5.4.4 Flood

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

5.4.4.1 Hazard Profile

This section provides profile information including description, location, extent, previous occurrences and losses, probability of future occurrences, and climate change impacts, as well as the vulnerability assessment for the flood hazard in Monroe County.

Description

Floods are one of the most common natural hazards in the United States. They can develop slowly over a period of days or develop quickly, with disastrous effects that can be local (impacting a neighborhood or community) or regional (affecting entire river basins, coastlines, and multiple counties or states) (Federal Emergency Management Agency [FEMA] 2008). Most communities in the United States have experienced some kind of flooding after spring rains, heavy thunderstorms, coastal storms, or winter snow thaws (George Washington University 2001).

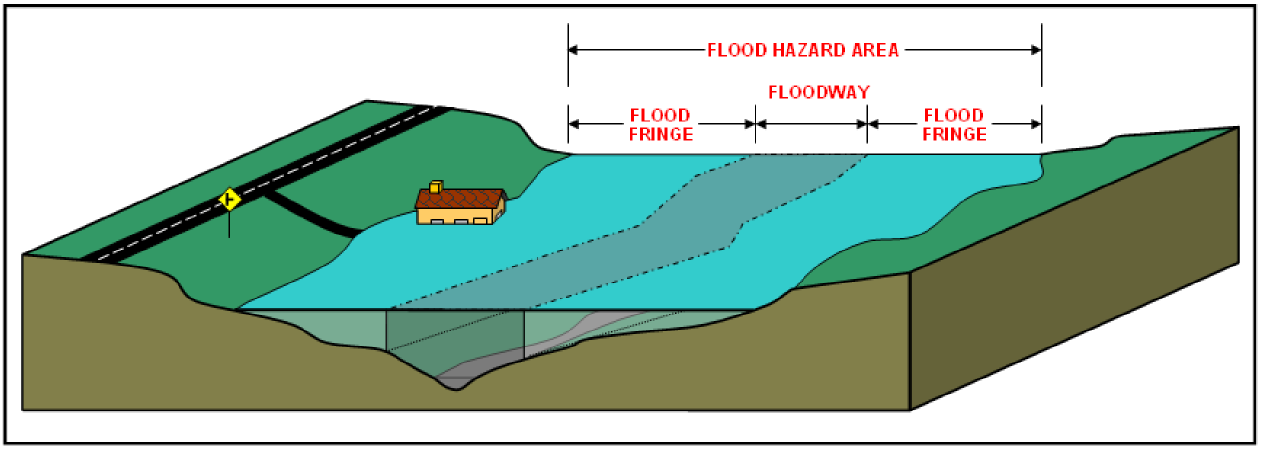
Floods are the most frequent and costly natural hazards in New York State (NYS) in terms of human hardship and economic loss, particularly in communities that lie within flood-prone areas or flood plains of a major water source. As defined in the NYS Hazard Mitigation Plan (HMP), flooding is a general and temporary condition of partial or complete inundation on normally dry land deriving from any of the following:

- Riverine flooding, including overflow from a river channel, flash floods, alluvial fan floods, dam-break floods, and ice jam floods
- Local drainage or high groundwater levels
- Fluctuating lake levels
- Coastal flooding
- Coastal erosion (NYS Division of Homeland Security and Emergency Services [DHSES] 2014)
- Unusual and rapid accumulation or runoff of surface waters from any source
- Mudflows (or mudslides)
- Collapse or subsidence of land along the shore of a lake or similar body of water caused by erosion, waves, or currents of water exceeding anticipated cyclical levels (FEMA 2014)
- Sea Level Rise
- Climate Change (U.S. Environmental Protection Agency [EPA] 2015)

A floodplain is defined as land adjoining the channel of a river, stream, ocean, lake, or other watercourse or water body that becomes inundated with water during a flood. Most often, floodplains are referred to as 100-year floodplains. A 100-year floodplain is not the flood that will occur once every 100 years; rather, it is the flood that has a 1-percent chance of being equaled or exceeded each year. Thus, the 100-year flood could occur more than once within a relatively short period of time. FEMA has properly defined this apparently misleading term as the 1-percent annual chance flood, and this FEMA definition of the 100-year flood is now the standard used by most federal and state agencies, and by the National Flood Insurance Program (NFIP) (FEMA 2005).

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

Figure 5.4.4-1. Floodplain



Source: New Jersey Department of Environmental Protection (NJDEP), date unknown

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

Riverine/Flash Floods

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 (FEMA 2005, The Illinois Association for Floodplain and Stormwater Management 2006).

A flash flood is:

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

Stormwater flooding described below is due to local drainage issues and high groundwater levels. Locally, heavy precipitation may produce flooding in areas other than delineated floodplains or along recognizable channels. If local conditions cannot accommodate intense precipitation through a combination of infiltration and surface runoff, water may accumulate and cause flooding problems. During winter and spring, frozen ground and snow accumulations may contribute to inadequate drainage and localized ponding. Flooding issues of this nature generally occur in areas with flat gradients, and generally increase with urbanization, which speeds 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 no surface flooding occurs. Basements are vulnerable to flooding resulting from 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).

Urban drainage flooding is caused by increased water runoff due to urban development and drainage systems. Drainage systems are designed to remove surface water from developed areas as quickly as possible to prevent localized flooding on streets and within other urban areas. A drainage system typically includes 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 (FEMA 2008).

Coastal (Lacustrine) Flooding

Coastal flooding occurs along the coasts of oceans, bays, estuaries, coastal rivers, and large lakes. For Monroe County, coastal flooding would be a result of the County's proximity to Lake Ontario. Coastal floods involve submersion of land areas along the ocean coast and inland waters caused by levels of seawater (or freshwater in the case of Monroe County) over and above normal tide action. Coastal flooding results from a storm surge causing local sea or lake levels to rise, often resulting in weakened or destroyed coastal structures. Winter snowmelt, hurricanes and tropical storms, severe storms, and Nor'easters cause most coastal flooding in Monroe County.

Coastal flooding poses many of the same problems as riverine flooding, but presents additional problems such as the following: beach erosion; loss or submergence of wetlands and other coastal ecosystems; saltwater intrusion (although this does not apply to Monroe County); high water tables; loss of coastal recreation areas, beaches, protective sand dunes, parks, and open space; and loss of coastal structures (FEMA 2011).

Coastal flooding exerts the following forces:

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

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

Ice Jam Flooding

As defined by the Northeast States Emergency Consortium and FEMA, an ice jam is an accumulation of ice that acts as a natural dam and restricts flow of a body of water. Ice jams occur when warm temperatures and heavy rains cause rapid snowmelt. The melting snow, combined with the heavy rain, causes frozen rivers to swell. The rising water breaks the ice layers into large chunks, which float downstream and often pile up near narrow passages and obstructions (bridges and dams). Ice jams may build up to thickness great enough to raise the water level and cause flooding (FEMA 2008). Ice jams may also be caused by frazil ice, which forms when mist freezes and then floats down a river, stream, or creek.

The two different types of ice jams are freeze-up and breakup. Freeze-up jams occur in the early to mid-winter when floating ice may slow or stop due to a change in water slope as it reaches an obstruction to movement. Breakup jams occur during periods of thaw, generally in late winter and early spring. The ice cover breakup is usually associated with a rapid increase in runoff and corresponding river discharge due to a heavy rainfall, snowmelt, or warmer temperatures (U.S. Army Corps of Engineers [USACE] 2002).

Dam Failure Flooding

A dam is an artificial barrier that can impound water, wastewater, or any liquid-borne material for the purpose of storage or control of water (FEMA 2010). Dams are man-made structures built across a stream or river that impound water and reduce downstream flow (FEMA 2003). They are built for purposes 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 2010). Dams can fail for one or a combination of the following reasons:

- Overtopping caused by floods that exceed the capacity of the dam (inadequate spillway capacity)
- Prolonged periods of rainfall and flooding
- Deliberate acts of sabotage (terrorism)
- Structural failure of materials used in dam construction
- Movement and/or failure of the foundation supporting the dam
- Settlement and cracking of concrete or embankment dams
- Piping and internal erosion of soil in embankment dams

- Inadequate or negligent operation, maintenance, and upkeep
- Failure of upstream dams on the same waterway
- Earthquake (liquefaction/landslides) (FEMA 2010)

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 dam breaks 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 2009).

Federal Programs

NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in participating communities. More detailed information on the NFIP, as well as related legislation and programs (i.e., the Community Rating System program and the Homeowners Flood Insurance Affordability Act of 2014) and risk management tools (Flood Insurance Studies [FIS], Flood Insurance Rate Maps [FIRMs], and Risk MAP) are available in Section 6 under the Summary of Plans, Programs, and Resources Available to Support Mitigation. Similarly due to the significant impact associated with dam failure, the federal government provides resources and programs to maintain and oversee that high-hazard and other dams are kept in a safe operating condition. More information on these programs is also available in Section 6, located after the information on federal floodplain management resources.

Location

Monroe County has significant exposure to water and vulnerability to the flood hazard. Water exposure in the County includes the following:

- 36.5 miles of shoreline with Lake Ontario
- 16,335 acres (3.8%) of wetlands
- 19,908 (4.5%) acres in the floodplain (Monroe County Comprehensive Plan 1978)
- Between 40-50 rivers, creeks, and streams, not including tributaries (FEMA FIS 2008)

Flooding is the primary natural hazard in NYS because combined effects of the State's latitude, topography, climatology, meteorology, water bodies, and waterways uniquely influence potential for flooding. Flooding occurs in every part of the State. Some areas are more flood-prone than others, but no area is exempt, including Monroe County. An estimated 700,000 people live within these flood-prone areas, while millions more work, travel through, or use recreational facilities within areas subject to flooding (NYS DHSES 2014).

Riverine/Flash Flooding

In some parts of NYS, annual spring floods result from snowmelt, and the extent of flooding depends on depth of winter snowpack and spring weather patterns. Within the northeast portions of the State, winter thaws, sometimes combined with rain, can also cause significant flooding. One of the most classic cases of this type of flooding took place in the Genesee Valley and Finger Lakes region in 1993. The area most affected from this kind of flooding is the Black River Basin east of Lake Ontario where lowland flooding from snowmelt and spring rains is a yearly ritual.

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 FIS 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 (Monroe County Department of Health 2015).

Additionally, 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. Areas of steep topography occur in the Allegany-Catskill plateau, which runs the entire width of NYS's Southern Tier, and in the Adirondack Mountains to the north (NYS DHSES 2014). 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.

Coastal (Lacustrine) Flooding

River basins and watersheds are not the only parts of the State threatened by flood exposure, but they are the natural features most likely to contribute to riverine or flash floods in Monroe County. NYS has more than 3,000 miles of marine and lacustrine coastline that often floods; however, the south shore of Lake Ontario is the only major coastline in the county, and thus the county's only scene of notable lacustrine 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.

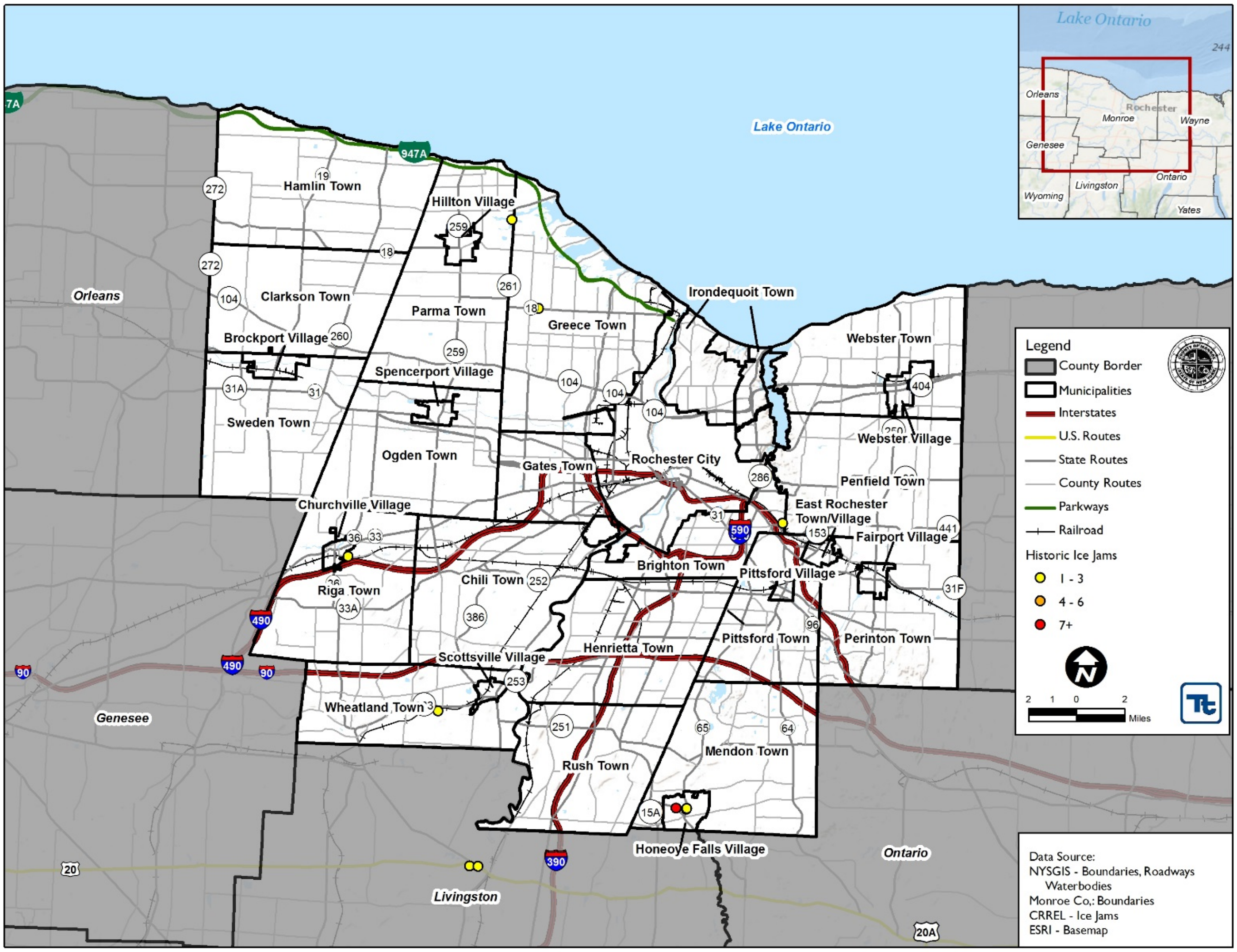
Most damaging floods from Lake Ontario occur when lake levels are high or during severe storms. Both scenarios create a temporary rise in the lake level and wave run-ups. Although these floods may occur throughout the year, they are most probable during spring (FEMA FIS, 2008).

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 2014).

