5.4.3 Flood

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

5.4.3.1 Profile

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

Hazard Description

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

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

Many floods fall into three categories: riverine, coastal and shallow (FEMA 2007). 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 Onondaga County Steering Committee, riverine, shallow, flash, ice jam, and dam and levee failure flooding are the main flood types of concern for the county. These types of flood are further discussed below.

Riverine (Inland) and Flash Flooding

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

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

Shallow Flooding

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

High groundwater levels can be a concern and cause problems even where there is no surface flooding. Basements are susceptible to high groundwater levels. Seasonally high groundwater is common in many areas, while elsewhere high groundwater occurs only after long 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 other urban areas. They make use of a closed conveyance system that channels water away from an urban area to surrounding streams. This bypasses the natural processes of water filtration through the ground, containment, and evaporation of excess water. Since drainage systems reduce the amount of time the surface water takes to reach surrounding streams, flooding in those streams can occur more quickly and reach greater depths than prior to development in that area (FEMA 2007).

Ice Jam Flooding

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

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

Dam and Levee Failure Flooding

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

from cohesive to cohesionless soils (USBR 2012). Dams and levees can fail for one or a combination of the following reasons:

- Overtopping caused by floods that exceed the capacity of the dam (inadequate spillway capacity);
- Prolonged periods of rainfall and flooding;
- Deliberate acts of sabotage (terrorism);
- Structural failure of materials used in dam construction;
- Movement and/or failure of the foundation supporting the dam;
- Settlement and cracking of concrete or embankment dams;
- Piping and internal erosion of soil in embankment dams;
- Inadequate or negligent operation, maintenance and upkeep;
- Failure of upstream dams on the same waterway; or
- Earthquake (liquefaction / landslides) (FEMA 2018a).

Flood Control Measures

Levees

Levees exist in the county that provide the community with some degree of protection against flooding. However, it has been ascertained that some of these levees may not protect the community from rare events such as the 1-percent-annual- chance flood (FEMA FIS 2010). According to the United States Army Corps National Levee Database, Onondaga County has 4 levee systems for a total of 1 mile (USACE 2019).

The Marcellus Tyler Hollow levee protects a small area of the Village of Marcellus along Nine Mile Creek. The Limestone Creek Levee protects nearly $30 million worth of property along Limestone Creek. Onondaga Creek in the City of Syracuse is protected with a levee on the left bank and right bank. The left bank system includes 1,400 feet of earthen levee. The right bank system includes 1,000 feet of earthen levee. The system includes 3.5 miles of realigned and straightened inlet channel between Ballantyne Road and the northern boundary of the Onondaga Indian Territory. For detailed information on the levee systems in Onondaga County, refer to Section 4 (County Profile).

Seneca/Oneida/Oswego River Water Level Control

Since the Canal System was designed more than 100 years ago there have been subsequent widenings, expansions, upgrades and realignments to the system and the watershed of the Canal System has undergone a complete transformation due to changes in land use and development patterns. This has occurred while the hydraulics of the system, the canal channel and water control facilities have not been modified to accommodate these changes. Additionally, the entities affecting water level throughout the system often have competing needs or priorities. As a consequence, the region has experienced Canal closures associated with high water and flooding, and negative impacts on canal-side property owners, business owners and boaters (Onondaga County 2019).

Today, water levels along the Canal System are directly affected by the actions of non-Canal decision makers who do not always take into account the impact of their actions on the basin downstream. The Finger Lakes are the largest set of interconnected waterways in the state. Six separate public entities and four hydropower generation companies affect the water levels for eight lakes. While not all flooding is preventable, a lack of coordination and cooperation has been the primary cause of "avoidable" Canal closures and the high-water conditions that negatively impact private Canal-side property owners. A Canal Flood Mitigation Task Force has been created by New York State with participation from state agency partners and local government officials to enhance and improve water management in the Oneida-Oswego-Seneca River Basin (Onondaga County 2019).

Extent

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

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

The severity of a flood depends not only on the amount of water that accumulates in a period of time, but also on the land's ability to manage this water. The size of rivers and streams in an area and infiltration rates are significant factors. When it rains, soil acts as a sponge. When the land is saturated or frozen, infiltration rates decrease and any more water that accumulates must flow as runoff (Harris 2008).

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:

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

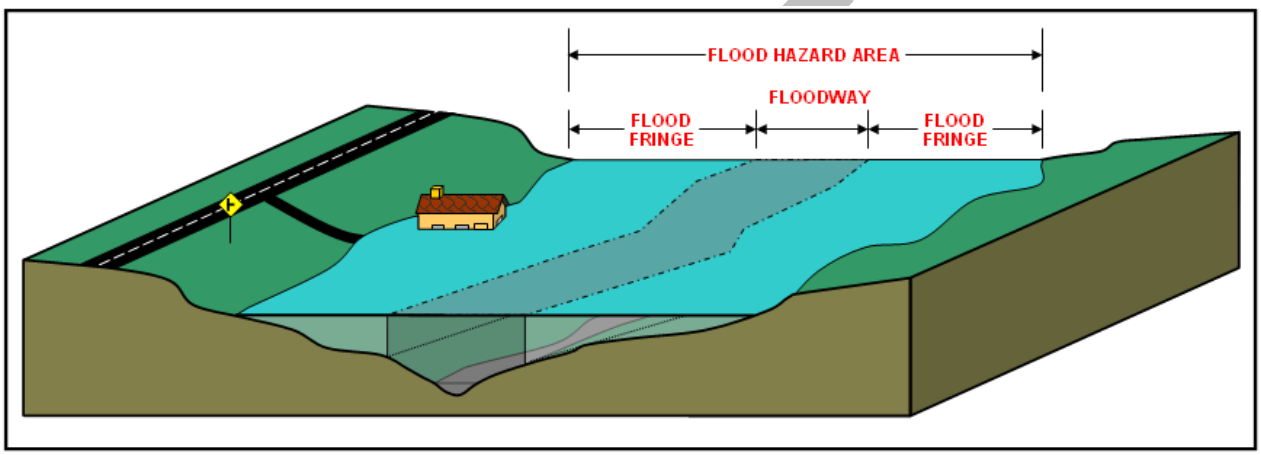
Location

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

Floodplains

A floodplain is defined as the land adjoining the channel of a river, stream, ocean, lake, or other watercourse or water body that becomes inundated with water during a flood. In Onondaga County, floodplains line the rivers and streams of the county. The boundaries of the floodplains are altered as a result of changes in land use, the amount of impervious surface, placement of obstructing structures in floodways, changes in precipitation and runoff patterns, improvements in technology for measuring topographic features, and utilization of different hydrologic modeling techniques. Figure 5.4.3-1 depicts the flood hazard area, the flood fringe, and the floodway areas of a floodplain.

Figure 5.4.3-1. Floodplain



Source: NJDEP, Date Unknown

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

Locations of flood zones in Onondaga County as depicted on the FEMA effective Digital Flood Insurance Rate Map (DFIRM) are illustrated in Figure 5.4.3-2 and the total land area in the floodplain, inclusive of waterbodies, is summarized in Table 5.4.3-1. Section 9 (Jurisdictional Annexes) includes a map of each jurisdiction depicting the floodplains. As depicted in Figure 5.4.3-2, flood hazard zones occur throughout the county at locations along the Seneca River (Erie Canal), at the confluence of the Seneca and Oneida Rivers, and associated with numerous creeks throughout the county but more exposure in the northern part of the county.

The Digital Flood Insurance Rate Map (DFIRM) data provided by FEMA for Onondaga County show the following flood hazard areas:

- 1-Percent Annual Chance Flood Hazard: Areas subject to inundation by the 1-percent-annual-chance flood event. This includes Zone A, Zone AE, and Zone A. Mandatory flood insurance requirements and floodplain management standards apply. Base flood elevations are provided in Zone AE. Zone AO has

associated flood depths derived from detailed hydraulic analyses. Zone A has no determined flood depths.

- 0.2-Percent Annual Chance Flood Hazard: Area of minimal flood hazard, usually depicted on FIRMs as the 500-year flood level or Shaded X Zone.

The total land area located in the one-percent and 0.2-percent annual chance flood zones was calculated using the regulatory FIRM for each jurisdiction, as presented in Table 5.4.3-1. Section 9 (Jurisdictional Annexes) contains information regarding specific areas of flooding for each participating municipality in Onondaga County.

Table 5.4.3-1. Total Land Area in the 1-Percent and 0.2-Percent Annual Chance Flood Zones (Acres)

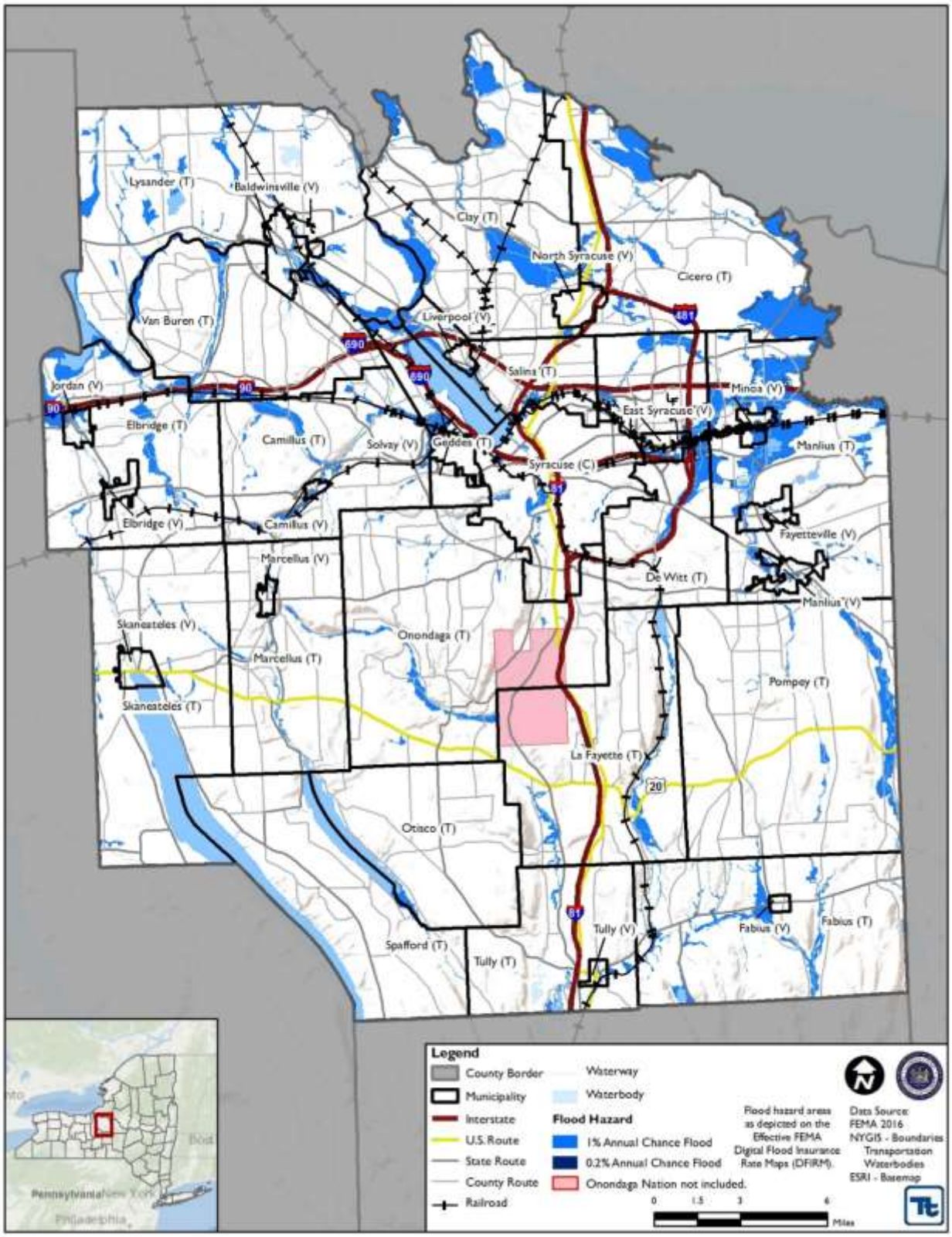
Municipality	Total Area (acres)	1% Flood Event Hazard Area		0.2% Flood Event Hazard Area	
		Area (acres)	Percent (%) of Total	Area (acres)	Percent (%) of Total
Baldwinsville (V)	2,071.5	299.7	14.5%	336.5	16.2%
Camillus (T)	21,764.9	1,653.3	7.6%	1,798.6	8.3%
Camillus (V)	224.2	53.3	23.8%	57.9	25.8%
Cicero (T)	30,487.6	5,282.6	17.3%	5,744.9	18.8%
Clay (T)	30,673.3	4,542.4	14.8%	5,089.8	16.6%
De Witt (T)	20,593.2	2,100.3	10.2%	2,348.0	11.4%
East Syracuse (V)	1,007.8	221.1	21.9%	280.3	27.8%
Elbridge (T)	23,120.2	2,903.4	12.6%	2,959.5	12.8%
Elbridge (V)	683.7	17.5	2.6%	19.7	2.9%
Fabius (T)	29,669.3	2,358.3	7.9%	2,358.4	7.9%
Fabius (V)	255.8	12.1	4.7%	12.1	4.7%
Fayetteville (V)	1,105.0	123.0	11.1%	127.8	11.6%
Geddes (T)	6,444.9	2,346.8	36.4%	2,539.7	39.4%
Jordan (V)	736.2	201.3	27.3%	224.2	30.5%
La Fayette (T)	28,391.3	1,416.2	5.0%	1,490.9	5.3%
Liverpool (V)	487.1	61.8	12.7%	72.1	14.8%
Lysander (T)	40,174.3	5,268.0	13.1%	5,403.2	13.4%
Manlius (T)	28,920.5	5,621.6	19.4%	6,294.5	21.8%
Manlius (V)	1,146.8	135.8	11.8%	169.7	14.8%
Marcellus (T)	20,443.2	461.1	2.3%	504.1	2.5%
Marcellus (V)	394.9	29.4	7.4%	33.1	8.4%
Minoa (V)	762.5	176.0	23.1%	274.2	36.0%
North Syracuse (V)	1,266.6	11.3	0.9%	11.3	0.9%
Onondaga (T)	39,806.6	1,000.7	2.5%	1,025.2	2.6%
Otisco (T)	19,915.3	1,252.8	6.3%	1,252.8	6.3%
Pompey (T)	42,564.1	2,021.0	4.7%	2,154.4	5.1%
Salina (T)	9,410.7	2,095.9	22.3%	2,300.3	24.4%

