; they destroyed 186 homes and 197 buildings and were responsible for the loss of seven civilian lives. The damage to improved property was estimated at over 8.5 million dollars. The wildfires of 1963 are often cited as a benchmark for fire protection comparisons across the United States.

Table 4.4.8.2-1
Major Historic Wildfires in New Jersey

	Acres Affected	Description
1930	267,547	The worst year for forest fires on record in New Jersey. A huge fire in May of that year destroyed the town of Forked River.
1936	58,000	Five Civilian Conservation Corps fire fighters were killed fighting a forest fire near Bass River.
1941	Not listed	Huge fires destroyed 400 structures in the Lakewood and Lakehurst area.
1954	20,000	A fire starting in Moore's Meadows threatened the town of Chatsworth.
1955	Not listed	Section Firewarden George Herbert was killed during an Easter Sunday fire in Ocean County when his power wagon was burned over by the fire.
1963	193,000	A series of 37 major fires burned on April 20-22. In the process, 186 homes and 197 outbuildings were burned, seven people were killed and $8.5 million in property damage was caused. One fire burned 76,000 acres, traveling 21 miles from New Lisbon to the Garden State Parkway.
1971	21,000	The Manahawkin Fire burned 21,000 acres in 7 hours and 13 minutes.
1977	15,000	A 15,000-acre fire on March 31 burned six homes and caused extensive damage in Burlington, Ocean and Atlantic counties. On July 22, a 2,300-acre fire in Bass River State Forest killed four firefighters from Eagleswood Volunteer Fire Department and forced the evacuation of the Bass River Recreation Area.
1992	14,000	A series of four major fires burned 14,000 acres on May 3. A 4,800-acre fire in Lacey Township, Ocean County, threatened and closed down the Oyster Creek Nuclear Power Plant. A 2,900-acre fire in Woodland Township, Burlington County, destroyed one home and threatened 100 others. On June 13, a 5,400-acre fire burned through Lacey Township.
1995	19,225	On April 4, a wind-driven 19,225-acre fire burned through Manchester, Lacey and Ocean townships in Ocean County, threatening the Wynnewood and Bamber Lake communities.
1997	2,700	On July 19, the 800-acre Wrangle Brook wildfire damaged 52 homes and threatened over 300 additional Ocean County homes. Later that month, on July 29, the 1,900 Rockwood II wildfire threatened the Batsto Historic Site and 80 Atlantic County homes.
1999	11,975	On April 30, the Bass River fire burned 11,975 acres and threatened Bass River State Forest.
2002	1,200	On June 20, the Jakes Branch Fire destroyed one home with additional property damage exceeding one million dollars.
2007	12,800	May 15, a wildfire destroyed 5 homes in two senior citizen housing developments in Barnegat and 13 homes along the border between Ocean and Burlington counties were damaged.
2007	3,500	June, a wildfire in the Wharton State Forest near Atsion burned for several days and forced the closing of State Route 206.

http://www.state.nj.us/dep/parksandforests/fire/fire_history.htm

Figure 4.4.8.2-2.
Points of Forest Fire Origin



To manage wildfire danger and to protect communities within the State, the NJ Forest Fire Service has historically applied a series of prevention, preparedness, and suppression programs. These programs have been informally developed through practical experience over many years; however, it is now desired that they be planned, integrated and implemented on a landscape scale.

4.4.8.3 Severity of Wildfires

Each year an average of 1,500 wildfires damage or destroy 7,000 acres of New Jersey's forests. Since 99% of all forest fires are caused by people, either through carelessness or intentional acts, education is the primary mitigation (http://www.state.nj.us/dep/newsrel/2005/05_0016.htm)

Defining the potential losses by wildfires in New Jersey is difficult. Weather, the main influence on how a wildfire burns, is a variable that can only be predicted on a short- term basis. A ten-year average of three major fires (greater than 100 acres) occurs per year, and nearly 1,600 other wildfires burn annually. Actual dollar loss, therefore, will be specific to each wildfire and each year.

Table 4.4.8.3-1
New Jersey Wildfires of more than 10 acres 1996-2006

ounty	Occurrences	Deaths	Injuries	Property Damage
Atlantic	22	0	0	**0**
Bergen	7	0	0	**0**
Burlington	27	1	2	**0**
Camden	26	0	0	**$400**
Cape May	7	0	1	**0**
Cumberland	23	0	1	**$85,575**
Essex	2	0	0	**0**
Gloucester	12	0	0	**0**
Hudson	2	0	0	**0**
Hunterdon	6	0	0	**50K**
Mercer	1	0	0	**0**
Middlesex	25	0	0	**$3,900**
Monmouth	3	0	0	**$18,000**
Morris	8	0	0	**0**
Ocean	32	0	1	**$510,800**
Passaic	7	0	0	**0**
Salem	6	0	0	**0**
Somerset	2	0	0	**0**
Sussex	11	0	2	**0**
Union	0	0	0	**0**
Warren	9	0	0	**0**
Statewide Totals	**238**	**0**	**7**	**$618,675**

http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms

Tables 4.4.8.3-3 and 4.4.8.3-4 below provide the most recent available data for the number of fire incidents per year and the number of acres burned, for the period 1996 to 2006.

Table 4.4.8.3-2
Number of Fire Incidents per Year by New Jersey County: 1996 to 2006

County	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Totals	Annual Average
Bergen	126	214	224	206	155	232	250	163	127	149	251	**2,097**	190.6
Bergen	1	7	8	8	6	13	4	5	5	5	10	**72**	6.5
Burlington	99	121	133	140	88	128	109	64	56	71	102	**1,111**	101.0
Camden	55	138	126	145	124	143	103	45	62	76	110	**1,127**	102.5
Cape May	59	86	71	84	50	92	80	40	62	52	55	**731**	66.5
Cumberland	93	151	206	173	100	140	102	58	88	111	117	**1,339**	121.7
Essex	0	0	0	0	0	0	0	0	1	0	2	**3**	0.3
Gloucester	34	67	53	72	36	73	78	23	28	68	67	**599**	54.5

County	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Totals	Annual Average
Hudson	0	0	0	0	0	0	0	0	0	1	0	**1**	0.1
Hunterdon	21	37	28	69	44	66	41	26	14	30	48	**424**	38.5
Mercer	0	0	0	5	0	4	26	8	1	5	5	**54**	4.9
Middlesex	18	54	50	87	62	106	106	41	35	75	87	**721**	65.5
Monmouth	30	30	34	50	35	75	54	42	32	51	69	**502**	45.6
Morris	62	113	99	139	58	65	87	63	48	53	86	**873**	79.4
Ocean	196	347	304	412	265	374	287	227	213	228	325	**3,178**	288.9
Passaic	17	37	50	71	29	61	39	21	13	22	43	**403**	36.6
Salem	22	36	47	24	10	38	37	15	14	16	20	**279**	25.4
Somerset	6	50	17	65	15	50	86	41	20	60	59	**469**	42.6
Sussex	38	137	109	176	85	162	129	102	49	47	101	**1,135**	103.2
Union	0	0	0	0	0	0	0	0	2	2	4	**8**	0.7
Warren	33	56	94	129	75	90	144	55	37	107	71	**891**	81.0
Total	**910**	**1,681**	**1,653**	**2,055**	**1,237**	**1,912**	**1,762**	**1,039**	**907**	**1,229**	**1,632**	**16,017**	**1,456.1**

Table 4.4.8.3-3
State of New Jersey Annual Number of Acres Burned* by Wildfires County: 1996 – 2006

County	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Totals	Annual Average
Atlantic	130	2,150	136	188	189	166	206	88	51	55	138	**3,497**	**318**
Bergen	0.25	49	42	103	8	98	10	2	13	5	12	342	**31**
Burlington	130	282	121	12,857	340	215	57	26	22	26	225	14,301	**1,300**
Camden	61	265	220	171	283	279	806	382	34	404	106	3011	**274**
Cape May	33	69	30	54	178	60	32	26	23	51	57	613	**56**
Cumberland	149	138	222	290	514	994	78	50	52	119	182	2788	**253**
Essex	0	0	0	0	0	0	0	0	0.25	0	21	21.25	**2**
Gloucester	44	134	117	173	36	110	111	12	8	359	114	1218	**111**
Hudson	0	0	0	0	0	0	0	0	0	25	0	25	**2**
Hunterdon	7	38	44	108	12	30	21	7	14	10	68	359	**33**
Mercer	0	0	0	4	0	60	19	1	0.25	2	2	88.25	**8**
Middlesex	26	99	145	196	78	279	118	124	38	117	796	2016	**183**
Monmouth	81	22	30	33	20	30	24	18	35	26	35	354	**32**
Morris	58	422	37	102	25	52	63	42	25	56	64	946	**86**
Ocean	136	1,023	138	712	123	1,806	4,089	109	141	95	240	8,612	**783**
Passaic	32	18	35	77	16	24	16	32	3	14	106	373	**34**
Salem	58	74	62	37	40	19	30	6	17	13	486	842	**77**
Somerset	2	30	6	164	5	43	32	9	9	26	19	345	**31**
Sussex	17	69	62	84	99	165	112	28	15	45	106	802	**73**
Union	0	0	0	0	0	0	0	0	.5	0.75	1	2	**0**
Warren	51	23	20	1,058	98	32	43	6	19	66	28	1,444	**131**
Total	885	2,755	1,331	16,223	1,875	4,296	5,661	880	469	1,460	2,668	42000	3,818

*The number of incidents includes only those wildfires to which the NJ Forest Fire Service responded to in its designated response area. Numbers are rounded for clarity.

Figure 4.4.8.3-4

Wildfire Incidents in New Jersey, 1996 – 2006

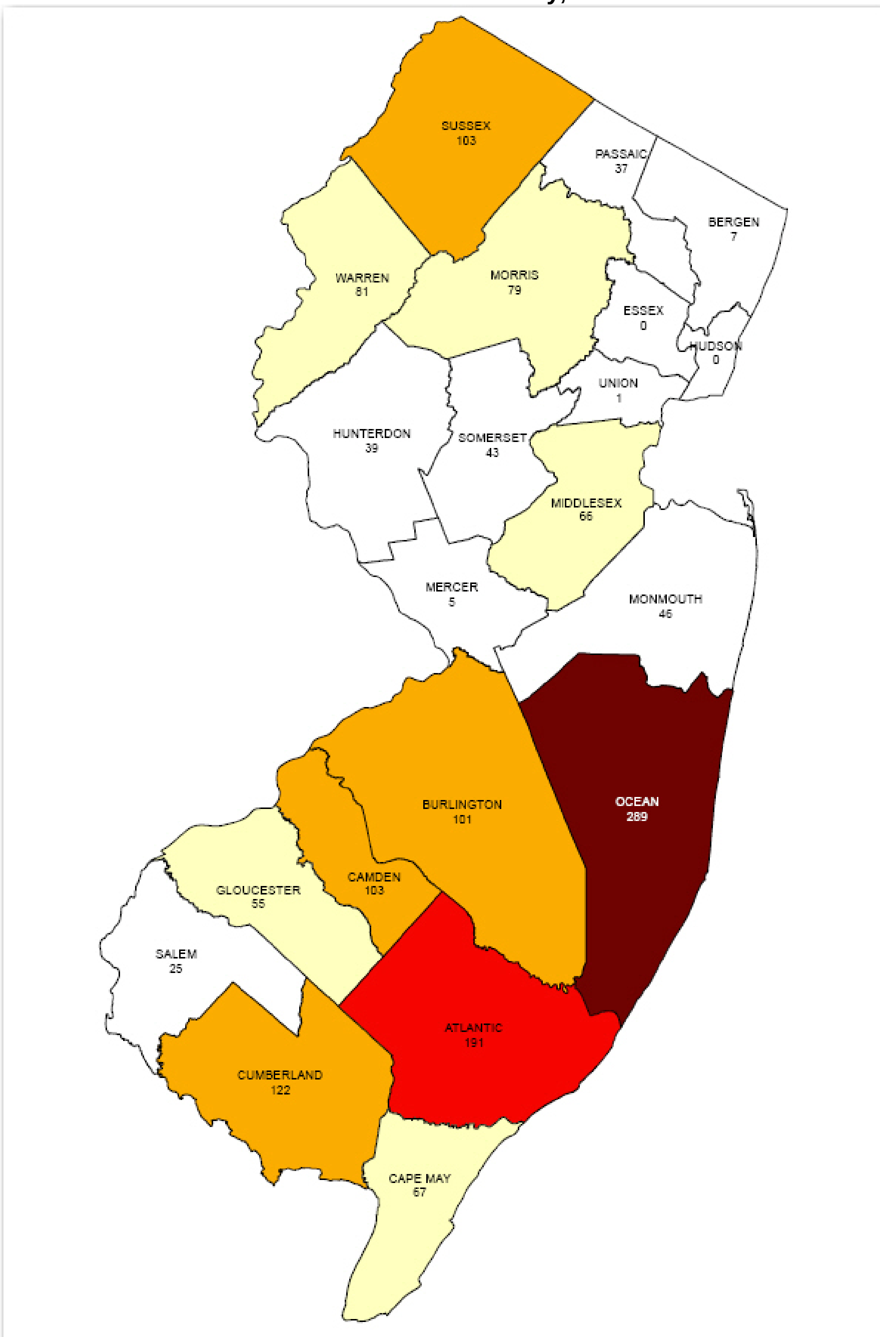
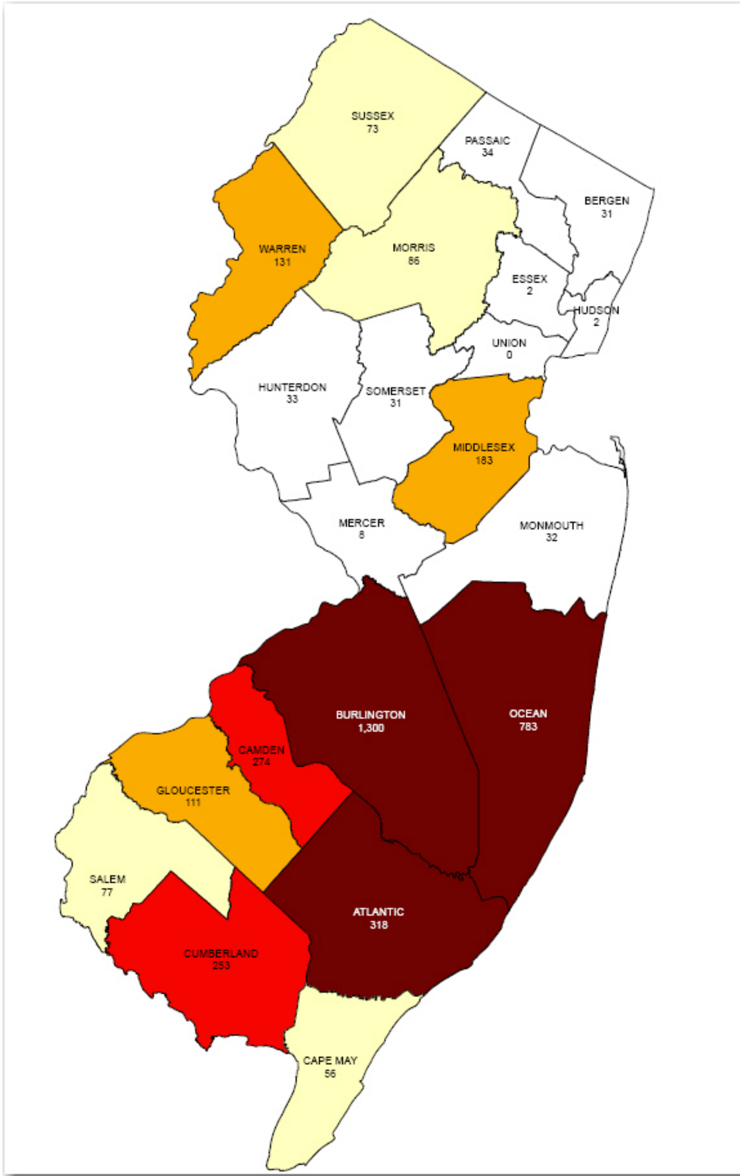


Figure 4.4.8.3-5

Acres Burned in Wildfires in New Jersey, 1996 – 2006



4.4.8.4 Probability of Wildfires

The probability exists that New Jersey will continue to face an average of three fires greater than 100- acres each year. A complete forest fire hazards analysis for all State-owned lands is being updated in a document published by the New Jersey Bureau of Forest Fire Management, of the Division of Parks and Forestry of the Department of Environmental Protection entitled the *New Jersey Forest Fire Management Plan*.

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4.4.9 Geologic Hazards of Landslides, Subsidence and Sinkholes

Note: Future updates of the NJ State Hazard mitigation Plan will address Landslide independently from the issue of Subsidence and sinkholes.

4.4.9.1 Nature of Landslide,

A landslide is a natural geologic process involving the movement of earth materials down a slope, including rock, earth, debris, or a combination of these, under the influence of gravity. However, there are a variety of triggers for landslides such as: a heavy rainfall event, earthquakes, or human activity. The rate of landslide movement ranges from rapid to very slow. A landslide can involve large or small volumes of material. Material can move in nearly intact blocks or be greatly deformed and rearranged. The slope may be nearly vertical or fairly gentle (Delano and Wilshusen, 2001).

Landslides are usually associated with mountainous areas but can also occur in areas of generally low relief. In low-relief areas, landslides occur due to steepening of slopes: as cut and fill failures (roadway and building excavations), river bluff failures, collapse of mine waste piles, and a wide variety of slope failures associated with quarries and open-pit mines (USGS, Landslide Types and Process, 2004). However landslides also occur to naturally steep slopes that haven't been touched by human activity. The location of landslides is highly site-specific, although Figures 4.4.9.3-1 and Figure 4.4..9.4-2 show the general location of the hazard, based on historical events and technical analysis.

Figure 4.4.9.1-1

Small landslide in an unidentified residential area in New Jersey

4.4.9.2 Nature of Subsidence and Sinkholes

Subsidence is the sinking of the top layer of ground resulting from the disappearance of material below the ground surface. Subsidence can occur as a result of natural geologic phenomenon or as a result of human alteration of surface and underground hydrology . Natural subsidence in the form of sinkholes occurs in areas where the bedrock consists of limestone, dolomite, or marble which is collectively referred to as carbonate rock and the areas are known as karst areas. Sinkhole formation typically begins when rainwater infiltrates to a layer of soluble bedrock composed primarily of calcium carbonate or a combination of calcium-magnesium carbonate and some insoluble materials. Anthropogenic subsidence resulting from underground mining or from excessive pumping of groundwater can cause otherwise stable ground to become unstable and collapse leaving depressions similar to natural sinkholes. They can occur in any geologic unit including carbonate rocks. Like landslides, the subsidence hazard is location-specific because it is the result of specific conditions such as karst geology, excessive groundwater extraction, or abandoned mines.

Naturally occurring subsidence and sinkholes in New Jersey occur within bands of carbonate bedrock. In northern New Jersey there are more than 225 square miles that are underlain by limestone, dolomite, and marble. In some localities, no sinkholes have appeared, while in others, sinkholes are common. In the southern part of the state there are about 100 square miles which are locally underlain by a limesand with thin limestone layers. No collapse sinkholes have been identified, but there are some features which could be either very shallow solution depressions or wind blowout features. Sinkholes in New Jersey are generally concentrated in the northwestern part of the State, as shown in Figures 4.4.9.4-2, 4.4.9.5-2 and 4.4.9.5-3 The carbonate formations are listed on Figure 4.4.9.5-4.

A sinkhole is a depression in the surface of the ground that results from collapse of the "roof" of a "cave" in carbonate rocks, or from subsidence of surface material into subsurface openings produced by dissolution of the carbonate bedrock. Cave collapse sinkholes are extremely rare in New Jersey, whereas soil subsidence sinkholes are common. A naturally occurring sinkhole is a closed, usually circular depression in an area underlain by soluble rock which drains internally to the subsurface. Sinkholes generally form along linear trends aligned with fractures and joints in the underlying bedrock. The fractures occur generally parallel to faults and fold axes within the bedrock.

Limestone, dolomite and marble, collectively known as carbonate rocks, are soluble in acid. Rainwater, which is slightly acidic from atmospheric carbon dioxide (CO_2), can become more acidic where decaying vegetation is available in the soil through which water passes on its way down to the bedrock. The acidic ground water slowly dissolves the carbonate bedrock creating voids and sometimes caves in the rock. Soil can then filter down into the openings in the rock, leaving voids. These soil voids can slowly settle or suddenly collapse forming sinkholes.

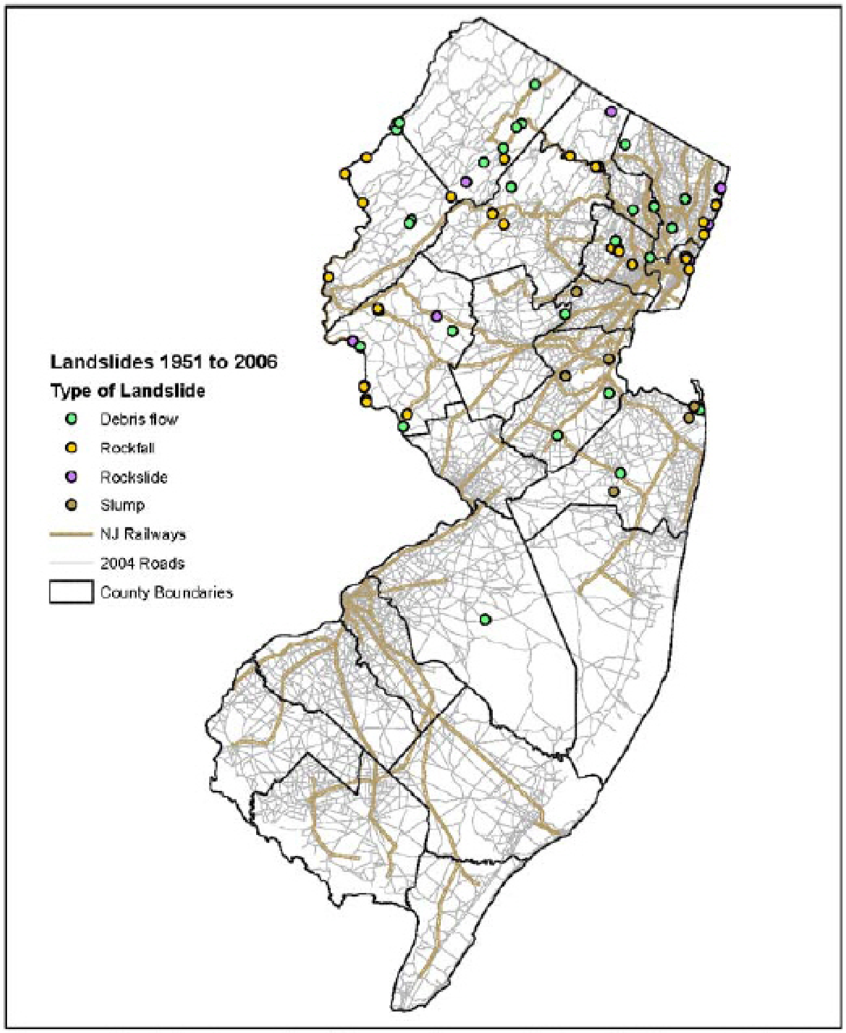
When subsidence develops slowly, it may first be seen in misaligned curbs, cracked foundations and walls, or jammed windows and doors. More often a sinkhole or collapse feature occurs rapidly, in a few hours or days. If it is in a field or woods away from structures and utilities, it may serve only as an annoyance, perhaps causing turbidity for a time in nearby wells or tripping up grazing livestock. If subsidence occurs in a developed area, costly damage may result. Buried utilities may sag and break, roads and curbs can collapse, and foundation walls can crack or rupture and cinderblock walls can lose support or crumble.

As a building subsides, inside plaster cracks and falls and eventually, floors buckle and facing material falls away. As the situation worsens, total collapse of the structure may occur.

4.4.9.3 Previous Landslide Occurrences

As shown in Figure 4.4-9.3-1, landslides are not particularly common in New Jersey, and tend to occur in the northern Counties.

Figure 4.4.9.3-1
Landslides in New Jersey, 1951 to 2006 (NJGS)



Map prepared for the New Jersey Office of Emergency Management February 2007. Transportation locations obtained from the National Atlas of the United States of America http://www.NationalAtlas.gov; December 2006. Landslide locations obtained from the New Jersey Geological Survey.

4.4.9.4 Previous Sinkholes and Subsidence

In New Jersey, sinkhole and subsidence activity occurs primarily in the Counties of Warren, Sussex, Passaic, Morris, Somerset and Hunterdon, which are located along northern and northeastern part of the State. One of the largest documented sinkholes to occur within the State of New Jersey occurred in 1983 in Phillipsburg, Warren County. This hole was large enough to cause a two-story house to rotate on its foundation until the front part of the house had sunk to the second story and the back was ten or more feet off its foundation. A second hole over twenty feet wide opened between the house and the street. All this occurred in a few hours as a result of a broken water main in the street. On March 17, 2010 a large sinkhole which was 15 feet by 18 feet by 25 feet deep opened up on Brantwood Terrace, in Mansfield Township, Warren County. It took 5 truck loads of concrete to fill the throat of the hole in the bedrock. Then the sinkhole was backfilled with several truckloads of stone and soil.- The 2006, a sinkhole near the New Jersey State Department of Human Resources in Trenton (Figure 4.4.9.4-1) is not a true sinkhole since the area is not underlain by carbonate rock. .

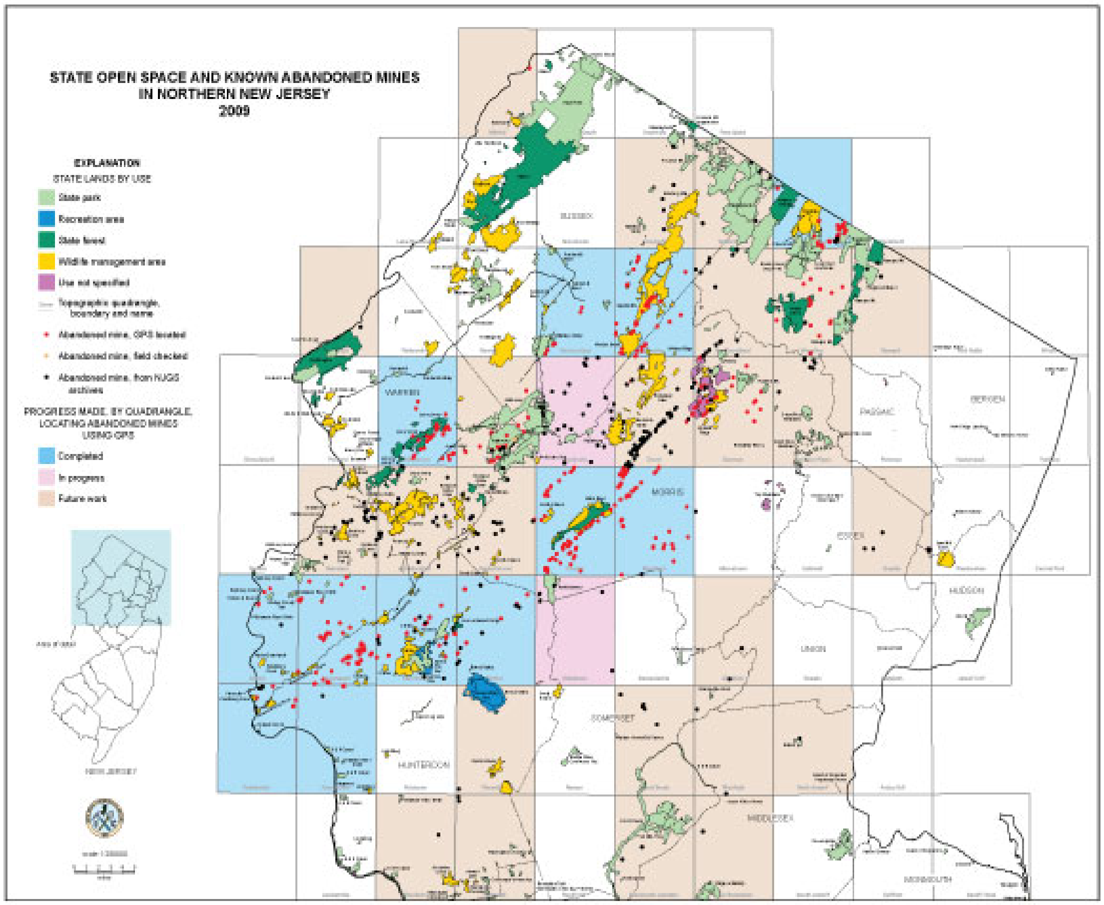
Figure 4.4.9.4-1
Sinkhole in front of the New Jersey State Department of Human Services in Trenton

Incidents of subsidence also have occurred above areas underlain by abandoned mines. About 588 known abandoned mine workings (Figure 4.4.9.4-2) have been documented in the northern part of the state, and the ground above several of these mines has recently collapsed. Examples include mines in Ringwood Borough, Passaic County; Rockaway and Chester Townships, Morris County; Jefferson Township, Morris County; and Bethlehem Township, Hunterdon County. In most instances, the collapse was within a few tens of feet of existing homes. In addition, the collapses in Ringwood, Jefferson and Rockaway Townships threatened sections of heavily-traveled roads, and another collapse in Rockaway Township occurred in the road at the location of a school bus stop (Figure 4.4.9.4-3). Moreover, subsidence has been noted at several mines that are proximal to hiking trails frequented by the general public.

Prior mining operations, largely from the 19th century, have left most of the northern part of the state susceptible to subsidence and collapse. The subsurface voids from of most of the old mine workings have either been improperly filled, or were left unfilled after mining ceased. Over the years, soil and rock material have settled or washed into the subsurface voids, causing them to migrate closer to the surface and eventually collapse.

New Jersey Geological Survey geologists and New Jersey Department of Labor and Industry mine safety inspectors have worked collaboratively to investigate incidents of subsidence and collapse and they have concluded that future subsidence should be expected. Based on historic and recent incidents of collapse, the potential for costly property damage and possibly for loss of life as well from additional collapse in the future is a distinct possibility, especially in areas that are more densely populated.

Figure 4.4-9.4-2
State Open Space and known Abandoned Mines in Northern New Jersey, 2009



Map prepared for the New Jersey Office of Emergency Management, February 2010. Transportation locations obtained from the National Atlas of the United States of America, December, 2006. Abandoned mine locations from the New Jersey Geological Survey.

Section 4 -Risk Assessment

Figure 4.4.9.4-3
Collapse in road above school bus stop, Rockaway Township

4.4.9.5 Probability of Landslide, Sinkhole and Subsidence Occurrences

Landslide probabilities are largely a function of surface geology, but are also influenced by both weather and human activities, as noted above. As part of a HAZUS-based earthquake risk assessment, the NJGS determined landslide susceptibility for seven of the most at-risk Counties in the State, as shown in the series of figures in Appendix W. Figure 4.4.9.5-1 is an overlay of population density (in gray shades) and landslide susceptibility. The graphic was developed by the New Jersey Geologic Survey.

Although this graphic may be of some use on a regional level, landslides are generally somewhat localized, so better-resolved maps and site-specific engineering and geological data are required for a risk assessment.

As development density increases and spreads throughout the State, the effects of sinkhole and collapse subsidence may become more common. Homes and other buildings, roads, utilities, water supplies, and septic systems, as well as dams and other engineered structures in areas prone to sinkhole or collapse development are all subject to damage.

Figure 4.4.9.5-2 depicts those geologic units that are prone to the development of natural sinkholes. The figure also shows an area in the southern part of the state that is underlain by lime sand, but no significant sinkhole have been identified there to date.

Figure 4.4.9.5-1
Landslide Susceptibility and Population Density in New Jersey

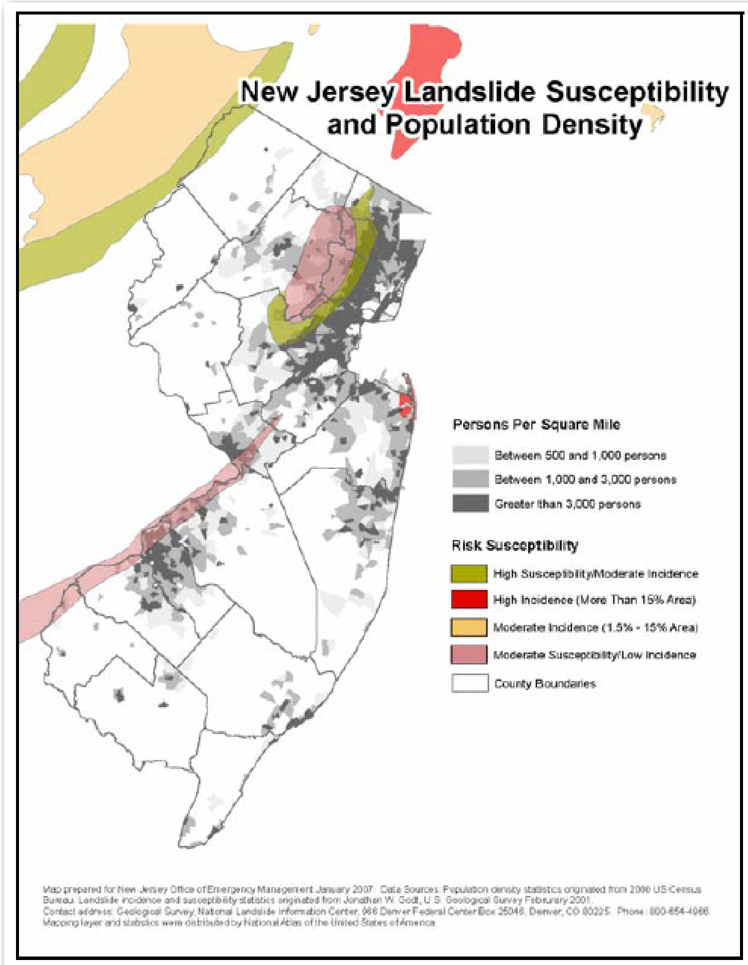
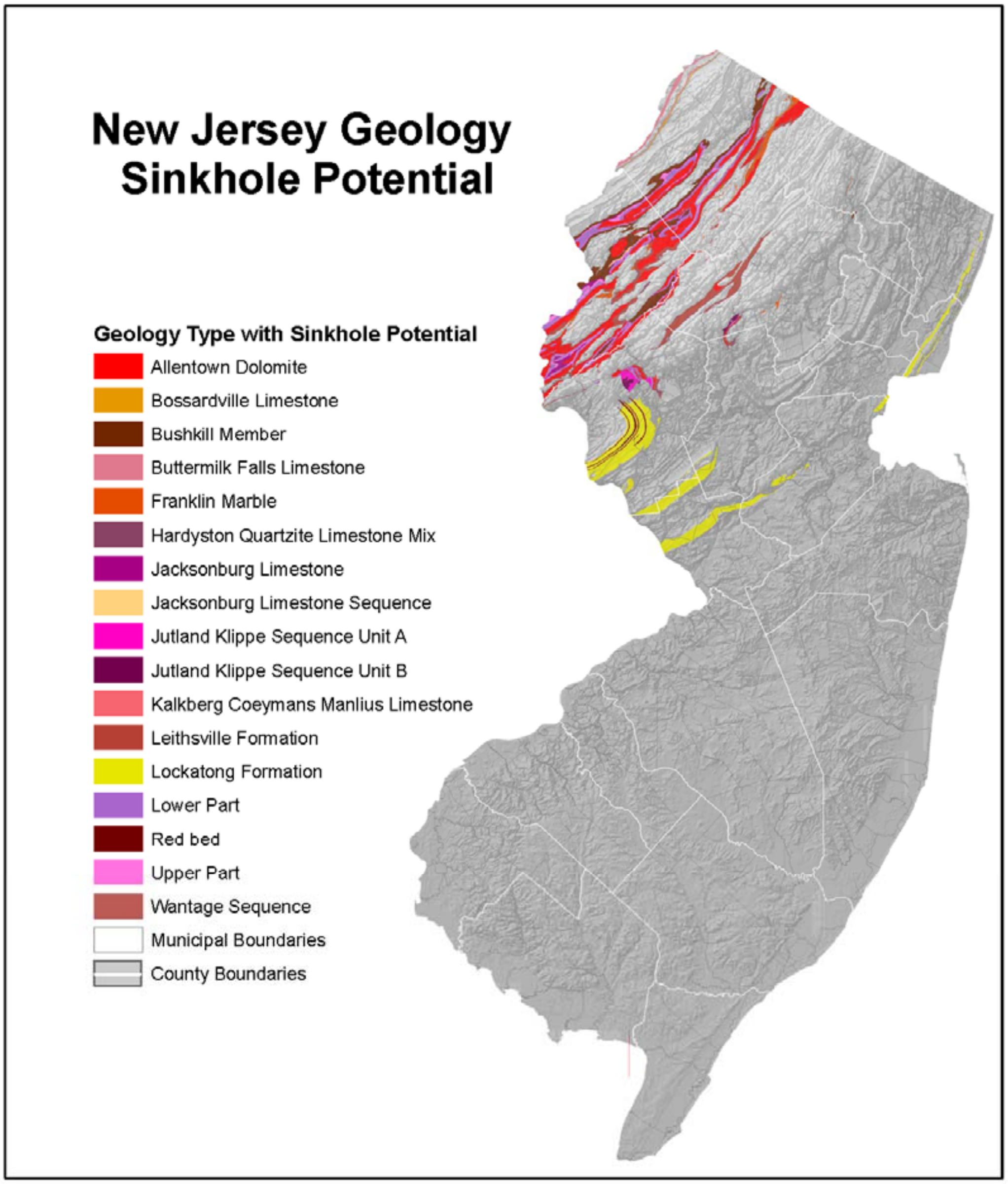


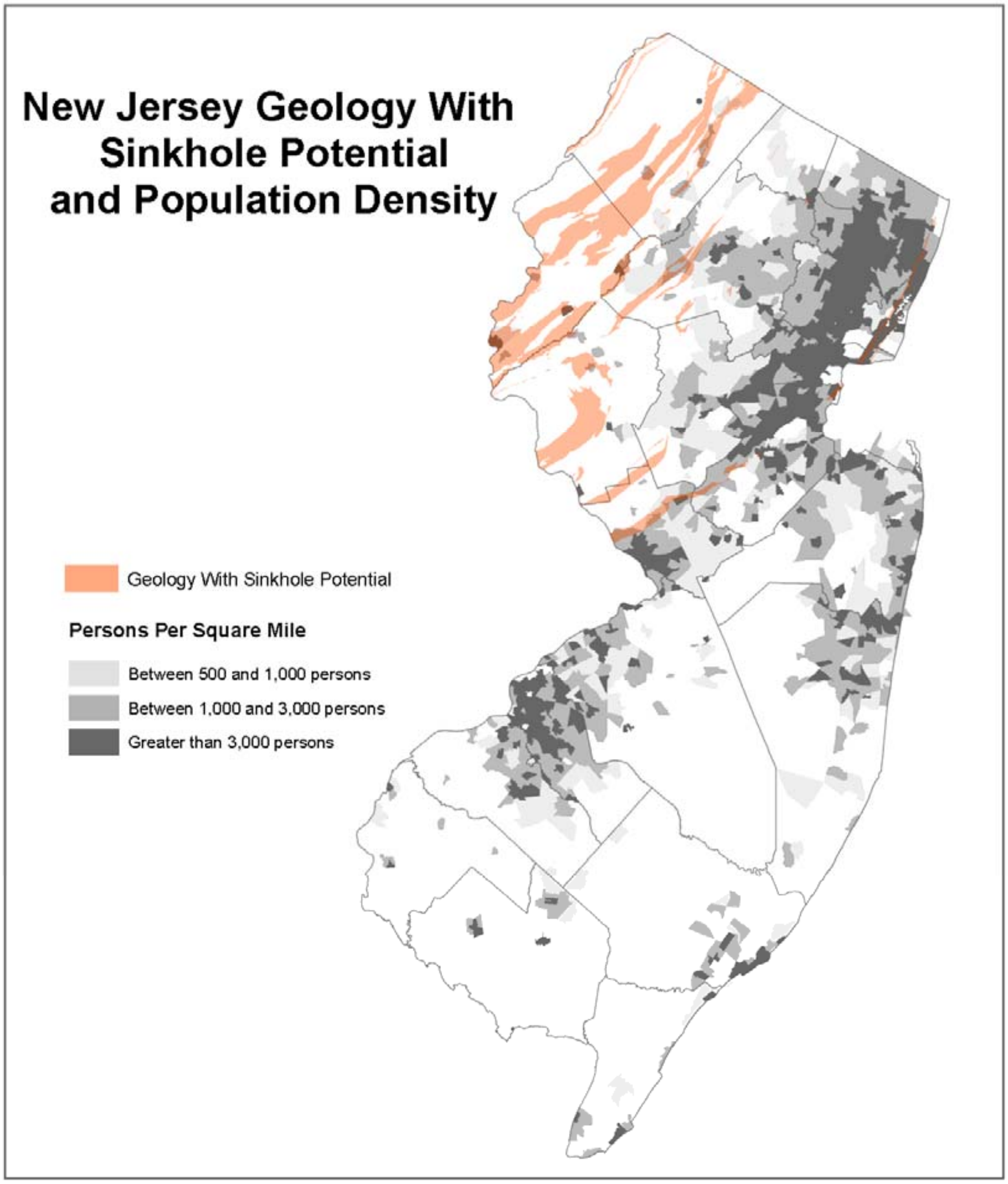
Figure 4.4.9.5-2
New Jersey Geology with Sinkhole Potential



This map was created for the New Jersey Office of Emergency Management, February 2007. Source: Geological statistics used to generate this map were obtained from the New Jersey Geological Survey: http://www.nj.gov/dep/njgs/geodata/dgs04-6.htm. GIS data used was scanned and digitized from United States Geological Survey Miscellaneous Investigations and Open-File Series 1:100,000 scale geologic maps compiled from 1984 to 1993.