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 2015 (USACE 2015). Ice Jams have formed along Oatka Creek, Honeoye Creek, Genesee River, Black Creek, Crystal Brook, Canandiagua 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 5.4.4-2 shows the number of ice jam incidents in Monroe County from 1780 to 2014. Historical events are also cited in the "Previous Occurrences" section of this hazard profile.

Figure 5.4.4-2. Ice Jams in Monroe County, 1780 to 2014

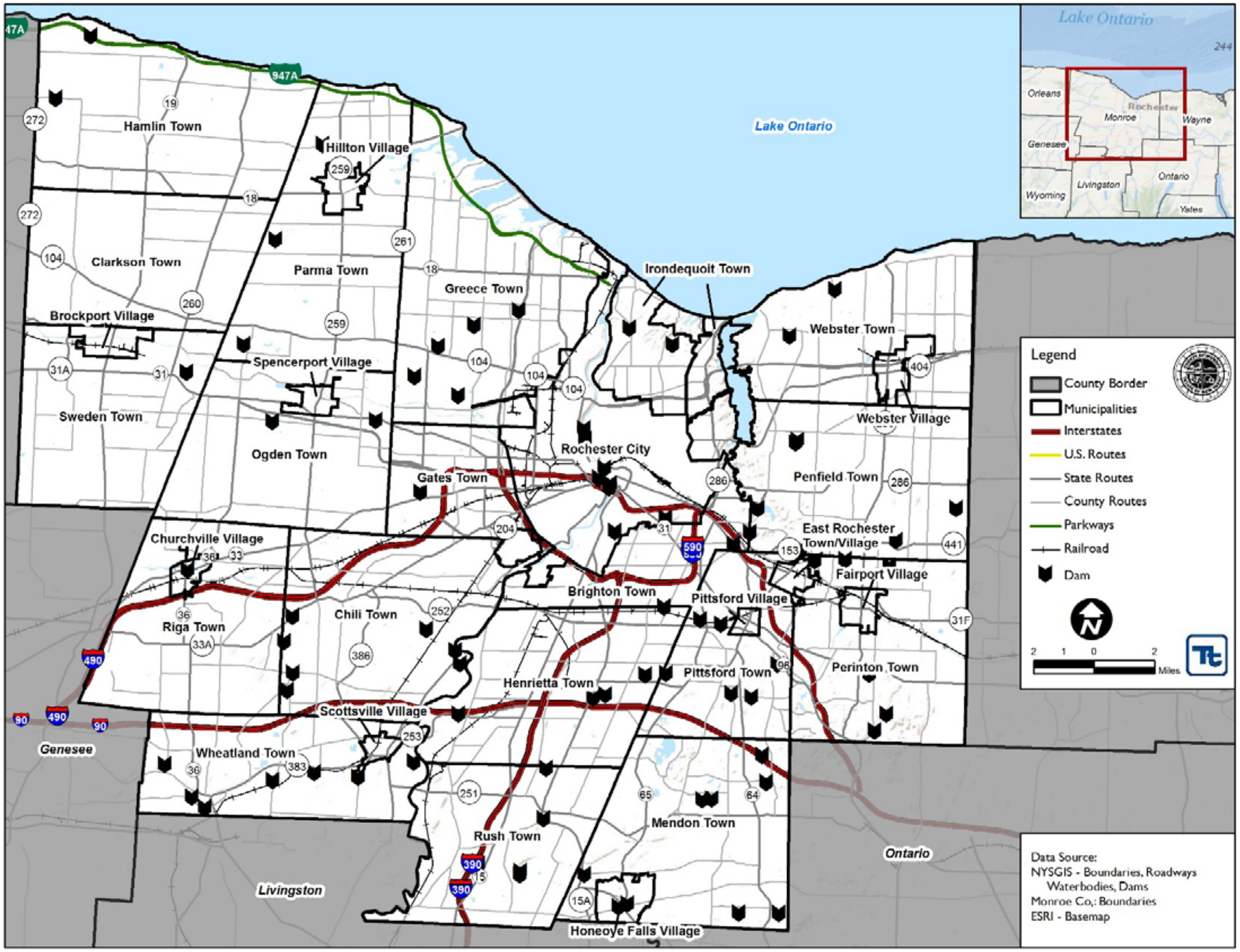


Source: CRREL 2015

Dam Failure

Locations of the dams in Monroe County are shown on Figure 5.4.4-3.

Figure 5.4.4-3. Dams in Monroe County



Source: NYS Geographic Information System (GIS) 2015

Extent

Regarding 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 are necessary (NWS 2011).

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

The most severe consequence of flooding, whether coastal or riverine, is loss of life. Flood-related deaths take up the largest portion of natural hazard-related deaths in the United States. The National Oceanic and Atmospheric Administration (NOAA) forecasts coastal flood conditions so communities can take action. The NWS monitors coastal flooding conditions 24 hours a day, 7 days a week. The NWS issues forecasts, watches, and warnings, similar to local statements regarding hurricanes. These forecasts, watches, and warnings provide details pertaining to a storm's impact on an area. NOAA's National Ocean Service monitors and distributes real-time water levels, which are used to assess storm surge conditions at stations throughout the United States. NOAA issues website alerts on high-water conditions caused by severe weather (NOAA date unknown).

Frequency and severity of flooding are measured according to 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 reference historical records to determine probabilities of occurrence of the different discharge levels. Flood frequency equals 100 divided by the discharge probability. For example, the 100-year discharge has a 1% chance of being equaled or exceeded in any given year. The "annual flood" is the greatest flood event expected to occur in a typical year. These measurements reflect statistical averages only; it is possible for two or more floods with a 100-year or higher recurrence interval to occur within a short time period. The same flood can recur at different intervals at different points on a river.

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

The 100-year flood, the standard used by most federal and state agencies, is used by the NFIP as the standard for floodplain management and to determine need for flood insurance. A structure within a special flood hazard area (SFHA) shown on an NFIP map has a 26% chance of undergoing flood damage during the term of a 30-year mortgage.

Extent of flooding associated with a 1% annual probability of occurrence (the base flood or 100-year flood) is used as the regulatory boundary by many agencies. Also referred to as the SFHA, this boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities. Many communities have maps that show the extent and likely depth of flooding for the base flood. Corresponding water-surface elevations describe the water elevation resulting from a given discharge level, which is one of the most important factors used in estimating flood damage.

The term "500-year flood" is the flood that has a 0.2% chance of being equaled or exceeded each year. The 500-year flood could occur more than once within a relatively short period of time. Statistically, the 0.2% (500-year) flood has a 6% chance of occurring during a 30-year period of time, the length of many mortgages.

While riverine flooding severity can be measured by discharge rates, FEMA evaluates the potential impact of a flood event along the coastline through coastal hydraulic analysis, which consists of a combination of transect layout, field reconnaissance, erosion analysis, and overland wave modeling. Transects show elevations of ground both onshore and offshore, and transect data are used in overland wave height modeling. Transects are selected through consideration of local topography, land use, shoreline features, and shoreline orientation to capture the most useful data. In addition to considering wave heights, coastal hydraulic analysis may also evaluate stillwater elevations. The Monroe County 2008 FIS primarily uses stillwater elevations, rather transect data, to determine Lake Ontario flood sources and vulnerabilities. A summary of these elevations is in Table 5.4.4-1:

Table 5.4.4-1. Summary of Stillwater Elevations for Lake Ontario and Irondequoit Bay

Source/Location	Elevation (feet NAVD)			
	10-Percent	2-Percent	1-Percent	0.2-Percent
Entire shoreline within Town of Greece	247.9	248.7	248.9	249.6
Entire shoreline within Town of Hamlin	247.8	248.6	248.8	249.5
Entire shoreline within Town of Irondequoit	247.9	248.7	248.9	249.6
Entire shoreline within Town of Parma	247.8	248.6	248.8	249.5
Entire shoreline within City of Rochester	247.9	248.7	248.9	249.6
Entire shoreline within Town of Webster	247.9	248.7	248.9	249.6
Reach 1 within Town of Irondequoit	250.6*	251.2*	251.4*	251.8*

Source: FEMA FIS 2008

**Elevation = Stillwater + Wave Run-up*

Note:

NAVD North American Vertical Datum of 1988

Dam Failure

Anticipated extent or magnitude of damage from a dam failure event can be estimated by reference to the classification of the dam. FEMA has three hazard classification levels of dams: low, significant, and high. The classification levels build on each other. The hazard potential classification system should be utilized with the understanding that failure of any dam or water-retaining structure could pose a danger to downstream life and property (FEMA 2004).

- **Low hazard potential dams** are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

- **Significant hazard potential dams** are those where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or other impacts of concern. Many significant hazard potential dams are within predominantly rural or agricultural areas.
- **High hazard potential dams** are those where failure or mis-operation would probably cause loss of human life.

USACE developed the classification system listed in Table 5.4.4-2 for hazard potentials of dam failures. This USACE hazard rating system is based only on potential consequences of a dam failure; it does not take into account probability of such failures.

Table 5.4.4-2. United States Army Corps of Engineers Hazard Potential Classification

Hazard Category[1]	Direct Loss of Life[2]	Lifeline Losses[3]	Property Losses[4]	Environmental Losses[5]
Low	None (rural location, no permanent structures for human habitation)	No disruption of services (cosmetic or rapidly repairable damage)	Private agricultural lands, equipment, and isolated buildings	Minimal incremental damage
Significant	Rural location, only transient or day-use facilities	Disruption of essential facilities and access	Major public and private facilities	Major mitigation required
High	Certain (one or more) extensive residential, commercial, or industrial development	Disruption of essential facilities and access	Extensive public and private facilities	Extensive mitigation cost or impossible to mitigate

Source: FEMA 2012

Note(s):

(1) Categories are assigned to overall projects, not individual structures at a project.

(2) Loss-of-life potential is based on inundation mapping of area downstream of the project. Analyses of loss-of-life potential should take into account the population at risk, time of flood wave travel, and warning time.

(3) Lifeline losses include indirect threats to life caused by interruption of lifeline services because of project failure or operational disruption—for example, loss of critical medical facilities or access to these.

(4) Property losses include damage to project facilities and downstream property, and indirect impacts from loss of project services, such as impact from loss of a dam and navigation pool, or impact from loss of water or power supply.

(5) Environmental losses include environmental impacts downstream caused by the incremental flood wave produced by the project failure, beyond what would normally be expected for the magnitude flood event under which the failure occurs.

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 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:

- **Class A (Low Hazard) dam** – a dam failure is unlikely to result in damage to anything more than isolated or unoccupied buildings, undeveloped lands, and minor roads such as town or county roads; is unlikely to result in interruption of important utilities, including water supply, sewage treatment, fuel power, or cable or telephone infrastructure; and/or is otherwise unlikely to pose threat of personal injury, substantial economic loss, or substantial environmental damage.
- **Class B (Intermediate Hazard) dam** – a dam failure may result in damage to isolated homes, main highways, and minor railroads; may result in interruption of important utilities, including water supply, sewage treatment, fuel power, or cable or telephone infrastructure; and/or is otherwise likely to pose threat of personal injury and/or substantial economic loss or substantial environmental damage. Loss of human life is not expected.

- **Class C (High Hazard) dam** – a dam failure may result in widespread or serious damage to home(s); damage to main highways, industrial or commercial buildings, railroads, and/or important utilities, including water supply, sewage treatment, fuel, power, or cable or telephone infrastructure. Substantial environmental damage could occur. Loss of human life or widespread substantial economic loss is likely.
- **Class D (Negligible or No Hazard) dam** – a dam has been breached or removed, or it has failed or otherwise no longer materially impounds waters, or it is 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.

According to NYS Geographic Information System (GIS) data, the majority of dams in Monroe County are categorized as Class A (44 dams) or Class D (17 dams), meaning that they are low hazard or negligible/no hazard. Six dams in the County are considered Class B, and 9 are Class C. Six other dams did not receive a hazard code. The nine High Hazard dams (Class C) consist of the following (associated basin and river names in parentheses):

- Highland Park Reservoir Dam (Central Lake Ontario Basin)
- Cobbs Hill Reservoir Dam (Central Lake Ontario Basin)
- Rush Reservoir Dam (Genesee Basin)
- Lock 33 Dam Erie Canal (Central Lake Ontario Basin/NYS Barge Canal)
- Court Street Dam (Genesee Basin/Genesee River)
- Larkin Creek Dam (Western Lake Ontario Basin/Larkin Creek)
- Round Pond Creek Dam (Western Lake Ontario Basin/Round Pond Creek)
- English Road Detention Facility Dam (Western Lake Ontario Basin/Paddy Hill Creek)
- Lock 32 Dam Erie Canal (Central Lake Ontario Basin/NYS Barge Canal)

Previous Occurrences and Losses

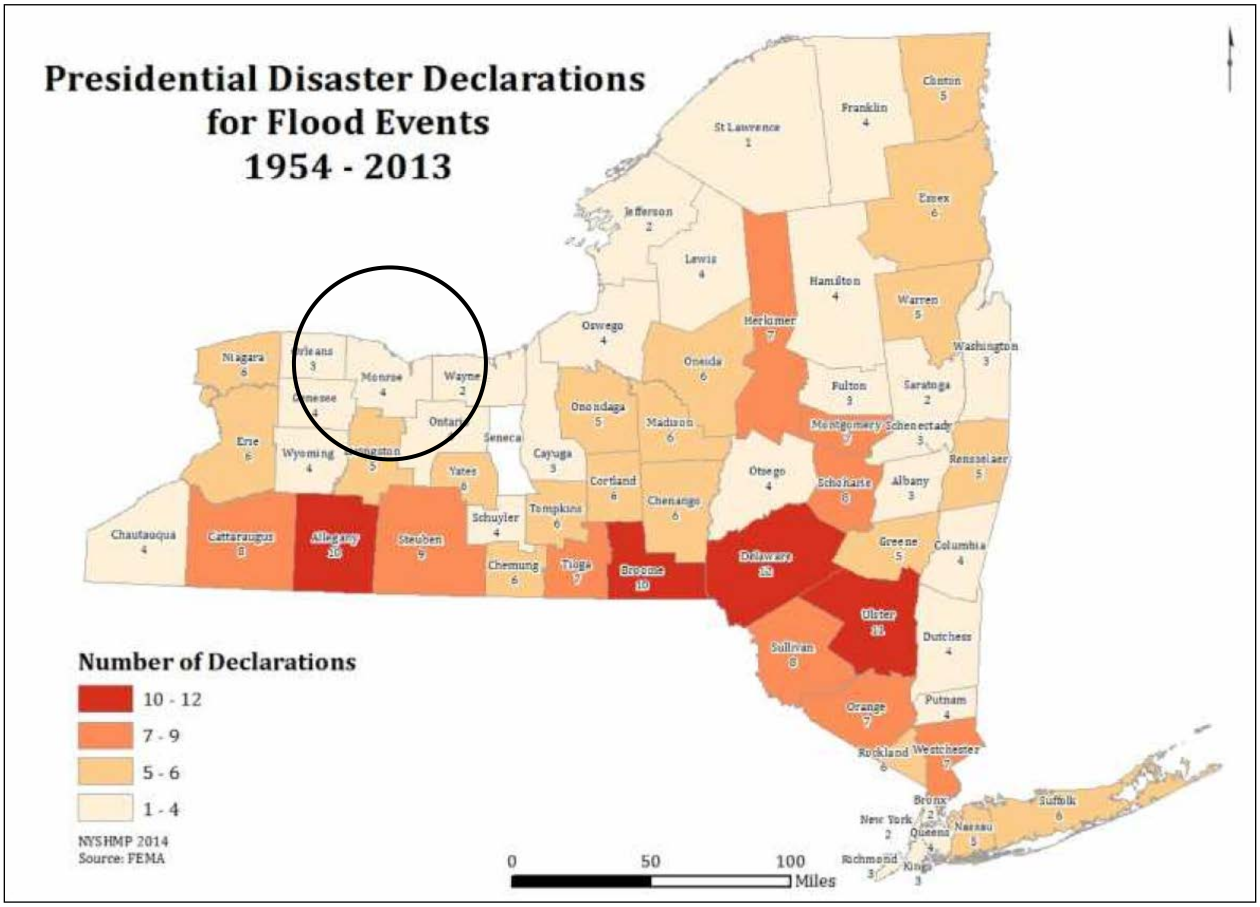
Historical information regarding previous occurrences and losses associated with flooding events throughout NYS and areas within Monroe County was obtained from many sources. Given so many sources reviewed for the purpose of this HMP, loss and impact information regarding many events could vary depending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

Between 1953 and 2015, NYS was included in 41 flood major disaster (DR) or emergency (EM) declarations. These declarations were classified as one or a combination of the following: coastal storms, high tides, heavy rain, flash flooding, flood, flooding, hurricane, wave action, ice storm, Nor'Easter, inland flooding, tornadoes, landslides, and winds. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. However, not all counties were included in the DR and EM declarations. The NYS HMP and other sources indicate that Monroe County has been under DR or EM declarations during four flood events (FEMA 2015).

