5.4.4 FLOOD

This section provides a profile and vulnerability assessment for the flood hazard.

HAZARD PROFILE

This section provides profile information including description, location, extent, previous occurrences and losses and the probability of future occurrences.

Description

Floods are one of the most common natural hazards in the U.S. They can develop slowly over a period of days or develop quickly, with disastrous effects that can be local (impacting a neighborhood or community) or regional (affecting entire river basins, coastlines and multiple counties or states) (Federal Emergency Management Agency [FEMA], 2010). Most communities in the U.S. have experienced some kind of flooding, after spring rains, heavy thunderstorms, coastal storms, or winter snow thaws (George Washington University, 2001). Floods have been and continue to be the most frequent, destructive, and costly natural hazard in the State of New Jersey. The large majority of the State's damage reported for major disasters is associated with flooding (NJOEM, 2011). There are a number of flood categories in the U.S., which include:

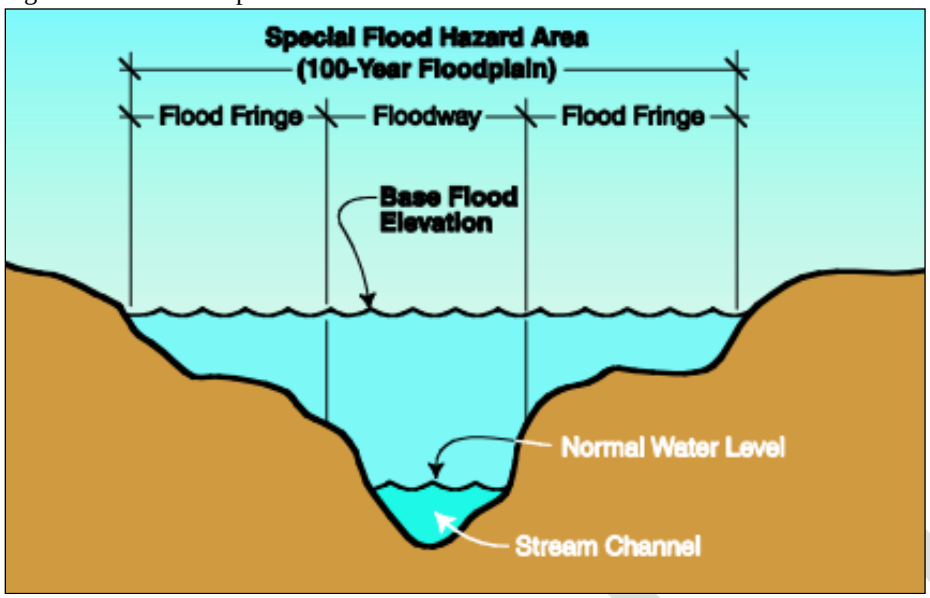
- Riverine flooding, including overflow from a river channel, flash, alluvial fan, ice-jam, and dam breaks
- Local drainage or high groundwater levels
- Fluctuating lake levels
- Coastal flooding, including storm surges
- Debris flow (NJOEM, 2011)

A floodplain is defined as the land adjoining the channel of a river, stream, ocean, lake, or other watercourse or water body that becomes inundated with water during a flood. Most often floodplains are referred to as 100-year floodplains. A 100-year floodplain is not the flood that will occur once every 100 years, rather it is the flood that has a one-percent chance of being equaled or exceeded each year. Thus, the 100-year flood could occur more than once in a relatively short period of time. With this term being misleading, FEMA has properly defined it as the one-percent annual chance flood. This one percent annual chance flood is now the standard used by most Federal and State agencies and by the National Flood Insurance Program (NFIP) (FEMA, 2003).

One hundred-year floodplains (or 1% annual chance floodplain) can be described as a bag of 100 marbles, with 99 clear marbles and one black marble. Every time a marble is pulled out from the bag, and it is the black marble, it represents a 100-year flood event. The marble is then placed back into the bag and shaken up again before another marble is drawn. It is possible that the black marble can be picked one out of two or three times in a row, demonstrating that a 100-year flood event could occur several times in a row (Interagency Floodplain Management Review Committee, 1994).

Figure 5.4.4-1 depicts the special flood hazard area, the flood fringe, base flood elevation, and the floodway areas of a floodplain.

Figure 5.4.4-1. Floodplain



Source: NJOEM, 2011

Many floods fall into three categories: riverine, coastal and shallow (FEMA, 2005). Other types of floods may include ice-jam floods, alluvial fan floods, dam failure floods, and floods associated with local drainage or high groundwater (as indicated in the previous flood definition). For the purpose of this HMP and as deemed appropriate by the County, riverine/flash, dam failure, and coastal flooding are the main flood types of concern for the County. These types of flood or further discussed below.

Riverine/Flash Floods – Riverine floods are the most common flood type and occur along a channel, and include overbank and flash flooding. Channels are defined, ground features that carry water through and out of a watershed. They may be called rivers, creeks, streams or ditches. When a channel receives too much water, the excess water flows over its banks and inundates low-lying areas (FEMA, 2005; FEMA, 2008).

Flash floods are "a rapid and extreme flow of high water into a normally dry area, or a rapid water level rise in a stream or creek above a predetermined flood level, beginning within six hours of the causative event (e.g., intense rainfall, dam failure, ice jam). However, the actual time threshold may vary in different parts of the country. Ongoing flooding can intensify to flash flooding in cases where intense rainfall results in a rapid surge of rising flood waters" (NWS, 2009).

Dam Failure Floods – A dam is an artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material for the purpose of storage or control of water (FEMA, 2010). Dams are man-made structures built across a stream or river that impound water and reduce the flow downstream (FEMA, 2003). They are built for the purpose of power production, agriculture, water supply, recreation, and flood protection. Dam failure is any malfunction or abnormality outside of the design that adversely affect a dam's primary function of impounding water (FEMA, 2011). Dams can fail for one or a combination of the following reasons:

- Overtopping caused by floods that exceed the capacity of the dam (inadequate spillway capacity);
- Prolonged periods of rainfall and flooding;
- Deliberate acts of sabotage (terrorism);

- Structural failure of materials used in dam construction;
- Movement and/or failure of the foundation supporting the dam;
- Settlement and cracking of concrete or embankment dams;
- Piping and internal erosion of soil in embankment dams;
- Inadequate or negligent operation, maintenance and upkeep;
- Failure of upstream dams on the same waterway; or
- Earthquake (liquefaction / landslides) (FEMA, 2010).

Coastal Flooding - Coastal flooding generally occurs along the coasts of oceans, bays, estuaries, coastal rivers and large lakes. Coastal floods are the submersion of land areas along the ocean coast and other inland waters caused by seawater over and above normal tide action. Coastal flooding is a result of the storm surge where local sea levels rise often resulting in weakening or destruction of coastal structures. Hurricanes and tropical storms, severe storms, and Nor'Easters cause most of the coastal flooding, including flooding in New Jersey. Coastal flooding not only results in the many problems identified for riverine flooding but could also include additional problems such as beach erosion, loss or submergence of wetlands and other coastal ecosystems, saltwater intrusion, high water tables, loss of coastal recreation areas, beaches, protective sand dunes, parks and open space, and loss of coastal structures (sea walls, piers, bulkheads, bridges, or buildings) (FEMA, 2011).

There are several forces that occur with coastal flooding:

- *Hydrostatic forces* against a structure are created by standing water or slowly moving water. Flooding can cause vertical hydrostatic forces or flotation.
- *Hydrodynamic forces* on buildings are created when coastal floodwaters move at high velocities. These high-velocity flows are capable of destroying solid walls and dislodging buildings with inadequate foundations. High-velocity flows can also move large quantities of sediment and debris that can cause additional damage. In coastal areas, high-velocity flows are typically associated with one or more of the following:
    - Storm surge and wave run-up flowing landward through breaks in sand dunes or across low-lying areas
    - Tsunamis
    - Outflow of floodwaters driven into bay or upland areas
    - Strong currents parallel to the shoreline, driven by waves produced from the storm
    - High-velocity flows

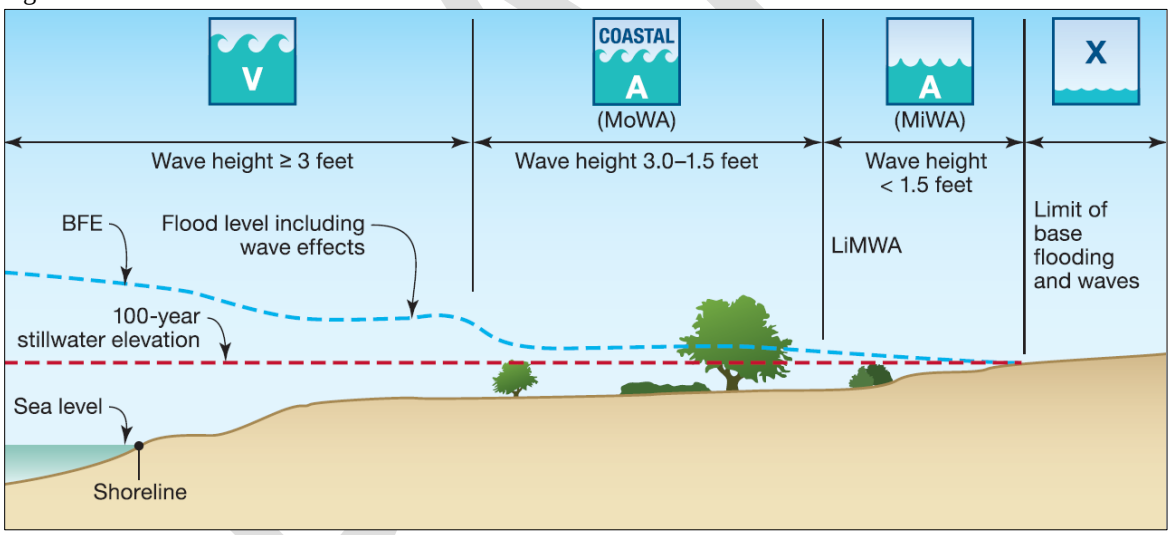
  High-velocity flows can be created or exacerbated by the presence of manmade or natural obstructions along the shoreline and by weak points formed by roads and access paths that cross the dunes, bridges or canals, channels, or drainage features.

- *Waves* can affect coastal buildings by breaking waves, wave run-up, wave reflection and deflection, and wave uplift. The most severe damage is caused by breaking waves. The force created by these types of waves breaking against a vertical surface is often at least 10 more times higher than the force created by high winds during a coastal storm.
- *Flood-borne debris* produced by coastal flooding events and storms typically includes decks, steps, ramps, breakaway wall panels, portions of or entire houses, heating oil and propane tanks, cars, boats, decks and pilings from piers, fences, erosion control structures, and many other types of smaller objects. Debris from floods is capable of destroying unreinforced masonry walls, light wood-frame construction, and small-diameter posts and piles (FEMA, 2011).

According to the 2011 Coastal Construction Manual, FEMA P-55, Zone V (including Zones VE, V1-30, and V) identifies the Coastal High Hazard Area, which is the portion of the special flood hazard area (SFHA) that extends from offshore to the inland limit of a primary frontal dune along an open coast and any other portion of the SFHA that is subject to high-velocity wave action from storms or seismic sources. The boundary of Zone V is generally based on wave heights (3 feet or greater) or wave run-up depths (3 feet or greater). Zone V can also be mapped based on the wave overtopping rate (when waves run up and over a dune or barrier). Zone A or AE, identify portions of the SFHA that are not within the Coastal High Hazard Area. These zones are used to designate both coastal and non-coastal SFHAs. Regulatory requirements of the National Flood Insurance Program (NFIP) for buildings located in Zone A are the same for both coastal and riverine flooding hazards. Zone AE in coastal areas is divided by the limit of moderate wave action (LiMWA). The LiMWA represents the landward limit of the 1.5-foot wave (FEMA, 2011).

The area between the LiMWA and the Zone V limit is known as the Coastal A Zone for building codes and standard purposes and as the Moderate Wave Action area by FEMA flood mappers. This area is subject to wave heights between 1.5 and 3 feet during the base flood. The area between the LiMWA and the landward limit of Zone A due to coastal flooding is known as the Minimal Wave Action area, and is subject to wave heights less than 1.5 feet during the base flood (FEMA P-55, 2011). Figure 10 1 is a typical transect illustrating Zone V, the Coastal A Zone and Zone A, and the effects of energy dissipation and regeneration of a wave as it moves inland. Wave elevations are decreased by obstructions such as vegetation and rising ground elevation (FEMA, 2011).

Figure 5.4.4-2. Transect Schematic



Source: FEMA, 2011

Extent

In the case of riverine or flash flooding, once a river reaches flood stage, the flood extent or severity categories used by the NWS include minor flooding, moderate flooding, and major flooding. Each category has a definition based on property damage and public threat:

- Minor Flooding - minimal or no property damage, but possibly some public threat or inconvenience.
- Moderate Flooding - some inundation of structures and roads near streams. Some evacuations of people and/or transfer of property to higher elevations are necessary.

- Major Flooding - extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations (NWS, 2011).

The severity of a flood depends not only on the amount of water that accumulates in a period of time, but also on the land's ability to manage this water. One element is the size of rivers and streams in an area; but an equally important factor is the land's absorbency. When it rains, soil acts as a sponge. When the land is saturated or frozen, infiltration into the ground slows and any more water that accumulates must flow as runoff (Harris, 2001).

Flood severity from a dam failure can be measured with a low, medium or high severity, which are further defined as follows:

- Low severity - No buildings are washed off their foundations; structures are exposed to depths of less than 10 feet.
- Medium severity - Homes are destroyed but trees or mangled homes remain for people to seek refuge in or on; structures are exposed to depths of more than 10 feet.
- High severity - Floodwaters sweep the area clean and nothing remains. Locations are flooded by the near instantaneous failure of a concrete dam, or an earthfill dam that turns into "jello" and washes out in seconds rather than minutes or hours. In addition, the flooding caused by the dam failure sweeps the area clean and little or no evidence of the prior human habitation remains after the floodwater recedes (Graham, 1999).

Two factors which influence the potential severity of a full or partial dam failure include (1) The amount of water impounded; and (2) The density, type, and value of development and infrastructure located downstream (City of Sacramento Development Service Department, 2005).

Several factors determine the extent of floods and are further discussed below.

- *Velocity of Water and Terrain*: High velocity floodwaters are more damaging than lower velocity floodwaters. Floodwaters flow more quickly in areas of steep topography (Burlington County HMP, 2008).
- *Size of a Watershed*: In large watersheds, it is often possible to predict flooding hours or even days in advance as conditions are observed building over time. In small watersheds in areas of steep terrain, flooding may come with little or no advance warning because of the speed of the water (Burlington County HMP, 2008).
- *Volume of Water*: As rainfall volume and intensity increase, so does the likelihood for flooding as the capacity of natural and man-made conveyances is exceeded. This is also true for higher volumes and rates of snowmelt (Burlington County HMP, 2008).

According to the National Weather Service Eastern Region Headquarters, 24-hour precipitation frequency estimates at observation stations in Burlington County are presented in Table 5.4.4-1.

Table 5.4.4-1. 24-Hour Precipitation Frequency Estimates Burlington County

Station	Inches Rain for Approximate Recurrence Interval									
	1-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	200-yr	500-yr	1000-yr
Burlington	2.75	3.33	4.25	5.03	6.21	7.22	8.34	9.58	11.4	13.1
Indian Mills	2.74	3.33	4.31	5.15	6.43	7.54	8.79	10.2	12.3	14.2
Moorestown	2.76	3.33	4.24	5.00	6.14	7.12	8.19	9.37	11.1	12.6

Station	Inches Rain for Approximate Recurrence Interval									
	1-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	200-yr	500-yr	1000-yr
Mount Holly	2.74	3.32	4.26	5.06	6.27	7.33	8.49	9.80	11.8	13.5
Pemberton	2.77	3.35	4.32	5.14	6.39	7.48	8.70	10.1	12.1	13.9
Springfield	2.83	3.42	4.39	5.22	6.47	7.55	8.75	10.1	12.1	13.9

Source: Hydrometeorological Design Studies Center, 2013

- *Ground Cover*: Impervious surfaces can lead to increased runoff and higher flood levels. According to the Burlington County Soils Survey, most of the soils in Burlington County are permeable, which means more rainwater and/or snowmelt is likely to infiltrate the soils (67% permeable, 22% rapidly permeable and 11% slowly permeable). However, urban areas with higher proportions of impervious surfaces (paved areas, buildings, etc.) as opposed to natural ground cover would exhibit a much higher runoff potential because they are in essence covering up the permeable soils. Urban ground cover is lowest in the southeastern portion of the county, and increases markedly in a northwestern direction approaching the County's population centers along the Delaware River. Thus, negative impacts of impervious surfaces would affect flooding more in northwestern communities than in southeastern communities (Burlington County HMP, 2008)

- *Topography:* Runoff will reach natural and man-made conveyance channels more rapidly in areas of steeper terrain. In general terms, southeastern areas of the County are generally flat, with increasing relief observed toward the northwestern areas (Burlington County HMP, 2008).

- *Tides*: The timing of storms as they relate to the tidal cycle often has a drastic effect on the severity of flooding in coastal areas. The level of coastal waters and tidally affected water courses increases at the time of high tide. The coincidence of a severe storm at the time of a high tide can exacerbate the effects of flooding. These effects can be combined with high intensity rainfall and urban runoff as storm sewer outlets become blocked by high tidal waters and runoff backs up through the system onto roadways. Tidal water bodies in Burlington County are identified in the County Profile section of this Plan (Burlington County HMP, 2008).

Location

Floods can occur almost anywhere in the State of New Jersey, although they tend to occur in and around areas near existing bodies of water, such as rivers, streams, and the Atlantic Ocean. According to FEMA Flood Insurance Studies (FISs) and Flood Insurance Rate Maps (FIRMs), the most damaging floods affecting developed areas occur in the northern half of the State. This is due to the number of physiographic and physical features of the landscape. Greater geographic relief in this part 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% of the northern counties in the State, these rivers and their tributaries are common locations for flooding (NJOEM, 2011).

Burlington County and its jurisdictions experience many types of flooding. While none of the County's municipalities directly border the Atlantic Ocean or Great Bay, many waterways are influenced by the

tides for at least some of their reaches. Flooding in Burlington County ranges from tidal and riverine flooding to shallow flooding which result from urban drainage issues.

Please refer to Section 4 (County Profile) for detailed information regarding the river basins and the hydrography/hydrology of Burlington County.

Advisory Base Flood Elevation (ABFE) Maps

Prior to Hurricane Sandy, FEMA had begun a coastal flood study to update FIRMs for portions of New York and New Jersey using improved methods and data to better reflect coastal flood risk. The studies included data that was collected and analyzed over a number of years. After Hurricane Sandy, FEMA released Advisory Base Flood Elevation (ABFE) maps which are based on the partially completed flood study for certain communities which were designed to help in rebuilding and recovery efforts. FEMA is currently in the process of releasing preliminary work maps that include full results of the coastal flood study (FEMA Region II, Date Unknown).

ABFEs provide a better picture of current flood risk than the existing FIRMs. The new ABFEs are the recommended elevation of the lowest floor of a building. Some communities may require that the lowest floor be built above the ABFE. ABFEs more accurately reflect the true one-percent annual chance flood hazard elevations in a given area. Following large storms, FEMA performs an assessment to determine whether the one-percent annual chance flood event, shown on the effective FIRMs, adequately reflects the current flood hazard. In some cases, FEMA determines that ABFEs need to be produced, based on the age of the analysis and the science used to develop the effective FIRMs. ABFEs are provided to communities as a tool to support in the recovery process that will aide in making those communities more resilient to future events (FEMA Region II, Date Unknown).

