5.4.4 Flood

The following section provides the hazard profile and vulnerability assessment for the flood hazard in Broome County.

5.4.4.1 Profile

This section provides information regarding the description, extent, location, previous occurrences and losses, climate change projections and the probability of future occurrences for the flood hazard.

Hazard Description

Floods are one of the most common natural hazards in the U.S. They can develop slowly over a period of days or develop quickly, with disastrous effects that can be local (impacting a neighborhood or community) or regional (affecting entire river basins, coastlines and multiple counties or states) (FEMA 2007). As defined in the NYS HMP (NYS DHSES 2014), flooding is a general and temporary condition of partial or complete inundation on normally dry land as a result of the following:

- Riverine overbank flooding
- Flash floods
- Alluvial fan floods
- Mudflows or debris floods
- Dam- and levee-break floods
- Local draining or high groundwater levels
- Fluctuating lake levels
- Ice-jams
- Coastal flooding

For the purpose of this HMP and as deemed appropriate by the Broome County Steering Committee, riverine, shallow, flash, ice jam, levee failure, and dam failure flooding are the main flood types of concern for the county. These types of flood are further discussed below.

Riverine (Inland) and Flash Flooding

Riverine floods are the most common flood type. They occur along a channel and include overbank and flash flooding. Channels are defined, ground features that carry water through and out of a watershed. They may be called rivers, creeks, streams, or ditches. When a channel receives too much water, the excess water flows over its banks and inundates low-lying areas (The Illinois Association for Floodplain and Stormwater Management 2006).

Flash floods are defined by the National Weather Service as "A flood caused by heavy or excessive rainfall in a short period of time, generally less than 6 hours. Flash floods are usually characterized by raging torrents after heavy rains that rip through river beds, urban streets, or mountain canyons sweeping everything before them. They can occur within minutes or a few hours of excessive rainfall. They can also occur even if no rain has fallen, for instance after a levee or dam has failed, or after a sudden release of water by a debris or ice jam." (National Weather Service [NWS], n.d.).

Shallow Flooding

Stormwater flooding described below is due to local drainage issues and high groundwater levels. Locally, heavy precipitation may produce flooding in areas other than delineated floodplains or along recognizable channels. If local conditions cannot accommodate intense precipitation through a combination of infiltration and surface runoff, water may accumulate and cause flooding problems. During winter and spring, frozen ground and snow accumulations may contribute to inadequate drainage and localized ponding. Flooding issues of this nature generally occur in areas with flat gradients and generally increase with urbanization which speeds the accumulation of floodwaters because of impervious areas. Shallow street flooding can occur unless channels have been improved to account for increased flows (FEMA 1997).

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 long periods of above-average precipitation (FEMA 1997).

Urban drainage flooding is caused by increased water runoff due to urban development and 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. They 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. Since 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 (FEMA 2007).

Combined sewer overflow (CSO), or the discharge from a combined sewer system that is caused by snowmelt or stormwater runoff can result in the discharge from a combined sewer system that is caused by snowmelt or stormwater runoff. CSOs are sewer systems that collect stormwater runoff, domestic sewage, and industrial wastewater in the same pipe and bring it to the wastewater treatment facility. They are designed to overflow during wet weather. CSOs are sewer systems that collect stormwater runoff, domestic sewage, and industrial wastewater in the same pipe and bring it to the wastewater treatment facility. They are designed to overflow during wet weather.

Ice Jam Flooding

An ice jam occurs when pieces of floating ice are carried with a stream's current and accumulate behind any obstruction to the stream flow. Obstructions may include river bends, mouths of tributaries, points where the river slope decreases, as well as dams and bridges. The water held back by this obstruction can cause flooding upstream, and if the obstruction suddenly breaks, flash flooding can occur as well (NOAA 2013). The formation of ice jams depends on the weather and physical condition of the river and stream channels. They are most likely to occur where the channel slope naturally decreases, in culverts, and along shallows where channels may freeze solid. Ice jams and resulting floods can occur during at different times of the year: fall freeze-up from the formation of frazil ice; mid-winter periods when stream channels freeze solid, forming anchor ice; and spring breakup when rising water levels from snowmelt or rainfall break existing ice cover into pieces that accumulate at bridges or other types of obstructions (NYS DHSES 2014).

Ice Jams
At a Glance

- ✓ **Freeze-up jams occur when floating ice may slow or stop due to a change in water slope as it reaches an obstruction to movement.**
- ✓ **Breakup jams occur during periods of thaw, generally in late winter and early spring.**

There are two main types of ice jams: freeze-up and breakup. Freeze-up jams occur when floating ice may slow or stop due to a change in water slope as it reaches an obstruction to movement. Breakup jams occur during periods of thaw, generally in late winter and early spring. The ice cover breakup is usually associated with a rapid increase in runoff and corresponding river discharge due to a heavy rainfall, snowmelt or warmer temperatures (USACE 2002; NYS DHSES 2014).

Dam and Levee Failure Flooding

A dam or a levee is an artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material for the purpose of storage or control of water (FEMA 2007). Dams are man-made structures built across a stream or river that impound water and reduce the flow downstream (FEMA 2003). They are built for the purpose of power production, agriculture, water supply, recreation, and flood protection. Dam failure is any malfunction or abnormality outside of the design that adversely affects a dam's primary function of impounding water (FEMA 2007). Levees typically are earthen embankments constructed from a variety of materials ranging from cohesive to cohesionless soils (USBR 2012). Dams and levees can fail for one or a combination of the following reasons:

- Overtopping caused by floods that exceed the capacity of the dam (inadequate spillway capacity due to uncontrolled release or exceedance of design);
- Prolonged periods of rainfall and flooding;
- Deliberate acts of sabotage (terrorism);
- Structural failure of materials used in dam construction;
- Movement and/or failure of the foundation supporting the dam;
- Settlement and cracking of concrete or embankment dams;
- Piping and internal erosion of soil in embankment dams;
- Inadequate or negligent operation, maintenance and upkeep;
- Failure of upstream dams on the same waterway; or
- Earthquake (liquefaction / landslides) (FEMA 2010).

Flood Control Measures

Levees exist in the county that provide the community with some degree of protection against flooding. However, it has been ascertained that some of these levees may not protect the community from rare events such as the 1-percent-annual- chance flood (FEMA FIS 2010). According to the United States Army Corps National Levee Database, Broome County has 13 levee systems for a total of 18 miles (USACE 2019). A summary of levees built as flood control measures is provided below.

The Endicott-Johnson City-Vestal project consists of four flood protection units that provide for the protection of communities within the Towns of Union and Vestal and the Villages of Endicott and Johnson City on the Susquehanna River Reach 1. The project is comprised of various levees, pumping units (including submersible pumps), flood walls, berms, and overflow channels. Two upstream dams at Whitney Point Lake on the Otselic River and East Sidney Lake on Ouleout Creek reduce flood hazards from the Susquehanna River, on both Reach 1 and Reach 2 (FEMA FIS 2010).

In the City of Binghamton, protective works consist of an earthen levee, concrete flood walls, channel excavation, pressure conduit, check dam and channel construction on Park Creek, channel paving, and appurtenant drainage and closure structures along the Susquehanna and Chenango Rivers. When supplemented by seven flood control dams located upstream from the area, the structures provide protection against flood discharges approximately 20 percent greater than the maximum flood of record (prior to construction), which occurred in July 1935 on the Chenango River and in March 1936 on the Susquehanna River (FEMA FIS 2010).

In the Village of Deposit, the Cannonsville Reservoir has a significant effect on flood reduction on the West Branch Delaware River. The concrete lining of the Bone Creek channel has prevented much flooding by increasing the channel carrying capacity and resulted in the construction of Palmers Pond Dam upstream of

Butler Brook, a diversion channel from Butler Brook to the West Branch Delaware River and a dike along Butler Brook and Big Hollow (FEMA FIS 2010).

Following the flood of 1935, dikes were constructed to protect the Village of Lisle along the Tioughnioga River and along Dudley Creek to the north and west of the village. Protective works at Lisle consists of earth levee, concrete flood wall, channel relocation and realignment along the Tioughnioga River, and relocation of about 3,000 feet of the Dudley Creek channel; raising of the Erie Lackawanna single-track railroad over the levee; relocation of about 1,600 feet of Cortland Street; a new bridge relocated over Dudley Creek; and construction of appurtenant drainage structures (FEMA FIS 2010).

In the Town of Nanticoke, in addition to the five detention basins constructed in the watershed of West Branch Nanticoke Creek prior to the 1976 flood, one basin was constructed on a tributary to East Branch Nanticoke Creek subsequent to this flood (FEMA FIS 2010).

Although not constructed for flood protection, incidental flood damage reduction is provided by Cannonsville Reservoir on the West Branch Delaware River and by the dam at North Sanford on Oquaga Creek (FEMA FIS 2010).

In the Town of Union, the Soil Conservation Service (SCS) has provided flood detention structures for Nanticoke Creek Watershed, which provide a small amount of protection. Other SCS structures on Little Choconut Creek, Finch Hollow Creek, Patterson Creek, and Brixius Creek reduce flood hazards from these streams (FEMA FIS 2010).

FEMA specifies that all levees must have a minimum of 3-foot freeboard against 1- percent-annual-chance flooding to be considered a safe flood protection structure (FEMA FIS 2010).

Specific information including a levee audit summary as well as collated information including levee feature information, accreditation information, design criteria and associate data regarding levees within Broome County is provided in Appendix H (Levee Information).

Extent

The severity of a flood event is typically determined by a combination of several factors including: stream and river basin topography and physiography; precipitation and weather patterns; recent soil moisture conditions; and degree of vegetative clearing and impervious surface. Generally, floods are long-term events that may last for several days.

Regarding the riverine flood hazard, once a river reaches flood stage, flood extent or severity categories used by the NWS include minor flooding, moderate flooding, and major flooding. Each category is defined as follows, based on property damage and level of 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).

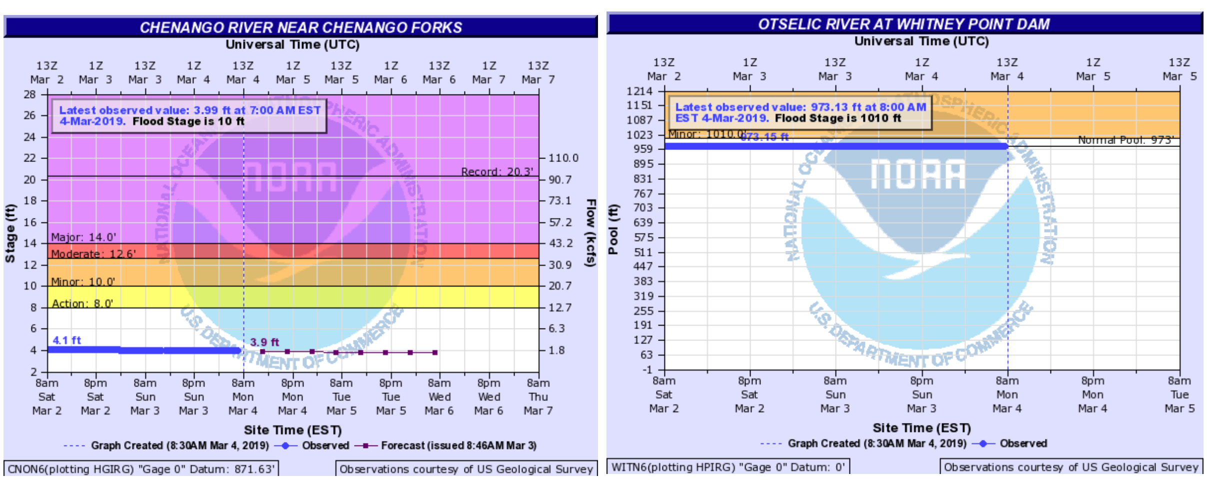
USGS uses stream gages to determine the severity of flood at different points along a body of water. There eight total gages in Broome County found along the Susquehanna, Tioughnioga, and Chenango Rivers; however, one gage along the Susquehanna River is no longer active. The flood stage is identified at each gage. Broome County and its municipalities rely on these gages to determine the height of the rivers during heavy rain events and to determine whether or not residents need to evacuate. Table 5.4.4-1 shows the eight gages in the county with their determined flood stage and their record flood event. The USGS website provides details about each of the gages (https://waterwatch.usgs.gov/index.php) and the gage heights of flooding events. The NWS provides the different flood stages for the gages (https://water.weather.gov/ahps/).