Table 5.4.3-1. Total Land Area in the 1-Percent and 0.2-Percent Annual Chance Flood Zones (Acres)

Municipality	Total Area (acres)	1% Flood Event Hazard Area		0.2% Flood Event Hazard Area	
		Area (acres)	Percent (%) of Total	Area (acres)	Percent (%) of Total
Skaneateles (T)	30,126.1	4,240.1	14.1%	4,261.9	14.1%
Skaneateles (V)	1,089.1	220.0	20.2%	222.6	20.4%
Solvay (V)	1,027.4	26.8	2.6%	27.2	2.6%
Spafford (T)	25,030.8	4,349.5	17.4%	4,349.5	17.4%
Syracuse (C)	16,406.3	945.8	5.8%	1,153.9	7.0%
Tully (T)	16,404.1	497.8	3.0%	497.8	3.0%
Tully (V)	393.5	33.5	8.5%	37.6	9.6%
Van Buren (T)	22,258.1	1,827.8	8.2%	1,904.8	8.6%
Onondaga County	**515,257.1**	**53,808.0**	**10.4%**	**57,338.7**	**11.1%**

Source: *FEMA 2016*
Note: *The area presented includes the area of inland waterways.*

Figure 5.4.3-2. FEMA Flood Hazard Areas in Onondaga County



Source: FEMA 2016

Riverine/Flash Flooding/Stormwater Flooding

The land area within Onondaga County drains into two major river drainage basins: the Seneca-Oneida-Oswego River Basin, which is part of the Lake Ontario watershed and the Susquehanna River Basin. Refer to Figure 4-4-3 in Section 4 (County Profile) for a map of the major drainage basins. However, most of Onondaga County falls within the Oswego River Basin (New York State Department of Environmental Conservation [NYSDEC] 2007) as shown in Figure 4-2 in Section 4 (County Profile) of this plan. The major waterbodies and tributaries within the Oswego River basin in Onondaga County that experience frequent flooding include, but are not limited to, the Oswego River (of the Oswego River sub-Watershed); the Oneida Lake, Oneida River, Butternut Creek, Limestone Creek (of the Oneida River sub-Watershed); Onondaga Lake, Otisco Lake, Onondaga Creek, Nine Mile Creek, Ley Creek, Bloody Brook, Harbor Brook, in the Onondaga Lake sub-watershed and the, Skaneateles Lake, , Skaneateles Creek, Seneca River (of the Lower Seneca River Watershed) (NYSDEC 2007, FEMA 2016).

The most documented location of historical flooding lies within the Onondaga Lake subwatershed, particularly along Onondaga Creek. The current creek channel conditions, and the large flood control structure (dam) located just below the junction of Onondaga Creek and its West Branch, located in the Onondaga Nation Territory, has reduced flooding within the City of Syracuse, but because of historical straightening of the creek, flood waters have been known to rapidly move through the city and can become dangerous during high-water events. Portions of the creek and its banks are fenced off to prevent injury and death during these flood periods (Onondaga Lake Partnership 2006).

Ice Jam Flooding

Ice jams can occur along any of Onondaga County's rivers and streams. According to the Ice Jam Database, maintained by the Ice Engineering Group at the USACE Cold Regions Research and Engineering Laboratory (CRREL), Onondaga County experienced 3 historic ice jam events between 1780 and 2018), along Limestone Creek, Meadow Brook, and Onondaga Creek (USACE 2018).

Dam and Levee Failure

According to the Dam Incident Notification (DIN) system maintained by the National Performance of Dam Program (NPDP), there are 29 dams in Onondaga County. Of the 29 dams, there are 6 classified as low hazard, 12 classified as significant hazard, and 11 classified as high hazard (NPDP 2018). However, these numbers differ from the New York State Inventory of Dams, which identifies 147 dams in Onondaga County: 63 low hazard, 7 intermediate hazard, 9 high hazard, and 68 negligible or no hazard classification (NYSDEC 2018). Refer to Figure 4-28 in Section 4 (County Profile) for a map of dam locations by hazard classification in Onondaga County.

Levees protect portions of the Village of Marcellus along Nine Mile Creek, the City of Syracuse along Onondaga Creek, and the Village of Fayetteville along Limestone Creek (USACE 2019). Failure of these levees could result in flooding of these jurisdictions.

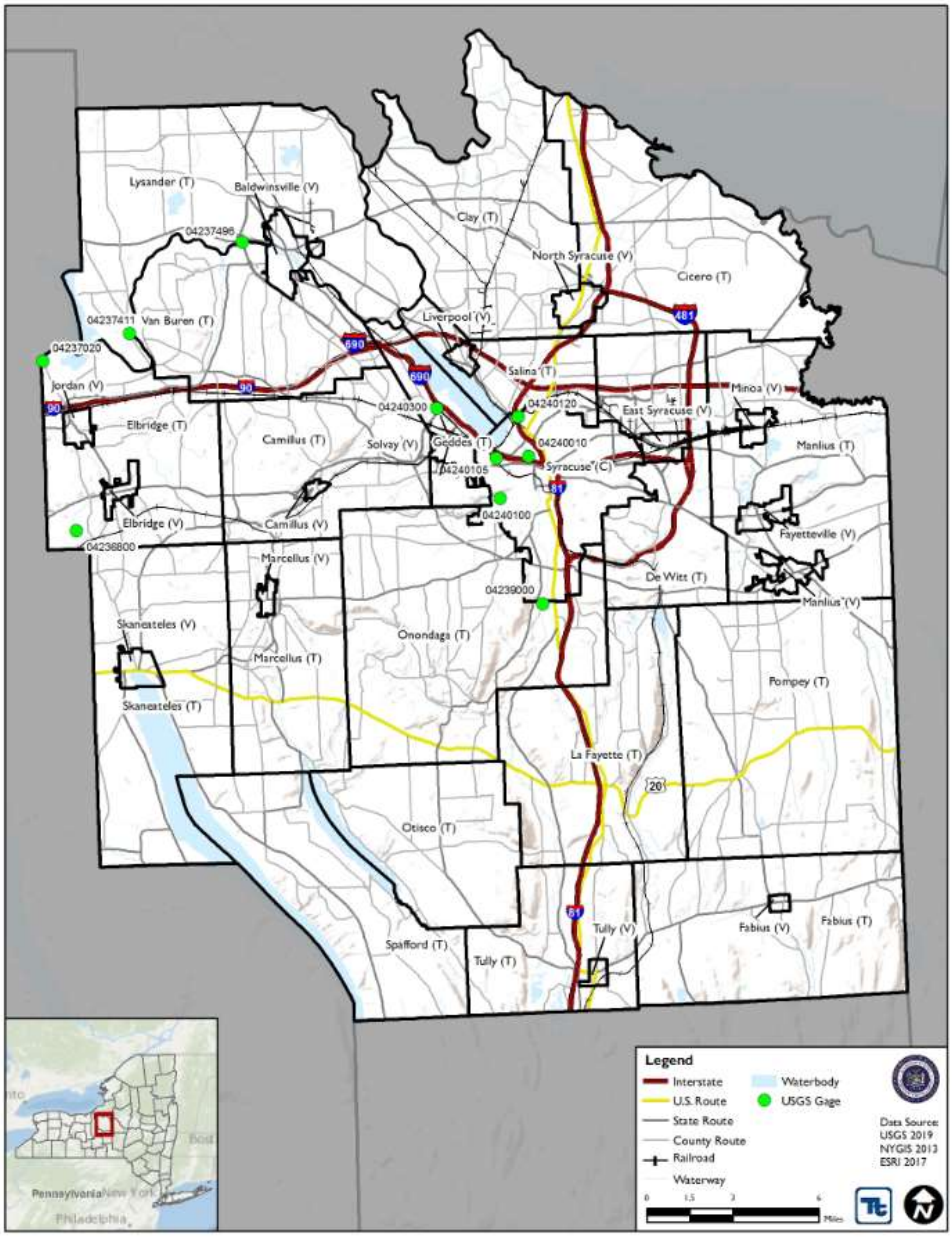
Flood Gages

The USGS National Water Information System (NWIS) collects surface water data from more than 850,000 stations across the country. The time-series data describes stream levels, streamflow (discharge), reservoir and lake levels, surface water quality, and rainfall. The data is collected by automatic recorders and manual field measurements at the gage locations. In Onondaga County, there are 10 USGS stream gages that collect data as indicated in Table 5.4.3-2 and Figure 5.4.3-3.

Table 5.4.3-2. USGS Gages Located in Onondaga County

USGS Gage Number	USGS Gage Name
4236800	Skaneateles Creek Near Skaneateles Junction NY
4237020	Seneca R (Barge Canal) at Cross Lake Nr Jordan NY
4237411	Seneca River, Mouth of State Ditch, Near Jordan NY
4237496	Seneca River Near Baldwinsville NY
4239000	Onondaga Creek at Dorwin Avenue, Syracuse NY
4240010	Onondaga Creek at Spencer Street, Syracuse NY
4240100	Harbor Brook at Syracuse NY
4240105	Harbor Brook at Hiawatha Boulevard, Syracuse NY
4240120	Ley Creek at Park Street, Syracuse NY
4240300	Ninemile Creek at Lakeland NY

Figure 5.4.3-3. USGS Gage Locations in Onondaga County



Previous Occurrences and Losses

Table 5.4.3-3 documents historical flood events from 1950 to August 2018 in Onondaga County based on data collected from the NCEI, National Performance of Dams Program (NPDP), and Cold Regions Research and Engineering Laboratory (CRREL) databases.