The ABFE maps will include delineated advisory flood hazard zones (Advisory Zone V, Advisory Zone A, and Advisory Zone X). The maps will also include ABFE elevations for 1% and 0.2% annual chance flood elevations. Area and limit of structurally damaging wave action and preliminary Hurricane Sandy high water marks will also be listed on the ABFE maps, along with coastal barrier resource areas (RiskMAP, Date Unknown).

The State of New Jersey has adopted emergency amendments to the Flood Hazard Area Control Act Rules (N.J.A.C. 7:13) which incorporate the use of ABFEs to determine flood elevations. Under these amendments, flood elevations are now determined either using the higher of the ABFE, the effective BFE or the design flood elevation shown on NJDEP flood maps; or site-specific calculations that demonstrate a different flood elevation (NJDEP, 2013a). ABFEs and Advisory Flood Hazard Maps shall take precedence over previous panels and FIS in only construction and development regulations. Where the SFHA and Advisory Flood Hazard Area maps conflict or overlap, whichever imposes the more stringent requirement will prevail (NJDEP, 2013b).

ABFEs are available in 10 New Jersey counties: Atlantic, Bergen, Burlington, Cape May, Essex, Hudson, Middlesex, Monmouth, Ocean, and Union (RiskMAP, Date Unknown).

Flood Hazard Areas

Base flood elevations and the boundaries of the 1-percent annual chance, or 100-year floodplains and the 0.2-percent annual chance, or the 500-year floodplains are shown on Flood Insurance Rate Maps (FIRMs), which are the principle tool for identifying the extent and location of the flood hazard. The FIRMs depict Special Flood Hazard Areas - those areas subject to inundation from the 1% annual chance flood (also known as the Base Flood or the 100-Year Flood). Those areas are defined as follows:

- Zones A1-30 and AE: Special Flood Hazard Areas that are subject to inundation by the base flood, determined using detailed hydraulic analysis. Base Flood Elevations are shown within these zones.
- Zone A (Also known as Unnumbered A Zones): Special Flood Hazard Areas where, because detailed hydraulic analyses have not been performed, no Base Flood Elevations or depths are shown.
- Coastal A Zone. A subset of Zone A. Specifically, that portion of the SFHA landward of Zone V (or landward of a coastline without a mapped Zone V) in which the principal source of flooding is coastal storms, and where the potential base flood wave height is between 1.5 and 3.0 feet.
- Zone AO: Special Flood Hazard Areas that are subject to inundation by types of shallow flooding where average depths are between 1 and 3 feet. These are normally areas prone to shallow sheet flow flooding on sloping terrain.
- Zone VE, V1-30: Special Flood Hazard Areas along coasts that are subject to inundation by the base flood with additional hazards due to waves with heights of 3 feet or greater. Base Flood Elevations derived from detailed hydraulic analysis are shown within these zones.
- Limit of Moderate Wave Action (LiMWA): Zone AE in coastal areas is divided by the LiMWA. The LiMWA represents the landward limit of the 1.5-foot wave. The area between the LiMWA and the Zone V limit is known as the Coastal A Zone for building code and standard purposes and as the Moderate Wave Action (MoWA) area by FEMA flood mappers. This area is subject to wave heights between 1.5 and 3 feet during the base flood. The area between the LiMWA and the landward limit of Zone A due to coastal flooding is known as the Minimal Wave Action (MiWA) area, and is subject to wave heights less than 1.5 feet during the base flood.
- Zone B and X (shaded): Zones where the land elevation as been determined to be above the Base Flood Elevation, but below the 500 year flood elevation. These zones are not Special Flood Hazard Areas.
- Zones C and X (unshaded): Zones where the land elevation has been determined to be above both the Base Flood Elevation and the 500 year flood elevation. These zones are not Special Flood Hazard Areas.

Flood Insurance Study (FIS)

In addition to FIRM and DFIRMs, FEMA also provides FISs for entire counties and individual jurisdictions. These studies aid in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. They are narrative reports of countywide flood hazards, including descriptions of the flood areas studied and the engineered methods used, principal flood problems, flood protection measures and graphic profiles of the flood sources (FEMA, Date Unknown).

A preliminary countywide FIS for Burlington County has been completed and is dated November 30, 2010. According to the FIS, the history of flooding within the County indicates that flooding may occur during any season of the year. The majority of floods have occurred during the summer and early fall months; however, floods have occurred at different times throughout the year. Portions of Burlington County experience tidal flooding from the Delaware River caused by extremely high tides, hurricane activity and tropical storms (FEMA, 2010).

The following discussion presents flood information as directly provided in the FEMA FIS document(s). The 2010 FIS discussed the principal flood problems throughout the County.

- *Township of Bass River* – flooding occurs at Bass River near Allens Dock at U.S. Route 9; at East Branch Bass River near Stage Road; and the Merrygold Branch of Wading River at Hammonton Road. All these flooding problems are affected by tidal flooding from the Great Bay.
- *City of Bordentown* – flooding is caused by runoff from intense rainfall and tidal flooding along the Delaware River.
- *Township of Bordentown* – the primary source of flooding in the Township is the Delaware River. The Township is also subject to tidal flooding.
- *City of Burlington* – tidal and riverine flooding from the Delaware River and Assicunk Creek. Heavy flooding damage has occurred in the area of U.S. Route 130.
- *Township of Burlington* – the primary source of flooding in the Township is the Delaware River. The Township is also subject to tidal flooding.
- *Township of Cinnaminson* – the Township experiences tidal, fluvial and poor drainage flooding. High tides on the Delaware River produce major flooding in Pompeston Creek's lower reaches. The upper reaches and tributaries, particularly the East Branch and Jacks Run, are subject to fluvial flooding and easily overflow during high intensity and short duration storm events.
- *Township of Delanco* – the Delaware River and Rancocas Creek are the primary sources of flooding when high tides occur due to hurricanes and large storms that pass along the Atlantic coast. In tidal areas, flooding may be intensified or produced from tidal swells created as a result of these storms. Flooding from runoff also affects the Township.
- *Township of Delran* – primary sources of flooding are the Delaware River, Rancocas Creek, Swede Run and Laurel Run.
- *Township of Eastampton* – flooding occurs in the low-lying areas adjacent to the North Branch of Rancocas Creek during hurricanes and large storms.
- *Township of Evesham* – flooding occurs in areas where culvert openings are inadequate to handle discharge and where debris at structures restricts the flow. Increasing development within the Township has aggravated flooding along Barton Run near Kenilworth Lake, the upstream reach of Rancocas Creek South Branch and the downstream reach of Pennsauken Creek South Branch.
- *Township of Florence* – the Delaware River is the primary source of flooding and the Township is subject to tidal flooding.
- *Township of Hainesport* – flooding is primarily due to hurricanes and large storms that pass along the Atlantic coast and cause high tides on the Delaware River, Rancocas Creek North and South Branches and Masons Creek.
- *Township of Lumberton* – torrential rainstorms are the primary cause of flooding. A flood occurred in September 1940 that caused dam failures at Taunton and Medford Lakes.
- *Township of Mansfield* – the Delaware River is the primary source of flooding. The Township is also subject to tidal flooding.
- *Township of Maple Shade* - Pennsauken Creek North and South Branches are the primary sources of flooding due to heavy rainfalls and thunderstorms.
- *Borough of Medford Lakes* – lakes are the primary source of flooding in the Borough. Flooding occurs when lakes levels are at their highest, typically during the summer months, and the lakes overtop their banks.
- *Township of Medford* – torrential rainstorms during summer and autumn months are the primary source of flooding in the Township. Record flood heights were reached on the Rancocas Creek North, South and Southwest Branches in September 1940. This even caused dam failures at Taunton and Medford Lakes.
- *Township of Moorestown* – residential, commercial and industrial structures located in the floodplains are subject to inundation from riverine and tidal flooding.
- *Township of Mount Holly* – flooding in the Township is mainly due from storms that produced riverine and tidal flooding. In tidal areas, flooding may be magnified or produced from tidal swells created as a result of the storm path over the ocean. Flooding along the Rancocas Creek

North Branch is made more severe due to undersized culverts connecting the dredged stream to the former stream under the Conrail embankment and from Buttonwood Run due to an increase in development upstream in the Township of Eastampton.

- *Township of Mount Laurel* – flooding is generated from the streams located within the Township which were studied by detailed methods.
- *Borough of Palmyra* – the Delaware River and the Pennsauken Creek are the primary sources of flooding. The Delaware River flows through tidal flatlands within the Borough and the Pennsauken Creek flows through the Borough to its confluence with the Delaware River. Both of the water bodies are affected by tidal flooding.
- *Borough of Pemberton* – the Rancocas Creek North Branch is the primary source of flooding in the Borough. A gauge is located on the downstream side of the Hanover Street Bridge.
- *Township of Pemberton* – flooding is primarily due to heavy rainstorms in the summer and autumn months. These events cause the Rancocas Creek North Branch to flood.
- *Township of Riverside* – the Rancocas Creek is the primary source of flooding in the Township. The Creek floods during hurricanes and other large storms that pass along the Atlantic coast and cause high tides on the Delaware River and subsequently, the Rancocas Creek.
- *Borough of Riverton* – flooding within the Pompeston Creek watershed occurs throughout the year. Both tidal and riverine flooding occurs within the Borough and inadequate drainage causes flooding as well. High tides on the Delaware River produce major flooding in Pompeston Creek's lower reaches. Jacks Run is frequently dry and can overflow easily during a high intensity rain storm. Urbanization within the Jacks Run area has decreased the ability of the watershed to absorb water which creates more surface water for a given frequency rainfall.
- *Township of Southampton* – the primary sources of flooding are the Rancocas Creek North Branch and the Beaverdam Creek. Floods occur during torrential rain storms in the summer and autumn months.
- *Township of Tabernacle* – flooding may occur from various sources during any time of the year; however, flooding in winter is infrequent. Springtime flooding, combined with ice and snowmelt, has occurred. The most extensive flooding has occurred during late summer and early fall and usually associated with hurricanes and/or tropical storms.
- *Township of Washington* – the Mullica River is the primary cause of flooding in the Township, typically associated with hurricanes and tropical storms. Downstream of the Pleasant Mills Bridge, flooding on the River is tidally influenced. Tributaries to the River have also experienced flooding, like the Batsto River.
- *Township of Westhampton* – the Rancocas Creek is the primary source of flooding due to large storms that pass along the Atlantic Coast and bring high tides on the Delaware River and subsequently the Rancocas Creek.
- *Township of Willingboro* – the primary source of flooding is the Rancocoas Creek due to large storms that pass along the Atlantic Coast and bring high tides on the Delaware River and subsequently the Rancocas Creek.
- *Township of Woodland* – flooding may occur on Bisphams Mill Creek and Wading River West Branch due to severe weather conditions during the summer and autumn months; however, flooding could occur any time of the year.

NJDEP Bureau of Dam Safety and Flood Control

A list of State Flood Hazard Area delineations were prepared by the NJDEP on May 15, 2002 for every county and municipality in the State. Flood Hazard Areas from this source within Burlington County are listed in Table 5.4.4-2. This was the most current list made available by the Bureau, dated January 2007.

Table 5.4.4-2. New Jersey State-Studied Streams in Burlington County

Municipality	River/Stream	Reach Studied
Bass River Township	None	N/A
Beverly City	None	N/A
Bordentown City	Blacks Creek	Entire Reach
	Crosswicks Creek	Entire Reach
Bordentown Township	Blacks Creek	Downstream Of U.S. Highway 206
	Crosswicks Creek	Entire Reach
	Delaware River	Entire Reach
	Delaware River Back Channel	Entire Reach
Burlington City	None	N/A
Burlington Township	Crosswicks Creek	Entire Reach
	Delaware River	Entire Reach
	Mill Creek	Downstream Of Interstate Highway 295
Chesterfield Township	None	N/A
Cinnaminson Township	None	N/A
Delanco Township	Delaware River	Entire Reach
	Rancocas Creek	Entire Reach
Delran Township	Rancocas Creek	Entire Reach
Eastampton Township	North Branch Rancocas Creek	Entire Reach
Edgewater Park Township	None	N/A
Evesham Township	Barton Run	Entire Reach
	Barton Run Tributary 1	Downstream Of New Road
	Barton Run Tributary 2	Downstream Of Taunton Lake Road
	Black Run	Downstream Of A Private Driveway Located Near Braddock Mill Road
	Black Run Tributary	Downstream Of Braddock Mill Road
	Cropwell Brook	Downstream Of North Cropwell Road
	Kettle Creek	Downstream Of A Point Located 1600 Feet Upstream Of Hopewell Road
	South Branch Pennsauken Creek	Downstream Of A Point Located 1500 Feet Upstream Of Old Marlton Pike
	Southwest Branch Rancocas Creek	Downstream Of A Point Located 1200 Feet Upstream Of Bon Air Drive
Fieldsboro Borough	Delaware River	Entire Reach
Florence Township	Bustleton Creek	Downstream Of U.S. Highway 130
	Crafts Creek	Downstream Of U.S. Highway 130
	Delaware River	Entire Reach
	Delaware River Back Channel	Entire Reach
Hainesport Township	Masons Creek	Entire Reach
	North Branch Rancocas Creek	Entire Reach
	South Branch Rancocas Creek	Entire Reach
Lumberton Township	Bobbys Run	Downstream Of Newbolds Corner-Mount Holly Road
	Little Creek	Entire Reach
	Masons Creek	Downstream Of Stacy Haines Road
	South Branch Rancocas Creek	Entire Reach
	South Branch Rancocas Creek Tributary	Downstream Of Stacy Haines Road
	Southwest Branch Rancocas Creek	Entire Reach
Mansfield	Crafts Creek	Downstream Of U.S. Highway 130

Municipality	River/Stream	Reach Studied
Township	Delaware River Back Channel	Entire Reach
Maple Shade Township	None	N/A
Medford Township	Ballinger Run	Downstream Of The Head Of Lake Stockwell
	Ballinger Run Tributary	Downstream Of A Point Located 90 Feet Upstream Of Birchwood Drive
	Barton Run	Entire Reach
	Barton Run Tributary 1	Entire Reach
	Blue Lake Run	Entire Reach
	Haynes Creek	Entire Reach
	Little Creek	Downstream Of State Highway 70
	Mimosa Lake Run	Downstream Of Scout Drive
	Sharps Run	Downstream Of Oliphants Mill-Hartford Road
	Skeet Run	Downstream Of Hawkin Road
	Southwest Branch Rancocas Creek	Entire Reach
	Taunton Lake Tributary	Downstream Of Centennial Avenue
Medford Lakes Borough	Ballinger Run	Entire Reach
	Lake Mishe-Mokwa Run	Downstream Of Hiawatha Trail
Moorestown Township	Rancocas Creek	Entire Reach
Mount Holly Township	Buttonwood Run	Downstream Of Branch Street
	Mill Race	Entire Reach
	Mount Holly By-Pass	Entire Reach
	North Branch Rancocas Creek	Entire Reach
Mount Laurel Township	Masons Creek	Entire Reach
	Rancocas Creek	Downstream Of The Confluence Of The North And South Branches
	South Branch Rancocas Creek	Entire Reach
New Hanover Township	None	N/A
North Hanover Township	None	N/A
Palmyra Borough	None	N/A
Pemberton Borough	Budds Run	Downstream Of A Point Located 850 Upstream Of Hanover Street
	North Branch Rancocas Creek	Entire Reach
Pemberton Township	Baffin Brook	Downstream Of Upton Station-Whitesbogs Road
	Budds Run	Downstream Of A Point Located 850 Feet Upstream Of Hanover Street
	County Lake Tributary	Downstream Of Upton Station-Whitesbogs Road
	Cranberry Branch	Downstream Of Lakehurst Road
	Jefferson Lake	Upstream Of Oregon Trail
	Little Pine Lake	Entire Reach
	Mirror Lake	Upstream 11600 Feet From Lakehurst Road
	Mount Misery Creek	Downstream Of A Point Located 1300 Feet Upstream Of Greenwood Bridge Road
	North Branch Rancocas Creek	Downstream Of Mirror Lake
	Ong Run	Upstream 4230 Feet From Little Pine Lake
	Pole Bridge Branch	Between County Lakes Spillway And Whitesbogs Road
	Pole Bridge Branch Tributary	Downstream Of Lakehurst Road
Riverside Township	Rancocas Creek	Entire Reach
Riverton Borough	None	N/A
Shamong Township	None	N/A

Municipality	River/Stream	Reach Studied
Southampton Township	Beaverdam Creek	Downstream Of U.S. Highway 206
	Friendship Creek	Downstream Of State Highway 70
	Jade Run	Entire Reach
	Little Creek	Downstream Of A Point Located 2000 Feet Upstream Of Ridge Road
	North Branch Rancocas Creek	Entire Reach
	South Branch Rancocas Creek	Downstream Of Bed Beg Hill Road
Springfield Township	None	N/A
Tabernacle Township	None	N/A
Washington Township	Mullica River	Downstream Of County Route 542
Westampton Township	Assiskunk Creek Tributary	Downstream Of A Point Located 1280 Feet Upstream Of Oxmead Road
	Mill Creek	Downstream Of Interstate Highway 295
	Mill Creek Tributary	Downstream Of Woodlane Road
	Rancocas Creek	Downstream Of The Confluence Of The North And South Branches
	North Branch Rancocas Creek	Entire Reach
Willingboro Township	Mill Creek	Entire Reach
	Rancocas Creek	Entire Reach
	South Branch Mill Creek	Downstream Of Kennedy Parkway
Woodland Township	Bisphams Mill Creek	Between State Highway 70 And Cooper Road
	Burrs Mill Brook	Between A Point Located 9350 Feet Upstream Of Burrs Mill Road And A Point Located 17150 Feet Upstream Of Burrs Mill Road
	Shinns Branch	Downstream Of Lebanon State Forest
	West Branch Wading River	Between County Route 532 And Lebanon State Forest
Wrightstown Borough	None	N/A

Source: NJDEP, 2007

Note: NJDEP indicated that these sources are for informational purposes only and do not necessarily list all New Jersey State Studied Streams. Not all portions of a stream reach listed in the municipality are studied and not all municipalities are necessarily mentioned for each county.

Additional Flood-Prone Areas in Burlington County

Additional flood-prone areas in Burlington County include the following:

- *Burlington County OEM (BCOEM)* notes that, in addition to mapped flood hazard areas, there are many small flooding areas that occur during heavy rain storms that may not cause major damage but do present problems to the community. The BCOEM noted that this was particularly true for communities bordering the Delaware River and Rancocas Creek (Lumberton, Southampton, Pemberton, Eastampton, Delanco, Riverside, Mount Holly, and Washington) (Burlington County HMP, 2008).
- *Township of Bass River* – all of the Township except for Route 679/Leektown Road extending north/northwest sustained damages from Superstorm Sandy; damages to structures and property and some infrastructure (Township of Bass River, 2013).
- *Township of Bordentown* – areas prone to flooding along Jumble Gut Run and South Amboy Road (Township of Bordentown, 2013).
- *City of Burlington* – most of the City lies within the one-percent annual chance flood area. Potential for flooding includes the Delaware River, Assicunk Creek, JFK Lake, and Pope's Run.

These areas flood often during hurricanes and other severe storms when combined with high tide (City of Burlington, 2013).