Figure 5.4.4-4 shows the FEMA DR declarations for flooding events in NYS from 1954 to 2013 (the figure does not indicate EM declarations). This figure shows that Monroe County was included in four DR declarations. These events were for severe storms and flooding from August to September 2004 (DR-1564); severe storms and flooding from June to July 1998 (DR-1233); ice storm, severe storms, and flooding in March 1976 (DR-

494); and high winds, wave action, and flooding in March 1973 (DR-367). Monroe County has additionally been included in other DR declarations, specifically severe winter storms in January 1998 (DR-1196) and Hurricane Agnes in June 1972 (DR-338). While these events were not considered flood events by FEMA, they did result in flooding in the County.

Figure 5.4.4-4. Presidential Disaster Declarations for Flooding Events, 1954 to 2013



Source: NYS DHSES 2014

Note: Monroe County is within the black circle.

United States Department of Agriculture (USDA) crop losses provide another indicator of severity of previous events. Additionally, crop losses can significantly impact the economy by reducing produce sales and purchases. Such effects may have long-term consequences, particularly if crop yields are low the following years as well. Although Monroe County has undergone annual crop losses due to natural hazard events, USDA does not note in its records from 1989 to 2014 that any of these losses resulted from flood damages (USDA 2015).

For this 2015 Plan update, flood events were summarized from 1972 to 2015. Table 5.4.4-3 lists flooding events and FEMA disaster declarations between 1972 and 2015. With flood documentation for NYS and Monroe County being so extensive, not all sources have been identified or researched. Therefore, Table 5.4.4-3 may not include all events that have occurred throughout the county.

Table 5.4.4-3. Flooding Events in Monroe County, 1972 to 2015

Date(s) of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
June 23-26, 1972	Hurricane Agnes	DR-338	Yes	Tropical Storm Agnes and associated weather systems produced the most destructive widespread flooding of record over eastern United States. In the Genesee Basin, the predominant portion of rainfall occurred from 9 p.m. on 20 June, to 6 a.m. on 23 June. The maximum total storm rainfall, 13.72 inches, and maximum daily rainfall, 6.57 inches, were recorded at the Wellsville gage. A "bucket survey" of the Genesee Basin by USACE personnel indicated a maximum of about 16 inches of rainfall in the upper reaches of Dyke Creek near Andover, New York. Average total basin rainfall during the period 20-25 June was 7.1 inches, while the average for the same period on the upper basin (above Mount Morris dam) was 10.20 inches. Regulation during a portion of this flood required controlled release of dam outflows exceeding downstream channel capacity to prevent overtopping the spillway with debris-laden flows. The reservoir pool reached a maximum elevation of 755.8 feet, thus occupying approximately 96 percent of total reservoir storage. This was the highest pool elevation ever attained in the Mount Morris Reservoir. Detailed information on this flood appears in Buffalo District's "Report of Flood, Tropical Storm Agnes, 21-23 June 1972, Genesee River Basin," dated August 1973 (USACE "Genesee River Flood Emergency Exercise Manual, February 1992," p. H-4). Rochester received more than 4 inches of rain. Meanwhile, destructive floods washed out roadways and bridges, and even caused building damage on the upper Genesee River. It took nearly all summer to drain local fields (*Democrat & Chronicle*, June 22, 2006).
1972	Lake Ontario - High Levels	N/A	N/A	None recorded.
March 21, 1973	High Winds, Wave Action, Flooding	DR-367	Yes	FEMA Disaster Declaration.

Date(s) of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
Spring 1973	Coastal (Lacustrine) Flooding	N/A	N/A	The most severe flooding along the Lake Ontario shoreline was during spring 1973. Lake Ontario's water levels rose to 249.6 feet above sea level as a result of excessive rain in 1972 throughout the Great Lakes Basin. This level of water rise was recorded as having an approximately 100-year recurrence interval. Damages resulting from the water rise and associated flooding included extensive property damage, public utility interruption, and destruction of roads. Flooding also contaminated local water supply and reduced the effectiveness of effluent disposal (FEMA FIS 2008).
October 29, 1974	Localized Flooding	N/A	N/A	A sewer tunnel being constructed under the Barge Canal in Bushnell's Basin cracked and gave way, sending over 200 million gallons of water down Tributary 21 and into Brook Hollow Rd. Because the flood was so localized, it was not designated a disaster area. 41 homes damaged, 2 demolished Power outages in 165 homes 100 homes without gas Displaced residents Roads destroyed Millions of dollars in property damage 1 minor injury
February and July 1976	Severe Storms, Heavy Rains, Flooding, and Thunderstorms	N/A	N/A	During the period 16-23 February, approximately 2.6 inches of rain fell over the upper basin. This rainfall, augmented by about 2 inches of snowmelt runoff, resulted in a peak reservoir elevation on 23 February of 727.6, or about 71 percent of available storage. During the remainder of February, every effort was made to discharge as much water as possible consistent with downstream conditions. At the end of the month, the pool elevation was 709, or about 56 percent of capacity. During the period 1-6 March, about 2.5 inches of rain, including some snowmelt, caused the pool to rise again. On 6 March, the reservoir pool peaked at 744.1 feet, thus utilizing 85% of total storage. Peak inflows to Mount Morris Reservoir during the February and March runoff events reached 32,500 cfs and 28,000 cfs, respectively. Although the peak inflows were not particularly impressive, the volume of water received caused the pool elevation to be the second highest of record, exceeded only by that of Tropical Storm Agnes (USACE, "Genesee River Flood Emergency Exercise Manual, February 1992," p. H-4).

Date(s) of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
March 28-30, 1993	Flood	N/A	N/A	Flooding on some creeks and rivers. “The most significant occurred along Black Creek in Monroe County. A dozen homes along the creek were surrounded by water. Large segments of roads were inundated and still closed at months end. The Genesee River rose just above floodstage at Avon and Rochester even with closure of all gates at the Mt. Morris Dam. The dam stored over 5 inches of runoff and used 85% of its storage capacity.” The County EOC was activated on March 30th for 4 hours.
April 1-5, 1993	Flood	N/A	N/A	Flooding continued as a result of additional rain and snowmelt—the worst flooding since Hurricane Agnes in 1972. The County EOC was activated on April 1st for 39.5 hours. Additional information is available at County OEM: USACE, “After Action Report for the Flood of 1993”; NOAA’s, “Natural Disaster Survey Report: The Great Flood of 1993,” and the County’s Disaster Response File.
April 1993	High Levels	N/A	N/A	Lake Ontario. County files available at the OEM.
March 23-24, 1994	Flood	N/A	N/A	Rainfall combined with snowmelt caused flooding. Black Creek at Churchville reached flood stage on the 23rd. Oatka Creek reached flood stage at Garbutt on the 24th.
April 14, 1994	Flood	N/A	N/A	Spring rains, together with saturated ground, raised the level of the Genesee River about a foot and a half above flood stage. A few roads had minor flooding.
January 21, 1995	Flood	N/A	N/A	Heavy rains on the 20th caused Black Creek to exceed flood stage and overtop its banks at various locations along its reach.
August 3, 1995	Flash Flood	N/A	N/A	Flash flooding in Monroe County caused $35,000.00 in damages.
January 19, 1996	Rising Waters	N/A	N/A	The County EOC was activated for 2 hours to assess and coordinate agency activity associated with rising waters due to a “January Thaw” and rainfall.
April 14-15, 1996	Flood	N/A	N/A	A general 1- to 2-inch rainfall, combined with lingering snowmelt from higher elevations, resulted in considerable lowland flooding. Most major creeks and rivers rose to bankful. The Genesee River was above flood stage for 5 hours. Oatka Creek was above flood stage for 31 hours. Black Creek was above flood stage for 8 hours and caused $15,000.00 in damages.

Date(s) of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
June 12, 1996	Flash Flood	N/A	N/A	Thunderstorms moving across the southern portion of the county produced torrential rains and caused flash flooding on the west side. Several roads in Chili were flooded and had to be closed until sewers could handle the storm runoff. Estimated property damage was $20,000.00.
July 30, 1996	Flash Flood	N/A	N/A	Thunderstorms during the late afternoon hours dropped over 2 inches of rain within 4 hours, resulting in flash floods. The waters flooded over 200 basements in the City of Rochester and caused an estimated $45,000.00 in damages.
October 19-20, 1996	Flash Flood	N/A	N/A	Flash flooding occurred, causing an estimated $100,000.00 in damages.
1997	High Levels	N/A	N/A	Lake Ontario. County response files available at the OEM.
February 5, 1997	Dam Failure/Flood	N/A	N/A	An earthen dam gave way, causing flood waters to spill onto roadways and several backyards. Damage was estimated at $4,000.00.
1998	High Levels	N/A	N/A	Lake Ontario. County response files available at the OEM.
January 8 and 11, 1998	Flood	DR-1196	Yes	Western (and Central) NYS was drenched with unprecedented January rainfalls over a 36-hour period. Generally, 3 to 4 inches of rain fell on bare, saturated ground across the Genesee basin. The Genesee River crested at 36.4 feet at Avon (the highest since 1972) and at 16.8 feet in Rochester (the highest since 1984). Black Creek crested at Churchville at 9.2 feet (the highest since 1960). At Garbutt, Oatka Creek crested at 8.7 feet (a record flood). Damages were estimated at $375,000.00. Local fire fighting and public works departments were called to pump water from flooded basements. The floodwaters overwhelmed several municipal wastewater treatments plants, and water emergencies were declared. Several States of Emergency were declared at various locations in Western/Central NYS. The Town of Webster had estimated damages of $100,000.00 resulting from flash flooding. The County EOC was activated for 30 minutes on January 8th. This event prompted a Disaster Declaration by President Clinton, FEMA-1196-DR-NY.

Date(s) of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
June 13, 1998	Flood	N/A	N/A	Thunderstorms crossed the western Finger Lakes during the early evening hours, dropping several inches of rain in less than an hour. The heavy rains flooded roads and forcing closures throughout Monroe County. Chili Center had estimated damages of $30,000.00.
June 25-July 10, 1998	Severe Storms and Flooding	DR-1233	Yes	FEMA Declared Disaster.
June 30, 1998	Flood	N/A	N/A	Thunderstorms throughout the day dropped several inches of rain over the same area. The heavy rains resulted in urban and drainage flooding in the Rochester metro area. The Town of Brighton had estimated damages of $13,000.00.
July 8, 1998	Flood	N/A	N/A	Nearly 3 inches of rain fell at the Rochester airport, with slightly higher amounts reported over the southern suburbs. Urban flooding resulted in Rochester, Pittsford, and Penfield. In Penfield, basements of the Forest Hills Condominium complex flooded for the second time that year. Many of the basements and appliances had just been repaired and replaced following floods in January. The Town of Penfield had damages estimated at $100,000.00, and the Town of Pittsford reportedly had $150,000.00 in damages.
August 25, 1998	Flood	N/A	N/A	Slow moving thunderstorms moved across the Rochester metro area producing 2 to 4 inches of rain in just a few hours. Widespread urban flooding occurred. The Sheriff reported numerous roads closed across the south and southeast areas of the County. Estimated damages were $35,000.00.
January 23-24, 1999	Flood	N/A	N/A	Warm temperatures melted the snowpack from record snowfall in late December and early January. Nearly 2 feet of ripe snowpack dissolved to just a few inches. The runoff caused flooding in poor drainage and low lying regions across the area, with roads closed at some locations for a couple of days. One of the hardest hit areas in Monroe County was the Town of Chili, where evacuations occurred. Damages were estimated at approximately $55,000.00.

Date(s) of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
May 12, 2000	Flash Flood	N/A	N/A	Thunderstorms rolled across the Niagara Peninsula and then along the Lake Ontario shore counties. Only small hail was reported with the storms; however, the storms produced hurricane-force winds. An 86 mph wind gust was recorded at the Niagara Coast Guard Station in Youngstown. The high winds buffeted the area, taking down trees and power lines. Various communities reported power outages of 12 hours or more. In Irondequoit, Monroe County, Kings Highway and Bayview Road caved in as a result of erosion.
May 13, 2000	Flash Flood	N/A	N/A	A second round of thunderstorms crossed the area during the early afternoon hours. The heavy rains that fell on already saturated ground resulted in flash flooding in Monroe and Wayne Counties. In Webster, for example, 4 to 6 inches of water covered Schlegel Road. Road closures were common in the area for several hours.
July 16, 2000	Flash Flood	N/A	N/A	Thunderstorms brought heavy rains to the area, dropping 2 to 3 inches of rain. West Henrietta and Jefferson, roads had to be closed due to the flood waters. In the City of Rochester, police closed Romona Street, Mt. Read Boulevard, and Lexington, Driving Park, and LaGrange Avenues. Damages were estimated at $15,000.00.
March 18, 2003	Flood	N/A	N/A	An abrupt change to warmer weather at mid-month resulted in a quick meltdown of the winter snowpack. Area creeks rose to near or above bankful, with three creeks in western NYS exceeding flood stage. At Churchville, Monroe County, the Black Creek crested at 6.7 feet or about a half a foot above flood stage. Oatka Creek at Garbutt, Monroe County, crested at 6.2 feet, just above its 6-foot flood stage. Tonawanda Creek overflowed its banks, with flooding along the Erie/Niagara county border. The creek crested at 13.8 feet, almost 2 feet above the flood stage.
May 24, 2004	Flash Flood	N/A	N/A	A weak cold front crossed the area during the overnight hours. The slow moving thunderstorms that accompanied the front produced damaging winds and torrential rains. Trees and power lines were downed, with scattered power outages reported. Roads were closed in Irondequoit and Ishua. Additionally, NWS Buffalo Office data on flash floods indicated basement and road flooding in Irondequoit.

