



4.3.6 Flood

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the flood hazard in Morris County.

2020 HMP Changes

- All subsections have been updated using best available data.
- The discussion of urban flooding has been expanded.
- Previous events between 2014 and 2019 are listed with a comprehensive list of previous events in Appendix E (Risk Assessment Supplement).
- The FEMA 2017 preliminary DFIRM was used to conduct the risk assessment.

4.3.6.1 Profile

Hazard Description

A flood is the inundation of normally dry land resulting from the rising and overflowing of a body of water. 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) (FEMA 2007). Floods are frequent and costly natural hazards in New Jersey in terms of human hardship and economic loss, particularly to communities that lie within flood-prone areas or floodplains of a major water source.

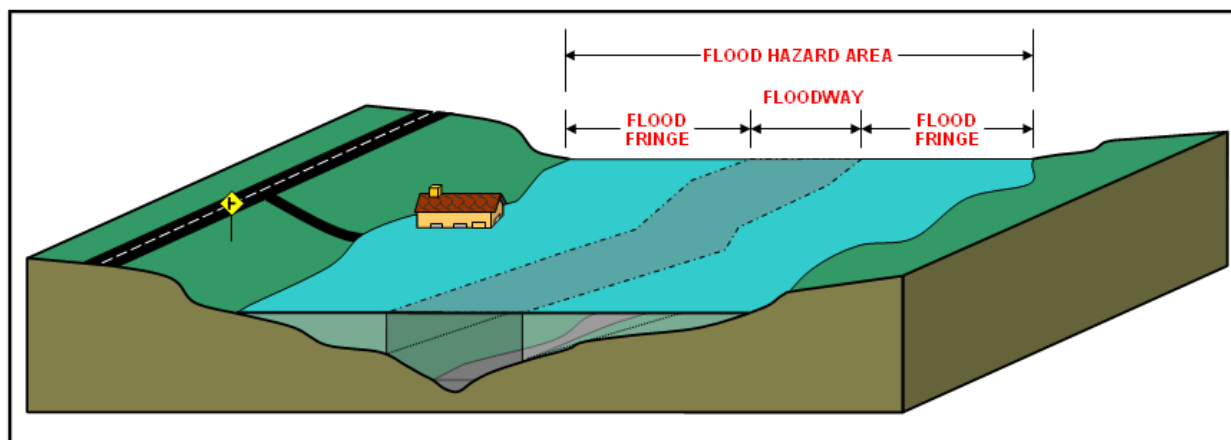
The flood-related hazards most likely to impact Morris County are riverine (inland) flooding, urban flooding, and flooding as a result of a dam failure. Dam failure is discussed in Section 4.3.1 (Dam Failure). In addition, Morris County also experiences urban flooding which is the result of precipitation and insufficient drainage.

Riverine (Inland) Flooding

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. In Morris County, floodplains line the rivers and streams of the County. The boundaries of the floodplains are altered as a result of changes in land use, the amount of impervious surface, placement of obstructing structures in floodways, changes in precipitation and runoff patterns, improvements in technology for measuring topographic features, and utilization of different hydrologic modeling techniques. Figure 4.3.6-1 depicts the flood hazard area, the flood fringe, and the floodway areas of a floodplain.



Figure 4.3.6-1. Floodplain



Source: New Jersey Department of Environmental Protection (NJDEP) Date Unknown

Urban Flooding

Heavy rainfall that overwhelms a developed area's stormwater infrastructure causing flooding is commonly referred to as urban flooding. Urban flooding can be worsened by aging and inadequate infrastructure and over development of land. The growing number of extreme rainfall events that produce intense precipitation are resulting in increased urban flooding (Center for Disaster Resilience 2016). While riverine and coastal flooding is mapped and studied by FEMA, urban flooding is not.

NOAA defines urban flooding as the flooding of streets, underpasses, low lying areas, or storm drains. (NOAA 2009). Urban drainage flooding is caused by increased water runoff due to urban development and inadequate drainage systems. Drainage systems are designed to remove surface water from developed areas as quickly as possible to prevent localized flooding on streets and other urban areas. The systems make use of a closed conveyance system that channels water away from an urban area to surrounding streams. This bypasses the natural processes of water filtration through the ground, containment, and evaporation of excess water. Because drainage systems reduce the amount of time the surface water takes to reach surrounding streams, flooding in those streams can occur more quickly and reach greater depths than prior to development in that area (Harris 2008).

High groundwater levels can be a concern and cause problems even where there is no surface flooding. Basements are susceptible to high groundwater levels. Seasonally high groundwater is common in many areas, while elsewhere high groundwater occurs only after a long period of above-average precipitation (FEMA 1997).

Location

Flooding potential is influenced by climatology, meteorology and topography. Extensive development, such as that seen in Morris County, also can impact flooding potential as it leaves fewer natural surfaces available to absorb rainwater, forcing water directly into streams, rivers, and existing drainage systems swelling them more than when more natural surface buffered the runoff rate.

Passaic River



The Passaic River is one of the major flood areas throughout Morris County. Municipalities flooded by the Passaic River include: Chatham Borough, Chatham Township, East Hanover, Florham Park, Hanover, Harding, Lincoln Park, Long Hill and, Montville (FEMA FIS 2017).

The source of the Passaic River begins near the Borough of Mendham (Morris County) where small streams come together to form a brook where the River continues through open farm land and eventually winding through seven counties, 45 municipalities, and into the Newark Bay. At its source, the River is approximately 600 feet above sea level and flows along for approximately 90 miles. The River's southeasterly flow goes south of Jockey Hollow at Morristown national Historical Park and becomes the boundary between Somerset and Morris Counties, east of Bernardsville and Basking Ridge and southwest of the Great Swamp National Wildlife Refuge (FEMA FIS 2017).

When the Passaic River reaches Morris County, through a wide valley, wetlands and marshes. At this point, it divides Morris and Essex Counties, flowing slowly past Livingston, Florham Park, Hanover and East Hanover, the Caldwelles, Montville, Fairfield, and Lincoln Park. The Rockaway River joins the Passaic River at Pine Brook at the southeast end of Hook Mountain. At this point, its flow is turned directly between Fairfield and Lincoln Park to Two Bridges and is joined by the Pompton River. It then continues northeast into Passaic County and flows into Newark Bay (FEMA FIS 2017).

Pompton River

The Pompton River is a tributary of the Passaic River, it is formed by the confluence of the Ramapo, Wanaque and Pequannock rivers. It flows south, passing between Lincoln Park and Pequannock. Located in the northeastern section of Morris County, the Pompton River significantly floods areas in Lincoln Park and Pequannock; the two most flood-prone municipalities in Morris County (FEMA FIS 2017).

Rockaway River

The Rockaway River originates in Jefferson Township and flows to the southwest and then to the east, emptying into the Boonton Reservoir. The River flows through the Townships of Jefferson, Rockaway, Denville, Boonton, Randolph, Parsippany Troy Hills, and the Boroughs of Wharton, Rockaway, and the Towns of Boonton and Dover.

Municipalities that have flooded due to the Rockaway River include: Town of Boonton, Denville, Jefferson, Parsippany-Troy Hills and Rockaway Twp. In August 2011, the Rockaway set a new flood record, carving out a section of Interstate 287 and causing two major slope failures in the Town of Boonton. Stream gage analysis in 20-year increments of USGS no. 01380500 in Boonton from 1938-2011 show an increase in average annual peak flow of 84% (FEMA FIS 2017).

Whippany River

The Whippany River is a major tributary of the Rockaway River. It rises in Mendham Township and flows East-North-East until it joins the Rockaway River in Hatfield Swamp, just above the confluence of the Passaic River.

The following municipalities are flooded by the Whippany River: East Hanover, Morris Township, Morristown, and Parsippany-Troy Hills (FEMA FIS 2017).



According to the 2017 preliminary FEMA Flood Insurance Study (FIS), flooding of various origins may be experienced in any season of the year particularly as New Jersey is located within the major storm tracks of North America. Flooding during winter months is less frequent, but spring flooding compounded by ice and snow melt has occurred. The most extensive floods have occurred mostly in late summer and early fall, and are usually associated with tropical disturbances moving north along the Atlantic coast. Flooding potential for each type of flooding that affects Morris County is described in the subsections below. For additional information on floodprone areas in each of the municipalities, refer to Section 9 (Jurisdictional Annexes).

Floodplains

In August 2017, FEMA released updated preliminary Digital Flood Insurance Rate Maps (DFIRMs) for five Morris County municipalities affected by map amendments made in neighboring counties (East Hanover, Lincoln Park, Montville, Parsippany and Pequannock). All other Morris County municipalities have preliminary FIRM released by FEMA in February 2016. The countywide preliminary DFIRM data provided by FEMA on their Map Service Center for download are dated August 22, 2017. The preliminary DFIRM shows the following flood hazard areas:

- 1-Percent Annual Chance Flood Hazard: Areas subject to inundation by the 1-percent annual chance flood event. This is also referred to as the Special Flood Hazard Area (SFHA). Mandatory flood insurance requirements and floodplain management standards apply.
- 0.2-Percent Annual Chance Flood Hazard: Area of minimal flood hazard, usually depicted on FIRMs as the 500-year flood level or Shaded X Zone.

Locations of flood zones in Morris County as depicted on the FEMA 2017 preliminary DFIRMs are illustrated in Figure 4.3.6-2 and the total land area in the floodplain, inclusive of waterbodies, is summarized in Table 4.3.6-1. A comparison analysis was conducted to understand changes in flood hazard area between the 2015 HMP, which used the 2011 preliminary DFIRMs, and the current 2017 preliminary DFIRMs. Overall, there is an overall increase in the 1-percent annual chance floodplain and the 0.2-percent annual chance event floodplain countywide, although this varies by jurisdiction. The preliminary maps are still under review.

Table 4.3.6-1. Changes in Land Area between the 2011 preliminary FEMA DFIRMs and the 2017 preliminary FEMA DFIRMs

Total County Area (acres)	2011 preliminary FEMA DFIRM used in the 2015 HMP (acres)		2017 preliminary FEMA DFIRM (acres)		Change in Floodplain Area (acres)	
	1-Percent Annual Chance	0.2-Percent Annual Chance	1-Percent Annual Chance	0.2-Percent Annual Chance	1-Percent Annual Chance	0.2-Percent Annual Chance
308,121	40,720	44,364	40,996	44,563	+ 276 acres (0.67%)	+ 199 acres (0.45%)

Source: FEMA 2011/2017; NJOIT 2012

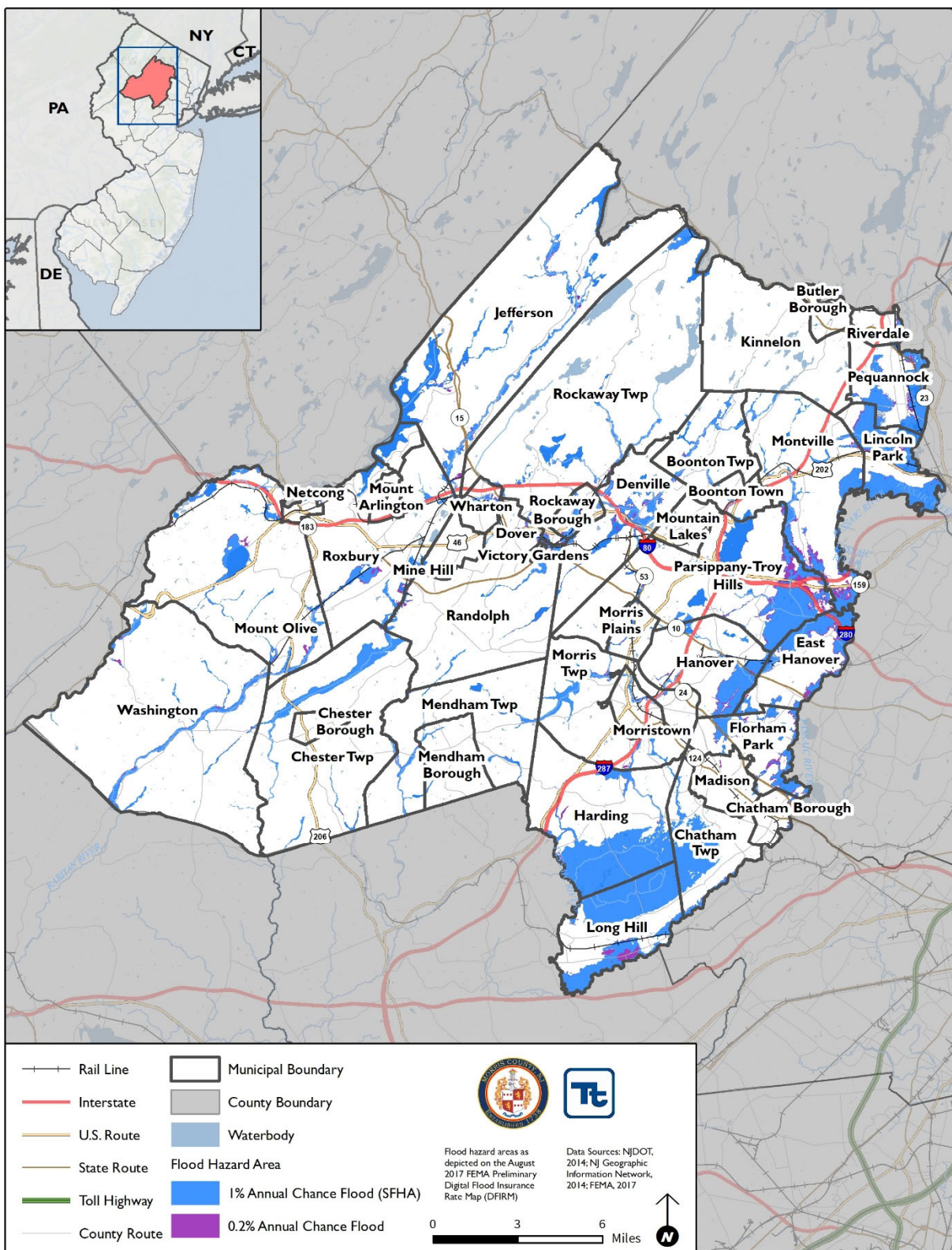
The area presented includes the total area of the County, which may include waterways.

In addition, FEMA has a Flood Map Change Viewer that may be accessed online at the web address below to look more closely at changes in the flood hazard at a property level:

<https://fema.maps.arcgis.com/apps/webappviewer/index.html?id=e7a7dc3ebd7f4ad39bb8e485bb64ce44>



Figure 4.3.6-2. Preliminary 2017 FEMA Flood Hazard Areas in Morris County





A majority of the 1 percent annual chance flood hazard zones are located in eastern Morris County, along the Pompton and Passaic Rivers. In southwestern Morris County, the Black River has areas of the 1-percent annual chance flood hazard zones.

Flood Insurance Study (FIS)

The following discussion presents flood information as directly provided in the preliminary FEMA 2017 FIS document(s). The FIS also included dates of historic flood events, which will also be included in this section. Please note, at times Hurricane Irene is noted as Tropical Storm Irene in the FEMA FIS.

