5.4.5 Flood

The following section and vulnerability assessment of the flood hazard for Monroe County.

5.4.5.1 Hazard 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 2019), 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-break floods
- Local draining or high groundwater levels
- Fluctuating lake levels
- Ice-jams
- Coastal flooding
- Urban flooding

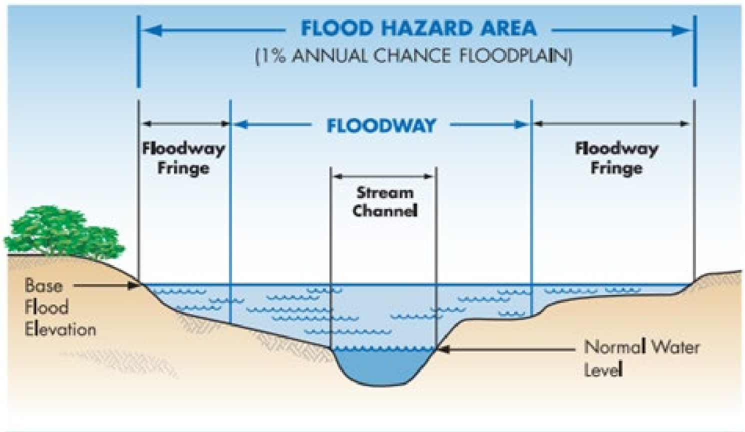
For the purpose of this HMP and as deemed appropriate by the Monroe County Steering Committee, the main flood types of concern discussed in this section include: riverine, flash, stormwater/urban, lakeshore, ice jam, and dam failure flooding. In addition, coastal erosion is considered as a cascading hazard in the coastal areas. These types of floods are further discussed below.

Riverine 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 (Illinois Association for Floodplain and Stormwater Management 2006)

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 Monroe County, floodplains line the rivers and streams of the County and the lakeshore areas. The boundaries of the floodplains are altered as a result of changes in land use, the amount of impervious surface, placement of obstructing structures in floodways, changes in precipitation and runoff patterns, improvements in technology for measuring topographic features, and utilization of different hydrologic modeling techniques. Figure 5.4.5-1 depicts the flood hazard area, the flood fringe, and the floodway areas of a floodplain.

Figure 5.4.5-1. Illustration of a Floodplain



Source: NJDEP 2015

Flash Flooding

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 riverbeds, 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 2009).

Stormwater/Urban Flooding

Stormwater/urban 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 a long period of above-average precipitation (FEMA 1997).

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

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

Coastal/Lakeshore Flooding, Seiches, and Erosion

Great Lakes storms can occur any time of the year and at varying levels of severity. Natural protective features within coastal erosion hazard areas provide buffering and protection to shorelines from erosion. Dunes and bluffs are effective against storm-induced high water and related wave action (NYS DHSES 2019).

Wind and weather conditions on the Great Lakes may create a seiche, an oscillating wave which can be several feet high. In many of the Great Lakes, the time period between the "high" and "low" of a seiche may be between 4 and 7 hours. As this is similar to the 6-hour time period of the tides on the ocean, it is frequently mistaken for a tide.

Coastal/lakeshore flooding may cause beach erosion; loss or submergence of wetlands and other coastal ecosystems; high water tables; loss of coastal recreation areas, beaches, protective sand dunes, parks, and open space; and loss of coastal structures. Coastal structures can include sea walls, piers, bulkheads, bridges, or buildings (FEMA 2011).

There are several forces that occur with coastal/lakeshore flooding:

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

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

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

As waves approach a shoreline, they crest and break, losing some initial energy. The remaining wave runs up the beach before pulling back down. Depending on the size of the wave, angle of wave "attack," and the wave period, waves can cause erosion or accretion of sediment. Seasonal high temperatures and seiches contribute to elevated lake levels allowing larger waves to reach the shoreline. Greater water depths near shore also result in less loss of wave energy from shoaling.

Elevated lake levels contribute to higher rates of coastal erosion. Higher lake levels will magnify the reach of currents and wave action. Unlike oceans which have tides, the Great Lakes are considered to be non-tidal and experience change in water levels primarily because of meteorological effects. Water levels in the Great Lakes have long-term, annual, and short-term variations. Long-term variations depend on precipitation and water storage over many years. Annual variations occur with the changing seasons with an annual high in the late spring and a low in the winter. These changes occur at a rate that can be measured in feet per month (NOAA 2020).

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 2019).

> 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.

Dam Failure Flooding

A dam is an artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material for the purpose of storage or control of water (FEMA 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). Dams can fail for one or a combination of the following reasons:

- Overtopping caused by floods that exceed the capacity of the dam (inadequate spillway capacity 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 2007).

A break in a dam can produce extremely dangerous flood situations because of the high velocities and large volumes of water released by such a break. Sometimes they can occur with little to no warning. Breaching of dams often occurs within hours after the first visible sign of dam failure, leaving little or no time for evacuation (FEMA 2007).

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 Monroe County is described in the subsections below.

Floodplains

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 Monroe County, floodplains line the rivers, streams, and lakeshores 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 (NJAFM 2015).

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 2020). The 1-percent annual chance floodplain establishes the area that has flood insurance and floodplain management requirements.

Figure 5.4.5-2. Flood Map Terms

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

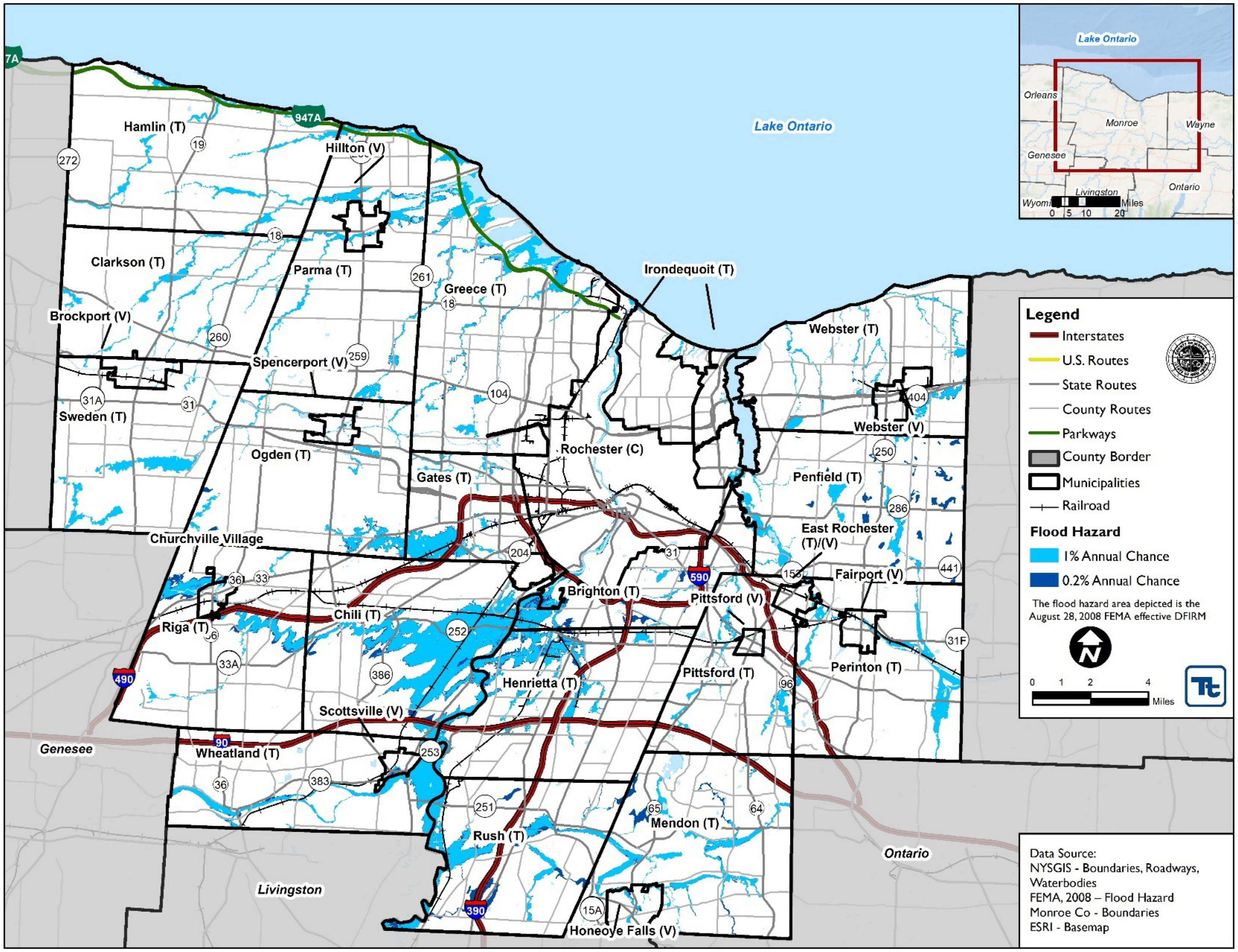
Locations of flood zones in Monroe County as depicted on the FEMA preliminary Digital Flood Insurance Rate Map (DFIRM) are illustrated in, Figure 5.4.5-3 and the total land area in the floodplain, inclusive of waterbodies, is summarized in Table 5.4.5-1. Refer to Section 9 for a map of each jurisdiction depicting the floodplains. Flood hazard zones occur throughout the County.

Table 5.4.5-1. Number of Acres Monroe County Is Exposed to 1-Percent and 0.2-Percent Annual Chance Flood

Jurisdiction	Total Acres of Land Area	Total Acres of Land Area (Excluding Waterbodies) Located in the Flood Hazard Areas			
		Total Acres Located in the 1-Percent Annual Chance Flood Event	Percent of Total	Total Acres Located in the 0.2-Percent Annual Chance Flood Event	Percent of Total
Brighton (T)	9,868	879	8.9%	1,402	14.2%
Brockport (V)	1,375	26	1.9%	26	1.9%
Chili (T)	25,234	5,967	23.6%	6,681	26.5%
Churchville (V)	743	57	7.6%	89	11.9%
Clarkson (T)	21,170	1,114	5.3%	1,130	5.3%
East Rochester (T/V)	837	28	3.3%	29	3.4%
Fairport (V)	1,002	66	6.5%	71	7.1%
Gates (T)	9,740	1,324	13.6%	1,434	14.7%
Greece (T)	30,096	2,714	9.0%	3,001	10.0%
Hamlin (T)	27,493	1,442	5.2%	1,443	5.2%
Henrietta (T)	22,578	2,250	10.0%	2,856	12.6%
Hilton (V)	1,119	78	6.9%	89	8.0%
Honeoye Falls (V)	1,621	147	9.0%	178	11.0%
Irondequoit (T)	9,626	204	2.1%	211	2.2%
Mendon (T)	23,684	1,672	7.1%	2,156	9.1%
Ogden (T)	22,551	1,164	5.2%	1,372	6.1%
Parma (T)	25,575	1,563	6.1%	1,727	6.8%
Penfield (T)	23,840	1,615	6.8%	2,292	9.6%
Perinton (T)	20,874	1,335	6.4%	1,352	6.5%
Pittsford (T)	14,399	798	5.5%	852	5.9%
Pittsford (V)	449	5	1.2%	5	1.2%
Riga (T)	21,706	1,204	5.5%	1,572	7.2%
Rochester (C)	22,860	565	2.5%	681	3.0%
Rush (T)	19,410	1,966	10.1%	2,804	14.4%
Scottsville (V)	615	45	7.3%	80	13.0%
Spencerport (V)	813	42	5.1%	52	6.4%
Sweden (T)	20,200	1,145	5.7%	1,146	5.7%
Webster (T)	20,270	1,327	6.5%	1,449	7.1%
Webster (V)	1,392	4	0.3%	7	0.5%
Wheatland (T)	18,892	2,124	11.2%	2,254	11.9%
Monroe County (Total)	**420,035**	**32,866**	**7.8%**	**38,442**	**9.2%**

Source: FEMA 2008; Monroe County GIS 2022
Note: C = City, T = Town, V = Village, % = Percent

Figure 5.4.5-3. FEMA Flood Hazard Areas in Monroe County



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. USGS uses stream gages to determine the severity of flood at different points along a body of water. There are numerous gages in Monroe County, in addition to others just outside of the County's boundary, that provide critical flood data for waterways affecting the County.