Figure 4.4.9.5-2 shows areas that have the potential to develop sinkholes. Note that areas of high sinkhole potential are generally the less populated in the State. Although sinkholes and subsidence may potentially occur within any area that has carbonate geology, the probability of occurrence is greatest in areas where there is a history of past occurrences. As stated in the previous section, past occurrences have historically been in Warren, Sussex, Morris, Somerset and Hunterdon counties.

Figure 4.4.9.5-3
New Jersey Geology with Sinkhole Potential and Population Density

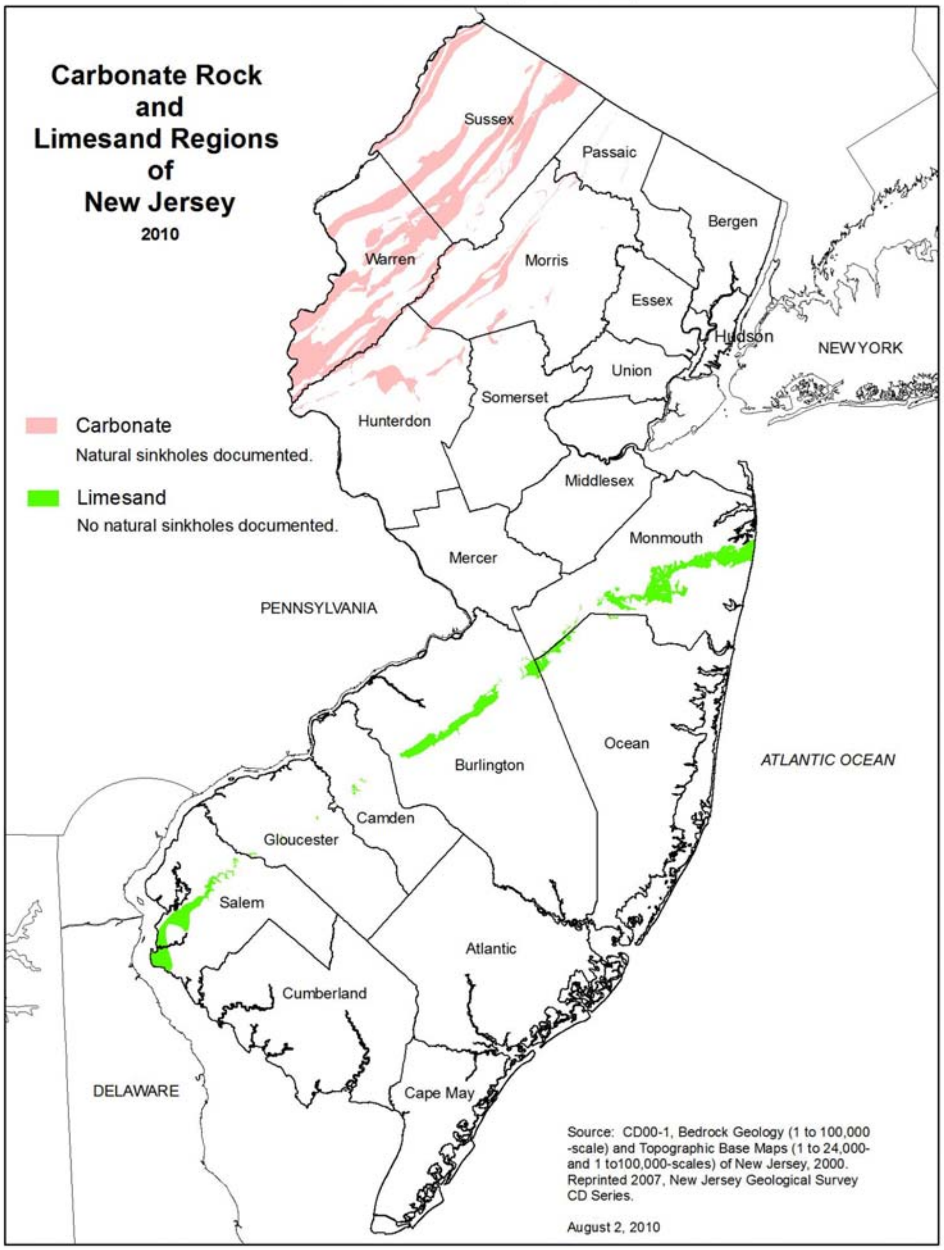


Map prepared for New Jersey Office of Emergency Management January 2007. Data Sources: Population density statistics originated from 2000 US Census Bureau. Geological statistics used to generate this map was obtained from the New Jersey Geological Survey: http://www.nj.gov/dep/njgs/geodata/dgs04-6.htm. GIS data used was scanned and digitized from United States Geological Survey Miscellaneous Investigations and Open-File Series 1:100,000 scale geologic maps compiled from 1984 to 1993. Types of geological bedrock prone to sinkhole development includes: calcite, calcium carbonate, marble, dolomite, calcium magnesium carbonate, and limestone.

Carbonate rock traverses the counties of Hunterdon, Morris, Passaic, Somerset, Sussex and Warren, suggesting an increased potential for the development of sinkholes in those areas.

Figure 4.4.9.5-4 (Note: As used in this Plan)
Carbonate Rock and Limestone Regions of New Jersey

Figure 4.4-9-6
Carbonate Rock and Limesand Regions of New Jersey



4.4.10 Hail

4.4.10.1 Nature of the Hail Hazard

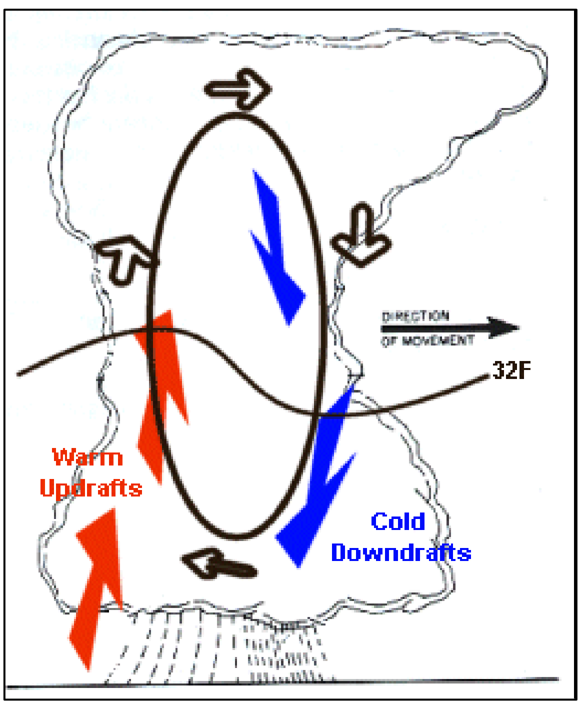
Note: Future editions of the NJ State Hazard Mitigation Plan will include additional information on hail as developed by NOAA.

Hail is a form of precipitation comprised of spherical lumps of ice. Known as hailstones, these ice balls typically range from 5 mm–50 mm in diameter on average, with much larger hailstones forming in severe thunderstorms. The size of hailstones is a direct function of the severity and size of the storm.

4.4.10.2 Characteristics of Hail

Hail is an outgrowth of severe thunderstorms and develops within a low-pressure front as warm air rises rapidly in to the upper atmosphere and is subsequently cooled, as shown in Figure 4.4.10.2-1, leading to the formation of ice crystals. These are bounced about by high-velocity updraft winds and accumulate into frozen droplets, falling as precipitation after developing enough weight. The National Weather Service (NWS) defines severe thunderstorms as those with downdraft winds in excess of 58 mph and/or hail at least .75" in diameter. While only about 10% of thunderstorms are classified as severe, all thunderstorms are dangerous because they produce numerous dangerous conditions, including one or more of the following: hail, strong winds, lightning, tornadoes, and flash flooding.

Figure 4.4.10.2-1
How Hail Is Formed
(Source: NOAA)



Hailstorms occur most frequently during the late spring and early summer. During this period, extreme temperature changes occur from the surface up to the jet stream, resulting in the strong updrafts required for hail formation.

The size of hailstones varies and is related to the severity and size of the thunderstorm that produced it. The higher the temperatures at the earth's surface, the greater the strength of the updrafts, and the greater the amount of time the hailstones are suspended, giving the hailstones more time to increase in size. Hailstones vary widely in size, as shown in Table 4.4.12-1. Note that penny size (.75" in diameter) or larger hail is considered severe as shown in Figure 4.4.10.2-1.

Table 4.4.10.2-1
Estimating Hail Size
(Source: NOAA)

Size	Inches in Diameter
Pea	.25 inch
Marble/mothball	.50 inch
Dime/Penny	.75 inch
Nickel	.875 inch
Quarter	1 inch
Ping-Pong Ball	1.5 inches
Golf Ball	1.75 inches
Tennis Ball	2.5 inches
Baseball	2.75 inches
Tea Cup	3 inches
Grapefruit	4 inches
Softball	4.5 inches

Figure 4.4.10.2-2
Large Hailstone
(Source: NOAA)

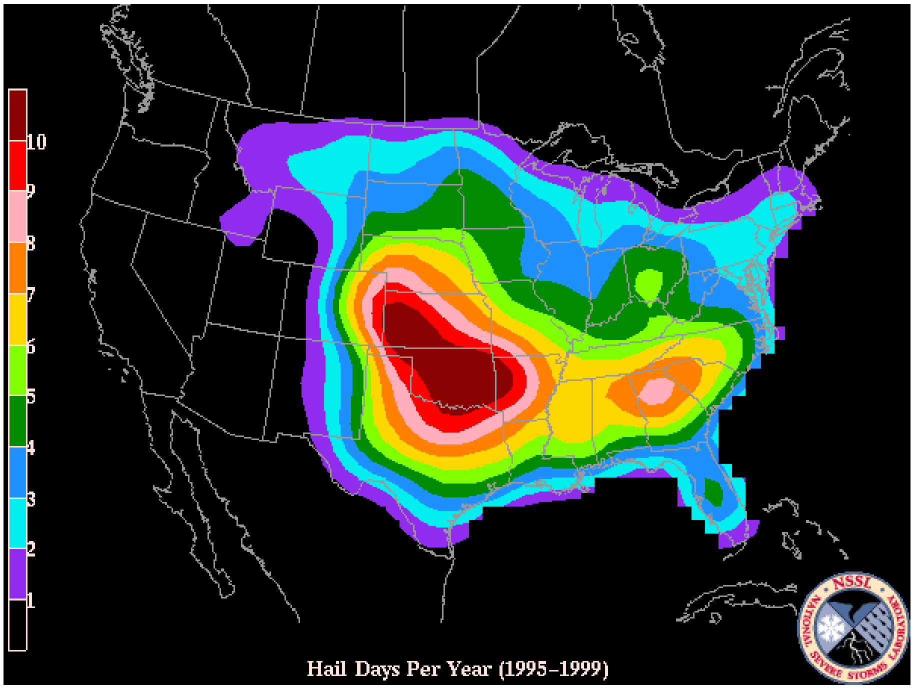
4.4.10.3 Location and Extent of the Hail Hazard

Hailstorms occur more frequently during the late spring and early summer, when the jet stream migrates northward across the Great Plains. This period has extreme temperature changes from the ground surface upward into the jet stream, which produces the strong updraft winds needed for hail formation. The land area affected by individual hail events is not much smaller than that of a parent thunderstorm, an average of 15 miles in diameter around the center of a storm.

4.4.10.4 Probability of Hail

Shown below is NOAA's national probability map for hail (¾ inch or greater) and note that it shows, in light blue, a probability of 2 to 3 hail days per year for New Jersey.

Figure 4.4.10.4-1
Hail Days per Year (1995-1999)
Source: NOAA



The potential for hail exists over the entire planning area, although the probability is relatively low compared to other parts of the United States. There are at least a few incidences of hail almost every year in the planning area, although for the most part they are minor.

Severity of the Hail Hazard

The severity of hailstorms is measured by duration, size of the hail itself, and geographic extent. All of these factors are directly related to the weather phenomena that create the hail, thunderstorms. There is wide potential variation in these severity components. The planning area has a relatively low potential for significant hail events, based on previous records.

Impact on Life and Property

There are no known instances of injuries or death from hail events in any New Jersey County. The NCDC database indicates there has been no reported property damage in the State from hail events. Presumably there are some damages, but most of these are likely addressed by citizens or insurance companies, and therefore there is no readily accessible record of damages. Damages that do occur are presumably orders of magnitude less than other hazards such as floods or hurricane winds.

Occurrences of the Hail Hazard

The NCDC reported 534 hail events in New Jersey from the period 1950 through 2009. Some of the noted hail storms occurred in more than one county. Actual events may be significantly less. Hailstone sizes ranged in diameter from 0.5" to 2.0". Table 4.4.10.4-1 summarizes all New Jersey hail events.

Table 4.4.10.4-1
Hail Events, in New Jersey, 1950-2009
(Source: NOAA/NCDC)

County	# of Reported Incidents	Deaths	Injuries	Property Damage $	Crop Damage $
Atlantic	31	0	0	0	5,000,000
Bergen	25	0	0	0	0
Burlington	66	0	0	0	0
Camden	27	0	0	0	2,000
Cape May	14	0	0	0	0
Cumberland	17	0	0	75,000	0
Essex	19	0	0	0	0
Gloucester	32	0	0	0	5,000,000
Hudson	12	0	0	0	0
Hunterdon	26	0	0	0	100,000
Mercer	28	0	0	0	0
Middlesex	23	0	0	10,000	0
Monmouth	26	0	0	0	0
Morris	29	0	0	0	0
Ocean	38	0	0	1,000	0
Passaic	22	0	0	0	0
Salem	16	0	0	250,000	5,000,000
Somerset	24	0	0	100,000	1,000
Sussex	25	0	0	0	1,000
Union	18	0	0	0	0
Warren	16	0	0	0	0
Total	534	0	0	436,000	15,104,000

Where the greatest "Crop Damage" has been noted, hailstones were reported as large as 2.00 inches in diameter in Atlantic and Gloucester Counties and 1.75 inches in diameter in Salem County.

Based on historical records from the NCDC database, the future probability of hail events in New Jersey is reasonably high. On average, a hail event occurs every two years based on past records. However, property damage and impact to life in the State is considered minimal compared to the potential damage from other hazards.

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4.4-11 Extreme Heat

This section deals with extreme heat. Extreme cold is discussed as part of Unit 4 – Winter Storms of this Section of the Plan.

4.4.11.1 Nature of the Extreme Heat Hazard

Extreme summer heat is the combination of very high temperatures and exceptionally humid conditions. If such conditions persist for an extended period of time, it is called a heat wave (FEMA, 1997). Heat stress can be indexed by combining the effects of temperature and humidity, as shown in Table 4.4.11.1-1. The index estimates the relationship between dry bulb temperatures (at different humidity) and the skin's resistance to heat and moisture transfer. The higher the temperature or humidity, the higher the apparent temperature.

Table 4.4.11.1-1
Heat Index and Disorders
Sources: FEMA, 1997; NWS, 1997

Danger Category		Heat Disorders	Apparent Temperatures (°F)
IV	Extreme Danger	Heatstroke or sunstroke imminent.	>130
III	Danger	Sunstroke, heat cramps, or heat exhaustion likely; heat stroke possible with prolonged exposure and physical activity.	105-130
II	Extreme Caution	Sunstroke, heat cramps, and heat exhaustion possible with prolonged exposure and physical activity.	90-105
I	Caution	Fatigue possible with prolonged exposure and physical activity.	89-90

The major human risks associated with extreme heat are as follows.

- Heatstroke: Considered a medical emergency, heatstroke is often fatal. It occurs when the body's responses to heat stress are insufficient to prevent a substantial rise in the body's core temperature. While no standard diagnosis exists, a medical heatstroke condition is usually diagnosed when the body's temperature exceeds 105°F due to environmental temperatures. Rapid cooling is necessary to prevent death, with an average fatality rate of 15 percent even with treatment.

- Heat Exhaustion: While much less serious than heatstroke, heat exhaustion victims may complain of dizziness, weakness, or fatigue. Body temperatures may be normal or slightly to moderately elevated. The prognosis is usually good with fluid treatment.

- Heat Syncope: This refers to sudden loss of consciousness and is typically associated with people exercising who are not acclimated to warm temperatures. Causes little or no harm to the individual.

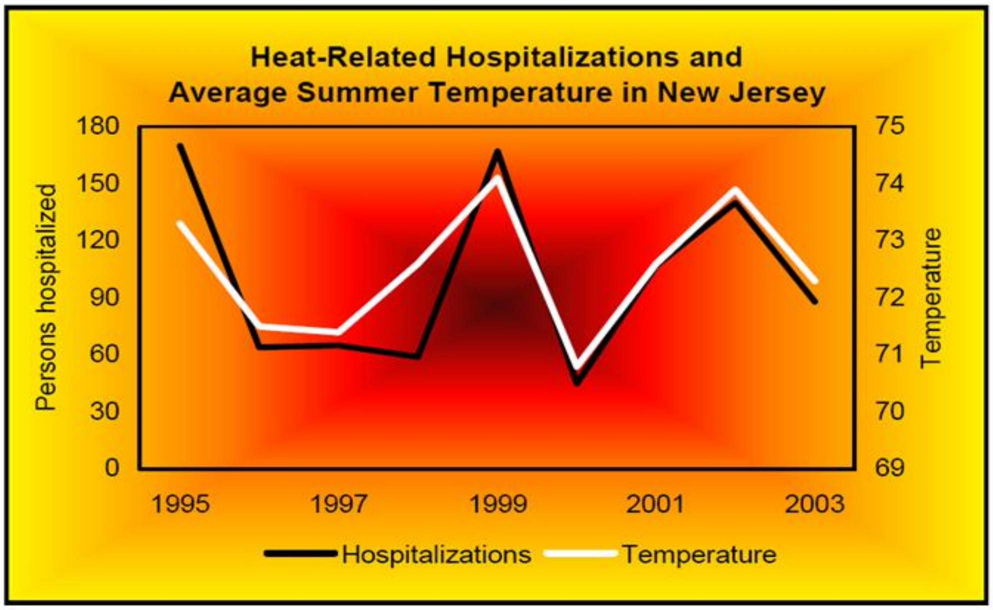
- Heat Cramps: May occur in people unaccustomed to exercising in the heat and generally ceases to be a problem after acclimatization.

New Jersey has a geographic location that results in the State being influenced by wet, dry, hot, and cold airstreams, making for daily weather that is highly variable. In the summer months extreme heat is not unusual and occurs, especially in the southern portion of the state. Extreme heat is temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks. Humid or muggy conditions, which add to the discomfort of high temperatures, occur when a "dome" of high atmospheric pressure traps hazy, damp air near the ground. (CDC October, 2007). Extreme heat events can occur anywhere in the State.

Extreme heat is dangerous and can cause human related illnesses and death. These illnesses include sunburn, heat cramps, heat exhaustion, and heat stroke. In New Jersey extreme heat is responsible for approximately five deaths annually and overexposure to summer heat causes between 25 and 170 hospitalizations in New Jersey every year, depending on the average outdoor temperature. The majority of those hospitalized for this cause are male, aged 65-84, and are hospitalized for three or more days.

Additionally, less severe cases of heat-related illness send many people to hospital emergency departments or only require treatment at home (New Jersey Department of Health, Health Data Fact Sheet 2005). Figure 4.4-11-1 shows the trends in heat related hospitalizations from 1995 to 2003. As temperature goes up so do the number of people hospitalized for heat related illnesses.

Figure 4.4-11.1-1
Heat-related Hospitalizations vs. Average Temperature in New Jersey



Source: (Jersey Department of Health, Health Data Fact Sheet 2005).

4.4.11.2 Previous Extreme Heat Occurrences

The NCDC database reports 61 extreme heat events between 1950 and 2009, with 60 deaths and 294 injuries. . According to the NOAA National Climatic Data Center (NCDC), the hottest day on record in New Jersey was July 10, 1936 the temperature reached 110 degrees Fahrenheit at the Runyon monitoring station (http://www.ncdc.noaa.gov/oa/pub/data/special/maxtemps.pdf).

4.4.11.3 Probability of Extreme Heat Occurrences

Based on the data available at the NCDC, there is an annual average of about 1.4 extreme heat events in New Jersey. Although global warming effects and normal fluctuations in the weather may influence this average, it is reasonable to assume that this average reflects probabilities going forward in time for this hazard.

4.4-12 Coastal Erosion

Note: Future editions of the NJ State Hazard Mitigation plan will incorporate information developed as part of the NJ Hurricane Evacuation Study.

4.4.12.1 Nature of the Coastal Erosion Hazard

Coastal erosion is a dynamic process that is constantly occurring at varying rates along the coasts and shorelines of the U.S. Numerous factors can influence the severity and rate of coastal erosion including human activities, tides, the possibility of rising sea levels, and the frequency and intensity of Nor'easters and hurricanes. Strong storms can erode large sections of coastline with a single event. The process of coastal erosion results in permanent changes to the shape and structure of the coastline. Human activities such as poor land use practices and boating activities can also accelerate the process of coastal erosion.

Billions of dollars of economic development are potentially threatened by the impacts of coastal erosion. In a report to Congress in the year 2000 FEMA estimated that erosion may cost property owners along the coast $500 million a year in structural damages and loss of land. The report also stated as many as 87,000 residential homes may be at risk of eroding into the oceans or Great Lakes over the next 60 years.

On the east coast of the United States, Nor'easters and Hurricanes cause a significant amount of severe beach erosion, as well as flooding in low-lying areas. Beach residents in these areas may actually fear the repeated depredations of nor'easters over those of hurricanes, because they happen more frequently, and cause substantial damage to beach-front property and their dunes.

The State of New Jersey has over 130 miles of coastline, most of which is within close proximity to major metropolitan centers of the mid-Atlantic as can be seen in Figure 4.4-12-1. Beach restoration and maintenance is an ongoing process for New Jersey. The State legislature provides $25 million annually for beach restoration and every beach on the Atlantic is currently under either a design, engineering or construction phase. According to the New Jersey Department of Environmental Protection (NJDEP) web site there are 13 Federal coastal engineering projects and 23 State projects that are either in planning, under construction, or recently completed. The Long Branch-Manasquan Project, between Sandy Hook and Manasquan Inlet, is one of the largest beach construction projects completed in the U.S. with over 25 million cubic yards of sand placed on 25 miles of beaches (Source: U.S. Department of Interior).

By virtue of their location at the interface between oceans and land, coastal areas are among the most dynamic environments on earth susceptible to a broad range of natural hazards. Many parts of New Jersey's densely populated coast are highly vulnerable to the effects of flooding, storm surge, episodic erosion, chronic erosion, sea level rise, and extra-tropical storms.

As described in the NJ DEP Coastal management Program web-site, manifestations of these hazards occur at broadly different rates. Their expression ranges from the gradual, such as sea level rise and chronic erosion that can be measured on a decadal time-scale, to catastrophic events like hurricanes, extra-tropical storms, and storm surges that can be measured in terms of days or even hours. Just as their rates of occurrence differ, so are their effects expressed in profoundly different ways.

- CATASTROPHIC events alter the natural features of the shoreline, such as beaches, dunes, and wetlands, and threaten people and property. In New Jersey, construction of new residential development, reconstruction of existing residential development, and the conversion of single family dwellings into multi-unit dwellings continue in hazardous areas. Although application of more stringent construction standards and techniques results in more storm-resistant structures, the value of property at risk has appreciably increased. With anticipated accelerating sea level rise and increasing storm frequency and intensity, vulnerability to the risks of coastal hazards will be exacerbated and the costs of damages and losses resulting from the events will increase. Catastrophic events require anticipatory preparations for the inevitability of an event, the capacity for rapid response to an imminent threat of an event, and preparation for addressing the aftermath of an event.

- GRADUALLY OCCURRING phenomena are more predictable and allow for long-range planning and measured preparation. On-going data collection, research, and modeling continue to refine our knowledge concerning the effects of climate change on the expression of phenomena that are regarded as coastal hazards. The U.S. Geological Survey evaluated the vulnerability of the mid-Atlantic region to the effects of sea level rise. The results of the study are presented in the report, Potential for Shoreline Changes Due to Sea-Level Rise Along the U.S. Mid-Atlantic Region. The USGS study indicates that most of New Jersey's coast is highly susceptible to the effects of sea level rise.

- SEA LEVEL CHANGE - While the precise rate of sea level rise is uncertain, current models indicate that climate change will cause the rate to increase. Based on the trend of sea level rise from 1961 through 2003, sea level would rise by almost 6-inches by the end of this century in the absence of any effects of climate change. Taking climate change into account, sea level is projected to rise between 7 and 21 inches by 2100. This increase would result in the threat of more sustained extreme storm surges, increased coastal erosion, escalating inundation of coastal wetlands and saline intrusion. The Grant F. Walton Center for Remote Sensing & Spatial Analysis at Rutgers University, in partnership with the American Littoral Society examined the potential effects of sea level rise on coastal habitats. The results of their study is presented in the report Vulnerability of New Jersey's Coastal Habitats to Sea Level Rise.

- COASTAL WETLANDS buffer uplands from chronic and episodic erosion caused by wave action. Conserving areas that allow for the landward migration of coastal wetlands in response to sea level rise is an example of a step that can be taken to enable the persistence of this valuable and productive feature of our coast.

  New Jersey's Coastal Management Program in concert with other State programs, as well as federal and local agencies, and non-profit organizations is proceeding on many fronts to reduce the societal, economic, and environmental risks associated with coastal hazards. The Coastal Management Program is collecting information that will be used to determine the relative vulnerability of coastal areas to natural hazards. Part of this effort involves examining the factors that are conducive to the landward migration of coastal wetlands, the development of pioneering coastal wetlands along open water areas and the transformation of freshwater wetlands to tidal wetlands.

- CLIMATE CHANGE - Several agencies, organizations, and academic institutions have addressed the potential effects of climate change on New Jersey and its coast. The New Jersey Global Warming Web site provides information regarding the State's initiatives regarding climate change. The Union of Concerned Scientists prepared an overview of how climate change may affect New Jersey including the state's coastal area. The Woodrow Wilson School of Public and International Affairs at Princeton University examined the potential effects of climate induced accelerated sea level rise on the New Jersey coast.

4.4.12.2 Preparing For Coastal Hazards & Climate Change

New Jersey Sea Grant College Program prepared a thorough manual that provides valuable guidance for addressing coastal hazards. “The Manual for Coastal Hazard Mitigation”* (PDF) is,"... intended to serve as a resource for individuals, and federal, state, and local officials with which to form the basis of informed coastal hazard mitigation decisions."

Another important resource that provides strategies for coping with coastal hazards is the, “No Adverse Impact in the Coastal Zone”, prepared by the Association of State Floodplain Managers and NOAA. "…no Adverse Impact floodplain management provides vision, principles, and tools through which a private owner, a local community, or a number of adjoining communities can effectively and permanently manage land within a region."

Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments, provides a process designed to guide regions and communities in preparing for the effects of climate change. In addition, The Heinz Center has prepared a report on human vulnerability to coastal disasters.

ON-LINE RESOURCES

The following links to additional resources should be of value to coastal officials, coastal residents and others. We invite you to explore these resources and believe that you will find them informative and useful.

Products provided by NOAA Coastal Services Center:

NOAA Coastal Storms Program: Provides tools, information, and forecast models to assist coastal communities to lessen the impacts of coastal storms.

Community Vulnerability Assessment Tool: An informational aid designed to assist communities in their efforts to reduce hazard vulnerability.

Storm Data Resource Guide: Data and tools that coastal officials need before, during, and after the storm.

Hurricane Planning and Impact Assessment Reports: Provides coastal managers, emergency managers, researchers, and the public with information that may assist in planning for and mitigating against the next hurricane.

Risk and Vulnerability Assessment Tool: Helps to identify people, property, and resources that are at risk of injury, damage, or loss from natural hazards.

*_Manual for Coastal Hazard Mitigation_, compiled by Thomas O. Herrington, Ph.D for the New Jersey Sea Grant College Program. The New Jersey Coastal Management Program sincerely thanks Dr. Herrington and the NJ Sea Grant College Program for allowing us to provide the this thorough reference on our website. The Coastal Management Program also acknowledges the contributions of both the NJ Marine Sciences Consortium and Stevens-New Jersey Cooperative Extension in Coastal Processes in enabling the preparation of this manual

Figure 4.4.12.2-1
Beach Nourishment Project in Sea Girt, New Jersey
(Source: NJDEP)

Figure 4.4.12.2-2
New Jersey Coastal Boundary Map
(Source: NOAA)

The coastal erosion problem is studied by various Federal, State and local agencies and organizations. New Jersey Beach Profile Network (NJBPN) has been monitoring and surveying beach erosion along the New Jersey coastline since 1986. The survey data produced by the NJBPN includes cross-sectional profiles and quantitative measurements of volumetric changes along the profiles over time. The NJBPN was developed after the coastal damage caused by a 1984 northeast storm and Hurricane Gloria in 1985. The lack of survey data for any New Jersey coastal region prior to the storm events restricted the State's ability to substantiate the amount of damage and severity of the storm losses from beaches, which prevented the State from quantifying any damage for reimbursement from the Federal Emergency Management Agency (FEMA) (Source: NJBPN).

The NJBPN is designed to provide regional information on coastal zone changes and long term trends, at enough sites to be statistically meaningful to State and local coastal zone managers. The database consists of 100 beach profile locations between Raritan Bay (3 sites in the lower bay), the Atlantic Ocean coast line, and Delaware Bay (4 sites on the western shoreline of Cape May County). Each site has been visited annually in the fall since 1986 and semiannually in the fall and in the spring since 1994. Information collected consists of photographs of the beach/dune system at each site, a topographic profile of the dune, beach and seafloor to a depth of 12 feet; and field notes on significant conditions or geologic change in progress. Any construction activity is noted and necessary information regarding any quantity and duration of such activity is gathered.

4.4.12.3 Previous Coastal Erosion Occurrences

Nor'easter and Hurricanes can result in significant coastal erosion along New Jersey's shoreline. Four of the past six nor'easters have been severe enough to result in Presidential disaster declarations. All of these storms caused some degree of coastal erosion. Table 4.4.11-1 describes these events.

Table 4.4.12.3-1
Storm-Induced Coastal Erosion Events

Date(s)	Description
March 6-8, 1962	FEMA Disaster # 124: The most damaging northeast storm since the 1888 Blizzard struck New Jersey. Although this storm did not produce record surge levels, it inflicted substantially greater overall damages and loss of life than any other storm. This was primarily due to the prolonged duration of the storm that caused damaging overwash and flooding through five successive high tides. Increased development along the coast since the 1944 hurricane also accounted for increased damages. This storm was also responsible for the loss of 22 lives, completely destroyed 1,853 homes and caused major damage to approximately 2,000 additional homes. The total damage caused by this storm to public and private property was about $85 million (1962 dollars).
December 18, 1992	FEMA Disaster #973: This storm impacted Ocean, Monmouth, Atlantic, Cape May, Cumberland, Bergen, Salem, Middlesex, Somerset, Union, Essex, Hudson counties. Public Assistance, Individual Assistance, Hazard Mitigation Programs were granted with the total eligible amount of $51.0 million Public Assistance (25% state share $12.5 million) $10.5 million Individual Assistance (25% state share $1.32 million) $ 2.2 million Hazard Mitigation (50/50 share). In addition 238 municipalities were eligible for Public Assistance.
March 3, 1998	FEMA Disaster # 1206: A severe Nor'easter in February impacted Atlantic, Cape May, and Ocean counties. Various programs were activated for Public Assistance, Individual Assistance, and Hazard Mitigation. The dollar amounts awarded were: Public Assistance $2.2 million (12.5% state share, 12.5% local share) Disaster Housing Program $1.1 million Individual/Family Grant Program $88,184 million ($28,000 state share) Hazard Mitigation $477,000.