- Boonton, Township of: Increased flooding along the Rockaway River may be attributed to increased urbanization, which produces increased rainfall runoff and results in greater flood damage. Greater flood damage is also due to the low permeability of certain soils, interacting with a high degree of development, and a lack of adequate storm sewers in the town. Some areas are subject to frequent flooding and ponding of surface water, especially during localized thunderstorms and tropical storms in the summer and fall. Such conditions exist between Oak and Green Streets in the northern portion of the community, and in the Sheep Hill section. In the southern portion of the town, where slopes are flat, periodic flooding is encountered between Boonton High School and at the rear of the Kanouse Street properties. Lands bordering on the Rockaway River from Greenback Road to the Montville corporate limits along Vreeland Avenue are also vulnerable to flooding. Discharge records along the Rockaway River at the USGS gage (No. 01380500) above Boonton Reservoir, in the Town of Boonton, indicate a maximum recorded discharge of 8,210 cubic feet per second (cfs) and gage height of 9.31 on August 27, 2011, during Tropical Storm Irene. Thousands of power outages occurred across the County during Tropical Storm Irene. In Boonton, Interstate Route 287 Northbound had lanes sheared away by the Rockaway River due to Tropical Storm Irene. This gage station was discontinued on August 27, 2011. On March 7, 2012, a new gage No. 01380450 was installed to replace this gage (USGS No. 01380500, 2014).
- Butler, Borough of: The low-lying areas in this community are subject to periodic flooding caused by the overflow of the Pequannock River and Stonehouse Brook. The greatest flood of record occurred in 1903. The second largest flood occurred on March 2, 1902, resulting from snow melt and heavy rain. Other severe floods occurred in the area in August 1955, October 1955, and May 1968. The storm of August 1955 caused some flooding along the Passaic River from Two Bridges to Paterson, Passaic County, but most of the flooding occurred on tributaries, including the Pequannock River (Richard P. Browne Associates, 1976). The storm of May 1968 caused widespread damage over the Passaic River basin, but flooding was most severe on the Pompton, Ramapo, Wanaque, and Pequannock Rivers. Severe damage also resulted from flooding caused by Stonehouse Brook in May 1968. The floods of 1971 and 1976 are the most recent floods to cause severe damage to the Borough. The dam on Terrace Lake was damaged in June 1976.
- Chatham, Borough of: High Water Marks (HWMs) are the evidence of the highest water levels during a flood. The average HWM at the Borough of Chatham over the Passaic River was 176.66 feet at Lower Chatham Bridge/Passaic Avenue due to Tropical Storm Irene.
- Chatham, Township of: Flooding that occurs in the Green Village/Britten Road area from Loantaka Brook. The height of floodwater diminishes below Green Village Road as water spreads out into a section of the Great Swamp between Britten and Meyersville Roads. Natural stream flow is augmented by the effluence from the Woodland Road Treatment Plant in the Township of Morris. Black Brook B floods regularly in the vicinity of several houses as it crosses Green Village Road. The Great Swamp and the Millington Gorge affect the flow of the Passaic River. The Great Swamp acts as a storage area, while the Millington Gorge restricts the passage of flood levels. The highest flood ever recorded at the Millington Gorge gage No. 01379000 occurred in 1996. The flow was measured at 2,290 cfs. During Tropical Storm Irene, on August



29, 2011, the discharge measured 2,120 cfs at this gage station. In the last four decades, the greatest discharge measured at the Chatham gage No. 01379500 was 3,380 cfs in August 1973. During Tropical Storm Irene, the discharge at the gage was 2,620 cfs on August 29, 2011.

- Chester, Township of: The Township lies in two watershed systems. The western and northern-most parts of the Township are part of the Lamington River watershed while the remaining part of Chester lies in the upper North Branch Raritan River watershed. Both watersheds are major contributors to the North Branch Raritan River Basin. USGS gaging station No. 01398500 is located on the North Branch Raritan River near Far Hills, New Jersey. Based on data collected from this gage since 1919, probable dates of major flooding events for the upper North Branch Raritan River Basin are: July 13, 1919 (7,000 cfs); August 28, 1971 (6,390 cfs); October 19, 1996 (5,090 cfs); September 16, 1999 (5,300 cfs); and August 28, 2011 (5,460 cfs).
- Denville, Township of: Flooding along the Rockaway River occurs virtually throughout the entire length of the river within the township. The greatest amount of damage occurs in the general area along Riverside Drive and the riverfront properties in the vicinity of the Diamond Spring Road bridge. Damage from flooding along Beaver Brook B is relatively light as a result of flood waters being limited to the largely undeveloped low-lying areas along the stream. Damages resulting from flooding associated with Den Brook occur along the shorelines of both Lake Estling and Indian Lake. Further downstream, additional damages are incurred in the Peck Meadow Brook and Woodland Avenue areas. The combined effect of flooding on Den Brook and the Rockaway River have inundated both U.S. Route 46 and Denville Center on a number of occasions. Flood damages on the Tributary 2 to Rockaway River are relatively light, and no major problems are apparent. The flood of record in Denville occurred in 1903 when a discharge of 7,300 cfs was recorded. Other major floods occurred in 1936, 1968, 1971, 1973, 1977, 1979, 1984, 1996, 1999, 2007, and 2011. Tropical Storm Irene in August 2011 caused severe flooding and damage throughout Morris County affecting all communities.
- Dover, Town of: The Rockaway River flows through the heart of the town in a broad channel with varying banks. Tributaries within the study area are intermittent and flow in narrow channels.
- East Hanover, Township of: Flooding in the Passaic River and the Whippany River basins occurs as a consequence of heavy rain in the summer and fall months and is usually associated with localized thunderstorms and hurricanes in the township. Due to the low permeability of certain soils within the Township, some areas are subject to frequent flooding and ponding of surface water during these periods of heavy rain. Discharge records from the Passaic River gaging station (USGS No. 01379500) at nearby Chatham, New Jersey, indicate a maximum recorded discharge of approximately 3,380 cfs on August 2, 1973. Discharges of 2,730 cfs and 2,620 cfs were measured on March 15, 2010, and August 29, 2011, respectively. In recent years, maximum discharges of 2,630 cfs and 3,780 cfs were recorded on the Whippany River at gaging station 01381500 in Morristown, New Jersey, for the floods of September 16, 1999, and August 28, 2011, respectively.
- Florham Park, Borough of: Flooding in the Passaic River system within the borough occurs as a result of heavy rainfall.
- Hanover, Township of: Flooding in the Whippany River Basin has historically occurred as a consequence of heavy rain, usually associated with localized thunderstorms and hurricanes, during the summer and fall months. Less intense rains, falling on snow or frozen ground in the winter months, have produced lesser floods. Due to the low permeability of certain soils within the Township, some areas are subject to frequent flooding and ponding of surface water during periods of heavy rain.
- Harding, Township of: The Township is basically a rural residential and farming area with little commercial and industrial development. The area east of U.S. Route 202 has very poor natural drainage and low permeability because of the shallow shale soils. These soils result in rapid runoff, which adds to the flooding problems. Local flooding has been experienced not only in the lowlands of Harding, which are along the



Passaic River, but also along portions of Great Brook, Silver Brook, Tributary of Great Brook, Primrose Brook, and various locations in the Green Village area. These inundations are a consequence of heavy rains, usually associated with localized thunderstorms and hurricanes during the summer and fall months. Problem flooding locations identified at various times include the areas along Great Brook crossing Pleasant Plains Road, Long Hill Road, Meyersville Road, Woodland Road, Village Road, and Van Beuren Road, which have been inundated frequently; Silver Brook has overflowed its overbank areas for its entire length within the corporate limits; and the Baileys Mill Road crossing of Primrose Brook at Youngs Road and Lee's Hill Road have been constant problems during severe storms.

- Jefferson, Township of: Due in part to the low intensity of development in the river valleys, the township has not historically experienced a significant amount of flood damage. The flooding of populated areas is usually confined to lakefront homes and is considered relatively minor. One notable exception occurs along the Rockaway River at Berkshire Valley Road just downstream of State Route 15. With scattered exceptions, all other flooding in the Township is limited to the undeveloped low-lying areas adjacent to the streams.
- Lincoln Park, Borough of: Low-lying areas of the Borough are subject to periodic flooding caused by the overflow of the Passaic River, the Pompton River, Beaver Dam Brook, East Ditch, and West Ditch. The greatest flood of record occurred in 1903. The flood peak from 1903 is still the peak at the Passaic River and the Pompton River, NJ stream gages even after Tropical Storm Irene in August 2011.
- Long Hill, Township of: The Township has experienced severe flooding as a consequence of heavy rains. The low-lying swamps adjacent to the Passaic River, its tributaries, and a system of manmade and natural defiles connecting with the Passaic River increase flood potential in the Stirling area of the Township. The most severe flood during 135 years of record occurred on October 10, 1903. Extensive losses were sustained as a result of this flood. Numerous storms of major proportion since then have caused considerable damage. Tropical Storm Irene in August 2011, has caused the most damage to property in recent years.
- Madison, Borough of: Flooding along Spring Garden Brook and Black Brook B has historically occurred as a result of heavy rainfall. Water levels along Spring Garden Brook and Black Brook B within the Borough are not affected by the water levels of the Passaic River; therefore, flooding of the Passaic River due to stream water runoff from other parts of the river basin will not cause flooding in the Borough. Few flooding problems in Madison originate outside the Borough. Drainage problems within Madison can be attributed to inadequate culverts and storm sewers. Storm sewer inlets along steeply sloping streets are inefficient and storm water runoff has a tendency to flow over these outlets. Therefore, flooding may occur in the flat areas of the Borough due to the additional runoff. Areas subject to this kind of flooding are located near Kings Road and near the tributary to Black Brook B in the Anthony Drive and North Street area.
- Mendham, Borough of: The recorded history of flooding at the North Branch Raritan River gaging station 01398500 near Far Hills, New Jersey, began in 1919 (USGS, 1990). Large floods have occurred on July 23, 1919 (7,000 cfs); August 28, 1971 (6,390 cfs); September 16, 1999 (5,300 cfs); and August 28, 2011 (5,460 cfs).
- Mendham, Township of: The Township has reported flooding at three locations within the community. Flooding occurs on the North Branch Raritan River just upstream from the confluence of Burnett Brook. This area has a wide floodplain, and the flooding along this section has been attributed to a topographic constriction near the Roxiticus Road crossing. Several homes along Roxiticus Road are affected by this situation. Flooding on the Whippany River occurs in the area of Tingley Road and has been attributed to the wide flat floodplain in this area. The municipal offices for the Township and several other structures are affected by this situation.
- Mine Hill, Township of: The streams and rivers in Mine Hill contribute to the South Branch Raritan River basin, the Musconetcong River basin, or the Lamington River basin. There are no USGS recording or crest-



stage gaging stations on Drakes Brook, which is part of the South Branch Raritan River system. USGS gaging station No. 01396500 on the South Branch Raritan River near High Bridge, New Jersey, is approximately 16 miles downstream of the mouth of Drakes Brook in Mount Olive (USGS, 1976). According to this gage, which has continuous records from 1896 to the present. The dates of major flooding events include February 6, 1896 (7,560 cfs), January 25, 1979 (6,910 cfs), and August 28, 2011 (6,640 cfs). The history of recorded gage No. 01457000 in the Musconetcong River basin near Mine Hill began in 1929. Since then, several major floods have occurred and minor floods have been a common occurrence. Based on peak stages and discharges at USGS gaging station No. 01455500 at the outlet of Lake Hopatcong near Mine Hill, the date of the latest major flooding event was August 8, 2000 (1,900 cfs). There are no USGS recording or crest-stage gaging stations located on any of the remaining detailed studied streams, including the Lamington River.

- Montville, Township of: Flooding in the township is a result of heavy rainfall produced by hurricanes moving up the Atlantic coast, large frontal storms from the west and south, and local thunderstorms. Large-magnitude floods along the Passaic River occurred 18 times during the past 200 years. The largest of these floods occurred in 1902, 1903, 1936, 1945, 1984, 2007, and 2011. The 1903 flood, caused by a dam failure and with an estimated peak discharge of 31,700 cfs at Little Falls on the Passaic River at USGS gage No. 01389500, inundated large areas, caused damage to buildings, and disrupted transportation and utility lines. The flood peak on August 28, 2011, during Tropical Storm Irene was 20,800 cfs at this gage station. Most of the flooding occurred along the Passaic and Rockaway Rivers. The flood peaks from the 1903 storm are still the peaks of record at the Passaic River at Little Falls, New Jersey (01389500), and the Pompton River at Pompton Plains, New Jersey (01388500), stream gages even after recent Tropical Storm Irene.
- Morris Plains, Borough of: The flooding along Watnong Brook and Jaquis Brook in Morris Plains is caused by heavy rain, usually associated with localized thunderstorms and hurricanes during the summer and fall months. Problem flooding locations identified at various times include the area along Watnong Brook at the Warner-Lambert Plant, at the Lutheran Church near Mountain Way, and several houses at Jaquis Pond near Hanover Avenue, which have all experienced flooding during severe rainstorms.
- Morris, Township of: The Township is a developing residential community with several land tracts devoted to light industry. Factors that affect flooding in the community include increased runoff from development, steep land slopes, and low permeability of the soils. Flooding occurs along Whippany River, Watnong Brook, Great Brook, and Loantaka Brook. The major flood of 1971 created considerable overbank flooding along these streams and caused traffic interruption and property damage. Various problem flooding areas such as the area near Whippany River, Washington Valley Road crossing, Whitehead Road, and Tracy Court were identified in the past and the Township of Morris Committee adopted flood damage prevention measures to prevent future losses.
- Morristown, Town of: The Town is a highly developed urban community with buildings and paved areas covering most of the land area; therefore, land available to absorb precipitation is significantly reduced, and the amount of runoff is increased. The hilly topography of the area further increases the rate of runoff and could result in flooding where drainage is inadequate. The major watercourse traversing Morristown is the Whippany River. According to the recollections of persons interviewed, the Whippany River has been responsible for major flooding since the late 1920s. All evidence indicates that the water levels reached during flood periods have not dramatically changed over the years. However, the frequency of these occurrences and the damage caused have both increased. Although the Whippany River is considered the major flooding source in Morristown, there are other areas that have become increasingly prone to flooding and resultant flood damage. In recent years, Great Brook has been subject to flooding owing to development within the floodplains and watershed areas. As early as April 1924, Water Street (now known as Martin Luther King Avenue) was flooded as far west as Spring Street. From all available evidence, it appears that



until the 1950s, floods would recur approximately once every 10 years. However, with the increase in development throughout the Whippany River valley following World War II, the frequency of flooding increased dramatically. During the 1970s, floods occurred almost annually. Continued development of the upstream floodplains and watershed areas has created a condition that results in flooding or threats of flooding more frequently than has been the case in the past. Throughout northeastern New Jersey in 1971, Tropical Storm Doria caused great destruction. Discharge records for the Whippany River at gage No. 01381500 indicate discharge of 2,800 cfs on August 28, 1971, during Tropical Storm Doria. Tropical Storm Irene indicates a maximum recorded discharge of 3,780 cfs on August 28, 2011.

