Section 3: Flood Hazard Identification and Profiling

Requirement §201.6(c) (2) (i): *[The plan shall include a] description of the … location and extent of …natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.*

With the aim to identify and profile this region's most serious natural hazard - flooding, this section is broken down into the following five sections:

- Nature of the Flood Hazard
- Types of Flooding
- History of Past Flood Events
- Location and Extent of Flood Hazard
- Analysis of Repetitive Loss Properties

Nature of the Flood Hazard

Flooding is a natural and recurring event for a river or stream which is a result of heavy or continuous rainfall exceeding the absorptive capacity of soil and the flow capacity of rivers, streams, and coastal areas. This causes a watercourse to overflow its banks onto adjacent lands. As illustrated in Figure 3-1, floodplains are land areas adjacent to rivers and streams that are subject to recurring inundation.

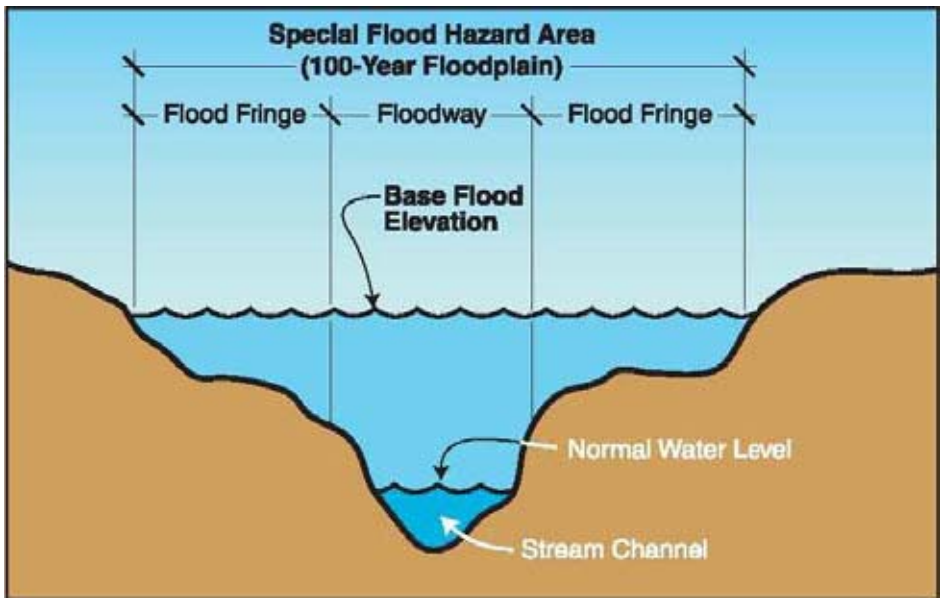

Figure 3-1: Floodplain definition (Source: FEMA, August 2001)

Floodplains are a vital part of the river ecosystem. From the human and economic perspective, flooding is a problem for communities which are built on and around floodplains. But, undeveloped floodplains provide numerous benefits to neighboring communities. These benefits include:

1. **Temporary storage of flood waters.** During intense precipitation events and periods of

high water, floodplains store excess runoff which is then slowly released. This storage capacity slows floodwater velocity and reduces peak flows downstream.

2. **Improvement of water quality.** As stormwater runoff traverses the floodplain, established vegetation improves water quality by filtering out pollutants and sediment before they enter the receiving water. In addition, floodplains store excess sediments which are deposited during flooding events, creating a deposition of nutrient rich sediments historically attracting farming activities to the floodplain.
3. **Stabilization of river banks.** Vegetation along the stream bank anchors and stabilizes the soils, effectively reducing erosion and providing shade to maintain water temperatures.
4. **Habitat.** Floodplains provide habitat for plants and animals and are particularly important as breeding and feeding areas.
5. **Recreation.** Floodplains are appropriate areas for open space, parks, greenways, and recreation areas, all of which protect the natural functions of the floodplain.

In an attempt to quantify the eco-service value of undeveloped land in New Jersey, the NJDEP released an April 2007 report entitled, "Valuing New Jersey's Natural Capital: An Assessment of the Economic Value of the State's Natural Resources". One acre of riparian buffer was reported to have an eco-service value of nearly $117,000 per acre for goods and services alone (this did not include ecotourism benefits). Riparian buffers in this report were defined as areas adjacent to the river that were not classified as freshwater wetlands. One acre of freshwater wetlands was reported to have an eco-service value of $393,000 per acre. It can be surmised that the most benefit from a floodplain is realized when it is left in its natural state.

Floods are natural events that are only considered hazards 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). People have been lured to floodplains since ancient times, by the rich alluvial soil, by the need for access to water supplies, water transportation, and power development, and later as value was assigned to property and development in close proximity to scenic waterways. Human activity has profound impacts on flooding. While some activities can be designed to mitigate the effects of flooding, many current practices and structures have increased the flood risk.

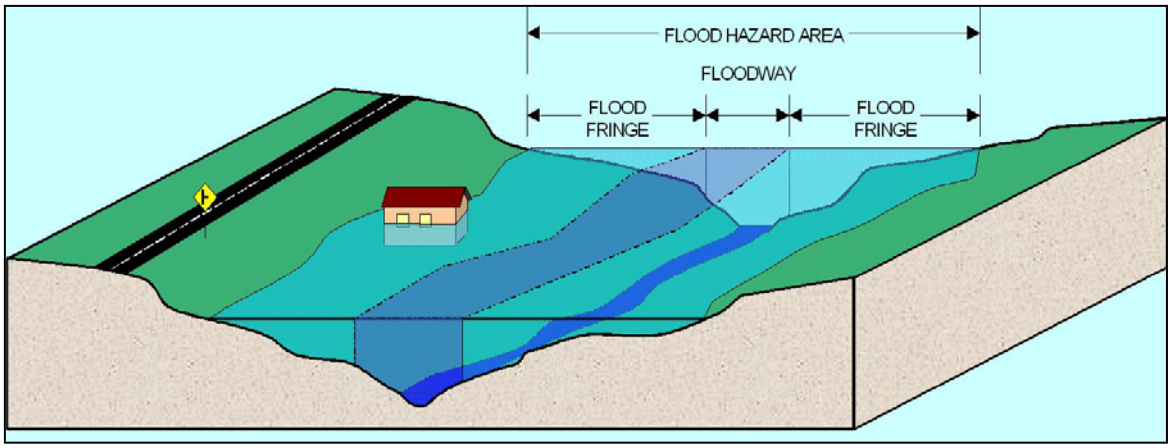

Figure 3-2: Development in the Floodplain (Source: NJDEP, 2007)

National Flood Insurance Program

In 1968, Congress established the National Flood Insurance Program (NFIP). In 1979, the Federal Emergency Management Agency (FEMA) became responsible for administering the NFIP. The NFIP is a Federal program enabling property owners in participating communities to purchase insurance as a protection against flood losses. Participation in the NFIP is based on an agreement between communities and the Federal Government. If a community adopts and enforces a floodplain management ordinance to reduce future flood risk to new construction in floodplains, the Federal Government will make flood insurance available within the community as a financial protection against flood losses. The NFIP is composed of three components: 1) floodplain identification and mapping; 2) floodplain management; and 3) flood insurance.

In addition to providing flood insurance and reducing flood damages through floodplain management regulations, FEMA is required to identify and map the Nation's flood-prone areas and to establish flood-risk zones. Two standard flood zones used to describe risk are the 100-year and 500-year flood zone. The term "100-year" flood zone, also known as the Special Flood Hazard Area (SFHA), is depicted on Flood Insurance Rate Maps (FIRMs) produced by FEMA. The SFHA is essentially the regulatory floodplain, composed of both the floodway and the flood fringe (Figure 3-2). The SFHA is the area where the NFIP's floodplain management regulations must be enforced and the area where the mandatory purchase of flood insurance applies.

Definition of a "100-Year Flood"

The phrase "100-Year Flood" is a cause of confusion among the public, government officials, and insurers. Many continue to believe it is a description of a flood that occurs only once every 100 years. In fact, "100-Year Flood" is an abbreviated way of describing a flood of such magnitude that has a 1-percent (or 1 in 100) statistical probability of being equaled or exceeded in any given year. This terminology describing flood events is often found to be misleading because it is based on statistical probabilities, not periodicity.

Floods are classified according to their statistical frequency of frequency and depth. For instance, there are 10-Year, 25-Year, 50-Year, 100-Year, and 500-Year Floods. A 10-Year flood event occurs more frequently than a 100-Year flood event, but a 100-Year flood event has a larger volume and greater depth of water. The NFIP, adopted the "100-Year Floodplain" as the national standard to describe Special Flood Hazard Areas (SFHA) that are depicted as Zone A on Flood Insurance Rate Maps (FIRMS). In an effort to better communicate flood risk, use of term "100-Year Floodplain" has been replaced with the term "base flood". Base Flood Elevations (BFEs) are listed on FIRMs and are used on Elevation Certificates to indicate the expected depth of water should a flood occur.