April 26, 2007	FEMA Disaster # 1694: This was on of the worst Nor'easter storms to hit New Jersey in several decades. While filing for federal disaster relief, acting Governor Codey of New Jersey indicated that the storm caused $180 million in property damage in New Jersey, making it the second-worst rain storm in its history, after Hurricane Floyd. Individual and Public Assistance programs were issued for Bergen, Burlington, Essex, Passaic, Somerset, Camden, Mercer, and Union Counties. Public Assistance was issued for Atlantic, Hudson, Middlesex, Sussex and Warren Counties. Gloucester County for Individual Assistance.
December 22, 2009	FEMA Disaster # 1867: At 4:00 am EST, November 7, 2009, the center of Tropical Storm Ida was located about 975 miles SSE of New Orleans, LA and 530 miles SSW of Key West, FL. Ida slowly moved toward the north near 8 mph. The storm twisted and turned and eventually hit New Jersey from November 11 to 15. Maximum sustained winds increased were near 45 mph with higher gusts. Individual and Public Assistance were declared for Atlantic, Cape May and Ocean Counties.

Two other significant storms caused severe damage to parts of the State in 1994 and 1996, but were not declared Presidential disasters. A storm occurred on December 22, 1994 and dissipated on December 26th. This storm caused $17 million in damages. The long duration of north winds pushed New Jersey tides 2.5 feet above normal, leading to significant coastal erosion and flooding.

4.4.12.4 Probability of Coastal Erosion

As mentioned above, coastal erosion problem is an ongoing problem along many areas of the New Jersey coastline. It is difficult, if not impossible, to assign a probability to the near constant small ongoing erosion that may occur over a continuous period of time. However, a probability can be assigned to larger storm events such as Nor'easter's and Hurricanes which can result in significant storm induced coastal erosion. As described in the sections above related to Nor'easters and Hurricanes, the probabilities of these events range from a few a year (Nor'easters) to less than one significant event per decade on average (hurricanes). The period of time over which this data is provided suggests the probability of coastal erosion will be about the same in the future, with year-to-year variations.

4.4-13 Eliminated Hazards

4.4.13.1 Avalanche

4.4.13.1.1 Nature of Avalanche

An avalanche is a rapid flow of snow down a slope, from either natural triggers or human activity. Occurring in mountainous terrain, an avalanche can mix air and water with the descending snow. Powerful avalanches have the capability to entrain ice, rocks, trees, and other material on the slope. Avalanches are primarily composed of flowing snow in mountainous terrain and are among the most serious hazards to life and property, with their destructive capability resulting from their potential to carry an enormous mass of snow rapidly over large distances.

4.4.13.1.2 Location and Extent of an Avalanche

Based on the review of US Forest Service National Avalanche Center web site the topography and climate of New Jersey do not support conditions required for the occurrence of avalanches. Avalanches occur in mountainous area greater in any slope found in New Jersey.

4.4.13.1.3 Probability of an Avalanche

The potential for an avalanche does not exist in New Jersey.

4.4-13.2 Volcano

4.4.13.2.1 Nature of Volcano

A volcano is a mountain that opens downward to a reservoir of molten rock below the surface of the earth. . When pressure from gases within the molten rock becomes too great, an eruption occurs. Eruptions can be quiet or explosive. There may be lava flows, flattened landscapes, poisonous gases, and flying rock and ash.

Active volcanoes in the U.S. are found mainly in Hawaii, Alaska, and the Pacific Northwest.

4.4.13.2.2 Location and Extent of a Volcano

Based on the review of the USGS Volcano Hazards web site there are no known or active volcanoes within 2,000 miles of New Jersey.

4.4.13.2.3 Probability of a Volcano

The potential for a volcano does not pose a threat to New Jersey as compared to other parts of the United States.

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4.4.14 Other Hazards

Since this is a State-level hazard mitigation plan it is useful to identify the hazards that go beyond the limitation of solely natural hazards. Through the efforts described in this Natural Hazards Mitigation Plan, the program will identify human-caused hazards that potentially impact the jusrisdiction using a broad range of sources. This analysis will assess the risk and vulnerability of people, property, the environment and the program/entity operations from these hazards.

The “Other Hazards” include the nan-made hazrds of:
4.4.14.1 Animal Diseases
4.4.14.2 Civil Unrest
4.4.14.3 Crop Failure
4.4.14.4 Fishing Failure
4.4.14.5 Hazardous Waste – Fixes Sites
4.4.14.6 Hazardous Waste – Transportation
4.4.14.7 Hazardous Waste – Off Shore
4.4.14.8 Nuclear Hazard Issues
4.4.14.9 Pandemic
4.4.14.10 Power Outages
4.4.14.11 Terrorism

Many hazards and risks are addressed by other jurisdictions and New Jersey State departments. Reference made here are to illustrate the coordination of efforts in dealing with all hazards mitigation plans and efforts. The identified human-caused hazards have been noted here as threats to the State and greater discussion will be included in subsequent Plans. Consequences of the noted human-caused hazards on the public and property; responsers, facilities and infrastructure; the environments; continuity of operations and delivery of service; the economic condition of the State; and public confidence in the States governance are discussed below.

Additional Informtion will be developed on the identification of a specific agency with primary responsibility, location of the “response Plan; and contact information for more details.

Included will be information on the evaluation by specific criteria dealing with the implementation of mitigation strategies including:

- Ability to participate in federal, state, regional and local mitigation programs
  Note: The New Jersey State (All Natural) Hazard Mitigation Plan lists the FEMA grant programs that are available to deal with mitigation the effects of natural hazards. Other potential grant funds will be identified in the development of each human-cause hazards.
- Capability to identify ongoing mitigation opportunities and track repetitive losses
  Note: The New Jersey State (All Natural) Hazard Mitigation Plan tracks repetitive flood losses. Other recurring incidents wil be discussed for each specific human-caused hazard.
- Maintains mitigation goals, objectives and actions that sets priorities and rankings that include reduction of vulnerability to the identified hazard and including a benefit / cost analysis
  Note: XXXXXXXXXXX
- Encourages public / private partnerships
  Note: XXXXXXXXXXX
- Supports public education and outreach
  Note: XXXXXXXXXXX

Section 4 -Risk Assessment

4.4.14.1 – Animal Diseases

Discussion of animal deseases should be expanded to include those affecting:

- Farm animals such as "foot and mouth" transmitted animal to animal– the responsibility of Dept of Agriculture
- Rabies that can be transmitted from animals to humans– the Dept of Heath
- Wild animal populations - The DEP Division of Fish and Wildlife
- Domestic animals

Animal diseases may threaten public health, animal health, food production, agriculture, livestock production, wildlife, soils, and rangelands, as well as have cascading effects, including economic impact. An example of a highly contagious or economically devastating animal disease is Foot and Mouth Disease. It is non-zoonotic, meaning it is not transmitted between animals and humans and does not present a direct public health risk to humans.

Humans can cross-contaminate farms and animals through their movement, causing extensive casualties in animals/livestock. If not identified in time, this has the ability to disrupt travel and cause severe and far-reaching economic losses to the State and even the country. A zoonotic agricultural event is capable of spreading from animal to human and causing widespread illness and possible death. In both cases, the resulting loss would be severe and far reaching.
Animal diseases will always be present and minimizing its damage and death toll can be done through public awareness and messaging campaigns at the beginning of an event. In the State of New Jersey there were 4,973 human cases of Lyme disease in 2009. Also in 2009 there were 3,558 human cases of Novel Influenza A in New Jersey. Cases such as these can cause widespread panic and alter the way people go through their day. People may be more cautious to eat food that could be contaminated, travel where there is a potential for diseased animals, or lose confidence in the cleanliness of public areas.

The economic impact a large scale animal disease event could have would be catastrophic to the State. Agriculture and aquaculture are a large source or revenue for the State and could impact farmers and state commerce.

Reference information to be fully developed in future All Natural Hazard Plan:

- Agency with primary responsibility
- Where the "Response Plan" is located
- Contact information

Consequences:

The impact of a specific animal disease is based on the percentage of the population and animals infected and the virulence of the disease. The animal disease hazard review continues with an examination and evaluation of consequences by specific criteria its impact on:

- THE PUBLIC – An animal disease could have significant consequences for the general public. Illnesses and death among pet owners and farmers will be present during a severe event. Any individual can become infected by animals that have diseases such as Rabies or Lyme Diseases which can have serious consequences to human health. Contamination of food supplies and water from animal diseases will disrupt the normal public routine.

- RESPONDERS – Highly trained personnel must respond to an Animal Disease Hazard. A highly contagious or economically devastating agricultural event may create a number of illnesses and deaths in response and support personnel, thus limiting the capabilities of personnel to handle the response. In addition, fear from coming in contact with entities that would put the responder and the responder's family at risk, will also limit capabilities of the disaster response.

- CONTINUITY OF OPERATIONS INCLUDING DELIVERY OF SERVICES – The Department of Agriculture, Office of Emergency Management, and the Department of Health and Senior Services have robust continuity of operations plans that will go into effect during an Animal Disease hazard.

- PROPERTY – The impact of animal disease on property, other than livestock, will be minor due to the nature of the hazard. State officials may need to take additional steps to ensure proper prevention or spread of the disease to other locations. These steps may involve issuing quarantine orders on the property in question.

- FACILITIES – The impact of animal disease on facilities will be minor due to the nature of the hazard. These areas may need to take additional steps to ensure proper prevention or spread of this disease to other locations. These steps may involve issuing a quarantine on the facility in question.

- INFRASTRUCTURE – The impact of animal disease on infrastructure will be minor due to the nature of the hazard. Large scale water suppliers who have become contaminated may be forced to shut down operations until their water supply is deemed safe.

- THE ENVIRONMENT – Animal disease could have long term impacts on the fish and wildlife in New Jersey. A serious event can completely deplete a species of its population.

- THE ECONOMIC CONDITION OF THE STATE – An Animal Disease event has the potential to cause significant economic damage to the State of New Jersey, especially in agriculture and aquaculture. A disease impacting agriculture and/or aquaculture could result in long term economic impacts for farmers and state commerce. New Jersey ranked eighth in the nation in expanded wholesale value of floriculture crops with a value of $178 million.[i] The number of farms in New Jersey in 2010 was estimated to be 10,300. The Land in farms in the Garden State is estimated to be 730,000 acres.

- PUBLIC CONFIDENCE IN THE STATE'S GOVERNANCE – Regardless of the animal(s) affected by an emergency of a highly contagious or economically devastating agricultural event in New Jersey, the disease will severely impact animals raised, bred, or marketed in the State, instill fear among consumers, and bring into question the safety of meat and food products generated in New Jersey. This threat will necessitate swift response to any likely highly contagious or economically devastating agricultural event.

Implementation

The flood hazard review further continues with an examination and evaluation by specific criteria dealing with the implementation of mitigation strategies as stated in the State Hazard Mitigation Plan:

- ABILITY TO PARTICIPATE IN FEDERAL, STATE, REGIONAL AND LOCAL MITIGATION PROGRAMS – The FEMA approved All Natural Hazard Mitigation Plan (as described in Sections 2.3.1 and 2.3.2 of the NJ 2011 Hazard Mitigation Plan) enables the State to participate in:
  - Public Assistance Mitigation Programs
  - Pre- and Post-Disaster Mitigation Program
  - The Fire Management Grant and

- The Emergency Management Grant Programs.

- CAPABILITY TO IDENTIFY ONGOING MITIGATION OPPORTUNITIES AND TRACK REPETITIVE LOSSES – Only flood issues are tracked using Repetitive Loss Information. The New Jersey State Hazard Mitigation Plan is updated every three years and county and municipal local jurisdictional plans are updated every five years. The coordination of local planning efforts provides the framework to identify ongoing mitigation opportunities developed by adjoining counties and municipalities and to track repetitive losses through:
  - The State Hazard Mitigation Goals and Objectives listed in Section 5.2.2 of the Plan.
  - Repetitive Flood Loss data included in Sections 4.4.1.6.1, 4.4.1.6.2 and 4.4.1.6.3 of the Plan that uses NFIP Flood Claim information.
  - The State Repetitive Loss Strategy developed in Section 5.2.3.
  - Through the use of Green Acres/Blue Acres land acquisition funds acquisition of repetitive loss and severe repetitive loss properties are accomplished.

- MAINTAINS MITIGATION GOALS, OBJECTIVES AND ACTIONS THAT SETS PRIORITIES AND RANKINGS THAT INCLUDE REDUCTION OF VULNERABILITY TO THE IDENTIFIED HAZARD AND INCLUDING A BENEFIT / COST ANALYSIS - Mitigation goals, objectives and actions are included in the Plan. The NJ State's five mitigation goals are:
  - To protect life
  - To protect property
  - To increase public preparedness
  - Develop and maintain an understanding of natural hazard risks
  - Enhance capabilities to make New Jersey less vulnerable to hazards
  -

  The above noted goals are further developed through 18 objectives and the Repetitive Loss Strategy included in Section 5.2 of the Plan.

  Specific action items (included in Section 5.4.3) address each of the mitigation goals with action items include:
    - Information the rationale for action
    - Priority (up to 3 years)
    - How the action contributes to the Mitigation Strategy
    - STAPLEE Assessment of Mitigation Actions.

  A Benefit / Cost Analysis is a requirement of most FEMA grant projects. The analysis is generally prepared when a project moves closer to being undertaken and costs are developed. Instructions and information on Benefit / Cost are included as a Handout of the Plan. Benefit/Cost training sessions are sponsored regularly for state and local FEMA grant application developers.

- ENCOURAGES PUBLIC / PRIVATE PARTNERSHIPS – Coordination between agencies include participation in the Hazard Mitigation Plan development by:
  - State Departments and Agencies
    - Attorney General
    - Banking and Insurance
    - Community Affairs
    - Environmental Protection
    - NJ State Police, Office of Emergency Management
    - Office of the Governor
    - Public Utilities

    - State Climatologist
    - State Geologist
    - State Office of Information Technology
    - Transportation
    - Treasury
    - Veterans Affairs
  - Intra-state agencies
    - Delaware and Raritan Canal Commission
    - Delaware River Basin Commission
    - Delaware River Basin Interstate Flood Mitigation Task Force
    - FEMA Portfolio Management
    - NJ Association of Flood Plain Managers
    - NJ Flood Mitigation Task Force
    - NJ League of Municipalities
    - Passaic River Basin Flood Advisory Commission
    - USACE Silver Jackets

- SUPPORTS PUBLIC EDUCATION AND OUTREACH – Public Education and Education is included in the plan as a mitigation strategy for most identified hazards. NJOEM prepares "handouts" on subjects of interest in response to questions raised at training and outreach sessions. Outreach sessions are conduct as FEMA grant program funding availability announcements are made. Benefit/Cost refresher training courses are given on a regular basis. NJOEM is a regular presenter at annual meetings of the NJ League of Municipalities, the NJ Association of Emergency Managers, Delaware River Greenway Partnership, etc.

4.4.14.2 – Civil Unrest

Civil unrest is a public crisis that occurs with or without warning and that may adversely impact significant portions of the population. These disturbances may be the actions of any number of persons causing disruption of the populace. Civil unrest can be defined to include those acts that involve criminal activity by a group that comprises a threat to the lives and property of others. These disturbances may be precipitated by a specific event, or result from longstanding grievances.

Civil unrest like terrorism is a hazard which, while the frequency of occurrence can seldom be predicted, necessitates considerable planning on the part of the agency(s) responsible for addressing it. In addition, depending on the magnitude of the incident(s), civil unrest can rapidly deplete the available resources of any single agency.

Planning for and responding to civil disturbances is primarily the responsibility of local law enforcement and associated resources. Unless other considerations warrant, all other city and county departments are responsible for maintaining their own operations and services during this type of event. When situations occur which are beyond the capabilities of the involved jurisdiction, additional support may be necessary from other jurisdictions and/or the state.

The State of New Jersey has experienced several occurrences of civil unrest. Most have been connected with organized labor activities or racial tensions present in communities. In 1913 the City of Patterson experienced a massive strike by workers in the City's silk industry. This resulted in the arrest of over 1,800 individuals. In the 1960's and 1970's the State saw the explosion of riots several major cities. These actions led to over 25 deaths, several occurrences of fire bombings and over $10 Million in property damages.

The potential for instances of civil unrest to occur in New Jersey is high, many activities that normally take place in the State could lead to acts of civil unrest. New Jersey has several large sports arenas and meeting places that could be the site of major riots if an incident were to occur. The State has also seen demonstrations by labor unions and other advocacy groups that had the potential to erupt into an act of civil unrest. It is important to note that instances of civil unrest may occur in response to other hazard events. For example, the occurrence of a natural disaster could lead to large scale looting or rioting

Reference information to be fully developed in future All Natural Hazard Plan:

- Agency with primary responsibility
- Where the "Response Plan" is located
- Contact information

Consequences:

- THE PUBLIC – The general population could serve as participants or targets in actions of civil unrest. Wide spread unrest could cause fear amongst the populace and cause them to be absent from school or work activities. During an event, bystanders may be harmed due to the activities of participants.

- RESPONDERS – Response to civil unrest events are general handled at the local level. In a large event the resources of a local jurisdiction may be exceeded. In this instance State resources would be activated to fill the need. During an event responders may become targets, this could hamper their effectiveness.

- CONTINUITY OF OPERATIONS INCLUDING DELIVERY OF SERVICES – The outbreak of widespread rioting or looting could have potential impact on the State's ability to provide services and conduct its normal operations. Protesters could occupy government buildings and interrupt the normal functions of government, or targeted attacks on government facilities could interrupt operations entirely.

- PROPERTY – Private property often serves as a target in instances of civil unrest. Businesses can be targeted for looting or vandalism. If an event is particularly large, damages could reach the millions of dollars and take years to recover from.

- FACILITIES – Often in acts of civil unrest government facilities become the focal point of protests or targets for vandalism. Damages suffered during an event or a inability of a facilities workers to enter a facility may greatly reduce a facilities effective capacity or close it completely.

- INFRASTRUCTURE – Similar to government facilities, public and private infrastructure can become targets of civil unrest. Damages to transportation, communications or utilities infrastructure could further exacerbate the situation.

- THE ENVIRONMENT – Normally, instance of civil unrest will have a minimum of impact on the environment. However, if chemical facilities were a target a vandalism or large scale fires occurred, the impact on the environment could be significant.

- THE ECONOMIC CONDITION OF THE STATE – Civil unrest could prove economically crippling to the State of New Jersey. Large scale events are usually accompanied by wide spread absenteeism and damages to private property.

- PUBLIC CONFIDENCE IN THE STATE'S GOVERNANCE – If an event becomes prolonged or is perceived to be mismanaged, it could greatly decrease public confidence in the governance of the State. If the response is seen to be inadequate, individuals may attempt to protect their property by their own means and further degrade the situation.

Implementation

The civil unrest hazard review further continues with an examination and evaluation by specific criteria dealing with the implementation of mitigation strategies as stated in the State Hazard Mitigation Plan:

- ABILITY TO PARTICIPATE IN FEDERAL, STATE, REGIONAL AND LOCAL MITIGATION PROGRAMS – The FEMA approved All Natural Hazard Mitigation Plan (as described in Sections 2.3.1 and 2.3.2 of the NJ 2011 Hazard Mitigation Plan) enables the State to participate in:
  - Public Assistance Mitigation Programs
  - Pre- and Post-Disaster Mitigation Program
  - The Fire Management Grant and
  - The Emergency Management Grant Programs.

- CAPABILITY TO IDENTIFY ONGOING MITIGATION OPPORTUNITIES AND TRACK REPETITIVE LOSSES – Only flood issues are tracked using Repetitive Loss Information. The New Jersey State Hazard Mitigation Plan is updated every three years and county and municipal local jurisdictional plans are updated every five years. The coordination of local planning efforts provides the framework to identify ongoing mitigation opportunities developed by adjoining counties and municipalities and to track repetitive losses through:
  - The State Hazard Mitigation Goals and Objectives listed in Section 5.2.2 of the Plan.
  - Repetitive Flood Loss data included in Sections 4.4.1.6.1, 4.4.1.6.2 and 4.4.1.6.3 of the Plan that uses NFIP Flood Claim information.
  - The State Repetitive Loss Strategy developed in Section 5.2.3.
  - Through the use of Green Acres/Blue Acres land acquisition funds acquisition of repetitive loss and severe repetitive loss properties are accomplished.

- MAINTAINS MITIGATION GOALS, OBJECTIVES AND ACTIONS THAT SETS PRIORITIES AND RANKINGS THAT INCLUDE REDUCTION OF VULNERABILITY TO THE IDENTIFIED HAZARD AND INCLUDING A BENEFIT / COST ANALYSIS - Mitigation goals, objectives and actions are included in the Plan. The NJ State's five mitigation goals are:
  - To protect life
  - To protect property
  - To increase public preparedness
  - Develop and maintain an understanding of natural hazard risks
  - Enhance capabilities to make New Jersey less vulnerable to hazards

  The above noted goals are further developed through 18 objectives and the Repetitive Loss Strategy included in Section 5.2 of the Plan.

  Specific action items (included in Section 5.4.3) address each of the mitigation goals with action items include:
  - Information the rationale for action
  - Priority (up to 3 years)
  - How the action contributes to the Mitigation Strategy
  - STAPLEE Assessment of Mitigation Actions.

  A Benefit / Cost Analysis is a requirement of most FEMA grant projects. The analysis is generally prepared when a project moves closer to being undertaken and costs are developed. Instructions and information on Benefit / Cost are included as a Handout of the Plan. Benefit/Cost training sessions are sponsored regularly for state and local FEMA grant application developers.

- ENCOURAGES PUBLIC / PRIVATE PARTNERSHIPS – Coordination between agencies include participation in the Hazard Mitigation Plan development by:
  - State Departments and Agencies
    - Attorney General
    - Banking and Insurance
    - Community Affairs
    - Environmental Protection
    - NJ State Police, Office of Emergency Management
    - Office of the Governor
    - Public Utilities
    - State Climatologist
    - State Geologist
    - State Office of Information Technology
    - Transportation
    - Treasury
    - Veterans Affairs
  - Intra-state agencies
    - Delaware and Raritan Canal Commission
    - Delaware River Basin Commission
    - Delaware River Basin Interstate Flood Mitigation Task Force
    - FEMA Portfolio Management
    - NJ Association of Flood Plain Managers
    - NJ Flood Mitigation Task Force
    - NJ League of Municipalities
    - Passaic River Basin Flood Advisory Commission
    - USACE Silver Jackets

- SUPPORTS PUBLIC EDUCATION AND OUTREACH – Public Education and Education is included in the plan as a mitigation strategy for most identified hazards. NJOEM prepares "handouts" on subjects of interest in response to questions raised at training and outreach sessions. Outreach sessions are conduct as FEMA grant program funding availability announcements are made. Benefit/Cost refresher training courses are given on a regular basis. NJOEM is a regular presenter at annual meetings of the NJ League of Municipalities, the NJ Association of Emergency Managers, Delaware River Greenway Partnership, etc.

4.4.14.3 – Crop Failure

Crop failures can prove disastrous to agricultural industries, farmers and economies. The threat of a crop failure in the State of New Jersey could have major effects on the price of food in the state, as well as hinder the growth of the state wide economy.

The agricultural industry in the State of New Jersey is vulnerable to a crop failure from a multitude of different sources. They include but are not limited to, drought, flood, other severe weather events, agraterrorism, chemical contamination, botanical diseases and wild fire. New Jersey experienced prolonged droughts in the 1960's and 1990's which had a definite effect on the State's agricultural production. In 2008, ten New Jersey counties were designated as disaster areas due to adverse weather conditions and it's affects on crops. Also, in 2010 sixteen New Jersey counties due to excessive heat and lack of rain and its effect on farm products.

Whatever the cause of a crop failure, a widespread event could pose a distinct risk to the economy and food supply of the State. The market value of agricultural products sold in the state in 2008 was $1.1 billion dollars. New Jersey agriculture ranks third in importance (behind pharmaceuticals and tourism) in economic importance to the state. New Jersey's horticulture industry is the largest sector of the State's agricultural economy, represent one-third of total sales.

Reference information to be fully developed in future All Natural Hazard Plan:

- Agency with primary responsibility
- Where the "Response Plan" is located
- Contact information

Consequences:

- THE PUBLIC – The effects of a crop failure on the public of New Jersey could be potentially great. In the event of a crop failure food supplies could be interrupted and the public could experience a rise in overall food prices. Also, a wide spread failure due to contamination by a foreign agent or a biological organism could create doubts about the safety of the food supply.
- RESPONDERS – Due to the nature of the hazard few consequences should be expected for responders outside of those generated for the general public.
- CONTINUITY OF OPERATIONS INCLUDING DELIVERY OF SERVICES – Due to the nature of the hazard few consequences should be expected in the realm of continuity of operations.
- PROPERTY – A crop failure by its nature would see the destruction of agricultural property. The specific affects would depend on the nature of the hazard and its duration.
- FACILITIES – Due to the nature of the hazard few consequences should be expected for facilities.
- INFRASTRUCTURE – Due to the nature of the hazard few consequences should be expected for infrastructure.
- THE ENVIRONMENT – A crop failure could have a potentially severe impact on the environment if it were due to contamination by a foreign agent or a biological organism. In this event, large swathes of agricultural crop land may have to be abandoned or water sheds may need to be monitored for contamination.
- THE ECONOMIC CONDITION OF THE STATE – The economic conditions of the State could be moderately affected by a crop failure. New Jersey's economy is somewhat dependent on agricultural production and consumers may see a rise in food prices in the event of a crop failure.
- PUBLIC CONFIDENCE IN THE STATE'S GOVERNANCE – If the response to a crop failure was seen to be mismanaged by the public it could lead to a loss in confidence in the States effective governance. This coupled with a rise in food prices may lead to acts of civil unrest.

Implementation

The crop failure hazard review further continues with an examination and evaluation by specific criteria dealing with the implementation of mitigation strategies as stated in the State Hazard Mitigation Plan:

- ABILITY TO PARTICIPATE IN FEDERAL, STATE, REGIONAL AND LOCAL MITIGATION PROGRAMS – The FEMA approved All Natural Hazard Mitigation Plan (as described in Sections 2.3.1 and 2.3.2 of the NJ 2011 Hazard Mitigation Plan) enables the State to participate in:
  - Public Assistance Mitigation Programs
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  - The State Repetitive Loss Strategy developed in Section 5.2.3.
  - Through the use of Green Acres/Blue Acres land acquisition funds acquisition of repetitive loss and severe repetitive loss properties are accomplished.

- MAINTAINS MITIGATION GOALS, OBJECTIVES AND ACTIONS THAT SETS PRIORITIES AND RANKINGS THAT INCLUDE REDUCTION OF VULNERABILITY TO THE IDENTIFIED HAZARD AND INCLUDING A BENEFIT / COST ANALYSIS - Mitigation goals, objectives and actions are included in the Plan. The NJ State's five mitigation goals are:
  - To protect life
  - To protect property
  - To increase public preparedness
  - Develop and maintain an understanding of natural hazard risks
  - Enhance capabilities to make New Jersey less vulnerable to hazards

  The above noted goals are further developed through 18 objectives and the Repetitive Loss Strategy included in Section 5.2 of the Plan.

  Specific action items (included in Section 5.4.3) address each of the mitigation goals with action items include:
  - Information the rationale for action
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  A Benefit / Cost Analysis is a requirement of most FEMA grant projects. The analysis is generally prepared when a project moves closer to being undertaken and costs are developed. Instructions and information on Benefit / Cost are included as a Handout of the Plan. Benefit/Cost training sessions are sponsored regularly for state and local FEMA grant application developers.

- ENCOURAGES PUBLIC / PRIVATE PARTNERSHIPS – Coordination between agencies include participation in the Hazard Mitigation Plan development by:
  - State Departments and Agencies
    - Attorney General
    - Banking and Insurance

    - Community Affairs
    - Environmental Protection
    - NJ State Police, Office of Emergency Management
    - Office of the Governor
    - Public Utilities
    - State Climatologist
    - State Geologist
    - State Office of Information Technology
    - Transportation
    - Treasury
    - Veterans Affairs
  - Intra-state agencies
    - Delaware and Raritan Canal Commission
    - Delaware River Basin Commission
    - Delaware River Basin Interstate Flood Mitigation Task Force
    - FEMA Portfolio Management
    - NJ Association of Flood Plain Managers
    - NJ Flood Mitigation Task Force
    - NJ League of Municipalities
    - Passaic River Basin Flood Advisory Commission
    - USACE Silver Jackets

- SUPPORTS PUBLIC EDUCATION AND OUTREACH – Public Education and Education is included in the plan as a mitigation strategy for most identified hazards. NJOEM prepares “handouts” on subjects of interest in response to questions raised at training and outreach sessions. Outreach sessions are conduct as FEMA grant program funding availability announcements are made. Benefit/Cost refresher training courses are given on a regular basis. NJOEM is a regular presenter at annual meetings of the NJ League of Municipalities, the NJ Association of Emergency Managers, Delaware River Greenway Partnership, etc.

4.4.14.4 – Fishing Failure

A failure in the fishing industry in New Jersey could be disastrous to the state’s fishing industry, economy and coastal communities. A fishing failure could occur for many different reasons, including over fishing, disease, changing migration patterns or climate change.

New Jersey has a rich tradition in the fishing industry which continues to this day. Over 100 different species of finfish and shellfish were harvested in the Garden State and local products are shipped to major seafood markets throughout the world. Six major fishing ports are located in this state – Atlantic City, Barnegat Light, Belford, Cape May, Point Pleasant and Port Norris – with a commercial fleet of more than 1,500 vessels employing nearly 3,000 fishermen. New Jersey also boasts 15 seafood processing plants and 81 wholesalers employing more than 2,200 workers.

All told, the industry brings in $4.5 billion annually from fisheries, aquaculture and recreational fishing. This is part of a $50 billion-a-year “Coastal Zone” sector of the state’s economy, which employs one out of every six people working in New Jersey. The value of the seafood harvest extends well beyond the industry itself. The effects of a prosperous seafood industry are felt in other waterfront activities such as shipbuilding, maintenance and repair, support services (equipment, fuel, materials and supplies) and ecotourism. Most importantly, the dollars earned in fishing communities tend to remain in those communities, adding incrementally to the local economy and in turn strengthening the relationship between the industry and its home port.

Reference information to be fully developed in future All Natural Hazard Plan:

- Agency with primary responsibility
- Where the "Response Plan" is located
- Contact information

Consequences:

- THE PUBLIC – The effects of a fishing failure on the public of New Jersey could be potentially great. In the event of a fishing failure food supplies could be interrupted and the public could experience a rise in overall food prices. Also, a wide spread failure due to contamination by a foreign agent or a biological organism could create doubts about the safety of the food supply.
- RESPONDERS – Due to the nature of the hazard few consequences should be expected for responders outside of those generated for the general public.
- CONTINUITY OF OPERATIONS INCLUDING DELIVERY OF SERVICES – Due to the nature of the hazard few consequences should be expected in the realm of continuity of operations.
- PROPERTY – Due to the nature of the hazard few consequences should be expected for facilities, outside of secondary effects on fishing related property (boats, processing facilities, etc.) created by the hazard.
- FACILITIES – Due to the nature of the hazard few consequences should be expected for facilities.
- INFRASTRUCTURE – Due to the nature of the hazard few consequences should be expected for infrastructure.
- THE ENVIRONMENT – A fishing failure could have a potentially severe impact on the environment if it were due to contamination by a foreign agent or a biological organism. If a massive fish kill was associated with the event clean up and recovery could take months.
- THE ECONOMIC CONDITION OF THE STATE – The economic conditions of the State could be greatly affected by a fishing failure. New Jersey's economy is somewhat dependent on the fishing industry, but, the impacts could be severe on coastal towns that rely on the fishing industry. Also, a fishing failure may have an impact on the tourism industry.
- PUBLIC CONFIDENCE IN THE STATE'S GOVERNANCE – If the response to a fishing failure was seen to be mismanaged by the public it could lead to a loss in confidence in the States effective governance. This coupled with a rise in food prices may lead to acts of civil unrest.

Implementation

The fishing failure hazard review further continues with an examination and evaluation by specific criteria dealing with the implementation of mitigation strategies as stated in the State Hazard Mitigation Plan:

- ABILITY TO PARTICIPATE IN FEDERAL, STATE, REGIONAL AND LOCAL MITIGATION PROGRAMS – The FEMA approved All Natural Hazard Mitigation Plan (as described in Sections 2.3.1 and 2.3.2 of the NJ 2011 Hazard Mitigation Plan) enables the State to participate in:

- Public Assistance Mitigation Programs
- Pre- and Post-Disaster Mitigation Program
- The Fire Management Grant and
- The Emergency Management Grant Programs.

- CAPABILITY TO IDENTIFY ONGOING MITIGATION OPPORTUNITIES AND TRACK REPETITIVE LOSSES – Only flood issues are tracked using Repetitive Loss Information. The New Jersey State Hazard Mitigation Plan is updated every three years and county and municipal local jurisdictional plans are updated every five years. The coordination of local planning efforts provides the framework to identify ongoing mitigation opportunities developed by adjoining counties and municipalities and to track repetitive losses through:
    - The State Hazard Mitigation Goals and Objectives listed in Section 5.2.2 of the Plan.
    - Repetitive Flood Loss data included in Sections 4.4.1.6.1, 4.4.1.6.2 and 4.4.1.6.3 of the Plan that uses NFIP Flood Claim information.
    - The State Repetitive Loss Strategy developed in Section 5.2.3.
    - Through the use of Green Acres/Blue Acres land acquisition funds acquisition of repetitive loss and severe repetitive loss properties are accomplished.

- MAINTAINS MITIGATION GOALS, OBJECTIVES AND ACTIONS THAT SETS PRIORITIES AND RANKINGS THAT INCLUDE REDUCTION OF VULNERABILITY TO THE IDENTIFIED HAZARD AND INCLUDING A BENEFIT / COST ANALYSIS - Mitigation goals, objectives and actions are included in the Plan. The NJ State's five mitigation goals are:
    - To protect life
    - To protect property
    - To increase public preparedness
    - Develop and maintain an understanding of natural hazard risks
    - Enhance capabilities to make New Jersey less vulnerable to hazards

  The above noted goals are further developed through 18 objectives and the Repetitive Loss Strategy included in Section 5.2 of the Plan.

  Specific action items (included in Section 5.4.3) address each of the mitigation goals with action items include:

    - Information the rationale for action
    - Priority (up to 3 years)
    - How the action contributes to the Mitigation Strategy
    - STAPLEE Assessment of Mitigation Actions.

  A Benefit / Cost Analysis is a requirement of most FEMA grant projects. The analysis is generally prepared when a project moves closer to being undertaken and costs are developed. Instructions and information on Benefit / Cost are included as a Handout of the Plan. Benefit/Cost training sessions are sponsored regularly for state and local FEMA grant application developers.

- ENCOURAGES PUBLIC / PRIVATE PARTNERSHIPS – Coordination between agencies include participation in the Hazard Mitigation Plan development by:
    - State Departments and Agencies
        - Attorney General
        - Banking and Insurance
        - Community Affairs
        - Environmental Protection
        - NJ State Police, Office of Emergency Management

- Office of the Governor
- Public Utilities
- State Climatologist
- State Geologist
- State Office of Information Technology
- Transportation
- Treasury
- Veterans Affairs
- Intra-state agencies
  - Delaware and Raritan Canal Commission
  - Delaware River Basin Commission
  - Delaware River Basin Interstate Flood Mitigation Task Force
  - FEMA Portfolio Management
  - NJ Association of Flood Plain Managers
  - NJ Flood Mitigation Task Force
  - NJ League of Municipalities
  - Passaic River Basin Flood Advisory Commission
  - USACE Silver Jackets

- SUPPORTS PUBLIC EDUCATION AND OUTREACH – Public Education and Education is included in the plan as a mitigation strategy for most identified hazards. NJOEM prepares "handouts" on subjects of interest in response to questions raised at training and outreach sessions. Outreach sessions are conduct as FEMA grant program funding availability announcements are made. Benefit/Cost refresher training courses are given on a regular basis. NJOEM is a regular presenter at annual meetings of the NJ League of Municipalities, the NJ Association of Emergency Managers, Delaware River Greenway Partnership, etc.

4.4.14.5 – Hazardous Waste (Fixed Site)

Hazardous Materials emergencies may occur as a result of accidents in facilities that manufacture, store or use toxic materials or during the transport of chemicals. Hazardous Materials emergencies may also occur as a result of an attack on a manufacturing or storage facility or by the deliberate release of toxic chemicals. The release of hazardous materials can serve as a threat to humans, animals and the environment.

The State of New Jersey is particularly vulnerable to the release of hazardous materials due to the high number of chemical manufacturers in the State, as well as other manufacturing concerns which utilize hazardous materials or create hazardous materials as a bi-product.

New Jersey ranks second in specialty chemical manufacturing and shows five petroleum refineries. In combination, these two factors put New Jersey's population at a great overall risk. Also a hazardous waste emergency puts New Jersey's environment at great risk depending on the severity of the event.

For example, in 1995 the Napp Technologies, Inc. Chemical Plant explosion caused great panic and damage. This hazardous waste emergency occurred in Lodi, NJ and had several perilous hazards associated with it. There was both an explosion and fire during this emergency which put those surrounding the area and responding to the scene in great danger. Also a chemical release took place which posed both a threat to human life and the environment when it leaked into the Saddle River.