Date(s) of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
August 29, 2004	Flash Flood	N/A	N/A	A cold front stretching across the lower Great Lakes became nearly stationary. Occasional showers and thunderstorms persisted along the front during the late morning and early afternoon hours. The thunderstorm winds, estimated to 60 mph, downed trees and power lines in Caledonia, Livingston County; Henrietta and Brighton, Monroe County; Croghan, Lewis County; and Lorraine, Jefferson County. The training thunderstorms produced heavy rains, leaving parts of Monroe and Wayne Counties under water up to waist high. Weather radar estimated that rainfall totaled 4 to 6 inches over parts of those counties. Additionally, NWS Buffalo Office data on flash floods indicated widespread street flooding in Rochester.
August to September, 2004	Severe Storms and Flooding	DR-1564	Yes	Monroe County did not activate the EOC for this event. Hurricane Frances, "…inundated western and central New York with drenching rain as its remnants drifted north across the region. Areawide rainfall totaled 3 to 5 inches with the bulk of it falling in a 6- to 9-hour period from very late September 8th to midday September 9th. Several creeks recorded their greatest flows and highest gage levels ever in a non-winter/spring season. The heaviest rain was in a swath …across Monroe and western Wayne counties, with between 3.5 to 4.5 inches" (NWS, The Lake Breeze, Spring 2006). The NYS, Buffalo Office issued a Flood Warning (0300 hours). Three villages and one town declared States of Emergency due to flooding and road closures. The Hilton Fire Department evacuated its Fire Station due to flooding. The Red Cross and local community shelters housed 163 evacuees. The Ogden Highway Superintendent evacuated two houses on Washington Street because flood waters from the Erie Canal had reached the first floor windows. OEM distributed 1,350 sandbags. The Red Cross distributed 75 clean-up kits. FEMA opened a Disaster Recovery Center at the Ogden Town Hall (November 22 – December 3, 2004) and deployed a Community Relations Team. FEMA financial assistance: $256,481 – Public Assistance; $1,964,092.96 – Individual Assistance; and $72,426 – Mitigation, HMGP (OEM Disaster Response File).
September 9, 2004	Flood	N/A	N/A	Western and central New York were inundated by drenching rains as the remnants of hurricane Frances drifted north across the region on Thursday September 9th. Areawide rainfall totaled 3 to 5 inches, with the bulk of it falling within a 6- to 9-hour period from very late Wednesday to midday Thursday. Several creeks in the Buffalo and Rochester areas recorded their greatest flows and highest gage levels ever in a non-winter/spring season.

Date(s) of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
April 3, 2005	Flood	N/A	N/A	Deep low pressure over Pennsylvania brought copious amounts of precipitation to western and central New York...falling mainly as rain across much of the area. Rainfall totals generally ranged from 2 to 3 inches. The rain, combined with snowmelt, produced flooding. Basement flooding was reported in Gorham and Rochester. The heavy rains produced slick roads that were blamed for numerous automobile accidents in Monroe and Wayne Counties. Six area creeks and rivers reached flood stage.
June 10, 2005	Flash Flood	N/A	N/A	Slow moving thunderstorms produced 2 to 2.5 inches of rain within an hour over parts of Livingston and Monroe Counties. Creeks overflowed, and roads and homes flooded. Additionally, NWS Buffalo Office data on flash floods indicated basement flooding in Charlotte.
July 14, 2005	Flash Flood	N/A	N/A	Thunderstorms developed in an unseasonably hot and humid airmass during the late afternoon and early evening hours. The storms downed trees and power lines in Rochester, Lockport, Evans, Batavia, Orchard Park, and Spencerport. A house chimney was damaged by the downburst winds in Rochester. In Chili, a woman was slightly injured while talking on the telephone when lightning traveled through the home's telephone line. Also in Chili, a house fire on Chili Avenue Extension was blamed on a lightning strike. The heavy rains that accompanied the storms resulted in flash flooding in parts of Lewis and Monroe Counties. In the Rochester metro area, numerous reports were received of flooded roads and basements. In Turin, the flood waters washed out a portion of Fish Creek Road. Additionally, NWS Buffalo Office data on flash floods indicated basements flooded in Chili.
July 16-17, 2005	Flood	N/A	N/A	More than 0.5 inch of rain fell within 60 minutes and 20 minutes, respectively, during these evenings. The NYS, Buffalo Office reported that strength of the rain caused streets to look and feel like creeks. Lightning struck a house and caused a fire" (*Democrat & Chronicle*, July 18, 2005).
September 16, 2005	Flood	N/A	N/A	"...More than 2 inches of rain fell in the Rochester area within the span of three hours and 3.08 inches for the entire day. The amount broke a 130-year record of the day. ...Some residents experienced a severe backup of sewer lines into their basement. Water from flooded streets was blamed...as well as surcharging of basement drains" (*Democrat & Chronicle*, October 22, 2005). "This rainfall fits the definition of flash flooding" (*Democrat & Chronicle*, September 18, 2005).

Date(s) of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
June 26-28, 2006	Flooding	N/A	N/A	Monroe County resources responded to flooded Southern Tier counties when called for Mutual Aid. Ambulances, Special Operations tactical teams from the Fire Service, and 911 Dispatchers deployed in Task Forces and Strike Teams through requests from the NYS Fire Mobilization Plan, the NYS Department of Health, and local Emergency Managers for assistance with specific assets (OEM Disaster Response File).
July 12, 2006	Flash Flood	N/A	N/A	A warm front stretching across the region focused heavy rain over the counties along the south shore of Lake Ontario. Two to 4 inches fell across Orleans and Monroe Counties, with more than 5 inches over a portion of Wayne and northern Cayuga Counties. The rains inundated roads, buildings, and crops. Sections of roads were washed away in Wolcott, Irondequoit, and Webster, among others. Cars damaged in high water numbered in the thousands. States of Emergency were declared in several towns and villages, including Wolcott. The rain water inundated agricultural fields, and hundreds of thousands of dollars' worth of squash, potatoes, and corn were ruined. Rochester's rainiest July day on record (3.33 inches) overflowed creeks, flooded basements, and even created sinkholes behind some Irondequoit homes. Thirty percent of city firefighters' calls were for water-related problems. In Irondequoit, the force of water pushing through a drainage system forced the ground to implode, creating a 25-foot-wide by 10-foot-deep crater. The heavy showers came in a series of training storms. Flooding closed a portion of Interstate Route 390, and stranded cars in several shopping center parking lots. NYS Route 404 was closed after a 25-foot-wide sinkhole formed. Localized flash flooding resulted in drain and sewer back-ups, many of them clogged by debris. The County Health Department discouraged swimming in Lake Ontario for 72 hours due to heavy discharge from streams, bays, and the Genesee River (*Democrat & Chronicle*, July 13, 2006; July 14, 2006). The Erie Canal was re-opened. A significant stretch had been closed due to flooding, stranding boaters for up to 2 weeks (*Democrat & Chronicle*, July 15, 2006). Additionally, NWS Buffalo Office data on flash floods indicated Rochester I-390 closed.

Date(s) of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
July 28, 2006	Flood	N/A	N/A	"Heavy rain... caused flooding and accidents throughout the area. Parts of the Empire State Games were delayed. Nearly 2 inches of rain fell at the Airport, and 3 inches fell in Webster. Numerous accidents were reported and NYSDOT closed a portion of Route 104 due to flooding. Rochester firefighters pumped water from the roof of Rural/Metro Medical Services. And, the rainfall is believed to have caused a landslide in Irondequoit at German Village" (*Democrat & Chronicle*, July 29, 2006).
March 14, 2007	Flood	N/A	N/A	Saturated ground, snowmelt from warm weather, and additional rainfall constituted ideal conditions for spring flooding. Thirteen of the area river and creek forecast points exceeded flood stage.
March 15, 2007	Flood	N/A	N/A	Saturated ground, snowmelt from warm weather, and additional rainfall constituted ideal conditions for spring flooding. Thirteen of the area river and creek forecast points exceeded flood stage. (Continuation of event from day prior.)
April 15-28, 2007	Coastal Flood	N/A	N/A	A Nor'easter that battered the East Coast affected our area beginning on the 15th, with the NWS, Buffalo Office issuing a Coastal Flood Advisory that included the Lake Ontario shoreline in Monroe County. The 911 Center deployed "HyerReach" calls to more than 2,200 homes along the shore to inform occupants of the impending flood threat and to encourage them to take precautionary measures in response to the rising water. The County Parks Department placed sandbags around the historic carousel at Ontario Beach Park to mitigate wave run-up and water damage. NOTE: Subsequent to this storm, Monroe County provided sandbags to shoreline municipalities for residential and business flood fighting efforts. Conditions in other areas affected airline transportation, imposing delays and cancellations at the Rochester Airport. About 4.7 inches of snow prompted extended shifts for DPW crews and several motor vehicle accidents. Black Creek flooded on the 17th, prompting a Flood Warning by the NWS, Buffalo Office. Monroe County closed Ellison Park due to flooding on Irondequoit Creek. The city fire department responded to about 25 structural damage calls due to the weather. Precipitation on the 16th set a new daily record of 1.1 inches of rain at the Airport (*Democrat & Chronicle*, April 16, 2007; April 18, 2007; OEM Disaster Response File; Monroe County New Release, April 30, 2007).

Date(s) of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
April 2007	High Levels	N/A	N/A	"A nor'easter earlier in April, recent rainfall and snow that's still melting have delayed the opening of New York's canal system, traditionally scheduled to open on May 1st. Until water levels recede, operations to place water control structures in position and set buoys and other critical navigational aids cannot commence" (*Democrat & Chronicle*, April 30, 2007)." " 'The flooding from last month's nor'easter might seem mild if the thousands of dams in the state continue to decline,' Senator Charles Schumer said. There are nearly 2,000 federally recognized dams in New York...and the April storm exposed serious flaws in dams." (*Democrat & Chronicle*, May 8, 2007).
July 23, 2008	Flash Flood	N/A	N/A	Thunderstorms developed across the area, including in Monroe County, as an upper level low was centered over the Great Lakes region. Storms developed rapidly along an outflow boundary from the Niagara Peninsula to Erie County. Thunderstorms that developed produced damaging winds estimated to 60 mph and hail measured up to 1 inch in diameter. Scattered power outages were reported. The storms also dropped several inches of rain within a short span of time over parts of Rochester, resulting in flash flooding. Nearly 1 foot of water across the road resulted in closing of portions of Interstates 490 and 390 for several hours right at the start of the evening rush hour. Additionally, NWS Buffalo Office data on flash floods indicated 2W Rochester Rte 490 closed between Mt. Read and 390.
December 28, 2008	Flood	N/A	N/A	Unseasonably warm temperatures in the 60s, combined with 1.25 inches of rain, melted a snowpack of 4 to 8 inches. This resulted in flooding of creeks and streams in western NYS. In Monroe County, low-lying areas, roadways, and basements flooded, and some evacuations were ordered.
February 12, 2009	Flood	N/A	N/A	A major thaw and additional rainfall resulted in rapid snowmelt and runoff, with several area creeks exceeding their flood stages. Two to 5 inches of water in the snowpack quickly melted as temperatures climbed into the upper 50s and 60s. Some backyard and basement flooding occurred from Churchville to Chili.

Date(s) of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
March 9, 2009	Flood	N/A	N/A	Soaking rains over a 4-day period beginning on the 7th provided the region (including Monroe County) with nearly all of the month's precipitation, between 2 and 3 inches. The rain combined with the melting winter snowpack and frozen ground to result in widespread flooding on area rivers and creeks. Numerous reports of road closures along those rivers and creeks were received. This was the third winter flood event this season, a rare occurrence in western NYS.
June 2009	Flood	N/A	N/A	"The last week of June featured a variety of weather (including) thunderstorms that produced localized flooding (in Monroe County)...." (*Democrat & Chronicle*, July 2, 2009).
July 13, 2010	Flash Flood	N/A	N/A	An area of low pressure slowly moved across the region, bringing rainfall amounts of up to 2 inches in some areas. The heavy rains produced localized flash floods that flooded some homes and roads. Roads reported closed by flood waters included: Blossom Road in Rochester (three cars stuck in water at least 3 feet deep), County Route 26 in Canadice and Richmond (a mudslide deposited up to 4 feet of mud in some areas), State Route 64 in Bristol Center (closed from County Rte 32 to Dugway Road), and County Route 33 in Honeoye. At 1447 hours, the NYS, Buffalo Office issued a Flash Flood Warning for "'Eastern Monroe County, including the City of Rochester, Irondequoit, East Rochester and Brighton until 1745 hours" (NWS Bulletin, July 13, 2010).
August 14, 2011	Flash Flood	N/A	N/A	Heavy rains and embedded thunderstorms dropped up to 4 inches of rain over parts of the region within just a few hours. Flash flooding occurred in Allegany County, where roads were flooded and closed in Cuba and Canadea. In metro Rochester, Monroe County, major roads such as I-490 and I-590 were closed. Cars were submerged to the windows in some areas. Flash flooding was also reported in Webster and Irondequoit.
April 13, 2013	Flood	N/A	N/A	A warm frontal boundary lifted north and stalled across the lower Great Lakes, leading to a period of significant rainfall across the region between the 9th and 12th. The rainfall pushed many area streams and creeks in western NYS above action stage. Black Creek at Churchville exceeded flood stage (6 feet) for around 21 hours, cresting at 6.37 feet. This resulted some backyard and basement flooding in Churchville and Chili.