Table 3-1 shows the statistical chances of a building located in the 100-Year Floodplain (or Zone A on the Flood Insurance Rate Maps) experiencing different levels of flood events over different periods of time. By definition, more than one 100-year flood event or base flood can occur within the span of a single year or one might not be witnessed on time scales of greater than 100 years. **Based on probability theory, a building in the Special Flood Hazard Area has a 26 % (or 1 in 4) chance of experiencing a 100-year flood over the entire life of a 30-year mortgage.**

Table 3-1: Statistical Chance of Being Flooded

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

Source: National Flood Insurance Program's Watermark (Fall/Winter 1998 issue)

Flood Frequency

Following the three floods, the flood magnitude and frequency for the eight active streamflow-gaging stations along the main stem Delaware River in New Jersey, New York, and Pennsylvania was updated to include the three recent floods. The Delaware River flood frequency report, "Flood magnitude and frequency of the Delaware River in New Jersey, New York, and Pennsylvania: U.S. Geological Survey Open-File Report 2008–1203" was published in 2008 and is now on line at: http://pubs.er.usgs.gov/usgspubs/ofr/ofr20081203

The updated flood-frequency values indicate that the recurrence interval of the September 2004 flood ranged from 20 to 35 years, the recurrence interval of the April 2005 flood ranged from 40 to 70 years, and the recurrence interval of the June 2006 flood ranged from 70 to greater than 100 years.

Precipitation Frequency

A 100-year precipitation event does not automatically produce a 100-year flood. This is because several factors, including topography, soil moisture and ground cover, independently influence the cause-and-effect relation between rainfall and streamflow. A 100-year rainfall event and a 100-year flood are completely different statistical accounts and cannot often be correlated. In determining precipitation frequency, two key elements are rainfall intensity and duration. Precipitation frequency tables developed by the National Oceanic and Atmospheric Administration can be used to determine the statistical probability for the combination of these two factors for the period of observed record in a specific area (NOAA Atlas 14; http://hdsc.nws.noaa.gov/hdsc/pfds/orb/nj_pfds.html).

Flood Depth, Velocity and Duration

Flood damage is often a function of three factors: flood depth, velocity and duration. The floodway, which is the inner portion of the flood hazard area nearest the stream or river, is characterized by deeper flows and higher velocities during a flood. New construction is generally prohibited in floodways because it is unsafe and obstructs the passage of floodwaters. However, areas immediately adjacent to floodways are often subject to flood depths and velocities similar to those of the floodway.

Deeper flooding means greater hydrostatic pressure on walls and floors, more of the building

contents get wet and water soaks materials and contents for a longer time. Flood velocity is important because the faster water moves, the more pressure it puts on a structure and the more it will erode stream banks and scour the earth around a building's foundation. Another concern is how long floodwaters remain, or duration. The longer the duration, the more damage will be done to property and the longer businesses and roads will stay closed.

FEMA Flood Insurance Studies include the "average floodway velocity" for those streams that were studied in detail. This figure is specific to location and is helpful in determining the relative hazard of an area, but is not an accurate indication of the velocity of a flood at any individual site. Sites close to the channel will probably have higher velocities than this figure and sites at the fringe of the floodplain will be subject to lower velocities.

The Corps of Engineers are currently producing digital flood inundation maps for the main stem Delaware using existing data. These maps are expected to be completed by the close of 2008 and will be available through NWS AHPS website and to County Emergency Managers. This mapping is expected to provide useful, detailed information which will convey flood depths at specific locations given a predicted stage height at a nearby stream gage.

Types of Flooding

Riverine flooding is when the rate of rainfall or snowmelt exceeds the rate of infiltration to the ground and the excess water, called runoff, moves across the ground to the lowest section of the watershed. As surface water enters stream channels, stream levels increase. If the rate of runoff is high enough, water in the stream overflows the banks and flooding occurs. Riverine flooding is the type of flooding most often observed in this part of New Jersey.

Two key contributors to flooding are rainfall intensity and duration. Rivers and streams may flood when prolonged rainfall occurs over the course of several days or when intense rainfall occurs over a short period of time. Conditions prior to a rainfall event greatly influence the amount of stormwater runoff into waterways. Thus, topography, soil conditions, and ground cover play important roles. Dry soil allows more infiltration of rainfall and reduces the amount of runoff entering streams. Conversely, soil that is saturated as a result of previous rains has a lower capacity for infiltration, and results in higher rates of surface water runoff.

Floods are the result of a multitude of naturally occurring and human-induced factors, but all can be defined as the accumulation of too much water in too little time in a specific area. Flood hazards include riverine and stormwater flooding, including overflow from a river channel, flash floods, ice-jam floods, flooding due to dam failure, local drainage or high groundwater levels, and erosion.

Regional Floods: Regional floods along the Delaware are often associated with one of the following: spring snow melt combined with heavy rains, slow-moving, low-pressure or frontal storm systems including decaying hurricanes, tropical storms or nor'easters or heavy rainstorms. Regional floods most often occur along the Delaware when one of these weather events occurs during times of saturated soil conditions. Extended wet periods during any part of the year can create saturated soil conditions, after which rain runs off into streams and rivers rather than infiltrate into soil, until river capacities are exceeded. In addition, floods can occur seasonally

when winter or spring rains coupled with snowmelt fill river basins with too much water too quickly. During these times, the ground may be frozen and vegetation dormant, thereby preventing or reducing infiltration into the soil and increasing runoff.

Historically, the flood of 1955 was caused by the remnants of two hurricanes, Connie and Diane, which converged on the Delaware Basin within the span of one week. The remnants of Hurricane Ivan, interacting with a cold front produced tremendous rainfall amounts in September 2004. Two back-to-back early spring rainstorms combined with snowmelt to cause major flooding in the Delaware River Basin in April 2005. Extremely heavy rainfall during June 2006 caused flash flooding and record to near-record flood crests along the Delaware. An intense nor'easter brought heavy rain and flooding to New Jersey in April 2007. All of these events were dependant on both extreme weather events and precursor conditions which caused saturated conditions and set the stage for flood events. More detail can be found later in this Section.

As a recent example of the importance of precursor conditions, one can look to the extreme rainfall in October 2005 caused by the remnants of Tropical Storm Tammy. This event did not cause regional flooding due to below normal precipitation over multiple months preceding the storm which resulted in very low streamflow, soil moisture, reservoir storage, and ground water levels. The soil, vegetation, rivers and reservoirs were able to absorb and contain this event.

Flash Floods: Flash floods can occur within several seconds to several hours, with little warning. Flash floods may be deadly because they produce rapid rises in water levels and have high flow velocities. Several factors can contribute to flash flooding. Among these are rainfall intensity, rainfall duration, surface conditions, and topography and slope of the receiving basin. Urban areas are susceptible to flash floods because a high percentage of the surface area is composed of impervious streets, roofs, and parking lots where runoff occurs rapidly. Mountainous areas also are susceptible to flash floods, as steep topography may funnel runoff into narrow low-lying areas.

Ice-Jam Floods: Ice-jam floods occur on rivers that are totally or partially frozen. A rise in water level will break up a frozen river and create ice flows that can pile up on channel obstructions such as shallow riffles, log jams, or bridge piers. The jammed ice creates a dam, allowing for more jamming to occur. Backwater upstream from the ice dam can rise rapidly and overflow the channel banks. Flooding moves downstream when the ice dam fails, and the water stored behind the dam is released. At this time the flood takes on the characteristics of a flash flood, with the added danger of ice flows that, when driven by the energy of the floodwaters, can inflict damage to structures.

Dam- and Levee-Failure Floods: Fortunately, New Jersey has not had the misfortune of experiencing a catastrophic dam failure but there have been an increasing number of small dam failures. This is largely attributed to the lack of maintenance and inspection as well as the fact that many of the dams in the state are nearing the end of their design life. Dams and levees are built for various purposes and are usually engineered to withstand a flood with a computed risk of occurrence. Like all structures, dams and levees can deteriorate. Many dam owners, including most private dam owners, lack the resources necessary to perform dam maintenance or to make significant repairs. Lack of maintenance causes dams to be more susceptible to failure.

If a large flood occurs, and the dam or levee fails or is washed out, the water behind it is released to become a flash flood. Failed dams or levees can create floods that are catastrophic to life and property because of the energy of the released water.

In 1912, the legislature of the State of New Jersey instituted laws relating to the construction, repair, and inspection of existing and proposed dam structures. The law was amended in 1981 and became known as the Safe Dam Act. New Jersey's Dam Safety program is administered by NJDEP's Division of Engineering & Construction, Dam Safety Section, under the rules and regulations promulgated in May 1985 known as the Dam Safety Standards. Dams under State jurisdiction are artificial barriers, together with appurtenant works that raise the waters of a stream more than five (5) feet above the usual mean low water height.