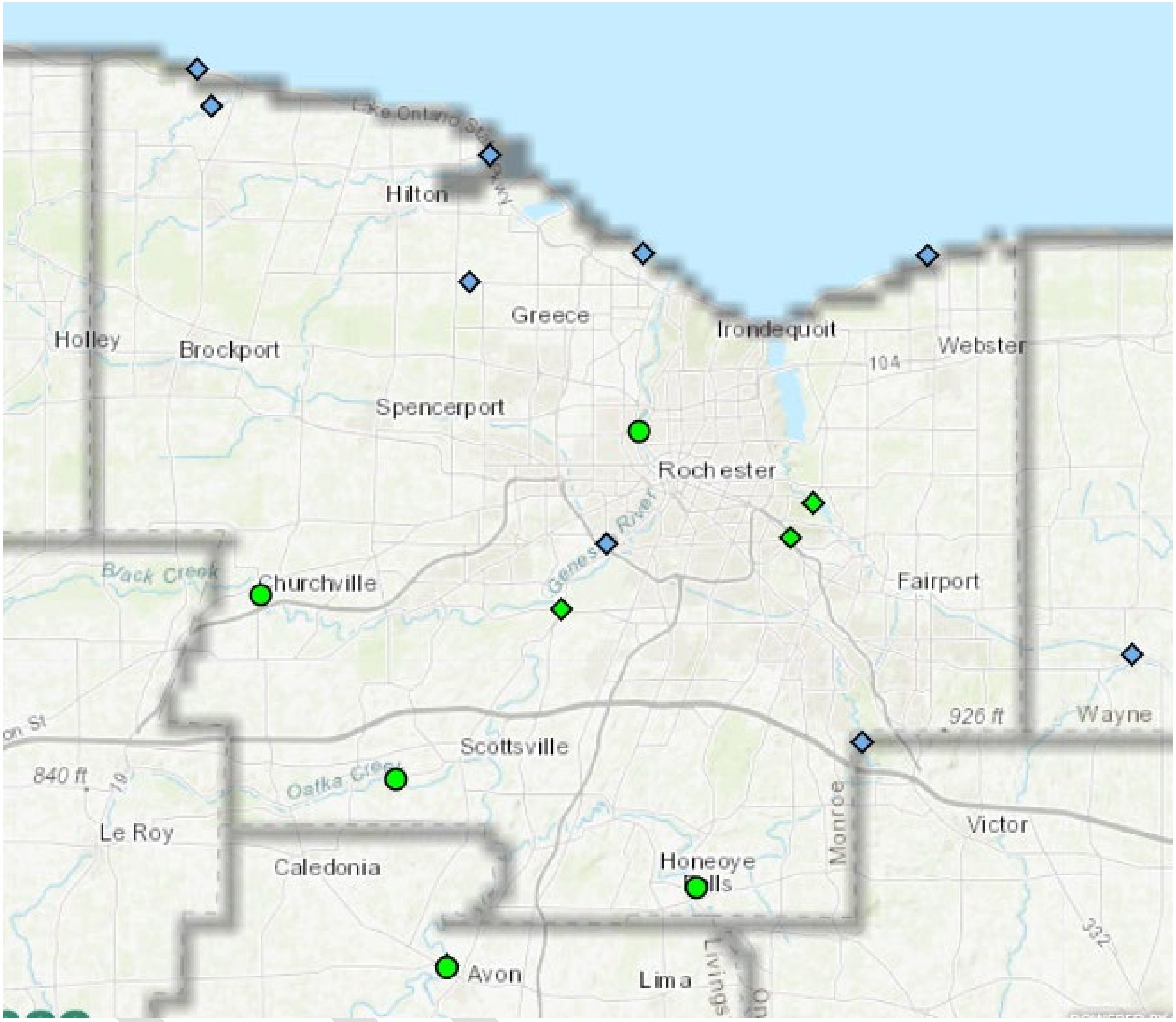
There are 10 stream gages in the County and 4 gages on Lake Ontario. Table 5.4.5-2 shows the stream gages in the County and details about each gage. The USGS website provides details about each of the gages (https://waterwatch.usgs.gov/index.php) and the gage heights of flooding events. The NWS provides the different flood stages for the gages (https://water.weather.gov/ahps/).

Table 5.4.5-2. Gages in Monroe County

Gage Site Number	Site Name	Flood Stage Height	Record Flood Height
04220223	Sandy Creek at North Hamlin	Unavailable	14.79
0422026250	Northrup Creek at North Greece	Unavailable	5.01
04232050	Allen Creek at Rochester	5	Unavailable
04231000	Black Creek at Churchville	6	9.44
04232040	Irondequoit Creek at Railroad Mills	8	Unavailable
04232042	Irondequoit Creek at Rochester	Unavailable	Unavailable
04228500	Genesee River at Rochester	15	24.50
04232000	Genesee River at South Rochester	17	Unavailable
04229500	Honeoye Creek at Honeoye Falls	6.5	8.42
04230500	Oatka Creek at Garbutt	6	8.64

Source: FEMA FIS 2022; NWS 2022; USGS 2022

Figure 5.4.5-4. Stream Gages in Monroe County



Source: NWS 2022

Riverine Flooding

Riverine flooding is most severe around major creeks and riverbeds, including Red Creek, Black Creek, Oatka Creek, Honeoye Creek, Irondequoit Creek, Allens Creek, and the Genesee River. According to the County's FIS, major floods can occur on Irondequoit Creek and lower Genesee River any time of year, although most result from heavy rainfall or snowmelt in the basin. Flood problems along the Genesee River are most visible in low-lying areas, and high water periodically will inundate primary residences and vacation homes. Tropical Storm Agnes caused the largest flood on the lower Genesee River since the Mount Morris Dam began operations in 1951 (FEMA 2008).

Additionally, the Lower Black Creek (from Churchville to the river) is a very large and wide floodplain, and the area floods often. According to Monroe County Department of Health, this vulnerability is detailed in a USACE report from the 1950s. Smaller magnitude flooding can occur in the Red Creek basin in Henrietta and Rush; the lack of relief in many of these areas hinders drainage so that it frequently backs up when large amounts of water hit. Ellison Park in Brighton undergoes routine flooding as well; however, that is due to its location in the floodplain.

Lastly, a spot on Irondequoit Creek, in Perinton, has been noted as problematic, and there is concern over canal maintenance operations. These maintenance operations open bottom manholes during the winter to facilitate repairs, creating additional discharges. The additional discharges, while relatively small (<20 cubic feet per second [cfs]) take up storage in stream channels that could be hit with melt off discharges (FEMA 2008).

Flash Flooding

Flash flooding can occur throughout any region of NYS; however, the distinctive flash flood event characterized by fast moving water and damaging impacts requires a steep topography. While Monroe County could undergo flash floods (and has, in the past), the County is at a lower risk than other parts of the State for this type of flood event (NYS DHSES 2019).

Stormwater/Urban Flooding

Stormwater/urban flooding is not mapped by the State or FEMA but is most likely to occur in highly developed areas with high percentages of impervious coverage that contribute to high rates of runoff. Locations that have undersized stormwater components or stormwater components that are prone to becoming clogged or failing often experience stormwater flooding.

Coastal/Lakeshore Flooding, Seiches, and Erosion

The south shore of Lake Ontario is the only major coastline in the County, and thus the County's only scene of notable lakeshore flooding. Monroe County contains 36.5 miles of Lake Ontario shoreline, which increases residential risk from erosion and wave action, threatens local infrastructure, compromises sensitive environmental features, and contributes to general flooding events. Moreover, the geography along Lake Ontario increases likelihood of training thunderstorms (i.e., thunderstorms repeatedly moving across the same area), particularly along Lake Breeze Fronts.

Water levels in the Great Lakes have long-term, annual, and short-term variations. Long-term variations depend on precipitation and water storage over many years. Annual variations occur with the changing seasons with an annual high in the late spring and a low in the winter. These changes occur at a rate that can be measured in feet per month (NOAA 2020). Most damaging floods from Lake Ontario occur when lake levels are high or during severe storms. Both scenarios create a temporary rise in the lake level and wave run-ups. Although these floods may occur throughout the year, they are most probable during spring (FEMA 2008).

Coastal Erosion Hazard Area

The coastline of Lake Monroe is designated by NYS DEC as an area at risk to coastal erosion from natural and human activities and is therefore regulated. NYS DEC has two programs focused on the protection of coastal erosion: Coastal Erosion Hazard Area (CEHA) permit program and the United States Army Corps of Engineers (USACE) Civil Works Program. The CEHA program regulates and issues permits for activities within a coastal erosion hazard area. NYS DEC works with USACE to study coastal erosion problems along coastlines and to develop coastal erosion solutions. These are usually large-scale projects that impact entire communities (NYS DEC n.d.)

Because of the consistent coastal erosion problems along the New York State coastline, the State Legislature passed the CEHA Act (Article 34 of the Environmental Conservation Law [ECL]), establishing the state's coastal policy in August 1981. Under this act:

- Areas prone to coastal erosion are identified.
- Activities in areas subject to coastal erosion are undertaken in such a way that damage to property is minimized, increases in coastal erosion are prevented, and natural features are protected. Public actions likely to encourage new development in CEHA should not be undertaken unless the areas are protected by structural or other erosion control projects, which could prevent erosion damage during the life of the proposed action.
- Erosion control projects are publicly financed only where needed to protect human life for existing or new development, which absolutely requires a location within a given hazard area.
- Public and private erosion control projects should minimize damage to other human-made property, natural protective features, and other natural resources.

Regulated CEHA communities have various actions that are restricted, prohibited, or require a permit (NYS DEC n.d.). The following municipalities are Certified CEHA communities in Monroe County:

- Town of Greece
- Town of Hamlin
- Town of Irondequoit
- Town of Parma
- Town of Penfield
- City of Rochester
- Town of Webster (NYS DEC n.d.)

NYS DEC has established a general permit (Great Lakes Erosion Control General Permit) for various shoreline stabilization and structural repair activities in state-regulated waters, wetlands, and coastal erosion hazard areas along Lake Monroe, Lake Ontario, Niagara River, and St. Lawrence River. The Great Lakes Erosion Control General Permit (GP-0-20-004) was issued on May 8, 2020 for a five-year term in response to recurring high-water events in these systems and the ongoing need for affected property owners to install shoreline stabilization measures and repair damaged property (NYS DEC n.d.).

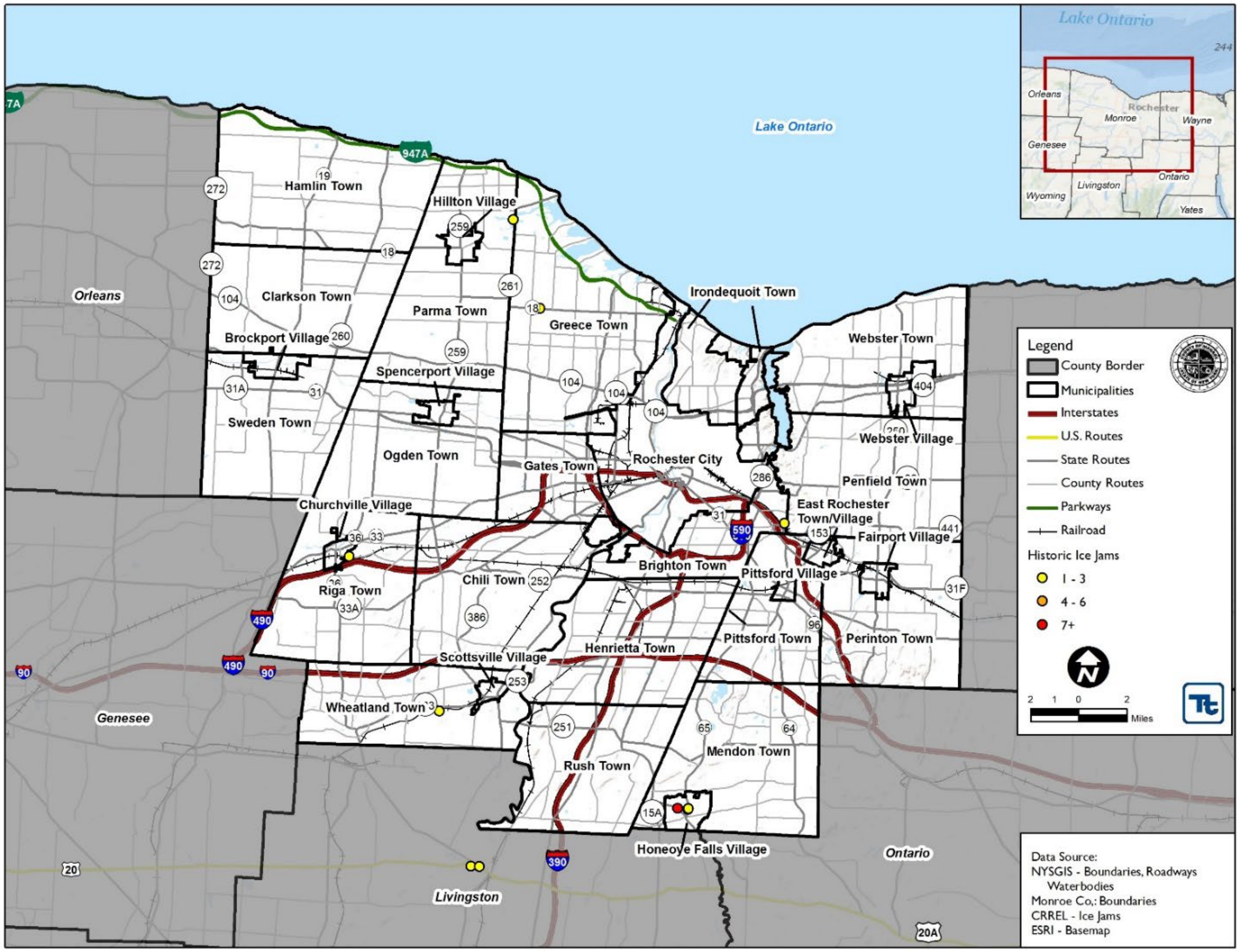
Ice Jam Flooding

Ice jams are common in the northeast United States, and NYS is not an exception. In fact, according to USACE, NYS ranks second in the United States for total number of ice jam events, with over 1,600 incidents documented between 1867 and 2015. Areas of NYS that include characteristics lending to ice jam flooding are the northern counties of the Finger Lakes region and far western New York, the Mohawk Valley of central and eastern NYS, and the North Country (NYS DHSES 2019).