Date(s) of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
June 13, 2013	Flood	N/A	N/A	A warm front associated with a low pressure system that moved across the Ohio Valley and Pennsylvania resulted in a swath of 1 to 2 inches of rain from the Rochester metro area east to near Fulton. This created minor flooding issues on area roadways, along with flooding of Ellison Park in Rochester when Irondequoit Creek rose above bankful. The creek crested at 9.23 feet around 4 p.m. on the 14th, and receded to its banks on the morning of the 15th.
July 3, 2013	Flood	N/A	N/A	Thunderstorms developed over the northern Finger Lakes along a lake breeze in a warm humid air mass. The thunderstorms produced damaging winds that downed trees and power lines. These were reported in Shelby Center, Fairport, Pittsford, Macedon, Palmyra, Newark, and Lyons. The thunderstorms also produced hail up to 1 inch in diameter in Waterport. Between 1.5 and 2.5 inches of rain was measured across parts of Monroe and Wayne Counties. This amount of rain within a very short time resulted in poor drainage flooding in the City of Rochester. Several city streets were inundated, included Amsterdam Road and Monroe Avenue.
December 22, 2013	Flood	N/A	N/A	A surface front stalled across the region acted as a pathway for periods of heavy precipitation. Rainfall amounts of 1.5 to 3.0 inches fell across the Niagara Frontier and parts of the Genesee Valley and Finger Lakes. The heavy rain combined with snowmelt to produce flooding. In addition to many of the gauged rivers and creeks reaching flood stage, flooding in low-lying and poor drainage areas was common. In urban areas, runoff of the heavy rain and snowmelt was hindered by snow- and ice-clogged storm drains.
May 13-22, 2014	Flood	DR-4180	No	On the 16th, heavy rain along a slow moving cold front produced flooding across parts of the Genesee River valley and Finger Lakes region. Rainfall amounts of 2 to 3 inches fell on already rain-soaked soils. Honeoye Creek crested at 5.63 feet, a moderate flood. It was the fourth highest crest on record, causing flooding in and around the Village of Honeoye Falls. Roads were reported flooded in Monroe County in Brighton and Fairport. Resulting damages were enough to warrant a State Disaster Declaration. Monroe County had a public sector cost of $87,377.48 for flood damages or other costs (i.e. labor costs associated with maintaining sewer systems) for this event.

Date(s) of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
July 28, 2014	Flash Flood	N/A	N/A	Low pressure slowly moved across western and central New York, and brought heavy rains and embedded thunderstorms to the region. Rainfall totaled 3 to 6 inches during the afternoon hours and resulted in flash flooding in several areas of the Finger Lakes region. In Monroe County, flooding was reported in Riga, Caledonia, and South Chili. The NYS Thruway was forced to close between Exits 46 and 47. In Honeoye, a bridge on Cole Road washed out, as did portions of Egypt Road in Bristol.
August 1, 2014	Flood	N/A	N/A	Thunderstorms developed in a moderately unstable airmass along the lake breeze boundary that extended across the lower Genesee Valley and Western Finger Lakes. The thunderstorms produced damaging winds that downed trees and wires in Greece and Newark. Hail also fell during the storms: 1-inch hail was reported in Rochester, and 0.75-inch hail covered the ground in Newark. Heavy rains resulted in urban flooding. Storm sewers could not contain flows from the intense rainfall, and streets closed in Newark and Greece.

Source(s): FEMA 2014, NYS DHSES 2014, NCDC 2014, NWS 2010; Democrat & Chronicle 2010; USACE 2010; Monroe County 2010

Notes:

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

DHSES	*Division of Homeland Security and Emergency Services*
DPW	*Department of Public Works*
DR	*Federal Disaster Declaration*
EOC	*Emergency Operations Center*
FEMA	*Federal Emergency Management Agency*
FIS	*Flood Insurance Studies*
HMGP	*Hazard Mitigation Grant Program*
mph	*Miles per hour*
N/A	*Not applicable*
NCDC	*National Climate Data Center*
NOAA	*National Oceanic and Atmospheric Administration*
NYS	*New York State*
NYSDOT	*New York State Department of Transportation*
OEM	*Office of Emergency Management*
USACE	*U.S. Army Corps of Engineers*

Coastal (Lacustrine) Flood Events

As noted above, the most severe flooding along the Lake Ontario shoreline was during spring 1973. Lake Ontario's water levels rose to 249.6 feet above sea level as a result of excessive rain in 1972 throughout the Great Lakes Basin. This level of water rise was recorded as having an approximately 100-year recurrence interval. Damages resulting from the water rise and associated flooding included extensive property damage, public utility interruption, and destruction of roads. Flooding also contaminated local water supply and reduced effectiveness of effluent disposal (FEMA FIS 2008).

Ice Jam Events

Based on review of the CRREL database, Table 5.4.4-4 lists the ice-jam events that have occurred in or near the County between 1780 and 2015. Events listed below that occurred outside of the County were included because they were close enough to the County borders to cause possible flooding impacts on Monroe County. Information regarding losses associated with these reported ice jams was limited.

Table 5.4.4-4. Ice Jam Events in Monroe County between 1780 and 2015

Jam Date	City (Additional Geographic Identifier)	River	Water Year	Gage Number
1/19/1926	Ithaca	Fall Creek	1926	4234000
1/22/1927	Ithaca	Fall Creek	1927	4234000
2/8/1928	Ithaca	Fall Creek	1928	4234000
2/27/1929	Ithaca	Fall Creek	1929	4234000
2/20/1930	Ithaca	Fall Creek	1930	4234000
3/4/1934	Ithaca	Fall Creek	1934	4234000
2/16/1935	Ithaca	Fall Creek	1935	4234000
12/1/1944	Ithaca	Cayuga Inlet	1945	4233000
12/18/1945	Chapin	Canandiagua Lake Outlet	1946	4235000
3/2/1946	Ithaca	Fall Creek	1946	4234000
1/16/1947	Churchville	Black Creek	1947	4231000
2/19/1948	Ithaca	Fall Creek	1948	4234000
3/16/1948	Honeoye Falls	Honeoye Creek	1948	4229500
3/20/1948	Syracuse	Onondaga Creek	1948	4140202
12/3/1950	Chapin	Canandiagua Lake Outlet	1951	4235000
12/4/1950	Honeoye Falls	Honeoye Creek	1951	4229500

Jam Date	City (Additional Geographic Identifier)	River	Water Year	Gage Number
2/13/1951	Honeoye Falls	Honeoye Creek	1951	4229500
12/21/1951	Ithaca	Cayuga Inlet	1952	4233000
12/21/1951	Ithaca	Fall Creek	1952	4234000
12/11/1952	Ithaca	Fall Creek	1953	4234000
12/29/1954	Honeoye Falls	Honeoye Creek	1955	4229500
1/1/1955	Warsaw	Crystal Brook	1955	Unknown
2/22/1955	Ithaca	Fall Creek	1955	4234000
3/7/1956	Honeoye Falls	Honeoye Creek	1956	4229500
1/22/1957	Ithaca	Fall Creek	1957	4234000
1/23/1957	Honeoye Falls	Honeoye Creek	1957	4229500
1/25/1957	Avon	Genesee River	1957	4228500
2/28/1958	Ithaca	Fall Creek	1958	4234000
3/5/1958	Hilton	West Creek	1958	2020004
12/10/1958	Honeoye Falls	Honeoye Creek	1959	4229500
1/21/1959	Ithaca	Fall Creek	1959	4234000
1/23/1959	Garbutt	Oatka Creek	1959	4230500
1/30/1959	Avon	Genesee River	1959	4228500
2/15/1959	Hilton	West Creek	1959	2020004
3/22/1959	Churchville	Black Creek	1959	4231000
1/1/1960	Brighton	Genesee River	1960	Unknown
2/26/1961	Honeoye Falls	Honeoye Creek	1961	4229500
2/6/1962	Hilton	West Creek	1962	2020004
2/27/1962	Honeoye Falls	Honeoye Creek	1962	4229500
2/28/1962	Ithaca	Fall Creek	1962	4234000
3/12/1962	Moravia	Owasco Inlet	1962	4235300
3/12/1962	Rochester	Allen Creek	1962	4232050
3/13/1962	Phelps	Flint Creek	1962	4235250
1/24/1963	Rochester	Allen Creek	1963	4232050

Jam Date	City (Additional Geographic Identifier)	River	Water Year	Gage Number
3/17/1963	Ithaca	Fall Creek	1963	4234000
3/17/1963	Phelps	Flint Creek	1963	4235250
3/17/1963	Phelps	Flint Creek	1963	4235250
1/1/1966	Nedrow	Hemlock Creek	1966	Unknown
2/21/1971	Ithaca	Fall Creek	1971	4234000
1/1/1977	Ithaca	Fall Creek	1977	4234000
1/11/1978	Warsaw	Oatka Creek	1978	4230380
3/15/1978	Ithaca	Fall Creek	1978	4234000
3/23/1978	Sterling	Sterling Creek	1978	4232100
1/4/1979	Sterling	Sterling Creek	1979	4232100
1/5/1979	Warsaw	Oatka Creek	1979	4230380
1/25/1979	Warsaw	Oatka Creek	1979	4230380
2/15/1979	Port Byron	Owasco Outlet	1979	Unknown
2/24/1979	Honeoye Falls	Honeoye Creek	1979	4229500
3/2/1979	Ithaca	Fall Creek	1979	4234000
3/5/1979	Phelps	Flint Creek	1979	4235250
3/5/1979	Avon	Genesee River	1979	4228500
3/6/1979	Sterling	Sterling Creek	1979	4232100
12/1/1982	Port Byron	Owasco Outlet	1983	Unknown
3/16/1989	South Trenton	Ninemile Creek	1989	Unknown
3/1/1993	Port Byron	Owasco Outlet	1993	Unknown
1/19/1994	Port Byron	Owasco Outlet	1994	Unknown
1/1/1996	Port Byron	Owasco Outlet	1996	Unknown
1/24/1999	North Greece	Northrup Creek	1999	4.22E+08
3/3/2003	Ithaca	Fall Creek	2003	4234000
3/10/2003	Honeoye Falls	Honeoye Creek	2003	4229500
3/16/2003	Phelps	Flint Creek	2003	4235250
1/20/2004	Jacks Reef	Seneca River	2004	Unknown

Jam Date	City (Additional Geographic Identifier)	River	Water Year	Gage Number
2/11/2009	Ithaca	Fall Creek	2009	4234000
2/12/2009	Ithaca	Fall Creek	2009	4234000

Source: CRREL 2015

Probability of Future Events

Given the history of flood events that have impacted Monroe County, it is apparent that future flooding of varying degrees will occur. Based on previous occurrences of flooding events and presence of elements required for flooding in the vicinity of the county, many people and properties are at risk from flood hazards in the future. Annual direct and indirect impacts of floods on the county are expected to continue. Some flooding events may induce secondary hazards such as water quality and supply concerns, and may lead to evacuations, infrastructure deterioration and failure, utility failures, power outages, transportation delays/accidents/inconveniences, and public health concerns.

Table 5.4.4-5 lists probabilities of occurrences of severe storm events. Based on historical occurrences, thunderstorm events are the most common in Monroe County, followed by hail events. However, the information used to calculate probabilities of occurrences is based only on NOAA-NCDC storm events database results.

Table 5.4.4-5. Probability of Occurrence of Flood-Related Events

Hazard Type	Number of Occurrences Between 1950 and 2015	Probability	Average Number of Events Per Year
Flood	36	81.9%	0.84
Flash Flood	16	36.3%	0.37
Lacustrine Flooding	8	18.2%	0.19
Ice Jam	25	56.8%	0.58
Other Flood-Related Events	1	2.27%	0.02

Sources: FEMA 2014, NYS DHSES 2014, NCDC 2014, NWS 2010, Democrat & Chronicle 2010, USACE 2010, Monroe County 2010, CRREL 2015

Note:

Probabilities were calculated from years 1972 to 2015.

In Section 5.3, the identified hazards of concern for Monroe County were ranked. Probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence of flood in the county is considered “frequent” (likely to occur within 25 years).

Climate Change Impacts

Climate change is beginning to affect both people and resources in NYS, and these impacts are projected to continue growing. Impacts related to increasing temperatures and sea level rise are already evident within the State. The Integrated Assessment for Effective Climate Change in NYS (ClimAID) was undertaken to provide decision-makers with information on the State’s vulnerability to climate change, and to facilitate development of adaptation strategies informed by both local experience and scientific knowledge (NYS Energy Research and Development Authority [NYSERDA] 2011).

Each region within NYS, 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).

Temperatures are expected to increase throughout the State by 2.0 to 3.4 degrees Fahrenheit (ºF) by the 2020s, 4.1 to 6.8ºF by the 2050s, and 5.3-10.1ºF by the 2080s. The lower ends of these ranges are for lower greenhouse gas emissions scenarios and the higher ends for higher emissions scenarios. This could lead to an increase of about a month to the growing season, more intense summers, and milder winters.

Annual average precipitation is projected to increase by up to 1 to 8 percent by the 2020s, by 3 to 12 percent by the 2050s and 4 to 15 percent by the 2080s. During the winter months, additional precipitation will most likely occur, in the form of rain, and with the possibility of slightly reduced precipitation projected for the late summer and early fall. Northern parts of the State of New York are expected to see the greatest increases in precipitation (NYSERDA 2014).

The projected increase in precipitation is expected to occur via heavy downpours and less in the form of light rains. Increase in heavy downpours could affect drinking water; heighten the risk of riverine flooding; flood key rail lines, roadways, and transportation hubs; and increase delays and hazards related to extreme weather events. Increasing air temperatures intensify the water cycle by increasing evaporation and precipitation, which can cause an increase in rain totals during storm events, with longer dry periods between those events. These changes can result in various effects on the State's water resources.

Over the past 50 years, heavy downpours have increased, and this trend is projected to continue, contributing to localized flash flooding in urban areas and hilly regions. Flooding could increase pollutants in the water supply and inundate wastewater treatment plants and other vulnerable facilities within floodplains. Less frequent rainfall during the summer months may negatively affect water supply systems. Increasing water temperatures in rivers and streams will impact aquatic health and reduce capacities of streams to assimilate effluent from wastewater treatment plants.

Total precipitation amounts have slightly increased in the northeastern states by approximately 3.3 inches over the last 100 years. The number of 2-inch rainfall events over a 48-hour period has increased since the 1950s (a 67-percent increase). The number and intensity of extreme precipitation events are increasing in NYS as well. More rain heightens the danger of localized flash flooding, streambank erosion, and storm damage (Cornell University College of Agriculture and Life Sciences 2011).

5.4.4.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed and vulnerable in the identified hazard area. For the flood hazard, areas identified as hazard areas include the 1-percent and 0.2-percent annual chance flood event boundaries. The following text evaluates and estimates potential impacts of flooding on Monroe County, including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impacts on: (1) life, health, and safety of residents; (2) general building stock; (3) critical facilities; (4) economy; (5) environment; and (6) future growth and development
- Effect of climate change on vulnerability

- Change of vulnerability as compared to that presented in the 2011 Monroe County Hazard Mitigation Plan
- Further data collections that will assist understanding this hazard over time.