History of Past Flood Events

Significant flood damage occurs annually in the basin. Figure 3-3 presents peak annual stage at the USGS gage in Trenton, NJ from 1900 through 2007. The figure demonstrates that the Delaware River Basin has had two periods of intense flooding in the last 107 years with relatively quiescent periods between more active flooding periods. Of note, the 1904 flood crest was created by backwater behind an ice jam and not necessarily the result of high stream flows, although heavy rain did precede the event.

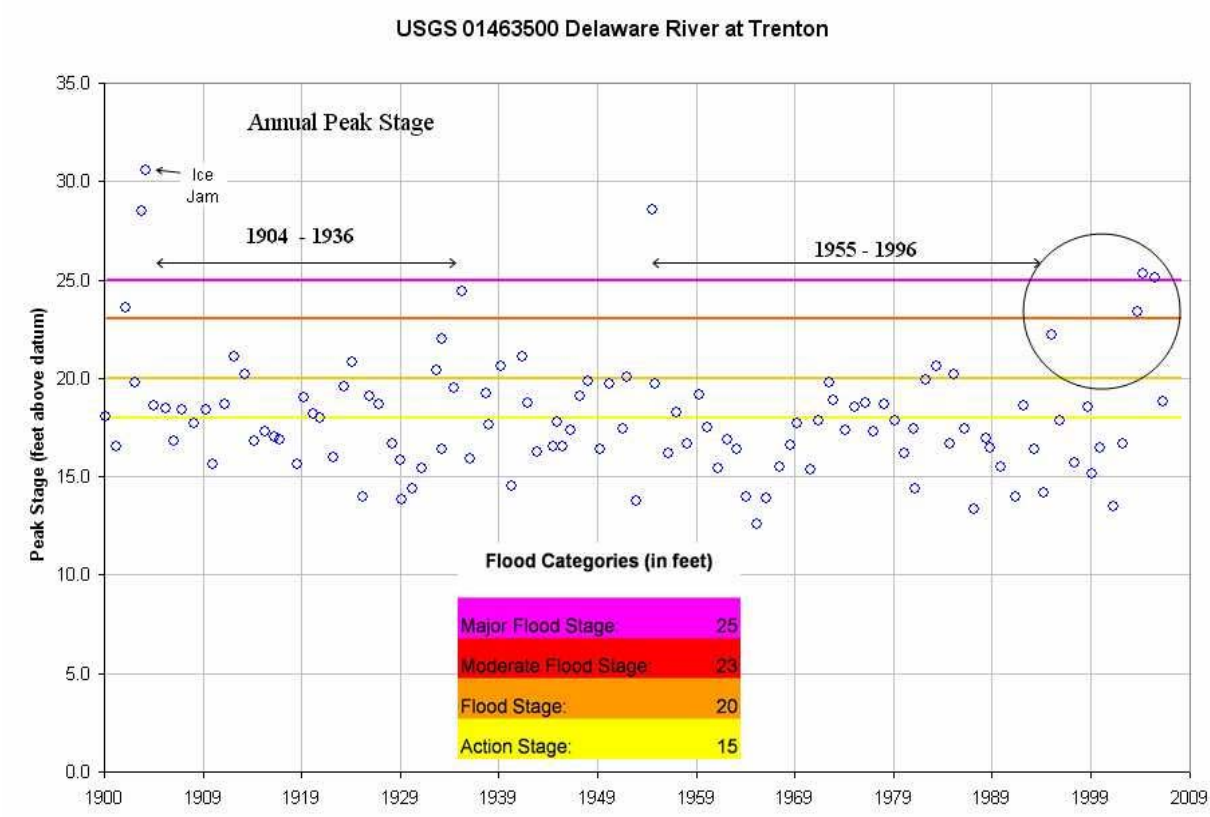

Figure 3-3: Peak Annual Stage at Trenton, New Jersey (Source, USGS)

Table 3-2 presents the ranked flood stage peaks and flows recorded at selected USGS gages

located along the Delaware River. Inspection of the table indicates that 2005 and 2006 floods were among the worst seen on the Delaware River since 1955.

Table 3-2: Top Ten Peak Stage Measurements at Selected USGS Gages in New Jersey

Rank	Montague		Riegelsville		Lambertville		Trenton	
	Date	Stage (ft)	Date	Stage (ft)	Date	Stage (ft)	Date	Stage (ft)
1	10/10/1903	35.5	8/20/1955	38.85	8/20/1955	24.27	3/8/1904*	30.6
2	8/19/1955	35.15	10/10/1903	35.9	10/11/1903	21.8	8/20/1955	28.6
3	6/29/2006	32.16	4/3/2005	34.07	4/4/2005	19.6	10/11/1903	28.5
4	4/3/2005	31.69	6/29/2006	33.62	6/29/2006	19.08	4/4/2005	25.33
5	3/18/1936	28.45	3/19/1936	32.45	3/19/1936	18	6/29/2006	25.09
6	1/20/1996*	26.61	9/19/2004	30.95	01/08/1841	17.9	3/19/1936	24.43
7	5/23/1942	25.7	1/20/1996*	28.72	3/2/1902	17.8	3/2/1902	23.6
8	4/1/1940	24.33	5/24/1942	27.5	03/15/1846	15.5	9/19/2004	23.41
9	6/30/1973	23.4	4/1/1940	26.47	1/20/1996*	15.34	1/20/1996*	22.2
10	3/15/1986	23.28	12/12/1952	25.4	5/24/1942	14.23	5/24/1942	21.12

* Flood caused by backwater from ice jam.
Source: National Weather Service Advanced Hydrologic Prediction Service (6/2008)

Since 1996, seven floods have resulted in Presidential Disaster Declaration for at least one or more of the four NJ counties in this study. Table 3-3 presents a summary of the presidential declared disasters in New Jersey from 1955 – 2007.

Table 3-3. Summary of Presidential Declared Disasters in New Jersey from 1955-2007

New Jersey Disaster Declarations 1955-2007 y = yes, county declared n = no county information			All NJ	Atlantic	Bergen	Burlington	Camden	Cape May	Cumberland	Essex	Gloucester	Hudson	**Hunterdon**	**Mercer**	Middlesex	Monmouth	Morris	Ocean	Passaic	Salem	Somerset	**Sussex**	Union	**Warren**
Aug-55	Hurricane, floods	41-DR	n																					
Mar-62	Severe storms, high tides, flooding	124-DR	n																					
Aug-65	Water shortage	205-DR	n																					
Jun-68	Heavy rains, flooding	245-DR	n																					
Sep-71	Heavy rains, flooding	310-DR	n																					
Aug-73	Severe storms, flooding	402-DR	n																					
Jul-75	Heavy rains, high winds, hail, tornadoes	477-DR	n																					
Aug-76	Severe storms, high winds, flooding	519-DR	n																					
Feb-77	Ice conditions	528-DR	n																					
Apr-84	Coastal storms, flooding	701-DR	n																					
Oct-85	Hurricane Gloria	749-DR	n																					
Mar-92	Coastal storm	936-DR		y				y	y							y		y						
Dec-92	Coastal storm	973-DR		y				y	y	y					y	y		y		y	y		y	
Jan-96	Snow, blizzard	1088-DR		y	y	y		y	y	y					y	y	y	y	y	y	y	**y**	y	**y**
Nov-96	Flooding	1145-DR			y		y					y		**y**	y						y		y	
Sep-97	Severe storms, flooding	1189-DR		y							y	y												
Mar-98	Coastal storm	1206-DR		y				y				y						y						
Sep-99	Hurricane Floyd	1295-DR								y			**y**		y		y		y		y			
Aug-00	Flooding	1337-DR												**y**			y					**y**		**y**
Jul-04	Severe storm, flooding	1530-DR				y	y																	
Oct-04	Tropical Depression Ivan	1563-DR											**y**	**y**								**y**		**y**
Apr-05	Severe storms and flooding	1588-DR			y					y	y		**y**	**y**			y		y				y	**y**
Jul-06	Severe storms and flooding	1653-DR											**y**	**y**								**y**		**y**
Apr-07	Severe storms,inland and coastal flooding	1694-DR		y	y	y	y			y	y	y		**y**	y		y		y		y	**y**	y	**y**

Descriptions of major floods that have historically occurred in the study area are presented below. Data presented was obtained from municipalities, counties and the NOAA National Climatic Data Center (NCDC) Storm Event Database (www4.ncdc.noaa.gov). Where data is readily available, the effect of flooding on specific municipalities and counties is presented.