Table 5.4.3-3. Flood Events 1950-2018

Hazard Type	Number of Occurrences Between 1950 and 2018	Total Fatalities	Total Injuries	Total Property Damage ($)	Total Crop Damage ($)
Flash Flood	19	2	0	$35.9 million	$0
Flood	6	0	0	$70,000	$0
Dam Failure	0	0	0	$0	$0
Ice Jam	1	-	-	-	-
Levee Failure	0	-	-	-	
Total	26	2	0	$36 million	$0

Source: NOAA-NCEI 2018; CRREL 2018
Note: Ice Jam data from CRREL does not have fatalities, injuries, property damage, or crop damage data available

Between 1954 and 2018, FEMA included New York State in 85 flood-related major disaster (DR) or emergency (EM) declarations classified as one or a combination of the following disaster types: severe storms, flooding, hurricane, tropical depression, heavy rains, landslides, ice storm, high tides, nor'easter, tornado, snowstorm, severe winter storm, and inland/coastal flooding. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Onondaga County was included in eight of these flood-related declarations; refer to Table 5.4.3-4.

Table 5.4.3-4. FEMA DR and EM Declarations for Flood Events in Onondaga County, 1954 to 2018

FEMA Declaration Number	Date(s) of Event	Event Type
DR-338	June 23, 1972	Flood: Tropical Storm Agnes
DR-447	July 23, 1974	Flood: Severe Storms & Flooding
DR-487	October 2, 1975	Flood: Storms, Rains, Landslides, and Flooding
DR-1095	January 19-30, 1996	Flood: Severe Storms and Flooding
DR-1335	May 3, 2000-August 12, 2000	Severe Storms: Severe Storms and Flooding
DR-1534	May 13-June 17, 2004	Severe Storm: Severe Storms and Flooding
DR-1564	August 13-September 16, 2004	Severe Storm: Severe Storms and Flooding
DR-1993	April 26-May 8, 2011	Flood: Severe Storms, Flooding, Tornadoes, and Straight Line Winds

Source: FEMA 2018

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans available to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2012 and 2018, Onondaga County has been included in the following three USDA disaster declarations in relation to flooding:

- S3593 – May 1 - October 1, 2013 – combined effects of excessive rain and related flooding, high winds, and hail
- S3747 – April 1 - July 8, 2014 – combined effects of excessive rain and flash flooding

- S3885 – May 1-July 14, 2015 – combined effects of excessive rain, high winds, hail, lightning, and tornado

For this update, flood events were summarized from 2012 to 2018. Known flood events, including FEMA disaster declarations, which have impacted Onondaga County between 2012 and 2018 are identified in Table 5.4.3-5. Please see Section 9 for detailed information regarding flood impacts to each municipality. For events prior to 2012, refer to Appendix E (Supplementary Data).

Table 5.4.3-5. Flood Events in Onondaga County, 2011 to 2018

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Event Details
August 3, 2014	Flash Flood	N/A	N/A	Significant urban flash flooding was occurring. Hiawatha Boulevard was flooded, and the on-ramp to Interstate 690 was impassable. Roads were closed due to water rushing across them near the Lourdes camp. There were numerous roads in the region with water over them. Many roads were impassable in both the Town of Marcellus and the Town of Otisco. Flooding caused $135,000 in property damages.
June 30, 2015	Flash Flood	N/A	N/A	An unseasonably strong storm system tapping into above normal moisture sources across the Great Lakes and Northeast triggered multiple heavy rain producing thunderstorms across the region. Localized torrential rainfall in central New York caused serious urban flash flooding in the City of Syracuse metropolitan area. Flooding caused $3,500,000 in property damages.
July 1, 2015	Flash Flood	N/A	N/A	An unseasonably strong storm system, tapping into above normal moisture sources across the Great Lakes and Northeast, triggered multiple heavy rain producing thunderstorms across the region. It affected the Town of DeWitt and Town of Salina causing $520,000 in property damages.
July 8, 2015	Flash Flood	N/A	N/A	Torrential rain producing thunderstorms moved slowly through the Finger Lakes region to the Upper Mohawk Valley. Extreme rainfall rates produced rain amounts in excess of 2 inches within 45 to 90 minutes. This led to areas of serious street and small stream flooding in central New York, affecting parts of Clairmont Farms and Long Branch Manor. Flooding caused $5,015,000 in property damages.
July 1, 2017	Flash Flood	N/A	N/A	A tropical moisture laden air mass produced numerous showers and thunderstorms which traveled repeatedly over the same areas of the Finger Lakes Region and Upper Mohawk Valley. Widespread flash flooding of most creeks and urbanized areas occurred throughout the Towns of LaFayette, Onondaga, and Tully. Flooding caused $5,367,000 in property damages.

Sources: *FEMA 2018; NOAA-NCDC 2018; NYS HMP 2014; SPC 2018*
Note: *Many sources were consulted to provide an update of previous occurrences and losses; event details and loss/impact information may vary and has been summarized in the above table.*
FEMA *Federal Emergency Management Agency*
N/A *Not Applicable*

Climate Change Projections

In the Tug Hill Plateau ClimAID region, in which Onondaga County is located, is estimated that precipitation totals will increase between 4 and 10 percent by the 2050s and 6 to 12 percent by the 2080s (baseline of 42.6

inches, mid-range projection). Table 5.4.3-6 displays the projected seasonal precipitation change for the Tug Hill Plateau ClimAID Region (NYSERDA 2014).

Table 5.4.3-6. Projected Seasonal Precipitation Change in Region 6, 2050s (% change)

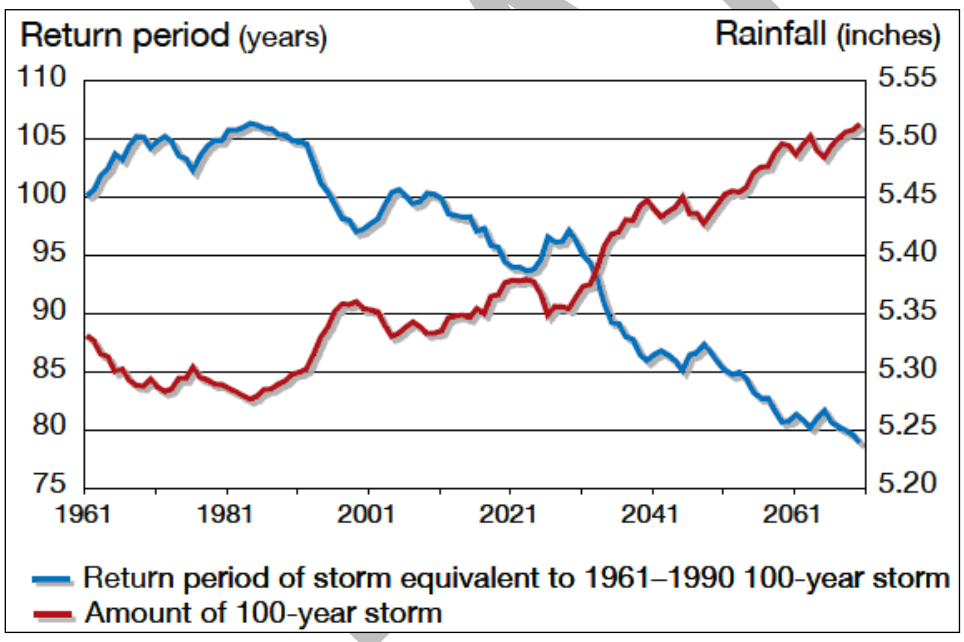
Winter	Spring	Summer	Fall
+5 to +15	0 to +10	-5 to +10	-5 to +10

Source: NYSERDA 2011

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

Increasing air temperatures intensify the water cycle by increasing evaporation and precipitation. This can cause an increase in rain totals during events with longer dry periods in between those events. These changes can have a variety of effects on the State's water resources (NYSERDA 2011). Figure 5.4.3-4 displays the projected rainfall and frequency of extreme storms in New York State. The amount of rainfall in a 100-year event is projected to increase, while the number of years between such storms (return period) is projected to decrease. Rainstorms will become more severe and more frequent (NYSERDA 2011).

Figure 5.4.3-4. Projected Rainfall and Frequency of Extreme Storms



Source: NYSERDA 2011

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

Probability of Future Occurrences

Based on the historic and more recent flood events in Onondaga County, it is clear that the county has a high probability of flooding for the future. The fact that the elements required for flooding exist and that major flooding has occurred throughout the county in the past suggests that many people and properties are at risk from the flood hazard in the future. It is estimated that Onondaga County will continue to experience direct and indirect impacts of flooding events annually that may induce secondary hazards such as coastal erosion, storm surge in coastal areas, infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, and transportation delays, accidents and inconveniences.

As defined by FEMA, geographic areas within the 1 percent annual chance flood area in Onondaga County are estimated to have a one-percent chance of flooding in any given year. A structure located within a 1 percent annual chance flood area has a 26-percent chance of suffering flood damage during the term of a 30-year mortgage. Geographic areas in Onondaga County located within the 0.2 percent annual chance flood area boundary are estimated to have a 0.2-percent chance of being flooded in any given year (FEMA, 2007).

According to the 2014 New York State HMP, between 1960 and 2012, Onondaga County had 37 flooding events which resulted in one fatality, one injury, over $22.5 million in property damage and over $816,000 in crop damage. These statistics indicate that the county has a 71 percent chance of floods occurring in the future with a recurrence interval of one (NYS DHSES 2014). However, according to the NOAA NCEI and the CRREL database, Onondaga County experienced 26 flood events between 1950 and 2018, including 6 floods, 19 flash floods, one ice jam, and no dam failures. The table below shows these statistics, as well as the annual average number of events and the percent chance of these individual flood hazards occurring in Onondaga County in future years based on the historic record (NOAA NCEI 2018).

Table 5.4.3-7. Probability of Future Occurrence of Flooding Events

Hazard Type	Number of Occurrences Between 1950 and 2018	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent (%) chance of occurrence in any given year
Flash Flood	19	0.3	3.6	0.3	27.5%
Flood	6	0.1	11.5	0.1	8.7%
Dam Failure	0	0	0	0	0%
Ice Jams	1	0	69.0	0	1.5%
Levee Failure	0	0	0	0	0%
Total	**26**	**0.4**	**2.7**	**0.4**	**37.7%**

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

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

In Section 5.3, the identified hazards of concern for Onondaga County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for flood in the county is considered *occasional*, having between 10-percent and 100-percent annual probability of the hazard occurring, as presented in Table 5.3-2 in Section 5.3 (Hazard Ranking).

5.4.3.2 Vulnerability Assessment

To assess Onondaga County's risk to the flood hazard, a spatial analysis was conducted using the best available spatially-delineated flood hazard areas. The 1- and 0.2-percent annual chance flood events were examined using the 2016 FEMA Effective DFIRM to determine the assets located in the hazard areas and to estimate potential loss using the FEMA HAZUS-MH v4.2 model. These results are summarized below. Delineated dam failure inundation areas and areas prone to flash flooding/stormwater flooding were not available for this plan, and their impacts will be discussed qualitatively with the overall impacts to flooding. Refer to Section 5.1 for additional details on the methodology used to assess flood risk.