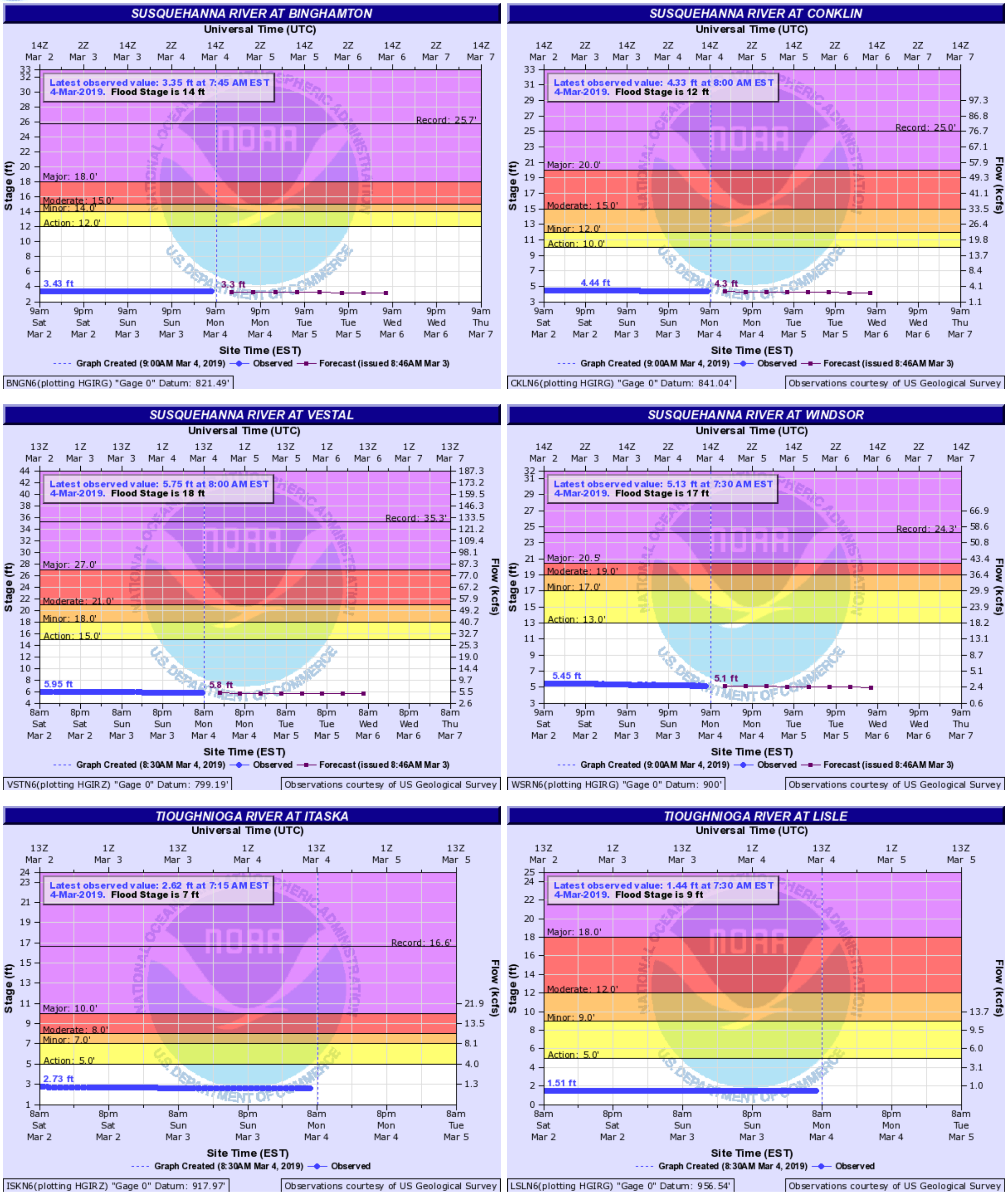
Table 5.4.4-1. Stream Gage Statistics for Broome County

Gage Site Number	Site Name	Action Stage (feet)	Minor Flood Stage (feet)	Moderate Flood Stage (feet)	Major Flood Stage (feet)	Record Flood
1502731**	Susquehanna River at Windsor NY	13.0	17.0	19.0	20.5	24.27 feet on June 29, 2006
1503000	Susquehanna River at Conklin NY	10.0	12.0	15.0	20.0	25.02 feet on June 28, 2006
1503500	Susquehanna River at Binghamton NY	12.0	14.0	15.0	18.0	25.73 feet on September 8, 2011
1513500	Susquehanna River at Vestal NY	15.0	18.0	21.0	27.0	35.26 feet on September 8, 2011
1509520	Tioughnioga River at Lisle NY	5.0	9.0	12.0	18.0	10.38 feet on April 2, 2005
1511500	Tioughnioga River at Itaska NY	5.0	7.0	8.0	10.0	16.61 feet on July 8, 1935
1511000	Whitney Point Lake at Whitney Point NY	1,009.0	1,010.0	N/A	N/A	978.08* on September 19, 2018
1512500	Chenango River near Chenango Forks NY	8.0	10.0	12.6	14	20.3 on July 8, 1935

Source: USGS 2018
N/A Not Available
**Recent maximum stage (within the past 365 days)*
***Gage is no longer active*

Figure 5.4.4-1. Flood Hydrographs for the Gages in Broome County





Source: *NWS 2019*

Severity of a flood depends not only on the amount of water that accumulates within a period of time, but also on the land's ability to manage this water. Sizes of rivers and streams in an area and infiltration rates are significant factors. During rain events, soil acts as a sponge. When land is saturated or frozen, infiltration rates decrease and any more water that accumulates must flow as runoff (Harris 2001).

According to the NYSDEC Division of Water Bureau of Flood Protection and Dam Safety, the hazard classification of a dam is assigned according to the potential impacts of a dam failure pursuant to 6 New York

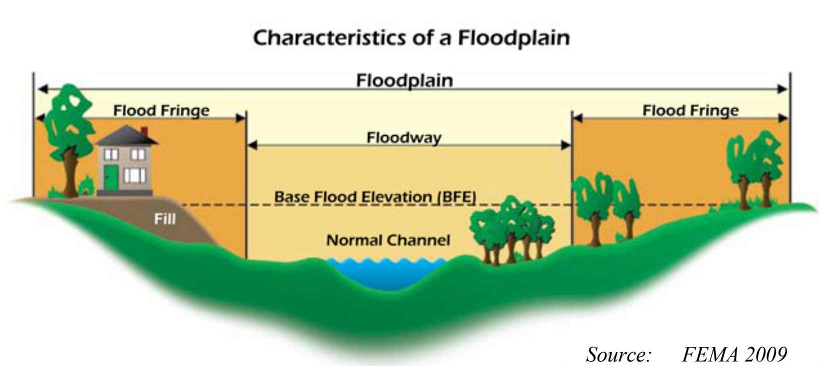
Codes, Rules, and Regulations (NYCRR) Part 673.3 (NYSDEC 2009). Dams are classified in terms of potential for downstream damage if the dam were to fail. These hazard classifications are identified and defined below:

- *Low Hazard (Class A)* is a dam located in an area where failure will damage nothing more than isolated buildings, undeveloped lands, or township or county roads and/or will cause no significant economic loss or serious environmental damage. Failure or mis-operation would result in no probable loss of human life. Losses are principally limited to the owner's property
- *Intermediate Hazard (Class B)* is a dam located in an area where failure may damage isolated homes, main highways, minor railroads, interrupt the use of relatively important public utilities, and/or will cause significant economic loss or serious environmental damage. Failure or mis-operation would result in no probable loss of human life, but can cause economic loss, environment damage, disruption of lifeline facilities, or impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.
- *High Hazard (Class C)* is a dam located in an area where failure may cause loss of human life, serious damage to homes, industrial or commercial buildings, important public utilities, main highways or railroads and/or will cause extensive economic loss. This is a downstream hazard classification for dams in which excessive economic loss (urban area including extensive community, industry, agriculture, or outstanding natural resources) would occur as a direct result of dam failure.
- *Negligible or No Hazard (Class D)* is (1) a dam that has been breached or removed, or has failed or otherwise no longer materially impounds waters, or (2) a dam that was planned but never constructed. Class "D" dams are considered to be defunct dams posing negligible or no hazard. The department may retain pertinent records regarding such dams.

Location

Flooding potential is influenced by climatology, meteorology, and topography (elevations, latitude, and water bodies and waterways). Flooding potential for each type of flooding that affects Broome County is described in the subsections below.

Floodplains



Source: FEMA 2009

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 Broome 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.

Flood Map Terms

- Flood hazard areas identified on the Flood Insurance Rate Map are identified as a Special Flood Hazard Area (SFHA).
- SFHA = the area that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year.
- 1-percent annual chance flood = the base flood or 100-year flood.
- SFHAs are labeled as Zone A, Zone AO, Zone AH, Zones A1-A30, Zone AE, Zone A99, Zone AR, Zone AR/AE, Zone AR/AO, Zone AR/A1-A30, Zone AR/A, Zone V, Zone VE, and Zones V1-V30.
- Zone B or Zone X (shaded) = Moderate flood hazard areas and are the areas between the limits of the base flood and the 0.2-percent-annual-chance (or 500-year) flood.
- Zone C or Zone X (unshaded) = Areas of minimal flood hazard, which are the areas outside the SFHA and higher than the elevation of the 0.2-percent-annual-chance flood, are labeled

Source: FEMA, 2018

Flood hazard areas are identified as Special Flood Hazard Area (SFHA). SFHA are defined as the area that will be inundated by the flood event having a 1 percent chance of being equaled to or exceeded in any given year. The 1 percent annual chance flood is also referred to as the base flood or 100-year flood. 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. Similarly, the moderate flood hazard area (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 (FEMA 2018). The 1-percent annual chance floodplain establishes the area that has flood insurance and floodplain management requirements.

Locations of flood zones in Broome County as depicted on the FEMA preliminary Digital Flood Insurance Rate Map (DFIRM) are illustrated in Figure 5.4.4-2 and the total land area in the floodplain, inclusive of waterbodies, is summarized in Table 5.4.4-1. Refer to Section 9 for a map of each jurisdiction depicting the floodplains. Flood hazard zones occur throughout the county, with the largest areas along the Susquehanna River. The Digital Flood Insurance Rate Map (DFIRM) data provided by FEMA for Broome County show the following flood hazard areas: County show the following flood hazard areas:

- 1-Percent Annual Chance Flood Hazard: Areas subject to inundation by the 1-percent-annual-chance flood event. This includes Zone A, Zone AE, and Zone A. Mandatory flood insurance requirements and floodplain management standards apply. Base flood elevations are provided in Zone AE. Zone AO has associated flood depths derived from detailed hydraulic analyses. Zone A has no determined flood depths.
- 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.

Table 5.4.4-2. Total Land Area in the 1-Percent and 0.2-Percent Annual Chance Flood Zones (Acres)

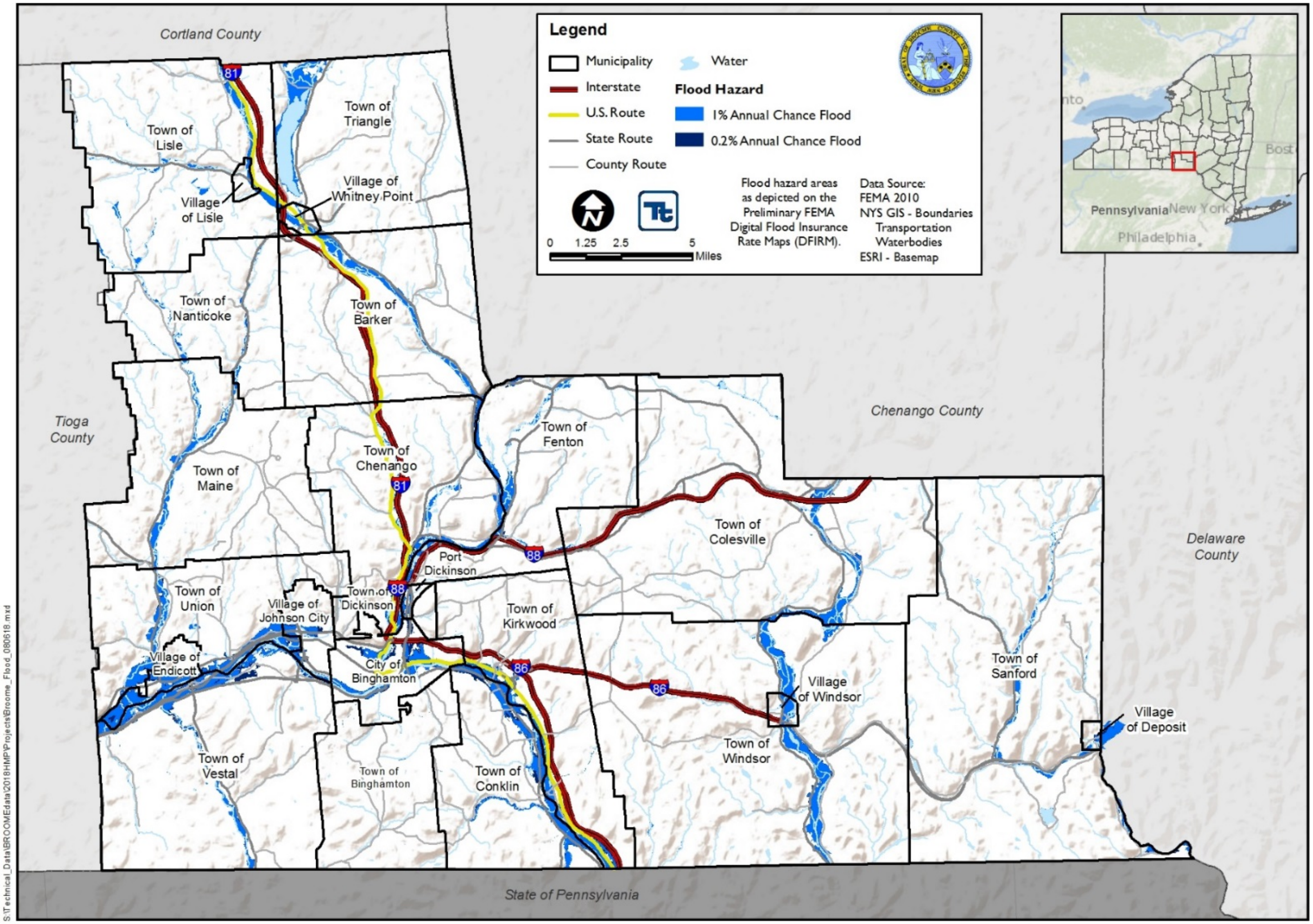
Municipality	Total Area (acres)	1% Flood Event Hazard Area		0.2% Flood Event Hazard Area	
		Area (acres)	Percent (%) of Total	Area (acres)	Percent of Total
Barker (T)	26,762.1	1,146.4	4.3%	1,151.9	4.3%
Binghamton (C)	7,076.0	1,340.0	18.9%	1,728.7	24.4%
Binghamton (T)	16,147.2	38.4	0.2%	40.0	0.2%
Chenango (T)	21,976.6	1,187.2	5.4%	1,337.1	6.1%
Colesville (T)	50,834.9	1,466.9	2.9%	1,539.1	3.0%
Conklin (T)	15,890.6	1,842.3	11.6%	2,168.5	13.6%