1903 - October

In October of 1903, the river stage reached 28.50 ft at Trenton, the third highest recorded crest to date. The flood waters caused nearly one million dollars in damage and 9 bridges were washed away including the bridge between Lambertville and New Hope, the Yardley Bridge, and a new steel bridge between Byram and Point Pleasant. The wreckage from bridges was distributed over 57 miles. Train tracks were also washed out or submersed by flood waters and the Delaware and Raritan Canal embankments failed in several places.

1904 - March

In March 1904, Trenton experienced its worst flood of record to date. After a few days of heavy rains, ice melt upstream, and an ice jam at Terriwig Bar in South Trenton, the river rose rapidly and crested at 30.6 ft. A great majority of South Trenton was underwater, the statehouse boiler room was flooded with at least two feet of water, and the City Water Works pump house was submerged. The New York Times reported that the Pennsylvania Railroad parked loaded coal cars on a new three million dollar bridge to prevent it from being washed away.

1936 - March

The March 1936 warm rain fell on a significant amount of snow creating flooding from the combined rainfall and snow melt runoff. The USGS reported (Water Supply Paper 799) that "two extraordinarily heavy" rain events occurred in succession over the Northeastern U.S. and noted that the precipitation amounts from the storms ranged from 10 to 30 inches. Combined with the accumulated snow and warm temperatures, the amount of water to be drained overwhelmed the waterways. Flooding events in the Delaware and other areas in 1936, most notably the Johnstown flood, contributed to the justification for the Flood Control Act of 1936.

1955 - August

After a relatively quiescent period between the 1904 flood and the 1936 flood, the basin was hit by the remnants of two hurricanes, Connie and Diane, in one week. Although Connie did not inflict damage, saturated conditions were created throughout the basin. When Diane hit two weeks later, little water could soak into the ground and flash flooding conditions occurred. The flood stage was the highest on record since the flood of 1903 and the ice jam flood of 1904.

The 1955 flood killed between 25 and 99 individuals in the Delaware River Basin according the National Weather Service and newspapers, respectively. In August 1955, Pennsylvania, New York, New Jersey, and Connecticut declared emergencies due to wide-spread flooding. The New York Times reported that the Delaware River overtopped its banks around the Port Jervis, Sussex County area and smaller tributaries began to flood parts of the towns that were not affected by the Delaware River. Northwestern New Jersey was also adversely affected by the storm. The National Weather Service reports that Diane caused $831,700,000 worth of damage. Without adjusting for inflation, this makes Hurricane Diane the 27th costliest mainland tropical cyclone from 1900-2006.

The Washington Crossing Bridge is battered by the fury of what was to become known as the Great Flood of 1955. Further downstream, the steel bridge linking Ewing Township, N.J. to Yardley, Pa. was destroyed by the Delaware's record-high flows.

1996 - January

The winter flood of mid-January 1996 was the result of heavy snowfall, a frozen river and several unseasonably warm days with constant rainfall. In the days leading up to the flooding, temperatures reached into the 50's and created ideal conditions to melt the snowpack that was covering the entire basin. Intense rainfall accelerated the snowmelt, resulting in large amounts of runoff being directed to streams and the rivers. A Pennsylvania State University weather forecaster said the flooding was the result of the primarily density of the snow pack rather than the warm weather and rainfall. The snow pack was so dense in places that four or five inches melted yielded an inch of water. The break-up of an ice jam on the Delaware River near the Delaware Water Gap (Kittatinny Point) caused a rapid rise of the river on the 20th. This flooding was the worst to hit the basin in more than 20 years. Some smaller streams broke their all-time flood records.

In Mercer County, more than 2,000 persons were evacuated from Hopewell, Ewing and Trenton as the Delaware rose above flood stage on the 20th and 21st. The flooding from the river reached the State House Annex and parking lot in Trenton. The Assunpink Creek also flooded basements along Mulberry Street and caused what was described as a "littany of street closures".

In Hunterdon County, flooding forced the evacuation of over 500 residents, over half of which were from Lambertville. The worst damage occurred in Kingwood, Lambertville and Holland. Some homes in Lambertville had up to 5 feet of water in them. The footbridge to Lewis Island washed away.

In Warren County, about 800 persons were evacuated by boat, half of which from Harmony Township. Hardest hit were Harmony, Pohatcong, White and Knowlton Townships. Water from

the Delaware surrounded many homes. Some homes had water damage up to the second floor. Porches were washed away and chunks of ice were left behind. It was estimated that 130 residences including mobile homes and apartment buildings were badly damaged along with about twenty businesses. Besides the Delaware, flooding along the Musconetcong River inundated homes in Hackettstown; flooding along the Shabbecong Creek forced the evacuation of 50 people and caused water damage to 70 homes and flooding along the Pequest River inundated homes and businesses on Water and Wall Streets in Belvidere.

In Sussex County, the worst damage was in Montague, Sandyston, Vernon and Walpack Townships. There were many washed out roads and damage to culverts and bridges.

1996 - October

Rain, heavy at times, especially during the morning of the 19th caused widespread urban flooding and the flash flooding of several streams within Mercer County. The rain was over by early afternoon, but flooding along the Assunpink Creek lasted through the morning of the 20th. Flood waters from the Assunpink Creek reached the stoops of houses on two blocks in Trenton. The worst flooding was along Mulberry Street.

1999 - September

Hurricane Floyd spread heavy rainfall throughout the basin on September 16, 1999, producing six- to ten-inches over an 18-hour period. Extensive flooding damage occurred along tributaries in the lower portion of the basin. The hurricane caused record breaking flooding in the Raritan River Basin. Several people lost their lives and many homes were severely damaged. In addition, the transportation systems were disrupted and a number of bridges were destroyed.

In Mercer County about 400 persons were evacuated in Ewing, Lawrence, and Trenton. About 85 major roads were closed including sections of Interstate 95, U.S. Routes 1 and 130 and New Jersey State Route 33. Hundreds of water rescues from trapped vehicles occurred. In Trenton the worst flood damage occurred along the Assunpink Creek. Forty homes and three businesses were damaged on Mulberry Street, Dickinson Street and North Clinton Avenue. In Ewing Township, about 150 residents were evacuated from the Willow Creek Rehabilitation and Care Center. In Lawrence Township, six homes were badly damaged by flood waters from the Delaware and Raritan Canal. Businesses, car dealerships and residents near the Shabakunk Creek also suffered flood damage.

In Hunterdon County five homes were destroyed, 117 had major damage and 582 had minor damage. Two apartments suffered major damage and 7 suffered minor damage. Twenty-four businesses also were damaged. About 125 persons were evacuated. Five percent of all county roads were damaged and three bridges were expected to remain closed through mid November. Hardest hit was Lambertville, especially the south side of the city near Swan Creek. Nearly 100 homes were flooded and half the evacuations within the county occurred in this city. The flooding creek also cracked a water pipe leaving the south side of the city with no water. Elsewhere the elementary school was flooded with nearly two feet of water (damage estimate 1.1 million) as a creek behind the school overflowed. Other streams and rivers flooded in Alexandria, Califon, Frenchtown and Holland Townships.

On a relative basis the effects of Floyd diminished across Warren and Sussex Counties. About 38,000 homes and businesses lost power in these counties. Hardest hit were Byram Township, Frankford Township, Hopatcong Borough and the town of Newton. Flooding caused by Floyd contaminated municipal wells in Andover and Hampton Townships.

2004 - September

The remnants of Hurricane Ivan, interacting with a cold front that dropped into the northeastern United States late Friday, September 17, 2004, produced tremendous rainfall amounts across northeast Pennsylvania and southern New York. Most of the Delaware River Basin upstream of Trenton received three- to five-inches of rain in a 12-hour period, with some isolated areas receiving as much as seven or eight inches. Much of the heavier rain occurred in the mountainous regions of the basin in the Poconos and Catskills, while many areas in the southern half of the watershed received an inch or less. This rain fell on soils already saturated by a wet summer, including Tropical Storm Frances just a week before. Even before the rains from Ivan arrived, the Delaware River at Montague and Trenton, N.J. was flowing at 298 percent and 265 percent of normal, respectively, for the first half of September. The flooding on the main stem Delaware River was the worst since August 1955. No fatalities were reported in the basin as a result of Ivan, thanks in large part to the efforts by the National Weather Service, emergency management officials (including police, fire, and other rescue personnel), and the media, among others. New warning products and other tools that were developed or upgraded since the last time major flooding occurred along the Delaware in January 1996, such as Advanced Hydrologic Prediction Service (AHPS), helped to provide the necessary lead time to get hundreds of people out of harms way.

While the rain was not as heavy in Mercer and Hunterdon County, the runoff from the heavy rain upstream produced the worst flooding along the Delaware River since 1955. Townships and roadways along the Delaware River were hardest hit. Damage was estimated at two and a half million dollars in Mercer County and close to one million dollars in Hunterdon County (reported by the National Climatic Data Center).