Reference information to be fully developed in future All Natural Hazard Plan:

- Agency with primary responsibility
- Where the "Response Plan" is located
- Contact information

Consequences:

The impact of a specific hazardous waste event is based on the percentage of the population affected and the type of the chemical involved. The hazard waste review continues with an examination and evaluation of consequences by specific criteria its impact on:

- THE PUBLIC – A serious hazardous waste event that takes place at a fixed site can have a great impact on the public surrounding the site. The impact will depend upon the nature of the hazardous waste, the amount of contact an individual has with the chemical, and any other explosion or fire associated with the event. Immediate notification to the public regarding the hazardous waste event is vital in maintaining public safety.

- RESPONDERS – The immediate first responders on scene may be hesitant to perform their duties due to the nature of a hazardous waste event. If the proper precautions and personal protective equipment is not used responders can put their health and lives in danger during a hazardous waste event. Any type of long or short term contact with a chemical can be hazardous to a responder.

- CONTINUITY OF OPERATIONS INCLUDING DELIVERY OF SERVICES – A hazardous waste event occurring at a fixed site will have an impact on the continuity of operations in the immediate area of the event.

- PROPERTY – Real property may become generally unusable due to contamination depending on the nature of the hazardous waste event. Also, it may be impossible to occupy industrial or business sites due to contamination.

- FACILITIES – Facilities in the immediate vicinity of a hazardous waste event could become temporarily or permanently uninhabitable due to contamination.

- INFRASTRUCTURE – Public and private infrastructure could be shut down or destroyed by a hazardous waste event. The type of infrastructure destroyed would depend on the nature of the event and the extent of its effects.

- THE ENVIRONMENT – The impact on the environment that a hazardous waste event will have depends on where the event is located and the extent of the contamination. The animals, plants and other wildlife surrounding the hazardous waste event will certainly be impacted. Underground water and soil can become contaminated when exposed to hazardous material which makes for a very costly cleanup.

- THE ECONOMIC CONDITION OF THE STATE –Hazardous wastes can be particularly destructive to economic conditions. A hazardous waste event can leave localities or entire regions uninhabitable. They can destroy facilities and contaminate water/food stocks. Areas that have been affected by an event are also not attractive to tourists.

- PUBLIC CONFIDENCE IN THE STATE'S GOVERNANCE – A government's inability to contain hazardous waste events can sew widespread fear and panic in a population and cause them to lose confidence in their elected officials.

Implementation

The hazardous waste fixed site review further continues with an examination and evaluation by specific criteria dealing with the implementation of mitigation strategies as stated in the State Hazard Mitigation Plan:

- ABILITY TO PARTICIPATE IN FEDERAL, STATE, REGIONAL AND LOCAL MITIGATION PROGRAMS – The FEMA approved All Natural Hazard Mitigation Plan (as described in Sections 2.3.1 and 2.3.2 of the NJ 2011 Hazard Mitigation Plan) enables the State to participate in:
  - Public Assistance Mitigation Programs
  - Pre- and Post-Disaster Mitigation Program
  - The Fire Management Grant and
  - The Emergency Management Grant Programs.

- CAPABILITY TO IDENTIFY ONGOING MITIGATION OPPORTUNITIES AND TRACK REPETITIVE LOSSES – Only flood issues are tracked using Repetitive Loss Information. The New Jersey State Hazard Mitigation Plan is updated every three years and county and municipal local jurisdictional plans are updated every five years. The coordination of local planning efforts provides the framework to identify ongoing mitigation opportunities developed by adjoining counties and municipalities and to track repetitive losses through:
  - The State Hazard Mitigation Goals and Objectives listed in Section 5.2.2 of the Plan.
  - Repetitive Flood Loss data included in Sections 4.4.1.6.1, 4.4.1.6.2 and 4.4.1.6.3 of the Plan that uses NFIP Flood Claim information.
  - The State Repetitive Loss Strategy developed in Section 5.2.3.
  - Through the use of Green Acres/Blue Acres land acquisition funds acquisition of repetitive loss and severe repetitive loss properties are accomplished.

- MAINTAINS MITIGATION GOALS, OBJECTIVES AND ACTIONS THAT SETS PRIORITIES AND RANKINGS THAT INCLUDE REDUCTION OF VULNERABILITY TO THE IDENTIFIED HAZARD AND INCLUDING A BENEFIT / COST ANALYSIS - Mitigation goals, objectives and actions are included in the Plan. The NJ State's five mitigation goals are:
  - To protect life
  - To protect property
  - To increase public preparedness
  - Develop and maintain an understanding of natural hazard risks
  - Enhance capabilities to make New Jersey less vulnerable to hazards

The above noted goals are further developed through 18 objectives and the Repetitive Loss Strategy included in Section 5.2 of the Plan.

Specific action items (included in Section 5.4.3) address each of the mitigation goals with action items include:

- Information the rationale for action
- Priority (up to 3 years)
- How the action contributes to the Mitigation Strategy
- STAPLEE Assessment of Mitigation Actions.

A Benefit / Cost Analysis is a requirement of most FEMA grant projects. The analysis is generally prepared when a project moves closer to being undertaken and costs are developed. Instructions and information on Benefit / Cost are included as a Handout of the Plan. Benefit/Cost training sessions are sponsored regularly for state and local FEMA grant application developers.

- ENCOURAGES PUBLIC / PRIVATE PARTNERSHIPS – Coordination between agencies include participation in the Hazard Mitigation Plan development by:
  - State Departments and Agencies
    - Attorney General
    - Banking and Insurance

- Community Affairs
- Environmental Protection
- NJ State Police, Office of Emergency Management
- Office of the Governor
- Public Utilities
- State Climatologist
- State Geologist
- State Office of Information Technology
- Transportation
- Treasury
- Veterans Affairs

o Intra-state agencies

- Delaware and Raritan Canal Commission
- Delaware River Basin Commission
- Delaware River Basin Interstate Flood Mitigation Task Force
- FEMA Portfolio Management
- NJ Association of Flood Plain Managers
- NJ Flood Mitigation Task Force
- NJ League of Municipalities
- Passaic River Basin Flood Advisory Commission
- USACE Silver Jackets

- SUPPORTS PUBLIC EDUCATION AND OUTREACH – Public Education and Education is included in the plan as a mitigation strategy for most identified hazards. NJOEM prepares "handouts" on subjects of interest in response to questions raised at training and outreach sessions. Outreach sessions are conduct as FEMA grant program funding availability announcements are made. Benefit/Cost refresher training courses are given on a regular basis. NJOEM is a regular presenter at annual meetings of the NJ League of Municipalities, the NJ Association of Emergency Managers, Delaware River Greenway Partnership, etc.

4.4.14.6 – Hazardous Waste (Transportation)

Hazardous Materials Transportation emergencies may occur as a result of traffic collisions, act of terrorism or train derailment. Transport can be over rail, highway, air, or maritime routes. The release of hazardous materials can serve as a threat to humans, animals and the environment.

The State of New Jersey is particularly vulnerable to the release of hazardous materials due to the high number of chemical manufacturers in the State, as well as other manufacturing concerns which utilize hazardous materials or create hazardous materials as a bi-product. Hazardous materials/chemicals are also routinely transported through the State by rail, air, maritime and ground transportation.

New Jersey ranks first in population density, land development, and the number of roads per square mile. New Jersey ranks second in specialty chemical manufacturing. In combination, these two factors put New Jersey's population at a great overall risk. Also a hazardous waste emergency puts New Jersey's environment at great risk depending on the severity of the event.

For example, in 2001 a hazardous waste event took place in Denville, NJ that posed a threat to both the public and the environment. During this event an explosion took place on the Route 80 Bridge in Denville due to hazardous waste. This explosion put those in the immediate area of it in danger as well as the other occupants of the bridge. Also petroleum leaked into Den Brook causing an environmental issue. This hazardous waste event caused severe damage to the integrity of the bridge and cost $6 million to replace the Denville Bridge.

Reference information to be fully developed in future All Natural Hazard Plan:

- Agency with primary responsibility
- Where the "Response Plan" is located
- Contact information

Consequences:

The impact of a specific hazardous waste event is based on the percentage of the population affected and the type of the chemical involved. The hazard waste review continues with an examination and evaluation of consequences by specific criteria its impact on:

- THE PUBLIC – A serious hazardous waste event that takes place can have a great impact on the public surrounding the area of the event. The impact will depend upon the nature of the hazardous waste, the amount of contact an individual has with the chemical, and any other explosion or fire associated with the event. Immediate notification to the public regarding the hazardous waste event is vital in maintaining public safety. A transportation accident could also, shut down normal transportation routes that the public relies on in their daily commute.

- RESPONDERS – The immediate first responders on scene may be hesitant to perform their duties due to the nature of a hazardous waste event. If the proper precautions and personal protective equipment is not used responders can put their health and lives in danger during a hazardous waste event. Any type of long or short term contact with a chemical can be hazardous to a responder.

- CONTINUITY OF OPERATIONS INCLUDING DELIVERY OF SERVICES – A hazardous waste event occurring due to a transportation incident will have an impact on the continuity of operations in the area of the event. Whether it is on the roads or rails a hazardous waste event can take time to get under control and the means of transportation affected can greatly impact continuity of operations.

- PROPERTY –Real property may become generally unusable due to contamination depending on the nature of the hazardous waste event. Also, it may be impossible to occupy industrial or business sites due to contamination.

- FACILITIES – Facilities in the immediate vicinity of a hazardous waste event could become temporarily or permanently uninhabitable due to contamination.

- INFRASTRUCTURE – Public and private infrastructure could be shut down or destroyed by a hazardous waste event. The type of infrastructure destroyed would depend on the nature of the event and the extent of its effects.

- THE ENVIRONMENT – The impact on the environment that a hazardous waste event will have depends on where the event is located and the extent of the contamination. The animals, plants and other wildlife surrounding the hazardous waste event will certainly be impacted. Underground water and soil can become contaminated when exposed to hazardous material which makes for a very costly cleanup.

- THE ECONOMIC CONDITION OF THE STATE – Hazardous wastes can be particularly destructive to economic conditions. A hazardous waste event can leave localities or entire regions uninhabitable. They can destroy facilities and contaminate water/food stocks. Areas that have been affected by an event are also not attractive to tourists.

- PUBLIC CONFIDENCE IN THE STATE'S GOVERNANCE – A government's inability to contain hazardous waste events can sew widespread fear and panic in a population and cause them to lose confidence in their elected officials.

Implementation

The flood hazard review further continues with an examination and evaluation by specific criteria dealing with the implementation of mitigation strategies as stated in the State Hazard Mitigation Plan:

- ABILITY TO PARTICIPATE IN FEDERAL, STATE, REGIONAL AND LOCAL MITIGATION PROGRAMS – The FEMA approved All Natural Hazard Mitigation Plan (as described in Sections 2.3.1 and 2.3.2 of the NJ 2011 Hazard Mitigation Plan) enables the State to participate in:
    - Public Assistance Mitigation Programs
    - Pre- and Post-Disaster Mitigation Program
    - The Fire Management Grant and
    - The Emergency Management Grant Programs.

- CAPABILITY TO IDENTIFY ONGOING MITIGATION OPPORTUNITIES AND TRACK REPETITIVE LOSSES – Only flood issues are tracked using Repetitive Loss Information. The New Jersey State Hazard Mitigation Plan is updated every three years and county and municipal local jurisdictional plans are updated every five years. The coordination of local planning efforts provides the framework to identify ongoing mitigation opportunities developed by adjoining counties and municipalities and to track repetitive losses through:
    - The State Hazard Mitigation Goals and Objectives listed in Section 5.2.2 of the Plan.
    - Repetitive Flood Loss data included in Sections 4.4.1.6.1, 4.4.1.6.2 and 4.4.1.6.3 of the Plan that uses NFIP Flood Claim information.
    - The State Repetitive Loss Strategy developed in Section 5.2.3.
    - Through the use of Green Acres/Blue Acres land acquisition funds acquisition of repetitive loss and severe repetitive loss properties are accomplished.

- MAINTAINS MITIGATION GOALS, OBJECTIVES AND ACTIONS THAT SETS PRIORITIES AND RANKINGS THAT INCLUDE REDUCTION OF VULNERABILITY TO THE IDENTIFIED HAZARD AND INCLUDING A BENEFIT / COST ANALYSIS - Mitigation goals, objectives and actions are included in the Plan. The NJ State's five mitigation goals are:
    - To protect life
    - To protect property
    - To increase public preparedness
    - Develop and maintain an understanding of natural hazard risks
    - Enhance capabilities to make New Jersey less vulnerable to hazards

  The above noted goals are further developed through 18 objectives and the Repetitive Loss Strategy included in Section 5.2 of the Plan.

  Specific action items (included in Section 5.4.3) address each of the mitigation goals with action items include:
    - Information the rationale for action
    - Priority (up to 3 years)

- How the action contributes to the Mitigation Strategy
- STAPLEE Assessment of Mitigation Actions.

A Benefit / Cost Analysis is a requirement of most FEMA grant projects. The analysis is generally prepared when a project moves closer to being undertaken and costs are developed. Instructions and information on Benefit / Cost are included as a Handout of the Plan. Benefit/Cost training sessions are sponsored regularly for state and local FEMA grant application developers.

- ENCOURAGES PUBLIC / PRIVATE PARTNERSHIPS – Coordination between agencies include participation in the Hazard Mitigation Plan development by:
  - State Departments and Agencies
    - Attorney General
    - Banking and Insurance
    - Community Affairs
    - Environmental Protection
    - NJ State Police, Office of Emergency Management
    - Office of the Governor
    - Public Utilities
    - State Climatologist
    - State Geologist
    - State Office of Information Technology
    - Transportation
    - Treasury
    - Veterans Affairs
  - Intra-state agencies
    - Delaware and Raritan Canal Commission
    - Delaware River Basin Commission
    - Delaware River Basin Interstate Flood Mitigation Task Force
    - FEMA Portfolio Management
    - NJ Association of Flood Plain Managers
    - NJ Flood Mitigation Task Force
    - NJ League of Municipalities
    - Passaic River Basin Flood Advisory Commission
    - USACE Silver Jackets

- SUPPORTS PUBLIC EDUCATION AND OUTREACH – Public Education and Education is included in the plan as a mitigation strategy for most identified hazards. NJOEM prepares "handouts" on subjects of interest in response to questions raised at training and outreach sessions. Outreach sessions are conduct as FEMA grant program funding availability announcements are made. Benefit/Cost refresher training courses are given on a regular basis. NJOEM is a regular presenter at annual meetings of the NJ League of Municipalities, the NJ Association of Emergency Managers, Delaware River Greenway Partnership, etc.

4.4.14.7 *Hazardous Waste – Off Shore*	*Off shore hazardous materials most often comes in the form of oil spills. These substances are most often released as a result of shipping or drilling accidents. The released hazardous materials in various forms can impact both human and economic life and the environment.* Reference information to be fully developed in future All Natural Hazard Plan:

	o Agency with primary responsibility o Where the "Response Plan" is located o Contact information *Also, information will be developed as to the hazards risk and vulnerability* • *To People* • *To property* • *To the environment, and* o *To the operation of the operation of the program.*

4.4.14.8 – Nuclear Hazard Issues

New Jersey is unique in regards to a possible nuclear hazard issues due to the its various medical facilities, industrial processes, transportation networks, and nuclear power plants. New Jersey is home to two nuclear power plants, Oyster Creek and Salem / Hope Creek. In addition, there are six additional nuclear power plants located within the region that could pose a threat.

Other sources of possible nuclear/radiological events include contamination from industrial processes and accidents, laboratory accidents, transportation accidents, and naturally occurring radiation.

A nuclear event has the ability to cause a wide range of devastating environmental, long term public and mental health, and economic impacts on the State. Additionally, use of a Radiological Dispersion Device (RDD) as an act of terrorism may also cause economic impacts. However, the public health impact of the event would be limited.

The most recent radiological event that has taken place in New Jersey was in 2003. This event took place in central and southern New Jersey and was caused from naturally occurring Radium contamination to ground water. The Radium levels in the ground water exceeded Federal Standards. Also those who came in contact with these high levels of Radium in the ground water had a three-fold higher risk of developing Ostesarcoma, a rare form of bone cancer.

Economically New Jersey can suffer in many ways due to a Radiological event. Residents may move out of state in fear of being contaminated with radiation. Also tourism to New Jersey may decrease also due to the fear of coming in contact with radiation. If the radiological event affects wildlife such as fish, recreational activities and the fishing industry will be impaired.

Reference information to be fully developed in future All Natural Hazard Plan:

- Agency with primary responsibility
- Where the "Response Plan" is located
- Contact information

Consequences:

The impact of a specific radiological event is based on the percentage of the population affected and the severity of the event. The radiological hazard review continues with an examination and evaluation of consequences by specific criteria its impact on:

- THE PUBLIC – The effect of a radiological event on the public varies. The length of exposure is a key factor in determining the impact to human life. If food or water supplies have been tainted with radiological material the public will suffer greatly if food or water is ingested.

- RESPONDERS – Responders may come in contact with radiation if the proper precautions are not taken. Exposure to radiation can cause long term illnesses and death. Response by personnel may be hampered due to radiation levels, damaged infrastructure and secondary incidents.

- CONTINUITY OF OPERATIONS INCLUDING DELIVERY OF SERVICES – Delivery of services can be impacted on the roadways from traffic caused by mass evacuations. Also a perimeter surrounding the radiological event will be established that will not allow movement into the contaminated area. Continuity of operations within this perimeter will be hampered.

- PROPERTY – Real property may become irradiated and general unusable. Large sections of the housing stock may become permanently uninhabitable in the event of a nuclear hazard event. Also, it may be impossible to occupy industrial or business sites due to contamination.

- FACILITIES – Facilities in the immediate vicinity of a nuclear hazard event could become temporarily or permanently uninhabitable due to radiological contamination. Also, facilities electrical systems can be irreparable damaged due to interacting with an electromagnetic pulse.

- INFRASTRUCTURE – Public and private infrastructure could be shut down or destroyed by a nuclear event. They type of infrastructure destroyed would depend on the nature of the event and the extent of its effects.

- THE ENVIRONMENT – The impact on the environment that a radiological event will have depends on where the event is located and the extent of irradiation. The animals, plants and other wildlife surrounding the radiological event will certainly be impacted. Underground water and soil can become contaminated when exposed to radiological material which makes for a very costly cleanup.

- THE ECONOMIC CONDITION OF THE STATE – Nuclear hazards can be particularly destructive to economic conditions. A nuclear/radiological event can leave localities or entire regions uninhabitable. They can destroy facilities and contaminate water/food stocks. Areas that have been affected by an event are also not attractive to tourists.

- PUBLIC CONFIDENCE IN THE STATE'S GOVERNANCE – The psychological fallout of a nuclear hazard event can be as devastating as their physical effects. A government's inability to contain nuclear events can sew widespread fear and panic in a population and cause them to lose confidence in their elected officials.

Implementation

The flood hazard review further continues with an examination and evaluation by specific criteria dealing with the implementation of mitigation strategies as stated in the State Hazard Mitigation Plan:

- ABILITY TO PARTICIPATE IN FEDERAL, STATE, REGIONAL AND LOCAL MITIGATION PROGRAMS – The FEMA approved All Natural Hazard Mitigation Plan (as described in Sections 2.3.1 and 2.3.2 of the NJ 2011 Hazard Mitigation Plan) enables the State to participate in:
    - Public Assistance Mitigation Programs

- Pre- and Post-Disaster Mitigation Program
- The Fire Management Grant and
- The Emergency Management Grant Programs.

- CAPABILITY TO IDENTIFY ONGOING MITIGATION OPPORTUNITIES AND TRACK REPETITIVE LOSSES – Only flood issues are tracked using Repetitive Loss Information. The New Jersey State Hazard Mitigation Plan is updated every three years and county and municipal local jurisdictional plans are updated every five years. The coordination of local planning efforts provides the framework to identify ongoing mitigation opportunities developed by adjoining counties and municipalities and to track repetitive losses through:
  - The State Hazard Mitigation Goals and Objectives listed in Section 5.2.2 of the Plan.
  - Repetitive Flood Loss data included in Sections 4.4.1.6.1, 4.4.1.6.2 and 4.4.1.6.3 of the Plan that uses NFIP Flood Claim information.
  - The State Repetitive Loss Strategy developed in Section 5.2.3.
  - Through the use of Green Acres/Blue Acres land acquisition funds acquisition of repetitive loss and severe repetitive loss properties are accomplished.

- MAINTAINS MITIGATION GOALS, OBJECTIVES AND ACTIONS THAT SETS PRIORITIES AND RANKINGS THAT INCLUDE REDUCTION OF VULNERABILITY TO THE IDENTIFIED HAZARD AND INCLUDING A BENEFIT / COST ANALYSIS - Mitigation goals, objectives and actions are included in the Plan. The NJ State's five mitigation goals are:
  - To protect life
  - To protect property
  - To increase public preparedness
  - Develop and maintain an understanding of natural hazard risks
  - Enhance capabilities to make New Jersey less vulnerable to hazards

  The above noted goals are further developed through 18 objectives and the Repetitive Loss Strategy included in Section 5.2 of the Plan.

  Specific action items (included in Section 5.4.3) address each of the mitigation goals with action items include:

  - Information the rationale for action
  - Priority (up to 3 years)
  - How the action contributes to the Mitigation Strategy
  - STAPLEE Assessment of Mitigation Actions.

  A Benefit / Cost Analysis is a requirement of most FEMA grant projects. The analysis is generally prepared when a project moves closer to being undertaken and costs are developed. Instructions and information on Benefit / Cost are included as a Handout of the Plan. Benefit/Cost training sessions are sponsored regularly for state and local FEMA grant application developers.

- ENCOURAGES PUBLIC / PRIVATE PARTNERSHIPS – Coordination between agencies include participation in the Hazard Mitigation Plan development by:
  - State Departments and Agencies
    - Attorney General
    - Banking and Insurance
    - Community Affairs
    - Environmental Protection
    - NJ State Police, Office of Emergency Management

- Office of the Governor
- Public Utilities
- State Climatologist
- State Geologist
- State Office of Information Technology
- Transportation
- Treasury
- Veterans Affairs

o Intra-state agencies

- Delaware and Raritan Canal Commission
- Delaware River Basin Commission
- Delaware River Basin Interstate Flood Mitigation Task Force
- FEMA Portfolio Management
- NJ Association of Flood Plain Managers
- NJ Flood Mitigation Task Force
- NJ League of Municipalities
- Passaic River Basin Flood Advisory Commission
- USACE Silver Jackets

- SUPPORTS PUBLIC EDUCATION AND OUTREACH – Public Education and Education is included in the plan as a mitigation strategy for most identified hazards. NJOEM prepares “handouts” on subjects of interest in response to questions raised at training and outreach sessions. Outreach sessions are conduct as FEMA grant program funding availability announcements are made. Benefit/Cost refresher training courses are given on a regular basis. NJOEM is a regular presenter at annual meetings of the NJ League of Municipalities, the NJ Association of Emergency Managers, Delaware River Greenway Partnership, etc.

4.4.14.9 - Pandemic

Pandemics cause sudden, pervasive illness in all age groups on a local or global scale. A pandemic is a novel virus that humans have no natural immunity to and spreads person-to-person. Global influenza epidemics are referred to as “influenza pandemics.” Three such pandemics occurred in the 20th century, causing millions of deaths. Experts consider them to be an inevitable fact of nature.

A pandemic will cause both widespread and sustained effects and is likely to stress the resources of both the State and Federal Government. An epidemic occurs when new cases of a certain disease, in a given population, substantially exceed what is expected. An epidemic may be restricted to one locale, or it may be global at which point it is called a pandemic. The broad resource strain will make it difficult to shift resources between states, and reinforces the need for each state to develop a plan, requiring a substantial degree of self-reliance.

New Jersey is the most densely populated state with a population of over 8.5 million people, including large populations of immigrants. Nearly half of New Jersey’s population lives in the urban/suburban areas of the northeastern third of the state near New York City.

Pandemics are inevitable and arrive with very little warning. For example, should an influenza pandemic virus again appear that behaves as the 1918 strain, even taking into account the advances in medicine since then, unparalleled tolls of illness and death would be expected. Air travel could hasten the spread of a new virus, and decrease the time available for implementing interventions. Outbreaks are expected to occur simultaneously throughout much of the United States, preventing shifts in human and material resources that usually occur in response to other disasters.

The effect of an epidemic on individual communities will be relatively prolonged (weeks to months) in comparison to other types of disasters. Healthcare systems could be rapidly overburdened, economies strained, and social order disrupted. Depending on where the initial outbreak begins, the U.S. will have no lead time to a maximum of three months lead time. Historically speaking, it is expected that in any locality, the length of each wave is approximately six to eight weeks.

New Jersey's geographic and demographic characteristics make it particularly vulnerable to importation and spread of infectious diseases, including influenza. Up to 50% of the population may be affected either through illness, caring for those with illness, or changing lifestyle in response to an pandemic. No vaccine may be available for at least 6 months and then there may be limited quantities available on a periodic basis. Limited vaccine, when available, will be distributed to target groups.

Reference information to be fully developed in future All Natural Hazard Plan:

- Agency with primary responsibility
- Where the "Response Plan" is located
- Contact information

Consequences:

The impact of a specific pandemic event is based on the percentage of the population infected and the virulence of the disease. The pandemic hazard review continues with an examination and evaluation of consequences by specific criteria its impact on:

- THE PUBLIC – –??????
- RESPONDERS – –??????
- CONTINUITY OF OPERATIONS INCLUDING DELIVERY OF SERVICES – To continue normal operations the State may have to enact social distancing policies or provide vaccinations for workers. In the event of a major pandemic, the public could experience a wide spread reduction in government services.
- PROPERTY – –??????
- FACILITIES – A pandemic would not have any direct physical effect on facilities. However, it could lead to facilities operation at reduced capacity or closing due to absenteeism.
- INFRASTRUCTURE – A pandemic in the State of New Jersey has the potential to cause widespread disruptions to transportation networks within the state.
- THE ENVIRONMENT – If the Pandemic is zoonotic in nature then it could have widespread impacts on the population, agriculture, and environment. In a non-zoonotic event the primary damage to the environment would be the result of failure to maintain critical facilities. There is a potential for the lack of maintenance to cause unintended consequences.

- THE ECONOMIC CONDITION OF THE STATE – A Pandemic would be economically devastating to the State of New Jersey. The longer the Pandemic event continued the greater the impact to the economic condition of the state. Both the Public and Private sector would be hit by high absenteeism resulting in inadequate capabilities to perform business as usual. The result would be far reaching economic loss that may not be recoverable for some businesses.

- PUBLIC CONFIDENCE IN THE STATE'S GOVERNANCE –??????

Implementation:

The flood hazard review further continues with an examination and evaluation by specific criteria dealing with the implementation of mitigation strategies as stated in the State Hazard Mitigation Plan:

- ABILITY TO PARTICIPATE IN FEDERAL, STATE, REGIONAL AND LOCAL MITIGATION PROGRAMS – The FEMA approved All Natural Hazard Mitigation Plan (as described in Sections 2.3.1 and 2.3.2 of the NJ 2011 Hazard Mitigation Plan) enables the State to participate in:
  - Public Assistance Mitigation Programs
  - Pre- and Post-Disaster Mitigation Program
  - The Fire Management Grant and
  - The Emergency Management Grant Programs.

- CAPABILITY TO IDENTIFY ONGOING MITIGATION OPPORTUNITIES AND TRACK REPETITIVE LOSSES – Only flood issues are tracked using Repetitive Loss Information. The New Jersey State Hazard Mitigation Plan is updated every three years and county and municipal local jurisdictional plans are updated every five years. The coordination of local planning efforts provides the framework to identify ongoing mitigation opportunities developed by adjoining counties and municipalities and to track repetitive losses through:
  - The State Hazard Mitigation Goals and Objectives listed in Section 5.2.2 of the Plan.
  - Repetitive Flood Loss data included in Sections 4.4.1.6.1, 4.4.1.6.2 and 4.4.1.6.3 of the Plan that uses NFIP Flood Claim information.
  - The State Repetitive Loss Strategy developed in Section 5.2.3.
  - Through the use of Green Acres/Blue Acres land acquisition funds acquisition of repetitive loss and severe repetitive loss properties are accomplished.

- MAINTAINS MITIGATION GOALS, OBJECTIVES AND ACTIONS THAT SETS PRIORITIES AND RANKINGS THAT INCLUDE REDUCTION OF VULNERABILITY TO THE IDENTIFIED HAZARD AND INCLUDING A BENEFIT / COST ANALYSIS - Mitigation goals, objectives and actions are included in the Plan. The NJ State's five mitigation goals are:
  - To protect life
  - To protect property
  - To increase public preparedness
  - Develop and maintain an understanding of natural hazard risks
  - Enhance capabilities to make New Jersey less vulnerable to hazards

  The above noted goals are further developed through 18 objectives and the Repetitive Loss Strategy included in Section 5.2 of the Plan.

  Specific action items (included in Section 5.4.3) address each of the mitigation goals with action items include:

Section 4 -Risk Assessment

- Information the rationale for action
- Priority (up to 3 years)
- How the action contributes to the Mitigation Strategy
- STAPLEE Assessment of Mitigation Actions.

A Benefit / Cost Analysis is a requirement of most FEMA grant projects. The analysis is generally prepared when a project moves closer to being undertaken and costs are developed. Instructions and information on Benefit / Cost are included as a Handout of the Plan. Benefit/Cost training sessions are sponsored regularly for state and local FEMA grant application developers.

- ENCOURAGES PUBLIC / PRIVATE PARTNERSHIPS – Coordination between agencies include participation in the Hazard Mitigation Plan development by:
  - State Departments and Agencies
    - Attorney General
    - Banking and Insurance
    - Community Affairs
    - Environmental Protection
    - NJ State Police, Office of Emergency Management
    - Office of the Governor
    - Public Utilities
    - State Climatologist
    - State Geologist
    - State Office of Information Technology
    - Transportation
    - Treasury
    - Veterans Affairs
  - Intra-state agencies
    - Delaware and Raritan Canal Commission
    - Delaware River Basin Commission
    - Delaware River Basin Interstate Flood Mitigation Task Force
    - FEMA Portfolio Management
    - NJ Association of Flood Plain Managers
    - NJ Flood Mitigation Task Force
    - NJ League of Municipalities
    - Passaic River Basin Flood Advisory Commission
    - USACE Silver Jackets

- SUPPORTS PUBLIC EDUCATION AND OUTREACH – Public Education and Education is included in the plan as a mitigation strategy for most identified hazards. NJOEM prepares “handouts” on subjects of interest in response to questions raised at training and outreach sessions. Outreach sessions are conduct as FEMA grant program funding availability announcements are made. Benefit/Cost refresher training courses are given on a regular basis. NJOEM is a regular presenter at annual meetings of the NJ League of Municipalities, the NJ Association of Emergency Managers, Delaware River Greenway Partnership, etc.

4.4.14.7 – Power Outages

Power outages can be defined as any interruption or loss of electrical service due to disruption of power transmission caused by accident, sabotage, natural hazards or equipment failure. A significant power failure is defined as any incident of a long duration which would require the involvement of the local and/or state emergency management organizations to coordinate provision of food, water, heating, cooling and shelter.

Power outages have occurred on numerous occasions in various locations throughout the State. Since a power failure may be caused by many different circumstances, the probability of failure occurrences persist. New Jersey was subject to wide spread outages in 1965, 1977 and 2003.

The State of New Jersey is concerned with both short-term power outage consequences as well as longer-term impacts. Security and safety issues at large venues and retail establishments, for example, present short-term concerns. Longer-term impacts can be anticipated if disruptions continuously occur in utility, transportation, health care, communications systems and commerce.

The time of year that power outages occur can also cause secondary events. If a power outage were to occur in the summer during a heat wave small children and the elderly could be at risk for heat exhaustion resulting in hospitalization or even death. During the winter months residents of New Jersey could face freezing temperatures, as well as, an increased risk of carbon monoxide poising from fossil fuel heaters.

Reference information to be fully developed in future All Natural Hazard Plan:

- Agency with primary responsibility
- Where the “Response Plan” is located
- Contact information

Consequences:

- THE PUBLIC – The effects of a power outage on the public could potentially be widespread. Power outages can lead to instances of civil disturbance, including looting. Also, the effects of the power outage can be variable on the nature of the event and the time of year in which the event occurs.
- RESPONDERS – The ability of responders to conduct their duties can be effected in multiple ways. Without a consistent power supplies responders may be unable to charge equipment or operate critical systems, such as computer networks or communications devices. Response efforts could be hampered by the traffic delays caused by inoperable signals.
- CONTINUITY OF OPERATIONS INCLUDING DELIVERY OF SERVICES – The State of New Jersey’s offices and departments maintain Continuity of Operations Plans and would enact them. However, normal operations would definitely be affected and could lead to a drop in level of services or inability to provide certain services.
- PROPERTY – In the event of a power outage, the electrical network runs a definite risk of being damaged. Transformers and sub stations can be damaged in a domino effect of overloading. Real property and personnel assets also are at risk due to secondary incidents, such as fires and looting.
- FACILITIES – Most government facilities face the same issues as private facilities. They can lose the ability to conduct normal business if a backup generator is not available. Some facilities are highly vulnerable to power failure, such as hospitals and correctional facilities.
- INFRASTRUCTURE – Infrastructure can be affected, shut down or irreparably damaged to a power failure. A power failure in on area can cause a cascading effect, damaging components in other parts of the electrical grid. Water systems can suffer complete shut down and backups that can cause significant damage. Transportation

and traffic systems can see widespread interruptions, as many of these systems require electricity to operate (example: commuter rail trains and traffic signals).

- THE ENVIRONMENT – Power outages are not generally threats to the environment, unless, there is a major secondary incident.

- THE ECONOMIC CONDITION OF THE STATE – A widespread prolonged power outage would cause extensive to the economy of New Jersey. New Jersey hosts the busiest commuter rail network in the country, which operates primarily on electricity. Disruption in the rail network would mean that thousands of workers would not be able to travel to their jobs. Other factors include New Jersey's chemical industry and pharmaceutical industry which rely heavily on power for manufacturing purposes.

- PUBLIC CONFIDENCE IN THE STATE'S GOVERNANCE – The in-ability to return power to residents would be catastrophic to the State of New Jersey's public confidence. Residents would fear for the health and welfare and this would damage the credibility of the State as a governing authority.

Implementation

The power outages hazard review further continues with an examination and evaluation by specific criteria dealing with the implementation of mitigation strategies as stated in the State Hazard Mitigation Plan:

- ABILITY TO PARTICIPATE IN FEDERAL, STATE, REGIONAL AND LOCAL MITIGATION PROGRAMS – The FEMA approved All Natural Hazard Mitigation Plan (as described in Sections 2.3.1 and 2.3.2 of the NJ 2011 Hazard Mitigation Plan) enables the State to participate in:
    - Public Assistance Mitigation Programs
    - Pre- and Post-Disaster Mitigation Program
    - The Fire Management Grant and
    - The Emergency Management Grant Programs.

- CAPABILITY TO IDENTIFY ONGOING MITIGATION OPPORTUNITIES AND TRACK REPETITIVE LOSSES – Only flood issues are tracked using Repetitive Loss Information. The New Jersey State Hazard Mitigation Plan is updated every three years and county and municipal local jurisdictional plans are updated every five years. The coordination of local planning efforts provides the framework to identify ongoing mitigation opportunities developed by adjoining counties and municipalities and to track repetitive losses through:
    - The State Hazard Mitigation Goals and Objectives listed in Section 5.2.2 of the Plan.
    - Repetitive Flood Loss data included in Sections 4.4.1.6.1, 4.4.1.6.2 and 4.4.1.6.3 of the Plan that uses NFIP Flood Claim information.
    - The State Repetitive Loss Strategy developed in Section 5.2.3.
    - Through the use of Green Acres/Blue Acres land acquisition funds acquisition of repetitive loss and severe repetitive loss properties are accomplished.

- MAINTAINS MITIGATION GOALS, OBJECTIVES AND ACTIONS THAT SETS PRIORITIES AND RANKINGS THAT INCLUDE REDUCTION OF VULNERABILITY TO THE IDENTIFIED HAZARD AND INCLUDING A BENEFIT / COST ANALYSIS - Mitigation goals, objectives and actions are included in the Plan. The NJ State's five mitigation goals are:
    - To protect life
    - To protect property
    - To increase public preparedness
    - Develop and maintain an understanding of natural hazard risks

- Enhance capabilities to make New Jersey less vulnerable to hazards

The above noted goals are further developed through 18 objectives and the Repetitive Loss Strategy included in Section 5.2 of the Plan.

Specific action items (included in Section 5.4.3) address each of the mitigation goals with action items include:

- Information the rationale for action
- Priority (up to 3 years)
- How the action contributes to the Mitigation Strategy
- STAPLEE Assessment of Mitigation Actions.

A Benefit / Cost Analysis is a requirement of most FEMA grant projects. The analysis is generally prepared when a project moves closer to being undertaken and costs are developed. Instructions and information on Benefit / Cost are included as a Handout of the Plan. Benefit/Cost training sessions are sponsored regularly for state and local FEMA grant application developers.