Impact on Life, Health and Safety

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

An estimated 10,850 people reside in the 1-percent annual chance flood boundary, and 14,496 people within the 0.2-percent annual chance flood boundary. These residents may be displaced by the flooding of their homes, requiring them to seek temporary shelter with friends and family or in emergency shelters. The Town of Cicero has the greatest estimated number of individuals residing in the floodplain—approximately 1,920 and 2,405 people in the 1-percent and 0.2-percent chance flood boundaries, respectively. The Village of Jordan has the highest percentage of population within the 1-percent annual chance floodplain (16.3 percent, or 223 of its 1,368 total Village population). The Village of Minoa has the highest percentage of population residing in the 0.2-percent annual chance floodplain (28.1 percent of the total Village population, or 970 residents). Table 5.4.3-8 lists the population residing in the mapped FEMA flood hazard zones by municipality.

Table 5.4.3-8. Estimated Population Located in the FEMA Flood Hazard Zones

Municipality	Total Population	1-Percent Chance Event		0.2-Percent Chance Event	
		Total Number	Percent (%) of Total	Total Number	Percent (%) of Total
Baldwinsville (V)	7,378	139	1.9%	242	3.3%
Camillus (T)	22,954	348	1.5%	571	2.5%
Camillus (V)	1,213	98	8.1%	115	9.5%
Cicero (T)	29,641	1,920	6.5%	2,405	8.1%
Clay (T)	53,397	838	1.6%	1,284	2.4%
Dewitt (T)	22,754	149	0.7%	264	1.2%
East Syracuse (V)	3,084	96	3.1%	216	7.0%
Elbridge (T)	3,496	278	8.0%	290	8.3%
Elbridge (V)	1,058	12	1.1%	14	1.4%
Fabius (T)	1,612	48	3.0%	48	3.0%
Fabius (V)	352	0	0.0%	0	0.0%
Fayetteville (V)	4,373	288	6.6%	290	6.6%
Geddes (T)	10,534	2	0.0%	41	0.4%

Table 5.4.3-8. Estimated Population Located in the FEMA Flood Hazard Zones

Municipality	Total Population	1-Percent Chance Event		0.2-Percent Chance Event	
		Total Number	Percent (%) of Total	Total Number	Percent (%) of Total
Jordon (V)	1,368	223	16.3%	254	18.6%
Lafayette (T)	4,952	132	2.7%	154	3.1%
Liverpool (V)	2,347	19	0.8%	41	1.7%
Lysander (T)	17,175	886	5.2%	970	5.6%
Manlius (T)	19,844	1,476	7.4%	1,910	9.6%
Manlius (V)	4,704	142	3.0%	233	4.9%
Marcellus (T)	4,397	14	0.3%	22	0.5%
Marcellus (V)	1,813	5	0.3%	7	0.4%
Minoa (V)	3,449	478	13.8%	970	28.1%
North Syracuse (V)	6,800	2	0.0%	2	0.0%
Onondaga (T)	23,101	161	0.7%	166	0.7%
Onondaga Nation Reservation	468	-	-	-	-
Otisco (T)	2,541	5	0.2%	5	0.2%
Pompey (T)	7,080	154	2.2%	185	2.6%
Salina (T)	31,363	245	0.8%	444	1.4%
Skaneateles (T)	4,669	94	2.0%	94	2.0%
Skaneateles (V)	2,540	22	0.9%	22	0.9%
Solvay (V)	6,584	7	0.1%	7	0.1%
Spafford (T)	1,686	103	6.1%	103	6.1%
Syracuse (C)	145,170	1,742	1.2%	2,311	1.6%
Tully (T)	1,865	46	2.4%	46	2.4%
Tully (V)	873	55	6.3%	72	8.2%
Van Buren (T)	10,391	624	6.0%	698	6.7%
Onondaga County	**467,026**	**10,850**	**2.3%**	**14,496**	**3.1%**

Sources: FEMA 2016
Note: The FEMA DFIRM boundaries were overlaid on the residential buildings from the custom general building stock; the structures with their centroids within the hazard areas were totaled for each municipality. The 2010 U.S. Census Average Household Size (2.40) used to estimate exposed population. *FEMA DFIRM data not available for the Onondaga Nation.*
C City
T Town
V Village

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 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.

Recent updates to the FIRM for Syracuse have forced a large number of residents to purchase mandated flood insurance. To lessen the economic burden, NYS has approved a tax break for impacted residents. The bill offers a tax break for homes in a flood zone whose owners buy flood insurance and are in an economically stressed area as well as households outside those designated economic areas with household income less than $62,985. Approximately 630 properties are eligible for the tax break (Syracuse.com 2019).

Approximately 1,039 people over the age of 65 and 2,494 people considered low income populations reside in the 1-percent annual chance flood boundary, and approximately 1,407 people over the age 65 and 3,377 people considered low income populations reside in the 0.2-percent annual chance flood boundary.

HAZUS-MH v4.2 estimates the potential sheltering needs as a result of a 1-percent chance flood event. For the 1-percent annual chance flood event, HAZUS-MH v4.2 estimates 12,157 people will be displaced, and 561 people will seek short-term sheltering. These statistics are presented in Table 5.4.3-9.

On February 4, 2019, the City of Syracuse Common Council passed an ordinance that will provide tax exemptions for city residents living in designated special flood hazard areas. Residents can apply for $81,000 in property tax exemptions if they are insured by a federally-backed flood insurance plan (for example, the NFIP). This exemption will help city residents who own homes in economically stressed areas of the city.

Table 5.4.3-9. Estimated Population Displaced or Seeking Short-Term Shelter from the 1-Percent Annual Chance Flood Event

Municipality	1-Percent Annual Chance Event	
	Displaced Population	Persons Seeking Short-Term Sheltering
Baldwinsville (V)	150	1
Camillus (T)	394	6
Camillus (V)	134	4
Cicero (T)	1,653	54
Clay (T)	766	25
Dewitt (T)	244	4
East Syracuse (V)	93	1
Elbridge (T)	119	0
Elbridge (V)	9	0
Fabius (T)	68	0
Fabius (V)	2	0
Fayetteville (V)	345	19
Geddes (T)	42	0
Jordon (V)	155	1
Lafayette (T)	141	1
Liverpool (V)	142	5
Lysander (T)	509	11
Manlius (T)	1,638	84
Manlius (V)	361	23
Marcellus (T)	34	0
Marcellus (V)	67	2
Minoa (V)	443	19
North Syracuse (V)	10	0
Onondaga (T)	252	0
Onondaga Nation Reservation	-	-
Otisco (T)	14	0
Pompey (T)	192	0
Salina (T)	897	44
Skaneateles (T)	38	0
Skaneateles (V)	28	0
Solvay (V)	2	0
Spafford (T)	8	0
Syracuse (C)	2,854	253
Tully (T)	28	0
Tully (V)	70	1

Table 5.4.3-9. Estimated Population Displaced or Seeking Short-Term Shelter from the 1-Percent Annual Chance Flood Event

Municipality	1-Percent Annual Chance Event	
	Displaced Population	Persons Seeking Short-Term Sheltering
Van Buren (T)	255	3
Onondaga County	**12,157**	**561**

Source: HAZUS-MH 4.2
Note: Population estimates are based on the 2010 U.S. Census data.
C City
T Town
V Village

Total numbers of injuries and casualties resulting from typical riverine flooding are generally limited based on advance weather forecasting, blockades, and warnings. Injuries and deaths generally are not anticipated if proper warning and precautions occur. In contrast, warning time for dam failure events or flash flooding is limited. These events are frequently associated with other natural hazard events such as earthquakes, landslides, or severe weather, which limits their predictability and compounds the hazard. Populations without adequate warning of the event are highly vulnerable to this hazard; this includes populations downstream of a dam failure event that cannot evacuate within the allowable time frame. The population adversely affected by a dam failure event can also include those beyond the disaster area that rely on the dam for providing potable water. Like riverine flooding, economically disadvantaged populations and the elderly are more vulnerable to impacts from a sudden dam failure event or flash flooding.

Cascading impacts may also include exposure to pathogens such as mold. After flood events, excess moisture and standing water contribute to the growth of mold in buildings. Mold may present a health risk to building occupants, especially those with already compromised immune systems such as infants, children, the elderly and pregnant women. The degree of impact will vary and is not strictly measurable. Molds can grow in as short a period as 24-48 hours in wet and damaged areas of buildings that have not been properly cleaned. Very small mold spores can easily be inhaled, creating the potential for allergic reactions, asthma episodes, and other respiratory problems. Buildings should be properly cleaned and dried out to safely prevent mold growth (CDC, 2017).

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

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

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

Impact on General Building Stock

To assess potential impacts on buildings, both exposure and estimated loss were examined for the 1- and 0.2-percent annual chance flood events. Table 5.4.3-10 and Table 5.4.3-11 summarize these results. There are 5,670

buildings located in the 1-percent annual chance flood boundary with an estimated $3.3 billion of building and contents exposed. In total, this represents approximately 2.8% of the county's total general building stock inventory (approximately $118 billion). Based on this analysis, the Village of Minoa has the greatest percentage of the buildings exposed (greater than 14 percent of the total buildings in the Village, 227 buildings); the Town of Cicero has the greatest number of buildings exposed to the 1-percent annual chance flood event (884 buildings).

An estimated 7,500 buildings are located in the 0.2-percent annual chance flood boundary with an estimated $4.4 billion of building and contents exposed. This represents approximately 3.8% of the county's total general building stock inventory. Based on this analysis, the Village of Minoa has greater than 27 percent (440 buildings) of its buildings located in the 0.2-percent annual chance flood hazard area; and the Town of Cicero has the greatest number of buildings in the hazard area (1,115 buildings) when compared to the other municipalities in the county.

Table 5.4.3-10. Estimated General Building Stock Located in the 1- Percent Annual Chance Flood Boundary

Municipality	Total # Buildings	Total Replacement Cost Value (Structure and Contents)	Total			
			# Buildings	Percent (%) Total	Total Replacement Cost Value (Structure and Contents	Percent (%) Total
Baldwinsville (V)	3,321	$1,504,827,309	90	2.7%	$52,265,825	3.5%
Camillus (T)	11,611	$4,945,293,987	177	1.5%	$60,509,890	1.2%
Camillus (V)	490	$182,330,235	48	9.8%	$18,148,539	10.0%
Cicero (T)	15,558	$7,104,912,499	937	6.0%	$294,180,786	4.1%
Clay (T)	22,004	$13,377,871,396	456	2.1%	$141,568,546	1.1%
Dewitt (T)	11,191	$11,163,898,629	137	1.2%	$401,022,919	3.6%
East Syracuse (V)	1,662	$901,239,284	96	5.8%	$122,420,454	13.6%
Elbridge (T)	3,020	$1,214,372,973	141	4.7%	$49,616,823	4.1%
Elbridge (V)	654	$243,606,959	6	0.9%	$4,114,273	1.7%
Fabius (T)	1,717	$873,582,692	24	1.4%	$7,363,082	0.8%
Fabius (V)	245	$100,916,840	0	0.0%	$0	0.0%
Fayetteville (V)	1,999	$1,065,416,400	160	8.0%	$91,096,365	8.6%
Geddes (T)	6,048	$3,940,020,462	82	1.4%	$326,444,877	8.3%
Jordon (V)	754	$324,416,761	99	13.1%	$28,924,864	8.9%
Lafayette (T)	3,742	$1,385,373,038	64	1.7%	$18,538,497	1.3%
Liverpool (V)	1,379	$585,988,259	33	2.4%	$47,853,261	8.2%
Lysander (T)	9,513	$5,511,947,365	495	5.2%	$164,849,663	3.0%
Manlius (T)	10,101	$5,931,420,911	690	6.8%	$286,309,996	4.8%
Manlius (V)	1,724	$1,225,609,003	64	3.7%	$66,707,319	5.4%
Marcellus (T)	3,442	$1,592,818,810	7	0.2%	$1,125,067	0.1%
Marcellus (V)	790	$446,005,634	5	0.6%	$6,555,768	1.5%
Minoa (V)	1,579	$677,670,815	227	14.4%	$74,845,466	11.0%
North Syracuse (V)	3,297	$1,347,498,685	1	0.0%	$321,152	0.0%
Onondaga (T)	11,826	$5,889,094,715	79	0.7%	$26,647,143	0.5%
Onondaga Nation Reservation	638	$182,143,705	-	-	-	-
Otisco (T)	2,567	$1,070,059,196	3	0.1%	$291,783	0.0%
Pompey (T)	5,096	$2,547,562,317	78	1.5%	$27,716,703	1.1%