In Warren County, storm totals averaged 3 to 6 inches with locally higher amounts throughout the county. The torrential rain caused widespread poor drainage, creek and river flooding. Damage was estimated at twenty-eight million dollars. The Delaware River washed a home from Harmony Township. The home crashed into the Easton-Phillipsburg Free Bridge. The impact sheared the roof from the home and the remainder floated under the bridge. In White Township officials condemned more than two dozen cottages as Delaware River flood waters broke windows and filled the homes with mud.

In Sussex County, Doppler Radar storm total estimates averaged between 2 and 5 inches throughout the county. The torrential rain caused widespread poor drainage, creek and river flooding.

On September 28, 2004, the remnants of Tropical Storm Jeanne brought four to eight inches of rain to the Philadelphia metropolitan area, primarily in Delaware, Pennsylvania, and New Jersey north of the "Fall Line" (a geologic divide that separates the Coastal Plain from the more highly elevated Piedmont region to the west). The heavy precipitation caused widespread urban

and small stream flooding. Streams from northern Delaware to central New Jersey rose rapidly above flood stage during the evening hours, making roadways hazardous and evacuation difficult.

2005 – April

Two back-to-back early spring rainstorms, the first on March 28-29 and a second on April 2-3, 2005, combined with snowmelt to cause major flooding in the Delaware River Basin. Along the main stem of the Delaware River, the flood crests exceeded those reached in Tropical Storm Ivan only six-and-a-half months earlier, and again caused evacuations, bridge and road closures, and extensive damage. The first storm brought over two inches of rain to western and northern portions of the basin. Warm temperatures melted about half of the snow pack, which totaled over three inches water equivalent in some northern watersheds. The second storm produced three- to five-inches of rain in the middle half of the basin, over two inches in the Catskill headwaters, and melted most of the remaining snow. By April 3rd, flood stages were exceeded on rivers and streams throughout the Delaware River Basin. Flooding was the most severe along the main stem Delaware River and headwater tributaries. Until 2006, flood stages from these events ranked third at several USGS monitoring locations, including Montague, Belvidere, Riegelsville, and the fourth largest at Trenton.

In Sussex, Warren, Hunterdon, Mercer and Morris Counties, about 1,800 homes and businesses were flooded, 25 homes were destroyed. Many of the homes and businesses that were flooded, had flooding into the first floor of their dwellings. About 4,000 people were evacuated from the five counties. Many major roads and a dozen low-lying bridges from Trenton north were closed. As river levels rose, low-lying bridges across the Delaware River were damaged. Damage to the bridges was estimated at $1.5 million with the greatest damage and longest closure to the Washington Crossing Bridge between Bucks and Mercer Counties. Total statewide damage from this storm was estimated at $52 million dollars. Miraculously there were no deaths or major injuries.

In Mercer County about 1,900 people were evacuated from Trenton, Ewing and Hopewell Township. Many roads (including New Jersey State 29) were flooded and bridges were closed. In Trenton, the entire Island section between the Delaware River and New Jersey State Route 29 was evacuated. Additional evacuations occurred in the Glen Afton section and the West Ward. The Island residents could not return until April 8, 2005. Over 100 homes had to be rewired as flooding reached into the first floor. Flooding reached up to eight feet in the lower level of the Statehouse parking lot, and prevented non-essential state personnel from working on April 4-5. About 500 persons were evacuated in Ewing Township including residents in the River Edge Apartments. A few evacuations also occurred in the Titusville Section of Hopewell Township. The Calhoun Street Bridge was reopened on the 5th and New Jersey State Route 29 was reopened on the 6th. The Washington Crossing Bridge was briefly reopened during the afternoon of the 6th, but was closed shortly thereafter when erosion was found around one of the bridges piers. A 3 foot by 8 foot section of one pier was eroding. It was believed that had been struck by a dumpster.

In Hunterdon County, Lambertville, Frenchtown, Stockton and Milford Boroughs were affected the most by the flooding along the Delaware River. In Lambertville, the Delaware

River merged with the Delaware and Raritan Canal. Swan Creek also flooded. Flood waters inundated the first floor of the Justice Complex. About 200 homes were damaged as first floor flooding occurred. South Union Street and Lambert Lane were hit the hardest. In Frenchtown Borough about 50 homes suffered substantial damage as did the borough's post office. The sewage treatment plant was also damaged. Four hundred feet of River Road was washed away. New Jersey State Route 29 between Frenchtown and Lambertville was closed. In Stockton, the locks in the canal at Prallsville Mills broke and sent Delaware River water into the borough. Five homes on Mill Street were condemned as the water blew out some back doors. In Alexandria Township, mudslides tore down trees and wires. In Kingwood Township, sheds were ripped from their foundations. The Musconetcong River flooded along the Hunterdon and Warren County border. In the Delaware River itself, flooding at the Treasure Island Boy Scout Camp located between Pt. Pleasant, PA and Frenchtown, NJ forced the closure of the facility for the year.

In Warren County, about 1,350 people were evacuated from every municipality along the Delaware River as well as along the U.S. Route 46 corridor. U.S. Route 46 was closed for days. Knowlton and Harmony Townships along the Delaware River suffered the most monetary damage. Flooding also occurred along the Musconetcong, Paulins Kill, and Pequest Rivers. Fourteen homes in the county were destroyed, one hundred ninety-two suffered major damage, one hundred twenty-five homes suffered minor damage and another eighty-four had water in their basements. The Easton-Phillipsburg Bridge was closed from the 3rd through the 7th and suffered some superficial damage. In Harmony Township, about 350 people were evacuated. Several trailers were displaced from their foundations. The Town of Phillipsburg evacuated about 500 persons.

In Sussex County, the hardest hit townships were Montague and Sandyston Townships along the Delaware River. Two homes in each township were destroyed. All inhabitants of Mashipacong Island in Montague Township were evacuated. Other residents along the Delaware River were also evacuated in Montague and Sandyston Townships. The Dingman's Ferry Bridge between Layton (Sandyston Township) and Pike County was closed. Flooding problems also occurred in Byram, Hardyston and Stillwater Townships. A voluntary evacuation was suggested for residents in Hardyston and Franklin Townships after the Summit Lake Dam was found to be leaking. The dam did not fail. Numerous basements were flooded in Newton and Lubbers Run flooded in Byram Township. Numerous roads throughout the county were closed. In addition to the destroyed homes, four homes in the county suffered major damage while 62 others suffered minor damage.

2006 - June

Extremely heavy rainfall over the Delaware River Basin during the June 24-28 period caused flash flooding and record to near-record flood crests along many streams and rivers throughout the basin, including the main stem Delaware River. Although hydrologic conditions were normal to dry prior to Saturday, June 24, the broad area of the rainfall and its intensity in the western half of the basin produced the flooding. National Weather Service data indicate that six to over 15 inches of rain fell in the Schuylkill, Lehigh, and upper Delaware River watersheds during the period. At least five inches fell throughout nearly all of the Delaware River Basin, with the exception of portions of New Jersey and the immediate Philadelphia area which received less.

Heavy rainfall during June 24-26 saturated the ground and produced bank full and minor flooding conditions by early Tuesday, June 27. Then, precipitation on June 27 and early on Wednesday, June 28 produced an additional two to over six inches of rainfall in the Schuylkill, Lehigh, and Lackawaxen watersheds as well as in Sullivan and Delaware counties in New York State. The high rate of runoff combined with the already bank full conditions to produce the near-record flooding conditions. The flood crests on the main stem Delaware River occurred on June 28 and 29. To date, the June 2006 storm is the third largest crest at Montague, fourth largest crest at Belvidere and Riegelsville, and the fifth largest crest at Trenton.

Between Mercer and Sussex Counties ten Delaware River bridges operated by the Delaware River Joint Toll Bridge Commission were closed. In Mercer County, over 400 homes and apartments were flooded, one was destroyed and over 50 suffered major damage. Over 4,000 people were evacuated, mainly from Ewing Township and Trenton. In Trenton, about 1,500 people were evacuated from the Island and Glen Afton sections. About 280 homes were flooded. Evacuations included senior citizens from the Water's Edge Convalescent Home. Most people returned by the 4th of July, except for residents in two apartment complexes. Trenton's water filtration system was shut down because of the debris in the Delaware River. A water emergency was declared for all areas served by the Trenton Water Works in Trenton, Lawrence, Ewing, Hamilton and Hopewell. Water use restrictions and calls for conservation were in place. The system started running at half of capacity on the 30th and was back at full strength on July 1st when the water emergency was cancelled. Non-essential state workers were told to stay home from the 28th through the 30th. The Statehouse parking garage suffered over half a million dollars in damage to its electrical and mechanical equipment after it flooded. Major New Jersey State Route 29 was flooded and closed in and out of Trenton. In Ewing, about 2,500 people from apartments and condominiums from Lower River Road to Upper Ferry Road were evacuated. In the Titusville section of Hopewell Township, about 20 homes were evacuated between the Raritan and Delaware Canal and the Delaware River. The Washington's Crossing State Park was also flooded and closed.