- Mount Olive, Township of: The history of flooding in the township indicates that flooding may be experienced during any season of the year since New Jersey lies within the major storm tracks of North America. Flooding in the Musconetcong River basin near Hackettstown has been recorded since 1922. Since then several major floods have occurred and minor flooding has been a common occurrence. Recorded history of flooding for the South Branch Raritan River began in 1896 at USGS gage No. 01396500 near High Bridge. Based on peak stages and discharges at that gaging station, major flooding events occurred on February 6, 1896 (7,560 cfs); March 15, 1940 (5,160 cfs); and August 28, 2011 (6,400 cfs).
- Netcong, Borough of: The recorded history of flooding in the Musconetcong River basin near the outlet to Lake Hopatcong began in 1929 in the Borough. Several major floods have occurred in the Borough and minor floods have been a common occurrence.
- Parsippany-Troy Hills, Township of: The Township has had a history of severe flooding. The residential community of Lake Hiawatha and sections of the Township south of U.S. Route 46 have been subject to flooding from the Whippany River, Troy Brook, and Eastmans Brook, which flow east into Troy Meadows and eventually into the Rockaway River. Also, Watnong Brook has caused minor flooding in the Mount Tabor area of Parsippany-Troy Hills. Tropical Storm Irene in August 2011 is the most recent flood to cause damage to the Township.
- Pequannock, Township of: Low-lying areas of the Township are subject to periodic flooding caused by the overflow of the Pompton River, the Pequannock River, the Ramapo River, East Ditch, West Ditch, and the tributaries to East Ditch. The greatest flood of record occurred in 1903.
- Randolph, Township of: Major flooding in the township is a result of heavy rains, usually associated with localized thunderstorms and hurricanes during the summer and fall months.
- Riverdale, Borough of: Low-lying areas of Borough are subject to periodic flooding caused by the overflow of the Pequannock River. The greatest flood of record occurred in 1903. Tropical Storm Irene in August 2011 is the most recent floods to cause damage to the Borough.
- Rockaway, Borough of: The majority of flooding in the Borough occurs along the Rockaway River. Those areas affected include portions of Franklin Drive, between East Main Street and Rockaway Avenue, the eastern end to Nicholas Drive, and the industrial areas along the upstream corporate limits with the Township of Denville. Flooding also occurs along the entire lengths of Beaver and Fox Brooks within the Borough; however, damage has been relatively light.
- Rockaway, Township of: Flooding in the Township is mostly due to the Rockaway River, a major tributary of the Passaic River. There are no USGS recording or crest-stage gaging stations located on any of the remaining detailed studied streams, including the Lamington River within the township of Roxbury and Township of Washington due to large difference in drainage area size between the limits of the detailed study along the Lamington River and the Pottersville gage.
- Wharton, Borough of: The history of flooding along the streams within Wharton indicates that flooding usually takes place during the summer and fall and is almost always associated with thunderstorms and tropical storms.



Ice Jams

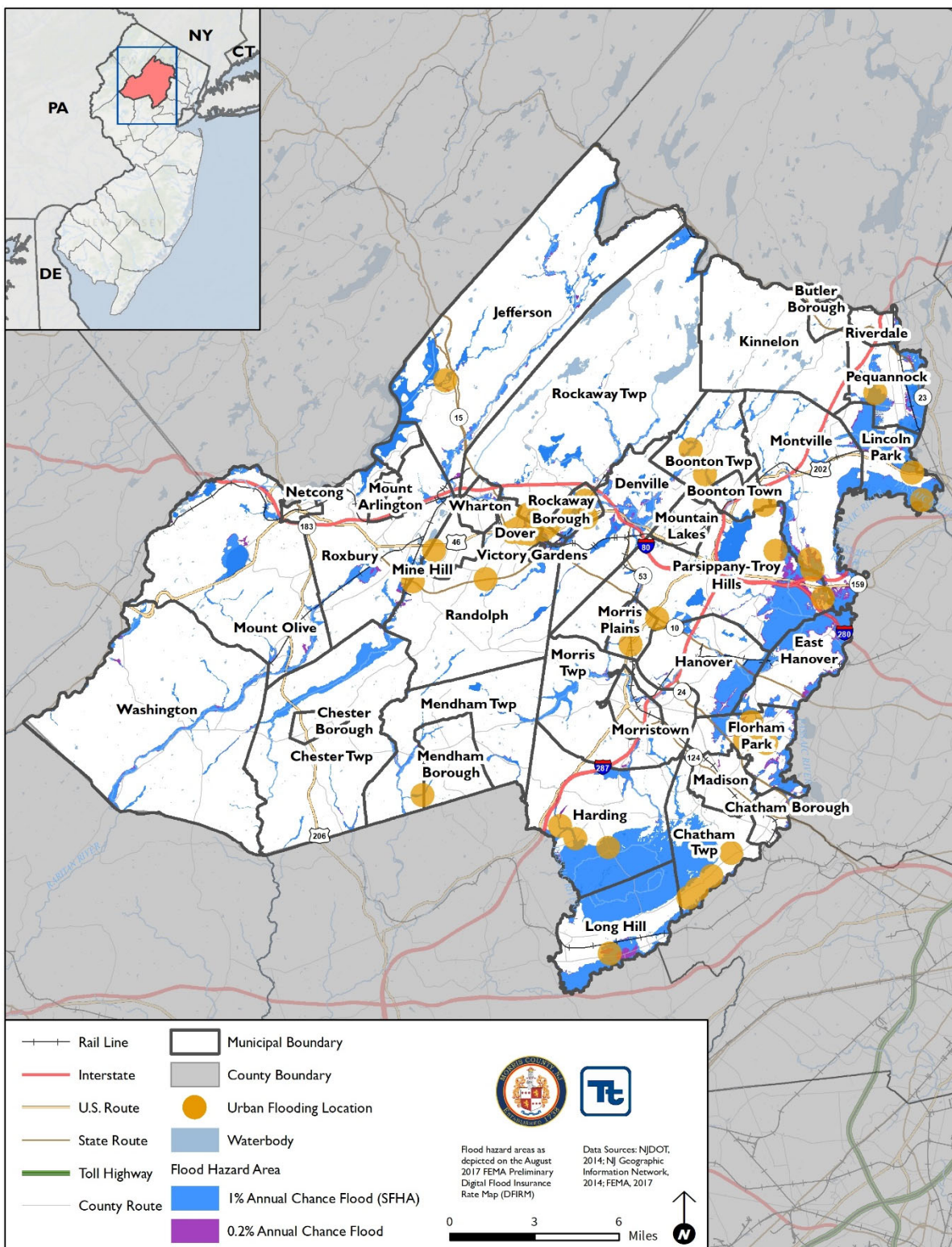
Ice jams can occur along rivers and creeks. In Morris County, ice jams have occurred along the Passaic River at Chatham and on Green Brook (USACE CRREL 2020).

Urban Flooding

Throughout Morris County, low-lying surface flooding and interior shallow ponding occurs as a result of heavy rainfall and inadequate capacity of stormwater systems. While riverine flooding is mapped by FEMA, urban flooding is not. Each municipality was asked to identify areas that flood outside the FEMA-mapped floodplain in an attempt to identify problem areas and assist with identifying mitigation solutions. Figure 4.3.6-3 illustrates the urban flood areas identified by the municipalities participating in the 2020 HMP update.



Figure 4.3.6-3. Urban Flood Areas Identified in Morris County





Extent

The frequency and severity of riverine flooding are measured using a discharge probability, which is the probability that a certain river discharge (flow) level will be equaled or exceeded in a given year. Flood studies use historical records to determine the probability of occurrence for the different discharge levels.

Floodplains are often referred to as 100-year floodplains. A 100-year floodplain is not a flood that will occur once every 100 years; the designation indicates a flood that has a 1-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. Due to this misleading term, FEMA has properly defined it as the 1-percent annual chance flood, or the SFHA. Similarly, the 500-year floodplain will not occur every 500 years but is an event with a 0.2-percent chance of being equaled or exceeded each year. The "1-percent annual chance flood" is now the standard term used by most federal and state agencies and by the National Flood Insurance Program (NFIP) (FEMA 2003). The 1-percent annual chance floodplain establishes the area that has flood insurance and floodplain management requirements and is also referenced as the regulatory floodplain.

The NJDEP is mandated to delineate and regulate flood hazard areas pursuant to N.J.S.A. 58:16A-50 et seq., the Flood Hazard Area Control Act. This Act authorizes the DEP to adopt land use regulations for development within the flood hazard areas, to control stream encroachments and to integrate the flood control activities of the municipal, county, state and federal governments. The State's Flood Hazard Area delineations are defined by the New Jersey Flood Hazard Area Design Flood which is equal to a design flood discharge 25% greater in flow than the 1-percent annual chance flood. In addition, the floodway shall be based on encroachments that produce no more than a 0.2-foot water surface rise above the 1-percent annual chance flood.

The USGS National Water Information System (NWIS) collects surface water data from more than 850,000 stations across the country. The time-series data describes stream levels, streamflow (discharge), reservoir and lake levels, surface water quality, and rainfall. The data is collected by automatic recorders and manual field measurements at the gage locations. Morris County has numerous active USGS stream gages; in addition, stream gauges are located upstream in neighboring counties.

In the case of riverine flood hazard, 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. The size of rivers and streams in an area and infiltration rates are significant factors. When it rains, soil acts as a sponge. When the land is saturated or frozen, infiltration rates decrease and any more water that accumulates must flow as runoff (Harris 2008).

Currently, there is no measurement used to further define the frequency and severity of urban flooding.

Previous Occurrences and Losses

Many sources provided historical information regarding previous occurrences and losses associated with flooding throughout the State of New Jersey and Morris County; therefore, the loss and impact information for



many events varies depending on the source. The accuracy of monetary figures discussed is based only on the available information in cited sources.

FEMA Major Disasters and Emergency Declarations

Between 1954 and 2019, FEMA declared that the State of New Jersey experienced 43 flood-related disasters (DR) or emergencies (EM) classified as one or a combination of the following disaster types: hurricane, tropical storm, Nor'Easter, snowstorm, severe storms, flooding, inland and coastal flooding, coastal storm, high tides, heavy rain, and severe storms. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Morris County was included in 23 of these flood-related declarations; refer to Table 4.3.6-2.

Table 4.3.6-2. Flood-Related Disaster (DR) and Emergency (EM) Declarations 1954-2019

Declaration	Event Date	Declaration Date	Event Description
DR-245	June 18, 1968	June 18, 1968	Flood: Heavy Rains & Flooding
DR-310	September 4, 1971	September 4, 1971	Flood: Heavy Rains & Flooding
DR-477	July 23, 1975	July 23, 1975	Flood: Heavy Rains, High Winds, Hail & Tornadoes
DR-701	March 28-April 8, 1984	April 12, 1984	Flood: Coastal Storms & Flooding
DR-973	December 10-17, 1992	December 18, 1992	Flood: Coastal Storm, High Tides, Heavy Rain, & Flooding
EM-3106	March 13-17, 1993	March 17, 1993	Snow: Severe Blizzard
DR-1088	January 7-12, 1996	January 13, 1996	Snow: Blizzard of 96 (Severe Snow Storm)
DR-1145	October 18-23, 1996	November 19, 1996	Severe Storms/Flooding
EM-3148	September 16-18, 1999	September 17, 1999	Hurricane: Hurricane Floyd Emergency Declarations
DR-1295	September 16-18, 1999	September 18, 1999	Hurricane: Hurricane Floyd Major Disaster Declarations
DR-1337	August 12-21, 2000	August 17, 2000	Severe Storms, Flooding and Mudslides
EM-3181	February 16-17, 2003	March 20, 2003	Snow: Snow
DR 1588	April 1-3, 2005	April 19, 2005	Severe Storm(s): Severe Storms and Flooding
DR-1694	April 14-20, 2007	April 26, 2007	Severe Storm(s): Severe Storms and Inland and Coastal Flooding
DR-1897	March 12-April 15, 2010	April 2, 2010	Severe Storm(s): Severe Storms and Flooding
EM-3332	August 26-September 5, 2011	August 27, 2011	Hurricane: Hurricane Irene*
DR-4021	August 27-September 5, 2011	August 31, 2011	Hurricane: Hurricane Irene*
DR-4048	October 29, 2011	November 30, 2011	Severe Storm(s): Severe Storm
DR-1954	December 26-27, 2010	February 4, 2011	Severe Winter Storm and Snowstorm
EM-3354	October 26-November 8, 2012	October 28, 2012	Hurricane: Hurricane Sandy**
DR-4086	October 26-November 8, 2012	October 31, 2012	Hurricane: Hurricane Sandy**
DR-4264	January 22-24, 2016	March 14, 2016	Severe Storm(s): Severe Winter Storm and Snowstorm
DR-4368	March 6-7, 2018	June 8, 2018	Severe Storm(s): Severe Winter Storm and Snowstorm

Source: FEMA 2019

*May also be referred to as Tropical Storm Irene

**May also be referred to as Superstorm Sandy



U.S. Department of Agriculture Disaster Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2015 and 2019, Morris County was not included in any USDA declaration involving flooding.

The USDA crop loss data provide another indicator of the severity of previous events. Additionally, crop losses can have a significant impact on the economy by reducing produce sales and purchases. Such impacts may have long-term consequences, particularly if crop yields are low the following years as well. Between 2015 and 2019, Morris County did not report any crop losses due to flooding.

Flood Events

The National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI) Storm Events database records and defines flood events as follows:

- Flash Flood is reported in the NOAA-NCEI database for a life-threatening, rapid rise of water into a normally dry area beginning within minutes to multiple hours of the causative event (e.g., intense rainfall, dam failure, ice jam).
- Flood is reported in the NOAA-NCEI database for any high flow, overflow, or inundation by water which causes damage. In general, this would mean the inundation of a normally dry area caused by an increased water level in an established watercourse, or ponding of water, that poses a threat to life or property.

For the 2020 HMP update, known flood events that have impacted Morris County between May 2014 and June 2019 are identified in Table 4.3.6-3. For events prior to May 2014, refer to the Appendix E.



Table 4.3.6-3. Flooding Events in Morris County, 2014 to 2019

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Morris County Designated?	Location	Description
April 30 – May 1, 2014	Flood	N/A	N/A	Morris County	<p>Very heavy rain caused poor drainage flooding as well as minor to moderate flooding in the Passaic Basin. Some of the flooding along the Passaic River did not start until May 1st. That flood information is included below and will be repeated in May's storm data entry. In Roxbury Township, the exit ramps in both directions off of U.S. Route 46 were flooded and closed. The heavy rain forced emergency repair lane closures on Interstate 287 in Parsippany-Troy Hills and Morristown. Mass transit was not immune. Service was suspended along a section of New Jersey Transit's Montclair-Boonton Line until May 5th as workers repaired a track washout. Buses were made available to shuttle passengers between Montclair State University and Denville. The flooding washed away the stones that support the rails between Boonton and Towaco stations early on May 1st. The Passaic River flooded sections of Long Hill Township and Chatham. Some roadways remained closed into May 2nd.</p> <p>The Passaic River at Chatham had minor flooding and was above its 6-foot flood stage from 637 p.m. EDT on the 30th through 515 a.m. EDT on May 1st. It crested at 6.46 feet at 815 p.m. on the 30th. The Pequannock River at the Macopin Dam had minor flooding and was above its 5.5-foot flood stage from 1120 p.m. EDT on the 30th through 1130 a.m. EDT on May 2nd. It crested at 6.07 feet at 155 p.m. EDT on May 1st. The Whippany River at Morristown had minor flooding and was above its 6-foot flood stage from 711 p.m. EDT on the 30th and 700 a.m. EDT on May 1st. It crested at 6.37 feet at 1100 p.m. EDT on April 30th.</p> <p>In May, the Passaic River at Millington had minor flooding and was above its 8-foot flood stage from 7 a.m. EDT on May 1st through 445 a.m. EDT on May 3rd. It crested at 8.24 feet at 730 p.m. EDT on May 1st. The Passaic River at Chatham had a second round of minor flooding with a slightly lower crest. The river was above its 6-foot flood stage from 130 p.m. EDT on May 1st through Noon EDT on May 4th. It crested at 6.34 feet at 600 a.m. EDT on May 2nd. The Passaic River at Pine Brook had moderate flooding and was above its 19-foot flood stage from 120 p.m. EDT on May 1st through 845 a.m. EDT on May 6th. It crested at 20.23 feet at 300 p.m. EDT on May 2nd. Lastly, the Passaic River at Two Bridges had minor flooding and was above its 9-foot flood stage from 345 p.m. EDT on May 1st through 730 a.m. EDT on May 6th. It crested at 10.76 feet at 330 a.m. EDT on May 3rd. The Rockaway River below the Boonton Reservoir had minor flooding and was above its 5-foot flood stage from 120 a.m. EDT on May 1st through 300 a.m. EDT on May 3rd. It crested at 6.62 feet at 330 p.m. EDT on the 1st.</p> <p>Event precipitation totals included 4.89 inches in Chatham, 4.74 inches in Florham Park, 4.70 inches in Madison, 4.58 inches in Chester Township, 4.56 inches in Long Hill Township and 4.53 inches in Morris Township. Flooding resulted in approximately \$1.25 million.</p>



Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Morris County Designated?	Location	Description
June 13, 2014	Flash Flood	N/A	N/A	Hanover	Thunderstorms with heavy rain caused poor drainage and small stream flooding in East Hanover Township. New Jersey State Route 10 was closed within the township with some underpasses totally submerged. Entire event precipitation totals included 2.41 inches in Denville, 2.28 inches in Mendham Township and 2.11 inches in Mine Hill Township.
June 24, 2017	Flood	N/A	N/A	Pine Brook	A band of gusty convective showers moved through during the morning hours in association with the remnants of tropical storm Cindy. Several reports of damage were reported from the winds. Thousands lost power.
July 7, 2017	Flood	N/A	N/A	Towaco	A stationary frontal boundary draped across the Delaware Valley lead to a period of heavy rainfall during the morning of July 7 th . Widespread rainfall amounts over 2 inches occurred, with isolated amounts upwards of 5 inches in Warren County, which lead to flooding. Several roads closed due to flooding including I-287, 80 and state road 46.
July 17, 2017	Flood	N/A	N/A	Mount Freedom	A hot and humid airmass was present ahead of a frontal boundary which slowly moved southeast toward and then through the state. Several rounds of thunderstorms moved through the region ahead of this front over the course of a few days. Numerous roads were flooded.
August 2, 2017	Flash Flood	N/A	N/A	Cedar Knolls	A hot and humid airmass with weak boundaries led to slow moving strong to severe thunderstorms with damaging winds, hail and flooding. Over 2,000 people lost power. In Cedar Knolls, flooding took place at the intersection of Route 10 and 222 with many other roads impassable. In Flanders, the intersection of Route 206 and Flanders Bartley Road was flooded.
September 16, 2017	Flood	N/A	N/A	Morristown	A series of disturbances in the jet stream and a weak surface trough lead to sufficient lift within a tropical air mass to produce slow moving, heavy rain showers across portions of New Jersey. This lead to localized urban and poor drainage flooding during the evening of Saturday, September 16 th . Flooding on I-287 Southbound at exits 35 and 36 forced lane closures. Start time estimated.
October 29, 2017	Flood	N/A	N/A	Dover, Budd Lake	A strong low-pressure system moved up the east coast producing heavy rain and strong winds. Power outages I as a result of downed trees and wires across the state. Rainfall totals were over 2 inches in every county of New Jersey outside of the New York City area. Thousands of people lost power due to the storm. Gusts in most locations topped out between 40 and 50 mph. Flooding took place in Dover on State Highway 10 near Center Grove Road. In Budd Lake, I-80 west at exit 27 was closed due to flooding.



Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Morris County Designated?	Location	Description
April 16-17, 2017	Flood	N/A	N/A	Boonton, Hanover Airport	A backdoor front resulted in a widespread 1 to 3 inches of rainfall occurred, with localized amounts over 4 inches. The Rockaway River at Boonton Below the Reservoir rose above flood stage of 5.0 feet and reached a maximum of 5.28 feet. The Passaic River at Pine Brook rose above flood stage of 19.0 feet to a maximum of 19.24 feet.
July 3, 2018	Flash Flood	N/A	N/A	Lincoln Park	Severe thunderstorms caused wind damage across portions of southwestern New Jersey on the evening of July 3. Rainfall amounts of 1 to 3 inches fell along the Interstate 95/New Jersey Turnpike Corridor in a short amount of time. A few locations received 3 to 4 inches of rain. Widespread roadway flooding was reported in Lincoln Park.
August 4, 2018	Flash Flood	N/A	N/A	Pine Brook, Parsippany	Heavy rain fell in northern New Jersey during the morning hours of August 4. Rainfall totals of 3 to 5 inches were common in the northwestern part of the state. Significant flooding occurred along US Route 46 in Parsippany-Troy Hills. At least one water rescue took place. Also, Edwards Road was closed between US Route 46 and New Road due to flooding.
August 11, 2018	Flash Flood	N/A	N/A	Randolph Township	Several areas of flash flooding occurred due to heavy rain. Rainfall totals of 2 to 5 inches were reported in northern New Jersey. Additionally, severe thunderstorms impacted the area. Two vehicles were trapped in flood waters at the intersection of Route 10 and the Sussex Turnpike in Randolph Township.
August 11, 2018	Flash Flood	N/A	N/A	Pine Brook	Several areas of flash flooding occurred due to heavy rain. Rainfall totals of 2 to 5 inches were reported in northern New Jersey. Additionally, severe thunderstorms impacted the area. Route 46 westbound was closed between North Beverwyck Road and Baldwin Road in Parsippany-Troy Hills due to flooding.
October 2, 2018	Flash Flood	N/A	N/A	Budd Lake, Netcong	Thunderstorms brought locally heavy rain to northern New Jersey on the evening of October 2. Sections of US Route 46 in Netcong were closed due to flooding.

Source: FEMA 2019; NCEI 2019; NWS 2019; SPC 2019; NJOEM 2019; NHC 2019; NOAA 2019

Note: Not all events that have occurred in Morris County are included due to the extent of documentation and the fact that not all sources have been identified or researched.

K: Thousand

DR Disaster Declaration (FEMA)

FEMA Federal Emergency Management Agency

Mph miles per hour

N/A Not Applicable



Probability of Future Occurrences

Morris County is expected to continue experiencing direct and indirect impacts of flooding in the future. Table 4.3.6-4 summarizes data regarding the probability of occurrences of flood events in Morris County based on the historic record. The information used to calculate the probability of occurrences is based solely on NOAA-NCEI storm events database results.

Table 4.3.6-4. Flood Events in Morris County 1950 to 2019

Hazard Type	Number of Occurrences Between 1950 and 2019	Rate of Occurrence	Recurrence Interval (in years)	Probability of Event Occurring in Any Given Year	Percent (%) Chance of Occurring in Any Given Year
Flash Flood	45	0.65	1.56	0.64	64.29
Flood	76	1.10	0.92	1.09	100
Total	121	1.75	0.58	1.73	100

Source: NOAA-NCEI 2019

Note: Not all events that have occurred in Morris County are included due to the extent of documentation and the fact that not all sources have been identified or researched.

K: Thousand

M: Million

In Section 5.3, the identified hazards of concern for Morris 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 Steering and Planning Committees, the probability of occurrence for flood in the County is considered ‘frequent’; refer to Section 4.4 – Hazard Ranking.

Climate Change Impacts

According to the NJDEP, New Jersey is experiencing increased intensity, frequency and duration of storm events (NJDEP 2019). Northern New Jersey’s 1971-2000 precipitation average was over five inches (12-percent) greater than the average from 1895-1970 (Sustainable Jersey Climate Change Adaptation Task Force [CATF] 2011). The heaviest 1% of daily rainfalls have increased by approximately 70% between 1958 and 2011 in the Northeast (Horton et al. 2015). Average annual precipitation is projected to increase in the region by four to 11-percent by the 2050s and five to 13-percent by the 2080s (New York City Panel on Climate Change [NPCC] 2015). Increased rainfall and heavy rainfalls increase the risk of flooding events.

Annual precipitation for New Jersey has been about 8-percent above average over the last 10 years. The number of extreme precipitation events has also been above average over the last 10 years. During 2010–2014, the state experienced the largest number of extreme precipitation events (days with more than 2 inches) compared to any other 5-year period, about 50 percent above the long-term average. Winter and spring precipitation is projected to increase for the 21st century; extreme precipitation is also projected to increase. The projections of increasing precipitation are characteristic of a large area of the Northern Hemisphere in the northern middle latitudes, as well as increases in heavy precipitation events. This may result in increased coastal and inland flooding risks throughout the state (NCEI 2019).



4.3.6.2 Vulnerability Assessment

To assess Morris County's risk to the flood hazard, a spatial analysis was conducted using the best available spatially-delineated flood hazard areas. The 1- and 0.2-percent annual chance flood events as depicted on the preliminary 2017 DFIRMs were examined to determine the assets located in the hazard areas and to estimate potential loss using the FEMA HAZUS-MH flood model. These results are summarized below. Refer to Section 4.2 (Methodology and Tools) for additional details on the methodology used to assess flood risk.

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 adequate warning time is provided to residents. Hazard exposure represents the population living in or near floodplain areas that could be impacted should a flood event occur. However, exposure is not limited to only those who reside in a defined hazard zone, but all individuals 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.

Based on the spatial analysis, there are an estimated 12,578 people living in the Special Flood Hazard Area (SFHA, or 1-percent annual chance event floodplain) and an estimated 20,814 people living in the 0.2-percent annual chance flood event floodplain. These residents may be displaced due to their homes flooding, requiring them to seek temporary shelter with friends and family or in emergency shelters. The Borough of Lincoln Park has the greatest percentage of its population located in the floodplain; approximately 24.6% and 31.4% for the 1-percent annual chance event and 0.2-percent annual chance event, respectively. The Township of Pequannock has the greatest number of residents located in the floodplain. The potential population exposed should be used as a guide for planning purposes.

Table 4.3.6-5. Estimated Population Exposed to the Flood Hazard

Municipality	ACS 2017 Total Population	1-percent Annual Chance Flood Event		0.2-percent Annual Chance Flood Event	
		Number	% of Total	Number	% of Total
Town of Boonton	8,390	0	0.0%	6	0.1%
Township of Boonton	4,353	44	1.0%	77	1.8%
Borough of Butler	7,780	58	0.7%	74	1.0%
Chatham Borough	9,003	14	0.2%	89	1.0%
Chatham Township	10,507	67	0.6%	67	0.6%
Chester Borough	1,540	0	0.0%	0	0.0%
Chester Township	7,931	3	0.0%	8	0.1%
Denville Township	16,822	1,013	6.0%	1,691	10.1%
Town of Dover	18,307	1,406	7.7%	2,160	11.8%
Township of East Hanover	11,241	495	4.4%	1,332	11.9%
Borough of Florham Park	11,792	92	0.8%	211	1.8%
Township of Hanover	14,436	71	0.5%	82	0.6%
Township of Harding	3,887	108	2.8%	112	2.9%
Township of Jefferson	21,440	158	0.7%	345	1.6%
Borough of Kinnelon	10,242	0	0.0%	0	0.0%
Borough of Lincoln Park	10,464	2,579	24.6%	3,287	31.4%
Township of Long Hill	8,763	477	5.4%	1,086	12.4%
Borough of Madison	16,080	2	0.0%	128	0.8%



Municipality	ACS 2017 Total Population	1-percent Annual Chance Flood Event		0.2-percent Annual Chance Flood Event	
		Number	% of Total	Number	% of Total
Borough of Mendham	4,992	11	0.2%	14	0.3%
Township of Mendham	5,877	43	0.7%	58	1.0%
Township of Mine Hill	3,609	0	0.0%	0	0.0%
Township of Montville	21,739	457	2.1%	1,221	5.6%
Township of Morris	22,498	102	0.5%	133	0.6%
Borough of Morris Plains	5,605	14	0.3%	20	0.3%
Town of Morristown	18,833	6	0.0%	6	0.0%
Borough of Mount Arlington	5,405	6	0.1%	6	0.1%
Township of Mount Olive	29,010	372	1.3%	506	1.7%
Borough of Mountain Lakes	4,309	0	0.0%	0	0.0%
Netcong Borough	3,245	0	0.0%	0	0.0%
Township of Parsippany-Troy Hills	53,444	1,294	2.4%	3,324	6.2%
Township of Pequannock	15,499	2,831	18.3%	3,377	21.8%
Township of Randolph	25,918	61	0.2%	82	0.3%
Borough of Riverdale	4,238	362	8.5%	514	12.1%
Borough of Rockaway	6,473	94	1.5%	260	4.0%
Township of Rockaway	24,758	114	0.5%	198	0.8%
Township of Roxbury	23,458	54	0.2%	62	0.3%
Borough of Victory Gardens	1,655	0	0.0%	31	1.8%
Township of Washington	18,713	170	0.9%	243	1.3%
Borough of Wharton	6,591	0	0.0%	4	0.1%
Morris County (Total)	498,847	12,578	2.5%	20,814	4.2%

Sources: American Community Survey (ACS) 5-year Estimate, 2017; FEMA, 2017

Research has shown that some populations, while they may not have more hazard exposure, may experience exacerbated impacts and prolonged recovery if/when impacted. This is due to many factors including their physical and financial ability to react or respond during a hazard. Of the population exposed, the most vulnerable include the economically disadvantaged and the population over age 65. Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on net economic impacts on their families. The population over age 65 is also more vulnerable because they are more likely to seek or need medical attention that may not be available due to isolation during a flood event, and they may have more difficulty evacuating. Within the 1-percent annual chance event floodplain, there are approximately 2,101 people over the age of 65 and 688 people below the poverty level. These populations are all located within the SFHA. As for the 0.2-percent chance event, there are approximately 3,426 people over the age 65 and 1,090 people below the poverty level.

HAZUS-MH estimates the potential sheltering needs as a result of a 1-percent annual chance flood event. The demographic data in HAZUS-MH has not been updated and these sheltering needs are based on 2010 U.S. Census data. Therefore, the sheltering needs may be underestimated due to the measured population growth in the County since 2010. For the 1-percent flood event, HAZUS-MH estimates 22,268 people will be displaced, and 1,342 people will seek short-term sheltering. These statistics, by municipality, are presented in Table 4.3.6-6. The estimated displaced population and number of persons seeking short-term sheltering differs from the number of persons exposed to the 1-percent annual chance flood, because the displaced population numbers take into consideration that not all residents will be significantly impacted enough to be displaced or to require short-term sheltering during a flood event.

**Table 4.3.6-6. Estimated Population Displaced or Seeking Short-Term Shelter from the 1-Percent Annual Chance Flood Event**

Municipality	ACS 2017 Total Population	1-Percent Annual Chance Event	
		Displaced Households*	Persons Seeking Short- Term Sheltering*
Town of Boonton	8,390	89	0
Township of Boonton	4,353	176	1
Borough of Butler	7,780	304	10
Chatham Borough	9,003	190	7
Chatham Township	10,507	330	14
Chester Borough	1,540	0	0
Chester Township	7,931	53	0
Denville Township	16,822	1980	98
Town of Dover	18,307	3337	166
Township of East Hanover	11,241	1188	75
Borough of Florham Park	11,792	1134	78
Township of Hanover	14,436	342	10
Township of Harding	3,887	202	1
Township of Jefferson	21,440	764	17
Borough of Kinnelon	10,242	0	0
Borough of Lincoln Park	10,464	3867	252
Township of Long Hill	8,763	1016	33
Borough of Madison	16,080	109	2
Borough of Mendham	4,992	29	0
Township of Mendham	5,877	172	0
Township of Mine Hill	3,609	15	0
Township of Montville	21,739	1681	79
Township of Morris	22,498	375	9
Borough of Morris Plains	5,605	368	15
Town of Morristown	18,833	422	30
Borough of Mount Arlington	5,405	9	0
Township of Mount Olive	29,010	738	16
Borough of Mountain Lakes	4,309	0	0
Netcong Borough	3,245	22	0
Township of Parsippany-Troy Hills	53,444	2,835	145
Township of Pequannock	15,499	3,887	201
Township of Randolph	25,918	206	3
Borough of Riverdale	4,238	243	8
Borough of Rockaway	6,473	256	9
Township of Rockaway	24,758	673	19



Municipality	ACS 2017 Total Population	1-Percent Annual Chance Event	
		Displaced Households*	Persons Seeking Short- Term Sheltering*
Township of Roxbury	23,458	621	34
Borough of Victory Gardens	1,655	15	0
Township of Washington	18,713	472	8
Borough of Wharton	6,591	148	2
Morris County (Total)	498,847	28,268	1,342

Sources: HAZUS-MH v4.2

*Sheltering estimates are based on 2010 U.S. Census data.