Municipality	Total # Buildings	Total Replacement Cost Value (Structure and Contents)	Total			
			# Buildings	Percent (%) Total	Total Replacement Cost Value (Structure and Contents	Percent (%) Total
Salina (T)	14,486	$8,140,248,129	163	1.1%	$147,342,337	1.8%
Skaneateles (T)	4,439	$2,334,223,245	62	1.4%	$18,603,712	0.8%
Skaneateles (V)	1,583	$871,003,682	18	1.1%	$6,439,165	0.7%
Solvay (V)	3,003	$1,402,099,960	3	0.1%	$863,618	0.1%
Spafford (T)	2,302	$826,800,666	67	2.9%	$14,211,670	1.7%
Syracuse (C)	51,837	$25,010,023,305	812	1.6%	$673,180,307	2.7%
Tully (T)	1,585	$882,534,759	24	1.5%	$7,371,053	0.8%
Tully (V)	511	$314,789,328	39	7.6%	$16,882,287	5.4%
Van Buren (T)	5,971	$3,347,767,581	283	4.7%	$82,885,301	2.5%
Onondaga County:	**221,685**	**$118,465,389,533**	**5,670**	**2.6%**	**$3,287,218,511**	**2.8%**

Source: FEMA 2016, Syracuse-Onondaga County Planning Agency
Note: The 1-percent flood boundary was overlaid on the custom general building stock inventory; the structures with their centroids within hazard areas were totaled for each municipality. Small structures, including sheds, garages, or accessory buildings, were not removed from the inventory and are present in the municipal counts. FEMA DFIRM data not available for Onondaga Nation.
Notes:
C City
T Town
V Village

Table 5.4.3-11. Estimated General Building Stock Exposure to the 0.2-Percent Annual Chance Flood Event

Municipality	Total # Buildings	Total Replacement Cost Value (Structure and Contents)	Total			
			# Buildings	Percent (%) Total	Total Replacement Cost Value (Structure and Contents	Percent (%) Total
Baldwinsville (V)	3,321	$1,504,827,309	150	4.5%	$83,056,692	5.5%
Camillus (T)	11,611	$4,945,293,987	274	2.4%	$88,713,771	1.8%
Camillus (V)	490	$182,330,235	56	11.4%	$20,185,122	11.1%
Cicero (T)	15,558	$7,104,912,499	1199	7.7%	$408,852,771	5.8%
Clay (T)	22,004	$13,377,871,396	680	3.1%	$237,918,019	1.8%
Dewitt (T)	11,191	$11,163,898,629	223	2.0%	$532,692,131	4.8%
East Syracuse (V)	1,662	$901,239,284	163	9.8%	$176,946,233	19.6%
Elbridge (T)	3,020	$1,214,372,973	146	4.8%	$50,537,389	4.2%
Elbridge (V)	654	$243,606,959	7	1.1%	$4,329,142	1.8%
Fabius (T)	1,717	$873,582,692	24	1.4%	$7,363,082	0.8%
Fabius (V)	245	$100,916,840	0	0.0%	$0	0.0%
Fayetteville (V)	1,999	$1,065,416,400	161	8.1%	$91,274,567	8.6%
Geddes (T)	6,048	$3,940,020,462	122	2.0%	$380,013,817	9.6%
Jordon (V)	754	$324,416,761	112	14.9%	$34,571,048	10.7%
Lafayette (T)	3,742	$1,385,373,038	80	2.1%	$31,304,707	2.3%
Liverpool (V)	1,379	$585,988,259	47	3.4%	$58,326,033	10.0%
Lysander (T)	9,513	$5,511,947,365	543	5.7%	$195,221,273	3.5%
Manlius (T)	10,101	$5,931,420,911	882	8.7%	$466,585,232	7.9%
Manlius (V)	1,724	$1,225,609,003	109	6.3%	$102,637,286	8.4%
Marcellus (T)	3,442	$1,592,818,810	10	0.3%	$2,893,179	0.2%

Municipality	Total # Buildings	Total Replacement Cost Value (Structure and Contents)	Total			
			# Buildings	Percent (%) Total	Total Replacement Cost Value (Structure and Contents	Percent (%) Total
Marcellus (V)	790	$446,005,634	6	0.8%	$8,440,640	1.9%
Minoa (V)	1,579	$677,670,815	440	27.9%	$159,605,379	23.6%
North Syracuse (V)	3,297	$1,347,498,685	1	0.0%	$321,152	0.0%
Onondaga (T)	11,826	$5,889,094,715	81	0.7%	$28,256,692	0.5%
Onondaga Nation Territory	638	$182,143,705	-	-	-	-
Otisco (T)	2,567	$1,070,059,196	3	0.1%	$291,783	0.0%
Pompey (T)	5,096	$2,547,562,317	93	1.8%	$34,035,163	1.3%
Salina (T)	14,486	$8,140,248,129	266	1.8%	$214,596,815	2.6%
Skaneateles (T)	4,439	$2,334,223,245	63	1.4%	$18,690,023	0.8%
Skaneateles (V)	1,583	$871,003,682	18	1.1%	$6,439,165	0.7%
Solvay (V)	3,003	$1,402,099,960	3	0.1%	$863,618	0.1%
Spafford (T)	2,302	$826,800,666	67	2.9%	$14,211,670	1.7%
Syracuse (C)	51,837	$25,010,023,305	1,084	2.1%	$847,630,101	3.4%
Tully (T)	1,585	$882,534,759	24	1.5%	$7,371,053	0.8%
Tully (V)	511	$314,789,328	48	9.4%	$22,768,791	7.2%
Van Buren (T)	5,971	$3,347,767,581	316	5.3%	$95,104,971	2.8%
Onondaga County	**221,685**	**$118,465,389,533**	**7,501**	**3.4%**	**$4,432,048,513**	**3.7%**

Source: FEMA 2016, Syracuse-Onondaga County Planning Agency
Note: The 0.2-percent flood boundary was overlaid on the custom general building stock inventory; the structures with their centroids within hazard areas were totaled for each municipality. Small structures, including sheds, garages, or accessory buildings, were not removed from the inventory and are present in the municipal counts. FEMA DFIRM data not available for the Onondaga Nation.
Notes:
C City
T Town
V Village

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

The HAZUS-MH v4.2 model estimated potential damages to buildings in Onondaga County for the 1-percent annual chance flood event. Table 5.4.3-12 summarizes these results. In total, HAZUS-MH v4.2 estimates $408.8 million in potential building damages, which equates to less than 1 percent of the total replacement cost value in the county. HAZUS-MH v4.2 estimates $190 million in residential building loss which 46.7 percent of the total potential loss for all occupancy classes.

Table 5.4.3-12. Estimated General Building Stock Potential Loss to the 1-Percent Annual Chance Flood Event

Municipality	Total Replacement Cost Value	1% Annual Chance Event							
		All Occupancies		Residential		Commercial		Agricultural, Industrial, Religious, Education and Government	
		Estimated Loss	Percent (%) of Total	Estimated Loss	Percent (%) of Total	Estimated Loss	Percent (%) of Total	Estimated Loss	Percent (%) of Total
Baldwinsville (V)	$1,504,827,309	$5,783,228	< 1%	$2,025,959	< 1%	$3,113,646	< 1%	$643,623	< 1%
Camillus (T)	$4,945,293,987	$12,032,188	< 1%	$4,694,363	< 1%	$1,122,916	< 1%	$6,214,909	< 1%
Camillus (V)	$182,330,235	$2,588,588	1.4%	$550,206	< 1%	$1,861,098	1.1%	$177,284	< 1%
Cicero (T)	$7,104,912,499	$16,823,293	< 1%	$11,255,589	< 1%	$1,525,726	< 1%	$4,041,978	< 1%
Clay (T)	$13,377,871,396	$25,487,358	< 1%	$15,799,445	< 1%	$795,736	< 1%	$8,892,177	< 1%
Dewitt (T)	$11,163,898,629	$24,181,114	< 1%	$8,277,818	< 1%	$13,220,462	< 1%	$2,682,833	< 1%
East Syracuse (V)	$901,239,284	$12,251,939	1.4%	$3,586,234	< 1%	$8,632,384	1%	$33,321	< 1%
Elbridge (T)	$1,214,372,973	$8,049,688	< 1%	$4,340,629	< 1%	$3,586,696	< 1%	$122,363	< 1%
Elbridge (V)	$243,606,959	$7,210	< 1%	$7,210	< 1%	$0	0%	$0	0%
Fabius (T)	$873,582,692	$503,217	< 1%	$488,847	< 1%	$9,717	< 1%	$4,653	< 1%
Fabius (V)	$100,916,840	$0	0%	$0	0%	$0	0%	$0	0%
Fayetteville (V)	$1,065,416,400	$21,898,569	2.1%	$5,963,701	< 1%	$4,974,085	< 1%	$10,960,783	1%
Geddes (T)	$3,940,020,462	$19,941,355	< 1%	$26,924	< 1%	$17,442,141	< 1%	$2,472,290	< 1%
Jordon (V)	$324,416,761	$2,289,462	< 1%	$1,569,691	< 1%	$251,846	< 1%	$467,925	< 1%
Lafayette (T)	$1,385,373,038	$2,211,387	< 1%	$1,875,983	< 1%	$0	0%	$335,404	< 1%
Liverpool (V)	$585,988,259	$12,197,266	2.1%	$273,250	< 1%	$11,269,582	1.9%	$654,433	< 1%
Lysander (T)	$5,511,947,365	$40,715,232	< 1%	$17,203,511	< 1%	$14,030,473	< 1%	$9,481,248	< 1%
Manlius (T)	$5,931,420,911	$25,495,318	< 1%	$21,372,083	< 1%	$2,801,324	< 1%	$1,321,912	< 1%
Manlius (V)	$1,225,609,003	$5,696,554	< 1%	$2,439,289	< 1%	$3,257,265	< 1%	$0	0%
Marcellus (T)	$1,592,818,810	$194,997	< 1%	$194,997	< 1%	$0	0%	$0	0%
Marcellus (V)	$446,005,634	$2,283,189	< 1%	$108,678	< 1%	$26,777	< 1%	$2,147,734	< 1%
Minoa (V)	$677,670,815	$12,592,985	1.9%	$5,555,693	< 1%	$3,805,616	< 1%	$3,231,676	< 1%
North Syracuse (V)	$1,347,498,685	$0	0%	$0	0%	$0	0%	$0	0.00%
Onondaga (T)	$5,889,094,715	$5,278,351	< 1%	$3,373,961	< 1%	$62,603	< 1%	$1,841,787	< 1%