In Hunterdon County nearly 400 homes and businesses were damaged. Nearly 100 homes and about 5 Lambertville businesses suffered major damage. About 1000 people were evacuated from river municipalities. The worst reported damage was in Frenchtown, Lambertville and Stockton. Flood damage was also reported on West Amwell, Delaware, Kingwood, Alexandria, Milford and Holland Townships. Flooding caused approximately one million dollars in roadway damage. In Lambertville, a 39-year-old man was found dead in Swan Creek near the Lambertville Municipal Court on the 29th. He was last seen alive leaving the Inn of the Hawk on South Main Street. The borough's sewage and dechlorination plant were under water. In Stockton, a levee breach compounded the flooding. In Frenchtown, the sewage treatment plant was damaged. Most of the home damage in the borough occurred along River Road where up to four feet of water amassed on the first floor. Flood waters from the Delaware River backed the Nishisakawick Creek, which also flooded. In Holland Township, 15 homes were flooded into their first floor. In the middle of the Delaware River, about 200 boy scouts and counselors were evacuated from the Treasure Island Boy Scout Camp. For the second year in a row, extensive damage caused its closure for the season. Bull's Island Recreation Area was also badly damaged by the flooding.

In Warren County, about 400 homes, businesses and apartments were affected by the flooding and 1300 persons were evacuated from seven riverside municipalities. Three homes and one business were destroyed. Nearly 200 homes suffered major damage. A shelter was opened in Phillipsburg where up to 900 persons were evacuated. In the borough, about a dozen roads were closed and 14 streets near the Delaware River were evacuated. Evacuations also occurred in Belvidere, Harmony, Knowlton, Pohatcong and White Townships. Harmony Township though suffered the worst property damage as one home was literally lifted off its foundation. In Belvidere, water from the Delaware River backed up the Pequest River, which also flooded in the borough. Flood waters reached into the first floor of some homes. The water treatment plant in Hackettstown was closed because of the flooding. Major U.S. Route 46 was closed from exit four of Interstate 80 in Knowlton Township to its intersection with County Route 519 in White Township.

In Sussex County, twelve homes were damaged in the county by flood waters, ten suffered major damage. Most of the damaged homes were in Montague Township along River Road. About 60 homes in the township were evacuated. People were evacuated from Sandyston Township and five people were rescued from Mashipacong Island. The Dingman's Ferry Bridge in Sandyston Township was closed after chunks of roadway were displaced. Beaches at the Delaware River Water Gap National Recreational Area were closed for three weeks.

2007 – April

An intense nor'easter brought heavy rain and flooding to New Jersey that started on the 15th. The worst flooding occurred along the Raritan and Passaic River Basins. It was the worst flooding in the Raritan Basin since Hurricane Floyd in 1999. Numerous streams and rivers flooded, but the flooding along the Delaware River was minimal. Statewide damage was estimated at $180 million dollars.

In Mercer County, many major roadways in the county were flooded and closed in sections including U.S. Routes 1, 130 and 206 and New Jersey State Route 33. It was estimated that over 1,000 basements were flooded in the county. Flooding waterways included the Assunpink, Little Brook and Stony Brook. In Trenton, Assunpink Creek flooding affected eight homes on Mulberry Street. North Olden Street was also flooded by the creek.

In Hunterdon County, the Delaware River only flooded low-lying areas. In Raritan Township, about a dozen people evacuated from the Darts Mills Grove section. In Stockton, the school was flooded into the first floor. In Lebanon Township, flooding along both the Musconetcong River and the South Branch of the Raritan River flooded three roads. Major roadways that were closed included U.S. Route 22 in Clinton and Readington and New Jersey State Route 29 in West Amwell Township.

In Warren County, heavy rain caused several creeks and streams to flood and forced the closure of eighteen major roadways. Westbound Interstate 80 was closed in Knowlton Township because of a rockslide. In Blairstown both the Paulins Kill and Blair Creek flooded. There were a few evacuations near the flooded creek and one home suffered flood damage. The Paulinskill overflowed a bridge in the township and forced the closure of State Route 94. Roads were also closed in White, Hardwick, Harmony, Pohatcong and Greenwich Townships. Flooding was also

reported along the Pohatcong Creek and the Musconetcong River.

In Sussex County, the heavy rain and flooding caused several major roads including New Jersey State Route 23 in Wantage and Hardyston, New Jersey State Route 94 in Hardyston and Vernon, U.S. Route 206 in Newton and County Route 517 in Hamburg and Hardyston.

Precipitation Trend

Figure 3-4 presents the 72 month precipitation departure between April 2002 and March 2008 for the United States. The New Jersey municipalities in the project area received between 50 and 65 inches of excess rainfall in the past six years. The excess rainfall amounts to between 8 and 11 inches per year on average, or up to 25 percent greater rainfall than normal. In the upper Delaware Basin, the watershed experienced an even greater departure from normal of up to 80 inches.

Although many factors contributed to flooding in the Delaware River, excess precipitation clearly played a major role.

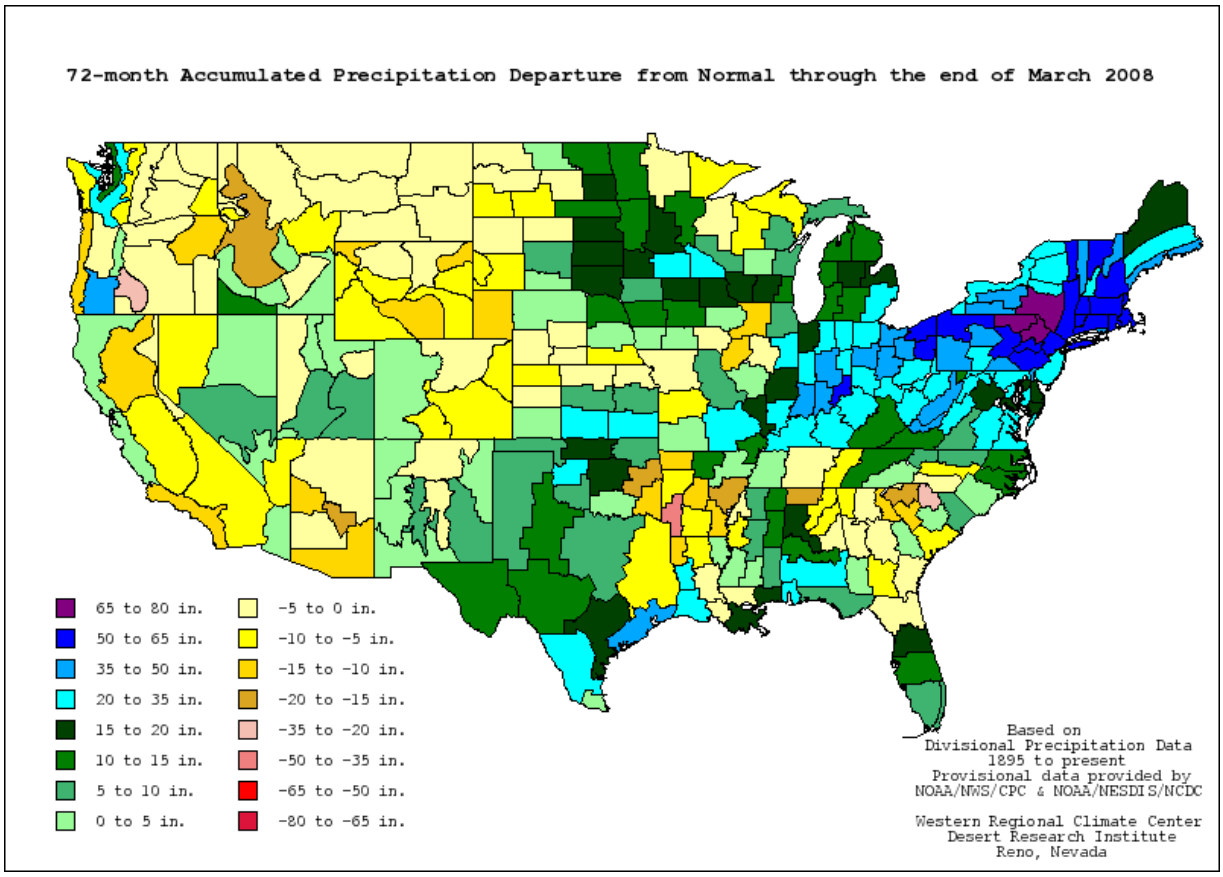

Figure 3-4. Nation-wide Precipitation Departure from Normal for the Past Six Years

Location and Extent of Flood Hazard

Although the area in floodplains is not a perfect indicator of flood, it nevertheless provides a reasonable proxy for potential exposure. Table 3-3 shows the number and percentage of floodplain acres per County and the percentage of those floodplains that ultimately drain to the Delaware River Basin (DRB). County-level graphics of the FEMA Q3 data are located in Appendix D.