Table 5.4.4-2. Total Land Area in the 1-Percent and 0.2-Percent Annual Chance Flood Zones (Acres)

Municipality	Total Area (acres)	1% Flood Event Hazard Area		0.2% Flood Event Hazard Area	
		Area (acres)	Percent (%) of Total	Area (acres)	Percent of Total
Deposit (V)	425.3	72.4	17.0%	87.7	20.6%
Dickinson (T)	2,772.0	324.0	11.7%	379.6	13.7%
Endicott (V)	2,160.8	875.8	40.5%	1,009.1	46.7%
Fenton (T)	21,236.0	1,278.8	6.0%	1,392.6	6.6%
Johnson City (V)	2,974.0	365.3	12.3%	438.4	14.7%
Kirkwood (T)	19,936.5	1,288.1	6.5%	1,420.6	7.1%
Lisle (T)	29,655.4	1,320.8	4.5%	1,351.7	4.6%
Lisle (V)	553.5	94.5	17.1%	94.5	17.1%
Maine (T)	29,016.5	1,068.8	3.7%	1,069.4	3.7%
Nanticoke (T)	15,518.9	474.5	3.1%	556.3	3.6%
Port Dickinson (V)	404.7	115.6	28.6%	152.3	37.6%
Sanford (T)	57,961.0	1,407.8	2.4%	1,470.6	2.5%
Triangle (T)	24,845.8	2,174.4	8.8%	2,174.4	8.8%
Union (T)	18,081.6	1,900.7	10.5%	2,084.5	11.5%
Vestal (T)	33,682.7	2,294.6	6.8%	2,684.9	8.0%
Whitney Point (V)	727.8	259.3	35.6%	259.3	35.6%
Windsor (T)	58,613.7	2,311.0	3.9%	2,405.6	4.1%
Windsor (V)	726.6	276.8	38.1%	286.2	39.4%
Broome County	**457,980.3**	**24,924.4**	**5.4%**	**27,282.8**	**6.0%**

Source: *FEMA 2010*
Note: The area presented includes the area of waterways.
C = City
T = Town
V = Village

Figure 5.4.4-2. FEMA Preliminary DFIRM Flood Hazard Areas in Broome County



Source: FEMA 2010

Riverine/Flash Flooding/Stormwater Flooding

Broome County is located in the Susquehanna River Basin; the second largest basin east of the Mississippi River. The Susquehanna River Basin encompasses most of the south-central portion of New York State. The drainage area includes most of Broome, Chenango, Cortland, Otsego and Broome Counties, portions of Delaware, Madison and Chemung Counties, and small parts of Schuyler, Tompkins, Onondaga, Oneida, Herkimer and Schoharie Counties (NYSDEC 2009). According to the NYS HMP, the Susquehanna River Basin experiences severe riverine flooding. The Susquehanna River, located in the Susquehanna River Basin, is the largest river that flows through the county, and municipalities along the river are known to sustain extensive damage during flood events.

According to the Broome County Flood Insurance Study (FIS) of 2010, flooding may occur in the county during any season of the year but is most likely to occur in the late winter-early spring months when the melting snow may combine with intense rainfall to produce increased runoff. During the winter, flooding has been a threat when ice and debris jam in the channel and at bridges. Summer and fall floods occur due to hurricane and thunderstorm activity. Since 1913, the Susquehanna River has left its banks over 100 times. Many of these floods have caused extensive damage to commercial and industrial developments, roads, crops, farm buildings, and homes. The flood of record for the Susquehanna River Reach 1 and the Susquehanna River Reach 2 occurred in June 2006 as a result of heavy rains from extra-tropical storm Ernesto. The flood caused widespread damage throughout the Susquehanna River basin and nearly breached flood protection levees along Susquehanna River Reach 1 (FEMA FIS 2010). Since the FIS for Broome County was published, several other major flood events occurred. There are four river gages along the Susquehanna River, as noted in Table 5.4.4-1. For two of the gages located at Windsor and Conklin, the flood of record occurred in June 2006. For the two gages located in Binghamton and Vestal, the flood of record occurred in September 2011.

Concerns over Choconut Creek flooding prompted officials to close roads and advise evacuation for certain areas of Vestal on August 14, 2018
Source: Pressconnects 2019

Schnurbusch Park flooding in the Town of Conklin
Source: Press Connect 2018

For Castle Creek and other smaller streams in the Town of Chenango, stream bank and highway embankment erosion caused by high flow velocities present the most serious flooding problems. In the Village of Deposit, flooding on several streams has caused damage. Butler Brook floods almost every year, causing damage to residential, farm, and commercial properties on the east side of the village. Flooding from Big Hollow has also damaged the school and residential properties. Oquaga Creek can flood residential and commercial properties in the Borden Street area. The West Branch Delaware River floods infrequently and normally floods a relatively small area. Some agricultural flood damage above the Pine Street bridge occurs as well as some residential and commercial flood damage between Pine Street and the CONRAIL embankment (FEMA FIS 2010).

In the Village of Johnson City, Finch Hollow Creek and Little Choconut Creek are sources of minor flooding. Flooding on these creeks has basically the same causes as flooding on the Susquehanna River, but with the added effect of backwater from the Susquehanna River. In the Town of Sanford, all streams in the community have caused floodwater damage. (FEMA FIS 2010).

The Broome County Watershed Flood Hazard Mitigation Analysis was completed in May 2016. One of the goals of the plan was to locate frequent flood hazard locations in the county. The plan identified the following locations. For details on each location, refer to: http://www.gobroomecounty.com/files/planning/_pdf/BCWFHMA%20-%20Report%20for%20Web.pdf

- Choconut Creek and Lower Choconut in the Town of Vestal
- Thomas Creek in the Towns of Chenango and Fenton and small portions of the Towns of Dickinson and Kirkwood, the Village of Dickinson and the City of Binghamton
- Patterson Creek in the Town of Union and portions of the Village of Endicott and the Towns of Maine and Vestal

In addition to the areas listed above, in *Building Resiliency* prepared in 2016, several floodprone areas were identified as well. This includes:

- Carlin Creek in the Town of Conklin
- Porter Hollow Creek in the Town of Fenton
- Chamberlain Creek in Kirkwood and Binghamton
- Nanticoke Creek in the Town of Maine

Ice Jam Flooding

Ice jams can occur along any of Broome County's rivers and streams. Ice jams have recently formed along Susquehanna River at Windsor and Conklin and on the Chenango River at Chenango Forks and Chenango Bridge (USACE 2018).

Dam Failure

NYSDEC maintains an inventory of dam failure data. Hazard classification, location, volume, elevation, and condition information for each dam in Broome County that has a federal identification number is included in the inventory. Currently, 170 dams are within Broome County, as shown in Section 4 (County Profile). Of these 170 dams in Broome County: 106 low hazard, 13 intermediate hazard, 23 high hazard, and 17 negligible or no hazard classification and 11 have an unknown classification (NYS DEC 2018). The county further notes that there are numerous dams that are below the threshold impoundment size for monitoring by NYSDEC, however such dams still pose significant risk and threat to the region that must be managed to protect public safety (Broome County HMP 2013).

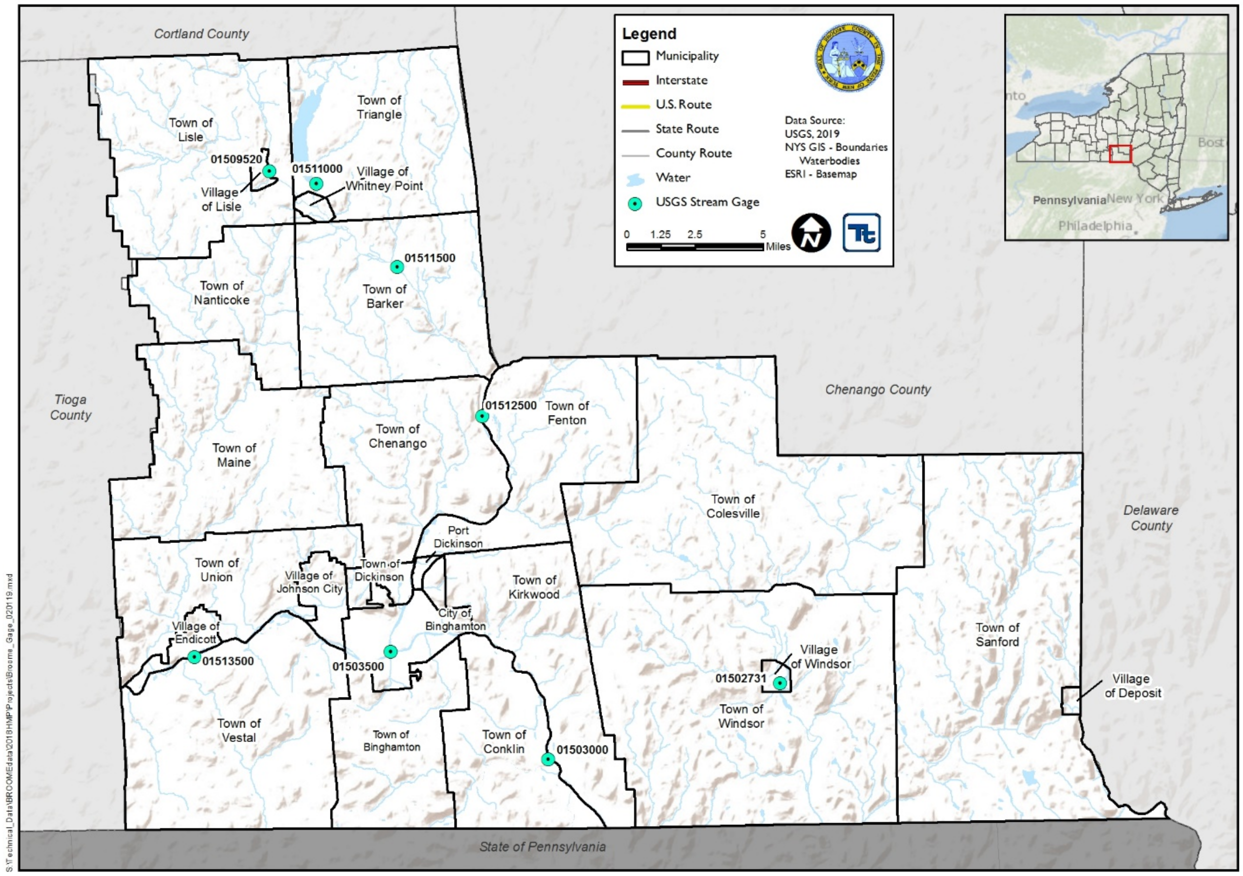
Levee Failure

Levees protect portions of the Town of Union, Town of Vestal, City of Binghamton, Village of Johnson City, Village of Endicott along the Susquehanna River and the Village of Lisle along the Tioughnioga River (USACE 2019). Failure of these levees could result in flooding of these jurisdictions.

Flood Gages

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. In Broome County, there are eight stream gages that collect data along the Susquehanna, Tioughnioga, and Chenango Rivers (Figure 5.4.4-3).

Figure 5.4.4-3. USGS Stream Gages in Broome County



01502731 Susquehanna River at Windsor NY
01503000 Susquehanna River at Conklin NY
01503500 Susquehanna River at Binghamton NY
01509520 Tioughnioga River at Lisle NY
01511000 Whitney Point Lake at Whitney Point NY
01511500 Tioughnioga River at Itaska NY
10152500 Chenango River near Chenango Forks NY
01513500 Susquehanna River at Vestal NY

Previous Occurrences and Losses

Table 5.4.4-3 documents historical flood events (including ice jams) from 1950 to August 2018 in Broome County based on data collected from the NCEI, National Performance of Dams Program (NPDP), and Cold Regions Research and Engineering Laboratory (CRREL) databases.

Table 5.4.4-3. Flood Events 1950-2018

Hazard Type	Number of Occurrences Between 1950 and 2018	Total Fatalities	Total Injuries	Total Property Damage ($)	Total Crop Damage ($)
Flash Flood	49	7	3	$328.202 million	$0

Hazard Type	Number of Occurrences Between 1950 and 2018	Total Fatalities	Total Injuries	Total Property Damage ($)	Total Crop Damage ($)
Flood	43	0	0	$479.655 million	$0
Dam Failure	0	0	0	$0	$0
Ice Jam	17	-	-	-	-
Levee Failure	0	0	0	0	$0
TOTAL	**109**			**$807.857 million**	**$0**

Source: NOAA-NCEI 2018; CRELL 2018, International Levee Performance Database 2019
Notes: CRELL data does not include information on total fatalities, injuries, property damages, or crop damages; M Million

Between 1954 and 2018, FEMA included New York State in 85 flood-related major disaster (DR) or emergency (EM) declarations classified as one or a combination of the following disaster types: severe storms, flooding, hurricane, tropical depression, heavy rains, landslides, ice storm, high tides, nor'easter, tornado, snowstorm, severe winter storm, and inland/coastal flooding. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Broome County was included in 18 of these flood-related declarations; refer to Table 5.4.4-4.