- ENCOURAGES PUBLIC / PRIVATE PARTNERSHIPS – Coordination between agencies include participation in the Hazard Mitigation Plan development by:
  - State Departments and Agencies
    - Attorney General
    - Banking and Insurance
    - Community Affairs
    - Environmental Protection
    - NJ State Police, Office of Emergency Management
    - Office of the Governor
    - Public Utilities
    - State Climatologist
    - State Geologist
    - State Office of Information Technology
    - Transportation
    - Treasury
    - Veterans Affairs
  - Intra-state agencies
    - Delaware and Raritan Canal Commission
    - Delaware River Basin Commission
    - Delaware River Basin Interstate Flood Mitigation Task Force
    - FEMA Portfolio Management
    - NJ Association of Flood Plain Managers
    - NJ Flood Mitigation Task Force
    - NJ League of Municipalities
    - Passaic River Basin Flood Advisory Commission
    - USACE Silver Jackets

- SUPPORTS PUBLIC EDUCATION AND OUTREACH – Public Education and Education is included in the plan as a mitigation strategy for most identified hazards. NJOEM prepares "handouts" on subjects of interest in response to questions raised at training and outreach sessions. Outreach sessions are conduct as FEMA grant program funding availability announcements are made. Benefit/Cost refresher training courses are given on a regular basis. NJOEM is a regular presenter at annual meetings of the NJ League of Municipalities, the NJ Association of Emergency Managers, Delaware River Greenway Partnership, etc.

4.4.14.11 – Terrorism

The population, property and environmental resources of the State of New Jersey are vulnerable to terrorist attack. A terrorist incident could result in: the release of harmful chemical, biological, or radiological materials; detonation of an explosive device; or disruption of services dependent on computers, telecommunications, and the Internet. Such an incident could have the potential to result in large numbers of fatalities, injuries, property damage and/or economic losses. It is also possible that valuable environmental/agricultural resources necessary for the State's welfare could be rendered unusable through contamination or other forms of damage.

The State of New Jersey is a particularly attractive target of a potential terrorist act due to its dense population and location relative to major urban areas. The State also houses the busiest commuter rail system in the United States, as well as the headquarters of major corporations in economically vital sectors such as financial, and pharmaceutical industries.[ii] New Jersey also hosts one of the busiest port facilities in the world.

Terrorism events that take place within the State of New Jersey or the surrounding region are inevitable and will come with no warning. For example, if a large scale terrorism event takes place with the same magnitude of the September 11, 2001 attacks on the World Trade Center the vast number of injured and deceased will be unpredictable. Also, secondary attacks are a concern and may cause the injured and death toll to rise, along with responders being overwhelmed with the subsequent event.

A very real concern regarding a terrorism event in the State of New Jersey is from homegrown extremists. Homegrown extremists are harder to detect than a large scale terrorism organization and are already living in our State. Also homegrown extremists have the ability to communicate with terrorists overseas through social networks and other methods of communication. Homegrown extremists have been present recently in the State of New Jersey and surrounding region. The May 8, 2007 Fort Dix Planned Attack and the May 1, 2010 Time Square attempted car bombing are both examples of this threat.

The effect of a terrorism event can vary depending on the type of attack and the magnitude of the event or events. A terrorism event can cause fear into the public to use mass transportation or to leave their homes in the event of a biological or nuclear attack. Communication systems, both public and private, can fail due to over whelming amount of usage or damage to its infrastructure. Healthcare facilities can become quickly inundated and must be prepared to triage injured patients, handle mass casualties, and conduct decontamination operations.

Reference information to be fully developed in future All Natural Hazard Plan:

- Agency with primary responsibility
- Where the "Response Plan" is located
- Contact information

Consequences:

The impact of a terrorism event is based on the type of attack and the target of the attack. The terrorism hazard review continues with an examination and evaluation of consequences by specific criteria its impact on:

- THE PUBLIC – New Jersey's dense population, major lines of commerce, travel, communication and industrial base contribute to its potential as a terrorist target. The public in the area surrounding an event will be in grave danger. Also transportation may be hindered to the public due to the inaccessibility of roads or other forms public transportation.

- RESPONDERS – A significant threat or act of terrorism may cause the State of New Jersey to respond simultaneously to the crisis and consequences of an attack. First responders to a terrorism event will quickly become both physically and psychologically fatigued. Supplying the proper resources and personnel to the responders of a terrorism event can be difficult due to debris in the road or traffic and must be coordinated in order to perform effective rescue efforts. First responders may be targeted in the event of secondary attacks.

- CONTINUITY OF OPERATIONS INCLUDING DELIVERY OF SERVICES – State of New Jersey offices and departments maintain Continuity if Operations Plans and in the event of a terrorist attack will enact them. However, due to the specific nature of an event some governmental operations and services may be interrupted.

- PROPERTY – Damage to property will depend on the specific event. Effects could include, loss of data networks, damage or destruction of real property or areas becoming uninhabitable.

- FACILITIES – Government facilities may suffer damage of destruction as a result of a terrorist attack. Given the nature of terrorist hazards, government facilities may be the targets of attacks. If facilities are affected they may lose their ability to conduct normal operations.

- INFRASTRUCTURE – Like facilities, infrastructure may be damaged as the result of an attack or be the target of a specific threat. Many critical infrastructure pieces have been hardened to resist attack but may become inoperable.

- THE ENVIRONMENT – An act of terrorism may impact the environment depending on the type and location of the attack. A radiological dispersion device or an improvised nuclear device would have a long term impact that could cost billions to remediate. Additionally, an attack on natural gas, oil, and / or chemical facilities could also have long term environmental implications for the State.

- THE ECONOMIC CONDITION OF THE STATE – The economic condition of the State will depend completely on the success of a terrorism event and the overall impact it has on statewide public and private sectors. If the damage is low but the psychological impact is high, the area could face relocation of private sector assets due to the cost of the event.

- PUBLIC CONFIDENCE IN THE STATE'S GOVERNANCE – Public Confidence in State governance will depend entirely on the initial response to the terrorism event. A well planned response to the event can lead to a successful mitigation and the establishment of public confidence in the government's ability to respond to such events. The key to public confidence is to keep the public informed about the event and what is being done to address the concerns related to that event.

Implementation

The terrorism hazard review further continues with an examination and evaluation by specific criteria dealing with the implementation of mitigation strategies as stated in the State Hazard Mitigation Plan:

- ABILITY TO PARTICIPATE IN FEDERAL, STATE, REGIONAL AND LOCAL MITIGATION PROGRAMS – The FEMA approved All Natural Hazard Mitigation Plan (as described in Sections 2.3.1 and 2.3.2 of the NJ 2011 Hazard Mitigation Plan) enables the State to participate in:
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  - The State Hazard Mitigation Goals and Objectives listed in Section 5.2.2 of the Plan.
  - Repetitive Flood Loss data included in Sections 4.4.1.6.1, 4.4.1.6.2 and 4.4.1.6.3 of the Plan that uses NFIP Flood Claim information.
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  - To protect life
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  - To increase public preparedness
  - Develop and maintain an understanding of natural hazard risks
  - Enhance capabilities to make New Jersey less vulnerable to hazards

  The above noted goals are further developed through 18 objectives and the Repetitive Loss Strategy included in Section 5.2 of the Plan.

  Specific action items (included in Section 5.4.3) address each of the mitigation goals with action items include:
  - Information the rationale for action
  - Priority (up to 3 years)
  - How the action contributes to the Mitigation Strategy
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    - Attorney General

- Banking and Insurance
- Community Affairs
- Environmental Protection
- NJ State Police, Office of Emergency Management
- Office of the Governor
- Public Utilities
- State Climatologist
- State Geologist
- State Office of Information Technology
- Transportation
- Treasury
- Veterans Affairs

- Intra-state agencies
  - Delaware and Raritan Canal Commission
  - Delaware River Basin Commission
  - Delaware River Basin Interstate Flood Mitigation Task Force
  - FEMA Portfolio Management
  - NJ Association of Flood Plain Managers
  - NJ Flood Mitigation Task Force
  - NJ League of Municipalities
  - Passaic River Basin Flood Advisory Commission
  - USACE Silver Jackets

- SUPPORTS PUBLIC EDUCATION AND OUTREACH – Public Education and Education is included in the plan as a mitigation strategy for most identified hazards. NJOEM prepares "handouts" on subjects of interest in response to questions raised at training and outreach sessions. Outreach sessions are conduct as FEMA grant program funding availability announcements are made. Benefit/Cost refresher training courses are given on a regular basis. NJOEM is a regular presenter at annual meetings of the NJ League of Municipalities, the NJ Association of Emergency Managers, Delaware River Greenway Partnership, etc.

For the most part, the discussion of the "Other Hazards" is limited and will appear, if appropriate, as a "mitigation strategy" items of things to be done for the 2014 update. .

4.4.15 Natural Hazards Consequences and Implementation of Strategies

The identified natural hazards have been grouped for a better understanding the natural hazards impacting the State of New Jersey in terms of examining and evaluating the consequences, and the implementation of mitigation strategies as stated in the State Hazard Mitigation Plan. Each natural hazard has been reviewed separately and some comments and response are duplicated.

4.4.15.1 - Floods

- Riverine flooding, including overflow from a river channel, flash, alluvial fan, ice-jam, and dam breaks
- Local drainage or high groundwater levels
- Fluctuating lake levels
- Debris flows

4.4.15.2 - Hurricanes, Tropical Storm and Nor-Easters

- Coastal flooding
- Back bay flooding
- Storm surges
- Strong tidal action
- Coastal erosion

4.4.15.3 – Winter storms

- Winter storm.
- Blizzard. Snow
- Ice storms
- Cold Waves
- Wind Chill

4.4.15.4 - Tornadoes and High Winds

- Tornadoes
- Thunderstorms
- Straight-line winds
- Hail

4.4.15.5 - Drought

- Drought Watch
- Drought Warning
- Drought Emergency

4.4.15.6 - Wildfires

4.4.15.7 - Geological Land Disturbances

- Earthquakes
- Sinkholes
- Subsidence
- Landslides
- Abandoned Mines

4.4.15.8 - Extreme Heat

- Heatstroke
- Heat Exhaustion
- Heat Syncope
- Heat Cramps

4.4.15.1 - Floods

Riverine flooding is the accumulation of water within a water body (e.g., stream, river, lake, or reservoir) and the overflow of excess water onto adjacent floodplains. Floodplains are usually lowlands adjacent to water bodies that are subject to recurring floods. Floods are natural events that are considered hazards only when people and property are affected. Nationwide, hundreds of floods occur each year, making them one of the most common hazards in the U.S. (FEMA, 1997) and floods have been and continue to be the most frequent, destructive, and costly natural hazard facing the State of New Jersey. Flooding occurs most frequently between November and April, with a peak from February through April. In this discussion there are a number of categories of floods including:

- Riverine flooding -overflow from a river channel
- Flash floods,
- Ice-jams caused floods
- Dam and levee breaks
- Local drainage or high groundwater levels
- Debris flow blockages

Human activity impacts flooding through land use changes and the building of flood control structures. The transportation network associated with land use change it creates the increased potential for flooding. In addition to the impacts of impervious paved surfaces, bridges and culverts usually constrict stream channels and flood plains. This aggravates upstream flooding, especially when the constrictions become clogged with ice or debris.

There are two major types of flooding that occur in New Jersey: riverine flooding and coastal flooding (Coastal flooding is discussed in a subsequent unit.) Riverine flooding is when the rate of rainfall or snowmelt exceeds the rate of infiltration to the ground, the excess water, called runoff, moves across the ground surface toward the lowest section of the watershed. As the surface runoff enters stream channels, stream levels increase. If the rate of runoff is high enough, water in the stream overflows the banks and flooding occurs.

FEMA Flood Insurance Studies and Flood Insurance Rate Maps (FIRMs and DFIRMs), as a rule, identify that the most damaging floods affecting developed areas in New Jersey occur in the northern part of the State. This is a function of a number of physiographic and physical features of the landscape. Greater geographic relief results in flowing water moving down steeper gradients, naturally or artificially channelized through valleys and gullies. Development patterns have resulted in denser development in North Jersey, and proximity to New York City boosts property values and thus damage dollar totals. Extensive development also leaves less natural surface available to absorb rainwater, forcing water directly into streams and rivers, swelling them more than when more natural surface existed. Since the Delaware, Raritan and Passaic rivers drain more than 90 percent of the northern counties in the State, these rivers and their tributaries are common locations for flooding.

Consequences:

The impact of a specific flood event is based on the extent of the incident measured in terms of depth of water, area flooded and population displaced. The flood hazard review continues with an examination and evaluation of consequences by specific criteria its impact on:

- THE PUBLIC – Floods affect those in the flood event and all of the surrounding areas not only in the watershed but the state as a whole A flood event anywhere in the state becomes a major news event covered by the TV networks and newspapers. Public awareness of the flood hazard is heightened and flood insurance coverage in the state is among the highest in the nation.

- RESPONDERS – Fire and police, and emergency responders are called on to evacuate people from the flood area, close roads, pump out flooded basements, attend to the injured and direct traffic away from the flooded area and roads. On those presidential declared disasters, emergence response costs are significant reimbursement elements.

- CONTINUITY OF OPERATIONS INCLUDING DELIVERY OF SERVICES – To continue ongoing operations overtime may be required. To date, there have been few or no flood incidents that have shut down state, county or municipal governmental operations. Continuity of operations Plans are a requirement of the state and local governments.

- PROPERTY – Market value of flooded property is significantly reduced. Areas of repetitive flooding are generally shunned by new home purchasers in favor of less threatened home sites. Eligibility under the approved 2011 Hazard Mitigation Plan qualifies homeowners and businesses for FEMA Individual Assistance disaster funding.

- FACILITIES – Floods impact roads and bridges, schools, hospitals, in some cases directly and in others making access much more difficult. Detours and road closures also add to the cost of the flood event. Eligibility under the approved 2011 Hazard Mitigation Plan qualifies local governments and certain non-profit agencies for FEMA Public Assistance Recovery and Pre-Disaster Mitigation disaster funding.

- INFRASTRUCTURE – Transportation, communications and the general operation of governmental services may be effected by a flood incident. In most reported flood incidents roads and bridges have been reported as the major infrastructure elements impacted by a flood. Eligibility under the approved 2011 Hazard Mitigation Plan qualifies local governments and certain non-profits for FEMA Public Assistance Recovery and Pre-Disaster Mitigation disaster funding

- THE ENVIRONMENT – Floods, by their nature effect the environment by: spreading pollution; overloading water and wastewater treatment plants; carrying silt and debris; and disturbing the wildlife and natural areas.

- THE ECONOMIC CONDITION OF THE STATE – A flood drains resources of the state, county and municipality. Even if some of the costs can be recouped through federal grant reimbursements, there is a fiscal impact on the local government.

- PUBLIC CONFIDENCE IN THE STATE'S GOVERNANCE – Governmental response, on all levels – state, county and municipal, requires immediate action must be immediate and effective to maintain public confidence. In New Jersey, the availability of the State's Open Space Green Acres funds supports immediate action to provide relief to flooded property owners through acquisition.

Implementation

The flood hazard review further continues with an examination and evaluation by specific criteria dealing with the implementation of mitigation strategies as stated in the State Hazard Mitigation Plan:

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  - The Fire Management Grant and
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- CAPABILITY TO IDENTIFY ONGOING MITIGATION OPPORTUNITIES AND TRACK REPETITIVE LOSSES – Only flood issues are tracked using Repetitive Loss Information. The New Jersey State Hazard Mitigation Plan is updated every three years and county and municipal local jurisdictional plans are updated every five years. The coordination of local planning efforts provides the framework to identify ongoing mitigation opportunities developed by adjoining counties and municipalities and to track repetitive losses through:
    - The State Hazard Mitigation Goals and Objectives listed in Section 5.2.2 of the Plan.
    - Repetitive Flood Loss data included in Sections 4.4.1.6.1, 4.4.1.6.2 and 4.4.1.6.3 of the Plan that uses NFIP Flood Claim information.
    - The State Repetitive Loss Strategy developed in Section 5.2.3.
    - Through the use of Green Acres/Blue Acres land acquisition funds acquisition of repetitive loss and severe repetitive loss properties are accomplished.

- MAINTAINS MITIGATION GOALS, OBJECTIVES AND ACTIONS THAT SETS PRIORITIES AND RANKINGS THAT INCLUDE REDUCTION OF VULNERABILITY TO THE IDENTIFIED HAZARD AND INCLUDING A BENEFIT / COST ANALYSIS - Mitigation goals, objectives and actions are included in the Plan. The NJ State's five mitigation goals are:
    - To protect life
    - To protect property
    - To increase public preparedness
    - Develop and maintain an understanding of natural hazard risks
    - Enhance capabilities to make New Jersey less vulnerable to hazards

  The above noted goals are further developed through 18 objectives and the Repetitive Loss Strategy included in Section 5.2 of the Plan.

  Specific action items (included in Section 5.4.3) address each of the mitigation goals with action items include:
    - Information the rationale for action
    - Priority (up to 3 years)
    - How the action contributes to the Mitigation Strategy
    - STAPLEE Assessment of Mitigation Actions.

  A Benefit / Cost Analysis is a requirement of most FEMA grant projects. The analysis is generally prepared when a project moves closer to being undertaken and costs are developed. Instructions and information on Benefit / Cost are included as a Handout of the Plan. Benefit/Cost training sessions are sponsored regularly for state and local FEMA grant application developers.

- ENCOURAGES PUBLIC / PRIVATE PARTNERSHIPS – Coordination between agencies include participation in the Hazard Mitigation Plan development by:
    - State Departments and Agencies
        - Attorney General
        - Banking and Insurance
        - Community Affairs
        - Environmental Protection
        - NJ State Police, Office of Emergency Management
        - Office of the Governor
        - Public Utilities
        - State Climatologist
        - State Geologist
        - State Office of Information Technology
        - Transportation

- Treasury
- Veterans Affairs
  - Intra-state agencies
    - Delaware and Raritan Canal Commission
    - Delaware River Basin Commission
    - Delaware River Basin Interstate Flood Mitigation Task Force
    - FEMA Portfolio Management
    - NJ Association of Flood Plain Managers
    - NJ Flood Mitigation Task Force
    - NJ League of Municipalities
    - Passaic River Basin Flood Advisory Commission
    - USACE Silver Jackets

- SUPPORTS PUBLIC EDUCATION AND OUTREACH – Public Education and Education is included in the plan as a mitigation strategy for most identified hazards. NJOEM prepares "handouts" on subjects of interest in response to questions raised at training and outreach sessions. Outreach sessions are conduct as FEMA grant program funding availability announcements are made. Benefit/Cost refresher training courses are given on a regular basis. NJOEM is a regular presenter at annual meetings of the NJ League of Municipalities, the NJ Association of Emergency Managers, Delaware River Greenway Partnership, etc.

4.4.15.2 Hurricanes, Tropical Storm and Nor-Easters including Coastal Erosion

Hurricanes, tropical storms and Nor-Easters have similar impacts as riverine and interior flood events with increased impact on the 127 miles of the New Jersey coastline. Issues include:

- Coastal flooding
- Back bay flooding
- Storm surges
- Strong tidal action
- Coastal erosion

A hurricane is a tropical storm that attains hurricane status when its wind speed reaches 74 or more miles an hour. Tropical systems may develop in the Atlantic between the Lesser Antilles and the African coast, or may develop in the warm tropical waters of the Caribbean and Gulf of Mexico. These storms may move up the Atlantic coast of the United States and impact the Eastern seaboard, or move into the U.S. through the states along the Gulf Coast, bringing wind and rain as far north as New England before moving off shore and heading east.

Because of its northern location on the Atlantic coastline, direct hits by storms of hurricane strength have a relatively low probability of impacting New Jersey, compared to the Southern coastal and Gulf States. It is possible for the entire State to be impacted by hurricanes, although wind and surge effects tend to be concentrated in coastal areas, as well as specific riverine regions that may experience storm surge backwater effects.

The cooler waters off the coast of New Jersey can serve to diminish the energy of storms that have traveled up the eastern seaboard in the Gulf Stream current. However, historical data shows that a number of hurricanes/tropical storms have impacted New Jersey, often as the remnants of a large storm hitting the Gulf or Atlantic coast hundreds of miles south of New Jersey, but maintaining sufficient wind and precipitation to cause substantial damage to the State.

A nor'easter is a macro-scale storm whose winds come from the northeast, especially in the coastal areas of the Northeastern United States and Atlantic Canada. More specifically, it describes a low pressure area whose center of rotation is just off the coast and whose leading winds in the left forward quadrant rotate onto land from the northeast. The precipitation pattern is similar to other extra-tropical storms. They also can cause coastal flooding, coastal erosion and gale force winds. As with hurricanes, coastal areas of the State tend to be affected most by Nor'easters because of their proximity to the ocean, but all parts of New Jersey have some exposure to the hazard, and past effects have been widespread.

Nor'easters are usually formed by an area of vorticity associated with an upper level disturbance or from a kink in a frontal surface that causes a surface low pressure area to develop. Such storms often move slowly in their latter, frequently intense, mature stage. Until the nor'easter passes, thick dark clouds often block out the sun. During a single storm, the precipitation can range from a torrential downpour to a fine mist. Low temperatures and wind gusts of up to 90 miles per hour are also associated with nor'easters.

Coastal erosion is a dynamic process that is constantly occurring at varying rates along the coasts and shorelines of the U.S. Numerous factors can influence the severity and rate of coastal erosion including human activities, tides, the possibility of rising sea levels, and the frequency and intensity of Nor'easters and hurricanes. Strong storms can erode large sections of coastline with a single event. The process of coastal erosion results in permanent changes to the shape and structure of the coastline. Human activities such as poor land use practices and boating activities can also accelerate the process of coastal erosion.

Billions of dollars of economic development are potentially threatened by the impacts of coastal erosion. In a report to Congress in the year 2000 FEMA estimated that erosion may cost property owners along the coast $500 million a year in structural damages and loss of land. The report also stated as many as 87,000 residential homes may be at risk of eroding into the oceans or Great Lakes over the next 60 years.

On the east coast of the United States, Nor'easters and Hurricanes cause a significant amount of severe beach erosion, as well as flooding in low-lying areas. Beach residents in these areas may actually fear the repeated depredations of nor'easters over those of hurricanes, because they happen more frequently, and cause substantial damage to beach-front property and their dunes.

The State of New Jersey has over 127 miles of coastline, most of which is within close proximity to major metropolitan centers of the mid-Atlantic. Beach restoration and maintenance is an ongoing process for New Jersey. The State legislature provides $25 million annually for beach restoration and every beach on the Atlantic is currently under either a design, engineering or construction phase. There are 13 Federal coastal engineering projects and 23 State projects that are either in planning, under construction, or recently completed. The Long Branch-Manasquan Project, between Sandy Hook and Manasquan Inlet, is one of the largest beach construction projects completed in the U.S. with over 25 million cubic yards of sand placed on 25 miles of beaches.

By virtue of their location at the interface between oceans and land, coastal areas are among the most dynamic environments on earth susceptible to a broad range of natural hazards. Many parts of New Jersey's densely populated coast are highly vulnerable to the effects of flooding, storm surge, episodic erosion, chronic erosion, sea level rise, and extra-tropical storms.

As described in the NJ DEP Coastal management Program web-site, manifestations of these hazards occur at broadly different rates. Their expression ranges from the gradual, such as sea level rise and chronic erosion that can be measured on a decadal time-scale, to catastrophic events like hurricanes, extra-tropical storms, and storm surges that can be measured in terms of days or even hours. Just as their rates of occurrence differ, so are their effects expressed in profoundly different ways.

Consequences

The impact of a specific a hurricanes, tropical storm or nor-Easter event is based on the extent of the incident measured in terms of duration of the event, quantity of associated rainfall, area of impact and population displaced.

The hazard review of these storms continues with an examination and evaluation of consequences by specific criteria its impact on:

- THE PUBLIC – The New Jersey shore is a tourist and vacation destination. Since hurricane season also corresponds to the summer vacation season, the public includes the large vacationing families – both the New Jersey residents and out of state tourists. To protect residents and tourist coastal evacuation routes have been established and are activated when necessary. Storm watches and warning are posted.

- RESPONDERS – In addition to the fire, police and normal emergency responders associated with any disaster event, beach lifeguards are called on to protect the public and enforce the necessary beach closures.

- CONTINUITY OF OPERATIONS INCLUDING DELIVERY OF SERVICES – To continue ongoing operations overtime may be required. To date, there have been few, if any, hurricane, tropical storms or nor-Easters that have shut down governmental operations for any significant time. Continuity of Operation Plans are a requirement of State and local governments.

- PROPERTY – Residential properties and commercial properties impacted or destroyed by a coastal event rebuild quickly after an incident. Market value of coastal properties do not appear to be effect in the long term.

- FACILITIES – Coastal incidents impact roads, bridges, schools and hospitals in the same was as floods with the added problems of drifting sand from storm surges and winds.

- INFRASTRUCTURE – Transportation, communications and the general operation of governmental services may be effected by a coastal incident. In most reported cases sand covered roads and bridges have been reported as impacted infrastructure elements.

- THE ENVIRONMENT – Beach erosion is the major environmental impact. The natural environment recovers. The "economic" environment recovery is supported by state and US Corps of Engineers beach restoration programs. The "tourist" environment homes and businesses recover quickly.

- THE ECONOMIC CONDITION OF THE STATE – The New Jersey coast is an important part of the state's economy including the Atlantic City entertainment industry.

- PUBLIC CONFIDENCE IN THE STATE'S GOVERNANCE - Governmental response, on all levels – state, county and municipal, immediate action must be immediate and effective to maintain public confidence. In New Jersey, the availability of the State's Coastal Green Acres funds supports immediate action to provide relief to flooded property owners through acquisition for those who do not want to rebuild.

Implementation

The hurricane, tropical storm and Nor-Easters hazard review continues with an examination and evaluation by specific criteria dealing with the implementation of mitigation strategies as stated in the State Hazard Mitigation Plan:

- ABILITY TO PARTICIPATE IN FEDERAL, STATE, REGIONAL AND LOCAL MITIGATION PROGRAMS – The FEMA approved All Natural Hazard Mitigation Plan (as described in Sections 2.3.1 and 2.3.2 of the NJ 2011 Hazard Mitigation Plan) enables the State to participate in:
  - Public Assistance Mitigation Programs
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- CAPABILITY TO IDENTIFY ONGOING MITIGATION OPPORTUNITIES AND TRACK REPETITIVE LOSSES – Only flood issues are tracked using Repetitive Loss Information. The New Jersey State Hazard Mitigation Plan is updated every three years and county and municipal local jurisdictional plans are updated every five years. The coordination of local planning efforts provides the framework to identify ongoing mitigation opportunities developed by adjoining counties and municipalities and to track repetitive losses
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    - Public Utilities
    - State Climatologist
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    - State Office of Information Technology
    - Transportation
    - Treasury

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        - Delaware River Basin Commission
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4.4.15.3 Winter Storms

Heavy snowfall and extreme cold can immobilize an entire region. Even areas that normally experience mild winters can be hit with a major snowstorm or extreme cold. Winter storms can result in flooding, storm surge, closed highways, blocked roads, downed power lines and hypothermia.
The following descriptions provide the commonly used definitions of winter storms:

- Winter storm. A storm with significant snowfall, ice, and/or freezing rain; the quantity of precipitation varies by elevation. Non-mountainous areas - heavy snowfall is 4 inches or more in a 12-hour period, or 6 or more inches in a 24-hour period. Mountainous areas - 12 inches or more in a 12-hour period or 18 inches or more in a 24-hour period
- Blizzard. A storm with considerable falling and/or blowing snow combined with sustained winds or frequent gusts of 35 mph or greater that frequently reduces visibility to less than one-quarter mile.
- Snow
- Ice storms
- Cold Waves
- Wind Chill

These storms derive their energy from the clash of two air masses of substantially different temperatures and moisture levels. An *air mass* is a large region above the Earth, usually about 1,000-5,000 km in diameter, with a fairly uniform temperature and moisture level. In North America, winter storms usually form when an air mass of cold, dry, Canadian air moves south and interacts with a warm, moist air mass moving north from the Gulf of Mexico. The point where these two air masses meet is called a *front*. If cold air advances and pushes away the warm air, it forms a *cold front*. When warm air advances, it rides up over the denser, cold air mass to form a *warm front*. If neither air mass advances, it forms a *stationary front*.

Winter storms affect the entire State of New Jersey about equally, and are responsible for many deaths each year. Of reported deaths, more than 33 percent were attributed to automobile and other accidents; about 30 percent to overexertion, exhaustion, and consequent heart attack; about 13 percent to exposure and freezing; and the rest to combustion heater fires, carbon monoxide poisoning in stalled cars, falls on slippery walks, electrocution from downed wires, and building collapse. Communications systems and medical care delivery can be disrupted during winter hazard conditions, exacerbating hazards already part of the winter experience. Some of these deaths may be eliminated through the application of better forecasting and mitigation measures.

Older people are particularly sensitive to overexposure because of their economic and physical condition. Often senior citizens do not feel they have the income to heat their homes properly and they leave their homes far less heated than they should. In addition, senior citizen's changing sensitivities to heat and cold often result in their not realizing the temperatures they are experiencing are dangerously low. This leads to increased stresses on the body, especially when exerting themselves outside.

Heavy snow accumulations can immobilize a region and paralyze a city, stranding commuters, stopping the flow of supplies, and disrupting emergency and medical services. Ice storms can be accompanied by high winds, and they have similar impacts, especially to trees, power lines, and residential utility services. New Jersey, because of its unique location at a climactic crossroads and distinctive geography, experiences the full effect of all four seasons, and winter is no exception. Snowstorms are the most obvious manifestation of intense winter weather.

The most common conditions for snowstorm formation begin with the formation of a storm-system somewhere in a crescent-shaped zone running from Texas through the northern Gulf of Mexico to the Atlantic Ocean waters off Georgia and the Carolinas. Storm centers moving northeast pass near Cape Hatteras and continue over the Ocean toward Cape Cod and Nantucket. If this mass of air meets a northeast already cooled by cold arctic air, a snowstorm can form. Snow begins in cooling clouds as water droplets freezing around an ice-covered particle of matter. Once the ice crystal grows large enough to leave the cloud, it falls as a snowflake. If the air into which the snow is falling through has not cooled sufficiently, the snow will ultimately fall as rain.

The trajectory of the storm center, whether it passes close to the New Jersey coast or at a distance, largely determines both the intensity and the duration of the snowfall over the State. The zone of heaviest snowfall across New Jersey usually occurs in the southwest-to-northeast strip about 150 miles wide, approximately parallel to the path of the storm center, and about 125 and 175 miles northwest of it. (Figure 4.4-4-1 Average Yearly Snowfall) If the center passes well offshore, only South Jersey receives substantial snowfall. When the track passes close to shore, warm air from the Ocean is drawn into the surface circulation, resulting in rain falling over South Jersey and snow over the rest of the State. Often, a passing storm center brings rain to the South, mixed precipitation to central sections and snow to the north.

Seasonal snowfall in New Jersey varies from an average of about 15 inches at Atlantic City to about 50 inches in Sussex County. There is, however, great variability from year to year. In addition, February is the month when maximum accumulations on the ground are usually reached. After three major snows in February 1961, total accumulations reached 30 to 50 inches from Trenton to the Highlands

Most extreme snowfall events occur as the result of strong low pressure systems moving to the north, northeast off of the coast of New Jersey from early winter through mid-spring. If the conditions are right, these coastal lows transport Atlantic moisture over a cold layer of air over New Jersey resulting in extremely high snowfall rates and occasionally blizzard conditions. Between 1926 –2010 significant snowfalls have occurred in 1933, 1947, 1958, 1961, 1978, 1996, 2001, 2003, and 2010, with the greatest single day snowfall of 28.4 inches occurring along the coast in Long Branch, NJ on December 26, 1947

Beyond disruption to transportation, the main hazard associated with snow is the weight of the frozen liquid on buildings and utilities. The ground snow load in pounds per square foot varies with the amount of water content in the ice crystals that make up the snow. Large snowfalls with low water content can generate the same snow load as a light snowfall with high water content. Ground snow loads in pounds per square foot with a 2% probability of being exceeded have been tabulated by the American Society of Engineers Standard ASCE 7-98, Minimum Design Loads for Buildings and Other Structures. Snow loads with a 1 in 50 chance of occurring over 100 years range from 20 lb/sq. ft. south of the Atlantic City Expressway and along the Atlantic Ocean coast to over 35 lb/sq.ft. in Northwester New Jersey. Extreme variations in snow loads within the Highlands section of New Jersey require the use of specific engineering case studies to determine appropriate ground snow loads.

Although snow is the weather phenomenon most commonly associated with winter, ice storms are a much greater winter menace. The freezing rain that coats all objects in a sheath of ice can cause power outages, structural damage, and damaging tree falls. Ice storms occur when rain droplets fall through freezing air and but do not freeze until they touch objects such as trees, roads, or structures. A clear icy sheath, known as a glaze, forms around branches, structures and wires and has been known to bring down high-tension utility, radio, and television transmission towers.

All regions of New Jersey have been and continue to be subject to ice storms. Besides temperature, their occurrence depends on the regional distribution of the pressure systems, as well as local weather conditions. The distribution of ice storms often coincides with general distribution of snow within several zones in the State. A cold rain may be falling over the southern portion of the State, freezing rain over the central region, and snow over the northern counties as a coastal storm moves northeastward offshore. A locality's distance to the passing storm center is often the crucial factor in determining the temperature and type of precipitation during a winter storm.

Normally experiencing lower temperatures on most winter days, the north has a greater chance of all types of winter storms occurring. Elevation can play a role in lowering the temperature to cause ice and snow to form on hilltops while valley locations remain above freezing, receiving only rain or freezing rain. Often a difference of only one or two hundred feet can make a difference between liquid rain, adhering ice, and snow. Essex County's Orange Mountains, with an elevation of only two hundred feet above the valley, have on occasion been locked in an icy sheath while valley residents have experienced only rain. Conversely, ice storms may occur in valleys and not on hilltops if cold air gets trapped in the valleys of regions with greater relief.

Two dangers of winter do not even involve precipitation. A cold wave, as used in the U.S. National Weather Service, a rapid fall in temperature within 24 hours to temperatures requiring substantially increased protection to agriculture, industry, commerce, and social activities and involves both the rate of temperature fall and the minimum to which it falls. A cold wave is classified as a rapid drop of 20 degrees, to below between 28 and 10 degrees, depending on the time of year and whether the drop occurs in the southern or northern half of the State.

The extreme northwest corner of New Jersey can expect temperatures as low as zero degrees almost every year, and the State's entire northwest quarter about once every two years. In this section of New Jersey, the combined effects of latitude, topography, and elevation create favorable radiational cooling conditions at night, with low temperatures resulting. A second area of lower temperatures is found in the Pine Barrens, where the flat terrain and strong radiational quality of the sandy soil produce low temperatures. The central part of Burlington County, the center of the Pine Barrens, can expect a zero reading once every two years.

The central and south coasts are the least susceptible to zero temperatures, with a zero reading occurring less than once every ten years. Urban complexes, such as Newark and Trenton, can expect a zero reading only once or twice in ten years, because of the heat-island effect resulting from the retention of heat by buildings and pavements, the reduction of nocturnal radiation by pollution-laden atmosphere, input of heat into the atmosphere from fossil fuel combustion, and emanation of waste heat from heated and cooled buildings.

Wind chills can make winter a more dangerous. Very strong winds combined with temperatures slightly below freezing can have the same chilling effect as a temperature nearly 50 degrees F lower in a calm atmosphere. Arctic explorers and military experts have developed what is called the "wind-chill factor", which calculates an equivalent calm-air temperature for the combined effects of wind and temperature. In effect, the index describes the cooling power of air on exposed flesh and to a lesser extent a clothed person. Wind-chill temperatures throughout New Jersey annually fall below zero a number of times each winter, with wind chills in Northwestern New Jersey occasionally reaching 30 degrees F below zero.

Consequences

The impact of a specific winter storm event is based on the extent of the incident measured in terms of depth of snow, area inundated, temperature and infrastructure and transportation displaced. The hazard review continues with an examination and evaluation of consequences by specific criteria its impact on:

- THE PUBLIC – Winter storms can affect regions or the state as a whole. An event anywhere in the state becomes a major news event covered by the TV networks and newspapers. Warnings and advice of upcoming events is made available in advance of the approaching storm.

- RESPONDERS – Fire and police, and emergency responders are called on to evacuate people from the snow impacted area, close roads, attend to the injured, and direct traffic away from the dangerous area. On those presidential declared disasters, emergence response costs are significant reimbursement elements.

- CONTINUITY OF OPERATIONS INCLUDING DELIVERY OF SERVICES – To continue ongoing operations overtime may be required. To date, there have been a few winter storm incidents that have shut down state, county or municipal governmental operations for a day or two.

- PROPERTY – A winter storm has little effect, if any, on property values. Major damage can be caused by heavy snow and ice loads.