Total numbers of injuries and casualties resulting from typical riverine and urban flooding are generally limited based on advance weather forecasting, blockades, and warnings. Injuries and deaths generally are not anticipated if proper warning and precautions occur. In contrast, warning time for flash flooding is limited. 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.

Cascading impacts may also include exposure to pathogens such as mold. After flood events, excess moisture and standing water contribute to the growth of mold in buildings. Mold may present a health risk to building occupants, especially those with already compromised immune systems such as infants, children, the elderly and pregnant women. The degree of impact will vary and is not strictly measurable. Molds can grow in as short a period as 24-48 hours in wet and damaged areas of buildings that have not been properly cleaned. Very small mold spores can easily be inhaled, creating the potential for allergic reactions, asthma episodes, and other respiratory problems. Buildings should be properly cleaned and dried out to safely prevent mold growth (CDC 2019).

Molds and mildews are not the only public health risk associated with flooding. Floodwaters can be contaminated by pollutants such as sewage, human and animal feces, pesticides, fertilizers, oil, asbestos, and rusting building materials. Common public health risks associated with flood events also include:

- Unsafe food
- Contaminated drinking and washing water and poor sanitation
- Mosquitos and animals
- Carbon monoxide poisoning
- Secondary hazards associated with re-entering/cleaning flooded structures
- Mental stress and fatigue

Current loss estimation models such as HAZUS-MH are not equipped to measure public health impacts. The best level of mitigation for these impacts is to be aware that they can occur, educate the public on prevention, and be prepared to deal with these vulnerabilities in responding to flood events.

Impact on General Building Stock

Exposure to the flood hazard includes those buildings located in the flood hazard zone. Potential damage is the modeled loss that could occur to the exposed inventory measured by the structural and content replacement cost value. There are an estimated 5,461 buildings located in the SFHA with a replacement cost value of approximately \$4.78 billion of building and contents. This represents approximately 3.8% of the County's total general building stock inventory replacement cost value (approximately \$127 billion).



There are 8,727 buildings located in the 0.2-percent annual chance flood boundary with approximately \$7.87 billion of building/contents in replacement cost value (or 6.2% of the County's total replacement cost value). The Township of Pequannock has the greatest number of its buildings located in the floodplain; approximately 1,164 and 1,368 located in the 1-percent chance event and 0.2-percent chance event boundaries, respectively. Refer to Table 4.3.6-7 and Table 4.3.6-8 for the building flood exposure analysis results by municipality.

HAZUS-MH estimates \$634 million in building and content damage as a result of the 1-percent annual chance flood event (or 0.5% of the total building stock replacement cost value). Of the \$634 million in potential loss, \$200 million is estimated to residential structures. Refer to Table 4.3.6-9 for the potential losses estimated by HAZUS-MH by municipality.

Table 4.3.6-7. Estimated General Building Stock Exposure to the 1-Percent Annual Chance Flood Event – All Occupancies

Municipality	Total # Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed			
			Number of Buildings - 1-percent Annual Chance Flood	% of Total	RCV - 1-percent Annual Chance Flood	% of Total
Town of Boonton	3,262	\$1,832,625,537	0	0.0%	\$0	0.0%
Township of Boonton	1,898	\$1,388,780,135	27	1.4%	\$15,544,185	1.1%
Borough of Butler	2,701	\$1,489,686,071	36	1.3%	\$19,170,863	1.3%
Chatham Borough	3,286	\$1,673,960,469	22	0.7%	\$40,149,387	2.4%
Chatham Township	4,080	\$2,300,237,613	28	0.7%	\$8,632,360	0.4%
Chester Borough	853	\$694,668,411	0	0.0%	\$0	0.0%
Chester Township	3,680	\$2,782,631,274	7	0.2%	\$5,334,258	0.2%
Denville Township	7,198	\$4,397,845,504	503	7.0%	\$282,448,772	6.4%
Town of Dover	4,514	\$2,640,787,978	482	10.7%	\$380,283,612	14.4%
Township of East Hanover	4,848	\$4,740,072,304	218	4.5%	\$193,643,609	4.1%
Borough of Florham Park	3,805	\$3,768,421,982	38	1.0%	\$90,660,645	2.4%
Township of Hanover	7,090	\$5,609,469,027	112	1.6%	\$349,873,206	6.2%
Township of Harding	2,230	\$1,808,255,972	90	4.0%	\$47,732,628	2.6%
Township of Jefferson	9,625	\$4,421,074,958	125	1.3%	\$39,069,916	0.9%
Borough of Kinnelon	4,093	\$2,858,766,250	0	0.0%	\$0	0.0%
Borough of Lincoln Park	4,166	\$2,125,371,898	882	21.2%	\$688,552,685	32.4%
Township of Long Hill	3,643	\$2,253,461,094	311	8.5%	\$245,650,873	10.9%
Borough of Madison	6,301	\$3,066,320,935	1	0.0%	\$40,842	0.0%
Borough of Mendham	2,139	\$1,479,178,043	7	0.3%	\$4,216,933	0.3%
Township of Mendham	2,667	\$2,099,041,883	26	1.0%	\$9,874,031	0.5%
Township of Mine Hill	1,590	\$766,971,485	1	0.1%	\$905,738	0.1%
Township of Montville	8,179	\$6,714,034,036	234	2.9%	\$372,298,816	5.5%
Township of Morris	9,713	\$6,091,077,654	52	0.5%	\$24,250,122	0.4%
Borough of Morris Plains	2,378	\$1,738,775,034	8	0.3%	\$13,017,966	0.7%
Town of Morristown	4,413	\$2,945,511,672	9	0.2%	\$4,663,192	0.2%
Borough of Mount Arlington	2,333	\$1,065,424,961	29	1.2%	\$9,544,383	0.9%
Township of Mount Olive	9,115	\$7,181,400,421	128	1.4%	\$79,672,753	1.1%
Borough of Mountain Lakes	1,642	\$1,183,405,498	0	0.0%	\$0	0.0%
Netcong Borough	1,100	\$695,081,980	1	0.1%	\$182,743	0.0%



Municipality	Total # Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed			
			Number of Buildings - 1-percent Annual Chance Flood	% of Total	RCV - 1-percent Annual Chance Flood	% of Total
Township of Parsippany-Troy Hills	17,064	\$11,747,551,200	499	2.9%	\$162,369,226	1.4%
Township of Pequannock	5,642	\$3,911,039,941	1,164	20.6%	\$1,330,167,376	34.0%
Township of Randolph	8,600	\$6,709,486,516	38	0.4%	\$53,145,730	0.8%
Borough of Riverdale	1,183	\$1,165,082,666	93	7.9%	\$68,198,580	5.9%
Borough of Rockaway	2,617	\$1,612,749,951	65	2.5%	\$79,799,573	4.9%
Township of Rockaway	11,485	\$7,225,058,745	79	0.7%	\$78,355,686	1.1%
Township of Roxbury	9,544	\$5,918,169,131	35	0.4%	\$11,423,489	0.2%
Borough of Victory Gardens	339	\$163,035,099	0	0.0%	\$0	0.0%
Township of Washington	8,062	\$5,265,032,309	107	1.3%	\$54,505,470	1.0%
Borough of Wharton	2,051	\$1,539,335,501	4	0.2%	\$20,730,246	1.3%
Morris County (Total)	189,129	\$127,068,881,137	5,461	2.9%	\$4,784,109,892	3.8%

Sources: FEMA 2017; Microsoft 2018; NJOIT 2018; MCOIT 2019

Table 4.3.6-8. Estimated General Building Stock Exposure to the 0.2-Percent Annual Chance Flood Event – All Occupancies

Municipality	Total # Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed			
			Number of Buildings - 0.2-percent Annual Chance Flood	% of Total	RCV - 0.2-percent Annual Chance Flood	% of Total
Town of Boonton	3,262	\$1,832,625,537	4	0.1%	\$1,065,975	0.1%
Township of Boonton	1,898	\$1,388,780,135	45	2.4%	\$23,164,207	1.7%
Borough of Butler	2,701	\$1,489,686,071	51	1.9%	\$38,291,351	2.6%
Chatham Borough	3,286	\$1,673,960,469	52	1.6%	\$55,178,850	3.3%
Chatham Township	4,080	\$2,300,237,613	29	0.7%	\$8,704,383	0.4%
Chester Borough	853	\$694,668,411	0	0.0%	\$0	0.0%
Chester Township	3,680	\$2,782,631,274	9	0.2%	\$6,046,672	0.2%
Denville Township	7,198	\$4,397,845,504	768	10.7%	\$406,050,377	9.2%
Town of Dover	4,514	\$2,640,787,978	683	15.1%	\$486,552,090	18.4%
Township of East Hanover	4,848	\$4,740,072,304	567	11.7%	\$483,530,707	10.2%
Borough of Florham Park	3,805	\$3,768,421,982	75	2.0%	\$146,223,395	3.9%
Township of Hanover	7,090	\$5,609,469,027	131	1.8%	\$394,545,422	7.0%
Township of Harding	2,230	\$1,808,255,972	102	4.6%	\$60,821,975	3.4%
Township of Jefferson	9,625	\$4,421,074,958	237	2.5%	\$92,280,762	2.1%
Borough of Kinnelon	4,093	\$2,858,766,250	0	0.0%	\$0	0.0%
Borough of Lincoln Park	4,166	\$2,125,371,898	1,128	27.1%	\$865,769,279	40.7%
Township of Long Hill	3,643	\$2,253,461,094	583	16.0%	\$499,491,240	22.2%
Borough of Madison	6,301	\$3,066,320,935	50	0.8%	\$14,060,145	0.5%
Borough of Mendham	2,139	\$1,479,178,043	9	0.4%	\$5,001,978	0.3%
Township of Mendham	2,667	\$2,099,041,883	34	1.3%	\$15,169,183	0.7%
Township of Mine Hill	1,590	\$766,971,485	1	0.1%	\$905,738	0.1%
Township of Montville	8,179	\$6,714,034,036	508	6.2%	\$1,143,998,960	17.0%



Municipality	Total # Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed			
			Number of Buildings - 0.2-percent Annual Chance Flood	% of Total	RCV - 0.2-percent Annual Chance Flood	% of Total
Township of Morris	9,713	\$6,091,077,654	71	0.7%	\$34,605,149	0.6%
Borough of Morris Plains	2,378	\$1,738,775,034	11	0.5%	\$14,070,904	0.8%
Town of Morristown	4,413	\$2,945,511,672	25	0.6%	\$24,337,520	0.8%
Borough of Mount Arlington	2,333	\$1,065,424,961	31	1.3%	\$11,004,618	1.0%
Township of Mount Olive	9,115	\$7,181,400,421	173	1.9%	\$100,217,659	1.4%
Borough of Mountain Lakes	1,642	\$1,183,405,498	0	0.0%	\$0	0.0%
Netcong Borough	1,100	\$695,081,980	1	0.1%	\$182,743	0.0%
Township of Parsippany-Troy Hills	17,064	\$11,747,551,200	1,080	6.3%	\$593,481,076	5.1%
Township of Pequannock	5,642	\$3,911,039,941	1,368	24.2%	\$1,467,171,536	37.5%
Township of Randolph	8,600	\$6,709,486,516	51	0.6%	\$167,542,739	2.5%
Borough of Riverdale	1,183	\$1,165,082,666	138	11.7%	\$187,861,546	16.1%
Borough of Rockaway	2,617	\$1,612,749,951	137	5.2%	\$149,454,326	9.3%
Township of Rockaway	11,485	\$7,225,058,745	118	1.0%	\$152,354,654	2.1%
Township of Roxbury	9,544	\$5,918,169,131	292	3.1%	\$83,713,703	1.4%
Borough of Victory Gardens	339	\$163,035,099	10	2.9%	\$16,469,074	10.1%
Township of Washington	8,062	\$5,265,032,309	145	1.8%	\$84,069,690	1.6%
Borough of Wharton	2,051	\$1,539,335,501	10	0.5%	\$34,824,169	2.3%
Morris County (Total)	189,129	\$127,068,881,137	8,727	4.6%	\$7,868,213,791	6.2%

Sources: FEMA 2017; Microsoft 2018; NJOIT 2018; MCOIT 2019



Table 4.3.6-9. Estimated General Building Stock Potential Loss to the 1-Percent Annual Chance Flood Event

Municipality	Total Replacement Cost Value	1-Percent Annual Chance Event							
		All Occupancies		Residential		Commercial		Agricultural, Industrial, Religious, Education and Government	
		Estimated Loss	% of Total	Estimated Loss	% of Total	Estimated Loss	% of Total	Estimated Loss	% of Total
Town of Boonton	\$1,832,625,537	\$0	0.0%	\$0	0.0%	\$0	0.0%	\$0	0.0%
Township of Boonton	\$1,388,780,135	\$2,523,840	0.2%	\$668,806	0.0%	\$296,430	0.0%	\$1,558,605	0.1%
Borough of Butler	\$1,489,686,071	\$546,606	0.0%	\$122,001	0.0%	\$330,957	0.0%	\$93,648	0.0%
Chatham Borough	\$1,673,960,469	\$2,417,687	0.1%	\$32,557	0.0%	\$1,544,936	0.1%	\$840,194	0.1%
Chatham Township	\$2,300,237,613	\$788,125	0.0%	\$681,309	0.0%	\$0	0.0%	\$106,815	0.0%
Chester Borough	\$694,668,411	\$0	0.0%	\$0	0.0%	\$0	0.0%	\$0	0.0%
Chester Township	\$2,782,631,274	\$839,085	0.0%	\$42,850	0.0%	\$0	0.0%	\$796,234	0.0%
Denville Township	\$4,397,845,504	\$46,249,076	1.1%	\$21,001,405	0.5%	\$16,945,880	0.4%	\$8,301,790	0.2%
Town of Dover	\$2,640,787,978	\$53,170,915	2.0%	\$14,338,052	0.5%	\$20,251,513	0.8%	\$18,581,349	0.7%
Township of East Hanover	\$4,740,072,304	\$8,777,443	0.2%	\$7,190,453	0.2%	\$842,828	0.0%	\$744,162	0.0%
Borough of Florham Park	\$3,768,421,982	\$4,041,495	0.1%	\$2,203,904	0.1%	\$776,887	0.0%	\$1,060,703	0.0%
Township of Hanover	\$5,609,469,027	\$15,198,152	0.3%	\$882,903	0.0%	\$3,885,371	0.1%	\$10,429,878	0.2%
Township of Harding	\$1,808,255,972	\$5,363,149	0.3%	\$2,934,763	0.2%	\$83,266	0.0%	\$2,345,120	0.1%
Township of Jefferson	\$4,421,074,958	\$1,961,866	0.0%	\$1,265,531	0.0%	\$1,411	0.0%	\$694,924	0.0%
Borough of Kinnelon	\$2,858,766,250	\$0	0.0%	\$0	0.0%	\$0	0.0%	\$0	0.0%
Borough of Lincoln Park	\$2,125,371,898	\$103,330,819	4.9%	\$48,792,643	2.3%	\$3,951,283	0.2%	\$50,586,893	2.4%
Township of Long Hill	\$2,253,461,094	\$31,202,234	1.4%	\$7,642,004	0.3%	\$15,680,815	0.7%	\$7,879,415	0.3%
Borough of Madison	\$3,066,320,935	\$0	0.0%	\$0	0.0%	\$0	0.0%	\$0	0.0%
Borough of Mendham	\$1,479,178,043	\$473,906	0.0%	\$273,253	0.0%	\$0	0.0%	\$200,653	0.0%
Township of Mendham	\$2,099,041,883	\$740,056	0.0%	\$495,012	0.0%	\$0	0.0%	\$245,044	0.0%
Township of Mine Hill	\$766,971,485	\$141,855	0.0%	\$0	0.0%	\$0	0.0%	\$141,855	0.0%
Township of Montville	\$6,714,034,036	\$14,927,044	0.2%	\$4,609,631	0.1%	\$4,217,552	0.1%	\$6,099,860	0.1%
Township of Morris	\$6,091,077,654	\$1,238,208	0.0%	\$439,633	0.0%	\$571,249	0.0%	\$227,327	0.0%
Borough of Morris Plains	\$1,738,775,034	\$1,679,812	0.1%	\$971,724	0.1%	\$582,822	0.0%	\$125,265	0.0%
Town of Morristown	\$2,945,511,672	\$68,629	0.0%	\$0	0.0%	\$26,209	0.0%	\$42,420	0.0%