Table 3-3. Land Area per County in the Special Flood Hazard Area

County	Acres of Floodplain per County	Percentage of Total Land Area	Acres of Floodplain in the DRB	Percentage of Floodplains in the DRB
Mercer	15,564	10.65%	12,107	77.79%
Hunterdon	14,546	5.19%	5,466	37.57%
Warren	13,212	5.69%	13,212	100%
Sussex	24,350	7.38%	13,946	57.27%

Source: 2008 State of New Jersey Hazard Mitigation Plan (data derived from FEMA Q3 data)
Notes:

1. Floodplain in this table is defined as the FEMA designated Special Flood Hazard Area. This risk zone is depicted on FEMA Flood Insurance Rate Maps (FIRMs) as Zone A. An A Zone is equivalent to an area with a 1% annual chance of flooding (otherwise known as the 100-year floodplain)
2. DRB = Delaware River Basin, i.e. drains to the Delaware River

Analysis of Repetitive Loss Properties

Flooding affects all watersheds in the Delaware River Basin. However, flood damage potential is a function of human development in floodplains. The National Flood Insurance Program (NFIP), administered by the Federal Emergency Management Agency (FEMA), makes federally-backed flood insurance available in communities that adopt and enforce floodplain management ordinances in the effort to help reduce future flood losses. Through the collection of insurance premiums, the program aims to transfer the cost of flood loss reimbursement from tax payers to floodplain property owners. In addition to reimbursing flood victims for their losses, NFIP encourages development away from flood-prone areas and requires new and substantially improved structures to be constructed in a way that minimizes or prevents flood damage.

Close to 20,000 flood insurance claim reimbursements have been awarded in the Delaware Basin since the late 1970s. Flood insurance claims reflect only a fraction of the total cost of property damage caused by flooding. The numbers presented in this analysis are most likely grossly underestimated and do not represent all properties that have experienced flood loss. This is due in part to the fact that only a small percentage of property is insurable. For example, roads, bridges, public utilities and the natural environment cannot be insured. Further, many owners choose not to purchase the insurance because they are required to do so only if their property was purchased with a federally-backed mortgage and is located in the Special Flood

Hazard Area (100-year flood zone). Notwithstanding these limitations, insurance claims (since the NFIP's inception in the late 1970's) can provide a general depiction of flood damage centers.

Repeat flood insurance claims indicate areas where floodplain occupancy continues in spite of repeated inundation. As of 01/31/08, FEMA identified 562 repetitive loss[1] and 60 severe repetitive loss[2] properties in Mercer, Hunterdon, Warren and Sussex counties. The definition of a repetitive loss property is 2 or more flood losses, where the definition of a severe repetitive loss property is 4 or more flood losses or when the payments exceed the building value.

As an example of the severity of flooding in recent years, the number of **repetitive loss properties in the entire Delaware River Basin prior to September 2004 was 317.** Between September 2004 and February 2007, **an additional 2,266 properties** were added to this list. Repetitive loss properties by of the four counties in this plan are presented in Table 3-4. These numbers are for each entire county and include both participating and nonparticipating municipalities, as well as, municipalities that fall outside of the study area of this Plan but are within county boundaries.

Table 3-4. Repetitive Loss Properties by County

County	Number of Repetitive Loss Properties	Total Payouts for Repetitive Loss Properties	Number of Severe Repetitive Loss Properties	NFIP Policies in Force as of 01/31/08
Mercer	197	$27,699,461	5	2389
Hunterdon	169	$25,085,048	10	1032
Warren	192	$27,926,993	45	724
Sussex	4	$639,765	-	322

Source: Federal Emergency Management Agency (FEMA); 01/31/08

Notes:

1. FEMA provided the repetitive loss properties list to DRBC. Properties were then mapped and summaries compiled by DRBC using Lat/Long coordinate points provided by FEMA. On occasion, the Lat/Long location does not match the FEMA assigned community name for specific claims.
2. Entire counties are represented in the above table, all municipalities that have repetitive loss properties are included whether or not they participated in the Plan.
3. This analysis does not capture uninsured flood damage.
4. Only FEMA validated severe repetitive loss properties are included.

Flood prone communities often state that available funds are not sufficient for either

[1] A property is considered a repetitive loss property by FEMA when there are 2 or more losses reported which were paid more than $1,000 for each loss. The 2 losses must be within 10 years of each other and be at least 10 days apart.

[2] A property is considered a severe repetitive loss property by FEMA either when there are at least 4 losses each exceeding $5000 or when there are 2 or more losses where the building payments exceed the property value.

acquisition or elevation of residences and other buildings that are repeatedly flooded. As a means of illustrating the need for additional funding and in an effort to identify the most flood-prone communities, a summary of participating municipalities with the greatest number of repetitive loss properties is presented below.

Table 3-5. Top Ranked Participating Municipalities with Repetitive Loss Properties

Municipality	County	Number of Repetitive Loss Properties	Total Payouts for Repetitive Loss Properties	Number of Severe Repetitive Loss Properties	NFIP Policies in Force as of 01/31/08
City of Trenton	Mercer	155	$22,611,451	3	470
Harmony Township	Warren	66	$27,926,993	24	105
Lambertville	Hunterdon	64	$9,278,749	1	225
Town of Belvidere	Warren	36	$9,567,744	4	96
Stockton Borough	Hunterdon	32	$5,257,575	2	92
Knowlton Township	Warren	32	$4,702,982	6	61
Pohatcong Township	Warren	27	$3,994,785	5	73
Kingwood Township	Hunterdon	24	$3,357,547	4	47
Ewing Township	Mercer	22	$2,354,703	1	402
Frenchtown Borough	Hunterdon	20	$2,974,853	0	78

Source: Federal Emergency Management Agency (FEMA); 01/31/08

Each of the following four pages present a table and map of repetitive loss properties for each County. All data presented in this analysis was supplied by FEMA and includes closed claims reported up to and including January 31, 2008. FEMA provided the repetitive loss and validated severe repetitive loss listings. Properties were then mapped and summaries compiled by DRBC using Lat/Long coordinate points provided by FEMA. On occasion, the Lat/Long location does not match the FEMA assigned community name for specific claims. Therefore, the numbers of repetitive loss properties in each municipality may differ slightly from other numbers published by FEMA.

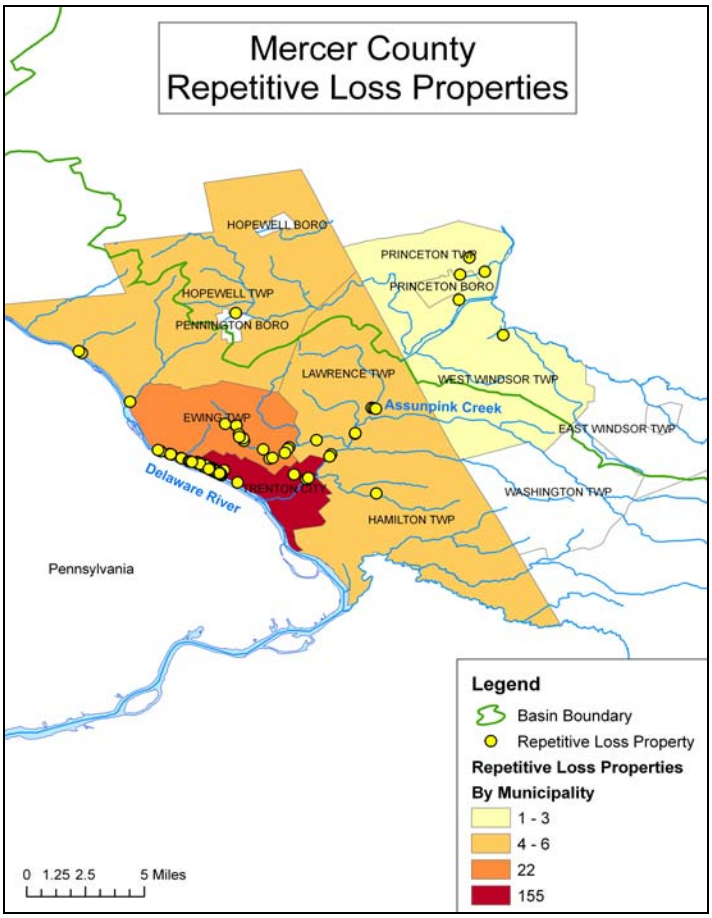

Table 3-6. Mercer County Municipalities Ranked by Repetitive Loss Properties

Municipality	Number of Repetitive Loss Properties	Total Payouts for Repetitive Loss Properties	Number of Severe Repetitive Loss Properties	NFIP Policies as of 01/31/08
City of Trenton	155	$22,611,451	3	470
Ewing Township	22	$2,354,703	1	402
Hopewell Township	6	$771,947	-	81
Hamilton Township	5	$853,613	-	770
Lawrence Township	4	$624,795	-	232
Princeton Township**	3	$210,434	1	112
West Windsor Township*	1	$171,736	-	118
Princeton Borough**	1	$100,782	-	52