Table 5.4.4-4. Flood-Related FEMA Declarations for Broome County, 1954 to 2018

FEMA Declaration Number	Date(s) of Event	Event Type	Details
DR-290	July 22, 1970	Flood	Heavy Rains & Flooding
DR-338	June 23, 1972	Flood	Tropical Storm Agnes
DR-487	October 2, 1975	Flood	Storms, Rains, Landslides & Flooding
DR-515	July 21, 1976	Flood	Severe Storms & Flooding
DR-1095	1996	Flood	Severe Storms and Flooding
DR-1222	1998	Severe Storm	Severe Storms and Tornadoes
DR-1534	May 13-June 17, 2004	Severe Storm	Severe Storms and Flooding
DR-1564	August 13-September 16, 2004	Severe Storm	Severe Storms and Flooding
DR-1565	September 16-24, 2004	Severe Storm	Tropical Depression Ivan
DR-1589	April 2-4, 2005	Severe Storm	Severe Storms and Flooding
DR-1650	June 26-July 10, 2006	Severe Storm	Severe Storms and Flooding
DR-1670	November 16-17, 2006	Severe Storm	Severe Storms and Flooding
DR-1993	April 26-May 8, 2011	Flood	Severe Storms, Flooding, Tornadoes, and Straight-Line Winds
EM-3341	September 7-11, 2011	Severe Storms and Flooding	Remnants of Tropical Storm Lee
DR-4031	September 7-11, 2011	Severe Storms and Flooding	Remnants of Tropical Storm Lee
EM-3351	October 27-November 8, 2012	Hurricane	Hurricane Sandy
DR-4129	June 26-July 10, 2013	Flood	Severe Storms and Flooding
DR-4397	August 13-15, 2018	Flood	Severe Storms and Flooding

Source: FEMA 2018

For this update, flood events were summarized from 2012 to 2018. Known flood events, including FEMA disaster declarations, which have impacted Broome County between 2012 and 2018 are identified in Table 5.4.4-5. Appendix E (Supplemental Data) contains details on flood events that occurred prior to 2012.

Table 5.4.4-5. Flood Events in Broome County, 2012 to 2018

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Event Details
August 14, 2012	Flood	N/A	N/A	Showers and thunderstorms increased across central New York during the afternoon of the 14th, as partly sunny skies brought increased instability to the area ahead of a low pressure system tracking from the Ohio Valley into western New York. Only isolated storms produced localized wind damage, with heavy downpours also causing some minor flooding. Heavy rain caused flooding along Route 26 in West Endicott. No property damages were reported.
June 28, 2013	Flash Flood	DR-4129	Yes	A low pressure system acted on a moist and unstable airmass to bring severe thunderstorms to central New York. Ballyhack Creek was out of its banks with flooding on Albany and Canal Streets in Port Crane. Portions of State Route 7B have been washed out. Port Crane reported $20,000 in property damages. In Langdon, Schnurbusch Park flooded, as well as residential yards across the street resulting in $5,000 in property damages.
July 1, 2013	Flash Flood	N/A	N/A	A stationary frontal boundary extending from the Gulf states to the Northeast provided the focus for several rounds of thunderstorms across Central New York. A near tropical environment provided the source for torrential rain in several parts of the region. Route 79 was closed due to water flowing over roadway. Itaska reported $5,000 in property damages.
July 7, 2013	Flash Flood	N/A	N/A	Thunderstorms containing torrential rainfall developed within a warm, humid and considerably unstable environment across upstate NY during the mid to late evening hours. Storms moving over the same locations produced areas of significant flash flooding throughout the central Leatherstocking region and the western Mohawk River valley. Several roads were flooded in the Town of Port Crane resulting in $50,000 in property damages. Water was flowing over roads near the Interstate 88 Port Crane exit and along the intersection of State Route 36 and Pine Street. Flood waters helped to collapse a wall into a creek near a construction site. Chenango Bridge reported $50,000 in property damages.
August 28, 2013	Flash Flood	N/A	N/A	A weak upper level disturbance triggered isolated, slow moving thunderstorms across the region. Oquaga Lake Road washed out due to rapidly flowing water over the road. Oquaga Lake reported $25,000 in property damage.
January 11, 2014	Flash Flood, Ice Jam	N/A	N/A	A brief warm up, accompanied by periods of rain, occurred on January 11th with temperatures rising into the 50s across the region. These conditions melted off the existing snow cover, causing area rivers and streams to swell and release their ice cover into the stream channels. An ice jam on Stratmill Creek caused up to one foot of water, and large ice chunks to spill onto Court Street on the east side of the City of Binghamton, New York. An ice jam caused flood waters to spill into Schneiders Market near the Five Mile Point area. Langdon reported $30,000 in property damages.
May 16, 2014	Flash Flood	DR-4180	No	A slow moving, steady area of heavy rainfall brought 1 to 3 inches of rain to the region, causing areas of flash flooding. Areas in the Finger Lakes region were hardest hit again. Flooding occurred in areas along Route 41 between Sanford and North Sanford, including North Sanford Road, Blowers Road,

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Event Details
				and Wheeler School Road in Sanford resulting in $50,000 in property damages.
July 13, 2014	Flash Flood	N/A	N/A	A weak frontal boundary and a strong upper level disturbance helped develop numerous severe and torrential rain producing thunderstorms. Thunderstorms which repeatedly moved over the same locations along the Southern Tier of New York produced rainfall estimates of 3 to 4 inches in a short amount of time. This resulted in widespread areas of minor urban flooding and isolated flash flooding. Flooding was reported along Old Route 17 and Route 41 near Deposit and Windsor. Several creeks were out of their banks in the area. Sanford reported $25,000 in property damages.
January 8, 2015	Ice Jam	N/A	N/A	A freeze-up in the Chenango River resulted in an ice jam at Chenango Bridge.
May 18, 2015	Flash Flood	N/A	N/A	Clusters of thunderstorms moving through Central New York set up along a west to east corridor across the middle portion of Broome county. These storms produced incredible rainfall rates in excess of 4 inches per hour. Localized rainfall amounts were in the 2 to 3 inch range, and much of this rainfall fell within 1 to 1.5 hours on the evening of May 18th. Several areas of washed over roads and extensive ponding of water were reported throughout the Triple Cities. Water was flowing rapidly down several streets in the Village of Chenango Bridge. Damage occurred on Clarendon Drive, and also at the Chenango Bridge Golf Course where several greens and sand traps were washed out. Water was several inches deep at the Northgate Plaza and other locations on Upper Front Street. Chenango Bridge reported $5,000 in property damages. In Johnson City, water, along with mud and rocks washed over Deyo Hill road near the Town of Dickinson line resulting in $2,000 in property damages. Serious ponding of water in parking lots and water washing over roadways was reported in Port Crane. A small debris flow coming off of a sheer cliff was observed in the Town of Fenton. Port Crane reported $1,000 in property damages. There was extensive street, parking lot and underpass flooding in the City of Binghamton. Binghamton reported $5,000 in property damages.
June 14, 2015	Flash Flood	N/A	N/A	A warm front stalled across New York and northern Pennsylvania, providing the focus for repeating clusters of thunderstorms in the Finger Lakes and Southern Tier NY regions. A tropical-like airmass was in place allowing for a stripe of 2-4 inches of very heavy rain to fall in a narrow band extending from near Watkins Glen to areas north of Binghamton. Severe flash flooding was encountered with numerous roads and culverts destroyed by raging water. In some areas, homes, schools and other businesses were flooded. Cumulative damage estimates across the affected areas were about $10 million dollars.

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Event Details
				Flooding had washed out Daugherty Road, and damaged the Newark Valley-Maine Road. West Corners reported $100,000 in property damages. Numerous roads were flooded in the Colesville area resulting in $100,000 in property damages.
June 28, 2016	Flood	N/A	N/A	A cold front moved into the area during the afternoon. Heavy rain producing thunderstorms brought 4 to 6 inches of rain in less than 3 hours over portions of the Western Catskills in New York. This led to isolated flash flooding and debris flows over several roadways. One to two inches of thunderstorm rainfall caused typical urban flooding in several locations around the Triple Cities, including the railroad underpasses in the City of Binghamton, the Vestal Parkway, and downtown Endicott. Binghamton reported $50,000 in property damages.
April 6, 2017	Flood	N/A	N/A	Rain and melting snow swelled rivers and streams around Central New York during the first week in April. The Susquehanna River flooded in many areas with levels reaching moderate flood stage at Conklin and Vestal. The lake level on Cayuga Lake at Ithaca also reached the moderate flood stage causing high water problems with docks along the lake shore. Moderate flooding occurred along the Susquehanna River near Conklin, NY. The river crested at 15.11 feet on April 7th at 4:00 AM. Langdon reported $25,000 in property damages. Moderate flooding occurred along the Susquehanna River near Vestal, NY. The river crested at 21.99 feet on April 7th at 11:30 AM. Ross Corners reported $40,000 in property damages.
July 14, 2017	Flash Flood	N/A	N/A	A warm front began advancing across Central New York by early in the afternoon. This feature triggered numerous rounds of heavy rain producing thunderstorms from the southern Finger Lakes through the Southern Tier of NY. Localized rainfall amounts were estimated to exceed 3 inches across southern Cortland county. Several storms moved over the same locations, contributing to areas of urban and small stream flash flooding. Flash flooding led to deep flooding on numerous roads and streets within the City and Town of Binghamton. Water was waist deep on Vestal Ave, stranding several people in their vehicles. Stella reported $25,000 in property damages. Numerous roads were flooded by deep water, stranding several people in their vehicles throughout the Town of Vestal and the Village of Johnson City. Ross Corners reported $10,000 in property damages.
July 17, 2017	Flash Flood	N/A	N/A	Warm and humid air was in place across the region as a slow moving frontal system drifted into central New York. An upper level disturbance passed over the frontal boundary during the afternoon, triggering numerous torrential rains producing thunderstorms. Flash flooding developed in several areas, including the larger populated area of Greater Binghamton. Underpasses in the Village of Endicott were flooding out with rapidly moving water. West Endicott reported $8,000 in property damages. Thunderstorms with excessive rainfall rates caused many roads and underpasses to be flooded. Port Crane reported $5,000 in property damages.
July 23, 2017	Flash Flood	N/A	N/A	A stationary front poised in the vicinity of central New York and northeast Pennsylvania was the focus for very warm and moist atmospheric conditions across the region. Heavy rain producing thunderstorms developed during the late afternoon and evening hours as an upper level jet stream punched into the area. Widespread thunderstorms produced swaths of 3 to 4 inches of

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Event Details
				rain in just a few hours' time during the late evening and overnight hours. Rapid rises of area streams and creeks resulted in severe flash flooding for the Nichols, NY and Vestal, NY areas. Heavy rainfall closed several roads in the Binghamton area due to high water collecting within several underpasses and other poor drainage areas. Interstate 81 was down to a single lane due to flooding. Binghamton reported $165,000 in property damages. Flash flooding caused the closure of Route 11 due to high water. Langdon reported $30,000 in property damages. Flash flooding extended across Corbettsville Road. Evacuations of several homes were underway. Corberttsville reported $45,000 in property damages.
July 24, 2017	Flood	N/A	N/A	A stationary front poised in the vicinity of central New York and northeast Pennsylvania was the focus for very warm and moist atmospheric conditions across the region. Heavy rain producing thunderstorms developed during the late afternoon and evening hours as an upper level jet stream punched into the area. Widespread thunderstorms produced swaths of 3 to 4 inches of rain in just a few hours' time during the late evening and overnight hours. Rapid rises of area streams and creeks resulted in severe flash flooding for the Nichols, NY and Vestal, NY areas. The crest of the flood wave along Choconut Creek had reached the Town of Vestal with flooding of structures occurring along Main Street. Vestal reported $130,000 in property damages. Flood waters from Choconut Creek encroached on 11 homes along Richards Ave. Residents were evacuated. Flood waters from Choconut Creek spread into areas around West Hill Road in Vestal Center. Flooding along Choconut Creek continued to spread across roads and into more homes. Two residences were evacuated around this time. Vestal Center reported $410,000 in property damages.
August 13-15, 2018	Flash Flood	DR-4397	Yes	Heavy rainfall from severe storms resulted in severe flash flooding. Roadways were shut down and evacuation of homes took place. Local shelters were opened.

Sources: FEMA 2018; NOAA-NCEI 2018; NYS HMP 2014; SPC 2018; International Levee Performance Database 2019
FEMA Federal Emergency Management Agency
HMP Hazard Mitigation Plan
Mph Miles Per Hour
NCDC National Climatic Data Center
NOAA National Oceanic and Atmospheric Administration
NYS New York State
N/A Not Applicable
SPC Storm Prediction Center
Note: Many sources were consulted to provide an update of previous occurrences and losses; event details and loss/impact information may vary and has been summarized in the above table.