- FACILITIES – Winter storm snow and ice impact roads and bridges, schools, hospitals, in some cases directly and in others making access much more difficult. Detours and road closures also add to the cost of the event. Eligibility under the approved 2011 Hazard Mitigation Plan qualifies local governments and certain non-profits for FEMA Public Assistance Recovery and Pre-Disaster Mitigation disaster funding.

- INFRASTRUCTURE – Transportation, communications and the general operation of governmental services may be effected by a winter storm incident. In most reported incidents roads and bridges have been reported as the major infrastructure elements impacted. Eligibility under the approved 2011 Hazard Mitigation Plan qualifies local governments and certain non-profits for FEMA Public Assistance Recovery and Pre-Disaster Mitigation disaster funding.

- THE ENVIRONMENT – Winter storms, by their nature effect the environment by:
  - Buckling roads
  - Causing ice jams
  - Breaking tree limbs

- THE ECONOMIC CONDITION OF THE STATE – A winter storm event drains resources of the state, county and municipality. Even if some of the costs can be recouped through federal grant reimbursements, there is a fiscal impact on the local government.

- PUBLIC CONFIDENCE IN THE STATE'S GOVERNANCE – Governmental response, on all levels – state, county and municipal, immediate action must be immediate and effective to maintain public confidence. In New Jersey, the availability of the State's Open Space Green Acres funds supports immediate action to provide relief to flooded property owners through acquisition.

Implementation

The winter storm hazard review further continues with an examination and evaluation by specific criteria dealing with the implementation of mitigation strategies as stated in the State Hazard Mitigation Plan:

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  - The Fire Management Grant and
  - The Emergency Management Grant Programs.

- CAPABILITY TO IDENTIFY ONGOING MITIGATION OPPORTUNITIES AND TRACK REPETITIVE LOSSES – In the event that the winter storm creates flooding is "the normal" Repetitive Loss Information tracked. Other mitigation opportunities are such as roadway improvements, structure retrofit including building and bridges, and stream improvement and channelization are incorporated into mitigation action programs on the state and local levels.

  The New Jersey State Hazard Mitigation Plan is updated every three years and county and municipal local jurisdictional plans are updated every five years. The coordination of local planning efforts provides the framework to identify ongoing mitigation opportunities developed by adjoining counties and municipalities and to track repetitive losses
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4.4.15.4 Tornadoes, High Winds and Hail

The State of New Jersey is susceptible to high winds from several sources – most notably thunderstorms and hurricanes/tropical storms, which can all spawn tornadoes and straight line winds. High straight-line winds related to thunderstorms affect nearly all areas of the State equally, although tornadoes are relatively uncommon in the northeast part of the U.S. compared to the central and south-central States. The potential for a tornado strike is about equal across New Jersey, except in the northern parts of the State, which generally have steeper terrain, are less likely to experience tornadoes. Categories in this section include:

- Tornadoes
- Thunderstorms
- Straight-line winds
- Hail

Tornadoes are nature's most violent storms and can cause fatalities and devastate a neighborhood in seconds. A tornado appears as a rotating, funnel-shaped cloud that extends from a thunderstorm to the ground with whirling winds that can reach 250 miles per hour. Damage paths can be in excess of one mile wide and 50 miles long. Before a tornado hits, the wind may die down and the air may become very still. A cloud of debris can mark the location of a tornado even if a funnel is not visible. Tornadoes generally occur near the trailing edge of a thunderstorm. It is not uncommon to see clear, sunlit skies behind a tornado. Tornadoes are typically developed from either a severe thunderstorm or hurricane as cool air rapidly over-rides a layer of warm air. This causes the warm air to rise rapidly as a funnel shaped cloud.

The most violent tornadoes are capable of tremendous destruction with wind speeds of 250 mph or more. The severity of tornadoes is measured by the Fujita Scale. This table provides the level of destruction which may occur with each level of intensity.

Tornado season in New Jersey is generally March through August, though tornadoes can occur at any time of year. Over 80 percent of all tornadoes strike between noon and midnight. Approximately five tornadoes occur each year within the State, and in general, they tend to be weak. But the entire State is also in a hurricane-susceptible region.

Along with high winds, thunderstorms can bring other hazards including lightning, hail and flash flooding. In the United States, an average of 300 people is injured and 80 people are killed each year by lightning. Dry thunderstorms that do not produce rain that reaches the ground are most prevalent in the western United States. Falling raindrops evaporate, but lightning can still reach the ground and can start wildfires. Thunderstorms affect relatively small areas when compared with hurricanes and winter storms. The typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Despite their small size, thunderstorms are dangerous.

During the warm season, thunderstorms are responsible for most of the rainfall. Cyclones and frontal passages are less frequent during this time. Thunderstorms spawned in Pennsylvania and New York State often moves into Northern New Jersey, where they often reach maximum development in the evening. This region has about twice as many thunderstorms as the coastal zone, where the nearby ocean helps stabilize the atmosphere. The conditions most favorable to thunderstorm development occur between June and August, with July being the peak month for all weather stations in New Jersey.

Straight line winds and microbursts, though not contained in tornadoes, can still reach very high speeds and are in fact for a much greater volume of injuries and damage. Quite often, straight-line winds are associated with thunderstorms and their intense downbursts; however, any frontal passage, storm, or significant gradient between high and low pressure zones in the region can be result in damaging winds. These winds have been known to cause tornado like damage and even be mistaken for tornadoes to the untrained observer. Straight-line winds occur more often in areas with large expanses unbroken by buildings or geographic relief and as with tornadoes are associated with thunderstorms. They often cause extensive crop damage

Hail is a form of precipitation comprised of spherical lumps of ice. Known as hailstones, these ice balls typically range from 5 mm–50 mm in diameter on average, with much larger hailstones forming in severe thunderstorms. The size of hailstones is a direct function of the severity and size of the storm.

Hail is an outgrowth of severe thunderstorms and develops within a low-pressure front as warm air rises rapidly in to the upper atmosphere and is subsequently cooled, leading to the formation of ice crystals. These are bounced about by high-velocity updraft winds and accumulate into frozen droplets, falling as precipitation after developing enough weight. The National Weather Service (NWS) defines severe thunderstorms as those with downdraft winds in excess of 58 mph and/or hail at least .75" in diameter. While only about 10% of thunderstorms are classified as severe, all thunderstorms are dangerous because they produce numerous dangerous conditions, including one or more of the following: hail, strong winds, lightning, tornadoes, and flash flooding.

Hailstorms occur most frequently during the late spring and early summer. During this period, extreme temperature changes occur from the surface up to the jet stream, resulting in the strong updrafts required for hail formation. The size of hailstones varies and is related to the severity and size of the thunderstorm that produced it. The higher the temperatures at the earth's surface, the greater the strength of the updrafts, and the greater the amount of time the hailstones are suspended, giving the hailstones more time to increase in size. Hailstones vary widely in size, as shown in Table 4.4.12-1. Note that penny size (.75" in diameter) or larger hail is considered severe.

Hailstorms occur more frequently during the late spring and early summer, when the jet stream migrates northward across the Great Plains. This period has extreme temperature changes from the ground surface upward into the jet stream, which produces the strong updraft winds needed for hail formation. The land area affected by individual hail events is not much smaller than that of a parent thunderstorm, an average of 15 miles in diameter around the center of a storm.

The potential for hail exists over the entire state, although the probability is relatively low compared to other parts of the United States. There are at least a few incidences of hail almost every year, although for the most part they are minor. The severity of hailstorms is measured by duration, size of the hail itself, and geographic extent. All of these factors are directly related to the weather phenomena that create the hail, thunderstorms. There is wide potential variation in these severity components. The planning area has a relatively low potential for significant hail events, based on previous records.

There are no known instances of injuries or death from hail events in any New Jersey County. The NCDC database indicates there has been no reported property damage in the State from hail events. Presumably there are some damages, but most of these are likely addressed by citizens or insurance companies, and therefore there is no readily accessible record of damages. Damages that do occur are presumably orders of magnitude less than other hazards such as floods or hurricane winds.

Consequences

The impact of a specific tornadoes, high winds and hail event is based on the extent of the incident measured in terms of wind speed and force, area covered, size of hail and population displaced. The hazard review continues with an examination and evaluation of consequences by specific criteria its impact on:

- THE PUBLIC – Tornadoes, High Winds and Hail can a specific area or the state as a whole. An event anywhere in the state becomes a major news event covered by the TV networks and newspapers. Some incidents are forecasted but others are unpredictable.

- RESPONDERS – Fire and police, and emergency responders are called on to evacuate people from the impacted area, close roads, attend to the injured, and direct traffic away from the disaster area. On those presidential declared disasters, emergence response costs are significant reimbursement elements.

- CONTINUITY OF OPERATIONS INCLUDING DELIVERY OF SERVICES – To continue ongoing operations overtime may be required. To date, there have been few or no Tornadoes, High Winds and Hail incidents that have shut down state, county or municipal governmental operations.

- PROPERTY – Market value of property is not significantly reduced. Impact areas are undefined. If a disaster is declared, eligibility under the approved 2011 Hazard Mitigation Plan qualifies local governments, homeowners and businesses for FEMA Individual Assistance disaster funding.

- FACILITIES – Tornadoes, High Winds and Hail impact roads and bridges, schools, hospitals, in some cases directly and in others making access much more difficult. Detours and road closures also add to the cost of the flood event. Eligibility under the approved 2011 Hazard Mitigation Plan qualifies local governments and certain non-profits for FEMA Public Assistance Recovery and Pre-Disaster Mitigation disaster funding.

- INFRASTRUCTURE – Transportation, communications and the general operation of governmental services may be effected by an incident. In the few reported Tornadoes, High Winds and Hail incidents roads and bridges have been reported as the major infrastructure elements impacted. Eligibility under the approved 2011 Hazard Mitigation Plan qualifies local governments and certain non-profits for FEMA Public Assistance Recovery and Pre-Disaster Mitigation disaster funding

- THE ENVIRONMENT – Tornadoes, High Winds and Hail, by their nature effect the environment by: possibly spreading debris and pollution; damaging sewer and wastewater treatment plants; and disturbing the wildlife and natural areas.

- THE ECONOMIC CONDITION OF THE STATE – A Tornadoes, High Winds and Hail can drain resources of the state, county and municipality. Even if some of the costs can be recouped through federal grant reimbursements, there is a fiscal impact on the local government.

- PUBLIC CONFIDENCE IN THE STATE'S GOVERNANCE – Governmental response, on all levels – state, county and municipal, immediate action must be immediate and effective to maintain public confidence. In New Jersey, the availability of the State's Open Space Green Acres funds supports immediate action to provide relief to damaged property owners through acquisition for open space.

Implementation

The Tornadoes, High Winds and Hail hazard review further continues with an examination and evaluation by specific criteria dealing with the implementation of mitigation strategies as stated in the State Hazard Mitigation Plan:

- ABILITY TO PARTICIPATE IN FEDERAL, STATE, REGIONAL AND LOCAL MITIGATION PROGRAMS – The FEMA approved All Natural Hazard Mitigation Plan (as described in Sections 2.3.1 and 2.3.2 of the NJ 2011 Hazard Mitigation Plan) enables the State to participate in:

o Public Assistance Mitigation Programs
o Pre- and Post-Disaster Mitigation Program
o The Fire Management Grant and
o The Emergency Management Grant Programs.

- CAPABILITY TO IDENTIFY ONGOING MITIGATION OPPORTUNITIES AND TRACK REPETITIVE LOSSES – In the event that the Tornadoes, High Winds and Hail storm creates flooding is "the normal" Repetitive Loss Information tracked. Other mitigation opportunities are such as roadway improvements, structure retrofit including building and bridges, and stream improvement and channelization are incorporated into mitigation action programs on the state and local levels.

  The New Jersey State Hazard Mitigation Plan is updated every three years and county and municipal local jurisdictional plans are updated every five years. The coordination of local planning efforts provides the framework to identify ongoing mitigation opportunities developed by adjoining counties and municipalities and to track repetitive losses

o The State Hazard Mitigation Goals and Objectives are listed in Section 5.2.2 of the Plan.
o Repetitive Flood Loss data is included in Sections 4.4.1.6.1, 4.4.1.6.2 and 4.4.1.6.3 of the Plan that uses NFIP Flood Claim information.
o The State Repetitive Loss Strategy is developed in Section 5.2.3.
o Through the use of Green Acres/Blue Acres land acquisition funds acquisition of repetitive loss and severe repetitive loss properties are accomplished.

- MAINTAINS MITIGATION GOALS, OBJECTIVES AND ACTIONS THAT SETS PRIORITIES AND RANKINGS THAT INCLUDE REDUCTION OF VULNERABILITY TO THE IDENTIFIED HAZARD AND INCLUDING A BENEFIT / COST

ANALYSIS - Mitigation goals, objectives and actions are included in the Plan. The NJ State's five mitigation goals are:

- To protect life
- To protect property
- To increase public preparedness
- Develop and maintain an understanding of natural hazard risks
- Enhance capabilities to make New Jersey less vulnerable to hazards

  The above noted goals are further developed through 18 objectives and the Repetitive Loss Strategy included in Section 5.2 of the Plan.

Specific action items (included in Section 5.4.3) address each of the mitigation goals. Action items include:

- Information the rationale for action
- Priority (up to 3 years)
- How the action contributes to the Mitigation strategy
- STAPLEE Assessment of Mitigation Actions.

A Benefit / Cost Analysis is a requirement of most FEMA grant projects. The analysis is generally prepared when a project moves closer to being undertaken and costs are developed. Instructions and information on Benefit / Cost are included as a Handout of the Plan. Benefit/Cost training session are sponsored regularly for state and local FEMA grant application developers.

- ENCOURAGES PUBLIC / PRIVATE PARTNERSHIPS – Coordination between agencies include participation in the Hazard Mitigation Plan development by:
  - State departments
    - Attorney General
    - Banking and Insurance
    - Community Affairs
    - Environmental Protection
    - NJ State Police, Office of Emergency Management
    - Office of the Governor
    - Public Utilities
    - State Climatologist
    - State Geologist
    - State Office of Information Technology
    - Transportation
    - Treasury
    - Veterans Affairs
  - Intra-state agencies
    - Delaware and Raritan Canal Commission
    - Delaware River Basin Commission
    - Delaware River Basin Interstate Flood Mitigation Task Force
    - FEMA Portfolio Management
    - NJ Association of Flood Plain Managers
    - NJ Flood Mitigation Task Force
    - NJ League of Municipalities
    - Passaic River Basin Flood Advisory Commission
    - USACE Silver Jackets

- SUPPORTS PUBLIC EDUCATION AND OUTREACH – Public Education and Education is included in the plan as a mitigation strategy for most identified hazards. NJOEM prepares "handouts" on subjects of interest in response to questions raised at training and outreach sessions. Outreach sessions are conduct as FEMA grant program funding availability announcements are made. Benefit/Cost refresher training courses are given on a regular basis. NJOEM is a regular presenter at annual meetings of the NJ League of Municipalities, the NJ Association of Emergency Managers, Delaware River Greenway Partnership, etc.

4.4.15.5 Drought

Drought is a period of drier-than-normal conditions that results in community water issues. Low precipitation may also dry out soils and threaten agriculture. When precipitation is less than normal for long enough, stream flows decrease, water levels in lakes and reservoirs fall and the depth to reach well water increases. Although below-normal rainfall does not automatically result in drought conditions, persistent dry weather and water-supply issues may evolve into a drought emergency. Because droughts are generally the results of meteorological patterns, the entire State of New Jersey is about equally subject to their effects. Nearly every County in the State has experienced at least one drought in the past ten years. Droughts are partly a function of antecedent conditions, so areas that are already experiencing dry conditions are likely to experience more problems when meteorological droughts occur.

The first evidence of drought is usually recorded with below normal rainfall. Nevertheless, the impact of a drought on streams, river flows, and reservoir levels may not be evident for weeks or months. The water level in deep wells may take a year or more before showing drought impacts whereas shallow wells may be affected as quickly as streams are. The classification of drought includes:

- Drought Watch
- Drought Warning
- Drought Emergency

There are numerous nationally-used indices that measure average precipitation levels. Although none of the major indices are inherently superior in all circumstances, some indices are better suited than others for certain uses. The Palmer Index has been widely used by the U.S. Department of Agriculture to determine when to grant emergency drought assistance to states and municipalities. Although the Palmer Index is better suited for large areas of uniform topography it does not generally work well with areas that encompass differing regional environments. Palmer values generated typically lag emerging droughts by several months. Additionally, when conditions change from dry to normal or wet, the index indicates the drought termination without taking into account stream-flow, lake and reservoir levels and other longer term hydrologic impacts. The Palmer Index also neglects to measure the human impact on water balance such as irrigation.

During the New Jersey droughts that occurred during 1998 and 1999 the New Jersey Department of Environmental Protection had difficulty comparing the severity of drought throughout the state. To improve monitoring and measurement of drought severity from region to region, the New Jersey Department of Environmental Protection devised a unique set of indices specifically designed for the unique characteristics and needs of the state. These were implemented in January 2001. This new set of state-wide indicators supplements the Palmer Index with the measurement of regional precipitation, stream-flow, reservoir levels, and ground-water levels. New Jersey currently measures the status of each indicator as: near or above normal; moderately dry; severely dry; and extremely dry. The status is based on a statistical analysis of historical values with generally the driest 10% being classified as extremely dry, from 10%-30% as severely dry, and 30%-50% as moderately dry.

New Jersey is divided into six drought regions. The goal is to allow the State to respond to changing conditions without imposing restrictions on areas not experiencing water-supply shortages. As indicated in Figure 4.4.7.1-1 the regions are: Northeast, Central, Northwest, Southwest, Coastal North, and Coastal South. Each region is based on regional similarities in water-supply sources and rainfall patterns that correspond closely to natural watershed boundaries and municipal boundaries. These regions were developed based upon hydro geologic conditions, watershed boundaries, municipal boundaries, and water-supply characteristics. Drought region boundaries are contiguous with municipal boundaries because during a water emergency the primary enforcement mechanism for restrictions is municipal police forces.

Consequences

The impact of a specific drought event is based on the extent of the incident measured in terms of depth of water, area flooded and population displaced. The flood hazard review continues with an examination and evaluation of consequences by specific criteria its impact on:

- THE PUBLIC – Drought affects those in a local, regional or the state as a whole A drought event usually takes a long time in developing, can be anywhere in the state and becomes a major news event covered by the TV networks and newspapers.

- RESPONDERS – Fire and police, and emergency responders are called on to evacuate people to shelter areas, suppress fires, attend to the injured, and direct traffic away from possible wildfire areas. On those presidential declared disasters, emergence response costs are significant reimbursement elements.

- CONTINUITY OF OPERATIONS INCLUDING DELIVERY OF SERVICES – To continue ongoing operations overtime may be required. To date, there have been few or no drought incidents that have shut down state, county or municipal governmental operations.

- PROPERTY – Market value of property in a drought area is not significantly reduced.

- FACILITIES – Drought has little impact on facilities. Eligibility under the approved 2011 Hazard Mitigation Plan qualifies local governments and certain non-profits for FEMA Public Assistance Recovery and Pre-Disaster Mitigation disaster funding.

- INFRASTRUCTURE – Transportation, communications and the general operation of governmental services may be effected by a drought incident. In most reported drought incidents water delivery systems and forest areas are impacted. Eligibility under the approved 2011 Hazard Mitigation Plan qualifies local governments and certain non-profits for FEMA Public Assistance Recovery and Pre-Disaster Mitigation disaster funding

- THE ENVIRONMENT – Drought, by their nature effect the environment by: causing wildfires; overloading water and wastewater treatment plants; creating dust storms; and disturbing the wildlife and natural areas.

- THE ECONOMIC CONDITION OF THE STATE – A drought drains resources of the state, county and municipality. Even if some of the costs can be recouped through federal grant reimbursements, there is a fiscal impact on the local government.

- PUBLIC CONFIDENCE IN THE STATE'S GOVERNANCE – Governmental response, on all levels – state, county and municipal, immediate action must be immediate and effective to maintain public confidence. In New Jersey, the availability of the State's Open Space Green Acres funds supports immediate action to provide relief to property owners through acquisition.

Implementation

The drought hazard review further continues with an examination and evaluation by specific criteria dealing with the implementation of mitigation strategies as stated in the State Hazard Mitigation Plan:

- ABILITY TO PARTICIPATE IN FEDERAL, STATE, REGIONAL AND LOCAL MITIGATION PROGRAMS – The FEMA approved All Natural Hazard Mitigation Plan (as described in Sections 2.3.1 and 2.3.2 of the NJ 2011 Hazard Mitigation Plan) enables the State to participate in:
    - Public Assistance Mitigation Programs

- Pre- and Post-Disaster Mitigation Program
- The Fire Management Grant and
- The Emergency Management Grant Programs.

- CAPABILITY TO IDENTIFY ONGOING MITIGATION OPPORTUNITIES AND TRACK REPETITIVE LOSSES – In the event that a drought later creates flooding is "the normal" Repetitive Loss Information would be tracked. Other mitigation opportunities may present themselves and would be incorporated into mitigation action programs on the state and local levels.

- MAINTAINS MITIGATION GOALS, OBJECTIVES AND ACTIONS THAT SETS PRIORITIES AND RANKINGS THAT INCLUDE REDUCTION OF VULNERABILITY TO THE IDENTIFIED HAZARD AND INCLUDING A BENEFIT / COST ANALYSIS - Mitigation goals, objectives and actions are included in the Plan. The NJ State's five mitigation goals are:
  - To protect life
  - To protect property
  - To increase public preparedness
  - Develop and maintain an understanding of natural hazard risks
  - Enhance capabilities to make New Jersey less vulnerable to hazards

  The above noted goals are further developed through 18 objectives and the Repetitive Loss Strategy included in Section 5.2 of the Plan.

  Specific action items (included in Section 5.4.3) address each of the mitigation goals. Action items include:
  - Information the rationale for action
  - Priority (up to 3 years)
  - How the action contributes to the Mitigation strategy
  - STAPLEE Assessment of Mitigation Actions.

  A Benefit / Cost Analysis is a requirement of most FEMA grant projects. The analysis is generally prepared when a project moves closer to being undertaken and costs are developed. Instructions and information on Benefit / Cost are included as a Handout of the Plan. Benefit/Cost training session are sponsored regularly for state and local FEMA grant application developers.
- ENCOURAGES PUBLIC / PRIVATE PARTNERSHIPS – Coordination between agencies include participation in the Hazard Mitigation Plan development by:
  - State departments
    - Attorney General
    - Banking and Insurance
    - Community Affairs
    - Environmental Protection
    - NJ State Police, Office of Emergency Management
    - Office of the Governor
    - Public Utilities
    - State Climatologist
    - State Geologist
    - State Office of Information Technology
    - Transportation
    - Treasury
    - Veterans Affairs
  - Intra-state agencies
    - Delaware and Raritan Canal Commission
    - Delaware River Basin Commission

- Delaware River Basin Interstate Flood Mitigation Task Force
- FEMA Portfolio Management
- NJ Association of Flood Plain Managers
- NJ Flood Mitigation Task Force
- NJ League of Municipalities
- Passaic River Basin Flood Advisory Commission
- USACE Silver Jackets

- SUPPORTS PUBLIC EDUCATION AND OUTREACH – Public Education and Education is included in the plan as a mitigation strategy for most identified hazards. NJOEM prepares "handouts" on subjects of interest in response to questions raised at training and outreach sessions. Outreach sessions are conduct as FEMA grant program funding availability announcements are made. Benefit/Cost refresher training courses are given on a regular basis. NJOEM is a regular presenter at annual meetings of the NJ League of Municipalities, the NJ Association of Emergency Managers, Delaware River Greenway Partnership, etc.

4.4.15.6 Wildfires

Wildfires represent a serious threat to life, property and natural resources. The Forest Fire Service was established in 1906 under N.J.S.A. Title 13, Chapter 9, "for the protection of forests, and property adjacent thereto, wherever the department shall determine the necessity therefore". The statute further states that, "The Legislature declares it to be the policy of the State to prevent, control, and manage wildfires on or threatening the forest or Wildland of New Jersey in order to preserve forests and other natural resources; to enhance the growth and maintenance of forests; to protect recreational, residential, wildlife, plant life, watershed, air shed, and other values; to promote the stability of forest using industries; and to prevent loss of life, bodily injury and damage to property from wildfire and conflagrations.

The New Jersey Pinelands is a fire adapted forest community that takes advantage of wildfire to reproduce. The Pinelands are classified as Fuel Model B of the National Fire Danger Rating System with California chaparral and a number of other high hazard types. Fuel loadings exceed twenty tons per acre in some locales. This has been equated to having an inch of gasoline covering all of south and central New Jersey. Pinelands fires burn extremely hot and spread rapidly. Crown fires are fairly common, spreading from treetop to treetop, as is long range spotting where flying embers start new fires in advance of the main fire.

From the hillside farms and oak forests of northern New Jersey, to the phragmites covered coastal areas along the Atlantic Ocean and the Delaware Bay; and from the state's core of urban development to the desolation within a sea of trees known as the Pinelands, these vast differences hint at the challenge and difficulties in protecting the state's citizens from the threat of wildfire.

New Jersey's high population density has created land use pressures in which more people are moving from urban areas to build homes in rural wildland areas. With more people living in, and enjoying the state's wildlands for various forms of recreation, the number of fires started and the seriousness of their consequences increases. A potentially explosive combination is created when the factors of hazardous wildland fuels, interface home development, and an increased risk of human caused ignition come together under extreme fire weather conditions. Although many plants in the Pine Barrens ecosystem rely on fire for a part of their reproductive cycle, the homes and property of the people who live there do not. Although Pinelands fires generally do not cause casualties, property loss can amount to thousands of dollars for each fire.

Although wildfires can occur during all months of the year, spring is the period when the most devastating incidents typically happen. With the coming of longer days, drying conditions, stronger winds, the weather provides excellent conditions for the rapid spread of fire. A second "season" develops in the northern part of the State during the fall when the abundance of freshly fallen leaves provide a bed of fuel for wildfire to race rapidly up the slopes. Wildfire locations in the State tend to be in the less developed areas because they are more likely to have sources of fuel for fires, and because detection and suppression are somewhat less likely because there is lower population.

To manage wildfire danger and to protect communities within the State, the NJ Forest Fire Service has historically applied a series of prevention, preparedness, and suppression programs. These programs have been informally developed through practical experience over many years; however, it is now desired that they be planned, integrated and implemented on a landscape scale.

One of the most consistent and serious impacts of drought is the contribution to conditions conducive to forest fires. This applies particularly to the Pine Barrens, where drying conditions favor the combustion of forest fuels. Generally, a relative humidity of less than 40 percent, winds greater than 13 miles an hour, and precipitation of less than 0.01 inches during a month are ideal conditions for forest fires in the Pine Barrens. Given the proper conditions, stray cigarette butts, improperly extinguished campfires, and intentional matches can all start fires in the Pine Barrens. The season of greatest fire threat runs from March through May, though extensive fires have occurred in the summer and autumn months.

The New Jersey Pine Barrens is widely recognized as one of the most hazardous fuel types in the country. The Pinelands National Reserve is located in the south-central part of New Jersey and has similar wildfire behavior as the chaparral of California. Recognized for its globally unique fire-dependent ecosystem, the many threatened and endangered plant and animal communities located in the Pine Barrens are protected through the Pinelands Commission, an authority that regulates development within the Reserve. Within relatively vast areas of this hazardous fuels co-exist many homes in isolated developments that were developed prior to the Pinelands Commission, surrounded by nearly solid development on the perimeter of the Reserve. This development continues to challenge efforts to reduce the risk of devastating wildfires in New Jersey.

The NJ Forest Fire Service protects a primary response area of 3.25 million acres within the suburban and rural areas of the state. The goal of the Forest Fire Service is to limit the number of wildfires to less than 2,000 annually, and the acreage burned to less than one half of one percent (0.5%) of the area protected, or 15,750 acres. The Service accomplishes these goals by maintaining an aggressive fire management program that addresses the hazards and risks unique to each region of the state.

Fire has played a significant role in the development and distribution of the natural communities found within New Jersey. The New Jersey Pinelands is a fire adapted forest ecosystem that depends on wildfire for reproduction and the control of fuel buildup. This forest community is one of the most hazardous wildland fuel types in the nation. Additionally, the oak forests of the north, particularly those found on the slopes of the Appalachian Mountains within the state, produce rapid rates of spread and were once considered a greater threat due to slash piles and scattered debris left after logging for charcoal for furnaces in the late 1800's. Phragmites, an invasive grass with its 10 foot height dominating over native species, became established and is a seasonal threat to homes along the "Jersey Shore".

The frequency and severity of wildfires is dependent on weather and human activity. Nearly all wildfires in New Jersey are human-caused (99%) with arson, children and careless debris burning being the major causes of wildfires. When not promptly controlled, wildfires may grow into catastrophic events. Fire has been a major factor in New Jersey's environment since prehistoric times. Natural fires and Native American burning played a major role in shaping the land and providing the vast expanses of forestland that greeted early settlers. These settlers soon realized that the Pinelands of New Jersey is one of the most hazardous fuel types in the nation.

Consequences

The impact of a wildfire event is based on the extent of the incident measured in terms of area burned, rate of spread and population displaced. The wildfire hazard review continues with an examination and evaluation of consequences by specific criteria its impact on:

- THE PUBLIC – Wildfire affect those in the event and through the ash fallout and smoke, all of the surrounding areas not only in the fire but possibly the state as a whole A wildfire event in the pinelands or anywhere in the state becomes a major news event covered by the TV networks and newspapers.

- RESPONDERS – Fire and police, and emergency responders are called on to evacuate people from the fire area, close roads, create fire breaks, attend to the injured, and direct traffic away from the area. On those presidential declared disasters, emergence response costs are significant reimbursement elements.

- CONTINUITY OF OPERATIONS INCLUDING DELIVERY OF SERVICES – To continue ongoing operations overtime may be required. To date, there have been few or no fire incidents that have shut down state, county or municipal governmental operations.

- PROPERTY – Areas of repetitive wildfire are generally shunned by new home purchasers in favor of less threatened home sites. Eligibility under the approved 2011 Hazard Mitigation Plan qualifies homeowners and businesses for FEMA Individual Assistance disaster funding.

- FACILITIES – Wildfires impact roads and bridges, schools, hospitals, in some cases directly and in others making access much more difficult and creating air pollution situations. Detours and road closures also add to the cost of the fire event. Eligibility under the approved 2011 Hazard Mitigation Plan qualifies local governments and certain non-profits for FEMA Public Assistance Recovery and Pre-Disaster Mitigation disaster funding.

- INFRASTRUCTURE – Transportation, communications and the general operation of governmental services may be effected by a wildfire incident. In most reported fire incidents roads and bridges have been reported as the major infrastructure elements impacted by a flood. Eligibility under the approved 2011 Hazard Mitigation Plan qualifies local governments and certain non-profits for FEMA Public Assistance Recovery and Pre-Disaster Mitigation disaster funding

- THE ENVIRONMENT – Wildfires, by their nature effect the environment by: spreading pollution; creating health problems; carrying ash and smoke; and disturbing the wildlife and natural areas.

- THE ECONOMIC CONDITION OF THE STATE – A wildfire drains resources of the state, county and municipality. Even if some of the costs can be recouped through federal grant reimbursements, there is a fiscal impact on the local government.

- PUBLIC CONFIDENCE IN THE STATE'S GOVERNANCE – Governmental response, on all levels – state, county and municipal, immediate action must be immediate and effective to maintain public confidence. In New Jersey, the availability of the State's Open Space Green Acres funds supports immediate action to provide relief to flooded property owners through acquisition.

Implementation

The flood hazard review further continues with an examination and evaluation by specific criteria dealing with the implementation of mitigation strategies as stated in the State Hazard Mitigation Plan:

- ABILITY TO PARTICIPATE IN FEDERAL, STATE, REGIONAL AND LOCAL MITIGATION PROGRAMS – The FEMA approved All Natural Hazard Mitigation Plan (as described in Sections 2.3.1 and 2.3.2 of the NJ 2011 Hazard Mitigation Plan) enables the State to participate in:
  - Public Assistance Mitigation Programs
  - Pre- and Post-Disaster Mitigation Program
  - The Fire Management Grant and
  - The Emergency Management Grant Programs.

- CAPABILITY TO IDENTIFY ONGOING MITIGATION OPPORTUNITIES AND TRACK REPETITIVE LOSSES – Only flood issues are tracked using Repetitive Loss Information. Burned areas have a tendency to acerbate flooding with the destruction of ground cover. The New Jersey State Hazard Mitigation Plan is updated every three years and county and municipal local jurisdictional plans are updated every five years. The coordination of local planning efforts provides the framework to identify ongoing mitigation opportunities developed by adjoining counties and municipalities and to track repetitive losses

- MAINTAINS MITIGATION GOALS, OBJECTIVES AND ACTIONS THAT SETS PRIORITIES AND RANKINGS THAT INCLUDE REDUCTION OF VULNERABILITY TO THE IDENTIFIED HAZARD AND INCLUDING A BENEFIT / COST ANALYSIS - Mitigation goals, objectives and actions are included in the Plan. The NJ State's five mitigation goals are:
  - To protect life
  - To protect property
  - To increase public preparedness
  - Develop and maintain an understanding of natural hazard risks
  - Enhance capabilities to make New Jersey less vulnerable to hazards

  The above noted goals are further developed through 18 objectives and the Repetitive Loss Strategy included in Section 5.2 of the Plan.

  Specific action items (included in Section 5.4.3) address each of the mitigation goals. Action items include:
  - Information the rationale for action
  - Priority (up to 3 years)
  - How the action contributes to the Mitigation strategy
  - STAPLEE Assessment of Mitigation Actions.

  A Benefit / Cost Analysis are a requirement of most FEMA grant projects. The analysis is generally prepared when a project moves closer to being undertaken and costs are developed. Instructions and information on Benefit / Cost are included as a Handout of the Plan. Benefit/Cost training session is sponsored regularly for state and local FEMA grant application developers.
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    - Environmental Protection
    - NJ State Police, Office of Emergency Management
    - Office of the Governor
    - Public Utilities
    - State Climatologist
    - State Geologist
    - State Office of Information Technology
    - Transportation
    - Treasury
    - Veterans Affairs
  - Intra-state agencies
    - Delaware and Raritan Canal Commission
    - Delaware River Basin Commission
    - Delaware River Basin Interstate Flood Mitigation Task Force

- FEMA Portfolio Management
- NJ Association of Flood Plain Managers
- NJ Flood Mitigation Task Force
- NJ League of Municipalities
- Passaic River Basin Flood Advisory Commission
- USACE Silver Jackets

- SUPPORTS PUBLIC EDUCATION AND OUTREACH – Public Education and Education is included in the plan as a mitigation strategy for most identified hazards. NJOEM prepares “handouts” on subjects of interest in response to questions raised at training and outreach sessions. Outreach sessions are conduct as FEMA grant program funding availability announcements are made. Benefit/Cost refresher training courses are given on a regular basis. NJOEM is a regular presenter at annual meetings of the NJ League of Municipalities, the NJ Association of Emergency Managers, Delaware River Greenway Partnership, etc.

4.4.15.7 Geological Land Disturbances

Geological Land Disturbances include:

- Earthquakes
- Sinkholes
- Subsidence’s
- Landslides
- Abandoned Mines

In the popular press, earthquakes are often described by their Richter Magnitude (M). Magnitude is a measure of the total energy released by an earthquake. In addition to Richter magnitude, there are several other measures of earthquake magnitude used by seismologists, but such technical details are beyond the scope of this discussion. It is important to recognize that the Richter scale is not linear, but rather logarithmic. A Magnitude (M) 8 earthquake is not twice as powerful as an M4, but rather thousands of times more powerful. An M7 earthquake releases about 30 times more energy than an M6, while an M8 releases about 30 times more energy than an M7, and so on. Thus, great M8 earthquakes may release hundreds or thousands of times as much energy as do moderate earthquakes in the M5 or M6 range.

It is often assumed that the larger the magnitude of an earthquake the “worse” the earthquake. Thus, the “big one” is the M8 earthquake and smaller earthquakes (M6 or M7) are not the “big one”. However, this is true only in very general terms. Larger magnitude earthquakes affect larger geographic areas, with much more widespread damage than smaller magnitude earthquakes. However, for a given site, the magnitude of an earthquake is not a good measure of the severity of the earthquake at that site. Rather, the intensity of ground shaking at the site depends on the magnitude of the earthquake and on the distance from the site to the earthquake.

An earthquake is located by its epicenter - the location on the earth’s surface directly above the point of origin of the earthquake. Earthquake ground shaking diminishes (attenuates) with distance from the epicenter. Thus, any given earthquake will produce the strongest ground motions near the epicenter with the intensity of ground motions diminishing with increasing distance from the epicenter. Thus, for a given site, a moderate earthquake (such as an M5.5 or M6.0) which is very close to the site could cause greater damage than a much larger earthquake (such as an M7.0 or M8.0) which is quite far away from the particular site. However, earthquakes at or below M5 are not likely to cause significant damage, even locally very near the epicenter. Earthquakes between about M5 and M6 will cause damage near the epicenter. Earthquakes of about M6.5 or greater will cause major damage, with larger earthquakes resulting in greater damage over increasingly large areas.