- *Township of Burlington* – the Township indicated that flooding occurs along the Assicunk Creek and the Delaware River along Linden Road. In addition, flooding along Route 130 and Beverly Road occurs with heavy rain and an overflow or breach of the lower and upper Sylvan Lakes Dams threaten the Township (Township of Burlington, 2013).
- *Township of Cinnaminson* – the Township indicated areas prone to flooding include Riverside Drive, Canal Street, areas around Steels Pond and Calhoun and Adams Streets (Township of Cinnaminson, 2013).
- *Township of Delran* – the Township has identified Riverside Park as an area of concern for flooding, particularly during Nor'Easters and severe storms (Township of Delran, 2013).
- *Township of Eastampton* – the Township noted that the extent of the flood hazard in their community has prompted two evacuations along the North Branch of the Rancocas Creek in the 18 month period preceding April 2007 (Burlington County HMP, 2008).
- *Township of Edgewater Park* – the Township indicated that sediment within Bogg's Ditch contributes to flooding of several Township properties. In addition, the Township stated there are issues with flooding around Adams Avenue due to the failure of pump stations and overtopping at the Adams Avenue Basins (Township of Edgewater Park, 2013).
- *Township of Evesham* – the Township reported that roadways commonly impacted by flooding include the Old Marlton Pike, Route 73 at Baker, Route 70 at Conestoga, Tauton Lake Road, and Barton Run Boulevard.
- *Township of Florence* – the Township identified flood problem areas related to high tide for the Delaware River, coupled with heavy rain events. In addition, the Township identified two private residences along Hornberger Avenue that are prone to flooding and two pump stations prone to flooding (Township of Evesham, 2013).
- *Township of Lumberton* - the South Branch of the Rancocas Creek flows through the Township. The Township noted their experience of several floods of the downtown area in the last seventy years. The most severe flooding events occurred in 1939 and 1940 and more recently July 12-13, 2004. These floods were all the result of record-setting rainfall and the subsequent collapse of upstream dams. The major area of flooding is the village or historical center of the town. This area once contained small businesses and factories but is now all residential. Little or no development along the creek floodplain is expected to occur (Burlington County HMP, 2008).
- *Township of Mansfield* – the Township reported that flood events in 2006 and 2007 caused primarily basement flooding in their community (Burlington County HMP, 2008).
- *Township of Maple Shade* – the Township identified areas along the Pennasauken Creek that is particularly vulnerable to flooding (Township of Maple Shade, 2013).
- *Township of Medford* – the Township indicated that severe flooding occurs at the southwest branch of the Rancocas Creek. In 2004 and 2007, significant flooding caused damage to homes and public infrastructure along the area of the Creek. The Township continually monitors local dams in effort to mitigate failure and associated flooding issues (Township of Medford, 2013).
- *Borough of Medford Lakes* – severe flooding occurs along the Upper and Lower Aetna Lakes as well as Ballinger Lake. The Borough monitors the local dams in effort to mitigate dam failure and associated flooding issues. Part of this monitoring includes working with Colony Club (private entity that owns several dams in the Borough) (Borough of Medford Lakes, 2013).
- *Township of Moorestown* – the Township identified flooding issues associated with New Albany Road at Glen Avenue, Albany Road at Pomperton Creek, and North Statewide Road at Pond View (Township of Moorestown, 2013).
- *Township of Mount Laurel* – the Township identified the following areas prone to flooding:
    - Flooding of the North Branch of Pennsauken Creek in the Ramblewood and Countryside sections of the Township

  - Flooding of the Rancocas Creek along Union Mill Road between Hartford and Briggs Roads; Hartford Road between State Highway 38 and Union Mill Road
  - New residential development of Rancocas Point, off of Creek and Centerton, lie in a potential flood zone by the Rancocas Creek
  - Centerton Bridge between Mount Laurel and Westampton Townships is susceptible to flooding of the Rancocas Creek
  - Township has 144 storm water management retention basins that overflow as a result of heavy rains resulting in flooded local roadways
  - Flooding of Masons and Parker Creeks cause closing and impassibility of local roads (Township of Mount Laurel, 2013)
- *Borough of Palmyra* – the Borough noted issues with the Borough's waste water treatment plan storm drain outfall (Borough of Palmyra, 2013)
- *Township of Pemberton* – the Township identified issues with the Bayberry and Hanover Dams (Township of Pemberton, 2013)
- *Borough of Pemberton* – the Borough noted that their fire station is located on the banks of the Rancocas Creek, which could be affected by floods (Burlington County HMP, 2008).
- *Township of Riverside* – the Township reported that flooding occurs with heavy rain and high tide on the Rancocas Creek, on Polk Street and Pavilion Avenue at the Delanco-Riverside Bridge. This causes the bridge to be closed until water recedes, and occurs about two to three times per year (Burlington County HMP, 2008).
- *Township of Shamong* – the Township noted that the July 2004 flood event, which had a severe impact on many of Burlington County's jurisdictions, had a limited impact upon their municipality (Burlington County HMP, 2008).
- *Township of Southampton* – the Township indicated flooding in various areas, including Floyd Avenue, Meadowyck, Retreat/Big Hill, and Bridle Path (Township of Southampton, 2013).
- *Township of Tabernacle* – the Township noted hazard areas along the stream crossing at Bread and Cheese Run and the steam crossing at McKendum Creek (Township of Tabernacle, 2013).
- *Township of Washington* – the Township noted the following problem areas: Route 542 west of Green Bank, near Crowley Landing mile markers 10 to 11, tidal flooding; Route 542 between Lower Bank and Wading River near mile marker 16, non-tidal; Route 652/River Road in Lower Bank between Charles Avenue and the Mullica River, tidal. Washington Township also identified areas of tidal flooding of highways in adjacent jurisdictions that have direct effects upon local highways, streets and emergency services. They are: Atlantic County Rote 563 approaching Green Bank Bridge from Weekstown (fire and emergency medical mutual aid from Weekstown and Mullica Township); Atlantic County Lower Bank Road ("2 Mile Stretch") approaching Lower Bank Bridge/Route 652 from Egg Harbor City/Atlantic County Route 563 (fire and emergency medical mutual aid from Egg Harbor City); and Burlington County Route 542 in Bass River Township at Merrygold Creek (emergency medical response from Washington Township via State Route 9/Garden State Parkway to Atlantic City Medical Center, mutual aid via Route 9 from New Gretna and Ocean County Fire and EM, and law enforcement response via Route 9 from NJSP – Tuckerton Station (Burlington County HMP, 2008).
- *Township of Westampton* – the Township noted minor flooding occurs along the Rancocas Creek that affects six homes (Township of Westampton, 2013).
- *Township of Willingboro* – the Township noted only isolated incidents of flooding in the past. The Township reported that several locations throughout the area have experienced damage mainly in terms of stream scouring behind residential properties, and that these areas are in need of stream bank restoration and repair to prevent stream blockages from downed trees which lead to flooding in the rear areas of residential properties. In addition, they noted the following locations which have experienced flooding in the past: Northampton Drive, Pennypacker Drive

(Bridge Area floods), Mainbridge Outfall Extension, Fleetwood Place Outfall repair (leads to flooding on Fleetwood Court) (Burlington County HMP, 2008).

- *Township of Woodland* - flooding occurs in remote areas only and does not impact local roadways (Burlington County HMP, 2008).

Dam Break Hazard Area

According to FEMA, three classification levels are adopted for dams: low, significant, and high. The classification levels build on each other. For example, the higher order classifications add to the list of consequences for the lower classification levels, as noted in Table 5.4.4-3. This hazard classification system categorizes dams based on the probable loss of human life and the impacts where persons are only temporarily in the potential inundation area. The classification levels are as follows:

- **Low Hazard Potential** – Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are primarily limited to the owner's property.
- **Significant Hazard Potential** – Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant potential classification dams are often located in predominately rural or agricultural areas but could also be located in areas with population and significant infrastructure.
- **High Hazard Potential** – Dams assigned the high hazard potential classification are those where failure or misoperation will most likely cause loss of human life (FEMA, 2004).

Table 5.4.4-3. Hazard Potential Classification for Dams

Hazard Potential Classification	Loss of Human Life	Economic, Environmental, Lifeline Losses
Low	None expected	Low and generally limited to owner
Significant	None expected	Yes
High	Probable; one or more expected	Yes (but not necessary for this classification)

Source: FEMA, 2004

According to the New Jersey Department of Environmental Protection (NJDEP), there are four hazard classifications of dams in New Jersey. The classifications relate to the potential for property damage and/or loss of life should the dam fail:

- Class I (High-Hazard Potential) - Failure of the dam may result in probable loss of life and/or extensive property damage
- Class II (Significant-Hazard Potential) - Failure of the dam may result in significant property damage; however loss of life is not envisioned.
- Class III (Low-Hazard Potential) - Failure of the dam is not expected to result in loss of life and/or significant property damage.
- Class IV (Small-Dam Low-Hazard Potential) - Failure of the dam is not expected to result in loss of life or significant property damage. Dam must also meet the requirements of a Class IV dam above.

Refer to Figure 4-X in the County Profile (Section 4) for dams located in Burlington County. Below are descriptions of high-hazard potential dams in the County that have experienced historical dam flooding.

Table 5.4.4-4. High Hazard Dams in Burlington County

NPDP ID	Dam Name	Dam Type	Location	River	Dam Height (ft)	Dam Storage (acre-feet)
NJ00041	Atsion Lake Dam	Earth Gravity	Shamong Township	Mullica River	19	250
NJ00043	Smithville Dam	Timber Crib	Eastampton Township	North Branch Rancocas Creek	10	65
NJ00151	Sylvan Lake Dam	Earth Gravity	Burlington Township	Mill Stream	18	99
NJ00396	Vincentown Mill Dam	Earth Gravity	Southampton Township	South Branch Rancocas Creek	12	107
NJ00416	Timber Lake Dam	Earth Gravity	Medford Township	Haynes Creek-Tr	19	55
NJ00419	Mishe - Mokwa Dam	Earth Gravity	Medford Lakes Borough	Haynes Creek	13	120
NJ00424	Centennial Lake Dam	Earth Gravity	Medford Township	Haynes Creek	18	344
NJ00425	Breakneck Dam	Earth Gravity	Medford Township	Haynes Creek	14	354
NJ00458	Mirror Lake Dam	Earth Gravity	Pemberton Township	Rancocas Creek	18	1900
NJ00459	Hanover Lake Dam	Earth	Fort Dix	Hartshorne Mill	8	880
NJ00583	Ballinger Lake Dam	Earth Gravity	Medford Lakes Borough	Rancocas Creek-Tr	11	21

Source: NPDP Multi-Attribute Dams Directory Query Summary, Date Unknown.

It is required by the State of New Jersey that all High Hazard and Significant Hazard dams must have NJDEP-approved Emergency Action Plans in place. It is the responsibility of the dam owner to review and update the EAP on an annual basis. New Jersey Dam Safety Standards also require that are periodically inspected to identify conditions that may adversely affect the safety and functionality a dam its appurtenant structures; to note the extent of deterioration as a basis for long term planning, periodic maintenance or immediate repair; to evaluate conformity with current design and construction practices; and to determine the appropriateness of the existing hazard classification. Inspection guidelines, as identified in the State Hazard Mitigation Plan, are reproduced in Table 5.4.4-5 in brief. Complete inspection and operating requirements for dams can be found in the New Jersey Dam Safety Standards (N.J.A.C 7:20-1.11).

Table 5.4.4-5. New Jersey Dam Inspection Requirements

Dam Size/Type	Regular Inspection	Formal Inspection
Class I (High Hazard) Large Dam	Annually	Once every 3 years
Class I (High Hazard) Dam	Once every 2 years	Once every 6 years
Class II (Significant Hazard) Dam	Once every 2 years	Once every 10 years

Dam Size/Type	Regular Inspection	Formal Inspection
Class III (Low Hazard) Dam	Once every 4 years	Only as required
Class IV (Zero Hazard) Dam	Once every 4 years	Only as required

In New Jersey, every dam in the State as defined in the Safe Dam Act, N.J.S.A. 58:4 is required to meet State dam safety standards. Dam Safety Laws provide the NJDEP with enforcement capabilities to achieve statewide compliance with dam safety standards. This includes issuing orders for compliance to dam owners, and pursuing legal action if the owner does not comply (with the goal of compliance and possible fines levied on a per-day basis for violations).

Previous Occurrences and Losses

Many sources provided historical information regarding previous occurrences and losses associated with flooding events throughout the State of New Jersey and Burlington County. With so many sources reviewed for the purpose of this HMP, loss and impact information for many events could vary depending on the source. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP.

According to NOAA's NCDC storm events database, Burlington County experienced 45 flood events between April 30, 1950 and December 31, 2012. Total property damages, as a result of these flood events, were estimated at $165.5 million. Total crop damages, as a result of these flood events, were estimated at $1 million. According to the Hazard Research Lab at the University of South Carolina's Spatial Hazard Events and Losses Database for the U.S. (SHELDUS), between 1960 and 2012, 21 flood events occurred within the County. The database indicated that severe storm events and losses specifically associated with Delaware County and its municipalities totaled over $176.5 million in property damage and over $10,000 in crop damage. However, these numbers may vary due to the database identifying the location of the hazard event in various forms or throughout multiple counties or regions.

Between 1954 and 2012, FEMA declared that the State of New Jersey experienced 28 flood-related disasters (DR) or emergencies (EM) classified as one or a combination of the following disaster types: coastal storm, high tides, heavy rain, hurricane, tropical storm, Nor'easter, mudslides, and tropical depression. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. However, not all counties were included in the disaster declarations. Of those events, Burlington County has been declared as a disaster area as a result of eight flood events (FEMA, 2012).

Based on all sources researched, known flooding events that have affected Burlington County and its municipalities are identified in Table 5.4.4-6. With flood documentation for the State of New Jersey being so extensive, not all sources have been identified or researched. Therefore, Table 5.4.4-6 may not include all events that have occurred throughout the County and region. Events previously reported in the 2008 County HMP are sourced as "Burlington County HMP".

Table 5.4.4-6. Flooding Events between 1933 and 2013.

Date of Events	Event Type	FEMA Declaration Number	County Designated?	Location and Description	Source(s)
August 1933	Flooding	N/A	N/A	A storm that was approximately equivalent to a four-percent annual chance event struck Burlington County. Local gages recorded flood stages of 9.4 feet at the Delaware River, 8.8 feet at the mouth of Pompeston Creek, and 9 feet at the mouth of Pennsauken Creek. A high water mark was recorded in the Borough of Fieldsboro at 9.3 feet.	FEMA FIS
September 1940	Flooding	N/A	N/A	This was a record event that struck the County. In the Township of Pemberton, 6.7 inches of rain fell. Along the Rancocas Creek North Branch, a gage recorded 1,480 cfs (flood stage of 14.8 feet). A high water mark along the same stream was recorded at 25.6 feet, higher than the deck of the bridge. A gage recorded a flood stage of 12.8 feet along Rancocas Creek South Branch at the Marne Highway bridge. In the Townships of Mount Holly and Lumberton, 150 people were left homeless. The storm also resulted in the failure of the Medford and Taunton Lakes dams.	FEMA FIS
August 17, 1955	Hurricanes Connie and Diane	N/A	N/A	Hurricanes Connie and Diane struck near Burlington County in August. Precipitation from the remnants of Hurricane Diane fell upon soil saturated by rainfall from the remnants of Hurricane Connie that fell only five days earlier. This flood caused record damage in the Delaware and Passaic River Basins. Statewide, 191 deaths and over $460 million in damages were recorded (1955 dollars). In Burlington County, the City of Burlington was particularly hard-hit, with more structures inundated than in any other community along the Delaware (956 structures damaged).	Burlington County HMP, FEMA FIS
August 26-28, 1971	Heavy Rains and Flooding (Tropical Storm Doria)	DR-310	Yes	Tropical Storm Doria struck New Jersey and resulted in peak flows greater than any recorded at 41 streams throughout the state, including Crosswicks Creek (16.24 feet recorded). Heavy precipitation fell for 32 hours. In Burlington County, northwest areas suffered the greatest in the Delaware River Basin. Burlington County received rainfall ranging from three inches in Bass River to 11 inches at McGuire Air Force Base. In the Delaware River Basin, flooding was primarily along tributaries to the Delaware.	Burlington County HMP, FEMA FIS
July 1975	Heavy Rains, High Winds, Hail and Tornadoes	DR-477	Yes	No reference and/or no damage reported.	FEMA

Date of Events	Event Type	FEMA Declaration Number	County Designated?	Location and Description	Source(s)
July 14, 1994	Flooding	N/A	N/A	Northwest Portion. Estimated $500,000 property damage. No further description reported.	Burlington County HMP
January 19, 1996	Flooding	N/A	N/A	No reference and/or no damage reported.	Burlington County HMP
June 19, 1996	Flooding	N/A	N/A	Northwest Portion. Nearly stationary thunderstorms doused northwestern parts of Burlington County. In Tabernacle, 2.75 inches of rain fell within 45 minutes. Three inches of rain fell in Mount Holly, 2.8 inches in Mount Laurel, 2.45 inches in Willingboro and 2.21 inches in Westampton. This caused flash flooding on roadways and smaller creeks. The foundation of one house in Mount Holly collapsed. Up to four feet of water accumulated on several roadways including Burlington County Roads 528 and 537 in North Hanover Township.	Burlington County HMP
July 31, 1996	Flooding	N/A	N/A	Southwest and West Portion. Thunderstorms with heavy rain caused poor drainage flooding and flooding of some of the smaller streams in southwestern and extreme western Burlington County. Kings Highway (New Jersey State Route 41) had four feet of water in several places. Rainfall totals included 1.93 inches in Mount Laurel, 1.84 inches in Mount Holly, and 2.20 inches in Beverly, most of which fell within a two hour period.	Burlington County HMP
August 16, 1996	Flooding	N/A	N/A	Northwest Portion. Thunderstorms caused considerable urban and poor drainage flooding as well as flooding of the smaller streams in the area. Hardest hit was Hanover Township. Storm totals included 3.15 inches at McGuire Air Force Base and 2.49 inches in Mount Holly. Most of this fell within two hours between 6 p.m. and 8 p.m.	Burlington County HMP
October 19, 1996	Flooding	N/A	N/A	Northwest Portion. Rain, heavy at times, during the first half of the day on the 19th caused urban and poor drainage flooding and flash flooding of some of the smaller streams within Burlington County including Barker Brook and Beaverdam Creek. The heavy rain and high astronomical tides forced the closure of the Delanco-Riverside Bridge both the nights of the 19th and 20th. It was the first time in two years that the bridge was closed due to tidal flooding. Representative storm totals included 5.41 inches in Blackwell Mills, 3.8 inches in Mount Holly, 3.68 inches in New Lisbon, 3.39 inches in Willingboro, 3.3 inches in Mount Laurel and 2.44 inches in Atsion.	Burlington County HMP
August 20, 1997	Flooding	N/A	N/A	New Gretna. Torrential rain fell for several hours across the extreme southeast tip of Burlington County. Doppler Radar estimated 6 to 8 inches of rain fell across the extreme	Burlington County HMP