Municipality	Total Replacement Cost Value	1% Annual Chance Event							
		All Occupancies		Residential		Commercial		Agricultural, Industrial, Religious, Education and Government	
		Estimated Loss	Percent (%) of Total	Estimated Loss	Percent (%) of Total	Estimated Loss	Percent (%) of Total	Estimated Loss	Percent (%) of Total
Onondaga Nation Territory	$182,143,705	$0	0%	$0	0%	$0	0%	$0	0%
Otisco (T)	$1,070,059,196	$56,230	< 1%	$43,357	< 1%	$0	0%	$12,874	< 1%
Pompey (T)	$2,547,562,317	$4,732,332	< 1%	$1,938,771	< 1%	$0	0%	$2,793,561	< 1%
Salina (T)	$8,140,248,129	$28,719,274	< 1%	$5,533,612	< 1%	$22,236,180	< 1%	$949,482	< 1%
Skaneateles (T)	$2,334,223,245	$1,263,430	< 1%	$545,510	< 1%	$34,789	< 1%	$683,131	< 1%
Skaneateles (V)	$871,003,682	$411,905	< 1%	$340,214	< 1%	$0	0%	$71,692	< 1%
Solvay (V)	$1,402,099,960	$120,140	< 1%	$120,140	< 1%	$0	0%	$0	0%
Spafford (T)	$826,800,666	$2,948,821	< 1%	$1,065,922	< 1%	$68,862	< 1%	$1,814,037	< 1%
Syracuse (C)	$25,010,023,305	$97,992,346	< 1%	$57,332,697	< 1%	$3,504,033	< 1%	$37,155,615	< 1%
Tully (T)	$882,534,759	$512,852	< 1%	$380,400	< 1%	$75,292	< 1%	$57,160	< 1%
Tully (V)	$314,789,328	$293,841	< 1%	$128,763	< 1%	$112,713	< 1%	$52,365	< 1%
Van Buren (T)	$3,347,767,581	$13,257,251	< 1%	$11,586,331	< 1%	$399,876	< 1%	$1,271,044	< 1%
Onondaga County:	**$118,465,389,533**	**$408,810,910**	**< 1%**	**$189,999,777**	**< 1%**	**$118,221,838**	**< 1%**	**$100,589,296**	**< 1%**

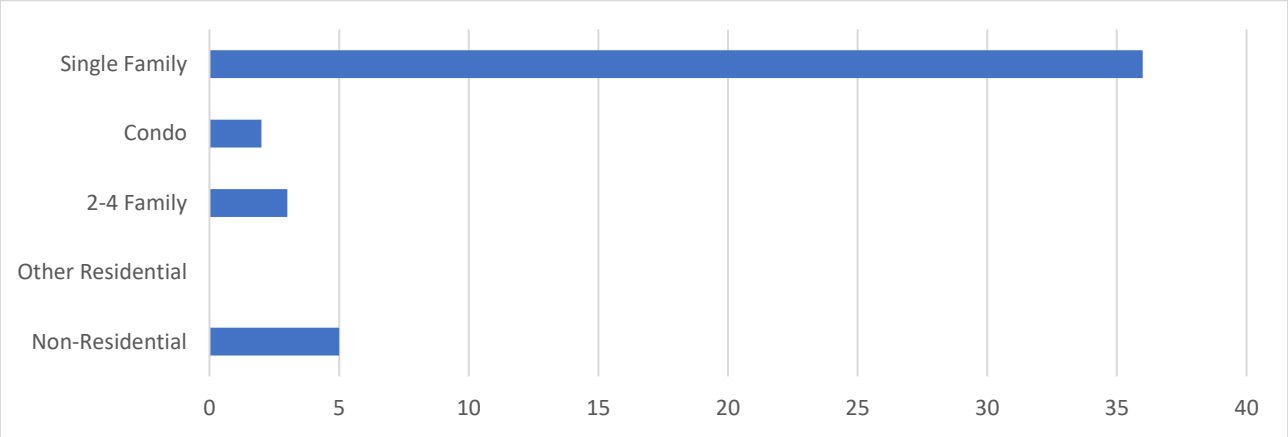
Source: HAZUS-MH 4.2
C City
T Town
V Village

NFIP Statistics

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

Table 5.4.3-13 summarizes the NFIP policies, claims, and repetitive loss statistics for Onondaga County. In total, 2,530 residents are NFIP policy holders, and there have been 889 claims totaling $6.5 million. Of the 1,753 policies, 945 policies (53.9 percent of the total) are located in the 1-percent annual chance floodplain; this may indicate inaccuracies with floodplain mapping or stormwater/localized flooding issues that may not be reflected in the FEMA delineated floodplains. Single-family residences account for approximately 78.3 percent of the total RL properties in Onondaga County (FEMA 2018). Of the 46 RL properties, 36 are "single-family" residences, 3 are "2-4 family" residences, 2 are "assumed condo" residences, and 5 are "non-residential." There are no severe repetitive loss properties in the county. Figure 5.4.3-5 shows NFIP RL properties in Onondaga County by occupancy class.

Figure 5.4.3-5. Occupancy Class of Repetitive Loss Structures in Onondaga County



Source: *FEMA Region 2 2018*
Note: *Repetitive loss and severe repetitive loss statistics provided by FEMA Region 2 and are current as of 05/31/2018.*
RL *Repetitive Loss*

Table 5.4.3-13. Occupancy Class of Repetitive Loss Structures in Onondaga 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
Village of Baldwinsville	0	0	0	0	0	0	0	0	0	0
Town of Camillus	0	0	0	0	0	0	0	0	0	0
Village of Camillus	0	0	0	0	0	0	0	0	0	0
Town of Cicero	1	0	0	0	22	0	0	0	0	0
Town of Clay	0	0	0	0	0	0	0	0	0	0
Town of DeWitt	0	2	5	0	1	0	0	0	0	0
Village of East Syracuse	0	0	0	0	0	0	0	0	0	0
Town of Elbridge	0	0	0	0	2	0	0	0	0	0
Village of Elbridge	0	0	0	0	0	0	0	0	0	0
Town of Fabius	0	0	0	0	0	0	0	0	0	0
Village of Fabius	0	0	0	0	0	0	0	0	0	0
Village of Fayetteville	0	0	0	0	0	0	0	0	0	0
Town of Geddes	0	0	0	0	0	0	0	0	0	0
Village of Jordan	0	0	0	0	0	0	0	0	0	0
Town of Lafayette	0	0	0	0	1	0	0	0	0	0
Village of Liverpool	0	0	0	0	0	0	0	0	0	0
Town of Lysander	0	0	0	0	3	0	0	0	0	0
Town of Manlius	1	0	0	0	1	0	0	0	0	0
Village of Manlius	0	0	0	0	0	0	0	0	0	0
Town of Marcellus	0	0	0	0	0	0	0	0	0	0
Village of Marcellus	0	0	0	0	0	0	0	0	0	0
Village of Minoa	0	0	0	0	0	0	0	0	0	0
Village of North Syracuse	0	0	0	0	0	0	0	0	0	0
Town of Onondaga	0	0	0	0	0	0	0	0	0	0
Town of Otisco	0	0	0	0	0	0	0	0	0	0
Town of Pompey	0	0	0	0	0	0	0	0	0	0
Town of Salina	0	0	0	0	1	0	0	0	0	0
Town of Skaneateles	0	0	0	0	0	0	0	0	0	0
Village of Skaneateles	0	0	0	0	1	0	0	0	0	0
Village of Solvay	0	0	0	0	0	0	0	0	0	0

Table 5.4.3-13. Occupancy Class of Repetitive Loss Structures in Onondaga 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
Town of Spafford	0	0	0	0	0	0	0	0	0	0
City of Syracuse	1	0	0	0	4	0	0	0	0	0
Town of Tully	0	0	0	0	0	0	0	0	0	0
Village of Tully	0	0	0	0	0	0	0	0	0	0
Town of Van Buren	0	0	0	0	0	0	0	0	0	0
Onondaga County	**3**	**2**	**5**	**0**	**36**	**0**	**0**	**0**	**0**	**0**

Source: FEMA Region 2 2018
Note (1): Policies, claims, repetitive loss and severe repetitive loss statistics provided by FEMA Region 2, and are current as of 05/31/2018
Note (2): The statistics were summarized using the Community Name provided by FEMA Region 2.
Note (3): The total number of repetitive loss properties does not include the severe repetitive loss properties.

Table 5.4.3-14. NFIP Policies, Claims and Repetitive Loss Statistics

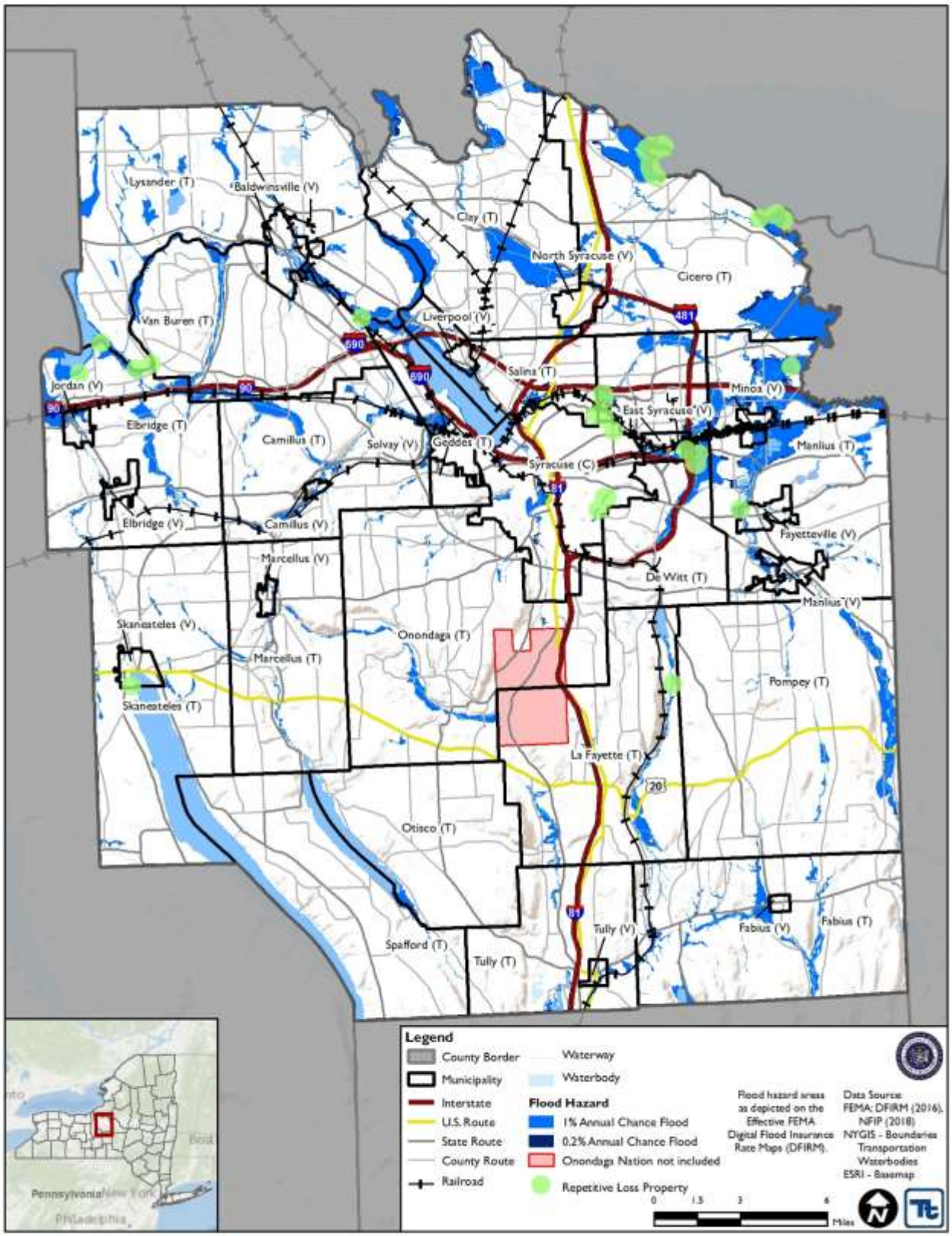
Municipality	# Policies (1)	# Claims (Losses) (1)	Total Loss Payments (2)	# Rep. Loss Prop. (1)	# Severe Rep. Loss Prop. (1)	# Policies in the 1% Flood Boundary (3)
Village of Baldwinsville	32	19	$151,732	0	0	19
Town of Camillus	50	15	$24,945	0	0	28
Village of Camillus	18	5	$15,233	0	0	11
Town of Cicero	292	193	$1,444,825	23	0	179
Town of Clay	167	57	$273,628	0	0	85
Town of DeWitt	115	90	$2,309,680	8	0	33
Village of East Syracuse	22	6	$9,030	0	0	16
Town of Elbridge	19	23	$125,267	2	0	12
Village of Elbridge	1	0	$0	0	0	0
Town of Fabius	7	1	$1,037	0	0	2
Village of Fabius	0	0	$0	0	0	0
Village of Fayetteville	58	56	$229,864	0	0	45
Town of Geddes	6	6	$84,143	0	0	0
Village of Jordan	27	4	$5,386	0	0	18