The Ice Jam Database, maintained by the Ice Engineering Group at the USACE Cold Regions Research and Engineering Laboratory (CRREL), currently consists of over 19,000 records from across the United States. According to the USACE-CRREL, Monroe County underwent or may have been impacted by 74 historic ice jam incidents between 1780 and 2022, though no events have occurred in the last 25 years (USACE 2022). Ice Jams have formed along Oatka Creek, Honeoye Creek, Genesee River, Black Creek, Crystal Brook, Canandaigua Lake Outlet, Cayuga Inlet, Fall Creek, Flint Creek, Hemlock Creek, Ninemile Creek, Onondaga Creek, Owasco Outlet, Seneca River, Northrup Creek, West Creek, Sterling Creek, and Allen Creek.

Figure 5.4.5-5 shows the number of ice jam incidents in Monroe County from 1780 to 2022. Historical events are also cited in Appendix H.

Figure 5.4.5-5. Ice Jams in Monroe County, 1780 to 2022



Dam Failure

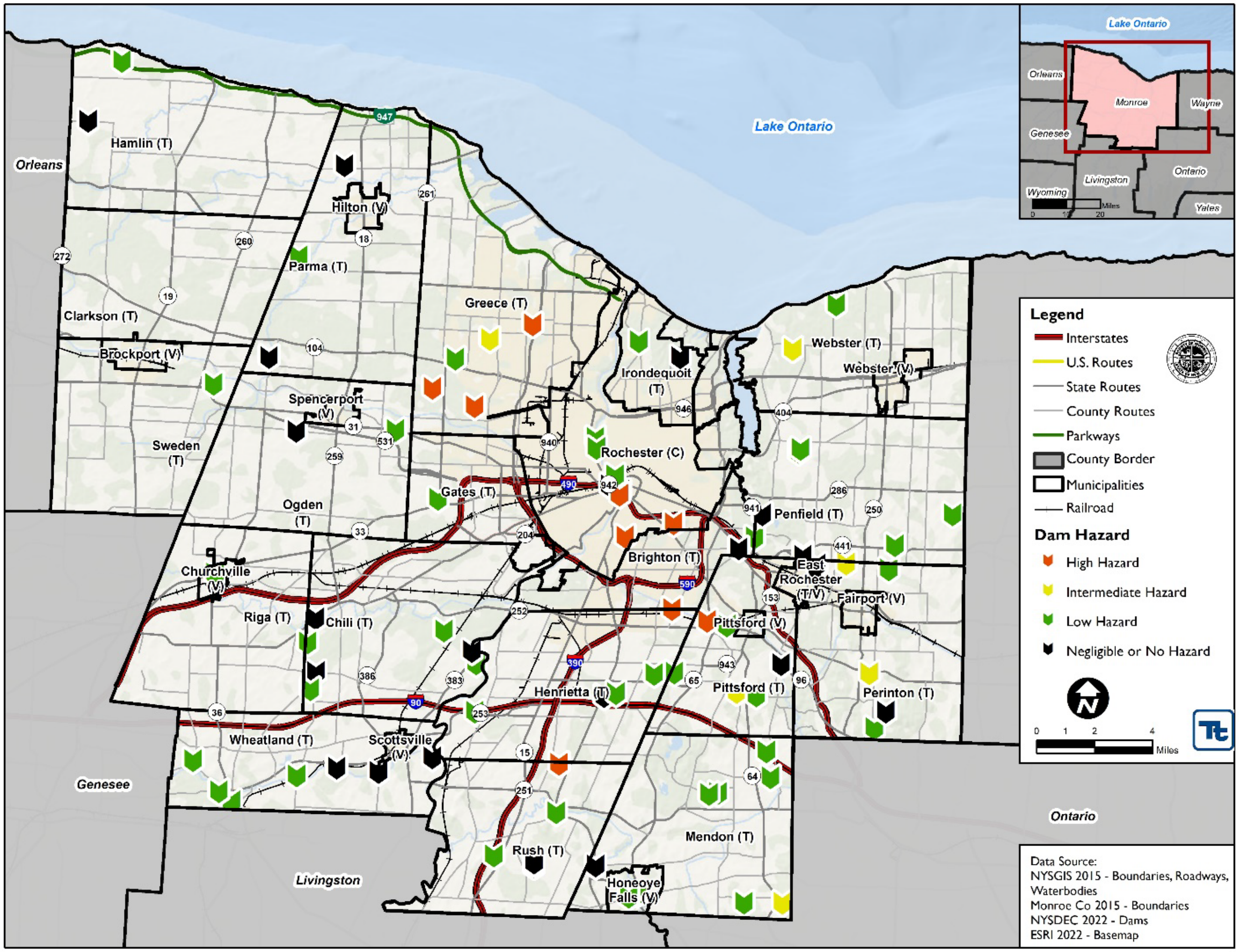
Locations of the dams in Monroe County are shown in Figure 5.4.5-6**.** The number of dams by classification per municipality is listed in Table 5.4.5-3. Dam failure can result in flooding of areas downstream of the failed dam. According to NYS DEC data, Monroe County has 23 dams with negligible or no hazard, 43 low hazard dams, 6 intermediate hazard dams, and nine high hazard dams (NYS DEC 2022). High hazard dams are required to develop emergency action plans.

Table 5.4.5-3. Dams by Hazard Classification per Jurisdiction in Monroe County

Jurisdiction	High Hazard Dams within Jurisdiction	Intermediate Hazard Dams within Jurisdiction	Low Hazard Dams within Jurisdiction	Negligible or No Hazard Dams within Jurisdiction
Brighton (T)	0	0	0	1
Brockport (V)	0	0	0	0
Chili (T)	0	0	4	3
Churchville (V)	0	0	1	0
Clarkson (T)	0	0	0	0
East Rochester (T/V)	0	0	0	0
Fairport (V)	0	0	0	0
Gates (T)	0	0	1	0
Greece (T)	3	1	1	0
Hamlin (T)	0	0	1	1
Henrietta (T)	1	0	3	1
Hilton (V)	0	0	0	0
Honeoye Falls (V)	0	0	2	0
Irondequoit (T)	0	0	1	1
Mendon (T)	0	1	5	1
Ogden (T)	0	0	1	1
Parma (T)	0	0	1	2
Penfield (T)	0	0	5	3
Perinton (T)	0	2	2	2
Pittsford (T)	1	1	3	1
Pittsford (V)	0	0	0	0
Riga (T)	0	0	0	0
Rochester (C)	3	0	3	2
Rush (T)	1	0	3	1
Scottsville (V)	0	0	0	0
Spencerport (V)	0	0	0	0
Sweden (T)	0	0	1	0
Webster (T)	0	1	1	0
Webster (V)	0	0	0	0
Wheatland (T)	0	0	4	3
Monroe County (Total)	**9**	**6**	**43**	**23**

Source: NYSDEC 2022

Figure 5.4.5-6. Dams in Monroe County



Flood Protection Structures

Monroe County has a variety of flood protection structures in place including the following dams and retention basins:

- Dams
  - Churchville Dam on Black Creek about 0.5 miles south of Village of Churchville – Town of Riga border
    - Provides some retention of storm waters with 1-percent annual chance recurrence but has negligible effects with larger storms.
  - Driving Park Dam on the Genesee River about 2.3 miles south of City of Rochester – Town of Irondequoit Border
    - Controlled during normal flows by the Rochester Gas and Electric Company. During flood flows, reverts from detention facilities to run-of-the river structures .
  - Central Avenue Dam on the Genesee River about 3.1 miles northeast of City of Rochester – Town of Chili border
    - Controlled during normal flows by the Rochester Gas and Electric Company. During flood flows, reverts from detention facilities to run-of-the river structures
  - Court Street Dam on the Genesee River about 2.7 miles northeast of City of Rochester – Town of Chili border
    - Operated by New York State. During flood flows, reverts from detention facilities to run-of-the river structures
  - Mount Morris Dam on the Genesee River about 25 miles south of the Chili – Wheatland border
    - Constructed by the USACE in 1951. Since operation began, significant damages to lower Genesee River Valley were averted during floods.
  - Honeoye Creek has several dams and one dike which provides protection to the Sewage treatment plant for a 500-year flood
- Retention Basins
  - East Branch Larkin Creek: Significantly reduce downstream peak flood flows and effectively reduce the width of the floodplain
  - Round Pond Creek: Significantly reduce downstream peak flood flows and effectively reduce the width of the floodplain (FEMA 2022)

Extent

The severity of a flood event is typically determined by a combination of several factors depending on the type of flooding event.

Riverine and Flash Flooding

The severity of riverine and flash flooding is 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. Severity depends not only on the amount of water that accumulates in a period of time, but also on the land's ability to manage this water. One element is the size of rivers and streams in an area; but an equally important factor is the land's absorbency. When it rains, soil acts as a sponge. When the land is saturated or frozen, infiltration into the ground slows and any more water that accumulates must flow as runoff (Harris 2008).

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

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

- ***Minor Flooding*** – minimal or no property damage, but possibly some public threat or inconvenience.
- ***Moderate Flooding*** – some inundation of structures and roads near streams. Some evacuations of people and/or transfer of property to higher elevations are necessary.
- ***Major Flooding*** – extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations (NWS 2011).

Stormwater/ Urban Flooding

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

Coastal/Lakeshore Flooding, Seiches, and Erosion

The extent of coastal flooding due to storms is determined by three factors: 1) the nature of the storm with respect to intensity, duration, and path; 2) astronomical tide conditions at the time the seiche or storm surge wave reaches the shore; and 3) the physical geometry and bathymetry of a particular area, which affects the time and passage of the seiche or surge wave.

Coastal erosion is measured as the rate of change in the position or horizontal displacement of a shoreline over a period of time. Geologists measure the severity of erosion in two ways, as a rate of linear retreat (feet of shoreline recession per year) and volumetric loss (cubic yards of eroded sediment per linear foot of shoreline frontage per year) (NYCEM 2019).

Ice Jam

Ice jam flooding events often occur suddenly and difficult to predict, allowing for little time to prepare for and warn of an event. The size of the snowpack and the rate of snowmelt controls the extent of an ice jam (Rokaya 2018).

Dam Failure

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 (NYSDEC 2009).

Previous Occurrences and Losses

Historical information regarding previous occurrences and losses associated with flooding events throughout NYS and areas within Monroe County was obtained from many sources. Given so many sources reviewed for the purpose of this HMP, loss and impact information regarding many events could vary depending on the source.

FEMA Major Disaster and Emergency Declarations

Between 1954 and 2022, New York State was included in 25 FEMA declared flood specific disasters (DR) or emergency declarations (EM). Monroe County was included in four of these flood-related declarations (Table 5.4.5-4).

Table 5.4.5-4. FEMA DR and EM Declarations for Flood Events in Monroe County, 1954 to 2020

FEMA Declaration Number	Date(s) Of Event	Event Type	Details
DR-338	June 23, 1972	Flood	Tropical Storm Agnes
DR-367	March 21, 1973	Flood	High Winds, Wave Action & Flooding
EM-3004	November 2, 1974	Flood	Flooding (NYS Barge Canal)
4348	May 2, 2017 – August 6, 2017	Flood	Flooding

Source: FEMA 2022

USDA Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2015 and 2022, Monroe County was included in the following USDA-designated agricultural disasters that included or may have included losses due to flood events:

- S3885 – 2015: Excessive Rain, High Winds, Hail, Lightning, and Tornado
- S4274- 2017: Flooding (USDA 2022)

The USDA crop loss data provide another indicator of the severity of previous events. Additionally, crop losses can have a significant impact on the economy by reducing produce sales and purchases. Such impacts may have long-term consequences, particularly if crop yields are low the following years as well. USDA records indicate that Monroe County has experienced crop losses from flood events in the years when USDA disasters were declared. Table 5.4.5-5 provides details regarding crop losses in Monroe County according to USDA records.