Municipality	Total Replacement Cost Value	1-Percent Annual Chance Event							
		All Occupancies		Residential		Commercial		Agricultural, Industrial, Religious, Education and Government	
		Estimated Loss	% of Total	Estimated Loss	% of Total	Estimated Loss	% of Total	Estimated Loss	% of Total
Borough of Mount Arlington	\$1,065,424,961	\$79,263	0.0%	\$2,763	0.0%	\$5,448	0.0%	\$71,052	0.0%
Township of Mount Olive	\$7,181,400,421	\$6,606,724	0.1%	\$4,569,896	0.1%	\$127,500	0.0%	\$1,909,328	0.0%
Borough of Mountain Lakes	\$1,183,405,498	\$0	0.0%	\$0	0.0%	\$0	0.0%	\$0	0.0%
Netcong Borough	\$695,081,980	\$68,809	0.0%	\$0	0.0%	\$0	0.0%	\$68,809	0.0%
Township of Parsippany-Troy Hills	\$11,747,551,200	\$20,392,230	0.2%	\$12,286,865	0.1%	\$6,195,581	0.1%	\$1,909,784	0.0%
Township of Pequannock	\$3,911,039,941	\$280,384,660	7.2%	\$60,115,927	1.5%	\$59,900,398	1.5%	\$160,368,334	4.1%
Township of Randolph	\$6,709,486,516	\$2,715,168	0.0%	\$1,632,381	0.0%	\$306,760	0.0%	\$776,027	0.0%
Borough of Riverdale	\$1,165,082,666	\$3,981,314	0.3%	\$2,832,560	0.2%	\$50,968	0.0%	\$1,097,786	0.1%
Borough of Rockaway	\$1,612,749,951	\$9,466,365	0.6%	\$958,898	0.1%	\$2,645,831	0.2%	\$5,861,636	0.4%
Township of Rockaway	\$7,225,058,745	\$6,497,264	0.1%	\$940,237	0.0%	\$3,603,545	0.0%	\$1,953,482	0.0%
Township of Roxbury	\$5,918,169,131	\$290,897	0.0%	\$157,064	0.0%	\$4,635	0.0%	\$129,197	0.0%
Borough of Victory Gardens	\$163,035,099	\$0	0.0%	\$0	0.0%	\$0	0.0%	\$0	0.0%
Township of Washington	\$5,265,032,309	\$4,880,585	0.1%	\$2,614,224	0.0%	\$650,680	0.0%	\$1,615,681	0.0%
Borough of Wharton	\$1,539,335,501	\$3,321,936	0.2%	\$0	0.0%	\$502,792	0.0%	\$2,819,144	0.2%
Morris County (Total)	\$127,068,881,137	\$634,365,217	0.5%	\$200,699,249	0.2%	\$143,983,550	0.1%	\$289,682,418	0.2%

Source: HAZUS-MH v4.2



NFIP Statistics

FEMA Region 2 provided a list of NFIP policies, past claims, repetitive loss properties (RL), and severe repetitive loss properties (SRL) in Morris County. According to FEMA, a RL property is a NFIP-insured structure that has had at least two paid flood losses of more than \$1,000 in any 10-year period since 1978. A SRL property is a NFIP-insured structure that has had four or more separate claim payments made under a standard flood insurance policy, with the amount of each claim exceeding \$5,000 and with the cumulative amount of such claims payments exceeding \$20,000; or at least two separate claims payments made under a standard flood insurance policy with the cumulative amount of such claim payments exceed the fair market value of the insured building on the day before each loss (FEMA 2018).

Table 4.3.6-11 through Table 4.3.6-13 and Figure 4.3.6-4 summarize the NFIP policies, claims and repetitive loss statistics for Morris County. The Morris County 2019 policy and claim statistics are from the FEMA's webpage where this data can be downloaded by state: <https://www.fema.gov/policy-claim-statistics-flood-insurance>. Table 4.3.6-11 and Table 4.3.6-12 summarize the occupancy classes of the repetitive loss and severe repetitive loss properties in the County. Single family residences account for 86% of the RL properties and 91% of the SRL properties. This information is current as of April 26, 2019.

Table 4.3.6-11. Occupancy Class of Repetitive Loss Structures in Morris County

Occupancy Class	Total Number of Repetitive Loss Properties	Total Number of Severe Repetitive Loss Properties	Total (RL + SRL)
Single Family	601	328	929
Condo	15	4	19
2-4 Family	26	11	37
Other Residential	2	0	2
Non-Residential	52	17	69
Morris County	696	360	1056

Source: FEMA 2019; State of NJ 2019

Note: Repetitive loss and severe repetitive loss statistics provided by FEMA and are current as of 04/26/19

The total number of repetitive loss properties does not include the severe repetitive loss properties. The severe repetitive loss properties totals only include validated properties.



Table 4.3.6-12. Occupancy Class of Repetitive Loss Structures in Morris County, by Municipality

Municipality	Repetitive Loss Properties (excludes SRL)					Severe Repetitive Loss Properties (Valid Only)				
	Single Family	Assumed Condo	2-4 Family	Other Residential	Non-Residential	Single Family	Assumed Condo	2-4 Family	Other Residential	Non-Residential
Town of Boonton	0	0	0	0	0	0	0	0	0	0
Township of Boonton	7	1	0	0	0	2	0	0	0	0
Borough of Butler	2	0	0	0	4	0	0	0	0	0
Borough of Chatham	0	0	0	0	0	0	0	0	0	0
Township of Chatham	1	0	0	0	0	0	0	0	0	0
Borough of Chester	0	0	0	0	0	0	0	0	0	0
Township of Chester	0	0	0	0	0	0	0	0	0	0
Township of Denville	51	1	2	0	3	31	0	0	0	1
Town Dover	9	5	15	2	6	1	0	3	0	4
Township of East Hanover	5	0	0	0	2	1	0	0	0	0
Borough of Florham Park	0	0	0	0	0	0	0	0	0	0
Township of Hanover	4	2	0	0	4	0	0	0	0	1
Township of Harding	0	0	0	0	0	0	0	0	0	0
Township of Jefferson	10	0	0	0	0	0	0	0	0	0
Borough of Kinnelon	0	0	0	0	0	0	0	0	0	0
Borough of Lincoln Park	178	2	5	0	6	163	4	2	0	4
Township of Long Hill	12	0	1	0	6	6	0	0	0	0
Borough of Madison	1	0	0	0	0	0	0	0	0	0
Borough of Mendham	0	0	0	0	0	0	0	0	0	0
Township of Mendham	2	0	0	0	0	0	0	0	0	0
Township of Mine Hill	0	0	0	0	0	0	0	0	0	0
Township of Montville	3	0	0	0	0	2	0	0	0	0
Township of Morris	4	0	0	0	0	0	0	1	0	0
Borough of Morris Plains	0	0	0	0	0	0	0	0	0	0
Town of Morristown	0	0	0	0	0	0	0	0	0	1
Borough of Mount Arlington	0	0	0	0	0	0	0	0	0	0
Township of Mount Olive	3	0	1	0	0	0	0	0	0	0



Municipality	Repetitive Loss Properties (excludes SRL)					Severe Repetitive Loss Properties (Valid Only)				
	Single Family	Assumed Condo	2-4 Family	Other Residential	Non-Residential	Single Family	Assumed Condo	2-4 Family	Other Residential	Non-Residential
Borough of Mountain Lakes	0	0	0	0	0	0	0	0	0	0
Borough of Netcong	0	0	0	0	0	0	0	0	0	0
Township of Parsippany-Troy Hills	45	0	0	0	0	4	0	1	0	0
Township of Pequannock	222	3	2	0	14	114	0	4	0	5
Township of Randolph	1	0	0	0	1	0	0	0	0	0
Borough of Riverdale	21	0	0	0	0	1	0	0	0	0
Borough of Rockaway	6	0	0	0	2	0	0	0	0	1
Township of Rockaway	3	0	0	0	3	0	0	0	0	0
Township of Roxbury	0	0	0	0	0	0	0	0	0	0
Borough of Victory Gardens	0	0	0	0	0	0	0	0	0	0
Township of Washington	11	1	0	0	1	2	0	0	0	0
Borough of Wharton	0	0	0	0	0	1	0	0	0	0
Morris County (Total)	601	15	26	2	52	328	4	11	0	17

Source: FEMA 2019; State of NJ 2019

Note: Repetitive loss and severe repetitive loss statistics provided by FEMA and are current as of 04/26/19

The total number of repetitive loss properties does not include the severe repetitive loss properties. The severe repetitive loss properties totals only include validated properties.



Table 4.3.6-13. NFIP Policies, Claims and Repetitive Loss Statistics

Municipality	NFIP # Policies	WYO # Policies	NFIP Claims	WYO Claims	NFIP Payments	WYO Payments	# Rep. Loss Prop (Excludes SRL) <i>Valid</i>	# Severe Rep. Loss (SRL) Properties <i>Valid</i>	# Severe Rep. Loss (SRL) Prop. <i>Pending</i>	Total RL + SRL (RL + Valid SRL)	# Total RL/SRL (valid) that have been Mitigated (Yes/No)
Town of Boonton	0	4	12	2	\$18,638	\$7,238	0	0	0	0	No
Township of Boonton	3	20	21	35	\$236,852	\$819,621	8	2	0	10	No (10)
Borough of Butler	7	29	4	31	\$20,244	\$309,829	6	0	0	6	No (6)
Chatham Borough	2	43	1	8	\$0	\$2,753	1	0	0	1	No (1)
Chatham Township	6	39	3	19	\$3,741	\$100,782	0	0	0	0	No
Chester Borough	0	0	0	0	\$0	\$0	0	0	0	0	No
Chester Township	0	17	0	0	\$0	\$5,162	0	0	0	0	No
Denville Township	72	257	303	515	\$4,913,826	\$12,908,710	57	19	1	76	Yes (13) / No (63)
Town of Dover	37	169	245	327	\$2,890,107	\$3,751,171	37	8	6	45	No (51)
Township of East Hanover	33	130	39	60	\$524,933	\$1,112,841	7	1	0	8	No (8)
Borough of Florham Park	5	65	3	5	\$424	\$3,372	0	0	0	0	No
Township of Hanover	5	57	17	60	\$163,392	\$3,304,690	10	1	0	11	No (11)
Township of Harding	2	40	3	14	\$27,896	\$212,202	0	0	0	0	No
Township of Jefferson	14	104	24	72	\$163,398	\$1,008,165	10	0	0	10	No (10)
Borough of Kinnelon	0	0	0	0	\$0	\$0	0	0	0	0	No
Borough of Lincoln Park	170	427	1,624	1,639	\$27,106,495	\$35,436,546	191	173	3	364	Yes (72) / No (295)
Township of Long Hill	65	100	43	124	\$367,977	\$2,399,940	19	6	0	25	Yes (3) / No (22)
Borough of Madison	4	29	4	2	\$3,953	\$0	1	0	0	1	No (1)
Borough of Mendham	2	13	0	1	\$0	\$31,377	0	0	0	0	No
Township of Mendham	1	23	4	26	\$10,517	\$169,231	2	0	0	2	No (2)
Township of Mine Hill	1	8	0	1	\$0	\$0	0	0	0	0	No



Municipality	NFIP # Policies	WYO # Policies	NFIP Claims	WYO Claims	NFIP Payments	WYO Payments	# Rep. Loss Prop (Excludes SRL) <i>Valid</i>	# Severe Rep. Loss (SRL) Properties <i>Valid</i>	# Severe Rep. Loss (SRL) Prop. <i>Pending</i>	Total RL + SRL (RL + Valid SRL)	# Total RL/SRL (valid) that have been Mitigated (Yes/No)
Township of Montville	23	176	62	63	\$730,654	\$2,429,340	3	2	0	5	No (5)
Township of Morris	13	81	28	39	\$270,741	\$560,805	4	1	0	5	No (5)
Borough of Morris Plains	2	17	6	9	\$22,015	\$85,478	0	0	0	0	No
Town of Morristown	10	36	8	14	\$510,072	\$108,123	0	1	0	1	No (1)
Borough of Mount Arlington	1	13	1	2	\$446	\$3,361	0	0	0	0	No
Township of Mount Olive	5	69	18	45	\$59,773	\$609,165	4	0	0	4	No (4)
Borough of Mountain Lakes	0	0	0	0	\$0	\$0	0	0	0	0	No
Netcong Borough	0	2	1	2	\$2,792	\$1,014,505	0	0	0	0	No
Township of Parsippany-Troy Hills	48	276	392	245	\$3,559,035	\$10,104,106	45	5	0	50	Yes (15) / No (35)
Township of Pequannock	211	461	809	1,408	\$21,336,414	\$44,766,820	241	123	1	364	Yes (60) / No (305)
Township of Randolph	4	51	4	22	\$1,764	\$207,610	2	0	0	2	No (2)
Borough of Riverdale	5	48	29	99	\$218,944	\$646,620	21	1	0	22	Yes (2) / No (20)
Borough of Rockaway	6	28	29	53	\$355,345	\$1,085,762	8	1	0	9	No (9)
Township of Rockaway	4	45	30	41	\$44,608	\$463,872	6	0	0	6	No (6)
Township of Roxbur	3	58	15	17	\$8,399	\$81,004	0	0	0	0	No
Borough of Victory Gardens	0	0	0	0	\$0	\$0	0	0	0	0	No
Township of Washington	10	49	29	68	\$211,101	\$1,665,394	13	2	0	15	Yes (1) / No (14)
Borough of Wharton	2	4	1	8	\$0	\$77,648	0	1	0	1	No (1)
Morris County (Total)	776	2,988	3,812	5,076	\$63,784,495	\$125,493,244	696	360	11	1,056	Yes (166) / No (901)