Date of Events	Event Type	FEMA Declaration Number	County Designated?	Location and Description	Source(s)
				southeast tip of the county. Storm totals decreased quickly farther northwest. Only 3.48 inches of rain fell in Atsion, 3.43 inches in New Lisbon and 1.51 inches in Mount Holly. The torrential rain helped set a new record stage height for the East Branch of the Bass River at New Gretna. The river crested at 7.28 feet. The previous record was 6.36 feet on July 4, 1978. According to the United States Geological Survey, this represents a recurrence interval of greater than 100 years. No major damage or injuries were reported.	
August 14, 1999	Flooding	N/A	N/A	Northwest Portion. A series of thunderstorms with torrential downpours caused urban and poor drainage flooding as well as flash flooding of streams and creeks in Mercer County and also in adjoining sections of Northwestern Burlington County. Doppler Radar storm total estimates ranged between 2 and 5 inches across the area. Most of the rain fell within three hours. In Burlington County, storm totals included 3.91 inches at McGuire AFB. No serious injuries were reported.	Burlington County HMP
August 26, 1999	Flooding	N/A	N/A	Northeast Portion. During the late afternoon and early evening of the 26th thunderstorms with torrential downpours caused considerable poor drainage flooding as well as flooding of some of the smaller creeks and streams in northeastern Burlington County around the Lebanon State Forest and in central and northeast Ocean County. Doppler Radar storm total estimates around six inches Manchester Township in Ocean County and Pemberton and Woodland Townships in Burlington County. In Burlington County, several roads in Browns Mills were under water. Reported storm totals included 2.90 inches in New Lisbon and 2.19 inches at the McGuire AFB.	Burlington County HMP
September 16-18, 1999	Hurricane Floyd	EM-3148	Yes	Countywide. Estimate $7 million in property damage. Hurricane Floyd battered New Jersey (especially the central and northern thirds) and brought with it torrential and in some areas, unprecedented and record breaking rains and damaging winds. The effects of Floyd's outer bands were impacting Mount Holly as early as the 15th, as Floyd was just making landfall at the Mouth of Cape Fear or Bald Head Island in North Carolina. At 5pm on the 16th, Floyd was downgraded to a tropical storm as it passed about 10 miles east of Atlantic City. This hurricane was the greatest natural disaster to ever effect the State of New Jersey. Statewide, most storm totals ranged from three to ten inches, with storm totals increasing	Burlington County HMP

Date of Events	Event Type	FEMA Declaration Number	County Designated?	Location and Description	Source(s)
				farther west with locations along the Delaware River receiving the heaviest amounts. The highest verifiable total was 14.5 inches in Pompton Lakes (Passaic County). The combination of winds funneling into the Delaware Bay and the Delaware River and the record runoff from inland waterways produced minor to moderate tidal flooding at the times of high tide in Cumberland, Salem, Gloucester, Camden and Burlington Counties. Evacuations occurred in low-lying areas near the river. The evening high tide on the 16th also slowed the discharge of streams into the Delaware. In Burlington County, some of the worst flooding occurred along the larger waterways in the area (including the Rancocas Creek) and along tidal sections of tributaries to the Delaware River. Tidal flooding peaked during the evening high tide. In Burlington County, some evacuations occurred in Riverside around the Delanco-Riverside Bridge. The bridge was also closed. Farther upstream along the Rancocas Creek the Centerton Bridge in Willingboro was closed. Voluntary evacuations also occurred along the Delaware River in Delran and roads near the Rancocas Creek were closed. Several evacuations also occurred along the Assiscunk Creek in Burlington City. Creek flooding (mainly the Rancocas) occurred in Medford, Mount Holly and Westampton Townships. About 10 roads in the county were closed due to flooding. The North Branch of the Rancocas Creek in Pemberton crested at 3.2 feet at 9pm on the 17th; flood stage is 2.7 feet. Highest reported wind gusts were 62 mph in Browns Mills. Precipitation storm totals for the four highest report amounts in Burlington County were: 7.07 inches in Mount Laurel, 6.48 inches in New Lisbon, 6.32 inches in Willingboro, and 6.20 inches in Mount Holly. The highest wind gusts were mainly less than 60 mph. Preliminary damage estimates were, for the entire state, $1.1 billion. Bergen and Somerset Counties were hit the hardest. A federal disaster declaration was issued, but Burlington County, though hard-hit, was not declared. Nearby Philadelphia international airport set a new daily precipitation record of 6.63 inches, and a new 24-hour record of 6.77 inches.	
August 12, 2000	Flooding	N/A	N/A	Northwest Portion. Thunderstorms with copious amounts of rain drifted across northwestern Burlington County during the afternoon and early evening of the 12th. The heaviest rain fell in a swath from Willingboro east through Westampton and Southampton Townships. Residential and poor drainage	Burlington County HMP

Date of Events	Event Type	FEMA Declaration Number	County Designated?	Location and Description	Source(s)
				flooding was reported in Burlington City, Edgewater Park and Willingboro. An off-duty National Weather Service Employee in Willingboro reported that 3 inches of rain fell in 45 minutes. Four major roadways were closed. Farther to the east, two roadways were closed in Westampton Township and U.S. Route 206 was closed in both Eastampton and Southampton Townships. The Rancocas Creek caused some low lying farmland flooding in Eastampton and Southampton Townships. Storm totals included 3.08 inches in Willingboro, 2.31 inches in New Lisbon, 2.14 inches in Lumberton Township and 2.12 inches in Mount Holly. Although no stream flooding was reported, heavy rain in nearby Camden and Mercer Counties produced some poor drainage flooding. In Camden County, U.S. Route 130 from Collingswood to the Airport Circle was flooded. Storm totals included 2.17 inches in Somerdale (Camden County), 1.97 inches in Trenton (Mercer County), 1.65 inches in Pennsauken (Camden County) and 1.43 inches in Hightstown (Mercer County)	
December 17, 2000	Flooding	N/A	N/A	West Portion. An unseasonably warm air mass and an intense low pressure system and cold front produced heavy rain, flooding and high winds across southwest New Jersey. In Burlington County, northwest areas were affected. Doppler Radar storm total estimates were 1.5 to 3.0 inches within this band with the heaviest rain falling in Camden and Burlington Counties. In Willingboro, Beverly-Rancocas Road was closed because of a flooded creek. A flooded creek caused the closure of Rancocas Road in Westampton Township. Storm totals in Burlington County included 2.78 inches in Mount Laurel, 2.70 inches in Mount Holly, and 2.24 inches in Willingboro.	Burlington County HMP
August 4, 2001	Flooding	N/A	N/A	Beverly. Slow moving thunderstorms with torrential downpours produced urban flooding and flash flooding of smaller streams in and around Beverly. Numerous roads were flooded in Beverly. Doppler Radar one hour precipitation estimates reached between 3 and 3.5 inches.	Burlington County HMP
June 19, 2002	Flooding	N/A	N/A	Marlton. Thunderstorms also produced very heavy rain across Evesham Township and caused poor drainage and stream flooding. Vehicles were flooded up to their chassis at the Marlton Traffic Circle (intersection of New Jersey State Routes 73 and 70). Doppler Radar storm total estimates reached between 2 and 3 inches in the township, most of which fell in	Burlington County HMP

Date of Events	Event Type	FEMA Declaration Number	County Designated?	Location and Description	Source(s)
				about an hour.	
July 19, 2002	Flooding	N/A	N/A	Palmyra. Thunderstorms with very heavy rain caused considerable urban and poor drainage flooding as well as creek flooding from Palmyra south to Evesham. Adjusted Doppler Radar storm total estimates indicated that 4 to 5 inches of rain fell within a three hour period in this area. In Mount Laurel Township, State Route 38 near Interstate 295 was flooded. South Jersey Regional Airport in Lumberton Township reported a storm total of 3.04 inches. Elsewhere in the county, the heavy rain apparently contributed to a fatal accident in which three teenage boys were killed on State Route 38 in Southampton Township. The driver was heading westbound and lost control of the vehicle and veered into the eastbound lanes where it struck another vehicle.	Burlington County HMP
July 12, 2004	Severe Storms and Flooding	DR-1530	Yes	Central Portion. Estimated $50 million in property damage. Thunderstorms with torrential downpours kept on redeveloping along the Interstate 295 corridor in southern Burlington County and moved east, continuing for several hours and resulting in widespread storm totals exceeding 6 inches across most of the Rancocas Creek Basin. A storm total of 13.2 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. 21 dams were destroyed (eight of the dams were classified as significant hazard and 13 were classified as low hazard) and another 26 dams were damaged. Widespread poor drainage flooding also occurred. The combination of the dam failure and stream flooding led to the evacuation of 760 residents; the destruction of seven homes in Lumberton and Southampton Townships; major flood damage to around 200 homes; flood damage to about 1,000 homes; countless water rescues from vehicles and homes; the closing of 25 major roads including the New Jersey Turnpike, New Jersey State Routes 70 and 73; the contamination of drinking water and failure of sewage systems and the serious damage or destruction of fourteen bridges. Hardest hit municipalities included Lumberton, Medford (receiving over 17 inches of	Burlington County HMP, FEMA

Date of Events	Event Type	FEMA Declaration Number	County Designated?	Location and Description	Source(s)
				rainfall that resulted in the failure of several dams in Medford and Medford Lakes, and causing severe flooding in the Birchwood Lakes, Oakwood Lakes, and Lake Cotoxen areas as well as all along the Rancocas Cree, with numerous homes damaged or destroyed and total damage to public property of an estimated $2 million, according to Medford Township), Medford Lakes, Mount Laurel, Pemberton and Southampton all of whom declared states of emergency. Agricultural damage was estimated in the millions of dollars, especially to the cranberry bogs where many retention walls and earthen roads were damaged. Property damage was estimated at $50 million. Rainfall totals in Burlington County included 13.2 inches in Tabernacle, 11.23 inches in New Lisbon, 7.5 inches at Mount Holly Airport, 6.27 inches in Mount Laurel, and 6.17 inches at McGuire Air Force Base. One hundred and twenty-five homes were damaged and three were destroyed. Most of the flooded homes remained flooded for several days. Although there was no warning to the residents of Lumberton in advance of the flood there were no serious injuries. Lumberton's only fire house was flooded and could not have responded to a fire emergency. A sanitary sewer pump station was inundated and had to be replaced. Route 541 was flooded and could not be used to transport victims/patients to the area hospital in Mount Holly. Property losses in Lumberton covered by FEMA amounted to $3.4 million and additional losses were estimated at $9.1 million.	
August 31, 2004	Flooding	N/A	N/A	Central Portion. Thunderstorms with heavy rain associated with the remnants of Tropical Storm Gaston caused poor drainage flooding and some stream flooding mainly across the central portion of Burlington County. Doppler Radar storm total estimates exceeded 1.50 inches across much of the central portion of the county. While smaller streams flooded, the crests were much lower than they were on July 12th (during the dam break event). In Pemberton Township, flooding was reported in the Lace Valley Development and flood waters reached vehicle's windows on College Avenue. Storm totals included 7.00 inches in Southampton Township, 3.74 inches in New Lisbon, 3.20 inches in Mount Holly, 2.28 inches in Mount Laurel Township and 2.09 inches in Lumberton Township.	Burlington County HMP
August 8,	Flooding	N/A	N/A	Northwest Portion. Repeated thunderstorms with very heavy	Burlington County

Date of Events	Event Type	FEMA Declaration Number	County Designated?	Location and Description	Source(s)
2005				rain caused poor drainage flooding and flooding of some of the smaller streams in northwestern Burlington County from Mount Laurel and Burlington Townships east through Medford Lakes Borough. Saint Andrews Drive in the Ramblewood section of Mount Laurel looked like a lake. Specific storm totals included 3.00 inches in Tabernacle and 2.78 inches in Burlington Township.	HMP
October 14, 2005	Flooding	N/A	N/A	Rancocas Basin. County-wide three-day storm totals of 3 to 6 inches. Around 20 families in Eastampton and Lumberton Townships evacuated. In Eastampton Township, flooding along Rabbit Run and the North Branch of the Rancocas Creek cause evacuations from three blocks in the Ewansville Section of the township. Several dozen homes were surrounded by flood waters. In Lumberton Township, two blocks of the downtown section were evacuated. In Southampton Township, minor flooding occurred along the South Branch of the Rancocas Creek in the Vincentown Village. The Trinity Episcopal Church barely avoided being flooded again. In Pemberton Township, two roads were closed near the North Branch of the Rancocas Creek.	Burlington County HMP
January 4, 2006	Flooding	N/A	N/A	A low pressure system that exited the Delaware coast on the 3rd and runoff from the heavy rain produced some minor tidal flooding during the daytime high tide on the 4th in Upper Delaware Bay and along the Delaware River as well as along tidal sections of its tributaries.	Burlington County HMP
December 31, 2006	Flooding	N/A	N/A	Widespread minor tidal flooding during the daytime high tide along the Delaware River and tidal sections of its tributaries during the late morning and afternoon.	Burlington County HMP
June 24, 2006	Flooding	N/A	N/A	West Central Portion. Thunderstorms with heavy rain caused flooding of roadways and small streams from central Gloucester County northeast through central portions of Burlington County. Doppler Radar storm total estimates average 2 to 4 inches in this area. Roadway closures in Burlington County occurred in Burlington, Pemberton and Southampton Townships. Measured storm totals included 2.89 inches in Medford and 2.59 inches in Wrightstown.	Burlington County HMP
June 27, 2006	Flooding	N/A	N/A	Freshwater run-off from heavy rain combined with the higher of the two astronomical high tides of the day to cause moderate tidal flooding during the early morning on the 28th and 29th and minor tidal flooding during the early morning on the 27th and 30th. To a lesser degree flooding extended inland on tidal	Burlington County HMP

Date of Events	Event Type	FEMA Declaration Number	County Designated?	Location and Description	Source(s)
				sections of tributaries to the Delaware River. The highest tides occurred during the early morning on the 29th. In Burlington County minor flooding occurred with the early morning high tides on the 27th through the 29th in Burlington City, Delran and Bordentown. The Delanco-Riverside Bridge was closed around the early morning high tide on the 28th and 29th.	
October 6-7, 2006	Flooding	N/A	N/A	No reference and/or no damage reported.	Burlington County HMP
October 28, 2006	Flooding	N/A	N/A	No reference and/or no damage reported.	Burlington County HMP
November 8, 2006	Flooding	N/A	N/A	Heavy rain caused flooding along Parkers Creek in Mount Laurel. Union Mill Road was closed. Storm totals included 3.47 inches in Wrightstown, 2.86 inches in Willingboro, 2.54 inches in Medford, 2.51 inches in Chatsworth, 2.47 inches in Mount Laurel, 2.38 inches in Burlington Township and 1.94 inches in Southampton.	Burlington County HMP
November 16, 2006	Flooding	N/A	N/A	No reference and/or no damage reported.	Burlington County HMP
January 1, 2007	Flooding	N/A	N/A	No reference and/or no damage reported.	Burlington County HMP
January 8, 2007	Heavy Rain and Flooding	N/A	N/A	Heavy rain that fell during the evening and overnight on the 7th caused poor drainage flooding and flooding along Parkers Creek in Mount Laurel Township. Union Mill Road was closed between Briggs and Hartford Roads. Storm totals included 1.83 inches in Mount Laurel and Southampton, 1.77 inches in Lumberton, 1.75 inches in Medford, 1.71 inches in Mount Holly and 1.66 inches in Willingboro.	Burlington County HMP
March 2, 2007	Flooding	N/A	N/A	High stages along the Delaware River	Burlington County HMP
April 14-20, 2007	Severe Storms and Inland and Coastal Flooding	DR-1694	Yes	Major flooding in locations throughout the State and County. The April 15 and 16 nor'easter dumped upwards of 7 inches of rain across the state. The damage cost in Burlington County was estimated at $8.3 million, with Lumberton, Medford and Southampton among the most seriously affected. The Rancocas watershed was particularly impacted, with heavy rainfall coupled with unusually high tides. Gages along the main stem of the Delaware River experienced 1.5-year to 4-year events. Tributaries to the Delaware River generally experienced 4-15 year return interval floods, except on the Southwest Branch and South Branch of the Rancocas Creek in Burlington County where peaks equaled approximately the	BCOEM, NWS, local news reports, NJOEM, FEMA, NOAA-NCDC, SHELDUS, Planning Committee Input

Date of Events	Event Type	FEMA Declaration Number	County Designated?	Location and Description	Source(s)
				30 and 50-year return interval flood, respectively. In Delran Township, roads were closed in the Riverside Park neighborhood. The fire department responded to numerous calls for assistance pumping out basements. Maple Shade Township experienced power outages. EMS, police and DPW employees worked overtime. Pemberton Township had road closures, utility outages and commercial closures and had an estimated $29 K in losses. Acting Governor Codey declared a state of emergency for New Jersey. Damages for the State were estimated at over $180 M in property damages. FEMA issued a disaster declaration for this event, which included Burlington County. Overall, FEMA approved $18,821,508.61 in IA and $17,513,033.42 in PA.	
June 6, 2008	TSTM / Flooding	N/A	N/A	Thunderstorms brought heavy rain during the late afternoon of the 6th, causing roadway flooding and flooding of smaller creeks in and around Palmyra Borough. Several roads in Palmyra were flooded and some minor flooding also occurred at the entrance of the Palmyra Tacony Bridge.	NOAA-NCDC
September 6, 2008	Remnants of Tropical Storm Hanna	H/A	N/A	Heavy rain associated with Tropical Storm Hanna caused widespread heavy rain and poor drainage flooding, especially in the northern part of New Jersey. The runoff also caused some isolated flooding along some of the smaller streams and creeks in the area. Flash flooding occurred in and around Palmyra Borough. The Tacony-Palmyra Bridge Toll Plaza was flooded and all eastbound traffic into New Jersey was halted for about 45 minutes until the water receded. Two other roadways in Palmyra were also closed. Doppler Radar adjusted storm total amounts exceeded three inches in the borough. Some roadway lane closures occurred in Pemberton Township because of the heavy rain. Event precipitation totals included 2.25 inches in Willingboro Twp., 2.18 inches in Mount Holly Twp., 1.98 inches in Wrightstown Borough and 1.76 inches in Burlington Twp.	NOAA-NCDC
June 13, 2009	Flooding	N/A	N/A	Widely scattered but slow moving thunderstorms with heavy rain affected southern New Jersey during the afternoon on the 13th and caused isolated flooding. The torrential rain caused poor drainage and stream flooding in Medford Township. Several roads were closed. Hardest hit roadways were the intersection of New Jersey State Route 70 and Hartford Road	NOAA-NCDC

Date of Events	Event Type	FEMA Declaration Number	County Designated?	Location and Description	Source(s)
				in the township. One car was stranded in the flood waters. Doppler Radar storm total estimates reached between 3 and 4 inches in parts of Medford and Southampton Townships; most fell within one hour.	
December 26, 2009	Melting Snow / Flooding	N/A	N/A	The combination of melting snow and between 1.5 and 3.0 inches of rain led to poor drainage and widespread river flooding in New Jersey. The North Branch of the Rancocas Creek at Pemberton Twp. was above its 2.5 foot flood stage from 8:15 p.m. on the 26th through 11:00 a.m. on the 30th. It crested at 3.06 feet at 100 a.m. on the 28th. Event precipitation totals included 2.34 inches in Medford Twp., 2.1 inches in Moorestown Twp., 2.02 inches in Mount Laurel Twp., 1.92 inches in Pemberton Twp. and 1.74 inches in Mount Holly Twp.	NOAA-NCDC
February 24, 2010	Snowstorm	DR-1873	Yes	A protracted period of rain coupled with snow melt caused flooding of some of the more flood prone creeks and rivers in central and southern New Jersey from the 24th into the 27th. Ironically it was snowing when some of the waterways were above flood stage on the 25th and 26th. The North Branch of the Rancocas Creek at Pemberton was above its 2.5 foot flood stage from 11 a.m. on the 24th through 330 p.m. on the 27th. It crested at 2.66 feet at 2 a.m. on the 25th. Precipitation totals included 1.69 inches in Pemberton Twp., 1.31 inches in Medford Twp., 1.15 inches in Moorestown Twp., 1.09 inches in Mount Laurel Twp., and 0.97 inches in Burlington Twp.	NJOEM, NOAA-NCDC, FEMA
March 13, 2010	Flooding	N/A	N/A	Four days of rain, heaviest on the 13th, culminated in major flooding in the Passaic and Raritan Basins and flooding throughout New Jersey. Four day storm totals averaged around 2.5 to 6 inches with the highest amounts in the Raritan and Passaic Basins. It was the worst flooding in the Raritan Basin since April of 2007 and the worst flooding in the Passaic Basin since April of 1984. Damage was estimated at 30 million dollars as thousands of homes and businesses were damaged. New Jersey Governor Chris Christie declared a state of emergency on March 14th. The North Branch of the Rancocas Creek at Pemberton Twp. was above its 2.5 foot flood stage from 545 p.m. on the 13th through 615 a.m. on the 19th. It crested at 3.68 feet at 115	NOAA-NCDC, NJOEM