Climate Change Projections

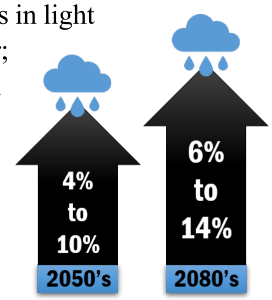
In the Southern Tier region, it is estimated that precipitation totals will increase between 4 and 10% by the 2050s and 6 to 14% by the 2080s (baseline of 35.0 inches, middle range projection). Table 5.4.4-6 displays the projected seasonal precipitation change for the Southern Tier ClimAID Region (NYSERDA 2014).

Table 5.4.4-6. Projected Seasonal Precipitation Change in Region 3, 2050s (% change)

Winter	Spring	Summer	Fall
+5 to +15	0 to +15	-10 to +10	-5 to +10

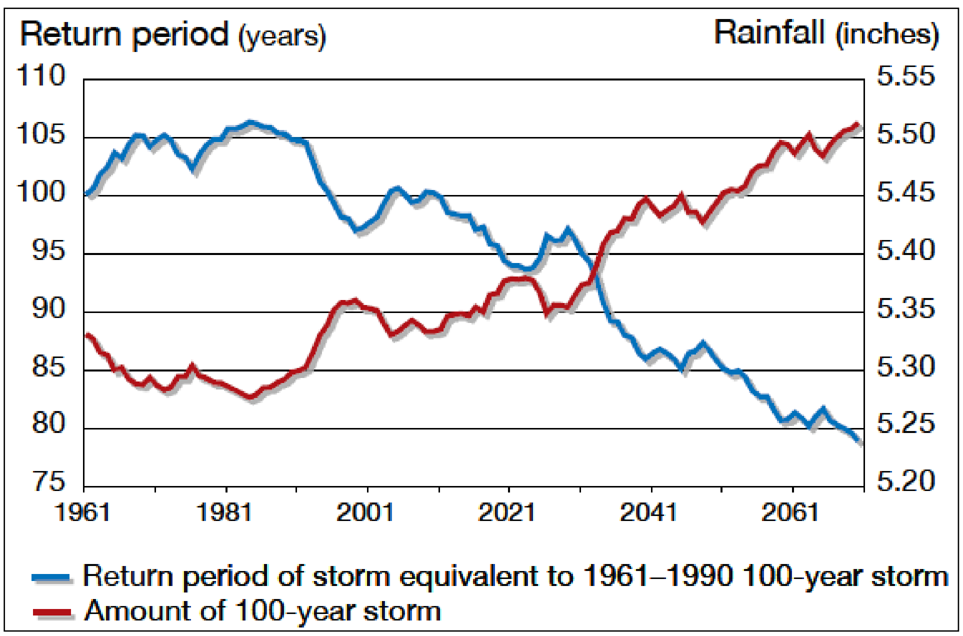
Source: NYSERDA 2011

The projected increase in precipitation is expected to fall in heavy downpours and less in light rains. The increase in heavy downpours has the potential to affect drinking water; heighten the risk of riverine flooding; flood key rail lines, roadways and transportation hugs; and increase delays and hazards related to extreme weather events (NYSERDA 2011).



Increasing air temperatures intensify the water cycle by increasing evaporation and precipitation. This can cause an increase in rain totals during events with longer dry periods in between those events. These changes can have a variety of effects on the State's water resources (NYSERDA 2011). Figure 5.4.4-4 displays the project rainfall and frequency of extreme storms in New York State. The amount of rain fall in a 100-year event is projected to increase, while the number of years between such storms (return period) is projected to decrease. Rainstorms will become more severe and more frequent (NYSERDA 2011).

Figure 5.4.4-4. Projected Rainfall and Frequency of Extreme Storms



Source: NYSERDA 2011

Dams are designed partly based on assumptions about a river's flow behavior, expressed as hydrographs. Changes in weather patterns can significantly affect the hydrograph used for the design of a dam. If the hygrograph changes, the dam conceivably could lose some or all of its designed margin of safety, also known as freeboard. Loss of designed margin of safety increases possibility that floodwaters would overtop the dam or create unintended loads, which could lead to a dam failure.

Probability of Future Occurrences

Based on the historic and more recent flood events in Broome County, and the future climate projections for this region, it is clear that the county has a high probability of future flooding. It is estimated that Broome County will continue to experience direct and indirect impacts of flooding events annually that may induce secondary hazards such as infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, and transportation delays, accidents and inconveniences.

As defined by FEMA, geographic areas within the 1-percent annual chance flood area in Broome County are estimated to have a one-percent chance of flooding in any given year. A structure located within a 1-percent annual chance flood area has a 26-percent chance of suffering flood damage during the term of a 30-year mortgage. Similarly, the 0.2-percent annual chance flood has a 6-percent chance of occurring during a 30-year time period.

Dam failure events are infrequent and usually coincide with events that cause them, such as earthquakes, landslides, and excessive rainfall and snowmelt. However, the risk of such an event increases for each dam as the dam's age increases and/or frequency of maintenance decreases.

According to the NOAA National Climate Data Center (NCDC) and the CRREL database, Broome County experienced 109 flood events between 1950 and 2018, including 43 floods, 49 flash floods, 17 ice jams, and no dam failures. The table below shows these statistics, as well as the annual average number of events and the percent chance of these individual flood hazards occurring in Broome County in future years based on the historic record (NOAA NCDC 2018).

Table 5.4.4-7. Probability of Future Occurrence of Flooding Events

Hazard Type	Number of Occurrences Between 1950 and 2018	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	% chance of occurrence in any given year
Flash Flood	49	0.72	1.41	0.71	71.01%
Flood	43	0.63	1.60	0.62	62.32%
Dam Failure	0	0	0	0	0%
Ice Jams	17	0.25	4.06	0.25	24.64%
Levee Failure	0	0	0	0	0%
TOTAL	**109**	**1.60**	**0.63**	**1.58**	**100%**

Source: NOAA-NCDC 2018; CRREL 2018; NPDP 2018

Climate change is expected to increase the severity and frequency of heavy rain events in Broome County. This is likely to lead to an increase in flooding events, dam failure events, and levee failure events.

In Section 5.3, the identified hazards of concern for Broome County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for flood in the county is considered 'frequent' (hazard event has 100% annual probability and may occur multiple times per year).

5.4.4.2 Vulnerability Assessment

To assess Broome 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 were examined using the 2010 FEMA Preliminary DFIRM to determine the assets located in the hazard areas and to estimate potential loss using the FEMA HAZUS-MH v4.2 model. These results are summarized below. Delineated dam failure inundation areas and areas prone to flash flooding/stormwater flooding were not available for this plan, and their impacts will be discussed qualitatively with the overall impacts to flooding. Refer to Section 5.1 for additional details on the methodology used to assess flood risk.

Impact on Life, Health and Safety

Impacts of flooding on life, health, and safety depend on several factors including severity of the event and whether adequate warning time is provided to residents. Vulnerable populations are all populations residing or located in the floodplain or downstream of dam failures that are incapable of escaping the area within the required timeframe to reach safety. However, exposure should not be limited only to those who reside within a defined hazard zone, but everyone who may be affected by a hazard event (e.g., people are considered at risk if they are traveling in flooded areas, or their access to emergency services is compromised during an event). Flash floods can be localized events that affect areas outside of the floodplain due to localized drainage issues and can directly impact populations and comprise access to emergency services. The degree of that impact varies and is not strictly measurable.

An estimated 15,314 people reside in the 1-percent annual chance event boundary, and 23,527 people within the 0.2-percent annual chance flood boundary. These residents may be displaced by the flooding of their homes, requiring them to seek temporary shelter with friends and family or in emergency shelters. The City of Binghamton has the greatest estimated number of individuals residing in the floodplain—approximately 5,464 and 8,521 people in the 1-percent and 0.2-percent chance events, respectively. The Village of Whitney Point has the highest percentage of population within the 1-percent annual chance floodplain with 22.4 percent of the population living within the floodplain and the Village of Deposit has the highest percentage in the 0.2-percent annual chance floodplain with 38.0 percent of the population living within the floodplain. Table 5.4.4-8 lists population estimates within flood hazard zones by municipality in Broome County.

Table 5.4.4-8. Estimated Population Exposed to the Flood Hazard

Municipality	Total Population	1-Percent Chance Event		0.2-Percent Chance Event	
		Total Number	Percent (%) of Total	Total Number	Percent of Total
Barker (T)	2,732	114	4.2%	128	4.7%
Binghamton (C)	47,377	5,464	11.5%	8,521	18.0%
Binghamton (T)	4,941	0	0.0%	0	0.0%
Chenango (T)	11,252	283	2.5%	599	5.3%
Colesville (T)	5,232	216	4.1%	283	5.4%
Conklin (T)	5,441	947	17.4%	1,420	26.1%
Deposit (V)	819	155	19.0%	311	38.0%
Dickinson (T)	3,637	19	0.5%	84	2.3%
Endicott (V)	13,392	2,394	17.9%	3,492	26.1%
Fenton (T)	6,674	135	2.0%	209	3.1%
Johnson City (V)	15,174	541	3.6%	1,213	8.0%
Kirkwood (T)	5,857	283	4.8%	450	7.7%
Lisle (T)	2,431	51	2.1%	58	2.4%
Lisle (V)	320	67	21.0%	67	21.0%
Maine (T)	5,377	213	4.0%	213	4.0%
Nanticoke (T)	1,672	60	3.6%	137	8.2%
Port Dickinson (V)	1,641	183	11.2%	496	30.3%
Sanford (T)	1,588	46	2.9%	93	5.8%

Table 5.4.4-8. Estimated Population Exposed to the Flood Hazard

Municipality	Total Population	1-Percent Chance Event		0.2-Percent Chance Event	
		Total Number	Percent (%) of Total	Total Number	Percent of Total
Triangle (T)	1,982	5	0.2%	5	0.2%
Union (T)	27,781	2,079	7.5%	2,893	10.4%
Vestal (T)	28,042	1,589	5.7%	2,334	8.3%
Whitney Point (V)	964	216	22.4%	216	22.4%
Windsor (T)	5,358	232	4.3%	269	5.0%
Windsor (V)	916	23	2.5%	37	4.1%
Broome County	**200,600**	**15,314**	**7.6%**	**23,527**	**11.7%**

Sources: FEMA, 2010
Note: *The FEMA DFIRM boundaries were overlaid on the residential buildings from the custom general building stock; the structures with their centroids within the hazard areas were totaled for each municipality. 2010 U.S. Census Average Household Size used to estimate exposed population.*

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 available medical services may be disrupted and as 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.

Approximately 3,275 people over the age of 65 and 5,174 people considered low income are reported within the 1-percent annual chance flood boundary, and approximately 4,200 people over the age 65 and 6,872 people considered low income are reported within the 0.2 percent annual chance flood boundary.

Using 2010 U.S. Census data, HAZUS-MH v4.2 estimates the potential sheltering needs as a result of a 1-percent chance flood event. For the 1-percent flood event, HAZUS-MH v4.2 estimates 18,629 people will be displaced, and 1,402 people will seek short-term sheltering. These statistics are presented in Table 5.4.4-9.

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

Municipality	U.S. Census 2010 Population	1-Percent Annual Chance Event			
		Displaced Population	% Displaced Population	Persons Seeking Short-Term Sheltering	% Persons Seeking Short -Term Sheltering
Barker (T)	2,732	139	5%	1	0%
Binghamton (C)	47,376	5,479	12%	655	1%
Binghamton (T)	4,942	14	0%	0	0%
Chenango (T)	11,252	540	5%	14	0%
Colesville (T)	5,232	266	5%	7	0%
Conklin (T)	5,441	1,247	23%	66	1%
Deposit (V)	819	185	23%	4	0%
Dickinson (T)	3,637	79	2%	0	0%
Endicott (V)	13,392	2,445	18%	249	2%
Fenton (T)	6,674	279	4%	4	0%
Johnson City (V)	15,174	658	4%	34	0%
Kirkwood (T)	5,857	319	5%	5	0%
Lisle (T)	2,431	113	5%	1	0%

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

Municipality	U.S. Census 2010 Population	1-Percent Annual Chance Event			
		Displaced Population	% Displaced Population	Persons Seeking Short-Term Sheltering	% Persons Seeking Short -Term Sheltering
Lisle (V)	320	90	28%	2	1%
Maine (T)	5,377	383	7%	11	0%
Nanticoke (T)	1,672	82	5%	0	0%
Port Dickinson (V)	1,641	271	17%	16	1%
Sanford (T)	1,588	104	7%	0	0%
Triangle (T)	1,982	51	3%	0	0%
Union (T)	27,780	2,891	10%	142	1%
Vestal (T)	28,043	2,367	8%	175	1%
Whitney Point (V)	964	298	31%	7	1%
Windsor (T)	5,358	185	3%	1	0%
Windsor (V)	916	144	16%	8	1%
Broome County	**200,600**	**18,629**	**9%**	**1,402**	**1%**

Source: HAZUS-MH v4.2

Total numbers of injuries and casualties resulting from typical riverine 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 dam failure events or 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; this includes populations downstream of a dam failure event that cannot evacuate within the allowable time frame. The population adversely affected by a dam failure event can also include those beyond the disaster area that rely on the dam for providing potable water Like riverine flooding, economically disadvantaged populations and the elderly are more vulnerable to impacts from a sudden dam failure event or flash flooding.

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, 2017).