Table 5.4.5-5. Flood Related USDA Crop Losses from in Monroe County (2015-2022)

Year	Crop Type	Cause of Loss	Losses
2015	Wheat	Excessive Moisture/Precipitation/Rain	$383,497
2015	Corn	Excessive Moisture/Precipitation/Rain	$189,525
2015	Sweet Corn	Excessive Moisture/Precipitation/Rain	$44,445
2015	Processing Beans	Excessive Moisture/Precipitation/Rain	$17,125
2015	Dry Beans	Excessive Moisture/Precipitation/Rain	$185,704
2015	Green Beans	Excessive Moisture/Precipitation/Rain	$219,586
2015	Cabbage	Excessive Moisture/Precipitation/Rain	$193,576
2015	Soybeans	Excessive Moisture/Precipitation/Rain	$383,497
2017	Wheat	Excessive Moisture/Precipitation/Rain	$32,855
2017	Oats	Excessive Moisture/Precipitation/Rain	$400
2017	Corn	Excessive Moisture/Precipitation/Rain	$2,078,194
2017	Sweet Corn	Excessive Moisture/Precipitation/Rain	$82,456
2017	Processing Beans	Excessive Moisture/Precipitation/Rain	$69,108
2017	Dry Beans	Excessive Moisture/Precipitation/Rain	$148,863
2017	Green Peas	Excessive Moisture/Precipitation/Rain	$21,267
2017	Cabbage	Excessive Moisture/Precipitation/Rain	$291,050
2017	Soybeans	Excessive Moisture/Precipitation/Rain	$807,200

Source: USDA 2022

Previous Events

Table 5.4.5-6 identifies the known flood events that impacted Monroe County between 2015 and 2022. For events prior to 2015, refer to Appendix E (Supplementary Data). For detailed information on damages and impacts to each municipality, refer to Section 9 (Jurisdictional Annexes).

Table 5.4.5-6. Flood Events in Monroe County, 2015 to 2022

Dates of Event	Event Type	FEMA Declaration Number	Monroe County Designated?	Location	Losses / Impacts
August 20, 2015	Flash Flood	N/A	N/A	Beechwood, Gates Center	A slow moving cold front brought heavy rain and thunderstorms to the Genesee Valley and Finger Lakes. In Monroe County, the thunderstorms produced rainfall measured at near two inches in about twenty minutes. The heavy rains overwhelmed many storm systems in the Rochester area. Numerous underpasses were flooded and some cars were inundated by water. The flood waters produced some damage at Highland Hospital in Rochester. $35,000 in property damage was reported at Beechwood. $100,000 in property damage was reported in Beechwood. $35,000 in property damage was reported in Gates Center.
April 6-8, 2017	Flood	N/A	N/A	Churchville	The month of April began on a wet note following a wet March. Several areas creeks reached flood stage. Irondequoit Creek in Monroe County peaked at 9.44 feet at 9:45 AM EST on the 7th. Flooding occurred at Ellison Park and along Blossom Road with additional flooding along Allen Creek. The Black River at Watertown crested at 10.48 feet on the 8th at 11:15 AM EST. Flood stage is 10 feet. Farmland flooding was reported in the Flats with some minor flooding to riverfront properties in Dexter. Black Creek at Churchville, in Monroe County, crested at 6.76 feet on the 8th at 8:30 AM EST. Churchville reported $20,000 in damage over the event.
May 1, 2017	Flood	N/A	N/A	Morton, Greece	A strong cold front moved across the region during the afternoon and evening hours. A line of thunderstorms just ahead of the front produced damaging winds that downed trees and wires across western New York through the Finger Lakes Region as well as areas east of Lake Ontario. A few falling trees caused minor structural damage. Wind gusts were measured to 60 mph. The line of storms also dropped heavy rainfall in a short period of time, with amounts of 0.75 to 1.5 inches common over a few hours. While not overly excessive rates, on top of very wet antecedent conditions, there were reports of road closures due to flooding mainly in flood prone areas such as low-lying land and underpasses. $8,000 in property damage was reported in Morton.
May 6-7, 2017	Flood	N/A	N/A	Brighton, Churchville	Soaking rains fell across the region. Combined with the antecedent wet conditions (the three month March through May period was the second wettest on record in Rochester) area creeks rain high and in some cases overflowed. Black Creek at Churchville crested at 6.21 feet at 6:30 AM EST on the 7th. Irondequoit Creek crested at 8.62 feet at 8:15 PM EST on the 6th. $10,000 in property damage was reported in Brighton. $15,000 in property damage was reported in Churchville.
June-November, 2017	Lakeshore Flooding	DR-4348	Yes	Town of Hamlin, Town of Parma, Town of Greece, City of Rochester, Town of Irondequoit, Town of Webster,	During the first six months of 2017, more than twice the normal amount of water accumulated on Lake Ontario while the Ottawa River saw the highest flows in more than 50 years, leading to widespread flooding across the Lake Ontario St. Lawrence River system. Inflows to Lake Ontario from Lake Monroe were above average from January through June. Lake Ontario saw two of the wettest months ever recorded in April and May of 2017. Water levels were impacted by precipitation falling directly onto the lake's surface and by runoff. Variable ice conditions in the St. Lawrence River from January through March along with high Ottawa River flows limited outflow from Lake Ontario. The lake reached a record level of 248.95 feet. Flooding began in early May and continued into early fall. Waves destroyed public and private breakwalls all along the lake shore. Thousands of homes and buildings were affected flood waters. Several homes dropped off bluffs. In some areas shoreline erosion of 50 to 100 feet deep occurred. Sanitary sewer systems in lakeside communities were affected. Beaches, marinas and state parks were closed all summer long

Dates of Event	Event Type	FEMA Declaration Number	Monroe County Designated?	Location	Losses / Impacts
				Town of Penfield.	with unknown economic losses to mainly seasonal businesses. In late May, the Governor imposed a 5 mph speed limit within 600 feet of the Lake Ontario and St. Lawrence River shore. The shoreline counties of Lake Ontario and the St. Lawrence River sustained enough damage to qualify for both a New York State and Federal Disaster Declaration. By summer's end, damage estimates included $3 Million in Monroe County.
November 6-8, 2017	Flood	N/A	N/A	Mumford, Scottsville, Churchville	After a warm front brought soaking rains to the region, a cold front brought additional rain. The heavy precipitation fell on already saturated ground resulting in both area and river flooding. Rainfall amounts of three to four inches were reported. Roads were flooded and closed in Akron, Rapids, Wolcottsville, Rochester, Athol Springs, Warsaw, Brighton, Cassadaga, and Macedon. Several area creeks and river exceeded flood stage. Black Creek at Churchville crested at 6.32 feet at 6:00 PM on the 7th (Flood Stage is 6 feet). $10,000 in property damages were reported in Scottsville. $10,000 were reported in Churchville.
August 14, 2018	Flash Flood	N/A	N/A	Railroad Mills, Bushnell Basin, Blackwatch Hills	A mid-level closed low, more typical of the cold season, passed slowly through PA and into eastern NY. Abundant moisture in the presence of this anomalous forcing produced heavy rain and flash flooding. The main corridors of heavy rain developed along fairly subtle deformation zones and subtle low level convergence zones in Oswego, Wayne, and Ontario counties, reaching eastern Monroe County by mid-morning.
May 17-31, 2019	Flood	N/A	N/A	Troutberg, Manitou Beach	Excessive runoff into the Ottawa River Basin in Canada restricted the outlet of Lake Ontario. This combined with above normal precipitation into the Lake Ontario Basin, record levels on the Great Lakes above Lake Ontario, and higher than normal flows into the lake from the Niagara River pushed the lake to well above normal levels. Over the course of May, the levels quickly approached those reached in 2017, surpassing 5 feet above low water datum on May 17. The levels continued to increase through the end of the month, rising to near 5.5 feet above low water datum by May 31. $2 million in property damage was reported in Troutberg.
June 1-30, 2019	Flood	N/A	N/A	Troutberg, Union Hill	Excessive runoff into the Ottawa River Basin in Canada restricted the outlet of Lake Ontario. This combined with above normal precipitation into the Lake Ontario Basin, record levels on the Great Lakes above Lake Ontario, and higher than normal flows into the lake from the Niagara River pushed the lake to well above normal levels. Over the course of June, new records were broken as the lake pushed to nearly 6 feet above low water datum and eclipsed the levels set in 2017. The lake peaked on June 10. $1,000 in property damage was reported in Troutberg.
June 20, 2019	Flash Flood	N/A	N/A	Mendon, Henrietta, Bushnell Basin, Rush	Though the primary west to east oriented frontal boundary with upper 60s to low 70s dewpoints streaming into it remained south across Ohio and Pennsylvania, a deepening low pressure system crossing New York State and a very moist air mass resulted in a dynamic moisture-laden system dropping heavy rain from the Southern Tier through Oswego County. The rainfall intensity was also enhanced by a mesolow that moved through simultaneously. Overall, multiple locations saw rainfall totals over 3 inches in less than 12 hours. Numerous road closures occurred during the event including both directions of the Thruway near Rochester. The flooding was so extensive that a State of Emergency was declared for the entire County on Thursday afternoon. Many flash flood and areal flood warnings were issued during this event and some of these persisted well into Friday

Dates of Event	Event Type	FEMA Declaration Number	Monroe County Designated?	Location	Losses / Impacts
					morning. $40,000 in property damages were reported in Mendon. $10,000 in property damages were reported in Henrietta.
July 1-31, 2019	Flood	N/A	N/A	Troutberg	Excessive runoff into the Ottawa River Basin in Canada restricted the outlet of Lake Ontario. This combined with above normal precipitation into the Lake Ontario Basin, record levels on the Great Lakes above Lake Ontario, and higher than normal flows into the lake from the Niagara River pushed the lake to well above normal levels. Over the course of July, water levels began to slowly recede, however after starting the month about 5.5 feet above low water datum, the lake only fell to just below 5 feet above low water datum over the entirety of the month. $500,000 in property damages were reported in Troutberg.
August 1-24, 2019	Flood	N/A	N/A	Troutberg, Forest Lawn	Excessive runoff into the Ottawa River Basin in Canada through the early half of the summer restricted the outlet of Lake Ontario. This combined with above normal precipitation into the Lake Ontario Basin, record levels on the Great Lakes above Lake Ontario, and higher than normal flows into the lake from the Niagara River pushed the lake to well above normal levels. Over the course of August, while ongoing precipitation gradually started to seasonally decrease, and outgoing flows through the Moses Saunders Dam increased, it took the majority of month before the lake finally decreased below 4 feet above low water datum and flooding along the lakeshore finally subsided. $50,000 in property damages were reported in Troutberg.
July 11, 2020	Flash Flood	N/A	N/A	Point Pleasant, Maplewood, West Webster	A sharp short wave trough embedded within a broad upper level trough over the northeastern U.S. supported a wave of convection that moved across the entire area. A precipitable water value of 1.65 inches was observed on the KBUF sounding, and models suggested over 2 inches in portions of the area. This combined with an incoming mesoscale convective vortex to drive slow-moving and heavy rain-producing thunderstorms. While shear was minimal in the environment, the MCV resulted in locally higher shear values, which enhanced wind damage across portions of the area.
July 8, 2021	Flash Flood	N/A	N/A	Point Pleasant	Showers and thunderstorms developed during the afternoon along a west-to-east oriented frontal boundary along the south shore of Lake Ontario. Thunderstorms developed first over the Niagara Peninsula, which then tracked into the Buffalo area. Another line of storms formed from Oswego to Onondaga counties. This line of storms expanded in coverage and severity while a north-south line of storms approached from Lake Ontario. These two lines merged over northern Oswego and southwest Jefferson counties, as velocity values increased near Sackets Harbor, where several trees were reported down. In Point Pleasant, Flooding was reported on Route 104 and 590. Deep water was reported on Titus Ave and Ridge Drive. Several water rescues were performed. $50,000 in property damages were reported.
August 7, 2021	Flash Flood	N/A	N/A	Scottsville	An upper level trough axis moved into western New York during the evening hours. This feature moved into a modestly unstable environment fairly unimpressive precipitable water values of only just slightly over one inch. Further, low level moisture transport was unimpressive. A cluster of storms congealed around northern Livingston and southern Monroe counties. Weak flow and some back-building allowed for torrential rain over the area. A few spots had three inches per hour rainfall rates that lasted up to 55 minutes. This resulted in roads closed with water flowing over them in Monroe County.