Date of Events	Event Type	FEMA Declaration Number	County Designated?	Location and Description	Source(s)
				p.m. on the 15th. Event precipitation totals included 4.16 inches at the McGuire Air Force Base, 3.86 inches in Medford Twp., 3.84 inches in Moorestown Twp. and 3.06 inches in Mount Holly Twp.	
March 29, 2010	Flooding	N/A	N/A	A series of low pressure systems that brought between two and five inches of rain from the evening of the 28th into the early morning of the 31st. Coupled with already wet antecedent conditions, the rain caused renewed flooding in New Jersey, especially in the Raritan and Passaic Basins. While the flooding was not as severe as it was in the middle of the month, it took until early April for all of the rivers to recede back within bankfull. The North Branch of the Rancocas Creek at Pemberton was above its 2.5 foot flood stage from 715 p.m. EDT on the 29th through 100 p.m. EDT on April 3rd. It crested at 3.51 feet at 1230 p.m. EDT on the 31st. Event precipitation totals included 3.70 inches in Pemberton Twp., 3.30 inches in Mount Holly Twp. and 3.21 inches in Mount Laurel Twp.	NOAA-NCDC
April 1, 2010	Severe Storms and Flooding	DR-1897	Yes	River and stream flooding from the heavy rain that fell on March 28th and 30th continued through April 4th in parts of Morris, Somerset, Burlington, Ocean, Salem and Cumberland Counties. A federal disaster was declared for the State of New Jersey (DR-1897) for severe storms and flooding, and Individual Assistance funding was made available. The North Branch of the Rancocas Creek at Pemberton Twp. was above its 2.5 foot flood stage from 715 p.m. on March 29th through 1:00 p.m. on April 3rd. It crested at 3.51 feet at 12:30 p.m. on March 31st.	NOAA-NCDC, FEMA, NJOEM
July 14, 2010	Flooding	N/A	N/A	For the second consecutive day, thunderstorms with torrential downpours caused flash flooding of smaller creeks as well as urban and poor drainage flooding in the Philadelphia suburbs in southwestern New Jersey. Doppler Radar two day storm total estimates reached as high as 6 inches. Torrential downpours caused the closure of Northbound State Route 73 near Greentree Road in Evesham Twp. Two day Doppler Radar storm total estimates reached 5 to 6 inches in Burlington County. At South Jersey Regional Airport in Lumberton Twp., 3.72 inches of rain fell during the afternoon of the 14th.	NOAA-NCDC

Date of Events	Event Type	FEMA Declaration Number	County Designated?	Location and Description	Source(s)
April 16-17, 2011	Flooding	N/A	N/A	Heavy rain caused poor drainage and stream and river flooding, mainly in west central and northern New Jersey. Major flooding occurred again in sections of the Passaic River Basin. Flooding along Parkers Creek in Mount Laurel Township forced the closure of Union Mill Road. The heavy rain also caused basement flooding of homes on Oregon Trail in Medford Township. Event precipitation totals included 2.89 inches in Mount Laurel Twp., 2.79 inches in Lumberton Twp., 2.78 inches in Westampton Twp., 2.61 inches in Medford Twp., 2.50 inches in Wrightstown Twp., 2.46 inches in Moorestown Twp., 2.43 inches in Southampton Twp., 2.33 inches in Medford Lakes Twp. and 2.32 inches in Burlington Twp. SHELDUS reported $250,000 in damages for Burlington County.	SHELDUS, NOAA-NCDC
July 6, 2011	Flooding	N/A	N/A	Scattered strong to severe thunderstorms affected central New Jersey during the afternoon and into the early evening of the 6th. Flash flooding occurred in northwestern Burlington County. Adjusted Doppler Radar storm total estimates were 3 to 4 inches in parts of Florence, Mansfield and Bordentown Townships. Thunderstorms with heavy rain caused flash flooding along the U.S. Route 206 corridor in Bordentown Twp. A couple of water rescues occurred and no injuries were reported. Adjusted Doppler Radar storm total estimates were 3 to 4 inches in parts of Bordentown Twp. More small stream and roadway flash flooding occurred in Florence Township, where adjusted Doppler Radar storm total estimates were 3 to 4 inches. An observer in neighboring Chesterfield Township measured 2.49 inches of rain.	NOAA-NCDC
September 4, 2012	Hurricane Irene	DR-4021 EM-3332	Yes	Successive waves of thunderstorms with very heavy rain overnight on the 3rd into the 4th produced flash flooding in southeastern Burlington County, including small stream and poor drainage flooding in sections of Bass River and Woodland Township. The runoff from the torrential rains caused flooding along the Oswego and Wading Rivers that lasted into the 6th. Additional thunderstorms during the next	NOAA-NCDC, Planning Committee Input

Date of Events	Event Type	FEMA Declaration Number	County Designated?	Location and Description	Source(s)
				couple of days slowed the recession of the flooding along those rivers. Flooding affected Burlington County Routes 563 and 679. Burlington County Route 563 was closed and barricaded at the Evans Bridge in Wading River. The bridge was expected to remain closed at least into the 7th until it could be evaluated for damage. The roadway itself was closed between Greenbank-Chatsworth Road in Washington Township and Leektown Road in Bass River Township. In Delran Township, roads were closed throughout. In Evesham Township, the Township experienced power outages, road closures and damages, and flooding. Residential structures had flood damage. Doppler Radar storm total estimates reached around 10 inches in southeastern Burlington County, more than half of which fell with the first wave of torrential downpours. Event precipitation totals included 5.19 inches in Chatsworth (Woodland Township).	
August 28-31, 2011	Hurricane Irene	EM-3332 DR-4021	Yes Yes	Hurricane Irene hit the State of New Jersey on August 27th, resulting in a state disaster declaration August 29th and a presidential disaster declaration August 31st. Irene produced torrential downpour rains that resulted in major flooding and a number of record breaking crests on area rivers, including the Rancocas Creek in Burlington County. Flooding lasted as long as September 5th. Thousands of homes were flooded; including approximately 300 basements in Burlington City. Record flooding along the North Branch of the Rancocas Creek affected Mount Holly Twp. About 300 families were evacuated. The township municipal building, the county courthouse, and many downtown roads were flooded. Farther upstream, many properties were flooded in the Unionville section of Eastampton Twp. and the North Pemberton Railroad Station was badly damaged. Dozens of homes were flooded in downtown Lumberton Twp. along the South Branch of the Rancocas Creek. In the southeastern part of the county, flooding occurred at both the Mullica and Batsto Rivers, and Batsto Village was damaged. In Maple Shade Township, shelters had to be open to house residents who were affected. The Township had numerous road closures and approximately	NOAA-NCDC, SHELDUS, Planning Committee Input

Date of Events	Event Type	FEMA Declaration Number	County Designated?	Location and Description	Source(s)
				$33 K in property damages. Mansfield Township experienced numerous road closures and power outages. Westampton Township reported road closures, utility outages and commercial closures. Washington Township opened a shelter for residents; experienced flooding and power outages. Batsto and Pleasant Mills Bridges/Route 542 were damaged. Tabernacle Township reported minor power outages. Springfield Township had power outages and road closures; roads were damaged and the fire department had to pump out basements. Southampton Township had to evacuate residents; flooding caused extensive damage to portions of the Township (south branch of the Rancocas River). Roads were closed due to debris and flooding. Forty-six homes had minor damage. Pemberton Township had road closures, utility outages and commercial closures and had an estimated $42 K in losses. Palmyra Borough experienced downed trees and utility lines. Shelters were open for residents. The North Branch of the Rancocas Creek at Pemberton had a record breaking major flooding crest of 4.91 feet at 8:15 a.m. on the 29th. The creek was above its 2.5 foot flood stage from 11:45 p.m. on the 27th through 6:45 p.m. on Sept. 1st. Event rainfall totals included 7.14 inches in Chesterfield Twp., 6.67 inches in Mount Laurel Twp., 6.66 inches in West Moorestown Twp., 6.37 inches in Hainesport Twp. and 6.28 inches in Moorestown Twp. Damage from the storm was so widespread that for the first time in state history, all 21 counties became eligible for both Individual Assistance (IA) and Public Assistance (PA). At the time of this report, a total $176.6M in IA had been approved and $111.9M in PA had been obligated throughout the state of New Jersey. Burlington County had approximately $500K in damage due to the storm.	
September 1, 2011	Flooding	N/A	N/A	While all the highest crests with Irene occurred in August, river and creek flooding persisted into September in parts of Burlington County. The North Branch of the Rancocas Creek at Pemberton Twp. had a record breaking major flooding crest of 4.91 feet at 8:15 a.m. on August 29th. The creek was above its 2.5 foot flood stage from 11:45 p.m. on August 27th through 6:45 p.m. on September 1st.	NOAA-NCDC

Date of Events	Event Type	FEMA Declaration Number	County Designated?	Location and Description	Source(s)
September 29, 2011	Flooding	N/A	N/A	The combination of fresh water runoff, unusually high spring astronomical tides and a weak southeasterly flow produced moderate tidal flooding during the afternoon high tide cycle along tidal sections of the Delaware River and its tributaries. While the worst tidal flooding for this event occurred during that afternoon, minor tidal flooding also occurred during the afternoon of the 28th, early morning of the 29th, and the late afternoons of September 30th, October 1st and October 2nd. In Burlington County, tidal sections of the Rancocas Creek also flooded. Flooding along the Delaware River affected Stewart Avenue and River Drive in Delran Township. Tidal flooding also affected the East Riverton section of Cinnaminson Township as the Pompeston Creek also flooded. Dozens of homes were flooded along Zeisner Avenue and Kern Street. River Road was also flooded. In both Delran and Cinnaminson, flood waters reached into basements and made it impossible to use indoor plumbing. In Camden County, the Admiral Wilson Boulevard flooded. The afternoon high tide in Burlington City reached 10.51 feet above mean lower low water. There is no current categorical tide gage information for this site. Burlington County had approximately $100K in damages.	SHELDUS. NOAA-NCDC
September 2012	Flooding	N/A	N/A	In Washington Township, the Evans Bridge/Route 563 sustained damage. Roads were closed due to flooding. The Pine Island Cranberry Company sustained damage to agricultural infrastructure and crops.	Planning Committee Input
October 26 – November 8, 2012	Hurricane Sandy	EM-3354 DR-4086	Yes Yes	Hurricane Sandy made landfall in New Jersey on October 28, causing widespread damage. The result of the storm was devastation to homes and infrastructure along the Delaware River and near the Atlantic coast in Burlington County, and record disruptions of transportation and communications. The heavy rain caused urban and poor drainage flooding and exacerbated the tidal flooding along the Delaware River and near the Atlantic coast in Burlington County. Along the Delaware River, tidal flooding occurred in the Columbus Park Development along the Assiscunk Creek in Burlington City. The most widespread damage (mainly tidal and flood related)	SHELDUS, NOAA-NCDC, NJOEM, FEMA, Planning Committee Input

Date of Events	Event Type	FEMA Declaration Number	County Designated?	Location and Description	Source(s)
				was reported in Bass River Township. Westampton Township reported road closures, utility outages and commercial closures. Tabernacle Township reported minor damage with power outages. Springfield Township had power outages and road closures; many pieces of road and safety equipment were lost during the storm. Southampton Township reported utility outages in the Liesuretowne section of the Township which affected 342 homes, in addition to homes in the areas of Burrs Mills Road and Firelane for four days. Thirty homes experienced minor to major damage. Pemberton Township had road closures, utility outages and commercial closures. The Bayberry Dam had infrastructure damage. In Mount Laurel Township, Union Mill Road was closed because Parkers Creek flooded. The North Branch of the Rancocas Creek at Pemberton was above its 2.5 foot flood stage from 430 p.m. on the 30th through 6 p.m. on the 31st It crested at 2.58 feet at 130 a.m. on the 31st. The McDonald's Branch in Woodland Township was above its 1.7 foot flood stage from 345 p.m. through 944 p.m. on the 27th, cresting at 1.71 feet at 4 p.m. In Delran Township, roads were closed throughout the Township. In Evesham Township, power outages, road closures and damages, and flooding were all reported. Minor damages were reported to roadways and sidewalks due to downed trees. The MUA pump station experienced minor damage. The Township reported approximately $29K in damages. Hainesport Township had to remove debris throughout the Township as a result of hurricane-force winds. The Township DPW building sustained damage. Mansfield Township experienced numerous road closures and power outages. Event precipitation totals included 4.10 inches in Medford Township, 3.51 inches in Woodland Township at Chatsworth, 3.15 inches in Medford Lakes Borough, 2.92 inches in Mount Laurel Township, 2.82 inches in Moorestown Township, and 2.42 inches in Westampton Township. A federal emergency declaration was announced for New Jersey on October 29, and a major disaster declaration	

Date of Events	Event Type	FEMA Declaration Number	County Designated?	Location and Description	Source(s)
				followed the next day, making IA and PA funds available to affected residents. At the time of this report, a total $274.9M in IA had been approved and $81M in PA had been obligated throughout the State of New Jersey.	

Note (1): Monetary figures within this table were U.S. Dollar (USD) figures calculated during or within the approximate time of the event. If such an event would occur in the present day, monetary losses would be considerably higher in USDs as a result of increased U.S. Inflation Rates.

B	Billion
DR	Federal Disaster Declaration
EM	Federal Emergency Declaration
FEMA	Federal Emergency Management Agency
IA	Individual Assistance
K	Thousand ($)
M	Million ($)
N/A	Not applicable
NCDC	National Climate Data Center
NOAA	National Oceanic Atmospheric Administration
NWS	National Weather Service
PA	Public Assistance
SHELDUS	Spatial Hazard Events and Losses Database for the U.S.
Twp.	Township

Federal Programs

National Flood Insurance Program

The NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in participating communities. For most participating communities, FEMA has prepared a detailed Flood Insurance Study (FIS). The study presents water surface elevations for floods of various magnitudes, including the 1-percent annual chance flood and the 0.2-percent annual chance flood (the 500-year flood). Base flood elevations and the boundaries of the 100- and 500-year floodplains are shown on Flood Insurance Rate Maps (FIRMs), which are the principle tool for identifying the extent and location of the flood hazard.

The FIRMs depict Special Flood Hazard Areas - those areas subject to inundation from the 1-percent annual chance flood (also known as the Base Flood or the 100-Year Flood). Those areas are defined as follows:

- Zones A1-30 and AE: Special Flood Hazard Areas that are subject to inundation by the base flood, determined using detailed hydraulic analysis. Base Flood Elevations are shown within these zones.
- Zone A (Also known as Unnumbered A Zones): Special Flood Hazard Areas where, because detailed hydraulic analyses have not been performed, no Base Flood Elevations or depths are shown.
- Zone AO: Special Flood Hazard Areas that are subject to inundation by types of shallow flooding where average depths are between 1 and 3 feet. These are normally areas prone to shallow sheet flow flooding on sloping terrain.
- Zone VE, V1-30: Special Flood Hazard Areas along coasts that are subject to inundation by the base flood with additional hazards due to waves with heights of 3 feet or greater. Base Flood Elevations derived from detailed hydraulic analysis are shown within these zones.
- Zone B and X (shaded): Zones where the land elevation as been determined to be above the Base Flood Elevation, but below the 500 year flood elevation. These zones are not Special Flood Hazard Areas.
- Zones C and X (unshaded): Zones where the land elevation has been determined to be above both the Base Flood Elevation and the 500-year flood elevation. These zones are not Special Flood Hazard Areas.

NFIP data for Burlington County is presented further in in the Vulnerability Assessment section of this profile.

Biggert-Water Flood Insurance Reform Act of 2012

In July 2012, the U.S. Congress passed the Biggert-Water Flood Insurance Reform Act of 2012 (BW-12) which calls on FEMA and other agencies to make a number of changes to the way the NFIP is run. Key provisions of the legislation will require the NFIP to raise rates to reflect true flood risk, make the program more financially stable, and change how FIRM updates impact policyholders. BW-12 also eliminated the Repetitive Flood Claims and Severe Repetitive Loss programs and made significant changes to the Flood Mitigation Assistance (FMA) program. These changes include:

- The definitions of repetitive loss and severe repetitive loss properties were modified
    - A severe repetitive loss property is a structure that is covered under a contract for flood insurance made available under the NFIP. These properties have incurred flood-related damage for which four or more separate claims payments have been made under flood

insurance coverage with the amount of each such claim exceeding $5,000 and with the cumulative amount of such claims payments exceeding $20,000. Or for which at least two separate claims payments have been made under such coverage, with the cumulative amount of such claims exceeding that market value of the insured structure.

  - A repetitive loss property is a structure covered by a contract for flood insurance made available under the NFIP that has incurred flood-related damage on two occasions, in which the cost of the repair, on average, equaled or exceeded 25% of market value of the structure at the time of each such flood event. Also, at the time of the second incidence of flood-related damage, the contract for flood insurance contains increased cost of compliance coverage.

- There is no longer a State cap of $10 million or a community cap of $3.3 million for any five-year period
- There is no longer a limit on in-kind contributions for the non-federal cost share
- Mitigation reconstruction is an eligible activity
- Cost-share requirements have changed to allow more federal funds for properties with repetitive flood claims and severe repetitive loss properties
- The development or update of mitigation plans shall not exceed $50,000 federal share to any applicant or $25,000 federal share to any sub applicant
- There is no longer a restriction that a planning grant can only be awarded not more than one every five years to a state or community (FEMA, 2013).

Homeowners of certain older properties in high-risk areas have been charged premiums that do not reflect the full flood risk. Only properties known as "pre-FIRM" were eligible for these subsidies. Only 20% of NFIP policies are subsidized. BW-12 requires FEMA to phase out these subsidies for certain properties and prohibits FEMA from offering subsidies for other pre-FIRM properties. Not all subsidies will be removed the same way at the same time (FEMA, 2013). Increases to pre-FIRM subsided rates include the following:

- By January 1, 2013 – owners of non-primary residences with pre-FIRM subsidized rates will see a 25% annual increase until full-risk rates are reached
- By October 1, 2013:
  - Owners of businesses with pre-FIRM subsidized rates will see a 25% annual increase until full-risk rates are reached
  - Owners of properties of one to four residences with a pre-FIRM subsidized rate that have experienced severe or repetitive flooding will see a 25% annual increase until full-risk rates are reached
  - Pre-FIRM subsidized policies first in effect on or after July 6, 2012 will move directly to full-risk rates
  - Pre-FIRM subsidized policies on homes purchased on or after July 6, 2012 will move directly to full-risk rates
  - Lapsed pre-FIRM subsidized policies reinstated on or after October 4, 2012 will move directly to full-risk rates (FEMA, 2013)

Upon a revised or updated flood map, BW-12 requires adjustment and phase-in rates over five years to accurately reflect the current risk of flood to properties (FEMA, 2013).

In New Jersey there are a total of 2,097 SRL properties throughout the State. Burlington County has a total of nine SRL properties.

Community Rating System (CRS)

The CRS is a voluntary program within the NFIP that encourages floodplain management activities that exceed the minimum NFIP requirements. Flood insurance premiums are discounted to reflect the reduced flood risk resulting from community actions to meet the CRS goals of reducing flood losses, facilitating accurate insurance rating, and promoting awareness of flood insurance.

For participating communities, flood insurance premium rates are discounted in increments of 5%. For example, a Class 1 community would receive a 45% premium discount, and a Class 9 community would receive a 5% discount (Class 10 communities are those that do not participate in the CRS; they receive no discount.) The CRS classes for local communities are based on 18 creditable activities in the following categories:

- Public information
- Mapping and regulations
- Flood damage reduction
- Flood preparedness.