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 (CDC 2012)

Current loss estimation models such as HAZUS-MH v4.2 cannot measure public health impacts. The best ways to mitigate these impacts are 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

To assess potential impacts on buildings, both exposure (located in the hazard area) and estimated loss to the exposed inventory generated by HAZUS-MH v4.2 were examined for the 1- and 0.2-percent annual chance flood events. Table 5.4.4-10 and Table 5.4.4-11 summarize these results. There are 7,586 buildings located in 1-percent annual chance flood boundary with an estimated $17 billion of building and contents exposed. In total, this represents approximately 8.6 percent of the county's total general building stock inventory (approximately $199.1 billion). Based on this analysis, the Villages of Lisle and Whitney Point have the greatest percentage of the buildings exposed (both greater than 27 percent); the City of Binghamton has the greatest number of buildings exposed to the 1-percent annual chance flood event (2,658 buildings).

An estimated 11,569 buildings are located in the 0.2-percent annual chance flood boundary with an estimated $26.1 billion of building and contents exposed. This represents approximately 13.1 percent of the county's total general building stock inventory. Based on this analysis, the Village of Deposit has greater than 35 percent of its buildings located in the 0.2-percent annual chance flood hazard area; and the City of Binghamton has the greatest number of buildings in the hazard area (4,124 buildings) when compared to the other municipalities in the county.

Table 5.4.4-10. Estimated General Building Stock Exposure to the 1- Percent Annual Chance Flood Event – All Occupancies

			Total (All Occupancies)			
Municipality	Total # Buildings	Total Replacement Cost Value (Structure and Contents)	# Buildings	% Total	Total Replacement Cost Value (Structure and Contents	% Total
Barker (T)	1,265	$688,813,868	51	4.0%	$23,319,465	3.4%
Binghamton (C)	25,243	$77,847,328,827	2,658	10.5%	$9,393,384,038	12.1%
Binghamton (T)	2,121	$1,228,624,612	1	0.0%	$2,304,377	0.2%
Chenango (T)	5,183	$4,543,298,114	150	2.9%	$167,541,689	3.7%
Colesville (T)	2,476	$2,981,791,633	108	4.4%	$73,831,024	2.5%
Conklin (T)	2,520	$1,795,243,811	500	19.8%	$478,931,227	26.7%
Deposit (V)	468	$459,195,313	96	20.5%	$151,254,752	32.9%
Dickinson (T)	1,446	$1,446,559,666	9	0.6%	$24,523,567	1.7%
Endicott (V)	7,011	$11,814,240,767	1,133	16.2%	$3,191,071,500	27.0%
Fenton (T)	3,166	$1,763,698,720	66	2.1%	$44,010,473	2.5%
Johnson City (V)	7,904	$31,593,599,188	297	3.8%	$611,488,622	1.9%
Kirkwood (T)	2,628	$3,589,691,107	152	5.8%	$264,249,836	7.4%
Lisle (T)	1,108	$568,905,916	26	2.3%	$24,241,351	4.3%
Lisle (V)	135	$107,968,636	37	27.4%	$31,112,928	28.8%
Maine (T)	2,431	$1,702,703,387	93	3.8%	$22,173,808	1.3%
Nanticoke (T)	762	$395,739,757	28	3.7%	$9,505,433	2.4%
Port Dickinson (V)	845	$525,142,613	82	9.7%	$43,555,240	8.3%
Sanford (T)	1,399	$770,815,458	20	1.4%	$7,848,356	1.0%
Triangle (T)	915	$576,956,692	2	0.2%	$1,158,308	0.2%

Municipality	Total # Buildings	Total Replacement Cost Value (Structure and Contents)	Total (All Occupancies) # Buildings	% Total	Total Replacement Cost Value (Structure and Contents	% Total
Union (T)	12,997	$30,465,363,557	1,004	7.7%	$1,393,675,935	4.6%
Vestal (T)	9,532	$21,589,049,741	836	8.8%	$930,019,764	4.3%
Whitney Point (V)	439	$519,433,248	119	27.1%	$190,611,716	36.7%
Windsor (T)	2,685	$1,424,173,576	103	3.8%	$44,928,019	3.2%
Windsor (V)	435	$719,873,967	15	3.4%	$9,786,501	1.4%
Broome County	**95,114**	**$199,118,212,175**	**7,586**	**8.0%**	**$17,134,527,929**	**8.6%**

Source: FEMA 2010, Broome County GIS & Mapping Services
Note: The 1-percent flood boundary was overlaid on the custom general building stock inventory; the structures with their centroids within hazard areas were totaled for each municipality.
Notes:
C City
T Town
V Village

Table 5.4.4-11. Estimated General Building Stock Exposure to the 0.2-Percent Annual Chance Flood Event – All Occupancies

Municipality	Total # Buildings	Total Replacement Cost Value (Structure and Contents)	Total (All Occupancies) # Buildings	% Total	Total Replacement Cost Value (Structure and Contents	% Total
Barker (T)	1,265	$688,813,868	58	4.6%	$31,552,587	4.6%
Binghamton (C)	25,243	$77,847,328,827	4,124	16.3%	$15,314,154,526	19.7%
Binghamton (T)	2,121	$1,228,624,612	1	0.0%	$2,304,377	0.2%
Chenango (T)	5,183	$4,543,298,114	330	6.4%	$498,248,217	11.0%
Colesville (T)	2,476	$2,981,791,633	138	5.6%	$89,704,185	3.0%
Conklin (T)	2,520	$1,795,243,811	720	28.6%	$621,863,553	34.6%
Deposit (V)	468	$459,195,313	167	35.7%	$257,926,626	56.2%
Dickinson (T)	1,446	$1,446,559,666	54	3.7%	$117,870,923	8.1%
Endicott (V)	7,011	$11,814,240,767	1,665	23.7%	$3,637,320,273	30.8%
Fenton (T)	3,166	$1,763,698,720	114	3.6%	$94,709,358	5.4%
Johnson City (V)	7,904	$31,593,599,188	602	7.6%	$782,626,739	2.5%
Kirkwood (T)	2,628	$3,589,691,107	246	9.4%	$395,827,387	11.0%
Lisle (T)	1,108	$568,905,916	30	2.7%	$28,980,386	5.1%
Lisle (V)	135	$107,968,636	37	27.4%	$31,112,928	28.8%
Maine (T)	2,431	$1,702,703,387	93	3.8%	$22,173,808	1.3%
Nanticoke (T)	762	$395,739,757	63	8.3%	$27,519,393	7.0%
Port Dickinson (V)	845	$525,142,613	217	25.7%	$126,105,253	24.0%
Sanford (T)	1,399	$770,815,458	40	2.9%	$14,198,087	1.8%
Triangle (T)	915	$576,956,692	2	0.2%	$1,158,308	0.2%
Union (T)	12,997	$30,465,363,557	1,386	10.7%	$1,722,455,869	5.7%
Vestal (T)	9,532	$21,589,049,741	1,220	12.8%	$2,039,789,168	9.4%
Whitney Point (V)	439	$519,433,248	119	27.1%	$190,611,716	36.7%
Windsor (T)	2,685	$1,424,173,576	119	4.4%	$51,479,697	3.6%
Windsor (V)	435	$719,873,967	24	5.5%	$15,743,123	2.2%
Broome County	**95,114**	**$199,118,212,175**	**11,569**	**12.2%**	**$26,115,436,486**	**13.1%**

Source: FEMA 2010, Broome County GIS & Mapping Services
Note: The 0.2-percent flood boundary was overlaid on the custom general building stock inventory; the structures with their centroids within hazard areas were totaled for each municipality.
Notes:
C City
T Town
V Village

All buildings located within the dam failure inundation areas are considered exposed and potentially vulnerable to a hazard event. The primary impact to buildings would result from the velocity of the water flowing from the dam. Properties located closest to the dam inundation zone have the greatest potential to experience the largest, most destructive surge of water.

The HAZUS-MH v4.2 model estimated potential damages to buildings in Broome County for the 1-percent annual chance flood event. Table 5.4.4-12 summarizes these results. In total, HAZUS-MH v4.2 estimates $4.2 billion in potential building damages, which equates to approximately 2.1 percent of the total county building stock replacement cost value. Potential damage estimated by HAZUS-MH v4.2 to the residential general building stock inventory associated with the 1-percent annual chance flood is approximately $3.0 billion, or 2.0 percent of the total residential building stock replacement cost value and 71.1 percent of the total potential loss for all occupancy classes.

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

Municipality	Total Replacement Cost Value	1% Annual Chance Event							
		All Occupancies		Residential		Commercial		Industrial, Religious, Education and Government	
		Estimated Loss	% of Total	Estimated Loss	% of Total	Estimated Loss	% of Total	Estimated Loss	% of Total
Barker (T)	$688,813,868	$3,536,827	<1%	$3,523,020	<1%	$13,807	<1%	$0	0.0%
Binghamton (C)	$77,847,328,827	$2,409,999,689	3.1%	$2,054,312,979	2.6%	$172,047,371	<1%	$183,639,338	<1%
Binghamton (T)	$1,228,624,612	$1,233,409	<1%	$0	0.0%	$1,233,409	<1%	$0	0.0%
Chenango (T)	$4,543,298,114	$9,151,918	<1%	$4,310,449	<1%	$4,602,698	<1%	$238,772	<1%
Colesville (T)	$2,981,791,633	$29,612,714	1.0%	$4,756,713	<1%	$1,490,902	<1%	$23,365,100	<1%
Conklin (T)	$1,795,243,811	$120,554,657	6.7%	$42,863,587	2.4%	$58,206,931	3.2%	$19,484,139	1.1%
Deposit (V)	$459,195,313	$3,799,803	<1%	$1,645,195	<1%	$1,407,107	<1%	$747,501	<1%
Dickinson (T)	$1,446,559,666	$329,494	<1%	$180,576	<1%	$0	0.0%	$148,918	<1%
Endicott (V)	$11,814,240,767	$796,294,272	6.7%	$662,712,328	5.6%	$70,135,419	<1%	$63,446,524	<1%
Fenton (T)	$1,763,698,720	$4,758,805	<1%	$2,970,313	<1%	$1,788,491	<1%	$0	0.0%
Johnson City (V)	$31,593,599,188	$129,933,126	<1%	$14,361,006	<1%	$80,382,800	<1%	$35,189,320	<1%
Kirkwood (T)	$3,589,691,107	$24,204,418	<1%	$14,407,818	<1%	$4,002,041	<1%	$5,794,558	<1%
Lisle (T)	$568,905,916	$3,952,522	<1%	$1,663,250	<1%	$0	0.0%	$2,289,271	<1%
Lisle (V)	$107,968,636	$3,764,788	3.5%	$1,116,443	1.0%	$389,534	<1%	$2,258,811	2.1%
Maine (T)	$1,702,703,387	$3,392,649	<1%	$3,303,223	<1%	$89,426	<1%	$0	0.0%
Nanticoke (T)	$395,739,757	$381,843	<1%	$367,190	<1%	$14,653	<1%	$0	0.0%
Port Dickinson (V)	$525,142,613	$2,599,378	<1%	$1,972,674	<1%	$626,705	<1%	$0	0.0%
Sanford (T)	$770,815,458	$357,964	<1%	$357,964	<1%	$0	0.0%	$0	0.0%
Triangle (T)	$576,956,692	$222,190	<1%	$222,190	<1%	$0	0.0%	$0	0.0%

Municipality	Total Replacement Cost Value	1% Annual Chance Event							
		All Occupancies		Residential		Commercial		Industrial, Religious, Education and Government	
		Estimated Loss	% of Total	Estimated Loss	% of Total	Estimated Loss	% of Total	Estimated Loss	% of Total
Union (T)	$30,465,363,557	$345,294,556	1.1%	$107,962,826	<1%	$103,187,003	<1%	$134,144,726	<1%
Vestal (T)	$21,589,049,741	$323,867,107	1.5%	$83,169,846	<1%	$195,539,256	<1%	$45,158,005	<1%
Whitney Point (V)	$519,433,248	$17,161,397	3.3%	$4,277,757	<1%	$10,567,580	2.0%	$2,316,060	<1%
Windsor (T)	$1,424,173,576	$5,950,165	<1%	$5,048,225	<1%	$764,126	<1%	$137,814	<1%
Windsor (V)	$719,873,967	$1,377,477	<1%	$532,163	0.1%	$143,143	<1%	$702,171	<1%
Broome County	**$199,118,212,175**	**$4,241,731,167**	**2.1%**	**$3,016,037,734**	**1.5%**	**$706,632,404**	**<1%**	**$519,061,028**	**<1%**

Source: HAZUS-MH v4.2; C: City; T: Town; V: Village

NFIP Statistics

FEMA Region 2 provided a list of NFIP policies, past claims, repetitive loss properties (RL), and severe repetitive loss properties (SRL) in Broome County. According to the metadata provided, "The (*sic* National Flood Insurance Program) NFIP Repetitive Loss File contains losses reported from individuals who have flood insurance through the Federal Government. A property is considered a repetitive loss property when there are "two or more losses reported which were paid more than $1,000 for each loss. The two losses must be within 10 years of each other and be at least 10 days apart. Only losses from (*sic* since) 1/1/1978 that are closed are considered. An SRL property is defined as a residential property covered under an NFIP flood insurance policy, and satisfying either of conditions 1 and 2, as well as condition 3 (Section 1361A of the National Flood Insurance Act 42 *United States Code* 4102a):

1. "At least four NFIP claim payments for the property (including building and contents) over $5,000 each have occurred, and the cumulative amount of such claims payments exceeded $20,000.
2. At least two separate claims payments for the property (building payments only) have occurred, and the cumulative amount of the building portion of such claims exceeded the market value of the building.
3. For either of the above, at least two of the referenced claims must have occurred within any 10-year period and must have occurred more than 10 days apart".