Source: FEMA 2019; State of NJ 2019

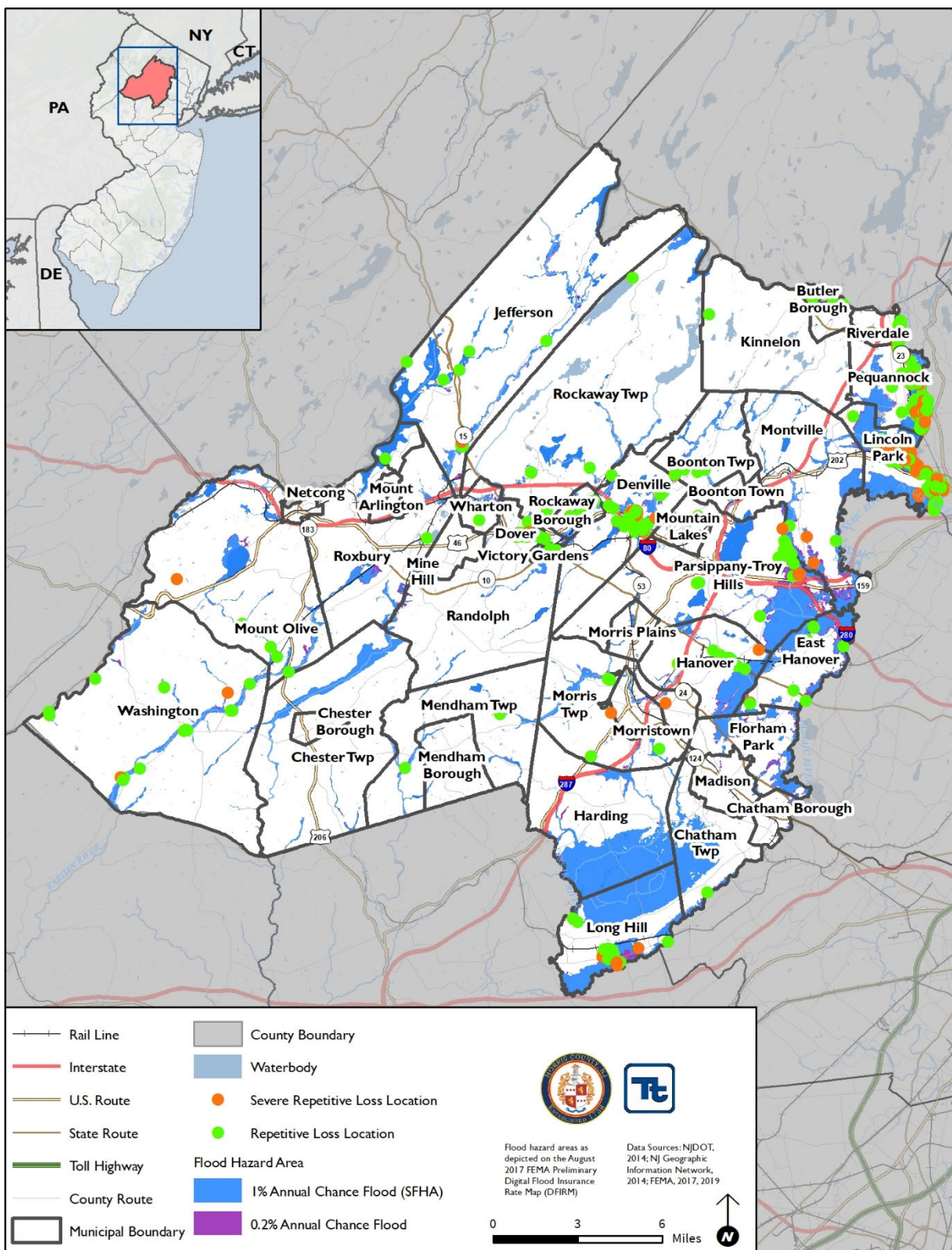
Rep. = Repetitive

Repetitive loss and severe repetitive loss statistics provided by FEMA and are current as of 04/26/19. Policies and claims are current as of 9/11/2019. The total number of repetitive loss properties does not include the severe repetitive loss properties. The repetitive loss and severe repetitive loss properties totals only include validated properties.

Total building and content losses from the claims file provided by FEMA: <https://www.fema.gov/policy-claim-statistics-flood-insurance>



Figure 4.3.6-4. NFIP Repetitive Loss Properties in Morris County





Impact on Critical Facilities

It is important to determine the critical facilities and infrastructure that may be at risk to flooding, and who may be impacted should damage occur. Critical services during and after a flood event may not be available if critical facilities are directly damaged or transportation routes to access these critical facilities are impacted. Roads that are blocked or damaged can isolate residents and can prevent access throughout the planning area to many service providers needing to get to vulnerable populations or to make repairs.

Critical facility exposure to the flood hazard was examined. In addition, HAZUS-MH was used to estimate the flood loss potential to critical facilities located in the FEMA mapped floodplains. Table 4.3.6-14 summarizes these results. Figure 4.3.6-5 and Figure 4.3.6-6 display the distribution of critical facilities in the 1- and 0.2-percent annual chance flood event boundaries. Of the 74 critical facilities located in the 1-percent annual chance flood event boundary, 31 were identified as community lifelines.

Figure 4.3.6-7 displays the major roadways that may be impacted by the 1-percent annual chance flood event. An exposure analysis was completed to determine the number of miles of major highways that intersect the 100-year and 500-year flood extents. The analysis found that 13.38 miles of highway is exposed to the 1-percent annual chance flood event, and 21.21 miles of highway is exposed to the 0.2-percent annual chance flood event. The major highways exposed to the 1-percent annual chance flood extent include portions of: I-280, I-287, I-80, NJ 10, NJ 124, NJ 15, NJ 159, NJ 181, NJ 183, NJ 23, NJ 24, NJ 53, US 202, US 206, and US 46. These are also the highways exposed to the 0.2-percent annual chance flood extent.

Bridges washed out or blocked by floods or debris also can cause isolation. Floodwaters can get into drinking water supplies, causing contamination. Culverts can be blocked by debris from flood events, also causing localized urban flooding. Sewer systems can be backed up, causing wastewater to spill into homes, neighborhoods, rivers, and streams.

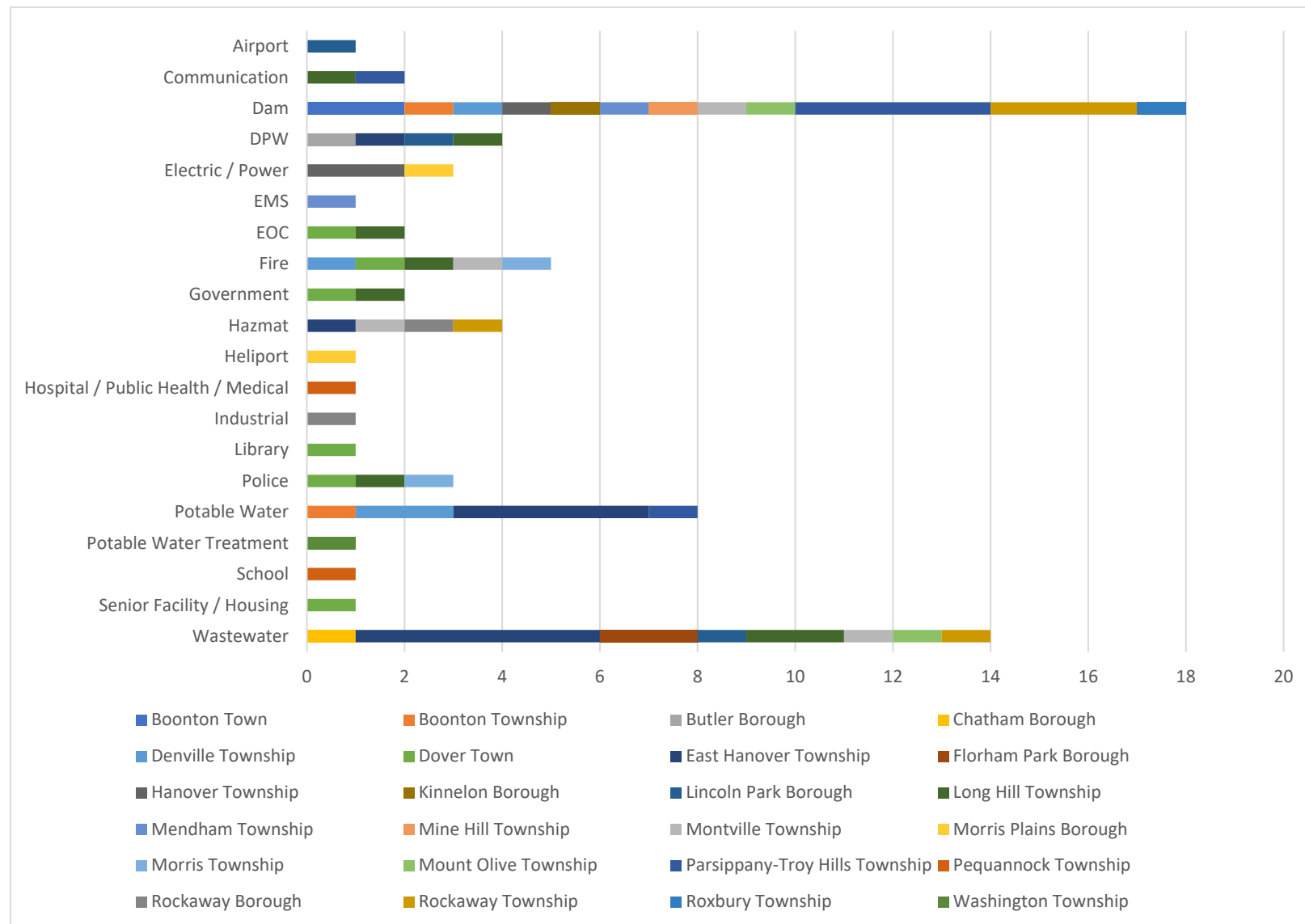
Flooding concerns specific to each municipality have been discussed above. Municipalities within the County should review how critical facilities are distributed throughout its community and where these facilities are located in relation to flood hazard areas. According to the analysis, majority of the critical facilities that fall within the 1-percent chance flood hazard area are located in the Township of East Hanover. Out of the 11 facilities within the Township of East Hanover that fall within the 1-percent chance flood hazard area, 10 are lifeline facilities.

Further, critical facilities that are near an area where frequent urban flooding occurs are even more vulnerable to flood damages. Urban flooding is defined by FEMA as flooding caused by rain that falls on densely populated areas that have increased amounts of impervious surfaces, which overwhelms the capacity of drainage systems (Natural Resources Defense Council 2019). This type of flooding can be exacerbated by riverine flooding within the County.

Debris from flood events may also affect culverts and sewer systems by creating bottlenecks in the wastewater system, which could not only cause or exacerbate localized urban flooding, but also cause wastewater to spill into homes and neighborhoods or contaminate local rivers and streams. As a result, contamination of drinking water supplies can be a significant secondary event created by major flood events.



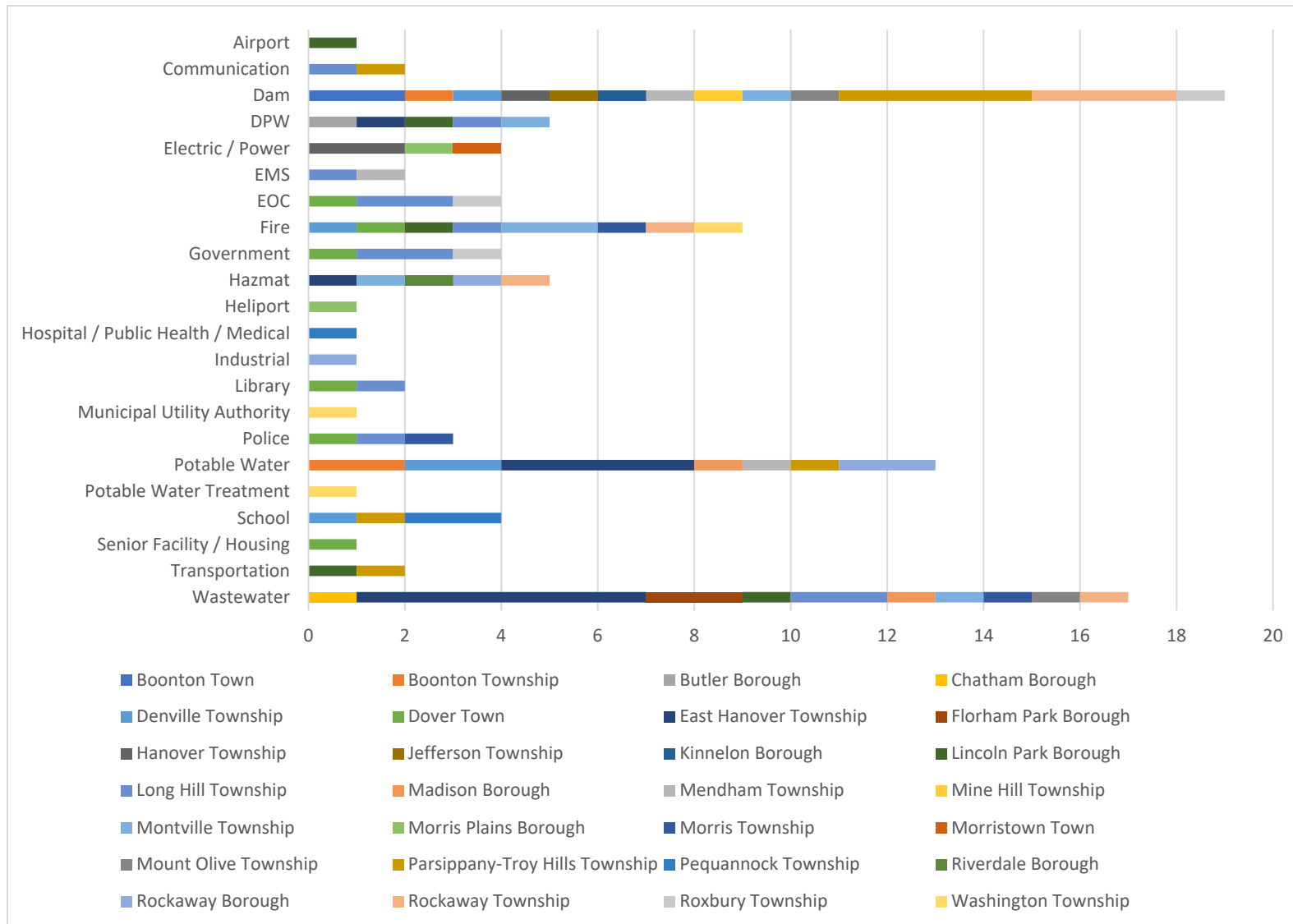
Figure 4.3.6-5. Distribution of Critical Facilities in the 1-Percent Annual Chance Flood Event Floodplain by Type and Municipality



Sources: FEMA 2017; MCOIT 2019



Figure 4.3.6-6. Distribution of Critical Facilities in the 0.2-Percent Annual Chance Flood Event Floodplain by Type and Municipality