Dates of Event	Event Type	FEMA Declaration Number	Monroe County Designated?	Location	Losses / Impacts
October 26, 2021	Flood	N/A	N/A	Brighton Po, Northeast Henrietta	An upper level closed low meandered through the Great Lakes while slowly phasing with an Atlantic Nor'easter. Convergence along an inverted trough coincided with a strong push of Atlantic moisture to force periods of heavy rainfall south of Lake Ontario from Rochester eastward through the latter half of the day.
October 29-31, 2021	Flood	N/A	N/A	East Rochester, Brighton, Rigney Bluff	A broad occluded low advanced northeastward from the Ohio Valley. Easterly moisture feed off the Atlantic ahead of this system brought precipitable water values above 1 inch. A vast area of moderate and occasionally heavy rainfall resulted in areas of flooding.
December 11, 2021	Seiche	N/A	N/A	Monroe County	A strong cold front crossed the region. Selected peak wind gusts included 60 mph at Rochester Airport. Strong surface high pressure over the southern Plains amplified the pressure gradient such that a lake seiche did occur on Lake Monroe with a smaller one evident on Lake Ontario, as well.

Source: NOAA-NCEI 2022; FEMA 2022; USACE 2022

Climate Change Impacts

Climate change is affecting both people and resources in New York State, and these impacts are projected to continue growing. *ClimAID: the Integrated Assessment for Effective Climate Change in New York State (ClimAID)* was undertaken to provide decision-makers with information on the State's vulnerability to climate change and to facilitate the development of adaptation strategies informed by both local experience and scientific knowledge (NYSERDA 2011).

Each region in New York State, as defined by ClimAID, has attributes that will be affected by climate change. Monroe County is part of Region 1, Western New York and Great Lakes Plain. Attributes that will be affected by climate change include agricultural revenue, relatively low rainfall that may increase summer drought risk, high-value crops that may need irrigation, and projected improved conditions for grapes (NYSERDA 2011).

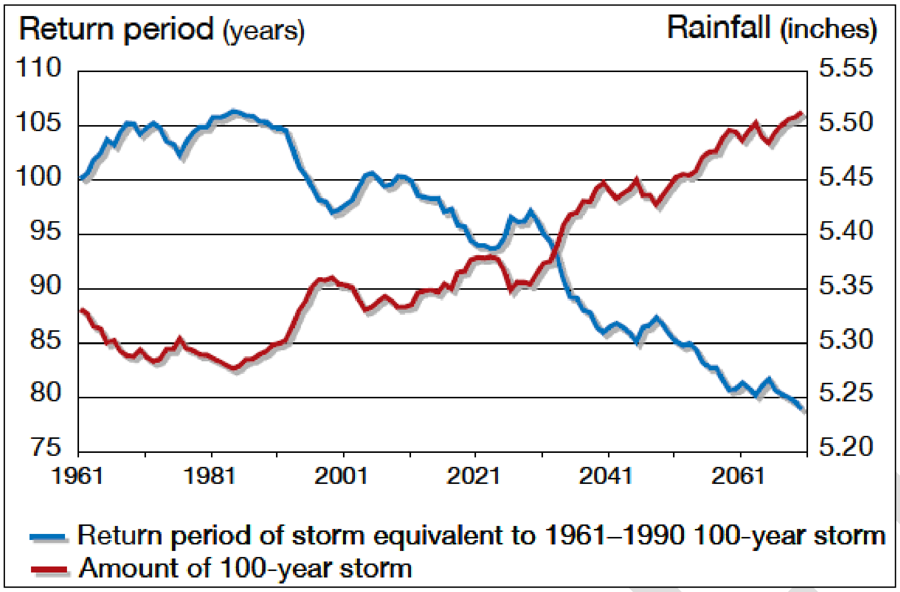
In Region 1, it is estimated that temperatures will increase by 3.7 ºF to 7.3 ºF by the 2050s and 4.2 ºF to 12.0 ºF by the 2080s (baseline of 47.7 ºF). Precipitation totals will increase between 2 to 12 percent by the 2050s and 1 to 17 percent by the 2080s (baseline of 34.0 inches) (NYSERDA 2014).

The projected increase in precipitation is expected to occur in heavy downpours and less in light rains. Downpours are very likely to increase in frequency and intensity (NYSERDA 2014). Heavy rainfall can result in flooding events.

Overall regional precipitation is the primary driver of average Great Lakes water levels. Increases in annual precipitation will impact the elevation of lakes. Projected increases in precipitation totals are likely to increase the elevation of Lake Ontario. Temperatures are predicted to increase in Monroe County, which may lead to an increase in intensity and frequency of severe storm events. This increase may lead to more weather patterns that cause flooding events.

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 5.4.5-7 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 5.4.5-7. Projected Rainfall and Frequency of Extreme Storms



Source: NYSERDA 2011

Assumptions about a river's flow behavior, expressed as hydrographs are influences for dam design. 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 Monroe County, and the future climate projections for this region, the County has a moderate probability of future flooding. It is anticipated that Monroe 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. Additionally, climate change is expected to increase the severity and frequency of heavy rain events in Monroe County. This is likely to lead to an increase in flooding events. According to available record keeping, Monroe County has a 100% annual chance of occurrence of flood events in any given year.

Table 5.4.5-7. Probability of Future Occurrence of Flooding Events

Hazard Type	Number of Occurrences Between 1996 and 2022	% chance of occurrence in any given year
Coastal/Lakeshore Flood	8	30.77%
Dam Failure	0	0%
Flash Flood	31	100%
Flood	30	100%
Ice Jam	0	0%
Seiche	1	3.85%
TOTAL	**70**	**100%**

Source: NOAA-NCEI 2022; USACE 2022; NPDP 2022; FEMA 2022
Note: Disaster occurrences include federally declared disasters and selected flood events between January 1, 1996 and January 1, 2022. Due to limitations in data, not all flood events occurring between 1996 and June 2022 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated.

Section 5.3 ranks the identified hazards of concern for Monroe County. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Steering Committee, the probability of occurrence for flood in the County is considered ‘frequent’ (100 percent annual probability; a hazard event may occur multiple times per year. as noted in Table 5.3-2).

5.4.5.2 Vulnerability Assessment

To assess Monroe County's risk to the flood hazard, a spatial analysis was conducted using the FEMA Risk Map effective dated 2008. Preliminary products dated September 30, 2022 were received from FEMA at the completion of the risk assessment. Information from the Preliminary Flood Insurance Study was used to update the flood profile but the analysis used for the vulnerability assessment is based on the effective FIRM. The 1 and 0.2-percent annual chance flood events were examined to determine the assets located in the hazard areas and to estimate potential loss using the FEMA Hazus riverine flood model. These results are summarized below.

Impact on Life, Health and Safety

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

To estimate population exposure to the 1-percent and 0.2-percent annual chance flood events, the DFIRM flood boundaries were used. Based on the spatial analysis, there are an estimated 6,364 residents living in the 1-percent annual chance floodplain or 0.8 percent of the County's total population. There are an estimated 9,104 residents living in the 0.2-percent annual chance floodplain, or 1.2 percent of the County's total population. The Town of Gates has the greatest number of residents living in the floodplain, with approximately 2,059 residents living in the Special Flood Hazard Area (SFHA) and 2,261 people living in the 0.2-percent annual chance floodplain. Table 5.4.5-8 summarizes the population exposed to the flood hazard by jurisdiction.

Table 5.4.5-8. Estimated Population Exposed to the 1-percent and 0.2-percent Annual Chance Flood Event Hazard Area

Jurisdiction	Total Population (2020 Decennial Census)	Estimated Population Located in the Flood Hazard Areas			
		Number of Persons Located in the 1-percent Annual Chance Flood Event Hazard Area	Percent of Total	Number of Persons Located in the 0.2-percent Annual Chance Flood Event Hazard Area	Percent of Total
Brighton (T)	37,137	199	0.5%	546	1.5%
Brockport (V)	7,104	0	0.0%	0	0.0%
Chili (T)	29,123	721	2.5%	1,050	3.6%
Churchville (V)	2,091	7	0.4%	27	1.3%
Clarkson (T)	6,904	18	0.3%	21	0.3%
East Rochester (T/V)	6,334	0	0.0%	0	0.0%
Fairport (V)	5,501	33	0.6%	33	0.6%
Gates (T)	29,167	2,059	7.1%	2,261	7.8%
Greece (T)	96,926	351	0.4%	528	0.5%
Hamlin (T)	8,725	427	4.9%	427	4.9%
Henrietta (T)	47,096	722	1.5%	1,265	2.7%
Hilton (V)	6,027	32	0.5%	63	1.0%
Honeoye Falls (V)	2,706	12	0.5%	84	3.1%

Jurisdiction	Total Population (2020 Decennial Census)	Estimated Population Located in the Flood Hazard Areas			
		Number of Persons Located in the 1-percent Annual Chance Flood Event Hazard Area	Percent of Total	Number of Persons Located in the 0.2-percent Annual Chance Flood Event Hazard Area	Percent of Total
Irondequoit (T)	51,043	366	0.7%	621	1.2%
Mendon (T)	6,389	58	0.9%	93	1.5%
Ogden (T)	16,585	53	0.3%	133	0.8%
Parma (T)	10,190	460	4.5%	501	4.9%
Penfield (T)	39,438	167	0.4%	234	0.6%
Perinton (T)	39,128	91	0.2%	115	0.3%
Pittsford (T)	25,714	101	0.4%	202	0.8%
Pittsford (V)	1,419	0	0.0%	0	0.0%
Riga (T)	3,495	41	1.2%	77	2.2%
Rochester (C)	211,328	78	0.0%	177	0.1%
Rush (T)	3,490	12	0.4%	65	1.9%
Scottsville (V)	2,009	39	1.9%	160	8.0%
Spencerport (V)	3,685	18	0.5%	23	0.6%
Sweden (T)	6,140	12	0.2%	12	0.2%
Webster (T)	39,676	244	0.6%	296	0.7%
Webster (V)	5,651	0	0.0%	8	0.1%
Wheatland (T)	2,888	43	1.5%	80	2.8%
Monroe County (Total)	**753,109**	**6,364**	**0.8%**	**9,104**	**1.2%**

Source: FEMA 2008; US Census 2020
Notes: % = Percent; C = City; T = Town; V = Village

Research has shown that some populations, while they may not have more hazard exposure, may experience exacerbated impacts and prolonged recovery if/when impacted. This is due to many factors, including their physical and financial ability to react or respond during a hazard. Of the population exposed, the most vulnerable include the economically disadvantaged and the population over age 65. Economically disadvantaged populations may be more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on net economic impacts on their families. The population over age 65 is also more vulnerable because they are more likely to seek or need medical attention that may not be available due to isolation during a flood event, and they may have more difficulty evacuating. Within Monroe County, there are approximately 127,588 people over the age of 65 (16.9 percent of the County population) and 100,484 people below the poverty level (13.3 percent of the County population (American Community Survey 2020).

The Centers for Disease Control and Prevention (CDC) 2016 Social Vulnerability Index (SVI) ranks U.S. Census tracts on socioeconomic status, household composition and disability, minority status and language, and housing and transportation. Monroe County's overall score is 0.5204, indicating that its communities have a moderate to high level of social vulnerability (CDC 2018). This score indicates that some County residents may not have enough resources to respond to flood events.

Using 2020 U.S. Census data, Hazus estimates the potential sheltering needs as a result of a 1-percent annual chance flood event. For the 1-percent flood event, Hazus estimates 15,752 individuals will be displaced, and

3,775 people will seek short-term sheltering. These statistics, by jurisdiction and by flood zone, are presented in Table 5.4.5-9.