CRS activities (discussed below) can help to save lives and reduce property damage. Communities participating in the CRS represent a significant portion of the nation's flood risk; over 66 percent of the NFIP's policy base is located in these communities. Communities receiving premium discounts through the CRS range from small to large and represent a broad mixture of flood risks, including both coastal and riverine flood risks. The CRS program is administered by the Insurance Services Office (ISO) under contract to FEMA.

As of May 2013, FEMA reports that two communities in Burlington County participate in the CRS, achieving benefits in the form of premium discounts for their policy holders, in recognition of the community's efforts to exceed the minimum requirements of the NFIP (see Table 5.4.4-7).

Table 5.4.4-7. CRS Communities in Burlington County

Community Name	Community Number	CRS Entry Date	Current Effective Date	Current Class	Discount for Special Flood Hazard Areas	Discount for Non-Special Flood Hazard Areas	Status
Burlington, City of	345287	04/01/98	10/01/03	8	10%	5%	Current
Palmyra, Borough of	340110	10/01/09	10/01/09	8	10%	5%	Current

Source: FEMA, 2013
Note: Current as of May 1, 2013

Probability of Future Events

Given the history of flood events that have impacted Burlington County, it is apparent that future flooding of varying degrees will occur. The fact that the elements required for flooding exist and that major flooding has occurred throughout the county in the past suggests that many people and properties are at risk from the flood hazard in the future.

In Section 5.3, the identified hazards of concern for Burlington County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for flood in the County is considered 'frequent' (likely to occur within 25 years, as presented in Table 5.3-3).

VULNERABILITY ASSESSMENT

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For the flood hazard, the 1% annual chance event (100-year) is examined for exposure and estimated losses and the 0.2-percent annual chance event (500-year) for exposure. The following text evaluates and estimates the potential impact of flooding in Burlington County including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, safety and health, (2) general building stock, (3) critical facilities and infrastructure, (4) economy and (5) future growth and development
- Effect of climate change on vulnerability
- Further data collections that will assist understanding of this hazard over time

Overview of Vulnerability

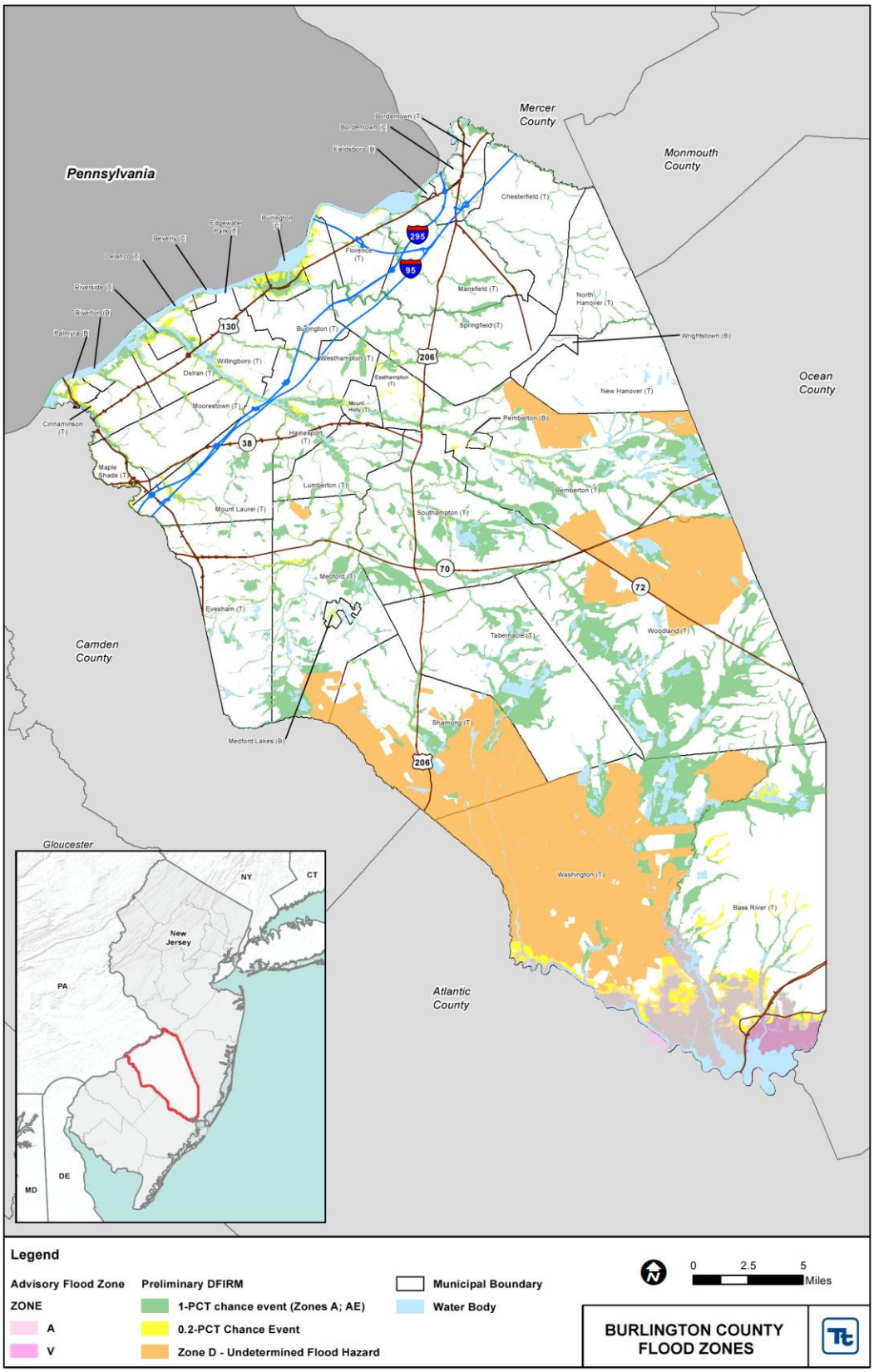
Flood is a significant concern for Burlington County. To assess vulnerability, potential losses were calculated for the County for 1-percent annual chance (100-year) Mean Return Period (MRP) flood events. The flood hazard exposure and loss estimate analysis is presented below.

Data and Methodology

The 1-percent annual chance flood event was examined to evaluate Burlington County's risk and vulnerability to the flood hazard. The Preliminary Digital Flood Insurance Rate Map (DFIRM) with the addition of the Advisory Base Flood Elevation V-zone were used to estimate exposure and estimate potential losses using HAZUS-MH. HAZUS-MH flood modeling was used to generate approximate 1-percent annual chance flood boundaries within the areas covered by the two military installations where data is not available in the preliminary DFIRM.

The HAZUS-MH model uses 2000 U.S. Census demographic data. This data was not updated for this analysis due to technical availability; however, the 2010 U.S. Census data was used to estimate population exposure to provide the best available output. In terms of building data, both the total improved values from the parcel dataset provided by Burlington County Department of Information Technology and the parcel data from New Jersey's Geographic Information Network (for the City of Beverly only), and the HAZUS-MH default general building stock replacement cost values were used for this analysis. Figure 5.4.4-2 illustrates the flood boundaries used for this vulnerability assessment.

Figure 5.4.4-2. Burlington County Flood Zones



Source: FEMA preliminary DFIRM and Advisory boundaries provided by Burlington County GIS

Impact on Life, Health and Safety

The impact of flooding on life, health and safety is dependent upon several factors including the severity of the event and whether or not adequate warning time is provided to residents. Exposure represents the population living in or near floodplain areas that could be impacted should a flood event occur. Additionally, exposure should not be limited to only those who reside in a defined hazard zone, but everyone who may be affected by the effects of a hazard event (e.g., people are at risk while traveling in flooded areas, or their access to emergency services is compromised during an event). The degree of that impact will vary and is not strictly measurable.

To estimate the population exposed to the 1-percent flood event, the floodplain boundaries were overlaid upon the 2010 Census population data in GIS (U.S. Census 2010). Census blocks do not follow the boundaries of the floodplain. The 2010 Census blocks with their centroid the flood boundaries were used to calculate the estimated population exposed to this hazard. Using this approach, it is estimated that 21,740 people are within the 1-percent annual chance floodplain or 4.8% of the total County population. Table 5.4.4-8 lists the estimated population located within the 1-percent annual chance flood zone by municipality.

Table 5.4.4-8. Estimated Burlington County Population Exposed to the 1-Percent Flood Hazard (2010 Census)

Municipality	Total Population	1-Percent Annual Chance Event	
		Estimated Population Exposed	Percent Population in Boundary
Bass River (T)	1,143	326	28.5%
Beverly (C)	2,577	125	4.9%
Bordentown (C)	3,924	137	3.5%
Bordentown (T)	11,367	751	6.6%
Burlington (C)	9,920	5,560	56.0%
Burlington (T)	22,629	571	2.5%
Chesterfield (T)	7,689	22	0.3%
Cinnaminson (T)	15,560	539	3.5%
Delanco (T)	4,283	191	4.5%
Delran (T)	16,896	570	3.4%
Eastampton (T)	6,069	36	0.6%
Edgewater Park (T)	8,881	0	0.0%
Evesham (T)	45,538	1,450	3.2%
Fieldsboro (B)	540	0	0.0%
Florence (T)	12,109	88	0.7%
Hainesport (T)	6,051	175	2.9%
Lumberton (T)	12,559	911	7.3%
Mansfield (T)	8,546	110	1.3%
Maple Shade (T)	19,172	464	2.4%
Medford (T)	23,006	1,466	6.4%
Medford Lakes (B)	4,146	243	5.9%
Moorestown (T)	20,815	171	0.8%
Mt. Holly (T)	9,536	606	6.4%
Mt. Laurel (T)	42,102	673	1.6%

Municipality	Total Population	1-Percent Annual Chance Event	
		Estimated Population Exposed	Percent Population in Boundary
New Hanover (T)	7,385	0	0.0%
North Hanover (T)	7,686	160	2.1%
Palmyra (B)	7,398	599	8.1%
Pemberton (B)	1,412	0	0.0%
Pemberton (T)	27,909	1,734	6.2%
Riverside (T)	8,079	271	3.4%
Riverton (B)	2,779	35	1.3%
Shamong (T)	6,493	281	4.3%
Southampton (T)	10,464	1,588	15.2%
Springfield (T)	3,374	52	1.5%
Tabernacle (T)	6,971	166	2.4%
Washington (T)	695	348	50.1%
Westampton (T)	8,816	487	5.5%
Willingboro (T)	31,629	621	2.0%
Woodland (T)	1,782	167	9.4%
Wrightstown (B)	804	46	5.7%
Burlington County (Total)	**448,734**	**21,740**	**4.8%**

Source: FEMA preliminary DFIRM and Advisory boundaries provided by Burlington County GIS; U.S. Census 2010

Of the population exposed, the most vulnerable include the economically disadvantaged and the population over the age of 65. Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on the net economic impact to their family. The population over the age of 65 is also more vulnerable because they are more likely to seek or need medical attention which may not be available due to isolation during a flood event and they may have more difficulty evacuating.

Using 2000 U.S. Census data, HAZUS-MH 2.1 estimates the potential sheltering needs as a result of a 1-percent chance flood event. For the 1-percent flood event, HAZUS-MH 2.1 estimates 28,797 households will be displaced and 20,666 people will seek short-term sheltering, representing approximately 5% of the Burlington County population seeking short-term shelter. These statistics, by municipality, are presented in Table 5.4.4-9.

Table 5.4.4-9. Estimated Population Displaced or Seeking Short-Term Shelter from the 1-Percent Annual Chance Flood Events

Municipality	Total Population (2010 U.S. Census)	1-Percent Annual Chance Event	
		Displaced Households	Persons Seeking Short-Term Sheltering
Bass River (T)	1,143	314	214
Beverly (C)	2,577	147	117
Bordentown (C)	3,924	155	104
Bordentown (T)	11,367	460	280

Municipality	Total Population (2010 U.S. Census)	1-Percent Annual Chance Event	
		Displaced Households	Persons Seeking Short-Term Sheltering
Burlington (C)	9,920	5,502	4,849
Burlington (T)	22,629	731	538
Chesterfield (T)	7,689	379	27
Cinnaminson (T)	15,560	921	618
Delanco (T)	4,283	156	98
Delran (T)	16,896	636	475
Eastampton (T)	6,069	226	143
Edgewater Park (T)	8,881	1	0
Evesham (T)	45,538	1,958	1,498
Fieldsboro (B)	540	32	4
Florence (T)	12,109	314	221
Hainesport (T)	6,051	438	322
Lumberton (T)	12,559	801	578
Mansfield (T)	8,546	230	71
Maple Shade (T)	19,172	518	468
Medford (T)	23,006	119	22
Medford Lakes (B)	4,146	2,084	1,554
Moorestown (T)	20,815	684	324
Mt. Holly (T)	9,536	566	328
Mt. Laurel (T)	42,102	1,966	1,624
New Hanover (T)	7,385	650	516
North Hanover (T)	7,686	880	754
Palmyra (B)	7,398	584	409
Pemberton (B)	1,412	47	8
Pemberton (T)	27,909	2,518	1,536
Riverside (T)	8,079	279	155
Riverton (B)	2,779	73	50
Shamong (T)	6,493	380	188
Southampton (T)	10,464	1,354	866
Springfield (T)	3,374	290	85
Tabernacle (T)	6,971	243	101
Washington (T)	695	272	195
Westampton (T)	8,816	385	192
Willingboro (T)	31,629	1,176	962
Woodland (T)	1,782	186	60
Wrightstown (B)	804	142	112
Burlington County (Total)	**448,734**	**28,797**	**20,666**

Source: HAZUS-MH v2.1; U.S. Census 2010
Note: The population displaced and seeking shelter was calculated using the 2000 U.S. Census data (HAZUS-MH 2.1 default demographic data).
B = Borough; C = City; T = Township

The total number of injuries and casualties resulting from typical riverine flooding is generally limited based on advance weather forecasting, blockades and warnings. Therefore, injuries and deaths generally are not anticipated if proper warning and precautions are in place. Ongoing mitigation efforts should help to avoid the most likely cause of injury, which results from persons trying to cross flooded roadways or channels during a flood. Mitigation action items addressing this issue are included in Section 9 (Mitigation Strategies) of this plan.

All population in a dam failure inundation zone is considered exposed and vulnerable. Similar to riverine flooding, of the population exposed to dam failure and flash flooding, the most vulnerable include the economically disadvantaged and the population over the age of 65.

There is often limited warning time for dam failure and flash flooding. These events are frequently associated with other natural hazard events such as earthquakes, landslides or severe weather, which limits their predictability and compounds the hazard. Populations without adequate warning of the event are highly vulnerable to this hazard. Ongoing mitigation efforts including dissemination and early warning systems are noted in Section 9 (Mitigation Strategies) of this plan should help to avoid the most likely cause of injury, which results from persons trying to cross flooded roadways or channels during a flood.

Impact on General Building Stock

After considering the population exposed and vulnerable to the flood hazard, the built environment was evaluated. Exposure in the flood zone includes those buildings located in the flood zone. Potential damage is the modeled loss that could occur to the exposed inventory, including structural and content value.

The total land area located in the 1- and 0.2-percent annual chance flood zones was calculated for each municipality, as presented in Table 5.4.4-10 below.

Table 5.4.4-10. Total land area located in the 1- and 0.2-percent annual chance flood zones (acres)

Municipality	Total Area (acres)	1% Flood Event Hazard Area				0.2% Flood Event Hazard Area		D Zone	
		A-Zone Area Exposed (acres)	% of Total	V-Zone Area Exposed (acres)	% of Total	Area Exposed (acres)	% of total	Area Exposed (acres)	% of total
Bass River (T)	50,140	6,178	12%	7,356	15%	17,063	34%	6.25	<1%
Beverly (C)	486	173	36%	0	-	185	38%	0	-
Bordentown (C)	618	104	17%	0	-	119	19%	0	-
Bordentown (T)	5,926	1,338	23%	0	-	1,338	23%	0	-
Burlington (C)	2,426	1,331	55%	0	-	1,897	78%	0	-
Burlington (T)	8,992	771	9%	0	-	1,119	12%	0	-
Chesterfield (T)	13,736	734	5%	0	-	773	6%	0	-
Cinnaminson (T)	5,099	950	19%	0	-	1,146	22%	0	-
Delanco (T)	2,190	843	38%	0	-	1,124	51%	0	-
Delran (T)	4,654	888	19%	0	-	1,046	22%	0	-
Eastampton (T)	3,723	450	12%	0	-	613	16%	0	-
Edgewater Park (T)	1,976	85	4%	0	-	106	5%	0	-
Evesham (T)	18,943	1,834	10%	0	-	1,904	10%	0	-
Fieldsboro (B)	224	18	8%	0	-	73	33%	0	-
Florence (T)	6,559	622	9%	0	-	755	12%	0	-
Hainesport (T)	4,344	977	22%	0	-	1,159	27%	0	-
Lumberton (T)	8,327	1,380	17%	0	-	1,414	17%	0.01	<1%
Mansfield (T)	14,010	1,282	9%	0	-	1,319	9%	0	-
Maple Shade (T)	2,451	154	6%	0	-	265	11%	0	-
Medford (T)	812	73	9%	0	-	173	21%	0	-
Medford Lakes (B)	25,474	5,587	22%	0	-	5,901	23%	1,821	7.2%
Moorestown (T)	9,585	712	7%	0	-	854	9%	0	-
Mt. Holly (T)	1,837	226	12%	0	-	377	21%	0	-
Mt. Laurel (T)	14,066	1,249	9%	0	-	1,524	11%	0	-
New Hanover (T)	14,483	134	1%	0	-	140	1%	7.7	<1%
North Hanover (T)	11,203	667	6%	0	-	671	6%	0	-

Municipality	Total Area (acres)	1% Flood Event Hazard Area				0.2% Flood Event Hazard Area		D Zone	
		A-Zone Area Exposed (acres)	% of Total	V-Zone Area Exposed (acres)	% of Total	Area Exposed (acres)	% of total	Area Exposed (acres)	% of total
Palmyra (B)	1,673	591	35%	0	-	896	54%	0	-
Pemberton (B)	403	50	12%	0	-	70	17%	0	-
Pemberton (T)	40,171	10,260	26%	0	-	10,536	26%	6,560.3	16.3%
Riverside (T)	1,048	308	29%	0	-	432	41%	0	-
Riverton (B)	614	215	35%	0	-	250	41%	0	-
Shamong (T)	28,791	2,155	7%	0	-	2,203	8%	16,638.8	57.8%
Southampton (T)	28,446	7,484	26%	0	-	7,575	27%	5.47	<1%
Springfield (T)	18,924	1,900	10%	0	-	1,863	10%	0.41	<1%
Tabernacle (T)	31,688	5,988	19%	0	-	5,975	19%	0.17	<1%
Washington (T)	66,539	14,208	21%	0	-	17,284	26%	43,524.4	65.4%
Westampton (T)	7,104	1,030	14%	0	-	1,049	15%	0	-
Willingboro (T)	5,175	672	13%	0	-	806	16%	0	-
Woodland (T)	61,001	16,635	27%	0	-	16,491	27%	15,525.4	25.5%
Wrightstown (B)	1,146	28	2%	0	-	28	2%	2.2	<1%
Burlington County (Total)	**525,009**	**97,640**	**19%**	**7,356**	**1.4%**	**108,514**	**21%**	**84,091.97**	**16.0%**

Source: FEMA preliminary DFIRM and Advisory boundaries provided by Burlington County GIS
The area presented includes the area of inclusive water bodies.