Overview of Vulnerability

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

Data and Methodology

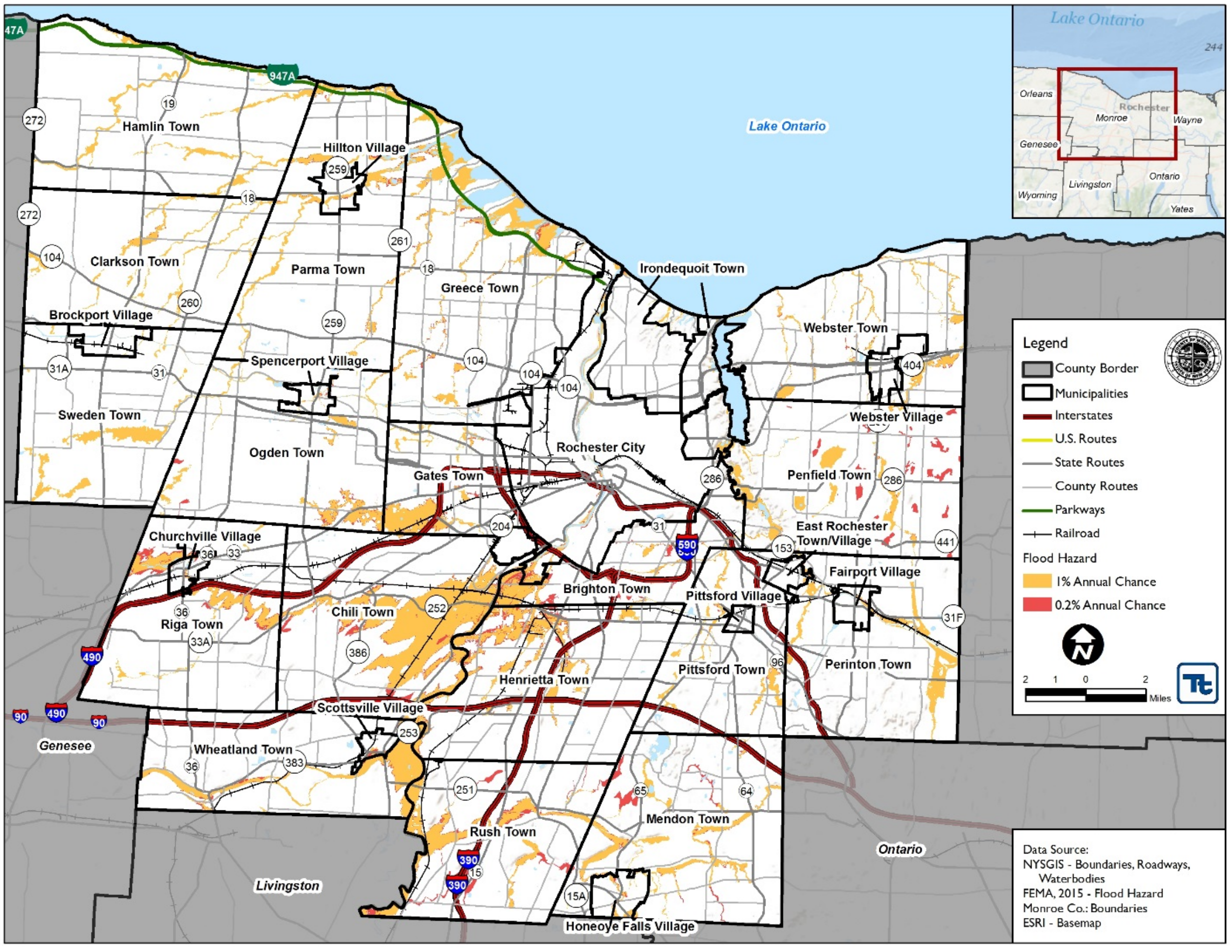
The 1- and 0.2-percent annual chance flood events were examined to evaluate the County's risk from the flood hazard. These flood events are generally those considered by planners and evaluated under federal programs such as the NFIP.

The FEMA effective work map released in May 2015 for Monroe County was used to evaluate the county's exposure to this hazard. An exposure analysis was conducted for the 1- and 0.2-percent annual chance flood events. Data used for this analysis are shown on Figure 5.4.4-5.

To estimate potential losses, the Hazards U.S. Multi-Hazard (HAZUS-MH) flood model was used. A depth grid was created using base-flood elevation and cross section data from the 2015 effective FEMA Digital Flood Insurance Rate Map (DFIRM) and the 1/3 arc-second Digital Elevation Map (DEM) model provided by the U.S. Geological Survey (USGS); areas without elevation data from FEMA were generated using the HAZUS-MH Enhanced Quick Look tool. The depth grids were integrated into HAZUS-MH, and the model was run to estimate potential losses at the structure level using the County's custom structural building inventory for the 1-percent annual chance flood event.

The HAZUS-MH 2.2 model uses 2010 U.S. Census demographic data. HAZUS-MH 2.2 calculated estimated damages to the general building stock and critical facilities based on the custom inventories, provided depth grid, and the default HAZUS damage functions in the flood model.

Figure 5.4.4-5. Monroe County FEMA 1-Percent and 0.2-Percent Annual Chance Flood Zones



Source: FEMA 2015

Impact on Life, Health, and Safety

Impacts of flooding on life, health, and safety depend on several factors, including severity of the event and whether 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 a hazard event (e.g., people are at risk while traveling in flooded areas, or their access to emergency services is compromised during an event). The degree of that impact will vary and is not strictly measurable.

To estimate the population exposed to the 1- and 0.2-percent flood events, the floodplain boundaries were overlaid upon the 2010 Census population data in GIS (U.S. Census 2010). The 2010 Census blocks with their centroid in the flood boundaries were used to calculate the estimated population exposed to this hazard. Within the floodplain population, senior citizens and the population in poverty are two especially vulnerable groups that must be taken under special consideration when planning for disaster preparation, response, and recovery.

Census blocks do not follow the boundaries of the floodplain and can grossly overestimate or underestimate the population exposed when the centroid or the intersect of the Census block is used with these zones. Limitations of these analyses are recognized, and as such the results are used only to provide a general estimate. Respective total land areas within the 1-percent and 0.2-percent annual chance flood zones were calculated for each jurisdiction by use of the regulatory DFIRM, as presented in Table 5.4.4-6.

Calculation of the 0.2-percent annual chance flood event results is cumulative, as the population exposed to the 1-percent flood event will also be exposed to the 0.2-percent annual chance flood event. Using this approach, it was estimated that 24,174 people are exposed to the 1-percent annual chance event and 28,879 people are exposed to the 0.2-percent annual chance flood event. Refer to Table 5.4.4-7 for results by municipality.

Table 5.4.4-6. Total Land Areas in the 1-Percent and 0.2-Percent Annual Chance Flood Zones (Acres)

Municipality	Total Area (acres)	1% Flood Event Hazard Area		0.2% Flood Event Hazard Area	
		Area (acres)	% of Total	Area (acres)	% of Total
Brighton (T)	9,985	957	9.6%	1,481	14.8%
Brockport (V)	1,408	49	3.4%	49	3.4%
Chili (T)	25,492	6,197	24.3%	6,912	27.1%
Churchville (V)	776	89	11.4%	121	15.6%
Clarkson (T)	21,203	1,127	5.3%	1,142	5.4%
East Rochester (V/T)	839	30	3.6%	31	3.7%
Fairport (V)	1,026	82	8.0%	88	8.6%
Gates (T)	9,805	1,372	14.0%	1,481	15.1%
Greece (T)	31,730	4,301	13.6%	4,589	14.5%
Hamlin (T)	27,751	1,619	5.8%	1,619	5.8%
Henrietta (T)	22,725	2,353	10.4%	2,961	13.0%
Hilton (V)	1,129	87	7.7%	99	8.7%
Honeoye Falls (V)	1,655	179	10.8%	211	12.8%
Irondequoit (T)	9,785	356	3.6%	363	3.7%
Mendon (T)	23,972	1,911	8.0%	2,399	10.0%
Ogden (T)	22,677	1,258	5.5%	1,466	6.5%
Parma (T)	25,825	1,738	6.7%	1,905	7.4%
Penfield (T)	23,985	1,733	7.2%	2,411	10.1%
Perinton (T)	21,071	1,441	6.8%	1,459	6.9%
Pittsford (T)	14,521	838	5.8%	893	6.1%
Pittsford (V)	462	16	3.4%	16	3.4%
Riga (T)	21,850	1,322	6.1%	1,691	7.7%
Rochester (C)	23,487	1,109	4.7%	1,225	5.2%
Rush (T)	19,610	2,129	10.9%	2,968	15.1%
Scottsville (V)	618	48	7.7%	83	13.4%
Spencerport (V)	829	54	6.6%	65	7.9%
Sweden (T)	20,309	1,203	5.9%	1,203	5.9%
Webster (T)	20,454	1,468	7.2%	1,590	7.8%

Table 5.4.4-6. Total Land Areas in the 1-Percent and 0.2-Percent Annual Chance Flood Zones (Acres)

Municipality	Total Area (acres)	1% Flood Event Hazard Area		0.2% Flood Event Hazard Area	
		Area (acres)	% of Total	Area (acres)	% of Total
Webster (V)	1,392	4	<1%	7	<1%
Wheatland (T)	19,057	2,260	11.9%	2,390	12.5%
Monroe County (Total)	**425,428**	**37,326**	**8.8%**	**42,920**	**10.1%**

Source: FEMA

Notes:
The area presented includes the area of inland waterways and excludes bays or oceans.
% Percent
C City
T Town
V Village

Table 5.4.4-7. Estimated Population Exposed to the Flood Hazard

Municipality	Total Population	1-Percent Chance Event		0.2-Percent Chance Event	
		Total Number	% of Total	Total Number	% of Total
Brighton (T)	36,609	592	1.6%	1,373	3.8%
Brockport (V)	8,366	56	<1%	56	<1%
Chili (T)	28,625	1,047	3.7%	1,451	5.1%
Churchville (V)	1,961	0	0.0%	114	5.8%
Clarkson (T)	6,588	65	1.0%	65	1.0%
East Rochester (V/T)	6,587	120	1.8%	120	1.8%
Fairport (V)	5,353	94	1.8%	94	1.8%
Gates (T)	28,400	4,159	14.6%	4,306	15.2%
Greece (T)	96,095	1,810	1.9%	2,435	2.5%
Hamlin (T)	9,045	252	2.8%	252	2.8%
Henrietta (T)	42,581	6,693	15.7%	8,123	19.1%
Hilton (V)	5,886	59	1.0%	437	7.4%
Honeoye Falls (V)	2,674	199	7.4%	199	7.4%
Irondequoit (T)	51,692	522	1.0%	522	1.0%
Mendon (T)	6,478	149	2.3%	329	5.1%
Ogden (T)	16,255	1,891	11.6%	1,924	11.8%
Parma (T)	9,747	1,224	12.6%	1,224	12.6%
Penfield (T)	36,242	1,795	5.0%	1,992	5.5%
Perinton (T)	41,109	261	<1%	280	<1%
Pittsford (T)	28,050	1,315	4.7%	1,315	4.7%
Pittsford (V)	1,355	0	0.0%	0	0.0%
Riga (T)	3,629	234	6.4%	283	7.8%
Rochester (C)	210,565	445	<1%	545	0.3%
Rush (T)	3,478	131	3.8%	234	6.7%
Scottsville (V)	2,001	78	3.9%	145	7.2%
Spencerport (V)	3,601	19	<1%	19	<1%
Sweden (T)	5,957	174	2.9%	174	2.9%
Webster (T)	37,242	543	1.5%	551	1.5%

Table 5.4.4-7. Estimated Population Exposed to the Flood Hazard

Municipality	Total Population	1-Percent Chance Event		0.2-Percent Chance Event	
		Total Number	% of Total	Total Number	% of Total
Webster (V)	5,399	56	1.0%	89	1.6%
Wheatland (T)	2,774	191	6.9%	228	8.2%
Monroe County (Total)	**744,344**	**24,174**	**3.2%**	**28,879**	**3.9%**

Sources: U.S. Census 2010, FEMA 2015

Notes:
% Percent
C City
T Town
V Village

Table 5.4.4-7 indicates that approximately 3.2 percent of the total population is exposed to the 1-percent annual chance flood event, and approximately 3.9 percent of the total population is exposed to the 0.2-percent annual chance flood event. The Town of Henrietta will experience the greatest impact on population, with approximately 15.7% and 19.1% for the 1-percent chance event and 0.2-percent chance event, respectively. For this project, the potential population impacted is used as a guide.

Of the population exposed, the most vulnerable include the economically disadvantaged and the population over the age of 65. Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on net economic impacts on their families. The population over the age of 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.

Using 2010 U.S. Census data, HAZUS-MH 2.2 estimates potential sheltering needs as a result of a 1-percent chance flood event. HAZUS-MH 2.2 estimates that 23,895 households will be displaced, and 18,208 people will seek short-term sheltering, representing approximately 2.45% of the Monroe County population seeking short-term shelter. These statistics, by municipality, are listed in Table 5.4.4-8.

Table 5.4.4-8. Estimated Populations Displaced and Seeking Short-Term Shelter from the 1-Percent Chance Flood Events

Municipality	Total Population	1-Percent Annual Chance Event	
		Displaced Households	Persons Seeking Short-Term Sheltering
Brighton (T)	36,609	800	511
Brockport (V)	8,366	54	18
Chili (T)	28,625	1,912	1,580
Churchville (V)	1,961	57	15
Clarkson (T)	6,588	321	136
East Rochester (V/T)	6,587	51	48
Fairport (V)	5,353	139	76
Gates (T)	28,400	3,303	2,938
Greece (T)	96,095	2,558	1,790
Hamlin (T)	9,045	503	274
Henrietta (T)	42,581	4,464	4,268
Hilton (V)	5,886	327	281
Honeoye Falls (V)	2,674	216	118

Municipality	Total Population	1-Percent Annual Chance Event	
		Displaced Households	Persons Seeking Short-Term Sheltering
Irondequoit (T)	51,692	444	317
Mendon (T)	6,478	415	172
Ogden (T)	16,255	913	710
Parma (T)	9,747	978	644
Penfield (T)	36,242	1,200	904
Perinton (T)	41,109	1,021	825
Pittsford (T)	28,050	1,214	858
Pittsford (V)	1,355	4	0
Riga (T)	3,629	191	93
Rochester (C)	210,565	694	536
Rush (T)	3,478	192	74
Scottsville (V)	2,001	96	47
Spencerport (V)	3,601	148	26
Sweden (T)	5,957	152	56
Webster (T)	37,242	1,316	824
Webster (V)	5,399	19	3
Wheatland (T)	2,774	193	66
Monroe County (Total)	**744,344**	**23,895**	**18,208**

Source: 2010 U.S. Census, Hazus-MH 2.2
Notes:
C City
T Town
V Village

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

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

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

Impact on General Building Stock

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

To provide a general estimate of the structural/content replacement value exposure, the 1- and 0.2-percent DFIRM flood boundaries were overlaid upon the county's updated building stock inventory at the structure level. Buildings with their centroids in the hazard areas were totaled for each municipality. Table 5.4.4-9 and Table 5.4.4-10 summarize these results. In summary, 3,679 buildings are within the 1-percent annual chance flood boundary, with an estimated $4.6 billion of building/contents exposed (based on estimated replacement cost value). In total, this represents approximately 1.7% of the county's total general building stock inventory (approximately $279 billion). Within the 0.2-percent annual chance flood boundary are 4,824 buildings with an estimated $7.6 billion of building/contents exposed, representing approximately 2.7% of the county's total general building stock inventory.