Table 5.4.5-9. Estimated Population Displaced or Seeking Short-Term Shelter from the 1-percent Annual Chance Flood Event Hazard Area

Jurisdiction	Total Population (2020 Decennial Census)	1-Percent Annual Chance Flood Event	
		Displaced Population*	Persons Seeking Short-Term Sheltering
Brighton (T)	37,137	617	209
Brockport (V)	7,104	38	20
Chili (T)	29,123	1,354	153
Churchville (V)	2,091	41	14
Clarkson (T)	6,904	164	94
East Rochester (T/V)	6,334	40	3
Fairport (V)	5,501	136	23
Gates (T)	29,167	2,761	450
Greece (T)	96,926	1,384	478
Hamlin (T)	8,725	346	79
Henrietta (T)	47,096	3,170	455
Hilton (V)	6,027	251	53
Honeoye Falls (V)	2,706	151	37
Irondequoit (T)	51,043	351	99
Mendon (T)	6,389	244	71
Ogden (T)	16,585	410	138
Parma (T)	10,190	599	131
Penfield (T)	39,438	796	214
Perinton (T)	39,128	340	124
Pittsford (T)	25,714	823	263
Pittsford (V)	1,419	4	1
Riga (T)	3,495	141	26
Rochester (C)	211,328	308	131
Rush (T)	3,490	138	38
Scottsville (V)	2,009	85	16
Spencerport (V)	3,685	79	34
Sweden (T)	6,140	31	19
Webster (T)	39,676	812	373
Webster (V)	5,651	8	8
Wheatland (T)	2,888	130	21
Monroe County (Total)	**753,109**	**15,752**	**3,775**

Source: Hazus v5.1; Census 2020; FEMA 2008
Notes: C = City; T = Town; V = Village
**The number of displaced persons may overestimate the impacted population located in the 1-percent annual chance flood hazard area due to the limitations of the Hazus model using Census 2010 census block data*

The total number of injuries and casualties resulting from flooding is generally limited based on advance weather forecasting, blockades, and warnings. More likely, persons could become displaced from their homes or may seek shelter due to the impacts of a flood event. Therefore, injuries and deaths generally are not anticipated if proper warning and precautions are in place. Ongoing mitigation efforts should help to avoid the most likely cause of injury, which results from persons trying to cross flooded roadways or channels during a flood.

Dam failure can cause, in the most extreme case, loss of life and extensive property damage, or in the least extreme case, no loss of life or significant property damage. Dam failure can cause persons to become displaced if flooding of structures occurs. Dam failure may mimic flood events, depending on the size of the dam reservoir and breach. Dam failure inundation modeling estimates the potential impacts of a failure; however, this data is considered sensitive information and is not displayed or discussed further in the HMP.

Cascading impacts of flooding and dam failure inundation 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. Mold spores can grow in as short a period as 24–48 hours in wet and damaged areas of buildings that have not been properly cleaned. Very small mold spores can easily be inhaled, creating the potential for allergic reactions, asthma episodes, and other respiratory problems. Buildings should be properly cleaned and dried out to safely prevent mold growth (CDC 2019).

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

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

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

Impact on General Building Stock

Exposure to the flood hazard includes those buildings located in the flood zone or those that are built downstream in other flood inundation areas such as dam failure inundation areas. The potential damage is the modeled loss that could occur to the exposed inventory measured by the structural and content replacement cost value. There are an estimated 3,434 and 4,741 buildings located in the 1-percent and 0.2-percent annual chance flood event hazard area, respectively. This represents approximately 1.7 percent and 2.4 percent of the County's total general building stock inventory replacement cost value, respectively (approximately $315 billion). The Town of Amherst has the greatest number of its buildings located in the 1-percent annual chance floodplain (859 buildings or 7.3 percent of its total building stock). The Town of Gates also has the greatest number of its buildings located in the 0.2-percent annual chance floodplain (948 buildings or 8.0 percent of its total building stock). Refer to Table 5.4.5-10 and Table 5.4.5-11 for the estimated exposure of 1-percent and 0.2-percent flood events by jurisdiction. Refer to Table 5.4.5-12 for the Hazus estimated losses by jurisdiction, for residential, commercial, and other occupancy structures, respectively.

Table 5.4.5-10. Estimated General Building Stock Exposure to the 1-percent Annual Chance Flood Event

Jurisdiction	No. of Bldgs.	Total RCV	Estimated Building Stock Exposed to 1-percent Annual Chance Flood Total (All Flood Zones)			
			No. of Bldgs.	% of Bldgs.	RCV	% of RCV
Brighton (T)	11,693	$14,443,886,002	103	0.9%	$213,586,534	1.5%
Brockport (V)	2,224	$5,158,789,593	1	0.0%	$39,636	0.0%
Chili (T)	11,534	$9,206,843,885	393	3.4%	$482,297,684	5.2%
Churchville (V)	1,112	$938,164,078	8	0.7%	$24,672,941	2.6%
Clarkson (T)	3,411	$1,887,392,030	19	0.6%	$5,637,155	0.3%
East Rochester (T/V)	2,924	$3,440,171,127	10	0.3%	$12,439,986	0.4%
Fairport (V)	2,394	$2,281,456,075	24	1.0%	$111,099,188	4.9%
Gates (T)	11,801	$12,220,599,285	859	7.3%	$958,205,170	7.8%
Greece (T)	36,414	$26,954,378,684	177	0.5%	$201,638,152	0.7%
Hamlin (T)	5,539	$2,318,778,027	263	4.7%	$92,814,703	4.0%
Henrietta (T)	15,982	$23,460,566,322	298	1.9%	$752,071,581	3.2%
Hilton (V)	2,143	$2,120,287,988	26	1.2%	$29,214,194	1.4%
Honeoye Falls (V)	1,155	$1,813,180,690	10	0.9%	$62,440,877	3.4%
Irondequoit (T)	21,885	$13,427,006,840	167	0.8%	$200,796,580	1.5%
Mendon (T)	3,835	$2,852,155,915	66	1.7%	$26,404,916	0.9%
Ogden (T)	7,407	$5,558,087,440	37	0.5%	$16,130,704	0.3%
Parma (T)	5,509	$3,373,412,574	273	5.0%	$116,899,100	3.5%
Penfield (T)	15,882	$11,119,233,991	114	0.7%	$533,803,786	4.8%
Perinton (T)	16,817	$13,125,415,407	61	0.4%	$129,204,988	1.0%
Pittsford (T)	10,590	$10,686,774,000	67	0.6%	$79,733,209	0.7%
Pittsford (V)	804	$1,776,834,511	0	0.0%	$0	0.0%
Riga (T)	2,356	$1,539,492,845	43	1.8%	$14,096,853	0.9%
Rochester (C)	89,392	$119,943,371,056	92	0.1%	$630,278,220	0.5%
Rush (T)	2,808	$1,816,445,354	32	1.1%	$26,123,114	1.4%
Scottsville (V)	1,069	$908,716,753	27	2.5%	$52,390,410	5.8%
Spencerport (V)	1,654	$1,580,844,696	16	1.0%	$109,432,916	6.9%
Sweden (T)	3,465	$3,402,258,236	12	0.3%	$33,922,259	1.0%
Webster (T)	16,660	$11,510,191,170	186	1.1%	$298,781,447	2.6%
Webster (V)	1,633	$3,634,066,282	0	0.0%	$0	0.0%
Wheatland (T)	1,926	$2,509,077,040	50	2.6%	$149,490,023	6.0%
Monroe County (Total)	**312,018**	**$315,007,877,896**	**3,434**	**1.1%**	**$5,363,646,328**	**1.7%**

Source: FEMA 2008; Monroe County GIS - 2022
Notes C = City; T = Town; V = Village
No. = Number Bldgs. = Buildings RCV = Replacement Cost Value % = Percent

Table 5.4.5-11. Estimated General Building Stock Exposure to the 0.2-percent Annual Chance Flood Event

Jurisdiction	No. of Bldgs.	Total RCV	Estimated Building Stock Exposed to 0.2-percent Annual Chance Flood Total (All Flood Zones)			
			No. of Bldgs.	% of Bldgs.	RCV	% of RCV
Brighton (T)	11,693	$14,443,886,002	239	2.0%	$442,678,446	3.1%
Brockport (V)	2,224	$5,158,789,593	1	0.0%	$39,636	0.0%

Jurisdiction	No. of Bldgs.	Total RCV	Estimated Building Stock Exposed to 0.2-percent Annual Chance Flood Total (All Flood Zones)			
			No. of Bldgs.	% of Bldgs.	RCV	% of RCV
Chili (T)	11,534	$9,206,843,885	550	4.8%	$630,401,906	6.8%
Churchville (V)	1,112	$938,164,078	30	2.7%	$45,548,971	4.9%
Clarkson (T)	3,411	$1,887,392,030	20	0.6%	$6,117,188	0.3%
East Rochester (T/V)	2,924	$3,440,171,127	10	0.3%	$12,439,986	0.4%
Fairport (V)	2,394	$2,281,456,075	25	1.0%	$116,287,556	5.1%
Gates (T)	11,801	$12,220,599,285	948	8.0%	$1,087,132,130	8.9%
Greece (T)	36,414	$26,954,378,684	263	0.7%	$237,007,370	0.9%
Hamlin (T)	5,539	$2,318,778,027	263	4.7%	$92,814,703	4.0%
Henrietta (T)	15,982	$23,460,566,322	528	3.3%	$1,504,472,788	6.4%
Hilton (V)	2,143	$2,120,287,988	39	1.8%	$62,058,166	2.9%
Honeoye Falls (V)	1,155	$1,813,180,690	40	3.5%	$73,122,162	4.0%
Irondequoit (T)	21,885	$13,427,006,840	266	1.2%	$231,863,436	1.7%
Mendon (T)	3,835	$2,852,155,915	101	2.6%	$54,743,506	1.9%
Ogden (T)	7,407	$5,558,087,440	71	1.0%	$34,660,734	0.6%
Parma (T)	5,509	$3,373,412,574	293	5.3%	$155,829,272	4.6%
Penfield (T)	15,882	$11,119,233,991	147	0.9%	$578,866,676	5.2%
Perinton (T)	16,817	$13,125,415,407	72	0.4%	$134,944,860	1.0%
Pittsford (T)	10,590	$10,686,774,000	106	1.0%	$98,807,281	0.9%
Pittsford (V)	804	$1,776,834,511	0	0.0%	$0	0.0%
Riga (T)	2,356	$1,539,492,845	67	2.8%	$22,112,002	1.4%
Rochester (C)	89,392	$119,943,371,056	146	0.2%	$1,073,233,890	0.9%
Rush (T)	2,808	$1,816,445,354	77	2.7%	$117,508,300	6.5%
Scottsville (V)	1,069	$908,716,753	99	9.3%	$109,706,429	12.1%
Spencerport (V)	1,654	$1,580,844,696	24	1.5%	$151,780,270	9.6%
Sweden (T)	3,465	$3,402,258,236	12	0.3%	$33,922,259	1.0%
Webster (T)	16,660	$11,510,191,170	231	1.4%	$362,010,249	3.1%
Webster (V)	1,633	$3,634,066,282	4	0.2%	$3,498,418	0.1%
Wheatland (T)	1,926	$2,509,077,040	69	3.6%	$162,556,051	6.5%
Monroe County (Total)	**312,018**	**$315,007,877,896**	**4,741**	**1.5%**	**$7,636,164,640**	**2.4%**

Source: FEMA 2008; Monroe County GIS - 2022
Notes: C = City; T = Town; V = Village; No. = Number; Bldgs. = Buildings; RCV = Replacement Cost Value; % = Percent

Table 5.4.5-12. Estimated Building Stock Potential Loss by Occupancy to the 1-percent Annual Chance Flood Event