Table 5.4.4-15 summarizes the NFIP policies, claims, and repetitive loss statistics for Broome County. In total, 2,530 residents are NFIP policy holders in the county, and there have been 2,991 claims totaling $135.8 million. Of the 2,530 policies, 1,356 policies (53.6 percent of the total) are located in the floodplain; this may indicate inaccuracies with floodplain mapping or stormwater/localized flooding issues that may not be reflected in the FEMA delineated floodplains. Single-family residences account for approximately 81.4 percent of the total RL properties in Broome County (FEMA 2018). Of the 486 RL properties, 396 are "single-family" residences, 32 are "2-4 family" residences, 13 are "assumed condo" residences, 7 is "other residential," and 38 are "non-residential." There are 11 severe repetitive loss properties in the county, all of which are "single-family" residences. Table 5.4.4-13 and Table 5.4.4-14 summarizes the NFIP RL properties, by occupancy class, in Broome County.

Table 5.4.4-13. Occupancy Class of Repetitive Loss Structures in Broome County

Occupancy Class	Total Number of Repetitive Loss Properties	Total Number of Severe Repetitive Loss Properties	Total (RL + SRL)
Single Family	396	11	407
Assumed Condo	13	0	13
2-4 Family	32	0	32
Other Residential	7	0	7
Non-Residential	38	0	38
Total	**486**	**11**	**497**

Source: FEMA 2018
Notes:
RL and SRL statistics provided by FEMA Region 2, and current as of May 31, 2018.
Statistics summarized using the Community Name provided by FEMA Region 2. Total number of RL properties does not include SRL properties.
Figure only presents municipalities with repetitive loss properties.

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

Municipality	Repetitive Loss Properties					Severe Repetitive Loss Properties				
	2-4 Family	Assumed Condo	Non-Residential	Other Residential	Single Family	2-4 Family	Assumed Condo	Non-Residential	Other Residential	Single Family
Barker (T)	0	0	0	0	0	0	0	0	0	0
Binghamton (C)	6	2	4	4	26	0	0	0	0	0
Binghamton (T)	0	0	1	0	0	0	0	0	0	0
Chenango (T)	0	1	0	0	8	0	0	0	0	0
Colesville (T)	0	0	1	0	13	0	0	0	0	0
Conklin (T)	9	3	13	0	115	0	0	0	0	8
Deposit (V)	2	0	2	1	11	0	0	0	0	0
Dickinson (T)	0	0	0	0	6	0	0	0	0	0
Endicott (V)	1	0	2	0	5	0	0	0	0	0
Fenton (T)	0	0	0	0	7	0	0	0	0	0
Johnson City (V)	1	0	2	0	25	0	0	0	0	0
Kirkwood (T)	1	4	3	0	30	0	0	0	0	1
Lisle (T)	0	0	0	0	1	0	0	0	0	0
Lisle (V)	0	0	0	0	0	0	0	0	0	0
Maine (T)	0	0	0	0	1	0	0	0	0	0
Nanticoke (T)	0	0	0	0	1	0	0	0	0	0
Port Dickinson (V)	0	0	0	0	0	0	0	0	0	0
Sanford (T)	0	0	0	1	2	0	0	0	0	0
Triangle (T)	0	0	0	0	0	0	0	0	0	0
Union (T)	10	3	8	1	65	0	0	0	0	1
Vestal (T)	2	0	2	0	69	0	0	0	0	1
Whitney Point (V)	0	0	0	0	1	0	0	0	0	0
Windsor (T)	0	0	0	0	8	0	0	0	0	0
Windsor (V)	0	0	0	0	2	0	0	0	0	0
Broome County	**32**	**13**	**38**	**7**	**396**	**0**	**0**	**0**	**0**	**11**

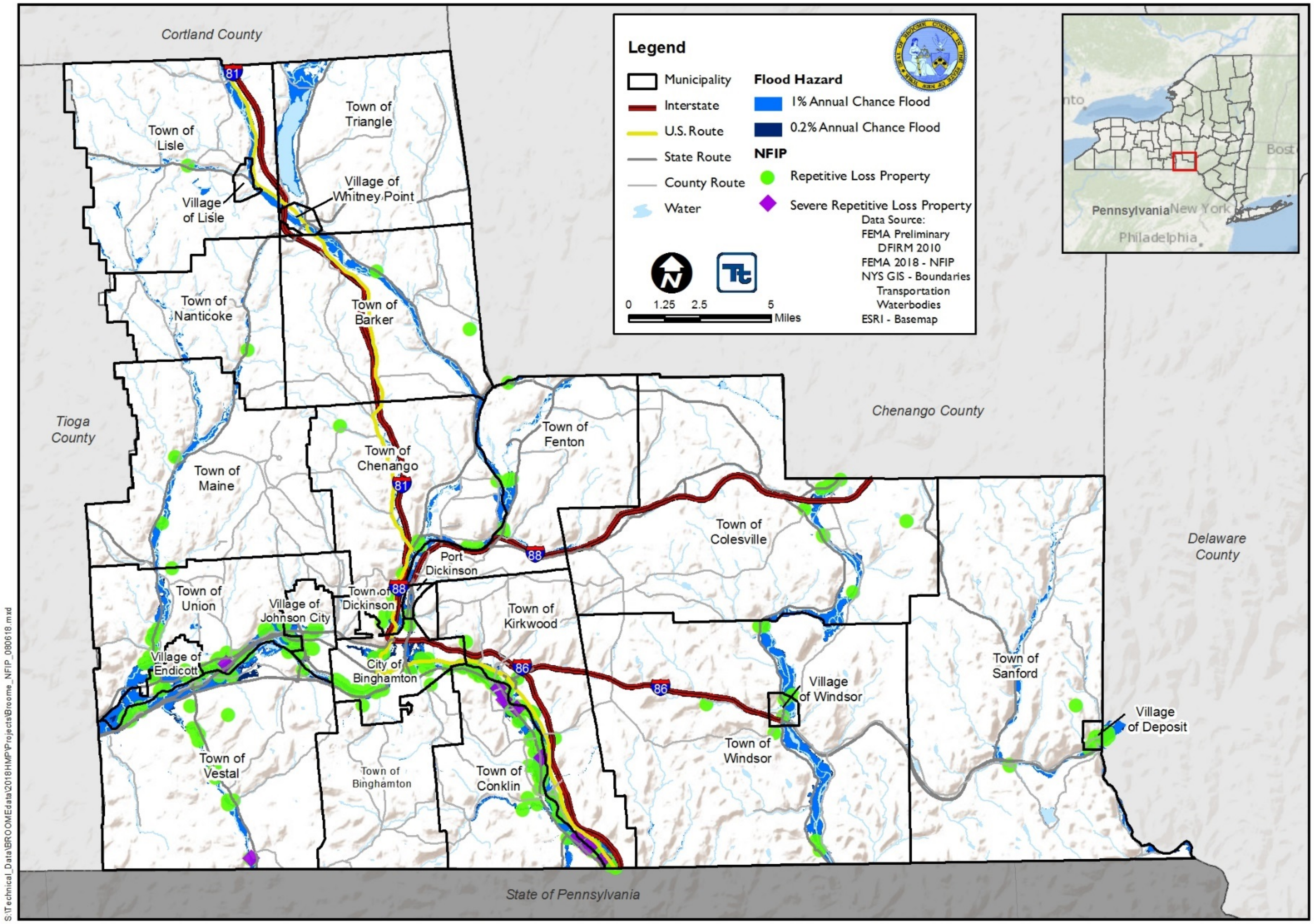
Source: FEMA 2018
Notes:
RL and SRL statistics provided by FEMA Region 2, and current as of May 31, 2018.
Statistics summarized using the Community Name provided by FEMA Region 2. Total number of RL properties does not include SRL properties.
C City
T Town
V Village

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

Municipality	# Policies	# Claims	Total Loss	# Rep.	# Severe Rep.	# Policies in the
Barker (T)	9	17	$83,242	0	0	6
Binghamton (C)	399	299	$16,591,799	42	0	201
Binghamton (T)	8	6	$148,564	1	0	0
Chenango (T)	111	81	$1,977,608	9	0	32
Colesville (T)	49	69	$1,608,140	13	0	17
Conklin (T)	285	741	$35,956,107	137	8	191
Deposit (V)	94	38	$1,185,236	16	0	83
Dickinson (T)	32	42	$1,077,186	6	0	12
Endicott (V)	93	76	$3,724,023	8	0	51
Fenton (T)	38	37	$318,937	6	0	11
Johnson City (V)	289	185	$13,954,272	28	0	155
Kirkwood (T)	62	205	$7,914,451	36	1	35
Lisle (T)	9	4	$17,449	1	0	2
Lisle (V)	1	1	$7,958	0	0	1
Maine (T)	32	21	$702,004	1	0	9
Nanticoke (T)	9	4	$64,181	1	0	1
Port Dickinson (V)	28	21	$445,259	0	0	10
Sanford (T)	34	22	$256,442	3	0	3
Triangle (T)	0	1	$3,427	0	0	0
Union (T)	388	578	$24,241,637	87	1	210
Vestal (T)	518	476	$24,072,693	73	1	319
Whitney Point (V)	4	0	$0	1	0	1
Windsor (T)	23	57	$1,371,857	7	0	4
Windsor (V)	15	10	$112,819	2	0	3
Broome County	**2,530**	**2,991**	**$135,835,292**	**478**	**11**	**1,356**

Source: *FEMA Region 2, 2018*
(1) *Policies, claims, repetitive loss and severe repetitive loss statistics provided by FEMA Region 2 and are current as of 05/31/2018.*
The total number of repetitive loss properties does not include the severe repetitive loss properties. The number of claims represents claims closed by 05/31/2018.
(2) *Total building and content losses from the claims file provided by FEMA Region 2.*
(3) *The policies inside and outside of the flood zones is based on the latitude and longitude provided by FEMA Region 2 in the policy file.*
Notes: *FEMA noted that where there is more than one entry for a property, there may be more than one policy in force or more than one GIS possibility.*
A zero percentage denotes less than 1/100th percentage and not zero damages or vulnerability as may be the case.
Number of policies and claims and claims total exclude properties located outside county boundary, based on provided latitude and longitude.

Figure 5.4.4-5. NFIP Repetitive Loss Properties – Broome County



Source: FEMA Region 2, 2018

Impact on Critical Facilities

It is important to determine the critical facilities and infrastructure within the county that may be at risk to flooding (riverine, dam failure, flash/stormwater 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. Utilities such as overhead power, cable, and phone lines could also be vulnerable due to utility poles damaged by standing water or the surge of water from a dam failure event. Loss of these utilities could create additional isolation issues for the inundation zones.

Major roadways that may be impacted by the 1-percent annual chance flood event include I-88, I-81, I-86, NY-17, NY-12, NY-201, NY-26, NY-41, NY-7, NY-41, NY-363, NY-992E, NY-990F, NY-990G, NY-990J, NY-991C, NY-434, and US-11. Bridges washed out or blocked by floods or debris also can cause isolation. Water and sewer systems can be flooded or backed up, causing health problems. 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.

Critical facility exposure to the flood hazard was examined. In addition, HAZUS-MH v4.2 was used to estimate the flood loss potential to critical facilities exposed to the flood risk. Table 5.4.4-16 summarizes these results.

Table 5.4.4-16. Critical Facility Types Located in the 1- and 0.2-Percent Annual Chance Event Floodplain and Estimated Damage