Table 5.4.4-9. Estimated General Building Stock Exposure to the 1-Percent Annual Chance Flood Event – All Occupancies

			Total Exposure (All Occupancies)			
Municipality	**Total # Buildings**	**Total Replacement Cost (Structure and Contents)**	**# Buildings**	**% Total**	**Total Replacement Cost (Structure and Contents)**	**% Total**
Brighton (T)	10,545	$18,462,216,409	120	1.1%	$133,383,802	0.7%
Brockport (V)	1,604	$2,035,910,815	0	0.0%	$0	0.0%
Chili (T)	9,774	$8,342,622,610	373	3.8%	$322,079,094	3.9%
Churchville (V)	807	$920,696,714	16	2.0%	$27,061,912	2.9%
Clarkson (T)	2,040	$1,812,049,577	51	2.5%	$31,517,071	1.7%
East Rochester (V/T)	2,495	$2,846,820,718	2	<1%	$6,129,413	<1%
Fairport (V)	2,056	$2,449,020,743	27	1.3%	$106,707,118	4.4%
Gates (T)	10,550	$9,547,208,635	783	7.4%	$706,357,198	7.4%
Greece (T)	32,375	$25,595,860,286	243	<1%	$218,227,438	<1%
Hamlin (T)	2,808	$1,737,395,194	238	8.5%	$127,706,770	7.4%
Henrietta (T)	12,657	$13,259,007,785	229	1.8%	$566,810,884	4.3%
Hilton (V)	1,884	$1,664,654,730	21	1.1%	$58,500,847	3.5%
Honeoye Falls (V)	922	$1,119,568,668	39	4.2%	$77,950,887	7.0%
Irondequoit (T)	19,765	$16,075,218,322	154	<1%	$60,703,983	<1%
Mendon (T)	2,366	$2,996,719,632	91	3.8%	$83,367,709	2.8%
Ogden (T)	5,331	$4,469,332,464	96	1.8%	$90,419,903	2.0%
Parma (T)	3,743	$2,595,035,929	317	8.5%	$201,397,892	7.8%
Penfield (T)	13,077	$14,501,168,927	131	1.0%	$321,318,313	2.2%
Perinton (T)	14,901	$17,896,609,894	108	<1%	$111,271,673	<1%
Pittsford (T)	9,159	$12,295,191,719	151	1.6%	$195,759,433	1.6%
Pittsford (V)	656	$2,204,429,074	0	0.0%	$0	0.0%
Riga (T)	1,271	$1,283,085,436	58	4.6%	$79,347,146	6.2%
Rochester (C)	58,996	$94,424,953,585	48	<1%	$557,959,357	<1%
Rush (T)	1,433	$1,453,693,815	34	2.4%	$60,891,682	4.2%
Scottsville (V)	747	$706,870,704	26	3.5%	$13,337,806	1.9%
Spencerport (V)	1,253	$1,862,825,476	29	2.3%	$186,847,089	10.0%
Sweden (T)	1,986	$1,771,453,297	28	1.4%	$14,237,755	<1%
Webster (T)	13,477	$11,420,618,527	229	1.7%	$260,799,228	2.3%
Webster (V)	1,305	$1,799,326,797	0	0.0%	$0	0.0%
Wheatland (T)	991	$1,061,455,206	37	3.7%	$28,233,250	2.7%
Monroe County (Total)	**240,974**	**$278,611,021,689**	**3,679**	**1.5%**	**$4,648,324,654**	**1.7%**

Source: Monroe County, FEMA 2015
Notes:
% Percent
C City
T Town
V Village

Table 5.4.4-10. Estimated General Building Stock Exposure to the 0.2-Percent Annual Chance Flood Event – All Occupancies

Municipality	Total # Buildings	Total Replacement Cost (Structure and Contents)	Total Exposure (All Occupancies)			
			# Buildings	% Total	Total Replacement Cost (Structure and Contents	% Total
Brighton (T)	10,545	$18,462,216,409	240	2.3%	$266,917,952	1.4%
Brockport (V)	1,604	$2,035,910,815	0	0.0%	$0	0.0%
Chili (T)	9,774	$8,342,622,610	484	5.0%	$396,552,713	4.8%
Churchville (V)	807	$920,696,714	36	4.5%	$57,379,522	6.2%
Clarkson (T)	2,040	$1,812,049,577	51	2.5%	$31,517,071	1.7%
East Rochester (V/T)	2,495	$2,846,820,718	2	<1%	$6,129,413	<1%
Fairport (V)	2,056	$2,449,020,743	28	1.4%	$107,318,682	4.4%
Gates (T)	10,550	$9,547,208,635	863	8.2%	$760,281,039	8.0%
Greece (T)	32,375	$25,595,860,286	348	1.1%	$298,653,418	1.2%
Hamlin (T)	2,808	$1,737,395,194	238	8.5%	$127,706,770	7.4%
Henrietta (T)	12,657	$13,259,007,785	405	3.2%	$1,207,006,192	9.1%
Hilton (V)	1,884	$1,664,654,730	33	1.8%	$65,114,136	3.9%
Honeoye Falls (V)	922	$1,119,568,668	60	6.5%	$90,340,116	8.1%
Irondequoit (T)	19,765	$16,075,218,322	249	1.3%	$76,329,507	<1%
Mendon (T)	2,366	$2,996,719,632	110	4.6%	$99,855,103	3.3%
Ogden (T)	5,331	$4,469,332,464	128	2.4%	$109,866,352	2.5%
Parma (T)	3,743	$2,595,035,929	341	9.1%	$217,257,501	8.4%
Penfield (T)	13,077	$14,501,168,927	192	1.5%	$509,243,357	3.5%
Perinton (T)	14,901	$17,896,609,894	118	<1%	$115,900,689	<1%
Pittsford (T)	9,159	$12,295,191,719	187	2.0%	$221,109,353	1.8%
Pittsford (V)	656	$2,204,429,074	0	0.0%	$0	0.0%
Riga (T)	1,271	$1,283,085,436	79	6.2%	$91,558,015	7.1%
Rochester (C)	58,996	$94,424,953,585	85	<1%	$1,897,693,647	2.0%
Rush (T)	1,433	$1,453,693,815	73	5.1%	$158,121,636	10.9%
Scottsville (V)	747	$706,870,704	73	9.8%	$41,992,416	5.9%
Spencerport (V)	1,253	$1,862,825,476	37	3.0%	$194,461,996	10.4%
Sweden (T)	1,986	$1,771,453,297	28	1.4%	$14,237,755	<1%
Webster (T)	13,477	$11,420,618,527	272	2.0%	$351,522,222	3.1%
Webster (V)	1,305	$1,799,326,797	9	<1%	$5,395,672	<1%
Wheatland (T)	991	$1,061,455,206	55	5.5%	$39,285,796	3.7%
Monroe County (Total)	**240,974**	**$278,611,021,689**	**4,824**	**2.0%**	**$7,558,748,043**	**2.7%**

Source: Monroe County, FEMA 2015
Notes:
% Percent
C City
T Town
V Village

The HAZUS-MH model estimated potential damages to the buildings in Monroe County at the structure level using the custom county structure inventory developed for this plan update. Table 5.4.4-11 below indicates that potential damage estimated by HAZUS-MH to the general building stock inventory associated with the 1-percent annual chance flood is approximately $775 million, or less than 1 percent of the total building stock replacement cost value. Potential damage estimated by HAZUS-MH to the residential general building stock inventory associated with the 1-percent annual chance flood is approximately $265 million, or less than 1 percent of the total building stock replacement cost value.

Table 5.4.4-11. Estimated General Building Stock Potential Loss to the 1-Percent Annual Chance Flood Event

Municipality	Total Replacement Cost Value	1% Annual Chance Event							
		All Occupancies		Residential		Commercial		Industrial, Religious, Education and Government	
		Estimated Loss	% of Total	Estimated Loss	% of Total	Estimated Loss	% of Total	Estimated Loss	% of Total
Brighton (T)	$18,462,216,409	$20,673,419	<1%	$9,870,230	<1%	$5,069,452	<1%	$5,733,737	<1%
Brockport (V)	$2,035,910,815	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Chili (T)	$8,342,622,610	$63,439,530	<1%	$24,090,400	<1%	$851,620	<1%	$38,497,510	<1%
Churchville (V)	$920,696,714	$14,423,636	1.6%	$1,399,797	<1%	$514,223	<1%	$12,509,616	<1%
Clarkson (T)	$1,812,049,577	$4,785,937	<1%	$3,699,877	<1%	$1,086,060	<1%	$0	0.0%
East Rochester (V/T)	$2,846,820,718	$443,458	<1%	$0	0.0%	$368,032	<1%	$75,427	<1%
Fairport (V)	$2,449,020,743	$14,028,431	<1%	$2,038,067	<1%	$31,361	<1%	$11,959,003	<1%
Gates (T)	$9,547,208,635	$128,507,100	1.3%	$46,758,304	<1%	$3,106,533	<1%	$78,642,263	<1%
Greece (T)	$25,595,860,286	$24,949,110	<1%	$17,269,771	<1%	$538,046	<1%	$7,141,293	<1%
Hamlin (T)	$1,737,395,194	$14,672,085	<1%	$14,255,448	<1%	$416,637	<1%	$0	0.0%
Henrietta (T)	$13,259,007,785	$49,249,752	<1%	$11,440,796	<1%	$3,807,169	<1%	$34,001,786	<1%
Hilton (V)	$1,664,654,730	$5,918,287	<1%	$1,073,731	<1%	$2,323,609	<1%	$2,520,947	<1%
Honeoye Falls (V)	$1,119,568,668	$4,611,165	<1%	$2,881,584	<1%	$1,729,581	<1%	$0	0.0%
Irondequoit (T)	$16,075,218,322	$13,148,222	<1%	$10,825,095	<1%	$2,323,127	<1%	$0	0.0%
Mendon (T)	$2,996,719,632	$12,202,201	<1%	$10,170,907	<1%	$1,433,135	<1%	$598,159	<1%
Ogden (T)	$4,469,332,464	$17,212,429	<1%	$9,880,522	<1%	$7,331,907	<1%	$0	0.0%
Parma (T)	$2,595,035,929	$36,887,982	1.4%	$22,693,369	<1%	$6,117,058	<1%	$8,077,555	<1%
Penfield (T)	$14,501,168,927	$74,844,795	<1%	$9,337,063	<1%	$5,010,920	<1%	$60,496,812	<1%
Perinton (T)	$17,896,609,894	$22,615,011	<1%	$10,354,296	<1%	$907,018	<1%	$11,353,697	<1%
Pittsford (T)	$12,295,191,719	$32,376,898	<1%	$16,817,593	<1%	$15,415,310	<1%	$143,994	<1%
Pittsford (V)	$2,204,429,074	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Riga (T)	$1,283,085,436	$8,768,348	<1%	$4,729,297	<1%	$620,894	<1%	$3,418,157	<1%
Rochester (C)	$94,424,953,585	$160,673,206	<1%	$1,348,302	<1%	$130,559,838	<1%	$28,765,065	<1%
Rush (T)	$1,453,693,815	$9,483,533	<1%	$3,648,224	<1%	$356,347	<1%	$5,478,962	<1%
Scottsville (V)	$706,870,704	$2,186,541	<1%	$1,776,694	<1%	$409,847	<1%	$0	0.0%

Municipality	Total Replacement Cost Value	1% Annual Chance Event							
		All Occupancies		Residential		Commercial		Industrial, Religious, Education and Government	
		Estimated Loss	% of Total	Estimated Loss	% of Total	Estimated Loss	% of Total	Estimated Loss	% of Total
Spencerport (V)	$1,862,825,476	$1,721,981	<1%	$1,721,981	<1%	$0	0.0%	$0	0.0%
Sweden (T)	$1,771,453,297	$1,912,100	<1%	$1,912,100	<1%	$0	0.0%	$0	0.0%
Webster (T)	$11,420,618,527	$32,167,437	<1%	$21,261,387	<1%	$5,973,443	<1%	$4,932,607	<1%
Webster (V)	$1,799,326,797	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Wheatland (T)	$1,061,455,206	$3,441,734	<1%	$3,361,583	<1%	$3,641	<1%	$76,510	<1%
Monroe County (Total)	**$278,611,021,689**	**$775,344,328**	**<1%**	**$264,616,418**	**<1%**	**$196,304,807**	**<1%**	**$314,423,102**	**<1%**

Source: HAZUS-MH 2.2
Notes:
% Percent
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 which were paid more than $1,000 for each loss. The two losses must be within 10 years of each other & be as least 10 days apart. Only losses from (*sic* since) 1/1/1978 that are closed are considered."