Table 5.4.3-14. 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)
Town of Lafayette	15	9	$26,105	1	0	3
Village of Liverpool	8	8	$5,221	0	0	3
Town of Lysander	119	63	$559,107	3	0	68
Town of Manlius	189	43	$214,565	2	0	110
Village of Manlius	43	28	$100,960	0	0	18
Town of Marcellus	10	6	$8,225	0	0	0
Village of Marcellus	8	4	$0	0	0	4
Village of Minoa	71	13	$10,940	0	0	54
Village of North Syracuse	5	3	$0	0	0	0
Town of Onondaga	33	14	$28,470	0	0	15
Town of Otisco	4	4	$7,042	0	0	0
Town of Pompey	19	13	$51,329	0	0	6
Town of Salina	65	15	$32,362	1	0	16
Town of Skaneateles	18	7	$69,903	1	0	4
Village of Skaneateles	10	3	$21,109	0	0	3
Village of Solvay	4	7	$12,398	0	0	0
Town of Spafford	12	1	$0	0	0	3
City of Syracuse	200	136	$365,786	5	0	112
Town of Tully	3	1	$0	0	0	2
Village of Tully	6	1	$0	0	0	5
Town of Van Buren	97	35	$269,659	0	0	71
Onondaga County	**1,753**	**889**	**$6,457,953**	**46**	**0**	**945**

Source: *FEMA Region 2 2018*
(1) *Policies, claims, repetitive loss and severe repetitive loss statistics provided by FEMA Region 2, and are current as of 05/31/18.*
The total number of repetitive loss properties does not include the severe repetitive loss properties. The number of claims represents claims closed by 05/31/18.
(2) *Total building and content losses from the claims file provided by FEMA Region 2.*
(3) *The policies inside and outside of the flood zones is based on the latitude and longitude provided by FEMA Region 2 in the policy file.*
Notes: *FEMA noted that where there is more than one entry for a property, there may be more than one policy in force or more than one GIS possibility.*
A zero percentage denotes less than 1/100th percentage and not zero damages or vulnerability as may be the case.
Number of policies and claims and claims total exclude properties located outside county boundary, based on provided latitude and longitude.

Figure 5.4.3-6. NFIP Repetitive Loss Properties – Onondaga County

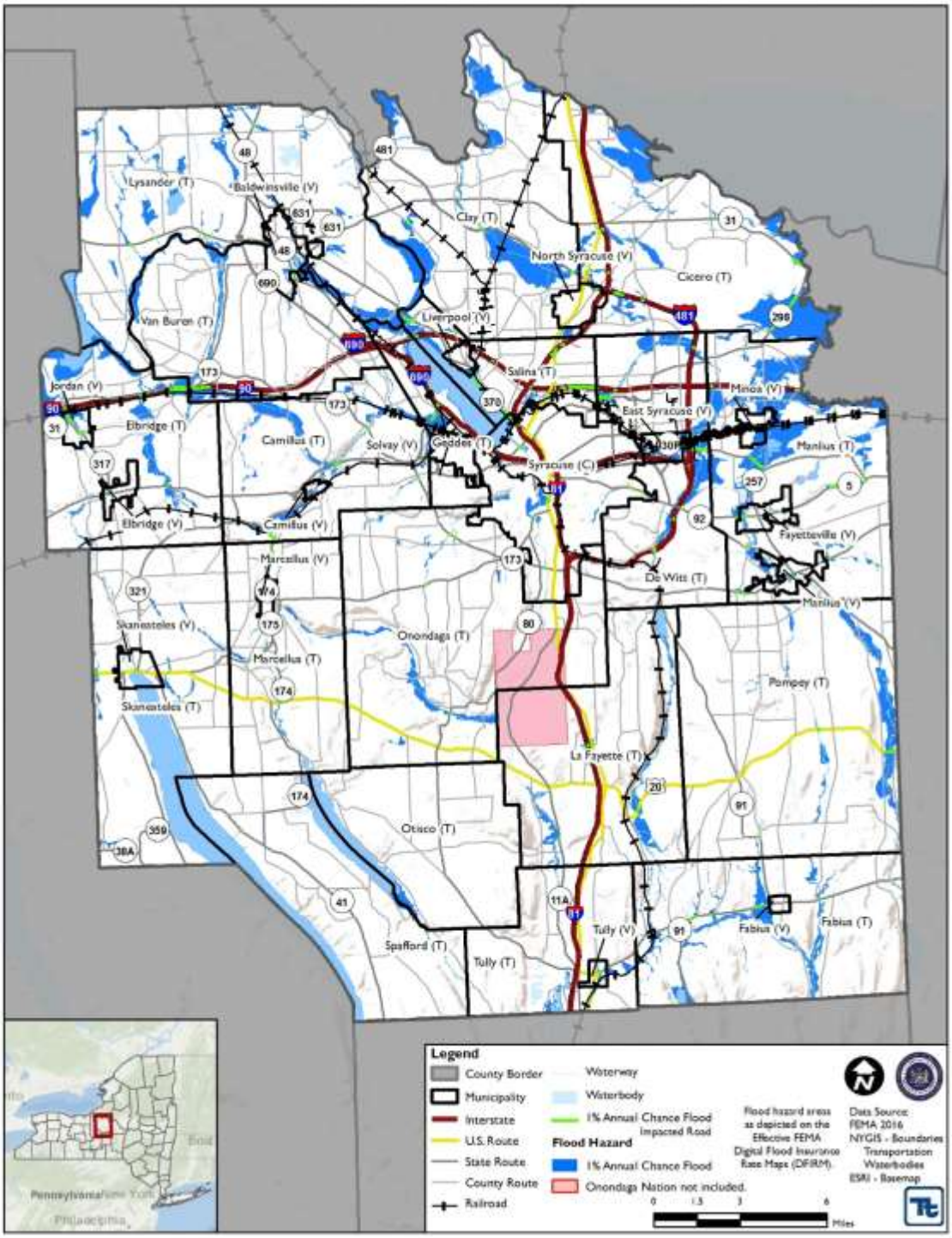


Impact on Critical Facilities

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

Figure 5.4.3-7 displays the major roadways that may be impacted by the 1-percent annual chance flood event. These include I-81, I-90, I-481, I-690, multiple state routes, and US-11 and US-20. Bridges washed out or blocked by floods or debris also can cause isolation. Floodwaters can get into drinking water supplies, causing contamination. Culverts can be blocked by debris from flood events, also causing localized urban flooding. Sewer systems can be backed up, causing wastewater to spill into homes, neighborhoods, rivers, and streams.

Figure 5.4.3-7. Major Roadways Impacted by the 1-percent Annual Chance Flood Event



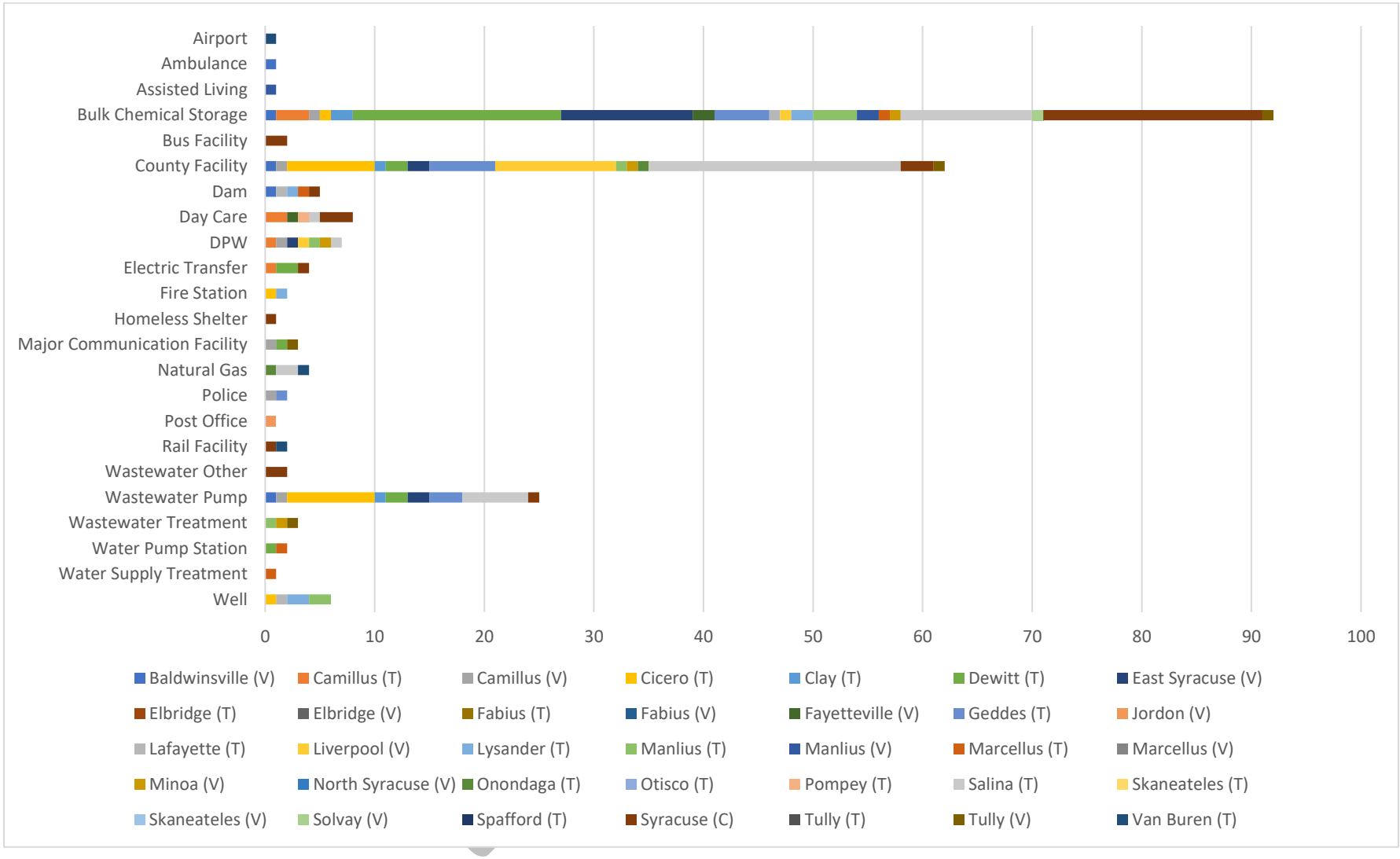
Critical facility exposure to the flood hazard was examined. In addition, HAZUS-MH v4.2 was used to estimate the flood loss potential to critical facilities located in the FEMA mapped floodplains. Table 5.4.3-15 summarizes these results. Figure 5.4.3-8 and Figure 5.4.3-9 display the distribution of critical facilities in the 1- and 0.2-percent annual chance flood event boundaries; due to the number of bridges located in the floodplain, they were omitted from the figures.