To provide a general estimate of number of structural/content replacement value exposure, the FEMA DFIRM flood boundaries (1-percent flood zone) was overlaid upon Burlington County's parcel data to get an estimated total improved value exposed, and the building stock replacement cost values in HAZUS-MH at the Census-block level. Refer to Table 5.4.4-11 and Table 5.4.4-12X below.

There is approximately $1.85 billion of total improved value exposed to the 1-percent annual chance flood in Burlington County. This represents approximately 5% of the County's total improved value inventory ($36 billion) available from the parcel data.

There is approximately $3.4 billion of building/contents replacement cost value exposed to the 1-percent annual chance flood in Burlington County. This represents approximately 5.5% of the County's total general building stock replacement value inventory ($62.7 billion). For the 0.2-percent annual chance flood event, it is estimated there is nearly $5.2 billion of buildings/contents exposed in Burlington County. This is approximately 8.3% of the County's total general building stock replacement value inventory.

The potential damage estimated to the general building stock inventory associated with the 1-percent annual chance flood is greater than $889 million.

Table 5.4.4-11. Total Improved Value Exposure to the 1-Percent Annual Chance Flood Event

Municipality	Total Improved Value	1% Annual Chance Flood Boundary	
		Estimated Improved Value Exposure	% of Total
Bass River Township	$112,293,600	$62,321,000	55.5%
Beverly*	$72,091,800	$4,096,900	5.7%
Bordentown	$298,534,950	$3,879,600	1.3%
Bordentown Township	$997,461,800	$ 64,332,000	6.4%
Burlington	$571,882,875	$459,532,300	80.4%
Burlington Township	$2,097,110,708	$46,002,100	2.2%
Chesterfield Township	$666,455,492	$4,704,100	0.7%
Cinnaminson Township	$1,304,483,700	$90,518,700	6.9%
Delanco Township	$290,621,560	$66,109,600	22.7%
Delran Township	$1,474,866,100	$73,603,600	5.0%
Eastampton Township	$421,225,400	$9,741,800	2.3%
Edgewater Park Township	$528,294,400	$7,691,400	1.5%
Evesham Township	$4,389,240,875	$36,230,700	0.8%
Fieldsboro Borough	$48,903,400	$10,699,800	21.9%
Florence Township	$1,040,584,300	$18,115,800	1.7%
Hainesport Township	$367,702,666	$8,739,700	2.4%
Lumberton Township	$1,164,991,807	$36,534,600	3.1%
Mansfield Township	$899,612,400	$3,506,500	0.4%
Maple Shade Township	$1,405,067,900	$162,072,900	11.5%
Medford Lakes Borough	$1,297,069,100	$55,366,700	4.3%
Medford Township	$980,612,600	$91,571,200	9.3%

Municipality	Total Improved Value	1% Annual Chance Flood Boundary	
		Estimated Improved Value Exposure	% of Total
Moorestown Township	$3,410,132,200	$67,226,100	2.0%
Mount Holly Township	$1,079,081,000	$90,062,500	8.3%
Mount Laurel Township	$2,396,695,600	$44,262,800	1.8%
New Hanover Township	$852,205,300	$5,678,800	0.7%
North Hanover Township	$498,418,446	$3,997,800	0.8%
Palmyra Borough	$254,304,240	$75,508,245	29.7%
Pemberton Borough	$63,520,200	$312,800	0.5%
Pemberton Township	$2,014,515,095	$66,340,720	3.3%
Riverside Township	$349,218,580	$47,046,320	13.5%
Riverton Borough	$207,879,600	$21,903,500	10.5%
Shamong Township	$294,159,200	$5,621,500	1.9%
Southampton Township	$549,437,950	$33,725,300	6.1%
Springfield Township	$282,324,750	$13,142,700	4.7%
Tabernacle Township	$580,603,200	$9,669,500	1.7%
Washington Township	$13,020,400	$ 6,276,200	48.2%
Westampton Township	$919,859,000	$11,364,900	1.2%
Willingboro Township	$1,705,779,550	$21,719,900	1.3%
Woodland Township	$305,887,600	$6,839,700	2.2%
Wrightstown Borough	$47,025,100	$ 3,983,550	8.5%
Burlington County	**$36,253,174,444**	**$1,850,053,835**	**5.1%**

Source: FEMA preliminary DFIRM and Advisory boundaries provided by Burlington County GIS
Notes: * The City of Beverly improvement value data 2011 NJGIN MODIV

Table 5.4.4-12. Estimated General Building Stock Exposure to the 1-Percent Annual Chance Flood Event

Municipality	Total RCV	1% Annual Chance Flood Boundary	
		Estimated RCV Exposure	% of Total
Bass River (T)	$158,762,000	$25,096,000	15.8%
Beverly (C)	$351,041,000	$14,690,000	4.2%
Bordentown (C)	$611,161,000	$22,536,000	3.7%
Bordentown (T)	$1,225,803,000	$47,635,000	3.9%
Burlington (C)	$1,419,313,000	$761,446,000	53.7%
Burlington (T)	$3,257,758,000	$79,372,000	2.4%
Chesterfield (T)	$482,451,000	$2,784,000	0.6%
Cinnaminson (T)	$2,375,176,000	$112,410,000	4.7%
Delanco (T)	$484,972,000	$5,474,000	1.1%
Delran (T)	$2,136,079,000	$77,216,000	3.6%
Eastampton (T)	$712,944,000	$15,276,000	2.1%
Edgewater Park (T)	$959,473,000	0%	0.0%
Evesham (T)	$6,451,252,000	$298,462,000	4.6%
Fieldsboro (B)	$72,125,000	$3,842,000	5.3%
Florence (T)	$1,509,320,000	$27,215,000	1.8%
Hainesport (T)	$839,062,000	$13,001,000	1.6%
Lumberton (T)	$1,504,149,000	$132,384,000	8.8%
Mansfield (T)	$1,954,839,000	$37,575,000	1.9%
Maple Shade (T)	$2,346,098,000	$20,928,000	0.9%
Medford (T)	$560,603,000	$373,385,000	66.6%
Medford Lakes (B)	$3,746,510,000	$21,913,000	0.6%
Moorestown (T)	$4,209,509,000	$195,075,000	4.6%
Mt. Holly (T)	$1,650,406,000	$82,109,000	5.0%
Mt. Laurel (T)	$6,985,988,000	$72,650,000	1.0%
New Hanover (T)	$1,604,641,000	0%	0.0%
North Hanover (T)	$685,211,000	$33,483,000	4.9%
Palmyra (B)	$942,785,000	$88,139,000	9.4%
Pemberton (B)	$187,379,000	0%	0.0%
Pemberton (T)	$3,248,981,000	$289,072,000	8.9%
Riverside (T)	$885,809,000	$69,606,000	7.9%
Riverton (B)	$352,198,000	$22,139,000	6.3%
Shamong (T)	$797,191,000	$32,852,000	4.1%
Southampton (T)	$1,305,540,000	$217,814,000	16.7%
Springfield (T)	$461,104,000	$20,662,000	4.5%
Tabernacle (T)	$931,897,000	$27,544,000	3.0%
Washington (T)	$108,601,000	$29,667,000	27.3%

Municipality	Total RCV	1% Annual Chance Flood Boundary	
		Estimated RCV Exposure	% of Total
Westampton (T)	$1,326,163,000	$50,733,000	3.8%
Willingboro (T)	$3,602,996,000	$101,801,000	2.8%
Woodland (T)	$115,483,000	$7,591,000	6.6%
Wrightstown (B)	$140,021,000	$11,856,000	8.5%
Burlington County (Total)	**$62,700,794,000**	**$3,445,433,000**	**5.5%**

Source: FEMA preliminary DFIRM and Advisory boundaries provided by Burlington County GIS; HAZUS-MH v2.1
Notes: % = Percent; RCV = Replacement cost value (structure and contents)

Table 5.4.4-13. Estimated General Building Stock Potential Loss to the 1-Percent Annual Chance Flood Event

Municipality	Total RCV	1% Annual Chance Flood Boundary	
		Estimated RCV Loss	% of Total
Bass River (T)	$158,762,000	$1,547,000	1.0%
Beverly (C)	$351,041,000	$4,292,000	1.2%
Bordentown (C)	$611,161,000	$12,832,000	2.1%
Bordentown (T)	$1,225,803,000	$32,256,000	2.6%
Burlington (C)	$1,419,313,000	$118,605,000	8.4%
Burlington (T)	$3,257,758,000	$31,789,000	1.0%
Chesterfield (T)	$482,451,000	$8,947,000	1.9%
Cinnaminson (T)	$2,375,176,000	$51,788,000	2.2%
Delanco (T)	$484,972,000	$7,235,000	1.5%
Delran (T)	$2,136,079,000	$35,726,000	1.7%
Eastampton (T)	$712,944,000	$3,832,000	0.5%
Edgewater Park (T)	$959,473,000	$4,000	0.0%
Evesham (T)	$6,451,252,000	$26,706,000	0.4%
Fieldsboro (B)	$72,125,000	$2,660,000	3.7%
Florence (T)	$1,509,320,000	$18,457,000	1.2%
Hainesport (T)	$839,062,000	$23,565,000	2.8%
Lumberton (T)	$1,504,149,000	$30,554,000	2.0%
Mansfield (T)	$1,954,839,000	$47,983,000	2.5%
Maple Shade (T)	$2,346,098,000	$12,046,000	0.5%
Medford (T)	$560,603,000	$76,554,000	1.0%
Medford Lakes (B)	$3,746,510,000	$5,509,000	2.0%
Moorestown (T)	$4,209,509,000	$45,454,000	1.1%
Mt. Holly (T)	$1,650,406,000	$17,264,000	1.1%
Mt. Laurel (T)	$6,985,988,000	$57,533,000	0.8%
New Hanover (T)	$1,604,641,000	$9,625,000	0.6%
North Hanover (T)	$685,211,000	$15,522,000	2.3%
Palmyra (B)	$942,785,000	$19,807,000	2.1%

Municipality	Total RCV	1% Annual Chance Flood Boundary	
		Estimated RCV Loss	% of Total
Pemberton (B)	$187,379,000	$1,090,000	0.6%
Pemberton (T)	$3,248,981,000	$49,124,000	1.5%
Riverside (T)	$885,809,000	$12,766,000	1.4%
Riverton (B)	$352,198,000	$3,115,000	0.9%
Shamong (T)	$797,191,000	$4,046,000	0.5%
Southampton (T)	$1,305,540,000	$27,750,000	2.1%
Springfield (T)	$461,104,000	$3,834,000	0.8%
Tabernacle (T)	$931,897,000	$8,835,000	1.0%
Washington (T)	$108,601,000	$3,812,000	3.5%
Westampton (T)	$1,326,163,000	$9,302,000	0.7%
Willingboro (T)	$3,602,996,000	$38,506,000	1.1%
Woodland (T)	$115,483,000	$1,172,000	1.0%
Wrightstown (B)	$140,021,000	$7,627,000	5.5%
Burlington County (T)	**$62,700,794,000**	**$889,071,000**	**1.4%**

Source: HAZUS- MH v2.1; 2000 CENSUS
Notes: % = Percent; RCV = Replacement cost value

In addition to total building stock modeling, individual data available on flood policies, claims, Repetitive Loss Properties (RLP) and severe RLP (SRLs) were analyzed. FEMA Region 2 provided a list of residential properties with NFIP policies, past claims and multiple claims (RLPs). According to the metadata provided: "The (*sic* National Flood Insurance Program) NFIP Repetitive Loss File contains losses reported from individuals who have flood insurance through the Federal Government. A property is considered a repetitive loss property when there are two or more losses reported which were paid more than $1,000 for each loss. The two losses must be within 10 years of each other & be as least 10 days apart. Only losses from (*sic* since) 1/1/1978 that are closed are considered."

SRLs were then examined for the County. According to section 1361A of the National Flood Insurance Act, as amended (NFIA), 42 U.S.C. 4102a, an SRL property is defined as a residential property that is covered under an NFIP flood insurance policy and:

- Has at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or
- For which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.
- For both of the above, at least two of the referenced claims must have occurred within any 10-year period, and must be greater than 10 days apart.

Table 5.4.4-15summarizes the NFIP policies, claims and repetitive loss statistics for Burlington County. According to FEMA, Table 5.4.1-X summarizes the occupancy classes of the repetitive loss and severe repetitive loss properties in Burlington County. The majority of the repetitive loss occupancy class is single family residences (85%). All severe repetitive loss properties as classed as single family residences (100%) (FEMA Region 2, 2013). This information is current as of February 28, 2013.

Table 5.4.4-14. Occupancy Class of Repetitive Loss Structures in Burlington County by Municipality

Municipality	Repetitive Loss Properties					Severe Repetitive Loss Properties					Total per Municipality
	2-4 Family	Assumed Condo	Non Residential	Other Residential	Single Family	2-4 Family	Assumed Condo	Non Residential	Other Residential	Single Family	
Bordentown (C)					1						1
Burlington (C)					6						6
Burlington (T)					1						1
Cinnaminson (T)					8					1	9
Delran (T)					8						8
Eastampton (T)					2					1	3
Evesham (T)					2						2
Lumberton (T)	1		1	1	29					2	34
Maple Shade (T)				1							1
Medford Lakes (B)					1						1
Medford (T)		10	1		6					1	18
Mount Holly (T)					2						2
Mount Laurel (T)					1						1
Palmyra (B)					1					1	2
Pemberton (T)					2						2
Riverside (T)					3						3
Southampton (T)			1		13					3	17
Washington (T)					1						1
Westampton (T)					2						2
Willingboro (T)					1						1
Totals by structure	***1***	***10***	***3***	***2***	***90***	***0***	***0***	***0***	***0***	***9***	***115***

Note: Only municipalities with RL/SRL structures are included in this table. Unlisted municipalities do not have reported RL/SRL properties.

Source: FEMA Region 2, 2013

(1) Statistics provided by FEMA Region 2 are current as of February 28, 2013.

The location of the properties with policies, claims and repetitive and severe repetitive flooding were geocoded by FEMA with the understanding that there are varying tolerances between how closely the longitude and latitude coordinates correspond to the location of the property address, or that the indication of some locations are more accurate than others.

Table 5.4.4-14 indicates the repetitive loss areas within the County. Information regarding the locations of the NFIP policies and claims is cataloged at the County.

Table 5.4.4-15. NFIP Policies, Claims and Repetitive Loss Statistics

Municipality	# Policies (1)	# Claims (Losses) (1)	Total Loss Payments (2)	# Rep. Loss Prop. (1)	# Severe Rep. Loss Prop. (1)	# Policies in the 1% Flood Boundary (3)	# Policies in the 0.2% Flood Boundary (3)	# Policies Outside the Combined 1% and 0.2% Flood Boundaries Hazard Areas (3)
Bass River, Township Of	62	53	$1,317,833	0	0	42	57	5
Beverly, City Of	9	1	$3,514	0	0	0	2	7
Bordentown, City Of	11	6	$31,802	1	0	5	6	5
Bordentown, Township Of	54	3	$112,099	0	0	6	7	47
Burlington, City Of	1058	120	$501,475	6	0	852	1019	39
Burlington, Township Of	107	21	$254,229	1	0	35	45	62
Chesterfield, Township Of	10	2	$2,128	0	0	0	0	10
Cinnaminson, Township Of	261	91	$945,575	8	1	120	160	101
Delanco, Township Of	84	9	$67,299	0	0	23	55	29
Delran, Township Of	137	58	$557,562	8	0	64	92	45
Eastampton, Township Of	37	83	$715,586	2	1	17	21	16
Edgewater Park, Township Of	14	4	$35,201	0	0	0	0	14
Evesham, Township Of	159	23	$250,315	2	0	10	12	147
Fieldsboro, Borough of	0	1	$707	0	0	0	0	0
Florence, Township Of	34	2	$16,325	0	0	9	9	25
Hainesport, Township Of	29	3	$25,021	0	0	9	11	18
Lumberton, Township Of	94	141	$6,227,869	32	2	68	68	26
Mansfield, Township Of	25	1	$4,060	0	0	2	2	23
Maple Shade, Township Of	40	5	$240,619	1	0	0	8	32
Medford Lakes, Borough Of	65	20	$224,385	1	0	0	14	51
Medford, Township Of	298	127	$3,197,307	17	1	90	104	194
Moorestown, Township Of	150	27	$252,772	0	0	25	35	115
Mount Holly, Township Of	99	70	$1,139,746	2	**0**	35	78	21
Mount Laurel, Township Of	326	43	$400,697	1	**0**	53	93	233
New Hanover, Township Of	6	2	$889	0	**0**	1	1	5
North Hanover, Township Of	3	1	$13,060	0	**0**	1	1	2
Palmyra, Borough Of	188	22	$152,868	1	**1**	58	144	44

Municipality	# Policies (1)	# Claims (Losses) (1)	Total Loss Payments (2)	# Rep. Loss Prop. (1)	# Severe Rep. Loss Prop. (1)	# Policies in the 1% Flood Boundary (3)	# Policies in the 0.2% Flood Boundary (3)	# Policies Outside the Combined 1% and 0.2% Flood Boundaries Hazard Areas (3)
Pemberton, Borough Of	5	1	$459	2	**0**	0	0	5
Pemberton, Township Of	237	64	$825,155	0	**0**	92	96	141
Riverside, Township Of	88	31	$124,837	3	**0**	36	79	9
Riverton, Borough Of	44	2	$9,225	0	**0**	9	15	29
Shamong, Township Of	15	4	$8,927	0	**0**	1	1	14
Southampton, Township Of	127	109	$2,208,330	14	**3**	73	78	49
Springfield, Township Of	18	5	$136,102	0	**0**	5	5	13
Tabernacle, Township Of	18	1	$6,407	0	**0**	7	7	11
Washington, Township Of	45	22	$697,601	1	**0**	23	41	4
Westampton, Township Of	29	13	$165,778	2	**0**	11	13	16
Willingboro, Township Of	84	9	$40,453	1	**0**	9	15	69
Woodland, Township Of	3	1	$862	0	**0**	2	2	1
Wrightstown, Borough Of	7	1	$15,632	0	**0**	2	2	5
Burlington County (Total)	**4,080**	**1,202**	**$20,930,712**	**106**	**9**	**1,795**	**2,398**	**1,682**

Source: FEMA Region 2, 2013

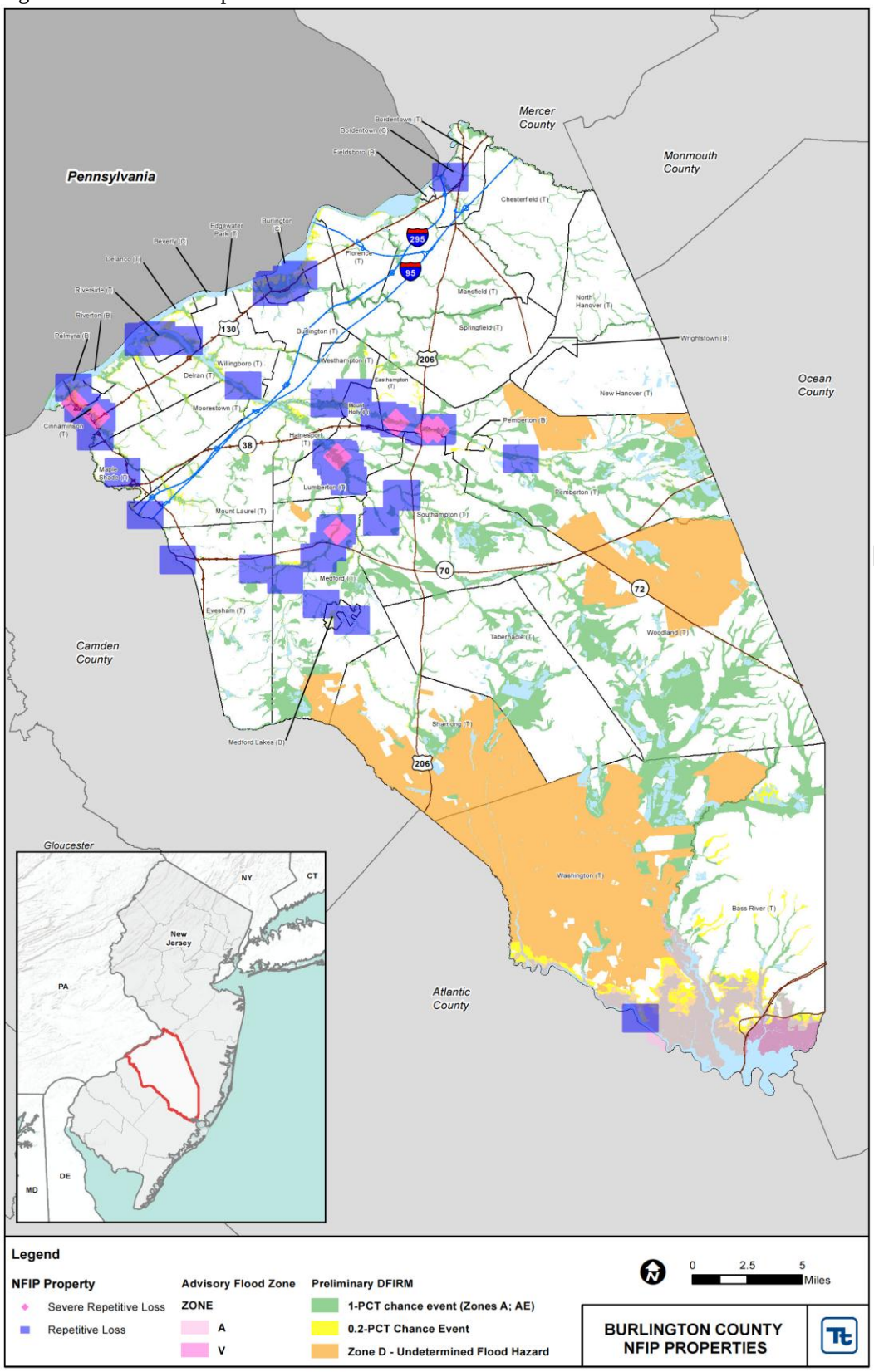
(1) Policies, repetitive loss and severe repetitive loss statistics provided by FEMA Region 2, and are current as of February 28, 2013. Please note the total number of repetitive loss properties excludes the severe repetitive loss properties. The number of claims represents claims closed by February 28, 2013.