SRLs were then examined for 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 5.4.4-12 through Table 5.4.4-14 summarize NFIP policies, claims, and repetitive loss statistics for Monroe County. According to FEMA, Table 5.4.4-12 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 (FEMA 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 5.4.4-12. 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 5.4.4-13. 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
Sweden (T)	0	0	0	0	0	0	0	0	0	0

Table 5.4.4-13. 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
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 5.4.4-14. 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 5.4.4-14. 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

A repetitive loss area includes both repetitive loss properties, as determined by FEMA, and properties that may undergo repetitive flood damage but are not technically considered repetitive loss properties. This situation can occur for a variety of reasons, including the following:

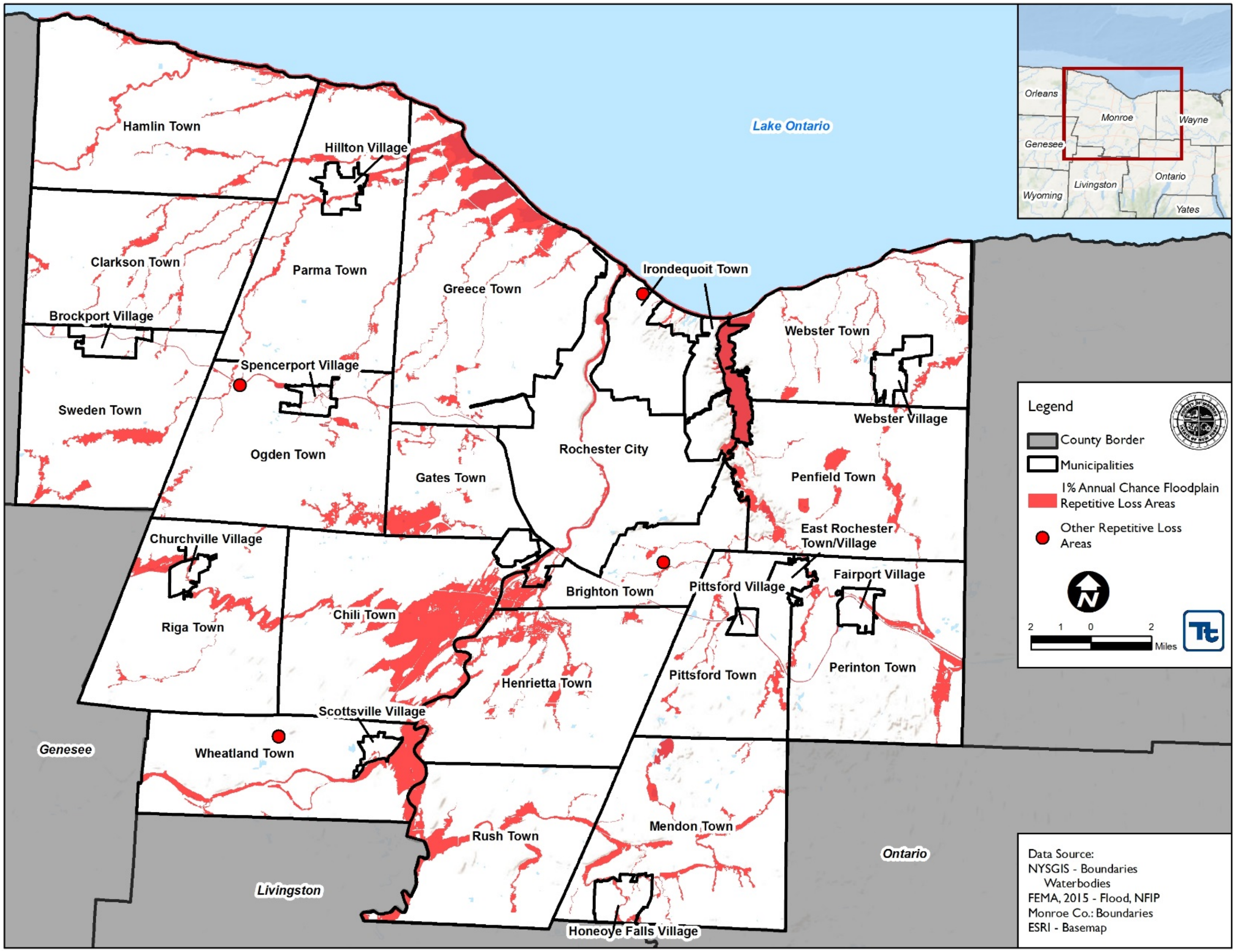
- Property owner may not have flood insurance. Only properties within the floodplain and with a federally-backed mortgage are required to carry flood insurance.
- Owner of a flooded property may choose not to file a claim, even if the owner has flood insurance.
- The flood damage may not meet the minimum $1,000 threshold necessary for repetitive loss, but the property may still undergo recurring flood damage.

In Monroe County, the majority of repetitive loss properties are in the floodplain. The cause of repetitive flooding at these properties is commensurate with the flood risk reflected on the current effective FIRM for the community. The county has five repetitive loss areas. In addition to the floodplain, the county's other four repetitive loss areas are so designated because of local topography, presence of development encouraging additional flooding, or drainage issues. The other four repetitive loss areas are in:

- Town of Wheatland: Properties along Blue Pond Manor and around Blue Pond
- Town of Ogden: Properties along Washington Street, between the Erie Canal and Dresser Road
- Town of Brighton: Single residence along Victoria Drive
- Town of Irondequoit: Single residence along Sheffield Road

Figure 5.4.10-6 below shows NFIP Repetitive Loss Areas in Monroe County, as well as the floodplain and municipal boundaries.

Figure 5.4.4-6. NFIP Repetitive Loss Areas



Source: FEMA Region 2 2015

Impact on Critical Facilities

In addition to considering general building stock at risk, risk of flood to critical facilities, utilities, and user-defined facilities was evaluated. HAZUS-MH was used to estimate potential flood loss to Monroe County's critical facilities. Using depth/damage function curves, HAZUS-MH estimates the percent of damage to buildings and contents of critical facilities. Table 5.4.4-15 and Table 5.4.4-16 summarize the number of critical facilities within the FEMA flood zones by type and by jurisdiction.

If a hazard causes short-term deficiencies in functionality, other facilities of neighboring municipalities may have to increase support response functions during a disaster event. Rochester Institute of Technology (RIT) already maintains a list of areas on campus that are susceptible to flooding. It also tracks information related to flood-induced losses. Mitigation planning should consider means to reduce impacts on critical facilities and ensure sufficient emergency and school services remain when a significant event occurs. Actions addressing shared services agreements are included in Section 9 (Mitigation Strategies) of this plan update. RIT has noted that it does not have any mitigation activities planned for new or potential development; however, it ensures that all construction complies with the local Town of Henrietta codes for building development, flood damage prevention, stormwater management, et al.

Table 5.4.4-17. Number of Critical Facilities Within the 1-Percent Annual Chance Flood Zone

Municipality	Facility Types														
	Communication	Court	Dam	DPW	Fire Station	Government Building	Military	Police	Post office	Recreation Center	School	Shelter	Town Hall	Wastewater Pump Station	Wastewater Treatment Facility
Brighton (T)	0	0	1	0	1	0	0	0	0	0	1	1	0	0	0
Brockport (V)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chili (T)	0	0	3	0	1	0	0	0	0	0	0	0	0	6	0
Churchville (V)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clarkson (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
East Rochester (V/T)	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Fairport (V)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gates (T)	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0
Greece (T)	1	0	2	0	0	0	0	1	0	0	0	1	0	2	0
Hamlin (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Henrietta (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Hilton (V)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Honeoye Falls (V)	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0
Irondequoit (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mendon (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ogden (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parma (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Penfield (T)	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0

Table 5.4.4-17. Number of Critical Facilities Within the 1-Percent Annual Chance Flood Zone

Municipality	Facility Types														
	Communication	Court	Dam	DPW	Fire Station	Government Building	Military	Police	Post office	Recreation Center	School	Shelter	Town Hall	Wastewater Pump Station	Wastewater Treatment Facility
Perinton (T)	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
Pittsford (T)	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Pittsford (V)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Riga (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rochester (C)	0	0	4	0	1	2	1	2	0	0	0	0	0	1	0
Rush (T)	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0
Scottsville (V)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spencerport (V)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sweden (T)	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Webster (T)	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0
Webster (V)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wheatland (T)	0	0	5	0	0	0	0	0	0	0	0	0	0	1	2
Monroe County (Total)	**1**	**1**	**22**	**3**	**3**	**2**	**1**	**3**	**1**	**1**	**3**	**2**	**1**	**13**	**2**

Source: FEMA, Monroe County
C City
T Town
V Village

Table 5.4.4-18. Number of Critical Facilities Within the 0.2-Percent Annual Chance Flood Zone

Municipality	Facility Types															
	Communication	Court	Dam	DPW	Fire Station	Golf Course	Government Building	Military	Police Station	Post Office	Religious Center	School	Shelter	Town Halls	Wastewater Pump Station	Wastewater Treatment Plant
Brighton (T)	0	0	1	0	1	0	0	0	0	0	0	2	1	0	0	0
Brockport (V)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chili (T)	0	0	3	0	1	0	0	0	0	0	1	0	0	0	7	0
Churchville (V)	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Clarkson (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
East Rochester (V/T)	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Fairport (V)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gates (T)	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
Greece (T)	1	0	2	0	0	0	0	0	1	0	0	0	1	0	2	0

Hamlin (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Henrietta (T)	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0
Hilton (V)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Honeoye Falls (V)	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0
Irondequoit (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mendon (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ogden (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parma (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Penfield (T)	0	0	2	0	0	0	0	0	0	1	0	1	0	0	0	0
Perinton (T)	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
Pittsford (T)	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Pittsford (V)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Riga (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rochester (C)	0	0	4	0	1	0	2	1	2	0	0	0	0	0	1	1
Rush (T)	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0
Scottsville (V)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spencerport (V)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sweden (T)	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Webster (T)	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Webster (V)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wheatland (T)	0	0	5	0	0	0	0	0	0	0	0	0	0	0	1	2
Monroe County (Total)	**1**	**1**	**24**	**3**	**3**	**1**	**2**	**1**	**3**	**1**	**1**	**4**	**2**	**1**	**16**	**2**

Source: FEMA, Monroe County
C City
T Town
V Village

Impact on the Economy

For impact on economy, estimated losses from a flood event are considered. Losses include but are not limited to general building stock damages, agricultural losses, business interruption, and effects on tourism and tax base within Monroe County (although tourism is a much more minor economic driver than the other industries, for the County). Damages to general building stock can be quantified using HAZUS-MH as discussed above. Estimated measures of other economic components such as loss of facility use, functional downtime, and social/economic factors are less certain.

Flooding can cause extensive damage to public utilities and disruptions to delivery of services. Loss of power and communications may occur, and drinking water and wastewater treatment facilities may be temporarily out of operation. According to Table 5.4.5-15, 49 facilities are exposed and potentially vulnerable to the 1-percent annual chance flood event. Flooded streets and road blocks make it difficult for emergency vehicles to respond to calls for service. Floodwaters can wash out sections of roadways and bridges. In addition to travel along the roadways, public transit would be greatly impacted, causing problems for emergency responders.

Direct building losses are estimated costs to repair or replace damage to buildings. Refer to the "Impact on General Building Stock" subsection, which discusses these potential losses. These dollar value losses to the county's total building inventory replacement value, in addition to damages to roadways and infrastructure, would greatly impact the local economy.

HAZUS-MH estimates the amount of debris generated during 1-percent annual chance flood events. The model breaks down debris into three categories: (1) finishes (dry wall, insulation, etc.), (2) structural (wood, brick, etc.), and (3) foundations (concrete slab and block, rebar, etc.). These distinctions are necessary because of the different types of equipment needed to handle debris. Table 5.4.4-17 summarizes the debris HAZUS-MH 2.2 estimates for these events (the table represents only estimates of debris generated by flooding, and does not include additional potential damage and debris possibly generated by storm surge along Lake Ontario and/or wind).

Table 5.4.4-19. Estimated Debris Generated from the 1-Percent Flood Event

Municipality	1% Flood Event			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Brighton (T)	2,456	1,271	702	483
Brockport (V)	351	268	37	46
Chili (T)	2,269	1,793	269	207
Churchville (V)	243	89	89	64
Clarkson (T)	394	325	41	28
East Rochester (V/T)	358	145	126	87
Fairport (V)	415	385	18	12
Gates (T)	3,318	3,109	126	83
Greece (T)	4,495	3,028	833	634
Hamlin (T)	1,918	1,559	219	140
Henrietta (T)	3,740	2,348	633	759
Hilton (V)	1,635	641	571	423
Honeoye Falls (V)	585	282	176	126
Irondequoit (T)	5,794	1,541	1,980	2,273
Mendon (T)	555	385	101	69
Ogden (T)	3,349	1,060	1,202	1,087
Parma (T)	2,717	1,837	536	345
Penfield (T)	10,452	2,598	4,552	3,302
Perinton (T)	3,968	2,861	675	432
Pittsford (T)	2,975	1,623	743	609
Pittsford (V)	74	57	10	7
Riga (T)	252	187	40	25
Rochester (C)	3,076	976	1,373	727
Rush (T)	1,140	383	442	314
Scottsville (V)	311	114	110	86
Spencerport (V)	361	169	102	89
Sweden (T)	138	104	21	13
Webster (T)	7,071	2,669	2,297	2,105
Webster (V)	13	13	0	0
Wheatland (T)	1,101	649	252	200
Monroe County (Total)	**65,523**	**32,471**	**18,275**	**14,777**

Source: HAZUS-MH 2.2
Notes:

% *Percent*
C *City*
T *Town*
V *Village*

Animal operations also can undergo economic losses. Although this is a concern, because agricultural operations are an important aspect of the county economy, many animal operations are on higher ground to protect their animals during a flood event. Some operations follow the historical recommendation of letting the animals roam, in which case many animals would eventually reach paved roads and high ground. Monroe County Community College's Agriculture and Life Sciences Institute issues public safety protocols for farm animal safety and flood conditions. Regarding crop operations and flood-related crop losses, most farmers would plow under, compost, or otherwise recycle flood-contaminated crops (Monroe County Community College 2015).

Impact on the Environment

As discussed, floodplains serve beneficial and natural functions on ecological/environmental, social, and economic levels. Areas in the floodplain that typically provide these natural functions and benefits are wetlands, riparian areas, sensitive areas, and habitats for rare and endangered species. Floods however can also lead to negative impacts on the environment. Loss of riparian buffers, land use change within a watershed, and introduction of non-natural contaminants may cause environmental issues when floods occur (Montz and Tobin 1997; Rubin 2013).

The basic environmental impact of major flooding is morphological; the shape of the river valley is often determined more by a catastrophic event. This process is a primary factor in forming the natural habitat for flora and fauna and may influence habitats beyond the river corridor (Hickey and Salas 1995).

Flooding can cause a wide range of environmental impacts. Impacts include but are not limited to erosion, loss of vegetation and habitats which may lead to decreased protection of the waterbody from adjacent land uses and degraded water quality. In addition, floods may generate large amounts of tree and construction debris (refer to Table 5.4.4-17), disperse household hazardous waste into the fluvial system, and contaminate water supplies and wildlife habitats with extremely toxic substances. Floods of greater depth are likely to result in greater environmental damage than floods of lesser depth. Long duration floods could exacerbate environmental problems because clean-up will likely be delayed and contaminants have the potential of remaining in the environment for a longer period of time. Cleaning up after a flood presents additional environmental concerns. The volume of debris to be collected, the extent to which public utilities (water supply systems and sewer operations) have been damaged, and the quantity of agricultural and industrial pollutants entering water bodies might present additional issues (Montz and Tobin 1997; Rubin 2013).

Effect of Climate Change on Vulnerability

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

Future Growth and Development

As discussed in Section 4, areas targeted for future growth and development have been identified across the county. Any areas of growth could be impacted by the flood hazard if within identified hazard areas. The county intends to discourage development within vulnerable areas or to encourage higher regulatory standards on the local level. Please refer to the specific areas of development indicated in tabular form in the jurisdictional annexes in Volume II, Section 9 of this plan.

Change of Vulnerability

Monroe County and its municipalities continue to be vulnerable to the flood hazard. However, several differences are evident between the exposure and potential loss estimates of this plan update and those of the 2011 HMP. The previous HMP looked at significant historical flood events and provided a qualitative assessment of the county's risk and vulnerability. For this plan update, a quantitative assessment of the county's population, building stock, and critical facilities was conducted to determine the county's risk and vulnerability.

Overall, this vulnerability assessment uses a more accurate and updated building inventory which provides more accurate estimated exposure and potential losses for Monroe County.

Additional Data and Next Steps

A HAZUS-MH flood analysis of Monroe County used the most current and best available data including updated building and critical facility inventories, and DFIRM. For future plan updates, additional potential loss analyses may be conducted utilizing FEMA's wave and surge modeling conducted on Lake Ontario.

Specific mitigation actions addressing improved data collection and further vulnerability analysis are included in Volume II, Section 9 of this plan update.