The intensity of ground shaking from an earthquake, and the resulting damage, varies not only as a function of M and distance, but also depends on soil types. Soft soils may amplify ground motions and increase the level of damage. Thus, for any given earthquake there will be contours of varying intensity of ground shaking. The intensity will generally decrease with distance from the earthquake, but often in an irregular pattern, reflecting soil conditions (amplification) and possible directionality in the dispersion of earthquake energy.

There are many measures of the severity or intensity of earthquake ground motions. A very old scale, but still commonly used, is the Modified Mercalli Intensity scale (MMI), which is a descriptive scale that relates severity to the types of damage experienced. MMIs range from I to XII. For reference, the MMI intensity scale is shown below. However, it is important to note that these descriptions are not particularly applicable to modern buildings and that for any level of ground shaking, damage patterns for specific buildings or infrastructure will vary markedly depending on the specific vulnerabilities of each facility.

The level of seismic hazard – the frequency and severity of earthquakes – is substantially lower in New Jersey than in more seismically active States such as California or Alaska. However, the level of seismic risk – the threat to buildings, infrastructure, and people – is significant in New Jersey, especially in the northern part of the State. The level of seismic *risk* (i.e. potential damages) in New Jersey is higher than might be expected because the vast majority of the buildings and infrastructure in New Jersey have been built with minimal or no consideration of earthquakes. Thus, the inventory of buildings and infrastructure in New Jersey is much more vulnerable to earthquake damage than the buildings and infrastructure in more seismically active States where much of the inventory has been built with consideration of earthquakes.

In New Jersey, earthquakes are most likely to occur in the northern parts of the State, where significant faults are concentrated. However, low-magnitude events can and do occur in many areas of the State. The New Jersey Geological Survey and the U.S. Geological Survey have compiled considerable bodies of information about earthquake hazards across the State, as discussed below. It is important to recognize that earthquake risk (the potential for damage) is determined by factors other than proximity to faults. As discussed in this section, the nature of soils and the vulnerability of the built environment are also significant determinants of risk.

For New Jersey, major damaging earthquakes are low probability events. However, when they do occur they may have very high consequences because of the nature of the built environment in the State, much of which (particularly older structures) was not designed to withstand the stresses induced by shaking forces. Generally speaking, the effects of high-severity (and hence relatively lower probability) hazards are more difficult and expensive to mitigate than are hazards with higher probabilities and lower consequences.

A landslide is a natural geologic process involving the movement of earth materials down a slope, including rock, earth, debris, or a combination of these, under the influence of gravity. However, there are a variety of triggers for landslides such as: a heavy rainfall event, earthquakes, or human activity. The rate of landslide movement ranges from rapid to very slow. A landslide can involve large or small volumes of material. Material can move in nearly intact blocks or be greatly deformed and rearranged. The slope may be nearly vertical or fairly gentle (Delano and Wilshusen, 2001).

Landslides are usually associated with mountainous areas but can also occur in areas of generally low relief. In low-relief areas, landslides occur due to steepening of slopes: as cut and fill failures (roadway and building excavations), river bluff failures, collapse of mine waste piles, and a wide variety of slope failures associated with quarries and open-pit mines (USGS, Landslide Types and Process, 2004). However landslides also occur to naturally steep slopes that haven't been touched by human activity.

Subsidence is the sinking of the top layer of ground resulting from the disappearance of material below the ground surface. Subsidence can occur as a result of natural geologic phenomenon or as a result of human alteration of surface and underground hydrology . Natural subsidence in the form of sinkholes occurs in areas where the bedrock consists of limestone, dolomite, or marble which is collectively referred to as carbonate rock and the areas are known as karst areas. Sinkhole formation typically begins when rainwater infiltrates to a layer of soluble bedrock composed primarily of calcium carbonate or a combination of calcium-magnesium carbonate and some insoluble materials. Anthropogenic subsidence resulting from underground mining or from excessive pumping of groundwater can cause otherwise stable ground to become unstable and collapse leaving depressions similar to natural sinkholes. They can occur in any geologic unit including carbonate rocks. Like landslides, the subsidence hazard is location-specific because it is the result of specific conditions such as karst geology, excessive groundwater extraction, or abandoned mines.

Naturally occurring subsidence and sinkholes in New Jersey occur within bands of carbonate bedrock. In northern New Jersey there are more than 225 square miles that are underlain by limestone, dolomite, and marble. In some localities, no sinkholes have appeared, while in others, sinkholes are common. In the southern part of the state there are about 100 square miles which are locally underlain by lime sand with thin limestone layers. No collapse sinkholes have been identified, but there are some features which could be either very shallow solution depressions or wind blowout features. Sinkholes in New Jersey are generally concentrated in the northwestern part of the State.

A sinkhole is a depression in the surface of the ground that results from collapse of the "roof" of a "cave" in carbonate rocks, or from subsidence of surface material into subsurface openings produced by dissolution of the carbonate bedrock. Cave collapse sinkholes are extremely rare in New Jersey, whereas soil subsidence sinkholes are common. A naturally occurring sinkhole is a closed, usually circular depression in an area underlain by soluble rock which drains internally to the subsurface. Sinkholes generally form along linear trends aligned with fractures and joints in the underlying bedrock. The fractures occur generally parallel to faults and fold axes within the bedrock.

Limestone, dolomite and marble, collectively known as carbonate rocks, are soluble in acid. Rainwater, which is slightly acidic from atmospheric carbon dioxide (CO_2), can become more acidic where decaying vegetation is available in the soil through which water passes on its way down to the bedrock. The acidic ground water slowly dissolves the carbonate bedrock creating voids and sometimes caves in the rock. Soil can then filter down into the openings in the rock, leaving voids. These soil voids can slowly settle or suddenly collapse forming sinkholes.

When subsidence develops slowly, it may first be seen in misaligned curbs, cracked foundations and walls, or jammed windows and doors. More often a sinkhole or collapse feature occurs rapidly, in a few hours or days. If it is in a field or woods away from structures and utilities, it may serve only as an annoyance, perhaps causing turbidity for a time in nearby wells or tripping up grazing livestock. If subsidence occurs in a developed area, costly damage may result. Buried utilities may sag and break, roads and curbs can collapse, and foundation walls can crack or rupture and cinderblock walls can lose support or crumble.

As a building subsides, inside plaster cracks and falls and eventually, floors buckle and facing material falls away. As the situation worsens, total collapse of the structure may occur.

Consequences:

The impact of a specific geologic land disturbance event is based on the extent of the incident measured in terms of intensity, duration and population displaced. The hazard review continues with an examination and evaluation of consequences by specific criteria its impact on:

- THE PUBLIC – Geologic land disturbances affect those in the event area and, depending on the size and impact can affect all of the surrounding areas and the state as a whole An earthquake or sinkhole event anywhere in the state becomes a major news event covered by the TV networks and newspapers.

- RESPONDERS – Fire and police, and emergency responders are called on to evacuate people from the area, close roads, attend to the injured, and direct traffic away from the impacted area and roads. On those presidential declared disasters, emergence response costs are significant reimbursement elements.

- CONTINUITY OF OPERATIONS INCLUDING DELIVERY OF SERVICES – To continue ongoing operations overtime may be required. To date, there have been few no geologic land disturbance incidents that have shut down state, county or municipal governmental operations. Continuity of operations Plans are a requirement of the state and local governments.

- PROPERTY – Market value can be significantly reduced. Areas of known or repeated geologic land disturbance are generally shunned by new home purchasers in favor of less threatened home sites. Eligibility under the approved 2011 Hazard Mitigation Plan qualifies homeowners and businesses for FEMA Individual Assistance disaster funding.

- FACILITIES – Geologic land disturbance impact roads and bridges, schools, hospitals, in some cases directly and in others making access much more difficult. Detours and road closures also add to the cost of the event. Eligibility under the approved 2011 Hazard Mitigation Plan qualifies local governments and certain non-profit agencies for FEMA Public Assistance Recovery and Pre-Disaster Mitigation disaster funding.

- INFRASTRUCTURE – Transportation, communications and the general operation of governmental services may be effected by an incident. In predicted incidents roads and bridges would be the major infrastructure elements impacted. Eligibility under the approved 2011 Hazard Mitigation Plan qualifies local governments and certain non-profits for FEMA Public Assistance Recovery and Pre-Disaster Mitigation disaster funding

- THE ENVIRONMENT – Earthquakes, by their nature effect the environment more so than other land disturbances.

- THE ECONOMIC CONDITION OF THE STATE – An earthquake would seriously drain resources of the state, county and municipality. Even if some of the costs can be recouped through federal grant reimbursements, there is a fiscal impact on the local government.

- PUBLIC CONFIDENCE IN THE STATE'S GOVERNANCE – Governmental response, on all levels – state, county and municipal, requires immediate action must be immediate and effective to maintain public confidence. In New Jersey, the availability of the State's Open Space Green Acres funds supports immediate action to provide relief to property owners through acquisition.

Implementation

The geologic land disturbance hazard review further continues with an examination and evaluation by specific criteria dealing with the implementation of mitigation strategies as stated in the State Hazard Mitigation Plan:

- ABILITY TO PARTICIPATE IN FEDERAL, STATE, REGIONAL AND LOCAL MITIGATION PROGRAMS – The FEMA approved All Natural Hazard Mitigation Plan (as described in Sections 2.3.1 and 2.3.2 of the NJ 2011 Hazard Mitigation Plan) enables the State to participate in:
  - Public Assistance Mitigation Programs
  - Pre- and Post-Disaster Mitigation Program
  - The Fire Management Grant and
  - The Emergency Management Grant Programs.

- CAPABILITY TO IDENTIFY ONGOING MITIGATION OPPORTUNITIES AND TRACK REPETITIVE LOSSES – Only flood issues are tracked using Repetitive Loss Information.

- MAINTAINS MITIGATION GOALS, OBJECTIVES AND ACTIONS THAT SETS PRIORITIES AND RANKINGS THAT INCLUDE REDUCTION OF VULNERABILITY TO THE IDENTIFIED HAZARD AND INCLUDING A BENEFIT / COST ANALYSIS - Mitigation goals, objectives and actions are included in the Plan. The NJ State's five mitigation goals are:
  - To protect life

- To protect property
- To increase public preparedness
- Develop and maintain an understanding of natural hazard risks
- Enhance capabilities to make New Jersey less vulnerable to hazards

The above noted goals are further developed through 18 objectives and the Repetitive Loss Strategy included in Section 5.2 of the Plan.

Specific action items (included in Section 5.4.3) address each of the mitigation goals with action items include:

- Information the rationale for action
- Priority (up to 3 years)
- How the action contributes to the Mitigation Strategy
- STAPLEE Assessment of Mitigation Actions.

A Benefit / Cost Analysis is a requirement of most FEMA grant projects. The analysis is generally prepared when a project moves closer to being undertaken and costs are developed. Instructions and information on Benefit / Cost are included as a Handout of the Plan. Benefit/Cost training sessions are sponsored regularly for state and local FEMA grant application developers.

- ENCOURAGES PUBLIC / PRIVATE PARTNERSHIPS – Coordination between agencies include participation in the Hazard Mitigation Plan development by:
  - State Departments and Agencies
    - Attorney General
    - Banking and Insurance
    - Community Affairs
    - Environmental Protection
    - NJ State Police, Office of Emergency Management
    - Office of the Governor
    - Public Utilities
    - State Climatologist
    - State Geologist
    - State Office of Information Technology
    - Transportation
    - Treasury
    - Veterans Affairs
  - Intra-state agencies
    - Delaware and Raritan Canal Commission
    - Delaware River Basin Commission
    - Delaware River Basin Interstate Flood Mitigation Task Force
    - FEMA Portfolio Management
    - NJ Association of Flood Plain Managers
    - NJ Flood Mitigation Task Force
    - NJ League of Municipalities
    - Passaic River Basin Flood Advisory Commission
    - USACE Silver Jackets

- SUPPORTS PUBLIC EDUCATION AND OUTREACH – Public Education and Education is included in the plan as a mitigation strategy for most identified hazards. NJOEM prepares "handouts" on subjects of interest in response to questions raised at training and outreach sessions. Outreach sessions are conduct as FEMA grant program funding availability announcements are made. Benefit/Cost refresher training courses are given on a regular basis. NJOEM is a regular presenter at annual meetings of the NJ League of Municipalities, the NJ Association of Emergency Managers, Delaware River Greenway Partnership, etc.

4.4.15.8 Extreme Heat

Extreme summer heat is the combination of very high temperatures and exceptionally humid conditions. If such conditions persist for an extended period of time, it is called a heat wave (FEMA, 1997). Heat stress can be indexed by combining the effects of temperature and humidity, as shown in Table 4.4.11.1-1. The index estimates the relationship between dry bulb temperatures (at different humidity) and the skin's resistance to heat and moisture transfer. The higher the temperature or humidity, the higher the apparent temperature. The major human risks associated with extreme heat are as follows.

- Heatstroke: Considered a medical emergency, heatstroke is often fatal. It occurs when the body's responses to heat stress are insufficient to prevent a substantial rise in the body's core temperature. While no standard diagnosis exists, a medical heatstroke condition is usually diagnosed when the body's temperature exceeds 105°F due to environmental temperatures. Rapid cooling is necessary to prevent death, with an average fatality rate of 15 percent even with treatment.
- Heat Exhaustion: While much less serious than heatstroke, heat exhaustion victims may complain of dizziness, weakness, or fatigue. Body temperatures may be normal or slightly to moderately elevated. The prognosis is usually good with fluid treatment.
- Heat Syncope: This refers to sudden loss of consciousness and is typically associated with people exercising who are not acclimated to warm temperatures. Causes little or no harm to the individual.
- Heat Cramps: May occur in people unaccustomed to exercising in the heat and generally ceases to be a problem after acclimatization.

New Jersey has a geographic location that results in the State being influenced by wet, dry, hot, and cold airstreams, making for daily weather that is highly variable. In the summer months extreme heat is not unusual and occurs, especially in the southern portion of the state. Extreme heat is temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks. Humid or muggy conditions, which add to the discomfort of high temperatures, occur when a "dome" of high atmospheric pressure traps hazy, damp air near the ground. (CDC October, 2007). Extreme heat events can occur anywhere in the State.

Extreme heat is dangerous and can cause human related illnesses and death. These illnesses include sunburn, heat cramps, heat exhaustion, and heat stroke. In New Jersey extreme heat is responsible for approximately five deaths annually and overexposure to summer heat causes between 25 and 170 hospitalizations in New Jersey every year, depending on the average outdoor temperature. The majority of those hospitalized for this cause are male, aged 65-84, and are hospitalized for three or more days.

Additionally, less severe cases of heat-related illness send many people to hospital emergency departments or only require treatment at home (New Jersey Department of Health, Health Data Fact Sheet 2005). Figure 4.4-11-1 shows the trends in heat related hospitalizations from 1995 to 2003. As temperature goes up so do the number of people hospitalized for heat related illnesses.

Consequences:

The impact of a specific extreme heat event is based on the extent of the incident measured in terms of duration, degrees and humidity. The hazard review continues with an examination and evaluation of consequences by specific criteria its impact on:

- THE PUBLIC – An extreme heat event can affect the state as a whole An event mostly impacts the elderly, the disadvantaged, and the handicapped.

- RESPONDERS – Fire and police, and emergency responders are called on to evacuate people from extreme heat conditions, operate shelters and cooling venues and attend to the injured.

- CONTINUITY OF OPERATIONS INCLUDING DELIVERY OF SERVICES – To continue ongoing operations overtime may be required. To date, there have been few or no extreme heat incidents that have shut down state, county or municipal governmental operations. Continuity of operations Plans are a requirement of the state and local governments.

- PROPERTY – Not applicable.

- FACILITIES – Public buildings would be made available for shelters and cooling areas. Eligibility under the approved 2011 Hazard Mitigation Plan qualifies local governments and certain non-profit agencies for FEMA Public Assistance Recovery and Pre-Disaster Mitigation disaster funding.

- INFRASTRUCTURE – Not applicable.

- THE ENVIRONMENT – Extreme heat can be associated with drought and violent weather conditions. Those hazards have a greater impact on the environment that heat.

- THE ECONOMIC CONDITION OF THE STATE – Extreme heat drains resources of the state, county and municipality. Under the most dreadful heat conditions can some of the costs be recouped through federal grant reimbursements, there is a fiscal impact on the local government.

- PUBLIC CONFIDENCE IN THE STATE'S GOVERNANCE – Governmental response, on all levels – state, county and municipal, requires immediate action must be immediate and effective to maintain public confidence.

Implementation

The Extreme heat hazard review further continues with an examination and evaluation by specific criteria dealing with the implementation of mitigation strategies as stated in the State Hazard Mitigation Plan:

- ABILITY TO PARTICIPATE IN FEDERAL, STATE, REGIONAL AND LOCAL MITIGATION PROGRAMS – The FEMA approved All Natural Hazard Mitigation Plan (as described in Sections 2.3.1 and 2.3.2 of the NJ 2011 Hazard Mitigation Plan) enables the State to participate in:
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  - The Emergency Management Grant Programs.

- CAPABILITY TO IDENTIFY ONGOING MITIGATION OPPORTUNITIES AND TRACK REPETITIVE LOSSES – Only flood issues are tracked using Repetitive Loss Information.

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- To increase public preparedness
- Develop and maintain an understanding of natural hazard risks
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- Information the rationale for action
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    - Community Affairs
    - Environmental Protection
    - NJ State Police, Office of Emergency Management
    - Office of the Governor
    - Public Utilities
    - State Climatologist
    - State Geologist
    - State Office of Information Technology
    - Transportation
    - Treasury
    - Veterans Affairs
  - Intra-state agencies
    - Delaware and Raritan Canal Commission
    - Delaware River Basin Commission
    - Delaware River Basin Interstate Flood Mitigation Task Force
    - FEMA Portfolio Management
    - NJ Association of Flood Plain Managers
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    - NJ League of Municipalities
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Section 4.5 Vulnerability Assessment and Loss Estimation

4.5.1 Introduction to Vulnerability Assessment and Loss Estimation

As described in the FEMA IFR for State-level hazard mitigation planning, loss estimation forms the basis of a rational decision-making process for mitigation actions:

> "Risk Assessments [that] provide the factual basis for activities proposed in the strategy portion of the mitigation plan. Statewide risk assessments must characterize and analyze natural hazards and risks to provide a Statewide overview. This overview will allow the State to compare potential losses throughout the State and to determine their priorities for implementing mitigation measures under the strategy, and to prioritize jurisdictions for receiving technical and financial support in developing more detailed local risk and vulnerability assessments. The risk assessment shall include the following…"
>
> (ii) An overview and analysis of potential losses to the identified vulnerable structures, based on estimates provided in local risk assessments as well as the State risk assessment. The State shall estimate the potential dollar losses to State owned or operated buildings, infrastructure and critical facilities located in the identified hazard areas.

This section of the Plan focuses on hazard vulnerabilities in the State of New Jersey, and provides a detailed calculation of potential future flood losses (risk). Required information about other specific hazards are found in Subsection 4.4, and some of these include risk calculations as well as profiles.

As noted earlier, the FEMA Interim Final Rule (IFR) related to State hazard mitigation planning draws a distinction between vulnerability and loss estimation (risk). In fact, most standard definitions of risk incorporate vulnerability as a component in risk calculation. The present subsection of the New Jersey Hazard Mitigation Plan (HMP) maintains the distinction established in the IFR. In the following subsection, the Plan establishes several measures of vulnerability and uses analysis of best available data to describe vulnerabilities on both the Statewide and County levels. This subsection also includes a detailed examination of flood risk for jurisdictions across New Jersey.

4.5.2 Definitions of Vulnerability and Loss Estimation

4.5.2.1 Vulnerability

Vulnerability assessments are most often done on a site-by-site (or asset-by-asset) basis because almost all buildings, people and operations have some specific qualities that determine how much they will be damaged when hazards affect them. However, such highly specific vulnerability assessments are well outside the purview of a State Hazard Mitigation Plan. Nevertheless, there are some very effective methods for characterizing Statewide vulnerabilities. In addition to forming the basis of the State risk assessment, the results of studies such as these can be used to inform local and regional planning efforts, and to help the State set mitigation priorities.

In the context of natural hazards, vulnerability is generally defined as the degree to which something is damaged at a given level of exposure to a hazard. For example, there is a robust body of knowledge about the amount of damage that buildings will experience at different levels of flooding. There are many ways to measure or estimate vulnerabilities. These methods vary by the kinds of assets and the specific natural hazard that are being assessed. As discussed in Section 4.2, vulnerability is one of three essential parts of a risk assessment, the other two elements being value and the probability and severity of hazard impacts. Section 4.2 also discussed the three general categories of risk:

- Direct physical losses to structures, infrastructure, contents of buildings, etc.
- Injuries and deaths
- Loss of function, i.e. interruption or cessation of business or government operations

These categories are well established in FEMA rules and guidance, which are in turn based on other federal directives, such as the Interim Final Rule and the President's Office of Management and Budget (OMB) Circular No. A-94, which describes how most federal agencies are supposed to conduct analyses of the effectiveness of their programs and activities.

It is worth noting that there is a natural increase in uncertainty in vulnerability determinations as the scale of the analysis increases, so information in this subsection should be considered only a general indicator. Most information about the effects of natural hazards on the built environment is compiled on a County basis, which makes it readily adaptable to a State mitigation plan.

While vulnerability information about specific facilities (buildings, for example), would typically include a wide range of very specific data, State-level vulnerability determinations rely on more general indicators such as:

- Population, and concentrations of population
- The value of assets that may be exposed to hazards
- Records of damages to public facilities (including where they occurred)
- Percentage of State facilities in hazard areas.

Although proximity to known hazard areas is often considered a measure of vulnerability, in fact location is a determinant of probability of impact (and severity), not vulnerability, so this factor is not discussed in the present section of the HMP.

4.5.2.2 Loss Estimation (Risk Assessment)

For the purposes of this Hazard Mitigation Plan, Loss Estimation is the same as Risk Assessment. Risk is defined as *expected future losses* expressed in monetary terms. There are several well-established methods for calculating risk, and the choice of methods is generally determined by the scale of the assessment (i.e. Statewide versus a single site) and the kind of data that is available. The methodologies used in these risk assessments are explained in the individual sections below. Risk is generally limited to three categories:

- Direct physical damages to assets and contents
- Injuries and casualties
- Interruptions or loss of functions

Loss estimations are included in the hazard profiles in Subsection 4.4. In accordance with the requirements described in OMB Circular No. A-94, all the calculations use a 7% discount rate, and limit the results to those that can legitimately be counted as "benefits" in program assessments. It should be noted that the accuracy of these risk assessments is entirely dependent on the quality of data that is available to conduct them.

4.5.3 General Indicators of Vulnerability

There are three main indicators of Vulnerability:

- Number of people
- Dollar Value of structures
- Dollar losses to public structures in declared disasters

4.5.3.1 Population Demographics and Location

New Jersey has over 8.4 million residents in its 12,535 square mile area, making it the most densely populated State in the nation. This figure represents an increase of nearly nine percent from the 1990 census. The oceanfront counties of Monmouth, Ocean, Atlantic and Cape May have a permanent population of over 1.3 million, while the Delaware Bay shore counties of Cumberland and Salem have a permanent population of over 200,000. In addition, the areas affected by riverine flooding, including Bergen, Essex, Hudson, Mercer, Middlesex, Somerset and Union counties have a permanent population of almost 3.8 million people.

As noted earlier, in many cases population and population density offer insight into vulnerabilities, particularly where populations are concentrated in areas that are subject to natural hazards. Table 4.5.3-1 below is from the 2008 version of the New Jersey Hazard Mitigation Plan, and shows New Jersey population projections by county.

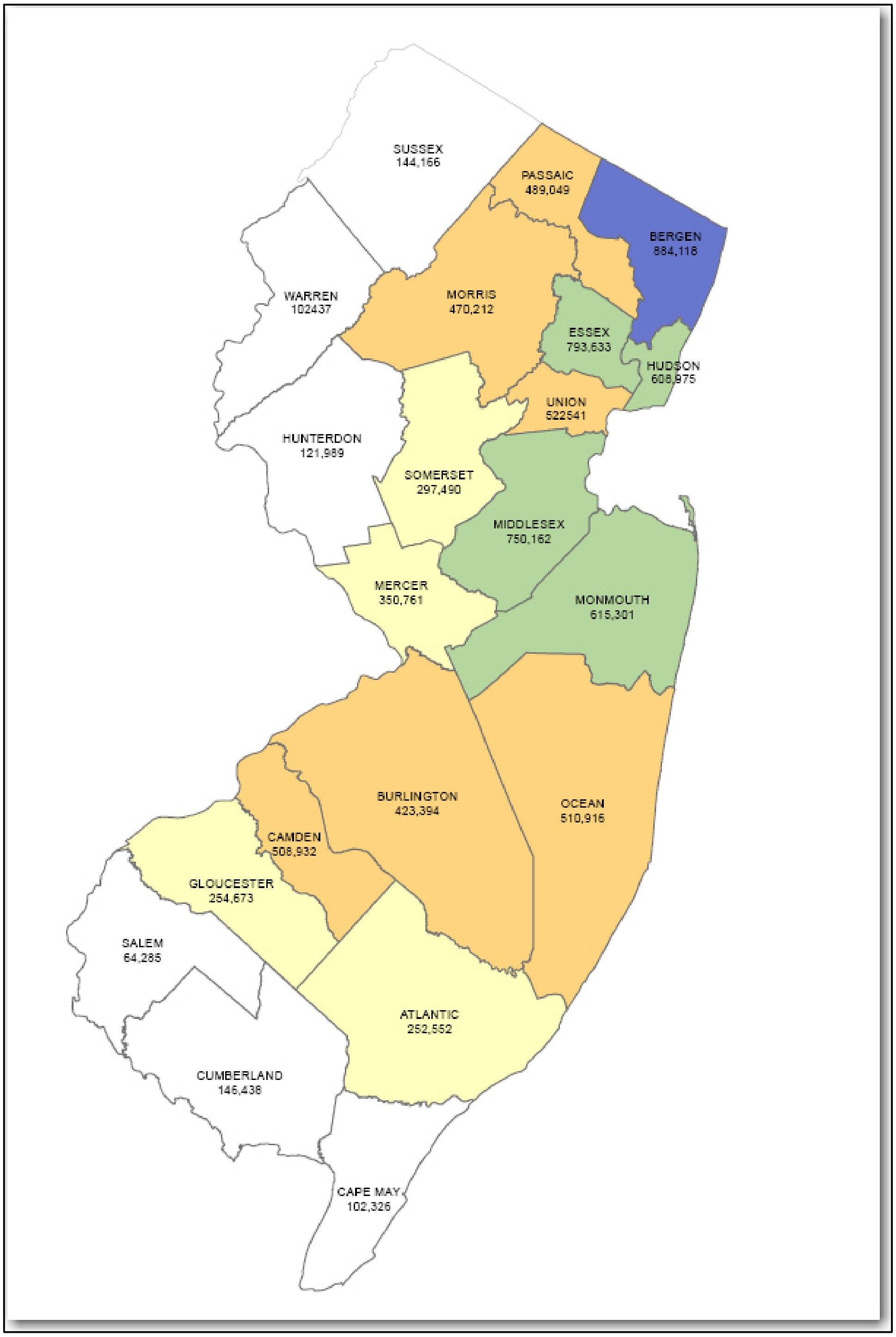
Table 4.5.3-1
New Jersey Population Projections by County

Sources: New Jersey Department of Labor 2003; North Jersey Transportation Authority for Bergen, Essex, Hudson, Hunterdon, Middlesex, Monmouth, Morris, Ocean, Passaic, Somerset, Sussex, Union. and Warren Counties 2003; South Jersey Transportation Organization for Atlantic, Cape May, Cumberland, and Salem Counties 2003; Delaware Valley Regional Planning Commission for Burlington, Camden., Gloucester and Mercer Counties 2003

	Census on April 1,		NJDOL Projections to July 1,			MPO Projections			
County	1990	2000	2005	2015	2020	2005 Forecast	2015 Forecast	2020 Forecast	2025 Forecast
Bergen	825,380	884,118	904,900	948,000	975,500	896,181	923,745	937,051	950,844
Hudson	553,099	608,975	624,100	678,400	700,200	629,951	688,258	704,007	733,161
Passaic	453,302	489,049	504,500	532,700	551,300	501,305	519,511	526,785	533,371
Sussex	130,943	144,166	151,400	166,500	176,700	148,537	162,130	164,760	171,103
Essex	777,964	793,633	811,700	868,900	896,200	805,291	834,165	844,099	858,741
Morris	421,361	470,212	488,900	523,300	540,800	481,289	513,196	529,781	542,886
Union	493,819	522,541	536,200	563,300	579,800	527,115	534,745	538,459	542,512
Warren	91,607	102,437	110,000	121,600	128,300	106,819	119,055	125,873	130,257
Hunterdon	107,802	121,989	128,200	140,500	147,700	129,173	148,125	158,736	167,449
Middlesex	671,811	750,162	793,700	869,200	910,600	779,191	844,329	859,268	894,402
Somerset	240,245	297,490	319,700	361,000	384,600	308,283	341,393	363,364	376,053
Mercer	325,824	350,761	363,400	380,200	395,700	362,090	385,530	395,970	404,850
Monmouth	553,093	615,301	643,200	691,000	719,400	657,072	687,320	703,494	731,557
Ocean	433,203	510,916	551,700	633,000	677,000	527,010	558,961	574,279	590,081
Burlington	395,066	423,394	446,100	481,100	505,700	438,780	476,550	496,490	513,450
Camden	502,824	508,932	515,000	536,400	550,500	511,770	512,790	514,760	513,530
Gloucester	230,082	254,673	267,800	292,300	309,500	265,500	292,940	308,330	322,520
Atlantic	224,327	252,552	263,500	286,300	296,700	266,316	295,766	311,451	330,367
Cape May	95,089	102,326	103,200	104,900	107,500	106,518	114,863	119,019	123,066
Cumberland	138,053	146,438	149,600	155,700	159,200	152,276	167,453	174,479	181,481
Salem	65,294	64,285	64,900	66,400	67,700	64,446	66,435	67,271	67,500
Statewide	**7,730,188**	**8,414,700**	**8,4741,700**	**9,400,700**	**9,780,600**	**8,664,913**	**9,817,258**	**9,417,726**	**9,679,180**

Figure 4.5.3.1-1 shows the population of all Counties in the State of New Jersey. Population is a relatively reliable and straightforward proxy for vulnerability because the presence of large numbers of people by itself creates risk from injuries and deaths, and also implies the presence of manmade assets and operations, the exposure of which to hazards creates risk.

Figure 4.5.3.1-1
Graphical Depiction of County Population,
State of New Jersey



4.5.3.2 Value and Exposure of Assets (Structures) and Contents Statewide

As noted earlier, ignoring variations in exposure to hazards, a key measure of vulnerability is simply the value of various assets Statewide that are exposed to hazards. Although this metric does not directly quantify from HAZUS (Hazards U.S., the FEMA risk assessment software). HAZUS uses the insurance term *exposure* for the value of assets, Assets include both structures and contents, and the dollar figures for the different classes (e.g. residential, agriculture, etc.) are part of the database underlying the HAZUS software. In a full risk calculation, HAZUS uses vulnerability information, it is a key component in any risk calculation, as a general indicator of potential loss. Data in the next table (4.5..3-1) shows the total value of structural and contents assets for all counties in New Jersey, ordered by total value.

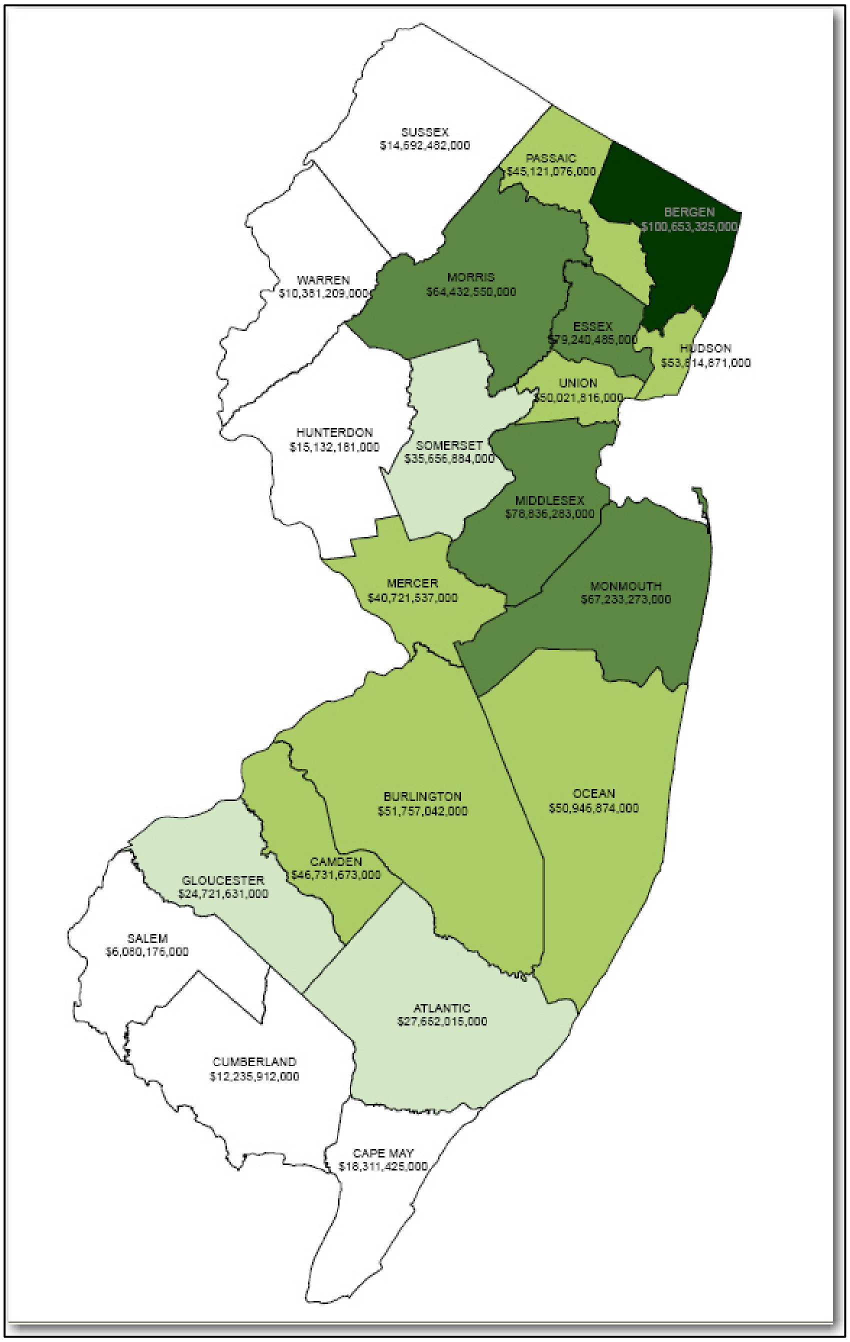
Table 4.5.3.2-1
Exposure (Value) Of Assets And Contents In New Jersey By Land Use Type, Sorted By Total Value

CO	Residential	Commercial	Industrial	Agriculture	Education	Government	Religious	Total
BE	$71,286,615,000	$20,729,149,000	$6,349,758,000	$128,554,000	$1,013,166,000	$343,583,000	$802,500,000	$100,653,325,000
MI	$56,158,892,000	$15,473,435,000	$5,333,036,000	$106,606,000	$1,024,059,000	$320,120,000	$824,337,000	$79,240,485,000
ES	$55,926,456,000	$15,341,625,000	$5,437,665,000	$106,606,000	$906,746,000	$292,848,000	$824,337,000	$78,836,283,000
MR	$51,139,977,000	$11,857,457,000	$2,818,921,000	$201,415,000	$454,813,000	$206,510,000	$554,180,000	$67,233,273,000
MN	$48,570,222,000	$11,266,338,000	$3,214,894,000	$195,557,000	$455,704,000	$201,208,000	$528,627,000	$64,432,550,000
HD	$36,072,515,000	$14,087,688,000	$2,445,376,000	$13,892,000	$497,565,000	$79,195,000	$618,640,000	$53,814,871,000
UN	$36,239,637,000	$11,707,425,000	$2,372,047,000	$609,120,000	$250,395,000	$123,210,000	$455,208,000	$51,757,042,000
BU	$37,789,825,000	$10,457,448,000	$1,371,565,000	$603,173,000	$243,119,000	$101,950,000	$379,794,000	$50,946,874,000
CA	$37,720,752,000	$8,689,025,000	$2,585,581,000	$63,443,000	$344,167,000	$120,087,000	$498,761,000	$50,021,816,000
OC	$37,589,243,000	$6,806,591,000	$1,438,328,000	$51,638,000	$340,608,000	$107,471,000	$397,794,000	$46,731,673,000
PA	$32,290,303,000	$8,432,506,000	$3,306,420,000	$51,096,000	$289,718,000	$234,331,000	$516,702,000	$45,121,076,000
ME	$28,489,113,000	$7,015,330,000	$1,328,580,000	$50,726,000	$2,925,936,000	$422,792,000	$489,060,000	$40,721,537,000
SO	$26,535,205,000	$6,278,643,000	$1,959,663,000	$69,474,000	$402,613,000	$111,328,000	$299,958,000	$35,656,884,000
AT	$21,246,799,000	$4,773,038,000	$617,441,000	$49,260,000	$511,721,000	$196,074,000	$257,682,000	$27,652,015,000
GL	$18,857,500,000	$3,497,256,000	$1,761,208,000	$80,902,000	$235,982,000	$56,173,000	$232,610,000	$24,721,631,000
CM	$15,830,334,000	$2,019,397,000	$168,963,000	$20,324,000	$68,484,000	$41,701,000	$162,222,000	$18,311,425,000
SU	$11,892,557,000	$2,132,672,000	$705,032,000	$65,582,000	$142,649,000	$40,635,000	$153,054,000	$15,132,181,000
HN	$11,560,317,000	$2,124,176,000	$597,985,000	$65,582,000	$151,716,000	$39,652,000	$153,054,000	$14,692,482,000
CU	$9,248,998,000	$1,801,904,000	$831,467,000	$50,728,000	$86,029,000	$57,162,000	$159,624,000	$12,235,912,000
WA	$8,167,150,000	$1,499,989,000	$366,838,000	$42,054,000	$182,016,000	$23,010,000	$100,152,000	$10,381,209,000
SA	$4,672,675,000	$887,637,000	$303,289,000	$28,204,000	$51,606,000	$28,537,000	$108,228,000	$6,080,176,000
TOT	$657,285,085,000	$166,878,729,000	$45,314,057,000	$2,653,936,000	$10,578,812,000	$3,147,577,000	$8,516,524,000	$894,374,720,000

This information was extracted in combination with other data (such as damage functions, probabilities, etc.) to determine the amount of damage that can be expected under various hazard scenarios. Although it is not used in that manner in the present section, the value of structures and assets is a very general proxy for vulnerability on a County level.