(2) Total building and content losses from the claims file provided by FEMA Region 2.

(3) The policies inside and outside of the flood zones is based on the latitude and longitude provided by FEMA Region 2 in the policy file.

Notes: FEMA noted that where there is more than one entry for a property, there may be more than one policy in force or more than one GIS possibility.

Figure 5.4.4-3. NFIP Repetitive Loss Areas



Source: Burlington County GIS; FEMA Region 2, 2013

Impact on Critical Facilities

In addition to considering general building stock at risk, the risk of flood to critical facilities, utilities, transportation facilities and user-defined facilities was evaluated. HAZUS-MH was used to estimate the flood loss potential to critical facilities exposed to the flood risk. Using depth/damage function curves, HAZUS estimates the percent of damage to the building and contents of critical facilities. Table 5.4.4-16 lists the critical facilities located in the FEMA flood zones and the percent damage HAZUS-MH 2.1 estimates to the facility as a result of the 1-percent annual chance event. Table 5.4.4-17 summarizes the utilities and transportation features located in the FEMA flood zones and the percent damage HAZUS-MH 2.1 estimates as a result of the 1-percent annual chance event.

In cases where short-term functionality is impacted by a hazard, other facilities of neighboring municipalities may need to increase support response functions during a disaster event. Mitigation planning should consider means to reduce impact to critical facilities and ensure sufficient emergency and school services remain when a significant event occurs. Actions addressing shared services agreements are included in Section 9 (Mitigation Strategies) of this plan.

In summary, there are 18 bridges were exposed to the flood hazard with a modeled damage of 2% or less for the 1-percent annual chance event and 20 bridges are estimated to have less than 3% damage for the 1-percent annual chance event.

Table 5.4.4-16. Critical Facilities Located in the 1-Percent and 0.2-Percent Annual Chance Flood Boundaries and Estimated Potential Damage for the 1-Percent Annual Chance Flood Event

Name	Municipality	Type	Exposure		Potential Loss from 1% Flood Event		
			1% Event	0.2% Event	Percent Structure Damage	Percent Content Damage	Days to 100-Percent[2]
Municipal	Burlington City	EOC	X	X	8.0	12.2	480
BURLINGTON BRISTOL BRIDGE POLICE DEPT	Burlington City	Police	X	X	9.3	17.3	480
BURLINGTON CITY POLICE	Burlington City	Police	X	X	7.0	8.0	480
NJSP MARINE POLICE	Burlington City	Police		X			
BULINGTON CITY FIRE DEPARTMENT	Burlington City	Fire	X	X	8.0	12.2	480
BULINGTON CITY FIRE DEPARTMENT	Burlington City	Fire	X	X	8.0	12.2	480
MITCHELL FIRE CO #3	Burlington City	Fire	X	X	9.4	17.5	480
NEPTUNE HOSE CO #5	Burlington City	Fire	X	X	8.8	15.1	480
NIAGARA HOSE CO 6	Burlington City	Fire	X	X	10.4	26.8	480
ENDEAVOR EMERGENCY SQUAD	Burlington City	Fire		X			
ALL SAINTS SCHOOL	Burlington City	School	X	X	7.3	39.9	480
WILBUR WATTS INTERMEDIATE SCHL	Burlington City	School	X	X	7.7	43.1	480
HOLY LIGHT CHRISTIAN ACADEMY	Burlington City	School	X	X	5.3	28.8	480
BURLINGTON BOARD OF EDUCATION	Burlington City	School	X	X	9.0	59.3	480
BURLINGTON CITY HIGH SCHOOL	Burlington City	School	X	X	6.4	34.8	480
ST MARY'S HALL-DOANE ACADEMY	Burlington City	School		X			
CAPTAIN JAMES LAWRENCE SCHOOL	Burlington City	School		X			
ELIAS BOUDINOT ELEMENTARY SCHL	Burlington City	School		X			
SAMUEL SMITH ELEMENTARY SCHOOL	Burlington City	School		X			
Home For Aged Women	Burlington City	Senior	X	X	23.8	31.1	
BURLINGTON CITY MUNICIPAL BUILDING	Burlington City	Municipal	X	X	22.7	27.5	
LUMBERTON FIRE CO #1	Lumberton Township	Fire	X	X	10.9	36.4	480
MAPLE SHADE RESCUE SERVICE	Maple Shade Township	Fire		X			
BURLINGTON COUNTY INSTITUTE OF TECH	Medford Township	School	X	X	6.1	32.9	480
CHALLENGER ELEMENTARY SCHOOL	Medford Township	School	X	X	5.6	30.2	480

Name	Municipality	Type	Exposure		Potential Loss from 1% Flood Event		
			1% Event	0.2% Event	Percent Structure Damage	Percent Content Damage	Days to 100-Percent(2)
CRANBERRY PINE ELEMENTARY SCHOOL	Medford Township	School	X	X	9.0	59.4	480
MOUNT HOLLY TWP POLICE DEPT	Mount Holly Township	Police		X			
BURLINGTON COUNTY COLLEGE	Mount Holly Township	School		X			
MOUNT HOLLY TOWNSHIP MUNICIPAL BUILDING	Mount Holly Township	Municipal		X			
TACONY PALMYRA BRIDGE POLICE DEPT	Palmyra Borough	Police	X	X	8.1	12.3	480
SHAMONG BOARD OF EDUCATION	Shamong Township	School		X			
SHAMONG TOWNSHIP SCHOOL DIST	Shamong Township	School		X			
VINCENTOWN EMERGENCY SQUAD	Southampton Township	Fire	X	X	7.6	10.4	480
Section B3 (17, 18, 29, 43)	Tabernacle Township	Fire	X	X	4.7	5.3	480
NJ STATE PARK SERVICE - SOUTHERN REGION	Washington Township	Police		X			
WASHINGTON TOWNSHIP MUNICIPAL BUILDING	Washington Township	Municipal		X			

Source: HAZUS-MH 2.1
Notes: x = Facility located within the flood boundary.
(1) HAZUS-MH 2.1 provides a general indication of the maximum restoration time for 100% operations. Clearly, a great deal of effort is needed to quickly restore essential facilities to full functionality; therefore this will be an indication of the maximum downtime (HAZUS-MH 2.1 User Manual).

Table 5.4.4-17. Utilities and Transportation Facilities Located in the 1-Percent and 0.2-Percent Annual Chance Flood Boundaries

Name	Municipality	Type	Exposure	
			1% Event	0.2% Event
Beverly Sewerage Authority	Beverly City	Sewer	X	X
Bordentown Sewerage Authority	Bordentown City	Sewer	X	X
Cinnaminson Sewerage Authority	Cinnaminson Township	Sewer	X	X
Central Avenue Sewerage Treatment Plant	Burlington Township	Sewer	X	X
Delran Sewerage Authority	Delran Township	Sewer	X	X
Florence Sewerage Treatment Plant	Florence Township	Sewer	X	X
Medford Lakes Sewerage Treatment Plant	Medford Lakes Borough	Sewer	X	X
Riverside Sewerage Treatment Plant	Riverside Township	Sewer	X	X
Riverton Sewerage Treatment Plant	Riverton Borough	Sewer	X	X
Common Council Burlington City	Burlington City	Sewer	X	X
Palmyra Sewerage Treatment Plant	Palmyra Borough	Sewer	X	X
PSE&G Substation – Fairview St.	Riverside Township	Electric	X	X
PSE&G Substation – Broad St.	Cinnaminson Township	Electric	X	X
Commerce Square	Burlington City	Water	X	X
Medford	Medford Township	Water	X	X
Burlington Heliport	Burlington City	Airport	X	X
Mount Holly Heliport	Mount Holly Township	Airport	X	X
Burlington South Park & Ride	Burlington City	Rail	X	X
Mount Holly Municipal Utility Authority	Mount Holly Township	Sewer		X
Medford Water Pollution Control	Medford Township	Sewer		X
PSE&G Substation – W. Broad St.	Burlington City	Electric		X
PSE&G Burlington Generation Station	Burlington	Electric		X
Fenimore Mobil Home Park	Eastampton Township	Water		X
Pacemaker Heliport	Washington Township	Airport		X
Burlington Town Center Station	Burlington City	Rail		X
Delanco	Delanco Township	Rail		X
Cinnaminson	Cinnaminson Township	Rail		X

Source: HAZUS-MH 2.1
Notes: x = Facility located within the flood boundary.

Impact on the Economy

For impact on economy, estimated losses from a flood event are considered. Losses include but are not limited to general building stock damages, agricultural losses, business interruption, impacts to tourism and tax base to Burlington County. Damages to general building stock can be quantified using HAZUS-MH as discussed above. Other economic components such as loss of facility use, functional downtime and social economic factors are less measurable with a high degree of certainty. For the purposes of this analysis, general building stock damages are discussed further.

Flooding can cause extensive damage to public utilities and disruptions to the delivery of services. Loss of power and communications may occur; and drinking water and wastewater treatment facilities may be temporarily out of operation. Flooded streets and road blocks make it difficult for emergency vehicles to respond to calls for service. Floodwaters can wash out sections of roadway and bridges (Foster, Date Unknown).

Direct building losses are the estimated costs to repair or replace the damage caused to the building. The potential damage estimated to the general building stock inventory associated with the 1-percent flood is approximately $889 million which represents less than one-percent of the County's overall total general building stock inventory. These dollar value losses to the County's total building inventory replacement value, in addition to damages to roadways and infrastructure, would greatly impact the local economy.

HAZUS-MH estimates the amount of debris generated from the flood events as a result of 1- and 0.2-percent events. The model breaks down debris into three categories: 1) finishes (dry wall, insulation, etc.); 2) structural (wood, brick, etc.) and 3) foundations (concrete slab and block, rebar, etc.). The distinction is made because of the different types of equipment needed to handle the debris. Table 5.4.4-18 summarizes the debris HAZUS-MH 2.1 estimates for these events.

Table 5.4.4-18. Estimated Debris Generated from the 1-Percent Flood Event

Municipality	1% Flood Event			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Bass River (T)	117	90	9	18
Beverly (C)	553	296	160	97
Bordentown (C)	2,548	665	1,093	791
Bordentown (T)	3,771	1,082	1,555	1,134
Burlington (C)	4,551	4,085	283	182
Burlington (T)	1,094	570	300	224
Chesterfield (T)	1,172	393	521	258
Cinnaminson (T)	2,432	1,353	629	451
Delanco (T)	508	235	156	116
Delran (T)	1,259	588	384	287
Eastampton (T)	402	188	104	110
Edgewater Park (T)	0	0	0	0
Evesham (T)	561	442	70	49
Fieldsboro (B)	360	80	162	118
Florence (T)	2,285	545	971	769

Municipality	1% Flood Event			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Hainesport (T)	822	420	224	178
Lumberton (T)	1,905	620	727	559
Mansfield (T)	3,403	495	1,639	1,270
Maple Shade (T)	485	420	38	28
Medford (T)	395	2,142	1,143	43
Medford Lakes (B)	4,116	290	62	831
Moorestown (T)	661	434	131	96
Mt. Holly (T)	1,586	644	543	399
Mt. Laurel (T)	879	597	163	119
New Hanover (T)	738	633	59	45
North Hanover (T)	2,112	913	640	558
Palmyra (B)	1,050	405	379	267
Pemberton (B)	75	65	6	4
Pemberton (T)	2,630	1,734	478	419
Riverside (T)	511	224	156	130
Riverton (B)	301	165	82	53
Shamong (T)	257	134	62	61
Southampton (T)	2,299	1,292	539	468
Springfield (T)	207	125	46	35
Tabernacle (T)	534	330	125	80
Washington (T)	237	212	16	8
Westampton (T)	140	98	25	18
Willingboro (T)	7,223	1,980	3,018	2,226
Woodland (T)	65	57	3	4
Wrightstown (B)	455	312	87	56
Burlington County (Total)	**54,698**	**25,355**	**16,787**	**12,557**

Source: HAZUS-MH 2.1

Effect of Climate Change on Vulnerability

Climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of extremes such as flood events. While predicting changes of flood events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society and the environment (U.S. Environmental Protection Agency [EPA], 2006).

Future Growth and Development

As discussed in Section 4, areas targeted for future growth and development have been identified across the County. Any areas of growth could be potentially impacted by the flood hazard if located within the identified hazard areas. Figure 5.4.4-4 illustrates the identified areas of potential new development in relation to the flood boundaries. It is the intention of the County to discourage development in vulnerable areas or to encourage higher regulatory standards on the local level.

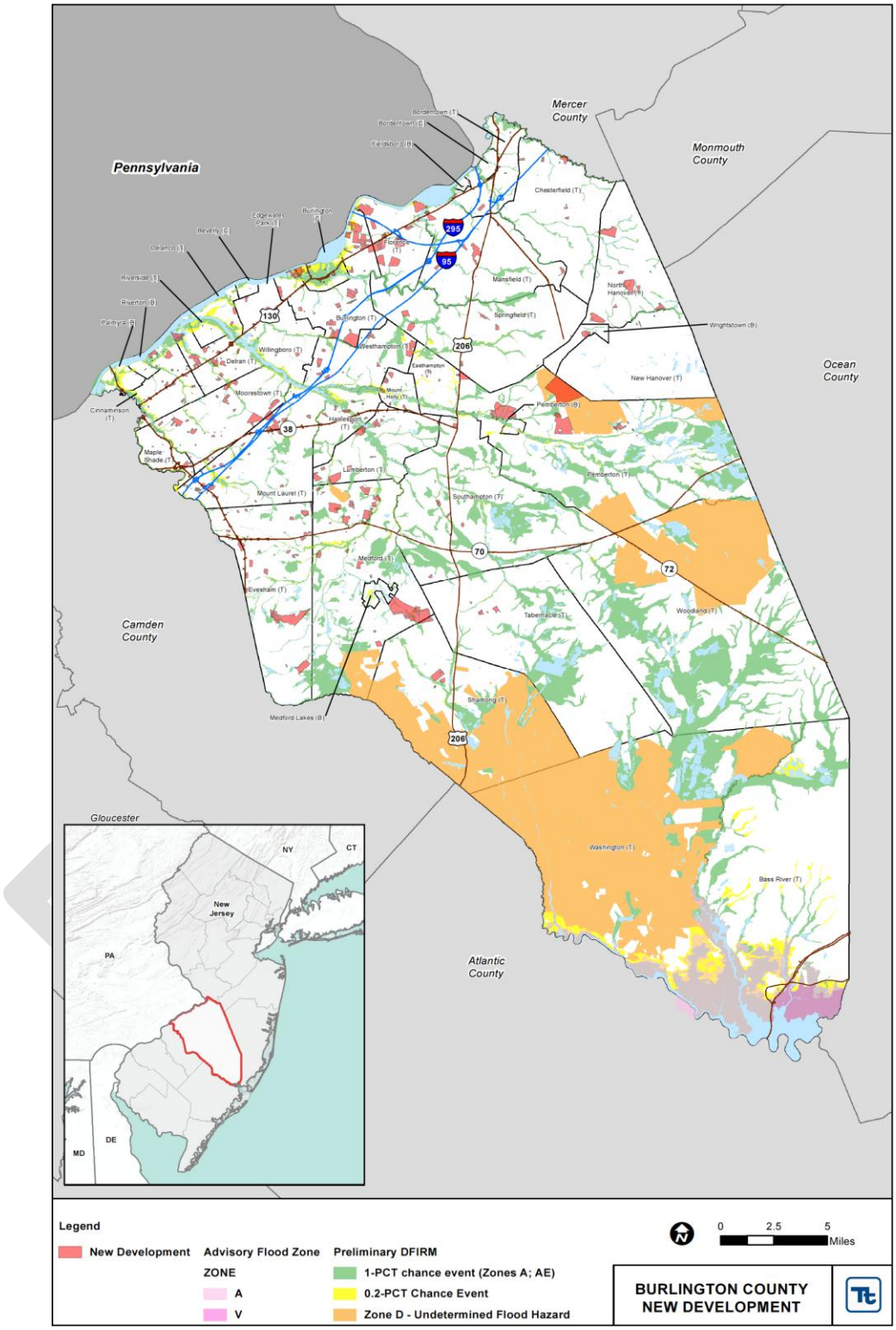
Additional Data and Next Steps

A HAZUS-MH riverine flood analysis was conducted for Burlington County using the most current and best available data including critical facility inventories, preliminary DFIRMs, advisory zones and DEM created using 10-foot contours. For future plan updates, more accurate exposure and loss estimates can be produced by replacing the national default demographic inventory with 2010 U.S. Census data when it becomes available in the HAZUS-MH model, as well as a custom building inventory with the HAZUS analysis conducted at the structure level. In addition, the 0.2-percent annual chance flood event may be analyzed to estimate potential losses for the inventories discussed.

FEMA's Risk Mapping, Assessment, and Planning (Risk MAP) program provides the flood depth and analysis grids as part of the publicly available DFIRM deliverable. When these depth grids are available for Burlington County, they can be incorporated into HAZUS and used to recalculate the potential losses to the County's inventory for these recurrence intervals.

Specific mitigation actions addressing improved data collection and further vulnerability analysis is included in Section 9 (Mitigation Strategies) of this plan.

Figure 5.4.4-4. Potential New Development and Flood Boundaries



Source: Burlington County GIS 2013