Jurisdiction	Total Replacement Cost Value (RCV)	All Occupancies		Residential		Commercial		Agricultural, Industrial, Religious, Education and Government	
		Estimated Loss	Percent of Total Replacement Cost Value	Estimated Loss	Percent of Total Replacement Cost Value	Estimated Loss	Percent of Total Replacement Cost Value	Estimated Loss	Percent of Total Replacement Cost Value
Brighton (T)	$14,443,886,002	$46,986,950	0.3%	$3,156,992	<0.1%	$43,829,959	0.3%	$0	0
Brockport (V)	$5,158,789,593	$16,321	<0.1%	$16,321	<0.1%	$0	0.0%	$0	0.0%
Chili (T)	$9,206,843,885	$89,948,027	1.0%	$14,294,304	0.2%	$71,643,615	0.8%	$4,010,108	0.0%
Churchville (V)	$938,164,078	$12,837,066	1.4%	$245,553	<0.1%	$12,591,513	1.3%	$0	0.0%
Clarkson (T)	$1,887,392,030	$1,320,813	0.1%	$494,101	<0.1%	$826,712	<0.1%	$0	0.0%
East Rochester (T/V)	$3,440,171,127	$7,048,982	0.2%	$0	0.0%	$7,048,982	0.2%	$0	0.0%
Fairport (V)	$2,281,456,075	$26,312,562	1.2%	$597,695	<0.1%	$16,298,446	0.7%	$9,416,420	0.4%
Gates (T)	$12,220,599,285	$161,774,175	1.3%	$64,828,565	0.5%	$24,908,268	0.2%	$72,037,342	0.6%
Greece (T)	$26,954,378,684	$44,027,928	0.2%	$3,763,943	<0.1%	$29,924,197	0.1%	$10,339,787	0.0%
Hamlin (T)	$2,318,778,027	$9,885,201	0.4%	$6,076,084	0.3%	$3,809,117	0.2%	$0	0.0%
Henrietta (T)	$23,460,566,322	$102,716,207	0.4%	$19,502,735	0.1%	$75,471,577	0.3%	$7,741,895	0.0%
Hilton (V)	$2,120,287,988	$13,740,978	0.6%	$5,473,538	0.3%	$3,699,699	0.2%	$4,567,741	0.2%
Honeoye Falls (V)	$1,813,180,690	$5,595,603	0.3%	$788,497	<0.1%	$4,807,106	0.3%	$0	0.0%
Irondequoit (T)	$13,427,006,840	$24,526,845	0.2%	$9,376,740	0.1%	$15,150,105	0.1%	$0	0.0%
Mendon (T)	$2,852,155,915	$4,254,529	0.1%	$1,364,496	<0.1%	$2,797,623	0.1%	$92,411	0.0%
Ogden (T)	$5,558,087,440	$7,749,493	0.1%	$1,283,128	<0.1%	$6,466,365	0.1%	$0	0.0%
Parma (T)	$3,373,412,574	$15,599,682	0.5%	$4,334,718	0.1%	$11,235,526	0.3%	$29,438	0.0%
Penfield (T)	$11,119,233,991	$180,269,903	1.6%	$3,635,455	<0.1%	$77,381,175	0.7%	$99,253,273	0.9%
Perinton (T)	$13,125,415,407	$31,658,359	0.2%	$1,158,016	<0.1%	$30,212,859	0.2%	$287,485	0.0%
Pittsford (T)	$10,686,774,000	$31,917,544	0.3%	$4,384,133	<0.1%	$27,027,912	0.3%	$505,498	0.0%
Pittsford (V)	$1,776,834,511	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Riga (T)	$1,539,492,845	$4,657,675	0.3%	$1,800,825	0.1%	$2,856,851	0.2%	$0	0.0%
Rochester (C)	$119,943,371,056	$99,048,238	0.1%	$4,470,305	<0.1%	$94,554,734	0.1%	$23,199	0.0%
Rush (T)	$1,816,445,354	$6,468,363	0.4%	$1,911	<0.1%	$1,558,162	0.1%	$4,908,291	0.3%
Scottsville (V)	$908,716,753	$27,743,284	3.1%	$797,907	0.1%	$23,096,795	2.5%	$3,848,583	0.4%
Spencerport (V)	$1,580,844,696	$714,602	0.0%	$535,322	<0.1%	$179,280	<0.1%	$0	0.0%
Sweden (T)	$3,402,258,236	$12,072,993	0.4%	$13,171	<0.1%	$12,059,821	0.4%	$0	0.0%
Webster (T)	$11,510,191,170	$78,992,844	0.7%	$5,052,492	<0.1%	$71,274,252	0.6%	$2,666,101	0.0%

Jurisdiction	Total Replacement Cost Value (RCV)	All Occupancies		Residential		Commercial		Agricultural, Industrial, Religious, Education and Government	
		Estimated Loss	Percent of Total Replacement Cost Value	Estimated Loss	Percent of Total Replacement Cost Value	Estimated Loss	Percent of Total Replacement Cost Value	Estimated Loss	Percent of Total Replacement Cost Value
Webster (V)	$3,634,066,282	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Wheatland (T)	$2,509,077,040	$33,260,790	1.3%	$774,805	<0.1%	$1,849,023	0.1%	$30,636,962	1.2%
Monroe County (Total)	**$315,007,877,896**	**$1,081,145,959**	**0.3%**	**$158,221,751**	**0.1%**	**$672,559,674**	**0.2%**	**$250,364,535**	**0.1%**

Source: Hazus v5.1; Monroe County GIS 2022; FEMA 2008
Notes: C = City; T = Town; V = Village

NFIP Statistics

In addition to total building stock modeling, individual data available on flood policies, claims, repetitive loss (RL) properties, and severe RL (SRL) properties were analyzed. FEMA Region 2 provided a list of residential properties with NFIP policies, past claims, and multiple claims (RLs). 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 that were paid more than $1,000 for each loss. The two losses must be within 10 years of each other & be as least 10 days apart. Only losses from (*sic* since) 1/1/1978 that are closed are considered."

SRLs were then examined for Monroe County. According to Section 1361A of the National Flood Insurance Act, as amended (NFIA), 42 *United States Code* (U.S.C.) 4102a, 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:

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 5.4.5-13 through Table 5.4.5-15 summarizes NFIP policies, claims, and repetitive loss statistics for Monroe County. According to FEMA, Table 5.4.5-13 summarizes occupancy classes of RL and SRL properties in Monroe County. The majority of properties within the RL occupancy class are single-family residences (86.7%). All SRL properties are also single-family residences (Region 2 2015). This information is current as of June 30, 2015.

Locations of the properties with policies, claims, and repetitive and severe repetitive flooding were geocoded by FEMA with the understanding that differences (and variations in those differences) were possible between listed longitude and latitude coordinates of properties and actual locations of property addresses—namely, that indications of some locations were more accurate than others.

Table 5.4.5-13. Occupancy Class of Repetitive Loss Structures in Monroe County

Occupancy Class	Total Number of Repetitive Loss Properties	Total Number of Severe Repetitive Loss Properties	Total (RL + SRL)
Single Family	9	2	11
Condo	0	0	0
2-4 Family	2	0	2
Other Residential	1	0	1
Non-Residential	1	0	1
Monroe County	**13**	**2**	**15**

Source: FEMA Region 2 2015
Notes: Policies, claims, repetitive loss, and severe repetitive loss statistics provided by FEMA Region 2, and current as of June 30, 2015. The total number of repetitive loss properties does not include severe repetitive loss properties.
RL Repetitive Loss; SRL Severe Repetitive Loss

Table 5.4.5-14. Occupancy Class of Repetitive Loss Structures in Monroe 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
Brighton (T)	0	0	0	0	0	0	0	0	0	0
Brockport (V)	0	0	0	0	0	0	0	0	0	0
Chili (T)	0	0	0	0	1	0	0	0	0	0
Churchville (V)	0	0	0	0	0	0	0	0	0	0
Clarkson (T)	0	0	0	0	0	0	0	0	0	0
East Rochester (V/T)	0	0	0	0	0	0	0	0	0	0
Fairport (V)	0	0	0	0	0	0	0	0	0	0
Gates (T)	0	0	0	0	0	0	0	0	0	0
Greece (T)	1	0	0	0	0	0	0	0	0	0
Hamlin (T)	0	0	0	0	1	0	0	0	0	0
Henrietta (T)	0	0	0	1	0	0	0	0	0	0
Hilton (V)	0	0	0	0	0	0	0	0	0	0
Honeoye Falls (V)	0	0	0	0	0	0	0	0	0	0
Irondequoit (T)	0	0	0	0	1	0	0	0	0	0
Mendon (T)	0	0	0	0	0	0	0	0	0	0
Ogden (T)	1	0	0	0	0	0	0	0	0	0
Parma (T)	0	0	0	0	0	0	0	0	0	0
Penfield (T)	0	0	1	0	0	0	0	0	0	0
Perinton (T)	0	0	0	0	2	0	0	0	0	0
Pittsford (T)	0	0	0	0	2	0	0	0	0	0
Pittsford (V)	0	0	0	0	0	0	0	0	0	0
Riga (T)	0	0	0	0	0	0	0	0	0	0
Rochester (C)	0	0	0	0	1	0	0	0	0	0
Rush (T)	0	0	0	0	0	0	0	0	0	0
Scottsville (V)	0	0	0	0	0	0	0	0	0	0
Spencerport (V)	0	0	0	0	0	0	0	0	0	0

Table 5.4.5-14. Occupancy Class of Repetitive Loss Structures in Monroe 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
Sweden (T)	0	0	0	0	0	0	0	0	0	0
Webster (T)	0	0	0	0	0	0	0	0	0	0
Webster (V)	0	0	0	0	0	0	0	0	0	0
Wheatland (T)	0	0	0	0	1	0	0	0	0	2
Monroe County (Total)	**2**	**0**	**1**	**1**	**9**	**0**	**0**	**0**	**0**	**2**

Source: FEMA 2015
Notes:
Policies, claims, repetitive loss and severe repetitive loss statistics provided by FEMA Region 2, and current as of June 30, 2015.
Statistics summarized using the Community Name provided by FEMA Region 2. The total number of repetitive loss properties does not include severe repetitive loss properties.
C City
T Town
V Village

Table 5.4.5-15. NFIP Policies, Claims, and Repetitive Loss Statistics

Municipality	# Policies (1)	# Claims (Losses) (1)	Total Loss Payments (2)	# Rep. Loss Prop. (1)	# Severe Rep. Loss Prop. (1)	# Policies in the 1% Flood Boundary (3)
Brighton (T)	110	13	$50,901	0	0	35
Brockport (V)	3	1	$1,238	0	0	0
Chili (T)	181	24	$111,637	1	0	136
Churchville (V)	8	0	$0	0	0	4
Clarkson (T)	6	6	$9,711	0	0	3
East Rochester (V/T)	0	0	$0	0	0	0
Fairport (V)	7	1	$500	0	0	5
Gates (T)	336	18	$53,777	0	0	290
Greece (T)	192	63	$384,960	1	0	62
Hamlin (T)	81	23	$100,161	1	0	53
Henrietta (T)	180	26	$126,713	1	0	89
Hilton (V)	20	11	$435,822	0	0	10

Table 5.4.5-15. NFIP Policies, Claims, and Repetitive Loss Statistics

Municipality	# Policies (1)	# Claims (Losses) (1)	Total Loss Payments (2)	# Rep. Loss Prop. (1)	# Severe Rep. Loss Prop. (1)	# Policies in the 1% Flood Boundary (3)
Honeoye Falls (V)	18	2	$17,355	0	0	4
Irondequoit (T)	72	11	$28,451	1	0	35
Mendon (T)	23	3	$20,426	0	0	13
Ogden (T)	26	5	$152,841	1	0	11
Parma (T)	100	9	$46,158	0	0	77
Penfield (T)	62	21	$444,541	1	0	26
Perinton (T)	59	20	$229,926	1	0	24
Pittsford (T)	82	15	$116,032	1	0	26
Pittsford (V)	4	0	$0	0	0	2
Riga (T)	8	1	$1,476	0	0	6
Rochester (C)	90	17	$88,889	1	0	35
Rush (T)	10	3	$1,850	0	0	4
Scottsville (V)	18	2	$12,920	0	0	14
Spencerport (V)	13	10	$161,550	0	0	4
Sweden (T)	6	1	$1,515	0	0	3
Webster (T)	71	26	$95,931	0	0	43
Webster (V)	8	2	$101,403	0	0	0
Wheatland (T)	21	22	$599,758	1	2	4
Monroe County (Total)	**1,815**	**356**	**$3,396,444**	**13**	**2**	**1,108**

Source: FEMA Region 2 2015
Note (1): Policies, claims, repetitive loss, and severe repetitive loss statistics provided by FEMA Region 2, and are current as of June 30, 2015. The total number of repetitive loss properties does not include severe repetitive loss properties. Number of claims represents claims closed by June 30, 2015.
Note (2): Total building and content losses from the claims file provided by FEMA Region 2.
Note (3): Number of policies inside and outside of flood zones is based on latitude and longitude provided by FEMA Region 2 in the policy file.
FEMA noted that for a property with more than one entry, more than one policy may have been in force or more than one Geographic Information System (GIS) specification was possible. Number of policies and claims, and claims total, exclude properties outside Monroe County boundary, based on provided latitude and longitude coordinates.
C City
T Town
V Village

Impact on Critical Facilities

It is important to determine the critical facilities and infrastructure within the County that may be at risk to flooding and who may be impacted should damage occur. Critical services during and after a flood event may not be available if critical facilities are directly damaged or transportation routes to access these critical facilities are impacted. Roads that are blocked or damaged can isolate residents and can prevent access throughout the planning area to many service providers needing to get to vulnerable populations or to make repairs. 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 Interstates I-490, I-390, and I-590, and various state and County roads. There are several issues associated with transportation routes flooding, including isolation caused by bridges being washed out or blocked by floods or debris, health problems caused by water and sewer systems that are flooded or backed up, drinking water contamination caused by floodwaters carrying pollutants in water supplies, and localized urban flooding caused by culverts blocked with debris.

Critical facility exposure to the 1-percent and 0.2-percent annual chance flood hazard event boundary was examined. In addition, Hazus was used to estimate the flood loss potential to critical facilities located in the FEMA mapped floodplains. Table 5.4.5-16. and Table 5.4.5-17 summarize the number of critical facilities exposed to the 1-percent and 0.2-percent flood inundation areas by jurisdiction. Of the 59 critical facilities located in the 1-percent annual chance flood event boundary, all 59 are considered lifelines for the County. Out of the 71 critical facilities located in the 0.2-percent annual chance flood event boundary, 70 are considered lifelines for the County. Table 5.4.5-18. shows the number of lifeline facilities by category in the 1-percent and 0.2-percent annual chance flood event boundary. Refer to Section 4 (County Profile) for more information about the critical facilities and lifelines in Monroe County.