Source: Federal Emergency Management Agency (FEMA); 01/31/08
Notes: * non-participating municipality, ** municipality outside of study area

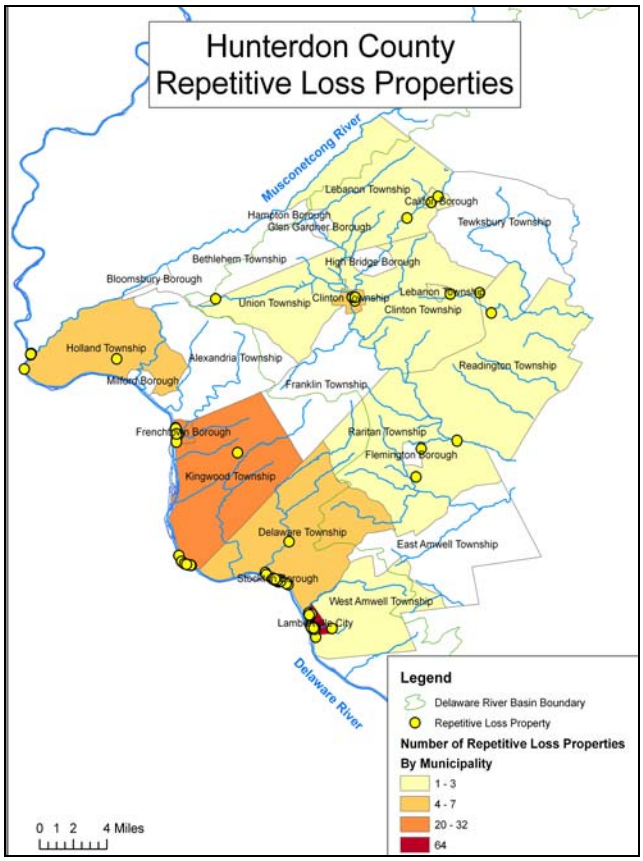

Table 3-7. Hunterdon County Municipalities Ranked by Repetitive Loss Properties

Municipality	Number of Repetitive Loss Properties	Total Payouts for Repetitive Loss Properties	Number of Severe Repetitive Loss Properties	NFIP Policies as of 01/31/08
Lambertville	64	$9,278,749	1	225
Stockton Borough	32	$5,257,575	2	92
Kingwood Township	24	$3,357,547	4	47
Frenchtown Borough	20	$2,974,853	-	78
Holland Township*	7	$1,002,137	1	35
Delaware Township	6	$916,463	1	31
Clinton Township**	5	$727,583	-	40
Raritan Township	3	$479,228	-	69
Califon Borough**	2	$129,278	1	19
Lebanon Township	2	$194,669	-	42
West Amwell Township	2	$304,464	-	10
Readington Township**	1	$89,316	-	41
Union Township**	1	$84,191	-	10

Source: Federal Emergency Management Agency (FEMA); 01/31/08
Notes: * non-participating municipality, ** municipality outside of study area

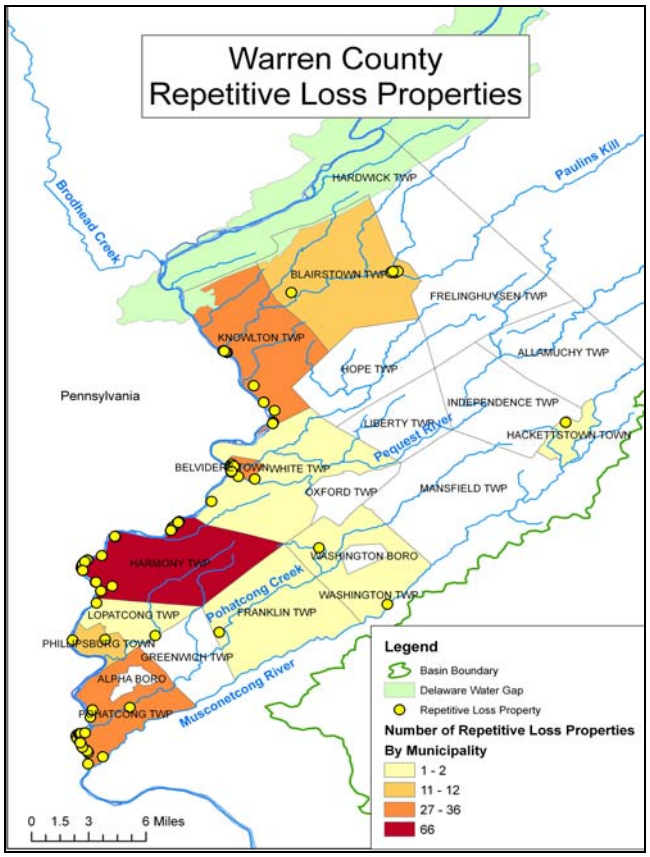

Table 3-8. Warren County Municipalities Ranked by Repetitive Loss Properties

Municipality	Number of Repetitive Loss Properties	Total Payouts for Repetitive Loss Properties	Number of Severe Repetitive Loss Properties	NFIP Policies as of 01/31/08
Harmony Township	66	$27,926,993	24	105
Town of Belvidere	36	$9,567,744	4	96
Knowlton Township	32	$4,702,982	6	61
Pohatcong Township	27	$3,994,785	5	73
Town of Phillipsburg	12	$1,742,751	3	39
Blairstown Township	11	$1,779,621	1	49
Lopatcong Township	2	$273,656	-	17
Washington Township*	2	$183,149	1	26
White Township	2	$276,901	-	28
Franklin Township	1	$131,508	-	7
Hackettstown	1	$124,832	1	78

Source: Federal Emergency Management Agency (FEMA); 01/31/08
Notes: * non-participating municipality, ** municipality outside of study area

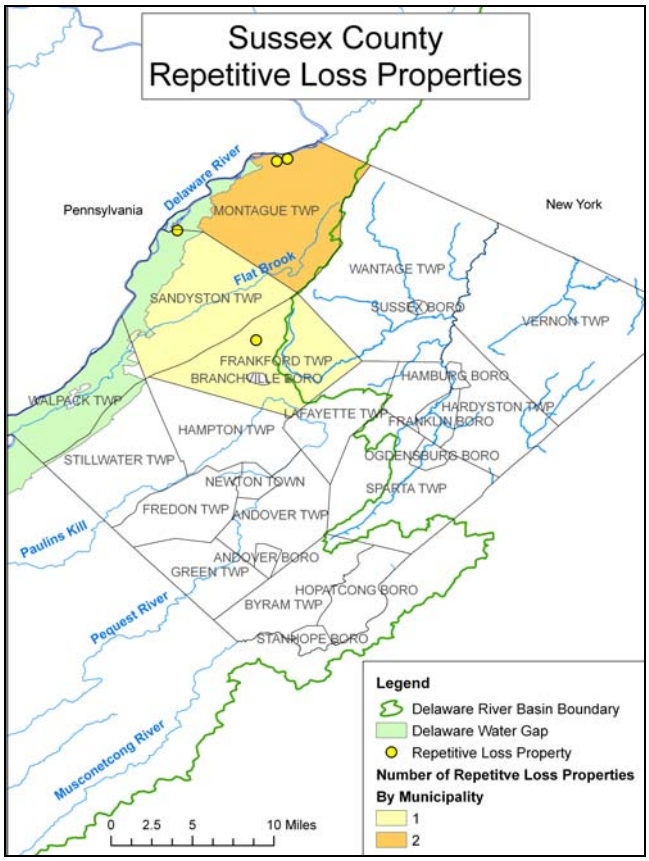

Table 3-9. Sussex County Municipalities Ranked by Repetitive Loss Properties

Municipality	Number of Repetitive Loss Properties	Total Payouts for Repetitive Loss Properties	Number of Severe Repetitive Loss Properties	NFIP Policies as of 01/31/08
Montague Township	2	$304,566	-	19
Frankford Township	1	$168,535	-	22
Sandyston Township	1	$166,664	-	15

Source: Federal Emergency Management Agency (FEMA); 01/31/08
Notes: * non-participating municipality, ** municipality outside of study area