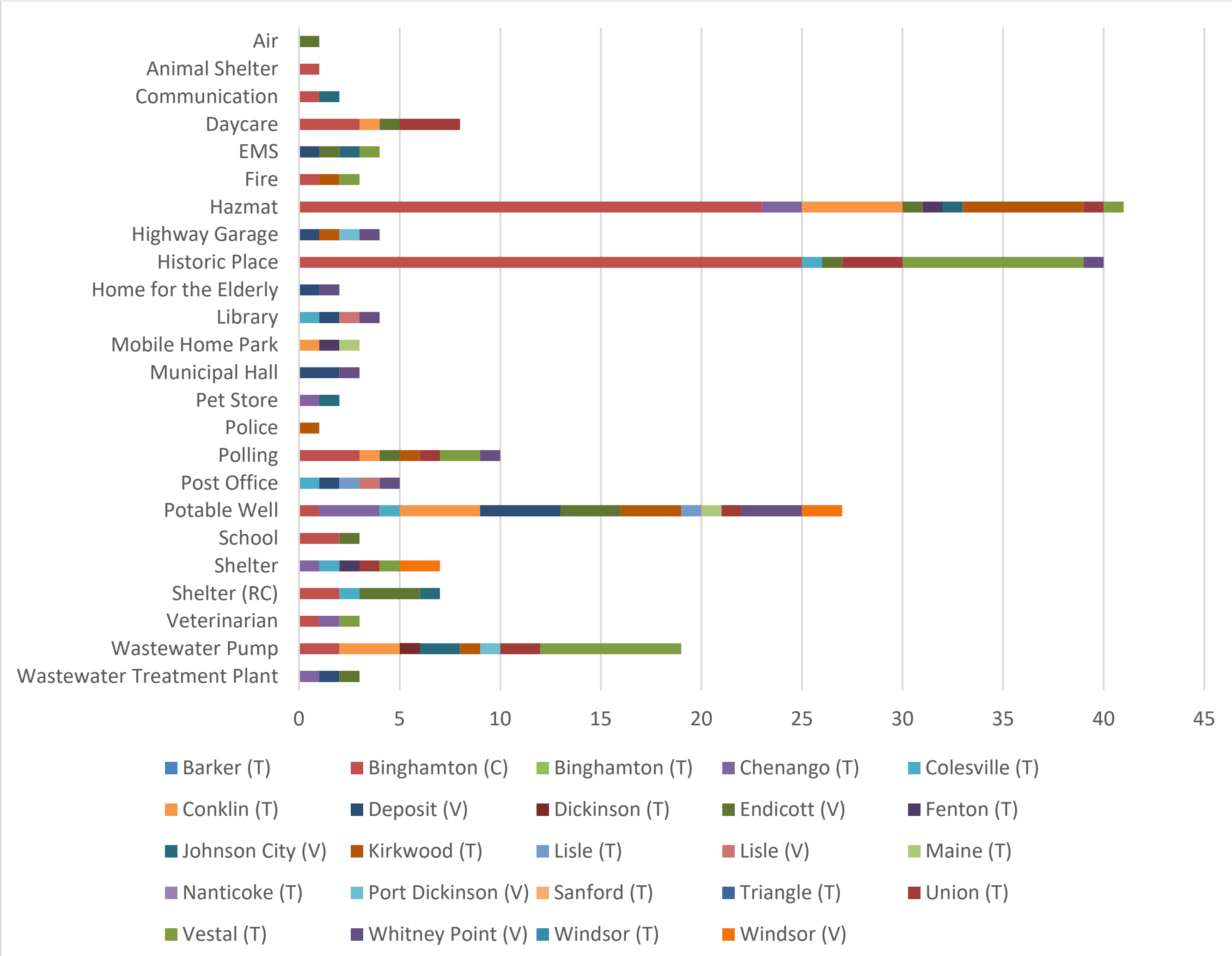
Facility Type	Number of Facilities Located in the 1-Percent Annual Chance Event	Number of Facilities Located in the 0.2-Percent Annual Chance Event	Average % of Total Value Damaged (1-percent Annual Chance Event)	
			Structure	Content
Airport	1	1	0	0
Animal Shelter	1	2	None Estimated	None Estimated
Bridge	165	198	None Estimated	None Estimated
Communications	2	5	None Estimated	None Estimated
County	0	6	None Estimated	None Estimated
Daycare	8	14	22.1	25.6
DPW	4	7	None Estimated	None Estimated
EMS	4	5	4.8	11.2
Fire	3	6	11.2	33.8
Hazardous Materials	41	72	None Estimated	None Estimated
Historic	40	50	8.8	18.7
Library	4	4	0.0	0.0
Medical	0	1	None Estimated	None Estimated
Mobile Home Park	3	8	0.0	0.0
Municipal Hall	3	6	None Estimated	None Estimated
Pet Store	2	2	0.0	0.0
Police Station	1	2	21.1	36.3

Facility Type	Number of Facilities Located in the 1-Percent Annual Chance Event	Number of Facilities Located in the 0.2-Percent Annual Chance Event	Average % of Total Value Damaged (1-percent Annual Chance Event)	
			Structure	Content
Polling	10	16	1.4	7.4
Post Office	5	7	2.3	1.8
Potable	0	1	None Estimated	None Estimated
Potable Well	27	32	11.8	-
School	3	3	5.5	34.8
Senior	2	2	0.0	0.0
Shelter	7	10	0.0	0.0
Shelter (RC)	7	9	0.0	0.0
Veterinarian	3	5	0.1	0.1
Wastewater Pump	19	24	20.0	-
Wastewater Treatment Facility	3	3	None Estimated	None Estimated
Total/Average	**368**	**501**	**6.4**	**11.3**

Source: Broome County GIS & Mapping Services; FEMA 2010; HAZUS-MH v4.2

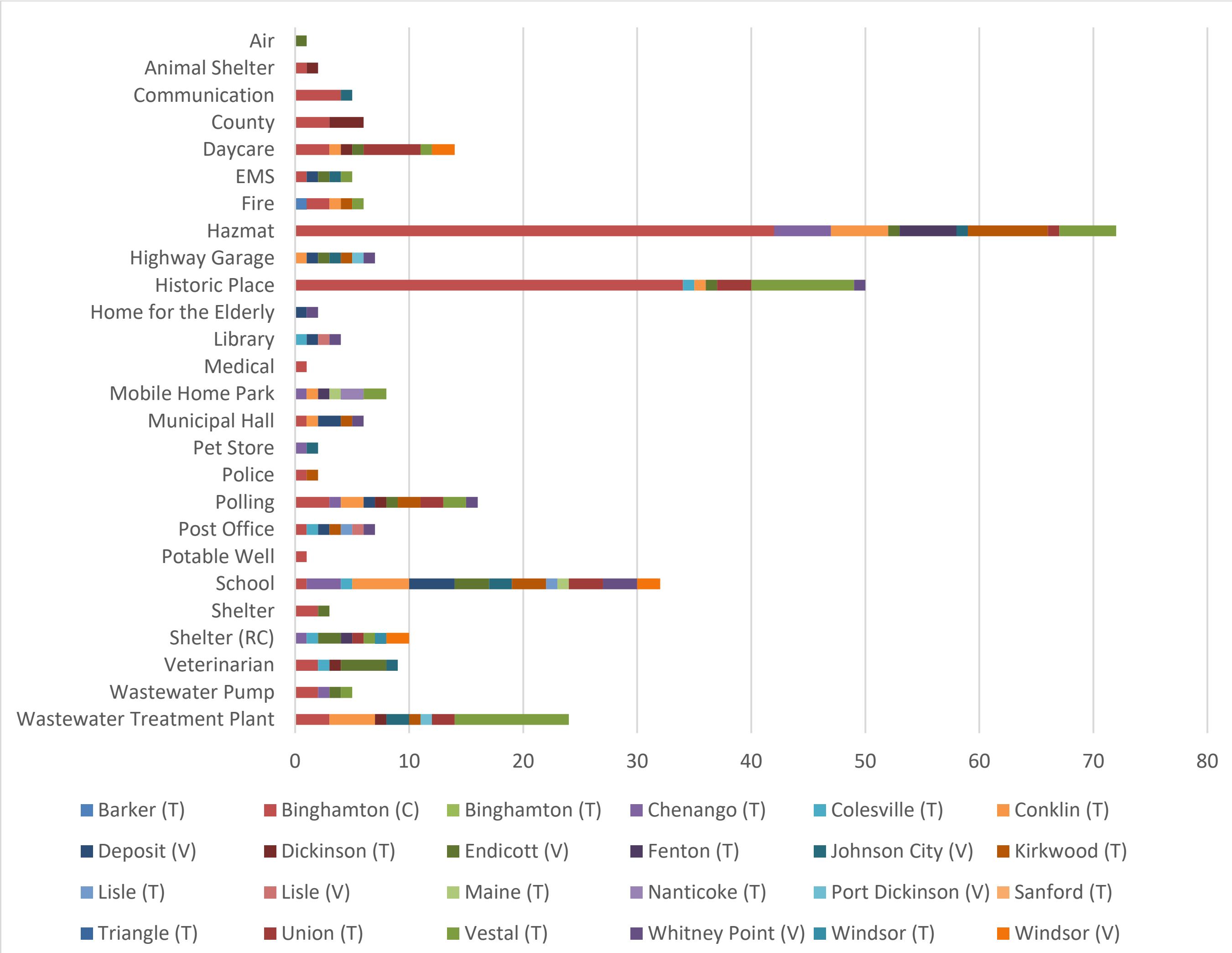
Figure 5.4.4-6 and Figure 5.4.4-7 display the distribution of critical facilities in the 1- and 0.2-percent annual chance flood event boundaries; due to the number of bridges located in the floodplain, they were omitted from the figures.

Figure 5.4.4-6. Distribution of Critical Facilities in the 1-Percent Annual Chance Flood Event Floodplain by Type and Municipality



Sources: FEMA 2010; Broome County GIS & Mapping Services
Notes:
C: City T: Town V: Village

Figure 5.4.4-7. Distribution of Critical Facilities in the 0.2-Percent Annual Chance Flood Event Floodplain by Type and Municipality



Sources: FEMA 2010; Broome County GIS & Mapping Services
Notes:
C: City T: Town V: Village

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 the 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. As presented in Figure 5.4.4-6, 368 critical facilities are exposed and potentially vulnerable to the 1-percent annual chance flood event.

Debris management may also be a large expense after a flood event. HAZUS-MH v4.2 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 5.4.4-17 summarizes the HAZUS-MH v4.2 countywide debris estimates for the 1-percent annual chance flood event. Note: 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 5.4.4-17. Estimated Debris Generated from the 1-Percent Flood Event

Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
137,350.5	72,424.1	36,587.3	28,339.1

Source: HAZUS-MH v4.2

Impact on the Environment

Floodplains serve beneficial and natural functions on ecological, environmental, social, and economic levels. Areas in the floodplain that typically provide these natural functions and benefits are wetlands, riparian areas, sensitive areas, and habitats for rare and endangered species. Floods, however, can also lead to negative impacts on the environment. Disruption of natural systems and the benefits they provide can have long-term consequences for entire regions. According to FEMA, well-known, water-related functions of floodplains include the following:

- Natural flood and erosion control
- Provide flood storage and conveyance
- Reduce flood velocities
- Reduce flood peaks
- Reduce sedimentation
- Surface water quality maintenance
- Process organic wastes
- Moderate temperatures of water
- Groundwater recharge
- Filter nutrients and impurities from runoff
- Promote infiltration and aquifer recharge
- Reduce frequency and duration of low-surface flows

Future Changes that May Impact Vulnerability

Understanding future changes that impact vulnerability in the county can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. 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

Any areas of growth could be impacted by the flood hazard if located in the floodplain. According to recent development data provided by the county, 58 parcels developed in the last 5 years are located in the 1- and 0.2-percent annual chance flood hazard areas; 40 of which are located within the 1-percent annual chance flood hazard area. During the past 5 years, 18 parcels were developed in the Town of Union representing the highest rate of development in the floodplain in the county, 12 of which are located in the 1-percent annual chance flood event boundary. The City of Binghamton, Towns of Chenango, Conklin, Fenton, Kirkwood, and Vestal, and the Villages of Deposit, Johnson City, Port Dickinson, and Windsor have at least 1 development located within the 0.1 or 0.2-percent annual chance flood event boundary. Information was not available regarding any mitigation measures at these locations.

Broome County GIS & Mapping Services conducted a developable land analysis to determine potential locations for relocating homes out of hazard areas or building homes once properties in hazard areas have been acquired. This analysis is intended to provide an initial indication of possible areas to develop in the event that developed areas in the County are impacted by a hazard incident that would require permanent relocation of development, in which case each site would be further evaluated for suitability for development. The criteria for determining potential locations is detailed in Section 4.6.8 (Housing and Relocation) in the County Profile. The spatial layers used to determine potential locations for development were used to calculate a percent of developable area for each vacant parcel; parcels with a percentage greater than zero were considered "developable." Of the 15,751 vacant parcels, 14,802 are potentially developable. A total of 2,118 parcels are exposed to the 1-percent annual chance flood event; the Town of Union has the greatest number of parcels exposed with 358 of its 1,468 parcels (24.4%). A total of 2,377 parcels are exposed to the 0.2-percent annual chance flood event; the Town of Union has the greatest number of parcels exposed with 385 of its 1,468 parcels (26.2%).

Projected Changes in Population

According to population projections from the Cornell Program on Applied Demographics, Broome County will experience a continual population decrease through 2040 (over 17,400 people in total by 2040). While less people will reside in the county, those that remain may move into locations that are more susceptible than others. This includes areas that are directly impacted by flood events and those that are indirectly impacted (i.e., isolated neighborhoods, flood-prone roadways, etc.). Refer to Section 4.4.2, Population Trends in the County Profile, for additional discussion on population trends.

Climate Change

As discussed earlier, 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 (NYSERDA 2014). 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.

Change of Vulnerability Since the 2013 HMP

Updated FEMA DFIRM data has not been released for Broome County since the 2013 HMP. The depth grid generated for the 2013 HMP was utilized for this plan update as well; localized flood studies for the portions of the Chenango River and Lower Choconut Creek were used to update those reaches of the original depth grid. An updated general building stock was generated using updated County GIS and tax assessor data and 2018 RS Means valuations, and an updated critical facility inventory was generated using update inventories from Broome County. Due to differences in the data used to assess flood risk (i.e., updated critical facility inventories), a direct comparison between plan vulnerability assessment results could not be conducted to determine whether there has been a change over time.

Overall, the vulnerability assessment presented uses a more accurate and updated building inventory, which provides more accurate exposure and potential loss estimates for Broome County. Broome County and its municipalities continue to be vulnerable to the flood hazard; however, progress has been made to decrease vulnerability. Mitigation measures undertaken by each jurisdiction are described in the jurisdictional annexes in Section 9 of this HMP.

Identified Issues

The County and municipalities are experiencing the development within vulnerable areas and should encourage higher regulatory standards on the local level. Specific areas of development are indicated in tabular form in the jurisdictional annexes in Volume II, Section 9 of this plan update.

A significant number of communities have a high population exposed to flooding, with the Villages of Whitney Point and Lisle each having greater than 20% population exposed to. Similarly, these communities have a considerable number of structures vulnerable to flooding.

The Village of Lisle has the highest need for temporary housing (28% population) in the event of a one percent chance flood event occurrence.