Table 5.4.5-16. Number of Critical Facilities Located in the 1-percent Annual Chance Flood Hazard Area

Jurisdiction	Total Critical Facilities Located in Jurisdiction	Total Lifelines Located in Jurisdiction	Number of Critical Facilities and Lifeline Facilities Located in the 1-Percent Annual Chance Flood Event Hazard Area			
			Critical Facilities	Percent of Total Critical Facilities	Lifelines	Percent of Total Lifelines
Brighton (T)	69	65	4	5.8%	4	6.2%
Brockport (V)	29	28	0	0.0%	0	0.0%
Chili (T)	111	102	11	9.9%	11	10.8%
Churchville (V)	24	23	0	0.0%	0	0.0%
Clarkson (T)	14	10	0	0.0%	0	0.0%
East Rochester (T/V)	31	29	1	3.2%	1	3.4%
Fairport (V)	17	16	0	0.0%	0	0.0%
Gates (T)	58	54	2	3.4%	2	3.7%
Greece (T)	165	158	6	3.6%	6	3.8%
Hamlin (T)	23	22	0	0.0%	0	0.0%
Henrietta (T)	111	103	1	0.9%	1	1.0%
Hilton (V)	21	20	0	0.0%	0	0.0%

Jurisdiction	Total Critical Facilities Located in Jurisdiction	Total Lifelines Located in Jurisdiction	Number of Critical Facilities and Lifeline Facilities Located in the 1-Percent Annual Chance Flood Event Hazard Area			
			Critical Facilities	Percent of Total Critical Facilities	Lifelines	Percent of Total Lifelines
Honeoye Falls (V)	17	16	3	17.6%	3	18.8%
Irondequoit (T)	103	100	0	0.0%	0	0.0%
Mendon (T)	21	20	0	0.0%	0	0.0%
Ogden (T)	42	38	0	0.0%	0	0.0%
Parma (T)	18	16	0	0.0%	0	0.0%
Penfield (T)	73	68	3	4.1%	3	4.4%
Perinton (T)	64	57	2	3.1%	2	3.5%
Pittsford (T)	45	39	2	4.4%	2	5.1%
Pittsford (V)	14	13	0	0.0%	0	0.0%
Riga (T)	20	18	1	5.0%	1	5.6%
Rochester (C)	639	605	11	1.7%	11	1.8%
Rush (T)	29	26	3	10.3%	3	11.5%
Scottsville (V)	14	13	0	0.0%	0	0.0%
Spencerport (V)	13	13	0	0.0%	0	0.0%
Sweden (T)	11	11	1	9.1%	1	9.1%
Webster (T)	55	53	1	1.8%	1	1.9%
Webster (V)	16	15	0	0.0%	0	0.0%
Wheatland (T)	23	21	7	30.4%	7	33.3%
Monroe County (Total)	**1,890**	**1,773**	**59**	**3.1%**	**59**	**3.3%**

Source: FEMA 2008; Monroe County GIS 2022
Notes: C = City; T = Town; V = Village % = Percent

Table 5.4.5-17. Number of Critical Facilities Located in the 0.2-percent Annual Chance Flood Hazard Area

Jurisdiction	Total Critical Facilities Located in Jurisdiction	Total Lifelines Located in Jurisdiction	Number of Critical Facilities and Lifeline Facilities Located in the 0.2-Percent Annual Chance Flood Event Hazard Area			
			Critical Facilities	Percent of Total Critical Facilities	Lifelines	Percent of Total Lifelines
Brighton (T)	69	65	4	5.8%	4	6.2%
Brockport (V)	29	28	0	0.0%	0	0.0%
Chili (T)	111	102	13	11.7%	13	12.7%
Churchville (V)	24	23	3	12.5%	3	13.0%
Clarkson (T)	14	10	0	0.0%	0	0.0%
East Rochester (T/V)	31	29	1	3.2%	1	3.4%
Fairport (V)	17	16	0	0.0%	0	0.0%
Gates (T)	58	54	3	5.2%	3	5.6%
Greece (T)	165	158	7	4.2%	7	4.4%

Jurisdiction	Total Critical Facilities Located in Jurisdiction	Total Lifelines Located in Jurisdiction	Number of Critical Facilities and Lifeline Facilities Located in the 0.2-Percent Annual Chance Flood Event Hazard Area			
			Critical Facilities	Percent of Total Critical Facilities	Lifelines	Percent of Total Lifelines
Hamlin (T)	23	22	0	0.0%	0	0.0%
Henrietta (T)	111	103	4	3.6%	3	2.9%
Hilton (V)	21	20	0	0.0%	0	0.0%
Honeoye Falls (V)	17	16	3	17.6%	3	18.8%
Irondequoit (T)	103	100	0	0.0%	0	0.0%
Mendon (T)	21	20	0	0.0%	0	0.0%
Ogden (T)	42	38	0	0.0%	0	0.0%
Parma (T)	18	16	0	0.0%	0	0.0%
Penfield (T)	73	68	4	5.5%	4	5.9%
Perinton (T)	64	57	2	3.1%	2	3.5%
Pittsford (T)	45	39	2	4.4%	2	5.1%
Pittsford (V)	14	13	0	0.0%	0	0.0%
Riga (T)	20	18	2	10.0%	2	11.1%
Rochester (C)	639	605	11	1.7%	11	1.8%
Rush (T)	29	26	3	10.3%	3	11.5%
Scottsville (V)	14	13	0	0.0%	0	0.0%
Spencerport (V)	13	13	0	0.0%	0	0.0%
Sweden (T)	11	11	1	9.1%	1	9.1%
Webster (T)	55	53	1	1.8%	1	1.9%
Webster (V)	16	15	0	0.0%	0	0.0%
Wheatland (T)	23	21	7	30.4%	7	33.3%
Monroe County (Total)	**1,890**	**1,773**	**71**	**3.8%**	**70**	**3.9%**

Source: FEMA 2008; Monroe County GIS 2022
Notes: C = City; T = Town; V = Village % = Percent

Table 5.4.5-18. Lifelines Exposed to the 1 and 0.2-percent Annual Chance Flood Event Boundary

FEMA Lifeline Category	Number of Lifelines	Number of Lifelines Located in the 1-percent Annual Chance Flood Event Hazard Area	Number of Lifelines Located in the 0.2-percent Annual Chance Flood Event Hazard Area
Communications	68	2	2
Energy	14	0	0
Food, Water, Shelter	286	17	23
Hazardous Material	1	0	0
Health and Medical	93	1	2
Safety and Security	1,274	39	42
Transportation	36	0	1
Monroe County (Total)	**1,772**	**59**	**70**

Source: FEMA 2008; Monroe County GIS 2022

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

Impact on 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 on utilities and infrastructure, business interruption, and impacts on tourism. In areas that are directly flooded, renovations of commercial and industrial buildings may be necessary, disrupting associated services. The Impact on General Building Stock subsection above discusses direct impacts on buildings in Monroe County.

Debris management may also be a large expense after a flood event. HAZUS 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 5.4.5-19. summarizes the Hazus v5.1 countywide debris estimates for the 1-percent annual chance flood event. This table only estimates structural debris generated by flooding and does not include non-structural debris or additional potential damage and debris possibly generated by wind that may be associated with a flood event or storm that causes flooding. Overall, Hazus estimates that there will be 46,819 tons of debris generated during the 1-percent annual chance flood event in Monroe County.

Table 5.4.5-19. Estimated Debris Generated from the 1-percent Annual Chance Flood Event

Jurisdiction	1-Percent Annual Chance Flood Event			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Brighton (T)	2,767	1,599	647	521
Brockport (V)	920	748	89	83
Chili (T)	1,668	1,375	168	125
Churchville (V)	134	67	39	28
Clarkson (T)	245	187	30	27
East Rochester (T/V)	331	114	128	90
Fairport (V)	606	566	25	16
Gates (T)	3,087	2,973	70	44
Greece (T)	2,122	1,662	263	197
Hamlin (T)	1,332	1,173	93	66
Henrietta (T)	4,804	3,595	577	631
Hilton (V)	2,653	739	1,194	720
Honeoye Falls (V)	461	198	157	106
Irondequoit (T)	4,409	1,335	1,421	1,653
Mendon (T)	234	185	28	21
Ogden (T)	732	412	154	166
Parma (T)	1,424	1,017	231	176
Penfield (T)	4,747	1,754	1,567	1,426
Perinton (T)	1,167	906	153	108
Pittsford (T)	2,957	1,355	992	610
Pittsford (V)	76	59	10	7
Riga (T)	148	129	12	7

Jurisdiction	1-Percent Annual Chance Flood Event			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Rochester (C)	2,121	496	963	662
Rush (T)	1,175	464	413	298
Scottsville (V)	546	221	199	125
Spencerport (V)	401	150	129	122
Sweden (T)	205	138	38	29
Webster (T)	4,168	2,066	1,122	981
Webster (V)	15	15	0	0
Wheatland (T)	1,163	641	289	233
Monroe County (Total)	**46,819**	**26,338**	**11,202**	**9,279**

Source: FEMA 2008; HAZUS v5.1
Notes: V = Village, T = Town, C = City

In addition to replacement costs and the cost of debris generated, estimated losses were generated through Hazus for losses of inventory, relocation, buildings, contents, wages, rentals, and income.

Table 5.4.5-20. Estimated Losses for the 1-percent Annual Chance Flood Event

Inventory Loss	Relocation Loss	Building Loss	Content Loss	Wage Loss	Rental Loss	Income Loss
$22,260,000	$232,910,000	$580,820,000	$1,051,390,000	$651,950,000	$133,780,000	$453,720,000

Source: FEMA 2008; HAZUS v5.1

Impact on the Environment

As Monroe County and its jurisdictions evolve with changes in population and density, flood events may increase in frequency and/or severity as land use changes, more structures are built, and impervious surfaces expand. Furthermore, flood extents for the 1-percent annual chance flood event will continue to evolve alongside natural occurrences such as climate change and/or severe weather events. These flood events will inevitably impact Monroe County's natural and local environment.

Furthermore, the environmental impacts of a dam failure can include significant water quality and debris-disposal issues. Flood waters can back up sanitary sewer systems and inundate wastewater treatment plants, causing raw sewage to contaminate residential and commercial buildings and the flooded waterway. The contents of unsecured containers of oil, fertilizers, pesticides, and other chemicals get added to flood waters. Hazardous materials may be released and distributed widely across the floodplain. Water supply and wastewater treatment facilities could be offline for weeks. After the flood waters subside, contaminated and flood-damaged building materials and contents must be properly disposed of. Contaminated sediment must be removed from buildings, yards, and properties. In addition, severe erosion is likely; such erosion can negatively impact local ecosystems.

Cascading Impacts On Other Hazards

Flood events can exacerbate the impacts of land sliding and utility failure. The New York City (NYC) 2019 Hazard Mitigation Plan suggests that flooding may cause a loss of stabilizing plant material caused by inundation and erosion (NYCEM 2019). Flooding of contaminated waters and flood water containing debris may also cause failure of utilities, particularly if the utilities are disrupted by debris clogging treatment systems or flood waters inundating power sources. More information about the landslide hazard of concern can be found in Section 5.4.8.

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

Section 4 identifies areas targeted for future growth and development across the County. Any areas of growth located in the special flood hazard area could be potentially impacted by flooding. Areas outside of the special flood hazard can also be impacted by urban flooding and less frequent and more severe flooding events. Specific areas of recent and new development are indicated in tabular form and/or on the hazard maps included in Volume II, Section 9 (Jurisdictional Annexes) of this plan.

Projected Changes in Population

According to the 2020 Census, the population of the County has increased by approximately 1.2 percent since 2010. The County's population is anticipated to slightly increase over the next decade (0.7 percent increase by 2030). Changes in the density of population can impact the number of persons exposed to erosion. As forests continue to be cleared for new development and run-off persists, the population in the County will remain exposed to this hazard. Refer to Section 4 (County Profile), which includes a discussion on population trends for the County.

Climate Change

Climate is defined not simply as average temperature and precipitation but also by the type, frequency, and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of events that exacerbate coastal erosion. While predicting changes of coastal erosion under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society, and the environment (US EPA 2009). Warmer temperatures may lead to an increase in frequency of storms, thus leading to more weather events with potentially increased severity, that cause erosion.

Change of Vulnerability Since 2017 HMP

Monroe County continues to be vulnerable to the flood hazard. However, there are several differences between the exposure estimates of this plan update and the results reported in the 2017 HMP. Updated population statistics and building stock was used in the current risk assessment. Further, exposure for both the population and critical facilities was analyzed. These updated datasets provide a more accurate exposure analysis to the coastal erosion hazard.