Sources: FEMA 2017; MCOIT 2019



Figure 4.3.6-7. Major Roadways Located in the 1-percent Annual Chance Floodplain

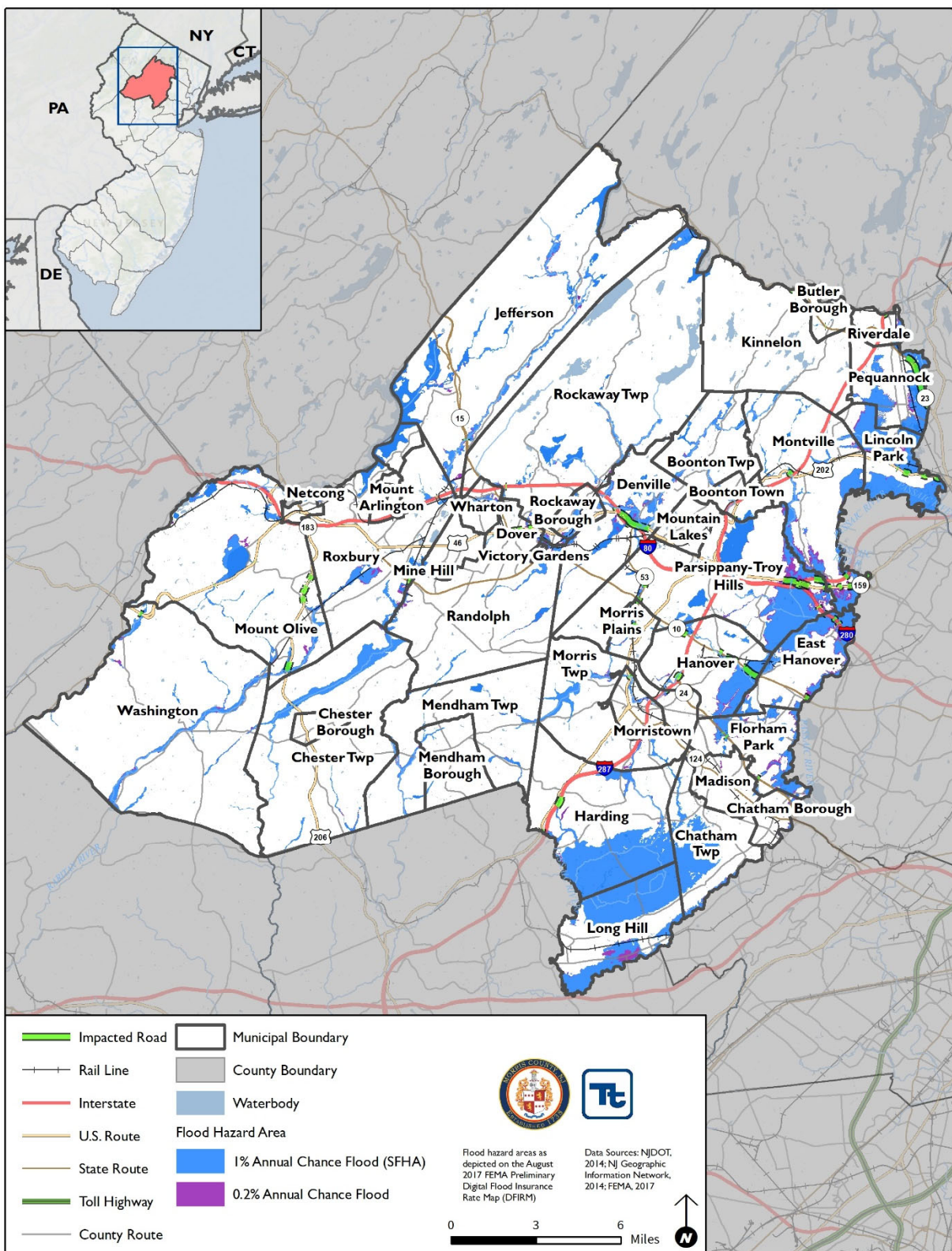




Table 4.3.6-14. Critical Facilities Located in the 1- and 0.2-Percent Annual Chance Event Floodplains

Facility Type	Number of Critical Facilities Located in the 1-Percent Annual Chance Event Floodplain	Number of Critical Facilities Located in the 0.2-Percent Annual Chance Event Floodplain
Air	1	1
Bus	0	1
Communication	2	2
County Building	0	1
Dam	18	19
DPW	4	5
Electric Power	0	1
EMS	1	2
EOC	2	4
Fire	5	9
Hazmat	4	5
Heliport	1	1
Hospital	1	1
Industrial	1	1
Library	1	2
Municipal Hall	2	4
Municipal Utility Authority	0	1
Natural Gas	2	2
Police	3	3
Potable	1	2
Potable Water	1	2
Private School	1	2
Pump Station	1	1
Rail	0	1
School	0	2
Senior	1	1
Sewer Utility	0	1
Substation	1	1
Wastewater	12	14
Wastewater Pump	2	2
Water	4	4
Water Utility	0	1
Well	2	4
Total	74	102

Source: Morris County, 2019; FEMA 2017; HAZUS-MH v4.2

* Only one facility was estimated to have structure and contents losses

EMS = Emergency Medical Services

EOC = Emergency Operations Center



Impact on the Economy

Flood events can significantly impact the local and regional economy. This includes but is not limited to general building stock damages and associated tax loss, impacts to utilities and infrastructure, agricultural losses, business interruption, and effects on tourism. In areas that are directly flooded, renovations of commercial and industrial buildings may be necessary, disrupting associated services. Refer to the section earlier which discusses direct impacts to buildings in Morris County.

Flooding can cause extensive damage to public utilities and disruptions to delivery of services. Loss of power and communications may occur and drinking water and wastewater treatment facilities may be temporarily out of operation.

Debris management may also be a large expense after a flood event. HAZUS-MH estimates the amount of structural debris generated during a flood event. 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.). These distinctions are necessary because of the different types of equipment needed to handle debris. Table 4.3.6-15 summarizes the HAZUS-MH countywide debris estimates for the 1-percent annual chance flood event. This table only estimates structural debris generated by flooding and does not include non-structural debris or additional potential damage and debris possibly generated by wind that may be associated with a flood event or storm that causes flooding.

Table 4.3.6-15. Estimated Debris Generated from the 1-Percent Flood Event

Municipality	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Town of Boonton	43	39	2	1
Township of Boonton	98	97	1	0
Borough of Butler	52	45	4	3
Chatham Borough	185	185	0	0
Chatham Township	380	380	0	0
Chester Borough	0	0	0	0
Chester Township	49	49	0	0
Denville Township	2,505	2,070	267	167
Town of Dover	917	913	2	1
Township of East Hanover	1,179	1,122	35	22
Borough of Florham Park	678	677	1	0
Township of Hanover	315	313	1	1
Township of Harding	389	387	1	1
Township of Jefferson	181	172	5	4
Borough of Kinnelon	0	0	0	0
Borough of Lincoln Park	3,002	2,016	578	407
Township of Long Hill	920	864	34	21
Borough of Madison	20	20	0	0
Borough of Mendham	30	28	1	1
Township of Mendham	107	99	5	3
Township of Mine Hill	12	12	0	0
Township of Montville	1,087	758	199	130
Township of Morris	153	153	0	0
Borough of Morris Plains	1,102	258	488	356



Municipality	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Town of Morristown	76	75	1	0
Borough of Mount Arlington	1	1	0	0
Township of Mount Olive	373	369	3	2
Borough of Mountain Lakes	0	0	0	0
Netcong Borough	7	7	0	0
Township of Parsippany-Troy Hills	1,032	920	66	46
Township of Pequannock	6,661	4,471	1,296	894
Township of Randolph	227	129	58	40
Borough of Riverdale	339	282	34	23
Borough of Rockaway	163	160	1	1
Township of Rockaway	345	289	34	22
Township of Roxbury	121	120	1	0
Borough of Victory Gardens	4	4	0	0
Township of Washington	301	253	27	20
Borough of Wharton	35	35	0	0
Morris County (Total)	23,087	17,773	3,145	2,169

Source: HAZUS-MH v4.2

Impact on the Environment

As Morris County and communities grow, flood events may increase in frequency and/or severity as land use changes, more structures are built, and impervious surfaces expand. Furthermore, flood extents for the 1-percent and 0.2-percent annual flood events will continue to evolve alongside natural occurrences such as climate change and/or severity of storms. These flood events will impact Morris County's natural and local environment.

Table 4.3.6-16 shows the acres of natural landcover, including area classified as endangered species, within Morris County that falls within the 1-percent and 0.2-percent annual chance floodplains.

Table 4.3.6-16. Natural Environment Area Within the 1-percent and 0.2-percent Annual Chance Floodplain

Type	Area in the 1-Percent Annual Chance Floodplain (acres)	Area in the 0.2-Percent Annual Chance Floodplain (acres)
Wetlands	5,177	5,267
Forest	1,106	1,208
Endangered Species	5,329	5,486

Source: NJDEP 2015; NJDEP 2017; FEMA 2017

Furthermore, impacts from changes in climate such as the frequency and intensity of weather events have an impact on the flood extents in Morris County. 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 Changes that May Impact Vulnerability

Understanding future changes that affect vulnerability can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The County considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Projected Development

As discussed in Section 3 (County Profile), 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 floodplain, there is insufficient stormwater drainage capacity present and/or mitigation measures are not considered. It is the intention of the County and all participating municipalities to discourage development in vulnerable areas or to encourage higher regulatory standards at the local level; refer to new HMP goal #1 and objectives 1D and 5B in Section 6 (Mitigation Strategy).

Each municipality identified areas of recent development and proposed development in their community. Development that could be located using an address or Parcel ID were geocoded and overlain with the FEMA preliminary 2017 DFIRM boundaries to determine exposure to the flood hazard. Based on this analysis, there are eight anticipated future developments located in the SFHA. These development locations will be vulnerable to flooding if they are not sited outside the floodplain or if mitigation measures are not considered. The results of this analysis were shared with each jurisdiction. Refer to Section 3 (County Profile), and Volume II Section 9 (Jurisdictional Annexes) for more detailed information on potential new development areas in Morris County. Refer to Figure 4.3.6-8 for a map of proposed new development and the FEMA preliminary 2017 DFIRM boundaries for Morris County.

Projected Changes in Population

The County has and is projected to continue experiencing population growth. In 2017, the Morris County Strategic Plan Steering Committee reviewed population trends for their community. However, the results of the report show that employment is expected to decrease, the population is generally getting older, and household sizes are shrinking (Morris County 2017). Changes in demographic and their location relative to hazard areas should be considered as Morris County identifies short and long-term mitigation measures. Refer to Section 4.3.1, Population Trends in the County Profile, which includes a discussion on population trends for the County.

Climate Change

As discussed above, most studies project that the State of New Jersey will see an increase in average annual temperatures and precipitation. Annual precipitation amounts in the region are projected to increase, primarily in the form of heavy rainfalls, which have the potential to increase the risk to flash flooding and riverine flooding, and flood critical transportation corridors and infrastructure. Increases in precipitation may alter and expand the floodplain boundaries and runoff patterns, resulting in the exposure of populations, buildings, and critical facilities and infrastructure that were previously outside the floodplain. This increase in exposure would result in an increased risk to life and health, an increase in structural losses, a diversion of additional resources to response and recovery efforts, and an increase in business closures affected by future flooding events due to loss of service or access.

Existing dams may not be able to retain and manage increases in water flow from more frequent, heavy rainfall events. Heavy rainfalls may result in more frequent overtopping of these dams and flooding of the County's



assets in adjacent inundation areas. However, the probable maximum flood used to design each dam may be able to accommodate changes in climate.

The North Jersey Transportation Planning Authority (NJTPA) recently completed the Passaic River Basin Climate Resilience Planning Study (2019) which assessed the potential for increasingly severe and frequent storm and heat events along with rising sea levels in the Passaic River Basin. The riverine spatial data generated as a result of this study (25- and 100-year precipitation events for today and planning horizons 2045 and 2080) were used to help understand potential changes in Morris County as the climate changes.

Table 4.3.6-17. Estimated Population Exposed to the Existing and Projected 25- and 100-year Precipitation Events in the Passaic River Basin

Municipality	25-year		100-year		
	Current	2045	Current	2045	2080
Lincoln Park Borough	5	6	9	12	25
Montville Township	16	22	46	83	192
Population Total	21	28	55	95	217

Source: NJTPA 2019

Table 4.3.6-17 through 4.3.6-18 summarize the population and number of buildings exposed to future projected flood inundation extents, respectively. It is important to note that not the entire 1-percent annual chance floodplain was included in this analysis; only the existing 100-year precipitation event in the Passaic River Basin was evaluated. As summarized in the table, the climate models anticipate an increase in flood inundation extents in 2045 and 2080 for the 25- and 100-year precipitation events, respectively, leading to an increase in number of buildings and persons exposed to the flood hazard.

Table 4.3.6-17. Estimated Population Exposed to the Existing and Projected 25- and 100-year Precipitation Events in the Passaic River Basin

Municipality	25-year		100-year		
	Current	2045	Current	2045	2080
Lincoln Park Borough	5	6	9	12	25
Montville Township	16	22	46	83	192
Population Total	21	28	55	95	217

Source: NJTPA 2019

Table 4.3.6-18. Estimated General Building Stock Exposure to the Existing and Projected 25- and 100-year Precipitation Events in the Passaic River Basin

Municipality	25-year Event		100-year		
	Current	2045	Current	2045	2080
Lincoln Park Borough	13	16	27	33	68
Montville Township	26	35	75	123	281
Buildings Total	39	51	102	156	349

Source: NJTPA 2019

*The all representative concentration pathway scenario was used for this analysis. Buildings were only exposed to riverine data.



Change of Vulnerability Since 2015 HMP

Preliminary DFIRMs for Morris County were released in 2017. A direct comparison of the change in vulnerability between HMPs is challenging because of the different flood maps and inventories used. Refer to Table 4.3.6-1 which summarizes changes in floodplain area between the preliminary 2011 DFIRM used in the 2015 HMP, and the preliminary 2017 DFIRMs used for the 2020 HMP updated risk assessment. As noted, the 2017 preliminary DFIRM did expand the floodplain area countywide but this change varies by jurisdiction. The updated vulnerability assessment provides a more current exposure analysis for the County.

When comparing the exposure of the 2020 HMP building inventory to the flood hazard using the 2011 preliminary and the 2017 preliminary DFIRMs, there is an overall increase in the number of buildings at risk to the flood hazard countywide; refer to Table 4.3.6-19. Please note, the updated building stock analysis used for the 2020 HMP update was used for this comparative analysis. The 2017 maps are still considered preliminary and under review.

Table 4.3.6-19. Changes in Structure Vulnerability to the Flood Hazard Comparing the 2011 preliminary FEMA DFIRMs to the 2017 preliminary FEMA DFIRMs

Number of Buildings in the Floodplain	
2011 preliminary FEMA DFIRM (2015 HMP)	2017 preliminary FEMA DFIRM (2020 HMP)
5,133	5,462

Source: FEMA 2011/2017; Microsoft 2018; ; NJOIT 2018; MCOIT 2019

The entire County continues to be vulnerable to the flood hazard. Several differences exist between the 2015 HMP flood vulnerability assessment and the assessment performed for this update. As summarized in Section 4.2 (Methodology and Tools), an updated general building stock based upon replacement cost value from MODIV tax assessment data and 2019 RS Means, and an updated critical facility inventory were developed and used in the 2020 HMP risk assessment. The 2017 American Community Survey population estimates were used and estimated at a structural level in place of the 2010 U.S. Census blocks in an effort to provide a more accurate estimate of population hazard exposure.

There was a change in NFIP statistic sources used when compared to the 2015 HMP. The 2020 HMP references FEMA's HUDEX data to determine the number of claims and policies that have been issued in the County. Furthermore, updates from FEMA provided 2019 NFIP RL and SRL statistics. Since 2015, the County has seen a decrease in the number of policies, and an increase in the number of claims and repetitive and severe repetitive loss properties. There was an overall decrease in the number of policies countywide (decrease of 783 policies) with some municipalities experiencing an increase while others a decrease. The greatest increase in policies occurred in the Township of Morris (65 policies), while the greatest decrease in policies occurred in the Borough of Lincoln Park (-167 policies).

When comparing the NFIP statistics from the 2015 HMP, there were 1,302 new claims and an increase in losses claimed (approximately \$533,890) as presented earlier in this section. The number of claims and losses include NFIP and Write Your Own (WYO) policies. Further, there was an increase of 177 repetitive loss properties and 77 severe repetitive loss properties. Most of these additional repetitive loss properties are located in the Township of Pequannock (37). Changes in these numbers may be a reflection of conflicting information between the sources used to categorize this data. There have not been major flood events since 2015 for these statistics to substantially increase; furthermore, the Township of Pequannock is actively elevating RL and SRL properties and the number of these properties is anticipated to change upon completion of these projects.



Overall, the 2020 HMP vulnerability assessment presented uses a more accurate and updated building inventory, which provides more accurate exposure and potential loss estimates for Morris County. Morris County and its municipalities will continue to be vulnerable to the flood hazard as evidenced by the updated flood mapping and the climate change projections; however, progress has been made to decrease vulnerability through the implementation of mitigation projects (i.e., acquisition and elevation of flood-prone properties). Mitigation measures undertaken by each jurisdiction are described in the jurisdictional annexes in Section 9 (Jurisdictional Annexes) of this HMP.



Figure 4.3.6-8. Potential New Development and Floodplain Boundaries