Exposure (value) of Assets and Contents in New Jersey by Land Use Type, Sorted by Total Value
(Source: FEMA HAZUS) [ref: NJMHP2 structure exposure_HAZUS data sorted_122607_with sum]

Figure 4.5.3.2-1
Total Value of Assets in New Jersey Counties



4.5.3.3 FEMA Public Assistance Program Project Worksheets

The third method for conducting a general assessment of vulnerabilities at the State level is to analyze FEMA Public Assistance (PA) Program Project Worksheets (PWs). Following Presidentially-declared disasters, FEMA engineers visit damage sites and prepare reports (PWs) that describe the damages and estimate the costs to repair them. The PWs are the first step in the process of applicants receiving FEMA grant funds for repairs. The PWs are entered into a database with key information parameters, such as date of loss, amount of loss, how much insurance was paid, etc. The database is a good source of information about damages to public facilities throughout the State.

As part of the 2008 Plan update, the State of New Jersey contacted FEMA Region II and requested PW records. The Region provided detailed records for the six declared Presidentially-(from 9/99 to 4/07) disasters. These are summarized in tables below. Appendix D includes detailed descriptions of these events.

Table 4.5.3.3-1
Summary of Recent Presidentially-declared Disasters in New Jersey
(six recent disasters for which data was provided by FEMA Region II)

FEMA Disaster #	Disaster Date	# Counties	Type of Disaster
DR-1295	09/18/1999	9	Hurricane Floyd
DR-1337	08/17/2000	2	Severe storms, flooding and mudslides
DR-1530	07/16/2004	2	Severe storms and Flooding
DR-1563	10/01/2004	4	Tropical Depression Ivan
DR-1653	07/07/2006	3	Severe storms and Flooding
DR-1694	04/26/2007	12	Severe storms and Flooding

Note: Information on 2009 and 2010 disasters was not available at the time of publication.

Table 4.5.3.3-2 summarizes the project worksheet data from these six disasters. Appendix P includes summary spreadsheets on each of these six disasters, showing the data underlying this summary. Note that in performing the analysis, NJOEM included what were presumed to be insurance payments to the applicants that would normally be deducted from PW amounts under duplication of benefits rules applied by FEMA. In this case these amounts are included because they reflect total losses regardless of who paid them. This is considered a more accurate figure than the FEMA PWs alone.

Table 4.5.3.3-2
Losses by New Jersey County from Recent Presidentially-Declared Disasters,
all FEMA Public Assistance Categories, ordered by Amount of Loss
(Source: FEMA Region II, September 2007)

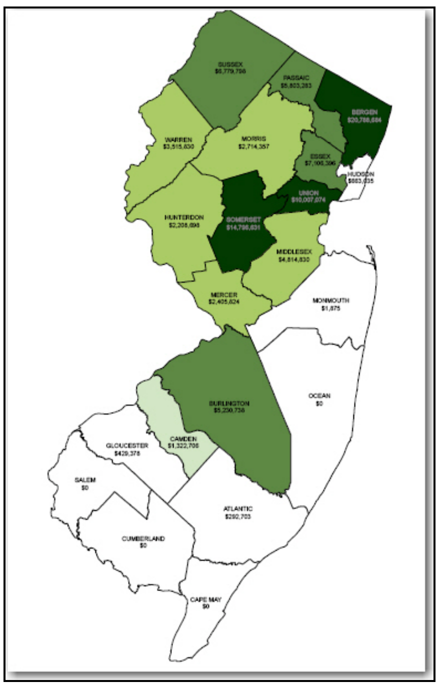
County	DR-1295	DR-1337	DR- 1530	DR-1563	DR-1653	DR-1694	Total
Bergen	$15,886,075	$0	$0	$0	$0	$4,902,608	**$20,788,683**
Somerset	$12,556,858	$28,383	$0	$0	$0	$2,211,389	**$14,796,630**
Union	$8,629,782	$0	$0	$0	$0	$1,377,291	**$10,007,073**
Essex	$5,228,770	$0	$0	$0	$0	$1,877,623	**$7,106,393**
Sussex	$102,213	$6,018,541	$0	$167,252	$13,451	$478,339	**$6,779,796**
Passaic	$3,754,788	$0	$0	$0	$0	$2,048,494	**$5,803,282**
Burlington	$0	$0	$4,140,560	$0	$0	$1,090,170	**$5,230,730**
Middlesex	$2,383,231	$0	$0	$0	$0	$2,431,601	**$4,814,832**
Warren	$158,978	$0	$0	$2,981,911	$213,099	$161,839	**$3,515,827**
Morris	$2,074,306	$640,050	$0	$0	$0	$0	**$2,714,356**

Mercer	$701,307	$0	$0	$358,633	$788,499	$557,387	**$2,405,826**
Hunterdon	$1,619,290	$0	$0	$322,836	$266,573	$0	**$2,208,699**
Camden	$0	$0	$369,476	$0	$0	$953,235	**$1,322,711**
Hudson	$20,877	$0	$0	$0	$0	$642,157	**$663,034**
Gloucester	$0	$0	$179,795	$0	$0	$249,584	**$429,379**
Atlantic	$0	$0	$0	$0	$0	$292,703	**$292,703**
Monmouth	$0	$0	$0	$0	$0	$1,875	**$1,875**
Total	**$53,116,475**	**$6,686,974**	**$4,689,831**	**$3,830,632**	**$1,281,622**	**$19,276,295**	**$88,881,829**

Note: Cape May, Cumberland, Ocean and Salem Counties were not in the data provided by FEMA Region II, presumably because they were not included in the Presidential disaster declarations.

Figure 4.5.3.3-1 graphically depicts the data in the table above.

Figure 4.5.3.3-1
Total Dollar Value of Losses Reported through FEMA Public Assistance Program Records for Six most Recent Declared Disasters



Although FEMA Public Assistance records cannot be used to draw a direct inference about vulnerabilities, where there is a sufficient amount of data they nevertheless offer an alternative way to study where damages are most likely to occur, based on past experience. In the context of a hazard mitigation plan, risk and its component vulnerability are closely related to the presence of manmade assets, people and operations. Because of this, areas that are heavily developed and populated tend to be the most at risk, other factors being equal. Of course, not all other factors are equal, and the exposure to the hazards, effective use of development controls, and so forth, can significantly alter the potential for damages from hazards when they do impact an area.

4.5.4 Flood Vulnerabilities

4.5.4.1 Flood Vulnerability Measure 1: County Land Area in FEMA-Designated A, V, and X Flood Zones

Given that flooding is the most significant natural hazard in New Jersey, the primary method of assessing vulnerability to this hazard on a Statewide basis is to determine the potential exposure to flooding as measured by the amount of land area that is in FEMA-designated floodplains. The information in the following four tables is drawn from GIS analysis of FEMA "Q3" and Digital Flood Insurance Rate Maps (DFIRMs). These types of maps generally represent the best available data for general analysis of flood risk, i.e. loss estimation over a broad geographic area. Similar data is used in the Risk Assessment section of this Plan. Note that the information in these tables can be obtained by local, County and regional jurisdictions by contacting NJOEM.

The tables below order data by area in "A", "V", and "X" flood zones by area, and by percentage of County land in the two zone designations. The area figure has more utility as a Statewide comparative measure of vulnerability, whereas the percentage figure may be more useful as a measure of vulnerability internal to the Counties. It is important to recognize that the figures do not suggest that the Counties with the highest areas or percentages in the zones are at more risk, because there is no indicator of how many manmade assets (and operations) are in the zones. These metrics are discussed in more detail in the Risk Assessment section of the Plan.

Table 4.5.4.1-1
Land Area and Percentage of County in FEMA-designated "A" Flood Zones, New Jersey Counties, ordered by Number of Acres in Zone.

County	Acres in A Zones	Percentage of County in A Zones
Atlantic	127,638	32.46%
Ocean	126,426	25.89%
Cumberland	103,661	31.56%
Burlington	98,372	18.77%
Cape May	86,413	46.43%
Salem	79,043	33.18%
Morris	41,832	13.61%
Gloucester	35,402	16.43%
Bergen	34,082	20.32%
Middlesex	28,759	13.92%
Monmouth	26,437	8.52%
Sussex	25,350	7.38%
Somerset	20,029	10.26%
Passaic	15,816	12.55%
Mercer	15,564	10.65%
Hunterdon	14,546	5.19%
Hudson	14,025	35.59%
Warren	13,212	5.69%
Essex	13,165	15.89%
Camden	9,907	6.80%
Union	8,578	6.76%
Statewide	**938,258**	

Figure 4.5.4.1-1
Land Area and Percentage of Counties in New Jersey In FEMA-designated "A" Flood Zones,

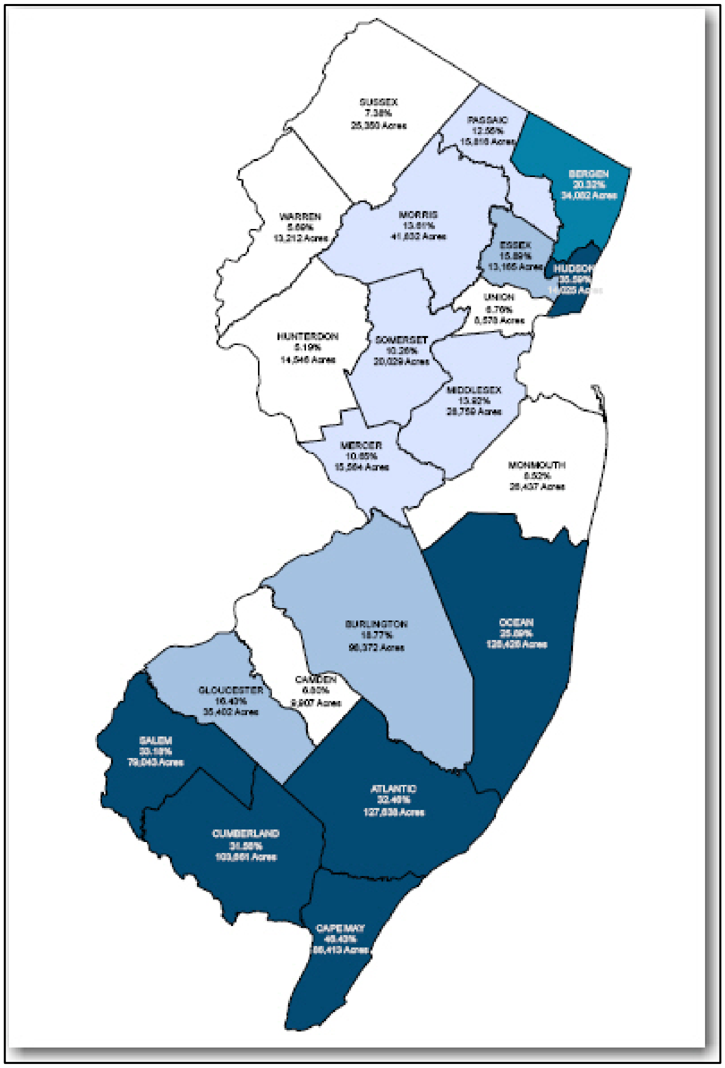
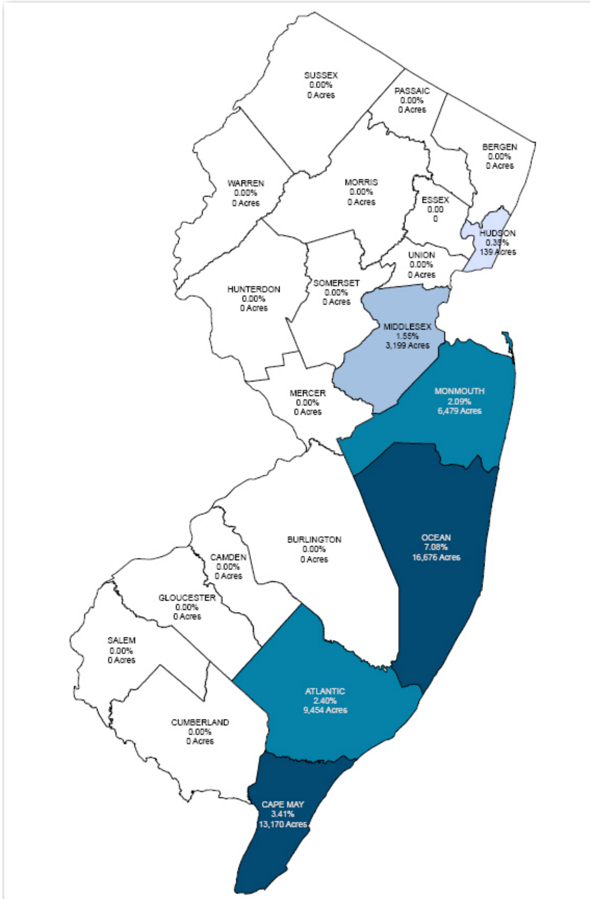


Table 4.5.4.1-2
Land Area and Percentage of County in FEMA-designated "V" and "VE" Flood Zones, New Jersey Counties, ordered by Area in Acres (non-zero Counties only)

County	Acres in V and VE Zones	% in V and VE Zones
Ocean	16,675	3.41%
Cape May	13,170	7.08%
Atlantic	9,454	2.40%
Monmouth	6,479	2.09%
Middlesex	3,199	1.55%
Hudson	139	0.35%
Totals	**49,118**	

Figure 4.5.4.1-2
Land Area and Percentage of Counties in New Jersey
In FEMA-designated "V" and "VE" Flood Zones



4.5.4.2 Flood Vulnerability Measure 2: Land Uses in FEMA-Designated Flood Zones

Using GIS technology and open-source data, NJOEM compiled data about the range of land uses in New Jersey, and the area of these land uses that is in FEMA-designated floodplains. Although this information is not absolutely complete (and the uncertainty in it cannot be accurately characterized), it nevertheless offers a good supplement to other data in this section. Table 4.5-7 summarizes the results of the analysis.

Note that the source dataset included a much larger range of land uses than what is shown in these tables. These included a variety of open-space and differentiated forest and wildland areas that are not normally considered "at risk" when they are exposed to natural hazards, so they were removed from the list in this analysis. It should also be noted that some similar land uses were combined in order to simplify the analysis and results. For example, there were numerous sub-categories of "residential" land uses (single-family, multi-family, etc.), for which these distinctions are irrelevant in vulnerability assessments.

Table 4.5.4.2-1
Areas of Selected New Jersey Land Uses in FEMA Flood Zones (in acres), ordered alphabetically by Land Use

Land Use	A Area of special flood hazard	D Undetermined	V and VE With tidal velocity	X and X-500 Moderate	Total
Agriculture	102,791	839	15	559,657	**663,303**
Airport Facilities	1,466	0	0	1,579	**3,045**
Altered Lands	33	0	0	28	**60**
Commercial/Services	16,406	1,274	146	111,894	**129,720**
Extractive Mining	1,618	15	11	16,172	**17,816**
Industrial	15,398	118	29	50,500	**66,045**
Major Roadway	2,086	10	17	17,736	**19,847**
Residential	96,991	4,761	671	811,098	**913,521**
Stadiums, Theaters, Cultural, Zoos	365	0	0	806	**1,171**
Stormwater Basin	78	0	0	1,055	**1,133**
Transportation, Communications, Utilities	11,720	952	100	25,281	**38,053**
Urban	19,235	858	42	71,267	**91,401**
Total	**268,186**	**8,826**	**1,032**	**1,667,072**	**1,945,116**

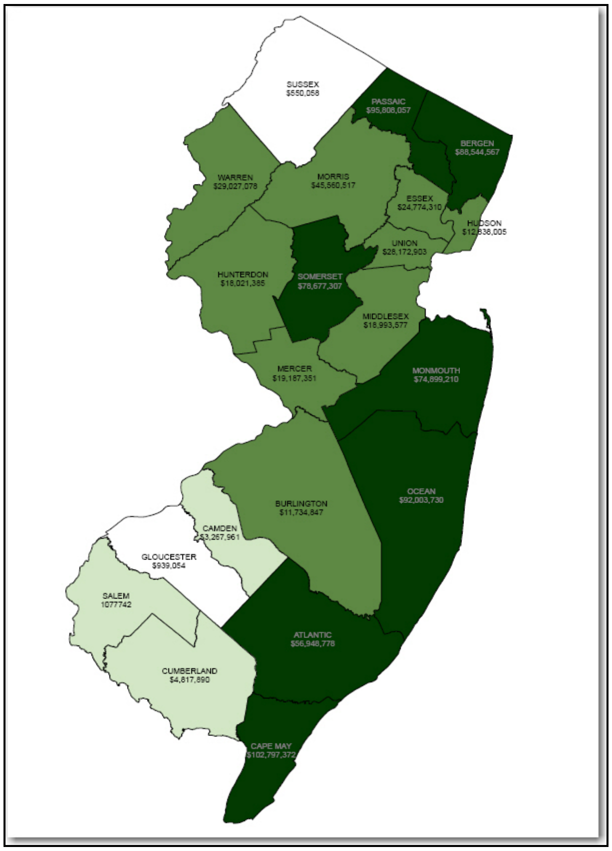
4.5.4.3 Flood Vulnerability Measure 3: Analysis of FEMA National Flood Insurance Program Records

Table 4.5.4.3-1
Selected Data Parameters Related to Flood Insurance Claims in the State of New Jersey, 1979-2007, ordered by Dollar Amount of Total Historical Claims
[Source: FEMA Headquarters, query June 30, 2007)

County	# Historical Claims	Total Historical Claims	Average Claim
Cape May	15,599	**$102,797,372**	$6,590.00
Passaic	7,921	**$95,808,057**	$12,095.45
Ocean	12,765	**$92,003,730**	$7,207.50
Bergen	6,304	**$88,544,567**	$14,045.78
Somerset	3,121	**$78,677,307**	$25,209.01
Monmouth	7,079	**$74,899,210**	$10,580.48
Atlantic	8,464	**$56,948,778**	$6,728.35
Morris	4,977	**$45,560,517**	$9,154.21
Warren	1,034	**$29,027,078**	$28,072.61
Union	3,317	**$28,172,903**	$8,493.49
Essex	2,646	**$24,774,310**	$9,362.93
Mercer	1,710	**$19,187,351**	$11,220.67
Middlesex	1,782	**$18,993,577**	$10,658.57
Hunterdon	947	**$18,021,385**	$19,029.97
Hudson	1,034	**$12,838,005**	$12,415.87
Burlington	1,077	**$11,734,847**	$10,895.87
Cumberland	644	**$4,817,890**	$7,481.20
Camden	894	**$3,267,961**	$3,655.44
Salem	399	**$1,077,742**	$2,701.11
Gloucester	299	**$939,054**	$3,140.65
Sussex	108	**$550,058**	$5,093.13
Total	**82,121**	**$808,641,699**	

The next measure of flood vulnerability discussed in this Plan is FEMA National Flood Insurance Program (NFIP) records. New Jersey has one of the highest rates of claims payments of any State in the U.S. In addition to suggesting a high level of risk (discussed here and in the Risk Assessment section of this Plan), the data accumulated by the NFIP over the more than 30 years of its history offers a rich source of information that can be used to inform the vulnerability assessment.

Figure 4.5.4.3-1
Historic flood claims in the State of New Jersey,
1979-2007, ordered by Dollar Amount of Total Historical Claims
[Source: FEMA Headquarters, query June 30, 2007)



There are several results of this table that have some bearing on the State's vulnerability to the flood hazard. First, the total amount and number of historical claims are perhaps the best measures of vulnerability because they indicates the amount of monetary losses and claims experienced in the various Counties over a relatively long period of time. Second, the average amount of claims may be even a more significant measure of vulnerability because it often indicates the relative severity of events (deeper water, or faster-moving water tends to cause more damages, and these are measures of severity for floods). Note that Somerset and Warren Counties in the table above have relatively high average claims. The most common reason for very high average claims is that only one or two very significant events impacted an area, and that there have been relatively few minor events that would bring the average closer to the Statewide mean. This is discussed in more detail in the Risk Assessment Section, but is nonetheless a valid indicator of vulnerability to floods.

It should be noted that damages related to flooding may be under-represented in these figures for various reasons, such as the fact that not all citizens and businesses are insured, that losses that are not covered by insurance (such as those to government operations, or ones that are simply not included in policy coverages) are not represented, and that some policyholders may have been under-insured.

4.5.4.4 Flood Vulnerability Measure 4: HAZUS Critical Facilities in Floodprone Areas

This vulnerability measure is based on information about critical facilities that are represented in the FEMA HAZUS database. As shown in a State query of HAZUS indicates that New Jersey has 3,754 critical facilities in the categories shown in the left column (Type). Of these, 54 are in FEMA-designed A (various iterations of A, including AO, etc.), V and VE zones. The majority of facilities are in X-zones. The abbreviation ANI indicates "area not included", meaning that the flood zone designation was not available through GIS resources. In addition to the ANI designations, there were numerous null fields for flood zone designation in the database – these were merged with the ANI designations.

Table 4.5.4.4-1
Selected HAZUS Critical Facilities and FEMA Flood Zone Designations

Facility Type	A zone	V or VE Zone	X zone	X500 zone	ANI/na	Total
Police Stations	6	1	503	15	76	**601**
Fire Stations	8	1	630	23	80	**742**
EOCs	2	0	117	9	2	**130**
Health Care	3	0	84	2	10	**99**
Hazmat Sites	35	0	1,502	106	539	**2,182**
Total	**54**	**2**	**2,836**	**155**	**707**	**3,754**

Section 4.6 Jurisdictions most Threatened, and most Vulnerable to Damage and Loss

Flooding is the greatest hazard threatening the State of New Jersey.

- Annual flooding in the Passaic, Raritan and Delaware River Basins has been recognized and been the subject of the Governor's initiatives and Tasks forces. The vulnerability of communities such as Wayne, Little Falls and Pompton Lakes on the Passaic River; Bound Brook and Manville on the Raritan River; and Harmony and Lambertvile on the Delaware are among the most vulnerable municipalities in the State.
- Coastal storms on New Jersey's shore communities can wreak tremendous devastation. Although the last major coastal storm struck New Jersey in 1962, efforts are continuously underway to protect the shoreline, enhance the dunes and provide safe evacuation routes while at the same time offer homeowners mitigation assistance through acquisition under the Coastal Blue Acres Program and elevation with FEMA funded assistance.

Holding other factors constant, jurisdictions with the most assets, infrastructure and people are the most vulnerable to damage and loss. However, for the most significant hazards in New Jersey, the exposure to hazards is related to location and elevation, and by definition varies from place to place. Flooding is clearly the hazard that has caused the most damage to the State, and has the most potential for future damage (risk). The subsection on Flood Hazard Identification and Profiling describes this in detail.

Table 4.6-1 summarizes some of the metrics used in this Plan to characterize risk from natural hazards. As discussed in various other parts of the document, some of these figures (such as exposure and the percentages of Counties in flood zones) are measures of vulnerability, while others (such as the hurricane wind column) are actual risk calculations. Sections 4.4 and 4.5 include much more detailed explanations of these figures and how they should be used by the State and Counties in the context of hazard mitigation activities. This table is intended to provide a "snapshot" of various hazard parameters in order to comply with the requirements of the IFR, and to very generally identify where the State may want to assign higher priorities to mitigation activities and strategies.

It should be noted that not all of the hazards that are profiled earlier in this section are included on this list because there are no useful metrics to include in the table, and potential exposure is relatively uniform across the State.

Table 4.6-1
Summary of Counties Most Threatened by Natural Disasters by Selected Data Parameters

County	$ Exposure [1000s]	% County A Zone	% County V Zone	NFIP Claims	# SRL Properties	FEMAS PA $ Losses	Hurricane Wind [1000s]	Earthquake {1000s]
AT	$27,652,015	32.46%	2.40%	8,464	5	$292,703	$340,118	$801,908
BE	$100,653,325	25.89%	0.00%	6,304	7	$20,788,683	$259,873	$2,918,946
BU	$50,946,874	31.56%	0.00%	1,077	0	$5,230,730	$82,894	$1,477,459
CA	$50,021,816	18.77%	0.00%	894	13	$1,322,711	$94,436	$1,450,633
CM	$18,311,425	46.43%	7.08%	15,599	2	$0	$347,237	$531,031
CU	$12,235,912	33.18%	0.00%	644	17	$0	$11,902	$354,841
ES	$78,836,283	13.61%	0.00%	2,646	11	$7,106,393	$200,477	$2,286,252
GL	$24,721,631	16.43%	0.00%	299	18	$429,379	$47,378	$716,927
HD	$53,814,871	20.32%	0.35%	1,034	15	$663,034	$142,528	$1,560,631
HN	$14,692,482	13.92%	0.00%	947	10	$2,208,699	$38,616	$426,082
ME	$40,721,537	8.52%	0.00%	1,710	14	$2,405,826	$67,354	$1,180,925
MI	$79,240,485	7.38%	1.55%	1,782	12	$4,814,832	$843,336	$2,297,974
MN	$64,432,550	10.26%	2.09%	7,079	9	$1,875	$770,679	$1,868,544
MR	$67,233,273	12.55%	0.00%	4,977	3	$2,714,356	$143,627	$1,949,765
OC	$46,731,673	10.65%	3.41%	12,765	6	$0	$753,916	$1,355,219
PA	$45,121,076	5.19%	0.00%	7,921	1	$5,803,282	$123,498	$1,308,511
SA	$6,080,176	35.59%	0.00%	399	0	$0	$12,420	$176,325
SO	$35,656,884	5.69%	0.00%	3,121	8	$14,796,630	$91,055	$1,034,050
SU	$15,132,181	15.89%	0.00%	108	0	$6,779,796	$44,528	$438,833
UN	$51,757,042	6.80%	0.00%	3,317	16	$10,007,073	$142,355	$1,500,954
WA	$10,381,209	6.76%	0.00%	1,034	4	$3,515,827	$30,728	$301,055

Section 4.7 Vulnerabilities of State Owned and Operated Facilities

4.7.1 State Owned and Operated Facilities

The State of New Jersey does not have a comprehensive GIS mapping database of State owned and leased facilities. The Department of Treasury is continually updating its GIS mapping capabilities for State owned and leased facilities. The Office of Management and Budget within the Department of Treasury has developed a centralized Statewide Land and Building Asset Management Database (LBAM) that is currently being populated with an updated and expanded inventory of land, building improvements, infrastructure and inspections data. State agencies maintaining facilities included in LBAM include:

- Department of Corrections
- Department of Environmental Protection
- Juvenile Justice Commission
- Military and Veterans' Affairs
- Office of Counter Terrorism
- Transportation
- Department of Treasury

While extremely imprecise, the State Office of Emergency Management currently has the capability to apply general county hazard lists to a text listing of State owned and leased property, sorted by county, to provide a rudimentary analysis of State facilities that are vulnerable to hazards. The State of New Jersey, through its Department of Treasury is currently working with the state's casualty insurers and others to determine the value of State infrastructure.

In conducting the 2008 Plan update, the State and consultant team met with representatives of the State Department Treasury, and obtained the most current version of the LBAM database. Although there appears to be progress in populating the various fields, a review and analysis of the data indicates that most facilities are not geocoded, and significant data fields for the majority of State-owned facilities are not sufficiently populated to allow NJOEM to determine if the facilities are in hazardous areas. Although the State expects to continue progress on populating these fields, staffing and financial constraints will likely limit this effort.

NJOEM is aware that one of the most important elements of the State HMP is to identify and prioritize State owned and operated facilities that may be at risk from the impacts of natural hazards. As noted in the Mitigation Strategy section, NJOEM intends to initiate a process to contact all major State agencies to request them to identify facilities that they consider critical, based on objective criteria such as function, numbers of people in buildings, size of facilities. The survey will also request information about known vulnerabilities to natural hazards. The information collected in this process will allow NJOEM to prioritize facilities for additional study and data collection, depending on resources.

During the HMP update process, members of the planning team also contacted State staff responsible for matters related to insurance coverage for State facilities. Although this is potentially a rich source of information, the State does not presently keep any detailed records of past damages or insurance claims, either from the self-insurance fund or from reinsurance claims. As noted in Section 4.5 of this Plan, FEMA Region II provided detailed records of damages to public facilities during the last six Presidentially-declared disasters in the State. Table 4.7-1 shows data for New Jersey State agencies that applied for FEMA Public Assistance Grant Applications for six recent disasters. This information clearly does not identify the exact facilities that were damaged in the events (the large majority of damages are related to flooding). However, it does give a general sense of the level of damage to State-owned and operated facilities for the various FEMA Public Assistance categories.

Table 4.7-1
Summary of FEMA Public Assistance Grant Application Amounts for Six Recent Disasters

Disaster	Category A	Category B	Category C	Category D	Category E	Category F	Category G	Total
DR-1694	$21,019	$2,959,810	$95,290	$47,600	$111,517	$0	$209,583	**$3,444,819**
DR-1653	$117,294	$1,363,469	$0	$0	$0	$0	$0	**$1,480,763**
DR-1563	$27,108	$658,701	$344,167	$0	$495,967	$40,700	$10,426	**$1,577,069**
DR-1530	$61,083	$659,490	$480,610	$332,107	$235,068	$0	$180	**$1,768,538**
DR-1337	$0	$3,283	$0	$199,689	$38,807	$0	$0	**$241,779**
DR-1295	$938,911	$3,439,527	$336,040	$465,194	$289,189	$52,402	$1,975,249	**$7,496,512**
Total	**$1,165,415**	**$9,084,280**	**$1,256,107**	**$1,044,590**	**$1,170,548**	**$93,102**	**$2,195,438**	**$16,009,480**

The FEMA Public Assistance categories are generally defined as follows

- Category A: Emergency work, primarily debris clearance.
- Category B: Emergency protective measures.
- Category C: Permanent repair work, roads and bridges.
- Category D: Permanent repair work, water control facilities.
- Category E: Permanent repair work, public buildings.
- Category F: Permanent repair work, utilities.
- Category G: Permanent repair work, parks and recreation facilities.

Source: FEMA.gov

Table 4.7-2 shows the dollar amounts of damages to facilities that appear to be State-owned or -operated, based on the applicants listed on the Project Worksheet summaries provided by FEMA Region II. With additional research it would be possible to identify the exact facilities that were damaged and the nature of the damage to them. However, because flood damages are highly related to specific sites, such information would offer only limited insight into vulnerabilities, except insofar as certain facilities have been damaged repeatedly.

4.7.2 Critical Facilities

Included in Appendix Maps of HAZUS Critical Facilities Statewide

i. Statewide Emergency Center Locations
ii. Statewide Dam Locations
iii. Statewide HAZMAT Locations
iv. Statewide Police Stations
v. Statewide Fire Station Locations
vi. Statewide Care Facilities

The Mitigation Action described on Page 31 of Section 5 calls for the compilation of "a GIS-based inventory of critical facilities statewide. The Department of the Treasury, through its Land and Building Assets Management (LBAM) inventory is in the process of coordinating the LBAM inventory with the comprehensive Geographical Inventory System (GIS) maintained by the Department of Environmental Protection. With such coordination in place, state owned and leased facilities will be mapped and documented to include:

- Location and Use
- History and vulnerability to hazards
- Building construction and potential hazard mitigation

Table 4.7-2
New Jersey State Government FEMA Public Assistance Grant Applicants from Six Recent Presidentially-declared Disasters

FEMA Public Assistance Grant Applicant	Category A	Category B	Category C	Category D	Category E	Category F	Category G	Total
Delaware River Joint Toll Bridge Commission	$0	$16,163	$276,095	$0	$0	$0	$0	**$292,258**
Banking and Insurance	$0	$13,126	$0	$0	$0	$0	$0	**$13,126**
Environmental Protection	$189,768	$1,527,988	$165,691	$916,449	$27,653	$10,125	$589,890	**$3,427,564**
Law and Public Safety	$0	$0	$12,233	$0	$0	$0	$0	**$12,233**
Treasury	$0	$30,215	$0	$1,440	$468,314	$0	$9,570	**$509,539**
Meadowlands Conservation Trust	$0	$0	$0	$47,600	$0	$0	$0	**$47,600**
Board of Public Utilities	$0	$2,420	$0	$0	$0	$0	$0	**$2,420**
Dept. of Corrections	$0	$105,082	$0	$0	$0	$0	$0	**$105,082**
Health and Senior Services	$0	$6,173	$0	$0	$0	$0	$0	**$6,173**
Dept. of Agriculture	$0	$2,074	$0	$0	$0	$0	$0	**$2,074**
Dept. of Community Affairs	$0	$203,254	$0	$0	$0	$0	$0	**$203,254**
Dept. of Human Services	$0	$296,397	$3,013	$0	$252,839	$0	$0	**$552,249**
Military/Veteran's Affairs	$0	$1,400,746	$0	$0	$0	$0	$0	**$1,400,746**
Highway Authority [Garden State Parkway]	$74,424	$0	$29,925	$0	$0	$0	$0	**$104,349**
Office of Emergency Management	$0	$0	$3,227,803	$0	$0	$0	$0	**$3,227,803**
State Dept. of Transportation	$674,082	$1,048,624	$495,964	$0	$0	$0	$0	**$2,218,670**
NJ Transit	$98,189	$666,236	$273,424	$0	$382,934	$52,402	$1,216,218	**$2,689,403**
NJ Water Supply Authority	$67,870	$148,612		$82,075		$30,575		**$329,132**
State Police		$725,362			$38,807		$1,795	**$765,964**
State University of New Jersey		$76,188	$18,131					**$94,319**
Total	**$1,104,333**	**$6,268,660**	**$4,502,279**	**$1,047,564**	**$1,170,547**	**$93,102**	**$1,817,473**	**$16,003,958**

Section 4.8 Incorporation of Risk and Vulnerability Data from Local and Regional Hazard Mitigation Plans

At the time of the 2008 State mitigation plan update, only two municipal plans had been approved in the State, although every County and local jurisdictions were either already engaged in the required planning development, or had obtained grant funds and was commencing the process. NJOEM expects that the plans will include a significant amount of information that can be incorporated into the State plan eventually. In addition to using this data in future updates, the State commits to the following, to ensure that the local plans include sufficient data about risks and vulnerabilities.

- NJOEM will provide technical information such as NFIP data about severe repetitive loss and repetitive loss data to local and regional planners. This information will include the risk calculations completed as part of the plan update process.

- To the extent practicable, NJOEM will offer advice and feedback on key technical sections of local and regional mitigation plans as they are developed.

- NJOEM will encourage local and regional planners to include vulnerability assessments and risk calculations in all plans, as required by the FEMA IFR. This will be emphasized during the State-level review process, and the State will provide detailed feedback on these sections.

See Chapter 6 pages 2 and 3 - Tables 6.2-1 and 6.2-2 for plan approval status as of May 2010.

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[i] USDA, National Agriculture Statistics Service, New Jersey Field Office, "New Jersey Farm Facts", May 2011. http://www.nass.usda.gov/Statistics_by_State/New_Jersey/Publications/Farm_Facts/NJFF1105.pdf