Table 5.4.3-15. Critical Facility Types Located in the 1- and 0.2-Percent Annual Chance Event Floodplain and Estimated Damage

Facility Type	Number of Critical Facilities Located in the 1-Percent Annual Chance Event	Number of Critical Facilities Located in the 0.2-Percent Annual Chance Event	Average Percent (%) of Total Value Damaged (1-percent Annual Chance Event)	
			Structure	Content
Airport	1	1	None Estimated	None Estimated
Ambulance	1	1	0.2%	0.2%
Assisted Living	1	1	0.0%	0.0%
Bulk Chemical Storage	92	118	None Estimated	None Estimated
Bus Facility	2	2	None Estimated	None Estimated
County Facility	62	69	9.2%	52.8%
Dam	5	5	None Estimated	None Estimated
Day Care	8	16	11.2%	17.0%
DPW	7	10	5.9%	16.9%
Electric Transfer	4	5	None Estimated	None Estimated
Fire Station	2	2	8.4%	23.2%
Homeless Shelter	1	2	9.1%	53.5%
Major Communication Facility	3	3	None Estimated	None Estimated
Natural Gas	4	5	None Estimated	None Estimated
Police	2	2	4.4%	5.6%
Post Office	1	2	0.0%	0.0%
Rail Facility	2	5	None Estimated	None Estimated
Wastewater Other	2	3	None Estimated	None Estimated
Wastewater Pump	25	28	None Estimated	None Estimated
Wastewater Treatment	3	5	None Estimated	None Estimated
Water Pump Station	2	4	38.0%	65.3%
Water Supply Treatment	1	2	None Estimated	None Estimated
Well	6	6	12.3%	34.9%
Total/Average	**237**	**297**	**9.0%**	**41.8%**

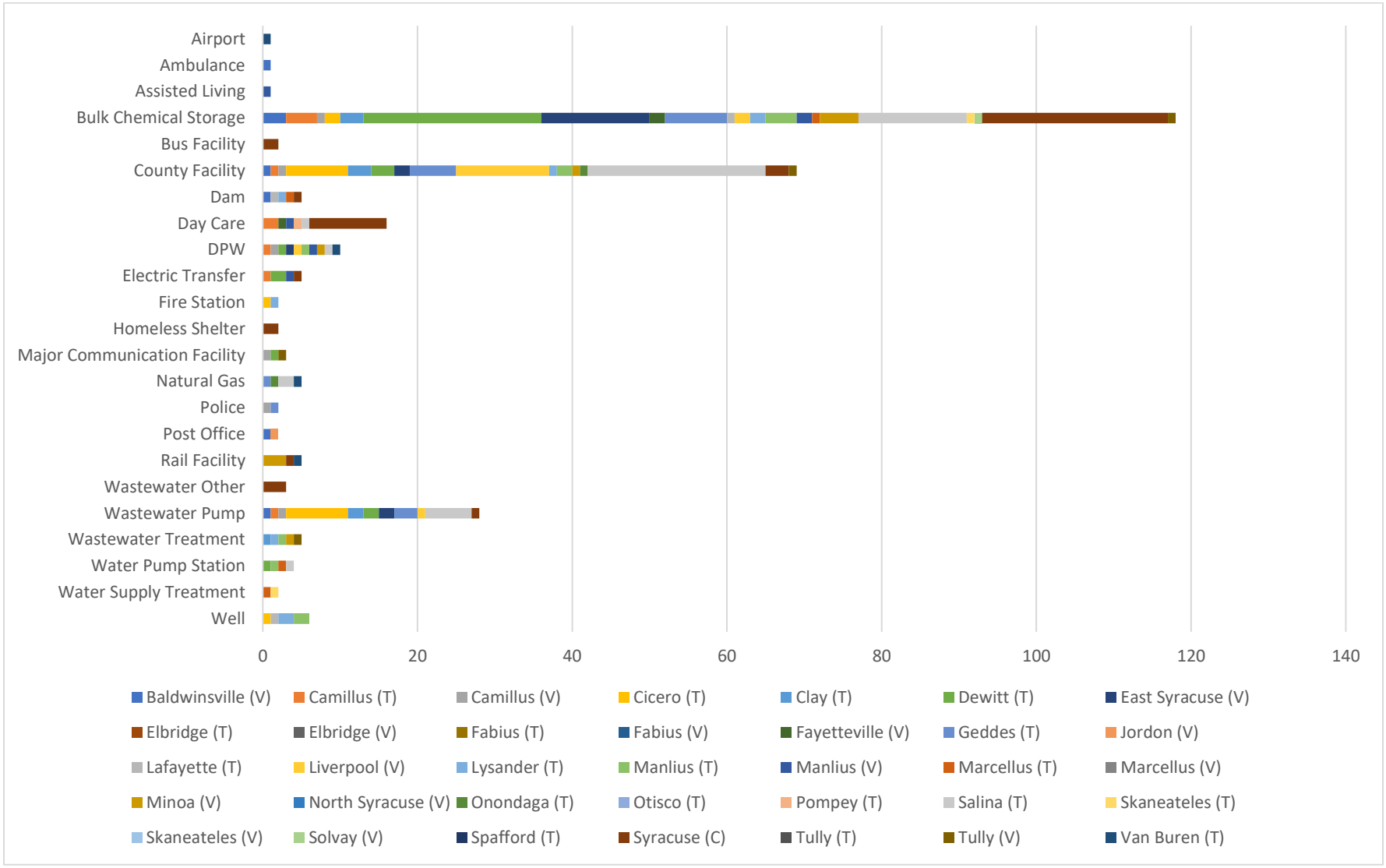
Source: Syracuse-Onondaga County Planning Agency; FEMA 2016; HAZUS-MH v4.2

Figure 5.4.3-8. Distribution of Critical Facilities in the 1-Percent Annual Chance Flood Event Floodplain by Type and Municipality



Sources: FEMA 2016; Syracuse-Onondaga County Planning Agency
Notes:
C: City T: Town V: Village

Figure 5.4.3-9. Distribution of Critical Facilities in the 0.2-Percent Annual Chance Flood Event Floodplain by Type and Municipality



Sources: FEMA 2016; Syracuse-Onondaga County Planning Agency
Notes:
C: City T: Town V: Village

Impact on the Economy

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

Flooding can cause extensive damage to public utilities and disruptions to delivery of services. Loss of power and communications may occur and drinking water and wastewater treatment facilities may be temporarily out of operation. As presented in Figure 5.4.3-8, 237 critical facilities are exposed and potentially vulnerable to the 1-percent annual chance flood event.

Debris management may also be a large expense after a flood event. HAZUS-MH v4.2 estimates the amount of structural debris generated during a flood event. The model breaks down debris into three categories: (1) finishes (dry wall, insulation, etc.); (2) structural (wood, brick, etc.); and (3) foundations (concrete slab and block, rebar, etc.). These distinctions are necessary because of the different types of equipment needed to handle debris. Table 5.4.3-16 summarizes the HAZUS-MH v4.2 countywide debris estimates for the 1-percent annual chance flood event. This table only estimates structural debris generated by flooding and does not include non-structural debris or additional potential damage and debris possibly generated by wind that may be associated with a flood event or storm that causes flooding.

Table 5.4.3-16. Estimated Debris Generated from the 1-Percent Flood Event

Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
19,015.4	13,425.1	3,138.1	2,452.2

Source: HAZUS-MH v4.2

Future Changes that May Impact Vulnerability

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

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

Projected Development

Any areas of growth could be affected by the flood hazard if the growth areas are within identified hazard areas. Each municipality identified areas of recent development and proposed development in their community. Developments that could be located using an address or Parcel ID were geocoded and overlain with the FEMA DFIRM boundaries to determine vulnerability to flooding. There are 10 recent and proposed developments vulnerable to the flood hazard; this represents approximately 13.0 percent of the 77 identified developments. There are 9 developments located in the 1-percent annual chance flood event boundary, 6 of which are proposed developments. There is 1 proposed development located in the 0.2-percent annual chance flood event boundary. The City of Syracuse has the most developments located in the 1- and 0.2-percent annual chance flood event boundaries (3); all 3 developments are proposed developments. Information was not available regarding mitigation measures at these locations.

The county and participating municipalities intend to discourage development within vulnerable areas or to encourage higher regulatory standards on the local level. Specific areas of development are indicated in tabular form in the jurisdictional annexes in Volume II, Section 9 of this plan update.

Projected Changes in Population

According to population projections from the Cornell Program on Applied Demographics, Onondaga County will experience a slight population decrease through 2040 (less than 10,000 people in total by 2040). Population change is not expected to have a measurable effect on the overall vulnerability of the county's population over time. As discussed in *Long Range Transportation Plan 2050: Moving Towards a Greater Syracuse*, the population of Syracuse has decreased as the other municipalities in the county have seen an increase (Syracuse Metropolitan Transportation Council, 2015). Those moving from areas of lower vulnerability to higher will increase their vulnerability to flood, though not in a dramatic fashion. This includes areas that are directly impacted by flood events and those that are indirectly impacted (i.e., isolated neighborhoods, flood-prone roadways, etc.). Refer to Section 4.4.2, Population Trends in the County Profile, includes a discussion on population trends for the county.

Climate Change

As discussed earlier, annual precipitation amounts in the region are projected to increase, primarily in the form of heavy rainfalls, which have the potential to increase the risk to flash flooding and riverine flooding, and flood critical transportation corridors and infrastructure (NYSERDA 2014). Increases in precipitation may alter and expand the floodplain boundaries and runoff patterns, resulting in the exposure of populations, buildings, and critical facilities and infrastructure that were previously outside the floodplain. This increase in exposure would result in an increased risk to life and health, an increase in structural losses, a diversion of additional resources to response and recovery efforts, and an increase in business closures affected by future flooding events due to loss of service or access.

Existing dams may not be able to retain and manage increases in water flow from more frequent, heavy rainfall events. Heavy rainfalls may result in more frequent overtopping of these dams and flooding of the county's assets in adjacent inundation areas. However, the probable maximum flood used to design each dam may be able to accommodate changes in climate.

Change of Vulnerability

There are several differences between the HAZUS-MH models and floodplains used to assess vulnerability when comparing data from the previous HMP to the update. DFIRMs were not available to use for the 2013 HMP, so Quality 3 data was used to perform a modified Level 1 analysis in HAZUS-MH MR3. The effective 2016 FEMA DFIRM data was used for the 2019 HMP update. HAZUS-MH MR3 utilized 2000 U.S. Census demographic data and default general building stock based on 2006 RS Means valuations. An updated general building stock was generated for this update using updated County GIS and tax assessor data and 2018 RS Means valuations. A direct comparison between plan vulnerability assessment results could not be conducted to determine whether there has been a change over time.

There have been changes to the county's NFIP statistics since the 2013 HMP. The 2013 HMP summarized 2009 NFIP statistics provided by FEMA, while the 2019 HMP summarizes 2018 NFIP statistics. Since 2009, the county has seen an increase in the number of claims and repetitive loss properties. There were 297 new claims worth approximately $1.5 million, and an increase of 19 repetitive loss properties. Most of these additional repetitive loss properties are in the Town of Cicero (10). There was an overall decrease of 48 policies with some municipalities experiencing an increase while others a decrease. The greatest increase occurred in the Town of DeWitt (39 policies), while the greatest decrease occurred in the Town of Cicero (-62 policies). The source of

this trend is not clear but may be related to the realignment of the regulatory flood hazard areas due to updated flood insurance rate maps.

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

Identified Issues

The following flood-related issues have been identified:

- Flash flood events have resulted in 2 recorded deaths. All flood events documented during the 2013 plan performance period were flash flood events.
- The Town of Cicero has the greatest amount of NFIP repetitive loss properties (23) but the Town of DeWitt has the greatest amount of loss payments for NFIP insured properties ($2,309,680). Approximately 61-percent of the insured properties in the Town of Cicero and approximately 28-percent of the insured properties in the Town of DeWitt are outside the regulatory floodplain which may indicate stormwater flooding issues.
- Stream clearing, development application reviews, higher regulatory standards such as increased freeboard or cumulative substantial improvement requirements, installation of stream gages to provide historical water flows/levels help improve flood forecasting may support reduction of flood impacts.